REPORT ON THE MINERAL EXPLORATION IN SABAH, MALAYSIA

PHASE Ⅲ

MARCH, 1988

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 Government of Japan agreed to conduct a collaborative mineral exploration project to confirm the possibility of occurrence of mineral resources in Sabah region, Malaysia and entrusted the survey to the Japan International Cooperation Agency and the Metal Mining Agency of Japan. This project is designed to be carried out in three phases spaced over three years commencing at the beginning of August, 1985.

Phase III of the project consisting mainly of drilling was accomplished jointly by a Japanese team and staff of the Geological Survey of Malaysia, Sabah, in 1987.

This report summarizes the results of the afore-mentioned undertaking and also forms a part of the final consolidated report which will be submitted to the Government of Malaysia after completion of the project.

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

We with to express our deep appreciation to the Governmental Organizations of Malaysia for their close cooperation extended during the course of the project.

February, 1988

Kensuke Yanagiya
President
Japan International Cooperation Agency

Jun-ichiro Sato
President
Metal Mining Agency of Japan

Yin Ee Heng
Director-General
Geological Survey of Malaysia

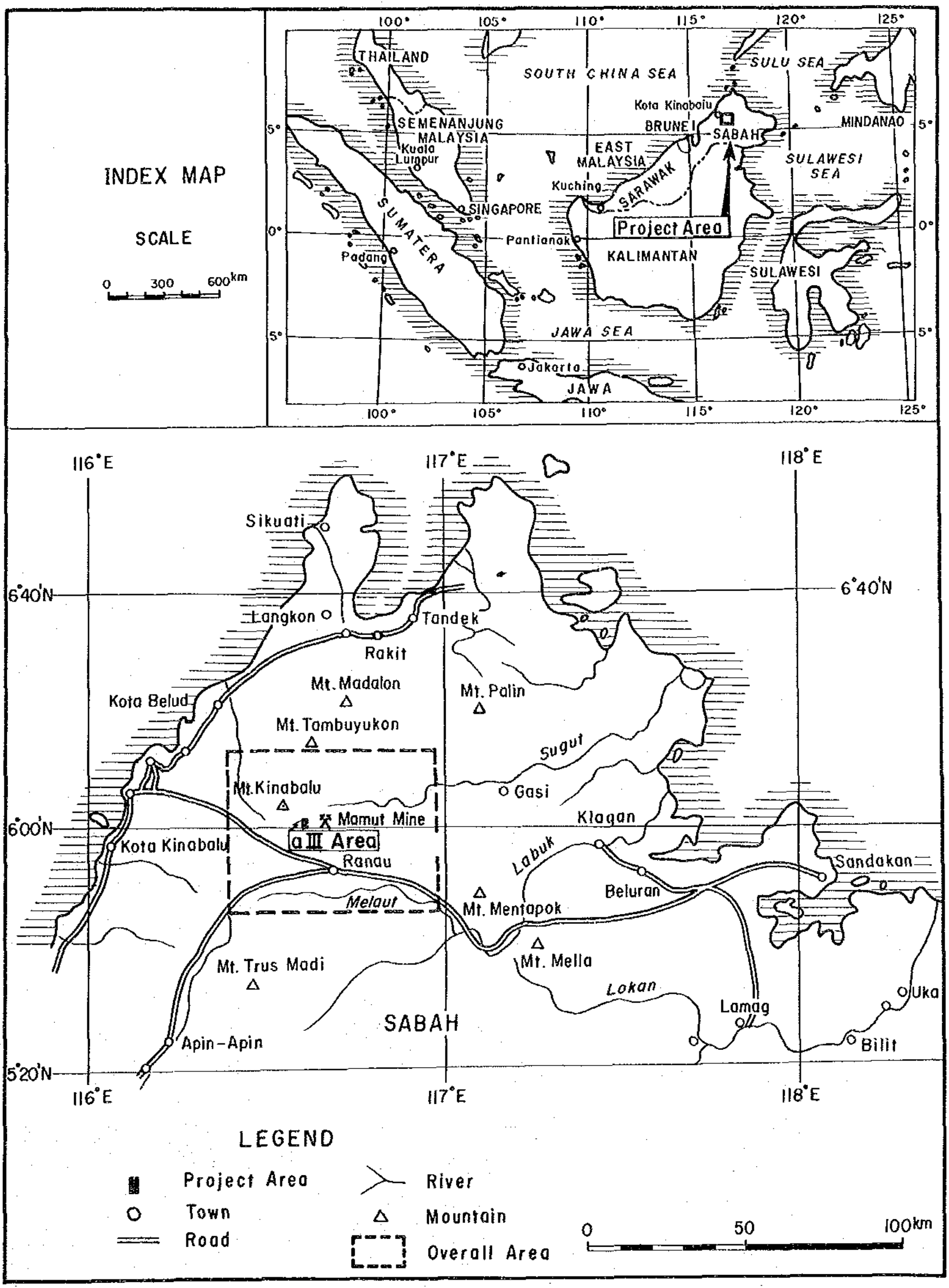


Fig. 1 Location Map of Survey Area

Contents

PART I GENERAL

PART II DRILLING

PART III CONCLUSIONS AND RECOMMENDATIONS

LIST OF ILLUSTRATIONS

LIST OF TABLES

LIST OF APPENDICS

ABSTRACT

In the Mt. Kinabalu - Ranau area, Sabah, Malaysia, thick geosynclinal sediments (from later Cretaceous to early Miocene), ultrabasic to basic igneous rocks (later Miocene) and intermediate to acidic igneous rocks (latest Miocene) are widely distributed.

The copper showings of porphyry copper type, a series of massive sulphide floats of the Cyprus-type ore deposit and the occurrence of massive chromite ore deposit have been recognized. Among all of these, the predominant one is the porphyry copper type mineralization, one of which is the Mamut copper mine now in operation since 1975.

The collaborative mineral exploration programme, in Sabah, Malaysia has the purpose to assess potential anomalies and mineral showings delineated by the previous surveys.

The geological, geochemical and geophysical survey method followed by the drilling were applied in three selected areas, namely, Bambangan, Mankadau and Paliu.

The Phase III programme consists of the drilling, conducted in the Bambangan (namely, aIII) area to confirm not only the lateral and vertical extent of porphyry copper type mineralization, but also the grade of ore, which was found in Phase I and Phase II programme.

The drill hole MJM-8, located in the west bank of Bambangan creek, were sunk for testing the geophysical IP·SIP anomalies (showing 3 - 4% of Frequency Effect).

The said IP·SIP anomalies were concluded to the result from the veinlet/network shape of disseminated chalcopyrite-pyrite.

Assay values for the mineralized sections, immediately below the thick layers of the Pinosuk Gravels (from surface to a depth of 107.80m), are as follows:

Secondary (oxidized) zone

length of drilling: 72.20m (107.80m - 180.00m)

Au 0.1 gr/t, Cu 0.12%, Mo 7ppm

Primary zone

length of drilling: 111.10m (180.00m - 291.10m)

Au 0.2 gr/t, Cu 0.44%, Mo 59ppm

Two more drill holes (MJM-11 and MJM-12) were sunk in Phase II programme to confirm the extension of the said mineralized zone, one for the north, the other for the south, of the zone, respectively.

The extensions of the mineralization discovered by the hole MJM-8 in Phase I, were also confirmed by these two drill holes, indicating a continuation of more than 400m towards north-south.

The average grade of the mineralized zone in hole MJM-12 is shown as follows:

length of mineralization: 81.7 m

Au 0.15 g/t, Cu 0.28%, Mo 33ppm

Based on the results of Phase II drilling survey, five drill holes in Phase III programme were drilled in the southern side of hole MJM-8, with the aggregate depth of 1,507.10m. Finally, the mineralized zone was confirmed to extend about 250m to the south from MJM-8, however, the grade of mineralization decreases towards the south.

As the results of three years survey, it was confirmed that the mineralized zone along the Bambangan creek is a porphyry copper type containing mostly dissemination/fine veinlets of pyrite and minor chalcopyrite.

This zone has an extension of 400M along N-S direction 200-250M along E-W, and a thickness of 90m at the central part, with an average grade of Cu 0.14%, Au 0.07 g/t, Mo 31ppm. However, this mineralized zone is overlain by the Pinosuk Gravels of 70 - 170m thick and with a grade of mineralization is very low in comparison with that from the Mamut ore deposit (Cu 0.56%, Au 0.6 g/t).

The above results seem to be suggestive that, so far as present stage is concerned a low possibility of new mine development is seen.

However, it is suggested that some mineralized zone which may be as similar zone as these of the Bambangan, occurs in some places underneath of the Pinosuk Gravels.

In A-area other than the A-1 area, two low resistivity zones were detected by CSAMT method. Among these, A-3 zone in Kundasang side seems to have a relation with mineralization, but no further survey has been done. Therefore, for this anomaly (A-3), the follow-up IP·SIP geophysical survey (and drilling based upon the results of IP.SIP survey) is considered necessary.

PART I GENERAL

Chapter 1 Introduction

1-1 Background of Survey

In the Mt. Kinabalu area, Sabah, Malaysia, ultrabasic to acidic igneous rocks are widely distributed and various types of mineralization have been known to occur, including copper mineralization of porphyry type and Cyprus-type and chromite ore deposit related to ultrabasic rocks.

Furthermore, there also occur several geochemically anomalous zones which have been found by exploration activities during the past years.

Three areas which seem to have potential for mineralization, have been selected (for the collaborative mineral exploration programme in Sabah region), namely the Bambangan, the Mankadau and the Paliu areas.

The field work for these areas has been carried out since 1985 of Phase I to clarify the geology, the geological structure, volcanic activities and the characteristics of mineralization and to delineate and evaluate the occurrence of mineralization.

The survey results of Phase I (1985) and Phase II (1986) are summarized as follows:

1. Bambangan (A, a, 100 km^2) area

Phase I programme involved the geophysical survey (CSAMT, IP and SIP methods) and the drilling, Phase II involved the geological mapping and the drilling survey, to find a significant mineralization similar to the Mamut.

The survey results are summarized as follows; the porphyry copper type mineralization occurring in the stock of adamellite porphyry and in the surrounding hornfels was disclosed in the Bambangan area.

2. Mankadau (B, b, 100 km^2) area

Phase I programme including the geological mapping, the soil geochemistry and the geophysical survey (CSAMT method) were implemented in the Lingangaa creek area, a tributary of the Mankadau river to investigate the source of floats of extremely high grade (Cu 25 - 60%) of the Cyprus-type copper ore associated with copper mineralization, as well as to test a further potential of chromite ore which was newly discovered as floats in the uppermost stream of the Lingangaa creek, and the other occurring of the chromite ore deposit in the Paranchangan.

All of these areas were covered by semi-detailed geochemical soil survey for Phase II programme together with the semi-detailed geological mapping.

However, neither sources for floats of both copper ore and chromite were detected, nor the extension of known chromite ore deposit or a new indication and anomaly were found.

3. Paliu (c, 4km²) area

Phase I programme including the geological mapping and stream sediment/soil geochemistry, followed by the trenching survey of Phase II, was conducted in the area to clarify the nature of known Cu-Pb-Zn geochemical anomalies.

However, no anomalous zone and mineralization to warrant further exploration were detected.

1-2 Conclusions and Recommendations of Phase II Survey

1-2-1 Conclusions of Phase II Survey

The conclusions obtained from the result of Phase II survey in each area are as follows:

1. Bambangan area

(1) The mineralized zone in adamellite porphyry intersected by the drill hole MJM-8 occurs also in hornfels and peridotite.

(2) The stock of microdiorite near the mineralized zone controls the distribution of mineralization.

(3) The area of mineralization seems to occur in the stock of adamellite porphyry and in the surrounding host rock with an elliptical shape, spreading the area of about 600m in N-S direction and about 300m in E-W direction.

(4) The pyritized zone in the hole MJM-5 of Phase I was not confirmed by the hole MJM-13 of Phase II.

2. Mankadau area

Regarding the floats of massive sulphide copper ore, its source and occurrence were unrecognizable, despite of the geological survey and the soil geochemistry covering wide areas in Phase II.

It is almost confirmed that the indication of chromite mineralization is partial and small in scale, because of the discovery as only floats during Phase I and the survey of the Paranchangan outcrop in Phase II.

It is assumed that the zone of pyrite impregnation in the west part of the survey area has a low potentiality to develop into a large scaled ore deposit due to its limited occurrence.

3. Paliu area

The result of ten trenches made in the weakly anomalous zone shows a little significant values of the chemical analysis for both Pb content in No. 2 trench and Au content in No. 6 trench, but no continuity of the mineralization could be traced as well as these in the other trenches.

1-2-2 Recommendations for Phase III Survey

The recommendations for Phase III survey based on the result of Phase II survey is as follows:

Regarding aIII (Bambangan) area, the diamond drilling is recommended to confirm the extension of the mineralized zone, detected in the central zone, which is delineated as porphyry copper type mineralization.

For bII (Mankadau) area and cII (Paliu) area, no further survey is advisable, since the area shows a poor mineralization and is not worthwhile for the exploration.

1-3 Outline of Phase III Survey

1-3-1 Survey Area

The survey area, as shown in Fig I and Fig I-1, was a small area (as aIII) of the Bambangan, within A area (100km²), where the mineralized zone was obtained in the northern end of the same area of Phase I and Phase II.

The area is located 2.5km west of the Mamut mine which is 12km NNW of Ranau.

The Ranau town is located 70km direct east from Kota Kinabalu, the state capital of Sabah.

Within the survey area (aIII) the water intake for the Mamut mine is located and there is a gravel road which belongs to the mine, so that the accessibility is rather convenient.

1-3-2 Purpose of Survey

Based on the recommendations of phase II survey, the phase III drilling aimed at checking a southousand lateral and vertical extension of the mineralized zone along the Bambangan creek, and charifying its occurrence and grade in order to assess its potential for development.

1-3-3 Method of Survey

To achieve the above-mentioned purposes, five drill holes were allocated in the southern side of the hole MJM-8, including two holes (MJM-14, MJM-15) in east side and the rest of three holes in west side of the Bambangan creek (Fig.II-1).

			Drill Length m	
Hole No.	Bearing	Inclination	Planned	Actual
MJM-14	-	-90°	300	301.00
MJM-15	-	-90°	300	300.60
MJM-16	-	-90°	300	304.00
MJM-17	-	-90°	300	301.00
MJM-18	-	-90°	300	300.50
Total			1,500	1,507.10

Two drilling machines equipped with a wire-line (TGM-2C and TGM-5) were used. All holes were drilled in "BQ" size and the core recovery was kept as high as possible.

The core samples, which contain the sulphide mineralization, were chemically analysed for six elements of Cu, Au, Mo, Pb, Zn and Ag in the Geological Survey of Malaysia, Sabah, Kota Kinabalu.

For the representative core samples of rock and ore mineral, the laboratory study of thin section, polished section and X-ray diffractive analysis were carried out.

The list of analysis-test for specimens is as follows:

(Holl No.)	No. of Core Sample	(No. of Elemnts)	Rock Thin Section	Ore Polished Section	X-Ray Diffractive
MJM-14	121	(726)	3	5	2
MJM-15	91	(546)	3	3	3
MJM-16	64	(384)	2	1	1
MJM-17	84	(504)	1	3	4
MJM-18	110	(660)	3	3	3
Total	470	(2,820)	12	15	13

1-3-4 Organization of Mission

The members participating in the planning and negotiation of the survey and in the field survey are as follows.

Planning and Negotiation

Japanese Counterparts

Seiichi Ishida — Metal Mining Agency of Japan

Natsumi Kamiya — " " "

Malaysian Counterparts

Yin Ee Heng, Geological Survey (Head Office in Kuala Lumpur)

Fateh Chand, " " (" " ")

David Lee Thien Choi, Geological Survey (Sabah Office)

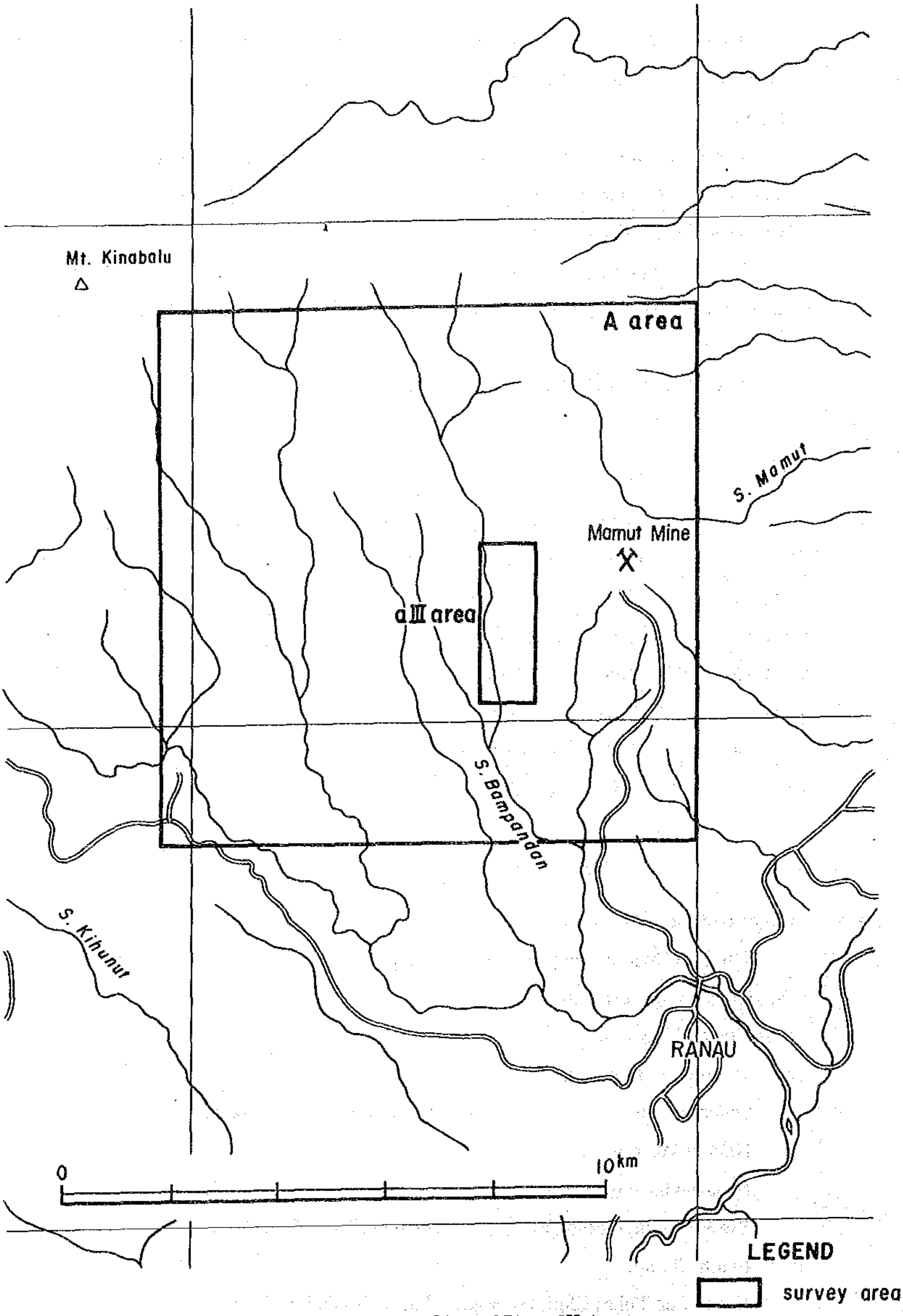


Fig. I-1 Location Map of Phase III Area

Field Survey

Japanese Team

Hajime Shimizu	(Leader; geology, geochemistry, core logging and report)	Bishimetal Exploration Co., Ltd.	(1st July- 1st Sept.)
Hirofumi Taniguchi	(Leader, core logging and report)	〃	(26th Aug.- 9th Oct.)
Tadashi Yamakawa	(Geology and geochemistry)	〃	
Mahito Hamazaki	(Drilling)	〃	
Shigeo Sekiguchi	(〃)	〃	
Takashi Satoh	(〃)	〃	
Yoshihito Masuto	(〃)	〃	
Yoshio Itoh	(〃)	〃	
Hiroshi Saito	(〃)	〃	

Malaysian Team

Lim Peng Siong	(Administration and report)	Geological Survey of Malaysia, Sabah
Francis Intang	(Core logging)	〃 〃
Chan Fook On	(Chemical analysis)	〃 〃

Technical Assistant

Japili Samin	(Drilling)	〃 〃
Roger Jinijo Totu	(〃)	〃 〃
Francis Geoffery	(〃)	〃 〃
Chua Yun Ling	(〃)	〃 〃

1-3-5 Duration of Survey

The field work was started on 1st July, 1987 and completed on 9th October, 1987. Data interpretation and report preparation were made in Japan. All the works were completed on 10th February, 1988.

