granite rocks having an alteration of red brown to white in color. In the outcrop, coarse muscovites are observed in quantities in the granite rocks. In the sample analysis of granite (A01TK003, A01TK004) and white clay (A01TK005), Serite is detected in the samples. The ASTER images are thought to have extracted these as alteration zones.

6) Characteristics of the satellite image

The ASTER false color images show this area in a light green color, making it distinguishable from the granite rocks in the surroundings. Also, theiso-grain model images show alunite-kaolinite, sericite and geothite as intensive alteration zones.

7) Comments

This area was selected by the ASTER images, but no mineralization was recognized. The alteration zone is generated by the weathering of granite rocks near the faults. Unidentified alteration zones, though small in scale, are extracted about 10 km to the north (alteration zone No. 86, etc.) and about 12 km to the southwest (alteration zone No. 78, etc.) of this alteration zone, and future identification work of these is desired.

The fact that the surrounding granite rocks, which are identified as the same granite in the geology map, are not extracted as an alteration zone consequently leads us to assume that the granite rocks are not homogeneous. Verification is also desired on this point.

8) Reference materials

5-2-31 Vaca Vizcana mineral showings (Zone 42)

1) Location

This place is located about 35 km north of Hualfin, Belen County, Catamarca State, at lat. 26°55' 27.0" S, long. 66°45' 52.7" W and about 2,800 to 2900 m above sea level.

2) Access

This place is accessed by driving from Hualfin to El Eje on National Road 40, going northward on State Rode 53, and then riding a horse at a point about 5 km to the north of Barranca Larga and going westward along the valley for about two hours.

3) Past surveys

* 1972: Discovered during geological survey on the scale of 1 to 50,000. After that, a geological map on the scale of 1 to 5,000 was prepared and geochemical exploration was carried out.

* 1973: Maria A. L. Auriemma studied petrography and alteration. J. Hanzlik-Curcio carried out IP exploration and set two potential drilling sites.

* 1977: Two drillings were executed.

* 1984: As a part of Plan NOA, Servicio Minero Nacional published a comprehensive report of the above-mentioned surveys. According to this report, although an anomaly of IP exploration consists with distribution of sulfide on ground surface, neither geochemical exploration nor drilling exploration (2 holes, 365 m in total) have brought about good results.

4) Geology and tectonics

Devonian granite rocks compose the basement rock of this place and are distributed unconformably surrounding intrusive rocks of El Aspero formation. On the east side, these rocks contact Barranca Larga formation at a fault. In the western part, the above-mentioned granite rocks are distributed along Vaca Vizcana Valley. The major rock is migmatitic granite rocks. The portion near intrusive rock has received alteration and texture and composition change.

Pliocene El Aspero formation intrudes into Devonian Chango Real formation and is distributed along Vaca Vizcana Valley. It is composed of dacitic porphyry, silicifited audesitic breccia and an andesitic porphyry vein.

Dacitic porphyry is exposed most widely in El Aspero formation. The border with the basement rock is clear, and xenolith of the same quality is taken. This porphyry presents the form extending from northwest to southeast. Length and width on the ground surface are 900 m and 620 m, respectively. This rock is classified as quartz monzonite by Gozalvez de Valoy (1976). In the quartz to feldspar groundmass, there are plagioclase phenocryst and a small amount of mafic minerals that show quartz-like or feldspatic zonal structure. Groundmass is often cut by stringers of calcite. The color is bright gray to greenish gray, and the greenish gray ones include amphibole.

Silicified andesitic breccia is distributed along Vaca Vizcaya Valley on the west side of intrusive rocks and forms an oval outline 360 m in length and 180m in width, which extends in a NE to SW direction on the ground surface. This breccia is dark gray to black and contains rock flakes of dacitic porphyry. The matrix consists of rock flakes of the same quality. The parts bordering with dacitic porphyry and basement rock are clear.

Andesitic porphyry veins of various scales intrude in different directions all over this area, and they tend to crisscross the outline of the main porphyry. This porphyry is exposed around the head of Fronteria Valley and on the opposite side of a diverting point of El Medanito Valley. It has width of 0.3 m to 1.5 m and presents a porphyritic texture. Its color is dark gray, and the part contacting the wall rock is clear. Composition is dacitic porphyry, and it age is considered to be the same that of the main porphyry of the same quality.

5) Mineral showings and alteration

Mineralization of sulfide concentrates in an area of about 800m in length and 100m in width in the direction of west-northwest to south-southeast along Vaca Vizcana Valley. Distribution of alteration zones is wider, about 1.5km x 1.0m. Mineralization is related to intrusive rocks of El Aspero formation, and the main mineral is pyrite with the impregnation-like or stringer-like form. In addition, the reported minerals include small amounts of chalcopyrite and bornite, and much smaller amount of magnetite, covellite, sphalerite, gold, malachite and azurite.

Zonations of alteration zones have irregular forms, but there are alteration zones of the porphyry type. Along Vaca Vizcana Valley, where mineralization concentrates, granitic basement rock and dacitic porphyry have received potassic alteration. In granitic basement rock outside of these, sericitic alteration and pyrite disseminated develop widely, although this becomes weaker in the places farther from the part contacting intrusive rocks. Between Medanito Valley and Fronterita Valley, mainly andesitic porphyry veins have received propylitic alteration, and feldspar and mafic minerals are replaced by epidote, chlorite and carbonate minerals. Argillized alteration exists in several scattered small-scale zones and is represented by dacitic porphyry with argillization of plagioclase. In the argillized alteration zone, very small scale silicified alteration is observed. On the right bank where Medanito Valley and Vaca Vizcana Valley join, there is a zone where pyrite has been oxidized by meteoric water, and yellowish-brown to dark-brown limonite is distributed, accompanied by gypsum.

In the field survey, we investigated a place entering Medanito Valley from Vaca Vizcana Valley that is said to be the place where two drillings were carried out. On the right bank where Vaca Vizcana Valley and Medanito Valley join, small scale granite rocks with limonite gossan are observed. In the area slightly upstream, there is distribution of dacitic porphyry having received alteration to quartz or biotite. Minerals observable with the naked eye there are pyrite, chalcopyrite, epidote, chlorite, magnetite (and pyrrhotite?) and stringers of gypsum, besides quartz and biotite. In the judgement of polished thin section of samples of this rock (A01RT015), these samples were judged as biotite amphibolitic diorite. Minerals identified in this judgement are a very large amount of plagioclase, a large amount of biotite, a moderate amount of hornblende, and a small amount of titanite and apatite. Secondary minerals identified are a small amount of chlorite, epidote and calcite. A moderate amount of magnetite was also identified as an opaque mineral. Minerals identified from X-ray diffraction of the same samples are a large amount of plagioclase, and a moderate amount of quartz and potassium. The place where these samples were collected is located in the transition part of the potassic alteration zone and propylitic alteration zone on the alteration zone map prepared by Gonzalvez de Valoy M. (1979). The samples taken from the further upstream (A01RT016) are dacitic porphyry without mafic minerals due to silicification, and pyrite disseminated is observed. From the results of X-ray diffraction, a large amount of quartz and plagioclase, a moderate amount of potassium and a very small amount of chlorite are identified. The samples taken from the area further upstream (A01RT017) are granitic xenolith captured in porphyry and have received alteration to quartz or biotite. A lot of biotite exists in stringer form, and dissemination of pyrite and a very small amount of chalcopyrite are observed. From the result of the judgement of polished thin section of the same samples, these were classified as meta-granite(?). Judged minerals are a large amount of quartz, potassium and biotite, a moderate amount of plagioclase, a small amount of apatite, and a very small amount of zircon. A small amount of chlorite was judged as a secondary mineral. Opaque minerals judged are a moderate amount of pyrite, a very small amount of sphalerite, chalcopyrite and

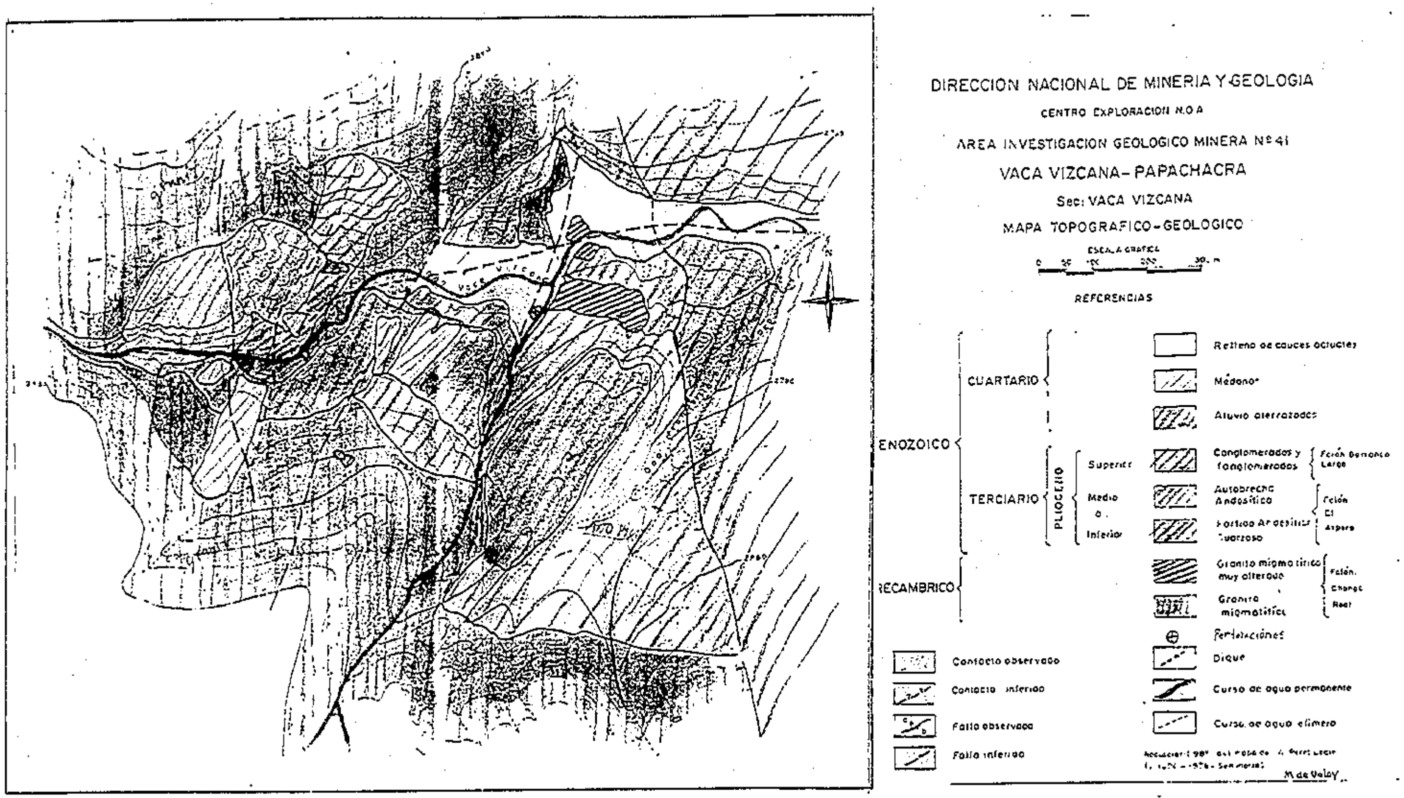


Fig.II-5-2-31-1 Simplified geological map of Vaca Vizcana area.
(taken from Gonzalo, C.Z.,1984)

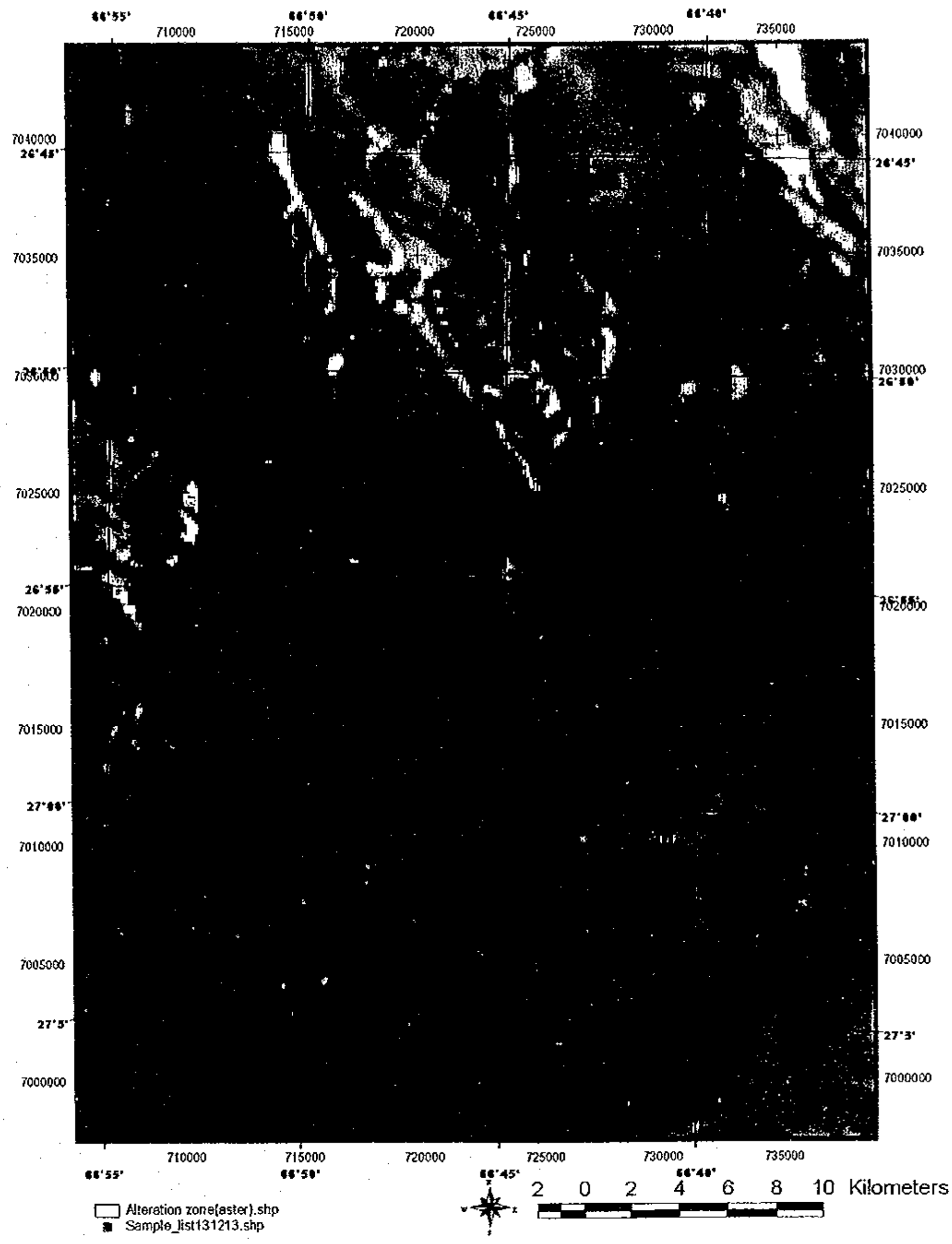


Fig.II-5-2-31-2 Vaca Vizcana mineral showing(Landsat TM BGR=145) tetrahedrite?. Sample A01RT018 is dacitic porphry having received weak argillic alteration, feldspar rocks and mafic minerals survive. Although pyrite is disseminated, there is no biotite. From the results of chemical analysis of Samples A01RT015 to 018, no remarkable abnormality was detected.

6) Characteristics of the satellite image

7) Comment

In this area, several surveys were carried out in the past as a mineral showings of the porphyry type, but expectable results were not obtained. The number of drillings made in the past is only two, and it is hard to say that the surveys carried out were sufficient. However, as the range of distribution of sulfide mineralized zones and alteration zones on the ground surface is not so wide, and both mineral showings and alteration are weak, there is a low possibility that porphyry deposits of economic effectiveness exist under the ground.

5-2-32 El Alisar mineral showings (Zone 46)

1) Location

This place is located about 30 km west of San Miguel de Tucuman and about 12 km east of Tafi del Valle, at lat. 26°50' 16.8" S, long. 65°35' 06.8" W, and about 2,300 m above sea level.

2) Access

El Alisal is reached by horse from Tafi del Valle and going over Mt. Tafi, which takes about 7 hours. Otherwise, El Alisal is accessed by riding a horse from a pasture along Tablas River in the northwest of San Miguel de Tucuman for about 10 hours.

3) Past surveys

* 1971: Geochemical exploration of placer and rock (Cu, Pb and Zn) was carried out according to Plan NOA of the United Nations. In this investigation, no geochemical anormaly was discovered (Gonzalez, 1971).

* 1994: Martinez y Chipulina made lineament analysis using satellite images. From investigation of boulders, there was a discovery of boulders of hypabyssal rock and lava, which had received porphyry mineralization or alteration. The range where these boulders were distributed was limited to Tablas River on the eastern slope of Cumbres Calchaquies Mountain or the catchment area of Membrillo river. The area was further narrowed from these basins (100), and El Alisal block and Cerro Pabellon block were selected as those with distribution of andesitic volcanic rocks, hypabyssal rocks and breccia. In El Alisal block (Area 10), geological surveys, zonation of alteration zones, geology and tectonics investigation, geochemical exploration and petrological study were done (Martinez L. V. y Chipulina M. A., 1996). As a result, it was confirmed that a Tertiary complex of volcanic rocks and semi-plutonic rocks (El Alisal Volcanic Complex) are distributed and porphyry copper mineralization and alteration

zones exist in El Alisal block.

4) Geology and tectonics

Geology of this area has distribution of metamorphic rocks of the Proterozoic to the Lower Cambrian, Ordovician granite rocks and a complex of Tertiary volcanic rocks to hypabyssal rocks (Fig. II-5-3-32-1).

Ordovician granite rocks pass through basement metamorphic rocks, and the Tertiary complex intrudes into it. It is called Mala Mala granodiorite, which has granodiorite as the main mineral and is accompanied by aplite and pegmatite. The main minerals comprising granodiorite are plagioclase, quartz and microcline, and they are accompanied by biotite, muscovite, apatite and opaque minerals.

The complex of Tertiary volcanic rocks and hypabyssal rocks is called El Alisal Volcanic Complex in this area. It is made up of hypabyssal intrusive rocks, breccia rocks, lava-like or massive andesite, dacite, basaltic andesite and dike swarm. This complex has close relation with mineralized alteration in this area.

Hypabyssal intrusive rocks whose distribution is the widest have massive andesitic porphyry as the main mineral, and exposure on the ground surface accounts to 3.2. The texture is a porphyritic one of fine groundmass. Phenocryst changes to glomero-porphyritic or mosaic texture and resembles that of volcanic rocks partly. As hydrothermal alteration, the complex has received k-silicatic alteration, propylitic alteration, and serisitic to argillic alteration. Phenocryst minerals consist of plagioclase (andesine), quartz, hornblende and biotite, and secondary minerals are added or replaced due to the alteration of the respective minerals. In the widest k-silicatic alteration zone, secondary alkali-feldspar, quartz and biotite are added or replaced as phenocryst, and groundmass is composed of microcrystalline of plagioclase, alkali-feldspar and biotite.

Breccia rocks are divided into breccia intruding into the edge and hydrothermal breccia. Breccia intruding into the edge are distributed near the place where porphyritic intrusive rocks contact Ordovician granite rocks, and are comprised of porphyry rubble, rubble originating in granodiorite and magmatic matrix represented by andesitic porphyry. Hydrothermal breccia are composed of matrixes with various origins consisting of rubble of porphyric intrusive rocks and also consisting of debris of rocks filled by secondary quartz and clay minerals that have been broken into grains with various diameter. Breccia rocks have received k-silicate alteration or propylitic alteration in some places.

Lava or massive andesite survives as lava flow on basement granite rocks or survives being passed through by porphyritic intrusive rocks locally in geologically high places. It has received propylitic alteration. Phenocryst is plagioclase (andesine), quartz, hornblende, and laminar/platelike altered mafic minerals. Groundmass consists of similar altered minerals.

Dacite is hosted on a small scale in granite rocks contacting the west side of porphyritic intrusive rocks. Texture is porphpyritic, and the comprising mineral is groundmass of the same properties as phenocryst of plagioclase, quartz and mafic minerals. This dacite looks gray to light green due to weak propylitic alteration.

Basaltic andesite is distributed on a small scale in the area covered with Quaternary sediments in the northeast part of porphyritic intrusive rocks. The texture is porphyritic, and the color is dark brown to black. The comprising mineral is phenocryst of plagioclase, amphibole and biotite, and dark groundmass with the same properties. This andesite presents weak propylitic alteration.

Dikes intrude into basement granite rocks and a complex of volcanic rock and hypabyssal rocks, and the thickness of intrusion is various. The composition is andesitic, and the texture is porphyritic. These dikes look greenish gray, yellowish green or gray due to alteration. Comprising minerals are phenocryst of plagioclase, biotite and hornblende, and holocrystaline groundmass where feldspar is dominant. It has received weak propylitic alteration and strong k-silicate alteration.

Although a radiometric dating has not been determined, it is considered hypothetically, from the similarity to calc-alkali magmatic activity in Farallon Negro region and mineralization rich in copper and gold, that the age of this magmatic activity is the Miocene. In this survey, rhyolite (A01KN006) showed the K- Ar age of 16 Ma.

The dominant structure in this area is N 30 - 40° W, N40 - 45° E and N0-10° E tending lineaments. It is deemed that the former two lineaments brought about mineralization in this area and controlled intrusive activity. In several peripheral regions including this area, it is possible to confirm a Tertiary effusive center (El Alisal volcanic Complex) and ring structure indicating the outline of intrusive rocks or difference of geology.

5) Mineral showings and alteration

It was difficult to extract alteration zones from the satellite image because vegetation was thick and there were many clouds. According to Matinez L. V. y Chipulina M. A. (1996), alteration zones are distributed in the form of semi-ring/concentric circles or asymmetrically. There is distribution of potassic alterations, sericite and argillic alteration zones and propylitic alteration zones outside of the center.

