JAPAN INTERNATIONAL COOPERATION AGENCY

METAL MINING AGENCY OF JAPAN

REPORT
ON
THE MINERAL EXPLORATION
IN
THE PACHAPIRIANA AREA
REPUBLIC OF PERU

(PHASE Ⅳ)

MARCH 1992

JAPAN INTERNATIONAL COOPERATION AGENCY
METAL MINING AGENCY OF JAPAN

Preface

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

The JICA and MMAJ sent to the Republic of Peru a survey team headed by Mr. Hiroshi Hama from June 24 to August 5, 1991. The team exchanged views with the officials concerned of the Government of the Republic of Peru and conducted a field survey in the Pachapiriana area. After the team returned to Japan, further studies were made and the present report has been prepared.

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

We wish to express our deep appreciation to the officials concerned of the Government of the Republic of Peru who concerned with this survey for their close cooperation extended to the team.

March, 1992

Kensuke YANAGIYA
President
Japan International Cooperation Agency

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President
Metal Mining Agency of Japan

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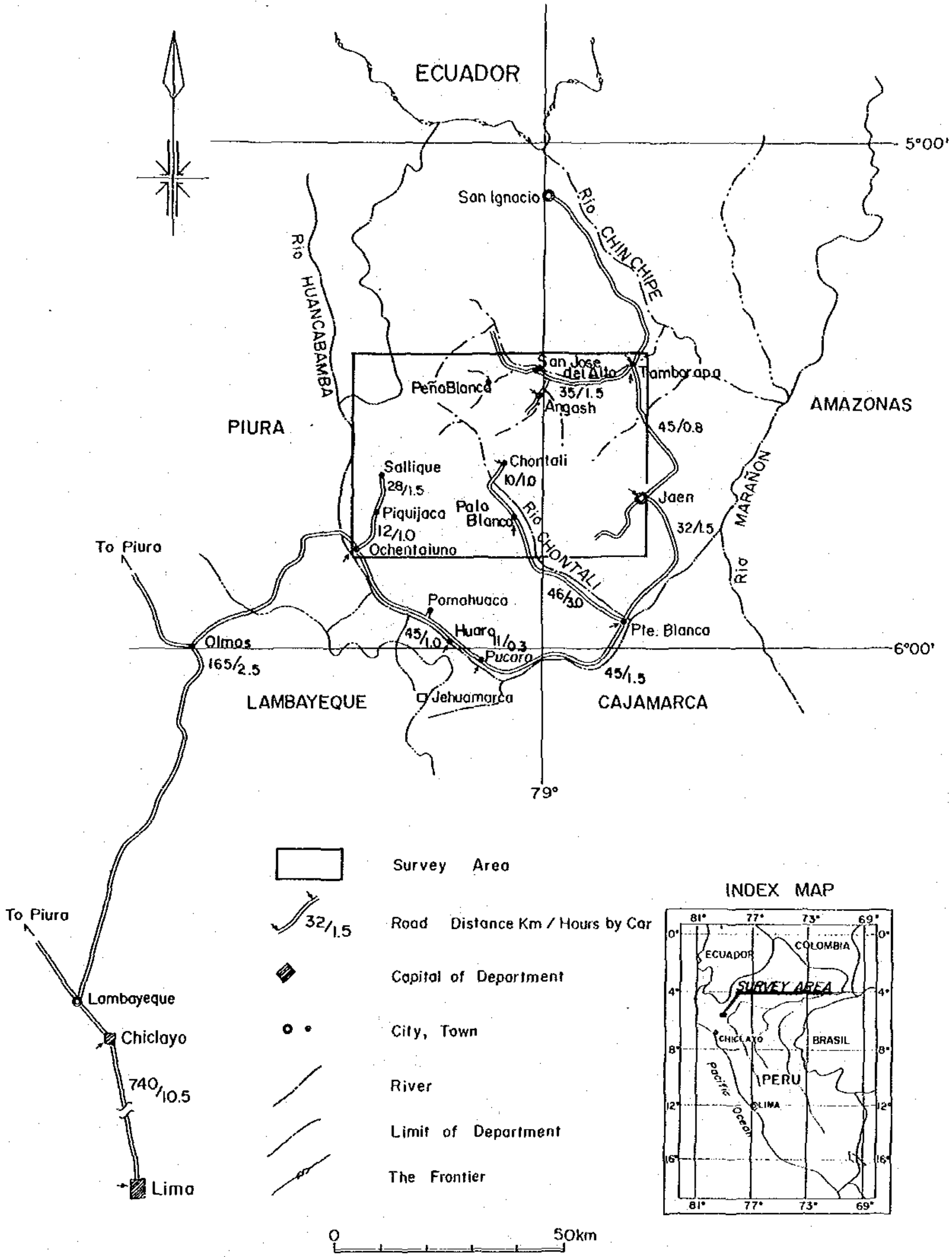


Fig.I−1 (1) Location and Accessibility of the Survey Area

SUMMARY

This report summarizes the fourth year results of the surveys conducted in the Pachapiriana area, Peru. The surveys aimed to reveal potentiality of an existence of useful mineral resources in the area through clarification of geological setting in the area. The field survey was carried out from June to August, 1991.

