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REPORT
ON
THE COOPERATIVE MINERAL EXPLORATION
IN
THE TORAJA AREA, SULAWESI
THE REPUBLIC OF INDONESIA

PHASE III

FEBRUARY 1994

JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

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PREFACE

The Japanese Government, in response to a request extended by the Government of Indonesia, decided to conduct a mineral exploration of the Toraja project, Sulawesi, and entrusted the survey to the Japan International Cooperation Agency (JICA) and the Metal Mining Agency of Japan (MMAJ).

The Government of the Republic of Indonesia appointed the Directorate of Mineral Resources to execute the survey as a counterpart to the Japanese team. The survey was carried out from 1991 jointly by experts from both governments.

The Third Phase of the Cooperative Mineral Exploration consists of drilling exploration for gold resources in the Toraja project area.

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

We wish to express our sincere appreciation to the officials concerned of the Government of the Republic of Indonesia for their close cooperation extended to the team.

February 1994

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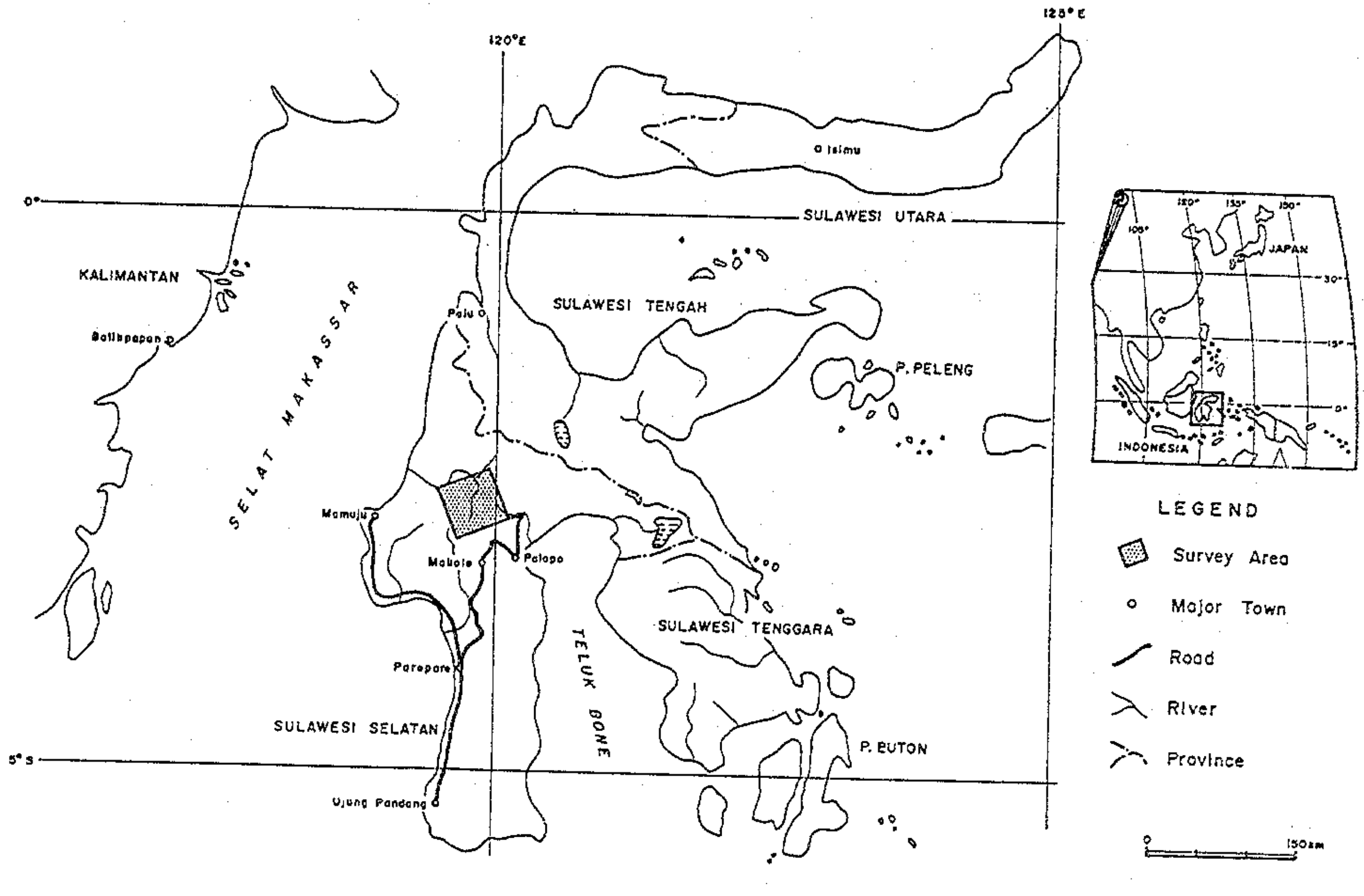

Fig.1-1 Location Map of the Survey Area

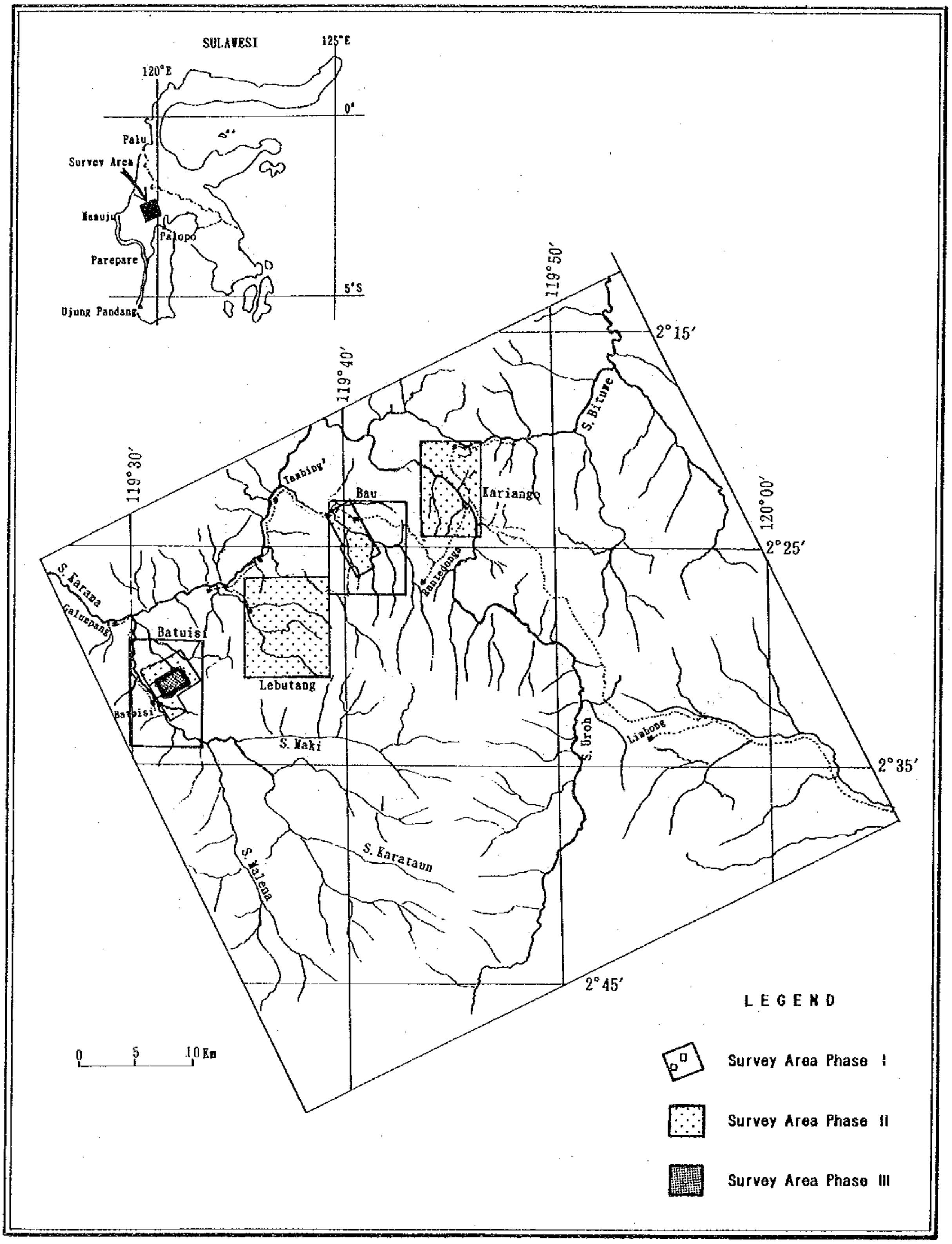

Fig. 1-2 Map Showing the Area of the Third Phase Survey

SUMMARY

Exploration works have been carried out for three years in the Batuisi prospect of the Toraja project.

In 1991, preliminary investigation and the first phase field survey comprising regional geological survey and geochemical exploration, and semi-detailed geological survey and geochemical exploration were made. The extensive development of quartz veins and quartz stockworks were found in the Batuisi prospect. Anomalous gold values were detected at the hill northwest of S. Tarawa by preliminary soil sampling.

In 1992, successive field works consisting of detailed geological survey and geochemical exploration in the Batuisi and Bau prospects, and semi-detailed geological survey and geochemical exploration in the S. Lebutang and Kariango prospects continued in the Toraja project area. As a result of the second phase survey, the central part of the Batuisi prospect was selected as the prime target area for gold exploration. Distinctive gold anomalies were delineated over the area in the Batuisi prospect. The geology, geologic structure and the mode of occurrence of gold mineralization were investigated in the second phase. A small scale drilling programme for the reconnaissance purpose was practiced at the upper reaches of S. Tarawa in the Batuisi prospect.

In 1993, drilling exploration was carried out in the Batuisi prospect. It corresponds to the third phase of the cooperative mineral exploration in the Toraja project area. The purpose of this phase was to define and evaluate gold resources which were outlined in the previous survey. Three promising target zones -- the Tondoratte zone, the middle reaches of S. Bone zone, and the Malela-Pongo zone -- were picked up from several geological and geochemical indications in the prospect.

A geological drilling programme was conducted at the Tondoratte zone and the middle reaches of S. Bone zone in the Batuisi prospect. The programme consisted of 4 inclined holes of diamond drilling totalling 680.80 m. They aimed mainly at the deeper extension of the most significant Au anomalies which were defined in the previous survey. More than one hundred samples for ore assay and other samples for laboratory studies were obtained.

The trenching work was carried out at the Malela-Pongo zone in the Batuisi prospect. The exploration consisted of 3 lines of shallow trenches totalling 159.90 m. More than thirty samples for ore assay and other samples for laboratory studies were obtained from trenches.

Three holes of 200 m in depth each were drilled at the Tondoratte zone. They aimed at the vertical extensions of some of the most significant gold indications defined by the previous survey. Numerous quartz veins and quartz stockworks with the dissemination of sulphide minerals were encountered in every hole nearly at the right depths which have been expected in the drilling programme. Several interesting intersections of gold, up to 40.22 g/t Au at 36 cm in width, were obtained. The existence of ore-grade gold mineralization in the depth below the surface showings, that was predicted in the second phase, was confirmed. On the basis of these results, the potential of gold resources in this area is thought to be high.

Two distinctive zones of auriferous quartz stockworks were found at the middle reaches of S. Bone zone within a geochemical gold anomaly detected in the second phase. A couple of significant gold values was obtained from some of grab samples collected during the surface investigation prior to drilling. One short hole, 80 m deep, was drilled to test one of the quartz stockwork zones. The results were disappointing. However the work this phase has not been sufficient for the evaluation of this mineralized zone. Further drilling to follow up the surface indications is necessary in this area.

A series of quartz veins and silicified zones, which contains a small amount of pyrite and chalcopyrite, was excavated in trenches at the Malela-Pongo zone. At the same period, surface indications of gold mineralization were looked for at the upper reaches of S. Malela and S. Pongo where the Quaternary volcanic rocks lie over the mineralized horizon. Some exposures were newly found and investigated within this zone. The results this year show that the mode of occurrence of quartz veins/stockworks is similar to the Tondoratte zone. It probably corresponds to the northeastern extension of the Tondoratte mineralized zone. This zone, along with an area lying between Tondoratte and Malela, seems to be attractive for exploration.

As a result of exploration for three years, gold mineralization which is represented by the distribution of extensive outcrops of quartz veins and quartz stockworks and outlined by the distribution of distinctive geochemical anomalies has been confirmed in the Batuisi prospect. The type and condition of gold mineralization in the prospect were discussed on the basis of petrology, mineralogy, hydrothermal alteration and fluid inclusion studies. It was interpreted that the gold-bearing quartz veins and quartz stockworks were formed under mesothermal conditions. The gold mineralization is hosted by andesite and shale of the Cretaceous Latimojong Formation. The prospect is located on the western flank of an anticlinorium formed by the emplacement of the Mamasa granite which is exposed several kilometers to the south of the prospect. This geological setting is probably a crucial factor for the formation of gold-bearing quartz veins. Gold was thought to be depleted in the shallow part by the lateritic weathering process. Ore-grade gold was returned from the lower part of oxidized zone below 100 m from the surface.

The grade of gold intersections caught at the Tondoratte zone this phase is significant. However they are rather narrow. The maximum width among three holes at a cut-off grade of 1 g/t Au is 66 cm (14.31 g/t). The question whether it is a small scale mineralization or there may exist a bigger orebody in another place is open to further discussion. The surface indications are distributed within an area of 2,500 m (NE-SW) x 1,500 m (NW-SE), centered at the top of the ridge near Tondoratte and extending from the middle reaches of S. Tarawa and S. Bone up the northeastward to the Malela-Pongo area. The scale appears to be medium from their indications. Based on these considerations, it is concluded that the drilling in the third phase has not been sufficient for the full-evaluation of the mineralization. Drilling exploration is still necessary in the Batuisi prospect. The confirmation of the scale and structure of gold mineralization has been carried over to the next stage

It is recommended that the mineralized zone defined by the third phase survey in the prospect would be fully drill-tested in the future exploration. The purpose of the exploration must be bilateral; ① to make an evaluation of the entire mineralized zones which are delineated by the surface indications, ② to follow-up the Tondoratte zone in order to investigate the details of grade distribution and structure.

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PART I OVERVIEW

Chapter 1 Introduction

1-1 Background and Objective

The Indonesia-Japan Cooperative Mineral Exploration has been carried out in six areas of the Republic of Indonesia; Sulawesi (1970-1972), Kalimantan (1974-1977), West Kalimantan (1979-1981), North Sumatra (1982-1984), South Sumatra (1985-1987), and Pegunungan Tigapuluh (1989-1990). As a result of these works, a large amount of information regarding metallic mineral resources was obtained. The exploration also contributed to the technical progress of the Geological Survey of Indonesia and the Directorate of Mineral Resources, as well as to the acquisition and accumulation of knowledge regarding geology and mineral deposits of the country.

The Ministry of Mines and Energy of Indonesia planned to conduct mineral exploration of the Toraja project, Sulawesi, and requested the cooperation of the Japanese Government. In August 1991, the Japanese Government, complying with the request, sent a mission for project-finding, discussing the Scope of Work and to make a preliminary survey trip to the area. As a result of consultations with the Directorate General of Geology and Mineral Resources, the counterpart of the Metal Mining Agency of Japan, an agreement was reached for the cooperative mineral exploration in the Toraja area on September 5, 1991.

The principal objective of this project is to find a new mineral deposit in the Toraja area through the exploration and examination of geology and mineralization. It is also important to pursue technology transfer to the Indonesian counterpart organization in the course of the project.

In 1991, preliminary investigation and the first phase field survey were carried out for the purpose of assessing the potential of mineral resources in the Toraja project area. The major works conducted during the first phase were satellite imagery photogeological interpretation, regional geological survey and geochemical exploration, semi-detailed geological survey and geochemical exploration, and application tests of plant leaf biogeochemistry and mercury gas geochemistry to the tropical rainforest land. The entire survey area was 3,000 km^2, and the semi-detailed survey was made in two prospects -- Batuisi and Bau.

In 1992, successive field works continued in the Toraja area. It corresponded to the second phase of the exploration programme. The major purpose of the second phase was to define target zones for the further exploration within the survey area. It was also required for the further exploration to elucidate the nature of mineralization in the survey area. Exploration efforts were concentrated on the prospective areas which were extracted in the first phase survey. They were composed of detailed geological survey and geochemical exploration in the Batuisi and Bau prospects, and semi-detailed geological survey and geochemical exploration in the S. Lebutang and Kariango prospects. A small scale drilling programme for the reconnaissance purpose was practiced at the upper reaches of S. Tarawa in the Batuisi prospect. The area was 130 km^2 in total.

In 1993, drilling exploration was continued in the Batuisi prospect. It corresponds to the third phase of the cooperative mineral exploration of the Toraja project. The purpose of this phase is to define and evaluate gold resources which were outlined in the previous survey. Three promising target zones for drill testing were picked up from several geological and geochemical indications in the prospect.
The sequence of exploration steps and current phase in the process is illustrated in Fig. 1-3.

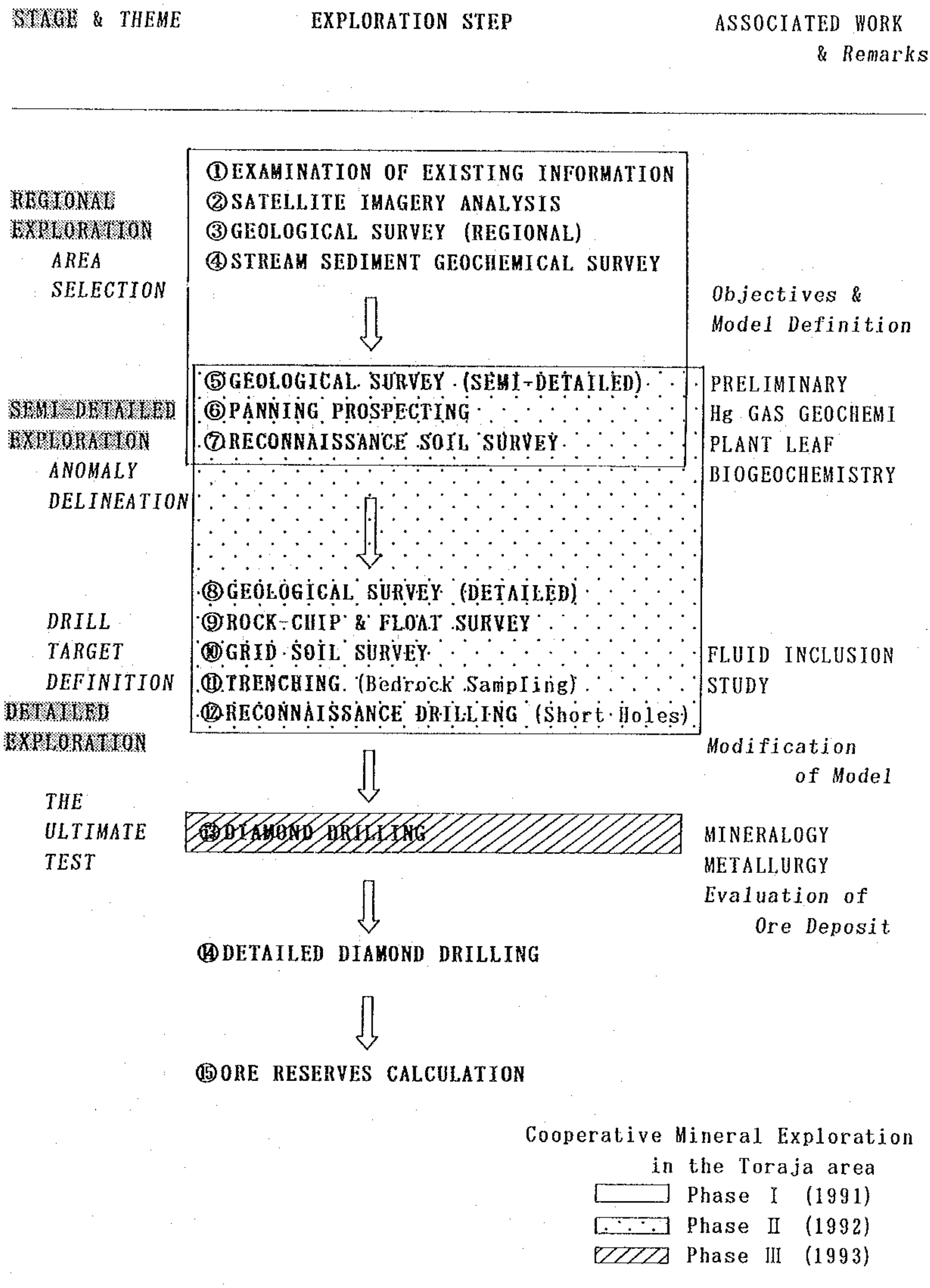

Fig. 1-3 Sequence of Exploration Steps and Current Phase in the Process

1-2 Conclusions and Recommendations of the Second Phase Survey

1-2-1 Conclusions of the Second Phase Survey

On the basis of the results of the second phase exploration in four prospects, the following conclusions were obtained.

Batuisi prospect

(1) The geology of the prospect is composed of black shale, siltstone, tuff, and andesite of the Cretaceous Latimojong Formation. The Mamasa granite batholith is exposed several kilometers to the south of the prospect. Small stocks of diorite which were inferred to be related to the granite body occur within the prospect. From the structural point of view, the prospect is located on the western flank of an anticlinorium (whose axis is N-S) formed by the emplacement of the Mamasa granite.

(2) Extensive development of quartz veins and quartz stockworks was confirmed in the prospect. Several vein systems were distinguished, and the formation of the vein pattern was discussed. The most dominant vein system -- NNW system -- was interpreted to be formed as a normal fault in the direction of compression probably generated by the emplacement of a granite body. The other major two systems -- N-S system and NW system -- may correspond to the synthetic-antithetic strike-slip faults formed by the compression.

(3) Two styles of quartz and sulphide mineralization were found mainly along S. Tarawa, S. Bone, S. Malela, and S. Pongo in the prospect. One is massive quartz veins with the dissemination of pyrite and chalcopyrite mainly found at the middle reaches of S. Tarawa and S. Malela. Another is quartz stockworks which accompany an impregnation of pyrite and chalcopyrite within the zone. The stockwork system was caught mainly at the area extending from the upper reaches of S. Tarawa to the upper reaches of S. Bone.

(4) Significant gold values were returned from outcrops, floats, rock-chips, and trench samples within the area. An assay result of 1.34 g/t Au at 7 cm in width was obtained from a part of a massive quartz vein at the middle reaches of S. Tarawa. A quartz rock-chip of 1,685 ppb Au was found at the middle reaches of S. Bone. A value of 0.53 g/t at 80^{+} cm in width was obtained from an outcrop of massive quartz vein at the northern side of the upper reaches of S. Bone. The best result of channel samples in trenches is 1.52 g/t Au at 3.2 m in width.

