

## 10) Assessment

In this district, high-sulfidation epithermal mineralization is expected because kaolin deposit was formed by acid hydrothermal water activities and silicified zone exists in the central part. However, none of metallic mineralization except limonite was confirmed, and none of noticeable chemical analysis results were obtained in this survey. It is considered that the hydrothermal activities formed kaolin deposit, but these were not accompanied by metallic mineralization. Therefore, this district is judged not to have the necessity to be surveyed in Phase-2.

### 3-2-28 Mina Gato district

#### 1) Location

This district is located about 35km northwest of Alt Rio Senguerr town, in the southwest of Chubut province (Fig. II-3-1). The area is lat. 44° 47' 24" to 44° 53' 24" S, and long. 71° 05' 24" to 71° 10' 48" W, and about 100km<sup>2</sup> (Fig. II-3-2-28a). The representative coordinate is lat. 44° 50' 13.6" S, and long. 71° 08' 30.6" W at old kaolin exploitation pit.

#### 2) Topography and Vegetation

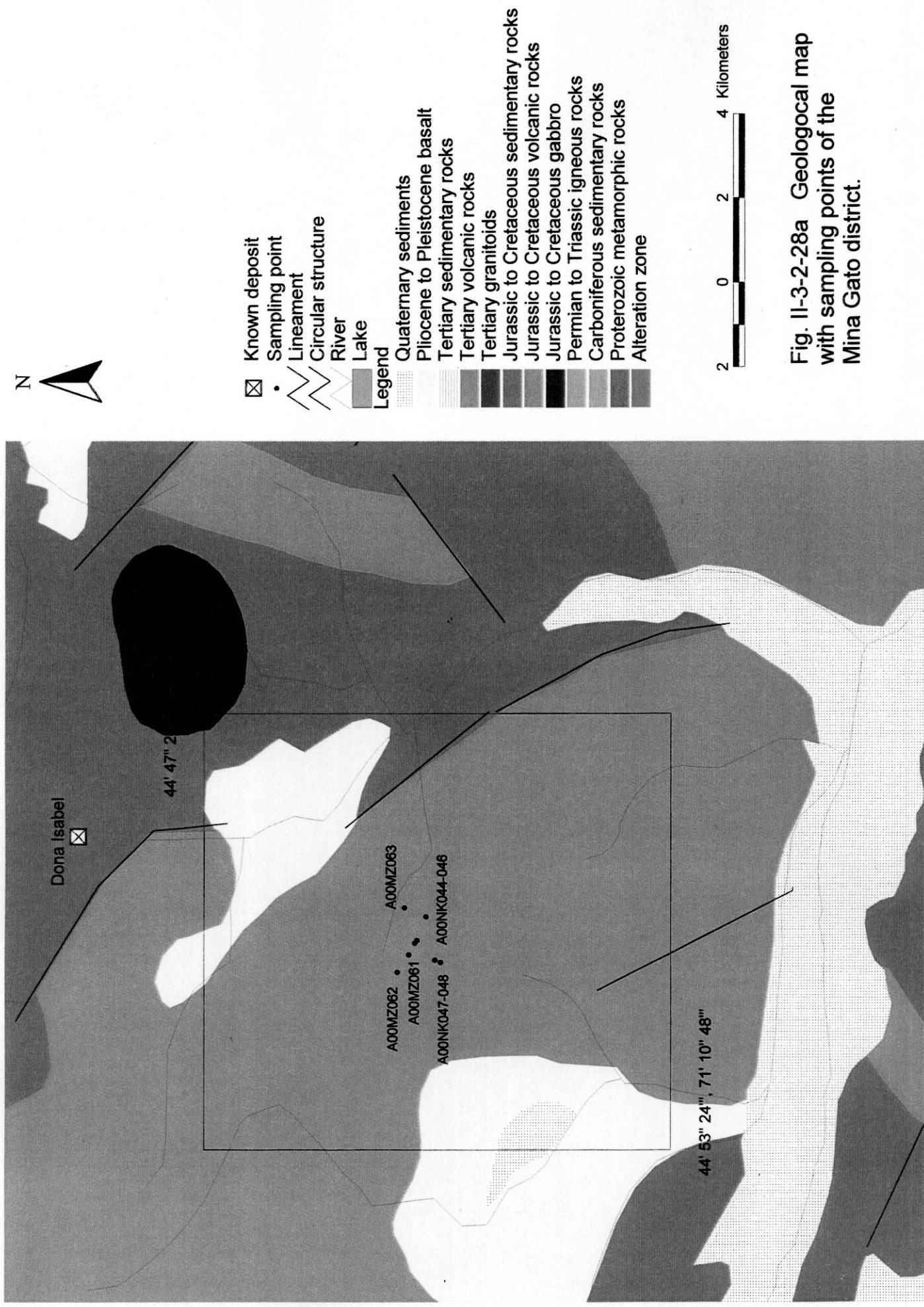
This area is located at about 8km from the border with Chile. Mountains of Cordillera del Gato ranges in NNW direction. Arroyo Seco and Arroyo Leon run to south in eastern side and western side of Cordillera del Gato respectively, these rivers join to Arroyo Gato running to east-southeast. Cordillera del Gato is relatively gentle mountains with altitude of 1,000 to 1,500m above sea level. Vegetation is sparse with low plants. Hydrothermal alteration zones with old kaolin exploitation pits are located on the ridges of Cordillera del Gato.

