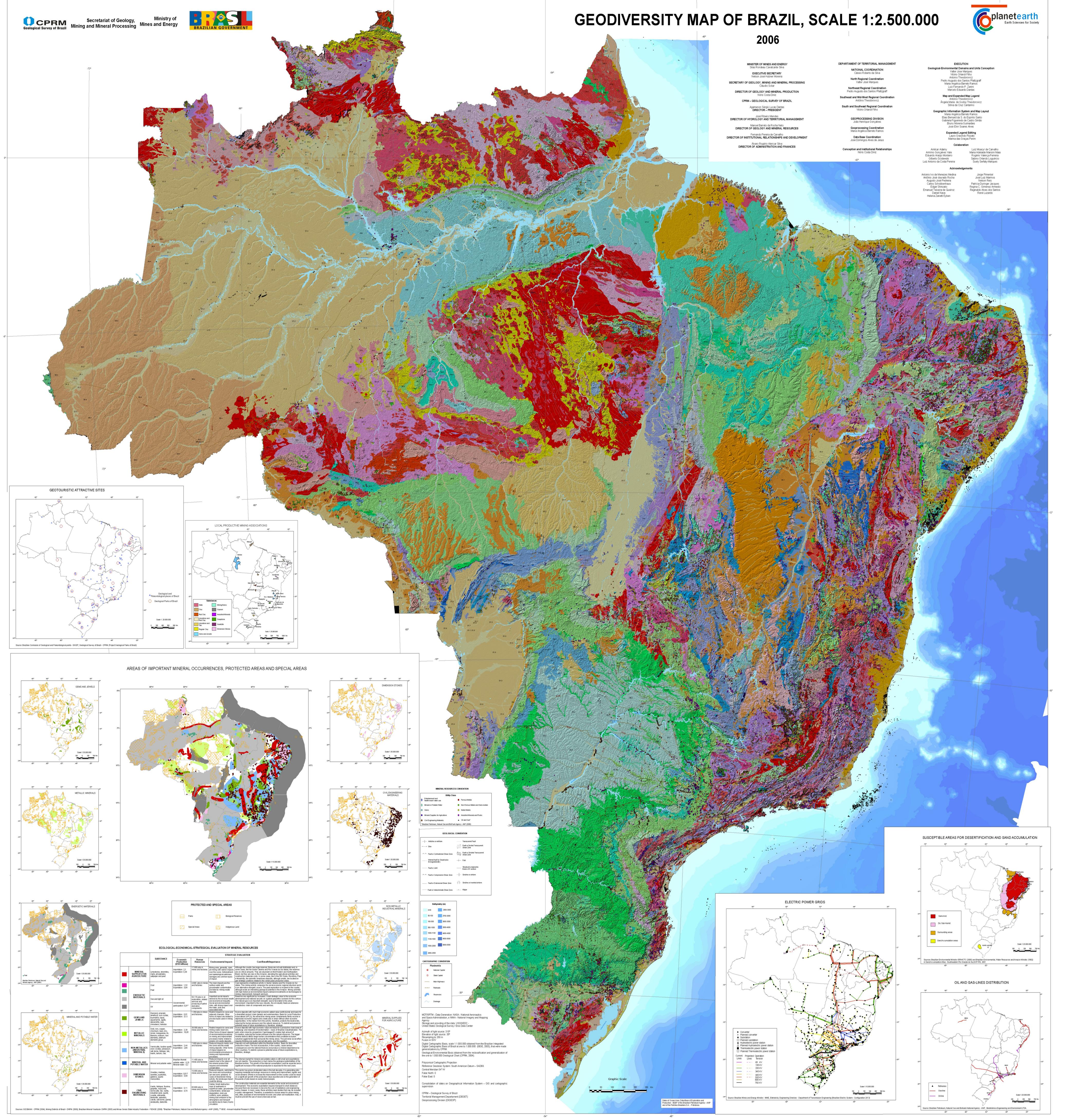
| GEOLOGICAL-<br>ENVIRONMENTAL<br>DOMAINS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | GEOLOGICAL-<br>ENVIRONMENTAL<br>UNITS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | THE EXECUTION OF CIVIL V                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                             | JENCE OF GEOLOGY ON THE SUITABILITY, LIMITATIONS  THE AGRICULTURE  Suitability                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | AND POTENTIALITIES IN VIEW OF USE POLLUTANT SOURCES Suitability                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | AND OCCUPATION TO:  GROUNDWATER RESOURCES  Limitations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | MINERAL<br>POTENTIAL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | ENVIRONMENTAL ASPECTS<br>AND TOURISTIC POTENTIAL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
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| Domain D1  Quaternary unconsolidated sediments mainly represented by sand, silt, clay and pebble layers associated to very different depositional environments.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | D1.2  Clay, sand and p e b b l e associated to alluvial plains.  Fluviolacustrine s e d i m e n t s associated to l a r g e s edimentary                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Predominance of soils with a low supporting capacity and of unconsolidated sediments: the buildings may present fracturing and falling time of the year.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | higher than the flooding level: areas less exposed to frequent floods.  Soils and unconsolidated sedi-                                                                                                                                                                                                                                                                      | Morphostructural configuration favorable for the existence of poorly drained soils, with many marshes, where the water table outcrops or is near to the superficies and where puddles are formed in rainy days: these are unsuitable terrains to plant deep rooted species; they are difficult to mechanize in rainy periods; agricultural contaminants may directly contact the groundwater. To improve                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | In most of these terrains the water table may outcrop or be close to the surface: very high vulnerability to superficial contaminants.  Poor drainable; the drainage system has water with a low oxygenation potential and its characteristics favor the concentration rather than the dis-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Porous aquifers exposed or very close to configuration to recharge a                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | vial plains and terraces of the Amazoniar and center western regions of Brazi.  A favorable environment to mine industrial sand and sand for civil architecture, regular and and dis-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Transitional between terrestrial and aquatic ecosystems. Important suppliers for the air humidity. Unhealthy for the human being. Containing both permanent and temporary lagons that are important to the fish reproduction and that constitute the habitat for several aquatic and terraces associated to the mountainous areas of the southern region are very hot in summertime and very cold in wintertide, when thick frosts may be formed.  There are marshy areas associated to these terrains, such as the P a n t a n a I Matogrossense and the                                                             |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | D1.4  L a g o o n a l sediments, with predominance of clay.  S e d i m e n t s associated to coastal paludal environment, w i t h predominance S e d i m e n t s associa-ted to coastal marine                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Existence of organic matter-rich clays and soils that may release corrosive acids and methane, a highly inflammable gas that may present a spontaneous and very mobile combustion: buried buildings are rapidly damaged; gas may infiltrate in the building plumbing favoring the occurrence ter-rich layers are                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | tration. Horizontal layers: good lateral geomechanical and hydraulic ho- mogeneity. Stable and flat- tened relief: very low susceptibility to erosion and no potential for natu- ral mass move- ments.                                                                                                                                                                      | the soil drainage it is necessary to dig deep ditches that interfere negatively in the superficial and groundwater dynamics and in the regularity of the air moisture of the regional microclimate.  In rainy areas the soil moisture keeps high in most of the year: this is a favorable environment to the proliferation of several types of agricultural plagues (fungi, bacteria and insects); unsuitable terrains to plaguesus (fungi, bacteria to plaguesus (fungi, bacteria and insects); unsuitable terrains to plague-susceptible species.  are very porous, with a good natural fertility and a high capacity to retain and fix nutrients; they give a good response to fertilization and pH correction; they present proper charac-teristics to the plant growing.  Morphological configuration of flat to gently                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | persion of elements: pollutants are dispersed and purified only after a long time; special care must be taken with any potentially pollutant source. Existence of many permanently soaked portions and of soils and organic sediments that release corrosive acids: underground buildings for storage and circulation of pollutant substances must be built with bigh                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | the superficies: very vulnerable to contamina- tion. In places where occur organic matter-rich sedi- ments and soils the groundwa- ter may present a strong offen- sive odor.  Charge of groundwater: are a big hydric importance. Occurrence of layers with potential to store and circul ter and with a good lateral h namic homogeneity and siveness. Superficial aquifers compounconsolidated sediments to easy to exploit a low costs.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | a good ate waydrody-expressised by that are labeled by the are labeled | Medicinal sulfur-rich and slightly salty water may exist; areas with numerous sambaquis (manmade shell accumulations).  Littoral environments that contain freshwater lagoons and marshes which are important habitats to the fish reproduction and to the bird nesting.  Areas under the influence of the wave and tide movements.                                                                                                                                                                                                                                                                                   |
| Down in DO                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | denosits                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | works may occur.  The drainage system is in a silting up process.  Very soft and water-saturated organic clays are more likely to occur.  Unconsolidated coverings characterized by a mixture of soil,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                                                                                                                                                                                                                             | Occurrence of organic matter-rich soils; very acid, they need to have their pH frequently corrected by dolomitic limestone.  The colluvial and talus deposits are little worked  undulated terrains: very low suscep-tibility to erosion. In dry periods they can be easily worked by motorized machines.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | The collusied and taken deposite use                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | may be brackish due to the influence of seawater.  Deposits with a very he                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | sand) in the coastal sands Rio de Janeiro                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Coastal environments composed by drowned river valleys, deltas, estuaries and rivers subjected to the action of waves, containing both fresh and salty water.                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| Quaternary unconsolidated sediments as are formed by a mixture of soil, blocks a ened from the steep areas and are generand feet of the hills in areas with a high report of the hills in a high report of the  | nd boulders that are loos-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | pebbles, blocks and boulders with different shapes and formed by many different rocks: their geomechanical and hydraulic behavior is very heterogenous.  Naturally unstable, they increase much the occurrences of natural mass movements.  They generally contain blocks and boulders of hard and abra-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | The reefs act as protection barriers for the sea coast.                                                                                                                                                                                                                                                                                                                     | transported soils. So they usually have a very heterogeneous texture, from the clay to the boulder fraction. They are generally rocky. Their natural fertility depends on the source material and their agricultural quality may vary very much from place to place, from very good to very bad.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | The colluvial and talus deposits use to be very permeable and naturally unstable. Buildings implanted on them or buried in them may easily become unstable.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Deposits of hard rock blocks and boulders: difficult to be exca-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | poor con-<br>bus and<br>tion of pebble, gravel and rock<br>re thick<br>blocks for landscape architec-<br>ture, wall building and decora-<br>tive uses.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | It is a naturally moving material: very prone to the occurrence of mass movements.  Reefs are ecosystems that bear an extraordinary variation of marine plants and animals; in the low                                                                                                                                                                                                                                                                                                                                                                                                                                |
| puaternary bioclastic deposits formed by pral skeletons, algae and mollusk, some the continental shelf, between the shoreling portion by the continental shelf by the continental shelf by the continental shelf by the continent by the co | times sandy. They occur in the and the surf zone.  D4.1 Moving dunes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Unconsolidated quartzose sandy coverings with well-rounded quartz grains: very erodible and subjected to liquefaction (quicksand-type); they easily disintegrate and are eroded in cutout slopes and embankments.  Friable sandy coverings: in dry periods they are continuously moved by the wind; buildings may be buried by this sand movement.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | They are important to break the energy of the waves and to protect the coast from erosion.                                                                                                                                                                                                                                                                                  | Only unconsolidated quartzose sandy coverings, with no or poorly developed soils: extremely erodible. Excessively acid. Very low hydric capacity: they loose water very quickly. Low capacity to retain and fix elements: they give a bad response to fertilization. They have no nutrient-supplier minerals: their natural fertility is very low.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Unconsolidated quartzose coverings with well-rounded quartz grains: highly permeable, very low capacity to retain, fix and eliminate pollutants. Very important recharging areas to groundwater.  Free superficial aquifers very vulnerable to contamination: special care must be taken with any potentially pollutant source.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Superficial aquifers without a purifying mantle: extremely vulnerable to contamination.  Deposits formed almost except by quartz sand- to silt-sized good granulometric sorting roundness and frequent bing grain size: very porous a meable; they form superficiters with an easy and low-oploitation.  Important fresh water sour the coastal region.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | grains,<br>g, high<br>nodality<br>and per-<br>al aqui-<br>cost ex-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | tide beautiful natural pools are formed among them. It is a very important marine zone to the fishing and a very attractive tourist place.  The associated deposits are generally submitted to strong wind action in the major part of the year; terrains with no or very poor vegetation; formed by a succession of intermixed dunes and temporary or permanent lagoons. Very beautiful landscapes, very attractive to tourism.  Typical vegetation that is in permanent developing process and must be preserved.                                                                                                   |
| Domain D5 enozoic detrital, detrito-lateritic and irbonate sedimentary coverings.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | C e n o z o i c detrito-lateritic and C en o z o i c detrito-lateritic and C en o z o i c detrito-lateritic and C en o z o i c detrito-lateritic and C en o z o i c detrito-lateritic and C en o z o i c detrito-lateritic and C en o z o i c detrito-lateritic and C en o z o i c detrito-lateritic and C en o z o i c detrito-lateritic and C en o z o i c detrito-lateritic and C en o z o i c detrito-lateritic and C en o z o i c detrito-lateritic and C en o z o i c detrito-lateritic and C en o z o i c detrito-lateritic and C en o z o i c detrito-lateritic and C en o z o i c detrito-lateritic and C en o z o i c detrito-lateritic and C en o z o i c detrito-lateritic and C en o z o i c detrito-lateritic and C en o z o i c detrito-lateritic and C en o z o i c detrito-lateritic and C en o z o i c detrito-lateritic and C en o z o i c detrito-lateritic and C en o z o i c detrito-lateritic and C en o z o i c detrito-lateritic and C en o z o i c 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detrito-lateritic and C en o z o i c detrito-lateritic and C en o z o i c detrito-lateritic and C en o z o |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Lateritic soils with predominance of kaolinite: low natural erodibility and good stability in cutout slopes.                                                                                                                                                                                                                                                                | Laterites are excessively leached and aluminum-rich materials: the soils derived from them usually have a low natural fertility and contain much aluminum: they are very acid and difficult to have their pH corrected. In many places they are very rocky and consequently very difficult to work with mechanic equipments.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Laterites are materials with a low capacity to retain, fix and eliminate pollutants. They are very permeable: special care must be taken with any potentially pollutant source.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Lateritic coverings are free superficial aquifers: very vulnerable to contamination.  The groundwater is stored and flows through small leaching caves: they are porous aquifers that discharge and recharge very quickly.  The potential use of the water is                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Potential for the occurrence of secondary mineralization of gold, bauxite, kaolin, mangatinese and nickel.  Laterites may be used as distance and decorative stones.  They have the proper physicon chemical characteristics to be                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | i-<br>e<br>o-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| and the second s | derived from the c h e m i c a l precipitation of carbonates that                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Coverings associated to carbonate terrains; carbonate rocks are easily dissolved by the water; they generally have little or big underground caves, subjected to karstic falls (collapses). In carbonate terrains, caves that directly connect the superficial and groundwater flows (dolines and drainage sinks) are common; gas may be stored in these caves.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | erodible clayey soils that are stable in cutout slopes: suitable to be used as building material.  They are suitable to be exploited as aggregates (flint); in rainy regions the alteration mantle is generally thick                                                                                                                                                       | pled by cattle. Carbonate terrains commonly have many places that directly connect the superficial and groundwater flows (dolines and drainage sinks). They may give way to the agricultural pollutants to rapidly reach the                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Carbonate terrains use to present many places that directly connect the superficial and groundwater flows (dolines and drainage sinks). They may give way to the agricultural pollutants to rapidly reach the groundwater without any purification.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | In carbonate rocks the groundwaster flows and is stored in underground caves: they are karstic aquifers that rapidly discharge and crecharge; they have complex hydrodynamic characteristics and a to caves, underground streat very irregular hydrogeologic poftential, which depends on the existence and size of the caves and on                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | ain big ment, soil pH corrector and                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | d derground rivers.  They are very fragile face to any use or occupation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Domain D6  Tertiary sedimentary coverings relavely thick, poorly or medium consoliated, associated to small to large sedinentary basins characteristically susained by irregular piles of layers with ifferent thickness composed by clayey, ilty, sandy and conglomeratic sedinents                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | D6.1 Associated to coastal tables showing irregular intercalation of silty-clayey, sandy and Sandy and Sandy and Sandy conglomeratic and silty-clayey coverings associated to erosion  Associated to small continental rifts where silty-clayey sediments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | The sudden lithologic c h a n g e s a r e geomechanical and hydraulic discontinuities that make easy the unstableness in cutout slopes. The lithostructural configuration favors the existence of large alluvial plains that present t h e s a m e geotechnical restrictions of the suddensin 1.1.  The big vertical                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Pile of non-deformed horizontal layers that present a good lateral geotechnical and hydraulic homogeneity.  Predominance of poorly consistent sediments: they have a low resistance to cut and penetration and may be easily excavated only by tools and                                                                                                                    | Irregular intercalation of sediments that alter to clayey, silty-clayey or sandy soils: in high relief areas with a great variation in elevation, the residual soil texture may vary from region to region or from place to place, depending on which layer outcrops.  Where the silty-clayers outcrop, the pres-  response to fertilization); alkation in exponse to fertilization in exponse to fertilization); alkation in exponse to fertilization in exponse to fertilization in exponse to fertilization in exponse to fertilization); alkation in exponse to fertilization in exponse to fertiliz | F a v o r a b l e morphostructural configuration for the occurrence of lations of silty-clayey sediments that are very little permeable and have a high capacity to fix and eliminate pollut-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Predominance of clayey sediments and residual soils presenting a low permeability which alter to very little permeable clayey soils.  Irregular intercalation of horizontal layers of sediments that present either high or low per-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | A very favor-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | The exposition of layers in the coastal zone favors their erosion and washout by the wave action, forming beautiful cliffs.  Favorable morpholithostructural configuration for the predominance of pedogenesis over the morphogenesis, thus favoring deep, well-evolved and laterized soils.  