REPORT
ON
THE MINERAL EXPLORATION
IN
GUANACASTE-NICOYA AREA
THE REPUBLIC OF COSTA RICA

MARCH 1976

JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

REPORT
ON
THE MINERAL EXPLORATION
IN
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THE REPUBLIC OF CHILE

PHASE II

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PREFACE

In response to the request by the Government of Republic of Chile, the Japanese Government decided to conduct a Mineral Exploration Project in Guanaca・Cholqui Area Project and entrusted the Survey to the Japan International Corporation Agency(JICA) and Metal Mining Agency of Japan(MMAJ).

The JICA and MMAJ sent to Chile a survey team headed by Mr.Jun-ichi Ishikawa from 21 October to 30 December,1997.

The team exchanged views with the officials concerned of the Government of Chile and conducted a field survey in the Guanaca-Cholqui area. After they returned to Japan, further studies were made and the present report has been prepared.

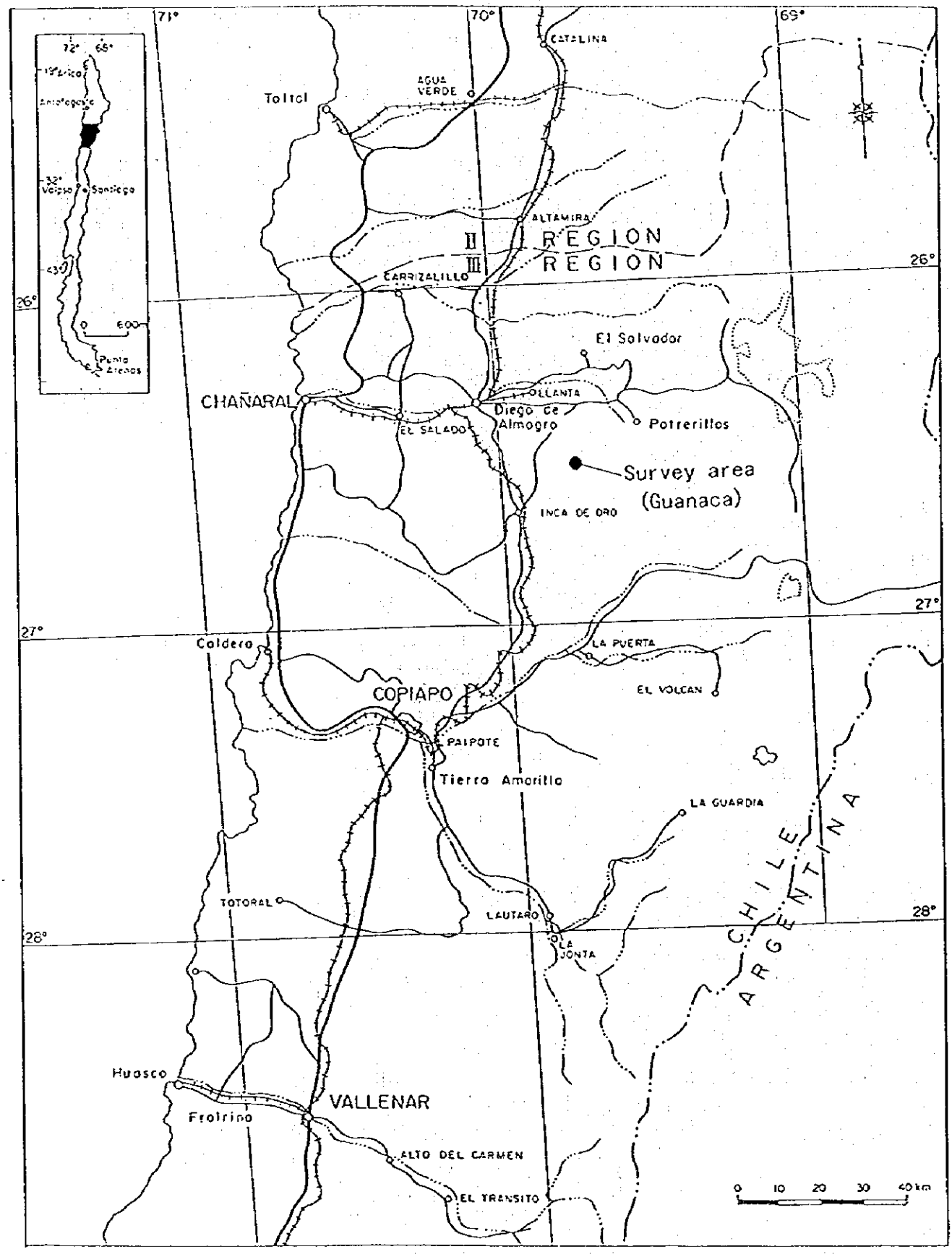
We hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

We wish to express our deep appreciation to the officials concerned of the Government of the Chile for their close corporation extend to the team.

March 1998

Kimio Fujita
President
Japan International Cooperation Agency

Hiroaki HIYAMA
President
Metal Mining Agency of Japan



Locality map of survey area

ABSTRACT

This survey is a Cooperative Mineral Exploration project worked in the Guanaca-Cholqui area of the Republic of Chile (hereinafter referred to as " the Survey"), based on the Scope of Work that was signed on August 14th, 1996, between the Japanese Government and the Chilean Government.

The Survey is in the Phase II step and the objective of the Phase II was to intersect the downward extensions of surface mineralized zones defined and located in the Phase I survey last year with two drill holes (MJCG-1 and MJCG-2) at La Rinconada prospect and Central prospect in Guanaca area. The geological reconnaissance was also carried out in the area of La Escondida prospect nearby.

MJCG-1(direction : E, dip : -60°, and length : 400.0 m) was drilled to intersect subsurface extensions of mineralized fractures at La Rinconada prospect. Since sericite associated mineralized fractures and geochemical anomalies (Cu, Au etc.) were found by the first year's survey, the gold-rich porphyry copper-type deposit was expected to underlie the prospect. However, only weak mineralization was encountered at a depth from 133.8 m to 134.2 m, from 242.6m to 242.7 m and from 322.0m to 322.3m, all hosted by aplitic granite, same as shown on surface. The mineralization occurs in the form of veinlets of quartz and epidote with specularite and malachite within the white altered zone. The alteration is generally intense, and epidote and chlorite occur in almost all of the core with silicification. Sericite is shown at the contact zone with veinlets. Such veinlets are deemed to be extensions from the surface, however, no sulfide minerals were observed, and the result of chemical analysis suggests that copper was rather leached near the veinlets. The possibility for existence of phillic alteration zone that was expected prior to the drilling was not justified and only showed low potential of a porphyry copper-type deposit in the lower part or the periphery of the hole.

MJCG-2(direction : N20° E, dip : - 60°, and length : 300.2m) was drilled to intersect the subsurface extensions of mineralized fractures at Central prospect. The porphyry copper-type deposit was expected under the prospect, since fractures with the evidence of hydrothermal activities and geochemical anomalies(Cu, Mo etc.) were shown on surface.

However, only several veinlets of a few millimeters in width associated

with chalcopyrite mineralization were encountered below 93.5m hosted by granodiorite with xenolith of diorite and gneiss.

The alteration is generally very weak except chloritization near the veinlets. There are no positive indication which shows potential for porphyry copper-type deposit.

The lithology in La Escondida prospect consists of granodiorite, and dykes of quartz porphyry, rhyolite and andesite, which intruded into granodiorite. The older structure of WNW-ESE direction and the younger structure of NNE-SSW direction exist in this prospect area. The intrusion of andesite dykes is related to the former structure and primary mineralization is found in the structure. The intrusion of quartz porphyry and rhyolite is related to the latter structure where faults are developed.

The area of mineralized zone covers approximate 400,000km^2(500m × 800m)which is larger than the zone shown in La Rinconada former structure is related to the initial mineralization and the intrusion of andesite, and the latter is related to the intrusion of quartz porphyry and rhyolite, associated with faults. The mineralized zone extends over about, which is larger than the zone of La Rinconada prospect. Although quartz porphyry dyke observed in the area, it seems to be post mineralization activity and the size of alteration zone is small.

There are no positive indication which shows potential for porphyry copper type deposit.

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PART I General Remarks

Chapter 1 Introduction

1-1 Background and Objectives

The republic of Chile is the biggest copper producer in the world and has world largest undeveloped copper resources. Also the country is the biggest supplier of copper metal for Japan, and Japan is the largest copper importing country for Chile. Thus, seven resources development cooperative fundamental surveys carried out since 1995, in consideration of those relationship between two countries, and their results have contributed in the area of prospecting, improvement and technological accumulation of resources prospecting data in the Republic of Chile.

In response to a request by the Chilean government, the Japanese government dispatched a preliminary survey mission to the Republic of Chile in 1996. The Japanese side, the Japan International Cooperation Agency (JICA) and the Metal Mining Agency of Japan (MMAJ), and the Chilean side, Ministerio de Mineria, Agencia de Cooperacion Internacional (AGCI) and Empresa Nacional de Mineria (ENAMI) entered into an agreement on August 14th, 1996. Based on this agreement, a three-year project named as the Cooperative Mineral Resources Exploration in the Guanaca-Cholqui Area, was started in 1996 and this represents the works of the Phase II.

1-2 Conclusion and Recommendation of the Phase I

1-2-1 Conclusion of the Phase I

1. Geology and geological structure

The geology of the Survey area consists of volcanic rocks, plutonic rocks, Cenozoic sedimentary rock(Atacama gravel) and intrusive rocks. They tend to be older toward northwest.

Volcanic rocks consist of Cretaceous – Paleogene andesitic lava - pyroclastic rock (Ba), dacitic lapilli tuff – welded tuff (Dpf), andesitic lava-pyroclastic rock (Ga), Ocoita-andesite (Oa) and rhyolitic volcanic breccia–lava (Rd). They are distributed in the whole survey area. Cretaceous(Paleogene) and/or Eocene granitic rocks intrude into the volcanic rocks. Besides La Guanaca mine and La Rinconada prospect, some local areas of mineralization in which green copper occur in quartz veins were identified in the Survey area, especially in the central and southern areas. Three main prospect areas were deemed.

Plutonic rocks consist of monzonite(M), quartz monzonite(Md), adamellite(Ad), aplitic granite(Ag), granodiorite-1(Gd1), granodiorite-2 (Gd2), granodiorite-3 (Gd3) and granodiorite-4 (Gd4). Monzonites are dominant in the northwestern part of the Survey area. Granodiorites are dominant in the central part of the Survey area. Granites are dominant in the southeastern part of the Survey area. Whole plutonic rocks are probably created by the Paleocene igneous activities, and monzonite is thought the oldest to be Eocene. Granodiorite are thought to be relatively young.

