centre of the area and the others are around Futaleufu town. Deposits in Alto Palena town area occur in Coyhaique formation of Cretaceous age and those in Futaleufu town area occur in Jurassic rocks. On the other hand, the Estero la Cascada deposit occur in the eastern edge of Patagonia Batholith.

Ore metals are principally copper and lead other than iron. The iron deposits which are listed on the above Table are composed of mainly pyrite and/or gossan. Many deposits in the area are classified into vein-type. Detailes of each deposit are described in Table2 in Appendices. As shown in the Table, all deposits are on a small scale and of poor grade. Concerning gold, only a part of samples contain about 0.1g/t Au, otherwise are below detection limit. Whereas, assays of copper in the prospect Garcia II show about 1%, but the others are in a range of ppm.

3.1.4. Area No 4: Alto Cisnes-El Toqui area

In the area, there are many rich and large deposits of gold and lead-zinc. This survey investigated following five deposits.

A. El Toqui deposit
B. Cerro Estatuas deposit
C. Katterfeld deposit
D. Santa Teresa deposit
E. Rio Cisnes entre Rio Pedregoso y Estero Buitre deposit

All deposits except for deposit E listed above are rich and large. The El Toqui mine is in operation. The Cerro Estatuas and the Katterfeld deposits are being explored. Whereas, Santa Teresa deposit used to be mined, but the operation is suspended at the moment(there is a rumour of it reoperating in near future).

Investigation on the deposits A, B and C was not admitted by the mining title holder because they are in operation or exploration stage. Therefore, only a brief site inspections were executed.

A. The El Toqui Deposit

a. Location

The deposit is about 80km north of Coyhaique city on the upriver of the El Toqui river which is a branch of the Maniguales river. Altitude in the mine office level are 530m and outcrops of ore are at 800m. A way to the mine is to go past the Pedro Aguirre Cerda Lake heading to north on Carretera Austral main road from Coyhaique city and then turn off to go up along the El Toqui river to get the mine. The road is kept under good condition except for the section along the El Toqui river. It takes about 2.5 hours to reach the mine from Coyhaique city by vehicle.

b. History of Mine

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

c. Geology and Mineralization

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

According to a mine geologist, three formations undelie the mine area: Ibañez Formation, Coyhaique Formation and Divisadero Formation in ascending order. Sills of quartz porphyry intrude into the contact of the lower two formations. The stratiform deposit occur in nearby top of the Sill intruded into Coyhaique Formation (Fig.Ⅱ-3-3).

c.1 Stratiform replacement deposit(Manto deposit)

The stratiform deposit is replacement deposit of lead-zinc which occurs in calcareous sequence of Coyhaique formation(Lower Cretaceous; Skarmeta,1978). Orebodies are divided into three strata as exhibited in Fig.Ⅱ-3-4.: (a) Manto Principal, (b) Manto Superior and (c) Manto Alto ordering from bottom to top. At the moment, only the Manto principal is in operation.

(a) Manto Principal orebody

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

The orebody is 6 to 8m thick and bounded by banded tuff of turbidite on the hanging wall and crystalline tuff on the foot wall. Assay result on the typical ore sample is as follows:-

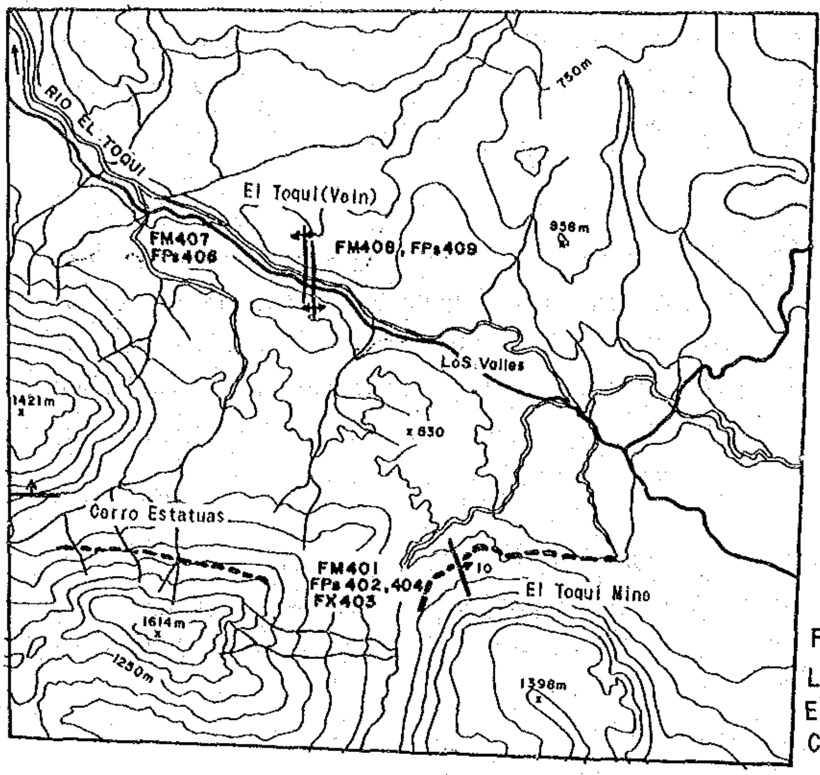


Fig. II-3-2
Location Map of
El Toqui Mine and the
Cerro Estatuas Mine

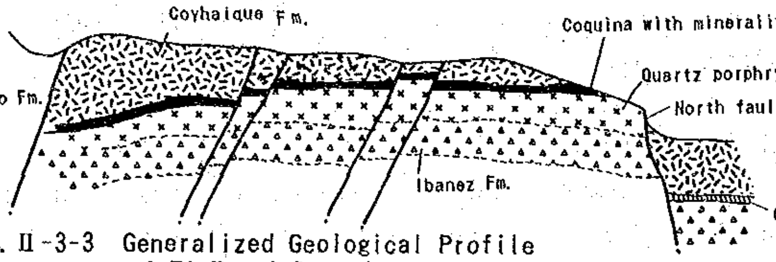


Fig. II-3-3 Generalized Geological Profile
of El Toqui Deposit

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

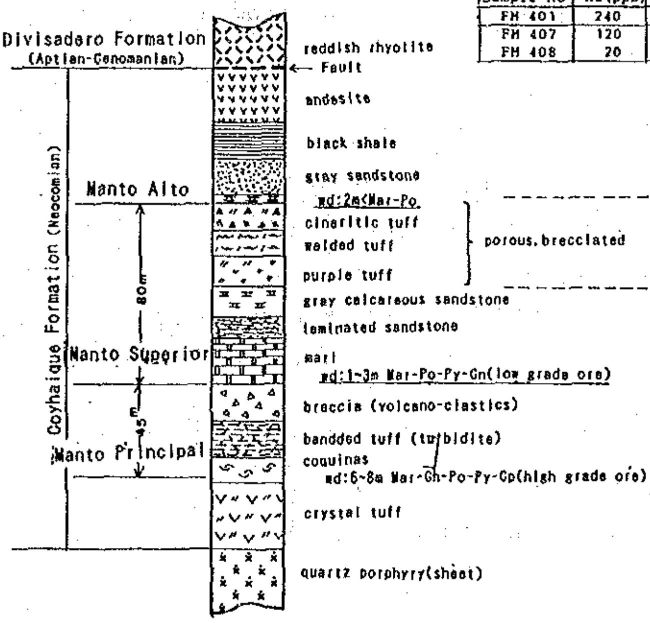


Fig. II-3-4 Schematic Stratigraphy of El Toqui Mine

Au; 240ppb, Ag; 4.7ppm, Cu; 440ppm, Pb; 180ppm, Zn; 7.56%, Mo; 2ppm, As; 14ppm, S; 12.42%

The direction of bonanza, NW-SE, corresponds to the principal trend of pre-mineralization fractures. Whereas normal faults of the post-mineralization with N-S trend dislplace orebody to devide orebodies into several blocks. Those blocks are named San Antonio, Mallin Alto, Monica and Dona Rosa from west to east. Eastern blocks are depressed relatively to the western blocks. The contact of Mallin Alto block and Monica block is not bounded by fault, but by quartz porphyry dyke mentioned above.

Thickness of orebody is steady but ore grades are very variable.

(b) Manto Superior orebody

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

(c) Manto Alto orebody

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

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

c.2 Vein-type deposit

The follwing two deposits are known in the mine area. The mining of those veins were completed.

(a) Antolin vein

The vein are located 2.5km west of the stratiform deposit mentioned above. The vein strikes N-S and dips 90° extending 100m along strike and 80m toward depth. Average width is 1.5m. The country rock is andesite of the Ibañez Formation. It is said that the vein ends by anastomosing feature at its margin.

The vein comprises sphalerite, galena, pyrrohotite,pyrite, chalcopyrite, silver minerals, muscovite and chlorite etc.

An assay on the wasted ore sample from the dump shoewd 120ppb Au, 16.1ppm Ag, 420ppm Cu, 680ppm Pb, 6.86% Zn, <1ppm Mo, 31ppm As and 5.08% S.

(b) Zuniga vein

The vein is about 200m east of the Antolin vein striking N20°W and dipping 90°. This vein is similar to the Antolin vein in size, mineralogy and ore grade. The country rock is breccia of the Ibanez Formation. An assay on the sample from the dump showed 20ppb Au, 66ppm Ag, 0.65% Cu, 3.85% Pb, 30.1% Zn, 1ppm Mo, 18ppm As and 18.4% S. The grades of lead and zinc among them are considered to be higher than average grade of total ore produced so far.

B. Cerro Estatuas Deposit

a. Location

The Cerro Estatuas mine are located in about 4km west of the El Toqui mine, 4.5km upstream of the La Concordia river which is a branch of the El Toqui river. A road connects from the El Toqui mine. Mine office is at 950m in altitude(Fig.Ⅱ-3-2).

b. History

Many exploration works have been conducted on the deposit for the recent ten years. The exploration of the Metallgesellschaft, a German mining company, was the most extensive. Although the company continued drilling exploration for several years, they colud not advance to make decision to mine and sold out thir right to the Sociedad Contractual Minera Toqui(SCM Toqui), current title holder.

SCM Toqui commenced the first stage of mining but suspended soon. Recently they are fixing the road in order to restart the exploration.

c. Geology and Mineralization

The deposit occurs in the Upper Coyhaique Formation(CORFO,1982 defined it as Ibañez Formation). The features of mineralization are fairly similar to them of the El Toqui deposit. The outcrops which was observed on this survey strikes E-W and dips 10°N with 3.20m thickness. Mineralization is found along 1,700m of strike.

The orebody consists of sulfide-rich ore that contains mainly marmatite with a small amount of galena, chalcopyrite, calcite and amphibole etc. CORFO(1982) described pyrite, arsenopyrite, magnetite and marcasite as well.

It is believed that this deposit is vesicular green tuff replacement deposit. Ore-bearing stratum is thought to be correlated stratigraphicaly to the strata of the El Toqui deposit ranging between Manto Alto orebody at the bottom and the Purple tuff bed at the top (Fig.Ⅱ-3-4).

An assay on the outcrop showed as follows:-
200ppb Au, 380ppm Ag, 0.73% Cu, 4.50% Pb, 39.6% Zn, 4ppm Mo, 466ppm As and 26.62% S

C. Katterfeld(or Nirehuao) Deposit

a. Location

The deposit is located in 75km northeast of Coyhaique city. Altitude at the mine office is 1,200m. The Mt.Trinchera rise high in the 2km west of the mine and the border line with Argentine lies in 2.5km east. To reach the mine, it is about four hours trip from Coyhaique city. The deposit is developped on the both side of the Nirehuao river.

b. History

Current title holder is the Sociedad Legal Minera Katterfeld which is a subsidiary fully owned by Minera Lac Chile S.A. The deposit is vein type making up two different styles of mineralization: (i) copper-lead-zinc(gold) and (ii) gold. Mine geologists call "old vein" deposit for the vein of the former style and "new vein" deposit for the latter style.

The "old vein" deposit was mined in 1960s. CORFO(1982) reported that mining for the "old vein" started in 1959. The vein yielded production of 10kg of gold, 15kg of silver and 20 tonnes of copper in 1966. Now the production was suspended and all the adits were abandoned.

Whereas, the "new vein" deposit was discovered around 1970 and explored for about one year. After that, any active work was not conducted untill the commencement of drilling by El Toqui mine to have hit significant intersection of gold. Exploration in underground by adits is in progress now. A total of 30m of crosscut has been dug till February,1990.

c. Geology and Mineralization

(i) "New vein" deposit

"New vein" deposit is developped on the eastern slope of the Mt. Trinchera. The deposit is composed of quartz accompanied with gold, strikes

N70°E and dips 90°. Country rock is andesite with strong propylitic alteration. Vein width is very variable, ranging between 20cm and 150cm. A total numbers of some ten veins are estimated to occur.

Spacing of veins is usually 5 to 10m. Stockworks are developped between veins. Those stockworks comprise quartz, hematite and pyrite. Comb crystals of quartz growth in the center of quartz vein with being surrounded by translucent banded quartz. In the margin of vein, disseminated pyrite and small amount of chalcopyrite are concentrated. Most of pyrite is converted into hematite so that the mineralized zone is found as a gossaneous area of reddish brown. The gossaneous zone extends more than 2km along strike and about 1km in width(Fig.II-3-5).

Assays on ore outcrop showed as follows:-

	Sample	Width meters	Au ppb	Ag ppm	Cu ppm	Pb ppm	Zn ppm	Mo ppm	As ppm	S %
Stockwork	FM 413	1.0	80	1.2	181	150	88	54	105	5.34
Single vein	FM 414	10.0	120	2.2	228	0.10%	34	3	188	1.18

(ii) "Old vein" deposit

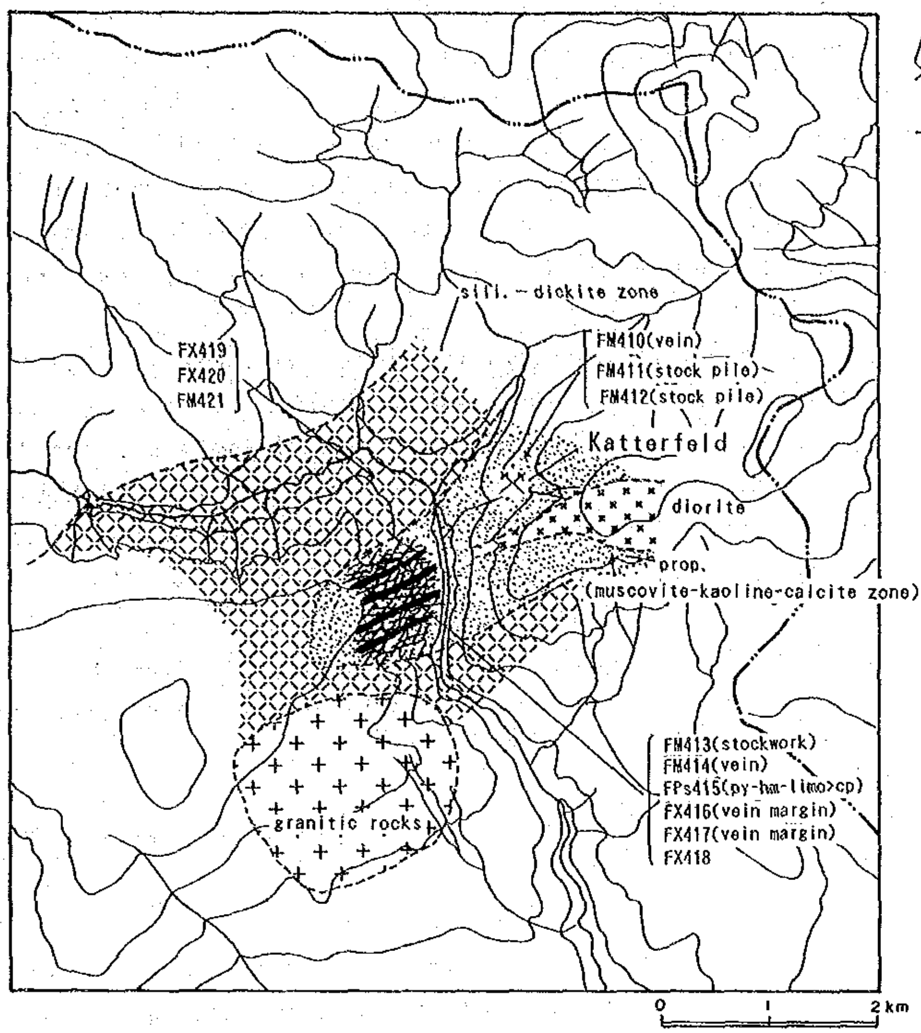
The deposit is about 1km northeast of the outcrops of the "new vein" deposit and occurs in propylite. A vein strikes N30°E and dips 80-90°. Only one vein was defined on this investigation, but CORFO(1982) described parallel narrow vein.

Drafts along vein were found in three levels. The vein mined is 1 to 4m wide. CORFO(1982) reported the proved strike length was 29m. This amount is seemed too small taking the past production amounts into consideration.

Vein comprises mainly quartz with chalcopyrite, pyrite, sphalerite and galena. The mineralization of "old vein" is characterized by much more sulfide-rich ore than "new vein". Other than those sulfide minerals, a small amount of free gold, chalcocite and anglesite are recognized on microscopic study. Assay results of this survey and ore grade reported by CORFO(1982) are as presented in the following Table.

	Sample	Width	Au	Ag	Cu	Pb	Zn	Mo	As	S
Vein(this survey)	FM 410	1.0m	3.26	19.1	1.75%	450	0.15%	13	250	18.78%
Dump(ditto)	FM 411	-	660	8.6	480	0.51%	389	2	145	1.36%
Average ore grade (CORFO, 1982)		-	4	150	1.89%	2%	4%			

Grades are expressed as ppm other than specified



Assay Results								
Sample No	Au (ppb)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mo (ppm)	As (ppm)	S (%)
FM 410	3.26ppm	19.1	1.75%	450	0.15%	13	250	18.78
FM 411	660	8.6	480	0.51%	389	2	145	1.36
FM 413	80	1.2	181	150	88	54	105	5.34
FM 414	120	2.2	228	0.10%	34	3	188	1.18
FM 421	20	0.2	19	40	29	12	35	0.13

Fig. II-3-5 Generalized Geological Map of Katterfeld Deposit Area

Alteration of the country rock shows a zoning(Fig.Ⅱ-3-5). Quartz-muscovite-kaolinite-calcite zone occurs in the center of mineralization in which both of "new vein" deposit and "old vein" deposit occur. The zone is about 1km wide. The rock of this zone has dark greenish colour in principal and is mottled by hematite of reddish brown colour so that appearances look like rock of dark greenish red colour totally. Besides, narrow clay zone comprising mainly muscovite is recognized in country rock of "new vein" deposit adjoining vein.

A weak silicification-argilization zone envelopes the quartz-muscovite-kaolinite-calcite zone of yellowish brown colour. Dickite is characteristic clay mineral of this zone. The zone is 1 to 1.5km wide. In the dickite zone, no deposit has not been discovered so far. Although a small network veinlets of hematite was recognized on this surney, that was barren: i.e.,20ppb Au, 0.2ppm Ag, 19ppm Cu, Pb, 29ppm Zn, 12ppm Mo, 35ppm As, 0.13% S

As mentioned above, it is noted that gossaneous zone with 1km width is developped in the center of mineralized area and width of alteration zone is more than 4km.

D. Santa Teresa Deposit(another name: Veta Torcaza, El Condor or Katterfeld Ⅱ)

a. Location

The deposit is located in about 20km north of the El Toqui mine. It takes about four hours to reach the mine by vehecle from Coyhaique city.

b. History

Current mining title holder is SCM Toqui. A detailed history of the mine is not known. As could be guessed from fact of it having many names, the owner of mine seem to change several times. Although nobody is in the mine site at the moment, stockpile are still left there and drilling cores of about 1,000m are stored.

Several adits were found in at least five levels. Ore chutes are builed along a part of drifts with interval of 15m. Those suggest the mine had exploited much ores when the mine was cloed out. According to people in the vicinity of mine, the mine was closed out five or six years ago, but the current owner of mine seems to have a plan to reopen the mine in 1992.

c. Geology and deposit

The deposit is vein type of gold-lead-zinc. It is noted that sometimes gold is contained in vein. Andesite of Divisadero Formation and intrusion of quartz porphyry are developed in the area. The deposit occurs in mainly quartz porphyry.

The main vein is single vein. Some parallel veinlets lie in the vicinity of the main vein. The main vein strikes N50°W in southeast but turns gradually into E-W in north. Dip is 65-70°N. Width of vein is variable within 2-5m and 5m in the outcrop at 1,300m altitude.

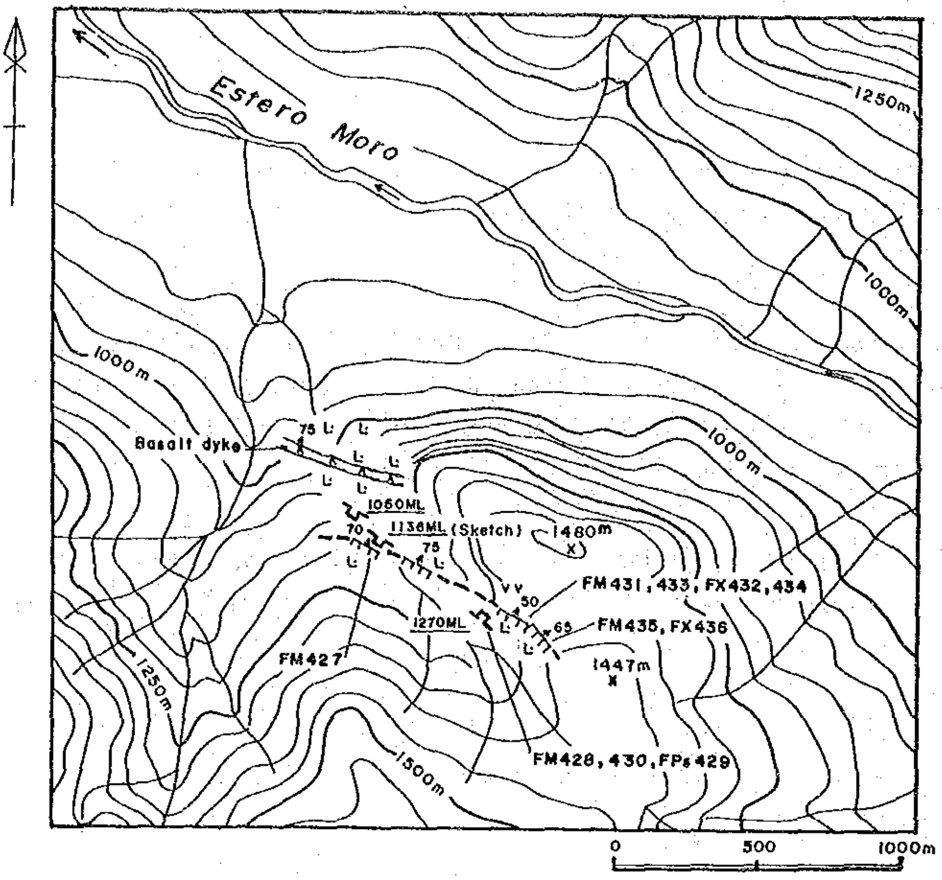
The size of vein is estimated to extend 900m along strike and at least 250m in dip side(see Fig.Ⅱ-3-6). Adits were found in the following five levels.:-

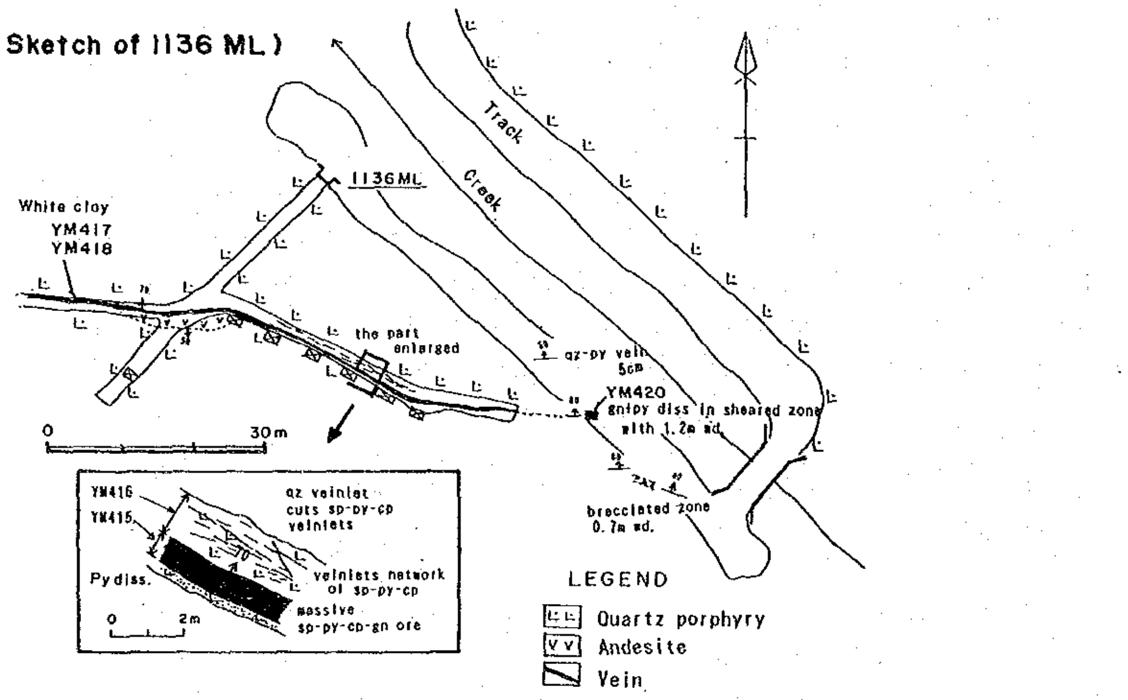
1,060 ML	A crosscut of 8m length
1,136 ML	A drift of 70m length which the exploitation was completed (Fig.Ⅱ-3-6)
1,223 ML	A crosscut of 82m length
1,270 ML	Collapsed adit(crosscut and drift?)
1,300 ML	A shaft driving down from the outcrop. The surface sank due to the exploitation

Principal vein constitution minerals are chalcopyrite, galena, sphalerite and quartz. A small amount of free gold and free silver are accompany as well. Sulfide minerals occur as dissemination and/or veinlet, and quartz vein, veinlet or network crosscut sulfide minerals. Gold and silver is believed to be accompany probably quartz vein. Assay results are as follows:-

Sample	Sample point		width m	Au g/t	Ag g/t	Cu ppm	Pb %	Zn %
FM 427	1136ML	outcrop	2.0	40ppb	2.7	29	0.49	1.06
FM 428	1270ML	ore stock		64.8	171	1.42%	5.41	9.29
FM 430	1270ML			420ppb	9.6	56	0.36	0.65
FM 431	1280ML	outcrop	1.0	160ppb	14.3	820	6.22	0.41
FM 433	1280ML	outcrop	3.0	400ppb	1.2	26	0.16	0.45
FM 435	1300ML	outcrop	5.0	11.6	215	550	5.45	1.03
YM 415				14.5	224	0.98%	1.56	11.8
YM 416				5.2	83	0.23%	0.64	8.03
YM 417				60ppb	0.5	10	160ppm	256ppm
YM 418	1136ML	vein at drift	0.5	22.7	155	0.34%	5.39	14.4
YM 429	1136ML	outcrop	1.2	1.10	15.9	77	0.33	2.16

Wall rock fragments involved into the vein are kaolinitzed to be greyish





Assay Results								
Sample No	Au (ppb)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mo (ppm)	As (ppm)	S (%)
FM 427	40	2.7	29	0.49%	1.06%	6	7	0.41
FM 428	64.8ppm	171	1.42%	5.41%	9.29%	2	99	12.91
FM 430	420	9.6	56	0.36%	0.65%	<1	9	1.80
FM 431	160	14.3	820	6.22%	0.41%	4	17	0.89
FM 433	400	1.2	26	0.16%	0.45%	1	<5	0.07
FM 435	11.6ppm	215	550	5.45%	1.03%	1	32	4.26
YM 415	14.5ppm	224	0.98%	1.56%	11.8%	3	39	7.32%
YM 416	5.20ppm	83	0.23%	0.64%	8.03%	3	23	4.83
YM 417	60	0.5	10	160	256	1	9	0.07
YM 418	22.7ppm	155	0.34%	5.39%	14.4%	1	42	12.34
YM 420	1.10ppm	15.9	77	0.33%	2.16%	5	11	1.41

Fig. II-3-6 Location map of Santa Teresa Deposit and Plan Map of Vein at Level 1136m white colour. Alteration affections, mainly weak sericitization, extend 50 or 60 cm surrounding the vein.

