a) Existence of fault scarps.
b) Existence of linear valleys (fault valleys).
c) Rivers with very linear flow pattern.
d) Existence of kerncols and kernbuts.
e) Linear arrangement of break points of mountain slopes.

These topographic features are affected by the geology, geologic structure, and the age of the rocks. Thus, there are considerable areal variation in their development, but most of the lineaments can be understood by empirical interpretation of these topographic features.

1.3. Results of Analysis

1.3.1. Geological Interpretation

Eleven geological units, A to K, were delineated from these images (Fig.1-1-3.). Their major features are as follows:-

(1) Unit A

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 drainage system, an important topographic feature, shows dendric pattern of medium density in the southern part, but of high density in the northen and central part on the side of the Pacific Ocean. The resistance of the rocks are high to form steep mountains in the southern part, while those are low in the central and northern part and mauntains are gentle. Some topographic features suggesting bedding or schistosity are observed as well in the southern area.

This unit consists of, according to existing materials, chiefly metamorphic rocks of Paleozoic ages.

(2) Unit B

This unit is 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 drainage systems show the dendric pattern of medium density. The resistance of the rocks are generally around medium except for the area around the Lake General Carrera. Mountains are gentle in general. The topographic feature showing beddings are observed in some places.

This unit consists of the volcanic rocks of Jurassic age, according to the

existing marerials.

(3) Unit C

This unit is distributed around Area No 1, around the border line with Argentine of the central part of the region and in the part on the western side of the southern part of the region. The drainage systems show the dendric pattern of low density. The resistance of the rocks are generally not high. Mountains are relatively. The topography suggesting the beddings are reconized in the around Area No1 and in a part of the central portion of the region.

This unit is distributed in the localities of, according to existing data, volcanic rocks and sedimentary rocks of Cretaceous age.

(4) Unit D

This unit is distributed in the northern part on the side of Argentine and southern part around the border line with Argentine. The drainage systems are dendric pattern of low density in general, but parallel or pinnate pattern in the north. The resistance of the rocks are medium to low. The unit forms mauntain ridges which the portion of the medium resistance are slightly projected outwardly on the portion of low resistance. Those subunits of two resistance, medium and low, are arranging parallely so that the unit can be followed up on the image. The topograpy showing beddings is recognized clearly and thus the folding structure can be easily extracted. Many numbers of the folding structures were observed especially in the northern part. Also the front slopes and the back slopes are visible in several places.

The visual characteristics on photographs such as tone of colour is very distinguishable from the other units: the colour tone is yellowish grey in the north but greyish white in the south with a light tint throughout the region.

The distribution of this unit, according to existing data, is in localities of mainly Cretaceous sedimentary rocks.

(5) Unit E

This unit is distributed, on a small scale, in the western part of the area extending from the central to the northern part of the region and in the southern part of Puerto Montt where is situated in the central part of the region.

Drainage systems show dendric pattern of high density. The resistance of

the rocks is low. Topographical undulations are gentle to form small and narrow ridges. The distributed part extending from the central to the northern part shows a lowland and mosaic pattern suggesting farmland.

The distribution of the unit, according to existing data, is in mainly Miocene volcanic rocks and sedimentary rocks localities.

(6) Unit F

This unit is distributed in the northern part of the region. Drainage systems show dendric pattern of high density. The resistance of the rocks is high so that the surface undulates deeply to show deep valleys and steep mountains. Topographic features suggesting beddings are almostly not observed, but the unit looks massive.

The distribution of the unit, according to existing data, is in localities of mainly Miocene volcanic rocks.

(7) Unit G

The unit is distributed broadly from the part near the border line with Argentine to the western part of Argentine extending from the north to the south. Drainage systems generally show dendric pattern of medium density, but partly parallel pattern in the part from the central to the northern part of the distribution area. The resistance of the rocks are relatively high. Topography undulates deeply and forms steep mountain ranges in the central to the southern part of the distribution area. Whereas, the central to the northern part is characterized by flat forms. The texture is fine-grained.

The distribution of the unit, according to existing data, is mainly in Pliocene volcanic rocks.

(8) Unit H

This unit is distributed in the eastern part of the region over Argentine. Development of drainage systems is very poor with nearly flat form. Tableland-shaped landform extends over some ten kilometers and ends to the steep cliff. The colour tone is dark green or dark brown with generally dark tint. The texture is smooth.

The distribution of this unit, according to existing data, is in localities of Quarternary basic volcanic rocks in the north and Tertiary basic volcanic rocks.

(9) Unit I

This unit is distributed in the central part of the region arranging from the north to the south and in southeast end of the region on a small scale. The drainage systems show radial pattern in the central part showing cone landforms with some kilometers to 30 km in diameter. Those cone-shaped landforms arranges with N-S direction. Some of them have concave form to indicate crater. The drainage systems in the southeast end develops poorly and the landform is flat resembling that of the unit H. These two units are separated standing on the reason which the unit I is underlain by the unit H. The colour tone is generally dark tint. Especially in the central part, the colour tone is deep black and this black portion shows flow-shaped patterns at low elevation part of valleys.

This unit, according to existing data, corresponds to Quarternary volcanos.

(10) Unit J

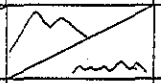
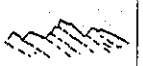
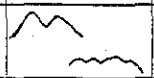
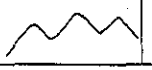
This unit is distributed in the western side on the area from the central part to the northern part of the region, in the eastern side on the area from the central part to the southern part of the region and otherwise in some places scatteringly. Drainage systems show dendric pattern of low density in the western side on the area from the central part to the northern part or meandering pattern of low density in the eastern side on the area from the central to the southern part. In the zones where the unit is develped scattreringly, the unit is seen along the major rivers and the drainage systems show meandering pattern. The resistance of the rocks are very low. The texture is generally fine-grained throughout the distribution areas. The mozaic pattern suggesting farmland is recognized in the western side on the area from the central part to the northern part.

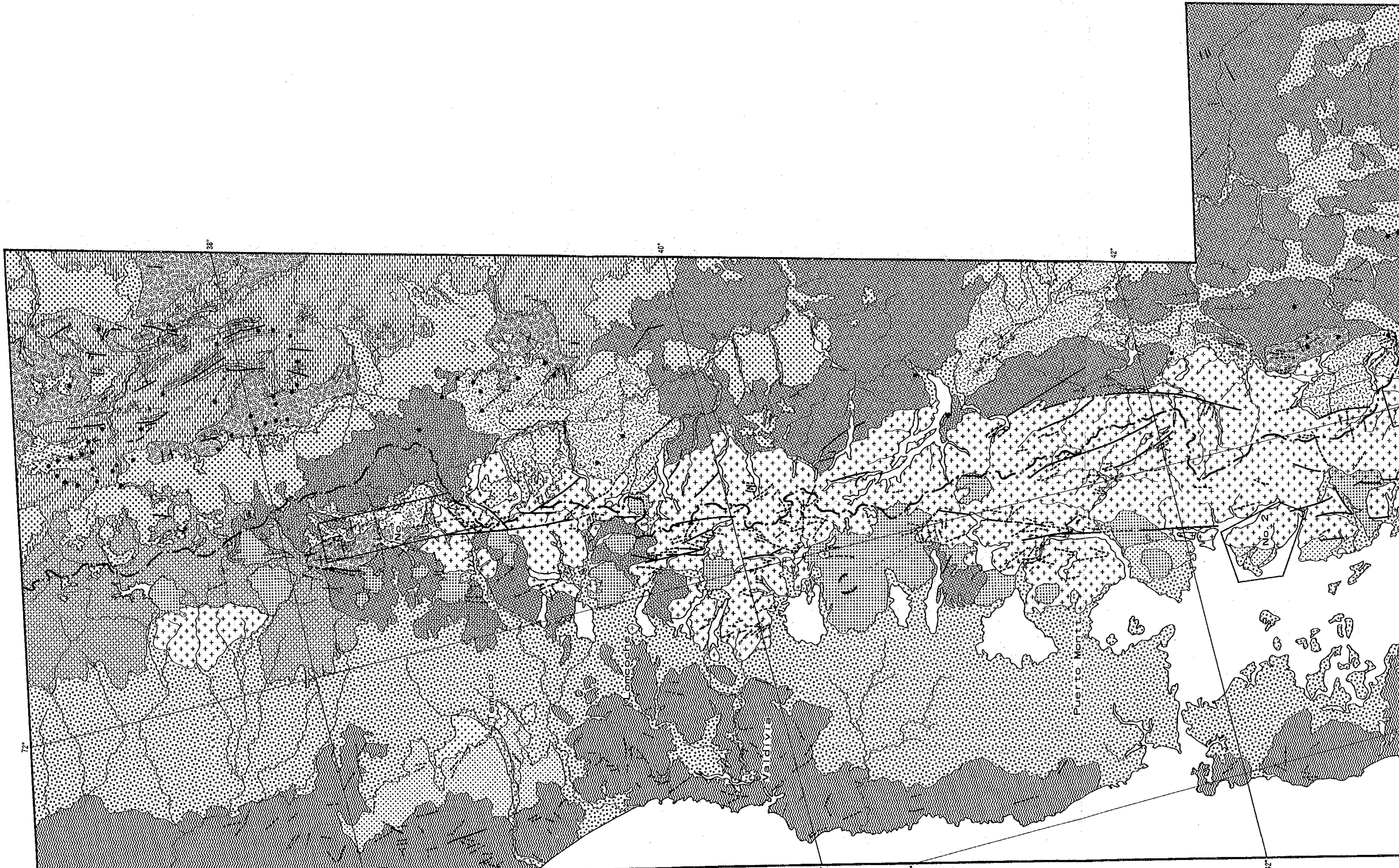
This unit, according to existing data, is in localities of Quarternary glacial deposits, and alluvium etc.

(11) Unit K

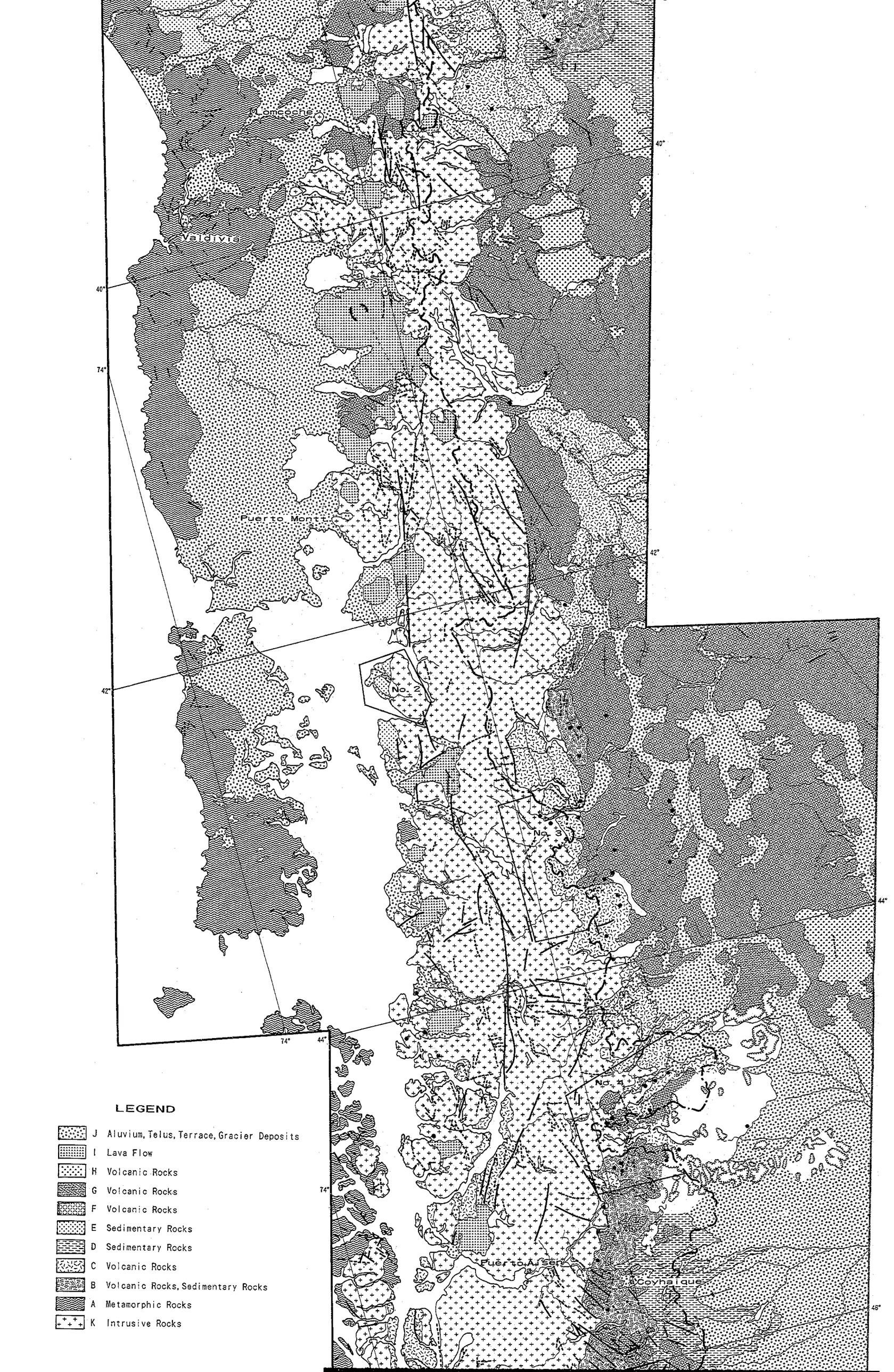
This unit is distributed broadly elongating from the northern part to the southern part of the region. Drainage systems are dendric pattern of high density. The resistance of the rocks are high or very high. The surface undulates deeply and the landforms are characterized by the deep valleys and steep mountains. Topographic features suggesting beddings are almostly not

Table Ⅱ-1-3 Photogeological Interpretation Chart

Unite	Photo-Characteristics		Mophological-Expression					Cover	Conclusion	
	Tone	Texture	Drainage		Rock Properties			vegetation	Probable Lithlogy	Existing Geological data
			Pattern	Density	Registance	Cross sec.	Bedding			
A	light (whitish red)	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 (jurasic)
C	red	coarse	dendritic	low	low		partly bedded	dense	volcanic rocks	volcanic rocks, sedimentary rocks (cretaceous)
D	light (yellowish gray)	fine	dendritic parallel	low	medium~low		very well bedded	none~sparse	sedimentary rocks	sedimentary rocks (cretaceous)
E	red	rough	dendritic	high	low		none	dense	volcanic rocks	volcanic rocks (miocene)
F	red	fine	dendritic	high	high		very massive	very dense	volcanic rocks	volcanic rocks (miocene)
G	yellowish brown	fine	dendritic, parallel	medium	high		massive	moderate	volcanic rocks	volcanic rocks (pliocene)
H	red dark gray	fine	parallel	very low	medium		very massive	moderate	volcanic rocks	basic volcanic rocks (quaternary, terciary)
I	dark gray	fine	radial	low	high~medium		massive	none~dense	volcanic rocks, lava flow	lava (quaternary)
J	red yellowish gray	fine	dendritic meandring	low	very low		none	dense	sediments	aluviam, telus terrace (quaternary)
K	red	coarse	dendritic	high	very high		massive	very dense	intrusive rocks	granitic rocks



38°
40°
42°
72°
74°
Temuco
Loncoche
Valdivia
Puerto Montt


Lomcoche
Valdivia
Puerto Montt
Puerto Aysen
Coyhaique
No. 2
No. 3
Nd
40°
42°
44°
46°
74°
LEGEND
J Aluvium, Telus, Terrace, Gracier Deposits
I Lava Flow
H Volcanic Rocks
G Volcanic Rocks
F Volcanic Rocks
E Sedimentary Rocks
D Sedimentary Rocks
C Volcanic Rocks
B Volcanic Rocks, Sedimentary Rocks
A Metamorphic Rocks
K Intrusive Rocks

