CHAPTER 4 PALMA AREA

4-1 Purpose of the Survey and Procedure Used

The Palma area concerns the zones where anomalies were extracted by geochemical suevey using the stream sediments as a part of the "Proyecto Integral Chinchipe". After the suevey, no follow-up study has been performed. This year's survey included a semi-detailed geological suevey to find out the source of said anomalies, to clarify geological setting of such anomalies and to evaluate latent possibility of an existence ore deposits, in addition, a detailed survey was implemented to verify a concrete mineral showings.

The base camp was set up in the city of Jaen located in the eastern end of the survey area (Fig. I-1, Fig. I-2). This area contains a blank zone of the 1/25,000 scale topographical map published by IGN (Institute Geografico Nacional). In these area string measures, clinometers and/ or clinocompasses were used for the survey within semidetailed survey. Five survey teams were organized in the same way as in the Chontali area, and nightly discussions were held among team members to determine the next day's route.

Samples for geochemical analysis were taken at a relatively dense rate with the same objective as the Chontali area.

4-2 Geology

According to Davila et al. (INGEMMET, unpublished), this survey area consists of the Zana Group as basement, from the base upward, the Goyllarisquizga Group, Inca and Chulec Formations and intrusive rocks which intrude into the formers.

The Zana Group trends mainly N-S in the eastern parts of the survey area. This Group consists of calcareous rocks and andesitic volcanics belonging to the upper of late Triassic to early Jurassic, and lying under the Oyotun Volcanics. The Cretaceous System from the Goyllarisquizga Group to Chulec Formation occurs at the southeastern flange of the survey area.

Intrusive rocks consisting of tonalite to granodiorite extend trending N-S in the western part of the area.

4-3 Survey Results

1) Geological survey

This survey area consists of volcanics with mainly lapilli tuff, quartzite~siliceous sandstone~arkose sandstone with intercalating shale, alternation of sandstone and shale, and intrusive rocks through them.

The volcanics are widely spread throughout the survey area, mainly being lapilli tuff, however, predominate in the north andesite and decite with intercalated lapilli tuff and in south tuff breccia accompanying with rounded cognate and accidental gravels. Particularly, in the southern part, intercalated thin tuffaceous shale were found out, allowing to assume that their sedimentary environments are very different between the northern and southern zones.

Another distinctive aspect is that the volcanics in this survey area contain several layers of dark claret agglomerate throughout. This suggests that these layers could be used as a key bed for comparison of horizons in the area. Additionally, thin layers and/or boulder zones of limestone were observed through the center from north to south may be also used as the key bed. An age of deposits of these volcanics cannot be readily obtained as there is no available fossil, however, judging from their rock facies and the fact that being intruded by the early Tertiary granite, it may be correlative with Oyotun Volcanics. However, quartzite having cross beddings that are found around the village of Zonanga Alta are reported to be the parting of these volcanic rocks, from the facies, can also be correlated to the Goyllarisquizga Group. In this case, the overlying valcanics should be correlative with the Pulluicana Formation as the volcanics are overlying over them and, in addition, the upper limit is controlled by the intrusion of granites mentioned above.

Sedimentary rocks are found at the central part of the eastern and southeastern flanges of the survey area. In the eastern flange they conformably overlie the Oyotun Volcanics. The base is a quartzite having a cross bedding and grading upward siliceous sandstones to arkose sondstone with intercalating shale. The sedimentary rocks distributed to the west of Naranja are very brittle, apparently presenting as quartz sand. The sedimentary rocks exposing along the southeastern flange occure in fault contact with the Oyotun Volcanics, and are formed in alternation of sandstone and shale, thus being very different from those found at the eastern flange. They also show a difference of geological structure: the sedimentary rocks at the eastern flange are folded together with the Oyotun Volcanics in relatively short wavelengths while those around the southeastern flange show monoclinic structure, with trending NW-SE and dipping slightly toward the northeast. From these findings, sedimentary rocks of both localities could have deposited in different ages, but they could not be clearly identified this in this year's survey, therefore, for reasons of convenience, they correspond to the same geologic unit in this paper. Although no fossils were available from these sedimentary rocks, they may be correlative with the

Goyllarisquizga Group as they conformably coverlie the Oyotun Volcanics and are intruded by the early Tertiary granite. If the underlying sequence is correlative with the Pulluicana Formation instead of the Oyotun Volcanics, an unidentified new geological unit must be hypothetically set out as that sequence belongs to the late Cretaceous to the early Tertiary. At present, therefore, it may be concluded that the correlation with the Pulluicana Formation is not be rational.

Relatively large-sized intrusive bodies are found out in the central part of this survey area, and smaller bodies in the northern part. Main intrusive rocks in this area consist of diorite-granodiorite, granite, monzonite, quartz-granite porphyries and andesite, as same as in other semi-detailed survey areas.

Compared with other semi-detailed survey areas, the diorite-granodiorite in this area are very small in size, the greatest distributed in the center slightly toward north being 1 km × 2.5 km. Other significant differences with other semi-detailed survey areas are that they are fine-grained and that accompany with disseminated pyrite due to hydrothermal alteration around their periphery and/or in themselves. Assay result from the altered small scaled body (V20804, Apx. 8) shows 0.75 g/t Au, it is indicated that the existance of gold mineralization occurs in hydrothermal alteration stage. Granite intrudes into diorite-granodiorite. The granite in this area is megascopically characterized by their pink color as abundent pink potassium feldspars are contained within. Also, minor granite bodies in the north contain many xenoliths of andesite and andesitic tuff breccia. Under the microscope (Apx. 1), they vary from granite (adamellite) consisting of plagiodase, quartz, potassium feldspar, hornblende and biotite (Sample No. M20603) to syenite consisting of pottasium feldspars, plagioclase, quartz and biotite (Sample No. H20303). The absolute age of Sample No. M20603, which was taken from the greatest granite body in the area and located in the central part, is estimated at 47.6±2.4 million years (Eocene) determined by the K/Ar method. However, sericite is observed as alteration minerals, it may be shown a younger age.

Monzonite intruds into the above-mentioned rocks and found out foward the north from the central part of this area. Under the microscope, the monzonite sampled from the north flange of the Zonanga detailed survey zone (Sample No. K21201), is composed of plagioclase, potassium feldspar and quartz, thus can be classified into a granite (adamellite). Quartz-granite porphyries also appear to the north of the central part as small-scaled dykes through all the geological units previously described. These porphyries are generally characterized by their hydrothermal alteration and contact metasomatism with wall rocks. Andesite occurs also as small dykes in whole of the area, and varies its facies and its alteration grade in each dyke, it can be assumed that their intrusion is ranging widely.

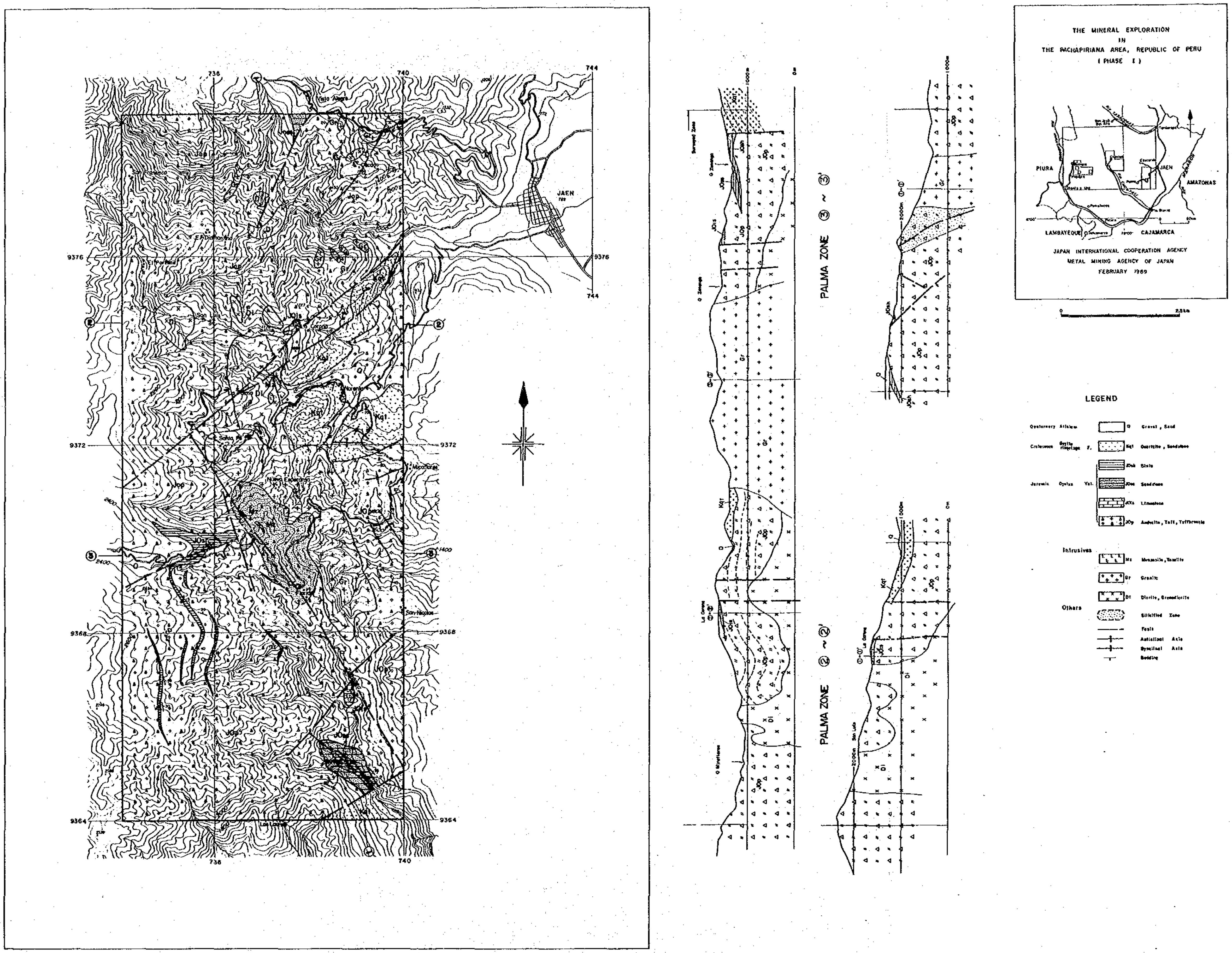


Fig.II－20 Geological Map and Profiles of The Palma Area

Fault fissure system in this area are combined by two systems, one trending NE-SW and the other NW-SE. The former constitutes the major tectonic line of this area, causing a great dislocation of the units. Although this fault system was identified directly at only one occurrence in the southeastern flange of the area, based on the airphotograph analysis, it is supposed they dip very steep and are right lateral slip faults. The latter, NW-SE system was observed in the southern part of the area. A fault trending NNW-SSE, deemed to have been derived from this fault system is also a right lateral slip fault, therefore, the whole fault system should have been laterally slipped toward the right in the same way as the former.

Alteration which is relatted to mineralization in this area occurs in two zones: one along the south bank of the Miraflores River, and the other along the east bank of the Zonanga. The former a contact zone between granite and quartz-granite porphyries and mother rocks, Oyotun Valcanics, as the chlorite-epidote skarn zone. This skarn zone is fine and compact, and thus no ore minerals were megascopically observed. Assay result (M20703, Apx. 8) shows under the geochemical threshald value without Zinc. Its scale is also relatively small about ten and several cm to several m in wide and several m to several 10 m in length. The latter, the Zonanga is a hydrothermal alteration zone in the Oyotun Volcanics, extending between the granite and the NW-SE fault system. The alteration here is relatively strong and spreads widely, its scale is about 1.5 km in width (NE-SE) and 3 km in length (NW-NE) inhere including silicified and/or combined silicified and argillized zones. Through an X-ray diffractive analysis, quartz, sericite, chlorite, halloysite and smectite were verified as altered minerals (Apx. 5). A detailed survey was carried out in this hydrothermal alteration zone as the Zonanga zone, and green copper indication was verified at the fault zones mentioned and the silicified zone.

