REPORT
ON
THE MINERAL EXPLORATION
IN THE ORURO-UYUNI AREA
OF
THE REPUBLIC OF BOLIVIA

(PHASE II)

MARCH 2001

JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

PREFACE

In response to the request of the Government of the Republic of Bolivia, the Japanese Government decided to conduct a Mineral Exploration in the Oruro-Uyuni Area Project and entrusted the survey to the Japan International Cooperation Agency (JICA) and the Metal Mining Agency of Japan (MMAJ).

The JICA and MMAJ sent to the Republic of Bolivia a survey team headed by Mr. HASHIMOTO Morio from November 11,2000 to February 9, 2001.

The team exchanged views with the officials concerned of the Government of the Republic of Bolivia and conducted a field survey in the Oruro-Uyuni area. After the team returned to Japan, further studies were made and the present report has been prepared.

We hope that this report will serve for the development of the Project and contribute to the promotion of friendly relations between our two countries.

We wish to express our deep appreciation to the officials concerned of the Government of the Republic of Bolivia for their close cooperation extended to the team.

March, 2001

Kunihiko Saito
President
Japan International Cooperation Agency

Naohiro Tashiro
President
Metal Mining Agency of Japan

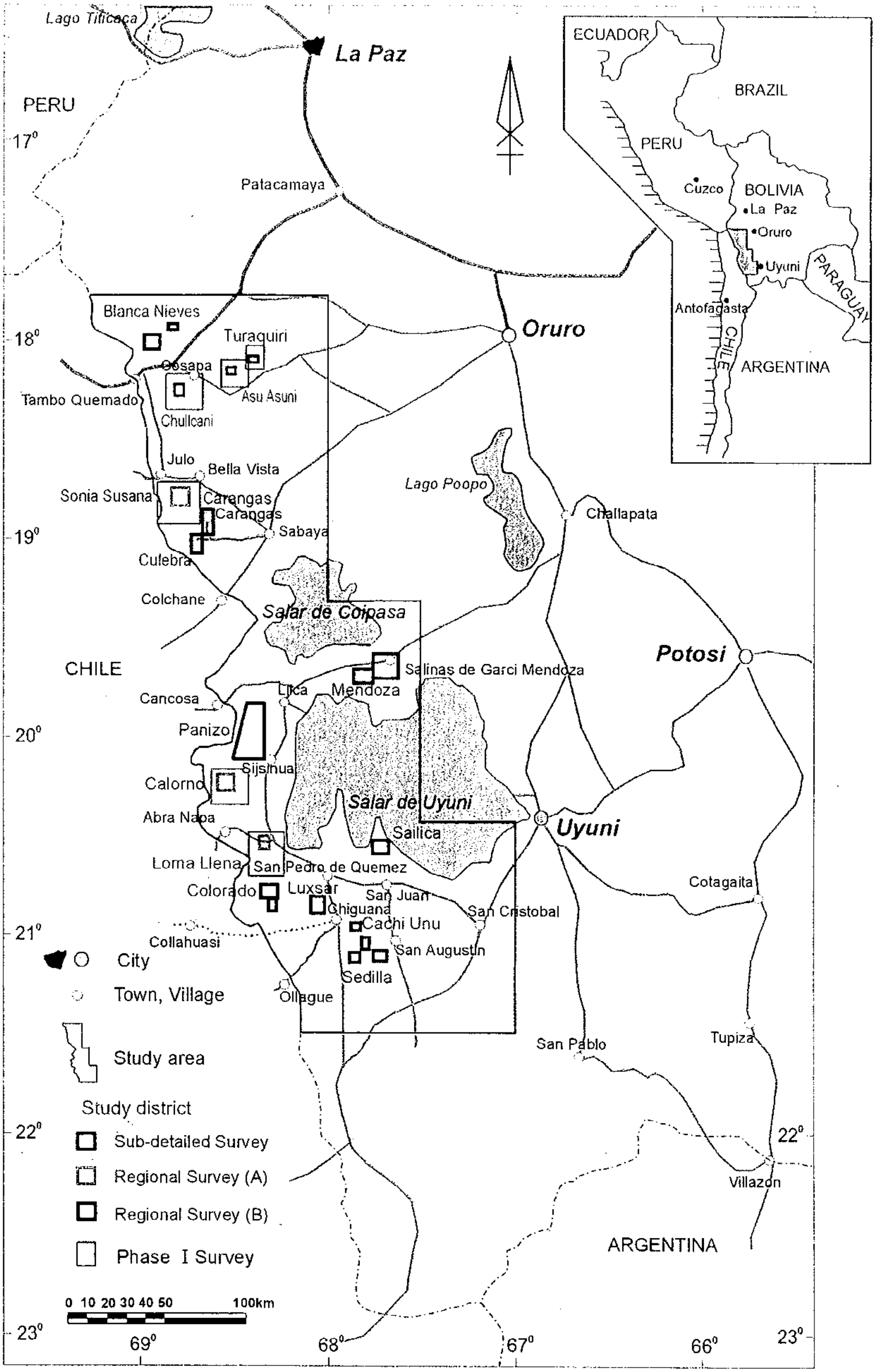

Fig. I-1 Location Map of the Survey Area

SUMMARY

This report sums up the survey in Phase-II (FY 2000, the second FY of the survey) implemented in the Oruro-Uyuni region of the Republic of Bolivia, under the technical cooperation.

Survey findings, overall evaluation and exploration guidelines for Phase-III are summarized in the following paragraphs.This report sums up the survey in Phase II (FY2000, the second fiscal year of the survey) implemented in the Oruro-Uyuni region of the Republic of Bolivia, under the Technical Cooperation for Mineral Exploration.

The survey findings, overall evaluation and exploration guidelines for Phase III are summarized in the following paragraphs:

Survey Findings

(1) Sub-detailed survey district (scale 1/10,000): 3 districts

In the Chulcani district, the alteration zones of silicification and argillization with hydrothermal breccia encircle the gold anomaly zone. Silicified and hydrothermal breccia veins, showing a radial form, suggest the existence of intrusive rocks at the deeper part of the alteration center

(2) Regional survey area (scale 1/25,000): 3 districts

In the Colorno district, although broad alteration zones of silicification and argillization are accompanied by hydrothermal breccia, no remarkable geochemical anomaly zones are shown and only many small anomaly portions are scattered widespreadly.

(3) Regional survey (scale 1/50,0000): 10 districts

At the Carangas and Todos Santos mines, epithermal deposits were confirmed with dome or intrusive rocks accompanied by hydrothermal breccia.

At the La Deseada mine in the Medoza district, a vertical change of the characteristics of the veins from the upper to the lower was confirmed. This will be a helpful indicator for future exploration.

At the west of the La Deseada mine, both Co. Mokho and Co. Chorka prospects are shown silicified zones with hydrothermal breccia and geochemical anomalies.

At Panizo prospect in the Panizo district, alteration zones of silicification and argillization with hydrothermal breccia are scattered. There are two anomaly zones detected: one zone shows an anomaly of gold, silver, lead, arsenic, and antimony, and the other zone shows an anomaly of copper, arsenic and antimony.

Overall Evaluation

The survey revealed that the hydrothermal alteration zones widespread in the Oruro-Uyuni region are likely to host epithermal ore deposits at depth. It is assumed an epithermal deposit ,rich in gold, silver, lead and zinc,related with shallow volcanic rocks; epithermal deposit of precious metals related with sub-volcanic intrusive rocks (upper part of porphyry type deposit?); high sulfididation type of gold, silver copper ore deposit (quartz-alunite vein type); and low sulfididation type (quartz-adularia vein type) are expected.

The promising area selected on the basis of the Phase I geological and geochemical surveys are from the Chullucani district, Turaquiri district, Panizo prospect in Panizo district and Calorno district.

Exploration Guidelines for Phase III

For Phase-III, it is recommended to continue exploration in the above area to select a promising area by confirming a 3-D model of mineralization of the study area. In the Chullucani and Turaquiri districts, more information is needed to consider the structure of the deeper part. In addition, detailed geological and geophysical surveys are recommended to concretely clarify the geological structure. Borehole drilling exploration will hopefully be carried out.

At the Panizo prospect, it is suggested that a detailed geological survey carried out to obtain more detailed geological information at the site of three geochemical anomaly zones. In addition, it is hoped that a geophysical survey be carried out for the consideration of the structure of the deeper part under the anomaly zone.

At Calorno district, remarkable geochemical anomalies were not detected yet but a regional geophysical survey will hopefully be carried out where we have much information to evaluate the same type of alteration zone.

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PART I GENERAL REMARKS

Chapter 1 Introduction

1.1 Background of Survey

To comply with the request of the Government of Bolivia, the subject mineral resources survey in the Oruro-Uyuni region of the Republic of Bolivia is undertaken by the Government of Japan, in conformity to the Scope of Work agreed to between the two governments on 10 December 1999.

1.2 Conclusions and Recommendations of Phase I Survey

1-2-1 Conclusions of Phase I Survey

The regional geological and geochemical surveys were carried out in six districts, which are Turaquiri, Asu Auni, Chullcani, Sonia-Susana, Calorno and Loma Llena, that were selected as promising districts as the result of the analysis of existing data and satellite image interpretation implemented in Phase I.

The Phase I survey revealed that the Oruro-Uyuni region was extensively underlain by hydrothermal alteration zones and existence of epithermal ore deposits can be expected at depth of the zones.

After the analysis, the Chullcani, Turaquiri, Calorno, Sonia-Susana districts were selected as promising areas, in order of its potential.

1-2-2 Recommendations of Phase I Survey

It was recommended that a secondary geological survey should be conducted in the districts investigated in Phase I. Furthermore regional geological and geochemical surveys should be conducted in the remaining districts where a survey was not carried out in Phase I but were selected by satellite image and data analysis.

In addition, stream sediment geochemical survey is proposed for the whole area to determine the existence of small-scale alteration zones and showings.

1-3 Outline of Phase I Survey

1-3-1 Survey Area

The Oruro-Uyuni region is situated approximately between 150 km and 560 km south of La Paz, the capital city. (Fig. I-1) The western half of the region is constituted by mountainous zones, alt. 4,000 m to 5,000 m, whereas the eastern half consists mainly of moderately inclined plateaus and saline lakes of altitudes up to 4,000 m above sea level.

1-3-2 Survey Purpose

For effectively selecting a potential area for a mineral deposit in the short-term, a geological survey to reveal the geological setting and occurrence of mineral deposits will be carried out in the Oruro-Uyuni region, Republic of Bolivia.

1-3-3 Survey Method

For Phase II, different scales of geological and geochemical surveys were carried out in the six districts of Phase I and ten new districts for Phase II for a total of 16 districts. Furthermore, chemical analysis was done for stream sediment samples taken by a counterpart organization of the Bolivia government.

Sub-detailed geological and geochemical surveys (scale of 1/10,000) were carried out in the districts of Turaquiri, Asu-Asuni and Chullcani where alteration zones are rather smaller (survey area of 60 sq. km with total route length of 66 km).

Regional geological and geochemical surveys (scale of 1/25,000) were carried out in the districts of Sonia-Susana, Calorno and Loma Llena where alteration zones are relatively larger (survey area of 330 sq. km with route length of 192 km).

Also regional geological and geophysical surveys (scale of 1/50,000) were carried out for the districts of Blanca Nieves, Carangas, Culebra, Mendoza, Panizo, Sailica, Colorado, Luxsar, Cachi Unu, and Sedilla, which were not surveyed in Phase I (survey area of 2,040 sq. km and route length of 551 km).

A mobile camp was set up at villages of the respective districts.

Route maps for the geological and geochemical surveys were prepared by enlarging a 1:50 000-scale topographic map. The GPS was utilized for positioning. Outcrops of special importance were sketched on 1:100 to 1:200 scales and photographed in color. The survey findings were incorporated into each scale geologic map.

Simultaneously, with the geological survey, sampling of various types at the quantities indicated in Table 1-1-1 was conducted and the laboratory tests were carried out.

Table I -1-1 List of Laboratory Test

CONTENT	Items and amount of Laboratory tests	
Geological & Geochemical surveys	①Chemical Analysis (rock) (11 elements)	2,600
	②Chemical Analysis (ore) (11 elements)	150
	③Chemical Analysis (stream sediments) (48 elements)	2,000
	④Thin Section	80
	⑤Polished Section	50
	⑥X-ray analysis	280
	⑦Measurement of F.I(Temp.& Salinity)	20
	⑧Dating (K-Ar method)	28

11Elements of chemical analysis : Au,Ag,Cu,Pb,Zn,As,Sb,Hg,Mo,Ba,Sn

48Elements of chemical analysis : Au,Ag,Al,As,B,Ba,Be,Bi,Ca,Cd,Ce,Co,Cr,Cu,Fe, Ga,Ge, Hg,In,K,La,Li,Mg,Mn,Mo,Na,Nb,Ni,P,Pb,Rb, S,Sb, Sc,Se, Sn,Sr,Ta,Te,Th,Tl,Ti,U,V,W,Y,Zn,Zr

1-3-4 Survey Team

The names of the members of the Japanese survey team and their counterparts in Bolivia are as follows:

Japan		Bolivia Republic	
Name	Entity	Name	Entity
HASHIMOTO Morio (Head/General) (Chief Geologist)	MINDECO	Fernando Murillo Salazar (Coordinator) (Chief Geologist)	SERGEOMIN
TAKEBE Akimitsu (Geologist)	〃	Ivar Alcocer Rodrigez (Geologist)	〃
ISOGAI Koichi (Geologist)	〃	Oscar Almendras Alarcon (Geologist)	〃
KATSUNO Yutaka (Geologist)	〃	Manuel Menacho Leon (Geologist)	〃
HIBI Fukuji (Geologist)	〃	Guido Quezada Cortez (Geologist)	〃
	〃	Yerco Santa Cruz Salvatierra (Geologist)	〃

● Mitsui Mineral Development Engineering Co., Ltd.

1-2-5 Survey Period

Survey Period is shown in Table I-1-2

Table I-1-2 Period of the Survey

	2000		2001		
	Nov.	Dec.	Jan.	Feb.	Mar.
Preparation	10				
Field surv.	11			9	
Lab.work		1			10
Reporting				10	21

Chapter 2 Geographic Setting of Survey Area

2-1 Topography and Drainage System

The study area is located on the two physiographic provinces, in the westernmost part of Bolivia, which are: first, the Altiplano or a flat plain at an elevation of about 3,700 m above the sea level, with longitudinal and transversal elevations covering an area of about 100,000 km^2. The most prominent geographic feature of an extensive Puna - Altiplano plateau, which is after the Tibetan plateau, the world highest and large plateau (700 x 200 km), covered by an extensive array of Neogene volcanic centers.

The second is a volcanos chain, defining the natural border with Perú and Chile with altitudes of higher than 6,000 m.a.s.l. (Sajama, 6,542 m; Parinacota, 6,132 m; Payachatas, 5,982 m; Tunupa, 5,000 m.), developed along 620 km from north (Perú) to south (Argentina) running in the NW - SE direction.

The drainage of the area belongs to the central basins or lacustrine, which covers almost all the Altiplano and is formed by: Lago Titicaca, Lago Poopó, Salar de Coipasa, Salar de Uyuni and Río Desaguadero.

Lago Poopó is located in the Oruro department (Prov. Poopó, Sancari and Abaroa) at 3,868 m. Its main rivers are: Pazña, Challapata, Conde, Sevaruyo, and Kimpara.

The Lakajahuira River is the only drainage between Poopó and Salar de Coipasa, Ríos Lauca and Sabaya run into Salar de Coipasa.

The main rivers to drain into the Salar de Uyuni are Río Grande or Quetena in the south and Río Chica Chica in the east. Among them, almost all the rivers are very small and intermittent, having water only during rain season (December - March) making it difficult for transportation because of a lack of bridges.

2-2 Climate and Vegetation

Bolivia is in the south latitude (10° - 23°) so the climate should be tropical to subtropical however due to the altitude in the study area over 3,600 m is dry and cold. During nighttime, temperature is below zero almost all throughout year.

Rainy season corresponds to summer (December to March) and the annual precipitation is about 400 mm (Table 1).

In some parts of the area due to the intensive cold, rain is converted to snow or ice. The maximum temperature of this season is about 22°C, and the minimum temperature is -5°C approximately.

The dry season belongs to wintertime, and the maximum temperature rises 18°C and the minimum is -22°C, even the temperature makes it the best time for fieldwork. In winter, winds are very strong from the west and temperature difference between day and night are 30°C making very cold during night and the humidity varies between 0 and 22% (Table I-2)

Table I-2 Temperature and Humidity in Oruro City

	Ene.	Feb.	Mar.	Abr.	May.	Jun.	Jul.	Ago.	Sep.	Oct.	Nov.	Dic.	Anual
Temp.Ambiente °C	11.5	11.0	10.5	9.2	5.8	3.4	2.7	4.9	7.2	9.4	10.9	11.7	8.2
Temp. Maxima Media	18.3	18.5	17.8	17.9	16.3	14.3	14.1	16.5	17.6	18.7	19.6	19.5	17.40
Temp. Minima Media	4.7	3.5	3.2	0.5	-4.7	-7.4	-8.7	-6.6	-3.2	0.2	2.3	3.9	-1.0
Precipitation mm	87.1	48.8	64.3	25.4	8.2	3.7	5.8	5.6	22.7	26.5	27	39.5	364.6
Humedad Relativa	61	53	59	54	52	44	43	41	42	41	43	45	48
Direction y vel. Nudos	E-7	E-6	E-6	S-5	S-3	S-2	NW-4	S-4	S-5	S-6	S-7	E-5	S-5

Station : Oruro, Province : Llocodo, Departament : Oruro

Period : 1995 – 1999 Latitud Sur : 17°58', Longitud Oeste : 67°04', Altitud : 3,702 m

To describe the vegetation of the area, it is necessary to divide the Altiplano in two sectors:
-Altiplano Central. - (18° - 20° 30' Lat. S) is distinguished by its cold and dry climate, as a result a large sand covers the pampas in which grows intermittently, thola (lepidophyllum quadrangulare), yareta (azorella sp) and paja brava (stipa ichu). Among this in some places cultivate quinua, potato, barley and other typical tubers.

Around the slopes of the volcanic cones grow small trees and bushes: Keñua, Kiswara and Thola.

-Altiplano Sur.- (20°30"- 22°51"Lat. S) is a dessert and sandy zone, where lives parihuanas or flamencos (phoenicopterus chilensis). Around the western edge of Salar de Uyuni (Llica - Salinas de Garci Mendoza) are developed big areas of quinua crops.

Chapter 3 General Geology

3-1 General Geology in the Surrounding Areas

Bolivia is roughly divided into five geotectonic provinces which, from west to east, are called the Cordillera Occidental, the Altiplano, the Cordillera Oriental, the Sub-Andes - Beni-Chaco Plain, and the Brazilian Shield.

The survey area pertains to the Cordillera Occidental and the Altiplano. (Figs. I-3-1 and I-3-2)

Cordillera Occidental

The Cordillera Occidental is extensively covered by Tertiary to Recent volcanic rocks that effused along the N-S uplifting axis of the Mesozoic to Paleozoic basement rocks, where continental to netric sediments lie between the volcanic bodies.

The volcanic rocks that constitute mountains are chiefly late Miocene to Pliocene andesite and rhyolite lava, while Quaternary dacite is also present in the vicinity of the mountain tops.

The large-scale and widespread volcanic activity, characteristic of the Cordillera Occidental, was brought about by the subduction of the Nazca Plate under the South American Continental Plate. Accompanying the volcanic activity, numerous stratovolcanoes were formed.

Altiplano

The Altiplano has the Proterozoic to Paleozoic basement extensively covered by formations of vast volcanic product and continental sediments of the Cretaceous to the Recent age.

The continental sediments are composed of late Cretaceous continental molasse sediments (red bed) and Eocene to Oligocene foreland basin sediments (sandstone, and alternated beds of sandstone and mudstone).

Igneous activity took place in the Miocene to Pliocene time. Andesitic effusive activity continued during the Miocene time in the southern part whilst, in the northern part, effusive activity of rhyolitic pyroclastic rocks continued from the Miocene to Pliocene time, which caused a huge amount of continental volcanic product to be deposited.

A schematic geologic column of the survey area is exhibited in Fig. I-3-3.

Cordillera Oriental

The Cordillera Oriental is underlain by abyssal to terrigenous sediments of the Paleozoic age and marine to continental shelf carbonate rocks of the Mesozoic age.

These are composed of thick sedimentary rocks of the Paleozoic to Mesozoic age (miogeosyncline sediments) deposited on the Precambrian basement, where thrust faults with N-S axes and complicated fold structures were formed by the Caledonian (Ordovician), Hercynian