The timetable of Phase III work is shown in Table I-1.

Table I-1 Timetable of Phase III Work

	July, 1987	Aug., 1987	Sept., 1987	Oct., 1987	Nov., 1987	Dec., 1987	Jan., 1988	Feb., 1988
Mobilization & Preparation	1 – 16							
Drilling Work								
Hole MJM-14	17 – 31							
Hole MJM-15	21 –	– 3						
Hole MJM-16			11 – 26					
Hole MJM-17		13 – 25						
Hole MJM-18		11 –	– 4					
Dismantlement & Demobilization			27 –	– 6				
Analysis & Compilation (in Malaysia)			27 –	– 9				
Analysis & Compilation (in Japan)				10 –			– 15	
Report							16 –	– 10

Chapter 2 Geography of Survey Area

2-1 Topography and River System

The area for survey (aIII) is located within the area showing a steep topography.

The Bambangan area is located around the steep portion on the south-east side of Kinabalu mountain. The highest point in the northern end of the survey area lies at an elevation of 1,833.20m ASL, decreasing the elevation towards south. The lowest point in the south end of the area has an elevation of 1,300m ASL, and the topography changes to the elevated plain. Bambangan valley running to the south with a rapid current forms a deeply desected V-shaped valley with steep cliffs on both sides. The eastern part of the area has a topography of steep cliff in places due to the occurrence of hard portion of "solid" Pinosuk Gravels.

The river systems run from north to south where the Bambangan creek is joining into Liwaou river in Ranau area, then running to east direction.

2-2 Climate and Vegetation

Climate in Sabah state is tropical and oceanic.

Ranau area belongs to the inland region, it has been said that the period of the rainy season is from October to the following February, next year. However, the seasonal change of precipitation is rather small.

The annual precipitation in the mountainous area is from 1,500 to 2,000 milimetres and exceeds more than 3,000 milimetres in the mountains. The annual precipitation in Mamut mine falls in the range of 2,100 milimetres to 4,000 milimetres.

No seasonal variation of the temperature is clearly recorded. It varies from 12°C to 22°C in the mountainous area, showing a notable daily variation. The humidity is high throughout the region.

The area is located in the midst of the densely tall and dwarf trees, harbaceous plants and ferns grow very thick due to the high moisture, leading to take time for making the route for drilling.

Chapter 3 General Geology

The Geology of the project area including Mt. Kinabalu and its vicinity, as is shown in Fig. I-2, comprises the thick sequence of volcanic and sedimentary rocks of the "Northwest Borneo Geosyncline" overlying the crystalline basement, which are intruded in places by igneous rocks of ultrabasic to acidic composition.

1. Stratigraphy

Volcanics and sedimentary sequence of the area are divided into five units in ascending order; (1) basement, (2) Undifferentiated sedimentary and metamorphic rocks, (3) Chert-Spilite Formation, (4) Rajang Group, and (5) Pinosuk Gravels (Fig. I-3). The main lithofacies of these rocks can be summarized as follows.

(1) Basement

The basement rock around Mt. Kinabalu is generally called "Crystlline Basement" consisting of schist and gneiss of Jurassic to Triassic or older age. Small exposures of the Crystalline Basement are distributed in the headwaters of the Bambangan valley and in the western flank of Mt. Kinabalu.

(2) Undifferentiated Sedimentary and Metamorphic Rocks

This unit, which is composed of hornfels of mudstone and sandstone origin, is distributed from the northern part of Mamut mine to upstream of the Mankadau river.

(3) Chert-Spilite Formation

This formation consisting chiefly of spilitic basalt lava with interbeded chert, sandstone and mudstone is believed to be derived from basic volcanic activities of the Northwest Borneo Geosyncline of early stage, probably of late Cretaceous to Paleocene. The spilitic basalt lava is characterized by pillow structure. The Chert-Spilite Formation is well exposed to the north of the Mankadau river, though not shown in the geologic map of the Kinabalu area (Fig. I-2).

(4) Rajang Group

This is composed of the thick sedimentary sequence deposited in the Northwest Borneo Geosyncline during the Paleocene to early Miocene age. The difference of lithofacies allows the unit to be divided into the Trusmadi Formation of Paleocene to Eocene and the Crocker Formation of Oligocene to early Miocene. The stratigraphy of the two formations has not fully been established yet, as each of them indicates

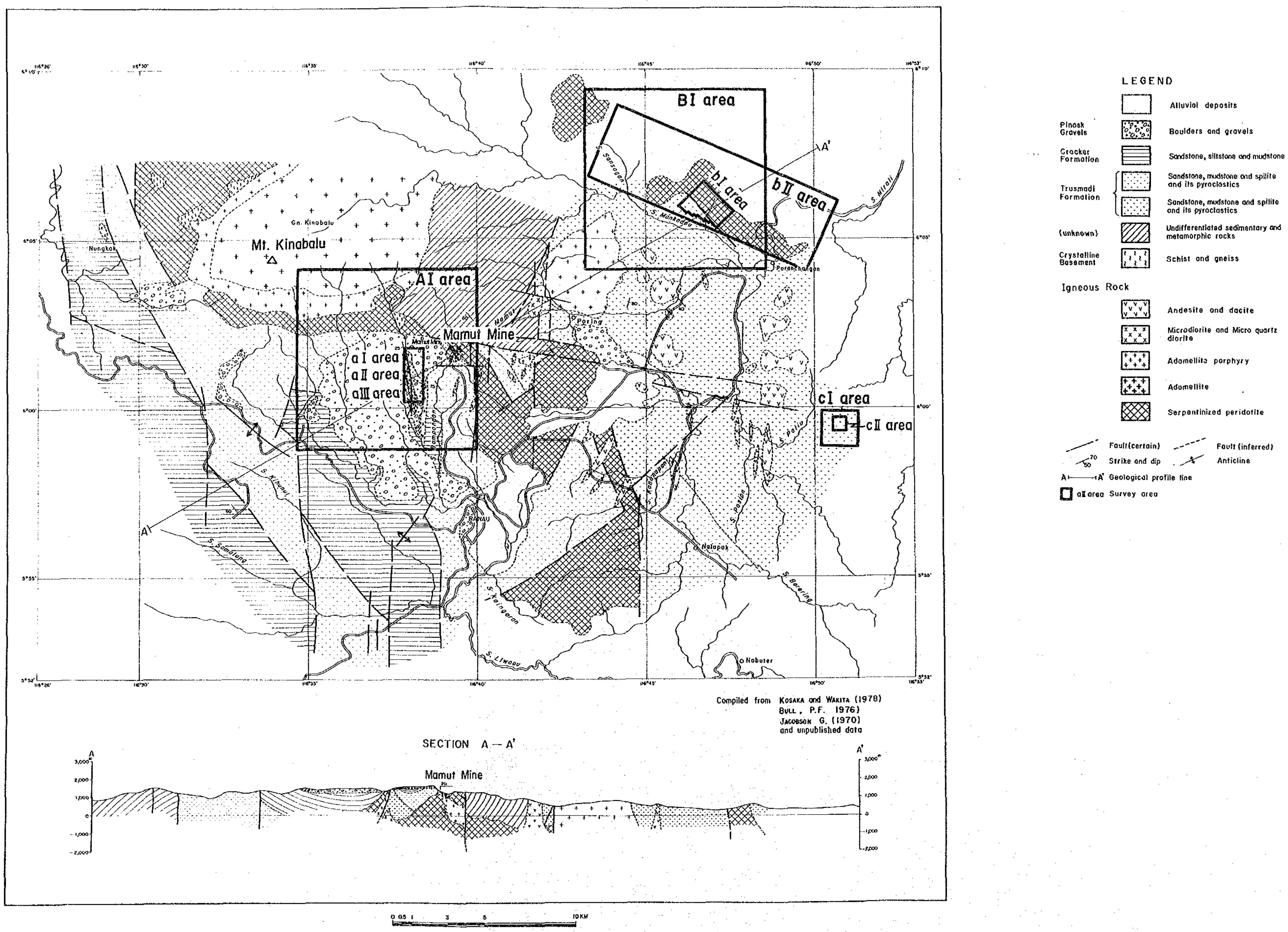
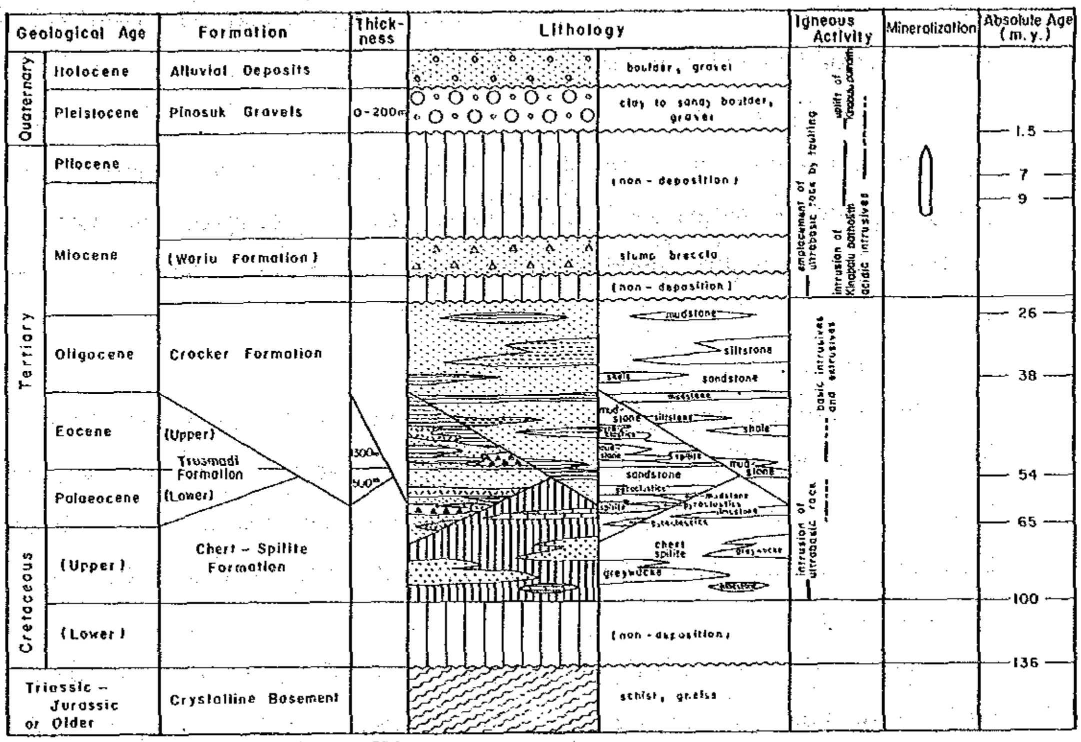
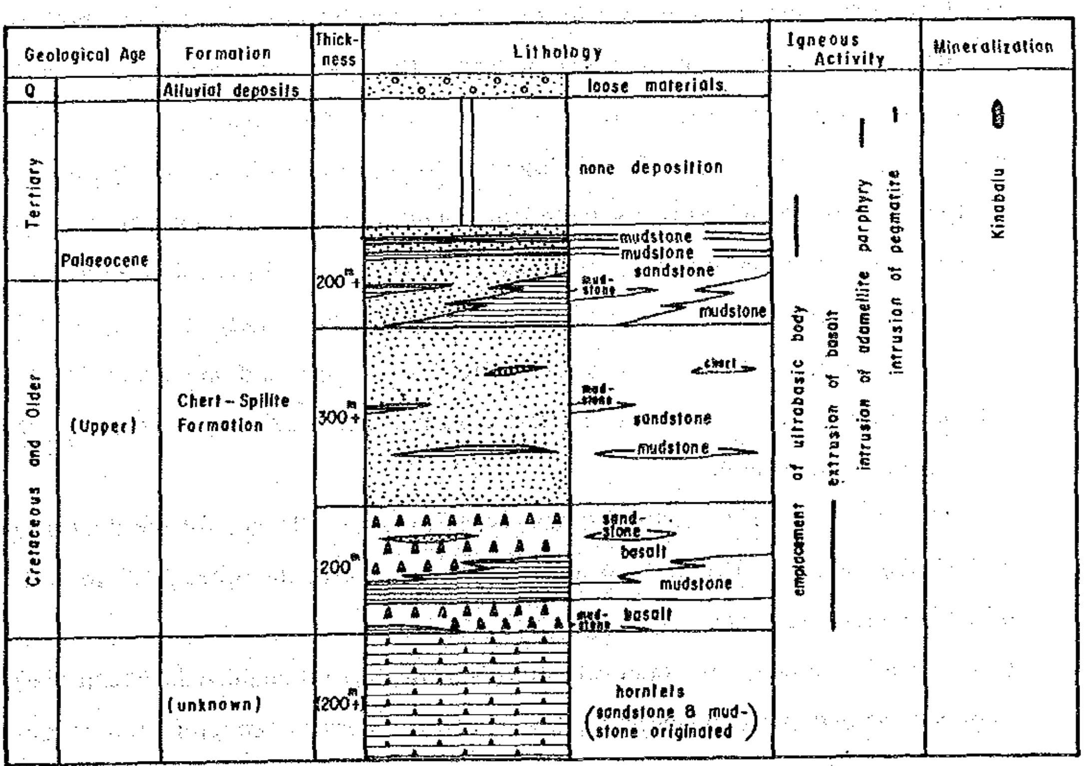


Fig. I-2 Geological Map of Kinabalu Area



(Compiled mainly from Kosaka and Wakita, 1975)

(1) Kinabalu – Ranau Region



(2) Mankadau Area

Fig. I-3 Generalized Stratigraphic Section of Kinabalu Area contemporaneous heterotopic facies in the interfingered part. The lithofacies and distribution of the two formations are given below.

(i) Trusmadi Formation

This formation is made up of gray to dark gray argillaceous rocks, slate and partly siltstone and sandstone with occasional occurrence of pyroclastic material. Its distribution is generally limited to the east side of N-S tie-line between Mamut & Ranau.

(ii) Crocker Formation

The Crocker Formation is widely exposed in the area from the west of the above N-S tie-line to Kundasang and also around the small adamellite stock of Mt. Nungkok. The Formation is chiefly composed of sandstone, siltstone and gray to red slate. Generally arenaceous facies is more dominant in this formation than in the Trusmadi.

(5) Pinosuk Gravels

Overlying the above described units are Quaternary sediments. This unit is distributed for an approximate aerial extent of 50km^2 at an elevation between 1,200 and 1,500 metres on the southern side of Mt. Kinabalu from the upper flank of the relatively gentle slope, where a steep landform of the intrusive mass comes to an end, towards the south through the Pinosuk settlement. The lower end of the unit collapsed and flowed out as mud flow to reach the Ranau floodplain on the southeast, and the large boulders have been left in the riverbed of the drainage system flowing along the western margin and in the alluvial floodplain of the Ranau basin. The pebbles are composed of every kind of rocks in the area, including adamellite, adamellite porphyry, peridotite, Tertiary sedimentary rocks, and even mineralized rocks occasionally. The size of pebbles widely ranges from 1 - 50cm to 1 - 5m, rarely reaching up to 10 - 20m. They are generally subangular and sometimes breccias and rarely round pebbles are also found. The groundmass is variably solidified, consisting of coarse-grained sand of adamellite origin.

Radiocarbon dating of buried wood has given 7,980 ± 100 years for the uppermost, and 34,000 (+2,200 - 1,800) years and 39,900 ± years for the other parts, indicating of the late Pleistocene age.

Unconformity showing on genetical differences of the bed enabled Jacobson (1970) to divide the bed into two layers; the lower section consists of conglomerate resulting from periglacial phenomena during the ice age of Mt. Kinabalu, while the upper section consists of sediments of mudflow from high peaks partly containing reworked glacial moraine.

2. Intrusive Rocks

Around Mt. Kinabalu there are various kinds of intrusive rocks, which are chiefly composed of adamellite and peridotite. Their characteristics are summarized as follows.

(1) Adamellites

Adamellite is an intrusive batholith constituting the main part of Mt. Kinabalu, showing a peculiar landform with an altitude of 4,101 metres ASL. Its exposure has an area of 155 square kilometres (i.e., 60 square miles) extending rather northeasterly, whereas its subsurface distribution is considered to spread over 500 square miles (i.e. 1,300 square kilometres) (Jacobson, 1970).

Therefore, the surface and subsurface distribution of adamellite batholith extends over the whole project area. Its periphery tends to be porphyritic, particularly on the southern and western slope zonally around Mt. Kinabalu.

It is also exposed north of the Poring settlement, forming a low maintain mass, and extending northeasterly with an elevation of about 750 metres and a diameter of 5 kilometres.

The whole area of Mamut ore deposit which is adjacent to the south of Mt. Kinabalu, is considered to lie on the extent of batholith.

The cupolas or apophyses branched off from the adamellite batholith of Mt. Kinabalu resulted in the formation of adamellite porphyry stock, which is considered to be genetically related to mineralization of the Mamut deposit, and formation of dikes abundantly occurred on the top and periphery of Mt. Kinabalu. The adamellite porphyry stock, which has a surface extent of about 800 metres in N-S and 300 metres in E-W with an eastward dip of 40°, (Kosaka and Wakita, 1975), forms the major host rock of the Mamut deposit.

