

Stream sediment gold anomaly in metasedimentary rocks of the Ceará Complex, Borborema Province, NE Brazil

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Abstract

Anomalous stream sediment gold contents have been found during regional geochemical survey in the 1:100,000 Independência and Várzea do Boi sheets, Ceará State, northeastern Brazil. The highest geochemical gold values occur within the metasedimentary rocks domain of the Neoproterozoic Independência Unit, Ceará Complex, northern Borborema Province. The effect of outlier values is observed in the boxplot analysis of gold contents, with a lognormal distribution and a population of values in excess of 3 ppb Au. The values between 3 and 6 ppb Au in stream sediment samples are very similar to concentrations found in famous mineralized areas worldwide, such as the gold-bearing domains of the Quadrilátero Ferrífero region, central Brazil. According to our preliminary interpretations on structural geology and aeromagnetic data, we might speculate the possibility of gold mineralization associated with the main NW-SE trending shear/fault zone, later displaced by a dextral NE-SW shear/fault zone.

Keywords: Stream sediment, geochemistry, gold, structure.

INTRODUCTION

We present results from Geological and Mineral Resources Integration of Troia-Pedra Branca area, within Relevant Mineral Interest Area (ARIM), located in the central region of the Ceará State, ca. 200 km from Fortaleza (Figure 1). This research is inserted in the program Evaluation of Mineral Resources of Brazil, linked to the Strategic Management of Geology, Mining and Mineral Transformation major program, sponsored by the Growth Acceleration Program – PAC of the Brazilian Government, in development by the Fortaleza CPRM Office.

After integration of the stream sediment geochemical data, we emphasize here the presence of gold contents between 3 and 6 ppb in stream sediments sampled in the cropping area of Neoproterozoic rocks of the Independência Unit, Ceará Complex, where up to now there is no application and permit for exploration for gold and no known gold occurrence (Figure 2).

The lithologic and structural control on these stream sediment gold contents is still under investigation. However, preliminary geophysical and geological data suggest a possible structural control on the gold mineralization (Figures 3 and 4).

GEOLOGICAL SETTING

The anomalous stream sediment gold contents occur in catchment basins that drain metasedimentary rocks of the Independência Unit, associated to the Ceará Complex (Cavalcante et al., 2003) (Figure 1).

According to Arthaud et al. (2014), the deposition of this unit occurred from ca. 750 Ma on. This metasedimentary sequence occurs in tectonic contact with the west portion of the Troia Massif, which represents one of the main Archean – Paleoproterozoic nuclei of the northern domain of the Borborema Province (Figure 1). This massif is mainly constituted of Neoproterozoic (2.7-2.8 Ga; Fetter, 1999) TTG gneisses,

surrounded by Paleoproterozoic (2.2-2.0 Ga; Martins et al., 2009; Costa et al., 2015) granite-greenstone terranes (Figure 1). The Independência Unit comprises a thick pack of aluminous mica schists and paragneisses, intercalated with layers of quartzites, metacarbonates, and locally amphibolite lenses (Cavalcante et al., 2003).

A series of syn- to late-transcurrent Neoproterozoic (580-530 Ma) plutonic bodies occur intruded in the Independência Unit, being related to the Tamboril-Santa Quitéria Complex (640-620 Ma) (Figure 1).

METHODOLOGY

The nine 1:100,000 scale sheets that compose the Troia-Pedra Branca Block contain stream sediment geochemical information, surveyed between 2007 and 2013, using the CPRM approach, with systematic sampling of 1 sample/10-20 km², ICP-MS

multielement analyses, dilution with aqua-regia at the <80 mesh fraction, and semi-quantitative mineralogical analyses of pan concentrates. For the Independência and Várzea do Boi sheets area, stream sediment geochemical data with resolution for gold (0.2 ppb) were achieved at Acme Analytical Laboratories Ltd., Canada. In processing these data elemental geochemical distribution maps were produced and integrated to outline anomalous zones to develop provisional maps for gold and base metals (Cu, Pb, and Zn). Anticipating part of this information, we present here the elemental map for gold.