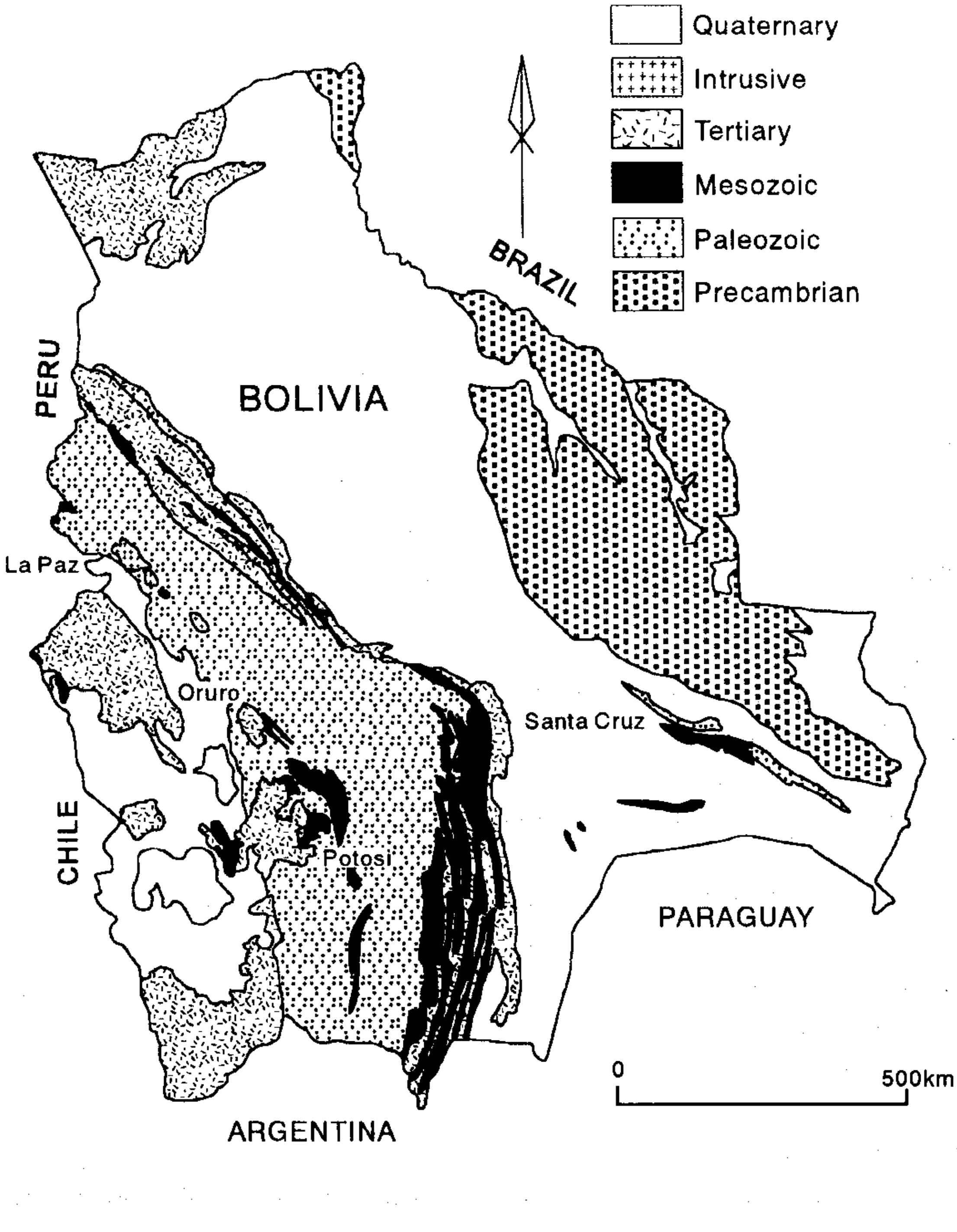


Fig. I-3-1 Geological Map of Bolivia

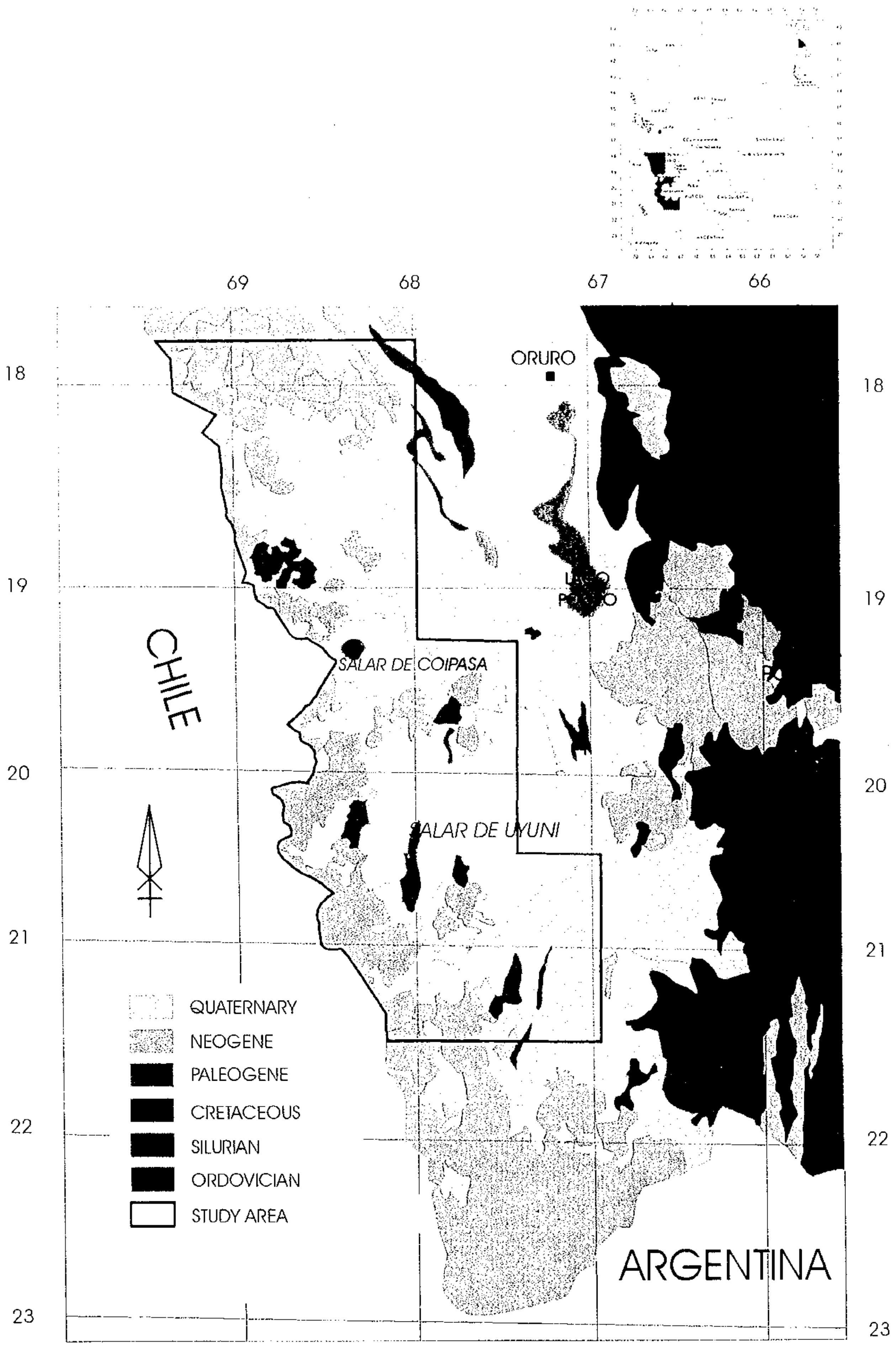


Fig. I-3-2 Schematic Geologic Map of the Area

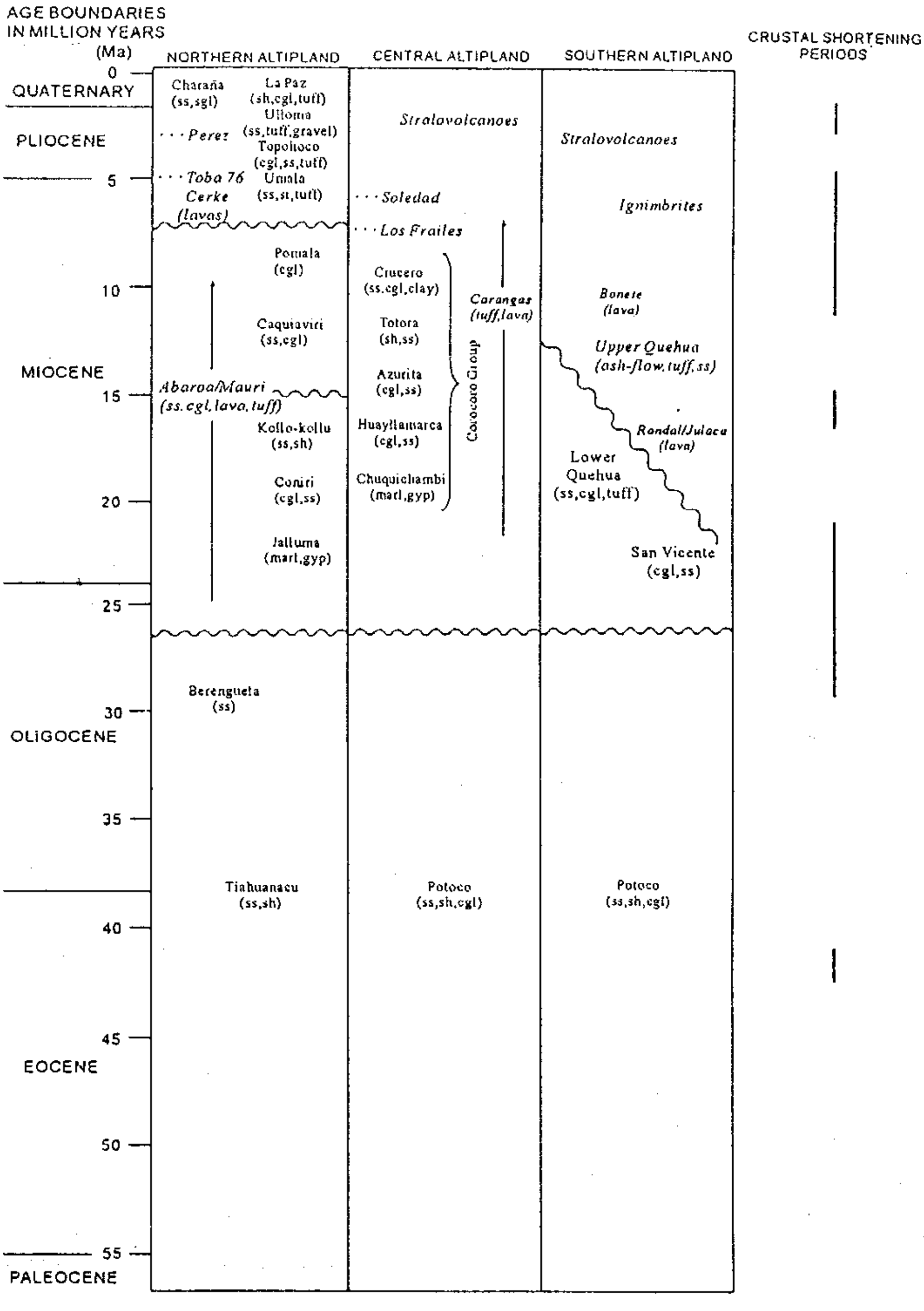


Fig.I-3-3 Schematic Geologic Column of the Survey Area

(Devonian to Triassic) and Andean (Cretaceous to Cenozoic) orogenic movements.

Simultaneously with the close of the Hercynian movement (Permian to Triassic), the subject region became a tension field where peralkaline volcanic activity and intrusion of granitic plutonic rocks occurred.

Afterwards, the plate subduction began, causing calc-alkaline volcanic activity which lasted from the Jurassic to the Cenozoic time.

At the time of the Andean orogenic movement (Tertiary), the Cordillera Oriental was uplifted by the E-W compressive stress, causing to form the fold zones and thrust fault zones. At the western side of the Cordillera, the andesitic volcanic activity, the ensuing intrusion of hypabyssal rocks and overthrust towards the Altiplano side took place.

Sub-Andes - Beni-Chaco Plain

The region consists of the fold mountains adjoining the eastern side of the Cordillera Oriental and the vast plain zones -- the Beni-Chaco Plain -- to the east.

The fold mountains are composed of Paleozoic and Neogene rocks. In the eastern plain zones, these formations are extensively underlain by Quaternary lake sediments and talus sediments.

Brazilian Shield

An extension of the Brazilian Shield stretches toward the eastern Bolivia to form a tropical rain forest zone covering an area of 22,000 km^2.

The region is underlain by Proterozoic to Cretaceous rocks, mostly Proterozoic altered rocks such as gneiss, biotite schist and quartz schist.

These altered rocks underwent laterization in the Tertiary or later time, covered by Quaternary alluvium.

3-2 Characteristics of Mineralization in Survey Area

Ore deposits of metallic minerals concentrate in the area that embraces the Cordillera Occidental, Altiplano and Cordillera Oriental, where copper mineralization accompanying alkali basalt, sedimentary copper mineralization accompanying late Tertiary red sandstone beds, so-called 'Bolivian-type' polymetallic mineralization mainly of tin and silver, and epithermal mineralization mainly of gold and silver are known to be present.

In the Cordillera Occidental, small-scale epithermal gold-silver veins embedded in Miocene dacitic volcanic rocks are known to exist, a part of which is accompanied by sulfide minerals such as copper, lead, zinc and bismuth.

Also present in the area are hydrothermal alteration zones, mainly argillized and widespread in dacitic volcanic rocks. Silicification and pyrite dissemination are observed partly in the alteration zones. Under these hydrothermal alteration zones, occurrence of porphyry-type gold-copper deposits is expected.

From the Cordillera Oriental to the Altiplano, the Bolivian-type polymetallic vein deposits are found, while copper deposits accompanied by alkali basalt and red sandstone are present from the north to the south of the central Altiplano.

The Bolivian-type polymetallic vein deposits, underlain by the upper Tertiary to Quaternary, have not yet been fully elucidated, but many of them are lead-zinc deposits with relatively low tin-tungsten contents and high copper content. A variety of Bolivian-type polymetallic vein deposits are known; they are roughly divided into those rich in silver and tin and those rich in silver, gold and copper.

Ore deposits rich in silver and tin are often seen in the Cordillera Oriental. These have mineralogically complex combinations of silver, tin, lead, zinc, tungsten, bismuth, gold, etc.

Typical of such ore deposits are found at such mines as Cerro Rico de Potos*, Pulacayo and Huanuni, which are classified into two types: one rich in silver sulfate minerals and the other in which the lower tin zones become exposed as a result of denudation of the upper silver zones.

Ore deposits rich in silver, gold and copper are seen in the Altiplano, the most typical of which is the Kori Kollo mine currently under operation. The deposit has silver, gold and some copper, apparently resembling auri-argentiferous iron sulfide deposits, but it is classified into the polymetallic deposit as it contains lead, zinc, antimony, tin, etc.

The mines and ore showings existent in the survey area are shown in Fig. I-3-4 .

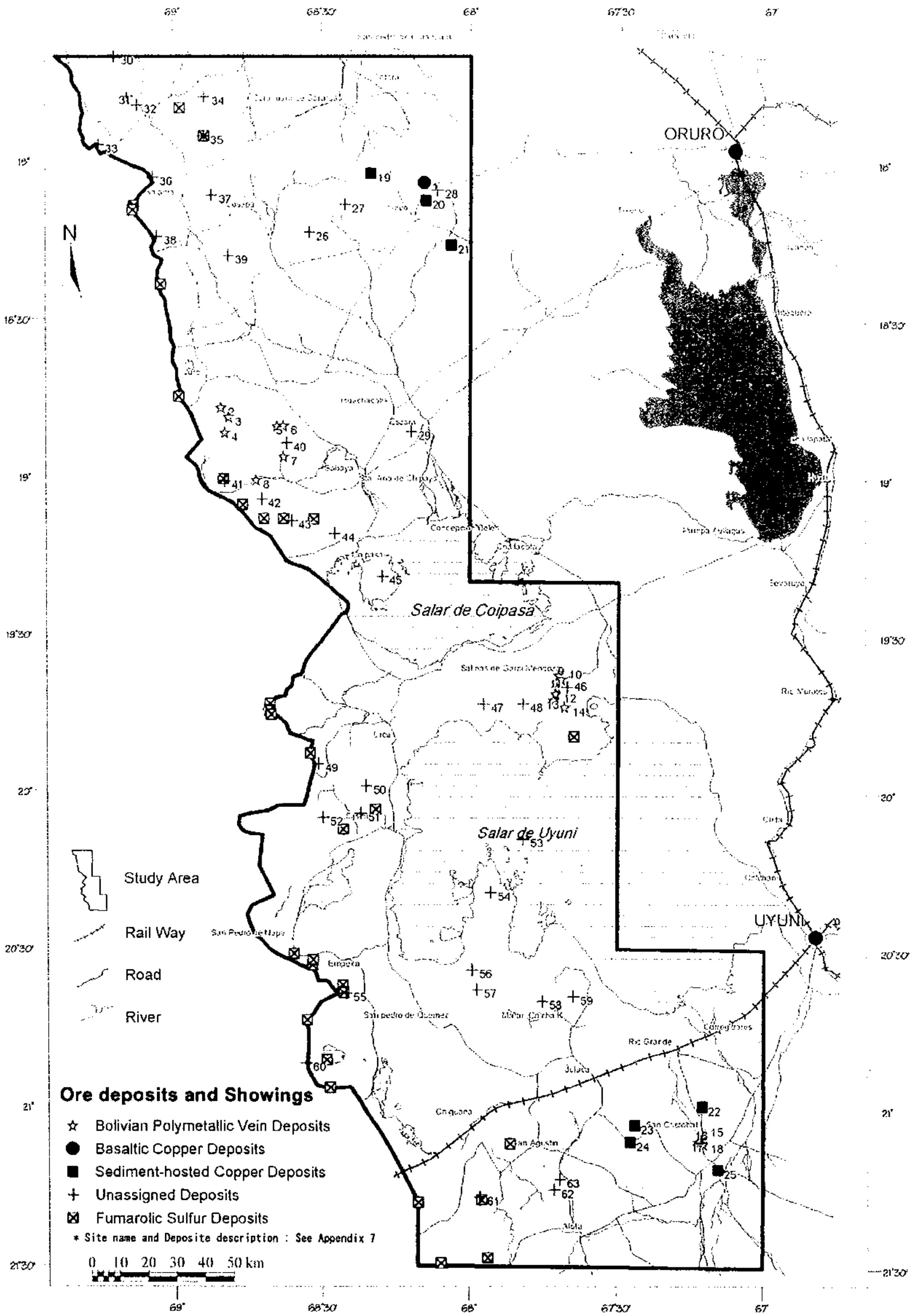


Fig. I-3-4 Ore deposits and showings in the area

Chapter 4 Comprehensive Analysis

4-1 Relationship of Geology and Geologic Structure with Mineralization

4-1-1 Geology

The survey area is extensively covered by volcanic rocks centering around the Cordillera Occidental, except crystalline schist and gneiss exposed in inliers to the southeast of the Chulcani district and continental sediments of Tertiary or a later age observed in some parts of the Altiplano.

The volcanic rocks generally form stratovolcanoes; alteration -- mainly argillization -- zones are widespread in the volcanic rocks. The known ore deposits are embedded in these alteration zones, presumably formed by the hydrothermal process.

4-1-2 Geological structure

Excepting the San Cristbal deposit(trending NE-SW) and the Eskapa district(trending N-S), mineralization is observed in fractures with the E-W trend; the trends are E-W at Turaquiri, E-W(N70° W) at Carangas and E-W(N80° E ~ N75° W) at Salinas de Garci Mendoza. The fractures with the E-W trend might have fulfilled an essential function.

4-1-3 Expected types of ore deposits

The following types of ore deposit are expected to be present in the survey area:

[1] Copper deposits accompanying alkali basalt

[2] Bedded copper deposits embedded in Paleogene red sedimentary rocks(The Corocoro-type)

[3] Epithermal deposits

[4] Bolivian-type polymetallic vein deposits

[5] Porphyry-type copper-gold deposits

Of these types, veinlet-type and disseminated copper deposits accompanying late Oligocene alkali basalt and the Corocoro-type deposits are not large enough in scale to be exploration targets.

Bolivian-type polymetallic vein deposits have a general tendency that sulfide mineral veins in the lower part change into barite-quartz or barite-chalcedony veins in the upper part, which is considered attributable to porphyry-type mineralization shifting to epithermal mineralization.

Therefore, the presence of these veins may suggest emplacement of Bolivian-type polymetallic vein deposits in the lower part and of porphyry-type deposits in the deeper part.

The deposits are classified into following types although it is difficult.

I Bolivian-type polymetallic deposits

(A) Ore deposits rich in silver-tin(mainly at Cordillera Oriental)
Mineral assemblage : silver-tin-lead-zinc-tungsten-bismuth-gold
Example : Potosí deposit, Pulacayo deposit, Huanuni deposit

(B) Ore deposits rich in silver-gold-copper(mainly at Cordillera Oriental)
Mineral assemblage : silver-gold -few copper(lead-zinc-antimony-tin)
Vein : sulfide vein
Example : Kori Kollo deposit

II Epithermal gold-silver-lead-zinc deposits related to shallow volcanic activity
Mineral assemblage : (gold)-silver-few lead-zinc-tin
Vein : barite-quartz vein
Example : San Cristóbal deposit

III Epithermal precious metal deposits related to shallow sub-volcanic intrusive activity
(upper part of porphyry type deposit or lower part of Bolivian-type deposit)
Mineral assemblage : gold-silver- lead- zinc- (copper)
Vein : alunite-kaolin-quartz vein, barite-quartz vein with neutral alteration zone
Example : Choquelimpie deposit, La Española deposit

IV High-sulfidation type deposits (quartz-alunite vein type deposit)
Epithermal gold-ailver-copper deposit
Mineral assemblage : (gold)-silver- copper(enargite)
Vein : alunite- barite- quartz vein
Example : Laurani deposit, Choquelimpie deposit, La Española deposit

V Low-sulfidation type deposits (quartz-adularia vein type deposit)
Sericitized zone with adularia, carbonate minerals
Neutral argillic alteration zone
Example : peripheral part in the La Española mine

Figs. I-4-1(1) and I-4-1(2) indicate schematic models of hydrothermal ore deposits including the Bolivian-type polymetallic vein deposits and porphyry copper-gold deposits accompanied by epithermal alteration, respectively.

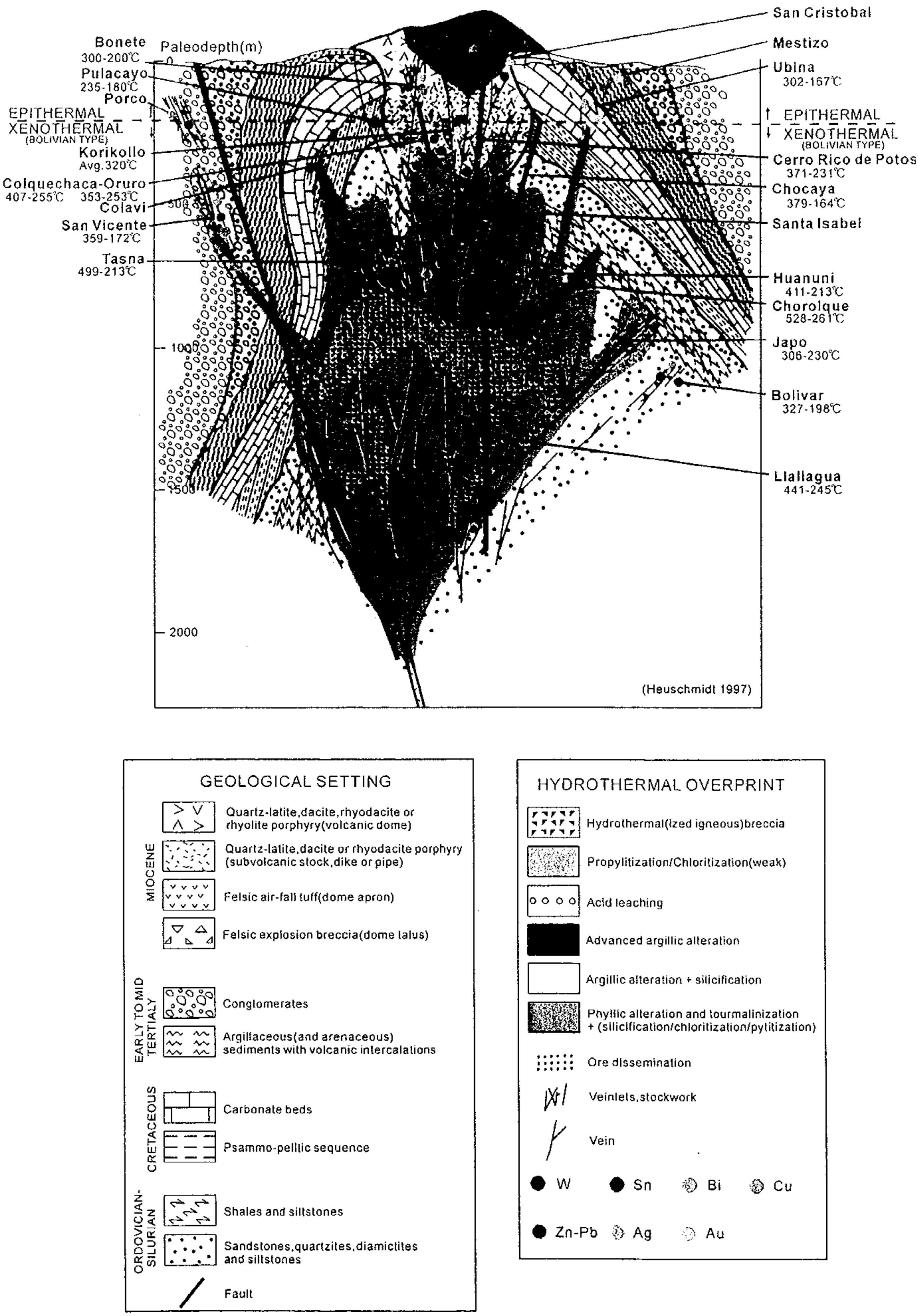
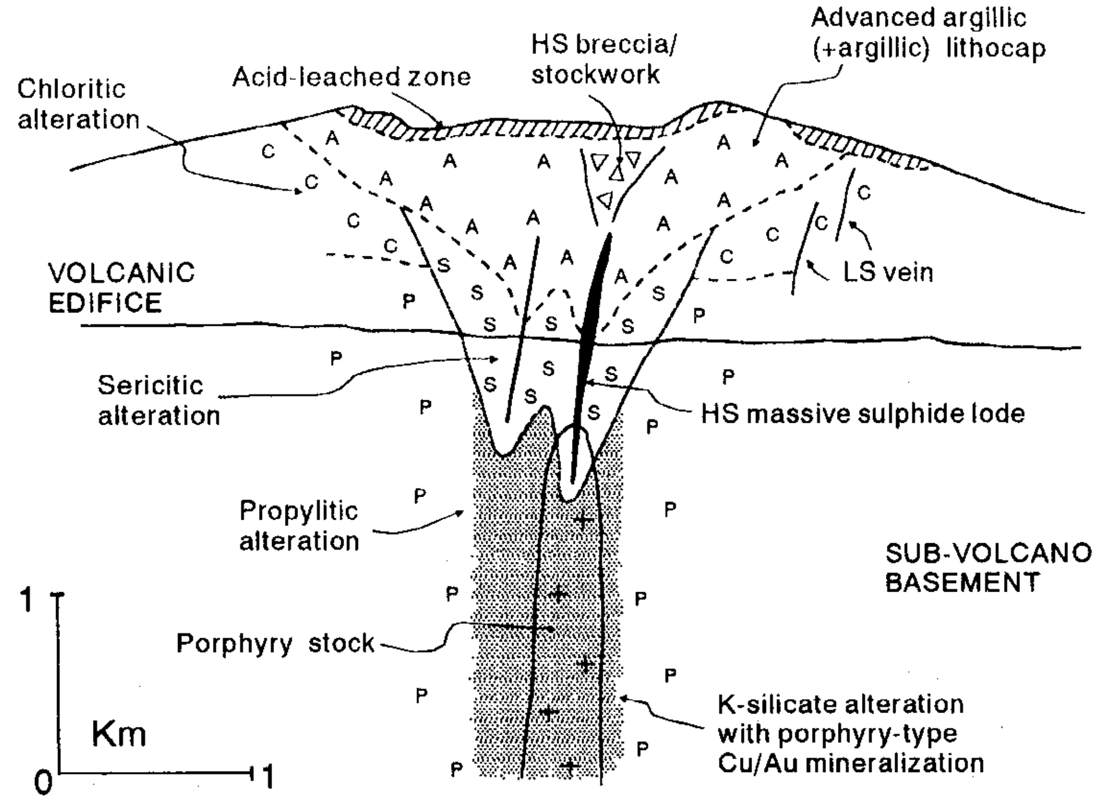


Fig. I -4-1 (1) Idealized Model of Bolivia Type Deposit



HS:High-sulphidation
Ls:Low-sulphidation

(After R.Sillitoe, 1995)

Fig. I-4-1(2) Idealized Lithocap and Underlying Porphyry Cu/Au Deposit

4-2 Survey Findings by District (Table I-4)

4-2-1 Turaquiri district (Fig. I-4-2(1))

The hydrothermal alteration zones cover about 2 km^2 in the dacitic volcanic rocks of late Miocene to Pliocene age.

