REPORT
ON
THE INVESTIGATION OF MINERAL POTENTIAL
IN
THE LONQUIMAY AREA AND REGIONS LOS LAGOS AND AYSEN, THE REPUBLIC OF CHILE
AYSEN AREA

CONSOLIDATED REPORT

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JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

国際協力事業団
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PREFACE

The Government of Japan, in response to a request extended by the Government of the Republic of Chile, agreed to conduct a metallic mineral exploration survey in the Aysen Area, Chile, and commissioned its implementation to the Japan International Cooperation Agency. The agency, taking into consideration the importance of the technical nature of the survey work, sought the cooperation of the Metal Mining Agency of Japan to accomplish the task.

The Government of the Republic of Chile appointed the Directorate of Mineral Resources to execute the survey as counterpart to the Japanese Team.

The survey has been conducted from 1989 to 1991, and has been completed on schedule with assistance of agencies of the Government of Chile.

This consolidated report hereby submitted, summarized the results of the said survey.

We wish to express our deep appreciation to the officials concerned of the Government of the Republic of Chile, Ministry of Foreign Affairs, Ministry of International Trade and Industry, and Japanese Embassy in the Republic of Chile for the close cooperation extended to the team.

February, 1992

Kensuke Yanagiya

Kensuke YANAGIYA
President,
Japan International Cooperation Agency

Gen-ichi FUKUHARA
President,
Metal Mining Agency of Japan

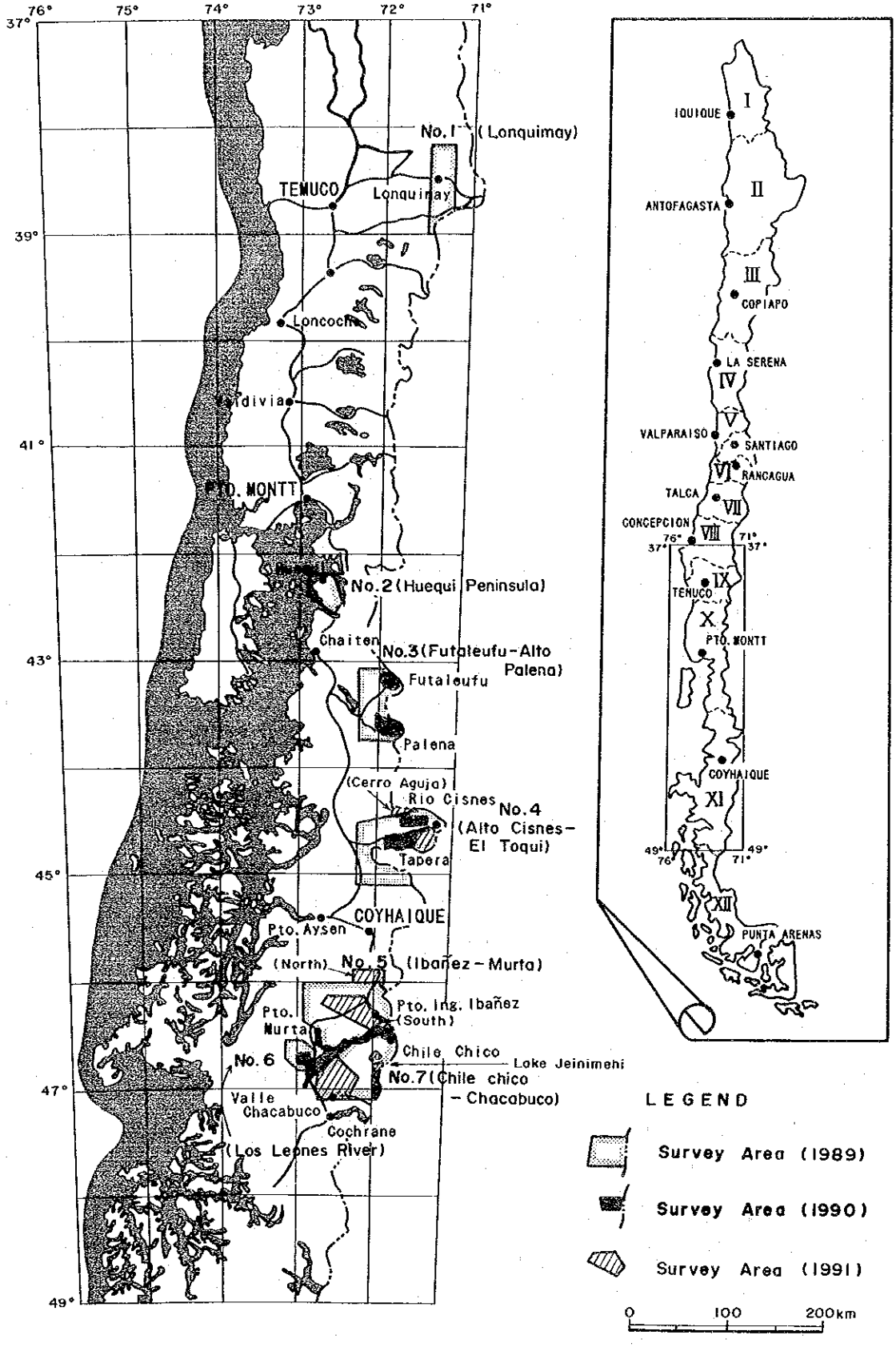


Figure I-1 Location Map of the Survey Areas

SUMMARY

The present survey was conducted in the Aysen Region of the Republic of Chile with the objective of understanding the mineralization/ore deposits through clarifying the geology, mineralization characteristics, structural control of the deposits and other relevant factors.

The survey area is located in the Andes Mountains near the border to Argentine from lat 38°S to 47°S. The elevation of the area ranges from 500 to 2500 m. The following seven areas (17,920 km^2) were selected from the above. These areas are located in Provinces VIII to XI.

- Lonquimay (No.1)
- Huequi Peninsula (No.2)
- Futaleufu-Alto Palena (No.3)
- Alto Cisnes-El Toqui (No.4)
- Ibañez-Murta (No.5)
- Río Los Leones (No.6)
- Chile Chico-Chacabuco (No.7)

During the first year of the project (first phase), the available information and data were compiled, 43 representative mineralized zones were selected by interpretation of Landsat MSS image, and these selected zones were surveyed. The following three types of mineralization were selected as targets. The major criteria for the selection of these types was that they have the possibility of developing into medium or larger ore deposits. For gold deposits, however, small deposits were also studied when the grade was high.

1. Silva type lead-zinc replacement mineralization
2. El Toqui type lead-zinc replacement mineralization
3. Laguna Verde type epithermal gold veins or stockwork mineralization

After the second year, geological and geochemical survey were carried out in areas with high potential of the targeted mineralization. The Laguna Verde Deposit is accompanied by a very widely developed hydrothermal altered zone and interpretation Landsat TM image and extraction of potential altered zones were carried out during the second year in order to locate this type of deposits effectively. A flow chart of the work carried out during the three years is shown in Table 1.

The result of the survey are as follows.

1) Lonquimay Area

This area is underlain by the Jurassic and the Cretacous Systems and the Cenozoic Group as well as intrusive rocks of Cretacous to Early Tertiary in age. The Jurassic and Cretacous Systems consist of marine sediments and andesitic volcanic rocks respectively.

There are small auriferous quartz veins, placer gold concentrations which probably were derived from the above veins, and low grade porphyry copper type mineralization. The quartz vein locally contains several to several tens of grams per ton of gold, but the size is very small. The placer deposit was formed in the glacier deposits along the Bio Bio River, and is been mined locally on a small scale. The deposit is very small. The porphyry copper mineralization is very small and is not noteworthy.

Au, Ag geochemical anomalies have been detected locally, and there is a possibility of the occurrence of gold-silver deposits in the upper stream areas. It is inferred, however, that these deposits would be small veins from the examples of known deposits in the area.

It is concluded, therefore, that the possibility of finding economic metal deposits of larger scale from this area is low. And the area does not warrant further detailed survey/exploration.

2) Huequi Peninsula Area

This area is situated at the western margin of the Patagonia Batholith and the geology is composed mainly of Paleozoic strata, plutonic bodies penetrating the Paleozoic and Tertiary sediments unconformably overlying them. There are ultramafic boulders near the Comau Range in the northern part of the peninsula, and it is inferred that ultramafic rocks are developed near the range.

Also Pt, Cr, Ni, Co, Pd anomalies have been detected by geochemical exploration of the stream sediments near the range and there might be possibilities of rare metal concentration associated with ultramafic bodies. Further accumulation of data is necessary for assessing the potential of these resources. The access of this area, is extremely difficult, thus considerable time and expenses will be necessary to investigate the area.

The major metal mineralization of the Aysen Region, on the other hand, is

concentrated in the eastern part of the Patagonia Batholith and the gold, silver, lead, zinc potential of this area is concluded to be low. Thus further detailed survey for these resources is concluded to be of low priority.

It is recommended that airborne magnetic survey be carried out for rare metal resources and that surface survey be conducted on the delineated targets.

3) Futaleufu-Alto Palena Area

The geology of this area consists the Jurassic,the Cretaceous and the Quaternary Systems as well as intrusive rocks. Two thirds (2/3) of this area is occupied by the Patagonia Batholith and only weak indications of copper, lead, and zinc occur in the periphery of the batholith.

As the mineralization of the Aysen Area is limited to the intruded zone in the eastern part of the Patagonia Batholith, the mineralized zone of this area is considered to be very narrow.

From the above, it is concluded that the mineral potential of this area is low.

4) Alto Cisnes-El Toqui Area

This area is underlain by the Jurassic,the Cretaceous,the Tertiary and the Quaternary Systems as well as intrusive rocks.

There are hydrothermal alteration zones in parts of this area, but promising indications were not found. The Cerro Aguja Alteration Zone is a large acidic altered zone, but only pyrite dissemination and weak concentration of arsenic were found. The zone is interpreted to have been developed by process similar to the formation of the hot-spring-type deposits, but precious or base metals do not seem to have been concentrated.

From the above, further detailed exploration is not warranted in this area.

5) Ibañez-Murta Area

The geology of this area is composed of the Paleozoic metamorphic rocks, the Jurassic, the Cretaceous and the Quaternary Systems as well as intrusive rocks.

Many potential altered zones were extracted from TM images in the northern part of this area and they were surveyed. A large number of quartz stockwork were located in the silicified zones (partly associated with sericite) but economic concentration of metals(maximum Au:0.24 ppm) was not discovered. Also it was concluded that the content would not improve in the deeper parts.

From the above, further detailed exploration is not warranted in this area.

6) Los Leones River Area

This area is underlain by the Paleozoic metamorphic rocks which are covered unconformably by the Jurassic System, and felsic intrusive rocks.

Weak copper (-silver) indications were observed at several localities. There are no other sign of mineralization in this area.

Paleozoic metamorphic units are widely distributed in this area, but limestone is not intercalated and the possibility of Silva type occurrence is very low.

Further exploration is not warranted in this area.

7) Chile Chico-Chacabuco Area

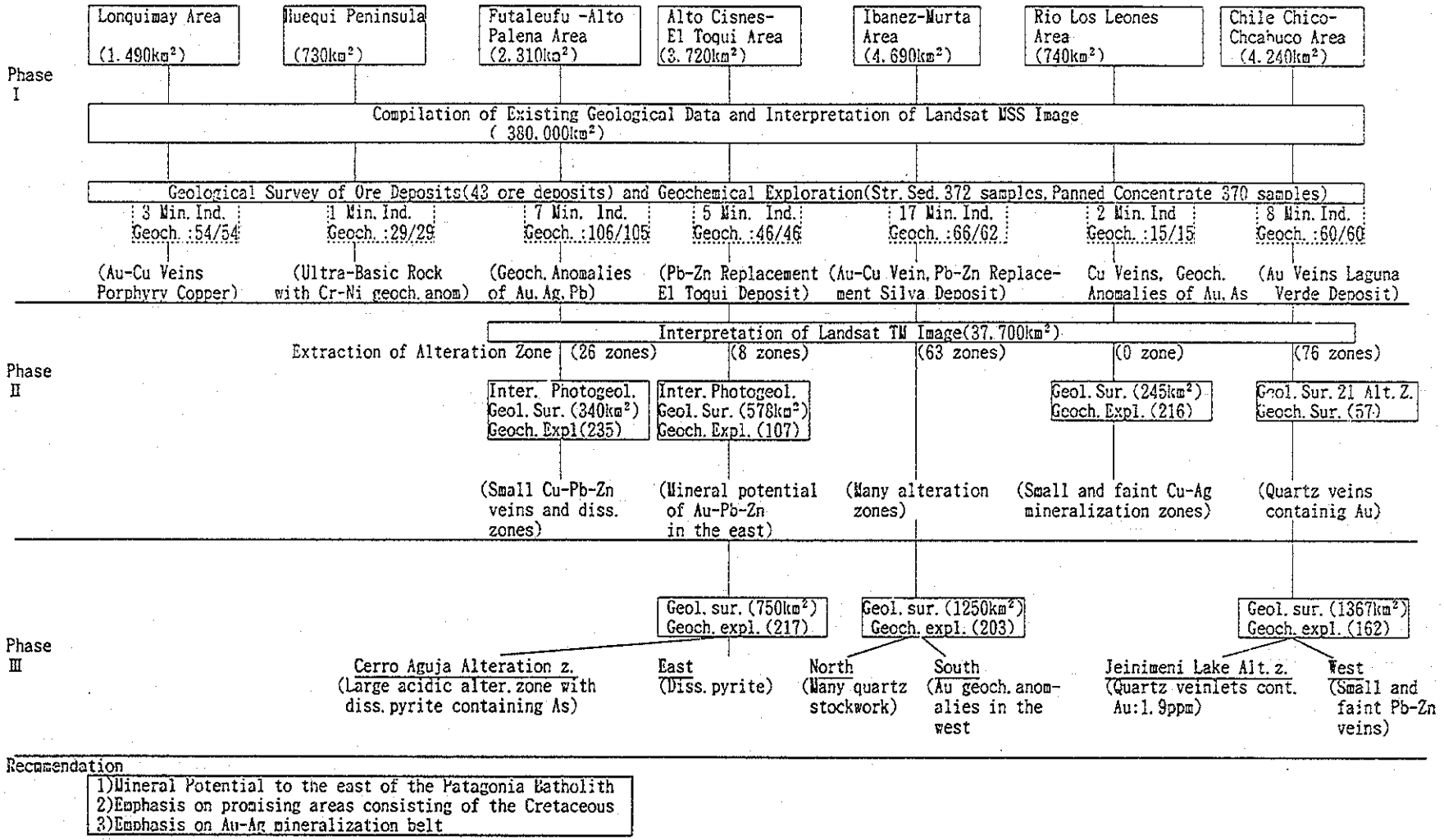
The geology of this area is composed of the Paleozoic metamorphic rocks, the Jurassic and the Cretaceous volcanic products, the Tertiary marine sediments and the Quaternary fluvial deposits as well as intrusive rocks.

There are small copper-lead-zinc veins at several localities in the western part of this area. Notable mineralization was not found. Although the Paleozoic formations are distributed widely, occurrence of limestone is very limited and the potential for Silva type lead-zinc concentration is considered to be very low.

During the second year, surface survey of the results of the TM images were carried out and gold mineralization was confirmed at some of the altered zones (Zones C and D) and detailed geological survey was conducted. Although auriferous quartz veins (Maximum Au: 1.9ppm) were located, their distribution is small and the veins are thin and weak.

Further exploration in this area is considered to be not warranted.

Table 1 Flow Chart of Survey in the Aysen Area



Abbreviation

diss: dissemination, Expl.: Exploration, Geoch.: geochemical, Geol.: geological, Inter.: interpretation, Ind.: indication, Min: Mineralization
Photogeol.: Photogeological, Sur.: survey

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PART I
OVERVIEW

CHAPTER 1. INTRODUCTION

1.1. Objective and survey Areas of the Work

1.1.1. Objective

Mines economically developed in the area are limited to base metal types located in the region around Lake General Carrera, even though so many types of mineral indications are found in the area. However, recent constructions of road system made detailed investigation possible in remote areas and also the potentiality of this area was spotlighted by modern exploration activities done by western companies. These circumstances encourage the selection to this survey area.

The aim of this project is to evaluate potentials of undiscovered ore deposit in Aysen Region, the Republic of Chile, through investigation for geological settings, geologic characteristics of known mineral deposits, features of mineralization, structural control for ore deposits and geochemical characteristics.

Active exploration works have been done by the National Company of Chile and European mining companies. However, no published report is available in the area. Therefore, the work of the first phase was started by collecting basic information concerning to general geology and mineralization and then followed by regional preliminary survey with special emphasis on the geological and geochemical features of present main ore deposits in order to select the target survey areas for the second and third phhases. The investigation later than the second phase was done by concentrating to the selected high potential areas.

1.1.2. Survey areas

The seven areas for the investigation are scattered between 38° S and 47° S in latitude in the Republic of Chile as shown in the following table and Fig.1-1. Areal Extents of these investigated areas are shown in the following table.

Survey Area

Survey area	Dim. (km²)	Survey area	Dim. (km²)
Lonqumay Area(No. 1)	1,490	Ibanez-Murta Area(No. 5)	4,690
Huequi Peninsula Area(No. 2)	730	Los Leones River Area(No. 6)	740
Futaleufu-Alto Palena Area(No. 3)	2,310	Chile Chico-Chacabuco Area(No. 7)	4,240
Alto Cisnes-El Toqui Area(No. 4)	3,720	Total	17,920

The surveyed areas of each phase are shown in the following table.

Survey Area Each Phase

	Phase I	Phase II	Phase III
Lonquimay	○		
Huequi Peninsula	○		
Futaleufu-Alto Palena	○	○	
Alto Cisnes-El Toqui	○	○	○
Ibanez-Murta	○		○
Los Leones River	○	○	
Chile Chico-Chacabuco	○	○	○

The first phase survey

(1) Interpretation of the Landsat MMS images

The interpretation was carried out for the area between 37°28′ and 48° in latitude including the seven areas mentioned above (Fig.Ⅱ-1-1)

(2) Geological and geochemical surveys

Geological survey for main ore deposits and geochemical survey for main streams were conducted within the above seven areas.

The second phase survey

(1) Interpretation of the Landsat TM images

The interpretaion was carried out for the area between 43° and 47°30′ in latitude including the southern part of the Futaleufu-Alto Palena Area.

(2) Photogeological interpretation of aerial photographs

This work covered the Futaleufu-Alto Palena and the Alto Cisnes-El Toqui Areas.

(3) Geological survey and geochemical exploration

The survey areas are shown in the following table.

	Futaleufu Sub-Area	Alto Palena Sub-Area	Alto Cisnes-El Toqui Area	Los Leones River Area	Chile Chico-Chacabuco Area
Nor.	43°06′S. Lat.	43°30′S. Lat.	44°25′S. Lat.	46°42′S. Lat.	46°40′S. Lat.
Sou.	43°13′S. Lat	43°38′S. Lat.	Bouder	46°49′S. Lat.	47°10′S. Lat.
East	71°50′W. Long	Bouder	71°22′W. Long	72°47′W. Long	Bouder
West	72°00′W. Long	72°03′W. Long	71°49′W. Long	73°01′W. Long	72°08′S. Long

The third phase survey

(1) Photogeological interpretation of acrial photographs

This work covered the two areas enclosed by the following coordinates.

a) Ibañez-Murata Area (South; 1,216 km²)

Northern limit 46°06′29″ S. Lat.
Southern limit 46°26′37″ S. Lat.
Eastern limit 71°51′24″ W Long.
Western limit 72°38′40″ W Long.

b) Chile Chico-Chacabuco Area (1,350 km²)

Northern limit 46°38′26″ S. Lat.
Southern limit 47°06′17″ S. Lat.
Eastern limit 72°11′08″ W Long.
Western limit 72°48′44″ W Long.

(2) Geological survey and geochemical exploratiom

Geological survey was carried in the following six areas and geochemical exploration was conducted in four areas except for the Ibañez-Murta Area (North) and Chile Chico-Chacabuco Area (Lake Jeinimeni Alteration Zone). Six areas are enclosed by the following coordinates.

1) Alto Cisnes-El Toqui Area (Cerro Aguja Alteration Zone; 170 km²)

Northern limit 44°23′10″ S. Lat.
Southern limit 44°31′12″ S. Lat.
Eastern limit 71°33′10″ W Long.
Western limit 71°48′30″ W Long.