2) Geochemical survey

Comparing the results on the average basis with other survey areas (Table II-2), this area is characterized by its high molybdenum grade (11.02 ppm). Other elements show very low grade. Analyzing the distribution of anomalous values or zones per each element (Fig. II-21(1),(2)), it is noted that those of gold is relatively concentrate in northern part, however, lead and silver are widely dispersed on a small scale. Zinc distribution is relatively extensive, but without continuity. Distribution of copper occurs on a small scale, tends to be clustered. The anomalous zone of molybdenum is relatively extensive, having relatively good continuity.

In terms of correlation with geological units, all the elements are distributed in the Oyotun Volcanics and intrusive rocks, except molybdenum which is found also in the Goyllarisquizga Group, which may be attributable to the effect of a small fissure trending NW-SE observed nearby. On gold, of which a little mentioned in paragraph of alteration previously, tends to gather near the dioritic rocks intruded mainly in the northern part of the area.

Relationship of geochemical anomalies of each element is extremely irregular. In the Zonanga detailed survey zone and its periphery it is observed such a zonal pattern as a small-scaled gold and lead anomalous zones as core, are overlapped by the copper and molybdenum anomalous zones with relatively concentrated, which is in turn surrounded by a small-scale zinc anomalous zone. It is recognized that the extension of these geoclemical anomalies also trend NE-SW as well as NW-SE which trending coinsides with abobe-mensioned fissure, thus suggesting the existance of NE-SW trending agglutinated fissure by alteration. No significant anomaly was found along the south banks of the Miraflores extracted as the skarn distribution zone, it may be concluded that it is an unmineralized skarn zone, as described in paragraph of alteration.

4-4 Review

The Palma area consists of the Oyotun Volcanics as basement, the Goyllarisquizga Group covers on it and intrusive rocks intrude into the formers. The Oyotun Volcanics contain alteration zone with silicification and argillization having an approximate area of 1.5 km in width and 3 km in length in the Zonanga zone. Overlapping with this alteration zone is found out lead, copper and molybdenum anomalous zones which are in turn surrounded by small-scaled zinc anomalous zones. These zonal distributions may suggest the possibility of an existence of porphyry copper type mineralized alteration.

No singnificant anomalies were found by geochemical prospecting in the skarn distribution zone, this fact may suggest to conclude that there is little possibility of an existence of skarn deposits.

Small-scaled molybdenum anomalous zones found in the Oyotun Volcanics almost coincide also a small-scaled alternation zones, which therefore suggests the presence of latent intrusive rocks. And it is also suggested that the diorites accompanies with gold mineralization.

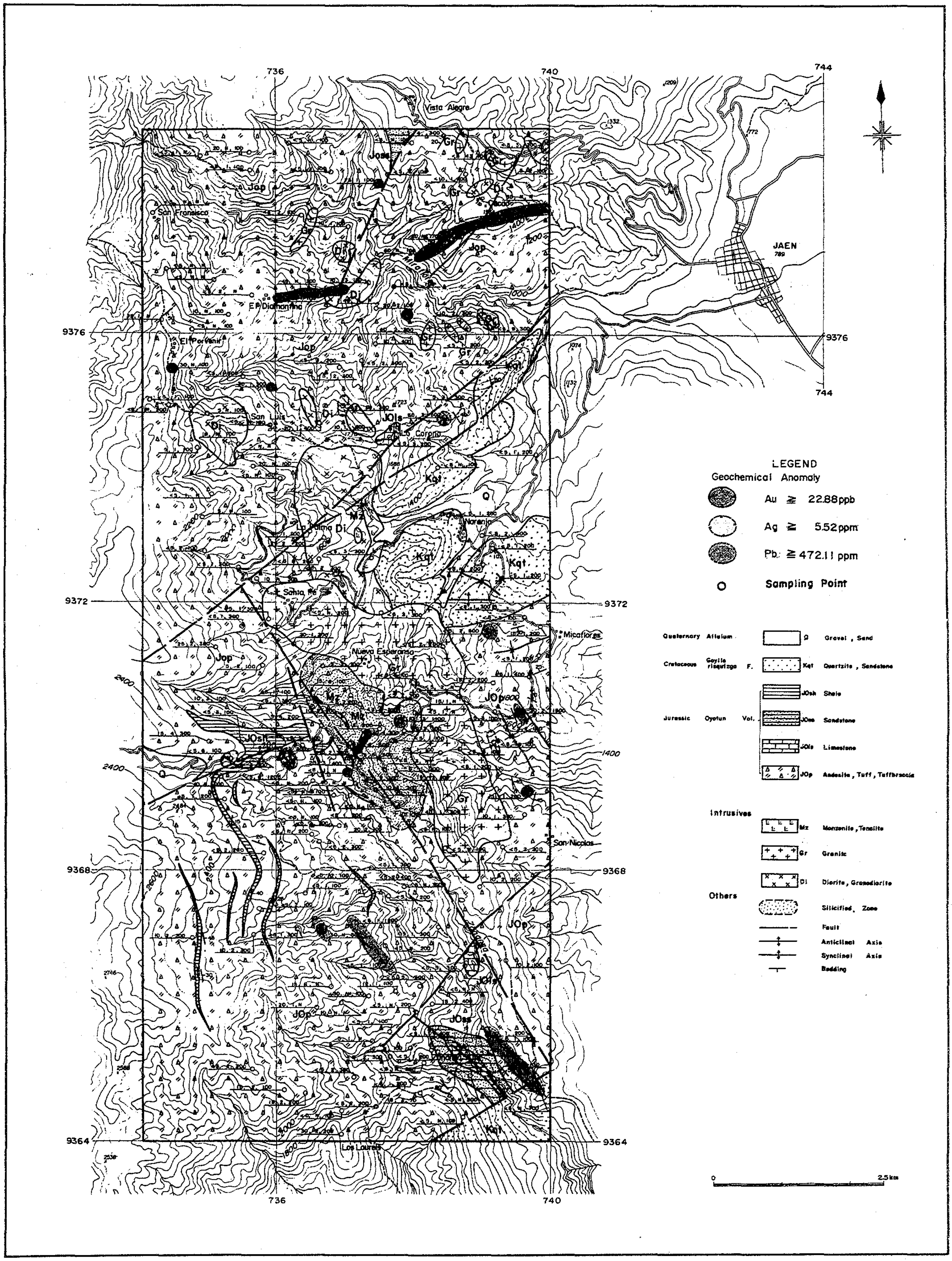


Fig.II−21 (1) Geochemical Map of The Palma Area (Au. Ag and Pb)

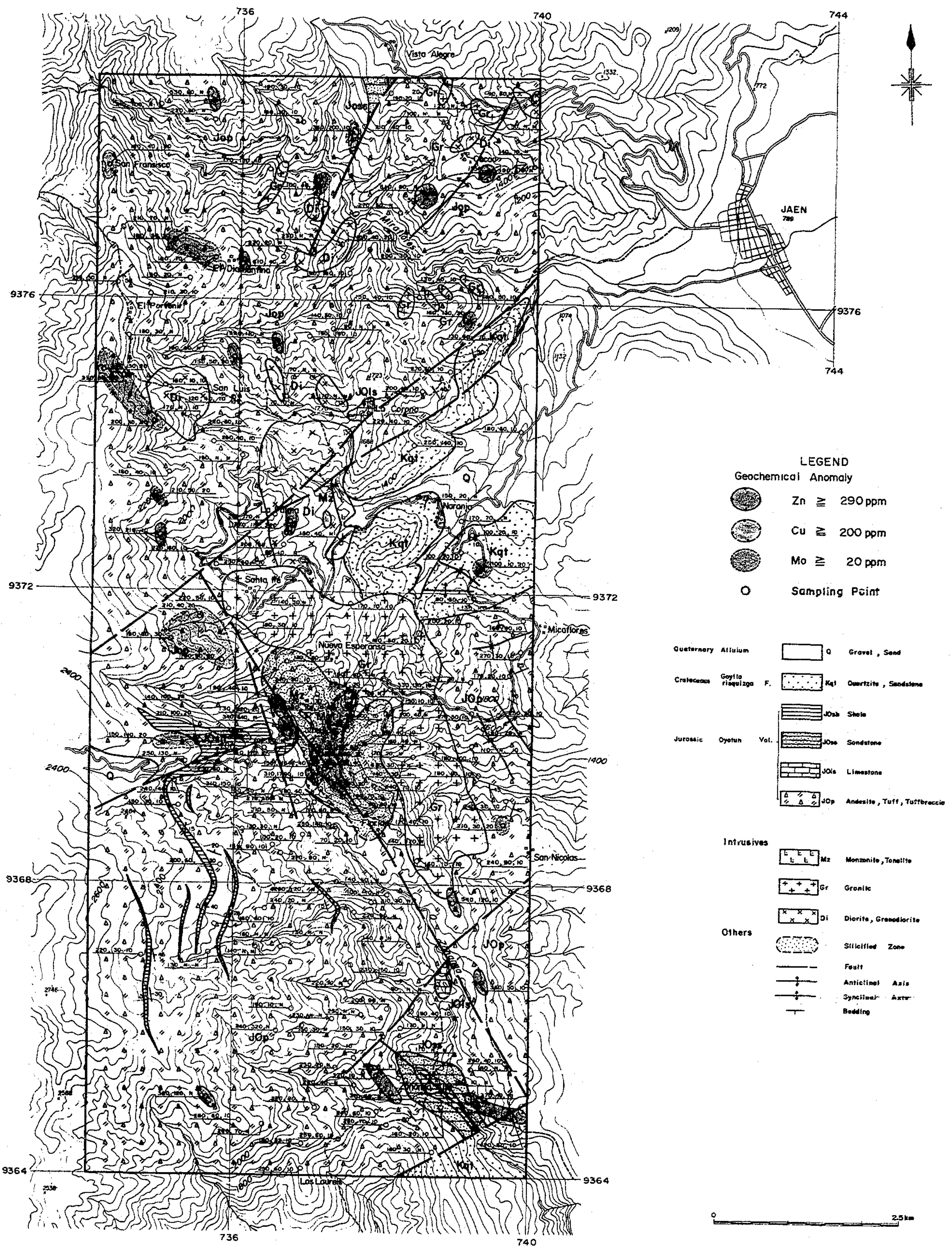


Fig.II−21 (2) Geochemical Map of The Palma Area (Zn. Cu and Mo)

5-1 Geological and Geochemical Surveys

5-1-1 Purpose of the Survey and Procedure Used

The Jehuamarca area includes the mineralized zone extracted by the follow-up study for the anomalies found out geochemical prospecting in the "Proyecto Geoquimico del Norte." The study was advanced by INGEMMET up to the phase of detailed survey on a scale of 1/2500. After this survey, no follow-up study was performed. Present survey was carried out by adopting a detailed geological survey with the geochemical survey of rock samples to re-evaluate the results obtained by INGEMMET.

Base camp set up at the simple camp of INGEMMET, located in the center of the survey area, was used together with a camping tent (Fig. I-1, Fig. I-2). In addition, a supply camp was set up in Pucara, a town located to the north of the surveyed area. Since the area is situated at highlands over 3,000 meters of elevation, there is little vegetation. Survey routes therefore were fittingly selected aiming outcrops. In the lowland virgin forests path-clearing teams were organized to obtain accessible routes.

