batholith, assuming increase of the K_2O contents in the southern part than northern area as same as in the North American granitic rock batholith. This tendency is probably caused by subduction of the plate from the north as explained by Katili (1973), Hamilton (1978) and others.

3-3 Absolute Ages of Granitic Rocks

Absolute age determination by K-Ar method was conducted on half (12 samples) of the granitic rocks which had been chemically analyzed in order to aim at clarification of activity period of this project granitic rocks. Selected samples are 1 sample of G. Sebiawak granodiorite, 4 samples of G. Raya granodiorite, 2 samples of Tiang quartz diorite, 2 samples of Sirih·Banyi tonalite, 1 sample of Serantak dacite and 2 samples of G. Ibu granitic rocks. The determination results are given in Table 2-2.

Based on the geological survey and the absolute age determination results, the ages of the granitic rocks in the project area is divided as showned below.

(a) Mesozoic, Cretaceous Granitic Rocks

G. Sebiwak granodiorite	124 m.y.	(early Cretaceous)
G. Raya granodiorite	114 to 103 m.y.	(middle Cretaceous)
G. Selantar granodiorite	98 to 95 m.y.	(middle Cretaceous)

(b) Younger Intrusion (Tertiary)

Serantak dacite	51 m.y.	(Eocene)
Sirih·Banyi tonalite	27 to 20 m.y.	(Oligocene - early Miocene)
G. Ibu area		
Sijangku quartz diorite	30 m.y.	(Oligocene)
G. Raya granodiorite *	30 m.y.	(Oligocene)

* It is different type of G. Raya granodiorite of the project, referring to T. Suhanda's report.

As a result of the dating, igneous rocks are divided into two ages, namely Cretaceous granitic rock batholith and Tertiary granitic rock intrusion. In G. Ibu area, younger granitic rock intrusions are also clarified, and also copper and molybdenum mineralization associated with these granitic rocks has relation with younger igneous activity.

Many granitic rocks were determined their age in Central to West Kalimantan (Katili 1973, 1981, Priom 1973, Haile and et al 1977, A.S. Sumartadipura, M.M.A.M. - D.M.R. 1979, 1980, 1981) as shown in Fig. 2-17, 18. According to the map, granitic rocks distributing at northern margin of the batholith are from 124 m.y. to 95 m.y. in their age, and granitic rocks in southern margin and continueing to Natuna and Andaman Islands are from 86 m.y. to 74 m.y. in their age, indicating that those in the southern margine are younger than those in the north.

3-4 Granitic Rock Classification by Opaque Minerals

The zone from the Thailand and Malyasian Peninsular to the islands of Bangka and Bilitong in the east of Sumatra is well known as the area of tin mining. However, no tin deposit has been discovered in the west Kalimantan granitic batholith which is considered to be the Cretaceous Magmatic Arc connected to the Malaysian Peninsular over the Sundaland (Hamilton, 1978).

Opaque minerals such as magnetite and ilmenite are commonly included in granitic rocks, and granitic rocks are classified into a magnetite series or ilmenite series according to content of these mineral. It is said that the former is related to porphyry copper deposit and the latter to tin deposit (S. Ishihara, 1977). Attempts were made to classify the granitic rocks in the project area by the opaque minerals and to compare chemical composition of granitic rock in the project area and others in tin producing areas.

Table 2-2 Result of K-Ar Absolute Age Determination in the Project Area and G.Ibu Area

No.	Sample No.	Locality	Rock Name	Mineral or Rock	SccAr ^{40}Rad/ gm x 10^{-5}	^{40}Rad% Ar	K%	Aze(m.y.)
1	79RB-24	S. Bamua	Sirih Tonalite	Hornblende	0.213 0.223	48.3 48.9	2.80 2.79	20.0±1.0
2	79RD-52	S. Banyi	Banyi Tonalite	Hornblende	0.126 0.137	30.1 43.9	1.20 1.21	27.8±1.4
3	79RE-50	S. Sakung	Tiang Quartz Diorite	Hornblende	0.367 0.354	73.3 70.0	0.90 0.93	98.6±4.9
4	79RP-19	S. Bala	G. Raya Granodiorite	Hornblende	0.225 0.215	62.9 45.0	0.53 0.53	100.7±5.2
5	80RA-31	S. Molo	Serautak Dacite Porphyny	Whole rock	0.061 0.062	43.1 50.5	0.30 0.31	51.3±2.6
6	80RC-64	S. Empawang	G. Raya Granodiorite	Whole rock	0.702 0.722	86.9 89.7	1.56 1.56	114±6
7	80RD-45	Kp Parikap	" "	Whole rock	0.572 0.586	87.0 88.6	1.28 1.31	111±6
8	80RD-67	S. Serape	Tiang Quartz Diorite	Whole rock	0.267 0.280	66.7 70.5	0.72 0.72	95.1±4.8
9	80RF-52	G. Ganarabak	G. Raya Granodiorite	Whole rock	0.968 1.01	90.8 92.3	2.30 2.30	107±5
10	81RX-53	Panji	G. Sebiawak Granodiorite	Biotite	2.22 2.36	77.4 84.6	4.60 4.60	124±8
11	81QD-1	G. Ibu	Sijanguk	Biotite	0.624 0.626	67.1 61.1	5.22 5.31	30.3±1.5
12	81GD-1	G. Ibu	G. Raya Granodiorite*	Biotite	0.548 0.553	75.3 69.3	4.61 4.63	30.4±1.5

* G. Raya Granodiorite of G. Ibu. (Different type of G. Raya Granodiorite in the Project Area)

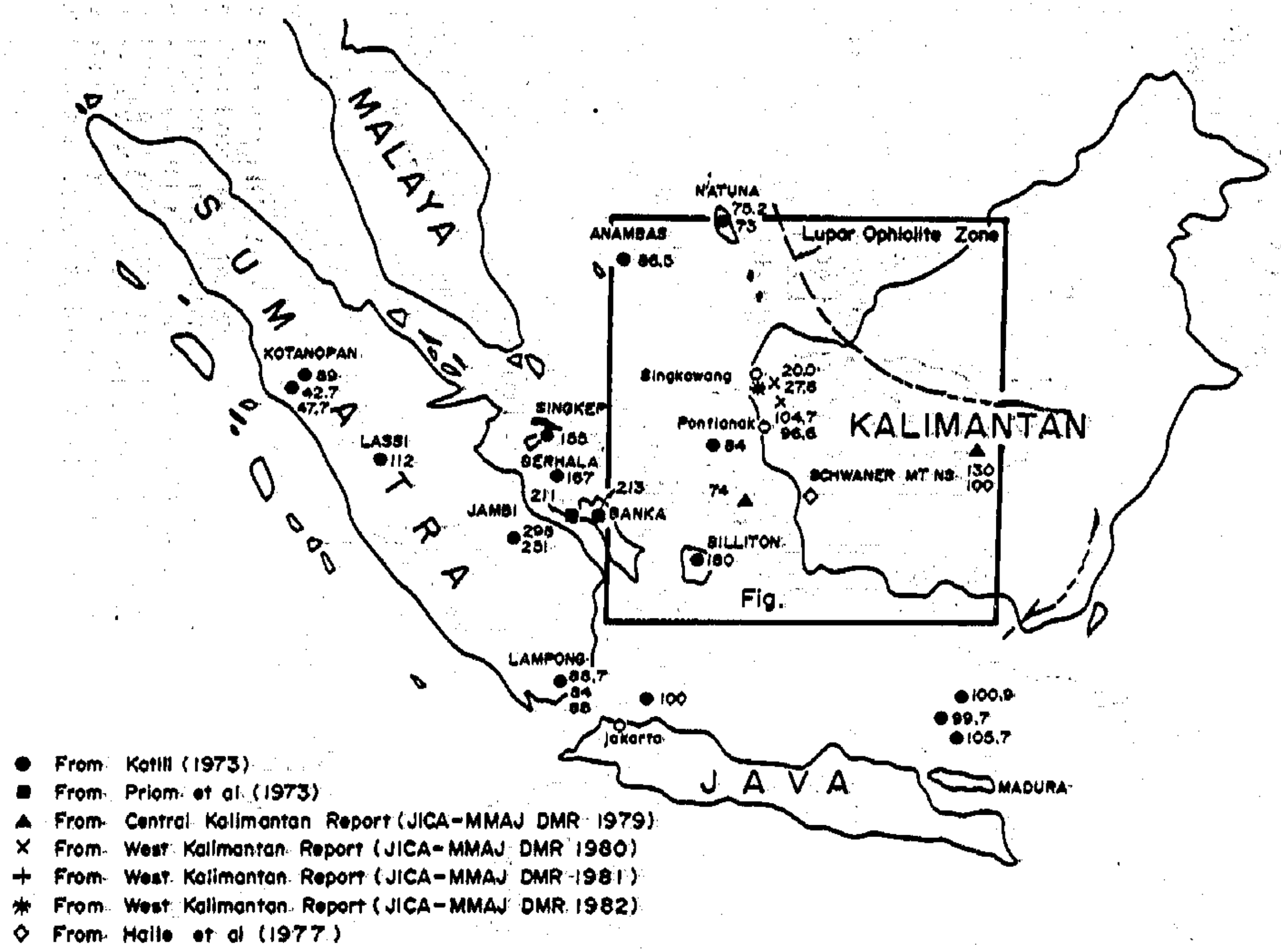


Fig. 2-18 Absolute Age of Granitic Rocks in West Indonesia

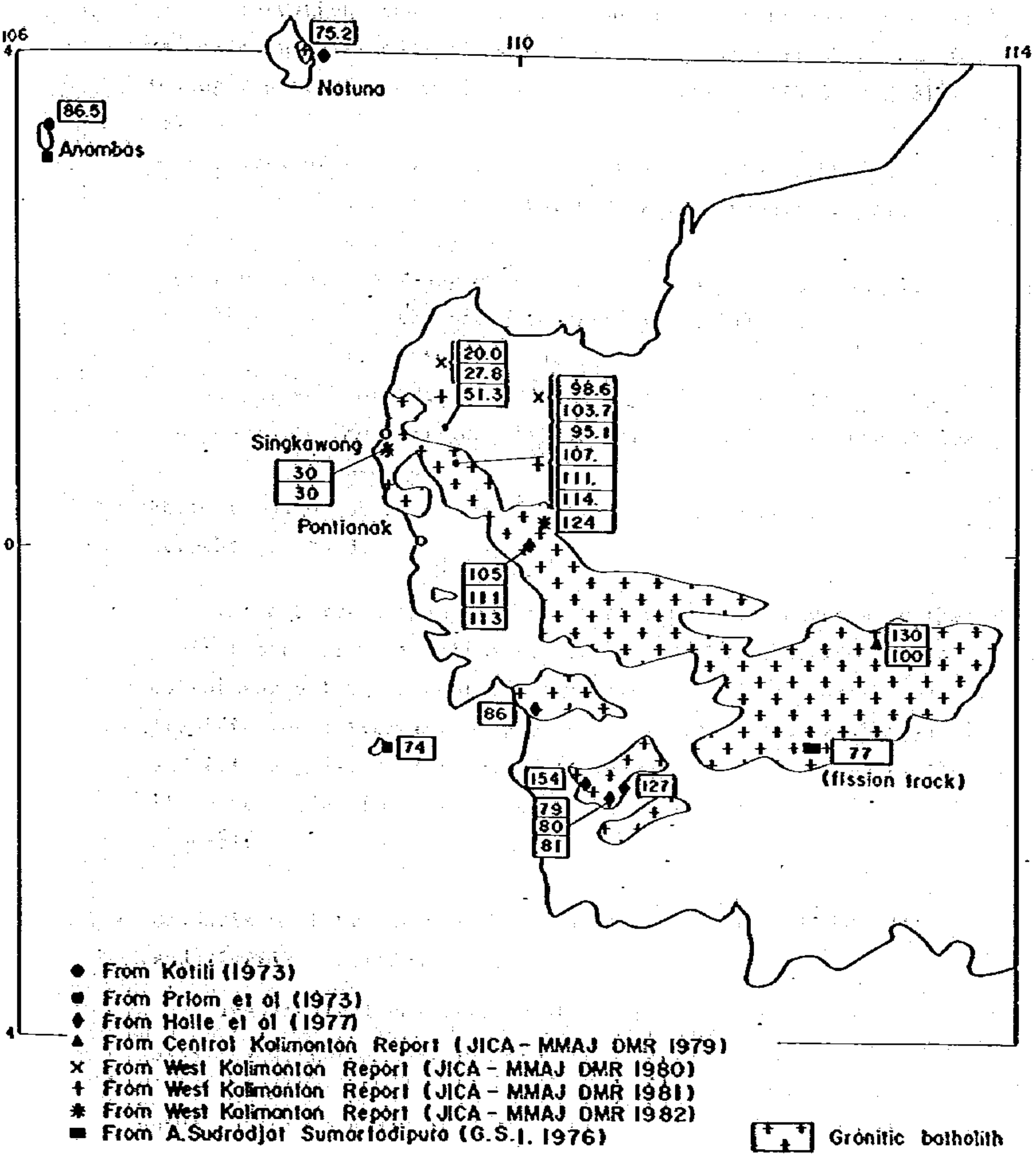


Fig. 2-19 Absolute Date of Granitic Rocks in West Kalimantan

3-4-1 Observation of Opaque Minerals

Observation study of opaque minerals (magnetite and ilmenite) was made on polished specimens under microscopic samples from following 2 pcs. of the G. Sebiawak granodiorite (81RX-37 and 81RY-38)

8 pcs. of the G. Raya granodiorite (80RC-64, 80RC-67, 80RD-45, 80RD-65, 80RE-21, 80RE-32, 80RE-51, and 80RF-52),

2 pcs. of the Tiang quartzdiorite (80RD-67 and 80RE-5),

1 pc. each of the Sirih tonalite (79RB-24) and Baniyi tonalite (79RD-52),

1 pc. each of granitic rock brought back from the Bangka and Bilitong islands both of which are tin mining areas.

Photographs of observation of them through a microscope are attached photo 3.

The observation results are that the granitic rocks in the project area of west Kalimantan belong to the magnetite series containing a large amount of magnetite, no or few ilmenite but the granitic rocks from the Bangka island (collected at Sambunggiri) and Belitong island (collected at Tajung Pandang) belong to the ilmenite series in which ilmenite is contained but hardly any magnetite.

3-4-2 Comparison of Granitic Rock Chemical Composition of Magnetite and Ilmenite Serieses

The chemical composition of the granitic rocks from the project was compared with the study results on the granitic rocks in the Southern Thai Land tin mining area (Ishihara, et al, 1980) since chemical analysis data on the granitic rocks from the Sumatra tin mining area (Bangka and Bilitong islands) were not available.

(a) Norm Quartz - Plagioclase (An + Ab) - Orthoclase Triangle Diagram

Fig. 2-16 is plotted of normative quartz - plagioclass (An + Ab) - potash feldspar contained in the granitic rocks of both the project area in west Kalimantan and the tin mining area in the south Thai Land on the triangle diagram. Granitic rocks are distributed in the tonalite - granodiorite area in west Kalimantan but in the case of tin mining area, they are distributed in the granitic rock area where differentiation has progressed, and furthermore, they contain much more quantity of K_2O than the former as showed in Fig. 2-20, K_2O - CaO - Na_2O triangle diagram.

(b) Tetrahedron Projection of Quartz - Anorthite - Albite - Potash Feldspar

The phase equilibrium of felsic magma can be expressed as the tetrahedron projection with quartz (Q) - anorthite (An) - albite (Ab) - orthoclase (or) as the vertex. There is another method of developing and expressing in the planes of Q - Ab - Or and An - (Ab + Or) - Q (Aramaki, 1972), as shown in Fig. 2-22. According to the diagram, the granitic rocks in the project area enter from primary field of the plagioclase and as the DI becomes higher (differentiation progress), the rocks near the minimum melting point of the A-Ab-Or plane, which is the same variation tendency as the Japanese granitic rocks (Aramaki et al, 1972). On the other hand, the granitic rocks in the southern Thai Land seem to have the tendency of entering from the primary field of Ab-Or, and the possibility of the two having different magma differentiation is infered. Projection triangle diagram of A-Ab-Or and Q-An-Ab are attached for reference (Fig. 2-23).

(c) Oxidation-Reduction State of Granitic Rocks

Fig. 2-21 shows the amounts of FeO, Fe_2O_3, and TiO_2 contained in the granitic rocks in the project area. The 4 lines in the

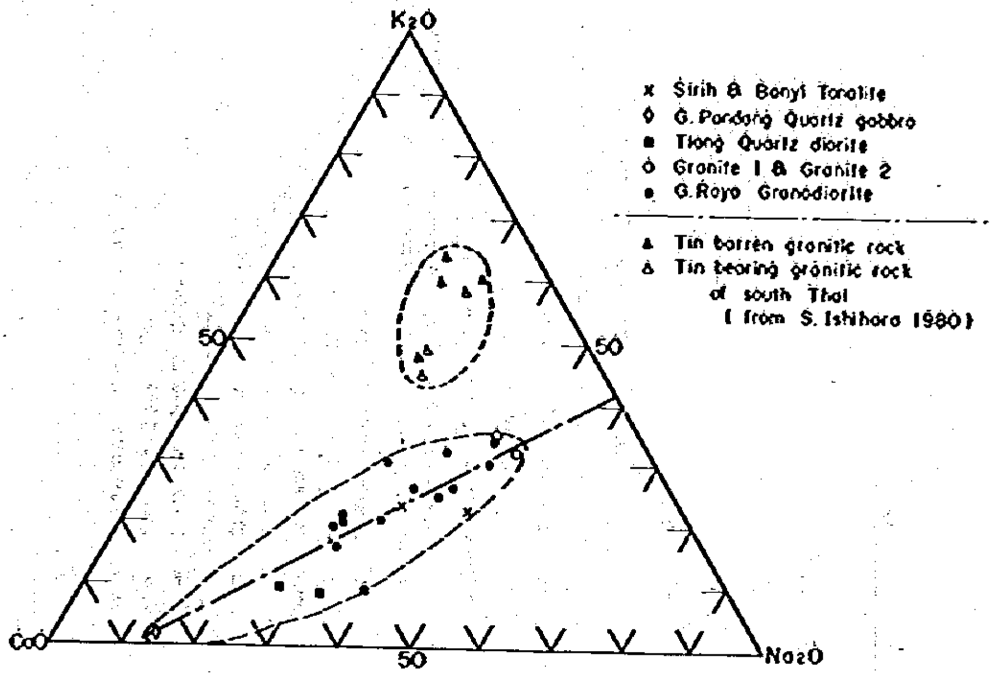


Fig. 2-20 Alkali and Lime Ratio of the Project Area and Southern Thailand

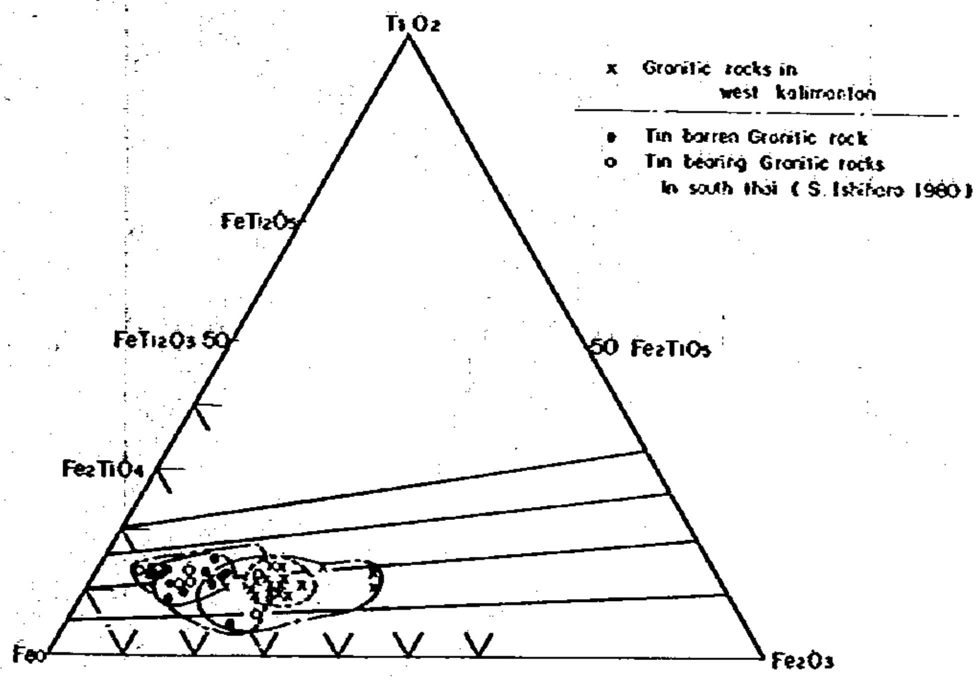


Fig. 2-21 TiO_2-FeO-Fe_2O_3(mol%) Diagram for the Granitic Rocks in the Project Area and Southern Thailand

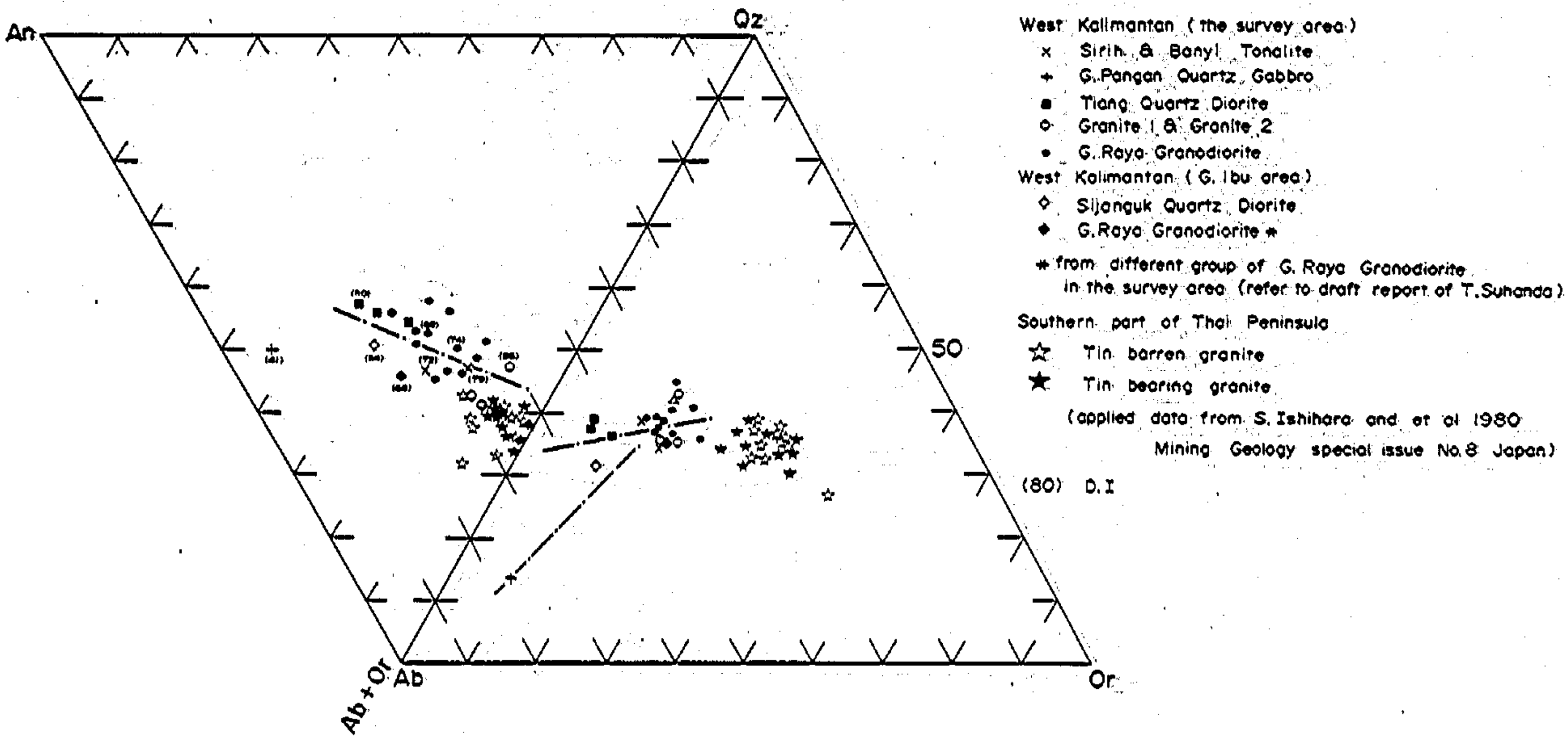


Fig. 2-22 Development of the tetrahedra An-(Ab+Or)-Or-Qz of the Project Area and Southern Thailand. The method was proposed by ARAMAKI (1972)

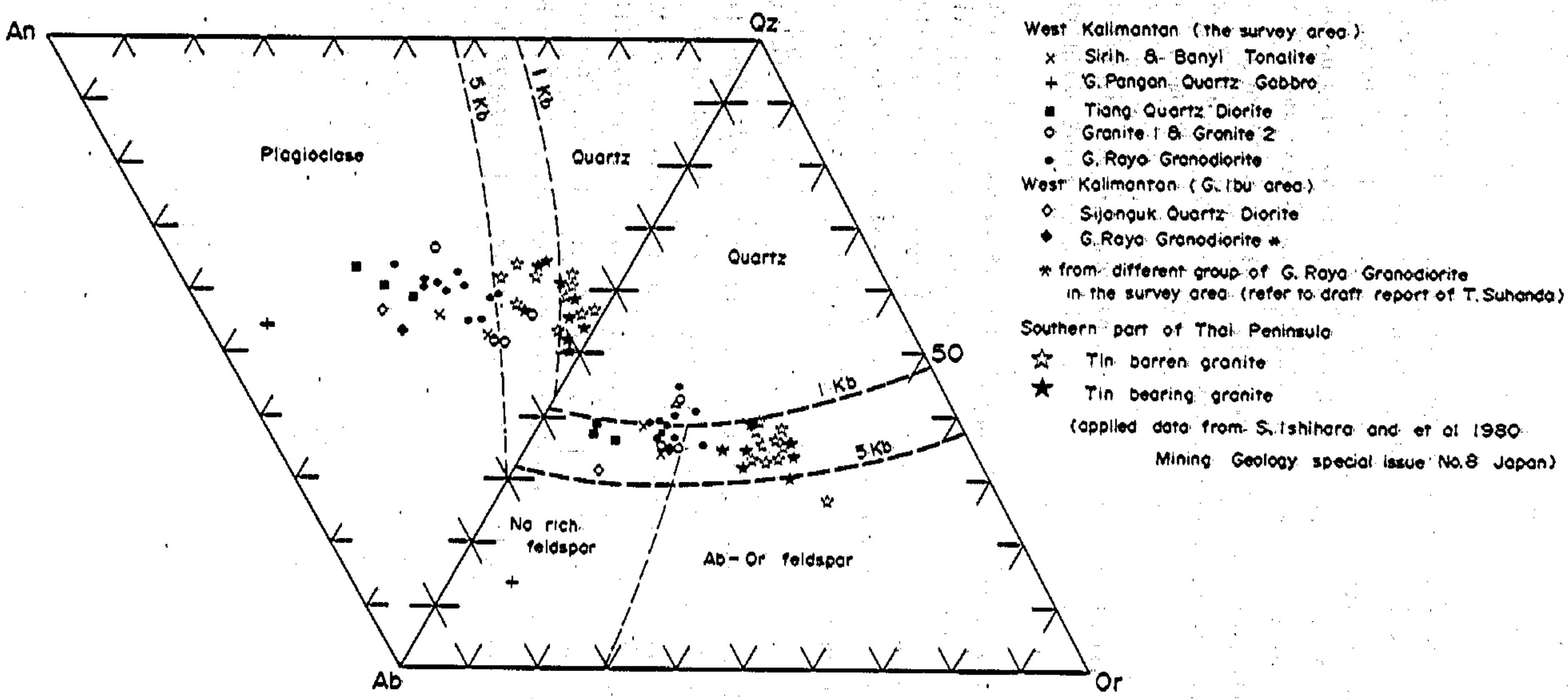


Fig. 2-23 Development of the Tetrahedra An-Ab-Or-Qz of the project Area and Southern Thailand. The method was proposed by ARAMAKI (1972)

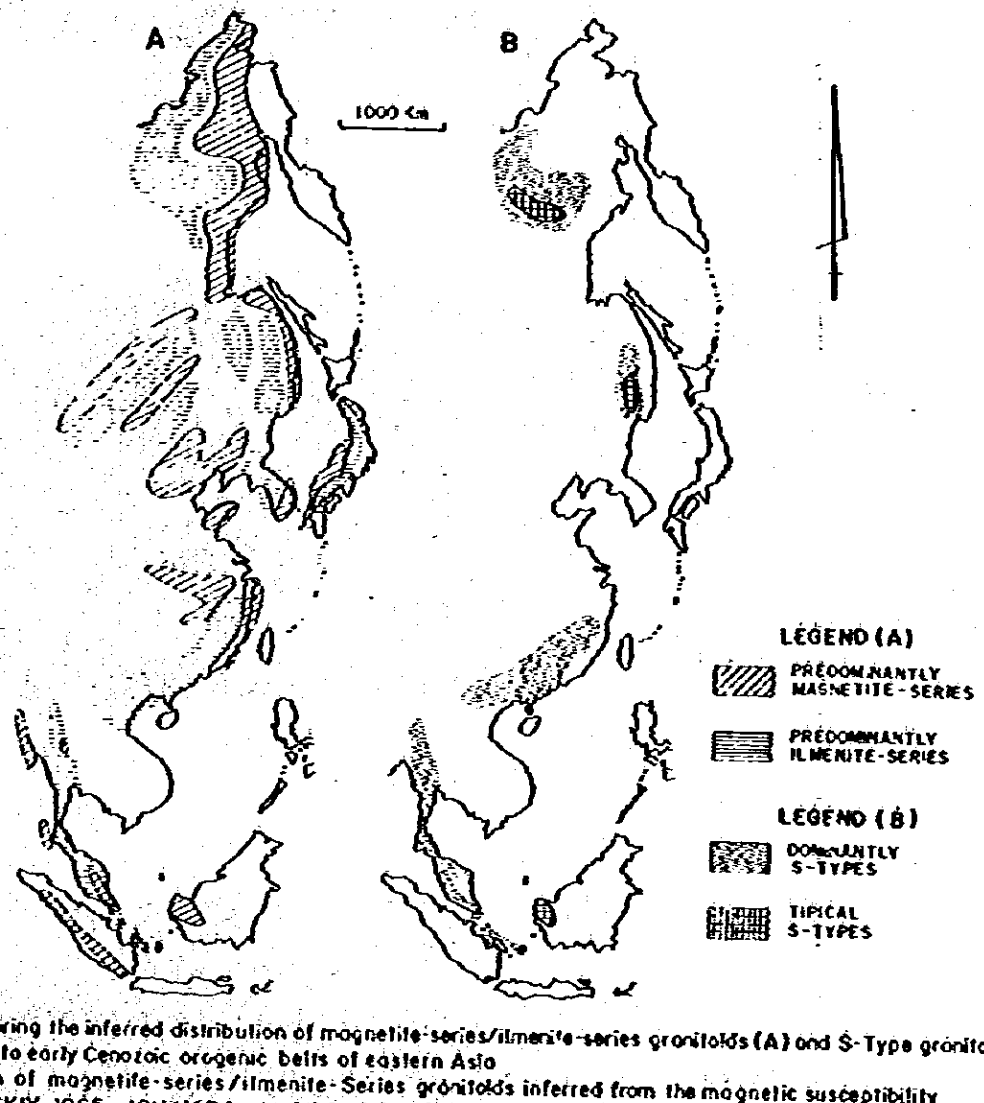
graph are called the "oxygen reaction lines" (Muan 1955, Taylor 1964) and it is understood that changes of the chemical formation along one of the lines are caused only by increase/decrease of the oxygen quantity (Tsusue, Ishihara, 1974). The granitic rocks in the project area seem to be in more oxidated state than those in the tin mining area of the southern Thai Peninsular, the same as the San-in Shirakawa granitic rocks containing rich magnetite, (Tsusue & Ishikawa 1974) in southwest Japan.