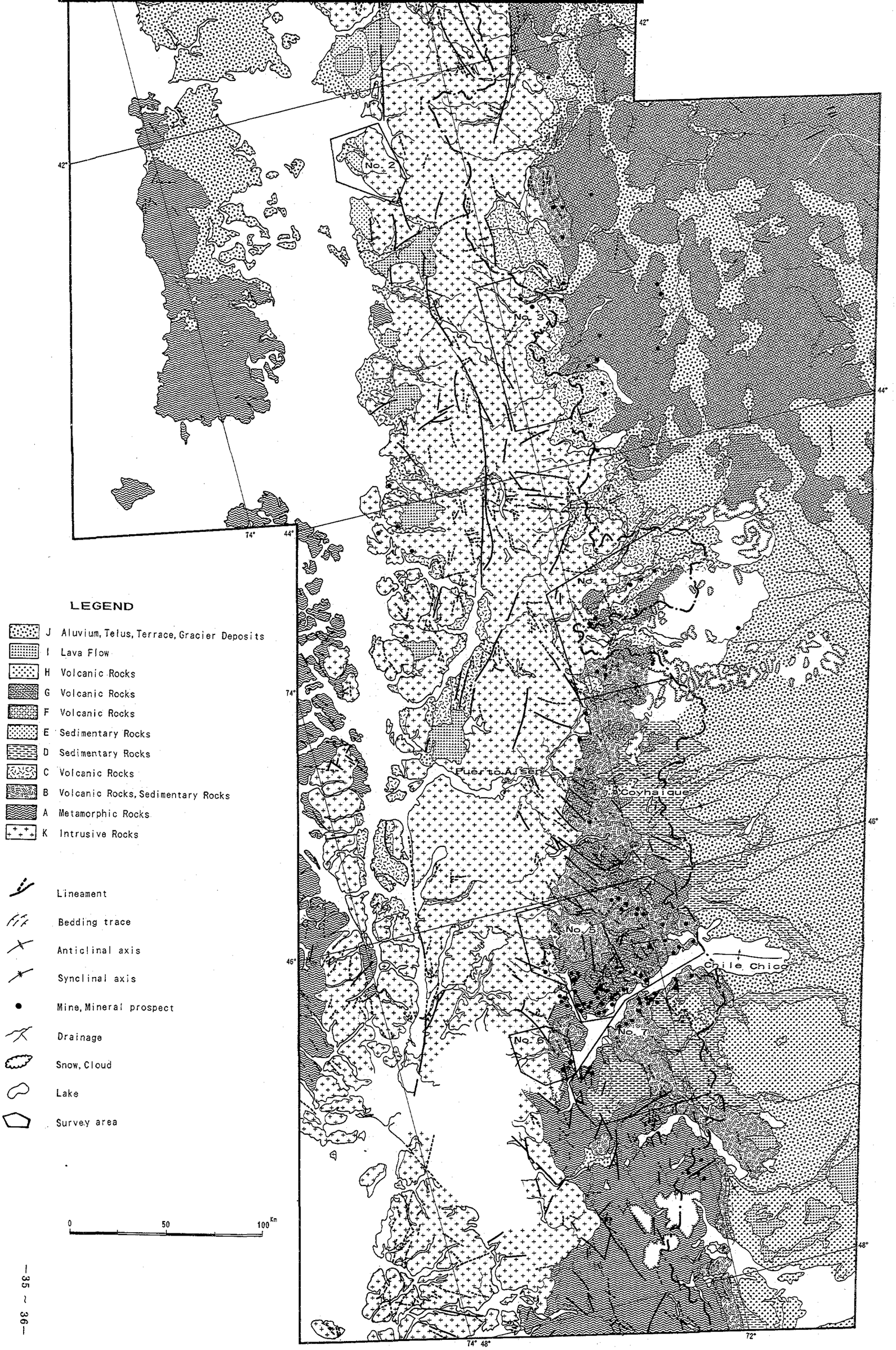


Fig. II-1-3 Photogeological Interpretation Map for Landsat MSS Image

observed, but are massive. The texture is rough.

The distribution of this unit, according to existing data, is in localities of Granitic rocks of Jurassic to Tertiary ages.

1.3.2. Interpretation of Geologic Structures

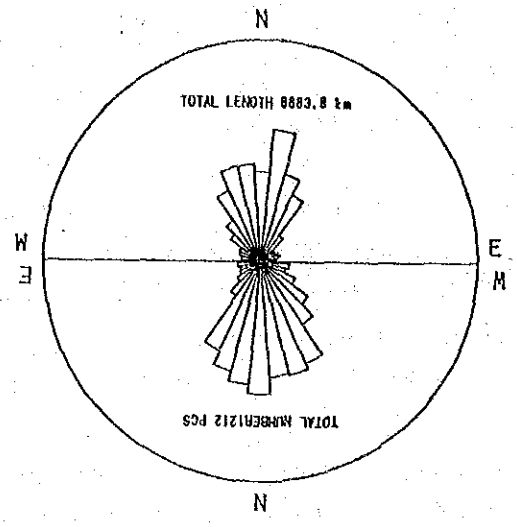
(1) Lineaments

One thousand two hundered and twelve lineaments were extracted and interpreted (Fig.Ⅱ-1-3). Rose diagrams of the number, length and a histogram of the lengths of the investigated area are laid out in Fig.Ⅱ-1-4. It is recognized that the most prevailing direction is generally N-S (N5°E to N5°W) occupying 11% of all lineaments and the two groups of directions of N5°E to N15°E and N15°W to N25°W are secondly prevailing with ten percentages occupations of each group. Looking over all directions of the lineaments, 66% of them are concentrated in the range of 70 degrees between N35°E and N35°W with a peak at N-S direction. Thus, it is recognized that lineaments tend to extend firstly with N-S direction and secondly with the oblique direction between N35°E and N35°W to the N-S systems.

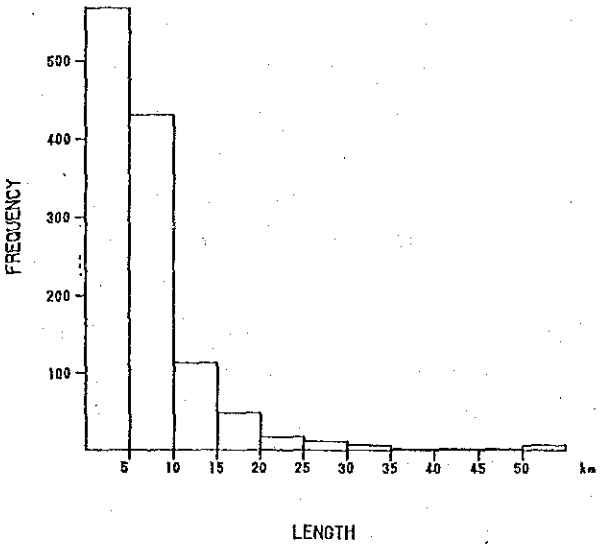
The total length of lineaments trending N5°E to N15°E is 14% in the total length of all the lineaments. The group of lineaments of N15°E to N25°E, N5°E to N5°W, N5°W to N15°W and N15°W to N25°W occupies ten percentages of total length of each group. Therefore the total length of lineaments within 50° from N15°E to N25°W is 54% in the total length of all the lineaments. The histogram of length stepping 5km indicates that the lineaments of 5km and less are the most prevailing in the numbers (47% in all) and the lineaments of 5-10km are secondly prevailing (35%). 82% of all lineaments, in total, are included in the both groupes, while several lineaments are of length of 50km and more. The lineaments of NNE-SSW system generally extend continuously and are developed in the central part of the investigated area.

Although the lineaments of NW-SE system are developed significantly in the southern part of investigated area (around the Lake General Carrera), they are lacking in continuity. In order to understand the distribution patterns of the lineaments visually, the lineament-density contour map was drawn based on the total length of the lineaments covered by a filter of 100km^2 (10kmx10km) stepping each 5km(Fig.Ⅱ-1-5). High density areas are distributed continuously from the northern part to the southern part of the investigated area longitudially on the central zone. A high density area lie in mountainous area along the border line with Argentine. A high density area of the southern part

RATIO OF LENGTH



RATIO OF NUMBER



DIRECTIONS	NUMBER PCS	%	LENGTH km	%
N90°E-N85°E	12	1	62.8	1
N85°E-N75°E	24	2	148.0	2
N75°E-N65°E	21	2	184.3	2
N65°E-N55°E	24	2	163.8	2
N55°E-N45°E	29	2	160.9	2
N45°E-N35°E	42	3	301.8	3
N35°E-N25°E	97	8	699.1	8
N25°E-N15°E	112	9	848.8	10
N15°E-N 5°E	122	10	1235.4	14
N 5°E-N 5°W	131	11	851.9	10
N 5°W-N15°W	114	9	920.7	10
N15°W-N25°W	116	10	923.6	10
N25°W-N35°W	110	9	741.1	8
N35°W-N45°W	75	6	470.4	5
N45°W-N55°W	59	5	358.0	4
N55°W-N65°W	39	3	225.7	3
N65°W-N75°W	27	2	210.2	2
N75°W-N85°W	29	2	193.2	2
N85°W-N90°W	29	2	184.1	2
TOTAL	1212		8883.8	

Fig. Ⅱ-1-4 Rose Diagrams of Lineaments

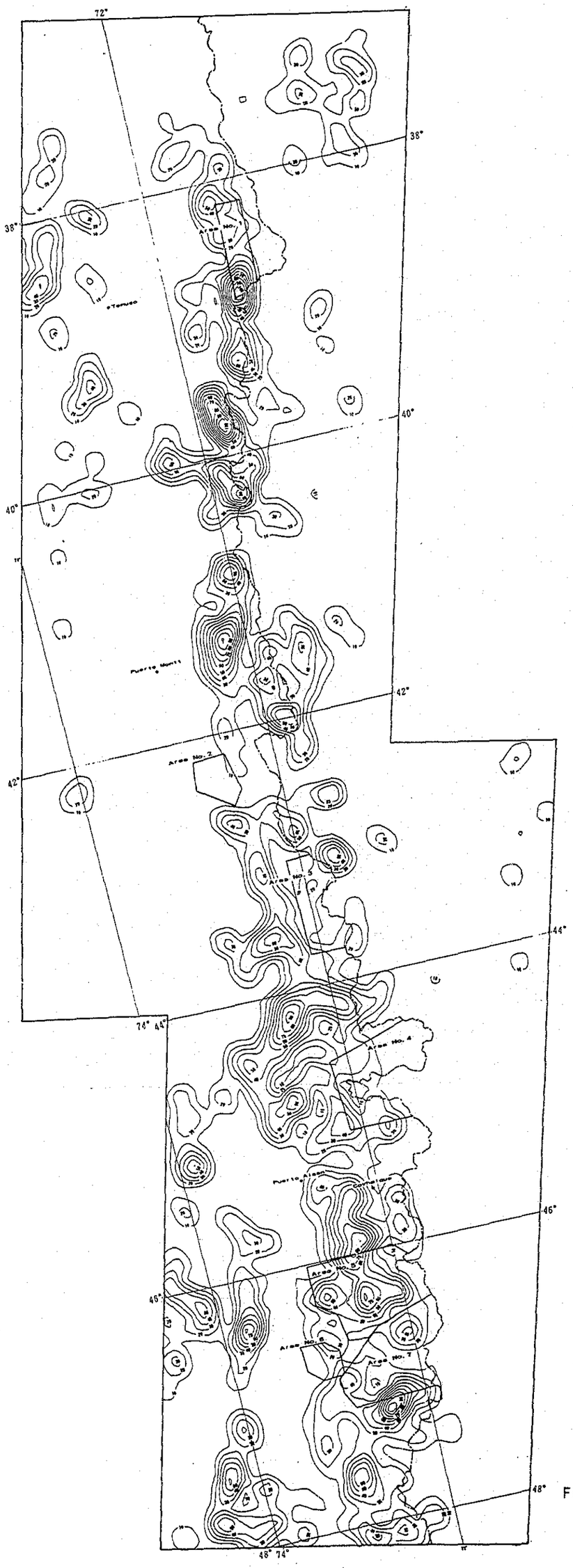


Fig. II-1-5 Density Map of Lineaments

is situated in the Coastal Mountain Range where lie on the side of the Pacific Ocean as well. On the other hand, the development of lineaments are very poor in the lowland area where lie between the Coastal Mountain Range and the Andes Mountains and in the western part of Argentine.

(2) Fold structure

Tracing the beddings was mainly carried out on the observation of the fold structures. The areas where beddings or schistosities were able to be recognized are the northeastern area, the central area and the southeastern area. The beddings in northeastern area are observed mainly in the area within Argentine where is underlain by the unit D. The fold axis generally trend east-west, while some of them extend from the northeast to the southwest and/or from the northwest to the southeast. Combination of anticlines and syncline with short interval is recognized in some localities. It is noted that fierce folding took place in the area. Also in the central area, fold structures were extracted on the side of Argentine of the area. The fold structures were recognized in the units C and G. Direction of fold axis is generally north-south. This direction becomes the northwest-southeast in the northern part. The fold structures in the sotheastern area are distributed from nearby the border line with Argentine to rather inside of Argentine. The area is underlain by chiefly the Unit D. The fold axis trend nearly north-south in the southern part of their distribution area, while they show east-west direction in the southern part.

The fold structures extracted by other viewpoints of photogeology were noted in two localities of the northern part of the investigated area: by the pattern of drainage systems and the features of mountain ridges; i.e. bended drainage systems and the horse-back shaped ridges. The direction of fold axis is north-south.

1.3.3. Discussions

The locations of the mines and prospects in the investigated area are plotted on Photogeological interpretation map (Fig.Ⅱ-1-3). The zones where known deposits are distributed are in the northeastern part (the northeastern and southeastern part of Area No 1), the central part (around areas of Area No 3 and No 4) and the southern part (surrounding area of the Lake General Carrera). The known deposits in the northeastern part of the investigated area occur mainly in the Units B, C and D, or partly in the Unit G as well. The deposits distributed around Area No 3 occur in the Unit D which is chiefly developed in western side of Argentine, while they are developed in the Unit G

as well. The deposits distributed around Area No 4 are developed in the Units B and C. In the area between Areas No 4 and No 5, the deposits occur in the Unit B. Most of deposits in the Areas No 5, 6 and 7 occur in the Unit B. Deposits in a part of those areas, i.e. in the western part of the Areas No 5, 6 and 7 or in the south of the Area No 7, occur in the Unit A. Although a part of deposits occur in the Unit J as well, numbers of them are very few.

As reported above, most of deposits tend to occur in the Units B, C and D throughout the investigated area. This leads to a conclusion that the mineralizations took place mainly in the areas of those Units developping.

As to the spatial relationship between the deposits and the lineaments, few deposits are situated on or near the large lineament extending NNE-SSW in the central part of the investigated area. The deposits seem to tend occuring in the area where short lineaments are developed. That is, the short lineaments trending mainly N-S and NW-SW extensively aggregate in the area around the Lake General Carrera where the distribution of deposit is most significant. There is another extensive distribution area of deposits in Argentine, a part of the northern part of the investigated area, inside of Argentine. This area is characterized by development of fold rather than that of lineament.

From those matters, it is believed that the deposits distributed in the investigated area tend to be found in the area strongly affected by tectonic movement such as the areas which lineaments and/or fold structures are developed.

Chapter 2 Compilation of Existing Data

2.1. Data

Data used for compilaion work are as follows:-

(1) No 1 Lonquimay Area

① Patrcio Salina Zurich(1979): Mapa Geologico de los Andes Alto Bio Bio,Ⅸ Region, Chile,1:50,000.

② JICA and MMAJ(1978): Reconocimiento Geologico Area Coihueco-Lonquimay, 1:50,000.

