Chapter 4 Synthetic interpretation

4-1 Control factors of mineralization

Various kinds of mineral deposits are expected in the survey areas, and the important deposits are porphyry Cu-Au deposits, epithermal Au deposits and auriferous polymetallic vein deposits, because of the economic viability for mine development.

Metallogeny and tectonic setting are inseparably related each other. Therefore, specific tectonic setting which control the objective mineralization should be primary extracted. For example, as to porphyry-type copper deposits and epithermal gold deposits, areas with intermediate to acidic igneous activity on land are selected, and, as to volcanogenic massive sulfide deposits, areas with submarine volcanic activity are selected (Sillitoe, 1980). In the cases of porphyry-type copper deposits and high-sulfidation epithermal gold deposits, areas with intermediate to acid igneous activity on land generating in a Chilean- or collision-type compressive stress field are selected. While, in the case of low-sulfidation epithermal gold deposits, restricting conditions due to a stress field are relatively small, but it is necessary to select areas with intermediate to acid volcanic activity on land such as an island arc, a back arc and a hot spot (Hedenquist, 1999). In the cases of regional scale and prospect scale with dimension narrowed, it is necessary to understand the evolution of tectonic development as well as geological phenomena corresponding to the control factors of mineralization, in comparison with a conceptual metallogenic model of the target deposit type.

4-1-1 Supra-regional scale

Porphyry Cu deposits and epithermal Au deposits in the South American Andes are concentrated in the Cenozoic magmatic arc in the middle Andes area, commonly called the Andean Copper Belt (Sillitoe, 1992). If tectonic setting with the same conditions is recognized, the high probability for existence of deposits is expected.

The history of geological structure development in the South American Andes area is considered as follows; The South American continent had been located at the western border of the Gondowana land as a result of reunification the Rodinia Supercontinent, since its breakup in late Proterozoic. Particularly in the Pacific side, allochthonous terranes collided successively in the period between early Paleozoic and early Mesozoic. There was an active continental margin where igneous activities were generated accompanying these collisions. Events of the collisions from late Cambrian to Carboniferous are called the "Famatinia Event" and those from late Carboniferous to early Jurassic are called the "Gondowana Event". In the "Famatinia Event", there occurred collision and accretion of Cuyania (Precordillera) terrane

and Chilenia terrane on the western margin of the Gondowana land, and accretionary prism and magmatic arc are formed on the western side of Cuyania terrene that located at the east to the Chilenia terrane across the oceanic basin. In the "Gondowana Event", the Patagonian terrane collided and accreted to the southern margin of the Gondowana land. After the Triassic, such collision events ceased. The Gondowana land broke up by the opening of Atlantic Ocean by "Mesozoic Event" in the Jurassic.

Plate subduction as the active continental margin from the Pacific side is presumed to begin in Paleozoic and was apparent in Cretaceous and became active as the "Andean Event" in Cenozoic. Subsequently, accretionary prisms and magmatic arcs were formed, and then Cordilleran type orogeny was generated. Subduction modes such as speeds, directions and angles were not uniform, and this diversity resulted in the generation of diversity in tectonics and igneous activity in the Andean zone. Major nonferrous metallic mineral resources in the Andean region were formed with close relation to igneous activity in these magmatic arcs.

The Southern Andes area is mainly located in Patagonia terrane, as the pre-accretion terranes. The south end part of Chilenia terrane in the north of the Neuquen province is also included in the survey area. These terranes have been influenced under the Cordilleran orogeny. Therefore, promising areas coincide with distribution of magmatic arcs related to the plate subduction from the Pacific side.

Intermediate to acidic igneous activity and mineralization related to them in magmatic arcs, which are recognized in the survey areas, are roughly divided into the following five periods. Due to difference of tectonic settings, difference of characteristics of mineralization is observed. The five groups are (1) plutonic igneous activity of Carboniferous and subsequent volcanic activity of Choiyoi group of Permian to early Triassic, (2) volcanic rocks in the Lago la Plata formation of Jurassic and plutonic rocks of the same period, (3) volcanic rocks in the Divisadero formation of Cretaceous and plutonic rocks of the same period, (4) volcanic rocks of Paleogene and plutonic rocks of same period, and (5) volcanic rocks of Neogene and plutonic rocks of same period. It is obvious that fields of these igneous activities overlap in many places because the subduction zone was near the present Chilean Trench.

Igneous activity corresponding to (1) above is volcanic arcs that developed in the collision and accretion of the Patagonia terrane to the Gondowana land (Kay et al., 1989). In the south of South America, subduction began in the west side of the Chilenia Terrane, i.e., the Pacific side. The tectonics setting is extension tectonics that is considered to be of the Mariana-type (Ramos et al., 1986). Alcaparrosa (San Juan province: 267 $\pm$4 Ma), San Jorge (Mendoza province: 270$\pm$4 Ma) and La Voluntad (Neuquen province: 281$\pm$4Ma) are known as porphyry Cu deposits considered to have been formed in this period (Sillitoe, 1976). In the survey areas, volcanic and plutonic rocks in this period are widely distributed in Cordillera del Viento in the north of Andacollo and in the zone extending from the area west of Zapala to the southeast

between lat. 39° S and 41° S. In the survey area including La Voluntad, remarkable mineralization in this period, however, has not been found out.