(d) Distribution of Magnetite Series and Ilmenite Series of Granitic Rocks in South Asia

For the reference, distribution map of magnetite series and ilmenite series of granitic rocks in South Asia area (Takahashi and S. Ishihara 1980) is shown in Fig. 2-24. On the map, magnetite series granitic rock in West Kalimantan is written together with I type granitic rock from data of second phase survey report.

As a result of above mentioned fact, granitic rocks in the project area, West Kalimantan, is classified into calc-alkali rock series granodiorite, having small amount of K_2O content, and also belongs to magnetite series granitic rocks based on Ishihara's classification. Furthermore, it is necessary to investigate comparison and classification between granitic rocks of northern margin zone and southern margin of Kalimantan granitic batholith on the characteristics of granitic rocks of point of view.

MAGNETITE-SERIES/ILMENITE SERIES VS I-TYPE/S-TYPE GRANITOIDS



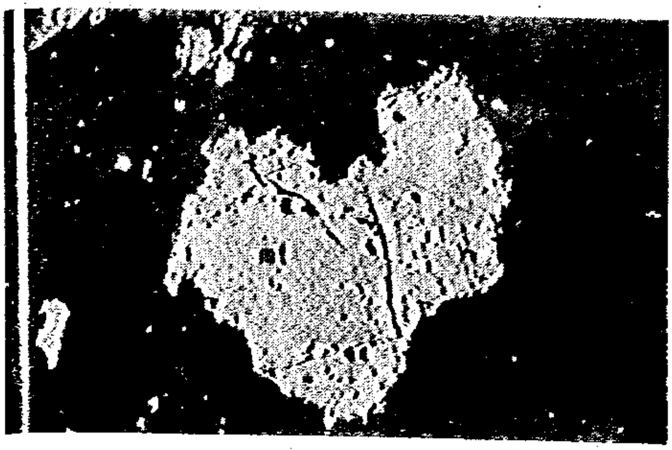
Maps showing the inferred distribution of magnetite-series/ilmenite-series granitoids (A) and S-Type granitoids (B) in the Mesozoic to early Cenozoic orogenic belts of eastern Asia

A. Distribution of magnetite-series/ilmenite-Series granitoids inferred from the magnetic susceptibility (PECHERSKIY, 1965 ; ISHIHARA unpublished data) petrography (Shilo and Milov 1977 ; ISHIHARA, 1977) and kind of deposits (ZONENSHAIN et al, 1974 ; KHERENOV et al, 1976 ; ISHIHARA, 1978)

B. Distribution of the S-type granitoids obtained by the ACF plots and petrographical discriptions (ZAGRUZINA, 1974)

(adopted data of MASAKI TAKAHASHI, ET AL, MIN.GEOL.SPESIAL ISSUE) No. 8, P. 13-28, 1980

Fig. 2-24 Magnetite Series / Ilmenite Series in South area



Sample No.: 81RX-37

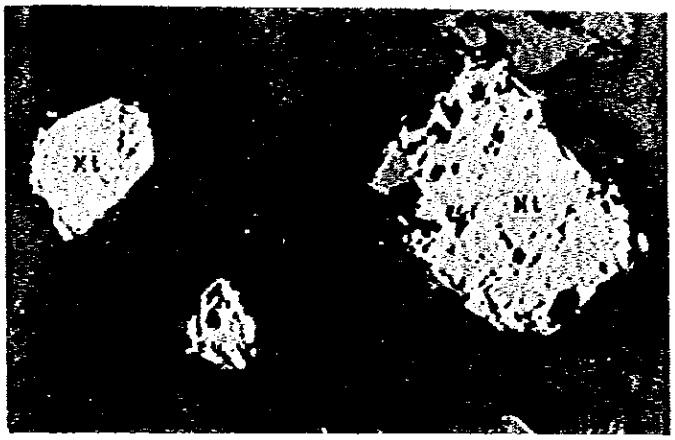
Locality : South of S.Menjarin

Rock Name : Granodiorite

Group : G.Sebiawak Granodiorite

mt : magnetite

0 0.2 mm



Sample No.: 80RE-51

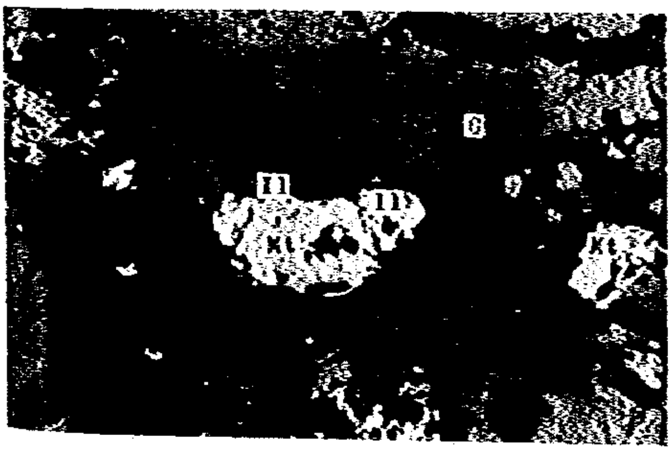
Locality : Emang

Rock Name : Granodiorite

Group : G.Raya Granodiorite

Mt : magnetite

0 0.2 mm



Sample No.: 80RD-67

Locality : Emtawa

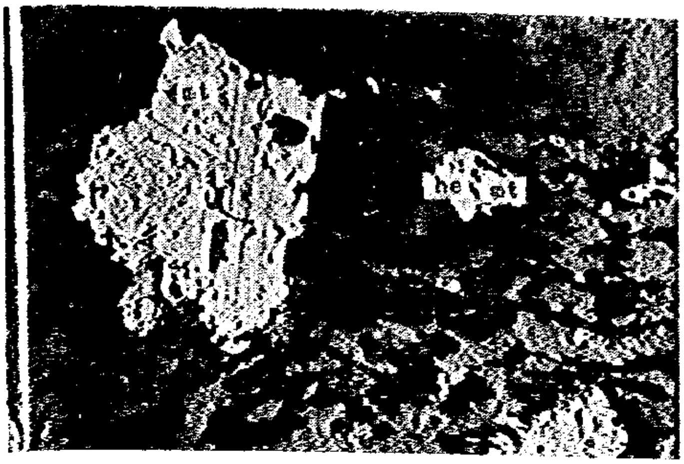
Rock Name : Quartz diorite

Group : Tiang Quartz diorite

Mt : magnetite
il : ilmenite

0 0.2 mm

Photo-3 Microphotographs of Polished Specimen for Opaque Mineral in Granitic Rock



Sample No.: 79RD-52
Locality : S.Banyi
Rock Name : Tonalite
Group : Silih
Tonalite

mt : magnetite
he : hematite

0 0.2 mm

Location : Bangka
Sambunggiri
Rock Name : Granodiorite

tm : titanmagnetite
il : ilmenite

0 0.2 mm

Location : Bilitong
Tanjung Pandang
Rock Name : Granodiorite

tm : titanmagnetite
il : ilmenite

0 0.2 mm

CHAPTER 4 GEOLOGICAL COMPARISON IN WESTERN KALIMANTAN AREA

The project area situated in west Kalimantan is at the north margin of the Sundaland, forming the southern end of the Asian Continent and the area is located along the Cretaceous Magmatic Arc (Katili 1973) or the Jurassic-Cretaceous volcanic and Granitic Rock Terrain (Hamilton 1978). The survey of this project elucidated the geology, stratigraphy, ages of the igneous rocks and the relation between the igneous activity and mineralization in the 1,500 km^2 area from Lumar to Bengakayang, Darit and Pahuman. Based on result of the survey, correlation between the stratigraphy of the area and other stratigraphy of Kalimantan, Seravak area and so on, was attempted. For the comparison, the correlation chart of the stratigraphy (Fig. 2-24) by Pupilli (1973) was used.

(1) Bengkayang Group

In the Bengkayang Group, there are sandstones containing taffaceous pyroclastic rocks and fine acidic tuff in the lower (Banan Formation) and they indicate that the Formation contain volcanic material by volcanic activities at the time. The upper Formations (especially the Sungaribetung Formation) is a flysh type marine deposit where there is a good bedding consisting of alternated beds of sandstones, mudstones and siltstone. Since the ammonite fossils indicating the lower Jurassic Lias Toarcian stage were discovered in the Bengkayang Group, the Group is corretative with the upper Triassic to Lower Jurassic.

The Bengayang Group can be compared with the Sadong Formation (conglomerate, sandstone, brown mud shale, greywacke rock, and maar limestone) of the Ketapang Complex Formation in the southwest Kalimantan.

The Toarcian stage ammonite fauna was discovered (Sato 1975) in Le Duc near Bienhoa in the Indochina Peninsular southern part, and the fauna is similar to the Tethys fauna, like the ammonite found in the Sungaribetung Formation, and it is considered that the

Bengkayang group was continued to the Himalayan-Tethys sea during the Toarcian period.

(2) Jirak and Belango Volcanic and Pyroclastic Rocks

The Jirak Formation consisting of andesite and andesitic pyroclastic rocks unconformably overlying the Sungaribetung Formation accompanied by thin conglomerate in the base. The Belango Formation, mainly consisting of dacitic pyroclastic rocks, overlies the Jirak Formation. These Formations of volcanic and pyroclastic rocks have been intruded by the G. Sebiawak and G. Raya granodioritic batholith, affected contact-metamorphism, and are distributed as the roof pendant on the granitic batholith.

The Jirak and Belang Formation is supposed to be correlative with the Serian Formation (andesite, basalt, dacitic tufaceous conglomerate, dacitic tuff and trachyte) which is a member of the Ketapan complex formation, and also the Matan complex rocks that are distributed in the south of the Schwaner mountain rnage. Also, if comparison is possible, the Serian Formation and Matan complex may be correlative with to the volcanic rock Formation extruded and deposited during the middle to upper Jurassic similar to Jirak and Belango Formations. These volcanic rock Formations may have been formed by the simultaneous igneous activities since they are closely related with the Cretaceous granodiorite, the same as the relation between Japan's Nobi rhyolite and the Cretaceous granodiorite, and further studies are necessary.

(3) Cretaceous Granodiorite

The granitic rocks (G. Sebiawak and G. Raya granodiorite) and the granodiorite in the G. Ibu area that are widely distributed in the project area as a part of igneous activities related to the magmatic arc that lies from middle Kalimantan up to the South China Sea through west Kalimantan and southern edge of the Indochina Peninsula were determined to be 124 to 95 m.y. through the K-Ar absolute age determination, confirming that these rocks were formed by the igneous activities of the Cretaceous Magmatic Arc. In the correlation chart prepared by Pupilli, they are regarded to be the same rocks as the west Kalimantan Bau granitic rocks. Also, the Bungran Formation (containing radiolarian chert, basic volcanic rocks and ultrabasic rocks) that is distributed from the Bungran island to west Sarawak is the subduction zone that accompanies by the magmatic zone.

(4) Younger Igneous Activities

The project area had became a craton and a part of the continent before the Paelogene period. Then, the northwest Borneo geosyncline occurred during the Tertiary period and the Rajang and Baram Groups were extensively deposited in the Sarawak area (Haile 1969). The Rajang Formation contains radiolarian chert, ophiolite, and limestone in addition to sandstone and mudstone and also has a imbricate structure, and called "mèlange" by Hamilton (Hamilton 1978).

This fact is interpreted that oceanic plate had subducted under the sundaland craton along Lupar Ohiolite - Chert zone existing in the boundary at Sarawak and Kalimantan (Katili 1973, 1981, Hamilton 1978, etc.). In the project area, dacite and tonalite have intruded during period of early to middle Tertiary, and mineralization of gold, copper, molybdenum, lead and zinc, mercury and antimony is considered to have been brought by these rocks.

Table 2-24 shows the geological stratigraphy and igneous activities of the project area being correlated with the table by Pupilli, for reference.

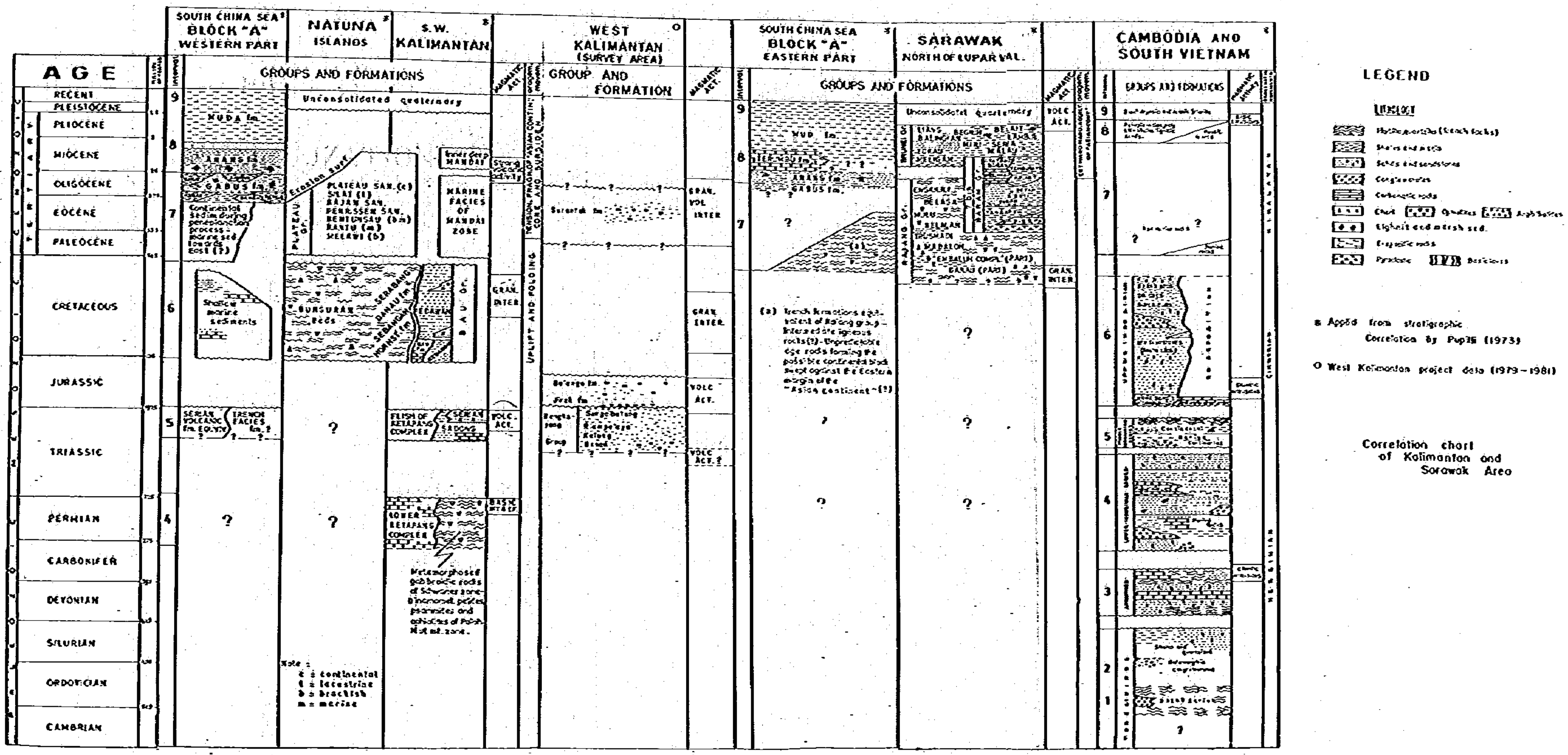


Fig. 2-25 Correlation Chart of Stratigraphy in Kalimantan and Serawak

PART Ⅲ

MINERALIZATION

CHAPTER 1 OUTLINE OF MINERAL DEPOSITS

Many Ore deposits and Mineralizations containing gold, mercury, antimony, copper, molybdenum and so on are well known in West Kalimantan and Malaysian West Sarawak (Fig. 2-2). Especially, it is well known that placer gold had been mined in the Chinese District locating at Mempawah, Sambas and Bengkayang during the period from 18th Century to early 19th Century, and gold ore deposits in Lumar, Sunturu, and Bengkayang, copper deposit in the area of Mandor, molybdenum ore deposits of G. Bawang had ever been prospected and explored.

These distributions show that mineralizations of copper and molybdenum associated by lead and zinc are usually distributed at marginal area of granitic rock batholith, and mineralizations of mercury, antimony and gold are situated at north zone of the batholith associated with younger granitic intrusion.

Based on the investigation result, the mineralizations in the project area are classified into following types;

1. Chalcopyrite-molybdenite mineralization
   a. tourmaline bearing chalcopyrite-molybdenite mineralization (Panji and Banyi)
   b. (Chalcopyrite)-molybdenite quartz vein (Sirih and Takap, Kunyit)
2. Gold and silver bearing chalcopyrite-spharelite-arsenopyrite ore vein (Selakean)
3. Gold bearing chalcopyrite-pyrrhotite ore deposit (Serantak)
4. Alluvial placer gold deposit (Bengkayang, Lumar and so on)
5. Manganese ore deposit (Sasan)

Gold quartz vein, gold bearing chalcopyrite ore vein are additionally found in vicinities of the above mentioned mineralizations. Many hydrothermal alteration areas disseminating with pyrite are located at contact area with sedimentary and volcanic rock Formations and granitic rocks. (Fig. 3-1).

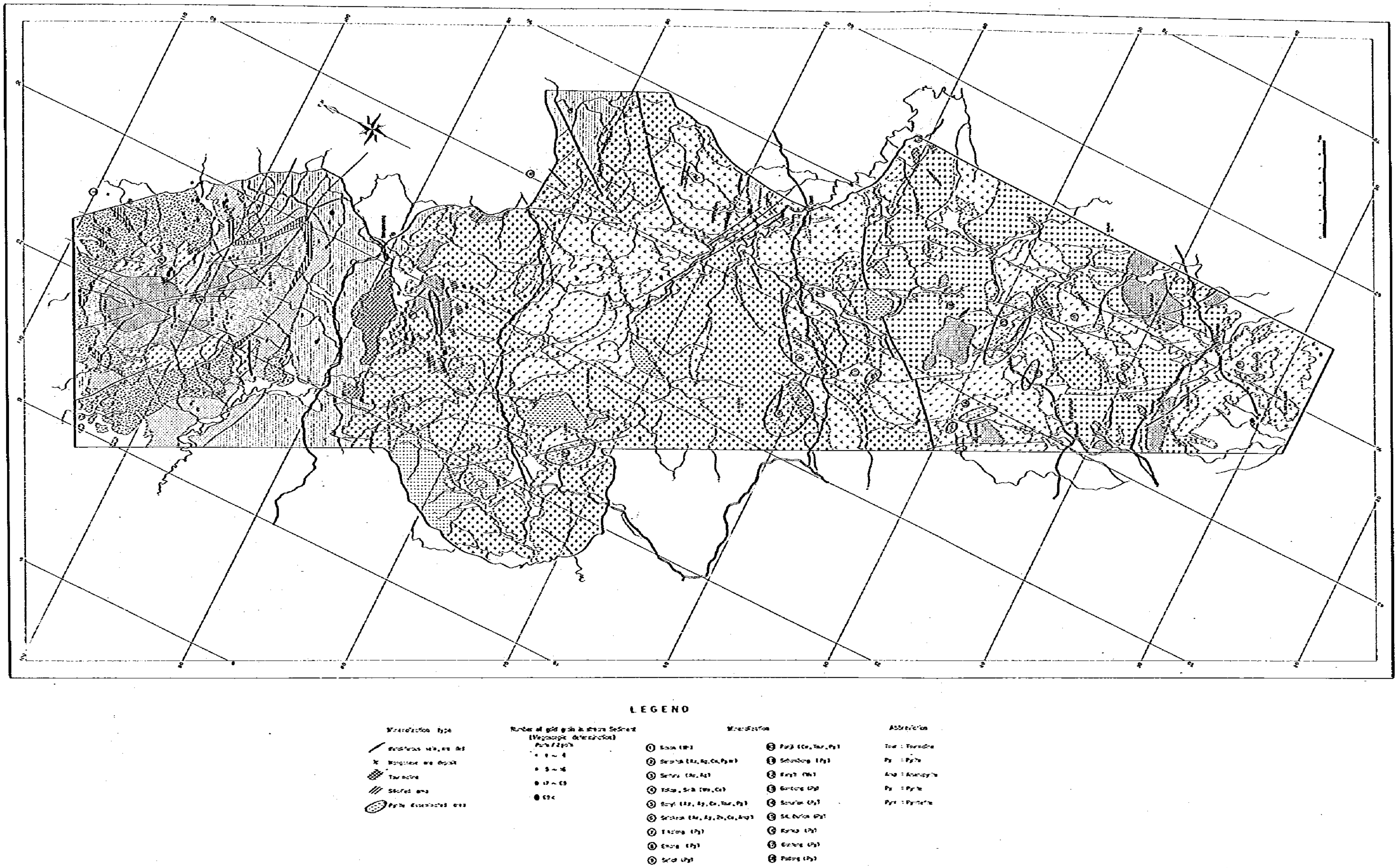


Fig. 3-1 Distribution Map of Mineralization in the Project Area

CHAPTER 2 DESCRIPTION OF MINERALIZATION AND ORE DEPOSIT

2-1 Chalcopyrite-Molybdenite Mineralization

2-1-1 Tourmaline Bearing Chalcopyrite-Molybdenite Mineralization

In Banyi and Panji areas, this type mineralizations were found.

(a) Banyi Area

Mineralizations in Banyi area are widely distributed in the range of 6 km in east-west and 3 km in south-north, and consists of Banyi mineralized zone, upper-stream S. Mempawah mineralized zone, barren tourmaline zone. Banyi mineralized zone consists of sporadical distribution of gold quartz veins and gold bearing chalcopyrite veins surrounding strong hydrothermal argilization along S. Banyi. Upper-stream Mempawah area is located at southern west part of Banyi mineralized zone, and has pyrite dissemination and network vein accompanied by tourmaline. At southern part of barren tourmaline zone, pyrite quartz vein, chalcopyrite and molybdenite indications are sporadically scattered. Judging from the distribution of mineralization, it seem to be roughly zonal arrangement of mineralization, namely centering barren tourmaline zone, tourmaline-pyrite, chalcopyrite-molybdenite, gold-pyrite-chalcopyrite are distributed in this order to outside.

Banyi mineralized zone is exposed from watershed of S. Banyi to north area, strong argilized alteration zone extends in the scale of 4.5 km in the east-west direction and 500 m in south-north direction along the S. Banyi. Weak alterated zone consisting of secondary minerals of chlorite from coloured mineral and sericite from plagioclase surrounds strong altered zone, expanding in the scale of 4.5 km in east-west and 2 km in south-north, accompanied by a number of gold bearing pyrite quartz veins, gold bearing chalcopyrite veins.

