between No. 4 and No. 8. The former corresponds to "Anomalous zone A" and the latter to "Anomalous zone B" described on pseudosection.

"Anomalous zone A" is zonally distributed to the normal direction of the lines, and can be seen between No. 9 and No. 11 on n=5 plan map shifting to the south at depths. This shift suggests that the polarizable rock causing this anomaly may dip northward to the depths. The continuity of "Anomalous zone B" is obsucure in comparison with that of "Anoamlous zone A".

The area between the Anomalous zones "A" and "B", and north of "Anomalous zone B" show low PFE, therefore there may be no existence of polalrizable rocks in these region.

2–3–3　In-Situ Measurement

In-situ measurement was conducted at ten locations, where some formations are exposed, in order to investigate the PFE and resistivity of the formation on the outcrops.

A measuring method is dipole-dipole configuration with 5 m electrode spacing. The results are shown on Table II–5. It can be seen that L_3PsB and S_2Ps formations have high PFE, whereas L_3dolB and L_3lsB formations have medium PFE and others have low PFE. While S_2Ps, L_2PsB, and L_3dolC formations show high resistivity, and others low resistivity less than 1,000 Ωm.

Table II–5　Results of In-Situ Measurement

Location	PFE (%)	Apparent Resistivity (AR : Ωm)	Average (PFE)	Average (AR)	Formation
I–1	5.5~7.3	1,290 ~2,830	6.2	2,100	L_3ps B
I–2	1.8~2.9	246 ~ 892	2.6	560	L_3dol B
I–3	1.8~2.9	176 ~ 633	2.2	354	L_3ls B
I–4	0.5~1.5	82 ~ 277	0.9	169	L_3ps A
I–5	0.8~1.5	694 ~1,830	1.1	974	L_3ls A
I–6	5.1~7.7	4,020 ~8,670	6.3	6,350	S_2ps
I–7	0.1~1.1	93 ~ 361	0.7	165	L_2
I–8	0.5~1.0	224 ~ 432	0.7	338	L_3dol A_2
I–9	0.1~0.8	239 ~ 623	0.5	465	L_3l_3C
I–10	0.7~0.9	1,370 ~3,130	0.8	2,220	L_3dol C

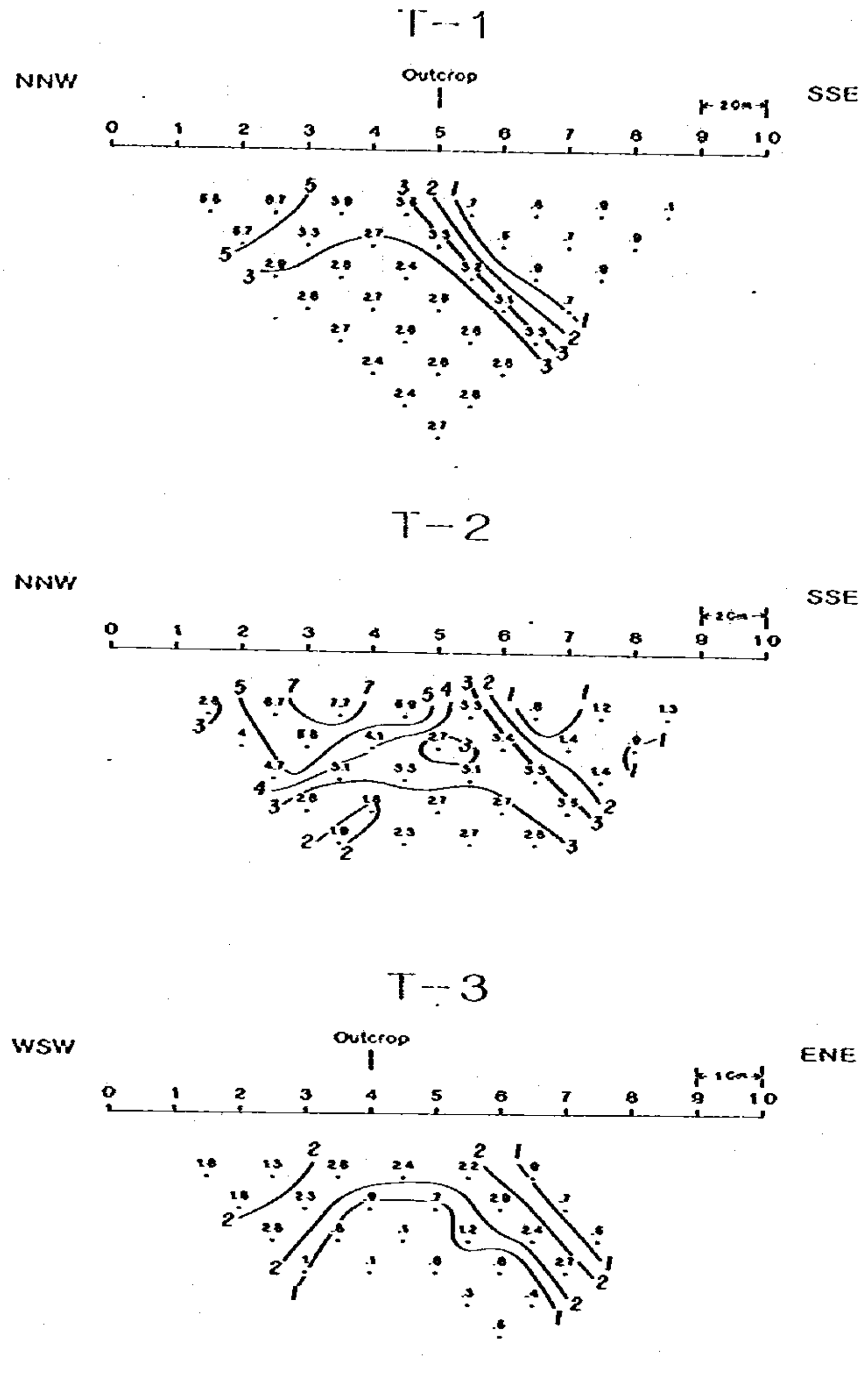


Fig. Ⅱ-21 Pseudosection of Percent Frequency Effect in Test Lines (T-1, T-2, T-3)

Moreover, in order to investigate the induced polarization effect caused by a vein, three IP test lines were set and in-situ measurement was carried out in the vicinity of St. Oswaldo outcrop, 150 m southeast of No. 9 on Line FA. Electrode configuration is dipole-dipole with 20 m electrode spacing on Lines T–1 and T–2, and 10 m on Line T–3. As results, a PFE anomaly of 3 to 4% was detected, which may be induced by St. Oswaldo outcrop, while strong PFE anomaly of more than 5% is considered to be caused by schist (Fig. II–18–1 ~ 2).

2–3–4 Model Simulation

In analyzing the contour pattern of PFE and AR, IP model simulation is frequently used as skillful means.

For the calculation, each section was divided into 2,750 elements and the assumed PFE and AR values were assigned to each element. A super computer CRAY–1 was used in the calculation by means of the finite element method. The computer prints out the calculated PFE and AR together with the assumed input model. By comparing the calculated values with the observed values, calculations are repeated to approach the observed value. In this procedure it is possible to simulate the geological structure. But, as a property of formation is variable, the combination of assumed electrical properties are so many that it would be difficult to reach close agreement between observed and calculated values. For the calculation, it is possible to set an assumption on 20 types of code. A model calculation was performed for Lines FA and FD. Mode pseudosections were primarily made up on the basis of geological sections, and a high value of 8 to 10% was designated for schist (S_2Ps formation) which would cause a strong IP anomaly, and also 4 to 8% for limestone (L_3lsB) and dolomite (L_3dolB). As for resistivity, high values of 5,000 to 8,000 Ωm for limestone (L_3lsA) and dolomite (L_3dolA$_2$) and low values less than 1,000 Ωm for limestone (L_3lsB) were assigned referring to the laboratory and in-situ measurement. Other parameters used are shown on the code table. After several iterations, a satisfactory agreement with the observed values was finally achieved for Lines FA and FD.

2–4 Relation of Results with Geology

The comparison of the geological map with plan map of PFE and AR on n=1 presents more interpretation for the relation with geology.

"Anomalous zone A", "Anomalous zone B", "L", and "H" are caused by the sources continued to the southwest direction, and these distribution match well with the geological structure.

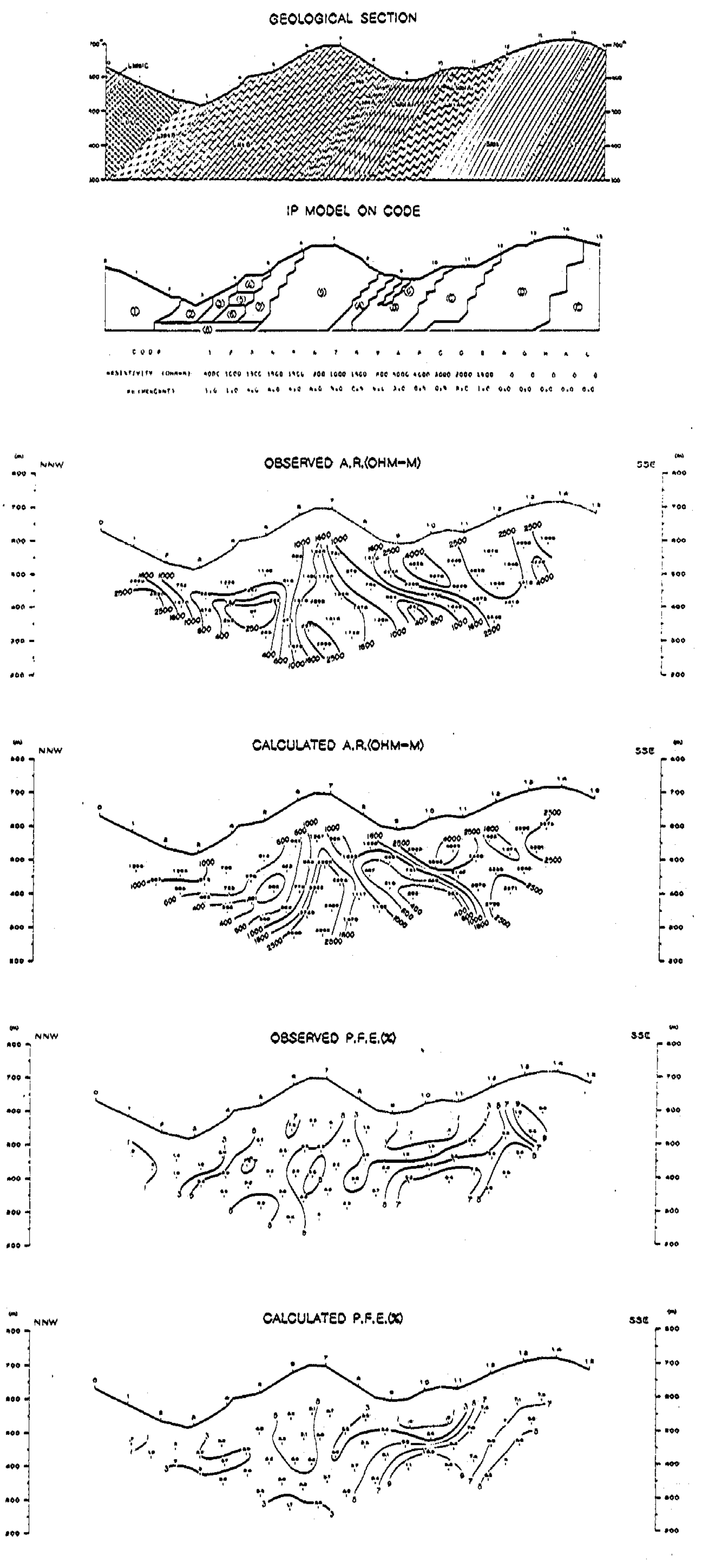


Fig. II-22-1 Model Simulation (Line-FA)

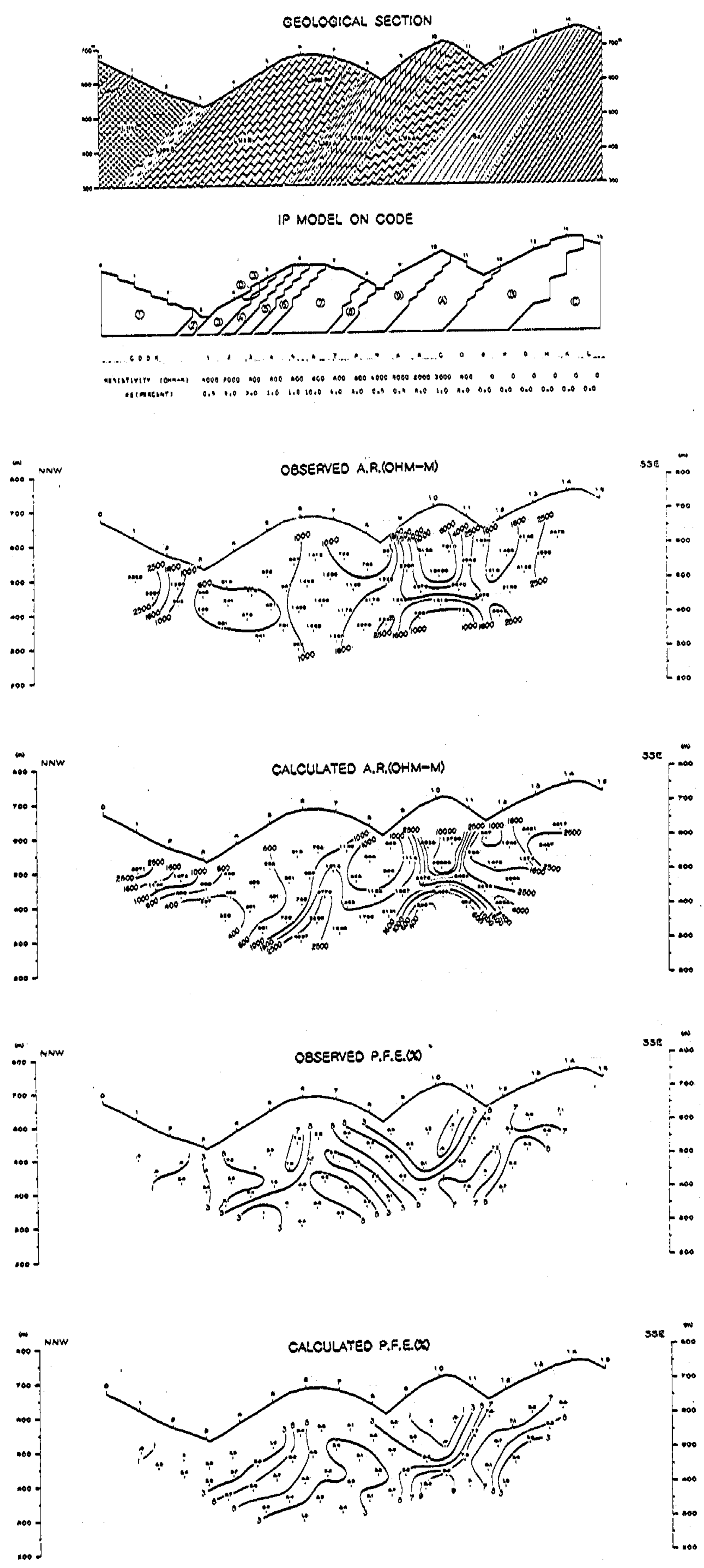
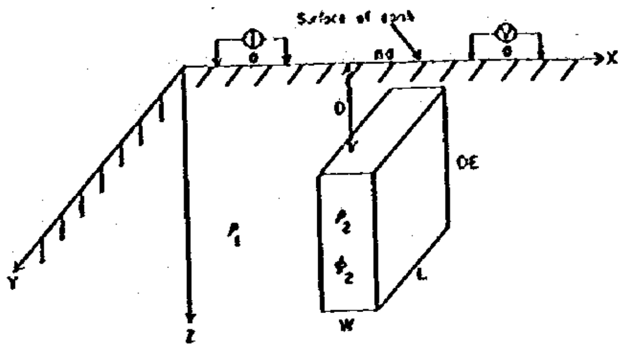
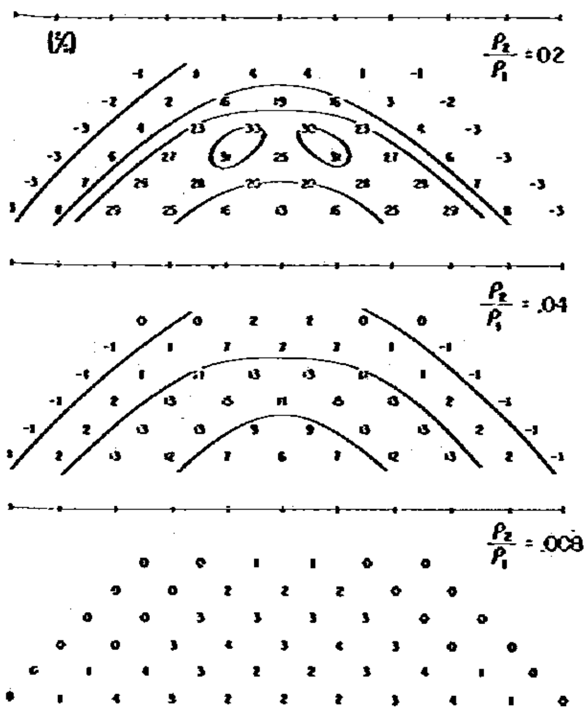


Fig. II-22-2 Model Simulation (Line-FD)

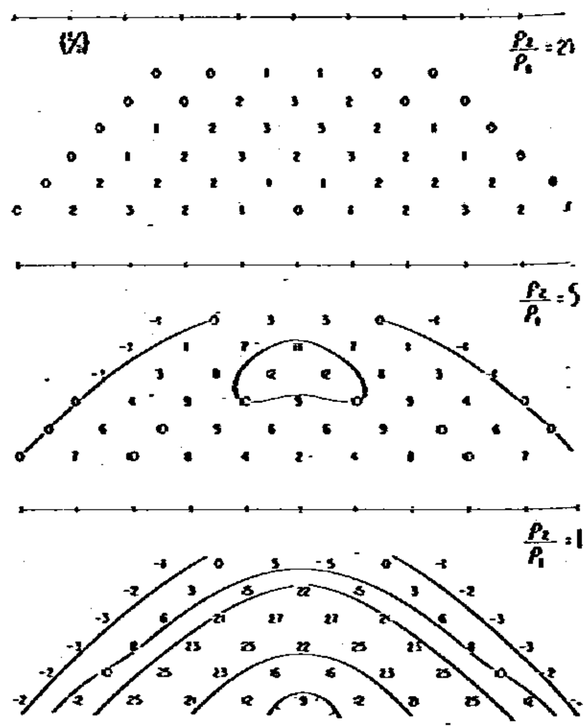


D : Depth from the surface
DE: Hight of Prism
L : Length of Prism
W : Width of Prism
ρ_1: Resistivity
ρ_2: Resistivity of Prism
ϕ_2: FE

Prism Model for IP Response Study



Effect of Resistivity Contrast on IP Response; D = 2, DE = 4, L = 5, W = 1



Effect of Resistivity Contrast on IP Response; D = 2, DE = 4, L = 5, W = 1

Fig. II-23 Example of Prism Model for IP Response

"Anomalous zone B" almost fits to the distribution of "L", in which limestone (L_3lsB) is mainly underlain. Normally limestone is of high resistivity, but L_3lsB shows low value. Low resistivity of L_3lsB may attribute to conductive materials such as muddy dolomite and selicite-schist containing graphite, interbedded along the dip of formation. More conductive portions seem to correspond to water saturation.

"Anomalous zone B" consists of PFE anomalies induced by small scale of polarizable objects. It seems that this anomaly would be due to pyrite dissemination in muddy dolomite interbedded in limestone (L_3lsB) according to the surface geology. Anomalous zones having more than −40 mrad would indicate a relatively concentrated portion of pyrite.

"Anomalous zone A" is due to schist (S_2Ps) and corresponds to medium resistivity. In general, schist has low resistivity, but in this area it shows almost the same value as limestone. This would be due to schist in the area which is relatively compact and contains a great deal of quartz. Anomaly detected within schist, is thought to be caused by film-shaped graphite and pyrite mineralization.

While, no IP anomaly are detected in the area underlain by limestone (L_3lsA) and dolomite (L_3dolA), which are the ore-bearing horizon in the Furnas mine, and "H" agree with the distribution of L_3lsA and L_3dolA.

Therefore, these formations are thought to be a non-polarizable and compact rock and there exist a small amount of pyritization in the formation. Accordingly, it seems not to have caused an induced polarization effect.

An anomaly caused by ore deposit under exploration, which is embedded approximately 150 m in depth under No. 8–9 on Line FA, was not detected by either IP and SIP method. While in-situ measurement, done over the outcrop of this deposit, detects an IP anomaly. Accordingly, it is considered that the reasons why no anomaly was detected are as follows: A scale of deposit is so small in comparison with the depth to the deposit, and an electric current flow from the surface was interrupted by the non-polarizable and resistive host rock, which does not excite induced polarization effect by the deposit.

2–5 Summary

The results obtained by IP and SIP surveys are summarized as follows:

(1) The distribution of AR correlates closely with the geological structure and the adrupt change of the AR indicates the boundary of formation, and AR would reflect lighology of formation.

(2) Two distinct anomalous zones were revealed in the area. One is detected in north (around No. 3 – No. 8) of each line with low resistivity and medium to high PFE. This anomaly seems to be caused by graphite interbedded in limestone, and shows spectral type of "C". Another is distributed in south (around No. 12 – No. 14) of each line with medium to high resistivity. This anomaly continues from the surface to the depths dipping northward and corresponds to the distribution of schist. In general, schist has low resistivity, but in this area it shows high resistivity. This would be due to compact schist in the area which contains a great deal of quartz. The anomaly caused by film-shaped graphite in the schist has spectral type of "B".

(3) These two anomalous zones "A" and "B" are considered to continue to the east and to the west beyond the survey area along the geological strike.

(4) The spectral type of limestone and dolomite in laboratory measurement is similar with type "C".

(5) The reasons why no anomalies were detected in the ore horizon are as follows: there are non-polarizable and resistive rocks in the horizon and a scale of deposit is so small for detection. If there exists a wide range of mineralization as the larger scale of deposit, an anomaly could be detectable.

(6) In the geological circumstances like the Furnas area, geophysical methods utilizing a drilling hole and gallery would be most useful for mineral exploration.

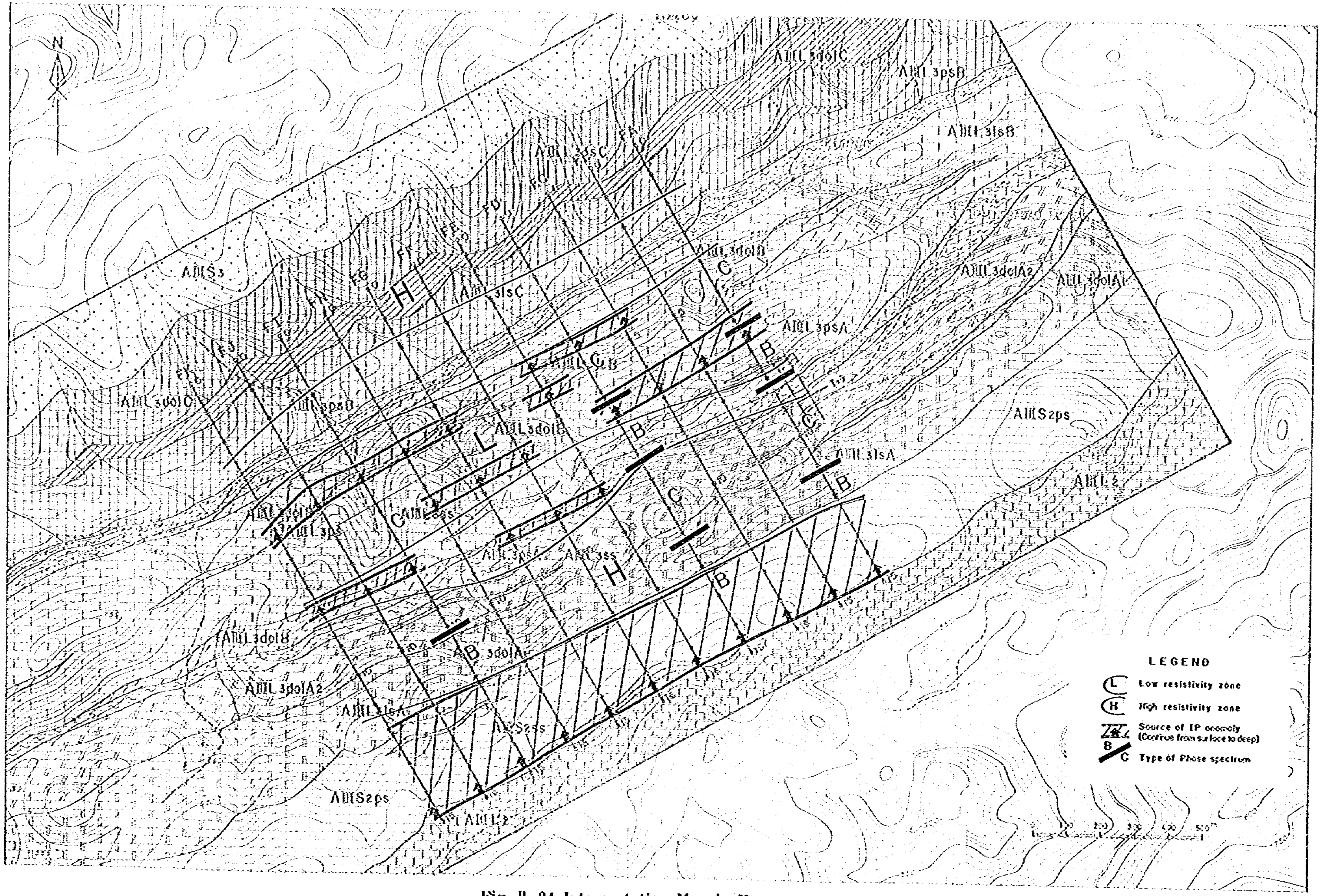


Fig. II-24 Interpretation Map in Furnas Area

PART Ⅲ DRILLING SURVEY

CHAPTER 1 SUMMARY OF DRILLING

1-1 Purpose of Survey

The drill survey in Phase IV in the Anta Gorda region in the Federative Republic of Brazil was conducted in the Perau area and the Barrinha area.

In the Perau area, three holes of AG-04, AG-05 and AG-06 were cut in order to confirm the continuity and the grade of ore of the stratiform lead and zinc deposit encountered by drilling performed in Phase III.

In the Barrinha area, two holes of AG-B1 and AG-B2 were drilled in order to make clear the condition of anomalies detected by geophysical survey (IP and SIP) conducted in Phase III and the geologic structure in the surroundings to lead to contribute to the survey in future.

1-2 Summary of Operation

The drill works of the survey at the site were performed by Companhia de Pesquisa de Recursos Minerais (CPRM), a Brazilian company for exploration and the Bishimetal Exploration Co., Ltd. supervised the works at the site, and conducted logging and analytical research.

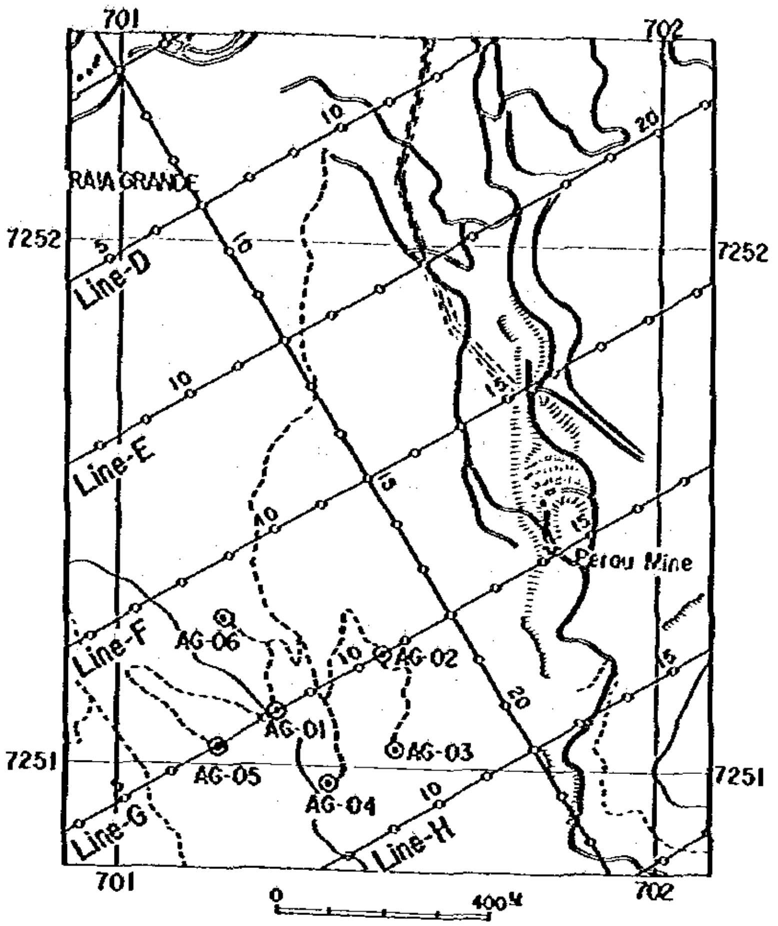
The drill works was initiated by collaring of Hole AG-B1 on September 9, 1983 and all the works were completed by finishing the drilling of Hole AG-05 on January 27, 1984.

Completion of the works was greatly delayed than the initial schedule because of the delay of start of drilling due to a heavy rain continued in the southern part of Brazil and the accident of breakage of rod (AG-05).

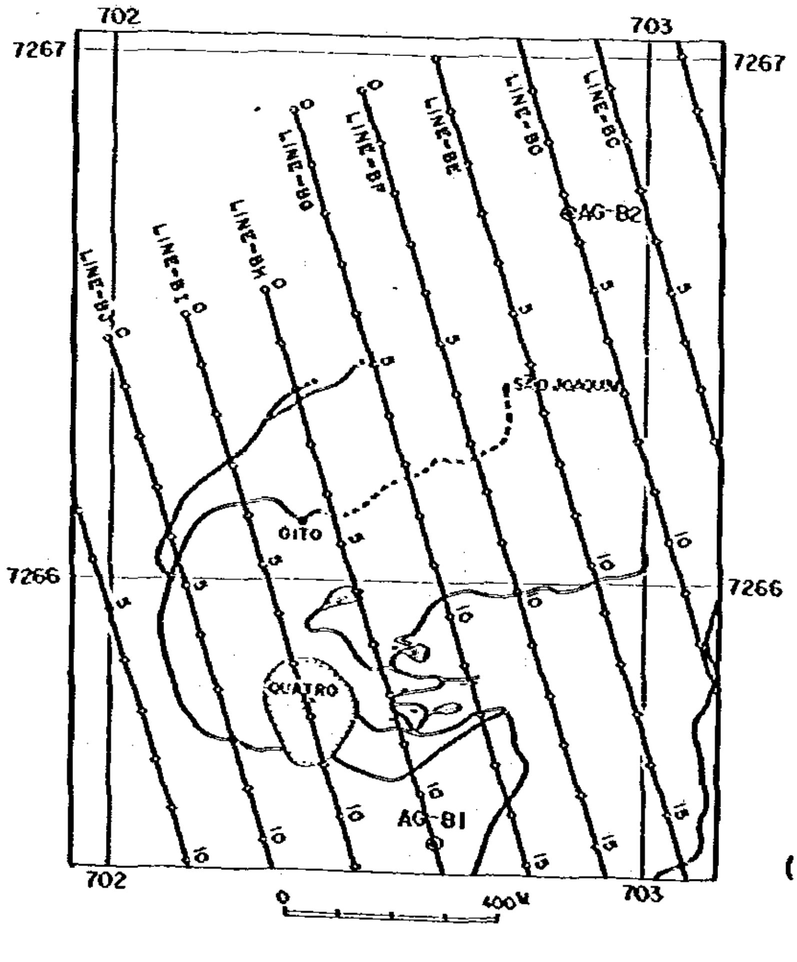
Four drilling machines were used, such as one Boyles Brothers BBS-56 (drilling capacity 600 m in NQ size and 1,000 m in BQ size), two BBS-35 (400 m in NQ size and 600 m in BQ size) and one Longyear L-34 (300 m in NQ size and 500 m in BQ size).

The drill works were carried out by two shifts of each 10 hours in principle.

The wireline method was used to improve core recovery and progress of work. The hole inclinations were measured by using Tro-Pari during the period of drilling or after completion of each hole.



