REPORT
ON
THE COOPERATIVE MINERAL EXPLORATION
IN
THE CURRAIS NOVOS AREA
FEDERATIVE REPUBLIC OF BRAZIL

(PHASE Ⅲ)

MARCH 1992

JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

PREFACE

In response to the request of the Government of the Federative Republic of Brazil, the Japanese Government decided to conduct a mineral exploration project in the Currais Novos area and entrusted the survey to the Japan International Cooperation Agency (JICA) and the Metal Mining Agency of Japan (MMAJ).

The JICA and MMAJ sent to the Federative Republic of Brazil a survey team headed by Kazuo Kawakami from July 6 to September 25, 1991.

The team exchanged views with the officials concerned of the Government of the Federative Republic of Brazil and conducted a field survey in the Currais Novos area. After the team returned to Japan, further studies were made and the present report has been prepared.

We hope that this report will serve for the development of the project and contribute to the promotion of friendly relations between the two countries.

We wish to express our deep appreciation to the officials concerned of the Government of the Federative Republic of Brazil for their kind cooperation extended to the team.

March, 1992

Kensuke Yanagiya
President
Japan International Cooperation Agency

Gen-ichi Fukuhara
President
Metal Mining Agency of Japan

ABSTRACT

The present survey was carried out in the Currais Novos area, state of Rio Grande do Norte, Brazil, in conformity with the Scope of Work agreed between the governments of the Federative Republic of Brazil and Japan, in July 11th, 1989. The project covers an area of 5,910 Km^2 (Fig. 1) over a period of 3 years. This survey corresponds to the third year's (Phase III), and was carried out by both Brazilian and Japanese members.

This year' survey can be outlined as composed by the following three main parts: **1)** Geophysical and trench surveys in area "A", which was selected as the most promising by the surveys carried out during the former 2 years; **2)** Soil geochemical survey in the southwestern portion of area "B", which was selected as a promising area from last year's results; and **3)** Reconnaissance geological and stream sediment geochemical surveys in area "C", located to the south of area "B". The area covered by these surveys within area "B" (area "B-I", Fig. 2) totaled 6 Km^2, while in area "C" they totaled 500 Km^2.

IP was the geophysical method used to prospect area "A", and the samples collected from trenches were analyzed for Au, Ag and W. Soil samples collected in area "B" were analyzed for Au, As and Sb. The stream sediments collected in area "C" were analyzed for 13 elements, namely Au, Ag, Fe, Mn, Mo, W, Sn, Nb, Ta, Be, Li, As and Sb. Some stream sediments collected in area C were panned in order to check for the presence of gold grains, and also analyzed for 7 elements, namely Au, Ag, Mo, W, Sn, Ta and Nb.

(1) Area "A"

Area "A-I" was prospected by trench survey, while area "A-II" was prospected by geophysical as well as trench surveys. In area "A-I", 6 trenches were opened, totaling 200 meters. In area "A-II", IP survey were carried out on 5 lines (evenly spaced by 200 meters), each with length of 2 kilometers, totaling 10 kilometers, while geochemical sample collection were executed on 4 trenches which totals 200 meters. Moreover, aiming at comparison, samples were also collected from a trench excavated inside the Sao Francisco mine.

Trenches opened in area "A-I" were located based on results of soil geochemical survey, but none of trenches revealed any trace of mineralization under or below these anomalies.

Previous soil geochemical survey and biogeochemical prospecting results were used in conjunction with IP geophysical results to locate trenches in area "A-II". IP survey results indicated anomalies at west, center and east of this area. Trenches were dug on all these three anomalous zones (Fig. 3). Analyses of samples collected from these trenches revealed that the central anomalous zone, which was the only one that overlapped biogeochemical anomalies, corresponds to a mineralized zone, although the Au contents are somewhat low. Anomalous Au contents (yet low) were confirmed in samples from all three trenches dug in this central anomalous zone, but did show a discontinuous character, so that a clear definition concerning to whether this anomaly is related to a mineralization stage or to a local feature of the regional rock itself could not be established.

(2) Area "B"

Soil geochemical survey as well as detailed geological survey were carried out in area "B-I" (Fig. 4). Since there is no clear correlation between Au and other analyzed elements, it was decided that prospecting should rely only on Au contents. Last year' survey confirmed the existence of outcrops of Au-bearing quartz veins in the mid-eastern part of area "B-I", but soil samples collected nearby these quartz vein outcrops did not yield Au anomalous contents. There seems that Au anomalies are rather scattered all over the area. However, the anomaly confirmed nearby the northern foothills of the Umburana Range seems to lay on the extension of the trend indicated by the sulfide-bearing quartz veins discovered during the detailed geological survey. Further prospecting is necessary to make clear this possible relationship.

(3) Area "C"

This area, similarly to those prospected in previous years of this project, is underlain mainly by Precambrian units, which are in turn overlain by small scale Tertiary and Quaternary units. Precambrian units are represented by the Archaean Caico Complex, and by the Equador and Serido Formations belonging to the Proterozoic Serido Group. The Jucurutu Formation, which outcrops in areas prospected in previous years, does not crop out within area "C". The Caico Complex is mainly represented by gneisses, the Equador Formation by quartzites, and the Serido Formation by biotite-schist. Rocks belonging to the Caico Complex are exposed mainly in the eastern part of this area, the Equador Formation predominates in the western part, while the Serido Formation is widely distributed all over the area.

N-S and WNW-ESE ~ ENE-WSW are the directions of main faults present in this area. N-S faults are all but part of the main fault that includes this entire area. In the eastern part, in special, where the Caico Complex is bound to the Serido Formation, the contact is made up by the Picui fault, one of the major structural features in northeast Brazil. Faults with WNW-ESE ~ ENE-WSW directions are also distributed all over the area. They are smaller than N-S faults, and there are places were basic rocks have intruded through them, so that they are thought to be of younger age. In the central part of the survey area, there is a 3 Km wide fold zone within the Serido Formation which runs parallel to N-S faults. This fold zone is also a large structure that cross over the entire C area.

Within area "C", mineralizations of Nb, Ta, etc. related to pegmatites are very common, but mineralizations of Au have not been confirmed in the survey carried out this year.

From the results of stream sediment geochemical survey, it is concluded that none of the analyzed elements show any well defined anomaly. Analytical results for Ag and Sb, specially, were all below the detection limit. Au anomalous zones are restricted to the area between Ermo and Casado rivers, in the northwestern part of the survey area. Also, though represented by one point, there is a spot in the mid-northern part of the survey area were the highest Au content (63 ppb) was registered (Fig. 5). Anomalies of other elements are considered to be all related to mineralizations related to pegmatites or to chemical characteristics of the country rock itself.

Statistical processing of analytical data showed that Fe-Mn and Ta-Nb are positively correlated, which were also evident in factor analysis results.

From the results stated above, the following surveys are suggested for further prospecting.

(1) Area "A"

Detailed prospecting of the area "A-II", in northern part of the Sao Francisco mine. Geophysical as well as trench surveys, that can provide key information on mineralizations, are recommended.

(2) Area "B"

In order to understand and to define the Au mineralization related to the anomalous zone at the southeastern foothills of Umburana Range, further detailed geological and geophysical prospecting are recommended.

(3) Area "C"

Concerning to the Au anomalous zones in the northwestern and mid-northern parts of the survey area, there seems that no priority should be given to understand the origin of that gold.

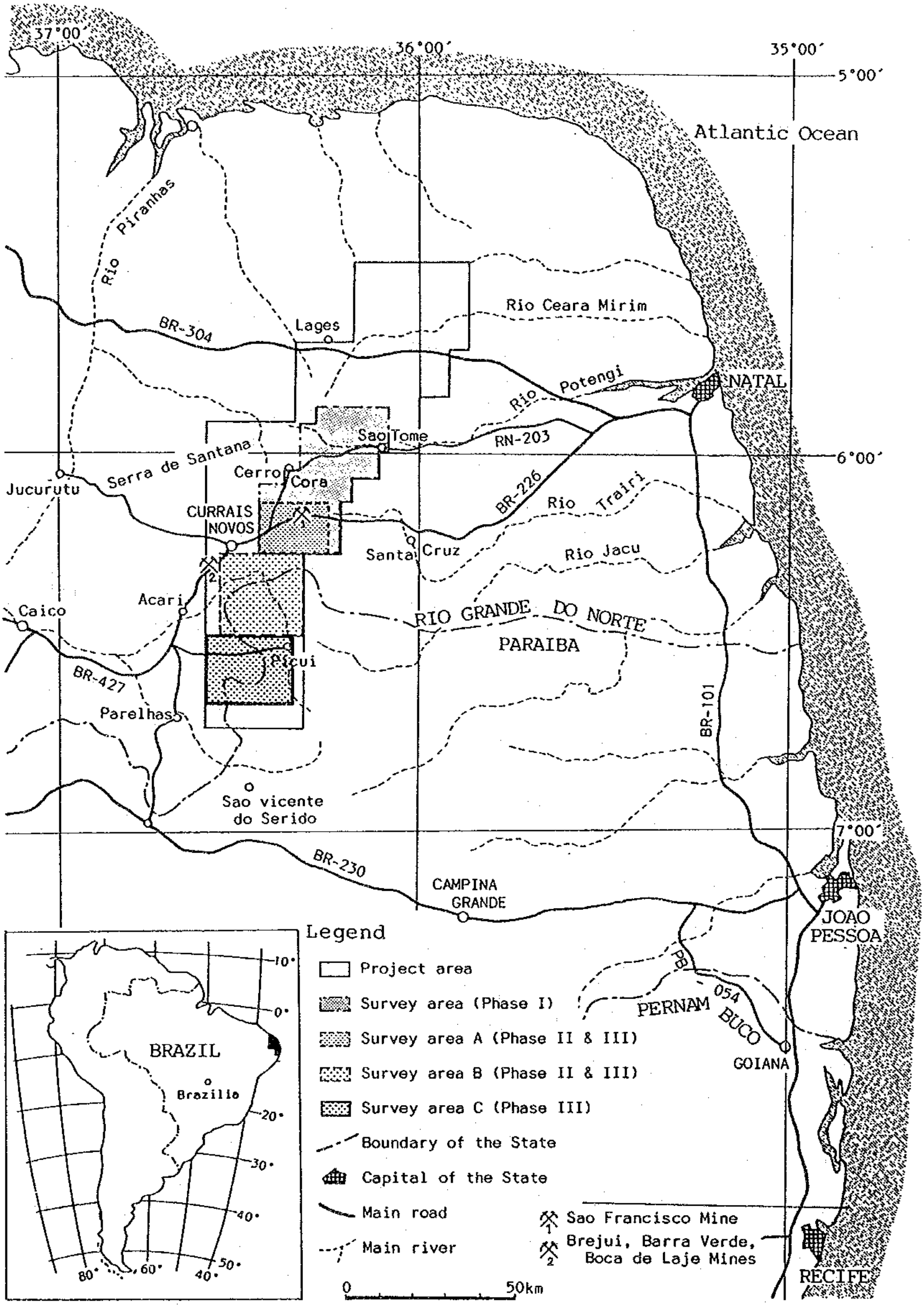


Figure 1 Location of the survey area (1)

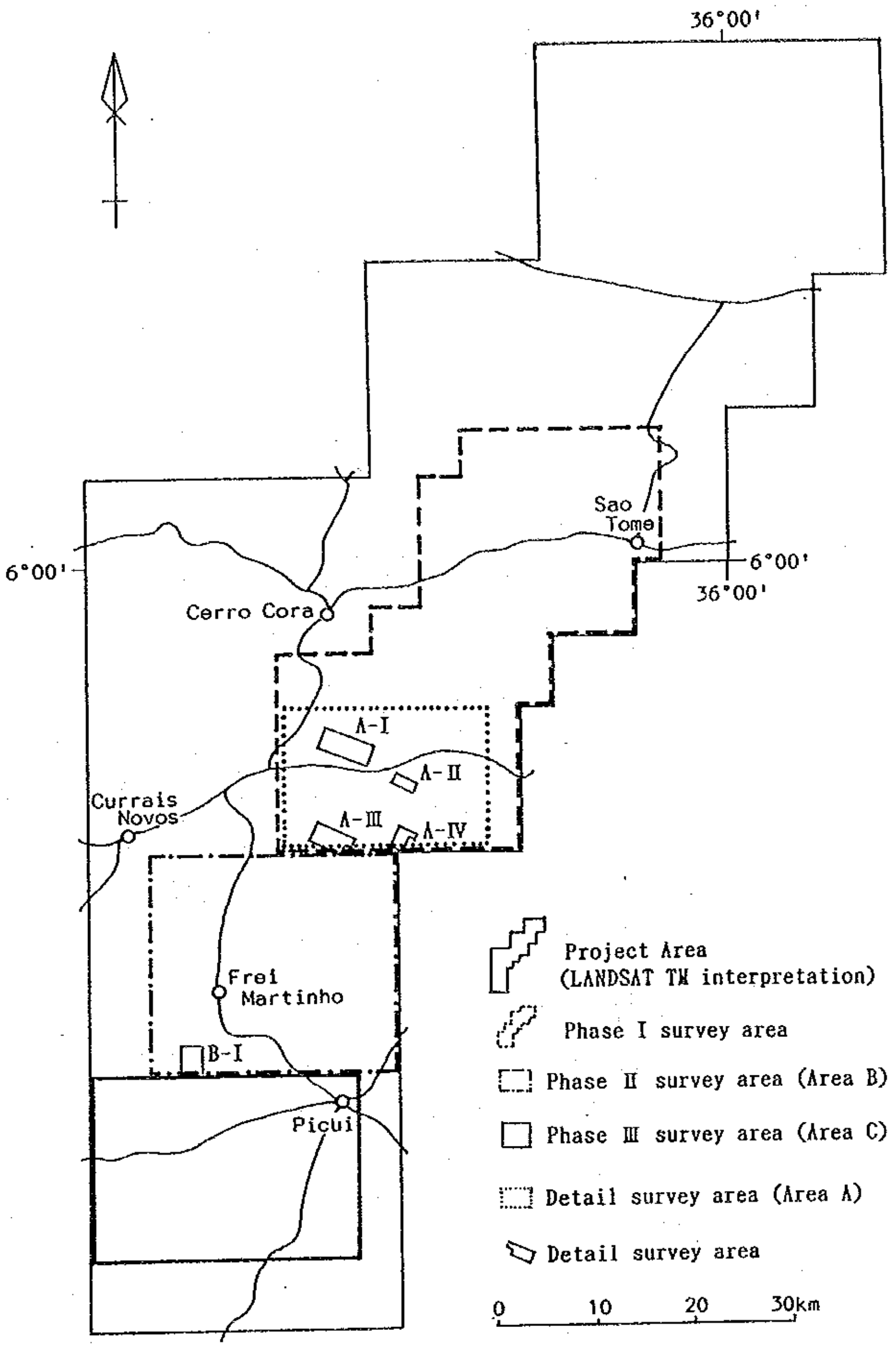


Figure 2 Location of the survey area (2)

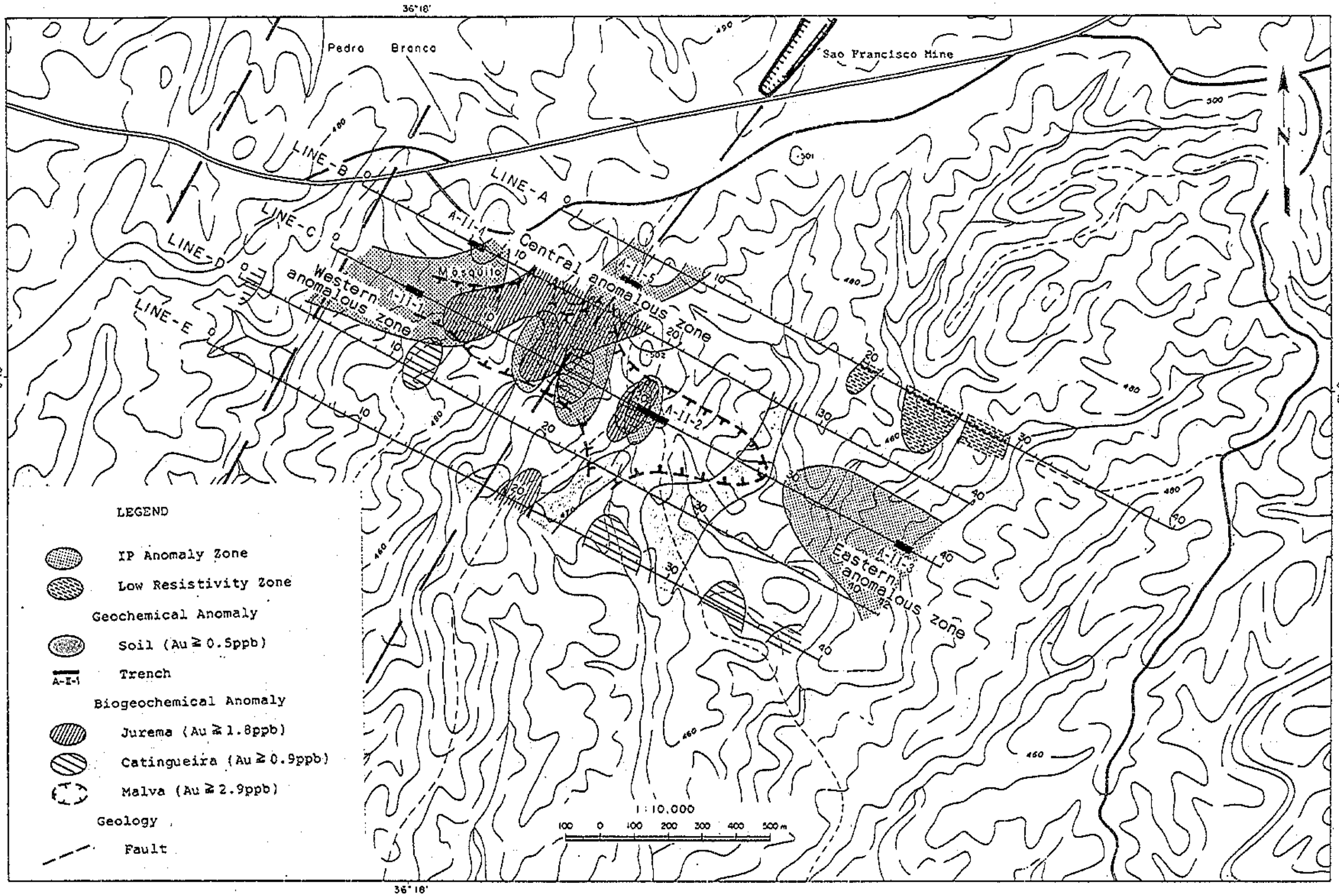
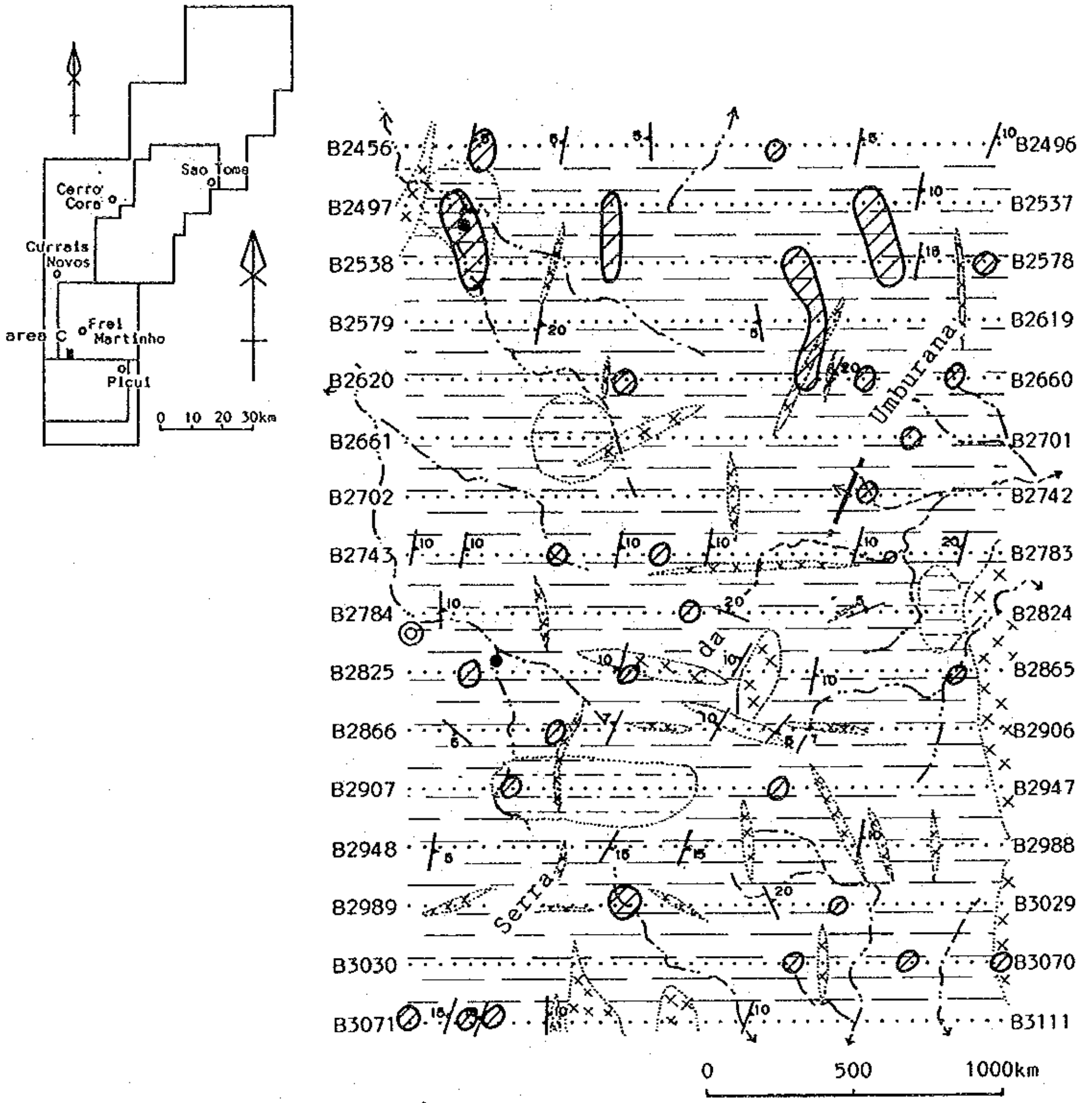