The fourth year survey included diamond drilling (2 holes, total length 220.70m) and detailed geological survey (16.25 km2).

The field observations show that the plunges of quartz veins at the intersection with the crossing fissure and the deflection of quartz vein are N30° W, 61° and S57° W, 85° respectively. In addition, the plunge can be also estimated to be S85° W, 70° based on the relationship between quartz vein on the surface and underground confirmed by drilling. Summarizing above-shown results and the grade at outcrop, it can be assumed that the mineralization zone has plunge dipping steeply southward and is intensely affected by the deflection of quartz vein.

The grade of outcrop in high grade zone tends to fluctuate intensely. The highest grade confirmed this year is as high as Au 56.23 g/t.

Homogenization temperature of fluid inclusions in quartz veins of the alteration zones range from 92 to 274℃. Only one sample gives the temperature of the most adequate for gold mineralization (180 to 230℃) and another shows high value of 274℃. Except for these two, the estimated temperature, ranging from 92 to 160℃ is much lower than the optimum temperature for gold deposition.

Therefore, it can be concluded that gold ore deposit is possible to exist deep underground in the survey area.

In the fourth year, the final year of this project, the survey was started out to clarify the grade and size of ore deposit in Chontali area, but the survey had not been completed due to unstabilization of security in Peru. However, the results of past three years' and this year's survey proved high potensial of gold deposit in the Chontali area.