Igneous activity corresponding to (2) and the early period of (3) above are characterized by highly-angled subduction of the oceanic plate from the Pacific side, as Mariana-type, in the "Mesozoic Events". In this period, manto-type deposits were generated in the volcanic arc formed on the northern part of Chilean shoreline (Sato, 1984). On the other hand, in Argentina as the back arc side, back-arc basins such as the Neuquen Basin and the Tarapaca Basin were formed. These formations continued from late Jurassic to early Cretaceous (Davidson and Mpodozia, 1996). Andesitic volcanic rocks in the Lago la Plata formation are widely distributed near lat. 42° S in the area. High-sulfidation epithermal gold deposit in Cerro Colorado of Chubut province is known in host rocks of the Lago la Plata formation (Perez and Sreda, 1989).

In the late period of (3), tectonic inversion from the Mariana-type to Chilean-type happened, and sedimentary basins disappeared and fold and thrust belts were formed in the back arc side (Ramos et al., 1996). In this period, porphyry Cu deposit of Campana Mahuida was formed in Neuquen province.

Igneous activity corresponding to group (4) resulted from Chilean-type subduction which became active from Paleocene to Miocene in particular. In Chile, large-scale mineral deposits were formed in this period, including porphyry Cu-Au deposits, and epithermal Au deposits (Sillitoe, 1991 and 1992). Particularly, large-scale porphyry Cu deposits were formed in Chuquicamata, Escondida, El Salvador, El Abra, etc. by oblique subduction of the Nazca Plate from late Eocene to Oligocene, with intrusive rocks that are controlled by large-sized lateral faults, such as the Domeyko Fracture Zone. In the survey area, magmatic arcs in this period occurred overlapping accretionary prisms, back-arc basins and fore-arc areas of late Paleozoic, and the Cerro Caicayen deposit of Neuquen province is formed with intrusive rocks.

Igneous activity corresponding to group (5) is activity subsequent to that of (4). In the northwest part of Argentina, porphyry-type copper and gold deposits including Bajo de la Alumbrera of Catamarca province, El Pachon of San Juan province and Paramillos Sur of Mendoza province were generated.

In the survey areas as well, it is judged that the potentialoty of mineralization is higher in magmatic arcs of late Cretaceous and afterward, in which the Mariana-type subduction was inverted to the Chile-type.

4-1-2 Regional scale

In the survey areas, (1) Los Maitenes - El Salvaje is known as a porphyry Au deposit, (2) Cerro Caicayen, (3) Pino Andino, (4) Campana Mahuida, (5) La Voluntad, (6) Cerro Gonzalo

and (7) Arroyo Luque are known as porphyry Cu deposits. In addition, (8) Cerro Riñon and (9) Cerro Colorado are known as high-sulfidation epithermal gold deposits. Deposits of (2), (3) and (4) are related to small-sized acid intrusive rocks of late Cretaceous and Paleogene, which intruded into sedimentary rocks in the Neuquen back-arc basin of Jurassic to early Cretaceous. They are arranged in the N-S direction between about lat. 37° 23' S and lat. 38° 12' S. This zone is considered as a fold and thrust belt and form a structural weak zone in the period of the tectonic inversion of Middle Cretaceous. Deposits of (6) and (7) exist in the distribution area of late Cretaceous batholith in the south of Esquel. Remarkable mineralization is not known in the distribution area of Neogene volcanic rocks in the survey areas. Therefore, it is judged that the potentiality of porphyry Cu and high-sulfidation Au deposits is higher in magmatic arcs of early Cretaceous to Paleogene in the survey area.

In the survey areas, low-sulfidation epithermal Au deposit is now known only in Joya del Sol of Chubut province. Besides this, neutral argillic alteration zones indicating low-sulfidation epithermal activity are known in Cushamen of Chubut province, but clear relation with tectonic setting and generation age are not known.

In the survey areas, the main auriferous polymetallic vein deposits are Andacollo (Erica and Sofia) of Neuquen province, Mina Maria of Rio Negro province, Huemules of Chubut province and Ferrocarrilera of Chubut province. Andacollo deposits hosted in the Choiyoi group have relation to Tertiary acidic intrusion. Mina Maria deposits are hosted in Paleogene volcanic rocks and Ferrocarrilera deposits are hosted in Jurassic volcanic rocks. On the periphery of these three deposits, there are deposits of similar type. In particular, Andacollo (Erica, Sofia) and Huemules deposits are noteworthy because gold contents of these deposits are high.

Erosion after the volcanic activity is one of the important factors to know the preservation level of deposits. In porphyry Cu deposits, according to the conceptual model of Sillitoe (1995), litho cap is formed on the volcano top, high-sulfidation epithermal Au deposits are under the litho cap, and the main body of porphyry Cu deposits are formed about 2 km below the volcano top. The erosion level is determined by the balance among the uplift of magmatic arcs, glaciers, weathering and meteoric water. In the Chilean Andes, major porphyry Cu-Mo deposits develop between lat. 32° S and 34° S, and porphyry Cu-Au deposits and high-sulfidation epithermal Au deposits develop between lat. 26° 30' S and 31° S. It is considered that this difference is due to the larger depth of erosion in the southward (Sillitoe, 1991). In Cretaceous to Paleogene magmatic arcs of the survey area, acidic hydrothermal alteration zones were identified in Cerro Colorado, Varvarco and Butalon Norte. There is a possibility that kaolin clay deposits in Mina Gato and Estrella Gaucha are litho caps. In late Cretaceous to Paleogene magmatic arcs, potassic alteration zones are observed in shallow depth or on surface in Campana Mahuida, Cerro Caicayen and Cerro Gonzalo. On the

other hand, acid alteration zones corresponding to high-sulfidation epithermal Au deposits or litho cap are not observed in these deposits, it can be interpreted that erosion reached the level of the deposit center. In Neogene magmatic arcs, volcanic topography is often preserved, and there is a high possibility that shallow parts of hydrothermal activity are also preserved. From this point of view, high- and low-sulfidation epithermal gold deposits are expected.