③ IIG(1973): Mapa Geologico Sector Lonquimay-Villarrica,1:250,000.

④ SERNAGEOMIN(in progress): Avance Geologico Hoja Curacautin,1:250,000.

(2) No 2 Huequi Peninsula Area

① ENAP Chile: Plano Isomagnetico,1:100,000.

② Providencia de Chiloe Depto.de Llanquiue(1949): Plano de Yacimientos Platiniferos de ;la Peninsula de Comau,1:20,000.

(3) No 3 Futaleufu-Alto Palena Area

① Thiele,R.,J.C.Castillo,R.Hein and M.Ulloa(1978): Mapa Geologico de Futaleufu y Palena,1:250,000.

② Castillo,J.C.(1983): Mapa Geologico del Sector Occidental de la Comuna de Futaleufu,1:50,000.

③ CORFO(1980): Prospecciones Mineras Zona Sur-Chiloe Continental Sector Sierra las Ventanas,1:50,000.

④ CORFO and IIG(1980): Mapa Geologico Sector Anomalia I de Cobre Futaleufu X Region,1:2,000.

(4) No 4 Alto Cisnes-El Toqui Area

① SERNAGEOMIN(1984): Carta Geologico de Chile Hoja Peninsula de Taito y Puerto Aisen,1:500,000.

② CORFO(1982): Mapa Metalogenico Pronostico del Sector Continental de Ⅸ Region,Comprendido entre las Lat.45°-47°S y el Estuario Elefantes-Canal Costa.

③ CORFO(1983): Complemento Mapa Metalogenico Ⅸ Region,Sector Norte Continental,Comprendido entre 45°Lat. Sur y el Limite con la X Region.

④ IIG(1978): Carta Geologico de Chile,Region Continental de Aysen entre el

Lago General Carrera y la Cordillera Castillo,1:250,000.

⑤ SERNAGEOMIN(1983): Informe Preliminar,Prospeccion Placeres Auriferos XI Region,1:100,000.

⑥ MMAJ(1977): Report on Overseas Geologic Structure Survey,in Japanese.

⑦ MMAJ(1978): Report on Overseas Geologic Structure Survey,in Japanese.

⑧ Rojo,M.(1977): Geologia de la Region entre el Rio Leones y el Rio Nef,XI Region,Aisen,1:50,000.

⑨ Rojo,M.(1977): Manifestaiones Mineralizadas Rio Leones-Rio Nef,1:250,000.

⑩ SERNAGEOMIN(1984): Complemento Mapa Metalogenico Pronostico XI Region Comprendido entre los 47° de Lat.Sur y Limite con la XI Region, 1:250,000.

The following materials were used commonly for all areas.

① SERNAGEOMIN(1982): Map Geologico de Chile,1:1,000,000.

② Ruiz,C.(1965): Geologia y Yacimientos Metaliferos de Chile.

③ JICA and MMAJ(1982): Estudio Geologico en la Republica Argentina, Face 1, 1:1,000,000.

2.2. Results of Previous Works

2.2.1. Existing Geological Data

(1) General Geology and Mineralization of the Aysen Area

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

The area is underlain by the basement of Paleozoic metamporphic complex, Jurassic system, Cretaceous system, Tertiary system, Quarternary system and granitic rocks(Patagonia Batholith) activated during Jurassic to Tertiary time. Basement rocks of north of latitude 47°S are distributed mainly on western side of the area and they consist of metamorphic rocks such as greenschist, phyllite, quartz schist, mica schist, metasandstone, marl and calcareous schist. Metamorphic rocks other than greenchist are considered to be metasediments. Those rocks are very deformed. Geologic time of sedimentary rocks is reported to be of Devonian to Carboniferous time in Aisen foreland mountains (Precordillera de Aisen) by Skarmeta et al.,1984), although it is not exactly known throughout the unit.

Jurassic system is distributed on east of the Patagonia Batholith elongating with N-S direction. Its distribution area enters into Argentine in

Table Ⅱ-2-1 Correlation Table of Stratigraphy

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 Buenos 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.	Aito Palena Fm.		
Jurassic		Ibañez Fm.	Ibañez Fm.	Ibañez Fm.	Ibañez Fm. / Lago Verde stm.	Tamango Fm. / Ventisquero M. / Tres Monjas M.		Cord. Lonquimay Fm. / Cordillera de Litrncura Fm.
					?	Huemul Fm.		
Paleozoic		Metamorphic basement	Metamorphic basement	Metamorphic basement		Lonconao stock	Metamorphic basement	Gualletue stratum

the north of 43°S. Rocks of Jurassic system consist of mainly intermediate or accidic volcanic rocks and pyroclastic rocks, while the Jurassic rocks distributed in Area No 1 are mainly sedimentary rocks of flysh. Skarmeta et al.(1984) reported that those sedimentary rocks are of Dogger to Malm series.

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

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

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 to 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. Development of glacier sediments are a characteristic geologic feature of Quarternary age.

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

Granitic intrusions of stock-shaped are distribued especially in the

eastern margin 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 accidic on the east(Skarmeta et al.,1984).

The basement rocks of Pre-Mesozoic age are deformerd extensively and contains tholeiitic metabasite. It is assumed from those that the basement is a mélange formed in the subduction zone(Skarmeta et al.,1984). The existence of subduction zone in the southwestern margin of Gondwanaland is discussed by many reserchers (Halpern et al.,1971,1972; Dalziel et al.,1975; De Wit,1977; Cox,1978; Forsthe and Mpodozis,1979).

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 Jurassic period. The area was intruded by plutonic rocks uncontinuously accompanying the volcanism and the huge Batholith body was formed by early Cenozoic(Jenks,1975). 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 direction is constant since Paleozoic to Recent. The fracture systems of N-S direction are prevailed by younger fractures formed in later Tertiary and after. They are concentrated in the Batholith area. Some long fractures extend 100-150km along strike. Quarternary volcanism took place along those fracures and hot springs are still scattered along them.

Fold structure formed during Paleozoic time show composite fold asssociated with drag folds and their axis trend N-S direction. Fold structures developed in Mesozoic rock are very gentle folds. No fold structures are not recognized in Cenozoic rocks. That is, the structural movements of Paleozoic and Mesozoic are characterized by lateral movement, while them of Cenozoic are vertical movement.

Many mineralizations of gold, silver, copper, lead, zinc and molybdenium are distributed in the investigated area: especially they are concentrated in south of 43°S of latitude. Features of those deposits are compiled in Table 1 of Appendices. Those deposits are distributed mainly in the eastern margin of the Patagonia Batholith as shown in Fig.Ⅱ-1-3 and their arrangement show a regional zoning of principal ore metals associations as follows:-

Outward(eastward direction) from eastern edge of batholith;

Molybdenium zone

Copper(gold) zone

Lead-zinc(silver) zone

Gold-silver zone

The farest deposit is about 100km apart from the eastern edge of the Batholith.

The molybdenium zone lie marginal zone or just nearby Batholith and the deposits are consist of narrow veins and occur in granitic rocks. They are distributed in mainly south of 44°S , but the numbers of them very few compered to deposits of other type.

Deposits of the copper(gold) zone in the investigated area are concentrated in south of 43°S. Whereas, they are distributed in Argentine at range of 43°S-44°S. Most of them are vein type, but some of them are massive or lense-shaped deposits. Deposits of the copper zone are almostly always accompanied with a small amount of lead and zinc or with gold in the upper portion in some cases. Deposits developed in the area are generally small scaled and no deposits were mined mainly for copper.

The lead-zinc(silver) zone lie out of the copper zone and most of deposits are distributed in the area between 45°S and 47°S. Deposits of this zone produced 75% of lead and zinc production all over Chile. Deposits are mainly vein type, but some deposits are replacement deposit limestone of Paleozoic and Mesozoic age in which are beded, massive and lense-shaped. Lead ores of deposits of this zone contain relativery high amount of silver; averagely 100g/t Ag. Most typical lead-zinc deposit is El Toqui deposit in Area No 4.

This deposit is calcareous rock replacement large deposit and ore-bearing bed is Coyhaique Formation of lower Cretaceous age; ore reserves are about twenty million tonnes at 183g/t silver, 4.5% lead and 12% zinc. Paleozoic limestone replacement deposit are represented by the Silva and the Rosillo deposits. Ore reserves of those deposits are approximately five hundred thousand to six hundred thousand tonnes at 30% lead and zinc united total, and 100-200 g/t silver.

The gold-silver zone lie outermost and deposits are mostly vein type. Placer gold deposit derived from vein type deposits occur in Area No 1.

Deposits in this zone are characterized by gold bearing quartz vein. They are generally accompanied with very small amount of sulfide minerals and are narrow veins swarm associated with broad accidic hydrothermal alteration zone. Country rocks are accidic to intermediate volcanic rocks or pyroclastic rocks. Typical deposits are "new vein" deposit of Katterfeld deposit of Area No 4 and Laguna Verde deposit of Area No 7.

Both deposits are recent discoveries and extensive exploration works are being conducted. Detailed features of both deposits have not revealed yet, but extensiveness of their exploration activities lead to an assumption that those deposits are very promissing. Consequently, discoveries of deposits of this type are expected to be increased hereafter, although not many deposits have found so far.

(2) Geology and Mineralization, and Past Exploration Activities

1) Area No 1: Lonquimay Area

A. Past exploration works (refer PL.2)

a. Geological survey

Following surveys cover throughout the area

* IIG(1973) at a scale of 1:250,000
* SERNAGEOMIN(1982) at a scale of 1:1,000,000
* SERNAGEOMIN(in progress) at a scale of 1:250,000

Following survey was conducted on a part of the area.

*JICA-MMAJ(1978) at a scale of 1:50,000 covering 600 km^2 and at a scale of 1:5,000 covering 26km^2

b. Geochemical Exploration

All the works except for SERNAGEOMIN(1973) carried out also geochemical exploration on the same covering areas.

c.Geophysical Exploration

JICA-MMAJ(1978 and 1979) applied IP method with 28.2km of total line for Galletue mineralization zone.

d.Drilling

JICA-MMAJ(1978 and 1979) conducted drilling exploration. Amount was 1,334.3m (8 holes) for Galletue mineralized zone.

e. Mining Claims

Conditions of Mining claims marked out in the area as of October,1989 are illustrated in PL.2. Those claims are intended for Placer gold mining.

B. Geology and Mineralization(Fig.Ⅱ-2-1)

a. Geology

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 dyke. 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 SERNAGEON(in progress) are shown in the legend of Fig.Ⅱ-2-1.

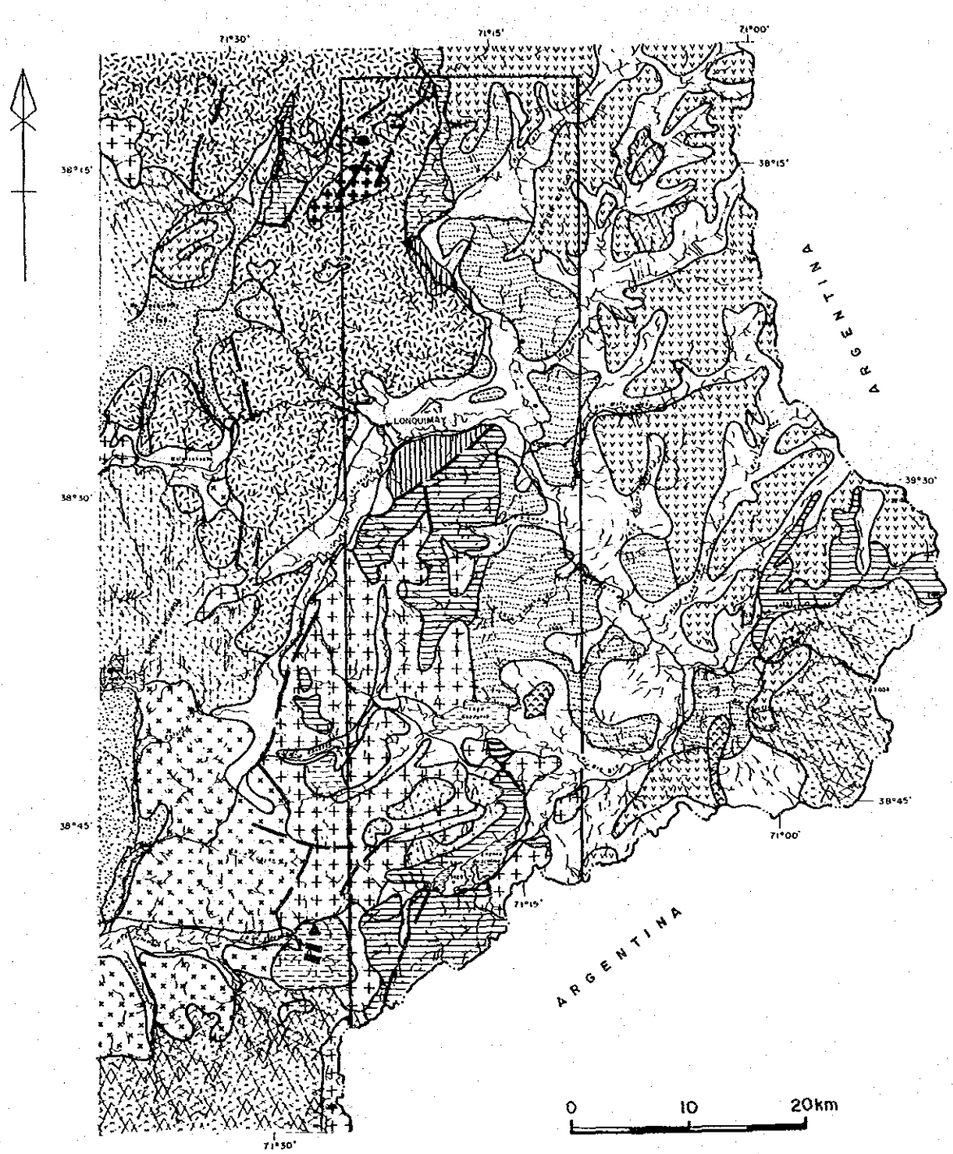
Pre Jurassic systems(Galletue Stratum)

This system is distributed sporadically in the southern coast of the 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 rock is not known.

Jurassic system

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 Codillera 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.

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 Lonquimai Formation. Jurassic system is estimated to be 3,600m thick(JICA-MMAJ,1978).



L E G E N D

Quaternary		Inconsolidated sediments, shallow tephra
Holocene ~ Late Pleistocene		Lonquimay and Llaima volcano
Late Pleistocene		Sollipulli, Callaqui, Tolguaca, Sierra Nevada Ignimbrita and Laguna Marihanqui volcano
Early Pleistocene		Peñón, El Marcial, Co. Ganasto, Pinosolo Tralihue pampas Rahue, Mitirauquén-Pacunto pampas, Cordillera 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		Guailetúe stratum
Intrusive rocks		
Tertiary		Rio Renaico granitoid
Cretaceous		Guailetúe granitoid
		Fault
		Vein type deposits, confirmed
		Dissemination and/or stockworks deposits, confirmed
		Survey area

Fig. II-2-1 Geological Map of Area No. 1(Lonquimay area)

Cretaceous system

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

Tertiary system

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 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)

Guapitrio volcanic rock complex is diistributed 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 Sierra Nevada Formation. Siera Nevada Formation, according to JICA-MMAJ(1978), consist of brecciated andesititc lava accompanied with andsitic tuff and partly tuffaceous sandstone is interbedded.

Rio Pedregoso Formation lies eastern part of the area extending from north to south and lie on the volcanic complex with conformity. This formation consist of altenating bed of sedimentary rocks of marine origine 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 Rio Pehuenco, Rios Llanquen-Ranquil and Co. Bateamahuida predominate in east of the Bio Bio river. Lithology is mainly andesitic lava.