Small sedimentary basins with a flattened relief enclosed by mountainous areas in the coastal zone compose a beautiful landscape.                                                                                                                                                                                       |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | coverings where continental fluvial pelites predominate.  Associated to continental erosion surfaces where sandy- conglomeratic  Predominance of quartzose sandy sediments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | lithologicăl variation in high relief areas, where it is a great variation in elevation, favors the outcropping of sediments and the occurrence of residual soils that have very varied and contrasting geotechnical characteristics.  High potential for the occurrence of massive, rigid, waxy and plastic silty-clayey sediments: they are difficult to be excavated or drilled (the drill machines block and tend to slide).  Occurrence of finely laminated or massive expansive clay minerals.  Predominance of very quartzose sediments: they are very subjected to collapse due to the occurrence of finely laminated silty-clayey sediments which bear expansive clay minerals: they easily fracture, disintegrate and become unstable in cutout slopes. They are very subjected to collapse due to the                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Predominance of quartzose sediments: they are highly resistant to the physicochemical weathering and have an alteration mantle suitable to be used as anti-dust and gravel material.                                                                                                                                                                                        | clusively by aluminum-rich minerals and alter to clayey soils bearing an excess of aluminum, very acid and presenting a low natural fertility. They become compacted and impermeable and suffer high laminar hydricerosion when submitted to a continuous work by h e a v y equipments or by cattle trampling.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | The groundwater is protected by thick layers of clayey sediments that have a low permeability and a high capacity to the ground-water contamination varies from very low to very high, depend-ing on the kind of sediment that outcrops.  Predominance of quartzose sandy sediments and residual soils: very permeable, with a low capacity to retain, fix an eliminate pollutants. Special                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | meability and porosity: favora by least the permetability and porosity favora by least the permetability and porosity of the sandy sediments may be reduced by a well-developed diagenesis or by silicification.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | environment for the prospecting of sand, clay, plastic clay, fireclay, pebbles and peat.  I ance of e sandy its that bear a lasity of and a pential for rage. porous meable mantle ors the                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | the occurrence of large alluvial plains subjected to frequent and long floodings; the drainage system has a low potential to disperse and purify pollutants.  Favorable morpholithostructural configuration for a relief shaped as large tables with flattened tops where pedogenesis prevails over morphogenesis, and steep slopes.  The main drainage generally has wide and flattened valleys enclosed by high relief forms, composing beautiful landscapes.  The secondary drainage system is in a cutting process, excavating more than deposing sediments, and forming beautiful rapids, waterfalls and natural |
| Domain D7  Mesozoic clasto-carbonate sedimenary coverings which are consolidated and associated to coastal rifts. They are composed by thick packs of sediments eposed in very different tectonolimatic environments such as contiental, marine, desertic, glacial and volanic. They are represented by illtstones, claystones, conglomerates, hales, limestones and evaporites.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Occurrence of carbonate rocks in different proportions that c o n t a i n intercalations of silty-clayey sediments.  Predominance of quartzose s andy and                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | expansion and contraction of the ex-  Pile of horizontal layers of sediments that have contrasting geomechanical and hydraulic characteristics that abruptly change from one layer to the other.  The sudden changes in the lithology are geomechanical discontinuities that make easy the unstableness in cutout slopes.  Occurrence of finely laminated silty-clayey sediments that usually bear expansive clay minerals: they easily split, disintegrate and become unstable in                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Limestone alter to clayey soils that are very little permeable; plastic with a high capacity of compaction; little erodible; good stability in cutout slopes; suitable for building material.  Thick and extensive horizontal, nondeformed layers of sediments with a good lateral geomechanic                                                                              | Carbonate rocks alter to very little porous clayey soils that become compacted, impermeable and very erodible when continuously worked by heavy equipments or trampled by cattle.  Pile of horizontal layers of sediments that alter to sandy, clayey and silty-clayey soils and sediments which do  Carbonate rocks alter to very little calcareous sediments alter to very clayey soils; poorly erodible residual soils with developed pedogenesis; they are very porous; good hydric capacity; they maintain a good water supply to the plants for a long time for a long time for a long time to developed the pedogenesis.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | and groundwater flows. By using this way the pollutants may infiltrate and rapidly reach the groundwater without any purification and they may be transported for long distances by the underground different permeability that alter to soils with different capacities to retain, fix and sediments an | In carbonate rocks the ground-water is stored and flows through caves formed by the dissolution of carbonates: it constitutes very complex karstic aquifers, which are rapidly discharged and recharged; a non-planned exploiting may cause an excessive lowering of the phreatic level, what may result in underground collapses and in the drying of the superficial waters; the hydrogeologic potential is local and irregular, depending on the existence and size of the caves and on the local climatic conditions; a well may present a good water yield and the neighbor one may be dry; the water may bear an excess of carbonate (hard water).  The primary permeability and porrosity of the quartzose sandy                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | the carterrains institute lent aterres- Favorable geologic environment for the occurrence of regular clay, plastic clay, sand, pebbles, oil, coal, gypsite, phos-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | A favorable geologic environment for the existence of beautiful karstic landscapes such as underground rivers, grottoes, caves, dolines and drainage sinks.                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | D7.3 Sediments that c o n t a i n intercalations of  Thick packs of silty-clayey sediments.  Irregular intercalations of silty-clayey and quartzose s a n d y sediments in  Predominance of silty-clayey sediments that h a v e intercalations of thin sandstone                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | are subjected to collapse due to the contraction and expansion of expansive clay minerals.  Occurrence of massive, rigid and waxy silty-clayey sediments: they have a very low permeability; difficult to be drilled because they block and make the drill machines slide.  Existence of conglomerates composed by hard and abrasive rock pebbles, blocks and even boulders: this material has a very heterogeneous geotechnical behavior; it is difficult to be                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | lic homogeneity.  Predominance of sediments with a moderate to h i g h diagenesis: good resistance to compression; good supporting capacity.                                                                                                                                                                                                                                | lease nutrients to                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | ants: in high relief areas, the potential for groundwater contamination may vary from place to place, from low to high, depending on the type of sediments that outcrops.  sandy residual soils that are very permeable and to retain, fix and eliminate pollutants where the residual soils are deep and far from the water streams, the risk for groundwater contamination is low.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | porosity of the quartzose sandy and conglomeratic sediments may be damaged by the well-  structural configuration for the existence of excellent porous, confined and semi-confined and groundwater.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | limestone, peat, bituminous shale, flagstone and other silty-clayey rocks that are detached as slabs which are suitable for decorative uses.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | cliffs, witness buttes displaying curious shapes and rivers that present rapids, waterfalls and natural pools. Favorable geologic environment for the occurrence of fossiliferous rocks.                                                                                                                                                                                                                                                                                                                                                                                                                              |
| esozoic and Paleozoic consolidated dimentary and volcano-sedimentary verings associated to broad and deep dimentary basins (syneclise-type) ed by thick and extensive packs of                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | of thick packs of s a n d y s e d i m e n t s,  Predominance of thick packs of q u a r t z o s e s a n d y a n d  Irregular intercalations of s and stones,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | drilled (the drill bits wear out rapidly).  Pile of horizontal layers of sediments that have contrasting geomechanical and hydraulic characteristics which change abruptly from one bed to the other.  Occurrence of quartzose sandy sediments that present a low resistance to shearing: they gener-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Very quartzose alteration mantle suitable to be used as grave and pebbles.                                                                                                                                                                                                                                                                                                  | Predominance of sediments that alter to very sandy, permeable and erodible soils; they have a low hydric capacity and a low ability to retain and fix nutrients and to assimilate organic matter. They give a bad response to fertilization and quickly lose water shortly after the rain. They are subjected to the accumulation of sand and to the formation of large gullies. Residual soils from conglomerates are generally stony.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Predominance of quartzose sandy sediments that generally present a high density of open fractures through which the pollutants may infiltrate and quickly reach the groundwater; they alter to very permeable soils with a low capacity to retain, fix and eliminate pollutants.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | In some regions the porosity and permeability of sandstones may be reduced by the high degree of diagenesis and by silicification.  Predomi of gen much fra sandstone have a gent tential to and transter.  Good permeability of sandstones may have a gent tential to and transter.  Good permeability of gen much fra sandstone have a gent tential to and transter.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | erally actured es that bod po- o store mit wa-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Areas subjected to the accumulation of sand and source for a high load of sandy detritus that silt up streams and rivers.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| rizontal layers of sandy, silty-clayey d conglomeratic sediments and, more trictedly, by calcareous and volcanic ks.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Silty-clayey sediments intercalated to  Predominance of foliaments of silty-clayey and sending and yellow paraconglomer at es with intercalations of silty clayey sediments with irregular intercalations of Thick packs composed by irregular intercalations of thin layers of thin layers of the sending paraconglomer at es with irregular intercalations of thin layers of thin layers of thin layers of thin layers of the sending paraconglomer at es with irregular intercalations of thin layers of thin layers of the sending paraconglomer at es with irregular intercalations of thin layers of the sending paraconglomer at es with irregular intercalations of thin layers of the sending paraconglomer at es with irregular intercalations of thin layers of the sending paraconglomer at establishment and the sending paraconglomer at e | ally are densely fractured and percolated; easily loose blocks and plates in cutout slopes; they are very a brasive; high-resistant to the physicochemical weathering and medium-to high-resistant to cut and penetration. They alter to very erodible soils. Existence of silty-clayey sediments that may be finely laminated or massive, rigid, very waxy that generally bear expansive clays; they easily split and loose plates in cutout slopes; the residual soils which have a poorly developed pedogenesis disintegrate and become very erodible.  Sandy rocks with kaolinic matrix: they easily disin-Coal beds release corrosive acids: buried materials quickly. Carbonate rocks easily are dissolved by the action of water, mainly where there are thick layers. Caves subjected to underlying collapses may occur, what may reflect in superficial collapses (sudden falls). Where rocks outside the physicochemical weathering and medium-to high-resistant to the physicochemical weathering and medium-to high-resistant to cut and penetration. They alter to very erodible soils.  Carbonate rocks easily are dissolved by the action of water, mainly where there are thick layers. Caves subjected to underlying collapses may occur, what may reflect in superficial collapses (sudden falls). Where rocks outside the physicochemical waterials with very contrasting geomechanical and hydraulic behavior in cutout slopes; the residual soils which have a poorly developed pedogenesis disintegrate and be- | homogeneity: the geo-mechanical and hydraulic characteristics have a little lateral variation. Predominance of sediments with a moderate to low resistance to cut: they may be easily excavated only by using cutting tools and ma-                                                                                                                                         | very acid. capacity; keep a calcium an good supply of magnesium t                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | pending on the type of sediments that outcrops.  clayey sediments outcrop and where limestones are altered to deep soils there is a low risk for the groundwater contamination: the silty-clayey sediments are little permeable and their residuals soils, as well as the ones from limestones, have a clayey texture with a strength of the carbonate terrains generally.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | the recharging of groundwater. So, the vegetal covering plays an important role to improve the infiltration potential of rainwater.  So, the vegetal covering plays an important role to improve the infiltration potential of rainwater.  So, the vegetal covering plays an important role to improve the infiltration potential of rainwater.  So, the vegetal covering plays an important role to improve the infiltration potential of rainwater.  So, the vegetal covering plays an important role to improve the infiltration potential of rainwater.  So, the vegetal covering plays an important role to improve the infiltration potential of rainwater.  So, the vegetal covering plays an important role to improve the infiltration potential of rainwater.  So, the vegetal covering plays an important role to improve the infiltration potential of rainwater.  So, the vegetal covering plays an important role to improve the infiltration potential of rainwater.  So, the vegetal covering plays an important role to improve the infiltration potential of rainwater.  So, the vegetal covering plays an important role to improve the infiltration potential of rainwater.  So, the vegetal covering plays an important role to improve the infiltration potential of rainwater.  So, the vegetal covering plays an important role to improve the infiltration potential of rainwater.  So, the vegetal covering plays an important role to improve the infiltration potential of rainwater.  So, the vegetal covering plays an important role to improve the infiltration potential of rainwater.  So, the vegetal covering plays an important role to improve the infiltration potential of rainwater.  So, the vegetal covering plays an important role to improve the infiltration potential of rainwater.  So, the vegetal covering plays an important role to improve the infiltration plays and important role to improve the infiltration plays and important role to important role | nd very soil ph                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | forms may occur, where morphogenesis prevails over pedogenesis.  Terrains with a very beautiful landscape, composed by witness buttes in curious shapes, caves and streams flowing over the rocky substratum forming rapids, waterfalls and natural pools.  There are also wide valleys surrounded by steep cliffs.                                                                                                                                                                                                                                                                                                   |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | D8.10  D8.10  Irregular intercalations of sandy and siltyclar intercalations of sandy and sandy and siltyclar intercalations of sandy and siltycla | and collapsible when submitted to the variation in the humidity degree; they are very clayey, adhesive and sliding when wet.  Existence of silty-clayey sediments that may be finely laminated or massive, rigid, very waxy that  directly connect the superficial and groundwater flows (dolines and drainage sinks) may occur, creating places with a high potential for collapses. Buildings must not be implanted                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Greater possibil-                                                                                                                                                                                                                                                                                                                                                           | plants for a long chemical reactime in dry peritivity: alkalin ods.  residual soils good natura                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | way used by pollutants to quickly reach the underground streams without any purifying; through these underlying rivers the pollutants may be transported for long distances.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | and flows through dissolution caves; they have complex hydrogeologic characteristics; the discharge and recharge are quick. The exploiting potential is local and very irregular and the water quality may be damaged by the high carbonate contents (hard water).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | corrector, lime flint and many other industrial uses. Horizontal lay ers with a good late r a compositional                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Potential for the existence of grottoes, caves and underground rivers.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| hick packs of Mesozoic quartzose andy sediments of eolian deposition ransported by the wind).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | of quartz sandstone, generally well consolidated, presenting subordinate intercalations of  Thick and extensive pack of quartz sandstone, moderate to little consolidated, present-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | fractures disposed in several directions: much percolated; they easily loose blocks and plates in cutout slopes.  They alter to excessively sandy, friable, permeable and erodible soils that easily disintegrate in cutout slopes.  They are composed by highly spherical quartz grains: residual soils subjected to liquefaction (quicksand-type).  Existence of rare intercalations of little permeable silty-clayey sediments: they are geomechanical and hydraulic discontinu-  Rocks with high cohe-  Basalts and                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | and extensive layers of sediments that have a good vertical and l a t e r a l geomechanical and hydraulic homogeneityl.  physicochemical weathering and to the compression.  Predominance of little consolidated sediments that have a low resis-                                                                                                                           | Predominance of sediments that alter to excessively sandy soils, very erodible, subjected to the sand accumulation and to the formation of large gullies; very poor natural fertility; excessively permeable; low hydraulic capacity; excessively drained, with a very low capacity to retain and fix nutrients and to assimilate organic matter; they give a bad response to fertilization; they are generally acid.  Basalts, gab-Basalts and                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | these may quickly reach the ground-water without any purification. Special care must be taken with any potentially pollutant source.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Porous aquifers with a high vulnerability to contamination. In some regions the permeability and porosity of sandstones may be reduced by the intensive silicification or by the developed diagenesis.  Sediments with predomina quartz that have the grain st tween sand and silt, good good roundness and fr grain-size bimodality: the very favorable hydrodynam acteristics for excellent grotter aquifers. Very thick porous aquifers large areal expressivity an lateral and vertical hydrod homogeneity.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | sorting, tance to the physico-se are ic charundwa-with a they are very digged by the stands and stones that have good characteristics to be used as they are very hard and suit-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | sand accumulation and to the formation of gullies.  Source of a great amount of sandy detristus that silt up the side biggest and best freshwater reservoirs of the world.  Favorable morpholithostructural configuration for the existence of a steep relief and witness                                                                                                                                                                                                                                                                                                                                             |
