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GOLD PROSPECTING NATIONAL PROGRAM - PNPO

NEW SYSTEMATICS BASED ON

THE QUANTITATIVE GEOLOGY

**BY
MÁRIO FARINA
GERSON M.M. MATOS
(DEPES)**

**TRANSLATION BY
JEAN MICHEL PONSINET
(DEPEX)**

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Gold Prospecting National Program

NEW SYSTEMATICS BASED ON THE QUANTITATIVE GITOLOGY

**Mario Farina
Gerson M.M. Matos**

I - IMPORTANCE OF GOLD AND ITS PROSPECTING - JUSTIFICATION OF THE PROGRAM -

The Brazilian Gold potential is undeniable due to the fact that the nation has 3,900.00 km² of its territory, about 46%, dominated by pre-cambrian rocks of recognized and metallogenetic importance, where several sequences of greenstone belts, old conglomerates, metavolcanic suites and frequent sheet-like veins swarm inserted in shear zones are to be detached as very promising geological environments.

The high number of occurrences, deposits mines and old and recent "garimpos" distributed in several regions, confirms this potentiality for Gold which is also based on three centuries of extraction of the yellow metal. It is worthwhile to emphasize that Brazil was in the eighteenth century the most important gold producer in the world.

On the other hand, the prospecting campaigns held up to now have been absolutely incompatible with the enormous and indisputable configured potential.

The value of the world gold production reached, in 1992, the sum of US\$ 24,50 billions in regard to 2,216 ton. The Brazilian gold production, including that informal resulting from "garimpos" reached 76,5 ton, representing only US\$ 0,845 billion, which is only 3.45% of the world total production. This is extremely small if one considers the Brazilian gold potentiality. Brazil holds a modest 7th place, preceded by South Africa, USA, CIS, Australia, Canada and China, if we take in consideration only the production from gold mines, excluding that from "garimpos", the Brazilian participation in the gold world production lowers to only 39 ton. The gold production of Brazil declined in 1993 to 75,7 ton, and a new decline is foreseen for 1994.

The Brazilian gold deposits, existent and yet to be found, urgently need to be prospected in order to accelerate the processes of utilization and generation of hard currencies. Gold is an extremely valuable gift from nature but it only becomes valuable if prospected, evaluated and produced.

Gold is unlimitedly convertible into any currency at the international market price. It can be exchanged, without any major difficulties, for goods and services produced anywhere, further to being usable without restrictions in the payment of our external engagements and to increase the monetary reserves of the country.

All currencies are, at a higher or lower degree, affected by inflation, whilst gold, and this, for thousands of years, has maintained and even increased its relative value. There are no indications that this valorization process may be reverted.

The Government has been centering its action on the basic geological mapping of the country, while private companies have been investing on the detailed research and evaluation of areas already reasonably known (aiming at the delimitation or magnification of the reserves) and principally on the opening of new mines or in the improvement or modernization of the existent ones.

However, a more effective action is still lacking in the middle section of the gold deposits generation process, namely in the prospecting. The latter, even in the more developed capitalist countries, has been mostly carried out by the public sector. In a poor country such as Brazil, where there is a great lack of capital for investment in the private sector, the governmental action is even more justified.

Conscious of the relevant importance of the production of gold for Brazil, CPRM - Companhia de Pesquisa de Recursos Minerais planned and put into effect the Gold Prospecting National Program - PNPO ("Programa Nacional de Prospecção de Ouro"), encompassing the whole national territory.

Under these circumstances and taking as irreversible the option of the Government for an each time greater private enterprise economy, the present Program aims at evaluating potential areas and targets to be posteriorly explored by private enterprise which will then be able to develop procedures for calculating reserves of new deposits or substantially increase the existent ones. This will create the necessary conditions for the exploitation of new gold mines and consequently the increase in the national gold production.