A value of 0.40 g/t Au was obtained from a quartz float zone at the S. Pongo area.

(5) The type and condition of gold mineralization in the prospect were discussed on the basis of petrology, mineralogy, hydrothermal alteration, and fluid inclusion studies. It was interpreted that the gold-bearing quartz veins and quartz stockworks were formed under mesothermal conditions. The similarity of the mineralization to the gold-bearing quartz veins of the Oya deposit in northern Japan was considered. This type of ore deposit sometimes shows a large fluctuation of gold grade within the vein. This nature needs to be considered in the evaluation of mineralization.

(6) Three distinctive Au anomalies and several minor anomalies were delineated from grid soil survey and rock-chip geochemistry. The major anomalies are located at the upper reaches of S. Tarawa, S. Malela, and the middle reaches of S. Bone. These anomalies are distributed within an area of 2,500 m (NE-SW) × 1,500 m (NW-SE) centered at the top of the ridge. They are composed of significant Au values of soil samples. The maximum value is 1,340 ppb Au. Anomalies of Cu and Zn almost overlap on the Au anomalies. The geochemical anomalies are well correlated to the areas where intensive quartz veins/stockworks were found. The size and magnitude of gold mineralization were estimated to be medium from the geochemical features.

(7) The result of drilling in 1992 is disappointing. Low-grade gold mineralization was found in two holes (0.50 g/t Au at 50 cm in MJT-3 and 0.53 g/t Au at 90 cm in MJT-4). No ore-grade value has been returned. However, only limited part of the mineralized zone was investigated. It was confirmed that the outcrops of quartz veins/stockworks and geochemical anomalies were the indicator of gold mineralization. There is a possibility of finding ore-grade parts within the zone. Some evidences of gold depletion by the lateritic weathering process, though circumstantial, were pointed out. Further drilling is necessary for the full-evaluation of this zone.

Bau prospect

(1) Two styles of mineralization were distinguished through detailed geological survey in the prospect. One consists of fissure filling quartz veins, and another is pyrite dissemination near dioritic stocks. The geologic environment was interpreted to be similar to that of the Batuisi prospect.

(2) Some of the quartz veins showed significant Au assay results. Each of the veins is small and discontinuous. Soil anomalies of Au and Cu obtained in the area are of low level and sporadic. From these evidences, it was concluded that the gold mineralization of this style had no sign of extensive development.

(3) Pyrite dissemination was found at the northern part of the prospect. Assay results were discouraging. Au anomalies of soil and rock-chip samples found near the pyrite dissemination are of low level and patchy. This style of mineralization probably has low potential.

S. Lebutang prospect

(1) Gold mineralization associated with pyrite dissemination or stringers in massive andesite was found at S. Taroto. A series of Au anomalies of moderate to low degrees was found to extend from S. Kanan through S. Taroto and S. Peko up to S. Talodo Basisi. Although the surface indications of this zone are significant, the assay result of ore samples is disappointing. It was believed to be a gold mineralization probably associated with pyrite dissemination within shear zones. The details of mineralization have not been fully investigated. It was presumed to be a low-grade gold mineralization on the basis of the data obtained during 1992.

(2) The other outcrops of quartz veins and geochemical anomalies found in the prospect were estimated to be of minor importance.

Kariango prospect

A limonite network zone and the subordinate Au anomaly of low level were found near S. Suluan. It was interpreted to be the product of small scale hydrothermal activity by a subsurface igneous intrusion. No other indication of gold mineralization has been discovered in the prospect. The potential of this prospect appears to be very small.

1-2-2 Recommendations for the Third Phase Survey

Batuisi prospect

It is recommended that the mineralized zone delineated by the second phase survey in the prospect be fully drill-tested during the third phase. The major promising locations for drilling to be carried out during the third phase are listed below. The depth of drill holes must be deep enough (around 200m) to penetrate through the oxidized zone.

① South of the second phase drill line at the upper reaches of S. Tarawa
② North of the second phase drill line at the upper reaches of S. Bone
③ Area between S. Pongo and S. Malela
④ S. Malela
⑤ Near the top of the ridge
⑥ Middle reaches of S. Bone
⑦ NW extension of the "Old Dutch Pit" vein.

Bau prospect

No further work is recommended in the Bau prospect.

S. Lebutang prospect

No further work is recommended in the S. Lebutang prospect.

Kariango prospect

No further work is recommended in the Kariango prospect.

1-3 Outline of the Third Phase Survey

1-3-1 Survey Area

The third phase survey was carried out in the Batuisi prospect. It is located in the central part of western Sulawesi, and corresponds to the northwestern part of the first phase survey area. The survey this phase was conducted at three zones in the Batuisi prospect: ① Tondoratte (near the top of the ridge), ② the middle reaches of S. Bone, and ③ Malela-Pongo. These zones were selected from several significant geological and geochemical anomalous zones which were delineated in the second phase survey and are distributed within an area of 2,500 m (NE-SW) x 1,500 m (NW-SE).

The administration of the area is under the jurisdiction of South Sulawesi Province. The location map is shown in Fig. 1-2.

1-3-2 Exploration Theme

The exploration this year corresponds to the third phase of the three-year cooperative mineral exploration programme of the Toraja project.

The work conducted this year was composed of 4 holes of diamond drilling totalling 680.80 m. The major theme of the drilling programme was to test the deeper part of the promising indications of gold mineralization which were defined in the second phase survey in the Batuisi prospect. The trenching exploration was also conducted this year.

1-3-3 Exploration Work

A diamond drilling programme was conducted at the Tondoratte zone and the middle reaches of S. Bone zone in the Batuisi prospect. The programme consisted of 4 inclined holes of diamond drilling totalling 680.80 m. The minimum size of the core was BQ. They aimed mainly at the deeper extension of the most significant Au anomalies which were defined in the previous survey. A series of drill logs of 1:200 scale was prepared. More than one hundred samples for ore assay and other samples for laboratory studies were obtained.

The trenching work was carried out at the Malela-Pongo zone in the Batuisi prospect. The exploration consisted of 3 lines of shallow trenches totalling 159.90 m. More than thirty samples for ore assay and other samples for laboratory studies were obtained from trenches.

The amount of exploration works and amount of samples for ore assay and laboratory studies are summarized in the following table.

Items	Amount
Survey Area	3.75 km^2
Diamond Drilling (4 Inclined Holes)	680.80 m
Trenching (3 Lines)	159.90 m
Samples	
① Ore Assay (Au,Ag,Cu,Pb,Zn)	139 pcs
② Thin Sections	6 pcs
③ Polished Sections of Ore	25 pcs
④ X-Ray Diffraction Analysis	20 pcs
⑤ Fluid Inclusion Studies (Homogenization Temperature)	20 pcs

1-3-4 Survey Team

The drilling exploration was conducted from July 1 to November 2, 1993. Laboratory studies and reporting succeeded to the field work. The organization of the survey team is as follows.

[Metal Mining Agency of Japan]

Satoshi SHIOKAWA	Coordinator and Geologist
Tetsuo SUZUKI	Coordinator and Geologist
Yoshiaki IGARASHI	Coordinator and Mining Engineer

[Indonesian members]

Simpwee Soeharto	(DMR)	Team Leader and Geologist
Wahyu Widodo	(DMR)	Geologist
Moe'tamar	(DMR)	Surveyor
Sudarman	(DMR)	Assistant
Suratman	(DMR)	Drilling Engineer

[Japanese members]

Kohei IIDA	(NED)	Team Leader and Chief Geologist
Hatsuo KUMANO	(NED)	Drilling Engineer
Mitsuo SASAKI	(NED)	Drilling Engineer
Fumio ENDO	(NED)	Drilling Engineer

*Note: DMR means Directorate of Mineral Resources
NED means Nikko Exploration and Development Co., Ltd.

Chapter 2 Geography of the Survey Area

2-1 Topography and Drainage System

The survey area is located in the central part of western Sulawesi.

Access to the area is; from Jakarta to Ujung Pandang by air, from Ujung Pandang to Mamuju by car on sealed road, from Mamuju to Tarailu by car on unsealed road, and from Tarailu to Galumpang by engine canoe along a river (Sungai Karama). Galumpang is the biggest village near the survey area. Mamuju, which is located some 70 km due west-southwest of the survey area, is the terminal town of sealed road at the western coast of South Sulawesi.

The survey area is situated on the western flank of a steep mountain range. The topography is rugged. There is a couple of high mountains of more than 1,000 m in the vicinity of the survey area. There are several little villages in the survey area. Access inland is slow and mainly on foot, generally following drainages. There is no vehicle road in the area. Only horse tracks and footpaths are available.

Rivers flow down to the west into Selat Makassar. S. Karama is the major drainage system in the survey area. All rivers in the survey area -- S. Karataun, S. Pongo, and S. Makaliki -- flow into S. Karama.

2-2 Climate and Vegetation

Even though it is situated in a tropical rain forest zone, the climate of the area is rather mild due to its peculiar land structure -- mountainous bony frame and surrounded by the sea on all sides. It has two seasons, rainy and dry. From June to October is usually the dry season, and the rainy season generally continues from November till May.

Mean temperature and monthly precipitation in the rainy season is 26 °C and 400 mm. Mean temperature and monthly precipitation in the dry season is 27 °C and 70 mm (climatological data for Makassar).

The lower part of mountains in the area is covered by tropical rain forest. The major part of the mountainous area, however, belongs to the tropical highland forest -- broad leaved evergreen vegetation and coniferous vegetation. Alluvial patches among mountains and even flanks of hills are reclaimed, and paddy rice is cultivated in such places. On steep hills among mountains, dry field rice, coffee plant, and ubikayu (a kind of taro) are cultivated by the slash-and-burn farming.

Chapter 3 Geology of the Survey Area

3-1 General Geology of the Central Part of Western Sulawesi

Sulawesi is formed of three major tectonic units -- western Sulawesi, eastern Sulawesi, and easternmost islands of Banggai-Sula and Buton --, and consists of four geographic arms -- north, south, east, and southeast arms. The western section, comprising north and south arms, is made up of a series of overlapping volcano-plutonic arcs of Mesozoic to Recent age.

The geology of the central part of western Sulawesi is composed of three major units:

① Cretaceous subduction complexes which are overlain by sediments perhaps deposited in an outer-arc basin.

② The Upper Paleogene continental shelf strata deposited on the Cretaceous sediments.

③ Neogene sedimentary and volcanic rocks. They are intruded by Neogene granitic rocks.

The oldest rocks of the area are Mesozoic gneiss and schist from the broad view of the western arc. Cretaceous volcanic-sedimentary complexes (metasediments) are widely distributed in the area. It consists mostly of clastic rocks - slate, black shale, turbiditic siltstone, greywacke, and minor limestone. Some of the rocks are partly sheared and weakly metamorphosed.

Overlying the Cretaceous turbiditic facies are the Upper Paleogene continental shelf sections, deformed only moderately. It is composed of marine and marly shale, quartz sandstone, and limestone.

At the Miocene time, the stable platform conditions changed drastically into active magmatism and extensive volcaniclastic sedimentation. Batholiths and stocks are widely developed in the area. Biotite granite and quartz monzonite are the dominant granitic rocks. According to age dating on the granitic rocks, the magmatism occurred at least mostly within the Middle and Late Miocene time. Extensive submarine volcanism, a major orogenic event started at the beginning of the Early Miocene and continued to the Pliocene time, took place elsewhere in the western arc. It consists of dacitic to andesitic volcanism. Renewed volcanic activity in the Plio-Pleistocene produced dacitic to andesitic pyroclastic rocks. Fig. 1-4 shows the regional geology of the central part of western Sulawesi.

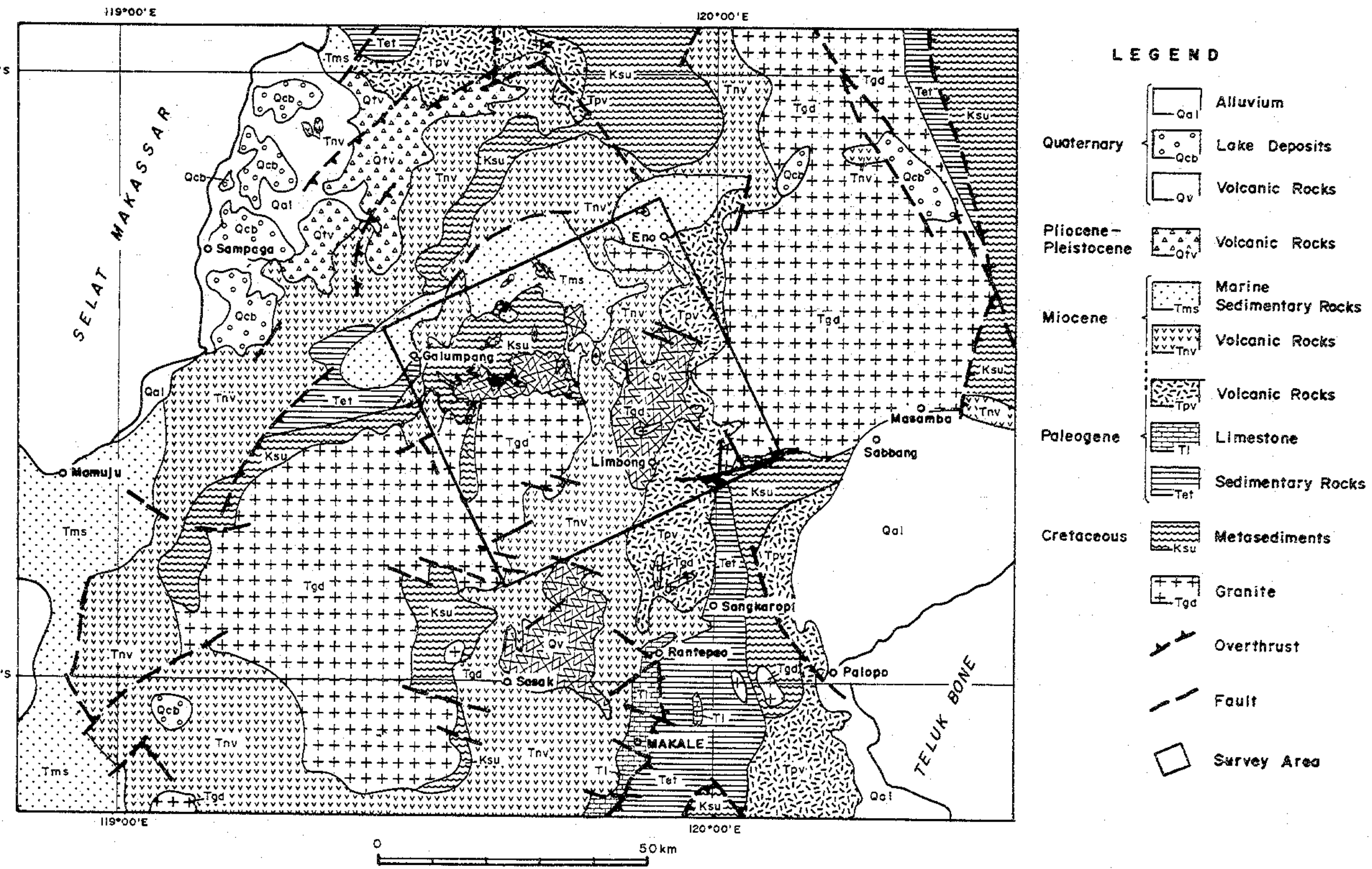

Fig.1-4 Regional Geology of the Central Part of Western Sulawesi

3-2 Geology and Geologic Structure of the Survey Area

The oldest rock in the survey area (which means the regional survey area) is biotite gneiss and mica schist of the Batuan Malihan metamorphic rocks. It occurs locally at the southwest of the survey area.

Metasediments are widely distributed in the area. It is composed of slate, phyllitic shale, and siltstone. It is called the Latimojong Formation, and supposed of Cretaceous age according to the existing geological information. Thin layers of andesite lava and dolerite are intercalated mainly in the upper part of the metasediments.

Overlying unconformably on the Cretaceous metasediments are Paleogene shelf sediments. It is composed of shale, sandstone, and limestone. It is called the Toraja Formation.

The eastern part of the survey area is covered by the Lower Miocene series called the Lamasi Volcanic Rocks. Acid to intermediate volcanic and pyroclastic rocks such as pumice tuff, tuff and dacite lava are the major constituents of the rocks. Shale and basalt lava occur in the lower part of the pyroclastic sequences in some places.

The alternation of calcareous sediments and basic tuffs occurs overlying the acid to intermediate pyroclastic rocks. The upper part gradually changes to basic lava. These rocks of the Middle to Upper Miocene series are subdivided into three sequences - the Beropa Tuffs, the Sekala Formation, and the Talaya Volcanic Rocks in ascending order.

Two granite batholiths are developed to the east and to the southwest of the area. Each batholith occurs with several small stocks. The eastern batholith is called the Kambuno granite, and the southwestern one the Mamasa granite.

Dacite lava and tuff of probably Pleistocene age occur at high altitudes in the survey area. Dacitic crystal tuff is the representative facies of the rocks. It is called the Barupu Tuffs.

The prominent direction of NNE to N-S system was embossed in the distribution of lineaments and fracture traces in the survey area through the satellite imagery photogeological interpretation in the first phase.

A regional anticlinal structure and some local folds were distinguished in the area. They have the axes of N-S direction.

Minor faults trending NW to WNW, E-W and NE were recognized in the survey area.

Fig. 1-5 shows the geology of the survey area. Fig. 1-6 shows the stratigraphy of the survey area.

3-3 Mineralization

There are three kinds of mineralization known in the central part of western Sulawesi. Those are; mesothermal gold-bearing quartz veins, massive sulphide deposits (Sangkaropi type) and porphyry copper-gold deposits (Sasak type). In the course of the regional survey in 1991, no positive indication of massive sulphide mineralization and porphyry copper-gold mineralization has been found.

Indications of mesothermal gold mineralization were caught at several places in the regional survey area. Semi-detailed and detailed geological survey and geochemical exploration have been carried out in four prospects -- Batuisi, Bau, S. Lebutang, and Kariango. Geological characteristic features of gold mineralization in the area are summarized as follows:

① Host rock is mainly metasediments of the Latimojong Formation.
② Extensive development of massive quartz veins.
③ Occurrence of comparatively coarse gold.
④ Associated with sulphide minerals such as pyrite, arsenopyrite, chalcopyrite, sphalerite, and galena.
⑤ The major constituents of veins are quartz, ankerite, and calcite.
⑥ Hydrothermal alteration mainly composed of silicification, chloritization, and sericitization.

From these evidences the mesothermal conditions of formation have been presented. Results of the fluid inclusion studies in the Batuisi prospect substantially supported the mesothermal origin of auriferous quartz veins.

Fissure patterns of quartz veins show the dominant NNW trend in both Bau and Batuisi prospects. The Batuisi prospect is situated on the western flank of an anticlinorium (whose axis is N-S) formed by the emplacement of the Mamasa granite batholith. Granitic intrusions were supposed to exist beneath the prospect. This geologic environment was thought to be the crucial factor for the formation of vein pattern in the prospect.

Geochemical features of gold mineralization are summarized as follows:

① Close spatial distribution among the occurrences of gold and some heavy minerals -- cinnabar, chalcopyrite and arsenopyrite -- in a broad scale (pan concentrates).

② Analytical values of Au do not show any intimate correlation with the other elements statistically (stream sediments and soils).

③ The occurrence of distinctive Au anomalies especially in the Batuisi prospect (soils). They are surrounded by anomalies of some basemetal elements such as Cu and Zn.