Quarternary system

Quarternary 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 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 lithology varies from tonalite to granite. This rock unit intruded into Jurassic and Cretaceous rocks and are overlain by Rio Pedregoso Formation uncomformably. Porphry copper-molybdenium deposit occur in a part of this rock unit. Rio Renaico granitic rocks lie vicinity of the Racura river where is west out of the area. Lithology is simmilar to 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 axis 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.

b. 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 the 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

mineralizations 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 mineralized zone. Several other mineralizations are known in the area, but they are almostly barren quartz veins. Araucaria deposit lie 12 km west of the Lake Icaluma and 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 mineralized 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.

2) Area No 2: Huequi Peninsula Area

A. Past Exploration Activities(see PL.3)

a. Geological Survey

The works covering throughout the area are listed as follows:-

* SERNAGEOMIN(1982) at a scale of 1:1,000,000
* IIG(1966) at a scale of 1:500,000

b. Geochemical Survey

SERNAGEOMIN conducted beach sand geochemical survey along the coast from the Comau mountain to Punta Baja.

c. Aeromagnetic Survey

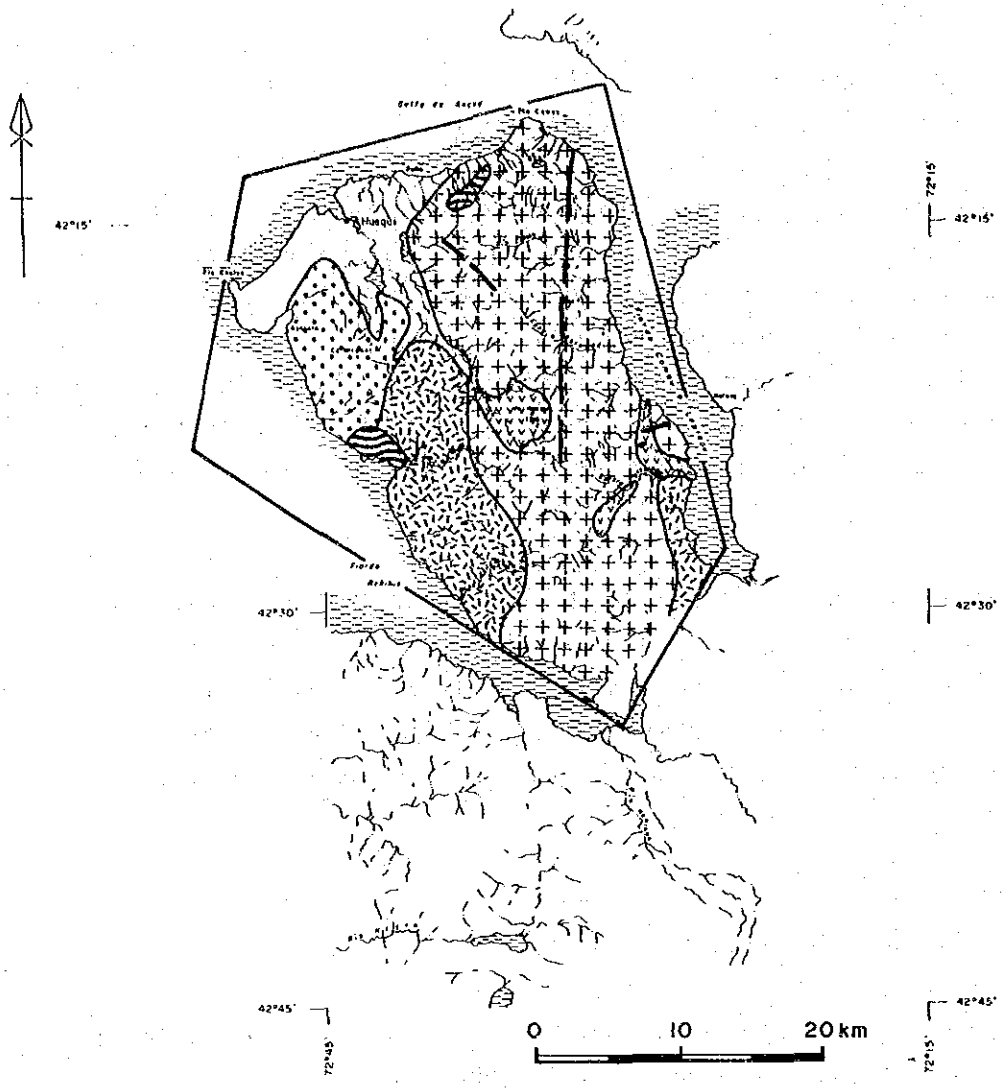
ENAP(1962) completed aeromagnetic survey on mainly marine area. Its coverage area overlaps the northern edge of the Peninsula.

d. Conditions of Mining Claims

No claim is marked out as of the Octobre, 1989.

B. Geology and Mineralization(see Fig.Ⅱ-2-2)

a. Geology



L E G E N D

Quaternary		Continental and marine sediments
		Volcanic rocks
Tertiary (Miocene-Eocene)		Marine sedimentary rocks
		Continental sedimentary rocks
Devonian		Marine and transitional sedimentary rocks
Intrusive rocks		Tonalite, migmatite, amphibolite, gneiss and pegmatite
		Fault
		Survey area

Fig. II-2-2 Geological Map of Area No. 2(Huequi Peninsula area)

Very few geological information are available. Only a geological map at scale of 1: 1,000,000 (SERNAGEOMIN,1982) was obtained through this work. Geology of the area, according to this material, is as follows:-

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

Quarternary volcanism such like Volcan Huequi etc. errupted volcanic ejectas of andesitic composition which are distributed in the eastern part of the Peninsula. Intrusive rocks mainly underlie eastern half of the Peninsula. Lithology of intrusive rocks is complicated with many rock types: tonalite, migmatite, amphibolite, gneiss and pegmatite etc.

Inferred faults of N-S and NW-SE systems occur in the intrusive rocks zone. Structures of Devonian system and Tertiary systems are not known well.

b) Mineralization

Any mineral deposit has not been discovered in the area, while platinum geochemical anomalies were established by SERNAGEOMIN and magnetic high anomaly was detected by ENAP(1962).

3) Area No 3: Futaleufu-Alto Palena Area

A. Past Exploration Activities

a.Geological Survey

Following works cover whole the area:

* SERNAGEOMIN(1982) at scale of 1:1,000,000
* Thiele et al.(1978) at scale of 1:500,000

Whereas the following works cover a part of the area

* CORFO(1979) at scale of 1:50,000
* CORFO(1980) at scale of 1:2,000(area: 4km^2)
* Castillo(1983) at scale of 1:50,000

b. Geochemical Exploration

CORFO(1980) carried out soil geochemical work in the area between Futaleufu town and the Lake Lonconao covering km². Amount of samples were 137 and three elements, Cu, Pb, Zn, were selected for the pathfinder elements.

c. Groundmagnetic Survey

CORFO(1979) conducted groundmagnetic survey at the same time with geochemical survey.

d. Conditions of the Mining Claims

No claim is marked out within the area as of October, 1989.

B. Geology and Mineralization(see Fig.Ⅱ-2-3 and Fig.Ⅱ-2-4)

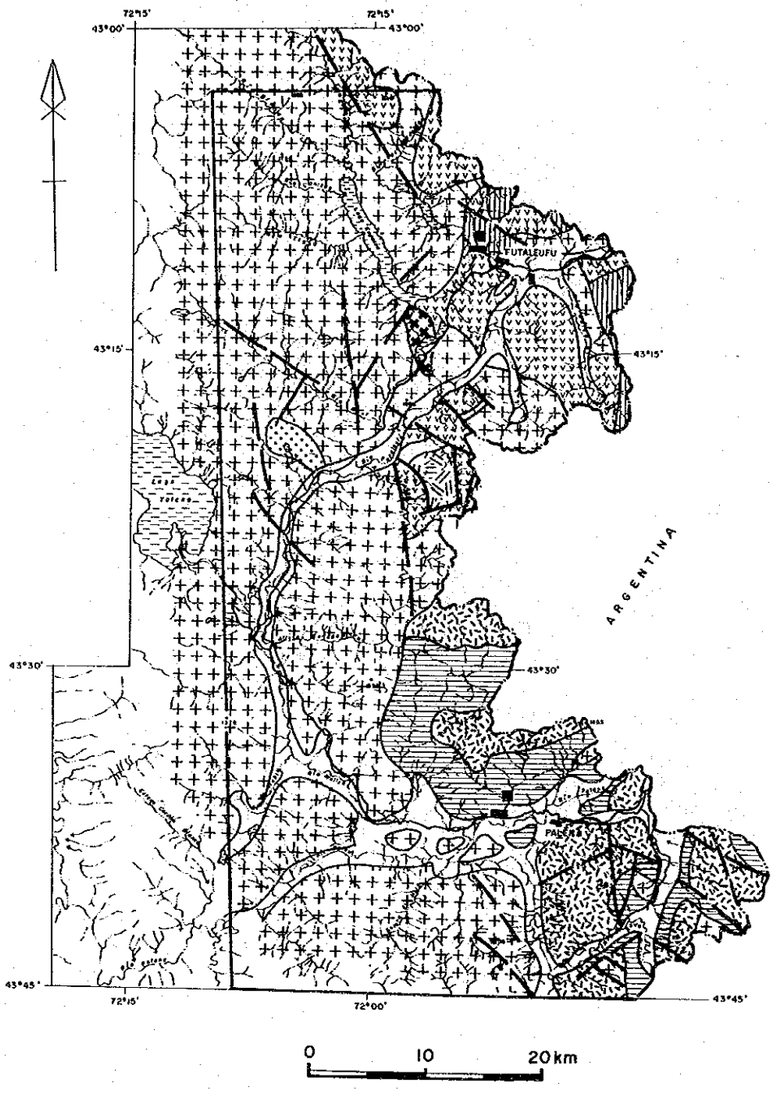
a. Geology

Regional geology of the area was compiled by Thiele et al.(1978) as shown in Fig.Ⅱ-2-3. Description of the geology on this section follows them.

The area is underlain by volcanic rocks, sedimentary rocks and intrusive rocks of Mesozoic and Cenozoic age. Mesozoic unit cosists of Jurassic system and Cretaceous system. Jurassic system is called Futaleufu group. This group is divided into two more units: Huemul Formation and Tamango Formation in ascending order. Cretaceous system is divided into Alto Palena Formation and Cordon de las Tobas Formation in ascending order.

Huemul Formation lies broad area around Futaleufu town where is located in the northern part of the area. This formation is composed of volcanic rocks and pyroclastic rocks errupted onto land. The base of this formation is not found, but the top of this is covered by Tamango Formation with conformity. Huemal Formation consists of mainly andesite and dacite interbeded with thin beds of chert and accidic tuff. This formation is 550 to 1,000m thick and seems to be of Lias series.

Tamango Formation is divided into Tres Monjas member of lower sequence and Ventisquero member of upper sequence. Tres Monjas member consists of mainly sedimentary rocks of marine origin containing fossils. This marine facies lie south of Futaleufu valley, while they interfinger with pyroclastic rocks deposited on land or very shallow aqueous zone. Sedimentary rocks of marine origin consist of mainly black shale and sandstone interbeded with thin beds of limestine. Pyroclastic rocks are composed of fine-tuff and lapilli tuff intercalated with dacite lava. This member is said to be of Dogger series.



L E G E N D

Quaternary	Fluvio-glacial deposits	Fluvial and alluvial
Tertiary	La cascada F.	Marine sediments
Late Cretaceous	Cordon de Los Tobas	Continental volcano sedimentary rocks
Early Cretaceous	Alto Palena F.	Marine and continental sedimentary rocks
Late Jurassic	Tamango F.	Volcanic rocks (Ventisquero member)
Middle Jurassic	Tamango F.	Marine sedimentary and volcanic rocks (Tres Monjas Menber)
Early Jurassic	Huemul F.	Continental volcanic rocks
Late Cretaceous		Futaleufú-Palena Batholith
Paleozoic		Lonconao stock
		Fault
		Vein type deposits, confirmed
		Strata-bound, manto and lenticular type deposits, confirmed
		Survey area

Fig. II-2-3 Geological Map of Area No. 3(Futaleufu-Alto Palena area)

Ventisquero member lies the Cos Picados mountain area where is in central part of the area, covering Tamango member conformably. This member consists of andesite, dacite and dacitic tuff. Northern part of distribution area of this member were eroded extensively so that only the volcanic neck remains. This member is said to be of Later Jurassic age.

Futaleufu group is correlated to Ibanez Formation developed in south of Area No 4(Niemeyer,1975).

Alto Palena Formation is distributed in north of Alto Palena town. It is generally composed of sedimentary rocks of marine origin, but volcanic rocks become prevailling in northern part of its distribution area. The base of this formation is not known. The top of it grades into Cordon de las Tobas Formation. Thickness is 1,240m. Age of this formation is determined to be Neocomian stage (Fuenzalida,1968). This formation is correlated to Coyhaique Formation (Lahsen, 1966; Skarmeta,1974).

Cordon de las Tobas Formation lie south of Alto Palena town. It consists of continental deposits: mainly andesitic volcanic rocks interbeded with sandstone and shale containing fossils of leaves rarely. The bottom of this sequence overlaps Alto Palena Formation conformably and the top is not identified yet due to errosion. This formation is estimated to be 560m thick and is correlative to Divisadero Formation (Skarmeta, 1974). Age of this is said to be Hauterivian to Albian stage(Thiele et al.,1978).

Cenozoic units are of Eocene series and Quarternary system. Formation of Eocene series is called La Cascada Formation. It lies central to northern part of the area sporadically. The bottom of the formation consists of basal conglomerate deposited during transgression and overlies granite unconformably. Top of this formation is not identified due to erosion. This formation consists of mainly of basal conglomerate and sandstone, and intercalates shale, wackestone and calcareous sedimentary rocks. Several beds containing coal materials and fossils are interbeded into the middle to upper portions of this formation. Niemeyer(1975) correlated this formation to Guadal Formation.

Quarternary system consists of alluvial and glacier depposits distributing along river.

Intrusive rocks are grouped into three rock bodies as follows:-

* Lonconao rock body
* Futaleufu-Palena rock body
* Matreras rock body

Lonconao rock body is a stock of tonalite lying the Lake Lonconao area. This rock body is the basement of Huemul Formation of Lias series so that it is pre-Jurassic rock. Futaleufu-Palena rock body occupies more than 80% in volume of all the intrusive rocks in this area and is distributed very broadly in the western part of the area. Rocks of this body varies from diorite to monzoni granite, but the latter predominates mostly. Time of intrusion event is said to be Later Cretaceous.

Matreras rock body is distributed in the Colorado mauntain area where lie on the sothern edge of the area. It is a stock of granite and shows very homogeneous lithofacies. This rock body intrudes Cordon de las Tobas formation and bounded with Futaleufu-Palena rock body by fault.

The formations of the area are gently deformed, but geologic structure is simple. Sedimentary rocks show gentle monocline structure. As to fractures, NW-SE system and NNE-SSW system predominate. It is said that those fracture pattern may reflect the block movement of the basement.