(Pérou Area)



(Barrinha Area)

Fig. Ⅲ-1 Location Map of the Drilling Holes

The amount of drill works is as follows:

Area	Hole No.	Dip	Hole length	Core length	Core recovery*
Perau	AG-04	-90°	220.00 m	214.40 m	97.45%
	AG-05	-90°	361.60	346.05	95.70
	AG-06	-90°	350.00	335.40	95.83
Barrinha	AG-B1	-90°	300.00	299.30	99.76
	AG-B2	-60° (S20°E)	300.00	292.00	97.33

1-3 Logging and Analysis Work

Identification of rock facies, alteration and mineralization were performed for all the cores recovered, and these were compiled to the geological columnar section 1 : 200 in scale (PL. III-1, 2).

For the ore section, a half of the core was sampled by using rock cutter, the samples for analysis were prepared, and they were analyzed for each element of Cu, Pb, Zn and Ag.

Thin sections and polished sections of the rocks and ore were produced for microscopic observation.

The number of samples analyzed and microscopically observed are as follows:

(1) Microscopic observation of polished section . . .10

(2) Analysis of ore (Cu, Pb, Zn, and Ag) 22

* Note: The length of overburden is not included in the calculation of core recovery

CHAPTER 2 DIAMOND DRILLING WORK

2–1 Access Road for Transporting Equipment and Materials

A Japanese member left Tokyo on August 26, 1983 in advance of others made preliminary survey of the drill site and consulted with the Brazilian counterparts and the staff of CPRM in charge of drilling on construction of access road and the plan for maneuvering of materials and machines.

The construction work was conducted for new road 3.5 m wide for about 2.0 km and for repairing for about 2.5 km by using two bulldozers (Caterpillar 5–D).

Because of a steep landform in the mountainous area of an altitude of 400 to 700 m above sea level and thick wooded hill and because of the soft ground after the long heavy rain continued in southern Brazil, the construction work of the road was extremely difficult. Especially, the mine road to the Perau mine was closed having been cut into pieces due to heavy rain. Therefore, a new road for transportation of ore was used in place, which was also closed by every rain fall. All these resulted in a great delay of construction of the maneuvering road.

2–2 Location of Drill Holes

The locations of the drill holes in the Perau and the Barrinha areas are as shown in Figure III–1, Plate III–1 and Plate III–2. The details of each hole are as follows:

Area	Hole	Distance in longitude	Distance in latitude	Altitude a.s.l.(m)	Survey line
Perau	AG–04	7250.96 N	701.40 E	460	Midway between G and H lines 8.4 m
	AG–05	7251.03 N	701.18 E	490	G-line 7.0 m
	AG–06	7051.38 N	701.18 E	440	Midway between F and Glines 8.3 m
Barrinha	AG–B1	7265.49 N	702.60 E	630	BH line 11.0 m
	AG–B2	7266.71 N	702.83 E	510	BD line 3.0 m

2–3 *Preparation Work*

2–3–1 Transportation of Mechanical Equipment and Material

Mechanical Equipment and materials, and the operators were transported by a truck of a large size and a pick-up truck from Poços de Caldas to the site on September 1. The materials and the operators were added on October 30.

2–3–2 Preparation

The preparation was first started at AG–06. Leveling of ground for setting of drill machine was made by a bulldozer.

Construction of road to AG–04 and AG–05 and leveling of the ground for these was made during the drilling of AG–06. The access was often disrupted by rain and time was wasted for repairing considerably.

Construction in the Barrinha area was started at AG–B1, That for AG–B2 was made during the drilling of AG–B1.

2–3–3 Water Supply for Drilling

The water supply for drilling was obtained, in the Perau area, from Barreiro Creek which runs through the area of drill site, by damming up the stream and pumping up water to feed it for drilling.

In the Barrinha area, the water for drilling was fed from a tributary of Barrinha do Forquilha Creek by damming up and pumping it up.

The heads of pumping at each hole were as follows.

Perau Area	AG–04	5 m
	AG–05	85 m
	AG–06	5 m
Barrinha Area	AG–B1	30 m
	AG–B2	120 m

2–4 Drilling Works

The overburden penetrated dug by a conventional method using NW metal bit. In the section where the overburden was thin (AG–05), drilling was started by NQ wireline method. After encountering the bed rock, NQ wireline was used finally reducing to BQ.

The status of drilling of each hole is as follows (Fig. III–2–1 ~ 5).

2–4–1 AG–04

Drill length	220.00 m
Core length	214.40 m
Core recovery	97.45%
Start of drilling	Oct. 25, 1983, Redrilling Nov. 19, 1983
Completion of drilling	Dec. 8, 1983

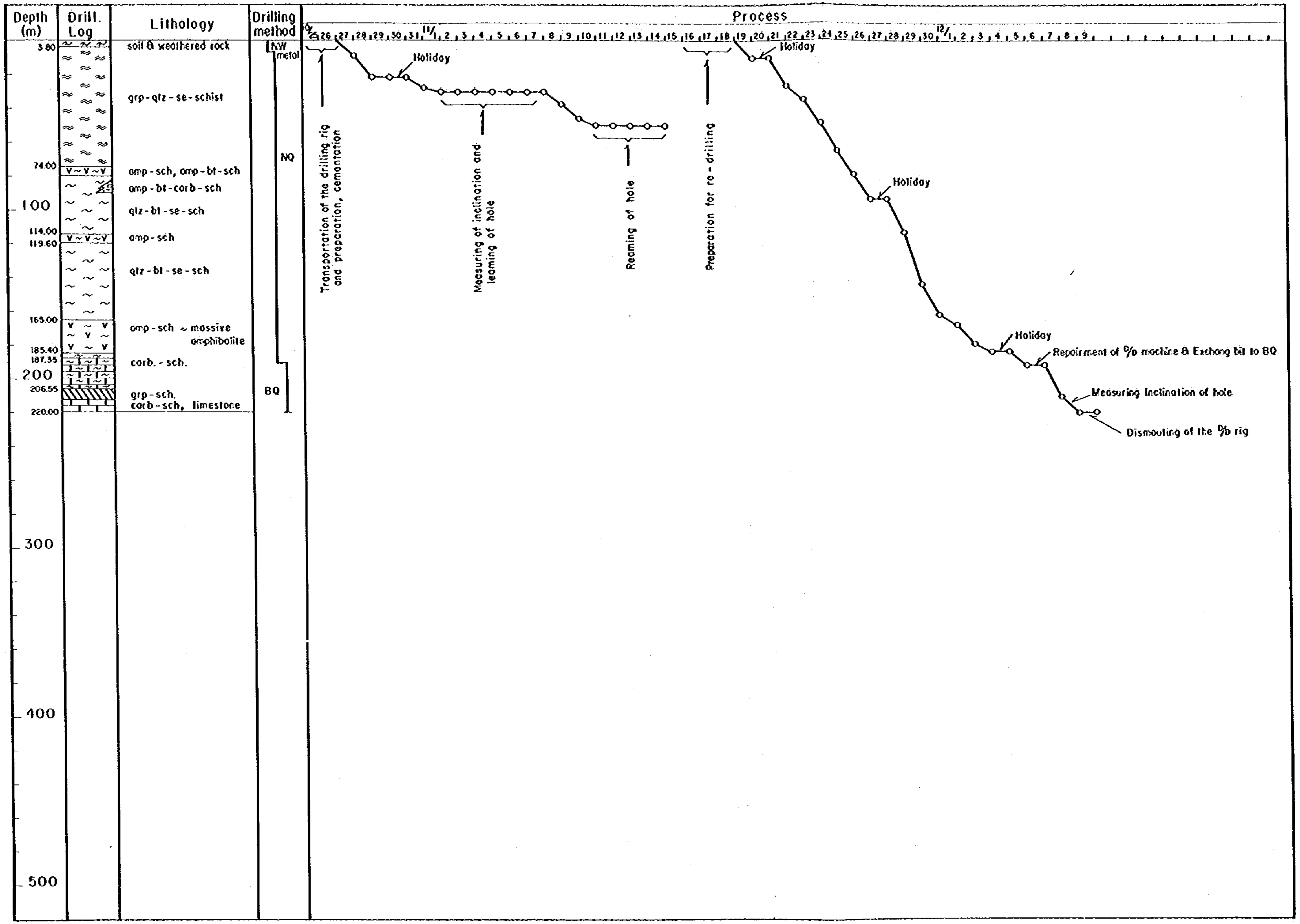


Fig. Ⅱ-2-1 Progress Record of Diamond Drilling of AG-04

The hole was drilled at first to the depth of 49.35 meters, but it was stopped because of strong deviation of the hole, and redrilled.

0 m ~ 3.80 m

The overburden was penetrated by the conventional method using NW metal bit.

3.80 m ~ 191.75 m

Mica schist, amphibolite, amphibole schist and carbonate schist were cut by the wireline method using NQ diamond bit.

The rocks were stable and drilled favorably up to 191.75 m.

Then, NQ diamond bit was replaced to BQ diamond bit.

191.75 m ~ 220 m

Carbonate schist, graphite schist to phyllite and limestone were drilled by the wireline method using BQ diamond bit. A weak mineralized zone of lead and zinc was encountered at about 200 m, then the drilling was stopped at 220.00 m by having confirmed graphite schist and limestone in the footwall.

2-4-2 AG-05

Drill length	361.60 m
Core length	346.05 m
Core recovery	95.70%
Start of drilling	Nov. 25, 1983
Completion of drilling	Jan. 27, 1984

0 m ~ 228.75 m

Since the bed rock was exposed at the collar, mica schist and amphibolite were drilled by the wireline method using NQ diamond bit. The rock was stable and drilled favorably to 228.75 m, where NQ bit was replaced by BQ diamond bit.

228.75 m ~ 327.00 m

Mica schist and amphibolite were cut up to 327.00 m by the wireline method using BQ diamond bit, but an argillized zone was encountered between 319.30 m and 328.60 m, in which drilling became impossible because of jamming. Reaming by NQ diamond bit was started from 228.75 m, and then the rod was broken at about 258.00 meters. It took 26 days to recover the hole (including the period of Christmas and New Year holidays from December 23 to January 2). After that, reaming was continued to 316 meters by NQ bit, where the bit was replaced by BQ bit. Then mica schist, amphibolite and carbonate rocks were drilled by BQ diamond bit. Lead and zinc ore was intersected at the section from

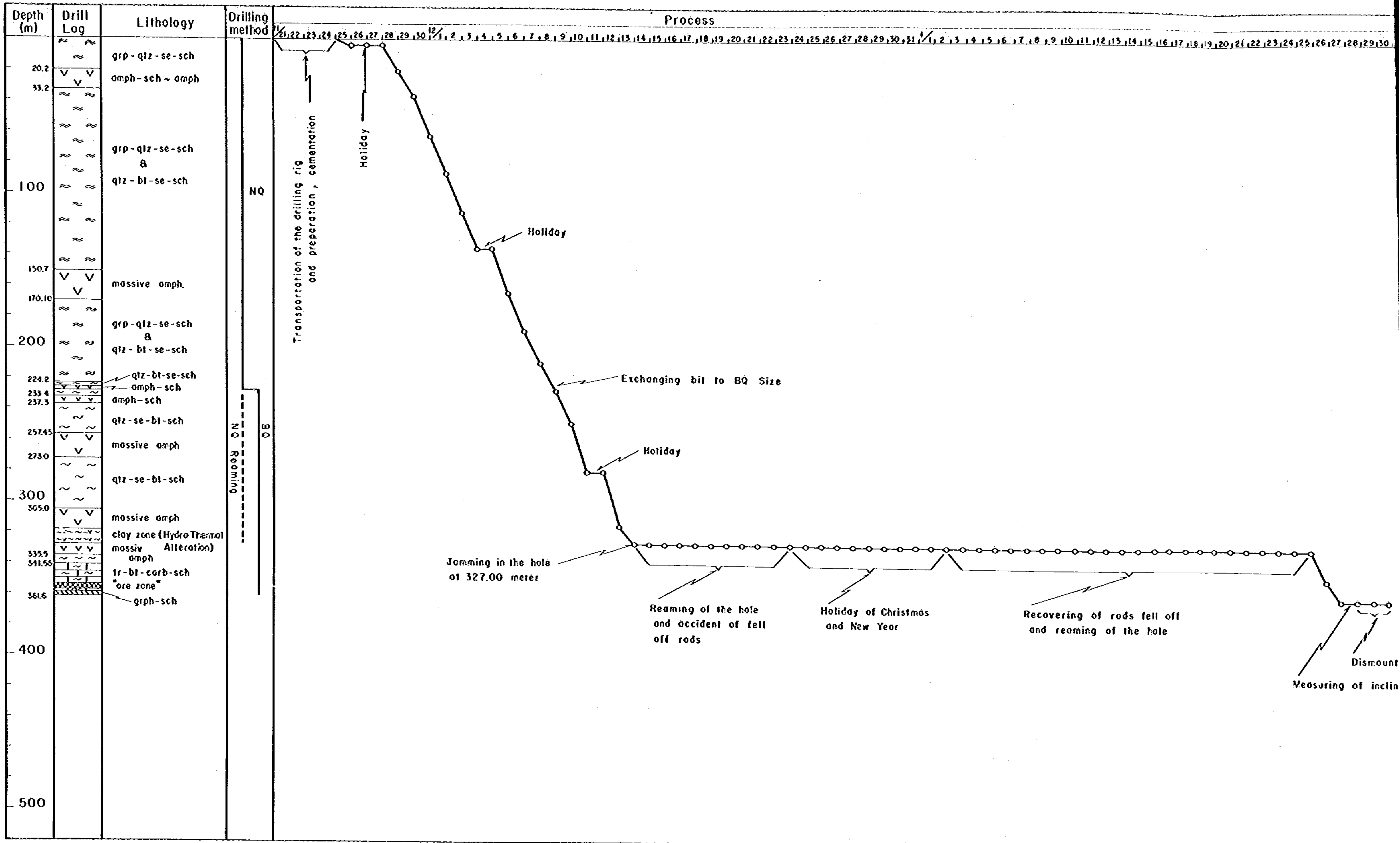


Fig. II-2-2 Progress Record of Diamond Drilling of AG-05

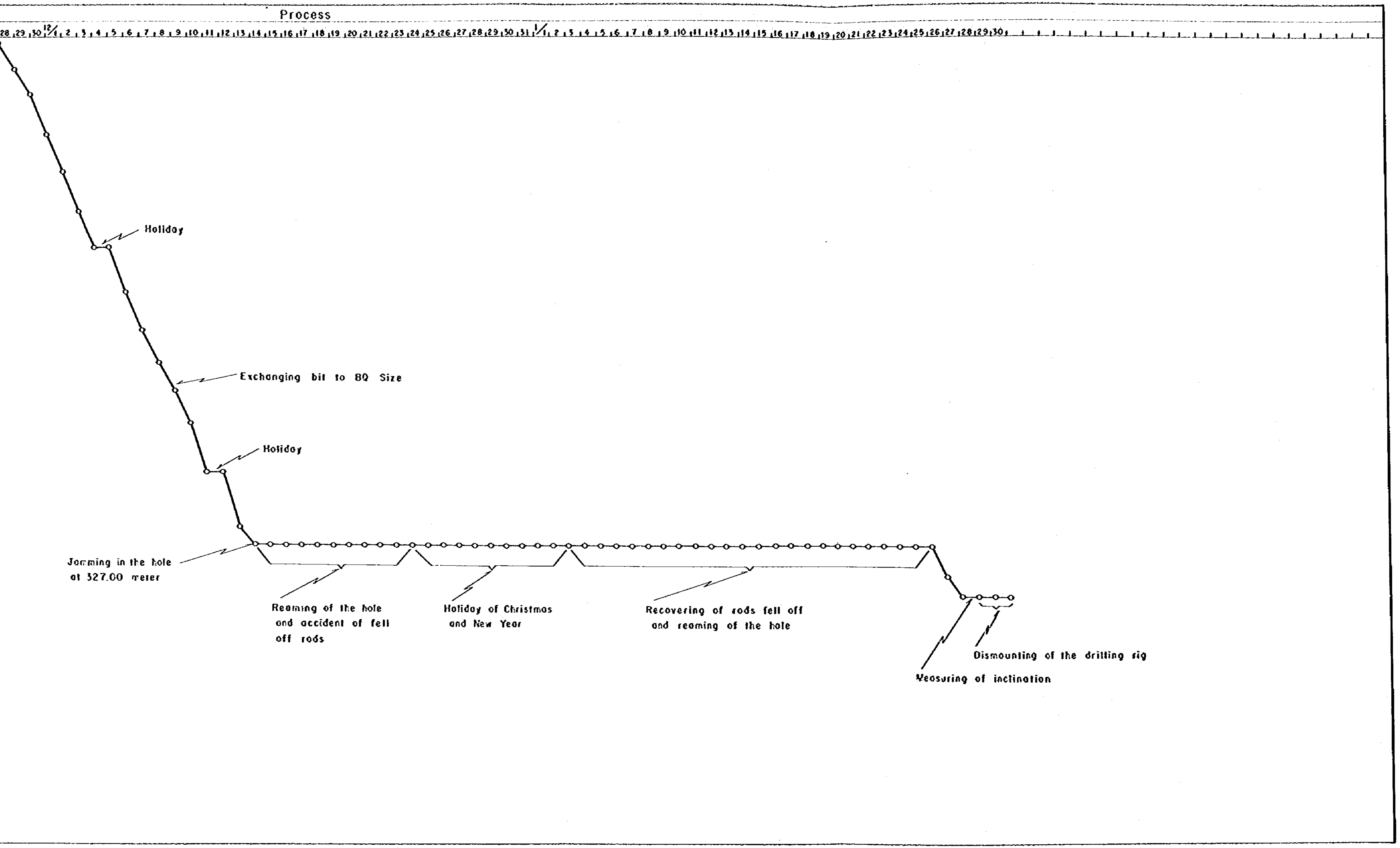


Fig. ▮-2-2 Progress Record of Diamond Drilling of AG-05

354.65 to 358.35 m. The hole was finished at 361.60 m by having confirmed graphite schist to phyllite in the footwall of the ore horizon.

2–4–3 AG–06

The hole was at first drilled down to 163.30 m, where it was stopped because of strong deviation of the hole, and it was redrilled.

Drill length	350.00 m
Core length	335.40 m
Core recovery	95.83%
Start of drilling	October 28, 1983
Completion of Drilling	December 20, 1983

0 m ~ 4.00 m

Overburden was penetrated by the conventional method using NW metal bit.

4.00 m ~ 219.65 m

Mica schist, amphibolite and diabase were drilled by wireline method using NQ diamond bit. Although the rocks were stable and drilling was favorable, the spindle arm of the drill machine (BBS–56) was broken at 182.55 mm, and it was judged to be impossible of repairing. Thus the machine was replaced by Longyear L–34 and drilling was continued.

219.65 m ~ 350.00 m

Mica schist, amphibolite and carbonate rocks were drilled down to 329.40 m by wireline method using BQ diamond bit, and lead and zinc mineralized zone was encountered between 327.55 and 329.40 m. After that, graphite schist to phyllite of the footwall of the mineralized zone was confirmed at the section from 329.40 m to 346.50 m, and further limestone was encountered below that. Thus the hole was finished at 350.00 m.

2–4–4 AG–B1

Drill length	300.00 m
Core length	299.30 m
Core recovery	99.76%
Start of drilling	September 9, 1983
Completion of drilling	October 6, 1983

0 m ~ 45.80 m

Overburden was penetrated by the conventional method using NQ metal bit and bentonite-mud water.

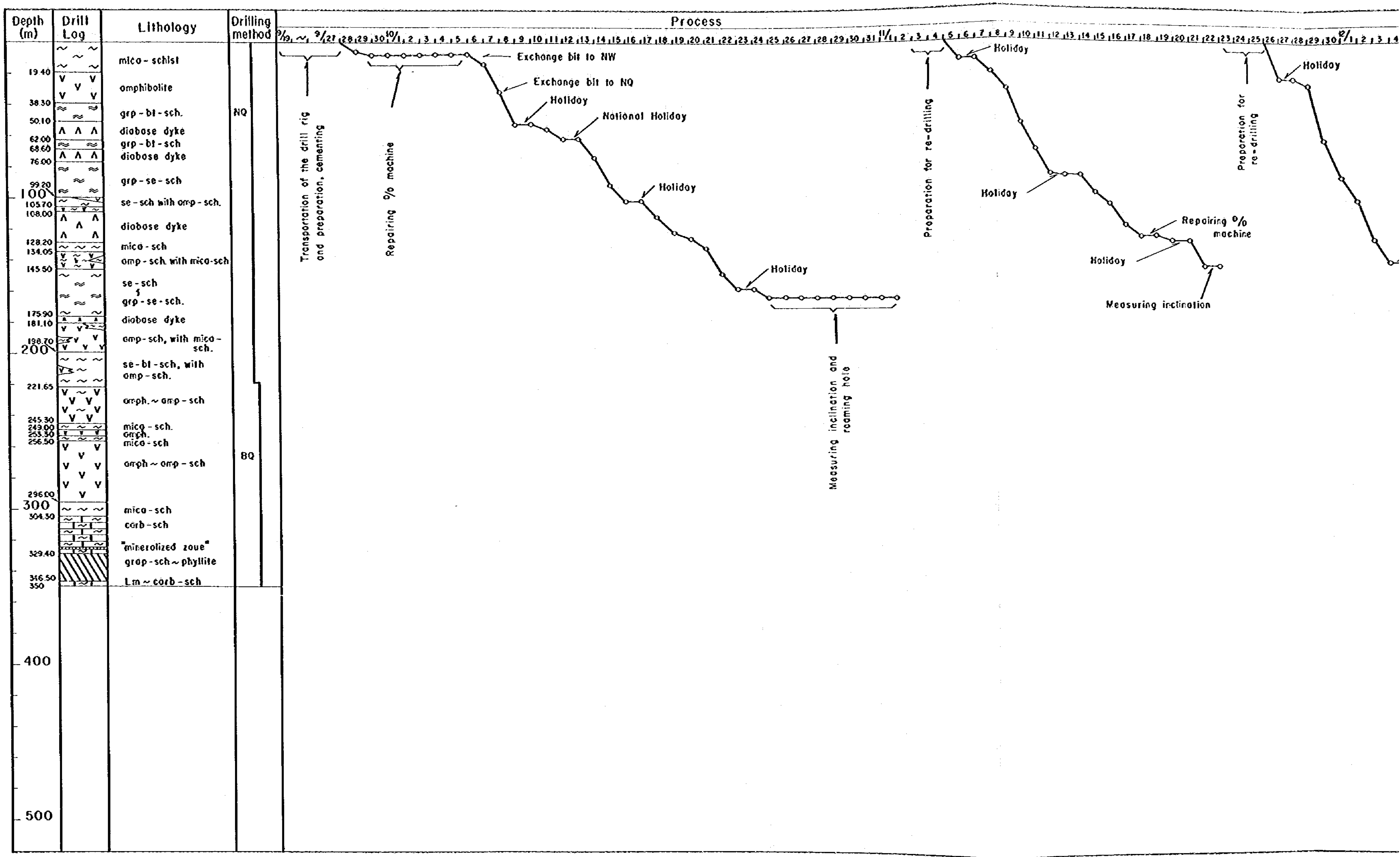


Fig. Ⅱ-2-3 Progress Record of Diamond Drilling of AG-06

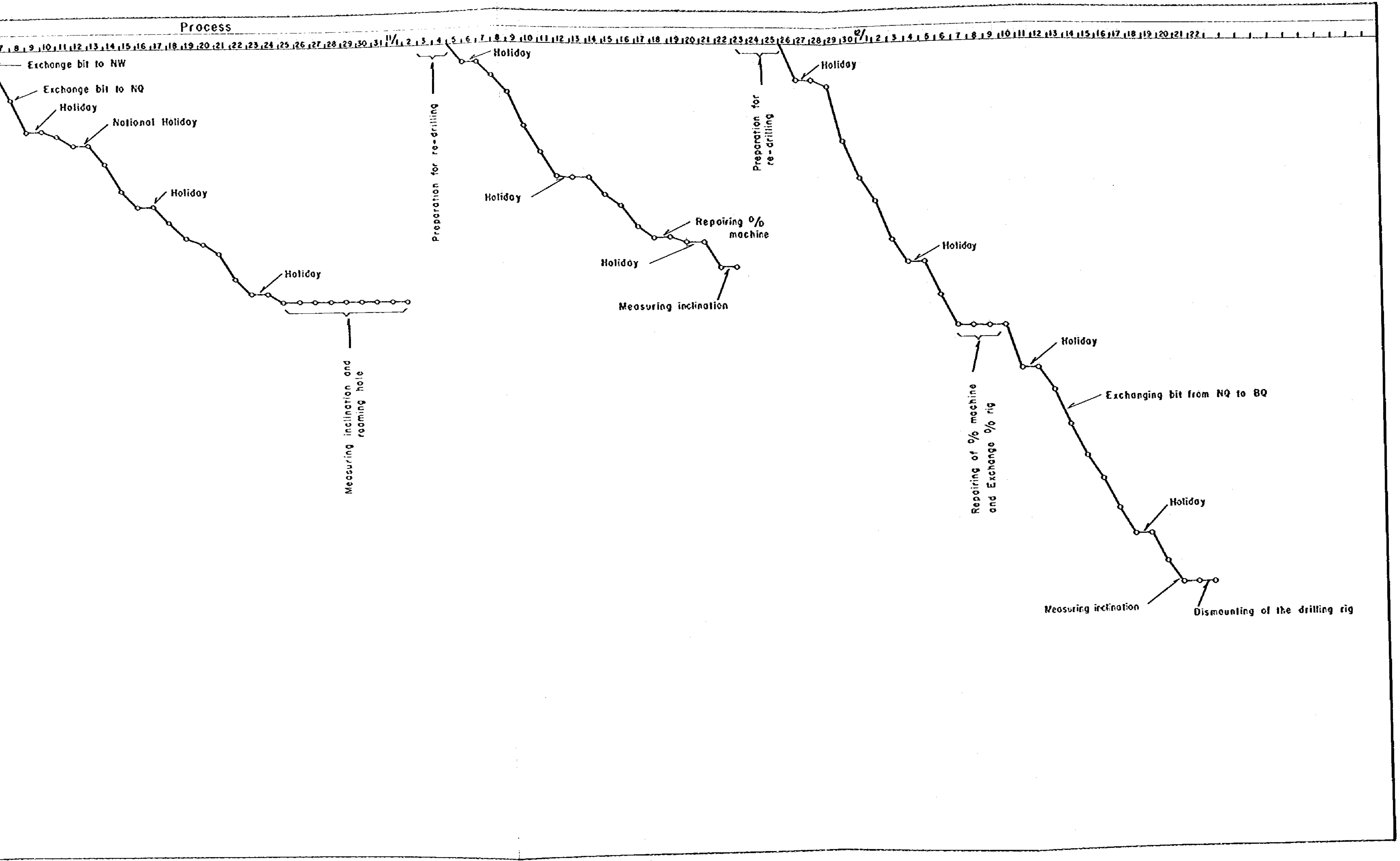


Fig. Ⅱ-2-3 Progress Record of Diamond Drilling of AG-06

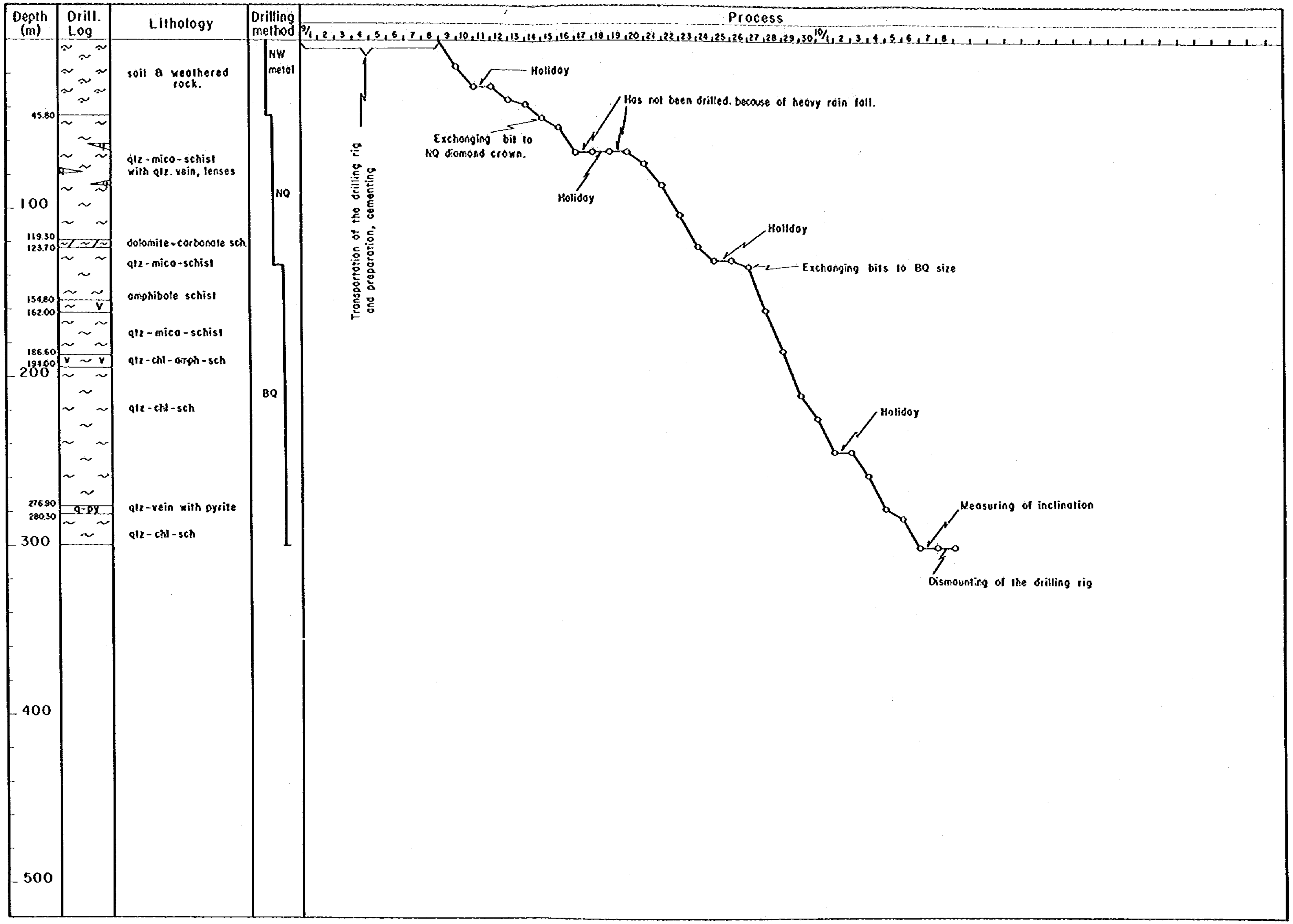


Fig. II-2-4 Progress Record of Diamond Drilling of AG-B1

45.80 m ~ 133.85 m

Chlorite schist, quartz veins and carbonate rocks were drilled by NQ diamond bit-wireline method by the use of bentonite-mud water. The core was often broken from 14.25 m to 45.80 m because of strong weathering of rocks, resulting in poor efficiency of drilling. When quartz vein was encountered, the drilling speed was markedly reduced and consumption of bit was remarkable. NQ diamond bit was exchanged to BQ diamond bit at 133.85 m.

133.85 m ~ 300.00 m

Chlorite-mica schist, quartz veins and amphibole-schist were drilled by the wireline method using BQ diamond bit. A quartz vein with notable mineralization of pyrite was encountered between 276.90 m and 280.30 m, then the hole was finished at 300.00 m as scheduled. The rocks were stable and drilled favorably.

2-4-5 AG-B2

Drill length	300.00 m
Core length	292.00 m
Core recovery	97.33%
Start of drilling	October 17, 1983
Completion of drilling	November 15, 1983

0 m ~ 14.25 m

Overburden was drilled by the conventional method using NW metal bit.

14.25 m ~ 204.55 m

Mica schist, quartzose schist to quartzitic schist, graphitic mica schist and diabase dyke were drilled by wireline method using NQ diamond bit. A remarkable oxidized zone continued up to 40 m, in which oxide iron was formed in the cracks, and core is breakable. The rocks were stable below 40 m, which was drilled favorably. NQ diamond bit was exchanged to BQ diamond bit at 204.55 m.

204.55 m ~ 300.00 m

Graphitic mica schist and diabase dyke were drilled by wireline method using BQ diamond bit. The rocks were stable and drilled favorably, and the hole was finished at 300 m as scheduled.