ANOMALY DESCRIPTION

The data processing of stream sediment geochemistry revealed in the northeastern area of the Independência sheet sediments containing 3 to 6

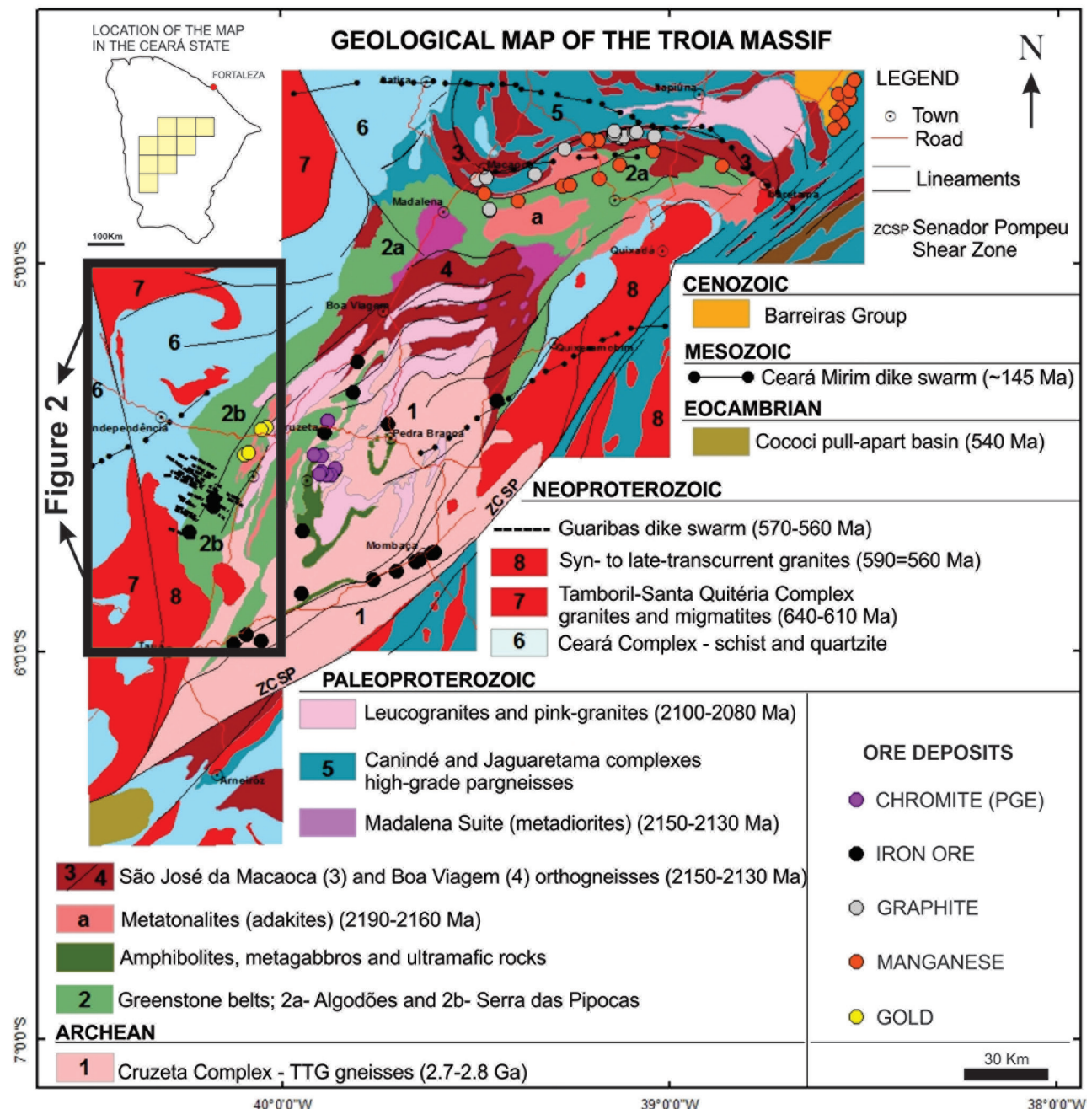


Figure 1: Simplified geological map of the Troia-Pedra Branca Block with location of the main mineral resources.

ppb Au in catchment basins that drain the Neoproterozoic Ceará Complex rocks (Independência Unit schists) (Figures 1 and 2).