Figure 3 Compilation of the survey in area A-II



⊘ ≧ 1ppb Au in soil

● ≧ 10,000ppb Au in pan concentrate

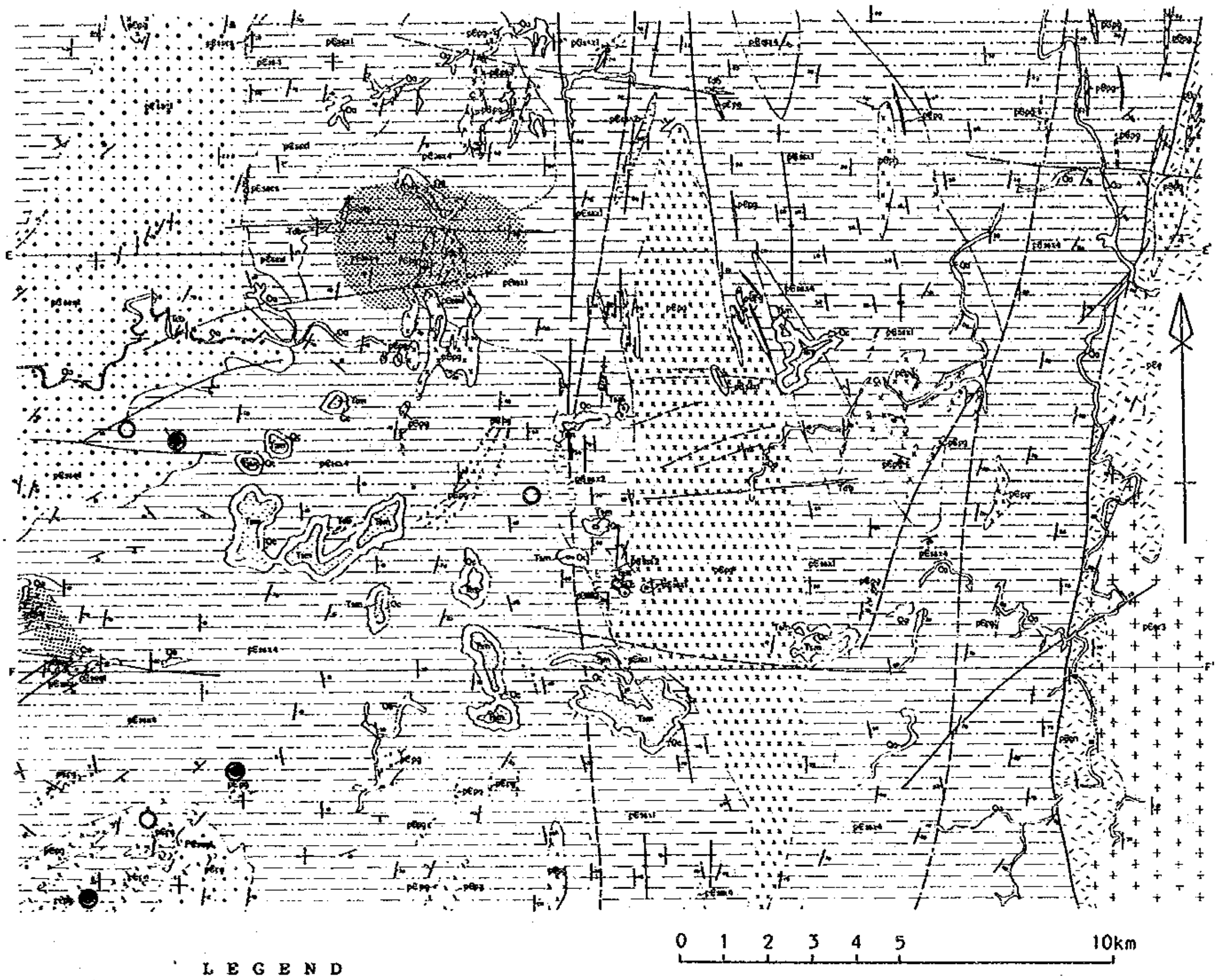
○ ≧ 1,000ppb Au in pan concentrate

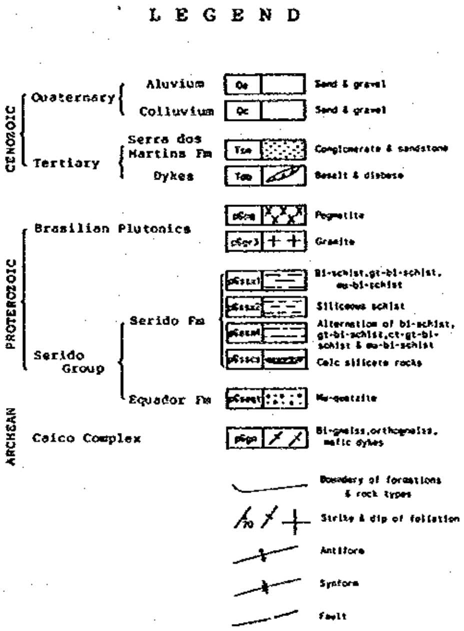
◎ Point where gold particle was found

Auriferous quartz vein (Au, 0.2ppm; Ag, 103ppm)

B3112 Soil sampling point & number

Figure 4 Compilation of the survey in area B-I





LEGEND

- Stream sediment Au anomalous area (Au ≧ 1ppb)
- ● Location of Au particles
- ○ High Au value in pan concentrate (Au ≧ 1,000ppb)

Figure 5 Compilation of the survey in area C

TABLE of CONTENTS

PART II - RESULTS and INTERPRETATION

PART I

GENERALITIES

and

OVERALL DISCUSSIONS

Chapter 1 - Introduction

1-1 OUTLINE and PROGRESS

1-1-1 Outline of the Survey

The present survey was carried out in the Currais Novos area, state of Rio Grande do Norte, Brazil, in conformity with the Scope of Work agreed between the governments of the Federative Republic of Brazil and Japan, in July 11^{th}, 1989. The project covers an area of 5,910 Km^2 (Fig. 1) over a period of three years. This survey corresponds to the third year's, and was carried out by both Brazilian and Japanese members.

In the first year of this project, LANDSAT (TM) images interpretation as well as a bibliographic survey covering the entire area of the project were carried out aiming at understanding the geological structure. Based on the results of this preliminary survey, the area under focus could be reduced to 1,000 Km^2, where geological and stream sediment geochemical surveys were executed. The results of these surveys indicated a concentration of Au anomalous zones to the south of the Sao Francisco Mine, which is located in the southern part of the survey area. This lead to the decision to carry out a detailed survey on this southern area as for the continuation of the project.

In the second year, biogeochemical as well as soil geochemical surveys were executed in the southern part of the first year' survey area, in order to delineate more clearly the anomalous zone (25 Km^2) defined in that area. Moreover, geological and stream sediment geochemical surveys were carried out in area "B" (500 Km^2), located to the south of the first year' survey area, in order to better understand the geological setting as well as the mineralization processes.

In the third year, the anomalous areas delineated as a result of the second year's biogeochemical and soil geochemical surveys were further prospected by geophysical (IP) and trench surveys, while the promising area (area B-I, located in the southwestern part of area "B") extracted by geological and stream sediment geochemical surveys was prospected by soil geochemical survey. Additionally, a new area (area "C": 500 Km^2), located to the south of area "B", were investigated by geological and stream sediment geochemical surveys, aiming at understanding the overall geological setting and the mineralization process(es).

1-1-2 Conclusions from the Second Year' Survey

The results of biogeochemical and soil geochemical surveys carried out in area "A" ("A-I", "A-II") indicated that there is no clear correlation among Au, As and Sb, so that it was concluded that Au is the only reliable element to be used for prospecting. The Au anomalous zones defined by soil geochemical survey and by biogeochemical prospecting, when analyzed in terms of spatial distribution and taking into account the neighboring topography, show a good correlation. Based on this finding, the southeastern part of area "A-I", the portion of area "A-II" that correspond to the southern extension of the Sao Francisco mine deposit, and also the area located 500 meters to the east from this southern extension, were concluded promising for gold.

In the southeastern edge of area "B", at the central part of the Umburana Range, a Au-Ag bearing quartz vein showing length of approximately 200 meters and width ranging between 0.3 and 2.0 meters were found, and this vein-type mineralization was considered as being of hydrothermal origin. Since this vein seems to not be structurally related with faults found in the neighborhood, and also has a different attitude from that of the schistosity of the country rock, it is concluded that further work are necessary to delineate the real spatial distribution of quartz veins, and also to clarify the geological structure of the neighborhoods.

1-1-3 Recommended Works for the Third Year' Survey

Concerning to area "A", detailed biogeochemical and soil geochemical surveys, or geophysical survey were recommended to be carried out on the southeastern part of area "A-I". The same surveys were also recommended to prospecting of areas to the south of area "A-II" and to the north of the Sao Francisco mine deposit.

Concerning to area "B", detailed geological and geophysical surveys on the neighborhood of the quartz vein outcrop at the northern foothills of the Umburana Range were recommended.

1-2 SUMMARY of the THIRD YEAR' SURVEY

The survey carried out during the third year of this project can be outlined as composed by three main parts. The focussed areas were those extracted as promising from results of the first and second year's surveys, namely area "A" ("A-I" and "A-II" areas) and area "B-I". Moreover, a new area (area "C), located to the south of area "B" was chosen to be prospected in this third year.

The survey in area "A" was aimed at carrying out detailed prospecting on promising areas extracted from the results of stream sediment and soil geochemical survey as well as biogeochemical survey. Trenches were dug in the southeastern part of area "A-I", in places where soil geochemical survey results indicated high Au concentrations, in order to make clear the relationship between geological and mineralization features in this area. With this same objective, geophysical survey (IP) was carried out over the entire "A-II" area in order to locate promising areas to be prospected by trenching. Samples in the trenches were collected at a regular spacing of 1 meter, and were analyzed for Au, Ag and W.

In areas within the area "B-I" where the existence of Au-Ag bearing quartz veins as well as Au anomalous zones were confirmed by geological and stream sediment geochemical prospecting, the survey was carried out aiming at obtaining a more detailed delineation of the anomalies. In order to attain this objective, soil geochemical surveys were executed covering the entire drainage basins of the streams where the Au anomalies were discovered, including also the area where the Au-Ag bearing quartz veins crop out. Samples were analyzed for Au, As and W.

The survey on area "C" was carried out aiming at understanding the geology as well as the Au mineralization process(es), and was executed similarly to those of the first and second years', through geological and stream sediment geochemical surveys. Geological survey was performed with a traversing density of approximately 0.8 Km/Km^2, with the purpose of clarifying the distribution of geological units, geological structures as well as their relationship with the mineralizations. Stream sediment geochemical survey was executed with a sampling density of 1.6 $samples/Km^2$ covering the entire area, with determination of 13 elements (Au, Ag, Fe, Mn, Mo, W, Sn, Nb, Ta, Be, Li, As, Nb), aiming at clarifying the spatial distribution of these elements and to understand their mutual relationship, specially with respect to Au. In addition, pan concentrates of stream sediments collected from locals selected based on previous reports and on this year's geological survey, were macroscopically analyzed for the presence of gold grains, and also chemically analyzed for 7 elements (Au, Ag, Mo, W, Sn, Ta, Nb), in order to improve the knowledge concerning to the distribution of these elements over the survey area.

The totals of field, office and laboratory works performed during this survey are listed in Tab. I-1-1.

1-3 SURVEY MEMBERS

The team that carried out the field works corresponding to the third year of this project was composed by the members listed below.

Japanese Members:

- Kazuo Kawakami	(Bishimetal Exploration Co., Ltd.)
- Masakatsu Onodera	(Bishimetal Exploration Co., Ltd.)
- Motomu Gotou	(Bishimetal Exploration Co., Ltd.)
- Tomio Tanaka	(Bishimetal Exploration Co., Ltd.)
- Kazuto Matsukubo	(Bishimetal Exploration Co., Ltd.)

Brazilian Members:

- Alarico A. F. Mont'Alverne	(DNPM)
- Jose Robinson A. Dantas	(DNPM)
- Roberto Batista Santos	(DNPM)
- Mauro Caldas Mendes	(DNPM)
- Luis Barbosa Barros	(DNPM)
- Antonio Honorio de Ml. Junior	(DNPM)
- Cicero Alves Ferreira	(CPRM)
- Jorge Luis da Costa	(DNPM)

1-4 PERIOD of the SURVEY

The survey corresponding to the third year of this project was carried out during the period given below.

- Field Works: 6th July through 25th September, 1991 (Date of departure from and arrival at Japan)

- Report Preparation: 26th September, 1991 through 31th January, 1992.

Table I-1-1 Summary of field works and laboratory tests

Area A

<table>
<tr><th colspan="6">Field works</th><th colspan="2">Laboratory tests</th></tr>
<tr><td colspan="6">IP Geophysical survey
5 lines (10km) , 556 measurements</td><td>Resistivity measurements
Polarization measurements
Chemical analysis (sullfer)</td><td>20
20
20</td></tr>
<tr><td colspan="6">Trench survey
Trenching (459m) Rock samples(501)</td><td colspan="2"></td></tr>
<tr><td colspan="3">Area A-I</td><td colspan="3">Area A-II</td><td colspan="2"></td></tr>
<tr><td>No.</td><td>Length</td><td>Number</td><td>No.</td><td>Length</td><td>Number</td><td rowspan="7">Chemical analyses
Rocks(Au, Ag, W)</td><td rowspan="7">
501</td></tr>
<tr><td>A-I-1</td><td>25m</td><td>25</td><td>A-II-1</td><td>50m</td><td>50</td></tr>
<tr><td>A-I-2</td><td>82m</td><td>76</td><td>A-II-2</td><td>100m</td><td>97</td></tr>
<tr><td>A-I-3</td><td>25m</td><td>25</td><td>A-II-3</td><td>50m</td><td>50</td></tr>
<tr><td>A-I-4</td><td>26m</td><td>26</td><td>A-II-4</td><td>50m</td><td>50</td></tr>
<tr><td>A-I-5</td><td>26m</td><td>26</td><td>A-II-5</td><td></td><td>53</td></tr>
<tr><td>A-I-6</td><td>25m</td><td>23</td><td></td><td></td><td></td></tr>
</table>

Area B

Field works		Laboratory tests	
Survey area	$6km^2$	Chemical analyses	
Geochemical samples		Soil(Au, As, Sb)	660
Soil samples	660		

Area C

Field works		Laboratory tests	
Survey area	$500km^2$	Chemical analyses	
Geological Traversing	498	Stream sediments(Au, Ag, Fe, Mn, Mo, W, Sn Nb, Ta, Be, Li, As, Sb)	807
Geochemical sampling		Rocks(SiO2, TiO2, Al2O3, Fe2O3, FeO, MnO, MgO, CaO, Na2O, K2O, P2O5, LOI, Au, Ag, Fe, Mn, Mo, W, Sn, Nb, Ta, Be, Li, As, Sb)	30
Stream sediments	807	Pan concentrates(Au, Ag, Mo, W, Sn, Ta, Nb)	83
Pan concentrates	83	Thin section observation	30
		Ore assay (Au, Ag)	3
		X-ray diffractometry	10

Chapter 2 - Geographic Features of the Survey Area

2-1 LOCATION and ACCESS

The project area as a whole extends from the mid-southern part of the Rio Grande do Norte State to the mid-northern part of the Paraiba State, northeast Brazil. This area is included between 5°30' to 6°45' south latitude and 35°50' to 36°35' west longitude. The area corresponding to the Phase I of this project was bound by 5°52' to 6°29' south latitude and 36°04' to 36°31' west longitude, while those prospected during Phase II were confined between 6°17' to 6°29' south latitude and 36°18' to 36°31'west longitude. The area prospected in this third phase of the project extends from 6°29' to 6°40' south latitude and 36°19' to 36°34' west longitude. The city of Currais Novos, with population of about 25,000, is situated to the west of area "A" and to the north of area "B", while to the northeast of area "C" there is the city of Picui (Fig. 1). The Currais Novos city, which is the largest in the neighborhoods, was chosen as the base site for this survey.

The city of Currais Novos can be reached by air and through roads. There are two regular flight lines, one departing from Recife (capital of the Pernambuco State) and the other from Natal (capital of the Rio Grande do Norte State). This city is also linked to these two capitals by paved roads. Departing from Recife, it is a journey of 420 Km through the route BR-101, PB-054 and BR-230. Departing from Natal, the journey is of only 190 Km through BR-226.

The route BR-226 passes across the central part of area "A" in approximately E-W direction. In the western part of area "B", there is an unpaved road crossing the area in N-S direction. Through this road, the city of Picui can be accessed, after passing the locality of Frei Martinho, in the State of Paraiba. The Picui city can also be reached through the BR-226 route, by heading southward from the Currais Novos city via the Acari city. This was the course more frequently used by the survey team.

In area "C", there are numerous unpaved roads and trails that allow traffic of cars. Since the topographic maps prepared for this project were based on aerial photographs taken in 1967, it should be noted that the present state of available and usable roads differs quite a lot from that recorded on the maps.

2-2 TOPOGRAPHY and HYDROGRAPHY

As stated in the Phase I report, the project area can be divided into three main areas in terms of topographic features. An undulating topography with rounded mountains ranging in altitude between 300 and 600 meters above the sea level occupies large portions of the area. Flat plains dominate in the northern part while the middle western part of the area in occupied by mountains of the Serra da Santana with altitudes up to 700m above the sea level. The areas prospected in Phase I and II were dominated by the undulating topography with altitudes ranging between 300 and 600 meters (please refer to the reports of Phase I and II for details).

The area "C" can also be included in the undulating topography type above described, but can be further subdivided into four sub-types. One of them is characterized by small mesas with altitude near 700 meters, and their occurrences are concentrated around the center of the area. The top of mesas are sustained by rocks belonging to the Tertiary Serra dos Martins Formation. Another sub-type is distributed over the northwestern part of this area, being characterized by a mountainous topography featuring deep valleys and with altitude ranging between 320 and 660 meters, and coincides with outcrops of quartzites belonging to the Equador Formation. The rest of the area consists of a gently undulating topography with altitude ranging between 400 and 600 meters, which is associated with outcrops of mica-schists belonging to the Serido Formation. The fourth sub-type occurs in the central part and near the eastern boundary of this area, and is characterized by a distinctive topography with elongated and rounded high-and-lows. The occurrence of this peculiar topography is, in the central part, closely associated with the distribution of pegmatites, while around the eastern boundary it is associated with outcrops of granites and gneisses.

Although not noticeable in the topographic maps, one more kind of relief could be confirmed during the field works. It consists of "galleries" and "walls" some meters wide and with height up to ten meters, and is associated with outcrops of pegmatite veins. The directions of these veins are mainly N-S in the northern part of this area, and NE-SW in the southern part, while in the central part they are oriented mainly in NE-SW and NW-SE directions.

The eastern and northern parts of area "C" is included in the hydrographic basin of the Picui river and, in a very general way, can be described as flowing from south to north, passing across the area "B", and going to west heading to the Piranhas river. In the western as well as the southwestern parts, the hydrographic system flows west and/or southwards, and it merges with the Picui river in a place to the west of the Acari city, which is located outside the survey area. The hydrographic system at the central and eastern parts of this area in poorly developed, probably reflecting the lithology comprised mainly of pegmatites and schists.

A closer look into the hydrographic system of area "C" reveals important information on its directions (Fig. I-2-1). It can be noticed that E-W and NE-SW directions are widely distributed throughout the area. The NE-SW direction is almost absent in areas "A" and "B", but is a conspicuous feature in area "C". In the central part of the survey area, N-S direction is also remarkable, and are extensions of those found in area "B", which seems to be related to the fold belt. All important hydrographic directions in this area seem to be associated with faults, fold belts, pegmatite veins or basic rock dykes.

2-3 CLIMATE and VEGETATION

The climate in the project area is semi-arid, according to the climate belt classification, and belongs to the BShs type of the Koppen's climate classification.

The annual climate in this area can be roughly divided into two major seasons. The rainy season lasts from February to May, and the rest of the year is considered the dry season. It rains intermittently during the rainy season, and only scarcely in the dry season.

The temperature is almost constant throughout the year, with maximum values of 40°C and mini-

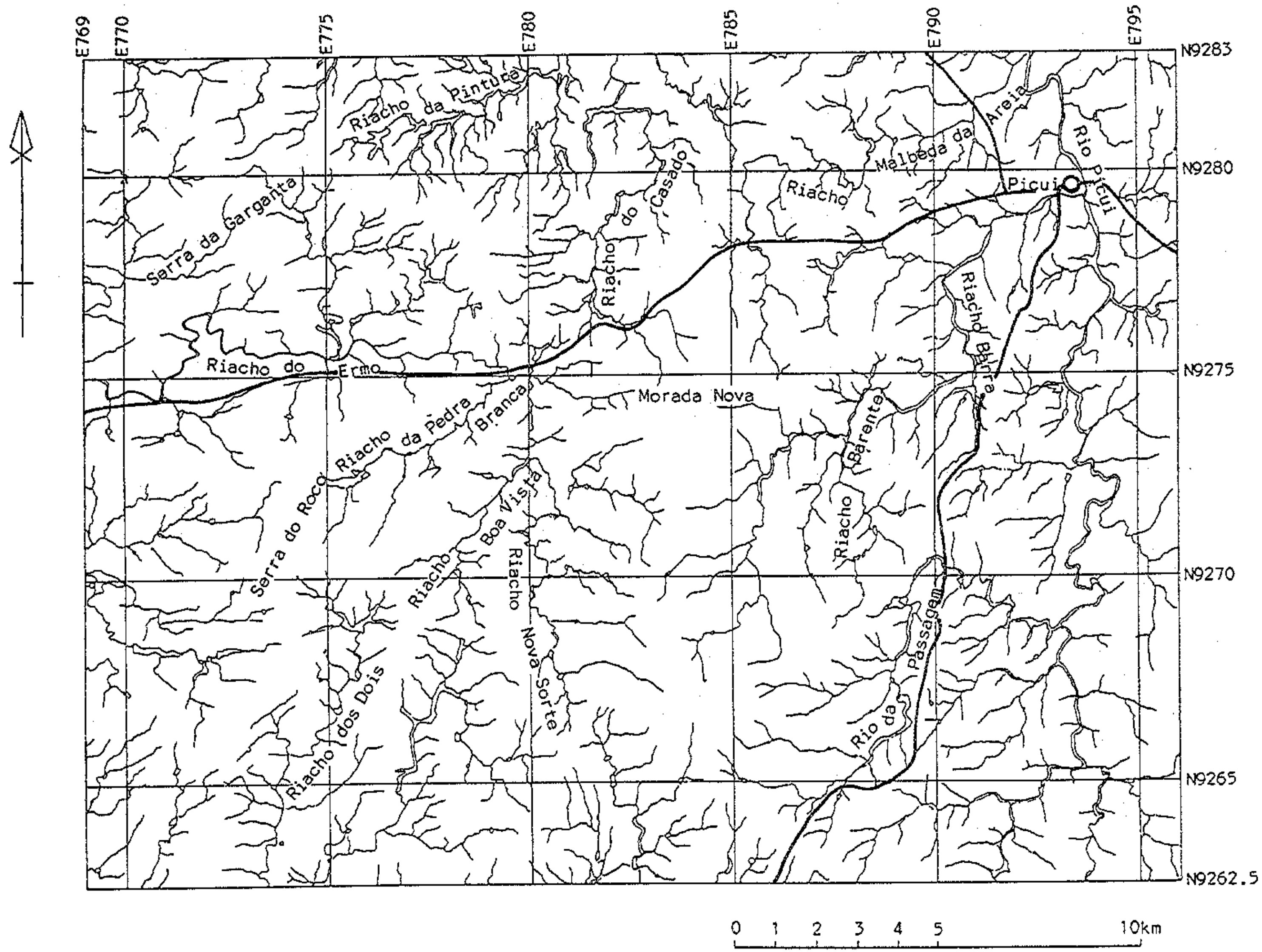


Figure I-2-1 Drainage system in the survey area C mums ranging from 20°C to 30°C.

The majority of streams in the project area have water only during the rainy season. Accordingly, during the field works of this Phase III almost all creeks were dried, despite some rainy days in the middle of July and in the end of November.

Concerning to the vegetation, in the same way as areas "A" and "B", the area "C" is included in the so called forest district of the northeast region of Brazil. Brushwood with bushes two to three meters tall are typical in the area. Some trees up to 10 meters tall grow sparsely along the creeks. The dominant vegetation type is the thorny Caatinga, which includes cactus and bushes such as Jurema, Caatingueira, Malva, Pereiro, Marmeleiro, Moleque-duro e Xique-xique.