4-1-3 Prospect scale

Generally, porphyry Cu deposits and epithermal Au deposits often exist in the central part of volcanic activity, and occur in the core part of an andesitic stratovolcano or a dacitic dome complex (Sillitoe, 1991). Structural weak zones of circular structures and concentrated lineaments can be mentioned as activity fields of intrusive rocks with the mineralization. Fig. II-4-1 shows the distributions of circular structures, lineaments and known deposits.

Cerro Caicayen, Pino Andino, Campana Mahuida, and Cerro Gonzalo are known porphyry Cu deposits in the survey area. Cerro Caicayen deposits locate in the places where NNE-SSW and NW-SE oriented lineaments intersect. Campana Mahuida deposits locate in the places where NNE-SSW oriented lineaments develop. Pino Andino deposits locate in the places where NNW-SSE oriented lineaments develop. In Cerro Gonzalo, clear lineaments are not identified. Lieaments concentrated region is important as environments of intrusive activities related to mineralization, although lineaments are not always related with mineralization.

On the other hand, many circular structures were extracted by satellite image analysis in Neogene magmatic arcs on the scenes of Malargue, Chos Malal and Zapala. On the Senguerr scene, several circular structures were extracted in Cretaceous magmatic arcs. However, any circular structures were not extracted in the porphyry Cu regions mentioned before. Extracted circular structures correspond to collapse calderas or slope collapse of Neogene volcanoes where erosion has not advanced so much.

In the relation between alteration zones and lineaments extracted from the satellite image analysis, ZA002 and ZA004 in Zapala scene, and SE002 to SE006 in Senguerr scene are located in or around the circular structures. And ZA006 to ZA033 in Zapala scene are located in lineaments concentrated region. Porphyry Cu-Au deposits and epithermal Au deposits are likely to be formed in alteration zones identified inside or near circular structures because it is the central part of volcanic activities. However, the preservation level of deposits may be deep because the erosion of volcano bodies have not been advanced so much,

Table II-4-1 shows the results of ground truth survey for alteration zones extracted from satellite image analysis. In the regions of Andacollo in Neuquen province, and Huemules and Joya del Sol in Chubut province, alteration zones were extracted with corresponding to the

Table II-4-1 Ground truth survey results for the alteration zones inferred from TM ratio image.

District	Alt. Zone (TM)	Ground Truth	POSAM
Varvarco	CM004	Silicification/Argillization	Pyrophyllite, Kaolinite
	CM005	Silicification/Argillization	Pyrophyllite
	CM006	Not altered	
Butalon Norte	CM010	Silicification	Kaolinite, Sericite
Andacollo	CM011	Silicification	Sericite
	CM012	Silicification/Argillization	Sericite
	CM013	Silicification	Sericite, Kaolinite
Campana Mahuida	N.I.	Silicification	
Palau Mahuida	ZA004 - 019	Not accessible	
Nireco	ZA026	Silicification/Argillization	Kaolinite
	ZA027	Silicification/Argillization	Sericite
	ZA028	Silicification/Argillization	Kaolinite
	ZA029	Weak silicification	Montmorillonite
El Bolson	SB022 - 024	Not accessibe. Floats of silicified breccia wth limonite	
Epuyen	SB081 - 083	Not accessibe. Floats of silicified rock wth pyrite dissemination	
Lago Cholila	SB050 - 057	Not accessibe. Floats of silicified breccia wth limonite	
Joya del Sol	LM022	Not accessible. Floats of silicified rocks with quartz veinlets	Sericite
	LM024	Silicification/Argillization	Sericite
Poncho Moro	LM032	Not accessible. Floats of silicified rocks with quartz veinlets	
Cerro Colorado	N.I.	Not accessible, Floats of silicified rocks	Pyrophyllite
Estrella Gaucha	N.I.	Silicification/Argillization	Kaolinite
Ea. Arroyo Victoria	N.I.	Not accessible. Floats of silicified rocks and quartz vein	Alunite
Cerro Blanco	N.I.	Argillization	Sericite

N.I. : Not interpreted although color anomaly of hydrothermal alteration is generated on TM ratio image.