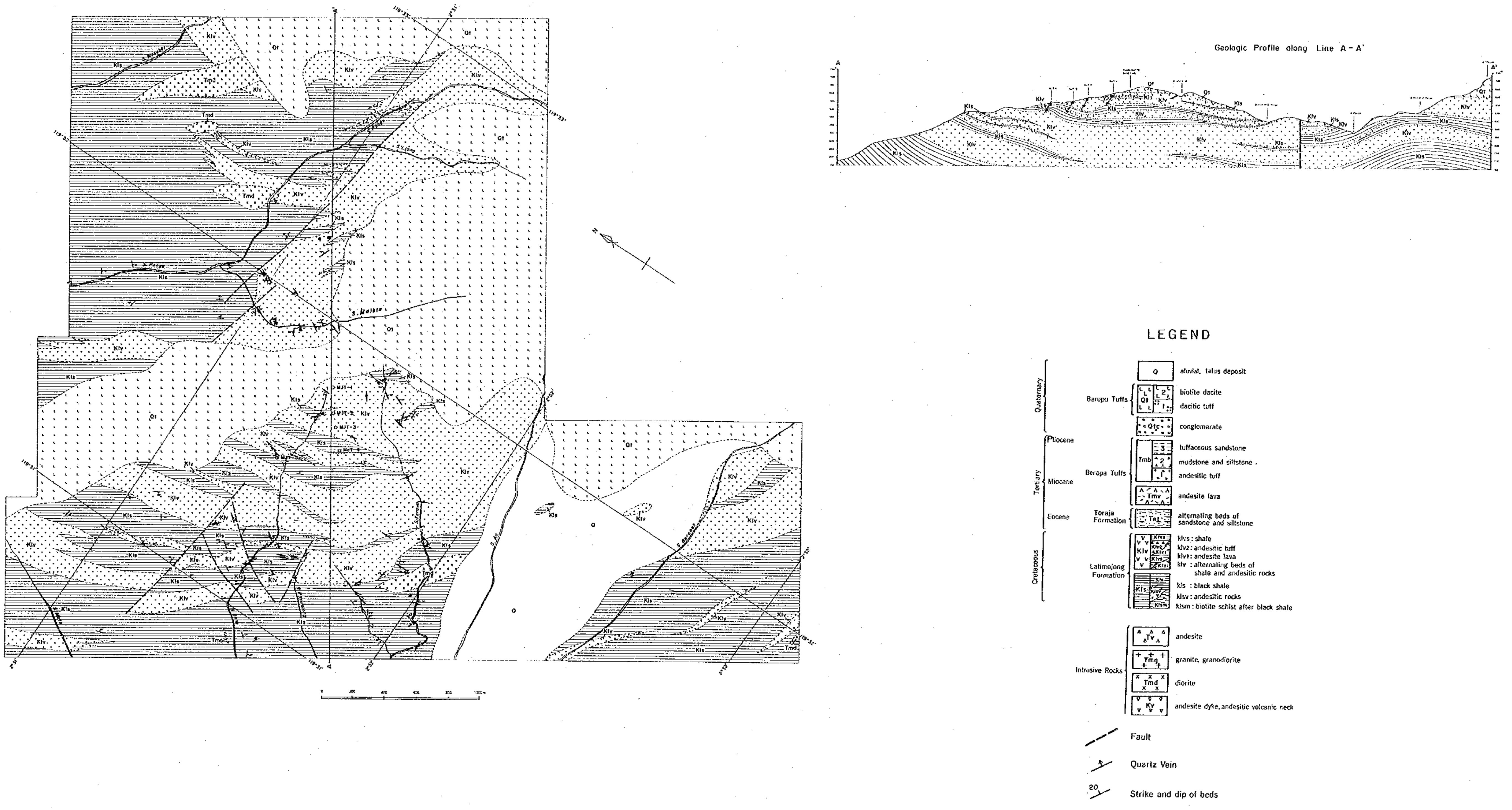

Fig. 1-5 Geology and Geologic Profile of the Survey Area
(Batuisi Prospect)

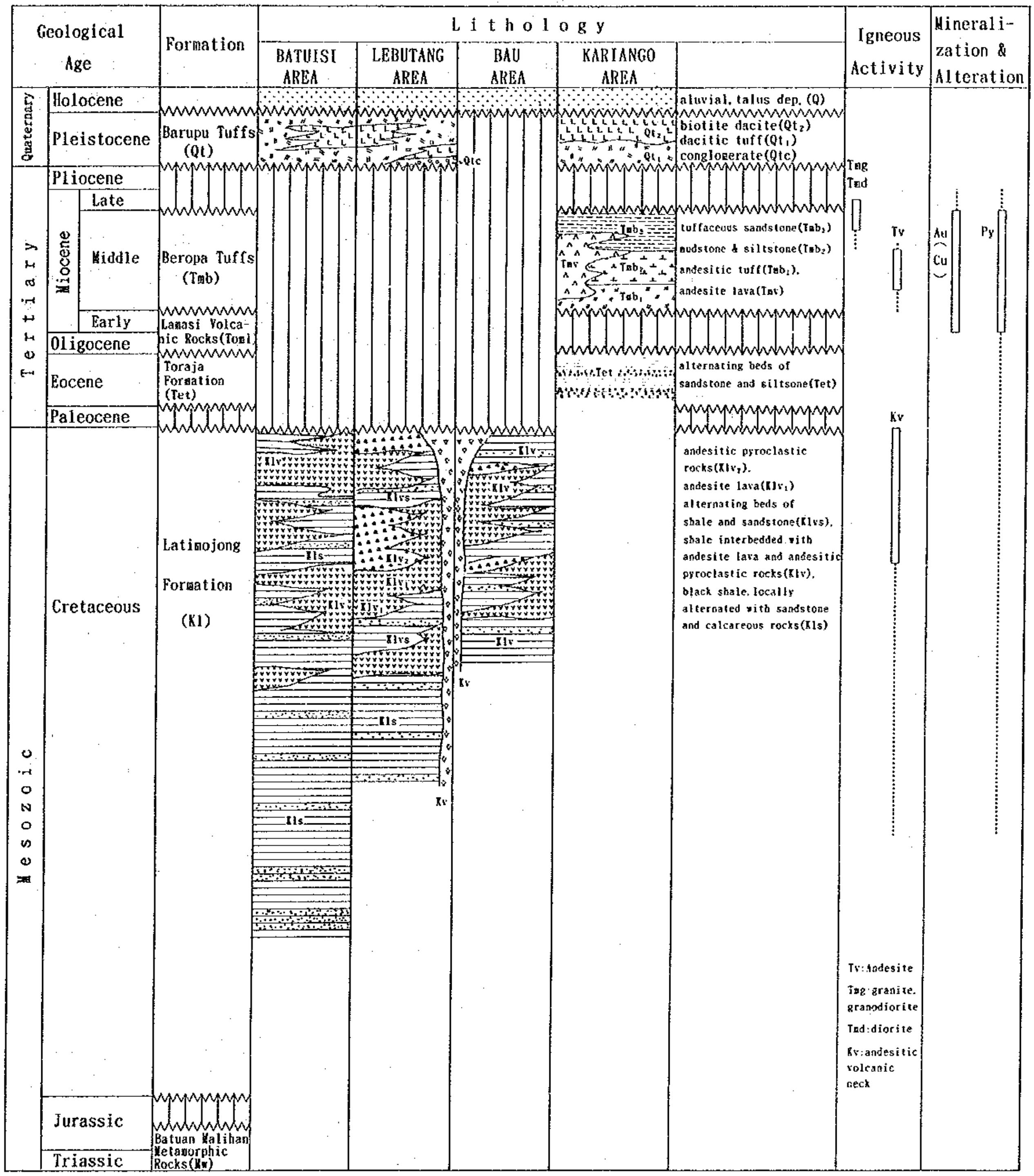

Fig.1-6 Stratigraphy of the Survey Area

Chapter 4 Discussions on the Results of the Third Phase Survey

4-1 Geology, Geologic Structure and Mineralization

The extensive development of auriferous quartz veins and quartz stockworks was confirmed over an area of 2,500 m x 1,500 m including S. Tarawa, S. Bone, Tondoratte, S. Malela, and S. Pongo. Quartz veins and quartz stockworks are hosted by volcanic-sedimentary strata of the Cretaceous Latimojong Formation.

From the structural point of view, the prospect is situated on the western flank of an anticlinorium (whose axis is N-S) formed by the emplacement of the Mamasa granite. The Mamasa granite batholith is exposed several kilometers to the south of the prospect. Small stocks of diorite occur within the prospect, and a granite body is believed to exist beneath the prospect. This geologic setting is the most important factor for the formation of vein pattern in the prospect. Several vein systems were observed in the prospect; NNW, N-S, and NW systems.

Two styles of quartz and sulphide mineralization -- massive quartz vein (single vein) and quartz stockwork system -- were distinguished in the Batuisi prospect. The major single veins occur at the lower to the middle reaches of S. Tarawa, the middle reaches of S. Bone, and S. Malela. Whereas stockworks are mainly developed at the Tondoratte area. Of course there are many places where these two styles coexist. From the lower reaches of S. Tarawa up to Tondorrate, the relative abundance of massive quartz veins of moderate to steep dip decreases. By contrast to this, the occurrence of quartz stockwork zones of mostly gentle dipping increases near the Tondoratte area. No displacement of wall-rocks has been recognized in quartz stockwork system. It means that stockworks at the Tondoratte zone were formed in tension cracks. The force which caused such tension cracks is unknown. On the contrary, massive quartz veins were probably deposited in faults as discussed above. There is no evidence of chronological difference between single vein and stockwork system.

The comparative density and intensity of quartz veining between volcanic facies and clastic facies are matters worthy to be considered. Most of quartz veins and stockworks were found in andesite in the Tondoratte zone. It is probably caused by the brittle property of the volcanic rock.

Based on the results of the reconnaissance drilling in the second phase, which indicated the possibility of the occurrence of gently NE-dipping quartz veins and stockwork zones in this area, the drilling programme of the third phase was designed. Significant results have been obtained from the drilling. Good intersections were caught in all three drill holes at the Tondoratte mineralized zone. Each of these major intersections can be correlated to the surface indications of gold mineralization. The dip of the veins, however, was only tentatively interpreted to be gentle NE by the evidence at hand. The distances of outcrops and drill intersections are quite large. It is still in an early stage of exploration. It is, of course, well known that steeply dipping veins are more common than gentle ones, and such possibility must be carefully considered in planning for future work.

Gold mineralization in this area shows the following five distinctive features which are characteristic to mesothermal gold-bearing quartz veins:

① Auriferous quartz veins often show massive features.
② Gold grains are comparatively coarse.
③ Gold is associated with sulphide minerals such as pyrite and chalcopyrite.
④ The major gangue minerals are quartz, ankerite, and calcite.
⑤ Hydrothermal alteration is mainly composed of silicification, chloritization, and sericitization.

Gold-bearing quartz veins and quartz stockworks in this area are hosted mainly by low-grade metamorphosed (sub-greenschist facies) Cretaceous volcanic-sedimentary strata. Quartz veins sometimes show hard, thick, and massive features. Quartz crystals have subrounded to subhedral morphology, and are white to light grey with silky or resin bright tint. It sometimes has chalcedonic appearance. The quartz grains are coarse, from slightly less than 1 mm up to several millimeters. Banded texture was rarely observed in quartz veins. The vein quartz in this area exhibits that of mesothermal veins morphologically.

The grain size of gold is estimated to be coarse from the study of pan concentrates in which a gold grain of up to 500 microns was reported during the first phase survey. Coarse gold is characteristic of mesothermal deposits, which often bear an erratic nature of gold mineralization.

Gold assays, some of which show significant grades, were obtained from a part of quartz veins where a small amount of sulphide minerals was impregnated. Pyrite and chalcopyrite are the minerals most closely associated with gold. Traces of arsenopyrite, sphalerite, galena and bornite were also found in such part. Silver mineral has not been identified in the sulphide mineral association.

Quartz, ankerite and calcite are accounted for the major part of gangue minerals. Adularia was seldom observed in quartz veins. Neither alunite nor hypogene kaolin has been found.

Silicification, chloritization and sericitization were recognized in andesite and shale around quartz veins and quartz stockworks. The other alterations identified within mineralized zones were pyritization and carbonatization. Pervasive propylitization was observed in this area. Wall-rock alteration in a hydrothermal system generally changes from silicification-propylitization in the deeper zone to argillic alteration in the upper part. Advanced-argillic alteration appears at the top of the system in some cases. The alteration in this area is very similar to the lower facies of the typical hydrothermal system.

The results of fluid inclusion studies in the Batuisi prospect provide the geochemical framework of vein formation.

Most of fluid inclusions in quartz are of two-phase liquid-rich type. The homogenization temperature of individual fluid inclusion ranges from 180°C up to 370°C. Although the salinity of fluid inclusions has not been measured, it was assumed to be medium from the microscopic observation of liquid-vapor phase relationship. Polyphase inclusions were discovered in some quartz samples. One of the daughter minerals is halite.

The indication which implies boiling phenomena has not been observed in fluid inclusions. Fluid boiling might have been occurred in much higher part of the hydrothermal system in this area.

Assay results of drill cores in the second phase and the third phase are interesting. Ore-grade values of gold were obtained approximately 100 m below surface. Only low grade values were returned from intersections in the shallow parts. There is a possibility of gold depletion by the lateritic weathering process. Strong weathering was recognized in trenches and drill holes at the Tondoratte zone. The oxidation of sulphide minerals was recognized from surface down to the deeper part of drill holes. In MJT-7, strong limonitization was observed even at the end of hole. Clayey zones which were thought as faults were caught in such depths in MJT-7. It was interpreted that the oxidation of sulphide minerals within quartz veins/stockworks was caused by surface water introduced along the faults. It is a remarkable feature of the Tondoratte area that the influence of weathering is recognizable in such depths. The results of drilling in this phase, together with those in the previous phase, indicate that the degree of weathering is an important factor for gold depletion. It may be a horizon of gold depletion from surface down to approximately 100 m. From 100 m deep there occur a primary (or slightly depleted) horizon. It probably corresponds to the lower part of oxidized zone.

The erratic nature of gold grade is another characteristic feature of gold mineralization in this area. Gold is thought to be associated with sulphide dissemination. Sulphide minerals, especially pyrite, are disseminated widely in and around the zone of quartz veining. However, ore grade parts occur in a limited zone of sulphide mineralization. The surrounding zone, still within a quartz vein or a quartz stockwork system, has very low grade in gold. High grade ores show a kind of nugget effect. It is a specific character of mesothermal gold deposit.

On the basis of these examinations, the process of vein formation in the Batuisi prospect is inferred as follows.

The Batuisi prospect is situated at the north of the Mamasa granite batholith. A granite body -- batholith or cupola -- may exist beneath the prospect. There is no direct evidence which connects gold mineralization with the emplacement of the Mamasa granite. However the distribution of gold showings around the granite body indirectly shows some genetic relationship between gold mineralization and granite. Therefore, the current surface is assumed to correspond to the lower part of a hydrothermal system which was originated from the deeper igneous body. An epithermal environment, which might produce a pervasive gold mineralization, was probably formed at much higher levels than the present surface. The convecting hydrothermal system was driven by heat derived from the igneous body beneath the area at a depth of several kilometers.

The origin of ore-forming fluid has not been identified. Generally speaking, there are three possibilities; fractional crystallization of felsic magma emplaced in the upper crust, devolatilization reaction during prograding metamorphism, and surfacial water infiltrating through deep fractures. The participation of magmatic water from granite body in some degrees is highly speculated. The timing of ore deposition has not been ascertained yet. The result of age dating on the Mamasa granite indicates that it may be at least sometime between the late Miocene and Pliocene.

4-2 Potential of Resources

During the first phase, surface indications of gold mineralization were found through semi-detailed geological survey, stream sediment geochemical survey, and reconnaissance soil survey in the Batuisi prospect. In the second phase, significant mineralized zones were delineated through detailed geological survey, grid soil survey, trenching, and reconnaissance drilling. Three distinctive Au anomalies and several minor anomalies were delineated from grid soil survey and rock-chip geochemistry during the second phase. The major anomalies are located at; ① the upper reaches of S. Tarawa and S. Bone (the Tondoratte mineralized zone), ② the area between S. Malela and S. Pongo (the Malela-Pongo mineralized zone), and ③ the middle reaches of S. Bone (the middle reaches of S. Bone mineralized zone). These anomalies are distributed within an area of 2,500 m (NE-SW) x 1,500 m (NW-SE) centered at the top of the ridge. Anomalies of Cu and Zn nearly overlap the Au anomalies. The geochemical anomalies agree well with the areas where intensive quartz veins/stockworks were found. These mineralized zones show common features to be mentioned above, although they have a minor difference in several aspects. Therefore, it is interpreted to be formed under the similar conditions. The area of geochemical anomalies on the surface may correspond roughly to the area of subsurface gold mineralization. The results of drilling in the second phase were disappointing. Only low grade gold mineralization came out from drill holes. No ore-grade value has been obtained. However a limited part of the mineralized zone was tested. It was composed of short holes. It was assumed that there was a possibility of near-surface gold depletion by lateritic weathering process in this area.

Based on these considerations, drilling exploration for testing the vertical extensions of some of the most significant gold indications was conducted in the third phase. The results are encouraging. Significant gold mineralization was confirmed in three drill holes at the Tondoratte zone. The intersections are composed of gold-bearing quartz veins of up to 40.24 g/t Au at 36 cm in width. They were obtained from rather deep parts of drill holes (96 ~ 134 m in depth). The gold potential of this area is rather difficult to assess at this stage, because the data are not sufficient. There are two possibilities; one is the existence of several gentle dipping fairly large auriferous quartz veins which was considered by the results of the survey of the previous phase, the other is the possibility of a significant network zone of relatively thin veins.

The existence of ore-grade gold mineralization was confirmed by the third phase exploration. It is interpreted that the Tondoratte mineralized zone may represent a part of extensive gold mineralization whose figure is expressed as geochemical anomalies on the surface. The integrated interpretation of the survey results in the Batuisi prospect is shown in Fig. 1-7.

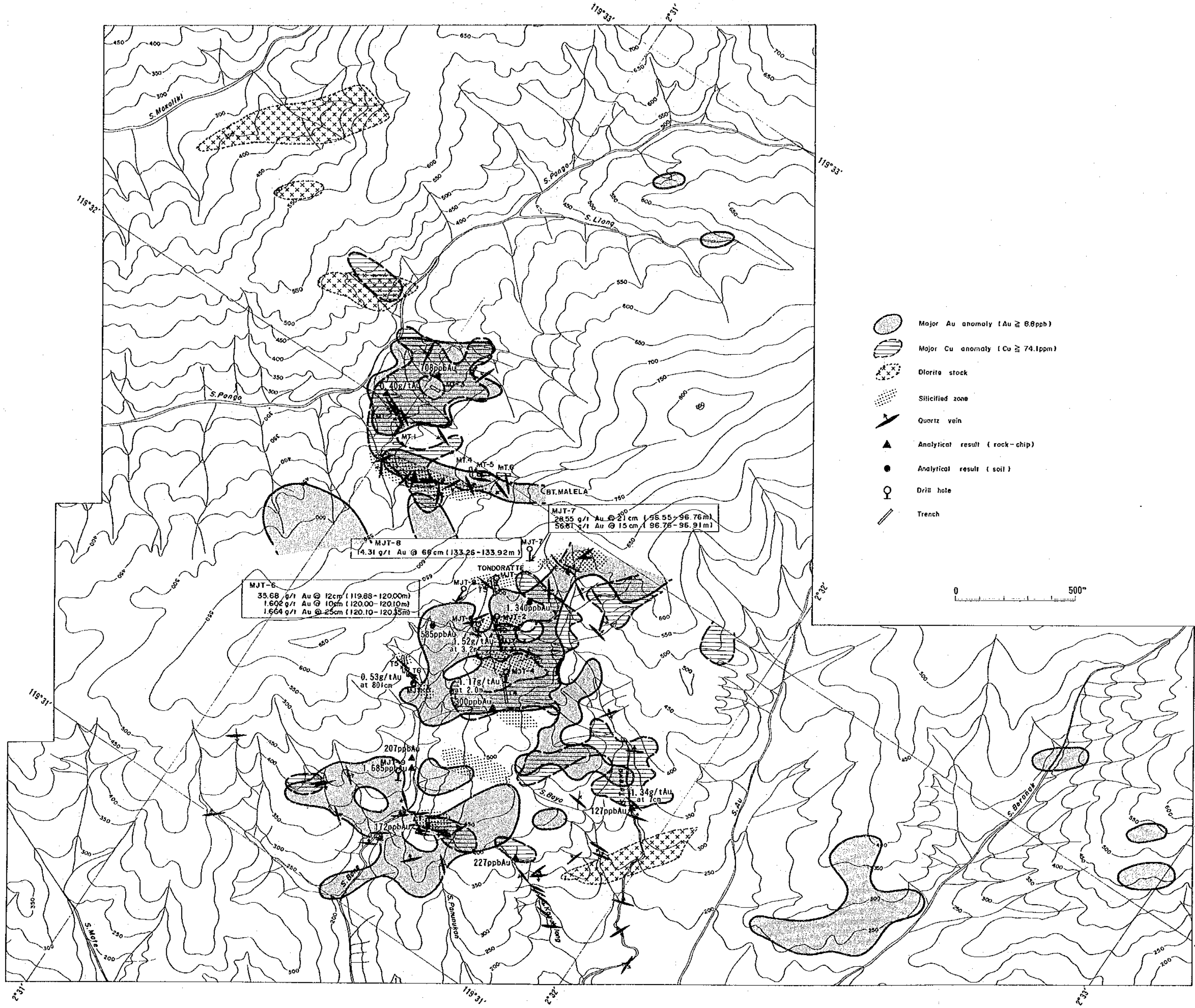

Fig. 1-7 Integrated Interpretation of the Survey Results in the Batuisi Prospect

Chapter 5 Conclusions and Recommendations

5-1 Conclusions

During the third phase, drilling exploration, trenching and some follow-up survey were carried out at three promising mineralized zones in the Batuisi prospect. As a result of these works, the following conclusions are obtained.

(1) Three holes of 200 m in depth each were drilled at the Tondoratte zone. They aimed at the vertical extensions of some of the most significant gold indications defined by the previous survey. Numerous quartz veins and quartz stockworks with the dissemination of sulphide minerals were encountered in every hole nearly at the right depths which have been expected in the drilling programme. Several remarkable intersections of gold, up to 40.22 g/t Au at 36 cm in width, were obtained. The existence of ore-grade gold mineralization in the depth below the surface showings, that was predicted in the second phase, was confirmed. On the basis of these results, the potential of gold resources in this area is thought to be high.

(2) Two distinctive zones of auriferous quartz stockworks were found at the middle reaches of S. Bone zone within a geochemical gold anomaly detected in the second phase. A couple of significant gold values was obtained from some of grab samples collected during the surface investigation prior to drilling. One short hole, 80 m deep, was drilled to test one of the quartz stockwork zones. The results were disappointing. However the work this year has not been sufficient for the evaluation of this mineralized zone. Further drilling to follow up the surface indications is necessary in this area.

(3) A series of quartz veins and silicified zones, which contains a small amount of pyrite and chalcopyrite, was excavated in trenches at the Malela-Pongo zone. At the same period, surface indications of gold mineralization were looked for at the upper reaches of S. Malela and S. Pongo where the Quaternary volcanic rocks lie over the mineralized horizon. Some exposures were newly found and investigated within this zone. The results this year show that the mode of occurrence of quartz veins/stockworks is similar to the Tondoratte zone. It probably corresponds to the northeastern extension of the Tondoratte mineralized zone. This zone, along with an area lying between Tondoratte and Malela, seems to be attractive for exploration.

(4) As a result of exploration for three years, gold mineralization which is

represented by the distribution of extensive outcrops of quartz veins and quartz stockworks and outlined by the distribution of distinctive geochemical anomalies has been confirmed in the Batuisi prospect. The type and condition of gold mineralization in the prospect were discussed on the basis of petrology, mineralogy, hydrothermal alteration and fluid inclusion studies. It was interpreted that the gold-bearing quartz veins and quartz stockworks were formed under mesothermal conditions. The gold mineralization is hosted by andesite and shale of the Cretaceous Latimojong Formation. The prospect is located on the western flank of an anticlinorium formed by the emplacement of the Mamasa granite which is exposed several kilometers to the south of the prospect. This geological setting is probably a crucial factor for the formation of gold-bearing quartz veins. Gold was thought to be depleted in the shallow part by the lateritic weathering process. Ore-grade gold was returned from the lower part of oxidized zone below 100 m from the surface.

(5) The grade of gold intersections caught at the Tondoratte zone this phase is significant. However they are rather narrow. The maximum width among three holes at a cut-off grade of 1 g/t Au is 66 cm (14.31 g/t). The question whether it is a small scale mineralization or there may exist a bigger orebody in another place is open to further discussion. The surface indications are distributed within an area of 2,500 m (NE-SW) x 1,500 m (NW-SE), centered at the top of the ridge near Tondoratte and extending from the middle reaches of S. Tarawa and S. Bone up the northeastward to the Malela-Pongo area. The scale appears to be medium from their indications. Based on these considerations, it is concluded that the drilling in the third phase has not been sufficient for the full-evaluation of mineralization in the prospect. Drilling exploration is still necessary in the Batuisi prospect. The confirmation of the scale and structure of gold mineralization has been carried over to the next stage

5-2 Recommendations for the Future Exploration

It is recommended that the mineralized zone defined by the third phase survey in the prospect would be fully drill-tested in the future exploration. The purpose of the exploration must be bilateral; ① to make an evaluation of the entire mineralized zones which are delineated by the surface indications, ② to follow-up the Tondoratte zone in order to investigate the details of grade distribution and structure.