Silicification and enclosing argillization are observed in small scale along the veins and fractures in the E-W direction and changed to propylitic zone.

The dominant trend of the faults, veins and fractures in the area is E-W, while those with the N-S trend are partially observed.

The ore deposits of Turaquiri district are epithermal barite- quartz veins associated with base metals and precious metals which occur along the east-westerly fractures formed by the development of caldera.

Based on the facts that the alteration is neutral type without tin minerals and any intrusives was not recognized in the area, the mineralization of the area has both characters of low-sulfidation epithermal deposit (Type V) and epithermal precious metal deposit (Type III).

Considering that only the mineralized veins have been mined in the previous mining operation, as the case of Tordos deposit at San Cristóbal mine, it is possible that a low grade stockwork or disseminated type deposits might have been left. Particularly the presence of mineralization is expected in the area where two veins are intersecting in deep underground.

A portion of parallel vein of Turaquiri main vein is confirmed by geological survey.

4-2-2 Asu Asuni district (Fig. I-4-2(2))

The hydrothermal alteration zones cover about 5km^2 in the volcanic rocks of late Miocene to Pliocene age.

A small alteration zone associated with hydrothermal breccia was found in the east of the alteration zone studied in the phase I survey.

In the area, faults, veins and fractures with the E-W trend prevail, besides N-S direction.

Only dissemination of pyrite, hematite and goethite is observable locally.

Mineralization type at Asu Asuni district is difficult to classify clearly.

No remarkable mineralization and geochemical anomaly are observed in alteration zone and if exist, the mineralization is probably weak or occurs in deeper part.

4-2-3 Chullcani district (Fig. I-4-2(3))

The hydrothermal alteration zones cover about 6.5km^2 in the volcanic rocks of late Miocene to Pliocene age.

As the result of phase II survey a ring-shaped hydrothermal alteration zone was found at the

Table I-4 Summary of Characteristics of Geology,Alteration and Mineralization at the Survey Areas

No	district	area	lithology	main direction of vein,fracture	rock age K-Ar (Ma)	rock age rock type	alteration area (km²)	alteration area arg/sil	alteration minerals (POSAM)	dome hyd br br pipe	alteration age K-Ar (Ma)	ore deposit,mineral showing: ore minerals	ore deposit,mineral showing: gangue minerals	ore deposit,mineral showing: ore reserve,ore grade	fluid inclusion homo.temp. (°C)	fluid inclusion salinity (Nacl wt%)	geochemical anomaly	potential: expected type	potential: estimate	exploration order
1	Turaquiri		da-lava,da-tf(Turaquiri F) rhy-tf(Mauri F.)	E-W	5.51±0.11	da tf	2		smc>>zeo>qz			py,cp,sph,gn,hem	ba,qz,sid,chl,aln,ga		ave.200	ave.10.8	Ba(wide),Pb,Zn,As,Cu	III, V	◎	2
2	Asu Asuni		an-da lava,tf,vol br,lp tf	E-W	4.1±1.2 3.27±0.10	an lava an lava	5	sil>arg	qz>>smc,ser,aln,zeo	hyd br		py,hem					Ba,(Zn)	II ?	△	
3	Chullcani		da-tf,tf br,lp tf an-ba lava, rhy dome	radial	5.31±0.14 1.52±0.05 6.14±0.12 6.13±0.12	bt-hb an lava rhy dome hb-bt an an lava	6.5	arg>sil	qz>aln>smc>zeo>ser,kao,pyph	rhy-dome hydr br br pipe	5.32±0.07 6.12±0.09	py,Mn-oxd,grn Cu					Au,Sb,Ba,Pb,Mo,Cu,Sn:wide	II, IV	◎	1
4	Sonia Susana		rhy-da-ba lava,dol-dyke an-rhy tf,lava(Carangas F) tf(Negrillos F)	E-W NE-SW	17.7±0.35 1.73±0.03 1.52±0.03	rhy-an tf an-da lava rhy lava	17	arg>>sil	ser,qz,smc>>kao,zeo	rhy-dome hydr br	1.75±0.10	py,gn,sph,grn Cu, Mn-oxd,mo			ave.195 ave.222	ave.4.7 ave.1.5	Au,(Ag),Cu,Pb,Zn,As,Mo,Ba,Sn:conc	IV, III	◎	
5	Calorno		an-da lava,an-dome? an-da tf,lp tf,tf br,vol br	N-S NW-SE	9.01±0.18 11.69±0.23	an lava(north) an lava(south)	28.5		qz>>aln,smc>kao,ser,pyph	an-dome? hyd br		py,al,lim					As,Sb,Cu,Pb,Mo,Ba,Sn,Hg:sctd	IV, II	◎	4
6	Loma Llena		an-ba lava tf ,tf br,lp tf,vol br	N-S NE-SW	6.24±0.12 4.07±0.08 3.75±0.08	an lava(north) an lava(south) an lava(south)	8	arg>>sil	aln>smc,qz>kao>ser,zeo,pyph	hyd br		py					Cu,As,Sb,Ba,Sn:sctd	IV, II	△	
7	Blanca Nieves	Blanca Nieves	an-rhy lava(west) an-rhy lava,an dome,tf br	E-W NE-SW	0.573±0.02 2.63±0.03	an lava(west) an dome	5	arg>>sil	qz,aln,zeo>smc>ser	an-dome hyd br,pipe		py					Ba,Sn,Cu,As:sctd	II	△	
		Titicayo	an lava,tf,tf br,lp tf,vol br	WNW-ESE	6.94±0.07 7.27±0.10	hb bt an da tf	3	arg>>>sil	smc>qz>zeo,ser>aln,kao	hyd br		Mn-oxd,lim,py					Ba,Pb,As,Cu,Sb,Ag,Sn,Hg,Zn	II	○	
8	Carangas	San Francisco mine	da-an tf,tf br,lp tf,ba-lava	N-S	21.7±0.7	bt an?	—	—	ser>smc			Mn-oxd>py,cp,grn Cu			ave.256	ave.1.7	Ag,Cu,Pb,Zn,Sb	III	△	
		Carangas mine	an-lava,tf,lp tf,tf br,rhy-dome	WNW-ESE	15.4±0.5	rhy dome	0.5	arg>sil	smc>>zeo,ser,qz	rhy-dome,hyd br		tet,sph,pru,pyr,gn	qz,ba,dol,mgs,py		ave.212	ave.3.4	Sb,Pb,Zn,Cu,Ag,As,Ba	III	○	
		others	an-tf,lp tf,tf br				2.5	arg>>sil	smc>kao,pyph								Sb	IV ?	△	
9	Culebra	Todos Santos mine	an-lava,lp tf,tf br,rhy-dome	E-W	6.1±0.2	rhy tf	0.5	arg>>>sil	smc>qz	rhy-dome,hyd br		lim,gn,sph		1.0mt(Au:0.07,Ag:70)			Sb,Pb,Zn,Ag	III	○	
		Culebra	an-lava,tf,lp tf,tf br, rhy-da dome,an-dyke	WNW-ESE	5.95±0.07 6.10±0.07 6.3±0.2	an dyke bi rhy hb an	3.5	sil>arg	qz>smc>aln>zeo,ser,kao	rhy-dome,hyd br da-dome		py,al					Sb,Sn,Ba	II	△	
10	Mendoza	Co.Kancha	an-lava,tf,lp tf,tf br,da-dome	NW-SE,E-W	7.27±0.08 8.0±0.2	da dome da sub vol	15+	arg>>sil	ser>smc>qz>aln,kao	da-dome,hyd br	16.37±0.20	Mn-oxd,lim					Cu,Pb,Zn,Sb,Ba:sctd	II	△	
		La Deseada mine ~Co.Mokho	an-lava,tf,tf br,lp tf	E-W ENE-WSW	17.6±0.2	Chufusa dio	4+	arg>>sil	qz,ser>smc>aln,kao chl,ep	hyd br		gn,sph,py	qz	2.5mt(Au:0.4,Ag:280)	ave.188	ave.2.5	Deseada:Au,Ag,Cu,Pb,Zn,As,Sb,Sn:conc Mokho:Au,Pb,Sb:conc	II, IV IV	◎ ◎	
		Guadalupe mine(G)~ ~Maria Luisa(M.L.)	an-lava,tf,lp tf,tf br an-rhy int.	E-W WNW-ESE			5+	sil>arg	qz>ser>smc>kao,aln	hyd br G:rhy-an int M.L:rhy-dome		gn,sph,py,en	qz	G:2.5mt(Au:0.4,Ag:280) M.L:0.175mt (Ag:471,Pb:1.11,Zn:1.83)	ave.256	ave.0.3	Au,Ag,Cu,Pb,As,Sb,Sn:conc	II, IV	○	
		Co.Chorka ~Iranuta	an-lava,tf,tf br,lp tf rhy-int	NE-SW NW-SE			5	arg>>sil	Chorka:qz>smc>kao,aln>ser,pyph Iranuta:qz>>ser,smc>kao	hyd br,br pipe					ave.258	ave.0.7	Chorka:Sb,Pb:sctd Iranuta:Pb,Zn,Cu,As,Sb:conc	II, IV III	◎ △	
11	Panizo	Vilasaca	rhy-an lava,lp tf,tf,tf br,ss?	NE-SW			4	arg>>sil	qz,smc>aln,kao	hyd br		py					As,Sn,Sb:sctd	II	△	
		Pacoloma	an-lava,tf,lp tf,tf br	NE-SW,N-S			3	arg>>sil	qz>smc>kao>aln,pyph	hyd br		hem,al					Sb,As:sctd	IV	△	
		Tulco	an-lava,tf,lp tf,tf br,ss,cgl	E-W,N-S	11.87±0.13		8	arg>sil	qz>>smc>aln>kao	hyd br		py,al(abund)					As,Sb,Sn,Pb:sctd	II	△	
		Chinchilhuma	an-lava,an-tf,tf br,lp tf	NE-SW			5	arg>>sil	ser>qz>smc	hyd br	9.18±0.10	Mn-oxd			ave.249	ave.2.7	Au,Ag,Sb,Zn,Pb,Ba,Cu,As:wide	III	○	
		Puquisa	an-lava,tf,tf br,lp tf,da-dome	N-S,NE-SW			1	sil>arg	qz>>aln>smc	da-dome,hyd br		Mn-oxd					(Ba)	II	△	
		Panizo	an-lava,rhy-lp tf,tf,an-dome	N-S,E-W,NE-SW	14.87±0.19	bt rhy tf	18	arg>sil	qz>>>aln>zeo,smc,pyph,ser	br,pipe,an-dome	13.79±0.42	py,al(abund)					Au,(Ag),Sb,As,Sn,Mo,Cu,(Pb):wide	II, IV	◎	3
12	Sailica	Plasmar mine	an-lava ,tf,lp tf,tf br,an-dome	E-W,NW-SE,N-S			10.5	arg>>sil	qz>>smc>kao>ser,aln,pyph	an-dome	8.23±0.13						Au,(Ag),Sb,As,Pb,,Sn,Zn,Cu,Mo:wide	II, IV	◎	
		Solución mine	da-an lava,tf,lp tf,tf br,ba-int	NE-SW	1.67±0.02		—		smc,qz>kao	hyd br		gn,sph		3,000t(Ag:24,Pb:1.4,Zn:1.4)			Sb,Zn	II	△	
13	Colorado	Bayos	an-lava,tf,lp tf,tf br	E-W,NE-SW	5.85±0.06	bt an	0.5	arg>>sil	smc,aln>qz>ser	hyd br,br pipe?		—					As,Sb,Ba,(Ag)sctd	II	△	
		Okhe	an-lava,tf,lp tf,tf br	E-W	8.6±0.5	an lava	11	arg>>>sil	qz>>aln>kao			—					Sb,As,Ba,(Sn):sctd	II	△	
		Perenal	an lava,tf,lp tf,tf br	NE-SW,NW-SE	10.0±0.6 11.8±0.6	an lava an lava	5	arg>sil	qz	hyd br		py					As,Sb,(Pb,Ba,Hg,Mo,Sn):sctd	II	○	
		Colorado	an-lava,tf,lp tf,tf br	E-W,NW-SE			3	arg>>sil	qz>smc>ser,kao>aln,pyph	hyd br,br pipe?		al					As,Sb,Ba,(Pb):sctd	IV	△	
14	Luxsar		an-lava,lp tf,tf,vol br,an-dome	NW-SE	5.55±0.09 5.6±0.3	px-hb an an lava	5.5	arg>>>sil	qz>>aln>smc,kao	hyd br,an-dome		py					—	II	△	
15	Cachi Unu		an-da lava,lp tf,tf br,lp tf	NW-SE	9.67±0.13 10.9±0.7	hb an lava an lava	1	arg>>sil	qz>>aln	hyd br		green Cu,py,hem					Ba,Sn,(Pb):sctd	I B, IV	△	
16	Sedilla	Chascos	an lava ,lp tf,tf br,vol br an-dome/int?		9.70±0.17 10.59±0.47 9.41±0.11 7.2±0.5	an lava px an an dome an lava(south)	1	arg>>>sil	—	an-dome(dry)		Mn-oxd					(As,Sb)	II ?	△	
		Sedilla	da-an lava,tf,lp tf,tf br	NNE-SSW NNW-SSE	6.9±0.5	an lava,vol br	1	arg>>sil	—	hyd br		hem,py?					As,Sn,(Sb)	II	△	
		Eskapa	da-an lava,lp tf,tf br,vol br	N-S NW-SE	6.3±0.1	an lava	4.5	arg>>>sil	qz,smc>ser>kao	hyd br	5.93±0.19	py,greenCu					Sb,As,Ag,Zn,Pb,Ba,Sn,Cu,(Mo):wide	II, III	◎	

an:andesite
da:dacite
tf:tuff
lp tf:lapilly tuff
ss:sandstone
dol:dolerite
int:intrusives

ba:basalt
rhy:rhyolite
tf br:tuff breccia
vol br:volcanic breccia
cgl:conglomerate

【K-Ar age】 3.75±0.08:(Phase I)
5.55±0.09:(Phase II)
8.0±0.2:(others)

qz:quartz,
smc:smectite
kao:kaolinite
chl:shlorite
zeo:zeolite

aln:alunite
ser:sericite
pyph:pyrophylite
ep:epidote

hyd br:hydrothermal breccia
br pipe:breccia pipe
int:intrusive rock

en:enargite
al:yellow alunite
sph:spharelite
gn:galena
py:pyrite
hem:hematite
mo:molybdenite
lim:limonite
Mn-oxd:Mn oxide

mgs:magnesite
dol:dolomite

ga:garnet
sid:siderite

Au,Ag : g/t
Pb,Zn : %

ave.195:(Phase I)
ave.222 (Phase II)

wide:widely spread　sctd:scattered
conc:concentration of anomaly

【ore deposit type】 I B:bolivian-type deposit(Ag,Au,Cu)
II :volcanic rock related epithermal deposit(Au,Ag,Pb,Zn)
III:Intrusive rock related epithermal deposit(Au-Ag-Pb-Zn-Cu vein)
IV:high sulfidation type epithermal deposit(Au-Ag-Cu vein)
V:low sulfidation type epithermal deposit(quartz-adularia vein)

【estimate】 ◎:high　○:moderate　△:low

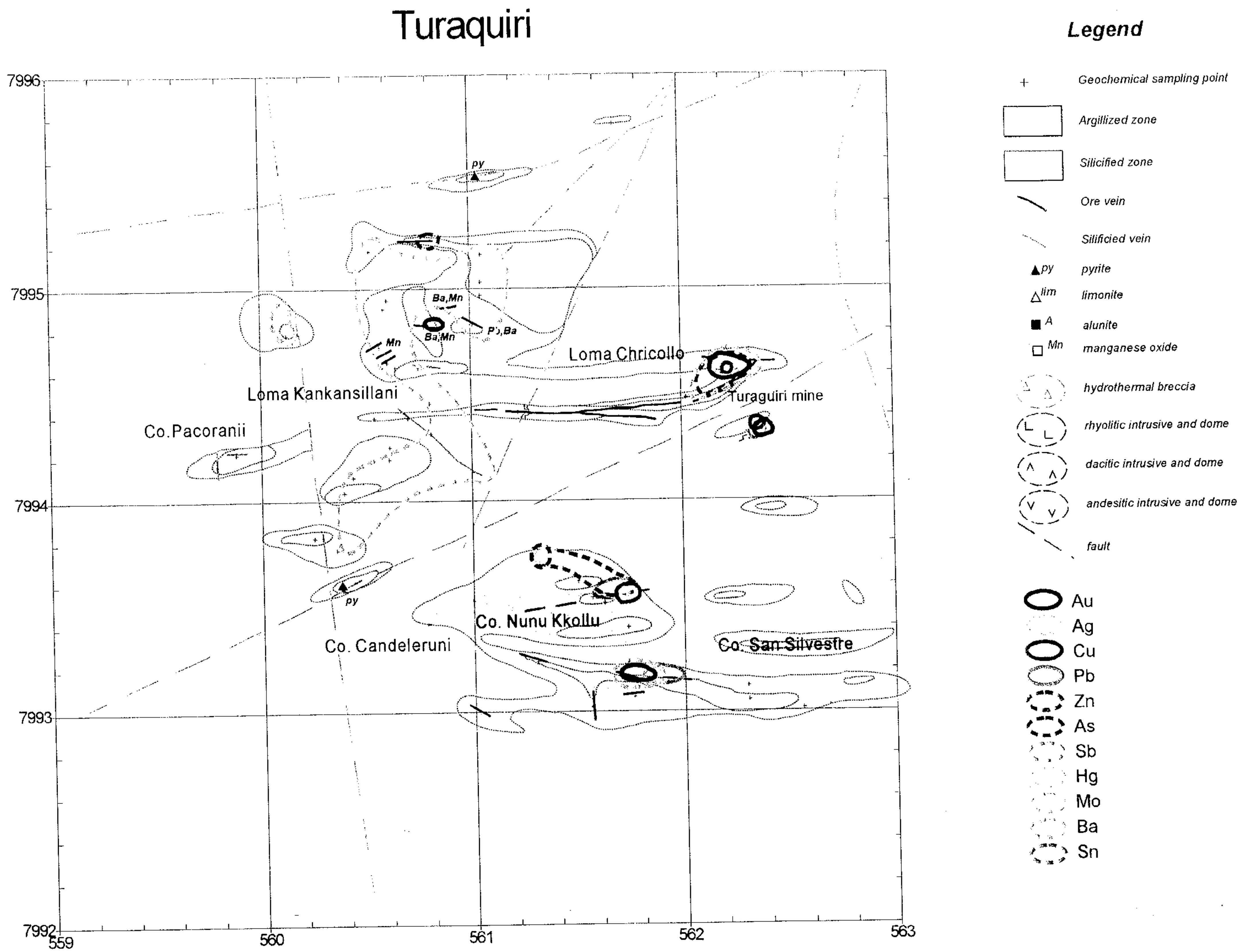


Fig.I-4-2 (1)Integrated Interpretation Map of the Turaquiri District

Asu Asuni

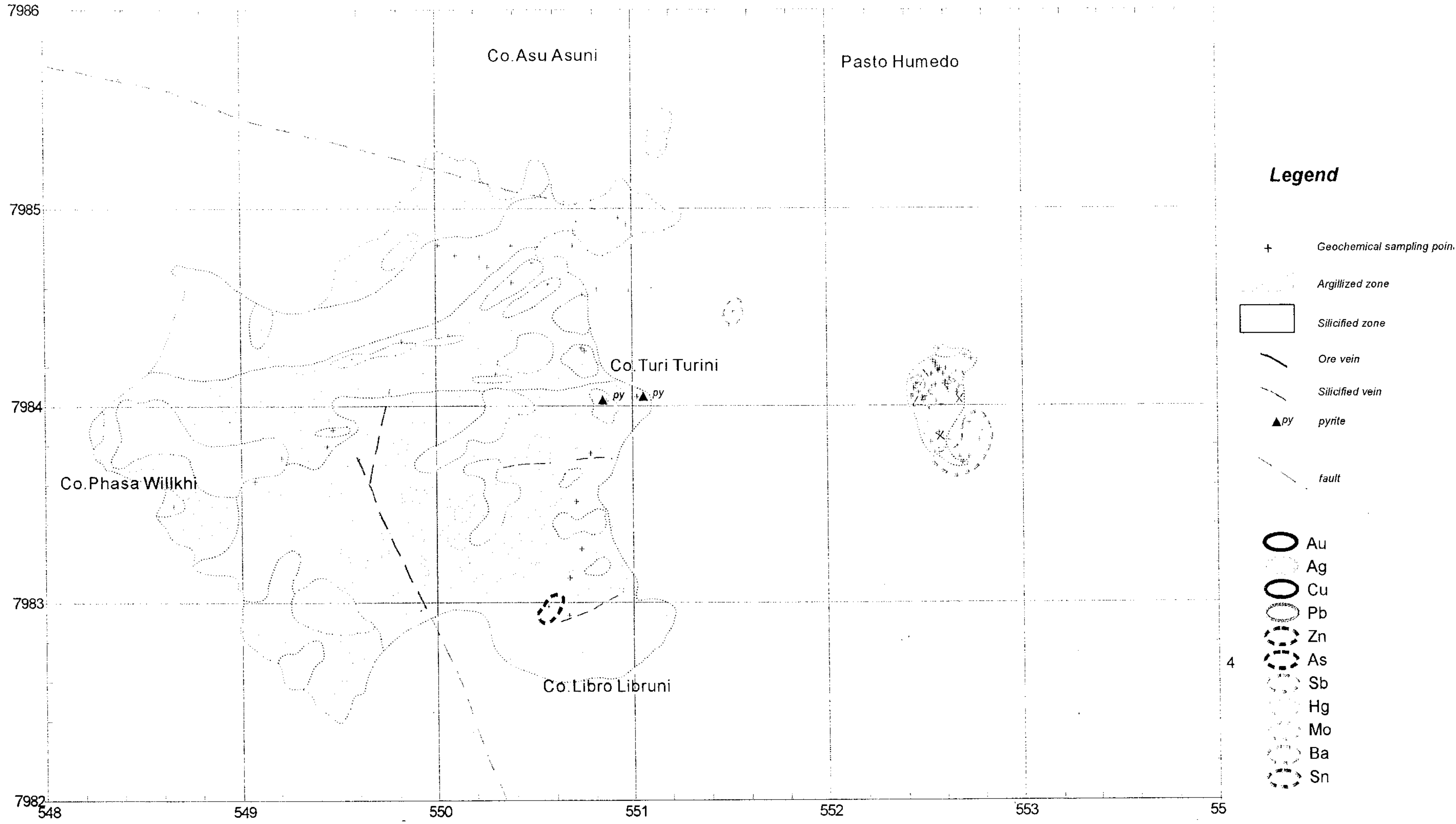


Fig.I-4-2 (2)Integrated Interpretation Map of the Asu Asuni District

Chullcani

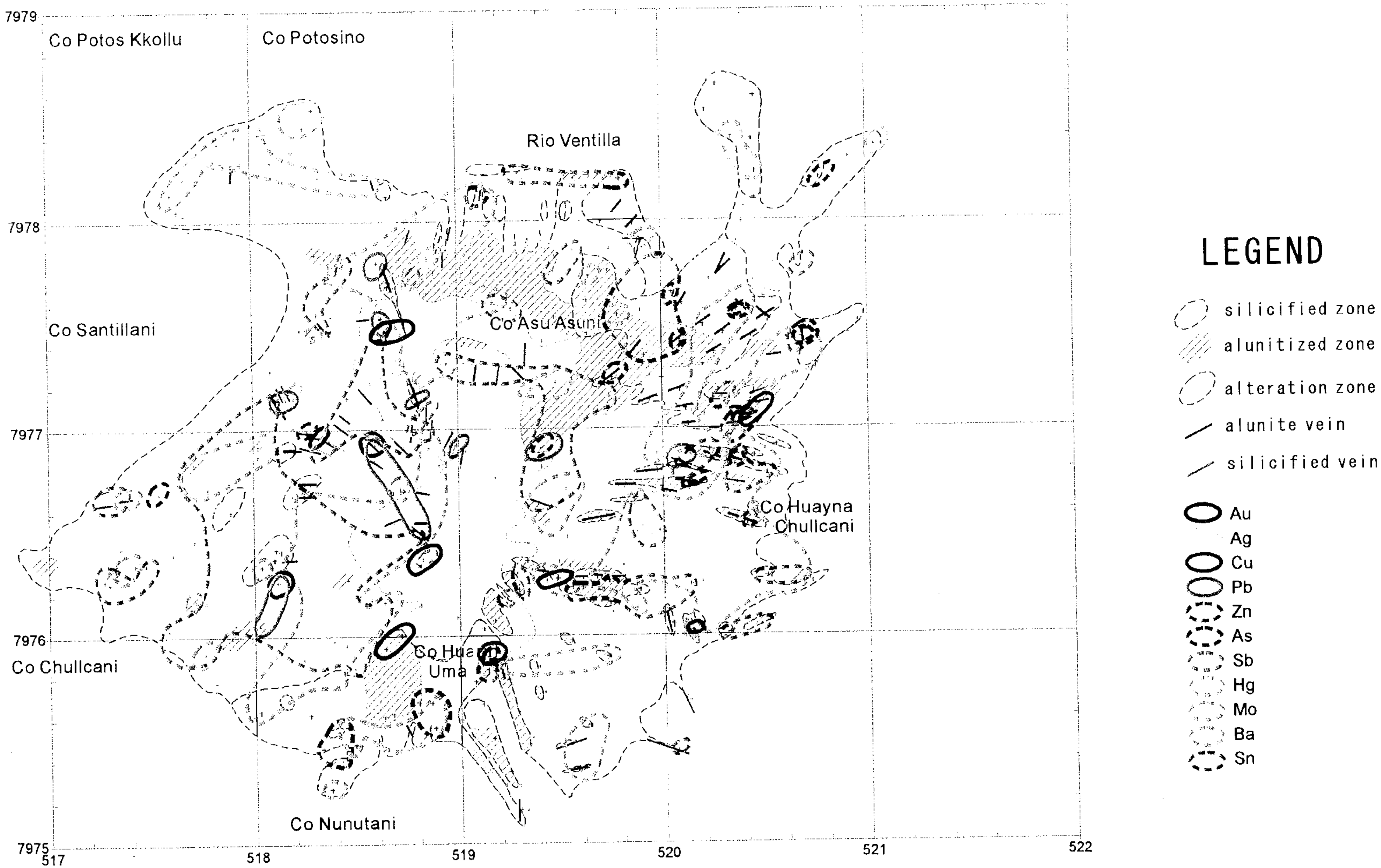


Fig.I-4-2 (3)Integrated Interpretation Map of the Chullcani District ridge of Loma Huarin Uma, and hydrothermal breccia (as dykes, pipes and masses) and silicified veins are distributed radially, suggesting the presence of crypto-intrusive in deep underground. Alunite, kaolinite and pyrophyllite were identified as alteration minerals indicating that the alteration is acidic type.