2-5 Measurement of Drill Holes

When drilling is made in the terrain of schistose rocks, the drill hole generally tends to

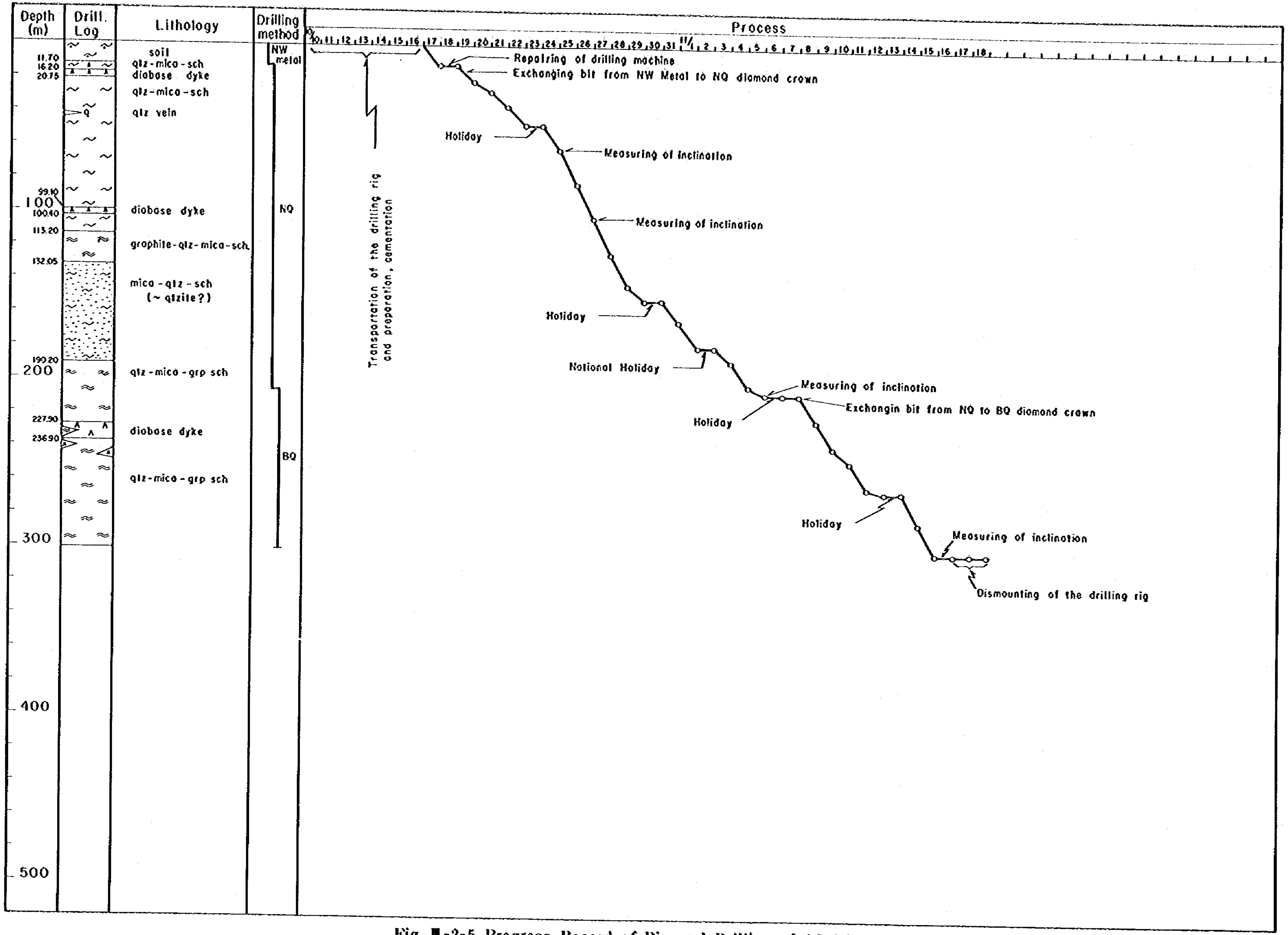


Fig. Ⅱ-2-5 Progress Record of Diamond Drilling of AG-B2 deviate to the direction perpendicular to the schistosity plane or bedding plane.

The measurement of deviation of holes using the Tro Pari survey instrument was conducted in order to get hold deviaiton accurately.

AG-04 and AG-06 were redrilled, because the measurement of holes were greatly deviated from the target position.

In the Perau area, the presence of pyrrhotite dissemination in the amphibolite and "magnetite zone" in the hanging wall of the ore horizon produce a notable error for measurement of values of azimuth.

The result of the survey is as follows:

AG-04 (planned dip, -90°)

Depth surveyed	Angle of deviation	Azimuth
70 m	5° ~ 7°	232°
125 m	8° ~ 10°	62°
170 m	18° ~ 10°	82°
220 m	19°	84°

AG-05 (planned dip, -90°)

Depth surveyed	Angle of devaition	Azimuth
80 m	2°	156°
130 m	5°	145°
180 m	10°	135°
230 m	18°	110°
280 m	25°	97°
330 m	25°	86°

AG-06 (Planned dip, -90°)	Angle of deviation	Azimuth
50 m	8°	122°
100 m	8°	160°
150 m	10°	160°
200 m	14°	119°
250 m	22°	116°
300 m	27°	111°
350 m	28°	116°

AG-B1 (planned dip, −90°)

Depth surveyed	Angle of deviation	Azimuth
50 m	1°	–
100 m	1°	–
150 m	6°	170°
200 m	24°	166°
250 m	36°	174°
300 m	49°	177°

AG-B2(planned dip, −60°, azimuth S20°E)

Depth surveyed	Angle of deviation	Azimuth
50 m	2°	–
100 m	6°	–
150 m	10°	–
200 m	17°	188°
250 m	22°	187°
300 m	22°	186°

CHAPTER 3 GEOLOGY AND MINERALIZATION DRILL HOLES

3-1 AG-04

(1) Purpose : The hole was drilled to clarify the extention of mineralized zone and the geologic structure in the area where AG-01 and AG-03 drilled in Phase III.

(2) Location : The hole was located near the point No. 8, in the midway between G-Line of IP survey line.

Latitude 7250.96 N

Longitude 701.40 E

Altitude 460 m

(3) Rock facies : The bed rock was encountered at 3.80 m, and up to 65.00 m, the rocks consist mainly of graphitic mica schist interbedded with thin layers of amphibolite to amphibole schist. Pyrite is found in graphitic mica schist along the schistosity plane or fractures in a form of film.

The section between 65.00 m and 187.35 m mainly consists of mica schist intercalated with thin and thick layers of amphibolite to amphibole schist. Especially, amphibolite to amphibole schist found from 165.00 m to 184.65 m is the rock facies to be found extensively forming thick strata in the hanging wall of the "Perau Horizon".

The section, Perau Horizon, between 184.65 m and 220.00 m is composed of carbonate schist, mineralized zone and alternating beds of graphite schist to phyllite and limestone, and dolomite, to carbonate rock.

Although magnetite crystals are scattered in the section between 91.50 m and 114.00 m, the so-called "Magnetite Zone" was intersected between 187.35 m and 190.30 m.

The mineralized zone consisting of barite-sulphide zone was intersected between 196.95 m and 197.15 m (0.20 m), in which mineralization of lead and zinc was very weak. In the sections such as 199.80 m ~ 199.90 m and 200.65 m ~ 200.75 m, dissemination of galena is found in the alternating beds of siliceous schist, cherty, and carbonate schist. Under the microscope, only galena and pyrite are observed and sphalerite can not be observed. The scale of mineralization of these parts are poorer than that of AG-03, showing an aspect of the tail end.

Graphite schist to phyllite to be the key bed of the footwall of the ore was encountered between 205.55 m and 212.55 m (6.00 m), and further the alternating beds of limestone and carbonate rock was confirmed below 212.55 m. Thus the hole was finished at 220.00 m.

(4) Mineralization and Assay : Although the assay values are as shown in Table A-4, the grades of the main mineralized parts are as follows:

Depth (m)	Interval (m)	Number of sample	Pb %	Zn %	Cu ppm	Ag ppm
196.95 ~ 197.15	0.20	1	1.60	0.46	330	26
199.80 ~ 199.90	0.10	1	8.00	0.03	18	200
200.65 ~ 200.75	0.10	1	4.50	1.60	30	100

While the mineralized section between 196.95 m and 197.15 m is correlated to the barite-sulphide mineralized zone, and the mineralization is very weak. The other two are the dissemination zone consisting of only galena.

3-2 AG-05

(1) Purpose : The hole was drilled to clarify the continuity toward the west of the mineralized zone encountered in AG-01 in Phase III and the geologic structure.

(2) Location : Station No.7 along G-Line of IP survey.

Latitude 7251.03 N

Longitude 701.18 E

Latitude 490 m

(3) Rock facies : The section between 0 m and 224.20 m consists mainly of graphitic mica schist interbedded with amphibolite to amphibole schist and mica schist. Among these, the section between 92.30 m and 143.20 m consists of dominant mica schist with scanty graphite schist. Pyrite is found in graphitic mica schist along schistosity planes and fractures in a form of film.

The section between 224.20 m and 341.55 m consists mainly of mica schist interbedded with amphibolite to amphibole schist. Graphitic mica schist can not be observed.

The section between 305.10 m and 335.50 m is composed of thick bed of amphibolite to amphibole schist to be present on the hanging wall of the "Perau Horizon". A section in the rock from 319.30 m to 328.60 m has undergone hydrothermal alteration to have formed silicified zone and argillized zone. It was very hard to cut through this alteration zone and caused to jamming trouble.

The section between 341.55 m and 361.60 m consists of carbonate schist and graphite schist of the "Perau Horizon". The "magnetite zone" concentrated by magnetite is found between 343.00 m and 351.50 m. Between 354.65 m and 358.35 m, lead and zinc mineralized zone in the barite-sulphide zone was intersected. The hole was finished at 361.60 m by having confirmed graphite schist in the footwall of the ore horizon between 359.50 m and 361.60 m.

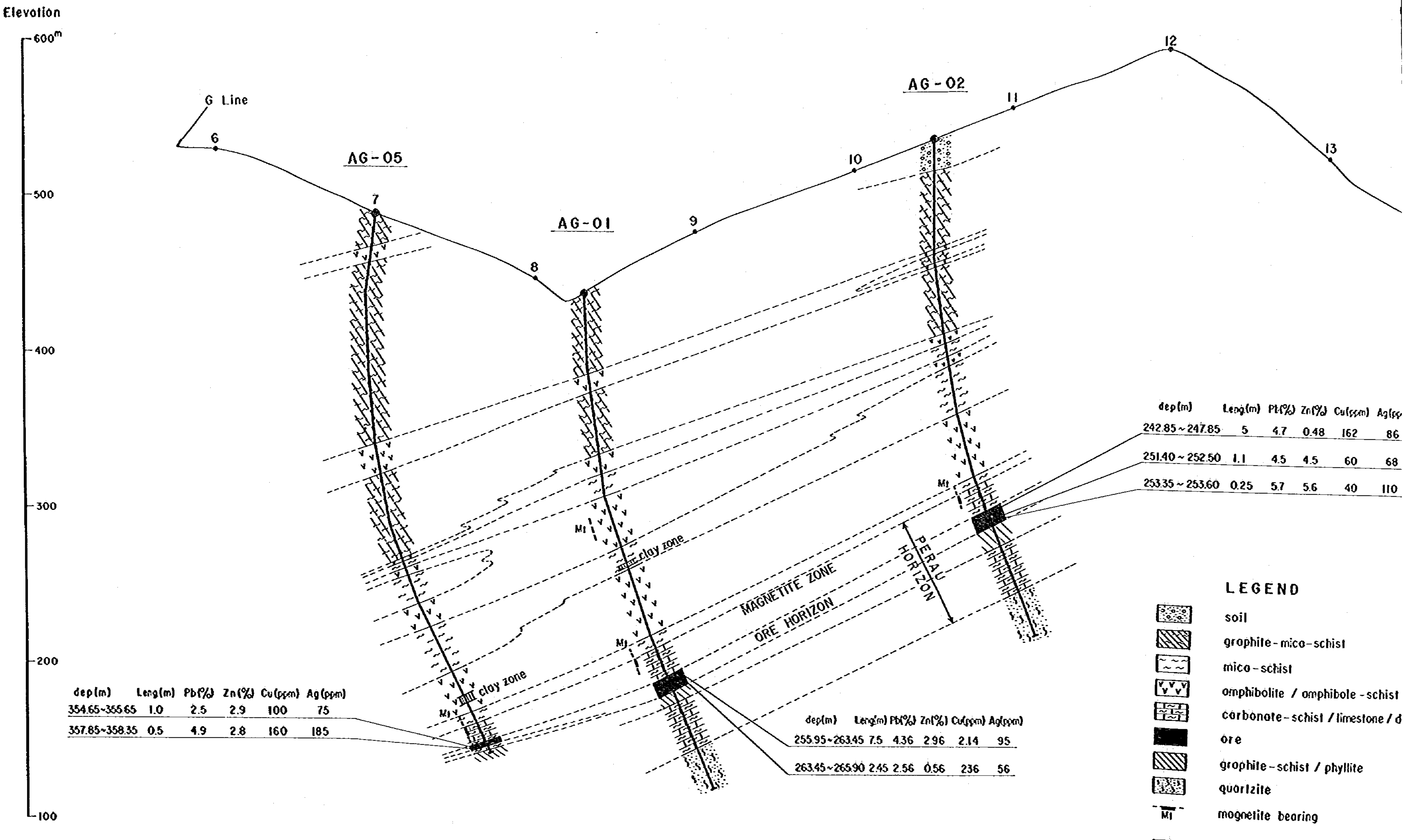


Fig. II-3-2 Geological Profile for AG-05, AG-01 and AG-02

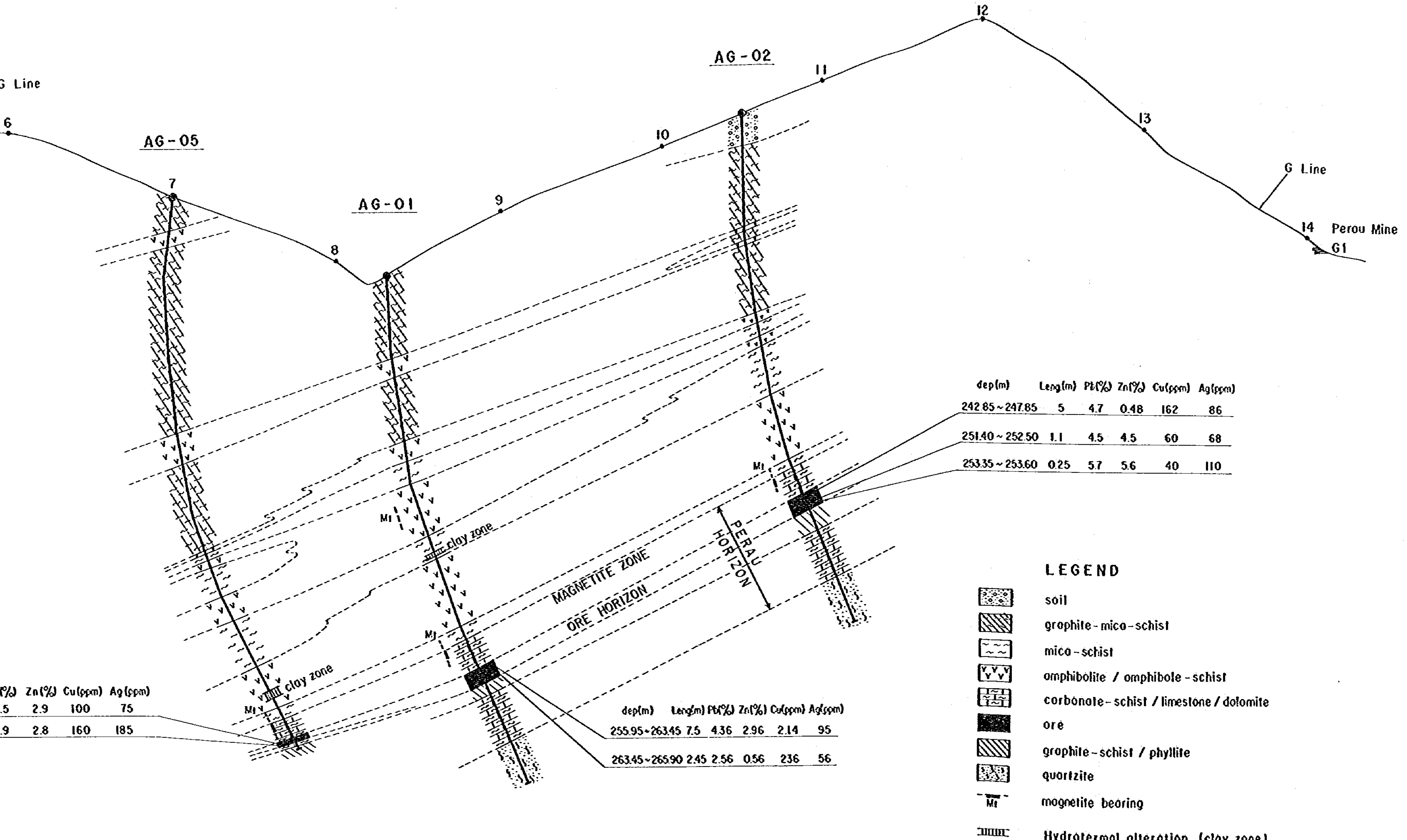


Fig. Ⅱ-3-2 Geological Profile for AG-05, AG-01 and AG-02

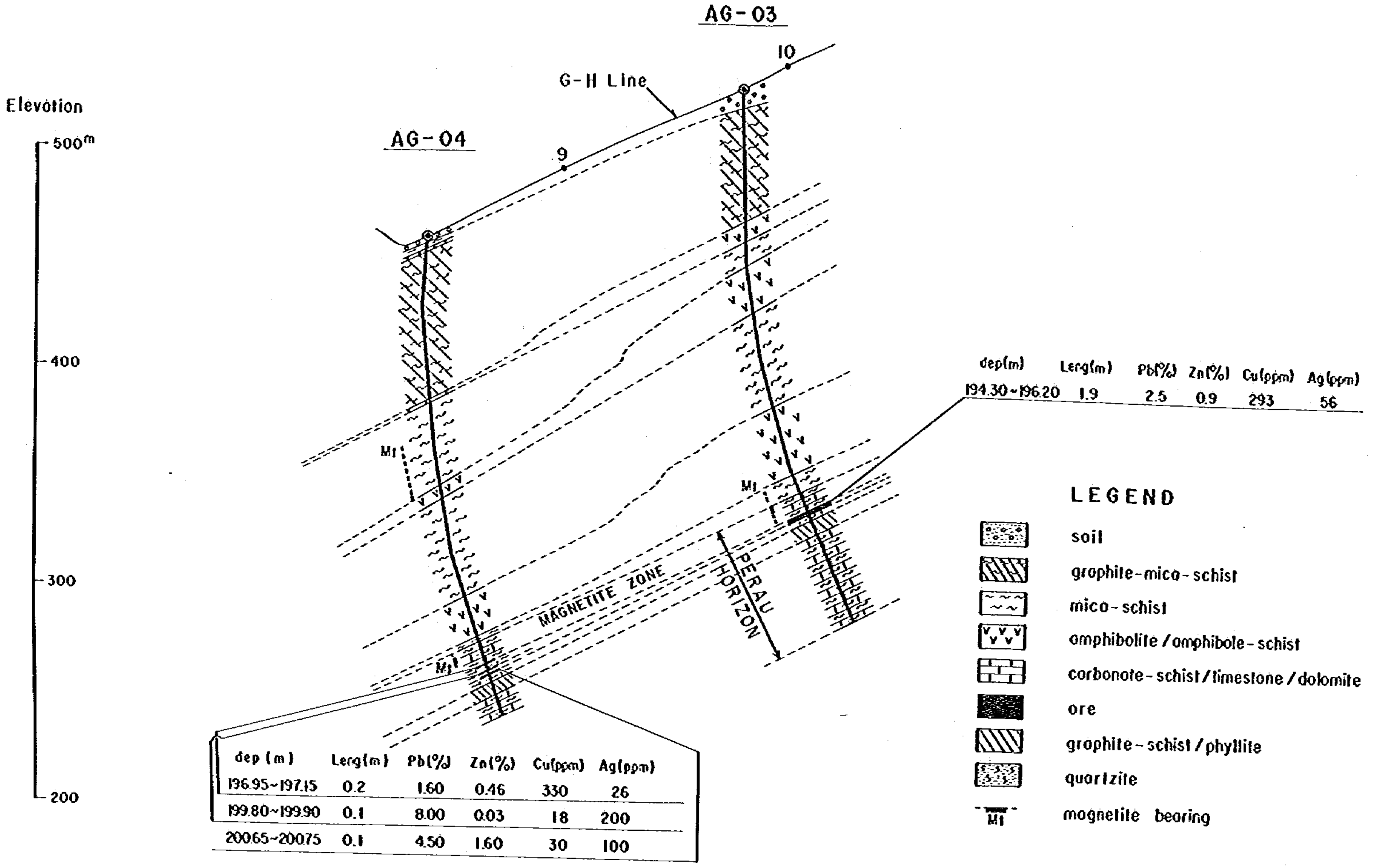


Fig. Ⅲ-3-1 Geological Profile for AG-01 and AG-03

(4) Mineralization and Assay : The mineralization and the assay values of the surroundings are as shown in Table A-4.

The high-grade part in the barite-sulphide zone are found between 354.65 m and 355.65 m (1.0 m), and also between 357.85 m and 358.35 m (0.5 m), in which galena sphalerite and pyrite are disseminated in barite-carbonate schist. The section between 357.65 m and 357.85 m is a weakly mineralized zone, in which pyrite is disseminated in barite-carbonate schist which shows a marked microfolding, accompanied by galena and sphalerite.

The main assay values are as follows:

Depth (m)	Interval (m)	Number of sample	Pb %	Zn %	Cu ppm	Ag ppm
354.65 ~ 355.65	1.0	1	2.5	2.9	100	75
357.85 ~ 358.35	0.5	1	4.9	2.8	160	185

The mineralized zone is small in thickness of the mineralized part as compared with those of AG-01 and AG-02, showing an aspect to be approaching the marginal part of the ore deposit.

3-3 AG-06

(1) Purpose : The hole was drilled to confirm the northern extension of the dominant stratiform deposit of barite-sulphide encountered in Hole AG-01 in Phase III.

(2) Location : In the vicinity of the station No.8 in the midway between F-Line and G-Line of IP survey.

Latitude 7251.38 N

Longitude 701.18 E

Altitude 440 m

(3) Rock facies : The bed rock was encountered at 4.00 m. The section between 4.00 m and 174.30 m consists mainly of graphitic mica schist interbedded with amphibolite to amphibole schist and mica schist. Diabase dykes are exposed at three places such as 50.10 m ~ 76.00 m, 108.00 m ~ 128.20 m and 175.90 m ~ 180.10 m penetrating the rocks in the above. A strong pyrite mineralization is observed in graphitic mica schist.

The section between 174.30 m and 304.30 m is dominated by amphibolite to amphibole schist, in which graphitic mica schist is not observed.

The section between 221.65 m and 296.00 m consists of thick bed of amphibolite to amphibole schist which constitutes the hanging wall of the Perau Horizon.

The section between 304.30 m and 350.00 m is composed of carbonate schist, mineralized

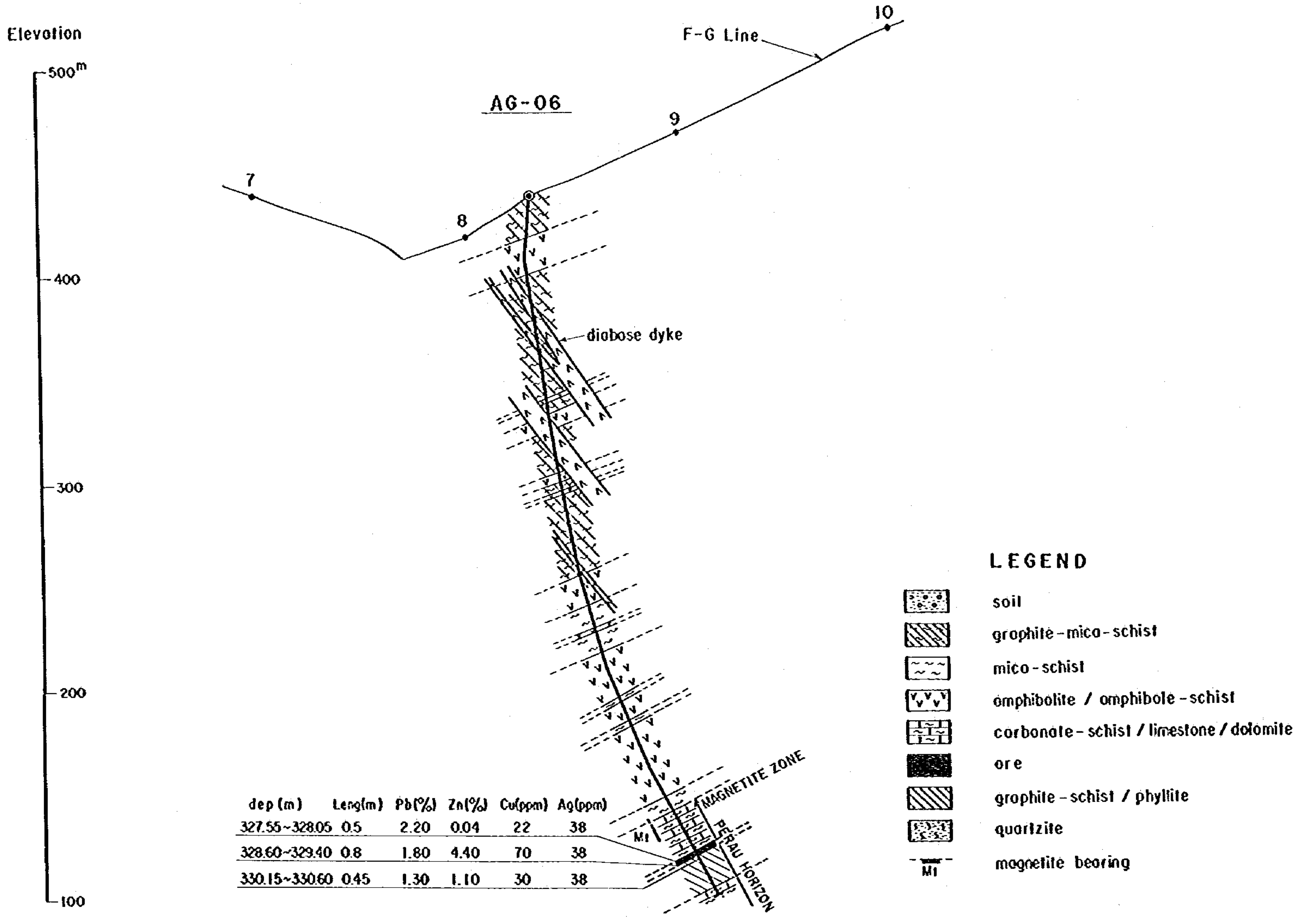


Fig. Ⅱ-3-3 Geological Profile for AG-06

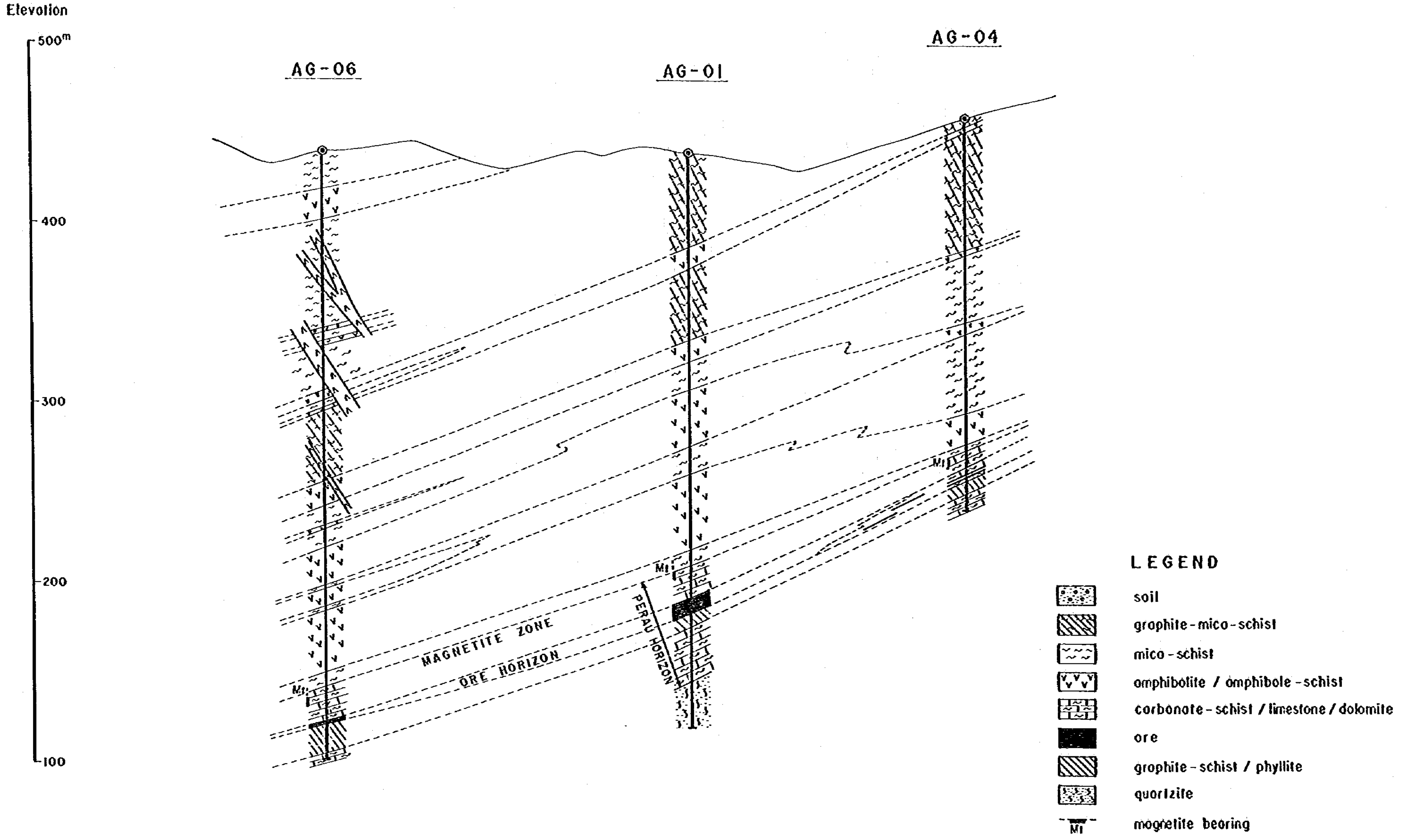


Fig. Ⅱ-3-4 Geological Profile for AG-06, AG-01 and AG-04

zone, graphite schist to phyllite and limestone to carbonate schist which belong to the "Perau Horizon". Magnetite crystals are scattered in mica schist in the sections such as 188.70 m ~ 196.00 m and 214.00 m ~ 221.50 m. The "magnetite zone" is predominant from 299.00 m to 312.50 m, especially in the section between 307.50 m and 312.50 m.

Lead and zinc mineralized zone in the barite-sulphide zone was encountered between 327.55 m and 329.40 m.

Graphite schist to phyllite to be the key bed of the footwall of the ore deposit was confirmed between 329.40 m and 346.50 m. The hole was finished at 350.00 m by having confirmed limestone to carbonate rock further below the above.

(4) Mineralization and Assay : Mineralization and the assay values are as shown in Table A-4. In the ore section of barite-sulphide, galena and pyrite dissemination is observed between 327.55 m and 328.05 m.

In the section between 328.05 m and 329.40 m, the main minerals are shown in dissemination of pyrite and pyrrhotite, while lead and zinc mineralization is weak.

The main assay values are as follows:

Depth (m)	Interval (m)	Number of sample	Pb %	Zn %	Cu ppm	Ag ppm
327.55 ~ 328.05	0.5	1	2.20	0.04	22	38
328.60 ~ 329.40	0.8	1	1.80	4.40	70	38
330.15 ~ 330.60	0.45	1	1.30	1.10	30	38

The mineralized zone is conspicuously inferior to those of AG-01 and AG-02 in grade as well as thickness, and seems to be the tail end of the barite-sulphide stratiform deposit.