Chapter 3 - Geological Features of the Survey Area

The project area is included in the Borborema Province (Almeida et al., 1981), one of the largest structural units of the northeastern region of Brazil.

The Borborema Province is composed of two basic petro-structural units, a Precambrian gneiss-migmatite-granite shield and a fold belt composed mainly of meta-volcanic and meta-sedimentary rocks (Brito Neves, 1975, 1983; Almeida et al., 1976). The survey area is settled within the meta-volcanic and meta-sedimentary fold belt. Brito Neves (1983) subdivided the Borborema Province into five "Geologic Domains", based on metamorphic and folding grades. According to this subdivision, the present survey area is included within the Serido Region of the Central Domain (Fig. I-3-1).

According to Jardim de Sa & Salim (1980), the Precambrian stratigraphy within the Serido Region is compose, from the bottom, by the Caico Complex followed by the Serido Group. This group comprises the Jucurutu, Equador and Serido Formations. Phanerozoic units consists of the Cretaceous Jandaira and Acu Formations, Tertiary Serra dos Martins, and Quaternary sediments.

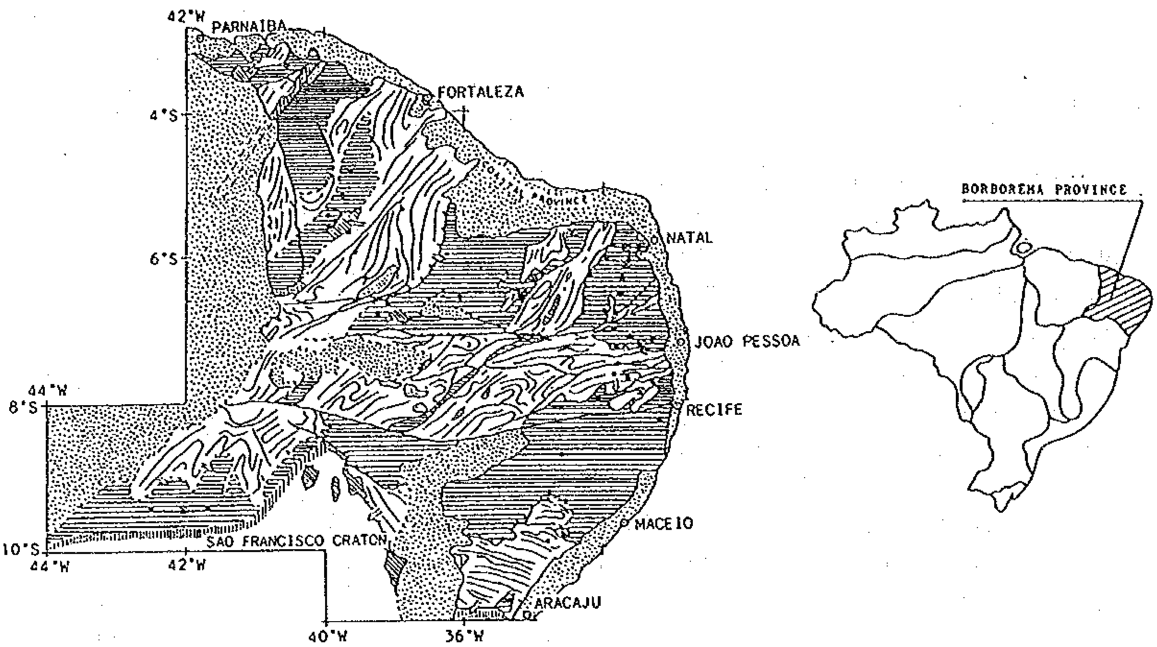
Rocks belonging to all units above quoted are found within the survey area, except outcrops of the Jandaira Formation. The contacts between the Caico Complex with the overlaying Serido Group, the Serido Group with the Acu Formation, and the Acu Formation with the rocks of the Serra dos Martins Formation are all normal. In some places, the contact among these last three units can be directly observed (Fig. I-3-2).

The geologic structure of the Borborema Province has been affected by the Jequie (2,900 ~ 2600 Ma), Transamazonico (2100 ~ 2600 Ma) and Braziliano (450 ~ 700 Ma) orogenic cycles. Especially in the Serido Region, two stages of tectonic movements during the Transamazonico cycle and three tectonic movements during the Braziliano orogenic cycle have been recognized (Fig. I-3-2). Structures formed during the Transamazonico cycle are characterized by low-angle shear zones, while those related to the Brasiliano orogenic cycle are characterized by high-angle shear zones (Jardim de Sa et al., 1988). In both orogenic cycles, there are evidences that the metamorphic grade reached the amphibolite facies. Along these shear zones, there occurred many intrusions of different types of rocks.

Concerning to major structures, it is worth noting the tectonic lines that make up the boundaries of the Structural Domains (Fig. I-3-1). Within the present survey area, one example is the tectonic line (Picui line) that divides the Central Domain and the Centro-Oriental Domain (Fig. I-3-2).

As it can be realized from figures I-3-1 and I-3-2, the litho-structural features of the survey area can be described as follow. Rocks belonging to the Archaean Caico Complex are distributed along the eastern and western borders, while those belonging to the Serido Group are distributed in between them, with directions predominantly NNE-SSW. In the northern half of the survey area, the Caico Complex and the Serido Group are intercalated, and both show directions predominantly NNE-SSW (Fig. I-3-2).

Among the units comprising the Serido Group, the Serido Formation is the most widely distributed in the survey area, followed by the Equador and Jucurutu Formations. Rocks belonging to the Equador Formation occur in the southwestern part of the area, and are also oriented in NNE-SSW direction. Outcropping of the Jucurutu Formation within the survey area are restricted to the south-



PHANEROZOIC SEDIMENTARY COVER

MOLASSES OF BRASILIANO CYCLE

SEDIMENTARY COVERS ASSOCIATED WITH THE FOLDED BELTS

PROTEROZOIC FOLD BELTS (BRASILIANO STRUCTURES)

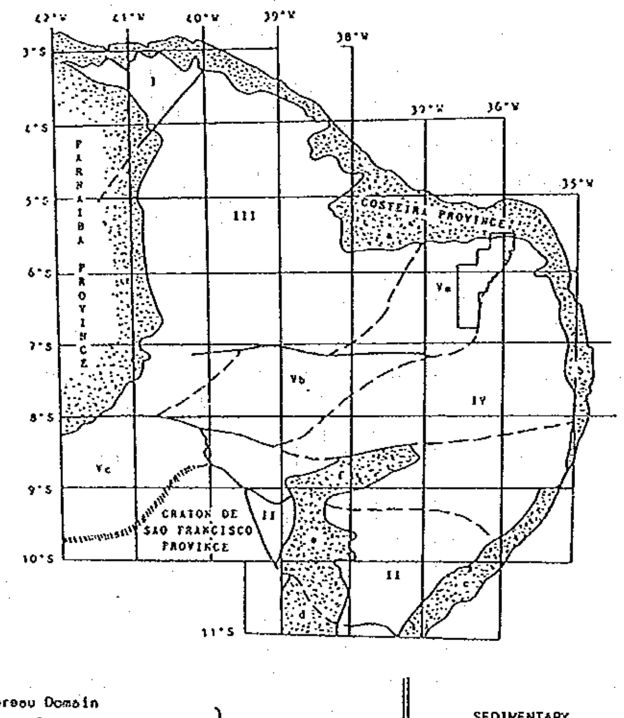
GNEISS MIGMATITIC MASSIFS

SAO FRANCISCO(CRATON)PROVINCE

• ISOCHRONS CONVENTIONAL Rb/Sr OR K/Ar AGES OF THE TRANS-AMAZONIAN CYCLE-EARLY PROTEROZOIC

ø CONVENTIONAL Rb/Sr AGES OF THE JEQUIE CICLE-ARCHAEAN (SOME FEW ISOCHRONS AND K/Ar AGES)

(a)Principal geologic elements, modified by Brito Neves in 1983



I - Rio Coreau Domain II - Sergipano Domain V - Central Domain Va - Serido Vb - Pianco-Alto Brigida Vc - Riacho Pontal-Rio Preto	CONVENTIONAL SYSTEMS (OROGENIC BELTS)		SEDIMENTARY BASINS PARNAIBA PROVINCE COSTEIRA PROVINCE a-Apodi b-Pernambuco-Paraiba c-Sergipe-Alagoas d-Tucano Sul e-Tucano Centro f- Jatoba
III - Jaguaribeano Domain IV - Centro-Oriental Domain	VESTIGIAL SYSTEMS and "MASSIFS"		

(b)Geologic domains after Brito Neves,1983

Figure I-3-1 Principal geologic elements (a) and geologic domains (b) in the Borborema Province

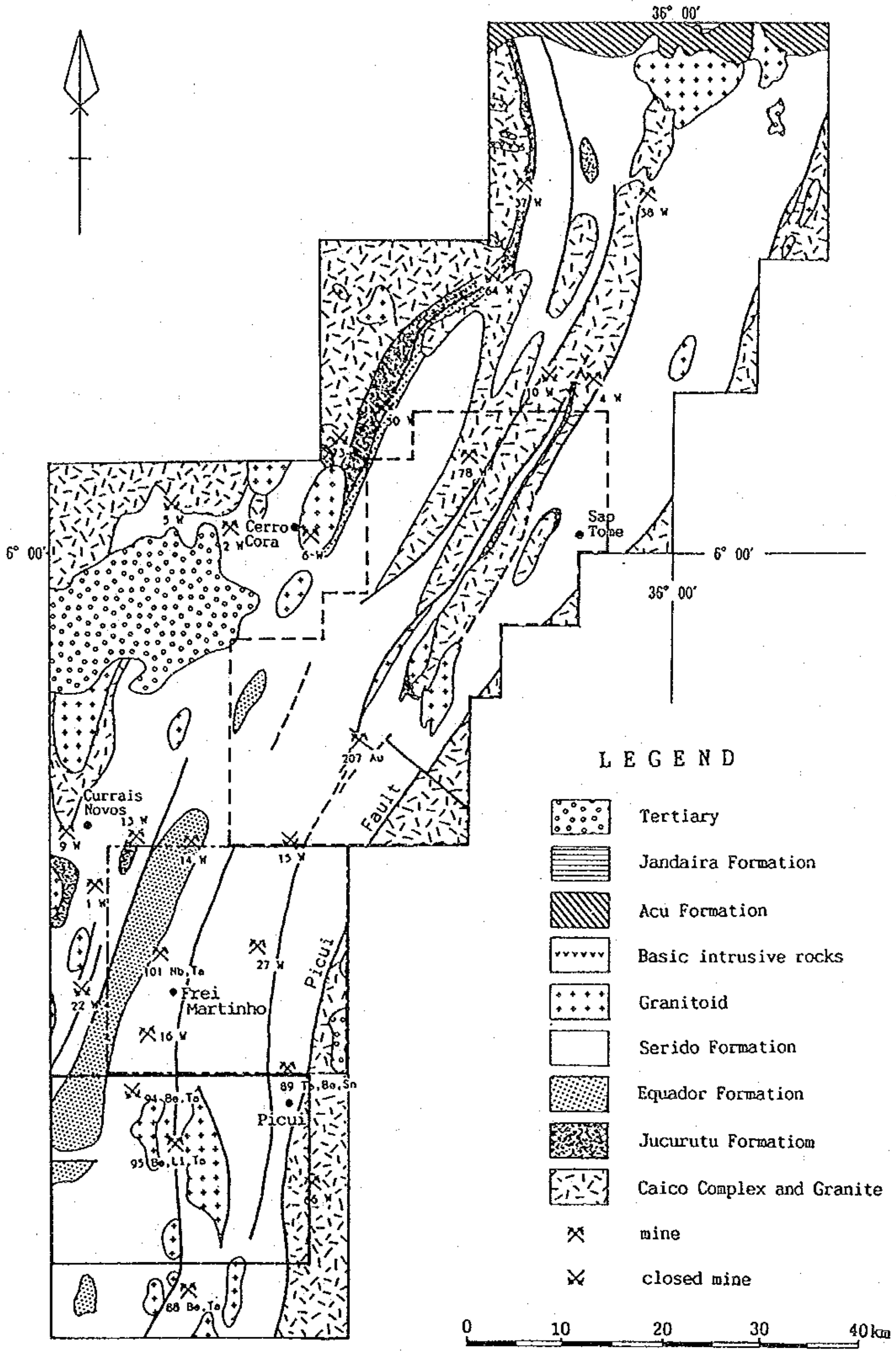


Figure I-3-2 General geology and known mineral deposits in the project area

western edge and to some small occurrences in the central part, spatially related with outcrops of the Caico Complex (Fig. I-3-2).

Petrographically, the Caico Complex is characterized by the tripartite gneiss-migmatite-granite, the Jucurutu Formation by gneisses with intercalation of limestone and carbonaceous siliceous rocks, the Equador Formation by (muscovite) quartzite, and the Serido Formation by (muscovite, cordierite, garnet) biotite-gneiss. Within the Serido Formation, similarly to the Jucurutu Formation, small occurrences of calc-silicate rocks have been observed.

Concerning to mineral deposits, skarn-type tungsten deposits, vein-type gold deposits, pegmatite and niobium-tantalum deposits are found within the limits of the survey area (Fig. I-3-2).

Finally, the distribution of rocks in the area prospected in this Phase III, as presented in figure I-3-2, makes up a distinguishing geological feature, with the Caico Complex on the borders and the Serido Group covering the remaining area. The general trend of the rocks in area "C" is close to N-S, and in area "B" is NNE-SSW, while in the areas prospected during the Phase I it is NE-SE to NNE-SSW. In the eastern border of the survey area, the Picui fault runs approximately N-S, marking the boundary between the Central and the Centro-Oriental Domains.

Chapter 4 - Overall Discussion on the Results

4-1 GEOCHEMICAL and GEOPHYSICAL SURVEYS in AREA "A"

4-1-1 Geochemical Survey

The locations where trenches were dug in area "A-I" were set based on results of soil geochemical survey. However, the analytical results of trench samples revealed that there exist no clear relationship between Au contents of soils and those of rocks underlying these soils. In all samples collected from trenches A-I-1, A-I-2 and A-I-3, the obtained Au contents were quite low.

Again, in the mineralized zone of the Sao Francisco mine, where a trench was dug for test purposes, soil results did not indicate any anomalous contents of Au, although samples collected from the trench indicated clearly the mineralization.

One explanation that can be given for the absence of correlation between Au contents in soil and in the underlying rocks is the poor development of soils in this area. Soils are typically 20 centimeters deep and are frequently quite sandy. Observing a vertical section of a typical soil, a pebbly layer containing different types of rocks can be observed right above the weathered basement. Taking into account the surrounding topography and the presence of pegmatitic pebbles in the pebbly layer, an extensive transportation of these pebbles seems barely possible. It can be concluded that the poor correlation between Au contents in soil and in the underlying rocks results from the combined effects of the poor development of soils and its transportation during the rainy season.

In area "A-II" on the southern edge of the mineralization being exploited in the Sao Francisco mine, no anomaly was found in soils right above the mineralized rocks, but weak anomalies were found in both side slopes, given that the mineralized zone makes up a ridge. In this case, it seems clear that the results can be explained by migration of soils. However, the Au contents in these anomalies are quite low (0.6 to 2.6 ppb), specially if compared to anomalous values found in area "A-I" (maximum of 208 ppb). Further works seems therefore necessary to understand how these high Au anomalous zones formed in area "A-I".

At the Sao Francisco mine, As anomalies match very well with Au anomalies. The same overlap was also clearly defined in an area 500 meters west of the mine. Nevertheless, the geophysical survey carried out on this area did not reveal any underground anomaly that could be associated to a mineralization, so that it was decided to not execute trench survey on this area in this Phase III. However, it seems worth making use of another prospecting technique to look further into this geochemical anomaly.

The results of the biogeochemical survey carried out in area "A-II" showed that the zone over which a overlap of Au and As anomalies was found by utilizing the Jurema Preta vegetation is a extension of the mineralized zone of the Sao Francisco mine.

4-1-2 Geophysical Survey

Geophysical anomalies were observed in three zones, in the western, central and eastern parts of the survey area. Trenches were dug on the locations indicated by geophysical results as most promising within each anomalous zone. Two trenches were dug in the western, one in the central, and one in the eastern anomalous zone. Anomalous Au contents that can be associated to mineralization were observed only in trench samples from the central zone (A-II-2), which is clearly displaced from the extension of the mineralized zone of the Sao Francisco mine. Au anomalous values were also found in other trenches, but all them were relatively low and lacked lateral continuity, not allowing to discern whether that Au content is an original feature of the country rock or is a result of a later mineralizing process.

At surface levels, the continuity of geophysical anomalies in the central zone is not very conspicuous, but at depths around 150 meters, an (geophysical) anomalous zone trending NNE-SSW was observed quite clearly. This direction is in accordance with the mineralized zone of the Sao Francisco mine.

However, on the western and eastern anomalous zones, geophysical anomalies lacked continuity, appearing in the form of spots from the surface to the maximum survey depth. Au anomalous contents were observed in trench samples collected from that one dug on the eastern zone, but due to the low absolute contents, there was no mean to determine whether these results have a real meaning concerning to mineralization.

4-2 DETAILED GEOCHEMICAL SURVEY in AREA "B"

Soil geochemical survey was carried out in area "B-I", southwestern part of area "B". Its results indicate that Au anomaly zones concentrate in the northeastern part of this area. In spite of the presence of these Au anomaly zones, the occurrence of Au-bearing quartz veins were not confirmed in this area. However, taking into consideration that this area is located close to the ridge of the Umburana Range, where NNE-SSW oriented sulfide-bearing quartz veins were found near the western foothills, and that the main geologic structures in this area is also NNE-SSW, there can be considered the possibility of those sulfide-bearing quartz veins extending up to the Au anomaly zones in area "B-I". Au-bearing quartz veins were found during last year' survey around the eastern foothills of the Umburana Range, but no Au anomaly in soil was found nearby these veins. Moreover, As anomaly was also not found nearby these quartz veins, in spite of the known fact that As accompanied Au mineralization, so that the relationship between Au mineralization and As anomalies could not be established.

From the above quoted findings, it can be said that, at least for this area, mineralization related to small scale quartz veins is not necessarily revealed by soil geochemical survey.

4-3 GEOLOGICAL and STRUCTURAL FEATURES of AREA "C"

The stratigraphy of area "C" is composed, from the bottom upwards, by the Archaean Caico Complex, the Proterozoic Serido Group represented by the Equador Formation, the Serido Formation, the Tertiary Serra dos Martins Formation and by Quaternary sediments. Moreover, all pre-Tertiary units are cut by pegmatite veins, and also by basic dykes of Tertiary age. A large pegmatite body crops out in eastern edge of the fold belt in the central part of this area.

With the exception of the Tertiary basic dykes, the main directions of all units, faults and foldings are NNE-SSW and N-S, similarly to the areas prospected in Phase I and II. The Tertiary basic dykes, as in the areas of Phase I and II, show predominantly WNW-ESE to ENE-WSW directions. A peculiar characteristic of this area arises from the fact that, unlike those in areas previously prospected during this project (N-S to NNE-SSW), pegmatites in the southwestern part of this area are oriented in NE-SW direction.

4-4 MINERALIZATION CONTROL in AREA "C"

Columbite-tantalite mineralization associated to pegmatites, and skarn type tungsten mineralization are widespread throughout area "C". Concerning to gold, although gold grains have been found in stream sediments, a clearly defined mineralization was not observed in nearby outcropping rocks.

The skarn-type tungsten deposits, in the same way as those in Phase I and II areas, are spatially closely associated to the Equador Formation, and are all small in size.

Deposits of columbite-tantalite are generally associated to pegmatites, but the results of Nb-Ta of stream sediments indicated that the anomalies of these two elements are spatially related to NNE-SSW oriented pegmatites, while no Nb-Ta anomaly was detected in areas where NE-SW oriented pegmatites are distributed. It seems too early to define any conclusion on this structural relationship, but should it be true it will be of great significance concerning to the structural evolution of this area.

4-5 MINERALIZATION and GEOCHEMICAL ANOMALIES in AREA "C"

As quoted above, this area is characterized by mineralization associated to pegmatites and skarns. Pegmatites are widely distributed throughout the survey area. Accordingly, geochemical anomalies of mineralization related to them are widespread over the entire area. Concerning to tungsten mineralization, geochemical anomalies were not clearly defined.

Gold anomalies are concentrated, in terms of topography and drainage system, in the northwestern part of the survey area, in the area enclosed by the Ermo and Casado rivers. Although pegmatites area found in the upstream of this drainage system, the results so far obtained do not indicate any gold occurrence in these rocks. It seems, therefore, that further prospecting is necessary to understand the origin of this gold. Moreover, although represented by one point only, the highest Au content (63 ppb) was found in the central part of the survey area. Further prospecting seems also necessary to make clear the origin of this anomaly.

4-6 POTENTIAL for DEPOSITS

In area "A-II", although geophysical results do indicate anomalous zones, there remains some places where trench survey did not allow grasping on the mineralization. All these geophysical anomalies do extend deep into earth, but the actual existence of mineralization was only prospected by trench survey at subsurface levels. Taking into account that the Sao Francisco mine has been prospected up to some tens of meters only, it seems necessary to prospect these geophysical anomalies to a depth of at least 100 meters.

Moreover, since a complete prospecting campaign involving geophysical and other methods has not yet been carried out in the northern part of the Sao Francisco deposit, information on the continuity of the mineralized zone remains with several unknown parameters, do not allowing evaluate its real potential. In order to make these results useful for other similar deposits, it seems necessary to evaluate its true potential.

In area "B-I", in spite of the occurrence of sulfide-bearing auriferous quartz veins, soil geochemical survey did not indicate any anomaly in the surroundings. The potential of these veins, however, has not been detailed prospected. As previously quoted, these quartz veins do occur oriented in NNE-SSW direction in the eastern side of the Umburana Range. Similarly, in the western side of that Range, sulfide-bearing auriferous quartz veins was found, but no anomaly related to them has been defined. It seems then worth prospecting the whole Range for gold in detail.

In area "C", considering that the obtained geochemical anomalies are small and weak, at this time its potential can not be considered high.

Chapter 5 - Conclusions and Recomendations

5-1 CONCLUSIONS

(1) AREA "A"

Trench surveys in area "A-I" did not confirm the anomalies defined by soil geochemical surveys. These results indicate that the possibility for existence of gold mineralization in this area is very low; no further prospecting works seems therefore necessary.

In area "A-II", a gold mineralization has been defined in an area 200 meters east of the Sao Francisco mine, where an overlap of geochemical and geophysical anomalies has been observed. This result indicates that gold mineralizations does also occur in areas outside the mineralized zone of the Sao Francisco mine. Moreover, geophysical results suggest that both mineralized zones are continuous up to the survey depth. However, biogeochemical as well as geophysical anomalies over this anomalous zone located 200 meters east of the Sao Francisco mine are mainly spot-shaped, suggesting a rather small scale mineralization. From these results, it can be concluded that, except for the Sao Francisco deposit, there is no other promising area for gold within area "A-II", so that no further prospecting works are needed.

Trench survey results indicated that the geophysical method utilized to prospect the present survey area is a valuable tool to obtain underground information on the distribution of quartz veins. On the other hand, soil geochemical survey did not yield satisfactory results for gold, probably due to the poor development of soils, typical of this area.

