(A00NK031, A00TM037, A00RM034, A00RM035), sericite and kaolin were identified (Appendix-5).

The sample of A00TM039, white quartz vein of 1 m width which is accompanied by medium-grained limonite, fluid inclusion study revealed homogenization temperatures of 215 to 283℃, averaging 259℃; salinities of 28.3 to 30.9 wt%, averaging 29.6 wt% (Appendix-10). The oxygen isotopic composition of same quartz sample was +9.7‰. Then + 1.2‰ is calculated for hydrothemal water, which generated quartz, by oxygen isotopic fractionation factor between water and quartz (Matsuhisa et al., 1979) at average homogenization temperature (Appendix-12). The oxygen isotopic composition of magmatic water shows heavy values from +6‰ to +9‰ (Taylor, 1974), while the oxygen isotopic composition of meteoric water generally shows light values from -4‰ to -14‰, although with regional differences (Craig, 1963). Therefore, the above-mentioned oxygen isotopic composition of hydrothermal water which formed the quartz vein indicates that magmatic water was mixed with meteoric water. It is assumed that magmatic water was relatively dominant in hydrothermal water of this district.

10) Assessment

Rhyolite intrusion is thought to be concerned with formation of alteration zones in this district because it is concordant with the distribution of potassium feldspar and tourmaline zone and argillized alteration zone. Homogenization temperature of fluid inclusions shows that these are epithermal type. Although it is assumed from the oxygen isotopic composition that magmatic water was concerned, no remarkable mineralization of gold, copper and molybdenum was confirmed. This district is judged to have low potentiality of mineralization. It is not necessary to conduct the survey in Phase-2.

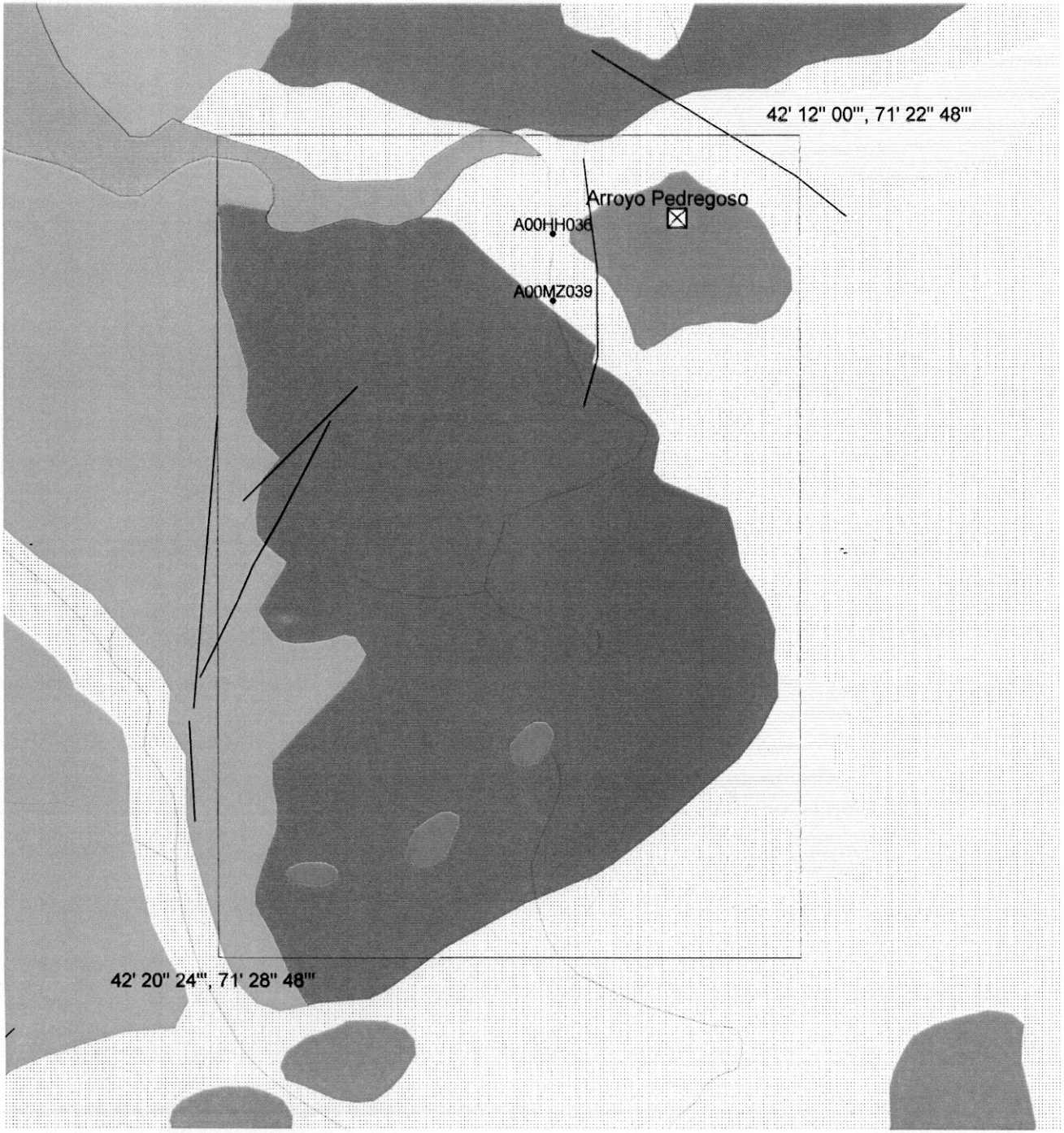
3-2-16 Epuyen district

1) Location

This district is located in the southwest of Epuyén town in the northwest of Chubut province (Fig. II-3-1). The area is lat. 42° 12' 00" to 42° 20' 24" S and long. 71° 22' 48" to 71° 28' 48" W (Fig. II-3-2-16a), and about 170 km^2. The hydrothermal alteration zones, SB081 to SB083, were extracted by satellite image analysis (Fig. II-2-15). The representative coordinate is lat. 42° 13' 51.9" S and long. 71° 25' 17.7" W at the sampling point of A00MZ039 in Pedrgoso riverside.

2) Topography and vegetation

The proximity of Epuyén town is low lands at around 300 m above sea level. Cordón de Cholila is steep mountains with altitude of 1,000 to 1,500 m above sea level, and the highest



Known deposit
Sampling point
Lineament
Circular structure
River
Lake

Legend

Quaternary sediments
Pliocene to Pleistocene basalt
Tertiary sedimentary rocks
Tertiary volcanic rocks
Tertiary granitoids
Jurassic to Cretaceous sedimentary rocks
Jurassic to Cretaceous volcanic rocks
Jurassic to Cretaceous granitoids
Permian to Triassic igneous rocks
Carboniferous sedimentary rocks
Proterozoic metamorphic rocks
Alteration zone

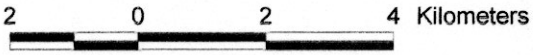


Fig. II-3-2-16a Geologocal map with sampling points of the Epuyen district.

peak at 2,082 m above sea level. Major ridges and streams run N-S to NNW. Woods spread in the low lands while the vegetation on the highlands is sparse. The Lago Epuyén is located in the northwestern part of this district.