Radiometric date of adamellite intrusives has 9m.y., corresponding to the later stage of the orogenic movement which took place from late Miocene to early Eocene, or immediately after that age.

(2) Peridotite

Peridotite in the project area lies in the southern and western parts of the Kinabalu mountain mass, in the southeastern part of Mamut and in the southwest of Ranau.

The rocks are mostly peridotite and local dunite. These rocks have been sheared and fractured into breccias in many cases. Serpentinization is generally observable. In

Sabah State, peridotite often occurs in contact with spilitic basalt lava of the Chert-Spilite Formation, and it shows a broad distribution in southern fault contact with spilitic basalt lava.

The age of peridotite intrusion is considered to be late Cretaceous, earlier than adamellite intrusion.

3. Alteration

Contact metamorphism, which resulted from the intrusion of adamellite batholith of Mt. Kinabalu, develops in the Rajang Group, particularly in the Trusmadi Formation close to the batholith (east to south of Mt. Kinabalu). A zone of contact metamorphism of hornfels generally extends over 1,500 metres from the contact with the batholith.

4. Geologic Structure

The project area is regionally located in the tectonic zone called "Kinabalu Fault" (Tokuyama and Yoshida, 1974) which is characterized by NW-SE trending strike-slip faults, where intrusive and extrusive igneous activities of ultrabasic to acidic rocks are predominant.

N-S trending faults in addition to NW-SE fault system also predominate in the project area around Mt. Kinabalu. Subsequent block movements occurred repeatedly in the formations distributed east to south of Mt. Kinabalu, with the southern and eastern side of the block slipped down. E-W and NE-SW trending faults, which are smaller in scale than those of NW-SE and N-S systems, are also present in the project area, giving a local control on the geologic structure.

Chapter 4 Overall Discussion of Survey Result

It was confirmed, by drilling in Phase III, the occurrence of the mineralized zone in the Bambangan creek, the characteristics of mineralization and its extension.
For this year, as the last phase of the collaborative mineral resources exploration survey, the potential of the occurrence of ore deposit was discussed.

1. The mineralized zone is of a porphyry copper type, forming in hornfels and peridotite and adamellite porphyry stock intruded along N-S direction in the Bambangan creek. An occurrence is as similar as these of the Mamut.

2. The ore minerals consist of pyrite and chalcopyrite accompanying a minor amount of molybdenite. In a shallow zone of the drill holes, it is found cuprite, tenorite, chalcocite and native copper, all as secondary minerals forming a weak oxidized zone.

3. The intensity of mineralization is different among host rocks, as it is predominant in adamellite porphyry stock as well as in hornfels occurring in the surrounding area of an intrusive mass.
   The mineralization becomes gradually weak as it goes away from the boundary zone. The mineralization in peridotite is weak and local.

4. The intrusive of adamellite porphyry stock is, as shown in Map I-4, of ellipsoidal shape, extending to N-S direction, and plunges to south.

5. The mineralized zone occurs around adamellite porphyry stock, and extends to the surrounding rocks. Based on the drilling results of 5 holes in Phase III together with those in Phases I and II, the mineralized zone seems to extend about 400 m in N-S direction and about 200-250 in E-W direction with a thickness of 90 m at the center.

6. Regarding the grade, the average value is as follows;
   1) 96m, Cu 0.06%, Au 0.04 g/t, Mo 24 ppm, for five holes in Phase III
   2) 91.4m, Cu 0.14%, Au 0.07 g/t, Mo 31 ppm for seven holes including MJM-8 and MJM-12. For reference, the average grade for MJM-8 in Phase I are:
      110m, Cu 0.44%, Au 0.2 g/t, Mo 59 ppm

and for MJM-12 in Phase III are:

51m, Cu 0.35%, Au 0.06 g/t, Mo 36 ppm

The above-mentioned figures show a much lower grade than those of the Mamut ore deposit (i.e. Cu 0.56%, Au 0.6 g/t).

7. The Pinosuk Gravels covers the mineralized zone with a thickness of 70 - 170m, as shown in Map I-4.

8. As stated above, the mineralized zone, discovered in the Bambangan creek, has a low possibility for becoming an economical ore deposit.

9. However, the discovery of blind mineralized zone under the thick Pinoruk Gravels by geophysical survey and drilling is much significant from the geological and exploratory points of view, which suggests a potential for existence of similar mineralized zones under the Gravels.

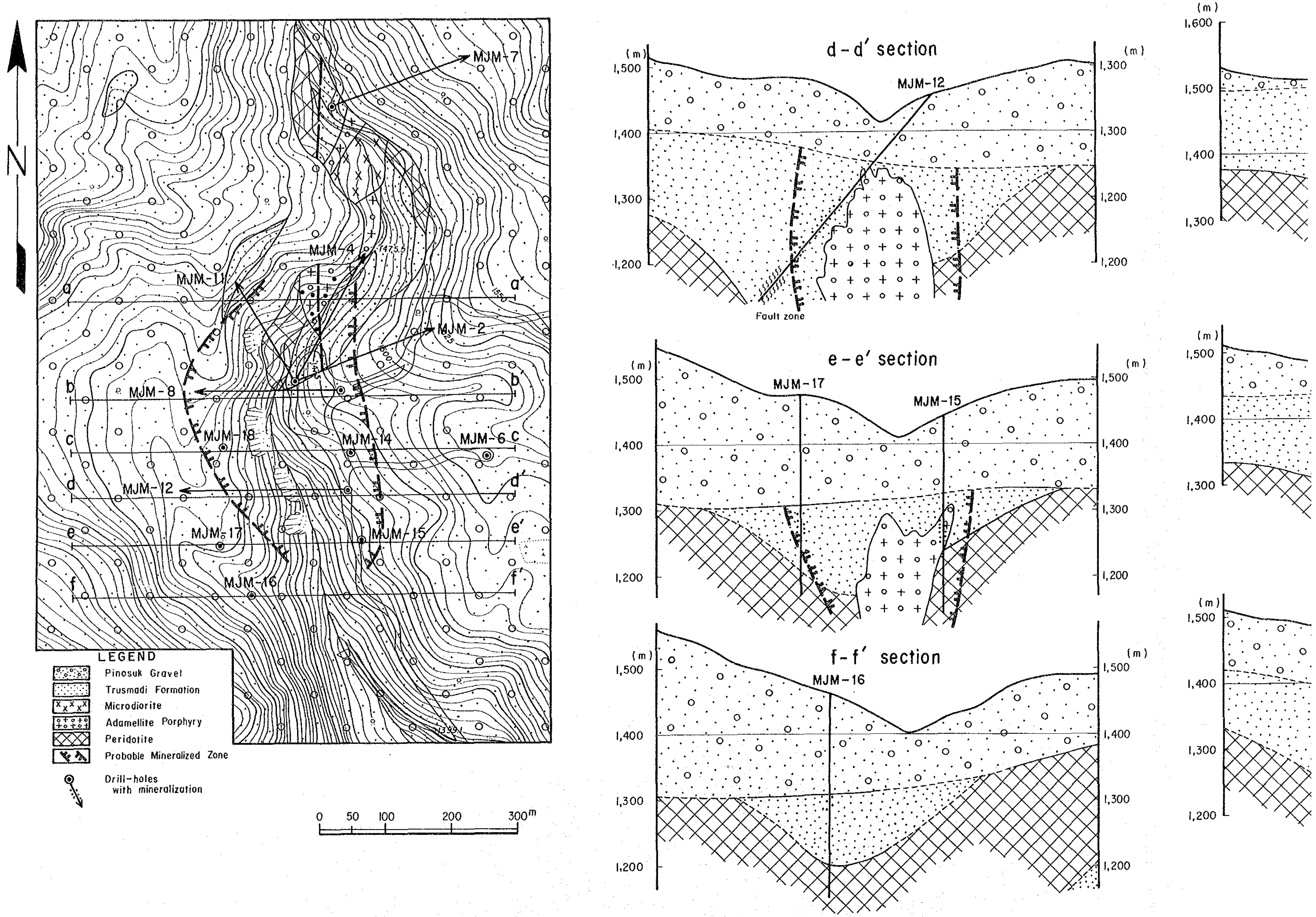


Fig. I-4 Geological Map of Drilling Survey Area and Profiles

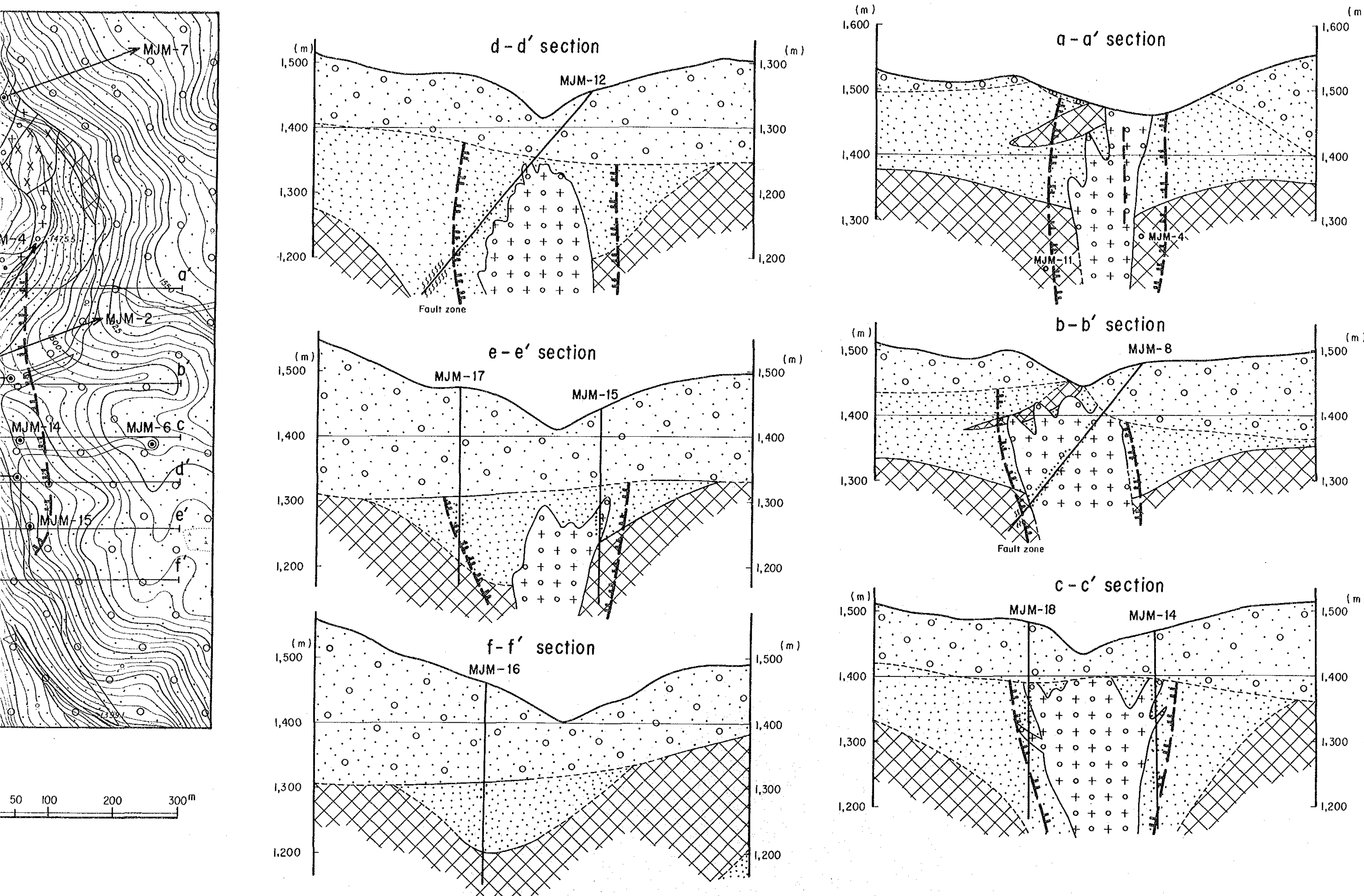


Fig. I-4 Geological Map of Drilling Survey Area and Profiles

Chapter 5 Conclusions and Recommendations

5-1 Conclusions

A porphyry copper type mineralized zone was discovered underneath thick Pinosuk Gravels in the Bambangan creek. However, its average grade of mineralized zone of seven drill holes (consisting MJM-8 and MJM-12 of Phase I and II, MJM-14 ~ MJM-18 of Phase III) is very low, with 91.4m in length of drilling vertical and with the grade of Cu 0.14%, Au 0.07 g/t, Mo 31 ppm (even though containing a better part of Cu 0.35 - 0.44% partially). The mineralized zone is covered by thick Pinosuk Gravels (70 - 170m thick). Therefore, it is thought that the mineralized zone presents a rather small economical value and consequently low potential for development so far at present stage is concerned.

However, it is suggested that some mineralized zone which may be the similar zone to these of the Bambangan, could be occurred in some places underneath the Pinosuk Gravels.

5-2 Recommendations

According to the above conclusions, no further exploration for the mineralized zone in the Bambangan area is seen necessary.

However, in A area other than A-1 area, two low resistivity zones were detected by CSAMT method. Among these, A-3 zone in Kundasang side seems to have a relation with meneralization, but no further survey has been done. Therefore, for this anomaly (A-3), the follow up IP.SIP method survey (drilling based upon the results of IP SIP survey) is considered necessary.

PART II DRILLING

Chapter 1 Drilling Method

1-1 Allocation of Holes

The location of the drill holes was selected in the south side of the hole MJM-8 to confirm the lateral and vertical extension of mineralized zone together with ore grade.

The allocation of five holes in Phase III is shown in Fig.II-1. .

1-2 Drilling Method

Regarding casing programme, for the portion of overburden, firstly the hole was started, using HW casing pipe equipped with diamond shoe. Secondly, inserting the NW casing pipes with diamond shoe, the work were continued by NQWL with diamond bit. Top part of the ground in all holes consists of the Pinosuk Gravels, having a fragile character. Therefore in the same drilling process, after drilling by NQWL, the diametre of hole were enlarged using NW casing. When NW casing pipe can not be inserted, it was started to drill by NQWL.

If the hole encountered the fractured zone before the depth of BW casing pipe to be inserted and the fractured zone showed the low or high water pressure, the cementation method was applied.

For the drilling, bentonite mud water method was applied, more-over mud water mixed with CMC mud oil and mud fluid ("Libonite") was used when the hole encountered the sheared zone or the Pinosuk Gravels.

1-3 Drilling Machine and Consumed Materials

The drilling machines consists of a set of Tone Boring TGM-5 and a set of TGM-2C (both drilling capacities are 510m in NQ size and 660m in BQ size). For the pump and mixer, the engines were overhauled before use.

The specifications of drilling machines and pumps, diamond bits and the details of consumed materials such as bentonite, light oil and mud materials are shown in Tables II-1, 2, 3.

1-4 Form of Works

For the preparations of drilling site, removal and dismantlement of drilling machine, one shift per day was applied, and the drilling work was done by three shifts of eight hours each in a day. The number of personnel for drilling work per shift were five, consisting of one Japanese engineer, one counterpart from the Geological Survey of Malaysia, Sabah and three local employees.

Results of the time table of drilling work are shown in Table II-4, the summary record of drilling results is in Table II-5, progress record of diamond drilling is in Fig.II-2.

1-5 Transportation of Machines, Equipments, Materials, and Preparatory Work

Immediately after the arrival of crew members, the preparatory work were carried out;

. maintenance of road leading to the drill site,

. the ground levelings of the site of holes MJM-14 and MJM-15,

. transportation of two machines, auxiliary equipments and materials which have been kept in the advanced base camp of the Geological Survey of Malaysia, Sabah near Batu-2 in Ranau.

(The starts of drilling work of MJM-14 hole and MJM-15 hole were on July 17 and on July 21, respectively.)

1-6 Water Supply

The water for drilling work of hole MJM-15 was collected from the upper reach of Bambangan creek, using a line of plastic pipe with a length of 250m.

For the other holes, the water was supplied from the upper reach of the creek nearby. The distances were 200m for hole MJM-14, 250m for hole MJM-18, 300m for hole MJM-17 and 300m for hole MJM-16.

1-7 Dismantlement

After the completion of drilling work, all items were collected, then the machines and equipments were shipped back to Japan, except some items which were donated to the Geological Survey of Malaysia in Kota Kinabalu.

All cores were put in the core box, and transferred to the office of Geological Survey of Malaysia, Sabah.