E. Rio Cisnes entre Rio Pedregoso y Estero Buitre Deposit

a. Location

The deposit is located in about 10km east-northeast of Tapera village where is in middle reach of Cisnes river.

b. History

There is a small pit on a size of 8mx3mx1.5m. History of mining for the deposit is not available.

c. Geology and deposit

Quartz-molybdenite veinlets occur in aplite. Numbers of veinlets are only three and width of those is about 1cm. Veinlets are composed of quartz, pyrite, hematite and molybdenite. As shown in Table2 in Appendices, assay shows a little high grade of molybdenium(210ppm-0.14%). Although CORFO(1983) reported a grade of 20g/t Au in a part of veinlets, no anomalous gold value was obtained.

3.1.5. Area No. 5: Ibañez-Murta Area

The following 16 mines and prospects were investigated.

Mine and Prospect	Ore Metals	Type of deposit	Country Rocks
Cerro El Coco	Cu	disseminated	Granodiorite
Veta perez	Cu	vein	Andesite(1)
Rio Resbalon	Cu	vein	Mica schist(2)
Ferix Barria I	Cu	skarn	Limestone(2)
Ferix Barria II	Cu	vein	ditto
Mina Cerro Castillo	Cu,Mo	vein	Granite
Las Chivas	Cu	vein	Mica schist(2)
Mina El Pelado	Pb,Zn	stratiform	Limestone(2)
Mina Silva	Pb,Zn	replacement	ditto
Rio Avellanos I	Cu Pb	vein	Tuff(1)
Mina Cascara	Cu,Au,Pb,Zn	vein	Lapillituff(1)
Mina Fenix	Pb,Zn,Cu	vein and disseminated	Volcanic Rock(1)
Vista Alegre	Pb,Zn	vein	Andesite(1)
Mina Rosillo	Pb,Zn	replacement	Limestone(2)
Veta Torres I	Cu	disseminated	Meta-andesite(1)
Veta San Jose	Au?	vein	Tuff(1)
Veta Torres II	Cu	vein	Aplite

(1):Ibañez Formation, (2):Paleozoic metamorphic complex

Most much numbers of the mine and prospects are distributed in this area. Vein deposit of copper are most prevailing, but they are small. Major lead-zinc depoisits are Paleozoic limestone replacement deposit and the size of them are small.

This report mentiones about large and rich deposits only among them. Others are compiled in Table2 of Appendices.

A. Silva Deposit

a. Location

The mine lies two kilometers north-northwest of the Port of Cristal where is situated in the northern coast of the Lake General Carrera. Zero meter level of the mine is at 980m above sea level. The mine is also situated in 47km southwest of the Port of Ingeniero Ibañez in direct distance, but no car road connects to the mine from the port so that ship is unique transportation system from the Ingeniero Ibañez on the Lake General Carrera. Rout on the Lake is about 75km and trip by ferry takes about seven hours. The ferry line are available each two weeks interval. This ferry can be hired.

b. History

1936: Antolin Silva discovered the deposit.
1941: A firm, Compania Minera del Lago Buenos Aires mined high grade lead ore on a small scale.
1945: A name of the firm was changed to Compania Minera Aysen.
1948: Mine operation started and yielded 1,100 tonnes of concentrates at 64% Pb, 7.8% Zn and 942g/t Ag
1963: The firm fell in a critical situation. CORFO took over a part of management and the name of firm was changed to Empresa Minera Aysen.
Total production amount until 1968 reached 233,000 tonnes of lead.
1978: The mine operation shisted to produce zinc ore instead of lead ore which had mined since start of mining. Production of ore was at the rate of 80 t /month at 6% Pb, 12% Zn and 40g/t Ag.
1980: The firm changed name again to E.M.A. Limitada and obtained the mining titles of small mines scattered around the Lake General Carrera. Production of the year was 9,432 t at 4.8% Pb, 10.4% Zn.
1988: Mine was closed down. Production of the year was 1,500 t at 12-14% Zn and 3-4% Pb

c. Geology and Mineralization

Geology of the mine area, according to the materials of the mine, consists of Paleozoic limestone and schist, granite and aplite intruded into the Paleozoic rocks(Fig.Ⅱ-3-7). Marble, country rock of the deposit, is developed from the center of the deposit to the eastern area. Granite is distributed broadly in west of the deposit and a skarn zone is formed in the contact of limestone and granite. Siliceous schist and greenschist are distributed in the southern part on a small scale. A fault of N-S system lies east of the deposit and the Rosillo deposit is situated in further east.

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

Ore outcrop is scattered within area of 80mx300m and occurs in a consistent horizon approximately as shown in Fig.Ⅱ-3-8. Extention to the west is cut by granite and eastward extention is made vague by a fault of N-S system on the Rosillo river.

Ore forming minerals observed on outcrop are mainly sphalerite, galena and chalcopyrite accompanied with small amount of magnetite and pyrite and trace

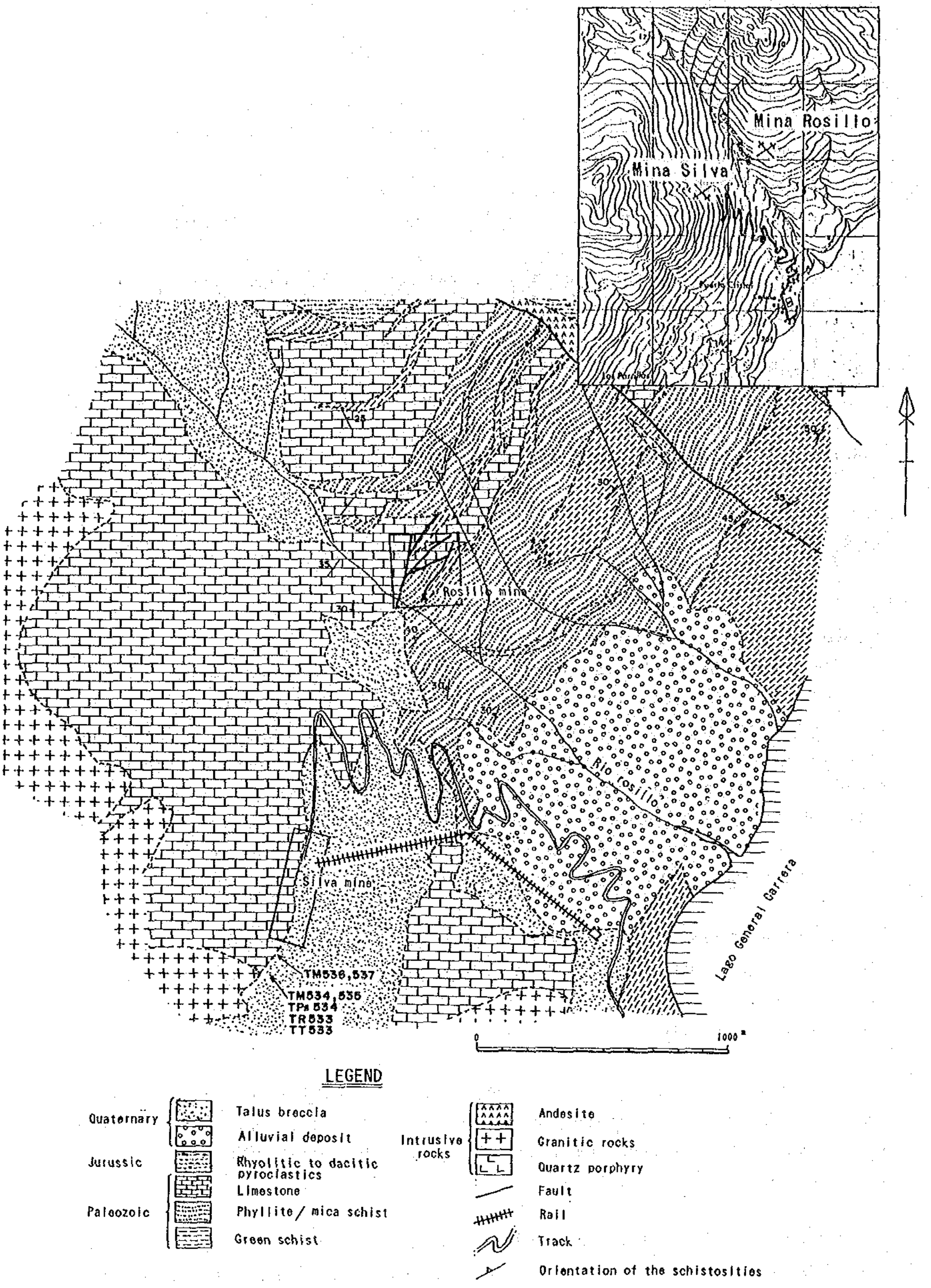


Fig. II-3-7 Generalized Geological Map of Silva Mine-Rosillo Mine Area

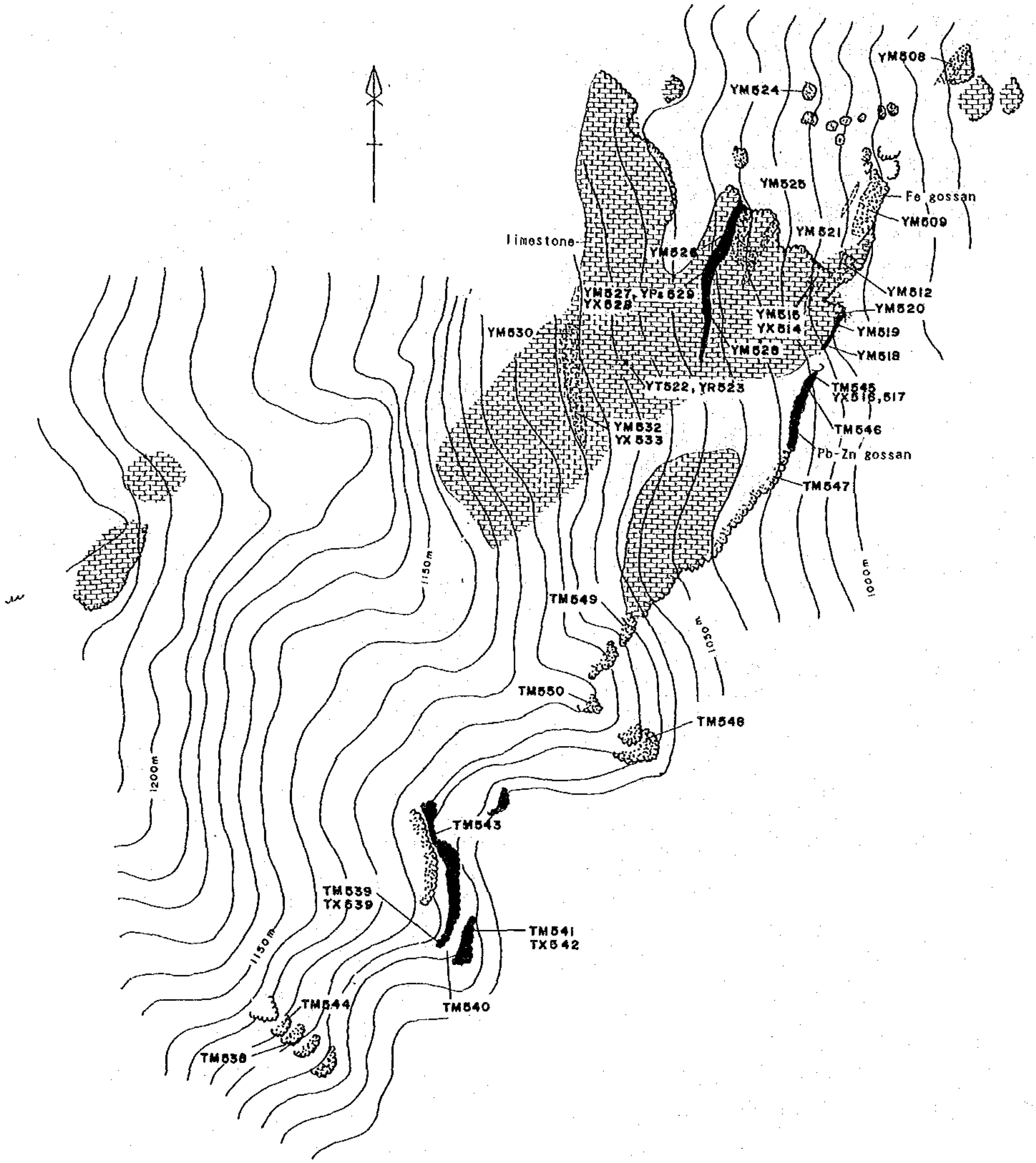


Fig. II-3-8 Plan Map of Outcrop Distribution in Silva Mine

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

of anglesite and silver minerals. Sphalerite shows very light brown colour indicating low iron content. Galena is coarse grained containing relatively high silver. Gangue minerals are chiefly calcite, quartz and chlorite, while plagioclase and siderite occur accidentary. Occurence of skarn minerals is limited to the contact of granite and limestone and they do not co-exist with lead and zinc ore. Assays on outcrops are shown on Fig.Ⅱ-3-8.

B. Rosillo Deposit

a. Location

The mine is located in 1.3km north-northeast of the Silva mine or 3km northeast of the Port of Cristal. Main level of the mine is at 745m above sea level.

b. History

Current mining title holder is E.M.A. Production seems to have started at least before 1960, but exact started year is not known. Production of crude ore of 4,984 t at 15.8% Zn was recorded in 1979. The mine operation was suspended in January, 1980 after producing ore of 101t at 8.14% Zn on that month. After that, the mine restarted operation producing ore of 30t/month at 12.05% Zn and 15g/t Ag.

c. Geology and Mineralization

Figure Ⅱ-3-9 is geological map of the mining area. The mining area is underlain by Upper Paleozoic unit consisting of blackschist, greenschist and marble, and intruded by granite through Paleozoic rocks. Also Jurrasic Ibañez Formation is distributed. A fault lies 200m west of the deposit on the Rosillo river. Granitic rocks are distributed broadly in east of the deposit. Ibañez Formation uncorfomably covers Paleozoic unit. Faults of E-W system are developed closely nearby the deposit.

The deposit occurs in contact of phyllite(or mica-schist) and limestone or in scist with bedded, lense-shaped and massive features(Fig.Ⅱ-3-10). About 20 orebodies were found so far and the size of orebodies is averagely 4mx4mx4m and maximamly 9mx40mx18m.

Whereas, two stratiform orebodies were discovered by drillings. Now a shortcut is reaching to the Manto 1 orebody. Outline of orebodies defined by exploration is as follows:-

Manto 1 orebody: ore reserve(in situ); 18,000t at 8.13% Zn and 2.12% Pb

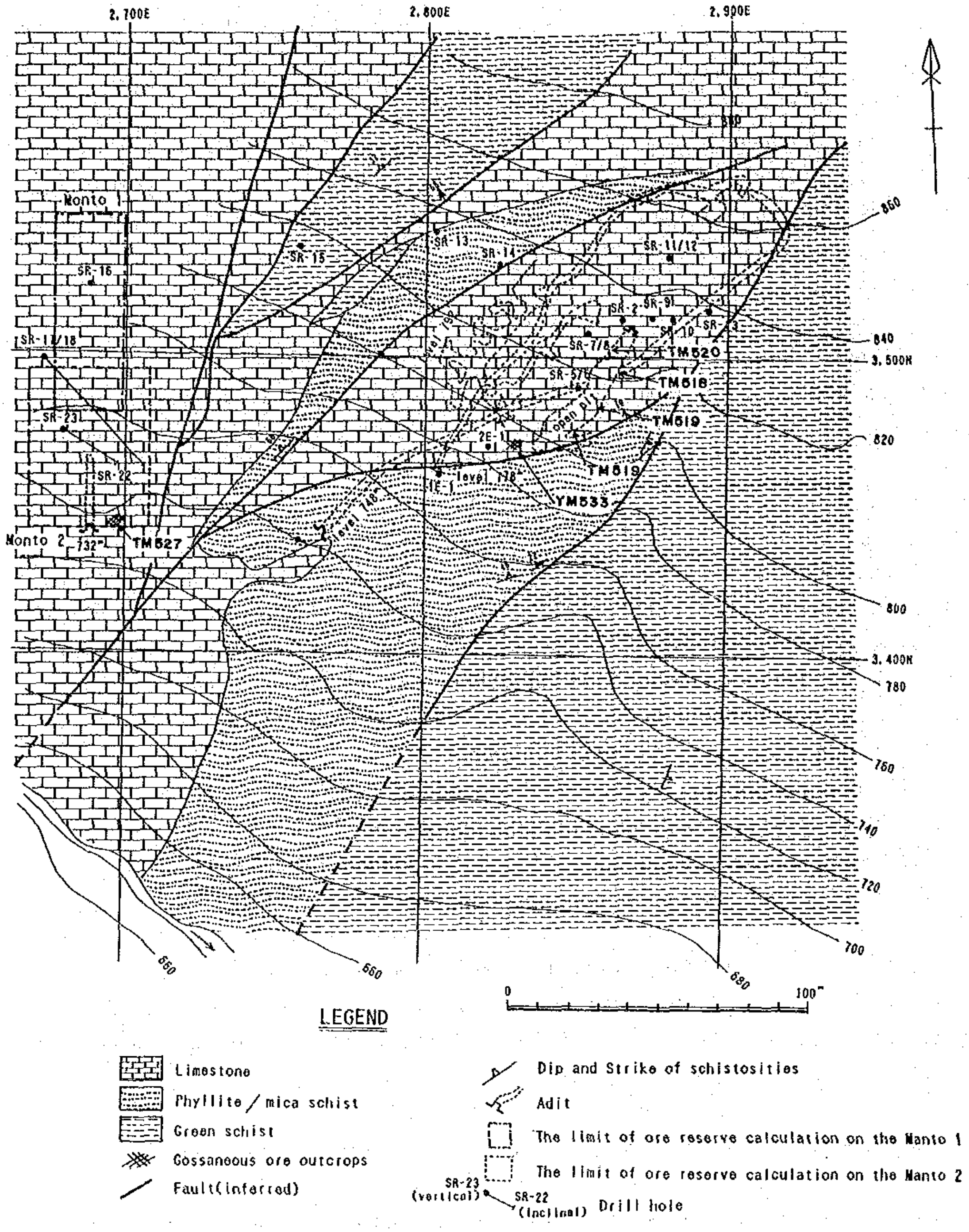
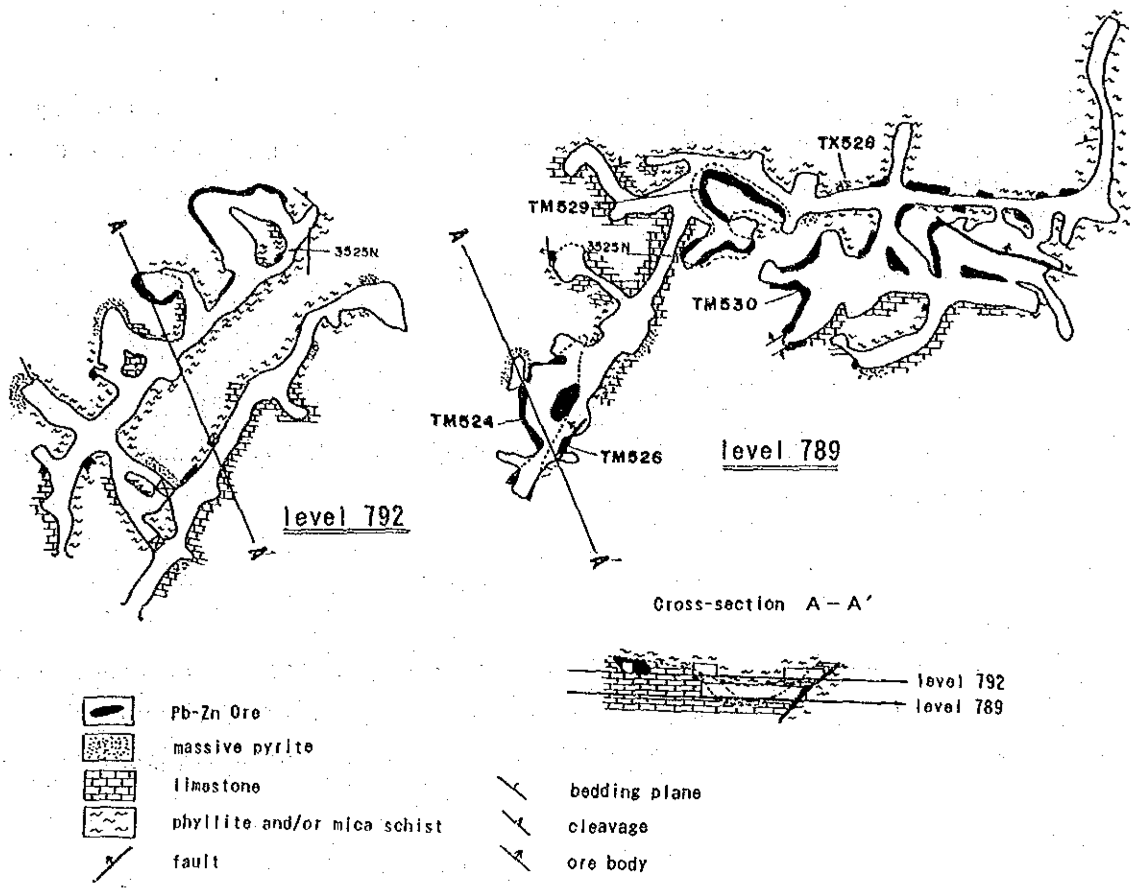


Fig. II-3-9 Geological Map of Rosillo Mine



Assay Results								
Sample No	Au (ppb)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mo (ppm)	As (ppm)	S (%)
TM 518	40	1.5	27	60	0.22%	8	2.76%	7.05
TM 519	<20	28.9	0.10%	860	32.9%	1	0.48%	21.34
TM 520	80	50	0.15%	450	22.8%	1	0.63%	19.27
TM 521	20	8.2	50	360	435	2	0.21%	43.29
TM 524	<20	0.2	12	<20	54	2	113	0.11
TM 526	20	125	257	720	47.5%	1	0.29%	26.94
TM 527	<20	4.0	0.40%	340	592	1	1.03%	0.32
TM 529	20	60	0.19%	820	41.7%	1	353	24.42
TM 530	<20	24.9	990	680	35.3%	2	100	20.71
YM 533	<20	1.2	19	0.10%	813	<1	293	0.27

Fig. II-3-10 Plan Map of Stope in Rosillo Mine

Manto 2 orebody: ore reserve(in situ); 2,800t at 6.56% Zn and 0.98% Pb

Ore minerals are mainly sphalerite accompanied with galena, pyrite, chalcopyrite and arsenopyrite. Gangue minerals are mainly calcite and small amount of hematite and magnetite.

Assays on samples from outcrops and mining site are as shown in Fig.II-3-10.

El Pelado deposit lying 8.5km west of the Rosillo deposit is of similar mineralization. The strata of El Pelado deposit are said to be same as that of the Rosillo deposit.

C. Las Chivas mine

a. Location

The mine is located in 12km direct distance of the Silva mine. Mining facilities are at 600-700m in altitude. Trip by ship takes 1.5 hours from the Port of Cristal to the Port of Sanchez and a road of four kilometers connects to the mine.

b. History

1957-1971: production amount; 165,000t at 4.68% Cu

1972-1981: production amount; 24,000t at 2.5% Cu

The mining completed in 1986. Mining title is owned by E.M.A.

c. Geology and Mineralization

Upper Paleozoic mica-schist and phyllite, and dykes of granodioritic rock intruding Paleozoic rocks are distributed in the area. The deposit is vein type deposit of copper occuring in Paleozoic rocks. A main vein and two parallel veins are developed.

Main vein strikes N60°W and dips 80°S. Width of it varies between 1m and 15m with 1.5m in average. The vein extends 1,700m along atrike and probably more than 200 m along dip, but lower limit has not been identified. Parallel veins are 0.2-1.0m wide. Both extend 60-70m along strike. Extention to depth is about 15m for one vein but not kown for the another vein.

Ore minerals are mainly chalcopyrite and pyrrohotite accompanied with small amount of galena,sphalerite, pyrite, arsenopyrite and magnetite. Gangue minerals are quartz and chlorite. No supergene enrichment zone is recognized.

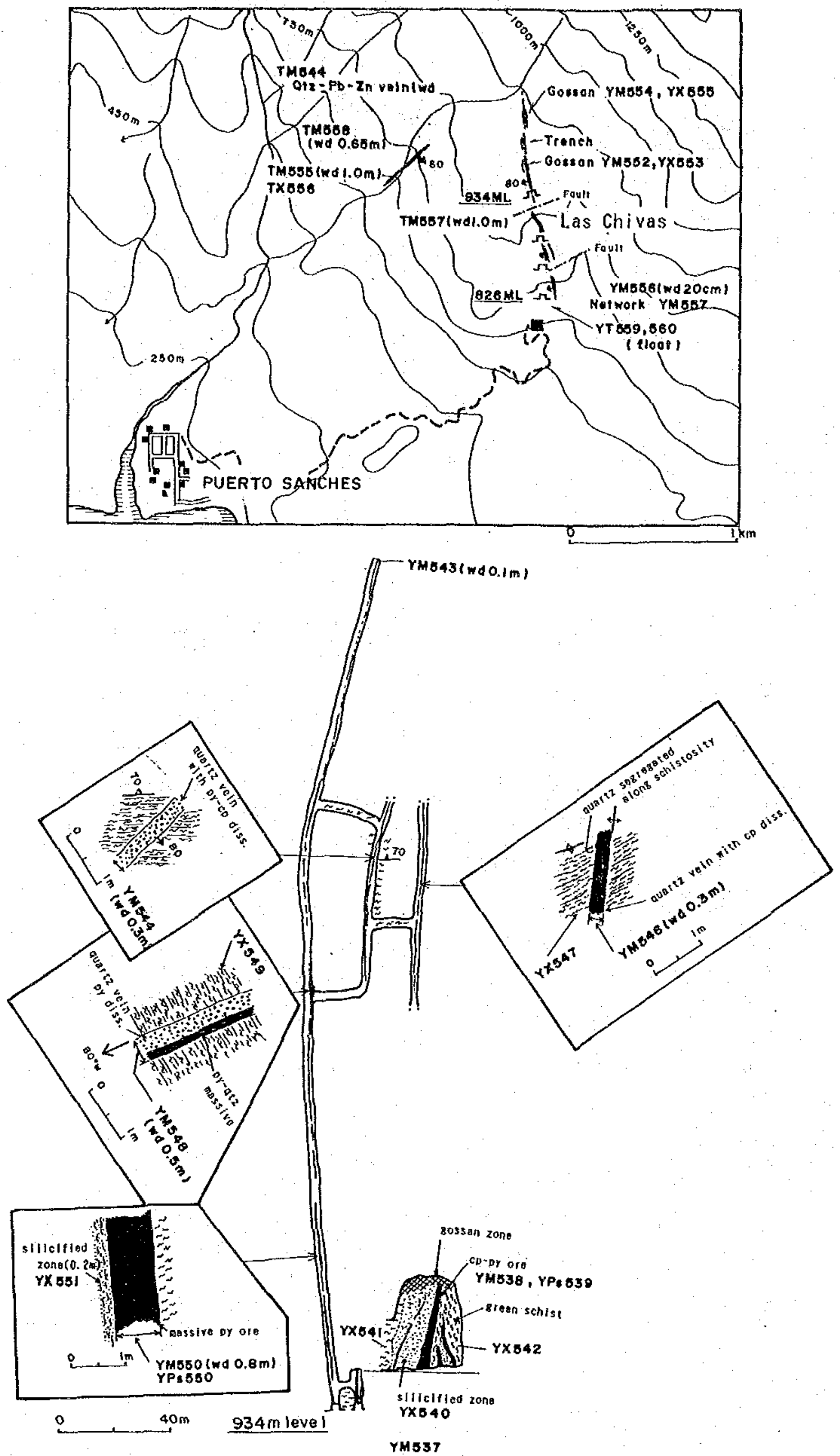


Fig. II-3-11 Location Map of Las Chivas Mine and Plan Map of Vein

Assay Results								
Sample No	Au (ppb)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mo (ppm)	As (ppm)	S (%)
YM 537	20	37	25.4%	320	0.13%	7	252	18.51
YM 538	40	80	5.02%	0.15%	0.48%	<1	302	27.24
YM 543	<20	1.5	0.35%	60	87	<1	69	0.48
YM 544	40	24	0.41%	100	982	<1	182	7.42
YM 546	<20	4.7	0.42%	80	135	<1	127	5.05
YM 548	<20	43	3.64%	40	905	<1	63	5.85
YM 550	40	66	6.08%	100	0.12%	1	217	22.16
YM 552	40	83	0.30%	<20	85	1	527	0.16
YM 554	<20	21	0.11%	<20	6	1	45	0.11
YM 556	<20	18	1.82%	140	317	<1	141	2.40
YM 557	<20	1.3	1.70%	50	132	1	141	2.40
TM 554	40	40.1	0.55%	3.79%	26.3%	<1	107	16.67
TM 555	40	61	0.54%	1.25%	1.83%	19	408	3.17
TM 557	40	2.3	0.20%	100	223	2	234	4.01
TM 558	100	199	1.01%	4.13%	11.3%	1	0.11%	14.19%
TM 559	20	0.2	21	20	53	4	7	0.11%

but primary ore only.