Cenozoic sedimentary layer is Atacama gravel.

Intrusive rocks consist of hornblende- plagioclase porphyry (Hp), aplite dyke (A), plagioclase porphyry(Pp), andesite dyke (Ad), dacite ~ rhyolite dyke (Dd) and quartz porphyry (Qp) .

2. Ore deposits

The mineralization of copper in quartz veinlets is observed at La Guanaca, La Rinconada and Central prospects.

1) La Guanaca prospect

La Guanaca prospect has two types of mineralization as follows.

a. Dissemination of chalcopyrite and pyrite in porphyry.

b. Veins of copper-oxide in granodiorite.

There are two types of copper-oxide veins observed. One is the copper-oxide veins with quartz and the other is the copper oxide of fracture filling type without vein quartz. The latter is dominant, and probably formed by the supergene enrichment in low temperature.

Sericite alteration is remarkable at this prospect. The green biotite and K-feldspar are observed but no epidote is observed.

The characteristics of alteration and a geochemical anomalies (Cu, Mo) described later suggests that La Guanaca prospect may be related to the mineralization of porphyry type.

2) La Rinconada prospect

The mineralization observed at La Rinconada de Villanueva (hereinafter referred to as " La Rinconada") prospect consists of copper

associated with gold, lead and zinc in quartz vein. Because chalcopyrite remains unoxidized within copper oxide, copper is probably a primary ore oxidized in situ.

Quartz veins occur within aplitic granite.

Sericite-alteration is observed at the contact zones of veins.

Tourmaline and epidote are frequently observed within quartz veins. Alteration of epidote and chlorite is remarkable in the place apart from veins. Smectite is observed, and it seems to be a generated in a supergene low temperature environment.

The homogenization temperatures of fluid inclusions in quartz veins show temperature in a range of 200~310℃. Although salinity of most of inclusions is low as it shows 1wt % (NaCl equiv.), a few inclusions show relative high salinity of 5~10 wt % (NaCl equiv.). As considering geochemical anomalies (Au, Cu, Pb, and Zn), the mineralization in La Rinconada is similar to a gold-base metal vein type mineralization often observed peripheral to a porphyry type deposit.

3) Central prospect

The copper mineralization occurs associated with quartz veins occurs in Central prospect. Chalcopyrite remains in oxide copper, therefore it seems not to be exotic, and copper mineralization is a primary one formed by oxidation in situ associated with quartz veins.

The host rocks are the Granodiorite-3 (Gd3), Granodiorite-4 (Gd4), and andesite of the Llanta formation and sericite alteration is observed near the quartz veins.

The homogenization temperatures of fluid inclusions of a quartz vein show temperature in a range of 300~340℃. The salinity of the inclusions have two groups. One is with relatively high salinity of 9~12wt%, and the other is less than 3wt% (NaCl equiv.). As considering the latter mentioned geochemical anomalies, the mineralization in Central prospect is also similar to a gold-base metal vein type mineralization peripheral of a porphyry type deposit.

3. Geochemical survey

Geochemical anomalies are distributed at La Guanaca prospect,

La Rinconada prospect to its southwestern area, Central prospect, south of Quebrada Enriqueta, and mountains in the southeastern part of the area. These districts with anomalies of most of the 8 elements (Au, Ag, As, Sb, Cu, Mo, Pb, and Zn) include first three areas above mentioned.

In La Guanaca prospect, anomalies of Ag, As, Sb, Cu, and Mo are shown and particularly anomalies of Cu and Mo are remarkable. The distribution of the potassium alteration and of the mineralized zone inspires the porphyry copper-type mineralization.

In La Rinconada prospect, anomalies of Au, Ag, As, Sb, Cu, Mo, Pb, and Zn are distributed, and anomalies of Au, Ag, As, Cu, Pb, and Zn is distributed in the southwestern area of the prospect.

In Central prospect, anomalies of Au, As, Cu, Pb, and Zn are distributed. Geochemical anomalies(rock) of Cu, Au, Pb and Zn are well detected. This indicates the mineralization of gold (lead) and zinc are expected in addition to the mineralization of copper. It is the characteristic of this prospect that the geochemical anomaly of molybdenum is observed.

4. Geophysical survey (IP method).

The apparent resistivity in this area is generally high : 500Ω·m ~ 5000Ω·m. However, the places of low resistivity (<500Ω·m) is shown in the following area.

- The area Atacama gravel is distributed (from the central part to the northeastern part of the area).
- Around La Rinconada prospect.

In the latter area, the geology does not support the result of the low resistivity. Further, there is a point with 129Ω·m in resistivity and more than 53.1mV/V in chargeability on the south of La Rinconada prospect, therefore it may be an anomaly caused by mineralization.

1-2-2 Recommendation to the Phase II Program

The survey results were summarized as follows:

There are three main prospects in the Survey area; La Guanaca,

La Rinconada, and Central prospect. Two possibilities for the type of mineralization in the three prospects are considered.

One is that these prospects may represent parts of the zoning related to a porphyry copper type mineralized system. The other possibility is that La Guanaca prospect has nothing to do with the Central and La Rinconada prospects. And Central and La Rinconada prospects may be pluton related vein-type mineralization. The results of the geophysical survey support the later possibility. Since La Guanaca prospect is owned by a private company, it is considered that La Rinconada prospect is the most promising one out of the three prospects. Favorable data include IP anomalies observed in near La Rinconada prospect and La Rinconada veins partly carry high gold values, more than 10 g/t Au.

In order to check the potential for the aforementioned mineralization, it is recommended to conduct drilling surveys at the following sites for Phase II survey.

1) La Rinconada prospect
2) The Central prospect

1-3 Outline of Phase II Survey

1-3-1 Survey Area

Based on the results of the Phase I survey, the drilling survey was carried out at Central prospect and at La Rinconada prospect. The locations of drilling holes are shown in figure II-1 .

The supplement geological reconnaissance was also carried out at La Escondida deposit.

1-3-2 Objective of Phase II

The objective of the survey is to evaluate the potential for downward extension of the mineralization in La Rinconada prospect and Central prospect confirmed by the Phase I survey by conducting drillings and to discover a promising deposit. It is also an objective of the survey to transfer the technology to the counterpart organization.

1-3-3 Method and Content of Survey

An indoor experimental item and survey quantity of this survey is shown in the following table.

(1) Drilling

Hole number	dip	direction	length
MJCG-1	-60°	90°	400m
MJCG-2	-60°	20°	300m
Total			700m

(2) Indoor test

item	quantity
1. Rock thin section	14
2. Polished section	12
3. X-ray diffraction test	25
4. Chemical ore analysis (Au, Ag. Cu, Mo, Pb, Zn, and S)	71
5. Fluid inclusion temperature measurement homogenization temperatures salinity	 6 6
6. Dating (K-Ar method)	2

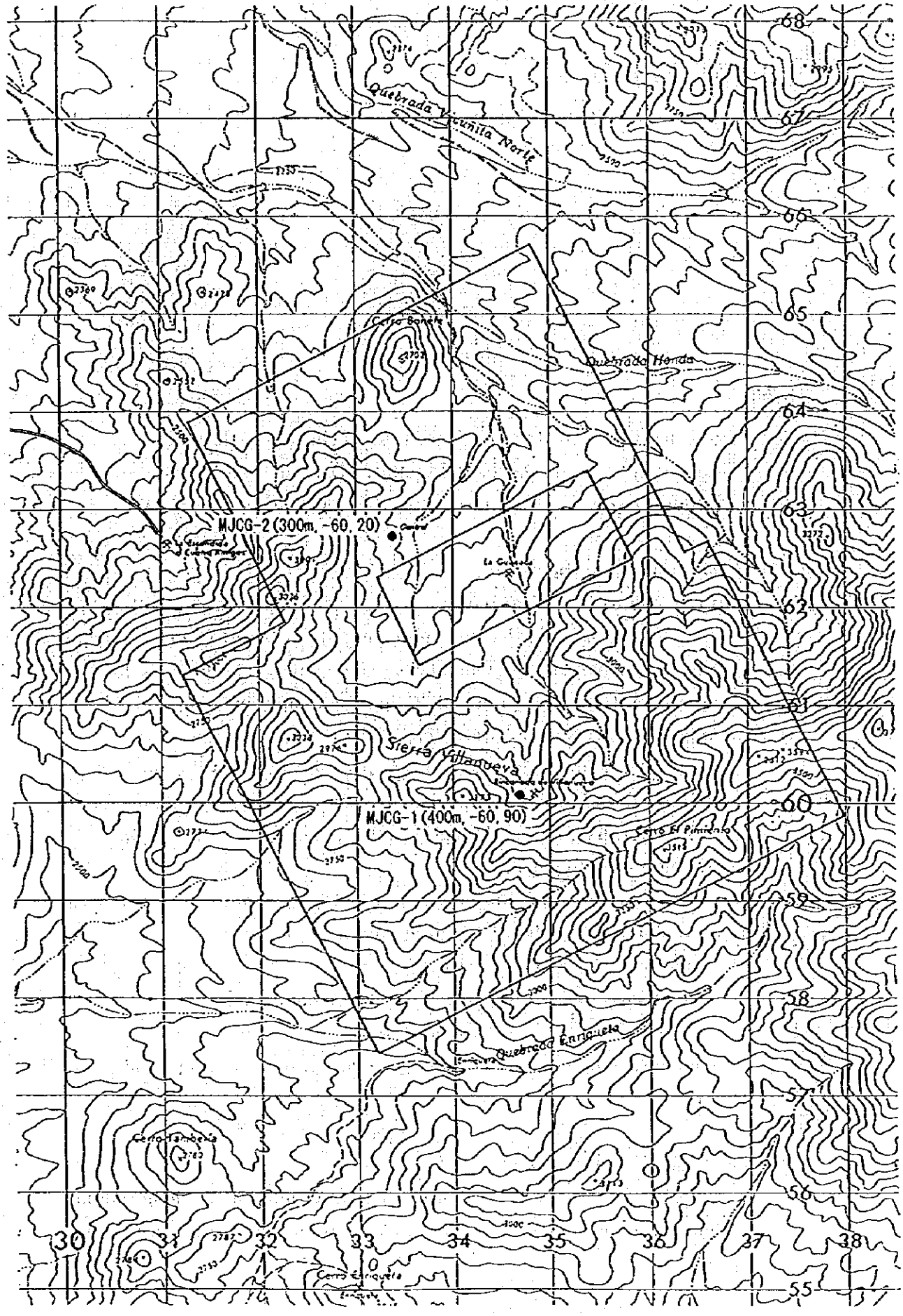

Fig. I-1 Location of drilling sites
Geological Map of La Guanaca Area

1-3-4 Survey Team

The engineers who participated in the Phase II survey are follows.