3-4 AG-B1

(1) Purpose : The hole was drilled to clarify the condition of anomalies obtained in the vicinity of No.11 along BH-Line of SIP survey conducted in Phase III and the geologic structure.

(2) Location : Station No. 11 on BH-Line of SIP survey.

Latitude 7265.49 N

Longitude 702.60 E

Altitude 630 m

(3) Rock facies : The section between 0 m and 45.80 m consists of overburden, in which the structure of biotite schist locally remains. Among it, the section from 40.3 m to 44.90 m consists of black to dark brown soil showing an appearance called "coffee powder", which seems to be a weathered product of carbonate rock. The bed rock was encountered at 45.80 m.

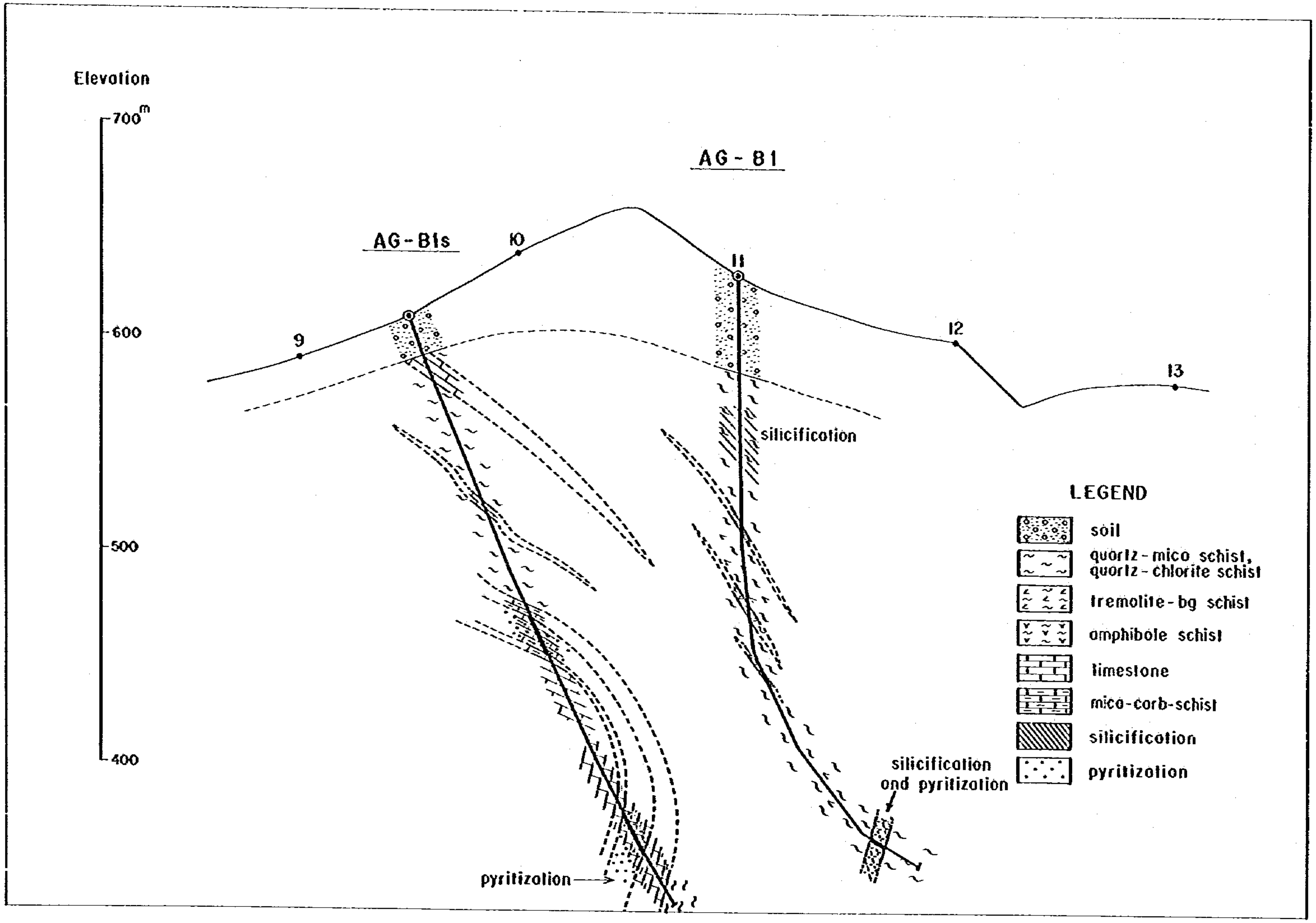


Fig. Ⅱ-3-5 Geological Profile for AG-B1

The section between 45.80 m and 300.00 m mainly consists of chlorite-mica schist, interbedded with dolomite to carbonate schist (119.30 m ~ 123.70 m) and chlorite-amphibole schist (144.00 m ~ 162.00 m). The oxidized zone continues up to about 57 m, in which oxide iron occurs along fractures. The core was apt to be chopped to pieces in this part. The section between 57 m and 80 m consists of silicified chlorite-mica schist, in which quartz veins and veinlets to dissemination of pyrite are found. In the section from 168.30 m to 265 m, hydrothermally altered clay veins are often observed.

In the section between 276.90 m and 280.30 m, a quartz vein accompanied by patchy to massive pyrite was encountered, being associated with silicified zone before and behind of it.

(4) Mineralization : Although pyrite-mineralized zones were encountered in the hole, no other notable mineralization could be observed.

The main pyrite zones are as follows:

57 m ~ 78 m ..... pyrite occurs as veinlets and dissemination in silicified zone and quartz vein,

147 m ~ 181 m ..... occurs as weak dissemination,

206 m ~ 290 m ..... occurs as veinlets, dissemination or patch. Especially it is dominant in the silicified zone from 226.70 m to 228.70 m and in quartz vein from 276.90 m to 280.30 m.

3–5 AG–B2

(1) Purpose : The hole was drilled to clarify the condition of IP anomaly detected by IP survey conducted in Phase III and the geologic structure.

(2) Location : Station No.3 on BD-Line of IP survey

Latitude 7266.71 N

Longitude 702.83 E

Altitude 510 m

(3) Rock facies : The bed rock was encountered at 11.70 m.

The section between 11.70 m and 113.20 m consists mainly of mica schist interbedded with quartzose schist and graphitic mica schist. It begins to contain graphitic material from around 70 m. Graphitic mica schist is the main rock in the section from 113.20 m to 300 m, which is interbedded with the layers of quartzose schist (132.05 m ~ 190.20 m). The content of graphite tends to increase apparently toward the lower.

Pyrite is found in graphitic schist in dissemination or in a form of film along the bedding plane and fractures.

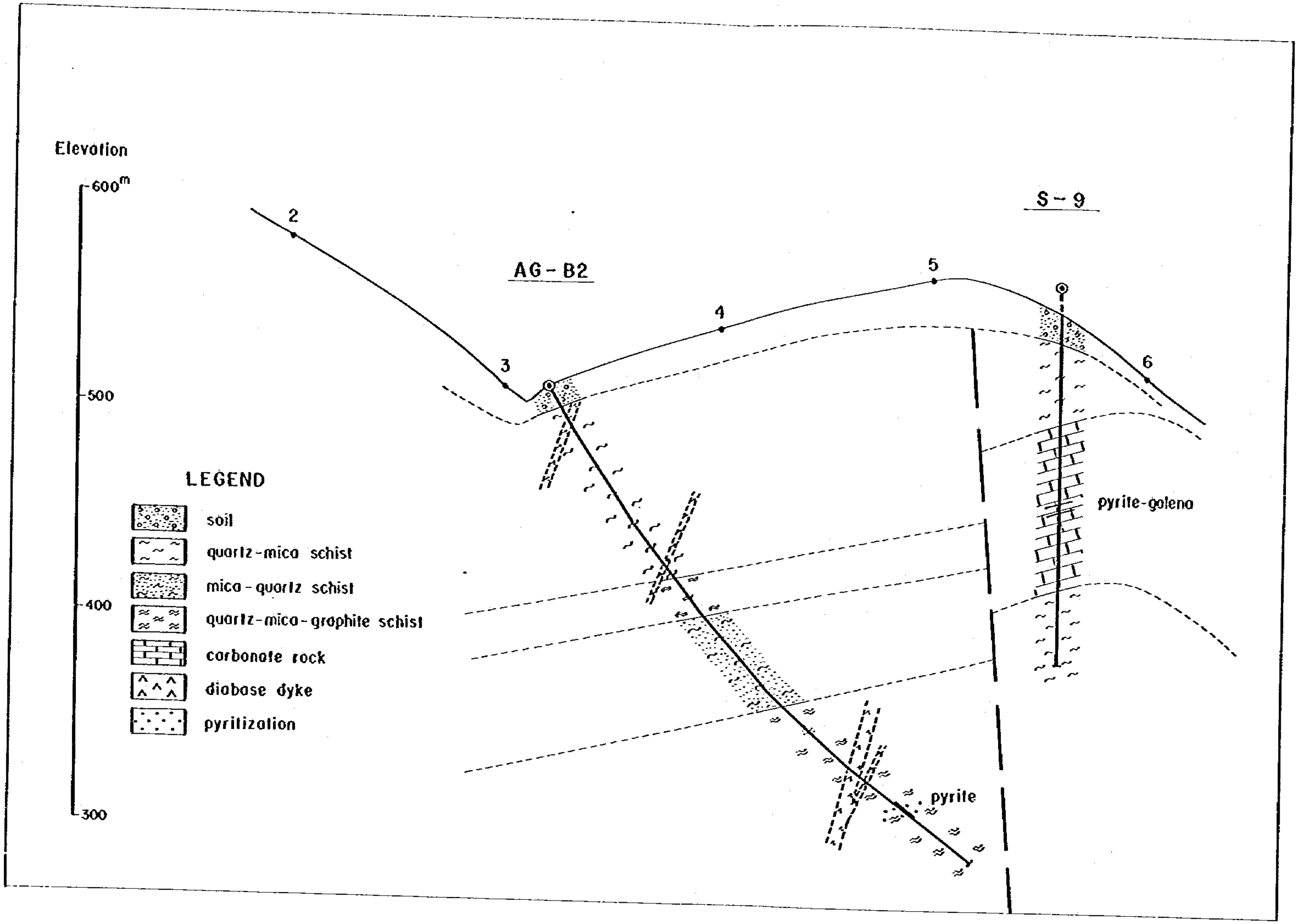


Fig. Ⅲ-3-6 Geological Profile for AG-B2

Diabase penetrates all the rocks in the above.

(4) Mineralization : Veinlets, dissemination and film of pyrite are observed throughout the rocks below 30 m. These are especially dominant in graphitic mica schist. No other notable mineralization is observed.

CHAPTER 4 DISCUSSION OF DRILLING SURVEY

4-1 Perau Area

The result of drill survey by three holes (AG-04, 05 and 06) conducted in Phase IV revealed the facts as in the following.

(1) Stratigraphy

Detailed correlation of stratigraphy has become possible based on the existing data and those obtained this time.

The main geology of the area consists of mica schist, amphibolite to amphibole schist and carbonate schist in which lead and zinc deposits are emplaced in the lower part of the Açungui I formation, which is further subdivided as follows:

graphitic mica schist, amphibolite to amphibole schist

mica schist, amphibolite to amphibole schist

Magnetite Zone	"Perau Horizon"
carbonate schist-mineralized zone	
graphite schist to phyllite	
limestone and carbonate schist	

In addition, diabase is found in Hole AG-06 penetrating all the rocks in the above.

(2) Geologic structure

The area is situated on the northwestern limb of the Perau anticline, and an homoclinal structure of gentle dip (25° ~ 30°) is shown from the stand-point of general view, although small folds are observed in mica schist and carbonate schist.

(3) Ore Deposit

The ore deposits encountered by the drill survey for consecutive two years of Phase III and Phase IV are the stratiform deposit of sulphide minerals (galena, sphalerite, pyrite and pyrrhotite) accompanied by barite, showing an elongated shape of distribution in the direction of NE-SW along G-Line of the geophysical survey line.

The southern limit of ore deposit seems to be around in the vicinity of Hole AG-03 and Hole AG-04, and the northwestern limit is in the vicinity of Hole AG-06. Although a relatively dominant mineralization is observed in Hole AG-05, it shows a tendency to become inferior both in scale and grade as compared with that of Hole AG-01.

Lateral variation of mineral assemblage is observed such as that Pb and Zn mineralization is dominant in Hole AG-01, that content of sphalerite increases in Hole AG-05 and that pyrrhotite is contained in abundance in Hole AG–06.

The ore reserve is estimated 1,000,000 t as the result of exploration by drilling 6 holes, and calculated on the basis of 400 m. (long-diameter) x 200 m (short-diamter) x 5 m (average thickness) x 3 (specific gravity) x 0.85 (recovery factor) ≑ 1,000,000 t, ore grades are Pb: 4%, Zn: 2%, Ag: 85 ppm, BaO: 15%.

(4) Promising Area for Future Exploration

Within the blank area to the north and the northeast of Hole AG–02, the one between the hole and the Perau mine is a promising area to warrant future exploration.

4–2 Barrinha Area

As the result of drill survey by the two holes (AG–B1 and AG–B2) and another hole (AG–B1S) which was added by the Brazilian side, excavated for the anomalies extracted on the basis of the geophysical survey (IP and SIP) conducted in Phase III, a very useful data for clarifying the complicated geologic structure and the promising area to warrant future exploration were obtained.

(1) Relationship between Geology in the Surrounding Area of Hole AG–B1 and SIP Anomaly

The hole is situated on the south of the Quatro deposit, and a steeply dipping fold structure is observed in the hole.

A high apparent resistivity is obtained because of presence of thick soil and weathered zone and also because of dominant silicified zone and quartz veinlet zone directly underneath them.

The presence of pyritization zone in carbonate rocks encountered in Hole AG–B1S seems to have caused the IP effect.

Since the pyritization zone is in the similar geological circumstance to that of the Quatro deposit, it is considered that possibility of lead deposit in this pyritization zone.

Future exploration would be performed in the southern area of Quatro deposit by drill survey.

(2) Relationship between Geology in the Surrounding Area of Hole AG–B2 and IP Anomaly

While neither limestone bed nor promising mineralized zone could not be encountered in Hole AG–B2, the data of the drill Hole S–9 conducted by the Barrinha mine might lead to an assumption of the presence of fault between the two holes.

A pyrite-lead mineralized zone was confirmed in the Hole S–9.

In Hole AG–B2, pyrite is contained in graphitic mica schist in a form of film and dissemination. The IP anomalies distributed in the surrounding area are considered to be the combined result of IP effect caused by these two factors.

Future exploration to be performed in limstone bed on the southern side of the fault.

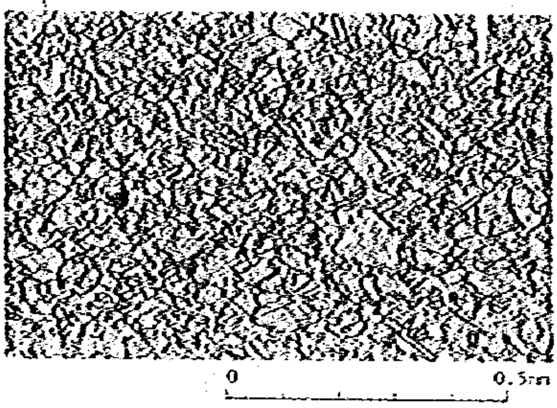
APPENDICES

Photo A–1 Microphotograph of Thin Section

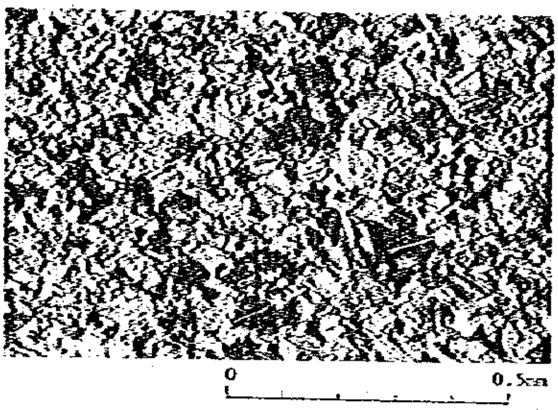
Abbreviations

q	:	quartz
pl	:	plagioclase
K–F	:	potash felspar
bt	:	biotite
mus	:	muscovite
hb	:	hornblende
chl	:	chlorite
cpx	:	clinopyroxene
act	:	actinolite
myr	:	myrmekite
diop	:	diopside
spn	:	sphane
zir	:	zircon
ep	:	epidote
hem	:	hematite
grp	:	graphite
cor	:	cordierite
And	:	andalusite
chlori	:	chloritoide

Sample No. : NI-06
Rock name : fine cry. limestone
: ($AIIIL_2$)
Location : SPO State Highway 165
Texture : lepidoblastic, granoblastic

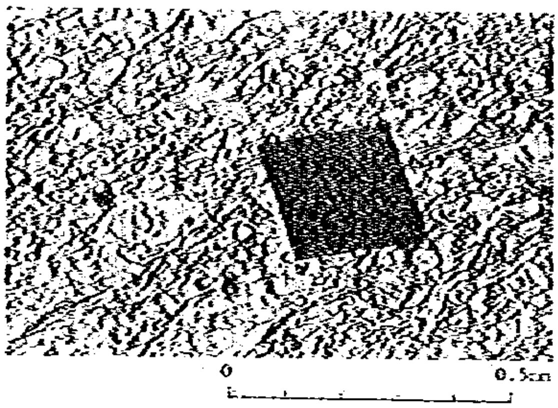


(only lower polar)



(crossed polars)

Sample No. : JG-14
Rock name : limy dolomite
($AIIIL_2$)
Location : east area
Texture : granoblastic, lepidoblastic



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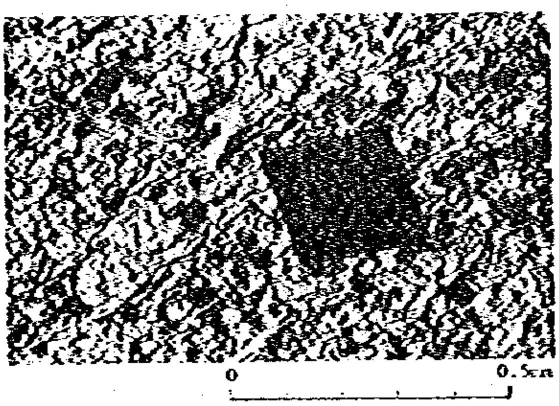
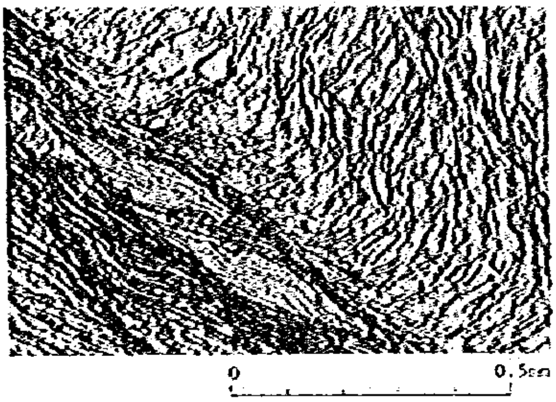
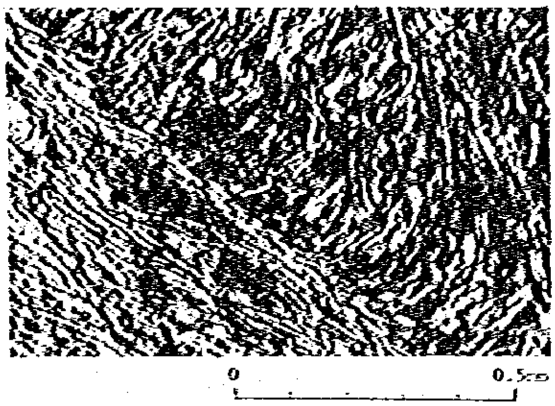


(crossed polars)

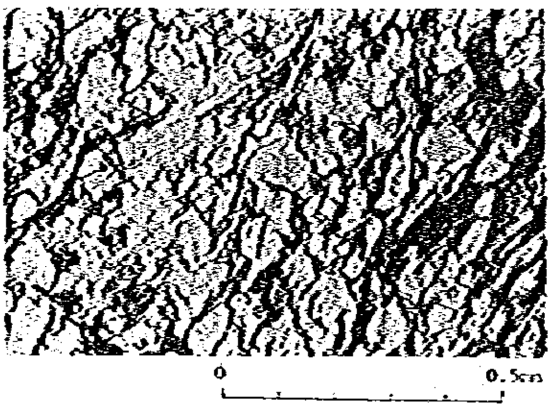


: NI-29
: chl-qtz-ser schist
($AIIS_2$)
: Corrego Furnas
: lepidoblastic

(only lower polar)



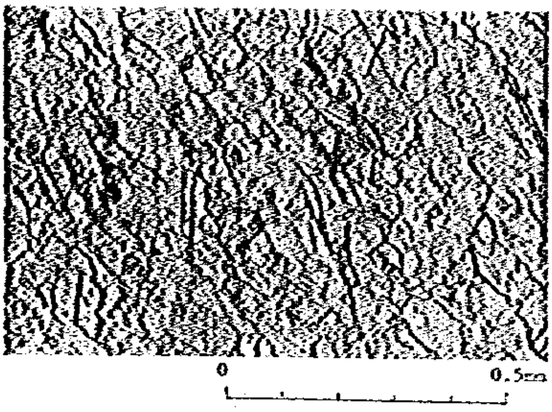
(crossed polars)



: JG-09
: ser-qtz schist
($AIIS_2$)
: FE-13.7
: lepidoblastic

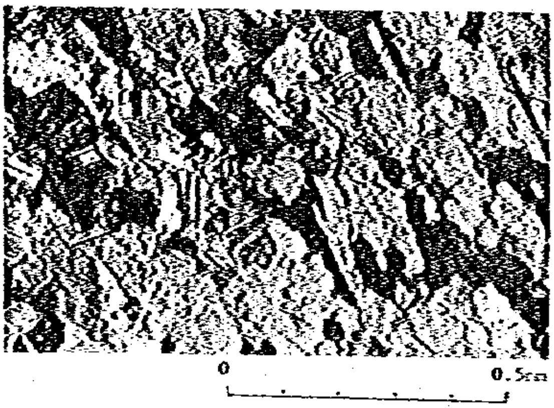
(only lower polar)

(crossed polars)

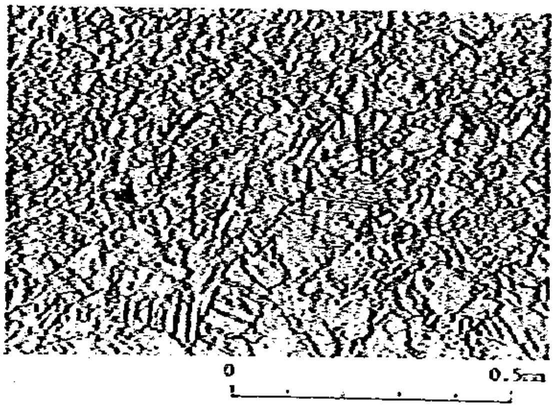


: JG-12
: limestone
(AIIIL₃lsA)
: FI-11.5
: granoblastic

(only lower polar)

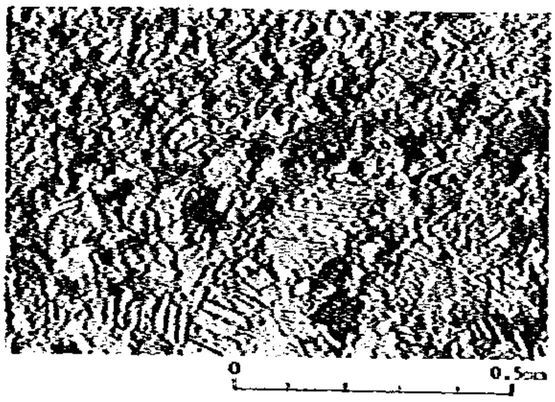


(crossed polars)

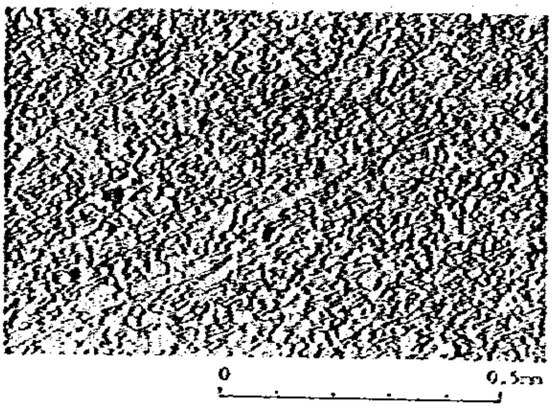


: NI-28
: banded cry. dol. limestone
($AIIIL_3dolA_2$)
: Maxixal
: porphyroblastic

(only lower polar)

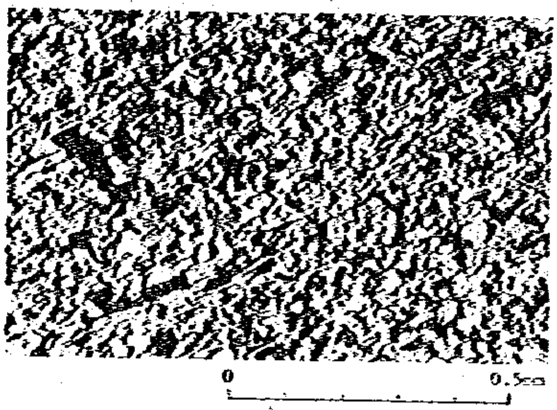


(crossed polars)

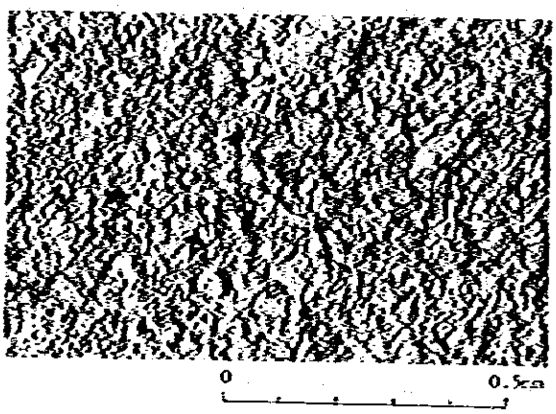


: NI–08
: fine pelitic dolomite
($AIIIL_3dolA_2$)
: SPO State Highway 165
: lepidoblastic

(only lower poler)

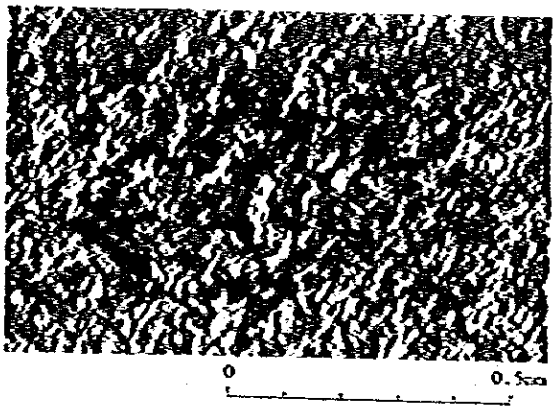


(crossed polars)

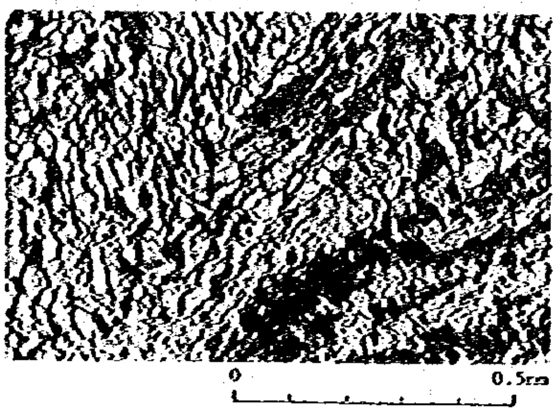


: NI–54
: qtz-ser schist
($AIIIL_3psA$)
: SPO State Highway 165
: lepidoblastic

(only lower polar)

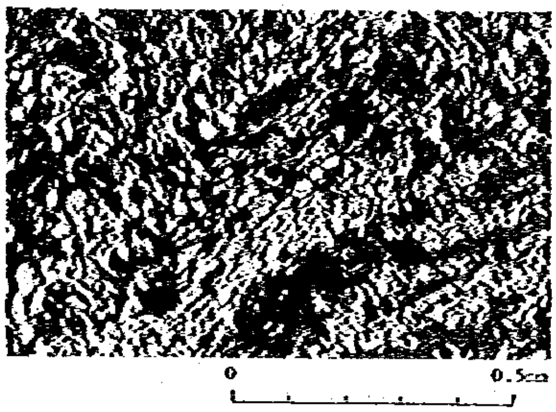


(crossed polars)

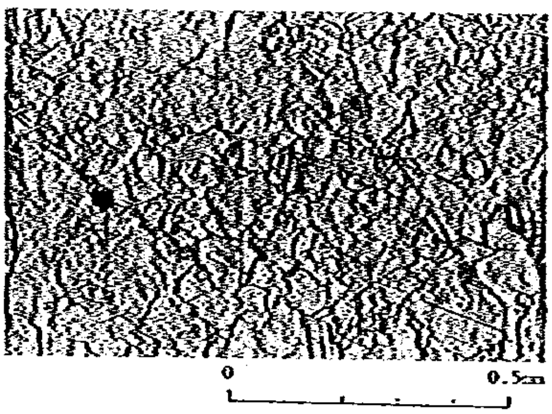


: NI–56
: alt. of ser sch. & ser-qtz sch. ($AIIIL_3psB$)
: SPO State Highway 165
: lepidoblastic

(only lower polar)

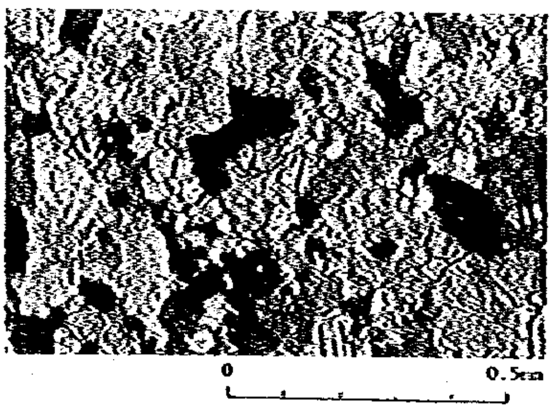


(crossed polars)

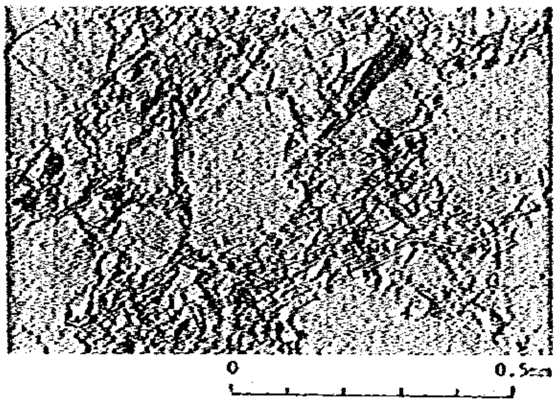


: JG–06
: dolomite ($AIIIL_3C$)
: west area
: granoblastic

(only lower polar)

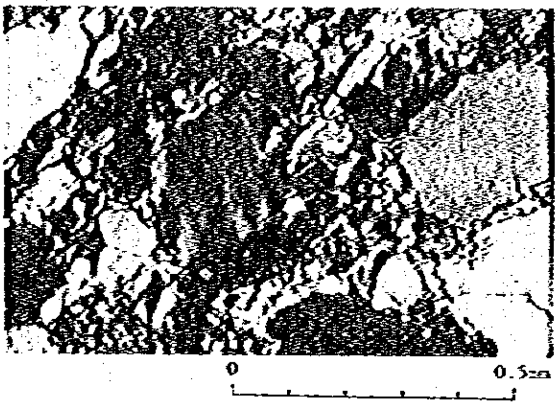


(crossed poalrs)

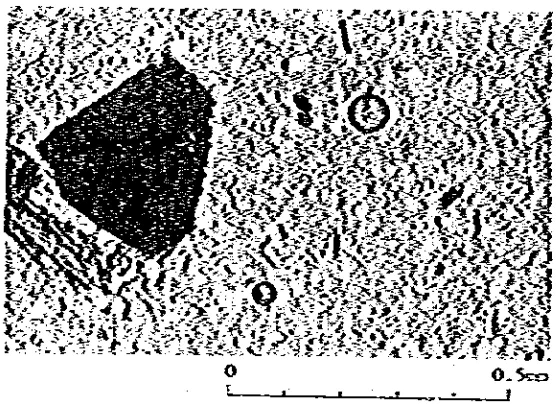


: NI-03
: meta qtz sandstone (AIIIS$_3$)
: SPO State Highway 165
: blastopsammitic