Geochemical survey sample was collected in a large numbers comparing with other survey areas, in order to reavaluate the results surveyed by INGEMMET. The combined silicified and argillized zones, distributed in the center were especially sampled intensively.

5-1-2 Geology

Regionally this survey area consists of the Oyotun Volcanics as basement and Porculla Volcanics unconformably covering it (Wilson, 1984), see Fig. I-3.

The area consists of lava, tuff bueccia and tuff belonging to the Porculla Volcanics, and they are intruded by rhyolite-dacite, andesite and brecciated dacite. Also distribute siliceous breccia and intrusive breccia, which trend NE-SW on the whole, and therefore, can be supposed to be intrusive rocks being accompanied with tectonic movement. Mineralization in this area are observed dissemination type and vein type. The vein type indication trends north-south with dipping toward east, which is auriferous quartz vein whilst dissemination type refers to polymetallic mineralization with copper, zinc, lead and silver and accompanied with fissures and/or fracture-filling mineralizations. The desseminated mineralizations are mainly formed in the breccia and tuff breccia, being less present in tuffs.

5-1-3 Survey Results

1) Geological survey

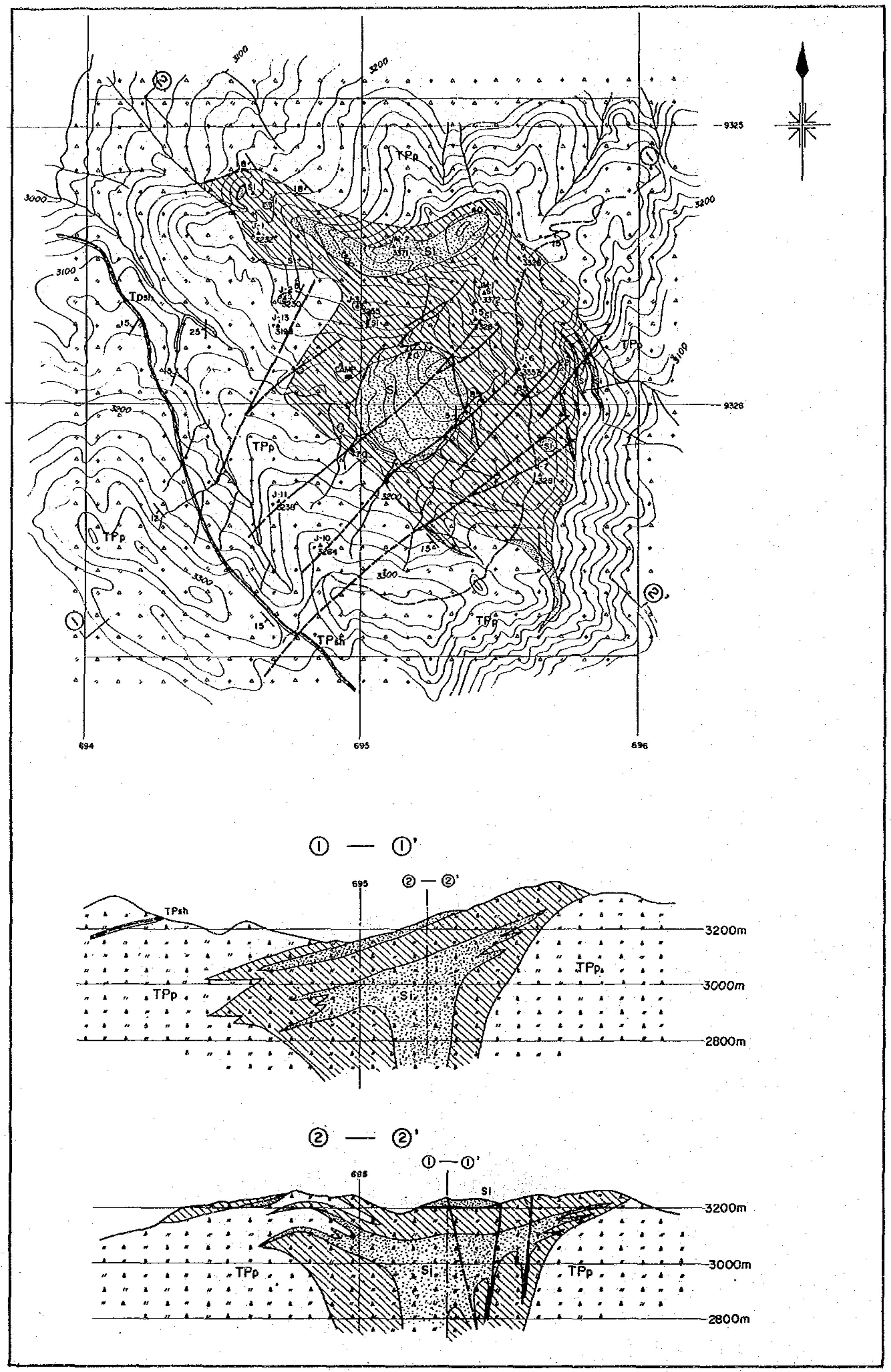
The geology of the survey area is characterized with pyroclastic rocks, mainly consisting of andesitic or dacitic tuff breccia and lapilli tuff with intercelating tuff, welded tuff and tuffaceous shales-siltstone.

These pyroclastics, though being slightly undulated, mainly trend NW-SE with gently dipping toward the southwest as monoclinic.

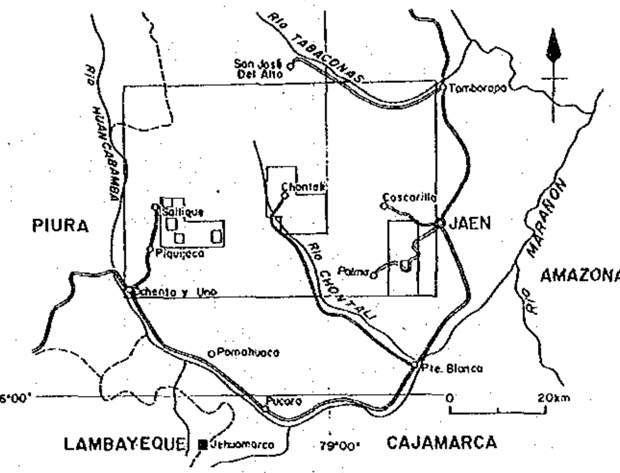
There is no conclusive evidence to prove their age of deposits, however, it is assumed to be clasified into the Tertiary as they unconformably cover both the Oyotun Volcanics which crop out the foothills in the survey area and the Mesozoic formations which overlie the Oyotun Volcanics, and can be correlative with the Porculla Volcanics, judging from rock facies. With respect to intrusive rock, rhyolite having a clear flow structure was only observed verified. Its intrusion type divide into the sill-like type, which is concordant with pyroclastics trending, and the dyke type, which is intersecting perpendicularly with the sedimental structure, the former being predominant. These intrusives lack in continuity and are very small in scale, with several centimeters to one meter in thickness and 10 to 20 meters in length. Under the microscope, flow texture is slightly observed in glassy matrix and a few amount of quartz crystals are recognized (sample No. H11703).

The fault fissure system trends NW-SE with dipping steeply and is intersecting perpendicularly with the sedimental structure is observed remarkably. Additionally, minor branched fissures trend NW-SE to NNW-SSE are also observed. These fissure systems scarecely disturb the sedimentary structure, therefore, they may be the secondary systems being orginated from the regional fault fissure system.

Alteration in this area may have developed taking the said fissure systems as passage. These fissure systems are accompanied with quartz veins and/of silicified zones, with zonal arrangement of alteration: silicification-argillization, argillization and/or propylization from center to outward. Silicification-argillization alteration zone is distributed in an elliptical form with approx. 2km in its major axis(NW-SE) and 1km in its minor axis(NE-SW), a little toward the north from the center of the survey area. Around the center and northern flange of this alteration, there are silicification-argillization and silicification alteration zones, surrounded by argillization alteration zones. Around the center of all these alteration zones, the mentioned fissure systems are concentrated: thus, the alteration might



THE MINERAL EXPLORATION
IN
THE PACHAPIRIANA AREA, REPUBLIC OF PERU
(PHASE I)



JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN
FEBRUARY 1989

LEGEND

Tertiary Porculla vol.
- TPp — Tuff, Lapilli tuff, Tuff breccia
- TPsh — Shale, Siltstone
- Si — Silisified rock
- Argillized zone
- Fault, Fissure
- Bedding

Fig.II—22 Geological Map and Profiles of The Jehuamarca Mineralized Zone

have progressed through these fissures. The geological analysis results allow us to speculate that these alteration zones would have developed at certain specific horizons, and that they were formed in harmony with the sedimentary structure. The condition of minor silicification zones found in the eastern fiange of the alteration zoning keeps with the layers, and thus, affirms this analytical view.

The major mineral component of the altered rocks in the silicified zone is only quartz (Sample No.M11803), with a little goethite predicting of suipbides. The argillization is characterized by an occurrence of sericites, without any other clay mineral detected by the X-ray diffractive analysis (Apx.5). An additional feature is that anatase, which is titanium oxide, is usually detected, in view that the clay mineral consists of only sericite and that its polytype is only of 1M, they should have been in a relatively uniform neutral to alkaline alteration environment.

On the chemical compositional variation of altered rock, assuming as chemical composition of weakly altered agglomerate (Sample No.M20403) sampled in the Palma area is as a source rock of the alteration in this Jehuamarca area, the silicified zone (Sample No. k11803) is characterized by addition of abundent SiO2 and reduction of Al2O3, CaO, Na2O and K2O, thus substantiating the existance of abundant quartz. Similar variation was observed in the combined silicified-argillized zones (Sample Nos. H11902 and K11906) except K2O which was added to a certain extent, and Al2O3 whose reduction rate was slightly small. These results coincide with the microscopic and X-ray diffractive analysis results.

2) Geochemical survey

As illustrated in Table II-2, the comparison of all the samples based on the average value indicates that four elements (gold, silver, lead and molybdenum) except zinc and copper outstandingly exceed the average value, being 130.01 mg/ton, 38.31 g/ton, 1,395.89 ppm and 22.88 ppm for the four elements, respectively. These values exceed the threshold value obtained from the cumulative frequency distribution of all the rocks sampled in the entire survey area this year, thus demonstrating that the whole of the Jehuamarca area locates in a geochemical anomaly zone. Analyzing the distribution of anomalous zones per each element (Fig. II-23(1),(2)), it is noted that those of gold, silver and lead are relatively concentrated and their distributions overlapped. Those of zinc, copper and molybdenum appear in a small-scaled scattered distribution.