Assay results by this investigation are as shown in Fig.Ⅱ-3-11.

Wall rock alteration is not significant otherwise some strong chloritization and sericitization are observed in the inside of vein.

D. Cerro Castillo Deposit

a. Location

The deposit is situated about 40km southwest of Coyhaique city. It takes about three hours by horse trip and about one hour by foot(Fig.Ⅱ-3-12).

b. History

Collapsed old workig was reported on existing materials. It was not confirmed by this site inspection, however. No other historical information is available.

c. Geology and Mineralization

Granite stock is distributed in mine area. Ibañez Formation is intruded by it. This deposit is vein deposit of copper-molybdenium occuring in granite. Some parallel veins of 0.3 to 1.0m wide occur, though they extend up to only 15m along strike(Fig.Ⅱ-3-12). Ore minerals are chalcopyrite, molybdenite, galena with being accompanied with oxide minerals of copper. Gangue mineral is quartz. Assays on ore outcrops are listed on Fig.Ⅱ-3-12 and Table 3 of Appendices.

E. Mina Cascara Deposit

a. Location

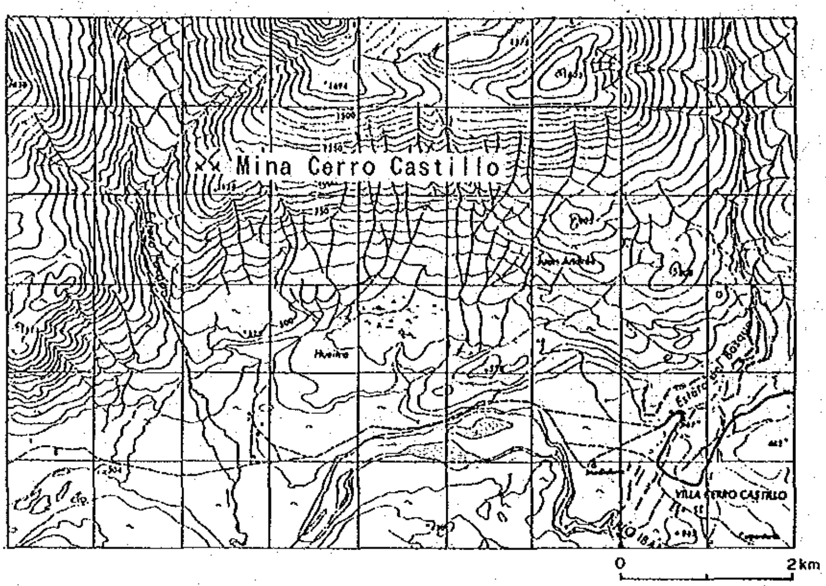
This mine is located 12.5km west-southwest of the Port of Ibañez(Fig.Ⅱ-3-13).

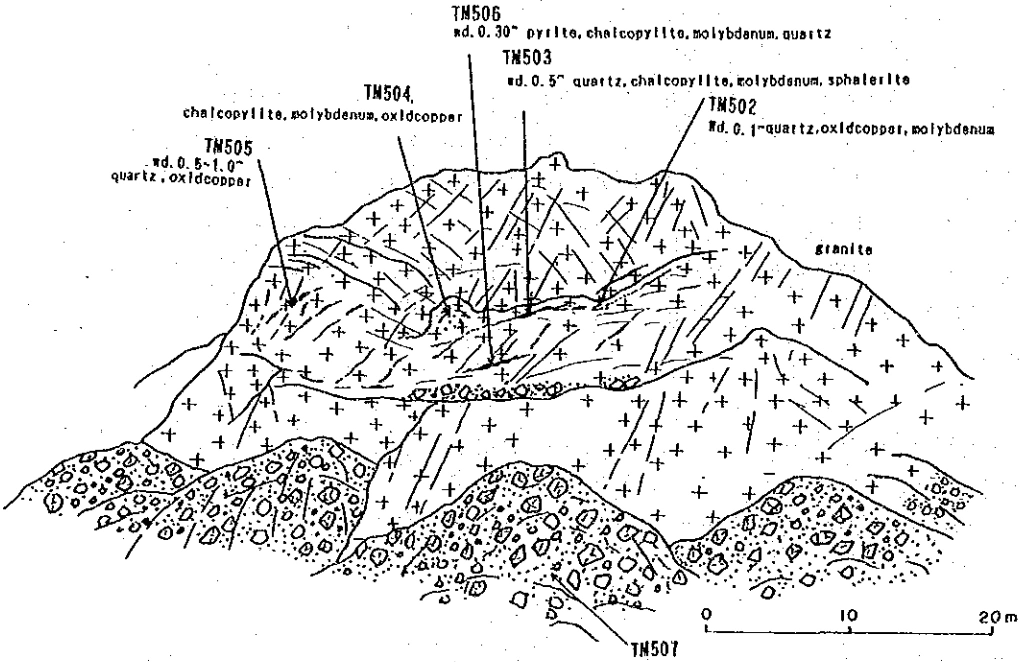
b. History

This mine was abandoned in 1953. Exploration by drift was carried out with about 150m length along vein as shown in Fig.Ⅱ-3-13. No real mining was commenced so far.

c. Geology and Mineralogy

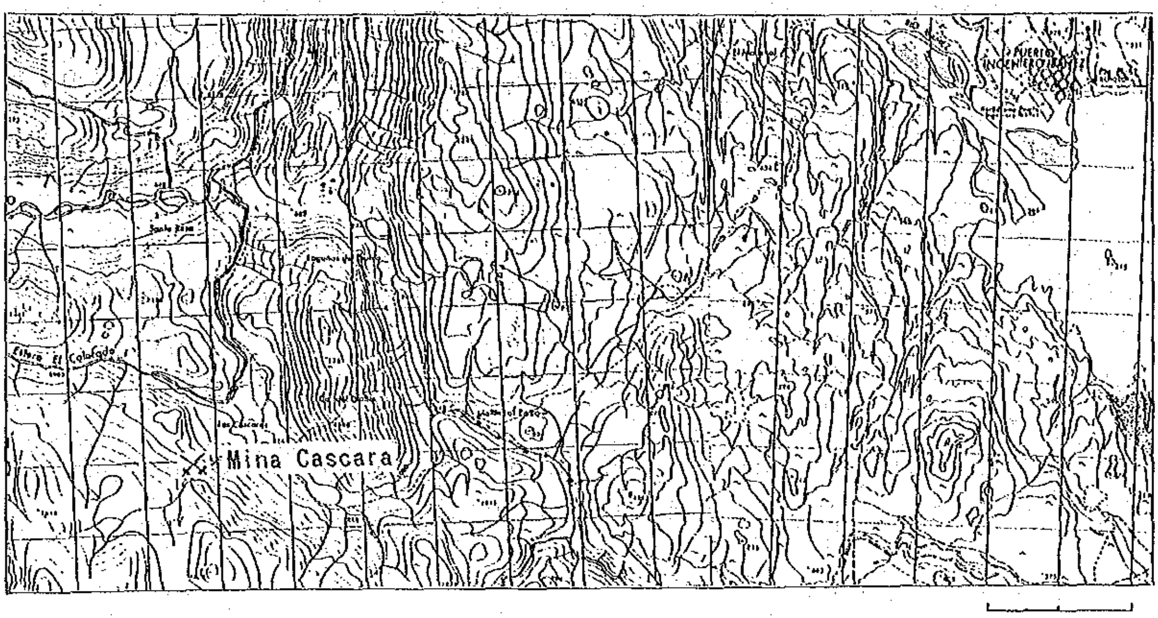
The mine area is underlain by Ibañez Formation and Divisadero Formation. The deposit is vein deposit of copper-lead-zinc, strikes N25°-35°E and dips 50° to 55°W occuring in lapillituff of Ibañez Formation. This vein is one

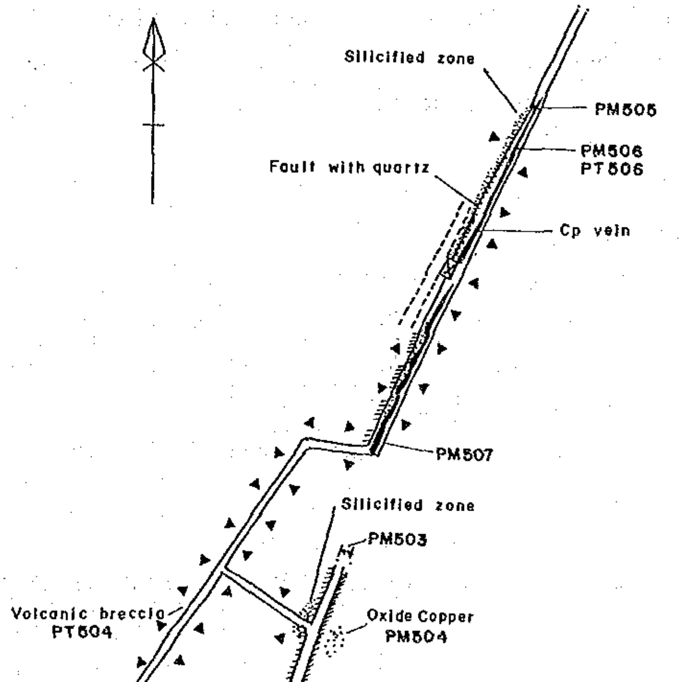




Assay Results								
Sample No	Au (ppb)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mo (ppm)	As (ppm)	S (%)
TM 502	20	0.5	770	<20	53	0.27%	82	1.91
TM 503	120	30.2	2.00%	40	114	0.84%	<5	2.27
TM 504	40	4.8	0.15%	30	112	3.52%	<5	3.71
TM 505	<20	0.2	103	<20	25	350	7	0.04
TM 506	20	1.1	0.12%	60	154	0.62%	52	4.06
TM 507	20	1.0	450	20	64	0.38%	27	0.74

Fig. II-3-12 Location Map and Geological Sketch of Cerro Castillo Mine





Assay Results								
Sample No	Au (ppb)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mo (ppm)	As (ppm)	S (%)
PM 502	<20	0.3	0.16%	<20	35	1	20	0.20
PM 503	140	1.5	340	100	4	<1	0.15%	18.45
PM 504	<20	0.2	66	20	578	2	28	0.05
PM 505	40	1.2	4	20	7	5	52	0.05
PM 506	780	13	0.58%	800	65	3	9	0.22
PM 507	<20	1.0	165	0.13%	508	47	25	0.16

Fig. II-3-13 Location Map and Plan Map of Cascara Mine meter wide and extends 120 to 150m along strike. Ore minerals are chalcopyrite, galena, sphalerite and oxide minerals of copper. Gangue mineral is quartz. Assay results are shown in Fig.Ⅱ-3-13.

F. Vista Alegre Deposit

a. Location

This deposit is situated 12.5km south of the Port of Ibañez, facing north coast of the Lake General Carrera(Fig.Ⅱ-3-14).

b. History

This mine was abandoned in 1960. Adits of 40m and three pits had been constructed before that. No mining was conducted so far.

c. Geology and Mineralization

This deposit is vein deposit of lead-zinc occuring in andesite of Ibañez Formation. This deposit is very small deposit:The vein is 0.2 to 0.3m wide and extends about 25m along strike as shown in Fig.Ⅱ-3-14. Assays on vein show low grade other than zinc grade in part.

3.1.6. Area No. 6: Los Leones Area

The following two deposits were surveyed.

Mine and Prospect	Ore Metals	Deposit	Country Rock
Rio Leones Sector Bajo	Cu	veinlet	Schist(1)
Rio Leones Sector Alto	Au?	veinlet	Granite

(1):Paleozoic metamorphic compex

Both deposits are very small and low grade(see Table2 and 3 of Appendices).

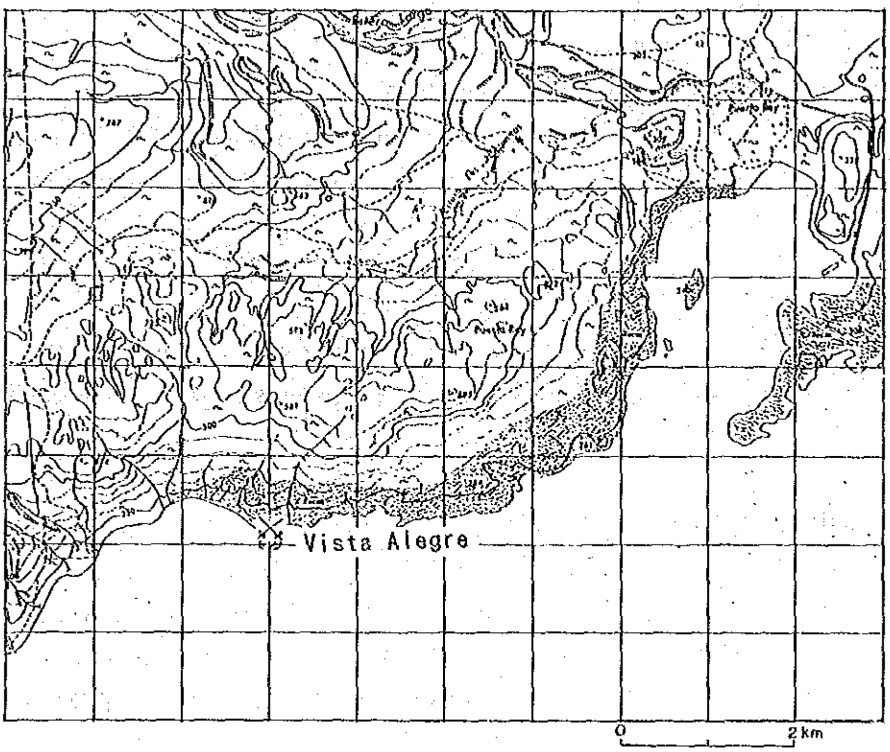
3.1.7. Area No 7: Chile Chico-Chacabuco Area

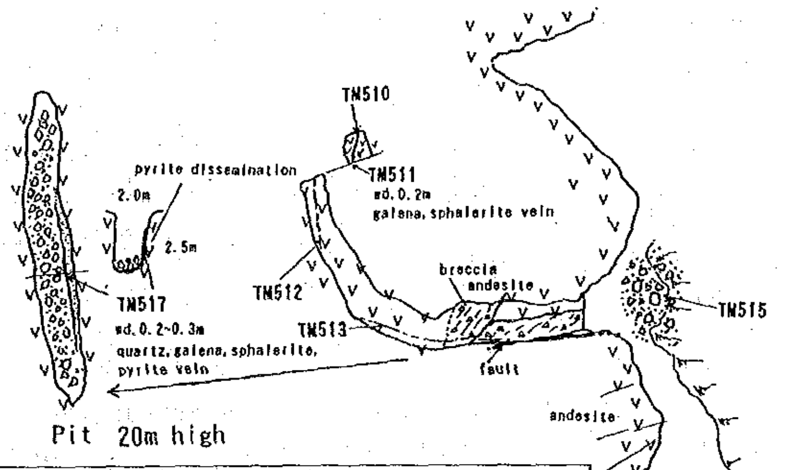
Numbers of mines and prospects investigated are eight as listed below

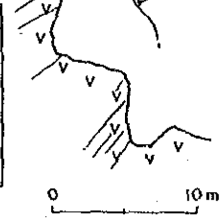
Mine and Prospect	Ore Metals	Deposit	Country Rock
La Paulina	Pb,Zn	stratiform	Tuff(1)
Laguna Verde	Au	vein	Dacite(1)
La Poza	Pb	stratiform	Black shale(1)
Valle del Rio Aviles	Cu	vein	Granite
Mina Escondida	Pb,Zn,Cu	vein	Mica schist(2)
Co. Bayo	Au?	vein	Quartz porphyry
El Colegio Alteration zone	Au?	stockwork	Dacite(1)
Veta Don Juan	Au	vein	ditto

(1):Ibañez Formation, (2):Paleozoic metamorphic complex

The report describes the large and rich deposits of them listed above.







Assay Results

Sample No	Au (ppb)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mo (ppm)	As (ppm)	S (%)
TM 510	200	33.2	430	0.44%	8.16%	21	253	8.39
TM 511	160	94	260	7.32%	9.25%	11	373	12.24
TM 512	20	1.5	10	200	0.11%	7	63	7.08
TM 513	40	1.6	10	600	984	5	86	5.25
TM 515	200	51.6	420	0.45%	13.0%	36	118	9.47
TM 517	1.44ppm	59	410	2.67%	10.0%	6	141	6.65

Fig. II-3-14 Location Map and Plan Map of Vista Alegre Mine

A. La Paulina Deposit

a. Location(Fig.II-3-16)

The deposit is located in 36km west of Chile Chico city, or 5km south-southeast of the Port of Fachinal. A road connected from Chile Chico lies near the old workings of La Paulina. It is about one hour drive by vehicle from Chile Chico city.

b. History

Current mining title holder is Empresa Minera de Aysen Ltda. Only one exploration adit of eight meters length was put in the area so far, and the deposit has not been mined.

c. Geology and Mineralization

The area is underlain by volcanic rocks which is considered to be Ibañez Formation and thin formation of marine origin is associated with volcanic rocks. Ore minerals are disseminated in the formation of marine origin to form ore zone. The ore zone is concordant to the formation(Fig.II-3-15).

The hanging wall of deposit is always red chert(partly limestone). The ore-bearing rocks are black shale and/or calcareous sandy tuff. On the other hand, chert of hanging wall partly contains small amount of disseminated galena in some case.

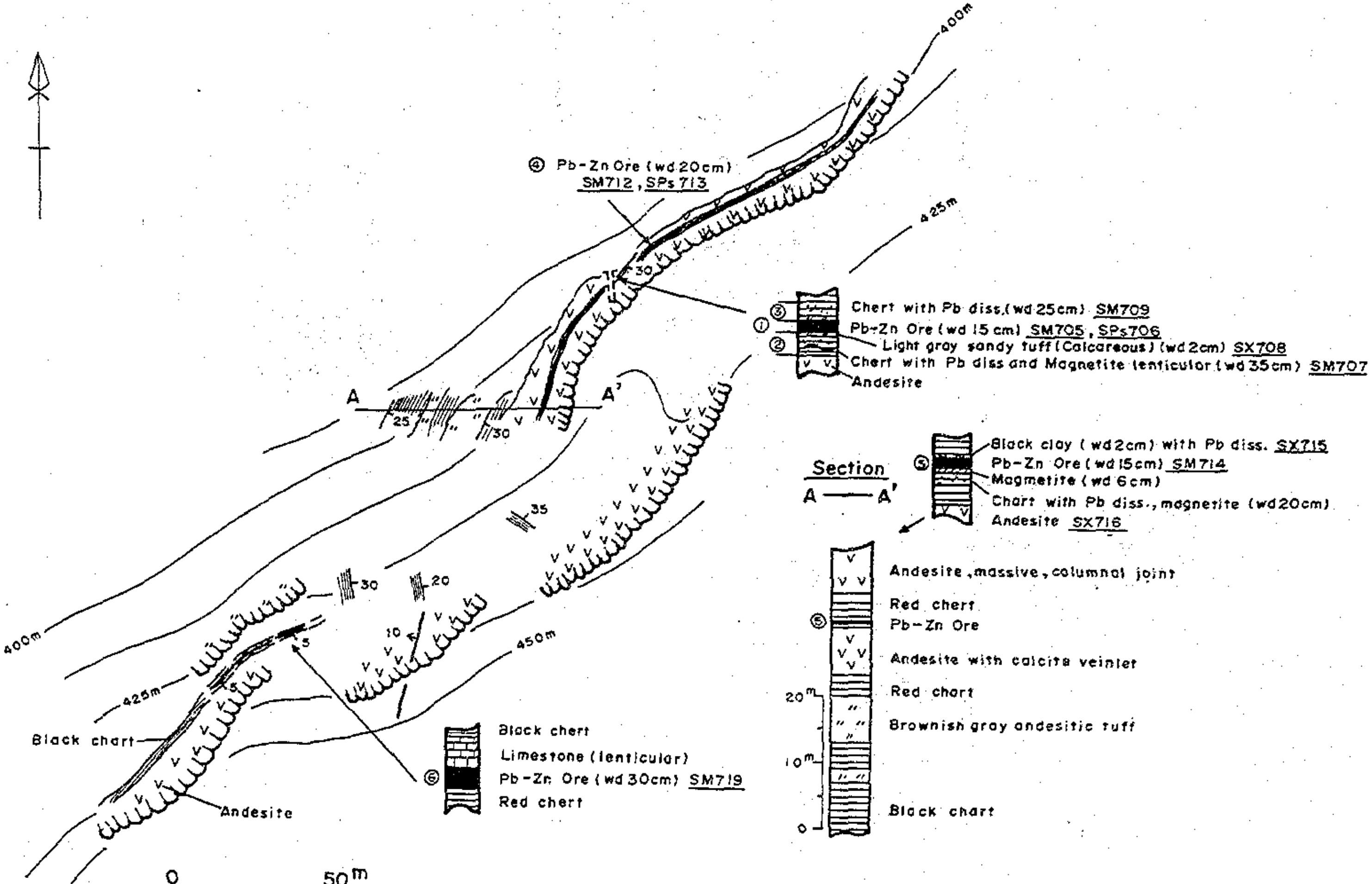
The deposit strikes N15°W and dips 35°E. Thickness is 0.2 to 0.7m. Mineralization is estimated to be found along more than 300 m of strike, but downward extention is not known. Only one horizon was recognized on this investigation.

Ore minerals are chiefly galena accompanied with a small amount of pyrrohotite and sphalerite. Those minerals are of very fine grain. Ore grade is 160-430g/t Ag, 2-8% Pb, 0.1-2% Zn. Grade of other elements are negligeble(see Table2 and 3 of Appendices).

Wall rock alteration is generally very weak even in ore zone or wall rock nearby ore. A small amount of muscovite, siderite and ankerite were determined by X ray diffraction.

B. La Poza Deposit

a. Location



Assay Results								
Sample No	Au (ppb)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mo (ppm)	As (ppm)	S (%)
①SM 705	<20	50	59	5.80%	0.24%	<1	36	2.69
②SM 707	<20	12	54	0.68%	2.14%	6	69	1.00
③SM 709	<20	51	33	2.60%	0.18%	12	88	1.09
④SM 712	<20	220	95	8.65%	0.35%	<1	80	4.84
⑤SM 714	<20	162	29	4.71%	.394	13	40	2.90
⑥SM 719	<20	430	86	4.51%	0.14%	2	128	4.26

Fig. II-3-15 Sketch of Paulina Deposit

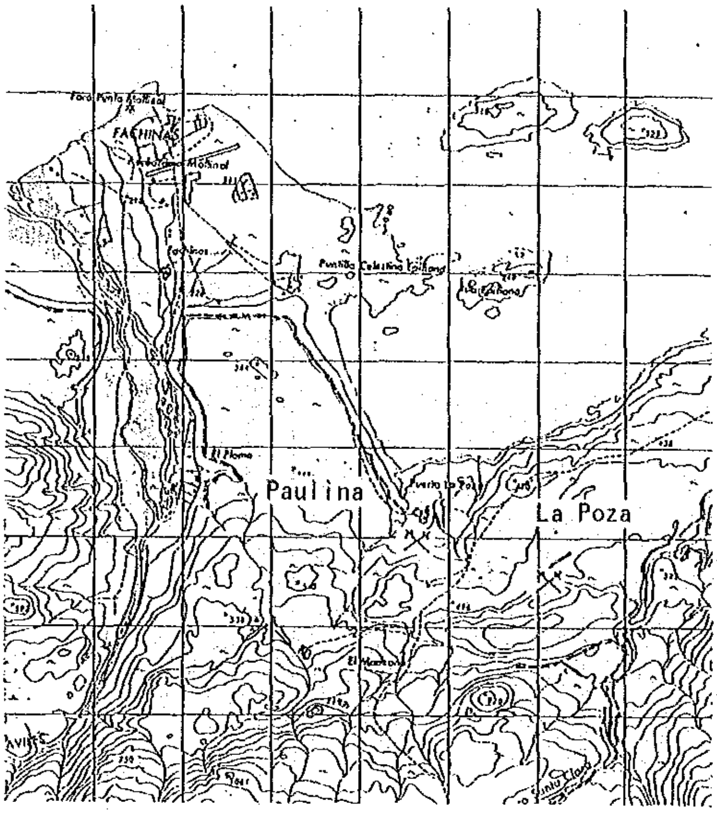


Fig. II-3-16 Location Map of Paulina and La Poza Deposits

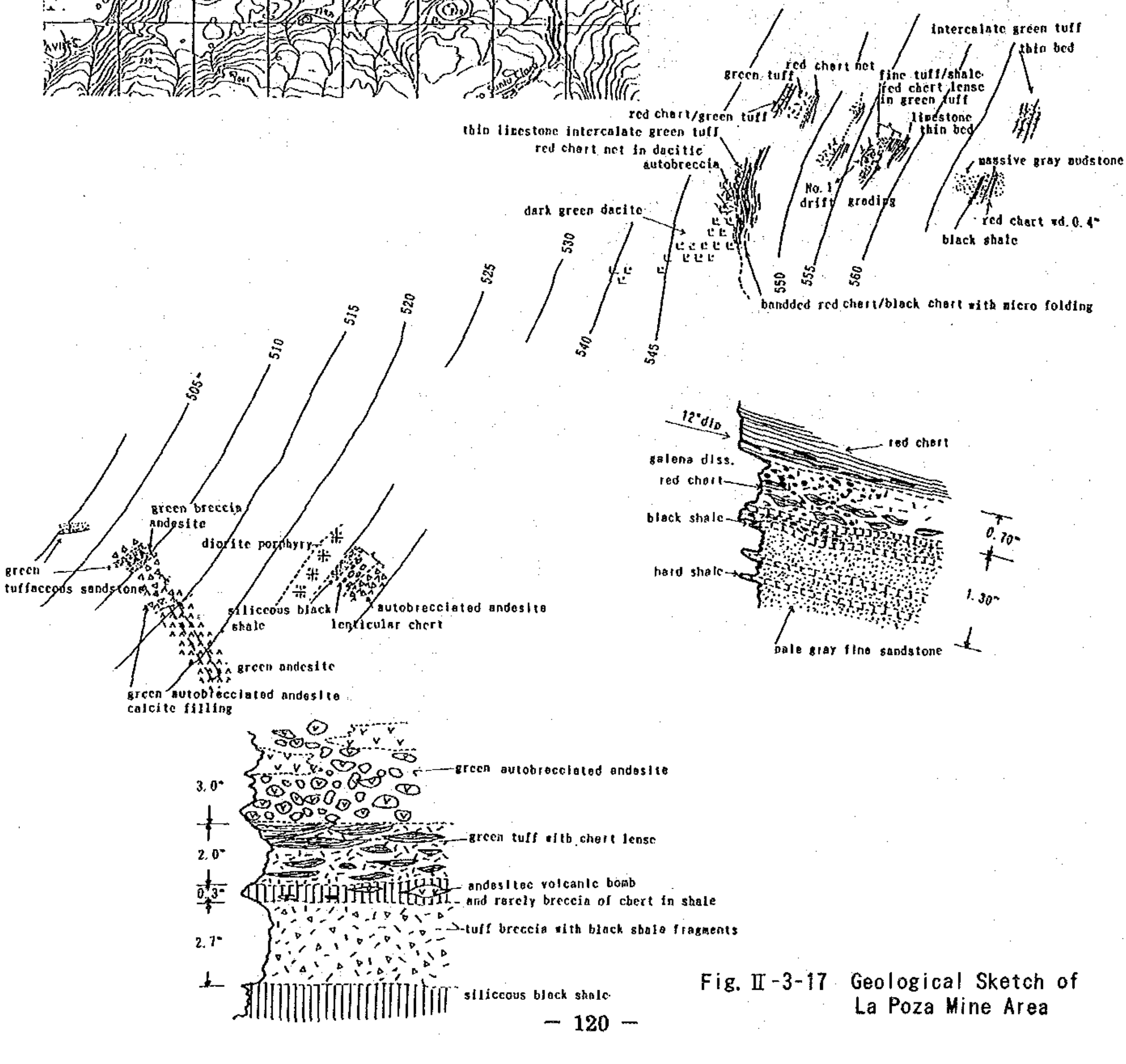


Fig. II-3-17 Geological Sketch of La Poza Mine Area

The mine is located in about 1.3 km east-southeast of the Paulina prospect. A road connects to the mine site; about one hour trip by vehicle from Chile Chico city(Fig.Ⅱ-3-16).

b. History

Current mining title holder is E.M.A. Four or five exploration drifts were constructed. Small amount of ore was yielded from these exploration in 1980 and 1981(CORFO,1983): 130t at 4.90% Pb and 2.0% Zn in 1980 ; 245t at 5.30% Pb, 1.2% Zn in 1981.

c. Geology and Mineralization

La Poza deposit is a stratiform deposit of similar style to La Paulina deposit mentioned above. The mine area is underlain by Ibañez Formation; dacitic lava, pyroclastic rocks and sedimentary rocks of marine origin. Lithostratigrapy is illustratrd in Fig.Ⅱ-3-19 and Ⅱ-3-20. Pyroclastic rocks consist of green tuff and fine tuff etc. and sedimentary rocks consist of red chert, marl, limestone, tuffaceous sandstone and shale. Upper unit of the formation is prevailed by sedimentary rocks but lowvolcanic rocks are prevailing in the lower unit.