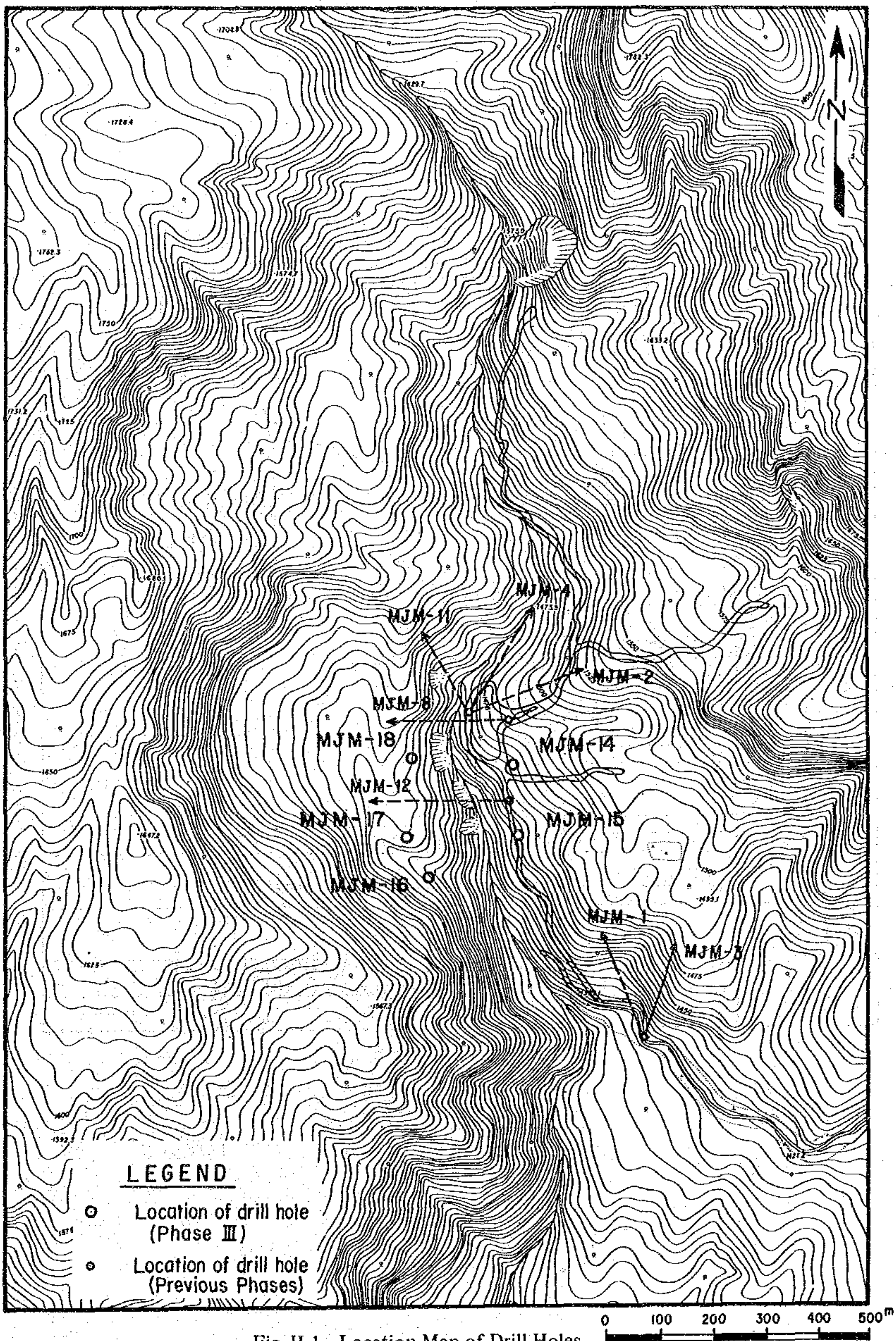


Fig. II-1 Location Map of Drill Holes

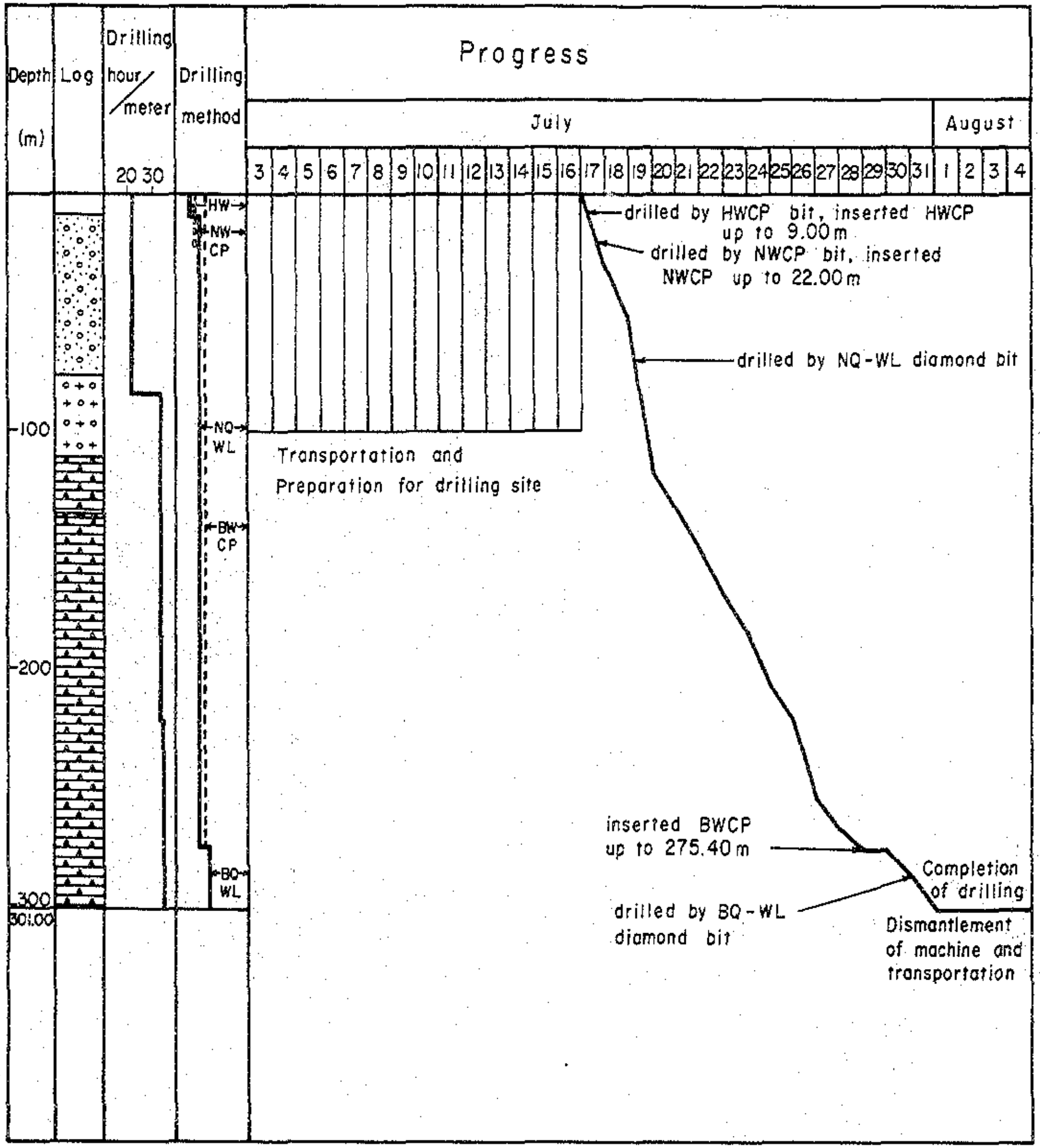


Fig. II-2-1 Progress Record of Drilling (MJM-14)

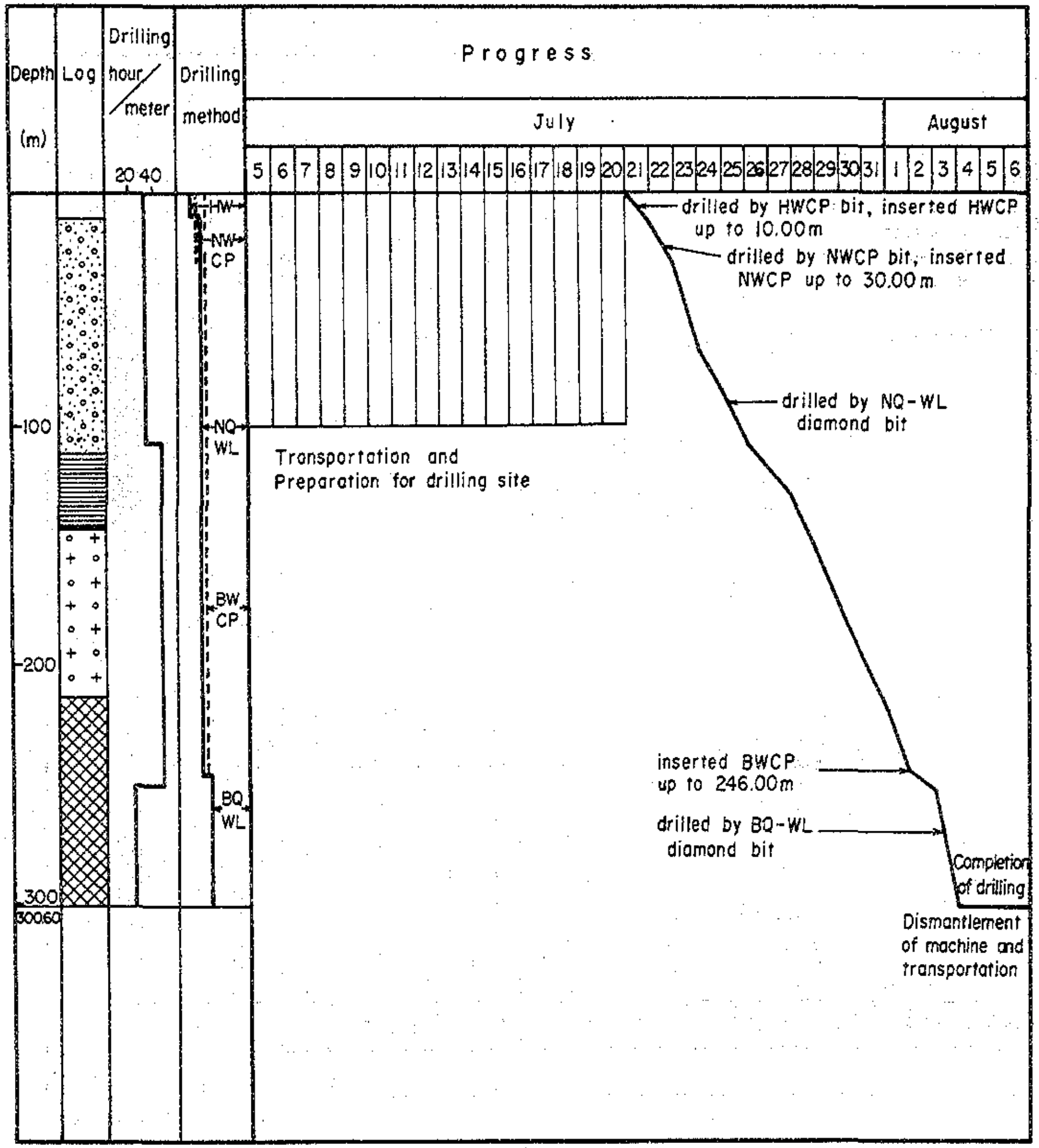


Fig. II-2-2 Progress Record of Drilling (MJM-15)

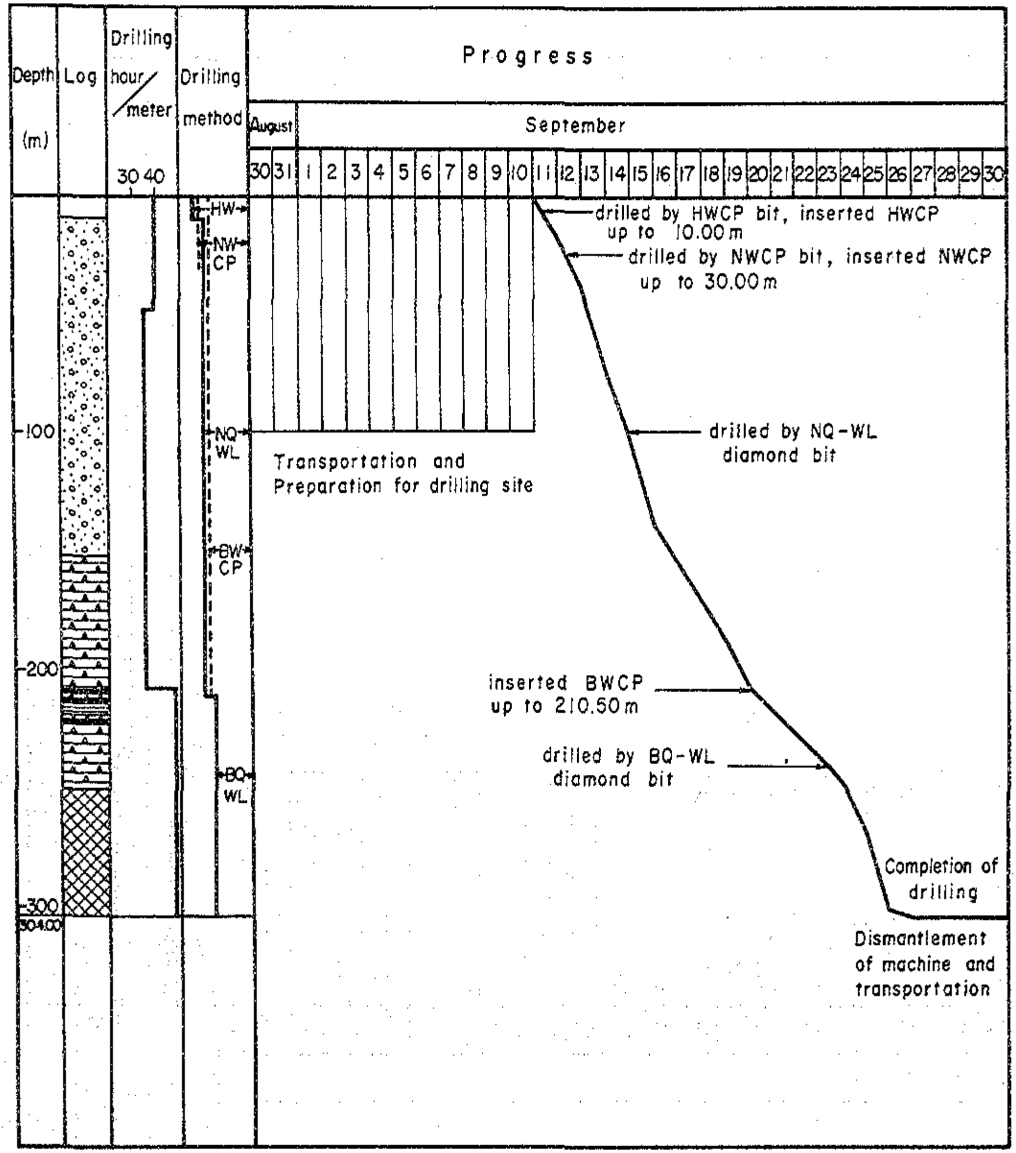


Fig. II-2-3 Progress Record of Drilling (MJM-16)

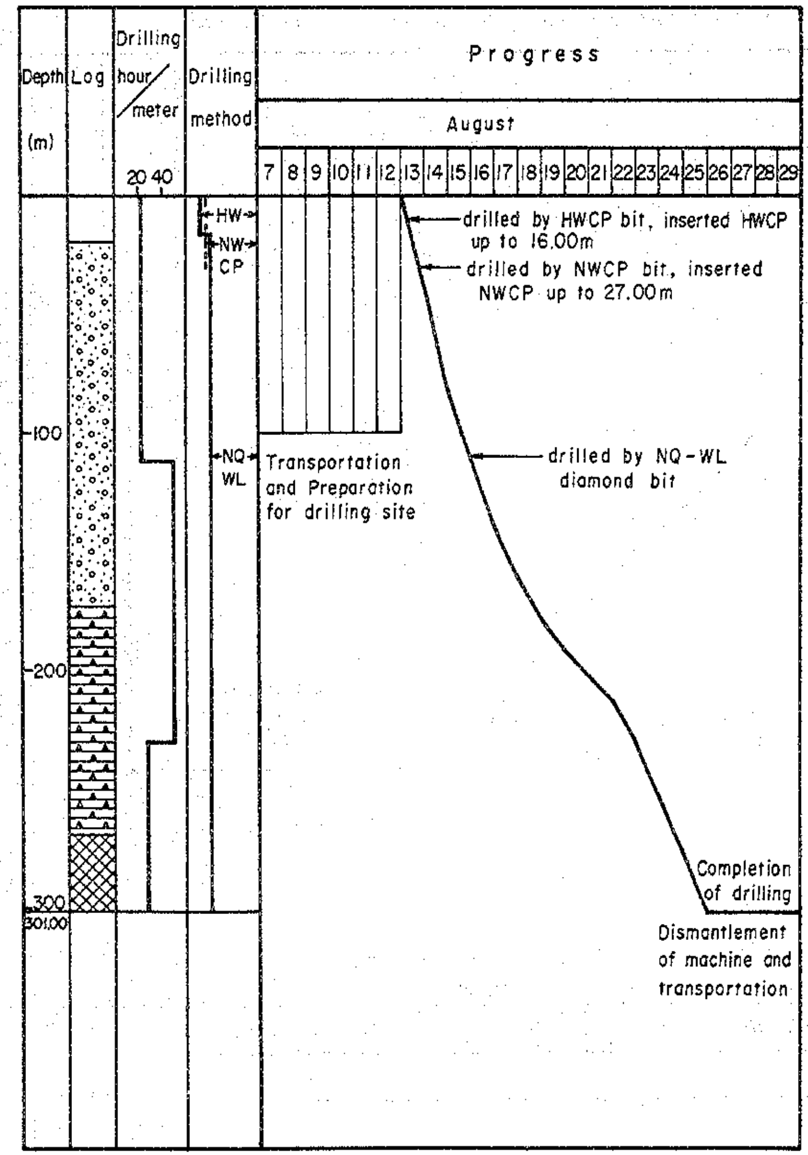


Fig. II-2-4 Progress Record of Drilling (MJM-17)

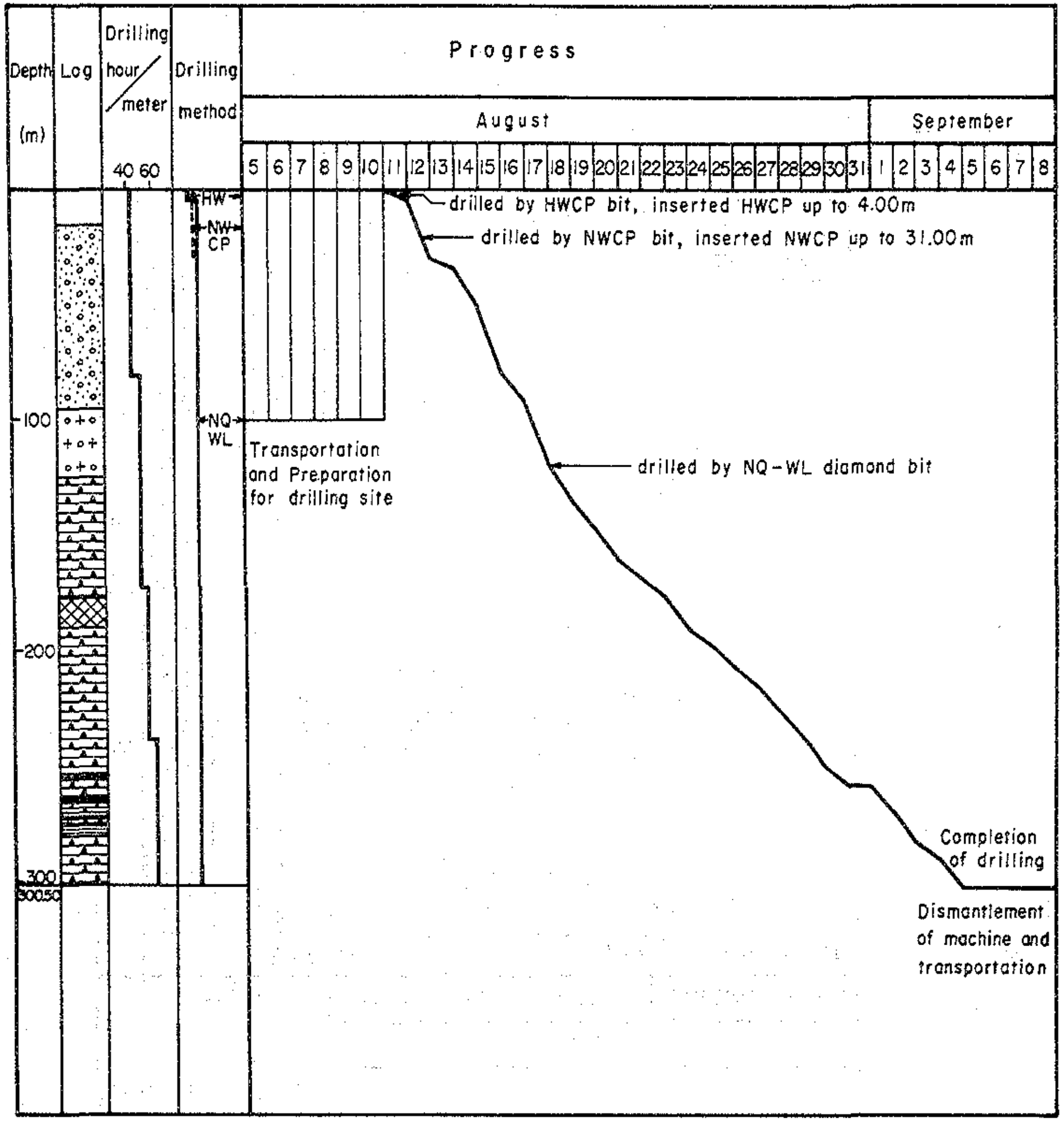


Fig. II-2-5 Progress Record of Drilling (MJM-18)