The effect of outlier values is observed in gold distribution data, as shown by histogram visual analysis, with lognormal distribution and population of values ≥ 3 ppb Au (Figure 2). Although the crustal average composition is 4 ppb Au (Levinson, 1980), the value of 3 ppb Au was used as threshold in China, allowing to delineate anomalies covering 800 km² with concentration centers of 6 ppb Au (Wang

et al., 2007). Using this approach, stream sediment survey and the 1:50,000 scale geological mapping allowed the discovery of cinnabar (HgS) and realgar (As₄S₄) mineralizations in wall rocks grading 1.5 g/t Au (Wang et al., 2007). In Brazil, in the region that includes known gold deposits since the 18th century, the Quadrilátero Ferrífero Province, in Minas Gerais State, Larizzatti et al. (2014) found stream sediments in areas nearby gold deposits grading up to 3.6 ppb Au for 90% of the samples (N = 3662) and only 5% of these presented >7.2 ppb Au.

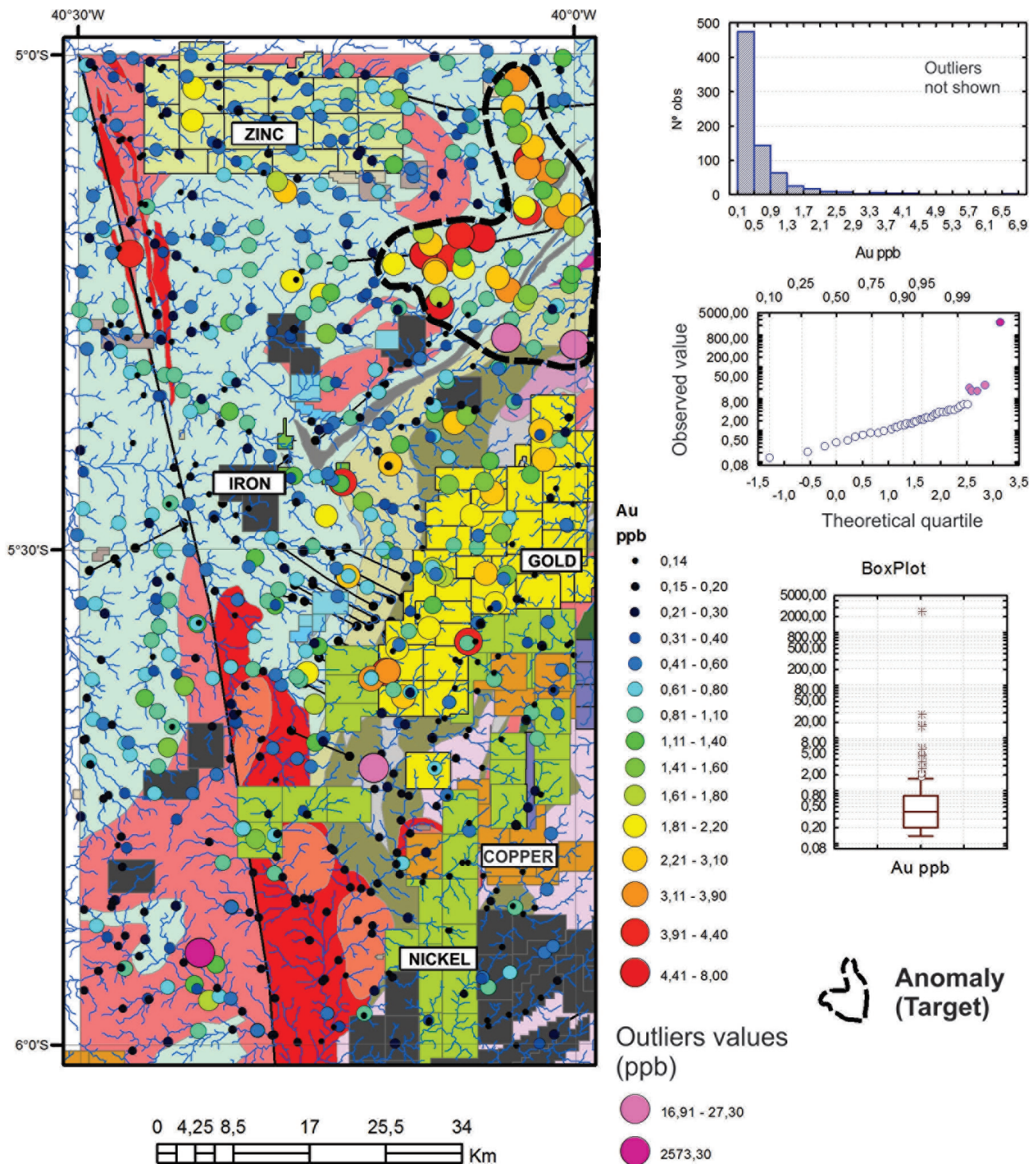


Figure 2: Stream sediment gold distribution map of the 1:100,000 scale Independência and Várzea do Boi sheets. Colored polygons represent application and permit for exploration extracted from www.dnpm.gov.br at November/2015. Map location is presented in Figure 1.

GEOPHYSICAL AND STRUCTURAL INTERPRETATION

The preliminary analysis of the stream sediment geochemical data, along with magnetometric geophysical images (Figure 3) and the structural framework (Figure 4), allow observing that the anomalous gold contents trending to NW-SE, which is