FigureⅡ-3-17 and Ⅱ-3-20 show lithostratigraphy of the outcrop of deposit. Lower unit consists of dark green thick dacite lava, middle unit consists of green tuff and upper unit consists of altenating bed of sandstone and shale. Those units are interbedded with several red chert beds. Three beds of them are relatively thick beds. The major ore-bearing bed lies foot wall of the uppermost chert bed of the three thick beds. This chert bed, banded bed of red and five meters thick, lies in near bottom of altenating bed of sandstone and shale(Fig.Ⅱ-3-20).

The ore is disseminated concordantly with beds in tafaceous sandstone or black shale and interbeded limestone in tafaceous sandstone lying just below the chert bed (Fig.Ⅱ-3-17 and Ⅱ-3-18). Major ore constitution mineral is galena accompanied with small amount of sphalerite. Chalcopyrite and anglesite are observed as well by microscopy. All the minerals are very fine-grained.

Small amount of galena, hematite and calcite are also recognized in networks occuring in the chert bed which is hanging wall of orebody. This orebody is 0.35 to 1.0 meters thick. Confirmed extention along strike is 400 meters but that to depth is not known. MMAJ(1978) reported that other several ore-bearing beds were recognized(see Fig.Ⅱ-3-19), but that was not confirmed

Assay Results								
Sample No	Au (ppb)	Ag (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Mo (ppm)	As (ppm)	S (%)
FM 716	20	0.2	6	180	251	77	470	0.32
FM 717	<20	0.9	9	170	312	21	169	2.07
FM 718	<20	2.0	8	300	289	4	92	0.11
FM 719	<20	0.8	5	0.10%	853	28	254	0.11
FM 720	<20	182	260	16.3%	3.32%	<1	134	6.69
FM 722	<20	134	140	12.6%	4.38%	<1	57	7.15
FM 723	<20	17.9	22	1.50%	0.94%	2	55	1.31
FM 724	<20	23	20	0.97%	1.79%	<1	56	3.99
FM 725	<20	0.9	3	0.12%	471	59	519	0.26

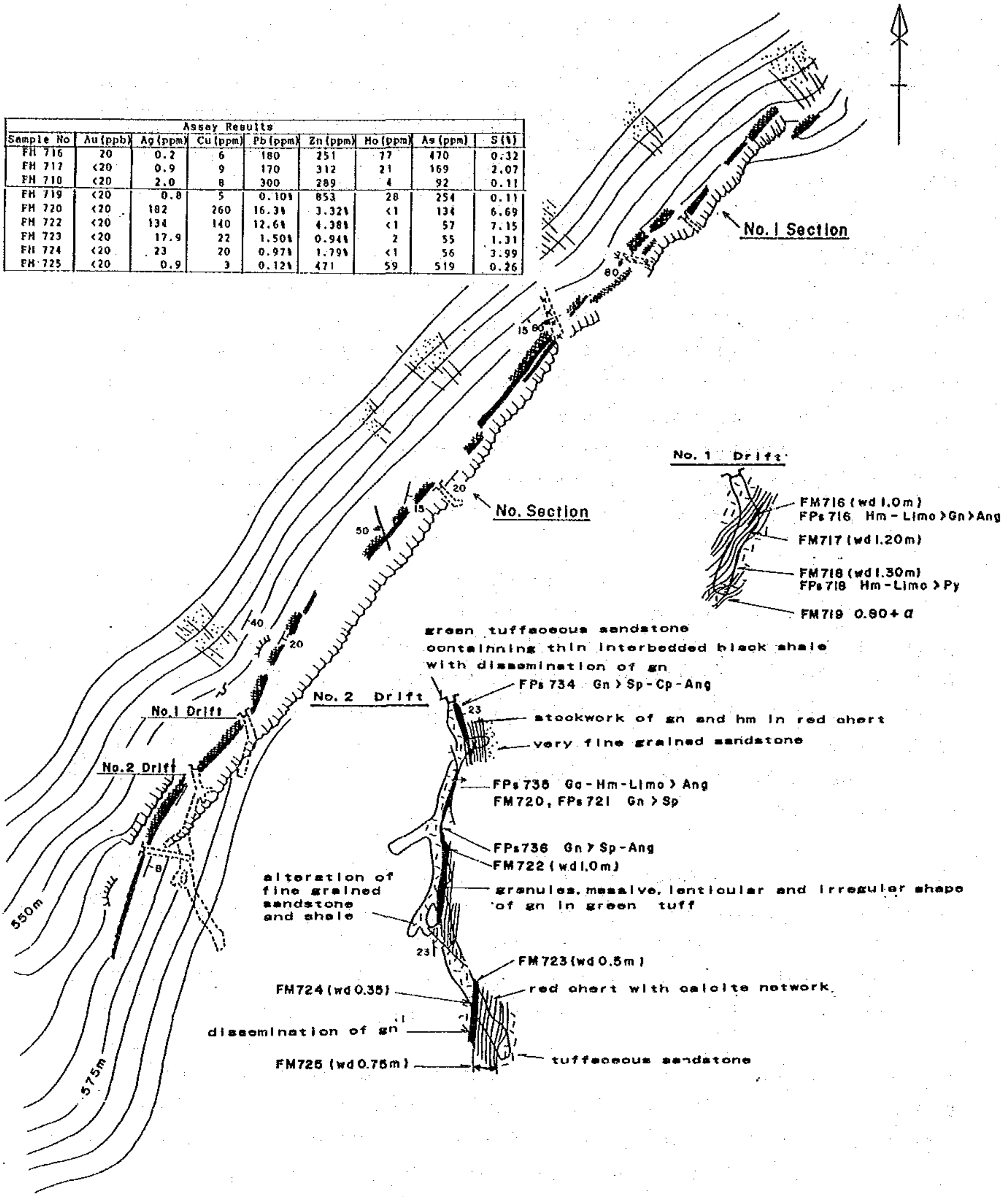


Fig. II-3-18 Geological Sketch of La Poza Deposit

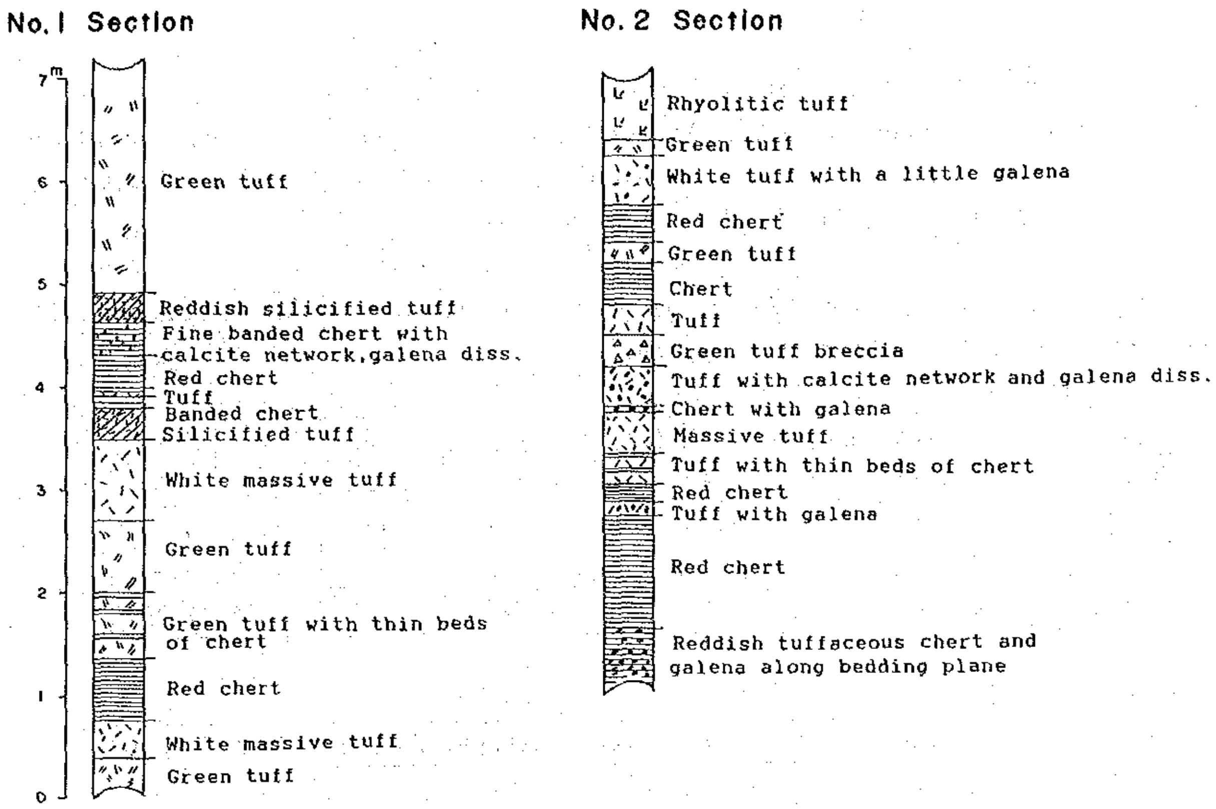


Fig. II-3-19 Schematic Geological Column of La Poza Deposit

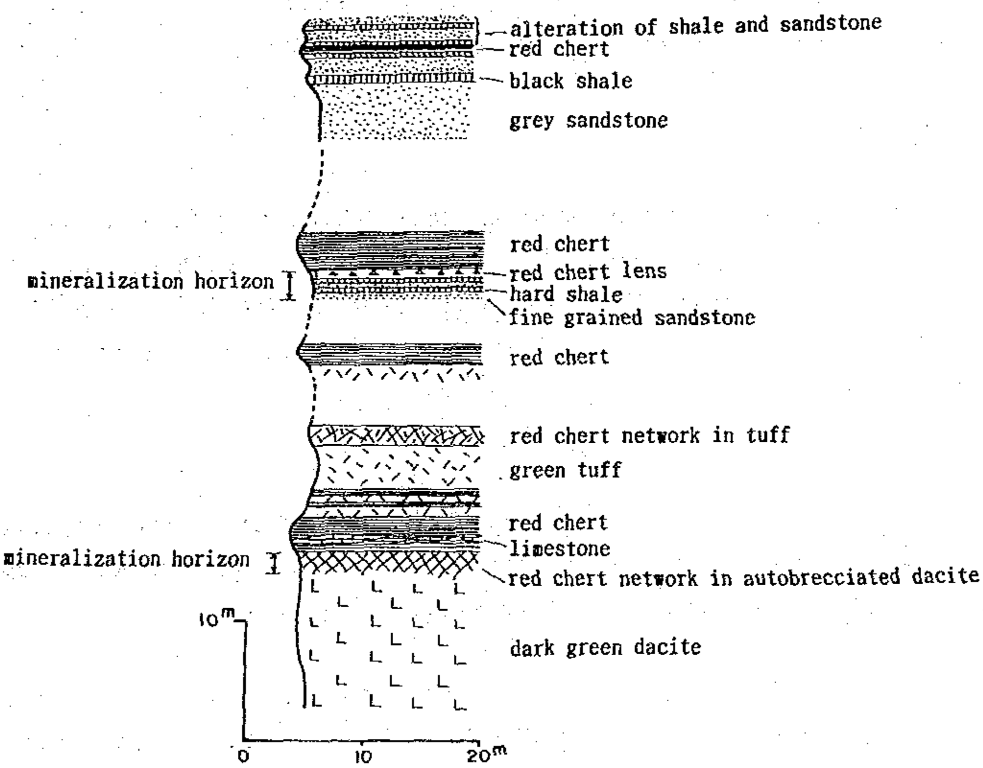


Fig. II-3-20 Schematic Stratigraphy of La Poza Mine Area by this survey. The strata of this deposit stands 350 meters above that of La Paulina deposit. However, if faults lie between both deposits, both would be inffered to be in same strata. Relationship between both deposits will be revealed by further investigations.

Assays on samples from the deposit are as follows. Detailes of the deposit are compiled in Table2 and 3 of Appendices.

Ore sample

Sample	Location	width	Au(ppb)	Ag(ppm)	Cu(ppm)	Pb(%)	Zn(%)
FM 720	No 2 Drift	1.0m	<20	182	260	16.3	3.32
FM 722	ditto	1.0m	<20	134	140	12.6	4.38
FM 723	ditto	0.5m	<20	17.9	22	1.50	0.94
FM 724	ditto	0.35m	<20	23	20	0.97	1.79

Samples from Chert beds

Sample	Location	width	Au(ppb)	Ag(ppm)	Cu(ppm)	Pb(ppm)	Zn(ppm)
FM 716	No 1 Drift	1.0m	20	0.2	6	180	251
FM 717	ditto	1.2m	<20	0.9	9	170	312
FM 718	ditto	0.8m	<20	2.0	8	300	289
FM 725	No 2 Drift	0.75m	<20	0.9	3	0.12%	471

Metal contents in Chert bed are very low as shown in above Table. Wall rock alteration is very weak or almostly not recognized.

C. Laguna Verde Deposit

a. Location

The deposit lies 18 kilometers west of Chile Chico city. A road lies from Chile Chico to the Port of Fachinal by way of the southern end of the mineralized zone. Trip through the road takes about 20 minutes by vehicle. The Lake Verde (Laguna Verde) is situated in the center of the mineralized zone and the deposit was named from name of the lake.

b. History

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

Recentry, a firm of the North America obtained mining title and carried out drilling explorations. It is said that they obtained promissing gold deposit and shifted to the more advanced exploration stage to delineate ore reserve. Now entering to their mining claim area is prohibited.

c. Geology and Mineralization

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

The zone is underlain by green tuff and dacite emplaced in green tuff. Much hematite-quartz veins occur in dacite. As shown in Fig.Ⅱ-3-21, the veins are of parallel and strike N50°-70°W with 60°-80°N dip. Vein widths vary very much between 0.02m and 2.3m. Spacings between veins range from some ten centimeters to several meters.

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

Assays on outcrops showed low grades as shown in Table 3 of Appendices. Gold was expected, but it graded nearly detection limit(20ppb) other than one sample showed 0.36g/t. Whereas, assays on some veins showed a little high values of arsenic, 117ppm and 335ppm.

Rocks in mineralized zone is affected by strong silicification and medium to weak graded kaolinitization(Table 6 of Appendices). Accidic alteration is very characteristic alteration feature of this deposit. The area of this alteration zone identified on this survey is 1kmx1km. This kind of alterations are distributed in north coast of the Lake General Carrera with range of some kilometers. The current drilling program of the owner of this area is considered to be targetted to this alteration zones.

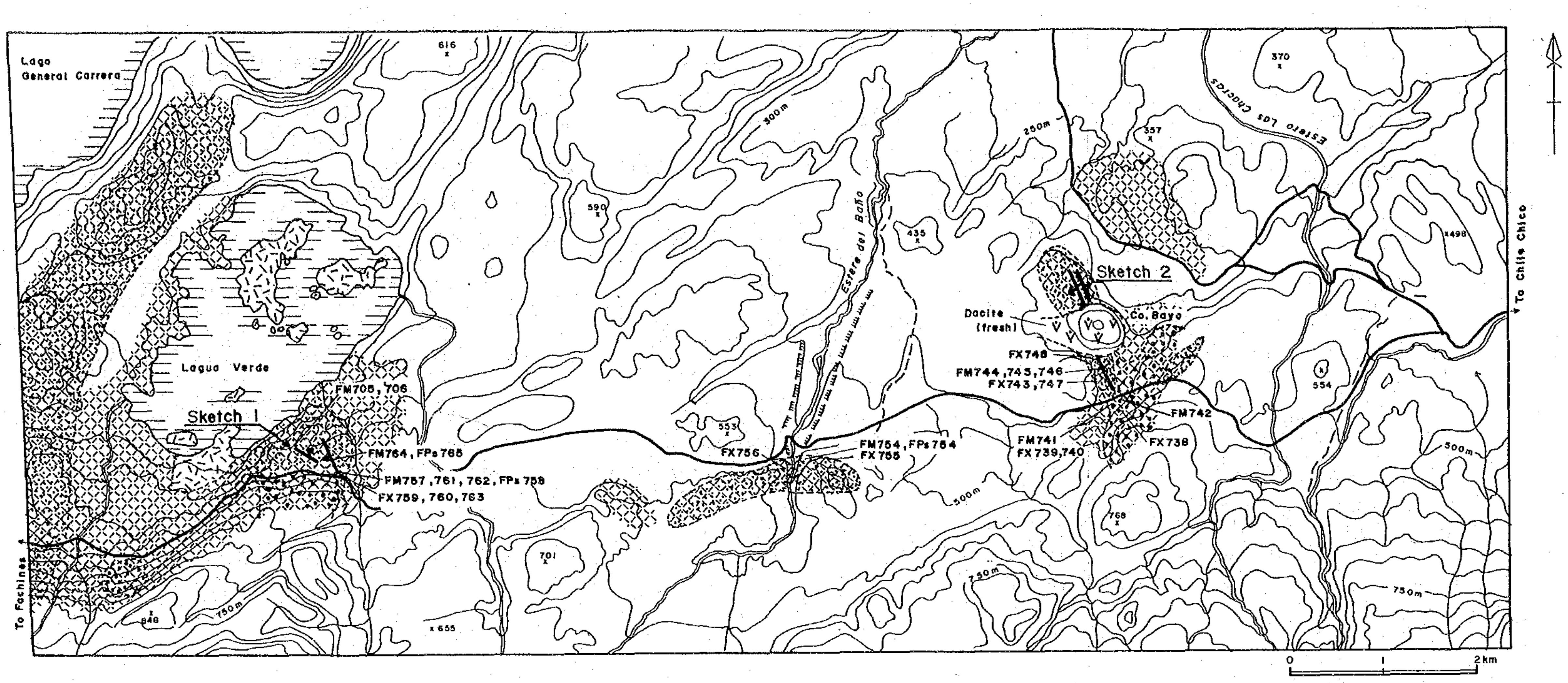
D. Cerro Bayo Mineralized Zone

a. Location

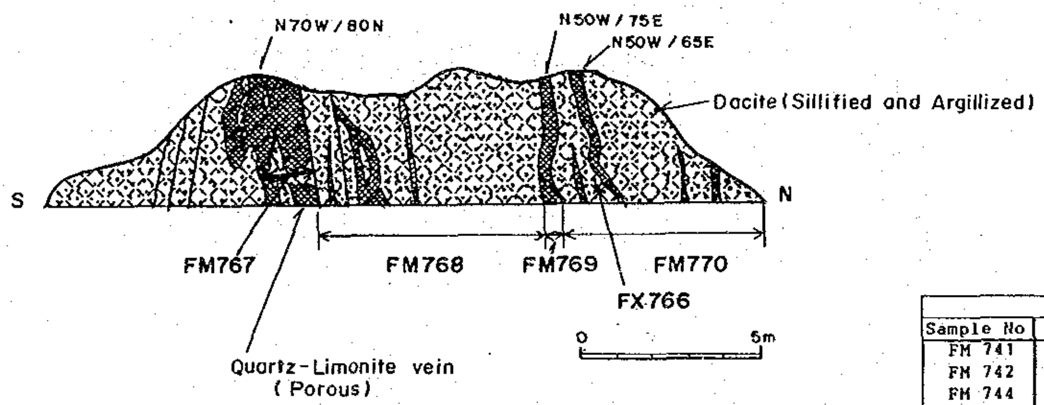
This zone lies about eight kilomrters east of the Lagna Verde deposit or about ten kilometers west of Chile Chico city(Fig.Ⅱ-3-21).

b. History

Current mining title holder is same as it of the Laguna Verde deposit. Surface survey was conducted, but no drilling works were carried out yet.

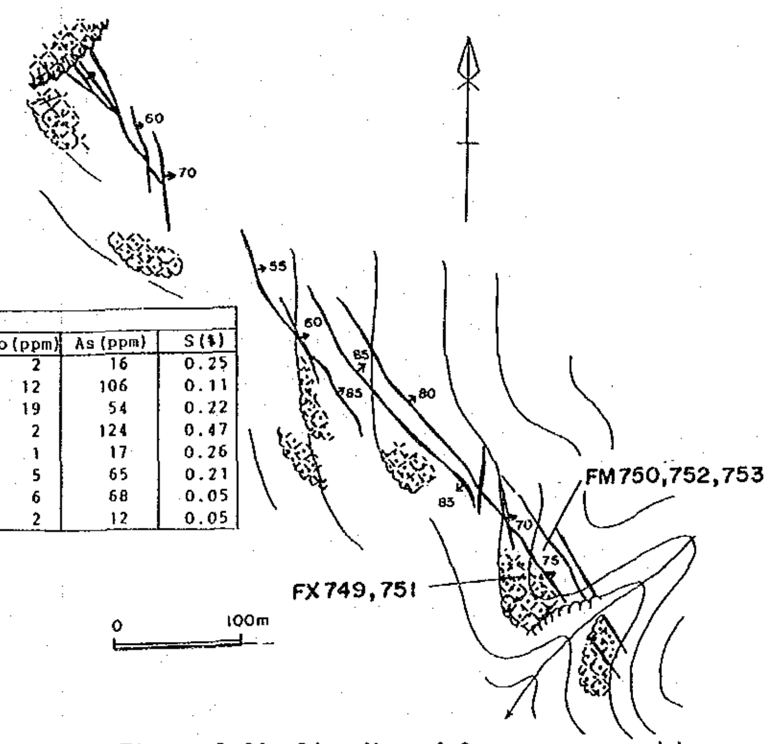


Sketch 1



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

Sketch 2



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

Fig. II-3-21 Plan Map of Outcrops around Laguna Verde Deposit

c. Geology and Mineralization

This zone is underlain by green tuff and lapillituff. These rocks are intruded by rhyolite. Other than them, post-mineralization lava dome of dacite overlies this zone.

This zone has very similar features of mineralization of the Laguna Verde deposit. That is, this mineralization is characterized by hematite-quartz vein and alteration of silicification and kaolinitization. The veins strike N35-50°W arranging with en echelon and dip 60-90°E in dacitic tuff. Vein widths are 0.2 to 0.5m. These en echelon veins extend more than 1.5km along strike.

Assays on outcrops show low grades. Partly 1.08g/t Au were obtained. Assay results of this survey was a little high compared to that of the Laguna Verde deposit.

Those veins are associated with alteration zone, which is mainly of silicification. Rock is affected by weak kaolinitization and medium sericitization as well. Sericitization is a little strong compared to that of the Laguna Verde deposit. This alteration zone extend 2.5km along strike with 0.5km width.

Other similar alteration zone, the El Colegio alteration zone, is found in surrounding area, though no indication of mineralization was recognized.

3.2. Characteristics of the Patagonia Batholith

As reported on the previous section (2.2.1.), Granitic rocks constituting the Patagonia Batholith underlie most of soutern Chile including the investigated area of this year. The known deposits are distributed mainly in the marginal zones of the Batholith. Whole rock chemical analysis and dating for chiefly granitic rocks were conducted on this investigation in order to obtain elemental data regarding the relationship between the mineralizations and the granitic magmatism.

3.2.1. Chemical Compositions

Total numbers of samples for chemical analysis are 36 including 22 samples from the batholith and 11 samples from intrusive stock bodies distributed in the surrounding areas of the batholith. As to the rocks other than granitic rocks, a dacite and a quartz porphry were taken as felsic rocks. One andesitic dyke in Silva mine of Area No 5, muscovite schist distributed in Areas No 5 to No 7 and one ultramafic rock in Area No 2 were taken as well.

Samples were submitted to the Chemex Labs., Canada and were analyzed for 13 elements including BaO. The analytical methods used for this study are potassium permanganate titration for FeO, and ICP-AES for other elements. Analytical results and caluculated C.I.P.W. norms are listed in Table7 of Appencices.

The Batholith and related felsic intrussive rock bodies are discussed in this section. FigureⅡ-3-22 shows the localities of the samples. Samples in Area No 3 and No 4 were taken along the road traversing from Futaleufu town of Area No 3 to Chaiten city on the coast and along the road lying on the northern half of the Area No 4. Both sampling lines traverse the Batholith. Whereas, felsic intrussive rocks were taken from the Areas No 5 to 7 and the Santa Teresa mine of the Area No 4.

FigureⅡ-3-23 is a normative plots of those felsic rocks on the classification diagram of felsic igneous rocks (I.U.G.S., Geotimes, Oct.1973). Most of the data is plotted on the area of normal calc-alkaline granite.

FigureⅡ-3-24 is normative projections on Q-Or-Ab-An tetrahedron. Plots in this figure are symboled by three different symboles corresponding to the values of differentiation index (D.I.): that is, D.I.≧70, 70>D.I.>50 and 50≧D.I. D.I. is expressed as normative Q+Or+Ab for felsic rocks and it corresponds to the distance from the bottom of Q-Or-Ab-An tetrahedron to An apex. Two projections are combined in this figure: the projection on the base of Q-Or-Ab from the apex An and the projection on Q-An-(Ab-Or) from apex An (the latterr is projected with parallel to the base and the side Ab-Or). So that the height from the base which means the amount of An is expressed directly. It appears by the left side of this figure that the trend of changing D.I. is in good accordance with the trend of decrease of An as indicated by experimental works for the origin of granitic magnas.

FigureⅡ-3-25 shows correlations between D.I. and oxides. They show close linear relationships. Those facts strongly suggest that the felsic rocks in the investigated area constitute a Petrographic Province originated by the same primary magma.

