REPORT
ON
THE COOPERATIVE MINERAL EXPLORATION
IN
THE CENTRAL SABAH AREA
MALAYSIA

(PHASE III)

MARCH 1997

JAPAN INTERNATIONAL COOPERATION AGENCY

METAL MINING AGENCY OF JAPAN

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PREFACE

In response to the request of the Government of Malaysia, the Japanese Government agreed to conduct a Mineral Exploration Project in the Sabah area and entrusted the project to the Japan International Cooperation Agency (JICA) and the Metal Mining Agency of Japan (MMAJ).

The JICA and MMAJ sent to Malaysia a survey team headed by Mr. Masatsugu Okazaki from September 8, 1996 to December 25, 1996.

The team exchanged views with the officials concerned of the Government of Malaysia and conducted a field survey in the central Sabah area. After the team returned to Japan, further studies were made and the present report has been prepared. This report includes the survey results of drilling survey in PhaseⅢ.

We hope that this report will serve for the development of the mineral resources and contribute to the promotion of friendly relations between Japan and Malaysia.

We wish to express our deep appreciation to the officials concerned of the Government of Malaysia for their close cooperation extended to the team.

March, 1997.

Kimio Fujita
President
Japan International Cooperation Agency

Shozaburo Kiyotaki
President
Metal Mining Agency of Japan

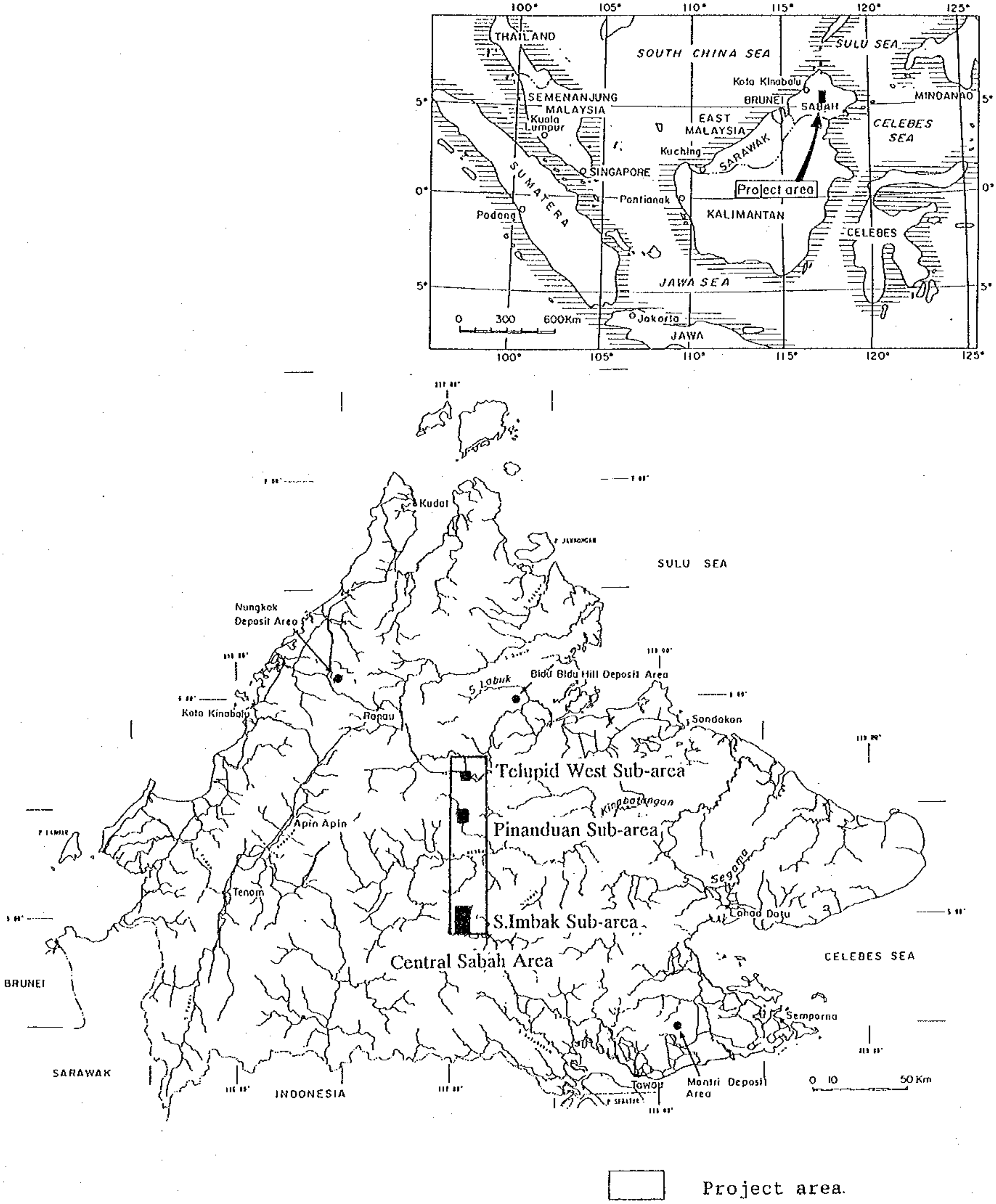


Fig. 1 Location map of the project area

ABSTRACT

The Government of Malaysia and the Government of Japan agreed a three-year mineral exploration project, starting from 1994, in the central Sabah area. The Scope of Work for this project was signed by both governments on 1st September 1994. The objective of this project is to explore and to assess the mineral potential of the survey area. This report includes the survey results of the third year (Phase III).

Drilling survey of two holes, MJSI-6 and MJSI-7, in the S. Imbak Sub-area North for evaluation of mineral potential of the area.

Mudstone, sandstone, sandstone with mud lamina and diorite porphyry intruding these sedimentary rocks were intersected by two holes. The dips of the sedimentary rock observed in the drilling core is 10 to 30 degree and diorite porphyry, generally, intrudes sub-parallel to the structure of the sedimentary rocks. The geological information of the surface and drilling survey suggest a larger volume of diorite porphyry in the underground than previously expected.

Mineralization is more intense in MJSI-7 and in diorite porphyry than in MJSI-6 and in sedimentary rocks. Weak pyrite, pyrrohtite and rarely chalcopyrite dissemination prevail all through diorite porphyry. The intensity of dissemination increase in accordance with silicification and chloritization. The most conspicuous mineralization in two holes is found from 272.80 m to 288.35 m at MJSI-7 where network of thin (1 cm to 1 mm wide) pyrite - arsenopyrite - chalcopyrite veins occurs coupled with dissemination of pyrrhotite, pyrite and chalcopyrite. The samples of approximately 3 m span (from 275.15m to 278.00 m) within this zone show assay results of Au 1.6 g/t to 4.3 g/t, Ag 1.6 g/t to 17.7 g/t and Cu 0.04 % to 0.12%.Other than this, some of few cm wide, quartz - sulfide veins in sandstone close to diorite porphyry (Au 2.9 g/t and Ag 58.1g/t) and in diorite porphyry (Au 5.1 g/t and Ag 71.5 g/t) show high Au and Ag. As same as previous results, gold seems to be associated with arsenopyrite.

The evidences found in the drilling core such as common occurrence of chlorite - sericite assemblage and colloform texture of pyrite surrounding euhedral pyrite grains suggests that the location of MJSI-6 and MJSI-7 belong to a peripheral area of the main mineralization.

Considering the results of drilling survey together with geophysical survey, the most possible geological environment of the drilling site is the one found in peripheral zone of mineralization similar to porphyry copper type.

The main mineralization is expected to exist at the center of "C" shape geophysical anomaly and drilling survey is recommended at the center of "C" shape geophysical anomaly.

CONTENT

Part I General

Part II Survey Results

Part III Conclusions and recommendations

Part I General

Chapter 1 Introduction

1-1 Background and objectives

In accordance with the Scope of Work signed between the Government of Malaysia and the Government of Japan on 1st of September 1994, the mineral exploration project was started in the Central Sabah area in the state of Sabah, Malaysia. Based on the results of the Supra-regional survey in Sabah area conducted during a period of 1989 to 1993, the Central Sabah Area (Fig. 1) was selected as an area of the highest mineral potential in Sabah. This project is three years project starting from 1994 and this report includes the survey results of PhaseIII.

The results of Phase I and II surveys conducted in three sub-areas (Telupid West, Pinanduan and S. Imbak) of the Central Sabah area revealed that an Au and possible Cu mineralization in the S. Imbak Sub-area North has the highest potential. Therefore, the PhaseIII survey was conducted in the S. Imbak Sub-area North to explore and to assess the mineral potential.

The survey of PhaseIII consists of a drilling survey in the S. Imbak Sub-area North.

1-2 Coverage and outline of PhaseIII survey

The Central Sabah Area, with a rectangular shape (NS 90 km× WE 20 km) extending southward from Telupid, is located in the central part of the Sabah and in the southern part of the Labuk Area of the Supra-regional survey (Fig. I -1). The survey of the PhaseIII was conducted in S. Imbak Sub-area North (Fig. I -2). The amount and content of the work for PhaseIII survey are given in Table I -1 and Table I -2.

In the Phase I survey, semi-detail geological survey and geophysical survey were conducted in the S. Imbak Sub-area North (28 km^2) and soil geochemical survey was conducted in the S. Imbak Sub-area South (70 km^2). Based on the results of the Phase I survey, the Phase II survey was conducted in the smaller area of higher potential in both of the S. Imbak Sub-area North1(4.75 km^2) and South(45.50 km^2). During the Phase II survey, for detail understanding of geology and mineralization of the area and pursuing the IP anomaly obtained in the PhaseI survey further to the south, detail geological survey, geophysical survey and drilling survey were conducted in S. Imbak Sub-area North. While, in the S. Imbak Sub-area South, semi-detail geological survey was conducted for understanding the geology and mineralization of the area.

In the Phase III survey, an additional drilling work was conducted in the Sungai Imbak Sub-area North at the location of higher potential

The base camp was established along the timber road at the nearest point to the S. Imbak Sub-area and drilling operation was conducted making camp at the drilling site.