3) Access

Alteration zones extracted by the satellite image analysis are located in the highlands of Cordón de Cholila. Although distant view of them were seen in the fielsd, it was not accessible by restrictions of time and accessibility. Therefore, floats were investigated at Pedregoso riversides running down to the north from the alteration zones. There is a farm road accessible to the survey site by car, but the gate on the road is locked.

4) Previous surveys

There is old Pedregoso mine of placer gold. Petersen and Bonorino (1974) described the geology of the western part of Chubut province. Beltramone (1978) reported the results of geological survey and geochemical survey of Lago Epuyen area as a part of the Plan Patagonia Comahue. The survey area was 1,400 km^2 from lat. 42° to 42°30' S and from long. 71° W to the border with Chile. Six hydrothermal alteration zones were reported. In addition, geochemical survey was conducted for copper, lead and zinc by stream sediments and rocks chips samples. As the result, a geochemical anomaly of 320 ppm Cu of rock sample was detected.

5) Mining properties

Private companies own several mining properties for gold and placer gold.

6) Geology and geological structure

The geology of this district, inascending order, Osta Arena formation of Jurassic sedimentary rocks, Cretaceous granitoids, Ventana formation Paleogene volcanic rocks, and Quaternary glacial sediments, colluvium and alluvium. The Cretaceous granitoids are distributed in the western side of Cordón de Cholila, Jurassic sedimentary rocks are distributed in that eastern side.

7) Mineralization and alteration

Spots and veinlets of zeolite were observed in andesite along the Arroyo Pedregoso where the floats were surveyed. The surface is partially limonitized. Floats were basalt to dacite and granitoids. Silicification, dissemination of pyrite and limonitization were observed for those floats.

8) Characteristics of the satellite images

On the false color image, the mountain zone on the west side looks green, and places higher than this zone look white to blue. This means that the higher parts have snow in the forest zone. The area along the stream where floats were surveyed looks pink, white to light green. On the periphery, lineaments of 5 to 10 km in length that orient to N-S and NW-SE are extracted.

On the ratio image, yellow is dominant in low places. The area along ridges of mountain district looks dark color and reddish purple on the whole. Relatively bright reddish purple is recognized along ridges in the southeast part, which is interpreted as hydrothermal alteration zones. These parts are located about 5 km north of the floats survey site.

9) Laboratory work results

A float of silicified andesite of A00MZ039 revealed 48 ppm As. It is considered as effect of hydrothermal alteration.

10) Assessment

It is a fact that placer gold was mined in this district in the past. In the satellite image analysis, hydrothermal alteration zones were extracted in the upstream of the alluvial gold deposits. A float of altered andesite revealed weak arsenic anomaly related with hydrothermal alteration. Although the alteration zones were not surveyed in-situ in this survey because of the restriction of time and accessibility, it is necessary to conduct the survey in Phase-2 to investigate the alteration nature and to find the source of placer gold.

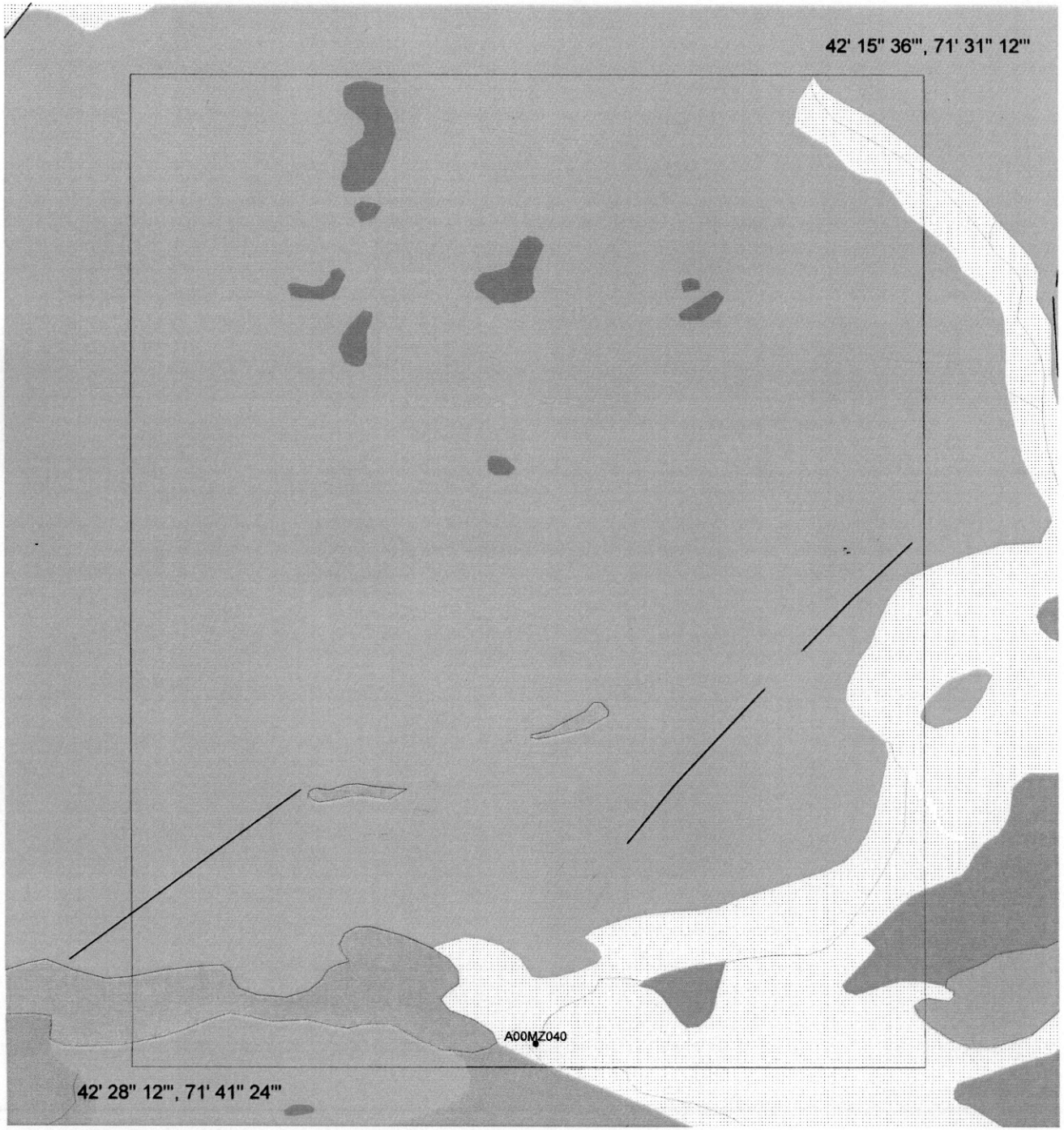
3-2-17 Lago Cholila district

1) Location

This distirict is located about 30 km to the southwest of Epuyén town, covering from a part of the Lago Cholia to its north part, in the northwest of Chubut province (Fig. II-3-1). The area is lat. 42° 15' 36" to 42° 28' 12" S and long. 71° 31' 12" to 71° 41' 24" W (Fig. II-3-2-17a), and about 440 km^2. The hydrothermal alteration zones, SB050 to SB057, were extracted by satellite image analysis (Fig. II-2-15). The representative coordinate is lat. 42° 28' 03.8" S and long. 71° 35' 53.2" W at the point where the Arroyo Pedregoso joins the Rio Carrileujú coming from the Lago Cholila lake.