PART 1 GENERAL REMARKS

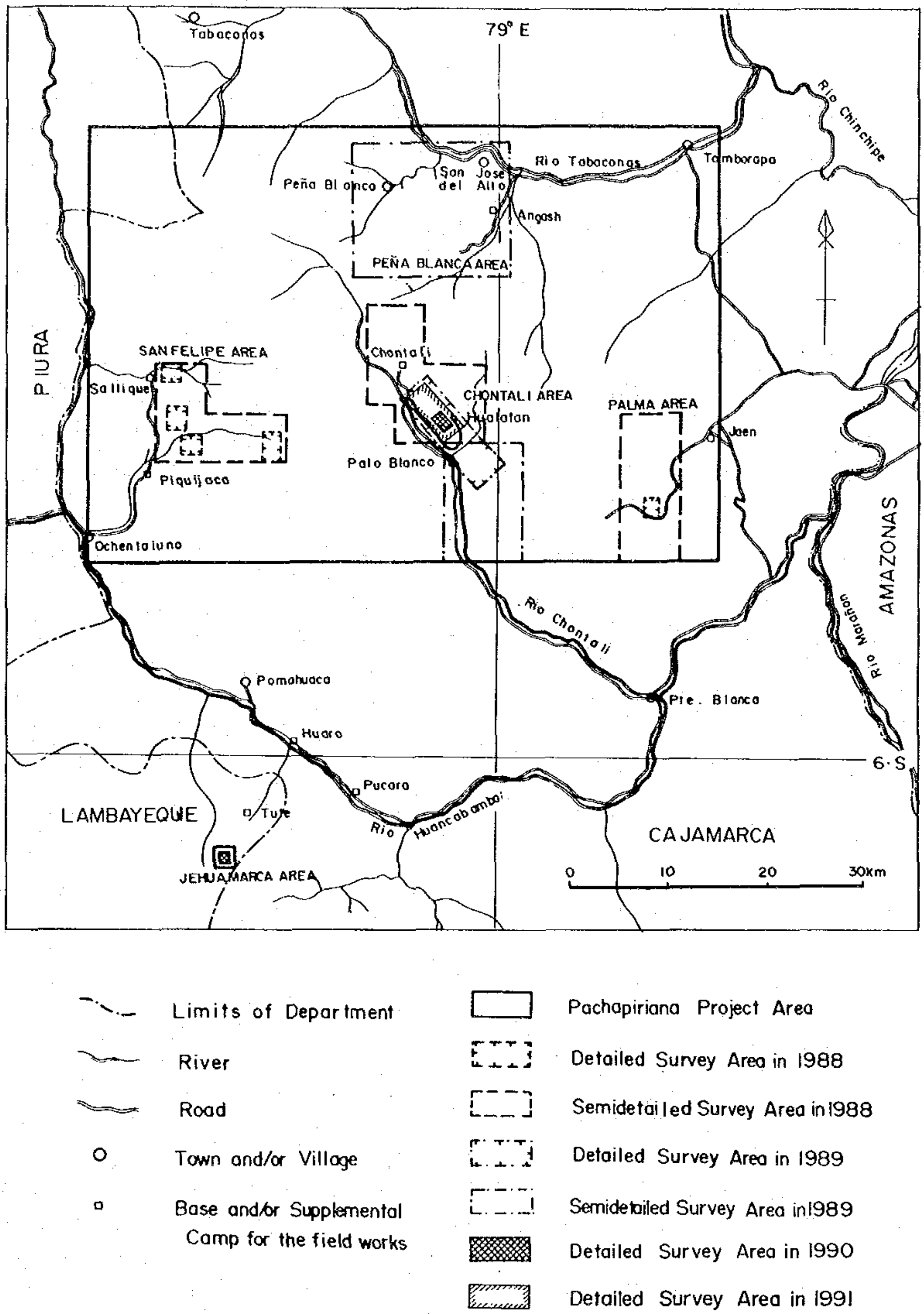


Fig. I - 1 (2) Location of the Survey Area

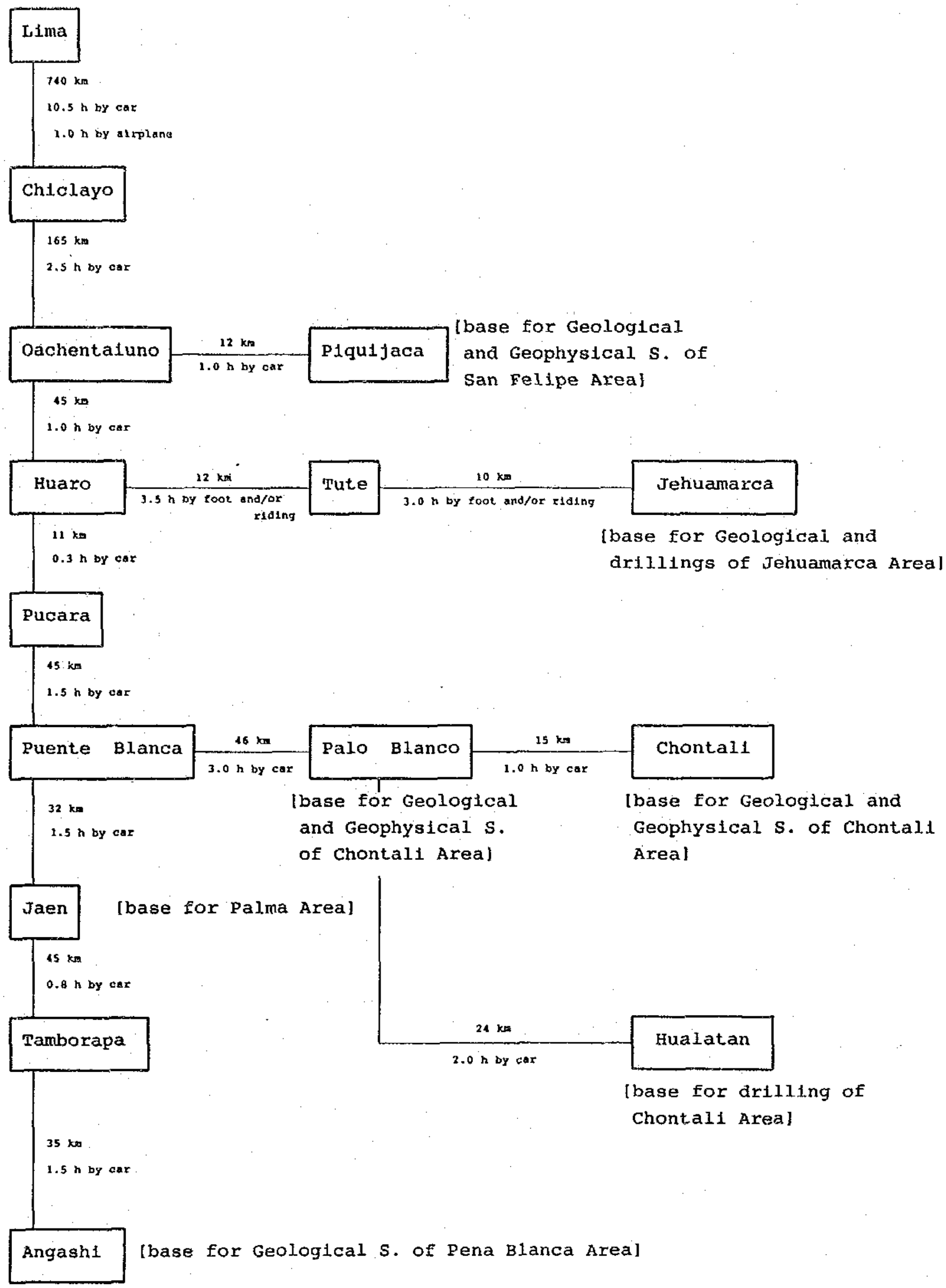


Fig. I-2 Summarized Accessibility of the Survey Area

CHAPTER 1 INTRODUCTION

1-1 Background of the Survey

The survey area is situated in a part of the region for which a geochemical survey using stream sediments was carried out under the Northern Geochemical Project(Proyecto Geoquemico del Norte) sponsored by the U.K. The detailed survey for the extracted geochemical anomalous zones was realized partially by INGEMMET (Instituto Geologica Minero y Metalurgico) itself and partially by German and French organizations. However, the major part was remained pending due to shortage of funds.

Under these circumstances, INGEMMET requested, through the Ministry of Foreign Affairs of the Republic of Peru, a technical cooperation from the Japanese Government for the follow-up survey in March 1988. In August 1988, a delegation for the preliminary survey and agreement negotiations for this purpose was organized among the Ministry of International Trade and Industry (MITI), Japan International Cooperation Agency (JICA) and Metal Mining Agency of Japan (MMAJ), and was sent to Peru. On August 15, 1988, the scope of work to the Pachapiriana area Project was signed between the parties.

According to the scope of work concluded among INGEMMET, JICA and MMAJ, the survey encompasses an area of 2,820 km2.

The first year survey included a semi-detailed geological survey which was conducted over a total area of 300 km2 in three areas among the geochemical anomalous zones assessed prospective by INGEMMET, combined with the LANDSAT image analysis of entire survey area. An additional detailed geological survey was also conducted over a total area of 21 km2, in five regions extracted from semi-detailed survey area and one area (4 km2) extracted by INGEMMET. Geophysical survey using CSAMT method was implemented over 25 km2 in two areas. During the second year survey, following the recommendation of the first year survey, detailed geological survey(42 km2), semi-detailed survey(80 km2) and geophysical survey using CSAMT method(35 km2) were conducted