Result of the geochemical survey shows that the anomalies of gold are scattered around the center of the alteration zone and the anomalies of antimony and barium are widely distributed over the alteration zone. Small anomalies of lead arsenic, molybdenum and tin are also scattered.

Based on the facts described above, the mineralization in Chullcani district is presumed to be epithermal gold- silver- lead- zinc deposit (Type II), related to shallow volcanic activity. Beside there is a possibility of existing ore deposits around the crypto-intrusive. In addition, as the presence of pyrophyllite and copper anomalies are recognized in part, there is a possibility of over-printing of mineralization by high-sulfidation epithermal deposit (type IV).

4-2-4 **Sonia - Susana district** (Fig. I-4-2(4))

The hydrothermal alteration zones cover about 12km^2 in the volcanic rocks of early Miocene to Pliocene age.

Faults, veins and fractures trending E-W are predominant in the eastern part of the district. In the central part, the NE-SW trend is dominant. In the west, the main trend is E-W but the N-S and NW-SE trends are also observable.

Pyrite dissemination is observed at various locations, as well as green copper mineralization accompanied by molybdenite.

Homogenization temperatures of two quartz samples indicate 222°C in average, and the salinity (NaCl equivalent) that was calculated from these values was 1.5 wt. % in average.

Geochemical anomalies of gold, copper, lead and zinc overlap at Santa Catalina Loma and on the western slope of Co. Sojta Kkota, and these of gold, tin, antimony and arsenic overlap at southeastern part of Co. Entre Campanani.

Tow type of geochemical anomalies, gold- copper- lead- zinc and gold- tin- antimony- arsenic, are recognized in the area. This implies different types of mineralizations have place at least in two stages. The former is the epithermal deposit related to shallow hypabyssal intrusion (Type III), and the later is the epithermal gold- silver-lead- zinc deposit related to shallow volcanic activity (Type II).

Porphyry type mineralization is expected to occur beneath the older mineralization, and epithermal precious metal deposit is expectable beneath the younger mineralized zone.

COMINCO Bolivia has carried out exploration including diamond drilling of 10 holes, geochemical survey and IP survey. Comprehensive study including these data is necessary.

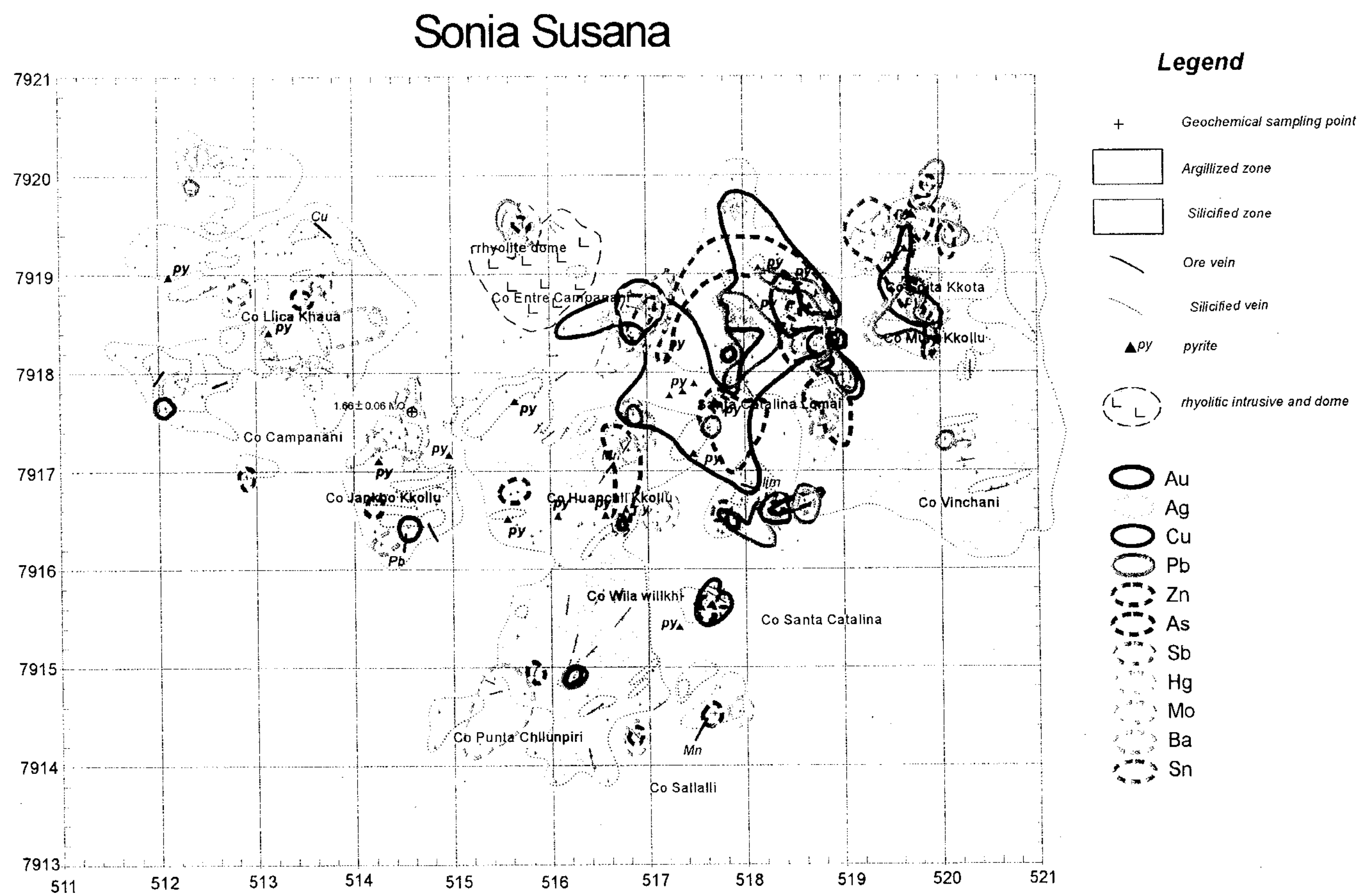


Fig.I-4-2 (4)Integrated Interpretation Map of the Sonia-Susana District

4-2-5 Calorno district (Fig. I-4-2(5))

The hydrothermal alteration zones, biggest in the whole area, cover about 28.5km^2 in the volcanic rocks of late Miocene to Pliocene age.

In the northeastern part of the district, faults, veins and fractures with the N-S trend are predominant, followed by those with the NW-SE trend. In the northwestern part, the N-S trend are predominant, followed by those with the ENE- SWS. In the central part of the district, the NW-SE trend is conspicuous while the NE-SW and E-W trends are also observable.

The hydrothermal alteration zones widespread in the district are considered to be situated at the topmost (outermost) parts of the alteration zones, because non-altered rocks are left on top of many mountains while no presence of propylite is known.

Gossans, mainly of geothite, that occur along the Rio Agua Milagro show arsenic and antimony anomalies at the uppermost part of the upper reaches; it is conceivable that thermal water effused from around the uppermost part and flowed down. As the district appears to be a little away from the center of a volcanic body, occurrence of low-sulfidization epithermal ore deposits is possible.

Pyrophyllite, a somewhat high-temperature, acidic mineral, has been.observed at several points. It is interpreted that a hydrothermal alteration zone was formed from strong acid solution, and also geochemical anomaly of tin exists, which suggest high-sulfidization epithermal deposit (type IV) or volcanic activity related epithermal Au-Ag-Pb-Zn deposit (type II).

Although the geochemical anomaly is not extensive, as the vast amount of hot water is spouting out and wide area is covered by the hydrothermal breccia existence of large deposits can be expected.

4-2-6 Loma Llena district (Figs. I-4-2(6))

The hydrothermal alteration zones cover about 8km^2 in the volcanic rocks of late Miocene to Pliocene age.

The faults, veins and fractures with N-S and NE-SW trends are dominant in the area.

Pyrite dissemination and veinlets observed only in the north of the area.

Since non-altered rocks are left on top of mountains and presence of propylite is unknown, hydrothermal alteration zones in the district are presumably situated at the topmost (outermost) parts of the alteration zones. Existence of pyrophyllite, considered as a rather higher temperature product, suggests possibility that some part of alteration zone was caused by strong acidic solution.

Tin anomaly exists and the high-sulfidation type deposit (type IV) or epithermal Au- Ag- Pb-Zn deposit related to shallow volcanic activity (type II) are expected.

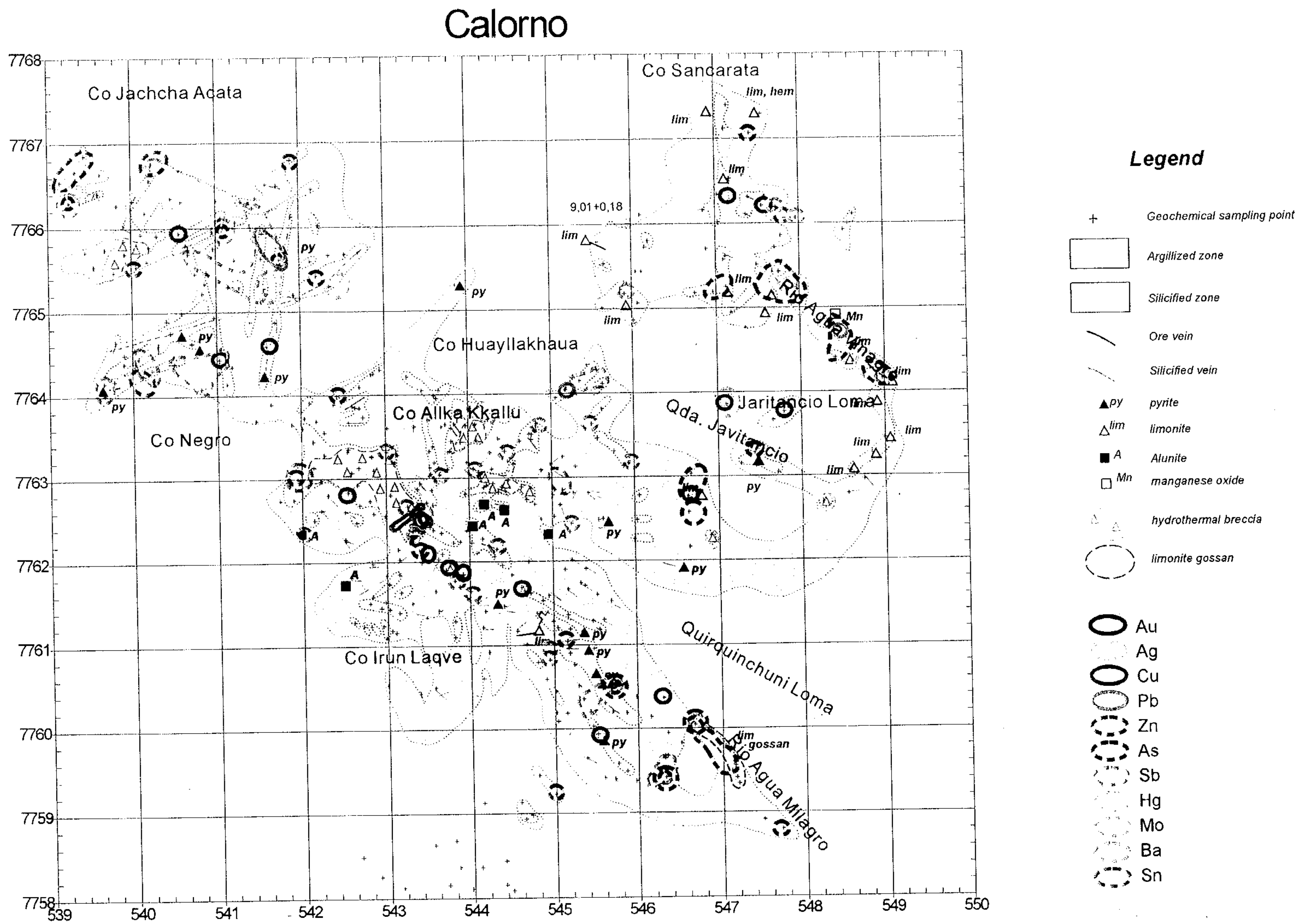


Fig.I-4-2 (5)Integrated Interpretation Map of the Calorno District

Loma Llena

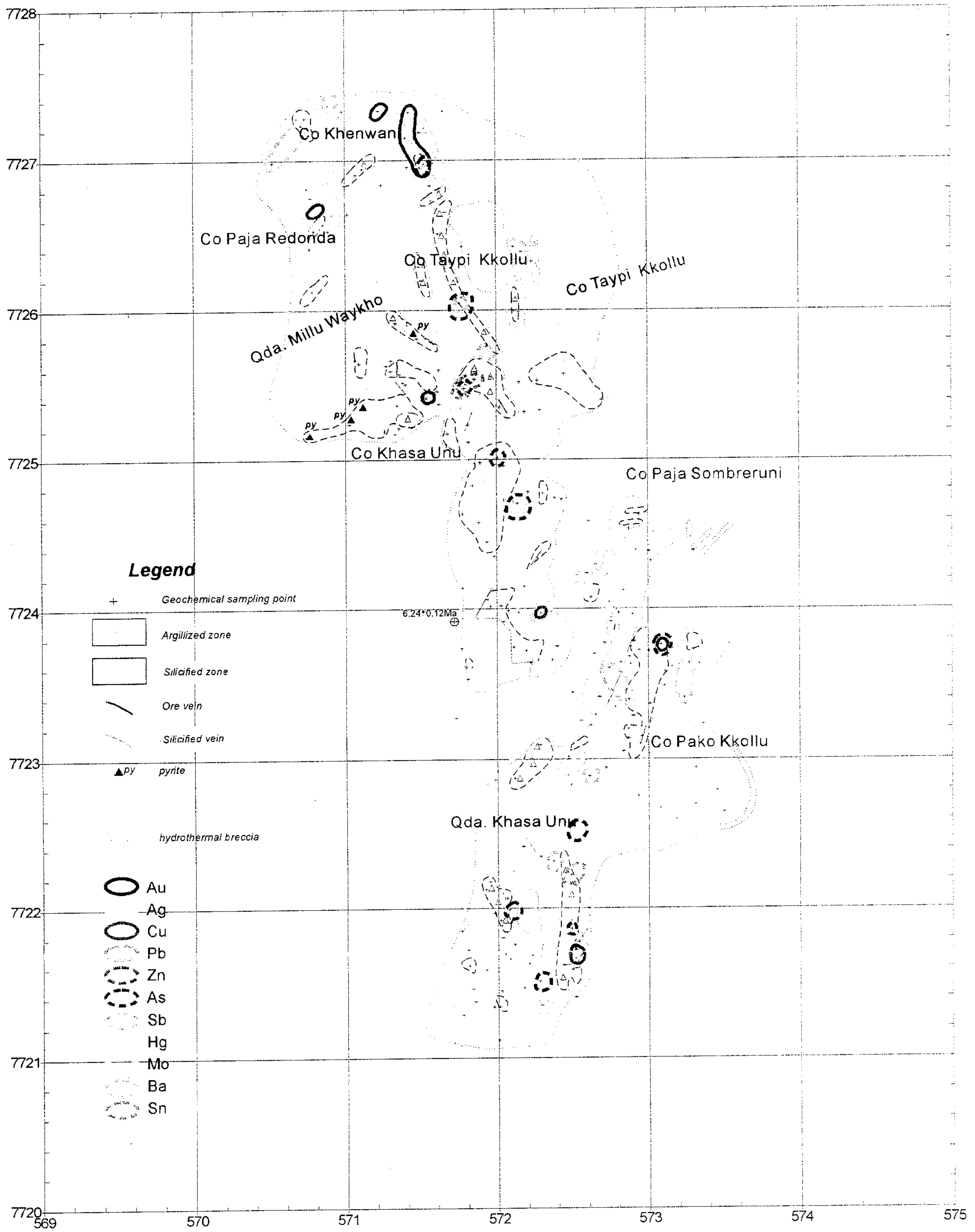


Fig.I-4-2 (6)Integrated Interpretation Map of the Loma Llena District

But geochemical anomaly is not dominant and mineralization, if any, is likely to be weak or to occur in depths.

4-2-7 Blanca Nieves district

(1) Blanca Nieves prospect (Figs. I-4-2 (7-1))

The hydrothermal alteration zones cover about $5km^2$ in the volcanic rocks of late Miocene to Pliocene age.

Pyrite dissemination is found locally.

The faults, veins and fractures with E-W and NE-SW trends are dominant.

The mineralization appears to correspond to an epithermal gold- silver- lead- zinc deposit (Type II) related to shallow volcanic activity from the presence of tin. The mineralization, however, is probably weak or deep-seated if exists.

(2) Titicayo prospect (Figs. I-4-2(7-2))

The hydrothermal alteration zones cover about $5km^2$ in the volcanic rocks of late Miocene to Pliocene age.

The faults, veins and fractures with WNW-ESE trend are dominant in the area, whereas the E-W and ENE-WSW trends are also observable.

The fractures of northwest direction are developed in the area, where manganese bearing silver mineralization was recognized. This mineralization , as similar to that of Carangas prospect, appears to correspond to the epithermal precious metal deposit (Type III) although any intrusives are not yet found.

4-2-8 Carangas district (Figs. I-4-2(8))

(1) San Francisco mine

Although the area is underlain by Carangas volcanic rocks of late Oligocene to early Miocene age, weak hydrothermal alteration is seen and no marked alteration zone are formed.

The mineralization in this district is thought to be an epithermal precious metal deposit (Type III) related to shallow hypabyssal intrusives, although the existence of intrusives not yet confirmed

Homogenization temperature of quartz sample indicates 256°C in average, and is considered to appear rather lower part of mineralized zone by erosion.

Geochemical anomaly zones cover widely and silver, copper, lead, zinc and antimony overlap in whole area.

However, the mineralization is probably weak, as the alteration zone is not extensive and development of the fracture is poor.

Blanca Nieves

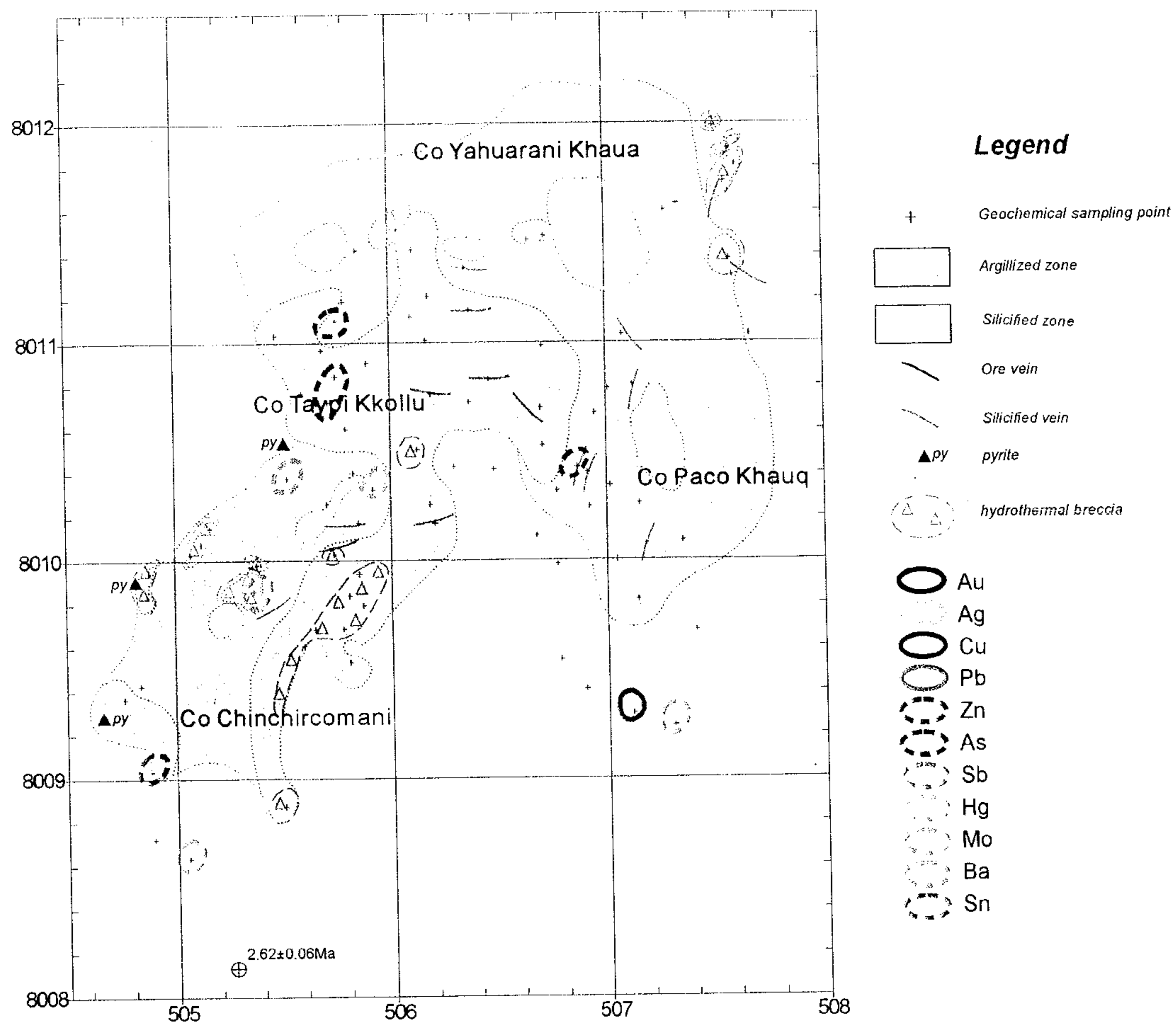


Fig.I-4-2 (7-1)Integrated Interpretation Map of the Blanca Nieves District (Blanca Nieves)