(2) AREA "B"

In area "B-I", soil geochemical survey were carried out by using Au, As and Sb as tracer elements. Sb results were all below detection limit, and even though Au and As did define some anomalous zones, no correlation between them has been obtained. It was concluded, therefore, that Au was the only reliable element to prospect for gold in this area.

Au anomalous points are rather scattered all over the area. In the northeastern part of the area, some anomalous points are somewhat concentrated along the western foothills of the Umburana Range, where sulfide-bearing quartz veins have also been observed. These points are located roughly on the extension of these veins in the direction of their strikes. In addition, sulfide-bearing auriferous quartz veins have been observed in the eastern foothills of the same mountain range, and these veins are only 300 meters far from those found in the western foothills. Tanking into consideration the overall spatial relationships, it seems possible that all these veins belong to a same stage, and that they are continuous at least up to the soil anomalies which lay on their extension.

However, considering that the size of these sulfide-bearing quartz veins are rather small, and the Au soil anomalies are quite low, the existence of larger scale mineralized veins seems to be very improbable. It is concluded, therefore, that there are only few possibilities to find an economically exploitable gold deposit in this neighborhood.

(3) AREA "C"

In area "C", Precambrian rocks are widely distributed, and are overlaid by small Tertiary and Quaternary coverings. Precambrian rocks are comprised by the Archaean Caico Complex and the Proterozoic Serido Group. The Serido Group is subdivided, from the bottom upwards, into Equador and Serido Formations. The Jucurutu Formation does not crop out in the present area. The Equador and Serido Formations are represented by quartzites and biotite schists, respectively. The distribution of these rocks within the survey area can be roughly described as follow. Rocks belonging to the Caico Complex are mainly exposed nearby the eastern margin, the quartzites belonging to the Equador Formation crop out mostly in the western part, while those rocks which make up the Serido Formation dominate the central part of the survey area. Large scale pegmatitic bodies are found within the Serido Formation. The contact between the Caico Complex and the Serido Formation are made up by the Picui fault. A N-S oriented fold zone has been observed crossing through the central part of the outcropping area of the Serido Formation, which is part of the fold zones found in areas "A" and "B". Concerning to rupturing structures, NE-SW ~ NNE-SSW and WNW-ESE ~ ENE-WSW are the directions of main faults observed in this area.

Concerning to mineralizations, apart from some Nb-Ta ones associated to pegmatites and small tungsten occurrences, no other clear mineralization could be defined.

Although 13 tracer elements were analyzed for the stream sediment geochemical survey, it was concluded that Au is the only reliable element for gold prospecting. Only few Au anomalies were obtained, and they did not concentrate within any topographically and/or hydrographically well defined area. Some anomalous Au points are somewhat clustered in the area enclosed by the Ermo and Casado streams, in the northwestern part of area "C". The highest Au content of 63 ppb was obtained from a sample collected in the central part of the area, but no other anomalous point was observed in the vicinity.

As above stated, Au contents in stream sediments in area "C" are quite low, and those samples with somewhat higher Au contents are rather scattered all over the area. Moreover, no vestige of mineralization has been found in basement rocks during the geological survey. It is concluded, therefore, that the potential for gold of this are is quite low.

5-2 RECOMMENDED FURTHER WORKS

As emphasized above, the possibility of finding a large gold deposit within the project areas is rather small. If, however, further works are to be carried out in this area, the following surveys are suggested.

(1) AREA "A"

Valuable information about the southern extension of the Sao Francisco mine deposit was obtained by geophysical prospecting, but none of such data are available on the northern extension. Since this kind of information will enhance not only the knowledge about this specific deposit, but will be also useful in prospecting similar mineralizations, geophysical as well as trench survey are recommended to be carried out in the northern extension of the Sao Francisco mine deposit.

(2) AREA "B"

Detailed geological and geophysical (IP method) surveys along the Umburana Range seems to be worthy of consideration, in order to clarify the actual state of that mineralization.

PART II

RESULTS

and

INTERPRETATION

Chapter 1 - Geophysical Survey in Area A

1-1 PURPOSES and SURVEY METHODS

1-1-1 Purposes

This survey was aimed at selecting, by realizing underground geophysical anomalies, the locations of trenches to be dug within anomalous areas defined by the geochemical survey. Moreover, geophysical prospecting of area "A-II" was expected to provide valuable information on the applicability of the IP method in searching for such a kind if vein-type auriferous mineralization.

1-1-2 Survey Method

As above mentioned, IP was the applied geophysical method. In order to optimize the definition of estimated structural features of quartz veins, survey lines were set parallel to those utilized for the geochemical survey carried out in Phase II. Measurement stations were set by making use of a 1:10,000 topographic map (enlarged from the original 1:50,000), and by additional surveying. IP measurements were carried out on 5 lines with an inter-line spacing of 200 meters, each line with a length of 2 kilometers, totaling 10 kilometers (Fig. II-1-1).

The utilized measurement method was the Dipole-Dipole, with a station spacing of 50 meters, and n-factor ranging between 1 to 3.

Aluminum foil buried in a hole of 50x100x50 centimeters was used as current electrode, which yielded a contact resistance varying between 400 and 600 ohms. Ceramic pots filled with copper-sulfate solution were used as potential electrodes. The equipments utilized in this survey are listed below:

Generator:	GX-140/GPU-2000
Transmitter:	CH-T7802 (Bishimetal/Chiba Electric Co.)
Receiver:	CH-89A (Bishimetal/Chiba Electric Co.)
Switching Unit:	CH-90A (BIshimetal/Chiba Electric Co.)

1-1-3 Processing and Interpretation

Data processing and interpretation has been carried out during the field campaign as well as after coming back to Japan. Based on the processing systematic showed below, AR (Apparent Resistivity) and PFE (Percent Frequency Effect) sections as well as plan maps were produced during the field works, in order to set the locations of trenches. The stage in Japan focussed on the overall interpretation, taking also into consideration the obtained results by trench prospecting.

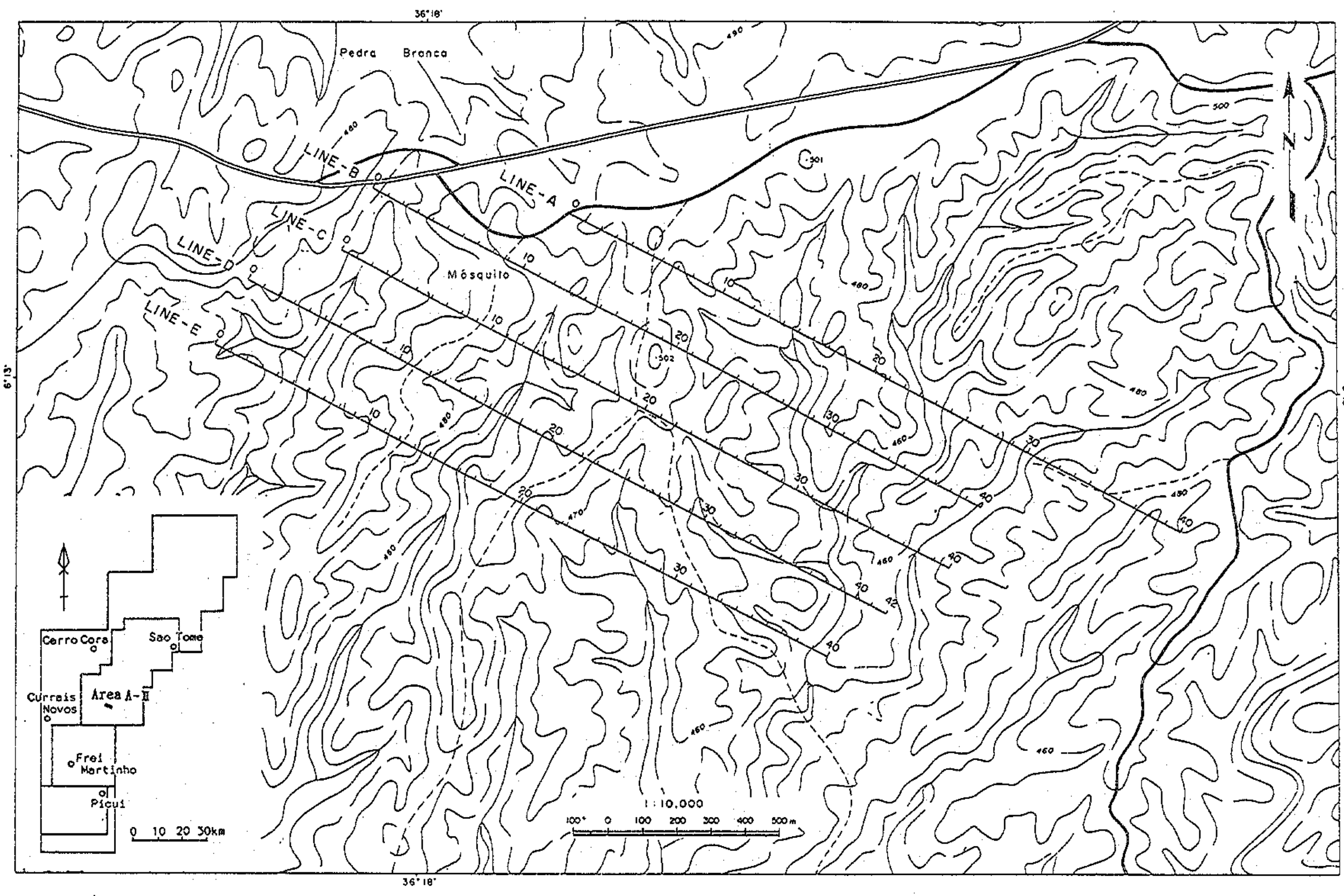


Figure II-1-1 IP survey area

PROCESSING and INTERPRETATION SYSTEMATIC

Data Acquisition -- Data Transfer
Calculation of AR and PFE
|
Production of AR • PFE Plan Maps and Sections
|
Definition of Anomalous Zones
| — Geological and Geochemical Information
Production of Interpretation Plan Maps and Section
|
Definition of Promising Areas
|
Setting of Trench Locations
| — Geological and Geochemical Information
Overall Interpretation

Calculation of AR and PFE

The survey was conducted by supplying electric current (Iac) at a frequency of 3.0 Hz into the ground through a pair of current electrodes (C_1, C_2) and measuring the correspondent potential difference (Vac) with a pair of potential electrodes.

The apparent resistivities (AR) of the ground was then calculated by substituting the measured potential differences in the following equation:

$$AR = K \cdot Vac/Iac \ (\Omega.m)$$

where K is a geometric factor that depends on the utilized electrode configuration, and calculated according to the following equation:

$$K = 2\pi/(1/C_1P_1 - 1/C_2P_1 - 1/C_1P_2 - 1/C_2P_2)$$

After reading the potential difference (Vac) at 3.0 Hz, the frequency was changed to 0.3 Hz while the current was kept constant. The frequency effect (PFE), which is a function of the potential variation between both frequencies, is then calculated according to the following equation:

$$PFE = \{(AR_{dc} - AR_{ac})/AR_{ac}\} \cdot 100 \ (\%)$$

The obtained values of AR and PFE were then plotted at the intersections of lines extending downward at 45° from the current and potential electrodes' midpoints. Since the values plotted on these intersections do not represent the actual physical properties of those points, the resultant sections can be termed as pseudo-sections of the subsurface distribution of the IP effect.

1-2 RESULTS

The obtained values of PFE ranged between 0.0 % and 3.6 %, while those of AR varied from 2 Ω.m to 1770 Ω.m. For convenience, these values were subdivided into the following categories:

(1) Apparent Resistivity (AR) Categories

≤ 99 Ω.m	Low (LAR)
100 ~ 299 Ω.m	Middle (MAR)
≥ 300 Ω.m	High (HAR)

(29 Percent Frequency Effect (PFE) Categories

≤ 1.9 %	Low (LPFE)
2.0 ~ 2.9 %	Middle (MPFE)
≥ 3.0 %	High (HPFE)

1-2-1 AR and PFE Sections

AR sections were drawn with contour values of 3, 5, 10, 50, 100, ..., 1000 Ω.m, while PFE sections were produced with contour interval of 1.0 %. Moreover, in order to enhance the shape of anomalies, a contour interval of 0.5 % was utilized in some portions of the PFE sections.

(1) Apparent Resistivity (AR) Sections (Fig. II-1-2)

(a) Section "A" (Line "A")

AR values ranged from 2 Ω.m to 822 Ω.m, and some LAR values are conspicuously distributed between stations 20 and 29. These LAR values indicate that in the intervals of stations 19 ~ 20, 24 ~ 25, and 28 ~ 29, a LAR layer is present at a shallow level. HAR values higher than 500 Ω.m are mainly located at deep levels, and occur rather as spots.

(b) Section "B" (Line "B")

AR values ranged from 6 Ω.m to 1026 Ω.m. These AR values vary largely in the portion west of station 10, but the eastern portion is mostly dominated by MAR and HAR values, where salient variations in AR values have not been recognized.

LAR values lower than 50 Ω.m are observed in the intervals of stations 3 ~ 5 and 8 ~ 10. HAR values make up east-dipping zones in the interval between stations 23 and 25, and in the portion to the west of station 17, while they make up west-dipping zones in the interval between stations 21 and 23 as well as in the portion east of station 31. These features are quite similar to those observed in section "A".

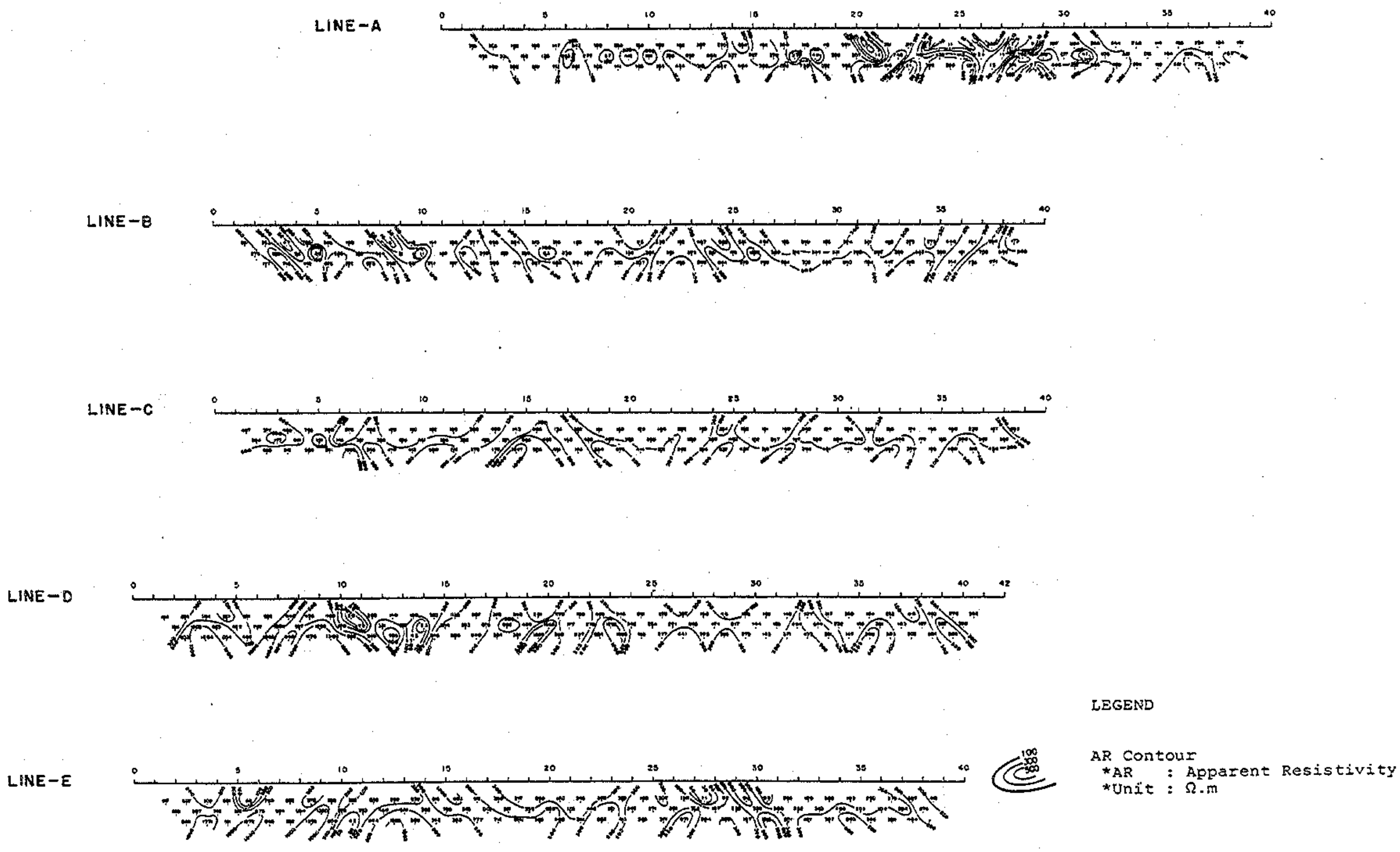


Figure II-1-2 Apparent Resistivity section

(c) Section "C (Line "C")

AR values ranged from 120 Ω.m to 1847 Ω.m, with no LAR values.

MAR values are observed intermittently in the portion east of station 6, except in the intervals of stations 24 ~ 25, 28 ~ 31 and 38 ~ 40, and are located mainly in shallow and intermediate (n = 1 ~ 2) levels. HAR values around 100 Ω.m are observed in the intervals of stations 5 ~ 7 and 14 ~ 15. Moreover, it is worth noting that AR values in this section show a trend of increasing southwards.

(d) Section "D" (Line "D")

AR values ranged from 20 Ω.m to 1856 Ω.m, and they show larger variation in the portion west of station 15. LAR values are observed in the intervals of stations 10 ~ 14, 28 ~ 29 and below station 37. In the interval between stations 10 and 14, LAR values do make up two zones, one dipping east and other dipping west, while in the interval between stations 28 and 29 and below station 37, LAR values are rather scattered at subsurface levels. HAR values higher than 500 Ω.m are observed in the interval between stations 38 and 39, and at deep levels in the intervals of stations 2 ~ 10, 15 ~ 18, 19 ~ 21, 32 ~ 34 and nearby station 36.

(e) Section "E" (Line "E")

AR values ranged from 11 Ω.m to 1771 Ω.m, and HAR values higher than 500 Ω.m are conspicuously distributed in the western portion of this section.

LAR values are observed in the intervals of stations 5 ~ 6, 10 ~ 11, 27 ~ 29 and 30 ~ 31. Apart from the interval between stations 10 and 11, all other three LAR zones are located in shallow levels (n = 1), but these zones are all small in size. HAR values higher than 500 Ω.m are observed in the portion west of station 10, and in the intervals of stations 11 ~ 24, 26 ~ 27, 29 ~ 31, 34 ~ 35 and nearby station 37. It should be added that, in the portion west of station 21, these HAR values are all but scattered, not making up large zones.

(2) Percent Frequency Effect (PFE) Sections (Fig. II-1-3, Fig. II-1-4)

(a) Section "A" (Line "A")

PFE values ranged from 0.2 % to 2.4 %, and a MPFE zone was observed between stations 5 and 9. This MPFE zone is made up by a west-dipping zone between stations 5 and 6, and by a east-dipping zone nearby station 9. In the portion west of this east-dipping MPFE zone, a gentle-dipping LPFE extending through some 100 meters is also observed. Moreover, in the portion east of station 10, some LPFE values occur scattered.

(b) Section "B" (Line "B")

PFE values ranged from 0.1 % to 2.4 %, and MPFE zones are observed between stations 8 and 10, and between stations 15 and 17, and in the portion west of station 17. In the portion east of station 17, PFE values are all lower than 1.0 %, so that no PFE anomaly could be defined.

The MPFE zone between stations 8 and 10 dips gently to east. The zone between stations 15 and 17 shows the shape of an inverted "V", indicating that this PFE anomaly could be caused by a