Table II-1-1 Specification of Drilling Machine (MJM-14)

Drilling Machine TGM-2C	1 set		
Specifications:			
Capacity	660m (BQWL)		
Dimensions LxWxH(mm)	2,430×990×1,520		
Hoisting capacity	2,200 kg		
Spindle speed (r.p.m.)	Forward 170, 405, 630, 825		
Engine	"F3L-912"		
Drilling Pump "NAS-3C"	1 set		
Cylinder bore dia.	75mm		
Capacity	22, 130ℓ/min		
Engine	"NS-130C"		
Water supply pump "NES-100B"			
Capacity	100ℓ/min		
Engine	"NS-65"		
Wire line Hoist "WHS-600"	1 set		
Rope capacity	600m		
Engine	Drilling machine's engine power take off		
Mud Mixer "MLE-100"	1 set		
Capacity	125ℓ		
Engine	"NS-65"		
Generator	1 set		
	YAMMAR Model "YSG-2SN"		
Drilling Tools			
Drilling Rod	NQ-WL	3.0m	92 pcs.
	BQ-WL	3.0m	101 pcs.
Casing Pipe	HW	1.0m	9 pcs.
	NW	1.0m	22 pcs.
	BW	3.0m	92 pcs.
Derrike	1 set		
	Model "DRP-9-5"		

Table II-1-2 Specification of Drilling Machine (MJM-15)

Drilling Machine TGM-5	1 set		
Specifications:			
Capacity	660m (BQWL)		
Dimensions LxWxH(mm)	2,720x1,130x1,640		
Hoisting capacity	2,200 kg		
Spindle speed (r.p.m.)	Forward 170, 405, 630, 825		
Engine	"F3L-912"		
Drilling Pump "NAS-3T4"	1 set		
Cylinder bore dia.	75 mm		
Capacity	22, 130ℓ/min		
Engine	"TS-155C"		
Water supply pump "NES-100"			
Capacity	100ℓ/min		
Engine	"NS-65"		
Wire line Hoist "WHS-600"	1 set		
Rope capacity	600m		
Engine	Drilling machine's engine power take off		
Mud Mixer "MLE-100"	1 set		
Capacity	125ℓ		
Engine	"NS-65"		
Generator	1 set		
	YAMMAR Model "YDG-2000E"		
Drilling Tools			
Drilling Rod	NQ-WL	3.0m	83 pcs.
	BQ-WL	3.0m	101 pcs.
Casing Pipe	HW	1.0m	10 pcs.
	NW	1.0m	30 pcs.
	BW	3.0m	83 pcs.
Derrike	1 set		
	Model "DRP-9-5"		

Table II-1-3 Specification of Drilling Machine (MJM-16)

Drilling Machine TGM-5	1 set		
Specifications:			
Capacity	660m (BQWL)		
Dimensions L×W×H(mm)	2,720×1,130×1,640		
Hoisting capacity	2,200 kg		
Spindle speed (r.p.m.)	Forward 170, 405, 630, 825		
Engine	"F3L-912"		
Drilling Pump "NAS-3T4"	1 set		
Cylinder bore dia.	75mm		
Capacity	22, 130ℓ/min		
Engine	"TS-155C"		
Water supply pump "NES-100"			
Capacity	100ℓ/min		
Engine	"NS-65"		
Wire line Hoist "WHS-600"	1 set		
Rope capacity	600m		
Engine	Drilling machine's engine power take off		
Mud Mixer "MLE-100"	1 set		
Capacity	125ℓ		
Engine	"NS-65"		
Generator	1 set		
	YAMMAR Model "YDG-2000E"		
Drilling Tools			
Drilling Rod	NQ-WL	3.0m	71 pcs.
	BQ-WL	3.0m	102 pcs.
Casing Pipe	HW	1.0m	10 pcs.
	NW	1.0m	30 pcs.
	BW	3.0m	71 pcs.
Derrike	1 set		
	Model "DRP-9-5"		

Table II-1-4 Specification of Drilling Machine (MJM-17)

Drilling Machine TGM-5	1 set		
Specifications:			
Capacity	660m (BQWL)		
Dimensions LxWxH(mm)	2,720x1,130x1,640		
Hoisting capacity	2,200 kg		
Spindle speed (r.p.m.)	Forward 170, 405, 630, 825		
Engine	"F3L-912"		
Drilling Pump "NAS-3T4"	1 set		
Cylinder bore dia.	75mm		
Capacity	22, 130ℓ/min		
Engine	"TS-155C"		
Water supply pump "NES-100"			
Capacity	100ℓ/min		
Engine	"NS-65"		
Wire line Hoist "WHS-600"	1 set		
Rope capacity	600m		
Engine	Drilling machine's engine power take off		
Mud Mixer "MLE-100"	1 set		
Capacity	125ℓ		
Engine	"NS-65"		
Generator	1 set		
	YAMMAR Model "YDG-2000E"		
Drilling Tools			
Drilling Rod	NQ-WL	3.0m	101 pcs.
Casing Pipe	HW	1.0m	16 pcs.
	NW	1.0m	27 pcs.
Derrike	1 set		
	Model "DRP-9-5"		

Table II-1-5 Specification of Drilling Machine (MJM-18)

Drilling Machine TGM-2C	1 set		
Specifications:			
Capacity	660m (BQWL)		
Dimensions LxWxH(mm)	2,430x990x1,520		
Hoisting capacity	2,200 kg		
Spindle speed (r.p.m.)	Forward 170, 405, 630, 825		
Engine	"F3L-912"		
Drilling Pump "NAS-3C"	1 set		
Cylinder bore dia.	75mm		
Capacity	22, 130ℓ/min		
Engine	"NS-130C"		
Water supply pump "NES-100B"			
Capacity	100ℓ/min		
Engine	"NS-65"		
Wire line Hoist "WHS-600"	1 set		
Rope capacity	600m		
Engine	*Drilling machine's engine power take off*		
Mud Mixer "MLE-100"	1 set		
Capacity	125ℓ		
Engine	"NS-65"		
Generator	1 set		
	YAMMAR Model "YSG-2SN"		
Drilling Tools			
Drilling Rod	NQ-WL	3.0m	101 pcs.
Casing Pipe	HW	1.0m	4 pcs.
	NW	1.0m	31 pcs.
Derrike	1 set		
	Model "DRP-9-5"		

Table II-2-1 Drilling Meterage by Diamond Bit

Item	Size of Bit	Type of Bit	Carats per Bit	Matrix	Stones per Carat	Water way	Total bit Used
Diamond Bit	75.3	NQ-WL	30	E	25	4	29
	Total		870				29
	59.6mm	BQ-WL	20	E	25	4	4
	Total		80				4
Grand Total			*950				33

E : for ordinary rock

* : Total amount of Diamond Carat

Table II-2-2 Drilling Meterage by Diamond Bit

Item	Size	Bit No.	Drilling Meterage by hole (m)					Total (m)
			MJM-14	MJM-15	MJM-16	MJM-17	MJM-18	
Diamond Bit	NQ-WL	ON6-12	50.80					50.80
		1851764	49.60					49.60
		187559	55.80					55.80
		187560	61.40					61.40
		187316	57.80					57.80
		187318		49.20				49.20
		187321		48.70				48.70
		187315		61.40				61.40
		187322		32.50				32.50
		187320		54.20				54.20
		187317			42.10			42.10
		187319			44.40			44.40
		187323			40.30			40.30
		187324			41.50			41.50
		187371			42.20			42.20
		187370				75.30		75.30
		187683				101.20		101.20
		187684				59.20		59.20
		187369				65.30		65.30
		187723					29.30	29.30
		187725					40.50	40.50
		187726					31.20	31.20
		187729					29.80	29.80
		187730					33.40	33.40
		187372					40.40	40.40
		187373					25.60	25.60
		187374					31.40	31.40
		187731					29.50	29.50
		187732					9.40	9.40
	Total		275.40	246.00	210.50	301.00	300.50	1333.40
Total			Drilled length/Bit (1,333.40/29)					45.98

Table II-2-3 Drilling Meterage by Diamond Bit

Item	Size	Bit No.	Drilling Meterage by hole (m)					Total (m)
			MJM-14	MJM-15	MJM-16	MJM-17	MJM-18	
Diamond Bit	BQ-WL	177198	25.60					25.60
		177197		54.60				54.60
		177202			55.50			55.50
		177196			38.00			38.00
	Total		25.60	54.60	93.50			173.70
Total				Drilled length/Bit (173.70/4)				43.43

Table II-3 Details of Consumed Materials in Drilling

Description	Specification	Unit	Quantity					Total
			MJM-14	MJM-15	MJM-16	MJM-17	MJM-18	
Light Oil		ℓ	650	4,830	1,440	1,145	4,530	12,595
Bentonite		kg	8,850	4,875	11,375	7,350	13,550	46,000
Liborite		kg	650	195	165	194	246	1,450
C.M.C.		kg	270	170	172	239	466	1,317
Cement		kg	200	1,000	400	560	400	2,560
Diamond Bit	NQWL	pc	5	5	5	4	10	29
do	BQWL	pc	1	1	2	0	0	4
do	NW	pc	1	1	1	1	1	5
do	HW	pc	1	1	1	1	1	5
Diamond Reamer	NQWL	pc	5	4	3	4	9	25
do	BQWL	pc	1	1	2	0	0	4
Core barrel Assy	NQWL	set	1	1	2	2	2	8
do	BQWL	set	1	1	1	0	0	3
Inner tube	NQWL	pc	2	2	3	4	4	15
Inner tube	BQWL	pc	2	2	2	0	0	6
Core lifter	NQWL	pc	2	3	2	4	5	16
Core lifter	BQWL	pc	2	2	2	0	0	6
Core lifter Case	NQWL	pc	2	3	2	5	6	18
Core lifter Case	BQWL	pc	2	2	2	0	0	6

Table II-4-1 Timetable of Drilling Work

Hole No.	Drilling			Shift		Working man		Working Time						G. Total
	Bit size	Drilling	Core length	Drilling	Total	Engineer	Worker	Drilling	Other Working	Recovering	Total	Removing	Road constructing and others	
		m	m	shift	shift	man	man	h	h	h	h	h	h	h
MJM-14	NW	9.00	0.00	1	15	49	384	8°10′	2°30′	0°00′	10°40′	48°00′	52°00′	110°40′
	NQ	266.40	201.80	35	35	35	165	123°20′	155°00′	0°00′	278°20′			278°20′
	BQ	25.60	18.40	9	13	21	94	21°30′	49°30′	0°00′	71°00′	32°00′		103°00′
	Total	301.00	220.20	45	63	105	643	153°00′	207°00′	0°00′	360°00′	80°00′	52°00′	492°00′
MJM-15	NW	10.00	0.00	1	17	51	204	9°20′	3°20′	0°00′	12°40′	64°00′	56°00′	132°40′
	NQ	236.00	207.20	33	33	33	135	158°00′	101°20′	0°00′	259°20′			259°20′
	BQ	54.60	52.80	6	9	15	79	20°30′	27°30′	0°00′	48°00′	48°00′		96°00′
	Total	300.60	260.00	40	59	99	418	187°50′	132°10′	0°00′	320°00′	112°00′	56°00′	488°00′
MJM-16	NW	9.00	0.00	2	14	21	143	10°30′	3°50′	0°00′	14°20′	56°00′	0°00′	70°20′
	NQ	201.50	186.40	27	27	40	107	125°50′	93°50′	0°00′	219°40′			219°40′
	BQ	93.50	65.90	17	22	39	116	69°20′	64°40′	0°00′	134°00′	72°00′		206°00′
	Total	304.00	252.30	46	63	100	366	205°40′	162°20′	0°00′	368°00′	128°00′	0°00′	496°00′

Table II-4-2 Timetable of Drilling Work

Hole No.	Drilling			Shift		Working man		Working Time						G. Total
	Bit size	Drilling	Core length	Drilling	Total	Engineer	Worker	Drilling	Other Working	Recovering	Total	Removing	Road constructing and others	
		m	m	shift	shift	man	man	h	h	h	h	h	h	h
MJM-17	NW	19.20	0.00	1	7	15	89	7°10′	2°30′	0°00′	9°40′	24°00′	0°00′	33°40′
	NQ	281.80	218.90	38	42	54	205	163°30′	128°30′	8°00′	300°00′	48°00′		348°00′
	Total	301.00	218.90	39	49	69	294	170°40′	131°00′	8°00′	309°40′	72°00′	0°00′	381°40′
MJM-18	NW	15.00	0.00	2	8	22	103	9°40′	3°30′	0°00′	13°10′	24°00′	136°00′	173°10′
	NQ	285.50	226.30	71	77	83	344	250°00′	294°50′	50°00′	594°50′	56°00′		650°50′
	Total	300.50	226.30	73	85	105	447	259°40′	298°20′	50°00′	608°00′	80°00′	136°00′	824°00′

Table II-5-1 Summary Record of Drilling Work, MJM-14

		Survey Period				total man day	
		Period	days	work day	off day	Engineer	worker
Operation	Preparation	3. 7. 1987 ~ 16. 7. 1987	14	14 days	0 days	49 man	384 man
	Drilling	17. 7. 1987 ~ 31. 7. 1987	15	drilling 15	0	44	205
				recovering 0	0	0	0
	Removing	1. 8. 1987 ~ 4. 8. 1987	4	4	0	12	54
	Total	3. 7. 1987 ~ 4. 8. 1987	33	33	0	105	643

Drilling length				
Length planed	300 m	Surface soil Overburden Quaternary	9.00 m
Increase or Decrease in length	+1.00 m	Core-length	220.20 m
Length drilled	301.00 m	Core recovery	75.41 %

Core recovery of 100m hole		
Depth of hole (m)	core recovery (%)	core recovery cumulated (%)
0 ~ 100	59.78	
100 ~ 200	79.40	70.37
200 ~ 300	85.10	75.43
300 ~ 301.0	70.00	75.41

working hours		h	%	%
	Drilling	153°00'	43	31
	Other working	207°00'	57	42
	Recovering			
	Total	360°00'	100	73
	Reassemblage	48°00'		10
	Dismantlement	32°00'		7
	Water transportation			
	Road construction and others	52°00'		10
	G. Total	492°00'		100

Efficiency of Drilling	
Total m/work period(m/day)	301.00m/15 days (20.07m/day)
Total m/total shift(m/shift)	301.00m/63shift (4.78m/shift)

Drilling length/bit(each sized bit)			
Bit size	NW	NQ	BQ
Drilled length	9.00 m	266.40 m	25.60 m
Core length	0	201.80	18.40

Casing pipe inserted				
Size	meterage (m)	meterage / drilling length x 100 (%)	Recovery (%)
HW	9.00	1.5	100
NW	22.00	7.3	100
BW	275.40	91.5	83.5

Table II-5-2 Summary Record of Drilling Work, MJM-15

		Survey Period				total man day	
		Period	days	work day	off day	Engineer	worker
Operation	Preparation	5. 7. 1987 ~ 20. 7. 1987	16	16 days	0 days	48 man	167 man
	Drilling	21. 7. 1987 ~ 3. 8. 1987	14	drilling 14	0	42	198
				recovering 0	0	0	0
	Removing	4. 8. 1987 ~ 6. 8. 1987	3	3	0	9	53
	Total	5. 7. 1987 ~ 6. 8. 1987	33	33	0	99	418

Drilling length				
Length planed	300.00 m	Surface soil Overburden Quaternary	10.00 m
Increase or Decrease in length	+0.60 m	Core length	260.00 m
Length drilled	300.60	Core recovery	89.47 %

Core recovery of 100m hole

Depth of hole (m)	core recovery (%)	core recovery cumulated (%)
0 ~ 100	84.89	
100 ~ 200	88.10	86.58
200 ~ 300	94.90	89.45
300 ~ 300.6	100	89.47

working hours	h	%	%
Drilling	187°50′	58	38
Other working	132°10′	42	27
Recovering			
Total	320°00′	100	65
Reassemblage	64°00′		13
Dismantlement	48°00′		10
Water transportation			
Road construction and others	56°00′		12
G. Total	488°00′		100

Efficiency of Drilling

Total m/work period(m/day)	300.60m/14 days (21.47 m/day)
Total m/total shift(m/shift)	300.60m/99 shift (3.04m/shift)

Drilling length/bit(each sized bit)

Bit size	NW	NQ	BQ
Drilled length	10.00 m	236.00 m	54.60 m
Core length	0	207.20	52.80

Casing pipe inserted

Size	meterage (m)	meterage / drilling length x 100 (%)	Recovery (%)
HW	10.00	3.3	100
NW	30.00	10.0	100
BW	246.00	81.8	100

Table II-5-3 Summary Record of Drilling Work, MJM-16

		Survey Period				total man day	
		Period	days	work day	off day	Engineer	worker
Operation	Preparation	30. 8. 1987 ~ 10. 9. 1987	12	12 days	0 days	22 man	142 man
	Drilling	11. 9. 1987 ~ 26. 9. 1987	16	drilling 16	0	36	184
				recovering 0	0	0	0
	Removing	27. 9. 1987 ~ 30. 9. 1987	4	4	0	42	40
	Total	30. 8. 1987 ~ 30. 9. 1987	32	32	0	100	366

Drilling length				
	Length planed	300.00 m	Surface soil Overburden Quaternary	9.00 m
	Increase or Decrease in length	+4.00 m	Core length	252.30 m
	Length drilled	304.00	Core recovery	85.52 %

Core recovery of 100m hole

Depth of hole (m)	core recovery (%)	core recovery cumulated (%)
0 ~ 100	98.02	
100 ~ 200	90.80	94.24
200 ~ 300	68.40	85.36
300 ~ 304.0	97.50	85.52

working hours		h	%	%
	Drilling	205°40′	56	41
	Other working	162°20′	44	33
	Recovering			
	Total	368°00′	100	74
	Reassemblage	56°00′		11
	Dismantlement	72°00′		15
	Water transportation			
	Road construction and others			
	G. Total	496°00′		100

Efficiency of Drilling

Total m/work period(m/day)	304.00m/16 days (19.00 m/day)
Total m/total shift(m/shift)	304.00m/63 shift (4.83 m/shift)