#### 3) Access

It is about 10 km drive to north on local road from Alt Rio Senguerr town, then about 20 km drive to west on another local road to reach near confluence of Arroyo Gato and Arroyo Seco. The road until this point is unpaved, but well maintained. From this point, it is about 10 km drive to north along Arroyo Seco, and drive to west to go up to Cordillera del Gato. It is accessible until old kaolin exploitation pit by 4-wheel vehicle, although the road condition is not good.

#### 4) Previous surveys

In 1970, the geology and alteration was described for kaolin deposits of Estrella Gaucha in north and Susana in west by an agreement between Chubut provincial government and Nacional Sur university (Hayase, 1970).



- ☒ 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 gabbro
- Permian to Triassic igneous rocks
- Carboniferous sedimentary rocks
- Proterozoic metamorphic rocks
- Alteration zone



Fig. II-3-2-28a Geological map with sampling points of the Mina Gato district.

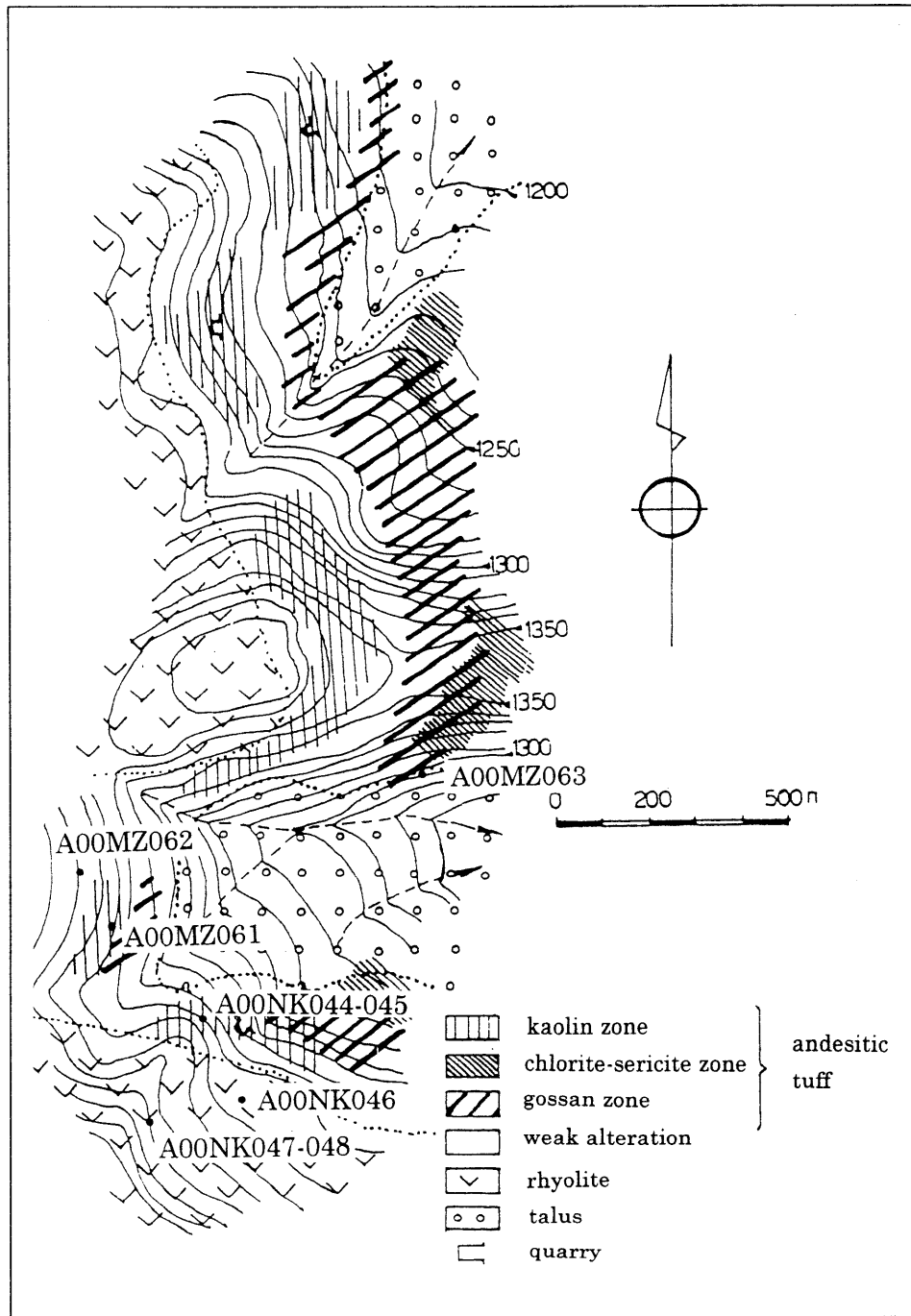


Fig. II-3-2-28b Geological map with alteration types by Maiz (1981) and sampling points of the Mina Gato district.