2) Topography and vegetation

This district is located in Cordillera de los Andes at about 35 km from the border with Chile. Glacial lakes including Lago Cholila are located in this district. The altitude is



Known deposit
Sampling point
Lineament
Circular structure
River
Lake

Legend

Quaternary sediments
Pliocene to Pleistocene basalt
Tertiary sedimentary rocks
Tertiary volcanic rocks
Tertiary granitoids
Jurassic to Cretaceous sedimentary rocks
Jurassic to Cretaceous volcanic rocks
Jurassic to Cretaceous granitoids
Permian to Triassic igneous rocks
Carboniferous sedimentary rocks
Proterozoic metamorphic rocks
Alteration zone

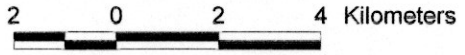


Fig. II-3-2-17a Geologocal map with sampling point of the Lago Cholila district.

approximately between 600 and 2,000 m above sea level. Although each mountain is prefixed with Cerro, meaning "hill," the mountains are significantly different in relative height in topography. The vegetation is thick with woods, but there are some places with sparse vegetation.

3) Access

It is 35 km drive from Epuyén town to south on No. 258 national road and No. 71 provincial road, then 10 km drive to east from the junction to lakeside of Lago Cholila. No. 258 national road is paved but others are unpaved. There is a camping area on the shore of Lago Cholila. Car is accessible until the lakeside, horse is necessary to go further into mountains.

4) Previous surveys

Petersen and Bonorino (1974) described the geology of the western part of Chubut province. Beltramone (1978) reported the results of geological survey and geochemical survey of Lago Epuyen area as a part of the Plan Patagonia Comahue. The survey area was 1,400 km^2 from lat. 42° to 42°30' S and from long. 71° W to the border with Chile. Six hydrothermal alteration zones were reported. In addition, geochemical survey was conducted for copper, lead and zinc by stream sediments and rocks chips samples. As the result, a geochemical anomaly of 320 ppm Cu of rock sample was detected.

5) Mining properties

Private companies and individuals own several mining properties.

6) Geology and geological structure

The geology of this district mainly consists of Cretaceous granitoids (Fig. II-3-2-17a). Divisadero formation of Cretaceous volcanic rocks is distributed on the south bank of Lago Cholila. Ventana formation of Paleogene volcanic rocks is distributed in the eastern part of Lago Cholila.

In this district, hydrothermal alteration zones were extracted by the satellite image analysis. However, it was not accessible to alteration zones by restrictions of time and accessibility. Therefore, floats were investigated at Pedregoso riversides running down from the alteration zones. At the sampling site of A00MZ040, floats of granodiorite were dominant. Also floats of andesite, basalt and quartz porphyry were observed, they are thought to be intrusions into granodiorite.

7) Mineralization and alteration

Silicified breccia with limonite was observed at riverside of Arroyo Pedregoso running down from the alteration zones extracted from the satellite image analysis.

8) Characteristics of the satellite images

The color tone of the false color image is mainly green and gradually changes from light gray to blue in highlands. This means that, although vegetation is thick on the whole, it is thin in highlands, and more higher places have snow. The structure due to topographical undulations is somewhat fine, and water systems are arborescent with moderate densities. Ridges are relatively clear with high resistance. Bedding planes are not recognized. NE-oriented lineaments are extracted. Eight hydrothermal alteration zones looking bright reddish purple color are extracted on the ratio image.

9) Laboratory work results

Float of silicified breccia with limonite of A00MZ040 revealed 2,490 ppm Cu, although gold and silver were in low grades of 0.005 g/t Au and less than 0.2 g/t Ag (Appendix-6). It is considered that hydrothermal alteration zones accompanied by copper mineralization exist in the upper stream area of Arroyo Pederegoso.