(only lower polar)

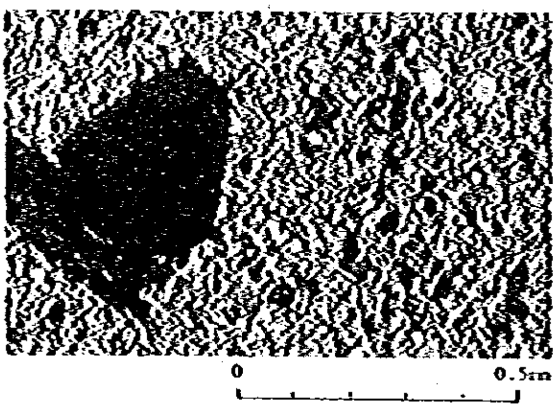


(crossed polars)



: NI-04
: metasiltstone (AIIIS$_3$)
: SPO State Highway 165
: blastoclastic

(only lower polar)

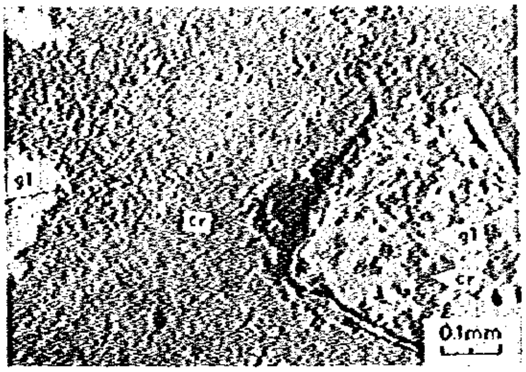


(crossed polars)

Photo A−2 Microphotograph of Polished Section

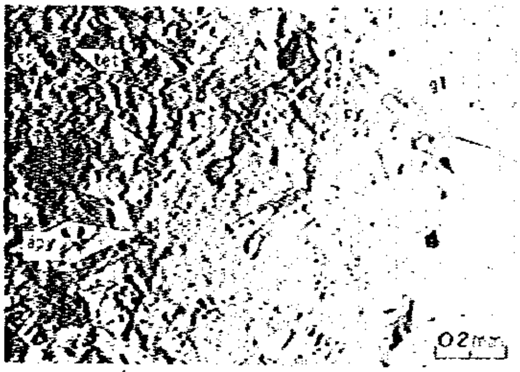
Abbreviation

Gn	:	galena
Py	:	pyrite
Te	:	tetrahedrite
Sp	:	sphalerite
Cp	:	chalcopyrite
Po	:	pyrrhotite
Mt	:	magnetite
Hm	:	hematite
Cr	:	cerussite
Ge	:	goethite
Cc	:	chalcocite
Dg	:	digenite



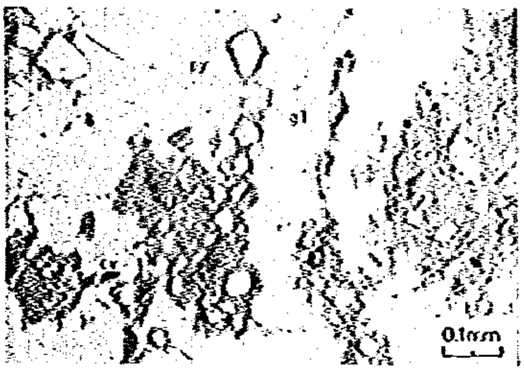
(only lower polar)

Sample No. : NI–18
Location : St. Antonio de Cima
Ore name : Cerussite-Galena Ore



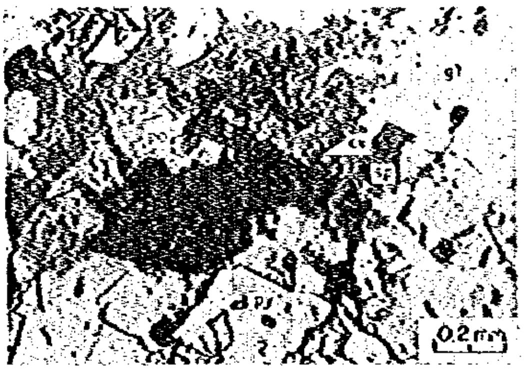
(only lower polar)

Sample No. : NI–24A
Location : east side of Barreira
Ore name : Galena Ore



(only lower polar)

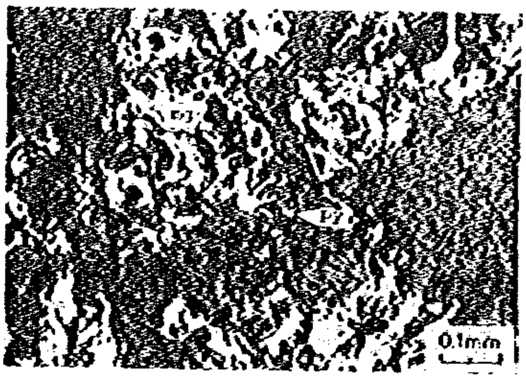
Sample No. : NI–25
Location : São José
Ore name : Cerussite-Galena Ore



(only lower polar)

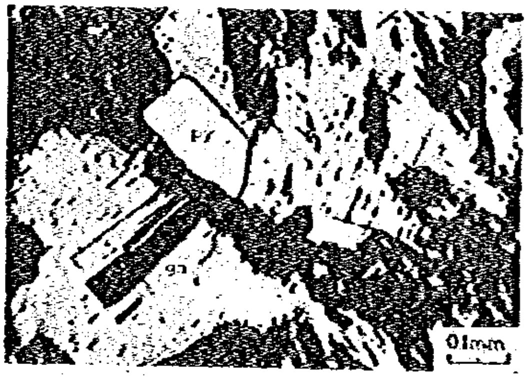
Sample No. : NI–52B
Location : St. Oswaldo
Ore name : Galena Ore

(Logging Core)



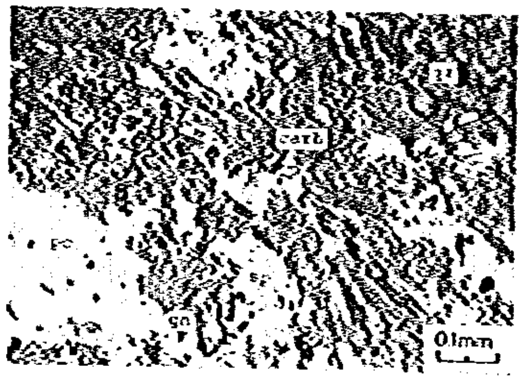
Sample No. : ED-39b
Depth : AG-04, 188.60 m
Ore name : Magnetite Ore

(only lower polar)



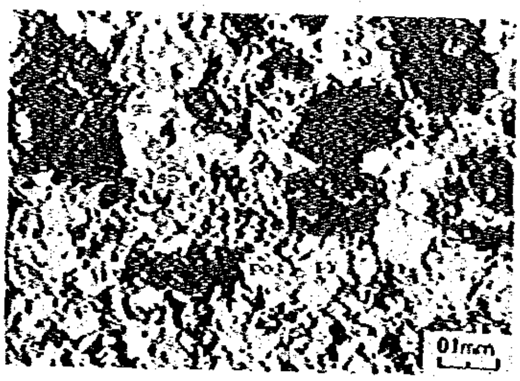
Sample No. : TS-17
Depth : MG-04, 198.85 m
Ore name : Pyrite-Galena Ore

(only lower polar)



Sample No. : ED-68c
Depth : AG-06, 328.80 m
Ore naem : Pyrrhotite-Pyrite-Sphalerite Ore

(only lower polar)



Sample No. : ED-68g
Depth : AG-06, 329.20 m
Ore name : Pyrite-Sphalerite-Pyrrhotite Ore

(only lower polar)

Table A-1 List of Mines and Showings in Furnas Area

No.	Name of Mine & Showing	Kind of Ore	Type	Status	Location	Host Rock	Ore Deposits		Grade				Ore Mineral	Remarks
							Strike & dip	Average Width	Pb%	Zn%	Cu%	Ag g/t		
1	São Manoel	Pb, Ag	Vein & pipe-like	closed	Furnas Mine	AIII L_3ℓsA doℓ~doℓ, ℓm.	N85°W, 75°NE	0.15 m	-	-	-	-	Gn, Hm	adit of N15°W in direction and 10m in length
2	Maxixal	do.	do.	do.	do.	AIII L_3doℓA_1 banded doℓ, ℓm.	N80°E, 75°SE	0.2~1.5m	31.46	0.05	0.0	1208.0	Gn, Cer	adit of S30°W in direction and 800m in length
3	Santa Barbara 2	Pb, Ag, (Zn)	do.	operating	do.	AIII L_3doℓA_2 doℓ~ℓm.	N80°E~80°W, 70°S~90°	0.6~10m	12.60	3.82	0.11	2586.0	Gn, Sp, Py	adit: S40°W, 1.5km(+) in length
4	Santa Barbara 1	do.	do.	do.	do.	do.	N60°E~80°W, 70°S	0.5~5m	30.37	0.14	0.04	181.7	Gn, Py	aidt: S20°W, 500m(+) in length
5	595m - E level	do.	do.	closed	do.	do.	N60°E, 60°~85°SE	1.0 m	3.43	2.80	0.15	8.7	Gn, Cer, Sp	adit: S35°W, 200m in length
6	645m level	do.	do.	do.	do.	do.	N60°E, 85°SE	0.6m >	-	-	-	-	-	adit: S35°W, 100m in length
7	open pit A	do.	do.	do.	do.	AIII L_3ℓsA limstone	N50°E	5m >	-	-	-	-	-	open pit: N50°E, 125 x 7m
8	open pit B	do.	do.	do.	do.	do.	(E ~ W)	10m <	-	-	-	-	-	do. : E-W, 40 x 25m
9	open pit C	do.	do.	do.	do.	AIII L_3doℓA_1 banded doℓ	do.	10m <	-	-	-	-	-	do. : E-W, 30 x 20~30m
10	open pit D	do.	do.	do.	do.	AIII L_3doℓA_2 limy doℓ	do.	5~15m	-	-	-	-	-	do. : E-W, 60 x 25m
11	Vala 8	do.	do.	do.	do.	do. do.	N15°E, 75°SE	0.15m	16.17	18.57	0.06	249.5	Gn, Cer	open pit 110 x 6 m , N60°E
12	east of Barreira	do.	Vein	do.	do.	do. doℓ, ℓm.	EW, 55°S	1.0m	68.75	1.93	0.03	2404.0	Gn, Sp, Cer	trench 6m, adit 6m , E-W
13	Barreira	do.	Vein & pipe-like	do.	do.	do.	E ~ W	10m <	-	-	-	-	-	open pit : E-W, 60 x 30m
14	Coqueirinho	do.	do.	do.	do.	do.	N80°W	4m >	-	-	-	-	-	trench 50m x 5m, N80°W
15	São José	do.	Vein	do.	do.	AIII L_3 doℓA_1 banded doℓ	N50°W, 70°SW	0.3m	70.96	0.77	0.06	779.8	Gn, Cer, Py	do. 30m x 5~10m, S10°E
16	Laranjeiras	do.	Vein & pipe-like	do.	do.	AIII L_3 doℓA_2 doℓ, ℓm.	N80°W	5m >	-	-	-	-	-	open pit 50 x 20m, N80°W
17	595m-W level	do.	do.	do.	do.	do.	-	-	-	-	-	-	-	adit: S35°W, 80m in length
18	St. Osvaldo	Pb, Ag	do.	do.	do. eastern Furnas Mine Area	do.	-	φ1.5m	72.12 2.92	0.60 0.60	0.01 0.03	1339.0 79.8	Gn, Cer, Hm	open pit 18 x 7m, N45°E
19	none	(Pb)	Vein	new occurrence and abandonted prospect	FA-9.0	do. ℓm.	N65°W, 45°NE	2 ~ 5cm	0.57 0.53	0.02 0.02	0.03 0.25	26.8 23.9	Gn, Cer	float?
20	do.	(Pb)	?	do.	FA-10.4	float of doℓ ℓm. in soil	-	-	-	-	-	-	-	adit of S65°W in direction, 10m in length
21	do.	-	Bedded vein	do.	FB-7.7	AIII L_3 doℓB doℓ	N70°E, 40°NW	0.6m	0.09	0.01	0.00	0.3	Hm	quartz vein
22	do.	-	?	do.	FB-7.9	float of quartz in soil	-	-	-	-	-	-	-	trench: N40°E, 3m in length adit: N10°E, 5m in length
23	do.	(Pb)	pyrite imp.	do.	FBC-10.0	AIII L_3 doℓA_2 doℓ, ℓm.	-	-	-	-	-	-	-	trench of S15°E in direction, 20m in length
24	St. Antônio de Cima	Pb, Ag	pipe-like	do.	FC-9.5 east	do.	-	φ2m	51.17	0.44	0.03	1036.0	Cer, Gn	trench of S10°E in direction, 6m in length
25	none	(Pb)	?	do.	FC-9.5	only soil	-	-	-	-	-	-	-	trench of S60°E in direction, 5m in length
26	do.	(Pb)	?	do.	FC-9.6~9.9	only soil	-	-	-	-	-	-	-	trench of S20°E in direction, 30m in length
27	do.	(Pb)	?	do.	FC-9.2 west	-	-	-	-	-	-	-	-	adit
28	St. Antônio de Baixo	Pb, Ag	pipe-like	do.	FCD-8.8	AIII L_3 doℓA_2 doℓ, ℓm.	-	?	25.58	0.24	0.04	150.5	Gn, Cer Hm, Goe	open pit φ10m
29	none	(Pb)	?	do.	FCD-9.7	only soil	-	-	-	-	-	-	-	trench of S5°E in direction, 20m in length
30	do.	(Pb)	Bedded vein	do.	FD-8.5	AIII L_3 doℓA_2 limy doℓ	N60°E, 40°NW	3.0 cm	0.07	0.02	0.00	5.9	Gn, Cer	outcrop
31	do.	(Pb)	?	do.	FE-10.2	float of doℓ ℓm. in soil	-	-	-	-	-	-	-	trench of S50°W in direction, 3m in length
32	do.	(Pb)	?	do.	FFG-7.0	-	-	-	0.13 0.16	0.01 0.01	0.00 0.03	1.2 1.4	Hm, Goe	floats of gossan
33	do.	(Pb)	?	do.	FGH-10.0	only soil	-	-	-	-	-	-	-	trench of S55°W in direction, 4m in length
34	do.	(Pb)	?	do.	FH-10.2	-	-	-	0.99	0.02	0.00	6.1	Hm	floats of gossan
35	do.	(Pb)	?	do.	FGH-11.0	-	-	-	-	-	-	-	-	trench
36	Três Bocas de Baixo	(Pb)	pyrite imp	do.	FHI-9.5	AIII L_3 doℓA_2 limy doℓ	-	-	-	-	-	-	Py	adit of N30°E, N40°E and N90°E in direction
37	Três Bocas de Cima	(Pb)	pipe-like?	do.	do.	do. doℓ, ℓm.	-	-	0.20 0.33	0.12 0.02	0.04 0.09	0.9 0.9	Hm, Goe	trench of S30°W in direction, 6m in length
38	none	(Pb)	?	do.	FJ-10.0	float of quartz in soil	-	-	0.08	0.01	0.00	0.2	-	trench of N20°E in direction, 3m in length
39	do.	(Pb)	Bedded vein	do.	FJK-3.5	AIII L_3 doℓB dolomite	N70°E, 52°NW	5.0cm	0.08	0.01	0.01	3.0	(Gn), (Hm)	qtz-limo. vein
40	do.	(Pb)	?	do.	west side of FK-10.0	-	-	-	0.67	0.41	0.03	3.5	Hm	float of gossan
41	do.	(Pb)	Bedded vein	do.	the western extremity	AIII L_3 doℓA_2 doℓ, ℓm.	N75°W, 35°NE	0.1~1.0m	0.41	0.02	0.01	4.7	Gn, Cer	limo.-cal. vein
42	do.	(Pb)	do.	do.	do.	AIII L_3 doℓA_1 banded doℓ	-	0.1~0.2m	0.43	0.02	0.04	29.1	do.	float of gn.-qtz. vein
43	do.	Au	?	do.	east side of the area	AIII L_3psB	-	-	2.24	0.15	0.01	23.4	-	float of gossan, Au: 125.3 g/t

Table A-2 Microscopic Observations (Thin Section) (Geological Survey)

Member	Sample No.	Location	Rock Name	Texture	quartz	plagioclase	k-feldspar	biotite	muscovite	clinopyroxene	anthophyllite	tremolite	actinolite	hornblende	garnet	opaque m.	tourmaline	chloritoid	andalusite	staurolite	zircon	sphene	apatite	graphite	sericite	chlorite	zoisite	epidote	calcite	dolomite	Remarks
AIII S_1	NI – 05	SPO State Highway 165	qtz-mus-ser schist	lepidoblastic, granoblastic	◎				○							○	•				•				◎	•		•			crenulation
AIII L_2	NI – 06	do.	fine cry. limestone	granoblastic	○	•		•	•							•										•		•	◎		calcite: 95%, qtz + mica: 5%>
	NI – 35	west area	limy dolomite	do.	○	•			•							•													○	◎	qtz-calcite vein (w: 0.15 mm), qtz + mica: 20%, siderite?
	JG – 14	east area	do.	do., lepidoblastic	○			•	•							•					•								○	◎	quartz: 10%, mica: 10%
AIII S_2	NI – 29	Corrego Furnas	chl-qtz-ser. schist	lepidoblastic	◎	•			•							○	•				•		•	•	◎	◎		•			
	JG – 09	FE-13.7	sericite-quartz schist (fine metasandstone)	do.	◎			•	○							○									○	○		•			
	JG – 10	do.	sericite schist	do.	○											○								•	◎		•	•			crenulation
AIII L_3&A	NI – 43	FH-11.3	dolomite	porphyroblastic	•	•			○							•														◎	intergrowth of qtz and muscovite: 5%, calcite-qtz vein (w: 0.05 mm)
	JG – 12	FI-11.5	limestone	granoblastic	•	•										•													◎		quartz: 4%
	NI – 50	FJ-10.7	meta quartz sandstone	granoblastic, porphyroblastic	◎	•	•		○							•					•					•					
AIII L_3dolA	NI – 28	Maxixal	banded cry. dolomite	porphyroblastic	○	•			•							•														◎	cal. 50%, dol. 30%, qtz + mica: 15%
	NI – 08	SPO State Highway 165	fine pelitic dolomite	lepidoblastic	○				○							•														◎	dolomite: 65%, qtz: 10~20%, mica: 10%
	NI – 20	Tres Bocas	dolomitic limestone	granoblastic	•											○								•					◎	○	quartz: 1~2%
	NI – 37	west area.	dolomite	lepidoblastic	○	•			○							•										•		•		◎	quartz: 10~20%, mica: 20%
AIII L_3psA	NI – 36	do.	bt-chl-ser-qtz schist	do.	◎			•	•							○							•		○	○					
	NI – 54	SPO State Highway 165	quartz-sericite schist	do.	◎											○					•				◎	•					calcite vein
AIII L_3B	NI – 13	west area	cry. dolomitic limestone	granoblastic	•				•							•					•								◎	○	calcite + dolomite: 85%, qtz + mica: 12%
	NI – 55	SPO State Highway 165	dolomite	granoblastic, lepidoblastic	○				•							○														◎	qtz: 10~15%, mica: 2~3%
	NI – 46	FG-7.0	meta quartz sandstone	granoblastic, porphyroblastic	◎	•	•		○							•					•					•					
AIII L_3psB	NI – 56	SPO State Highway 165	alternation of ser. schist and ser-qtz schist	lepidoblastic	◎				•							○					•				◎	•					crenulation
AIII L_3C	JG – 01	FC-1.0	dolomitic limestone	granoblastic	•											•												•	◎	•	quartz: 1%>
	JG – 02	FC-0.2	dolomite	do.												•												•	○	◎	
	JG – 06	west area	do.	do.												•													•	◎	
AIII S_3	NI – 03	SPO State Highway 165	meta quartz sandstone	blastopsammitic	◎				○							•	•					•			•	•		•			
	NI – 04	do.	meta siltstone	blastoclastic	◎				•							○	○				•				○	○		•	•		lithic fragment
	JG – 07	west area	quartzite	blastopsammitic	◎		•	•	○							•					•				•	•		•			

Table A-3-1 Microscopic Observations (Polished Section)
(Geological Survey)

No.	Sample No.	Location	Ore Name	Galena	Sphalerite	Pyrite	Pyrrhotite	Arsenopyrite	Marcasite	Chalcopyrite	Tetrahedrite	Chalcocite	Covelline	Maghemite	Hematite	Cerussite	Anglesite	Goethite
1	NI – 16	the western extremity	Cerussite-Galena Ore	•		(•)				(•)						•	(•)	
2	NI – 18	St. Antonio de Cima	do.	◎		•										●	•	•
3	NI – 19	St. Antonio de Baixo	Geothite-Hematite Ore												◎		(•)	●
4	NI – 21	Tres Bocas	Hematite-Goethite Ore			(•)				•			(•)		●			○
5	NI – 22	do.	do.		•	•	•		•	•	•			•	●			○
6	NI – 23	Vala 8	Cerussite-Galena Ore	◎	•	•					(•)					○		●
7	NI – 24A	east side of Barreira	Galena Ore	◎	●	•		•			(•)					●	(•)	●
8	NI – 24B	do.	do.	◎		●				(•)						●	(•)	
9	NI – 25	São José	Cerussite-Galena Ore	◎	•	●									•	○		●
10	NI – 30	the eastern outside	Hematite-Goethite Ore												●			○
11	NI – 40	FA-9.0	Galena Ore	●												•		
12	NI – 41	do.	do.	•		•				•		•				•		
13	NI – 51A	FB-7.7	Hematite Ore			(•)						(•)			●			
14	NI – 51B	do.	do.												•			•
15	NI – 52A	St. Oswaldo	Cerussite-Galena Ore	◎		•				•						○		
16	NI – 52B	do.	Galena Ore	◎	●	●	(•)						(•)			●	•	●
17	NI – 53A	do.	Hematite Ore		•										◎			●
18	NI – 53B	do.	Hematite-Goethite Ore											•	○			◎
19	NI – 57	FJK-3.5	Galena Ore	(•)		(•)									(•)			
20	JG – 15	FD-8.5	do.	•		(•)										•		
21	JG – 19	FFG-7.0	Hematite-Goethite Ore												○			○
22	JG – 20	do.	do.											•	●			○

Remarks: ◎ abundant ○ common ● a little • rare

1. SI-16

<u>Macroscopic Observation</u>

Ore minerals mainly occur in quartz, meanwhile very fine grains of ore minerals are disseminated in the laminated black silicified zone.

<u>Microscopic Observation</u>

Constituent Minerals	Area Ratio(%)
galena	1
cerussite	1
chalcopyrite	tr
pyrite	tr
anglesite	tr
gangue minerals	98

Galena occurs intimately associated with cerussite. The texture under the microscope shows that cerussite replaces galena (see Photo SI-16). Many tiny galena grains of irregular shapes are found in cerussite. Galena and cerussite occur along the cracks formed in quartz mass, meanwhile very fine chalcopyrite and pyrite grains of subhedral or euhedral shapes are disseminated in the black silicified zone. A small amount of anglesite is also observed in the silicified zone.

2. SI-18

<u>Macroscopic Observation</u>

The polished surface shows the zonal structure, that is, black cerussite zone occurs at the marginal parts of larger galena grains, and at the outer zone of cerussite reddish brown aggregates of goethite and gangue minerals distribute.

<u>Microscopic Observation</u>

Constituent Minerals	Area Ratio(%)
galena	70
cerussite	15
pyrite	4
anglesite	1
goethite and gangue	10

Galena predominates in sulfide minerals. Galena contains pyrite of subhedral or euhedral grains, and is replaced by cerussite along the cleavage and marginal parts. The cerussite zone bordering galena contains many irregular grains of galena, and small euhedral grains of pyrite. Anglesite occurs in the aggregates of goethite and gangue minerals which show thin-tabular and stringer textures.

3. SI-19

<u>Macroscopic Observation</u>

The sample is an oxide ore consisting mainly of goethite and hematite.

<u>Microscopic Observation</u>

Constituent Minerals	Area Ratio(%)
hematite	[illegible]
anglesite	tr
goethite and gangue	[illegible]

The sample is an oxide ore. No sulfide minerals are observed. Major constituent minerals are aggregates of fine-grain hematite and goethite. A small amount of anglesite occurs filling up the grain boundary of gangue minerals.

4. SI-21

<u>Macroscopic Observation</u>

This sample is a reddish brown oxide ore.

<u>Microscopic Observation</u>

Constituent Minerals	Area Ratio(%)
chalcopyrite	less than 1
covellite	tr
pyrite	tr
hematite	30
goethite and gangue	59

A small amount of sulfide minerals (less than 1%) occurs in the mass consisting mostly of goethite. Goethite mass contains a small amount of hematite grains of anhedral or thin-tabular shapes. The rim of chalcopyrite grain is partly replaced by covellite.

5. SI-22

<u>Macroscopic Observation</u>

This sample is an oxide ore, poor in sulfides.

<u>Microscopic Observation</u>

Constituent Minerals	Area Ratio(%)
marcasite	4
pyrite	2
sphalerite	1
chalcopyrite	less than 1
pyrrhotite	less than 1
tetrahedrite	less than 1
maghemite(?)	3
hematite	13
goethite and gangue	75

Goethite is the main ore mineral and occupies the most area of the polished surface. Goethite is partly altered to hematite showing a mottled surface. The aggregates of goethite contain many marcasite aggregates of idiomorphic or irregular shapes. Marcasite also shows the colloform texture forming alternating layers with pyrite. In the goethite mass, small amounts of pyrrhotite and chalcopyrite are also observed.

6. SI-23

<u>Macroscopic Observation</u>

The rim of galena grain is replaced by a black band of cerussite and the outer part is surrounded by aggregates of oxidized minerals and gangue minerals.

<u>Microscopic Observation</u>

Constituent Minerals	Area Ratio(%)
galena	63
pyrite	1
sphalerite	1
tetrahedrite	tr
cerussite	20
goethite and gangue	15

Galena predominates in the ore minerals forming a relatively smooth surface without many cleavage cracks. Galena grain is large (0.5mm - 1cm) and also contains many euhedral or corroded subhedral grains of pyrite. Small amounts of sphalerite and tetrahedrite are included in galena. The rim of a galena grain is replaced by cerussite. Cerussite occasionally develops along the cleavage cracks in large galena grain. Cerussite contains many tiny relicts of galena of irregular shape.

Grain size: galena, 0.5mm - 1cm; pyrite, 10 - 1000μm; sphalerite, 30 - 500μm; tetrahedrite, 10 - 100μm.

7. SI-24A

Macroscopic Observation

This sample is rich in galena. The rim of large galena grain is surrounded with cerussite of blackish color.

Microscopic Observation

Constituent Minerals	Area Ratio(%)
galena	60
sphalerite	5
pyrite	6
arsenopyrite	1
tetrahedrite	tr
cerussite	10
anglesite	tr
goethite and gangue	20

Galena occupies the most area of the polished surface. Large grains of galena (0.5 - 1cm) form a compact mass. In galena mass, many grains of irregularly corroded sphalerite and pyrite are observed. Sphalerite contains tiny grains of galena and pyrite of idiomorphic or lath shapes. Relatively large grains of pyrite contain galena grains. Arsenopyrite of an idiomorphic shape occurs in galena. The cleavage lines and triangular pits are very common in galena, and galena along them are partly replaced by cerussite. Cerussite also replaces the rim of galena grain. In cerussite, many tiny relicts of galena are observed. Grain size: galena, 10μm - 1cm; sphalerite, 30μm - 2mm; pyrite, 20μm - 1.5mm; arsenopyrite, 50 - 300μm; tetrahedrite, 10 - 20μm.

8. SI-24B

Macroscopic Observation

This sample contains several aggregates of galena and pyrite. Each aggregate is relatively large (0.5 - 1 cm).

Microscopic Observation

Constituent Minerals	Area Ratio(%)
galena	50
pyrite	10
chalcopyrite	tr
cerussite	10
anglesite	tr
gangue	30

Sulfide minerals are mostly of galena and pyrite. Galena grain is large (max. 1cm). The rim of galena grain is replaced by cerussite. Cerussite also develops intensively along the cleavage cracks formed in galena grains. Pyrite grain is relatively large (max. 0.8cm) At the marginal part of pyrite grain, anglesite aggregates of needle-like or thin-tabular textures occur. Aggregates of anglesite are also observed in the gangue minerals. Cerussite includes many relicts of galena of corroded shapes.

9. SI-25

Macroscopic Observation

This sample includes a massive galena. A thin dark band surrounds the galena grain.

Microscopic Observation

Constituent Minerals	Area Ratio(%)
galena	50
pyrite	5
sphalerite	less than 1
cerussite	20
hematite	less than 1
goethite and gangue	25

Galena predominates in ore minerals and shows a compact mass. In the mass of galena, many irregularly corroded grains of pyrite are observed, and cerussite develops along the cleavage cracks. The rim around galena grain is also replaced by cerussite which contains many tiny relicts of galena of irregularly corroded shapes. Hematite develops occasionally after the pseudomorph of pyrite grains. Grain size: galena, 500μm - 1.2cm; pyrite, 10 - 200μm; sphalerite, 30 - 150μm.

10. SI-33

Macroscopic Observation

This is an oxidized sample without any sulfide minerals.

Microscopic Observation

Constituent Minerals	Area Ratio(%)
hematite	15
goethite and gangue	85

No sulfide minerals are observed. The opaque mineral is only the aggregates of hematite. The surface is not smooth because of many cracks, and aggregates of goethite and gangue minerals.

11. SI-41

Macroscopic Observation

Ore minerals such as galena and cerussite occur in gangue mass consisting mainly of milky quartz.

Microscopic Observation

Constituent Minerals	Area Ratio(%)
galena	5
cerussite	1
gangue minerals	94

A small amount of opaque minerals disseminates in the gangue mass consisting mainly of quartz. Opaque minerals are principally galena. Galena occurs as an euhedral or corroded subhedral grain, and as a veinlet. Cerussite replaces the rim of galena grains and also fills up the cleavage cracks of galena. The tiny relicts of galena (< 10μm) of irregularly corroded shapes are observed in the aggregates of cerussite.

17. SI-53A

Macroscopic Observation

This is a reddish brown oxide ore.

Microscopic Observation

Constituent Minerals	Area Ratio(%)
sphalerite	less than 1
hematite	60
goethite and gangue	40

A small amount of irregularly corroded sphalerite grains is observed in hematite and goethite aggregates. Sphalerite rarely contains tiny hematite grains. Hematite is the major minerals in this sample. Hematite shows two types of occurrence on the basis of ore texture. The one is large grains (1mm - 5mm) forming a compact mass, and the other shows the colloform and reniform textures. The later is intimately associated with goethite, that is, the rim of goethite aggregate changes to hematite. Goethite shows commonly the colloform and reniform textures, and occurs in an intimate intergrowth with hematite.

18. SI-53B

Macroscopic Observation

This sample is a reddish brown oxide ore.

Microscopic Observation

Constituent Minerals	Area Ratio(%)
hematite	33
maghemite(?)	2
goethite	50
gangue	25

This sample consists of hematite, goethite and gangue minerals. No sulfide minerals are observed. Hematite occurs usually associated with aggregates of goethite. Hematite shows the tabular, thin-tabular, and laminated textures. Hematite also forms occasionally concentric nodules, and some ringed parts are porous and contain many aggregates and relicts of goethite. The goethite mass contains lath-shaped hematite and goethite aggregates of irregular shapes.

19. SI-57

Macroscopic Observation

This is the quartz sample having some carbonates and very few opaque minerals.

Microscopic Observation

Constituent Minerals	Area Ratio(%)
galena	tr
pyrite	tr
hematite	tr
gangue	about 100

Opaque minerals are very little. Galena occurs as relicts along cracks in quartz. Galena rarely contains very tiny grains of pyrite. A few amount of tiny grains of hematite is observed after the pseudomorph of pyrite.

20. SO-15

Macroscopic Observation

Milky quartz contains very few opaque minerals.

Microscopic Observation

Constituent Minerals	Area Ratio(%)
galena	2
pyrite	tr
cerussite	1
gangue	97

Ore minerals are very rare, and consist mostly of galena and cerussite. Galena occurs filling up cracks in quartz mass. Cerussite occurs replacing a part of galena, and it contains very few amount of tiny relicts of galena.