The anomalous zones of silver and lead basically coincide with the silicified to the combined silicfied-argillized zone distributions. That of gold accompanies with silicfied zone closely. It is observed that the silver anomalous zones are

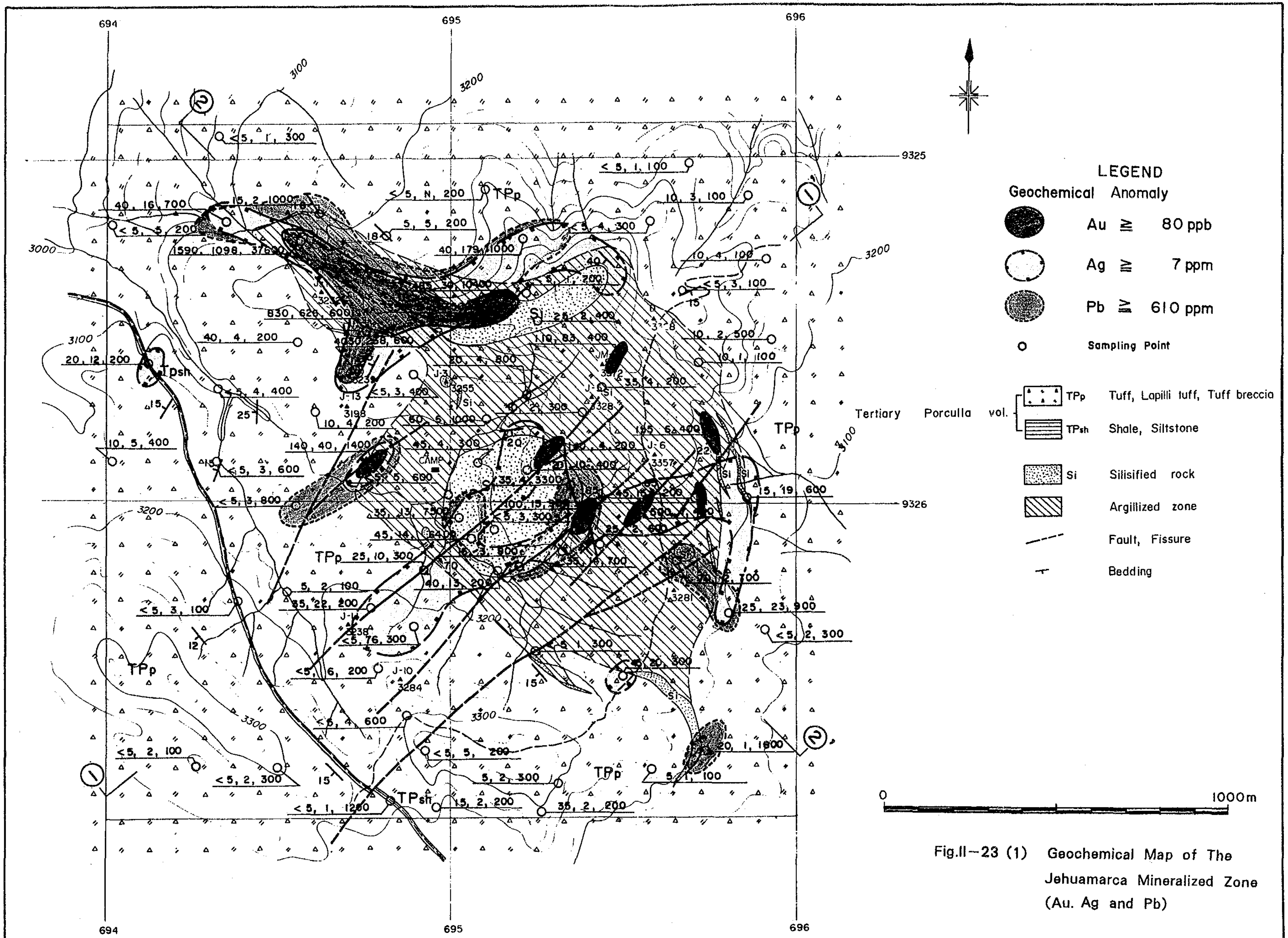


Fig.II−23 (1) Geochemical Map of The Jehuamarca Mineralized Zone (Au. Ag and Pb)

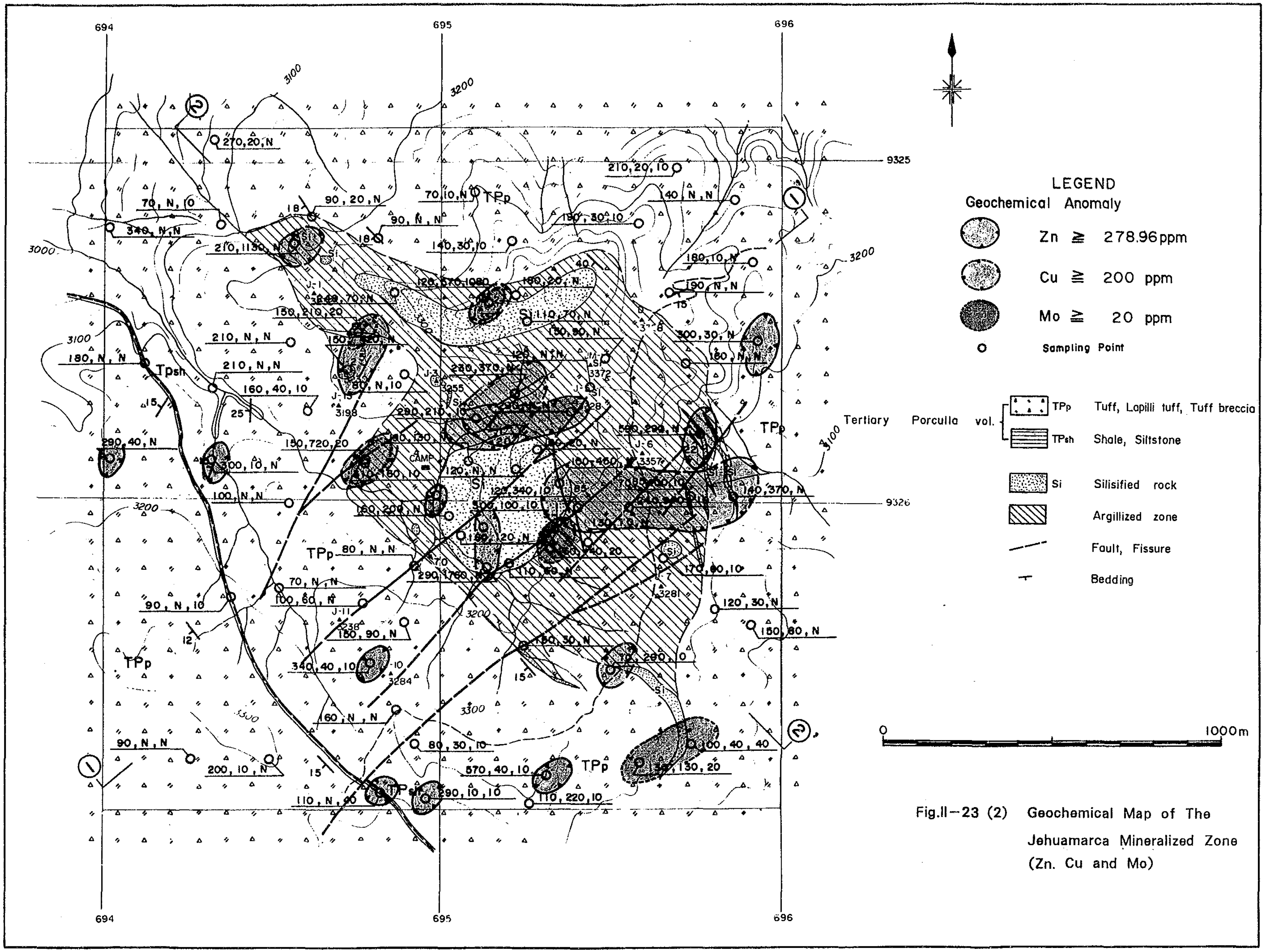


Fig.II−23 (2) Geochemical Map of The Jehuamarca Mineralized Zone (Zn. Cu and Mo)

acutely affected by the NE-SW fissure system. Though the anomaly of zinc, copper and molybdenum are not concentrated as mentioned above, their small scaled distributions presumably coincide with the distribution of small silicified zones included in the mentioned silicified or combined silicified-argillized and/or argillized zones. Hence, geochemically, the mineralization in this survey area may have been generated, through the NE-SW fissure systems as passage, being concentrated in the period when such silicification occurred.

5-2 Geophysical Survey

5-2-1 Purpose of the Survey

The purpose of the CSAMT survey is to elucidate resistivity structure and to explore mineralized zone.

5-2-2 Method of the Survey

CSAMT survey is executed at Jehuamaraca in the same way as at San Felipe. Only the parts deferring for that at San Felipe are described.

1) Scope of the survey
   The geophysical survey area is shown in Fig. II-7.
   The scope of the survey is as follows:

   Area: 4km²
   Station interval: 200m to 300m
   Number of station: 31 points

   Survey stations are dense in the center of the survey area. (see Fig. II-24)

2) Method of CSAMT survey

   (a) Signal source
   Electrode: 6,500m long, N125° E direction
   Resistance of entire transmitting bipole system: 20 ohms
   Transmitting current: Transmitting electric current of each frequency is as follows:

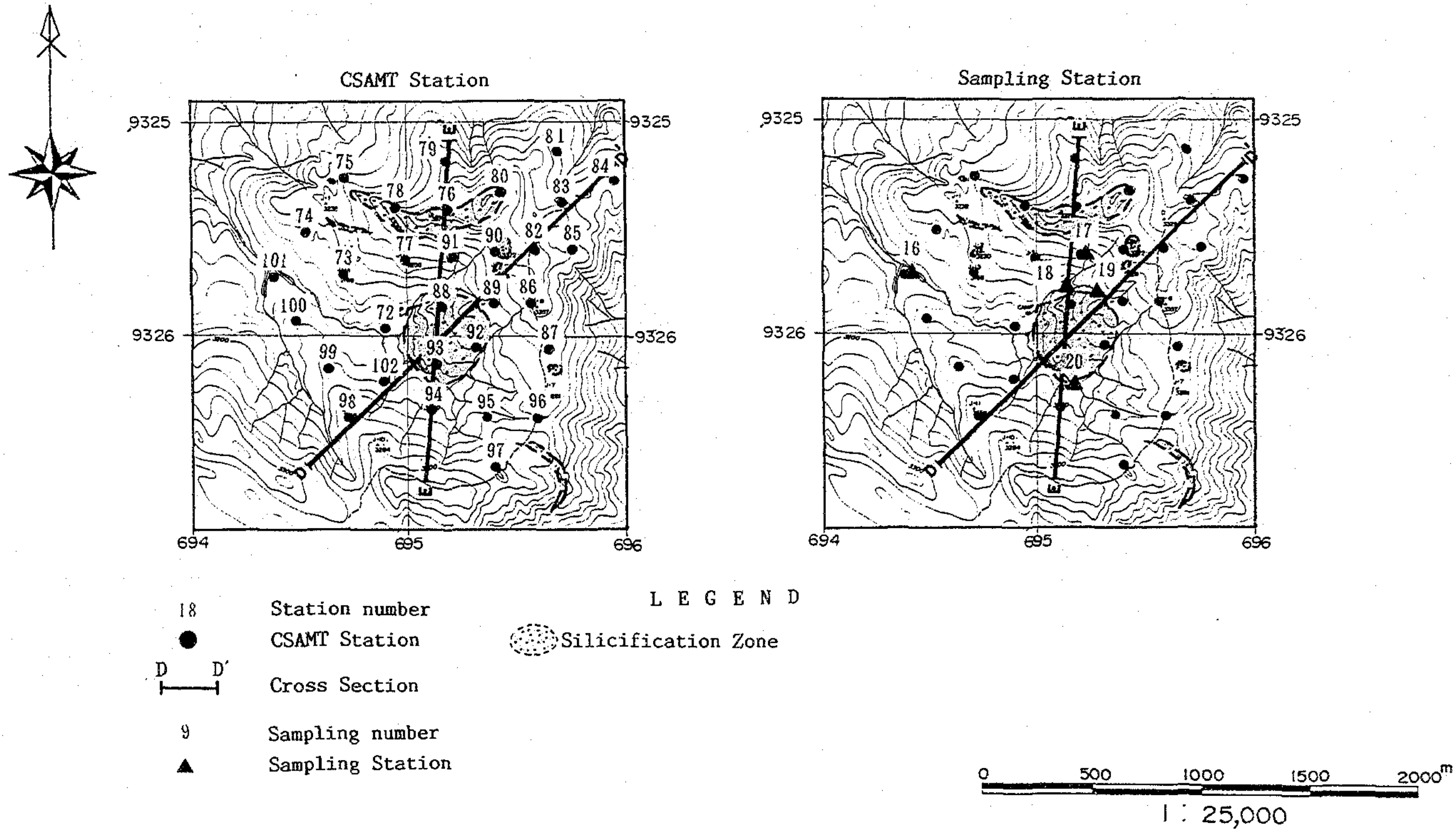


Fig.II−24 Location Map of CSAMT Station and Rock Sample

Frequency(Hz)	4	8	16	32	64	128	256	512	1024	2048
Bipole(Ampere)	12	12	12	12	12	12	12	6	6	3

5-2-3 Data Reduction and Analysis

Since near field effect is not observed in data of all the stations in the survey area, the correction is not necessary.