in Chontali area. Drilling was performed at three sites and total hole length reached 816.25 m in Jehuamarca. Semi-detailed geological survey (220 km2) was conducted in Pena Blanca area. During the third year survey, following the recommendation of the second year survey, detailed geological survey(2.5 km2) was conducted and drilling survey was performed at ten sites and total hole length reached 1001.55m in Jehuamarca. Geophysical survey (33 km2) was conducted and drilling survey was performed at six sites and total hole length reached 1332.51m in Chontali area.

1-2 Conclusion and Recommendation of the Third Year Survey

1-2-1 Conclusion of the third year survey

The conclusion of the third year survey is summarized as follows:

(1)Chontali area

1) It is clarified, through the gravity survey that the gravity basement with the high density of 2.8 g/cm3 is widely developed underground. This high density basement can almost coincide with high resistivity zone extracted through second year geophysical survey by CSAMT method.

2) Localized high density zone just above the gravity basement can coincide with localized mineralization-alteration zone such as highly carbonatized zone.

3) Quartz vein extracted by drilling survey exists in breccia (fracture) zone, suggesting that the breccia zone can continue even when quartz vein has been pinched out.

4)It is suggested that quartz vein could tend to have plunge*1 as it is pinched out within the fracture zone. If quartz vein tends to have plunge, it must be interpreted that the enriched part of mineralization zone*2 could also have plunge.

5)Although the analyzed results shows that the grade of quartz vein is as low as 5.75 g/t Au, which is lower than expected, native gold grain is confirmed by microscopic observation to suggest the possibility of an existence of high grade gold mineralization.

6) The homogenization temperature of fluid inclusion in quartz veins ranged from 102 to 194 , having rather lower values with a mean of 137 . It is inferred that a zone of most adequate for gold mineralization (180 to 230) can exist deeper than the depth of altitude 1700 m, which is deeper than the drilled depth of the third year survey.

