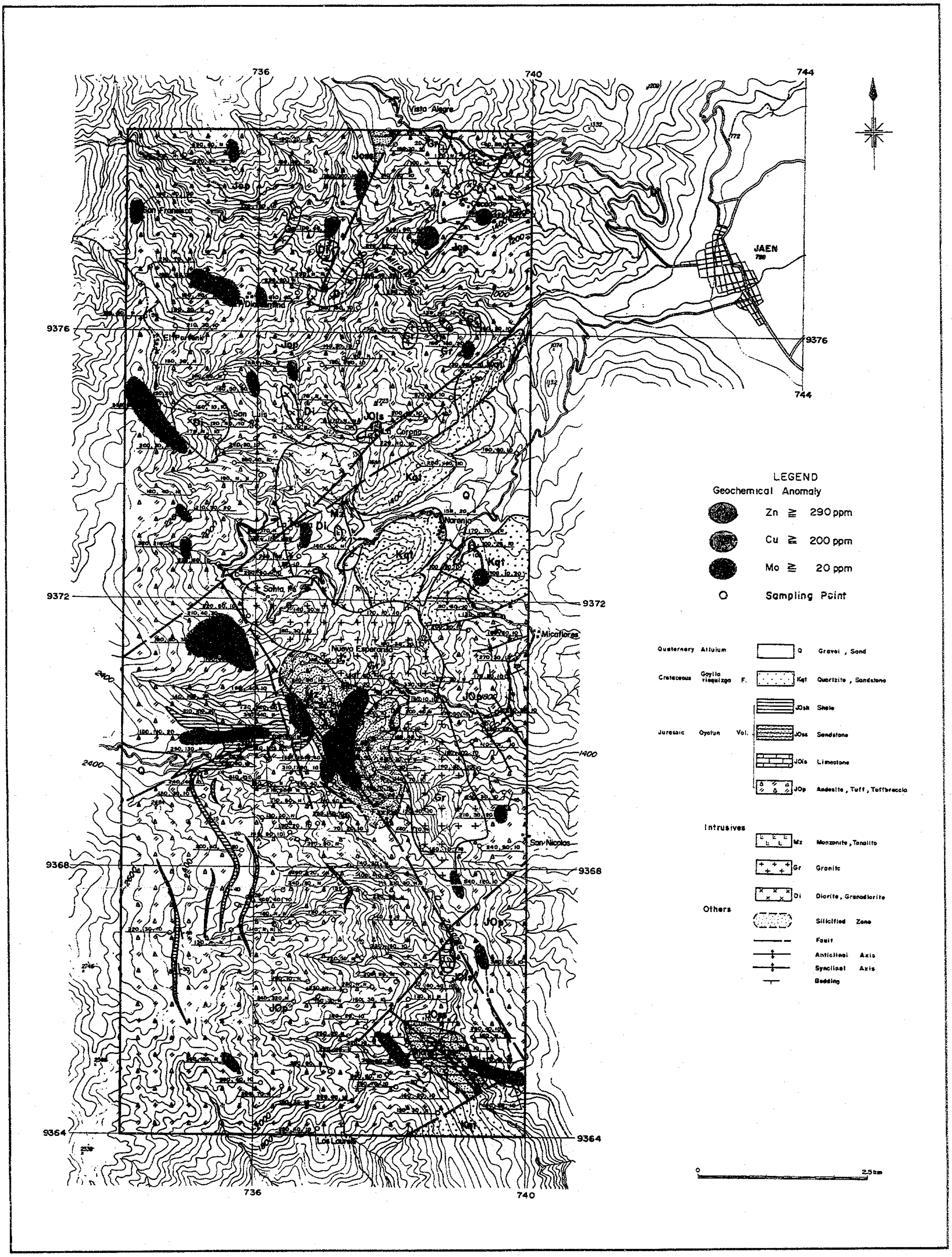


Fig. II −8(2) Geochemical Map of The Palma Area (Zn. Cu and Mo)

Chapter 4 PENA BLANCA AREA

4-1 Geological and Geochemical Surveys

4-1-1 Purpose of Survey

The Pena Blanca area includes the zones where anomalies were extracted through geochemical survey using the stream sediments by INGEMMMET as a part of the "Proyecto Integral Chinchipe". The area includes Pena Blanca geochemical anomaly at the upper stream of Pena Blanca as well as Angash anomaly at the upper stream of Angash.

In order to locate the source of geochemical anomalies and extract the showings of mineralization, semi-detailed geological mapping conbined with geochemical survey using rock sampling were conducted for this area in the second year.

4-1-2 Survey Results

1) Geological Survey (Fig. II-9)

The survey area consists of such weakly metamorphosed rocks as schist, phyllite, meta-pyroclastic rocks, micaceous sandstone as basement. They are unconformably covered by calcareous formation. The former rocks are in fault contact with pyroclastic rocks including andesite to dacite. All of these rocks are intruded by diorite-granodiorite, granite, monzonite-monzonite porphyry, quartz porphyry-rhyolite and andesite.

Weakly metamorphosed rocks are widely distributed in the central part of the area, showing a general trend of NE-SW. Phyllite mainly occupies the western and meta-pyroclastic rocks and micaceous sandstone the eastern parts. Schist is found only on the river bed of Nueva Esperanza river, flowing in the south of Angash. Micaceous sandstone sometimes has schistose structure. These are correlative with the Salas Group, because they are weakly metamorphsed. Total thickness of the rocks is more than 1,400m.

Calcareous formation occupies the mountains in the eastern part of this area, showing a general extension trend of N-S or NE-SW. Rock facies range from limestone to dolomite, partly changed to marble by metamorphism. Moreover, the rock close to the fissures contains such skarn minerals as diopside, grossularite and vesuvianite, suggesting that it has undergone silicification or Mg-addition. The formation is in contact with underlying Salas Group with parallel unconformity. The surface of unconformity contains paleosoil-like brown clay zone with the thickness of 20 to 30cm (at Vista Alegre west). This calcareous formation is correlative with the Leche Formation, because it covers parallel-unconformably the underlying rocks and have undergone metamorphism. Total thickness of the formation is more than 100m.

Pyroclstic rock is found in the eastern flange and the sourthern part of this area, being in fault contact with the former two geological units. The fault trends N-S and NE-SW. Southern extension of this rock continues to the pyroclastic rocks in the Chontali area, thus the rock is correlative to the Oyotun Volcanics. It is noteworthy that the rock in this area contains the autobrecciated basaltic lava. It is found on the routes from Cochalan to Angash and from Cochalan to San Jose del Alto. Under the microscope, it has undergone such alteration as albitization, carbonatization, sericitization and chloritization to disturb the original texture. As the rock is porous with hyalopilitic and autobrecciated textures, it can be formed by the underwater eruption. It is correlative to the upper Oyotun Volcanics. Pyroclastic rock composed mainly of dacitic lapilli tuff intercalated with andesitic thin lava is correlative to the lower Oyotun Volcanics, as in the case in the Chontali area.

Among the intrusive rocks, diorite-granodiorite is found as a large body trending NE-SW in the western part of this area and as a body constituting Mt. Huayanche in the southeastern part. It is also found as small bodies trending NE-SW along the Angash River. Modal composition is plotted in the area of quartz diorite. The absolute age determined by K/Ar method gives 122± 6 million years (early Cretaceous), which is the oldest age in this area. The rock on Mt. Huayanche is plotted in the area of granodiorite. The rock along the Angash River is plotted in the area of quartz monzonite to tonalite. The absolute age determined by K/Ar method gives 16.4± 0.8 million years (middle Miocene), which is the youngest age in this area. It is reasonable to consider that the relatively young igeneous activity occurs in this area.

Granite is found around Angash in the northeastern part of the area. Modal compositionis plotted in the area of granite. The absolute age determined by K/Ar method gives 102± 5 million years (early Cretaceous), which is the oldest age for granite in this area. The body constitutes a part of the intrusive body traversing N-S in the eastern part of the area. The N-S trending body is composed mainly of granodiorite. It is plotted in the area of quartz monzonite diorite. The absolute age determined by K/Ar method gives 88.4± 4.4 million years (late Cretaceous), which is inconsistent with the conclusion of the phase I that the granite is younger than dioritic rocks. Therefore the intrusion stage must be further studied along with the field survey. Monzonitic rocks is found only as very small dykes in this area. Monzonite porphyry intruding around Mt. Corcobado is plotted, through the microscopic modal analysis, in the area of quartz monzonite diorite.

Quartz porphyry and rhyolite occurs frequently as small-scaled dykes, and the frequency of occurrence is relatively higher in the eastern part of this area. Rhyolite on Mt. Collota is partly brecciated. Under the microscope, it is composed of rhyolitic fragments constituted by microcrystalline aggregate of felsic minerals, embedded in a matrix of quartz dominant felsic minerlas agglutinating the fragments. chemical analysis data shows that SiO2 content is higher than 95 %, suggesting that it has undergone silicification as well as brecciation. Andesite occurs frequently as small-scaled dykes, and the frequency of occurrence is relatively lower than the dykes of quartz porphyry and rhyolite.

Three fault fissure systems trending NE-SW, ENE-WSW and N-S to NNW-SSE are developed in the eastern and southern parts of this area. Among them, NE-SW trending one is inferred to be great, continued to the fault assumed in the area of Chontali. The latter two are assumed to be the subordinate fault systems being formed

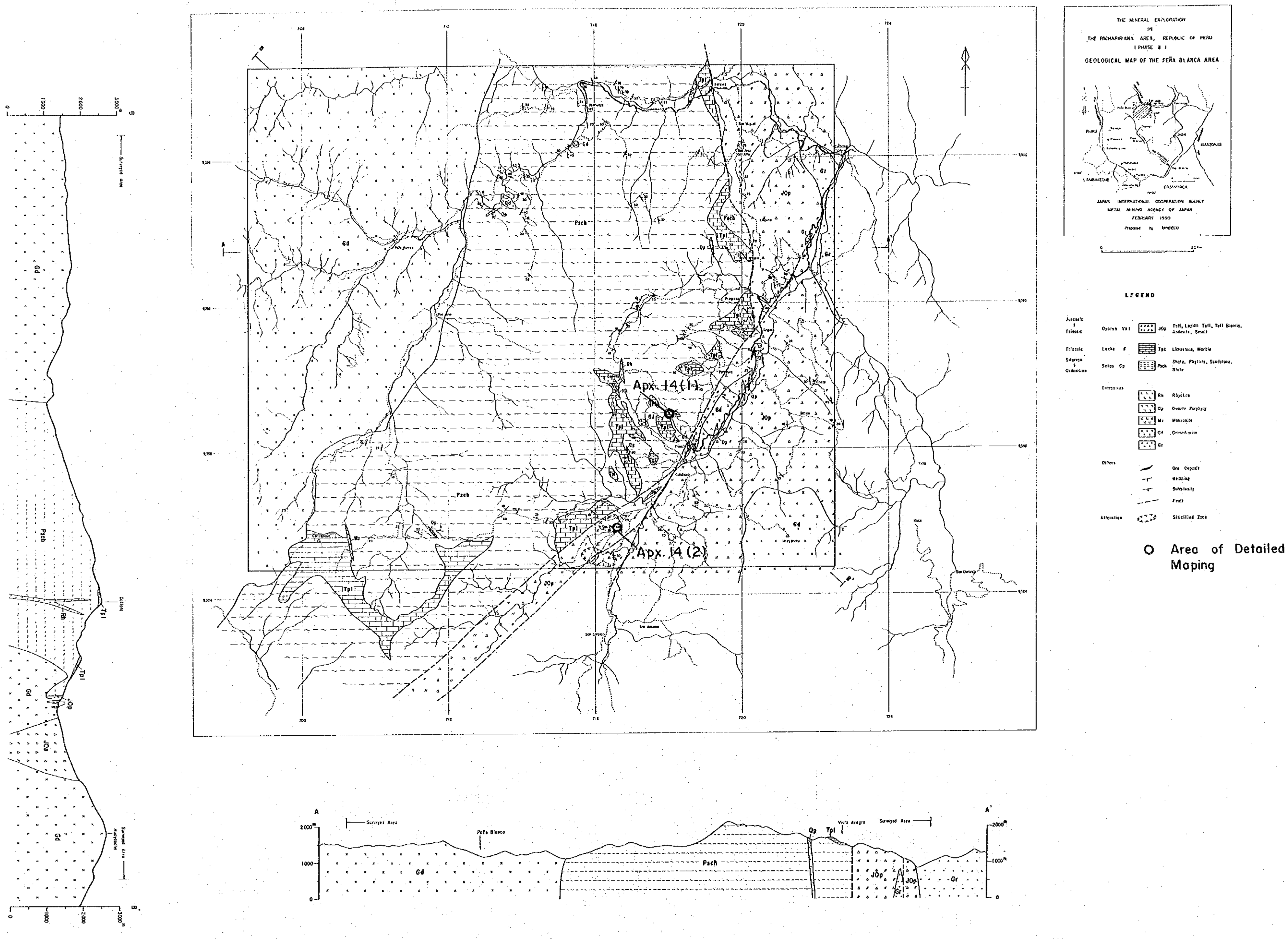


Fig. II - 9　　Geological Map and Profiles of the Peña Blanca Area

from the greater one.

Alteration in this area occurs mainly in the calcareous rocks of the Leche Formation and in the Oyotun Volcanics. That in the former is related mainly to the contact metamorphism and pneumatolytic alteration, associated with weak hydrothermal alteration. Namely, as shown in the description of the Leche Formation in this section, calcareous rocks contains skarn minerals and silicified limestone has undergone Mg-addition as well ad quartz addition to give ankerite. Therefore, there is a possibility that a small-scaled dolomite has been formed althrough the alteration by Mg-rich hydrotherma solution. The alteration in the Oyotun Volcanics is hydrothermal one, showing the occurrence similar, with naked eye, to that of the other areas. In the alteration zones in this area, however, development of quartz veins is poor and silicified zone is small in scale, characterized by argillization.

2) Geochemical Survey

Comparing the results on the average basis with the semi-detailed survey area in Chontali, this area is characterized by its rather high grade of copper, zinc and lead.

Analyzing the distribution of anomalous values of each element (Fig. II-10), that of copper is small, without continuity but seems to concentrate near the intrusive rocks, which intrude along the NE-SW trending fault. Distribution of lead occurs on a small scale and without continuity, having the tendency to concentrate near the intrusive rocks intruded along the NE-SW fault. The anomalous zones of gold, silver and molybdenum are scattered without continuity.

Relationship of geochemical anomalies of each element is extremely irregular, but it is recongnized that above-mentioned anomalous zones on a small scale tend to concenetrate near the NE-SW trending fault. Relationship between geochemical anomalies and aforementioned alteration zones is also irregular, but in the skarn type alteration zones it is observed such a zonal patterns as copper and zinc anomalies as core, are surroundedby small-scaled silver and lead anomalies without continuity. While, in the hydrothermal alteration zones gold and lead anomalies tend to be surrounded by copper and zinc anomalies.

4-2 Consideration

The Pena Blanca area consists of the Salas Group weakly metamorphosed rocks as basement, the Leche Formation, Oyotun Volcanics and intrusive rocks intruding into the formers. Structurally, lineament in a NE-SW direction is predominant, corresponding to the fault between the basement rocks and the Oyotun Volcanics in the eastern part, and to the boundary of intrusive bodies which intruded into the basement.

Along the NE-SW trending fault, a small granodiorite body intruded into calcareous Leche Formation which unconformably overlies the basement, to form skarn zone and to carry sulphide mineralization in the zone. The southwestern extension of the NE-SW trending fault running into Chontali, which is assumed to have played an important role for the formation of mineralized alteration zones in the Chontali area. Additionally, silicified-alteration zone is found in the Oyotun Volcanics between the fault and its sub-ordinate fault trending ENE-WSW, which traverse to the north of San Patricio.

As a result of chemical analysis of ores from skarn zone and silicified zone, it has been clarified that the former is characterized by gold, silver and copper mineralization and the latter by gold, lead and zinc, although the distribution of geochemical anomalies are not quite conformable with the above result.

In the Chontali area, mineralized alteration zones detected in the Oyotun Volcanics are genetically related with granitic rocks, which occupies the western part of the Chontali area. If it is assumed that the mineralized alteration zone in the Pena Blanca area has been formed contemporaneously with that in the former area, the age is very different from that of the formation of skarn zone. Namely, the irregularity of geochemical anomalies in this area may suggest the overlaping of two stages mineralization. Therefore, it is possible that the mineralization zones detected from the analysis of ore tend to concentrate along and around the NE-SW trending fault, though the distribution of anomalous values of the element is rather small and irregular.