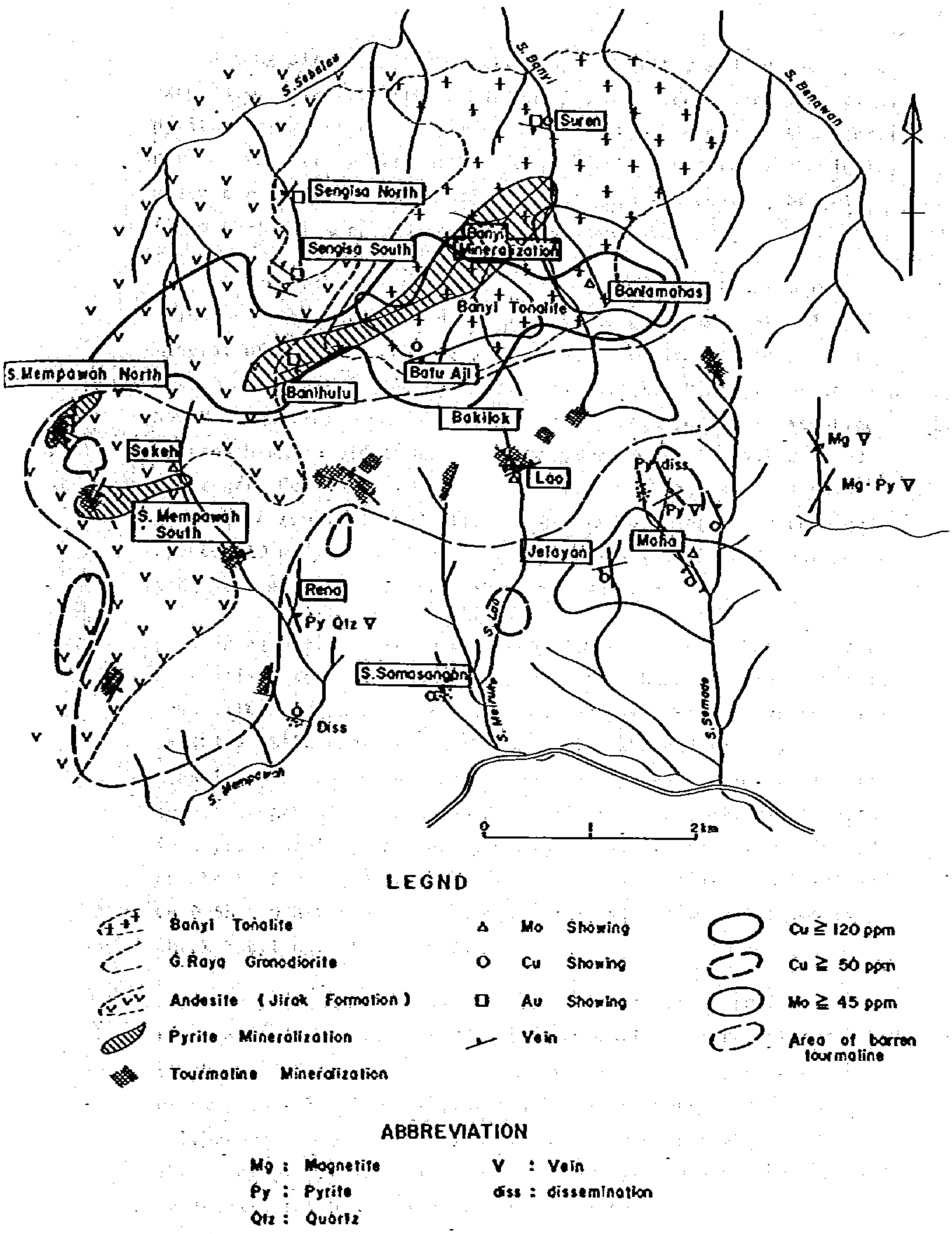


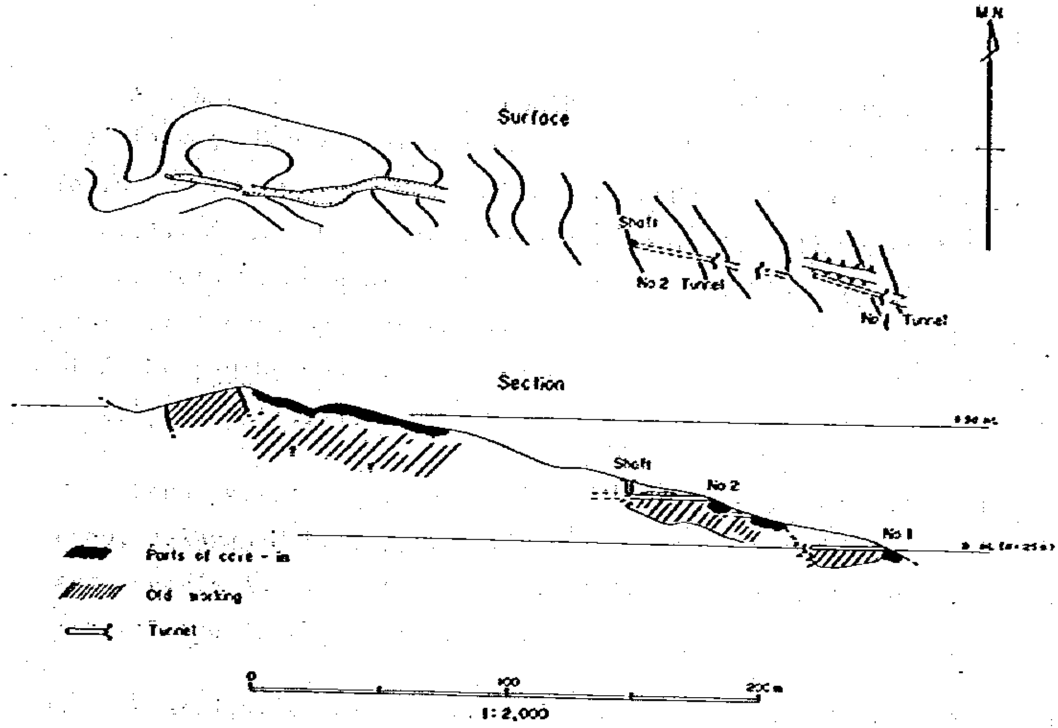
Fig. 3-2 Distribution Map of Mineralization in Banyi Area

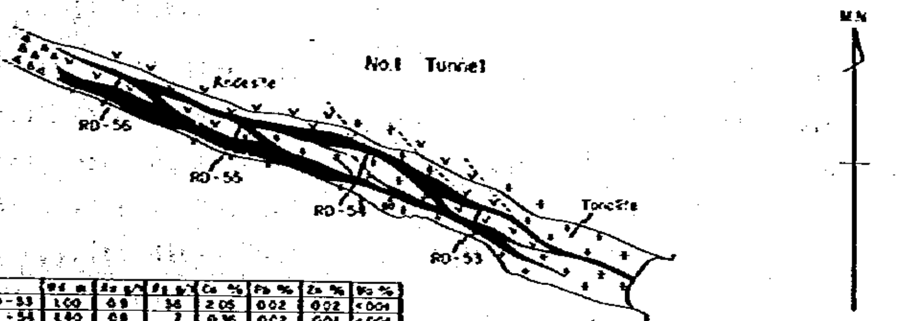
Strong altered is in mostly Banyi tonalite, and in some part extends to Jirak Formation and G. Raya granodiorite. Sericitization, pyrite dissemination and pyrite-quartz network occur in the center part of the strong alteration zone. However, result of chemical assay for the pyrite mineralization reveals low content of gold (less than 0.1 g/t) and copper (less than 0.1%).

In the weak altered zone, pyrite occur as small film in joint of country rock or as dissemination replacing colored mineral of country rock. Some of them is enriched gold content in limonite quartz vein by oxidation. Sungisa North vein striking N50°W and having 5 cm in width was prospected for 10 m extention by trenching in old time, and it shows grade of Au 34.9 g/t and Ag 12 g/t, Cu 0.09% by chemical assay. And Sungisa South Vein consisting of two veins and striking E-W and dipping 90° were prospected 10 m by trenching and contains 4.3 g/t of gold in 10 cm wide vein and 5.3 ∿ 0.1 g/t in 5 cm wide vein.

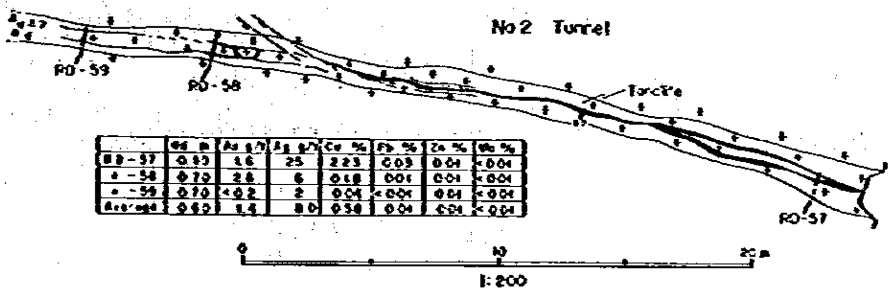
Suren ore deposit is situated at northern east part of Banyi mineralized zone, and is an only old mine which was mined in this area. This ore deposit is gold bearing pyrite-chalcopyrite veins striking N85°W and dipping 60°S, and is embedded in Banyi tonalite. Based on this geological survey result, in accessible tunnel length of the lode is about 300 m and average mined depth is approximately 20 m. Ready mined ore reservation is estimated at about 15,000 ton of crude ore. The vein contains Au 1 g/t and Cu 0.58 ∿ 0.81% and have 1.4 ∿ 0.4 m in width in estimation by check sampling. (Fig. 3-3).

Irregular net work limonite quartz veins embedded in the contact zone of G. Raya granodiorite and Banyi tonalite exist at the south part of the Banyi altered zone. The ore sampled from the outcrop contains 1.0 g/t of gold, 0.13% of copper and 0.02% of molybdenum. Boulder accompanied by green copper was found near the outcrop. It is confirmed that this ore contains chalcopyrite, chalcocite through microscopic observation.





	Wd m	Au g/t	Ag g/t	Cu %	Pb %	Zn %	Mo %
RD-53	1.00	0.9	36	2.05	0.02	0.02	<0.01
" -54	1.40	0.8	7	0.36	0.02	0.01	<0.01
" -55	1.30	3.5	13	0.93	0.03	0.01	<0.01
" -56	1.00	0.2	<2	0.09	<0.01	0.01	<0.01
Average	1.18	1.4	13.8	0.81	0.02	0.01	<0.01



	Wd m	Au g/t	Ag g/t	Cu %	Pb %	Zn %	Mo %
RD-57	0.93	1.6	25	2.23	0.03	0.01	<0.01
" -58	0.70	2.8	6	0.18	0.01	0.01	<0.01
" -59	0.70	<0.2	2	0.04	<0.01	0.01	<0.01
Average	0.80	1.4	8.0	0.58	0.01	0.01	<0.01

Fig. 3-3 Ore Vein Map of Suren Mine

Another molybdenite mineralization embedded along fine joint and crack in Banyi tonalite was found at Banitamahas as outcrop. In the upstream of S. Mempawah and S. Semade, the south of Banyi mineralized zone, tourmaline mineralized zone, filling fine fissure and brecciated zone are sporadically distributed. Except the tourmaline outcrop accompanied by pyrite in south upper stream of S. Mempawah, most tourmaline mineralized outcrops are barren of sulphide mineral.

Rena pyrite quartz vein, S. Samasangan chalcopyrite indication, Jelayan-Maha copper indication (accompanied by malachite, and contain Au 0.2 g/t and Cu 2.38% in vein width of 10 cm) are distributed in the southern end of tourmaline zone.

Distribution of the Banyi district mineralized zones is given in Fig. 3-2.

(b) Panji District

The Panji district is a newly discovered mineralized zone through reconnaissance and detailed exploration, and outcrops of the deposit are recognized in the east and southeast of the old Panji village. This mineralized zone consists of pyrite and chalcopyrite disseminations accompanied with tourmaline that be embedded in the Belango andesitic tuff and G. Sebiawak granodiorite. The following are the analysis results on the specimens from the outcrops.

Outcrop No.	Au g/t	Ag g/t	Cu %	Mo %
81RX-59	< 0.1	0.4	0.015	-
81RY-39	0.1	9.4	0.39	0.09
81RX-53	0.2	0.2	0.08	0.01

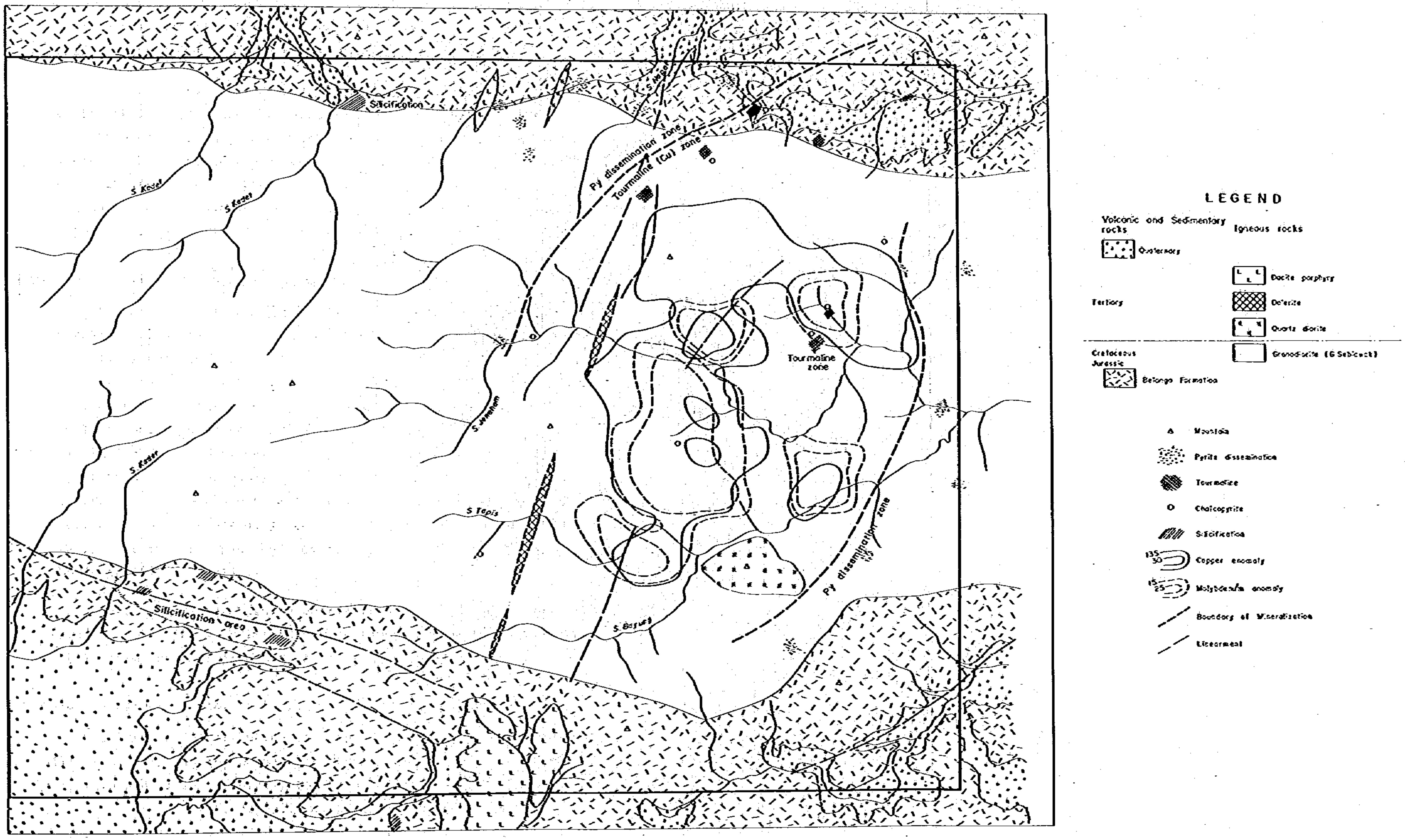


Fig. 3-4 Distribution Map of Mineralizations and Geochemical Anomalies in Panji

Pyrite dissemination is observable in the area surrounding this zone, especially along the S. Menjalin and S. Bayung.

The IP and geochemical surveys conducted in this area revealed their anomaly in the range of 1.5 km in the east-west direction and 2.0 km in south-north, and this area extends to the south of the above mentioned outcrops. Zonal arrangement that chalcopyrite mineralizations are distributed in the center part and pyrite disseminations surrounds them are reconizable, even outcrops are very poor in the area. (Fig. 3-4).

2-1-2 (Chalcopyrite)-Molybdenite-Quartz Vein

A number of quartz veins having 0.10 ∿ 0.50 m in width and striking N30°W are distributed in Sirih Tonalite determined as 20 m.y. by K-Ar method and regarded as intrusion in middle Tertiary (Early Miocene) at upper stream of S. Sirih and S. Bamua. Some of them are accompanied by chalcopyrite, molybdenite and small amount of sphalerite. Chalcopyrite are in sphalerite as exsolution dots. Many quartz veins have been found at area of upperstream of S. Banan by detailed survey carried out in the second phase. Molybdenite and chalcopyrite are recognizable in some of veins. Result of geochemical survey with stream sediment shows that the area has tendency of high background of Cu and Mo in the Sirhi Tonalite.

Furthermore, molybdenite-quartz vein, striking N65°W and dipping 85°S, having 5 cm in width were found in 2 km north of Kunyit village in the southern part of the project area.

2-2 Gold and Silver Bearing Chalcopyrite-Sphalerite-Arsenopyrite Vein

Old trenches distributing at area of 30 m × 40 m in the eastern hill of G. Selakean (G. Dulu) were dug to explore gold and silver, copper in old time. According to observation of lumped ore leaving the old trench, the ore deposite might be embedded in Jirak andesitic tuff and vein type with 10 cm in width. Ore contains chalcopyrite,

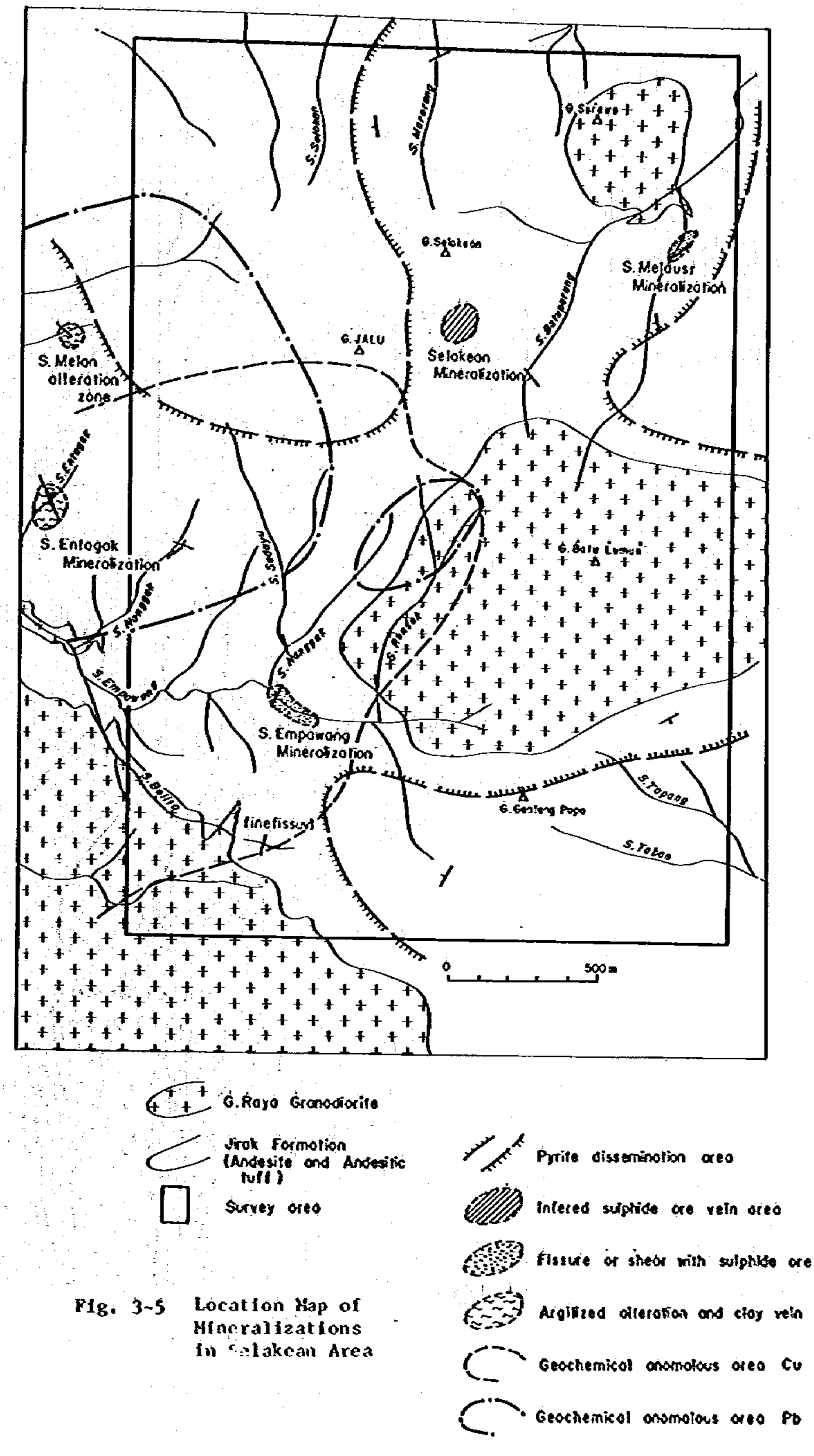
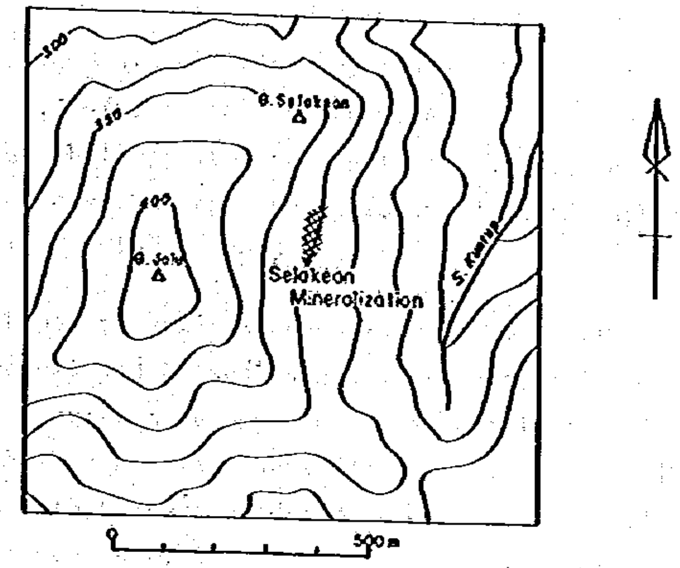
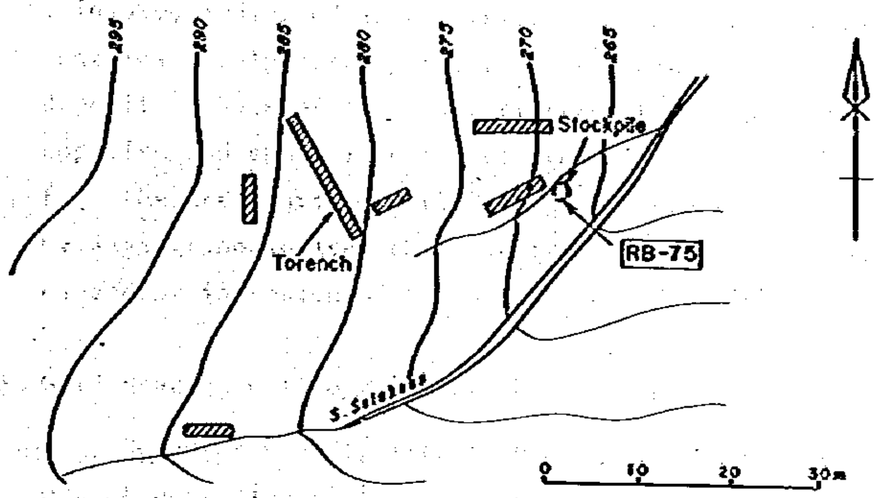
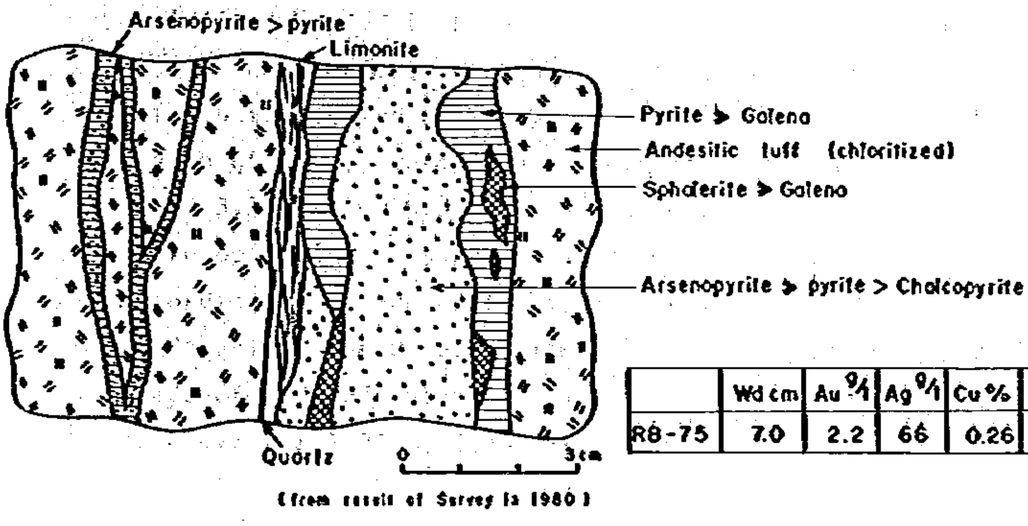


Fig. 3-5 Location Map of Mineralizations in Selakean Area







	Wd cm	Au g/t	Ag g/t	Cu %	Pb %	Zn %	Mo %
RB-75	7.0	2.2	66	0.26	0.04	0.19	<0.01

Fig. 3-6 Sketch Map of Selakean Ore Deposit

sphalerite and arsenopyrite. The analysis result is of width 7 cm, Au 2.2 g/t, Ag 66 g/t, Cu 0.26% and Zn 0.17%. Under a microscope, the chalcopyrite and sphalerite are in the relationship of exsolution and chalcopyrite is included in the sphalerite as dots or lamella. (Fig. 3-5 & 3-6).

S. Empawang argillization zone (accompanying pyrite bearing quartz veins) and Entagak argillization zone (accompanying chalcopyrite bearing arsenopyrite veins) are located in the Selakean area. These mineralizations fill fissure systems (N30°W, NE, N30°E, NW) that are considered to have been formed by the tectonic movements caused by intrusion of the G. Raya granodioritic batholith or intrusive rocks. Through the chemical analysis, the former zone indicated a slight amount of arsenic and the latter, being a massive vein ore, indicated arsenopyrite, and the Selakean mineralized zone contains mainly arsenopyrite. It is considered to be a mesothermal deposit because of the exsolution relationship between the chalcopyrite and sphalerite and paragenesis with arsenopyrite. Also from the structural control of the fissure zone being formed by the G. Raya granodiorite, the mineralization could be regarded as being caused by intrusion of the G. Raya granodiorite.

2-3 Gold Bearing Chalcopyrite-Pyrrhotite Ore Deposit

Serantak ore deposit, belonging to the ore deposit type, crops out at east side (386 m above sea level) of G. Serantak. The deposit is embedded in fine tuff of Banan Formation in the neibourhood of contact between Banan Formation and Serantak dacite. The outcrop is massive chalcopyrite-pyrrhotite ore deposit having the length of 15 m, average vein width of 1.27 m and average ore grade of Au 3.3 g/t, Cu 0.3%. Gossan outcrop producing gold by small scale operation is situated at 50 m northwest of the former outcrop. According to assay result by Directorate of Mineral Resources (Indonesia), the Gossan, with gold enriched by oxidation, has ore grade of 1.36 g/t along the sampling channel of 10.40 m, and 2.26 g/t per 7.27 m, 2.33 g/t per 3.60 m. (Fig. 3-8).

Pyrrotite has two politypes, namely hexagonal type (high temperature type) and monoclinal type (low temperature type), and their transition (β transition) is between 320°∿ 330°C. Determination of these type applies the peak shape of FeKα $2\theta = 56°$. ((d(102))), that is the hexagonal type has only one peak but the moloclinic type has two peak as Fig. 3-9 shows. Result of X-ray diffractive analysis on Serantak pyrrhotite ore indicated that the pyrrhotite is a typical hexagonal type, and though it is not clear, weak peak of pentlandite is also observable. Thus the Serantak ore deposit is considered to have been formed at a fairly high temperature from 330 to 450°C or more higher.

A number of quartz veins accompanied by pyrite and pyrrhotite exist around the Serantak dacitic stock, and these ore deposits are regarded to be hypothermal deposit or contact metasomatic deposit caused by igneous activities of Serantak dacite.

2-4 Placer Gold Alluvial Deposits

2-4-1 Outline

The terrace alluvial sediments in the central to northern parts of the project area, that is, the Lumar, S. Banyi, S. Sebalan districts, contain placer gold and the gold was mined actively in the past (18th century to 19th). The panning prospecting was conducted to explore the deposits or mineralized zones that brought the placer gold by measuring the gold contents in the river bed sediments.