(2) Jehuamarca area

1) Along the secondary or tertiary NW-SE and NE-SW fissure systems, which are branched from regional fault system, associated with small displacement and along bedding plane argillization under neutral to alkaline environment has progressed.

2)It was followed by silicification with mineralization under acidic condition.

3)It is inferred that three types of mineralization (i.e. base metal mineralization with silicification, high grade layered base metal mineralization within quartz zone and gold and silver mineralization within silicified breccia) shown in the second year survey are essentially a series of mineralization. Gold-silver mineralization in silicified breccia is a residual deposit, which is formed from auri-argentiferous base metal mineralization zone altered by meteoric water. High grade base metal mineralization zone in quartz zone is a typical base metal mineralization zone formed by silicification.

*1 plunge: In this report, plunge is used for the meaning of that quartz vein, mineralization zone or enriched mineralization zone spread having a direction with limited extent on a plane.

*2 enriched part of mineralization zone: mineralization zone is used for the zone having minable grade and enriched zone is especially high grade zone in the mineralization zone. Incidentally, mineral showing is used for the zone which is considered to have unminable low grade.

4)Silicified breccia occur contineously as a stratiform, but the mineralization zone of gold and silver is localized and their grade is erratic.

5)Quartz zone expected to associate high-grade base metal mineralization is discontinuous and changes its thickness and grade frequently, therefore there is a small possibility that it develops to a large scale high-grade ore body.

1-2-2 Recommendation for the Fourth Year Survey

The following surveys are proposed for the fourth year survey in Chontali area, where ore deposits are possible to exist.

1)Drilling survey at more than two holes to confirm the plunge of quartz vein and mineralization zone or enriched part in the vein.

2)More detailed geological survey for the quartz vein distributed are includ-ing detailed mapping and systematic sampling of quartz veins will be conducted.

1-3 Outline of the Fourth Year Survey

1-3-1 Area and Purpose of the Fourth Year Survey

During the fourth year survey, according to recommendations of the third year, geological survey and drilling were conducted in Chontali area.

In order to verify the plunge of mineralization zone, geological survey was performed. The structure of quartz veins and the grade of silver and gold in them were surveyed over a total area of 16.25 km2, using route map on the scale of 1/2000.

Drilling was planned to verify the plunge of quartz vein and the conditions of mineralization in the deep underground. Two holes were drilled, total hole length reaching 220.7 m.

1-3-2 Survey Procedure

The procedure of each survey is outlined as follows.

1) Geological survey

Geological mapping was carried out along measuring lines, which were drawn using string tape and pocket compasses with a scale of 1/2,000. The main purpose of the survey was to verify the distribution of quartz vein. It was planned , if a quartz vein was extracted, to conduct an outcrop survey with a scale of 1/200 to 1/500 at measuring points in every 10 to 15 m along the measuring line in order to verify the scale, structure and distribution of the grade. However, the survey could not be completed due to the stoppage of the plan. Measuring points along quartz vein were used as base points to discriminate the sampling localities. Sampling was performed by channel method using W.C. (tungsten carbide) chisel to cover uniformly whole width of quartz vein.

Samples were sent to Chemex Labs. LTD. in Canada and analyzed.

2) Diamond drilling

Drilling was performed by the local drilling company GEOTEC, S.A.

The base camp was set up at Huaratan as same as in the third year survey, to replenish mending parts, fuel oil, mud, cement, core boxes and food. Two transit bases were set up at the junction to the national road in Puente Blanco and at the edge of the bridge with a load limitation in Pena Blanca

3) Amount of the Survey

The survey of this year is summarized as follow:

	Geological survey		Drilling		
	Area	Route	Compiled route by past surveys	Hole No.	Hole length
Chontali	16.25km2	26,602.4m	28,222.1m	2	220.7m

The number of rock samples taken for laboratory test are summarized as follows:

Ore analysis	Fluid inclusion	X-ray diffraction	Thin section
54	10	15	5

1-3-3 Organization of the Survey Team and Period of the Survey

The survey team was organized by geological and drilling survey team, the former was sent during the period from June 24 to August 2, 1991 and the latter from June 24 to August 5, 1991.

The group members from Japan and their counterparts from Peru are as shown below:

From Japan:

Mr. Hiroshi HAMA	; General review, and geological and drilling	MINDECO
Mr. Akimitsu TAKEBE	; Geological survey	MINDECO

MINDECO: Mitsui Mineral Development Engineering Co.,Ltd. Japan

From Peru:

Mr. Carlos JIMENEZ VELASCO	;	General review and geological and drilling	INGEMMET
Mr. Celso PSSACIOS	;	Geological survey	INGEMMET

INGEMMET: Instituto Geologico Minero y Metalurgico

CHAPTER 2 GEOGRAPHY OF THE SURVEY AREA

2-1 Topography and Drainage System

The fourth year survey was conducted in the central part of the survey area as shown in Fig. I-1(2).