K-silicate alteration zones are distributed in an oval form of 500 x 700m on the ground surface, crossing over Cuchila Larga Valley, and extending to andesitic porphyry and breccia intruding into the edge. Alteration minerals are characterized by secondary biotite, quartz and alkali-feldspar (microcline). Secondary alkali-feldspar replaces plagioclase phenocryst. Secondary biotite accoampanies secondary quartz, replaces hornblende phenocryst partly or completely, and presents a stringer-like, particulate mosaic or patch-like form. Groundmass of porphyry, which is considered to be a central core of the k-silicate alteration zone, hosts quartz and magnetite stringers in addition to the above-mentioned secondary minerals.

Outcrops of sericite and argillic alteration zones appear only on a small scale on the ground surface due to cover above it. Alteration of moderate strength reaches andesitic porphyry and wall rock granorite rocks. There are places with sericite, clay and quartz alteration partly, but it is difficult to divide each altereation.

Propylitic alteration is distributed around the ridge of El Alisal mountains, and extends to andesitic porphyry, breccia rocks and lava rocks. As secondary minerals, chlorite, epidote and galena are characteristic. The strength of alteration is weak to moderate. Zeolitization is observed as an alteration following propylitic alteration and k-silicate alteration.

According to Martinez L. V. y Chipulina M.A.(1996), mineralization shows zonal distribution similarly to alteration zones. Sulfide is often produced in disseminated or stringer form accompanying secondary quartz or secondary quartz - biotite, or sometimes accompanying stockwork-like quartz. From geochemical exploration, a high anormaly of gold was detected in breccia intruding into the edge accompanied by stockwork quartz, hydrothermal breccia, and andesitic porphry having received k-silicate alteration.

As to ore minerals of each alteration zone, K-silicate alteration zones host pyrite, chalcopyrite, pyrrhotite, magnetite and hematite; propylitic alteration zones host pyrite, sphalerite, magnetite, limonite and oxidized copper ore; and sericite and clay alteration zones host pyrite and limonite in stringer or disseminated form. Primary sulfide includes pyrite, chalcopyrite, magnetite, sphalerite and pyrrhotite. In propylitic zones and sericite and clay zones near surface, primary sulfide is oxidized by supergene action. In these zones, pyrite has changed to limonite, apatite and hematite, while chalcopyrite has changed to oxidized copper ore.

As a result of X-ray diffraction of andesitic porphyry whitely argillized in the east part of porphyry intrusive rocks, which was collected in the field survey (A01RT022), large amounts of quartz and plagioclase were identified. The slightly fresh part (A01RT023) of the same rock was identified in the judgemnt of polised thin section as amphibole (?) quartz andesite having received albitization, calcitic alteration, chloritization and sericitic alteration. Minerals identified in this judgement are a large amount of quartz and plagioclase, a moderate amount of hornblende, a small amount of potassium and a very small amount of apatite. Secondary minerals identified are a moderate amount of chlorite and calcite and a small amount of sericite.

In the southwest part of porphyry intrusive rocks, impregnation of limonite is recognized in andesite (A01RT024), having received silicification and argillization near the part where andesite rocks contact granite rocks. A large amount of quartz and plagioclase and a small amount of sericite were identified by X-ray diffraction. Andesite (A01RT025), which is also near the contacting part, has become fine grains due to hydrothermal alteration (contact metamorphism), and impregnation of plagioclase, biotite, quartz and pyrite is observed in phenocryst. In the judgement of polished thin section, these were identified as quartz-andesitic tuff weakly welded. Minerals identified in this judgement are a very large amount of plagioclase, a moderate amount of quartz and biotite, a small amount of potassium and a very small amount of apatite. Secondary minerals identified are a moderate amount of sericite and a small amount of smectite. No abnormal values were obtained from chemical analysis of the same samples. Dacite (A01KN004 and A01KN005) was also identified in the judgement of polished thin section as quartz-andesitic tuff. Identified minerals are a very large amount of plagioclase, a large amount of quartz and biotite, a small amount of potassium and opaque minerals.

In Sample A00KN005, in addition to these minerals, a very small amount of chlorite, sericite and smectite were identified as secondary minerals. Along La Cuchilla Larga Valley, it was observed that pyrite and limonite slightly impregnate in granorite rocks, which have altered weakly. On the west side further upstream, rhyolite showing flow structure (A01KN006) was identified in the judgement of polished thin section as rhyolititic tuff. Identified minerals in this judgement are a very large amount of plagioclase, a large amount of quartz, potassium and biotite, a moderate amount of hornblende, and a small amount of opaque minerals and chlorite. Further upstream, near the part contacting basement granite rocks at the western edge of porphyry intrusive rocks, argillization and pyrite dissemination were observed both in basement granite rocks and intrusive rocks.

Along the ridge of El Alisal mountains in the south part of porphyry intrusive rocks, there is distribution of porphyry with sericitic alteration and argillization, and andesite with propylitic alteration breccia. From X-ray diffraction, a large amount of plagioclase, a small amount of quartz and sericite, and a very small amount of chlorite were identified in weakly argillized porphyry (A01RT026); a large amount of plagioclase, a moderate amount of quartz and potassium, and a very small amount of chlorite were identified in whitely argillized porphyry (A01RT028), while a large amount of quartz, plagioclase and a small amount of sericite were identified in whitely argillized porphyry (A01RT028). In Sample A01RT028, many traces that pyrite had been leached were observed.

Samples A01RT029 and A01RT030 were collected by the branch office of SEGEMAR Tucuman State in the past; these are andesitic porphyry having received quartz-biotite-potassium alteration. These samples have been chemically analyzed by Martinez L.V. y Chipulina M. A. (1996). As a result of re-analysis of Sample A01RT030 this time, no anormaly was recognized except that the content of Fe was a little higher.

6) Characteristics of the satellite image

7) Comment

In this area, El Alisal Deposits exist, which are porphyry copper deposits formed in the Neogene. This area is the jungle zone called "Selva"; vegetation is thick, and there are many periods of bad weather. Therefore, analysis of the satellite image cannot be applied. Porphyry copper mineralization was discovered relatively recently because the Tertiary volcanic rocks are not shown on the geological map of the wide-area scale. The size of alteration zones is relatively large, and it has been proven from past surveys that the core of k-silicate alteration is exposed on the ground surface. In this survey, partly because of time restrictions, remarkable mineralized zones on the ground surface could not be captured. The existing surveys were in the stage of rough investigation, and geophysical exploration and drilling surveys have not been carried out. Therefore, systematic and basic surveys are expected.

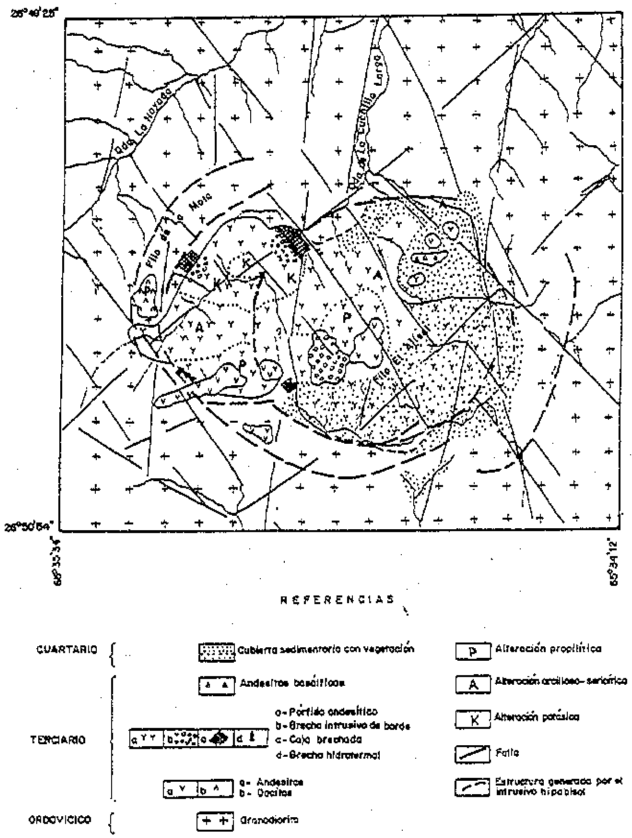


Fig.II-5-2-32-1(a) Schema of geology and hydrothermal alteration in El Alisal mineral occurence. (taken from Martínez L.V. y Chipulina M.A.,1996)

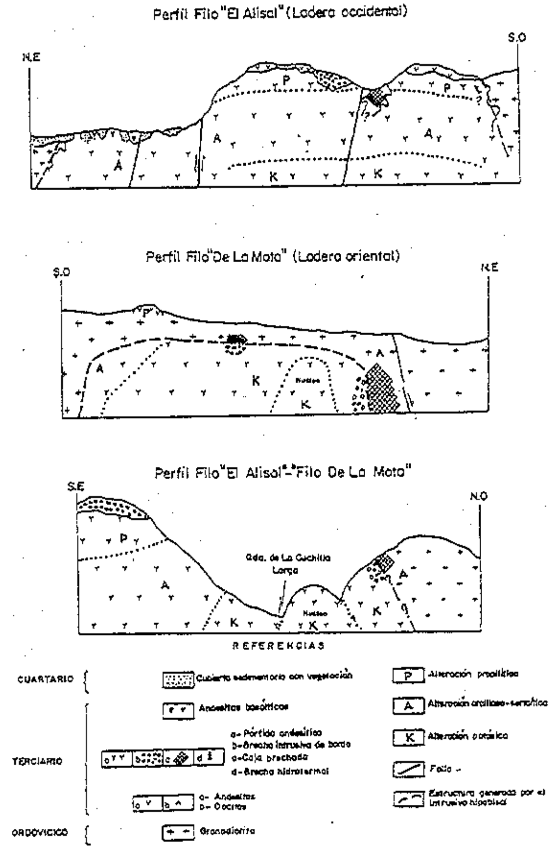


Fig.II-5-2-32-1(b) Schematic cross sections in El Alisal mineral occurrence. (taken from Martínez L.V. y Chipulina M.A.,1996)

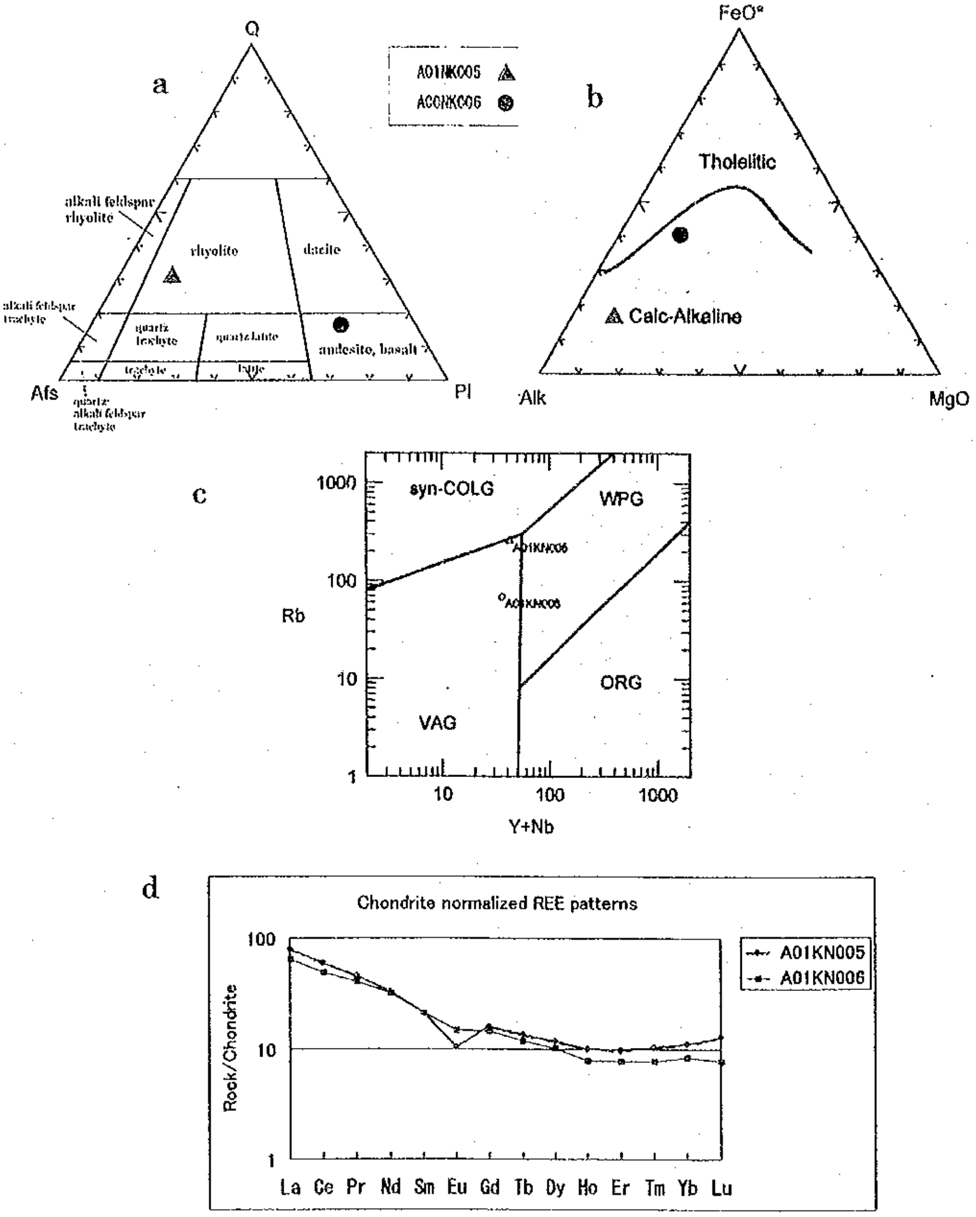


Fig.II-5-2-32-2 Discrimination diagrams for volcanic rocks

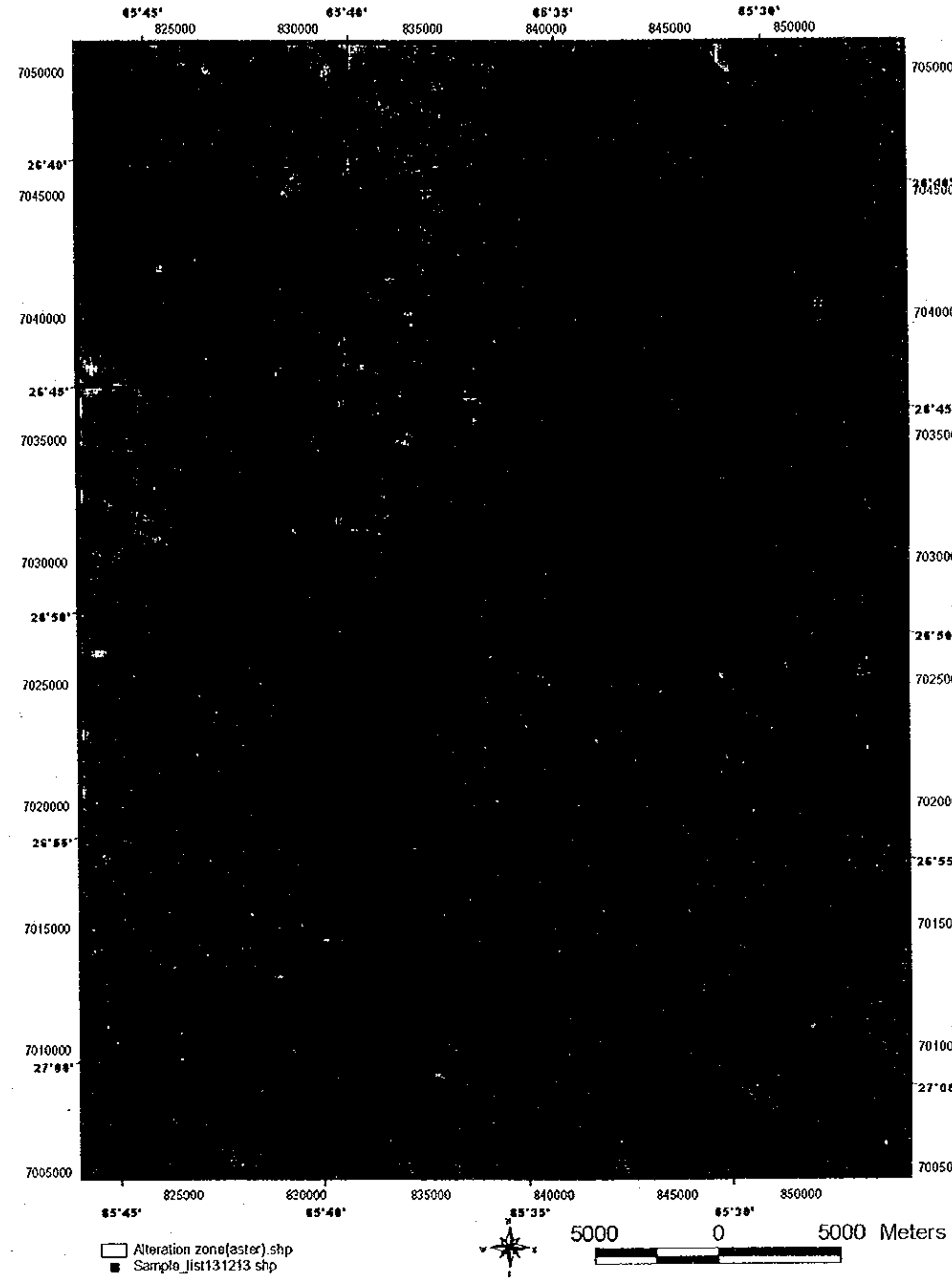
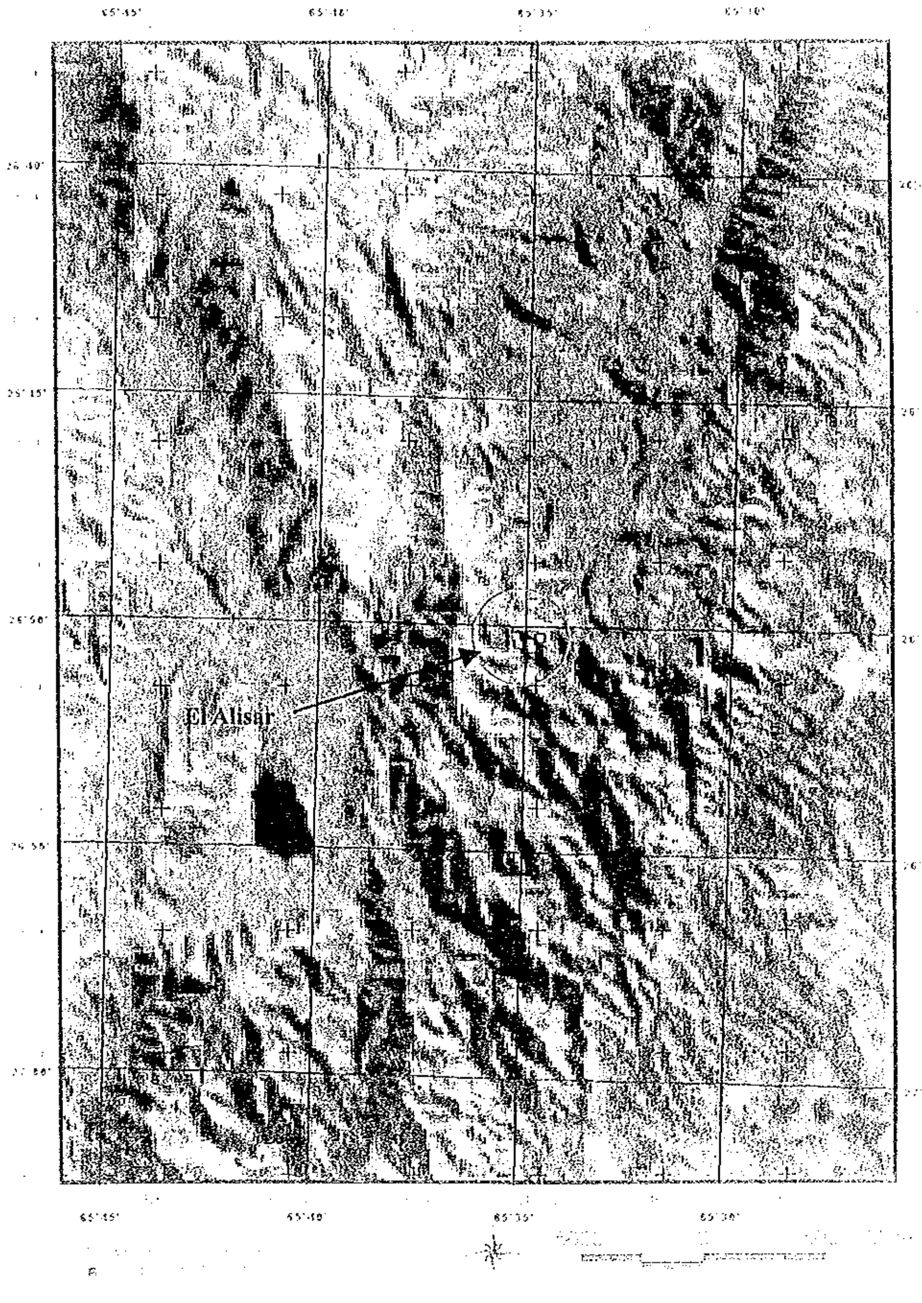


Fig.II-5-2-32-3 El Alisar mineral showing(Landsat TM BGR=145)


El Alisar

5-2-33 El Pago mineral showings

1) Location

At 27°05' S. Lat., 65°54' W. Long.

It is located about 70 km west-southwest of San Miguel de Tucuman, capital of Tucuman province, and about 30 km southwest of Tafi del Valle.

2) Access

There are no roads to the mineral showings. Therefore, access must be made by horseback from Tafi del Valle or via helicopter. Anyhow, access is extremely difficult.