5-2-4 Results of Survey and Analysis

1) Physical properties of rock samples

Five samples of representative rock-types from the survey area were tested in the laboratory for their resistivity and IP effect. The results are shown in Table II-4 and Fig. II-17.

The locations from where these rocks were sampled are indicated in Fig. II-24. As a result of our tests, one sample showed a high FE value of 10 percents. This sample is from pyroclastic rocks which are distributed extensively over this survey area. Traces of a relatively much pyrite can be observed in this sample under a magnifier. Pyrite is also evident, but a small amount, in other rock samples, with the exception of silicified rocks.

2) Apparent resistivity distribution (see Fig. II-25)

As this survey area is very small, the regional tendency of apparent resistivity distribution is unknown. However, the following two characteristics are noticeable in its apparent resistivity distribution:

i) Apparent resistivity is generally low.

ii) Resistivity is lower in the low frequency range.

No significant variation was observed in apparent resistivity distributions at the ten measured frequencies. Of these, therefore, apparent resistivity distributions at three frequencies, 4 Hz, 64 Hz and 2,048 Hz, which most reflect local variation, are described in the following section. For the convinience of explanation, apparent resistivity values are divided into five groups as below:

20	50	100	200	(Ω・m)
very low resistivity L L	low resistivity L	medium resistivit M	high resistivity H	very high resistivity H H

Apparent resistivity distribution at 4 Hz

i) Apparent resistivity at 4 Hz is lower than 100 Ωm. In terms of area, low apparent resistivity is distributed extensively, following which there are 3 very low apparent resistivity zones.

ii) At the center of the survey area, distribution of medium apparent resistivity is observed in N-S direction. This distribution is observed from 4 Hz to 500 Hz identically.

Apparent resistivity distribution at 64 Hz

i) High and medium apparent resistivities cover most of the survey area with some local very high and very low apparent resistivity zones.

ii) Compared with apparent resistivity distributions at 4 Hz, relatively higher apparent resistivity governs all the survey area. Medium aparent resistivity replaces where very low apparent resistivity was at 4 Hz, and medium apparent resistivity zones observed at 4 Hz in N-S direction are replaced by relatively higher and very high apparent resistivity distributions.

Apparent resistivity distribution at 2,048 Hz

i) In a similar manner to distribution at 64 Hz, high and medium apparent resistivity zones cover most of the survey area with some local very high and very low apparent resistivity distributions.

ii) Medium apparent resistivity zones become slightly narrower than at 64 Hz and merge into one integrated zone, showing a distribution tendency in NE-SW and NW-SE directions, which cuts the relatively higher apparent resistiviy zones that are one continuous zone in N-S direction at 64 Hz.

3) Apparent resistivity pseudo-section (see Fig. II-26)

Tendency of apparent resistivity distribution shown in each section is described below:

i) As can be seen in sections D-D' and E-E', high apparent resistivity zones which contain zones of very high resistivity run from the surface to a considerable depth.

ii) At the deepest layer low apparent resistivity zones are dominant with some local very low resistivity zones.

iii) Medium to low apparent resistivity zones are locally observed at 2,048 Hz near the surface. These zones are discontinuous from those of medium to low apparent resistivity at a greater depth.

4) Analytical results

Analysis of the measurements was conducted according to the procedure described in 2-2-3. Results of this resistivity analysis conducted at each station arranged along the traverse line are shown in Apx.11.

<u>D-D' and E-E' Sections</u>

Both of these resistivity sections are interpreted to three layers. The first layer near the surface is very thin with a resistivity of 100 Ωm at maximum. The second is relatively thick and contains high resistivity zones observed all over the area, with resistivity values of 200 to 900 Ωm. This resistivity layer continues to a considerable depth, centered at the station 88. The third, which is the deepest layer, forms a relatively low resistivity layer with 70 Ωm at maximum.

<u>Resistivity Structure Map (see Fig. II-27)</u>

For this survey area, resistivity structure plans have been prepared at the levels of elevation of 2,900 and 2,700 meters. Both structure plans show the average distribution in the second and third layers above-mentioned.

i) At a level of 2,900 meters the second layer is most extensive with high resistivity zones, with resistivity of 500 Ωm or more, present. The third layer, that contains low resistivity zones, is present in 3 distributions which mainly consist of low apparent resistivity zones found by measurement at 4 Hz.

ii) Presence of the second layer is reduced and local at a level of 2,700 meters and the third layer is predominant.

Geologically, pyroclastic rocks are distributed throughout this survey

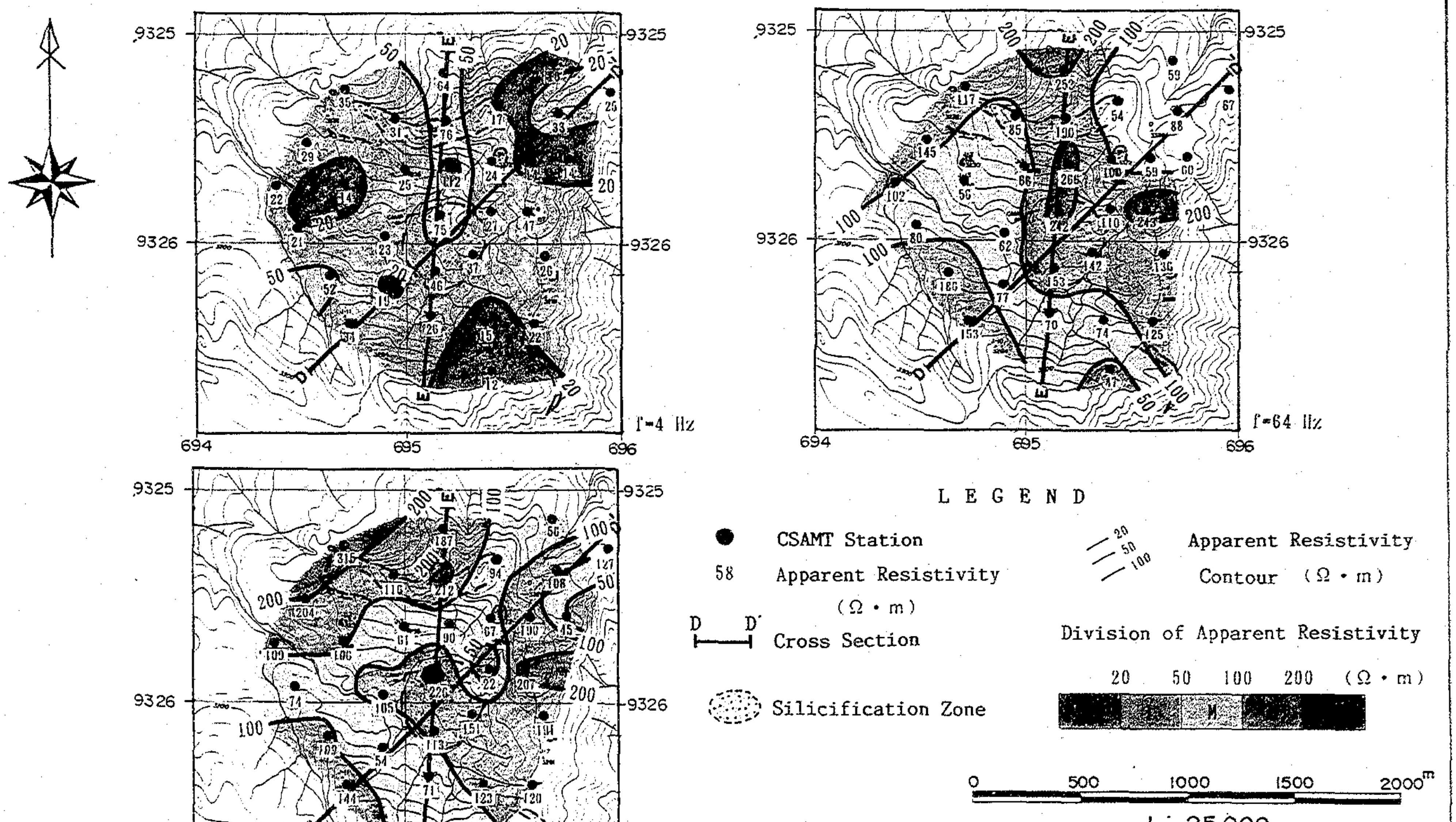


Fig.II−25 Apparent Resistivity Map of The Jehuamarca Mineralized Area

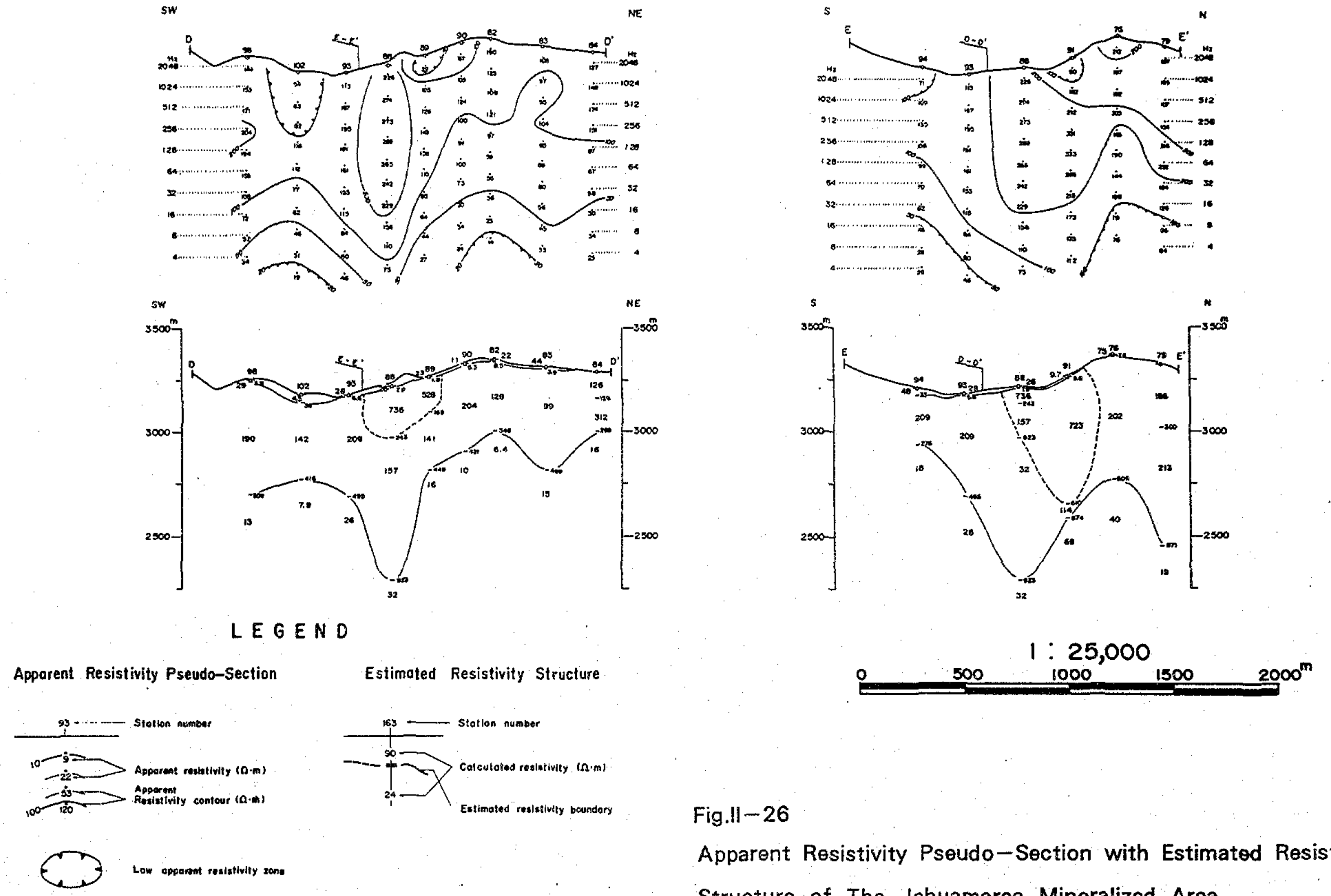


Fig.II−26

Apparent Resistivity Pseudo−Section with Estimated Resistivity Structure of The Jehuamarca Mineralized Area