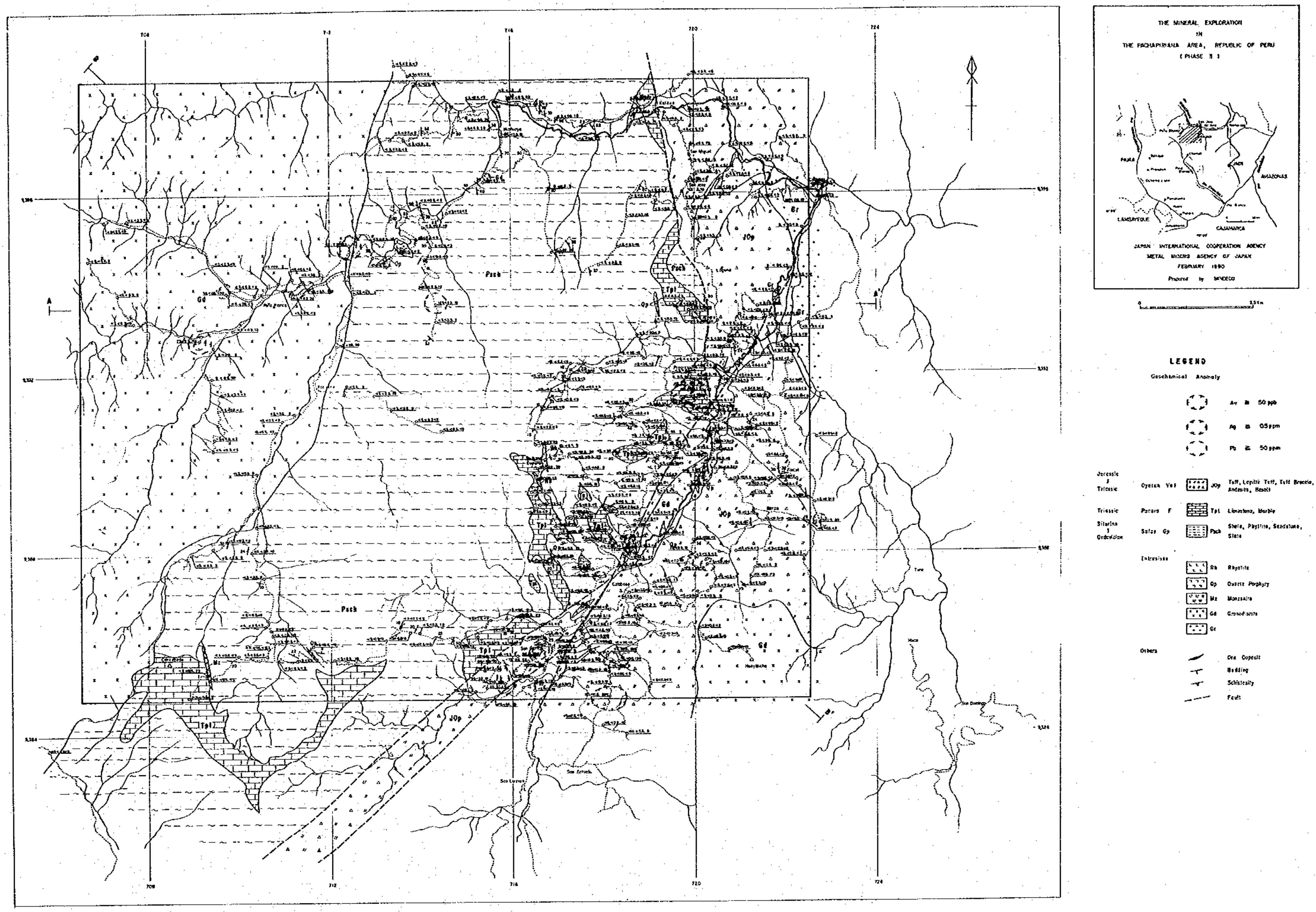


Fig. Ⅱ-10(1) Distribution of Geochemical Anomaly in the Peña Blanca Area (Au,Ag and Pb)

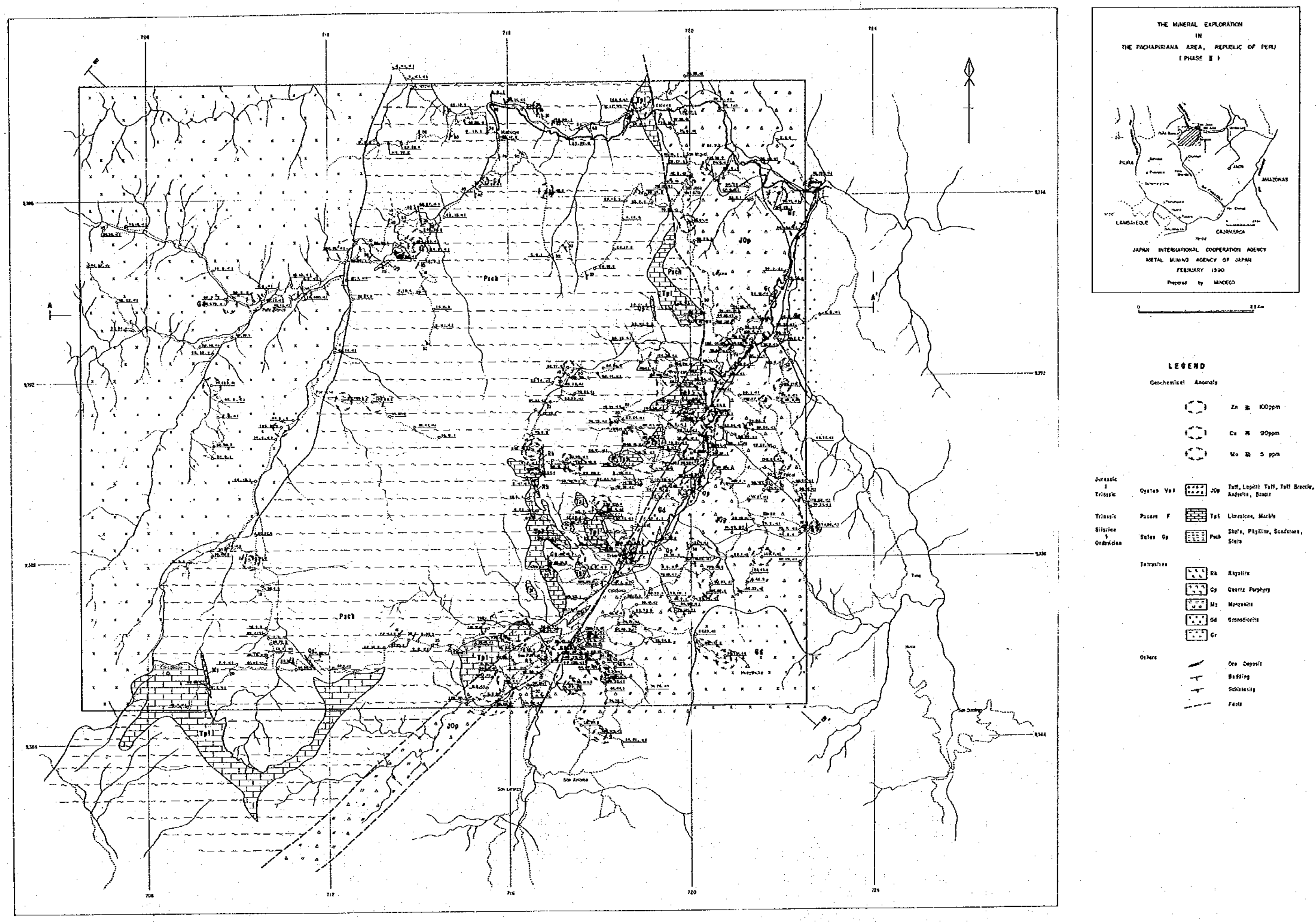


Fig. Ⅱ-10(2) Distribution of Geochemical Anomaly in the Peña Blanca Area
(Zn,Cu and Mo)

Chapter 5 JEHUAMARCA AREA

5-1 Geological and Geochemical Surveys

5-1-1 Purpose of survey

The Jehuamarca area includes the mineralized zone extracted by the follow-up study for the anomalies found out by geochemical prospecting in the "Proyecto Geoquimico del Norte". The study was advanced by INGEMMET up to the phase of detailed geological survey on a scale of 1/2500. The first year 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. Moreover geophysical survey using CSAMT method was conducted to clarify resistivity structure of deep underground and the possibility that silicified alteration zone, which was closely related with the mineralization as concluded from the geological survey, exists with a mushroomed structure.

During the second year survey, drilling was performed to verify the mineralization in underground silicified mineralization zone with a mushroom structure and in the silicified breccia with highest anomalous value in the survey area, and it was revealed that the existence of three types of mineralization zones as follows:

1) Silicified zone can be characterized by a mushroomed structure as interpreted and are associated with low grade base metal dissemination.
2) In the silicified zone, a layered quartz zone with high grade base metal occurs.
3) In the silicified breccia, existence of high grade gold and silver mineralization zone was confirmed.

During third year phase, detailed geological mapping to correspond to drilling, were made and compiled into a detailed geological map on the scale of 1/2,500. Trench survey was also performed to confirm the occurrence of silicified zone and silicified breccia.

5-1-2 Geology

Regionally, the survye area consits of the Oyotun Volcanics as basement and Porculla Volcanics unconformably covering it (Wilson, 1984). The area is characterized by development of pyroclastic rocks composed mainly of andesitic to dacitic tuff breccia and lapilli tuff, intercalated with tuff, welded tuff, tuffaceous shale or tuffaceous silt. These pyroclastic rocks have a gently waved structure and generally trend in NW-SE direction, showing a monoclinal structure dipping gently toward southwest.

The distinct fault fissure system trends NE-SW with dipping steeply and is intersecting the formations perpendicular to the geological structure. Additionally, minor fissures trending NNW-SSE to NW-SE are also observed, bridging between the main NE-SW fissurs. These fissure systems scarcely disturb the geological structure, therefore, they seems to be the secondary systems.

Alteration in this area may have developed taking the said fissures as passage. The central part concentrated by fissures are surrounded by the following zonal alteration zones: silicification-argillization, argillization and/or propylization from center outward. In the rim of the alteration zone, a small scale silicification zones in harmony with the bedding plane were often observed in the argillizationzone, suggesting that these alteration zones would have developed preferentially in the specific horizons.

Judged from the results of geochemical survey, the mineralizatin in this area developed through the NE-SW fissures as the passage and deposited in the silicification stage which is characteristic in gold mineralization.

5-1-3 Survey result

1) Geological survey(Fig. II-11, 12)

This survey are a consists of dacitic pyroclastic intercalated with tuffaceous shale beds, and andesitic and rhyolitic dykes intruding them.

Pyroclastic is correlatable with Porculla Volcanics, composed mainly of dacitic lapilli tuff intercalated with tuff and rarely with tuff breccia. Tuffaceous shale develops continuously in the southwestern part of the area. Tuff is extracted in the drill core, but its continuity is not so good, changing its thickness laterally. The occurrence of tuff breccia is localized. Microscopically, lapilli tuff shows such variable texture as relatively coarse-grained clastic or vitric fluidal, all of which have undergone intense sericitization and silicification.

Andesite occurs as a sheet dyke in the southwestern part of the area. Under the microscope, it is holocrystalline porphyritic with phenocrysts of plagioclase, skeleton hornblende replaced perfectly by sericite and chlorite, and sometimes biotite. The groundmass is composed of lath-shaped euhedral plagioclase, opaque minerals, apatite and such secondary minerals as chlorite and sericite. Rhyolite occurs as a small-scaled dyke or sheet in the northeastern and southwestern part ofthe area. Under the microscope, it is cryptocrystalline, showing flow and banded structures with 0.1 - 0.3mm interval.

The fault fissure system trends NW-SE and NE-SW. The displacement is as small as a couple of meter to 10m. The continuity of the fissure is not so good. These fissure systems, therefore, are inferred to be the secondary or third systems formed from major one.

Throughout the survey area, rocks have undergone such alteration as silicification, argilization and carbonatization.

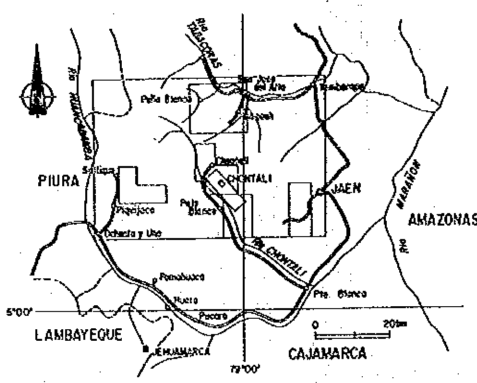
1. A zoning of alteration, silicified zone in the center and silicified-argillized zone and propylite zone in the rim, is recognized.
2. The main clay mineral in the silicified-argillized zone is sericite, and its polytype is 1M, indicating low temperature and neutral to alkaline condition.
3. The main clay minerals in the silicified zone and silicified breccia is sericite-

Fig II-11

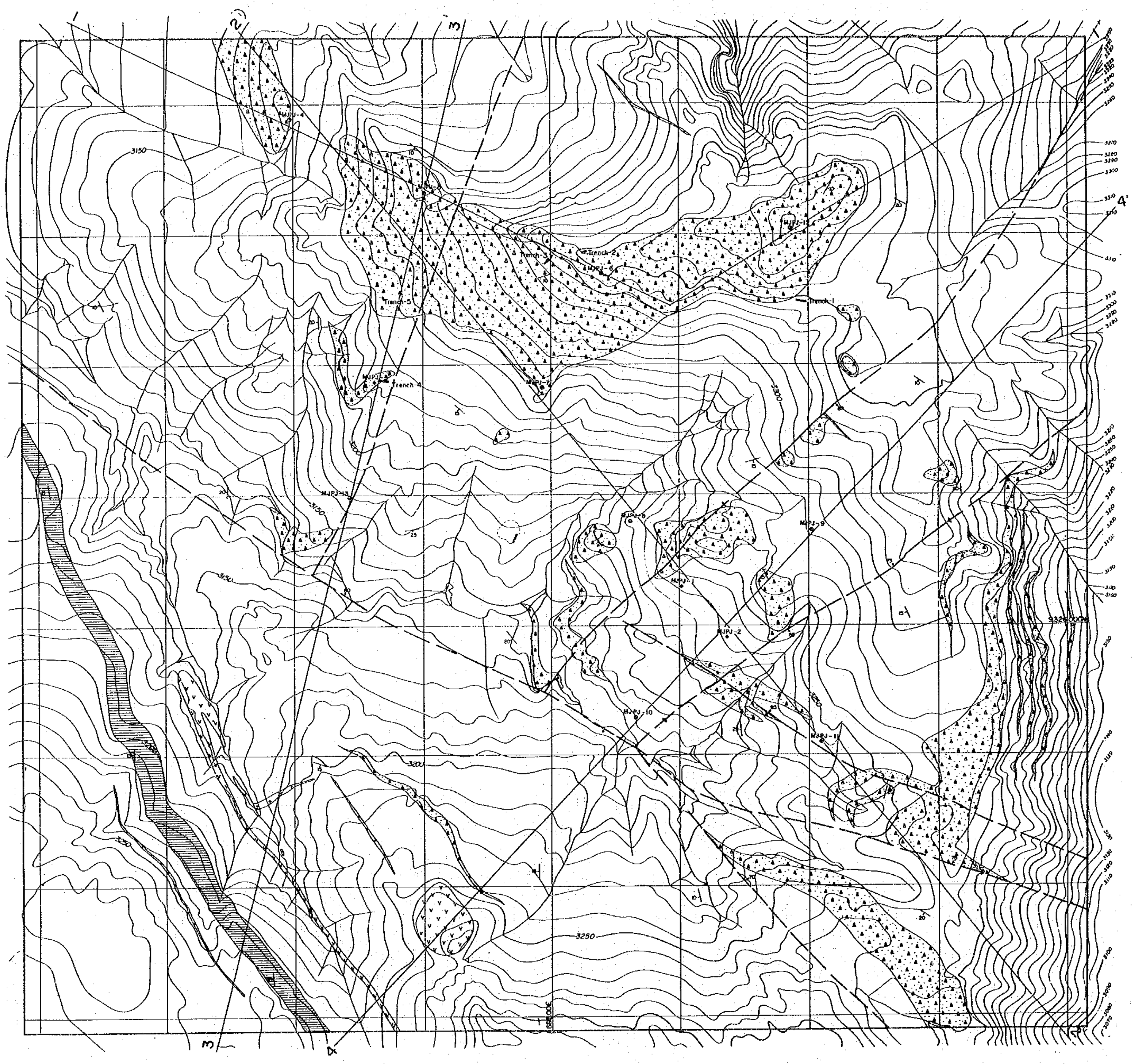
THE MINERAL EXPLORATION
IN
THE PACHAPIRIANA AREA, REPUBLIC OF PERU

(PHASE III)