Drilling length/bit(each sized bit)

Bit size	NW	NQ	BQ
Drilled length	9.00 m	201.50 m	93.50 m
Core length	0	186.40	65.90

Casing pipe inserted	Size	meterage (m)	meterage / drilling length x 100 (%)	Recovery (%)
	HW	10.00	3.3	100
	NW	30.00	9.9	100
	BW	210.50	69.2	91

Table II-5-4 Summary Record of Drilling Work, MJM-17

		Survey Period				total man day	
		Period	days	work day	off day	Engineer	worker
Operation	Preparation	7. 8. 1987 ~ 12. 8. 1987	6	6 days	days	18 man	82 man
	Drilling	13. 8. 1987 ~ 25. 8. 1987	13	drilling 12.5	0	38	150
				recovering 0.5	0	1	6
	Removing	26. 8. 1987 ~ 29. 8. 1987	4	4	0	12	56
	Total	7. 8. 1987 ~ 29. 8. 1987	23	23	0	69	294

Drilling length	Length planed	300.00 m	Surface soil Overburden Quaternary	19.20 m
	Increase or Decrease in length	+1.00 m	Core length	218.90 m
	Length drilled	301.00	Core recovery	77.67 %

Core recovery of 100m hole

Depth of hole (m)	core recovery (%)	core recovery cumulated (%)
0 ~ 100	91.95	
100 ~ 200	76.90	83.62
200 ~ 300	66.70	77.60
300 ~ 301.0	100.00	77.67

working hours	Drilling	170°40′ h	55 %	45 %
	Other working	131°00′	42	34
	Recovering	8°00′	3	2
	Total	309°40′	100	81
	Reassemblage	24°00′		6
	Dismantlement	48°00′		13
	Water transportation			
	Road construction and others			
	G. Total	381°40′		100

Efficiency of Drilling

Total m/work period(m/day)	301.00m/13 days (23.15 m/day)
Total m/total shift(m/shift)	301.00m/49 shift (6.14 m/shift)

Drilling length/bit(each sized bit)

Bit size	NW	NQ	BQ
Drilled length	19.20 m	281.80 m	m
Core length	0	218.90	

Casing pipe inserted	Size	meterage (m)	meterage / drilling length x 100 (%)	Recovery (%)
	HW	16.00	5.3	100
	NW	27.00	9.0	100
	BW			

Table II-5-5 Summary Record of Drilling Work, MJM-18

		Survey Period				total man day	
		Period	days	work day	off day	Engineer	worker
Operation	Preparation	5. 8. 1987 ~ 10. 8. 1987	6	6 days	0 days	18 man	91 man
	Drilling	11. 8. 1987 ~ 4. 9. 1987	25	drilling 23	0	71	307
				recovering 2	0	4	8
	Removing	5. 9. 1987 ~ 8. 9. 1987	4	4	0	12	41
	Total	5. 8. 1987 ~ 8. 9. 1987	35	35	0	105	447

Drilling length	Length planed	300.00 m	Surface soil Overburden Quaternary	15.00 m
	Increase or Decrease in length	+0.50 m	Core length	226.30 m
	Length drilled	300.50	Core recovery	79.26 %

Core recovery of 100m hole		
Depth of hole (m)	core recovery (%)	core recovery cumulated (%)
0 ~ 100	84.00	
100 ~ 200	81.20	82.48
200 ~ 300	73.20	79.22
300 ~ 300.5	100.00	79.26

working hours	Drilling	259°40′ h	43 %	31 %
	Other working	298°20′	49	36
	Recovering	50°00′	8	6
	Total	608°00′	100	73
	Reassemblage	24°00′		3
	Dismantlement	56°00′		7
	Water transportation			
	Road construction and others	136°00′		17
	G. Total	824°00′		

Efficiency of Drilling	
Total m/work period(m/day)	300.50m/23 days (13.07 m/day)
Total m/total shift(m/shift)	300.50m/85 shift (3.54m/shift)

Drilling length/bit(each sized bit)			
Bit size	NW	NQ	BQ
Drilled length	15.00 m	285.50 m	m
Core length	0	226.30	

Casing pipe inserted			
Size	meterage (m)	meterage / drilling length x 100 (%)	Recovery (%)
HW	4.00	1.3	
NW	31.00	10.3	
BW			

Chapter 2 Result of Survey

2-1 Geology and Mineralization

Table II-6 shows the results of work for each drill hole including number of samples for chemical analysis and the summary of result of each hole.

The columnar sections and geologic profiles of each hole are shown in Fig.II-3, A-1 and Fig.II-4, respectively.

The geological column of each hole, containing lithology and some assay values, is as follows:

The results of tests of, thin section, polished section and X-ray diffraction of selective cores are shown in A-2, A-3, A-4, A-5 and A-6.

1. MJM-14 (-90°, 301.00m)

(1) Geology

0 - 9.00m	surface soil
9.00- 77.10	Pinosuk Gravels, loose matrix to 19.50m and solid matrix from 19.50-77.10m; oxidation is widespread
77.10-111.70	adamellite porphyry, extensive brecciation and shearing; oxidation is pervasive to 98.10m
111.70-135.10	hornfels, dark gray-balckish gray color, fine grained, with abundant fissures, silicification and brecciation between 123.40m and 127.30m, a thin layer of turbidite present
135.10-136.50	adamellite porphyry
136.50-301.00	hornfels, dark gray-blackish gray, mostly compact; massive part with abundant fractured zones in place, intense shearing between 193.60-206.40m, 239.60-241.10m and 298.40-301.00m; thin layers of turbidite between 225.20-226.50m, 229.10-232.10m.

(2) Mineralization

Finely disseminated native copper occurs in adamellite porphyry and hornfels and is restricted to a depth of 167.20m in places, accompanied by disseminations and veinlets of pyrite, chalcopyrite and molybdenite in place. Dissemination of pyrite and chalcopyrite and/or veinlets of pyrite-chalcopyrite-quartz appear below a depth of 167.20m. Mineralization is confined to adamellite porphyry and hornfels.

Under the microscope, fine-grained pyrite and chalcopyrite are main minerals in the adamellite sample taken at 106.10m depth. They are associated with very fine-grained molybdenite, pyrrhotite and marcasite with a few sphalerite.

The result of chemical analysis is as follows:

Section	Au(g/t)	Cu(%)	Mo(ppm)
77.10-111.70m	0.07	0.145	16.7
(34.6m, in adamellite porphyry)			
incl. 77.10-98.10m	0.08	0.172	4.0
(21.0m oxide zone)			
111.70-191.50m	0.06	0.045	37.0
(79.8m, in hornfels)			

2. MJM-15 (-90°, 300.60m)

(1) Geology

0 - 10.90m	surface soil
10.90-111.40	Pinosuk Gravels, bearing boulders and cobbles of adamellite, adamellite porphyry and hornfels in well compacted matrix, weaker weathering and oxidation than those in MJM-14
111.40-141.70	turbidite, weak shearing in places.
141.70-142.70	peridotite, intensive serpentinization throughout, limited occurrence suggesting xenolithe within adamellite porphyry

LEGEND

PG	Pinosuk Gravels (loose)	
PG	Pinosuk Gravels (solid)	
Td	Turbidite	
Ss	Sandstone	
St	Siltstone	
Mt (Sh)	Mudstone (Shale)	
Hf	Hornfels	
Sp	Spilite	
Md	Microdiorite	
Ap (Ad)	Adamellite porphyry (Adamellite)	
Pt (Srp)	Peridotite (Serpentinite)	
arg	argillized	
bre (frag)	brecciated (fragmented)	
shr	sheared	
silic	silicified	

Abbreviations

bi	biotie	bo	bornite	mtx	matrix
cal	calcite	mal	malachite	gr	grained
chlo	chlorite	pyr	pyrrhotite	grvl	gravel
cly	clay	cup	cuprite	sdy	sandy
gt	garnet	pyrophy	pyrophyllite	imp	impregnation
qz	quartz	kaol	kaolinite	lns	lens
srp	serpentine	arg	argillized	netwk	network
tlc	talc	bg	bearing	oxd	oxidized
epi	epidote	blchd	bleached	strg	stringer
gt	garnet	bld	boulder	vlt	veinlet
ank	ankerite	bre	brecciated	wthd	weathered
cp	chalcopyrite	cls	clastic	xeno	xenolith
limo	limonite	diss	dissemination	(vp)	(very poor)
moly	molybdenite	fin	fine	(p)	(poor)
py	pyrite	flt	fault	(m)	(moderate)
mag	magnetite	fract	fractured	(a)	(abundant)
mar	marcasite	frag	fragmented		

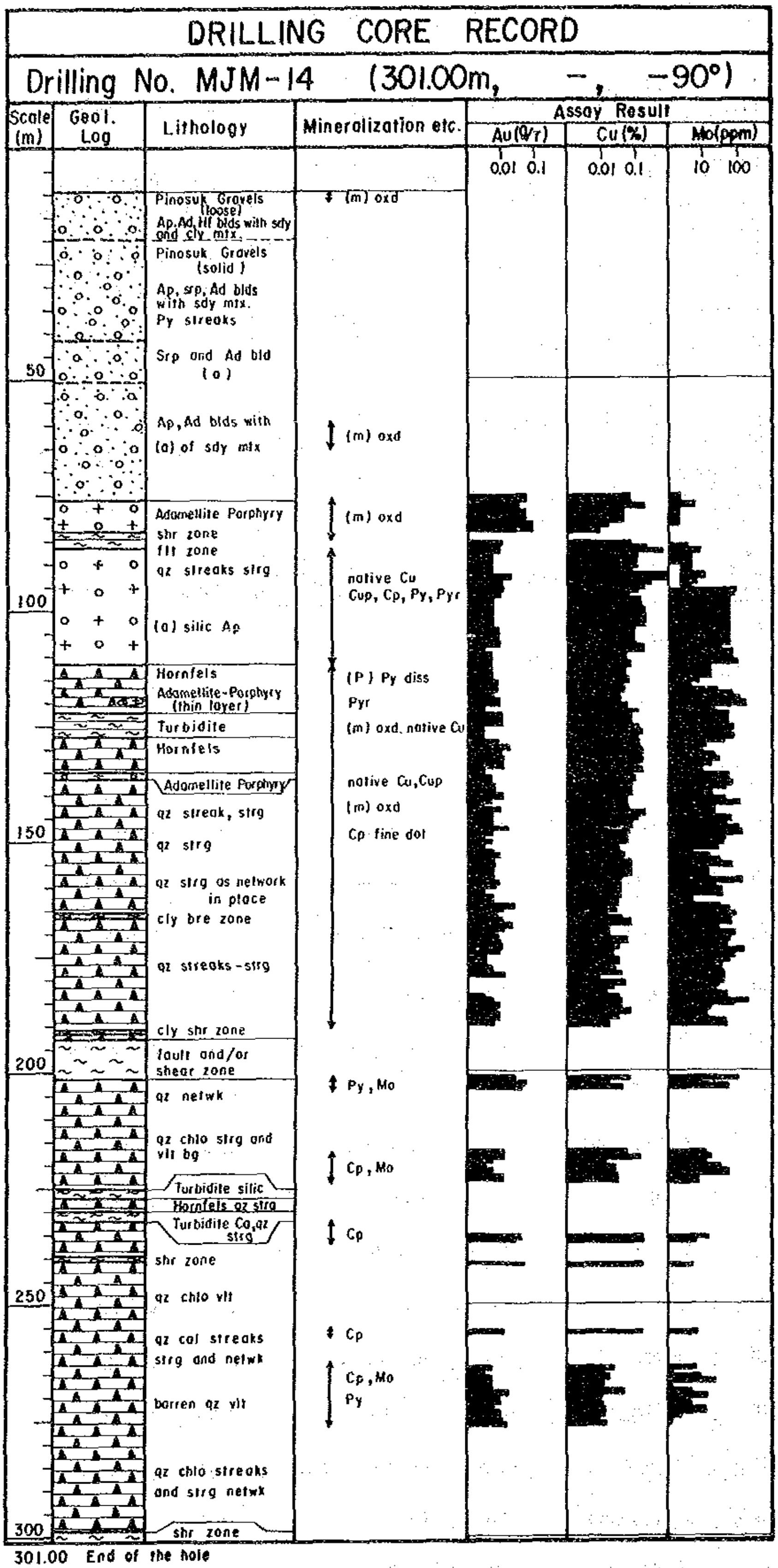


Fig. II-3-1 Columnar Section of Drill Hole (MJM-14)

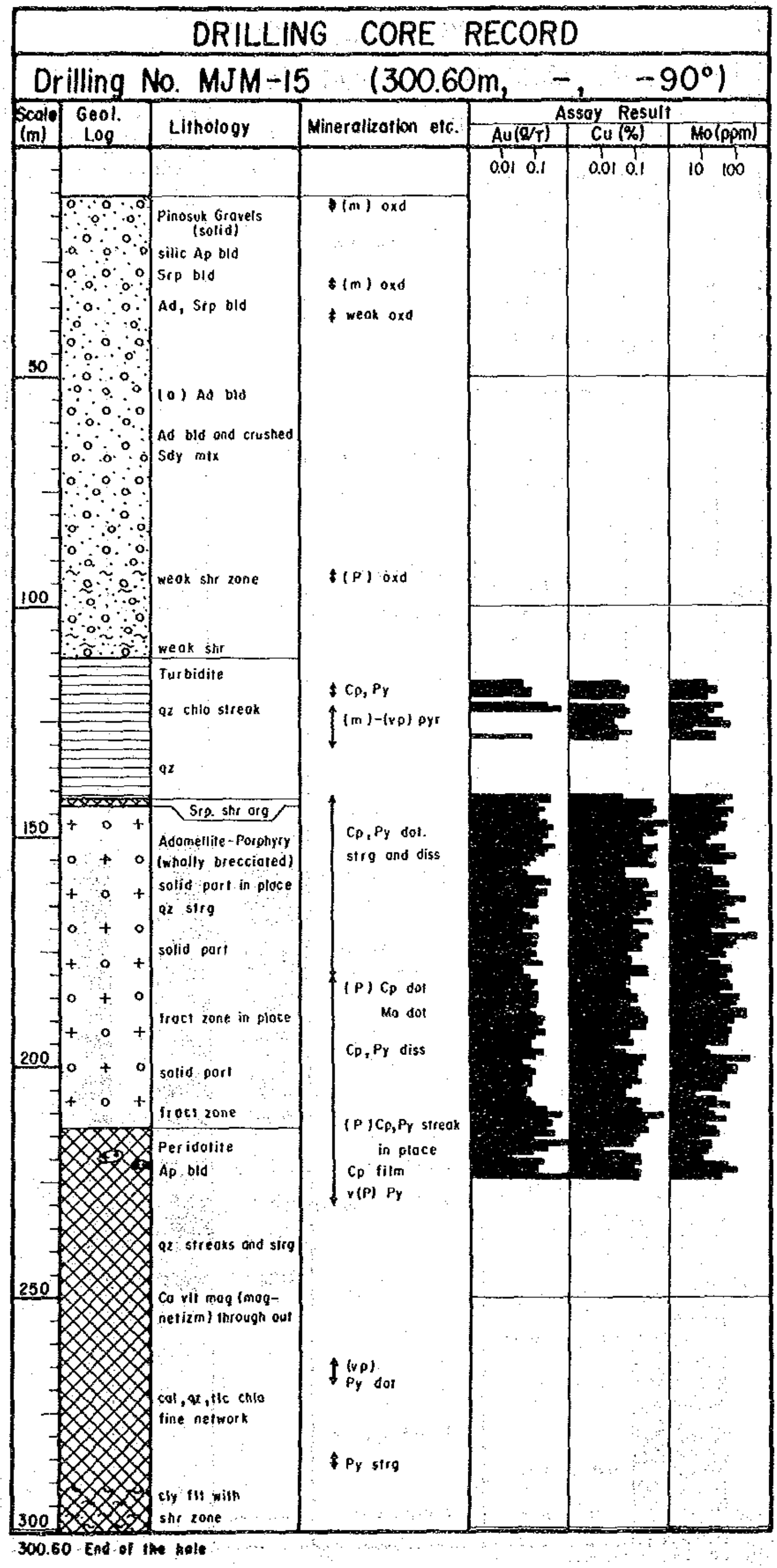


Fig. II-3-2 Columnar Section of Drill Hole (MJM-15)

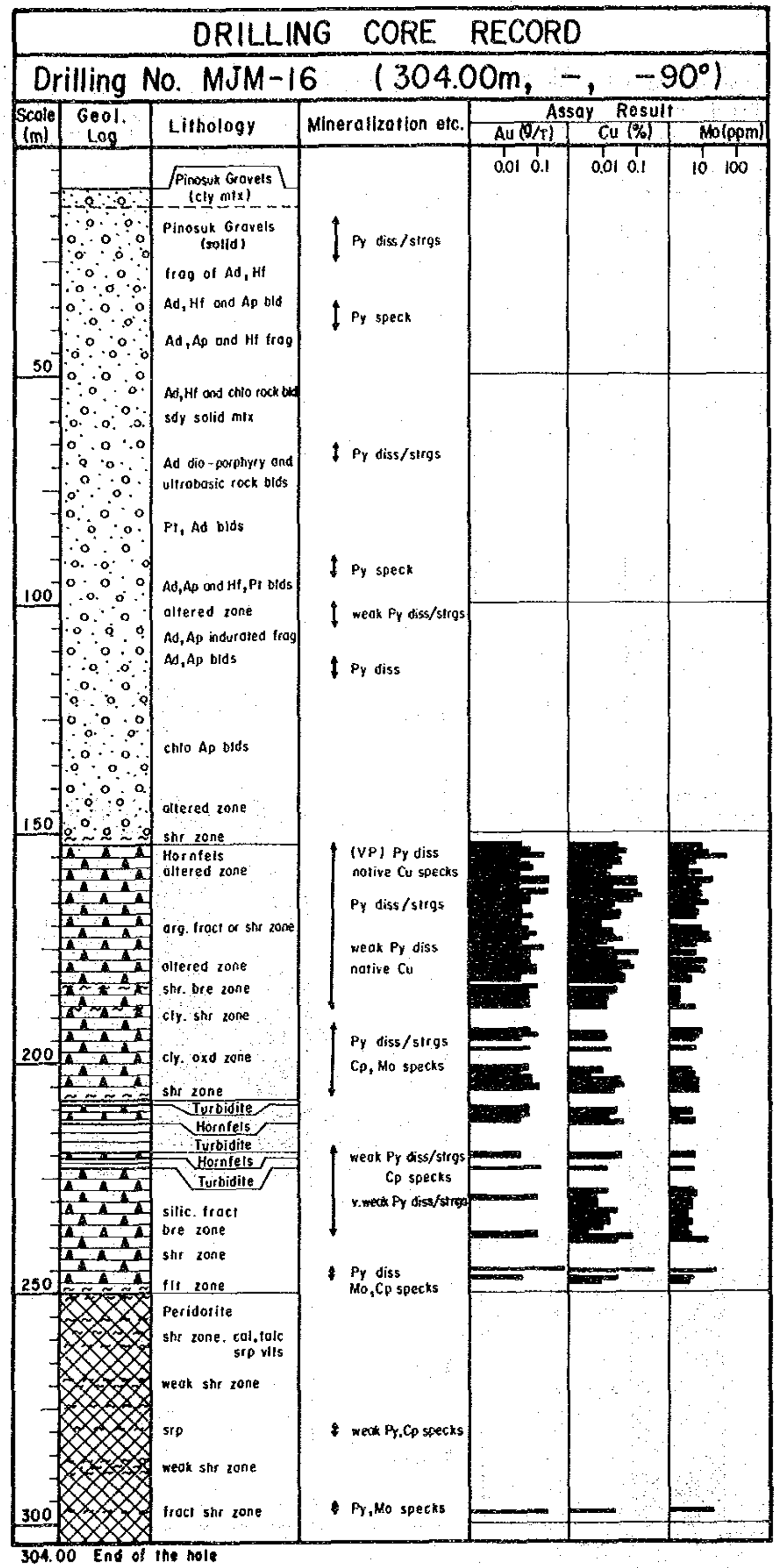


Fig. II-3-3 Columnar Section of Drill Hole (MJM-16)