21. SO-19

Macroscopic Observation

The sample is a reddish brown oxide ore.

Microscopic Observation

Constituent Minerals	Area Ratio(%)
hematite	25
goethite	23
gangue	65

Sulfide minerals are not observed. Hematite is associated with goethite. Aggregates of goethite partly change to hematite. And also, a part of hematite aggregates is replaced by fine-grained goethite. Aggregates of hematite and goethite occur forming the colloform, and reniform textures, and filling up cracks in gangue minerals.

22. SO-23

Macroscopic Observation

The polished surface shows the dark brown laminated structure.

Microscopic Observation

Constituent Minerals	Area Ratio(%)
maghemite(?)	2
hematite	5
goethite and gangue	93

The sample is an oxide ore. No sulfide minerals are observed. Aggregates of fine-grained goethite occupy the mass of polished surface. In the mass of goethite, very few amount of hematite is observed. Goethite mass contains very thin-tabular or fine-grained aggregates of goethite probably pseudomorph after hematite.

12. SI-03

Macroscopic Observation

This sample is an ore disseminated in quartz.

Microscopic Observation

Constituent Minerals	Area Ratio(%)
galena	3
pyrite	1
chalcopyrite	less than 1
chalcocite	less than 1
cerussite	2
gangue	93

Opaque minerals are very little. Ore minerals consist mostly of galena and cerussite and they occur in quartz. Aggregate of galena occur forming a thin band along the grain boundary of quartz. Galena is partly or wholly replaced by cerussite. Chalcopyrite which is partly replaced by chalcocite, is very seldomly observed. In gangue minerals except for quartz, fine euhedral grains of pyrite disseminate.

13. SI-51A

Macroscopic Observation

A corroded rectangular grain of hematite occurs in quartz.

Microscopic Observation

Constituent Minerals	Area Ratio(%)
pyrite	tr
chalcocite	tr
hematite	5
gangue	95

Ore minerals besides hematite are scarcely observed. Rectangular aggregate of hematite of fine grains predominates in ore minerals. A small amount of pyrite of euhedral or irregularly corroded subhedral shapes disseminatein quartz. Chalcocite occurs after the pseudomorph of chalcopyrite.

14. SI-51B

Macroscopic Observation

Very few ore minerals disseminate in quartz.

Microscopic Observation

Constituent Minerals	Area Ratio(%)
hematite	3
goethite	1
gangue	96

The opaque mineral is only hematite. Hematite forms the aggregates of very fine grains and contains the aggregates of goethite grains. No sulfide minerals are observed.

15. SI-52A

Macroscopic Observation

Nearly a half of the polished surface of this sample is occupied by galena. The rim of galena is bordered with a thin dark band of cerussite.

Microscopic Observation

Constituent Minerals	Area Ratio(%)
galena	60
pyrite	less than 1
chalcopyrite	less than 1
cerussite	25
gangue	15

A large crystal of galena occurs as a subhedral shape. It occupies nearly a half of the polished surface and is intensively replaced by cerussite along the cleavage cracks. In galena, triangular pits along the cleavage lines are very common. Cerussite occupies the large area next to galena, and mostly occurs as the replacement of the rim of galena. At the cerussite area near the rim of galena, many relicts of galena of irregularly corroded shapes are observed. With the distance from the rim of galena, the number of relicts of galena in cerussite decreases.

16. SI-52B

Macroscopic Observation

The sample is rich in galena.

Microscopic Observation

Constituent Minerals	Area Ratio(%)
galena	55
pyrite	5
sphalerite	5
pyrrhotite	tr
Covellite	tr
cerussite	10
anglesite	less than 1
goethite and gangue	35

Galena predominates in sulfide minerals, that is, it occupies nearly 55% of the polished surface. Cerussite replaces the rim of galena grain and fills up the cleavage cracks of galena. Cerussite contains tiny relicts of galena of irregularly corroded subhedral shapes. Some euhedral or subhedral pyrite grains occur in galena and cerussite. Pyrite also occurs as grains having mutual boundaries with goethite and gangue minerals. The size of pyrite grain ranges from 10 - 400μm. Small amounts of sphalerite and pyrrhotite are observed in galena. Covellite occurs as aggregates replacing sphalerite and pyrrhotite. Goethite occurs as the aggregates and veinlets and the rim of goethite aggregate is partly replaced by anglesite.

Table A-3-2 Microscopic Observations (Polished Section) (Logging Core)

No.	Sample No.	Depth	Ore Name	Galena	Sphalerite	Pyrite	Chalcopyrite	Pyrrhotite	Magnetite
1	ED-39b	AG-04, 188.60 m	Magnetite Ore			(•)			◎
2	TS-17	do. 198.85 m	Pyrite-Galena Ore	○		●	(•)		
3	TS-15a	do. 200.70 m	Sphalerite-Galena Ore	●	●	•	(•)		
4	ED-125d	AG-05, 355.05 m	Galena-Sphalerite-Pyrite Ore	•	•	●			
5	ED-66d	AG-06, 327.85 m	Galena Ore	•	(•)	•			
6	ED-68c	do. 328.80 m	Pyrrhotite-Pyrite-Sphalerite Ore	•	○	●		●	
7	ED-68d	do. 328.90 m	do.	•	●	●		●	
8	ED-68f	do. 329.10 m	Pyrrhotite-Pyrite-Sphalerite Ore	•	●	●		●	
9	ED-68g	do. 329.20 m	Pyrite-Sphalerite-Pyrrhotite Ore	●	○	○		○	
10	ED-70c	do. 330.30 m	Pyrrhotite-Sphalerite Ore	•	●	•		●	

Remarks: ◎ : abundant, ○ : common, ● : a little, • : rare

Table A-4 Assay Results of Drilling Core

No.	Sample No.	Depth (m)	Width (m)	Rock Type	Pb (%)	Zn (%)	Cu (ppm)	Ag (ppm)
AG-04		195.15						
1	TS-21	~196.95	1.8	amph-se-q-sch, carb-sch	0.03	0.01	190	3.5
2	TS-20	~197.15	0.2	gl.-zb. in barite	1.60	0.46	330	26
3	TS-19	~198.15	1.0	carb-sch	2.30	0.20	75	34
4	TS-18	~199.80	1.65	carb-sch	0.07	0.03	410	2.5
5	TS-17	~199.90	0.1	gl. ore	8.00	0.03	18	200
6	TS-16	~200.65	0.75	carb-sch	0.50	0.02	45	4.5
7	TS-15	~200.75	0.1	gl. ore	4.50	1.60	30	100
8	TS-14	~201.75	1.0	carb-sch	0.03	0.01	50	2
AG-05		353.65						
9	ED-124	~354.65	1.0	carb-sch	0.008	0.014	28	1
10	ED-125	~355.65	1.0	gl.-zb. in barite	2.5	2.9	100	75
11	ED-126	~356.65	1.0	do.	0.19	0.056	35	14
12	ED-127	~357.85	1.2	do.	0.06	0.07	55	8
13	ED-128	~358.35	0.5	do.	4.9	2.8	160	185
14	ED-129	~359.50	1.15	carb-sch	0.006	0.006	60	0.8
15	ED-130	~360.50	1.0	grph-sch	0.015	0.0035	40	0.8
AG-06		326.55						
16	ED-65	~327.55	1.0	carb-sch	0.04	0.01	25	1
17	ED-66	~328.05	0.5	gl.-zb. in barite	2.20	0.04	22	38
18	ED-67	~328.60	0.55	gl.-zb. poor ore	0.04	0.04	20	3
19	ED-68	~329.40	0.8	gl.-zb. ore	1.80	4.40	70	38
20	ED-69	~330.15	0.75	graph-sch	0.19	0.18	23	6
21	ED-70	~330.60	0.45	gl.-zb. ore	1.30	1.10	30	38
22	ED-71	~331.60	1.0	grph-sch	0.07	0.04	25	1

Fig. A-1 Raw Phase Pseudosection of Each Frequency

(Line-FA, FD, FI)

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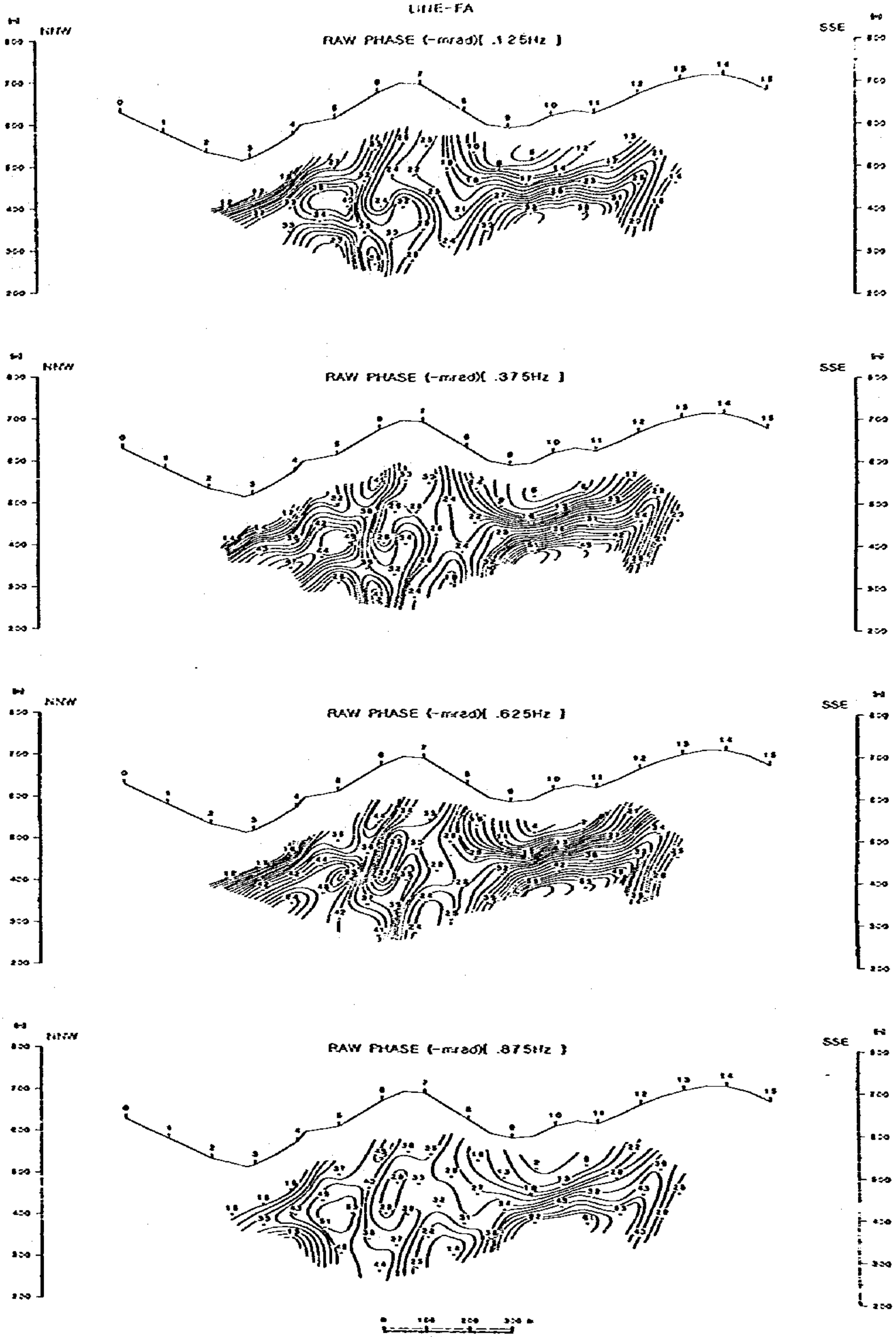
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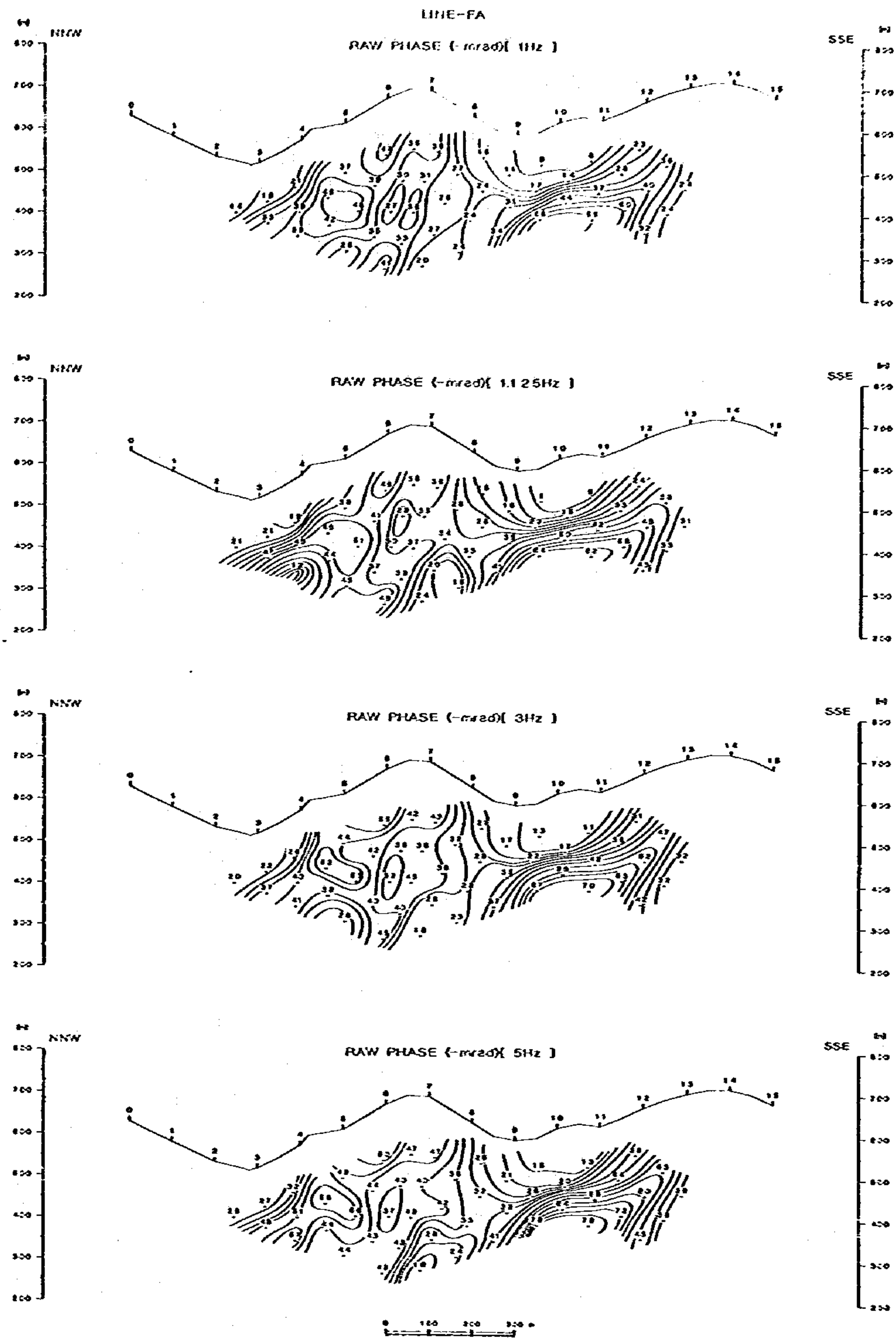
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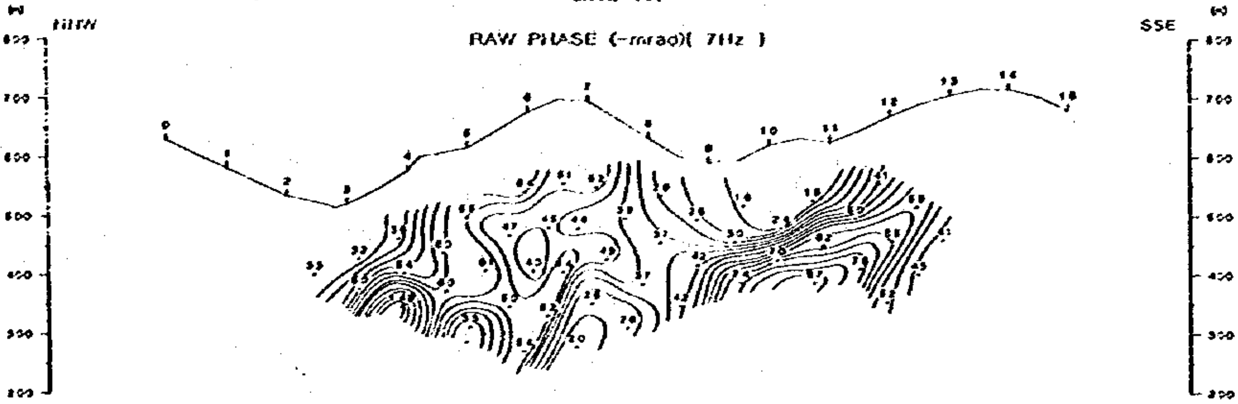
RAW PHASE (-mrad)(5Hz)

FA- 2

LINE-FA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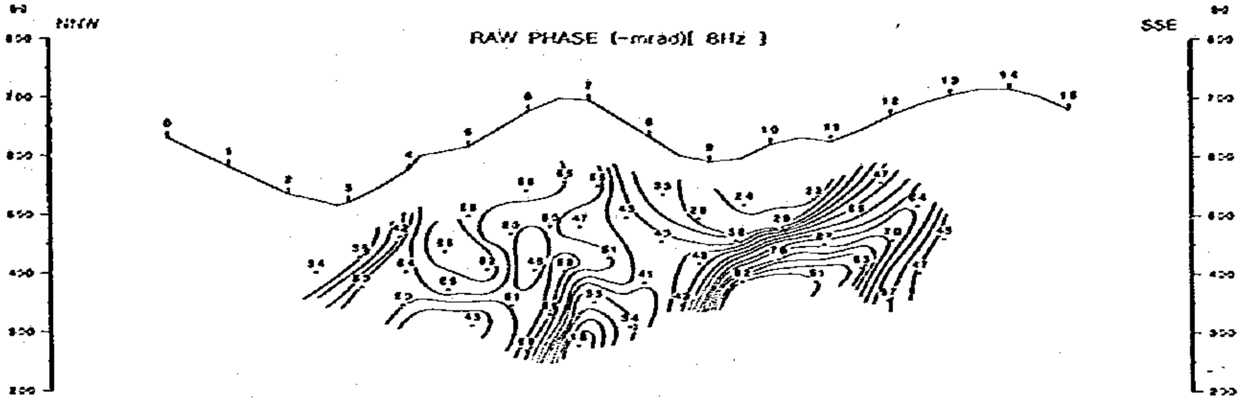
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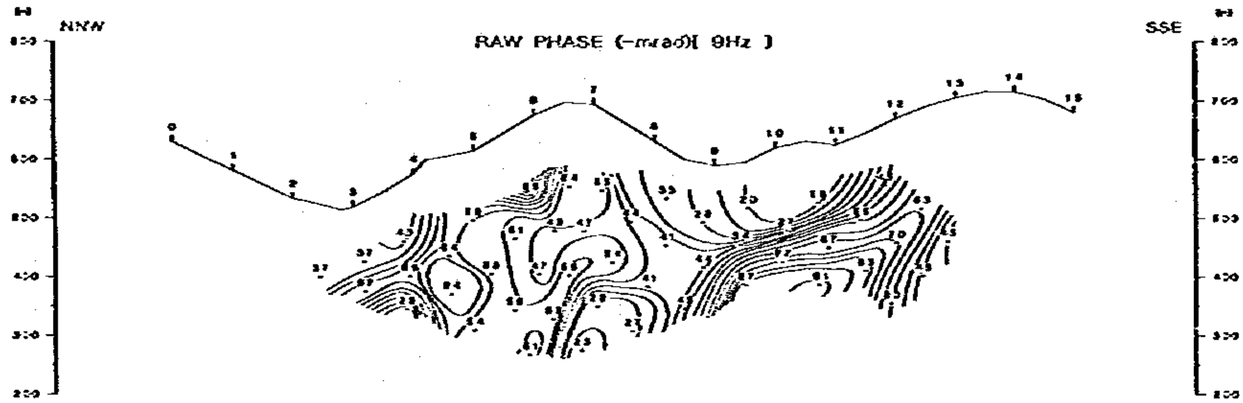
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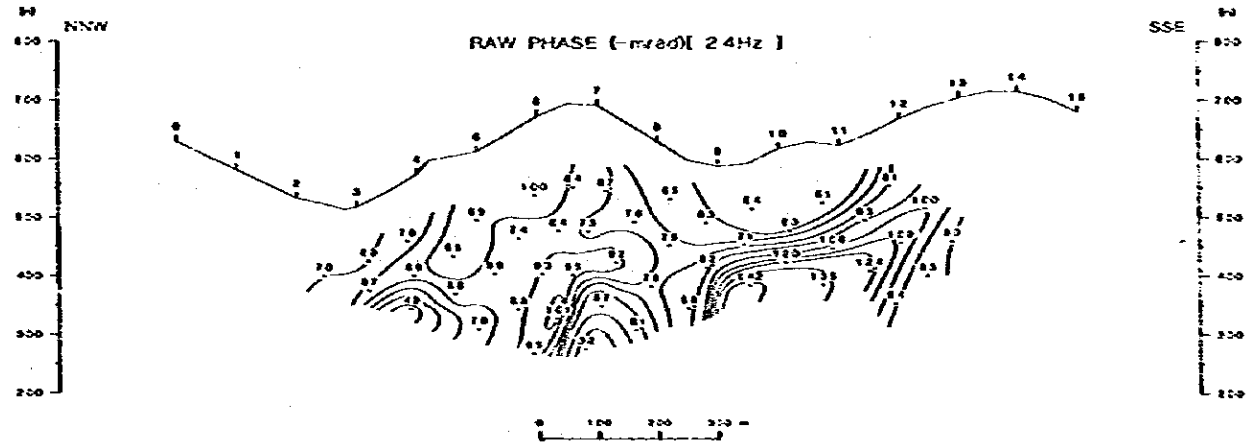
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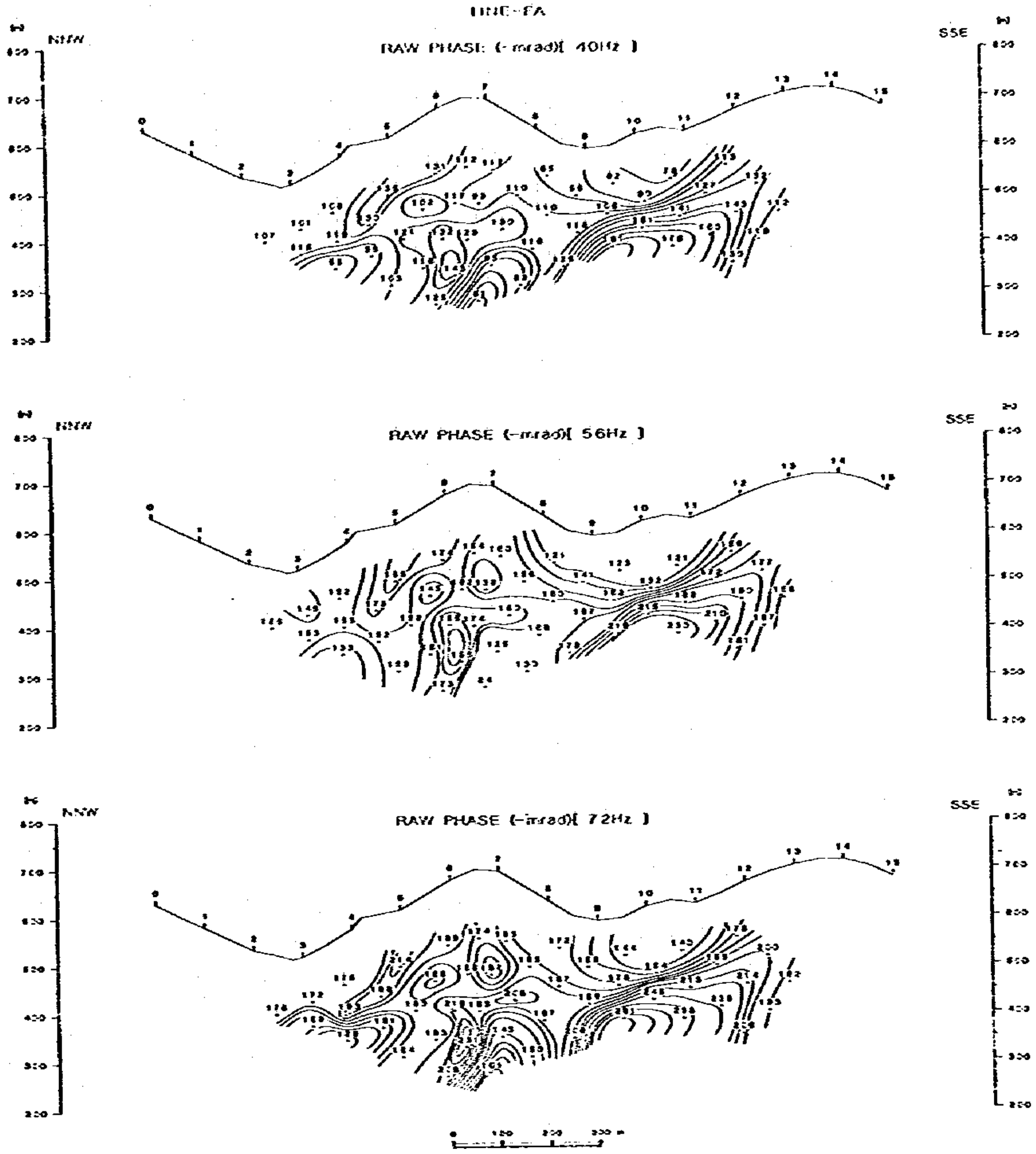
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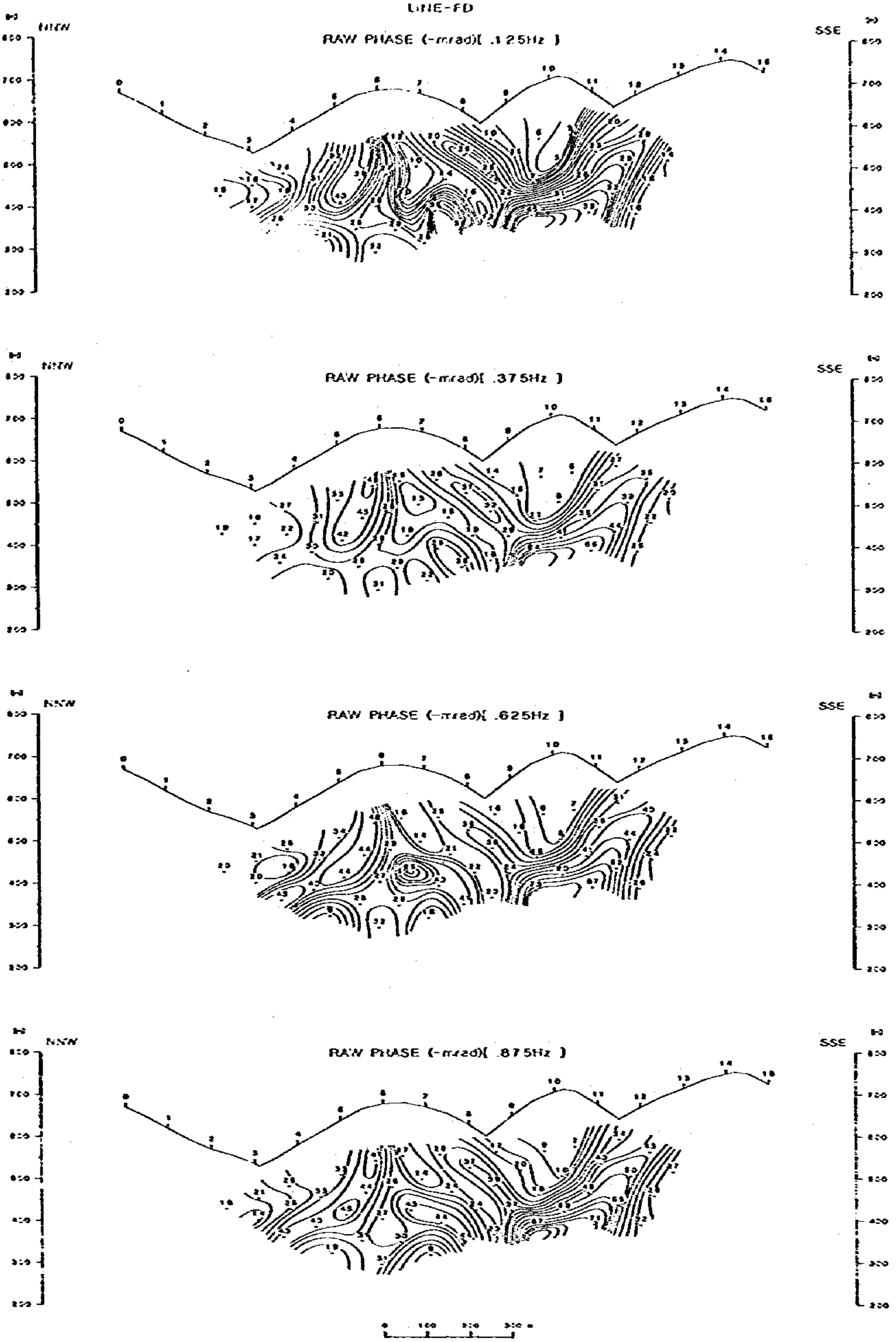
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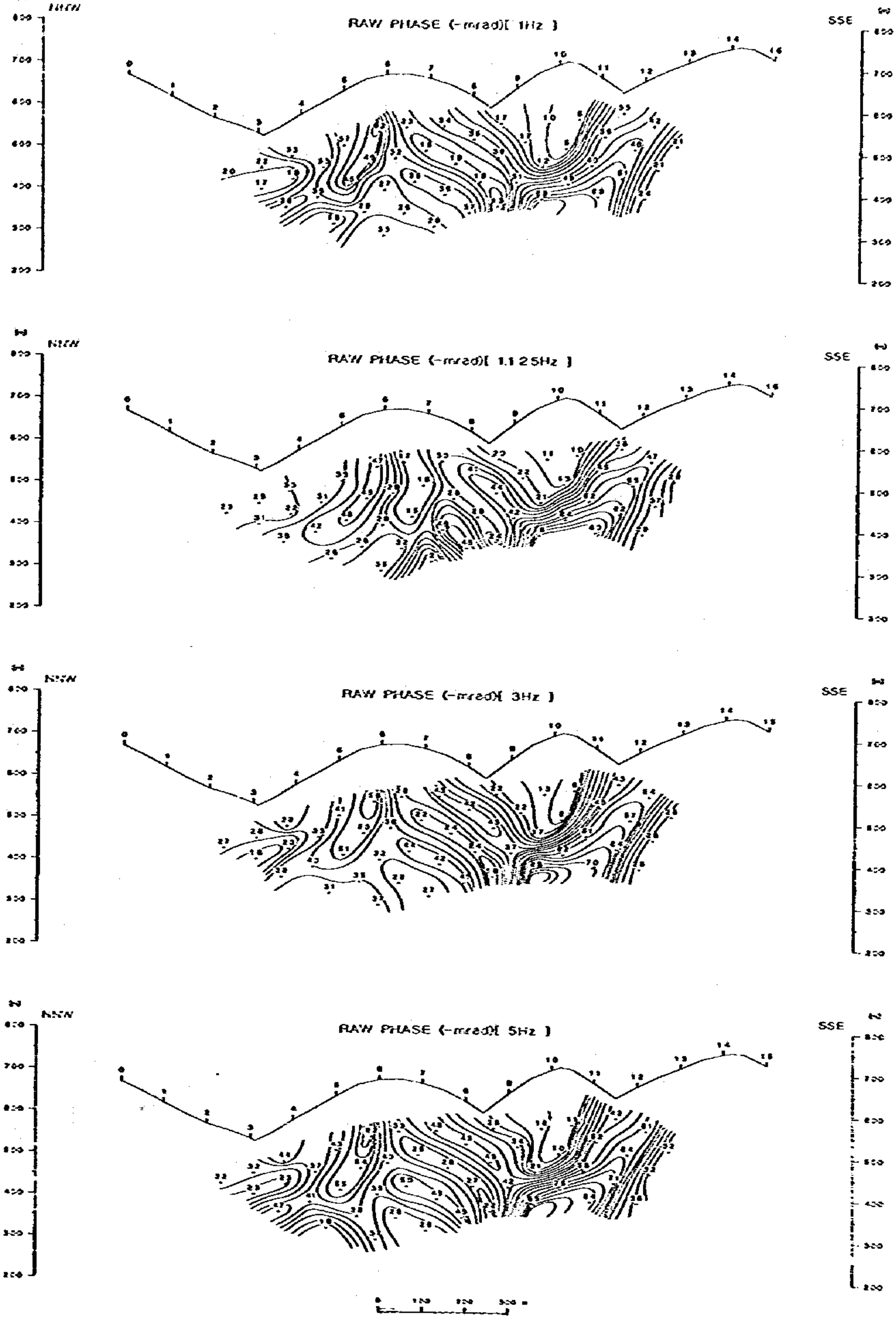
FD- 1