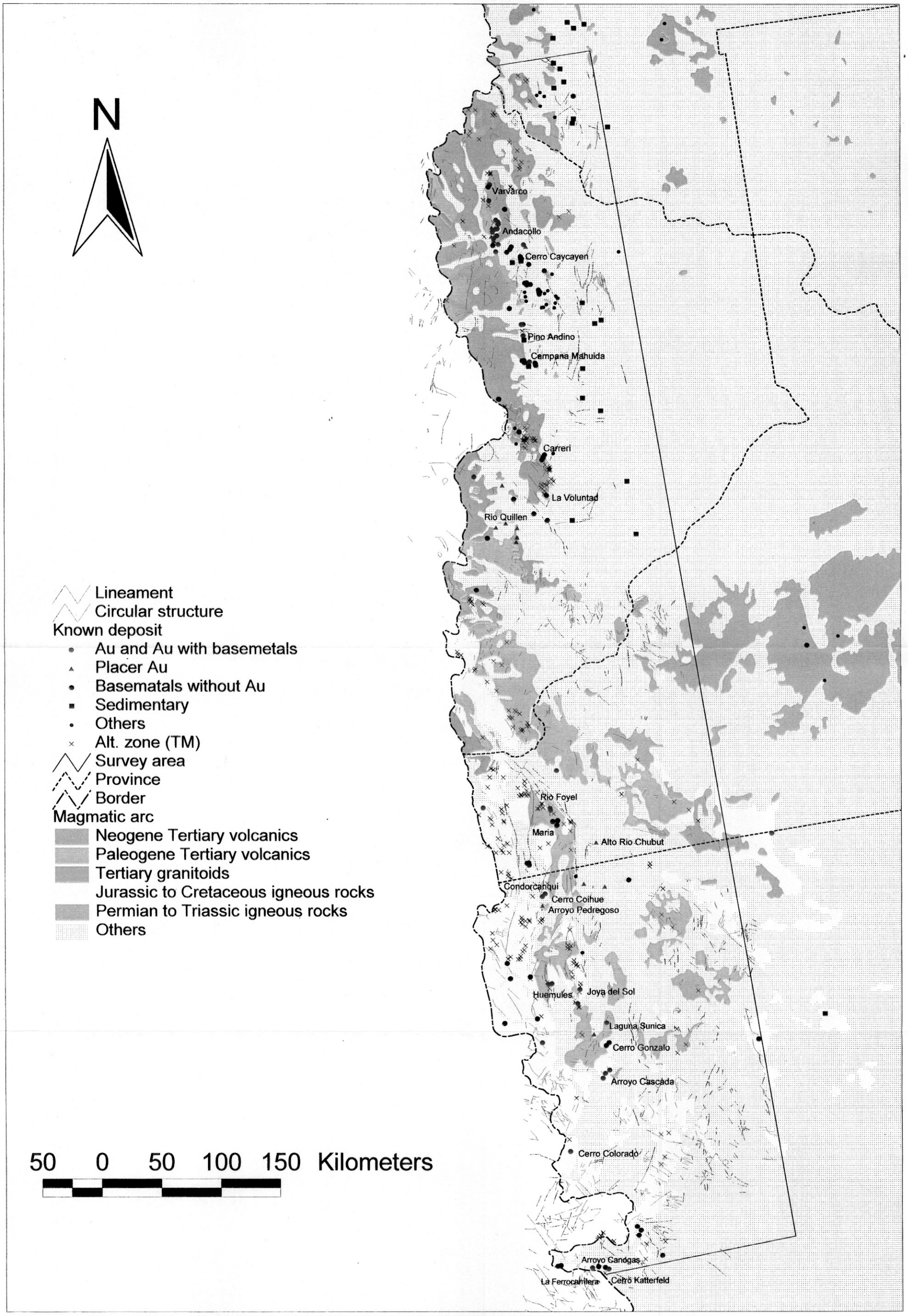

Fig. II-4-1 Syenthetical interpretation map for the control factors of mineralization.

known deposits.

4-2 Selection of promising districts

Synthetical interepretation results are shown in Fig. II-4-2 and Table II-4-2. Based on the synthetical interpretation for the results of existing data analysis, satellite image analyses and ground truth survey, seven districts were selected as objectives of Phase-2 survey in second year (Fig. II-4-3). In these districts, porphyry Cu-Au deposits, high- and low-sulfidation epithermal gold deposits and auriferous polymetallic vein deposits are expected with high potential. As these deposits are closely related to magmatic arcs generated since Permian, the reasons for the selection of the districts are classified by magmatic arcs as follows. In the case that magmatic arcs overlap in the same district, they are individually described.

4-2-1 Permian to Triassic magmatic arcs

Tectonic settings at the time of formation of Choiyoi group of Permian to Triassic are considered to be Mariana-type. However, porphyry Cu deposits such as Alcaparossa deposit in San Juan province (263±4 Ma) and San Jorge deposit in Mendoza province (270±4 Ma) are known to the north of the survey area. There are also gold deposits in El Indio and Maricunga Belt in Chile, porphyry Cu deposits such as El Pachon in San Juan province and Paramillos Sur in Mendoza province that are related with Tertiary intrusive rocks into the Choiyoi group. Deposits of the similar type are expected in Choiyoi group distribution in the survey area.

1) Varvarco district

In this district, alteration zones of CM004 to CM007 were extracted by the satellite image analysis. Distribution of acid alteration zones and silicified rock ledges were identified in the field. The age of hydrothermal activity that formed the acid alteration zones is unknown, but there is a possibility that the acid alteration zones correspond to the periphery of porphyry Cu deposit system. High-sulfidation epithermal Au deposits and porphyry Cu-Au deposits are expected. In addition, auriferous polymetallic vein deposits exist, precise comprehension on the condition of mineralization is necessary.