| Domain D10                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Thick and extensive bodies of basalt and diabase.  Thick and extensive bodies of vesicular basal.  Thick and extensive bodies of vesicular basal.  Thick and extensive bodies of basalt with secondary intercalations of sandstones.  Thick and extensive bodies of basalt with secondary intercalations of sandstones.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | sion and fine texture: they have a moderate to high resistance to cut and penetration: it is necessary the use of explosive to pull them down.  Densely fissured in several directions: percolated; they easily loose blocks in cutout slopes.  They alter to silty-clayey soils: adhesive and sliding when wet: it is not recommended the execution of works that include excavation and mass movements during rainy periods.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | ual soils with a good lateral and vertical and hydraulic homogeneity and a high resistance to compression. They alter to silty-clayey soils that are little permeable, plastic and have a good capacity to compact. The residual soils with a good lateral and vertical and hydraulic homogeneity.  Rocks and residual soils with a good lateral and hydraulic homogeneity. | Basalts and diabases alter and release much iron and aluminum: the residual soils with a develoo p e dogenesis they become compacted, impermeable and bear a high laminar hydric erosion when are continuously worked by heavy equipments or trampled by cattle.  Basalts and diabases alter and release much iron and aluminum: the residual soils with a develoo p e dogenesis generally are very porous; have a good hydric capacity; keep a good water supply to the plants for a long time in dry periods; they do not need to be frequently irrigated; the permeability varies from low in little evolved soils to moderate to high in the well servers.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Rocks that present a high density of open fissures, mainly close to the superficies, what makes easy the quick pollutant percolation: where these rocks outcrop the risk for groundwater contamination is high.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | I yield and the neighbor one may stone intercalations that ma                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | es) that wing of copper, platinum and gem (colored stones) deposits.  All is fafisanday congic baratories formations (where                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | the Itaimbezinho Rio Grande do Sul state. Terrains covered by predominantly little permeable soils. When it rains most of the water rapidly flows to the drainage channels which become subjected to big and sudden level and flow changes and, consequently, to the formation of floods with a high potential to remove and transport sediments. The vegetal covering plays an important role to retain the rainwater and so to increase the recharging potential of groundwater. Due to the good quality of their soils they are areas                                                                              |
| errains sustained by thick and exten- ive bodies of extrusive volcanic rocks with basic, intermediate and acid com- osition, Mesozoic in age, that are re- pectively represented by basalts, gab- ros, dacites and rhyolites.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Thick and extensive bodies  Thick and extensive bodies of rhyolites, andesites and rhyodacites.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | equipments become very plastered). They alter heterogeneously leaving blocks and boulders merged into the soil; these may be moved in cutout slopes and make unstable the buildings  Complex association of small or large                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | pedogenesis are little erodible and keep stable in cutout slopes.  Rhyolites, ande-sites and dacites are rocks with a moderate to high resistance to the                                                                                                                                                                                                                    | Rhyolites release fewer nutrients to the soils.  Rhyolites release fewer nutrients to the soils.  evolved ones; low natural erodibility; high capacity to retain and fix nutrients and to assimilate organic matter; they give a Predominance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |   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                                                                                         | dacites and andesites are rocks that present a g o o d physicochemical quality to be used as flintstone.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Due to the good quality of their soils they are areas submitted to an intensive mechanized agricultural activity. This compacts, turns impermeable and causes a strong laminar erosion on the clayey soils, which are naturally little erodible. More than spoil an excellent soil, this causes very negative impacts on the superficial and groundwater dy-                                                                                                                                                                                                                                                          |
| errains sustained by Mesozoic and roterozoic basic-ultrabasic-alkaline ineous rocks, both intrusive and extrusive. The terrains are characterized by a omplex association of small or large odies of rocks derived from several nagmatic pulses, with different chemical composition, that occurred in different times and that were crystallized in ifferent volcanic environments. So they nay present rocks with very diverse texures, colors and chemical/mineral comositions in short distances.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | canic rocks, tuffs, breccias, trachytes and lamprophyre dikes.  Syenomangeritic suite mainly represented by alkali syenite and mangerite.  Alkaline maficultramafic suite mainly represented by dunite, peridotite,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | That alter to very adhesive and sliding silty-clayey soils when wet and that become very compacted when submitted to heavy loads.  That alter in a very diverse way leaving blocks and boulders merged into the soil: ity to find hard even deep and high-pedogenic soils may rock blocks and                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | whose permeability varies from low in<br>the poorly evolved to moderate in the<br>well-evolved ones; plastic; when well-<br>evolved they are little erodible and                                                                                                                                                                                                            | Predominance of lithologies that alter to clayey-silty soils: residual soils whose permeability varies from low in the poorly evolved to moderate in the well-evolved ones; plastic; when well-evolved they are little erodible and keep a good stableness in cutout slopes; in this case they are good to be used as building material.  High incidence give a good response to fertilization; very porous and good hydric capacity; they keep a good water supply to the plants for a long time in dry periods: the                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | -                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | tion of faults and fractures and on the local climatic conditions.  Tractures that may bear groundwater reservoirs.  Potential for the existence of                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | logic environment to copper, apatite, magnetite, bauxite, uranium, rare earths, nickel, chromium, kaolin, niobium, titanium and phosphatic rock min er good min er alization.  Alkaline rocks have good physico- Greater potent                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | sion. More than spoil the soil, this interferes very negatively on the superficial and groundwater dynamics.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Domain D12  Sopaleozoic sedimentary or volcano- edimentary sequences associated to mall molassic basins, rift-type, little- or on-deformed or metamorphosed. They re sustained by sandstones, arkoses, raywackes, siltstones, mudstones,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | gabbro and carbonatite.  Volcano-sedimentary sequences with little sharing of volcanic rocks.  Volcan o-sedimentary sequences with a big sharing of volcanic rocks.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | als at the beginning of the alteration process; they are not suitable to be used in  Irregular pile of rocks with different composition, mineral array, consolidation degree and origin which were submitted to different metamor-phism and tectonic action. They are lithologies with very variable geomechanical and hydraulic characteristics both laterally and vertically; the dip of the bedding may vary from place to place, from horizontal                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | rocks: low to moderate resistance to cut and penetration; most of them may be easily disintegrated and excavated by using only cutting tools and machines.                                                                                                                                                                                                                  | Very big vertical lithologic variation on: the physicochemic al quality of the residual soils, mainly in the high relief areas, may vary much from region to region and, more often, from place to place mainly in high relief areas.  Very big vertical lithologic variation on: the physicochemic al quality of the residual soils, mainly in the high relief areas, may vary much from region to region and agricultural quality of the soils may vary very much from place to place mainly in high relief areas.  Existence of volcanogenic rock that alter to silty-clayey soils and release several nutrients: greate favorability for the existence of volcanogenic rock that alter to silty-clayey soils and from place to place, from very good to very bad.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | the groundwater contamination may vary much from region to region and mostly from place to place, from low to high. Favorable geologic environment for the occurrence of rocks that bear a high density of open joints, through which the pollutants may infiltrate and quickly reach the groundwater.  Predominance of lithologies that alter                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | In many places the permeability and the porosity of the sandy and conglomeratic sediments may be impaired by the strong diagenesis or by the silicification process.  Irregular pile of horizontal horizontal layers of rocks very different permeability a rosity and submitted to a continuous tenton of the continuous tenton | or subwith a and podifferent a b I e protant the ocurrence of ment for the occurrence of ment or as                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | of s                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |



| GEOLOGICAL-<br>ENVIRONMENTAL<br>DOMAINS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | GEOLOGICAL-<br>ENVIRONMENT<br>AL UNITS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   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                                                                                                                                            | THE EXECUTION OF CIV                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       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                                                                                                                                                                                                                                                | INFLUE                                                                                                                  | NCE OF GEOLOGY ON<br>THE AGRICULT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                  | BILITY, LIMI                                                                                                         | POLLUTANT SOURCES                                                                                                                                                                                                                                                                                                                                   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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                          | RCES                                                                                                            | MINE<br>POTE                                                                                              | ERAL<br>NTIAL                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | ENTAL ASPECTS<br>STIC POTENTIAL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      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| Domain D13  Thick and extensive Proterozoic sedimentary coverings, little- or non-folded                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Thick packs sandy and glomeratic s ments with sordinate intellations of s                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | con-<br>sedi-<br>sub-<br>irca-<br>silty-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | regular pile of horizontal and sub-<br>orizontal layers of lithologies that have<br>ontrasting geomechanical and hydrau-<br>c characteristics.<br>he changes of the lithologies are<br>eomechanical discontinuities that<br>hake easy the unstableness in cutout                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | of moderate- to high-resistant sediments to the                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                         | Predominance of sediments tha alter to very erodible sandy soils low natural fertility; very acid; excessively permeable; low hydricapacity; they rapidly lose wate and have a low capacity to retain                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | r                                                                                                                                |                                                                                                                      | Predominance of quartzose lithologies that generally present a high density of open fractures where the relitators find a way to                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Sediments with a moderate to high diagenesis degree: the permeability and porosity of the quartzose sandy sediments may be reduced by the high diagenesis or by the strong silicities.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | The ground-                                                                                              | Thick and extensive sandy and conglome-ratio packs that are generally versions.                                 | d<br>c<br>e                                                                                               | Potential fo<br>the occurrence<br>of diamantife<br>rous conglom<br>erates, indus<br>trial sand<br>gravel and re | r<br>-<br>-<br>-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    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| or metamorphosed. They are characterized by a pile of horizontal and subhorizontal layers with varied thickness of clasto-chemical sediments that have a diverse composition and are associated to very different tectono-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Thick packs stituted by in ular interco tions of sa and silty-cla                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            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                                                                                                                        | lopes.  xistence of generally fractured uartzose sediments: they easily loose locks in cutout slopes; very abrasive; sesistant to penetration; alter to very erodule self-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              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                                                                                                                                                                                                                            | rocks that alter<br>differently to<br>sandy, clayey<br>and silty-clayey                                                 | ter to very acid soils that are gener ally laterized and that may bea                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | d<br>-<br>-                                                                                                                      |                                                                                                                      | where the pollutants find a way to quickly reach the groundwater. They alter to permeable fine sandy soils that have a low capacity to retain, fix and eliminate pollutants.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | The groundwater quality may be damaged by the high iron o manganese contents.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | ate (hard water);<br>Potential for the                                                                   | fractured and<br>may have good<br>primary and secondary perme                                                   | Favorable geo-<br>logic environ-<br>ment to Pb, Ag,<br>Cu, Fe, Mn,<br>A u . p h o s-                      | Potential for iron and manganese de-                                                                            | existence of rivers flor<br>valleys enclosed by<br>rapids, waterfalls and                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | buttes and sandstones                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| sedimentary environments                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | sediments<br>ferriferous  Thick packs<br>silty-clayers<br>ments with                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | and ta<br>and ta<br>s of do<br>sedi-<br>sub-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Cocurrence of conglomerates that consist and rock pebbles, blocks and boulers: difficult to be drilled.  L i t h o l o g i e with very heteroc, waxy silty-clayey sediments: they are difficult to be excavated or drilled be-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | sive horizontal layers with a good lateral good horizontal                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | makes that the<br>soil texture,<br>thickness and<br>agricultural                                                        | Predominance of lithologies that alter to silty.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | t ce of rocks                                                                                                                    |                                                                                                                      | Pile of permeable and little permeable lithologies that alter to soils with high and low capacity to retain,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Predominance of little porous clayey sediments and residua soils that have a low                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | may be granular                                                                                          |                                                                                                                 | phate, barite<br>and fluorite<br>m i n e r -<br>alization.<br>Potential for<br>the exploiting             |                                                                                                                 | beautiful and curious:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | snapes.