2) Alto Cisnes-El Toqui Area (580 km²)

Northern limit 44°31′37″ S. Lat.
Southern limit 44°48′23″ S. Lat.
Eastern limit 71°11′24″ W Long.
Western limit 72°32′03″ W Long.

3) Ibañez-Murta Area (North; 270m²)

Northern limit	45°54′39″ S. Lat.
Southern limit	46°02′10″ S. Lat.
Eastern limit	71°50′01″ W Long.
Western limit	72°08′58″ W Long.

4) Ibañez-Murta Area (South; 980km²)

Northern limit	46°06′29″ S. Lat.
Southern limit	46°26′37″ S. Lat.
Eastern limit	71°51′24″ W Long.
Western limit	72°38′40″ W Long.

5) Chile Chico-Chacabuco Area (1,350km²)

Northern limit	46°38′26″ S. Lat.
Southern limit	47°06′17″ S. Lat.
Eastern limit	72°11′08″ W Long.
Western limit	72°48′44″ W Long.

6) Chile Chico-Chacabuco Area (17km²)

Northern limit	46°49′03″ S. Lat.
Southern limit	46°53′16″ S. Lat.
Eastern limit	71°59′07″ W Long.
Western limit	72°04′56″ W Long.

1.2. Survery Methods and Amount of the Work

1.2.1 Survey Methods

Methods employed in each phase are listed as follows.

Survey Methods of 3 Phases

Survey Area	Phase I	Phase II	Phase III
Lonquimay	MSS, Geol, Geoch.		
Peninsula Huequi	MSS, Geol, Geoch.		
Futaleufu-Alto Palena	MSS, Geol, Geoch.	TM, Photo, Geol, Geoch.	
Alto Cisnes-El Toqui	MSS, Geol, Geoch.	TM, Photo, Geol, Geoch.	Geol, Geoch.
Ibanez-Murta	MSS, Geol, Geoch.	TM	Photo, Geol, Geoch.
Rio Los Leones	MSS, Geol, Geoch.	TM, Geol, Geoch.	
Chile Chico-Chacabuco	MSS, Geol, Geoch.	TM, Geol, Geoch.	Photo, Geol, Geoch.

Abbreviation

Geol. : geological survey, Geoch. : geochemical survey, Photo. : photogeological interpretation of aerial photographs, MSS : Satellite Image Analysis by Multi-spectral Scanner, TM : Satellite Image Analysis by Thematic Mapper

1.2.2 Amount of the Work

Numbers of samples analyzed on each phase and area are given in Table I-1-1 to Table I-1-3.

1.3. Duration of the Work and Organization of the Survey Team

An annual duration of the survey is shown as follows and the geological staff who participated in this project are laid out in Table I-1-4.

Duration of the first phase survey

1) Satellite image interpretation: 11 December 1989 - 8 January 1990
2) Compilation of existing geological data: 21 December 1989 - 9 January 1990
3) Geological survey and geochemical exploration: 14 January - 6 March 1990
4) Report preparation: 7 March - 31 May 1990

Duration of the second phase survey

1) Photogeological interpretation of Satellite images and aerial photographs: 25 Augaust - 20 September 1990
2) Geological survey and geochemical exploration: 25 September 13 - 25 February 1990
3) Report Preparation: 14 December 1990 - 25 February 1991

Duration of the third phase survey

1) Photogeological interpretation: 5 August - 5 September 1991
2) Geological survey and geochemical exploration: 22 September 1991 - 3 January 1992
3) Report preparation: 4 January 1992 - 28 February 1992

Table I -1-1 Numbers of Samples Provided for Assaying and Laboratory Work of Phase I

Area	Classification of samples							
	Geochemical Analyses		Ore Assaying	Thin Section	Polished Section	X-Ray Diffraction	Dating	Whole Rock Analysis
	Stream Sediment	Pan Concentrate						
Area No 1 Lonquimay	70	54	23	1	1	2	1	1
Area No 2 Huequi Peninsula	29	29	2	5	0	0	1	3
Area No 3 Futaleufu-Alto Palena	106	105	20	5	13	5	1	13
Area No 4 Alto Cisnes El Toque	46	46	26	9	9	18	3	6
Area No 5 Ibañez-Murta	66	62	135	31	28	49	2	9
Area No 6 Los Leones	15	15	2	4	0	0	2	3
Area No 7 Chile Chico-Chacabuco	60	60	54	13	16	26	0	1
TOTAL	392	371	262	68	67	100	11	36

Table I -1-2 Numbers of Samples Provided for Assaying and Laboratory Work of Phase II

AREA	Pan Concentrate (Au, Ag, Cu, Pb, Zn, Mo, As)	Stream Sediment (Au, Ag, Cu, Pb, Zn, As)		Ore Assay (Au, Ag, Cu, Pb, Zn,)	Whole rock Analysis	Thin Section	Polished Section	X - Ray diffraction	Dating (K-Ar)
		Phase II	Phase I						
Futaleufu-Alto Palena Area Sub-Area Futaleufu	131	-	-	23	8	23	8	6	2
Sub-Area Alto Palena	-	104	-	4	4	16	3	2	1
Los Leones River Area	216	-	-	18	1	19	5	6	2
Chile Chico-Chacabuco Area	57	-	-	51	-	2	4	34	-
Alto Cisnes-El Toqui Area	-	107	-	8	2	14	-	5	-
Re-analysed samples of phase I	-	-	273	-	-	-	-	-	-
TOTAL	404	211	273	104	15	76	20	53	5

※ Stream sediment samples taken at the work of the Phase I were re-analyzed by the Chemex Labs. Canada as well as them listed above.
※※ Pan concentrated geochemical samples taken in this area were assayed for same elements as them for the Ore Assaying.

Table I-1-3 Numbers of Samples Provided for Assaying and Laboratory Work of Phase Ⅲ

Area		Area (km^2)	Traverse length(km)	Panned concentrate (Au, Ag, Cu, Pb, Zn, As)	Stream sed.	Ore Assey (Au, Ag, Cu, Pb, Zn, S)	Whole rock analysis	Thin section	Polish section	X-ray diffraction	Dating (K-Ar)
No. 4	Alto Cisnes-El Toqui Area	580	256	0	150	49	3	13	0	8	3
	Co. Aguja Alteration Zone	170	84	67	0	27	0	4	4	5	0
No. 5	Ibañez-Murta Area (North)	270	185.3	45	0	340	1	5	8	66	1
	Ibañez-Murta Area (South)	980	410	158	0	74	1	34	9	14	1
No. 7	Chile Chico-Chacabuco Area	1,350	242	0	162	23	1	12	7	3	1
	Lake Jeinimeni Alteration Zone	17	21	0	0	73	0	0	0	8	0
Total		3,367	1,198.3	270	312	586	6	68	28	104	6

Table I-1-4 Organization of the Survey Team

Japanese staff

Work	Phase I (1989)	Phase II (1990)	Phase III (1991)
Previos and S/W Mission	Kyoichi Koyama(MMAJ) Toru Motooka(MFA) Hiroyasu Kainuma(JICA) Hideya Metsugi(MMAJ)		
Planification and organization	Yoshio Kawabata(MMAJ) Hideya Metsugi(MMAJ) Nobuyuki Kawamura(MMAJ)		
Interpretation of Landsat	Susumu Takeda(NED)	Yuya Furukawa(NED) Susumu Takeda(NED)	
Photogeological interpretation		Yuya Furukawa(NED) Susumu Takeda(NED) Takashi Yoshie(NED)	Yuya Furukawa(NED) Masataka Oochi(NED) Susumu Takeda(NED)
Geological and geochemical exploration	Yuya Furukawa(NED) Susumu Takeda(NED) Kazuyasu Sugawara(NED) Takashi Yoshie(NED)	Yuya Furukawa(NED) Hideya Kikuchi(NED) Takashi Yoshie(NED) Kenji Sato(NED)	Yuya Furukawa(NED) Masataka Oochi(NED) Susumu Takeda(NED) Takashi Yoshie(NED) Kenji Sato(NED)

Chilian staff

Work	Phase I	Phase II	Phase III
S/W mission	Maria Teresa Canas Pinochet Jose Corvalan Diaz Carlos Portigliati Navarro		
Organi-zation	Jose Corvalan Diaz	Juan Carlos Parra Espinoza	Juan Carlos Parra Espinoza
Geological and geoch-chemical survey	Carlos Portigliati Navarro Orlando Rivera Sonia Vogel Briceno Lucia Cuitino	Carlos Portigliati Navarro Sonia Vogel Briceno	Carlos Portig-liati Navarro Sonia Vogel Bri-ceno

CHAPTER 2. PAST WORKS

The geological survey covering the whole project area was conducted by SERNAGEOMIN in 1982 and geological maps at a scale of 1:1,000,000 are available for this survey. These maps were used for compilation work with several geological maps at scales ranging from 1:1,000,000 to 1:50,000. Major previous works are as follows.

Lonquimay Area

Many geological and geochemical surveys were conducted in this area. SERNAGEOMIN is doing geological compilation work (named Advance Geologico Hoja Curacaution by SERNAGEOMIN, and is in preparation) at ascale of 1:250,000 including verification survey since several years ago. For Galletue mineralization zones located in the central part of the survey area, geological survey, geochemical and geophysical (IP method) prospecting and exploration drillings were conducted by JICA-MMAJ in 1978 and 1979.

Huequi Peninsula Area

Very few works were conducted for this area. Geological map covering whole area is only Geological Map of Chile(1:1,000,000) mentioned above. Preliminary geochemical exploration was carried out in the northern edge of the peninsula. Aero magnetic survey was done on the marine area by ENAP in 1962. The coverage area on land is very limited to just the northern edge of the peninsula.

Futaieufu-Alto Palena Area

The work of Thiele et al(1978) covers whole of the area. Scale of the map is 1:500,000. A preliminary geochemical survey and ground magnetic survey covered a small area in the vicinity Futaleufu Town.

Alto Cisnes-El Toqui Area

The following works covered whole of the area: geological maps made by CORFO(1982), SERNAGEOMIN(1983) and SERNAGEOMIN(1984). The first two maps are at a scale of 1:250,000 and the rest is at 1:500,000. Those works were completed by using Landsat images. Very few geochemical works were completed in this area. Only SERNAGEOMIN (1984?) made geochemical exploration just along the main road lying out of the area. Some mines are in operation at the moment, such as the El Toqui Mine. Geologist of the mines are exploring on their areas by themselves, but those data are not available.

Ibañez-Murta Area

Geological surveys covering whole of the area are carried out by SERNAGEOMIN (1982) and geological maps were prepared at scale of 1:250,000 (1982) and of 1:500,000 (1984). As far as an area around Lake General Carrera concerned, geological survey was conducted by MMAJ (1978 and 1979) and geological maps were prepared at a scale of 1:100,000. This area is characterized by concentration of known are deposits. MMAJ also completed the geological survey at scale of 1:10,000 in the Silva Mine and the Pelado Mine areas together with geophysical survey(IP method) and trenching work. Whereas only few surveys were made on the area between the Avellanos and Ibañez Rivers. Geochemical exploration was conducted by only SERNAGEOMIN along main loads around 1984.

Los Leones River Area

Geological survey covering whole of the area is the same as that in Ibañez-Murta Area. Almost no other geological works have been done. Geochemical survey was conducted by only SERNAGEOMIN along main loads lying from Ibañez-Murta Area around 1984.

Chile Chico-Chacabuco Area

This area is located on the south of the Ibañez-Murta Area. Works completed in this area are of same kind and same amount as those in the Ibañez-Murta Area. Gold mineralization was discovered in the Laguna Verde Deposit that is situated in the northern part of the area. This new discovery activated the exploration works of private companies.

CHAPTER 3. GENERAL GEOLOGY

The project area lies on the Andes orogenic belt formed along the western margin of sub-stable landmass, western part of the Brazilian shield.

The area is underlain by the basement of Paleozoic metamporphic complex, Jurassic System, Cretaceous System, Tertiary System, Quarternary System and granitic rocks(Patagonia Batholith) intruded during the time from Jurassic to Tertiary time. Basement rocks in the north from latitude 47°S are distributed mainly in the western side of the area and they consist of metamorphic rocks such as greenschist, phyllite, quartz schist, mica schist, metasandstone, marl and calcareous schist. Those rocks are intensely deformed. Geologic age of sedimentary rocks is reported to be of the Devonian to Carboniferous in Aysen foreland mountains (Precordillera de Aysen) by Skarmeta et al.,(1984).

The Jurassic System is distributed on the east of the Patagonia Batholith elongating with the N-S direction. Jurassic rocks consist mainly of intermediate or felsic volcanic rocks and their pyroclastic rocks. Skarmeta et al., (1984) reported that those sedimentary rocks are of Dogger to Malm Series.

The Cretaceous System is distributed to the east of the Patagonia Batholith. The Lower Cretaceous is composed mainly of sedimentary rocks of marine origin, intermediate to felsic volcanic rocks and their pyroclastic rocks in ascending order. The Upper Cretaceous consists mainly of volcanic rocks and continental sediments.

The Tertiary System lies on both sides of the Patagonia Batholith. It is composed of sedimentary rocks of marine origin, continental sediments and volcanic rocks.

Extensive andesitic and basaltic volcanism took place during end of Tertiary to early Quarternary mainly in the area of the Patagonia Batholith. A part of that volcanism still active the present.

Batholith of Mesozoic to Cenozoic (Andes Batholith) intruded along the western coast line throughout the South America from Cape Horn to Colombia. A part of the Batholith from 39°S of latitude southward are called the Patagonia Batholith which is distributed in the investigated area. Granitic intrusions of stock-shape are distributed in especially the eastern marginal zone of the

batholith. Period of intrusion is estimated to be Middle Jurassic to Oligocene based on many dating studies. Many rock types, granite to dunite are recognized in the batholith and chemical composition show basic on the west and acidic on the east(Skarmeta et al.,1984).

The basement rocks of Pre-Mesozoic age are intensely deformerd and contain tholeiitic metabasite. It is assumed from those that the basement is a mélange formed in the subduction zone(Skarmeta et al.,1984). Extensive volcanism caused by subduction was still maintained also during Mesozoic time in the western margin of the continent (Skarmeta et al.,1984). This activity is assumed to have begun in the middle or late Jurassic period. This igneous activity continued even in Cenozoic period and is partly still active at the present.

Regional geologic strucure is prevailed by N-S system for either fracture systems or fold structures. Those directions are constant since Paleozoic time to the Recent. Fold structure formed during Paleozoic time shows composite folds accompanied with drag folds and their axes trend in the N-S direction. Fold structures developed in Mesozoic rocks are very gentle. No fold structures are not recognized in the Cenozoic rocks. That is, the structural movements of Paleozoic and Mesozoic time are characterized by lateral movement, while those of Cenozoic are vertical movement.

CHAPTER 4. GEOGRAPHY

4.1. Location and Access

Lonquimay Area

Lonquimay is the largest town in the area, lies approximately on the eastern rim of the central part of the IX Region and about 600 km south of Santiago. The shortest trip from Santiago is to fly to Victoria by airplane and then reach to the area by vehicle.

Lonquimay Town is a center of the timber industry and therefore the road network is well developed.

Huequi Peninsula Area

The area is located in approximately 100km south-southwest of Puerto Montt, the capital city of the X Region. The only one road lies through the base of the peninsula from Puerto Montt. Any commercial transportation system is not available to reach to the apex of the peninsula, except for a voyage from Puerto Montt with hireling a vessel, which is the only way to reach the area. It takes about eight hours.

Development of the road network is very poor. Only some short roads run around the small villages in the apex of the peninsula.

Futaleufu-Alto Palena Area

The area is located in the southeastern part of the X Region. The area has two relatively large towns; Futaleufu and Palena. Direct distances to towns from Puerto Montt are about 200 km and 300 km respectively. Both towns have commercial airport and commercial regular air flights by small aircrafts are available from Chaiten situated in about 170 km south of Puerto Montt. An irregular commercial air flights by small aircrafts from Puerto Montt are available as well. Although the area is also accessible by vehicle from Puerto Montt, it takes at least two days because the road is disconnected in three places between Puert Montt and Chaiten and vehicles can be transported by the regular car ferry vessels in the disconnected parts. The main roads which lie through the both towns to the Argentine are on a good condition. Other ones diverging from main roads, however, do not develop well.

Alto Cisnes-El Toqui Area

The area is located in the northern part of the XI Region. The survey

area is composed of two subareas. The Alto Cisnes subarea is located in the north and the El Toqui subarea in the south, where are divided by Lake Fontana in Argentina. The Alto Cisnes subarea is in about 100 km north in direct distance and the El Toqui subarea in 60 km north both from Coyhaique, the capital city of the XI Region.

The main road traversing through the Alto Cisnes subarea to Argentina is kept on good condition. The El Toqui subarea has good conditioned roads as well because large mines such as the El Toqui Mine are in operation.

Ibañez-Murta Area, Rio Los Leones Area and Chile Chico-Chacabuco Area

These three areas are described here because these are located contiguously.

These areas surround a great lake, Lake General Carrera where is located in about 170 km south in direct distance from Coyhaique. There is no road surrounding completely the lake so that it is fairly hard to move within the group of areas.

There is the main road called Carretera Austral in the western part of the Ibañez-Murta Area and the road is very useful to reach the area by vehicle. In the eastern area, the road extend from Coyhaique to Ibañez, but a voyage from Puerto Murta to Pueruto Ibañez is the only way to the area. The main road passing through Puerto Murta extends to the Chile Chico-Chacabuco area and vehicle is able to reach directly from Coyhaique to either the Los Leones River Area or the southern part of the Chile Chico-Chacabuco Area.

There are two ways to reach the northern part of the Chile Chico-Chacabuco area. One way is to use a car-ferry from Puerto Ibañez to Chile Chico and the other way is to use the road reaching Pueruto Murta branches out from the main road extending south for Puerto Guadal. However, only one car ferry boat is available to the central part of the south bank of the lake.

4.2. Topography and Drainage Systems

Most of the survey area is in the mountainous region at the altitude of 1,000 to 2,500 m extending along the Andes Mountains nearby the border with Argentine. The topography in the region is characterized by the steep mountains. Especially the development of glacier and glacial lake is prominent except for the Lonquimay and the Huequi Peninsula Areas. Glacial

lakes are arranging north to south with the orientation of E-W or NEE-SWW. Whereas fijords are developed in the coast region which together with the rugged topography prevented from the constructions of the road network in the southern region. Drainage system is characterized by dendric pattern of the rivers. The rivers derived from the Andes Mountains are turned off by hard granitic rocks which occupy large areas.

The Lonquimay Area belongs to the temperate district characterized by a moderate climate. Other areas belong to cold climate district and is characterized by much precipitation throughout the year and is affected by westerlies. A part of the mountains higher than 1,500 m has generally no vegetations. Mainly coniferous forests are developed at the elevation below thatlevel. Lowlandss are covered by grass and used as pastoral area.

The following is the geographical description of villages and industries of the area.

Lonquimay Area

The Lonquimay, the largest town in the area is a center of the forestry industry. The tourist business is fairly flourishing here except for forestry. The placer mining of gold had been fairly flourishing in the Bio Bio River, but the operation has went out. Only one New Zealander mining company is still carring out exploration work.

Huequi Peninsula Area

There are only two small fishers villages at the northwest and west of the peninsula.

Futaleufu-Alto Palena Area

Futaleufu and Palena are large towns in the area. Both of them are flourishing as traffic centers. Cattle breeding is the main industry of the area and small scale tourist business are flourishing near Lake Los Espolon etc.

Alto Cisnes-El Toqui Area

The El Toqui Mine is in operation in the area and Manihaule is flourishing as residence area of labors. There are some other villages called Rio Cisnes and Tapera.

Ibañez-Murta Area, Rio Los Leones Area and Chile Chico-Chacabuco Area

Almost all villages are located at the sourroundings of Lake General Carrera. Major villages are Chile Chico, Puerto Ibañez, Pueruto Sanchez and Puerto Guadal. Chile Chico, the largest village in these areas has a population of 2,000. The twon is located near the Chile-Argentine border and the business with the country is active.

CHAPTER 5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

(1) Lonquimay Area

Mineralization of this area is characterized by gold and copper. Two types of gold mineralization are found in this area; that is, vein or stockwork vein deposit and placer gold deposit. The former occurs in intrusive rocks or Cretaceous rocks. Some veins have grade of several grams per ton to some ten grams per ton of gold in a part of them, while their sizes are very small. The latter is placer deposit accumulated in glacier sediments of the Bio Bio River. This deposit is locally being mined on a small scale, but scale of the deposit is very small.