LINE-FD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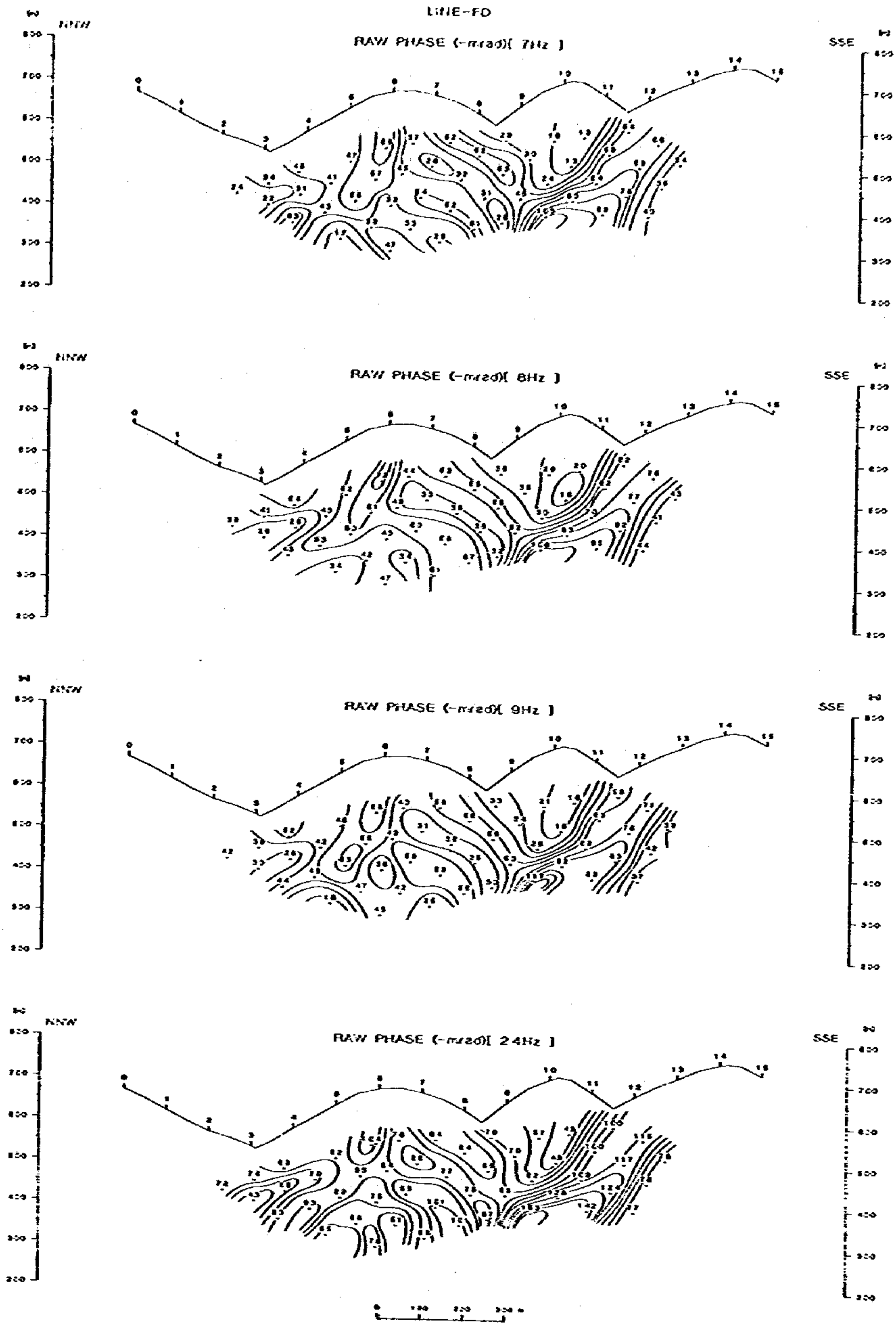

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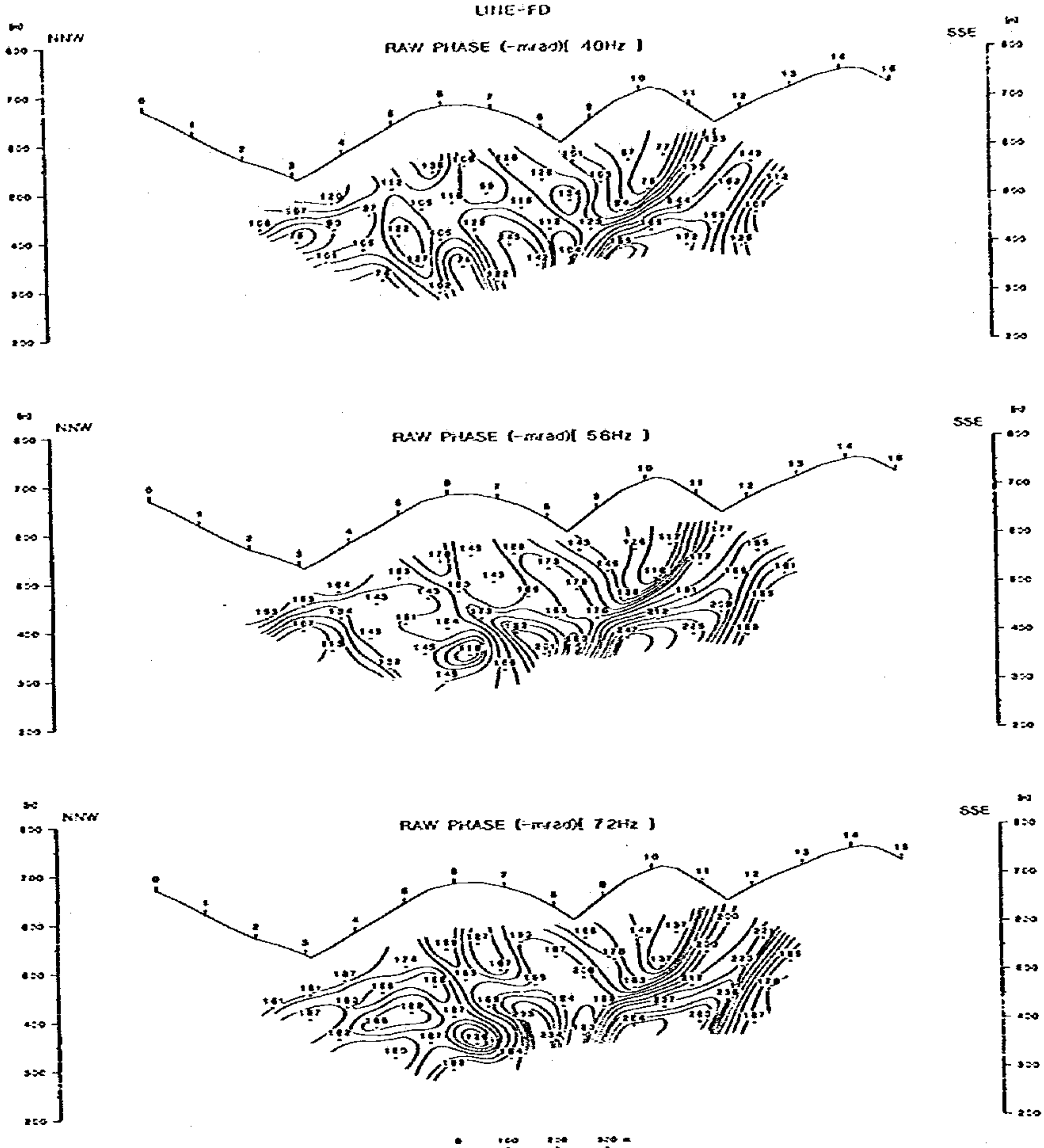
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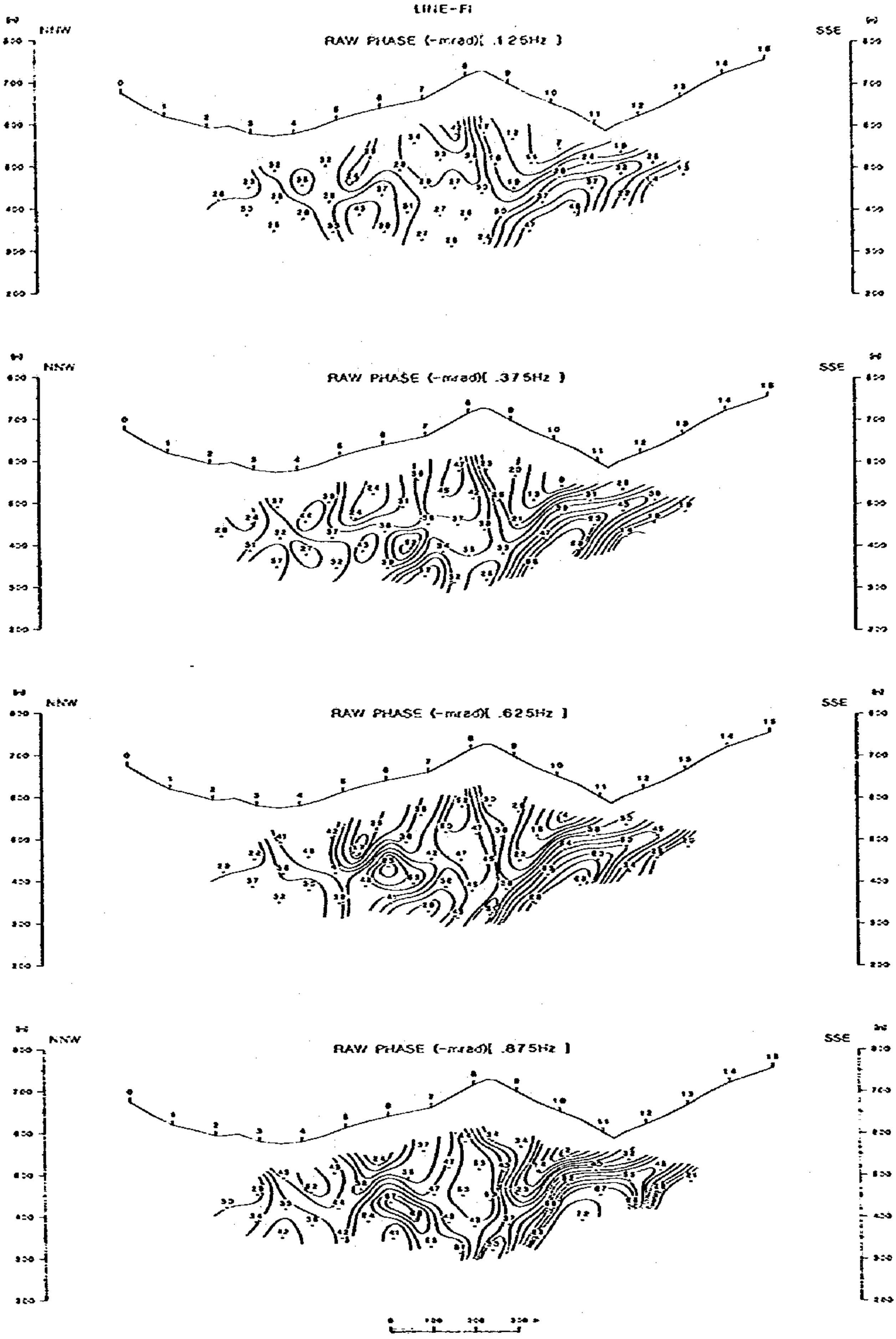
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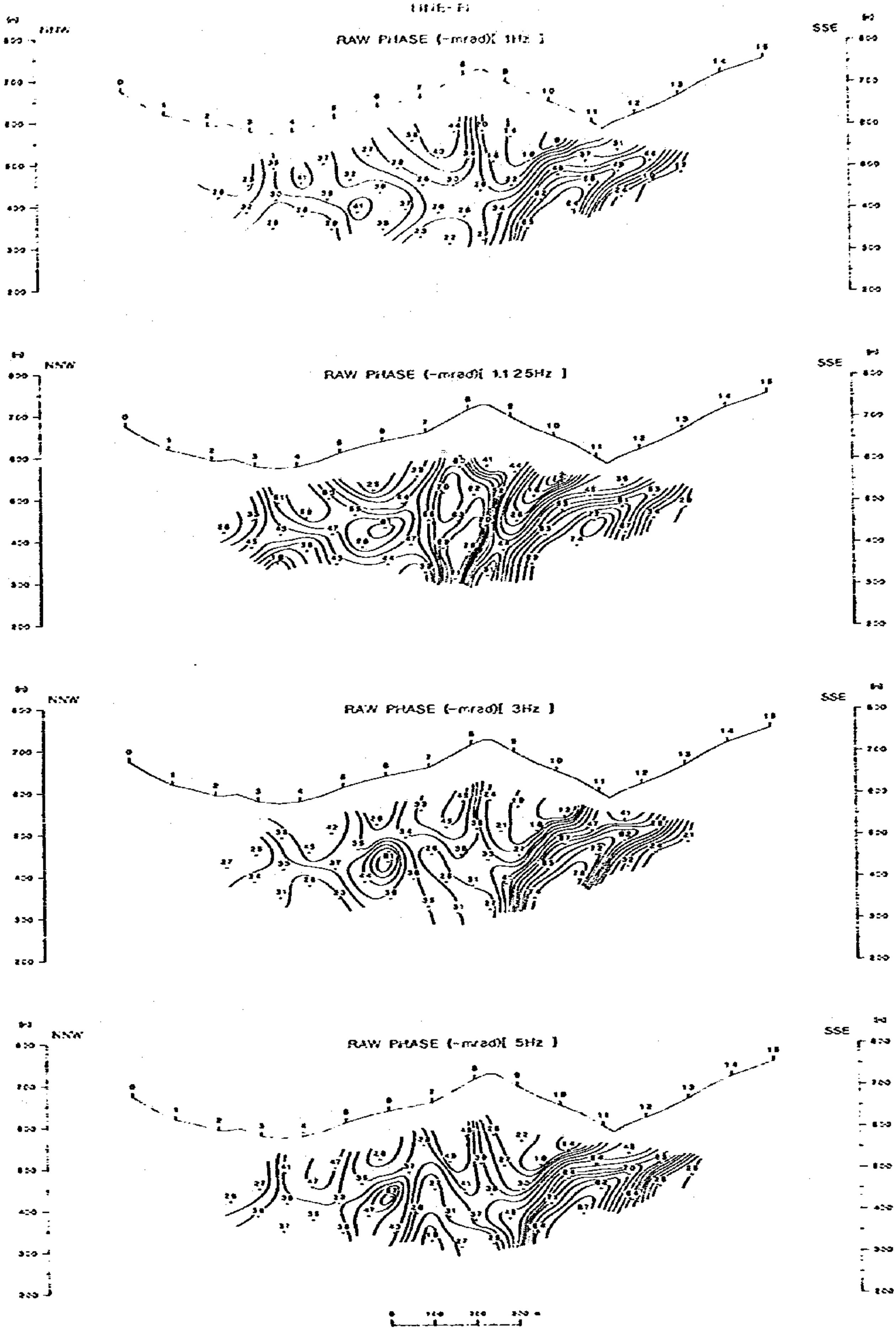
FI- 1

LINE-FI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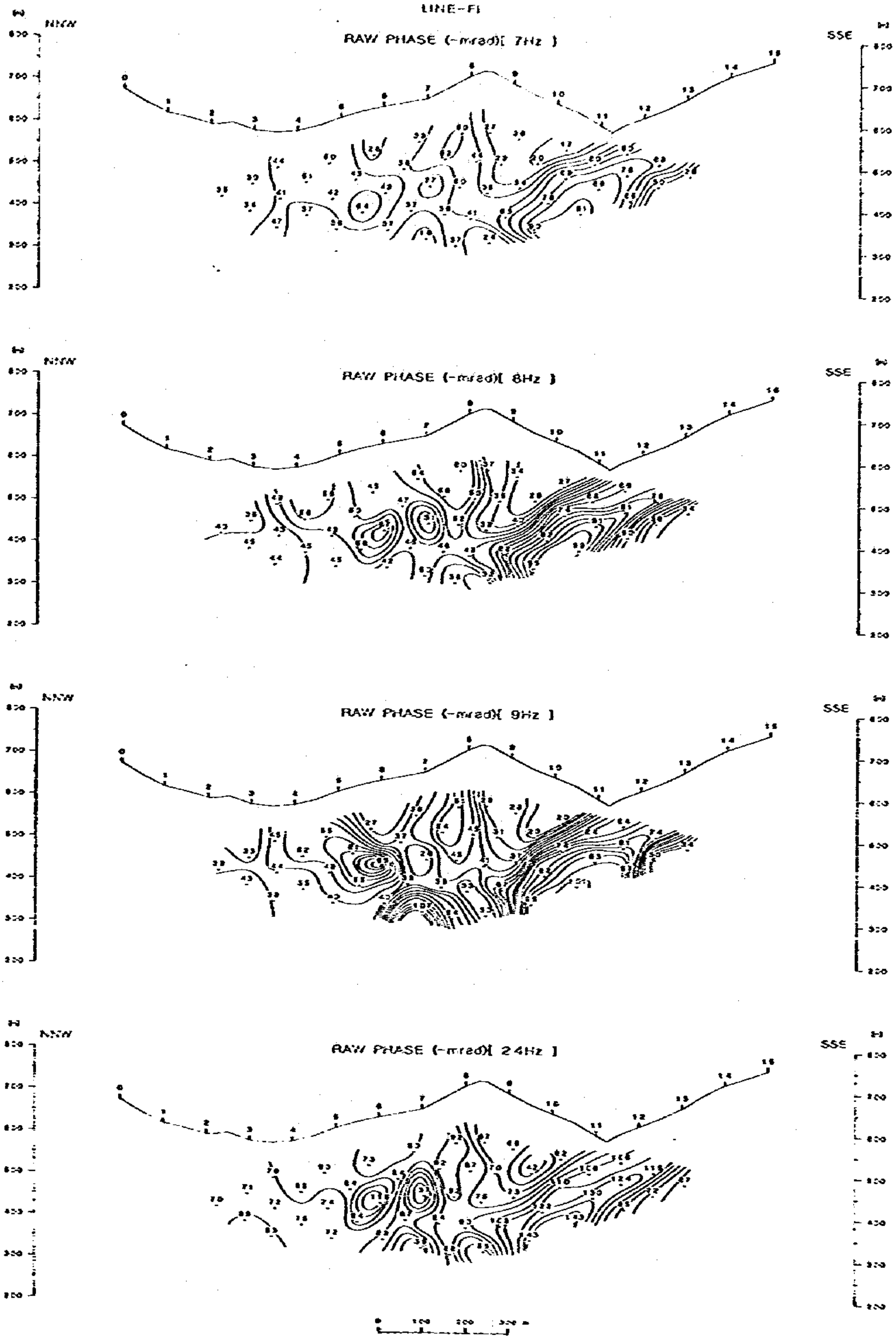
FI- 2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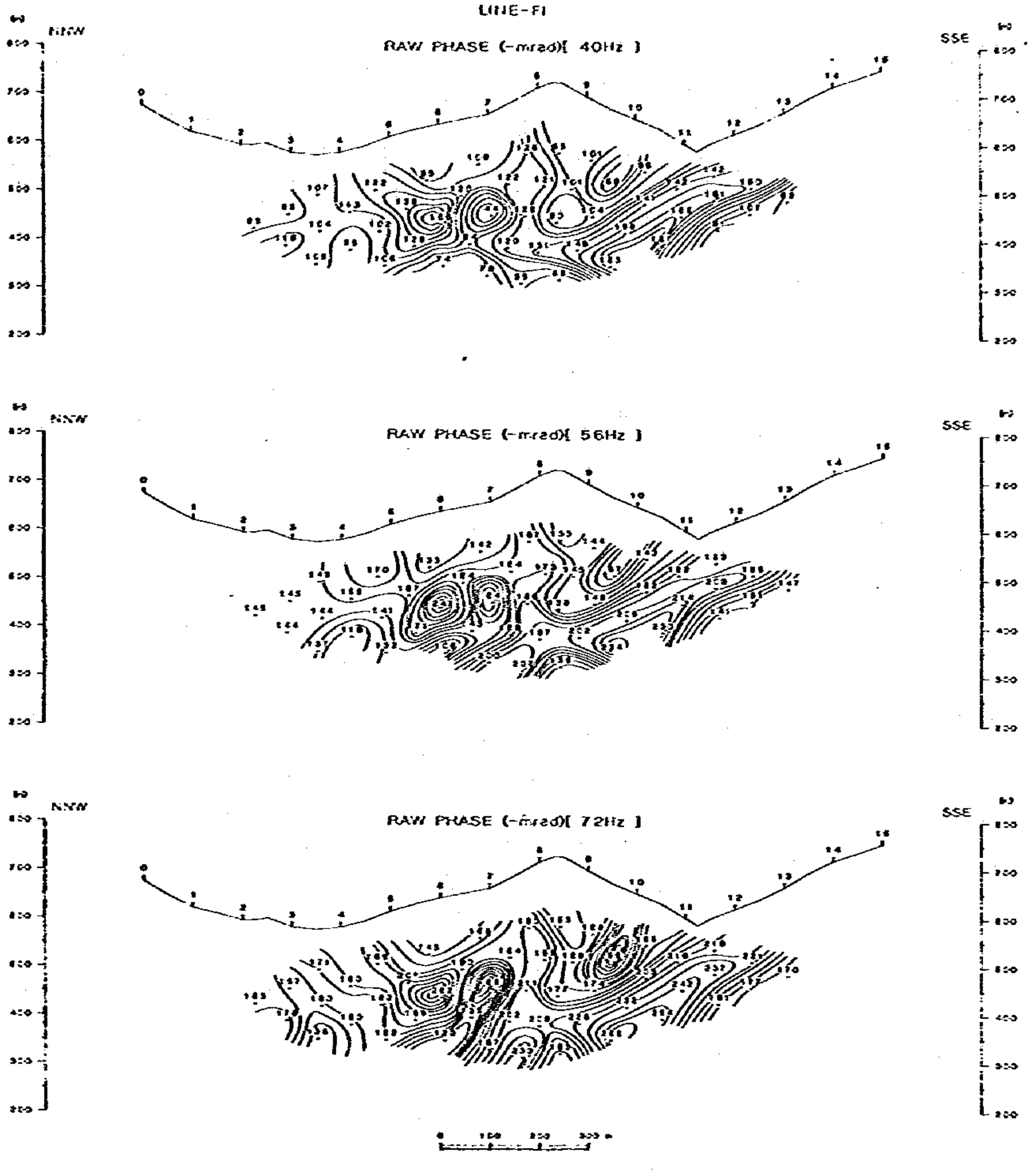
FI- 3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FI- 4

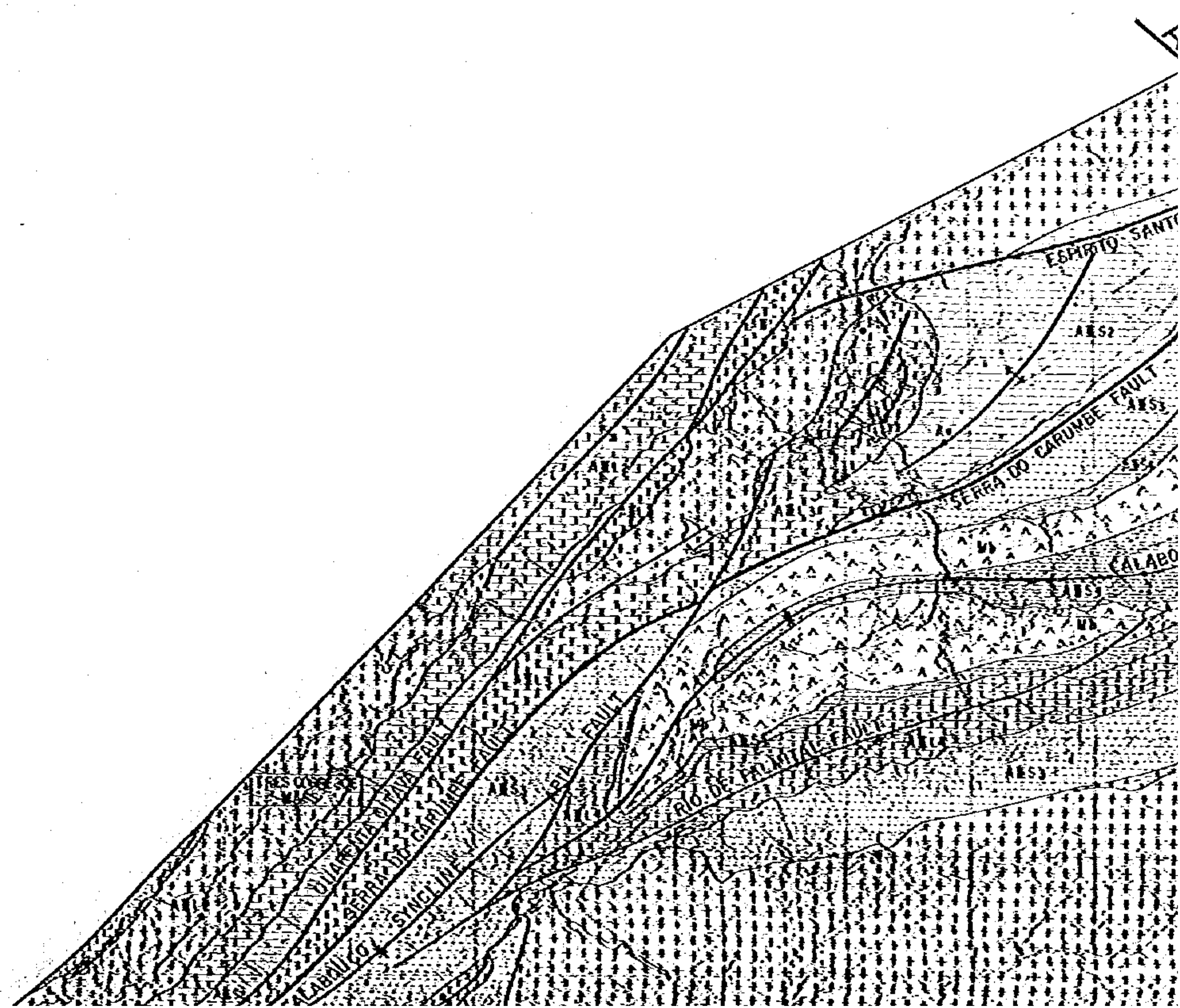
List of Mines and Showings in Survey Area

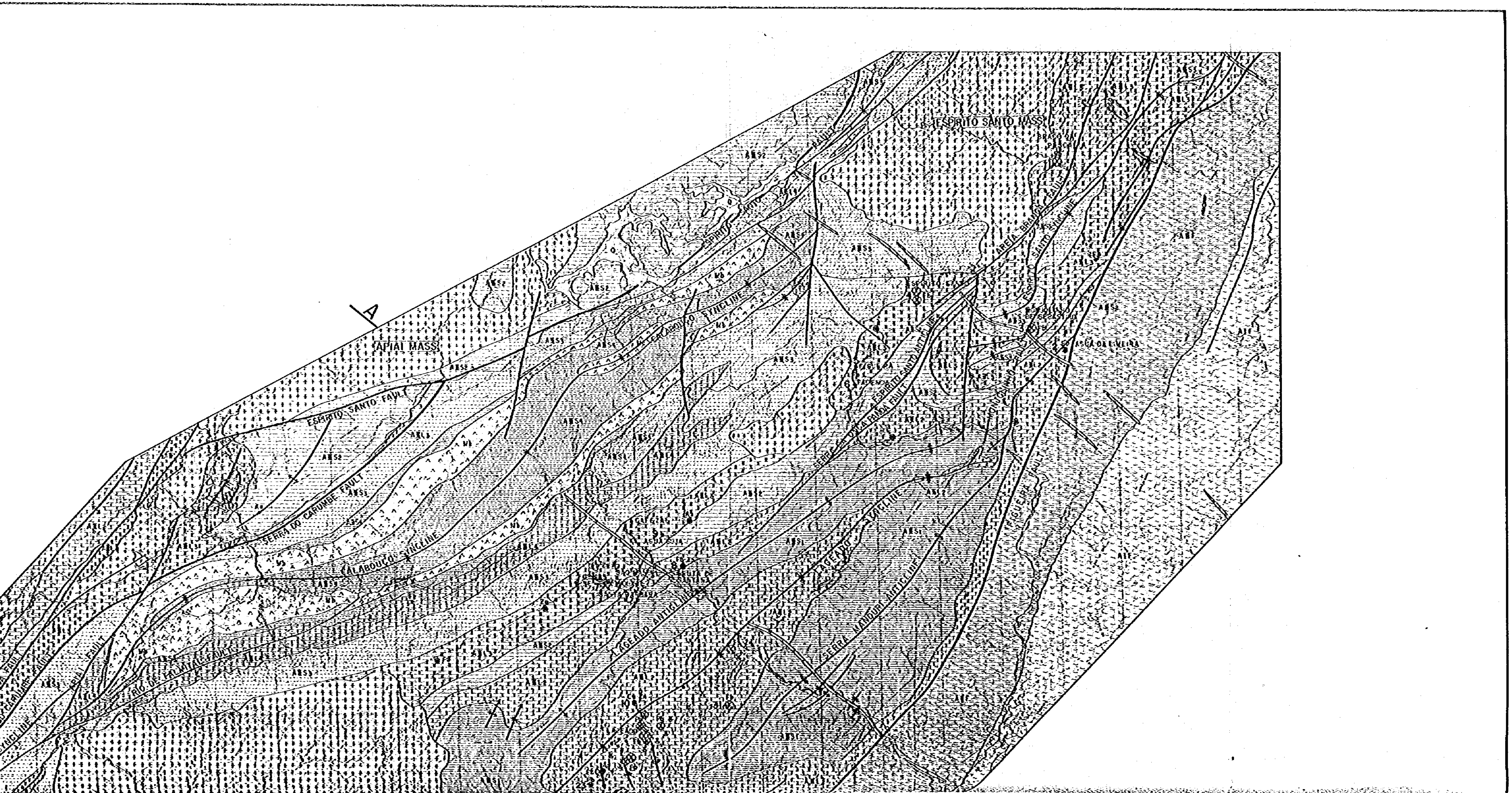
(1)