FigureⅡ-3-26 illustrates D.I. profiles across the Batholith showing the

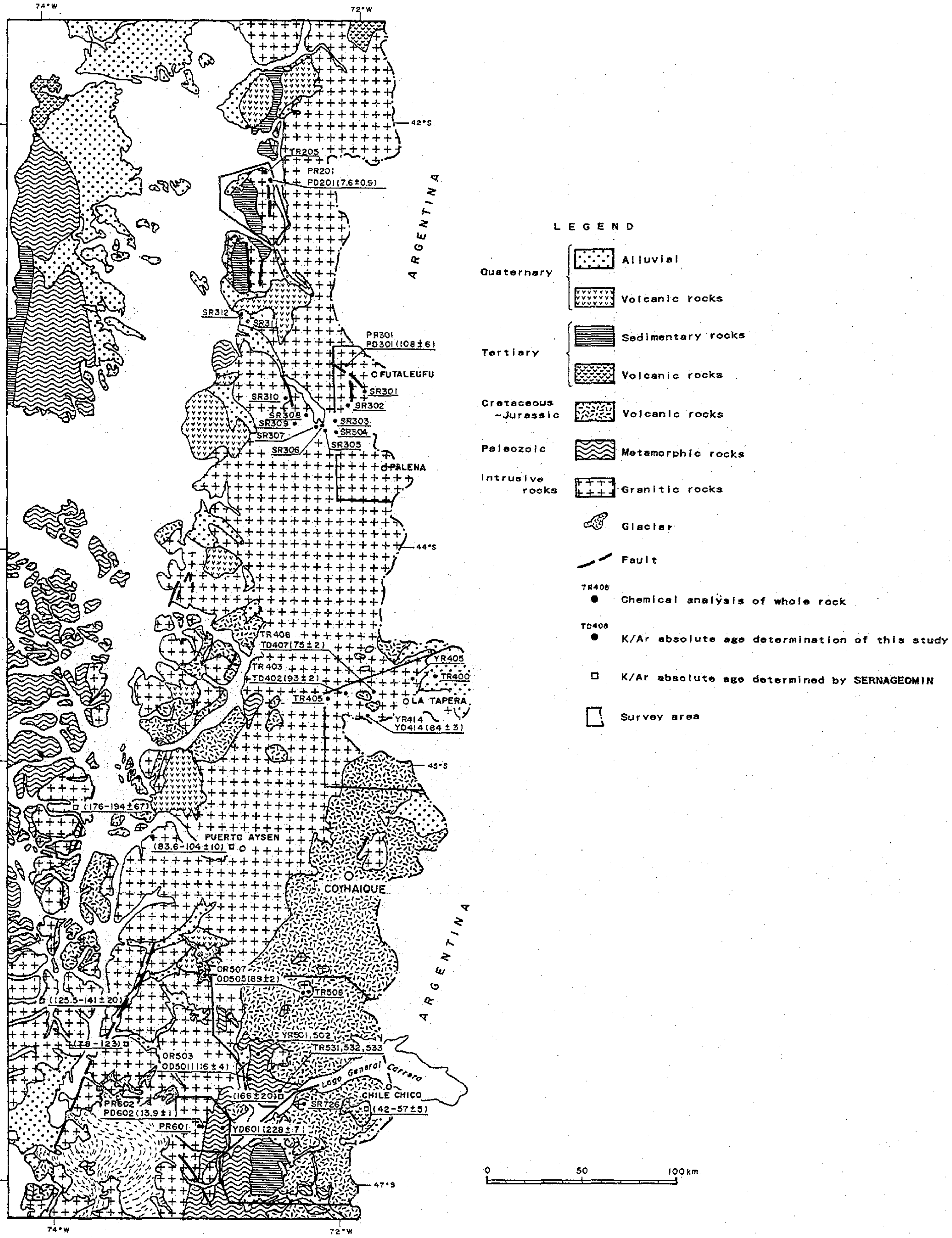


Fig. II-3-22 Location Map of Samples for Whole Rock Analysis and Dating

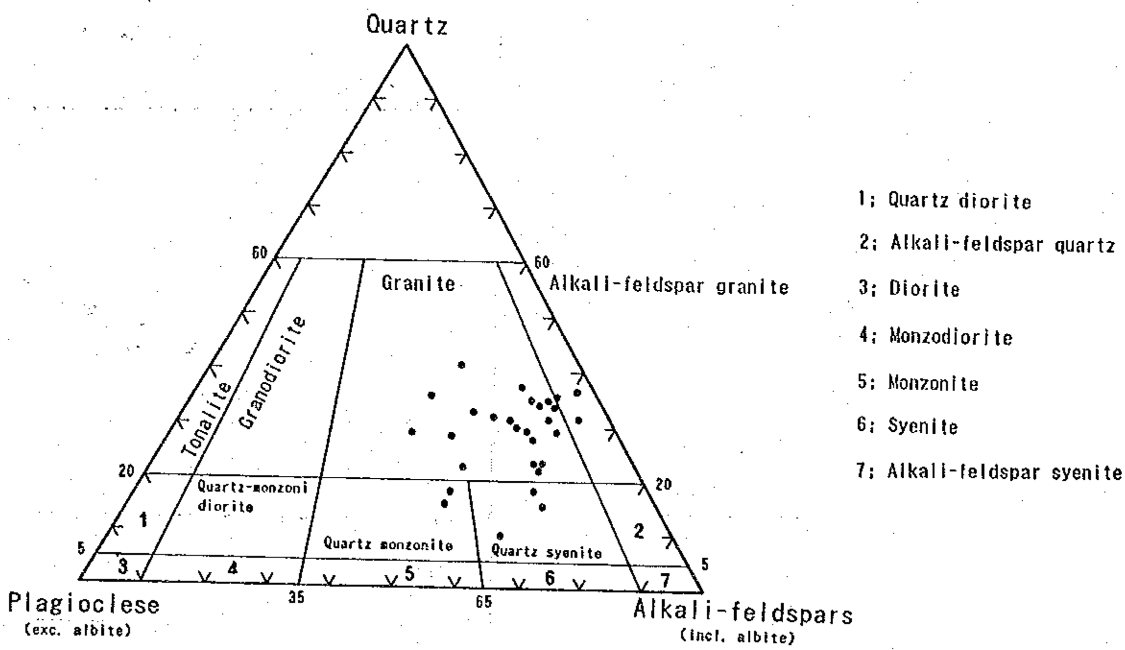


Fig II-3-23 Classification Diagram of Felsic Igneous Rocks

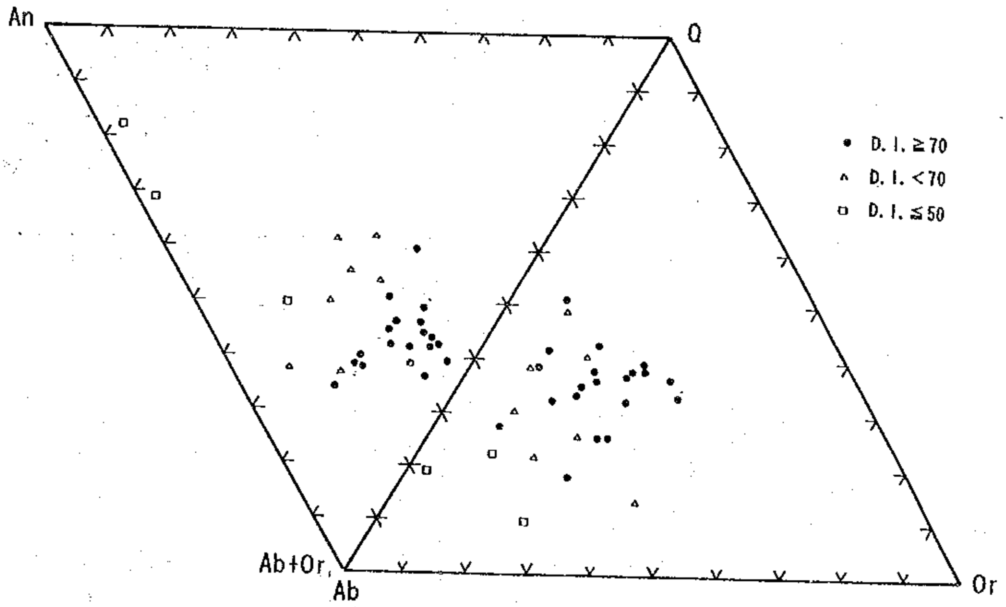


Fig. II-3-24 Projection of Composition of Granitic Rocks on Q-An-Ab-Or Tetrahedron.

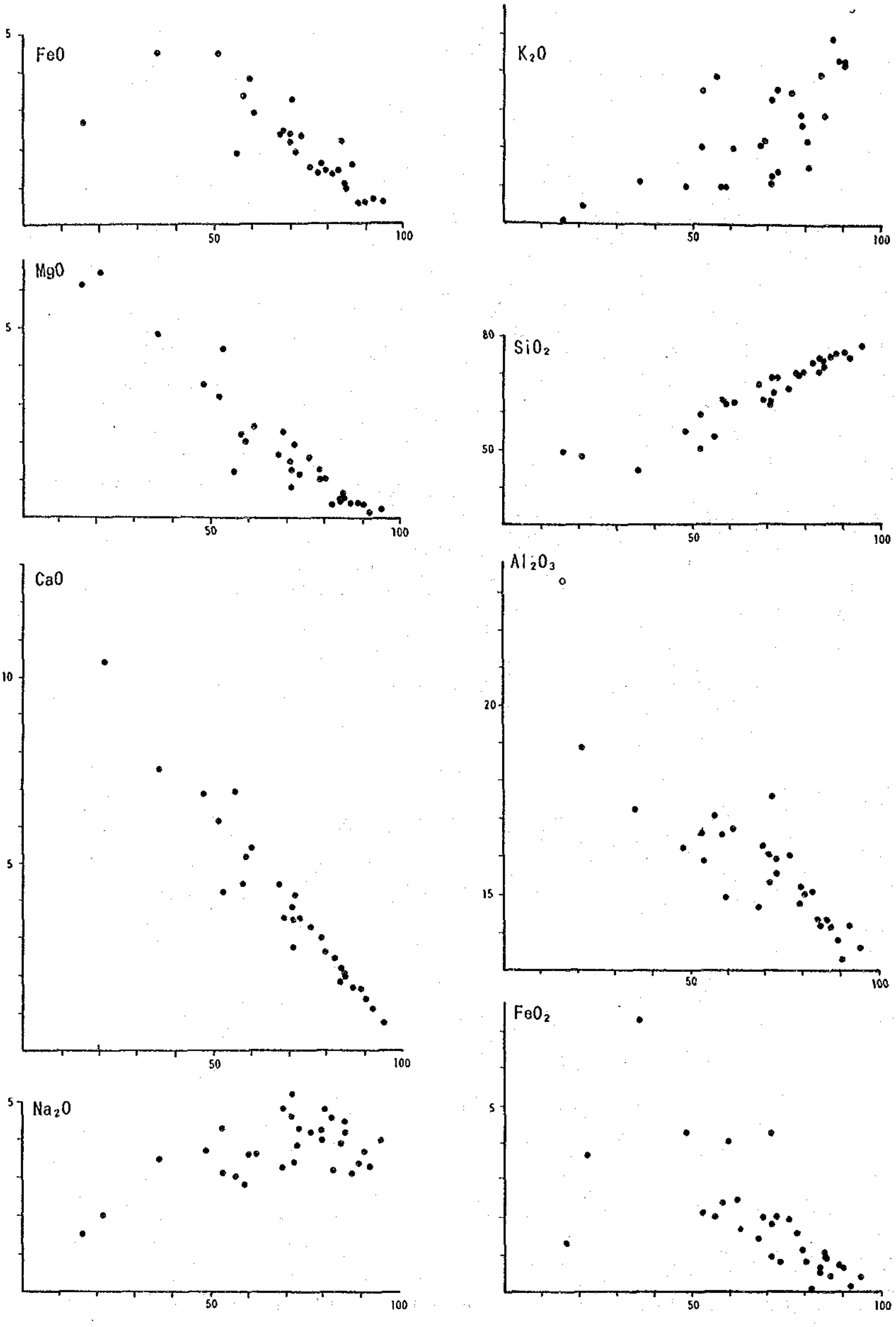
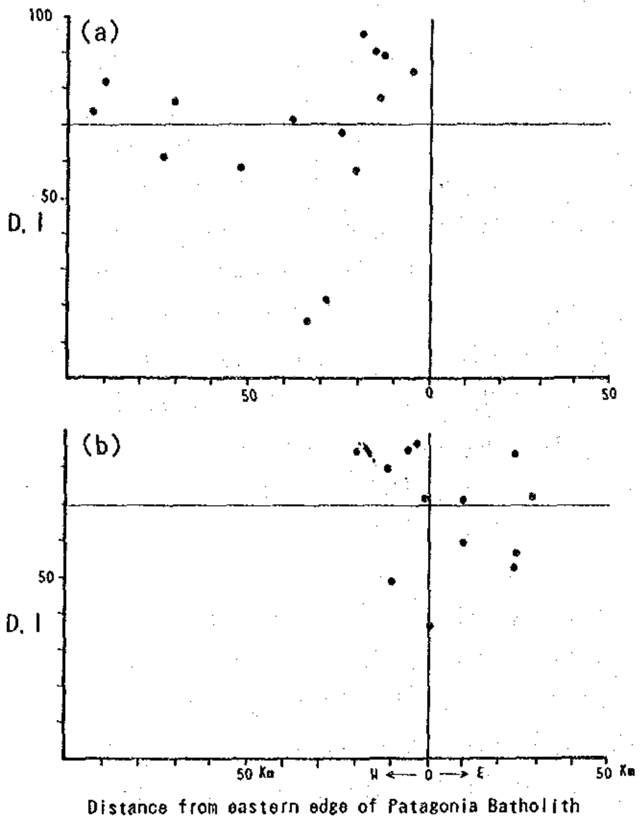


Fig. II-3-25 Differentiation Index(D. I.) versus Oxides of Granitic Rocks lateral changes of D.I.; x-axis expreses the shortcut distances from eastern edge of the batholith to sample points and D.I. is put in y-axis. Western side from the 0 point indicate that sample points are in the inside of the batholith and eastern side from 0 point means that samples were taken from intrussive bodies distributed in surroundig area of the batholith. Behaviour of D.I. tend to be low in the inside and high in the zone around eastern and western edges of the batholith. On the other hand, behaviour of D.I. values of intrussive rocks distributed in the east of the batholith is not specified, altough many values are higher than 70. FigureII-3-27 shows similar profiles for the Fe^{2+}/Fe^{3+}. It is recognized that the ratio of Fe^{3+} tend to be high in the marginal zone of the Batholith so that it is assumed that the rocks in this zone were formed under relatively higher oxidized condition.

FigureII-3-28 (a) exhibits the relationship of Fe^{2+}/Fe^{3+}-D.I. distinguishing the rocks associated with deposits from rocks with no deposit by adapting different symboles. Data are grouped into three groups on this figure. All the rocks associated with deposits are plotted in the group "b" which has higher Fe^{3+} ratios, i.e. solidized under higher oxidized condition. Also the compositions are classified into three groups on the Na_2O+K_2O-SiO_2 diagram (Fig.II-3-28 b). Most of the country rocks of deposits are involved in high alkaline group "a". Some of the rocks associated without deposit are plotted in the group "a" as well so that it is believed that this reflects the primary composition of rocks without affection of hydrothermal alteration. Granite distributed in the west of the Silva mine is considered to be post-mineralization intrusion as it separates the Silva deposit from the similar mineralization of Pelado deposit situated in the further west. Not all three samples from this granite behave in the same manner as other country rocks of granite, but those chemical nature is similar to them of other country rocks.

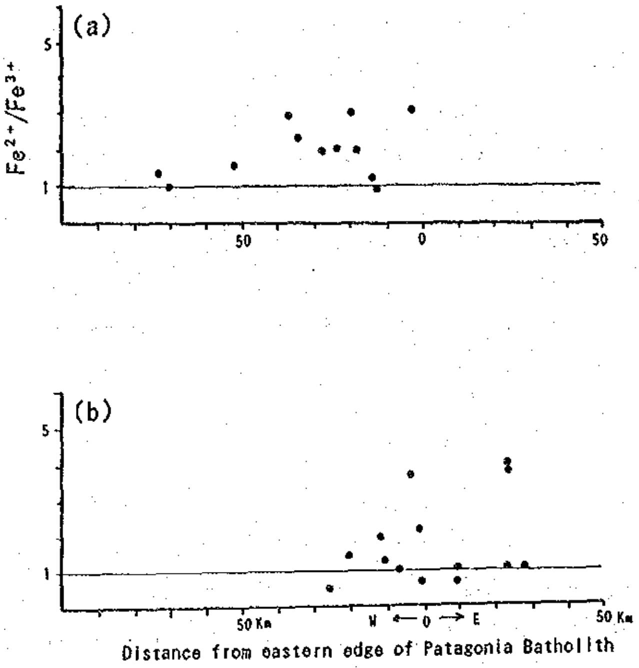
FigureII-3-29 is chemical composition plots on K_2O-CaO-Na_2O diagram. Most of felsic rocks associated with deposits and granite in the Silva mine mentioned above are plotted on narrow area of the diagram. Exceptional case is of two silicified accidic tuff sample with pyrite-chalcopyrite dissemination only. Assayings for heavy metals were not carried out on this study so that this study does not lead to clear conclusion regarding the relationship between mineralization and granite magmatism. Those facts mentioned above, however, are beliebed to suggest that original chemical composition might control mineralization to some extent.

On this study, an attempt was made to classify granitic rocks on the basis



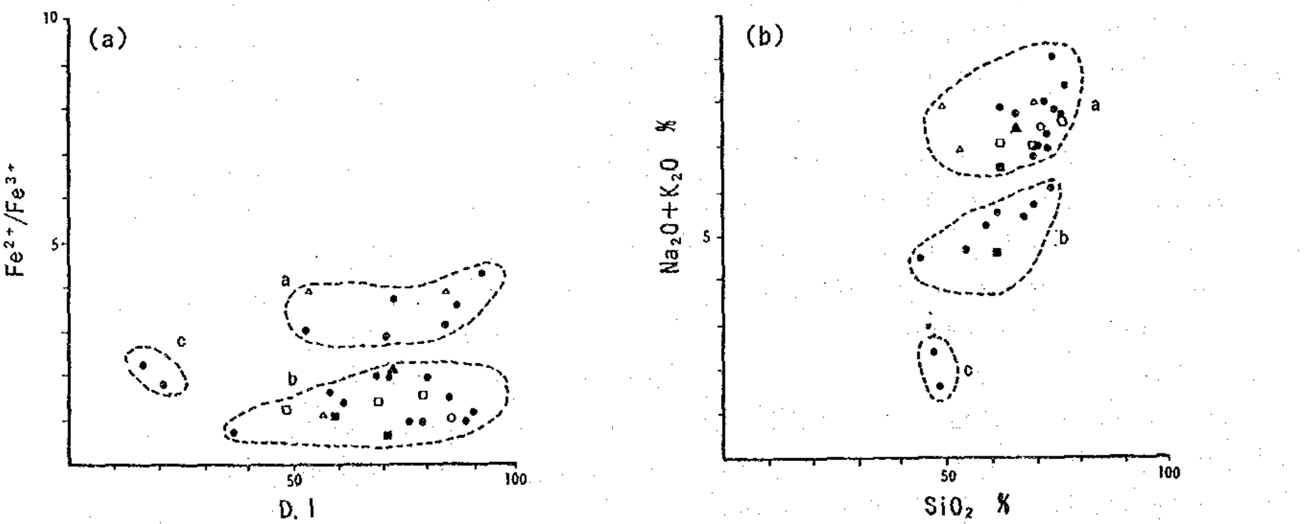
(a):A traverse line from Futaleufu to Huequi Peninsula
(b):The area No.4 to No.7

Fig. II-3-26 D. I. Profiles of Granitic Rocks across Patagonia Batholith



(a):A traverse line from Futaleufu to Huequi Peninsula
(b):The area No.4 to No.7

Fig. II-3-27 Fe^{2+}/Fe^{3+} Profiles of Granitic Rocks across Patagonia Batholith



□ :Granite:wall rocks of Mo deposits
▲ :Granite:wall rock of Cu vein type deposit(prospect 7-4)
○ :Quartzporphry :wall rock of Cu-Pb-Zn-Au vein-type deposit(prospect 4-3)
■ :Dacite:Py-Cp disseminated rock
△ :Granite in the Silva Mine:probably intruded after the deposit
● :Granite rock in no relation to deposits

Fig. II-3-28 Diagrams of Fe^{2+}/Fe^{3+} versus D. I. and Na_2O+K_2O versus SiO_2 of Granitic Rocks

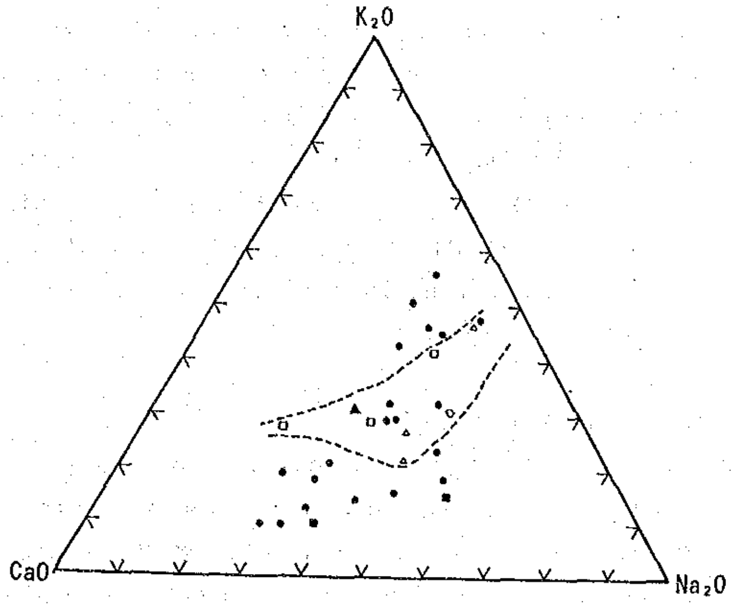


Fig. Ⅱ-3-29 K_2O-CaO-Na_2O Plot for Granitic Rocks

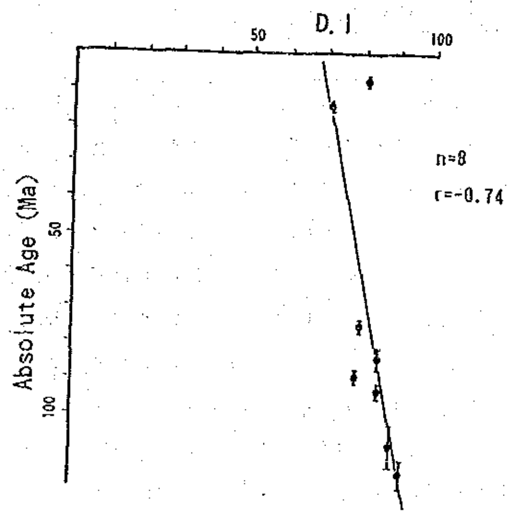


Fig. Ⅱ-3-30 D. I. versus Solidification Ages of Granitic Rocks of species of iron oxide minerals; magnetite and ilmenite. Classification, magnetite series or ilmenite series, was based on the existence of magnetite on polished section observed by low magnification. Results on microscopy are listed in Table 5 of Appendices(Sample numbers are SPs 301 to SPs 312). These twelve samples were taken from a traverse line across the batholith lying from Area No 3 to Chaiten. Two samples, SPs 309 and SPs 310, are regarded as rock of ilmenite series. They were derived from the deepest portion of the batholith. Chemical compositions of rocks taken on this traverse line generally tend to follow D.I. as mentioned above so that it would led to no conclusion regarding chemical behaviour in relation to the rock series from the evidences known at the moment.

3.2.2. Solidification Ages of Granite

Dating work was carried out for ten samples, mainly granite samples using K-Ar method. The sample PD 201 was determined for weathered biotite at first and was re-determined for muscovite. Thus, total of measurement is 11. Results are shown in Fig.Ⅱ-3-22 and TableⅡ-3-1. FigureⅡ-3-22 exhibits the prvious determination by SERNAGEOMIN as well. Measurement of the rocks other than granit and other felcic rocks were done for one muscovite-quartz schist (YD 601) developed in Areas No 5 to 7. The metamorphosed age of that is 228±7 Ma (early Triassic). Times of the mineralizations are not known because datings for hydrothermal alteration and/or ore minerals were not conducted.

Table Ⅱ-3-1 Result of Dating

Sample	Area	Age± 2σ (Ma)	Rock Type	Mineral	Event	K, %	Ar,atm.%
FD 104	No 1	73± 2	granodiorite	biotiote	primary	5.949	23
PD 201*	No 2	7.6± 0.9	granite	muscovite	primary?	8.632	76
PD 201†	No 2	4.2± 1.2		biotite	primary?	3.779	84
PD 301	No 3	108± 6	granite	biotite	primary	1.329	57
TD 402	No 4	93± 2	granite	biotite	primary	6.915	11
TD 407	No 4	75± 2	granite	biotite	primary	5.294	34
YD 414	No 4	84± 3	(1)	plagioclase	primary	1.468	24
OD 501	No 5	116± 4	granite	biotite	primary	4.941	7
OD 505	No 5	89± 2	granite	biotite	primary	6.391	12
PD 601	No 6	13.9± 1.0	granite	biotite	primary	7.098	44
YD 601	No 6	228± 7	(2)	whole rock	metamorphism	2.683	6

* and †: Biotite in rock "†" marked were very weathered so that the dating work was repeated to obtain a result of "*" using muscovite.

(1): Quartz porphyry, a country rock of the Santa Teresa deposit.
(2): Muscovite-quartz schist.
Rock types of granitic rocks were identified on diagram of Fig.Ⅱ-3-23

As to the solidification ages of granitic rocks, rocks of older than 100 Ma (uppermost of early Cretaceous age) are distributed in the part extending from centrl portion to western edge of the Patagonia Batholith in the surveyed area. Age of the oldest granitic rock which is known so far is 194±67 Ma corresponding to later Triassic. Granitic rocks distributed in the eastern margin of the Patagonia Batholith show approximately 75-116 Ma. Whereas, Tertiary rocks showing 7.6±1.2 Ma(sample PD 201) or 13.9 Ma(sample PD 601) are distributed in a part of marginal areas (Area No 2 and No 6). Consequently, activity of granitic magmatism formed the batholith was maintained for very long time; i.e. from later Triassic to Miocene. The main stage of magmatism seems to have taken place in later Cretaceous time.

FigureⅡ-3-30 shows relationship between D.I. and solidification age. Both factors are in close linear relationship. That is, the more age is older, the more D.I. is higher. With D.I. becoming higher or An decreasing, composition of liquid is reaching to the lowest melting point. If the huge mass of the batholith were formed at once, phenomenon brought by that would conflict with the fact shown by Fig.Ⅱ-3-30 because higher D.I. would be expected for the younger rocks. The batholith, however, seems to have taken very long times to be formed so that magmatism would have had to repeate very many times. As explanation for the phenomenon in Fig.Ⅱ-3-30 , it is believed to be appropriate idea that new granitic magmas originated by re-melting of old granitic rocks errupted up one after another. When granitic magma solidified, temperatures of that are expected to synclonize with D.I. reversely because the direction of differentiation of liquid is a decrease of anorthite. That is, the more D.I. is lower, the more melting temperature is higher or the more D.I. is higher, the more melting temperature is lower (refer the experimental works; ex. Piwinski,1973). Therefore, if re-melting happen, the re-melting begin from the rock with higher D.I. and continue to the rocks with lower D.I. Those re-melting would take place easily by heat and water supplies caused by intrusion of basaltic or andesitic magma. When those event happen, relationship between solidification ages of granitic rocks and their D.I. is expected to be like that shown in Fig.Ⅱ-3-30 Volcanism of mafic rocks was activated since Jurassic time in the area and it approximately corresponds to timing of those "Rejuvenescence of granite". All samples for this study were taken from the marginal zone of the Batholith. This zone are regarded as a kind of fracture zone and therefore the zone seems to be favorable for ascension of re-melted granitic magma. This also is considered to support the hypothesis mentioned above.

Difference of chemical characteristics between the rocks associated with deposits and them with no deposit are discussed in section 3.2.1. As known in Fig.Ⅱ-3-28, values of D.I. and/or SiO_2 do not seem to be related to the presence of mineralization. Rather, the presence of mineralization depends on the factors such as Fe^{2+}/Fe^{3+} and Na_2O+K_2O. Quartz-plagioclase-K rich alkaline feldspar assemblage is expected at final stage of differentiation of granitic magma so that the granitic rocks belonging to higher alkaline group may show higher D.I. Actual D.I.s, however, do not seem to follow this expection. Thus, the differences of alkaline content are believed to depend on variations of magmatic composition, but not depend on D.I. or timing of magmatism (both are in good correlation with solidification age in the case of this study).