2) Nireco district

In this district, eighteen alteration zones of ZA020 to ZA037 were extracted by the satellite image analysis, in the distribution of Permian to Triassic igneous rocks. In addition, lineaments oriented NNW-SSE and NNE-SSW are concentrated in this district. Alteration

zones of ZA027 to ZA029 were investigated by ground truth survey, and argillic alteration zones were identified. Although remarkable mineralization has not been confirmed, the potential of hydrothermal deposits can be expected from the presence of many alteration zones and concentrated lineaments. Porphyry Cu deposit is distributed in La Voluntad (281 ± 4 Ma), then the potential of the similar type deposits are expected.

3) Rio Quillen district

The ground truth survey was not executed for this district in Phase-1. Placer gold deposits are known all over the district. Gold deposits as sources of the placer gold are expected.

4-2-2 Late Cretaceous to Paleogene magmatic arcs

Magmatic arcs had been inverted to the Chilean-type since late Cretaceous. Particularly in Chile, large-sized porphyry Cu deposits were formed in Paleogene magmatic arcs. These magmatic arcs are the most noteworthy in Argentina.

1) Campana Mahuida district

Campana Mahuida and Pino Andino porphyry Cu deposits are known in this district, related with late Cretaceous acid to intermediate intrusives into fold belt in the western margin of the back-arc basin. Similar deposits are expected in the periphery.

2) Rio Foyel district

The ground truth survey was not executed for this district in Phase-1. Rio Foyel placer gold deposits are known in this district, and alteration zones are also extracted by the satellite image analysis. Gold deposits as sources of the placer gold are expected.

3) Epuyen district

Many alteration zones were extracted from the westward of El Bolson to the northward of Lago Cholila by the satellite image analysis. Placer gold deposit exists in the west of Epuyen. The value of 0.24% Cu was obtained for brecciated silicified rock of float sample in Lago Cholila. Hence, the presence of porphyry Cu deposits and epithermal Au deposits are expected. On the other hand, in Condorcanqui deposits, the sulfur isotopic composition of chalcopyrite suggests the possibility of high-sulfidation epithermal Au deposits.

4) Cerro Gonzalo district

Arroyo Luque to Cerro Gonzalo porphyry Cu deposits are distributed in the granite batholith of late Cretaceous. Several characteristics of porphyry Cu system have been

confirmed, such as hydrothermal breccia, small-sized secondary enrichment intersected by drilling and potassic alteration zones with chalcopyrite dissemination. Precise evaluation on the potential for the mineralization is desired.

4-2-3 Neogene magmatic arcs

1) Varvarco district

Neogene volcanic rocks are distributed from the northward to the westward of the varvaro district of Phase-1 survey, and circular structures have been extracted by the satellite image analysis. Alteration zones accompanied by mineralization are known in Cerro Blanco de Vaca Lauquen, Laguna Pajaritos, Arroyo Pajaritos, etc (CORMINE, 1996). Hence, hydrothermal deposits are expected.

2) Nireco district

Neogene volcanic rocks are distributed in and around Palau Mahuida. Erosion of volcanic rocks has not been advanced, and several paleovolcano bodies remain. Concentration of lineaments and 16 alteration zones were extracted by the satellite image analysis, in the places where these lineaments cross each other. In relating to these alteration zones, epithermal gold deposits are expected.