Japan	Chile
Jun-ichi Ishikawa (Total responsibility) (Dowa Engineering Co. Ltd,)	Jose Domingo Gomez S Empresa Nacional de Mineria(ENAMI)

Inspector: Takeshi HARADA(MMAJ:Metal Mining Agency of Japan, Overseas Activities Department)

1-3-5 Survey Period

Contractual period : October 17th, 1997 - February 27th, 1998
Site survey : October 28th, 1997 - December 28th, 1997
Drilling survey : November 18th, 1997 - December 20th, 1997

Chapter 2 Geography in the Survey Area

2-1 Location and Transportation

Guanaca area is located approximately 110km NNE of Copiapo in the 3rd region of the Republic of Chile, and is. And it is located approximately 40km south of El Salvador mine of Codelco, and the approximately 30km southeastern of the Potrerillos refinery.

The nearest town is Diego de Almagro. It takes 1 hour and 20 minutes from Santiago to Copiapo by daily commercial airplane, and it is a 2 hour drive by car through a 150 km of paved road to get Diego de Almagro from Copiapo.

There are an 70km unpaved, from Diego de Almagro to Guanaca area, and it takes almost 1 hour 20minutes by car.

approximately 800km approximately 150km
Santiago ---------- Copiapo ---------- Diego de Almagro
1h 20m.(by airplane) 1h(by automobile)

The infrastructure is basically good for ordinary living goods and telephone, etc.

2-2 Topography and Drainage

Northern Chile is characterized by four main longitudinal morphtectonic - physiographic provinces from the Pacific coast to the

eastward: Coastal Cordillera, Longitudinal Valley, Precordillera, and the Andean Cordillera. The survey area is located in the Precordillera region and consists of a mountainous land of the Sierra Villanueva which is a small mountain range at the western edge of the Cordillera Domeyko. Elevations in the Survey area range from 2,200m in the north to 3,600m in the south. The Survey area is divided into the mountainous land in the northwestern side and the one in the southeastern side by the wide valley elongate to the NE-SW. The northwestern mountain range also shows a trend to the NE-SW. The southeastern mountains are relatively steep, and a ridge (3,000m to 3,600m above sea level) trends EW to NE. La Guanaca mine and La Rinconada prospect. The Atacama gravel is widely distributed within the main NE-SW trending valley.

2-3 Climate and Vegetation

This area has a desert climate. The temperature at noon is 25℃ in summer and 2℃ in winter. Rain falls are normally almost none all year round with very limited snow in winter. The morning fog is common in lowlands and the daily difference of temperature is remarkable.

Visitation is sparse , with fleshy plants, shrubs and cactuses at dry craggy places that owe their like to some snow in winter and fog in summer.

Guanaco (a kind of deer), reptiles, birds and insects inhabit there with those restricted vegetation,

Climate this year was unusual. It rained much in late June and August around this area. Since there is little soil to reserve water, floods caused a lot of damages to roads, houses and others.

Chapter 3 Geology

3-1 Outline of Geology

3-1-1 Regional setting

The geology around the Survey area is characterized by the N-S trending geological zoning tends to be younger toward east. This zoning corresponds to the above mentioned topographical classification.

Coastal Cordillera mainly consists of Jurassic igneous rocks.

Longitudinal Valley contacts with Coastal Cordillera at Atacama fault. The narrow N-S trending is formed and it is characterized by accumulation of Oligocene sedimentary rocks and volcanic rocks.

Precordillera fundamentally corresponds to Domeyko mountains, and composes of Jurassic ~ Paleogene volcanic rocks, sedimentary rocks, and plutonic rocks.

Tertiary and Quaternary volcanic rocks are dominant in Andean Cordillera, that is called "Maricunga zone" and exploration works for mineral deposits are recently active in this zone.

The Survey area is located in the west of the Maricunga zone and Eocene volcanic rocks a little bit older than that in Maricunga zone are distributed there.

The history of the geological and structural development around the Survey area can be summarized as follows.

(1) Pre-Andean subduction zone formed in the east side of present Andes mountains, between late Cambrian and middle Devonian resulted in the deposition of 10km thick sequence of marine sediments that was elevated above sea level in the middle Permian .

(2) Then, Andean subduction zone associated with active volcanism was formed in the west of the sediments from late Triassic. "Andean batholith" (granodiorite etc.) intruded in this graben like zone between Cretaceous and Paleogene, and the graben was elevated above sea level by a sudden upheaval Oligocene.

(3) Coastal Cordillera is a mountainous range like horst and is underlain by pre-Camblian ~ Paleozoic basement , which got orogenesis twice in Paleozoic age. Based on recent theory, the aforementioned geological structural classification has been rationally explained by the continental movement – collision,

Lithological Map of GUANACA

Fig. Ⅱ-1 Geological columnar figures(MJCG-1, 2)

Lithological Map of GUANACA

Fig. II-1 Geological columnar figures (MJCG-1, 2)

subduction zone, accretionary zone, magmatic activity and strike movement fault. And is such as a crowded zone, and it is thought that Coastal Cordillera belongs to an accretionary zone.

(4) The formation of Andes mountains started since Oligocene till Quaternary, in the western edge of the south America continent. An igneous activity of calc-alkali amphibole andesite occurred in the whole Andes mountains.

Main metal deposits in Chile, porphyry copper deposits and others, are related to the granodiorite aforementioned, which intruded in Coastal Cordillera since Cretaceous till Paleogene.

3-1-2 Geological Setting and Outline of Geology

The geology of the Survey area consists of volcanic rocks, plutonic rocks, Cenozoic sedimentary rock (Atacama gravel) and intrusive rocks.

3-1-2-1 Volcanic rocks

Volcanic rocks consist of later Cretaceous Paleogene andesitic lava and a pyroclastic rock (Ba), dacitic lapilli tuff ~ welded tuff (Dpf), andesitic lava and pyroclastic rock (Ga), Ocoita-andesite (Oa) and rhyolitic volcanic breccia ~ lava (Rd).

Andesitic lava and clastics (Ba) are distributed in the northwestern and central part of the Survey area and trend NE-SW. The black colored pyroxene-hornblende andesitic lavas and clasitic rocks compose the basement of the Survey area. Most of these rocks have been subject to contact metamorphism and at the contact with granitic rocks. And the grain size of the andesite becomes. Partly Cu-oxide occurs associated with quartz veinlets. The andesite correlates with the Llanta Formation (KII) after Cornejo et al., (1993). The Llanta andesite is early Cretaceous in age and is extensively distributed around the Survey area. The type location is Llanta town.

Dacitic lapilli tuff - welded tuff (Dpf) are distributed on the western and southern ridge of the Survey area. These rocks are pyroclastic

flow deposits. White to grayish in color. The lapilli tuff contains black to gray in colored fragments of andesite. In some parts, the rock is welded. The rock is subjected to contact metamorphism at or near contacts with granitic rocks. This rock correlates with the Cerro Vicuña Ignimbrite (Tiv) after Cornejo et al., (1993). According to that the rock is Eocene in age. K-Ar age determined in Phase I is 42.6±2.1Ma, and it may represent the age of alteration.

Andesitic lava and clastics (Ga) are distributed in the southern and southeastern parts of the Survey area. The rocks are greenish andesite lavas and andesitic clastics. The clastics consist of volcanic breccia, tuff breccia, and lapilli tuff and are extensively altered to chlorite and epidote. These rocks are considered to overlie the Llanta Andesite (Ba). The volcanic breccia (Ga) is partly polymictic consisting of clasts of andesitic lava and lapilli tuff (Dpf), and overlies the Dacitic welded tuff (Dpf). Because of this relationships, the Ga andesite is considered to be younger and overlie the Dacitic lapilli tuff (Dpf.). This andesite correlates with the Cerro Vicuña dacitic dome and breccia complex (Tcdd) after Cornejo et al., (1993). According to Cornejo et al., (1993) these rocks are of Paleocene age. A K-Ar age determined Phase I is 42.3±2.1Ma and represents the age of alteration.

Ocoitic andesite(Oa) is distributed in the southern part of the Survey area, and to a much lesser degree in the eastern and western parts. These rocks are characterized by very large plagioclase phenocrysts up to 30mm in length and displaying a weak preferred orientation. There is no flow foot breccia at the base of the Ocoitic andesite, therefore the andesite have been intruded in the Green andesite(Ga) like a sill body. According to Cornejo et al.,(1993), the Ocoitic andesite is a member of the Llanta Formation, however we consider that the Ocoitic andesite does not belong to the Llanta Formation based on the above mentioned reason.

Rhyolitic volcanic breccia and lava (Rd) crop out in the south of the Survey area. These rocks are white rhyolitic volcanic breccia and lava. They are composed of flow banded rhyolitic blocks. This rhyolitic

breccia is thought to be an auto-brecciated lava due to its monolithologic character. The rhyolite probably intrudes the Andesite (Ga) judging from its dome like shape. Bleaching and silicification due to hydrothermal activity is observed in this rock. In the south of the Quebrada Enriqueta, outside of the Survey area, the rocks became white to yellowish brown in color due to the presence of illite/smectite interstratified clay minerals, and the rocks were silicified.

3-1-2-2 Plutonic rocks

Plutonic rocks is composed of a monzonite (M), monzonite rock body (Gr), quartz monzonite (Md), adamellite (Ad), aplitic granite (Ag), a granodiorite-1 (Gd1), granodiorite-2 (Gd2), and a granodiorite-3 (Gd3) and granodiorite-4 (Gd4).

Granites are dominant in the southern part of the Survey area. Granodiorites are dominant in the central part of the Survey area. And monzonites are dominant in the northwestern part in the Survey area.

Monzonite (M) are distributed in and surrounding the northwestern part of the Survey area. It is the oldest rock of plutonic rocks in the Survey area. And it is dark gray to greenish gray in color and have a medium grained, equigranular texture. The main mineral constituents are plagioclase, K-feldspar, quartz, hornblende, and biotite, plagioclase being most abundant. A little K-feldspar and quartz occupy irregular interspaces. Plagioclase is partly altered to sericite, while hornblende and biotite are partly altered to chlorite, epidote, carbonate, and opaque minerals. According to Cornejo et al. (1993), the K-Ar age of biotite from a monzonite sample collected in 8km away from the Survey area is approximately 63±2Ma and therefore of Paleocene age.