It leads to a conclusion from above discussions that genessis of granitic rocks associated with deposits is not related to time of magmatism, but the chemical compositions put control on the mineralization. It is assumed that granitic rocks associated with deposits were generated under relatively high oxygen fugacity, but more geological investigations focused on mode of occurence of granitic rocks are required to understand its mechanism.

3.3 Geochemical Exploration

3.3.1 Stream sediment geochemistry

(1) Sampling and chemical analysis

At all sample points, care was taken to avoid missing gold particles so that favorable places for gold concentrating were selected as follows:-

* upstream part of mid channel bars(up to one third of length)
* convex banks of meander rivers
* behind driftwoods(down strean side)
* roots of plants
* points of change from steep incline to gentle incline of river bed

The size of sediments taken is -30 mesh. Total amount of samples is 372 throughout the investigated areas. Numbers of samples in each area are listed on the following Table. PLATES 22 to 28 exhibit locations of sample points.

Numbers of Stream Sediment Samples

Area	Numbers of samples
No 1	54
No 2	29
No 3	106
No 4	46
No 5	62
No 6	15
No 7	60
TOTAL	372

Chemical analysis was conducted by laboratory of SERNAGEOMIN for all samples except for samples of area No 2. Samples of area No 2 were analyzed by Chemex Labs. Inc. of Canada. Elements analyzed in area No 2 are 14 elements:Au, Ag, Pt, Pd,Cu, Pb, As, Mo, Co, Fe, Mn, Ni, Cr. In other areas seven elements were analyzed:i.e., Au, Ag, Cu, Pb, Zn, Mo,As.

Analytical methods and detection limits are as listed on the following Table

Element	Method	Detection limit		Element	Method	Detection limit	
		lower	higher			lower	higher
Au	FA, ICP-AFS	2ppb	10,000ppb	Mo	ICP-AES	1ppm	10,000ppm
	AAS-MIBK	20ppb	20,000ppb				
Ag	ICP-AES	0.5ppm	200ppm	Pd*	FA, ICP-AFS	2ppb	10,000ppb
	AAS	0.1ppm	100ppm	Co*	ICP-AES	1ppm	10,000ppm
Cu	ICP-AES	1ppm	10,000ppm	Fe*	ICP-AES	0.01%	15.00%
	AAS	1ppm	10,000ppm	Mn*	ICP-AES	5ppm	10,000ppm
Pb	ICP-AES	5ppm	10,000ppm	Ni*	ICP-AES	1ppm	10,000ppm
	AAS	1ppm	5,000ppm	Cr*	AAS	2ppm	10,000ppm
Zn	ICP-AES	2ppm	10,000ppm	Pt*	FA-ICP-AFS	5ppb	10,000ppb
	AAS	1ppm	10,000ppm				
As	AA-hydrite/EDL	1ppm	10,000ppm				
	AAS	5ppm	10,000ppm				

Upper line on each columun is for Chemex Labs. Lower line is for laboratory of SERNAGEOMIN. Abbreviations in Table are: ICP-AES;Inductively Coupled Plasma-Atomic Emission Spectroscopy, FA; Fire Assay, AFS; Atomic Fluorescence Spectrometry, AAS; Atomic Absorption Spectrometry, EDL; Electrodeless Discharge Lamp, MIBK; Metil Isobutil Keton extraction..

Elements marked "*" are analyzed by Chemex Labs. only.

(2) Statistical Interpretation

1) Analytical method

When taking the similarity of geologic units into consideration, data were considered to be clasified into five mother populations: (i) Area No 1, (ii) Area No 2, (iii) Area No 3, (iii) Area No 3, (iv) Area No 4, (v) Area No 5, 6 and 7. Data-handling was completed for each mother population.

In general, geochemical data are lognormally distributed. Therefore values used for data-handling are natural logarithm of raw analytical value. If raw value was below detection limit, one half of detection limit value was applied.

2) Elemental statistical parameter

TableⅡ-3-2 indicates the elemental statistical parameters for each area and each element. Row data are listed on Table 8 of Appendices. General results of elemental statics are as follows:-

* Gold assays which showed over detection limit are obtained from each one sample in Areas No 1 and 4 other than results in Area No 2.
* Silver and molybdenium also tend to be below detection limit.
* Arsenic is a little high in Areas No 1, 3 and 4. In other areas, it is of low level.

Features in each area are as follows:-

Area No 1

Very many assays of Au, Ag, Mo and As are under detection limit. Proportions of samples shown under detection limit were 53/54 for Au, 27/54 for Ag, 54/54 for Mo and 52/54 for As.

Area No 2

All assays of Mo and Pt were under detection limit. Proportion mentioned above for some other elements are also very high: 28/29 for Ag, 28/29 for Pb and 26/29 for Pd. Those proportions of Au and Cu are 12/29 and 6/29 respectively.

Area No 3

All assays for Au were below detection limit. Au(93/96), Mo(66/106) and As(88/106) were of relativery high proportions mentioned above, where figures

Table II-3-2 Elemental Statistical Values of Stream Sediment Geochemistry

No1. Area

	Au(ppb)	Ag(ppm)	Cu(ppm)	Pb(ppm)	Zn(ppm)	Mo(ppm)	As(ppm)
Logarithmic Mean	10.28	0.07	16.78	3.03	56.99	0.50	2.58
Max.	45.00	0.20	42.00	15.00	107.00	0.50	7.00
Min.	10.00	0.05	6.00	1.00	22.00	0.50	2.50
M+σ	12.59	0.11	25.24	6.37	82.27	0.50	3.05
M+2σ	15.43	0.17	37.99	13.36	118.74	0.50	3.60

No2. Area

	Au(ppb)	Ag(ppm)	Cu(ppm)	Pb(ppm)	Zn(ppm)	Mo(ppm)	As(ppm)	Pd(ppb)	Pt(ppb)	Co(ppm)	Fe(ppm)	Mn(ppm)	Ni(ppm)	Cr(ppm)
Logarithmic Mean	2.69	0.26	4.04	2.56	45.69	0.50	7.90	1.10	2.50	10.19	2.72	339.50	19.91	233.70
Max.	8100.00	0.50	65.00	5.00	88.00	0.50	41.00	4.00	2.50	40.00	4.82	735.00	942.00	1650.00
Min.	1.00	0.25	0.50	2.50	14.00	0.50	2.00	1.00	2.50	4.00	1.15	130.00	3.00	112.00
M+σ	19.27	0.29	16.45	2.91	63.83	0.50	20.97	1.49	2.50	17.22	3.92	479.33	100.32	429.45
M+2σ	138.04	0.33	67.02	3.30	89.15	0.50	55.64	2.01	2.50	29.11	5.65	676.77	505.46	789.16

No3. Area

	Au(ppb)	Ag(ppm)	Cu(ppm)	Pb(ppm)	Zn(ppm)	Mo(ppm)	As(ppm)
Logarithmic Mean	10.00	0.06	14.63	6.32	43.85	0.68	3.11
Max.	10.00	3.10	69.00	144.00	465.00	3.00	25.00
Min.	10.00	0.05	1.00	1.00	12.00	0.50	2.50
M+σ	10.00	0.09	33.57	13.79	77.27	1.05	5.29
M+2σ	10.00	0.15	77.00	30.08	136.17	1.60	9.00

No4. Area

	Au(ppb)	Ag(ppm)	Cu(ppm)	Pb(ppm)	Zn(ppm)	Mo(ppm)	As(ppm)
Logarithmic Mean	10.31	0.08	3.70	3.50	33.42	0.54	2.64
Max.	40.00	0.10	34.00	22.00	115.00	2.00	31.00
Min.	10.00	0.05	1.00	1.00	19.00	0.50	2.50
M+σ	12.62	0.11	8.54	6.99	47.84	0.70	3.80
M+2σ	15.44	0.15	19.70	13.95	68.48	0.91	5.50

No5. 6. 7. Area

	Au(ppb)	Ag(ppm)	Cu(ppm)	Pb(ppm)	Zn(ppm)	Mo(ppm)	As(ppm)
Logarithmic Mean	10.00	0.09	12.05	10.92	60.28	0.54	7.56
Max.	10.00	3.30	82.00	74.00	231.00	3.00	140.00
Min.	10.00	0.05	1.00	1.00	15.00	0.50	2.50
M+σ	10.00	0.18	27.83	24.40	96.91	0.73	19.05
M+2σ	10.00	0.38	64.32	54.52	155.80	0.98	48.02

in parentheses indicate their proportions. All other elements were above detection limit.

Area No 4

Many assays for Au, Mo and As were under detection limit; their proportions are 45/46 for Au, 4/46 for Mo and 45/46 for As. Fourteen assays of silver were under limit for 46 samples, but assays for Ag of other samples were nearly detection limit.

Area No 5

All assay of Au were under detection limit. Proportions of assays under detection limit were high for Ag(19/62) and Mo(55/62).

Area No 6

Same situation is noted as that of Area No 5. Proportions of assays under detection limit are 8/15 for Ag and 13/15 for Mo.

Area No 7

Same situation is noted as that of Area No 5. Proportions of assays under detection limit are 28/60 for Ag and 57/60 for Mo.

3) Distribution pattern

Fig.Ⅱ-3-31 illustrates distribution patterns for each area and element. Natural logarithms of the values of the following elements are considered to be distributed following a normal law.

Area No 1	Cu, Zn
Area No 2	Zn, Mn
Area No 3	Cu, Pb, Zn
Area No 4	Pb, Zn
Area No 5, 6, 7	Cu, Pb, Zn

4) Correlationship between elements

Correlation coefficients are listed in TableⅡ-3-3. The following sets of elements are combinations of elements and these coefficients(in Parentheses) which correlate well having coefficient of 0.5 and more.

Area No 1	Au-As(0.82625)	Cu-Zn(0.77913)	Cu-Pb(0.58897)
Area No 2	Ni-Co(0.84138)	Ni-Cr(0.80702)	Fe-Mn(0.78841)
	Pd-Cr(0.78537)	Au-Ag(0.76876)	Cu-Co(0.76519)
	Co-Fe(0.71144)	Cr-Co(0.69645)	Co-Pd(0.69092)
	Ni-Pd(0.64969)	Ni-Cu(0.62649)	Zn-Mn(0.59832)

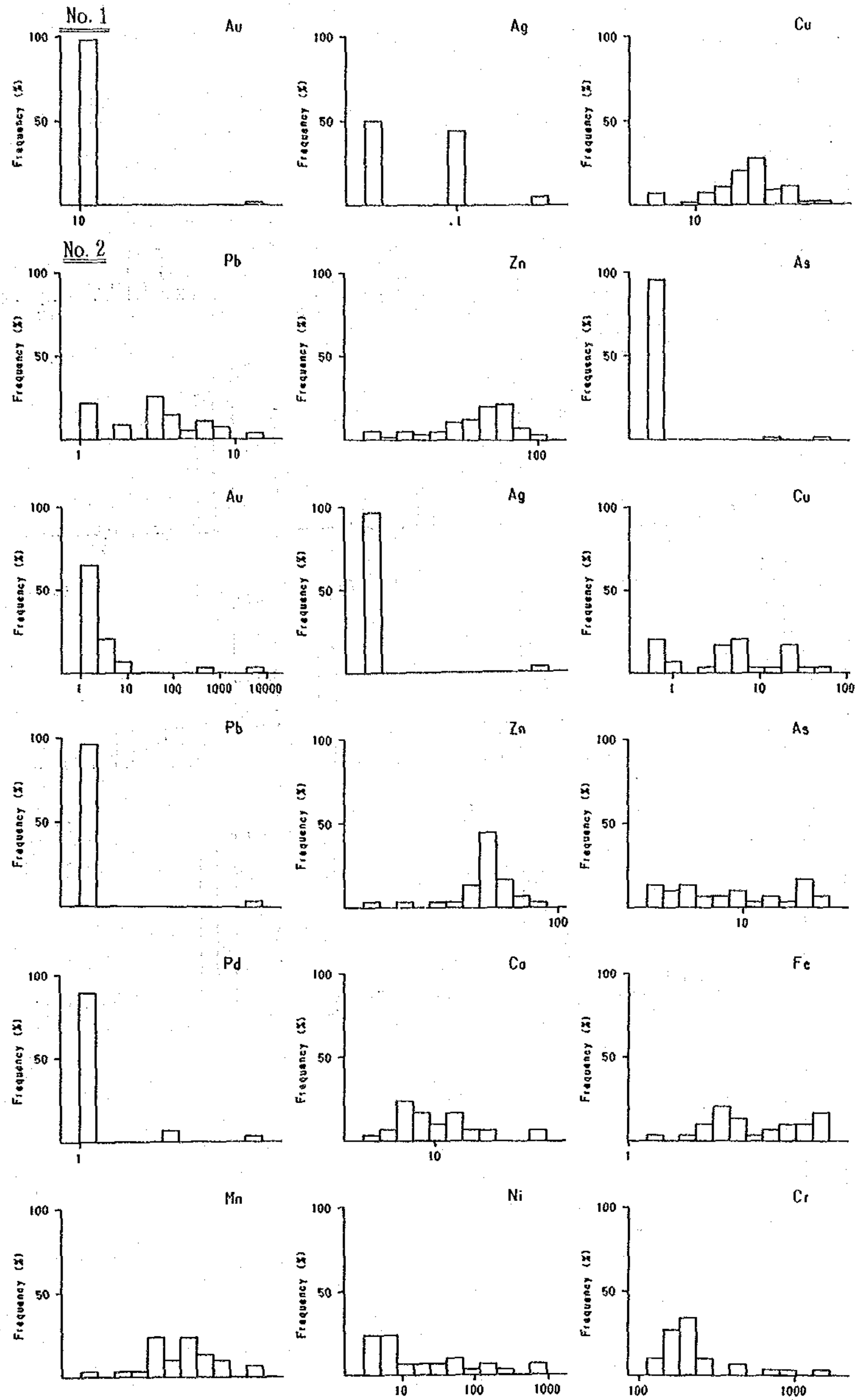
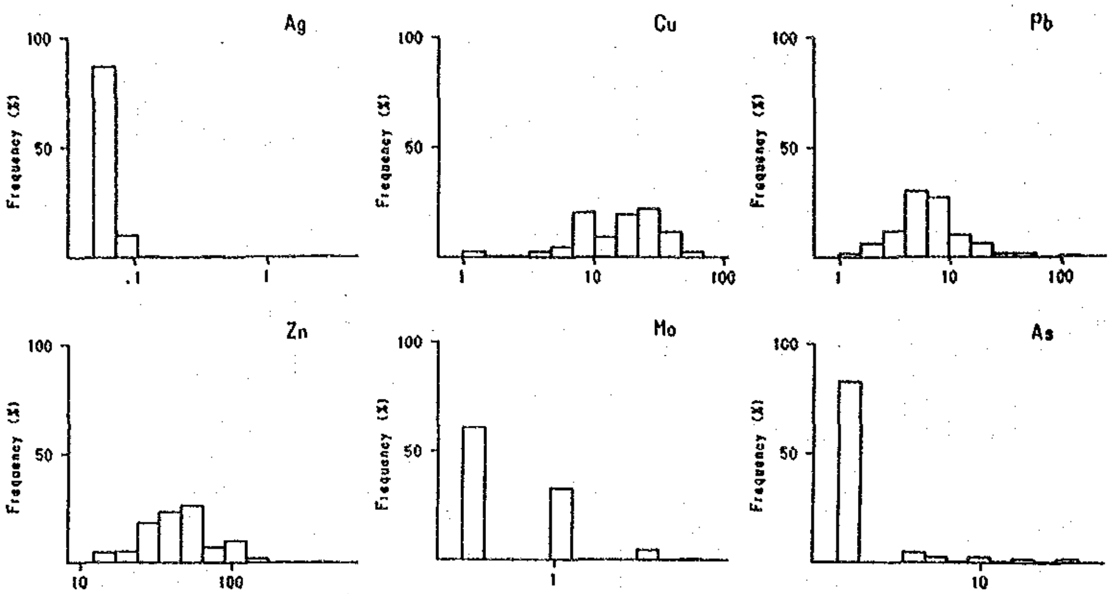
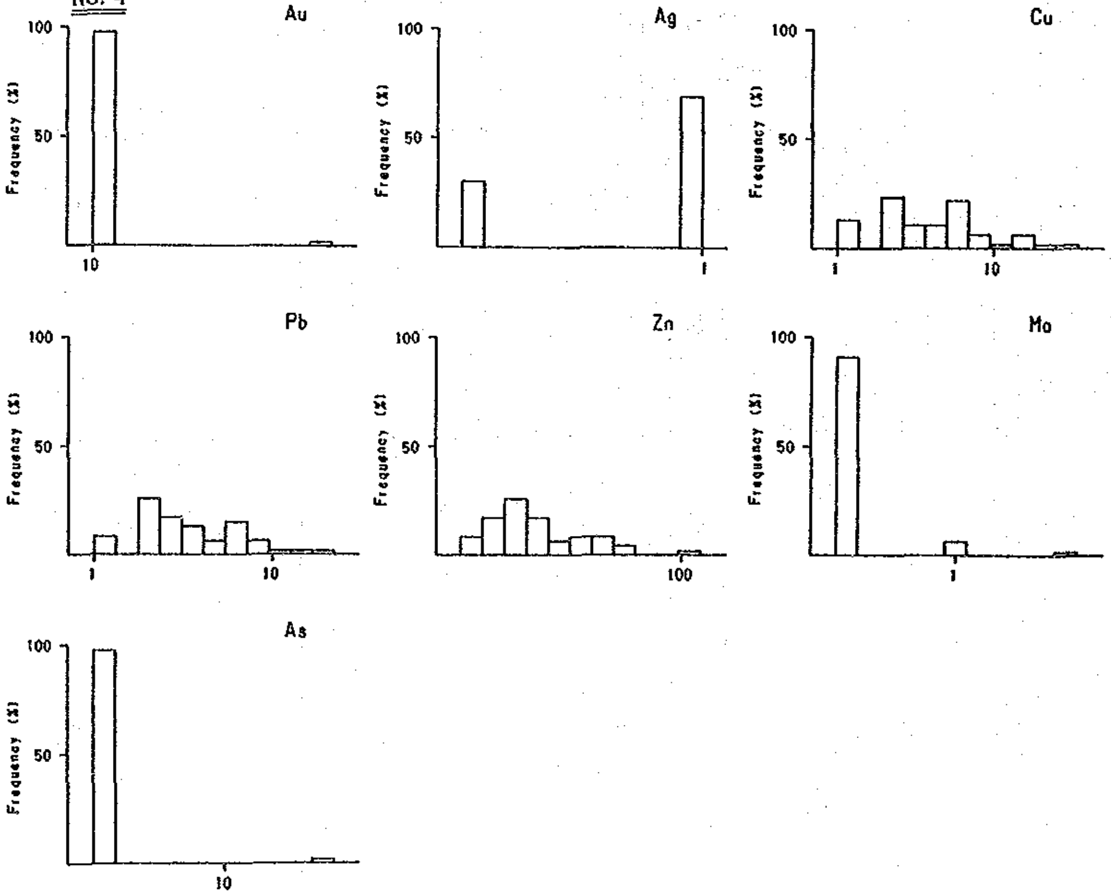


Fig. II-3-31 Frequency Distribution Histogram of Stream Sediment Geochemistry

No. 3


Ag
Cu
Pb
Zn
Mo
As
Frequency (%)
100
50
.1
1
10
100

No. 4


Au
Ag
Cu
Pb
Zn
Mo
As
Frequency (%)
100
50
1
10
100

No. 5, 6, 7

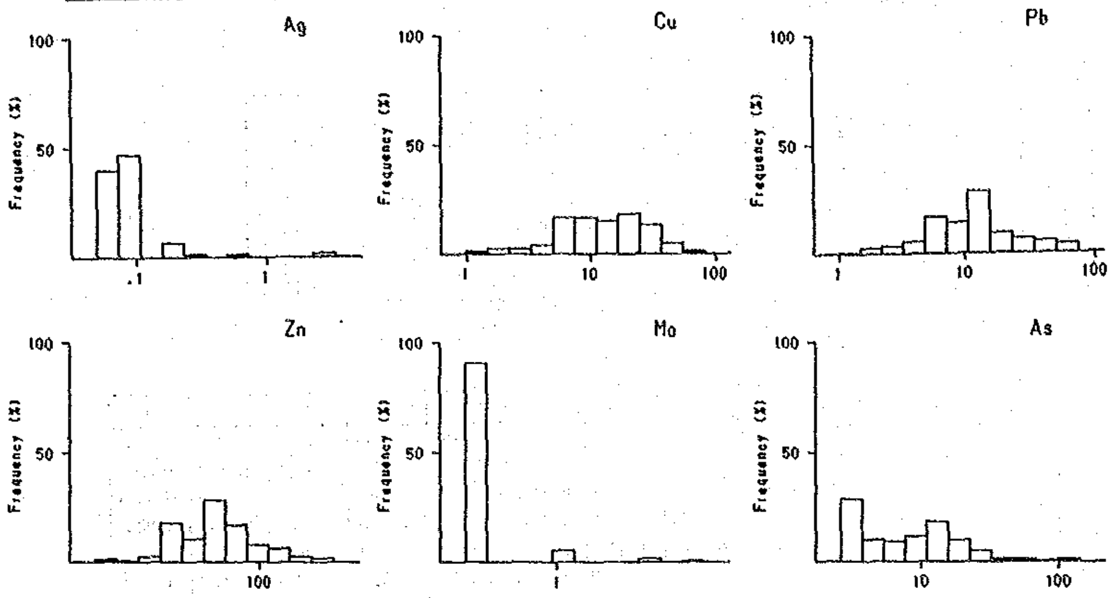


Table Ⅱ-3-3 Correlation Coefficients of Pairs of Elements for Stream Sediment Geochemistry

No1. Area

	Au	Ag	Cu	Pb	Zn	As
Au	1.00000	-0.12754	0.12037	0.09262	0.01923	0.82625
Ag		1.00000	0.29671	0.23729	0.36154	-0.04925
Cu			1.00000	0.58897	0.77913	0.16049
Pb				1.00000	0.34110	0.10640
Zn					1.00000	-0.00324
As						1.00000

N02. Area

	Au	Ag	Cu	Pb	Zn	As	Pd	Co	Fe	Mn	Ni	Cr
Au	1.00000	0.76876	0.25022	0.03812	0.10269	0.02883	-0.07583	-0.00260	0.03375	0.00879	-0.04243	-0.09399
Ag		1.00000	0.21525	-0.03571	0.00378	-0.05339	-0.08014	0.05885	0.01515	0.05449	0.08152	-0.02591
Cu			1.00000	0.20107	-0.07811	0.22199	0.41131	0.76519	0.54194	0.38527	0.62649	0.28779
Pb				1.00000	0.24119	0.31884	-0.06014	0.08767	0.12757	0.35584	0.09788	-0.06105
Zn					1.00000	0.11279	-0.23419	-0.04685	0.54191	0.59832	-0.30778	-0.15132
As						1.00000	0.36858	0.49909	0.30996	0.46552	0.44479	0.47767
Pd							1.00000	0.69092	0.30548	0.22161	0.64969	0.78537
Co								1.00000	0.71144	0.58293	0.84138	0.69645
Fe									1.00000	0.78841	0.35834	0.29785
Mn										1.00000	0.30322	0.30863
Ni											1.00000	0.80702
Cr												1.00000

No3. Area

	Ag	Cu	Pb	Zn	Mo	As
Ag	1.00000	0.06959	0.40380	0.30890	0.05014	0.12749
Cu		1.00000	0.38309	0.44585	-0.08322	0.01990
Pb			1.00000	0.82784	0.13132	0.17435
Zn				1.00000	0.02966	0.26628
Mo					1.00000	0.04761
As						1.00000

No4. Area

	Au	Ag	Cu	Pb	Zn	Mo	As
Au	1.00000	0.09860	0.11355	0.29892	0.25010	-0.04325	-0.02222
Ag		1.00000	0.25464	0.28203	0.16367	0.19190	0.09860
Cu			1.00000	0.72910	0.79115	0.22631	0.39552
Pb				1.00000	0.76512	0.00554	0.39635
Zn					1.00000	0.20078	0.51359
Mo						1.00000	-0.04325
As							1.00000

No5. 6. 7. Area

	Ag	Cu	Pb	Zn	Mo	As
Ag	1.00000	0.17821	0.34027	0.35947	0.18849	0.20742
Cu		1.00000	0.01429	0.36967	0.10069	0.11735
Pb			1.00000	0.67557	0.28189	0.62612
Zn				1.00000	0.17893	0.40337
Mo					1.00000	0.35025
As						1.00000

	Co-Mn(0.58293)	Cu-Fe(0.54194)	Zn-Fe(0.54191)
Area No 3	Pb-Zn(0.82784)		
Area No 4	Cu-Zn(0.79115)	Pb-Zn(0.76512)	Cu-Pb(0.72910)
	Zn-As(0.51359)		
Area Nos 5,6,7	Pb-Zn(0.67557)	Pb-As(0.62612)	

5) Principal Components Analysis(PCA)

By PCA, we can examine the interactions between various geochemical constituents and find the most efficient linear combination of them. In the application of this method for mineral exploration, the relationships among the variables (elements) and the variables caused by identical phenomena are compressed into small number of factors, the eigenvectors which is unique to the factor, and the proportions were caluculated. Then the characteristics of of the mineralization of significant regional information are obtained by interpreting the PCA. The caluculation is carried out on correlation matrix, or covariance matrix. In this work, correlation matrix was emploied. Numbers of the principal components as much as that of element. In this work, the principal components up to those which have the eigenvalues of more than 1.0 were taken into consideration for each area, following the traditional manner.

Result of caluculation are listed in TableⅡ-3-4 and Table10 of Appendices.

Interpretation

Area No 1:

First Principal Component; Cu, Pb and Zn have a little high eigenvectors of plus quantity.

Second Principal Component; Au and As show high positive value.

Judging from those results, the mineralization in the area is able to be classified into two style, Cu-Pb-Zn and Au-As.

Area No 2:

First Principal Component; the value of eigenvectors for Cu, Pd, Co, Fe, Mn, Ni and Cr are close each other and high as well.

Second Principal Component; Zn shows large eigenvector.

Third Principal Component;Au and Ag show large absolute values of eigenevectors.