Geological Map of the Jehuamarca Area



JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN
FEBRUARY 1991
prepared by MINDECO



0 100 200 250m

LEGEND

- Pyroclastics
- Silicified Breccia
- Shale and Tuffaceous Shale
- Andesite
- Rhyolite
- Bedding Plane
- Fault
- Drilling Site in 1989
- Drilling Site in 1990
- Trenching Site

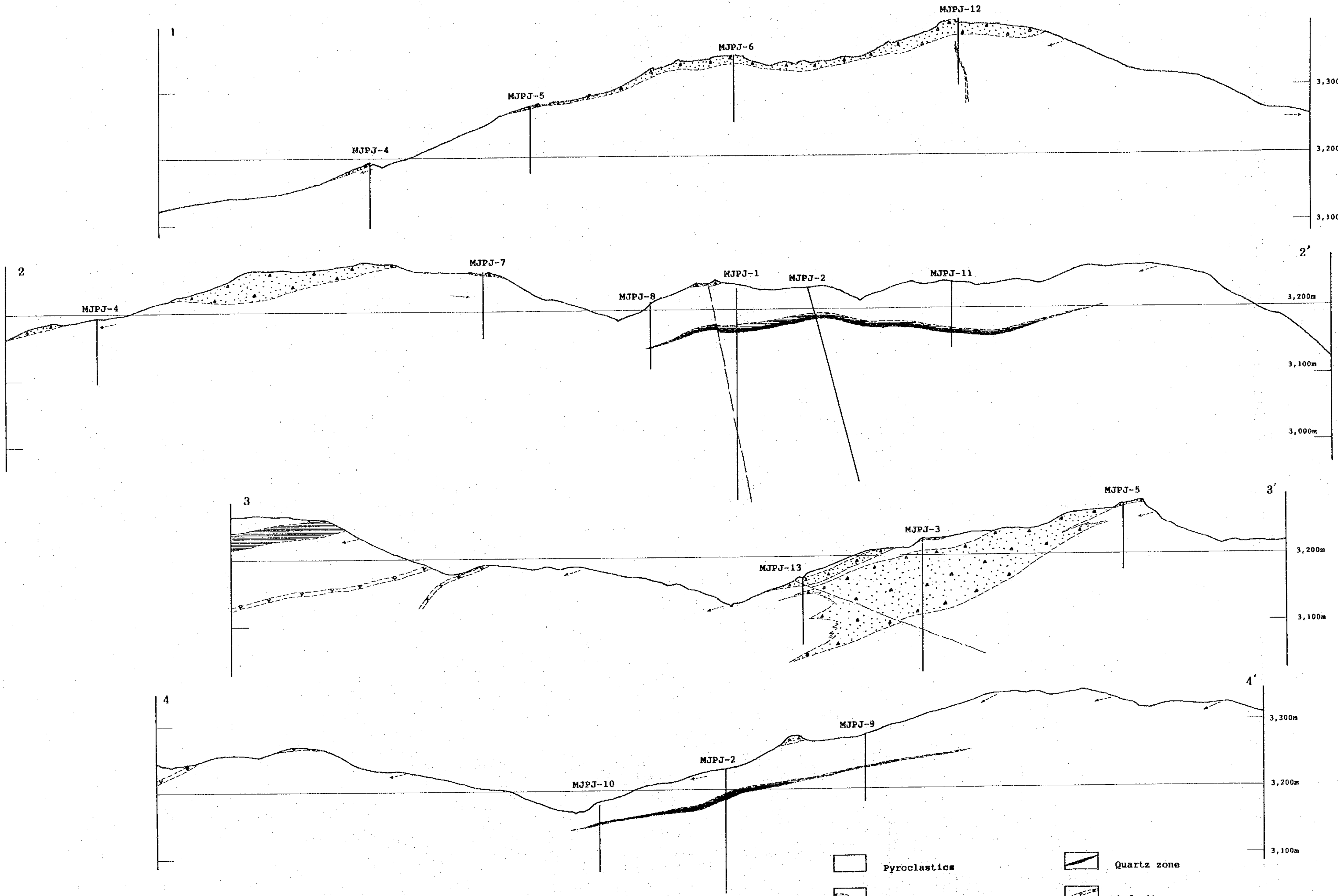


Fig. II -12 Geological Profiles of the Jehuamarca Area

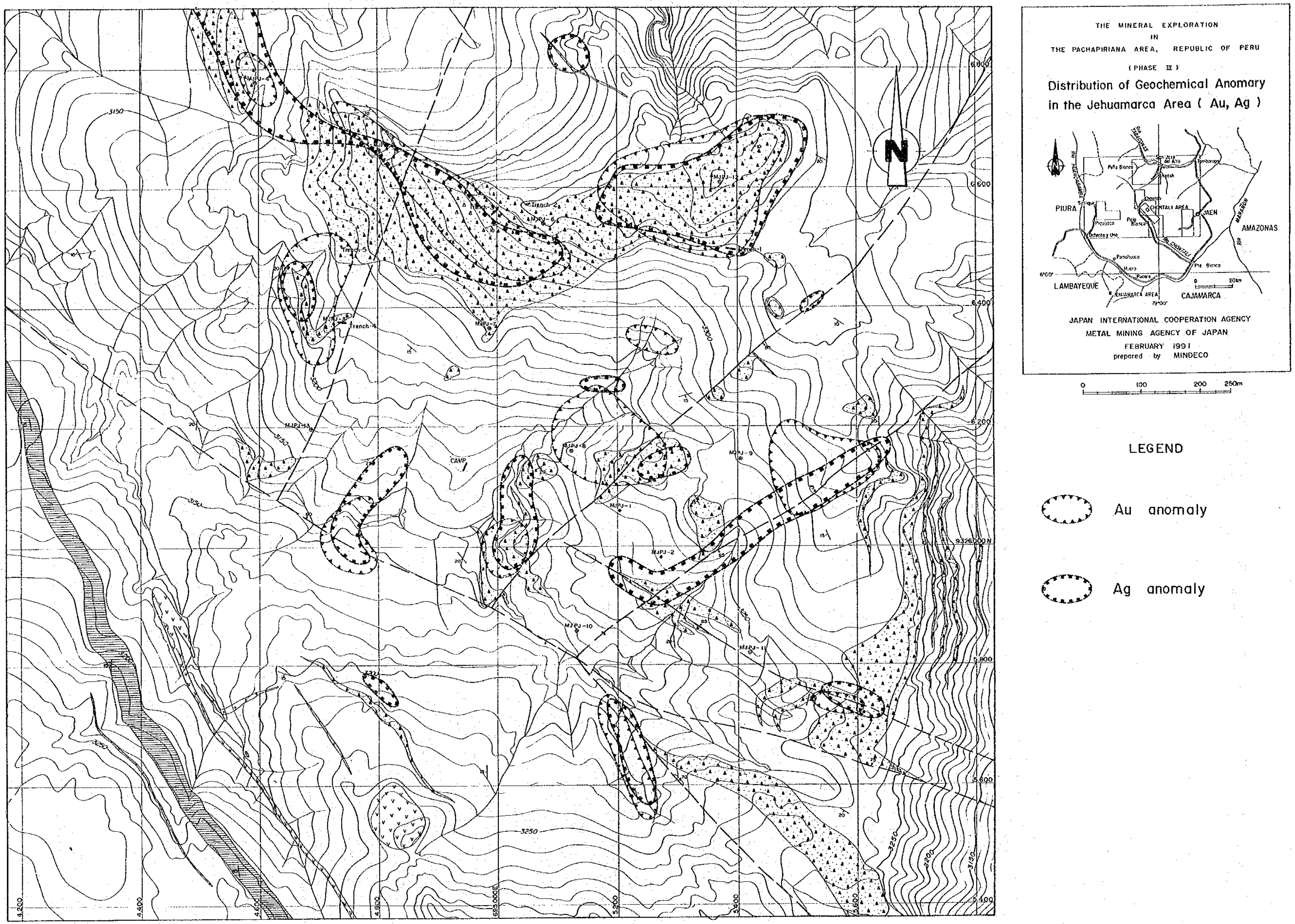


Fig. II - 13 (1)

Distribution of Geochemical Anomary in the Jehuamarca Area (Au,Ag)

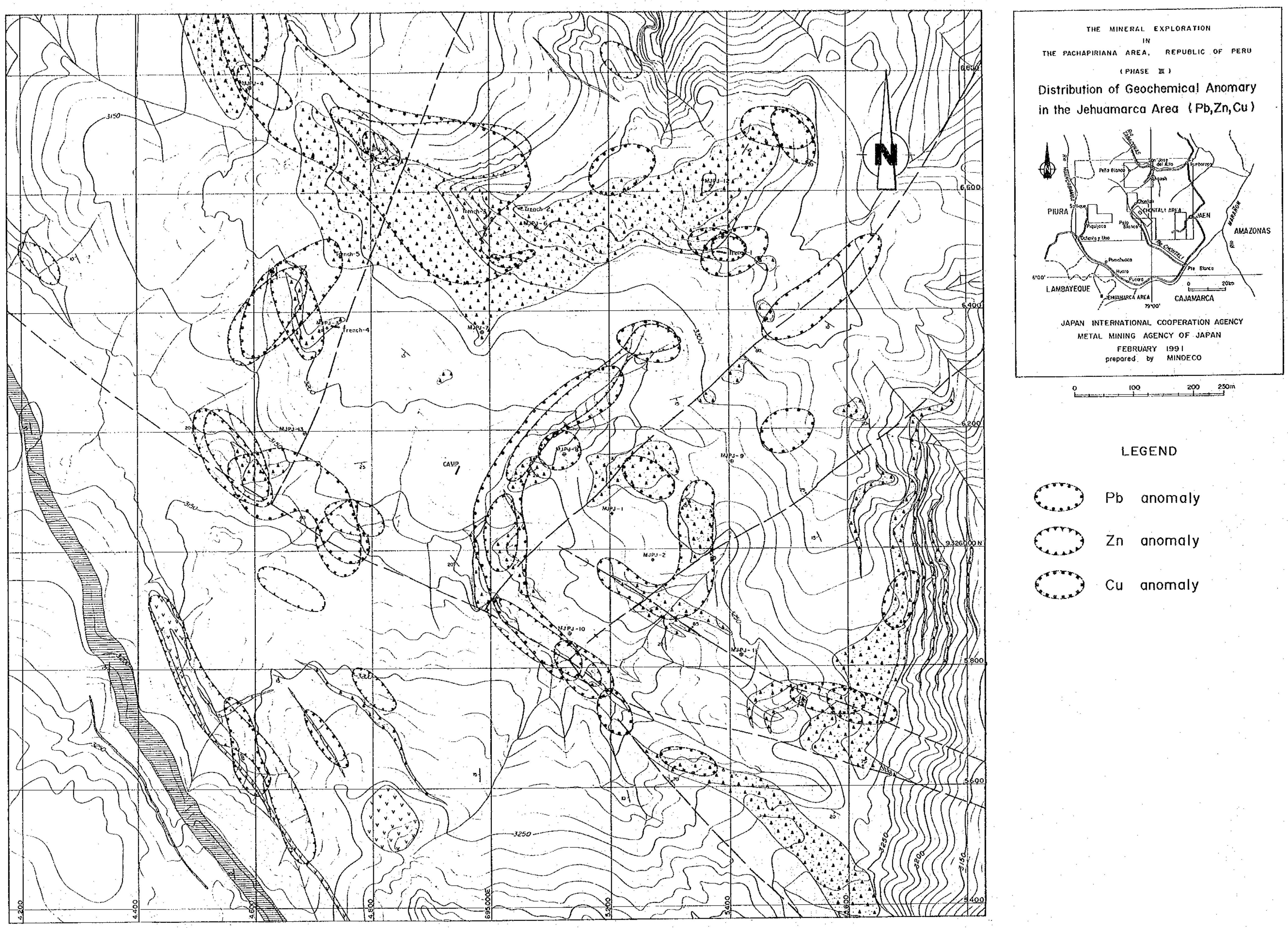


Fig. II - 13 (2)

Distribution of Geochemical Anomary in the Jehuamarca Area (Pb,Zn,Cu)

smectite mixed-layer. Halotrichite is also detected.

Therefore, it is suggested that silicified breccia and quartz vein have been formed under relatively low-temperature acidic condition.

During the third phase, trench survey was performed for the purpose of confirming the occurrence of silicified breccia mentioned above. At trench No.1 a high grade lead-zinc ore body (assumed thickness 4m, confirmed length 10m, Au 0.83 g/t, Ag 483.9 g/t, Cu 0.41%, Pb 0.77%, Zn 9.85%) was confirmed which occur concordantly to the structure of country rock. The occurrence of the ore body is similar to that of quartz zone with high grade base metal mineralization.

2) Geochemical survey

The geochemical assay data of Jehuamarca area with average for the whole area is shown in the following (analysis were made in the same laboratory and the values above 1g/ton Au and 200g/ton Ag, which can be deemed as obvious anomaly values responding to the ore grade were excluded).

	Au(ppb)	Ag(ppm)	Pb(ppm)	Zn(ppm)	Cu(ppm)
Average of Jehuamarca	19.83	2.905	157.0	34.95	33.22
Average of the second year survey	21.34	0.47	47.88	107.91	53.86
(Chontali, Chontali south, Pena Blanca, Jehuamarca)					

In comparison of the above, Au is similar, while Ag and Pb higher and Zn and Cu lower in Jehuamarca. As geochemical survey in the second year phase was conducted in the area including Chontali, where a high possibility of an existence of gold mineralization has been suggested, Au value of the second year survey seems to be too high to use it as mean value for the whole area.

As shown in the distribution of geochemical anomaly (Fig. II-13), gold anomaly tends to be concentrated along silicified breccia or fissures with quartz vein in central to northern and eastern parts of survey area. Silver anomaly tends to be distributed·overlapping to the zone of Au anomaly, but the effect by fissures is intense. Lead anomaly tends to be distributed overlapping to the former two anomalies but less continuous, shifting slightly outward. Zinc anomaly tends to be distributed overlapping to lead anomaly and shifting outward further. Zinc anomaly in the southwestern part of the area cold be associated with the andesite sheet intrusion. Copper anomaly sometimes tends to be distributed overlapping with the other anomalies, but sporadic.

5-2 Geophysical Survey

5-2-1 Outline of Survey

For the mineralization showings and alterations of disseminated and vein types ore deposits, to make clear the deep underground structure, electro-magnetic survey by CSAMT method has been done at 31 stations covering an area of 4km2 in the first year.

Apparent resistivity was measured in ten different cycles. Based upon this result combined with the measurement of representative rock samples, distribution of resistivity of the area was interpreted.

5-2-2 Result of Analysis

1) Resistivity Prufiles (Fig. II-14)
<u>D-D' and E-E' Section</u>

Both of these resistivity section, there are three layers. The first layer near the surface is very thin with the resistivity of 100Ωm at maximum. The second is relatively thick and 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.

2) Resistivity Structure Map (Fig. II-14)

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

i) At the level of 2,900 meters the second layer is most extensive with high resistivity zones, with resistivity of 500 Ωm or more. The third layer, that contains low resistivity zones found by measurement at 4 Hz, are present in three places.

ii) The area of the second layer become small and the third layer is wide at the level of 2,700 meters.

Geologically, pyroclastic rocks are distributed throughout this survey area, and among these rocks, many fissures run in the NE-SW direction, in which silicification zones were developed. Argilization zones are extensively distributed over the area.

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

The second layer contains resistivity layers of 500 Ωm or higher at its center in the deeper parts around the stations 88 and 89, and remain consistent at greater depths. A part of the second layer, of less than 500 Ωm, corresponds to the argilized tuff zones which are distributed all over the survey area.