Quartz monzonite (Md) is distributed in the southern part of the Survey area. It is dark greenish-gray to dark gray in color. The rock is mafic and looks like a gabbro in the field. The mineral constituents are plagioclase, quartz, K-feldspar, orthopyroxene, hornblende, and very minor biotite. A little K-feldspar and quartz occur as interstitial minerals. Both display graphic and granophyric texture. Plagioclase is partly altered to sericite and epidote, while pyroxene is partly altered to chlorite and

opaque minerals and hornblende to chlorite and epidote.

Adamellite(Ad) occurs in the central and southern part of the Survey area. It is dark greenish-gray to gray in color with a fine to medium grained texture. The main mineral constituents are plagioclase, hornblende, biotite, quartz, and K-feldspar.

Aplitic granite(Ag) is distributed between La Rinconada and Cerro El Pimiento. It composes an east-west ridge. All cores are this rock at MJCG-1 drilled in this survey. And it is fine grained and white to light gray in color. The dominant mineral constituents are plagioclase, K-feldspar, and quartz. Mafic minerals have been completely replaced by epidote and opaque minerals.

Granodiorite-1 (Gd1) constitute the NE-SW trending ridge in the southeastern part of the Survey area. This granodiorite has a medium to fine grained texture and is light greenish-gray to dark gray in color. Most of the mafic minerals are altered to chlorite. The main mineral constituents are plagioclase, quartz, K-feldspar, hornblende, and biotite. K-feldspar and quartz occur as interstitial minerals. K-feldspar is less abundant than quartz. Almost all of the hornblende and biotite are altered to chlorite. K-Ar age indicates the granodiorite has an age of 42.1 ± 2.1. This age may show a alteration age.

Granodiorite-2 (Gd2) is exposed in a restricted area within the Granodiorite (Gd3) mentioned below. Fine grained mafic minerals are abundant and resembles a dioritic rock in the field. This rock appears to be a big cognate inclusion of the Granodiorite-3 (Gd3) as the Gd2 rock is very similar to the dioritic inclusion of the Granodiorite-3 (Gd3) and Granodiorite-4 (Gd4). The mineral constituents are plagioclase, quartz, K-feldspar, hornblende, biotite, and opaque minerals.

Granodiorite-3 (Gd3) is distributed in the central part of the Survey area. All cores are this rock at MJCG-2 drilled in this survey. The rock is characterized by a small abundance of mafic minerals. The mineral constituents are plagioclase, quartz, K-feldspar, hornblende,

biotite, and opaque minerals. This rock is relatively fresh, with K-feldspar and quartz occurring interstitial. Two modes of occurrence of biotite are observed. This rock is the host rock to the oxide copper vein of La Guanaca prospect, and is also a host rock to the vein of Central prospect and La Escondida prospect.

Granodiorite-4 (Gd4) is distributed in the northern and low part of the Survey area, near Cerro Bonete. And it appears to be covered by the Atacama gravel. This rock is light gray in color and has a medium to coarse grained texture. In the south of Cerro Bonete, this rock intrudes the Llanta andesite (Ba). The main mineral constituents are plagioclase, quartz, K-feldspar, biotite, hornblende, and opaque minerals. Some of the quartz occurs as micrographic and granophyric intergrowths with K-feldspar. Biotite is partly altered to chlorite. Cornejo et al.(1993) reported that the K-Ar age of this rock are between 48±1.3Ma and 47.8±1.3Ma.

3-1-2-3 Cenozoic sedimentary rock

Cenozoic sedimentary rock is Atacama gravel.

Atacama gravel (Atg) is distributed in shallow part the low gently-sloping place of the Survey area. It covers a volcanic rocks and plutonic rocks. It includes subangular to angular various rock gravel that came from the surroundings area. The matrix is psammitic and includes limonite. It is solidified, however very soft.

It is the sediment that collapse materials were solidified through Cenozoic orogenesis.

3-1-2-4 dykes

In addition to the above rocks, some dykes are distributed in the Survey area. principal rocks are following.

Hornblende-plagioclase porphyry (Hp) is located at La Guanaca mine site. The porphyry occurs as a small stock in the Granodiorite-3 (Gd3). The porphyry is a host rock to mineralization of disseminated chalcopyrite and pyrite there. ENAMI (1995) showed that the porphyry also occurred at

a depth of 60m, and it also outcrops at surface. The rocks from underground are observed in the waste dump at the mine site. Those rocks from the waste dump have disseminated chalcopyrite and pyrite. The rocks that outcrop at the surface have suffered weak supergene oxidation. The sulfides have changed to hematite and limonite. The rocks are intensely sericitized. Green colored biotite was also observed in these rocks.

Aplite(A) dikes are intruding in the Llanta andesite in the mountains of the northwestern part of the Survey area. They have 5 to 15m in width, and extend more than 2km in length. Most of the aplite dykes are hundred to a few hundreds meters long and a few meters in width,. They are white to pale-yellowish-brown in color, and fine grained. Tourmaline clots are often observed in this rock.

Plagioclase porphyry(Pp) intrudes into quartz monzonite (Md) and the adamellite (Ad) in the southern part of the Survey area. This rock looks like the aplitic granite (Ag), except that plagioclase phenocrysts characterize this rock.

Andesite dike (Ad) located in the southern part of the Survey area and La Escondida prospect west of the Survey area. These dikes intrude in the aplitic granite(Ag) and others. And they are dark greenish gray in color. Epidote and chlorite are widespread in this rock. The copper mineral - quartz veins occur within the boundary of this rock and granodiorite at La Escondida prospect. This rock has chilled margin. It is fine and has weak flow structure.

Dacite and rhyolite dikes(Dd) intrude into Llanta andesite in the eastern part of the Survey area. This rock intrudes in granodiorite near La Escondida prospect and cuts andesite dikes and Cu-veins.

they are pale gray in color. The dikes are 10 to 20m in width, strikes N70W and dips 70N. Quartz phenocrysts of 1 to 5mm in diameter are observed. A thin green copper film with epidote are observed at the contact between the Llanta andesite and the dike rock.

Quartz porphyry (Qp) is distributed at La Escondida deposit, west

of the Survey area. It intrude mainly in a granodiorite-3 (Gd3). It cuts andesite dyke (Ad) and copper-mineral quartz vein. It resemble above-mentioned dacite ~ rhyolite dyke (Dd) about the distribution and the intruding direction. The color is pale gray. This rock are composed of quartz, plagioclase etc. It includes characteristically quartz phenocrysts of 4mm diameter. Alteration is so weak that it is only smectite-altered near the surface.

3-1-2-5 Relationships of the rocks

About the above mentioned rocks, by summing up the results of the results of dating, the condition and the correlation to the surrounding area and others, the following mutual relations are estimated in this area. Llanta andesite (Ba) is considered as Cretaceous lower part and is the oldest formation in the Survey area. After then, monzonite (M) intruded in the early time in Paleocene. And for a while, They received elevation and erosion.

In late Paleocene ~ Eocene, pyroclastic flow deposits = dacitic lapilli tuff and welded tuff (Dpf) flowed covering on Llanta andesite (Ba). Further, besides a little time gap, a green gray andesite · volcanic rocks s (Ga) of the same quality did covering of a dacitic lapilli tuff (Dpf).

It is estimated that Ocoita andesite (Oa) intruded in aforementioned volcanic rocks as the sheet.

After then, plutonic rocks and dykes, without monzonite (M), intruded. The relationship of plutonic rock bodies (quartz monzonite (Md), adamellite(Ad), and aplitic granite (Ag) in the southwestern division of the Survey area and granodiorites, which consist of granodiorite-1 (Gd1), granodiorite-2 (Gd2), granodiorite-3 (Gd3) and granodiorite-4 (Gd4), with the zone of NNE ~ SSW in the central western division is not clear. However, the former is estimated to be relatively old, as it is altered in the wide range,.

The andesite dyke intruded mainly in WNW ~ ESE . The activity of this dyke might be related to the mineralization at La Escondida etc. After that, dyke of dacite ~ rhyolite and, dyke of quartz porphyry intruded mainly in NNE ~ SSW direction.

In the process of Cenozoic orogenesis, collapse fragments and

gravel was piled up and became Atacama gravel.

3-1-2-6 Regional alteration

Entirely in the Survey area without the central granodiorite body, epidote and chlorite are observed. propyllitic alteration deems to have occurred in plural terms, considering the field observation and the result of dating. The first phased alteration is observed at the aplitic granite (Ag) at La Rinconada prospect. The result of dating is approximately 50Ma. The 2nd Phased alteration is widely observed at Llanta formation (Ba) and a green andesite (Ga). The result of dating of rock is approximately 42 ~ 44Ma. Epidote and chlorite probably occurred as the following process.

①The tectonic movement and the low grade metamorphism (green schist phase) in later Cretaceous.

②The contact metamorphism with intruding of plutonic rocks.

③Propyllitic alteration related to the hydrothermal activity.

It is difficult to distinguish strictly these three stages.

It means that, because the result of dating of early propyllitic alteration(approximately 50Ma) is than of a granodiorite (Gd) of the central part that (approximately 44Ma), it is not possible that epidote and chlorite of La Rinconada prospect are by means of the contact metamorphism related to intruding of a central granodiorite (Gd).

By Mpodozis and Allmendiger (1992), the chlorite - epidote - actinolite alteration is produced by the local metamorphism related to the reverse fault movement in later Cretaceous.

The alteration occurred at La Rinconada prospect as the period of epidote–chlorite-actinolite. Both of the local alteration and the propyllitic alteration by magmatic hydrothermal activity occurred approximately 50Ma ago. And alteration 42 ~ 44Ma ago may be related to the activity of central granodiorite (Gd), because the dating result is similar as the age of this granodiorite (approximately 44Ma) and younger than the regional metamorphism.

3-2 Mineralization and mineralized zone

In the north of the Survey area, there are El Salvador mine (operated by CODELCO, approximately 40km north), Potrerillos mine (Closed now, about 30km Northwest) and others. The ages of mineralization are 43 ~ 31Ma ago and 35Ma, respectively and these porphyry copper deposits are thought to be the most southern part of mineralized zone of Chilean porphyry copper belt in late Eocene to early Oligocene

The Survey area is located in the southern extension of the porphyry copper belt. Several small-scale mines exist at present in and around the area. La Guanaca mine, one of them, was located at the central part of this area, and oxide copper was mined until 1995. The ore from Guanaca was sent to the copper leaching plant of ENAMI at El Salado. ENAMI made financing and a technological instruction for this mine, and carried out a driving of exploration adit (non-core 5 hole, 573 m), geophysical survey (CSAMT, 10 lines with length of 400 - 500 m) in 1994. The reserve of oxide copper ore was estimated as 6,850,000 t (Cu : 0.64 %) (Godoy and Gonzalez, 1994).