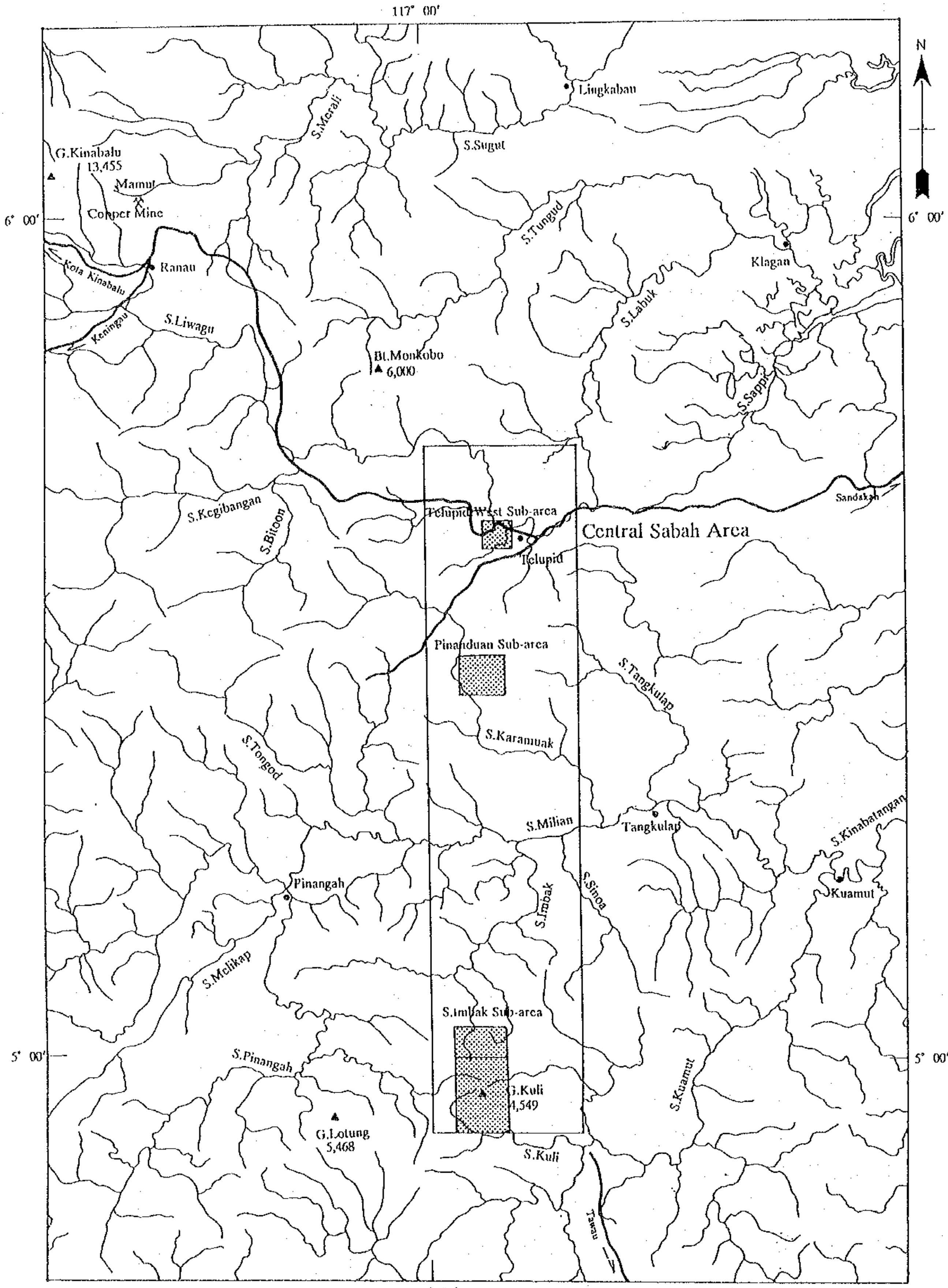


Fig. I -1 Location of the Central Sabah Area

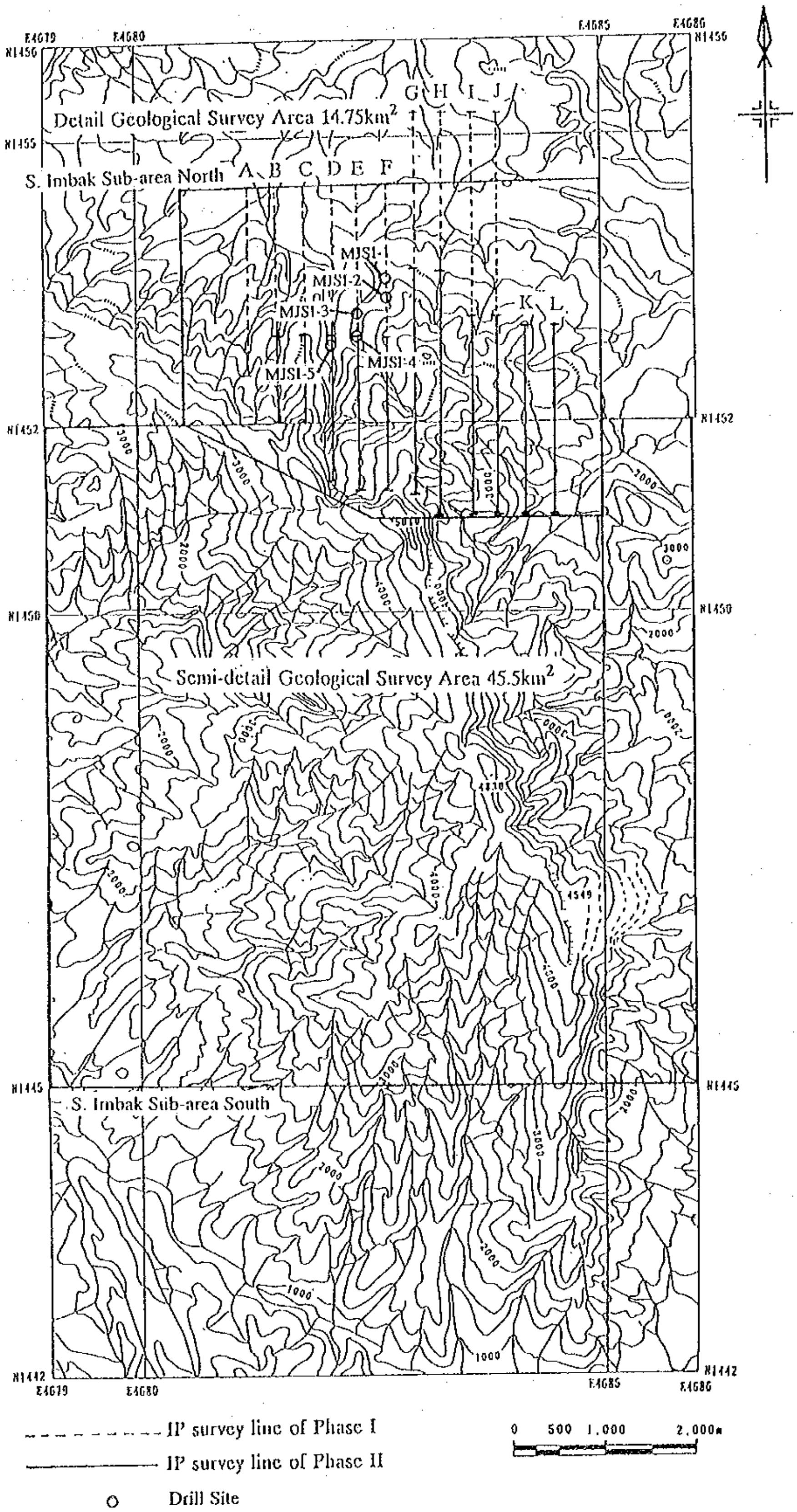


Fig. I -2 S. Imbak Sub-area

Table I -1 Amount of work

Content	Amount of Work
Drilling	(Hole No.) (Depth) MJSI-6 300.50 m Vertical MJSI-7 302.70 m Vertical

Table I -2 Work amounts of laboratory studies

Laboratory work	Amount
Drilling Survey	
1) Thin section	11 samples
2) Polished section	13 samples
3) X-ray diffraction analysis	22 samples
4) Chemical analysis	
Ore Assay (7 elements : Ag, Au, Cu, Mo, Pb, S, Zn)	51 samples

1-3 Member of the project

The members participated in the PhaseIII of the project are as followings:

(1) Inspection and arrangement of the Project

Eishi Endo	Metal Mining Agency of Japan
Naoki Sato	Manila office, Metal Mining Agency of Japan
Yoshiaki Igarashi	Metal Mining Agency of Japan

(2) Field survey

<u>Japanese Counterpart</u>

Masatsugu Okazaki	Team leader	Bishimetal Exploration Co., Ltd.
Junichi Yamagata	Drilling Survey	Bishimetal Exploration Co., Ltd.

<u>Malaysian Counterpart</u>

Alexander Yan	Deputy Director	Geological Survey of Malaysia
Joanes Muda	Geologist	Geological Survey of Malaysia
Salleh Adanan	Senior Assistant	Geological Survey of Malaysia

1-4 Survey period

The survey was conducted in Malaysia during the period shown below.

Drilling survey

Field Work	September 8, 1996	to	December 25, 1996
Interpretation Work	December 12, 1996	to	December 21, 1996

Chapter 2 Geography of the survey area

2-1 Location and access

Malaysia, a principal member of ASEAN countries, consists of Western Malaysia occupying the Malay Peninsular and East Malaysia occupying the northern and the northwestern parts of the Borneo island. The total population of West and East Malaysia is 18.0 millions. The area of the whole country is approximately 330,000 km².

The East Malaysia comprises the State of Sabah and State of Sarawak. The State of Sabah, occupying area of 73,700 km² in the northeastern part of the Borneo island, has population of approximately 1.393 millions. It is facing Kalimantan of Indonesia on the south, Sarawak on the southeast and surrounded by the sea such as South China, Sulu and Celebes, respectively, on the west, north and east.

The state capital is Kota Kinabalu on the west coast of Sabah. Direct flights from various cities, including outside of the country (Singapore, Hong Kong, Taiwan, Philippines, Japan) and domestic (Kuala Lumpure, Tawau, Sandakan) connecting the Kota Kinabalu International Airport make an easy access to the state of Sabah. The principal roads of shielded run connecting major cities such as Kota Kinabalu–Ranau–Sandakan and Sandakan–Lahad Datu–Tawau.

The Central Sabah area, occupying 1,800 km²(NS 90 km, WE 20 km), extends southward from Telupid in the center of Sabah (Fig I –1). The major road connecting Kota Kinabalu and Sandakan runs northern part of the area. However, other than this, existing roads in the area are the one that goes toward southeast from Telupid connecting small villages and the another one, a timber road, that goes south from Telupid along the project area. The latter one is recently connected to the timber road that goes up northward from Tawau. There is no road within the area of the S. Imbak Sub–area.

2-2 Topography and drainage system

The state of Sabah is occupied by four characteristic topographic features. Steep, rugged mountains, trending in north to northeast, dominate in the western part of Sabah along the coast. Highland occupies the eastern area and volcanic mountains are found in the southern part. Flat plain occurs along rivers and their lower tributaries. Mt. Kinabalu, which is the highest mountain in the southeast Asia, rises up to 13,455 ft in western end of the Kinabalu area where being occupied by steep topography. Highland dominates in the Labuk and Segama areas. Swamps are found at the lower part of main rivers where they are extremely meandered. Highland dominates in the Semporna area except the young volcanic region with volcanic topography.

The main drainage systems in Sabah are S. Pegalan, Sungai Sugut, Sungai Labuk, Sungai

Kinabatangan, Sungai Segama, Sungai Tingkayu, Sungai Kalumpang, Sungai Kalabakan. Among these river systems, Sungai Pegalan flows into the South China Sea, Sungai Kalumpang and Kinabatangan flow down to the Celebes Sea and other river systems flow into the Sulu Sea in the east. These river systems generally form deep valley at the upper stream and extremely meandered at down stream. The river also forms swamp area at the mouth to the sea.

2–3 Climate and vegetation

The survey area is situated in the tropical monsoon region. Generally, it is northeastern monsoon during early November to March. While, northeastern monsoon starts in May and ends in August. Annual precipitation varies depending on the region from 1,500 mm to 4,000 mm. In the west cost area, rainy season correspond to the season of the southwestern monsoon, while the east coast has rainy season during northeastern monsoon. In recent years, these distinction of rainy season and dry season is not clear. Temperature is 22 C° to 33 C° throughout the year.

The maximum and minimum temperature for each month and monthly rainfall in Kota Kinabalu on the west coast, Sandakan on the east coast and Tawau on the south coast are shown in Table I–3. As shown in the table, the east coast has more rainfall than the west coast.

The north to central part of the Central Sabah area is mainly covered by secondary jungle, while, in the south part primary jungle remains in many places. The S. Imbak Sub–area, which is located at the south end of the Central Sabah area, is totally covered by primary jungle.

Table I -3 Statistics of temperature and rainfall

Month	Kota Kinabalu			Sandakan			Tawau		
	Temperature (℃)		Rainfall	Temperature (℃)		Rainfall	Temperature (℃)		Rainfall
	Max.	Min.	(mm)	Max.	Min.	(mm)	Max.	Min.	(mm)
January	30.5	22.4	95.1	29.7	24.2	398.2	31.4	22.2	161.4
February	31.6	22.5	61.6	30.5	23.6	229.9	31.9	22.3	132.4
March	31.8	22.8	47.1	31.0	23.8	120.0	32.4	22.6	107.7
April	32.5	23.4	137.5	32.2	23.8	87.5	32.6	22.8	101.3
May	32.5	23.9	287.9	32.5	24.3	110.8	32.8	23.5	113.6
June	31.7	23.3	248.7	32.8	23.6	209.3	32.3	23.0	185.5
July	31.6	23.0	257.2	32.4	23.5	214.5	31.6	22.7	226.3
August	31.7	23.3	263.4	32.9	23.5	183.6	31.3	22.6	217.7
September	31.8	23.2	315.8	32.3	23.5	241.2	31.7	22.5	196.9
October	32.0	23.5	292.9	31.8	23.6	271.9	31.9	22.8	188.1
November	31.4	23.2	314.6	31.2	24.0	324.8	32.4	23.1	174.0
December	31.3	22.7	149.7	29.8	24.4	453.0	32.4	22.4	135.3

Temperature: 1989 and 1990 Rainfall: average of last 10 years(1981 - 1990)

Chapter 3 Geology and economic geology of Sabah, Malaysia

3-1 General geology

Sabah is geologically complex resulting from active tectonism since Mesozoic. The geological members constituting Sabah are metamorphic rock of Crystalline Basement(Cb), Cretaceous to Eocene sedimentary rocks accompanied by basaltic eruption (K, KP), Eocene to middle Miocene sedimentary rocks characterized by flysch sediments (P1, P2, P3 and P4) and early Miocene to Pleistocene sedimentary rocks (N1, N2, N3, N4 and N5). The geological map (Yin, 1985) of Sabah including the survey area is shown in Fig.I-3.

The Crystalline Basement(Cb), consisting of schist, gneiss and amphibolite, is pre-Triassic rock and forms a basement in this area.

The Chert-Spilite Formation (KPSC) and the Sapulut Formation (KPCp) are the Cretaceous to Eocene rocks. The Chert-Spilite Formation consists of limestone, radiolaria chert, sandstone, conglomerate, spilite, volcanic breccia, agglomerate dolerite and pillow lava. Together with ultramafic rocks and gabbro (Ub), these rocks of the Chert-Spilite Formation are considered to be fragments of ophiolite sequence rocks, a part of the oceanic lithosphere of early Cretaceous age. The blocks of dismembered ophiolite, being scattered all over Sabah, are emplaced by complicated tectonic movement during the Oligocene to Miocene, and thrusted over Eocene to middle Miocene sedimentary rocks. The Sapulut Formation mainly consists of mudstone accumulated at the center of an oceanic trough.

The Paleocene to Oligocene sedimentary rocks are distributed in western and northern parts of Sabah and represented by the Trusmadi Formation and Crocker Formation. The former consists of weakly metamorphosed slate, phyllite and quartzite and the latter consists of flysch type sediments of sandstone and mudstone.

The Miocene to Pliocene sedimentary rocks occur in the south, north and southwest parts of Sabah. They are the Kalabakan Formation, Kalumpang Formation, Garinono Formation, Labang Formation, Ayer Formation and Kuamut Formation. The latter four formations of slump sediments consist of blocks of older rocks, such as chert, limestone, gabbro, sandstone and serpentinite in mud matrix. They are considered to be a chaotic formation of tectonic melange. The late Miocene sedimentary rocks are the Tanjong Formation and Sandakan Formation consisting of a sequence of sandstone and mudstone of shallow marine sediments.