In Chontali area, Chontali river (called as the Huayllabamba or the Chunchuca, on different topographic maps) runs along the west boundary southward in the direction of NW-SE. Each tributary tends to join nearly at right angles to Chontali river, namely they are arranged in the direction of NE-SW.

The survey area is topographically so steep and the altitude difference is 1150 m between Chontali river (1050 m above the sea level) and the highest peak(2700 m) in the area.

2-2 Climate and Vegetation

As reported last year, vegetation in the survey area shows a particularly remarkable variation due to the altitude difference. Another critical factor for the variation is whether the land is reclaimed or not. The area belongs essentially to tropical to subtropical rainforest zones characterized by thick virgin forests with trees of 10 to 15 m high. In the progress of disaforestation, the desert has been expanded but the irrigated area are preserved as agricultural lands but non-agricultural lands become dry shrubbery zones. In Chontali, whole survey area has been reclaimed to be used as agricultural or pasture lands.

Temperature shows a remarkable variation due to the altitude. The average values decrease as the altitude becomes higher. The average temperature variation for each month is so small that it can be said the seasonal variation of temperature is slight. However, it is inferred that the diurnal variation is very large, as the difference between maximum and minimum temperatures for each month is more than 10℃.

Relative humidity tends to be higher as the altitude becomes high in contrast to the case of temperature. Judge from the average humidity for each month, the variation coincides with that of average temperature, independently to dry or rainy period.

The precipitation is not dependent on the altitude but fairly depend on the presence of virgin forest in the surrounding. Annual variation of precipitation is not so remarkable and there is not a clear distinction between the rainy and dry periods. If a month belonging to the rainy period is defined as with more than 100 mm precipitation, the rainy period covers December to March and the dry one June to November. Among the periods, January to April and July to September are relatively much and less precipitated, respectively.