The major promising locations for drilling are listed below. The depth of drill holes must be deep enough to penetrate through the oxidized zone.

① Southwest of MJT-7 at the Tondoratte zone

② At the middle reaches of S. Tarawa

③ At the upper reaches of S. Bone

④ At the middle reaches of S. Bone

⑤ At the top of the ridge near Tondoratte

⑥ Northeast of S. Malela

⑦ Southwest of S. Pongo

PART II
DETAILED DISCUSSIONS

PART II DETAILED DISCUSSIONS

Chapter 1 Tondoratte Zone

1-1 Introduction

The Tondoratte mineralized zone is located at the southwestern flank of the ridge which lies between S. Karataun and S. Pongo running southeast to northwest in the Batuisi prospect. This zone is situated at the upper most reaches of S. Tarawa and S. Bone. The altitude of the zone ranges from 400 m up to 650 m above sea level. The zone is geologically located among the area of metasediments of the Latimojong Formation. Dacite lava and volcanic breccia of the Barupu Tuffs occur at the high elevations of more than 600 m above sea level. The distribution of these young volcanics forms very steep ridges.

A distinctive Au anomaly was found in this area during reconnaissance soil survey in the first phase. Detailed soil sampling by a grid of 200 m x 50 m was made in the second phase, and remarkable soil anomalies of Au and some basemetals were delineated. The maximum value of Au in soil samples was 1,340 ppb. Six lines of trenches were dug, and five holes of shallow drilling were carried out in the second phase. Significant gold values, though low grade, were returned from the shallow part of quartz stockworks in drill holes MJT-3 (0.50 g/t Au at 50 cm) and MJT-4 (0.53 g/t Au at 90 cm).

On the basis of the results of the second phase exploration, this zone was selected for one of the gold targets in the third phase exploration. Three holes of diamond drilling were conducted in this zone in the third phase.

1-2 Geology and Mineralization of the Zone

The geology of the Tondoratte zone is mainly composed of the alternation of shale, siltstone, tuffaceous shale, and andesite lava of the Latimojong Formation. Dacite lava and volcanic breccia of the Barupu Tuffs occur at the top of the ridge.

Shale and siltstone commonly show dark grey to brown massive appearance. Andesite is green to greenish grey, massive propylitic rock. Some part of andesite is brecciated, showing hyaloclastic texture. Several units of lava flows were distinguished in andesite. The volcanic facies is predominant among volcanic-sedimentary series in the zone.

The trend of shale and siltstone changes variously. In the broad scale, they have a general strike direction of N-S to NNW and gentle W dip in the Batuisi prospect.

A group of quartz veins/stockworks is developed at the upper reaches of S. Tarawa and S. Bone. The vein quartz generally shows white to light grey color, translucent with resin-like brightness. The width is generally from a few centimeters to 70 cm. Very thick quartz veins -- 3 to 10 m in width -- were caught in MJT-1, MJT-2, and MJT-5 in the second phase. Each vein shows various trends, however they have gentle dipping and stockwork nature in common. The major trends of quartz veins recognized in the area are NNW and N-S～NNE. They crop out sporadically at the creeks. Several flocks of quartz floats and gravels are distributed at the hill between the two creeks.

Quartz veins sometimes contain a small amount of sulphide minerals such as pyrite, chalcopyrite, arsenopyrite, and sphalerite. Gold is thought to be intimately associated with sulphide dissemination. The major constituents of quartz veins are quartz, calcite, ankerite, chlorite, and opaque ore minerals. Silicification, chloritization, and sericitization were distinguished through the X-ray diffraction analysis as for the wall rock alteration associated with quartz veining.

Fluid inclusion studies in the second phase indicated that the auriferous quartz veins were formed under mesothermal conditions in the Batuisi prospect. The mesothermal origin of gold mineralization was also supported by other geological and mineralogical features of quartz veins in this area.

Strong lateritic weathering was recognized in trenches and drill holes during the second phase exploration. Oxidation of sulphide minerals was observed in the shallow part of drill holes. Pyrite is partly replaced by iron oxide minerals such as limonite, and chalcopyrite is replaced by covelline and malachite. A small amount of supergene kaoline was detected in some of the drill holes. Based on these evidences, gold was assumed to be leached out and transported away from the near-surface weathered zone.

1-3 Drilling

1-3-1 Outline of Work

A diamond drilling programme comprising three holes totalling 600 m was planned at the Tondoratte zone in the Batuisi prospect. The drilling area is situated over one of the most significant soil anomalous zones which were discovered during the second phase soil survey. The geology around the drill sites is composed of shale and andesite of the Latimojong Formation. Only small blocks of quartz float were observed on the surface.

The drilling programme was directed toward; ① the extension of auriferous quartz stockworks caught in trenches (1.52 g/t Au at 3.2 m in T-1 and 1.17 g/t Au at 2.0 m in T-4), ② the extension of the most significant soil anomaly (1,340 ppb Au), and ③ the extension of one of the significant soil anomalies (585 ppb Au). The programme consisted of three inclined holes of 200 m deep each. The target depth was set at 50～150 m from the surface. Details of each hole are summarized in the table below. The location map of drill holes is shown in Fig. 2-1.

Hole No.	Locality	Grid Coordinates		Elevation	Azimuth	Inclination	Hole Length
		N	E				
MJT-6	Tondoratte	0 N	1,500 E	570 m	235 °	-70 °	200.20 m
MJT-7	ditto	200 S	1,820 E	630	235	-70	200.20
MJT-8	ditto	100 S	1,650 E	625	270	-70	200.20
Total							600.60 m

A series of drill logs of 1:200 scale was prepared, and the whole drill cores were photographed in color. Ninety-six samples for ore assay were obtained. Six elements (Au, Ag, Cu, Pb, Zn, Fe) were analyzed for ore assay. The methods of analysis and limits of detection for ore assay are listed in Table 2-16. Twenty-two polished sections for ore microscopy and four thin sections for petrography were produced from the cores. Eighteen altered rock and clay samples were examined for X-ray powder analysis. Eighteen quartz chips were prepared for fluid inclusion studies.

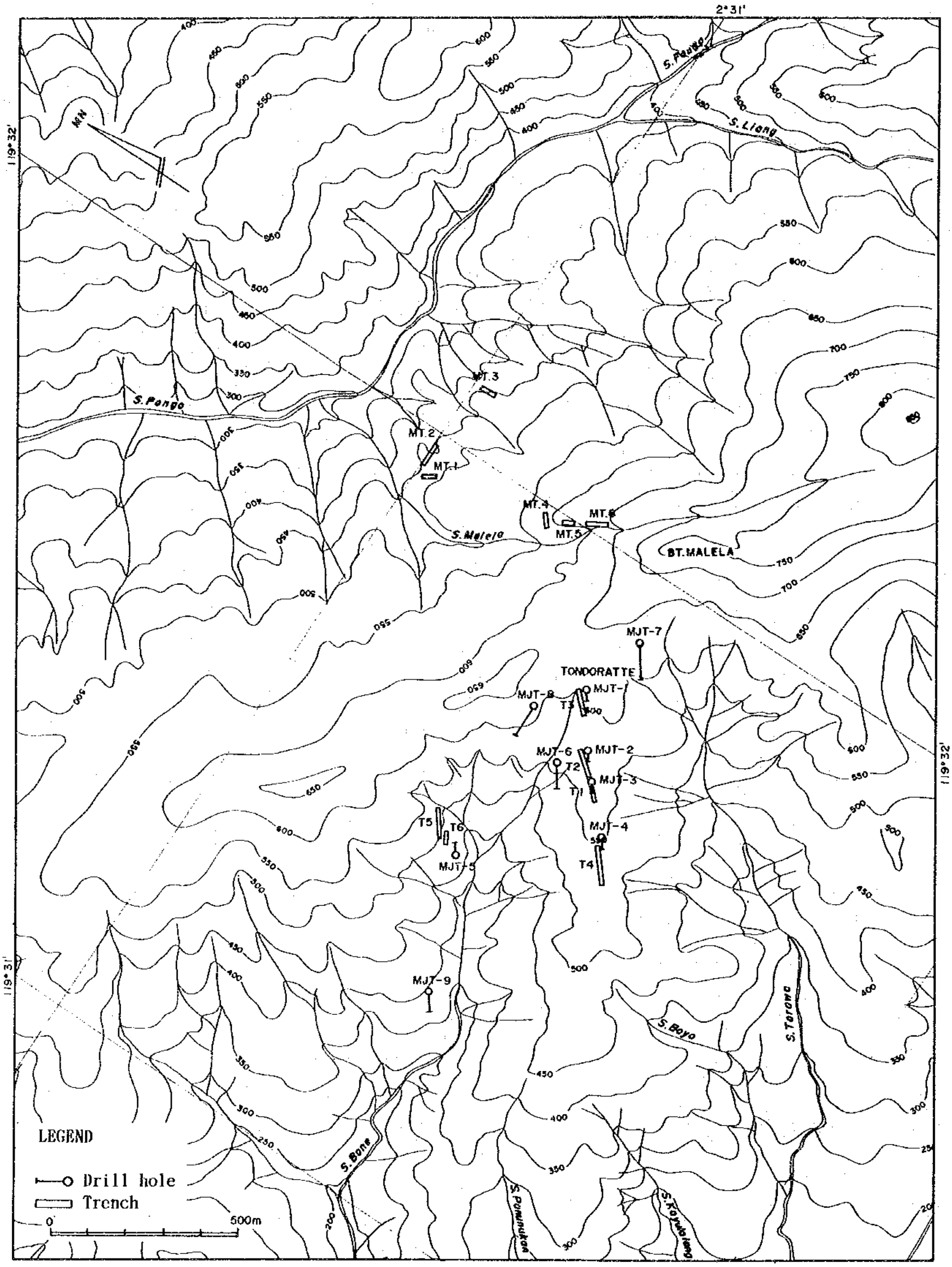

Fig. 2-1 Location Map of Drill Holes

1-3-2 Method and Equipment

Method

For surface soil and gravel layer (up to 4 m), drilling was done by HW casing shoe with inserting of HW casing pipes. Weathered bedrock and the upper part of bedrock zone were drilled by the conventional drilling method using NX diamond bit and core-pack tube. The weathered bedrock continued down to 20 ~ 30 m deep. NW casing pipes were inserted in this zone. For the upper part of bedrock zone, BW casing pipes were inserted down to 80 m. From 80 m to 200 m (the end of hole), drilling was made with BQ oversized diamond bit (62.0 mm in outer diameter and 36.5 mm in inner diameter) and BQ-WL core tube. Bentonite mud, lubricant chemical (Mud Oil), and CMC were usually mixed in the circulating drilling water. When the water was lost in the hole where fractures were developed, Tel-Stop and Seaclay (asbestos) were injected to recover the trouble. Borehole cementation was applied where water loss and the collapse of wall happened at the same time.

Equipment

The drilling site is located in the remote place. No vehicle road is available in the area. Transportaion is usually made by horses and labors. Because of this condition of transportation, drilling machine and equipment were selected on the basis of light weight and easy maintenance. A set of OE-8B drilling machine of Koken Boring Machine, and MG-15h drilling pump were brought into operation in the Tondoratte zone. Specifications of drilling machine and equipment are shown in Table 2-1. Diamond bits and expendable items used during the drilling are listed in Tables 2-2 and 2-3 respectively.

Working system

Drilling operation was carried out by three shifts per day (8 hours per shift), while the appurtenant works, such as rig construction, mobilization and demobilization, were done by one shift per day. A shift crew consisted of one drilling engineer and four workers normally. Additional thirty workers (round figures) were involved in case of the appurtenant work. A base camp for drilling operation was built near the drilling sites. A series of footpaths was cleared from Kp. Batuisi to the hill-top on which the base camp and drilling sites were located.

Table 2-1 Specifications of Drilling Machine and Equipment

Drilling machine ; Model OE-8L Capacity Dimensions (L x W x H) Weight Hoisting capacity Spindle speed Engine ; Model NFD-13K	1 set 400 m (AQ-WL nominal) 1,550 x 700 x 1,260 mm 530 kg (excl engine) 2,000 kg 100, 190, 320, 530 rpm 11.0 ps/2,400 rpm
Drilling machine ; Model YBM-05DA Capacity Dimensions (L x W x H) Weight Hoisting capacity Spindle speed Engine ; Model DY-41B	1 set 110 m (40.5 mm$^{\phi}$) / 50 m (65 mm$^{\phi}$) 1,040 x 550 x 950 mm 230 kg (excl engine) 500 kg 57, 110, 225 rpm 7.5 ps/1,750 rpm
Drilling pump ; Model MG-15h Piston diameter Stroke Capacity Dimensions (L x W x H) Weight Engine ; Model NFD-12K	1 set 89 mm 60 mm 200 ℓ/min (discharge) 2,314 x 800 x 1,130 mm 530 kg (excl engine) 10.0 ps/2,400 rpm
Drilling pump ; Model MG-5h Piston diameter Stroke Capacity Dimensions (L x W x H) Weight Engine ; Model NFAD7	1 set 68 mm 60 mm 70 ℓ/min (discharge) 1,630 x 470 x 680 mm 200 kg (excl engine) 6.0 ps/2,600 rpm
Wire line hoist ; Model WLH-4 Drum diameter Rope capacity Dimensions (L x W x H) Weight Engine ; Model NFAD6	1 set 120 mm 1,200 m (6 mm$^{\phi}$ rope) 1,130 x 450 x 1,000 mm 110 kg (excl engine) 5.4 ps/2,600 rpm
Water supply pump; Model TA-800 Plunger type Capacity Dimensions (L x W x H) Weight Engine ; Model LA90ASES	3 sets 3 planger lateral 88 ℓ/min (discharge) 554 x 354 x 424 mm 29 kg (excl engine) 8.0 ps/1,800 rpm
Derrick ; Model PD-8.5 Height Maximum load capacity	1 set 8.5 m 12,000 kg
Derrick ; Model PD-5.5 Height Maximum load capacity	1 set 5.5 m 3,000 kg
Mud mixer ; Model MCE-100A Capacity Engine ; Model NSA40C	1 set 100 ℓ / 800 rpm 4.5 ps/2,400 rpm
Generator ; Model YDG-3005 Capacity	2 sets 2.7 KVA (100V, 27A)
Generator ; Model YSG-2005 Capacity	2 sets 1.7 KVA (100V, 17A)
Drilling tools Drilling rods Casing pipes Core tubes	 NQ-WL 3.0 m x 40 pcs BQ-WL 3.0 m x 76 pcs 40.5 mm 1.5 m x 20 pcs HW CP 1.5 m x 2 pcs NW CP 1.5 m x 25 pcs BW CP 3.0 m x 40 pcs NQ-WL 3.0 m x 2 pcs NX-STH 1.5 m x 2 pcs BQ-WL 3.0 m x 2 pcs

Table 2-2 Drilling Meterage and Diamond Bit Consumption

Item	Size	Bit No.	Drilling Meterage/Each Bit				Total
			MJT-6	MJT-7	MJT-8	MJT-9	(m)
Diamond Bit	NX	3537890-1	18.65				18.65
		3537890-2		25.20			25.20
		3537890-3				25.10	25.10
		3537890-4			21.80		21.80
		Total	18.65	25.20	21.80	25.10	90.75
			Average Drilling Length/Bit (m)			22.69	
	NQ	13438	24.35				24.35
		13439	33.50				33.50
		13440		26.00			26.00
		13441		25.60			25.60
		13442			30.30		30.30
		13443			24.80		24.80
		Total	57.85	51.60	55.10	–	164.55
			Average Drilling Length/Bit (m)			27.43	
	BQ	12847	41.40				41.40
		12848	35.90				35.90
		12849	42.70				42.70
		12850		35.70			35.70
		12851		34.50			34.50
		12852		49.80			49.80
		12853				24.50	24.50
		12854				23.10	23.10
		12855			34.60		34.60
		13444			39.00		39.00
		13445			46.40		46.40
		Total	120.00	120.00	120.00	47.60	407.60
			Average Drilling Length/Bit (m)			37.05	
Diamond Casing Shoe	NW	12683				7.50	7.50
		Total	–	–	–	7.50	7.50
			Average Drilling Length/Bit (m)			7.50	

Table 2-3 Consumption of Expendable Items

Expendable Items	Spec	Unit	Consumption				Total
			MJT-6	MJT-7	MJT-8	MJT-9	Amount
Diesel fuel		l	1,175	1,438	1,020	760	4,393
Gasoline		l	260	250	230	235	975
Hydraulic oil		l	25	30	30	25	110
Engine oil		l	15	15	15	10	55
Grease		kg	18	20	18	12	68
Bentonite		kg	1,400	1,280	1,070	700	4,450
CMC		kg	62	37	135	39	273
Seaclay		kg	87	111	90	83	371
Libonite BX		kg	56	48	80	50	234
Tel-Stop		kg	97	100	125	55	377
Mud-Oil		l	84	52	167	20	323
Cement		kg	240	240	280	160	920
Diamond bit	NX	pcs	1	1	1	1	4
Diamond bit	NQ	pcs	2	2	2	0	6
Diamond bit	BQ	pcs	3	3	3	2	11
Diamond reamer	NX	pcs	1	-	1	1	3
Diamond reamer	NQ	pcs	1	1	1	0	3
Diamond reamer	BQ	pcs	2	1	2	1	6
Metal casing shoe	HW	pcs	1	-	1	0	2
Diamond casing shoe	NW	pcs	0	0	0	1	1
Core barrel assembly	NQ	set	1	-	-	0	1
Core barrel assembly	BQ	set	1	-	-	-	1
Core lifter	NQ	pcs	1	-	-	0	2
Core lifter	NX	pcs	0	0	0	1	1
Core lifter	BQ	pcs	1	1	2	1	5
Core lifter case	NQ	pcs	1	-	1	0	2
Core lifter case	NX	pcs	0	0	0	1	1
Core lifter case	BQ	pcs	1	1	2	1	5
Double core tube	NX	pcs	0	0	0	1	1
Inner tube	NQ	pcs	1	-	1	0	2
Inner tube	BQ	pcs	1	1	1	1	4
Inner tube stabilizer	NQ	pcs	1	-	1	0	2
Inner tube stabilizer	BQ	pcs	1	1	1	1	4
Thrust ball bearing	NQ	pcs	2	2	2	0	6
Thrust ball bearing	BQ	pcs	2	2	2	2	8
Cylinder liner	MG-15	pcs	1	-	1	0	2
Piston rod	MG-15	pcs	1	-	1	0	2
Piston rubber	MG-15	pcs	2	2	3	0	7
V-packing	MG-15	pcs	1	1	2	0	4
Wireline cable		m	300	-	-	-	300
Core case	NQ	pcs	12	12	12	5	41
Core case	BQ	pcs	12	13	12	5	42

Transportation

The machine and equipment were shipped from Yokohama to Ujung Pandang via Jakarta. After landed, they were transported to Mamuju by trucks. A Sikorsky helicopter was chartered for the transportation of heavy machine and equipment. Approximately 12 t of heavy cargoes were transported by helicopter between Mamuju and Tondoratte. Other cargoes, such as light weight parts, drilling mud, cement, fuel, and logistics were transported by the conventional method: They were transported by small trucks from Mamuju to Tarailu. From Tarailu to Galumpang (about 60 km along S. Karama), they were carried by engine canoes whose loading capacity was 400 ~ 600 kg. From Galumpang to Batuisi (16 km), they were carried by horses and labors. From Kp. Batuisi a footpath (short-cut) was constructed up to the drilling site, and the machine and equipment were carried up on labors' back. A little caterpillar carrier which can carry up to 300 kg was brought into site-to-site transportation this year.

Supply for the camp was made at least once in four weeks. Fuel and foods were bought at Ujung Pandang and Mamuju, and were transported along the same route as described above.

Drilling water

Water for drilling was pumped up from the middle reaches of S. Bone to the hill-top. Two stages of pumping station were established for the water head of 300 m. Piping length installed was more than 1,000 m.

Withdrawal

After the completion of drilling programme, the machine and equipment was withdrawn by helicopter through the same route to Mamuju. Then they were trucked until Ujung Pandang, and shipped back to Yokohama. The drill holes were capped, and drilling sites were cleaned and reclaimed. The drilling cores, of which the half was taken for assay samples, were kept in the storage house in Batuisi.

1-3-3 Progress of Drilling

The progress of each drill hole is described below. The summary of working time (Table 2-4), records of drilling operation (Tables 2-5 to 2-7), records of drilling performance (Tables 2-9 to 2-11), and charts of drilling progress (Figs. 2-2 to 2-4) are shown in tables and figures.

MJT-6 : For surface soil, saprolite and strongly weathered bedrock zones, the conventional drilling method by means of core-pack tubes was adopted aiming at the maximum core recovery. From 0 to 3.70 m, drilling was made by HW metal casing shoe, and HW casing pipes were inserted. From 3.70 to 22.35 m, drilling was made by NX (76 mm) core-pack bit, and NW casing pipes were inserted.

From 22.35 to 80.20 m, drilling was conducted by the wireline method using NQ-WL bit. BW casing pipes were inserted in this zone. Some part of this zone, especially in black shale, is clayey. Bentonite mud with CMC was used as a circulating drilling mud for this zone. A small amount of water was lost around 27.70 m where quartz veins occur. Telstop and Seaclay were injected to prevent the water loss. The weak vibration of drill rods happened around 40 m. Lubricant chemicals were mixed with mud and were sent in this case.

From 80.20 m down to the end of hole (200.20 m), drilling was made by the wireline method using BQ-WL bit. The wirelining went fairly well in andesitic rock, despite a few water losses in quartz stockwork zones. Whereas in black shale, which was encountered in the deeper horizon, many incomplete wirelinings were practiced. The cores were stacked frequently in the inner tube. Because it is easily broken into wedges. The recovery of cores was 97.8 % in total.

MJT-7 : HW casing pipes were inserted to 3.30 m. Drilling for the major part of surface soil and Quaternary rock (dacite) was undertaken by the conventional drilling method with NX core-pack bit and core-pack tube. NW casing pipes were inserted to 28.60 m.

From 28.60 to 80.20 m, drilling was carried out by the wireline method with NQ-WL diamond bit and NQ-WL core tube. BW casing pipes were inserted to 80.20 m. A small amount of water was lost at 49.00 and 72.00 m where quartz veins and veinlets occur.

From 80.20 m down to the end of hole (200.20 m), drilling was made by the wireline method using BQ-WL diamond bit and BQ-WL core tube. Bentonite and CMC were used as the major mud materials. Water was lost at 139.60 and 143.20 m where andesite is silicified to a certain degree. Telstop and Seaclay were injected to prevent the problem. Overall core recovery was 98.2 % in this hole.