Elements that show high eigenvectors and well correlationships in First Principal Component are contained abundantly in ultramafic rocks. That suggests the presence of ultramafic rocks. Results of Second and Third

Table I-3-4 Eigen vectors and eigen value (Correlation matrix)

No1. Area

	1	2	3	4	5	6
Au	0.17383	0.67279	0.09436	-0.05557	0.57348	-0.41983
Ag	0.31626	-0.26113	0.87790	0.22670	0.01699	-0.09700
Cu	0.59004	-0.07418	-0.23902	-0.18839	-0.48433	-0.56494
Pb	0.45709	-0.04401	-0.35510	0.76146	0.19851	0.20931
Zn	0.52476	-0.18701	-0.05073	-0.57449	0.36138	0.47586
As	0.19315	0.66087	0.18599	0.01314	-0.51600	0.47426
Eigen	2.39624	1.3644	0.77820	0.66265	0.19531	0.13116
Prop.	0.39937	0.30607	0.12970	0.11044	0.03255	0.02186
Cum. prop	0.39937	0.70545	0.83515	0.94559	0.97814	1.00000

No2. Area

	1	2	3	4	5	6	7	8	9	10	11	12
Au	0.01636	0.22460	-0.63484	-0.07862	0.19372	0.03436	-0.36820	0.32821	0.30666	-0.37255	-0.15403	0.03871
Ag	0.03167	0.15972	-0.65484	0.00228	0.18393	-0.14493	0.38018	-0.38870	-0.35079	0.23369	0.12627	0.02427
Cu	0.33203	0.04048	-0.24094	0.02681	-0.58951	0.18943	-0.22243	0.11844	0.17907	0.49520	0.27355	0.17414
Pb	0.09647	0.28980	0.11073	-0.75371	-0.27990	-0.43412	-0.03738	-0.00671	-0.14761	-0.16129	0.09417	-0.03806
Zn	0.03354	0.57335	0.19283	0.20353	0.25147	-0.20886	-0.10459	0.38667	-0.17319	0.47659	-0.18257	-0.20164
As	0.28510	0.05923	0.12129	-0.45755	0.44700	0.65092	-0.11390	-0.06997	-0.14645	0.13532	0.03945	0.09194
Pd	0.33723	-0.29707	0.01161	0.07586	0.17862	-0.38606	-0.60202	-0.38283	-0.10264	0.12694	-0.25763	0.09578
Co	0.44519	-0.05630	-0.02756	0.11321	-0.15516	0.13265	0.05146	-0.07226	-0.10889	-0.16012	0.00610	-0.83138
Fe	0.33053	0.33298	0.10501	0.37360	-0.12240	0.08233	-0.05689	0.01374	-0.43250	-0.48809	0.14625	0.39664
Mn	0.31119	0.40451	0.16052	0.07168	0.07719	-0.05501	0.26018	-0.41768	0.65646	-0.03798	-0.12736	0.09422
Ni	0.39022	-0.25311	-0.08101	-0.10265	-0.09343	-0.04634	0.42595	0.35893	-0.08183	0.03472	-0.62428	0.21863
Cr	0.35566	-0.27603	0.04132	0.01950	0.39253	-0.32783	0.16634	0.34271	0.17468	-0.02181	0.59574	0.05159
Eigen	4.66284	2.24085	1.83877	1.03608	0.85760	0.44014	0.36624	0.22860	0.13191	0.12800	0.04318	0.02578
Prop.	0.38857	0.18674	0.15323	0.08634	0.07147	0.03668	0.03052	0.01905	0.01099	0.01067	0.00360	0.00215
Cum. prop	0.38857	0.57531	0.72854	0.81488	0.88635	0.92302	0.95354	0.97259	0.98359	0.99425	0.99785	1.00000

No3. Area

	1	2	3	4	5	6
Ag	0.34331	0.28189	0.06919	0.78031	-0.42534	-0.09001
Cu	0.36759	-0.52958	-0.19613	-0.31132	-0.66815	0.05117
Pb	0.58706	0.02286	-0.14653	0.03621	0.38431	0.69596
Zn	0.58910	-0.08004	-0.00077	-0.10272	0.38201	-0.70005
Mo	0.06621	0.70038	-0.58621	-0.34402	-0.19232	-0.07819
As	0.22574	0.37766	0.76918	-0.40496	-0.20508	0.09344
Eigen	2.38857	1.10968	0.93663	0.86204	0.55119	0.15189
Prop.	0.39810	0.18495	0.15610	0.14367	0.09187	0.02532
Cum. prop	0.39810	0.58304	0.73915	0.88282	0.97468	1.00000

No4. Area

	1	2	3	4	5	6	7
Au	0.17340	-0.20914	-0.82765	0.21243	0.40323	-0.15149	-0.10257
Ag	0.21439	0.47878	-0.26575	-0.79417	0.03766	-0.06686	0.13261
Cu	0.50756	0.07773	0.11521	0.11897	-0.35080	-0.65848	-0.39019
Pb	0.50682	-0.14778	-0.11302	-0.04301	-0.32021	0.70727	-0.32235
Zn	0.52874	-0.06059	0.06673	0.21921	-0.03480	-0.01223	0.81418
Mo	0.12037	0.78709	0.07413	0.45804	0.30732	0.19646	-0.13291
As	0.33975	-0.27562	0.45648	-0.22429	0.71745	-0.00239	-0.18755
Eigen	3.01697	1.14923	1.05264	0.82274	0.57896	0.21747	0.16199
Prop.	0.43100	0.16418	0.15038	0.11753	0.08271	0.03107	0.02314
Cum. prop	0.43100	0.59517	0.74555	0.86308	0.94579	0.97686	1.00000

No5. 6. 7. Area

	1	2	3	4	5	6
Ag	0.34604	-0.23771	-0.11479	-0.86466	0.24857	0.03404
Cu	0.21353	-0.79814	0.31876	0.30462	0.18693	-0.29670
Pb	0.52502	0.27329	-0.31354	0.09537	-0.18498	-0.71277
Zn	0.50215	-0.24002	-0.29183	0.18234	-0.50602	0.56194
Mo	0.30565	0.26781	0.83560	-0.15711	-0.33358	0.02580
As	0.46200	0.32007	0.05933	0.30422	0.70832	0.29381
Eigen	2.59129	1.07850	0.86912	0.78515	0.48714	0.18880
Prop.	0.43188	0.17975	0.14485	0.13086	0.08119	0.03147
Cum. prop	0.43188	0.61163	0.75649	0.88734	0.96853	1.00000

Principal Components are interpreted to suggest the mineralizations of Zn and Au-Ag are independant each other.

Area No 3:
First Principal Component; Pb and Zn show high eigenvectors.
Second Principal Component; Mo and Cu show high absolute values of eigenvectors. Value for Mo is plus and value for Cu is minus.

It is believed that the mineralization in the area is characterized by Pb-Zn and Mo. Whereas, correlationship between Cu and Mo shows negative relationship.

Area No 4:
First Principal Component; Components with large value are Cu, Pb and Zn.
Second Principal Component; Eigenvector of Mo is large.
Third principal Component; Au and As show relatively large absolute values. While value of As is positive, Au shows negative value.

From First and Second Components, it is suggested that two style of mineralizations, Cu-Pb-Zn in Volcanic rocks or formation of marine origin of Mesozoic age, and Mo in granitic rocks exist in the area.

Area Nos 5, 6 and 7:
First Principal Component; Absolute values of Pb and Zn are large.
Second Principal Component; Absolute value of Cu is large.

Probably the mineralization of Pb-Zn and the mineralization of Cu occur in those areas.

6) Relationship between grain size and metal concentration

Relationship between grain size and metal concentration in stream sediments were studied for four categories of grain size.

In this work, pan concentrate samples were also collected in the same sample points as stream sediment sample points. Five stream sediment samples were selected based on presence of gold particles in pan concentrates. Mesh fractions are as follows:-

Ⅰ: 30-80 mesh
Ⅱ: 80-120 mesh
Ⅲ: 120-200 mesh

Ⅳ: under 200 mesh

TableⅡ-3-5 and Fig.Ⅱ-3-32 show results. All elements tend to concentrate on the fine grained portion under 120 mesh.

(3) Anomalous Values and Zone

1) Threshold

Threshold values for elements were fixed by method coupled following two methods: (ⅰ) when the natural logarithm values of raw data followed a normal law, the threshold values were fixed by the cumulative frequency method; (ⅱ) other than the case of (ⅰ), M+2σ was used as threshold, where M is mean value and σ is standard deviation.

In the case of (ⅰ), we employed the method modified Lepeltier(1967) and Sinclair(1976). That is, when the cumulative frequency distribution curve is linear on logprobabity graph, and when it breaks and is concave, the 2.5% point was used. Whereas, when the curve is convex, if the breaking point is at the point of more than 2.5%, the value at the point was used, and if at the point of 2.5% and less, then 2.5% point was selected. When set of data was composed of two and more mother populations, a middle point of part of the curve on which two mother populations are overlaped was used as threshold.

The threshold values fixed are listed in Table below.

Matrix showing the Threshold for Elements in Each Area

Element	Area No1	Area No 2	Area No3	Area No4	Area No5-7
Au(ppb)	15.425	138.035	-	15.441	-
Ag(ppm)	0.168	0.330	0.154	0.153	0.380
Pb(ppm)	13.356	3.297	30.077	13.050	54.524
Zn(ppm)	(95.499)	(76.366)	136.171	68.477	155.804
Cu(ppm)	(33.113)	67.023	76.997	19.698	(48.529)
Mo(ppm)	-	-	1.605	0.906	0.979
As(ppm)	3.596	55.638	9.005	5.503	(18.197)
Pt(ppb)		-			
Cr(ppm)		789.160			
Ni(ppm)		505.459			
Co(ppm)		29.113			
Pd(ppb)		2.007			
Fe(ppm)		5.648			
Mn(ppm)		676.773			

Where "-" means all raw data are below detection limit; 20ppb for Au, 5ppb for Pt and 1ppm for other elements

Table Ⅱ-3-5 Assays on Samples at Several Mesh Fractions

Sample No.		Au(ppb)	Ag(ppm)	Cu(ppm)	pb(ppm)	Zn(ppm)	Mo(ppm)	As(ppm)
SS-116	I	9.83	0.05	23.6	4.6	58.0	0.52	6.90
	II	10.20	0.10	22.4	8.2	69.4	0.31	4.08
	III	2440.00	0.89	29.8	17.9	95.2	0.89	11.9
	IV	178.60	1.07	107.1	71.4	214.3	5.36	71.4
FS-104	I	11.39	0.11	18.1	9.6	6.2	0.66	2.94
	II	10.55	0.05	13.9	8.4	52.7	0.63	2.74
	III	12.58	0.13	15.1	11.3	70.4	0.63	3.14
	IV	20.00	0.20	24.0	16.0	104.0	0.60	2.00
FS-111	I	10.09	0.20	20.2	14.3	75.9	0.59	2.61
	II	20.83	0.27	16.7	14.6	61.5	0.52	2.60
	III	10.42	0.42	16.7	14.6	63.5	0.52	2.60
	IV	14.16	0.50	29.7	25.5	92.1	0.21	2.10
FS-115	I	10.61	0.11	14.1	5.76	58.9	0.61	2.73
	II	12.16	0.06	7.3	3.65	38.9	0.61	3.04
	III	9.90	0.05	6.9	3.90	35.6	0.50	2.48
	IV	7.30	0.07	13.1	6.57	52.6	0.37	1.83
PS-508	I	9.84	0.10	5.1	11.80	84.6	0.59	2.56
	II	11.63	0.12	4.7	17.44	102.3	0.59	2.91
	III	12.76	0.20	7.7	20.41	58.7	0.38	1.28
	IV	56.25	7.81	15.6	62.50	671.9	2.34	7.81

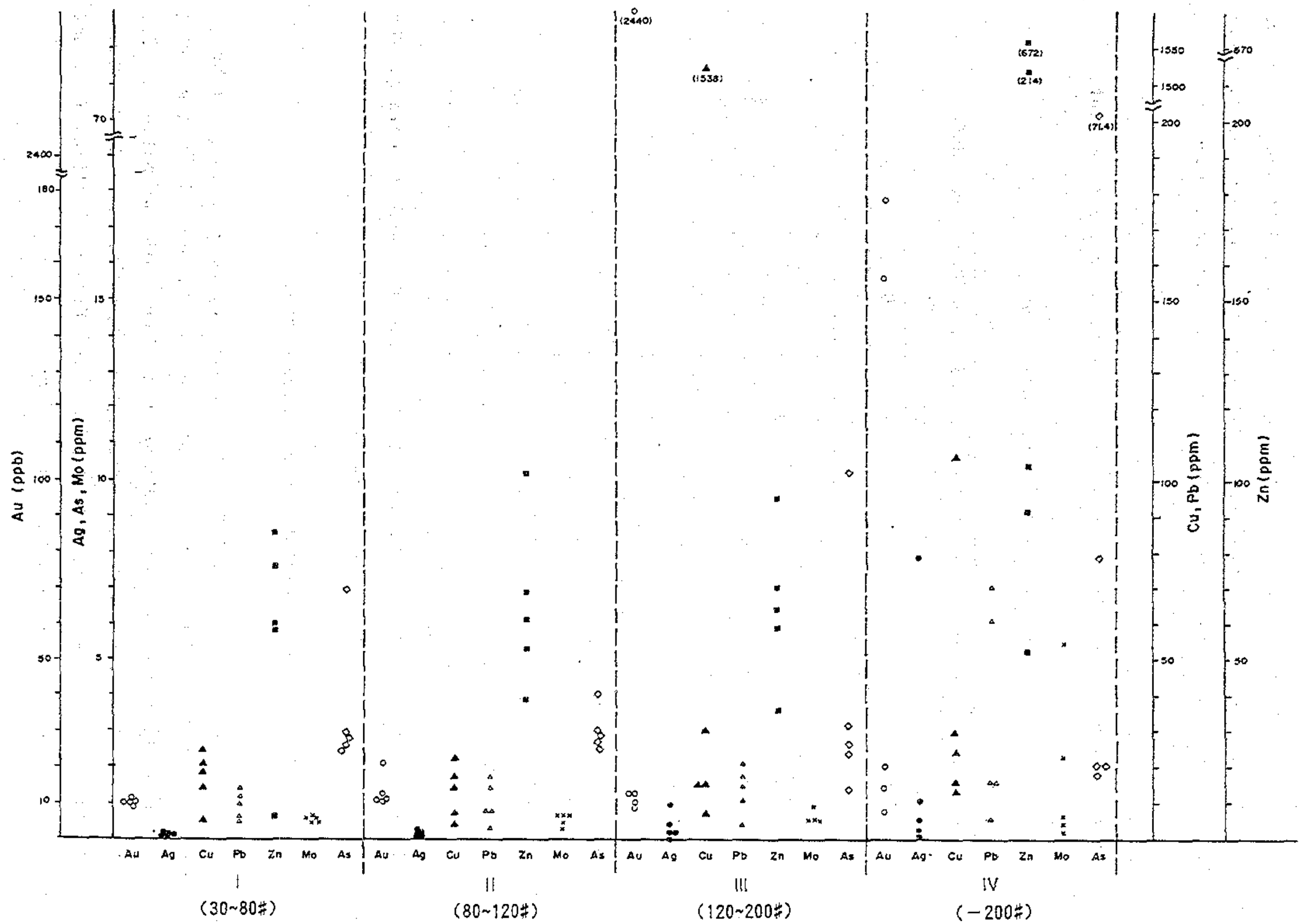


Fig. II-3-32 Assays on Samples at Several Mesh Fractions

Values in parentheses indicate the thresholds determined by the cumalative frequency distribution curves. Others are fixed by $M+2\sigma$. Figure II-3-33 shows the cumalative frequency distribution curves used for fixing thresholds.

2) Anomaulous Zones

Numbers of the anomalous values in each area are listed in following Table

Numbers of the Anomalous Value

Element	Area No1	Area No 2	Area No3	Area No4	Area No5-7
Au	1	2	0	1	0
Ag	3	1	3	0	5
Pb	1	1	4	2	5
Zn	1	1	1	1	5
Cu	1	0	0	1	2
Mo	0	0	6	4	12
As	2	0	9	1	21
Pt		0			
Cr		2			
Ni		2			
Co		2			
Pd		3			
Fe		0			
Mn		1			

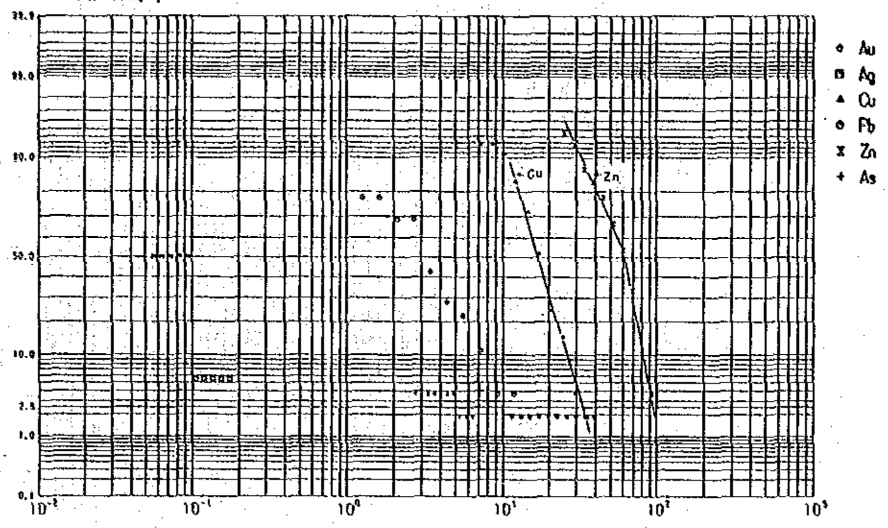
PLATES 11 to 21 illustrate the locations of these anomalous points. The general geochemical features are as follows:-

Area No 1: No element forms a widespread anomalous zone.

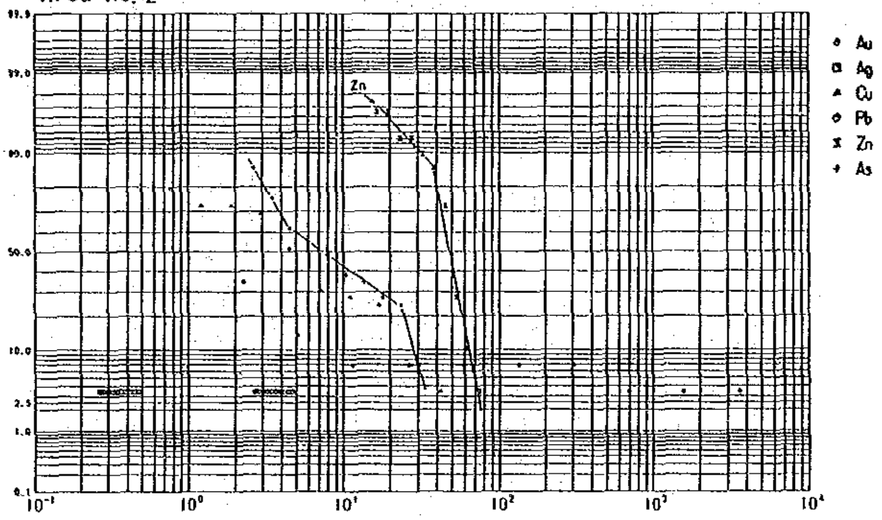
Area No 2: Some gold anomalies were detected in the Estero el Moro river which is a branch stream located west side of the Rio Huequi river and in a rivermouth of small river locating south of Cta. Ampe. Also anomalies of Cr, Ni, Co and Pd were established in three rivers trending toward the Comau channel on the north slope of Cerro Comau Mountais. Floats of ultramafic rock were found around the rivermouths of those rivers.

Area No 3: Anomalies of Pb are concentrated on the zone around Alto Palena town. In the western part of the area, Mo anomalies are scattered. On the other hand, anomalies of As are concentrated on the southeastern zone of Alto

Area No. 1



Area No. 2



Area No. 2

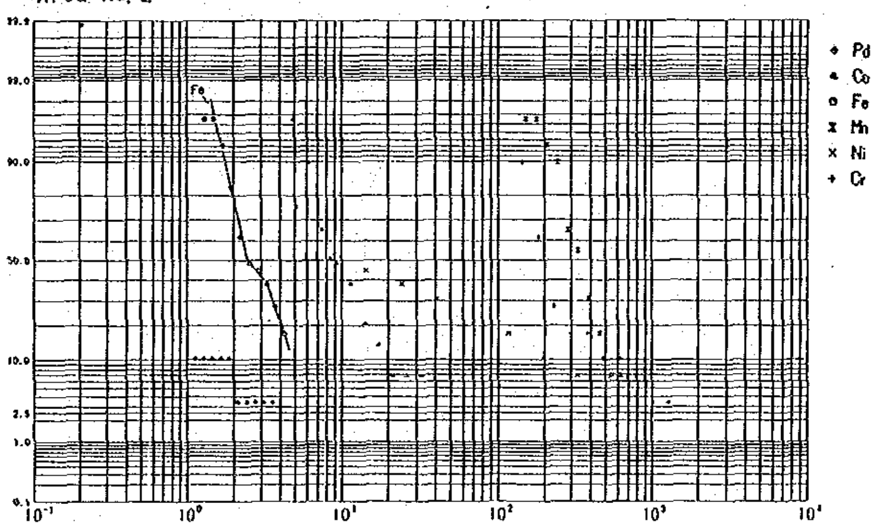
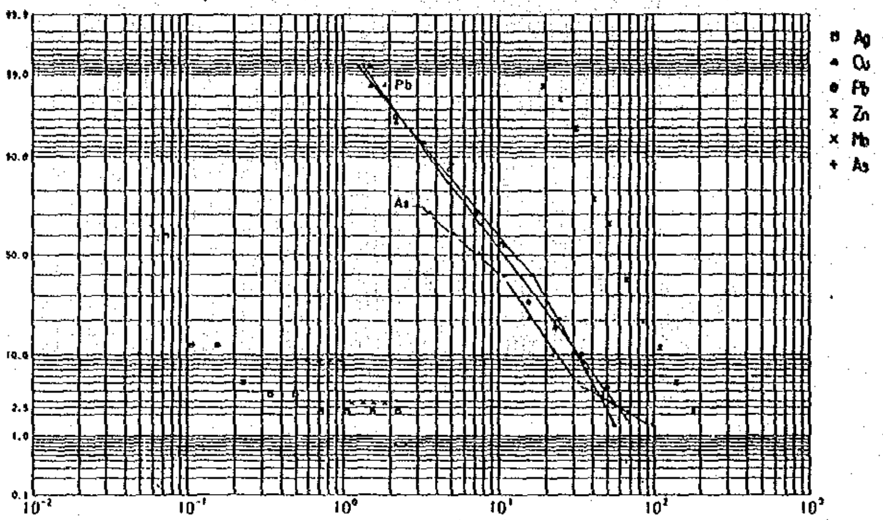


Fig. II-3-33 Cummulative Frequency Distribution Curves for Stream Sediment Geochemistry

Areas No. 5, 6, 7



Palena town(mainly in the basin of the Rio El Tigre river) and southeastern zone of Futaleufu town(the basin of Rio Chico river). Those As anomalies do not overlap to anomalolies of other elements.

Area No 4: Au, Cu, Pb and Zn anomalies were detected in the basin of the Estero Moro river. Whereas, Mo anomalies are scattered in granite area where is developed in the western part of the area.

Area No 5: Only one anomalous point of Ag was obtained in midll reach of the Muller river. Occasionary arsenic anomalies are found in downriver of the Avellanos river, midll reach of the Ibañez river, midll reach of the Muller river and midll reach of the Resbalon river. Isolated Mo anomalies were found in midll reach of the Resbalon river and downriver of the Ibañez river.

Area No 6: Mo, As and Pb anomalies are found densely in the southern part of basin of El Leon river.

Area No 7: Ag anomalies relatively are concentrated in the eastern basin of the Chacabuco river and the Rio Aviles river. Pb and Zn anomalies are not found densely to form large anomalous zone. Although many Mo and As anomalies were recognized, they are very sporadically scattered and never form widespread anomalous zone.

3.3.2. Pan Concentrate Geochemistry

(1) Sampling and Chemical Analysis

Samples were collected on the same sample points as stream sediments. Favourable places for gold accumulation was selected as same as done in sampling of stream sediments. That is, the pan concentrate samples were taken from nearby the base of a sequence of alluvial sediments, usually just above the surface rock which heavy detrital minerals characteristically occur in great abundance. Eight kilograms of sediments were always supplied for panning except for the sampling in the Area No 2. Amount of sediments for panning in the Area No 2 was not constant due to scarce amount of heavy minerals.

Amount of pan concentrate collected was 10 to 50 grams. In some cases, much light minerals were mixed into Pan concentrates due to inexperience of panning.

Total numbers of sample are 370 throughout the investigated areas. Numbers taken in each investigated area are listed on a Table below. Locations of samples are exhibited on PLATE 22 to 28.

Numbers of Pan Concentrate Samples

Area	Numbers of samples
No 1	53
No 2	29
No 3	105
No 4	46
No 5	62
No 6	15
No 7	60
TOTAL	370

All samples except for them in Area No 2 were submitted and analyzed in the laboratory of SERNAGEOMIN. Samples of Area No 2 were analyzed by Chemex Labs. of Canada. Elements analyzed are Au, Ag, Pt, Pd, Pb and Cr(six elements) for the Area No 2 and Au, Ag and Pb(three elements) for other areas. Detection limits are applied to same values for stream sediments.

(2) Statistical Data-handling

1) Method

Method applied for data-handling of pan concentrates samples is same as that for stream sediment sample. Raw analytical values used for caluculation, however, are net weight of the elements (Au and Ag:μg, Pb;mg) contained in pan concentrate samples. On the other hand, raw values are expressed as grades for the Area No 2.

2) Statistical Values

Elemental statistical values are listed in TableII-3-6. Row data are listed on Table 9 of Appendices. Results of assayings are summarized as follows:-

* Proportions of gold assays under detection limit are high all over the areas except for Area No 2. Those proportions are 46/53 for Area No 1, 3/29 for Area No 2, 36/105 for Area No 3, 37/46 for Area No 4, 47/62 for Area No 5, 9/15 for Area No 6 and 43/60 for Area No 7.

* Proportions mentiond above for Ag, Pb and Pd are high in Area No 2; 27/29 for Ag, 21/29 for Pb and 22/29 for Pd.

3) Frequency Distribution

Table Ⅱ-3-6 Elemental Statistical Values of Pan Concentrate Geochemistry

No1. Area

	Au(μg)	Ag(μg)	Pb(mg)
Logarithmic Mean	0.12	1.71	0.03
Max.	7.80	10.00	0.36
Min.	0.05	0.50	0.01
M+σ	0.32	3.63	0.09
M+2σ	0.85	7.70	0.24

No2. Area

	Au(ppb)	Ag(ppm)	Pb(ppm)	Pd(ppb)	Pt(ppb)	Cr(ppm)
Logarithmic Mean	49.98	0.24	0.94	2.73	6.34	365.36
Max.	10.00	2.00	10.00	30.00	75.00	9800.00
Min.	1.00	0.20	0.50	1.00	2.50	48.00
M+σ	1315.95	0.41	2.78	6.91	15.66	1556.93
M+2σ	34650.40	0.71	8.20	17.47	38.68	6634.71

No3. Area

	Au(μg)	Ag(μg)	Pb(mg)
Logarithmic Mean	0.31	2.82	0.08
Max.	54.00	40.00	1.63
Min.	0.05	0.50	0.05
M+σ	2.29	7.15	0.27
M+2σ	17.12	18.13	0.86

No4. Area

	Au(μg)	Ag(μg)	Pb(mg)
Logarithmic Mean	0.16	1.26	0.06
Max.	197.00	135.00	13.60
Min.	0.05	0.25	0.01
M+σ	1.04	4.37	0.24
M+2σ	6.57	15.22	1.00

No5. 6. 7. Area

	Au(μg)	Ag(μg)	Pb(mg)
Logarithmic Mean	0.23	3.72	0.39
Max.	206.00	255.00	48.60
Min.	0.05	0.25	0.01
M+σ	1.19	12.79	1.87
M+2σ	6.08	43.96	9.01

Fig.Ⅱ-3-34 shows the frequency distribution patterns for elements in each area.

The following elements are regarded to follow a normal law.

Area No 1	Pb
Area No 2	none
Area No 3	Ag and Pb
Area No 4	Ag and Pb
Area No 5-7	Ag and Pb

4) Correlationships between Elements

TableⅡ-3-7 show correlation coefficients. Among them, the pairs showed coefficients of 0.5 and more as absolute value are as follows:-

Area No 1	Au-Ag(0.55450)
Area No 2	Pd-Pt(0.95411)
Area No 3	Au-Ag(0.67324)
Area No 4	Au-Ag(0.76528)
Area No 5-7	Ag-Pb(0.71753)

Those results suggest that gold and silver in Areas No 1, 3 and 4 occur in electlum and silver in the Areas No 5-7 is contained in the lead-minerals. Platinum and Paladium which are believed to be contained in ultramafic rock show very close positive correlation.