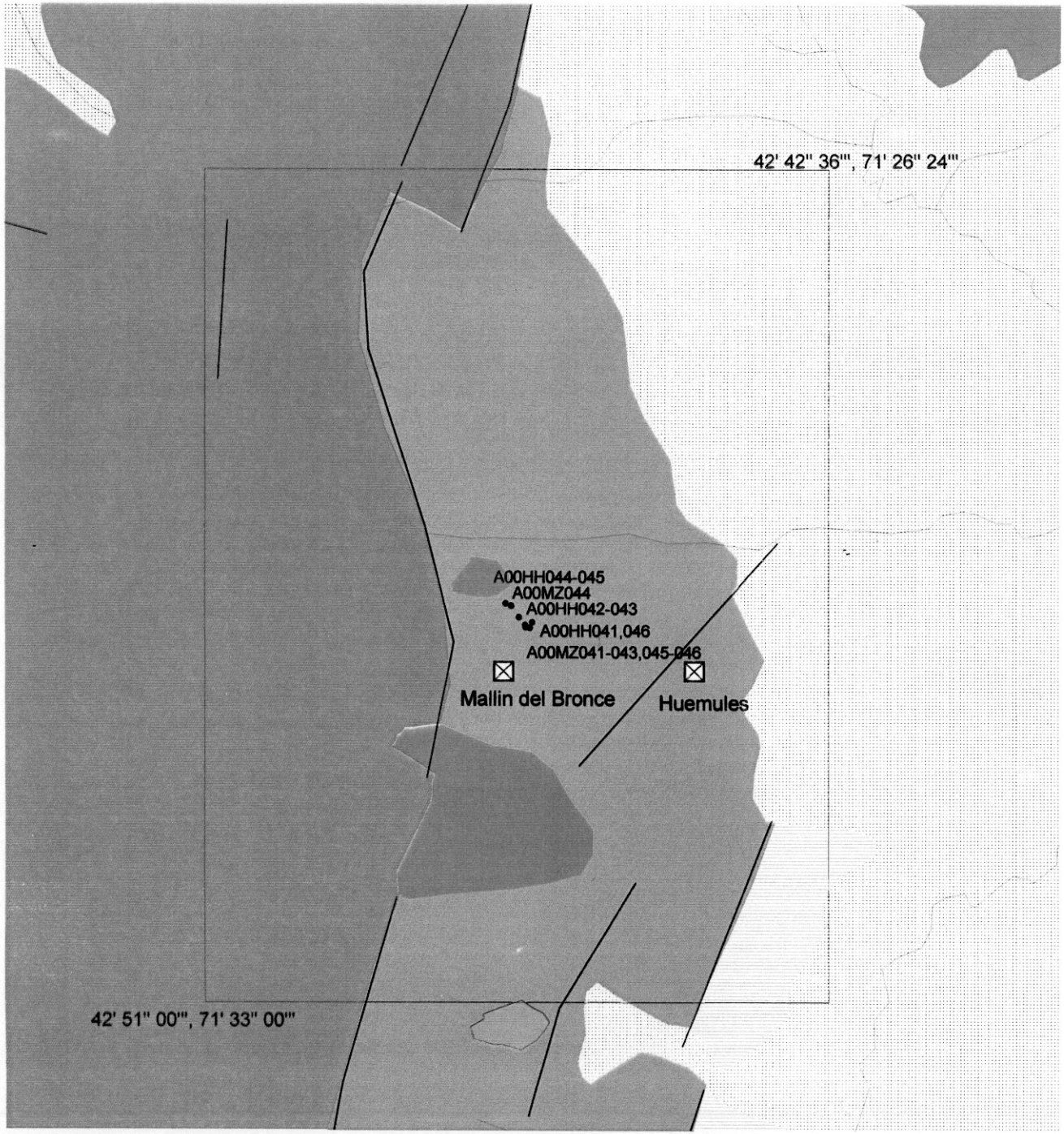
10) Assessment

Hydrothermal alteration zones were extracted by the satellite image analysis. The presence of hydrothermal alteration zones was also reported by Beltramone (1978). In addition, copper mineralization was confirmed for the float of silicified breccia by chemical analysis. Although the alteration zones were not surveyed in-situ in this survey because of the restriction of time and accessibility, it is necessary to conduct the survey in Phase-2 to investigate the alteration nature and to find the outcrops of copper mineralization.

3-2-18 Huemules district

1) Location

This district is located about 18 km to the northwest of Esquel city, in the northwest of Chubut province (Fig. II-3-1). The area is lat. 42° 42' 36" to 42° 51' 00" S and long. 71° 26' 24" to 71° 33' 00" W (Fig. II-3-2-17a), and about 180 km^2. The hydrothermal alteration zones, LM014 to LM015, were extracted by satellite image analysis (Fig. II-2-18). The representative coordinate is lat. 42° 47' 32.1" S and long. 71° 29' 45.9" W at adit entrance of Huemules Sur deposit.



Known deposit
Sampling point
Lineament
Circular structure
River
Lake

Legend

Quaternary sediments
Pliocene to Pleistocene basalt
Tertiary sedimentary rocks
Tertiary volcanic rocks
Tertiary granitoids
Jurassic to Cretaceous sedimentary rocks
Jurassic to Cretaceous volcanic rocks
Jurassic to Cretaceous granitoids
Permian to Triassic igneous rocks
Carboniferous sedimentary rocks
Proterozoic metamorphic rocks
Alteration zone

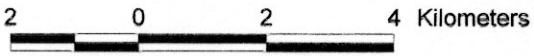


Fig. II-3-2-18a Geologocal map with sampling points of the Huemules district.

2) Topography and vegetation

Cordón de Rivadavia of 1,500 to 2,000 m above sea level is distributed with N-S direction in the northwest of Esquel city. Huemules deposits are located at around 1,600 m above sea level. Streams nearby run in E-W direction. Areas lower than 1,450 m above sea level are forests, while the vegetation at the elevation of the Huemules deposits is quite sparse.

3) Access

It is accessible by car from the Esquel city to the adit entrance of the Huemules Sur deposit. It is drive of 40 km and about 1 hour. The Huemules deposits are divided into three units of Norte, Centro and Sur for the convenience of exploration. The Huemlules Centro and Norte are not accessible by car because of the bad conditions of roads.

4) Previous surveys

The Huemules deposits are auriferous polymetallic vein deposits. The area has been known since old times as "Ancla de Oro" where lead and zinc ores were recognized in the stream. In 1973, the Pan Patagonia-Comahue Project was started. This district was included in priority survey areas because hydrothermal alteration and disseminated mineralization were observed. In 1977, UN Revolving Fund project was started and geological survey, geochemical survey, drilling survey, etc. were conducted. In 1983, the final report was submitted, and ore reserves were calculated as total 2,975,000 t. Among these, ore reserves with average grade of 9 g/t Au were re-calculated leter as 750,000 t (Viera and Hughes, 1999).

In 1985, the Huemules deposits were included in Plan de Expansión Minera (PEN) of Secretaría de Mineria of Argentine government, and drilling and underground surveys were conducted. The mining right was transferred to the provincial government in 1988, and general public tender for development was made in 1990. A company named EACA (Empresa Argentina de Cement Armado) had explored until 1993, and then conducted joint vemture exploration with Sunshine Mining. This company continued exploration until 1994, then withdrew. EACA established new joint venture with Minera el Desquite S.A. and started alternative exploration. However, positive results were not achieved and exploration is now suspended.

5) Mining properties

Several mining properties for exploitation and exploration cover the area of Huemules deposits and their periphery.

6) Geology and geological structure

The geology of this district comprises, in ascending order, Cañadón Huemules formation (Viera, 1980) of Jurassic to Lower Cretaceous volcanic rocks, Ventana formation of Paleogene volcanic rocks and Ñorquinco formation of Paleogene sedimentary rocks, and Quaternary glacial sediments, colluvium and alluvium.

Cañadón Huemules formation is made up of rhyolitic to andesitic rocks, accompanied by continental sediments. These rocks are the host rock of Huemules deposits and intruded by basalt to andesite dikes. Ventana formation is made up of rhyolitic to basaltic rocks and in fault contact with Cañadón Huemules formation in the western part. Ñorquinco formation distributed on the lowland in the southeast is composed of continental and marine epiclastic sandstone, mudstone and pyroclastic rocks.

Andesite dikes have the width of about 1 m and strike of N 40° W. Basalt plug dome that forms topographical rise is distributed in the northern part of Huemules Sur deposit

7) Mineralization and alteration

The Huemules deposits are vein type deposits along faults oriented to the NW-SE, and the total intermittent extension reaches 3,600 m. The deposits are divided into three deposits of Norte, Centro and Sur for the convenience of exploration. Only Huemules Sur deposit was surveyed in this survey.

Old adit entrance of Huemules Sur deposit is located at about 1,600 m above sea level. Mineralized zones continue from the site in direction of N 20° W along the stream. The mineralized zones are silicified zones with network of quartz veinlets and galena veinlets. The silicified zones have width of 1 to 30 m and strike of N20° to 30° W. Several zones are distributed in parallel. Quartz veins in the silicified zones have a maximum width of 15 cm and are accompanied by pyrite and galena. Hydrothermal alteration zone including these silicified zones is distributed for 500 m extension and 80 to 100 m width along two streams of NW-SE direction. Silicification is dominant and argillization is subordinate in the alteration zone with pyrite dissemination and liminitization.