MJT-8 : From 0 to 3.30 m, drilling was done by HW metal casing shoe, and HW casing pipes were inserted. Drilling for the major part of Quaternary rocks (a member of the Barupu Tuffs) was undertaken by the conventional drilling method using NX core-pack bit and core-pack tube. NW casing pipes were inserted to 25.10 m.

From 25.10 to 80.20 m, drilling was conducted by the wireline method with NQ-WL diamond bit and NQ-WL core tube. BW casing pipes were inserted to 80.20 m.

From 80.20 m down to the end of hole (200.20 m), drilling was made by the wireline method with BQ-WL diamond bit and BQ-WL core tube. Bentonite and CMC were used as the major mud materials. Water was lost at around 90.90, 170.90, and 185.00 m. These depths correspond to quartz veins and strongly silicified rocks. Telstop and Seaclay were injected to prevent the water loss. Overall core recovery was 95.0 % in this hole.

Table 2-4 Summary of Working Time

Hole No.	Drilling			Shift		Man Working*		Working Time**						
	Bit Size	Drilling Length (m)	Core Length (m)	Drilling Shift (shift)	Total Shift (shift)	Engineer (man)	Worker (man)	Drilling (h)	Other Work (h)	Sub-total (h)	Assem-blage (h)	Disman-tlement (h)	Trans-porta-tion (h)	Grand Total (h)
MJT-6	NX/NQ/BQ	200.20	195.70	34.0	39.0	72.0	771.0	173.10	98.50	272.00	12.00	8.00	20.00	312.00
MJT-7	NX/NQ/BQ	200.20	196.50	29.0	33.0	64.0	551.0	133.00	99.00	232.00	12.00	8.00	12.00	264.00
MJT-8	NX/NQ/BQ	200.20	190.10	33.0	37.0	64.0	502.0	142.30	121.30	264.00	8.00	8.00	16.00	296.00
MJT-9	NX/BQ	80.20	66.40	16.0	19.0	40.0	317.0	59.00	65.00	124.00	8.00	8.00	12.00	152.00
Total		680.80	648.70	112.0	128.0	240.0	2,141.0	507.40	384.20	892.00	40.00	32.00	60.00	1,024.00

* Geological logging inclusive
** Site preparation and road construction exclusive

Table 2-5 Record of Drilling Operation (MJT-6)

(MJT-6)

Date	Drilling Length (m)			Daily Total (m)		Shift (shift)		Man Working (man)	
	Shift 1	Shift 2	Shift 3	Drill'g	Core L	Drill'g	Total	Eng'er	Worker
Aug 5	Prepar'n & Transport'n								
6	ditto								
7	Transport'n & Assemb'e								
8	Assemblage								
9	3.70			3.70	3.70				
10	9.40			9.40	9.40				
11	5.90	4.00	4.90	14.80	14.20				
12	4.00	6.40	3.60	14.00	11.00				
13	4.80	8.20	8.70	21.70	21.70				
14	5.10	7.30	4.20	16.60	15.70				
15	0.00	3.00	6.00	9.00	9.00				
16	8.40	9.20	8.40	26.00	26.00				
17	6.40	3.70	8.70	18.80	18.80				
18	7.40	7.80	5.70	20.90	20.90				
19	2.60	6.70	9.00	18.30	18.30				
20	8.90	2.30	6.00	17.20	17.20				
21	7.00 2.8 Take-out CP			9.80	9.80				
22	Dismantlement					34.0	39.0	72.0	771.0
Total				200.20	195.70	34.0	39.0	72.0	771.0

Table 2-6 Record of Drilling Operation (MJT-7)

(MJT-7)

Date	Drilling Length (m)			Daily Total (m)		Shift (shift)		Man Working (man)	
	Shift 1	Shift 2	Shift 3	Drill'g	Core L	Drill'g	Total	Eng'er	Worker
Aug 23	Transportation								
24	Transport'n & Assemb'e								
25	Assemblage								
26	3.40			3.40	3.40				
27	6.60	7.00		13.60	10.50				
28	7.20	4.40		11.60	11.40				
29	4.50	6.90		11.40	11.20				
30	8.00	6.60	9.20	23.80	23.60				
31	7.70	5.80	2.90	16.40	16.40				
Sep 1	4.30	5.80	8.40	18.50	18.50				
2	8.30	8.90	9.30	26.50	26.50				
3	9.00	9.00	7.20	25.20	25.20				
4	6.90	8.90	9.20	25.00	25.00				
5	8.20	9.70		17.90	17.90				
6	6.90 Take-out CP			6.90	6.90				
7	Dismantlement					29.0	33.0	64.0	551.0
Total				200.20	196.50	29.0	33.0	64.0	551.0

Table 2-7 Record of Drilling Operation (MJT-8)

(MJT-8)

Date	Drilling Length (m)			Daily Total (m)		Shift (shift)		Man Working (man)	
	Shift 1	Shift 2	Shift 3	Drill'g	Core L	Drill'g	Total	Eng'er	Worker
Sep 18	Transport'n & Assemb'e								
19	3.30	4.30		7.60	7.20				
20	5.50	5.70	6.30	17.50	16.60				
21	4.50	7.70	8.20	20.40	20.40				
22	9.90	9.00	9.10	28.00	28.00				
23	6.70	5.50	7.10	19.30	19.30				
24	9.60	6.90	5.50	22.00	22.00				
25	5.70	6.70	7.10	19.50	15.20				
26	7.30	5.40		12.70	12.70				
27	6.80	7.40	6.70	20.90	20.90				
28	3.20	8.10	5.10	16.40	11.90				
29	5.10	6.40	3.10	14.60	14.60				
30	1.30 Take-out CP			1.30	1.30				
Oct 1	Dismantl't & Transport'n								
2	ditto								
3	ditto					33.0	37.0	64.0	502.0
Total				200.20	190.10	33.0	37.0	64.0	502.0

Table 2-8 Record of Drilling Operation (MJT-9)

(MJT-9)

Date	Drilling Length (m)			Daily Total (m)		Shift (shift)		Man Working (man)	
	Shift 1	Shift 2	Shift 3	Drill'g	Core L	Drill'g	Total	Eng'er	Worker
Sep 8	Prepar'n & Transport'n								
9	Transport'n & Assemb'e								
10	Assemb'e 2.50			2.50	2.50				
11	3.60			3.60	3.60				
12	3.50	3.70		7.20	6.10				
13	4.40	4.70	4.60	13.70	9.10				
14	5.80	2.60	10.00	18.40	12.20				
15	8.00	9.40	7.30	24.70	23.00				
16	8.40	1.70 Take-out C		10.10	9.90				
17	Dismantlement					16.0	19.0	40.0	317.0
Total				80.20	66.40	16.0	19.0	40.0	317.0

Table 2-9 Record of Drilling Performance (MJT-6)

	Survey Period: Period	Day	Work Day	Off Day	Total Man Day: Engineer	Worker
Operation						
Preparation	Aug 5 – Aug 8,1993	4.0	4.0	0	16.0	326.0
Drilling	Aug 9 – Aug21	13.0	13.0	0	52.0	405.0
Removing	Aug22	1.0	1.0	0	4.0	40.0
Total		18.0	18.0	0	72.0	771.0

Drilling Length	m		m
Length Planned	200.00	Over-burden	15.60
Increase/Decrease in L'th	+0.20	Core Length	195.70
Length Drilled	200.20	Core Recovery	% 97.8

Core Recovery of 200 m Hole (%)

Depth of Hole	Core Recovery	Cumulative Core Recovery
0 – 100.00 m	95.5	95.5
100.00 – 200.00 m	100.0	97.8

Working Hours	h	%	%
Drilling	173.10	63.7	55.6
Other Work	98.20	36.2	31.5
Recovering	0.30	0.1	0.1
Subtotal	272.00	100.0	87.2
Assemblage	12.00		3.8
Dismantlement	8.00		2.6
Water Transportation	0.00		0.0
Transportation	20.00		6.4
Grand Total	312.00		100.0

Efficiency of Drilling

Total Length/Total Work Days	m/day 11.1
Total Length/Total Shifts	m/shift 5.1

Drilling Length/Each Bit (m)

Bit Size	Drilled Length	Core Length
HW	3.70	3.70
NX	18.65	18.25
NQ	57.85	53.75
BQ	120.00	120.00

Casing Pipe Inserted

Size	Meterage	Meterage/Drilling Length x 100	Recovery
	m	%	%
HW	3.70	1.8	100.0
NW	22.35	11.2	98.2
BW	80.20	40.1	94.4

Table 2-10 Record of Drilling Performance (MJT-7)

	Survey Period: Period	Day	Work Day	Off Day	Total Man Day: Engineer	Worker
Operation						
Preparation	Aug23 – Aug25,1993	3.0	3.0	0	12.0	123.0
Drilling	Aug26 – Sep 6	12.0	12.0	0	48.0	360.0
Removing	Sep 7	1.0	1.0	0	4.0	68.0
Total		16.0	16.0	0	64.0	551.0

Drilling Length	m		m
Length Planned	200.00	Over-burden	7.75
Increase/Decrease in L'th	+0.20	Core Length	196.50
Length Drilled	200.20	Core Recovery	% 98.2

Core Recovery of 200 m Hole (%)

Depth of Hole	Core Recovery	Cumulative Core Recovery
0 – 100.00 m	96.3	96.3
100.00 – 200.00 m	100.0	98.2

Working Hours	h	%	%
Drilling	133.00	57.3	50.5
Other Work	94.20	40.7	35.7
Recovering	4.40	2.0	1.8
Subtotal	232.00	100.0	88.0
Assemblage	12.00		4.5
Dismantlement	8.00		3.0
Water Transportation	0.00		0.0
Transportation	12.00		4.5
Grand Total	264.00		100.0

Efficiency of Drilling

Total Length/Total Work Days	m/day 12.5
Total Length/Total Shifts	m/shift 6.1

Drilling Length/Each Bit (m)

Bit Size	Drilled Length	Core Length
HW	3.40	3.40
NX	25.20	21.90
NQ	51.60	51.20
BQ	120.00	120.00

Casing Pipe Inserted

Size	Meterage	Meterage/Drilling Length x 100	Recovery
	m	%	%
HW	3.30	1.6	100.0
NW	28.60	14.3	88.5
BW	80.20	40.1	95.4

Table 2-11 Record of Drilling Performance (MJT-8)

	Survey Period				Total Man Day	
	Period	Day	Work Day	Off Day	Engineer	Worker
Operation						
Preparation	Sep18,1993	1.0	1.0	0	4.0	30.0
Drilling	Sep19 – Sep30	12.0	12.0	0	48.0	358.0
Removing	Oct 1 – Oct 3	3.0	3.0	0	12.0	114.0
Total		16.0	16.0	0	64.0	502.0

Drilling Length	m		m
Length Planned	200.00	Over-burden	0.00
Increase/Decrease in L'th	+0.20	Core Length	190.10
Length Drilled	200.20	Core Recovery	% 95.0

Core Recovery of 200 m Hole (%)

Depth of Hole	Core Recovery	Cumulative Core Recovery
0 – 100.00 m	98.7	98.7
100.00 – 200.00 m	91.2	95.0

Working Hours	h	%	%
Drilling	142.30	54.0	48.1
Other Work	121.30	46.0	41.1
Recovering	0.00	0.0	0.0
Subtotal	264.00	100.0	89.2
Assemblage	8.00		2.7
Dismantlement	8.00		2.7
Water Transportation	0.00		0.0
Transportation	16.00		5.4
Grand Total	296.00		100.0

Efficiency of Drilling

Total Length/Total Work Days	m/day 12.5
Total Length/Total Shifts	m/shift 5.4

Drilling Length/Each Bit (m)

Bit Size	Drilled Length	Core Length
HW	3.30	3.30
NX	21.80	20.50
NQ	55.10	55.10
BQ	120.00	111.20

Casing Pipe Inserted

Size	Meterage	Meterage/Drilling Length x 100	Recovery
	m	%	%
HW	3.30	1.6	100.0
NW	25.10	12.5	94.8
BW	80.20	40.1	98.4

Table 2-12 Record of Drilling Performance (MJT-9)

	Survey Period				Total Man Day	
	Period	Day	Work Day	Off Day	Engineer	Worker
Operation						
Preparation	Sep 8 – Sep 9,1993	2.0	2.0	0	8.0	79.0
Drilling	Sep10 – Sep16	7.0	7.0	0	28.0	209.0
Removing	Sep17	1.0	1.0	0	4.0	29.0
Total		10.0	10.0	0	40.0	317.0

Drilling Length	m		m
Length Planned	80.00	Over-burden	0.00
Increase/Decrease in L'th	+0.20	Core Length	66.40
Length Drilled	80.20	Core Recovery	% 82.8

Core Recovery of 100 m Hole (%)

Depth of Hole	Core Recovery	Cumulative Core Recovery
0 – 50.00 m	73.8	73.8
50.00 – 80.00 m	93.7	82.8

Working Hours	h	%	%
Drilling	59.00	47.6	38.8
Other Work	65.00	52.4	42.8
Recovering	0.00	0.0	0.0
Subtotal	124.00	100.0	81.6
Assemblage	8.00		5.3
Dismantlement	8.00		5.3
Water Transportation	0.00		0.0
Transportation	12.00		7.8
Grand Total	152.00		100.0

Efficiency of Drilling

Total Length/Total Work Days	m/day 8.0
Total Length/Total Shifts	m/shift 4.2

Drilling Length/Each Bit (m)

Bit Size	Drilled Length	Core Length
NW	7.50	7.50
NX	25.10	19.30
BQ	47.60	39.60

Casing Pipe Inserted

Size	Meterage	Meterage/Drilling Length x 100	Recovery
	m	%	%
NW	7.50	9.4	100.0
BW	32.60	40.6	82.2

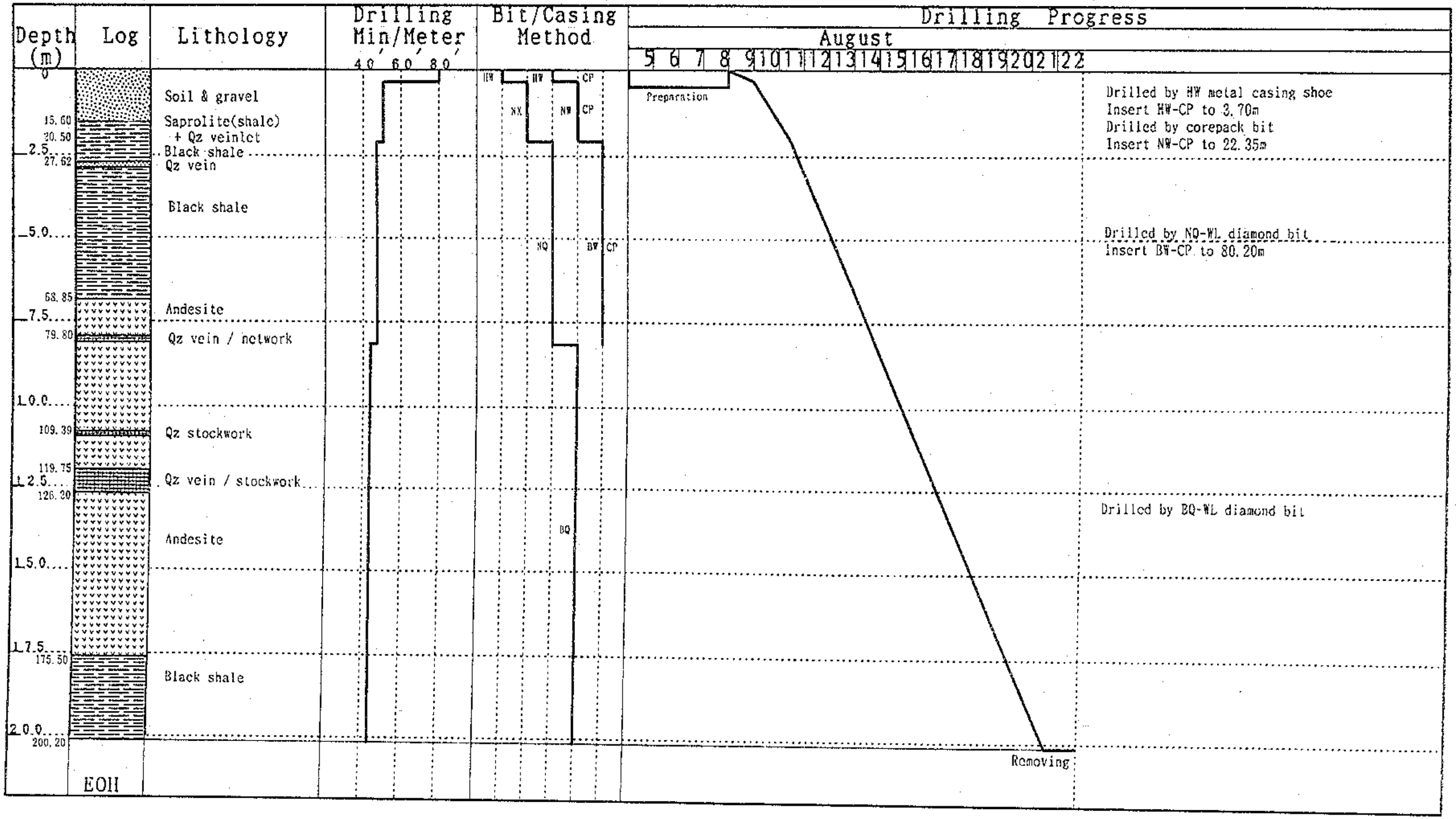

Fig. 2-2 Chart of Drilling Progress (MJT-6)

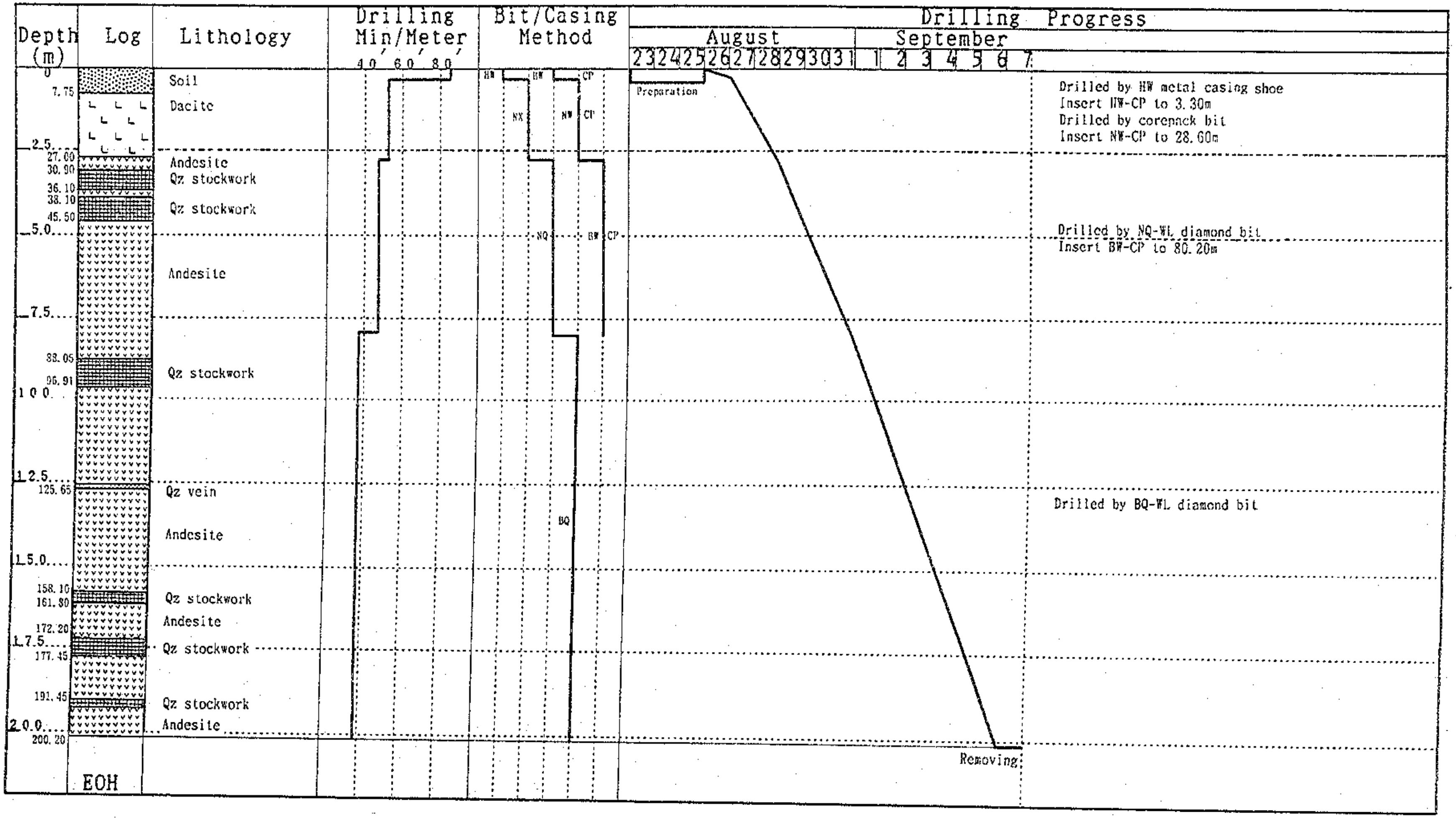

Fig. 2-3 Chart of Drilling Progress (MJT-7)