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | ordinate intellations of s                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | ause they block and make the drill mahines to slide.  xistence of silty-clayey sediments with remarkable and finely spaced bedding thythmites) or fissile sediments shales). They generally bear expansive                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | nomogeneity.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | region or even<br>from place to<br>place, from very<br>good to very<br>bad, in high re-<br>lief areas.                  | clayey soils: very poor per- meability; they become com- pacted, imper- meable and a poor natura fertility and a ger  Carbonate ter rains use to pres ent many place with a direct con                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | soils that have a low natura erodibility; are little perme- s able; porous                                                       |                                                                                                                      | carbonate terrains bear many caves that allow a direct connection between the superficial and                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | In carbonate rocks the ground water is stored and flows throug caves formed by the dissolution of carbonates: they are very con                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | h good lateral hy-<br>n drodynamic ho-<br>n-mogeneity and a                                              | may beer eveel                                                                                                  | s quartzite and leucophyllite.                                                                            | Carbonate                                                                                                       | Carbonate terrains n                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | nay display beautiful karst<br>caves, grottoes and unde                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | carbonate ru with subordi intercalation silty-clayey sandy so ments.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | nate cl<br>s of and edi-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | lay minerals: they split, loose plates and asily become unstable in cutout slopes; he residual soils with a poor edogenesis disintegrate as small slabs and become very erodible and collaps-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       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                                                                                                                                                                                                                                                | llet areas.                                                                                                             | bear high laminar hydric erosion when continuously worked by beauty against the superficial and groundwate flows (doline and drainage sinks). Through                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | hydric capac-<br>ity; keep a<br>good water<br>supply to the<br>plants for a                                                      | mainly calcium and magne- r sium: residual s soils have a good natural fertility, are al-                            | ants rapidly infiltrate without any purification.  They bear underground rivers that lithologies that alter the political political production.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | plex karstic aquifers; their recharging and discharging arrapid; the exploitation potential very irregular and depends of the existence and size of the caves and on the local climati                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | e-large areal<br>e expressivityl.<br>s<br>n<br>e                                                         | lent water reser<br>voirs associ<br>ated to underly<br>ing caves and<br>streams.                                | <br>-<br>/-                                                                                               | lime, soil ph<br>corrector, ce-<br>ment and sev-<br>eral other in-<br>dustrial uses                             | that may significantly acteristics.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | ace to any use or occupation terfere in their natural charaction must prevail over an exploitation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Domain D14                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Predomina<br>of acid and in<br>mediate ro<br>rhyolites                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | nce socks, b                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Ind dry conditions; they are very clayey, indick horizontal and tratified packs formed by irregular intercalations (dolines and drain thick horizontal and tratified packs formed by irregular intercalations). (dolines and drain thick horizontal and tratified packs are very clayey, indicate thick the control of the packs are very clayey.)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                            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            | ment or tram-  Rhyolites alter to soils with a moderate to leave a series a series to leave a series a | R h y o l i t e s<br>rhyodacites an                                                                                              | ; kaline and<br>,<br>d                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | good water yield and the neight<br>ix<br>it-<br>or<br>Fissural aquifer: the groundwa-<br>ter flows and is stored in faults                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | -                                                                                                        |                                                                                                                 |                                                                                                           | they are very<br>suitable to be<br>Rhyolites and<br>rhyodacites<br>are very suit<br>able to be                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Proterozoic volcano-sedimentary coverings, little- or non-folded or metamor-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | rhyodacite.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | ons or igneous and, nore restrictedly, olcanoclastic rocks with very different leomechanical and ydraulic characteris-ics.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | geneity.  They alter to clayey-silty soils that are plastic and have a poor perme-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Rocks that alte soils which becand impermeable                                                                          | er to clayey-silty come compacted e and suffer high                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | they have a goo capacity to retain and fix nutrient and to assimilat                                                             | d<br>n Basalts alte<br>s releasing sev<br>e eral nutrients                                                           | Rocks that generally bear a high density of open fractures disposed in several directions: very percolated, pollutants may use the fractures to rapidly reach the ground-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | fractures and other open joints<br>the hydrogeologic potential is<br>local and very irregular, depend-<br>ing on the existence, density<br>and interlinking of the fractures<br>and on the local climatic condi-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Rocks that nor open fractures d                                                                          | irregularly distrib                                                                                             | logic environ-<br>ment for the<br>occurrence of                                                           |                                                                                                                 | When it rains, little ward ground. Most of it rains channels, which are                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | tle permeable residual soil<br>ater infiltrates to the unde<br>pidly flows to the draina<br>subjected to big and sudde                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| phosed. They are mainly composed by thick sequences of basic, intermediate and acid volcanic rocks and display a tabular stratification.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | D14.2 Predomina of basic volce rocks, material basalts.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | anic a inly to                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | disintegrate as small slabs and be come very erodible and collapsible when submitted to an alternation of weathering that alter eaving blocks and boulers isolated into the                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | als.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | tinuously worked<br>ment or trampled                                                                                    | minerals, so the become very erodible when                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | ization. Very po                                                                                                                 | ones, have good naturally fertility.                                                                                 | a must be taken with any potentially pollutant source.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | tions. Clayey-silty residual soils mostly little permeable; unfavorable to the groundwater recharge; they store much wate but put very little in circulation                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Thick horizontal rocks that have expressivity.                                                           | stratified igneous<br>ve a big latera                                                                           |                                                                                                           |                                                                                                                 | changes in both leve<br>currence of floods tha<br>move and transport so                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | and flowage and to the o<br>t have a high potential to r<br>diments.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            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| D . D45                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Predomina<br>o<br>metasandsi                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | oil: the depth of the ocky substratum is buildings are rapidly damaged.  regular intercalations of yers or lenses in varied icknesses of metasedi-ments with a                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            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                                                                                                                                                                                                                                                                                                                                                                                                                   | f ter supply to the plants for a lon                                                                                             | e is derived the                                                                                                     | Predominance of generally much fractured                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | poor aquifer.                                                                                                                                                                                                                                                                                              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                                              | ates with intercalation Predomina                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | mer ingrare hys of the                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | ents that have contrast- g geomechanical and high resis- tance to the physico- c he mical revery expensive.  moderate to high resis- tance to the physico- c he mical weathering;                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          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                                                                                                                                                                                                                                                | Irregular inter-                                                                                                        | fertility; very sandy, erodible, per<br>meable and acid; low hydric capacity; they lose water rapidly after the<br>rain; low capacity to retain and finutrients and to assimilate organi                                                                                                                                                                                                                                                                                                                                                                                                                                                                     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                                                                                 | ronment with<br>Fe and Mn de-<br>posits and oc-<br>cur-rences<br>f a v o r                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | tion to the surrounded a eas may be associated these terrains.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Proterozoic metasedimentary sequences intensively folded and lowgrade metamorphosed. They are composed by irregular intercalations of layers and lenses of silty-clayey, sandy,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | sandy metas<br>m e n<br>(metasands<br>s and quartz<br>with irreg                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            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                                                                         | ne depth of the rocky libstratum is very irregure.  It is sare finely land in the existence of small and rock outcrops; very sandy land erodible stallations are finely land in the existence of hard rock outcrops; very sandy land erodible stallations are finely land in the existence of hard rock outcrops; very sandy land erodible stallations are finely land in the existence of hard rock outcrops; very sandy land erodible stallations are finely land in the existence of hard rock outcrops; very sandy land erodible stallations are finely land in the existence of hard rock outcrops; very sandy land erodible stallations are finely land in the existence of hard rock outcrops; very sandy land erodible stallations are finely land in the existence of hard rock outcrops; very sandy land erodible stallations are finely land in the existence of hard rock outcrops; very sandy land erodible stallations are finely land erodible.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | suitable to be used as gravel.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | small or large<br>b o d i e s o f<br>lithologies that                                                                   | Where the ferro-manganesiferou metasediments outcrop, the residual soils tend to be excessively                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | s<br>I-                                                                                                                          |                                                                                                                      | groundwater through the frac- tures; residual soils with a mod- erate to low ca- pacity to retain                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Fissured aquifers with a very irregular local potential; the exploiting potential depends or the density, size and interlinking                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | permeability and                                                                                         | s: good secondary<br>porosity.                                                                                  | y                                                                                                         | the existence<br>of quartzites                                                                                  | Due to the intensive<br>folding and to the lith-<br>ologic diversity, the<br>predominant terrains<br>have a very diverse<br>and high relief, dis-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    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| conglomeratic and calcareous meta-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     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                                                                                                                                            | ance of isoriented partz and generally very actured: they are very ercolated and abrasive: asily loose plates in cut- ut slopes; have moder-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               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                                                                                                                                                                                                                                                | e n t<br>physicoche-<br>mical charac-<br>teristics: the<br>agricultural<br>quality of the                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Predominance of metasediments that alter                                                                                         | 9                                                                                                                    | ternation of lithologies and residual soils that have high and low capacity                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | of the fissures and on the loca climate. One well may present an excellent water yield and the neighboone may be dry.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                          |                                                                                                                 | Favorable geo-<br>logic environ-<br>ment for Pb,<br>Ag, Cu, Fe,<br>Mn, Au, phos-<br>phate, barite         |                                                                                                                 | playing many moun-<br>tainous portions.<br>Mountainous envi-<br>ronments are favor-<br>able to the outcrop-<br>ping of the water table                                                                                                                                                                                                                                                                                                                                                                                                                                  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| and the second                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | metasedime  Predominane silty-clayey                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | ents. cu<br>to<br>ce of<br>neta-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | e to high resistance to the standard penetration; alter very erodible sandy oils.  c c u r r e n c e of minerals: they are subjected to slating they disintegrate in small sales.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          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                                                                                                                                                                                                                                                |                                                                                                                         | Predominance of lithologies that alter to silty-clayey soils that be-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | to little perme-                                                                                                                 |                                                                                                                      | to retain and purify pollutants: the vulnerability to the groundwater contamination may vary  Predominance of litt                                                                                                                                                                                                                                  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mineralization. Potential for the exploitation of flagston es,                               |                                                                                                                 | in several places;<br>they have a high<br>hydric importance<br>and contain rivers<br>that form rapids, wa-<br>terfalls and natural                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