8) Characteristics of the satellite images

On the false color image, bright green is dominant on lowlands below the altitude of about 1,500 m above sea level. This is consistent with thick vegetation. On highlands of Cordón de Rivadavia, blue is dominant on the west side of mountains, which corresponds to snow, and the east side looks white, light pink, pink and purple. N-S oriented lineament running through Cordón de Rivadavia continue for about 30 km in length. Several N-S lineaments length of less than 10 km are extracted.

On the ratio image, color tones are yellow, green, reddish purple, bluish purple, purple

and dark color. Yellow color corresponds to thick vegetation area. Alteration zone showing reddish purple color is extracted for the area of Huemules deposits and their northwestern part. Reddish purple color is more clear in the northwestern part than the area of Huemules deposits.

9) Laboratory work results

Ore samples of A00MZ041, A00MZ042 and A00MZ046 from Huemules Sur deposit revealed gold of 0.12 to 4.11 g/t Au, 3 to 17 g/t Ag, 0.03 to 0.74 % Cu, 0.06 to 3.82 % Pb and 0.11 to 19.95 % Zn (Appendix-9). Altered rock sample of A00HH044 revealed 0.59 g/t Au, 2.6 g/t Ag and 594 ppm Cu (Appendix-6). Based on these results, existence of gold mineralization was confirmed.

Sericite was identified by powdery X-ray diffraction for altered rocks of A00HH043 and A00HH044 (Appendix-5).

Average homogenization temperature of fluid inclusions in quartz of ore samples A00MZ043 and A00MZ046 was 121℃ to 130℃ and the average salinity was 1.8 to 2.2 wt% (Appendix-10). Oxygen isotopic composition of quartz of A00MZ043 and A00MZ046 were +9.2‰ and +8.5‰ respectively (Appendix-12). Then, -8.1‰ and -9.7‰ are calculated for hydrothermal water, which generated quartz, by the oxygen isotopic fractionation factor between water and quartz (Matsuhisa et al., 1979) at average hogenization temperatures. The oxygen isotopic composition of magmatic water shows heavy values from +6‰ to +9‰ (Taylor, 1974), while the oxygen isotopic composition of meteoric water generally shows light values from -4‰ to -14‰ with regional differences (Craig, 1963). Therefore, calculated values of -8.1‰ and -9.7‰ indicate that the hydrothermal water originated in meteoric water.

Sulfur isotopic composition of galena of sample A00MZ042 was measured as -1.8‰ (Appendix-11). Standard material of sulfur isotopic composition is Canyon Diablo Troilite (CDT). It is known that the sulfur isotopic composition in igneous rocks is relatively close to 0‰ of the standard and shows a narrow variation. Therefore, -1.8‰ of galena indicates that the sulfur originated in igneous rocks.

Scalamuk et al. (1999) also reported the data on oxygen isotopic compositions of quartz, sulfur isotopic compositions of sulfides and homogenization temperatures of fluid inclusions for Huemules deposits. Their data are generally consistent with data of this survey. However, more wide range of homogenization temperatures is reported by them.

Basalt sample A00MZ044 from the plug dome in northern part of Huemules Sur deposit was observed microscopically as olivine-pyroxene basalt (Appendix-3) and judged as calc-alkaline series by diagrams of Fig. II-3-2-18b and Fig. II-3-2-18c.

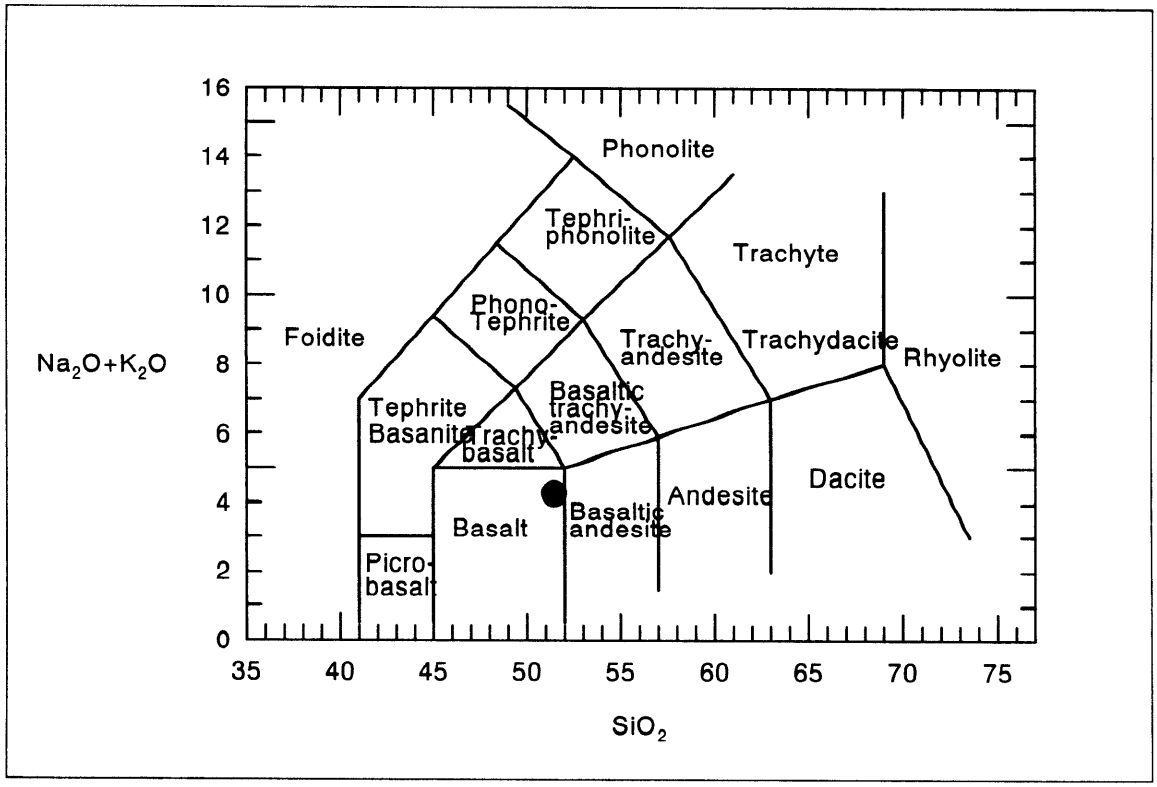


Fig. II-3-2-18b Na_2O+K_2O versus SiO_2 plot for basalt intrusion of the Huemules district.