Further exploration works seem to obtain no more large ore reserves of the both types of deposits.

Mineralization zone of the Porphyry copper type, according to existing data, are found in the southern coast area of Lake Galletue. Very disappointing results for this zone were obtained by exploration works including geochemistry and drilling which led to a conclusion that no more further work strike significant intersection(JICA-MMAJ,1979).

Gold and silver stream sediment geochemical anomalies were found densely in the area between the Mt.Maravilla and the Bio Bio River lying northern part of the suvey area.

(2)Huequi Peninsula Area

This area is situated at the western margin of the Patagonia Batholith. Geology of the area consists of Paleozoic System, plutonic rocks which penetrate the system and Tertiary sedimentary rocks which covers above mentioned rocks unconformably.

In this survey some floats of ultramafic rocks were found at northern part of the Comau mountain range located in Huequi Peninsula and the presence of those floats suggests the distribution of such ultramafic rock.

Anomalies of Pt,Cr,Ni,Co,Pd were detected by stream sediment geochemistry in an area where the floats were found and this suggests that rare metal deposits associated with ultramafic rock occur. Nevertheless many unknown data still remain on the factors such as distribution and extent of ultramafic rocks.

Although geochemical anomalies of Au, Ag, Pb and Zn were sporadically detected in some points, the prospectivity of these ore deposits is geologically small.

(3) Futaleufu-Alto Palena Area

This area lies on the eastern margin of the Patasgonia Batholith, and two third of the area is ccvered by the batholith. The intrusive rocks are distributed only in the vicinity of the Chile-Argentine border. Taking the concept that mineral deposits in the Aysen Region occur only in those intruded Jurassic formation, the area of mineral potential will be limited in small areas.

The mineralization zones and mineral indications are distributed at the surroundings of the Patagonia Batholith. This distribution pattern and combination of associated alteration minerals (chlorite, epidote and actinolite) suggest that those minerals have been formed by the mesothermal alteration occurred during the intrusion of the Batholith. The deposits are embedde in joints of host rocks or small scale faults. Therefore, the continuity is poor and their scale is small.

From the regional point of view, this area is considered to be closest to the Mo-Cu belt and to be located outside of the Pb-Zn and Au-Ag belts. Therefore, the mineralization of Au, Ag, Zn Pb etc is recognized in the area but their intensities are weak. Moreover, the lack of limestone suggests the difficulty of finding large scale lead-zinc deposits such as the Silva and El Toqui Deposits. The copper mineralization zones developed here are in poor continuity and of a small scale. The prospectivity of molybdenum deposit in the batholith area is considered to be small if any, because of regional geological point of view.

Geochemical exploration suggests the presence of Au-Ag mineralization near Mt.Teta, however, present geological survey and existing data did not find any significant mineralization zones or mineral indications. This will means that their sizes will be small, if any.

The deposit corresponding to geochemical anomalies of Au, Ag and Mo is expected to be of a small scale, if any. The prospectivity of copper deposit is very small because no indication was found in geological survey and few geochemical anomalies were detected.

(4) Alto Cisnes-El Toqui Area

The following conclusions are reached based on the survey in the areas between the south of Alto Cisnes River and the Chile-Argentine border, and Cerro Aguja Alteration Zone.

1) There is a small potential of copper, zinc and lead vein type deposits in the upper reaches of the Moro River, but is no chance to find large scale deposit.

2) El Toqui type deposits are not expected to occur in the area, because almost no distribution of calcareous rocks was confirmed.

3) Promising concentration of Au, Ag and base metal at the lower part of the Cerro Aguja alteration Zone is not expected to be found.

4) The alteration zone located in northeastern part is characterized only by pyritization, therefore, potentiality of other mineralization is extremely low in the part.

5) There is some possibility of vein type Mo deposits occurring within or in the periphery of the Patagonia Batholith, but they must be of a small scale.

6) No other geochemical anomaly was found except for anomaly of Au detected in the Moro River basen.

(5) Ibañez-Murta Area

1)The molybdenum deposits, which developed in plutonic rocks including the Patagonia Batholith and its surroundings, are so small to be worth notice.

2) The copper deposits of mesothermal type, are expected to occur near the Patagonia Batholith, but they will be small and their mineralization is generally weak.

3) Prospective area still remain on the lead-zinc deposit which occurs in the limestone of the Coyhaique Formation as unexplore area. However, its potential is not so high, because the distribution of intrusive rocks are very limited.

4) The chance to find gold-silver deposits still remain slightly to the east of Puerto Ibañez and area between the Long River and the Avellano Rivers(outside the surveyed area). However, it is concluded that the possibility to find a deposit such size as the Laguna Verde Deposit is low, and that it will be of small vein type deposit, if any.

5) The "a" type mineralization groups are located in the northern part of the Ibañez-Murta Area and they are situated the depositional condition of gold. However, mineralization of gold was not recognized there. Therefore,

the upgrading of gold at the lower part of the mineralization groups is not anticipated. The upgrading of lead-zinc is expected at the lower part of the groups, but it will be far from commercial level of concentration.

The "b" type mineralization groups do not warrant further exploration.

(6) Los Leones River Area

This area is underlain by the Patagonia Batholith on western part and Paleozoic unit on eastern part of the area. Au and As geochemical anomalies were obtained densely in the basins of the Los Leones River and the Cañal River. Whereas, no mineral potential was found.

(7) Chile Chico-Chacabuco Area

Although the crystalline schist, of the basements is widely distributed in this area, only one horizon of calcareous schist was found in this area. Therefore, there is no mineral potential of Silver type lead-zinc deposit. The copper-lead-zinc vein type deposit hosted in the basements will be possibly found but the scale will be small. The copper-lead-zinc vein type deposits hosted in the Ibañez and Divisadero Formations will be expected in this area but their size will be small. The middile of this area is covered by thick Tertiary marine sediments deposited after the mineralization. Therefore, it will be very difficult to find economical size of deposit below the sediments.

The Lake Jeinimeni Alteration Zone (Alteration Group C and D) is of epithermal type, and fairt gold mineralization(1-2g/t) and very weak faint lead mineralization along the quart veins were observed locally. However, quartz veins are sparsely distributed and their distribution area is small (200*200m). Alteration Group D is composed of the silicification zone with dissemination of pyrite. Neither quartz vein nor significant grades of useful metals were found in this group. Therefore, it is very difficult to expect the upgrading of gold at the lower part of this mineralization zone. Other mineralization zones are much more faint than Alteration Group C and D and mineral potential is low. This comment is not included in the prospects of private mining company.

5.2. Recommendations

(1) Lonquimay Area

It is concluded that the necessity of further exploration works in small.

(2) Huequi Peninsula Area

It is recommended that basic geological information should be collected at first. Existence of ultramafic rock has been identified by this survey so that its distribution and areal extent must be defined. However, the area is covered by dense primeval forest like as tropical jungle and no road is available even for a carriage. Therefore, long term will be required for the surface survey.

Air-born magnetic survey is believed to be the most effective method for that purpose. Therefore, it is recommended that delineation of distribution of ultramafic rocks by aeromagnetic survey will be followed by surface geological and geochemical survey.

(3) Futaleufu-Alto Palena Area

The mineral potential of commercial deposits of gold, silver and base metals is considered to be low. Therefore, no further exploration is needed in the area.

(4) Alto Cisnes-El Toqui Area

It is concluded that the necessity of further detailed exploration in the northern part of the area is small.

(5) Ibañez-Murta Area

This study leads to the conclusion that the necessity of further exploration works is small in this area.

(6) Los Leones River Area

It is concluded that there is small potentiality of existence of middle to large scale ore depost which is composed of gold, silver and base metals in this area. Therefore, further exploration works are not recommended for this area.

(7) Chile Chico-Chacabuco Area

It is concluded that mineral the potential in the western part of the area is low and further detailed exploration work is not recommended.

The mineralization zones discovered in Lake Jeinimeni Alteration Zone located at the eastern part of the area and the Alteration Zone A to I are faint. Therefore, it is considered that chance of upgrading is low, and that no further exploration work is not recommended.

PART II
DETAILED DISCUSSIONS

PART II DETAILED DISCUSSIONS

CHAPTER 1. INTERPRETATION OF LANDSAT IMAGES

1.1. Interpretation of Landsat MSS Images

The main aim of this work is to reveal the general geology and geologic structures.

1.1.1 Procedure of interpretation

The image data used for this analysis are 17 CCT (Computer Compatible Tape) scenes which were acquired by Multispectral Scanner (MSS) on Landsat 5. The areal coverage of images is shown in Fig.Ⅱ-1-1.

The abouve CCT scenes were processed and made to false color composite mages, combined 4,5 and 7 bands. These false color composite images were read and interpreted on geology and geologic structures, based on photogeological diagnostic criteria.

1.1.2 Results of interpretaion

(1) Geological unit

Eleven geological units, A to K, were delineated from these images. The photo-characteristics and geomorphological features of each geological units are shown in Table Ⅱ-1 and the interpretation map is given in PLATE 1. The intruded rocks are divided 11 units. In these 11 geological units, oldest unit is unit A that is interpreted chiefly as metamorphic rocks. This unit is distributed in the southern part of the region and also in the part on the side of the Pacific Ocean extending from the central to the northern part of the region.

The Unit D and J are composed of sedimentary rocks. According to the published data, the former unit corresponds to Cretaceous marine deposits, and the latter corresponds to river sediments, talus deposits, terrace deposits and glacial deposits. The unit D is distributed in the northern part of Argentine and southern part around the border with Argentine. The unit J is widely distributed along the Central Basin and in the side of Argentine, south-eastern part of the area.

The other intruded rocks are divided to 7 units. These are interpreted to be mainly composed of volcanic rocks. According to existing data, unit B corresponds to the Jurasic and unit C to the Cretaceos. Both units are

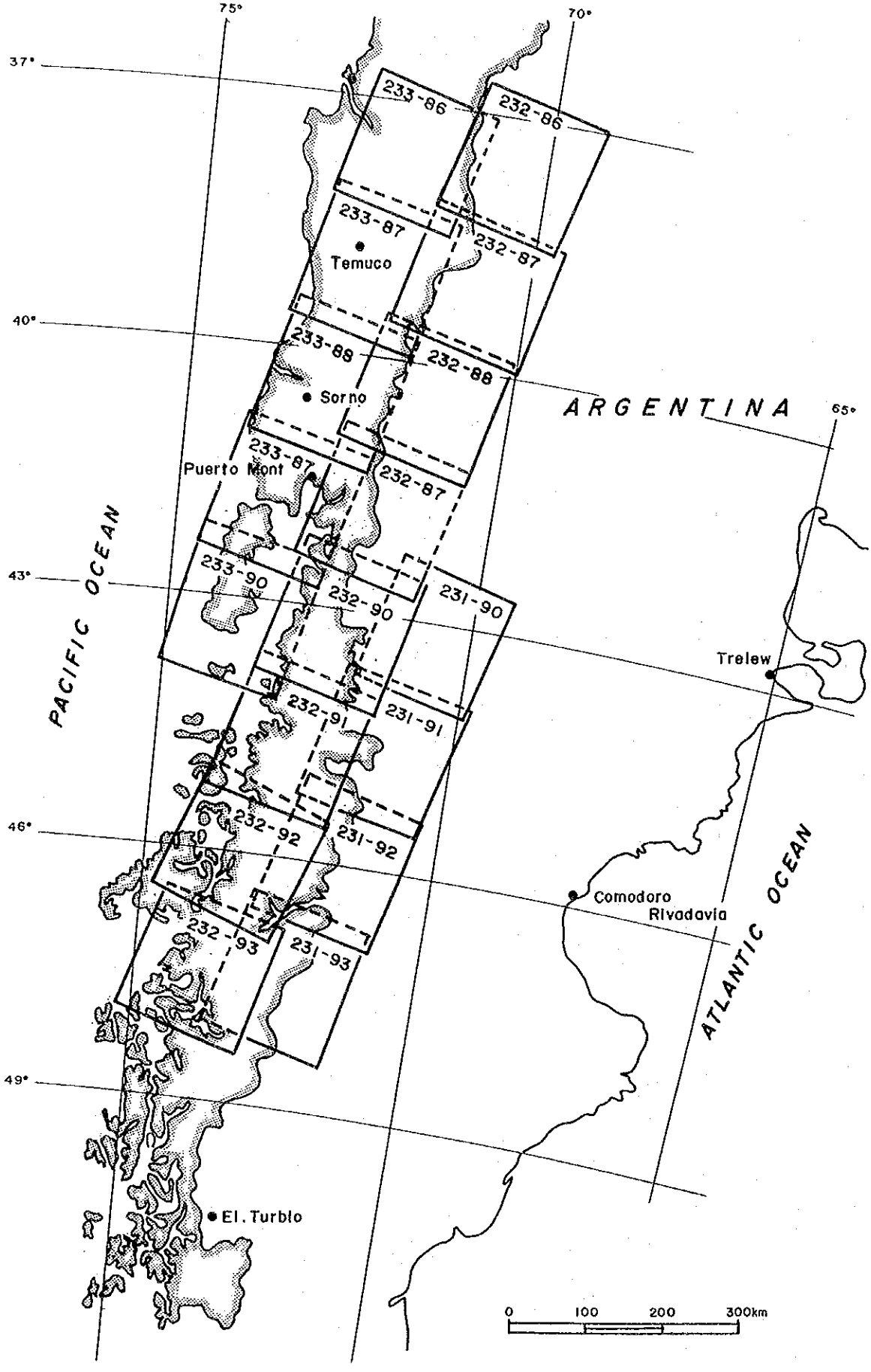
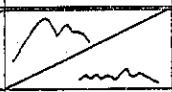
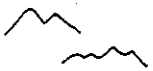


Fig. II-1-1 Location Map of Landsat

Table Ⅱ-1 Photogeological Interpretation Chart

Unit	Photo-Characteristics		Morphological Expression					Cover	Conclusion	
			Drainage		Rock Properties					
	Tone	Texture	Pattern	Density	Resistance	Cross Section	Bedding	Vegetation	Probable Lithology	Existing Geological data
A	light blue ~ blue	coarse	dendritic	high medium	high low		well bedded	very dense	metamorphic rocks	metamorphic rocks (Paleozoic)
B	red partly whitish gray	fine	dendritic	medium	medium		well bedded	dense~sparse	volcanic rocks sedimentary rocks	volcanic rocks (Jurassic)
C	light blue ~ blue	coarse	dendritic	low	low		partly bedded	dense	volcanic rocks	volcanic rocks. sedimentary rocks (Cretaceous)
D	light blue	fine	dendritic parallel	low	medium~low		very well bedded	dense	sedimentary rocks	sedimentary rocks (Cretaceous)
G	light yellow	fine	dendritic parallel	medium	high		massive	moderate	volcanic rocks	volcanic rocks (Pliocene)
H	dark brown	fine	parallel	very low	medium		very massive	moderate	volcanic rocks	basic volcanic rocks (Quaternary, Terciary)
J	yellowish brown	fine	dendritic meandring	low	very low		none	dense	sediments	alluviam, talus terrace (Quaternary)
K	blue, yellowish gray~gray	coarse	dendritic	high	very high		massive	very dense	intrusive rocks	granitic rocks

distributed in the northen part and in the part extending from the central to the southern part of the region with covering partly Argentine.

The Unit E,F,G and H correspond to the volcanic rocks from the middle and late Tertialy to early Quaternary. These units are distributed broadly from the part near the border with Argentine to the western part of Argentine extending from the north southward.

The Unit I corresponds to the recent volcanic rocks and distributed in the central part of the region arranging from the north southward.

The Unit K consists probably of intrusive rocks and corresponds to granite batholith of existing data. This unit is distributed broadly elongating from the northern to the southern parts of the region.

(2) Geologic Structure

1) Lineaments

One thousand two hundered and twelve lineaments were extracted through the interpretation. Looking over all directions of the lineaments, 66% of them are concentrated between N35°E and N35°W with a peak at N-S direction. Thus, it is recognized that lineaments tend to extend firstly with the N-S direction and secondly with the oblique direction between N35°E and N35°W to the N-S systems. But in the southern part from Coyhaique, the lineaments are prominent in the direction of NW-SE system.

The histogram of length stepping 5km indicates that the lineaments of 5 km and less are the most prevailing in the numbers (47% in all) and the lineaments of 5 to 10 km are secondly prevailing (35%). 82% of all lineaments, in total, are included in the both groupes, while several lineaments are of length of 50 km and more.

The lineament-density map shows that a high density area lies on mountainous area along the border with Argentine.

2) Fold structure

The fold structures are detected from unit B to unit G. In these units, the fold structures are clearly and dominantly developed in the unit D.

The metamorphic rocks corresponding to unit A are supposed to be strongly folded, but folded structures are not able to be interpreted in false color

composite images. The fold axes generally trend north-south, while the axes trend east-west in the area from Coyhaique to Chile Chico. Partial structure changes are recognized in these area, by lineaments trending NW-SE system. This structure changes suggest that there would be basement structure elongated in the NW-SE direction in the Argentine side near this area.

1.2. Interpretation of Landsat TM Image

This work was carried out in the main objects to extract alteration zones.

1.2.1. Procedure of interpretation

The images used in the interpretation are four CCT (Computer Compatible Tape) scenes which were acquired by Thematic Mapper (TM) on Landsat 5. The specific data of each scene is shown in Table 1. The coverage map of each scene is ginven shown in Fig.Ⅱ-1-2.

TM data, compared to those of MSS, have higher resolution, larger numbers of the bands and wider range of wavelength for observation. In producing false colour images, three bands, most suitable to extract the alteration zone, were selected from seven bands. Combining these three bands, false color composite images were produced.

Prior to the band selection, some experimental work was carried out determining the combinations most distinctively to be extracting the mineralized alteration zones, in well known alteration zone (in this case, the supervisor for identification was the alteration zone hosting the Laguna Verde gold deposit), and refering to the joint research work of MMAJ-ERSDAC (Earth Resources Satellite Data Analysis Center) which has been studied since 1982.

This study concluded that the bands 4-5-7 composite image is most useful for the extraction of alteration zones. As a result, this work employed the band conbination of 4-5-7 assigning colours to bands as follows; blue for band 4, green for band 5 and red for band 7. Examples of false colour composite images are shown in Fig.Ⅱ-1-3 to Fig.Ⅱ-1-5.