3) Review

Geophysical analysis, suggests that this survey area is composed of three layers of resistivity. The first layer shows low resistivity, and correlative with a 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. A high resistivity body of more than 500 Ωm was observed in the silicified-argillized zone in the center of the area presumably continuing deep underground. This can be interpreted that the second layer of high resistivity has a root to the depth at the center of area. Low resistivity, lower than 70 Ωm, was measured in the third layer.

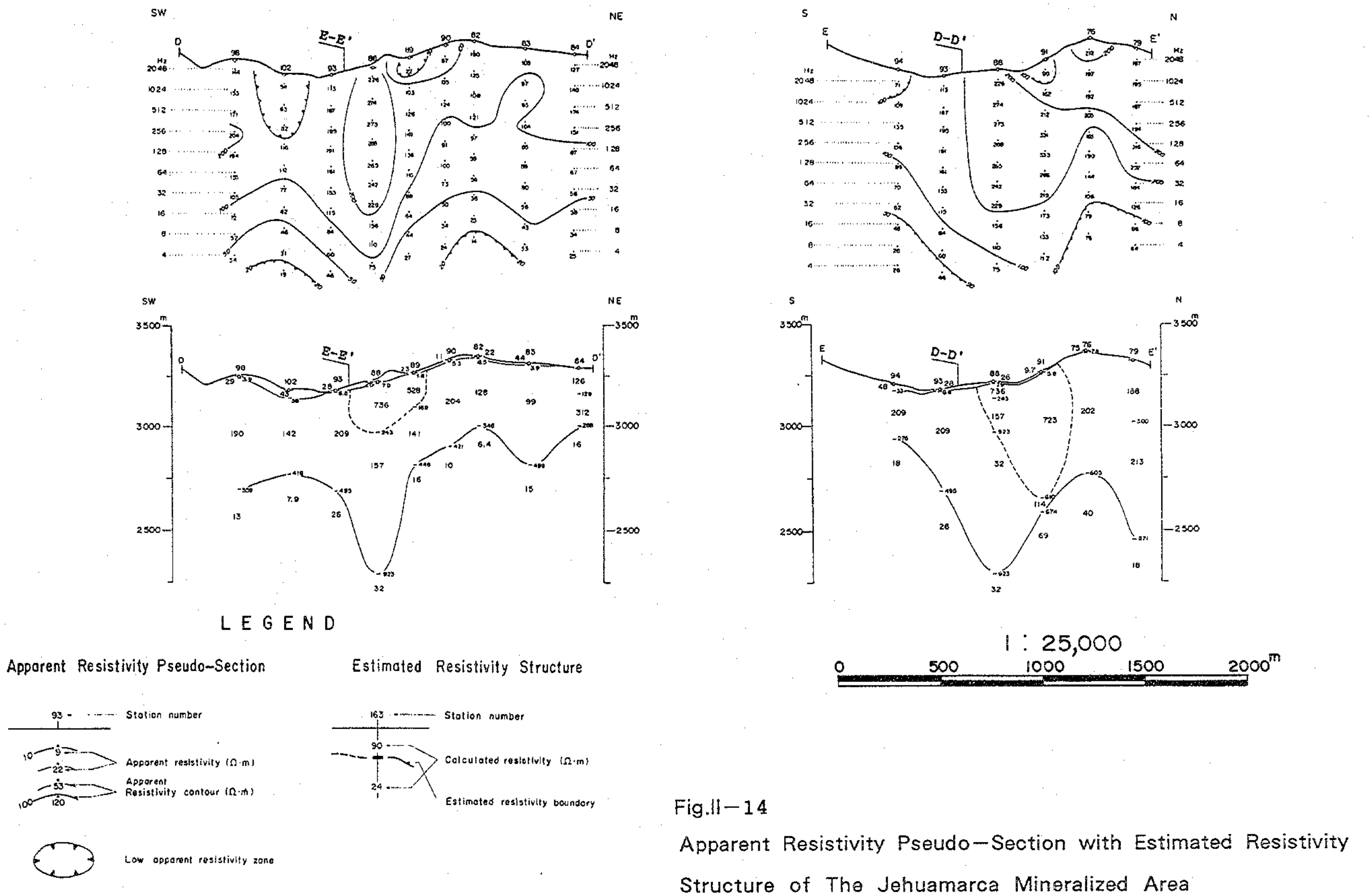


Fig.II—14

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

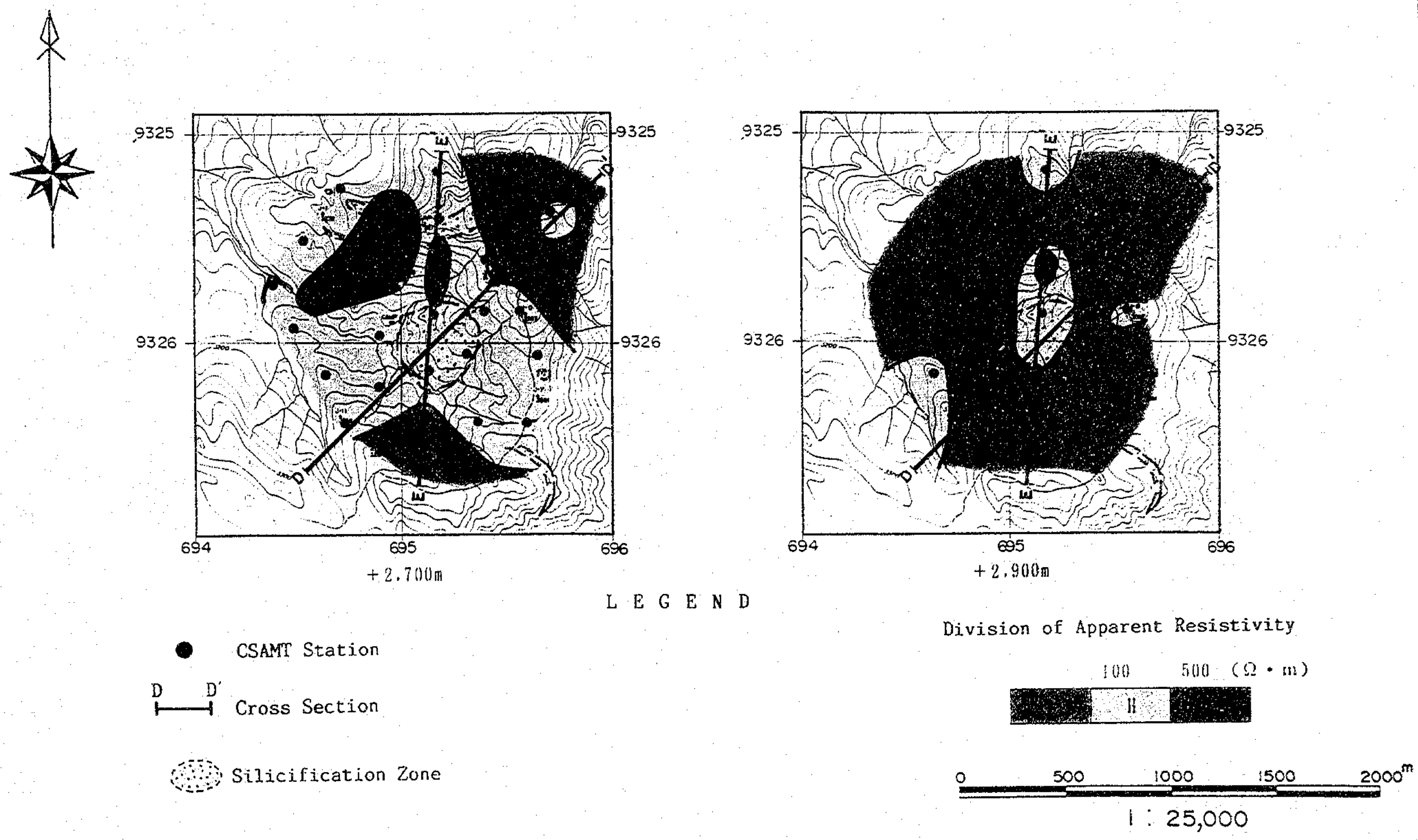


Fig.II−15 Resistivity Structure Map of The Jehuamarca Mineralized Area

Considering these results, the Jehuamarca area can be characterized by its epithermal alteration and mineralization. Furthermore, mineralization should have taken place in silicification zone, which is indicated as high registivity. A mushroom body of high resistivity, in the second layer may suggest an area of occurrence of ore deposits.

5-3 Diamond Drilling

5-3-1 Purpose of Survey

The first years survey was carried out by applying a detailed geological survey with the geochemical survey of rock samples to re-evaluate the results obtained by INGEMMET. Moreover geophysical survey using the CSAMT method was conducted to clarify resistivity structure in deep underground and the possibility that silicified alteration zone, which was closely related with the mineralization as concluded from the geological survey, exists with a mushroomed structure.

Drilling of the second year was carried out to determine the mineralization in the mushroom shaped silicified zone, the fissures which are thought to be the passage for mineralized solution and the silicified zone associated with the highest geochemical anomaly.

As shwon in the foregoing section, three types of mineralization zone has been confirmed in this area. Among them, low grade disseminated zone along the silicified zone seems to be in large but less profitable, even if its scale merit is considered. During the third year, therefore, drilling was conducted in order to verify the extension of high grade base metal mineralization in quartz vein and gold and silver mineralization in silicified breccia.

5-3-2 Outline of Drilling Work

Diamond drilling was done under contract by GEOTEC S.A. of Peru.

Drilling machinaries and parts are hauled to the drill site by the chartered helicopters of Air Foorce due to the very poor condition of hauling road. The materials including consumable articles are hauled by horses and donkeys.

Detail of diamond drilling is given in the following table. Drill site is shown Fig. II-16.

No. of Hole	Bearings	Inclination	Length	Coordinate N	Coordinate E	Elevation
MJPJ- 1	-	-90°	316.25m	9,326,058	695,205	3227.32m
MJPJ- 2	135°	-75°	300.00m	9,325,980	695,274	3233.95m
MJPJ- 3	-	-90°	200.00m	9,326,373	694,727	3231.39m
MJPJ- 4	-	-90°	100.00m	9,326,776	694,594	3195.28m
MJPJ- 5	-	-90°	100.00m	9,326,663	694,804	3274.87m
MJPJ- 6	-	-90°	100.00m	9,326,540	695,080	3351.21m

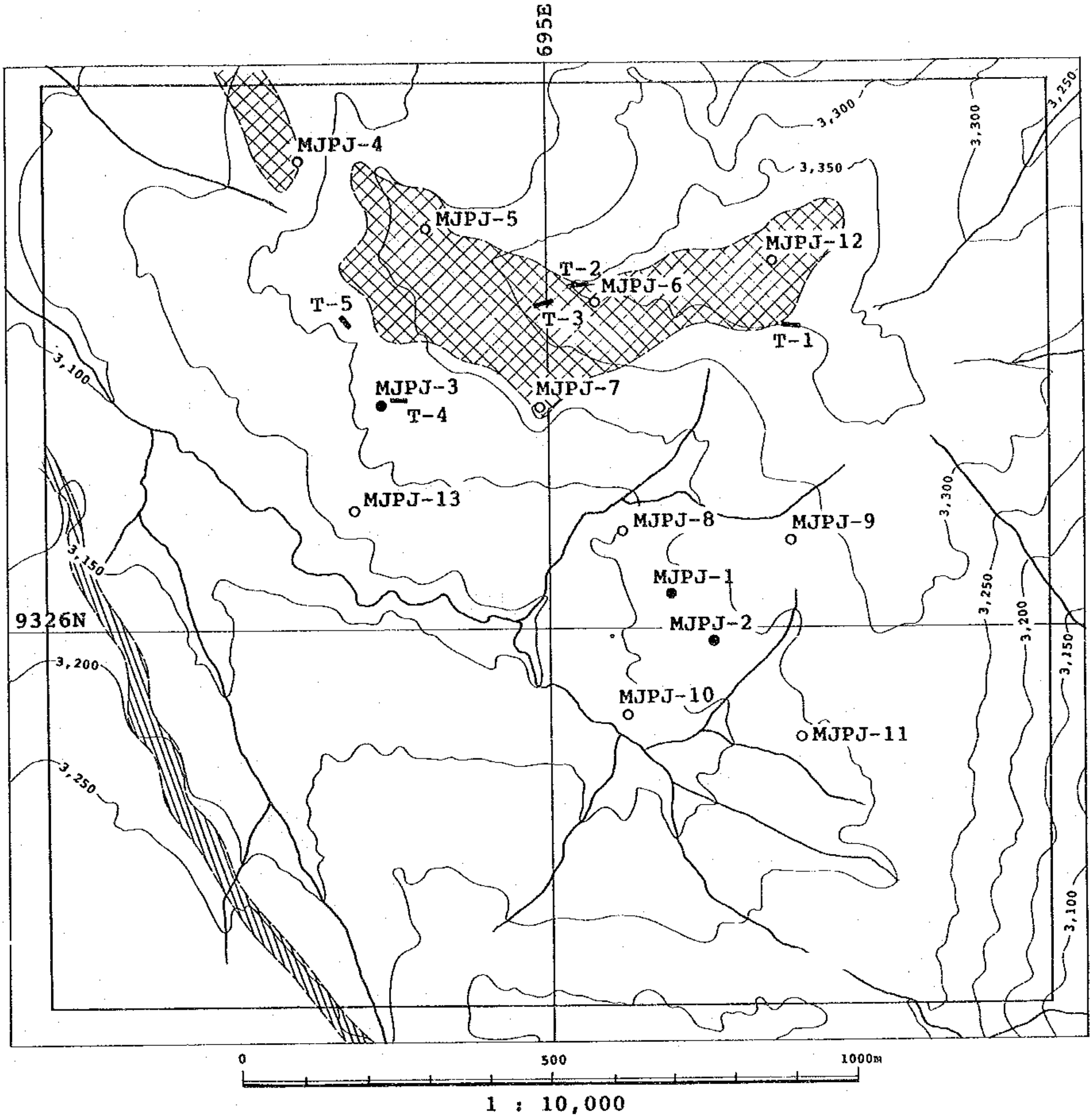
MJPJ- 7	-	-90°	100.00m	9,326,364	694,987	3259.87m
MJPJ- 8	-	-90°	100.00m	9,326,159	695,124	3211.70m
MJPJ- 9	-	-90°	100.00m	9,326,146	695,406	3280.40m
MJPJ-10	-	-90°	100.00m	9,325,858	695,132	3178.62m
MJPJ-11	-	-90°	100.00m	9,325,820	695,420	3239.81m
MJPJ-12	-	-90°	100.00m	9,326,608	695,172	3402.11m
MJPJ-13	-	-90°	100.00m	9,326,196	694,687	3167.56m

5-3-3 Results of Drilling

Mineralized zones have been intersected in the several drill holes as shown in the following table. Minimum grade of ore listed in the table is Au; 1 g/t, Ag; 85 g/t, Cu; 0.5%, Zn; 1.0%.