The laws which deal with the creation and transformation of CPRM, supply the legal coverage for the implementation of the gold prospecting, in governmental programs, bearing in mind its social attributions. On the other hand it is important to point out the syntonization of the objectives of the Program with the federal Government's main lines, supplementing the performance of the private enterprise.

In what concerns the environment, the activities foreseen are such as to care for its preservation, since the Program concerns the regularly constituted enterprises, which is to say primary deposits, thus avoiding the mercury contaminating processes which occur in several "garimpos".

II - OBJECTIVES

The objectives of the Program are as follows:

- To define the national geological-economical gold potentiality, distinguishing the more propitious areas.
- To stimulate the discovery of deposits and develop the economic exploitation of gold, supplementing the private enterprise action.
- To contribute significantly to the upgrading of the national primary gold production thus making possible an increase in the hard currencies cash reserves of the country, which is of recognized economic importance in foreign trade.
- To offer to those concerned a better knowledge of the national potentialities for gold exploration through a set of specials maps and an informatized data-bank.
- To contribute to an increase in the gold produced through non-polluting methods thus cooperating in the preservation of the environment

III - OPERATIONAL CHARACTERISTICS AND MAIN LINES

This Program is part of the "Pluriannual Plan 1991/1995" formalized to the Ministry of Mines and Energy. The Program was elaborated in 1991. The operational activities started in 1992, they were developed in 1993 and came into full execution in 1994. They are, in principle, permanent, with the achievement of a first large phase in 1995. It presently embraces 10 projects located at several regional units of CPRM all over Brazil and a coordinating and supervising center in Rio de Janeiro. Altogether 18 geologists work full-time on this Program, further to specialists in data processing.

The main operational segments of the Program are as follows:

- Reunion, interpretation and systematization of all main information concerning economic geology, prospection and gold exploration in Brazil. Such information is registered on a filing card, very detailed and specialized, known as FIBO (Ficha de Informação Bibliográfica de Ouro) - Gold Bibliographic Information Form, the elaboration of which is based on published and unpublished geological reports and research and mining special reports from DNPM (National Mineral Production Department) and Mining Companies. The information of the FIBO is meant to help in the calculation of the indexes, confection of specialized maps and towards the informatization of the Program, as described in the topics V, VI and VII.
- Calculation of Gitology-index and Prospectivity-indexes.
- Elaboration of maps based on index of gitology and indexes of prospectivity.
- Prospective field works.

- Divulcation of the results - Conferences, publication of articles divulgation of reports and maps, availability of a processed data system for consultation (Fig. 1)

The funds meant for the Program, allotted by the National Treasury were expected to amount to US\$ 12 million for the period 1991/1995, as stipulated in the Pluriannual Plan. However the budgetary difficulties only allowed the application of US\$1,130,000 up to the end of 1994, which obviously prevented the adequate development of the Program.

IV - QUANTITATIVE GITOLOGY

The modernness of geological sciences points to a conjugation of factual elements with quantitative factors. On one hand one tries to base the knowledge more on unchangeable concepts such as mineralogy, petrographic nature, morphology, etc. and on the other hand on quantitative elements such as dimension, volume, contents, production, reserves, indexes etc. This is the concept of each time more to quantify the geological accidents and moderate or even minimize the interpretations of phenomena which are generally unchangeable and inconstant and sometimes unreliable. This is a way to avoid the "I think" in the decision taking process which should be based more on quantitative elements and less on subjective or just qualifying ones such as those expressions commonly used "this area is hot", "violent anomaly", "there is too much sulphide", "the pan yellowed"... amongst others.

Gitology is a term increasingly used especially in Europe, to describe the study of ore-deposits in the broadest sense, including its geological environment and also its economic value (Etymology. French).

Quantitative gitology is concerned with the measure of the economic importance of the various types of ore-deposits, characteristics of certain geological environments through indexes and parameters based on the reserves and on the production of a given mineral good.