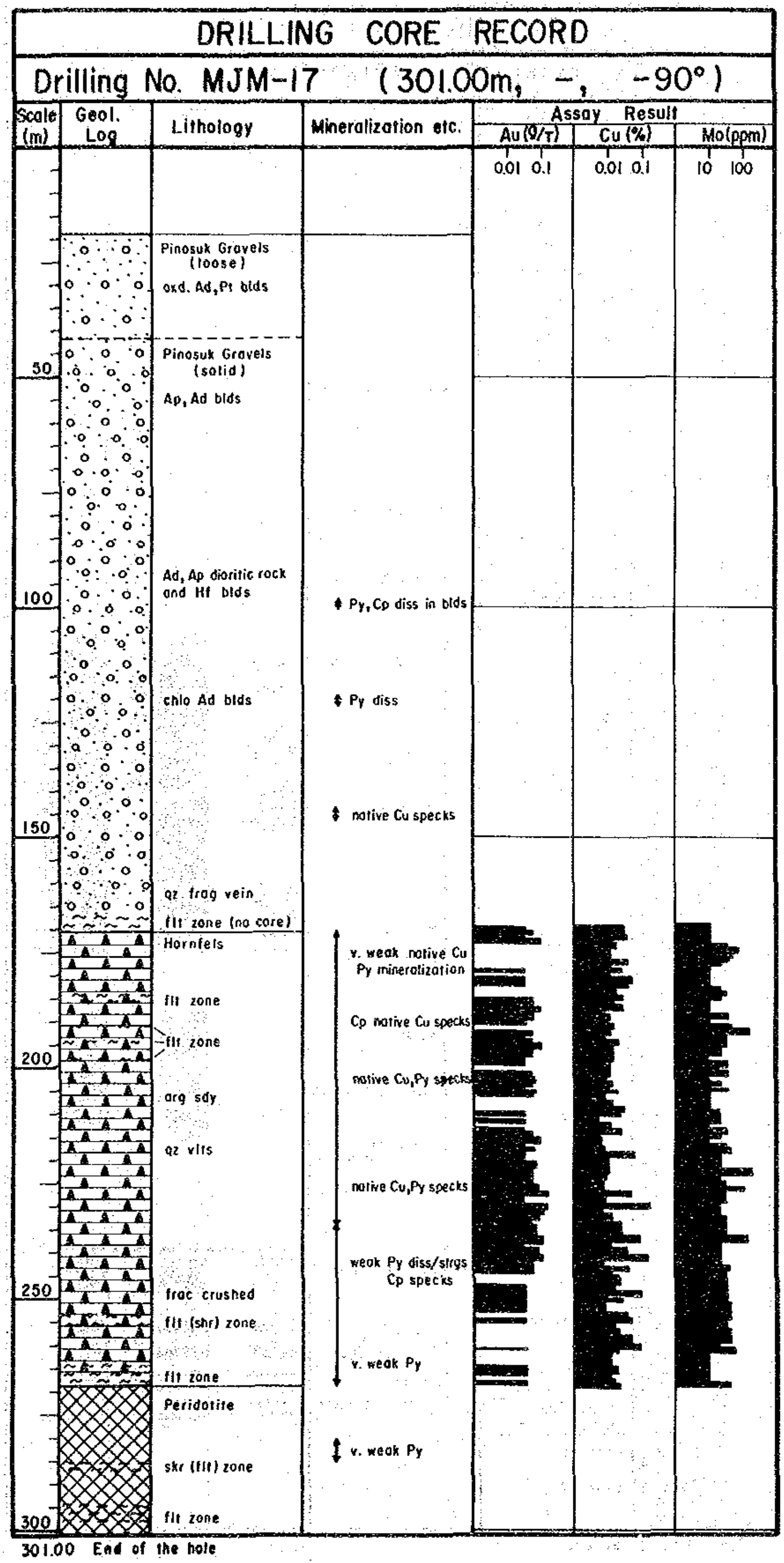


Fig. II-3-4 Columnar Section of Drill Hole (MJM-17)

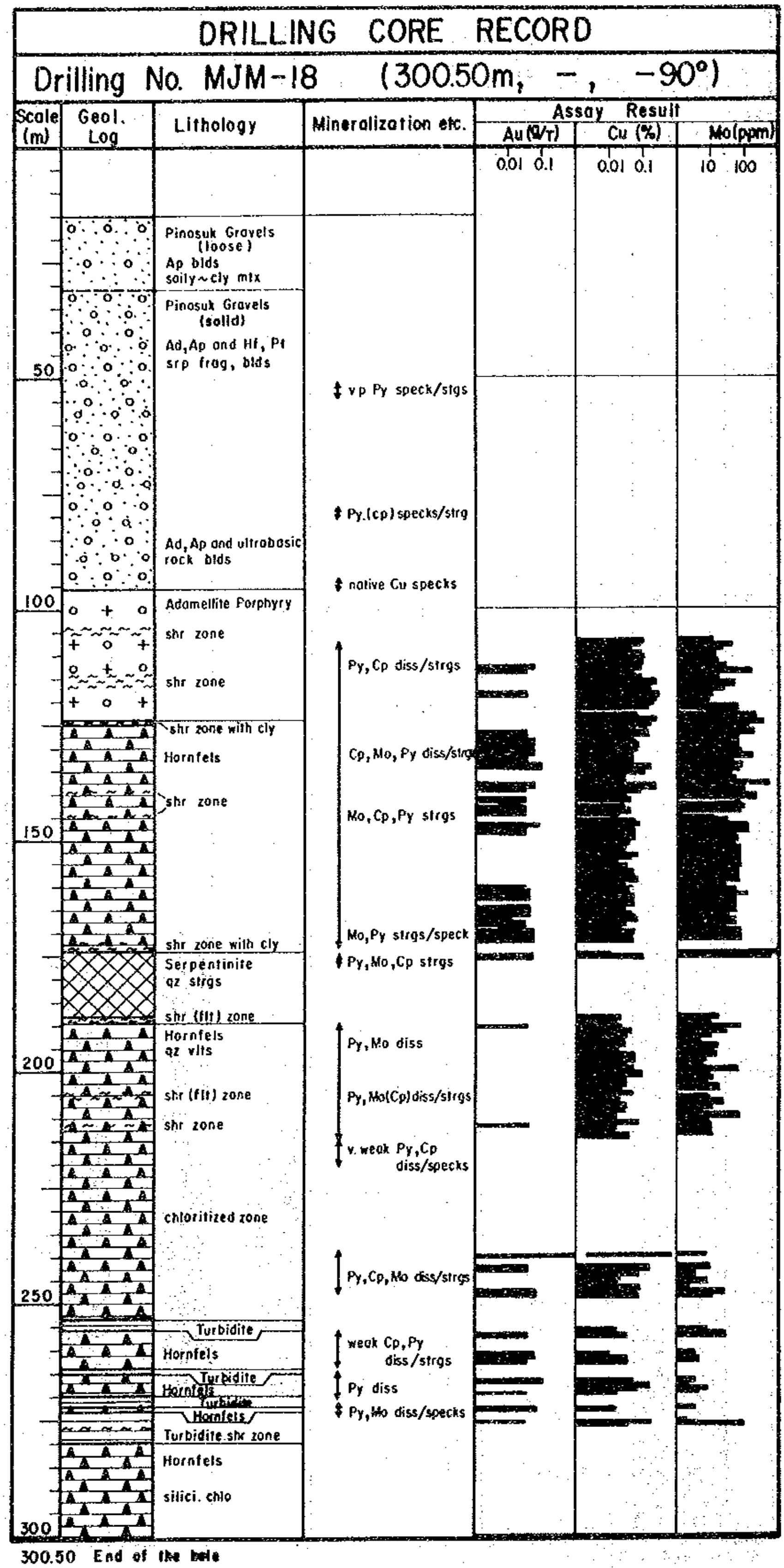


Fig. II-3-5 Columnar Section of Drill Hole (MJM-18)

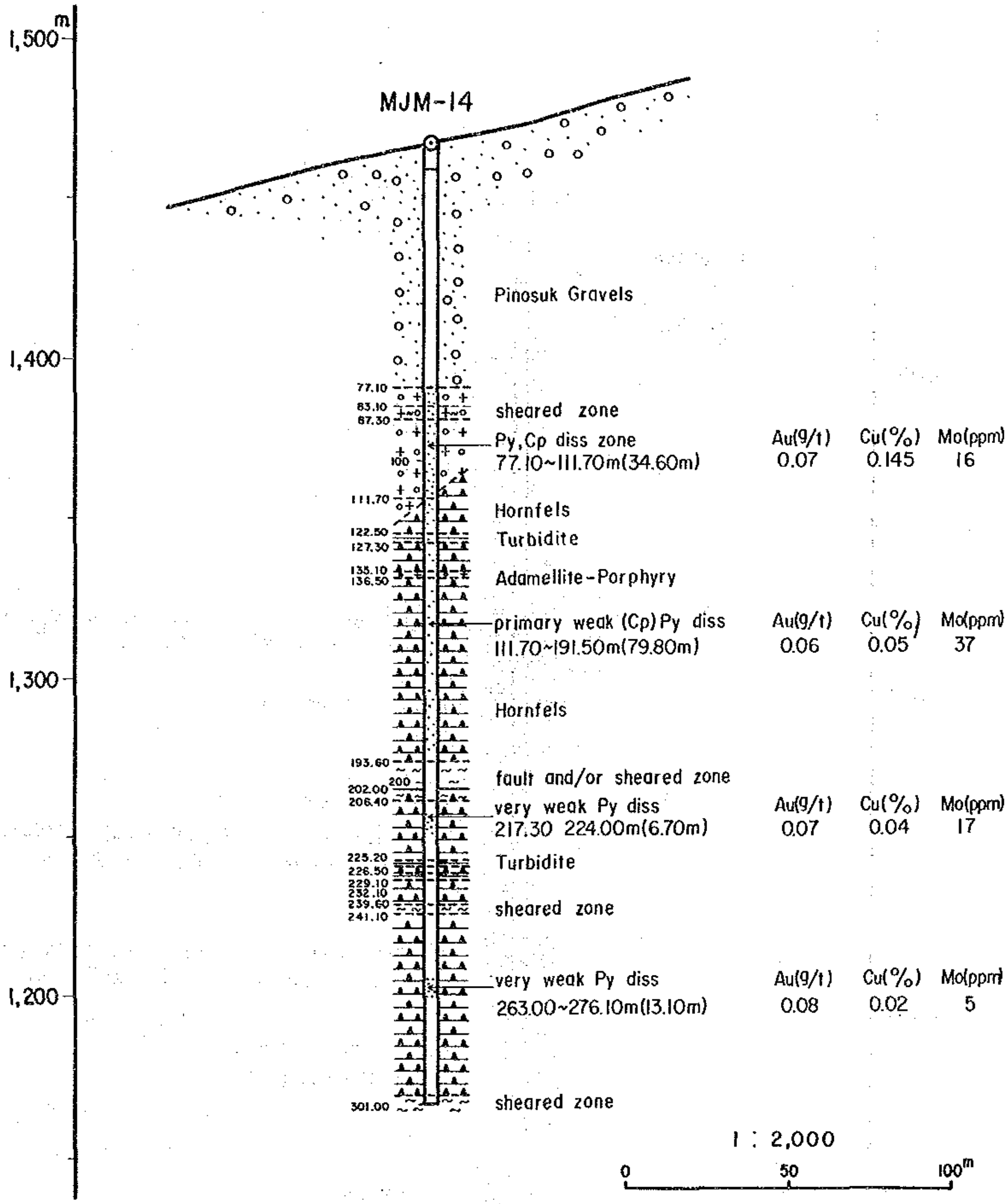


Fig. II-4-1 Geological Section of Drill Hole (MJM-14)

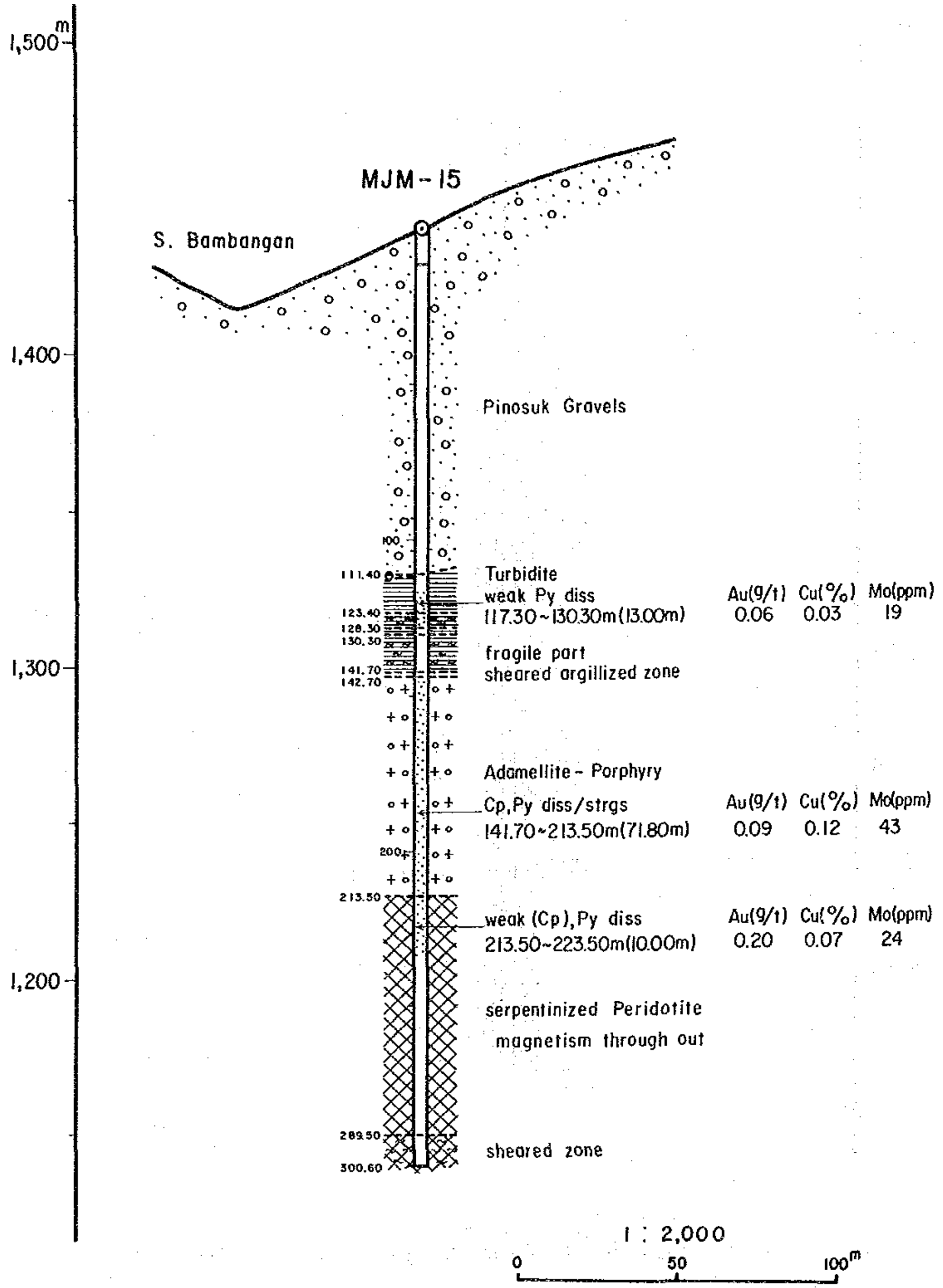


Fig. II-4-2 Geological Section of Drill Hole (MJM-15)

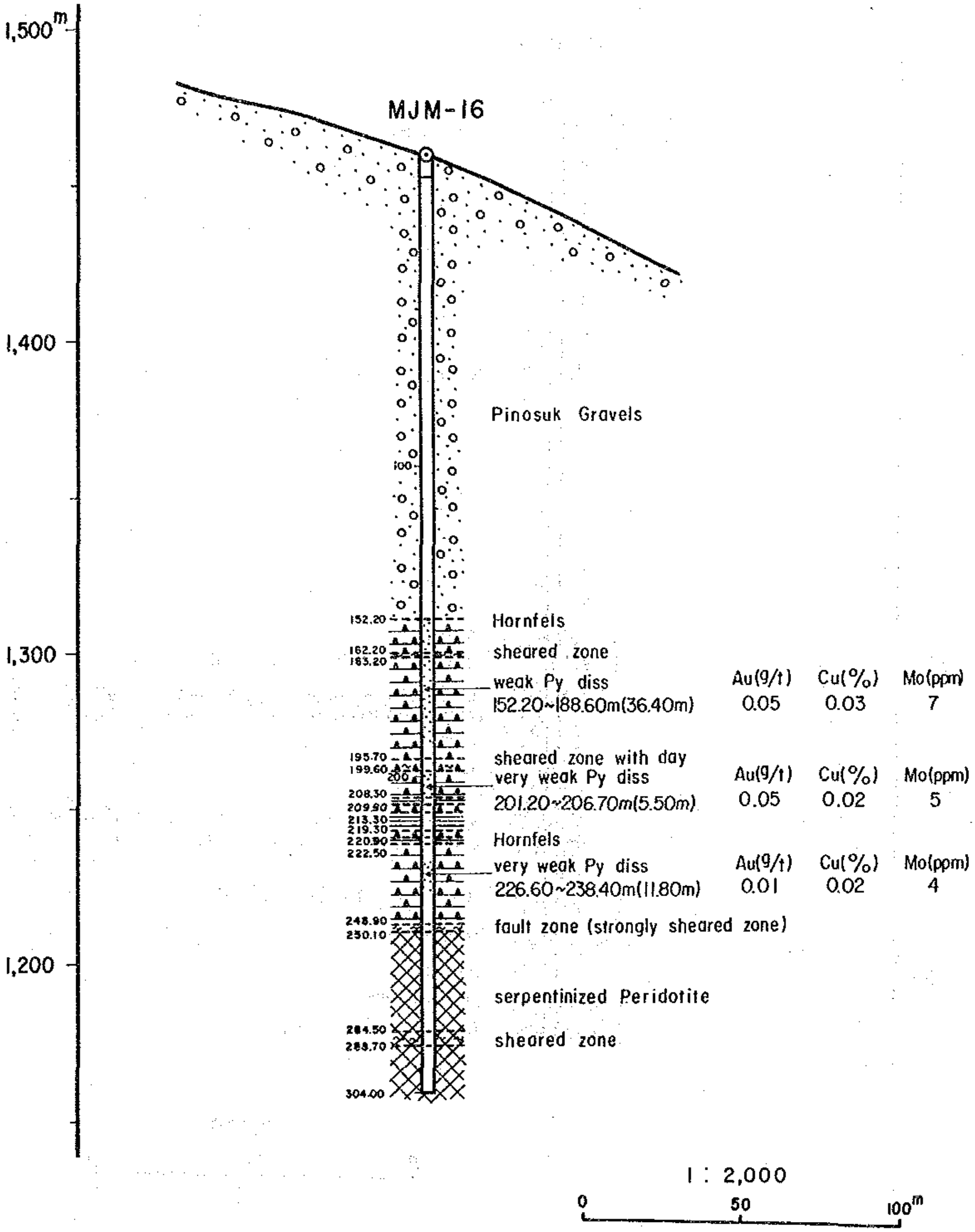


Fig. II-4-3 Geological Section of Drill Hole (MJM-16)