	DEPTH	LENGTH	Au	Ag	Cu	Pb	Zn	
	m m	m	g/t	g/t	%	%	%	
MJPJ- 1	60.9 - 65.55	4.65	1.59	95	0.05	2.2	7.9	Qtz Zone
	65.55- 69.5	3.95	0.52	27	0.03	0.7	2.7	Sil-Chl lp tf
	81.5 - 82.85	1.35	0.27	87	0.52	0.1	0.1	Qtz Zone Sil-Arg lp tf
	172.55-178.45	5.9	0.13	10	0.03	0.2	1.1	Sil-Arg lp tf
	209.05-215.05	5.2	0.18	6	0.04	0.4	1.2	Sil lp tf
MJPJ- 2	43.1 - 47.15	4.05	1.17	342	2.30	0.5	0.5	Qtz Zone
	150.1 -166.4	16.3	0.11	9	0.01	0.2	1.6	Sil-St Sil-Arg tf
	175.1 -182.7	7.6	-	9	0.01	0.5	1.9	Sil-St Sil tf
	187.45-189.8	2.35	0.17	9	0.01	0.5	1.0	St Sil tf
	208.35-211.65	3.3	0.25	5	-	0.1	1.0	St Sil lp tf
MJPJ- 3	19.15- 24.15	5.0	3.99	374	0.05	0.1	tr	leached Sil Br
	25.75- 62.0	25.75	0.64	193	0.49	0.1	0.1	Sil Br
	114.25-134.35	20.2	1.18	80	0.18	0.1	0.2	Sil lp tf
MJPJ- 6	6.1 - 12.85	6.75	1.81	73.7	0.05	0.1	tr	leached Sil Br
MJPJ- 7	81.75- 85.6	3.85	0.65	222.3	0.05	0.1	0.3	Qz Zone w/fault Br
MJPJ- 8	28.95- 29.65	0.75	0.75	23.5	1.23	0.1	0.4	Sil Br
	65.65- 68.1	2.45	0.25	24.7	0.03	0.1	1.1	Sil lp tf
	68.1 - 68.4	0.3	2.80	1065	5.11	1.0	9.2	Qtz Zone
	68.4 - 69.25	0.85	0.90	264.0	1.67	0.2	1.2	Sil lp tf
MJPJ- 9	21.1 - 28.3	7.2	0.36	11.6	tr	0.4	1.0	Sil lp tf
	92.9 - 97.1	4.2	0.04	6.9	tr	0.3	1.1	Sil lp tf
MJPJ-10	29.95- 47.2	17.2	0.12	5.3	0.05	0.3	2.5	Sil lp tf
MJPJ-11	65.7 - 68.35	2.65	0.39	26.8	0.07	0.2	1.7	Sil lp tf
MJPJ-13	9.95- 12.3	2.35	0.25	98.6	0.05	0.1	tr	Sil Br
	17.2 - 20.0	2.8	0.27	109.2	0.19	0.1	0.1	Sil tf Br(fault?)
	37.3 - 44.8	7.5	0.39	18.7	0.01	0.4	1.3	Sil lp tf

As ore minerals, pyrite, sphalerite and galena are common, and a few amount of



● Drilling Hole in 1989 (MJPJ-1 - MJPJ-3, 3 holes total length 816.25m)

○ Drilling Hole in 1990 (MJPJ-4 - MJPJ-13, 10 holes total length 1,001.55m)

▬ Trenching in 1990 (T-1 - T-5, 5 trenches total length 73.6m)

Silicified Breccia

Tuff and tuffaceous shale alternation zone

Fig. II-16 Location of the Drilling and Trenching sites in the Jehuamarca Area

chalcopyrite, tetrahedrite, tennantite, pyrrhotite are observed. In the secondary enriched zone chalcocite and covellite are often observed.

Vertical zoning of altration revealed by diamond drilling is summarized as follows;

1. Silicified zone occupies the center of alteration zone and continue down to the depth. As such minerals as diaspore and pyrophyllite were formed at the depth, the environment of alteration is presumed to be considerablly high temperature and acidic.
2. The fact that the polytype of sericite in quartz vein which occurs in the base of silicified breccia is 2M1, suggest the temperature was higher than that of the surroundings silicified-argillized zone where the polytype of sericite shows 1M.
3. The zone of propylite is developed in outer periphery of the silicified-argillized zone at shallow depth. Veinlets of rhodochrosite are often formed in the propylite zone, suggesting the alteration was formed in low temperature and neutral to alkaline environment.
4. The clay minerals in quartz zone is mixed layered mineral of sericite and smectite.

5-4 Consideration

The Porculla volcanic rocks in this survey area in monoclinic with a gently waved structure, though being slightly displaced and undulated by the fissure systems, which mainly trend NW-SE with gently dipping toward the southwest. It is rare to recognize on the drill core the underground continuation of fissure confirmed on the surface. It is also not the case to recognize the continuation of fault breccia zone which is confirmed in the drill core. The fissure systems, therefore, must be the secondary one branched from regional fault systems as Sallique fault.

Minor zones of stratified silitification developed in the argillization zone often observed in the cliffs of the eastern part of the survey area and the high temperature type of sericite polytype is observed at the base of silicified breccia or along fissures, that indicate the mineralization and alteration have taken place and spread out along bedding plane and suborrdinate fissures. Resistivity structure obtained by CSAMT method shows a mushroomshape high resistivity body corresponding to the silicification zone. It is interpreted that the mushroom was formed by the mineralized solution which ascend from the depth through fissures and apread out laterally along bedding plane of the specific formation. Relationship of the alteration zones and alteration minerals is shown in Table 6.

Three types of mineralization, silicified zone associating base metals dissemination, layered quartz zone associating high grade base metal and silicified breccia associating gold and silver mineralization were recognized. However, the above mentioned three types mineralization are presumed to be the pruducts of a series of mineralization, that is the gold and silver bearing silicified breccia is a residual product of the layered quartz zone associating base metals which is a part of the silicified zone associating base metal dissemination.

Summarizing the above, a model of ore deposition in this area is brielly described as follows;

1) Major fault systems and then subordinate fissure patterns are formed by Andes orogenic movement.
2) Resional movement also produced a series of open cruck along the specific horizon of sediments which turned into a layered brecciation zone.
3) Ore forming solution has passed and spread out through the subordinate fractures and the layered brecciation zones.
4) Silicified zone was formed under high temperature and acid environment at the center of mineralized field, and in the outer zone temperature decreased and the environment changed to neutral or alkaline.
5) Zinc mineralization was most predominant under the acid environment and then gold and silver minerals are precipitated in quartz vein or silicified breccia under decreasing temperature and weak acidic condition.
6) A part of mineralizing solution was precipitated forming a layered quartz zone under the shale which has acted as a cap rock.
7) Zinc mineralization continued until the environment became alkaline.
8) Regional upheaval and erosion took place by further orogenic movement which promote residual enrichment of gold and silver in the silicified breccia.

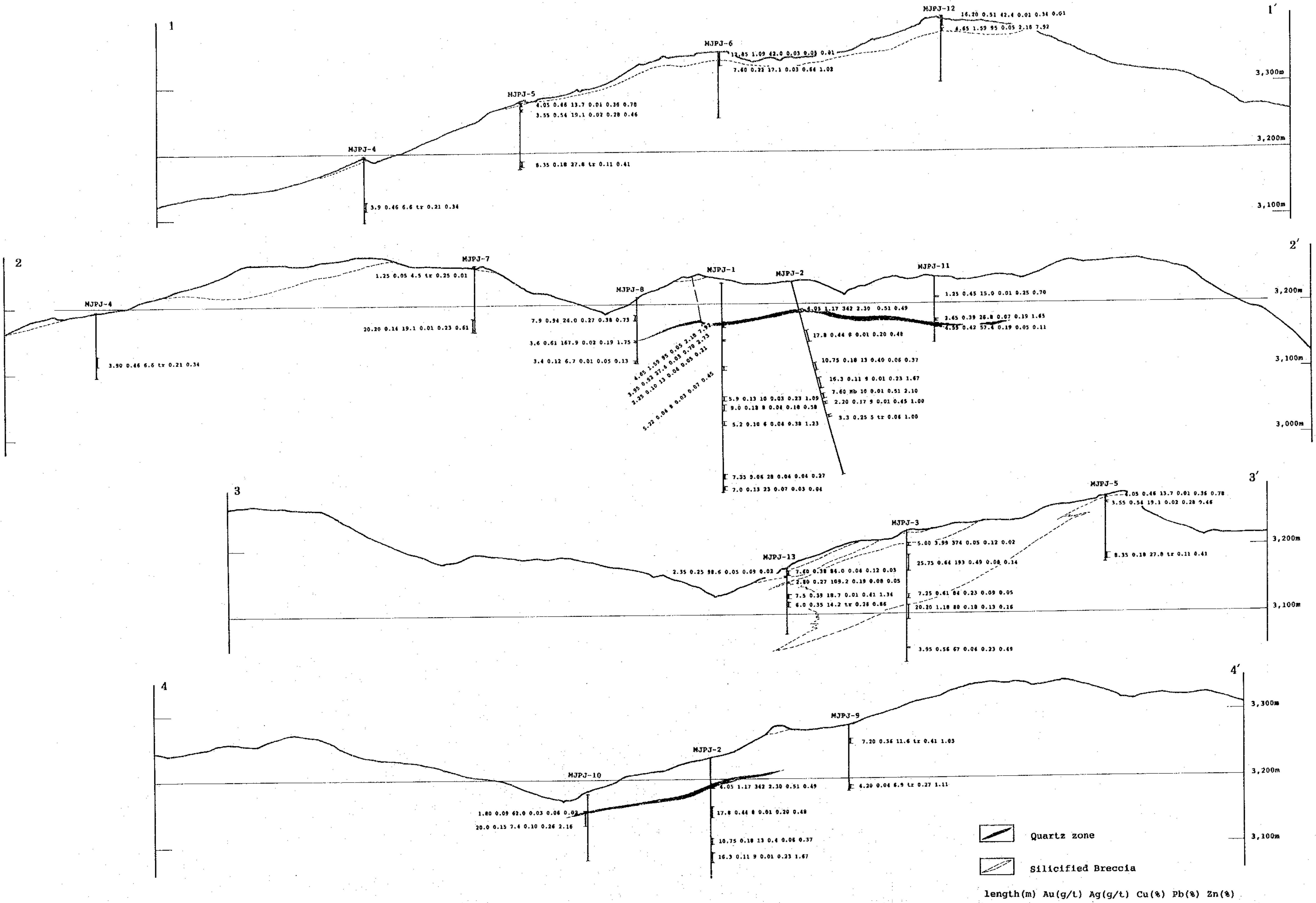


Fig. II -17 Assay Results on the Profiles of the Drillings in the Jehuamarca Area

Table 6 Correlation between Alteration Zones and Alteration Minerals

	Diaspore Pyrophyllite	Sericite-Smectite mixed layer	Sericite		Chlorite	Halotrichite	Rhodochrosite
			$2M^{1}$	1M			
Propylitized Zone					○		○
Argillized Zone				○			
Silicified Breccia Upper part		○					
Basal part			○			○	
Near fault			○			○	
Quartz Zone		○					
Silified Zone Shallow Zone		○					
Deeper Zone	○						

Chapter 6 CHONTALI AREA

6-1 Geological and Geochemical Surveys

6-1-1 Purpose and Outline of Survey

This area is the geochemically anomalous area, extracted by stream sediments geochemical survey carried out by INGEMMET as "Proyecto Integral Chinchipe". In the first year, semi-detailed geological mapping and geochemical survey by rock sampling were conducted on those anomalies distributing in the northern part of the area, and an alteration zone containing a number of quartz veins and geochemical anomalies for gold and silver in the alteration zone were found.

In the second year, detailed geological mapping and further geochemical survey by rock sampling were conducted to obtain the geological information of quartz veins and alteration zones. Geophysical survey by CSAMT method was also applied to the area of detail geological mapping to find the geological structure and alteration zone in the depth. Semi-detailed geological mapping and geochemical survey were also conducted in the southern part of the area.

In the third year, vertical panel drilling was carried out on the gold and silver bearing quartz veins in Hualatan which were found in the previous year. Beside, gravity survey to detect basement structure was conducted.

In the fourth year, in order to obtain more information about the structure and grade of quartz vein, detailed geological mapping and a series of panel drilling were conducted.

6-1-2 Geology

According to Reyes et al. (1987), this area consists of the Jurassic Oyotun Volcanics as basement, the early Cretaceous Goyllarisquizga Group overlying it and diorite intruded into them.

As a result of the first years survey, it was clarified that this area consists of the Salas Group of crystalline schists and phyllite as basement, the Oyotun Volcanics unconformably covering them, the Goyllarisquizga Group of quartzites almost conformably overlying the Volcanics which are covered by calcareous formation correlative with Inca or Chulec Formation. These rocks are intruded by diorite-granodiorite, granite, monzonite, quartz porphyry-granite porphyry and andesite. Based on the aerophotograph analysis, significant two lineaments trending NE-SW were extracted. Of these two, the one in the south appear to be a major fault with vertical displacement of about 500m.

6-1-3 Results of Surveys

1) Geological Survey (Fig. II-18)

The basement of this survey area is composed of crystalline schist and phyllite, which are covered by volcanic rocks unconformably. Over this, the sedimentary rocks are distributed conformably, and intrusive rocks intruded into above mentioned geological units.

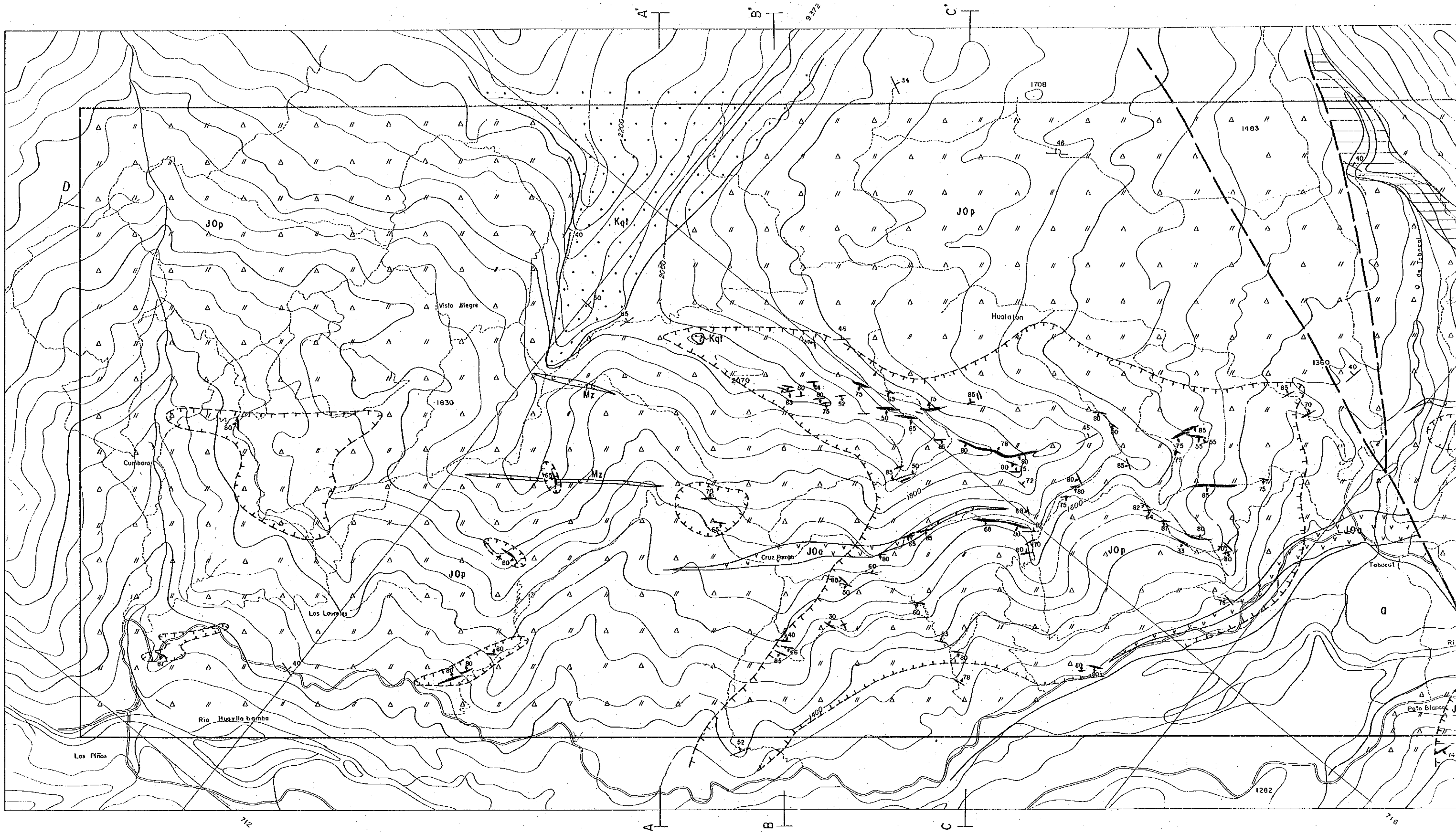
At the western end of the area, crystalline schist and phyllite extend in N-S to NW-SE trending. The schist consists of quartz-sericite schist and sericite-chlorite schist. In the metamorphic rocks area, boulders of arkose sandstones and/or quartzite are occasionally found out, which suggest that the source of metamorphic rocks could be the pelitic rocks with intercalated sandy rocks. The crystalline schist containing phyllite trends N-S, with a slight undulating structures dipping gently to the west and east. This seems to indicate that there was no violent tectonic movement. Assessing it from rock facies, it is correlative with the Salas Group.