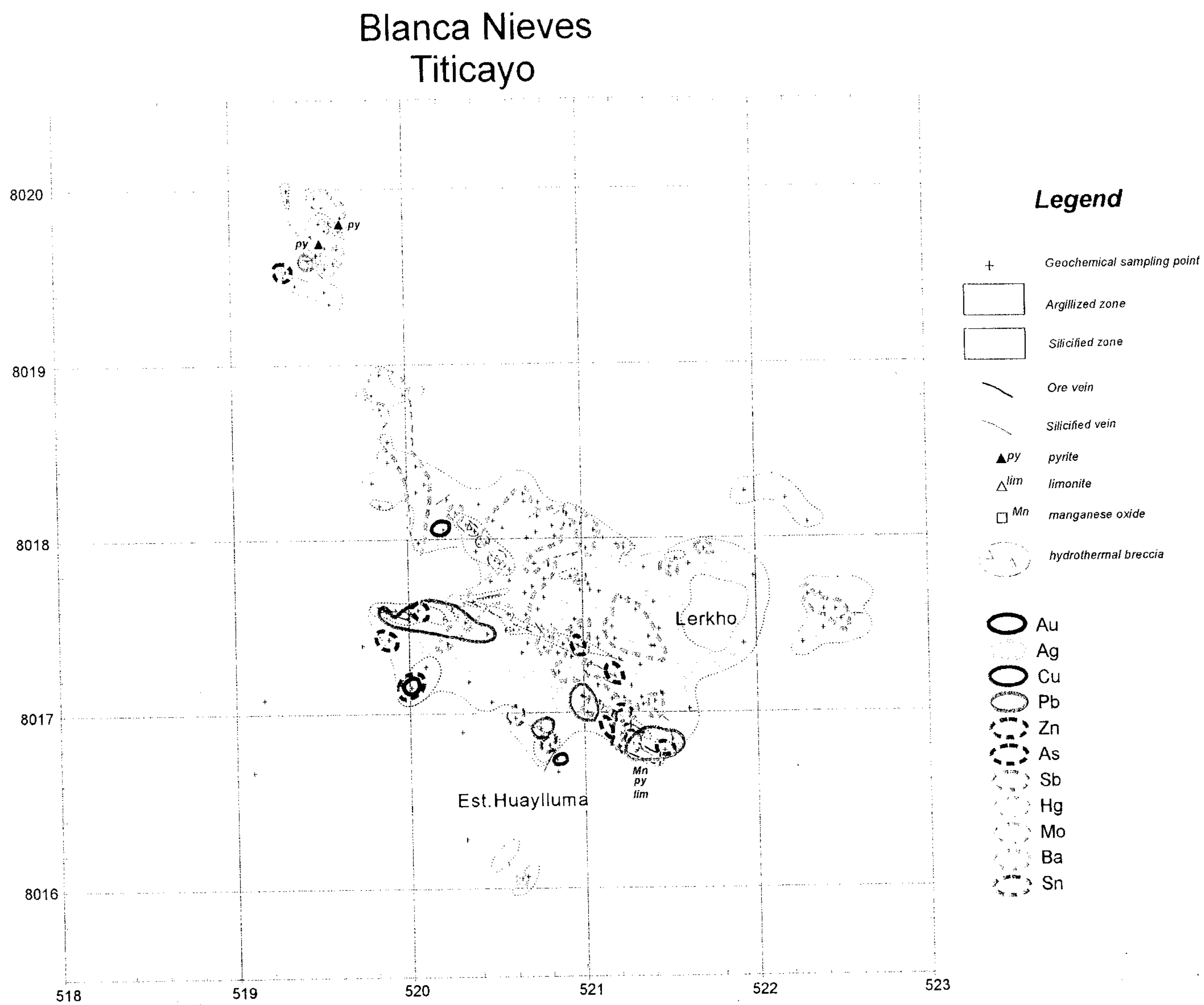


Fig.I-4-2 (7-2)Integrated Interpretation Map of the Blanca Nieves District (Titicayo)

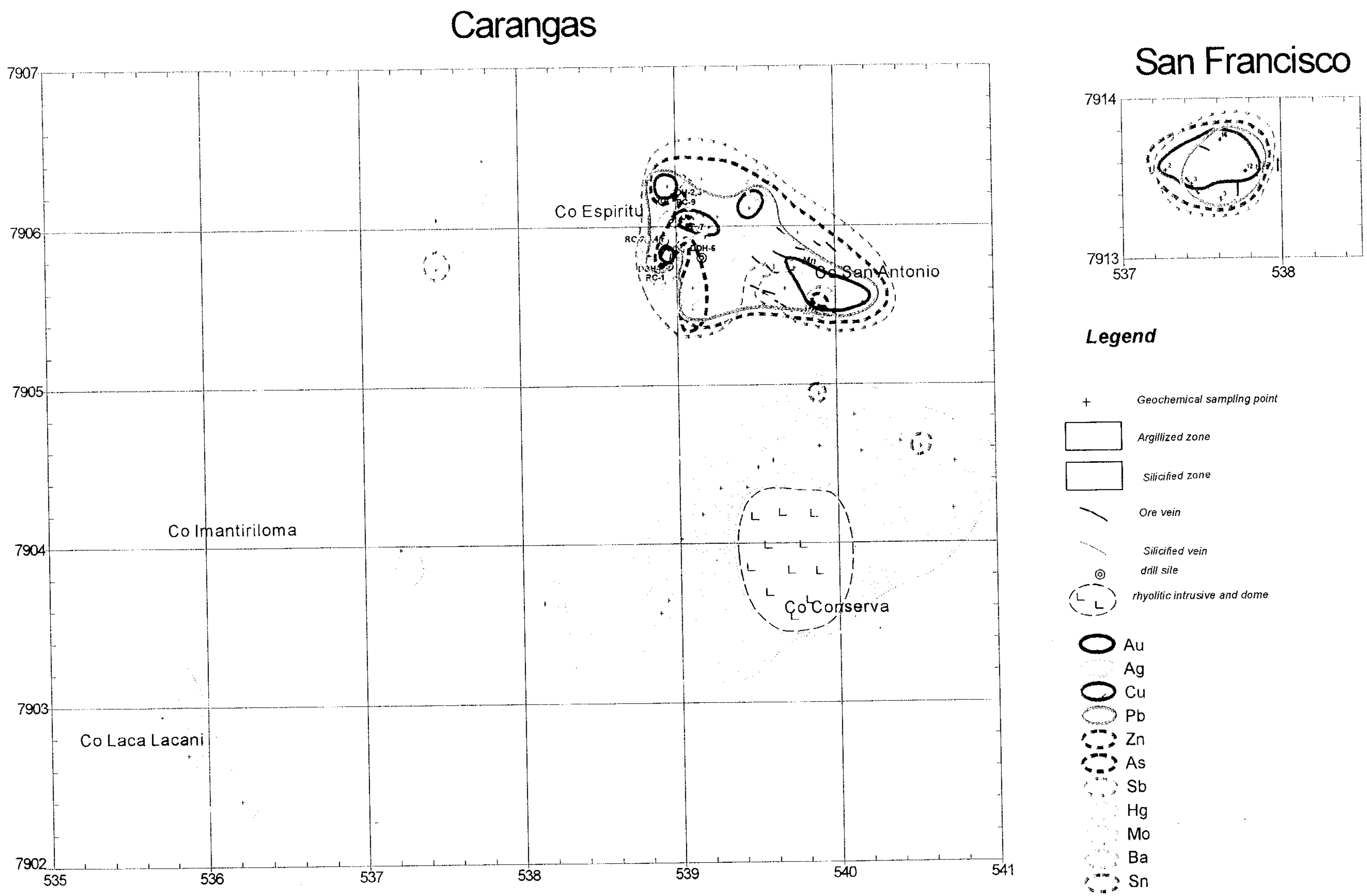


Fig.I-4-2 (8)Integrated Interpretation Map of the Carangas District

(2) Carangas mine

The hydrothermal alteration zones cover about 3km^2 in the volcanic rocks of late Oligocene to early Miocene age.

In Carangas mine an alteration zone is recognized at Co. Espiritu, and it is weak at Co. San Antonio. Both of them are neutral and tin anomaly is not yet found. The mineralization in this district is thought to be epithermal precious metal deposit (Type III) related to shallow hypabyssal intrusives which were recognized at Co. Espiritu.

Homogenization temperature of quartz and sphalerite samples indicates 212°C in average, but the salinity (NaCl equivalent) was 3.4 wt.% in average and is considered to appear rather lower part of mineralized zone by erosion.

Geochemical anomaly portions of silver, copper, lead, zinc and antimony overlap widely.

Silver- bearing manganese oxide mineralization is observed along the fractures at Co. San Antonio. The mineralization seems to be weak.

4-2-9 Culebra district (Figs. I-4-2(9))

(1) Todos Santos mine

The hydrothermal alteration zones cover about 0.5 km^2 in the volcanic rocks of late Oligocene to early Miocene age.

Numerous tunnels and E-W trend workings are left since the colonial periods.

As the alteration of Todos Santos mine is neutral and tin anomaly is not recognized, the mineralization in this district appears to be epithermal precious metal deposit (Type III) related to shallow hypabyssal intrusives, which was observed at Todos Santos mine.

(2) Culebra prospect

The hydrothermal alteration zones cover about 3.5km^2 in the volcanic rocks of Miocene to Pliocene age.

In the area, faults, veins and fractures with the WNW-ESE trend prevail.

The mineralization in Culebra prospect is presumed to be a gold- silver- lead- zinc deposit (type II) related to shallow volcanic activity from the presence of tin anomaly.

The mineralization is probably weak or deep-seated if exists.

4-2-10 Mendoza district

(1) Co. Kancha prospect(Figs. I-4-2(10-1))

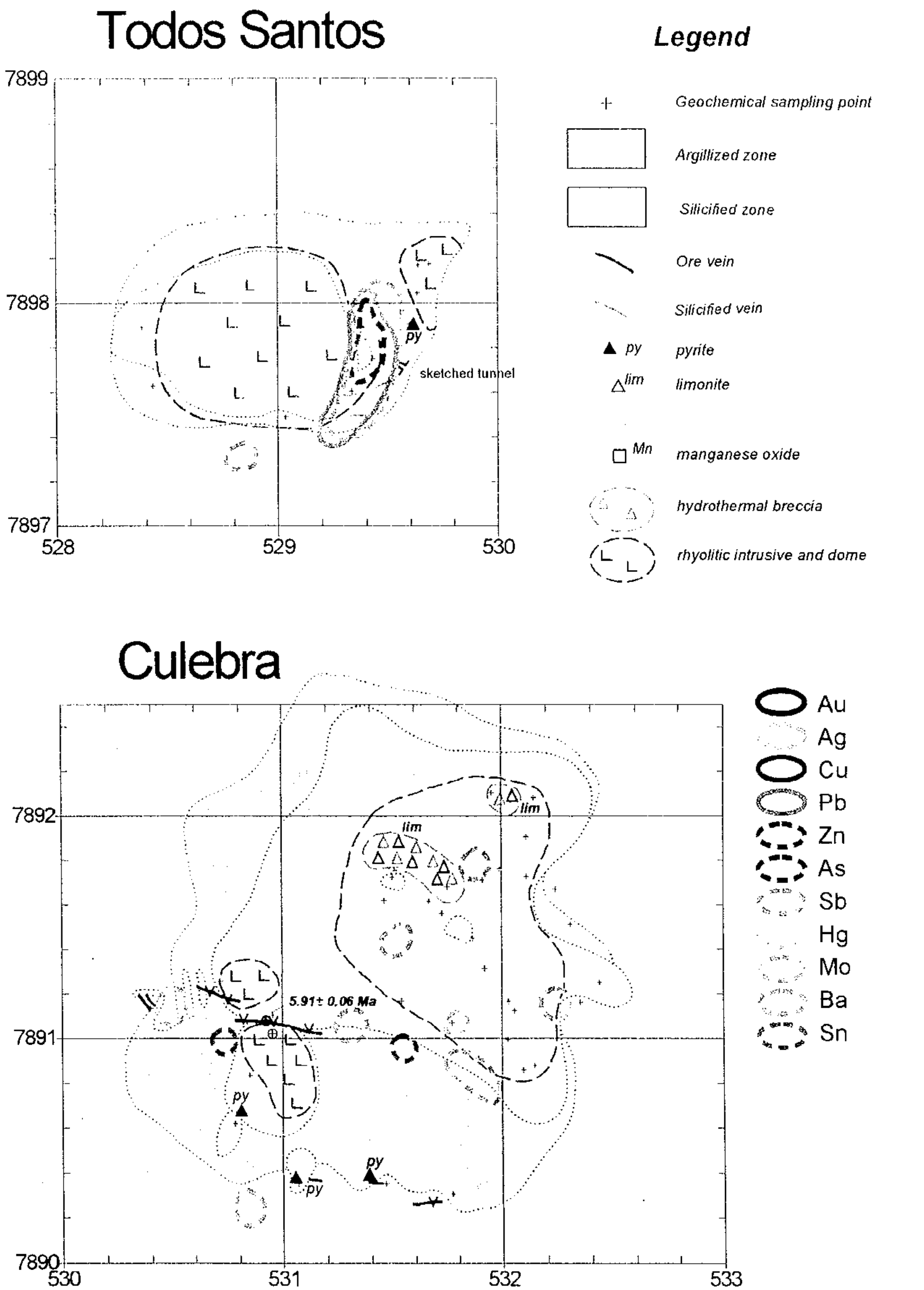


Fig.I-4-2 (9)Integrated Interpretation Map of the Culebra District

The hydrothermal alteration zones cover about 15km^2 in the volcanic rocks of late Oligocene to early Miocene age.

In the area, faults, veins and fractures with the NW-SE and E-W trends are dominant and the NE-Swand N-S trends are also observable.

The presence of epithermal gold- silver- lead- zinc deposit (Type II) related to shallow volcanic activity is presumed in Co. Kancha. The result of K-Ar dating of the alteration minerals shows 16 Ma, corresponding to middle Miocene, while the age of dacite laccolith intrusive in the east of the area is 8.0 Ma, it is suggested that the hydrothermal alteration took place at least twice in the area. The mineralization, however, is probably weak or deep-seated as the geochemical anomalies are weak and scattered.

(2) La Deseada mine(Figs. I-4-2(10-2))

The hydrothermal alteration zones cover about 4km^2 in the volcanic rocks of late Oligocene to early Miocene age.

In the area, faults, veins and fractures with the E-W and ENE-WSW trends are dominant.

The ore deposit of La Deseada mine is an epithermal gold- silver- lead-zinc deposit (Type II) related to shallow volcanic activity.

The characteristics of mineralization changes (vein materials and geochemical anomaly) from the upper margin to the lower of the deposit were well observed (Fig.II-2-10 (7)).

It is applicable to another prospects and can consider position of mineralized zone.

The existence of the similar ore deposit to La Deseada ore deposit is expected beneath the geochemical anomaly of Co. Mokho. Besides, as the alteration zone of Co. Mokho is continuously extended to La Deseada mine, the mineralization of two areas are probably connected.

(3) Guadalupe mine,Maria Lúisa mine (Figs. I-4-2(10-2))

The hydrothermal alteration zones cover about 5km^2 in the volcanic rocks of late Oligocene to early Miocene age.

In the area, faults, veins and fractures with the E-W and WNW-ESE trends are dominant.

The mineralization of both Guadalupe mine and Maria Lúisa mine is presumed to be an epithermal gold- silver- lead- zinc deposit (Type II) related to shallow volcanism assumed from the presence of tin anomaly. On the other hand, enargite collected from the waste of the portal suggest that there was a high-sulfidation epithermal mineralization (Type IV). As the ore of enargite and pyrite is brecciated, two stages of mineralization have probably taken place.

Mendoza
Kancha, San Lorenzo, Milluniloma

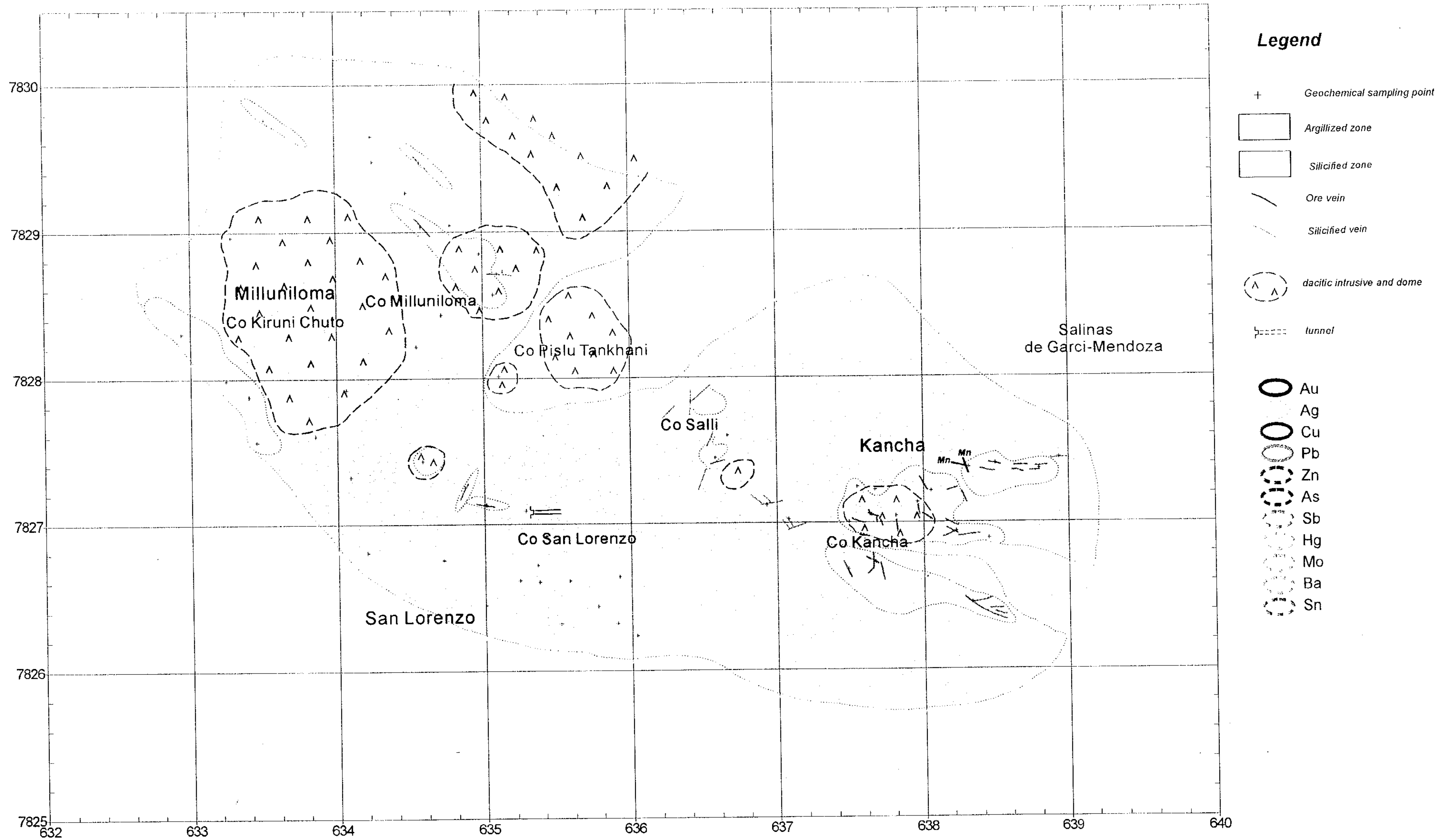


Fig.I-4-2 (10-1) Integrated Interpretation Map of the Mendoza District (Kancha)

Mendoza
Mina La Deseada, Mokho, Husachata, Mina Guadalupe

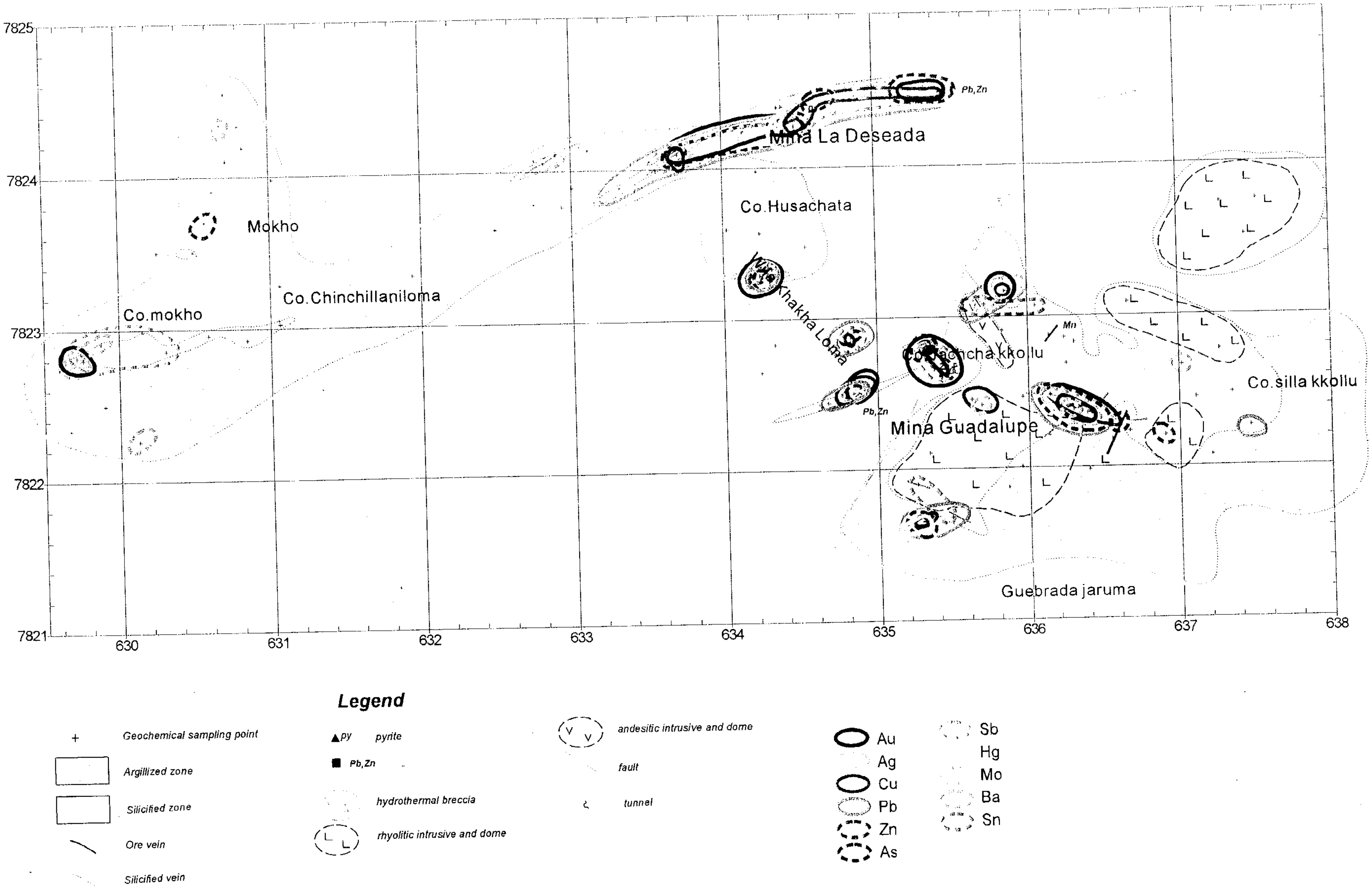


Fig.I-4-2 (10-2) Integrated Interpretation Map of the Mendoza District (La Deseada)

(4) Co.Chorka , Iranuta prospects (Figs. I-4-2(10-3))

The hydrothermal alteration zones cover about 5km^2 in the volcanic rocks of late Oligocene to early Miocene age.

In the area, faults, veins and fractures with the ENE-WSW, NE-SW and NW-SE trends are dominant.

The mineralization of Iranuta prospect correspond to epithermal deposit (type III) related to shallow hypabyssal intrusion judged from the facts that the alteration is neutral and tin anomaly is not recognized.

Homogenization temperature of quartz and calcite samples indicates 258°C in average, and is considered to appear rather lower part of mineralized zone by erosion.

It is expected a porphyry type deposit in depth, although no expansion of minaralized zone is confirmed.

The mineralization at Co. Chorka is presumed to be high- sulfidation epithermal deposit (Type IV), judged from the presence of acidic alteration minerals such as kaolinite, alunite and pyrophyllite, although the geochemical anomaly is not remarkable. As the anomalies of lead and antimony are more or less concentrated and hydrothermal breccia and breccia pipe which formed along the fractures are extensively developed, possibility of existing ore deposit in deeper portion is probably high.