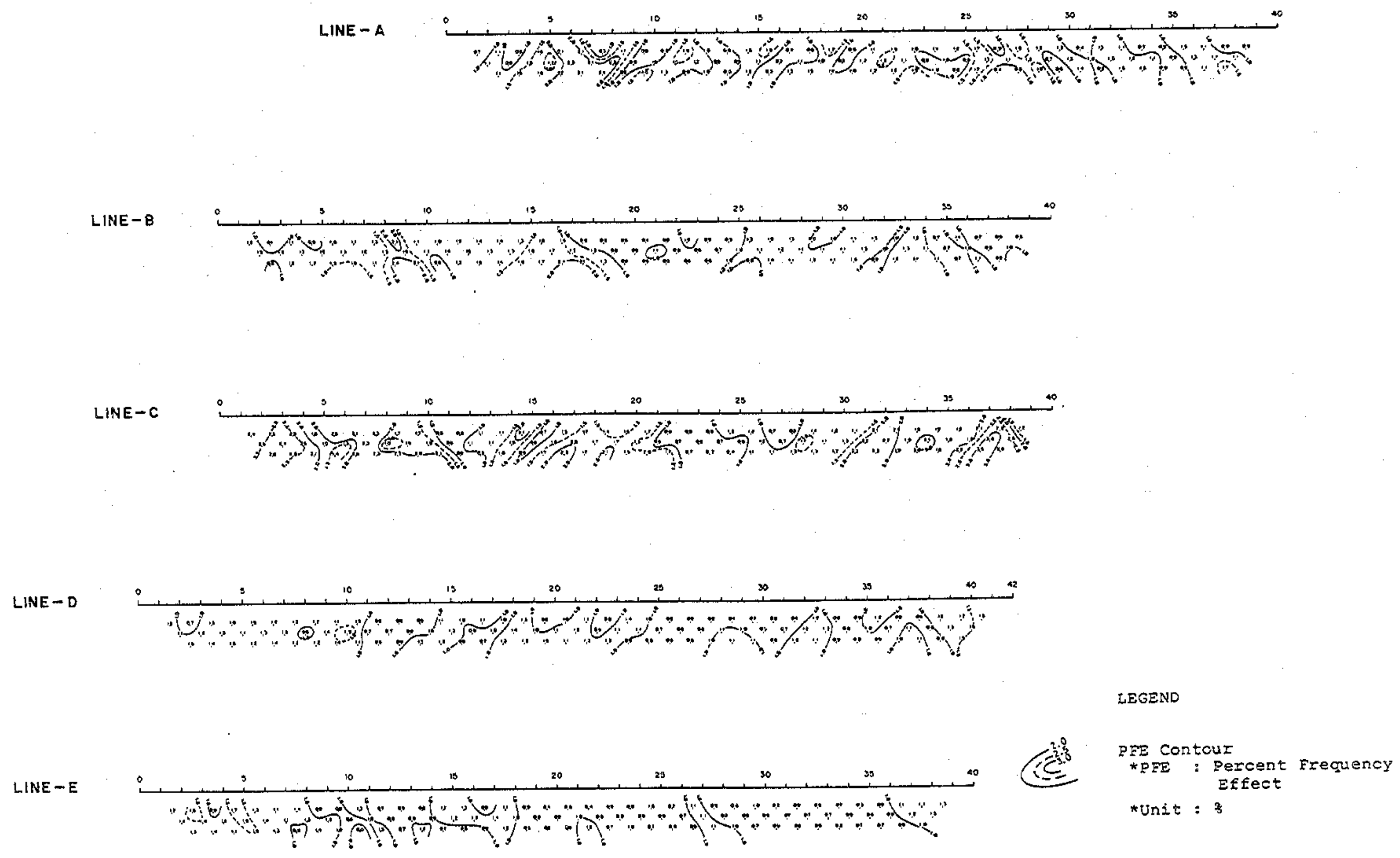


Figure II-1-3 Percent Frequency Effect section

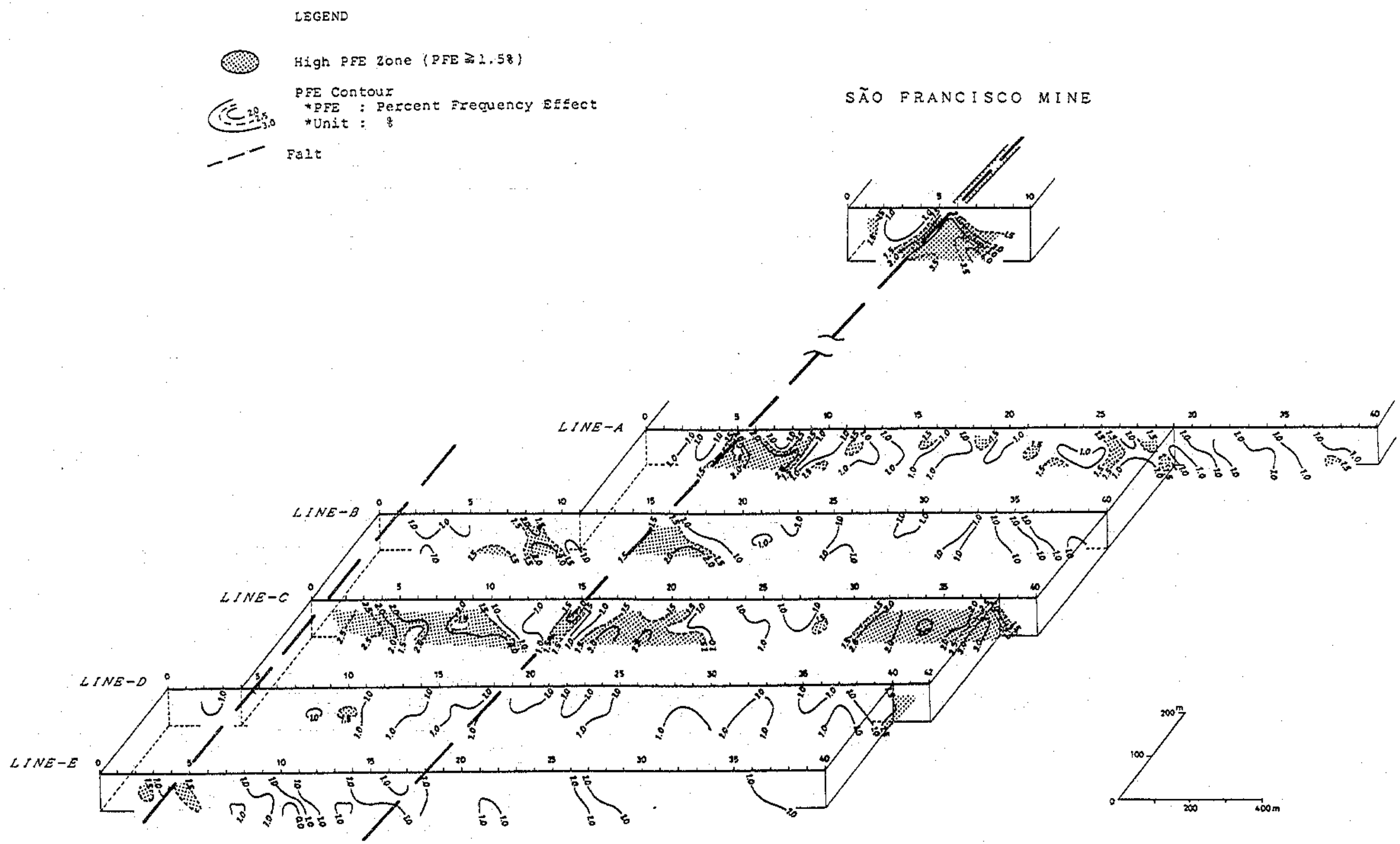


Figure II-1-4 Percent Frequency Effect diagram (Plate II-1-2) vertical body.

(c) Section "C" (Line "C")

PFE values ranged from 0.2 %to 3.6 %m and MPFE ~ HPFE zones are observed in the portions west of station 21 and east of station 30. These zones constitute the largest ones found so far in this area.

Concerning to the anomalous zone in the portion west of station 21, anomaly sources are inferred to exist in the portion west of station 4, in the interval between stations 5 and 9, and nearby stations 15, 18 and 21. Concerning to the anomalous zones east of station 30, that with its central portion located between stations 32 and 33 does dip westward, while that with its central portion located between stations 37 and 38 shows the shape of an inverted "V".

(d) Section "D" (Line "D")

PFE values ranged from 0.3 % to 1.9 , and LPFE values are observed in the portion east of station 40.

An important feature observed in this section arises from the fact that no conspicuous anomaly could be defined. PFE values decrease abruptly in the interval between sections "C" and "D". Nevertheless, in the portion west of station 11 as well as between stations 13 and 25, low anomalous zones (1.0 % to 1.5 %) are recognized, and they seem to be southern extensions of similar zones observed in section "C". These zones seems to correspond, in turn, to southern extensions of the mineralized zone of the Sao Francisco deposit.

(e) Section "E" (Line "E")

PFE values ranged from 0.0 % to 1.7 %, and values lower than 1.0 % are widely distributed in the portion east of station 11.

In the portion west of station 11, however, a LPFE zone is observed, and it seems to lay on the extension of the Sao Francisco mine deposit, which suggests that these mineralized zone extends further southwards. However, considering the low PFE values obtained, the amount of sulfides contained in this anomalous zone is inferred to be quite small.

1-2-2 AR and PFE Plan Maps

(1) Apparent Resistivity (AR) Plan Maps

(a) n = 1 (Fig. II-1-5)

This plan map shows the distribution of apparent resistivities at a depth of approximately 50 meters from the surface. MAR are the most widespread values within this map. LAR values occur rather scattered, without showing any particular orientation. On the other hand, HAR values are clustered in NNE = SSW to N-S oriented zones, which are intercalated within the MAR zone. LAR values, although scattered, are somewhat concentrated in the intervals between stations 20 and 30 of line "A", 3 and 5 of line "B", 7 and 9 of line "B", 10 and 11 of line "D", and 26 and 28 of line "E".

(b) n = 2 (Fig. II-1-6)

This plan map shows the distribution of apparent resistivities at a depth of approximately 75 meters from the surface. Compared with the plan map n = 1, MAR values in this map occur less conspicuously, while HAR values are more widespread. NNE-SSW oriented HAR zones stand out in the eastern, central and western portions of this map.

LAR values are rather scattered, occurring mainly as spots. Four of these spots are observed between stations 17 and 32 of line "A", two between stations 4 and 11 of line "B", and two between stations 10 and 15 of line "D".

(c) n = 3 (Fig. II-1-7)

This plan map show the distribution of apparent resistivities at a depth of approximately 100 meters from the surface. In this map, HAR values are more widespread compared with n = 1 and n = 2 maps.

MAR and HAR values make up zones which are mainly oriented in NNE-SSW direction, a result that matches quite well with the inferred geological structure. The changes from shallower levels are remarkable, specially in the western part of this map, where the LAR values observed in the n = 2 plan map practically disappeared. LAR values are observed only between stations 22 and 29 of line "A" and nearby station 10 of line "E".

(2) Percent Frequency Effect (PFE) Plan Maps

(a) n = 1 (Fig. II-1-8)

Low to middle PFE zones occur in the western, central and eastern portions of the area, but they are all located in the portion north of line "C". The western zone extends to west and north, the eastern to southeast, and the central one to north. Two MPFE zones are observed within these three zones, and they are thought to be the center of these anomalous zones. In the portion east of station 8 of line "A", a small LPFE zone is also observed.

(b) n = 2 (Fig. II-1-9)

PFE anomalies are observed in the western, central and eastern portions of this map. The location of these three anomalous zones are almost identical to those low to middle PFE zones of n = 1 plan map, but the western anomalous zone did subdivide into two zones. Moreover, the shape of the central anomalous zone to somewhat close to a " < " symbol, and did subdivided also into two zones. The eastern anomalous zone shows PFE values higher and becomes somewhat larger in area than that of plan map n = 1.

(c) n = 3 (Fig. II-1-10)

As in previous plan maps, PFE anomalies are observed in the western, central and eastern portions. The location of these three anomalies arca almost identical to those observed in maps n = 1 and n = 2, but their PFE values are all somewhat higher. The elongation directions of the western anomalous zones are almost identical to those observed in the map n = 1. The central anomalous zone