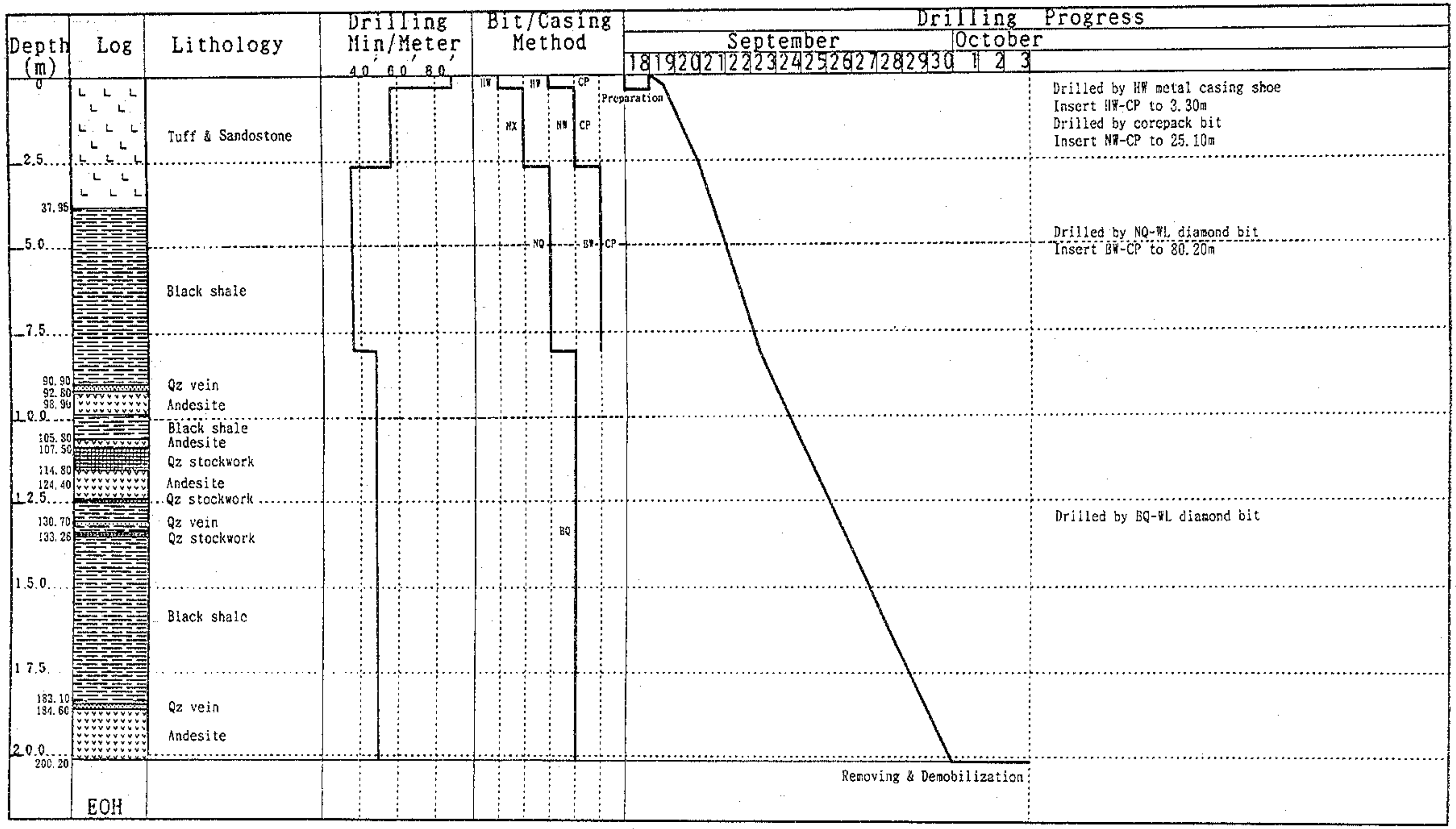

Fig. 2-4 Chart of Drilling Progress (MJT-8)

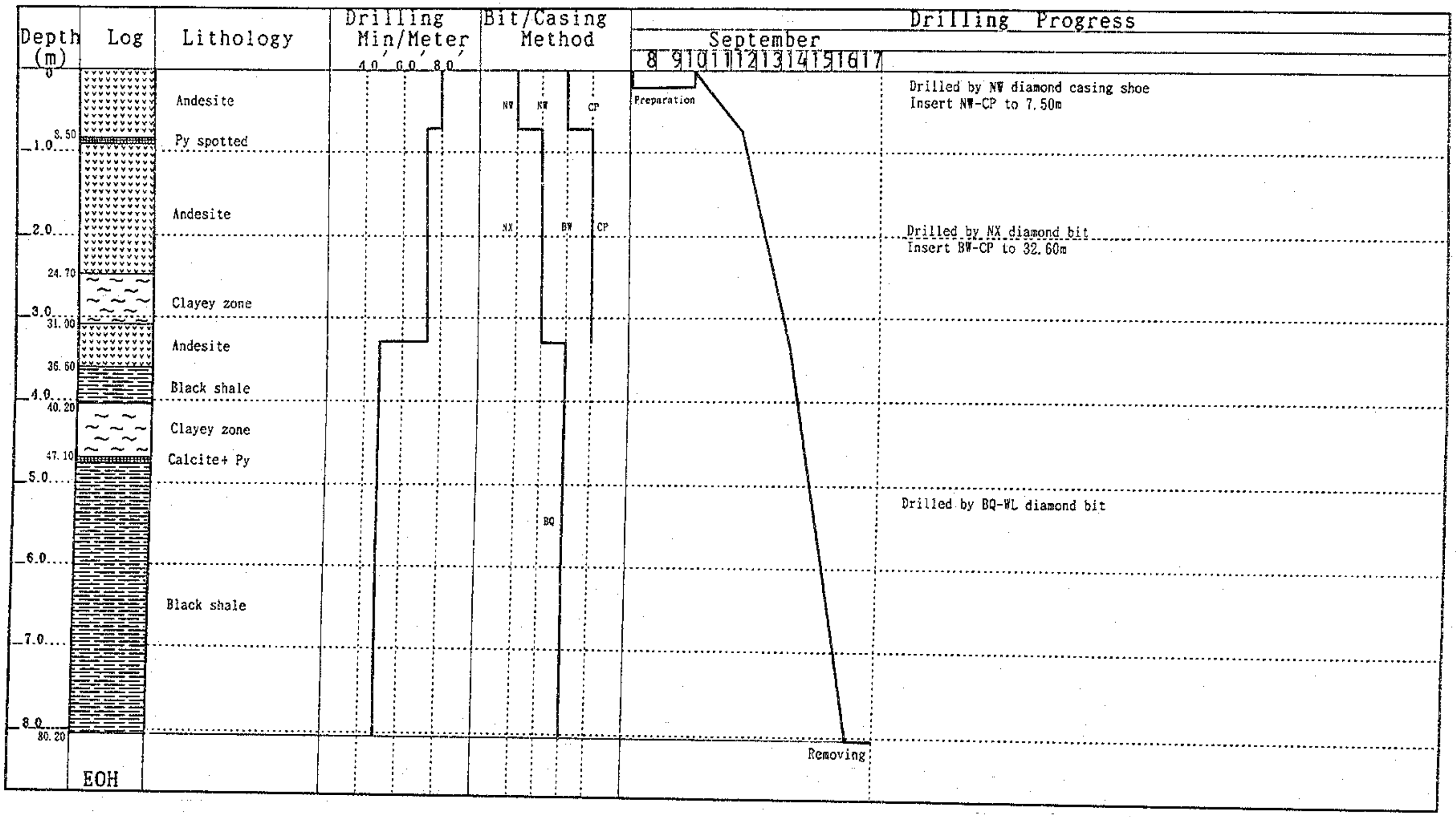

Fig. 2-5 Chart of Drilling Progress (MJT-9)

1-4 Geology and Mineralization of Drill Holes

1-4-1 Drill Hole Description

MJT-6 : The geology around the drill hole MJT-6 is composed of an alternating bed of andesite and black shale of the Latimojong Formation. It is located approximately 100 m north of the trench T-1, and approximately 250 m northeast of the trench T-4. The purpose of this hole is to test the lower extension of quartz stockwork zones which were caught in T-1 (1.52 g/t Au at 3.2 m) and T-4 (1.17 g/t Au at 2.0 m). The geology of the drill hole is described as follows:

0 ~ 15.60 m	Soil and gravel zone. Light brown to brownish grey. The gravels consist mainly of andesite and dacite of the Barupu Tuffs member. Fragments of vein quartz were observed near the bottom of this zone.
15.60 ~ 20.50 m	Saprolite. Yellow brown. Originally shale. Five quartz veinlets of 0.7 to 1.5 cm in width were found in this zone. Limonite and partly pyrite are associated with quartz veinlets.
20.50 ~ 42.15 m	Black shale. Massive. Numerous quartz veinlets of probably segregation origin were developed, and patchy aggregates of pyrite were contained. One quartz vein was caught at 27.62 ~28.05 m (43 cm). Limonite is weakly impregnated. The footwall side of the vein (about 1 m) is clayey.
42.15 ~ 45.45 m	Andesite. Pale green. Glassy, and partly hyaloclastic. A couple of shale blocks occurs in andesite lava.
45.45 ~ 68.85 m	Black shale. Massive. Quartz segregation veinlets and pyrite patches are contained.
68.85 ~ 175.50 m	Andesite. Greenish grey to light greenish grey, massive. Partly brecciated. Several quartz veins and stockworks were caught in this zone. The major ones are; 79.80 ~ 80.23 m (43 cm, quartz vein), 109.55 ~ 109.76 m (21 cm, quartz vein), 116.24 ~ 116.60 m (36 cm, quartz vein), 119.88 ~ 120.35 m (47 cm, quartz stockwork), 120.35 ~ 121.25 m (90 cm, quartz stockwork), 121.60 ~ 121.94 m (34 cm, quartz stockwork), 122.27 ~ 122.70 m (43 cm, quartz stockwork), 124.44 ~ 124.90 m (46 cm, quartz stockwork), 125.30 ~ 126.20 m (90 cm, quartz vein). Pyrite and chalcopyrite are disseminated in these quartz veins/stockworks. Pyrite is replaced by limonite in some case. Vein quartz shows white, medium- to coarse-grained,

and massive features in common.
A thin layer of black shale is intercalated at the lower part (160.00 to 160.30 m).

175.50 ~ 200.20 m (EOH) Black shale. Massive. Partly clayey, and partly silicified. One barren quartz vein (198.40 ~ 198.53 m, 13 cm) occurs in this zone.

MJT-7 : The drill hole MJT-7 is situated at the flank of high ridge which is composed of dacite and dacitic tuff of the Barupu Tuffs. The target of this hole is the lower extension of quartz veins and quartz stockwork zones which were found at S. Tarawa. It also aimed at one of the significant soil anomaly (1,340 ppb Au) found during the second phase survey in this area. The geology of the drill hole is described as follows:

0 ~ 7.75 m Soil. Yellow brown.

7.75 ~ 27.00 m Dacite of the Barupu Tuffs. The upper part consists of massive dacite, and the lower part consists of dacitic boulders. Weathered.

27.00 ~ 200.20 m (EOH) Andesite. Mostly massive, partly brecciated. Grey to greenish grey. Propylitic. Three major zones of quartz veins and stockworks with a small amount of sulphide minerals -- upper, middle, and lower -- were caught in andesite. The upper zone occurs at 30.90 to 45.50 m. It is composed of four quartz stockwork zones; 30.90 ~ 32.60 m (170 cm), 33.30 ~ 36.10 m (280 cm), 38.10 ~ 43.50 m (540 cm), and 44.50 ~ 45.50 m (100 cm). Pyrite and limonite are weakly disseminated in quartz stockworks. The middle zone occurs at 88.05 to 96.91 m. It is composed of several quartz veinlets and quartz stockworks. The major ones are; 90.30 ~ 94.40 m (410 cm, quartz veinlets/stockworks), 96.00 ~ 96.05 m (5 cm, quartz veinlet), and 96.55 ~ 96.91 m (36 cm, quartz stockwork). Pyrite and limonite are disseminated moderately. Some part of these zones show brownish earthy features.
From 151.85 m down to the end of hole, the lower zone which is composed of several quartz stockwork zones occurs. Those are; 151.85 ~ 152.40 m (55 cm), 158.10 ~ 158.35 m (25 cm), 161.40 ~ 161.80 m (40 cm), 164.25 ~ 164.60 m (35 cm), 164.80 ~ 166.10 m (130 cm), 172.20 ~ 172.30 m (10 cm), 172.70 ~ 172.80 m (10 cm), 173.55 ~ 175.00 m (145 cm), 176.40 ~ 177.57 m (117 cm), 183.25 ~ 183.45 m (20 cm), and 191.45 ~ 192.65 m (120 cm). Pyrite, chalcopyrite and arsenopyrite are strongly

disseminated in some part of these quartz stockworks.
It is a remarkable feature in this depth that pyrite is partly replaced by limonite, and chalcopyrite by malachite.
Some part of the quartz stockwork systems show clayey.

MJT-8 : The drill hole MJT-8 is located at the upper-most stream of S. Bone where is covered by the Barupu Tuffs. The purpose of this hole is to test the lower extension of quartz veins and quartz stockwork zones which were found at the upper reaches of S. Bone. It also aimed at one of the significant soil anomaly (585 ppb Au) detected during the second phase survey in this area. The geology of the drill hole is described as follows:

0 ~ 37.95 m The Barupu Tuffs. The upper part consists of andesitic to dacitic tuffs, and the lower part consists of sandstone and conglomerate. Weathered.

37.95 ~ 183.10 m The alternation of black shale and andesite. The clastic facies is dominant. Lavas are interbedded within black shale. The major occurrences of lavas are; 92.80 ~ 98.90 m, 105.80 ~ 114.80 m, 125.00 ~ 128.70 m, 141.60 ~ 143.60 m, and 167.65 ~ 171.10 m.
Many quartz veins and quartz stockworks were caught in this zone. The most significant one, which was found at 107.50 ~ 114.44 m, occurs within andesite. The second one occurs within black shale at the depth of 133.26 ~ 133.92 m (66 cm). Pyrite and chalcopyrite are disseminated in quartz stockwork systems.

183.10 ~ 200.20 m (EOH) Andesite. Greenish grey.
A massive quartz vein was caught in this zone; 184.60 ~ 185.35 m (75 cm). Pyrite and chalcopyrite are disseminated within quartz.

1-4-2 Mineralization

Numerous quartz veins and stockworks were found in drill holes in the Tondoratte mineralized zone. The major veins/stockworks were caught nearly at the right depths which have been expected in the drilling programme. Although the distance between outcrops (including those found in trenches) and drill intersections are fairly large, some veins/stockworks can be correlated with their surface indications. It is only tentative interpretations that they show a general trend of gentle NE dipping.

The extensive development of veins was mainly found in andesite. Several veins were caught in shale. However, the comparative density and intensity of veining in andesite are overwhelming. Most of veins, which are composed of quartz and calcite and are accompanied by spotted pyrite, were thought as of segregation origin in black phyllitic shale.

Quartz veins and stockworks commonly contain a small amount of sulphide minerals. The major sulphides are pyrite, chalcopyrite, and sphalerite. Traces of arsenopyrite, galena, covelline and chalcocite were observed in vein quartz under the ore microscope.

The oxidation of sulphide minerals was recognized in the deeper part of drill holes in the Tondoratte zone. Limonite after pyrite and malachite after chalcopyrite were sometimes found in drill cores from the near-surface down to of more than 100m deep. In MJT-7, strong limonitization was observed even at the end of hole. Clayey zones which are composed of quartz-calcite-chlorite(-montmorillonite)-limonite were caught in such depths in MJT-7. These zones were thought of fault origin.

Gangue minerals of veins consist mainly of quartz, calcite, and ankerite.

Silicification, chloritization and sericitization were sometimes observed in the vicinity of quartz veins and stockworks. Chlorite in quartz veins and alteration zones is mainly Fe-chlorite. A small amount of montmorillonite and mixed layer minerals was found in some part of weathered zone and fault-related clayey zone. The sample (BD7-12) was further examined by the preferred orientation and ethylene glycol treatments in the X-ray diffraction analysis. The result showed that the the mixed-layer mineral was montmorillonite-sericite mixed layer. A small amount of epidote, which was interpreted to have been altered from mafic minerals in andesite, was detected in some of the major quartz stockwork zones of MJT-7 by petrographic studies.

Significant gold intersections were obtained in every hole at the depths of 96 m ~ 134 m. An intersection of 10.33 g/t Au at 47 cm in width was returned from quartz stockwork in silicified andesite in MJT-6 (119.88 ~ 120.75 m). It is located at the upper part of a thick quartz stockwork zone developed from 119.88 to 126.20 m. The best assay is 35.68 g/t Au at 12 cm (119.88 ~ 120.00 m). Pyrite, arsenopyrite, chalcopyrite, sphalerite and limonite are disseminated in and around the gold ore. An intersection of 40.24 g/t Au at 36 cm was returned from quartz vein/stockwork in andesite in MJT-7 (96.55 ~ 96.91 m). It is composed of 28.55 g/t at 21 cm (96.55 ~ 96.76 m, quartz vein) and 56.61 g/t at 15 cm (96.76 ~ 96.91 m, quartz stockwork). Pyrite and limonite are disseminated moderately in this zone. A clayey zone occurs at the hanging wall of the intersection. A significant gold value (0.86 g/t Au at 50cm) was obtained in clayey andesite adjacent to the ore. An assemblage of quartz-calcite-chlorite-montmorillonite was detected in this clayey zone by X-ray diffraction analysis. An intersection of 14.31 g/t Au at 66 cm was caught from quartz stockwork in MJT-8 (133.26 ~ 133.92 m). Black shale which hosts this quartz stockwork is weakly silicified. Pyrite, chalcopyrite, sphalerite and limonite were observed in quartz and altered black shale. Several significant gold values were obtained in the vicinity of this horizon (0.42 g/t Au at 7 cm, etc.). Quartz-ankerite-chlorite was detected in such zones.

The results of petrographic observation, ore microscopy and X-ray diffraction analysis are shown in Tables 2-13 ~ 2-15. Assay results are listed in Table 2-17. The results of ore assay and lab studies for the major drill intersections are summarized in Table 2-19.

1-4-3 Fluid Inclusion Studies

(1) Methodology

A total of 20 quartz chips was sampled from drill cores, and tested under the heating-stage in this phase.

The same methods and procedures as in the second phase were adopted in the morphological observation and measurement of fluid inclusions in the third phase.

(2) Results of Studies

Measurements of homogenization temperature were difficult because most of the fluid inclusions in quartz chips were very fine. Fluid inclusions of larger than 10 microns in diameter were rather seldom. As a result of this fine nature of fluid inclusions, 13 samples out of 20 have been measured in total under the heating-stage. The results of the measurements are listed in Table 2-18.

Morphology of fluid inclusion

The number of fluid inclusions which was investigated under the microscope amounted to nearly 140. Ninty-eight percents of them are liquid-rich two-phase inclusions. Gas-rich two-phase inclusions are less than 2 % of them. The co-existence of liquid-rich inclusions and gas-rich inclusions which may indicate boiling phenomena was not observed in any sample.

Polyphase inclusions were found in some samples. It was difficult to identify the solid phase, because the fluid inclusion itself was very fine. One of the solid minerals showed anisotropism.

Homogenization temperature

Values of homogenization temperature of each fluid inclusion are distributed from 165°C up to 377°C. Most of them are settled within a range of 200 ~ 280°C.

The mean value of homogenization temperature of samples which showed a significant value of gold (28.55 g/t at 21 cm, MJT-7) is 252°C.

No specific tendency between the homogenization temperature of fluid inclusions and the depths of samples has been recognized in the third phase measurements.

Table 2-13 Results of Microscopic Observation of Thin Sections

Sample No.	Location		Rock Name	Formation	Texture	Phenocryst/Crystal Fragment									Groundmass/Matrix						Alteration
	Hole No.	Depth				Qz	Kf	Pl	Bi	Hb	Px	Ol	Ep	Op	Qz	Kf	Pl	Hb	Px	Gl	
BD6-10T	MJT-6	109.65m	Qz vein	–	Fractured & filled by Qz	●								•							Ch-Ca as veinlet & microfracture
BD6-28T	MJT-6	135.70m	Qz veinlet	–	Fractured & filled by Qz	●								•							Ch-Ca as veinlet & microfracture
BD7-15T	MJT-7	91.20m	Qz stockwork	–	Fractured & filled by Qz	●							•	•							Ch in matrix
BD7-31T	MJT-7	172.23m	Qz stockwork	–	Fractured & filled by Qz	●								•							Ch-Ca as veinlet & microfracture
BD8-19T	MJT-8	126.60m	Andesite silicified	Klv	Hol	○		•						•							Crosscut by Qz-Ca-Op veinlet
BD9-1T	MJT-9	8.55m	Andesite Py spotted	Klv	Hol	△		•						•							Se-Ch crosscut by Qz-Ca veinlet

Abundance of Minerals : ●;Abundant, ○;Common, △;Rare, •;Trace

Abbreviations

Formation Names: Kl;Latimojong For., Tmb;Beropa Tuffs, Qt;Barupu Tuffs, Tmg;Mamasa granite, Tmd;Diorite, Kv;Andesitic volcanic neck, Tv;Andesite(dyke)

Texture : Hol;Holocrystalline, Hypd-gr;Hypidiomorphic-granite

Minerals : Qz;Quartz, Kf;Potash feldspar, Pl;Plagioclase, Bi;Biotite, Hb;Hornblende, Px;Pyroxene, Ol;Olivine, Ep;Epidote, Op;Opaque Minerals, Gl;Glass, Ch;Chlorite, Se;Sericite, Ca;Carbonates

Table 2-14 Results of Ore Microscopy

Sample No.	Location	Minerals								Remarks
		Py	As	Cp	Sp	Ga	Cv	Cc	Io	
	MJT-6									
BD6-6P	27.70m	•							•	Quartz vein (Wd=47cm)
BD6-9P	109.40m	○			•					Quartz veinlet (Wd=5cm)
BD6-13P	120.60m	△		•						Quartz stockwork (Wd=90cm)
BD6-16P	121.90m	△	•	•	•				•	Quartz stockwork (Wd=34cm)
BD6-22P	123.85m	•		•	•				•	Quartz stockwork (Wd=72cm)
BD6-26P	125.35m	•		•	•					Quartz vein (Wd=90cm)
	MJT-7									
BD7-7P	39.80m	•	•	•					•	Quartz stockwork (Wd=540cm)
BD7-21P	96.60m	•							•	Quartz vein (Wd=21cm)
BD7-24P	134.40m	•	•	•	•		•	•	•	Quartz stockwork (Wd=55cm)
BD7-27P	161.45m	△		△	•				•	Quartz stockwork (Wd=40cm)
BD7-30P	165.75m	•		•	•				•	Quartz stockwork (Wd=130cm)
BD7-34P	174.43m	•		△	•		•	•	•	Quartz stockwork (Wd=145cm)
BD7-35P	177.15m	○		•	•		•	•	•	Quartz stockwork (Wd=117cm)
BD7-36P	191.45m	•							•	Quartz stockwork (Wd=120cm)
	MJT-8									
BD8-1P	67.00m	○		•					•	Quartz stockwork (Wd=50cm)
BD8-5P	108.90m	△	•	△	•					Quartz stockwork (Wd=355cm)
BD8-8P	111.50m	•		△	•	•				Quartz stockwork (Wd=63cm)
BD8-9P	112.20m	•		•	•				•	Quartz stockwork (Wd=80cm)
BD8-14P	117.70m	○		•					•	Quartz stockwork (Wd=24cm)
BD8-21P	133.80m	△		•	•				•	Quartz stockwork (Wd=66cm)
BD8-24P	182.30m	•		•					•	Quartz stockwork (Wd=50cm)
BD8-26P	184.90m	△		○	•					Quartz vein (Wd=75cm)
	MJT-9									
BD9-1P	8.60m	•		•					•	Py spotted in andesite
BD9-2P	9.20m	•		•	•				•	Py spotted in andesite
BD9-8P	79.85m	•								Quartz-calcite network