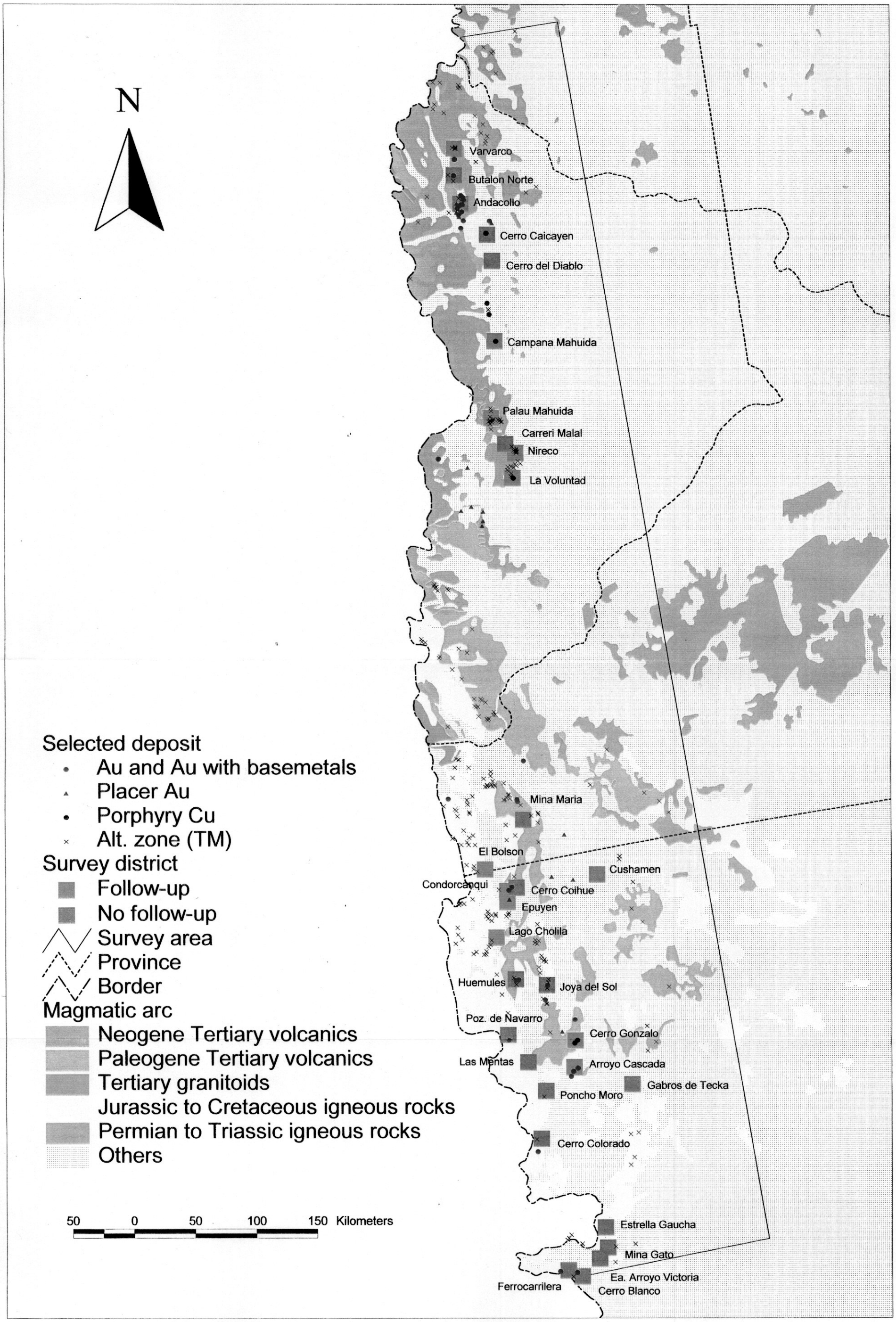

Fig. II-4-2 Noticeable districts based on the ground truth survey results.

Table II-4-2 Conclusions on the ground truth survey (1).