3) Past surveys

The following is a list of past surveys described by a geologist, Carlos H. Morello, who visited this El Pago mineral showings:

(Type)

4) Geology and tectonics

According to the geological map of Tucuman province with a scale of 1:500,000, the mineral showings is located within the area covered by the Upper Precambrian Suncho Gneiss. The Ordovician granitic rocks are distributed to the northeast and the Miocene volcanic complex distributed to the north and northeast. There is a possibility that the Miocene volcanic complex is distributed within this mineral showings.

According to Fig. II-5-2-33-1 obtained from the Tucuman branch of SEGEMAR, the rocks distributed in the area are roughly classified into three groups: i.e., basement rock, andesitic porphyry and lamprophyre.

5) Mineralization and alteration

According to Fig. II-5-2-33-1 quoted above, the alteration in the area is composed of potassium, sericite, clay, propylite and silica.

For the samples provided by the Tucuman branch of SEGEMAR, X-ray analysis was conducted on three samples of porphyry, four samples of metamorphic basement and three samples of lamprophyre, that is, ten samples in total. The sample location is shown in Fig. II-5-2-33-1, and the result of the X-ray analysis is shown in Table A-3. From the result of this X-ray analysis, the presence of the alteration zone shown in Fig. II-5-2-33-1 was practically verified. In addition, as SEGEMAR describes, the presence of chalcopyrite and pyrite was also verified.

6) Characteristics of the satellite image

Although it was difficult to grasp a broad view on the alteration zone distribution solely by means of Fig. II5-2-33-1, it is possible to recognize it on the ASTER images as a large-scale alteration

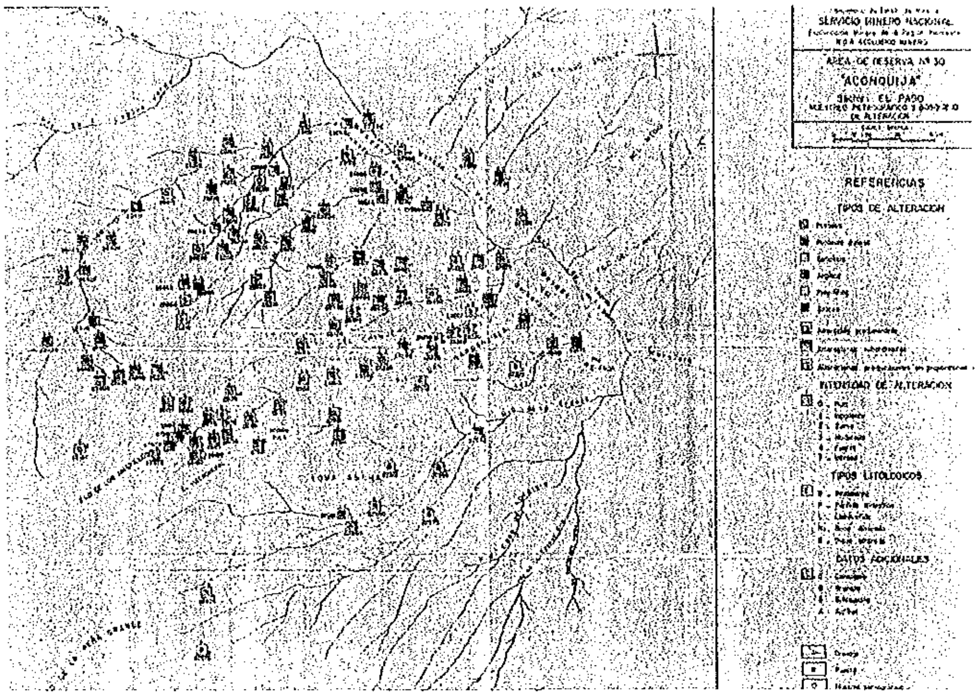


Fig.II-5-2-33-1 Distribution of rock type and alteration in the El Pago

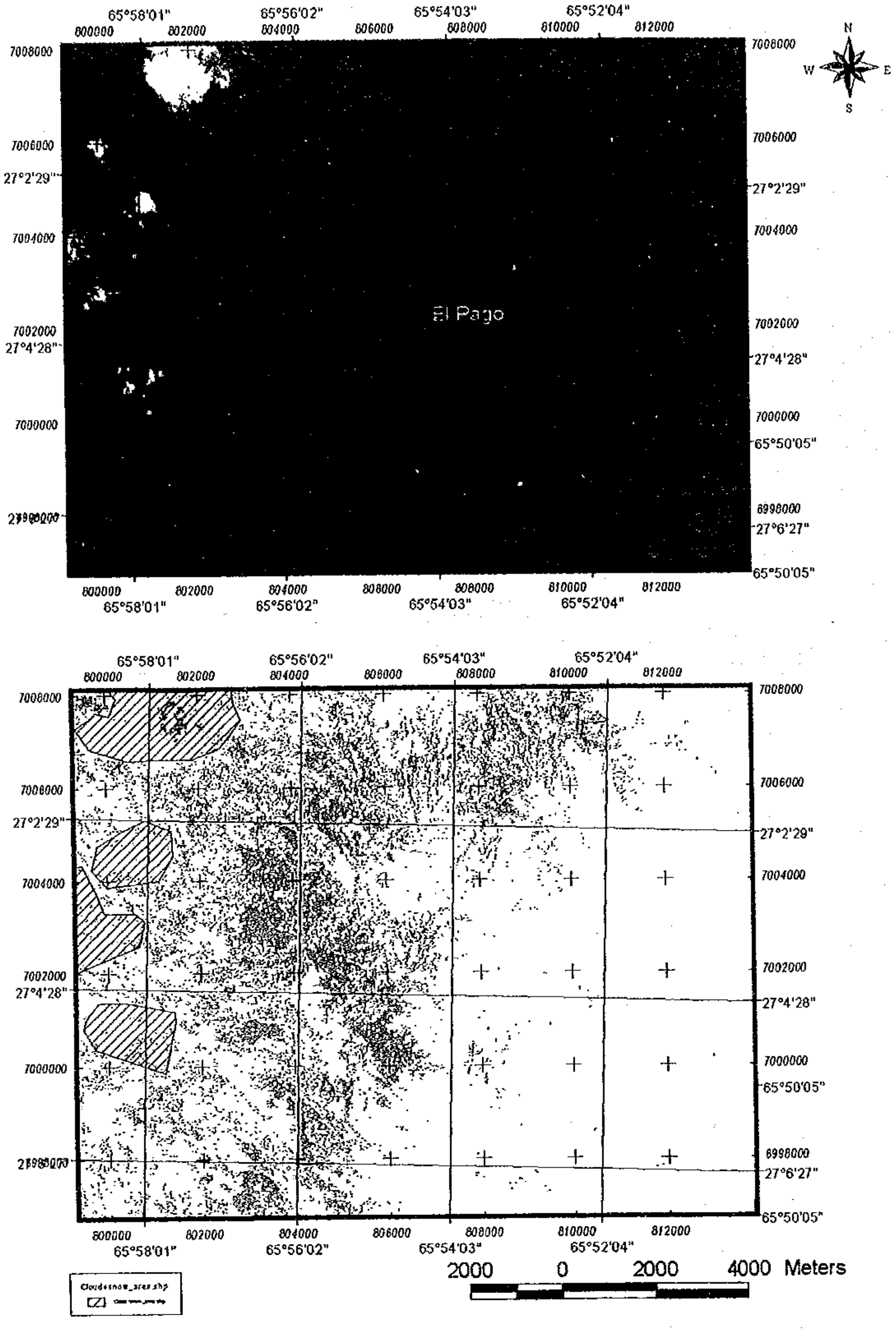


Fig.II-5-2-33-2 Distribution of alteration zones extracted by ASTER data, El Pago sector zone over the range of approximately 2 km by 2 km(Fig. II-5-2-33-2).

7) Comments

Assessment on the basis of the existing data and X-ray analysis results is difficult. Although the access is extremely bad at present, field surveys are desirable, if possible.

8) Reference materials

5-2-34 Alto de la Blenda (Laboreo, Nudo, Esperanza) ore deposit

1) Location

This deposit is located about 50 km northeast of Belen, Belen County, Catamarca State, at lat. 27°18'30.6" S, long. 66°39'40.2" W (outcrop of Esperanza Vein), and about 2,700 m above sea level.

2) Access

The mine gate is reached by driving a car about 40 minutes from Nachimientos de Abajo along National Road 40 southeastward on an unpaved road for the mine.

3) Past surveys

1938: A quartz vein containing Mn, Au and Ag was discovered.

- 1950s: Tucman University carried out prospecting.

1964: A development plan was discussed.

1978: Mining of Faralon Negro Vein was started.

- 1988: Twelve levels (5,044 m), three inclines (545 m), prospecting drilling of 638 m, and an air level of 2,150 m were dug.

In 1992, Mining was ended because ore reserves were exhausted. In the period between 1978 and 1992, 1,200,000 t (Au: 5.5 g/t) were mined in total.

1970s: Exploration was started in Alto de la Blenda Vein, which was discontinued for a while.

1986: Exploration was restarted.

-1988: A level of 3,581 m, prospecting drilling of 739 m and an air level of 411 m were excavated.

1988 - 1992: Alto de la Blenda Vein was investigated by exploration of JICA/MMAJ. Ore reserves of 1.455 Mt (Au: 6.53 g/t, Ag: 128 g/t) were secured, and underground mining was started.

1986 - 1991: Esperanza Vein in the extension of Blenda Vein was discovered from exploration of JICA/MMAJ (850,000 t).

1996: Low-grade ore reserves of Esperanza Vein were about 1,800,000 t (Au: 3.4 g/t, Ag: 71 g/t).

1998: High-grade ore reserves of Alto de la Blenda, Laborco Vein and Zona de Nudo were about 480,000 t (Au: 6.1 g/t, Ag: 112 g/t).

4) Geology and tectonics

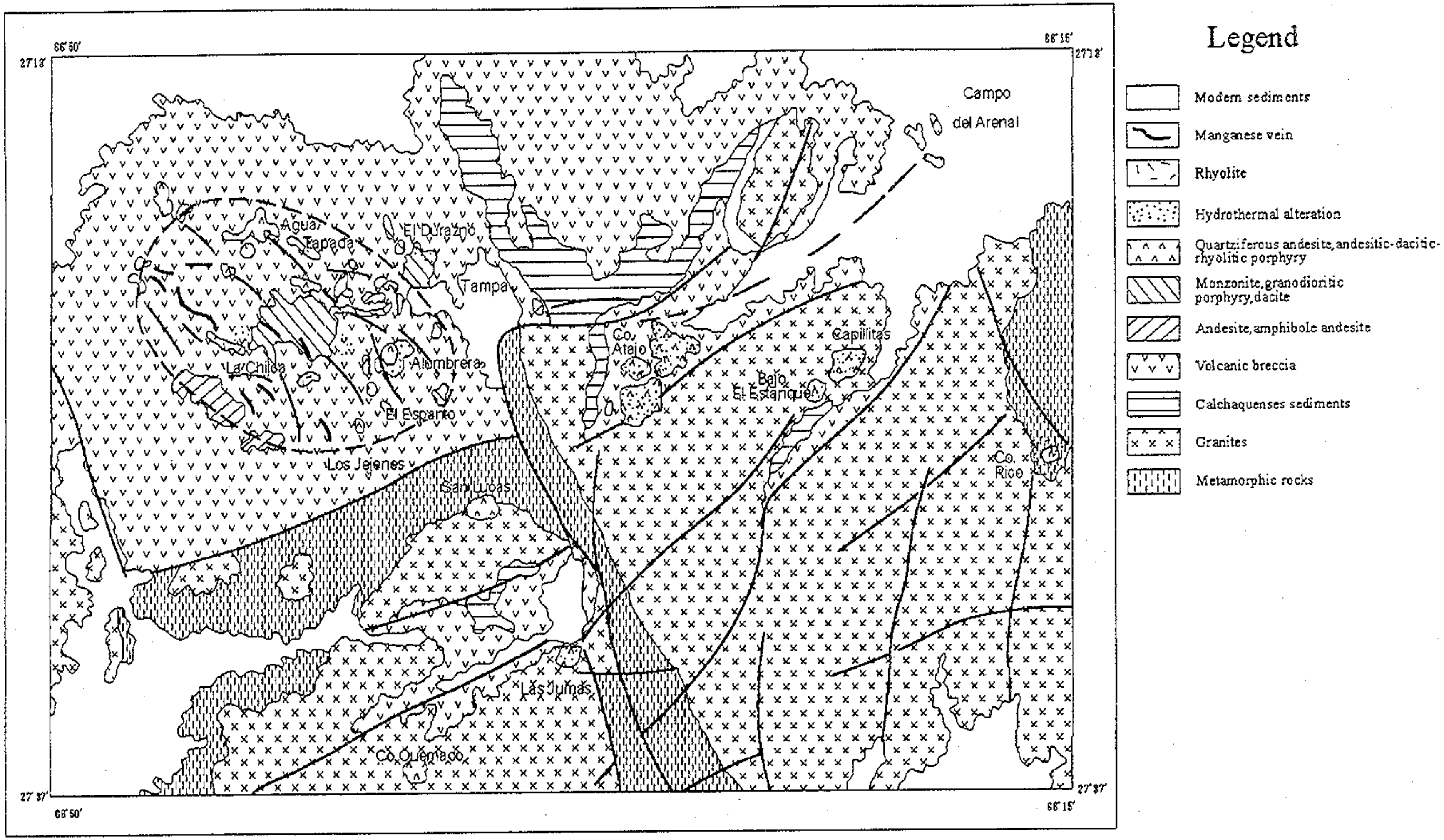


Fig. II-5-2-34-1 Simplified geological map aroud the Zone-43 (based on Llambias, 1970-1971, Acenolaza et al., 1982, Secretaria de Mineria-NOA Geologico Minero,1970-1978(inedited), International Musto Exploration Ltd.,1993)

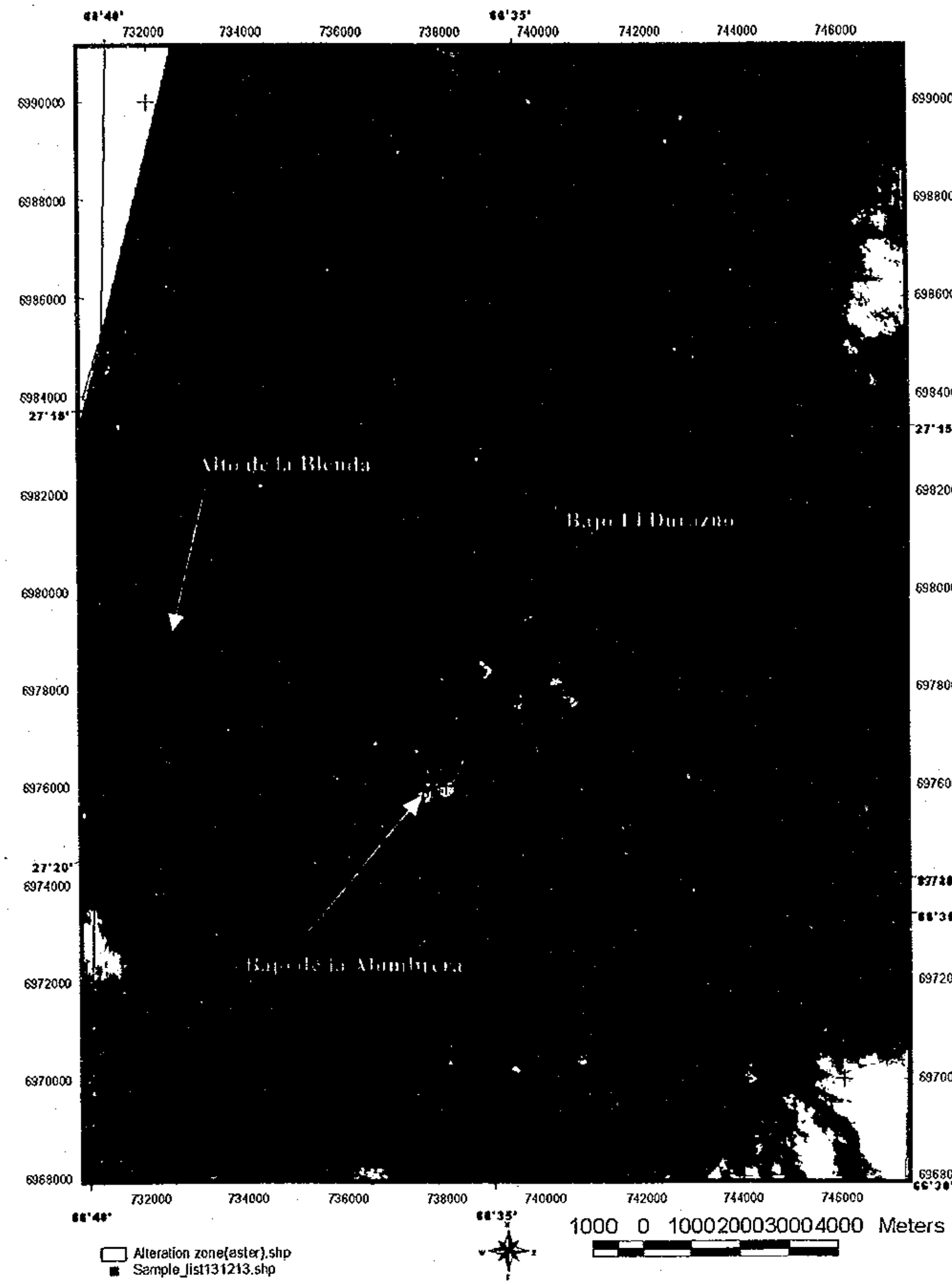


Fig.II-5-2-34-2 Alto de la Blenda (Laboreo, Nudo, Esperanza) deposit, Bajo de la Alumbrera deposit, Bajo El Durazno mineral showing (ASTER BGR=123)


Alto de la Blenda
Bajo El Durazno
Bajo de la Alumbrera

The geology of this area is Precambrian to Cambrian metamorphic basement rocks (El Suncho formation, gneiss and phyllite) Ordovician granite rocks (Capillitas Granite), Miocene red sandstone (El Morteritos formation), and Miocene volcanic rocks intruding into these and covering the upper part of them (Farallon Negro Volcanic Complex) (Fig. II-5-2-34-1). Mineralization appears as andesitic breccia in Farallon Negro Volcanic Complex and as quartz-manganese-calcite veins hosted in monzonite.

Farallon Negro Volcanic Complex is consist of andesitic breccia, monzonite stock, basalt lava, polymictic breccia, and rhyolite-dacite-andecite veins. Monzonite stock is fine grained and holocrystalline, and consists of potassium, biotite, clino-pyroxene, opaque minerals and a small amount of quartz. Dikes range in thickness from 1 to 20 m. A northwest to southeast strike and vertical to almost vertical direction are dominant, but northeast to southwest and south to north tending swarms also exist in this area.

5) Mineral showings and alteration

Farallon Negro area is located in a mining lot owned by YMAD (Catamarca State Resource Development Public Corporation) in Belen County, Catamarca State. The average elevation is 2,600 m above sea level. The veins are roughly divided into two groups, Farallon Negro Vein and Alto de la Blenda Vein. Gold and silver ores are now mined from Alto de la Blenda Vein. Ores in Farallon Negro - Alto de la Blenda Deposits are classified into two types, high-grade ores that are processed in a cynidation plant, and low-grade ores to which leachiñg treatment is applied. Production of crude high-grade and low-grade ores is 300 t/d (Au: 7 - 8 g/t, Merrill-Crowe Method) and 150 t/d (Au: 3 - 4 g/t, Heap leaching), respectively. Gold of 35 to 40 kg and silver of 300 to 400 kg are also produced monthly. This deposit is considered to be volcano bottom deposits of Farallon Negro Caldela, and it is regarded as low-sulfide system epithermal deposits. It comprises a group of several northwest-to-southeast tending veins. These veins are hosted in andesitic breccia and monzonite stock of Farallon Negro Complex, and roughly divided into two groups: Farallon Negro Vein and Alto de la Blenda Vein. As ore reserves have been exhausted in Farallon Negro Vein, mining is now carried out from Alto de la Blenda Vein. Alto de la Blenda Vein is located 500 m northeast of Farallon Negro Vein. It comprises three veins: Laboreo Vein (1,500 m in total length, 1 to 3 m in width, N35 - 55W, vertical to 70N), Portezuelo Vein (1,200 m in total length, 0.5 to 2 m in width, N20 - 30W, 60 to 65N) and Chica Vein (1,100 m in total length, 1 m in width, N25 to 35W, vertical) (Fig. II-5-2-34-2). Laboreo Vein and Portezuelo Vein join together in the southeast part, which is called Esperanza Vein (1,100 m in total length, 6 m in average vein width, N50 - 60° W, 60 to 70° N). The main gangue mineral of these veins is quartz that is accompanied by calcite and gypsum. Veins look striped, massive, or breccia, and mineralization of gold and silver are more in the striped parts. The striped parts consist of bands of oxidized Mn (black), carbonated Mn (light pink), quartz and calcite. Generally, the content of gold in the black part, i.e., oxidized Mn, is high. Ore minerals include electrum, native gold, polybasite, native silver, tetrahedrite, sphalerite, galena, pyrite, chalcopyrite, rhodochrosite and manganese oxide.

The age of mineralization is considered from the age of phylic alteration to be 6.55±0.14 Ma (SASSO et al., 1998). The homogenization temperature of fluid inclusion of quartz veins in Esperanza Vein is 203 to 239℃ (Alderete, 1999).

As wall rock alteration, propylitic alteration of monzonite and andesite is dominant, while sericitic alteration is also observed partly. In the northwest part of this area, argillized zones of andesitic volcaniclastic rocks are distributed.

Laboreo Vein in the mine is a vein of striped quartz, manganese and calcite, which is hosted in monzonite and andesite, and a black and white striped pattern made by oxidized manganese and calcite (and quartz) was observed. Oxidized manganese shows light pink color and is accompanied by quartz. Disseminations of pyrite and galena are partly observed. Wall rock has received propylitic alteration, and pyrite dissemination, calcite stringers, sericite stringers and chlorite were observed. Ore samples (A01RT002) collected in the pit belong to a white-light pink-black striped vein of calcite, manganese and quartz. The following values were obtained from chemical analysis: Au of 0.115 g/t, Ag of 15 g/t, Mn of more than 10,000 ppm, Pb of 1,062 ppm and Zn of 2,230 ppm.