Through the application of the quantitative gitology concepts the CPRM geologists involved in the project, elaborated a comparative table of the Standard Quantitative Gitology encompassing the varied geological environment related to the main gold deposits in the world, with the definition of gitologic types, to which are attributed the values of the production and of the gold reserves at world level (Fig. 2). Fourteen (14) gitologic types are to be distinguished, classified by geological environment category and characterized by the following elements: host rocks, morphology of the ore body, mineralogical association, texture and chemism of the ore, further to examples of deposits in the world and in Brazil.

The identification and characterization on a map, of the gitologic types defined in the quantification of the degrees of previous prospectivity and of demanded prospectivity are the major assignments of the Program. In order to reach these aims gitology index and prospectivity indexes were set as described in the next topic.

GOLD PROSPECTING NATIONAL PROGRAM - PNPO - GENERAL SCHEME

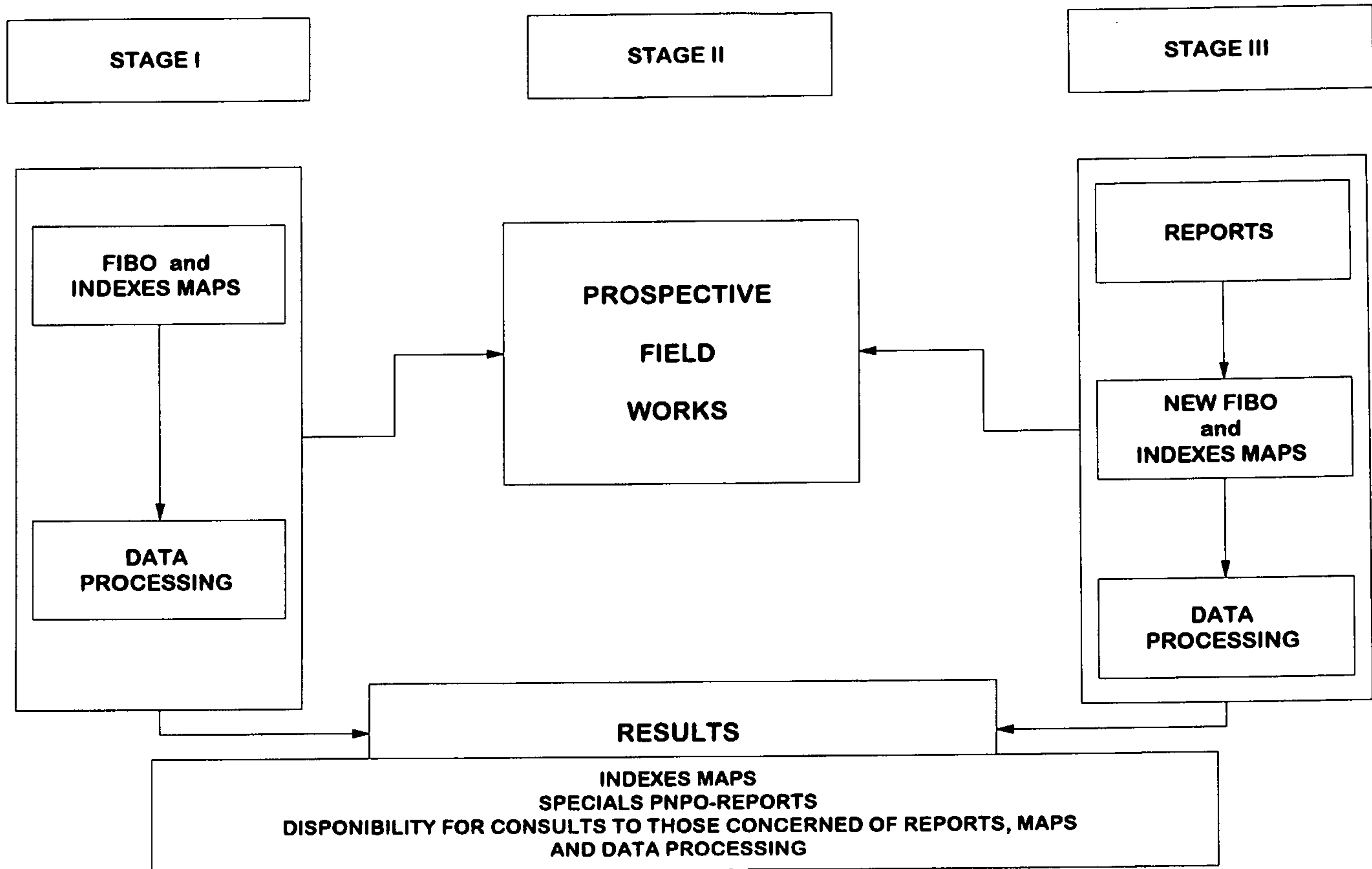


Fig.1

STANDARD GYTOLOGY QUANTITATIVE TABLE					
GEOLOGICAL ENVIRONMENT CATEGORY		TYPE	RESERVE AT 1991 + ACCUMULATED PRODUCTION UNTIL 1991		FGQP
			TON	%	
		I - RESIDUAL/ SUPERGENIC	625	0,4	15
		II - SULPHIDE RICH OFIOLITE	327,6	0,2	5