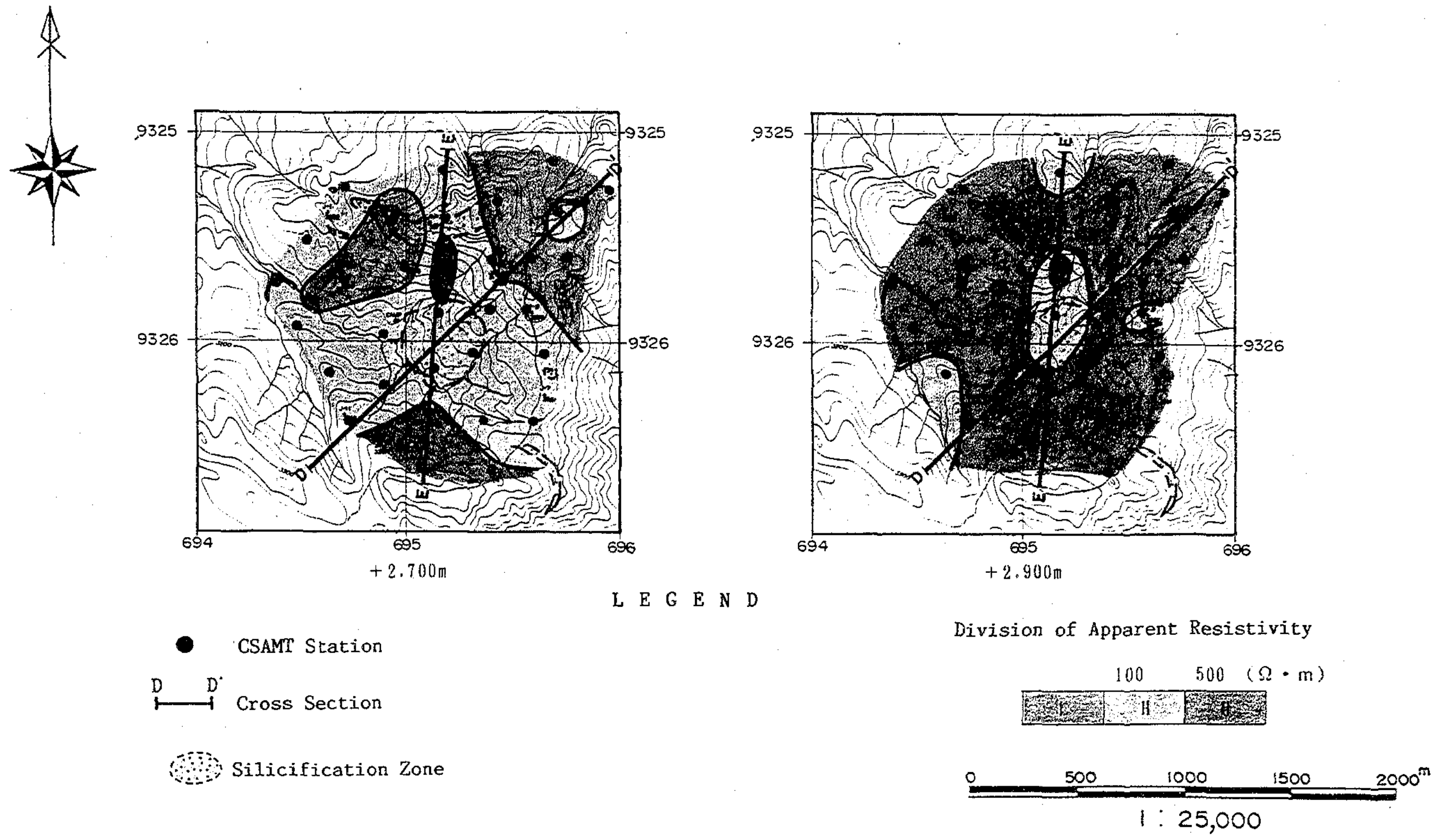


Fig.II−27 Resistivity Structure Map of The Jehuamarca Mineralized Area

area, and among these rocks, many fissures are arranged in the NE-SW direction. Siliceous zones are arranged in such a form that they fill these fissures. Argilized alteration zones are extensively distributed over the area.

The first layer, of low resistivity, is found in the shallow part of the surface and corresponds to the wet argilized zones widespread over the surface.

The second layer contains resistivity layers of 500 Ωm or higher at its center in blocks in the deeper parts around the stations 88 and 89. This indicates that they remain consistent at greater depths. Considering the siliceous rock body on the surface, the resistivity observed in the second layer may indicate the root of such a rock body. The part of the second layer, of less than 500 Ωm, corresponds to the argilized tuff zones which are distributed all over the survey area.

5-3 Review

The Jehuamarca area consists of andesitic - dacitic pyroclastic rocks which can be correlated with the Porculla Volcanics, among which numerous fissures occure trending NE-SW. It can be analyzed that the mineralization and alteration here developed through these fissures as their passage. The mineralization should have especially occurred in a significant scale in the silicification stage. Based on their distributions, these mineralized alteration are assumed to have developed preferentially in the specific horizons.

The geochemical survey provided with such results to substantiate the assumption above. Finally, it should be noted that intensive geochemical anomaly covered the entire area.

Geophysical analysis, on the other hand, suggests that this survey area is composed of three layers of resistivity. The first layer shows low resistivity near the surface, and thus, assemably correlative with a latent argillized zone under the silicified zone observed in surface, spreading throughout the area. The second layer is of relatively high resistivity, ranging from 200 to 800 Ωm, with a part having a resistivity higher than 500 Ωm in the central combined silicified-argillized zone presumably continuing deep underground. Namely, this can be interpreted that the second layer of high resistivity has a root at the depth of the center. Extremely low resistivity, lower than 70 Ωm, was measured in the bottom, third layer.

Considering these results, the Jehuamarca area can be characterized by its epithermal alteration and mineralization. Furthermore, as it can be supposed that the mineralization should have concentrated in silicification stage, and the hight registivity should indicate an existance of silicified zone, a mushroomed structure interpreted with the second layer of high resistivity, may suggest an area of occurrence of ore deposits.

PART Ⅲ
CONCLUSION AND RECOMMENDATION

CHAPTER 1 CONCLUSION

The Survey Area included as the basement Maranon Complex consisting of metamorphic rocks, mainly being gneiss correlative with the Precambrian; Paleozoic consisting of Olmos Complex (mainly crystalline shist) and Salas Group (mainly phyllite); Mesozoic consisting of Oyotun Volcanics (mainly pyroclastic rocks), Goyllarisquizga Group (mainly siliceous sandstone), and Inca, Chulec, Pariatambo and Pullicana Formations (mainly calcareous rocks); intrusive rocks intruding into those mentioned above, such as diorites, granites, monzonites and porphyries; and the Tertiary volcanics and Quaternary stream sediments unconformably covering them.

According to the geological survey, the sequence of intrusion was determined for intrusive rocks, from diorites, grantes, monzonites and porphyries in this order, which coincides with the results of the absolute age determination using the K/Ar method. The respective absolute ages are 119±6 milion years for diorites, 106±5 to 47.6±2.4 million years for granites, and 78.0± 3.9 million years for monzonites. The absolute age of 47.6±2.4 million years given to granites refers to the result of measurement for red granite sampled in the Palma area, which could have provided the age of alteration of potassium feldspar.

Thought the maximum peak of the frequency of extracted lineament was identified in a NNW-SSE direction by the lineament analysis of the LANDSAT images (Fig. II-2, I-3), in the field survey the most remarkable was the NE-SW fault fissure system. The former (NNW-SSE) concerns the so-called Andean trend, and the latter (NE-SW) corresponds to the lateral force direction that caused the Andean trend. However, while these are the right lateral slip faults substantiated the hypothesis above in Palma located in the eastern side of the survey area, in San Felipe, the western side, there is a depression structure as like the western block sinked down, thus could correspond to the extention area, which, if so, should disclose the history of tectonic movement in the Huancabamba Deflection Zone. Analyzing the fault fissure systems for each area, the fissures generally stretch in a north-south direction in the San Felipe area (Fig. II-5), consisting of combinations of NE-SW and NW-SE trendings. In the Chontali area (Fig. II-18), a relatively large-scaled fault fissure system was identified trending NE-SW by in airphotograph with minor fissure trending NW-SE, bridging the said major ones. In Palma (Fig. II-20) the major fissure system trends NE-SW, with secondary trending NW-SE crossing perpendicularly that major system. A multiple number of fissures trending NE-SE with little dislocation were identified. These fissures identified on field or through airphotographs could not be discriminated by the LANDSAT image analysis. This suggests that these fissures are subsidiary ones which has been derived from the major structure.

Alteration in the survey area is assumed to have occured through the subsidiary fissures mentioned above. In San Felipe, alteration zones, and the geochemical and geophysical anomalies were found out around the NE-SW or NW-SE trending fissures. In Chontali, alteration zones were occurred on the NW-SE fissure zone developed between the NE-SW lineaments. And in Palma, alteration zones occure dominantly between NE-SW trending fissure and granite body, and also predominantly along the NE-SW fissures in Jehuamarca. And in Jehuamarca, it is possible that selective alteration, in which alteration occurs in some specific horizons, occured preferentially. An assemblage of the alteration minerals indicates that their origin is attributable to epithermal alteration.

Geochemical anomalies were identified throughout the survey area. However, those overlapped with alteration zones deemed to be significant in relation to mineralization were observed only at Pena Verde and La Huaca in the San Felipe area, Chontali area, at Zonanga in the Palma area, and in the Jehuamarca area. The mineralized alteration zones in Pena Verde were represented by silver and copper anamalous zones overlapping with silicified zones, and those in La Huaca by copper, zinc and lead anomalous zones overlapping with combined silicified-argillized zones. In Chontali, the mineralized alteration zones were extracted as gold, silver and lead anomalies overlapping with combined silicified-argillized zones; those in Zonanga, as lead, copper and molybdenum anomalies overlapping with combined silicified-argillized zones; and in Jehuamarca, as gold silver and lead anomalies overlapping wtih silicified and combined silicified-argillized zones.

Geophysical anomalies were found out as low resistivity overlapping with alteration zones in San Felipe area , and as high resistivity within the low resistivity zone in Jahuamarca area. The former (in San Felipe) was developed surrounding intrusive rocks (monzonite and ring andesite), and suggests the presence of mineralized alteration of two types or two stages based on the relationship between geochemical anomaly occurrence and alteration zones. In Jahuamarca, a three layer structure of low resistivity/high resistivity/low resistivity was analytically identified. The high resistivity of the middle layer was interpreted as a mushroomed structure, having root at the center. This mushroom structure suggests a supply source of ore-forming and/or hydrothermal fluids, and may be a critical target for the future surveys.