Esperanza Vein on the ground surface has a quartz vein of 4 to 5 m in width and N20° W and 70° E. A gypsum vein of about 5 cm in width exists at the edge of hanging wall; a white fault argillized zone of about 1 m exists on this vein, and propylitized andesite, a wall rock, is placed on this zone. The argillized zone has lens of black manganese oxide in a narrow space.

6) Characteristics of the satellite image

7) Comment

This mine is a gold and silver mine of the vein type that has been known since the old age. In Esperanza Vein, the main vein, most of the ore reserves still survive. However, due to recent lowering of the grade of ores (Au: 2 - 4 g/t, Ag: 70 - 100 g/t), the mine requires severe operation. We would like to expect them to make vigorous efforts.

5-2-35 AguaTapada mineral showings (Zone 43)

1) Location

At 27°15'51.4" S. Lat., 66°40'43.3" W. Long., 2,490 m above sea level in Belen County, Catamarca state. Located about 65 km northeast of Belen, Catamarca state, and about 10 km northeast of Bajo de la Alumbrera deposit.

2) Access

Access is gained in the same way as to Bajo de la Alumbrera, by travelling on State Road 40 about 50 km to the northeast, then taking the road branching at Nacimientos de Abajo, and finally going along the branch road about 12 km to the southwest.

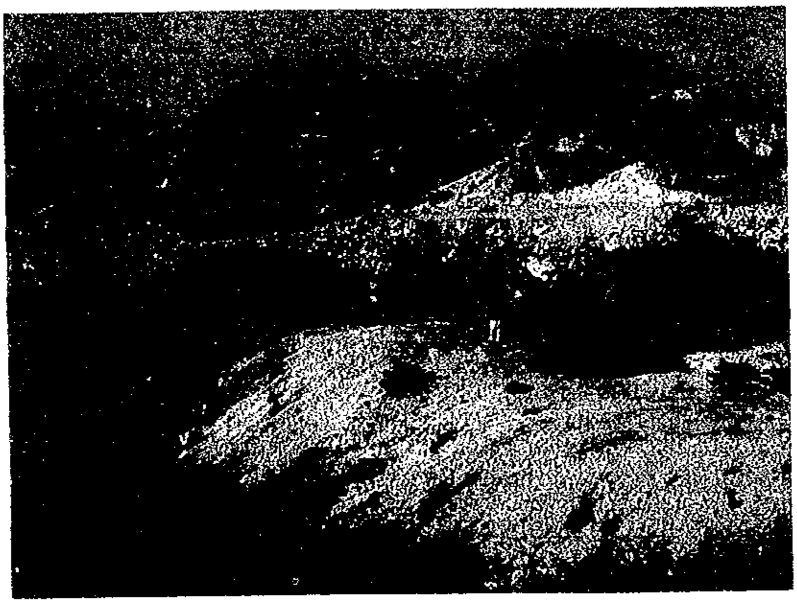


Fig. II-5-2-35-1 Agua Tapada occurrence

FigII-5-2-37-1 Bajo El Durazno occurrence

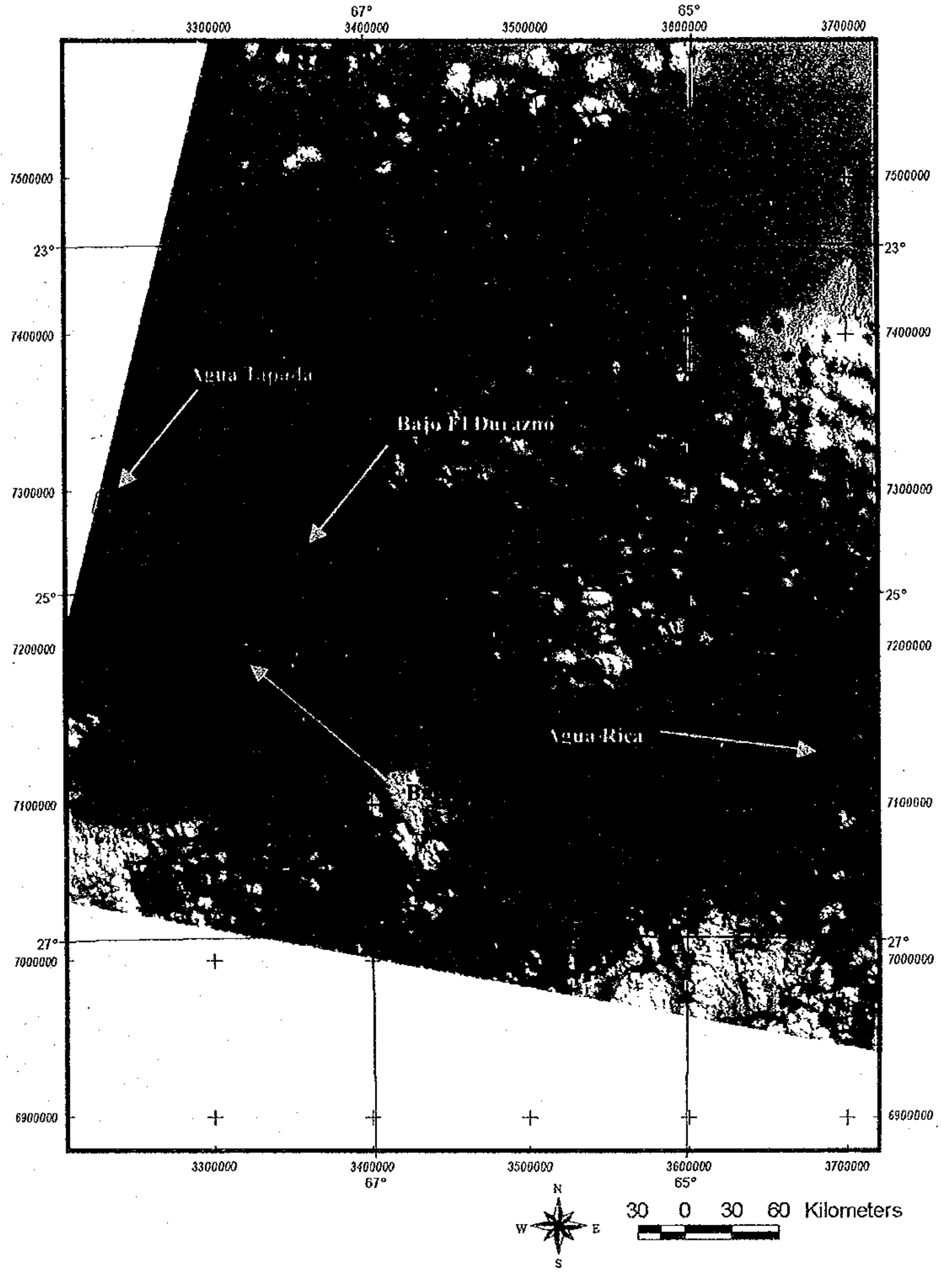
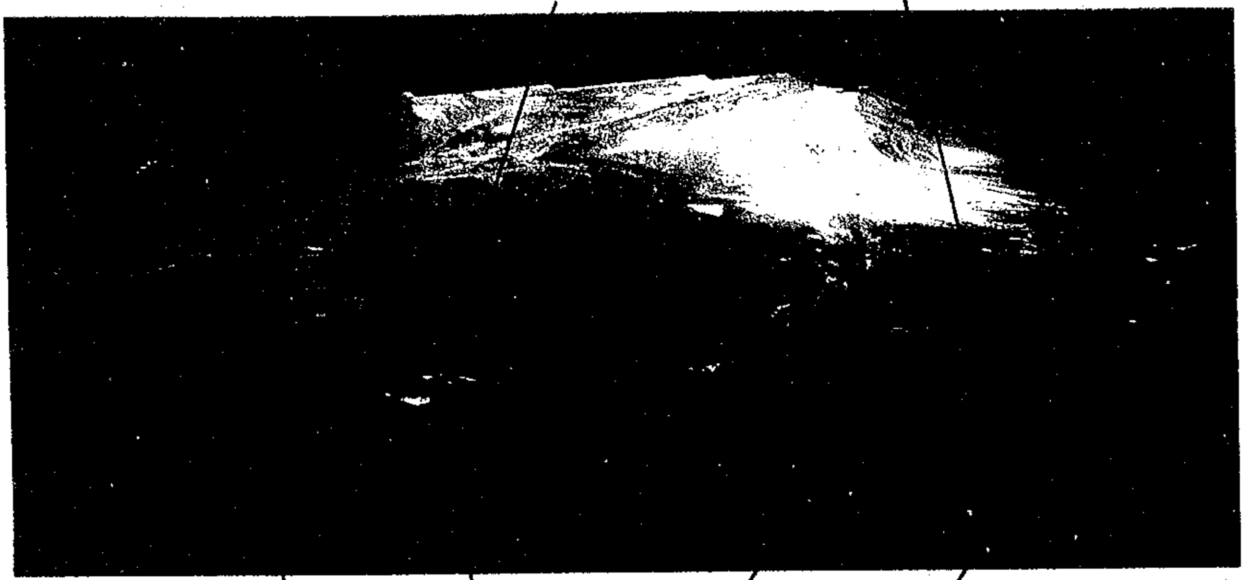
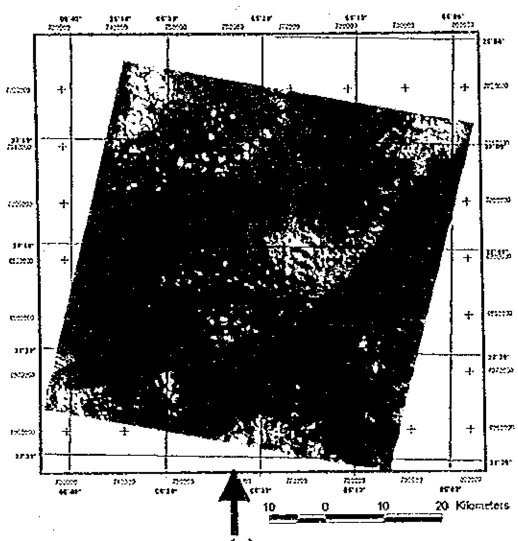


Fig.II-5-2-35-2 Bajo de la Alumbrera deposit, Agua Tapada, Bajo El Durazno (ASTER)

ASTER image 6601



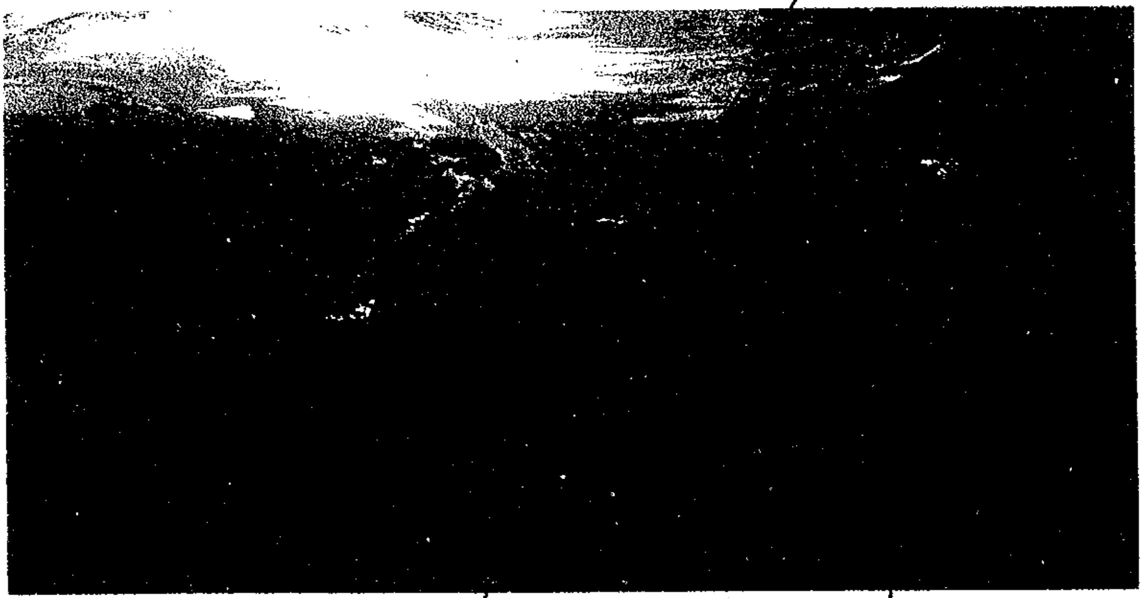


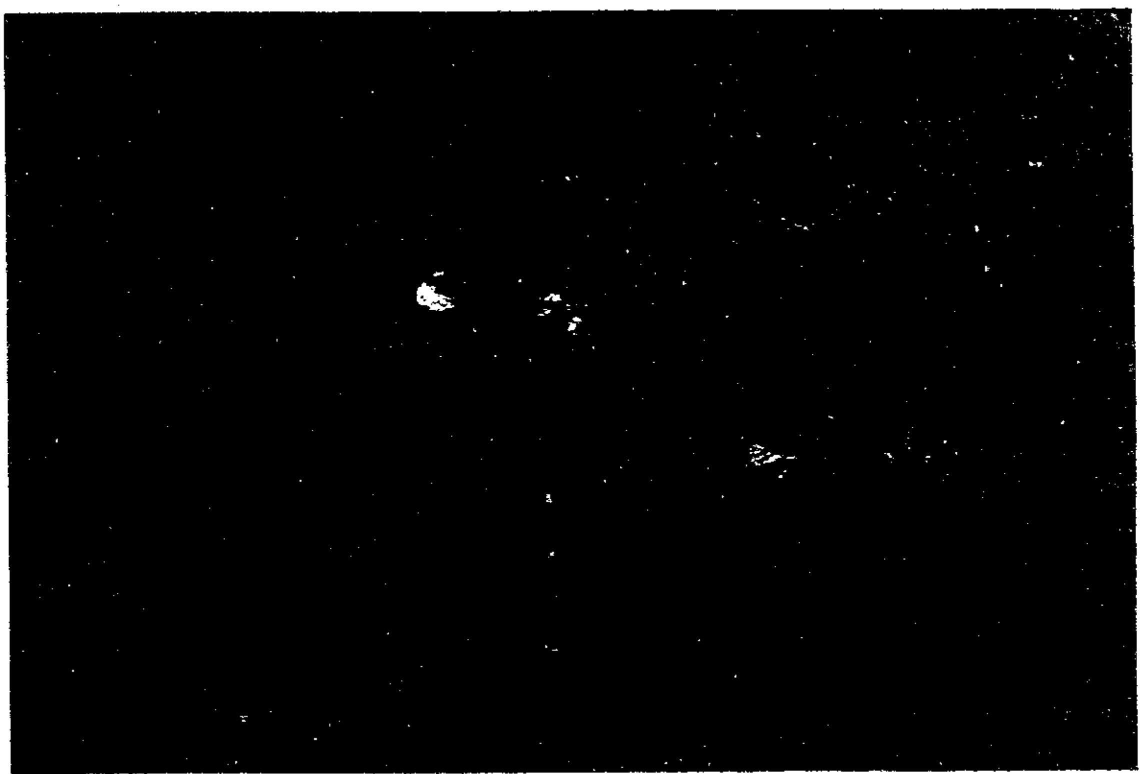
FigII-5-2-35-3 Agua Tapada occurrence, Bajo de la Alumbrera deposit, Bajo El Durazno occurrence
Agua Rica deposit, Capillitas deposit, Capillitas NE alteration

*DEM(ASTER6601 only) data source: SEGEMAR GEOSAT, SEGEMAR/JICA project

**BGR=123(VNIR),Vertical exaggeration 2.0, Processed by ENVI 3.4

ASTER image 6601





FigII-5-2-35-4 Bajo de la Alumbrera deposit, Bajo El Durazno occurrence, Agua Rica deposit
Capillitas deposit, Capillitas NE alteration

*DEM(ASTER6201 only) data source: SEGEMAR GEOSAT, SEGEMAR/JICA project

**BGR=123(VNIR),Vertical exaggeration 2.0, Processed by ENVI 3.4

3) Past surveys

Refer to the information given for Bajo de la Alumbrera.

4) Geology and tectonics

Refer to the information given for Bajo de la Alumbrera.

5) Mineral showings and alteration

The mineral showings (alteration No. 50) is located within the mine property of YMAD (Catamaraca State Resources Development Corporation) with its alteration zone developing in a white to light red color into a practically circular shape of nearly 2 km in diameter. The wall rocks are andesitic to dacite volcanic rocks and are said to be older than those existing in the vicinity of Farallon Negro. There is silicification in the center of alteration, shifting to argillic ~ propyritic toward the exterior.

6) Characteristics of the satellite image

On the ASTER false color images, the alteration zone is shown as a somewhat white distribution area, but it is not so clearly visible. On the color-ratio composites, however, it is distinguishable enough in a white color. Oniso-grain model images, (Kaoline + Alunite images), the central portion is clearly shown in a red color (with Kaoline distributed in this mineral showings) and a green area showing Sericite.is distributed in the surroundings. The clear gossan of Geothite is also accompanied. Further, a weak alteration zone in which Sericite is observed exists on its southeast side (alteration zone Nos. 39 and 45).

7) Comments

8) Reference materials

5-2-36 Bajo de la Alumbrera ore deposit (Zone 43)

1) Location

This deposit is located about 55 km northeast of Belen, Belen County, Catamarca State, at lat. 27°19' 47.2" S, long. 66°36' 20.7" W (outcrop of Esperanza Vein), and about 2,700 m above sea level.

2) Access

The mine gate is reached by driving a car for about one hour from Nachimientos de Abajo along National Road 40, then southeastward on an unpaved road for the mine.

3) Past surveys

* 1949: Tucman University carried out geological surveys of this area as a topographical depressed

ground (Bajo) showing abnormal color.
* 1963: Direccion Nacional de Geologia Mineria prepared a geological map drawn on a scale of 1 to 5,000 and carried out geochemical exploration.
* 1968 - 1982: A geological map, zonation map of alteration zone, geochemical exploration, IP exploration, drillings (71 holes, totally 18,970 m) were executed as a part of Plan NOA-1 prepared by YMAD and the United Nations. A k-silicate alteration in the central part and a quartz and magnetite zone were confirmed. As Cu anormaly in the K-silicate zone and an anormaly high value of Au were confirmed, the zone attracted attention as a large-scale porphyry copper and gold deposit.
* 1922: International Musto Exploration Ltd., a Canadian company, obtained the exploration right, re-analyzed about 10% portion of past drilling cores (20,000 m), and carried out new drillings (17, totally 7,400 m) and an F.S. (Feasibility Study).
* 1994: MIM Holdings Co., Ltd. took over 50% of the rights and interests, and carried out new drillings (12,950 m).
* 1995: International Musto Exploration Ltd., holding half of the rights and interests, was separated and merged into Rio Algom Co, Ltd. and North Ltd.
* August 1997: MIM officially started development in October 1997.
* February 1998: Full-scale production was started. Initial investment made until the opening of the mine was 1.2 billion dollars. The initial amount of soil and rock stripped was 25 Mt, and the stripping ratio was 1.4 to 1. Mine ownership wholly belongs to YMAD (a mining public company owned by Catamarca State Government (60%) and Tucman University (40%)). Minera Alumbrera Ltd. holds the mining lot exploitation right by lease. Shareholders of Minera Alumbrera Ltd. are Mount Isa Mining (MIM) Holdings Ltd. (50%), Rio Tinto plc. (25%) and BHP-Billiton (25%). Minera Alumbrera Ltd. pays 20% of earnings as royalty to YMAD (from 2002). Last December, the royalty to be paid to Catamarca State was determined to be 3% of the price in forest, from which cost is subtracted.

The present minable ores are 385 Mt (confirmed plus estimated; the average grade: 0.55 % Cu, 0.64 g/t Au, as of June 30, 2001). Crude ore production by open-cut mining is 80,000 t/day. In the production plan, that of copper (in fine ores) is 178,000 t/y (actual yield: 91 %) and that of gold (in fine ores) is 590,000 oz/y (actual yield: 70%). Production in the 2000 fiscal year was as follows: copper (in fine ores) was 160,116 t/y, gold (in fine ores) was 557,200 oz/y (actual yield: 70%) and silver (in fine ores) was 736,100 oz/y. Cash cost per pound is $0.42/lb, which means this mine is one of the prominent low-cost mines in the world. The range of mining at the open pit is 1.8 km x 1.8 km, and bench height is 17 m. Heavy mining machines used include five large-sized drills, 4 shovels with 43-bucket capacity, 35 dump trucks capable of loading 240 t and 2 auxiliary shovels. Fine ores are transported though slurry pipes to Tucman, 316 km away, carried to a dedicated port in Rosario, Santa Fe State, by rail after dehydratioon, and then exported to countries such as Japan and Korea by ship.