Maiza (1981) described the geology and alteration for Gato kaolin deposit of this district and other two deposits mentioned above. Temperature of alteration was estimated as between 200°C and 300°C based on the phase equilibrium diagram of alternation minerals.

#### 5) Mining properties

Mining properties for kaolin was abandoned now.

#### 6) Geology and geological structure

The geology of this district comprises, in ascending order, Cretaceous sedimentary and volcanic rocks, Pliocene basalt and Quaternary glacial sediments, colluvium and alluvium. A small gabbro intruded into Cretaceous sedimentary rocks.

Cretaceous sedimentary rocks of Apeleg formation consists of black mudstone and tuffaceous sandstone, etc. Cretaceous volcanic rocks of Dividasero formation consists of andesite, rhyolite and these pyroclastic rocks. Flow structure observed in silicified rhyolite shows strike of N50° E and dip of 25° SE.

#### 7) Mineralization and alternations

Host rock of kaolin deposit is Cretaceous volcanic rocks (Fig. II-3-2-28a). Alteration zones classified by Maiza (1981) are shown in Fig. II-3-2-28b. There is a 10m x 5m kaolin exploitation pit at the sampling point of A00MZ061. Kaolinized rocks retain the flow structure of rhyolite and are soft, light grey in color and with a silky sheen.

Strongly silicified rocks are distributed on highlands at sampling point of A00MZ062 to northwest of the kaolin pit. The strongly silicified rock is massive, white in color with a slight red tint, with a very small amount of limonite. It is intercalated with strongly silicified tuff breccia. Alunite was identified by POSAM measurement.

On lowlands to northeast of the kaolin pit, propylitic rocks with disseminated pyrite are distributed. Sericite was identified by POSAM measurement.

Rhyolite distributing in southern part, such as sampling point of A00NK048, shows weak alteration.

#### 8) Characteristics of the satellite images

The color tone of the false color image is dark yellowish brown to dark greenish grey, which means thin vegetation. The structure due to topographical undulations is fine. Water systems are latticelike with moderate densities. Ridges in the mountain are quasi-unclear with moderate resistance. Bedding planes are not recognized. Lineaments oriented to the NW are extracted. On the ratio image, bright reddish purple is recognized partially, but the brightness is inferior in comparison with alternation zones of other district.

#### 9) Laboratory work results

Microscopically, volcanic rock of the southern part was observed as rhyolitic tuff (Appendix-3). As the results of powdery x-ray diffraction, kaolin and alunite were identified for sample A00NK044, sericite and montmorillonite were identified for sample A00NK046 (Appendix-5). As the results of chemical analysis, strongly silicified rock of sample A00MZ062 revealed 0.015 g/t Au and 6 ppm Cu, sericitic altered rock of sample A00MZ063 revealed 0.01 g/t Au and 5 ppm Cu (Appendix-6).

#### 10) Assessment

It was confirmed that acid alteration of silicification and kaolinization, and neutral alteration of sericitization are distributed in different places of this district. However, gold and copper contents were proved to be in low grades. It is considered that hydrothermal activities formed kaolin deposit, but these were not accompanied by metallic mineralization. Therefore, this district is judged not to have the necessity to be surveyed in Phase-2.

#### 3-2-29 Estancia Arroyo Victoria district

##### 1) Location

This area is located 40km to northwest of Alt Rio Senguerr town, in the southwest of Chubut province (Fig. II-3-1). The area is lat. 44° 48' 36" to 44° 54' 36" S, and long. 71° 13' 12" to 71° 21' 00" W, and about 160km<sup>2</sup> (Fig. II-3-2-29a). The representative coordinate is lat. 44° 54' 11.1" S, and long. 71° 14' 43.6" W at riverside of Arroyo Huemul where floats were investigated.

##### 2) Topography and Vegetation

In northern part of this district, mountains of altitude 1,700 to 2,000 m run in directions of E-W to NE-SW where the border with Chile is demarcated. Arroyo Huemul and Arroyo Victoria run down from the mountains to southeast, and they converge to form Arroyo Gato running down to east-southeast. Altitude of this district is between 1,000m and 2,100m above sea level. Although each mountain is prefixed with Cerro, meaning "hill," the mountains are significantly different in relative height in topography. Vegetation is rather thick, with low-growing plants and some areas of woodland. The area contains two farms of Estancia Arroyo Gato and Estancia Arroyo Victoria. Lago Fontana is distributed to southwest of this district.

### 3) Access

It is about 10 km drive to north on local road from Alt Rio Senguerr town, then about 30 km drive to west on another local road to reach near confluence of Arroyo Gato and Arroyo Huemul. The road is unpaved, but well maintained. From this point, there is no road into northern mountains.

### 4) Previous surveys

This district was surveyed, as A. Pescado-A. Gato area, by the UN revolving fund project, executed from 1977 to 1982. However, any geochemical anomaly was not detected, although small-scale mineralized zones were recognized (UNDP, 1983)

### 5) Mining properties

Rio Tint Mining and Exploration Ltd owns mining properties.

### 6) Geology and geological structure

The geology of this district comprises, in ascending order, sedimentary and volcanic rocks of Cretaceous, basalt of the Pliocene, and glacial sediments, colluvium and alluvium of Quaternary. Small granitic intrusions intruded into Cretaceous sedimentary rocks.