The volcanics are distributed at the central part of the area trending NW-SE, consist of dacitic tuff, tuff breccia, andesitic lava and tuffaceous shale, and partly quartzite intercalated. The tuffaceous shale, which appears in the northwestern and southeastern parts of the area, corresponds to the lower part of the Volcanics. Andesite lava occur in a small area except for southeastern end of the survey area. Geological structure, except some undulations, is simple that basically trends NW-SE, with a gentle dipping to the northeast. The estimated thickness using an isopach mapping method shows about 1,600 meters. The age of these volcanic rocks cannot be readily determined because no fossils were present nor absolute age determination obtained. They, however, may be correlative with the Jurassic Oyotun Volcanics based on the assessment from their rock facies and the fact that they are intruded by the igneous rocks belongs to lower Cretaceous.

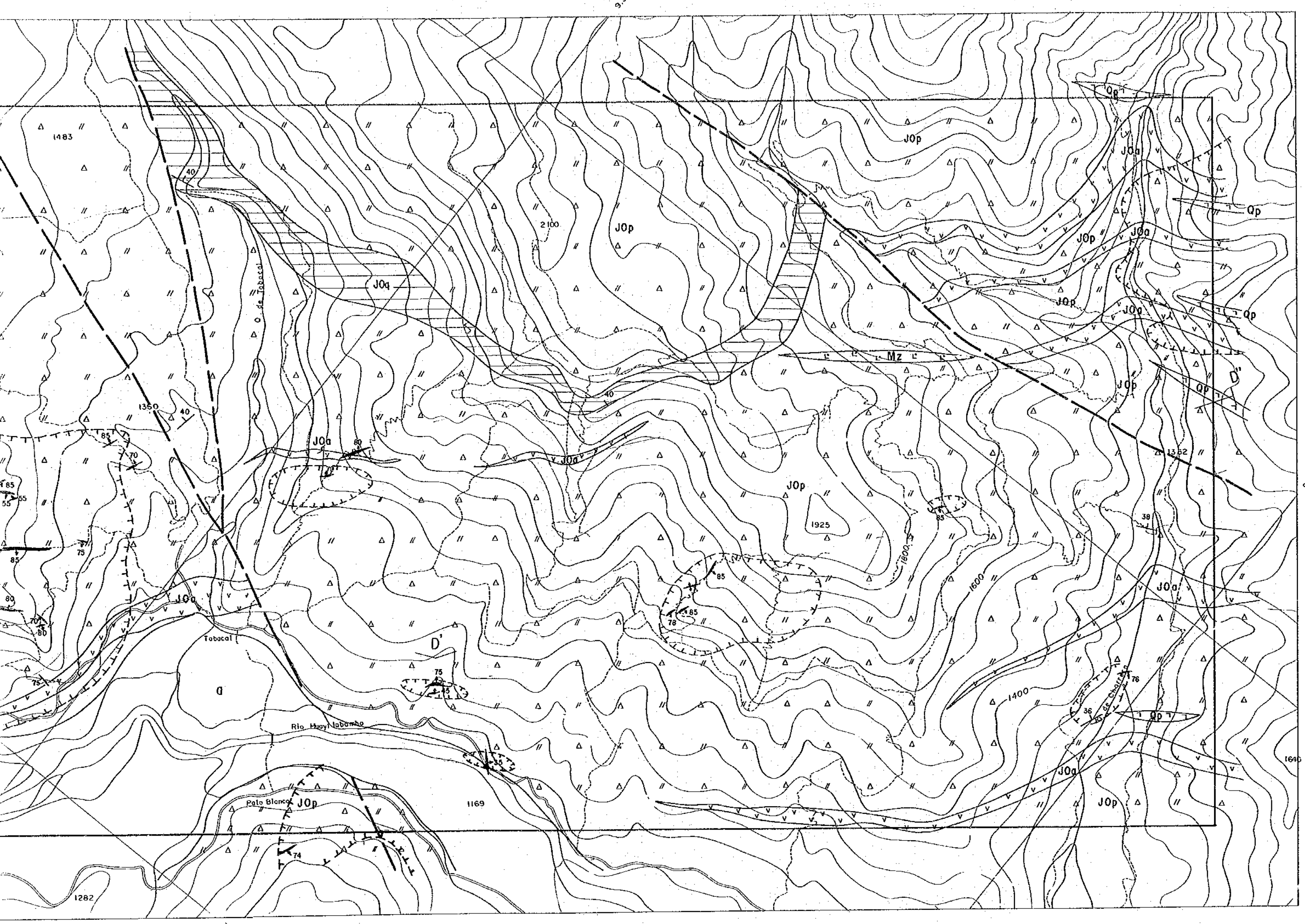
Sedimentary rocks are found out in the eastern part of the survey area. Though the relationship between these rocks and the underlying Oyotun Volcanics was not observed directly, it is assumed that these volcanics almost conformably grade to sedimentary rocks at the upstream the Tabacal River in the eastern end of the area. Also, the general structure of these rocks are nearly concordant with the lower unit. Therefore, it is presumed that there is a conformity between them. Their base consists of quartzite with well developed cross bedding, which grades into sandstone, alternation of shale and sandstone and limestone in ascending order. Further upper horizons are thickly covered with virgin forests, thus making it difficult to make geological observations. Although no fossils were available from these sedimentary rocks, they may be correlative with the Goyllarisquizga Group and overlying calcareous formation (e.g., Inca Formation, Chulec Formation) belongs to the lower Cretaceous, because they conformably cover the Oyotun Volcanics and are, on the other hand, intruded by monzonites.

Intrusive rocks in the area are found out from the western part through to the southwestern part, and can roughly be classified into diorite-granodiorite, granite, monzonite, quartz porphyry-granite porphyry and andesite, in the same way as in the San Felipe area.

The diorite-granodiorite are found out in the southwestern part of the area across the Salas Group and Oyotun Volcanics. Through the reconnaissance conducted along the Palma River, correlation was made that these dioritic rocks were same intrusive body as in the Paramo zone of the San Felipe area, described in the

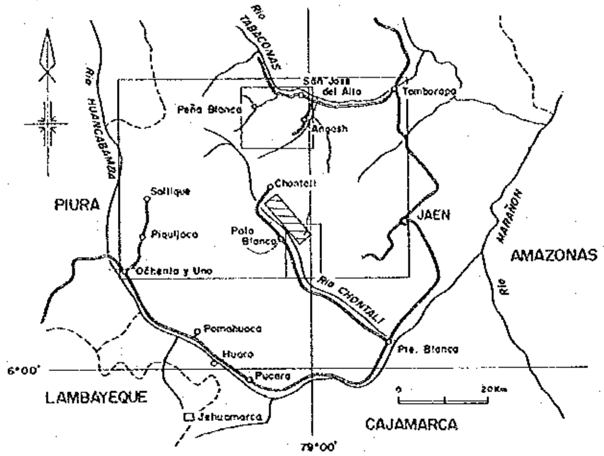


A'
B'
C'
D
9.372
JOp
Kqt
Mz
JOa
Q
Vista Alegre
Hualatan
Cumbaro
Los Laureles
Cruz Pampa
Tabacal
Rio Huayllabamba
Los Piños
Pato Blanco
1708
1483
1830
1282
2200
2080
1800
1600
1400
A
B
C
712
716



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

GEOLOGICAL MAP OF THE CHONTALI AREA

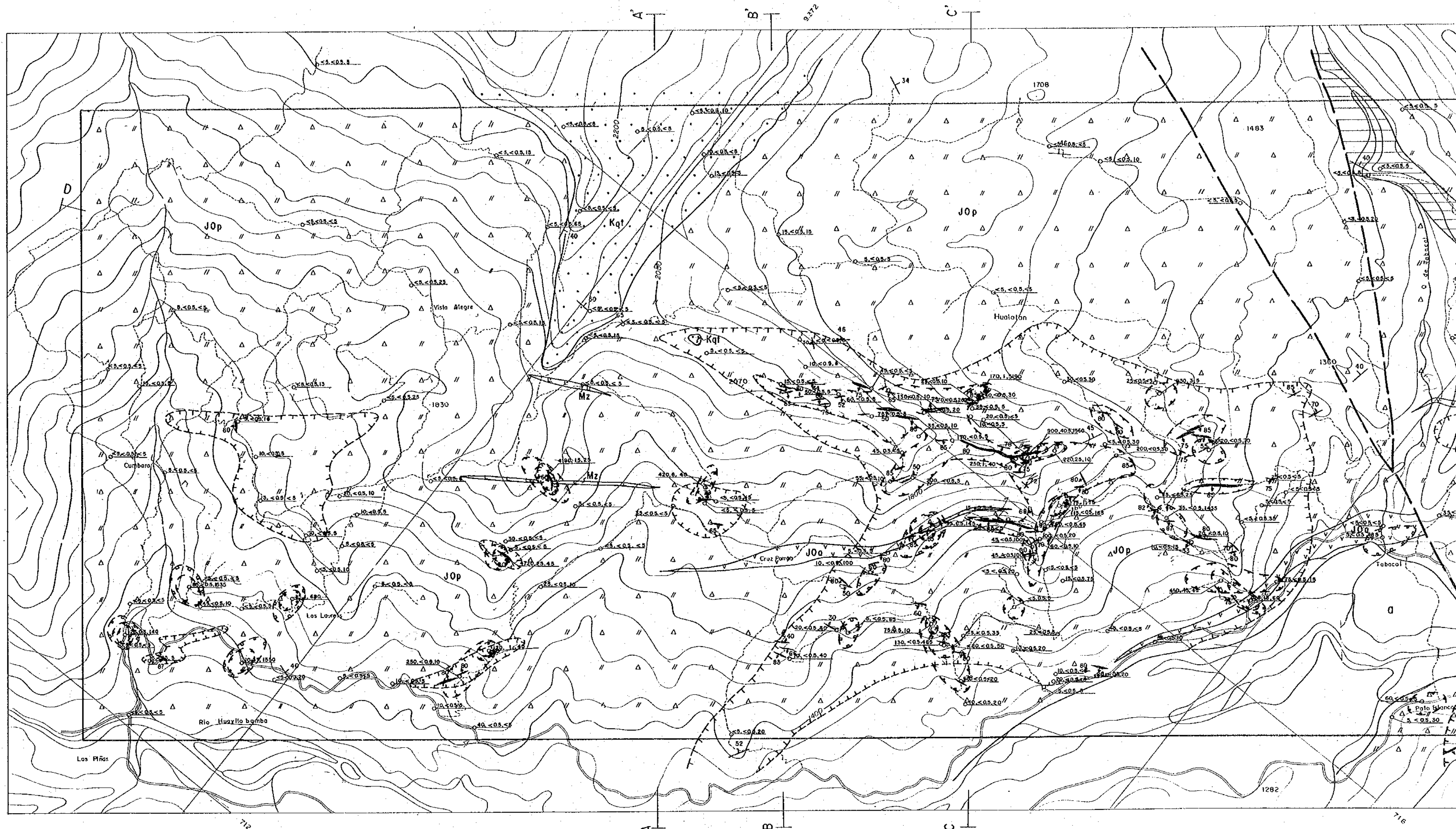


JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN
FEBRUARY 1990
Prepared by MINDECO

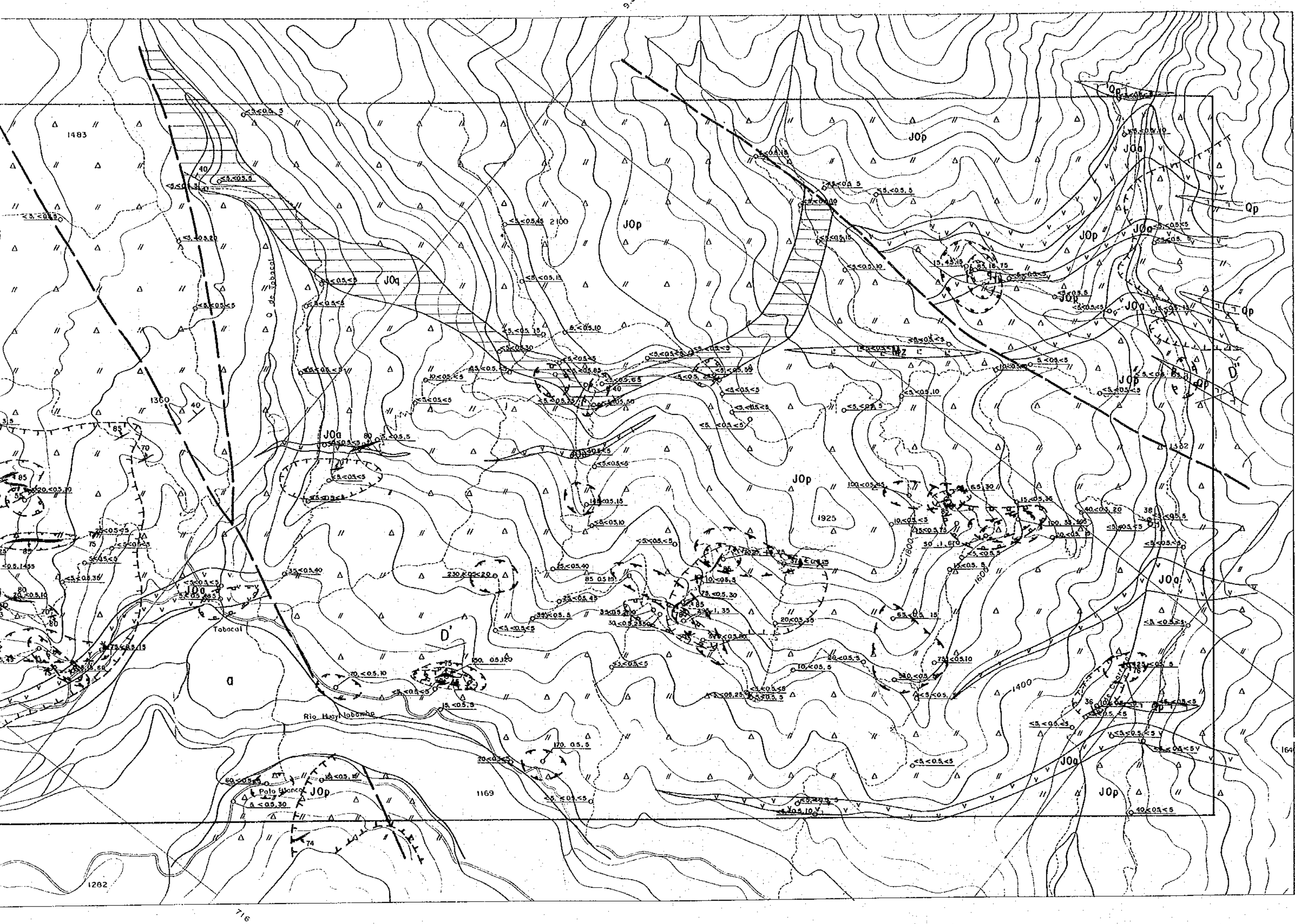
LEGEND

Quaternary	Alluvium	a	Gravel, Sand
Cretaceous	Goyllarisquizga GP.	Kgl	Quartzite
Jurassic – Triassic	Oyotun Vol.	JOq	Sandstone, Quartzite, Shale
		JOp	Tuff, Lapilli Tuff, Tuff Breccia
		JOa	Andesite
Intrusives		Mz	Monzonite
		Qp	Quartz Porphyry
Alteration			Silicified Zone or Silicified Zone with Argillization
Others			Quartz Vein
			Fault
			Bedding

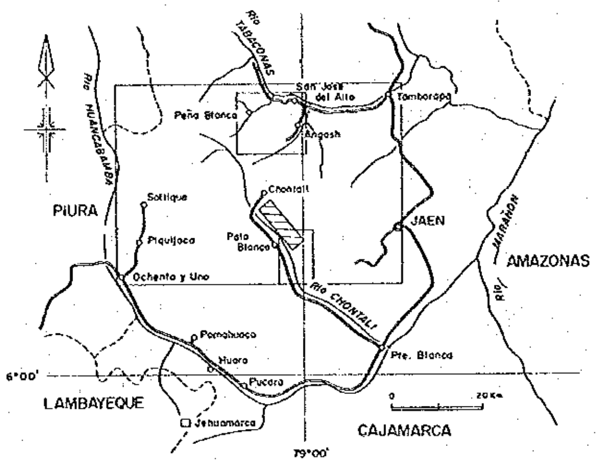
Fig. II-18 Geological Map of the Chontali Area