The Laguna Verde Deposit is an epithermal gold deposit located in the southern coast of Lake Generral Carrera. Dacitic rocks hosting the deposit are extensively affected by intensive silicification and weak kaolinitization suggesting interaction with acidic (or low K^+/H^+ ratio) solution. This alteration zone extends for 3x5km, and in false color image it generally pale

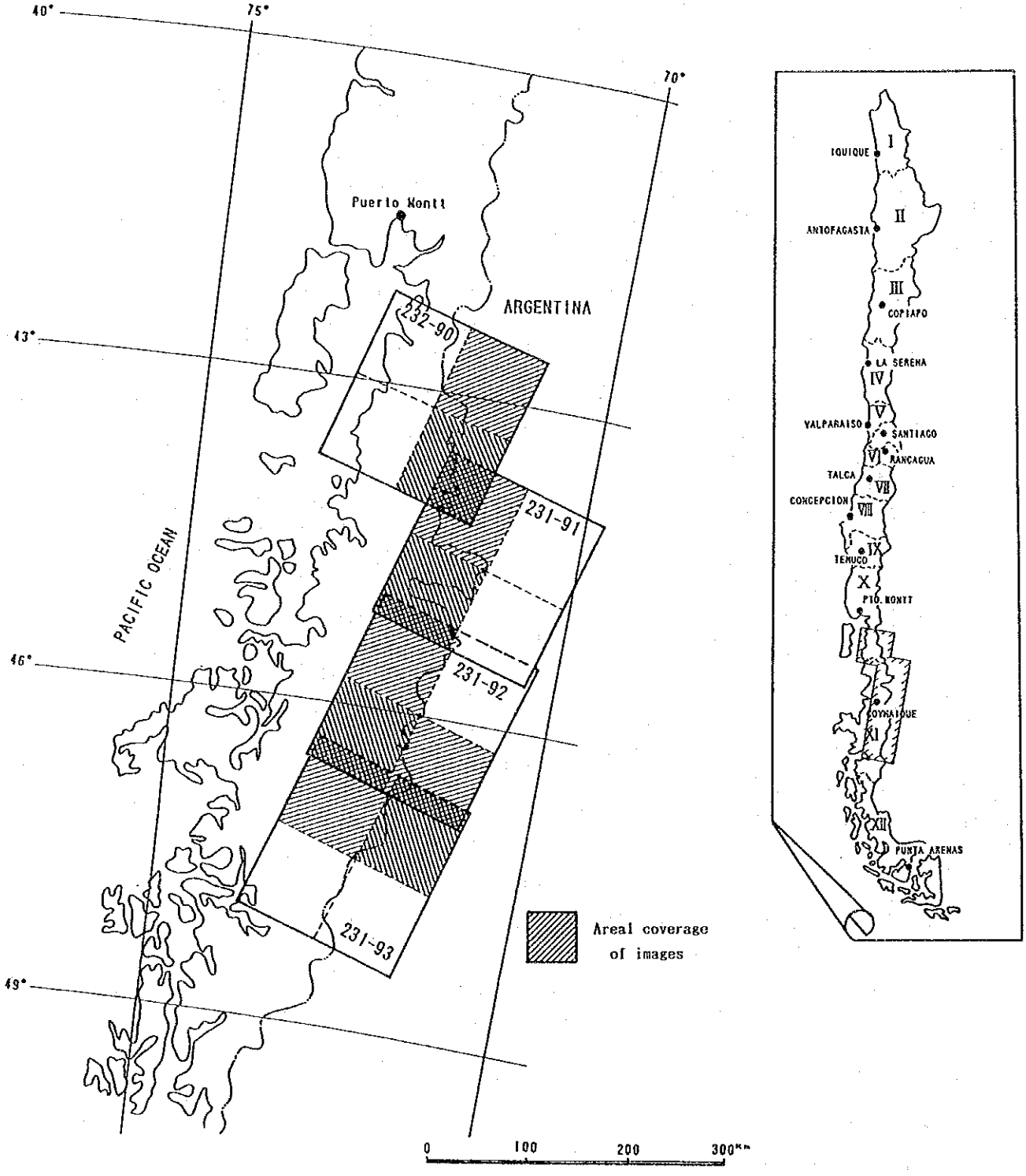


Fig. II-1-2 Landsat Images Coverage Map

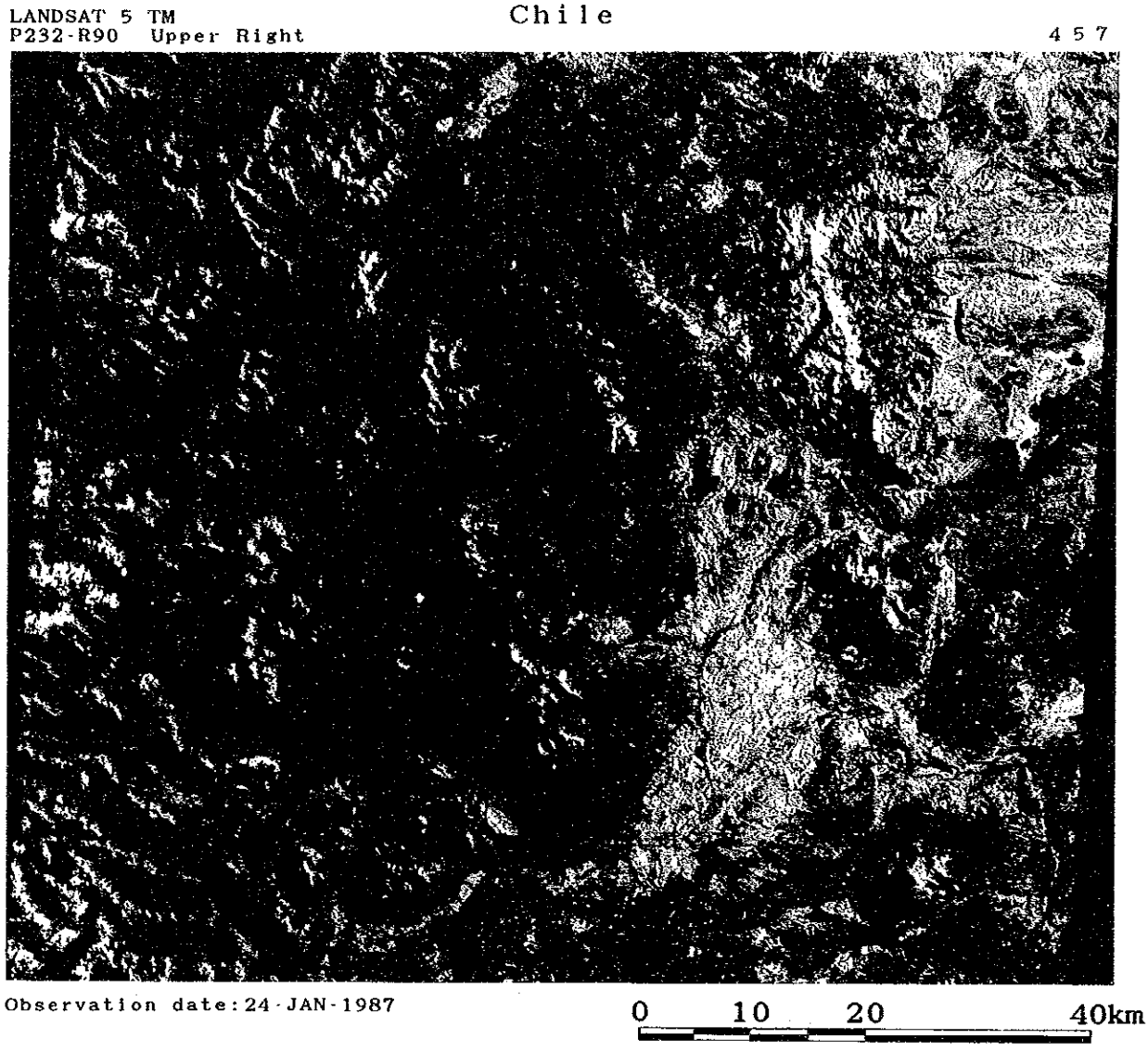


Figure II-1-3 False Color Image covering around the Futaleufu.

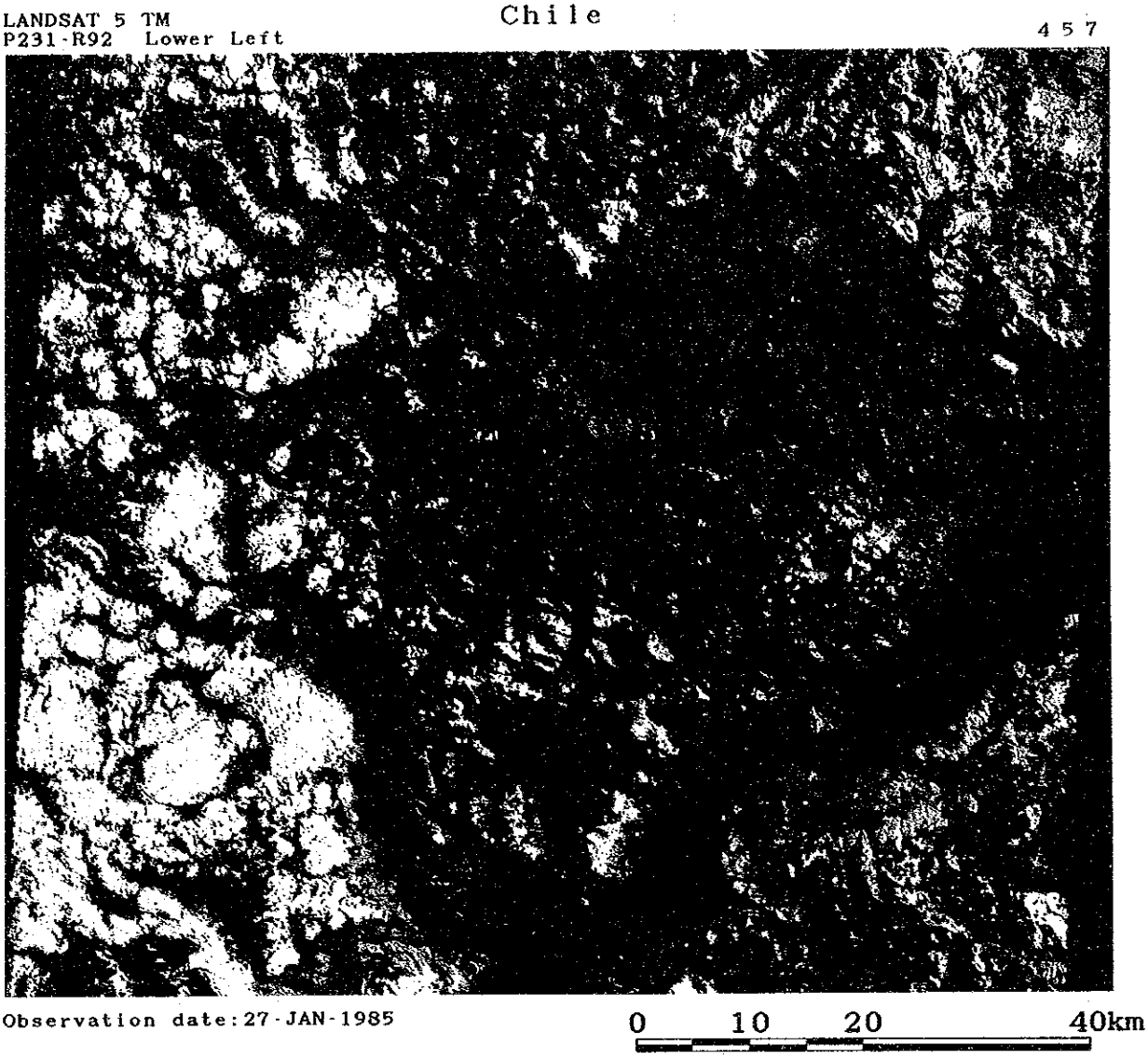


Figure II-1-4. False Color Image covering the North of the Lake General Carrera

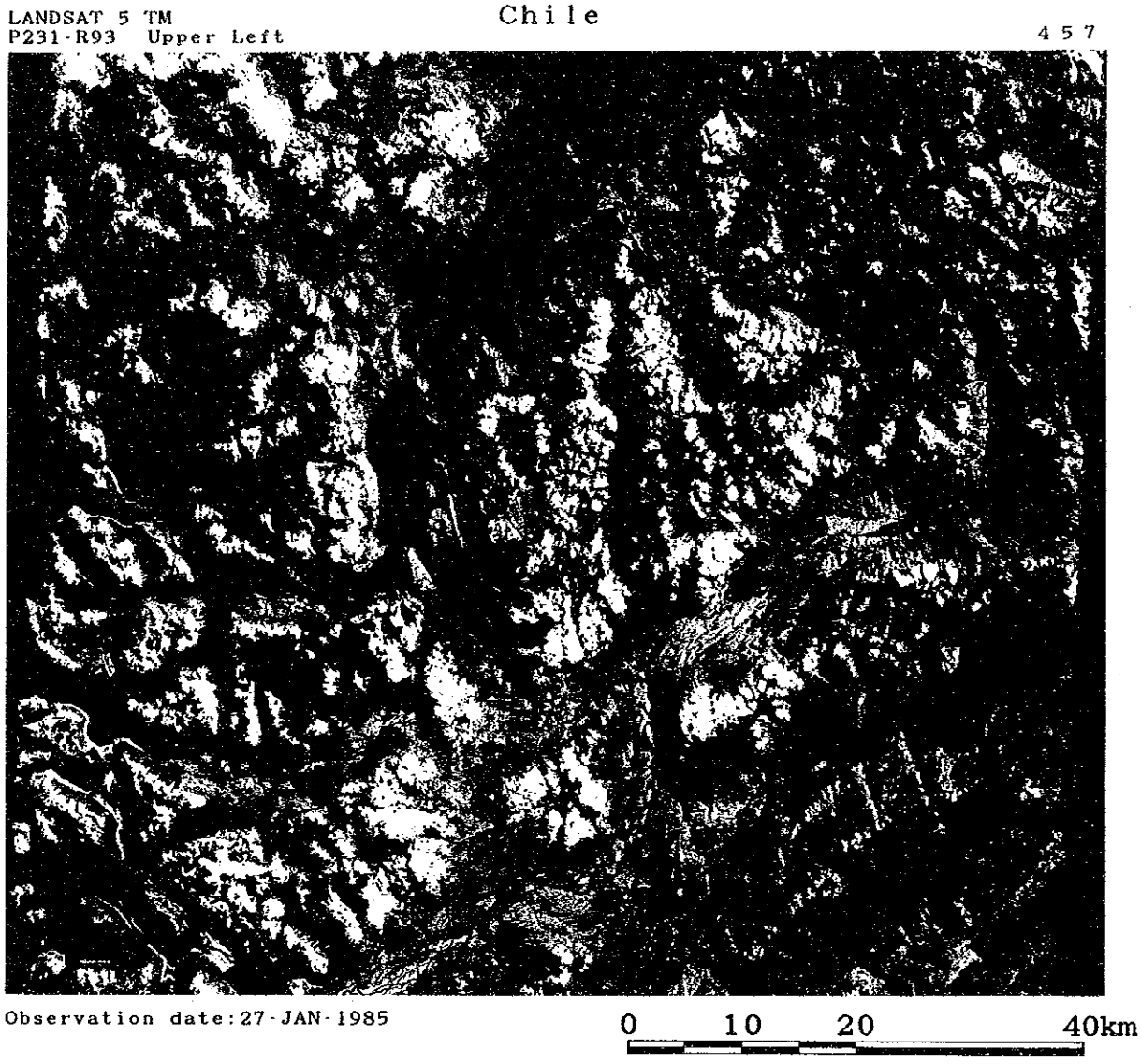


Figure II-1-5 False Color Image covering the South of the Lake General Carrera

yellow bicause of the high blightness of alteration zone in 5 and 7 band.

During the study of MMAJ-ERSDAC, false color TM images of several bands composite for two deposits in areas of arid climate and no vegetation were prepared the Goldfield Deposit, Nevada, U.S.A. and the Escondida Deposit, northern Chile. The alteration zones associated with those deposits were expressed as pale green on the same band composite false color images.

1.2.2. Results of interpretation

A total of 173 alteration zones were extracted from the area covered by the images. The dimensions of alteration zones are 0.3X0.3 km in minimum and 2.0X5.0 km in maximum. The numbers of alteration zones by surveyed sector are followings and distribution is shown in PLATE 1.

26	in the Futaleufu-Alto Palena Area
8	in the Alto Cisnes-El Toqui Area
63	in Ibañez-Murta Area
0	in the Los Leones River Area
76	in the Chile Chico-Chacabuco Area
173	in total

About 80% of them are concentrated in the area ranging southern from 46° S in latitude, largely arranged in the N-S direction. These zones occur in the photogeological units of A, B, C, D and E. The Units B, composed of the late Jurassic volcanics, and D, composed of the early Cretaceous marine sediments, host the largest number of these zones.

Six zones in the northeastern part of Ibañez-Murta Area and sixteen zones in the Chile Chico-Chacabuco Area were selected for ground truth survey from total of 173 zones extracted. Based on the ground survey, it is confirmed that the alteration zones were developed at the positions extracted, with the probability of more than 90%. Among the above zones, gold-mineralization was found in three alteration zones with a ppm order Au(maximum of 6.7 ppm Au). Details of the survey results will be described in Chapter 7 and 9.

CHAPTER 2. COMPILATION OF EXISTING GEOLOGICAL DATA

Existing geological data Of Aysen region was collected, compiled and interpreted in order to acquire the exploration target through the studies of characteristics of geology and mineralizations.

2.1. General Geology and Mineralization of the Aysen Region

The region lies on the Andes orogenic belt formed along the western margin of sub-stable landmass, western part of the Brazilian shield. The region is involved into the southern part of the Central Andes Geologic Province based on classification by Gansser(1973).

The region is underlain by the basement of the Paleozoic metamporphic complex, the Jurassic Sytem, Cretaceous Sytem, Tertiary Sytem, Quarternary Sytem and granitic rocks(Patagonia Batholith) activated during the Jurassic to Tertiary time. Basement rocks are distributed mainly on western side of the region and they consist of metamorphic rocks such as greenschist, phyllite, quartz schist, mica schist, metasandstone, marl and calcareous schist. Those rocks are intensely deformed. Geologic age of sedimentary rocks is reported to be of Devonian to Carboniferous time in Aiysen foreland mountains (Precordillera de Aisen) by Skarmeta et al.,1984), although it is not exactly known throughout the unit.

The Jurassic Sytem is distributed on th east of the Patagonia Batholith elongating with N-S direction. Its distribution area enters into Argentine in the area from 39°S to 43°S. Rocks of the Jurassic Sytem consist mainly of intermediate or felsic volcanic rocks and their pyroclastic rocks, while the the Jurassic rocks distributed in Lonkimai are mainly sedimentary rocks of flysh type. Skarmeta et al.(1984) reported that those sedimentary rocks are of Dogger to Malm Series.

The Cretaceous Sytem is devided into two groups; the Lower Cretaceous Sytem and the Upper Cretaceous Sytem. The Lower Cretaceous sysyem is developed in mainly south of 43°S, and the Upper Cretaceous Sytem is distributed in the north of that. The former consists of mainly sedimentary rocks of marine origin and intermediate to felsic volcanic rocks and their pyroclastic rocks in ascending order, and the latter is composed mainly of volcanic rocks and continental sediments.

The Tertiary Sytem in the north of 43°S is distributed mainly in the west

of the Patagonia Batholith. It is covered by the Quarternary Sytem broadly so that its distribution on surface is not continuous. Rocks of the Late Tertiary are prevailingly continental sediments and volcanic rocks, while sedimentary rocks of marine origin occur in the Early Tertiary strata occationary. The Tertiary Sytem in the south of 43°S is distributed chiefly to the east of the batholith in small scale. Rocks of the Late Tertiary distributed in the south are also prevailingly continental sediments and volcanic rocks. Plateau basalt associated with sediments of marine origin occur in horizon of the Early Tertiary .

Extensive volcanism of andesite to basalt took place mainly during end of Tertiary to early Quarternary in the area of the Patagonia Batholith. A part of that still continues at present. Alluvial deposits are developed broadly in the lowland (Central Basin) situating between the Andes Mountains and the Coastal Mountains in north of 43°S of latitude. Glacier sediments are a well developed as the Quaternary sediments. The correlation table of stratigraphy is indicated to Table Ⅱ-2-1.

Batholith of Mesozoic to Cenozoic (Andes Batholith) intruded along the western coast line throughout the South America from Cape Horn to Colombia. A part of the batholith on the south of 39°S of latitude is called the Patagonia batholith which is distrituted in the investigated area. This batholith is a backbone mountains of the area. It is distributed around the border with Argentine in a zone between 39°S to 43°S of latitude and distributed in the central area from 43°S of latitude southward.

Granitic intrusions of stock-shape are distribued especially in the eastern margin of the batholith. Period of intrusion is estimated to be Middle the Jurassic to Oligocene based on many dating studies. Many rock types, granite to dunite are recognized in the batholith and chemical composition show basic on the west and felsic on the east(Skarmeta et al.,1984).

Extensive volcanism caused by subduction still was maintained also during Mesozoic time in the western margin of the continent(Skarmeta et al.,1984). This activity is assumed to have begun in Middle or Late the Jurassic period. The area was intruded by plutonic rocks uncontinuously accompanying the volcanism and the huge Batholith body was formed in the early Cenozoic(Jenks,1975). This igneous activity continued even in Cenozoic period and is partly still active at present, with eruption of basaltic to andesitic

Table Ⅱ-2-1 Correlation Table of Stratigrphy

Geological Time		Survey Area No. 7	No. 6	No. 5	No. 4	No. 3	No. 2	No. 1
Quaternary	Holocene	Quaternary	Quaternary	Quaternary	Quaternary	Quaternary	Quaternary	Quaternary volcanics
	Pleistocene							
Tertiary	Pliocene	Meseta Buemos Aires Fm.		Meseta Buenos Aires Fm.	Frias Fm.		Marine and continental sedimentary rocks	Río Pedregoso Fm.
	Miocene	Galena Fm.		Galena Fm.				Guapitrio volcanic complex
	Oligocene	Guadal Fm.		Guadal Fm.		La Cascada Fm.		
	Eocene							
	Paleocene							
Cretaceous	Late	Divisadero Fm.		Divisadero Fm.	Divisadero Fm.	Cordón de Las Tobas Fm.		Cerro Loncotiugue Fm.
	Early			Coyhaique Fm.	Coyhaique Fm. / Lago Verde stm.	Alto Palena Fm.		
Jurassic		Ibañez Fm.	Ibañez Fm.	Ibañez Fm.	Ibañez Fm.	Tamango Fm. / Ventisquero M. / Tres Monjas M.		Cord. Lonquimay Fm. / Coradillera de Litrncura Fm.
					?	Huemul Fm.		
Paleozoic		Metamorphic basement	Metamorphic basement	Metamorphic basement		Lonconao stock	Metamorphic basement	Gualletue stratum

ejecta.