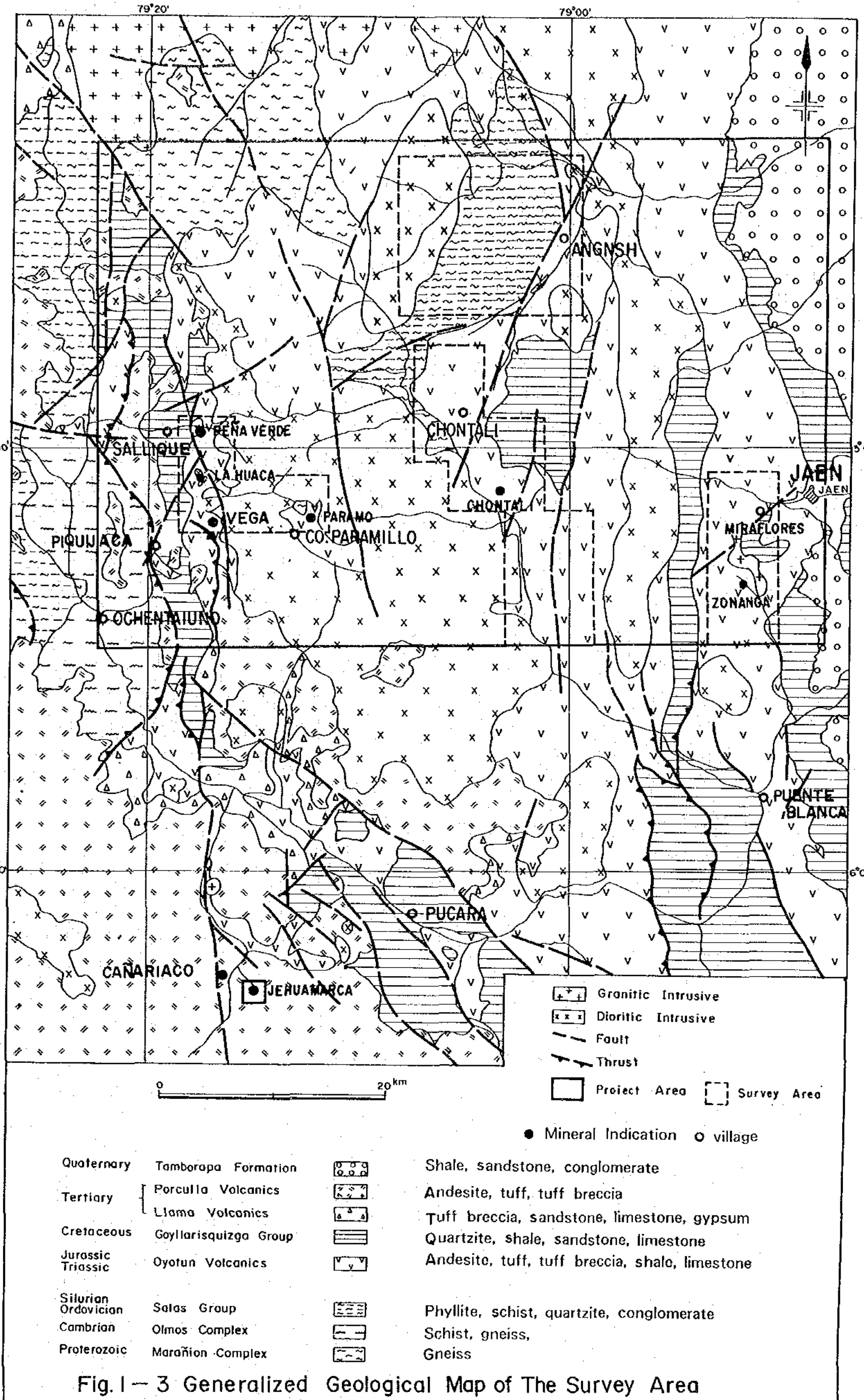
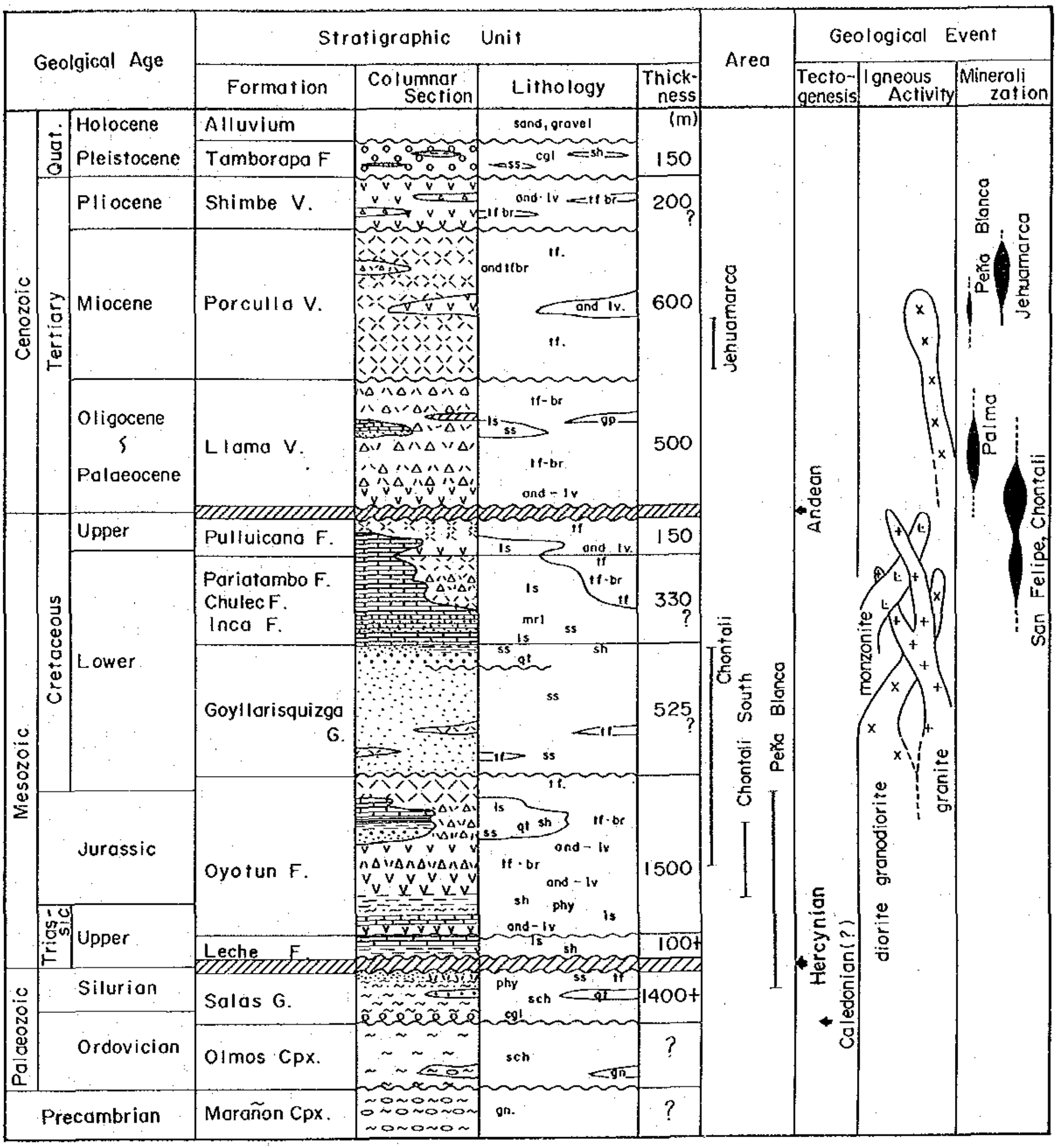