No.	Group	Name of Mine & Showing	Kind of Ore	Type	Status	Location	Host Rock	Strike & dip	Lateral Extension	Longitudinal Extension	Average Width	Au g/t	Ag g/t	Cu %	Pb %	Zn %	Ore Mineral	Remarks
								Ore Deposits				Grade						
1		Braço do Pescaria	Pb	Vein	closed	Areia Branca	Açungui III F Ly limestone	-	-	-	-	-	-	-	-	-	Ga	
2		Agua do Lineiro	Pb	do	do	East of Espirito Santo	Açungui III F Ly limestone	N40°~60°W, 30°~50°SW	1,200m	-	0.005 ~0.30m	0.4	554.0	0.56	11.09	0.09	Ga, Cp, Py, Ce, Cv	
3		Morginho de Sebastião	Pb	do	do	do	Açungui III F Ly dolomite	N40°E, 40°SE	10	-	network 0.03~0.10	0.8	204.0	0.90	7.70	6.09	Ga, Py, Cp	production several tons
4		Espirito Santo	Pb	do	do	Espirito Santo	Açungui III F Ly limestone	N50°E, 60°NW	250	100	0.30	0.0	65.9	0.05	0.57	0.46	Ga, Bn, Cer, Py, Cv	production several hundred tons
5		Figueira	Pb	do	do	Southeast of Espirito Santo	do	N50°E, 55°NW	-	-	0.15~0.20	-	-	-	-	-	Sp, Ga, Py, Cp	production several hundred kilograms
6		Paciencia	Zn, Pb	do	do	do	do	N60°E, 50°SE	-	-	0.85~1.50	-	-	-	-	-	Ga, Sp, Py, Cp	production Galena 200 kg
7		Furnas	Pb, Ag, Zn	Vein and pipe-like	operating	Furnas	do	N60°W, 80°SW; N45°E, 45°NW	400	100	-	0.2	2596.0	0.11	17.69	3.62	Ga, Sp, Py, Tt, Cer	production (1981), 500 T.M Pb 7%, Ag 3,000 g/T
8		Gruta de Santana	Pb	Vein	closed	East of Furnas	Açungui III F Ly limestone	-	-	-	network 0.01~0.05	0.9	7.9	0.02	5.92	1.79	Ga, Sp	production 10 tons
9		Agua Suja	(Pb)	(Vein)	do	Northeast of Furnas	Açungui III F Ly limestone	-	-	-	(0.02~0.04)	11.8	2.0	0.01	0.12	0.01	Bn, Ce	
10	Lageado Deposits	Occorrencia de Cobre	Cu, Zn	Vein	do	Lageado	Açungui III F Ly dolomite	N55°E, 50°SE	1.5	30	network 0.02	1.5	130.7	4.33	0.54	11.50	Ga, Cv, Py, Bn, Cer	
11	Lageado Deposits	Lourenço Velho (São Lourenço)	Pb	do	do	do	Açungui III F Ly limestone	N45°E, 75°SE	20~30	-	1.00	-	-	-	-	-	Ga, Cer	production 10 tons
12	Lageado Deposits	Santana Velha	Pb	do	do	do	do	N75°E, 70°SE	5	250	0.50	-	-	-	-	-	Ga, Sp	production 1,000 tons
13	Lageado Deposits	Pesco ou Pesco de Mato	Pb, Zn	do	do	do	do	N70°E, 70°SE	-	-	0.63~0.83	-	-	-	-	-	Ga, Sp, Py	production Ga, 3 tons
14	Lageado Deposits	Mamangava	Pb	do	do	do	do	N45°E, 70°SE	500	100	0.83	0	215	0.9	11.1	0.01	Ga, Sp, Py, Cer	by JICA (1981), production several thousand tons
15	Lageado Deposits	Santana Nova	Pb, Ag	do	do	do	do	N65°E, 75°SE	600	250	0.30	0.3	1174.0	0.58	12.24	0.01	Ga, Py, Cer, Cv	production several thousand tons Pb 5~55%
16	Lageado Deposits	Santana F	Pb	do	do	do	do	N65°E, 65°SE	-	100+	1.00~2.00	-	-	-	-	-	Ga, Py, Cer	production Ga, 20~30 tons
17	Lageado Deposits	Nova Esperança	Pb, Ag	do	do	do	do	N65°E, 70°SE	20	85+	0.50	0.5	1431.0	0.28	12.54	0.01	Ga, Cer, Py, Cp, Cv	production 83 tons Pb 45%
18	Lageado Deposits	São Vicente	Pb	do	do	do	do	N65°E, 55°SE	-	50	0.65	0.5	436.0	0.08	12.04	0.22	Ga, Bn, Cer	production 43 tons
19	Lageado Deposits	Coqueiro	Pb	do	do	do	do	N60°E, 67°SE	-	65	0.20	-	-	-	-	-	Ga, Py, Cer	production 5 tons
20	Lageado Deposits	Bagres	Pb	do	do	do	do	N65°E, 75°SE	-	150	0.30	-	-	-	-	-	Ga, Py	production 500 tons
21	Lageado Deposits	Jardim I·II	Pb, Ag	do	do	do	do	N55°~65°E, 65°SE	20	250	0.70	0.4	2153.0	0.58	12.14	0.58	Ga, Py, Bn, Cer	production 1,000 tons, 80 tons Pb 50% (?)
22	Lageado Deposits	São Rafael I·II·III	Pb	do	do	do	do	N70°E, 65°SE	-	150+	1.00	-	-	-	-	-	Ga, Py	by Sobrapa production 200~1,000 tons
23	Lageado Deposits	Boa Ventura	Pb	do	do	do	do	N70°E, 60°SE	5~10	80m (pyr vein 1,000m)	1.00~1.50	0.1	1373.0	0.05	11.54	0.27	Ga, Py, Bn, Cer	production 85 tons
24	Serra Deposits	Mangabinho	Pb	do	do	do	do	E-W, 45°S	-	-	0.15	-	-	-	-	-	Ga, Sp, Bn, Cer	production several hundred tons
25	Serra Deposits	Jaqueira	Pb, Zn	do	do	do	do	N50°E, 65°SE	-	50+	0.15~0.50	0.1	635.0	0.16	10.56	5.37	Ga, Cer, Sp, Py, Ml, Bn, Cv	production 93 tons
26	Serra Deposits	Sete Alqueires	Pb	do	do	do	do	N70°E, 75°SE	-	-	?	-	-	-	-	-	Ga, Bn	
27	Serra Deposits	Barra Funda I·II·III·IV	Pb	do	do	do	do	N70°E, 47°SE	-	-	0.20~0.33	-	-	-	-	-	Ga, Sp	
28	Serra Deposits	Alto da Barra (Descoberto III)	Pb	do	do	do	do	N70°E, 70°SE	-	-	0.30~0.43	-	-	-	-	-	Ga, Sp, Py	by Sobrapa, production Ga, 15 tons
29	Serra Deposits	Cova Velha	Pb	do	do	do	do	N65°E, 65°SE	-	200	0.12~0.43	tr	265	-	9.48	nd	Ga, Sp, Py, Bn, Cer	by Sobrapa
30	Serra Deposits	Sitio Novo	Pb	do	do	do	do	N65°E, 65°SE	-	-	0.20~0.30	-	-	-	-	-	Ga	
31	Serra Deposits	Barra do Leão	Pb, Ag	do	do	do	do	N45°E, 65°SE	-	65	0.25~0.33	0.0	1171.0	0.51	12.86	0.27	Ga, Sp, Py	
32		Santo Antonio do Pardo	Pb	do	do	Pardo	do	N40°W, 30°~45°NE	300	150+	0.15	0.0	51.0	0.20	4.29	0.36	Py, Ga	by Sobrapa, production 20 tons
33		Fluorita de Sete Barras	F	do	do	do	do	N57°E	50+	20	0.50	nd	(F) 24.6	nd	nd	nd	F	
34		Mina Empresa de Mineração	Cu	stratiform	do	do	Açungui III F calc-silicate rock	N57°W, 35°N	60	60	0.50	0.0	10	0.4	0.2	0.1	Cp, Py, (Ga)	

(2)

Ser. No.	Name of Mine & Showing	Kind of Ore	Type	Status Quo	Location	Host Rock	Strike & Dip	Lateral Extension	Longitudinal Extension	Average Width	Au g/t	Ag g/t	Cu (%)	Pb (%)	Zn (%)	Ore Mineral	Remarks
							Ore Deposits				Grade						
35	Perau	Pb, Ag	stratiform	operating do	Estado Paraná Município Adrianópolis	Açungui III F calc-silicate rock	N30E 30N	300+	200	0.50	0	120	0.2	14.3	2.0	Ga, Sp, Cp, Py	production (1981) 1,500 T.M Pb 8.5% Ag 120 g/T
36	Agua Clara	Cu, Pb, Ba	do	closed	do	Açungui III F dolomite	E-W 45S	10	50	0.20	0	8	0.8	0.3	0.0	Ga, Cp, Ba	
37	Pretinho	Ba	do	operating	do	Açungui III F calc-silicate rock	N10E 35S	1,500	150+	1.50	($BaSO_4$) 85	(S) 0.5	ppm 150	ppm 50	ppm 60	Ba	production (1981) 145 T.Y
38	Panelas	Pb	bedded vein & vein	operating	do	Açungui III F Ly limestone	N40E 55N	900	200	0.30	0	130	0.3	24.0	0.0	Ga, Sp, Py, Po	total production 1,230,000 T Pb 7.8%; production (1981) 2,500 T.M Pb 5.83 Ag 139 g/T
39	Laranjal	Pb	bedded vein do	closed	do	do	N70E 65N	-	-	0.50	1	223	0.6	17.4	0.3	Ga	
40	Cerrinho	Pb	do	do	do	Açungui III F Ly calcareous shale	E-W 60N	-	-	0.15~0.50	0	117	0.1	7.9	0.0	Ga, Cer	
41	Barrinha	Pb, Ag	do	under Exploration	do	Açungui III F Ly limestone & calcareous shale	N50~70E 45~65N	50~70	70~200	0.50~14.20	1	150	0.1	20.6	0.0	Ga, Sp, Cp, Py, Cbr, Pyar	
42	Diogo Lopes	Pb, Ag	do	closed	do	Açungui III F Ly limestone	N75~85E 55~70S	10	50	0.50	1	221	0.1	16.1	0.4	Ga, Py	total production 1,161 Pb 9.72%
43	Barone	Pb, Ag	do	do	do	do	N35E 55S	15	20	1.50	1	70	0.2	23.1	0.0	Ga, Py	total production 641 Pb 14.6%
44	Paqueiro	Pb, Ag	bedded vein & vein	do	do	do	N50~60E 85N~85S	1~70	40	0.20~1.20	1	214	0.5	9.6	0.0	Ga, Sp, Cp, Py	total production 14,300 T Pb 9%
45	Canoinha	Pb, Cu	vein	do	do	Açungui III F Ly limestone	-	-	-	-	-	-	-	-	-	Ga, Py, Cp, F	
46	Braz	F	do	do	do	do	-	-	-	-	-	-	-	-	-	F, Ga, Py, Cp	
47	Quarenta Oitava	Pb	do	do	do	Açungui III F Ly limestone	N10E, 90	-	-	-	-	-	-	-	-	Ga, Lim, Py, Sp, Bi	
48	Onça I	Pb	do	do	do	do	-	-	-	0.50	-	-	-	-	-	Ga	
49	Onça II	Pb	do	do	do	Açungui III F Ly limestone	N10E, 85NW	-	-	-	3.6	924	1.54	7.43	0.23	Ga, Lim, Py, Tt, Cp, Sp	
50	Rocha	Pb, Ag	do	operating	do	Açungui III F Ly dolomite	N15~30E 65S, 65E	450~400	150~200	0.10~2.00	1	450	0.5	15.0	0.0	Ga, Sp, Cp, Py	production (1981) 2,500 T.M Pb 6.5% Ag 139 g/T

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ESPIRITO SANTO MASS
APIAI MASS
ESPIRITO SANTO FAULT
SERRA DO CARUMBE FAULT
CALABOUÇO SYNCLINE
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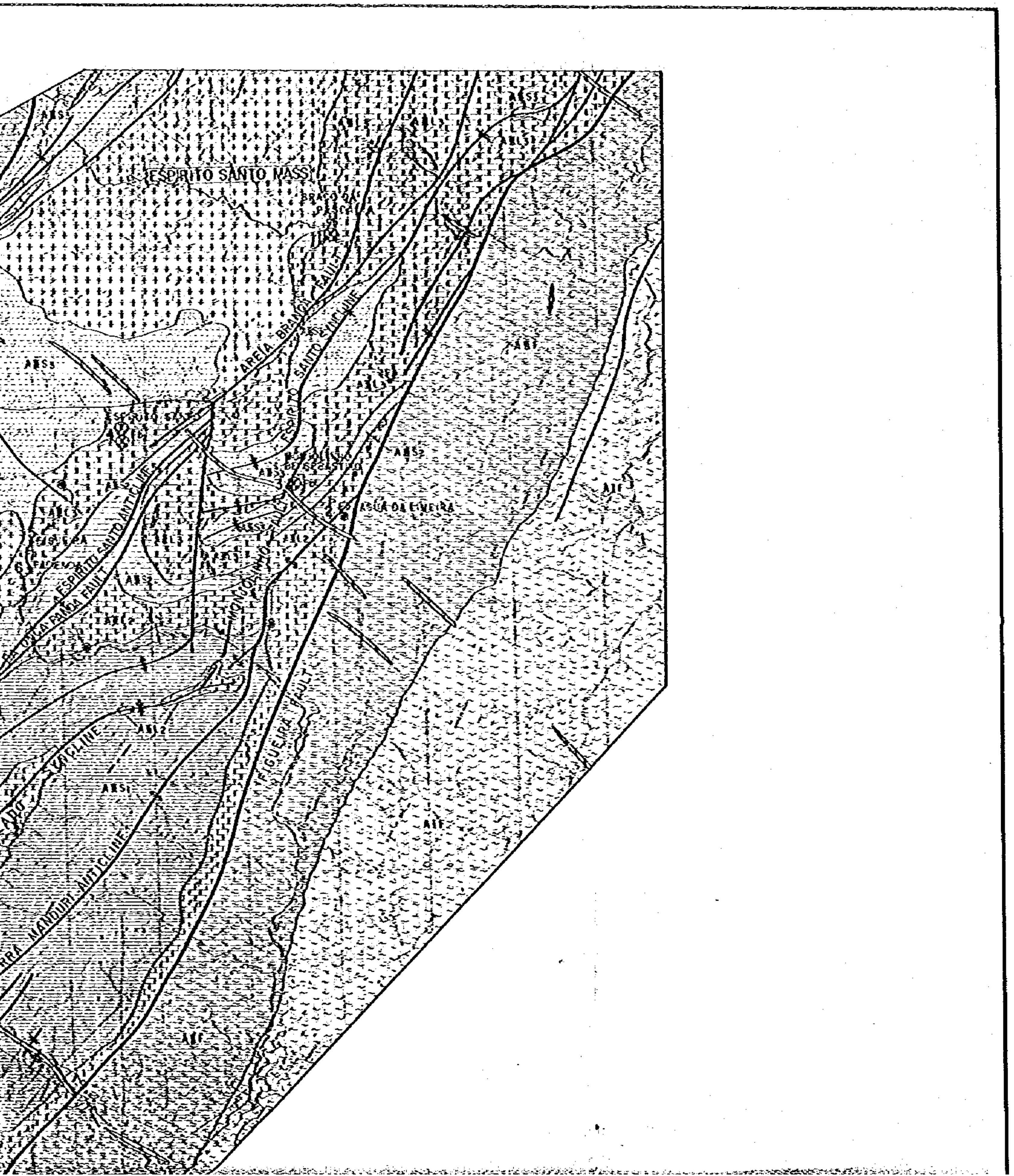
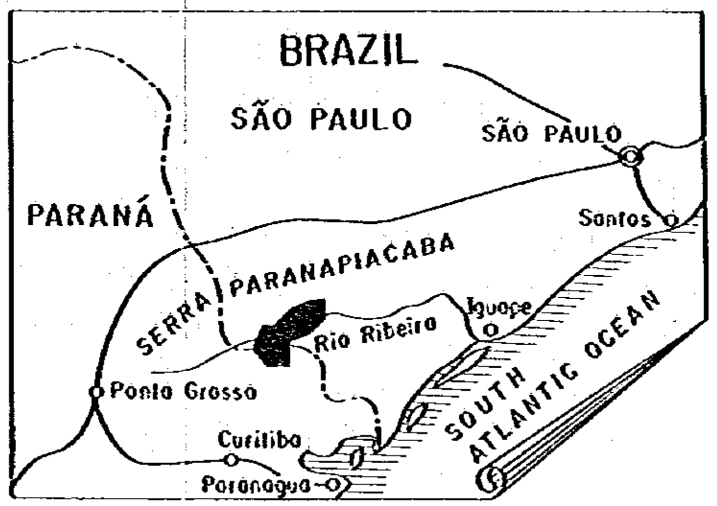
AGEADO ANTICLINE
SERRA MANDURI ANTICLINE



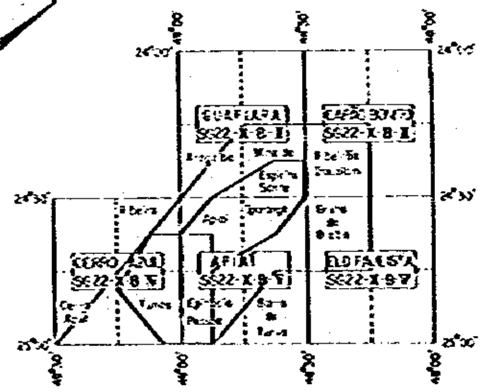
PL. 1

BRAZIL
GEOLOGICAL SURVEY OF ANTA GORDA AREA

Relation Map between Mineralization and Geological Structure in the Semi-detailed Surveyed Area



LOCATION INDEX



JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

MAR. 1984

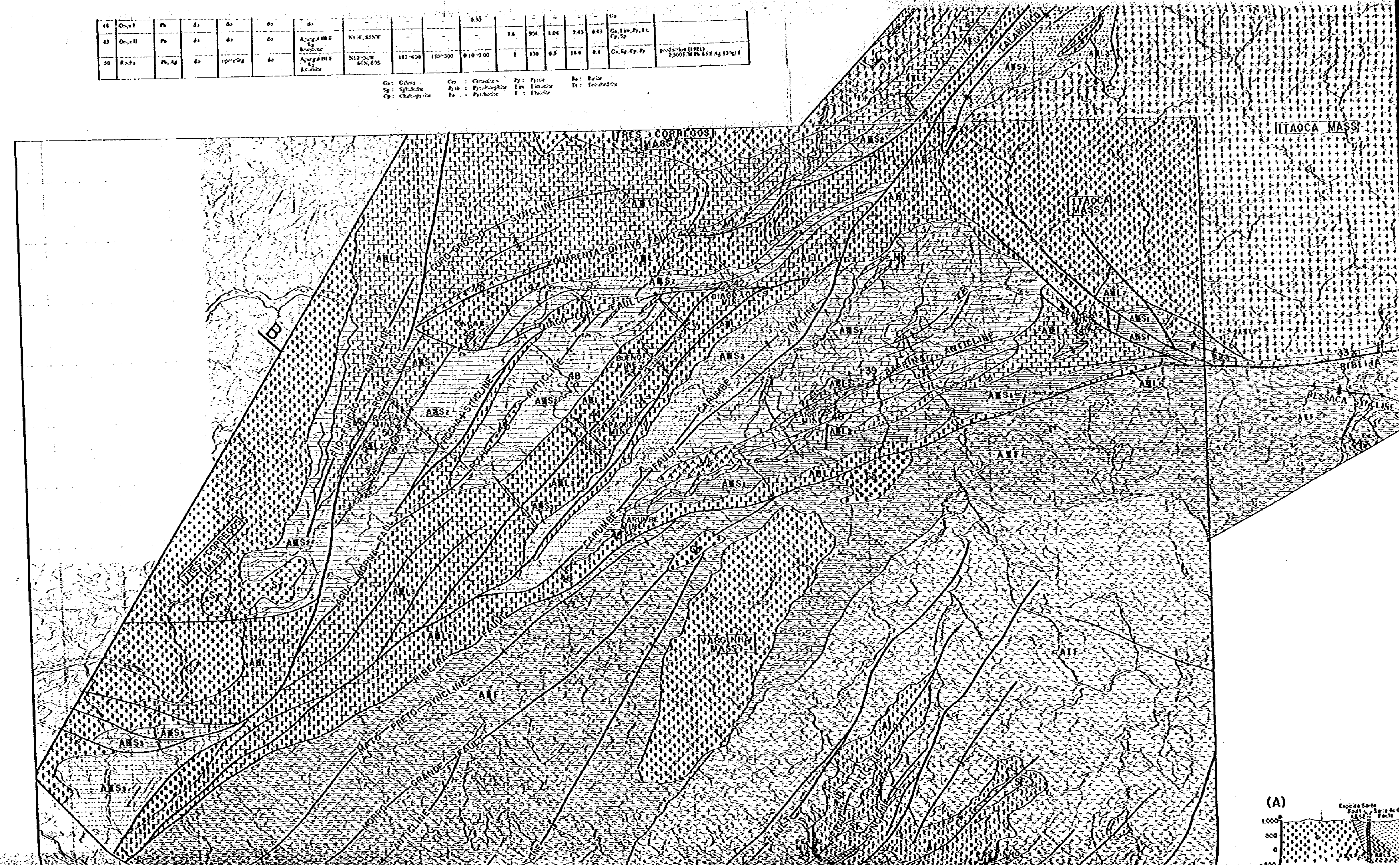
Prepared by Bishimetal Exploration Co.,Ltd.

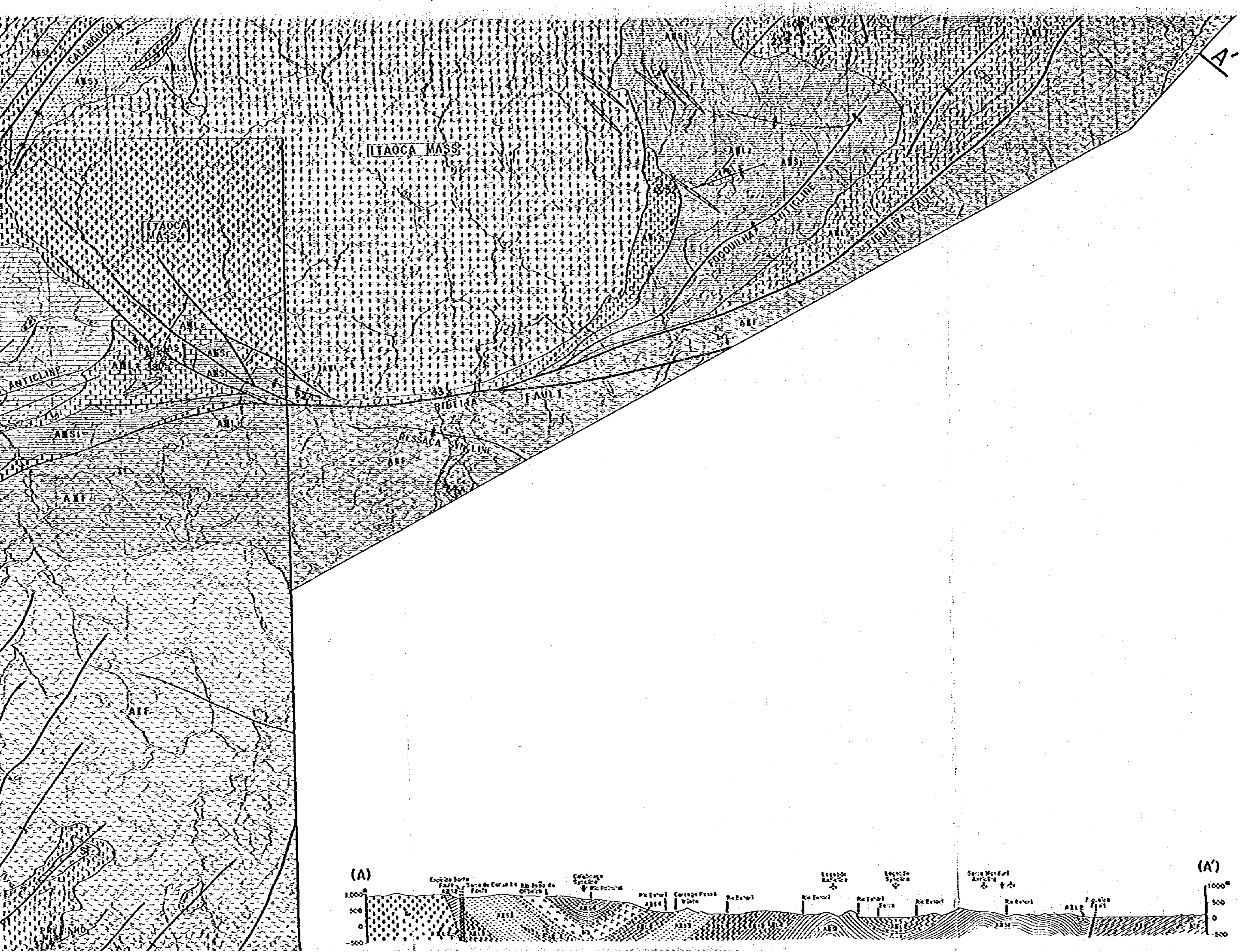
Scale 1:100,000

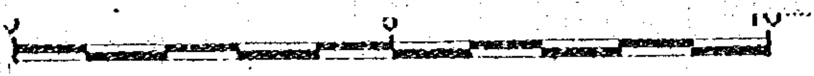
0 5 10km

45	Onça I	Pb	do	do	do	do	–	–	–	0.35	–	–	–	–	–	Ga	
43	Onça II	Pb	do	do	do	Apiaí gd III F Basalt	N13E, 85NW	–	–	–	3.6	904	1.04	7.43	0.03	Ga, Lim, Py, Tt, Cp, Sp	
50	Rocha	Pb, Ag	do	operating	do	Apiaí gd III F Dolomite	N10~30W 60N, 60S	100~400	150~300	0.10~2.00	1	130	0.5	18.8	8.4	Ga, Sp, Cp, Py	production (1981) 2,500 t/M Pb 6.5% Ag 130g/t

Ga : Galena
Sp : Sphalerite
Cp : Chalcopyrite
Cer : Cerussite
Pyro : Pyromorphite
Po : Pyrrhotite
Py : Pyrite
Lim : Limonite
F : Fluorite
Ba : Barite
Tt : Tetrahedrite




ITAOCA MASS
ITAOCA MASS
CALABOUÇO
ANTICLINE
FORQUILHA ANTICLINE
FIGUEIRA FAULT
RIBEIRA FAULT
BESSACA SYNCLINE
A'
(A)
(A')



LEGEND

Quaternory	Q	mud
Upper Precambrian, Açungui Group, Açungui Formation III	AIIIS4	meta siltstone, meta sandstone
	AIIIL4	limestone
	AIIIS3	meta quartz sandstone
	AIIIL3	limestone with dolomite, mica schist and meta siltstone
	AIIIS2	mica schist ~ phyllite with meta sandstone
	AIIIL2	limestone and dolomite with mica schist and meta siltstone
	AIIIS1	mica schist ~ phyllite and meta sandstone
	AIIIL1	limestone
Açungui Formation II	AIIF	mica schist ~ phyllite with meta sandstone, amphibole schist and calc-schist ~ limestone
Açungui Formation I	AIF	mica schist with meta sandstone, meta basalt ~ amphibolite and calc schist
	AIℓs	limestone, dolomite and calc-silicate rock (Perau horizon)
	AIqt	quartzite
	SF	gneiss
Intrusive rocks	Mb	meta basite
		granite
	Gb	gabbro
	Sy	syenite
		diabase

anticlinal axis

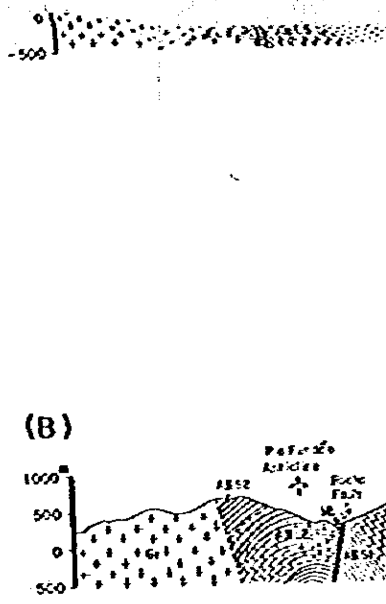
Synclinal axis

Fault

operating mine

closed mine


MORRO AGUDO MASS
MORRO GRANDE
RIBEIRÃO GRANDE
AGUA CLARA SYNCLINE
ANTA GORDA ANTICLINE
SYNCLINE
ANTICLINE
SF
ATF
B'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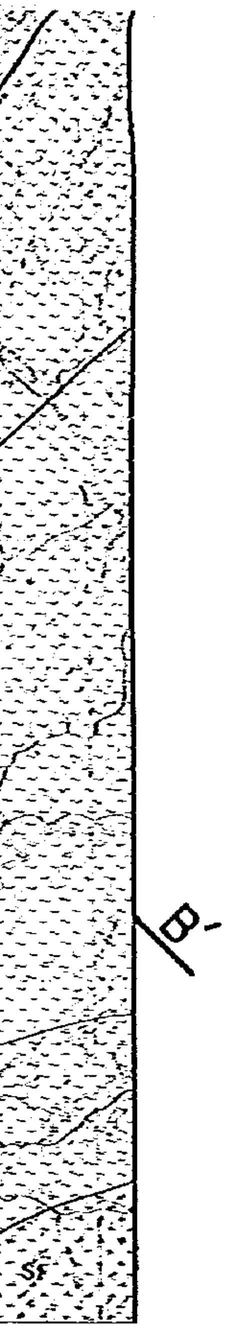
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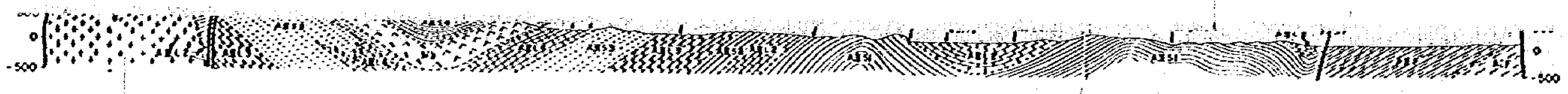

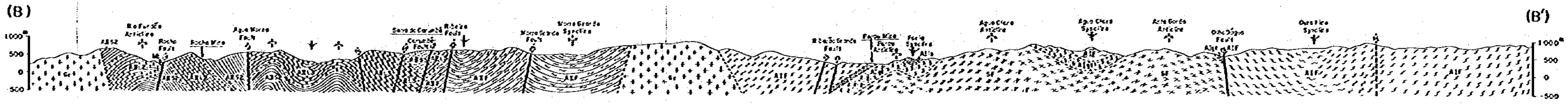
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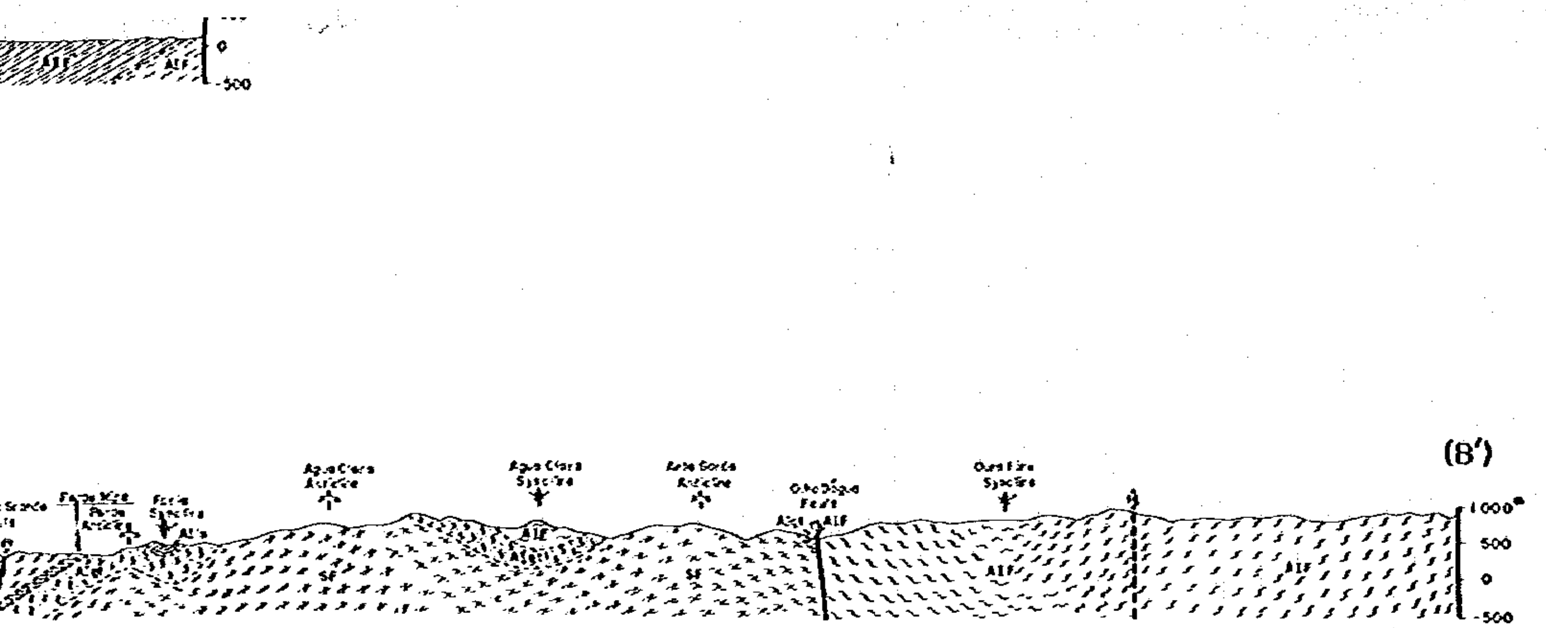

⚒ operating mine

⚒ closed mine