Three main periods of igneous activities are found in Sabah. The earliest one is early Triassic intrusions of tonalite, granodiorite, trondhjemite and granite which are associated with the pre-Triassic basement rocks. The second period is the early Cretaceous igneous activity of ophiolite sequence rocks such as gabbro, dolerite and basalt. The third period occurred in Late Miocene to Quaternary times and

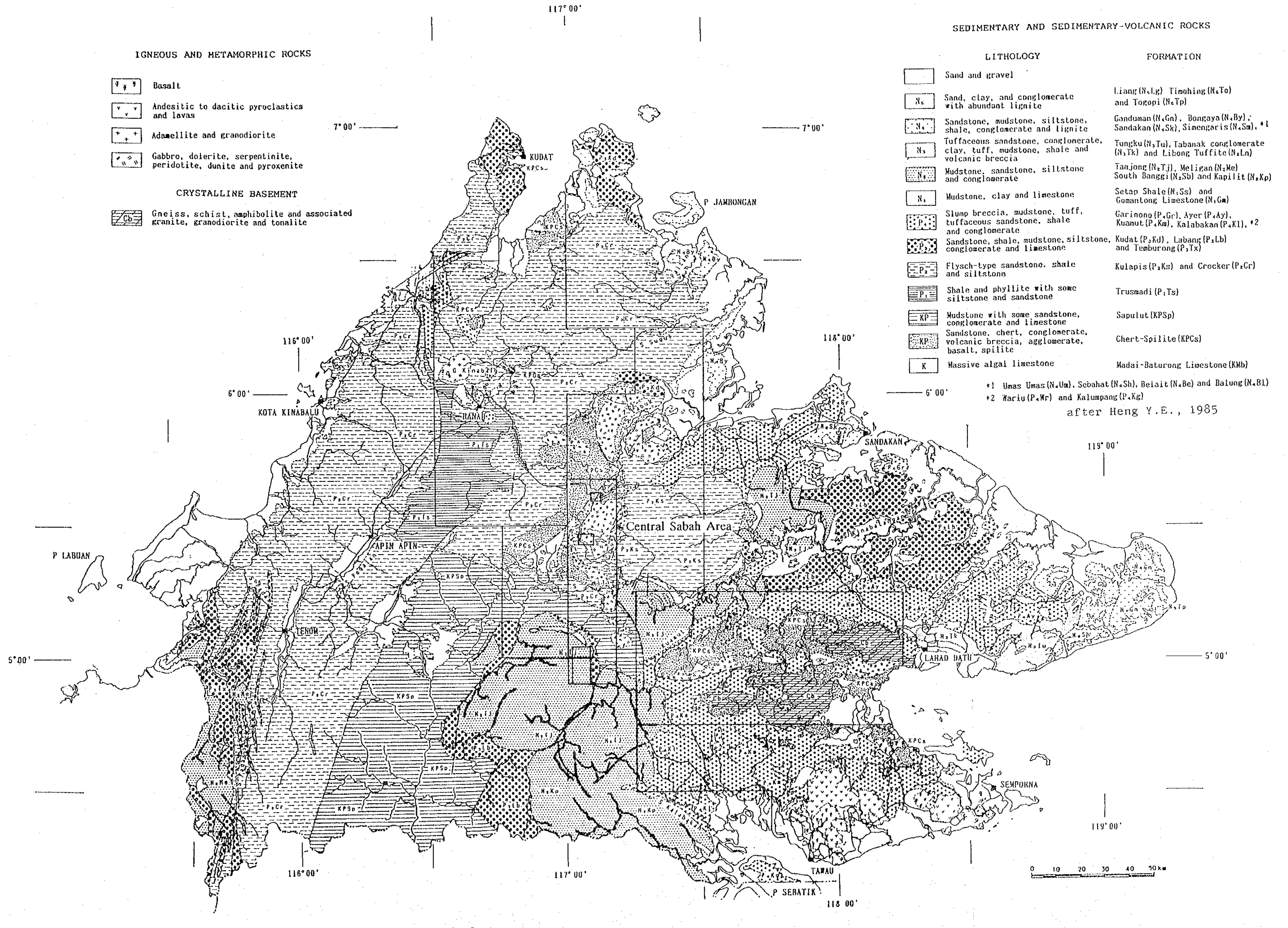


Fig. I -3 Geologic map of Sabah, Malaysia

is represented by post-orogenic intrusives and extrusives. The former one corresponds to the intrusion of granitic rocks such as adamellite and granodiorite in Gunong Kinabalu area and the latter corresponds to the calc-alkaline extrusive rocks, such as dacite, andesite and basalt, in the Semporna Peninsula.

In the Central Sabah Area, bodies of dismembered ophiolite consisting of ultramafic rocks and basalt with pillow structure are scattered over the northern part. The sedimentary rocks of the Central Sabah Area consist of Sapulut Formation (late Cretaceous to late Eocene), Kulapis Formation and Crocker Formation (Eocene to Oligocene), Labang Formation (Oligocene), Garinono Formation (Oligocene to middle Miocene), Tanjong Formation (early Miocene to middle Miocene). The Sapulut Formation is distributed in the southern part of Central Sabah area surrounding the ultramafic body and is overlain by the Labang Formation and Tanjong Formation. The Crocker Formation is widespread in the center of the Central Sabah Area surrounding the body of ultramafic rocks, while the Kulapis Formation occur in the central east of the area. The Garinono Formation, a tectonic melange, occurs at the eastern margin of ultramafic rocks.

3-2 Mineralization and mining activities

The principal metallic ore deposits in Sabah comprise porphyry copper deposit closely related with plutonic rocks, Cyprus-type massive sulfide deposit related to spilite extrusion and hydrothermal gold-silver deposits closely related with volcanic rocks. Chromium and platinum deposits are related to the ultra-basic rocks, lateritic aluminum and nickel deposits and manganese deposits in sedimentary rocks are also found. The distribution map of the main metallic ore deposits and mineral showings (after K.M. Leong, 1976) are shown in Fig. I-4.

The Mamut mine is the only active mine in Sabah. The Mamut deposit, a porphyry copper type, is located to the north of Ranau in the Kinabalu area. This ore deposit was discovered by a geochemical survey conducted by the United Nations Development Program (UNDP). The Overseas Mineral Resources Development Co., Ltd., Japan obtained the exploration right on the Mamut area through international tender in 1968, and carried out further exploration work from 1968 to 1972. The development work of the mine started in 1973 and operation was started in May, 1975. The current production of crude ore is 20 thousand tons per day with the grade of 0.47% Cu. Staffs and workers of the Mamut Copper Mining Sdn. Bhd. are about 1,200.

The Bidu Bidu Hill ore deposit is in the latest stage of exploration work and the development work will commence in the near future. This is a Cyprus-type massive sulfide deposit emplaced in basalt lava. Exploration work for this ore deposit is being carried out by a Malaysian company. The ore reserves of 3,600 thousand tons with Cu 3.6 %, Au 1 - 2 g/t and Ag 8-15 g/t have been confirmed by the drilling work (approximately 40,000 m) for this deposit.

The exploration work of gold-silver deposits occurred in volcanic rocks in the Semporna area is

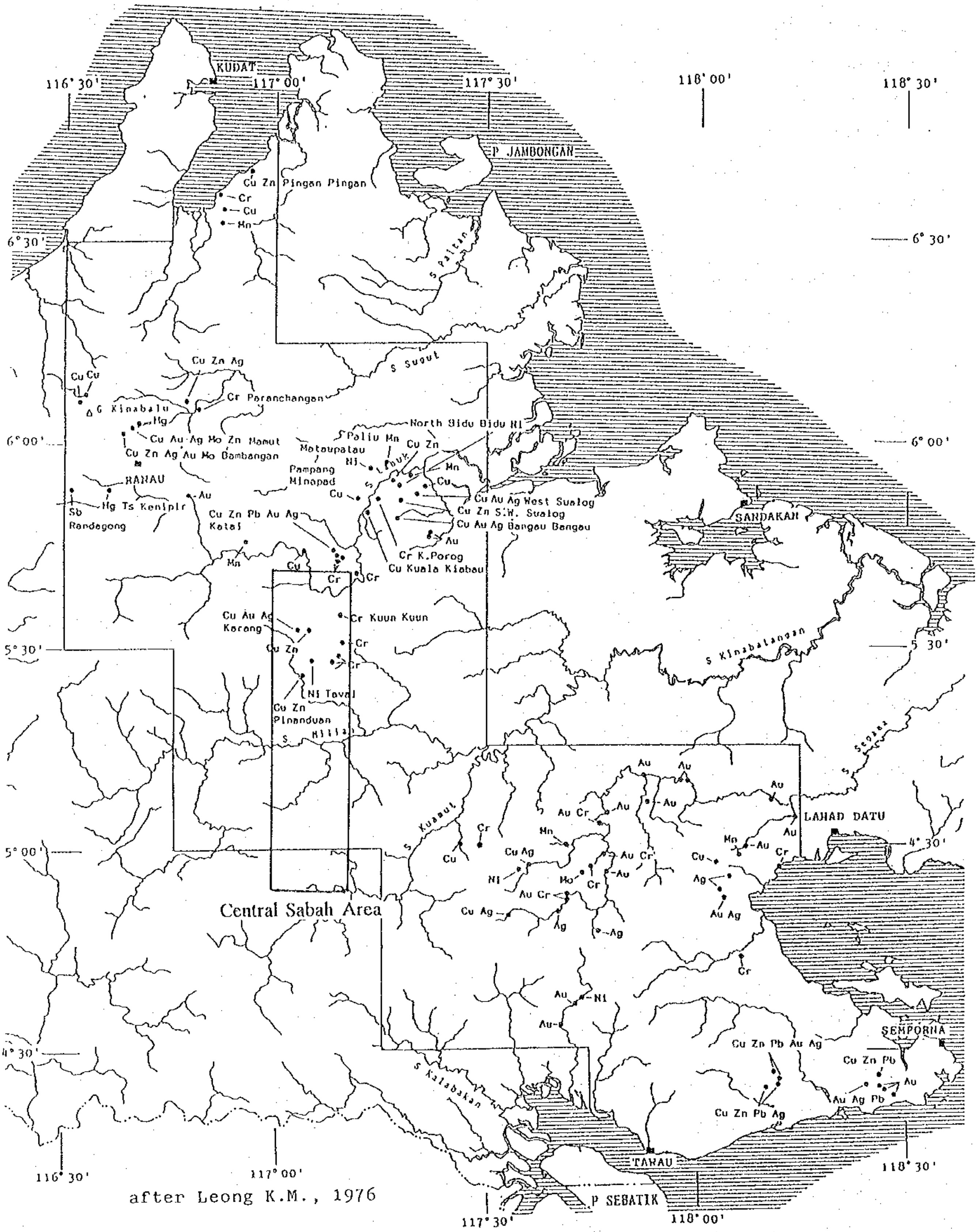


Fig. I -4 Distribution of mineral occurrences in the project area being carried out by a Malaysian company. The area surveyed by them covers a wide area from the west of Semporna to northern Tawau. The exploration work consists of mainly soil geochemical survey and trenching. A few drill holes have been completed for the Mantri area.

Within the Central Sabah area, exploration work, including drilling, augering and pitting was conducted in 1964 by the Soriamont Investment Co. in Pinanduan, an eastern tributary of the S. Karamuak. The boreholes showed that uncommercial zones of sulfides mineralization in peridotite, although at the surface there are more than a million tones of limonitic clay containing Cu 0.7 % as secondary oxides.

Chapter 4 Survey results

4-1 S. Imbak Sub-area North

The drilling survey of two drill holes (MJSI-6 and MJSI-7) was conducted in the S. Imbak Sub-area North.

Mudstone, sandstone, sandstone with mud lamina and diorite porphyry intruding these sedimentary rocks were intersected by the drill holes. The dips of the sedimentary rock observed in the drilling core is 10 to 30 degree and diorite porphyry, generally, intrudes sub-parallel to the structure of the sedimentary rocks. As shown in cross sections produced from geological survey at the vicinity of drilling site and drilling survey, the intrusion of diorite porphyry is parallel to sub-parallel on the surface and cross cutting at the depth. This, consequently, gives more volume of diorite porphyry expected in the depth than previously estimated.

Three types of diorite porphyry with clear porphyritic texture were found both from MJSI-6 and MJSI-7. The one in MJSI-6 has phenocrysts of plagioclase, hornblende and clinopyroxene and it is slightly fine grained compared with one in deeper part of MJSI-7. There is two types of diorite porphyry in MJSI-7. The one, occupying approximately 16 m of core length at shallower level is fine grained diorite porphyry with hornblende phenocryst and it shows similar appearance to andesite. The other one, occupying deeper level from 195.40m to the bottom of the hole, has phenocrysts of coarse plagioclase and fine hornblende. The relationships between these three diorite porphyries are not known. Other than silicification and oxidation in the sedimentary rocks at the contact with diorite porphyry, neither clear evidence of thermal metamorphism nor chilled margin in the diorite porphyry was observed. In diorite porphyry intensity of alteration, such as chloritization, silicification and argillization, varies in places to places. Zones of these alteration sporadically occur for core length of few tens of cm to few meters. In these zones porphyritic texture is obscured and a degree of dissemination of pyrite and pyrrhotite increases.