ASSOCIATION WITH VOLCANO SEDIMENTARY ROCKS	EVENTUALLY FOLDED AND METAMORPHOSED SEQUENCES	III - MARINE VOLCANO-SEDIMENTARY ROCKS WITH PREDOMINANCE OF A BIMODAL VULCANIC SUITE (THOLEIITIC TO CALC-ALKALIC SERIES) AND LESS SEDIMENTARY COMPONENTS	2,387,5	1,5	30
		IV - SULPHIDE MINERALIZATION PREDOMINANTLY ASSOCIATED TO SEDIMENTARY ROCKS WITH LESS VULCANICS COMPONENTS	440	0,3	15
		V - GREENSTONE BELTS AND SIMILAR	28.276,7	17,6	65
	MEDIAN TO LOW METAMORPHOSED, FOLDED SEQUENCES				
ASSOCIATION WITH VOLCANIC ROCKS		VI - SUBAEREOUS VOLCANIC, RELATED TO SUBDUCTION ZONE. BIMODAL CALCALKALIC ANDESITIC TO RHYOLITIC SUITE. CENOZOIC AGE	13.318,3	8,2	50
ASSOCIATION WITH PLUTONIC ROCKS		VII - PORPHYRY COOPER	9.442	5,8	40
		VIII - SKARN	1.035	0,6	20
		IX - QUARTZ-AURIFEROUS LOADS PERIPHERICAL TO INTRUSIVE ROCKS OF INTERMEDIARY TO ACID COMPOSITION	2.389,5	1,5	30
ASSOCIATION WITH SEDIMENTARY ROCKS	UNMETAMORPHOSED	X - RECENT PLACERS	24.508,3	15,2	5
	VERY LOW GRADE METAMORPHISMS	XI- CARBONACEOUS-CARBONATED ROCKS SEQUENCES	1.973,5	1,2	30
	LOW TO MEDIAN GRADE METAMORPHISMS	XII - ITABIRITES WITH FERRIFEROUS TO MANGANESIFEROUS CARBONATED LEVELS	96,4	0,1	5
		XIII - PALEOPLACERS OF ARCHEAN TO LOWER PROTEROZOIC	65.929	41,7	70
ASSOCIATION WITH SHEARED ROCKS		XIV - QUARTZ-AURIFEROUS LOADS RELATED TO LARGE CRUSTALS LINEAMENTS (INCLUDING FAULTS AND SHEAR ZONES)	9.407,2	5,7	40
TOTAL			160.156	100	-