No.	Disrict	Locality	Reason	Access	Topography	Vegitation	Unit	Formation	Rock	Intrusive	Fault	Lineament (TM)	Alt. zone (TM)	Alteration	Known deposit	Result	Conclusion	Phase-2 survey
1	Varvarco	Alt. zones, Granite area	Alteration zone from TM image, Known mineral ocurrence	Car, Walk	Hills	Thin	PTR	Choiyoi Fm.	Rhyolite etc	Granodiorite, Tonalite		NE, NW, N-S	CM004-007	Silicification, Pyrophyllite	Varvarco (Au-Ag-Basemetals vein)	64.7±3.2Ma for Tonalite, Pyrophyllite alteration.	Possibility of advanced argillic alteration and/or high sulfidation type mineralization. And Known Au mineralization should be surveyed.	○
2	Butalon Norte	Alt. zones	Alteration zone from TM image, Known mineral ocurrence	Car	Hills	Thin	PTR	Choiyoi Fm.	Andesite	Granodiorite, Tonalite		NE	CM009-010	Silicification	Butalon Norte (Low grade Au)	Sericite-kaolinite alteration in CM010.	No anomalous Au contents of chemical analysis results.	×
3	Andacollo	Mina Sofia, Sur los Maitenes, Arroyo Huaraco, Cero Colo, Alt. zones	Alteration zone from TM image, Known mineral ocurrence	Car	Mountains	Thin	C	Andacollo Group	Mudstone etc	Granite, Dacite porphyry etc	E-W to NE	NE	CM011-013	Sericite, Silicification	Sofia (Au-Ag-Basematals vein) etc	1.71 to 152.85 g/t Au for vein ore of the Sofia mine.	Mining activity is on-going. Potentiality had been already proved.	×
4	Cerro Caicayen	Quebrada del Bronce, Mina Hierro	Known mineral occurrence	Car	Hill	Thin	J	Cuyo Group	Mudstone etc	Granite		NE, NW, N-S		Montmorillonite, Kaolinite	Cerro Caicayen (Porphyry Cu, Replacement)	Hydrothermal alteration in el Bronce stream, Massive Fe in limestone.	No anomalous Cu contents of chemical analysis results.	×
5	Cerro del Diablo	Cerro del Diablo (Cu), Cerro del Diablo (Barite)	Known mineral occurrence	Car, Walk	Mountains	Thin	J	Cuyo Group	Shale, Sandstone, Tuff	Granodiorite		NE, NW		Silicification, Argillization	Cerro del Diblo (Cu dissemination, Barite vein)	Maximum width of sericite-kaolinite alteration is about 20m at Cu mineralized occurrence.	Scale of hydrothermal alteration was no so large. Drilling and geophysics are necessary for further exploration, but these are not available in phase-2.	×
6	Campana Mahuida	Campana Mahuida, Barite veins	Alteration zone from TM image, Known mineral ocurrence	Car	Hills	Thin	J	Cuyo Group	Sandstone etc	Granodiorite, Andesite porphyry		NE	N.I.	Phyllic	Campana Mahuida (Porphyry Cu) etc	Chalcocite enrichment is observed for drilling core.	Porphyry Cu productive area. Existence of undiscoverd deposits are expected.	○
7	Palau Mahuida	Palau Mahuida	Alteration zone from TM image	Horse is necessary	Mountains	Thin	Tα2	Cajon Negro Fm.	Andesite etc			Circular, NE, NW	ZA004-019	Not checked	Arroyo Manzano (Cu, Zn, Fe stockwork)	Only accessibility was checked. Horse is necessary for field survey.	Hydrothermal alteration zones inferred from TM ratio image should be surveyed in phase-2.	○
8	Carreri Malal	Carreri Malal	Known mineral occurrence	Car, Walk 1h	Mountain	Thin	CPg	Permian Granitoids	Granite	Granite		NE, NW	ZA020	Chlorite-Sericite	Carreri Malal (Ag-Basemetals vein)	Hydrothermal alteration is not developed, Low grade in Au mineralization.	Observed mineralization lacks promising feature.	×
9	Nireco	Alt. zones	Alteration zone from TM image	Car, Walk 2h	Hills	Thin	TQB	Campos basalticos de Zapala	Basalt etc			NE, NW, N-S	ZA021-030	Sericite, Kaolinite	None	Distributions of hydrothermal alteration were confirmed, but it is barren for mineralization.	All of alteration zones were not surveyed. Remain shoud be surveyed in phase-2.	○
10	La Voluntad	La Voluntad	Known mineral occurrence	Car, Walk 0.5h	Mountains	Thin	CPg	Permian Granitoids	Granite	Granite		NE, NW	ZA001,035-037	Potasic, Phyllic	La Voluntad (Porphyry Cu)	Previous exploration works proved low grade hypogene mineralization and lack of secondary enrichment.	Unchecked 4 alteration zones in NW part should be surveyed in phase-2.	○
11	Mina Maria	Mina Maria	Known mineral occurrence	Car	Mountains	Thin	Ta1	Ventana Fm.	Andesite		NE		SB073	Propylite	Mina Maria (Ag-Basemetas vein)	Hydrothermal alteration is not developed, Low grade in Au mineralization.	Observed mineralization lacks promising feature.	×
12	El Bolson	Rio Azul, Rio Lindo	Alteration zone from TM image	Car, Walk	Mountains	Forest	Kg	Cretacous granitoids	Granite, Granodiorite	Granite, Granodiorite		NNW, NE, N-S	SB022-024	Floats of silicified rocks	None	Float of granite with pyrite revealed 355ppm Cu.	Unchecked 3 alteration zones in Western part are preferable for phase-2 survey.	○
13	Cerro Coihue	Qda. Baya, Qda. Ferreyro	Known mineral occurrence	Car, Walk	Mountains	Rare	Kg	Cretacous granitoids	Tonalite, Granodiorite, Andesite	Tonalite, Granodiorite, Andesite		NW		Tourmaline, Chlorite, Sericite	Cerro Coihue (Porphyry Cu?)	Weak hydrothermal alteration and maximum 235ppm Cu content were proved.	Observed mineralization lacks promising feature.	×
14	Condorcanqui	Condorcanqui	Known mineral occurrence	Car, Walk 0.3h	Mountains	Forrest	Ta1	Ventana Fm.	Andesite		N-S, E-W	NE, NW		Propylite	Condorcanqui (Chalcopyrite veinlets)	Besides the chalcopyrite mineralization, high-sulfidation system might be expected based on the isotopic data.	Silicified zones repoted in previous works should be surveyed in phase-2.	○
15	Cushamen	Cushamen	Known mineral occurrence	Car, Walk	Moderate hills	Thin	Pc2	Chshamen Fm.	Metamorphic rocks, Granitoids	Tertiary rhyolite				Silicification, Argillization	Cushamen (Molybdenite vein)	Sericite-Kaolinite alteration and maximum 709ppm Mo; 364ppm Cu contents were proved.	Observed mineralization lacks promising feature.	×
16	Epuyen	A. Pedregoso de Epuyen	Alteration zone from TM image	Car	Mountains	Forrest	Ta1	Ventana Fm.	Andesite			NE, NW, N-S	SB081-083	Floats of silicified rocks	Arroyo Pedrgoso (Placer Au)	Float of silicified andesite revealed slight arsenic anomaly.	Unchecked 3 alteration zones in Cordon de Cholila should be surveyed in phase-2 to find the source of placer Au deposit.	○
17	Lago Cholila	A. Pedregoso de Lago Cholila	Alteration zone from TM image	Car	Mountains	Forrest	Kg	Cretacous granitoids	Granite, Granodiorite	Granite, Granodiorite		NE	SB050-057	Floats of brecciated and silicified rock	None	Float of brecciated and silicified rock revealed 2,490ppm Cu.	Unchecked alteration zones in northern mauntains should be surveyed in phase-2 to find the outcrops of Cu mineralization.	○

N.I. : Not interpreted although color anomaly of hydrothermal alteration is generated on TM ratio image.

Table II-4-2 Conclusions on the ground truth survey (2).