An alteration assemblages of chlorite - sericite - quartz is commonly observed in both of MJSI-6 and MJSI-7 with rare association of mixed layer of sericite/montmorillonite and montmorillonite. Because of a common appearance of chlorite-sericite in sedimentary rocks and diorite porphyry, the area of drilling survey seems to belong to transition zone between propylitic and phyllic zones of porphyry copper type mineralization..

Mineralization is more intense in MJSI-7 and in diorite porphyry than in MJSI-6 and in sedimentary rocks. Weak pyrite, pyrrhotite and rarely calcopyrite dissemination prevail all through diorite porphyry. The intensity of dissemination increase in accordance with silicification and chloritization. The most conspicuous mineralization in two holes is found from 272.80 m to 288.35 m at MJSI-7 where network of thin (1 cm to 1 mm wide) pyrite - arsenopyrite - chalcopyrite veins occurs coupled with dissemination of pyrrhotite, pyrite and chalcopyrite. The samples of approximately 3 m span (from 275.15m to 278.00 m) within this zone show assay results of Au 1.6 g/t to 4.3 g/t, Ag 1.6 g/t to 17.7 g/t and Cu 0.04 % to 0.12%.Other than this, some of few cm wide, quartz – sulfide veins with country rocks of sandstone close to diorite porphyry (Au 2.9 g/t and Ag 58.1g/t) and with country rock of diorite porphyry (Au 5.1 g/t and Ag 71.5 g/t) show high Au and Ag. As same as previous results, gold seems to be associated with arsenopyrite.

Pyrites, both in dissemination and quartz – sulfides vein, generally, show two types of occurrences. One shows euhedral grains and the other is an aggregates of very fine pyrite grains showing colloform texture. The former is usually surrounded by the latter, suggesting replacement of euhedral grains to the pyrite of colloform texture in the later stage.This implies that an abrupt crystallization of iron sulfide through an episode of a circulation of relatively low temperature hydrothermal solution has occurred at the late stage of the mineralization. This texture of sulfide, suggesting low temperature environment, tends to occur in outer margin of main mineralization where weak sulfide dissemination is observed.

Combining the results of Phase I to III, the mineralization in the area is summarized as follows:

(1) The mineralization in the area is characterized by Au – Ag, Cu and Zn, and it is closely related to the intrusion of diorite porphyry.

(2) Geological environment, such as lacking volcanic rocks, alteration zones similar to those of porphyry copper type and filling temperature of fluid inclusions (300℃ to 400℃) rules out a possibility of epithermal type mineralization.

(3) Filling temperature of fluid inclusion, occurrences of silver minerals such as argentite and acanthite, occurrences of samples with high Ag compared to Au suggest a mineralization slightly away from the center of igneous activity.

(4) Similar geological environment and contemporaneous activity of porphyritic rocks to the Mamut mine.

Considering the above, the most possible environment of mineralization in the S. Imbak Sub-area North is the one found in peripheral zone of mineralization similar to porphyry copper type. Based on typical alteration zones of porphyry copper type mineralization, the center of the silicification/pyrite dissemination zone in the S. Imbak Sub-area North corresponds to phyllic zone and it is surrounded by propylitic zone.

Clear anomalies of high chargeability were delineated by the IP survey conducted in the S. Imbak Sub-area North. The anomalies show a letter "C" shape opening to eastward and have an extent of approximately 2 km(NS) × 2 km (WE) being distributed overlapping the silicification-pyrite dissemination zone and geochemical anomalies of Ag, As, Au Cu.

The drilling survey of Phase II was conducted in the area of strong IP anomalies and failed to intersect distinguished mineralization. The strong IP anomalies in the area probably reflect pyrite veins and dissemination near the surface.

Letter "C" shape IP anomaly is commonly observed in the are of porphyry copper mineralization else where in the world and it is known that the main mineralization occurs in the center of letter "C" shape anomaly. If a mineralization similar to porphyry copper type exits in the S. Imbak Sub–area, the area at center of letter "C" anomaly with relatively lower IP anomaly seem to be better target for drilling. The drilling sites for Phase III was decided in the area of relatively lower IP anomaly at the center of letter "C" shape strong anomaly, then, it was, later, found that the area of the proposed drilling sites was covered by the area of Reserved Virgin Jungle in where cutting tree is strictly prohibited. Therefore, the drilling survey of Phase III was conducted shifting the drilling sites further east and it failed to intersect distinct mineralization.

The area at the center of letter "C" shape anomaly should be examined in future.

Chapter 5 Conclusions and recommendations

5-1 Conclusions

Mudstone, sandstone, sandstone with mud lamina and diorite porphyry intruding these sedimentary rocks were intersected by the drilling survey of two holes (MJSI-6 and MJSI-7). The dips of the sedimentary rock observed in the drilling core is 10 to 30 degree and diorite porphyry, generally, intrudes sub-parallel to the structure of the sedimentary rocks. The geological information of the surface and drilling survey suggest a volume of diorite porphyry more than previously expected in the depth.

Mineralization is more intense in MJSI-7 and in diorite porphyry than in MJSI-6 and in sedimentary rocks. Weak pyrite, pyrrhotite and rarely calcopyrite dissemination prevail all through diorite porphyry. The intensity of dissemination increase in accordance with silicification and chloritization. The most conspicuous mineralization in two holes is found from 272.80 m to 288.35 m at MJSI-7 where network of thin (1 cm to 1 mm wide) pyrite - arsenopyrite - chalcopyrite veins occurs coupled with dissemination of pyrrhotite, pyrite and chalcopyrite. The samples of approximately 3 m span (from 275.15m to 278.00 m) within this zone show assay results ofAu 1.6 g/t to 4.3 g/t, Ag 1.6 g/t to 17.7 g/t and Cu 0.04 % to 0.12%.Other than this, some of few cm wide, quartz - sulfide veins with country rocks of sandstone close to diorite porphyry (Au 2.9 g/t and Ag 58.1g/t) and with country rock of diorite porphyry (Au 5.1 g/t and Ag 71.5 g/t) show high Au and Ag. As same as previous results, gold seems to be associated with arsenopyrite.

The following evidence found in the drilling core suggests that the location of MJSI-6 and MJSI-7 belong to peripheral area of the main mineralization.

(1) Because of a common appearance of chlorite-sericite in sedimentary rocks and diorite porphyry, the area of drilling survey seems to belong to a transition zone between propylitic and phyllic zones of porphyry copper type mineralization..

(2) The colloform texture of pyrite commonly observed suggests low temperature environment at the late stage of the mineralization. This tends to occur in outer margin of main mineralization where weak sulfide dissemination is observed.

Considering the results of drilling survey together with geophysical survey, the most possible geological environment of the drilling site is the one found in peripheral zone of mineralization similar to porphyry copper type.

5-2 Recommendations

If the mineralization similar to porphyry copper type exists in the S. Imbak Sub-area North, the locations of drilling site conducted in PhaseII and Phase III are in the peripheral area of the main mineralization. The center of mineralization probably exists in the area at the center of a letter "C" shape geophysical anomaly. The drilling survey with more than 300 m deep holes is recommended in the area at the center of "C" shape geophysical anomaly for further evaluation of the S. Imbak Sub-area North (Fig. I -5). A similar type of mineralization occurs along the G. Kuli range in S. Imbak Sub-area North and South. In addition to these, a similar mineral showing was recently found in the area further south of these areas, south of S. Kuli. This suggests that the area along the G. Kuli range is cover by a similar type of mineralization with high potentiality for Au and Cu mineralization. A detail survey covering from the S. Imbak Sub-area to the south of S. Kuli is awaited.

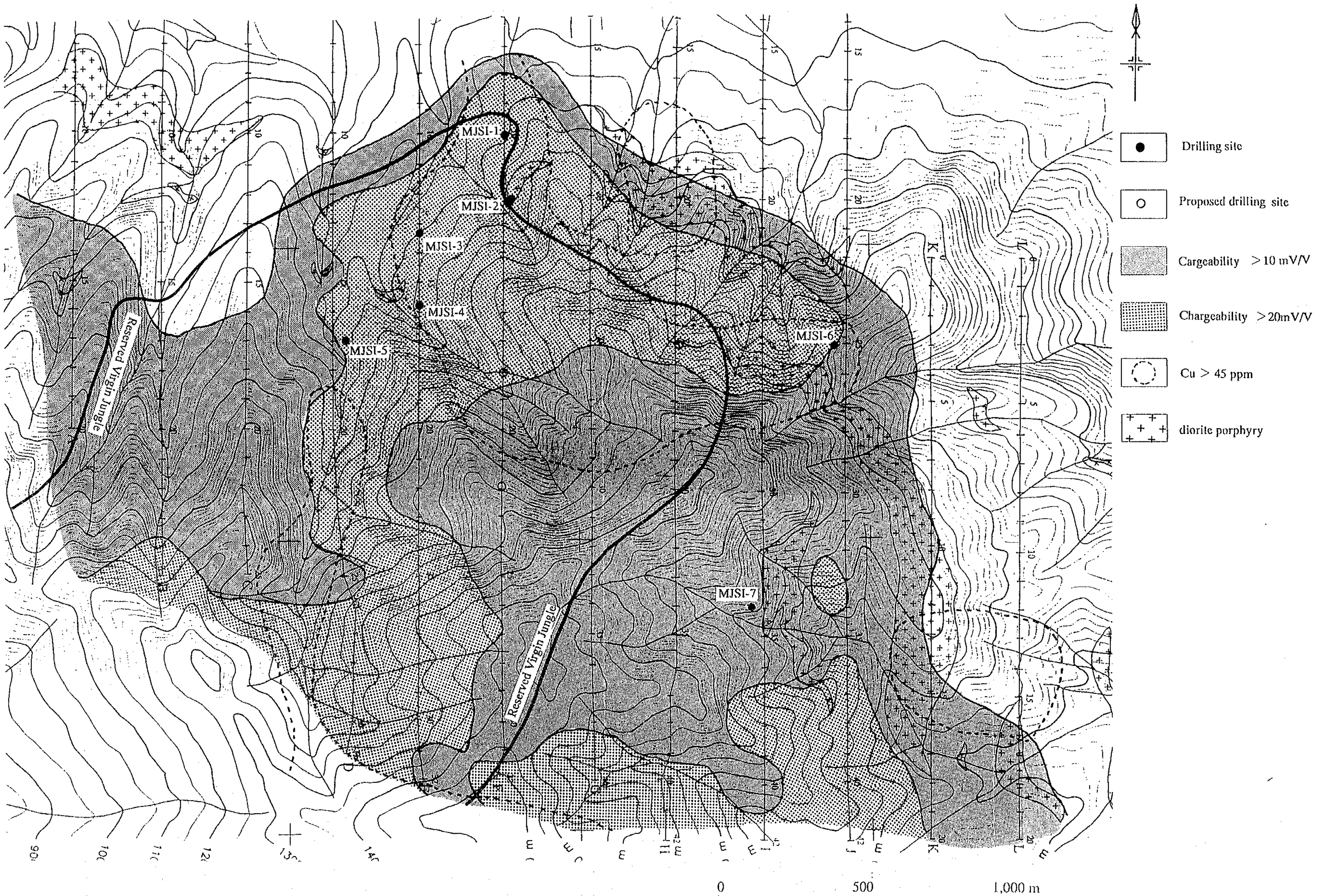


Fig. I -5 Recommendation for future work in S. Imbak Sub-area North

Part II Survey Result

Chapter 1 S. Imbak Sub-area North

1-1 introduction

1-1-1 Survey area

The S. Imbak Sub-area is located in the south end of the Central Sabah area and is separated into two parts, S. Imbak Sub-area North and South, by the south end line of Labuk area of the Supra-Regional Survey. The S. Imbak Sub-area North is a southern part of the Area T of Supra- Regional Survey, in where soil geochemical survey was conducted in 1993, while, the S. Imbak Sub-area South is located immediate south of the Supra-Regional Survey area.

For the Phase II survey, the S. Imbak Sub-area North was re-established to the area of 14.75 Km^2 (NW 4.5 km × EW 3.5km) and it occupies center to south part of the S. Imbak Sub-area North of Phase I. The south end of the area is slightly extended to the south for tracing the continuity of the mineralization of the area.

The main drainage system of the S. Imbak Sub-area North, which flows from south to north, belongs to southern tributaries of S. Imbak except southeast part of the area where streams flow to Sungai Kuamut. The area is occupied by the steep mountainous topography. The elevation of the north part of the area is 400 m then it reaches more than 1,500 m in south part of the area where a ridge with Gunong Kuli runs NNW-SSE direction.

The entire area of the S. Imbak North is covered by primary jungle and no trace of human activities such as cultivation and logging is found in the area. The access to the area is poor, only by a small trail. The base camp was established beside the timber road at a close point to the area and drilling equipments were transported to the base camp by vehicles. For the drilling survey, a helipad was constructed to each drill site and mobilization and remobilization of drilling equipments from the base camp to each drilling site was conducted by helicopter.

1-1-2 Background

A detail geological data had been lacking for the S. Imbak Sub-area before the start of the Supra-regional survey and the area had been considered to be overlain by monotonous Tertiary sediments. The stream sediments with high concentrations of Au and Hg (maximum: Au 6,530 ppb, Hg 24,735 ppb) obtained near the mouth and the upper stream of southern tributary of S. Imbak led to the subsequent semi-detail soil geochemical survey in the Area T, covering the catchment area of the tributary, during the Supra-regional Survey. Through the soil geochemical survey of the Area T, various evidences of Au and Ag mineralization were found in the southern part of the area, such as intrusions of diorite porphyry at eight locations, silicification/pyrite dissemination in sedimentary rocks surrounding the intrusions, Au, Cu, Hg, S and Zn anomalies of soil geochemical survey and occurrences of high Au and Ag (maximum Au 18.4 g/t, Ag 931.4 g/t) thin quartz veins and float along the main stream. These evidences strongly support a high potentiality of Au and Ag mineralization in the Area T and a possibility of the mineralization to be continued further south from the Area T.