3) Geology and tectonics

Geology around this area is Pre-Cambrian to Cambrian metamorphic basement rocks (El

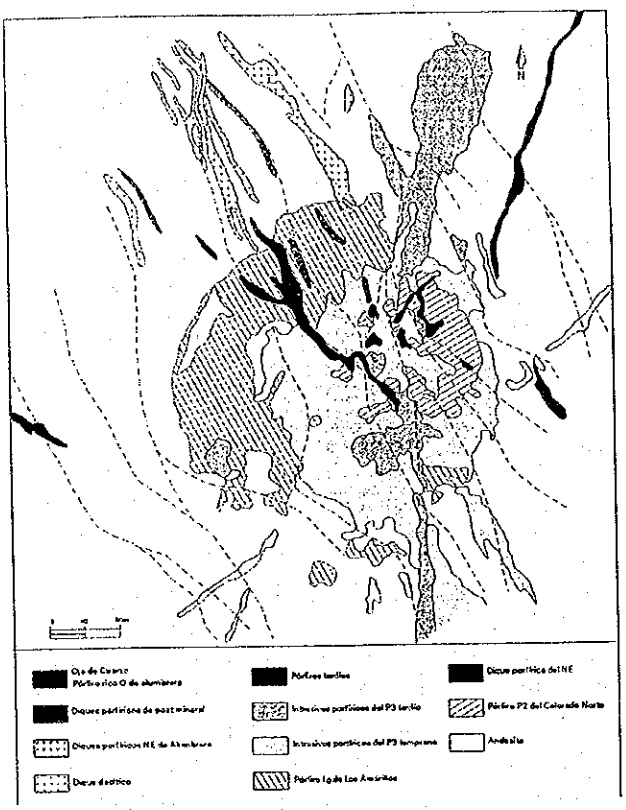


Fig.II-5-2-36-1 Geology of the Bajo de la Alumbrera mine.(taken from Angera,J.A.,1999)

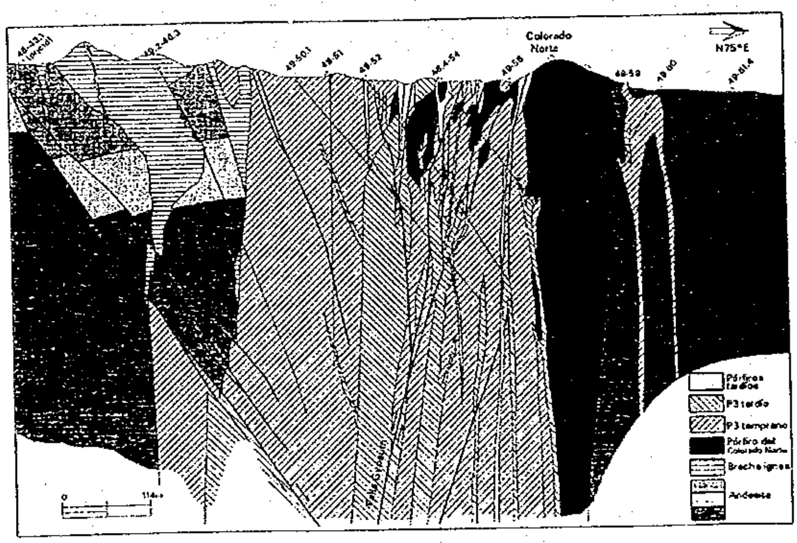


Fig.II-5-2-36-2 Geological sectiom of the Bajo de la Alumbrera mine.(taken from Angera,J.A.,1999)

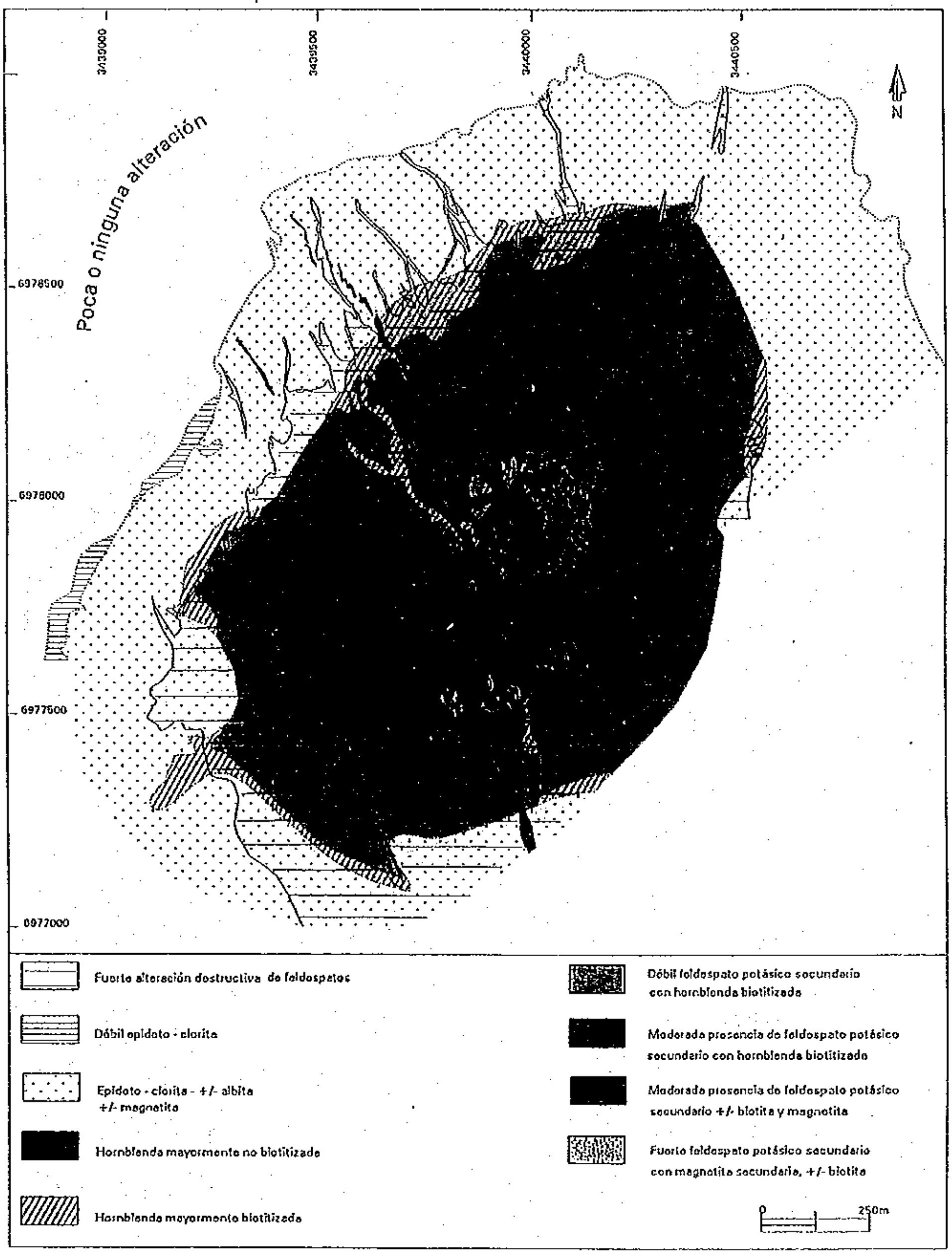


Fig.II-5-2-36-3 Hydrothermal alteration zones of the Bajo de la Alumbrera mine. (taken from Angera,J.A.,1999)

Suncho formation, gneiss and phyllite), Ordovician granite rocks (Capillitas Granite), and a Miocene volcanic rock composite body (Farallon Negro Volcanic Complex) (Fig. II-5-2-36-1). This deposit shows typical porphyry copper and gold mineralization and zonation of alteration zones. The topography before mining formed depressed ground (Bajo, 2.5) exposed on the ground surface by erosion of the volcano.

Farallon Negro Volcanic Complex is magmatic-arc volcanic rocks formed when magmatic-arc volcanic activity of the Andes expanded from the Chilean side to the Argentine side in the middle and late Miocene. Lithofacies are composed of volcanic ejecta of various compositions, such as volcanic rocks with andesite dominant, polymictic breccia, andesitic or basaltic lava flow and pyroclastic material lens, all of which are passed through by more alkali shallow intrusive rocks including dacite porphyry, monzonite porphyry and grnodiorite porphyry. It is considered that mineralization was brought about by small-scale dacite porphyry stock (7.10±0.13 Ma - 6.83±0.07 Ma), and extends to dacite porphyry stock and andesitic effusive rock in the impregnation form. Intrusive rocks are controlled by a wide-area structure and show a NW-SE tending strike.

5) Mineral showings and alteration

A geological map and a cross section of this deposit are shown in Figs.II-5-2-36-2 and II-5-2-36-3. It is considered that what exerted copper/gold mineralization in the dissemination or stringer form upon this deposit is a series of dacite porphry intruding into Faralon Negro Volcanic Complex. It intrudes into the center in a stock-like form and in the form with a dike of northwest to southeast strike. Mineralization extends to dacitic intrusive rocks and andesite of intruded rocks. Rocks in the mine are classified into several types according to difference in composition and texture (phenocryst). Namely, rocks are roughly classified as P1, P2, P3 (P is abbreviation of porphyry), barren cores and andesite ores.

Rocks of P1 are porphyry stock distributed in the north and northwestern parts. This porphry shows fine to equigranular texture and has quartz veins scattering locally. Its special feature is that feldspar is disintegrated by phylic alteration. Mineralization is weak.

Rocks of P2 are porphyry stock rich in mineralization of copper and gold. The primary minerals and texture are destroyed by strong k-silicate alteration. Although phenocryst is small, primary biotite, secondary biotite, secondary potassium and secondary quartz are observed. Plagioclase survives in the parts with weak alteration. Groundmass is pink, comprising quartz, potassium, biotite and magnetite, and has strong magnetism.

Rocks of P3 are also porphyry with k-silicate alteration. The difference from those of P2 is that these rocks have more phenocrysts and the degree of mineralization and k-silicate alteration are weaker than those of P2. In addition to having the same secondary minerals as P2, many phenocrysts of plagioclase survive.

The texture of barren-core rocks resembles that of P3, but impregnation of chalcopyrite is small as a natural result, and mineralization of pyrite and magnetite are observed. These rocks belong to the k-silicate alteration zone in the central deep part of porphyry stock.

Andesite ores are rocks intruded by the above-mentioned intrusive rocks, and andesite near rocks of P2 are important ores rich in mineralization. Alteration is k-silicate alteration and is characterized by development of magnetite and impregnation of pyrite and chalcopyrite.

In Alumbrera Deposits, oxidized zones and secondary additional zones are thin, and primary sulfide ore bodies are produced several tens of meters under the ground surface. Minerals to be mined are these primary sulfide ores. Produced minerals are chalcopyrite, native gold, molybdenite, pyrite, magnetite, galena and zincblende. Gold is 10 to 50 μ and accompanied by pyrite, chalcopyrite and gangue silicate. Secondary additional zones are thin and produce chalcocite, covelline and bornite.

Alternation zones form a zonal structure of typical porphyry copper deposits. Three alterations are widely arranged in the concentric-circle form (Fig. II-5-2-36-4). There is distribution of k-silicate alteration zones at the center, an epidote, chlorite alteration zones (propylitic) surrounding them, and alteration zones with disintegrated feldspar (phyric) covering the outer edge of the k-silicate alteration zones.

The k-silicate alteration zones are characterized by biotitic alteration of amphibolite, potassic alteration of plagioclase and development of quartz veins. The central part of the k-silicate alteration zones has strong alteration, is impregnated by secondary magnetite, and contains a core poor in mineralization (a barren core). The place around this core is a mineralized zone where copper thickens the most.

Epidote and chlorite alteration zones (propylitic) are distributed, surrounding k-silicate alteration zones. Outside of them, fresh andecite is distributed with a transition zone of several meters between. Mafic minerals change to chlorite, chlorite - magnetite, epidote - magnetite and epidote - chlorite, while plagioclase changes to albite, albite - epidote and partly sericite.

Alteration zones (phylic) with feldspar disappearing are distributed, surrounding or covering the copper mineralization zone in k-silicate zones. These zones are characterized by argillization (sericitic alteration) and silicification of feldspar, development of pyrite veins, and chloritic, clay or sericitic alteration of mafic minerals. In the end part, zones with high argilization are partly observed. Near the surface, oxidized or leached zones are also recognized, and jarosite capping and hematite capping are observed.

Andesite with mineralization (A01RT004) has received strong quartz - magnetite alteration, and the texture of its source rock is disintegrated. Impregnation of pyrite, chalcopyrite and a very small amount of bornite, and chlorite replacing mafic minerals are slightly observed. Although the amount of P2 porphyry (A01RT005) is small, the feldspar group survives a little. Dissemination and stringers of pyrite and chalcopyrite and a very small amount of bornite are observed. The following values are shown from the results of chemical analysis: Au of 0.46 g/t, Cu of 3,440 ppm and K of 3.0 %. P3 porphyry (A01RT006) has received weak k-silicate alteration. As phenocryst, potassium and plagioclase are observed and biotite and magnetite are also observed partly. Both mineralization and magnetism are weak. Barren core rocks (A01RT007) have a texture resembling that of P3 rocks and have many phenocrysts. The following minerals formed as a result of k-silicate alteration are observed: phenocryst of secondary potassium, secondary biotite and primary amphibolite, and fine secondary quartz, pyrite and magnetite.

6) Characteristics of the satellite image

7) Comment

This area is a large-scale porphyry copper and gold deposit operated now, and has been studied and surveyed most minutely in zone 43 (Farallon Negro in a broad sense). It is desired to utilize this area as a teaching field for analysis of ASTER images.

5-2-37 Bajo de la Durazno mineral showings (Zone 43)

1) Location

At 27°17'13" S. Lat., 66°34'25" W. Long., 3,100 m above sea level. The distance is the same as that to Bajo de la Alumbrera, Belen Counry, Catamarca state; it is located about 4 km northeast of the mine.

2) Access

Access is gained easily by the use of mine roads.

3) Past surveys

Refer to the information given for Bajo de la Alumbrera.

4) Geology and tectonics

Refer to the information given for Bajo de la Alumbrera.

5) Mineral showings and alteration

6) Characteristics of the satellite image

The ASTER images discriminated an alteration zone comprising Kaolinite and Sericite, and Geothite (alteration zone No. 40). Kaolinite concentrates locally. The alteration zone made up of Sericite develops a brown color on the ASTER false color images and is not distinctly discernible, but on the color-ratio composites it shows a white color clearly. In addition, a similar small-scale alteration is observed at a place about 1.5 ~ 4 km north of this mineral showings (alteration zones Nos. 48, 52, etc.).

7) Comments

8) Reference materials

5-2-38 Agua Rica (Zone 43)

1) Location

This place is located at the southwestern end of Aconquija mountains 25 km north-northeast of Andalgala, Angalgal County, Catamarca State, at lat. 27° 22' 15.3" S, long. 66° 16' 48.0" and about 3,000 to 3,200 m above sea level.

2) Access

This deposit is accessed by driving a four-wheel-drive car about 30 minutes from the town of Angalgala northward to the gate on private land of Aqua Rica (BHP), and then going on an unpaved mine road for about one hour.

3) Past surveys

1918: Deposit was discovered.

1950 - 1960: Several geological and resource geological surveys and studies.

1969: Grupo Mutio Co., Ltd. obtained eight mining rights including this area, and established Compania Minera Agua Rica S. A. by joint investment with another company. Five shallow drillings were carried out as preliminary investigation. Impregnated mineralization and a secondary enriched zone were confirmed.

1970 - 1972: Cities Service Argentina S.A. carried out geological survey, geochemical exploration, analysis of hydrothermal alteration zones and drillings (36, totally 7,927 m) according to an option contract. Upon the termination of the option right, ownership returned to Agua Rica S. A.

1993: Obtaining agreement with Agua Rica S.A., Recursos Americanos Argentinos Co., Ltd. (R.A.A.) established a joint venture with BHP Minerals Co., Ltd.

1994: A secondary enriched zone was captured by six drillings, but the level of economic effectiveness was not reached.

1995: Northern Orion Exploration Co., Ltd. purchased the rights of R.A.A., and joined the joint venture with BHP, which continues to the present time.

1999: Pre-feasibility study was completed. Drillings of 67,700 m in total were carried out, and two pits (350 m in total) for the metallurgic and environmentally scientific purpose were excavated.

2001: BHP-Billiton holds 70% of rights and interests and Northern Orion holds 30%.

3) Geology and tectonics

Geology around this deposit is metamorphic basement rocks of the Upper Proterozoic to the Lower Cambrian (Ambato Complex, Sierra de Aconquija Complex and Sunco Formation), Ordovician granite rocks (Aconquija Batholith and Capillitas Granite), a Neogene complex of sedimentary rocks and volcanic rocks, and intrusive rocks concerned (Fig. II-5-2-38-1).

The Neogene sedimentary rock and volcanic rock complex and intrusive rocks concerned are distributed near the bordering part of metamorphic rocks and Ordovician granite rocks. In the upper part of sedimentary rocks (in Calchaquenses layer), red sandstone originating in volcanic rocks is dominant, and is compared with Miocene El Morteritos multiple seam in Farallon Negro area. The volcanic rock complex and intrusive rocks (Farallon Negro Volcanic Complex) are distributed, accompanying several volcanic centers or covering sedimentary rocks. Lithology belongs to the acid (to basic) calc-alkali rock system, and lithofacies are intrusive rock bodies, breccia, tuff, lava flow and dikes.

Intrusive rocks are mainly classified into Melcho Intrusive Complex, Seca Porphyry and Trampeadero Porphyry. These intruded into the existing rocks in the Upper Miocene (8.6 - 5.87 Ma).

Melcho Complex is distributed over the 2 km x 2 km in the southern part of this area, and is comprosed of various porphyric intrusive rocks. Namely, it is mainly made up of quartz monzonitic diorite, quartz monzonite and monzonitic diorite. Besides these, the complex is accompanied by diorite, granodiorite and granite. Mineralization is weak and the main alteration is propylitic alteration. As the age of intrusion, 8.56 ± 0.48 Ma has been obtained by the Ar/Ar Method of amphibolite (Sasso y Clark, 1998).

Seca Porphyry is distributed over the 550 m x 550 m on the north side of Seca Valley in the west part of this area. Alteration is strong, and the texture of the source rock does not survive. The K-Ar age of secondary biotite is shown as 5.1 ± 0.05 Ma (Amdel, 1995). Strong phylic alteration (quartz-sericite-andalusite) overprints biotite-magnetite alteration preceding it. This porphyry has received strong mineralization.

Trampeadero Porphyry is distributed in Trampeadero in the east part of this area on a scale similar to Seca Porphyry. The texture of the source rock survives more than in Seca Porphyry. On the upper part of phylic alteration, a high clay alteration zone consisting of alunite and pyrophillite is observed. It has received strong mineralization. Breccia rocks are divided into hydrothermal breccia, igneous breccia and diatreme breccia, and are distributed, apparently filling space among the above-mentioned porphyry.

Hydrothermal breccia is distributed from the central part to the east part in this area. There are the main rock body with a ground-surface range of 700 m x 500 m at depth of about 700 m, and smaller breccia pipes. There are various types of breccia ranging from monomictic breccia (metasediments and porphry) with a little matrix which has moved little from the source rock, to polymictic breccia (metasediments, siliceous metamorphic rocks, granite, porphyry, quartz vein and breccia) that has much matrix and includes pebbles. The matrix is comprised of hydrothermal minerals (clay and sulfide) and fine rock flake. This breccia shows high clay alteration (partly phylic alteration) and has received strong sulfide mineralization.

Igneous breccia is distributed on the north side of the main rock bodies of Trampeadero Porphyry and of hydorthermal breccia generally in the northwest to southeast direction. The spread changes within 450 m in the strike direction and within 100 to 250 m from south to north. Rubble is polymictic, including metasediments, granite, mineralized porphyry, hydrothermal breccia, quartz vein rock flakes, vuggy quartz and siliceous metamorphic rocks. The volume of matrix changes from 0 to 50%. The main alteration is high clay alteration that is partly accompanied by silicified alteration of the leaching type. Mineralization of sulfide appears in relation to stringers with supergene origin and secondary enriched zones. On the other hand, there is no pultonic mineralization of sulfide.

Diatreme breccia is distributed in the northwest part of this area in a almost circular form of about 700 m in diameter. Sixty percent of rocks are matrix supported and the grain size is silt to sand. Grains are impregnated by pyrite and cemented by clay. Rubble is polymictic, including metasediments, granite, mineralized porphyry and quartz vein rock flakes.

3) Mineral showings and alteration

Mineralization in this area is, according to the report of BHP-Billiton Co., Ltd, classified into the following three different stages:

① Initial mineralization of porphyry type is related to Seca Porphyry and Trampeadero Porphyry, and shows impregnations in quartz-stockwork and impregnation forms. Mineralization in this stage consists of pyrite, molybdenite, chalcopyrite and a small amount of bornite and magnetite. Observed in Melcho Complex on the south side of the main part of the deposits is plutonic mineralization of the early time related to quartz stringers accompanied by pyrite, chalcopyrite and a small amount of bornite. The following K-Ar ages have been obtained regarding Melcho Complex: 7.03 $\pm$ 0.10 Ma and 6.29 $\pm$ 0.06 Ma for secondary biotite, and 6.10 $\pm$ 0.04 Ma for sericite.

② Following a porphyry event, mineralization in the epithermal stage occurred. This is observed in the phylic zone of hydrothermal breccia and Trampeadero Porphyry in the central part, and the high clay alteration zone. Comprising minerals are pyrite, covelline, bornite, enargite, molybdenite, galena, sphalerite, marcasite, rhodochrosite and native sulfur. These are hosted in the impregnation or stringer form or fill vacant spaces of rubble. Plutonic covelline is widely distributed in this area. This is considered to be pyrite/bornite in the porphyry stage that had received plutonic leaching.

③ Supergene chalcocite and covelline were formed by immature supergene enrichment of pultonic chalcopyrite and covelline. The remaining matter of the former continuous enriched blanket is distributed, covering both Seca Porphyry and Trampeadero Porphyry. The oxidized zone has a thickness of 50 to 150 m and extends over 260 m in the west part. In the oxidized zone, jarosite and goethite are dominant and accompanied by a small amount of hematite. Below the oxidized zone, there is a secondary enriched zone of immature and irregular form, the maximum thickness of which reaches 200 m. Powdery and slightly black chalcocite is dominant in the upper part of the secondary enriched zone, and it is gradually replaced by covelline downward. The content of copper in the secondary enriched zone is 0.5 to 1%, and reaches 1.5% locally.

Fig. II-5-2-38-2 shows a zonation map of alteration zones. In this area, k-silicate alteration zones are not remarkable, which is different from many other porphyry systems. Under the ground surface in the south part of this area where copper abnormality is not high, although there is survival of a core of hydrothermal biotite - magnetite/hematite, it is considered that almost all of the biotite, potassium and magnetite had been erased by later strong overprint of phylic alteration and high argillic alteration.