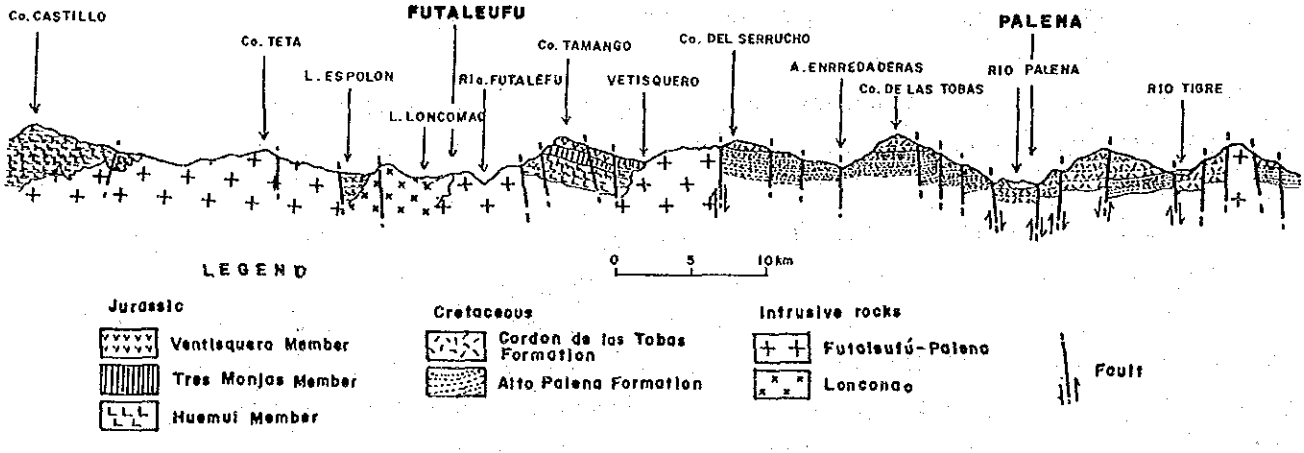


Fig. II-2-4 Schematic Geological Profile across Area No.3(Futaleufu-Alto Palena area)

b. Mineralization

Very few data for mineral prospects are available. Only CORFO(1980)

reported about prospcts of copper lying west of Futaleufu town. These prospects are situated on hill at 627m in elevation, 2km west of the town. The deposits are vein consisting of chalcopyrite and specularite. Most large prospect is called "Anomalia I de Cobre" in junction of the Espolon river and the Bella Vista river. Vein minerals are chalcopyrite, specularite, chalcocite and covelline etc. Conntry rock is reported as sedimentary rock of Huemul Formation. Veins are small; 0.15 to 0.20m wide, extend 15 to 20m along strike. Copper grade of 2.97% is reported. Other three similar mineralizations of similar style occur in the hill.

4) Area No 4: Alto Cisnes-El Toqui area

A. Past Exploration Activities(see PLATE 9)

a. Geological Survey

Following works cover whole the area:-

* SERNAGEOMIN(1983) at scale of 1:250,000
* SERNAGEOMIN(1984) at scale of 1:500,000
* CORFO(1982) at scale of 1:250,000

The first two data were edited by compiling following works listed below. Editorial work was completed mainly by using photogeological interpretations on aerial photographs and Landsat inages. Actual areas of field work are limited to the areas extended along the major rivers.

* Geological survey conducted by SERNAGEOMIN at scale of 1:250,000
* Photogeological interpretation on aerial photographs and Landsat images
* Other field surveies: Fuenzalida and Etchart(1975); Skarmeta and Niemeyer(1975); Joubin and Veltheim (1963); Katz(1961,1962); Duhart(1960) ; Lahsen(1966)

b. Geochemical Exploration

The work of SERNAGEOMIN(1984) is sole geochemical survey in the vicinity of the area. This work, however, was conducted only along the Carretera Austral main road in west out of the area. No geochemical data is available within the area.

c. Other Exploration Works

There are some large deposits in the area and the companies are conducting their exploration works by themselves. Most of explorations by companies have not been published.

d. Conditions of Mining Claims

Plate 9 illustrates the mining title marked out as of October,1989. That of northern part is of the Santa Teresa mine and those of southern part are of the El Toqui mine and the Cerro Estatuas mine.

B. Geology and Mineralization(Fig.Ⅱ-2-5)

Description in this section follow SERNAGEOMIN(1983 and 1984)

a. Geology

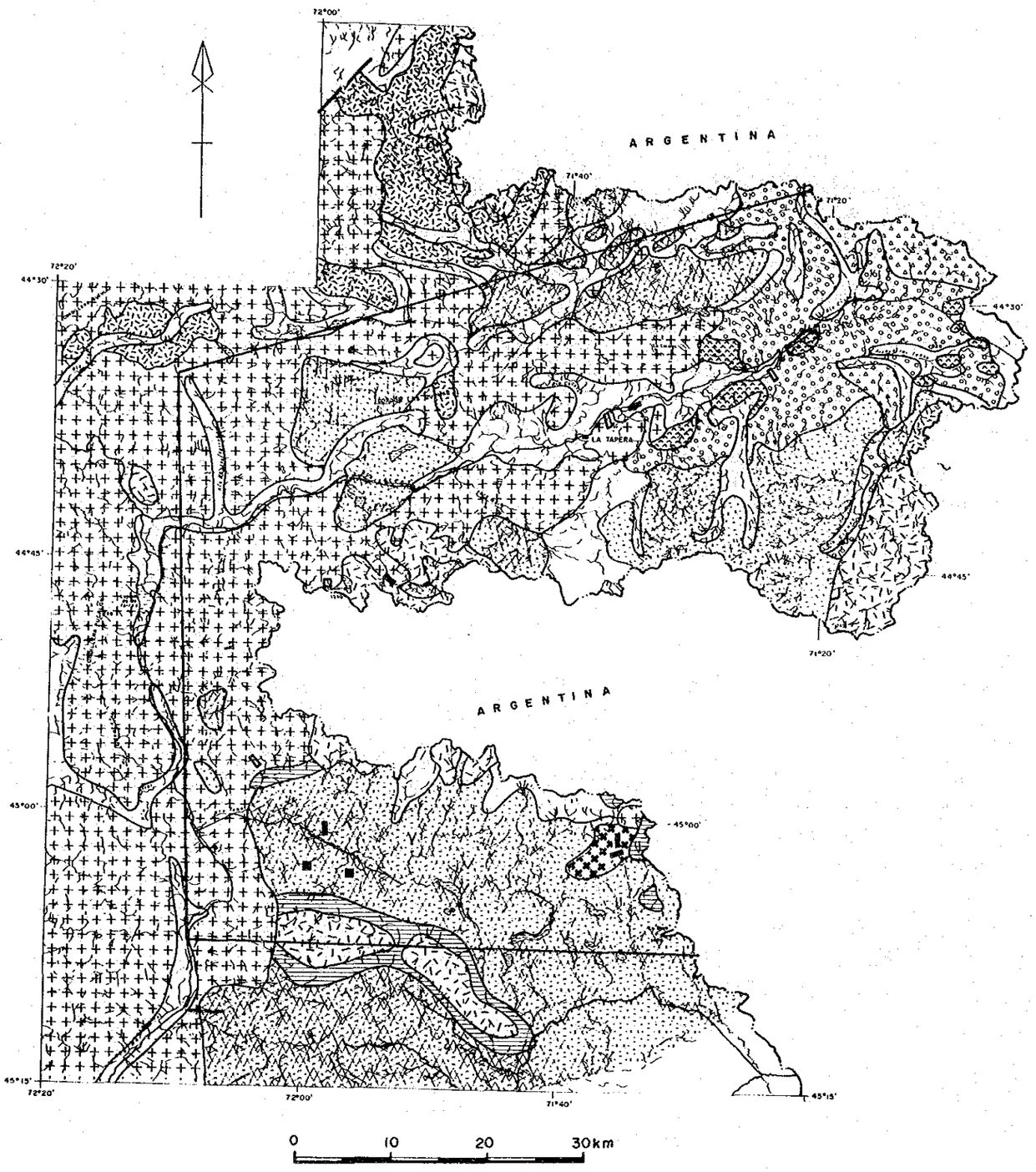
Geology of the area is grouped into the Patagonia Batholith on western side, and volcanic rocks and sedimentary rocks on eastern side. Geological units on eastern side are divided into Mesozoic unit and Cenozoic unit bounded by conspicuous angular unconformity. Mesozoic units are classified into the following four formations in ascending order.

* Ibañez Formation
* Coyhaique formation
* Lago Verde Formation
* Divisadero Formation

Ibañez Formation extends from northern part to southern part of the area. A part of this lie on the Patagonia Batholith with featuring roof-pendant. This formation mainly consists of pyroclastic rocks and volcanic rocks and their compositions show accidic to intermediate. Although it is known this formation overlies Paleozoic metamorphic rocks in the Lake General Carera district, relationship between this formation and inferior formation is not known in this area. Rock type are rhyolite, andesite, dacite and pyroclastics. Age is said to be Middle or Late Jurassic time(Niemeyer et al.,1984).

Coyhaique Formation lies southern part of the area overlying Ibañez Formation with conformity or partly unconformity. This formation consists of mainly shale and sandstone of marine origin containing fossils. In the El Toqui mining area, this formation intercalates many calcareous rock beds such as limestone and coquinite which are ore-bearing beds of the El Toqui deposit. Andesitic pyroclastic rocks and volcanic rocks are also intercalated into this formation in the mine area. Figure Ⅱ-2-6 shows a schematic stratigraphy in southern part of the area. Age of this formation, according to Niemeyer et al.,(1984), is said to be Early Cretaceous (Berriasian to Aptian stage).

Lago Verde Formation lies northern part of the area consisting of andesite



L E G E N D

Holocene	Fluvio-glacial deosits	Fluvial and alluvial
Pleistocene	Old fluvio-glacial deposits	Marine sediments
Pleistocene	Las Nacientes del Rio Cisnes stratum	Basalts and andesite
Neogene	Frias F.	Gravels, semi-consolidated, tuffs and tuffites
Late Cretaceous	Divisadero F.	Dacites, andesites and tuffs
Neocomian to Late Jurassic	Lago verde stratum	Green andesites, tuffs and lapilli tuffs
Neocomian	Coyhaique F.	Shales and sandstones
Late Jurassic	Ibañez F.	Rhyolites, dacites, andesites, tuff breccias and sandstones
Intrusive rocks		Granites to gabbros
Intrusive rocks		Quartz porphyry
		Fault
		Vein type deposits, confirmed
		Vein type deposits reported
		Strata-bound, manto and lenticular type deposits, confirmed
		Strata-bound, manto and lenticular type deposits, reported
		Survey area

Fig. II-2-5 Geological Map of Area No. 4(Alto Cisnes-El Toqui area)

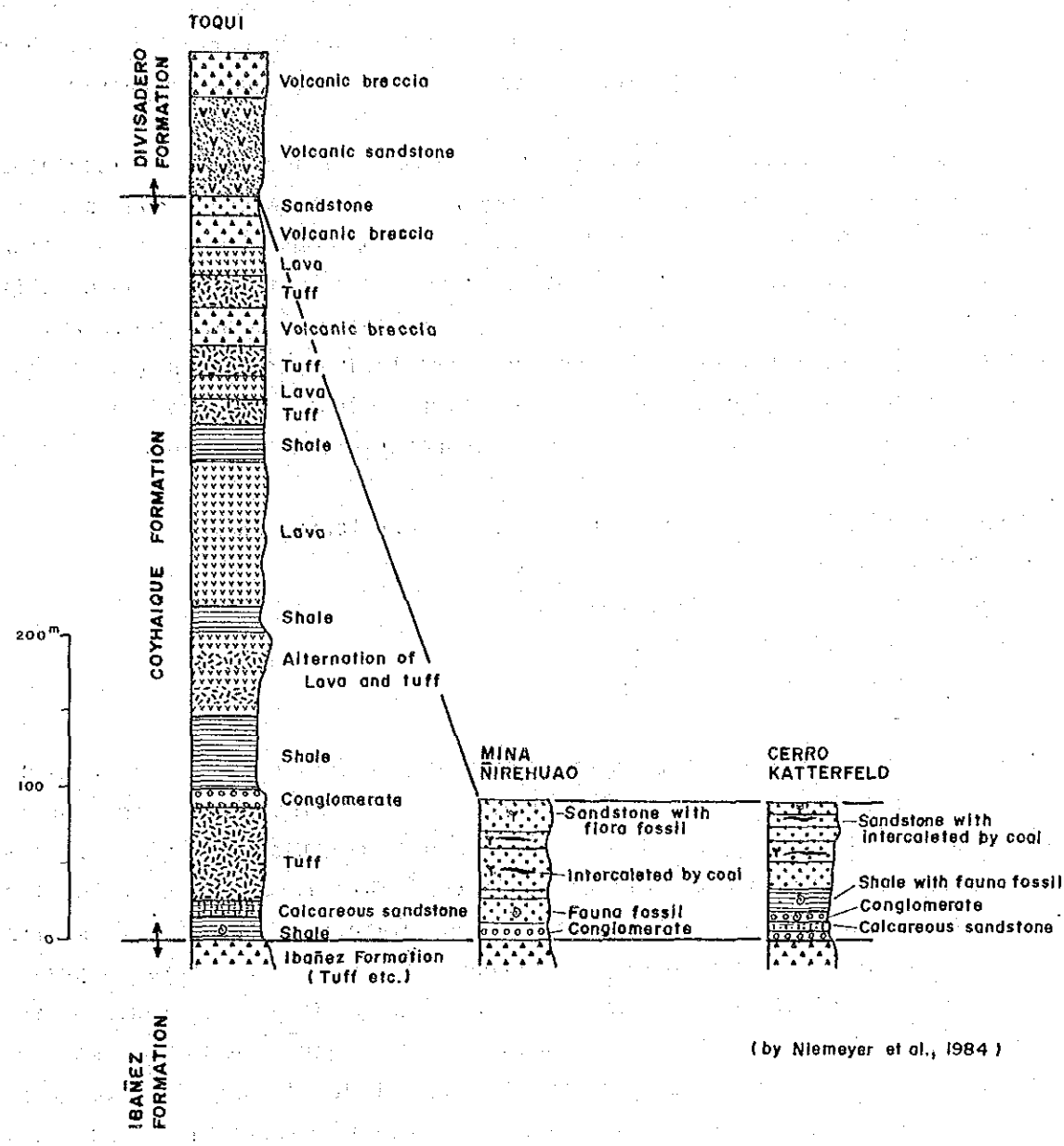


Fig. II-2-6 Schematic Geological Correlation Column on Area No. 4
(Alto Cisnes-El Toqui area)

lava, andesitic tuff and lapillituff and so on. Stratigraphy of this formation is not revealed well, but lower sequence is correlative to a part of Ibanez Formation and upper sequence is to a part of Divisadero Formation. Further investigations are required for identification of stratigraphic succession.

Divisadero Formation is distributed on high altitude part of mountains overlaying Coyhaique Formation conformably. This formation consists of pyroclastic rocks and intercalated lava. Chemical composition varies from andesitic to rhyolitic. Generally light green or light pink tuff or sandy tuff predominate in this formation. No fossils is contained in this formation so that age of sedimentation is estimated from stratigraphic relationships to the inferior formation and/or absolute chlonology. Those studies led to a conclusion that the formation is of Middle to Later Cretaceous time.

Cenozoic unit is classified into following four formations.

* Frias Formation
* Las Nacientes del Rio Cisnes Formation
* Older alluvial and glacial deposit
* Younger alluvial and glacial deposit

Frias Formation mainly lies upriver area of the Cisnes river. It consists of mainly half-loose sand and gravel interbeded with tuff. This formation is said to be of Neogene time. Las Nacientes del Rio Cisnes Formation lies sporadically the uppermost of the Cisnes river. This formation overlies the inferior formations unconformably forming lava plateau of basaltic rock. Age is said to be Alluvium age. Older and younger alluvial and glacial deposits overlie rocks of end of Tertiary to Early Quarternary time in the basin of the Cisnes river. Older alluvial and glacial deposits predominate in uppermost of the Cisnes river consisting of half-loose gravel. Older deposit is said to be of Alluvium age. Younger deposits consist of loose gravel, sand and mud etc. and is said to be of Holocene age.

Intrussive rocks distributed in the area are situated in eastern margin of the Patagonia Batholith. They predominate in western part of the area. Rocks vary from diorite to granite. As to the time of intrusion event, the folowing data are available.

Niemeyer et al.(1984): 107 and 109Ma (Rb-Sr method)
SERNAGEOMIN(1983): 70, 85, 100, and 125 Ma (K-Ar method)

Those values correspond to Cretaceous time.

b. Mineralization

Ten and several mines and/or prospects are known in the area as listed in Table 1 of Appendices. They are grouped into three categories based on principal ore metals associations. That is; gold-(copper) deposit, lead-zinc deposit and molybdenium-(copper) deposit.