At the start of the Central Sabah Project in 1994, for the further investigation and evaluation of the Au and Ag mineralization that found during the Supra-regional survey , the S. Imbak Sub-area consisting of south part of Area T (S. Imbak Sub-area North) and south extension of the Area T (S. Imbak Sub-area South) was established.

In the Phase I (1994) of the Central Sabah Project, semi-detail geological survey and geophysical survey were conducted in the S. Imbak Sub-area North and in the following year as Phase II survey of the Central Sabah Project, detail geological. survey, geophysical survey and drilling survey were conducted for the area of more potential within the S. Imbak Sub-area North. The results of surveys conducted in the S. Imbak Sub-area North during the PhaseI and II are summarized as follows.

The S. Imbak Sub-area North consists of the early to middle Miocene Tanjong Formation and diorite porphyry intruding to the Tanjong Formation. The mineralization of the area, closely associated with the intrusion of the diorite porphyry, occurs in the silicification/pyrite dissemination zone of approximately 3 km × 3 km wide in the center to south part of the area and it shows mainly two types of occurrences: quartz sulfides veins in the sedimentary rocks and network veins of sphalerite and dissemination of sulfides (pyrite, pyrrhotite, chalcopyrite) in the diorite porphyry.
The quartz-sulfides (pyrite, arsenopyrite, sphalerite, galena, chalcopyrite) veins of few cm to 25 cm wide sporadically occur in the sedimentary rocks of silicification/pyrite dissemination zone. These quartz-sulfides veins are classified into three types: Type① Au and Ag vein with Au≧Ag, Type ② Au and Ag vein with Ag>Au, Type ③ Pb and Zn vein. Type① and Type ② occur in a zone of higher alteration corresponding to phyllic zone in the west of the silicification/pyrite dissemination zone, while Type③ tend to occur in the east part of the silicification/pyrite dissemination zone.The assay results of Au and Ag veins show Au ranging from 8 g/t to 72 g/t and Ag ranging from 30 g/t to 196 g/t and two samples show small grains of native gold within arsenopyrite grains.
Among the five holes(MJSI-1 to MJSI-5) conducted during the PhaseII survey, the most prominent mineralization was found at MJSI-4 where sphalerite-(chalcopyrite) network veins and patches with Zn grade ranging from 0.40 % to 1.00 % occur in the diorite porphyry for la length of 15 m. This Zn mineralization zone includes 3 m long Ag rich (Ag 37.2 g/t to 90.5 g/t) zone.

The geological information, mineral assemblage of ore minerals, filling temperature of fluid inclusion (300° C to 400° C) suggest that the most possible geological environment of mineralization in the S. Imbak Sub-area is that of similar to the outer margin of the porphyry copper environment.

The IP survey conducted during the phase I and II surveys in the area of center to south part of the S. Imbak Sub-area North revealed the IP anomaly within area of silicified/pyrite dissemination zone overlapping with geochemical anomalies of Au, Ag, As and Cu. The high chargeability zone has a shape of letter "C" opening to east, which commonly observed in the environment of porphyry copper type mineralization else where in the world. The five drill holes conducted during the PhaseII survey over the distinguished anomaly (high chargeability and low resistivity) and its vicinity failed to intersect the prominent mineralization. For the finding of a massive, sulfide-rich mineralization, the IP anomaly of high chargeability and low resistivity (Type 1 anomaly) would be a promissing target. However, in this area, the IP anomaly of high chargeability and medium resistivity (Type 2 anomaly) seems to be a better target, because the mineralizations expected in the area are dissemination and vein type. The IP anomalies of Type 2 extending toward south and east from the most prominent anomaly (Type 1 anomaly) seem to be a better target the furthre exploration.

1-1-3 Survey method and amount of work

The Phase III of the Central Sabah Project consists of the drilling survey of two, 300 m deep, vertical drill holes.

1-2 Drilling Survey

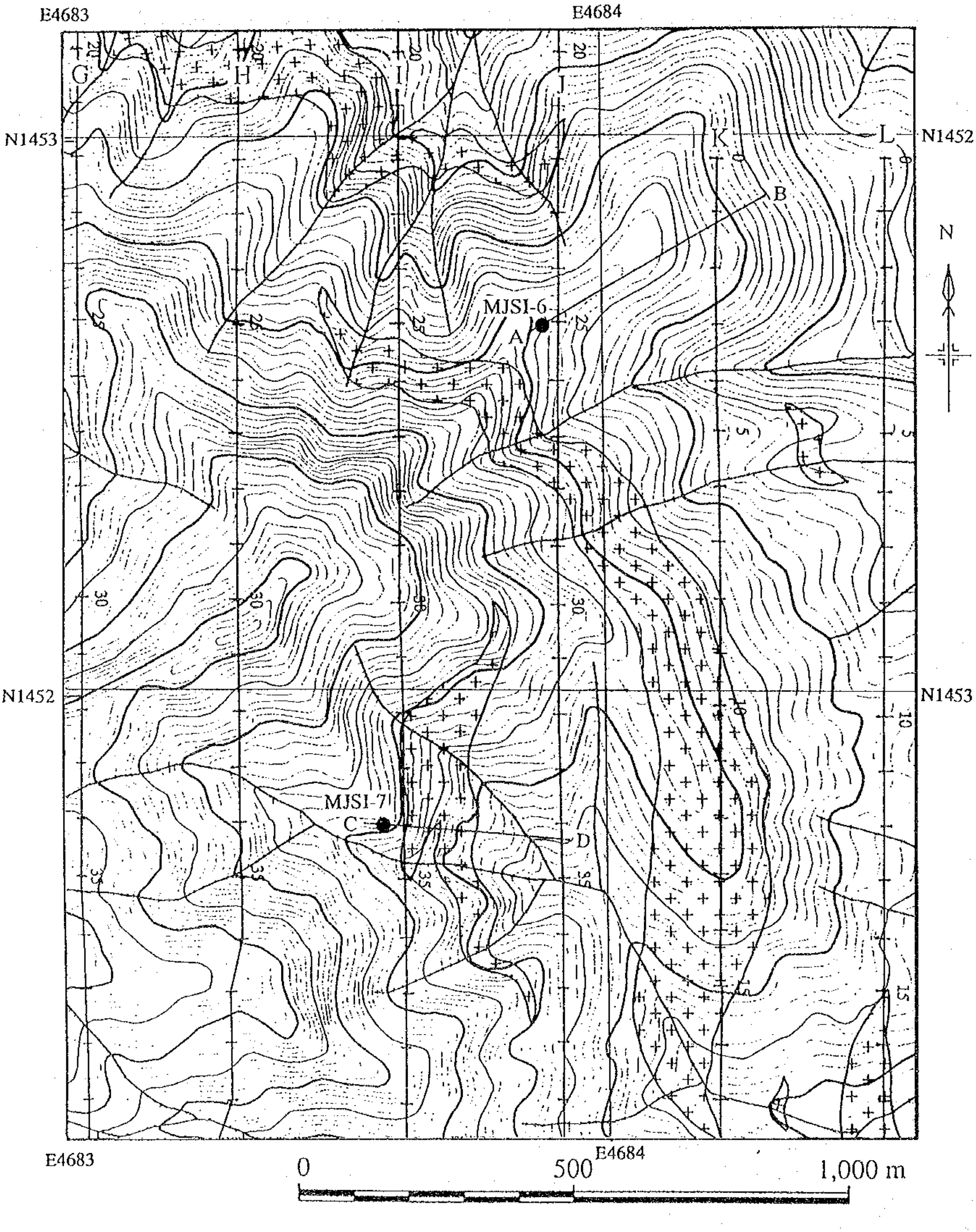
Based on the results of Phase I and II surveys, a drilling operation two drill holes (MJSI-6 and MJSI-7) was conducted in the S. Imbak Sub-area North for the detail understanding and evaluation of the mineralization of the area. The locations of the two drill holes are shown in FigII -1-1.

The IP survey of the area conducted in the Phase I and Phase II revealed the IP anomaly with a shape of letter "C" which commonly observed in an environment of porphyry copper type mineralization else where in the world. In these areas, it is known that the main mineralization, usually, dose not occur in outer zone of high IP anomaly, but it occurs in the center of the area with relatively weak IP anomaly. In the 1995, drilling operation was conducted at the targets of very strong IP anomaly, IP anomaly Type 1 with low resistivity and high chargeability,and not much encouraging result was obtained. The strong IP anomaly seems to reflect only pyrite dissemination. The target of this year was set at relatively weak IP anomalies, Type 2with medium resistivity and high chargeability and Type 3 with high resistivity and high chargeability. The drilling sites of MJSI-6 and MJSI-7 are located in the eastern part of the silicification/ pyrite dissemination zone with occurrences of relatively large bodies of diorite porphyry.

1-2-1 Survey method

The drilling operation of two holes was conducted in the S. Imbak Sub-area North. As given in Table II -1-1, all five holes are vertical holes and each hole is 300 m deep.

(1) Mobilization of equipment and set up



● drill site

Fig. II-1-1 Location of drill site

Table II-1-1 Specification of drill holes

Hole No.	Coordinates		Elevation	Bearing	Inclination	Depth
	N	E				
MJSI-6	1452.66	4683.89	982 m	-	-90°	300.50 m
MJSI-7	1451.77	4683.59	1,118 m	-	-90°	302.71 m

The equipments and various materials for drilling operation were transported by vehicles from Kota Kinabalu to the base camp located besides the timber road at the closest point to the S. Imbak Sub-area North. A long distance winching work was considered to be impossible because of the rugged topography of the area. For minimizing the winching work, a helipad was constructed close to each drill site. Mobilization and demobilization of the equipments and materials for drilling operation were conducted using a helicopter for both of the holes. The direct distance between the base camp and each drill site is approximately 7 km. A Bell 206 Jet Ranger was deployed for the operation and all the drilling equipments were dismantled to less than 300 kg each. One drilling machine (Mindrill F-31, Australia) was deployed for the drilling work and the helicopter operation was conducted as follows.

1st. helicopter charter
    Base camp to MJSI-6
2nd. helicopter charter
    MJSI-6 to MJSI-7
3rd. helicopter charter
    MJSI-7 to Base camp

(2) Drilling operation

The drilling work was conducted during a period of September, 1996 to December , 1996, establishing a camp at each drill site. The work such as preparation, set up, mobilization and demobilization were done only by day sift and actual drilling operation was conducted by two shifts. The drilling operation was done by wire line method using the Mindrill F-31 (Australia).

A summary of the drilling activities, progress record and a list of the drilling equipments are, respectively, given in Appendix 1, Appendix 2 and Appendix 3.

(3) Core logging

The description of the drill core was done either at the drill site or base camp during the drilling operation. For the sampling of laboratory work samples, the core was sprite into two portions and one portion was sent to laboratory and the other portion was preserved in the core box. If mineralization continues for the certain length, assay samples were collected for 1 m span to obtain average grade.

1-2-2 Survey results

Description of drill core at 1:200 scale is given in Appendix 4 and cross section of the surrounding area of the drilling site are shown in FigII -1-2. Microscopic observations of the thin sections and polished sections taken from the both of the drill core were summarized in TableII -1-2 and Table II -1-3. The results of X-ray diffraction analysis and assaying are, respectively, given in