High argillic alteration zones are arranged, surrounding hydrothermal breccia pipe in the central part of this area. The extension of the ground surface is about 800 x 1,000 m and the difference of elevation is approximately 800 m. The vicinity is surrounded by phylic zones, and silicified zones are also observed inside. Alteration minerals are represented by alunite and pyrophylite, which are accompanied by diaspore, dickite, kaolinite, zunnyite and topaz.

Phylic alteration zones are of the sericite-quartz-pyrite type; they are widely distributed and develop well in Seca Valley. On the other hand, phylic alterations do not have unity and are irregular due to high clay alteration located above the zones in Trampeadero. Sericite replaces phenocryst of porphyry and develops in impregnation or stringer form. Accompanying minerals are andalusite, corundum, rutile and zircon.

Propylite alteration zones are locally distributed in the parts along the outer edge of phylic alteration zones, and are particularly remarkable in Melcho Complex. Alteration minerals are mixture of chlorite, epidote, pyrite and calcite. Chlorite is further replaced by hornblende and biotite in many cases. Calcite stringers are also recognized in metasedimentary rocks outside the main alteration zone. Porphyry are in the peripheral part, and alteration of the sericite-chlorite-clay type is also observed.

Melcho monzonitic Porphyry (A01RT008) in the south part, which was examined in the field survey, is fresh Monzonitic Porphyry. Sample A01RT009 has become clay because it received alteration to sericite.

At an outcrop of Trampeaderao Porphyry having received strong alteration to quartz-alunite, quartz veins in stockwork form and vuggy quartz having received acid leaching were observed. The sample (A01RT010) is Trampeadero Porphyry strongly silicified, and has development of quartz veins and white, pink or yellowish white alunite veins. A large amount of quartz and pyrophylite and a moderate amount of Na alunite were identified by X-ray diffraction.

Ore samples (A01RT011) collected inside the mine are impregnated by pyrite, chalcopyrite, molybdenite, covelline and malachite. In the judgement of polished thin section, fine flake sericite and particulate calcite were recognized, and a very large amount of quartz was judged. The judged opaque minerals are a large amount of pyrite, a small amount of covelline, a very small amount of sphalerite, chalcopyrite and stannite. The following values were obtained from chemical analysis: Cu of 4,510 ppm, Au of 1.1 g/t and Mo of 1,050 ppm.

At outcrop of hydrothermal breccia having received high argillic alteration, rubble to pebbles, such as quartz, granite and porphyry, is matrix supported and strongly silicified. Minerals identified by X-ray diffraction of hydrothermal breccia pipe samples (A01RT012) are a large amount of quartz and alunite, and a moderate amount of pyrophylite.

As a result of X-ray diffraction of Seca Porphyry samples (A01RT013) having received typical phylic alteration, a large amount of quartz and sericite were identified.

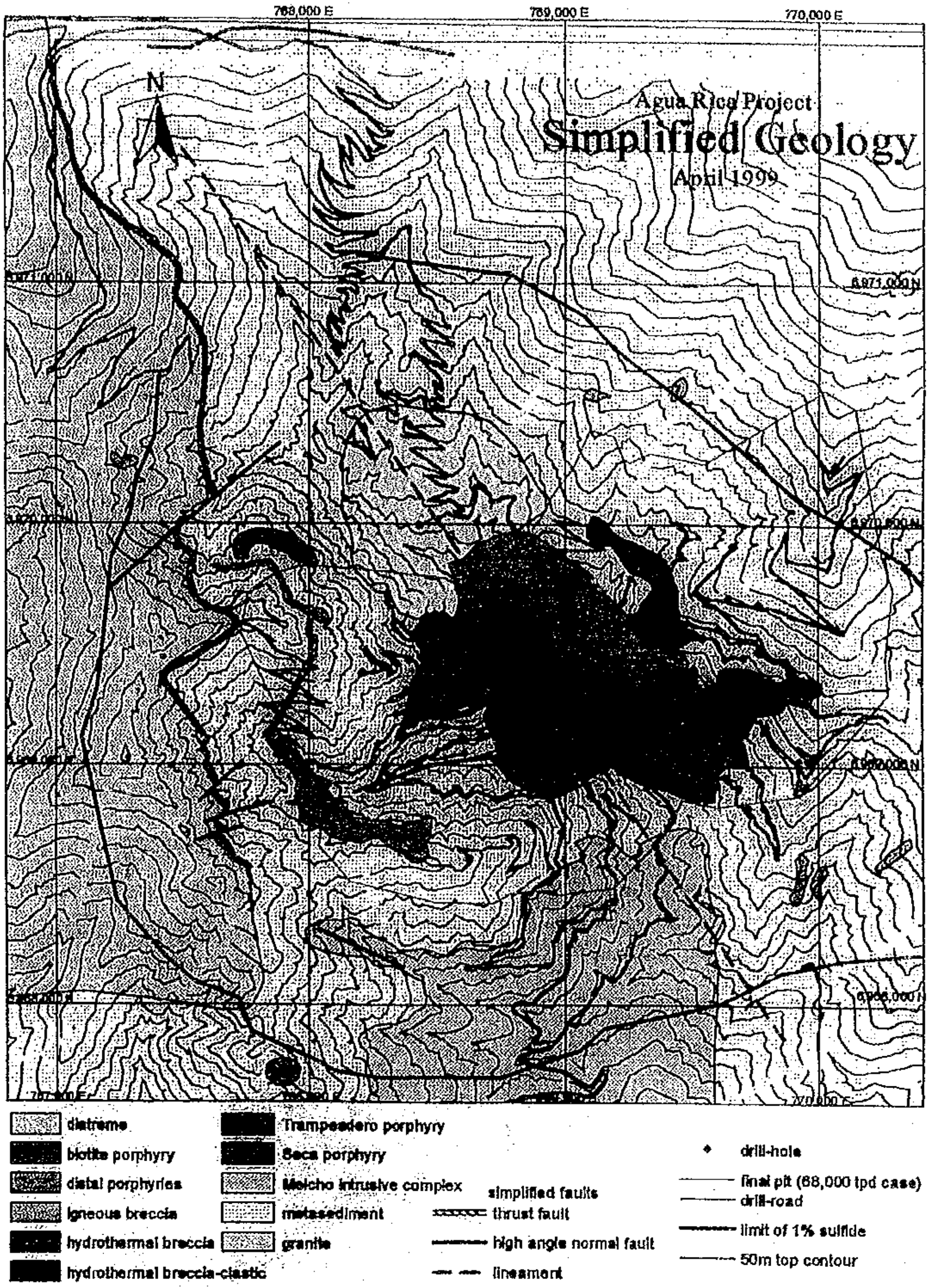


Fig.II-5-2-38-1 Simplified geological map of Agua Rica district.
(after BHP-Billiton and Northern Orion,2001)

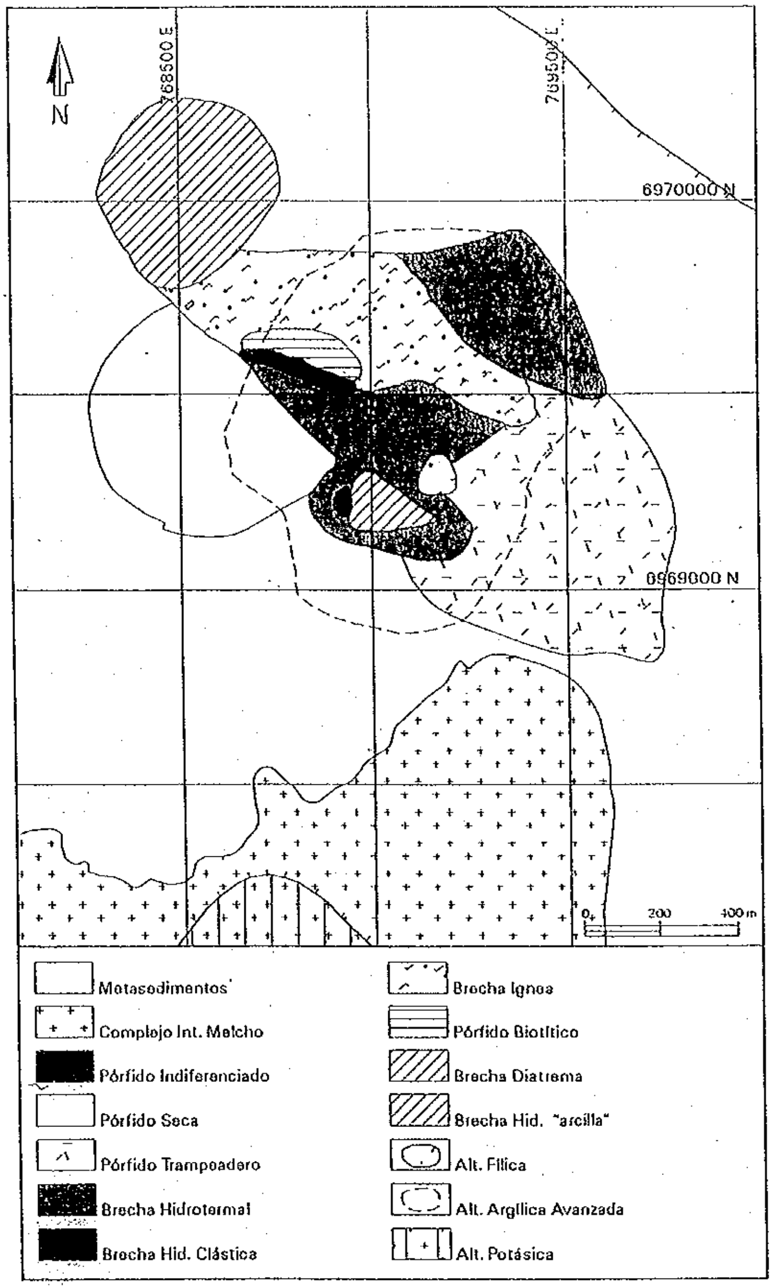


Fig.II-5-2-38-2 Hydrothermal alteration in Agua Rica district.
(taken from Roco,R. y Koukharsky,1999)

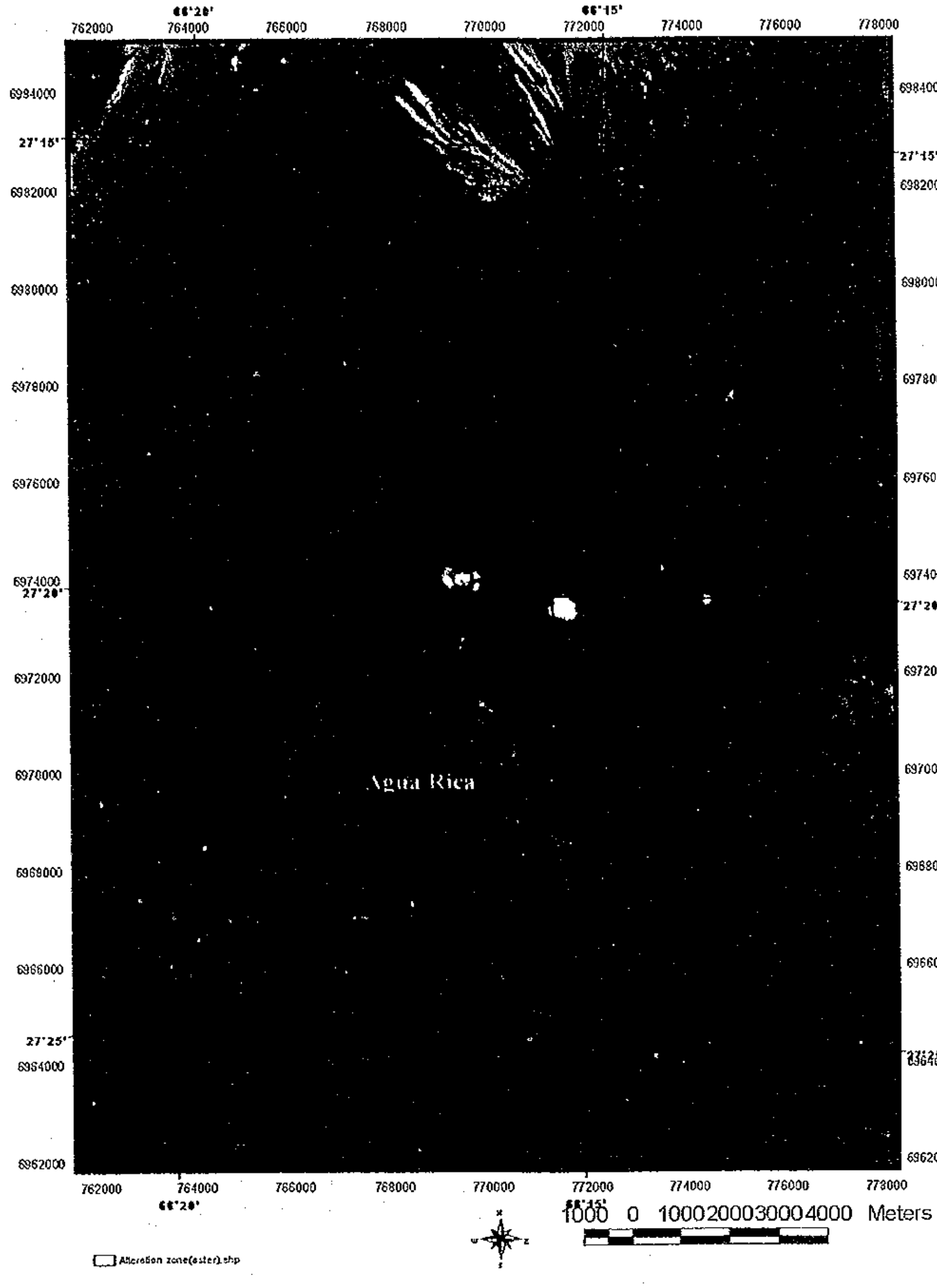


Fig.II-5-2-38-3 Agua Rica deposit(ASTER BGR=123)

4) Characteristics of the satellite image

5) Comment

A feasibility study has been finished in this project, and it is in the state of examination of development. Probably, recovery of copper price is indispensable for the start of development. In this deposit, although alteration zones were not identified from analysis of the LANDSAT TM image, alteration zones were extracted from analysis of the ASTER satellite image. As development has not been started yet and conditions of the ground surface are preserved, it is desired to utilize this deposit as a teaching field in the analysis of images in the future.

5-2-39 Capillitas mineral showings (Zone 43)

1) Location

This area is located on the eastern slope of the Capillitas mountains, 28 km north north-west of Andagala, in Angalgala county, state of Catamarca, at 2900 m above sea level, at lat. 27°20'29.8"S and long. 66°22'52.7"W.

2) Access

Approx. 60 km north from Angalgala via State Road 47, a three-hour drive by a four-wheeled vehicle.

3) Past surveys

*Before the colonial age: Intermittent gold mining.

*1950s and onwards: Drilling of rhodochrosite for jewelry.

*1940s: Mining of gallery and drillings (5 holes, 221 m) by the army. The quantity of minerals was calculated as follows, with a determined quantity of 42,118t (Au: 5.7 g/t, Ag: 250 g/t, Cu: 4.4%), an estimated quantity of 58,632t (Au: 4.1g/t, Ag: 196 g/t, Cu: 3.8%), and an expected quantity of 120,000t.

*1948-49: Mining of a gallery of 1 km, drillings (2 holes, 80 m) were carried out. The quantity of metal was calculated as follows, with a determined quantity of Au: 878.6 kg, Ag: 33,614 kg, and Cu: 6,991 t, and an estimated quantity of Cu: 2,931 t, Au: 322.6 kg, and Ag: 10,290 kg.

*1978-81: JICA has carried out a survey on abandoned pits, geophysical prospecting (IP, electromagnetics), geochemical survey, and drillings (4 holes, 1,724.8 m), and calculated a determined mineral quantity of 387,000 t (Au: 2.6 g/t, Ag: 108 g/t, Cu: 2.31%) and an estimated mineral quantity of 675,000 t.

*1988 and onwards: Interests of the mines have been leased to Minera Andina company, which drilled rhodochrosite for jewelry on a small scale.

4) Geology and techtonics

The geology around the mineral showings consists of Ordovician-Silurian granitic hedrocks (Capillitas granite), Miocene El Morterito formation, and upper Miocenic to lower Pilocene volcanic complex (Farallon Negro Volcanic Complex). (Fig.II-5-2-39-1)

Capilitas granite forms a foundation block of 15 km in length and 5 km in width. It is separated by two faults, one in a north-east direction and another in a south-west direction. The kind of rocks is mainly adamellite porphyry, often accompanied by xenolith such as crystalline schist and pegmatite. The ages of intrusion obtained in K-Ar age designation are 471 Ma and 414 Ma (Acenolaza et al., 1982).

Miocene El Morterito formation, similar to the Farallon Negro zone, consists mainly of reddish sandstone, and the extent of distribution is limited.

The upper-Miocene to lower-Pliocene volcanic complexes are located on the west side of the Aconquija mountains, covering the upper part of El Morterito formation and surrounded by granite rocks. These complexes form an oval-shaped diatreme extending NE-SW with a longer diameter of approx. 1,500 m. The kind of rocks are rhyolite, breccia rhyolite, rhyolito-granitic breccia, dacitic porphyry, rhyolito-trachytic acidic vein, basaltic basic rock vein and so on. These constitute the depository wall rock and are affected by alteration. JICA (1978-81) has determined the K-Ar age of dacite and rhyolite in these volcanic complex as 5 $\pm$ 0.5Ma.

5) Mineral showings and alteration

The deposit around the mineral showings is identified as a polymetall vein deposit of a highly sulfidic type. Nineteen mineral veins originate from granite and volcanic rocks. The veins extend in two directions, ENE-WSW and WNW-ESE. The veins take either lens-like or board-like form of 50-70 cm in width representing linear, undulated or mesh form on the ground surface. The structure of the mineral veins is often represented as stripes, or a variety of minerals forming multicolor bands. The ore minerals in the veins vary widely, with up to 120 kinds of minerals. The primary minerals mainly consist of pyrite, sphalerite, galena, mercasite, magnetic pyrite, chalcopyrite, tetrahedrite-tennantite, enargite, bornite, and gold, and the secondary minerals consist of chalcosite, covelline, bornite, malachite, linarite, limonite, cryptomelane, and pyrolusite. Gangue minerals mainly consist of quartz, rhodochrosite and alunite. The druse of the vein is often accompanied by crystals such as automorphic galena, pyrite, enargite, huebnerite, quartz and barite.

According to the study of homogenization temperature and salt concentration of the fluid inclusion in the quartz vein (and rhodochrosite), the inclusion is divided into two groups by homogenization temperature; a small quantity of secondary inclusion and pseudo-secondary inclusion at 160 - 210℃, and a large quantity of primary inclusion at 220 - 290℃ (with an average of 240 - 260℃). The occurrence of boiling has also been suggested. As for salt concentration, it is estimated in NaCl weight % as 6.5 - 1.1% (with an average of 4.2 - 1.3%). (Marquez-Zavalia, M.F., 1999)

Around the mineral showings, there is a wide distribution of hydrothermal alteration zones.