No.	Disrict	Locality	Reason	Access	Topography	Vegitation	Unit	Formation	Rock	Intrusive	Fault	Lineament (TM)	Alt. zone (TM)	Alteration	Known deposit	Result	Conclusion	Phase-2 survey
18	Huemules	Huemules Sur	Known mineral occurrence	Car	Mountains	None	JBa	Cañadón Huemules Fm.	Andesite	Basalt, Andesite	NW	NNW～NNE	LM014-015	Silicification	Huemules (Au-Ag-Basemetals vein)	0.12 to 4.11 g/t Au for vein ore of the Huemules deposots.	Ore reserves had been calculated. Potentiality had been already proved.	×
19	Joya del Sol	Joya del Sol	Alteration zone from TM image, Known mineral ocurrence	Car	Mountains	Thin, Rare	JBa	Lago la Plata Fm.	Andesite			NE, NW, N-S	LM022-024	Silicification	Joya del Sol (Auriferous quartz vein)	0.12 to 42.72 g/t Au for vein ore of the Joya del Sol deposots.	Drilling survey by private company is on-going. Potentiality had been already proved.	×
20	Cerro Gonzalo	Cerro Gonzalo-Arroyo Luque	Known mineral occurrence	Car	Hills	Thin	Kg	Cretacous granitoids	Granodiorite porphyry	Granodiorite porphyry		NE		Phyllic, Silicification	Cerro Gonzalo (Breccia pipe), Arroyo Luque (Porphyry Cu)	Maximum 2.57% Cu for oxide ore but 1,655ppm Cu for hypogene mineralization.	More wide area including known mineralized sites should be surveyed in phase-2 to evaluate the potentiality.	○
21	Arroyo Cascada	Arroyo Cascada	Known mineral occurrence	Car	Moderate mountains	Forrest	JBa	Lago la Plata Fm.	Andesite			NW		Silicification	Arroyo Cascada (Epithermal Au?)	4.07 and 18.87 g/t Au for quartz vein and silicified rock of the Arroyo Cascada deposit.	Further survey in phase-2 is necessary to unveil the Au mineralization potentiarity of this district.	○
22	Gabros de Tecka	Gabros de Tecka	Known mineral occurrence	Car	Hills	Thin	Mz	Tecka Fm.	Gabblo	Gabbro		NE, NW, E-W, N-S		None	None	Expected PGM mineralization in gabbro was not confirmed.	Further survey in phase-2 is not necessary to concentrate to other Cu-Au mineralized districts.	×
23	Pozones de Navarro	Pozones de Navarro, Estancia el Triunfo	Known mineral occurrence	Car	Mountains	Forrest	JBa	Lago la Plata Fm.	Andesite	Qz porphyry		NW, N-S		Silicification	Los Pozones (Cu veinlet)	Hydrothermal alteration is not developed, Low grade in Au mineralization.	Observed mineralization lacks promising feature.	×
24	Las Mentas	Las Mentas	Known mineral occurrence	Car, Walk	Moderate mountains	Forrest	JBa	Lago la Plata Fm.	Andesite			NE		Silicification	Las Mentas (Pb vein)	Hydrothermal alteration is not developed, Low grade in Au mineralization.	Observed mineralization lacks promising feature.	×
25	Poncho Moro	Arroyo Pedregoso, Arroyo Poncho Moro	Alteration zone from TM image	Car	Mountains	Forrest	JBa	Lago la Plata Fm.	Andesite			NE, NW	LM032	Floats of silicified rocks and quartz veins	None	Float of quartz vein revealed slight arsenic anomaly.	Unchecked alteration zones in mountains is preferable for phase-2 survey, but it has low priority.	×
26	Cerro Colorado	Co. Colorado, Co. Rinon	Alteration zone from TM image, Known mineral ocurrence	Car, Walk	Mountains	Forest	JBa	Lago la Plata Fm.	Andesite	Porphyrite			N.I.	Silicification	Cerro Colorado (High-sulfidation Au)	Floats of pyrophyllite alteration rocks	Au mineralization was reported and mining concession was claimed by major company. Potentiality had been alrady proved.	×
27	Estrella Gaucha	Estrella Gaucha	Alteration zone from TM image, Known mineral ocurrence	Car, Walk	Hills	Thin	Km, Ka	Apeleg Fm., Devisadero Fm.	Sandstone, Conglomerate, etc.	Basalt		NE, NW	N.I.	Silicification, Argillization	Estrella Gaucha (Kaolinite)	Kaolinite and sericite alterations were confiemed in deifferent places, but anomalous Au-Cu values were not obtained.	Observed mineralization lacks promising feature.	×
28	Mina Gato	Mina Gato	Alteration zone from TM image, Known mineral ocurrence	Car	Hills	Thin	Ka	Divisadero Fm.	Rhyolite etc			NW		Silicification	Mina Gato (Kaolinite)	Kaolinite and sericite alterations were confiemed in deifferent places, but anomalous Au-Cu values were not obtained.	Observed mineralization lacks promising feature.	×
29	Ea. Arroyo Victoria	A. Huemul	Alteration zone from TM image	Car	Mountains	Thin	Km	Apeleg Fm.	Mudstone etc	Granodiorite		NE, NW	N.I.	Silicification	None	Floats of silicified rocks	Observed mineralization lacks promising feature.	×
30	Ferrocarrilera	Ferrocarrilera	Known mineral occurrence	Car	Mountains	Forrest	JBa	Lago la Plata Fm.	Andesite		NW	E-W～WNW		Propylite	Ferrocarrilera (Basemetals vein)	Hydrothermal alteration is not developed, Low grade in Au mineralization.	Observed mineralization lacks promising feature.	×
31	Cerro Blanco	Cerro Blanco	Alteration zone from TM image, Known mineral ocurrence	Car, Walk	Mountains	Thin, Rare	JBa, Ka	Lago la Plata Fm., Divisadero Fm.	Sandstone, Mudstone, Volcanics	Qz porphyry, Andesite		NW, Circular	N.I.	Silicification, Argillization	Cerro Blanco (Au-Basemetals vein)	Hydrothermal alteration is developed and 1.575 g/t Au was obtained for qz vein.	Au mineralization was confirmed and mining concession was claimed by major company. Potentiality had been alrady proved.	×

N.I. : Not interpreted although color anomaly of hydrothermal alteration is generated on TM ratio image.