Abundance of Minerals: ○;Common, △;Rare, •;Trace
Abbreviation : Py;Pyrite, As;Arsenopyrite, Cp;Chalcopyrite
Sp;Sphalerite, Ga;Galena, Cv;Covelline
Cc;Chalcocite, Io;Iron Oxide

Table 2-15 Results of X-Ray Diffraction Analysis

No.	Sample No.	Altered Rock	Rock Unit	Location	Clay Mineral							Sulfate M.			Carbonate			Silicate			Feld.		Miscellaneous M.					
					Mo	Ch	Se	Mu	Ka	Ha	Mx	Al	Gy	Ja	Ca	Ak	Si	Cr	Tr	Qz	Pl	Kf	Py	Go	He	Im	Ho	At
				MJT-6																								
1	BD6-2	Qz veinlet in Sh	Kls	16.60~17.60m		•	•		•?											◎								
2	BD6-6	Qz vein	—	27.62~28.05m																◎					•?			
3	BD6-7	Qz stockwk in An	Klv	79.80~80.23m					•?							o				◎	•							
4	BD6-12	Qz stockwk in An	Klv	119.88~120.10m		•									○					◎	•							
5	BD6-18	Qz stockwk in An	Klv	122.43~122.47m		o									o					o	○							
6	BD6-23	Qz stockwk in An	Klv	124.44~124.51m		o									o					o	○							
7	BD6-27	Ca-Qz vein	—	130.30~130.45m		•									○					o	•							
				MJT-7																								
8	BD7-6	Qz stockwk in An	Klv	38.10~39.10m		o									•	◎				◎	•							
9	BD7-10	Qz stockwk in An	Klv	42.10~43.10m		•										○				◎	•				•?			
10	BD7-12	Clayey zone	Klv	44.50~45.50m		•			•		•					○				◎			•?		•?			
11	BD7-20	Qz stockwk in An	Klv	96.05~96.55m	•	•?			•						o					◎	•							
12	BD7-30	Qz stockwk in An	Klv	165.60~166.10m	•	•														◎	•							
13	BD7-33	Qz stockwk in An	Klv	173.55~174.30m		o									•?					◎	•							
14	BD7-37	Qz stockwk in An	Klv	192.05~192.65m		o									○					○	o							
				MJT-8																								
15	BD8-6	Qz stockwk in An	Klv	109.30~110.30m	•	•?			•							•				◎	•	•						
16	BD8-9	Qz stockwk in An	Klv	112.05~112.30m											•	•				◎		•?						
17	BD8-10	Qz stockwk in An	Klv	112.30~112.85m												•				◎		•?						
18	BD8-18	Qz veinlet in Sh	Kls	125.00~125.05m		•										o				◎	•							
19	BD8-27	An, altered	Klv	190.84~190.94m		•									◎	o				o	•							
				MJT-9																								
20	BD9-1	An. Py spotted	Klv	8.50~8.65m		o									○					•	○							
21	BD9-2	An. Py spotted	Klv	9.10~9.30m		•									○					o	○							
22	BD9-3	Qz netwk in Sh	Kls	47.10~47.30m		o	•													◎	•							

Abundance of Minerals: ◎;Abundant, ○;Common, o;Few, •;Rare

Abbreviations : Mo;Montmorillonite, Ch;Chlorite, Se;Sericite, Mu;Muscovite, Ka;Kaoline, Mx;Mixed layer, Ha;Halloysite, Al;Alunite, Gy;Gypsum, Ja;Jarosite
Ca;Calcite, Ak;Ankerite, Si;Siderite, Cr;α-Cristobalite, Tr;Toridymite, Qz;Quartz, Pl;Plagioclase, Kf;Potash feldspar, Py;Pyrite
Go;Goethite, He;Hematite, Im;Ilmenite, Ho;Hornblende, At;Anatase

Table 2-16 Methods of Analysis and Limits of Detection for Ore Assay

Element	Methods of Analysis	Detection Limit	Upper Limit
Au	Fire assay with AA finish	0.02 g/t	10 g/t
Au	Fire assay with gravimetric analysis	0.06 g/t	600 g/t
Ag	Nitric aqua regia with ICP-AES finish	2 g/t	500 g/t
Cu	ditto	0.001 %	2.50 %
Pb	ditto	0.001 %	2.50 %
Zn	ditto	0.001 %	2.50 %
Fe	ditto	0.01 %	50 %

※ AA means Atomic Absorption Method

※ Chemical analysis conducted by Chemex Labs Ltd.

Table 2-17 Assay Results of Ore Samples (1)

Sample No.	Depth From	Depth To	Width m	Au g/t	Ag g/t	Cu %	Pb %	Zn %	Fe %	Description
BD6-1	15.60	16.60	1.00	0.06	<2	0.008	0.003	0.016	4.71	Quartz stockwork
BD6-2	16.60	17.60	1.00	0.08	<2	0.011	0.023	0.018	6.60	Quartz stockwork
BD6-3	17.60	18.60	1.00	0.11	<2	0.009	0.013	0.019	5.76	Quartz stockwork
BD6-4	18.60	19.60	1.00	0.14	<2	0.008	0.006	0.016	6.26	Quartz stockwork
BD6-5	19.60	20.50	0.90	0.11	<2	0.008	0.003	0.022	4.92	Quartz stockwork
BD6-6	27.62	28.05	0.47	0.06	<2	0.003	0.025	0.017	1.44	Quartz vein
BD6-7	79.80	80.23	0.43	<0.02	<2	0.010	0.003	0.022	2.02	Quartz stockwork
BD6-8	103.75	103.87	0.12	<0.02	<2	0.004	0.001	0.004	4.01	Quartz vein
BD6-9	109.39	109.44	0.05	0.03	<2	0.186	0.001	0.072	7.00	Quartz veinlet
BD6-10	109.55	109.76	0.21	0.02	<2	0.100	0.001	0.497	1.90	Quartz vein
BD6-11	116.24	116.60	0.36	<0.02	<2	0.038	0.001	0.133	2.49	Quartz vein
BD6-31	119.75	119.88	0.13	0.06	2	0.003	<0.001	0.005	4.09	Quartz stockwork
BD6-32	119.88	120.00	0.12	35.68	4	0.004	<0.001	0.009	3.19	Quartz stockwork
BD6-33	120.00	120.10	0.10	1.60	2	0.006	0.001	0.012	3.40	Quartz stockwork
BD6-34	120.10	120.35	0.25	1.66	2	0.015	0.001	0.015	6.23	Quartz stockwork
BD6-13	120.35	120.75	0.40	0.11	2	0.127	0.001	0.015	4.39	Quartz stockwork
BD6-29	120.75	121.25	0.50	0.03	<2	0.038	<0.001	0.058	2.52	Quartz stockwork
BD6-14	121.60	121.67	0.07	<0.02	<2	0.030	<0.001	0.121	1.93	Quartz stockwork
BD6-15	121.76	121.80	0.04	<0.02	<2	0.109	0.002	0.103	5.43	Quartz stockwork
BD6-16	121.88	121.94	0.06	<0.02	<2	0.023	0.001	0.059	4.85	Quartz stockwork
BD6-17	122.27	122.34	0.07	<0.02	<2	0.122	<0.001	0.194	4.63	Quartz stockwork
BD6-18	122.43	122.47	0.04	<0.02	<2	0.012	0.001	0.047	4.74	Quartz stockwork
BD6-19	122.50	122.60	0.10	<0.02	<2	0.041	0.002	0.041	1.07	Quartz stockwork
BD6-20	122.62	122.70	0.08	<0.02	<2	0.012	<0.001	0.047	1.22	Quartz stockwork
BD6-21	123.62	123.67	0.05	<0.02	2	0.004	0.001	0.012	3.34	Quartz stockwork
BD6-22	123.79	123.88	0.09	<0.02	2	0.011	<0.001	0.050	2.33	Quartz stockwork
BD6-23	124.44	124.51	0.07	0.12	2	0.022	0.002	0.044	10.25	Quartz stockwork
BD6-24	124.60	124.70	0.10	<0.02	<2	0.008	<0.001	0.015	2.54	Quartz stockwork
BD6-25	124.80	124.90	0.10	<0.02	2	0.003	0.001	0.009	2.11	Quartz stockwork
BD6-26	125.30	126.20	0.90	<0.02	<2	0.057	0.001	0.088	0.90	Quartz vein
BD6-27	130.30	130.45	0.15	<0.02	<2	0.033	0.001	0.017	0.34	Quartz vein
BD6-28	135.68	135.73	0.05	<0.02	<2	0.004	<0.001	0.003	3.53	Quartz veinlet
BD6-30	198.40	198.53	0.13	<0.02	<2	0.002	0.001	0.002	0.92	Quartz vein

Table 2-17 Assay Results of Ore Samples (2)

Sample No.	Depth From	Depth To	Width m	Au g/t	Ag g/t	Cu %	Pb %	Zn %	Fe %	Description
BD7-1	30.90	31.90	1.00	<0.02	4	0.005	0.001	0.014	6.79	Quartz stockwork
BD7-2	31.90	32.60	0.70	<0.02	2	0.006	0.001	0.018	6.88	Quartz stockwork
BD7-3	33.30	34.30	1.00	<0.02	2	0.033	0.002	0.012	5.25	Quartz stockwork
BD7-4	34.30	35.30	1.00	<0.02	2	0.017	0.001	0.010	7.22	Quartz stockwork
BD7-5	35.30	36.10	0.80	<0.02	2	0.006	0.001	0.011	5.24	Quartz stockwork
BD7-6	38.10	39.10	1.00	0.05	<2	0.004	0.001	0.013	6.40	Quartz stockwork
BD7-7	39.10	40.10	1.00	<0.02	2	0.003	0.001	0.016	6.11	Quartz stockwork
BD7-8	40.10	41.10	1.00	0.02	2	0.023	0.001	0.049	6.01	Quartz stockwork
BD7-9	41.10	42.10	1.00	0.05	2	0.067	0.001	0.075	6.44	Quartz stockwork
BD7-10	42.10	43.10	1.00	<0.02	2	0.007	0.001	0.015	4.82	Quartz stockwork
BD7-11	43.10	43.50	0.40	<0.02	2	0.009	0.001	0.011	5.21	Quartz stockwork
BD7-12	44.50	45.50	1.00	<0.02	2	0.022	0.001	0.010	4.09	Quartz stockwork
BD7-13	88.05	88.09	0.04	<0.02	<2	0.005	<0.001	0.007	3.89	Quartz veinlet
BD7-14	89.63	89.70	0.07	<0.02	<2	0.020	<0.001	0.003	2.26	Quartz veinlet
BD7-15	90.30	91.30	1.00	<0.02	<2	0.004	0.001	0.006	5.49	Quartz stockwork
BD7-16	91.30	92.30	1.00	0.05	2	0.001	0.002	0.006	6.12	Quartz stockwork
BD7-17	92.30	93.30	1.00	0.11	2	0.009	0.001	0.008	6.64	Quartz stockwork
BD7-18	93.30	94.40	1.10	0.08	2	0.002	0.001	0.007	6.88	Quartz stockwork
BD7-38	94.70	96.00	1.30	0.05	<2	0.011	0.001	0.008	7.28	Clayey zone
BD7-19	96.00	96.05	0.05	0.02	<2	0.004	<0.001	0.006	6.56	Quartz veinlet
BD7-20	96.05	96.55	0.50	0.86	<2	0.002	0.001	0.005	5.19	Quartz stockwork
BD7-21	96.55	96.76	0.21	28.55	4	0.002	<0.001	0.004	3.49	Quartz vein
BD7-22	96.76	96.91	0.15	56.61	8	0.004	0.001	0.007	3.39	Quartz stockwork
BD7-23	125.65	125.95	0.30	<0.02	<2	0.068	0.001	0.043	1.79	Quartz vein
BD7-24	134.20	134.75	0.55	<0.02	<2	0.061	<0.001	0.006	3.87	Quartz stockwork
BD7-25	151.85	152.40	0.55	<0.02	2	0.003	<0.001	0.007	5.59	Quartz stockwork
BD7-26	158.10	158.35	0.25	0.03	2	0.019	0.001	0.018	4.36	Quartz stockwork
BD7-40	160.75	160.80	0.05	0.25	6	5.090	0.001	0.162	26.00	Quartz stockwork
BD7-27	161.40	161.80	0.40	<0.02	2	0.598	<0.001	0.033	5.63	Quartz stockwork
BD7-28	164.25	164.60	0.35	<0.02	<2	0.045	<0.001	0.006	4.43	Quartz stockwork
BD7-29	164.80	165.60	0.80	<0.02	<2	0.222	0.001	0.021	5.62	Quartz stockwork
BD7-30	165.60	166.10	0.50	<0.02	<2	0.264	0.001	0.028	6.44	Quartz stockwork
BD7-31	172.20	172.30	0.10	<0.02	4	1.090	0.001	0.023	6.70	Quartz stockwork
BD7-32	172.70	172.80	0.10	<0.02	<2	0.021	<0.001	0.008	6.14	Quartz stockwork
BD7-33	173.55	174.30	0.75	<0.02	2	0.357	<0.001	0.042	8.27	Quartz stockwork
BD7-34	174.30	175.00	0.70	<0.02	<2	0.096	<0.001	0.033	5.92	Quartz stockwork
BD7-35	176.95	177.45	0.50	<0.02	<2	0.118	<0.001	0.678	5.12	Quartz stockwork
BD7-36	191.45	192.05	0.60	0.06	<2	0.009	0.001	0.014	4.19	Quartz stockwork
BD7-37	192.05	192.65	0.60	<0.02	<2	0.027	0.006	0.015	6.77	Quartz stockwork
BD7-39	192.65	193.45	0.80	0.02	<2	0.008	0.001	0.014	6.77	Quartz stockwork

Table 2-17 Assay Results of Ore Samples (3)

Sample No.	Depth From	Depth To	Width m	Au g/t	Ag g/t	Cu %	Pb %	Zn %	Fe %	Description
BD8-1	67.00	67.50	0.50	0.03	<2	0.008	0.004	0.013	5.88	Quartz stockwork
BD8-2	90.90	91.04	0.14	<0.02	<2	0.003	0.001	0.007	2.10	Quartz vein
BD8-3	107.50	107.73	0.23	<0.02	<2	0.014	<0.001	0.013	2.10	Quartz stockwork
BD8-4	107.73	108.70	0.93	<0.02	<2	0.021	<0.001	0.009	2.19	Quartz stockwork
BD8-5	108.70	109.30	0.60	0.19	18	4.870	0.004	0.198	10.35	Quartz stockwork
BD8-6	109.30	110.30	1.00	<0.02	2	0.437	<0.001	0.021	3.79	Quartz stockwork
BD8-7	110.30	111.05	0.75	0.06	<2	0.009	0.001	0.069	2.84	Quartz stockwork
BD8-8	111.27	111.90	0.63	<0.02	<2	0.122	0.001	0.009	1.86	Quartz stockwork
BD8-9	112.05	112.30	0.25	<0.02	4	0.858	0.001	0.043	5.17	Quartz stockwork
BD8-10	112.30	112.85	0.55	<0.02	2	0.544	0.001	0.022	3.36	Quartz stockwork
BD8-11	112.98	113.20	0.22	<0.02	<2	0.011	<0.001	0.009	4.73	Quartz stockwork
BD8-12	113.38	113.83	0.45	<0.02	2	0.024	0.001	0.006	1.62	Quartz stockwork
BD8-13	113.90	114.44	0.54	<0.02	2	0.142	0.001	0.009	3.68	Quartz stockwork
BD8-14	117.63	117.87	0.24	0.08	2	0.018	<0.001	0.006	4.87	Quartz stockwork
BD8-15	118.20	119.10	0.90	0.08	<2	0.025	<0.001	0.027	3.49	Quartz stockwork
BD8-16	122.85	123.33	0.48	0.08	2	0.008	0.001	0.010	5.20	Quartz stockwork
BD8-17	124.40	124.57	0.17	0.17	2	0.012	0.001	0.004	3.62	Quartz stockwork
BD8-20	130.70	130.77	0.07	0.42	2	0.016	0.016	0.047	7.14	Quartz veinlet
BD8-21	133.26	133.92	0.66	14.31	2	0.037	0.002	0.019	4.94	Quartz stockwork
BD8-22	136.80	137.22	0.42	<0.02	4	0.117	0.001	0.018	3.11	Quartz stockwork
BD8-23	137.32	137.50	0.18	0.09	<2	0.004	<0.001	0.041	2.64	Quartz stockwork
BD8-24	182.05	182.55	0.50	0.03	<2	0.003	<0.001	0.006	3.45	Quartz stockwork
BD8-25	183.02	183.55	0.53	<0.02	<2	0.002	0.001	0.009	2.44	Quartz stockwork
BD8-26	184.60	185.35	0.75	0.06	4	1.510	0.001	0.105	5.59	Quartz vein
BD8-29	199.80	200.20	0.40	<0.02	<2	0.011	<0.001	0.003	3.87	Quartz stockwork
BD9-1	8.50	8.65	0.15	<0.02	<2	0.010	<0.001	0.009	5.94	Pyrite spotted
BD9-2	9.10	9.30	0.20	<0.02	<2	0.025	<0.001	0.010	3.87	Pyrite spotted
BD9-3	47.10	47.30	0.20	<0.02	<2	0.006	0.003	0.015	6.03	Calcite-Py network
BD9-4	69.00	69.10	0.10	<0.02	<2	0.002	0.008	0.008	3.66	Qz-calcite network
BD9-11	69.75	69.80	0.05	<0.02	<2	0.003	0.008	0.013	7.29	Qz-calcite network
BD9-5	72.85	73.25	0.40	<0.02	<2	<0.001	<0.001	0.001	2.85	Silicified zone
BD9-6	77.40	77.55	0.15	<0.02	2	0.004	0.003	0.013	4.67	Qz-calcite network
BD9-7	78.50	78.65	0.15	<0.02	<2	0.003	0.003	0.013	6.27	Qz-calcite network
BD9-8	79.80	79.95	0.15	<0.02	2	0.005	0.003	0.013	4.70	Qz-calcite network

Table 2-18 Results of Fluid Inclusion Studies

	Sample	Locality	n	Ave	SD	Remarks
1	BD6-6F	MJT-6, 27.80m	9	219	31.93	
2	BD6-7F	MJT-6, 79.80m	12	218	24.45	
3	BD6-8F	MJT-6,103.80m	8	239	18.34	
4	BD6-11F	MJT-6,116.40m	NA			
5	BD6-24F	MJT-6,124.65m	16	202	14.46	
6	BD6-28F	MJT-6,135.70m	NA			
7	BD7-6F	MJT-7, 38.70m	8	196	12.44	
8	BD7-10F	MJT-7, 42.95m	16	240	31.64	
9	BD7-17F	MJT-7, 93.10m	NA			
10	BD7-21F	MJT-7, 96.10m	4	252	5.12	
11	BD7-23F	MJT-7,125.90m	NA			
12	BD7-29F	MJT-7,165.30m	13	219	33.28	
13	BD7-33F	MJT-7,174.20m	5	198	9.21	
14	BD8-2F	MJT-8, 91.00m	NA			
15	BD8-3F	MJT-8,107.60m	9	204	19.83	
16	BD8-10F	MJT-8,112.50m	NA			
17	BD8-26F	MJT-8,184.90m	11	202	13.06	
18	BD8-28F	MJT-8,192.40m	20	254	61.93	
19	BD9-4F	MJT-9, 69.00m	5	275	35.43	
20	BD9-11F	MJT-9, 69.80m	NA			

Abbreviations: n;number of measured f-inclusions
NA;homo-temp not available
Ave;arithmetic mean of homo-temp (°C)
SD;standard deviation (°C)

Table 2-19 Summary of Ore Assay and Lab Studies of Drill Cores

Hole No.	Major Intersections	Assay Results	Ore Minerals	Alter'n Minerals	F. Incl Temp (°)	Remarks
MJT-6	15.60 - 20.50 m	Up to 0.14 g/t Au at 100 cm		Ch, Se, (Ka?)		Quartz stock work zone
	27.62 - 28.05 m		Py, Io		219	Quartz vein
	109.39 - 109.76 m		Py, Sp	Ch, Ca		Quartz vein
	119.75 - 126.20 m	Up to 35.68 g/t Au at 12 cm	Py, As, Cp, Sp, Io	Ca, Ch	202	Quartz stock work zone
MJT-7	30.90 - 36.10 m					Quartz stock work zone
	38.10 - 45.50 m		Py, As, Cp, Io	Ak, Ch, (Ca)	196	Quartz stock work zone
	88.05 - 96.91 m	Up to 56.61 g/t Au at 15 cm	Py, Io	Ch, Ca, (Se, Ep)	252	Quartz stock work zone
	158.10 - 161.80 m	Up to 0.25 g/t Au at 5 cm	Py, Cp, Sp, Io			Quartz stock work zone
	172.20 - 177.45 m		Py, Cp, Sp, Cv, Cc, Io	Ch, Ca	198	Quartz stock work zone
MJT-8	107.50 - 114.44 m	Up to 0.19 g/t Au at 60 cm	Py, As, Cp, Sp, Ga, Io	Ak, (Ca)	204	Quartz stock work zone
	130.70 - 130.77 m	0.42 g/t Au at 7 cm				Quartz veinlet
	133.26 - 133.92 m	14.31 g/t Au at 66 cm	Py, Cp, Sp, Io			Quartz stock work zone
	184.60 - 185.35 m		Py, Cp, Sp		202	Quartz vein