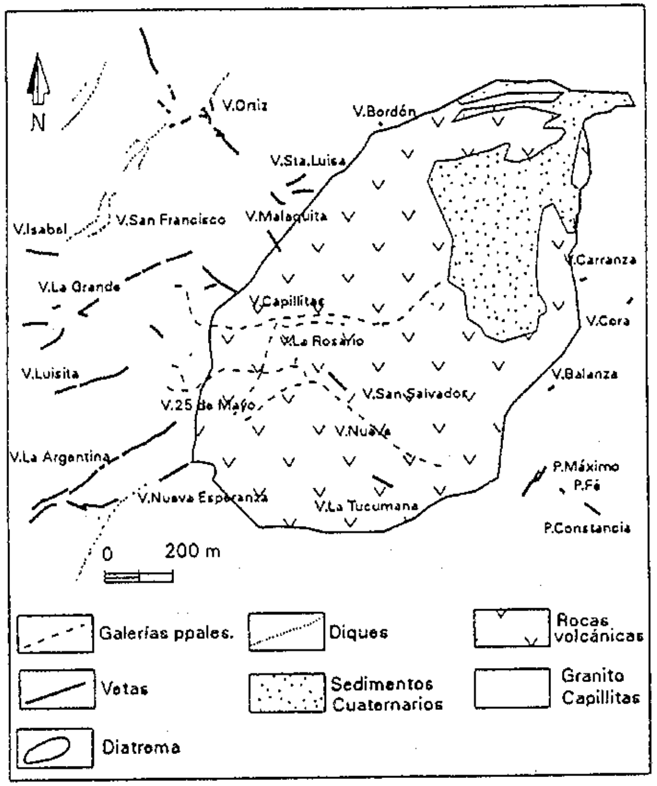


Fig.II-5-2-39-1(a) Mayor lithologic units and location of the veins in Capillitas mine.(taken from Márquez-Zavalía, M.F.,1999)

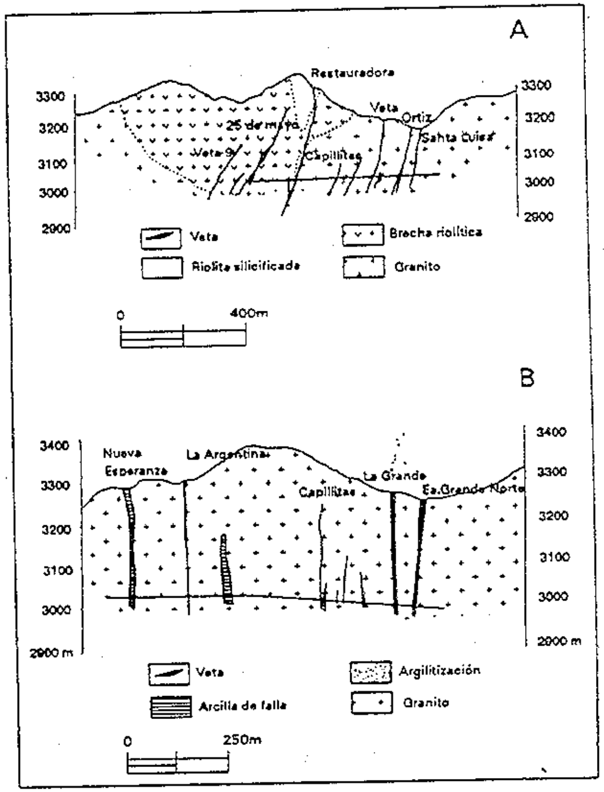


Fig.II-5-2-39-1(b) Schematic profiles.
A: from Nueva Esperanza vein to Isabel vein.
B: from Nueva vein to Santa Luisa vein.
(taken from Márquez-Zavalía, M.F.,1999)

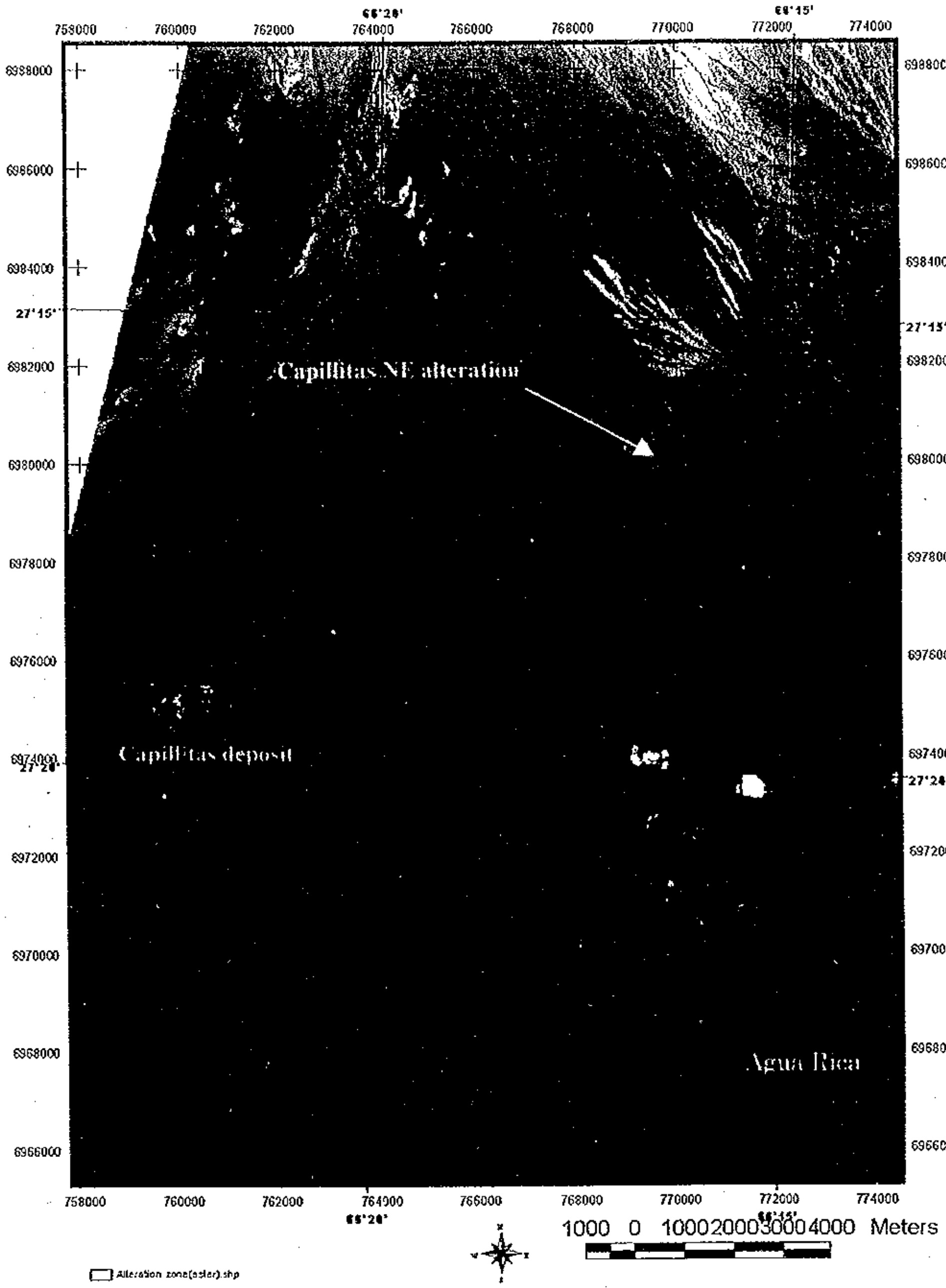


Fig.II-5-2-39-2 Capillitas deposit and Capillitas NE alteration zone(ASTER BGR=123)

But the type and strength of alteration differ according to rock facies. Silicification is widely developed, and in the center and western part of diatreme, a large quantity of quartz filling the druse can be observed. Gap filling quartz is in massive form, and occasionally contains sulfides and sulphosalts. In granitic rocks, silicification is limited to several meters from its contact with veins. A high level of argillization is developed more widely in volcanic rocks than in granitic rocks. An intermediate level of argillization is widely developed along the contact area of veins and wall rock. Sericitic alteration is low, mainly observed in rhyolite and basaltic veins. Propylite alteration is scarcely distributed over the rim.

The field survey revealed pit mouths facing southwest at approx. 2860 m above sea level, and the gallery lies along the vein of rhyolite-dacitic porphyry (5 - 10 m wide). The wall rock of the vein is volcanic breccia, whitened due to intense argillization and silicification. Black manganese gossans are visible over the surface of the vein. Samples (A01RT014) obtained from the vein are whitely silicificated and argillizated. A large amount of quartz and a small amount of pyrophylite has been identified through X-ray diffraction.

6) Characteristics of the satellite image

7) Comment

Although the life of the mine has been terminated, the zone is effective for the environmental prospecting as a highly sulfide epithermal vein deposit.

5-2-40 Capillitas NE alteration zone

1) Location

This area is located approx. 30 km north of Andalgala, Andalgala county, Catamarca state at 2,800 m above sea level, at lat. 27°18'34.8" S, and long. 66°19'16.2" W.

2) Access

Drive a car from Capillitas mine along State Road 47 for approx. 15 km north-east.

3) Past surveys

This alteration zone has been sampled from an analysis of ASTER images. No past surveys.

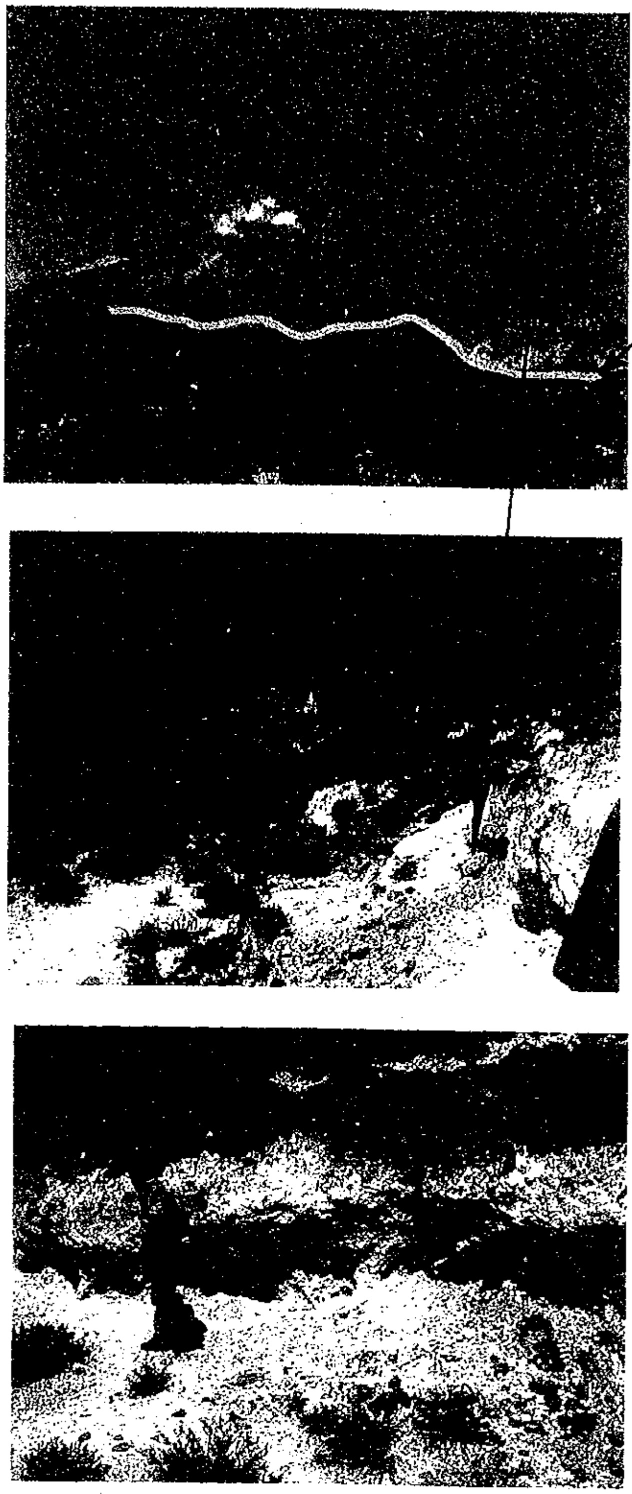
4) Geology and techtonics

The geological composition of this alteration zone is almost identical to that of Capillitas deposit area, but tertiary volcanic rocks are absent. Over the Aconquija mountains on the southeastern part of the alteration zone, metamorphic rocks such as gneiss, amphibolite, and migmatite from upper Proterozoic-lower Cambrian and Capillitas granite of Ordovician are distributed. The northwestern part of the zone is a large dune. A NE-SW oriented fault develops along the northwestern foot of the

(a)

(b)

(c)



Fault

Fig. II-5-2-40-1
Capillitas NE alteration zone.

(a) Distant view
(b) Closed view
(c) Outcrop of the fault zone

Aconquija mountains.

5) Mineral showings and alteration

This alteration zone sampled from ASTER images shows whitish argillization along the fault feveloped in the granite, with no sign of mineralization. Granites around the fault show whitish argillization for a width of 10 - 20 m. Two samples of whitely argillizated granites (A01TK001, A01TK002) were taken, and sericite has been identified in both by the POSAM method. From X-ray diffraction of A01TK001, a large amount of quartz and plagioclase, a moderate amount of potassium feldspar and sericite, and a very small amount of kaolinite have been identified. From X-ray diffraction of A01TK002, a large amount of quartz, plagioclase and sericite have been identified. These sericites are considered to originate from circulation of meteoric water along the fault, or from muscovite, a constituent of granite.

6) Characteristics of the satellite image

7) Comment

In this area, no mineralization or hydrothermal alteration has been observed, nor is there any distribution of Tertiary volcanic rocks. It is considered that the alteration zone was sampled through analysis of ASTER images because of the weathering of granites around the fault.

5-3 Preliminary study for presumption of a mineralized horizon by litho geochemistry (discriminant analysis)

5-3-1 Purpose

As a result of discriminant analysis carried out for core samples collected from the drill holes intersecting the SEDEX mineralized zone in the Mina Esperanza, discriminant coefficients to group the SEDEX mineralized zone, a hangingwall and a footwall of the zone were obtained with a high discriminant rate as 96.1%.

There are numerous uncertainties in applying the result of discriminant analysis of only two drill holes, including whether or not this result can apply to a wide area 100 km or more away where lateral changes are also expected and whether or not geochemical characteristics of the hangingwall found in the limited area with only about 500 m width in the Lower Ordovician (Cardonal, Lampazar and Padrioc formations) have such universality that they are held in the Upper Ordovician.

Here, discriminant analysis was attempted on the Ordovician sedimentary rock samples (Table II-5-3-1) collected in the northern part of the survey area in order to study what results will be obtained in relation to existing information and results of field surveys, and what approach will be possible, if the results of discriminant analysis are widely applied.

5-3-2 Development of the discriminant functions

Using the discriminant coefficients obtained above (Table II-5-2-12-4), we developed three discriminant functions (linear discriminant function $z = a_1x_1 + a_2x_2 + a_3x_3 \cdot \cdot \cdot \cdot a_0$) to discriminate between a hangingwall and a mineralized zone (G1-G2), a hangingwall and a footwall (G1-G3), and a minelarized zone and a footwall (G2-G3).

5-3-3 Results of discriminant analysis

For the 61 samples of the Ordovician sedimentary rock, Table II-5-3-2 shows the discriminant values among the hangingwall and the mineralized zone (G1 and G2), the hangingwall and the footwall (G1 and G3), and the mineralized zone and the footwall (G2 and G3). Fig.II-5-3-1 shows the results of grouping assumed from these values.

The following facts have been clarified from this table:

① Only one siltstone sample (A01YH047) taken from La Candelaria in Zone 15 was discriminated to the SEDEX mineralized zone (G2). The other two samples taken from La Candelaria were discriminated to the hangingwall (G1).

② Of the nine samples taken from the Rio Grande prospect to the north of Mine Esperanza in the same Zone 15, five samples were discriminated to the hangingwall (G1) and four samples were discriminated to the footwall (G3).

③ All of the four samples taken from Zone 2 were discriminated to the hangingwall (G1).

④ Of the ten samples collected from Zone 1, nine samples were discriminated to the hangingwall (G1), and only one sample discriminated to the footwall (3) is that of siliceous siltstone collected around Cienagillas town.

⑤ Of the 13 samples collected from zones 3 and 5, nine samples were discriminated to the hangingwall (G1) and four samples were to the footwall (G3).

5-3-4 Presumption of ore horizon

According to the results of discriminant analysis, siltstone (A01YH047) collected in La Candelaria is discriminated to the SEDEX mineralized zone (G2). According to the results of the filed survey, there is bedding comprising microcrystals of primary pyrite that is thin bedded alternation of siltstone and mudstone. Siltstone (A01YH046) taken around this bedding, which is also accompanied by microcrystals of primary pyrite, was discriminated to belong to the hangingwall (G1). But even if there is epigenetic mineralization of the vein type, there is a high probability that it will be discriminated to the SEDEX mineralized zone (G2). Therefore, unless the footwall (G3) is confirmed in the vicinity, it would be premature to conclude that this siltstone (A01YH047) is the horizon of the SEDEX mineralized zone (G2).

Although no samples were judged to belong to the mineralized zone (G2), if samples discriminated to belong to the hangingwall (G1) and footwall (G3) are distributed adjacently, and if this distribution can be explained geochemically, places like this are more suitable for the horizon of