The prospecting was conducted by sampling two pails of the sediment, each pail containing 20 litres, panning them to collect placer gold grains, and the number of grains were counted. Distribution of the placer gold thus found is shown in Fig. 3-1. The gold panning prospecting work was performed together with stream sediment sampling for geochemical survey at the same sampling points. The number of total sampling spots was 1,491

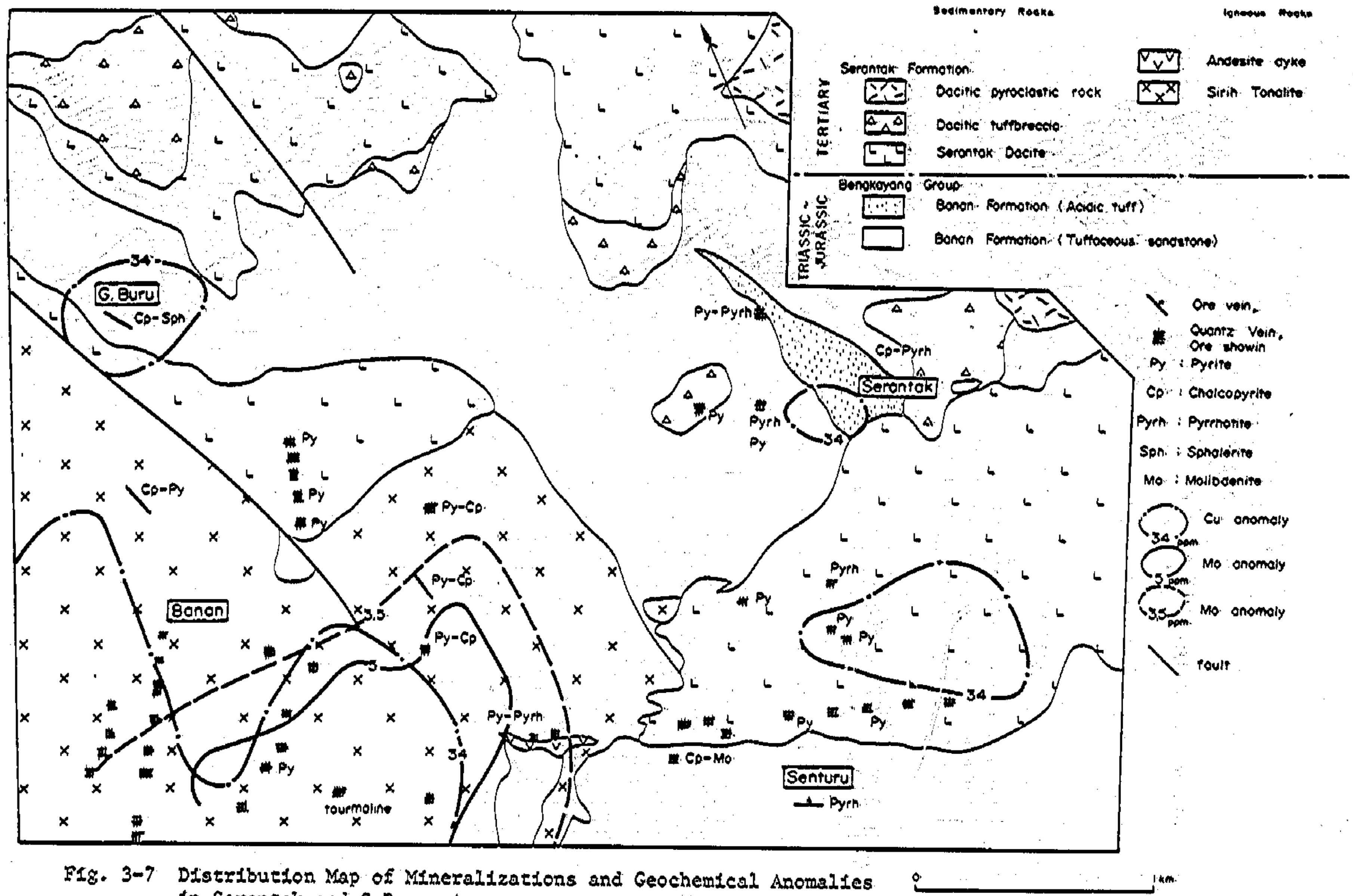
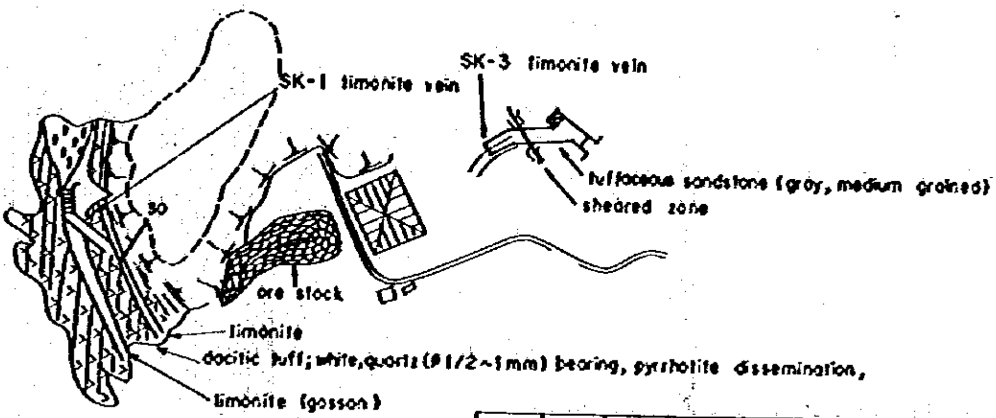
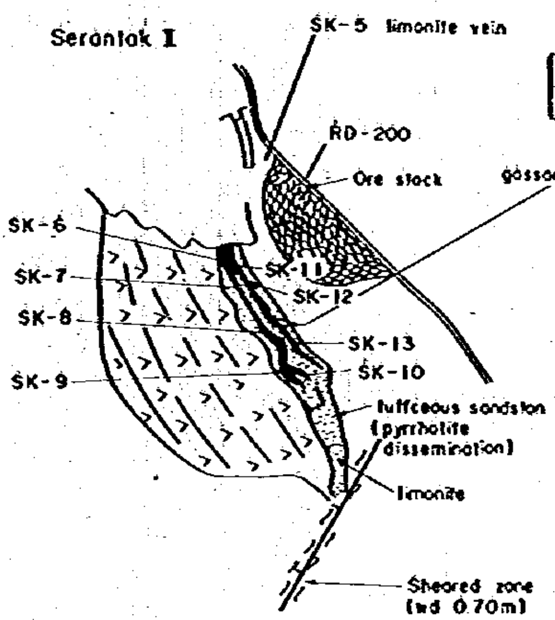


Fig. 3-7 Distribution Map of Mineralizations and Geochemical Anomalies in Serantak and S.Banan Area



	Wd m	Au g/t	Ag g/t	Cu %	Pb %	Zn %	Mo %
SK-1	Chip	0.3	< 2	<0.01	<0.01	0.04	<0.01
SK-3	0.6	0.2	< 2	0.01	<0.01	0.02	<0.01

Serantak I



	Wd m	Au g/t	Ag g/t	Cu %	Pb %	Zn %	Mo %
SK-5	0.45	1.2	7	0.35	0.01	0.01	≤0.01

	Wd m	Au g/t	Ag g/t	Cu %	Pb %	Zn %	Mo %
SK-6	0.5	0.5	2	0.17	<0.01	<0.01	<0.01
SK-7	0.3	0.6	< 2	0.28	<0.01	<0.01	<0.01
SK-8	0.7	10.3	2	0.14	<0.01	<0.01	<0.01
SK-9	0.5	0.1	< 2	0.18	<0.01	<0.01	<0.01
SK-10	0.3	0.1	2	0.25	<0.01	<0.01	<0.01
Aver.	0.57	3.4	< 2	0.19	<0.01	<0.01	<0.01
SK-11	0.7	1.1	2	0.27	<0.01	<0.01	<0.01
SK-12	0.9	5.3	14	0.60	<0.01	<0.01	<0.01
SK-13	0.5	2.7	2	0.24	<0.01	<0.01	<0.01
Aver.	0.7	3.3	7.4	0.40	<0.01	<0.01	<0.01

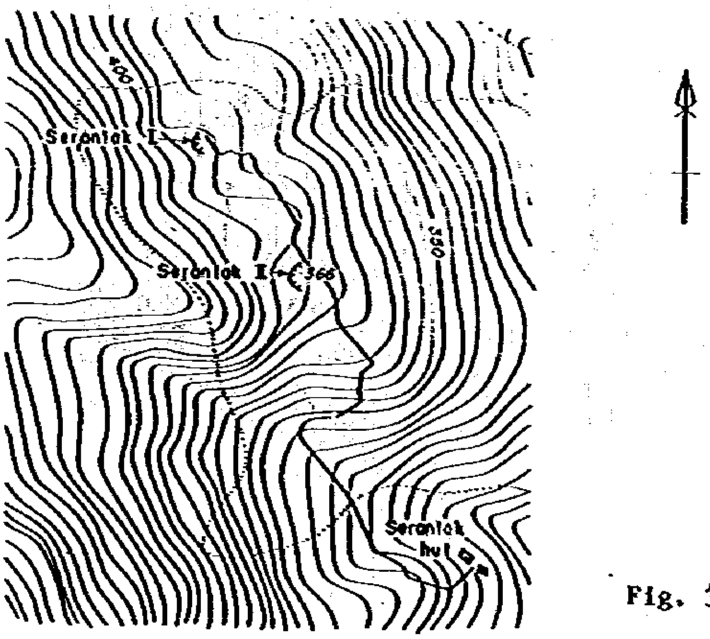


Fig. 3-8 Sketch Map of Serantak Mine

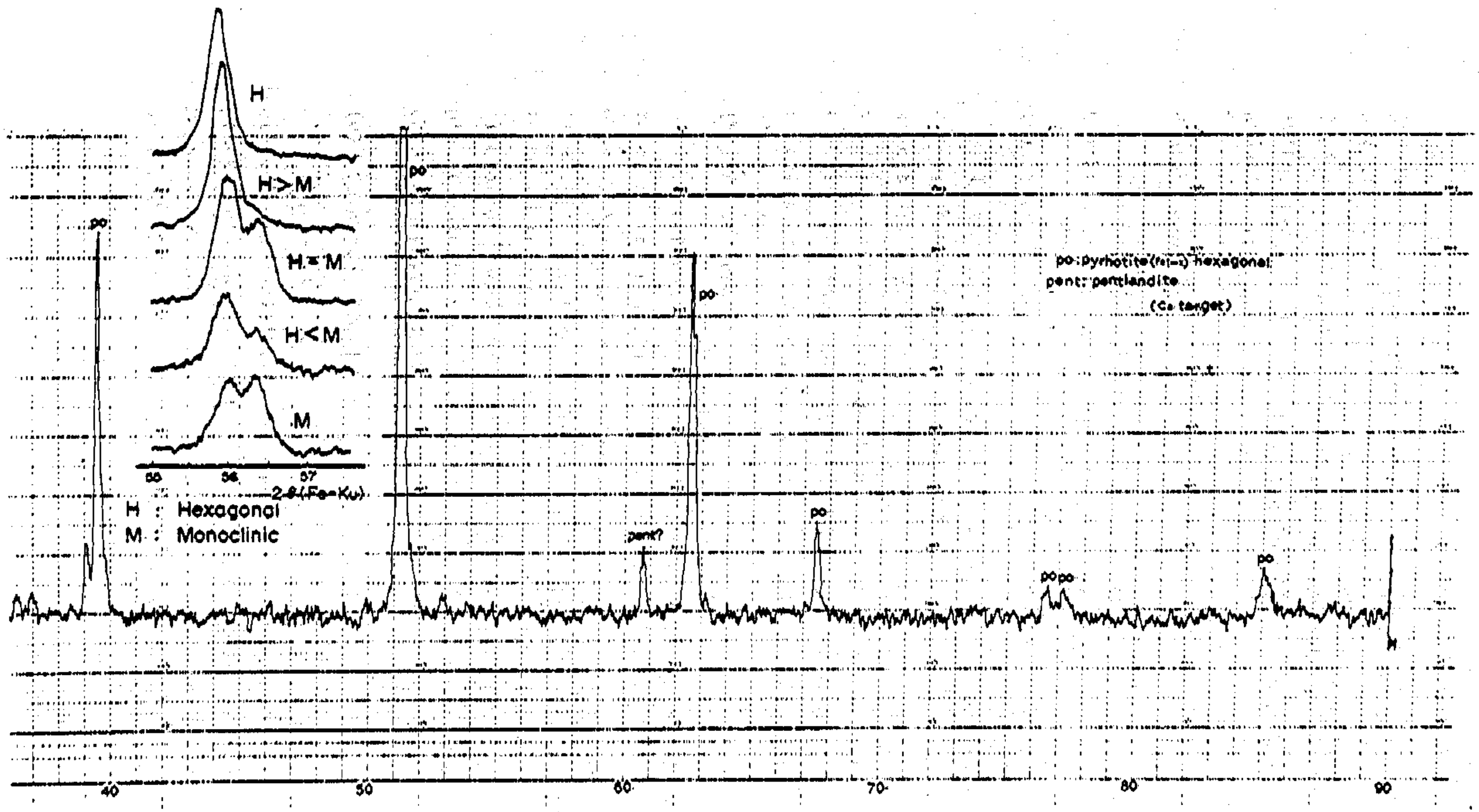


Fig. 3-9 Chart of X ray diffractive analysis of Serantak Pyrrhotite ore

(about 1 spot per km^2). The content rates were processed statistically and the results were plotted on the map in 5 classes of 0, 1 to 4, 5 to 16, 16 to 69 and 70 and higher. From the results, the situation of placer gold distribution in the project area is clear now.

2-4-2 Placer Gold Area

Placer golds are recognizable in the Serantak, Banyi, Selakean-Darit, Sebambang and G. Semang areas.

(a) Serantak Area

In the Serantak area, there is a mine in which gold is mined, though in a small scale, from Gossan of the Serantak gold bearing pyrrhotite deposit, and there are mineralization of copper, molybdenum and gold in area intruding the Tertiary Sirih tonalite and Serantak dacite intrusion. Placer gold in the Serantak area is considered to be brought from the mineralization.

(b) Banyi Area

Placer gold is recognized centering in the Banyi mineralized zone, and especially the S. Semade is well known as an area in which a large amount of placer gold was produced in the past. As mentioned before, there are gold bearing pyrite quartz veins in weak alteration zones in the margin of the Banyi strong alteration zone, such as Sungisa, Bayur and Banihulu, and the placer gold in the Banyi area is considered to be coming from these mineralizations.

(c) Selakean - Darit Area

Placer gold is panned in many places of the Selakean - Drit area, and especially remarkable one is panning of 170 grains of placer gold in the vicinity of the Sengga village in the S. Menyuke tributary. The Belango Formation is distributed in the area and the G. Raya granodiorite have intruded into the Formation. In the Sengga village vicinity, there is a silicificated zone of 1 km wide and 3.5 km long along the tectonic line of WNW-ESE strike, and it is considered that the placer gold in the vicinity of Sengga village could be brought from the silicificated zone.

(d) Sebambang Area

In this area there is an alteration zone, accompanying pyrite dissemination existing in the Belango dacitic and andesitic Formations that is distributed in the G. Sebiawak and G. Raya granodioritic batholith as roof pendant, and placer gold that is infered to be coming from the alteration zone is panned occasionally.

(e) Petni Area

108 grains of placer gold were panned in the S. Sambi tributary flowing through the Petni village vicinity, about 6 km SSW of the Pahuman village. A small amount of placer gold were panned in the gullies flowing down mainly in G. Semawung and G. Sebilang in the south of Pahuman. Existence of gold deposits is expected in G. Semawung and G. Sebilang.

2-5 Manganese Ore Deposit

Sasan manganese deposit is distributed at 600 m north of the Juratak Village, the northeastern edge of the project area. Exploration work was conducted during the second world war and after the war Geological Survey of Indonesia carried out a survey of the deposit under the advice of Dr. H. Walther.

The Serantak dacitic tuff is distributed in the mineralized area, and the manganese ore deposit is embedded in the Formation. The foot wall of the ore deposit is altered to white clay tuff, namely kaolinized tuff. The deposit is in a strata form, having the scale of about 200 m in length and 40 m in width, 1.25 m in average thickness. The ore has oolitic texture, showing concentric band, and consists of cryptomelane. Psilomelane, pyrolusita and braunite were detected through mainly X-ray diffractive method, and also hematite was unclearly recognizable. Analysis result of good lumped ore near the deposit are 42.65% of Mn, 0.1 g/t of Au and 0.04% of Zn.

Because of existence of oolitic texture and strata bound form in tuff stratum, the deposit could be regarded as a deposit formed by the Serantak dacitic volcanit activity in Tertiary age.

2-6 Relationship Between Igneous Activities and Mineralization

The relationship between abovementioned mineralizations and igneous activities, especially young igneous activities clarified by the project, is as follows;

(1) Many chalcopyrite-molybdenite quartz veins were found in Sirih tonalite, dated as 20 m.y. through this project. The tonalite partly underwent sericite of hydrothermal alteration at upperstream of S. Ledo, and has slight high back ground value of Mo and Cu, resulting geochemical survey with stream sediment.

(2) In Banyi area, centering strong hydrothermal alteration zone with sericite and a few pyrite, there are gold bearing quartz vein, gold bearing chalcopyrite vein, dissemination and net work mineralization of chalcopyrite and molybdenite, tourmaline zone with/without pyrite, in and around Banyi tonalite which also determined as younger igneous rock of 27 m.y. by K-Ar method.

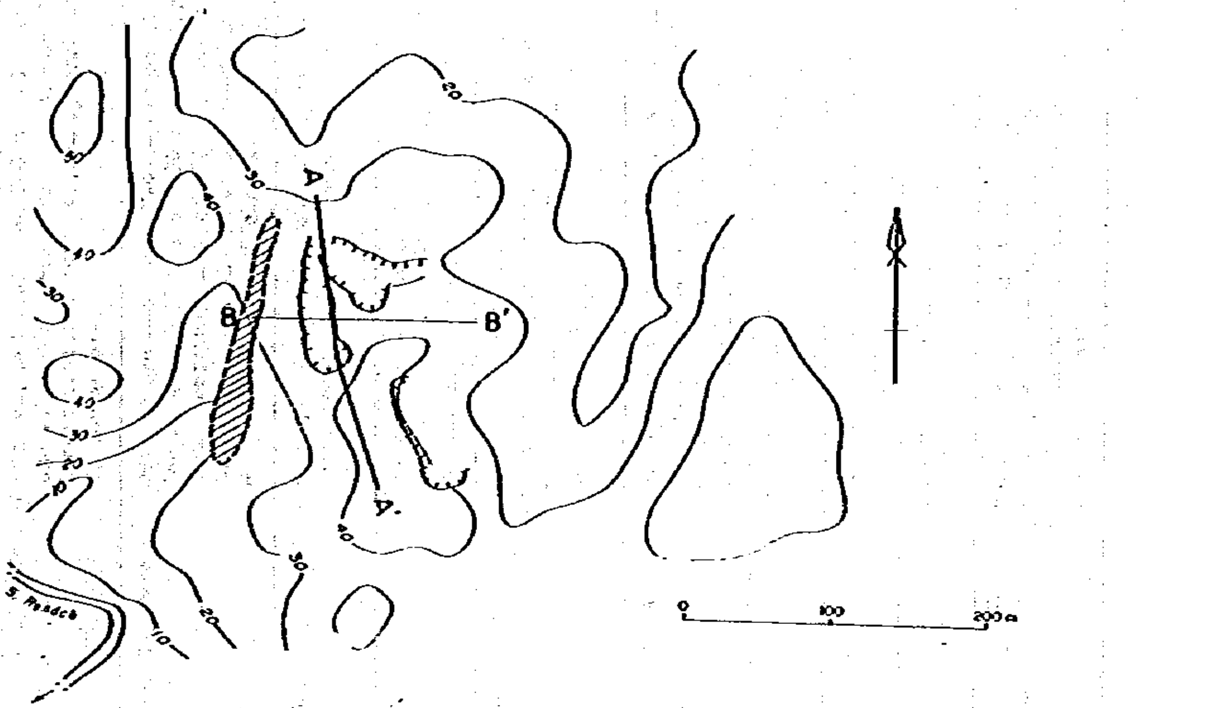
In the Central-West Kalimantan, same mineralizations associ ating with chalcopyrite and molybdenite have been known by pre- vious survey. At upper stream of Kahayan River, Central Kalimantan, Raea mineralization of chalcopyrite and molybdenite dissemination is embedded in Raea diorite porphyry, identified as younger intrusion because the rock has intruded into upper Cretaceous sedimentary rocks through geological survey of Central Kalimantan

(MMAJ-GSI 1978). Sijangku quartz diorite and G. Raya granodiorite in G. Ibu area near Singkawang accompanied by chalcopyrite-molibdenite veinlets have been dated as 30 m.y. showing younger igneous rocks by the age determination of the project.

(3) Many pyrite or pyrrhotite bearing quartz veins and a gold bearing chalcopyrite-pyrrotite massive ore deposit are distributed in and surrounding Serantak dacite stock at east side of G. Serantak. This dacite is also identified as younger igneous rock dated 51 m.y. by K-Ar method through the project, thus it can be suggested that the mineralization was deposited at during a period of the dacite intrusion.

(4) At Kp Juratak, northeastern edge of the project area, bedded manganese deposit has been also deposited conformably with Serantak tuff Formation of Tertiary, and is regarded as syngenetic deposit in Tertiary age.

Besides, mineralization caused by Cretaceous igneous activities has been found at several areas, for example Selakean chalcopyrite-sphalerite-arsenopyrite veins and pyrite dissemination at contact zone of Jurassic volcanic Formations and Cretaceous granitic rocks, young mineralizations are very familiar in West Kalimantan, and when exploration survey for metallic mineral resources takes place in West Kalimantan, further investigation of igneous activities during Tertiary age are useful and recommendable.



	Au g/t	Ag g/t	Cu %	Pb %	Zn %	Mn %
RA201	0.1	< 2	<0.01	<0.01	<0.01	42.65

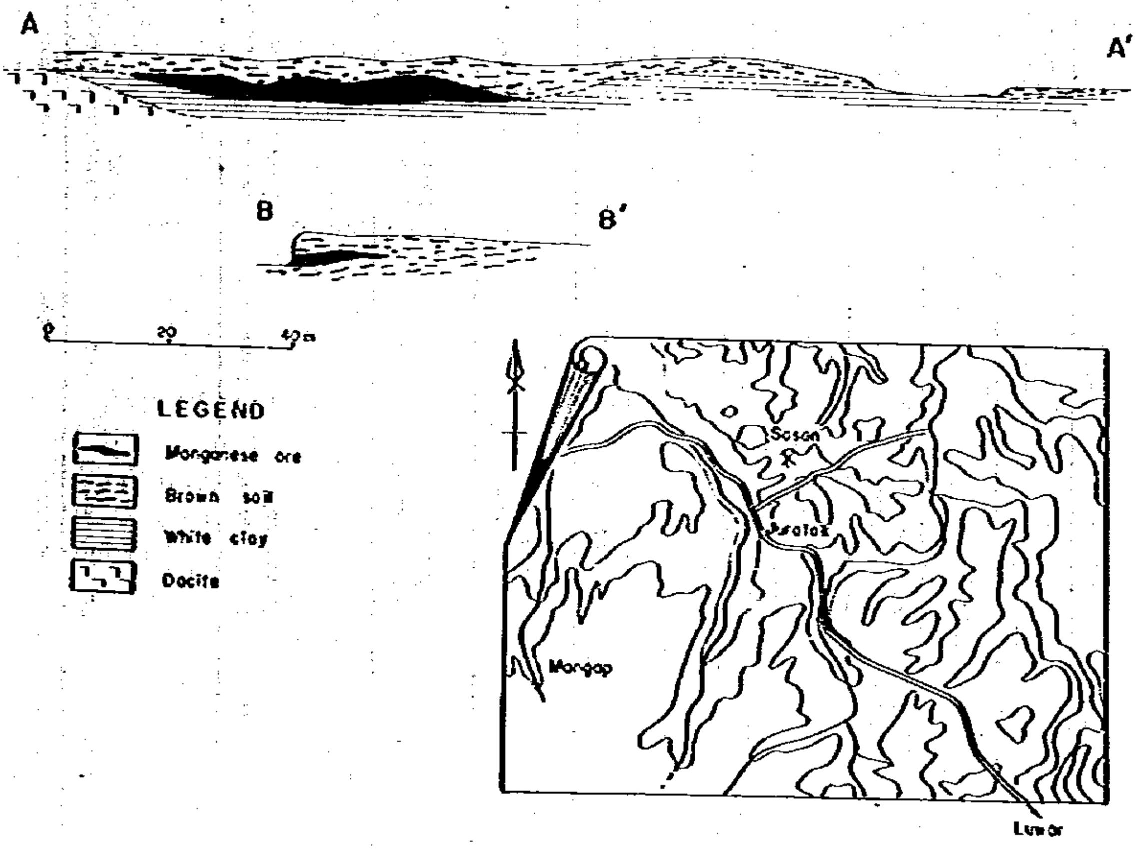


Fig. 3-10 Sketch Map of Sasan Manganese Ore Deposit

Table 3-1 Summary of Mineralization

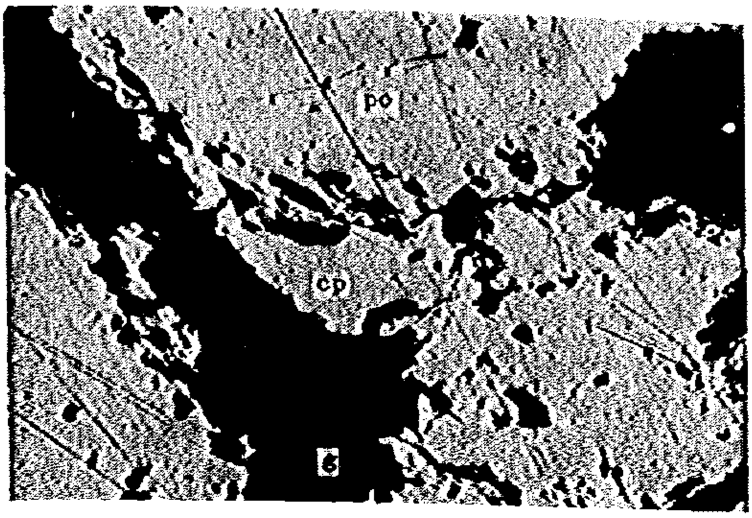
No.	Name	Location	Type	Host Rock	Mineral	Occurence
1	Sasan	Kp. Juratak	Bed	Serantak pyrocrastic rocks	Mn (Crypt, Brau Psi)	The ore deposit is conformably embedded in tuff stratum, and confirmed 200 m x 40 m in extension and 1.25 m in average thickness. Ore has oolitic banded texture. Mn: 42.65% by grab sampling in lumped ore.
2	Serantak	East side of G.Serantak	Mass	Asidic tuff of Banan Formation	Au, Cp, Pyrr	Primary ore outcrop: Two layers of 15 m in length with 0.57 m and 0.70 m in average thickness, containing 3.4 g/t, 2.7 g/t of Au. Gossan outcrop: Limonite ore contains 7 g/t of gold in 0.60 m thickness.
3	Senturu	South bank of S. Banan	Vein	Sandstone of Banan Formation	Au, (Qz)	Many collapsed adits and quartz vein with py, pyrr. are distributed around/in Serantak dacite stock.
4	Takap-Sirih	Upperstream of S.Bamua, S.Ledo S.Sirih, S.Banan	Vein	Sirih tonalite	Cp, Mo	Cp-Mo-Qz veins are in Sirih tonalite. Southend of the tonalite underwent sericite of thermal alteration.
5	Banyi	Southwest of Bengkayang	Vein, Diss	Andesite and andesitic tuff of Jirak Formation, G.Raya granodiorite, Banyi tonalite	Au, Cp, Mo	Centering barren tourmaline zone, Cp-Mo veinlets, Au-Cp-Py veins, Py-Au Qz veins, and Py-Se alteration zone are sporadically distributed in area of 4 km x 6 km.
6	Selakean	East of Kp. Teriak	Vein	Andesitic tuff of Jirak Formation	Cp, Sph, Arsp, Py	Lump ore in old pit shows the vein of Au-Cp-Spb-Arsp vein. Several mineralization outcrops are found in area of 3 km^2. Most veins contain arsenic mineral (Arsp).
7	Tikalong	East of Kp. Tikalong	Diss	Dacitic tuff of Belango Formation	Py	Silicification with Py dissemination
8	Emang	North of Kp. Emang	Diss	Tiang quartz diorite	Py (Cp)	Small amount of Cp are disseminated in quartz diorite
9	Seliat	Vicinity of Kp.Seliat	Diss	Andesitic rocks of Belango Formation	Py	Weak Py dissemination
10	Panji	Southeast of Kp.Panji	Diss	Andesitic tuff of Belango Formation, G.Sebiawak granodiorite	Py, Cp, Cov (Tour)	Three outcrops consisting of Tour bearing Cp, Cov, Py dissemination were found. Geochemical and IP anomalies are coinsided with the mineralizations.