(3) Geochemical Anomalous Values and Anomalous Zone

1) Threshold

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

Threshold Values for Pan Concentrate Geochemistry

	Area No1	Area No2	Area No3	Area No4	Area No5-7
Au(μg)	0.849	34.650ppb	17.120	6.570	(1.033)
Ag(μg)	(6.966)	0.707ppm	18.130	15.222	43.963
Pb(mg)	0.238	8,200ppm	0.858	0.997	9.013
Pt(ppb)		38.682			
Cr(ppm)		6,634.71			
Pd(ppb)		17.466			

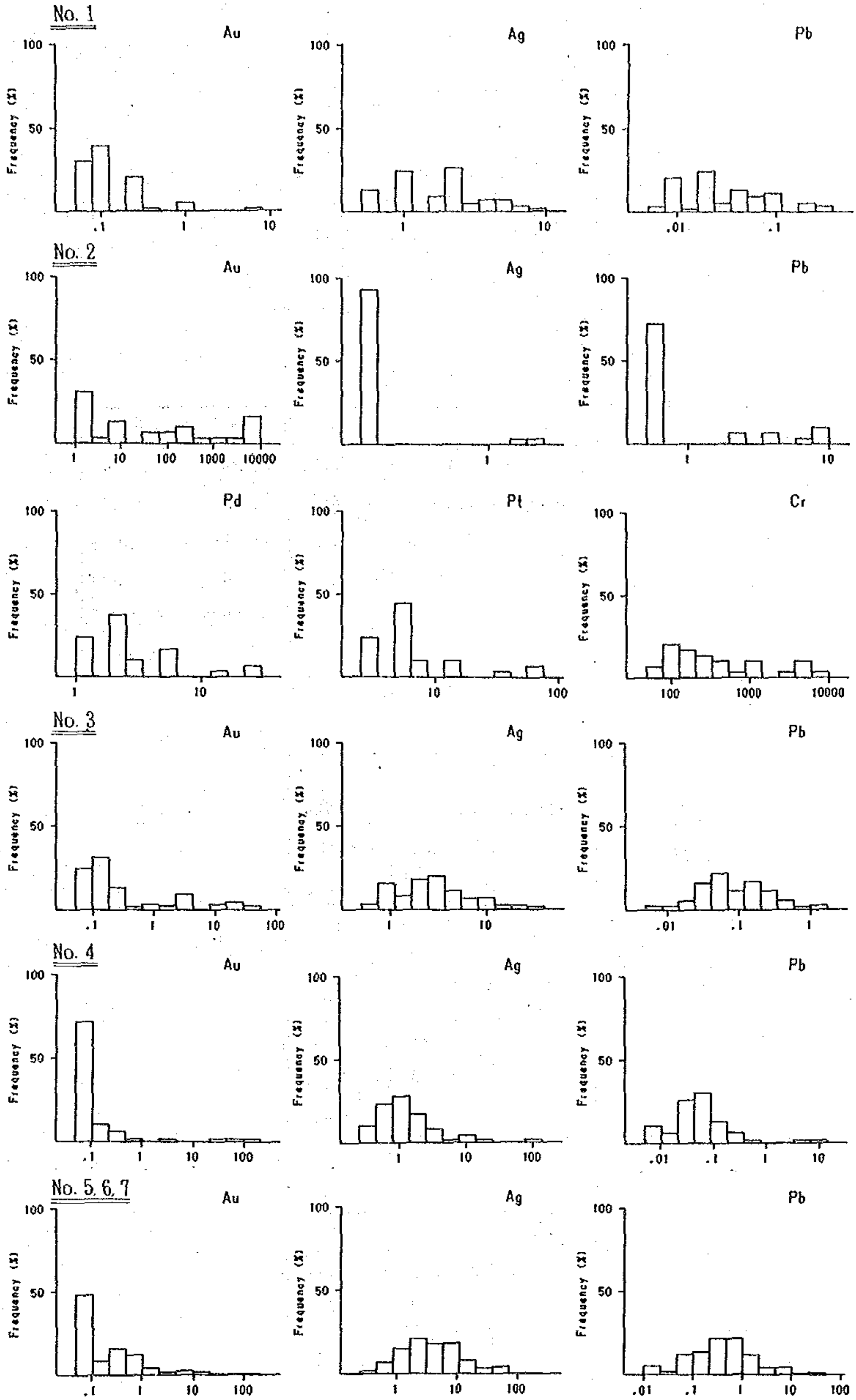


Fig. II-3-34 Frequency Distribution Histrgram of Pan Concentrate Geochemistry

Table Ⅱ-3-7 Correlation Coefficients of Pairs of Elements for Pan Concentrate Geochemistry

No. 1 地区

	Au	Ag	Pb
Au	1.00000	0.55450	0.38639
Ag		1.00000	0.53478
Pb			1.00000

No. 2 地区

	Au	Ag	Pb	Pd	Pt	Cr
Au	1.00000	0.10446	-0.06661	0.36721	0.36287	0.41906
Ag		1.00000	-0.15950	-0.04557	-0.18060	0.30387
Pb			1.00000	0.31467	0.37172	-0.40979
Pd				1.00000	0.95411	0.40333
Pt					1.00000	0.24787
Cr						1.00000

No. 3 地区

	Au	Ag	Pb
Au	1.00000	0.67324	0.11089
Ag		1.00000	0.21311
Pb			1.00000

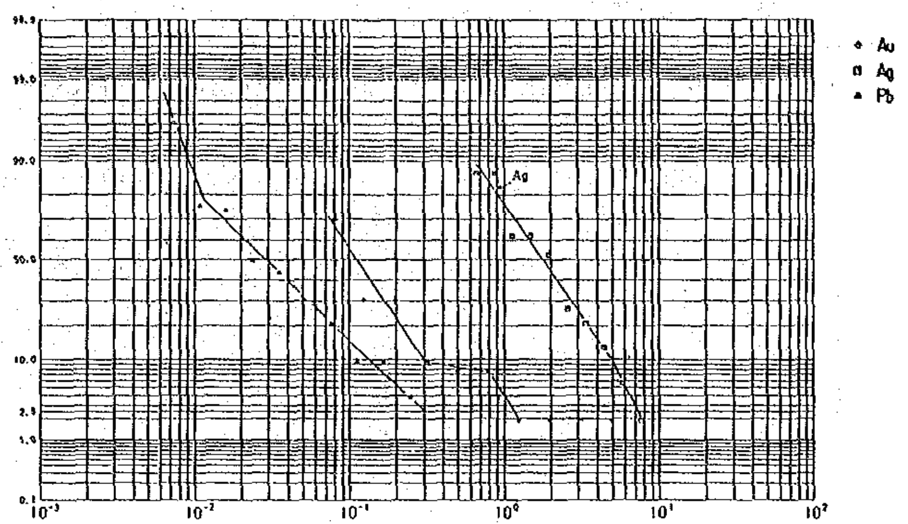
No. 4 地区

	Au	Ag	Pb
Au	1.00000	0.76528	0.38083
Ag		1.00000	0.61531
Pb			1.00000

No. 5, 6, 7 地区

	Au	Ag	Pb
Au	1.00000	0.44568	0.16588
Ag		1.00000	0.71753
Pb			1.00000

Area No.1



Areas No.5,6,7

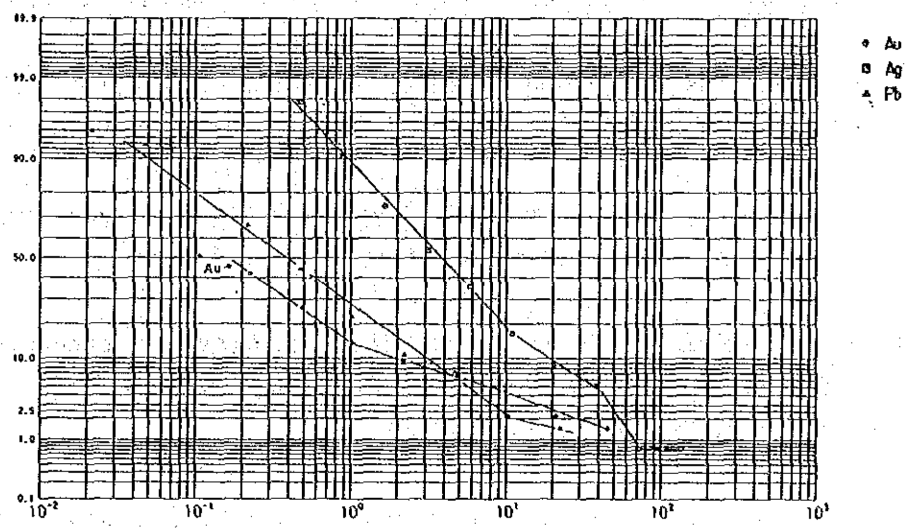


Fig. II-3-35 Cummulative Frequency Distribution Curves for Pan Concentrate Geochemistry

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

2) Geochemical Anomalies

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

Numbers of Anomalous Values in Each Area

Element	Area No1	Area No2	Area No3	Area No4	Area No5-7
Au	4	3	8	3	19
Ag	2	2	5	2	3
Pb	2	3	4	2	3
Pt		2			
Cr		1			
Pd		2			

Distributions of the anomalous points are shown in PLATES 11 to 21.

Area No 1: Anomalies of Au and Ag relatively concentrate on the zone between the east slope of the Cordon Maravilla Mountain and the Bio Bio river.

Area No 2: Anomalies of Pt, Pd and Cr are found in the rivermouth of a river on north slope of the Cerro Comau Mountain.

Area No 3: Anomalies of gold and silver relatively are concentrated on the rivers where are distributed from the Lago Espolon lake to the Lago del Noroeste lake in northwest of Futaleufu town.

Area No 4: Gold and silver anomalies were found in the basin of the Estero Moro river and the rivermouth of the Estero La Tobiana river.

Area No 5: Sporadical gold anomalies were established in the following areas: the Muller river, the Resbalon river, the Traiguanca river and the Avellanos river. Only one anomaly of Ag was obtained in midlle reach of the Ibañez river. Whereas, Pb, Zn and Cu anomalies were found in the basin of Muller river.

Area No 6: Relatively many Au anomalies were detected in the basin of Rio Leones river and Rio El Canal river.

Area No 7: Anomalies of Au, Ag, Cu, Pb and Zn were found densely in the western part of basin of the Aviles river.

3.3.3. A Discussion for Sampling Methods

Stream sediment sample and pan concentrate sample were taken from same sample point in this survey. This style of sampling revealed the following matters.

Numbers of samples assayed above detection limit for both stream sediment sample and pan concentrate samples were examined. They are summarized in Table below.

Areas		Au	Ag	Pb
Areas except for Area No2	Numbers of samples above detection limit	232/2	333/155	335/343
	Numbers of anomaly	34/2	12/11	11/12
Area No 2	Numbers of samples above detection limit	26/12	2/1	8/1
	Numbers of anomaly	0/2	2/1	3/1

Figures in Table indicate "pan concentrate/stream sediment"

In the Areas other than Area No 2, numbers of stream sediment samples showed above detection limit for Au are very few compared to pan concentrate, which eighty samples showed above detection limit. Whereas, both numbers are not very different in Area No 2.

As reported above, detection limit for Au is 20ppb all over the areas other than Area No 2. Although this limit is not problem of analytical technique, anomalous values may be missed for stream sediment geochemistry. Correlation coefficient of assay data of both methods were caluculated for all the areas.

That is,

Au: 0.13863(0.171073)

Ag: 0.11151(0.128087)

Pb: 0.64657(0.424684)

Where figures in parentheses indicate values caluculated by using net weight of each elements for data of pan concentrate; micro grams for gold, and milli grams for silver and lead.

Assays of both are correlated for Pb, while no correlations for Au and Ag.

It shoud be studied more whether pan concentrate geochemistry must be persisted or low level gold assaying is necessary.

Assays for lead are correlated well so that both methods are thought to be available. Correlations for silver are very poor.

CHAPTER 4 Discussions

4.1 Area No 1: Lonquimay Area

The area lies near the eastern margin of the batholith. Volcanic rocks and sedimentary rocks of marine origin, of Mesozoic to Middele Tertiary ages are developed in the area. It is believed that the geologic settings of the area are favorable for occurence of ore deposits assumigg from the features of ore deposits in the southern Chile. Mineral exploration, however, is expected to be very difficult due to broad cover of Quaternary volcanic ash deposits on the area.

Besides, it is concluded from the results of previous survey and this survey that existences of the base metal deposits are hardly expected apart from the favorableness of the geologic settings. On the contrary gold deposits are keenly expected to be present. Previous and/or this investigations reveal geochemical anomalies are concentrated on the basin of the Bio Bio river. Actually placer gold deposit occurs in the river: the deposit is partly in operation.

Problem of origin of the alluvial gold in the area has not been solved in spite of studies conducted so far. This survey also did not reveal the problem. We can mention only the following matters at the moment.

(i) No geochemical anomaly has not been obtained in the eastern area of the Bio Bio river and the area is covered by Quarternary volcanic ash sediments. It is reasonable based on those matters to exclude the area from the future exploration target.

(ii) It is considered that gold grains in the Bio Bio river were transported by the glaciers because this river is considered to be a Glacial Valley.

(iii) The placer gold of the Bio Bio river was possibly derived from the primary gold deposits which occur in the rock units of Mesozoic or Tertiary ages distributed around granitic rock area in the west of the Bio Bio river. The source primary deposits are possibly epithermal quartz vein deposit.

4.2. Area No 2: Huequi Peninsula Area

The area is situated in the western margin of the Patagonia Batholith showing a little different geologic setting. That is, the geology of the area consists of mainly Granitic rocks and Paleozoic sequences, and therfore deposits formed on high temperature are expected.

Granitic rocks distributed in the area are calc-alcaline granite and belong to magnetite series in advanced differentiation stage. Expected deposits in the area are assumed to be of gold, copper, lead, zinc or molybdenium. Any large deposit, however, has not been known in the western margin zones of the Patagonia Batholith so far.

Ultramafic rock was recognized around the Comau Mountain by the survey of this year. Despite that, the concentrations of several trace elements such as platinum, Nickel, cobalt and cronium are not over background values. Final conclusion aout that shold be pended because the surveyed area was limited to a narrow zone along the north coast of the Peninsula.

As mentioned before, a couple of gold geochemical anomalies were found in the downstream of the Huequi river where is situated in western part of the area. Sampling density and population of sample are very small so that the meanings of those anomalies are still unknown.

4.3. Area No 3: Futaleufu-Alto Palena Area

The area is situated in the eastern margin of the Patagonia Batholith, and underlain by Jurassic and Cretaceous systems as established by previous works. Limesone beds are interbedded into a part of Cretaceous rocks and limestone replacement Skarn mineralization of lead, zinc and copper was recognized as well (Prospect Arroyo Pedregoso I). This is considered to suggest that a potential of the similar style of mineralization to the El Toqui deposit could be hilighted on this area. Results of geochemistry seem to support that assumption: i.e., lead and zinc anomalies were found, although sporadical, and eigenvectors of lead and zinc are of large values on First Principal Component.

Development of epithermal gold deposit is expected around Futaleufu town because geochemical anomalies of gold are found densely and hydrothermal alteration zones associated with gossans are distributed.

4.4. Area No 4: Alto Cisnes- El Toqui Area

Many large gold and lead-zinc deposits are distributed in the area as described in section 3.1.4. The El Toqui style mineralization is stratiform and extend continuously. Those implies that some ten million tonnes of ore reserves would be expected for the similar mineralization as well as the El Toqui deposit.

On the other hand, visible features on surface from large distance are not associated with this style of mineralization so that application of Remote Sensing is difficult to make exploration terms short.

Assays on outcrops of the "new vein" of Katterfeld deposit showed low level as mentioned before. As those outcrops are situated on stratigraphically high portion, the "old vein" may correspond to the lower level of the "new vein". If standing on that assumption, an increase of gold and copper grades are expected. The "new vein" comrises many veins and is minable by a large scale mining, even if it is low grade.

Density of geochemical sample points is very rough. Consequently this geochemical survey hardly say any conclusion. One thing appeared by this study is a little concentrated distribution of molybdenium anomaly around Tapera village. This is believed to indicate molybdenium mineralization developed in the eastern margin of the Patagonia Batholith. In generall, molybdenium deposits developed in the batholith are usualy small throughout investigated areas and none of the minable econonical deposit is expected

4.5. Area No 5: Ibañez-Murta Area

Extention of the Silva deposit is blocked by granitic intrusion on west side and by fault on east side. By this reson, the exploration area is limited to very narrow zone. Rosillo deposit extends west up to the fault which bounds the mineralization of Silva deposit and that of Rosillo deposit. Whereas, limestone horizons which are principle country rock of the deposit extends northeast continuously. The northeastern area may be highlited for further exploration, but no indication of mineralization was not recognized on the surface according to MMAJ(1979). It is assumed that the deposit may lie in the depth even if it exist in the northeast extention of the mine.

Las Chivas deposit is a vein type deposit containing some millions tonnes ore reserve. Vein extends about 1,700m along strike and ends to be narrow vein. It is hard to expect extending more and the mining has been nearly completed. Almostly no promissing area for the further works where is still unexplored remain.

Many other deposits are distributed in the Area No 5, but all of them are small and/or low grade deposits which are not minable.

Those known deposits are distributed mainly in the area around coast of the Lake General Carrera. In contrast with that, distribution of deposits in the northern half of the Area No 5, especially in the area between the Ibañez river and the Avellanos river, is very rough where are underlain by Paleozoic units, Ibañez Formation, Coyhaique Formation and Granitic rocks as well as in the area around the coast. As the basic geologic settings are considered to be similar to them of the coast area, the reason of undiscovering deposit probanly were brought by topographical problems. Actually in those remote areas, only small numbers of villages are located with no car road but a few hoarse rode connected and the topography is very steep so that the investigation will be very difficult to complete. Despite that, the areas are remained to be virgin areas for exploration.

4.6. Area No 6: Los Leones Area

Western half of the area is occupied by the Patagonia Batholith. Eastern half is underlain by Paleozoic units. Some prospects of copper and gold occur in Paleozoic rocks. It was found that gold and arsenic geochemical anomalies are concentrated in the area where Paleozoic rocks are distributed.

From the matters mentioned above, the area is hilighted for the further exploration.

4.7. Area No 7: Chile Chico-Chacabuco Area

The Laguna verde deposit is possibly so called "Hot spring type" deposit or such kind of deposit formed in very shallow depth, although all the features were not identified by this survey. That is,:(i) vein comprises mainly comb quartz and oxide minerals. (ii) vein contains a very small amount of sulfide minerals other than small amount of pyrite. (iii) leached silicification zone is developed widespreadly. (iv) alteration mineral assemblage is quartz-kaolinite-(deckite). (v) vein partly contains much arsenic.

Gold mineralization of "Hot spring type" characteristically take place in mixture zone of sulfide minerals and oxide minerals situated above the sulfide minerals zone or just below the level of boiling. Therefore, it is probably reasonable idea that the gold assay becomes high in depth even if the assays on outcrops are low grade.

Extensive exploration works, mainly drilling, are being carried out at the moment. Judging from its extensiveness, it is assumed that significant results are obtained.

Although the known deposit occurs in Ibañez Formation, such kind of deposit would be able to occur in Divisadero Formation which overlie on the Ibañez Formation. The eastern part of the area is regarded as promossing area where mineralization of same type may have taken place because of the presence of extensive volcanic activity of Jurassic age.

The La Poza and the La Paulina deposits are possibly the volcanogenetic sub-marine deposit considering from the following mode of occurence.

(i) Mineralized areas are underlain by green tuff, chert, shale, tafaceous sandstone bearing glauconite, limestone and dacite.
(ii) Ores nearly always occur in the footwall of chert concordantly.
(iii) Ores comprise mainly galena with small amount of sphalerite, chalcopyrite and pyrite.
(iv) Galena contains much amount of silver and of very fine grain disseminating or aggregating in mainly shale.

Those features resemble very much to low grade part of the Kuroko deposit. It may be possible to find high grade Kuroko ore or Ohko ore by further exploration. The several ore-bearing horizons are believed to be developed so that they are hopefully of large ore reserves.

Geochemical anomalies of gold, silver, copper, lead and zinc distributed in western area of the Aviles river were obtained chiefly only from Pan concentrates except for silver anomalies. In that area, arsenic anomalies of stream sediments were found as well. Those anomalies are distributed dencely and the alteration zone associated with gossan lies in the up river zone of anomalous points: OP 710, OP 714 and OP 708. Those anomalies are probably derived from the alteration zone.

PART Ⅲ: CONCLUSIONS AND RECOMMENDATIONS

PART Ⅲ
CONCLUSIONS AND RECOMMENDATIONS

Chapter 1 Conclusions

1.1. Area No 1: Lonquimay Area

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

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

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

Gold and silver stream sediment geochemical anomalies were found a little densely in the area between the Maravilla mountain and the Bio Bio river lying northern part of the Area No 1.

1.2. Area No 2: Huequi Peninsula Area

This area lies on the western margin of the Patagonia Batholith. Granitic rocks and Paleozoic unit are distributed in the area. The survey of this year identified the existence of ultramafic rock intruded by granitic rock in the base of the Comau mountain situated in northern part of the peninsula. Distribution and size are not identified. Gold anomalies were found by stream sediment geochemistry in the western part of the area.

This area is one of areas lacking in sufficient geologic information. Some promissing indications, however, were obtained by this investigation so that further more surveyes are needed to get more knowledge.

1.3. Area No 3: Futaleufu-Alto Palena Area

This investigation identified indications of copper mineralization occuring in intermediate to accidic volcanic rocks. Whereas, no promissing deposit was found. However, it is believed that further exploration work may get new discovery of promissing deposit of gold, silver, lead and zinc in the distribution area of Jurassic system. This expectation stands on the following evidence:-

This area lies on the eastern margin of the Patasgonia Batholith, and is overlain by Jurassic volcanic rocks and calcareous rocks of marine origin(Ibañez Formation, Coyhaique Formation and Divisadero Formation) which are closely related to the mineralizations of the Aysen region. Furthermore, gold and silver geochemical anomalies were obtained in northwest of Futaleifu town. In the vicinity of Palena town, dense distribution of lead geochemical anomalies were found. Those are considered to lead to the above expectation.

1.4. Area No 4: Alto Cisnes-El Toqui Area

This area lies the eastern margin of the Patagonia Batholith and eastern part of the area is overlain by Mesozoic unit such as Ibañez Formation, Coyhaique Formation and Divisadero Formation. Large lead-zinc deposits, represented by the El Toqui and Cerro Estatuas, are considered to be formed by replacement of calcareous beds of Coyhaique Formation. Ore reserves of them may be some ten million tonnes. Vein deposit of gold also occurs in Ibañez Formation which is represented by the Katterfeld deposit. In Katterfeld deposit, parallel veins are distributed with about ten meters intervals and the mineralized zone is one kilometers wide. This zone is associated with gossaneous hydrothermal alteration zone of some kilometers width. Alteration assemblage is characterized by sericite-silicification-kaolinitization.

Those deposits are predominant in both scale and ore grade so that they would be targeted for exploration of undiscovered deposit so that further exploration works are required for volcanic rocks and sedimentary rocks of marine origin distributed in vicinity of the Batholith.

1.5. Area No 5: Ibañez-Murta Area

The Patagonia Batholith lies only small portion of this area. Mesozoic unit is distributed broader rather than the batholith. Although more than 70 mines and prospects are developed in the area, many of them are small. Deposits mined to date are replacement deposit of lead-zinc which replaced limestone interbeded into Paleozoic unit. Those deposits are represented by Silva and Rosillo deposits. Ore reserves of them is small ranging between five hundred thousand and seven hundred thousand tonnes.

Sufficient exploration works have not been conducted in the area between the Avellanos river and the Ibañez river due to access problem. This area is underlain by Paleozoic unit and Mesozoic unit, and intruded by many stocks of granitic rocks. Moreover, a gold prospect occurs in the down river of the Avellanos river(Prospect Rio Avellanos II). Those leads to a expectation that lead-zinc deposit of the El Toqui style or gold deposit of Katterfeld style are still remaind to be undiscovered.

No geochemical anomalies were obtained throughout the area No 5.

1.6. Area No 6: Los Leones Area

This area is underlain by the Patagonia Batholith on western part and Paleozoic unit on eastern part of the area. Gold and arsenic geochemical anomalies were obtained densely in the basins of the Leones river and the Cañar river. Whereas, molybdenium, arsenic and lead anomalies were densely found in southern part of the basin of the Leones river. No interesting deposit was recognized. Based on geology, depopsits expected to exist in this area are as follows; vein deposit of molybdenium in granitic rocks, lead-zinc deposit of Silva deposit type and gold-(copper) deposit of high tempertature.

1.7. Area No 7: Chile Chico-Chacabuco Area

Geology of this area consists of Paleozoic metamorphic rocks, Mesozoic unit, Cenozoic unit, and stocks and dykes derived from the Patagonia Batholith. About 20 deposits are known. Among them, gold mineralization of Laguna Verde style and lead mineralization of La Pozs style are noted.

Laguna Verde deposit is an epithermal vein deposit which may be classified into hot spring type. Numerous quartz veins occur in Ibañez Formation. This deposit is associated with broad hydrothermal alteration zone with assemblage of silicification and kaolinitization. Consequently, Vein swarm associated with alteration of this style shoud be noted.

La Poza deposit is possibly sub-marine volcanogenetic deposit. It is expected to have potential for the discovery of further ore.

Geochemical anomalies of gold, silver and arsenic were obtained densely and hydrothermal alteration zone associated with gossan was found in up river area of anomalies. Therefore, this anomalous zone is worth noting.

1.8. Detection Probrems of Geochemical Anomaly

Total of 341 stream sediment samples were assayed by SERNAGEOMIN throughout this survey project. Only 2 samples of them showed gold grade above detection limit, 20ppb. On the other hand, gold assays on 232 pan concentrate sampless of 341 samples showed grade above detection limit. This suggests that detection limit of 20ppb has problem to detect anomalous values from stream sediment samples. As to silver and lead, no problem was caused.

What high rate of samples were below detection limits for silver and molybdenium all over the areas are commonly characteristic matter for both stream sediment samples and pan concentrate samples. In the case of Area No 2, same feature was recognized for silver, lead and paladium.

Chapter 2 Recommendations

2.1. Selected Subjects for Further Explorations

The following lines are recommended for further explorations on the basis of the conclusions defined above.

Area No 1: Lonquimay Area

Gold mineralization should be targeted. Minable placer deposits lie this area, while the source of gold grains has not been identified. In order to find the source deposit, the work must forward to lead a line after integrated analyses of all geochemical data including them obtained by SERNAGEOMIN. It is also advisable to analyze geochemical anomalous zone lying around the Maravilla mountain.

Area No 2: Huequi Peninsula Area

It is recommended to get basical geological informations at first. Existence of ultramafic rock has been identified by this survey so that its distribution area and size will have to be defined. Aeromagnetic survey is believed to be the most suitable method for that purpose. Therefore, it is recommended that delineation of survey area by aeromagnetic survey will be followed by geological and geochemical survey.

Gold grain of about one millimeter in diameter was found in a geochemical anomalous point of gold. This anomalous zone is worth being followed up so that it is recommended to follow up ultrmafic rock and geochemical anomaliy of gold.

Area No3: Futaleufu-Alto Palena Area

To get undiscovered mineralization of the El Toqui style, horizon of ore-bearing beds will have to be chased by using aerial photograph interpretation at the first and then ground surveys including geochemical survey will test the mineralization.

Geochemical anomalies of gold are found a little densely in north of Futaleufu town. This anomalous zone will have to be re-surveyed more detailedly.

Gold mineralization of the Katterfeld style is associated with broad hydrothermal alteration zone so that it is advisable to extract the similar alteration zone by using Landsat TM image.

Area No 4: Alto Cisnes-El Toqui Area

Lead-zinc mineralization of the El Toqui style is expected in eastern part of the area. This kind of mineralization must be targeted and followed up by the same procedure as that of Area No 3.

Area No 5: Ibañez-Murta Area

Geological survey and geochemical exploration are advisable for the area between the Ibañez river and Avellanos river.

Area No 6: Los Leones Area

Following up the geochemical anomalous zone of gold and silver is recommended.

Area No 7: Chile Chico-Chacabuco Area

Mineralization of the Laguna Verde is associated with broad hydrothermal alteration. Landsat TM image analysis is suitable for discovering this type of mineralization.

La Poza and La Paulina deposits may be a sub-marine volcanogenetic deposit. Undiscovered minable ores are expected to be still remained. Therefore, detailed geological survey at scale of 1:5,000 is advisable.

Another advisable target is geochemical anomalous zone of gold and silver lying the basin of the Avilles river.

2.2. Recommendations for the Second Phase

The following investigations are especially recommended for the second phase.

* Landsat TM image analysis and geological survey for alteration zone extracted by TM image in the regional zone between eastern edge of the Patagonia Batholith and the border line with Argentina ranging from Area No 3 to Area No 7.

* Photogeology by using aerial photographs to follow up ore horizons and test survey including geochemistry for mineralization in distribution area of Mesozoic unit of Area No 3 and No 4.

* Geological and geochemical survey to follow up geochemical anomalous zone of gold and silver in northern part of Area No 3.

* Geological and geochemical survey to follow up geochemical anomalous zone of gold and silver in Area No 6.

* Detailed geological survey for La Poza deposit and La Paulina deposit in Area No 7.

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