There are La Escondida mine and La Pimienta mine to the west of the Survey area and to the south, Enriqueta mine CODELCO carried out a drilling program in the south of this area, targeting an alteration zone in 1995.

Within the survey area, La Guanaca prospect, La Rinconada prospect and a Central prospect are known.

1) La Guanaca prospect

The Granodiorite-3(Gd3) is dominantly exposed over this prospect with limited exposure of porphyry stock in the old pits site which intrudes the Granodiorite-3(Gd3). Two kinds of mineralization occur as follows.

(1) Vein type copper mineralization in the granodiorite.
(2) disseminated type chalcopyrite-pyrite mineralization in a small porphyry stock .

Oxide copper occurs along joints of the granodiorite and does not associate with quartz. Alteration is not observed in the margin of the vein (joint). The Oxide copper seems to be generated during supergene and exotic mineralization. Sulfide minerals are leached and oxidized near surface and are charged to hematite and limonite but oxide copper vein with remaining primary chalcopyrite is also partially observed. Judging from the boxwork texture of the limonite, it is thought that is observed the limonite is derived from in situ sulfide copper mineralization with copper sulfide and quartz. Disseminated chalcopyrite and pyrite in porphyry are observed in a grab sample from waste dump. The matrix of hydrothermal breccia in porphyry was sericitized. The flakes of sericite are large enough to be seen with the naked eye like muscovite. The potassic alteration seemed to occur in this prospect.

2) La Rinconada prospect

There are several old small pits within this prospect. And there oxide copper mineralization associated with quartz veins. The host rock is the Aplitic granite (Ag). The host rocks are often unclear. The width of the quartz veins range from a few centimeters to a few tens of centimeters. The margins of the quartz veins to the host rocks are not clear. The N-S strike veins are dominant and range from N10° ~40° E to N10° ~30° W, and dip is 70° to vertical.

The ore minerals consist of chrysocolla, malachite, brochantite, tenorite and chalcocite and as gangue minerals are quartz, sericite, chlorite, epidote and tourmaline are observed.

In the Phase I study, very small grains of chalcopyrite and chalcocite in oxide copper mineralization were observed under the microscope. Around the veins pale greenish-yellow colored smectite is observed. This smectite is supposed to have been produced during the supergene stage.

3) Central prospect

Copper mineralization associated with quartz veins is observed in this prospect. The width of the quartz veins usually main hosted by Granodiorite-3(Gd3) is the strike of the veins tends to N80° E~N60°

or E-W, which is similar to the strike observed in La Guanaca prospect, and dip is 60° S to vertical.

The ore minerals on the veins are cuprite, tenorite, chrysocolla, malachite, and brochantite. Chalcopyrite and pyrite remained in the oxide copper minerals are observed and this indicates that the copper mineralization in Central prospect occurred in situ and is not an exotic one.

4) La Escondida prospect

This prospect is located outside (NW) the Survey area. Several old pits exist there. There is an adit extended along a vein which strikes N80° W, which is hosted by granodiorite and andesite dykes.

The ore minerals observed are cuprite, tenorite, chrysocolla, malachite, and brochantite. Silicification is observed near margin of veins but it is not large.

5) Other mineralized zone

Quebrada Enriqueta mineralized alteration zone is located outside the Survey area.

Rhyolitic volcanic breccia - lapilli tuff (Rd) and andesitic volcanic breccia (Ga) are the host rocks of the zone. Matrix of these breccia is weakly silicified, and a hydrothermal breccia structure is observed.

Sericite - smectite mixed layer alteration in the zone but partly only sericite is observed. Minor Kaolinite, may be of supergene origin, is also observed.

Chapter 4 General Discussion on Survey Results

4-1 Geological Structure, Characteristics and control of Mineralization

4-1-1 Characteristics of Mineralization

The superior alteration zone and weak mineralization were confirmed in MJCG-1 at La Rinconada prospect. The mineralization is characterized by disseminated minerals and vein like mineralization observed on surface is rather few.

However, alteration is observed in spite of the weakness of mineralization. Since sericite alteration zone is small, the alteration seems to be the regional propyllitic alteration zone rather than phillic alteration. Therefore, only low potential for porphyry copper deposit near or around MJCG-1 is recognized.

At MJCG-2 of Central prospect, though many veinlets associated with pyrite and chalcopyrite were observed, alteration zones are restricted in the margin of veinlets. Therefore this mineralization is not a porphyry copper-type. High level of primary biotite and amphibole are detected by X-ray diffraction, and it is obvious that the type of alteration is very different from the one in La Rinconada prospect. Therefore it is estimated that, though hydrothermal water passed through fractures in granodiorite, host rock, and the condition for deposition of sulfide minerals in good, the scale of hydrothermal activity was small.

E-W strike fissures and fractures are dominant around the Central prospect, which are similar to La Escondida prospect to the west, rather than La Rinconada prospect.

4-1-2 Concept of ore genesis

It is reported that oxide copper networks are developed particularly in the intrusion below breccia up to 60m in depth from the surface, and pyrite-chalcopyrite zone (primary zone) occurs below 60m at La Guanaca deposit by Godoy and Gonzalez (1994).

Chalcopyrite - pyrite zone is associated with silicified - sericitized alteration zone. It is suggested that secondary copper deposits such as malachite observed in La Guanaca were formed by redeposition in fractures of copper ion, leached and remobilized from primary deposit, as oxide, hydro-oxide and/or carbonate minerals.

In case of La Rinconada prospect, post hydrothermal activity is superimposed on propyllitic alteration in the aplitic granite. But, Judging from low sulfide sulfide content and higher homogenization temperature of fluid inclusions in depth than surface, it is suggested that copper leaching environment was developed in depth.

At Central prospect, judging from very weak alteration in granodiorite, it is different to say that a porphyry type ore deposit may occur. Small-scale hydrothermal activity probably generated sulfide deposition settled in joints and small fractures.

4-2 Relationship between Geochemical Anomaly and Mineralization

4-2-1. La Guanaca prospect

This prospect is characterized by geochemical anomalies of copper (100s ppm) and molybdenum (10s ppm).

Although it is difficult to say that this is a small scale porphyry copper-type, judging only from its appearance of stockwork form, anomalies of copper and molybdenum, and potassic alteration indicate the possibility that a mineralization similar to a porphyry copper-type mineralization may exist.

4-2-2. La Rinconada prospect

Geochemical anomalies(rock chip sampling) of copper (100s ppm), gold (more than 100 ppb), lead (more than 300 ppm) and zinc (more than 200 ppm) are found at this prospect. However, Cu assay values of drilling cores of MJCG-1 are generally lower than those values of geochemical anomalies on surface. This may suggest that Cu was leached underground in depth.

4-2-3 Central prospect

Geochemical anomalies(rock chip sampling) of copper (100s ppm), lead (10s ppm) and zinc (more than 300 ppm) are found at this prospect. This result corresponds with the fact that, in addition to Cu mineralization, Pb and Zn mineralization is also observed in apart of the surface. It is a characteristic of this prospect that a geochemical anomaly of molybdenum is found. Those facts may suggest that a small-scale vein type mineralization exists in and around the prospect.

4-3 Relationship between Geophysical (IP) Anomaly and Mineralization

The mineralization of chalcopyrite - pyrite at La Guanaca may be related to a porphyry copper-type mineralization. If typical stock work mineralized zone may exist here, it is expected in deeper part of this prospect.

However, IP anomaly wasn't found and therefore, there is no geophysical indication of typical porphyry copper-type mineralized zone in La Guanaca prospect.

Some portions of low resistivity anomalies which are detected and distributed in SSE and East of La Rinconada prospect may be related to some mineralization. But these anomalies of low resistivity are not intense enough to indicate porphyry copper-type ore deposit.

4-4 Potentiality for New Ore Deposits

The Suvey area is located in the southern extension of the mineralized belt where Oligocene-Eocene major porphyry copper deposits such as El Salvador deposit and Potrerillos etc. are located. However, in the surroundings and the south of the Survey area, any typical porphyry copper deposit has not been discovered yet so far.

As a result of geochemical survey of phase I in this area, it was expected that porphyry copper-type mineralized zone centering around La Guanaca prospect may exist judging from assemblage of anomalous elements.

The distribution of the alteration zone also indicated a possibility that pophyry copper type mineralized zone may occur. However, the result of geophysical survey (IP method) didn't show that such a mineralized zone may be expected there. Therefore, although some extents of mineralization of copper and others exists in the prospect.

Judging from the characteristics of the alteration in La Rinconada prospect, it is difficult to say that the hydrothermal activity from which primary copper mineralization derives is related to the alteration as porphyry copper-type hydrothermal activity.

It is thought that those fractures observed in the Central prospect had a role for passageways of hydrothermal fluid judging from the existence of sulfide minerals and higher homogenization temperature

of fluid inclusions. As considering very weak alteration and there is no IP anomaly, the mineralized zone may be small.

Chapter 5 Conclusion

5-1 MJCG-1

① The geology of this hole consist of fine, grayish white and massive aplitic granite. Principal parts of mineralization were encountered as follows.

- 133.8 m ~ 134.2 m : intensely silicified zone associated with specularite and malachite etc.
- 242.6 m ~ 242.7 m :disseminated chrysocolla.
- 322.0 m ~ 322.3 m : network of chrysocolla and epidote .

No remarkable mineralized zone was encountered.

② The core is partly silicified, associated with epidote and chlorite.

③ The phillic alteration zone expected as a result of Phase I survey wasn't discovered. Therefore, potential for porphyry copper-type deposit around and lower part of the prospect is minimum.

5-2 MJCG-2

① The geology of this hole is composed of medium, gray, massive granodiorite, in which xenolith of gneiss or diorite is observed. Veinlets of several mm in width and disseminated zones of chalcopyrite are observed, as follows.

- 93.5m chalcopyrite - pyrite veinlet.
- 169.3m, pyrite - chalcopyrite disseminated zone - veinlet.
- 183.7m,217.9m,233.1m, (quartz) - chalcopyrite veinlet.
- 294.05m,295.0m,veinlet of chalcopyrite - chalcocite

② The alteration observed in granodiorite of this hole is very weak with only small-scale chloritization and silicification near margin of veinlets. The indication of a porphyry copper-type alteration was not encountered.

5-3 Survey of La Escondida prospect.

① The geology of this prospect is composed of massive granodiorite which is intruded by quartz porphyry dyke, rhyolite dyke and

andesite dyke. There are two structures in the prospect, an older WNW-ESE structure and a newer NNE-SSW structure. Andesite dyke intrudes in the former structure where quartz vein and copper-mineral vein are formed. On the other hand, quartz porphyry and rhyolite dykes intrudes in the latter where faults with sheared zone are developed. Those acidic dykes are thought to be post mineralization dykes.