4-2-11 Panizo district

(1) Vilasaca prospect(Figs. I-4-2(11-1))

The hydrothermal alteration zones cover about 4km^2 in the volcanic rocks of late Miocene to Pliocene age.

In the area, faults, veins and fractures with the NE-SW trend are dominant.

An epithermal gold- silver- lead- zinc deposit (Type II) related to shallow volcanic activity is expected to occur in Vilasaca prospect assumed from the presence of tin anomaly. As the geochemical anomaly is weak, the mineralization will be weak or deep-seated.

(2) Pacoloma district(Figs. I-4-2(11-1))

The hydrothermal alteration zones cover about 3km^2 in the volcanic rocks of late Miocene to Pliocene age.

In the area, faults, veins and fractures with the NE-SW and N-S trends are seen.

In Pacoloma prospect anomalies of arsenic and antimony are scattered and type of ore deposits is difficult to be estimated. The mineralization is also weak or deep-seated.

(3) Tulco prospect (Figs. I-4-2(11-2))

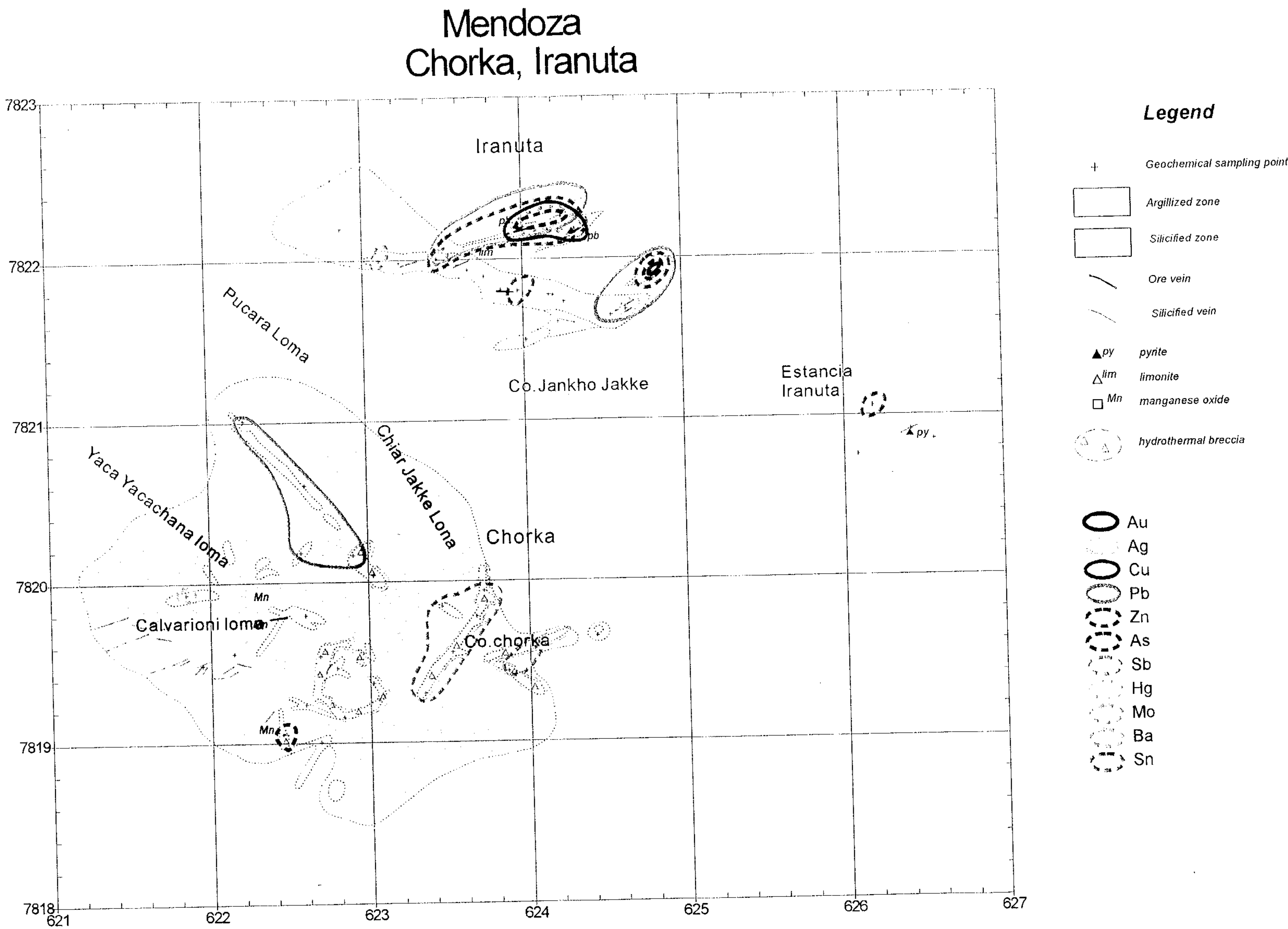


Fig.I-4-2 (10-3) Integrated Interpretation Map of the Mendoza District (Chorka)

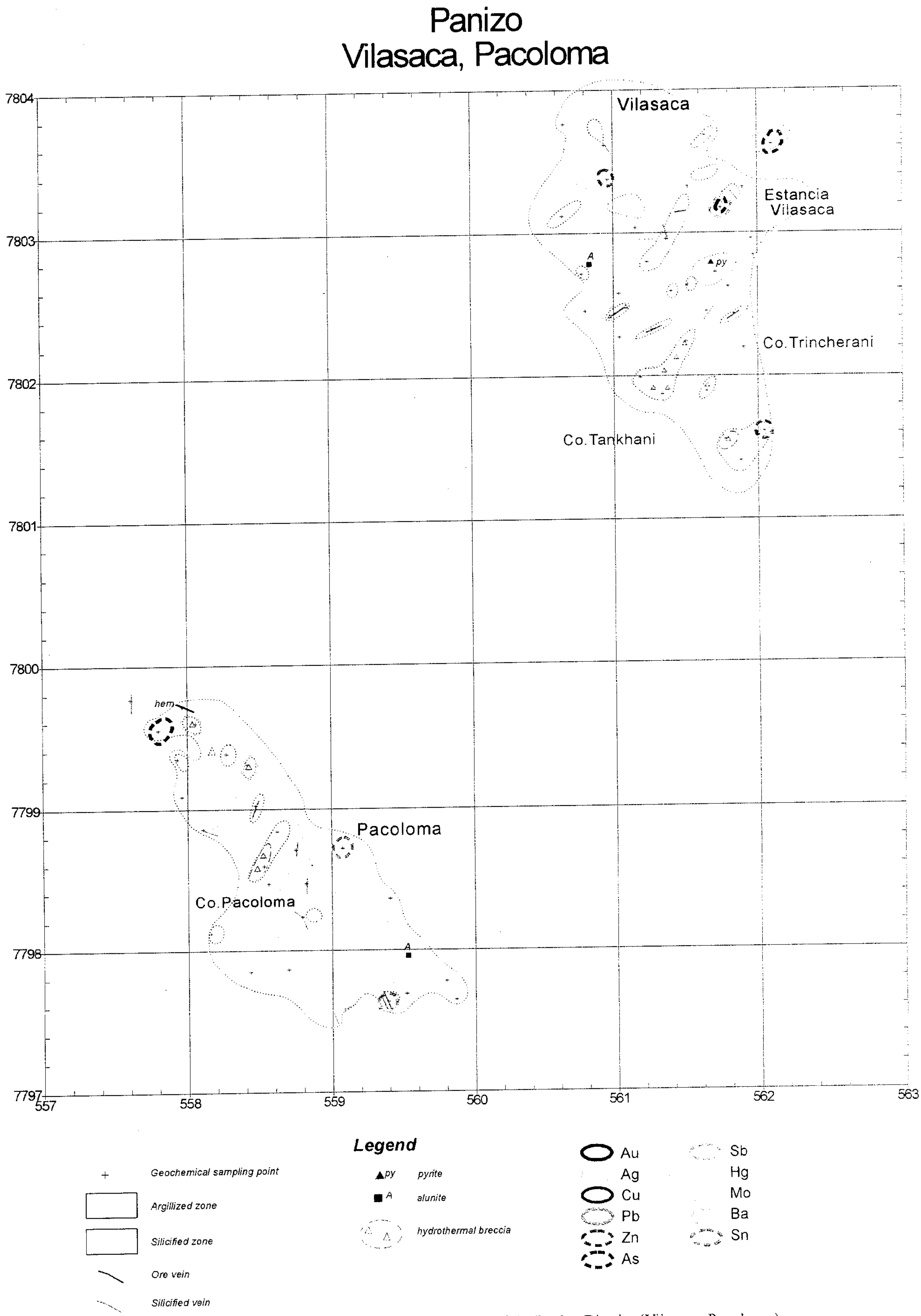


Fig.I-4-2 (11-1) Integrated Interpretation Map of the Panizo District (Vilasaca-Pacoloma)

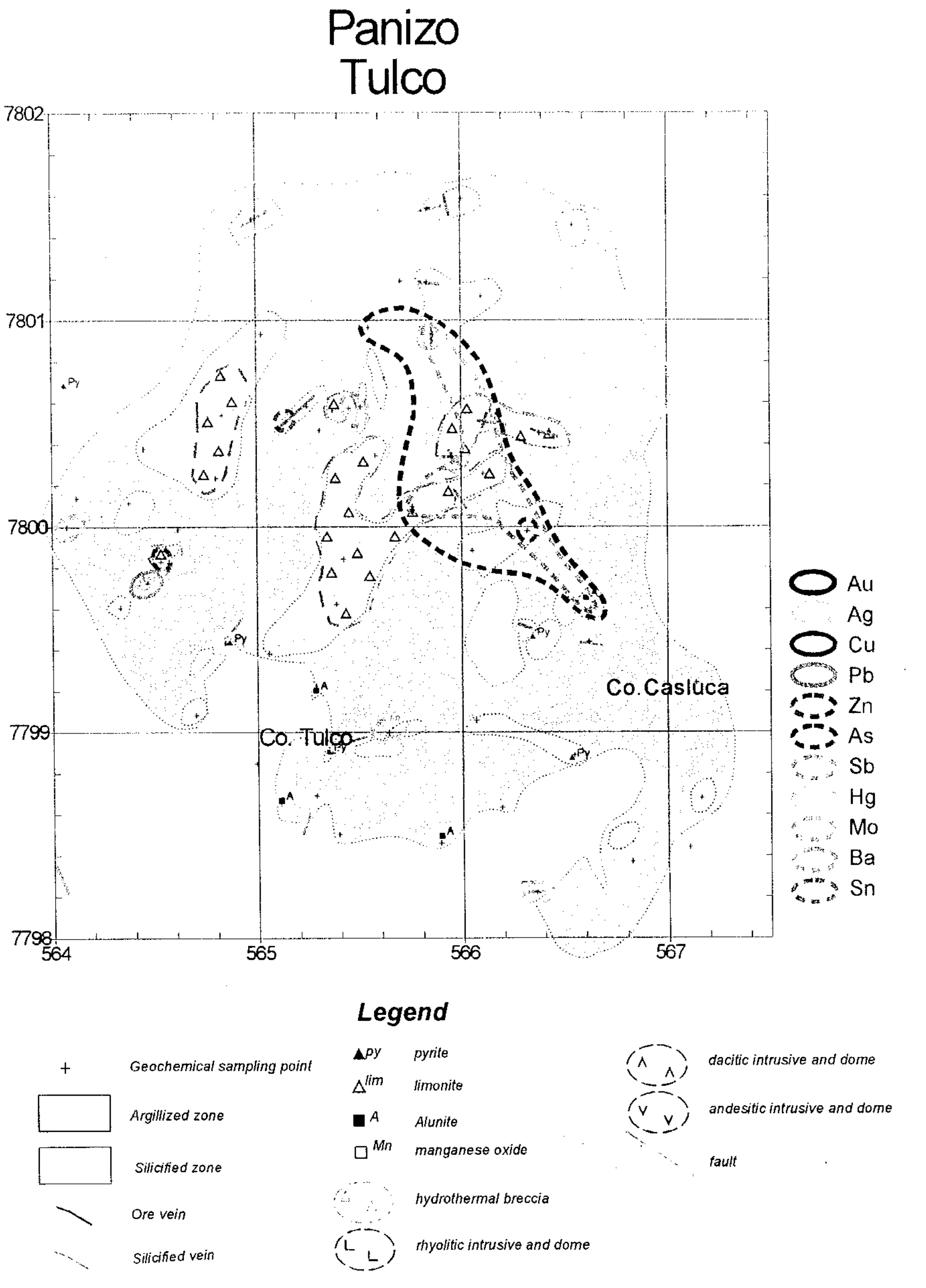


Fig.I-4-2 (11-2) Integrated Interpretation Map of the Panizo District (Tulco)

The hydrothermal alteration zones cover about 8km^2 in the volcanogenic sedimentary rocks of early to middle Miocene age and in the volcanic rocks of late Miocene to Pliocene age.

In the area, faults, veins and fractures with the E-W and N-S trends are dominant.

An epithermal gold- silver - lead- zinc deposit (Type II) related to shallow volcanic activity is expected to occur in Tulco prospect from the presence of tin. There is a possibility of existing ore deposits in the area where geochemical anomalies of arsenic and antimony are overlapped. But as there is no other geochemical anomaly, the mineralization will be deep if it exists.

(4) Chinchilhuma prospect (Figs. I-4-2(11-3))

The hydrothermal alteration zones cover about 5km^2 in the volcanic rocks of middle to late Miocene age.

In the area, faults, veins and fractures with the NE-SW trend prevail and N-S trend is also obserbable.

The ore deposits in Chinchilhuma prospect are appear to be epithermal precious metal deposit (Type III) related to shallow hypabyssal intrusion as the alteration zone is neutral and tin is not recognized.

The mineralization is similar to that of Sonia-Susana, except no presence of acidic alteration,it is likely to no overprint the high-sulfidation type mineralization (Type IV), or if any, occurs in depth.

(5) Puquisa prospect (Figs. I-4-2(11-4))

The hydrothermal alteration zones cover about 1 km^2 in the volcanic rocks of late Miocene to Pliocene age.

Faults, veins and fissures in the east of the Prospect trend N-S and NE-SW.

In Puquisa prospect, the alteration zone is small and geochemical anomalies are very weak. Therefore, mineralization type is not clear, and the mineralization will be weak or deep-seated if it exists.

(6) Panizo prospect (Figs. I-4-2(11-5))

The hydrothermal alteration zones cover about 18 km^2 in the volcanic rocks of middle to late Miocene age.

Though faults, veins and fissures in the Prospect trend mainly N-S, the NE-SW trend is increasingly dominant southward and, in the central and the southern parts, the E-W trend is predominant.

In Panizo prospect, There are anomalies of gold, arsenic, antimony in the northern part, anomalies of copper, arsenic, antimony, molybdenum and tin in the central part, and anomalies of

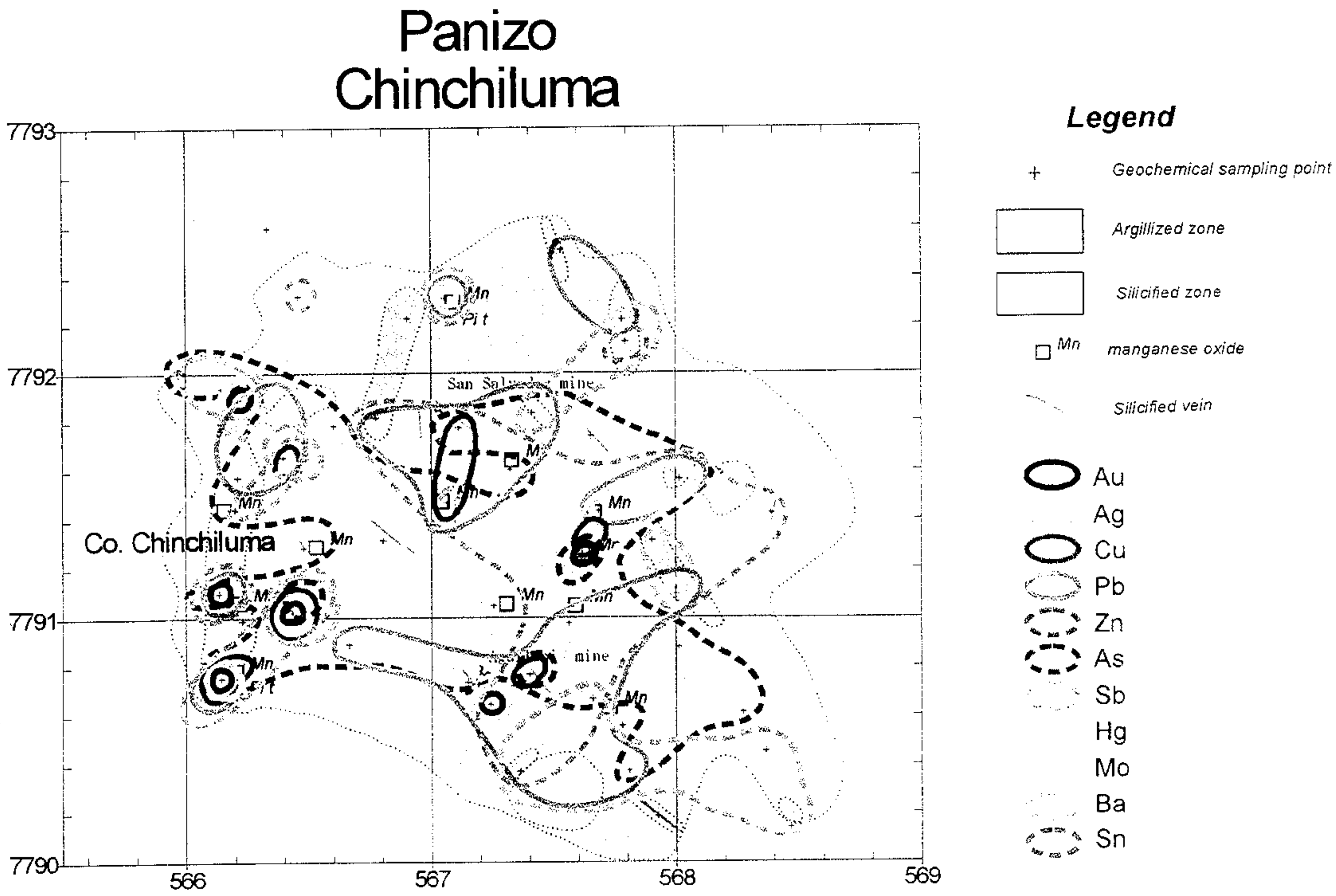


Fig.I-4-2 (11-3) Integrated Interpretation Map of the Panizo District (Chinchilhuma)

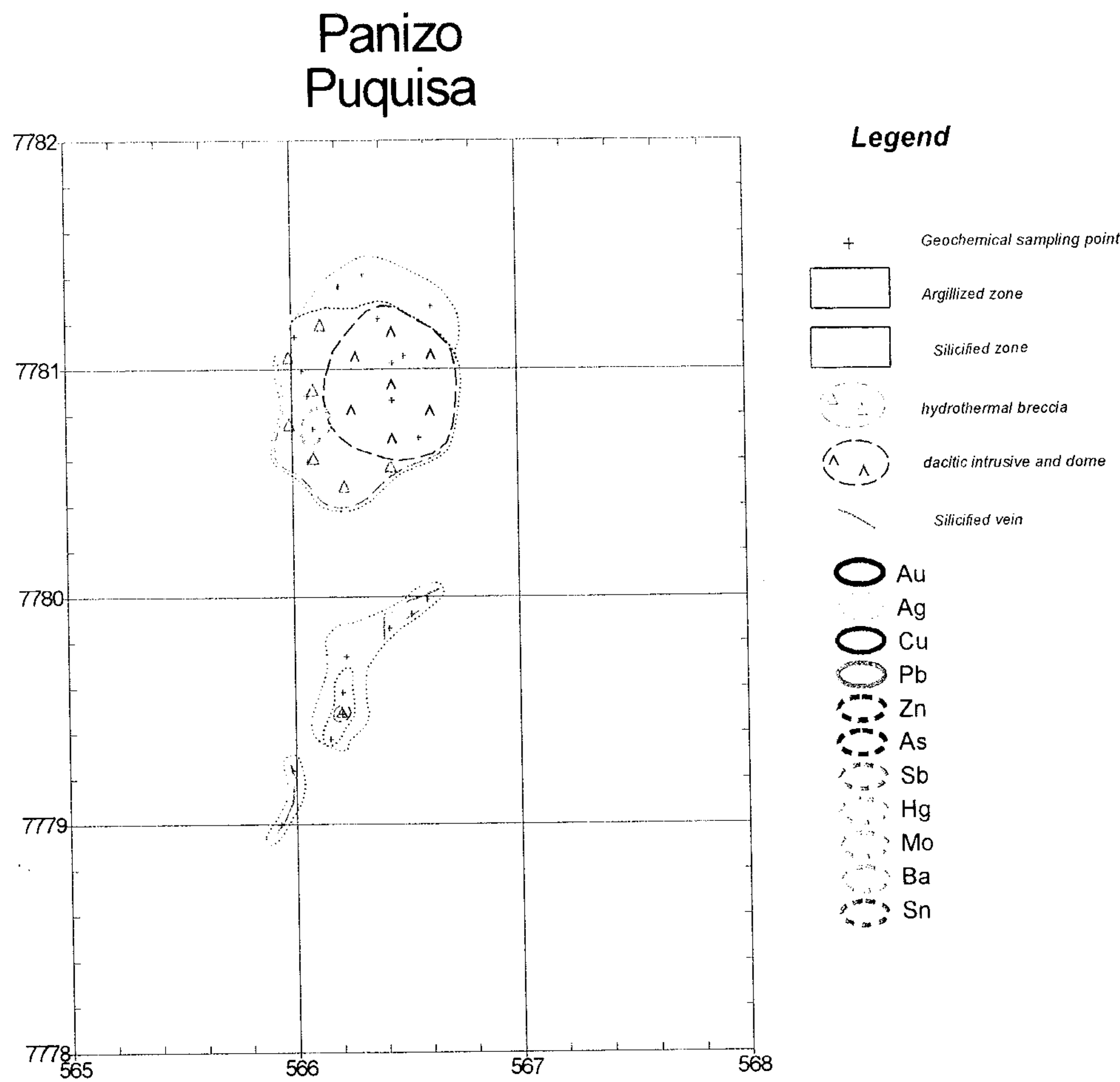


Fig.I-4-2 (11-4) Integrated Interpretation Map of the Panizo District (Puquisa)

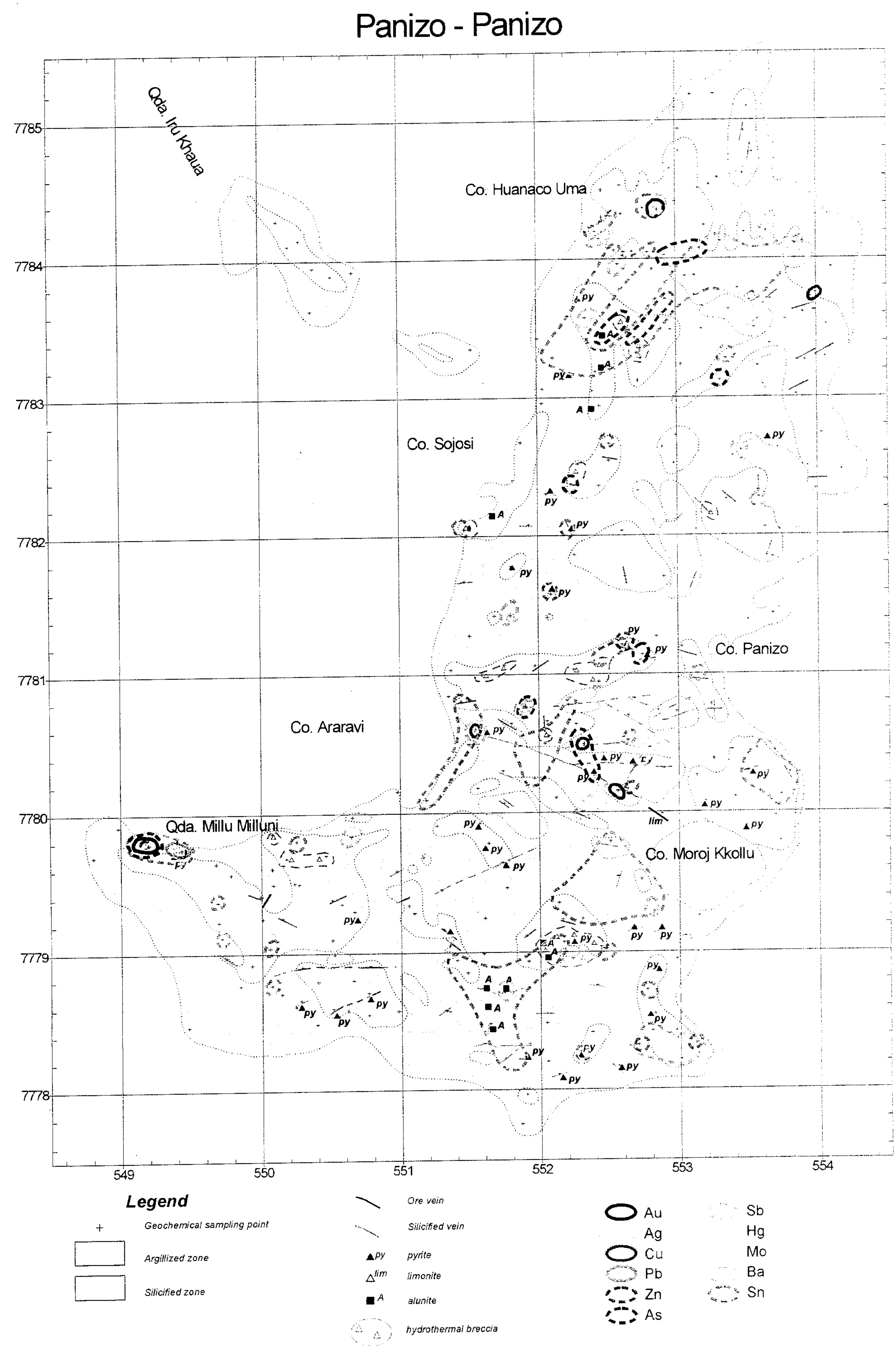


Fig.I-4-2 (11-5) Integrated Interpretation Map of the Panizo District (Panizo)

gold, silver, lead, arsenic, antimony and tin in south western part. Considering the presence of tin and pyrophyllite, the mineralization of north and southwestern parts of the area will be epithermal gold- silver- lead- zinc deposit (Type II), and in the central part high-sulfidation epithermal gold-silver- copper deposit (Type IV) are expected.