Assay results of ore samples from altered rocks and/or quartz vein, that all samples contain gold, particularly, trending NW-SE quartz vein forming the center of the Chontali mineralized alteration zones indicated average values (17 samples) of 1.37 g/ton Au, and 7 g/ton Ag (max. 10.3 g/ton Au and 29 g/t Ag). Therefore, it is concluded an existence of gold deposits is very probable. The assay results of two samples from sulphide dissemination zones *among combined silicified-argillized zones in Jehuamarca show 0.80 g/ton Au,* 495 g/ton Ag, 0.42% Pb, 0.69% Zn and 0.04% Cu. This also indicates a very high potential of an existence of auri-argentiferous base metal dissemination deposits in the area.

CHAPTER 2 RECOMMENDATIONS FOR THE SECOND YEAR SURVEY

The results of the first year survey verified that the geochemical anomaly from the stream sediments extracted by INGEMMET prove a high probability of mineralized indication. This induces to suppose that there is possibility that some important mineralized indications are included in the northern and southern areas of Chontali, Pena Blanca and Tuna, which remain pending for survey. It is therefore recommended that a raconnaissance survey be implemented for these areas. However, these areas of geochemical anomaly are far remote in location, where only accessible by horse, and moreover, there is no topographic map. Under these circumstances, the initial step will be to prepare a basic topographic map for the purpose of the proposed survey.

The mineralized alteration zones detected in Chontali under the semi-detailed survey this year are very promising from many of their aspects, including alteration zone scale, geochemical anomaly distribution, and occurrence frequency and scale of auriferous quartz veins. In effect, in the riverbed of the Huayabamba River that flows through the survey area longitudinally, alluvial gold was collected on a small scale. This is another piece of evidence of the high possibility of an existence of gold deposits. In conclusion, it is also recommended that a detailed geological survey as well as geophysical survey be conducted for more particular verification of mineralized alterations and of quartz vein forming mechanism, scale and ore grade.

A promising porphry copper type mineralized alteration was verified in Zonanga, the Palma area, where a detailed geological survey was conducted this year. In the areas extension of the north and east of this mineralized zone a detailed survey remains uncompleted as of yet. Continuation of this detailed geological survey on the prolongations mentioned above is recommended together with the implementation of reconnaissance geophysical prospecting, such as the CSAMT method, which should include some additional areas.

For the San Felipe area, where geophysical survey was conducted this year, further geophysical prospecting, e.g., by SIP or IP method, is recommended to clearly identify the details and nature of the low resistivity zones found out at Pena Verde and at La Huaca.

Final recommendation is that boring be conducted to directly verify the mineralized conditions in the high resistivity zones found out as a mushrooming structure within the low resistivity zones at the center of the Jehuamarca alteration zones.

Based on these recommendations, studying the priority of the surveying areas extracted by each survey method, their priority of each area is finally summarized as Table Ⅲ-1.

Table.III－1　Summarized Recommendation for The Future Survey

<table>
<tr><th rowspan="2" colspan="2"></th><th colspan="2">Geological Survey</th><th colspan="2">Geophysical Survey</th><th rowspan="2">Boring</th><th rowspan="2">Priority for Surveying Area</th></tr>
<tr><th>Semi-detailed</th><th>Detailed</th><th>CSAMT</th><th>IP</th></tr>
<tr><td rowspan="4">San Felipe</td><td>Pena Verde</td><td rowspan="4">● (90)</td><td>● (4)</td><td rowspan="2">● (21)</td><td>△</td><td></td><td rowspan="4">④</td></tr>
<tr><td>La Huaca</td><td>● (5)</td><td>○</td><td>△</td></tr>
<tr><td>Vega</td><td>● (4)</td><td>×</td><td></td><td></td></tr>
<tr><td>Paramo</td><td>● (5)</td><td>×</td><td></td><td></td></tr>
<tr><td rowspan="3">Chontali</td><td>Northern Area (Pachapiriana)</td><td>△ (48)</td><td></td><td></td><td></td><td></td><td rowspan="3">①</td></tr>
<tr><td>Central Area (Chontali)</td><td>● (120)</td><td>◎ (20)</td><td>→</td><td>◎</td><td>○</td></tr>
<tr><td>Southern Area</td><td>◎ (80)</td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Palma</td><td>Zonanga</td><td rowspan="2">● (90)</td><td>● (3)</td><td>○</td><td></td><td></td><td rowspan="2">⑤</td></tr>
<tr><td>Miraflores</td><td>×</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Jehuamarca</td><td>→</td><td>● (4)</td><td>● (4)</td><td>→</td><td>◎</td><td>②</td></tr>
<tr><td colspan="2">Pana Blanca</td><td>○ (220)</td><td></td><td></td><td></td><td></td><td>③</td></tr>
<tr><td colspan="2">Tuna</td><td>△ (152)</td><td></td><td></td><td></td><td></td><td>⑥</td></tr>
</table>

● Finished　　× Disused　　→ Omission

( ) Surveyed Area and/or Surveying Area in km²

Priority of the Each Surveying Method

◎ the First　　○ the Second　　△ the Third

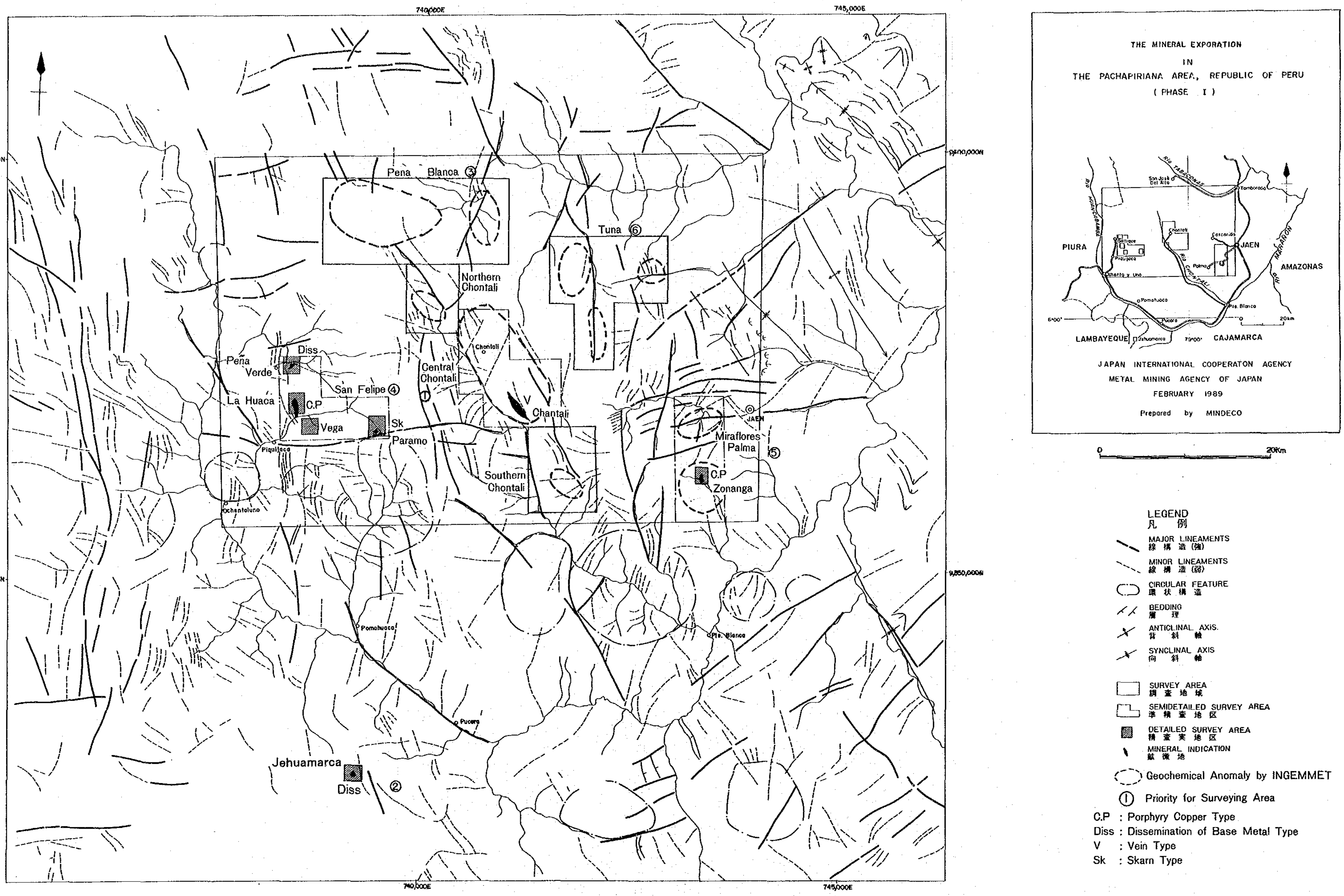


Fig.III－1 Location Map of The Recommended Survey Area for The Future

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APPENDIXES

Apx.1 result of Microscopic Observation (Thin Section)

Sample No.	Rock Name	Locality	Geological Unit	Main Component Minerals: Quartz	Plagio clase	K-feldspar	Biotite	Hornblende	Others	Accessary (Secondary) Mineras: Apatite	Zircon	Opaque	Others
K12309	Quartz Diorite	Chontali	Di	5 0.1~0.5	66 0.5~5.0		15 0.5~4.0	10 0.1~3.0	Au 4, 0.12~2.0	<1 <0.1	<1 <0.1		Sphene
K02505	Diorite porphyry	San Felipe	Di	< 1 2.5	68 0.1 ~7.0		3 ≦0.5		Px→ chl-cab-op-lm chl-cab	<1 <0.05		4 0.05~0.4	(chl) 25 <0.1
H12405B	Granodiorite	Chontali	Di	30 0.1~5.0	50 0.1 ~4.0	15 0.5~2.0	5 0.2~1.0			<1 0.1±	<1 0.1±	<1 <0.5	
H20303	Syenite	Palma	Gr	2 <2.0	10 <3.5	85 <4.0	2 <1.0			<1 <0.1	<1 <0.1	1 <0.7	Sphene <1 0.3
H11005	Granodiorite	San Felipe	Gr	45 0.05~1.25	40 0.03~0.2	10 0.05~0.2	5 0.02~0.25			<1 0.02	<1 0.05	<1 0.01~0.02	(Prehnite ep. chl) 0.025~0.02 0.01~0.08 0.08~0.2
M20603	Adamelite	Palma	Gr	25 0.2~2.0	35 0.2~2.0	20 0.5~5.0	10 0.2~1.5	10 0.1~3.0		<1 <0.1		<1 <0.5	(chl. ser. zoicite)
H03008	Tonalite	San Felipe	Gr	25 0.2~1.2	60 0.1~2.5		10 0.1~1.0	< 1 1.5			<1 <0.05	3 0.1~0.4	actinolite (chl.cab.ep.rutile) 2
H12418	Quartz Monzonite	Chontali	Gr	10 0.5~2.0	35 1.0~4.0	45 1.0~6.0	5 0.5~3.0	5 0.1~3.0		<1 <0.1	<1 <0.1	<1 <1.0	(ser.chl)
K21201	Adamelite	Palma	Mz	20 0.2~4.0	45 0.5~2.0	30 0.2~8.0	5 0.1~1.0			<1 <0.05		<1 <0.5	(ser. chl. zo)
H02503	Monzoni Syenite	San Felipe	Mz	1 0.02~0.2	79 0.5~5.5	10 0.1~0.8		10 0.25~2.5	Px → chl.ep.zo				(chl. ep, zo, all, cab) 0.025~2.5 0.5 0.05~0.2 0.1~0.25 0.02~0.15
K12501	Monzonite	Chontali	Mz	3 2 (app)	30 0.1~3.0	(20) Salic agg <0.05							(cab) 17
H12405A	Granite porphyry	Chontali	Gp	9 0.05~2.5	86 (Plagio clase + K-feldspar) 0.2 ~2.5		8 0.1		mus 3 0.1	<1 <0.1	<1 <0.1	< 1	(ser.chl)
H12404	Granophyre	Chontali	Gp	20 0.05~0.7	58 0.05~2.5	20 0.05~1.0						<1 0.01~0.5	(chl. czo. ser) 1 1 <1
H11203	Rhyorite	Jahuamarca	Ry	< 1 <0.2					glass				
M02503	Andesite	San Felipe	Oy	1 <0.1	81 0.5~5		15 0.05~0.5		Px → ep.chl.ur			3 <0.5	(ep. chl. ur. ac) 5 5 5 <1 0.1 0.5 0.2~0.5 <0.4
K12307	Andesite	Chontali	Oy	2 0.3	40 0.1~2.3		5 0.3~2.2		chl.ep.op				altered agg.(cab ep lm) 50 <1 <2 3
M20403	Dacite	Palma	Oy		24 ~3.5		5 → cab.chl.op.clay			1 <0.3		5	glass → fine salic. clay cab op 65
K11803	Siliceous Rock	Jahuamarca	Po	80 0.01~1.0			<1		ms <1			5	clay minerals cavity 10 5
H11902	Welded tuff	Jahuamarca	Po	2 0.02~0.8					glass →clay minerals 93				ss av 3 2 <1.5 <1.5
K11906	tuff	Jahuamarca	Po	2 <0.5					glass →clay minerals 66			2 0.4	av 30 <2.0