compatible with the Tauá shear zone (ZCT) strike (Figure 4). Apparently, this anomalous trend was displaced by a dextral NE-SW shear/fault zone (Figure 4). This structure fits very well the Riedel system, with the σ_1 tensor oriented to the NW-SE strike of the Guaribas dykes, ~580 Ma, which are hosted along extensional structures (Figure 4). Taking into account this geochemical-geophysical-structural picture, we suggest that there is gold mineralization in the Neoproterozoic Ceará Complex rocks, similarly to other Neoproterozoic (580-530 Ma) deposits found in metasedimentary rocks of the Seridó and Cachoeirinha groups in the Rio Grande do Norte and Pernambuco States, respectively (Coutinho, 1994; Legrand et al., 1996; Beurlen et al., 1997; Luiz-Silva, 2000; Araújo et al., 2002, 2005).

EMPHASIZING IMPORTANT POINTS

The stream sediment geochemical data processing, using ppb resolution, revealed 3 to 6 ppb

Au contents in Neoproterozoic Ceará Complex rocks, where up to now there is no effective application and permit for exploration for gold, nor known gold occurrence. The anomalous contents here considered (3 to 6 ppb Au) are similar to values found in other regions with known gold deposits, as for example the Quadrilátero Ferrífero region, Minas Gerais State, central Brazil.

According to preliminary interpretations through structural geology combined with aeromagnetic images, we suggest the possibility of gold mineralization associated to shear zones, similarly to other auriferous deposits found in the Borborema Province.