FIGURA 2

V - GITOLOGY AND PROSPECTIVITY INDEXES

INDEX OF QUANTITATIVE GITOLOGY - IGQ - It is representing the degree of geological favorability for gold which a given area or zone present, in function of its qualification in the Standard Quantitative Gitology Table, and of the existing knowledge about the presence of showing, occurrences, deposits or mines of gold. It varies between 0 and 100 and it is calculated from the sum of the factors, Standard Quantitative Gitology Factor - FGQP (see Fig. 2), varying from 0 to 70, and Mineralization Factor - FM, varying from 0 to 30, both in a directly proportional way to the geological favorability. Thus, the direct dependence of the value of the Gitologic Index on the two conditioning factors becomes evident.

INDEX OF PREVIOUS PROSPECTIVITY - IPP - It is a number which indicates how and to what extent a given area has already been prospected. It varies from 0 to 100 and is calculated through the sum of the values of the following factors: Geological Mapping Factor (FMG), Airbone Geophysics Factor (FAG) - Geochemical Prospection Factor (FPG), Ground Geophysics Factor (FGG), Pits and Trenches Factor (FPT), Drillings and Galleries Factor (FSO). The variation intervals of the values of each IPP conditioning Factor are established by observing a direct proportionality with the prospective importance of the types of field work carried out previously.

INDEX OF DEMANDED PROSPECTIVITY - IPD - It is a number which indicates the intensity with which a given area is to be prospected. It varies from 0 to 100 and is calculated through the conjugation of the IPP in such a way that for the result obtained there is an inverse proportionality between the value of the IPP and the value of the IPD, and a direct proportionality between the value of IGQ and that of the IPD. Thus, an area or a zone characterized as of high IGQ and IPP will show an high IPD, whilst another area characterized as of low IGQ and high IPP will present a low IPD.

It is important to elucidate that the calculations of the IGQ, IPP and IPD are effected with the help of various charts and formulas, elaborated in a systematic way and improved through their practical application in various Brazilian auriferous areas. Such charts and formulas are to be found in the Technical Manual of the National Gold Prospection Program and are available, to those interested, at CPRM.

VI - INDEXES MAPS

Zoning maps are being elaborated showing the distinction of the different indexes for all the auriferous and potencially auriferous areas of Brazil. Such Maps will be made as follows:

In the scale 1:250,000 - Only in areas selected as important for gold (Fig. 3).

- Maps of Quantitative Gitology Index - MIGQ
- Maps of Previous Prospectivity Index - MIPP

COMPANHIA DE PESQUISAS E RECURSOS MINERAIS

GOLD PROSPECTING NATIONAL PROGRAM

MAP OF DISTRIBUTION OF WORK AREAS



JULY/1995

FIG.3

- Maps of Demanded Prospectivity Index - MIPD.

In the scale 1:2.500.000 - Covering the entire national territory.

- Map of Auriferous Reserves and Production - where will be represented the annual total gold reserve and gold production of Brazil, indicated by the very tonnage

The preliminary selection identified areas with interest for the 1:250.000 maps in a total of 1.013.657 km², representing 11,92% of the national territory, 50% of which are located in the northern region.

VII - DATA PROCESSING

The data processing of the National Gold Prospecting Program - PNPO, comprehends the whole universe of data and information picked up concerning the economic geology, prospection, exploration, gold reserves and production of the whole national territory .

The sources of this data are published reports, articles and maps, unpublished private reports, the PNPO specialized thematic maps (MIGQ, MIPP and MIPD) and the results of the prospective field works to be carried out by the PNPO.

This set constitutes the GOLD SYSTEM (Sistema Ouro - SOU) with its various data bases (specially in what concerns metallogeny, geochemistry and geophysics, composing the PNPO System, which will be more extensive and will give to the users full conditions for the obtention of information and technical elements to take decisions in the scope within which the PNPO operates (Fig. 4).