No.	Name	Location	Type	Host Rock	Mineral	Occurence
11	Sebambang	Vicinity of Kp.Sebambang	Diss	Belango Formation, G.Sebiawak granodiorite	Py	Weak Py dissemination in andesite.
12	Kunyit	2 km northwest of Kp.Kunyit	Veni	G.Sebiawak granodiorite	Mo	Outcrop of Mo-Qz vein with 5 cm in thickness. (N60°W, 85°S)
13	Combang	Vicinity of Kp.Combang	Diss	Dacitic tuff of Belango Formation	Py	Py dissemination in area of 5 km x 2 km.
14	Sanurian	Vicinity of Kp.Sanurian	Diss	Andesitic rocks of Belango Formation	Py	Py dissemination in area of 1 km x 0.5 km

Diss: dissemination
Mass: massive ore deposit
Bed : bedded ore deposit

Py : pyrite
Cp : chalcopyrite
Cov : covelline
Sph : sphalerite
Pyrr: pyrrhotite
Arsp: arsenopyrite

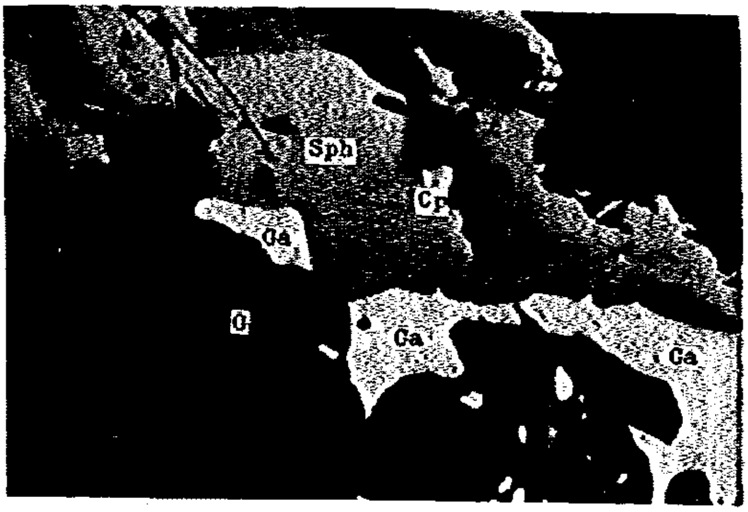
Qz : quartz
Tour: tourmaline
Se : sericite



Sample No. : Serantak (B)
Locality : Serantak
Name of Ore: Chalcopyrite bearing pyrrhotite

po : pyrrhotite
cp : chalcopyrite
g : gangue

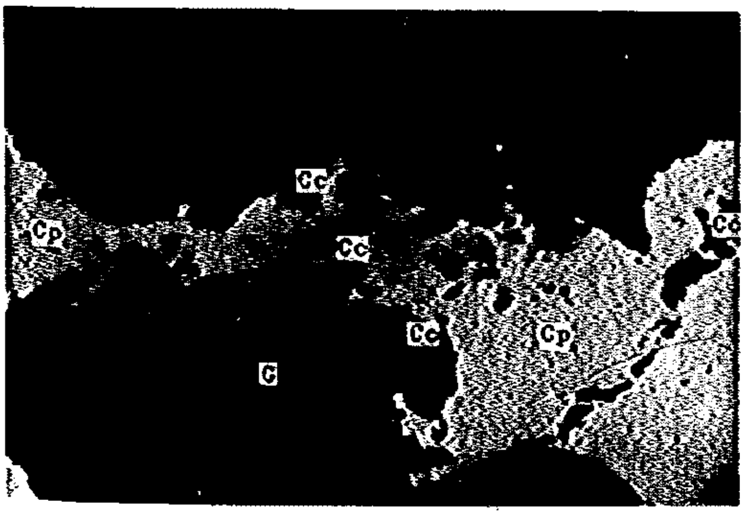
0 ______ 0.2 mm



Sample No. : 80RD-144
Locality : G.Buru Serantak area
Name of Ore: Chalcopyrite-vein

Cp : chalcopyrite
Ga : galena
Sph : sphalerite
G : gangue

0 ______ 0.2 mm

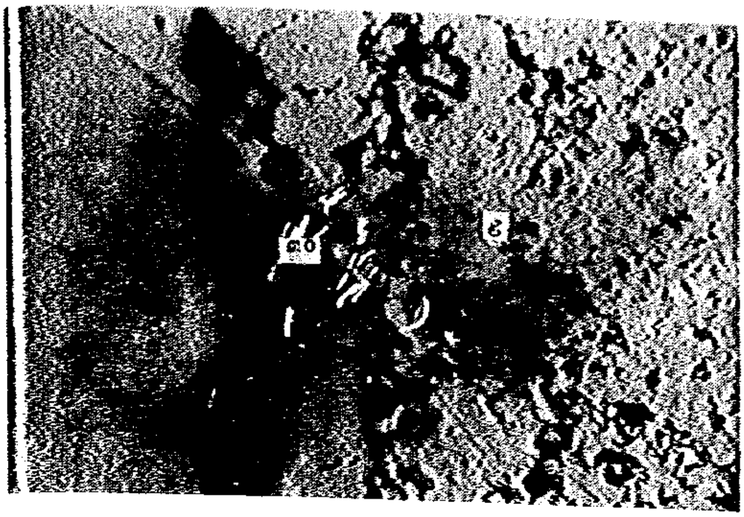


Sample No. : 80RD-138
Locality : upper stream of S.Banan Serantak area

Cc : chalcocite
Cp : chalcopyrite
G : gangue

0 ______ 0.2 mm

Photo-4 Microphotographs of Polished Ore Specimen



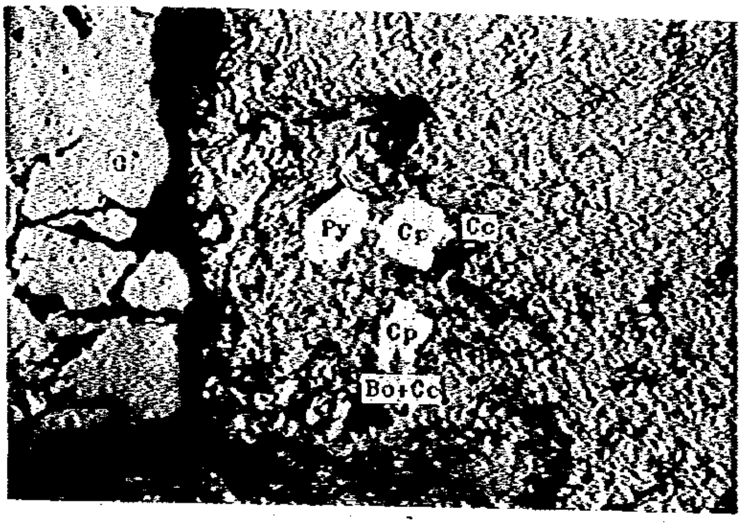
Sample No. : 79R1-62

Locality : Banitamahas

Name of Ore: Molybdenite veinlet

mo : molybdenite
g : gangue

0 ——— 0.2 mm



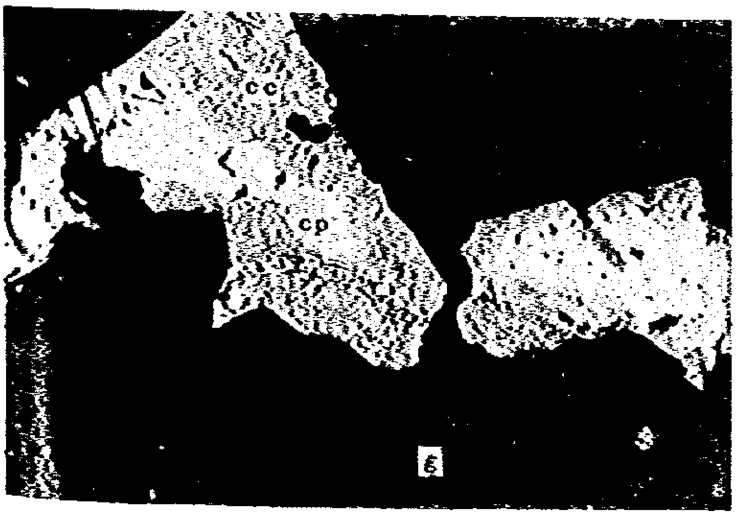
Sample No. : 80RP-132

Locality : Banyi area

Name of Ore: Chalcopyrite dissemination

Cp : chalcopyrite
Cc : chalcocite
Bo : bornite
Py : pyrite
G : gangue

0 ——— 0.2 mm



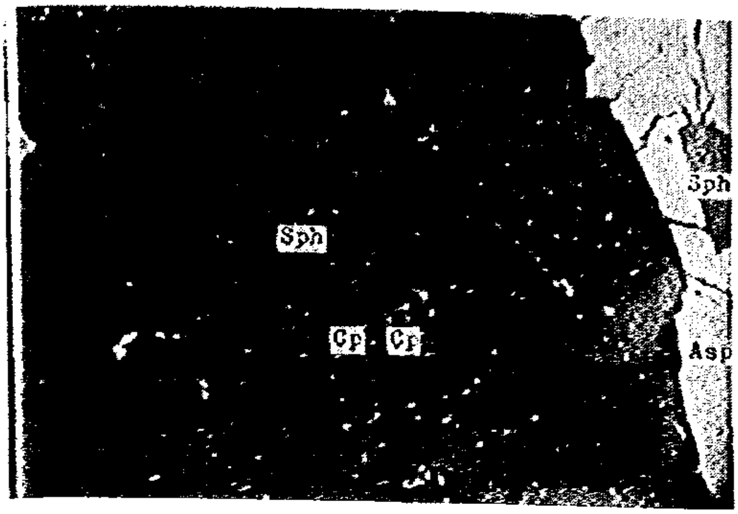
Sample No. : 79Rk-29

Locality : Batu Aji Banyi area

Name of Ore: Chalcopyrite dissemination

cp : chalcopyrite
cc : chalcocite
g : gangue

0 ——— 0.2 mm



Sample No. : 80RB-75

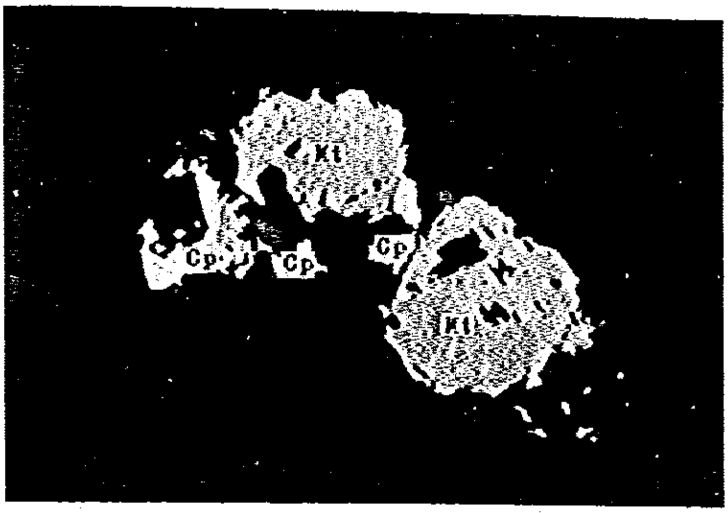
Locality : Selakean

Name of Ore: Chalcopyrite-sphalerite-arsenopyrite ore

Cp : chalcopyrite
Sph : sphalerite
Asp : arsenopyrite

(Exsolution of sphalerite and chalcopyrite)

0 ______ 0.2 mm



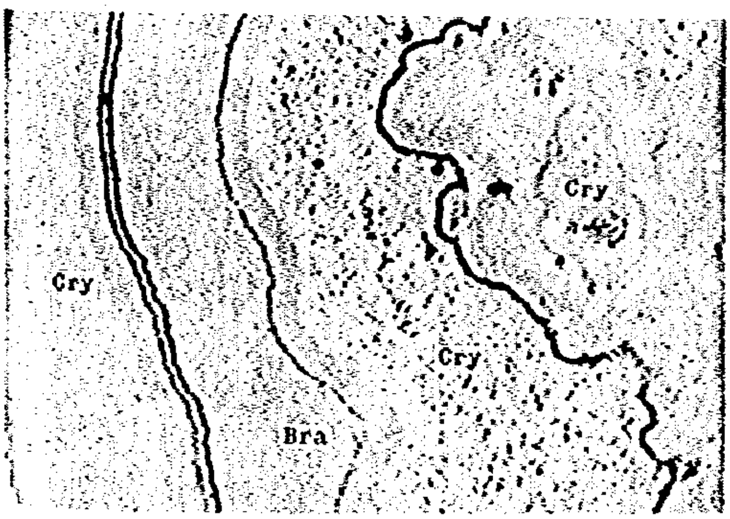
Sample No. : 80RD-30

Locality : Panji

Name of Ore: Chalcopyrite dissemination

Mt : magnetite
Cp : chalcopyrite

0 ______ 0.2 mm



Sample No. : 80RA-201

Locality : Sasan
Kp.Jeratak

Name of Ore: Manganese ore

Cry : cryptomelene
Bra : braunite

0 ______ 0.2 mm

PART IV

GEOCHEMICAL SURVEY

CHAPTER 1 OUTLINE OF GEOCHEMICAL SURVEY

In order to prospect and discover mineralized zones effectively in a short period of time through reconnaissance survey over the vast unsurveyed area, it is considered effective to conduct geochemical survey of stream sediments, keeping pace with geological survey. It is obvious from past instances that geochemical survey with soil sampling is effective in order to prospect more in detail of mineralized zones discovered through the reconnaissance survey.

For this project, geochemical surveys were conducted of stream sediments keeping pace with the geological surveys in the First and Second Phase reconnaissance surveys covering the survey area of 1,500 km^2, and several anomalous areas were discovered. Out of these anomalous areas, four areas (S. Banan-Serantak, Banyi, Selakean and Panji areas) were chosen for the detailed survey, and the geochemical surveys were conducted with soil sampling together with the detailed geological surveys. Anomalous areas interpreted in these detailed surveys coincided with the distribution of mineralizations, clarifying the scale and distribution of mineralizations.

At the first phase survey, geochemical survey of cold extractable copper was carried out in two anomalous areas discovered through the reconnaissance survey.

The results of geochemical surveys with stream sediments, soil sampling and cold extractable copper are summarized in Table 4-1.

Table 4-1 Details of Geochemical Survey in the Project Area

Phase	Survey	Analyzed sample	
		Stream sediment	Soil
Phase I	Reconnaissance Survey	Area : Northern area 500 km^2 Number of sample : 435 pcs Sampling density : 0.87 pcs/km^2 Pathfinder element : Cu, Mo, Zn	
Phase II	Reconnaissance Survey	Area : Central and Southern area 1,000 km^2 Number of sample : 837 pcs Sampling density : 0.84 pcs/km^2 Pathfinder element : Cu, Mo, Pb, Zn	
	Detailed survey		Area : Serantac 15 km^2, Banyi 35 km^2 Number of sample : 160 pcs Sampling density : 3.2 pcs/km^2 Pathfinder element : Cu, Mo
Phase III	Detailed survey		Area : Selakean 6 km^2, Panji 20 km^2 Number of sample : 127 km^2 Sampling density : 4.9 pcs/km^2 Pathfinder element : Selakean Cu, Pb; Panji Cu, Mo

CHAPTER 2 GEOCHEMICAL SURVEY WITH STREAM SEDIMENTS

2-1 Method of Survey and Data Processing

2-1-1 Method of Survey

The geochemical surveys were performed jointly with the geological surveys both in the First and the Second Phase Surveys as the reconnaissance survey over the area of 1,500 km^2 assigned to this project. Sampling work was carried out jointly with the geological survey at the branch rivers which flow into the main rivers, by fixing the route and sampling locations after they were checked to be evenly distributed in the survey area. 1,272 samples were collected in total, and the sampling density resulted in about 0.8 sample per km^2.

These samples were screened through an 80 mesh sieve under water and after having been dried in the sun at the camp, divided to two packs, one to Japan and the other to the Republic of Indonesia for the chemical analyses of Cu, Zn and Mo elements and Cu, Mo, Zn and Pb elements in the First and the Second Phase surveys respectively.

2-1-2 Data Processing

The analyzed values were statistically processed, after the surveyed area was divided according to the geological unit, in order to eliminate the backgrounds to be caused due to the difference in the geology at the sampling locations (Fig. 4-1). Namely, the assays analyzed were processed along seven blocks; two blocks (Northern sedimentary rocks block and G. Raya granodiorite block) for the First Phase Survey and five blocks (Northern sedimentary rock block and Darit volcanics block, G. Raya granodiorite block, Sebiawak granodiorite block and Senakin volcanics block) for the Second Phase Survey.

For the statistical processing of analyzed data, the analyzed values were standardized by the logarithmic conversion. Frequency distribution, cummulative frequency distribution, mean values and standard deviations were calculated per block to examine the backgrounds and determine anomalous values. As regards the anomalous values, a threshold value above the mean value plus two sigma (Mean + 2σ) was ranked at the 1st-class anomalous value, while a threshold value above the mean value plus one sigma (Mean + σ) was ranked at the 2nd-class anomalous value. The mean values, threshold values (M + σ, M + 2σ) and standard deviations are shown in Table 4-2.

2-2 Survey Results

The major anomalous areas of those discovered through statistical processing of the anlyzed values of the samples collected in the geochemical surveys are described below (Fig. 4-2).

2-2-1 Northern Sedimentary Rocks Block (79A, 80A)

Several Cu, Mo and Zn anomalous areas are distributed centering at G. Sirih tonalite intrusive rocks, of which Mo and Cu anomalous areas are overlapping in G. Bawang and from S. Banan to G. Buwah Oban. In these areas, copper-molybdenite mineralizations (Takap·Sirih Mineralizations) are found in Sirih tonalite.

2-2-2 G. Raya Granodiorite Block (79B)

The anomalous area is distributed in the range of 5 km × 2.5 km, covering Banyi tonalites. In this anomalous area, such mineralizations as chalcopyrite dissemination, copper-quartz vein, gold-quartz veins are distributed centering at S. Banyi.

Cu and Mo are distributed around G. Semale in the west southwest of Banyi anomalous area as the single anomalous area respectively, but no mineralizations were recognized. It is considered necessary to examine these anomalous areas because of

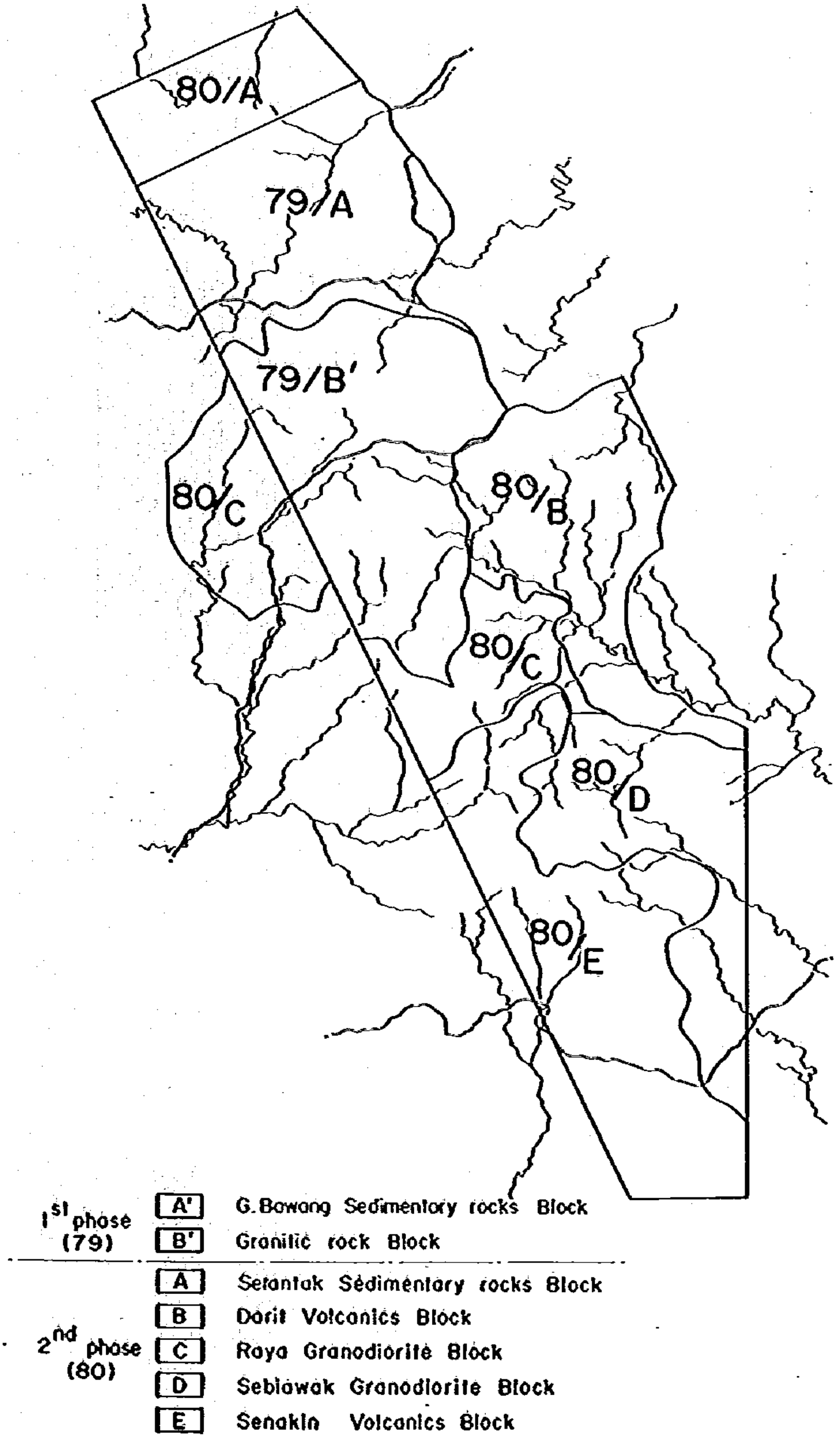


Fig. 4-1 Geological Block for Geochemical Interpretation in the Project Area

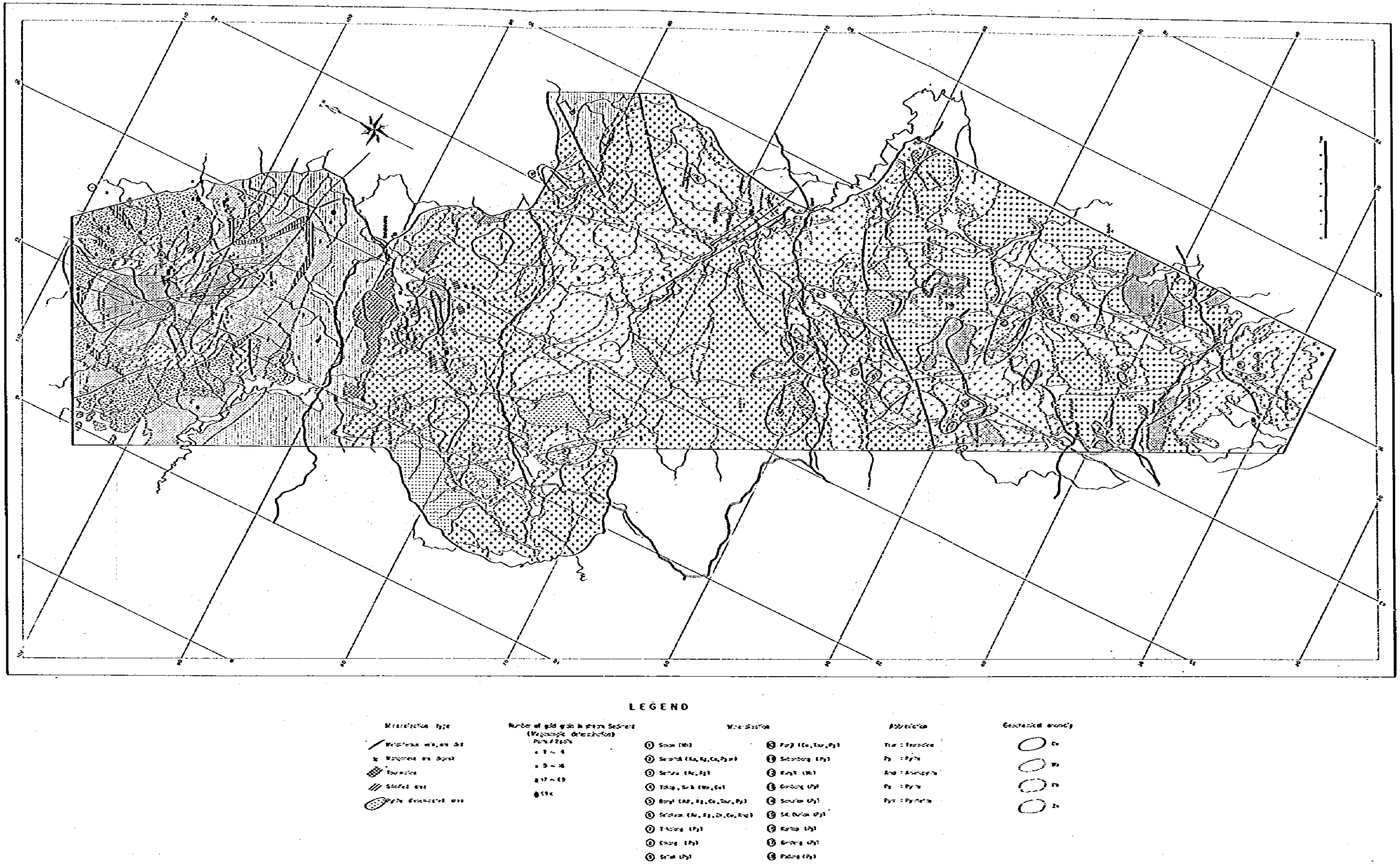


Fig. 4-2 Anomaly Map of Geochemical Reconnaissance Survey with Stream Sediment in the Project Area

Table 4-2 Mean Value and Threshold Value of Reconnaissance Geochemical Survey with Stream Sediment in the Project Area

Block	Element	Mean Value	Standard Deviation (σ) (Logarithmic Value)	M + σ	M + 2σ	Remarks
79/A	Cu	28,335		64,664	147,571	Sedimentary Formation Area
	Zn	71,857		113,800	180,226	
	Mo	1,130		1,693	2,538	
79/B	Cu	32,262		74,778	173,321	Raya Granodiorite Area
	Zn	63,018		110,452	193,592	
	Mo	1,027		1,183	1,361	
80/A	Cu	9,136	0.340	19,988	43,734	Sedimentary Formation Area
	Pb	13,129	0.214	21,514	35,253	
	Zn	59,904	0.281	114,371	218,362	
	Mo	3,159	0.2097	5,121	8,300	
80/B	Cu	21,736	0.298	43,210	85,900	Jirack Formation, Belango Formation Area
	Pb	14,022	0.276	26,468	49,964	
	Zn	32,740	0.305	66,149	133,649	
	Mo	3,609	0.1913	5,607	8,711	
80/C	Cu	18,070	0.382	43,591	105,155	Raya and Selantar Granodiorites Area
	Pb	8,731	0.332	18,762	40,316	
	Zn	25,084	0.385	60,912	147,917	
	Mo	3,058	0.206	4,911	7,883	
80/D	Cu	7,206	0.370	16,899	39,631	Sebiawak Granodiorite Area
	Pb	7,224	0.286	13,954	25,956	
	Zn	10,247	0.524	34,275	114,645	
	Mo	2,347	0.213	3,981	6,504	
80/E	Cu	12,551	0.326	26,603	56,391	Belango Formation Area
	Pb	8,437	0.229	14,289	24,200	
	Zn	25,054	0.405	63,718	162,049	
	Mo	2,491	0.228	7,134	4,215	

the existence of dacitic intrusive rocks and as they are situated in the extension of Banyi mineralization extending west southwest.

2-2-3 Darit Volcanics Block (80B)

G. Selakean anomalous area

1st and 2nd class anomalous areas of Cu, Mo, Zn and Pb are distributed centering at G. Selakean in the scale of 3 km × 3 km. G. Raya granodiorites have intruded into Jirak andesitic pyroclastic rocks, causing gold-silver bearing chalcopyrite-sphalerite-arsenopyrite veins.

2-2-4 G. Seblawak Granodiorite Block (80D)

Tajur anomalous area

This is a collective zone of 2nd-class Cu, Pb and Zn anomalous areas distributed northward from G. Satunok, overlapping each other, ranging 1 × 3 km. The geology consists of Banyi type tonalite intrusive rocks, but no mineralization is yet confirmed on the ground surface.

Panji area

This is a collective anomalous area of copper ranging 3 × 2.5 km and of Mo ranging 4 × 3 km, overlapping each other. In this anomalous area, there are chalcopyrite dissemination and tourmaline zone discovered in the geological survey, and this anomalous area is considered to express this mineralization.

2-2-5 Senakin Volcanics Block (80E)

Pekatan anomalous area

This is the largest scale of anomalous area in the survey area, ranging about 10 × 5 km, where there is a collective zone of Cu, Mo, Pb and Zn anomalies. The geology consists of Belango andesite, dacitic volcanic rocks and Banyi tonalites intruding into the formers. There is a poor exposure in the majority of this anomalous zone and almost noen of mineralization is found yet. Sanurian pyrite dissemination zone is found at south of this anomalous zone; Sebambang pyrite dissemination at north; and a thin vein of molybdenite in G. Sebiawak granodiorite at east end. These anomalies are thought express the possibility of the pyrite dissemination similarly as weak as them although not available to be found on the ground surface due to being covered by the surface soils.

The above geochemical survey results were interpreted together with the geological survey results to extract four areas, i.e. Serantak-S, Banan area, Banyi area, Selakean area and Panji area for the detailed survey.