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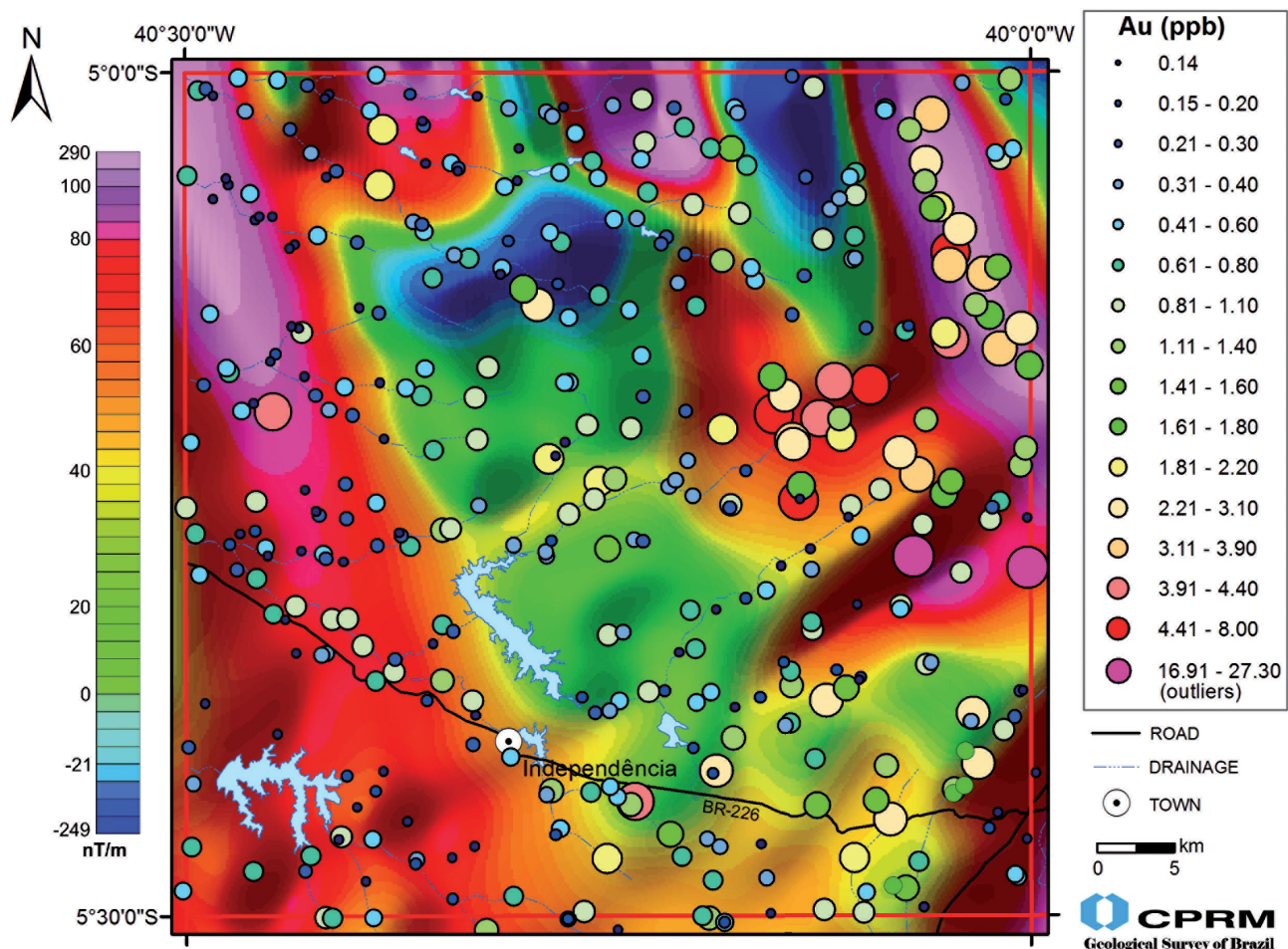


Figure 3: Stream sediment gold distribution for the 1:100,000 Independência sheet, superposed to the aeromagnetic image reduced to the magnetic pole, with anomaly top between 3 and 10 km deep, according to Spector & Grant (1970) model.