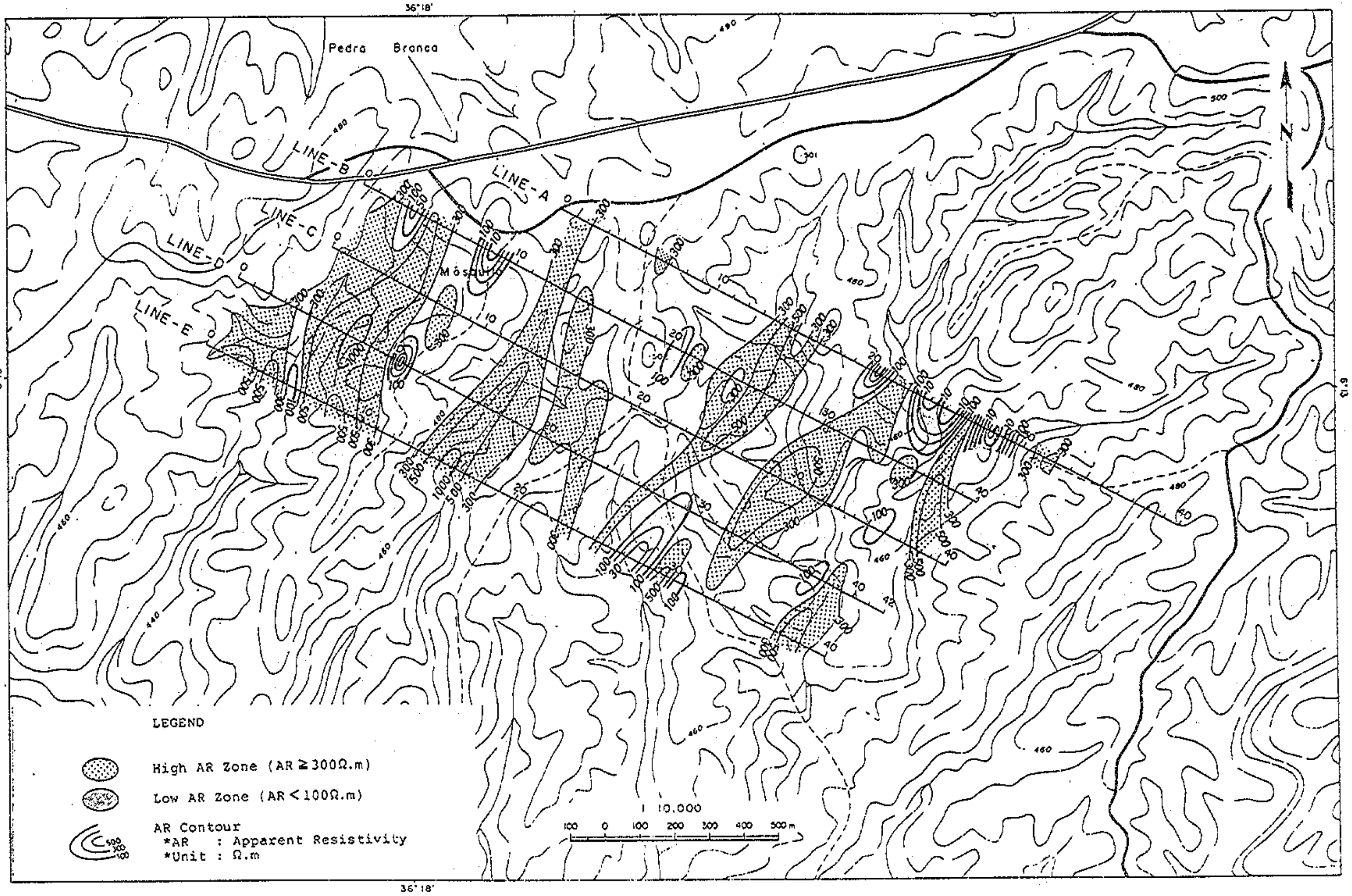


Figure II-1-5 Apparent Resistivity plane, n = 1

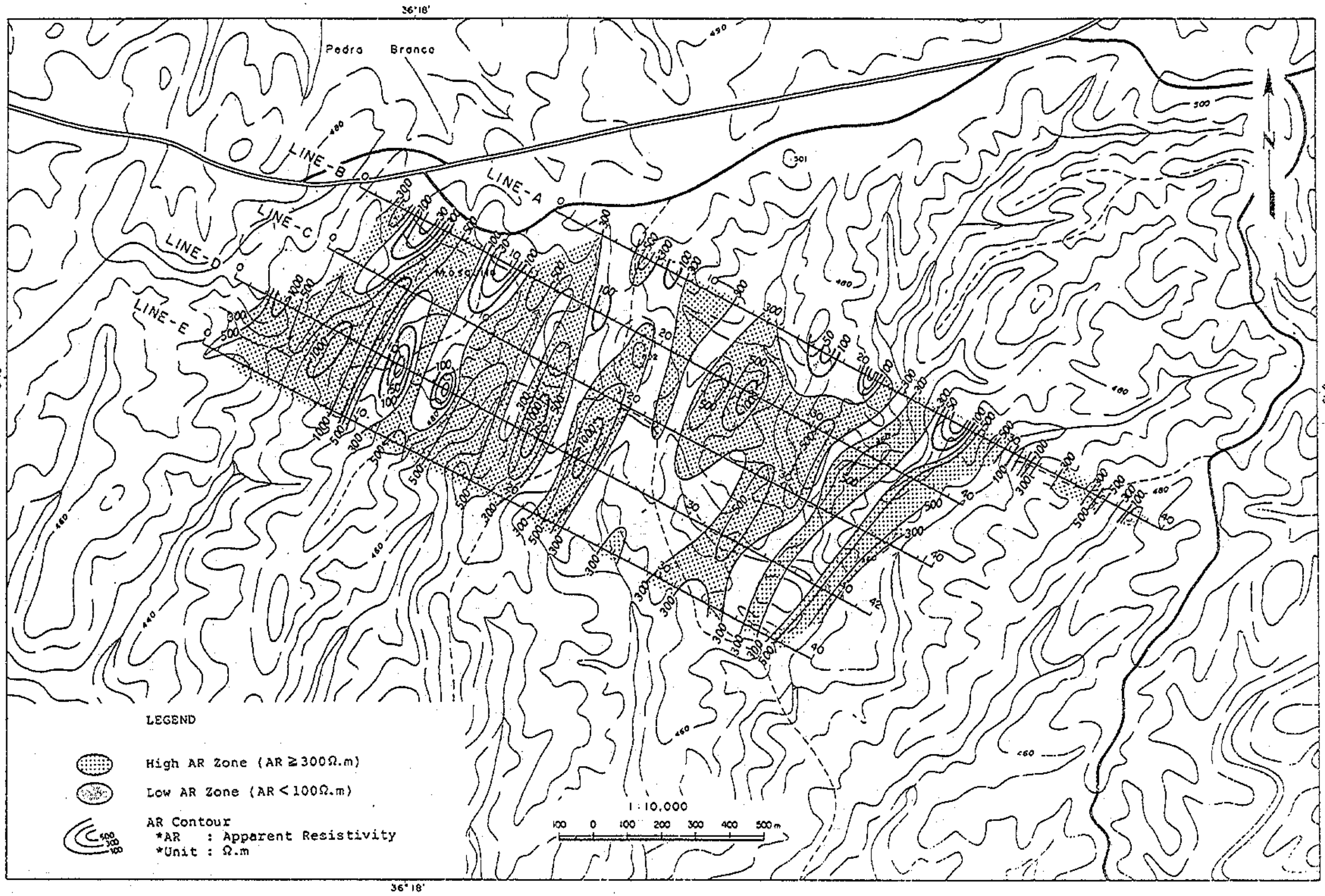


Figure II-1-6 Apparent Resistivity plane, n=2

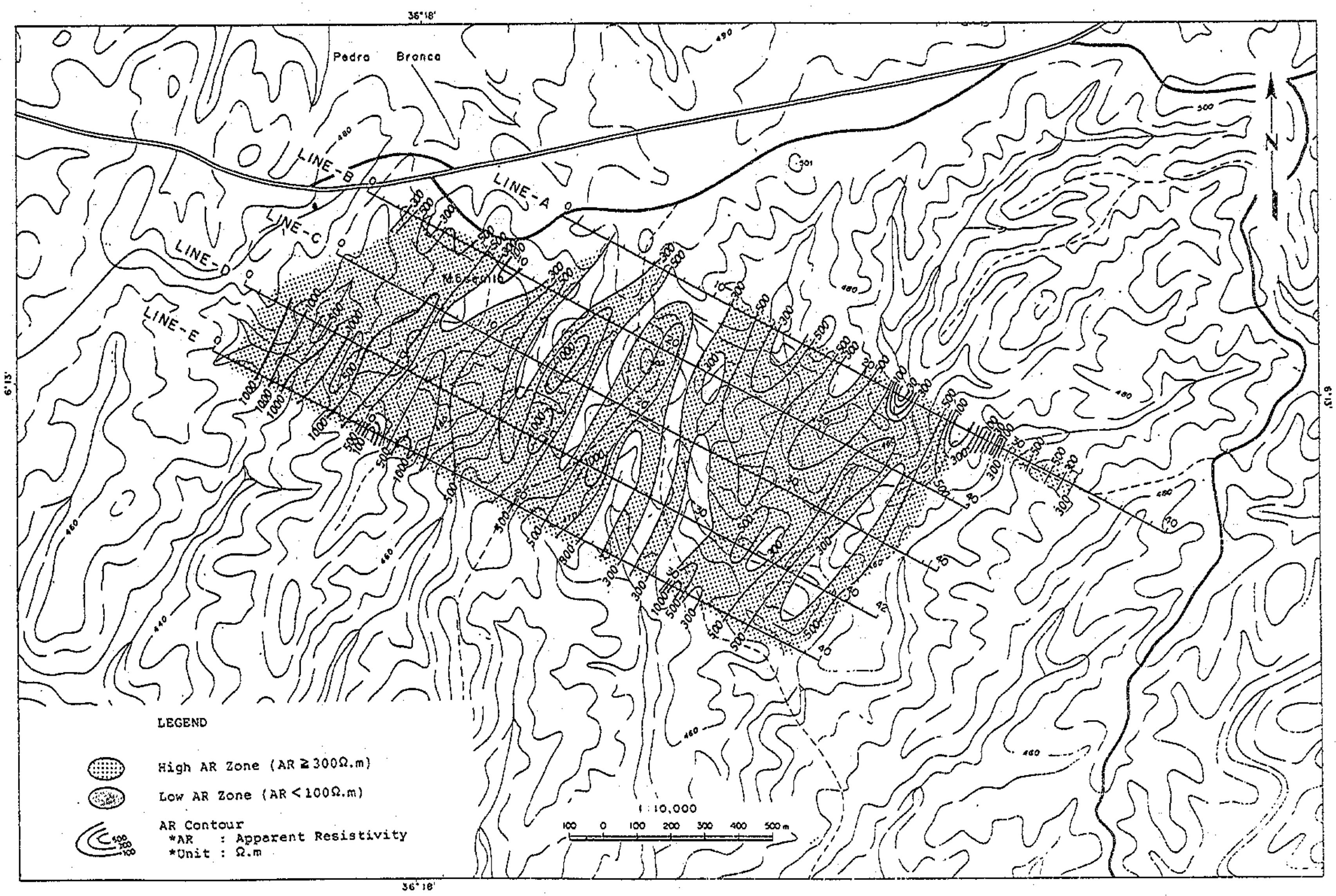


Figure II-1-7 Apparent Resistivity plane, n=3

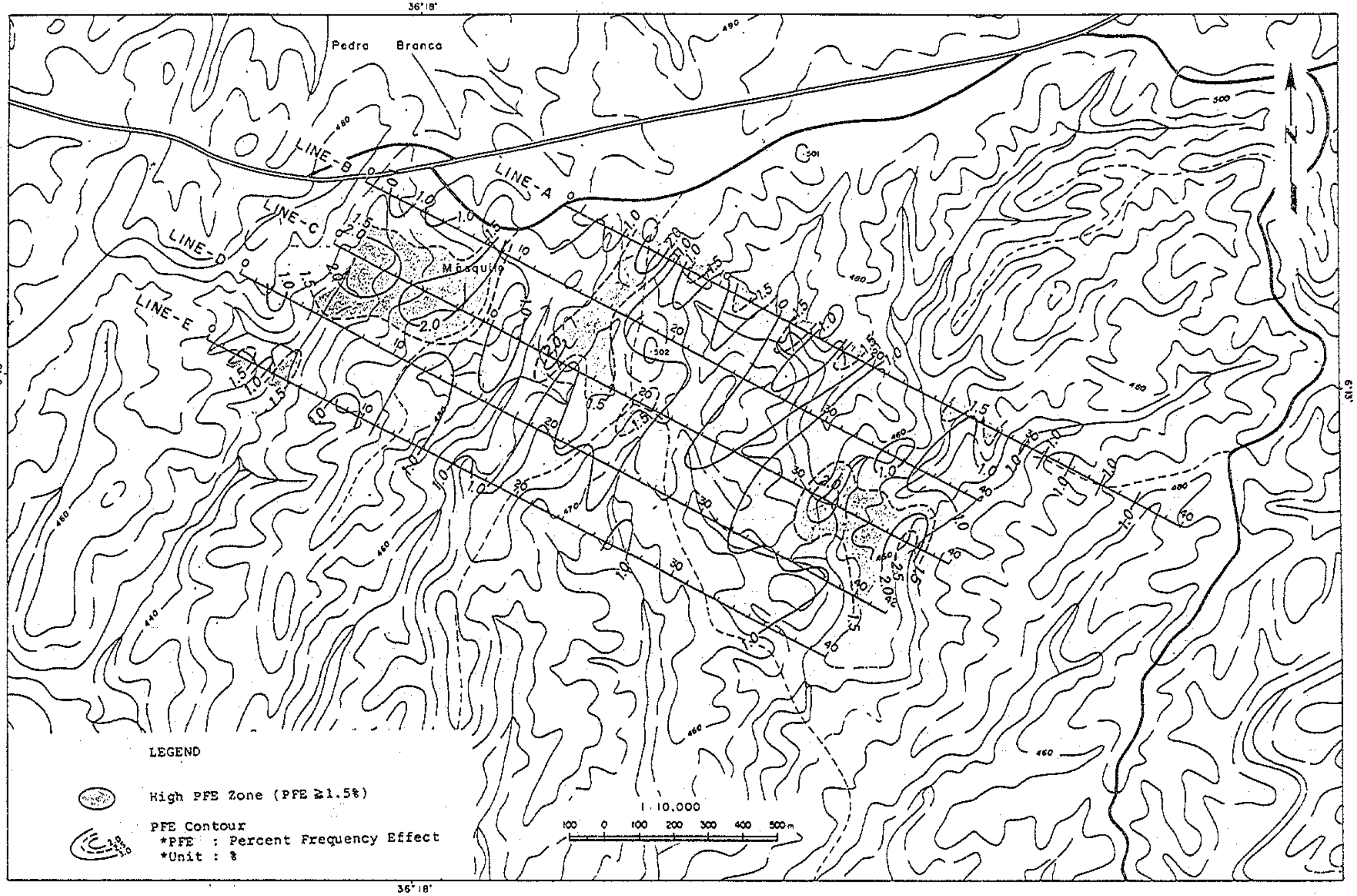


Figure II-1-8 Percent Frequency Effect plane, n=1

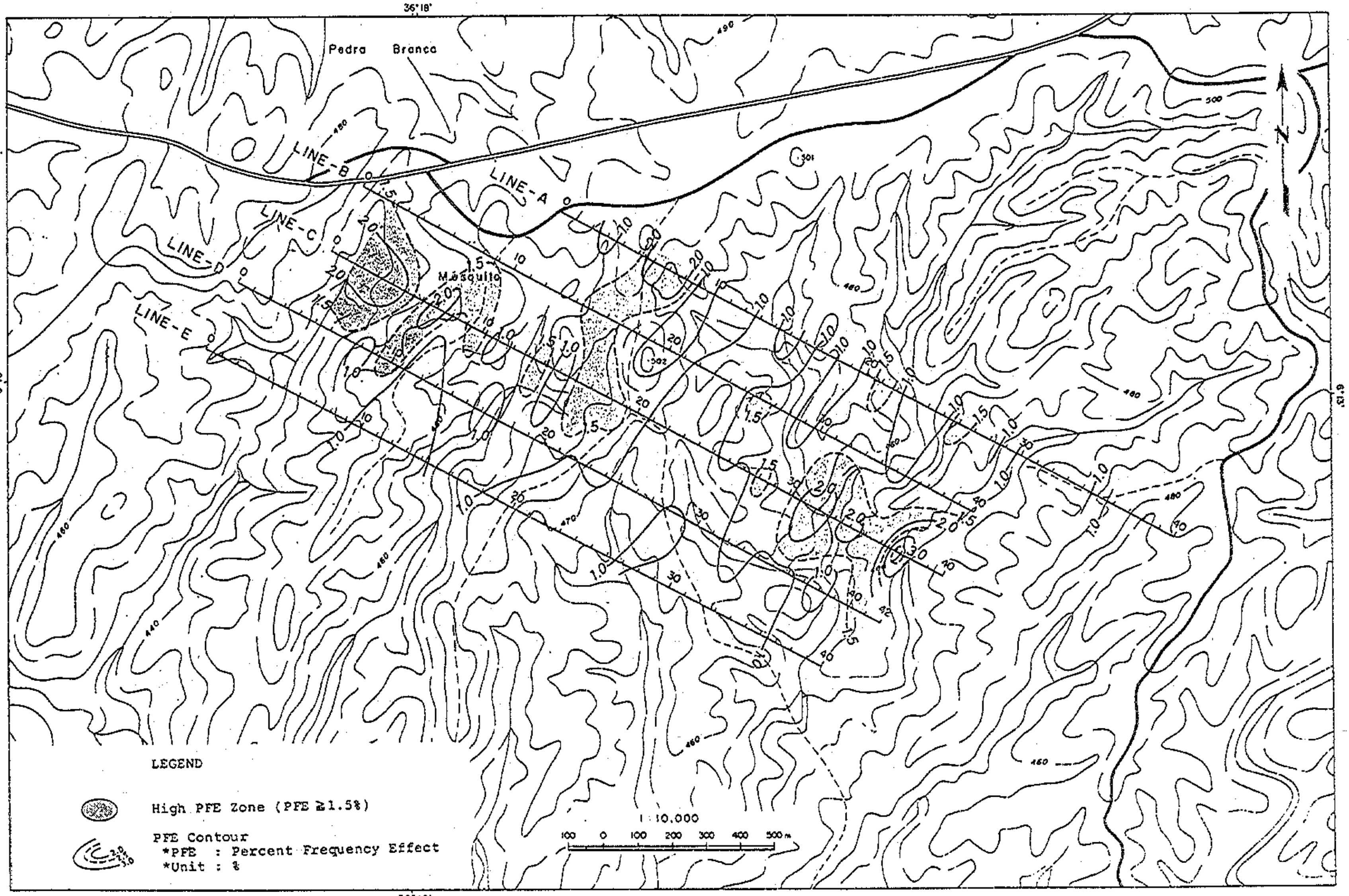


Figure II-1-9 Percent Frequency Effect plane, n=2

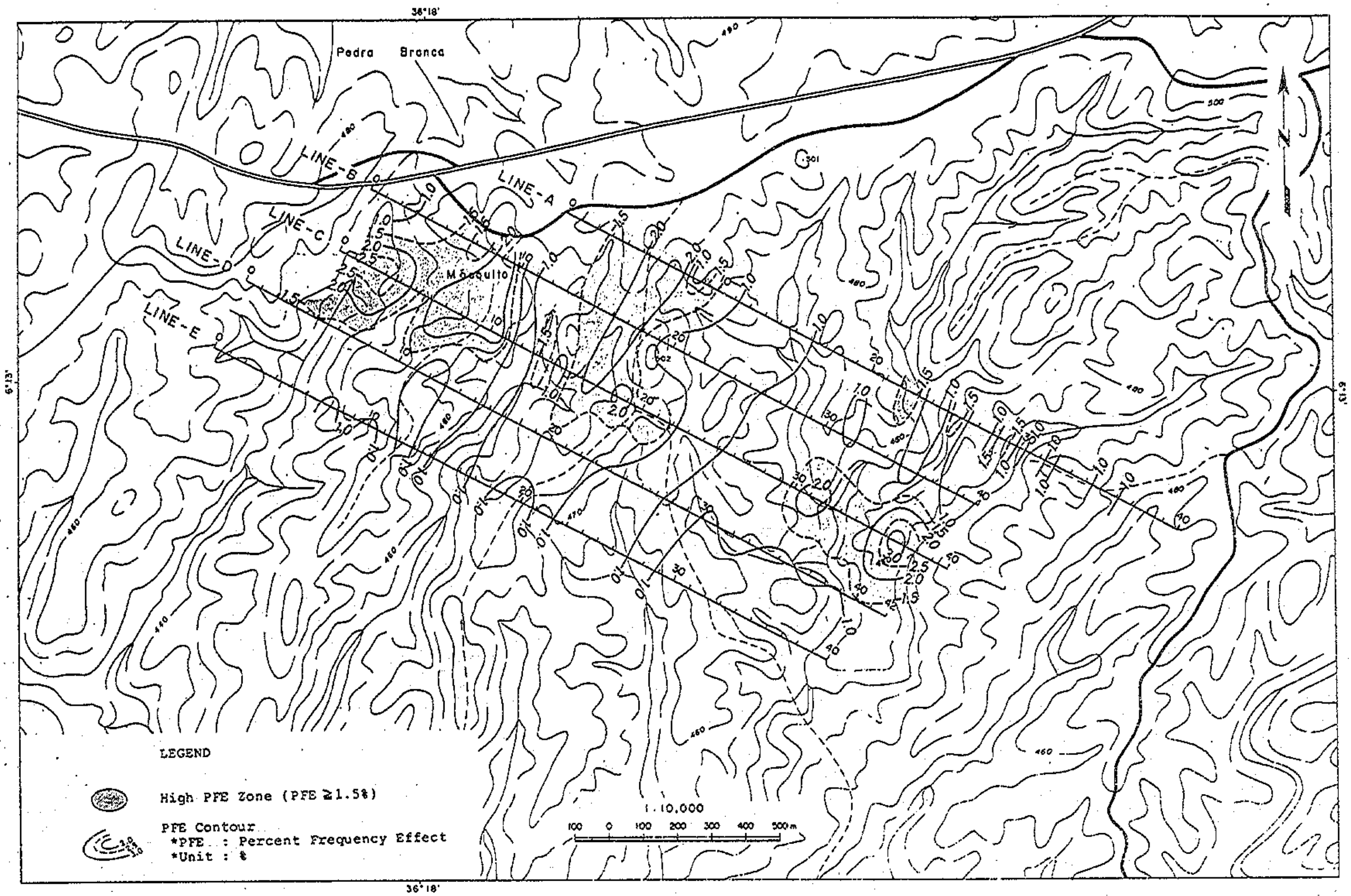


Figure II-1-10 Percent Frequency Effect plane, n=3

is larger than those observed in plan maps n = 1 and n = 2. The shape of the western anomalous zone is similar to that observed in plan maps n = 1, but its PFE values are closer to those observed in plan map n = 2.

From the above described AR and PFE plan maps, the following conjectures can be made:

(1) Conspicuous anomalies are observed in the western, central and eastern portions of the area. These are comprised of MAR and MPFE zones, which are continuous even in deep portions.

(2) All these three anomalous zones are restricted to the portion north of line "C", not extending southwards.

(3) The western as well as the central anomalous ones are oriented in approximately N-S direction, while the eastern one does not show a clear orientation.

(4) Middle to high AR zones are horizontally continuous, while low AR zones are rather spot-shaped.

(5) Middle to high PFE zones are not continuous. Since PFE anomalies do reflect mainly the sulfide contents of rocks, it is inferred that sulfides are not regularly distributed in rocks of this area.

(6) In the portion south of line "C", sulfides seem to decrease abruptly, while the mineralized zone of the Sao Francisco deposit seems to be continuous.

1-2-3 Laboratory Measurements

Twenty samples were collected for laboratory measurements of apparent resistivities as well as percent frequency effects. Moreover, sulfur (S) contents of each sample were also measured (Tab. II-1-1).

No clear correlation between the obtained sulfur contents and PFE values has been found, but sample C-33 does show the highest PFE and sulfur content. This sample was collected from the eastern anomalous zone, and its AR ad PFE values are quite similar to those measured at the Sao Francisco mine, suggesting that this sample may represent a sulfide-bearing mineralization. Some other samples like the A-25 and C-5 were also collected from within geophysical anomalous areas, but none of them yielded high PFE or AR values compatible with the anomalies.

1-3 DISCUSSION

1-3-1 Implications as for Geology and Mineralization

As a general feature, apparent resistivities in this area show a tendency of increasing toward deeper portions, and range from 2 Ω.m to 1856 Ω.m. Laboratory measurements showed that weathered samples tend to yield lower resistivities than fresh samples, and that those samples containing quartz veins or boudins tend to yield higher resistivities than those without such kind of quartz, so that these seems two other plausible generalizations. Moreover, HAR zones are oriented in NNE-SSW direction over the entire area.

Table II-1-1 AR, PFE and Sulfur Contents of Rock Samples

Sample	AR(Ω.m)	PFE (%)	S (%)	Description of Samples
A-13	725	0.4	0.010	bi schist with quartz boudins, strongly foliated.
A-23	7214	1.5	0.063	qtz-bi schist stained with Fe oxide.
A-25	2606	1.3	0.011	siliceous gt schist stained with Fe oxide.
A-29	20460	2.0	0.008	bi schist with qtz segregations, stained with Fe oxide.
A-31	101	0.5	0.012	gt-bi schist, rich in biotite, stained with Fe oxide.
B-1	7989	1.1	0.008	bi schist stained with Fe oxide, foliated.
B-5	190	0.2	0.008	gt-bi schist, rich in biotite, stained with Fe oxide.
C-5	265	1.2	0.012	gt-mus-bi schist, rich in biotite, weathered.
C-11	5575	2.3	0.010	gt-bi schist, rich in biotite, qtz boudin, weathered, Fe oxide.
C-13	2474	2.0	0.014	gt-ct-bi-schist, banded, weathered, Fe oxide.
C-33	6690	3.1	0.167	siliceous bi schist, Fe oxide, sulfide?
D-3	4091	0.1	0.008	pegmatite with mus, k-feld, qtz, tourmaline.
D-8	906	0.2	0.007	qtz boudin with gt, bi, open fracture with Fe oxide.
D-39	115	0.8	0.010	gt-bi schist (pelitic), foliated, weathered.
E-7	858	0.2	0.007	gt-bi schist (pelitic) foliated, with micro-folds.
E-10	1439	1.6	0.008	gt-bi schist, foliated, fractured, Fe oxide, siliceous.
E-20	361	0.6	0.010	pegmatite with mus, qtz, k-feld, Fe oxide.
E-27	198	0.6	0.012	mus-gt-bi schist (pelitic), foliated, open fracture, Fe oxide.
E-29	569	1.1	0.008	gt-bi schist, siliceous, foliated, open fracture, Fe oxide.
E-37	2276	2.3	0.008	gt-bi schist, siliceous, banded, Fe oxide.

From the above stated, it seems that LAR values do reflect weathered portions at shallow levels, while at deeper, they may reflect mineralized portions.

Based on facts like the lack of continuity and the absence of PFE anomalies, the northern LAR zone seems to rather represent strongly weathered or altered portions. On the other hand, the western LAR ~ MAR zones, which are located within a HAR zone, are overlapped by PFE anomalies and are also continuous up to deep portions, suggesting that they may represent LAR zones related to mineralization.

From the above reasoning, the following three are considered to be the most promising portions within this area (Fig. II-1-11):

(1) Central Anomalous Zone (CAZ): includes the intervals between stations 5 and 6 of line "A", 15 and 16 of line "B", and 16 and 20 of line "C".

(2) Western Anomalous Zone (WAZ): includes the intervals between stations 7 and 8 of line "B", and the portion west of station 10 of line "C".

(3) Eastern Anomalous Zone (EAZ): includes the portion east of station 30 of line "C".

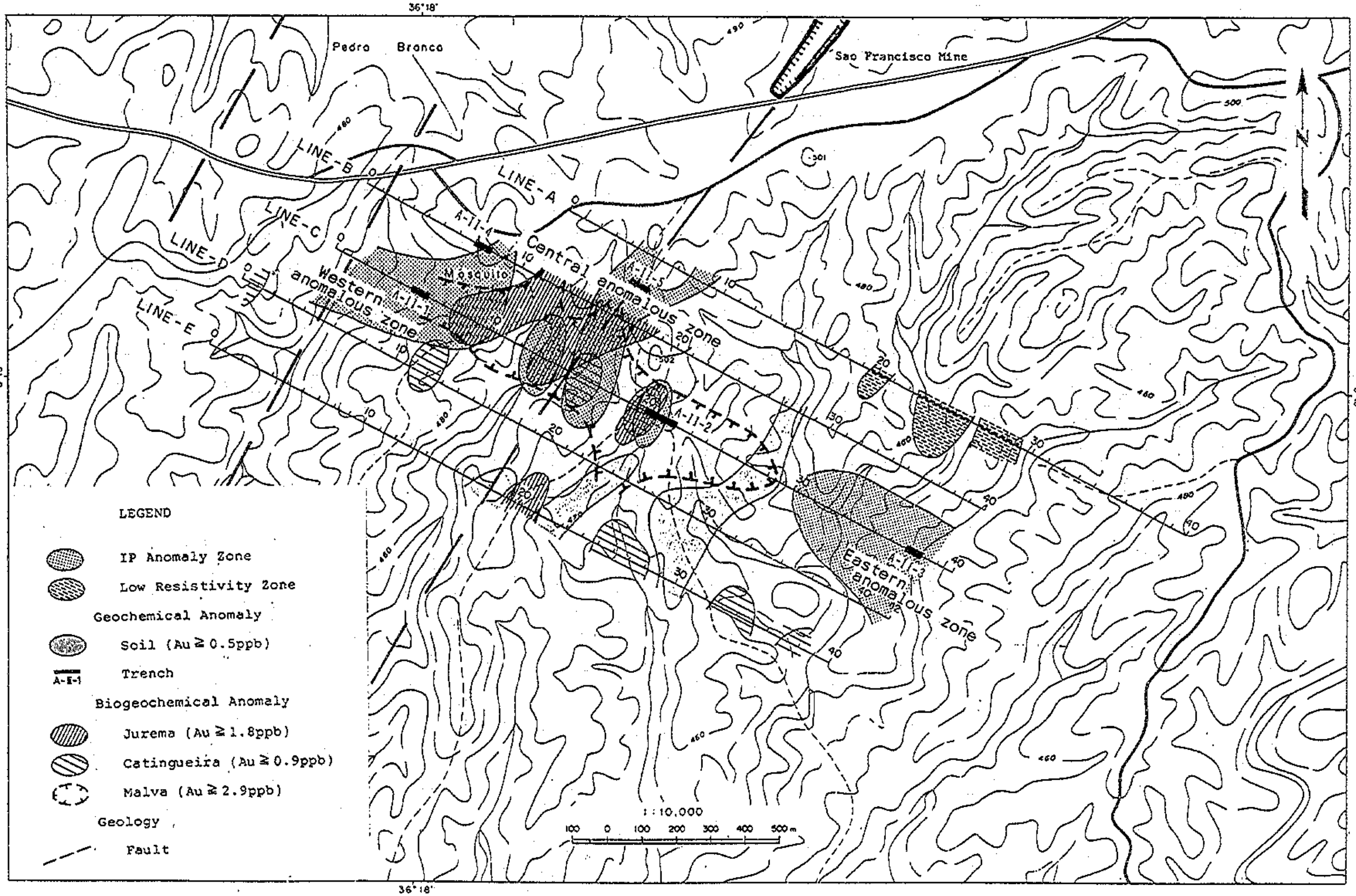


Figure II-1-11 Compilation of geochemical and geophysical surveys

EAZ is elongated in NW-SE direction, while CAZ and WAZ are both elongated in NNE-SSW direction, which is coincident with the general geological structure of this area. This good correlation of geophysical anomalies with geological structures in this area is emphasized by the fact that the CAZ is located close to and along an inferred fault zone. However, although this fault is inferred to extend further southwards, the PFE anomaly stops at line "C". This suggests that the portion south from line "C" is less promising that the northern portion. PFE and AR values in the interval between stations 37 and 38 of line "C" (within EAZ) are quite similar to those observed at the Sao Francisco mine deposit, indicating that this portion is very promising to embody a similar mineralization. It is also interesting that the elongation direction of this EAZ zone intersects that of the So Francisco mine mineralization. If a mineralization actually exists bellow this EAZ, it will have important implications on structural control considerations in this area.

In all anomalous zones defined in this survey, detailed variations could be detected in the direction of the survey lines. However, because the inter-line spacing was quite larger than the inter-station spacing, very few information could be obtained on variations in the direction perpendicular to the survey lines. Considering the reasonably good results obtained in this survey, by narrowing the inter-line spacing, it will be probably possible to look further into details and realize their actual implications.

1-3-2 Implications as for Geochemical Results

Au and As anomalies defined by soil geochemical results in area "A-II" are clustered in the eastern and central parts, and they are both elongated in NNE-SSW direction. In the central part of the area, the Au anomalous zone is parallel to the mineralized zone of the Sao Francisco mine. Also, Au anomalies have been recognized in the portions north and south of this mineralized zone. All these Au anomalies do overlap the IP central anomalous zone. In the eastern part, although Au and As anomalies do overlap each other, no geophysical anomaly has been recognized.

Within the Au and As anomalous zones defined by biogeochemical results, that portion corresponding to the western part of the mineralized zone of the Sao Francisco deposit does overlap roughly the central and western geophysical anomalies (Fig. II-1-11).

It is worth noting that geochemical anomalies have not been recognized on the eastern geophysical anomaly.

1-3-3 Setting of Trench Locations

Trenches were set on those locations were an overlap of Au, As and geophysical anomalies were observed, and also by giving priority to those locations not previously prospected by similar works (Fig. II-1-11).

(1) TRENCH A-II-1

Interval between stations 6 and 7 of line "C". AR < 500 Ω.m, PFE $= 2 \sim 3$ %, overlap of biogeochemical Au anomaly.

(2) TRENCH A-II-2

Interval between stations 20 and 22 of line "C". AR < 300 Ω.m, PFE = 1.5 %, overlap of biogeochemical Au anomaly.

(3) TRENCH A-II-3

Interval between stations 37 and 38 of line "C". AR < 300 Ω.m, PFE = 2~4 %. Although no overlap of geochemical anomaly has been observed, this location was chosen because of the similarities of AR and PFE ranges and anomaly shapes with those observed on the Sao Francisco deposit.

(4) TRENCH A-II-4

Interval between stations 7 and 8 of line "B". AR < 100 Ω.m, PFE = 1.1~2.4 %, overlap of Au anomaly of soil.

Chapter 2 - Trench Survey in Area "A"

2-1 PURPOSES and SURVEY METHODS

2-1-1 Purposes

This trench survey was carried out aiming at understanding in detail the subsurface mineralization in the promising areas "A-I" and "A-II" which were selected based on Phase I survey results.

2-1-2 Survey Methods

Based on results of Phase II's biogeochemical and soil geochemical surveys, trenches in area "A-I" were dug on those places with high Au anomalies (mainly of soil), rock samples were collected and analyzed, in order to grasp the relationship between lithology and mineralization in this area.

In area "A-II", the location of trenches was based in the results of biogeochemical and soil geochemical surveys carried out during Phase II, as well as in those of the geophysical survey executed this year. Trenches were dug, rock samples were collected and analyzed, in order to understand the relationship between lithology and mineralization in this area.

The location of trenches were selected based on the criteria listed below.

AREA "A-I"

Number	Au in Soil	As in Soil	Geology	Direction & Length	Notes
A-I-1	142 ppb	---	pCssx1	N70°W, 25m	
A-I-2	48 and 11 ppb	---	pCssx2	N70°W, 75m	
A-I-3	190 ppb	---	pCssx1	N70°W, 25m	
A-I-4	20 ppb	---	pCssx1	N70°W, 25m	Same layer as A-I-3
A-I-5	13 ppb	---	pCssx1	N70°W, 25m	
A-I-6	208 ppb	13 ppb	pCssx1	N70°W, 25m	

AREA "A-II"

Number	Geophysical Survey Results			Geochemical Results	Geology	Direction & Length
	Location	Resistivity	PFE			
A-II-1	line C,6-7	≤500 Ω.m	2 to 3 %	biogeochem. anomaly *1	pCssx4	N65°W, 50m
A-II-2	line C,20-22	≤300 Ω.m	1.5 to 2 %	biogeochem. anomaly *1	pCssx4	N65°W, 100m
A-II-3	line C,37-38	≤300 Ω.m	2 to 4 %	none	pCssx4	N65°W, 50m
A-II-4	line B,7- 8			soil anomaly *3	pCssx4	N65°W, 50m
A-II-5					pCssx4	N65°W, 50m

*1: Caatingueira = 2.4 ppb, Malva = 4.0 ppb
*2: Jurema Preta = 2.2 ppb, Caatingucira = 1.0, Malva = 6.6 ppb
*3: 1.1 ppb

Among those trenches listed above, the number A-II-5 was not dug this year. This is a trench that was excavated during exploration surveys of the Sao Francisco deposit, and samples were taken from this trench in order to compare them with those collected from other trenches.

The locations of trenches in area "A-I" are shown in Fig. II-2-1, while those of area "A-II" are shown in Fig. II-1-11.

Trenches were hand-dug using pickaxes and scoops. Sampling was carried out along the trench, with the size of one sample corresponding to 7cm(W)x2cm(D)x1m(L).

2-2 RESULTS

2-2-1 Trenches in Area "A-I"

(1) Trench A-I-1 (Pl. II-2-1)

1) Location

Flat mountain top. Trench direction and length: N65°W, 25 meters.