② Within an area of about 800m(E-W) by 500m(N-S), veins are distributed in this prospect. The mineralized zone of this prospect is larger than an La Rinconada prospect and Central prospect.

③ Judging from the type of mineralization and alteration assemblage, the potential for a deposit, other than vein type, like porphyry copper type is minimum.

PART II Details of the Survey

Chapter 1 Drilling Survey

1-1 Survey Method

1-1-1 Outline

The drilling work was ordered to Geotec Boyles Bros S.A., generally except to attached constructions (road land development and repair), equipment and materials of this.

1/200 columnar figure was arranged about the cores extracted, a reduced scale. Colored photographs are taken about all cores. And geological survey around drilling points was executed for the correlation with a geology of the hole and integrated evaluation. Chemical analysis and the observation of thin sections and polished sections ware executed. and observed a microscope representation. And X-ray diffraction test was executed in order to know the alteration.

1-1-2 Drilling Method and Equipment

The drillings were executed by wire-line method, and casings were inserted as responding the geologic situation. The holes were drilled protecting the walls by regulating the concentration of mud water.

Principal equipment, materials, supplies, diamond bits and reamers was indicated by Table II-10. The operated rig was CS3000 owned by Geotec Boyles Bros S.A.

1-1-3 Working Conditions

The construction and withdrawal were executed by 2-shifts per day. The penetration work was taken turns at 12-hours shifts, 2-shifts per day. 1 shift is organized of 1 Chilean engineer and 4 workers. And Japanese engineer usually directed them about general instruction . The base camp of drilling workers was set up at La Finca, and they commuted to the drilling sites by car.

1-1-4 Transportation of Equipment/Materials and Construction of Access Roads.

The equipment and materials for drilling survey were carried truck from Santiago, partly from Copiapo, to the drilling sites. And a bulldozer was also carried from Copiapo for road land development.

There is no-pavement road in the Survey area. Therefore the road was repaired by bulldozer. As drilling site were far-off from the

occurred roads, roads were built anew.

1-1-5 Demobilization

After the finish of Survey, equipment and materials owned by GEOTEC BOYLES BROS S.A. were taken out to Copiapo, partly to Santiago. Whole drilling cores were reserved at El Salado branch office of ENAMI.

1-1-6. Drilling Process Water

Drilling water was usually pumped up at La Finca, and transported by water trucks. And it was reserved in the tank pits in the drilling sites.

1-1-7. Progress of Drilling

The drilling hole line were indicated in figure I-1. The record and itinerary of penetration were indicated in table II-7.

(1) MJCG - 1

The drilling period is December 4 through December 20. From the surface, core rock is silicified aplitic granite, and it is very hard. However, there were faults at shallow part. the drilling was carried out up to the depth 102m by the HW wire line method and set HW casing. And the drilling carried out up to depth 400m by the NQ wire line method.

Though the rig broke down on December 14, drilling was restarted in the evening in December 17. for a result of improvement of the water truck and drilling equipment, drilling speed had increased. And the drilling carried out to reach predetermined depth, and finished on December 20.

(2) MJCG-2.

The drilling period is November 18 through December 2. Near the surface, granodiorite is soft by weathering. And joints and fissures were observed with 20-30 m interval. The drilling was carried out up to the depth 102m by the HW wire line method and set HW casing. And the drilling carried out up to depth 300.2m by the NQ wire line method.

Though the drilling stopped whenever the equipment and the water truck had broken down, the drilling had carried out almost smoothly and finished on December 2.

1-2 Results of Survey

1-2-1. Geology-mineralization-alteration.

Drilling logs are shown in a figure Ⅱ-1, and geological drilling section is indicated in figure Ⅱ-2~3. The result of chemical analysis (ore), X-ray diffraction, rock thin section and polished section appraisal are shown in table Ⅱ-1~2.

(1) MJCG-1 (La Rinconada prospect, direction E, dip -60°, length 400.0m)

① MJCG-1 drilled in fine, grayish white and massive aplitic granite, all down through the hole. Phenocrysts of this rock consist of quartz, K-feldspar, plagioclase, biotite and opaque minerals. Biotite is almost altered to chlorite, and epidote is observed almost all over the cores. Holocrystal and eqigranular textures and partly large phenocrysts of plagioclase are observed.

Principal part of mineralization were encountered as follows.

- 133.8 m ~ 134.2 m : intensely silicified zone associated with specularite and malachite etc.
- 242.6 m ~ 242.7 m : disseminated chrysocolla.
- 322.0 m ~ 322.3 m : network of chrysocolla and epidote.

Homogenization temperatures of fluid inclusions are 300 - 360 ℃, higher than the samples on surface(La Rinconada prospect) of Phase I. Salinities of them are generally low. It suggests that the condition to generate sulfide veinlets owes to altitude.

The results of dating by K-Ar method show 41.7±2.1Ma and 43.3±2.2Ma that indicate Eocene. They seem to be ages when alteration occurred as the core samples of altered aplitic granite were used for dating. Sericite in quartz veins at La Rinconada dated 45.6±1.2 and 46.0±1.2Ma dated in Phase I, and those dating results are almost same as the results of Phase II. Therefore it is concluded mineralization and hydrothermal activity occurred in Eocene.

Table II-6 Result of age determination (K-Ar method) of rocks

No	Well	Depth(m)	Rock name	K-Ar age(Ma)	Geologic age
1	MJCG-1	187.50	Aplitic Granite	41.7±2.1	Eocene
2	MJCG-1	227.20	Aplitic Granite	43.3±2.2	Eocene

(2) MJCG-2 (Central prospect, direction N20° E. dip -60°, length 300.2m))

① MJCG-2 drilled in medium grained gray and massive granodiorite with xenolith of gneiss~diorite all down through the hole. The phenocrysts consist of quartz, plagioclase, K-feldspar, biotite, hornblende, zircon and opaque mineral. Parts of biotite and hornblende are altered to chlorite and it has holocrystal and eqigranular textures are observed.

Veinlets of several mm in width and disseminated chalcopyrite zones are observed, as follows.

- 93.5m chalcopyrite - pyrite veinlet.
- 146.6m,chalcopyryte-pyrite (-sphalerite-galena) veinlet
- 169.3-171m, pyrite - chalcopyrite (-sphalerite-galena). disseminated zone - veinlet.
- 183.7m,217.9m,233.1m (quartz) - chalcopyrite veinlet.
- 294.05m,295.0m, chalcopyrite - chalcocite veinlets

② The alteration shown in of this hole is very weak with only small-scale chloritization and silicification near the margins of veinlets. In conclusion the indication of a porphyry copper-type deposit is not encountered.

③ Homogenization temperatures of fluid inclusions are 280 - 360 ℃, and have a large range. Salinity of them is high. Such the character resembles the samples of the surface(Central prospect) measured last year. It suggests that the condition to generate sulfide veinlets is hardly variable by altitude.

1-3 Discussion

Only weak IP anomaly zones one extracted in Phase I survey.

The silicified and white alteration zone within/ around MJCG-1 may be due to leaching, and the size of the zone is small. Therefore it is hard to say that it is phillic alteration zone. The potential for porphyry copper-type deposit is minimum around MJCG-1.

Although veinlets of chalcopyrite are observed at MJCG-2, and the alteration of this hole only shows choloritization at the margin of veinlets and the potential for porphyry copper-type deposit around MJCG-2 is also minimum. The relation between La Escondida deposit, located 2km west of the Survey area, and La Guanaca prospect are still unclear, although the type of host rocks and mineral assemblage are similar.

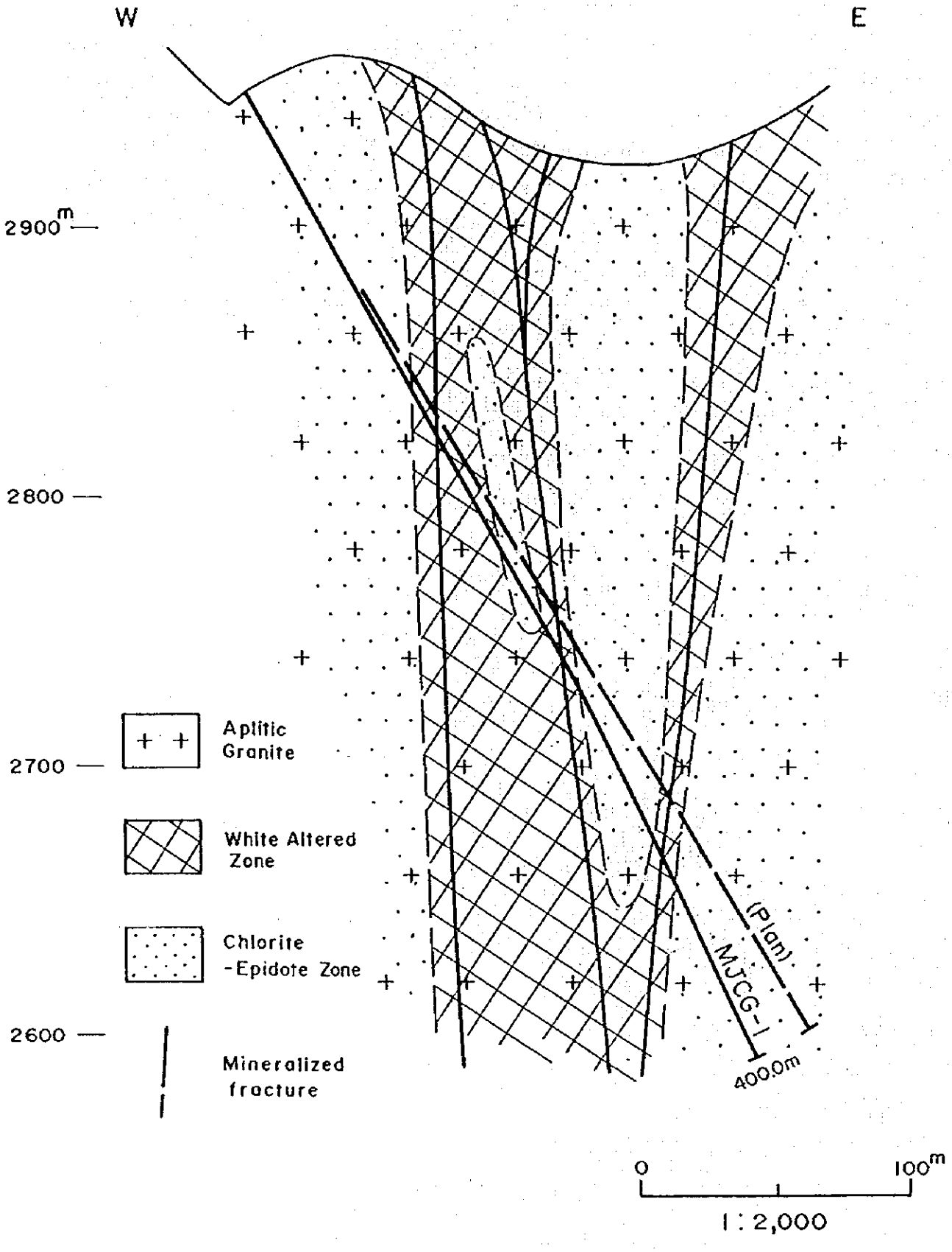

Fig. II-2 Geological Section (MJCG-1)