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                                              | intercalation<br>metagraywa<br>Irregular alte<br>tion of fine la                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | s of beckes book siverna-byers beckes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | sar pebbles, blocks and become very erodible and collapsible when submitted the alternation of moist and drawated or drilled, they are very heterogeneous                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | perfedominance of lithologies that a later to silty-clayey soils: the residual soils that have a well developed pedogenesis present a low natural erodibility, a good capacity to compaction and keep years stable in out.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                         | come com-<br>pacted and im-<br>permeable and<br>suffer a high<br>laminar hydric<br>erosion when                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | and to assimilate organic mat<br>ter; they give a<br>good response<br>to fertilization                                           | -<br>:-                                                                                                              | rains bear notential for contamin                                                                                                                                                                                                                                                                                                                   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and<br>leucophyllites.                                                                         | Limestone is a very important                                                                                   | erosion process, they                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 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                                                                                                                                            | callic characteristics.  xistence of metasedients with a phyllitic texical and underground flows (doline licaceous minerals, and drainage sinks) and many cay ties of several sizes subjected to the superfiction of the superfict       | 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                         | continu-ously worked by heavy equip- ment or tram- pled by cattle.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | very porous<br>may keep wa-<br>ter; good hydric<br>capacity; they<br>maintain a good                                             | magnesium residual soils have a good natural fertility alkaline: excel-                                              | very fractured ; and percolated:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | teristics; their recharge and dis<br>charge are rapid and so thei                                              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                                         |                                                                                                                 |                                                                                                           | modity for the production of s o i I p H corrector, cement and lime to be used as                               | the natural mass                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Associated to the carbo<br>ate terrains there are bea<br>tiful karstic landscape<br>bearing pretty cave                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        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                                              | metalimest bodies with ordinate intellations of clayey                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   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                                                                                                                                            | amily sericite, and meta- diments displaying a  semarkable fine silty- ayey plano-parallel bed- ng that generally bear  kpansive clay minerals:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            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                                                                                                                                                                                                                                                                                                                                                                                                                         | the plants for a                                                                                                                 | a lent chemica<br>reactivity (give<br>a very good<br>response to<br>fertilization).                                  | connection be-<br>tween the super-<br>ficial and                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | hydrogeologic potential is very<br>irregular, depending on the exis<br>tence and size of the caves and<br>on the local climatic conditions<br>one well may have an excellen<br>water yield and the neighbor one                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | i<br>i<br>i<br>t                                                                                         |                                                                                                                 |                                                                                                           | flintstone, dec-<br>orative stone<br>and severa<br>other indus-<br>trial uses; talo                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | dolines, drainage sinl<br>and underground rivers.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Proterozoic metavolcanosedimentary sequences that are folded and metamorphosed in low- to medium-grade. They are composed by layers, lenses or                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Predomina<br>of quartzites                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | ince or ne                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | regular intercalations of omplexly folded and dif-<br>rently tectonized layers lenses in varied thick-<br>ess of metasediments: e geomechanical and penetration; sandy and erocular and penetration and penetration; sandy and erocular and penetration and pene | physicochemical weathering; the<br>alteration mantle is suitable to be<br>used as gravel, sand and anti-dus                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                         | Predominance of metasediment<br>that alter to sandy soils with a lov<br>natural fertility; very erodible an<br>acid; very permeable; low hydri<br>capacity; they rapidly lose wate<br>shortly after the rain; low capacit                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | w d d c c er y                                                                                                                   |                                                                                                                      | Metasediments that generally bear a high den- sity of open joints; pollutants may infiltrate                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Quartzose metasedi- ments are fissural aqui- fers, very vul- nerable to con-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                          | Quartzose meta<br>sediments usu<br>ally bear a high<br>density of fis<br>sures that have a<br>good potential to | i-<br>h<br>s-<br>a<br>o                                                                                   | Potential for<br>the exploiting<br>of quartzite as<br>decorative<br>stone, sand<br>industrial sand              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Beautiful quartzitic range are associated to these to rains.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| deformed bodies in varied thickness of silty-clayey and sandy metasediments, metalimestones and calc-silicate rocks and subordinately acid metavolcanic and subvolcanic, intermediate and basic-ultrabasic rocks, paragneisses and ferromanganesiferous formations, all of                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Predomina of silty-cla                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | ince an                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | both rocky substratum of residual soils vary and contrast from region and, mostly, som place to place, later-ly as much as vertically.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | material for non-paved roads.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Irregular inter-<br>calations of lay-<br>ers lenses or                                                                  | ce of<br>lithologies                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Predominance of lithologies that alter to very                                                                                   |                                                                                                                      | that alter to clayey so                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | tamination.  Lithologies Predominance of little permeable lateral and lithologies and vertical variton of are unfavorable                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                          | store and circu<br>late the ground                                                                              |                                                                                                           | and gravel.                                                                                                     | Due to the intensive folding and to the lithologic diversity, there is a predomi-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| ferromanganesiferous formations, all of<br>them differently metamorphosed,<br>tectonized and folded.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | represented feldspaschist                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | by all tic The substitution of the substitutio | ly as much as vertically. The depth of the rocky abstratum is very irregure; it may be shallow in a cace and very deep in e other.  well-developed schistosity; greate potential for unstableness in cutous slopes and for natural mass move Carbonate rocks are easily dissolved by water; deformed carbonate rocks generally present man                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | ers, lenses or<br>bodies with a<br>varied thick-<br>n e s s o f<br>lithologies that<br>alter to soils<br>that have very | that release<br>much alumi-<br>num when                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | soils; they store much water and keep a good water supply to the plants for a long time in dry                                   | Carbonate<br>rocks alter to<br>calcium- and                                                                          | Very tectonized and fractured clayey soils with a high                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | The primary water flows and                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Terrains with fa-                                                                                        |                                                                                                                 | Favorable geo-                                                                                            | the production                                                                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Very beautiful karstic lan                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   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|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | of thick pack<br>metalimesto<br>with interc<br>tions of<br>beds of s<br>clayey me                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | ones lar<br>cala-<br>thin be<br>silty-<br>eta-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | caves that are exposed to under<br>gree bodies of metasedi-<br>ents that predominantly<br>ear isoriented quartz;<br>ey are generally very<br>actured and easily loose actured and easily loose                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Carbonate rocks are very suitable to be used as aggregates; they alter to plastic soils that have low expansiveness, are little erodible and keep                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | chemical<br>characteris-<br>tics, so the agri-                                                                          | Predominance<br>of lithologies<br>that alter to<br>clayey soils                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | capacity to re-<br>tain and fix nu-<br>trients and to<br>assimilate or-                                                          | rich clayey<br>soils; good natural fertility; alka-<br>line; very low                                                | Terrains with irregular alternation of lithologies and water flows eliminate pollutant where the soils and deep and distant from the dolines and from the dolines are the dolines and the dolines and the dolines are the dolines a | morphic pro- dynamic charac                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | for the existence of important hydrogeologic                                                             | may bear large<br>water reservoirs<br>associated to un<br>derground caves                                       | ment for Pb,<br>e Ag, Cu, Fe,<br>s Mn, Au, phos-<br>phate, barite<br>s and fluorite                       | corrector, ce-<br>ment, lime; as<br>decorative<br>stone, flint-<br>stone and for                                | environments for the outcropping of the water table in many places; they have a                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | generally are associated carbonate terrains.  Carbonate terrains generally bear many doline drainage sinks and underground rivers                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| and the second                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Diverse m sediments in calated                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | erogeneously; the depth of the rocky substratum uses to be ver irregular.  Predominance of finely laminate lithologies: they easily loose plate in cutout slopes; ferromangations and very erodible soils.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | They are low-resistant rocks to the chemical weathering: in rainy regions the alteration mantle is generally very deep.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | of the residual soils varies much from region to region and mostly                                                      | impermeable                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | permeability<br>varies from low<br>in the little                                                                                 | reactivity (red) tain and fix very well the nutri-                                                                   | retain and purify pollutants.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | fissural aqui-<br>fers that<br>have a very<br>irregular hy<br>dro-geologic po<br>tential ground-<br>water quality                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | and folds and to                                                                                         |                                                                                                                 | Potential for the exploiting of flagstones, quartzites and I e u c o - phyllites.                         | uses. Potential for                                                                                             | display rivers that form rapids, waterfalls and natural pools.  Predominance of                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | are places where it is a rect connection between                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
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                                              | metache<br>metavolca<br>rocks a                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | anic co<br>an d an<br>ence ab                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | etaconglomerates that ontain pebbles, blocks and boulders of hard and orasive rocks; very heter or o g e n e o u s                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Predominance of lithologies that                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | place; little<br>spots of very<br>good or very<br>bad soils may<br>irregularly alter-                                   | worked by<br>h e a v y<br>equipments or<br>trampled by                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | developed                                                                                                                        | sponse to fertilization.  Metabasic and metaultramafic                                                               | Predominance (                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | hydrogeolo-<br>gic potential;<br>a well may<br>of have an ex-<br>cellent water                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | characteristics                                                                                          | Occurrence o                                                                                                    | of                                                                                                        | logic environ-                                                                                                  | unbalanced relief<br>areas that are ex-<br>posed to a strong<br>erosional process<br>and that are sup-<br>ported by lithologies                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             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                                              | s metasandsi s, basic and                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                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                                                                                                                                            | kistence of metasedi- and boulders into the soil: the dept<br>ents with a prominent of the rocky substratum uses to b<br>chistosity, with very irregular; blocks and boulder                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | evolved residual soils have a low<br>natural erodibility and good<br>stableness in cutout slopes; little<br>permeable; plastic; good capacity of                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               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                                                                                                                                                                                                                                                                                                                                                                                                                         | 1: "                                                                                                                             | rocks alter to<br>soils with a<br>good natura<br>fertility and<br>have excellen<br>physical char-                    | good capacity to retail fix and eliminate polluants.  Metabasic and                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            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                                         | f                                                                                                        | igneous rocks<br>that generally<br>bear a high den<br>sity of open fis<br>sures which have<br>a good potentia   | s<br>y<br>n-<br>-<br>e                                                                                    | ment for the occurrence of iron and manganese de-                                                               | that favor natural mass movements.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 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| Domain D17                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | of metaba<br>a n<br>metaultram<br>rocks.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | d en<br>mafic wi<br>sil                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | oriented micaceous min-<br>als and metasediments<br>th a remarkable fine<br>ty-clayey plano-parallel<br>edding, generally bear-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | tance to the physicochemical weathering: in the rainy regions the alteration mantle is generally deep.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                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                                                                                                                                                                                                                                                                                                                                                                                                                         | Predominance                                                                                                                     | acteristics to<br>the agriculture.