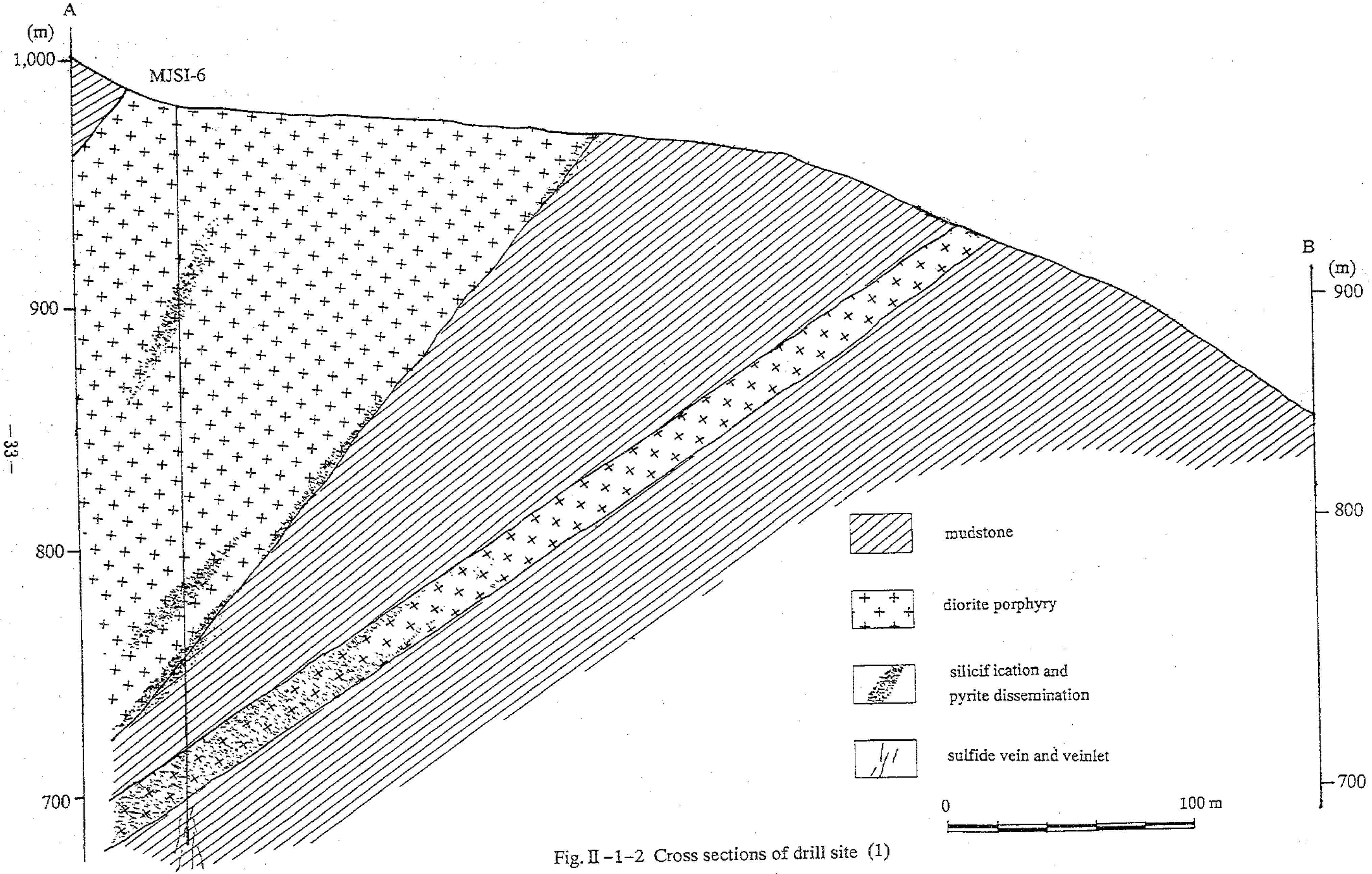


Fig. II -1-2 Cross sections of drill site (1)

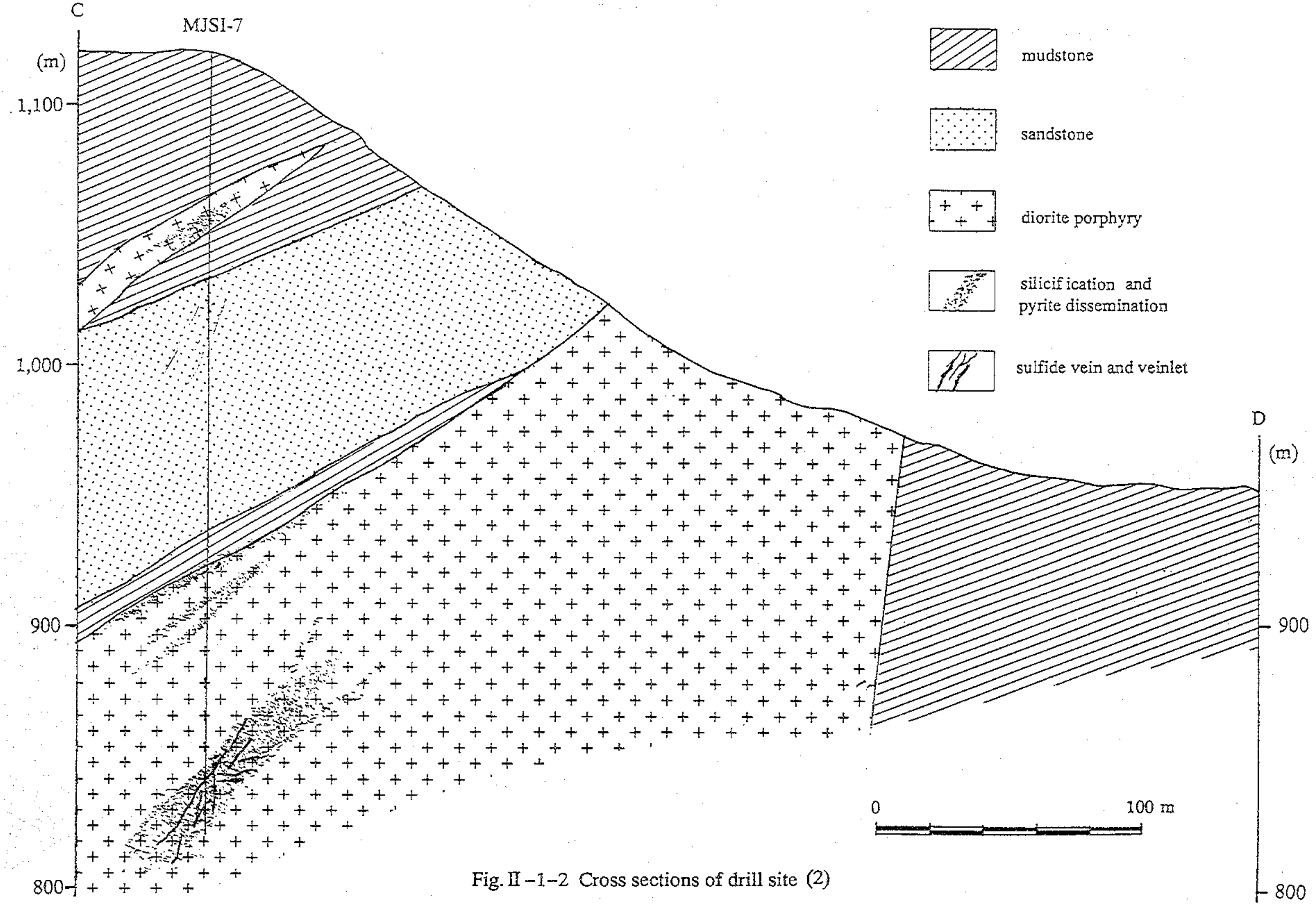


Fig. II -1-2 Cross sections of drill site (2)

Table II-1-2 Description of thin section of drilling core

Ser. No.	Sample No.	Hole No.	Depth	Rock Name	Texture	Phenocryst, crystal. & Rock Fragment							Groundmass, matrix, Accessory Minerals.								Secondary Minerals								Remarks
						Quartz	Plagioclase	Clinopyroxene	Hornblende	Biotite	Rock fragments	Others	Quartz	Plagioclase	Apatite	Sphene	Zircon	Tourmaline	Opaque minerals	Others	Quartz	Sericite	Calcite	Chlorite	Biotite	Epidote	Kaolinite	Others	
1	T-6-1	MJSI-6	132.40	diorite porphyry	porphyritic granoblastic		◎	○	○			•*	+	◎	•	•			•		+		+	○		+			*K-feldspar, weakly chloritized diorite porphyry
2	T-6-2	MJSI-6	189.90	diorite porphyry	porphyritic granoblastic		◎	+	+					◎	•				•	•*	•		+	•		•			*hornblende, relatively fresh diorite porphyry
3	T-6-3	MJSI-6	222.85	mudstone	clastic	◎							○				•		•			+	•						weakly sericitized mudstone
4	T-6-4	MJSI-6	241.76	mudstone	clastic	◎	+						+					•	•			○	•						sericitized mudstone
5	T-6-5	MJSI-6	274.65	diorite porphyry	granoblasitc									◎	•	•			•		○	○	○						strongly silicified and sericitized diorite porphyry
6	T-7-1	MJSI-7	63.20	diorite porphyry	porphyritic granoblastic		+		◎					◎	•	•			•		•		+	+		•		•*	*tremolite, relatively fresh diorite porphyry
7	T-7-2	MJSI-7	72.50	mudstone	clastic	◎	•						◎					•	•			○	+	•					relatively fresh mudstone
8	T-7-3	MJSI-7	153.60	sandstone	clastic	◎	•						◎				•	•	•			+	•	•					relatively fresh, fine, well sorted sandstone
9	T-7-4	MJSI-7	199.90	diorite porphyry	porphyritic fine granoblastic		○		◎					◎	•	•			•		+		+	+		+			relatively fresh diorite porphyry
10	T-7-5	MJSI-7	276.14	diorite porphyry	(porphyritic) granoblastic		+							+					+		◎	○	+	+					strongly silicified and sericitized diorite porphyry
11	T-7-6	MJSI-7	301.10	diorite porphyry	porphyritic granoblastic		+*		+*					+			•		+		◎	○	+	+					*pseudomorph, silicified and sericitized diorite porphyry

◎: abundant ○: common +: a little •: rare

Table II-1-3 Description of polished sections of drilling core

Ser. No.	Sample No.	Bore hole No and depth: No.	Bore hole No and depth: Depth(m)	Descriptions	Ore minerals: Chalcopyrite	Sphalerite	Galena	Pyrite	Arsenopyrite	Pyrrhotite	Magnetite	Hematite	Gang minerals	Cavity	Remarks
1	P-6-1	MJSI-6	79.50	Qz vein with Ap, Py, Sp in dio. por.	+	+	+	+	+	·			◎	+	
2	P-6-2	MJSI-6	199.60	argillized dio. por., Py, Ap dism.	·			+	+				◎		pyrite with colloform texture included +
3	P-6-3	MJSI-6	244.70	Py-rich lamina in mudstone, W. 1cm				◎					○		pyrite with colloform texture included ○
4	P-6-4	MJSI-6	248.80	Qz-Py vein in mudstone, W. 1cm				○					◎	+	pyrite with colloform texture included +
5	P-7-1	MJSI-7	61.10	silicified dio. por., Py dism.			·	+	+				◎		pyrite with colloform texture included ·
6	P-7-2	MJSI-7	63.50	Silicified dio. por., Po, Py dism	·	·	·	·		+			◎		
7	P-7-3	MJSI-7	159.90	Py-rich layer in mudstone, W. 5cm				◎					◎		pyrite with colloform texture included ◎
8	P-7-4	MJSI-7	217.00	Py vein in dio. por., W. 0.5cm	·			○		·	·	+	◎		pyrite with colloform texture included +
9	P-7-5	MJSI-7	249.45	chloritized dio. por. Po, Py dism.	·			·		+			◎		
10	P-7-6	MJSI-7	275.10	Py-Ap vein in dio. por	·			◎	◎	·	+	+		+	pyrite with colloform texture included ◎
11	P-7-7	MJSI-7	275.50	Py-Ap veinlet in dio. por	+			◎	◎		+		○	+	pyrite with colloform texture included ○
12	P-7-8	MJSI-7	275.80	Py-Ap veinlet in dio. por.	+			○	◎		+		◎		pyrite with colloform texture included +
13	P-7-9	MJSI-7	279.50	dio. por. with Po dism.	·			·		+			◎		

◎: abundant ○: common +: a little ·: rare

Table II -1-4 and Table II -1-5. The geology and the mineralization of each drill hole are given below.

1. MJSI-6

[Geology]: Gray diorite porphyry with plagioclase and hornblende phenocrtsts occupies from the surface to 227.70m, then, followed by dark gray laminated mudstone (227.70m to 300.50m). The mudstone is intruded by strongly silicified and argillized diorite porphyry from 260.55m to 280.40m. The lamina of mudstone dips 20 degree.

0.00 – 3.68	:overburden, orange silt with fragments of diorite porphyry
5.10 – 8.60	:brownish yellow saprolite of diorite porphyry
8.60 – 227.70	:gray diorite porphyry with few mm across phenocrysts of plagioclase, hornblende and clinopyroxene. The grain size is slightly finer compared with diorite porphyry of MJSI-7. There is some variations in ration of hornblende and plagioclase, however, plagioclase is always dominant phenocryst. In some plases, xenolith of few cm size, fine diorite occurs. It intruds sub-parallel to the lamina of mudstone and neither chilled margin in the diorite porphyry nor a clear indication of thermal metamorphisim in mudstone was observed. Generally, alteration is not storng and porphyritic texture is clear, however, few tens cm to few meter zones of silicification and weak alteration are scsttered all through the diorite porphyry. A zone of strong silicification occur between 75.35m to 83.10m.
227.70 – 260.55:	dark gray laminated mudstone, dipping 25 to 30 degree. Sandstone layers of few mm to few tens cm are slightly abundante between 246.50m to 260.55m. No clear alteration is observed other than at the vicinity to diorite porpyry
260.55 – 280.40:	pale gray, strongly silicified and argillized dioriote porphyry with no clear porphyritic texture.
280.40 – 300.50:	dark gray, laminated mudstone mudstone. core is crushed to bebble size from 293.20m to the bottom (300.50m).

Thin sections of diorite porphyry show clear porphyritic texture with 5 mm to 1 mm size phenocrysts of plagioclase, hornblende and clinopyroxene in order of abundance. Rarely K-feldspar is observed as phenocryst and quartz and hornblende appear in groundmass. Quartz, calcite, chlorite and epidote are secondary minerals in diorite porphyry. Original igneous texture is not preserved in the strongly silicified and argillized diorite porphyry (260.55m to 280.40m). Only original plagioclase is preserved in the groundmass and, other than this, secondary quartz, calcite and sericite are widespread.