CHAPTER 3 GEOCHEMICAL SURVEY WITH SOIL SAMPLING

3-1 Method of Survey and Data Processing

3-1-1 Method of Survey

The geochemical survey with soil sampling was conducted over the four detailed survey areas extracted through the reconnaissance survey. Namely, the Second Phase geochemical survey was carried out in Serantak area (15 km^2) and Banyi area (35 km^2), collecting soil samples at a rate of 3 points per km^2, totaling into 160 samples. The Third Phase geochemical survey was carried out in Selakean area (6 km^2) and Panji area (20 km^2), collecting soil samples at a rate of 5 points per km^2, and furthermore, at a rate of 1 point per every 200 meters of survey line (2 km × ten survey lines, extending for 20 km in total length) in Panji area where the geophysical survey (IP Survey) was conducted, totaling in 227 samples.

Soil samples were collected from B-horizon at ridge and mountain summit in order to prevent them from being contaminated by the rivers, applying the sub-grid sampling method. The samples were dried in the sun at the camp, screened through an 80 mesh sieve and divided to two packs, one to Japan and the other to the Directorate of Mineral Resources of Indonesia, for chemical analyzed for Cu and Mo as the pathfinder elements in Serantak, Banyi and Panji areas and for Cu and Pb as the pathfinder elements in Selakean area, considering expected mineralizations, and used for the interpretation of the geochemical survey.

3-1-2 Data Processing

The analyzed data were statistically processed in the same way as that of stream sediments, preparing Map of Geochemical Anomaly by threshold values.

3-2 Survey Result

The geochemical survey results in each area summarized below.

3-2-1 Serantak Area

In Serantak area, the 2nd-class anomalous value ($M + \sigma$) is Cu of 34 ppm and Mo of 3 ppm while the 1st-class anomalous value ($M + 2\sigma$) is Cu of 79 ppm and Mo of 6 ppm of which analytical absolute values are low. Four anomalous areas are recognized in view of the 2nd-class anomalous value (Fig. 3-7).

(a) Banan Anomalous Area

This anomalous area ranges 2.2 km toward E-W and 1.5 km toward N-S, centering at the tribunary bank of S. Banan. The geology of this anomalous area consists of Sirih tonalite, being accompanied by quartz vein and pyrite-molybdenite-quartz veins. In the southern Banan anomalous area, Takap-chalcopyrite-molybdenite-quartz veins at the upperstream of S. Banan is well known.

(b) G. Beru Anomalous Area

This is a 2nd-class copper anomalous area ranging in the width of 500 meters. The geology in this anomalous area is Banan sandstone Formation, being intruded by Serantak dacite. Quartz veins (20 cm wide) of strike N60°W outcrop in Banan Formation, accompanied by sphalerite, pyrite and chalcopyrite.

(c) Serantak Anomalous Area

This is a copper anomalous area ranging in 0.4 × 0.3 km at east mid hill of Gunung Serantak. The geology of this anomalous area consists of Late Triassic Banan Formation and Serantak dacite intruding into the former. This anomalous area is included in Serantak mineralization, and assumed to reflect a gold-chalcopyrite bearing pyrrhotite mineralization around Serantak decite.

(d) Senturu Anomalous Area

This is a copper anomalous area ranging in the scale of 0.6 × 0.4 km at the left bank of S. Banan downstream. The geology of this anomalous area consists of Serantak dacite, accompanying by quartz vein, pyrite-quartz vein, etc. This anomalous area is also assumed to reflect a mineralization around Serantak dacite.

3-2-2 Banyi Area

The distribution range of copper anomalous area (more than 120 ppm of Cu) extends 5.0 × 1.0 km, centering at the upper-stream of S. Banyi and S. Mapara at the near center of this survey area, and in trend toward E-W diagonally accrossing the intrusive direction of Banyi tonalite (Fig. 3-2)

The Mo anomalous area (more than 4.5 ppm of Mo) consists of three blocks, i.e. east blocks, at both of which overlapping with the copper anomalous area.

Most of them covers Banyi tonalite blocks, partly Jirak andesite Formation and G. Raya granodiorite.

These anomalous areas include the mineralized zones at Batu Aji, Banihulu and Banitamahas mineralized zone (fissures accompanying a molybdenite ore dissemination) centering at Banyi pyrite dissemination accompanyed by argillized zones. No anomalous area was recognized in barren tourmaline mineralization area in the center of this survey area.

3-2-3 Selakean Area

The distribution range of Cu anomalous area (more than 70 ppm of Cu) covers S. Empawang, S. Nanggak and S. Entagak in the southwestern area of this survey area. The geology of this area consists of Jirak andesite and G. Raya granodiorite intruding into the former, being altered by weak pyrite dissemination. Pyrite, arsenopyrite, chalcopyrite and sphalerite mineralized zones are distributed in the fissures striking N30°E and N30°W with weak mineralizations. The most predominant Selakean veins are slightly shifted from the Cu anomalous area. A Pb anomalous area (more than 36 ppm of Pb) is shifted about 500 m northward and does not overlap with the copper anomalous area (Fig. 3-5).

3-2-4 Panji Area

The distribution of Cu anomalous area (more than 135 ppm of Cu) almost overlaps with that of molybdenum anomalous area (more than 15 ppm of Mo). They are distributed southward from the midstream of S. Jenaham to S. Tapis. The geophical survey (IP Survey) was performed in this area, and IP anomalies nearly overlap with these anomalous areas, extending 2 km N-S and 1.5 km E-W in G. Sebiawak granodiorite area. A chalcopyrite dissemination accompanied by tourmaline is confirmed at the outcrop at east old Panji village situated to the north of the above anomalous areas (Fig. 3-4).

It was confirmed as the result of geochemical survey with soil sampling conducted in the detailed survey area that Cu and Mo anomalous areas overlapped with the distribution of mineralized zones, and that it was a very effective prospecting method to survey the range of mineralized zones.

CHAPTER 4 GEOCHEMICAL SURVEY BY COLD EXTRACTABLE COPPER METHOD

4-1 Purpose

Cu anomalous value obtained by geochemical survey for metallic minerals of stream sediment consists of clastic Cu anomaly and hydromorphic Cu anomaly. The former includes fragments of primary minerals, insoluble secondary minerals, and clay residual, and the latter includes Cu adhering to the surface of organic material, clays, rocks, or mineral grains in the form of iron or soluble salts.

This geochemical survey was conducted in the first phase survey, attempting to distinguish hydromorphic Cu from clastic Cu, and to compare both Cu anomaly locations to find their geochemical anomaly roles. Hydromorphic Cu is called cold extractable Cu (Cx-Cu), because it is analyzed after treatment by weak acid or sodium acetate. Total Cu is obtained by adding clastic Cu and Cx-Cu values.

4-2 Selection of Assayed Samples

Some samples were selected from total Cu anomaly area, namely Serantak-Berasi area and Banyi area. Total of 102 samples were selected, that is, 41 samples from Serantak-Berasi area and 61 samples from Banyi area, considering total Cu anomalies and drainage textures.

4-3 pH Measurement of River Water

Precipitation of Cx-Cu is affected by pH condition of river water. Namely, when surface water and pH are acid, Cx-Cu is not precipitated and when pH is weak and alkaline it tends to be deposited. Therefore, it is important to know stream pH. Thus pH value was measured by a litmus test paper (Toyo manufacture) at each stream sampling point of the First Phase geochemical survey, in order to determine the relationship of mineralization and pH,

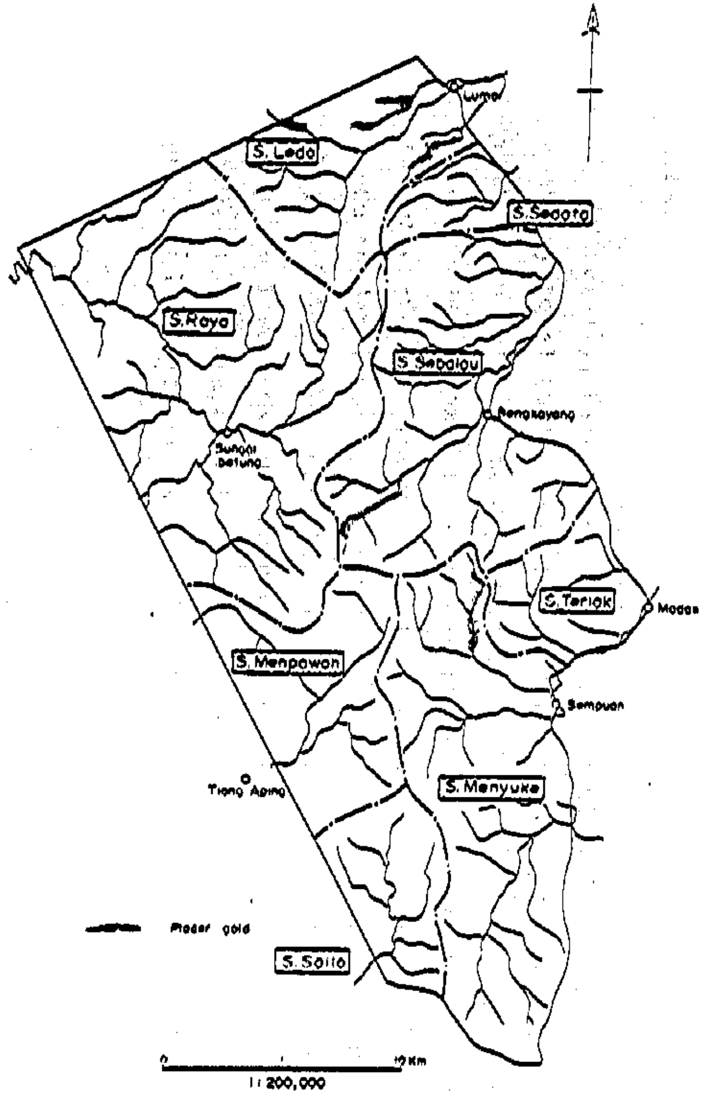


Fig. 4-3 Drainage map of Northern Project Area

Table 4-3 Frequency Distributions of pll Values in Each Drainages

pH	Northern Area				Southern Area				Total
	S. Sebalau	S. Raya	S. Sedata	S. Ledo	S. Menyuko	S. Teriak	S. Mempawah	S. Sailo	
5.0		1							1
5.2	2	3							4
5.4	2	16		1	1				20
5.6	24	29	1	12	1	1			68
5.8	38	24	2	13	12	3	4	1	97
6.0	4	34	1	12	28	3	5	5	92
6.2		5		22	21	14	19	6	87
6.4			1	3	19	7	4	2	36
6.5								2	2
6.6					2			1	3
6.8				1	1		3	5	10
6.9					1				1
7.0								2	2
7.2							4	2	6
7.3								1	1
Total	70	111	5	64	86	28	39	27	430
Mean value	5.7	5.8	5.9	6.0	6.1	6.2	6.3	6.5	6.0
	5.8				6.2				

resulting in S. Raya with the lowest value of 5.0 pH and in S. Sailo showing the highest value of 7.3 pH. The average pH value of 430 sampling point was 6.0 and slightly acid.

The pH values were divided into 8 drainage groups (Fig. 4-3), and these pH values differed slightly by each drainage group as shown in Table 4-3. Further, the results were divided into two geological groups, northern part and southern part for comparison. The northern area, consisting of sedimentary rocks and Tertiary tonalite intrusion, had an average pH value ranging from 5.7 to 6.0 and the southern area, representing granodiorite batholith, had an average pH value ranging from 6.3 to 6.5. This probably means that the former area has many mineralization areas in Serantak-Berasi area and Banyi area, while the latter on the contrary is occupied by a granodiorite balithoth without any prominent mineralization.

4-4 Interpretation of Results

Cx-Cu distribution was interpreted by drawing a Map with a Cx-Cu value contour line, not by applying statistical method of seeking threshold values (Fig. 4-4, 4-5)

In both areas, Cx-Cu anomaly area overlied the T-Cu anomaly area.

Generally, Cx-Cu value is low near a mineralized zone, on the contrary total Cu is high, because hydromorphic copper corresponding with Cx-Cu value is hardly deposited under low pH value in river water caused by oxidation of sulphide ores. Therefore, a comparison of Cx-Cu/T-Cu ratio was made among these assay result to know Cx-Cu tendency under weak acidic condition ranging from pH 5.7 to 6. (Fig. 4-6, 4-7). The result showed a widely scattered distribution, from the lowest Cx-Cu/T-Cu ratio of 15.9% to the highest ratio of 75.0% (the average ratio of 41 samples was 28.2%) in Serantak-Berasi area, and the lowest Cx-Cu/T-Cu ratio was 14.2% whereas the highest ratio was 50.0% (the average ratio of 61 samples was 30.2%) in Banyi area.

Points with Cx-Cu/T-Cu ratio under 20% are distributed near mineralized zones. Namely, in Serantak-Berasi area, such points are located near Takap molybdenite mineralization area, and in Banyi area they are centered at mineralization areas (Suren gold-copper mineralization and Batu Aji gold-copper mineralization) relating to Banyi tonalite.

If a ratio up to 30% is adopted, the area covers chalcopyrite-molybdenite mineralization distributed at S. Bamua and S. Sirih in Serantak area.

As described above, it can be stated that the geochemical survey by Cx-Cu is useful in prospecting for mineralization areas related to Cu under the conditions where stream pH is slightly acid.

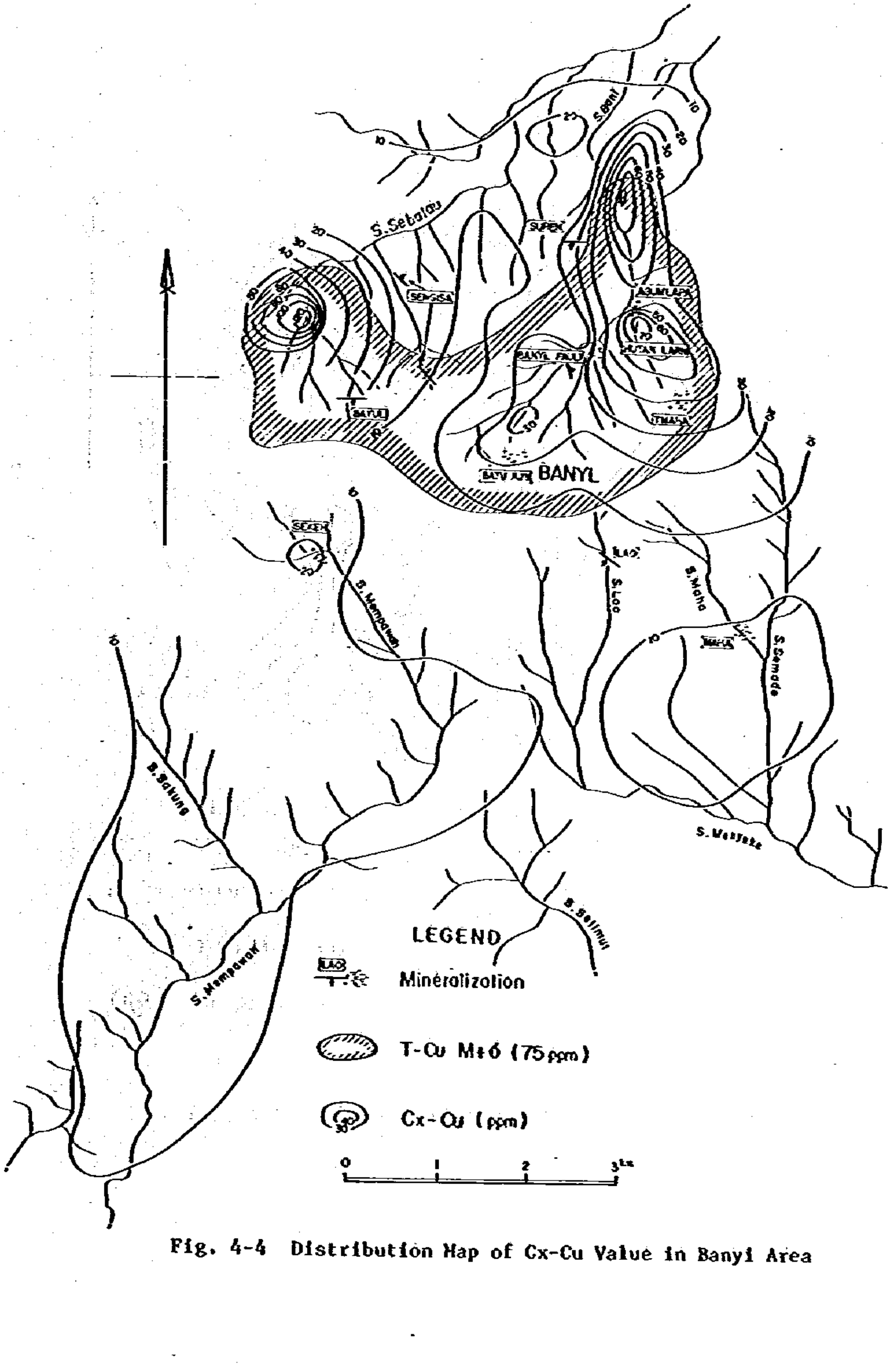


Fig. 4-4 Distribution Map of Cx-Cu Value in Banyi Area

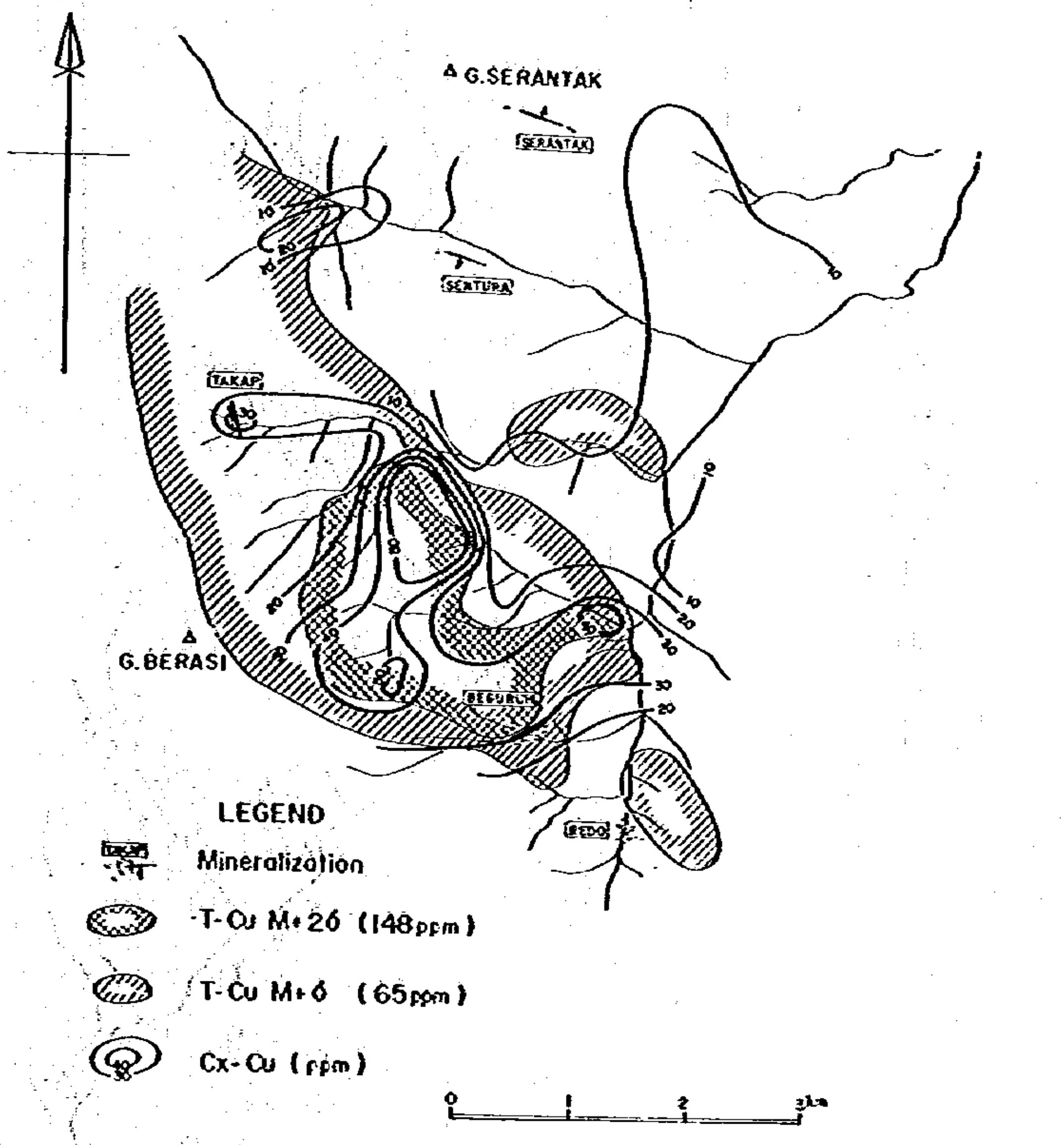


Fig. 4-5 Distribution Map of Cx-Cu in Serantak-Berasi Area

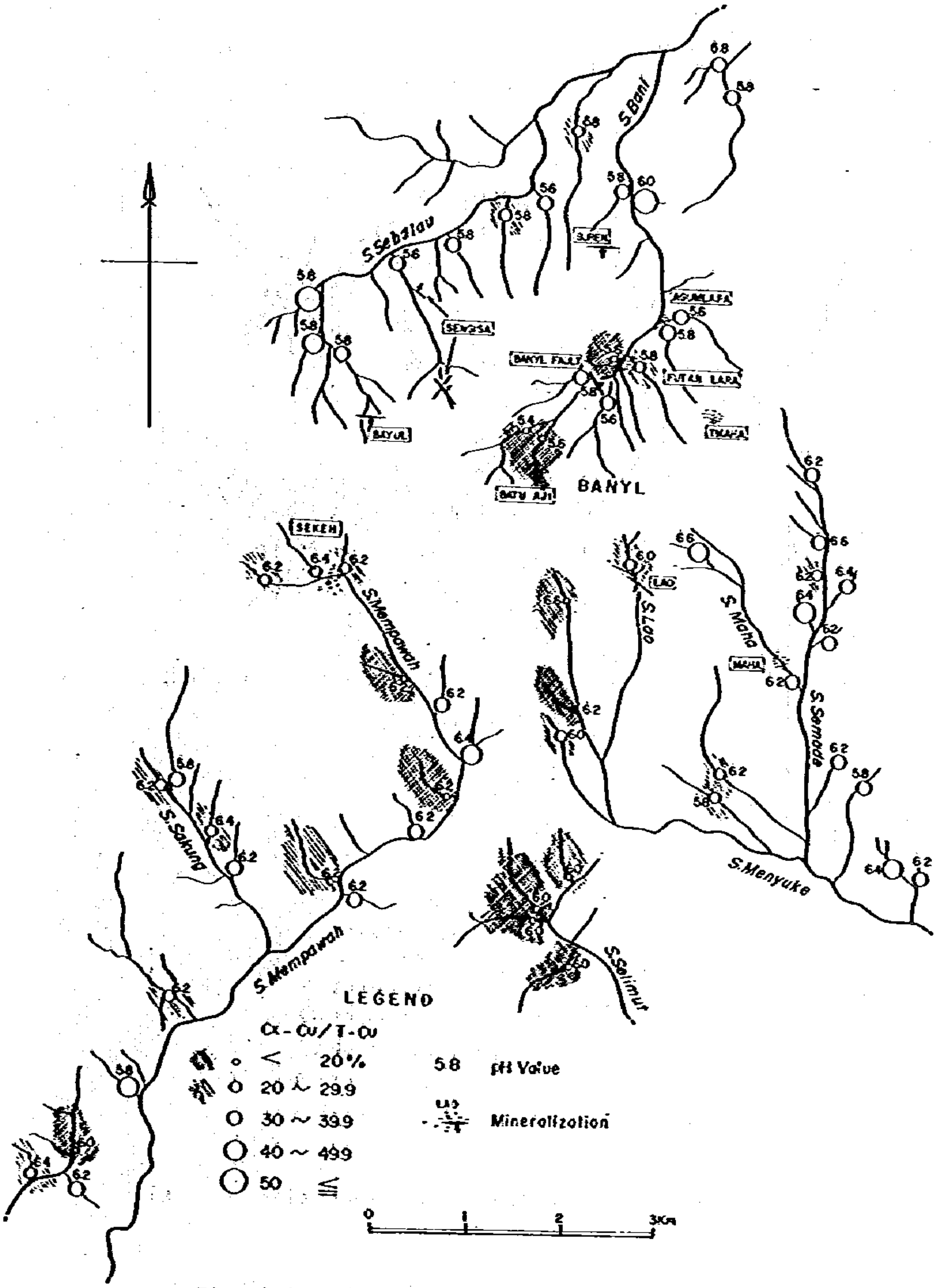


Fig. 4-6 Relation Map of Cx-Cu/T-Cu in Banyi Area

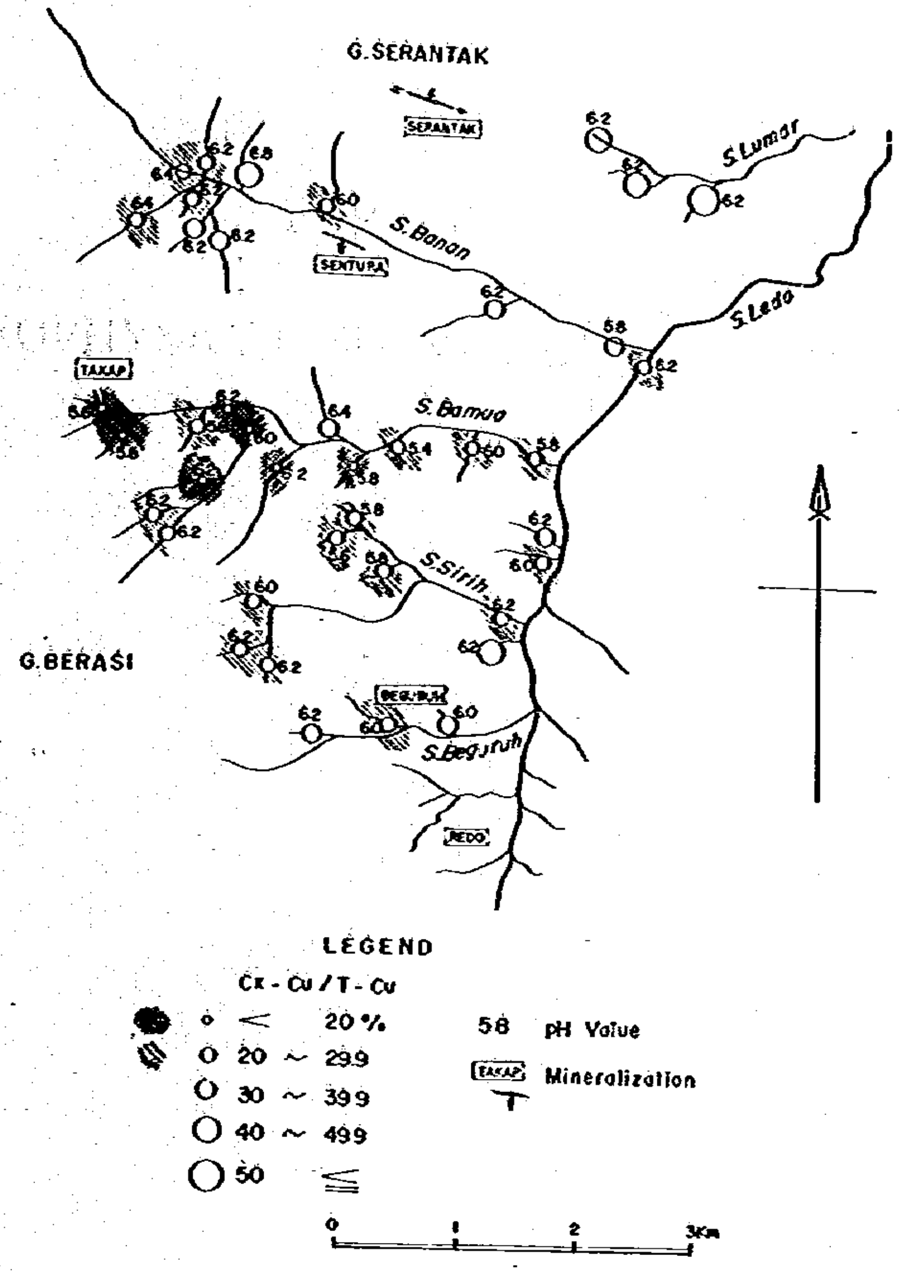


Fig. 4-7 Relation Map of Cx-Cu/T-Cu in Serantak-Berasi Area

PART V

GEOPHYSICAL SURVEY (IP METHOD)

CHAPTER I OUTLINE OF GEOPHYSICAL SURVEY

The IP (induced polarization) prospecting has been carried out in the Panji area, where was chosen as one of the most promising areas by the second phase geological survey. For the purpose of clarifying the lateral extent of the disseminated zone, the IP survey has been conducted in an area of 3.6 km^2, i.e. 1.8 km EW and 2 km NS, south of Old Panji Village. The survey network consists of 10 survey lines, 2 km-long in the NS direction and 200 m apart. The separation of the survey stations is 100 m. The IP measurements have been made by means of the dipole-dipole configuration with electrode separation coefficients of n = 1, 2 and 3.