2) Geology

From a regional point of view, this trench is included in the pCssx1 unit of the Serido Formation. A coarse-grained biotite schist, with alternating portions containing more or less biotite constitutes the predominant lithology. In some portions, the banding becomes very fine, from some centimeters up to ten centimeters in width. This rock is cut by several quartz veins that are frequently associated with write to brownish argillaceous material. These small vein range in width from less than one centimeter up to about 10 centimeters, and are commonly oriented parallel to the schistosity. A sample of the argillaceous material was collected at a point 8.1 meters from the western edge of this trench, and was analyzed by X-ray diffractometry (Table II-4-3). Results indicated that quartz, plagioclase, epidote, sericite and chlorite are the main mineral constituents.

3) Structure

Regionally, this trench is included in a NNE-SSW oriented fold zone which crosses the central part of the Serido Formation. The strike of the foliation varies widely, and there are places where micro-foldings can be observed.

4) Mineralization

A sample collected at the northwestern edge with Au content of 8 ppb was the best result obtained in this trench. Silver values are all lower than 0.2 ppm. In contrast, tungsten contents are high, specially in the western half of the trench where chemical results revealed values ranging between 70 and 388 ppm. Given that the background values for tungsten in schists obtained in this survey are all lower than 10 ppm (Tab. II-4-1), those high values can be

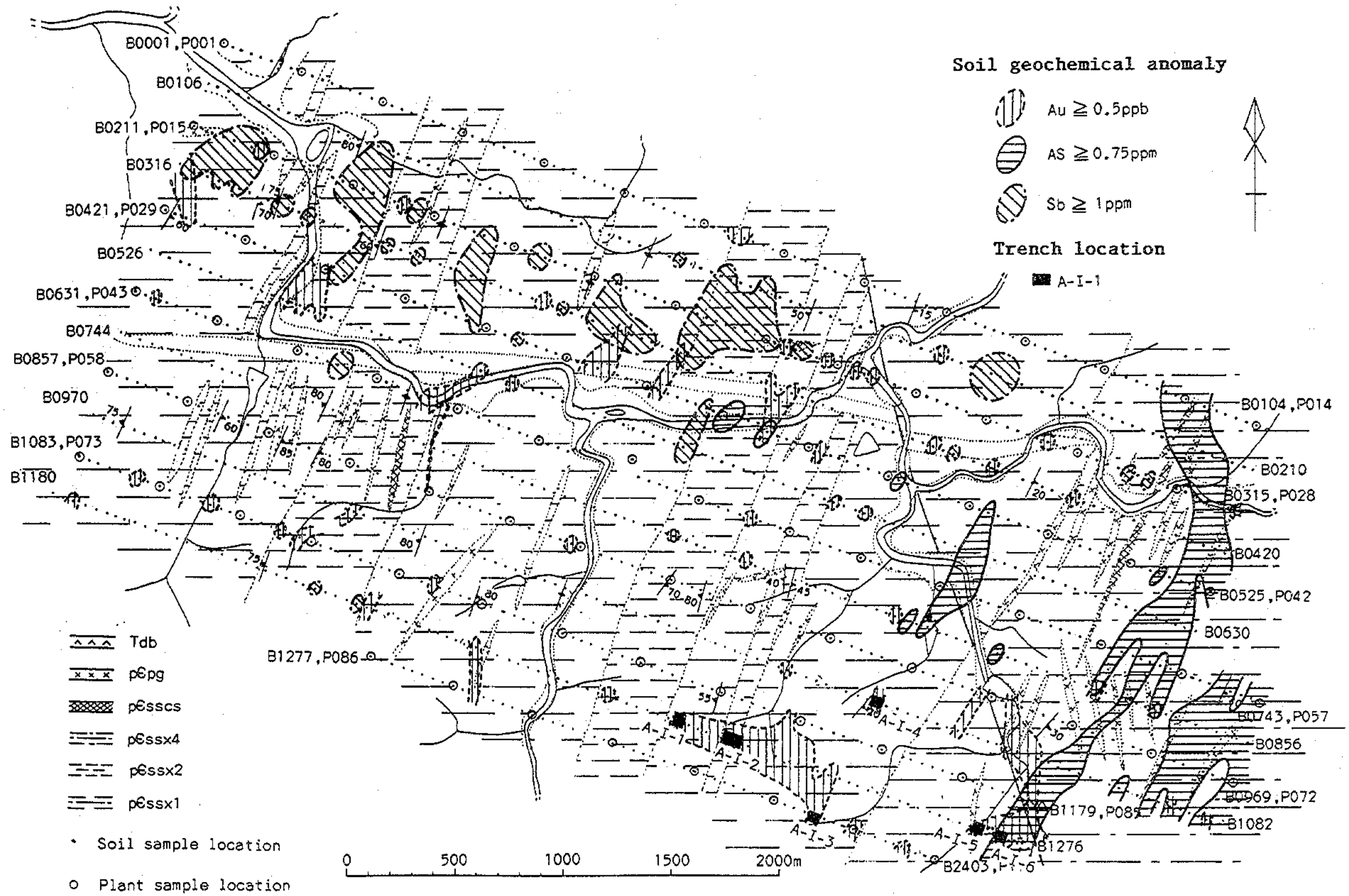


Figure II-2-1 Soil geochemical anomalies and trench locations in area A-I interpreted as a result of a mineralizing process. In those places where high tungsten values are found, argillaceous material are commonly associated with the quartz veins, a fact that would explain this relationship.

(2) Trench A-I-2 (Pl. II-2-2)

1) Location

Gentle northern slope. Trench direction and length: N65°W, 75 meters.

2) Geology

From a regional point of view, this trench is included in the pCssx1 unit of the Serido Formation. The predominant lithology is constituted of muscovite-biotite schist and biotite schist, both being intruded by pegmatite dykes. Some centimeter wide, white colored quartz veins are widespread, cutting the schists usually parallel to their foliation. A small amphibolite dyke as well as small dykes composed of potassium feldspar, hornblende and epidote are found in the northwestern part of this trench.

3) Structure

Regionally, this trench is included in a fold zone which crosses the central part of the Serido Formation. The foliation strikes NE-SW, but its dip varies largely.

4) Mineralization

Two high Au values were found, one at 29 meters (12 ppb) and other at 53 meters (17 ppb) from the northwestern edge. All other samples yielded Au contents ranging between 1 and 9 ppm, which are close to the usual Au contents of not-mineralized country rocks. It is not clear, therefore, whether these low Au contents resulted from or represent unaffected portions by the mineralizing process. Tungsten is found in higher contents (more than 10 ppm) in the western half, and in lower contents (between 2 and 9 ppm) in the eastern half of the trench. Although the high values in this trench are lower than those of trench A-I-1, they are still higher than the background values of the country rock, so that the action of a mineralizing process is very plausible.

(3) Trench A-I-3 (Pl. II-2-3)

1) Location

Gentle northwestern slope changing to a flat plain. Trench direction and length: N65°W, 25 meters.

2) Geology

From a regional point of view, this trench is included in the pCssx1 unit of the Serido Formation. Fine grained biotite schist constitutes the main lithology. Alternating stratification of bands with more and less biotite, presence of muscovite as well as silicification can be observed in some places.

In the entire extension of the trench, small quartz veins (approx. 2 cm wide) are observed, and in some portions they are associated with white-to-brownish argillaceous material. Some boudin-shaped quartz fragments are also observed, and they are usually elongated parallel to the foliation, although in some places they do cross cut each other.

3) Structure

Regionally, this trench is positioned in the eastern edge of a fold zone which crosses the central part of the Serido Formation. The foliation strikes NE-SW, and dips 40° to 70° SE.

4) Mineralization

Au contents of 6 ppb and 2 ppb were obtained from samples collected at 20 and 21 meters from the northwestern edge. Although these locations correspond to those where boudin-shaped quartz fragments are found, the Au values fall within the range of background values of the country rock, not allowing any conclusion concerning to the occurrence of a mineralizing process.

Silver contents in the samples are all lower than 0.2 ppm.

High tungsten contents (37 to 135 ppm) were found in samples collected in the interval between 6 to 10 meters from the northwestern edge, while all other samples revealed tungsten contents between 3 and 21 ppm. No special difference in lithology was found in the places where the samples with high tungsten contents were collected, and even the small amount of tiny quartz veins did not differ. However, considering that the high tungsten contents are all higher than the background values found in other places, it seems plausible that these results represent side effects of an actual mineralization.

(4) Trench A-I-4 (Pl. II-2-4)

1) Location

Flat plain changing to a gentle western slope. Trench direction and length: N65°W, 25 meters.

2) Geology

From a regional point of view, this trench is included in the pCssx1 unit of the Serido Formation. The predominant lithology is constituted of garnet-biotite schist. There were found two zones where quartz veins concentrate, cutting the country rock parallel to the foliation.

3) Structure

Regionally, this trench is located in the eastern edge of the fold zone above quoted. The foliation strikes N10° ~ 25°E, and dips 20° to 30°E.

4) Mineralization

Au as well as Ag contents are all lower than the detection limit of 0.5 ppb and 0.2 ppm, respectively. Tungsten contents range from 3 to 32 ppm, and they are lower, as a whole, than the contents obtained in trenches A-I-1 and A-I-2. Twelve samples yielded values higher than 10 ppm, and the same arguments advocated for the previous trench can be used to explain these results.

(5) Trench A-I-5 (Pl. II-2-5)

1) Location

Plain almost flat. Trench direction and length: N65°W, 25 meters.

2) Geology

From a regional point of view, this trench is located in the western edge of the pCssx4 unit of the Serido Formation. The lithology is characterized by alternation between biotite schist and muscovite schist. Small quartz veins parallel to the foliation as well as boudin-shaped quartz fragments are concentrated in the northwestern and southeastern parts. A smoky quartz vein was found in the northwestern part.

3) Structure

Regionally, this trench is positioned east of the fold zone mentioned above. The foliation strikes N25° ~ 50°E and dips 45° to 55°E.

4) Mineralization

Both Au and Ag in all samples yielded results lower than the detection limit of 0.5 ppb and 0.2 ppm, respectively. Tungsten contents are high (8 to 86 ppm) in the southwestern half, and low (4 to 9 ppm) in the southeastern half of the survey area. It seems highly probable that the high tungsten contents indicate the action of a mineralizing process. In the northwestern portion where high tungsten values were found, many small quartz veins as well as boudin-shaped quartz fragments are observed, but their relationship with the possible tungsten mineralization is unclear.

(6) Trench A-I-6 (Pl. II-2-6)

1) Location

Plain almost flat. Trench direction and length: N65°W, 25 meters.

2) Geology

From a regional point of view, this trench is located in the western edge of the pCssx4 unit of the Serido Formation. The predominant lithology consists of mainly of garnet-biotite schist, which is cut by pegmatites dykes of various sizes. Small quartz veins parallel to the foliation where found concentrated in four zones.

3) Structure

The foliation strikes N10° ~ 20°E, and dips 20° to 50°E.

4) Mineralization

Both Au and Ag in all samples yielded results lower than the detection limit of 0.5 ppb and 0.2 ppm, respectively. Tungsten contents (2 to 8 ppm) are lower than in any other trench above described. From these results, it is not possible to determine if these rocks were or not mineralized, since the country rock backgrounds for tungsten obtained in this survey are lower than 10 ppm. The location of this trench were selected based on results of soil geochemical survey, which indicated an arsenic anomaly. The results of gold, silver and tungsten of trench samples, however, do not indicate any kind of mineralization that could have arsenic associated.

2-2-2 Trenches in Area "A-II"

(1) Trench A-II-1 (Pl. II-2-7)

1) Location

A slope of approximately 30°. The western edge of the trench is on the eastern slope by crossing a stream. Trench direction and length: N70°W, 50 meters.

2) Geology

From a regional point of view, this trench is included in the pCssx4 unit of the Serido Formation. At the western edge, biotite schist predominates, while garnet-biotite schist is the main lithology in the remaining portion. The lithologic composition within the trench is almost constant, with few variation near the western edge, where alternating bands with more or less biotite can be observed. Small quartz veins parallel to the foliation and boudin-shaped quartz fragments are distributed rather evenly throughout the trench. Near the eastern edge, there occur a silicified zone which seems as filling a fracture parallel to the foliation. Moreover, an amphibolite dyke can be observed at the eastern edge. Whitish argillaceous material associated to quartz veins were collected at 41.7 and 46.3 meters from the western edge of this trench to be analyzed by X-ray diffractometry (Tab. II-4-3). Results indicated the presence of quartz, plagioclase, biotite, chlorite, sericite and dravite (tourmaline).

3) Structure

The foliation strikes N20° ~ 55°E and dips 40° to 65°E. Some fractures cross-cutting the foliation were found near the western edge (N65°E/80°N) and around the central portion (N70° ~ 80°E/80°N) of the trench.

4) Mineralization

Apart from a gold content of 4 ppb of a sample from the eastern edge, all other samples yielded Au contents lower than the detection limit of 0.5 ppb. Silver in all samples also yielded contents lower than the detection limit of 0.2 ppm. Tungsten contents are all low, ranging between 1 and 9 ppm. There seems unlikely that any kind of mineralization occurred.

(2) Trench A-II-2 (Pl. II-2-8)

1) Location

Foothills of the south to southeastern slope. Trench direction and length: N70°W, 100 meters.

2) Geology

From a regional point of view, this trench is included within the pCssx4 unit of the Serido Formation. The lithology is almost exclusively constituted of garnet-biotite schist. Small quartz veins and boudin-shaped quartz fragments are more frequent in the eastern side. Some pegmatite dykes can be observed intruding the schist. Whitish argillaceous material associated to quartz veins was collected at 68.0 meters from the western edge of this trench to be analyzed by X-ray diffractometry (Tab. II-4-3). Results indicated the presence of quartz, plagioclase, sericite/montmorillonite.

3) Structure

The foliation strikes N30° ~ 60°E, and dips 20° to 70°E. The foliation becomes more inclined eastwards.

4) Mineralization

In the western half of the survey area, apart from one sample which yielded a gold content of 9 ppb, all other samples yielded Au contents lower than the detection limit of 0.5 ppb. In contrast, excepting some samples, most of them revealed Au contents between 0.6 to 19 ppb. Although most of these Au values still fall within the country rock background range, they are very high compared to those obtained from trench A-II-1, and taking into account that these high values are continuous over around 60 meters, it is conceivable that there occurred a mineralization. The locations of samples that yielded these high Au contents coincide with those where quartz veins are more concentrated. Silver contents, however, were all below the detection limit of 0.2 ppm. Tungsten contents were also low, ranging between 1 to 13 ppm, with only two samples yielding contents higher than 10 ppm. The possible mineralization for gold seems to not be reflected by silver or by tungsten.

(3) Trench A-II-3 (Pl. II-2-9)

1) Location

Eastern slope. Trench direction and length: N70°W, 50 meters.

2) Geology

From a regional point of view, this trench is included within the pCssx4 unit of the Serido Formation. The lithology is constituted of alternation of muscovite-biotite schist layers, garnet-muscovite-biotite schist layers, and garnet-cordierite-biotite schist layers. It is worth noting that there are fewer quartz veins as well as of boudin-shaped quartz fragments compared with in other trenches. At the place where sample number 23 was collected, there occur a silicified zone 30 to 40 centimeters wide around a small fault, and some portions showed a dark-gray coloration. In the portion of the trench between the location where sample numbers 33 and 34 were collected, white-colored argillaceous material could be observed along fractures that cross-cut the foliation in low angles. The same king of argillaceous material was observed in fractures around the place where sample number 45 was collected. These argillaceous materials were collected and analyzed by X-ray diffractometry. Results indicated the presence of quartz, plagioclase and biotite, and minor amounts of chlorite. Among those fractures cross-cutting the foliation, some are open and filled with argillaceous material.

3) Structure

The foliation strikes N25°-35°E, and dips 50°-70°E, and shows little variation. Some open fractures, as mentioned above, cross-cut the foliation. Moreover, in some places, kink-band structures with a width of about 10 centimeters were observed. These kink-bands seems to have formed due to tectonic movements after the metamorphic event.

4) Mineralization

Samples numbers 2, 3 and 4 yielded Au contents ranging between 2 and 4 ppb, while those numbers 22, 23, 24 and 25 yielded Au contents between 2 and 9 ppb. These last samples were collected nearby the dark-colored silicified zone along the fault (see above), and although their gold contents are rather low, they seem indicate a weak mineralization. Tungsten contents ranged between 2 to 6 ppm, which are rather low or comparable to contents obtained in other trenches.

(4) Trench A-II-4 (Pl. II-2-10)

1)Location

Gentle eastern slope. Trench direction and length: N70°W, 50 meters.

2) Geology

From a regional point of view, this trench is included within the pCssx4 unit of the Serido Formation. The lithology is constituted almost exclusively of biotite schist. Small quartz veins as well as boudin-shaped quartz fragments parallel to the foliation are scattered throughout the entire trench. There is, however, a zone nearby the western edge where quartz veins are specially concentrated.

3) Structure

The foliation strikes N25° ~ 40°E, and dips 40° ~ 50°E. Some fractures striking E-W or N-S are observed.

4) Mineralization

Apart from a gold content of 10 ppb obtained for sample number 9, all samples yielded Au contents lower than the detection limit of 0.5 ppb. It should be emphasized that the sample number 9, which yielded an anomalous Au content, did not contain quartz veins. Silver results were also all below the detection limit of 0.2 ppm. Tungsten results ranged from 1 to 6 ppm, which are within the range found in other trenches, indicating that tungsten mineralization did not take place in this area.

(5) Trench A-II-5 (Pl. II-2-11)

1) Location

From a N-S oriented ridge toward the western slope. This trench is located on the southern extension of the Sao Francisco deposit, and has been dug during the exploration works of the Sao Francisco mine. Trench direction and length: N65°W, 66 meters.

2) Geology

From a regional point of view, this trench is located within the pCssx4 of the Serido Formation. The lithology is predominantly composed of garnet-biotite schist. Quartz veins parallel to the foliation are scattered throughout the trench, but they do concentrate specially within three small shear zones (see below) observed in the trench. Within these shear zones, the width of quartz veins range from 1 to 10 centimeters.

3) Structure

Shear zones are observed between the collection places of samples 51 to 53, 16 to 24, and 35 to 45. These shear zones matches reasonably well with a fault zone predicted from geological and geophysical results. The foliation strikes N30°-35°E and dips 45°-70°E, but its attitude changes near and within the shear zones.

4) Mineralization

On an average, gold contents are high. Specially samples 10 to 12, 21, 24, 30, 31, 34 to 44 and 48 yielded gold contents higher than 100 ppb, up to a maximum of 500 ppb (sample number 40). Among these, samples 21, 24, 30, 31, and 35 to 44 are all located within shear zones. These high Au values are clearly higher than those commonly found for schists in this area. By bearing in mind that a sample of a country rock collected inside the mine pit during the Phase I yielded a gold content of 635 ppb, the high values found in this trench, though discontinuous, seem to indicate a mineralization. The width of the zone which encloses the high Au values is approximately 50 meters.

Silver contents of samples collected within this zone, for the first time, yielded results higher than the detection limit, with a maximum content of 1.9 ppm (sample number 31). Analyses of samples collected during Phase I inside the Sao Francisco mine revealed that silver contents are usually 8 times those of gold. This relationship was also found in samples from this trench, suggesting that the silver contents in these rocks are also controlled by the mineralization.

Tungsten contents were all low, yielding for the first time results below the detection limit of 0.2 ppm, with a maximum value of 5 ppm.

2-3 DISCUSSION

2-3-1 Geochemical Results

Trench locations in area "A-I" were selected based on results of previous soil geochemical survey. Nevertheless, the analyses of channel rock samples revealed that there is no correlation between their gold contents and those of the overlying soils. Au contents of samples collected from trenches A-I-1, A-I-2 and A-I-3 are rather low. The obtained Au contents for trench samples are listed below, together with those of soils overlying them.

TRENCH No.	Au in SOIL	Au in TRENCH SAMPLE
A-I-1	142 ppb	8 ppb (1 sample only)
A-I-2	11 and 48 ppb	14 samples scattered over 82m, max. 17 ppb
A-I-3	190 ppb	6 and 2 ppb (2 samples only)
A-I-4	20 ppb	below detection limit
A-I-5	13 ppb	below detection limit
A-I-6	208 ppb	below detection limit

Moreover, although trench samples confirmed the occurrence of a mineralizing process in the extension of the mineralized zone of the Sao Francisco deposit, soil geochemical survey did not reveal any kind of anomaly.

One of the factors that can be alleged to explain the absence of correlation between soil and trench samples results is the poor development of soils in the survey area. Soils in this area are typically 20 centimeters deep and frequently sandy, and are underlain by a pebbly layer containing various types of rocks. Taking into account that most of the pebbles seems to have originated from pegmatites, and considering also the local topography, there seem implausible that these pebbles have been brought from long distances. However, the poor development of soils associated to their mobilization during the rainy season seems to be the most straightforward reasoning to explain the absence of compositional correlation between soil and the underlying rocks.

In the southern extension of the Sao Francisco deposit within the area "A-II", the mineralized zone is at least 50 meters wide, and gold has been found to be present in concentrations up to 500 ppb. Moreover, considering that the sampling in the trench was carried out in a channel with a width of one meter only, it seems reasonable to expect that this mineralized zone is to be easily detected by soil geochemical survey. Nevertheless, the soil right above the mineralized zone did not indicate any kind of anomaly. Gold anomalies in soil were instead find in both side of the mineralized zone. Since the mineralized zone is located on a ridge, this displacement seems to have been most influenced by the topography. The gold contents in the anomalous soil, however, is far lower than those found in area "A-I", remaining then the problem to explain how those anomalous high values (more than 100ppb) in soils of area "A-I" originated. Moreover, that mineralized zone confirmed by trench survey matches very well with the arsenic anomaly obtained by soil geochemical survey. A similar arsenic anomaly in soil was also detected in an area 500 meters east of the Sao Francisco deposit, which overlapped a gold anomaly in soil. However, the geophysical survey carried out on this area did not indicate any trace of anomalous resistivity, so that it was decided to not execute a trench survey in this area. It seems, therefore, that this area is worth to be further prospected utilizing other types of exploration methods.

The results of the biogeochemical survey carried out in area "A-II" by using the Jurema Preta vegetation indicated that the overlapping portion of gold and arsenic anomalies coincides with the mineralized zone of the Sao Francisco deposit.

2-3-2 Geophysical Results

The anomalies detected by the geophysical survey can be divided into western, central and eastern anomalies. Among these, the central anomaly zone matches roughly with the mineralized zone of the Sao Francisco deposit. Both the eastern and western anomaly zones are oriented in NW-SE direction, and represents rather a concentration of anomalous spots than a compact body. Trenches were dug in the most promising portions of each anomaly zone, but only that one in central anomaly (A-II-2) yielded results that indicate the effect of a mineralizing process. Gold has been detected in samples from other trenches, but the contents are generally low, and lack lateral continuity, so that it was concluded that they are undistinguishable from the background values obtained for the country rocks.

The central anomaly zone is continuous and elongated in NNE-SSW direction even at deep levels (up to approximately 150 meters), matching relatively well with the trend of the mineralized zone of the Sao Francisco deposit. In the western as well as the eastern anomaly zones, however, the spot-shaped anomalies remain unchanged even at deep levels. An interesting fact on the eastern anomaly zone is that the anomaly at its eastern edge shows similarities, in terms of PFE strength and pattern, with the anomaly obtained in a survey line that crosses transversely the mineralized zone of the Sao Francisco deposit. Analyses of samples taken from a trench dug on this eastern anomaly zone yielded only low gold contents, not allowing discern them from the background. Considering the fact that this eastern anomaly zone is steadily continuous up to the prospecting depth limit of the utilized geophysical method, it seems worth to be further prospected by other methods.