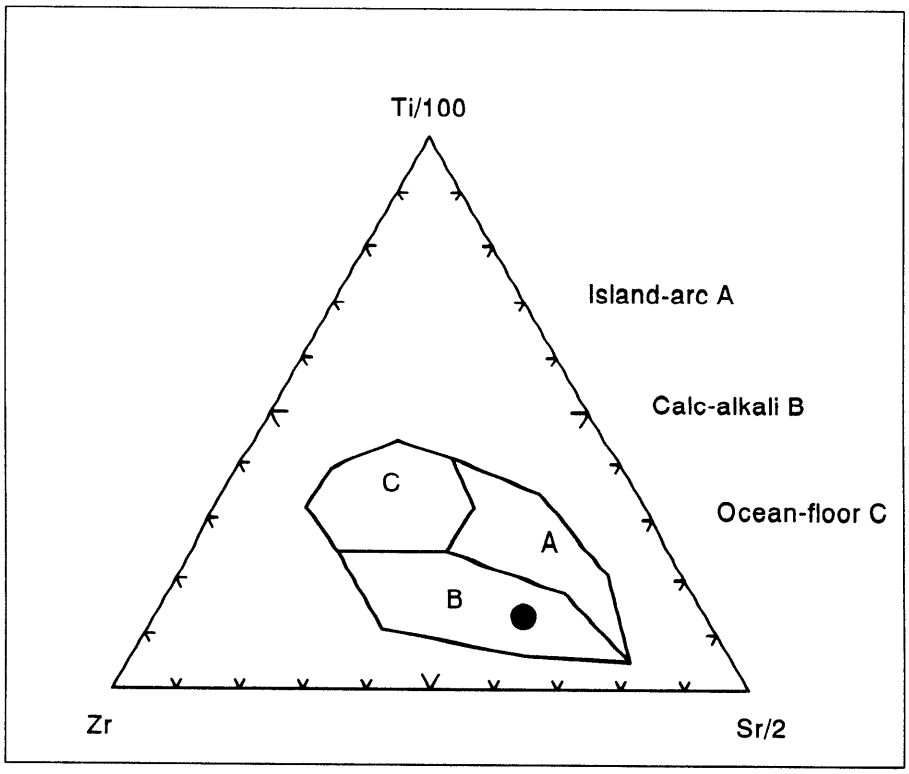


Fig. II-3-2-18c Tectonic discrimination diagram for basalt intrusion of the Huemules district. Island-arc A: island arc tholeiites; Calc-alkali B: calc-alkaline basalts; Ocean-floor C: mid-ocean ridge basalts (Pearce and Cann, 1973).

10) Assessment

Huemules ore deposits were fully explored in the past, and ore reserves have been already calculated. Minera el Desquite S. A., a mining property owner, also owns a mining property for Joya del Sol deposits that is located about 25 km east of Huemules deposits, and is promising gold deposits. If the Joya del Sol deposits are to be developed, probably development of Huemules deposits will be also considered.

The high potentiality of this district has been already proven. With consideration given to the purpose of this survey, that new promising areas should be extracted, it is considered that this district is not necessary to be surveyed in Phase-2.

3-2-19 Joya del Sol district

1) Location

This district is located about 10 km to the northeast of Esquel city, in the northwest of Chubut province (Fig. II-3-1). The area is lat. 42° 45' 36" to 42° 55' 48" S and long. 71° 06' 00" to 71° 15' 36" W (Fig. II-3-2-19a), and about 320 km^2. The hydrothermal alteration zones, LM022 to LM024, were extracted by satellite image analysis (Fig. II-2-18). The representative coordinate is lat. 42° 52' 22.1" S and long. 71° 12' 09.6" W at Gradriel vein of Joya del Sol deposits.

2) Topography and vegetation

Esquel city is located in a basin among mountains at approximately 700 m above sea level. In north of the city, Cordón de Esquel is running in N-S direction with about 25 km extension and altitude of 1,200 to 2,200 m above sea level. The auriferous quartz veins of Joya del Sol deposits are located on the ridges of Cordón de Esquel. Although each mountain is prefixed with Cerro, meaning "hill," the mountains are significantly different in relative height in topography. The vegetation is sparse with short grasses, and there are some places without vegetation.

3) Access

Esquel is a major city in northwest of Chubut province. It is about 10 km drive to southeast from Esquel city to join to No. 40 national road, then about 14 km drive to north-northeast on No. 40 national road, No. 40 national road is paved, then drive to west to go up to drilling sites on Cordón de Esquel. Totally, it takes about 1 hour from Esquel city.

4) Previous surveys

Geological survey in scale of 1/100,000 was conducted as a part of the Plan Patagonia Comahue (Herrero, 1981). Although the presence of hydrothermal alteration zones was recognized by the survey, geochemical analysis was not conducted.

In 1990, Empresa Argentina de Cemento Armado SA obtained the mining right. In 1997, Sunshine Mining obtained the mining right. Sunshine Mining reported 209,000 oz Au and 1,410,000 oz Ag at average grades of 5.8 g/t Au and 39.5 g/t Ag for auriferous quartz veins.

Minera el Desquite S.A. obtained the option right from Sunshine Mining in October 1998, and started systematic exploration in 1999 including total about 19,000 m of core-recovery drillings and reverse-circulation drillings. According to Internet information of February 2000, it was announced that 1,000,000 oz gold of which 75 % is in the measured and inferred categories was obtained by drilling surveys.

5) Mining properties

Minera el Desquite S.A. own the several mining properties.