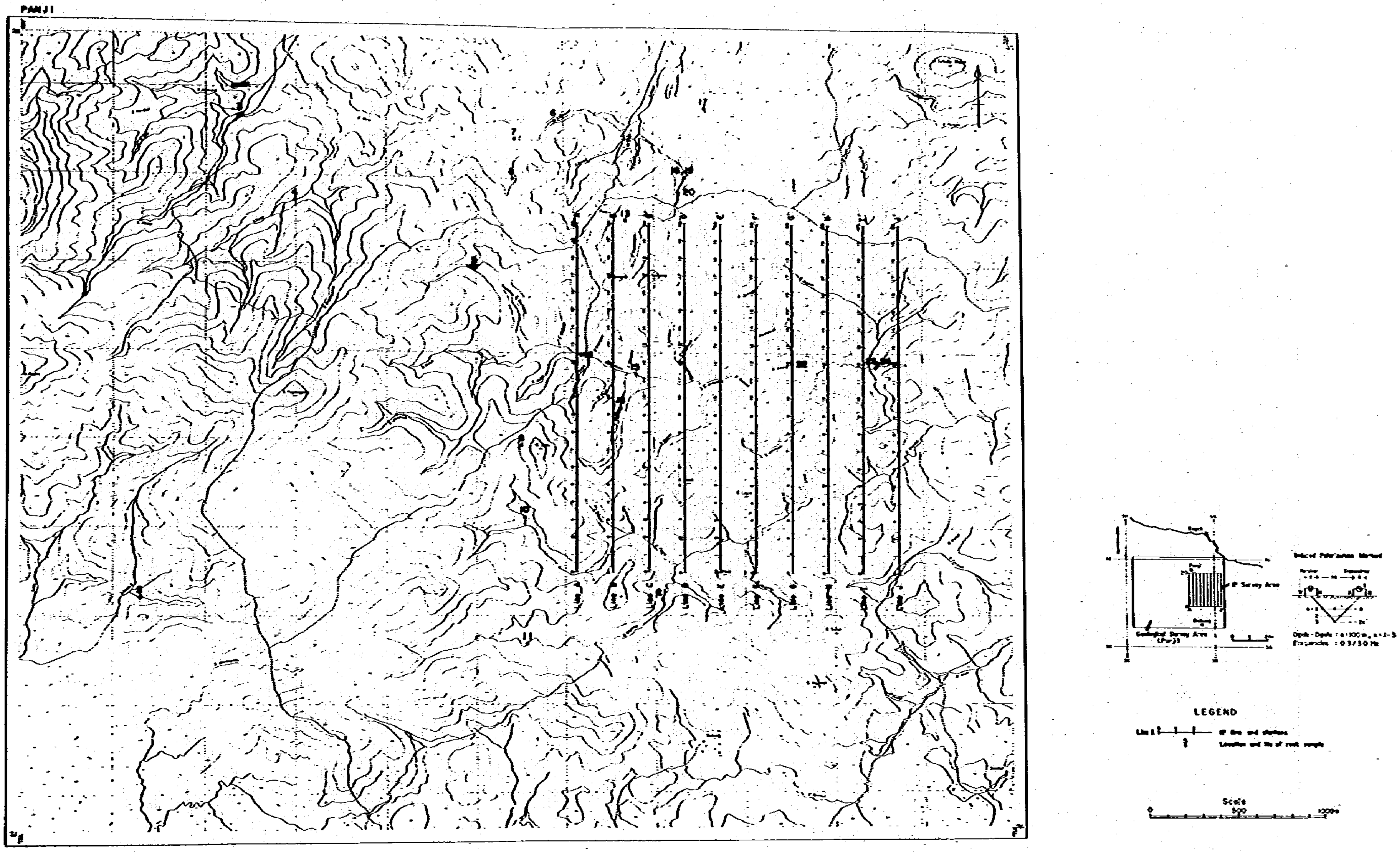


Fig. 5-1 IP Lines and Locations of Rock Samples

2-1 Principles of Measurement

The IP method is one of the most effective direct prospecting methods. It is applicable to metal mines, especially to sulfide ore deposits. The principle of this method is based on the physical fact that the electrical polarization phenomenon is induced in metal ore deposits by the electric currents sent into the ground. The principle of the dipole-dipole electrode configuration is shown schematically in Fig. 5-2.

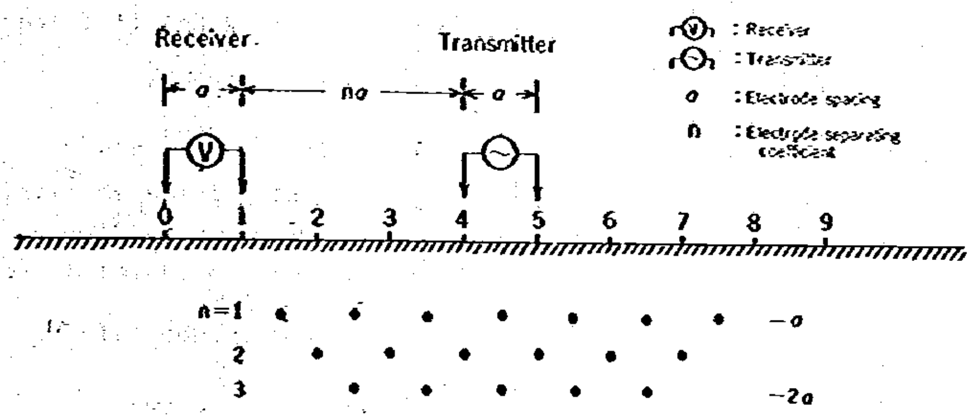


Fig. 5-2 IP Measurements of Dipole-Dipole Configuration

2-2 Definitions of Measured Value

(1) Frequency Effect (FE)

Frequency effect is defined by the following formula:

$$FE = \frac{V_{0.3Hz} - V_{3Hz}}{V_{3Hz}} \times 100\ (\%)$$

$$= \frac{\rho_{0.3Hz} - \rho_{3Hz}}{\rho_{3Hz}} \times 100\ (\%) \quad .... \quad (1)$$

where $V_{0.3Hz}$ and V_{3Hz} are the voltages (unit : V) at frequencies of 0.3 Hz and 3 Hz, respectively, and $\rho_{0.3Hz}$ and ρ_{3Hz} the apparent resistivities (unit : ohm-m) at frequencies of 0.3 Hz and 3 Hz, respectively.

(2) Apparent Resistivity (AR)

Apparent resistivity is defined by the following formulae:

$$\left.\begin{aligned} \rho_{0.3Hz} &= K \frac{V_{0.3Hz}}{I} \text{ (ohm-m)} \\ \rho_{3Hz} &= K \frac{V_{3Hz}}{I} \text{ (ohm-m)} \end{aligned}\right\} \qquad \cdots\cdots\cdots\cdots\cdots\cdots \text{(2)}$$

In the above formulae, I is the output current of a transmitter (unit : A) and K the electrode configuration factor given by

$$K = n(n + 1)(n + 2)\pi a$$

where n is the elctrode separation coefficient and a the electrode spacing (unit : m).

(3) Metal Conduction Factor (MF)

Metal conduction factor is defined as

$$MF = \frac{FE}{\rho} \times 1{,}000 \quad \cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots\cdots \text{(3)}$$

2-3 Rock Specimen Test

The measurement of physical properties of rock specimens which are sampled in the survey area provides us with important information for the interpretation of the field IP results. Fig. 5-3 shows a block diagram of the measuring apparatus.

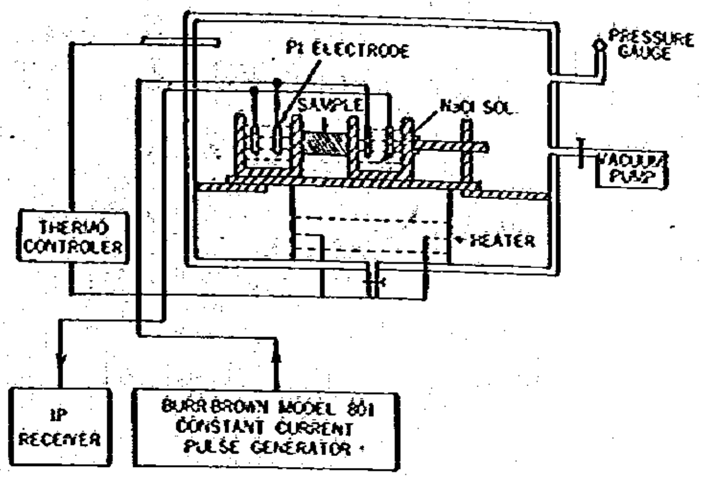


Fig. 5-3 A Block Diagram of the Laboratry Measuring Apparatus

2-4 Method of Analysis

The IP data are analyzed by two methods: qualitative analysis and quantitative analysis. The outlines of geological structure and the distribution of mineralized zones are comprehensively considered by the qualitative analysis of IP data on the basis of cross sections and plan maps. As a result, the boundary of rock and its lateral and vertical extent are qualitatively estimated. The quantitative analysis is a computer simulation for determining geological structure. Assuming model structures based on the field data, computations are repeatedly made to determine an optimum model by comparing with the field data. Such trial-and-error procedures obtain finally the dimension and depth of the anomaly, which represents the mineralized bodies.

Fig. 5-4 is a flow chart of the IP data processing and analysis.

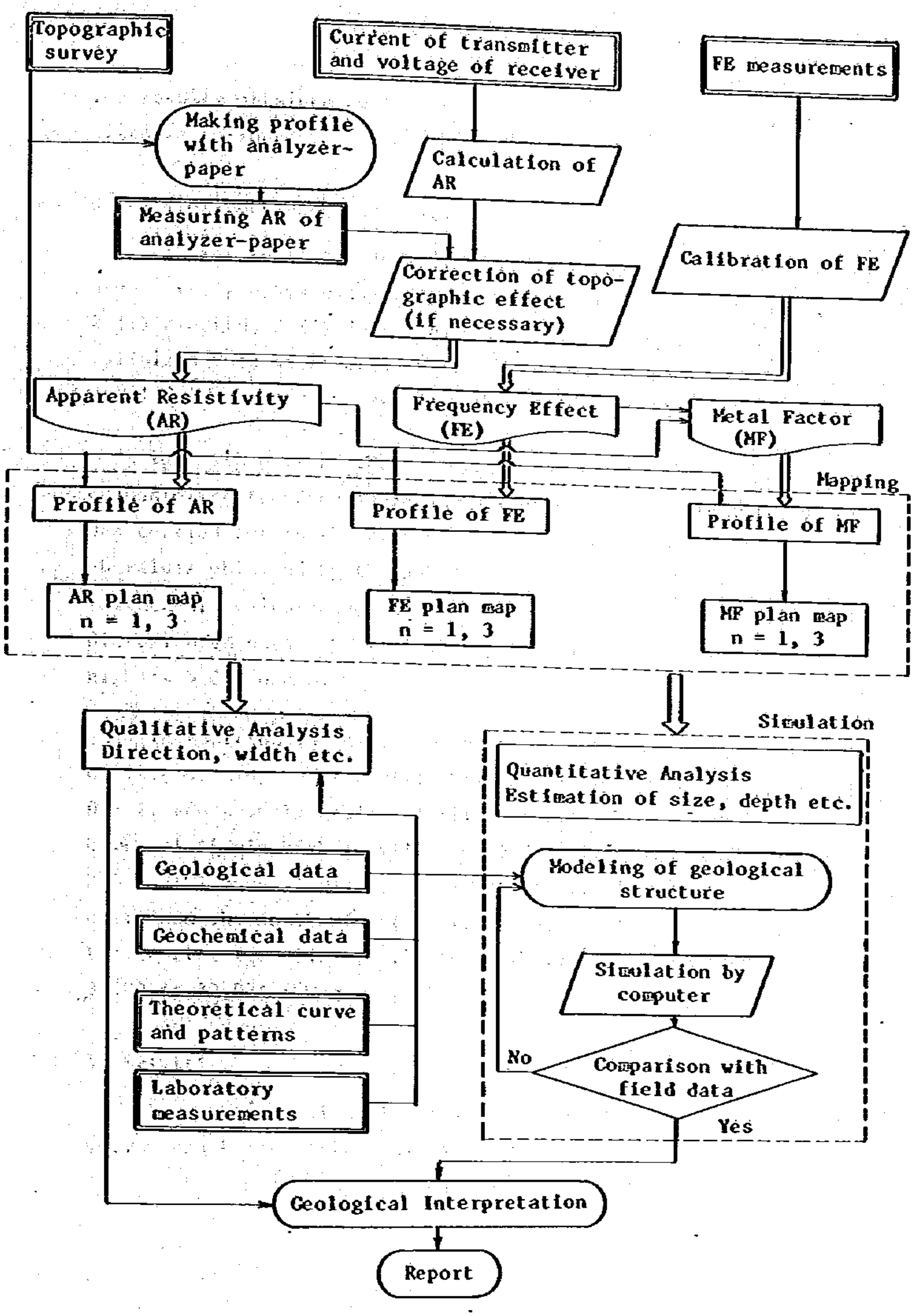


Fig 5 — 4 Flow Chart of IP Data Processing and Interpretation

CHAPTER 3 SURVEY RESULTS

The results obtained by the geophysical survey (IP method) are summarized as follows:

3-1 Results of Rock Specimen Tests

Laboratory tests are made to 24 rock specimens sampled in and around the geophysical survey area: i.e. 15 (4) granodiorite, 2 (1) diorite, 2 (1) dolerite, 1 dacite, 3 andesite and 1 tourmalinized rock specimens. Here ( ) denotes the number of specimens sampled in the survey area (see Fig. 5-1 and Table 5-1).

The main part of the geological survey area is occupied by granodiorite trending in the EW direction. The present IP survey was carried out in the east part of the geological survey area. The FE values obtained by the laboratory tests are estimated as 2 - 3% for non-disseminated specimens but higher than 6% for continuously disseminated ones. Most of the specimens have resistivities as high as 5,000 ohm-m.

In addition to the granodiorite systems, there are small-scale diorite outcrops near Station C-12 and in the southern tips of Lines D - F, and a small-scale dolerite outcrop near Station A-12. They have relatively high FE values of 4.9 - 103% but low AR over of 256 - 2191 ohm-m. Dacite and andesite are distributed over the north and the south of the survey area, respectively. They have low FEs ranging from 1.1 to 3.7% but high resistivities ranging from 3,500 to 30,924 ohm-m.

3-2 IP Results

The statistical analyses of the IP data obtained in the present survey can be summarized as follows:

Table 5-1 Results of Rock Sample Tests

No.	Rock Name	FE (%)	Mean	Resistivity (ohm-m)	Mean	Py (Cpy)(*)
1	Granodiorite	2.1		4,254		1
4	Granodiorite	4.0		2,632		1
5	Granodiorite	3.4		6,063		1
7	Granodiorite	6.5		5,099		1
8	Granodiorite	2.2		10,452		1
9	Granodiorite	2.4		5,580		1
11	Granodiorite	2.5		3,362		1
15	Granodiorite	4.0	3.35	5,753	4,789	3
16	Granodiorite	3.4		6,657		2
18	Granodiorite	0.9		6,875		2
19	Granodiorite	7.0		859		4
20	Granodiorite	1.5		5,992		1
21	Granodiorite	2.9		4,338		1
23	Granodiorite	3.6		1,863		2
24	Granodiorite	3.9		2,059		3
6	Diorite	4.9		2,191		1
22	Diorite	103.0		1,052		5
10	Dolerite	10.1		429		3
14	Dolerite	5.8		256		2
2	Dacite	1.1		30,924		1
3	Andesite	1.0		3,500		1
12	Andesite	3.1	2.60	10,087	9,045	1
17	Andesite	3.7		13,548		1
13	Tourmaline	0.0		1,216		1

(*) Pyrite Content

1. No pyrite grains.
2. 2 to 3 pyrite grains.
3. 5 to 6 pyrite grains.
4. Continuous pyrite grains.
5. Pyrite concentration.

The observed values of FE range from 1.8 to 6.8% and those of AR from 329 to 8,064 ohm-m. The histograms and the cumulative frequency distributions of the FE data and the AR ones are made. The criterion of "Anomaly", by which we can judge whether an observed value is anomalous or not, is determined by the cumulative frequency distributions. As a result, the values of FE > 6% and AR < 500 ohm-m are defined as "anomaly", and those of 5% < FE < 6% and 500 ohm-m < AR < 1,000 ohm-m are as "weak anomaly". The mean value of FE is 4.5%, and that of AR is 1,500 ohm-m (see Fig. 5-5).

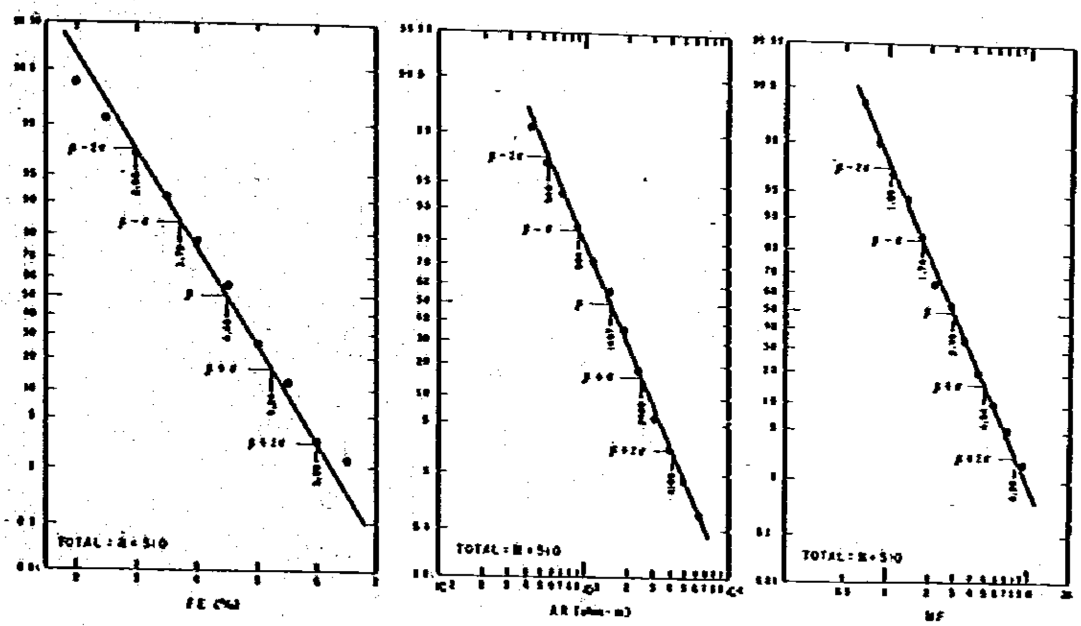
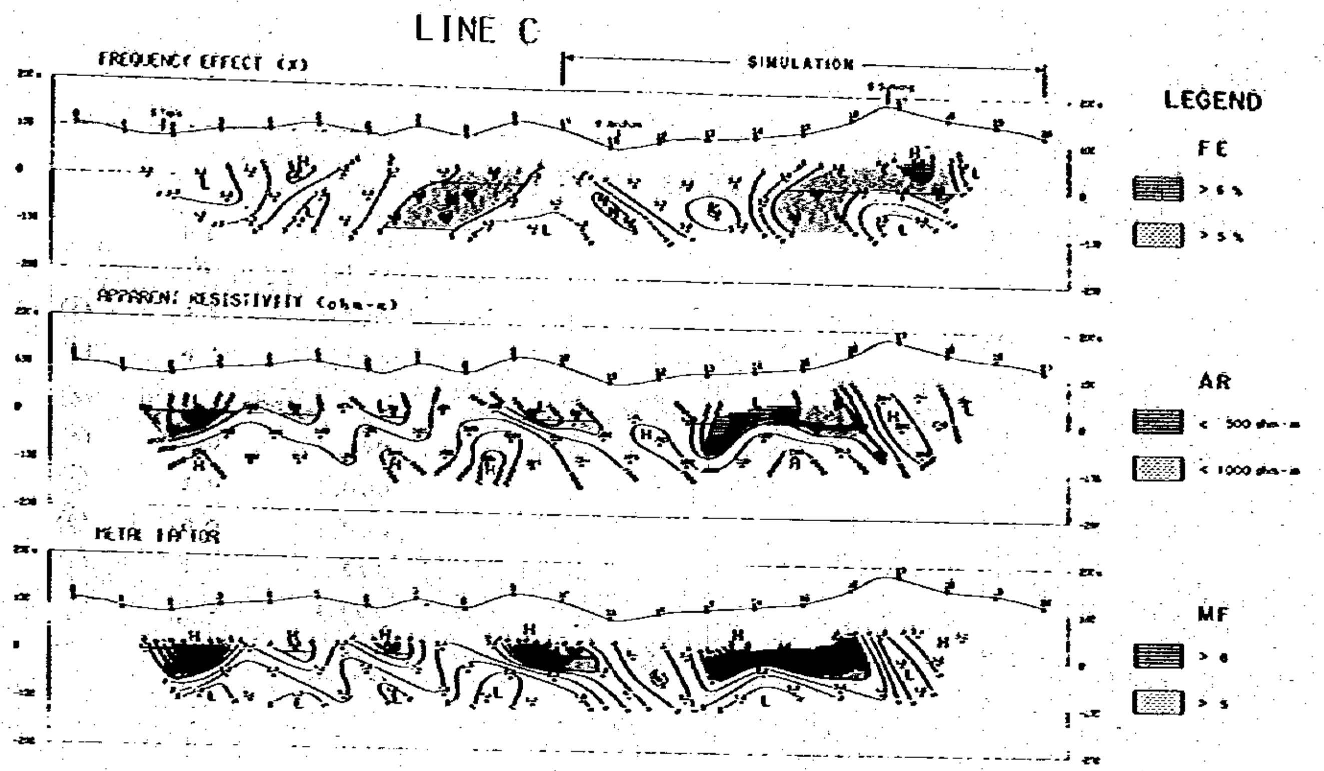


Fig. 5-5 Cumulative Frequency Distributions of FE, AR and MF

3-3 Distribution of Anomalies

Some typical anomalies are extracted from the IP plan maps and cross sections to undergo computer simulation tests. The size and depth of an anomaly source can be estimated by such simulation analyses (Figs. 5-6 and 5-7). The results thus computed are used for drawing up the quantitative-analyzing chart as shown in Fig. 5-8.



CODE	FE %	RESISTIVITY ohm-m
①	3.5	3,000
②	3.5	2,000
③	3.5	1,500
④	3.5	400
⑤	3.5	300
⑥	4.5	3,000
⑦	4.5	1,500
⑧	6.0	600
⑨	7.0	3,000
⑩	7.0	1,500

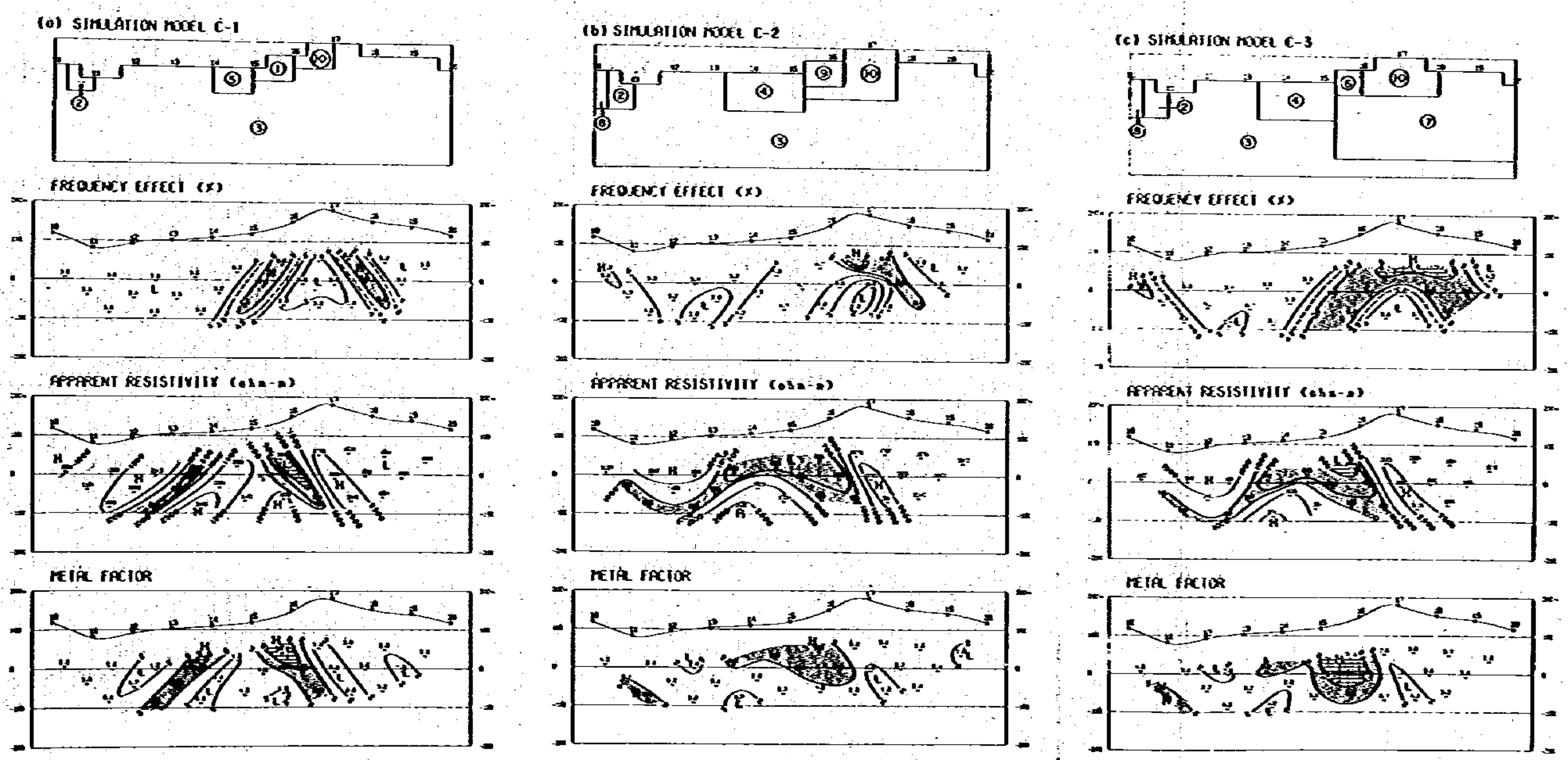
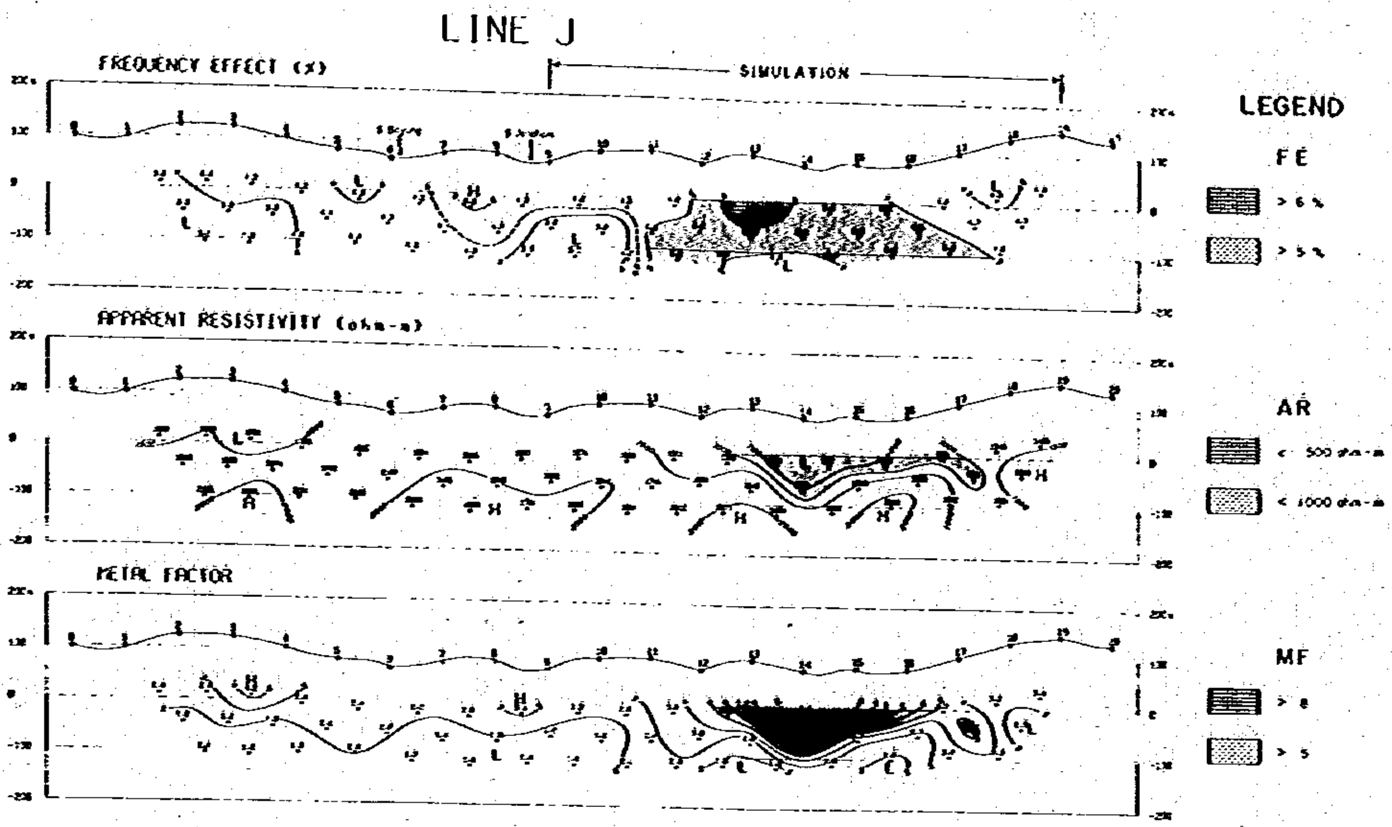