Also, if both the eastern and the western anomaly zones are really due to the existence of mineralized zones, it will be quite important to know their actual trend in more detail. Since in this survey the line spacing was 200 meters, narrowing this spacing to, say, 50 meters will allow obtain their trend with reasonable detail.

Chapter 3 - Geochemical Survey in Area "B-I"

3-1 GEOLOGICAL FEATURES of AREA "B-I"

This area is entirely included within the pCssx1 (schists) of the Serido Formation. Garnet-biotite schist constitutes the main lithologic unit, with cordierite-garnet-biotite schist associated in some portions (Fig. II-3-3). Two generation of pegmatitic dykes, one striking NNW-SSE and the other E-W, can be observed intruding frequently these rocks. The E-W oriented pegmatites are typical of these area.

Concerning to gold occurrences, pyrite-bearing auriferous quartz veins are found in the central to mid-eastern part (between soil samples B2731 and B2732) of this area. These quartz veins show a width of 0.3 to 2 meters and length up to 200 meters; contain malachite, hematite and limonite as accessory minerals, and have an attitude of N5°E/70°E. Chemical analyses carried out last year revealed that they contain 200 ppb of gold, 103 ppm of silver, 3.76 % of copper and 5 ppm of arsenic. Previous works have confirmed their continuity up to a depth of 7 meters.

During the survey carried out this year, the occurrence of quartz veins was confirmed in two other locations. One is in the central to northern part of the area (between soil samples B2803 and B2402) while the other is located in nearby the southern limit (around soil sample B3042) of the area. The strike of these veins is approximately N20°E, but their width and dip are unknown. These veins were sampled rather randomly and analyzed chemically, but all results for gold and silver yielded values lower than 0.1 ppm.

Apart from these gold occurrences, various occurrences of niobium, tantalum, beryllium and others associated to pegmatite dykes are found within the limits of this area.

3-2 SOIL GEOCHEMISTRY

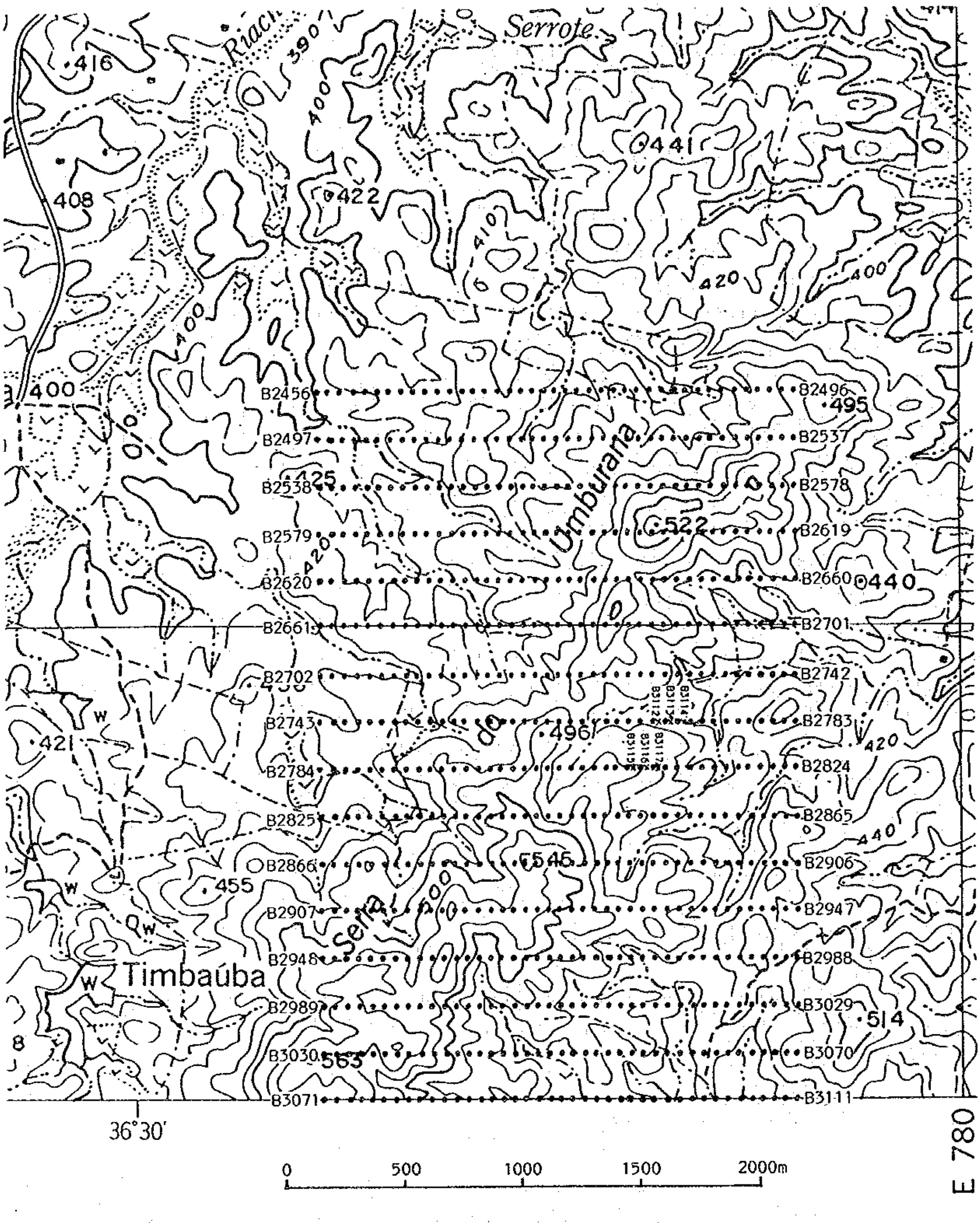
3-2-1 Objectives

This survey was aimed at narrowing down promising areas for gold within the area "B-I" which was selected based on geological and (stream sediment) geochemical surveys carried out during the Phase II of this project.

3-2-2 Survey Methodology

(1) Collection and Preparation of Samples

660 samples were collected on 16 lines oriented in E-W direction (Pl. II-1-1). The lines were set spaced 200 meters each other with a length of 2 kilometers, and the sample collection points on the lines were set at a spacing of 50 meters. In the area where auriferous quartz veins were known to exist, the sampling were carried out at a spacing of 25 meters (Fig. II-3-1).



•B3117 Sample location & number

Figure II-3-1 Soil sample location in area B-I

The soil in this area is poorly developed, with a mean depth of 20 to 30 centimeters. The "A" horizon is almost absent, and samples were collected from horizons "B" and "C", with a mean sampling depth of 15 to 20 centimeters.

The collected samples were left to dry naturally, and after dried they were sift to obtain the fraction under 80 mesh. This fraction was then quartered until a representative fraction of 50 grams was obtained. Also, information concerning to the stratigraphic positioning, soil horizon, sampling depth, color-granulometry-composition of the soil, topography, soil humidity, presence of vegetation, etc., were recorded for each sampling location.

(2) Chemical Analyses

After roughly adjusting their weight, the samples were sent to the brazilian GEOSOL (Geologia e Sondagens Ltda) laboratory to be analyzed for gold, arsenic and antimony contents. The analytical method together with its detection limit for each analyzed element are given in Tab. II-3-1, while the analytical results are listed in the Appendix 1.

(3) Data Processing

The analytical results were input in a HP-9000 series computer and statistically processed by using a software package developed by Bishimetal Exploration Co (Tab. II-3-2). The values lower than the detection limit were input as 0.2 ppb for gold, 1 ppm for arsenic and 0.5 ppm for antimony, to overcome practical problems. Moreover, since the entire area is included within the distribution area of the Serido Formation, all data were processed as one group, without the usual subdivision by lithologic types.

Statistical results indicate that there are no correlation among the three analyzed elements. The boundary values to define anomalous areas were obtained by utilizing the EDA method (Exploratory Data Analysis, Lurzul, H. (1988)) (Fig. II-3-2, Tab. II-3-3).

3-2-3 Results (for each element)

The distribution of anomalous areas for each analyzed element is presented below.

(1) Gold (Au)

The highest Au content found in samples from this area was 116 ppb, and the lowest was below the detection limit (0.5 ppb). Au contents below the detection limit comprised 93.9 % of the total, making the statistical processing almost meaningless. It was decided, therefore, to consider all contents above the detection limit as anomalous.

As shown in Fig. II-3-3, the spot-shaped anomalous zones defined by the distribution of samples with Au contents higher than 0.5 ppb are rather scattered over the entire area. Among these anomalous zones, those with values higher than 10 ppb are concentrated in the northeastern and southern parts of the area. The highest value found in this area (116 ppb) is located on the eastern edge of the anomaly lying over the line linking the soil collection points B2497 and B2537.

Table II-3-1 Methods and detection limits of chemical analyses

Sample media	Elements	Analytical methods	Detection limits
Soil	Au	Emission spectrometry	0.5 ppm
	As	Atomic absorption spectroscopy	1 ppm
	Sb	ditto	1 ppm
Stream sediment	Au*	Emission spectrometry	0.5 ppb
	Ag*	ditto	0.2 ppm
	Fe	X-ray fluorescence analysis and wet determination	10 ppm
	Mn	X-ray fluorescence analysis	5 ppm
	Mo*	Emission spectrometry	1 ppm
	W *	X-ray fluorescence analysis	10 ppm
	Sn*	Emission spectrometry	2 ppm
	Nb*	X-ray fluorescence analysis	10 ppm
	Ta*	ditto	10 ppm
	Be	Emission spectrometry	0.5 ppm
	Li	Atomic absorption spectroscopy	1 ppm
	As	ditto	1 ppm
	Sb	ditto	1 ppm

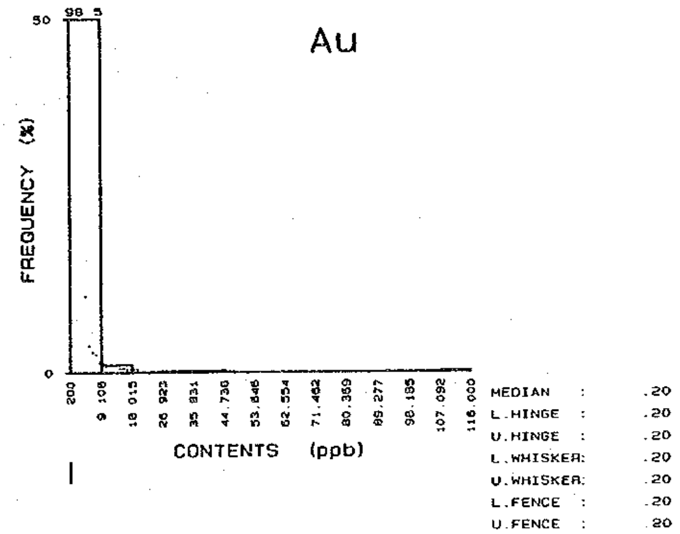
* Au of pan concentrate is analyzed by atomic absorption spectroscopy when the value is more than 500 ppb.
* Detection limit of W is 1ppm for trench sample analysis.

Table II-3-2 Statistical studies of soil analytical data

Elements	Mean	Variance	Standard deviation	Minimum	Maximum	Below detection limit(%)
Au(ppb)	0.749	26.373	5.135	0.200	116.000	93.9
As(ppm)	1.526	7.729	2.780	0.500	37.000	62.4
Sb(ppm)	0.500	0.000	0.000	0.500	0.500	100.0

Table II-3-3 EDA analysis of soil analytical data

Elements	Median	Lower fence	Lower whisker	Lower hinge	Upper hinge	Upper whisker	Upper fence	Upper fence or more(%)
Au(ppb)	0.200	0.200	0.200	0.200	0.200	0.200	0.200	6.1
As(ppm)	0.500	-0.250	0.500	0.500	1.000	1.000	1.750	18.0
Sb(ppm)	0.500	0.500	0.500	0.500	0.500	0.500	0.500	100.0



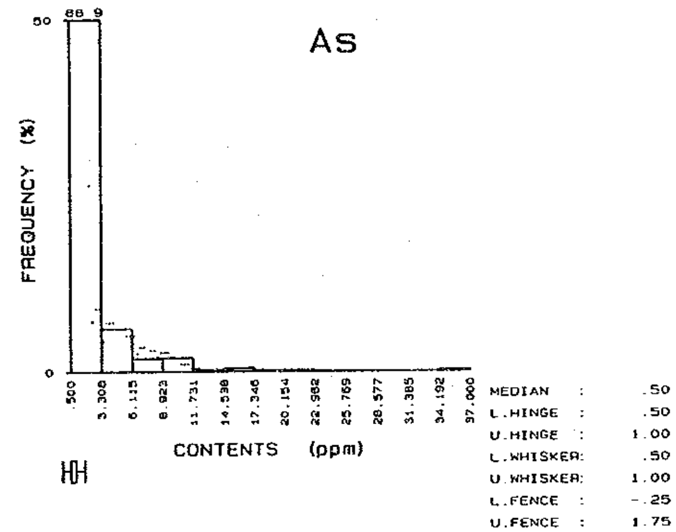


Figure II-3-2 Histograms and EDA boxplots for Au and As in soil

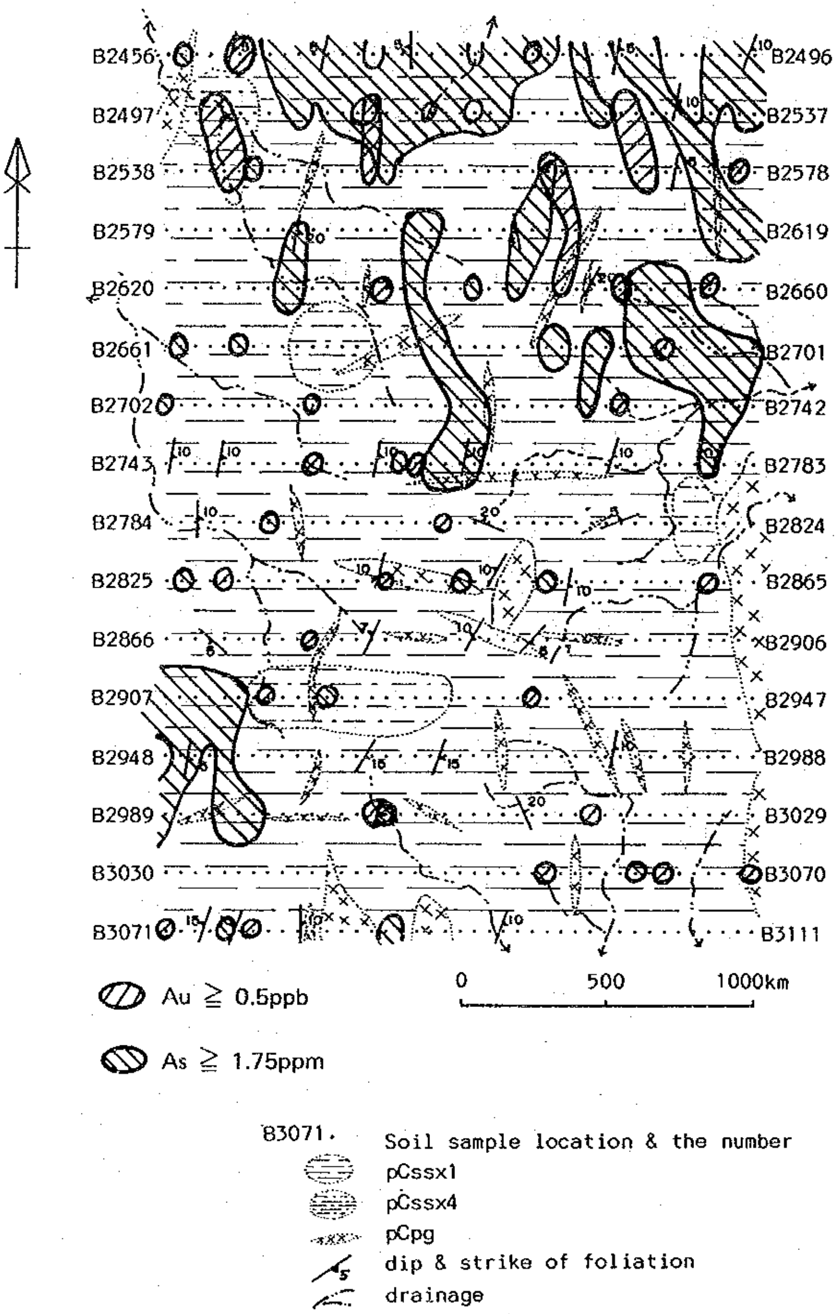


Figure II-3-3 Au and As anomalies in soil

(2) Arsenic (As)

The highest As content found in samples from this area was 37 ppm, and the lowest was below the detection limit (1 ppm). As contents below the detection limit comprised 62.4 % of the total. Considering the EDA upper fence value of 1.75 ppm obtained from the statistical processing, all those contents above this upper fence value were considered anomalous.

Anomalous zones defined by the distribution of samples containing As higher than 1.75 ppm are shown in Fig. II-3-3. The anomalous zones concentrate in the northern half of the area, and are all included within the distribution area of the pCssx1 unit. In the area "A" prospected last year, a high upper fence value of 6.75 ppm has been obtained, and an anomalous zone trending NNE-SSW was clearly defined. However, the anomalous values obtained in this area "B-I" are rather small, and their did not define any clear trend.

(3) Antimony (Sb)

All analyzed samples yielded antimony contents below the detection limit of 0.5 ppm. The survey carried out last year revealed very low Sb contents in samples from area "A", which are compatible with the results obtained in this area.

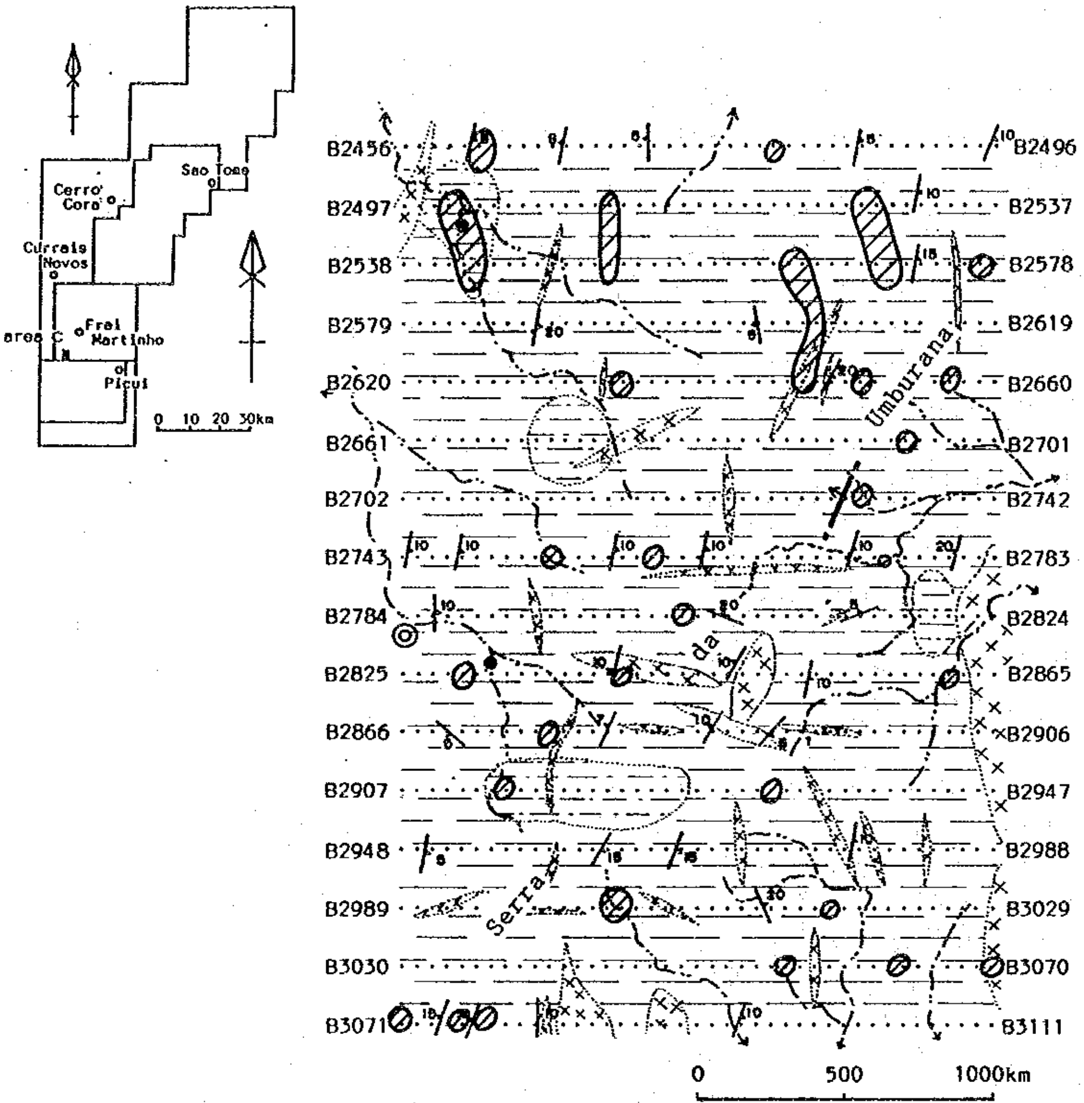
3-3 DISCUSSION

Auriferous quartz veins were not found during the detailed survey carried out on the northeastern Au anomalous zone. However, since this area is situated close to the ridge of the Umburana Range, and considering that NNE-SSW oriented sulfide-bearing quartz veins were found in the western foothills of this Range, it seems still plausible that similar quartz veins do exist somewhere nearby these obtained anomalies. (Fig. II-3-4)

The auriferous quartz veins discovered during last year' survey lay on the line linking the soil collection points B2702 and B2742, but no anomaly has been found around these veins, with 1 ppb in a sample collected from east of the veins being the highest content obtained in the vicinity. Moreover, sulfide-bearing quartz veins have been found during this year' survey on the line linking sample collection points B3030 and 3070, but no soil anomaly was found in the neighborhoods. Samples of quartz veins containing Fe oxides were collected nearby point B2642, and were analyzed by X-ray diffractometry in order to test for the presence of sulfides (Tab. II-4-3). Results indicated the presence of only limonite and hematite. Also, samples of dark-colored quartz veins were collected nearby points B3040 and B3042, and were analyzed by X-ray diffractometry. Results indicated the presence of quartz and dravite, and minor amounts of chlorite.

Furthermore, nearby those auriferous quartz veins above quoted, no arsenic anomaly in soils have been obtained. Since in this area arsenic seems to accompany gold mineralization, this result does not corroborate this relationship.

From the above stated, it can be concluded that, in this area, mineralization related to small scale auriferous quartz veins does not necessarily reflect in the composition of the overlying soils.



≧ 1ppb Au in soil

≧ 10,000ppb Au in pan concentrate

≧ 1,000ppb Au in pan concentrate

Point where gold particle was found

Auriferous quartz vein (Au, 0.2ppm; Ag, 103ppm)

B3112 Soil sampling point & number

Figure II-3-4 Summary of soil survey in area B-I