A'
B'
C'
9272
D
JOp
Kqt
Mz
JOa
Vista Alegre
Hualatan
Cumbara
Cruz Pampa
Tabacal
Las Piñas
Palo Blanco
Rio Huayllabamba
1708
1483
1830
2070
1360
1282
A
B
C
712
716



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



JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN
FEBRUARY 1990
Prepared by MINDECO

0 500 1,000m

LEGEND

Geochemical Anomaly

(dashed ring)	Au	≧ 50 ppb
(dashed ring)	Ag	≧ 0.5 ppm
(dashed ring)	Pb	≧ 50 ppm

Quaternary	Alluvium		a	Gravel, Sand
Cretaceous	Goyllarisquizga GP		Kgt	Quartzite
Jurassic – Triassic	Oyotun Vol.		JOq	Sandstone, Quartzite, Shale
			JOp	Tuff, Lapilli Tuff, Tuff Breccia
			JOa	Andesite

Intrusives

	Mz	Monzonite
	Qp	Quartz Porphyry

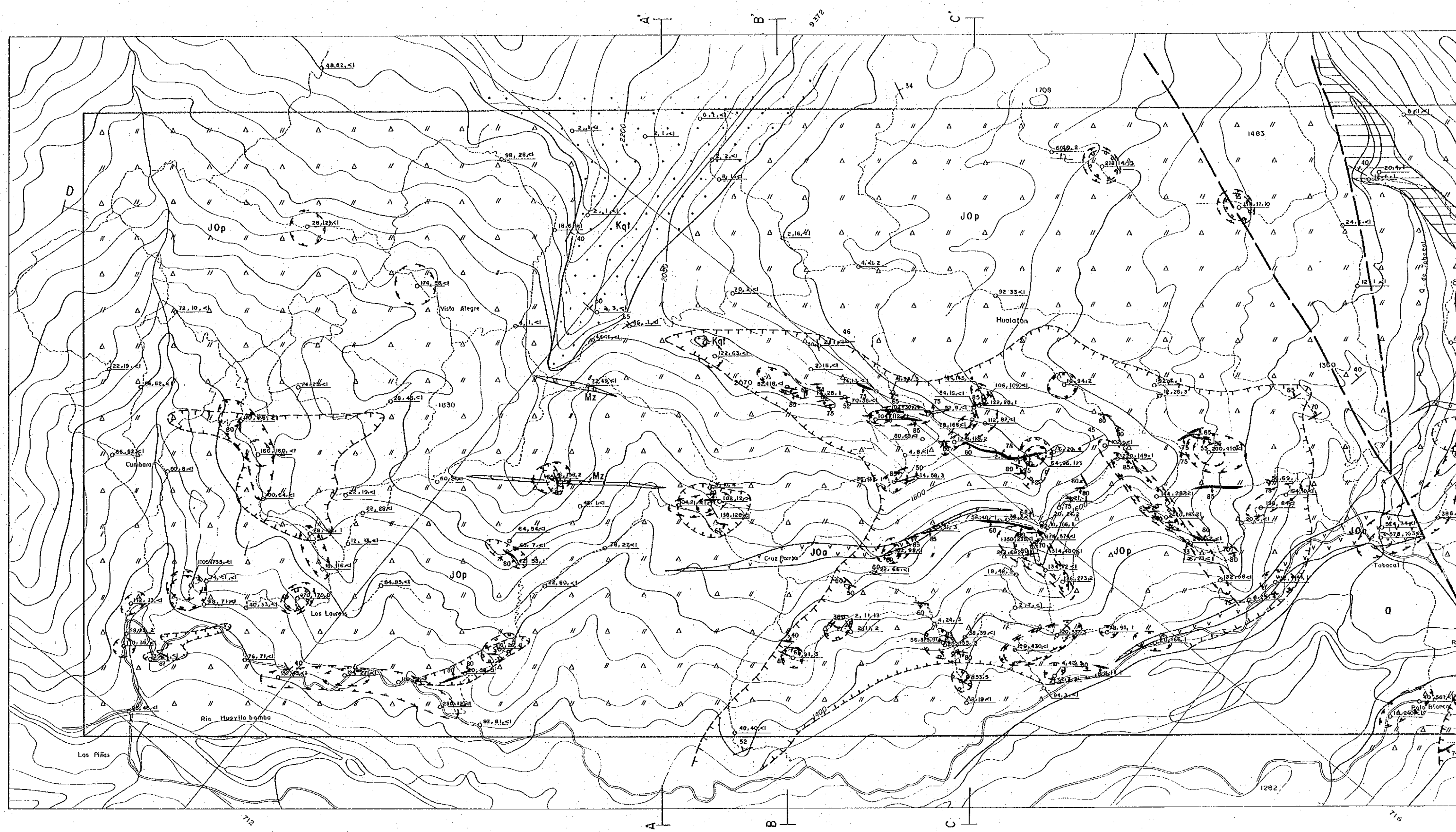
Alteration

Silicified and / or Argillized Zone

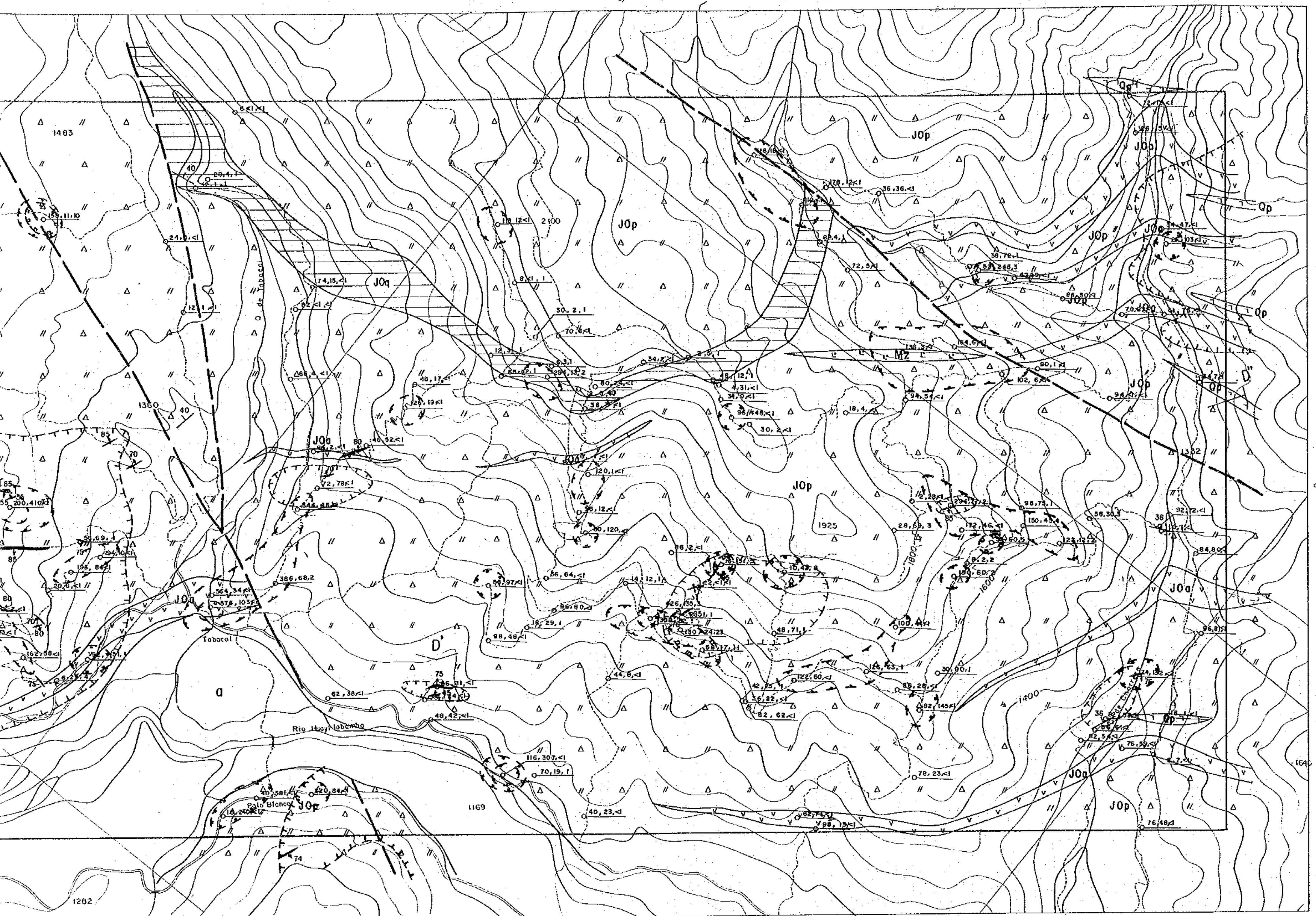
Others

Quartz Vein
Fault
Bedding

Fig. II-19(1) Distribution of Geochemical Anomaly in the Chontali Area (Au,Ag and Pb)

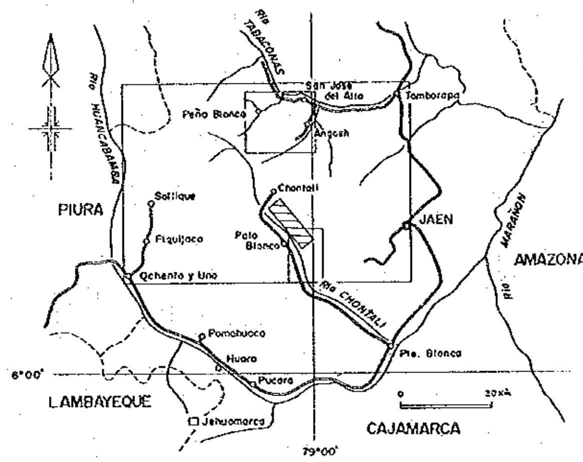


A'
B'
C'
D
JOp
Kqt
Mz
JOa
Vista Alegre
Cumbara
Cruz Pampa
Tabacal
Las Piñas
1708
1403
1830
1282
712
716
A
B
C



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

DISTRIBUTION OF GEOCHEMICAL ANOMALY IN THE CHONTALI AREA (Zn, Cu and Mo)



JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN
FEBRUARY 1990
Prepared by MINDECO

0 500 1,000m

LEGEND

Geochemical Anomaly

- Zn ≧ 100ppm
- Cu ≧ 90 ppm
- Mo ≧ 5 ppm

Quaternary	Alluvium		a	Gravel, Sand
Cretaceous	Goyllarisquizga GP.		Kgt	Quartzite
Jurassic	Oyotun Vol.		JOq	Sandstone, Quartzite, Shale
			JOp	Tuff, Lapilli Tuff, Tuff Breccia
Triassic			JOa	Andesite

Intrusives

- Mz — Monzonite
- Qp — Quartz Porphyry

Alteration

- Silicified and / or Argillized Zone

Others

- Quartz Vein
- Fault
- Bedding

Fig. II-19(2) Distribution of Geochemical Anomaly in the Chontali Area (Zn,Cu and Mo)