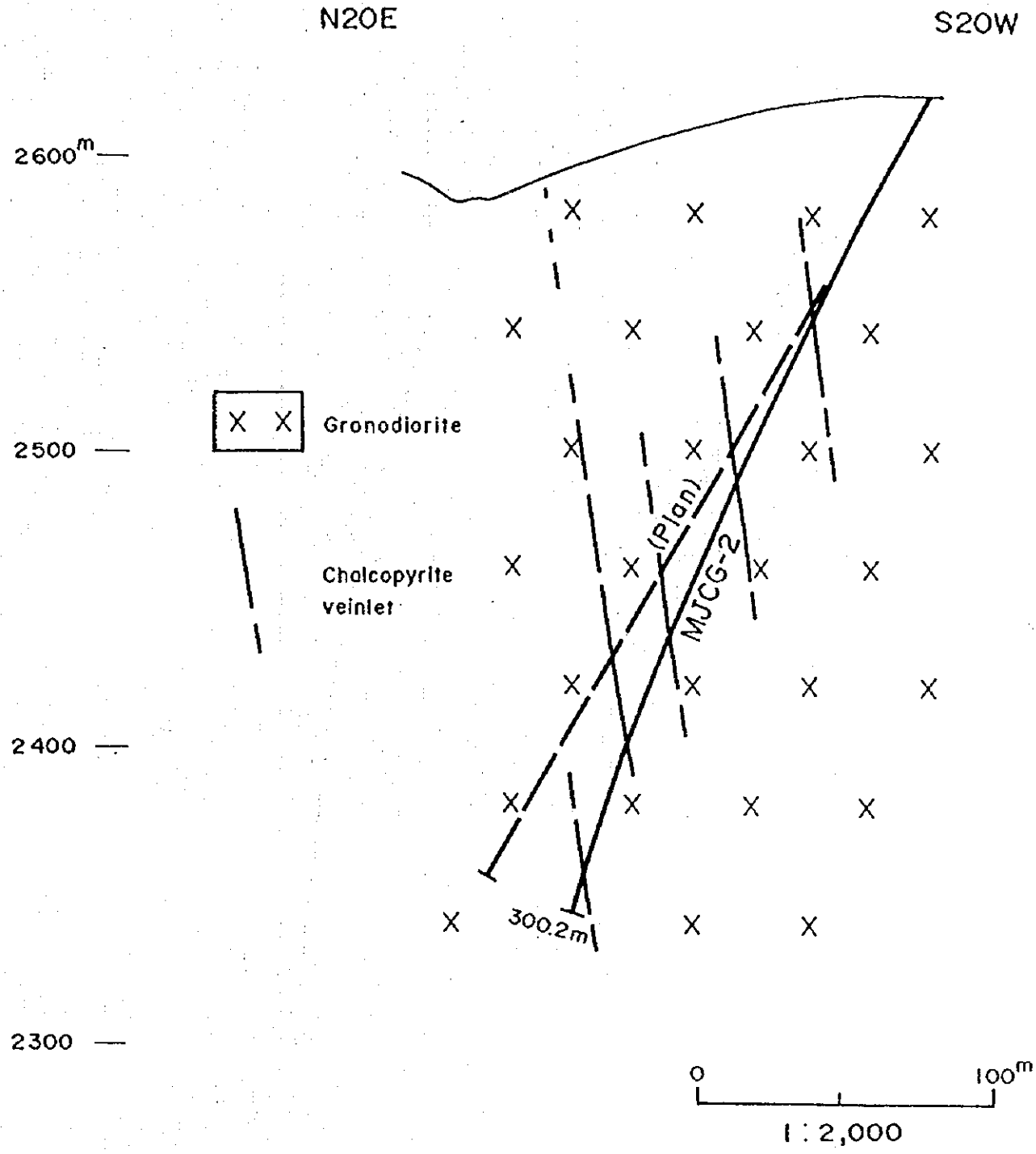

Fig. II-3 Geological Section (MJCG-2)

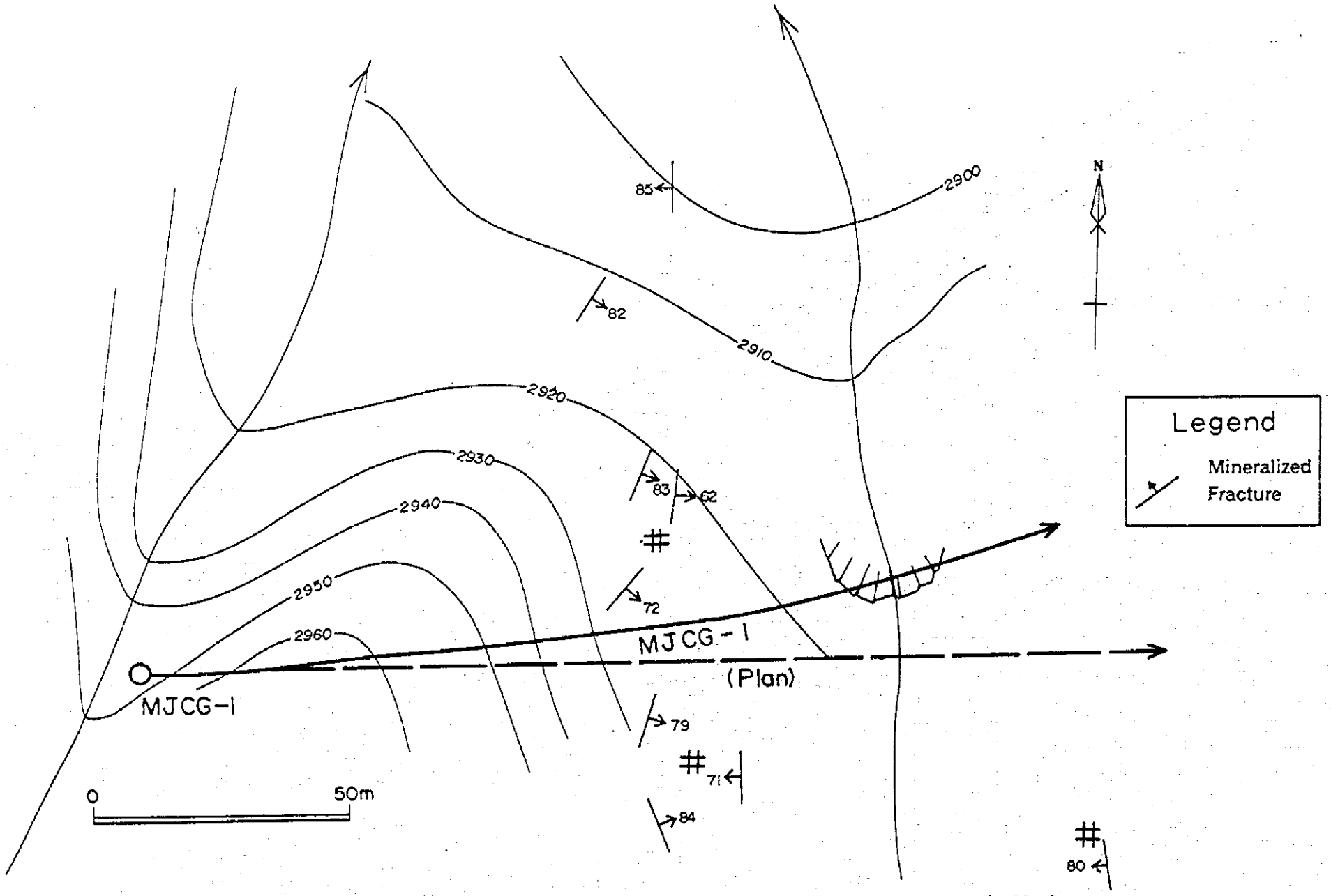

Fig. II-4 Result of measurement of Hole deviation and Drilling Lines (MJCG-1)