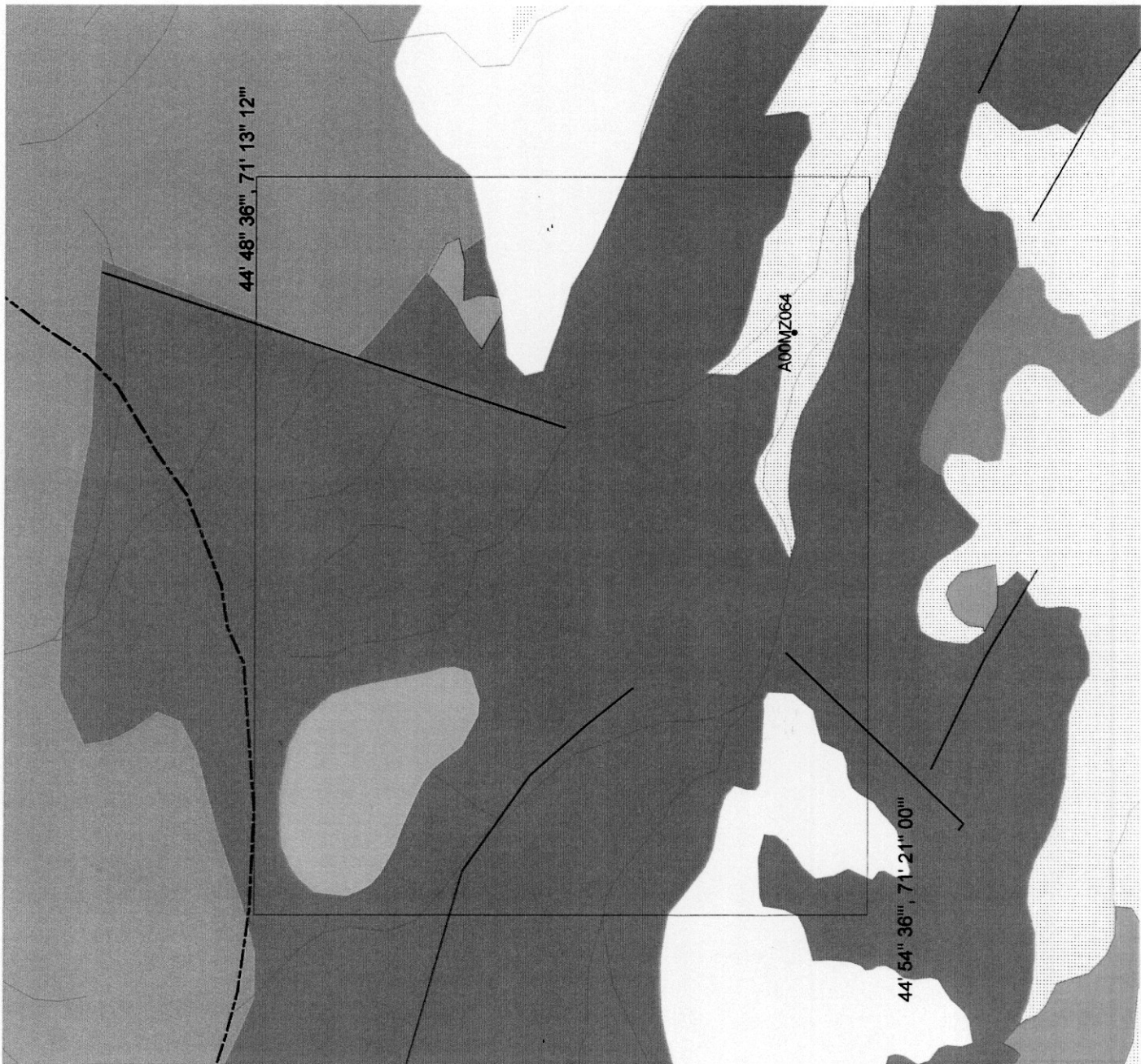
Cretaceous sedimentary rocks of Apeleg formation consists of black mudstone, sandstone, etc. The Cretaceous volcanic rocks of Dividasero formation consists of dacite, rhyolite and their pyroclastic rocks.

### 7) Mineralization and alteration

Although alteration zones were not extracted by satellite image analysis, color anomaly of reddish purple is recognized in northern mountains on the ratio image. It was not possible to reach the color anomaly zone because of the restriction of time and accessibility. Therefore, floats in the riversides of Arroyo Huemul and Arroyo Victoria were investigated where the rivers run down from the northern mountains. As the result, floats of silicified rocks with limonite and pyrite, and quartz veins were observed. Alunite was identified by POSAM measurement for whitened silicified rock.

### 8) Characteristics of the satellite images

On the false color image, color tone of green on lowlands means the vegetation, and dark yellowish-brown to reddish grey with patches of blue on highlands means the sparse vegetation with local fallen snow. The structure due to topographical undulations is fine, and water systems are dendritic with moderate density. Ridges on the mountains are relatively unclear with moderate resistance. Bedding planes are not recognized. Lineaments in the



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- Border
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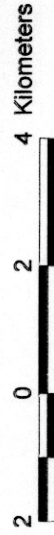


Fig. II-3-2-29a Geological map with sampling points of the Estancia Arroyo Victoria district.

directions of NW-SE and NE-SW are extracted. On the ratio image, a zone of bright reddish purple is recognized in the northern mountains.