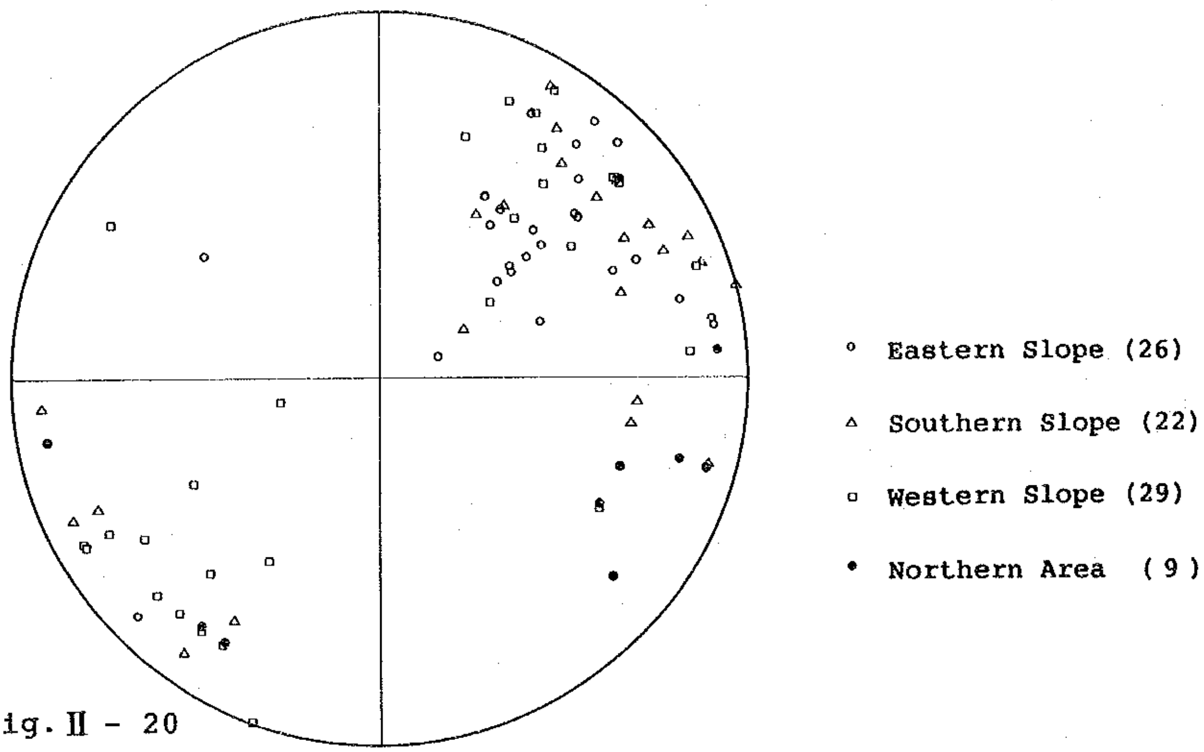


Fig. II - 20

Stereogram of Poles of Quartz Veins

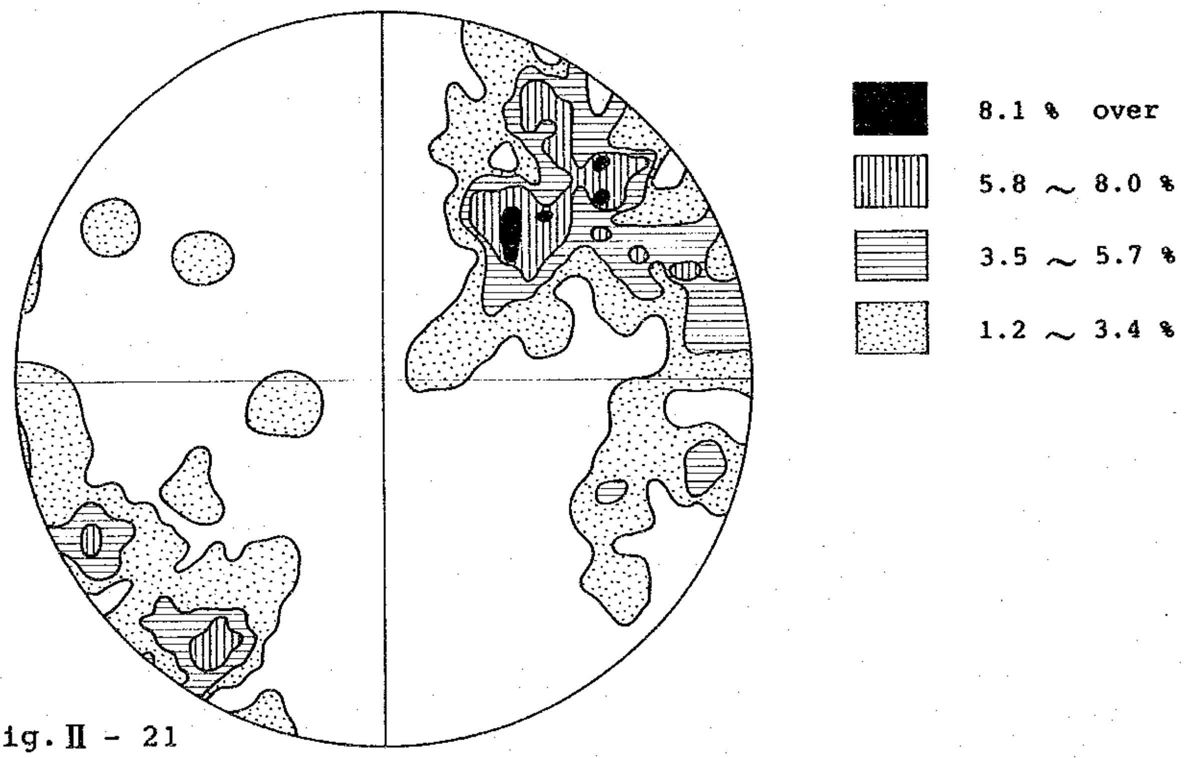
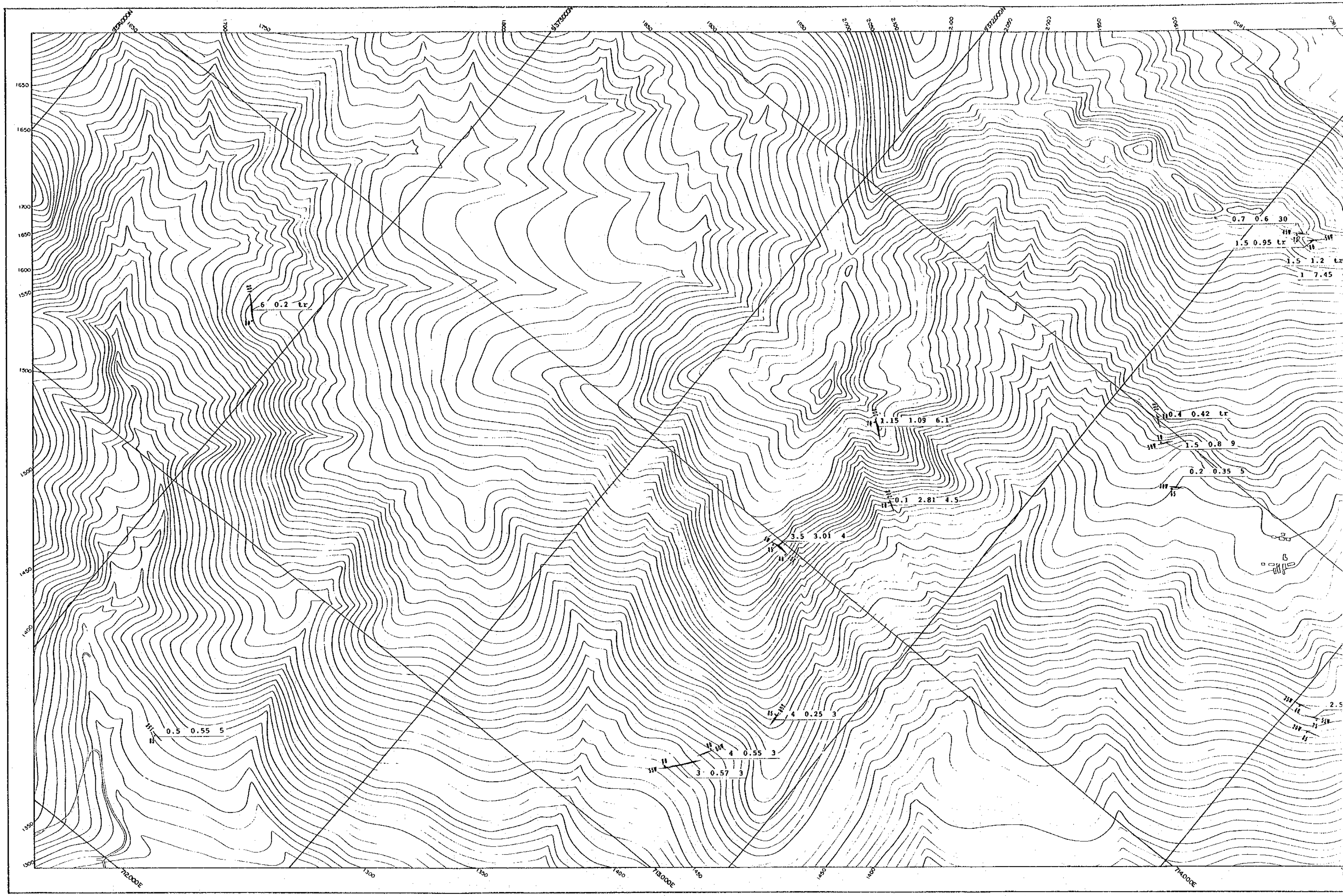


Fig. II - 21

The Projection of the above Stereogram Contoured and Shaded


0.7 0.6 30
1.5 0.95 tr
1 7.45
6 0.2 tr
1.15 1.09 6.1
0.4 0.42 tr
1.5 0.8 9
0.2 0.35 5
0.1 2.81 4.5
3.5 3.01 4
4 0.25 3
0.5 0.55 5
4 0.55 3
3 0.57 3
712000E
713000E
714000E

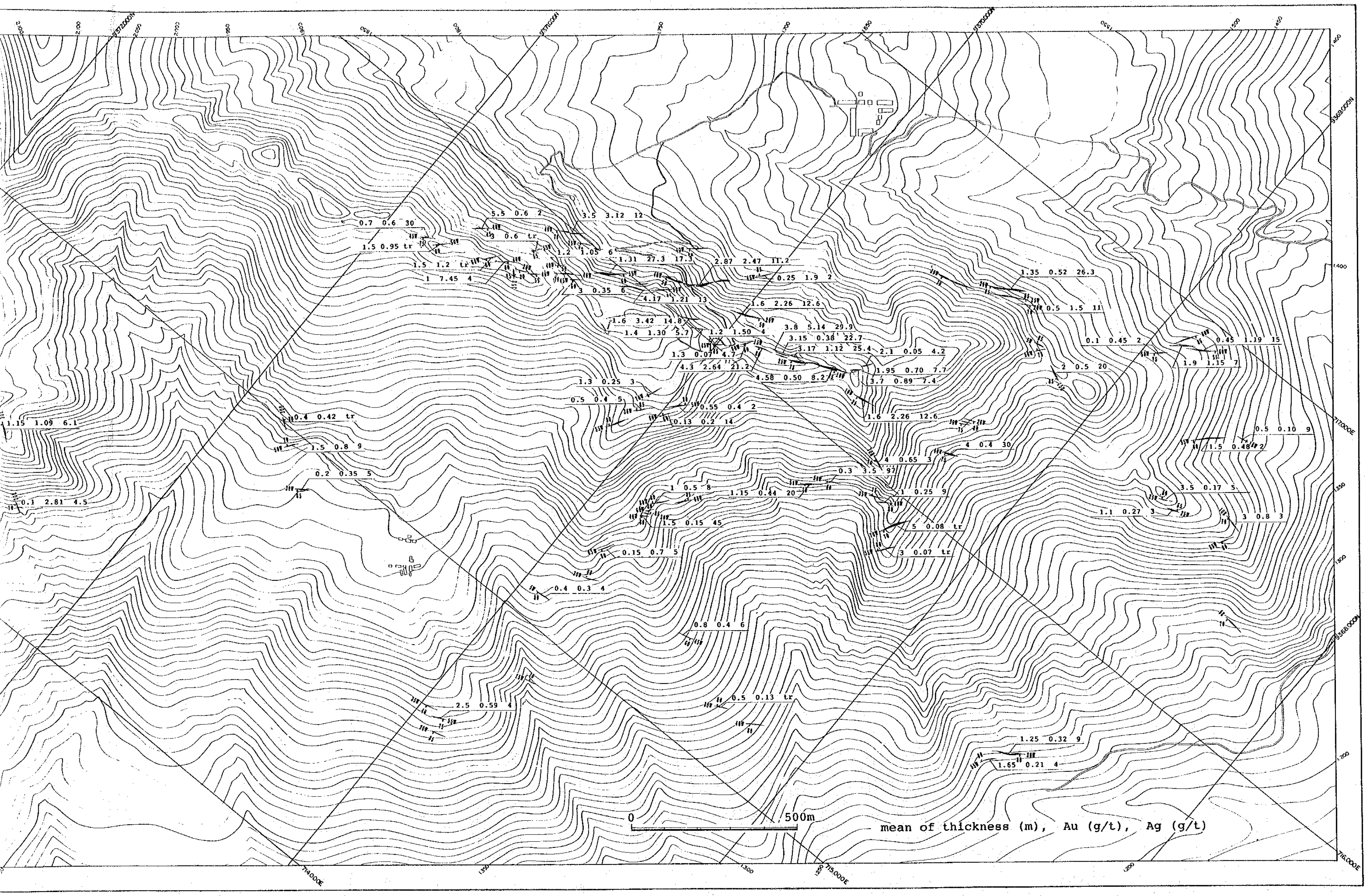
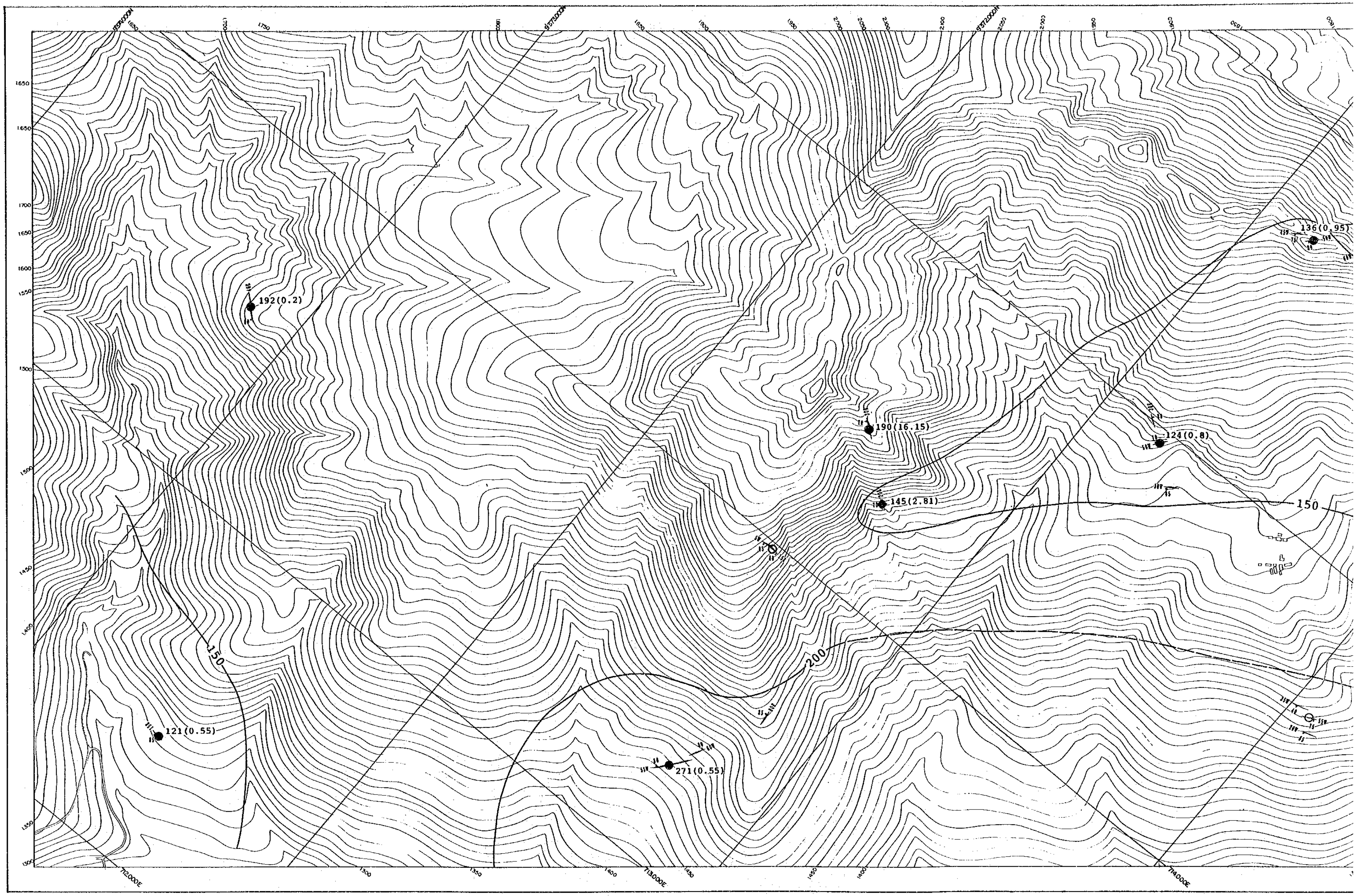


Fig. II - 22 Assay Results of Quartz Vein in the Chontali Area


192(0.2)
190(16.15)
145(2.81)
124(0.8)
136(0.95)
121(0.55)
271(0.55)
150
200
150
712000E
713000E
714000E

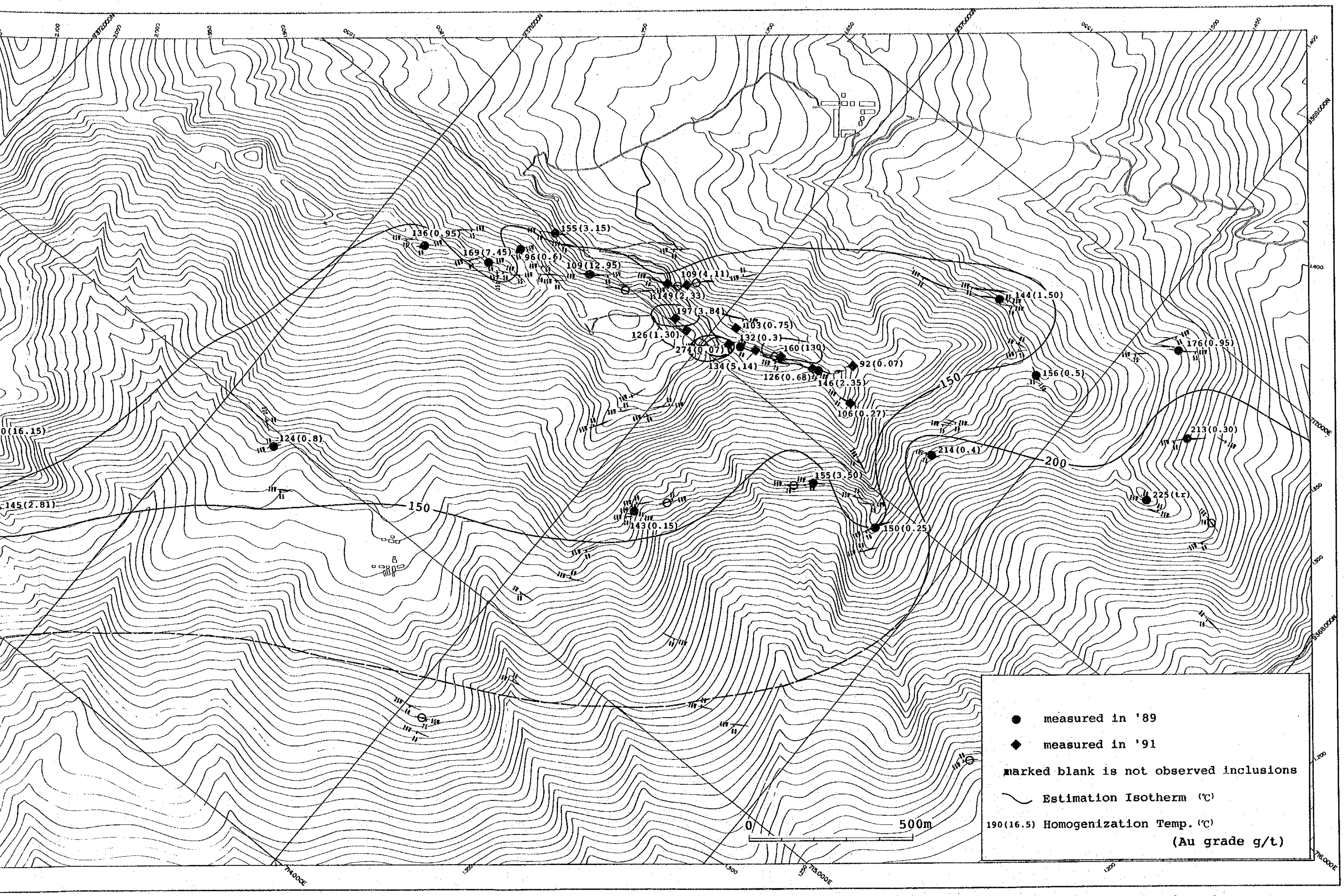


Fig. II-23 Distribution of Fluid Inclusion Homogenization Temperature of Quartz Vein in the Chontali Area