6) Geology and geological structure

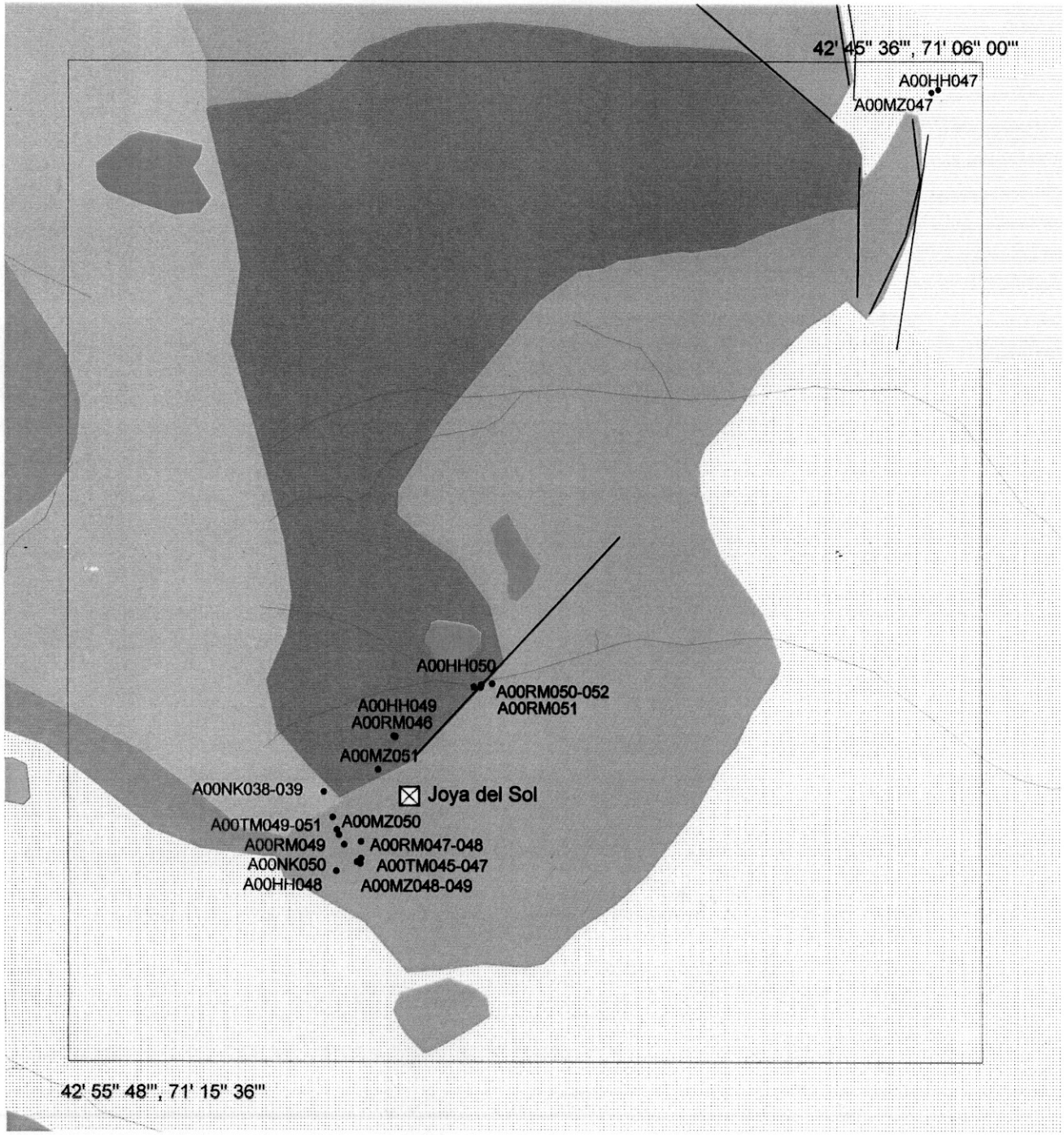
The geology of this district comprises, in ascending order, Tepuel formation of Carboniferous sedimentary rocks, Lago la Plata formation of Jurassic volcanic rocks and Osta Arena formation of Jurassic sedimentary, Ventana formation of Paleogene volcanic rocks and Ñorquinco formation of Paleogene sedimentary rocks, and Quaternary glacial sediments, colluvium and alluvium (Fig. II-3-2-19a). Intrusions of microdiorite and dacite also exist.

Tepuel formation of Carboniferous consists of marine and continental clastic sedimentary rocks. Lago la Plata formation of Jurassic consists of andesitic rocks. Osta Arena formation of Jurassic consists of marine black mudstone. Ventana formation of Paleogene consists of rhyolitic to basaltic rocks. Ñorquinco formation of Paleogene consists of continental and marine epiclastic sandstone, mudstone and pyroclastic rocks.

Auriferous quartz veins with strikes of N 20° E to N 15° W are hosted in andesitic rocks of Lago la Plata formation. There are NW-SE direction faults that cut the quartz veins.

7) Mineralization and alteration

Andesitic rocks of Lago la Plata formation that are host rocks of auriferous quartz veins are silicified on the whole. There are many outcrops of auriferous quartz veins. In this survey, observation was done for main veins named Galadriel, Elena Sur, Julia and Antonio. The dominant strike is N-S, and it changes from N 20° E to N 15° W . The inclination is mostly vertical, but it changes from 60° W to 80° E . Quartz veins are frequently transferred by NW-SE direction faults. The width is about 20 m in Galadriel and Antonio veins.



Known deposit
Sampling point
Lineament
Circular structure
River
Lake

Legend

Quaternary sediments
Pliocene to Pleistocene basalt
Tertiary sedimentary rocks
Tertiary volcanic rocks
Tertiary granitoids
Jurassic to Cretaceous sedimentary rocks
Jurassic to Cretaceous volcanic rocks
Jurassic to Cretaceous granitoids
Permian to Triassic igneous rocks
Carboniferous sedimentary rocks
Proterozoic metamorphic rocks
Alteration zone

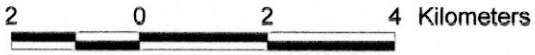


Fig. II-3-2-19a Geologocal map with sampling points of the Joya del Sol district.