All of gold-(copper) deposits are vein type and are represented by the Santa Teresa and the Katterfeld deposits. Table 1 of Appendices compiles settings of those deposits detailedly. In this section, outline of deposits is reported on the basis of existing data and results of this survey.

The Santa Teresa deposit (other name is the El Condor etc.) occurs in Quartz porphry. Vein consists of galena, sphalerite, chalcopyrite and quartz etc. Scale of vein is relatively large; 2 to 5m wide, extending 900m along strike and more than 290m toward depth. Wall rock alteration is generally weak, but sericitization is recognized just next to vein, but rock fragments involved in vein materials are kaolinitzed. Vein outcrops are slightly gossaneous but it grades into primary zone in just shallow depth.

The Katterfeld deposit consists of two different type of deposits. One shows similar features to the Santa Teresa deposit. That is, it is vein type deposit of copper, lead and zinc accompanied with gold. Another is vein type deposit consisting of quartz and hematite with very small amount of sulfide minerals. This deposit is targeted for exploration works of a company. Many parallel veins occur within a mineralized zone of one kilometer width. Assays on outcrop showed grade less than 1g/t, but grades in depth are not tested by this survey. This deposit is associated with reddish brown gossanious zone of 1kmx2km in size as well. Wall rock alteration, wall rock is andesite of Ibañez Formation, shows zoning; muscovite-kaolinite-calcite zone in center of mineralized zone and silicification-deckite zone in outer zone.

As to lead and zinc deposit, the El Toqui deposit which is in operation and the Cerro Estatuas deposit are noted. Both deposits are calcareous beds replacement deposit accompanied with skarn minerals. Ore-bearing beds are members of Coyhaique Formation. Three strata of ore-bearing beds are recognized in the El Toqui deposit. The strata of Cerro Estatuas is said to lie on more higher horizon than those of the El Toqui deposit. About ten million tonnes of ore reserves are estimated for both deposits each.

Molybdenium-(copper) deposit is vein deposit occuring in the Patagonia

Batholith. All of them are less than 0.2m wide and exploration works targeted for them are no more than small and shallow pits. Vein constituting minerals are molybdenite, chalcopyrite, pyrite and quartz. Molybdenium grade of relatively high grade ore (Veta Campamento) is 0.4%.

5) Area No 5: Ibañez-Murta Area

A. Past Exploration Activities(PLATE 5)

a.Geological Survey

Works covering whole the area are as follows:-

* SERNAGEOMIN(1978) at scale of 1:250,000
* SERNAGEOMIN(1982) at scale of 1:1,000,000
* SERNAGEOMIN(1982) at scale of 1:250,000
* SERNAGEOMIN(1984) at scale of 1:500,000

Whereas, the following works cover a part of area.

* MMAJ(1978) at scale of 1:100,000(covering area:2,000km^2)
* MMAJ(1979) at scale of 1:10,000(covering area:28.5km^2); trenching work of 100 meters in total is involved in this work.

b. Geochemical Exploration

Very few geochemical works were put in the area, while only SERNAGEOMIN(1984?) carried out pan concentrate geochemical survey along main road(PLATE 5).

c. Geophysical Survey

MMAJ(1979) conducted a geophysical survey by IP method (18.1km of total survey line).

d. Drilling Exploration

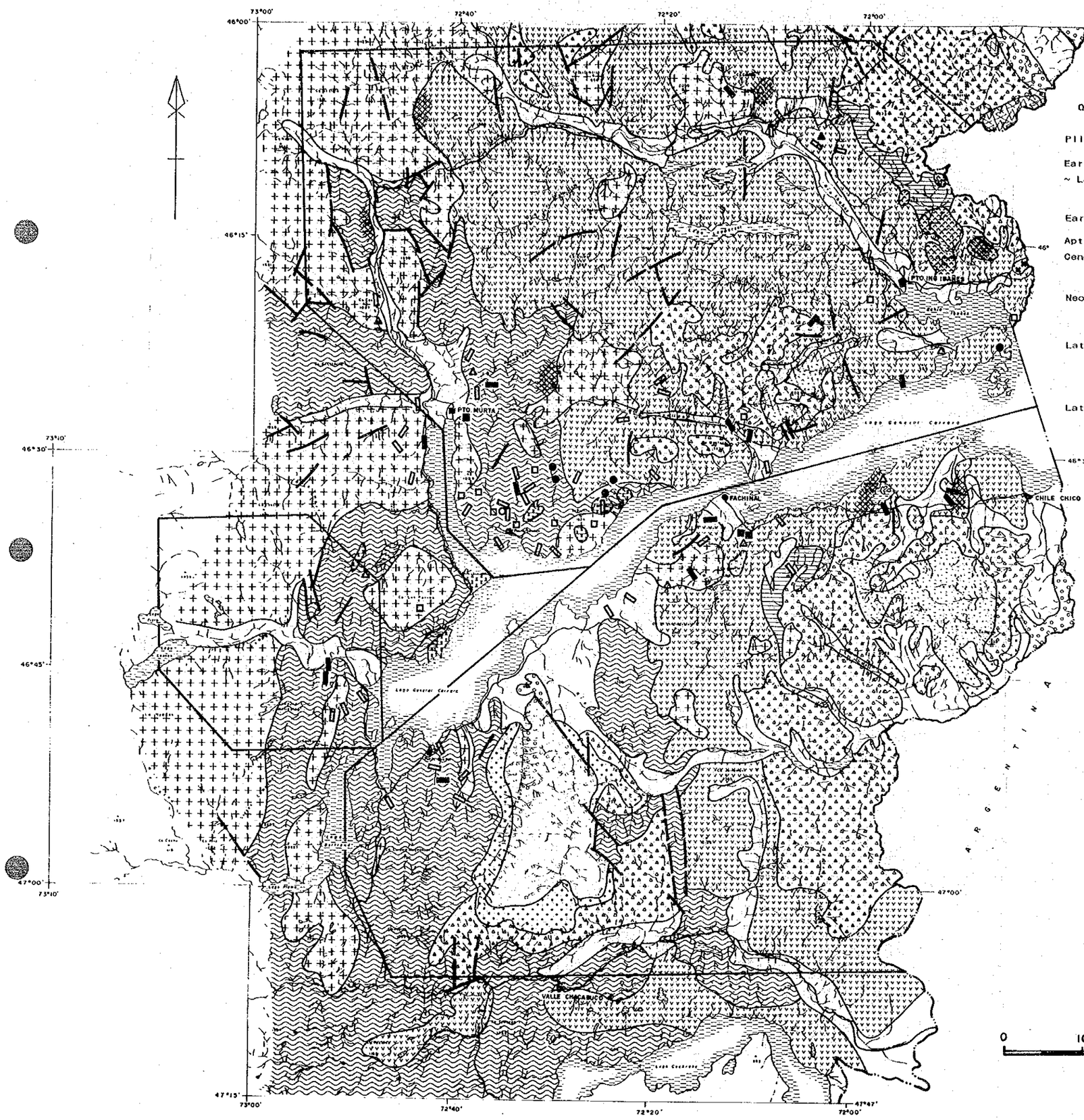
Informations concerning drilling works conducted by companies are very hardly available. Available data are as follows:-

El Pelado mine	10 holes in 1973
Silva mine	2 holes with total of 300m in 1989
Rosillo mine	9 holes with total of 717.87m in 1987

e. Conditions of Mining Claims

PLATE 5 illustrates mining titles marked out within the area as of October,1989.

B. Geology and Mineralization(see FigureⅡ-2-7)



LEGEND

Quaternary	Fluvio-glacial deposits	Alluvial, fluvial, colluvial and talus
Pliocene	Buenos Aires Mesta F.	Alcalic basaltic lavas
Early Miocene ~ Late Oligocene	Galera F.	Conglomerates, continental sandstones
Early Oligocene	Guadal F.	Marly marine sandstones
Aptian ~ Cenomanian	Divisadero F.	Rhyolitic tuff, andesites, tuff breccia and sandstone
Neocomian	Coyhaique F.	Fossiliferous black shales, sandstones partialy calcareous conglomerates
Late to Middle	Ibañez F.	Dacites, andesitic torhyolitic breccias and Jurassic andesitic tuff breccia
Late Paleozoic	Metamorphic basement	Amphibolite, schist, phyllite and quartzite
		Marl and calcareous schist
	Intrusive rocks	Basalt
		Rhyolitic dome Laguna Pollolla rhyolite
		Granites, tonalites and diorite
		Hydrothermal alteration

- Fault
- Unclassified deposits
- Vein type deposits, confirmed
- Vein type deposits reported
- Strata-bound, manto and lenticular type deposits, confirmed
- Strata-bound, manto and lenticular type deposits, reported
- Dissemination and/or stockworks deposits, confirmed
- Dissemination and/or stockworks deposits, reported
- Survey area

0 10 20 30km

Fig. II-2-7 Geological Map of Areas No. 5(Ibañez-Murta area), No. 6 (Los Leones area) and No. 7(Chile Chico-Chacabuco area)

a. Geology

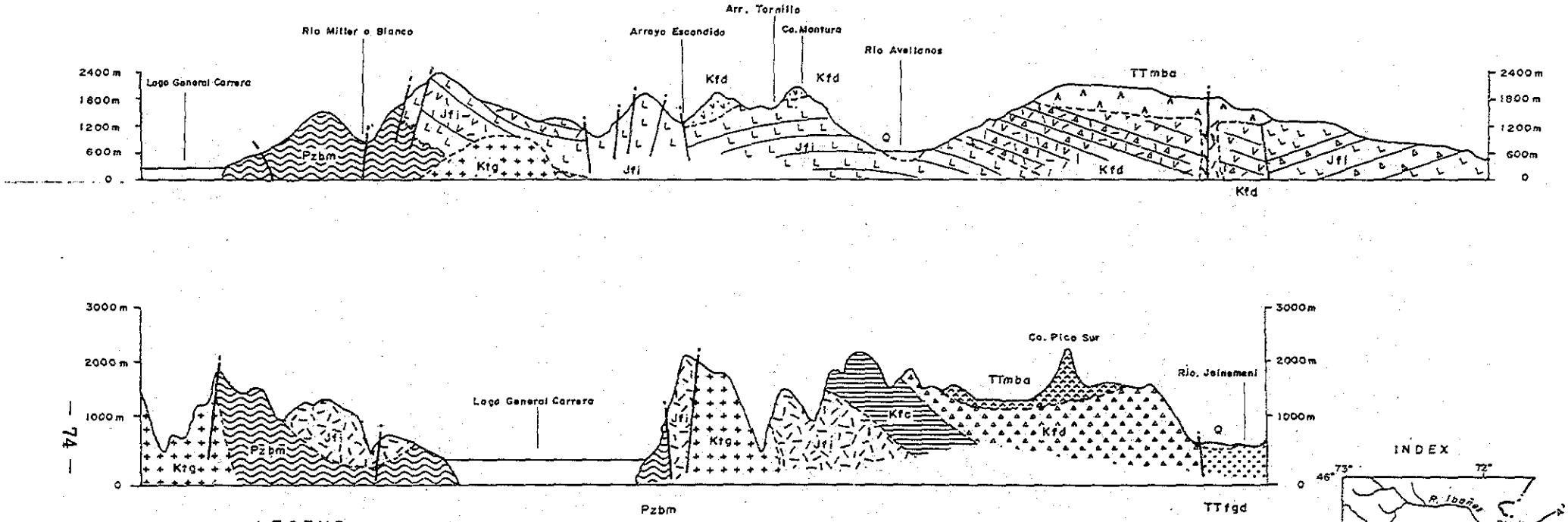
Basement of Later Paleozoic metamorphic rocks, Mesozoic unit and Cenozoic unit underlie the area. As to intrusive rocks, stocks and dyke related to the Patagonia Batholith are distributed in the area.

Metamorphic rocks lie western part of the area extending from north to south and are limited on their western edge by the Patagonia Batholith. Most of them (80-90%) consists of crystalline schists; mica schist and quartz schist grade into blackschist and/or greenschist. Those crystalline schists intercalate limestone, slate, phyllite and quartzite. Furthermore, much segragated quartz occur in schists. Limestone beds are divided into two units roughly. Upper unit is up to about 500 meters thick. Lower unit is composed of lenticular limestones which are 10 to 20 meters thick and uncontinuous. This lower unit is classified into more two or three beds. Greenschist generally occur in strata of limestone. It is said that initial sedimentation of those rock took place in Devonian to Permian age.

Mesozoic system is divided into three formations: Ibañez Formation, Coyhaique Formation and Divisadero Formation in ascending order. Ibañez Formation lies most of the area except for distribution area of Paleozoic unit on western part of the area. This formation consists of accidic and/or intermediate volcanic rocks. Lower portion of this formation consists of mainly rhyolite and dacitic pyroclastic rocks. Lithofacies of pyroclastic rocks are predominated by altenating beds of tuff and lapillituff. Upper portion is made up by chiefly andesitic pyroclastic rocks, while the base of this unit is lain by tuffaceous varieties of conglomerate, sandstone and shale. Figure Ⅱ-2-9 show lithostratigraphy on a typical outcrop. Age of this formation is said to be Middle to Later Jurassic age (Skarmeta,1978). Thickness is 344 to 1030 m.

Coyhaique Formation consists of altenating beds of sandstone and shale of marine origin, and overlies Ibañez Formation with conformity. Distribution is limited on northeastern part of the area. Abundant marine fossils occur in the shale of this formation. This formation intercalates calcareous rocks and conglomerate. FigureⅡ-2-9 shows the schematic litostratigraphy. This formation is said to be of Neocomian stage(Skarmeta,1978).