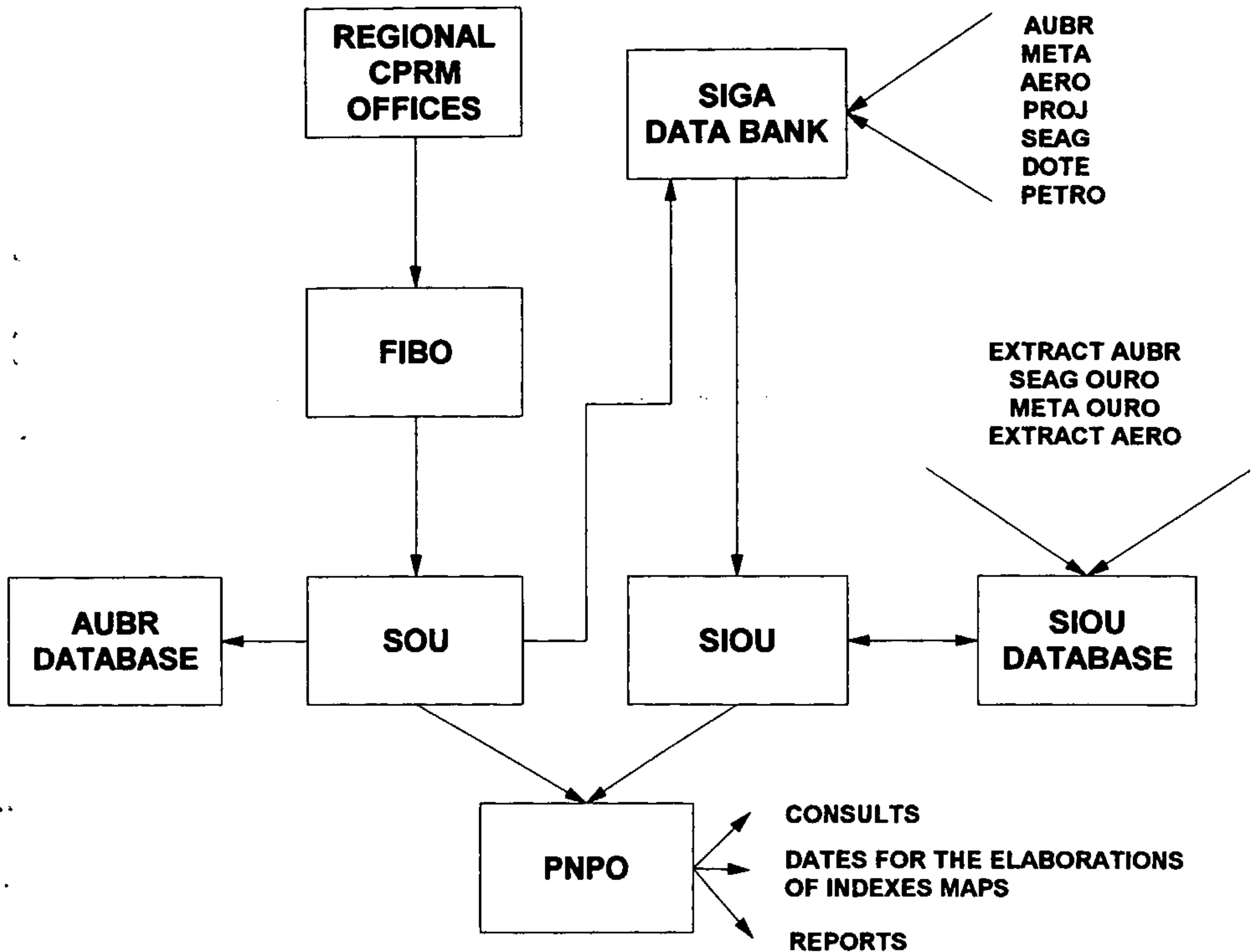
VIII - RESULTS

The results have been quite significant in spite of the complete unsuitability of the financial resources to the necessities of the Program.