Regional geologic strucure is prevailed by N-S Sytem for either fracture Sytems or fold structures. Those directions are constant since Paleozoic to the Recent. The fracture Sytem of the N-S direction is prevailed by younger fractures formed after the middle Tertiary. They are concentrated in an area covered by batholith. Some long fractures extend 100 to 150km along strike. Quaternary volcanism took place along those fracures and geothermal hot springs are scattered along them.

Fold structure formed during Paleozoic time shows composite folds asssociated with drag folds and their axes trend in the N-S direction. Fold structures developed in the Mesozoic rocks are very gentle. Fold structures are locally recognized in the Cenozoic rocks. That is, the structural movements of the Paleozoic and the Mesozoic are characterized by lateral movement, while those of Cenozoic are vertical movement.

Abundant mineralization of gold, silver, copper, lead, zinc, and molybdenum have already been recognized in this region and the adjacent area of Argentina. In Chilean region they are concentrated in the area from lat. 43°S southward. The distribution of ore deposits and mineral indications is mainly confined to the eastern marginal area of the Patagonia Batholith. Zonal arrangement of those mineralizations can be noticed from the eastern periphery of the batholith eastward as shown below(Fig.Ⅱ-2-1).

- Molybdenum belt
- Copper (-gold) belt
- Lead-zinc (-silver) belt
- Gold-silver belt

The remotest mineralization zone from the batholith is located about 100 km east of the batholith.

The molybdenum belt is situated in the periphery or in the vicinity of the batholith. Granitic rocks host the mineralization which occurs as stockwork veins. Mineral indications are relatively concentrated in the south of lat. 44°S, but are sparsely distributed as compared with other minerals.

Many ore deposits and mineral indications are found within the copper belt to the south of lat. 43°S. Their distribution is concentrated in

Argentina between lat. 43°S and 44°S, but in Chile from lat. 43°S southward. Ore deposits of this belt are usually accompanied by a small amount of lead and zinc and in some cases by gold in the upper part of deposits. The copper deposits in this region are generally of small dimensions. Therefore, no deposit was exploited as copper mine so far in Chile.

The lead-zinc (-silver) belt is situated on the east of the copper belt and the mines are densely distributed in an area between lat. 45° and lat. 47°S. The production of lead and zinc from those mines attains 75 % of total volume in Chile. Many deposits belong to the vein type. Whereas also stratiform, replacement, massive, and lenticular types of deposits occur in calcareous rocks of Paleozoic or Mesozoic age. The lead ore in this belt contains rather high grade of silver with an average of about 100 g/t Ag. The representative lead and zinc ore deposits are the El Toqui and the Silva Deposits which are located in the Alto Cisnes-El Toqui Area and the Ibañez-Murta Area respectively. The former is a large scale ore deposit of stratiform replacement type and occurs in the calcareous rocks of the Lower Cretaceous Coyhaique Formation. The ore reserves of this mine are estimated to be 10 million tons at 4.5 % Pb and 12 % Zn. The Silva Deposit is also stratiform replacement deposit which occurs in the Paleozoic limestone beds. The ore reserves are 500,000 to 600,000 tons or more at 15 to 20 % Pb and Zn, and 40 to 60 g/t Ag.

The gold-silver belt is situated in the eastern end of the zonal arrangement. Most of ore deposits in this zone are of vein type however, the alluvial gold deposit derived from that of vein type was also discovered. The deposits in this belt are represented by gold bearing quartz veins accompanied by a very small amount of sulfide minerals. The occurrence of the veins are characterized by concentration of veinlets and broad acidic hydrothermal alteration zone. Host rocks of the deposits are Mesozoic volcanic and pyroclastic rocks that range in composition from acidic to intermediate. The representative ore deposits are the Katterfeld and the Laguna Verde Deposits which are located in the Alto Cisnes-El Toqui Area and the Chile Chico-Chacabuco Area respectively. Both deposits are newly discovered by recent exploration and now are in advanced exploration. Although the details of those deposits still are not open to others, they are believed to be considerably promising deposits from very active exploration. Few deposits of this type have been discovered in this belt, however, other indications similar to those deposits are anticipated to occur in this belt.

LEGEND

- Quarternay
- Neogene
- Palaeogene
- Upper Cretaceous
- Lower Cretaceous
- Upper Jurassic
- Metamorphic rocks
- Plutonic rocks
- Fault
- Gold deposits
- Copper deposits
- Lead and Zinc deposits
- Molybdenum deposits

Fig. II-2-1 Distribution Map of Ore Deposits in the Southern Part of the Aysen Region

2.2. Mining History of the Survey Area

Mining activities of Chile, known as a mining country, were restricted to the northern half of the country so far. Whereas, recently the Aysen Region has been highlighted by increase of lead-zinc production and new discoveries of large gold deposits. This region was left developed insufficiently due to mainly physical problems such as severe climate and hard access conditions, though potentials of mineral resources were appreciated.

Zinc yielded from this region takes 75% of total zinc production in Chile instead of bad physical conditions. Twenty mines were and some of them are in operation in this region, according to CORFO(1982 and 1983). Alluvial mining is excluded from this figure. Among them, two mines are in operation(the El Toqui mine and the Rosillo mine) and four mines are being explored (the Cerro Estatuas, the Katterfeld, the Santa Teresa and the Laguna Verde). Only the Laguna Verde Deposit is a new discovery. Other three deposits are explored in order to obtain further ore reserves after completion of mining of old deposits mined in past.

The oldest mine is the Silva Mine of lead-zinc. This mine was discovered in 1936 and its production was continued for 52 years until it was closed at completion of mining in 1988.

Generalized mining history of the major mines are as follows:-

1930s : First discovery of the Silva Mine (1936)

1940s : Commencement of the production in the Silva Mine

1950s : Commencement of the production in the Rosillo Mine, La Chivas Mine and "old vein" deposit of the Katterfeld Mine

1960s : Productions of those Mines continued

1970s : Metallgesellshaht, a German company, conducted extensive exploration works for the Cerro Estatuas Deposit. Lac Minerals, Canadian company, discovered large gold deposit in Katterfeld Mine

1980s : Commencement of production of the La Poza Mine(1980)
Production of La Poza Mine was suspended(1982)
Commencement of production of the El Toqui Mine (vein deposit) and the Cerro Estatuas Mine(1983)
Commencement of production of stratiform deposit of the El Toqui Mine(1984)
Las Chivas Mine was closed out (1986)
Production of the santa Teresa Mine was suspended(1987?)
Large gold deposit was discovered in the Laguna Verde Deposit(1987)

The Silva Mine was closed out(1988)

Mining activities in the Aysen Region seems to have been activated mostly during the years between later 1970s and early 1980s. Production amounts of the XI Region was reported as follows.

Gold : 0.4kg(from alluvial mining)
Silver : 918.5kg (292kg from lead concentrate and 626.5kg from zinc concentrate)
Lead : 223 t
Zinc : 1,516 t
(after the mining statistic of SERNAGEOMIN)

2.3. Past Exploration Activities

Past exploration activities of each area are shown in the Table II-2-2, after published and unpublished documents.

2.4. Types of Major Ore Deposits

There are known aburdant ore deposits and mineral indications including gold, silver and base metals in the Aysen Region. The number of these deposits and indications attain totally to one hundred twenty and several places. The number of each area are shown in the followings.

Area	Number of Deposits and Known Mineral Indications
Lonquimay	12
Huequi Peninsula	1
Futaleufu-Alto Palena	8
Alto Cines-El Toqui	13
Ibañez-Murta	65
Los Leones River	5
Chile Chico-Chacabuco	22
Total	126

The numbers of ore deposits classified by principal ore minerals and type of deposit are given in the followings

Table Ⅱ-2-2 Past Exploration Works of the Survey Areas(Part 1)

	Geological Survey	Geochemical Expl.	Geophysical Expl.	Drilling	Other Expl.
Lonquimay Area	Whole area 1/1,000,000 Partly 1/50,000, 1/5,000	Whole area	Galletue Electrical expl. (IP method, 28.2 line km)	Galletue Drilling 1,334m(8 holes)	
Huequi Peninsula Area	Whole area 1/1,000,000 1/500,000	Panning Pt anomaly	Air borne magnetic survey(on sea)		
Futaleufu-Alto Palena Area	partly 1/1,000,000 1/250,000 partly 1/50,000, 1/2,000	partly soil(137 samples)	Magnetic survey on land		
Alto Cisnes-El Toqui Area	Whole area 1/500,000 1/250,000	Private company (unpublished)	Geophysical expl. by private company	Drilling by private company	

Table Ⅱ-2-2 Past Workes of the Surveyed Area(Part 2)

	Geologica Survey	Geochemical Expl.	Geophysical Expl.	Drilling	Other Expl.
Ibanez-Murta Area	Whole area 1/1,000,000 1/500,00, 1/250,000 partly 1/100,000 1/10,000		El Pelado Electric expl. (18.1 line km)	El Pelado:10holes Silva:2 holes Rosillo:9 holes	Drifts in the El Pelado, Silva and Rosillo Deposits
Los Leones River Area	Whole area 1/1,000,000 1/500,000 1/250,000 1/100,000 1/50,000	partly Panning			
Chile Chico-Chacaboco Area	Whole area 1/1,000,000 partly 1/250,000 1/500,000 1/100,000	Panning in Chacabuco river	Drilling in Laguna Verde Deposit		

Type of Deposit	Principal Ore Minerals						Total
	Au	Cu	Pb+Zn	Mo	Fe	Cr+Pt	
Vein	11	45	19	10	4	-	89
Stockwork and Dissemination-	7	3	-	2	1		13
Porphyry Copper	-	1	-	-	-	-	1
Replace	-	7	11	-	1	-	19
Kuroko	-	-	2	-	-	-	2
Alteration zone	-	-	-	-	2	-	2
Total	11	60	35	10	9	1	126

From the above deposits and indications, major 42 places were selected for surface survey. The number of mineralizations by each area are shown in the following table and the survey results are summarized in the Table 1 of appendix.

Area	Number of Ore Deposits and Known Mineral Indications known
Lonquimay	3
Huequi peninsula	1
Futaleufu - Alto Palena	7
Alto Cines - El Toqui	5
Ibañez - Murta	16
Los Leones River	2
Chile Chico - Chacabuco	8
Total	42

As a result of the above investigations, it is concluded that the representative ore deposits to be targetted for further exploration are the following three ore deposits.

① Laguna Verde gold Deposit
② El Toqui lead-zinc Deposit
③ Silva lead-zinc deposit

The Laguna Verde Deposit is now under exploratin work and its results are paid attention by the whole of Chile. The El Toqui Deposit is one of few mines under production. The Silva mine was closed in 1988 due to ore

exhausting, while this mine was operated in the past for fifty years. These mines are of medium scale ore deposits and considered to be most favorable for the targets of government - government cooperative investigations.

The geological and mineralogical features of these mines are as follow.

(1) Laguna Verde Deposit

1) Location

The deposit is located 18 km west of Chile Chico City. A road lies from Chile Chico to Puerto Fachinal by way of the southern end of the mineralized zone. It takes about 20 minutes through the road by vehicle. Lake Verde is situated in the middle of the mineralization zone and the deposit was named from name of the lake.

2) History

Existing data of CORFO(1982) and MMAJ(1978) described the deposit as polymetalic vein type deposit of copper-lead-zinc. The survey and exploration were conducted by Cia Minera Tamaya, Placermetal and MMAJ.

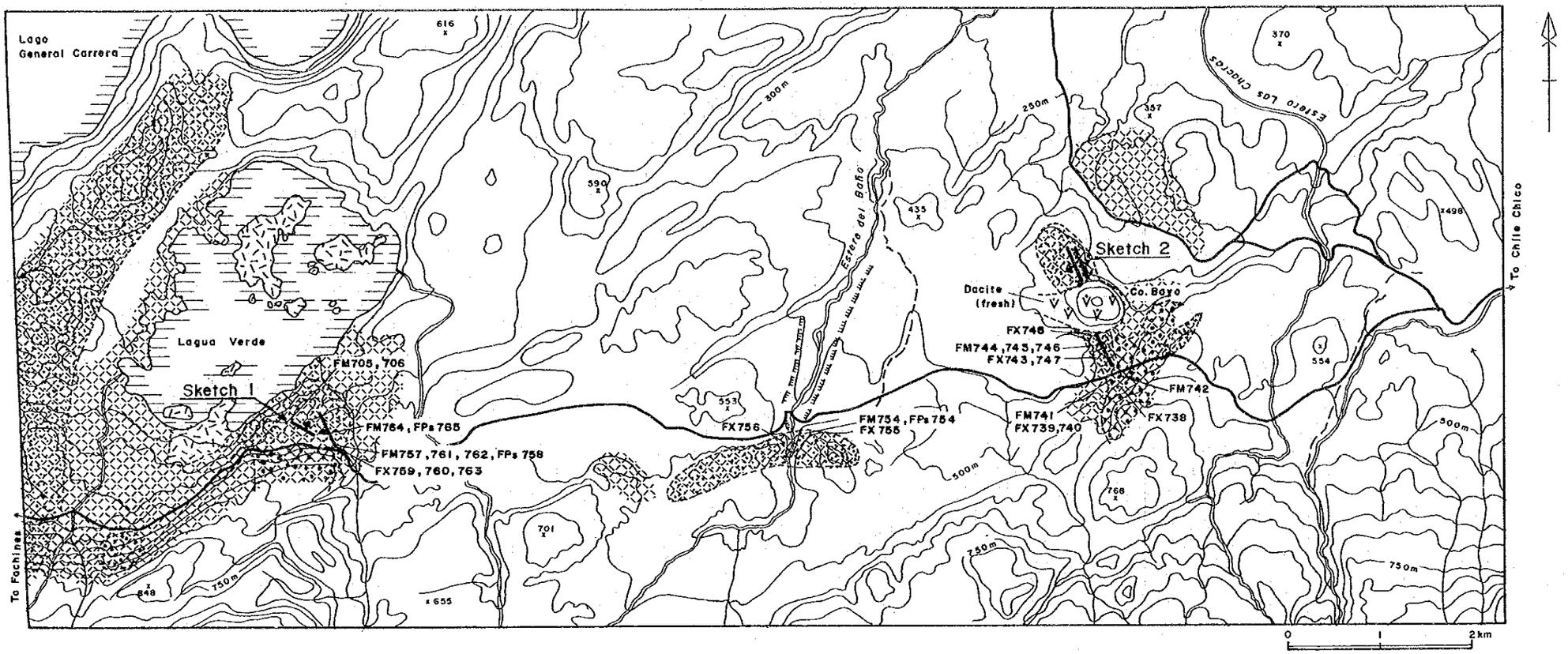
Recently, a firm of the North America obtained mining title and drilling exploration were carried out. It is said that they obtained promissing gold deposit and shifted to the more advanced exploration stage to delineate ore reserve.

3) Geology and mineralization

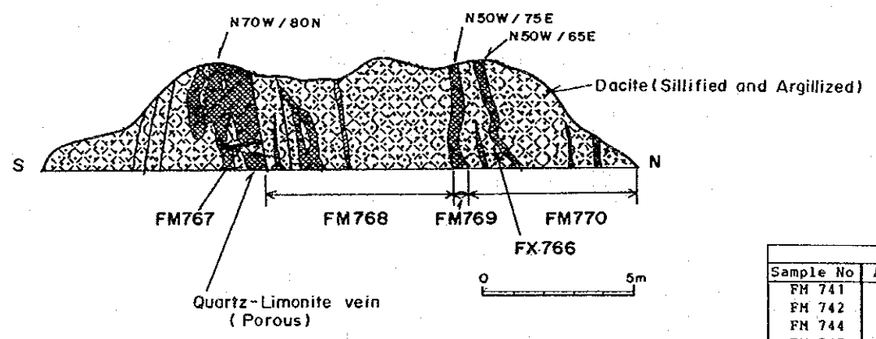
The Survey in the center of the mineralized zone was impossible due to no permission. Whereas, survey was able for the mineralization zone associated with alteration zone which is regarded as the southern edge of mineralization. This report describes about features of the zone.

The zone is underlain by green tuff and dacite emplaced in green tuff. Many hematite-quartz veins occur in dacite. As shown in Fig.Ⅱ-2-2, the veins are of parallel and strike N50°-70°W with 60°-80°N dip. Vein widths vary very much between 0 02 m and 2.3 m. Spacings between veins range from some ten centimeters to several meters.

Veins are composed of mainly quartz and hematite partly accompanied with trace amount of galena and pyrite. Quartz is generally porous and milky white or translucent. Always veins are accompanied with hematite so that the colour of them is reddish brown.

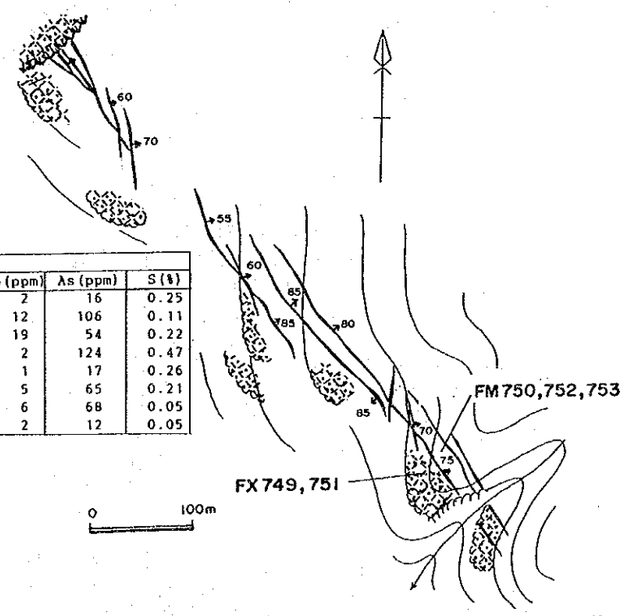


Sketch 1



Assay Results								
Sample No	Au (ppb)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mo (ppm)	As (ppm)	S (%)
FM 705	<20	0.5	24	490	273	1	29	0.16
FM 706	360	5.5	26	0.24%	386	4	335	0.27
FM 757	20	1.5	305	0.38%	1.04%	1	117	0.05
FM 761	<20	0.4	3	20	21	2	42	0.05
FM 762	20	0.3	6	30	55	1	44	0.05
FM 764	<20	0.5	6	540	50	3	32	0.32
FM 767	20	0.7	32	500	0.11%	4	16	0.05
FM 768	<20	0.3	9	50	62	1	30	0.05
FM 769	<20	0.4	24	250	260	3	19	0.05
FM 770	20	0.3	6	100	39	3	37	0.05

Sketch 2



Assay Results								
Sample No	Au (ppb)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mo (ppm)	As (ppm)	S (%)
FM 741	40	0.3	12	30	37	2	16	0.25
FM 742	20	0.5	5	30	13	12	106	0.11
FM 744	60	1.8	4	50	59	19	54	0.22
FM 745	20	4.3	2	20	24	2	124	0.47
FM 746	20	0.9	2	<20	10	1	17	0.26
FM 750	1.08ppm	48	4	90	11	5	65	0.21
FM 752	80	3.7	2	30	14	6	68	0.05
FM 753	80	5.5	1	<20	17	2	12	0.05

Fig. II-2-2 Plan Map of Outcrops around Laguna Verde Deposit

Assays on outcrops showed low grades as shown in Fig.Ⅱ-2-2. Gold was expected, but it graded nearly detection limit(20ppb) other than one sample showed 0.36g/t. Whereas, assays on some veins showed a little high values of arsenic, 117ppm and 335ppm.

Rocks in mineralization zone underwent strong silicification and medium to weak graded kaolinitization. The deposit is characterized by acidic alteration. The area of this alteration zone is not confirmed but is infered to lie around Lake Verde. The current drilling program of the owner of this area is considered to be targetted to this alteration zones. The mineralization and alteration zones similar to this zone are developed in an area in the vicinity this alteration zone(Fig.Ⅱ-2-2).