Table II-1-4 Results of X-ray diffraction analyses of drilling core (1)

Ser. No.	Hole No.	Sample No.	Depth	Description	Identified Minerals: Se/Mo mixed layer	Kaolinite	Chlorite	Sericite	Montmorillonite	Quartz	Plagioclase	K-feldspar	Epidote	Calcite	Dolomite	Pyrite	Remarks
1	MJSI-6	X-6-1	36.60	argillized diorite porphyry			○	+		◎	◎					○	
2	MJSI-6	X-6-2	79.00	silicified diorite porphyry			○	◎		◎	◎				○		
3	MJSI-6	X-6-3	97.30	argillized diorite porphyry	+		◎		○	◎	◎	○		○		○	
4	MJSI-6	X-6-4	133.60	silicified diorite porphyry			◎	○		◎	◎	◎		○		○	
5	MJSI-6	X-6-5	157.70	silicified diorite porphyry			○		○	◎	◎	◎				+	
6	MJSI-6	X-6-6	199.60	argillized dio. por. with py dism.			○	◎	+	◎	○		○			+	
7	MJSI-6	X-6-7	200.45	chloritized diorite porphyry			○	○		◎	◎	○				+	
8	MJSI-6	X-6-8	247.80	mudstone			○	○		◎	○			+			
9	MJSI-6	X-6-9	274.65	silicified and argillized dio. por.	+		○	○		◎	◎						
10	MJSI-6	X-6-10	298.30	silicified mudstone		○				◎			○		◎	○	

◎: abundant ○: common +: a little ・: rare

Table II-1-4 Results of X-ray diffraction analyses of drilling core (2)

Ser. No.	Hole No.	Sample No.	Depth	Description	Identified Minerals: Se/Mo mixed layer	Kaolinite	Chlorite	Sericite	Montmorillonite	Quartz	Plagioclase	K-feldspa r	Hornblende	Epidote	Calcite	Pyrite	Remarks
1	MJSI-7	X-7-1	22.90	oxidized mudsotne			+	○	・	◎							+:Lepidocrocite
2	MJSI-7	X-7-2	59.90	argillized fine diorite porphyry			◎	○		◎	+	○					
3	MJSI-7	X-7-3	66.60	chloritized and argillized dio. por.			○			○	◎	○	○				
4	MJSI-7	X-7-4	73.90	mudstone			○	○		◎						+	
5	MJSI-7	X-7-5	95.10	silicified sandstone			○	○	・	◎						+	
6	MJSI-7	X-7-6	132.20	chloritized sandstone			○	○		◎	+					○	
7	MJSI-7	X-7-7	174.70	silicified sandstone			○	○	・	◎						+	
8	MJSI-7	X-7-8	195.80	chloritized diorite porphyry			◎	○		◎	○					+	
9	MJSI-7	X-7-9	226.10	chloritized diorite porphyry			◎	○		◎	○				○	・	
10	MJSI-7	X-7-10	274.80	silicified diorite porphyry			◎	○		◎						○	
11	MJSI-7	X-7-11	276.10	silicified diorite porphyry			◎	○		◎		+				○	
12	MJSI-7	X-7-12	301.10	silicified diorite porphyry			◎	○		◎	○				+	+	

◎: abundant ○: common + : a little ・: rare

Table II-1-5 Assay results of drilling core (1)

Ser. No.	Hole No.	Sample No.	Sampling (m)			Descriptions	Assay results						
			From	To	Length		Au (g/t)	Ag (g/t)	Cu (ppm)	Pb ppm)	Zn (ppm)	Mo (ppm)	S (%)
1	MJSI-6	A-6-1	75.50	76.50	1.00	silicified dio. por. weak Py dism.	<0.1	1.1	113	93	182	3	0.33
2	MJSI-6	A-6-2	79.00	80.00	1.00	dio. por. with Qz vein of 2 cm wide	0.4	10.3	117	4,160	2,460	2	1.94
3	MJSI-6	A-6-3	80.00	81.00	1.00	silicified dio. por. weak Py dism.	<0.1	0.7	56	219	188	2	0.70
4	MJSI-6	A-6-4	97.20	97.50	0.30	argillized dio. por. weak Py dism.	<0.1	0.5	76	43	99	7	1.54
5	MJSI-6	A-6-5	103.85	104.00	0.15	argillized dio. por. weak Py dism.	<0.1	0.6	122	37	86	<1	2.57
6	MJSI-6	A-6-6	199.30	200.00	0.70	argillized dio. por. weak Py dism.	<0.1	4.1	41	1,480	394	1	1.23
7	MJSI-6	A-6-7	221.00	221.70	0.70	silicified dio. por. weak Py dism.	<0.1	0.4	55	47	79	<1	0.44
8	MJSI-6	A-6-8	221.70	222.70	1.00	silicified dio. por. weak Py dism.	<0.1	0.6	69	38	129	2	0.65
9	MJSI-6	A-6-9	242.80	243.00	0.20	mudstone with Py-rich lamina, 1cm wide	<0.1	0.3	40	92	155	<1	7.93
10	MJSI-6	A-6-10	247.80	248.00	0.20	mudstone with Qz-Py vein, 1cm wide	<0.1	0.3	44	50	77	<1	4.44
11	MJSI-6	A-6-11	266.85	267.25	0.40	mud block in silicified dio. por.	<0.1	3.7	28	1,310	550	<1	3.79
12	MJSI-6	A-6-12	275.20	276.20	1.00	argillized dio. por., weak Py dism.	<0.1	0.1	10	30	183	<1	0.33
13	MJSI-6	A-6-13	292.00	293.00	1.00	argillized mudstone with Py films	<0.1	0.5	37	51	154	<1	5.21
14	MJSI-6	A-6-14	299.50	300.50	1.00	mudstone with Py veinlets, few mm wide	<0.1	1.6	185	48	100	<1	10.52

Table II-1-5 Assay results of drilling core (2)

Ser. No.	Hole No.	Sample No.	Sampling (m)			Descriptions	Assay results						
			From	To	Length		Au (g/t)	Ag (g/t)	Cu (ppm)	Pb ppm)	Zn (ppm)	Mo (ppm)	S (%)
1	MJSI-7	A-7-1	60.80	61.70	0.90	silicified, argillized fine D¥dio.por.	<0.1	4.6	56	812	246	<1	0.89
2	MJSI-7	A-7-2	63.30	64.10	0.80	silicified fine dio. por. Py, Po dism.	<0.1	1.4	81	444	783	<1	0.97
3	MJSI-7	A-7-3	91.60	92.50	0.90	sandstone with Py films	<0.1	1.7	75	230	218	<1	1.41
4	MJSI-7	A-7-4	114.00	114.10	0.10	Py-rich mud layer, 3cm wide	0.2	4.6	424	80	137	<1	15.32
5	MJSI-7	A-7-5	125.55	125.65	0.10	Py-rich layer in sandstone	0.2	1.8	459	23	151	<1	8.78
6	MJSI-7	A-7-6	128.50	128.80	0.30	mud layer with Py	<0.1	2.2	574	35	147	<1	7.55
7	MJSI-7	A-7-7	159.90	160.00	0.10	Py-rich layer in mudstone, 5cm wide	0.8	2.5	386	45	95	<1	19.60
8	MJSI-7	A-7-8	167.60	167.90	0.30	silicified sandstone with Py vein	2.9	58.1	578	734	7,290	80	6.85
9	MJSI-7	A-7-9	195.85	196.70	0.85	chloritized dio. por. with Py dism.	0.2	0.4	203	28	113	2	1.45
10	MJSI-7	A-7-10	208.35	208.80	0.45	silicified dio. por. with Py, Po dism.	<0.1	0.3	172	27	81	<1	1.10
11	MJSI-7	A-7-11	216.40	216.90	0.50	chloritized and silicified dio. por.	0.2	0.2	257	37	69	<1	2.48
12	MJSI-7	A-7-12	225.55	226.20	0.65	chloritized dio. por. Po dism.	<0.1	<0.1	161	23	72	<1	1.17
13	MJSI-7	A-7-13	228.90	229.10	0.20	dio. por. with Qz-Py vein, 2cm wide	0.3	27.5	178	285	574	2	2.65
14	MJSI-7	A-7-14	248.55	248.80	0.25	chloritized dio. por. Po, Py dism.	<0.1	<0.1	35	25	85	1	2.14
15	MJSI-7	A-7-15	261.80	262.00	0.20	chloritized dio. por. Po, Py dism.	<0.1	<0.1	95	21	69	<1	1.03
16	MJSI-7	A-7-16	264.10	264.40	0.30	chloritized dio. por. Po, Py dism.	<0.1	<0.1	74	21	83	1	0.40
17	MJSI-7	A-7-17	267.55	268.00	0.45	chloritized dio. por. Po, Py dism	<0.1	0.4	273	30	68	<1	2.84
18	MJSI-7	A-7-18	271.50	271.75	0.25	dio. por. with Qz vein Py, Cp, Sp, W. 1cm	0.1	15.0	2,660	864	2,360	<1	4.10
19	MJSI-7	A-7-19	273.20	274.20	1.00	silicified dio. por. Po, Py dism.	<0.1	1.1	149	47	85	<1	1.16
20	MJSI-7	A-7-20	274.20	274.85	0.65	silicified dio. por. Po, Py dism.	0.2	4.6	487	137	864	2	3.86

Table Ⅱ-1-5 Assay results of drilling core (3)

Ser. No.	Hole No.	Sample No.	Sampling (m)			Descriptions	Assay results						
			From	To	Length		Au (g/t)	Ag (g/t)	Cu (ppm)	Pb ppm)	Zn (ppm)	Mo (ppm)	S (%)
21	MJSI-7	A-7-21	274.85	275.15	0.30	Py-Ap vein in dio.por	3.5	26.5	3,360	488	158	<1	31.41
22	MJSI-7	A-7-22	275.15	276.15	1.00	dio.por. with Py-Po veinlets, W.1-5cm	4.3	15.6	1,180	360	150	<1	11.94
23	MJSI-7	A-7-23	276.15	276.90	0.75	dio.por. with Py veinlet, W. 1-0.1cm	<0.1	2.2	725	32	71	<1	5.26
24	MJSI-7	A-7-24	277.10	277.85	0.75	silicified dio.por. with Po, Py, Ap	0.3	1.6	473	34	76	1	3.79
25	MJSI-7	A-7-25	277.85	278.00	0.15	argillized dio.por.	0.7	17.7	842	613	1,460	<1	17.02
26	MJSI-7	A-7-26	278.00	279.00	1.00	silicified dio.por. Po, Py dism.	<0.1	<0.1	209	20	62	<1	2.05
27	MJSI-7	A-7-27	279.00	280.00	1.00	silicified dio.por. Po, Py dism.	<0.1	0.1	192	32	64	<1	1.45
28	MJSI-7	A-7-28	280.00	281.00	1.00	silicified dio.por. Po, Py dism.	<0.1	0.7	204	33	80	1	1.53
29	MJSI-7	A-7-29	281.00	282.00	1.00	silicified dio.por. Po, Py dism.	<0.1	0.2	213	43	73	<1	1.71
30	MJSI-7	A-7-30	282.00	282.55	0.55	dio.por. with Qz-Py vein, W. 3 cm	5.1	71.5	1,240	11,500	2,340	2	8.25
31	MJSI-7	A-7-31	282.55	283.20	0.65	silicified dio.por. Po, Py dism.	<0.1	0.6	186	36	71	<1	1.63
32	MJSI-7	A-7-32	283.20	283.40	0.20	dio.por. with Qz-Py-Cp vein, W. 1 cm	0.3	2.9	667	70	83	<1	5.68
33	MJSI-7	A-7-33	283.40	284.20	0.80	silicified dio.por. Po, Py dism.	<0.1	0.2	306	26	68	<1	2.21
34	MJSI-7	A-7-34	284.20	285.10	0.90	silicified dio.por. Po, Py dism.	<0.1	0.9	344	36	66	1	2.73
35	MJSI-7	A-7-35	285.90	286.30	0.40	silicified dio.por. Po, Py dism.	<0.1	<0.1	247	16	66	<1	1.69
36	MJSI-7	A-7-36	291.40	292.25	0.85	silicified dio.por. Po, Py dism.	<0.1	0.2	82	26	68	1	0.70
37	MJSI-7	A-7-37	301.10	301.30	0.20	silicified dio.por. Po dism., Py film	<0.1	0.3	94	19	65	2	1.47

Mudstone consists of fine detrital grains of quartz, less than 0.1 mm across, and secondary sericite and calcite.

The results of X-ray reflection analysis for 10 samples of diorite porphyry and mudstone show common alteration assemblages of chlorite - sericite - quartz with rare association of mixed layer of sericite/montmorillonite and montmorillonite. Based on the alteration zoning established in the S. Imbak Sub-arc during the Phase II survey, MJSI-6 seems to belong to transition zone between propylitic and phyllic zones, because of the common occurrences of chlorite and sericite.

[Mineralization]: A conspicuous mineralization was not observed in MJSI-6. Very weak dissemination of pyrite, pyrrohtite and arsenopyrite is observed all through the core. In the zone of silicified and argillized diorite porphyry, typically from 75.35m to 83.10m, dissemination of these minerals are stronger and thin pyrite film of few mm wide associate with it. The strongly silicified and argillized diorite porphyry intruded in mudstone from 260.55m to 280.40m is weakly disseminated by pyrite, associated by pyrite films of few mm wide. In addition to this, quartz - sulfide (pyrite and arsenopyrite) veins of 2 cm to 0.3 cm wide rarely occur. In mudstone, pyrite dissemination is not clear and pyrite-rich nodules or patches of few cm across occur. In mudstone of deeper than 285m, pyrite dissemination becomes clearer associated by pyrite films of few mm wide.