The divulgation up to now, has been realized through lectures and discussion with the mineral community . The repercussion has been quite positive and stimulates the pursuit of the works.

The consolidation of a new and objective methodology based on the principles of the Quantitative Geology, modelled on concepts of the international bibliography, duly adapted to the brazilian condition and containing a strong dose of quantified geological elements represent a most useful and safe tool for the development of the economic geology and for gold prospecting, with quite encouraging results.

FUNCTIONAL STRUCTURE OF THE SYSTEM (DATA PROCESSING)



SYSTEMS:

- SOU - Gold System**
- SIOU - Integrated Gold System**
- SIGA - Geological Information System**

DATABASES:

- AUBR - Brazil Gold**
- SEAG OURO - Gold Geochemistry**
- META OURO - Gold Occurences**
- META - Mineral Occurences**
- AERO - Airborne Geophysics**
- PROJ - CPRM Projects**
- DOT - Bibliography**
- PETRO - Petrography**

Fig.4

At the present time 106 auriferous and potentially auriferous areas totalizing 1.013.657 km² were selected, representing 11,92% of the national territory (Fig.2).

Up to the end of 1994 the main results obtained were as follows:

- Establishment of a methodology to calculate the geology and prospectivity indexes.
- Composition of the Gold Bibliographic Information Form (FIBO)
- Development of the initial data processing phases concerning the economic geology, prospection and exploration for Gold in Brazil, thus allowing to put into practice, in a near future, the GOLD SYSTEM and the PNPO SYSTEM.
- Completed Gold Bibliographic Information Form (FIBO): 310
- Under elaboration Gold Bibliographic Information Form (FIBO): 158
- Sets of Maps being concluded: 47
- Sets of Maps concluded: 02

The main aims for 1995/1996 are the following:

- Filling - out of 546 FIBO;
- Digitation of 1.014 FIBO:
- Elaboration of 104 sets of maps (the foreseen total for the program is presently 106):
- Beginning of the field prospecting activities;
- Availability of the PNPO SYSTEM for consultation through the supply of the compatible financial resources.

IX - WORKING TEAM

Programatic conception and supervision: geologist Mário Farina (Rio de Janeiro); coordination: geologist Gerson M.M. Matos (Rio de Janeiro); execution: geologist Homero de Araújo Neto (Brasília), Ricardo Gallart de Menezes (Rio de Janeiro), João Ângelo Toniolo (Porto Alegre), Carlos Alberto Kischner (Porto Alegre), Luiz Moacyr de Carvalho (Salvador) Antônio José Barbosa (Recife), José Maria A. Carvalho Evandro Klein (Belém), Felicíssimo Rosa Borges (Manaus), Cipriano Cavalcante de Oliveira (Goiânia), Mario V. Albuquerque (Cuiabá), Luiz Manoel Alves Marçal (Belo Horizonte), Luiz Gilberto Dall'igna (Porto Velho), Eduardo Gazzoli Longo e Ivo Hermes Batista (São Paulo), geographer Helena S. Zanetti Eyben (Brasília); data processing support (Rio de Janeiro): Alfeu Zanon and José A. Calvente Filho.

This working team is entirely composed of CPRM technicians with the collaboration of professionals from other institutions, especially of the DNPM - Departamento Nacional da Produção Mineral (National Mineral Production Department).

The program is part of the activities of CPRM's Directory of Mineral Resources, headed by geologist Antônio Juarez Milmann Martins.

X - COMPLEMENTARY INFORMATION

The nature, complexity and high importance of the Program call the necessity of its permanent improvement. To this end comments, criticisms and suggestions will always be welcome, they may be addressed to the Departamento de Projetos Especiais (Special Projects Department) of CPRM, Av. Pasteur, 404 - Urca - Rio de Janeiro - Phone: (021) 295-5446 and Fax (021) 295-3647.

Complementary information concerning the Program may be obtained at the same address.