In the southwestern part, as there are abundant kaolinite, mineralization of high-sulfidation epithermal deposit could be overlapped.

As the K-Ar dating of the alteration showed late of middle Miocene, erosion has been considerably advanced. Beside the geochemical anomalies are rather intense, suggesting that there is a possibility of existing ore deposits in the place not very deep from the surface.

4-2-12 Sailica district (Figs. I-4-2(12))

(1) Plasmar mine

The hydrothermal alteration zones cover about 10.5 km^2 in the volcanic rocks of late Miocene to Pliocene age.

Faults, veins and fissures in the area trend E-W, NW-SE and NNE-SSW(N-S).

The mineralization of Plasmar mine correspond to epithermal gold- silver- lead- zinc deosit (Type II) related to shallow volcanic activity that is estimated from the previous data and result of geochemical survey. And there is a possibility of overlapping of high-sulfidation gold- silver-copper mineraliztion (Type IV) from the presence of pyrophyllite and copper anomalies. As there is an extensive alteration zone and remarkable geochemical anomaly, the possibility of existing ore deposits in deep underground seems to be high.

(2) Solución mine

The hydrothermal alteration is weak in the volcanic rocks of late Miocene to Pliocene age.

Faults, veins and fissures with the NE-SW trend are dominant in the area.

The mineralization of Solucion mine corresponds to epithermal gold- silver- lead- zinc deposit (Type II) related to shallow volcanic activity from the previous data analysis and geochemical assay result. Judging from the mode of occurrence and size of ore deposit in underground working, and extent of geochemical anomaly and alteration, the possibility of existing a large-scale ore deposit seems to be low.

4-2-13 Colorado district

(1) Bayos prospect (Figs. I-4-2(13-1))

The hydrothermal alteration zones cover about 0.5km^2 in the volcanic rocks of late Pliocene age.

Faults, veins and fissures in the Prospect trend E-W and NE-SW.

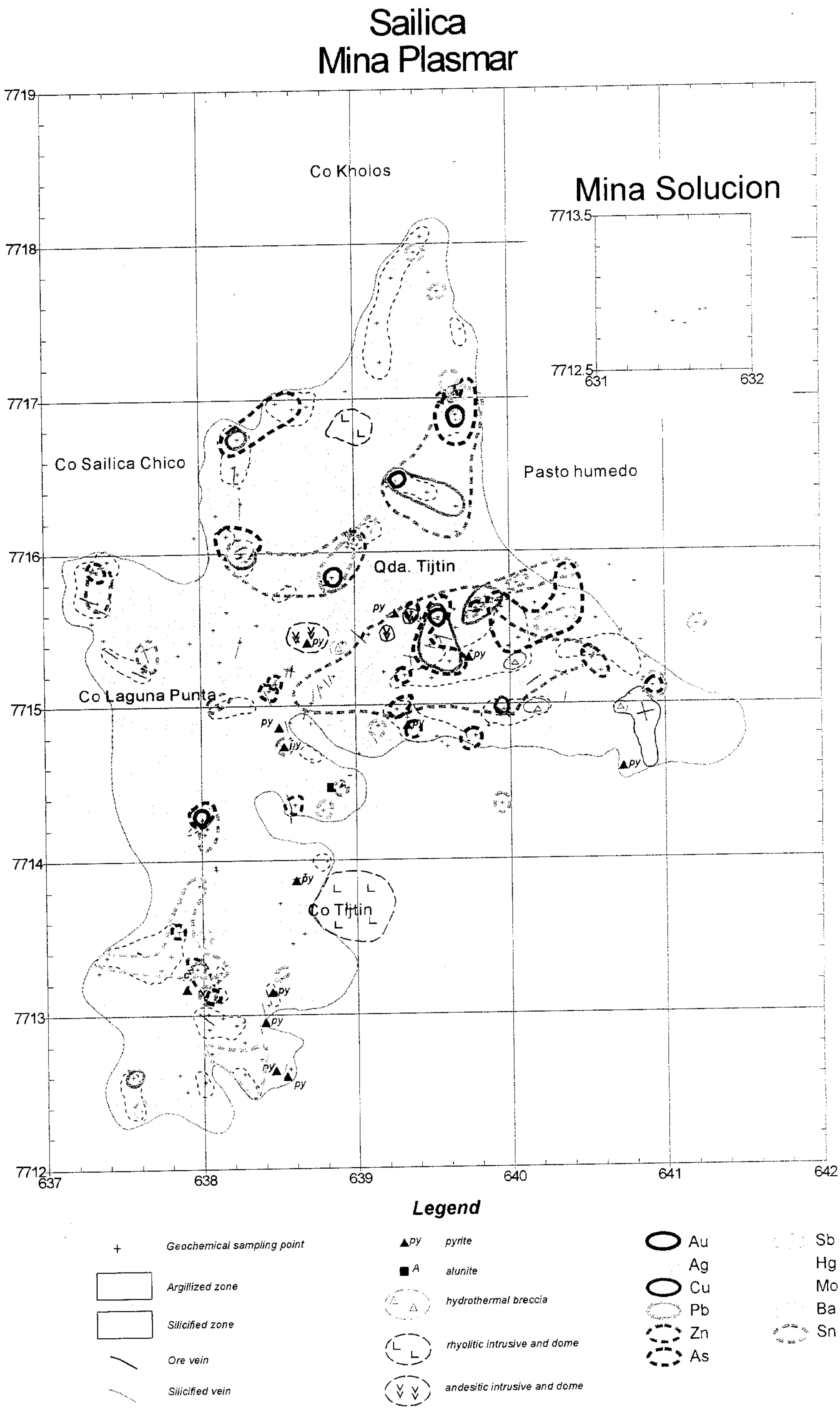


Fig.I-4-2 (12) Integrated Interpretation Map of the Sailica District (Plasmar, Solucion)

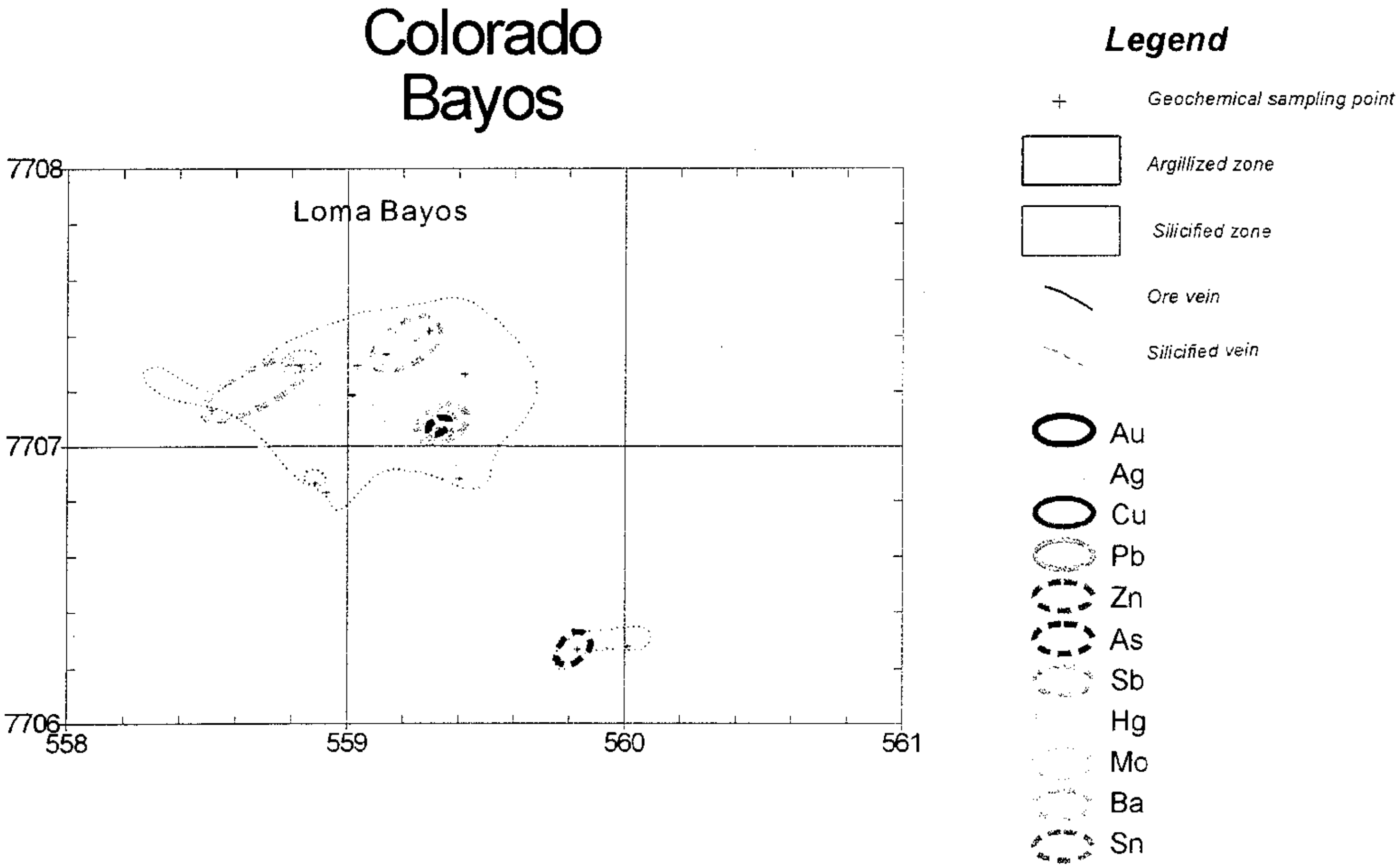


Fig.I-4-2 (13-1) Integrated Interpretation Map of the Colorado District (Bayos)

The mineralization in Bayos prospect seems to be weak or deep-seated if it exists, as the hydrothermal breccia is small, consisting mainly of argilization and there is non of remarkable geochemical anomaly.

(2) Okhe prospect (Figs. I-4-2(13-2))

The hydrothermal alteration zones cover about 11 km^2 in the volcanic rocks of late Miocene age.

Faults, veins and fissures in the Prospect trend NNW-SSE and NNE-SSW.

The mineralization in Okhe prospect is presumed to correspond to an epithermal gold- silver- lead- zinc deposit (Type II) related to shallow volcanic activity from the presence of tin. The mineralization seems to be weak or deep-seated if it exists, as the alteration and geochemical anomalies are weak.

(3) Perenal prospect (Figs. I-4-2(13-3))

The hydrothermal alteration zones cover about 5 km^2 in the volcanic rocks of middle Miocene age.

Faults, veins and fissures in the Prospect trend NE-SW and NW-SE.

The mineralization in Perenal prospect correspond to an epithermal gold- silver- lead- zinc deposit (Type II) related to shallow volcanic activity presumed from the presence of lead and tin. The existence of ore deposits is expected as the silicification is strong and extend toward north-west.

(4) Colorado prospect (Figs. I-4-2(13-4))

The hydrothermal alteration zones cover about 3 km^2 in the volcanic rocks of middle to late Miocene age.

Faults, veins and fissures in the Prospect trend E-W and NW-SE.

The mineralization in Colorado prospect correspond to a high-sulfidation mineralization (Type IV) from the presence of pyrophyllite. It is also possible to be an epithermal gold- silver- lead- zinc deposit (Type II) though there is no tin anomaly. The mineralization appears to be weak or deep-seated if it exists, as the area is located in outer most of alteration zone and geochemical anomalies are weak.

4-2-14 Luxsar district (Figs. I-4-2(14))

The hydrothermal alteration zones cover about 5.5 km^2 in the volcanic rocks of late Miocene age.

Faults, veins and fissures in the District trend NW-SE.

Although hydrothermal breccia is located around a dome, as the silicification is weak and

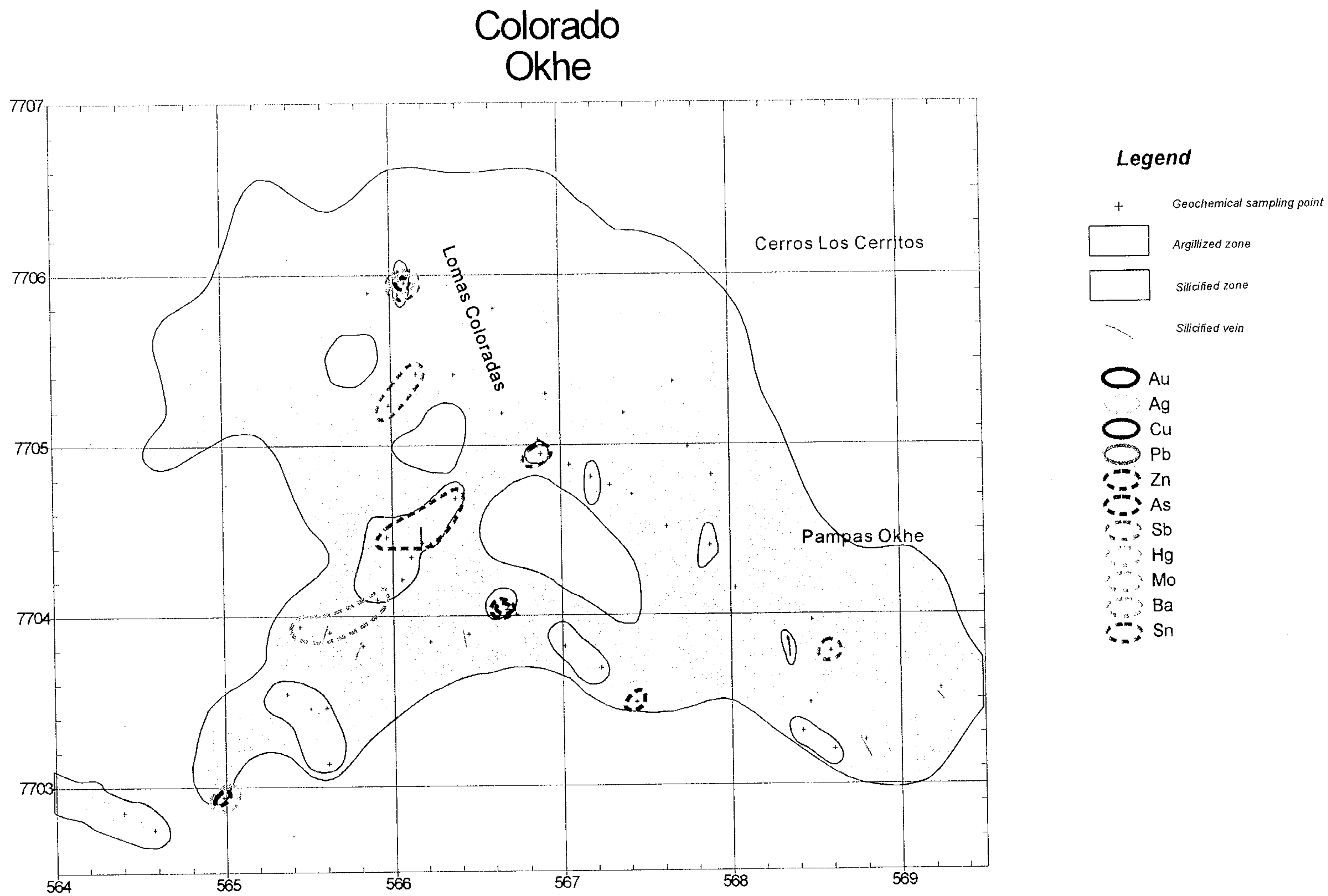


Fig.I-4-2 (13-2) Integrated Interpretation Map of the Colorado District (Okhe)

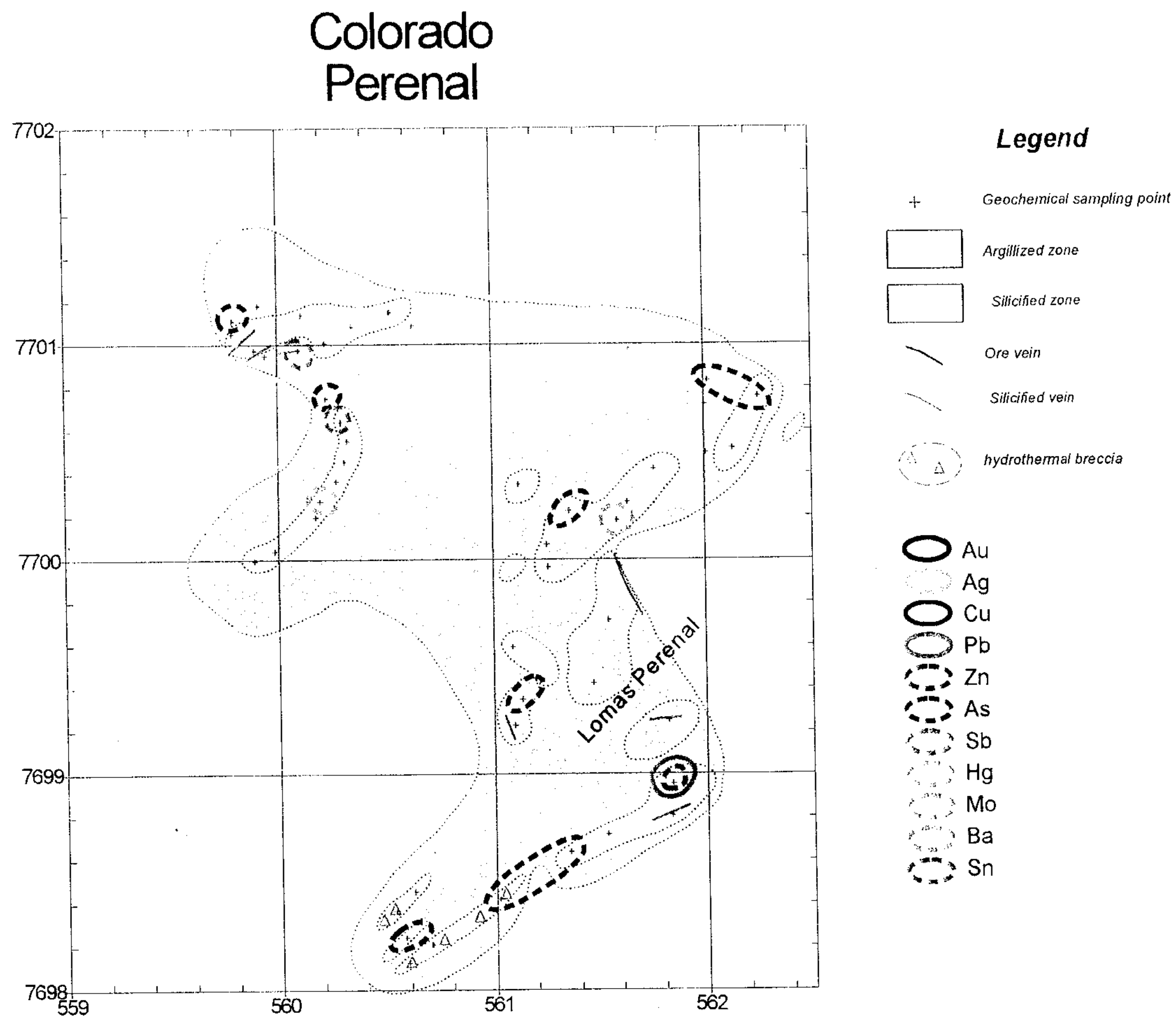


Fig.I-4-2 (13-3) Integrated Interpretation Map of the Colorado District (Perenal)

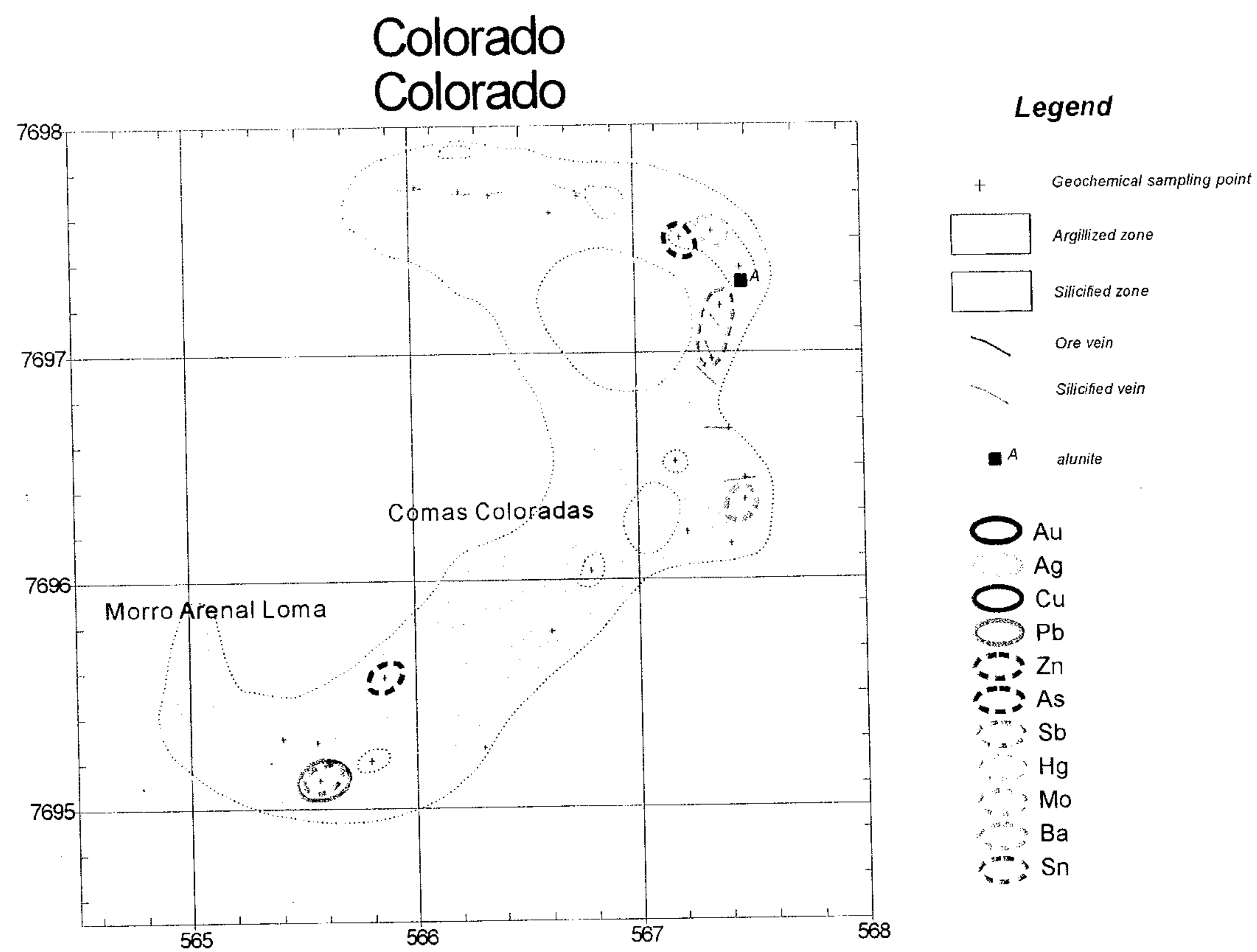


Fig.I-4-2 (13-4) Integrated Interpretation Map of the Colorado District (Colorado)