※ Abbreviations same as in the previous tables

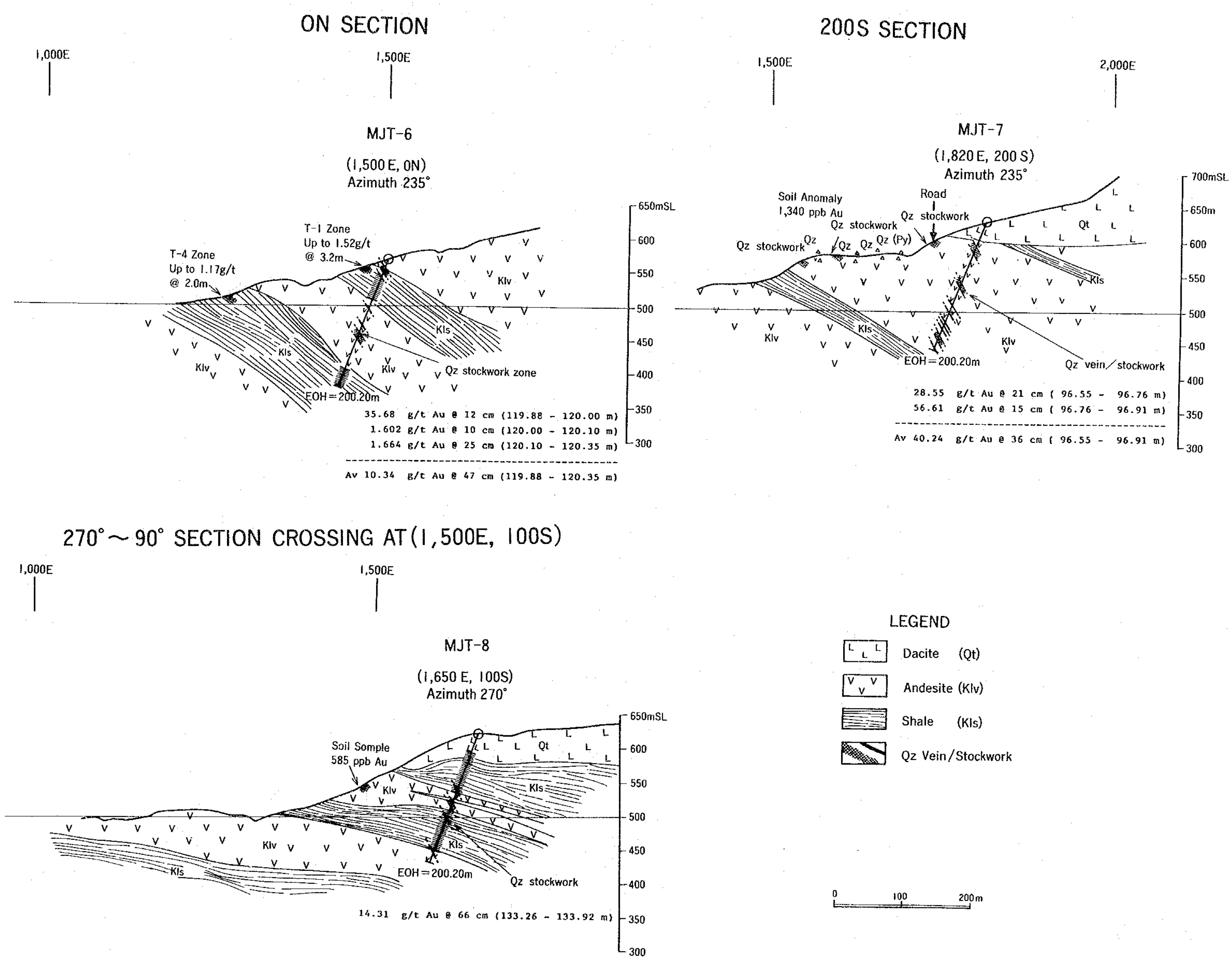

Fig. 2-6 Geologic Section along the Drill Holes in the Tondorrate Zone

1-5 Discussions

Two styles of quartz and sulphide mineralization -- massive quartz vein (single vein) and quartz stockwork system -- were distinguished in the Batuisi prospect. Single veins occur mainly at the lower to the middle reaches of S. Tarawa, the middle reaches of S. Bone, and S. Malela. Whereas stockworks are mainly developed at the Tondoratte area. Of course there are many places where two systems coexist. When going from the lower reaches of S. Tarawa up towards Tondorrate, the relative abundance of massive quartz veins of moderate to steep dipping decreases. By contrast with this, the occurrence of quartz stockworks of mostly gentle dipping increases near the Tondoratte area. The details of the mode of occurrence of the two systems were described in the second phase report. No displacement of wall-rocks has been recognized in quartz stockwork system. It means that stockworks at the Tondoratte zone is probably formed in tension cracks. The nature of massive quartz veins is not clear. There is no evidence which shows the chronological difference of formation between the two systems.

The comparative density and intensity of quartz veining between volcanic facies and clastic facies are interesting. Most of quartz veins and stockworks were caught in andesite. It is probably caused by the brittle property of the volcanic rock.

Based on the results of the reconnaissance drilling in the second phase, which indicated the existence of gently NE-dipping quartz veins/stockworks in this area, the drilling programme was designed. Consequently significant results have been obtained. Good intersections were caught in all three drill holes in the Tondoratte mineralized zone. Each of these major intersections can be corellated with the surface indications of gold mineralization. However it is only tentative interpretations that they show a general trend of gentle NE dipping. The distance of outcrops and drill intersections are fairly large. It is still in an early stage of exploration. It is easier to think about the mechanism of formation for steeply dipping quartz veins/stockworks rather than that for gently dipping ones. Such possibility must be sufficiently considered in a plan for the further drilling.

The oxidation of sulphide minerals was recognized in the deeper part of drill holes in the Tondoratte zone. In MJT-7, strong limonitization was observed even at the end of hole. Clayey zones which were thought as faults were caught in such depths in MJT-7. It is interpreted that the oxidation of sulphide minerals within quartz veins/stockworks is caused by surface water introduced along the faults. It is a remarkable feature in the Tondoratte area that the influence of weathering is recognizable in such depths. The results of drilling in this phase, together with those in the previous phase, indicate that the degree of weathering is an important factor for gold depletion. It may be a horizon of gold depletion from surface down to approximately 100 m. From 100 m deep there occur a primary (or slightly depleted) horizon. It probably corresponds to the lower part of the oxidation zone.

The erratic nature of gold grade is another characteristic feature of gold mineralization in this area. Gold is thought to be associated with sulphide dissemination. Sulphide minerals, especially pyrite, are disseminated pervasively in and around the zone of quartz veining. However, ore grade parts occur in a limited zone of sulphide mineralization. The surrounding zone, still within a quartz vein or a quartz stockwork system, has very low grade in gold. High grade ores show a kind of nugget effect. It is a specific character of mesothermal gold deposit.

Chapter 2 Middle Reaches of S. Bone Zone

2-1 Introduction

The middle reaches of S. Bone mineralized zone is located at the southwestern side of the hill which lies between S. Karataun and S. Pongo. This zone is situated approximately 2 km west-southwest of the Tondoratte mineralized zone. The altitude of the zone ranges from 250 m to 450 m above sea level. The zone is geologically located among the area of metasediments of the Latimojong Formation.

Some indications of gold mineralization were caught in this area during the semi-detailed survey in the first phase. Many quartz veins were found during the geological survey. One of them was named the quartz vein at the 'Old Dutch Pit' located at a hill between S. Bone and S. Tarawa. Gold was detected in pan concentrates collected along S. Bone. A couple of gold anomalies was detected in soil samples during the reconnaissance geochemical survey. Detailed soil sampling by a grid of 200 m x 50 m was made in the second phase, and significant soil anomalies of Au and some basemetals were obtained in this area. In addition to that, a couple of remarkable gold values was obtained from geochemical rock-chips in this area. The maximum value of Au in rock-chip samples was 1,685 ppb.

On the basis of the results of the second phase exploration, this zone was picked up for one of the gold targets in the third phase exploration. One hole of shallow diamond drilling was made at this zone in the third phase.

2-2 Geology and Mineralization of the Zone

The geology of the middle reaches of S. Bone zone is mainly composed of the alternation of shale, siltstone, and andesite of the Latimojong Formation.

Shale and siltstone show dark grey to brownish grey massive appearance. Some part of shale is weakly metamorphosed, and shows phyllitic features.

Andesite is green to greenish grey, massive propylitic rock. Some part of andesite is brecciated, and shows hyaloclastic texture. Thin layers of tuffaceous shale are intercalated with andesite and shale. The volcanic facies is relatively dominant among volcanic-sedimentary series in the zone.

The trend of shale and siltstone changes variously. In a scale of prospect-wide, they have a general strike direction of N-S to NNW and gentle W dip.

More than 30 quartz veins occur at the middle reaches of S. Bone and its branch creeks. The vein quartz generally shows white to light grey color, translucent with resin-like brightness. Some of them are slightly chalcedonic. The width changes from a few centimeters to 50 cm. A couple of massive quartz veins of 50 cm in width occurs at the Old Dutch Pit (the sketches were shown in the second phase report). The northwestern extensions of these quartz veins were traced to the middle reaches of S. Bone. The southeastern extension was caught at the middle reaches of S. Tarawa.

In the northwestern side of the middle reaches of S. Bone, several quartz floats and gravels were found during soil and rock-chip sampling in the second phase. Significant gold values (1,685 ppb Au and 207 ppb Au) were returned from some of such quartz samples. Prior to the drilling exploration in the third phase, several lines of surface geological traverse were made, and nearly twenty quartz veins/stockworks were caught in an area of approximately 200 m x 200 m. Three systems of quartz veins/stockworks -- NNW, NW, and NNE -- were recognized in this zone. The NW system with dipping to NE steeply is the most dominant one. It is composed of two major quartz stockworks and several minor quartz veinlets and stockworks. The width of the stockwork zones ranges from 90 cm to 170 cm. Strong pyrite dissemination is associated with quartz stockworking. Grab samples were collected from such stockworks in saprolite zone. Some of them showed significant gold values (55.0 ppm Au, 50.0 ppm Au, etc.). The distribution of quartz veins/stockworks at the northern side of the middle reaches of S. Bone is shown in Fig. 2-7. The major quartz stockworks have been correlated to the significant rock-chip gold anomalies at the field.

Quartz veins commonly contain a small amount of sulphide minerals such as pyrite, chalcopyrite, arsenopyrite, and sphalerite. Carbonates (calcite and ankerite), chlorite, sericite, and opaque ore minerals were observed as gangue minerals in quartz veins. Silicification, chloritization and sericitization were distinguished through the X-ray diffraction analysis.

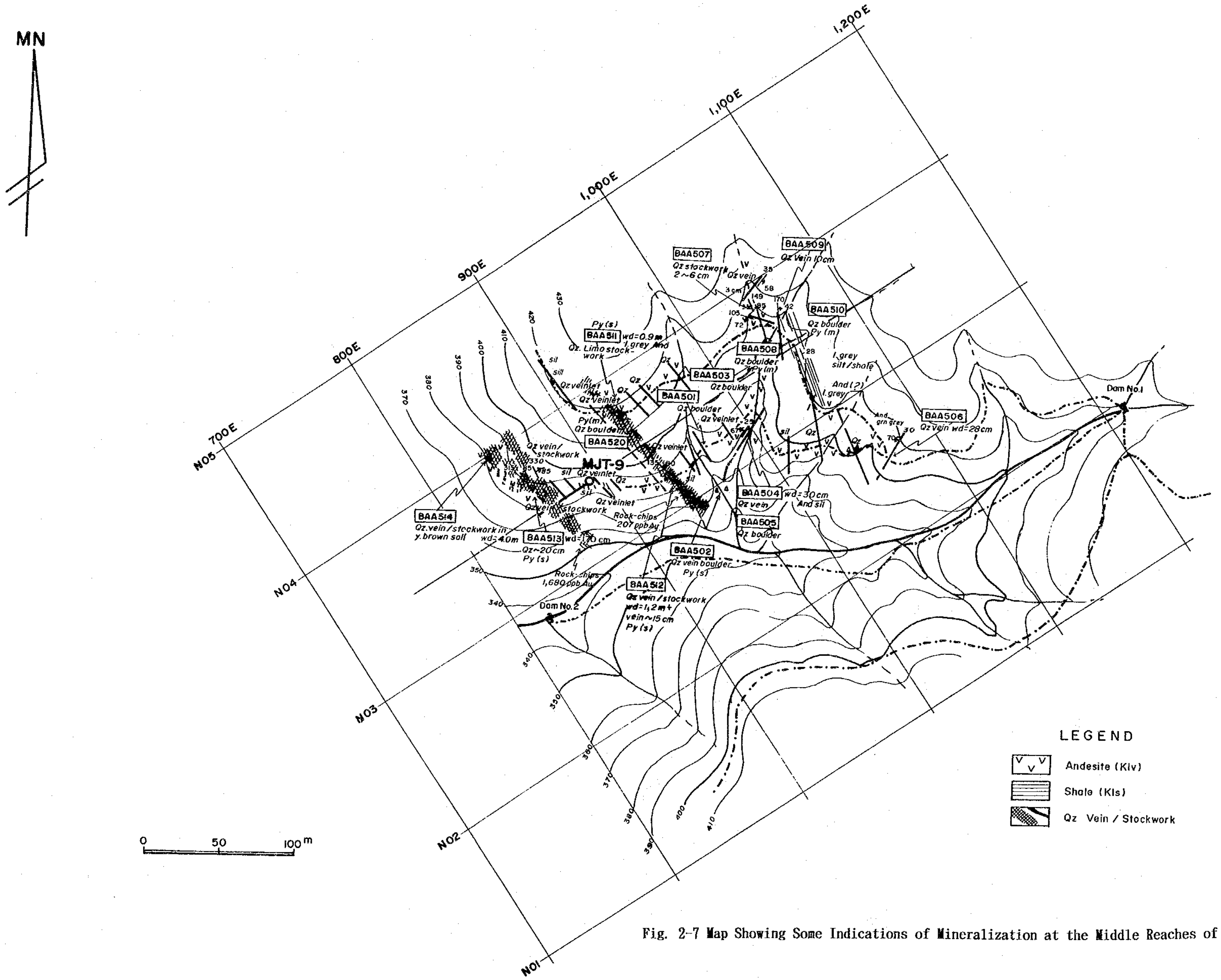

Fig. 2-7 Map Showing Some Indications of Mineralization at the Middle Reaches of S. Bone

350N SECTION

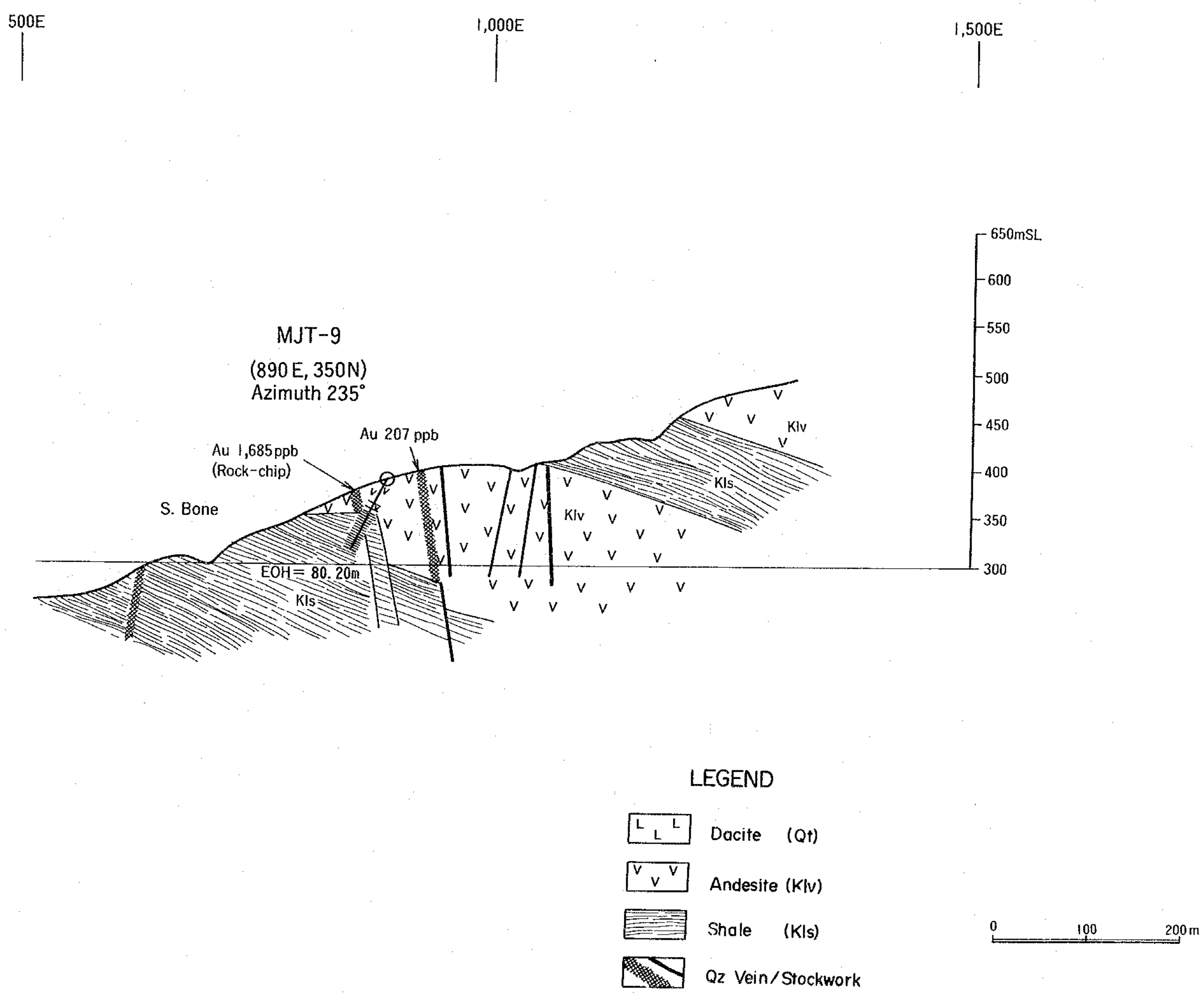

Fig. 2-8 Geologic Section along the Drill Holes at the Middle Reaches of S. Bone Zone

2-3 Drilling

2-3-1 Outline of Work

A small diamond drilling programme consisting of one hole of 80 m deep was planned at the middle reaches of S. Bone zone. The drilling area is situated over the significant soil and rock-chip anomalous zone which was caught during the second phase detailed survey. The geology around the drill hole is composed of shale and andesite of the Latimojong Formation. A couple of quartz veins and quartz stockworks was observed on the surface.

The target zone for drilling corresponds to the extension of the most significant rock-chip anomaly (1,685 ppb Au). The programme consisted of one inclined hole of 80 m deep. The target depth was set at 50 m from the surface. Details of the hole are summarized in the table below. The location map of drill hole is shown in Fig. 2-1.

Hole No.	Locality	Grid Coordinates		Eleva-tion	Azimuth	Incli-nation	Hole Length
		N	E				
MJT-9	Middle Reaches of S.Bone	350 N	890 E	390 m	235 °	-70 °	80.20 m
Total							80.20 m

A series of drill logs of 1:200 scale was prepared, and the whole drill cores were photographed in color. Eleven samples for ore assay were obtained. The elements for ore assay are same as in the Tondoratte zone. Three polished sections for ore microscopy and one thin section for petrography were produced from the cores. Two altered rock and clay samples were examined for X-ray powder analysis. Two quartz chips were prepared for fluid inclusion studies.

2-3-2 Method and Equipment

Method

For surface soil and gravel layer (down to 3 m), drilling was done by NW casing shoe with inserting of NW casing pipes. Weathered bedrock was drilled by the conventional drilling method with NX diamond bit and NX-STH core tube. The weathered bedrock continued down to 20 m deep, and BW casing pipes were inserted in this zone. For the bedrock zone, the wireline method was adopted with BQ oversized diamond bit (60 mm in outer diameter) and BQ-WL core tube. Bentonite mud, lubricant chemical (Mud Oil), and CMC were usually mixed in the circulating drilling water. When the water was lost in the hole where fractures were developed, Tel-Stop and Seaclay (asbestos) were injected to recover the trouble.

Equipment

The drilling machine and drilling pump are YBM-05DA of Yoshida Boring Machines and MG-5h, which are same as in the second phase. Specifications of drilling machine and equipment are shown in Table 2-1. Diamond bits and expendable items used during the drilling are listed in Tables 2-2 and 2-3 respectively.

Working system

The same system as in the Tondoratte was introduced in the middle reaches of S. Bone drilling.

Transportation

Same as in the Tondoratte drilling.

Drilling water

Water for drilling was pumped up from the down-stream of S. Bone.

Withdrawal

Same as in the Tondoratte zone.

2-3-3 Progress of Drilling

The progress of drill hole is described below. The summary of working time (Table 2-4), record of drilling operation (Table 2-8), record of drilling performance (Table 2-12), and chart of drilling progress (Fig. 2-5) are shown in tables and figures.

MJT-9 : For near-surface weathered zone, drilling was done by NW diamond casing shoe, and NW casing pipes were inserted to 7.50 m deep. Weathered andesite down to 32.60 m deep was drilled by the conventional drilling method with NX diamond bit and NX-STH core tube. BW casing pipes were inserted to 32.60 m. Thick bentonite mud and core-pack tube were adopted for weathered zone to increase the recovery of cores.

From 32.60 m down to the end of hole (80.20 m), drilling was carried out by the wireline method using BQ-WL diamond bit and BQ-WL core tube. Bentonite, CMC, Libonite and Mud-Oil were mixed with circulating water. Soft and clayey zones occurred at two depths; 24.70 ~ 31.00 m and 40.20 ~ 47.10 m. Although thick bentonite mud was used and careful drilling (slow spindle revolution and very low feed pressure) was conducted, only cutting sludge was returned in these zones. As a result of these clayey zones, the overall core recovery of 82.8 % was produced in this hole.

2-4 Geology and Mineralization of Drill Holes

2-4-1 Drill Hole Description

MJT-9 : One short hole (MJT-9) was drilled at the northern side of the middle reaches of S. Bone. The purpose of this hole is to test the lower extension of one of quartz stockwork zones, which was caught at this area at the early stage of this phase and was interpreted to be connected to the significant rock-chip anomaly (1,685 ppb Au) found during the second phase survey. The geology around the drill hole consists mainly of andesite. A thin layer of shale/siltstone is intercalated within andesite.

The geological description of the drill hole is given as follows:

0 ~ 36.60 m	Andesite. Brown grey to greenish grey. Massive, partly brecciated. Pyrite is spotted at 8.50 ~ 9.30 m. A clayey part occurs at 24.70 ~ 31.00 m. It was interpreted as a fault zone.
36.60 ~ 80.20 m	(EOH) Black shale. Calcite ± quartz veinlets are developed in this rock. A clayey part, which was interpreted as a fault zone, occurs at 40.20 ~ 47.10 m.

2-4-2 Mineralization

Although the extensive development of auriferous quartz veins/stockworks was watched on the surface in this area, no significant indication of mineralization, such as quartz vein or disseminated sulphide, has been obtained in the drill hole. Some part of shale and andesite in drill hole show an alteration mineral assemblage of quartz-chlorite-calcite. As far as the surface indications are concerned, gold mineralization in the middle reaches of S. Bone zone could be similar to that in the Tondoratte zone. Only the structural trend is different. Most of quartz veins and quartz stockworks dip steeply in this zone.