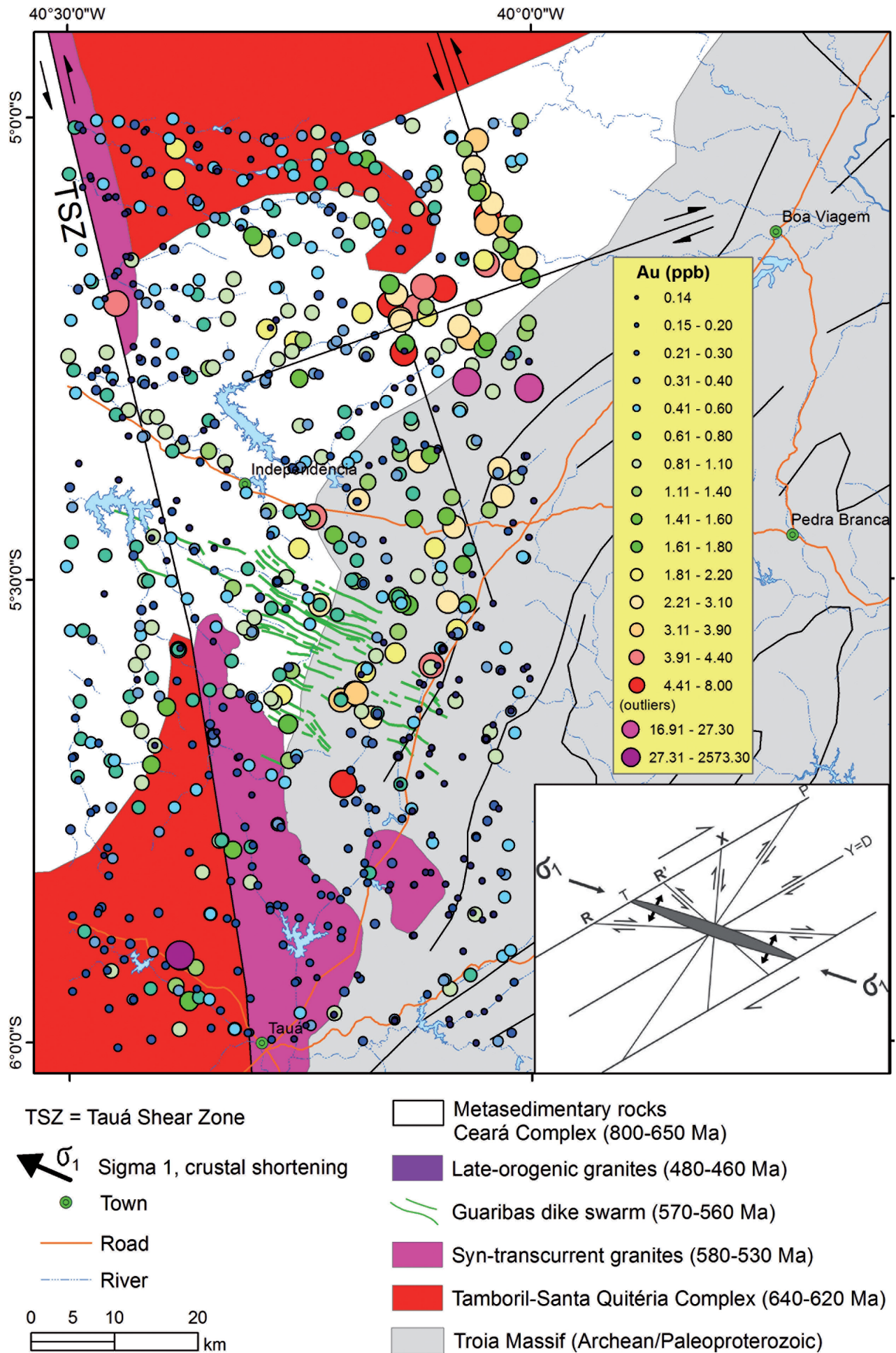


Figure 4: Structural interpretation of the study area, along with stream sediment geochemistry for the 1:100,000 scale Independência and Várzea do Boi sheets, suggesting a structural control for the regional gold mineralization.

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