#### 9) Laboratory work results

Alunite was identified by POSAM measurement for float of whitened silicified rock of sample A00MZ064 taken in reverse side of Arroyo Huemul. Chemical analysis result of the sample was under the detection limits of copper and gold (Appendix-6).

#### 10) Assessment

Existence of alteration zone was implied by color anomaly of the ratio image. Although it was not possible to reach the implied alteration zone because of the restriction of time and accessibility, existence of silicified rocks and quartz veins were confirmed by floats investigation where the river runs down from the implied alteration zone. However, none of noticeable results of chemical analysis were obtained. It is desired to survey the alteration nature in-situ in Phase-2. However, the priority is judged to be low.

### 3-2-30 Ferrocarrilera district

#### 1) Location

This district is located about 60km to west of Alt Rio Senguerr town, in the southwest of Chubut province (Fig. II-3-1). And it is 2 to 3 km to south of southern shore of Lago Fontana, and about 5 km to north of the border with Chile. The area is lat. 44° 53' 24" to 44° 57' 36" S, and long. 71° 33' 36" to 71° 37' 48" W (Fig. II-3-2-30a), and about 50km<sup>2</sup>. The representative coordinate is lat. 44° 56' 21.8" S, and long. 71° 35' 05.4" W at Ferrocarrilera deposits.

#### 2) Topography and Vegetation

The altitude of the shores of Lago Fontana is about 1,000m above sea level, and the surrounding land is hilly. The altitude gradually rises to southward from the lakeshore, and the altitude of Ferrocarrilera deposits is around 1,200 m above sea level. Vegetation is thick, and the area is forest.

#### 3) Access

It is drive on unpaved road to west from Alt Rio Senguerr town to a lodge on southern lakeshore of Lago Fontana. From the point, It is accessible to Ferrocarrilera deposits in south by 4-wheel vehicle. Totally, it is 73 km and about 2 hours drive from Alt Rio Senguerr town.



#### 4) Previous surveys

Ferrocarrilera deposits were discovered in 1939. A shaft of 30m depth and 4 adits of total 450m were excavated by Ferrocarrilera de Comodoro Company from 1940 to 1942. Additional underground works and 20 holes drilling of total 2,000m were conducted from 1947 to 1948. When the company was nationalized, the mining rights were restored to the original owner and the name of deposits was changed to La Illusion.

In 1979 through an agreement between the rights owner and the government, channel sampling, soil geochemical survey and geophysical survey were conducted under the UN revolving fund project. High grades obtained by the channel sampling for a vein of width 2.5m were 0.05% Cu, 1.25% Pb, 6.17% Zn, 2.8g/t Ag and 55g/t Au. Total 465 soil samples of A- and B-horizons were taken at 40m intervals of total 8,600m sampling lines. However, all of few geochemical anomalies correspond to known mineralization, and any geochemical anomalies suggesting the concealed mineralization were not detected. Concerning the geophysical survey, Turam and Sligram methods electromagnetic survey and magnetic survey were conducted. 11 lines of each 600m length and 200m intervals were set in direction across the veins. Detected resistivity anomalies were slight, and any of them did not continue to another line. Meanwhile, anomaly in excess of 1,000  $\gamma$  was detected by magnetic survey, but it was considered to be related with basic dyke rock.

In 1985, ore reserves were calculated by SEGEMAR based on the exploration data of previous surveys. As the results, 708,630t with average grades of 1.63% Pb, 4.49% Zn, 0.61% Cu, 0.1g/t Au and 14g/t Ag were reported (Zubia, 1985).

At the present time, no exploration works are being conducted, because the lower extensions can not be expected based on the previous data. 4 adit entrances and old shaft are left now.

#### 5) Mining properties

Private company owns the mining properties for exploitation and exploitation.

#### 6) Geology and tgeological structue

In this district, Jurassic volcanic rocks of Lago la Plata formation is distributed. Andesitic rocks are the host rock of Ferrocarrilera deposits. There are also distributions of Quaternary glacial sediments on the lowlands.

#### 7) Mineralization and alternation

Ferrocarrilera is basemetals vein deposits with gangue of quartz hosted in andesite and andesitic tuff breccia of Lago la Plata formation. Intermittent total extension of veins is about 1,200 m in N30° E direction. There are several veins of width 2cm to 5m within a mineralized