<br>Associated to<br>these terrains<br>spots of <i>Terra</i><br>of lithologies tha | rocks generally present a high density of open joints that may                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | lithologies tha<br>alter to little per<br>meable clayey<br>soils; poor super<br>ficial aquifers; the                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | t                                                                                                        | to store and circ u l a t e t h e groundwater.                                                                  | r- <b> </b>                                                                                               | environmen<br>for Cu, Cr, talo<br>and asbestos<br>mineralization                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | They are terrains of inte                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| Greenstone belt-type metasedimentary sequences, i.e., sedimentary and volcanogenic sequences that include lowmetamorphic komatiitic lavas                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Predomina of komatiitic c a n i c quences assated to schist, amph                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | for the existence of hard rock boulder immersed into the aracteristics: the geomechanical and ordraulic characteristics of both rocky subratum and residual soils vary and con-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | lithologies to the physicochemica weathering: in rainy areas the alteration mantle is generally deep and modified to clayey-silty soils.  The residual soils with an evolved                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                         | Predominance of lithologies that alter to clayey-silty soils that ar compacted, become impermeabl and bear a strong laminar hydrauli erosion when continuously worke                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | have a low rephysicochemica that alter to clay several nutrient sium: naturally dual soils: little                               | esistance to the                                                                                                     | e<br>d<br>g<br><br>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       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                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                          |                                                                                                                 |                                                                                                           | Potential fo<br>the occurrence<br>of iron depos<br>its.<br>Chert and sil<br>ica materials                       | Due to the intensive folding and to the                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | sive agricultural production due to the good quality of the soils derived from basifultrabasic rocks.  Due to the predominance little permeable clavey soil                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| (magnesium-rich) which are represented by silty-clayey and sandy metasediments, ferriferous formations and schistose or non-schistose basic, ultrabasic, acid and intermediate volcanic rocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | lites, che<br>ferriferous<br>mations<br>metaultraba<br>s.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | set very much from region to region and soils. Ferriferous formations are very aci and corrosive: but y very irregular and may vary from place place, from shallow to deep.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | keep a good stableness in cutour slopes; they are little permeable plastic; they have a good capacity to                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Irregular inter-<br>calations of<br>small or large<br>bodies of<br>lithologies that                                     | The residual soils of ferriferous for mations are very acid and usuall                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | capacity to retain and to assimilar they give a good tilization. They very porous, re                                            | in and fix nutrients<br>te organic matter<br>d response to fer<br>are little erodible<br>etain much water            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Lithologies that have a big lateral and vertical variation of the hydro-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Favorable                                                                                                |                                                                                                                 | Very favorable                                                                                            | that may be<br>used in the<br>glass and re<br>fractory indus<br>tries.                                          | there is a predominance of high and varied relief terrains with many mountainous portions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | there is a prevalence of te<br>rains that present a high de<br>sity of drainage channe<br>which have a rapid super<br>cial outflow. When it rain<br>most of the water rapid                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| voicanie residen                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | metasedim                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                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                                                                                                                                            | istence of small and large bodies of very actured metasediments that are rich in lartz and amorphous silica: they easily bear isoriente minerals: they easily expression to high resistance to cut                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         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                                                                                                                                                                                                                                                | alter to soils<br>with very differ-<br>ent physico-<br>chemical char-<br>acteristics: the<br>agricultural               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Carbonate roo                                                                                                                    | cks and chorite                                                                                                      | meability and a high capacity to retain and eliminate pollutants; the vulnerability the tential for the meability and a high potential for the meability and a high potential for the meability and a high potential for the predominance of lithologies that alter clayey and clayey-sile soils which have a good tential for the meability and a high product of the meability and a high product of the predominance of lithologies that alter clayers and clayey-sile soils which have a good tential for the meability and a high capacity to retain and eliminance of lithologies that alter clayers are producted to the meability and a high capacity to retain and eliminance of lithologies that alter clayers are producted to the meability and a high producted to th | to tics.; associated to the composition of the composition and the composition of the com | lithostructural configuration for the existence of i m p o r t a n t hydrogeologic                       | Associated to carbonate rocks                                                                                   | Au, Cu, Pb, Zn,<br>Cr, Fe, Mn min-<br>eralization and                                                     | Limestone is a<br>very importan<br>mineral com<br>modity for the<br>production o                                | Mountainous ter-<br>rains are favorable<br>t environments for<br>the outcropping of<br>the water table in<br>f many places; they                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Associated to carbona terrains there are very bea                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      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| Entrary.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | D17.2 sented by va<br>p h y l l i t o<br>chlorite so<br>quartzite                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | pre-sa<br>aried Ex<br>es, ph<br>hist, dir<br>and pla                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | kistence of metasediments that have a supplification constitution of the plano-parallel beding: prominent fissility; they easily loose areas and become unstable in cutout they are not suitable as aggregation.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Predominance of lithologies that have a moderate to low resistance to cut.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | quality of the<br>residual soils<br>may vary very<br>much from re-<br>gion to region<br>and sometimes                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | chemical read<br>where they out<br>soils are alkali                                                                              | ctivity: in areas<br>crop the residua<br>ne, have a good                                                             | to the ground- water contami- nation, mainly in high relief dareas, may vary from place to place, from high to low de- high to | ils have a very flows through irregular lo- nd cal hydro- or geologic po- il tantial: one hydrogoologic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | lithologies that have contrasting hydrodynamic behavior                                                  | containing excel<br>lent water reser<br>voirs may exist<br>the dolines and                                      | talc, vermicu-<br>l i t e ,<br>agalmatolite,<br>pyrophyllite,<br>limestone,                               | corrector, ce<br>ment and lime<br>to be used as<br>flint, decora<br>tive stone and                              | fountains and are very important to the maintenance of the regularity of the superficial hydric                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | tiful landscapes and curion<br>karstic panoramas, inclu<br>ing pretty caves, doline<br>drainage sinks and unde<br>ground rivers.<br>Carbonate terrains are ve                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        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                                                                                                                                            | cheracteristics they are not suitable as aggre-<br>tites; very waxy; difficult to be drilled. they alter in a diverse way; the depth of the rock substratum may be very irregular.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  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                                                                                                                                                                                                                                                | from place to<br>place, from<br>very good to<br>very bad, de-<br>pending on the<br>outcropping                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                  | give o good re-                                                                                                      | these are places nation is low.  high to low, depending on which lithology outcrops or is near to the superficies.  these are places through which the pollutants may rapidly reach the groundwater without any puri-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | well may characteristics present an their recharges excellent and discharges water yield are rapid; the exand the ploitation potenneighbor tial is local and                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 5   1100 tureo.                                                                                          | are places where<br>the groundwate<br>recharge is high.                                                         | precious stone                                                                                            | uses; talc may                                                                                                  | Predominance of                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | fragile face to any use ar<br>occupation that may signi<br>cantly interfere in their nat<br>ral characteristics.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     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                                              | n - tary<br>quences wi<br>high incide                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | lime and be are also are                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Irregular intercala deginning of the alteration process they be transformed in expansive clay miners, the little-evolved residual soils disinteate in small slabs and become very erode and collapsible when submitted to an and hydraulic chains and hydraulic chains.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             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                                                                                             | lithology.                                                                                                              | Intermediate volcanic rocks and<br>silty-clayey metasediments al-<br>ter to aluminum-rich soils: the<br>residual soils are generally very                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                  |                                                                                                                      | _ superioles.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                          |                                                                                                                 |                                                                                                           | Acid and inter<br>mediate volca<br>nic rocks are<br>good to be<br>used as flint                                 | mass movements.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    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| Domain D18                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             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                                                                                                                                            | acteristics.  ocks that have a stratiform igneous oring, complexely deformed, high-grade etamorphosed, generally presenting a                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              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| Differentiated and layered calc-alkaline intrusive complexes and differentiated alkaline-basic-ultrabasic complexes, metamorphosed, Paleo- to Meso-Proterozoic in age.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | peridotite, a thosite and so bro.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        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                                                                                                                                            | markable mineral foliation (schistose), ometimes with differentiated eformational bands: big vertical ecomechanical and hydraulic anisotropy. asic-ultrabasic rocks generate expanded at the beginning of the for the existence of the state of the state of the existence of the state of the stat       | f                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | clayey or<br>clayey-silty<br>soils: the resid-<br>ual soils be-<br>come com-<br>pacted, imper-                          | The agricultural potential of the                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | a moderate to<br>the physicocher<br>are enriched in<br>minerals and all<br>releasing many                                        | n ferromagnesian<br>ter to clayey soils<br>nutrients, mainly                                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Rocks where the groundwater is stored and flows through oper                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                          |                                                                                                                 |                                                                                                           |                                                                                                                 | the drainage channe<br>big and sudden chan                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | of the water rapidly flows<br>ls that become subjected<br>ges in the level and flowag                                                                                                                                                                                                                                                                                                                                                                                                                                     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                                                                                             | uite. wo                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | teration process: they are not suitable for orks subjected to oscillations in the huidity degree; their little evolved residual siliceous crusts. Greater possibility the slabbing process; become very erodle and collapsible when submitted to the                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Predominance of lithologies highly resistant to compression. They alter to little permeable and                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | very erodible<br>when continu-<br>ously submitted<br>to heavy loads.<br>Clayey soils                                    | residual soils may be damaged b<br>the existence of very hard siliceou<br>and lateritic crusts, in many places                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | potassium, sodi<br>and magnesium<br>sidual soils;<br>erodibility; the<br>deep and hav<br>pedogenesis; g                          | little natura<br>y are generally<br>e an advanced<br>ood natural fertil                                              | Predominance of rock                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | fissures (faults and fractures) fissural aquifers that have a very irregular local hydrogeologic potential. The potential for the exploitation is local and de-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                          |                                                                                                                 | Favorable de                                                                                              | ologic environ                                                                                                  | tential to remove and<br>are terrains where the<br>important role to ret<br>crease the potential<br>charge.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | of floods that have a high p<br>transport sediments. These<br>e vegetal covering plays a<br>ain the rainwater and to it<br>I for the groundwater re                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| Entra de la companya della companya | Alkali<br>syenit<br>mangeri<br>suite.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            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                                                                                                                                    | ternation of moist and dry states.  ney alter to iron- and aluminum-rich ayey soils: the residual soils use to be bery laterized; they may present very hard ad abrasive lateritic and siliceous crusts; bery acid and corrosive; buried installa-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | f The residual soils with a well-<br>developed pedogenesis have low<br>erosibility, high capacity of compac-<br>tion and good stableness in cutou                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | dust when dry<br>and become<br>very adhesive<br>and sliding<br>when wet: diffi-                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | much water and<br>ter supply to the                                                                                              | the well-evolved<br>rous, they store<br>I keep a good wa-<br>e plants for a long                                     | joints through which the pollutants may rapidly reach the groundwater: where the rocks outcrop and the soils are shallow, special care must be taken with any potentially soils are deep, the ris                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | tion, size, density and interlink ing of the fractures and on the local climatic conditions; a well may have an excellent wate yield and the neighbor one may be down.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Favorable geolog<br>the existence of<br>may bear good w                                                  | open fractures tha                                                                                              | ment for the e<br>or Cr, Co, Pt, Ag<br>at tion, bauxite,<br>vermiculite, de                               | existence of Cu                                                                                                 | soils, these are terra<br>sive and diversified a<br>cultural and cattle ra<br>into account that the<br>equipments and the                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | cultural quality of most of the ins where there is an integricultural activity. In the agaising uses it must be taken frequent work with head continuous trampling by the instance of the continuous trampling by the continuo |