However, it is said that several hundreds of quartz vein were obtained by drilling and that the zonation is observed from upper portion to lower portion; Au -> Ag -> Pb+Zn in the mineralization zone.

The Katterfeld Deposit is located in Alto Cisnes-El Toqui area with the similar features to those of the Laguna Verde Deposit.

(2) The El Toqui Deposit

1) Location

The deposit is about 80km north of Coyhaique city on the upriver of the El Toqui river which is a branch of the Manihuales river. Altitude in the mine office level are 530m and outcrops of ore are at 800m.

A way to the mine is to go past the Pedro Aguirre Cerda Lake heading to north on Carretera Austral main road from Coyhaique city and then turn off to go up along the El Toqui river to get the mine. The road is kept under good condition except for the section along the El Toqui river. It takes about 2.5 hours to reach the mine from Coyhaique city by vehicle.

2) History of Mine

Sociedad Contractual Minera Toqui commenced prodution in 1983. Formerly the mine exploited the vein deposit. However, at the completion of mining for the vein deposit in 1984, the main mining activity shifted to the stratiform deposit. As of February,1990, all production of the mine comes from the stratiform deposit; the mine is producing 1,200tonnes/month of crude ore at 6.8%Zn and 0.2%Pb with 60 employees.

3) Geology and Mineralization

The El Toqui deposit comprise two different types of deposits; vein-type and stratiform deposit which is called "Manto-type" in Chile(Fig.Ⅱ-2-3).

According to a mine geologist, three formations undelie the mine area: Ibañez Formation, Coyhaique Formation and Divisadero Formation in ascending order. Sills of quartz porphyry intrude into the contact of the lower two formations. The stratiform deposit occur in nearby top of the Sill intruded into Coyhaique Formation (Fig.Ⅱ-2-4). As shown in Fig.Ⅱ-2-5, the deposit is divided into three ore horizons that are called as follow from lower to upper horizons.

- Manto Principal
- Manto Superior
- Manto Alto

(a) Manto Principal orebody

This body is the main ore body in the mine. The principal ore-bearing material is the matrix of the coquina bed which contains much amount of broken shells. Ore minerals are mainly sphalerite accompanied with galna, pyrrohotite, pyrite,chalcopyrite and silver-bearing minerals etc. Gangue minerals are quartz, calcite, chlorite, actinolite, garnet and hedenbergite etc.

The orebody is 6 to 3m thick and bounded by banded tuff of turbidite on the hanging wall and crystalline tuff on the foot wall. Assay result on the typical ore sample is as follows:-

Au; 240ppb, Ag; 4.7ppm, Cu; 440ppm, Pb; 130ppm, Zn; 7.56%, Mo; 2ppm, As; 14ppm, S; 12.42%

The direction of bonanza, NW-SE, corresponds to the principal trend of pre-mineralization fractures. Whereas normal faults of the post-mineralization with N-S trend dislplace orebody to devide orebodies into several blocks. Those blocks are named San Antonio, Mallin Alto, Monica and Dona Rosa from west to east. Eastern blocks are depressed relatively to the western blocks.

The contact of Mallin Alto block and Monica block is not bounded by fault, but by quartz porphyry dyke mentioned above.

Thickness of orebody is steady but ore grades are very variable. The ore reserve is estimated about ten milion tons.

(b) Manto Superior orebody

This orebody is at the stratum 45m higher than the Manto Principal orebody. The oreboby lies the base of marl bed which is developed in the middle of the Coyhaique Formation. Thickness is 1 to 3m. The orebody consists of an intimate mixture of marmatite, pyrrohotite, pyrite and galena. However, it is not mined due to low grade.

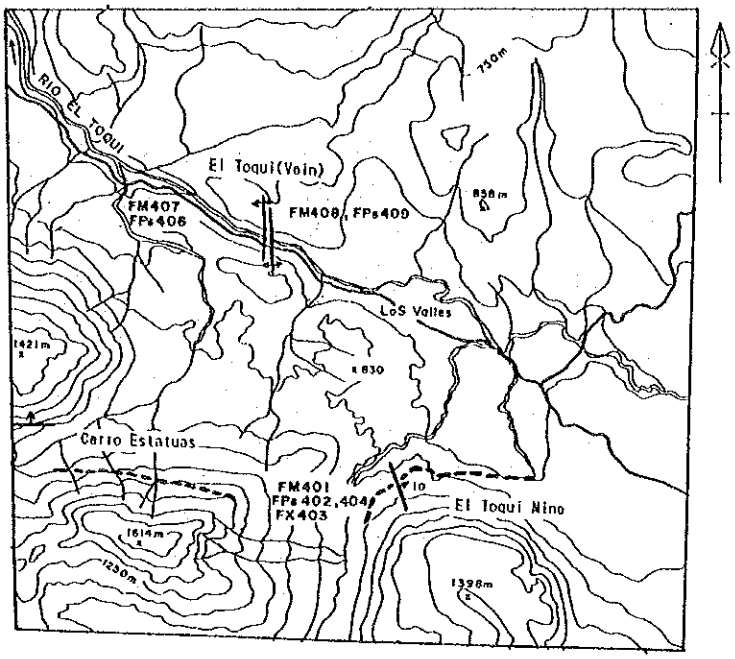


Fig. Ⅱ-2-3 Location Map of the El Toqui Mine and the Cerro Estatuas Mine

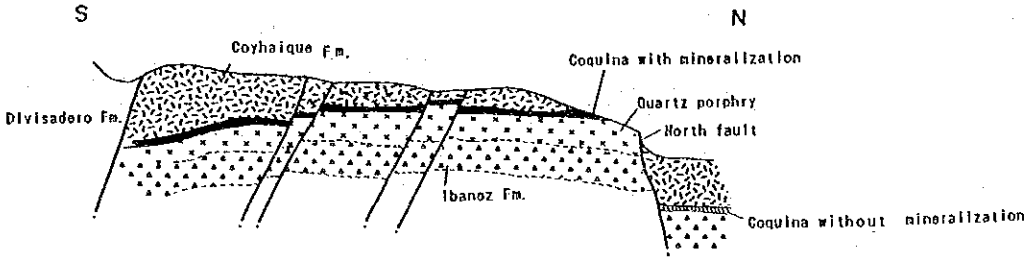
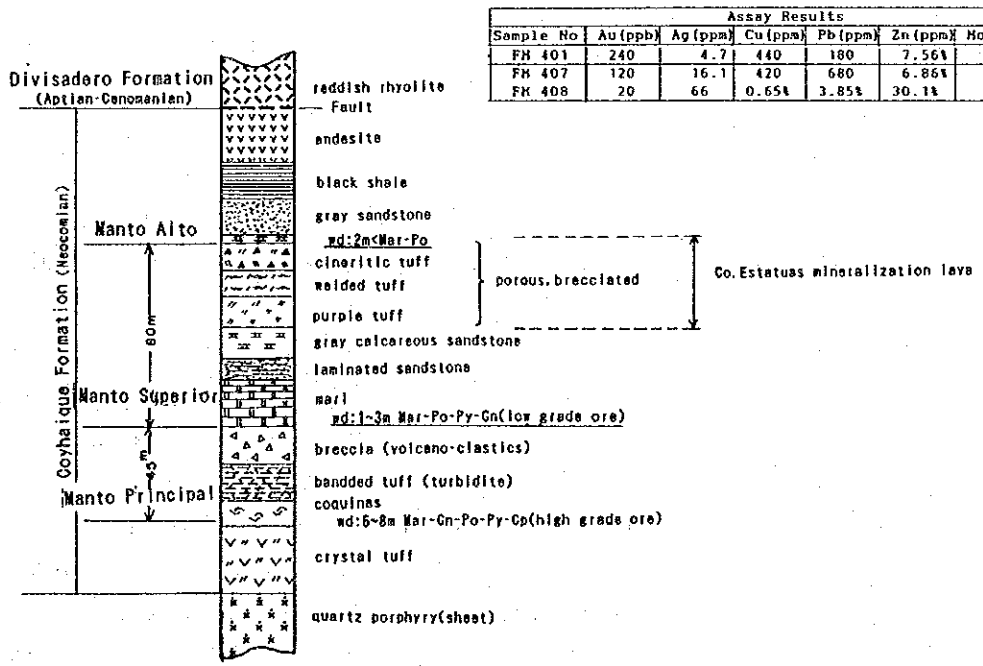


Fig. Ⅱ-2-4 Generalized Geological Profile of El Toqui Deposit



Assay Results

Sample No	Au(ppb)	Ag(ppm)	Cu(ppm)	Pb(ppm)	Zn(ppm)	Mo(ppm)	As(ppm)	S(%)
FM 401	240	4.7	440	180	7.56%	2	14	12.42
FM 407	120	16.1	420	680	6.86%	<1	31	5.08
FM 408	20	66	0.65%	3.85%	30.1%	1	18	18.14

Fig. Ⅱ-2-5 Schematic Stratigraphy of El Toqui Mine

(c) Manto Alto orebody

The orebody lies at the stratum 80m higher than the Manto Superior orebody. This is a calcareous bed replacement orebody occuring in the upper Coyhaique Formation. Thickness of the orebody is more than 2m. The hanging wall is sandstone and the foot wall is glassy tuff.

Constitution minerals are mainly marmatite and pyrrohotite. The ore grades seem to be a little too low to be mined at the moment.

As the same type deposit as El Toqui deposit, there is Cerro Esta Toas deosit located at 4km west from El Toqui deposit. Cerro Esta Toas deposit is under the strenuous exploration by the El Toqui Mine.

(3) Silva Deposit

1) Location

The mine lies two kilometers north-northwest of the Port of Cristal where is situated in the northern coast of the Lake General Carrera. Zero meter level of the mine is at 380m above sea level. The mine is also situated in 47km southwest of the Port of Ibañez in direct distance, but no car road connects to the mine from the port so that ship is unique transportation system from the Port of Ibañez on the Lake General Carrera.

Rout on the Lake is about 75km and trip by ferry takes about seven hours. The ferry line are available each two weeks interval. This ferry can be hired.

2) History

1936: Antolin Silva discovered the deposit.

1941: A firm, Compania Minera del Lago Buenos Aires mined high grade lead ore on a small scale.

1945: A name of the firm was changed to Compania Minera Aysen.

1948: Mine operation started and yielded 1,100 tonnes of concentrates at 64% Pb, 7.8% Zn and 942g/t Ag

1963: The firm fell in a critical situation. CORFO took over a part of management and the name of firm was changed to Empresa Minera Aysen.

Total production amount until 1968 reached 233,000 tonnes of lead.

1978: The mine operation shisted to produce zinc ore instead of lead ore which had mined since start of mining. Production of ore was at the rate of 80 t /month at 6% Pb, 12% Zn and 40g/t Ag.

1980: The firm changed name again to E.M.A. Limitada and obtained the mining titles of small mines scattered around the Lake General Carrera. Production of the year was 9,432 t at 4.8% Pb, 10.4% Zn.

1988: Mine was closed down. Production of the year was 1,500 t at 12-14%

Zn and 3-4% Pb

3) Geology and Mineralization

Geology of the mine area, according to the materials of the mine, consists of Paleozoic limestone and schist, granite and aplite intruded into the Paleozoic rocks(Fig.II-2-6). Marble, country rock of the deposit, is developed from the center of the deposit to the eastern area. Granite is distributed broadly in west of the deposit and a skarn zone is formed in the contact of limestone and granite. Siliceous schist and greenschist are distributed in the southern part on a small scale.

A fault of N-S system lies east of the deposit and the Rosillo deposit is situated in further east.

The Silva deposit is aggregate of small ore-pocket shaped orebodies. They are marble replacement deposit. Those orebodies strike N30°E and dip 15°N. The size of them varies between 500m^3 and 3,000m^3. Irregular small mineralizations occur between orebodies.

Ore outcrop is scattered within area of 80mx300m and occurs in a consistent horizon approximately. Extention to the west is cut by granite and eastward extention is made vague by a fault of N-S system on the Rosillo river.

Ore forming minerals observed on outcrop are mainly sphalerite, galena and chalcopyrite accompanied with small amount of magnetite and pyrite and trace of anglesite and silver minerals. Sphalerite shows very light brown colour indicating low iron content. Galena is coarse grained containing relatively high silver.

Gangue minerals are chiefly calcite, quartz and chlorite, while plagioclase and siderite occur accidentary. Occurence of skarn minerals is limited to the contact of granite and limestone and they do not co-exist with lead and zinc ore. Assays on outcrops are shown on Fig.II-2-7. The scale of ore deposit is five hundred to seven hundred tons of ore.

As the deposits similar to this, Rosillo Mine and El Perado Mine are known. The former is now under the production of 30t/day of crude ore(12.05% Zn, 15g/t Ag)(Feb.,1990). The latter was closed due to ore exhausted. The both mine are located near Silva deposit.

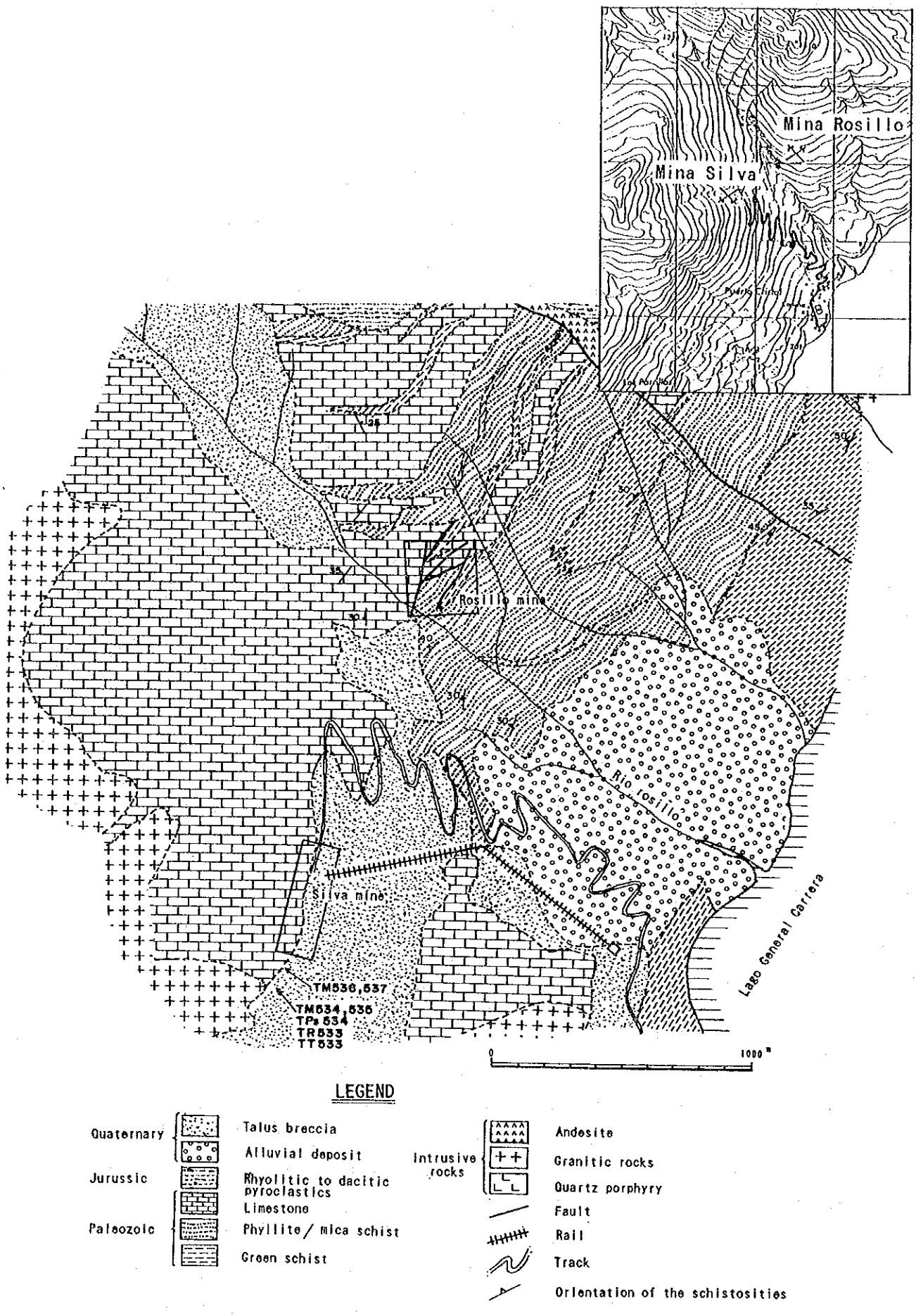
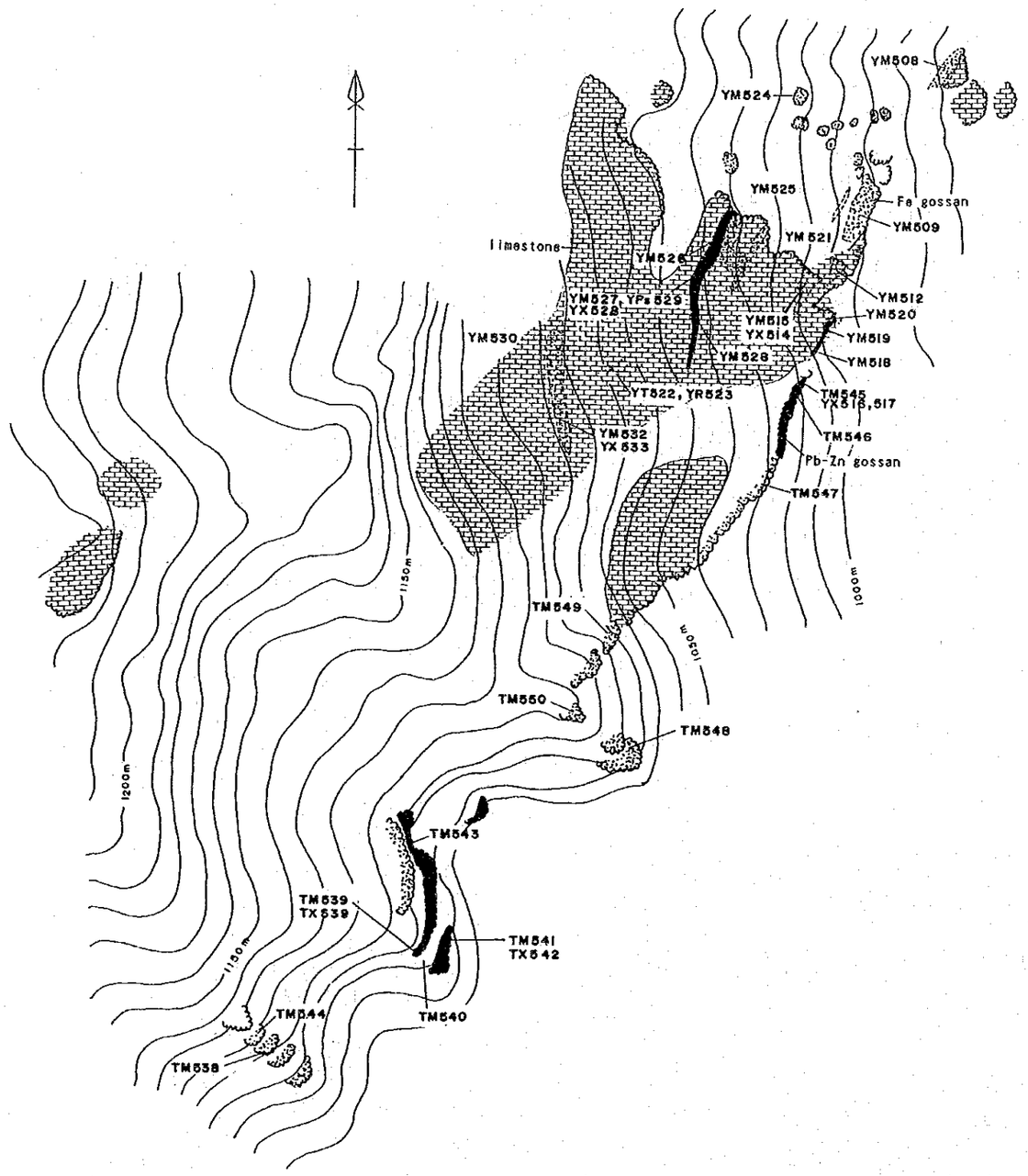


Fig. II-2-6 Generalized Geological Map of Silva Mine-Rosillo Mine Area



Assay Results

Sample No	Au (ppb)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mo (ppm)	As (ppm)	S (%)
TM 534	40	19.4	220	700	29.9%	1	323	24.65
TM 535	20	0.5	89	<20	0.15%	24	15	0.05
TM 536	<20	74	0.17%	870	41.8%	<1	452	25.06
TM 537	20	0.2	17	<20	423	<1	12	0.05
TM 538	40	0.2	2	<20	387	1	30	0.05
TM 539	20	0.2	2	<20	961	2	36	0.05
TM 540	20	0.3	2	<20	83	3	22	0.05
TM 541	<20	0.1	2	<20	48	1	<5	0.05
TM 543	<20	0.2	1	<20	320	<1	15	0.05
TM 544	20	0.7	2	20	245	<1	35	0.83
TM 545	20	0.8	2	40	508	1	42	0.05
TM 546	<20	29.1	450	0.30%	12.6%	1	0.19%	3.18
TM 547	40	15.5	83	200	8.04%	<1	840	4.22
TM 548	40	7.9	166	100	4.48%	2	0.33%	1.11
TM 549	40	132	550	3.50%	32.1%	1	230	18.50
TM 550	80	230	800	17.6%	0.12%	1	0.69%	4.54
YM 508	<20	<0.1	3	20	8	<1	14	0.05
YM 509	<20	0.1	29	<20	35	<1	127	0.05
YM 512	<20	0.2	12	<20	45	<1	19	0.01
YM 515	<20	0.1	2	<20	14	<1	14	0.05
YM 518	<20	0.2	5	<20	37	<1	12	0.05
YM 519	<20	0.5	395	20	9	<1	0.16%	0.11
YM 520	40	32	0.12%	0.83%	239	<1	0.47%	0.16
YM 521	<20	1.0	36	320	68	<1	80	0.11
YM 524	<20	<0.1	10	50	56	<1	5	0.11
YM 525	<20	1.9	0.14%	30	14	<1	0.11%	0.11
YM 526	840	1.2	6	280	0.16%	<1	0.45%	0.05
YM 527	<20	2.4	27	40	1.14%	<1	53	0.05
YM 528	40	530	966	13.88%	30.8%	2	570	18.87
YM 530	<20	0.5	14	110	0.23%	<1	68	0.11
YM 532	<20	0.1	2	80	0.11%	<1	32	0.01

Fig. Ⅱ-2-7 Plan Map of Outcrop Distribution in Siliva Mine

CHAPTER 3 LONQUIMAY AREA(No.1)

3.1. Geology and Geologic Structure

The area is underlain by Pre-Jurassic System, Jurassic System, Cretaceous System, Tertiary System and Quarternary Systems. Among them, volcanic rocks of Post Lower Tertiary age predominate in the area. Intrusive rocks are plutonic or volcanic rocks and they have various modes of occurence such as batholith, stock and dike. Intrusion activities were most activated during Middle Cretaceous to Early Paleogene time. Geologic structure is classified into three systems: NE-SW system, N-S system and NW-SE system. NE-SW system of them is most predominant structure system in connection with lineation and fold structure. Formation terminology and stratigraphy defined by SERNAGEOMIN(in progress) are shown in the Fig.Ⅱ-3-1.