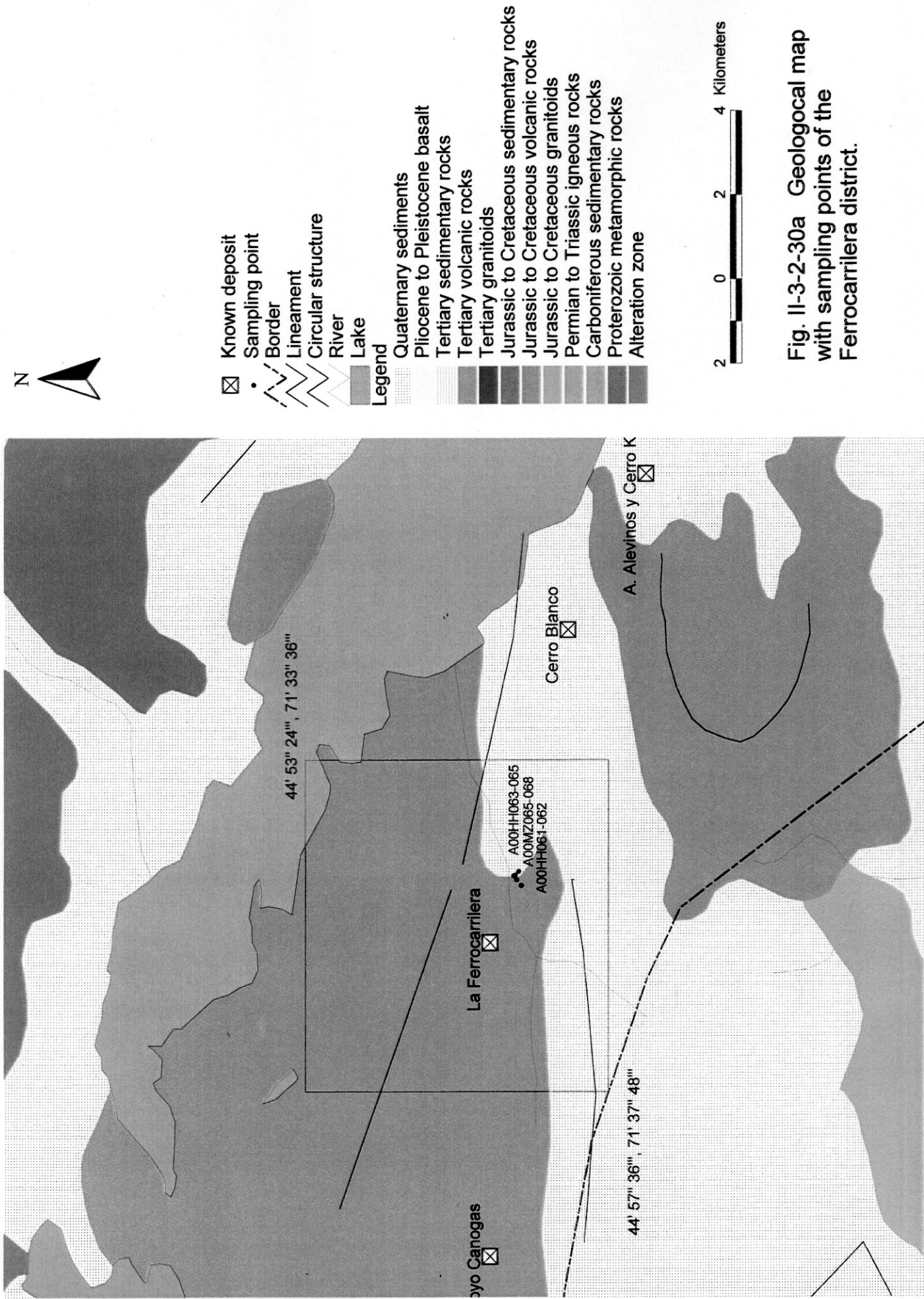


Fig. II-3-2-30a Geological map with sampling points of the Ferrocarrilera district.

zone of width 100 to 200m. The veins strike N30° E and dip 70° to 80° W, and transferred by E-W direction faults. Ore minerals comprise galena, sphalerite, pyrite and small amount of chalcopyrite. Sphalerite is light brown in color indicating low iron contents. There are two types of veins of quartz vein with disseminated sulfides and sulfides dominant veinlet. In latter case, it locally forms a wide lens-like vein with concentration of galena. Hydrothermal alteration is not significant, even the rock fragments in the veins are propylitic showing green color.

#### 8) Characteristics of the satellite images

On the false color image, color tone of lowlands around the south shore of Lago Fontana to the hilly lands is a light green, indicating thick vegetation. Further south, in highlands along the border with Chile, color tones range from white to pale pink to grey, with local blue places. Lineaments oriented NNE-SSW and NNW-SSE are recognized.

On ratio image, yellow is the predominant color. Five kilometers to south in the mountains along the border with Chile, the color is reddish-purple, indicating the possibility of a hydrothermal alteration zone. However, the reddish-purple zone also extends sporadically eastwards, and the colors to the east are brighter.

#### 9) Laboratory work results

As the result of microscopic observation, propylitic rock fragment in a vein of sample A00MZ065 was observed as basaltic lapilli tuff, and abundant chlorite, sericite and smectite were observed as alteration minerals (Appendix-3). As the result of powdery X-ray diffraction, chlorite was identified for sample A00HH062 of andesitic host rock. Propylitic alteration is confirmed based on these results. Andesite sample of A00MZ065 revealed 17 ppm As and 30 ppb Hg, it is considered as the influence of hydrothermal alteration.

Sample A00MZ068 of galena-sphalerite vein revealed 0.93g/t Au, 14g/t Ag, 0.115% Cu, 3.56% Pb and 13.4% Zn (Appendix-9). Microscopically, abundant sphalerite, galena and pyrite were observed for sample A00HH063 (Appendix-4).