Divisadero Formation lies on Coyhaique Formation conformably in northeastern part of the area. Top of this formation has not been identified due to erosion. Lithofacies, mainly tufaceous sandstone and rhyolitic or



LEGEND

Qurtarnary	Q	Alluvial	
Tertiary	TTmba	Meseta buenos aires Formation	
	TTfgd	Guadal Formation	
Cretaceous	Kfd	Divisadero Formation	
	Kfc	Coyhaique Formation	
Jurassic	Jfi	Ibañez Formation	
Paleozoic	Pzbm	Metamorphic basement	
Intrusive rock	Ktg	Granitic rocks	
		Fault	

Tuff breccia
Breccia
Volcanic sandstone
Rhyolitic porphyry and quartz porphyry
Andesite and basalt
Basalt

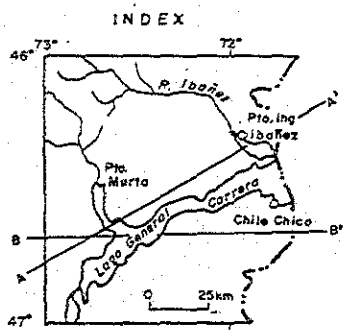


Fig. II-2-8 Geological Profile across Areas No 5(Ibañez-Murta area), No 6(Los Leones area) and No 7(Chile Chico-Chacabuco area)

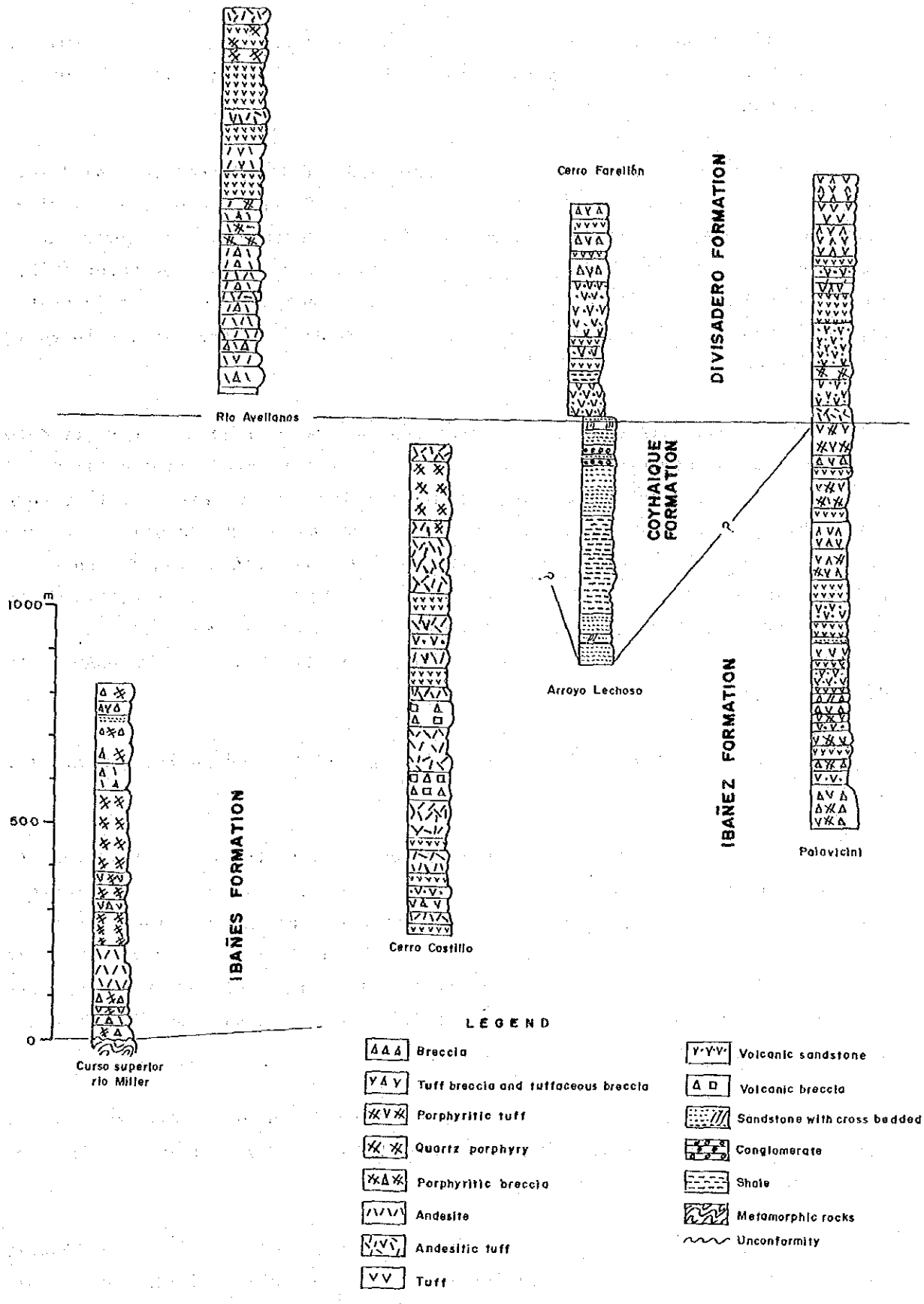


Fig. II-2-9 Schematic Geological Correlation Column on Areas No 5 (Ibañez-Murta area), No 6(Los Leones area) and No 7(Chile Chico-Chacabuco area)

dacitic tuff, grade into andesitic facies toward west. Age of this formation is Aptian to Cenomanian stages(Skarmeta,1978). It is estimated 819 meters thick maximumly.

Tertiary unit is divided into two formations: Galera Formation and Meseta Buenos Aires Formation in ascending order. Galera Formation overlies Divisadero Formation with unconformity. This formation is distributed on a small scale in northeast out of the area. Thickness is about 600 meters. This formation is costituted by tuff, shale, sandstone and conglomerate. Skarmeta(1976b) resulted age of this formation ranges between Miocene to Early Pliocene time.

Meseta Buenos Aires Formation overlies Galera Formation and Divisadero Formation unconformably. This formation is distributed sporadically in southern part and eastern edge of the area. Lithology is basaltic. This rock forms lava plateau and intrusive facies of pipe-shaped are recognized in the lower portion. This intrusive facies lie north of the Ibañez bay. Thickness in northern area of the Port of Avellano is about 200 m. Chemical composition is characterized by high MgO and low $FeO+Fe_2O_3$. Absolute ages of this rock, according to dating study by K-Ar method, are Oligocene and Palaeocene to Middle Eocene.

Quarternary system consists of alluvium, terrace deposit and glacier deposit.

Most of intrussive rocks are granitic rocks, while few basaltic intrusions are distributed in eastern part of the area. As to granitic rocks, eastern side of the Patagonia Batholith lies on western part of the area, otherwise stocks occur in central and eastern part of the area. Granitic rocks are granite, tonalite, granodiorite and adamellite. Times of the intrusion are grouped into two periods of 110-125Ma(Early Cretaceous) and 70-80Ma(Later Cretaceous) by K-Ar absolute age determination.

Complicated geologic structures are observed on only Paleozoic unit. Mesozoic unit shows gentle structure and Cenozoic unit is of nearly flat structure.

Four styles of deformation structure are recognized in Paleozoic metamorphic rocks; that is, schistosity, isoclinal fold inclining northeast, fold plunging northwest, and folds repeating anticline and syncline with

northeast trend.

Gelogic structures of Ibañez Formation, Coyhaique Formation and Divisadero Formation are simple showing gentle fold structure with north-south trend. Structures of Galera Formation and Meseta Buenos Aires Formation is almostly flat, though flexures of N-S to NE-SW direction are seen in northeastern part of Galera Formation.

All faults are normal fault dipping nearly vertical. In western part of the area, N-S and NNW-SSE systems predominate occuring along the contact of granitc rocks and metamorphic rocks. In the eastern part, N-S and NNE-SSW systems occur mainly in Ibañez Formation.

b. Miniralization

Seventy and a few more mines and/or prospects, according to CORFO(1982,1983) and MMAJ(1978,1979), are known in the area. Data for them are compiled in Table 1 of Appendices. Among them, 22 mines have been in oeration, 18 mines were explored in underground or by trenching on a small scale and 30 are still unexplored other than by very small exploraton pits.

From standpoint of principal ore metals associations, 33 are of copper, 32 are of lead-zinc, three are of gold-copper, three are of molybdenium and three are of alteration of surface only. Categorizing deposits on the basis of types of deposits, 49 are vein deposit, 20 are replacwment deposit, two are disseminated ore deposit and three are categorized into others. Type of deposits of operated mines are as follows; seven are vein deposit, 16 are replacement deposit. Those operated mines are also grouped based on principal ore metal species; that is, 18 are of lead-zinc, three are of copper and one is of molybdenium.

Characteristics of the mineralization in the area are summarized as follows:-

* Copper-lead-zinc mineralization predominates. Vein type deposit is the first prevailling style of the mineralization. Replacement deposit is ranked the second.

* Relatively large and rich deposits which were mined are mostly of replacement deposit of lead-zinc.

* Copper-molybdenium deposits are known as well. They are, howerver, very small in general. Numbers of gold deposit are very few.

Deposits are unevenly distributed in the distribution area of Paleozoic unit on western side of the area as shown in Fig.Ⅱ-2-7. Looking over the distribution of deposits, it is recognized that deposits are distributed with a zonal arrangement; molybdenium zone, copper zone, lead-zinc zone and gold zone toward east from west. As mentioned in the section 2.2.1., this zoning feature is a part of the regional metal zonig recognized throughout the Aysen region. This zonation is inferred to be related to the distance from the Patagonia Batholith.

Molybdenium deposits, all is vein type deposit, occur in the batholith and stock of granitic rocks, or in the vicinities of them. The deposits are accompanied mostly with copper minerals and quartz, or rarely with tungsten minerals(for instance, the Cerro Castillo mine). Generally veins are very narrow, 5 to 15 cm wide, and uncontinuous.

Copper deposits are concentrated on the distribution area of Paleozoic unit. Most of them are vein deposit, though a part of them are skarn deposit. Principal ore mineral is chalcopyrite accompanying small amount of pyrrohotite, pyrite and chlorite in many cases. Short extention along strike is noted for the most deposits except for Las Chivas deposit which extends 1,700 m along strike with average width of 1.5 m.

The lead-zinc deposits are characteristic deposit in the area so that the Aysen region including this area is known as lead-zinc production area. Typical lead-zinc deposits such as the Silva, the Rosillo and the El Pelado are replacement deposit with massive, lense-shaped and beded features which replaced limestone intercalated in Paleozoic metamorphic rocks. Each deposit consists of several to some ten orebodies in general. Ore minerals are sphalerite and galena with small amount of chalcopyrite and pyrite. Gangue minerals are generally not much.

Ore reserves of deposits of this type are about five hundred thausand to seven hundred thausand tonnes for the Silva and the Rosillo deposits which are regarded as the largest deposits in the area. Only the Rosillo mine is in operation in the area; now producing 30t of zinc crude ore a day.

Gold deposit lies outermost area from the Patagonia Batholith occuring in Ibañez Formation. The deposits are narrow vein deposit with width of less than

one meter. In many cases, quartz veins are accompanied with chalcopyrite. General scales of deposits have not been revealed well. The deposits of this type are represented by Rio Avellanos Ⅱ deposit. Assay on outcrop of this deposit is reported to be 20g/t Au and 4 to 5 % Cu.

6) Area No 6: Los Leones Area

A. Past Exploration Activities(see PLATE 5)

a. Geological Survey

Works covering whole the area are as follows:-

* SERNAGEOMIN(1982) at scale of 1:1,000,000
* SERNAGEOMIN(1984) at scale of 1:500,000

Whereas, the following works cover a part of the area:

* Rojo(1977) at scale of 1:50,000
* SERNAGEOMIN(1978) at scale of 1:250,000
* SERNAGEOMIN(1982) at scale of 1:250,000
* MMAJ(1978) at scale of 1:100,000 (covering area is 2,000km^2)

b. Geochemical Exploration

Very few geochemical works were done in this area. SERNAGEOMIN(1984?) carried out pan concentrate geochemical exploration in down river area of El Leon river(see PLATE 5).

c. Conditions of Mining Claims

No mining claim is applied in the area as of October,1989.

B. Geology and Mineralizatiion(Fig.Ⅱ-2-7)

a. Geology

This area is the southwestern extention of Paleozoic metamorphic rocks distributed in Area No 5 and the Patagonia Batholith. Ibañez Formation overlies Paleozoic unit in a small part of northeastern edge of the area.

Metamorphic rocks lie eastern half of the area extending from north to south. Western edge of this unit is limited by the Patagonia Batholith and eastern edge is in western side of the Lake General Carrera. Those metamorphic rocks, according to Rojo(1977), consist of carbonaceous schist, mica-quartz schist, phyllitic schist, greenschist, schist bearing nodule, marl, slate, phyllite, quartzite and metaconglomerate. Segregated quartz veins are developed in those rocks. Age of original rocks is said to be Devonian to

Permian time.

Distribution of Ibañez Formation is very small compared to that in Area No 5. In Area No 6, it is distributed only in a small area between hillside and summit of Las Parvas mountain. Skarmeta(1978) described that lower part of it is rhyolitic or dacitic porphry overlying metamorphic rocks unconformably and upper part is tuff breccia.

Granitic rocks lie western half of the area. Those rock masses are the batholith in western part, but stock-shaped bodies in eastern part. This batholith is a part of Patagonia Batholith. Rocks constituting the batholith, according to Rojo(1977), consists of very many varieties; granite, tonalite, granodiorite, monzonite, coarse and fine-grained gneiss, alkaline granite and migmatite. Migmatite and gneiss are recognized in contact zone with metamorphic rocks. No existing data is available for the age of intrusion.

Paleozoic unit is of very complicated fold structure (Rojo,1977). Fold axis trend E-W plunging east in southern part of the area(Skarmeta,1978), but that direction changes to N-S in northern part of the area. Those regional fold structures are cut many times by block movements to become very complicated structure. On the other hand, Skarmeta(1978) said that Ibañez Formation shows gentle syncline structure with about 30° inclination trending N-S. Faults are nearly vertical normal fault occuring mainly in metamorphic rocks. Prevailling directions of them are N-S and NNE-SSW.

b. Mineralization

CORFO(1982,1983) reported only three prospects for this area. Only five prospects are known including two obtained by this investigation. All prospects are of copper mainly. Deposits are vein deposit except for one skarn deposit. They are less than five meters wide and extend only about ten meters along strike. Copper grades of two deposits show 2 to 3% Cu, otherwise range of ppm Cu. Other elements are also low grade. Ore grades of each deposit are listed in Table 1 and 2 of Appendices. Those deposits occur in blackschist and granitic rocks.

Some geochemical anomalies of gold were established by SERNAGEOMIN a few years ago.

7) Area No 7: Chile Chico-Chacabuco area

A. Past Exploration Activities(PLATE 5)

a. Geological Survey

The following work covers whole the area.

* SERNAGEOMIN(1982) at scale of 1:1,000,000

Works covering a part of the area are as follows:-

* SERNAGEOMIN(1982) at scale of 1:250,000
* SERNAGEOMIN(1984) at scale of 1:500,000
* MMAJ(1978) at scale of 1:100,000(covering area is 2,000m^2)

b. Geochemical Exploration

Very few work were conducted so far. SERNAGEOMIN(1984?) carried out pan concentrate geochemical survey along main road, the Carretera Austral(PLATE 5).

c. Drilling Exploration

The Laguna Verde deposit has been drilled extensively by a North American company. They have released no information so that results of the exploration can not be obtained.

d. Conditions of Mining Claims

PLATE 5 shows areas of claims as of October,1989. Considerable exploration titles are marked out in the eastern half of the area. Many of them are owned by North American major mining companies. They seem to target gold deposit of the Laguna Verde style.

B. Geology and Mineralization(Fig.Ⅱ-2-7)

a. Geology

The area lies south of the Lake General Carrera so that the geology very resembles that of Area No 5. Mesozoic and Cenozoic units overlie the basement of Later Paleozoic metamorphic rocks. Intrusions are mainly stocks and dykes of grantic rocks derived from the Patagonia Batholith, while the Patagonia Batholith is not distributed in the area.

Metamorphic rocks lie western part of the area extended from Area No 5 with elongation of N-S direction. Western edge of them are cut by the Patagonia Batholith and eastern part of them is overlain by Ibañez Formation, Divisadero Formation and Guadal Formation unconformably. Those rocks are composed of mica schist, quartz schist, blackschist, greenschist, slate, phyllite and quartzite. Segregated quartz veins are developed also in this area. No intercalation of limestone occurs in the area.

Mesozoic unit consists of Ibañez Formation, Coyhaique Formation and Divisadero Formation in ascending order. Ibañez Formation overlies Paleozoic unit unconformably in eastern part of the area. This formation is composed of accidic and intermediate volcanic rocks. Lower portion is predominated by rhyolite and dacitic pyroclastic rocks. Lithofacies of pyroclastic rocks are predominated by altenating beds of tuff and lapillituff. Upper portion consists of chiefly andesitic pyroclastic rocks, while the base of this unit is lain by tuffaceous varieties of conglomerate, sandstone and shale. Age of this formation is said to be Middle to Later Jurassic time(Skarmeta,1978).

Coyhaique Formation consists of altenating beds of sandstone and shale of marine origin, and overlies Ibañez Formation unconformably. Distribution is limited on central to eastern part of the area. Abundant marine fossils occur in the shale of this formation. This formation intercalates calcareous rocks and conglomerate. This formation is said to be of Neocomian stage(Skarmeta,1978).

Divisadero Formation lies on Paleozoic unit and Ibañez Formation with unconformity, but on Coyhaique Formation with conformity. Distribution of this formation occupies two third of the area. Top of this formation has not been certified due to erosion. Lithofacies, mainly tufaceous sandstone and rhyolitic or dacitic tuff, grades into andesitic facies toward west. Age of the formation is Aptian to Cenomanian stages(Skarmeta,1978). It is 810m thick at the most.