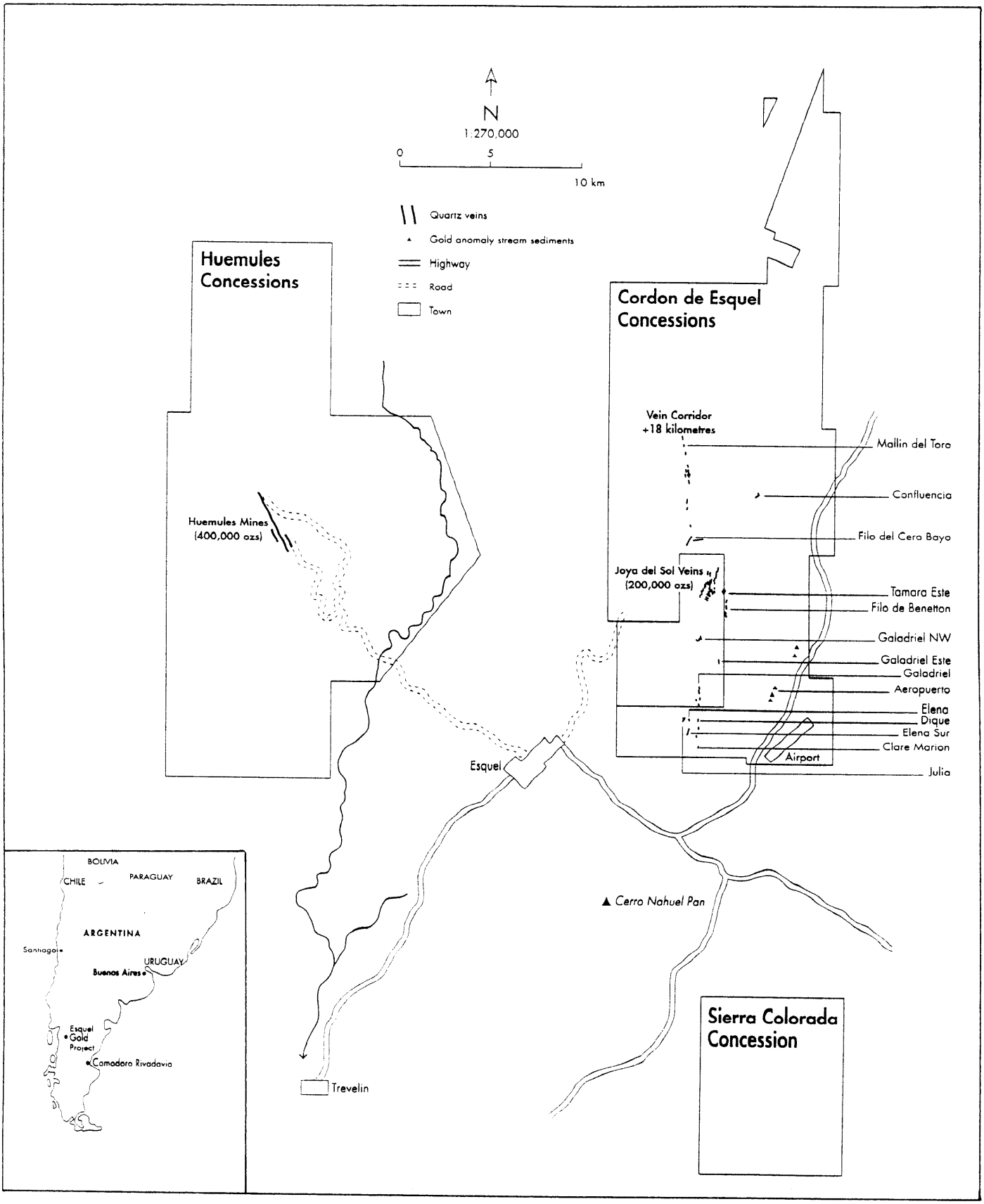


Fig. II-3-2-19b Joya del Sol and Huemules veins in the concessions of Minera el Desquite, S.A. (Brancote Holdings PLC, 1999).

Auriferous quartz veins are composed of black and white quartz. Black quartz is called "Black Chalcedony". There are places where one of them is dominant and places where both form banded structure. In the latter, rhythmic banded structure with the order of several millimeters was also observed. In addition, there are places where the structure of veins is disturbed due to boiling phenomena and places where clay fills up cavities after boiling. Sulfide minerals were scarcely observed in auriferous quartz veins.

Hydrothermal alteration zones were extracted by satellite image analysis. It was confirmed that silicified and argillized andesite showing light gray color is distributed at sampling point of A00HH050 (Figure II-3-19a). In the northeastern part of the district, floats were investigated in the riverside where the Arroyo Cancha runs from the alteration zone to west. As the results, silicifed and argillized rocks with quartz veinlets were observed and sericite was identified by POSAM measurement.

8) Characteristics of the satellite images

Color tones of the false color image are light green and reddish gray in lowlands and light reddish gray and blue in the mountains. This means that vegetation is existent or nonexistent in lowlands, and vegetation is almost nonexistent and there is snow on the mountains. The structure due to topographical undulations is relatively fine, and water systems are arborescent with relatively high densities. Ridges in the mountains are clear with high resistance. No bedding planes are recognized. Lineaments oriented to the NE, NW and N-S are extracted. On the ratio image, three hydrothermal alteration zones showing bright reddish purple are extracted.

9) Laboratory work results

Andesite of Lago la Plata formation is observed microscopically as hornblende andesite for sample A00RM048 (Appendix-3) and revealed 119.0±6.0 Ma of middle Cretaceous by K-Ar radiometric dating for sample A00NK050 (Appendix-13). Meanwhile, concerning the granite in Carboniferous in the west of this district, Lizuain (1981) reported 174 Ma and JICA/MMAJ reported 132 Ma.

Chlorite and sericte were identified as alteration minerals by powdery X-ray diffraction for silicified andesite of A00NK039 and A00TM050 that are host rocks of quartz veins (Appendix-5).

Concerning the Galadriel vein, white quartz of A00RM046 revealed 42.72 g/t Au and black quartz of A00TM049 revealed 0.12 g/t Au. Concerning the Elena Sur vein, white quartz of A00MZ048 revealed 2.94 g/t Au and black-white banded quartz of A00MZ049 revealed 14.4 g/t Au. From these results, it is indicated that gold is contained mainly in white quartz. Silver grades were low as equal to or less than 5 g/t Ag except one sample revealed 41 g/t Ag. Iron

grades were low as 0.05% to 0.85% Fe, regardless of white quartz or black quartz (Appendix-9). This means the black quartz does not contain iron sulfides. It is assumed that the black color of the black quartz resulted from graphite originating in black mudstone of the Carboniferous or Jurassic.

Homogenization temperatures and salinities of fluid inclusions in quartz vein samples of A00MZ48 and A00MZ051 are shown in Appendix-10 and the oxygen isotopic compositions of same quartz samples are shown in Appendix-12. Concerning the Galadriel vein, average of homogenization temperature and salinity were 147°C and 0.7 wt/% respectively, oxygen isotopic composition was +4.1‰. Then, -11.5‰ is calculated as oxygen isotopic composition of hydrothermal water, which generated quartz, by oxygen isotopic fractionation factor between water and quartz (Matsuhisa et al., 1979) at average homogenization temperature. Concerning Elena Sur vein, average of homogenization temperature and salinity were 131℃ and 1.4 wt% respectively, oxygen isotopic composition was +7.5‰. Then, -9.7‰ is calculated as oxygen isotopic composition of hydrothermal water, which generated quartz, by oxygen isotopic fractionation factor between water and quartz (Matsuhisa et al., 1979) at average homogenization temperature. The oxygen isotopic composition of magmatic water shows heavy values from +6‰ to +9‰ (Taylor, 1974), while the oxygen isotopic composition of meteoric water generally shows light values from -4‰ to -14‰ with regional differences (Craig, 1963). Therefore, calculated -11.5‰ and -9.7‰ indicate that hydrothermal water originated in meteoric water.

Huemules deposits are located about 25 km west of Joya del Sol deposits. Both are gold deposits formed by hydrothermal water of meteoric water origin. However, Joya del Sol is auriferous quartz veins without sulfides and Huemules is auriferous polymetallic veins rich in galena. In detail, there are slight differences between oxygen isotopic compositions of hydrothermal water and salinities of fluid inclusions. Data of Huemules deposits are -9.7‰ to -8.1‰ and 1.8 wt% to 2.2 wt%. While data of Joya del Sol deposits are -11.5‰ to -9.7‰ and 0.7 wt% to 1.4 wt%. Thus the data of Huemules deposits is slightly heavier or higher than that of Joya del Sol deposits. These differences mean that contribution of magmatic component is slightly large in Huemules deposits rather than Joya del Sol deposits. It is considered that the differences resulted in rich sulfides in Huemules deposits and poor sulfides in Joya del Sol deposits.

10) Assessment

The existence of epithermal auriferous quartz veins resulted from hydrothermal water that originated in meteoric water was confirmed in this district. Exploration activities are being actively conducted by private company in this district, and the high potentiality has been already proven. With consideration given to the purpose of this survey, that new