Fig 5 − 6 IP Pseudo-sections and Simulated Models for Line C



CODE	FE %	RESISTIVITY ohm-m
①	4.5	2,000
②	4.5	1,500
③	4.5	500
④	5.0	1,500
⑤	6.0	2,000
⑥	6.0	1,500
⑦	6.0	500
⑧	6.5	1,500
⑨	6.5	500

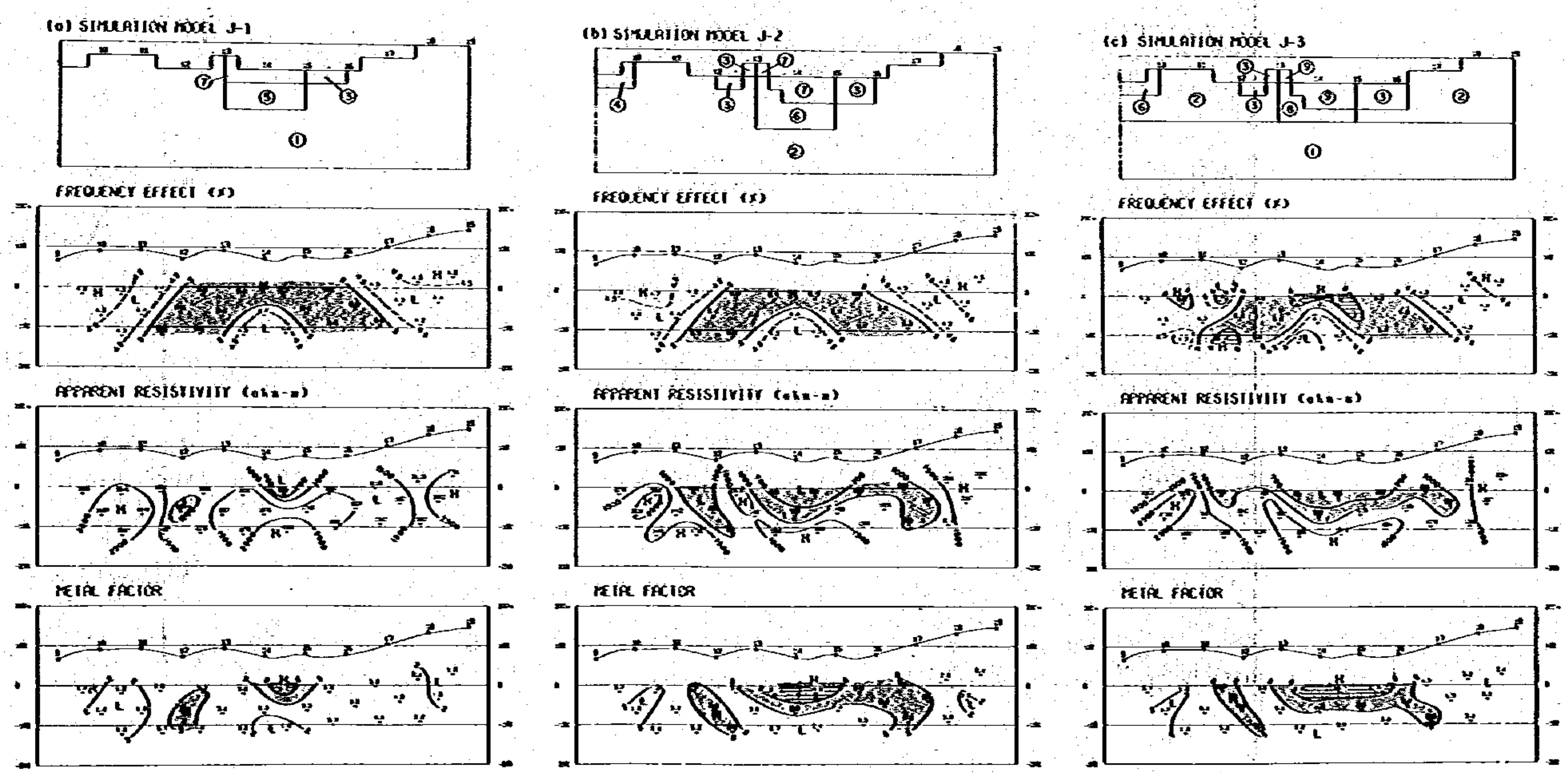


Fig 5 －7 IP Pseudo-sections and Simulated Models for Line J

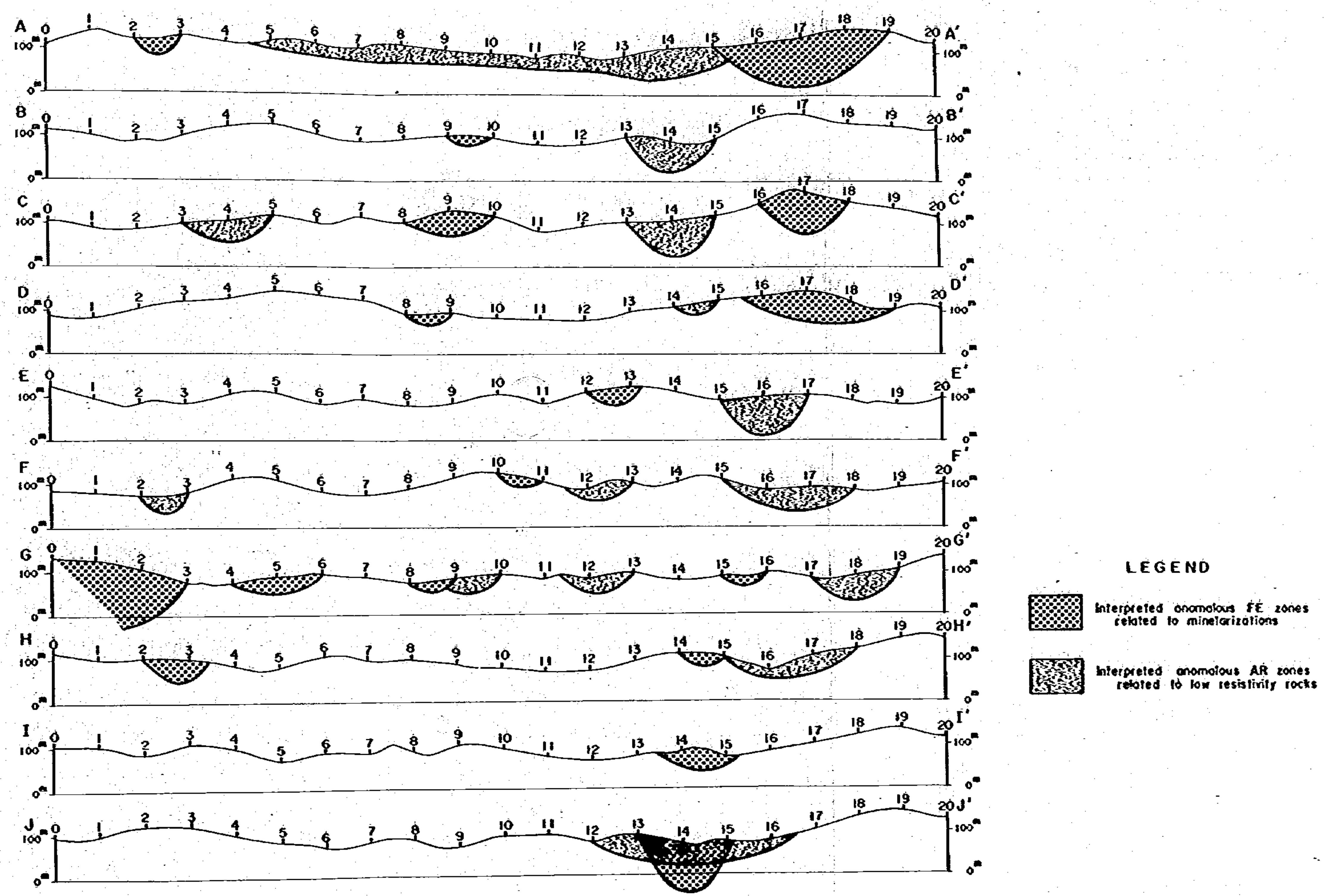


Fig 5 — 8 Results of Quantitative Analysis of IP Anomalies

The best-fitting models of the observed FE and AR on Lines C and J are determined by the simulation tests. It is verified, as a result, that the anomalies correspond to a FE higher than 6% and an AR lower than 500 ohm-m on the best-fitting models.

In order to make a comprehensive interpretation of the IP results of quantitative analyses, bird's-eye views of (a) the total FE distribution for a electrode separation coefficient of n = 1, (b) the distribution of FE larger than its mean value and (c) the distribution of FE larger than the weak anomaly standard are given in Fig. 5-9 (a), (b) and (c) respectively.

3-4 Consideration of Mineralization

In order to clarify the relation between the obtained IP results and the distribution of mineralizations, the IP results are compared with the geological and geochemical data. Fig. 5-10 is a comprehensive map, in which the IP anomalies are illustrated together with the geological and geochemical survey results. In this map, the FE anomalies are represented in distinction from the AR anomalies.

(1) FE Anomalies

The FE anomalies, which are denoted by M-1 ∿ M-7 in the map, are related with the mineralization. The depth of the anomaly sources is estimated to be shallower than 100 m below the ground surface.

The FE anomalies coincide with the copper anomalies obtained by the geochemical survey; such as M-1 (northern part of Lines C and D), M-3 (northern part of Lines G - J) and M-4 (central part of Lines B - D). They may be evidences for the chalcopyrite dissemination. On the other hand, some of the marked FE anomalies do not coincide with geochemical copper anomalies, for example, M-1 (northern part of Line A), east end of M-3 (on Line J) and southern part of M-6 (south end of Lines G and H). They are presumably caused by the pyrite dissemination.

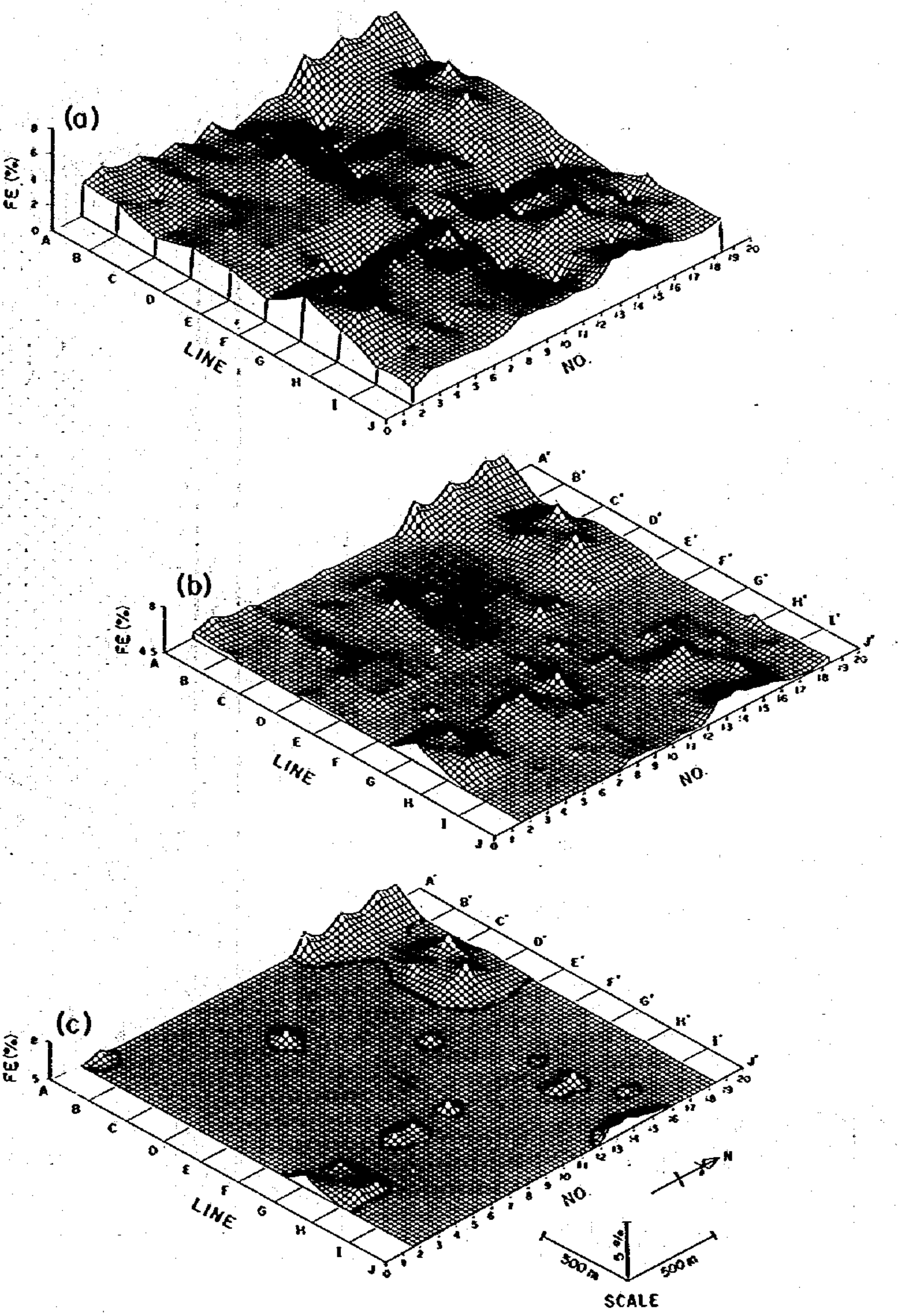
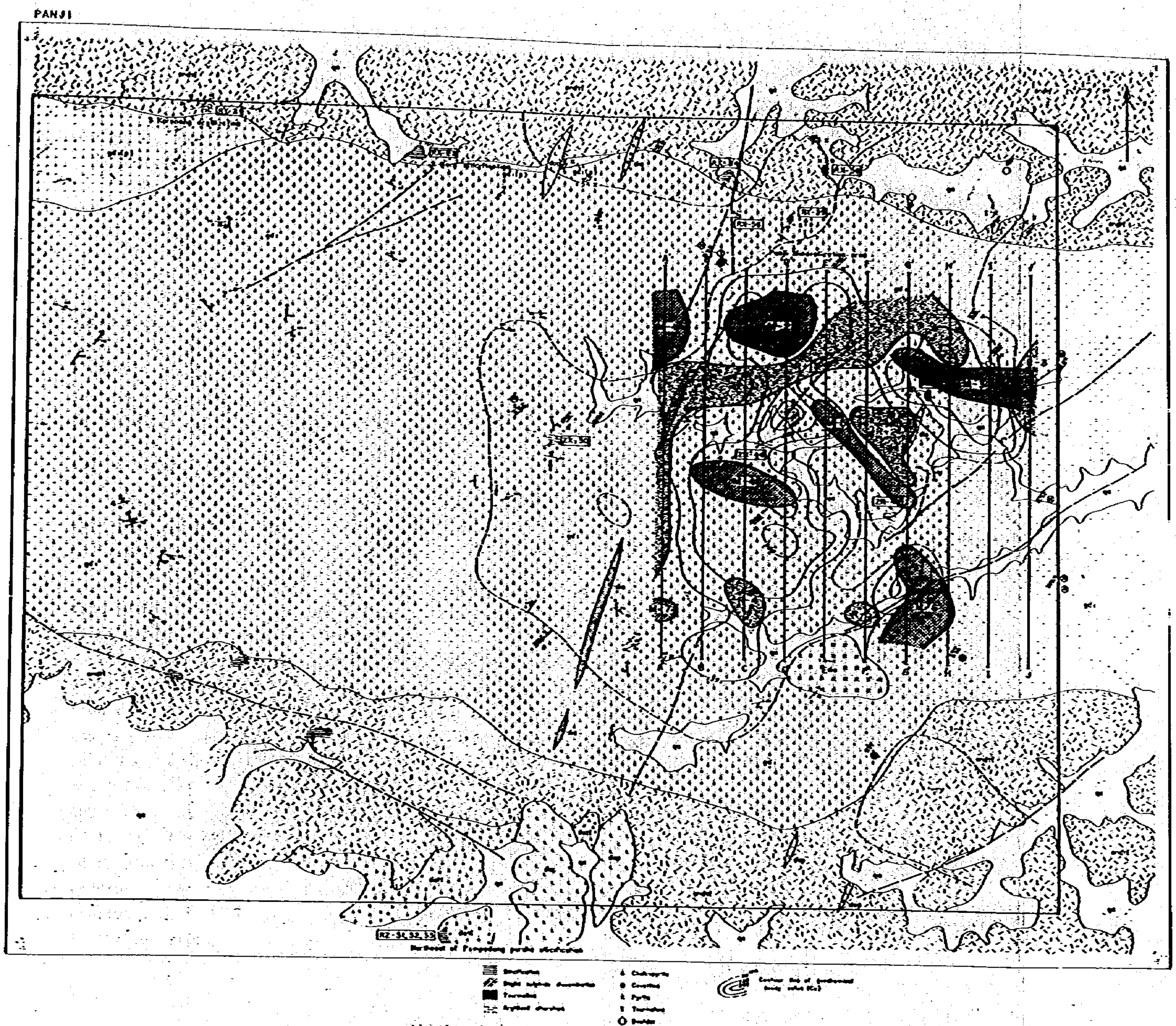
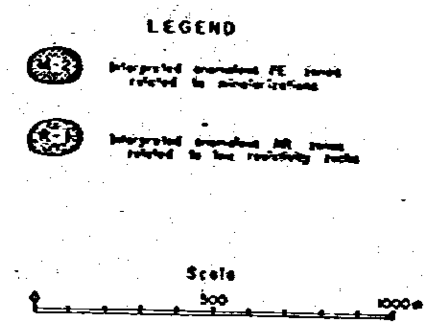


Fig 5 — 9 Bird's-eye View of FE Values for n=1
(a) FE>1.8%, (b) FE>4.5%, (c) FE 5.0%





[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	<0.1	0.4	0.30	0.03	–	–	[illegible]
	[illegible]	[illegible]	0.2	< 2	0.06	<0.01	[illegible]	[illegible]	–
	[illegible]	[illegible]	<0.1	0.4	0.015				
[illegible]	[illegible]	[illegible]	[illegible]	0.2	<0.001				
[illegible]	[illegible]	[illegible]	<0.1	0.6					
	[illegible]	[illegible]	<0.1	0.2					
	[illegible]	[illegible]	<0.1	<0.1					
[illegible]	[illegible]	[illegible]	<0.1	<0.1					

[illegible]

Fig. 5-10 Map of Relations between Geological-Geochemical Results and IP Results

The FE anomalies M-1, M-2 and M-3 are linearly arranged in the WNW-ESE direction. Their extension is parallel to the geochemical copper anomaly zone.

(2) AR Anomalies

The AR anomalies are represented as R-1 ∿ R-5 in the map. They are presumed to be caused by low resistivity layers. One of the most marked AR anomalies in the survey area is R-1 Anomaly, which trends in the WSW-ENE direction with a width of about 200 m across Lines A - H. The location of this anomaly neither coincides with that of the FE anomaly nor that of the geochemical copper anomaly. This may indicate that the R-1 anomaly does not correspond to a low resistivity zone related with mineralization.

(3) Mineralization Zones

The FE anomalies M-1, M-2 and M-3 are linearly arranged in parallel with the trend of the geochemical copper anomalies as mentioned above.

Such a parallelism may be caused by a simultaneous mineralization in the Panji area. Judging from the above, these three anomalies indicate probably mineralized zones. Especially, the M-2 anomaly is one of the most outstanding FE anomalies. This is located at the geochemically anomalous area near the Old Panji mineralization zone actually confirmed by the geological survey. These facts may show that the M-2 anomaly is one of the most promising anomalies in the survey area. The computer simulation analysis of this anomaly concludes that the related mineralized zone of 7% FE has a length of 400 m trending in the EW direction, a width of 200 m and thickness of 100 m. Its depth is very shallow. Such a value of FE is obtained by continuously pyrite/chalcopyrite disseminated specimens according to the rock specimen tests. On the above basis, it can be concluded that the M-2 anomaly corresponds to a disseminated zone in the superficial part of granodiorite.

PART VI

PHOTOGEOLOGICAL INTERPRETATION

CHAPTER 1 INTERPRETATION PROCEDURE

1-1 Outline

Photogeological interpretation was performed in order to interpret outline of geology and structural geology in the whole survey area (1,500 Km^2). Airphotographs on approximately 1/50,000 scale, covering the whole survey area, were interpreted and the result was compiled on topographic maps on 1/100,000 scale.

As a result of interpretation and study of already available geological information, geology of the area was divided into 16 units consisting of Mesozoic and Cenozoic sedimentary rocks, pyroclastic rocks, granitic rocks, quartz porphyry, and dacite.

Large scale fold and fault features were not apparent from the airphotographs. But many lineaments, which are supposed to be due to small scale faults, joints, and strike and dip of sedimentary rocks have been observed. Predominant lineaments trending NNW-SSE in G_2, D_1 and D_2 geological units were interpreted as fault lines.

1-2 Airphotographs

List of airphotographs used in the interpretation work is shown in Table 6-1.

These airphotographs were taken for the "Badan Koordinasi Survei Dan Pemetaan Nasional" project by Indonesian Government during the period from 1969 to 1971, and were prepared by Directorate of Mineral Resources.

Run Number	Photo Number	Sheets	Direction
430	19 ~ 20	2	E - W
4265	20 ~ 26	7	"
"	154 ~ 160	7	"
"	185 ~ 190	6	"
4271	0022 ~ 0032	11	"
"	0045 ~ 0055	11	"
"	0092 ~ 0103	12	"
"	161 ~ 170	10	"
4283	110 ~ 112	3	"
4286	11 ~ 13	3	"
4294	148 ~ 157	10	"
"	171 ~ 176	6	"
"	230 ~ 236	7	"
196	49 ~ 54	6	NE - SW
Total		101	

6-1 List of Airphotograph

1-3 Interpretation Procedure

Geological and geomorphological features such as drainage pattern, density, texture, resistance (relief energy and errosion), valley section, ridge pattern lineaments, geological boundaries, and strike and dip of bedding were noted. These features were drawn directly on the overlay of each photograph so that an interpreted chart was prepared. Classification of lithostratigraphic units and analysis of geological structure was thus obtained.

Results of interpretation were compiled on a 1/50,000 topographic map, reduced and used in the preparation of a photogeological map on 1/100,000 scale. The work was performed jointly by members of both Indonesian and Japanese team.

The photogeological map was prepared using supplementary geological data, kept by the Directorate of Mineral Resources, in order to clarify obscure boundary of each unit.

CHAPTER 2 INTERPRETATION

2-1 Geological Unit

2-1-1 Sedimentary Rocks

(1) Unit S_1

This unit is distributed around G. Mahmud in the northeastern part of the survey area. Its photographic characteristics are gray tone, and fine texture. It is topographically characterized by strong resistance to erosion, steep hills and parallel drainage. NW-SE lineaments predominate. It is covered by high and dense tree vegetation. Accordingly, it is identified as sedimentary rocks. The unit was regarded as hornfels in an old geological map.

(2) Unit S_2

This unit is widely distributed in northern part of the survey area. It is topographically characterized by high density and fine dendritic drainage, very weak resistance to erosion, and low ridges. Lineaments infered to be due to bedding are locally visible. Accordingly, it is identified as sedimentary rocks. This unit corresponds to the upper Triassic sedimentary rocks of the old geological map.

(3) Unit S_3

This unit occurs as a zone in the northern part of the survey area. Its photographic characteristics are gray tone and smooth texture. It is topographically characterized by medium dense, subparallel drainage, medium resistance to erosion, slightly elevated ridges, and a sharp cliff at the boundary with Unit S_2. Though this unit is regarded as the same group of Triassic sedimentary rocks, it is distinguished from Unit S_2 by different features of erosion resistance and profile of mountains.

Table 6 - 2 PHOTO - GEOLOGICAL INTERPRETATION CHART

UNIT	PHOTO CHARACT		TOPOGRAPHIC CHARACTERISTICS									VEGETATION	LITHOLOGY
			DRAINAGE			RESISTIVITY		LINEAMENT					
								FAULT JOINT					
	TONE	TEXTURE	PATTERN		DENSITY	ROCK	CROSS SEC	DIRECTION	INTENSITY	KINDS	BEDDING		
Q	light	smooth	meander		rare	very weak						large along stream	sand., gravel
S_8	gray	smooth	meander		rare	very weak					poor	large patchy	fine sedimentary rock
S_7	gray	fine smooth	dendritic		coarse	moderate					clear	small dence	sedimentary rock
S_6	light gray	fine	dendritic		dence	weak					clear	along stream	〃
S_5	gray	fine	dendritic		dence	weak					vague	patchy	〃 (silt, pyroclasitic rock)
S_4	gray	fine	dendritic		medium coarse	moderate weak					vague	patchy	〃 〃
S_3	gray	smooth	sub-parallel		medium dence	moderate		rare	medium	fault joint	clear	small	〃 (sandstne)
S_2	darkgray	rough	dendritic		dence	veryhigh		rare	medium	fault joint	clear	small	〃 (fine sandstone, silt)
S_1	darkgray	fine	parallel		rare	veryhigh		many	strong	fault joint	vague	dence	〃 (hornfels)
A_2	light	smooth rough	parallel sub-parallel		medium dence	moderate		rare	weak	fault	vague	small	pyroclastic rock
A_1	dark gray	rough	dendritic		coarse	high		mainly l	strong	fault		dence	andesite rock
D_2	gray dark gray	rough	dendritic / radial		coarse	veryhigh		many	strong	fault joint		large dence	dacite quartz porphyry
D_1	gray	rough	radial		coarse	very high		many	strong	fault		large dence	〃 〃
G_3	gray		radial		coarse	high		rare	weak	joint		small	granitic rock
G_2	dark gray	rough	dendritic		coarse	very high		many	strong	fault joint		dence	〃
G_1	dark gray	rough	dendritic		dence	weak		many	strong	fault joint		large dence	〃

(4) Unit S_4

This unit is distributed around Kampung Darit in central part of the survey area. Its photographic characteristics are gray tone and fine texture. It is topographically characterized by coarse, dendritic drainage, low resistance to erosion, low mountain relief and round-shaped ridges. Lineament suggesting strike of bedding is locally present, though it is unclear. On the basis of the topographic features, this unit is infered to consist of pyroclastic rocks, despite the fact that this rock was regarded as quartz porphyry in the previous geological map, which included it in the Unit D_1 quartz porphyry.

(5) Unit S_5

The unit is distributed around Sungai Data in the central eastern part of the whole survey area. It is characterized by weak resistance to erosion, and dense dendritic drainage. Mountain relief is not high, but mountain profile shows comparatively sharp ridges. Lineaments which are probably due to bedding, are locally observable. This unit is interpreted as consisting of pyroclastic rocks. It is separated from Unit S_4, based on different of photographic characteristics. According to previous data, this formation is quartz porphyry.

(6) Unit S_6

The unit is distributed around Kampung Negare in eastern part of the survey area. Its photo-characteristics are gray tone and fine texture. It is topographically characterized by weak resistance to erosion, dendritic drainage, low relief and gentle ridges. Ridge topography is sometimes flat. Lineament due to bedding is recognizable. On the basis of the above facts, the unit is considered to consist of sedimentary rocks. Considering the difference of features, this unit is separated from S_7. Previous reports indicate that this unit is a Triassic Formation.