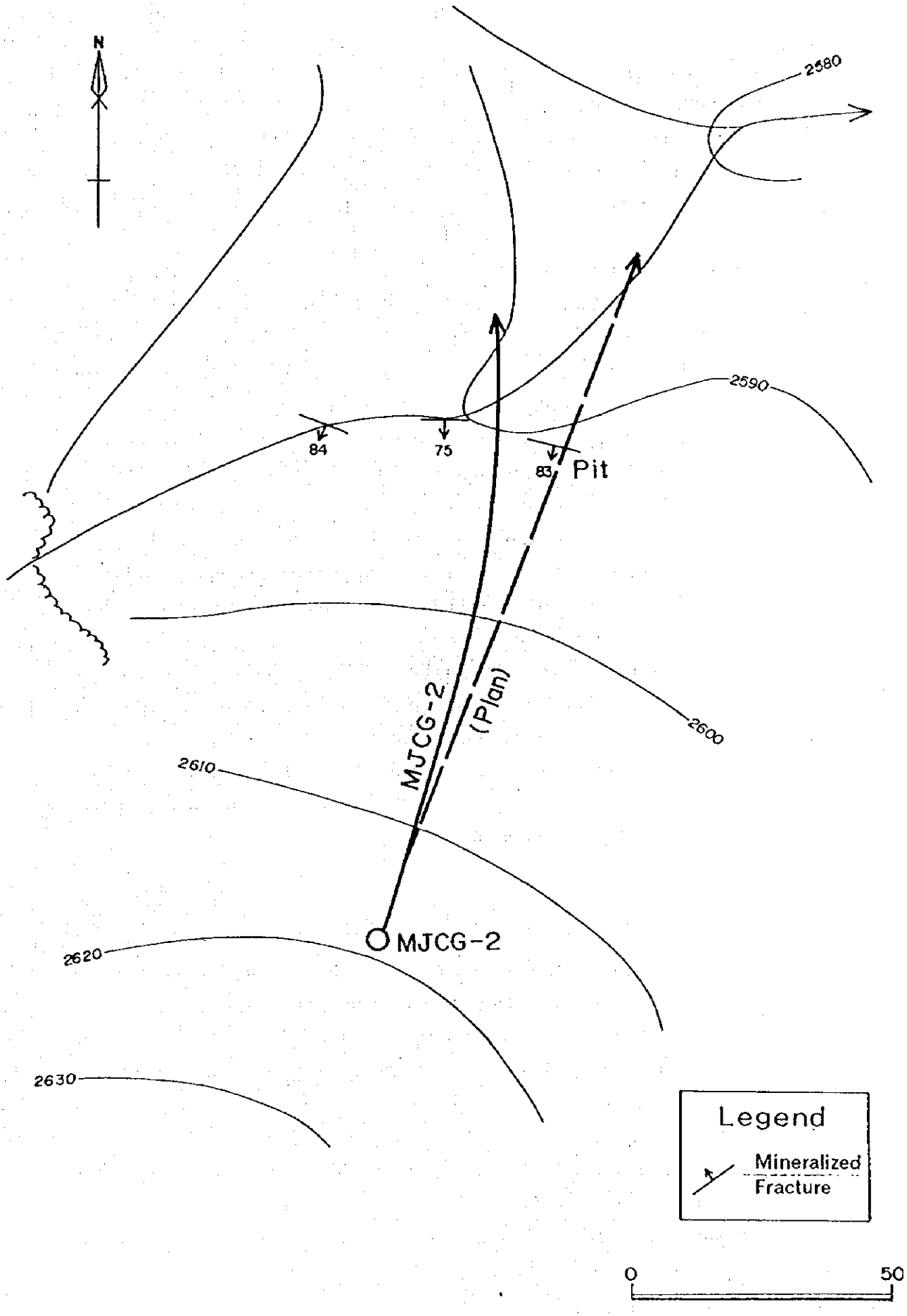

Fig. Ⅱ-5 Result of measurement of Hole deviation and Drilling Lines (MJCG-2)

Chapter 2 Supplement Survey (La Escondida prospect)

2-1 Survey Method

The surface geological reconnaissance of La Escondida prospect was intermittently carried out between November and December. The length of the total routes is approximately 4km.

2-2 Results of Survey

The result of the survey at La Escondida prospect is shown in Figure. Ⅱ-5.

① The geology of this prospect is composed of massive granodiorite which is intruded by quartz porphyry dyke, rhyolite dyke and andesite dyke. There are two structures in the prospect, an older WNW-ESE structure and a newer NNE-SSW structure. Andesite dyke intrudes in the former structure where quartz vein and copper-mineral vein are formed. On the other hand, quartz porphyry and rhyolite dykes intrudes in the latter where faults with sheared zone are developed. Those acidic dykes are thought to be post mineralization dykes.

② Within an area of about 800m(E-W) by 500m(N-S), veins are distributed in this prospect. The mineralized zone of this prospect is larger than an La Rinconada prospect and Central prospect.

③ Judging from the type of mineralization and alteration assemblage, the potential for a deposit, other than vein type, like porphyry copper type is minimum.

2-3 Discussion

Veins of this deposit occurs within relatively older structure (fracture) which trends to WNW~ESE. Some of the veins occur in contact between altered andesite dyke and granodiorite. Therefore, the andesite(dyke) seems to be related to the mineralization and it is suggested that those veins were formed associated with the hydrothermal activity occurred continuously after the intrusion of andesite dyke.

Quartz porphyry dyke which intrudes along the NNE ~ SSW structure (fracture) is thought to be of a post mineralization activity. Since the alteration of this rock is not intense, it may be difficult to

regard the quartz porphyry as an indication of porphyry copper-type deposit.

However, from a global stand point of view, there is still a possibility that andesite dykes shown on surface may be a part of products of a series of igneous activities and hidden porphyry or a complex of igneous rocks may exist underneath.

This prospect was not a target of the Scope of Work in 1996, however, in the future, it is desirable to test the potential for copper deposits by conducting IP geophysical survey (or electromagnetic survey, the electric charged potential method).

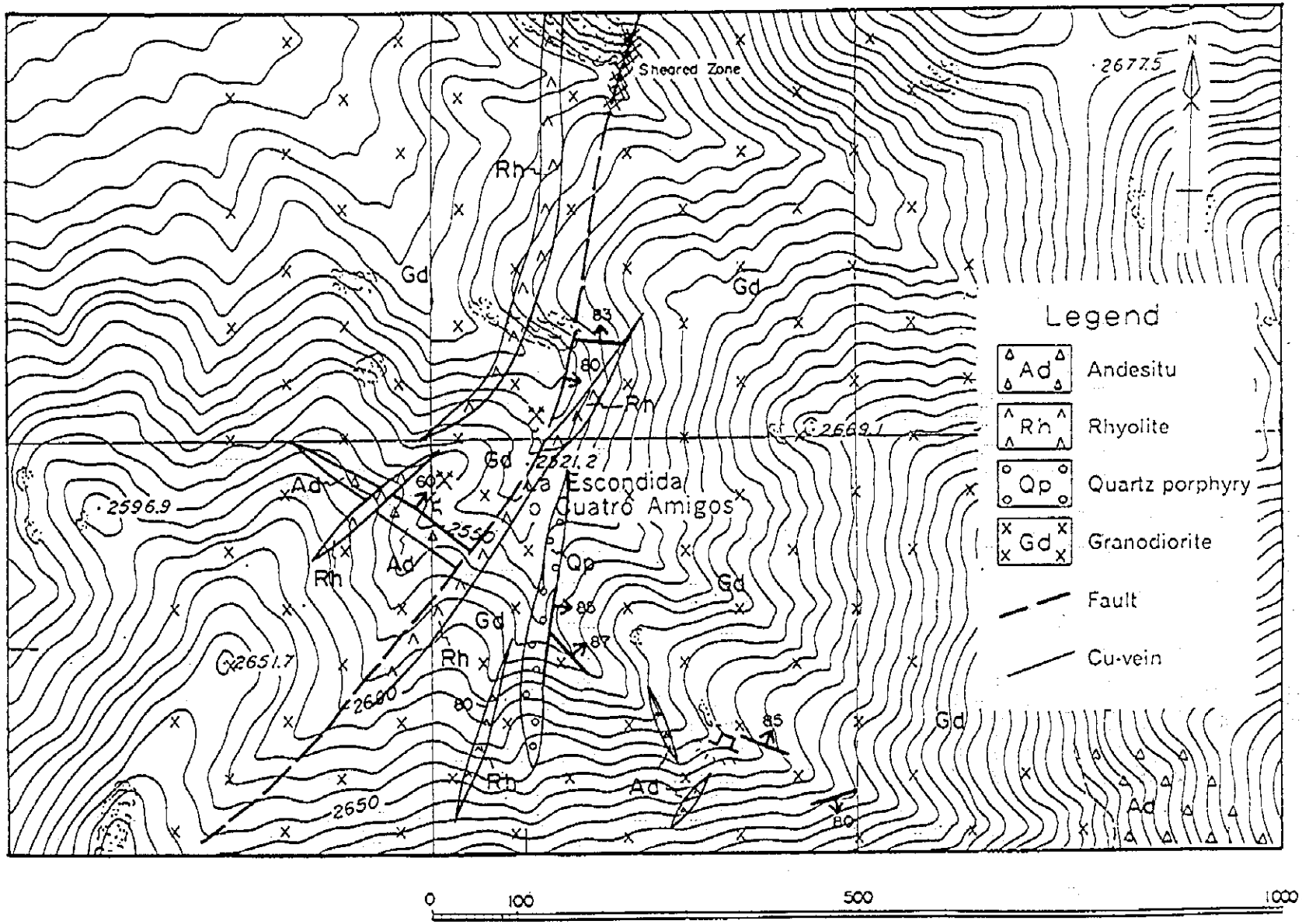

Fig. II-6 Result of La Escondida prospect

PART III Conclusion

Chapter 1 Conclusions

The Survey is in the Phase II step and the objective of the Phase II was to intercept the downward extensions of surface mineralized zones defined and located in the Phase I survey last year with two drill holes (MJCG-1 and MJCG-2) at La Rinconada prospect and Central prospect in Guanaca area. The geological reconnaissance was also carried out in the area of La Escondida prospect nearby.

1-1 MJCG-1 (La Rinconada prospect)

①MJCG-1 drilled in aplitic granite, all down through the hole. Phenocrysts of this rock consist of quartz, K-feldspar, plagioclase, biotite and opaque minerals. Biotite is almost altered to chlorite, and epidote is observed almost all over the cores.

Principal part of mineralization were encountered as follows.

- 133.8 m ~ 134.2 m : intensely silicified zone associated with specularite and malachite etc.
- 242.6 m ~ 242.7 m : disseminated chrysocolla.
- 322.0 m ~ 322.3 m : network of chrysocolla and epidote .

No remarkable mineralized zone was encountered.

② The core is partly silicified, associated with epidote and chlorite.

③ The phillic alteration zone expected in Phase I Survey wasn't discovered. Therefore, potential for porphyry copper-type deposit around and lower part of the prospect is minimum.

1-2 MJCG-2 (Central prospect)

① MJCG-2 drilled in granodiorite with xenolith of gneiss~diorite all down through the hole. Veinlets of several mm in width and disseminated chalcopyrite zones are observed, as follows.

- 93.5m chalcopyrite - pyrite veinlet.
- 146m,chalcopyryte-pyrite(-sphalerite-galena)veinlet
- 169.3-171m, pyrite - chalcopyrite (-sphalerite-galena). disseminated zone - veinlet.
- 183.7m,217.9m,233.1m, and (quartz) - chalcopyrite veinlet.
- 294.05m,295.0m,veinlet of chalcopyrite - chalcocite

② The alteration shown in of this hole is very weak with only small-scale chloritization and silicification near the margins of veinlets. In

conclusion the indication of a porphyry copper-type deposit is not encountered.

1-3 La Escondida prospect

① The geology of this prospect is composed of massive granodiorite which is intruded by quartz porphyry dyke, rhyolite dyke and andesite dyke. There are two structures in the prospect, an older WNW-ESE structure and a newer NNE-SSW structure. Andesite dyke intrudes in the former structure where quartz vein and copper-mineral vein are formed. On the other hand, quartz porphyry and rhyolite dykes intrudes in the latter where faults with sheared zone are developed. Those acidic dykes are thought to be post mineralization dykes.

② Within an area of about 800m(E-W) by 500m(N-S), veins are distributed in this prospect. The mineralized zone of this prospect is larger than an La Rinconada prospect and Central prospect.

③ Judging from the type of mineralization and alteration assemblage, the potential for a deposit, other than vein type, like porphyry copper type is minimum.

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