Sulfur isotopic composition was measured for pyrite in quartz vein of sample A00MZ066, and -0.4‰ was obtained (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, -0.4‰ of galena indicates that the sulfur originated in igneous rocks.

## 10) Assessment

Ferrocarrilera is lead and zinc vein deposits, and it is thought to be formed by magmatism based on the sulfur isotopic composition of pyrite. However, alteration is propylitic, even if it is close to veins. This phenomenon means that the scale of hydrothermal activities were not large. Besides that, gold mineralization was proved to be in low grades. Therefore, it is judged that this district has not necessity to be surveyed in Phase-2.

### 3-2-31 Cerro Blanco district

#### 1) Location

This district is located about 40km to west of Alt Rio Senguerr town, in the southwest of Chubut province (Fig. II-3-1), And it is located to south of the southern shore of Lago Fontana. The area is lat.  $44^{\circ} 55' 48''$  to  $45^{\circ} 02' 24''$  S, and long.  $71^{\circ} 25' 12''$  to  $71^{\circ} 33' 00''$  W (Fig. II-3-2-31a), and about  $130\text{km}^2$ . The representative coordinate is lat.  $45^{\circ} 00' 24.7''$  S, and long.  $71^{\circ} 27' 31.8''$  W at the sampling point of A00TM066.

#### 2) Topography and Vegetation

Topography of this district is gentle hills with altitude of 1,200 to 1,500m above sea level. The water system is weakly developed, and specific topographic feature is not recognized. Vegetation consists mainly of low-growing grasses, with sparse woodland in the valleys. In the northern part of this district, Lago Fontana lies with stretching east to west.

#### 3) Access

It is drive to west on unpaved No. 43 provincial road from Alt Rio Senguerr town to south shore of Lago Fontana. Then, it needs about 6 km drive on bad condition road and about 20 minutes walk to reach the survey sites.

#### 4) Previous surveys

The survey sites are the area where Billiton Argentina conducted the exploration activities. There are 5 trenches with direction of  $N80^{\circ} E$ , and 100 to 150m intervals.

In addition to the survey sites, Cerro Katterfeld, Cerro Katterfeld East, Arroyo de las Minas and Arroyo de las Alevinas deposits are distributed.

Cerro Katterfeld and Cerro Katterfeld East deposits are quartz veinlets with small amount of galena and chalcopyrite hosted in andesite and andesitic tuff. Chemical analysis results of 238 ppm Pb and 510 ppm Zn were reported. Arroyo de las Minas deposit is quartz veinlets with pyrite, chalcopyrite and galena in the silicified sandstone and conglomerate. Arroyo de las Alevinas deposit is lens-shaped alteration zone with sinter-like silicified rocks