| 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      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                                                                                                                                            | redominance of rocks with a moderate to gh resistance to cut and penetration. enerally contain many structurally weak anes in several directions: very percoted; easily loose blocks in cutout slopes.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     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                                                                                                                                                                                                                                                | worked with<br>machines in<br>rainy periods.<br>The residual<br>soils that show                                         |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | need to be fre<br>good capacity to<br>trients and to a<br>matter; they give<br>to fertilization.                                 | ods; they do no<br>quently irrigated<br>o retain and fix nu-<br>essimilate organic<br>e a good response              | t for the groundwater contamination is low.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Predominance of rocks that alte<br>to mainly little permeable clayey<br>soils: they supply little water to<br>circulation; the alteration mantle<br>has a low hydric potential; they<br>are unfavorable for the ground.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                          |                                                                                                                 |                                                                                                           | J.                                                                                                              | and impermeable, the<br>tration potential of<br>quently increasing the<br>runoff and the potent<br>sion; drastic shorter                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | clayey soils to be compacted us decreasing more the infulter rainwater and consider velocity of the superficible all for the laminar hydric ending of the groundwater recommends.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             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Calc-alkalic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | th:<br>we<br>or<br>Th                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | ney alter to clayey or clayey-silty soils and hydraulic cha at are very adhesive and sliding when et: they cause an excessively plastering machines and tools.  They alter very heterogeneously, leaving ocks and boulders merged into the soil:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | /<br>f                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | a little evolved<br>pedogenesis<br>use to bear ex-<br>pansive clays<br>and are very<br>erodible when                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | spots of Terra                                                                                                                   | these terrains Roxa-type soils the have excellent teristics for agri-                                                | t                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    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| Domain D19                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | suite.  Predomina of alka monzo-syen                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             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                                                                                    | ven when the soils are deep and the edogenesis is well developed, hard rock ocks and boulders may occur and be the soil.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Highly coherent rocks that have a good textural                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | unprotected by<br>a vegetal cov-<br>ering.<br>Predominance<br>of granitic<br>rocks that alter                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | rich soils: the                                                                                                                  | a predomi<br>nance of alka                                                                                           | i-<br>Ii                                                                                                                                                                                                                                                                                                                                                                                                    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| Non- or little deformed, late- to post-<br>tectonic granitoid complexes that are<br>composed by granites which have                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Predomina<br>of mon<br>granodio-rite                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | z o -<br>es. Pr<br>wl<br>fe                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | redominance of highly crystalline rocks hose mineralogy is mostly constituted by ldspars and, more restrictedly, quartz:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | and mineralogic homogeneity with predominance of feldspars and quartz: high resistance to company and mineralogic homogeneity predominance or granites that have a good textura a not company and managing the predominance or company and managin | n u trients<br>and much alu-<br>minum: resid-                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | residual soils with an ad- v an ce of pedogenesis have a moder- ate erodibility                                                  | feldspars and a moderate pro portion of ferro magnesian min erals as acces sories: residua                           | a<br>                                                                                                                                                                                                                                                     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                                                               | Terrains with a high potential for the occurrence of textural and out-                                    |                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           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                                              | Aluminous gites.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         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                                                                                                                                            | esh rocks highly resistant to cut and pen-<br>ration; the use of explosives is needed to<br>sintegrate them; they alter to clayey-<br>lty-sandy soils; the little evolved soils are<br>ery erodible and easily become unstable<br>cutout slopes; they favor natural mass                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | sistance to compression; poor primary porosity. Moderate to high resistance to the homogeneity.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | ual soils whose<br>erodibility var-<br>ies from mod-<br>erate in the<br>well-evolved<br>soils to high in                | Predominance of granites that are poor in minerals that may release nutrients and rich in min erals that release aluminum:                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | they are not ex-<br>cessively per-<br>meable and do<br>not need to be<br>frequently irri-<br>gated: they                         |                                                                                                                      | Predominance of rock                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | n  <br>-<br>:                                                                                            | gio on de                                                                                                       | tural and out-<br>cropping char-<br>acteristics (as<br>blocks and<br>boulders) that<br>are suitable to    |                                                                                                                 | physicochemical we<br>support are mostly no<br>beautiful landscapes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | are highly resistant to the athering, the terrains the countainous, displaying vewith rocky ridges and wat                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         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                                              | Staniferous ites.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        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                                                                                                                                            | ovements; not suitable for building mate- al specially in installations exposed to the ccumulation of rainwater. ranitic rocks alter very differently and most always leave blocks and boulders erged into the soils: the depth of the                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | physicochemica I weathering; they are suitable to be used as concrete aggre- gates in building                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | the little-<br>evolved ones;<br>moderate to<br>low natural fer-<br>tility; generally<br>very acid; they                 | residual soils with a very low natural fertility, generally very                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | have a good capacity to retain and fix nutrients and to assimilate organic matter; give a good                                   | -<br>1<br>3<br>-<br>-                                                                                                | Late- and post-tectonic granitic rocks generally bear many open fractures, especially in the border of the massifs. Through them, pollutants may rapidly reach the groundwater; where these rocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | trey are insural adulters with a very irregular loca hydrogeologic potential that depends on the existence, distribution, size, density and interdinking of the faults and fractures and on the local climatic conditions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | the existence of open fractures with age and flowage cially in the borders sifs: terrains                | If large and deep<br>ith good water stor<br>e potentials, espe<br>er zones of the mas<br>with a good            | p flintstones,<br>r- decoration<br>e- stones and<br>s- dimension                                          | ites mineral-<br>ized with cas-<br>s i t e r i t e<br>tantalite and                                             | streams that flow on<br>ing pretty rapids, wat<br>Predominance of a<br>cropping of the wate<br>they are areas that d<br>are very important to                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | the rocky substratum, forrerfalls and natural pools. favorable relief for the our table in several places. Sisplay many fountains whithe maintenance of the reg                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| Domain D20                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Predomina of alkal m o n z syenites.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | o - th                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | hen soils are deep and well evolved ere is a great possibility for the existence of fresh rock blocks and boulders that may ake difficult any excavation or drilling ork. These are terrains that require deliled geotechnical studies supported by a soil of the existence of the exi       | f clayey-silty-<br>sandy soils: the<br>partial alteration                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | become com-<br>pacted, imper-<br>meable and<br>suffer a strong<br>laminar hydric<br>erosion when<br>continuously        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | are very porous retain water have a good hydric capacity                                                                         | Granites having a predominance of alkali feld-                                                                       | groundwater: where these rocks outcrop and the residual soils are little evolved, the risk for groundwater contamination is high.  and eliminate pollu ants; where soils are deep, the risk for groundwater contamination is low.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | cellent water yield and the                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Residual soils of cially when thick evolved pedoge good superficial as                                   | of granites, espe<br>k and with a little<br>enesis use to be                                                    | e- potential for<br>e the exploita-                                                                       |                                                                                                                 | larity of the superficial Predominance of an idly being eroded. The tively high erodible turn these areas we movements and a s                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | I hydric regimen. unbalanced relief that is ra is characteristic and the rel octential of the granitic so ry susceptible to big ma- ource for a high load of file                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| Non- or little deformed, syn- to late-<br>tectonic granitoid complexes derived                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Predomina<br>of mon<br>granodiorite                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | closince sive sive s. G                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | ose drilling grid, what makes very expenve the planning and the execution of orks.  ranites use to be densely fractured in any directions in the border zones of the terand post-tectonic massifs: the easily                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | to be used as gravel. The residual soils with an advo a n c e d pedogenesis                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | worked by<br>h e a v y<br>equipments or<br>trampled by<br>cattle. These<br>practices in-                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | water supply to<br>the plants for a<br>long time in the                                                                          | o sories: residual<br>soils with a little<br>better natural<br>fertility.                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | ation mantle is unfavorable fo<br>the groundwater recharge.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                          |                                                                                                                 | veins and for<br>the occurrence<br>of fluorite, wol-<br>fram, cassiter-<br>ite, niobium,<br>tantalite and |                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | at silt up the water streams                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| from several magmatic pulses that have a big variation in the chemicomineral composition, granulation and color.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Aluminous g<br>ites.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     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                                                                                                                                            | ose blocks in cutout slopes.  a greate                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | r have a good r compaction ca- pacity; they are moderately plas- tic, little perme- able and little                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | crease the erodibility potential of the soil and reduce the infiltration potential of rain-                             | Residual soils excessively acid and with a very low natural fertility.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | v a n c e c<br>pedogenesis<br>the bad chemi-                                                                                     |                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                     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mineral-<br>ization.                                                                                |                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  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| Domain D21                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | TTG's terr where tonal granodior a n                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     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                                                                                                                                            | Granitoid rocks with an intensive heterogeneous ductile deformation have big textura                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | t Predominance of highly cohesive rocks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               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                                                                                                                                                                                                                                                                                                                                                                                                                         | Predominance<br>of rocks that al-<br>ter to clay-rich<br>soils: the resid-                                                       | Predominance                                                                                                         | 9                                                                                                                                                                                                                                                                                                                                                   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                                                                                                                                                                                                                                                                                                 |