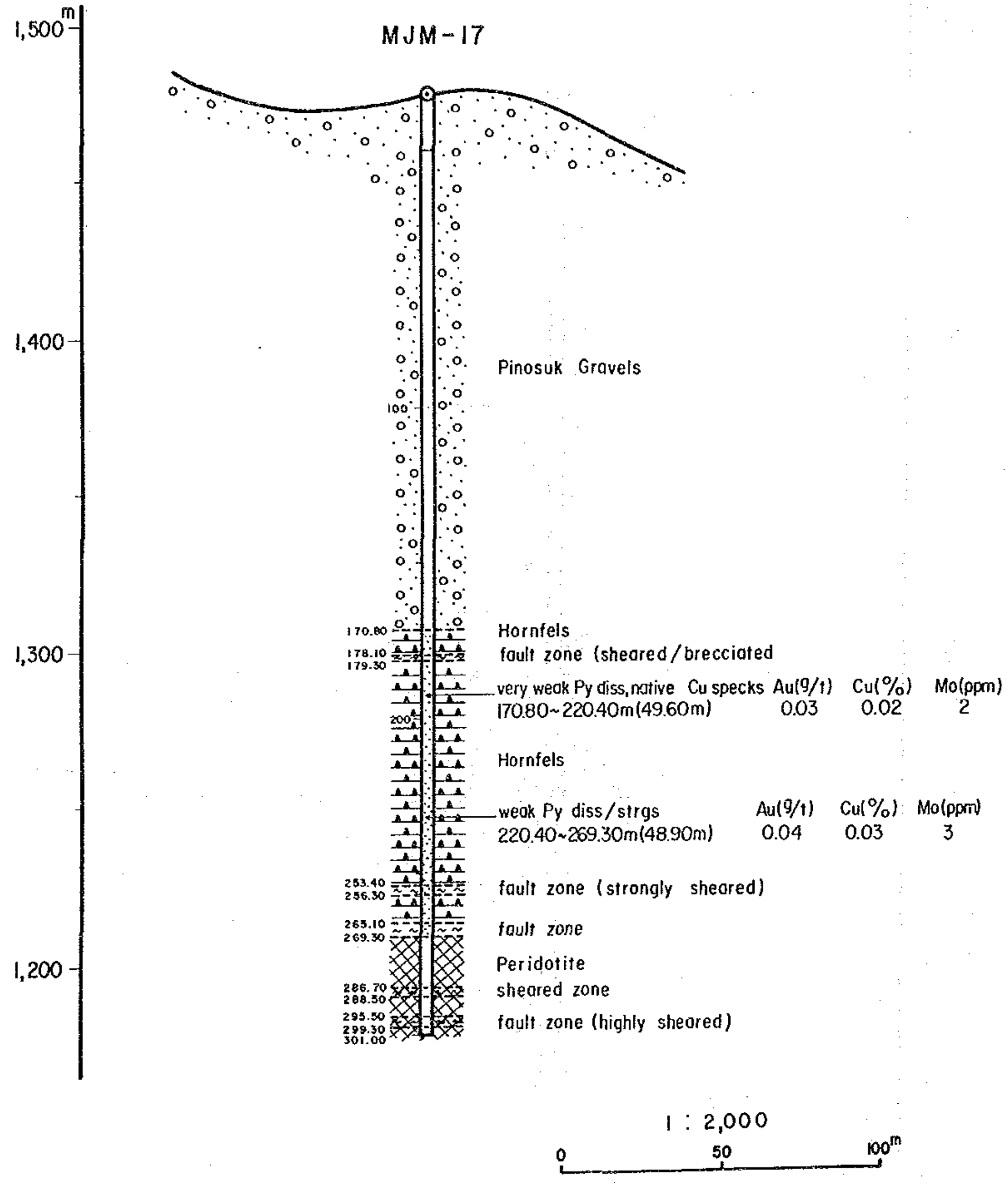


Fig. II-4-4 Geological Section of Drill Hole (MJM-17)

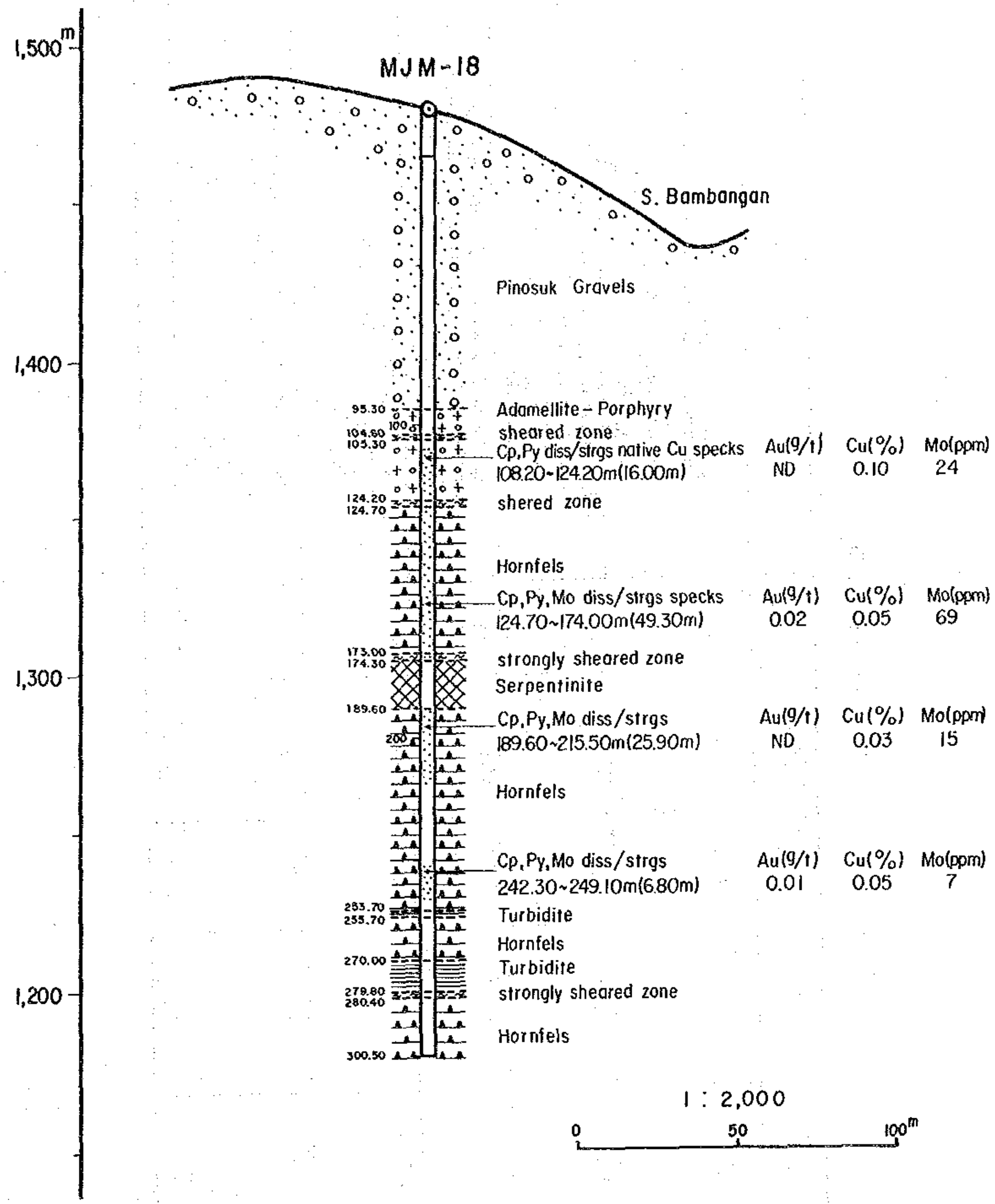


Fig. II-4-5 Geological Section of Drill Hole (MJM-18)

Table II-6 Summary of Results of Drilling Sruvey

Hole	Duration	Length of Drilling	Core	Core Recovery Total	Core Recovery Except Surface Soil	No. of Sample	Summary of Result
MJM-14	July 17 ~July 31	301.00 m	220.20 m	73.16 %	75.41 %	121 pcs	Rock : hornfels, adamellite porphyry Mineralization : occurring in boundary zone of both rocks Assay Result : (section, in m) Au (g/t) Cu (%) Mo (ppm) 77.10–111.70 0.07 0.145 16.7 111.70–191.50 0.06 0.045 37.0
MJM-15	July 21 ~Aug. 3	300.60	260.00	86.49	89.47	91	Rock : hornfels, adamellite porphyry and peridotite Mineralization : occurring in hornfels and adamellite porphyry Assay Result : 141.70–213.50 0.09 0.117 43 213.50–223.50 0.20 0.072 24
MJM-16	Sept. 11 ~Sept. 26	304.00	252.30	82.99	85.52	64	Rock : 152 m of Pinosuk Gravels hornfels, peridotite Mineralization : occurring in hornfels most weak among 5 holes Assay Result : 152.20–188.60 0.05 0.034 7
MJM-17	Aug. 13 ~Aug. 25	301.00	218.90	72.72	77.68	84	Rock : same as MJM-16 Mineralization : occurring in hornfels Assay Grade : 170.80–220.40 0.03 0.018 2 220.40–269.30 0.04 0.031 3
MJM-18	Aug. 11 ~Sept. 4	300.50	226.30	75.31	79.26	110	Rock : hornfels, adamellite porphyry and peridotite Mineralization : occurring in both hornfels and adamellite Assay Grade : 108.20–124.20 ND 0.096 24 124.20–174.00 0.02 0.050 69 189.60–215.50 ND 0.026 15
Total		1,507.10	1,177.70	78.14	81.51	470	

142.70-213.50	adamellite porphyry, weak silicification and argillization are widespread with brecciations and shearings, showing marginal facies
213.50-300.60	peridotite, dark green-blackish green color, massive, intensive serpentinization, encountered a predominant sheared zone from 239.50m to bottom

(2) Mineralization

Prominent pyrite-chalcopyrite disseminations occur abundantly adamellite porphyry and a lesser intensity in hornfels, associated with fine molybdenite crystals. Mineralization becomes very weaker in peridotite; however, compared with hole MJM-14, it shows less copper mineralizations unlike those of gold and molybdenum.

The result of chemical analysis is as follows:

Section	Au(g/t)	Cu(%)	Mo(ppm)
141.70-213.50m (71.8m, in hornfels and adamellite porphyry)	0.09	0.117	43.1
213.50-223.50m (10.0m, in peridotite)	0.20	0.072	24.2

3. MJM-16 (-90°, 304.00m)

(1) Geology

0 - 9.00m	surface soil
9.00-152.20	Pinosuk Gravels, loose type bearing less amounts of hornfels gravels in clayey matrix to a depth of 13.00m, solid part between 13.00m and 152.20m, including a section consisting solely of hornfels gravels between 133.20m and bottom

152.20-208.30	hornfels dark gray color, fine grain, sandy. sheared zone with thin clay layers in places accompanied with a limonite stains
208.30-222.50	hornfels-turbidite alternation 3 brown colored turbidite layers with thickness of 1.60m-6.00m in dark gray colored, fine grained hornfels, turbidite layers consisting mainly of silicified hornfels fragment in a muddy matrix
222.50-250.10	hornfels, same rock facies as above; however, shearing is weaker
250.10-304.00	peridotite, strong serpentinization with dark green, blackish green and greenish brown in color, abundant magnetite accompanied with hematite veinlets in places. fault contact with overlying hornfels judging from the occurrence of sheared zone with clayey layers between 248.90m and 250.10m

(2) Mineralization

Specks of native copper occurs in places along fine cracks of hornfels accompanied with a weak pyrite dissemination between 152.20m and 180.30m, and molybdenite dots are rarely found between 163.90m and 166.50m.

Extremely poor mineralization of chalcopyrite and molybdenite in places is observed between 180.30m and 247.80m accompanied by sporadic dissemination of weak pyrite. Finely disseminated pyrite between 280.35m and 283.10m, and dots of pyrite and molybdenite occur between 291.10m and 291.50m without significant chalcopyrite. It can be stated that the hole indicates the poorest mineralization among 5 drill holes in Phase III.

the pyrite stringer in hornfels at 194.70m depth microscopically consists of fine-grained pyrite, chalcopyrite and pyrrhotite.

Very fine gold of 0.006mm in size is also recognized in the pyrite.

The result of chemical analysis is as follows:

Section	Au(g/t)	Cu(%)	Mo(ppm)
152.20-188.60m (36.4m in hornfels)	0.05	0.034	7

4. MJM-17 (-90°, 301.00m)

(1) Geology

0 - 19.20m	surface soil
19.20-170.80	Pinosuk Gravels loose type between 19.20m and 43.45m, solid type between 43.45m and 170.80m, no adamellite and adamellite porphyry among those gravels between 140.60m and 170.80m
170.80-265.10	hornfels, dark gray color, fine grained (medium-coarse size in places), partly silicified and overall fracturing accompanied by strong shearing and brecciation between 178.10m and 179.30m, between 185.10m and 186.10m, between 253.40m and 256.30m
265.10-269.30	fault zone
269.30-301.00	peridotite, dark green-blackish green color, strong serpentinization and argillization

(2) Mineralization

Weak pyrite disseminations occur between 170.80m and 234.30m partly accompanied with specks of native copper along fine fissures. Based on visual observation, the grade of copper is expected less than 0.05%.

The mineralization between 234.30m and 269.30m consists of pyrite dissemination accompanied with impregnations and stringers of chalcopyrite; however, the grade of copper estimated by visual observation will be 0.1% and/or below, and poor compared with the holes MJM-14 and MJM-15.

The result of chemical analysis is as follows:

Section	Au(g/t)	Cu(%)	Mo(ppm)
170.80-220.40m	0.03	0.018	2
(49.6m in hornfels)			
220.40-269.30m	0.04	0.031	3
(48.9m in hornfels)			

5. MJM-18 (-90°, 300.50m)

(1) Geology

0 - 15.00m	surface soil
15.00- 95.20	Pinosuk Gravels, loose type between 15.00m and 31.10m, solid type between 31.10m and 95.10m, showing a strong oxidation down to a depth of around 72m.
95.20-124.20	adamellite porphyry, massive, however, showing a fractured structure, partly limonite stains, chloritization throughout and argillization in places.
124.20-174.30	hornfels, dark gray color, fine grained, massive shape, sheared in places
174.30-189.60	peridotite, greenish gray-dark greenish gray color, intensive serpentinization, veinlets of talc and quartz in places.
189.60-300.50	hornfels, rock facies are similar to those of overlying hornfels, intercalating thin layers of turbidite in the sections of 253.70m to 255.70m, and 270.00m to 279.80m

(2) Mineralization

Disseminations of pyrite and chalcopyrite were observed between 108.20m and 148.80m both in adamellite porphyry and hornfels.

Pyrite disseminations are followed at intervals down to a depth of 276.4m.

Remarkable mineralization occurs between 118.40m and 129.50m including the boundary between adamellite porphyry and hornfels; however, based on visual observation, the grade of copper is most likely less than those of MJM-14 and MJM-15.

Under the microscope, the mineralized peridotite at 177.20m depth contains pyrite, chalcopyrite and a few tetrahedrite, molybdenite, galena and sphalerite. Fine-grains of chromite are partly observed.

The result of chemical analysis is as follows:

Section	Au(g/t)	Cu(%)	Mo(ppm)
108.20-124.20m	ND	0.096	24
(16.0m in adamellite porphyry)			
124.20-174.00m	0.02	0.050	69
(49.8m in hornfels)			
189.60-215.50m	ND	0.026	15
(25.9m in hornfels)			

2-2 Summary of Results

The summary of drilling results is as follows:

1. The mineralized area along the Bambangan creek and its surroundings are composed of intersely thermally altered sandstone and mudstone (partly intercalated with turbidite) of the Trusmadi Formation, peridotite intrued into the Formation and adamellite porphyry which has intruded into the Formation and peridotite. Adamellite porphyry is a vertical dike extending in the N-S direction under the Bambangan creek (FigI-4).

2. The mineralization is of a porphyry copper type consisting of pyrite and a miner amount of chalcopyrite. It is clearly controlled by lithology as shown below,

adamellite porphyry:	remarkable
hornfels :	good near the contact with porphyry but weaken rapidly towards outside
peridotite :	local and weak mineralization

3. As shown in Fig. I-4, five holes, drilled in Phase III this year, have penetrated hornfels close to the marginal zone of adamellite porphyry intrusives.
   Therefore, mineral occurrences in host rocks have demonstrated that the mineralization may not extend in a broader area than what expected and that it occurs about 400m to N-S direction and about 200-250m to E-W direction.

4. Assay values of core samples with a length of at least continuous 5m are given below.

(No. of hole)	(Length of core, m)	Au(g/t)	Cu(%)	Mo(ppm)
MJM-14	134.0m	0.06	0.068	27
MJM-15	94.8	0.09	0.101	27
MJM-16	53.7	0.04	0.029	6
MJM-17	98.5	0.03	0.024	2
MJM-18	98.0	0.01	0.051	43
Average	96.0	0.04	0.058	24

   The average grade of mineralized zone is as low as 0.06% Cu.

5. The thickness of the Pinosuk Gravels layer varies from 70-170m in the area. It is much thicker than considered ever.