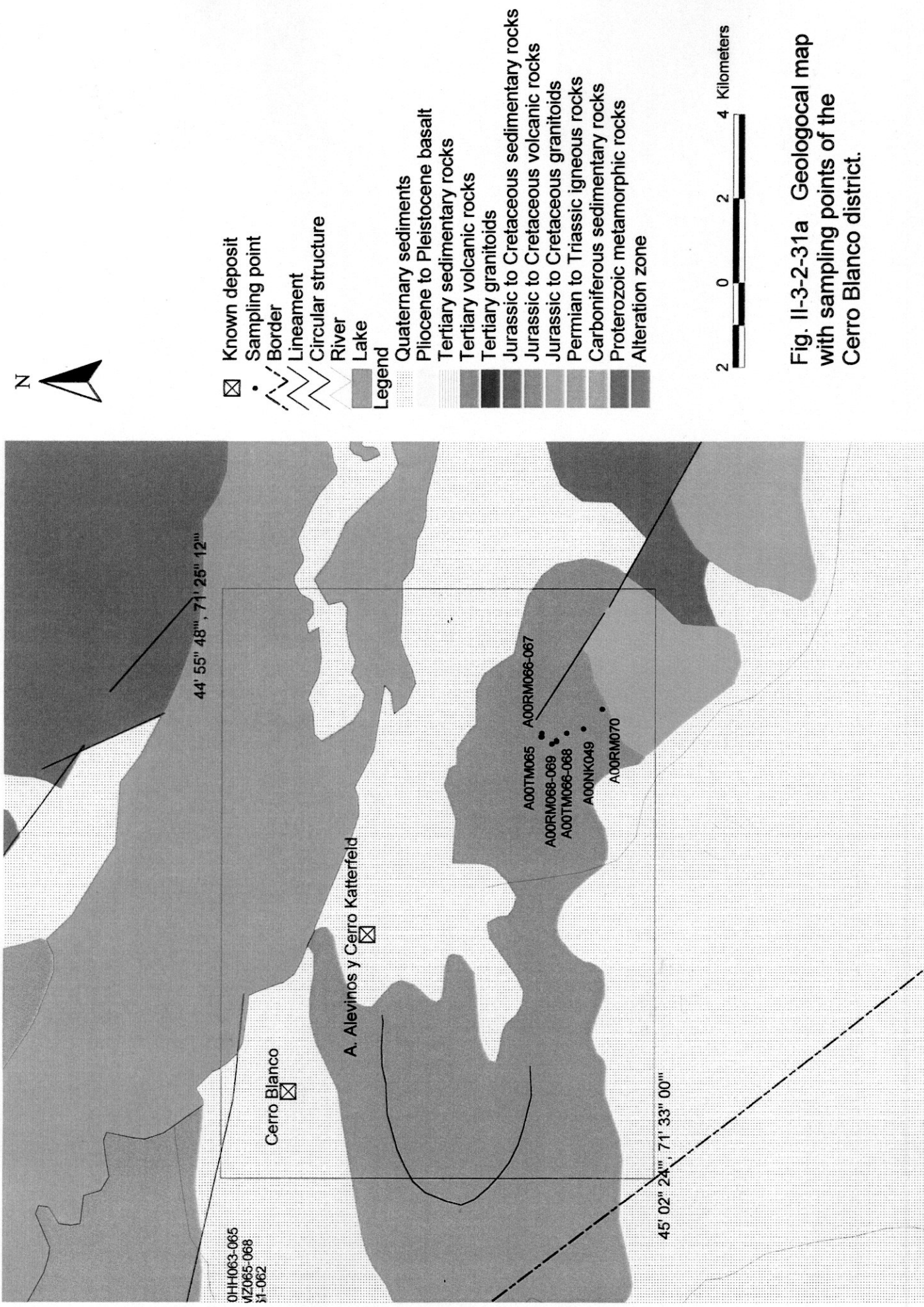


Fig. II-3-2-31a Geological map with sampling points of the Cerro Blanco district.

and limonitization. These mineralization are interpreted as epithermal or mesothermal polymetallic vein deposits (UNDP, 1983; Marquez and Parisi, 1995).

#### 5) Mining properties

Billiton Argentina B.V. SUC ARG and others own the mining properties for exploration.

#### 6) Geology and geological structure

The geology of this district comprises, in ascending order, Jurassic volcanic rocks of Lago la Plata formation and Jurassic sedimentary rocks of Coyhaique formation, lower Cretaceous sedimentary and volcanic rocks of Katterfeld formation, middle Cretaceous sedimentary rocks of Apeleg formation, and Quaternary glacial sediments. Granitic rocks intruded into Cretaceous and Jurassic rocks.

Around trenches excavated by the Billiton Argentina, sandstone and mudstone are widely distributed with intrusions of quartz porphyry. The quartz porphyry is considered to have the relation with mineralization. The sedimentary rocks are overlain by propylitic andesite. Andesite dykes intruded near the trenches.

#### 7) Mineraliation and alteration

Silicified and argillized alteration with limonite was observed in and around the trenches. Strongly silicified rocks are accompanied by quartz veinlets with pyrite. Maximum width of quartz veins is 20cm with strike of N-S direction.

At a point to several kilometers from the trenches, sinter-like silicified rocks are scatteredly distributed within a zone of 300m extension in N40° E and 50m width. Quartz in silicified rocks are white to clear, and partially chalcedonic. It seems to be products in low temperatures.

Sericite and kaolin were identified by both of POSAM measurement and powdery X-ray diffraction for the samples of argillized mudstone.

#### 8) Characteristics of the satellite images

In the southeast part of this district, a well-connected NW-SE lineament continuing for about 8km was extracted. In the western part, circular structure with a diameter of about 6km was extracted. The circular structure in Cretaceous volcanic rocks is collapse type, and accompanied by alteration zone of SE006 with a diameter of about 1 km. In addition to the alteration zone, color anomalies of reddish purple are recognized on the ratio image. On the false color image, this district displays a relatively monotonous topography, and vegetation can be recognized except the highlands.

#### 9) Laboratory work results

The samples were taken as follows; A00TM065, A00TM066 and A00RM066 are quartz veins with pyrite from the inside of trenches. A00TM068 and A00RM069 are quartz veins with limonite at distal point from the trenches. A00RM070 is sinter-like silicified rock.

Sample A00TM065 revealed 1.575g/t Au, 26 g/t Ag, 1,485 ppm Pb, 596 ppm Zn, 3,660 ppm As and 2,670 ppb Hg. Sample A00RM066 revealed 0.135 g/t Au, 39.2 g/t Ag, 2,770 ppm Pb, 2,170 ppm Zn, 3,880 ppm As and 520 ppb Hg. Sample A00RM069 revealed 0.17 g/t Au, 56.2 g/t Ag, 1,740 ppm Pb and 74 ppm Zn. Sample A00RM070 revealed 0.03 g/t Au, 8.8 g/t Ag, 192 ppm As and 460 ppb Hg. Gold mineralization and anomalous arsenic and mercury contents were confirmed.

As the results of powdery X-ray diffraction for host rocks of quartz veins of silicified and argillized sedimentary rocks, potassium feldspar and sericite were identified for sample A00NK049, chlorite and sericite were identified for sample A00RM068, and sericite and kaolin were identified for sample A00TM067.

#### 10) Assessment

In this district, existence of polymetallic vein deposits containing gold and silver is expected. It is considered that high potentiality of this district has been already proven, because the gold mineralization was confirmed by laboratory works of this survey, and mining properties are retained by major company. With consideration given to the purpose of this project, that new promising areas should be extracted, it is judged unnecessary to include this district in Phase-2 survey.