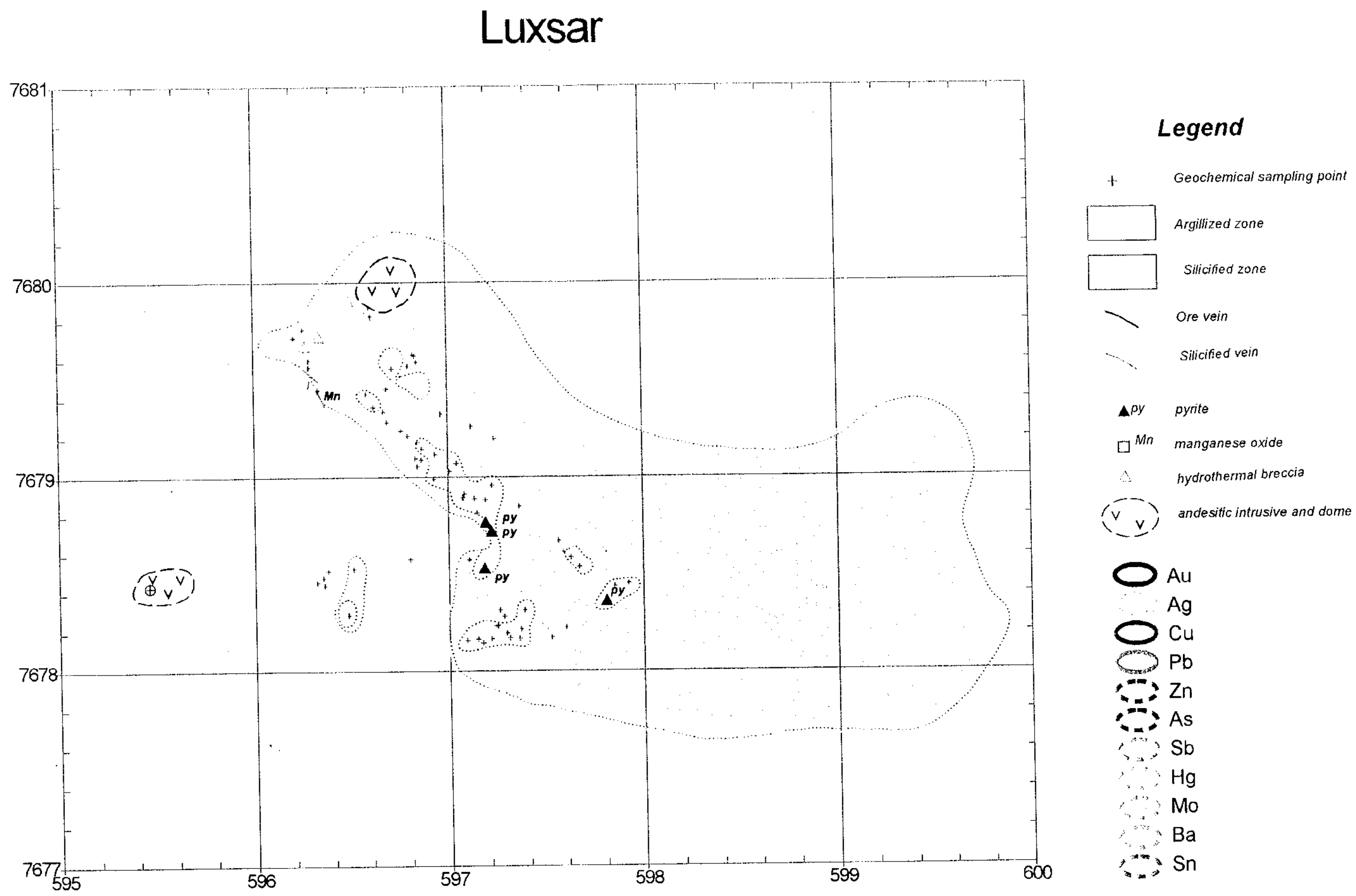


Fig.I-4-2 (14)Integrated Interpretation Map of the Luxsar District

there is no geochemical anomaly, the mineralization is probably weak or deep-seated.

4-2-15 Cachi Unu district (Figs. I-4-2(15))

The hydrothermal alteration zones cover about 1 km^2 in the volcanic rocks of middle to late Miocene age.

Although the dominant trend of faults, veins and fissures in the District is NW-SE some show the E-W trend.

The mineralization of this district is presumed to be correspond to Bolivian type polymetallic silver- copper deposit (Type I B) or high-sulfidation epithermal type (Type IV). Probably the mineralization is weak or deep-seated, as the alteration and geochemical anomaly is not remarkable.

4-2-16 Sedilla district

(1) Chascos prospect (Figs. I-4-2(16-1))

The hydrothermal alteration zones cover about 5.5 km^2 in the volcanic rocks of late Miocene age.

No remarkable geologic structure has been discerned in the Prospect.

The alteration is weak and only one geochemical anomaly portion of arsenic and antimony was detected in chascos prospect. The mineralization will be weak or deep-seated if it exists, as there is no hydrothermal alteration around a dome.

(2) Sedilla prospect (Figs. I-4-2(16-2))

The hydrothermal alteration zones cover about 1 km^2 in the volcanic rocks of late Miocene age.

Faults, veins and fissures in the Prospect trend NNE-SSW and NNW-SSE.

The mineralization in Sedilla prospect correspond to epithermal gold- silver- lead- zinc deposit (Type II) presumed from the presence of tin. Probably it is weak or deep-seated, as the alteration and geochemical anomaly are weak.

(3) Eskapa prospect (Figs. I-4-2(16-3))

The hydrothermal alteration zones cover about 4.5 km^2 in the volcanic rocks of late Miocene age.

A neutral-type alteration zone is widely distributed in Eskapa prospect,and ore deposit is expected in shallow portion.

The mineralization appears to correspond to epithermal gold- silver- lead- zinc deposit (Type II) from the presence of tin and silver- lead anomalies. It is also possible the mineralization of the area correspond to upper part of porphyry type mineralization from the presence of neutral

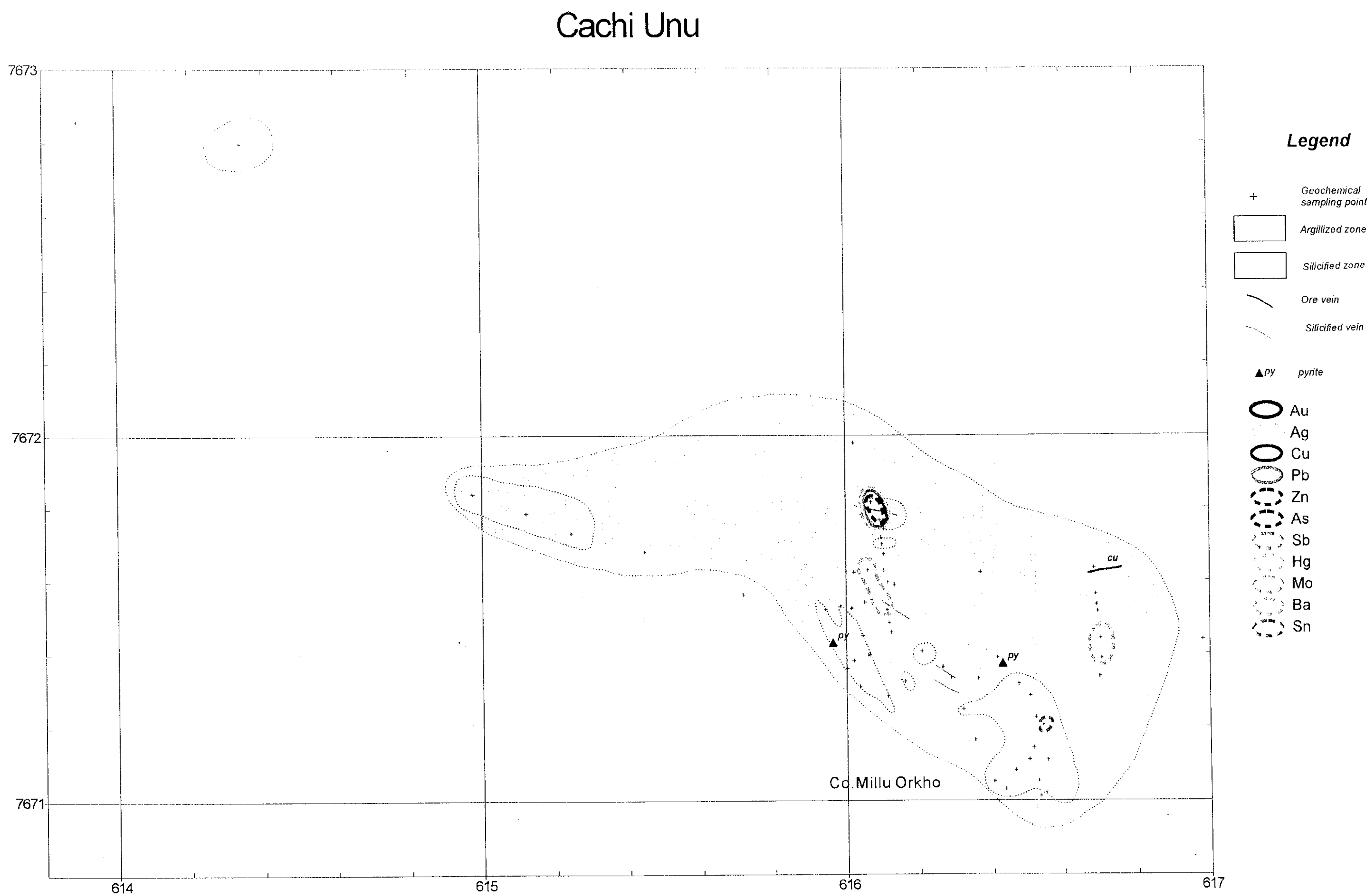


Fig.I-4-2 (15)Integrated Interpretation Map of the Cachi Unu District

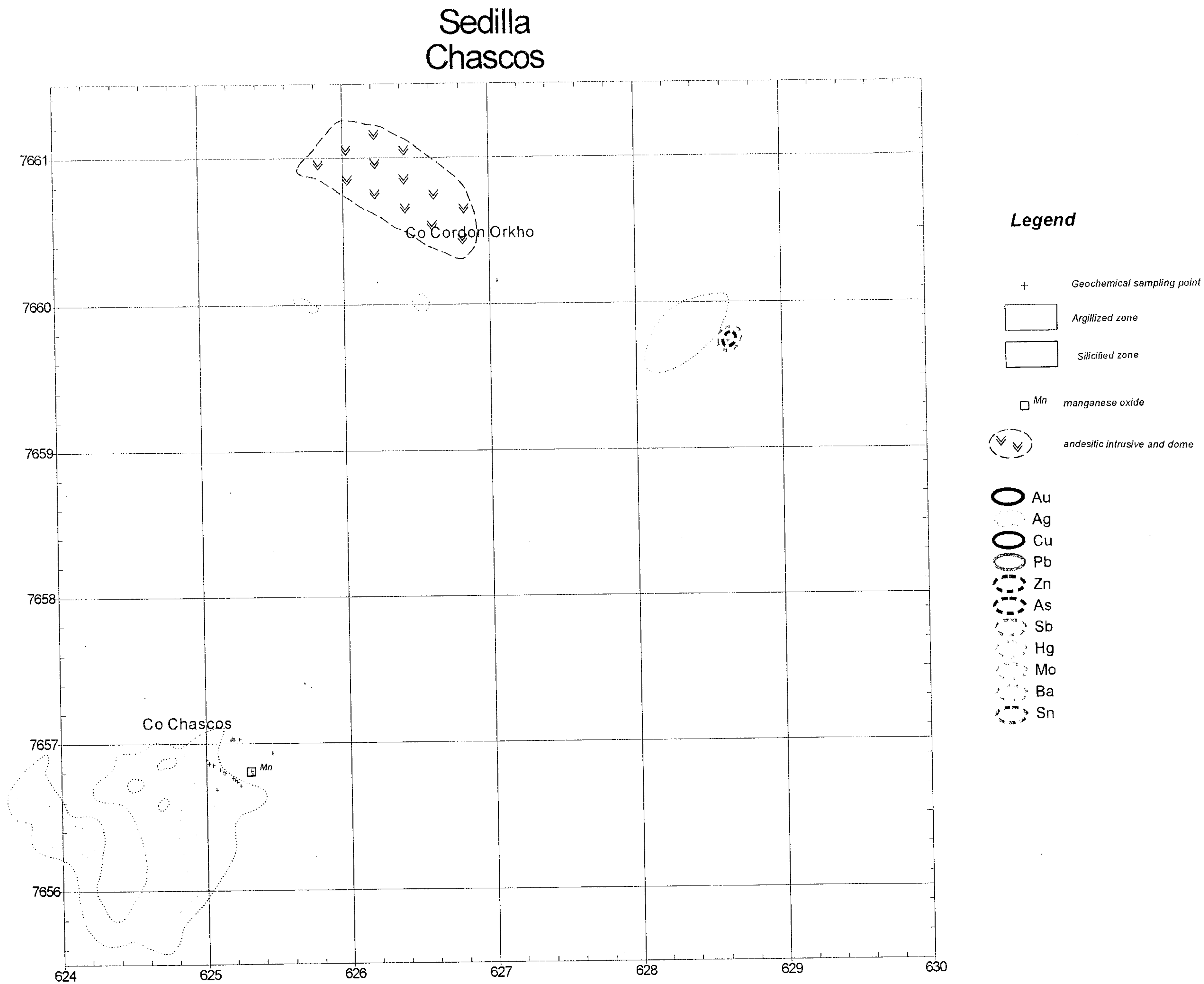


Fig.I-4-2 (16-1) Integrated Interpretation Map of the Sedilla District (Chascos)

Sedilla
Sedilla

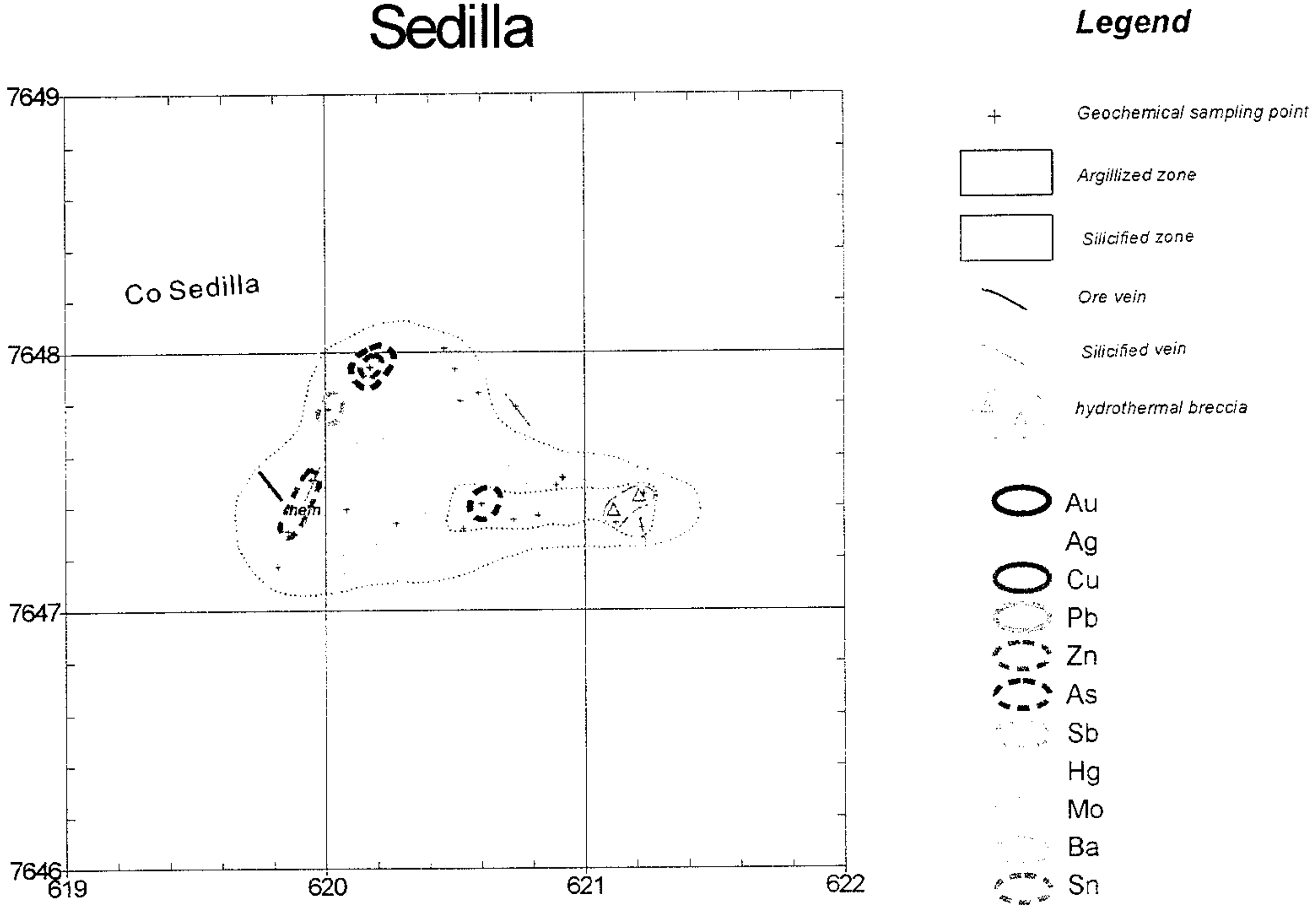


Fig.I-4-2 (16-2) Integrated Interpretation Map of the Sedilla District (Sedilla)

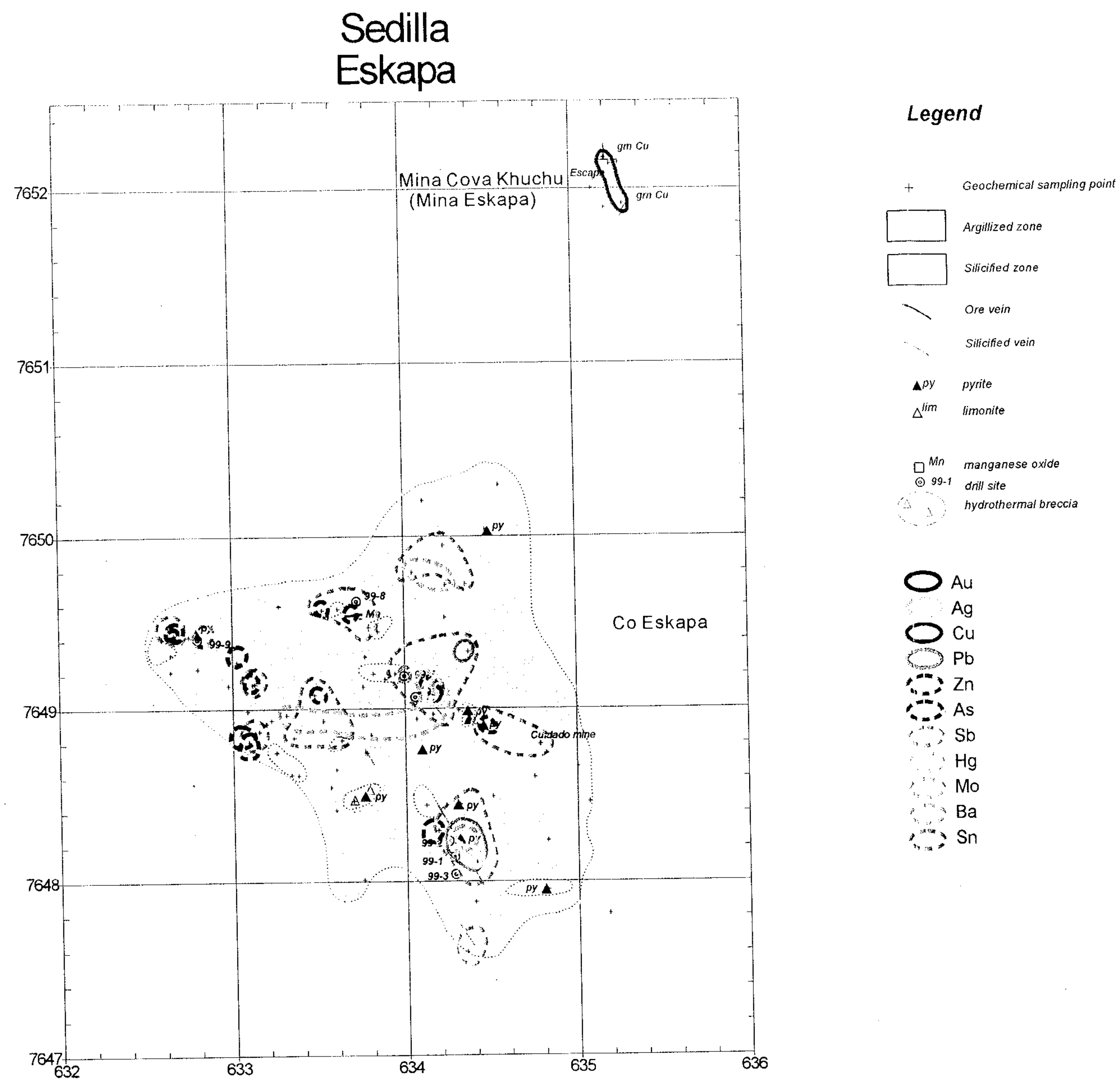


Fig.I-4-2 (16-3) Integrated Interpretation Map of the Sedilla District (Eskapa)

alteration.

At the time of the Phase-II survey, IP survey by a joint venture of the SAMEX and International Chalice Resources, Inc. was ongoing.

4-3 Potentialities of Occurrence of Ore Deposits

Summarizing the results of first and second years survey, the possibility of existing base metal bearing epithermal precious metal ore deposits beneath the widely spread hydrothermal alteration zones in the Cordillera Occidental is presumably high.

Existence of such ore deposits is expected where, 1) rock of ore bringer is located 2) passage of hydrothermal solution (mineralizing fluid) is located 3) hydrothermal solution was repeatedly supplied, and in addition, potentiality and location of ore deposits can be estimated from 4) the amount of erosion and 5) geochemical anomalies.

1) As regards to the ore bringer, a dome structure or intrusive rock has played a role of supplying the hydrothermal solution and heat. A number of intrusives are observed in the district of Mendoza, Co.Kancha and Guadalupe mine.
2) As regards to the passage of hydrothermal solutions, the areas where fractures are well developed and the presence of hydrothermal breccia or breccia pipe is recognized are thought to be suitable. Since a number of known ore deposits occur in the east-westerly fractures (e.g. ore deposits of Salinas de Garci Mmendoza, Todos Santos, Carangas and Turaquiri), the area where the east-westerly fractures were well developed is presumed.
3) As regards to the area where hydrothermal solution was repeatedly supplied, the area of composite volcano seems to be more promising than the area of stratovolcano. And in the area where old volcanics (alteration) and young volcanics (alteration) are co-existing, overprinting of mineralization can be expected. The size of hydrothermal alteration zone is generally larger in the area where the hydrothermal solution was repeatedly supplied. Co.Kancha in the Mendoza district (dacite intrusions were 16.2 Ma and 8.0 Ma), and Sonia –Susana district (hydrothermal alteration was 17 Ma and 1.75 Ma) are the example.
4) The amount of erosion is estimated from the data of age determination, homogenization temperature of fluid inclusion, geochemical anomalies and alteration minerals. In case of the erosion is well advanced and the mineralization is weak in the surface, an intense mineralization is not expectable in deep underground, so that the potential of the area is thought to be low.
5) As regards to the geochemical anomaly, useful information was obtained at La Deseada mine, where anomalies of lead, arsenic and antimony (locally gold and copper) are located

in the upper part of mineralization, and anomalies of gold, silver, copper, lead, zinc and antimony are located in the lower part of mineralization. Taking the above factors and vein character into consideration, the location in the mineralized zone can be presumed.

The potential area can be selected by comprehensive study of the above factors.

4-3 Geochemical Survey Findings of Stream Sediments (Figs.II-3-1(1),-1(2))

The third factor, combinations of Ag, Cd, Mn, Pb, Sb and Zn, considered to be the one related to the mineralization in the area is selected by the factor analysis of the assay values of 48 elements of the stream sediments.

The distribution of the third factor's score is shown in Figs. II-3-1(1) and (2). The high score zones of the third factor are found in the Sonia-Susana District and in the Chinshilhuma Prospect of the Panizo District.