| Very deformed pre- and syntectonic granitoid complexes characterized by an intricate association of small and large granitic bodies from several origins and ages presenting different textures and chemico-mineral composi-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           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                                                                                                                                            | almost always deformational an displaying a composition a differentiated deformational banding due to the first substitution of the rocky substituti       | ing minerals: high resistance to compression; poor primary porosity; moder- tous minerals: Due to the remarkable mineral foliation and to the                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | ual soils with ar<br>a d v a n c e c<br>pedogenesis<br>are little to mod-<br>erately erodible<br>non-permeable                   | of rocks whose<br>mineralogy is<br>rich in ferro<br>magnesian min<br>erals: residua                                  |                                                                                                                                                                                                                                             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                                                                             | tial is damaged<br>by the meta-<br>morphism that<br>rather dis-<br>persed than                            | damaged by<br>the foliated tex<br>ture, by the tex<br>tural heteroge<br>neity and by                            | Due to the                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  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| tures and chemico-mineral composi-<br>tions that were deformed and metamor-<br>phosed under high temperature and<br>pressure conditions.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | D21.2 Predomina of monzo-gr diorites.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    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                                                                                                                                            | bils that are pedoge- etically little evolved are ery erodible and easily ecome unstable in cut-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | chemical weathering; suitable to be used in foundable to be used to be us | much alumi-<br>num to clayey-<br>silty-sandy                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | good capacity to retain and fix nutrients and to assimilate organic matter they give a good                                      | good natura<br>fertility.                                                                                            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Rocks where the groundwater is<br>stored and flows through oper<br>fissures related to fractures and<br>faults: fissural aquifers with a<br>good hydrogeologic potential                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Favorable geolog                                                                                         | gic environment fo                                                                                              | the metallic<br>elements and<br>also by the<br>deep erosion                                               | of platy<br>micaceous mir<br>erals, more<br>and less con                                                        | high resistance to the ing and because the clavey soils, there is                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | hological variation, to the infered by the rocks, to the physicochemical weather a predominance of high rocks areas displaying beautopretty rocky ridges that a                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | D21.3 Charnockite rocks.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | at slopes. They are not ditable to be used as didding material in instaltions subjected to the procentration of rainware.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | dations, as con- ider eaggre- a gates and in iders merged into the soils. So, they are less difficult to be excavated or                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | ual soils use to<br>be very acid;<br>they become<br>compacted,<br>impermeable                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | response to fer-<br>tilization; very<br>porous; they<br>store much wa-<br>ter and keep a<br>good water sup-<br>ply to the plants | -<br>1                                                                                                               | other planar structures through which the pollutants rapidly may reach the groundwater: where the rocks outcrop and the soils are little evolved, the potential for the groundwater contamination in pollutants; where the                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | e-but the exploitation potential is<br>dy local and very irregular, depend-<br>th ing on the existence, size, den-<br>e-<br>sity and interlinking of faults and<br>fractures an on the local climation<br>conditions. One well may have                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | faults, fractures a discontinuities: with a good pote circulate water. The partial a                     | and other structural rocky substratural ential to store and                                                     | massifs. The favorable part for the occur- rence of miner- alization is al-                               | rocks tha<br>have good min<br>eralogical and<br>textural char-<br>acteristics in                                | Predominance of a cropping of the wate                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | favorable relief for the outland table in several places. S                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
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                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Predomina<br>of peralumin<br>granitoids<br>type).                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | nnce annous the                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | then they are altered bey may leave blocks and boulders merged into e soils, even if these are the pand well evolved. The loose material may be some and the solutions of the so       | d silty-sandy soils: the partial alter- ation mantle may be used as                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | ible when continuously worked by heavy equipments or                                                                    | Predominance of rocks that are poor in minerals that may release nutrients and rich in those that re lease aluminum: residual soils with a low natural fertility; generally ex                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | e dry periods<br>they do not<br>n need to be fre-                                                                                | n<br>;<br>t<br>-                                                                                                     | high Special core must be taken soils are deep the ris                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | n- n- n- neighbor one may be dry. Rocks that alter to very clayey soils: the well-evolved residua soils are little permeable and unfavorable to the groundwate                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | good primary and por meability and por it may constitute aquifer.                                        | nd secondary per rosity: where thick                                                                            | good potential                                                                                            | Potential fo<br>the existence<br>of rocks that<br>have good min<br>eralogical and<br>textural char              | are important to the reference of the superficial hydromaph of the superfi | have many fountains whin<br>naintenance of the regular<br>ic regimen.<br>unbalanced relief that is ra<br>d the characteristics of the<br>ke these areas very susce<br>ass movements and source                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| Domain D2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              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                                                                                                                                            | e moved in cutout when partially when partially als (muscovite an eartially supported by em.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | gravel. The residual soils with an advance a good compaction ca-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | trampled by cattle.                                                                                                     | SSSSIVELY ACIU.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | gated. The influence of the geology or the agricultura potential of the soils is rather positive than                            |                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | recharge.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                          |                                                                                                                 |                                                                                                           | light colors                                                                                                    | for a high load of fine the rivers.                                                                                                                                                                                          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| Indifferentiated granitoid complexes comsyntectonic granites that present very compositions and textural characteristics.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              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                                                                                                                                            | Terrains where granitoids have the same geotechnical limitations of the Domain 19, 20, 21 and 2 granitoids.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | pacity; low to moderate per-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          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                                                                                                                                                                                                                                                                                                                                                                                                                         | negative. If the<br>granitic soils are<br>correctly han-<br>dled and have a<br>favorable relief                                  | e e e e e e e e e e e e e e e e e e e                                                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          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| Domain D23                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Predomina of orthoder granit gneiss  Predomina                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | i c - 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Begin the state of       | f<br>-<br>F Predominance                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      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                                                                                                                                                                                                                                                 | Predominance<br>of rocks that al-<br>ter to very<br>clayey soils: re-<br>sidual soils with                                       | ?<br>-<br>/                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      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                                                                                                                         |
| Granitic-gneissic-migmatitic and granulitic complexes composed by an intricate association of rocks that resulted from the partial or total melting of very old rocks that were submitted to                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Predomina of parader                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | nce glaived ur                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | several directions and several dip an-<br>es: they easily loose blocks and become<br>histable in cutout slopes, mainly when<br>artially altered.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | ter to clayey- silty-sandy soils: the partial alter- ation mantle is suitable to be                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Predominance o                                                                                                          | of rocks that alter to clayey-silty                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | an advanced<br>pedogenesis<br>have low to mod<br>erate erodibility<br>and permeabil-                                             | Rocks with                                                                                                           | i                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | In granitic-gneissic-migmatitic rocks the groundwater is stored and flows in open fissures related to faults, fractures and other hydraulic discontinuities they are discontinuous fissure and flow from the hydrausical states.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 1<br>-<br>1<br>1<br>1                                                                                    |                                                                                                                 | logic environ-                                                                                            | the existence<br>of quartzose<br>rock bodies<br>suitable to ex<br>ploit sand, in<br>cluding indus               | Due to the lithologic of tonics and to the precessils, these are terrain                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | liversity, to the intensive te<br>ominance of little permeab<br>ns where the relief is very o                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| the superposition of several compressive tectono-metamorphic events along the geologic history of the Earth, under high temperature and pressure conditions. So, they were melted, re-melted,                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Ortho- a                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | and roun-<br>ated dis                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | cky substratum is usually very irregular, may vary from shallow to deep in short they constitute geomechanics and hydraulic dispendences; the little-evolved residual soils and hydraulic dispendences and hydraulic dispendence of the property of the proper       | the residual soils with an ad-<br>v a n c e d pedogenesis have a good                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | sandy soils: little-<br>ible.<br>Independently of<br>clayey soils become                                                | -evolved residual soils are very eroo<br>of the pedogenic evolution, ver<br>ome compacted, impermeable and                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Ity. Independently of the pedogenic evo- lution, the resid-                                                                      | and large bod i e s o metabasic and metacarbonate rocks: they alte to soils with a                                   | Predominance of very tectonized rocks that present many open fistures (faults and fractures) able clayey-silty-sand through which pollutants rapidly soils that have a high                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | aquifers; the hydrogeologic po-<br>tential is very irregular, depend-<br>ing on the existence, distribu-<br>tion, size, density and interlink<br>ing of the fissures and on the<br>local climatic conditions, reason                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Very tectonized r vironment for the tant hydrogeolog                                                     | existence of impor<br>gic traps related to                                                                      | ment for the<br>existence of<br>bauxite, man-<br>r- ganese, kaolin<br>o and lithium                       | trial sand and<br>gravel and fo<br>the occurrence<br>of carbonate<br>rocks which<br>may be mined                | verse and high, most sometimes a beaut rocky ridges and matthe rocky substratum falls and natural pools Predominance of fav                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | tly mountainous, displaying the landscape, with presence water streams flowing on the forming fair rapids, water streams flowing on the landscape water or the succession of the succession water or t |
|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | migmatitic rethat continued by the second small and by the second | ocks ar<br>tain ar<br>arge m                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | nd have very different alteration degree and physicochemical characteristics; they revery erodible if submitted to the accululation of rainwater and easily become instable in cutout slopes; they enlarge such the natural mass movements, even                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | compaction capacity, low to moderate permeability, are moderately plas-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | releasing a few n<br>tions that alter to<br>high relief areas                                                           | d by portions of material that alte<br>nutrients to the soil and by other por<br>o more and less quarztose soils: in<br>where the morphogenesis prevails                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | elements and to<br>assimilate or<br>ganic matter<br>they give a good                                                             | fertility; greate possibility fo the existence o spots of soils with a very                                          | soils are little evolved or shallow, there is a high potential for ground-water contamination; special care wust be taken with any potentially the risk for groundwater.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | why they are very heterogeneous aquifers, even in rainy areas. In one place a well may have an excellent water yield and the neighbor one may be dry.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | hydrogeologic dis<br>partial alteration<br>with good hydrod<br>istics: where it is<br>tute excellent sup | res and othe<br>scontinuities.<br>mantle (saprolite<br>dynamic charactei                                        | er associated to pegmatites. e) Favorable arreas for the exploitation of decorative stones flint-         | for marble and limestone.                                                                                       | predominance of faving of the water tal many fountains that a nance of the superficit Predominance of an high density of drainal cial flowage that lead                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | orable relief to the outcro<br>ole in many places, forminate important for the maint<br>al hydric regimen.<br>unbalanced relief that has<br>ge channels, a quick super<br>s to high hydric erosion at                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 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the acks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | here the declivity is not pronounced; in is case they are not suitable to be used is building material in works that are subcited to the accumulation of rainwater; ey may randomly contain blocks and cut and penetral tion and moderate the suitable to the accumulation of the cut and penetral tion and moderate the suitable to the suita       | little erodible. In this case, in opposition to little evolved soils, they are suitable that are very composed tha | tics and, consequencesidual soils must place, from very of                                                              | uently, the agricultural quality of the                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | response to ter-<br>tilization; are<br>very porous<br>store much wa-<br>ter; keep a good                                         | good natura<br>fertility and with<br>excellent physical characteris<br>tics for agricul                              | pollutant source. contamination is low.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | dry.  They are rocks that alter to highly clayey soils. The permeability ranges from poor in the little-evolved soils to moderate in the well-evolved ones: naturally little permeable soils; unfa-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                          |                                                                                                                 | stones, flint-<br>stones and<br>dimension                                                                 | granulition rocks have good textural and mineral ogical characters.                                             | cial flowage that lead<br>to the rapid consum-<br>characteristics of the                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | s to high hydric erosion at<br>e of this relief. This and the<br>e rocky substratum mal<br>sceptible to big natural ma                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
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                                                                                                                                            | t hose foundations are partially supported t hose foundations are partially supported t hose foundations are partially supported the physicochemical we at her in gupported by a close-spaced drilling grid greater potential by a large number of technologic anal-                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | building mate-<br>rial. pression; pool<br>primary porosity<br>moderate to high<br>resistance to the<br>physicochemica                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 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                                                                                                                                                                                                                                                                                                                                                                                                                         | the plants for a long time in dry periods; they do not need to be frequently irrigated.                                          | turaruses.                                                                                                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | rally little permeable soils; unfavorable to the groundwater recharge.                                                                                                                                                                                                                               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                                                                                 | teristics to be exploited as decorative s to n e s flintstones and dimension                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     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                                                                                                                                            | nd by a large number of technologic anal-<br>les on material collected in different many blocks an                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         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