Polished section of argillized diorite porphyry shows a small amount of chalcopyrite in addition to pyrite and arsenopyrite as dissemination minerals. The quartz-sulfides vein in the diorite porphyry consisted of arsenopyrite, sphalerite, galena, pyrite, calcopyrite and pyrrohtite in addition to quartz. Pyrite is the only sulfide found in pyrite rich lamina and quartz - pyrite veins in mudstone.

Pyrite of MJSI-6, generally, shows two types of occurrences. Euhedral grains and aggregate of very fine pyrite grains showing colloform texture. The fommer one is usually surrounded by the latter.

An encouraging assay results was not obtained from the samples of MJSI-6. The diorite porphyry with quartz - sulfides vein of 2 cm wide shows Au 0.4 g/t, Ag 10.3 g/t, Pb 0.41% and Zn 0.24% for sampling length of 1.0m. Strongly silicified and argillized diorite porphyry shows only low grade Ag (Ag 0.4 g/t to 4.1 g/t).

2. MJSI-7

[Geology]: Mudstone occupies from the surface to 84.20 m and it is intruded by fine diorite porphyry with a similar appearance to andesite. Sandstone occurs from 84.20 m to 184.60 m and it is underlain by mudstone with sand lamina from 184.60 m to 195.40 m. Diorite intrudes at 195.40 m and it continues to the bottom.Alteration and mineralization mainly occur in diorite porphyry. The lamina and bed of the sedimentary rocks dip approximately 10 to 30 degree.

0.00 – 3.90	:overburden.
3.90 – 43.50	:pale gray mudstone with pale brown surface. It is silicified and breached, and in some places original dark brown mudstone remains as patches. The core shallower than 33.75 m is crashed to few cm size breccia in many places.
43.50 – 52.40	: dark gray mudstone. It is partly oxidized, especially at vicinity of the contact with diorite porphyry. Sandstone beds of approximately 10 cm wide rarely occur.
52.40 – 68.65	: pale greenish gray, fine diorite porphyry. It has hornblende phenocryst of few mm to 5 mm across and shows a similar appearance to andesite. Silicified and chloritized part of few m wide sporadically occur.
68.65 – 84.20	:dark gray mudstone. It does not show clear lamination, and it is intruded by fine diorite porphyry from 69.55 m to 69.70 m. Silicification is observed in the mudstone at vicinity of contact to diorite porphyry.
84.20 – 184.60	:gray fine sandstone. Weak silicification and pyrite dissemination occur all through sandstone. Mud lamina of few mm thick commonly and dips 20 to 30 degree.
184.60 – 195.40	:dark gray mudstone with lamina and bed of few mm to 10 cm wide sandstone. Ratio of mudstone and sandstone is 70% to 30%.
195.40 – 302.71	:gray diorite porphyry. It is slightly coarser grained with plagioclase (approximately 5 mm across) and hornblende (approximately 1 mm across) phenocryst compared with diorite porphyry of MJSI–6. It shows clear contact with mudstone, cross cutting the lamina of it. Neither chilled margin in the diorite porphyry nor a clear indication of thermal metamorphism in mudstone was observed.Weak silicification and chloritization with weak dissemination of pyrite and pyrrhotite occur all through the diorite porphyry. Zones of relatively strong alteration sporadically occur for length of few tens cm to few meter. In these zones, intensity of pyrite and pyrrhotite dissemination increases, coupled with occurrences of few cm wide, quartz– sulfides veins. This, most typically, occur form 272.80m to 288.35m. Porphyritic texture is obscured by alteration in this zone.

Microscopic observation shows that mudstone mainly consists of less than 0.1 mm across, detrital grains of quartz and minor plagioclase and they are associated by secondary minerals such as sericite, calcite and chlorite. Sandstone is well sorted and fine grained consisting of dominant quartz and minor plagioclase grains of 0.1 mm to 0.2 mm across. The fine diorite porphyry, that occurs from 52.40 m to 68.65 m, shows hornblende phenocryst of 1 mm to 3 mm across with subordinate plagioclase phenocryst. While the diorite porphyry, occurring deeper than 195.40 m , shows a similar amount of plagioclase and hornblende phenocrysts. The size of phenocrysts reaches 5 mm across. Secondary minerals such as quartz, sericite, calcite and chlorite are observed. When alteration increases, amount of secondary quartz and chlorite increase and phenocrysts only remains as pseudomorph.

The results of X-ray reflection analysis for 12 samples of diorite porphyry and sedimentary rocks show common alteration assemblages of chlorite – sericite – quartz with rare association of montmorillonite. Based on the alteration zoning established in the S. Imbak Sub-are during the Phase II survey, MJSI-7 seems to belong to transition zone between propylitic and phyllic zones, because of the common occurrences of chlorite and sericite.

[Mineralization]: No clear mineralization is found in sedimentary rocks of shallower than 40 m. A weak pyrite dissemination associated by pyrite films of 1 mm wide occurs in sedimentary rocks of deeper than this. The dissemination of pyrite is slightly stronger in sandstone than in mudstone. Pyrrohtite dissemination, in addition to pyrite, occurs in diorite porphyry. Rarely, fine grains of chalcopyrite occur associated with pyrrohtite. Zones of intense silicification and chloritization with length of few tens cm to few meter, sporadically, occur in diorite porphyry. In these zones, a intensity of pyrite and pyrrohtite dissemination increases associated by network of pyrite films. The most distinguished alteration in MJSI-7 occurs for a length of approximately 15 m, from 272.80m to 288.35 m. Within the zone, 30 cm across (274.85m to 275.15m) patches or vein of sulfides consisting of pyrite, arsenopyrite and chalcopyrite occurs. A dense network of thin sulfides (pyrite, arsenopyrite and chalcopyrite) veins of 1 cm to 1 mm wide occurs from 276.15m to 278.15 m.

Polished sections show that pyrrohtite, pyrite and calcopyrite are sulfides disseminated in the silicified and chloritiszed diorite porphyry. While the fine diorite porphyry found from 52.40m to 68.65m shows sphalerite and galena in addition to these sulfides. The sulfides veins and veilets found in the mineralization zone from 274.85m to 278.15m consist of abundante arsenopyrite and pyrite with minor association of chalcopyrite and magnetite.Pyrite, generally, shows two types of occurrences. Euhedral grains and aggregates of very fine pyrite grains showing colloform texture. The fommer one is usually surrounded by the latter, suggesting replacement of euhedral grains to the pyrite of colloform texture in the later stage.

Assay results of Au 3.5 g/t, Ag 26.5 g/t and Cu 0.33 were obtained from the samples of sulfides patches found from 274.85 m to 275.15 m. The samples of diorite porphyry with sulfides veinlets collected for approximately 3 m span (from 275.15 m to 278.00m) immediate below sulfides patch show assay results of Au 1.6 g/t to 4.3 g/t, Ag 1.6 g/t to 17.7 g/t and Cu 0.04 % to 0.12%. Other than above, silicified and chloritized diorite porphyry samples of 1m span show low assay results of Au below than 0.1 g/t, Ag 4.6 g/t at the maximum and Cu 0.03 % at the maximum. Some of few cm wide, quartz – sulfide veins with country rocks of sandstone close to diorite porphyry (Au 2.9 g/t and Ag 58.1g/t) and with country rock of diorite porphyry (Au 5.1 g/t and Ag 71.5 g/t) show high Au and Ag.

1-3 Discussion

Mudstone, sandstone, sandstone with mud lamina and diorite porphyry intruding these sedimentary rocks were intersected by the drilling survey. The dips of the sedimentary rock observed in the drilling core is 10 to 30 degree and diorite porphyry, generally, intrudes sub-parallel to the structure of the sedimentary rocks. As shown in cross sections produced from geological survey at the vicinity of drilling site and drilling survey, the intrusion of diorite porphyry is parallel to sub-parallel on the surface and cross cutting at the depth. This, consequently, gives more volume of diorite porphyry expected in the depth than previously estimated.

Three types of diorite porphyry with clear porphyritic texture were found both from MJSI-6 and MJSI-7. The one in MJSI-6 has phenocrysts of plagioclase, hornblende and clinopyroxene and it is slightly fine grained compared with one in deeper part of MJSI-7. There is two types of diorite porphyry in MJSI-7. The one, occupying approximately 16 m of core length at shallower level is fine grained diorite porphyry with hornblende phenocryst and it shows similar appearance to andesite. The other one, occupying deeper level from 195.40m to the bottom of the hole, has phenocrysts of coarse plagioclase and fine hornblende. The relationships between these three diorite porphyries are not known. Other than silicification and oxidation in the sedimentary rocks at the contact with diorite porphyry, neither clear evidence of thermal metamorphism nor chilled margin in the diorite porphyry was observed. In diorite porphyry intensity of alteration, such as chloritization, silicification and argillization, varies in places to places. Zones of these alteration sporadically occur for core length of few tens of cm to few meters. In these zones porphyritic texture is obscured and a degree of dissemination of pyrite and pyrrhotite increases.

An alteration assemblages of chlorite - sericite - quartz is commonly observed in both of MJSI-6 and MJSI-7 with rare association of mixed layer of sericite/montmorillonite and montmorillonite. Because of a common appearance of chlorite-sericite in sedimentary rocks and diorite porphyry, the area of drilling survey seems to belong to transition zone between propylitic and phyllic zones of porphyry copper type mineralization..

Mineralization is more intense in MJSI-7 and in diorite porphyry than in MJSI-6 and in sedimentary rocks. Weak pyrite, pyrrhotite and rarely chalcopyrite dissemination prevail all through diorite porphyry. The intensity of dissemination increase in accordance with silicification and chloritization. The most conspicuous mineralization in two holes is found from 272.80 m to 288.35 m at MJSI-7 where network of thin (1 cm to 1 mm wide) pyrite - arsenopyrite - chalcopyrite veins occurs coupled with dissemination of pyrrhotite, pyrite and chalcopyrite. The samples of approximately 3 m span (from 275.15m to 278.00 m) within this zone show assay results ofAu 1.6 g/t to 4.3 g/t, Ag 1.6 g/t to 17.7 g/t and Cu 0.04 % to 0.12%.Other than this, some of few cm wide, quartz - sulfide veins with country rocks of sandstone close to diorite porphyry (Au 2.9 g/t and Ag 58.1g/t) and with country rock of diorite porphyry (Au 5.1 g/t and Ag 71.5 g/t) show high Au and Ag. As same as previous results, gold seems to be associated with arsenopyrite.

Pyrites, both in dissemination and quartz – sulfides vein, generally, show two types of occurrences. One shows euhedral grains and the other is an aggregates of very fine pyrite grains showing colloform texture. The former is usually surrounded by the latter, suggesting replacement of euhedral grains to the pyrite of colloform texture in the later stage.This implies that an abrupt crystallization of iron sulfide through an episode of a circulation of relatively low temperature hydrothermal solution has occurred at the late stage of the mineralization. This texture of sulfide, suggesting low temperature environment, tends to occur in outer margin of main mineralization where weak sulfide dissemination is observed.

Combining the results of Phase I to III, the mineralization in the area is summarized as follows:
(1) The mineralization in the area is characterized by Au – Ag, Cu and Zn, and it is closely related to the intrusion of diorite porphyry.
(2) Geological environment, such as lacking volcanic rocks, alteration zones similar to those of porphyry copper type and filling temperature of fluid inclusions (300℃ to 400℃) rules out a possibility of epithermal type mineralization.
(3) Filling temperature of fluid inclusion, occurrences of silver minerals such as argentite and acanthite, occurrences of samples with high Ag compared to Au suggest a mineralization slightly away from the center of igneous activity.
(4) Similar geological environment and contemporaneous activity of porphyritic rocks to the Mamut mine.

Considering the above, the most possible environment of mineralization in the S. Imbak Sub–area North is the one found in peripheral zone of mineralization similar to porphyry copper type. Based on typical alteration zones of porphyry copper type mineralization, the center of the silicification/pyrite dissemination zone in the S. Imbak Sub–area North corresponds to phyllic zone and it is surrounded by propylitic zone.

Clear anomalies of high chargeability were delineated by the IP survey conducted in the S. Imbak Sub–area North. The anomalies show a letter "C" shape opening to eastward and have an extent of approximately 2 km(NS) × 2 km (EW) being distributed overlapping the silicification–pyrite dissemination zone and geochemical anomalies of Ag, As, Au Cu.

The drilling survey of Phase II was conducted in the area of strong IP anomalies and failed to intersect distinguished mineralization. The strong IP anomalies in the area probably reflect pyrite veins and dissemination near the surface.

Letter "C" shape IP anomaly is commonly observed in the are of porphyry copper mineralization elsewhere in the world and it is known that the main mineralization occurs in the center of letter "C" shape anomaly. If a mineralization similar to porphyry copper type exits in the S. Imbak Sub–area, the area at center of letter "C" anomaly with relatively lower IP anomaly seem to be better target for drilling. The drilling sites for Phase III was decided in the area of relatively lower IP anomaly at the center of letter "C" shape anomaly, then, it was, later, found that the area of the proposed drilling sites was covered by the area of Reserved Virgin Jungle in where cutting tree is strictly prohibited. Therefore, the drilling survey of PhaseIII was conducted shifting the drilling sites further east and it failed to intersect distinguished mineralization.

The area at the center of letter "C" shape anomaly should be examined in future.