Table II-5-3-1 Analytical result of geochemical rock samples

Serial No.	Sample No.	Zone	Locality	Rock	g/t Au	ppm Ag	% Al	ppm As	ppm Ba	ppm Be	ppm Bi	% Ca	ppm Cd	ppm Co	ppm Cr	ppm Cu	% Fe	% K	% Mg	ppm Mn	ppm Mo	% Na	ppm Ni	ppm P	ppm Pb	% S	ppm Sb	ppm Sr	% Ti	ppm V	ppm W	ppm Zn	ppb Hg
1	A01YH033	Zone-01	Chocoite	Siltstone	<0.005	1.5	5.80	30	430	2.0	<2	0.60	<0.5	29	62	37	15.39	1.72	0.64	760	8	0.52	119	1200	10	0.03	<5	168	0.07	85	<10	230	10
2	A01YH034	Zone-01	Chocoite	Siliceous siltstone	<0.005	<0.5	5.82	10	690	0.5	<2	0.26	<0.5	9	31	29	2.61	0.64	0.69	135	1	3.01	30	810	2	<0.01	<5	110	0.13	48	<10	38	<10
3	A01YH036	Zone-01	Chocoite	Black shale	<0.005	<0.5	7.40	15	1520	2.5	<2	0.04	<0.5	8	66	18	4.48	2.71	0.91	220	4	0.76	43	480	8	0.21	<5	82	0.21	115	<10	72	<10
4	A01KN072	Zone-01	Cienaguillas	slate	-	<0.5	9.07	5	540	2.5	<2	0.08	<0.5	5	69	41	3.05	2.84	0.30	90	1	0.44	15	160	34	<0.01	<5	96	0.37	98	<10	44	<10
5	A01YH038	Zone-01	Cienaguillas	Black shale	<0.005	<0.5	6.73	5	330	1.5	<2	0.06	<0.5	8	43	27	3.17	1.84	0.33	100	<1	0.78	23	360	16	0.01	<5	72	0.16	67	<10	26	10
6	A01YH039	Zone-01	Cienaguillas	Black shale	<0.005	<0.5	9.09	15	530	2.5	<2	0.09	<0.5	15	76	31	5.17	2.99	0.65	270	<1	0.47	39	230	22	<0.01	<5	76	0.32	112	<10	106	10
7	A01YH040	Zone-01	Cienaguillas	Slate	<0.005	<0.5	8.98	10	630	2.5	<2	0.06	<0.5	10	69	33	3.49	2.85	0.39	165	1	0.57	21	260	16	<0.01	<5	76	0.34	115	<10	52	<10
8	A01YH041	Zone-01	Cienaguillas	Slate	<0.005	0.5	6.48	30	380	3.0	<2	0.22	<0.5	9	56	36	4.91	1.45	0.53	190	1	1.04	37	490	14	<0.01	<5	86	0.21	88	<10	106	<10
9	A01KN071	Zone-01	La Gateada	slate	-	0.5	8.31	15	580	2.5	<2	0.06	<0.5	7	65	17	3.77	3.08	0.89	215	<1	0.80	30	420	20	0.26	<5	77	0.26	95	<10	96	<10
10	A01YH037	Zone-01	La Gateada	Black shale	<0.005	<0.5	7.95	15	510	3.5	<2	0.05	<0.5	11	73	30	4.56	2.57	0.65	270	<1	0.64	42	210	14	<0.01	<5	75	0.29	109	<10	78	10
11	A01YH019	Zone-02	La Bergica	Siltstone	<0.005	<0.5	4.69	15	2100	1.0	<2	0.27	0.5	4	15	12	1.21	1.10	0.10	185	<1	0.91	5	1270	306	0.10	<5	964	0.18	42	<10	698	10
12	A01YH020	Zone-02	La Bergica	Siltstone	<0.005	<0.5	2.48	15	960	<0.5	<2	0.34	<0.5	3	16	35	3.31	0.34	0.05	790	<1	0.98	11	1530	18	0.03	5	89	0.08	12	<10	210	<10
13	A01YH021	Zone-02	Pumahuasi	Siltstone	<0.005	<0.5	7.69	25	510	2.0	<2	0.14	0.5	15	66	28	4.50	2.57	1.04	445	<1	0.92	34	400	54	0.67	<5	75	0.23	92	<10	654	<10
14	A01YH022	Zone-02	Sol de Mayo	Siltstone	<0.005	<0.5	6.71	15	690	2.0	<2	0.14	0.5	2	27	9	0.84	2.02	0.18	15	<1	1.34	9	520	12	<0.01	<5	177	0.24	62	<10	862	<10
15	A01YH023	Zone-03	Abra del Condor	Sandstone	<0.005	<0.5	5.51	10	540	2.0	<2	0.14	<0.5	3	27	17	1.49	2.59	0.28	120	<1	0.75	7	690	64	<0.01	<5	60	0.28	51	<10	58	<10
16	A01YH030	Zone-03	San Francisco	Grey slate	<0.005	<0.5	8.05	5	680	2.5	2	0.05	<0.5	8	71	24	4.17	3.10	1.09	320	<1	0.67	36	350	16	<0.01	<5	43	0.31	117	<10	94	<10
17	A01YH031	Zone-03	San Francisco	Phyllitic slate	<0.005	<0.5	6.38	15	360	1.5	<2	0.08	<0.5	4	48	18	4.36	1.63	0.87	320	<1	0.80	20	310	12	<0.01	<5	62	0.22	63	<10	80	<10
18	A01KN070	Zone-03	Santa Rosa	slate	-	<0.5	8.61	5	560	3.0	<2	0.10	<0.5	11	79	33	4.31	3.01	1.26	335	1	0.94	32	500	24	<0.01	<5	71	0.32	101	<10	96	<10
19	A01YH032	Zone-03	Santa Rosa	Phyllitic slate	<0.005	<0.5	8.29	40	6570	3.5	<2	0.05	<0.5	17	72	113	3.48	3.91	0.37	280	<1	0.11	31	490	116	0.14	<5	97	0.30	100	<10	50	10
20	A01YH027	Zone-05	Cerro Morado	Siltstone	<0.005	<0.5	7.90	5	780	2.5	<2	0.09	<0.5	14	72	30	4.89	2.57	0.91	240	<1	0.80	46	550	16	<0.01	<5	56	0.34	102	<10	110	10
21	A01YH028	Zone-05	Cerro Morado	Siltstone	<0.005	<0.5	8.09	<5	610	2.5	<2	0.18	<0.5	15	66	20	3.89	2.74	1.12	370	<1	1.09	37	640	20	<0.01	<5	56	0.36	99	<10	72	<10
22	A01YH029	Zone-05	Cerro Morado	Siltstone	<0.005	<0.5	8.14	10	610	2.0	<2	0.09	<0.5	5	68	44	4.02	2.90	0.95	135	<1	0.67	34	300	28	0.01	<5	46	0.30	177	<10	90	20
23	A01KN062	Zone-05	La Cienaga	slate	-	<0.5	8.29	5	580	2.5	<2	0.12	<0.5	17	72	41	5.30	2.39	1.24	410	<1	1.15	48	540	38	<0.01	<5	70	0.33	96	<10	140	10
24	A01KN067	Zone-05	La Cienaga	slate	-	<0.5	7.83	25	800	6.5	<2	0.23	<0.5	17	80	36	3.71	3.67	0.67	280	3	0.90	43	830	28	0.93	<5	79	0.36	136	<10	180	30
25	A01YH025	Zone-05	La Cienaga	Siltstone	<0.005	<0.5	4.98	5	1310	1.5	<2	0.16	<0.5	1	14	10	0.52	2.55	0.18	15	<1	0.05	7	810	136	0.03	<5	42	0.16	34	<10	42	<10
26	A01YH024	Zone-05	Paltoroa	Black shale	<0.005	<0.5	6.35	5	370	0.5	2	0.14	<0.5	5	43	10	4.04	1.23	0.93	315	1	1.52	28	670	22	<0.01	<5	65	0.24	74	<10	38	<10
27	A01YH026	Zone-05	Paltoroa	Siltstone	<0.005	0.5	6.55	5	380	1.5	<2	0.10	<0.5	11	45	17	5.30	1.47	1.12	320	<1	1.26	42	560	18	0.01	<5	53	0.23	66	<10	60	<10
28	A01KN075	Zone-08	Tupiza	Slate	-	1.0	8.69	5	590	3.0	<2	0.09	<0.5	26	83	52	4.90	3.19	1.09	435	1	0.73	48	400	22	<0.01	<5	85	0.33	107	<10	394	<10
29	A01YH043	Zone-08	Tupiza	Slate	<0.005	2.0	8.64	5	730	3.5	<2	0.04	<0.5	18	100	65	4.97	3.55	1.13	515	<1	0.59	18	370	38	<0.01	<5	70	0.35	136	<10	230	<10
30	A01KN079	Zone-11	La Purisima	Slate	-	<0.5	8.51	5	690	2.5	<2	0.07	<0.5	12	76	33	3.54	2.92	0.93	200	<1	1.18	37	490	18	<0.01	<5	56	0.38	109	<10	112	10
31	A01YH044	Zone-11	La Purisima	Slate	<0.005	0.5	8.45	25	1140	3.0	<2	0.05	<0.5	73	77	39	3.88	3.11	0.83	445	<1	0.73	126	420	30	<0.01	<5	54	0.34	112	<10	160	20
32	A01YH045	Zone-11	La Purisima	Black slate	<0.005	<0.5	7.26	15	760	1.5	<2	0.08	<0.5	5	59	25	4.01	2.21	0.96	205	13	1.30	37	560	28	0.09	<5	60	0.29	100	<10	76	40
33	A01RT080	Zone-15	La Candelaria	Shale/fine sand	<0.005	<0.5	6.78	5	480	2.0	<2	0.08	<0.5	3	54	78	3.15	2.41	0.40	70	2	0.36	17	340	26	0.01	<5	54	0.25	111	<10	52	110
34	A01YH046	Zone-15	La Candelaria	Siltstone	<0.005	<0.5	7.40	20	550	2.0	<2	0.07	<0.5	3	50	33	3.10	2.66	0.32	50	<1	0.64	15	320	20	0.01	<5	56	0.27	95	<10	56	<10
35	A01YH047	Zone-15	La Candelaria	Siltstone	<0.005	<0.5	9.70	15	1120	3.0	<2	0.07	<0.5	17	103	35	3.36	3.48	0.69	405	<1	0.73	34	430	42	<0.01	<5	45	0.64	161	<10	108	<10
36	A01AG078	Zone-15	Mina Aguilar	Slate	-	2.0	8.44	15	1080	3.0	<2	0.21	<0.5	16	77	42	4.19	3.81	1.18	250	1	0.92	41	510	18	0.62	<5	90	0.53	140	<10	126	<10
37	A01AG081	Zone-15	Mina Aguilar	Slate	-	<0.5	8.79	10	790	3.5	<2	0.63	1.0	14	78	38	4.20	3.63	1.25	465	3	1.03	37	730	32	0.41	<5	92	0.48	161	<10	256	<10
38	A01KN048	Zone-15	Rio Grande	Slate	-	<0.5	8.45	35	890	2.5	<2	0.06	<0.5	6	85	19	3.83	3.28	1.13	480	1	0.84	13	380	10	0.01	20	64	0.47	97	<10	124	<10
39	A01KN051	Zone-15	Rio Grande	Slate	-	<0.5	8.66	<5	1190	3.0	<2	1.25	<0.5	7	86	29	2.83	4.18	1.14	295	6	0.83	29	540	20	0.38	30	160	0.39	188	<10	62	<10
40	A01RT062	Zone-15	Rio Grande	Shale	-	<0.5	2.55	5	10	0.5	<2	50.00	<0.5	5	20	30	1.91	0.16	0.99	2140	<1	0.07	11	520	22	0.21	10	277	0.12	41	<10	52	<10
41	A01YH013	Zone-15	Rio Grande	Black shale	<0.005	<0.5	7.05	<5	2040	2.0	<2	0.09	<0.5	2	53	12	1.40	2.96	0.62	110	27	1.31	1	170	48	0.13	<5	85	0.33	117	<10	24	<10
42	A01YH014	Zone-15	Rio Grande	Black shale	<0.005	<0.5	7.06	5	1900	2.0	<2	0.27	0.5	2	68	21	1.35	3.28	0.72	155	7	0.72	4	400	52	0.02	<5	76	0.45	307	<10	44	<10
43	A01YH015	Zone-15	Rio Grande	Black shale	<0.005	<0.5	7.99	15	770	2.5	<2	0.12	<0.5	10	78	32	3.43	3.42	1.09	365	<1	0.89	31	370	28	0.22	<5	38	0.44	112	<10	136	<10
44	A01YH016	Zone-15	Rio Grande	Black shale and s.s.	0.0050	<0.5	5.40	5	210	3.5	<2	0.96	<0.5	35	51	137	5.16	1.06	0.76	295	2	0.93	127	1050	32	1.85	5	166	0.26	65	<10	86	<10
45	A01YH017	Zone-15	Rio Grande	Black shale	<0.005	<0.5	7.70	<5	1030	2.0	<2	0.20	<0.5	3	81	11	2.71	3.53	0.90	335	1	0.95	4	430	20	0.18	<5	99	0.46	218	<10	42	<10
46	A01YH018	Zone-15	Rio Grande	Black shale	0.0100	1.0	3.65	5	140	3.0	<2	0.54	<0.5	2	31	21	2.67	0.46	0.41	235	<1	1.60	6	630	92	0.18	<5	164	0.24	49	<10	34	<10
47	A01YH051	Zone-18	La Colorada	Schistoze rock	<0.005	1.0	3.80	20	10	<0.5	2	0.05	<0.5	35	38	7	8.39	0.08	0.97	455	<1	0.01	9	190	10	<0.01	<5	1	0.16	39	<10	60	<10
48	A01YH052	Zone-18	La Colorada	Schistoze rock	0.0100	<0.5	5.34	45	100	<0.5	<2	0.42	<0.5	55	53	54	21.66	0.12	1.21	4010	6	0.01	25	530	8	<0.01	<5	17	0.31	85	30	74	<10
49	A01YH053	Zone-18	La Colorada	Sandstone hornfels	<0.005	<0.5	4.63	10	330	0.5	<2	0.14	<0.5	12	40	6	4.93	1.12	0.87	520	1	0.07	12	500	6	<0.01	<5	21	0.26	46	<10	28	10
50	A01YH054	Zone-18	La Colorada	Sandstone	<0.005	<0.5	5.71	330	120	<0.5	<2	0.16	2.0	12	48	623	9.70	0.24	1.42	1615	1	0.02	7	220	24	0.03	<5	102	0.28	53	<10	1090	<10
51	A01YH055	Zone-18	La Colorada	Schistoze rock	<0.005	<0.5	9.19	5	970	3.0	2	0.35	<0.5	18	73	7	4.63	3.42	1.20	375	<1	0.97	46	620	6	<0.01	<5	119	0.47	112	<10	36	<10
52	A01YH056	Zone-18	La Colorada	Sandstone hornfels	<0.005	<0.5	7.95	20	700	2.0	<2	0.71	<0.5	14	55	6	3.39	2.11	0.83	195	<1	1.87	33	880	1	<0.01	<5	203	0.48	94	<10	20	<10
53	A01KN094	Zone-18	Limeca	Sandstone/slate	-	<0.5	7.24	20	480	2.0	<2	0.15	<0.5	5	52	18	2.92	2.54	0.87	390	<1	1.67	9	640	12	0.05	<5	84	0.34	72	<10	44	<10
54	A01YH057	Zone-18	Limeca	Phyllitic slate	<0.005	<0.5	7.99	10	450	2.5	2	0.06	<0.5	4	60	23	3.30	3.48	1.09	435	1	1.02	10	560	14	0.09	<5	39	0.34	108	<10	56	<10
55	A01YH058	Zone-18	Limeca	Phyllitic slate	<0.005	0.5	7.99	20	640	3.0	<2	0.10	<0.5	11	61	22	3.28	3.53	1.15	510	<1	0.89	30	510	4	<0.01	<5	40	0.34	130	<10	122	<10
56	A01YH059	Zone-18	Limeca	Siliceous slate	<0.005	<0.5	5.56	5	350	1.0	<2	0.17	<0.5	4	30	10	1.60	1.46	0.56	245	<1	2.44	16	570	10	<0.01	<5	96	0.26	44	<10	32	<10
57	A01YH060	Zone-18	Limeca	Phyllitic slate	<0.005	0.5	8.70	10	730	3.0	<2	0.05	<0.5	5	76	37	4.40	4.38	0.93	425	<1	0.34	19	510	1	0.01	<5	20	0.36	106	<10	72	<10
58	A01YH061	Zone-18	Limeca	Shale	<0.005	<0.5	7.28	20	480	2.5	<2	0.17	<0.5	8	58	29	3.26	3.00	0.82	365	<1	0.05	29	500	10	<0.01	<5	92	0.28	89	<10	108	<10
59	A01YH062	Zone-18	Limeca	Shale	<0.005	0.5	8.27	45	660	2.5	<2	0.07	<0.5	7	76	13	4.41	3.78	1.08	380	<1	0.83	18	480	12	0.01	<5	55	0.34	106	<10	52	<10
60	A01YH063	Zone-18	Limeca	Shale	<0.005	<0.5	7.69	5	460	2.5	<2	0.19	<0.5	8	63	19	4.27	2.42	1.30	565	<1	1.86	14	750	6	0.04	<5	91	0.42	82	<10	68	<10
61	A01YH064	Zone-22	Tusca	Shale	<0.005	<0.5	6.67	50	540	2.0	<2	0.20	<0.5	6	52	25	2.70	2.62	0.55	90	<1	0.99	20	470	22	0.01	<5	56	0.31	140	<10	100	30

Table II-5-3-2 Result of discriminant analysis applied for 61 samples from the Ordovician sedimentary rocks

Serial No.	Sample No.	Latitude			Longitude			Altitude	Zone	Locality	Rock	Discriminant function values			Discriminant group
		Degree	Minute	Second	Degree	Minute	Second	(m)				G1-G2	G1-G3	G2-G3	
1	A01YH033	22	21	30.6	65	47	58.7	3,701	Zone-01	Chocoite	Siltstone	36.18	4.94	-31.24	G1
2	A01YH034	22	20	5.9	65	48	10.8	3,744	Zone-01	Chocoite	Siliceous siltstone	29.73	-11.35	-41.07	G3
3	A01YH036	22	19	37.0	65	48	29.9		Zone-01	Chocoite	Black shale	23.73	0.73	-23.00	G1
4	A01KN072	22	6	15.7	65	46	6.2		Zone-01	Cienaguillas	Slate	14.64	14.42	-0.22	G1
5	A01YH038	22	6	0.0	65	48	55.3	3,774	Zone-01	Cienaguillas	Black shale	19.34	7.25	-12.09	G1
6	A01YH039	22	6	21.0	65	47	58.0	3,776	Zone-01	Cienaguillas	Black shale	16.07	7.63	-8.44	G1
7	A01YH040	22	6	30.6	65	46	48.4	3,748	Zone-01	Cienaguillas	Slate	11.48	8.74	-2.75	G1
8	A01YH041	22	7	55.8	65	44	41.5	3,623	Zone-01	Cienaguillas	Slate	25.08	2.92	-22.16	G1
9	A01KN071	22	19	37.5	65	48	30.6		Zone-01	La Gateada	Slate	20.25	3.62	-16.63	G1
10	A01YH037	22	19	50.0	65	49	34.8		Zone-01	La Gateada	Black shale	14.14	5.78	-8.36	G1
11	A01YH019	22	22	16.7	65	36	40.6	3,665	Zone-02	La Bergica	Siltstone	11.52	23.83	12.32	G1
12	A01YH020	22	22	19.7	65	36	37.9	3,670	Zone-02	La Bergica	Siltstone	7.14	7.60	0.45	G1
13	A01YH021	22	17	12.0	65	36	18.3	3,687	Zone-02	Pumahuasi	Siltstone	19.87	0.45	-19.42	G1
14	A01YH022	22	18	6.8	65	36	19.2	3,685	Zone-02	Sol de Mayo	Siltstone	32.49	7.63	-24.86	G1
15	A01YH023	22	23	50.9	65	17	3.2	4,530	Zone-03	Abra del Condor	Sandstone	8.55	10.40	1.86	G1
16	A01YH030	22	24	18.6	65	14	14.3	4,154	Zone-03	San Francisco	Grey slate	16.97	-0.52	-17.49	G3
17	A01YH031	22	23	52.8	65	15	37.0	4,260	Zone-03	San Francisco	Phyllitic slate	19.45	4.55	-14.90	G1
18	A01KN070	22	23	54.2	65	15	40.3		Zone-03	Santa Rosa	Slate	23.99	-0.36	-24.35	G3
19	A01YH032	22	24	4.8	65	15	33.9	4,262	Zone-03	Santa Rosa	Phyllitic slate	4.21	14.87	10.66	G1
20	A01YH027	22	24	20.6	65	6	7.1	3,950	Zone-05	Cerro Morado	Siltstone	19.32	3.76	-15.56	G1
21	A01YH028	22	24	24.5	65	7	27.7		Zone-05	Cerro Morado	Siltstone	19.62	-0.57	-20.19	G3
22	A01YH029	22	24	57.1	65	10	22.1	4,680	Zone-05	Cerro Morado	Siltstone	23.51	-3.99	-27.50	G3
23	A01KN062	22	23	24.1	65	5	29		Zone-05	La Cienaga	Slate	19.25	1.65	-17.60	G1
24	A01KN067	22	23	17.6	65	4	24.2		Zone-05	La Cienaga	Slate	17.60	0.44	-17.16	G1
25	A01YH025	22	23	18.0	65	4	25.4	3,903	Zone-05	La Cienaga	Siltstone	29.08	7.39	-21.69	G1
26	A01YH024	22	23	4.9	65	5	20.0	3,607	Zone-05	Paltorca	Black shale	16.94	0.27	-16.67	G1
27	A01YH026	22	23	45.9	65	4	56.4	3,886	Zone-05	Paltorca	Siltstone	20.69	1.45	-19.25	G1
28	A01KN075	22	42	24.2	66	5	58.8		Zone-07	Tupiza	Slate	19.86	2.95	-16.91	G1
29	A01YH043	22	45	49.9	66	5	55.3	3,794	Zone-08	Tupiza	Slate	13.01	1.34	-11.67	G1
30	A01KN079	22	49	35.8	65	32	23.9		Zone-11	La Purisima	Slate	15.47	1.17	-14.30	G1
31	A01YH044	22	49	32.0	65	32	10.1	4,030	Zone-11	La Purisima	Slate	6.83	3.23	-3.59	G1
32	A01YH045	22	49	26.2	65	32	8.0	4,019	Zone-11	La Purisima	Black slate	17.15	0.95	-16.20	G1
33	A01RT080	22	52	39.6	65	43	38.8	3,600	Zone-15	La Candelaria	Shale/fine sand	21.85	6.67	-15.18	G1
34	A01YH046	22	52	43.7	65	43	40.1	3,816	Zone-15	La Candelaria	Siltstone	20.78	8.77	-12.00	G1
35	A01YH047	22	52	38.5	65	43	37.4	3,609	Zone-15	La Candelaria	Siltstone	-6.27	7.47	13.74	G2
36	A01AG078	, 169.5m							Zone-15	Mina Aguilar	Slate	20.83	5.59	-15.24	G1
37	A01AG081	, 422.0m							Zone-15	Mina Aguilar	Slate	23.57	-1.82	-25.39	G3
38	A01KN048	23	7	7	65	40	47		Zone-15	Rio Grande	Slate	11.58	5.11	-6.47	G1
39	A01KN051	23	7	51.2	65	41	17.3		Zone-15	Rio Grande	Slate	38.99	-8.35	-47.33	G3
40	A01RT062	23	7	51.2	65	41	16.4	3950	Zone-15	Rio Grande	Shale	53.38	-4.67	-58.04	G3
41	A01YH013	23	8	4.0	65	40	53.7	3,910	Zone-15	Rio Grande	Black shale	12.13	0.86	-11.27	G1
42	A01YH014	23	7	58.3	65	41	3.2	3,912	Zone-15	Rio Grande	Black shale	14.03	-12.89	-26.92	G3
43	A01YH015	23	7	46.9	65	41	27.3	3,950	Zone-15	Rio Grande	Black shale	12.61	0.03	-12.58	G1
44	A01YH016	23	7	49.9	65	41	33.2	3,963	Zone-15	Rio Grande	Black shale and s.s.	32.22	8.05	-24.17	G1
45	A01YH017	23	7	51.2	65	41	16.5	3,935	Zone-15	Rio Grande	Black shale	14.75	-4.98	-19.73	G3
46	A01YH018	23	7	49.5	65	41	20.7	3,947	Zone-15	Rio Grande	Black shale	14.66	8.87	-5.80	G1
47	A01YH051	23	38	48.4	66	17	25.0	3,668	Zone-18	La Colorada	Schistoze rock	6.95	-14.42	-21.37	G3
48	A01YH052	23	38	49.1	66	17	25.5	3,660	Zone-18	La Colorada	Schistoze rock	27.87	-15.65	-43.52	G3
49	A01YH053	23	38	50	66	17	25.8	3,659	Zone-18	La Colorada	Sandstone hornfels	18.66	4.13	-14.53	G1
50	A01YH054	23	38	50.7	66	17	23.4	3,619	Zone-18	La Colorada	Sandstone	21.18	14.08	-7.10	G1
51	A01YH055	23	38	51.5	66	17	19.8	3,602	Zone-18	La Colorada	Schistoze rock	28.06	4.21	-23.85	G1
52	A01YH056	23	38	52.5	66	17	16.9	3,608	Zone-18	La Colorada	Sandstone hornfels	31.71	3.25	-28.46	G1
53	A01KN094	23	41	19.2	66	20	29.2		Zone-18	Limeca	Sandstone/slate	12.44	1.19	-11.24	G1
54	A01YH057	23	41	21.7	66	20	26.3	3,718	Zone-18	Limeca	Phyllitic slate	10.65	-2.01	-12.66	G3
55	A01YH058	23	41	25.3	66	20	11.0	3,696	Zone-18	Limeca	Phyllitic slate	18.42	-6.96	-25.39	G3
56	A01YH059	23	41	26.6	66	20	3.1	3,666	Zone-18	Limeca	Siliceous slate	9.29	-2.33	-11.62	G3
57	A01YH060	23	41	22.1	66	19	57.1	3,672	Zone-18	Limeca	Phyllitic slate	18.40	-4.14	-22.54	G3
58	A01YH061	23	41	16.2	66	19	50.9	3,661	Zone-18	Limeca	Shale	25.66	6.23	-19.43	G1
59	A01YH062	23	41	10.9	66	19	44.3		Zone-18	Limeca	Shale	17.82	0.52	-17.30	G1
60	A01YH063	23	41	7.8	66	19	39.9		Zone-18	Limeca	Shale	18.24	-0.68	-18.92	G3
61	A01YH064	23	39	59	65	42	0.2	4,068	Zone-22	Tusca	Shale	22.08	-0.83	-22.91	G3

Remarks; G1 : hangingwall of the mineralized zone, G2 : the mineralized zone(SEDEX), G3 : footwall of the mineralized zone the SEDEX mineralized zone.

For example, in the Rio Grande prospect to the north of Mina Esperanza, black shale and slate samples (A01KN051, A01RT062, A01YH014 and A01YH017) discriminated to the footwall (G3) gather in the middle reaches of the Rio Grande river. There are black shale samples (A01YH018, A01YH015 and A01YH016) discriminated to the hangingwall (G1) upstream from this part, and black shale and slate (A01YH013 and A01KN048) downstream. In fact, the presence of pyrrhotite ore beds (several tens of centimeter in thickness) was confirmed around the lowest bottom of the hangingwall on the upstream side. It is considered that this just corresponds to the extension of the SEDEX mineralized zone found in bore hole #3070.

Similarly, although no samples were discriminated to the mineralized zone (G2) in La Colorada, whose mineralization type is a topic of discussions (i.e., whether it is VMS or SEDEX), four samples including sandstone and schist in the central part and on the east side where the ex-prospecting exists were discriminated to the hangingwall (G1), and two samples of schist on the west side were discriminated to the footwall (G3). In Limeca to the south of this place, where SEDEX is said to have been discovered recently, there are slate or shale discriminated to the hangingwall (G1) in the middle part and slate or shale judged to belong to the footwall (G3) upstream and downstream. Judging from these results of discrimination analysis only, it is presumed that both places of mineral showings are in a geochemical environment similar to the place with the SEDEX mineralized zone.

Santa Victoria mountain range (Zone 3) and the area to the east of this range (Zone 5) are covered by the Santa Victoria Group, according to the geological map of "La Quiaca" with a scale of 1/250,000. Although details are unknown, the road to La Cienaga to the east of the place where samples were collected is mainly composed of siltstone discriminated to the footwall (G3). La Cienaga in the east, Santa Rosa in the west and the periphery of both places of mineral showings are mainly made up of slate discriminated to the hangingwall (G1). Therefore, the possibility of existence of a SEDEX mineralized zone still remains.

Zone 1 containing La Gateada mineral showings is classified as the distribution area of Cochinoca-Escaya composite rocks which is an upper layer of the Santa Victoria Group on the said map. Also from the results of discrimination analysis, it was discriminated to the hangingwall (G1). But silicified siltstone around Chocoite was discriminated to the footwall (G3). In either case, it would be necessary to fully examine the probability of existence of a SEDEX mineralized zone around the border between the hangingwall and the footwall.

Zone 2 containing Mina Pumahuasi is classified as the distribution area of the Acoite Formation which is an upper layer of the Santa Victoria Group on a geological map of "La Quiaca" with a scale of 1/250,000. As a result of discriminant analysis, the four samples collected were all positioned in the hangingwall (G1).