Di : Diorite
Gr : Granite
Mz : Monzonite
Ry : Rhyorite
Gp : Granite porphyry
Oy : Oyotun Formation
Po : Porculla Formation

Mode %
grain Sin in mm

chl : chlorite
cab : carbonate
Op : opaque
lm : limonite
ep : epidote
ser : sericite
zo : zoisite
all : allanite

czo : clinozoisite
ur : uralite
ac : actinolite
agg : aggregate
ms : muscovite
ss : sandstone
av : acidic volcanics

→ altered to
changed to

K 12309 Holocrystalline

pl : Euhedral ~ Subhedral, prismatic tabular.
Albite twining is common and carlsbad and Albite-carlsbad twinings are recognized. Zoning structure is rare.
"An" component is about 40% from extinction angles.

bi : Subhedral ~ Anhedral,
Pleochroism is observed X'=pale brown, Z'=brown

hb : Subhedral ~ Anhedral, Tabular.
Pleochroism shows X'=pale greenish brown and Z'=grayish green-brown. Twining is also recognized slightly.

qz : Anhedral. Corroded structure and wavy extinction are sometimes observed.

au : Subhedral ~ Anhedral, prismatic. Weak pleochroism is rarely recognized. Twining is frequently observed and they are often coexisting with hb.

K 02505 Holocrystalline Porphyritic

pl : Euhedral ~ Subhedral. The twining is shown as Albite frequently and a little Carlsbad. "An" component is about 68% from extinction angle.

Altered mafic minerals : The prismatic crystal is remarkable.
Altered completely to aggregation of chl, cab, op and Allanite. It seems that they might be originally pyroxene group minerals.

qz : Subhedral. There are as like corroded structure and reaction rim.

H 12405B Holocrystalline

Main components are pl, qz and kf and accompanied with bi and opaque mineral.

pl : Euhedral ~ Subhedral, Prismatic.
Twinings of Albite and Carlsbad and zoning are observed remarkably. "An" component from extinction angle is about 55%.

qz : Subhedral ~ Anhedral. Corroded structure is observed. There are pl, bi and op as inclusions.

kf : Anhedral. Perthite is sometimes observed slightly.

bi : Euhedral ~ Subhedral. Pleochroism is observed, X'=pale brown and Z'=grayish green. Partly altered to chl and op.

H 20303 Holocrystalline

kf : Subhedral ~ Euhedral. There are two types internal structure, the one has remarkable perthite structure and the other is racking it. The former is sometimes recognized carlsbad twining.

Pl : Euhedral Subhedral. Polysynthetic twining is remarkable.

qz : Subhedral. Myrmekitic texture with K-feldspar is observed frequently.

bi : Subhedral. Cholritization is remarkable. Weak pleochroism is recognized, X'=pale greenish, pale brown, Z'=pale green.

H 11005 Holocrystalline Equigranular

qz : Subhedral ~ Anhedral. Myrmekite texture is observed.

pl : Subhedral ~ Anhedral. Abundant albite twining and a few carlsbad twining are observed. Sometimes altered to prehnite and epidote. "An" component from extinction angle shows about 26%.

bi : Euhedral ~ Subhedral. Pleochroism is remarkably shown. X'=pale reddish brown and Z'=dark greenish brown. Partly they change to chlorite.

kf : Anhedral. Carlsbad twining and exsolution lamellar are observed.

M 20603 Holocrystalline

pl : Subhedral ~ Anhedral, prismatic ~ tabular. Alteration is commonly observed. Ser. and clinozoicite occur as alteration products.

qz : Anhedral, granular ~ irregular.

kf : Anhedral, granular ~ irregular. Perthite and a little mirocline are observed. Zoned structure is also observed indistinctly.

hb : Euhedral ~ Subhedral, prismatic. Pleochroism is X'=pale brown and Z'=grayish brown. Twining is observed whole of the crystal.

bi : Euhedral ~ Subhedral, tabular. Completely changed to aggregate of chl, ep and opaque minerals.

H 03008 Holocrystalline

pl : Euhedral ~ Subhedral, prismatic. Observed twining is Albite, Carlsbad and Albite-Pericline. Zoning is observed too. "An" components from extinction angle is about 45%.

qz : Anhedral. Containing fluid inclusion and pl inclusion occur as interstitial of pl.

bi : Euhedral ~ Subhedral. Change to chl, ac, ep and Rutile.

hb : Euhedral ~ Subhedral. Change to chl and cab completely.

ac : Euhedral. Coexisting with ep and chl.

H 12418 Holocrystalline

kf : Anhedral. Perthite is remarkable. Microcline texture is sometimes recognized.

pl : Euhedral Subhedral. Twinings of Albite, Carlsbad and Pericline and zoning are observed remarkably. "An" component from extinction angle is about 30%.

qz : Subhedral ~ Anhedral. Apatite and zircon occur as inclusions.

bi : Euhedral ~ Subhedral. Pleochroism is observed, X'=pale brown and Z'=greenish brown. Inclusions of zircon, apatite and opaque are common.

hb : Euhedral. Pleochroism is observed, X'=pale brown and Z'=grayish brown. Twining is common.

K 21201 Holocrystalline

pl : Subhedral, Prismatic～Tabular. Indistinct twining is observed. The alteration is moderate strong and the alteration products are ser, clinozoicite and chlorite.

kf : Subhedral～Anhedral. The large one contains perthite texture and having a irregular shape, but small one is granular shape.

qz : Subhedral Anhedral. Partly observed recrystallized fine grained crystal near the rim.

bi : Subhedral Tabular. Pleochroism is X'=pale brown and Z'=brown. Some crystal altered to chlorite completely.

H 02503 Holocrystalline Equigranular

pl : Euhedral, prismatic. The observed twinings are Albite, Carlsbad, Pericline and their combined. The zoning is recognized. "An" component from extinction angle is about 32%.
Usually altered to ep, czo, prehnite, chl, cab, albite and ser.

Altered Mafic minerals : Euhedral, prismatic. Completely changed to chl, ep and czo.

kf : Anhedral. Abundant albitization is observed.

qz : Anhedral. Occurs in interstitial of pl.

K 12501 Porphyritic

pl : Euhedral～Subhedral, Prismatic～Tabular. There are abundant Albite twining and a little Carlsbad twining. "An" component is about 25% from extinction angle. Alteration is observed and it's products are ser and cab.

Groundmass consists of pl and altered minerals. Altered minerals appear as aggregate of mosaic salic minerals, spotty sericite and opaque.

qz : Small one occurs as single crystal, but large one occurs as mosaic aggregation. Often shows wavy extinction.

H 12405A Holocrystalline Porphyritic

Phenocryst consists of pl and qz and groundmasss is feldspar, qz, ms and bi. Alteration is observed slightly.

qz : Anhedral～Subhedral. Sometimes observed corroded structure.

pl : Euhedral～Subhedral. Albite twining is remarkable.

ms : Subhedral, Tabular.

bi : Subhedral, Tabular. Pleochroism is observed, X'=colorless and Z'=pale green.

H 12404 Holocrystalline graphic.

pl : Subhedral ~ Anhedral. Albite and Carlsbad twinings are observed. "An" component from extinction angle is 30% in phenocryst and 28% in groundmass.

qz : Anhedral. Graphic texture is remarkable.

kf : Anhedral. Occurs in matrix with pl and Qz. Fine exsolution lamellae is recognized.

op : Euhedral. The color of open nicol is dark reddish brown.

H 11703 Cryptocrystalline

Composed of very fine grained crystals. Rhythmical lamination of very fine grained aggregated opaque minerals and salic minerals are observed.

Fragmental quartz is observed too.

M 02503 Holocrystalline equigranular

Main component is plagioclase. The other minerals change to secondary minerals. It seems that this rock has been metamorphosed into the green shist faces.

pl : Subhedral ~ Anhedral, prismatic ~ tabular ~ granular. Twinings of Albite and Carlsbad are observed. Ser and ep occur as alteration products.
And also albitization is commonly observed.

Altered mafic minerals are ep, chl, uralite, actinolite and opaque minerals.

qz : Frequently shows wavy extinction.

K 12307 Porphyritic

Phenocryst consists of plagioclase and altered mafic minerals. Groundmass shows intergranular texture.

pl : Euhedral ~ Subhedral. Alteration is commonly observed. The alteration minerals are ser, ep, chl, lm, and cab.

Altered mafic minerals : Prismatic crystal is common and changed to alteration mineral group as like chl and chl, ep and qz.

Altered minerals in groundmass is shown as chl, lm, calcedony and ep.

M 20403 Porphyritic

Phenocryst consists of pl and altered mafic minerals.
Groundmass is altered minerals only originated in glass.

pl : Euhedral ~ Subhedral. The alteration is moderately strong. So twining is observed very scarcely.

Altered mafic minerals : Prismatic Tabular Hexagonal prismatic. Completely changed to aggregates of cab and clay minerals and of chl, cab, sphene and opaque minerals. The opaque minerals occur as relics of the mafic minerals.

Groundmass consists of alteration products which are salic minerals, clay minerals, limonite, reddish black opaque mineral and cab. Partly observed aggregation of zeolite.

K 11803

qz : The shapes are many-sided and mosaic, so it is supposed that they occur as recristallization products.

bi : Filled up by the intergranular mosaic quartz in partly. Pleochroism is recognized, X'=pale greenish, Z'=green.

Fine grained salic minerals : Occur around the cavity and/or as irregular band.

Cavity : The shape is very irregular. Distributes in whole of the section heterogeneously.

H 11902

Plagioclase altered to mica group minerals completely, and quartz is corroded.
The matrix changes to kaoline, sericite, carbonate and albite and shows flow structure. Altered sandstone and acidic volcanics fragments are recognized.

K 11906

The matrix consists of fine grained clay minerals and mosaic salic minerals. It is supposed that they are altered from original materials. Rock fragments are also observed as alterated minerals aggregation. Quartz occurs as fragment and granular, and is sometimes recognized corroded structure.