Pre Jurassic System(Galletue Stratum) is distributed sporadically in the southern coast of Lake Galletue and consist of grayish massive fine-grained gneiss and dark gray biotite schist. Banded structure is very conspicuous in the gneiss. Segregation of quartz, schistocity and microfoling are seen in biotite schist. Those metamorphic rocks lie on Galletue batholith with featuring roof-pendant. Age of original rocks is not known.

Jurassic System lies on Pre-Jurassic System uncomformably and is divided into two units; lower Dogger to Lias Series and upper Dogger Series in ascending order. Lower unit is called Cordillera de Litrancura Formation and upper unit is called Cordillera Lonquimay Formation. Cordillera de Litrancura Formation is distributed mainly from central to southern area and is composed of chiefly black slaty shale interbeded by thin beds of limestone and sandstone.

The Cordillera Lonquimay Formation lies central part of the area on a small scale. This formation mainly consists of rhythmical altenating beds of dark grayish siliceous shale and sandstone with interbeded black slaty shale and lense-shaped limestone. Those Jurassic sedimentary rocks are of flysh. Cordillera de Littrancura Formation is shaly flysh, while normal flysh predominates in Cordillera Lonquimay Formation. Jurassic System is estimated to be 3,600m thick(JICA-MMAJ,1978).

Cretaceous System is distributed intermittently in the western part of the area elongating from south to north. It overlies Jurassic System with uncoformity. Formation of this system is called the Cerro Loncotigue

Formation. It is estimated to be 2,300m thick(JICA-MMAJ,1978). The formation consists of dark green brecciated lava accompanied with tuff breccia, lapilli tuff and thin tuffaceous sandstone.

Neither sedimentation nor volcanism took place until Miocene time since begining of Tertiary time. Miocene sedimentary rocks of marine origin interbeded with pyroclastic rocks lie on the area. Volcanism was activated in Later Tertiary time and much volcanic ejectas are distributed. SERNAGEOMIN(in progress) classified the system into the following formations in ascending order.

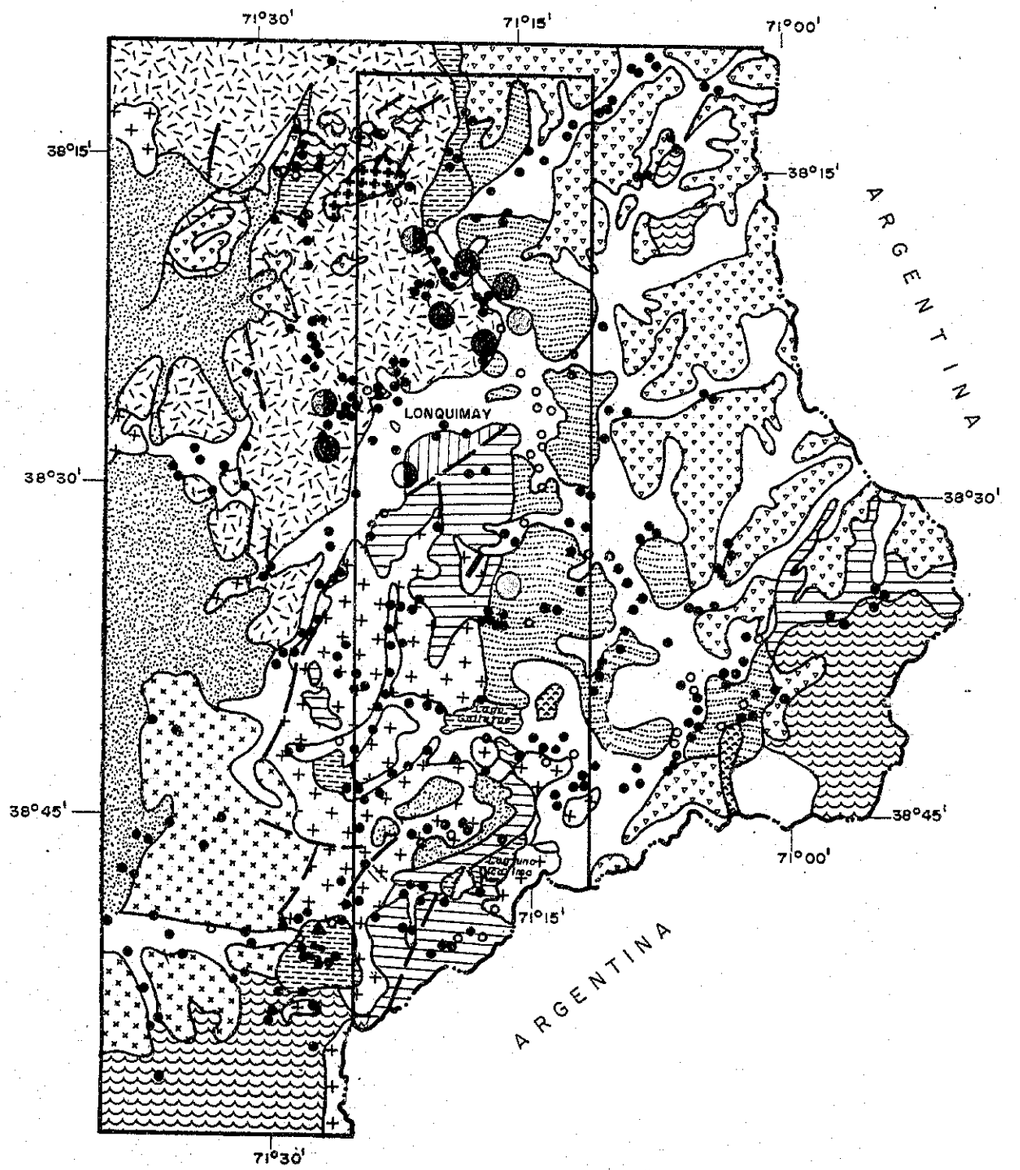
- Guapitrio volcanic rock complex(Miocene)
- Rio Pedregoso Formation (Huichahue member);(Miocene)
- Rio Pehuenco volcanic rocks(Later Miocene)
- Rios Llanquen-Ranquil and Co. Bateamahuida volcanic rocks(Pliocene)

The Guapitrio volcanic rock complex is distributed in the northwestern part of the area. This unit is composed of undivided volcanic rocks, their varieties of depth and sedimentary rocks. Those rocks are called Guapitrio volcanic rock complex altogether. JICA-MMAJ(1978) called the formation correlative with this formation the Sierra Nevada Formation. the Siera Nevada Formation, according to JICA-MMAJ(1978), consists of brecciated andesititc lava accompanied with andsitic tuff and partly tuffaceous sandstone is interbedded.

The Río Pedregoso Formation lies eastern part of the area extending from north to south and lie on the volcanic complex with conformity. This formation consists of altenating bed of sedimentary rocks of marine origin and pyroclastic rocks. Basal conglomerate covers Jurassic units uncomformably. Calcareous sedimentary rocks of marine origin predominates in lower part of this formation. Upper part of the formation consists of pyroclastic rocks, mainly tuff.

Tertiary volcanic rocks of the Río Pehuenco, the Rios Llanquen-Ranquil and the Co. Bateamahuida predominate in east of the Bio Bio River. Lithology is mainly andesitic lava.

Quaternary volcanism in the area have been cotinueing since Diuvial age, although not continuously. Volcanic ejectas originated by that volcanism covers east of the Bio Bio River and west of the Lonquimay River. Active volcanos representated by the Lonquimay volcano and Llaima volcano are



LEGEND

Quaternary		Inconsolidated sediments, shallow tephra
Holocene ~ Late Pleistocene		Lonquimay and Llaima volcano
Late Pleistocene		Sollipulli, Callaqui, Tolguaca, Sierra Nevada, Ignimbrita and Laguna Marinanqui volcano
Early Pleistocene		Penón, El Marcial, Co, Canasto, Pinosolo Tralihue pampas Rahue, Mitirauquén-Pacunto pampas, Cordillera de Huuisa volcanics and Pino Hachado Caldera
Early Pleistocene ~ Late Miocene		Cerro del Medio gabbro
Miocene		Rio Pedregoso Formation and Huichahue stratum
Guapitotrio volcanic complex		Indefferenciated and sedimentary intercalation
		Hipabyssal rock
Cretaceous		Cerro Loncotiuque Formation
Late Dogger		Cordillera Lonquimay Formation
Early Dogger ~ Lias		Cordillera de Litrancura Formation
Pre-Jurassic		Gualletúe stratum

Intrusive rocks

Tertiary		Rio Renaico granitoid
Cretaceous	+++	Gualletúe granitoid

Fault

Vein type deposits, confirmed

Dissemination and/or stockworks deposits, confirmed

Survey area

Geochemical anomalies

Au, Ag

Pb, Zn

Cu

As

Au≧0.37 µg (SERNAGEOMIN 1989)

Fig. II-3-1 Geological and Geochemical Map of Area No. 1 (Lonquimay Area)

situated in those areas. Their volcanic ejectas have chemical compositions of andesite or basaltic andesite so that their distribution area is very widespread due to their viscosities. They covers Tertiary rocks broadly.

Major intrusive rocks in the area are Later Cretaceous Galletue granitic rocks and Early Tertiary Rio Renaico granitic rocks. The former constitutes the batholith distributed from south of the Lonquimay River to Lake Icalma and its lithology varies from tonalite to granite. This rock unit intruded into Jurassic and Cretaceous rocks and are overlain by the Rio Pedregoso Formation uncomformably. Porphry copper-molybdenium deposit occur in a part of this rock unit. The latter(Rio Renaico granitic rocks lie in vicinity of the Racura River where is west out of the area. Lithology is simmilar to that of Galletue granitic rocks. Time of intrusion is inferred to be Early Tertiary time. This intrusive rocks constitutes the batholith as well.

Faults occur in every sequence from Pre-Juassic to Guapitrio volcanic rocks complex. Normal faults of N-S system and NE-SW system predominate in the area. Fold structures are apparent in the Jurassic unit. Direction of their axes trends NE-SW. Syncline and anticline repeat each other with about 45° inclinations of wing. Formations after Jurassic age are horizontal and no fold structure is recognized.

3.2. Mineralization

Major deposit in the area are Porphry copper-molybdenium deposit, gold bearing vein-type deposit and placer gold deposit.

Porphyry deposit is representated by Galletue Deposit. The mineralized zone lie about three kilometers south of Lake Galletue. Mineralization occur in tonalite showing various features such as dissemination, stockwork and veinlet. Ore minerals are mainly chalcopyrite and molybdenite. Quartz-sericite alteration zone is situated in the center of mineralized zone. JICA-MMAJ conducted drilling exploration(eight holes, 1 334m) targeted this mineralized zone in 1978 and 1979. The results, however, were very disappointing; 0.12%(maximum 0.43%) Cu and 23ppm(maximum 0 17%) Mo for average grades of intersections. Other than this deposit stockwork or disseminated mineralization such like the Rio Quinquen, the Estero El Saltillo and the Estero Cajon Cohico occur in the area, but all of them are of low grade mineralization consisting of mainly pyrite.

Vein type deposits are represented by Araucaria deposit and Rio Pacunto

mineralization zone. Several other mineralizations are known in the area, but they are almost barren quartz veins. Araucaria Deposit lie 12 km west of Lake Icaluma and is stockwork deposit of specularite bearing gold. Stockwork does not extend continuously along strike and total feature of the deposit resemble massive deposit of 4x8x3m in size. Assay results show partly 1-2g/t (maximum 9.5g/t) Au and 1-2% (maximum 10.9%) Cu, but most of gold assaying was less than 1g/t.

Quartz veins accompanied with gold occur in Rio Pacunto mineralization zone where lie 13km southeast of Lonquimay Town. Several veins occur in Quartz diorite. Ore grades are averagely low, although assay on a part of veins shows 38g/t Au. Placer gold deposit occur in glacier deposits of the Bio Bio River. Production of placer gold is ongoing on a small scale. Tayo deposit is typical deposit of this type.

3.3. Geochemical Exploration

Regional geochemical exploration(panning) was caried out in this area by SERNAGEOMIN. Many Au-anomalies were detected in the area Geochemical exploration in this survey was carried out in the area north of Lonquimay Town where samples were taken rather roughly in the SERNAGEOMIN's survey. Two kinds of samples, stream sediments and panned concentrate samples, were taken from the same point in this time.

The results of geochemical exploration are explained as followings,by the sample kind.

3.3.1 Stream sediment geochemistry

(1) Sampling and chemical analysis

The size of sediments taken is -30 mesh. The amount of sample is 100g/sample. Number of samples in the area is 54 samples.

Chemical analysis was conducted by laboratory of SERNAGEOMIN for all samples. Elements analyzed in the area are 7 elements;Au, Ag, Cu, Pb, Zn, Mo, As.

(2) Geochemical anomalies and anomalous zones

1) Determination of threshold value

The threshold value(t) deviding geochemical background and anomaly was determined as following two methods in this time.

• determined the threshold value by cumurative frequency curve, in the case that the data were distributing in the logalithmic normal and similar to its.

• determined the threshold value by mean(M) and standard deviation(σ);threshold value = M + 2σ

The threshold value of each element, based on the above, is shown in the following table

Threshold Value of each Element

Element	Threshold Value
Au(ppb)	15.425
Ag(ppm)	0.168
Pb(ppm)	13.356
Zn(ppm)	(95.499)
Cu(ppm)	(33.113)
Mo(ppm)	all<1
As(ppm)	3.596

Note: () shows the threshold value that determined by cumurative frequency curve. The others are deterined by M + 2σ

2) Geochemical anomalous zones

The number of anomalies by each element, based on the above threshold value, is shown in the followings.

Element	Number of anomaly
Au	1
Ag	3
Cu	1
Pb	1
Zn	1
Mo	0
As	2

The number of anomalies in each element is much few and its distribution is scattered. The anomalous points are shown in Fig.Ⅱ-3-1 with the results of panning geochemical exploration in the next section.

3.3.2 Panned concentrate geochemistry

(1) Sampling and chemical analysis

Samples were collected on the same sample points as stream sediments. Eight kilograms of sediments were always supplied for panning.

Amount of panned concentrate collected was 20 grams and suplied to laboratry.

Total number of samples is 53 as same as the number of stream sediments. All samples were submitted and analyzed in the laboratory of SERNAGEOMIN. The assay elements are three; Au, Ag, Pb.

Refer to the report of each phase, on statistical processing.

(2) Geochemical anomalous values and anomalous zone

1) Threshold value

The same method to fix the thresholds was used as that of stream sediments. Thresholds caluculated by each element are listed in Table below

Au(μg)	0.849
Ag(μg)	(6.966)
Pb(mg)	0.238

Values in parentheses are thresholds fixed by cumulative frequency distribution method. Others were determined by $M+2\sigma$

2) Geochemical anomalies

Anomalous values larger than from the thresholds mentioned above are as follows:-

Au	4
Ag	2
Pb	2

Anomalies of Au and Ag relatively concentrate on the zone between the east slope of the Cordon Maravilla Mountain and the Bio Bio River.

3.3.3 Summary

As the summary of the geochemical explorations, previous works carried out by SERNAGEOMIN(1989) and/or this investigations revealed that geochemical anomalies of Au are concentrated on the basin of the Bio Bio River and the north of Lonquimay Town(east slope of Mt.Maravilla).

3.4. Conclusions

Geology of the area consists of flysh sediments of Jurassic age, andesitic volcanic rocks of Cretaceous age, volcanic ash of Quarternary age and granitic intrussive rocks of Cretaceous to Early Tertiary age.

Mineralization of this area is characterized by gold and copper. Two types of gold mineralizations are found in this area; that is, vein or network vein deposit and placer gold deposit. The former occurs in intrusive rocks or Cretaceous rocks. Some veins have grade of several grammes per ton to some ten grammes per ton of gold in a part of them, while their scales are very small. The latter is placer deposit accumulated in glacier sediments of the Bio Bio River. This deposit is locally being mined on a small scale, but the scale of deposit is very small. Further exploration works seem to obtain no more large ore reserves of the both types of deposits.

Mineralization zone of the Porphyry copper type, according to existing data, are found in the southern coast area of Lake Galletue. Very disappointing results for this zone were obtained by exploration works.

Gold and silver stream sediment geochemical anomalies were densely found in the area between Mt, Maravilla and the Bio Bio River.

3.5. Recommendations

Gold mineralization should be targeted. Minable placer deposits lie on this area, while the source of gold grains has not been identified. In order to find the source deposit, the work must forward to lead a line after integrated analyses of all geochemical data obtained in the previous and present investigations. It is also advisable to analyze geochemical anomalous zone of Au and Ag, obtained in this investigation, lying around the east slope of Mt, Maravilla

CHAPTER 4 HUEQUI PENINSULA AREA(No.2)

4.1. Geology and Geologic Structure

The area is underlain by the basement which consists of Devonian rocks, the Tertiary System, the Quaternary System and intrusive rocks. the Devonian System is distributed in two km south of Mt.Comau and the Punta Bull area on the western coast. It consists of sedimentary rocks of marine origin and of transitional facies to continental deposit. The Tertiary System lie western half of the Peninsula. Those rocks are sedimentary rocks of marine origin in vicinity of Mt.Mirador, while continental deposit of Tertiary age lie southeast of Mt.Mirador. Terrains of rivers and plains are covered by alluvial deposit of Quaternary age.