Tertiary unit is divided into three formations: Guadal Formation, Galera Formation and Meseta Buenos Aires Formation.

Guadal Formation overlies Paleozoic unit with angular unconformity and Divisadero Formation with unconfomity of erosion distributed in east of the Port of Guadal. This formation overlies Divisadero Formation unconformably around the border line with Argentine where is eastern edge of the area. This formation mainly consists of sandstone of marine origin occationary intercalated with conglomerate, limestone(micrite and sparite facies), calcareous mudstone and carboneous matter. Niemeyer et al.(1984) led the age of this formation to Later Oligocene to Early Miocene. They thought the sedimentatation took place under a calcareous condition of shallow marine.

Galera Formation covers Guadal Formation with conformity, but Divisadero Formation with unconformity. Distribution area is western part of the area (east of the Port of Guadal) and eastern edge of the area. This formation consists of tuff, shale, sandstone and conglomerate. Skarmeta(1976b) led to a conclusion that the age of this formation ranges between Miocene and Early Pliocene.

Meseta Buenos Aires Formation overlies Guadal Formation and Divisadero Formation unconformably in eastern part of the area. The rock is alkaline basalt forming lava plateau. Absolute ages of this rock, according to dating study by K-Ar method, range between Oligocene and Middle Eocene. Quarternary system consists of alluvium, terrace deposit and glacier deposit.

Development of intrussive rocks is not extensive. Some stocks are distributed in central and western part of the area only. No information regarding the lithology of each stock is available, though they are described to be granite and diorite totally. No data for age of them are available as well, though it is assumed to resemble them of Area No 5.

Although some articles report that geologic structure of Paleozoic unit is complicated, detailed structure is not revealed yet. Mesozoic formations show gentle folds trending N-S as shown in Fig.Ⅱ-2-8. Guadal Formation and Galera Formation distributed in west also show syncline structure with N-S direction. Meseta Buenos Aires Formation is almostly flat.

Fault system is predominated by N-S and NNW-SSE systems. A part of faults extends upward to Guadal Formation of Middle to Later Tertiary age.

b. Mineralization

CORFO(1982,1983) and MMAJ(1977,1978) reported total of 19 mines and prospects in the area. Other than them, some hydrothermal alteration zones are developed with large gossaneous zone. Geological and mineralogical features of those deposits are compiled in Table 1 of Appendices. No mine is in operation at the moment and three of them were mined in the past. Two of them are lead-zinc deposit and one is copper deposit. Those 19 deposits are categorized into four group on the basis of princpal ore metal associations; nine are of lead-zinc, five are of copper, three are of molybdenium and two are of gold. Whereas, fourteen deposits are vein deposit, four are disseminated deposit and one is not known.

As understood from above, most significant mineralization in this area is lead-zinc mineralization and copper mineralization is ranked by second. Vein is the most conspicuous feature of mineralization and secondly disseminated deposit is. Characteristic features of those mineralization are summarized as follows:-

Molybdenium deposits are vein or network vein occuring in stock-shaped

granitic rocks. They are accompanied with copper minerals and rarely with tungsten minerals; for example, the Prospect Arroyo Pedregoso carries scheelite. They are generally narrow and uncontionuous. Width of vein ranges between 1 and 30cm. Two ore assays on the Prospect Valle del Rio Aviles showed 1.6% and 3.0% Mo, and 2.06% and 6.20% Cu. It is 0.05 to 0.1m wide and 7m long along strike. No data is available for other prospects.

Copper deposits are vein type deposit, and occur in Paleozoic unit and Ibañez Formation. Principal ore mineral is chalcopyrite. Galena and sphalerite often occur as well. Gangue minerals are quartz, calcite and chlorite etc., though no description was made for many prospects. Mineralization of this type is represented by the Escondida mine. This mine is located in about four kilometers south of the Port of Guadal and was in operation until 1981. The vein is 0.3m wide averagely and extends 350m along strike. Other deposits of this type are very small.

Lead-zinc deposits occur as either vein deposit or disseminated deposit developed in Paleozoic unit and Ibañez Formation. Vein deposits are represented by the San Sebastian deposit. A vein extends 325m along strike and 25m toward depth with 0.9m width occuring in Paleozoic unit. Ore minerals mainly consist of sphalerite and galena accompanied with chalcopyrite. Gangue mineral is quartz only. Ore grade is relatively high showing 250g/t Ag, 2.19% Cu, 28% Pb and 7.9% Zn.

As to disseminated ore deposits, La Poza deposit is most notable deposit. CORFO(1982) reported this deposit to be stratiform deposit. The investigation of this year revealed that this deposit consists of disseminated ore in tuffaceous shale occuring concordantly with bedding planes. Details of this deposit are reported in later section. Hanging wall is red chert, and foot wall is dacite or dacitic tuff. Principle ore mineral is galena. Assay on outcrop of rich ore shows 16% Pb and 182g/t Ag(CORFO,1982).

Only one deposit, the Veta de Oro, was reported as gold deposit by CORFO(1982), though it grades only less than 120ppb. A company, on the other hand, discovered very significant gold mineralization in the Laguna Verde deposit which occurs in Ibañez Formation. Extensive exploration works are still maintained as of February,1990, while no information was released from company as the policy of company.

This deposit was categorized into vein deposit of copper-lead by

CORFO(1982). However, it was revealed that this deposit is considered to be probably hot spring type gold deposit judging from the geology of this ore deposit. Datailes of this deposit are disccused in later section. A large quantity of quartz-hematite veins occur densely and the deposit is associated with broad hydrothermal alteration zone consisting of silicification and kaolinitization. Other several similar alteration zones, such as Cerro Bayo alteration zone, were found in the vicinity of the Laguna Verde deposit.

2.2.2. Selections of Localities for Site Inspection

Site inspection was planed for interesting mines and prospects on the basis of knowledge obtained after the compilation work. Selected deposits are listed on Table Ⅱ-2-2.

Chapter 3 Geological Survey and Geochemical Exploration

3.1 Geological Survey

Geological survey work was carried out for the mines and prospects which were elected through study of the previous investigations. The aim of the work is to reveal the features of geology and mineralization of those deposits. Total of 51 localities were surveyed as a result. Among them, the numbers of localities in the Silva mine are counted as 10, because many ore outcrops were known. Characteristic features of each deposit are summarized in Table2 of Appendices. Some localities were exchanged to other place due to access problem.

3.1.1 Area No.1: Lonquimay Area

The following three prospects were surveyed in the area.

(1) Araucaria mine
(2) Estero Curacatou Ⅰ
(3) Estero Curacatou Ⅱ

Other prospects, for example the Galletue prospect, are known in the area as well. However, investigation on those prospects was completed by the exploration project of JICA-MMAJ which was conducted in the year between 1977 and 1979. Therefore, the investigations for those prospects were excluded from the study of the this year.

A. Araucaria Deposit

a. Location

Table Ⅱ-2-2 Proposed Deposit for Site Inspection

Area	Deposit	Feature of deposit
No 1 Lonquimay	1-a Araucaria	Gold vein?
No 2 Huequi Peninsula	2-1 Punta Comau	Gold and platinum placer deposit Ultramafic rocks containing platinum
No 3 Futaleufu-Alto Palena		Polymetallic veins and porphry copper style mineralization
No 4 Alto Cisnes-El Toqui	4-1 Co.Estatuas	Stratatiform deposit of copper-lead-zinc
	4-2 Rio Pedregoso	Molybdenium-copper vein
	4-3 El Condor	Gold vein
	4-4 El Toqui	Polymetallic veins occuring in volcanic rocks
	4-4 El Toqui	Strata-bound deposit in sedimentary rocks
	4-5 Katterfeld	Polymetallic vein occuring in volcanic rocks
No 5 Ibañez-Murta	5-2 Cerro Coco	Copper-gold deposit occuring in contact of intrusive rock
	5-3 Veta Perez	Lead-zinc vein extending very long along strike
	5-4 Villarreta zone	Copper-gold veins. Extention along strike is 100m with 2m width Ore grade; 2-20% Cu and 1-4g/t Au
	5-5 Rio Resbalon	Copper-gold veins
	5-6 Felix Barria	Copper veins(two veins) occuring in hornfels
	5-7 Mina Co. Castillo	Veinlets of molybdenium-copper-lead-(tungusten-uranium)
	5-8 Mina Las Chivas	Copper vein
	5-9 Mina El Pelado	Stratiform lead-zinc-(silver-copper) deposit
	5-10to 5-19 Mina Silva	Ore pocket-shaped deposit of lead-zinc in limestone Ore grade; 4.5% Pb and 11-12% Zn
	5-20 Rio Anita Avellanos	Copper-(lead) vein. Ore grade; 13% Cu
	5-21 Mina Cascara	Copper-lead-zinc vein
	5-22 San Jose de Ibañez	Polymetallic vein extending up to 200m along strike
No 6 Rio Los Leones		Geochemical anomalies of gold
No 7 Chile Chico-Chacabuco	7-1 Paulina	Vein of lead-zinc-silver grading 4.9% Pb, 0.3% Zn and 277g/t Ag
	7-2 Laguna Verde	Stratiform deposit of lead-zinc-silver
	7-3 La Poza	ditto: Ore reserve of 200,000 tonnes
	7-4 Rio Aviles	Vein of copper-molybdenium-silver grading 2.6% Cu, 1.6-3.1% Mo, and 43-52g/t Ag
	7-5 Arroyo Escondida	Copper-zinc vein
	7-6 Arroyo El Saino	Copper mineralization associated with hydrothermal alteration
	7-7 Arroyo Mallin Chico	Stockwork vein accompanied with molybdenium

The mine is located in southwestern outside of the area or about 12km west of the Laguna de Icalma. An old workings consisting of two adits is in a mountainside at the altitude of 1,130m of the Mt.Cerro Loncotiaque.

b. Historical Production

A former miner provided a brief information that the mine exploited gold ore on a small scale untill March, 1989. Commencement of the mining is not known. Total production amount of 300t are estimated based on the size of cave and dump.

c. Geology and Mineralization

The deposit is a stockwork deposit. Stockwork occurs in Andesite and is composed of mainly hematite accompanying gold. Size of stockwork is only 4x8x3m. The deposit extend only 8m in strike length so that the shape of the deposit looks like a massive deposit. Spacings of each veinlet are three to five cm. The stockwork is believed to have filled autobrecciated portion of lava(Fig.Ⅱ-3-1).

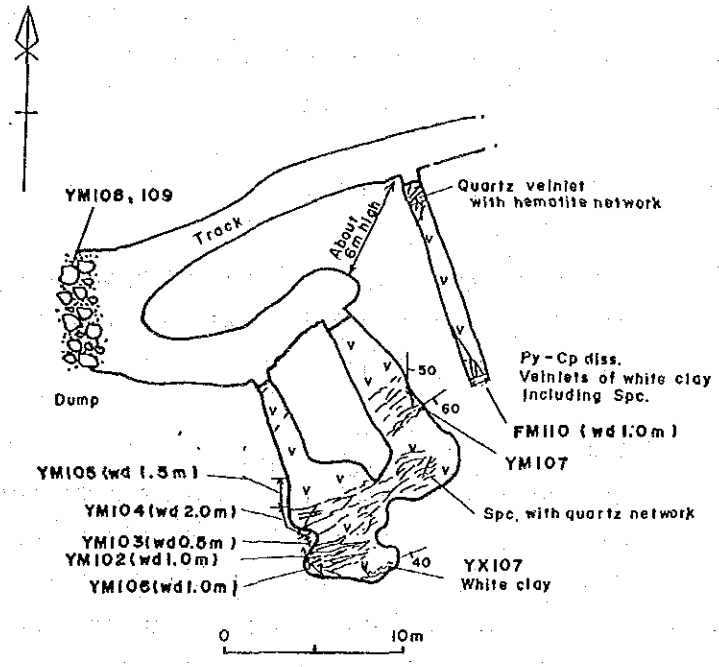


Fig. Ⅱ-3-1 Plan Map of the Stope in Araucaria Mine

Vein minerals mainly consist of specularite accopanyed with a small amount of chalcopyrite and trace of free gold. Assays on the most of ore samples

showed under 0.n g/t Au and 0.n% Cu other than a part of them from residual ore in cave, which showed 1 to 2g/t Au(9.50g/t at maximum) and 1 to 2% Cu(10.9% at maximum). Whereas, the other elements range low level(Table 3 in Appendices).

Alteration of the country rock is chiefly chloritization.

B. Prospect Estero Curacatou I and Estero Curacatou II

a. Location

The prospect Estero Curacatou I and The prospect Estero Curacatou II are located in 1.5km and 2km south of the Araucaria mine respectively. Estero Curacatou river lies between those prospects.

b. Previous Work

Neither exploration nor production has been done on the both prospects.

c. Geolgy and Mineralization

Both deposits are copper veins. Country rocks are granite for the prospect Estero Curacatou I and andesitic tuff for the Estero Curacatou II. Ore grades of the both prospects are of low level(see Table3 in Appendices). Detailes of deposits are described in Table2 in Appendices.

3.1.2 Area No 2: Huequi Peninsula Area

A. Punta Comau

Survey in the area was carried out along the north coast of the peninsula. An aim of the work is to test the presence of ultramafic rocks. That was identified in 2km west of the Punta Comau.

a. Distribution of Ultramafic Rock

Four parallel creeks run into the Pacific Ocean on the northwestern slope of Comau mountain ranges running with NE-SW trend. Floats of ultramafic rock were found in the river mouths of the western three creeks. Any ultramafic rock was not found except in those creeks so that the original rock body from which the floats were derived is not believed to be large.

b. Petrological Features of the Ultramafic Rock

Size of the floats of ultramaficrock range between size of sand grain and 1m in diameter, but the most of them is 0.5m in diameter. Shapes of them are mainly angular and/or subangular. Intrusion of granitic rock into the ultramafic rock is observed in some floats as well.

Colour of the rock is usually dark green with greasy luster. The rocks which are in advanced serpentinization have yellowis green colour. Those ultramafic rocks are classified to serpentinite containing much amount of antigorite. Texture of them is characterized by fibrous lamination. A float of hornfels consisting of forsterite and talc only was also recognized. Texture of it is characterized by granoblastic texture.

c. Chemical Composition of Serpentinite

A chemical composition of a float sample is as follows:-

Sample number:TR 201

Chemical composition: SiO_2; 40.12 Al_2O_3; 1.79 Fe_2O_3; 7.71 FeO; 4.75
MgO; 35.86 CaO ; 1.38 Na_2O ; 0.08 K_2O; 0.02
TiO_2;<0.01 P_2O_5; <0.01 MnO ; 0.04 BaO; 0.28
LOI ;11.05 Total;98.35%

Values are expressed as %.

Whereas, the following Table shows trace element concentrations.

Sample	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
TM 201	<2	<0.5	<2	<1	<1	<5	18	<1	1105	53	850	3.42	175
TM 203	<2	<0.5	<5	<2	2	<5	32	1	1440	69	2000	3.53	500

As shown in the Table, concentrations of the metal elements are not anomalous.

3.1.3 Area No 3: Futaleufu-Alto Palena Area

Survey was carried out for the following seven prospects.

Prospect	Principal Ore Metals	Type of Deposit	Country Rock
Puerto Reyes	iron	vein	Andesite(1)
Garcia Ⅰ	iron(+lead-copper)	vein	ditto
Garcia Ⅱ	iron,copper(lead)	replacement?	ditto
Arroyo Pedregoso Ⅰ	lead	skarn	Limestone(2)
Arroyo Pedregoso Ⅱ	iron	vein	Slate(2)
Estero la Cascada	iron?	vein	Granite
Lago Espelon	copper,lead	disseminated	Volcanic Rock(1)

(1):Huemul Formation, (2):Alto Palena Formation

Locations of those prospects are shown in PL.24. The Arroyo Pedregoso Ⅰ and Ⅱ are situated around Alto Palena town, the Estero la Cascada is in the