Quaternary volcanism such as Huequi Volcano errupted volcanic ejecta of andesitic composition which is distributed in the eastern part of the Peninsula. Intrusive rocks, belonged to the western end of the Patagonia Batholith, mainly underlie eastern half of the Peninsula. Ultra-mafic rocks,intruded by the above batholith, are widely distributed in the area, but those scales and distributions are not known in details, because only floats of them are recognized in the area.

Inferred faults of N-S systems are developed in the area.

4.2. Mineralization

Any mineral deposit has not been discovered in the area, while platinum geochemical anomalies of coast sands were detected by SERNAGEOMIN. Floats of ultramafic rock were found on the coast of 2km west of the Punta Comau in this survey. Those floats are classified to serpentinite containing much amount of antigorite. A float of hornfels, consisting of forsterite and talc only, was also recognized.Ultramafic rocks, infered by those floats being, were intruded by the Patagonia Batholith.

The following Table shows trace element concentrations of the above floats.

Sample No.	Au ppb	Ag ppm	Pt ppb	Pd ppb	Cu ppm	Pb ppm	Zn ppm	Mo ppm	Ni ppm	Co ppm	Cr ppm	Fe %	Mn ppm
TH 201	<2	<0.5	<2	<1	<1	<5	18	<1	1105	53	850	3.42	175
TH 203	<2	<0.5	<5	<2	2	<5	32	1	1440	69	2000	3.53	500

4.3. Geochemical Exploration

Two kinds of samples, stream sediment and heavy mineral, were taken at

the identical point, also in this area. Sampling works were carried out on the east coast from the north end to south of Huequi Peninsula.

4.3.1. Stream sediment geochemistry

(1) Sampling and chemical analysis

The size of sediments taken is -30 mesh and the amount of sample is 100g/sample. Number of samples is 29.

Chemical analysis was conducted by Chemex Labs. Inc. of Canada. Elements analyzed in area No 2 are 14 elements:Au, Ag, Pt, Pd, Cu, Pb, Zn, As, Mo, Co, Fe, Mn, Ni, Cr.

(2) Anomalous values and zone

1) Threshold

Threshold values for elements were fixed by same method as Lonquimay area, that are M(mean) + σ (standard deviation) except Zn. Threshold value of Zn is determined in the cumulative frequency curve.

The threshold values fixed are listed in Table below.

Element	Threshold
Au(ppb)	138
Ag(ppm)	0.33
Pb(ppm)	3
Zn(ppm)	*76
Cu(ppm)	67
Mo(ppm)	Under detection limit
As(ppm)	55
Pt(ppb)	Under detection limit
Cr(ppm)	789
Ni(ppm)	505
Co(ppm)	29
Pd(ppb)	2
Fe(ppm)	5
Mn(ppm)	676

Note: * mark shows the value determined in cumulative frequency curve, the others were determined by M + 2σ

2) Anormalous zone

Number of the anomalous value in each element is listed in following table.

Element	Number of anormalous value
Au	2
Ag	1
Pb	1
Zn	1
Cu	0
Mo	0
As	0
Pt	0
Cr	2
Ni	2
Co	2
Pd	3
Fe	0
Mn	1

Some gold anomalies were detected in the El Moro River which is a branch stream located west side of the Huequi River and in a rivermouth of thw Telele River. Also anomalies of Cr, Ni, Co and Pd were established in three rivers trending toward Golfo de Ancud on the north slope of Cerro Comau Mountain. Floats of ultramafic rocks were found around the rivermouths of those rivers.

4.3.2. Panned concentrate geochemistry

(1) Sampling and chemical analysis

Samples were collected on the identical sample points as stream sediments. The number of samples was 29. Twenty kg of sediments were supplied for panning. The amount of heavy minerals taken was 50g/sample, because it must be suplied to laboratory for analizing 5 elements; Au, Ag, Pb, Pd, Pt, Cr. The samples taken were analized by Chemex Lab. Inc.

(2) Geochemical anomalous values and anomalous zone

1) Threshold

The same method to fix the thresholds was used as that of stream sediments. Thresholds caluculated are listed in table below

Element	Threshold value
Au(ppb)	34,650
Ag(ppm)	0.7
Pb(ppm)	8,200
Pt(ppb)	38.6
Cr(ppm)	6,634
Pd(ppb)	17

2) Geochemical anomalies

Anomalous values of each element larger than from the thresholds mentioned above are as follows:-

Element	Number of anomalous values
Au	0
Ag	2
Pb	3
Pt	2
Cr	1
Pd	2

Anomalies of Pb, Pt, Pd and Cr are found in the rivermouth of a river, identical points of stream sediments, on north slope of Mt,Comau.

Anomalies of Pb were also detected in the branch of the Huequi River, the La Cascada Creek, the Telele River. Au anomaly of stream sediment was detected in the El Moro River that is the west branch of the Huequi River. In panned concentrate geochemistry, Ag anomaly was detected in the identical point.

The locations of anomalies are shown in Fig.Ⅱ-4-1, together with the results of stream sediment geochemistry.

4.3.4. Summary

Geochemical anomalies of stream sediments and heavy minerals were shown in Fig.Ⅱ-4-1 by elements. Elements recognized with generally high correlation, that is Au-Ag, Pb-Zn and etc, were shown by same marks. The distribution and characteristics are summarized as follows.

Ni-Co-Pd-Cr-Pt

The anomalies of these rare metal elements were concentrated in the river on north slope of the Comau Mountain. It is inferred that ultramafic rocks are

developed in the Comau Mountains and these rare metals are derived from the rocks.

Au-Ag

Three Au-Ag anomalies were sporadically detected at the 3 points, west branch of the Huequi River, Telele river and the point of 2.3km south-south west of Comau Cape.

Pb-Zn

Pb-Zn anomalies were sporadically detected at the points 3.3km north east of Huequi Town, branch of the Marilmo River, Telele River etc.

4.4. Conclusions

The area is situated in the western margin of the Patagonia Batholith. The geology of the area consists mainly of granitic rocks and Paleozoic sequences intruded by granitic rocks and Tertialy sedimentary rocks covering granitic and Paleozoic rocks. In this survey, floats of ultramafic rock intruded by tonalite was recognized in the Comau Mountain situated in the north of Huequi Peninsula.

Based on this, it would be supposed that ultramafic rocks would be developed in the area of the Comau Mountains. Anomalies of Pt, Cr, Ni, Co, Pd, in stream sediment geochemistry, were detected in the area where floats of ultramafic rocks were recognized.

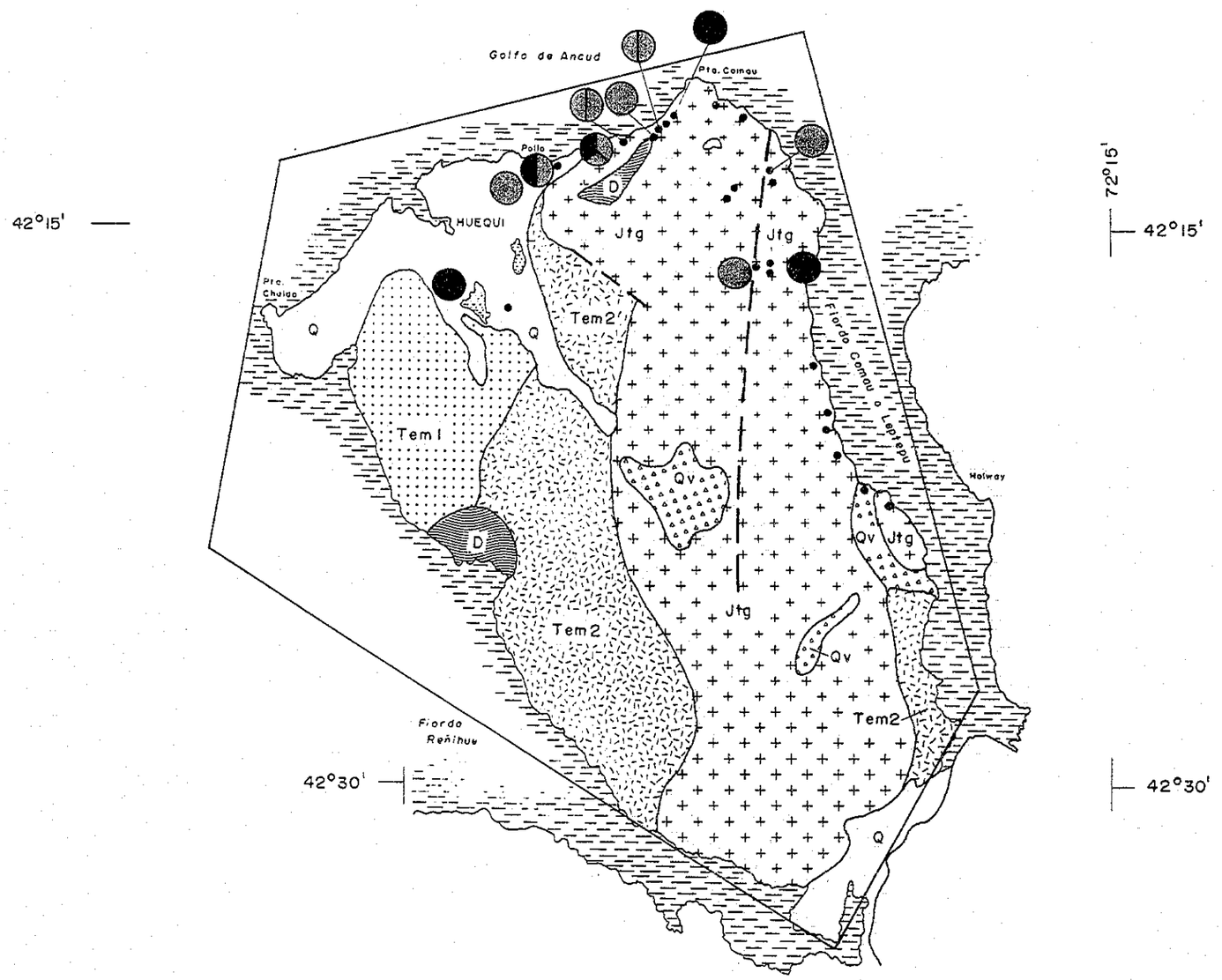
In accordance with these, it cuold be expected rare metal resorces to be distributed in these areas accompanying with ultramafic rocks. However, the geological data and distributions of ultramafic rocks are unkown in detail.

Although the geochemical anomalies of Au, Ag, Pb, Zn were sporadically detected, it could not be expected in geologically that the promising deposits of these elements are developed.

From the geological view points, the exploration targets of this area would be rare metals of Pt, Co, Ni acompanied by ultramafic rocks. In order to estimate the potentialities of these rare matal deposits, further geological and mineralogical data should be acquired.

4.5. Recommendations

It is recommended that basical geological informations should be



LEGEND

Quaternary		Q	Continental and marine sediments
		Qv	Volcanic rocks
Terriary	Miocene~Eocene	Tem_1	Marine sedimentary rocks
		Tem_2	Continental sedimentary rocks
Devonian		D	Marine and transitional and sedimentary rocks
intrusive rock		Jtg	Tonalite, migmatite, amphibolite, gneiss and pegmatite
			Fault
			Survey area

Geochemical anomalies

- Au, Ag
- Pb, Zn
- Cu
- As
- Ni, Co, Pd
- Cr
- Pt

Fig. II-4-1 Geological and Geochemical Map of Area No.2 (Huequi Peninsula Area)

collected at first. Existence of ultramafic rock has been identified by this survey so that its distribution and areal extent must be defined.

However,long duration of the surface survey is needed in this area because neither car roads nor horse roads are developed due to dense cover of primeval forests.

Therefore , aeromagnetic survey is believed to be the most effective method for that purpose. In this case , it is recommended that delineation of survey area by aeromagnetic survey will be followed by surface geological and geochemical survey.

CHAPTER 5 FUTALEUFU-ALTO PALENA AREA(No.3)

5.1. Geology and Geologic Structure

This area lies on eastern margin of the Patagonia Batholith. The west half of the area is underlain by the Patagonian Batholith and the east half is underlain by Mesozoic volcanics and sedimentary rocks. Mesozoic units consist of Jurassic and Cretaceous Systems(Fig.Ⅱ-5-1).

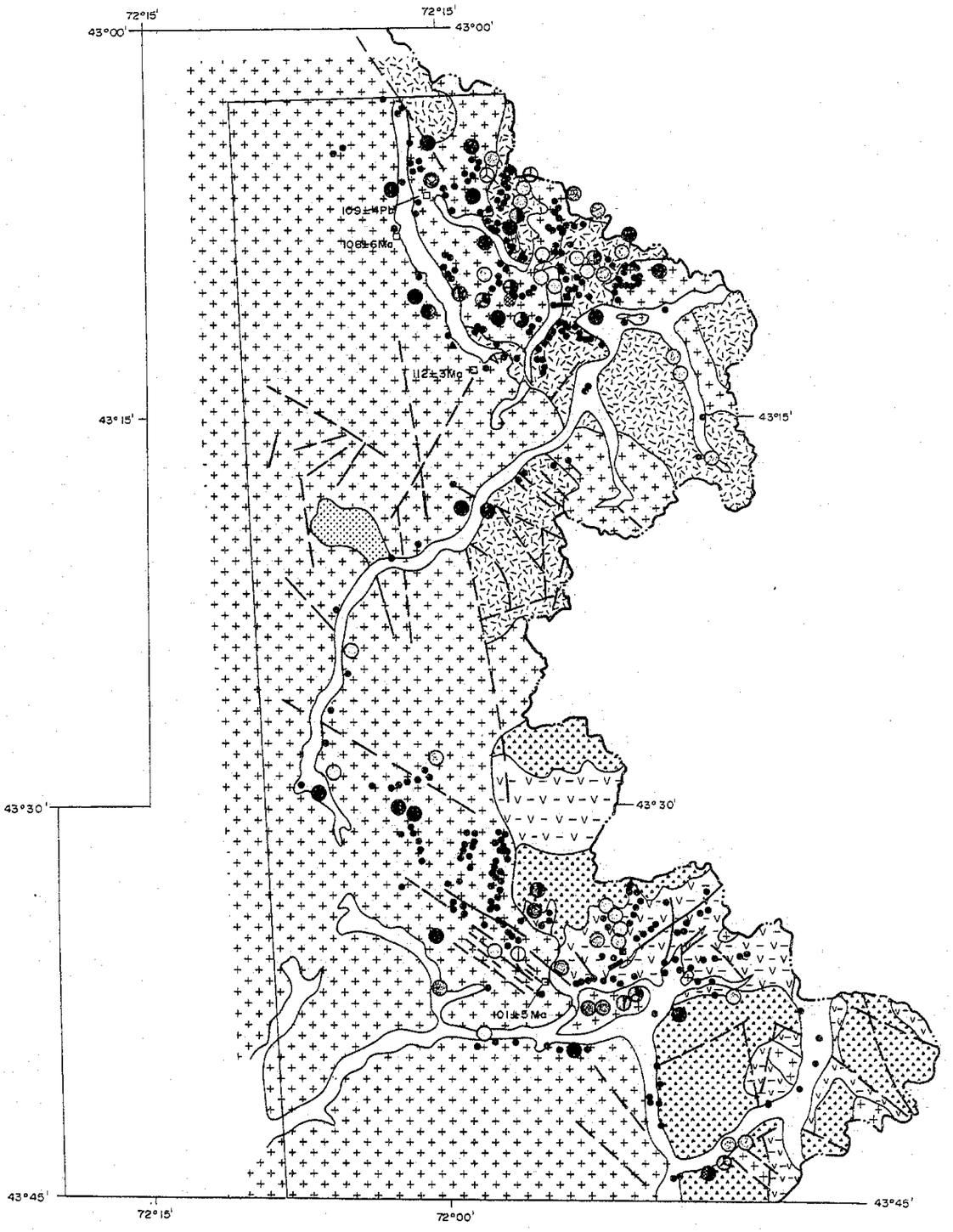
The Jurassic System lies in broad area around Futaleufu Town located in the northern part of the area. This system is composed of volcanic rocks and pyroclastic rocks erruptel onto land and placed marin origin thin beds in lower and upper parts. The base of this formation is not found. The thickness of this system is about 2,000m. The age of this formation is infered to Late Jurassic. This system is correlated to the Ibañez Formation developed in south of Area No 4(Niemeyer,1975).

The Cretaceous System is distributed around Alto Palena Town situated in the southern part of this area. This system is devided into two formations; the lower is the Alto Palena Formation and the upper is the Cordon de Las Tobas Formation.

The Alto Palena Formation is distributed in north of Alto Palena Town. The lower part of this formation is generally composed of calcarious sedimentary rocks of marine origin and the upper part is composed of andesitic volcanics. The relation between this formation and Jurassic is unkown, because it is not observed for the both to contact directly. The thickness of this formation is 2,900m. The shell fossils, ammonites and etc., are predominant in this formation. From these fossils, the age of this formation is determined to be Neocomian stage (Fuenzalida,1968). This formation is correlated to the Coyhaique Formation (Lahsen, 1966; Skarmeta,1974).

The Cordon de las Tobas Formation consists of continental deposits: mainly andesitic volcanic rocks interbeded with sandstone and shale containing fossils of leaves rarely. The bottom of this sequence overlaps the Alto Palena Formation conformably and the top is not identified yet due to errosion. This formation is estimated to be 600m thick and is correlative to the Divisadero Formation (Skarmeta, 1974). The age of this formation is reported to be Hauterivian to Albian stage(Thiele et al.,1978).

Tertiary unit lies in the central to northern part of the area sporadically. This unit is called the La Cascada Formation and estimated to



LEGEND

Quaternary		Alluvial, talus, terrace and glacial deposits
Tertiary		La Cascada Formation : marine sedimentary rocks
Late Cretaceous		Cordón de las Tobas Formation : andesite and its pyroclastic rocks
Early Cretaceous	V-V V-V	Alto Palena Formation : marine sedimentary and andesitic volcanic rocks
Jurassic		Tamango Formation : andesite and its pyroclastic rocks with intercalation of marine sedimentary rocks
		Huemul Formation : andesite and its pyroclastic rocks
Intrusive Rocks	+ +	Futaleufu-Palena Batholith

Fault

- Dissemination and stockwork, confirmed
- Vein type mineralization, confirmed
- Lenticular type mineralization, confirmed
- Hydrothermal alteration zone

Geochemical anomalies

- Au
- Ag
- Cu
- Pb
- Zn
- Mo
- As

- Stream sediment and/or panned concentrate samples
- K/Ar Absolute Age Determination

Fig. II-5-1 Geological and Geochemical Map of Area No. 3 (Futaleufu-Alto Palena Area)

be marine sediments of Eocene series. The bottom of the formation consists of basal conglomerate deposited during transgression and overlies unconformably granite of the Patagonia Batholith. Several beds containing coal materials and fossils are interbeded into the middle to upper portions of this formation. Niemeyer(1975) correlated this formation to the Guadal Formation.

The Quarternary System consists of alluvial and glacier depposits distributing along the main rivers.

Intrussive rocks are widely distbibuted in the west half of the area and belonged to the Patagonia Batholith. The Patagonia Batholith has complex rock bodies varying from diorite to granite. Time of intrusion event was determined at 100to112 Ma, the later half of Early Cretaceous, by absolute age determination.

The Jurassic System shows genarally monoclinic structure, inclined to north, 20°to40°. The Alto Palena Formation shows also generally monoclinic structure, while rises gently in the part around Alto Palena Town. The Cordon de las Tobas Formation shows almost horizontal structure.

As to fractures, NW-SE system, NNW-SSE system and NNE-SSW system predominate. Those fractures are predominant in the normal faults to be not continuous, and to have small heads, except for NNW-SSE system.

5.2. Mineralization

More than thirty mineral indications are known in this area but they are weak and of a small scale. They are developed mainly in the parts around the Patagonia Batholith(Fig.Ⅱ-5-1). Their host rocks are Mesozoic volcanics and sedimentary rocks. Their main constituent metals are Cu, Pb, Zn and Fe and rarely icluding Au and Mo.

They occur showing the types of veins, disseminations and stockworks. Their main constituent minarals are chalcopyrite, galena, sphalerite and rarely electrum, molybdenite and copper oxide. Gangue minerals are quartz, limonite, hematite, pyrite, chlorite and rarely magnetite, calcite and epidote.

Veins are small; 0.2 to 0.5m wide, but scarcely 3 to 5m. Most of them were not explored except the mineral indication of Anomalia I de cobre, Garcia I and Garcia Ⅱ. In this survey results, their horizontal or vertical extensions are to be estimated maxium several ten meters. The extensions of