Fig. I — 3 Generalized Geological Map of The Survey Area

modified from Wilson (1984), Reyes et al (1987) and Davila et al (unpubl)



Abbreviations.

and	andesite	gn	gneiss	md	mudstone	sch	schist
acd	acidic	gp	gypsum	mrl	marl	sh	shale
br	breccia	ls	limestone	phy	phyllite	ss	sandstone
cgl	conglomerate	lv	lava	qt	quartzite	tf	tuff
F.	Formation	V.	Volcanics	G.	Group.	Cpx.	Complex

Fig. I-4 Generalized Stratigraphic Column of the Survey Area

CHAPTER 3 GENERAL GEOLOGY

The survey area is situated in a tectonically disturbed zone, so called Huancabamba deflection zone. This causes a great variation in rock facies of each geological unit among the former surveys. In addition most of the survey area is uncivilized and the survey routes is limited, thus causing some confusion in correlation of geological formations and it requires further study.

An geological outline of the area is given below after Wilson(1984), Reyes y Caldas (1987) and Davila et al (unpublished), revised after the results of first, second and third years geological survey. A geological map and a stratigraphic column are generalized as shown in Figs. I-3 and I-4, respectively.

The survey area consists of metamorphic rocks correlative with Precambrian to Paleozoic, Mesozoic sedimentary and volcanic rocks and Cenozoic volcanic and intrusive rocks. The metamorphic rocks, consist of the basement Maranon Complex, Ordovician Olmos Complex and Silurian Salas Group, have such a wide lithofacies as gneiss, schist and phyllite. They are developed in the western half of the survey area.

Mesozoic rocks are the main constituent of the survey area and consist of the following units in ascending order: Leche Formation (mainly calcareous rocks), Oyotun volcanics (mainly pyroclastic rocks), Tinajones Formation (arenaceous rocks intercalated with tuffaceous rocks), Goyllarisquizga Group (mainly quartzite) and Inca, Chulec, Pariatambo and Pulluicana Formations (mainly calcareous rocks).

Cenozoic rocks composed mainly of volcanic rocks which in ascending order are Llama, Porculla and Shimbe Volcanics, distributed in western and southwestern parts of the survey area. Tamborapa Formation consists of conglomerate, with loose consolidation, being correlative with the Quaternary sediments. This formation occurs at the eastern flange of the survey area.

Intrusive rocks consist of gabbro, diorite and granite. Generally, gabbro and diorite are older than granite which are intruding even Porculla Volcanics. The absolute ages determined using K/Ar method are 119+6 million years for quartz diorite, 106+5 million years for quartz monzonite, 82.5+4 million years for granodiorite, 78+3.9 million years for monzoni-syenite and 47.6+2.4 for adamelite. The intrusive trends are tend to be NW-SE and N-S, reflecting the geological structure.

Geological structure of the survey area is characterized by its situation of which located at the southern part of a distorted zone of general Andean Trend. This distorted zone, so called the Huancabamba Deflection Zone, corresponds to the area at which the general NNW-SSE direction, the basic characteristic of the Andes, changes direction to the NE-SW trending of the Colombia-Venezuela area. This deflection zone is assumed to have been formed during the Mesozoic tectogenetic movement. This means it is the process of change in the Alpine type geosyncline and/or intercontinental environment rather than in the Andes type continental environment.

Two combined fault systems are observed in the survey area. One is E-W and NE-SW trending caused by an east-west lateral compression, and another is N-S and NNW-SSE trending by northwest-southeast compression. Both systems reflect the tectonic movement at the time when the Huancabamba Deflection Zone was formed.

CHAPTER 4 SURVEY RESULTS, COMPREHENSIVE ANALYSIS

4-1 Geological Structure, Characteristics and controlling Factors of the Mineralization

This survey area is located in the Huancabamba Deflection Zone, that is, the area belongs to a distorted zone of the general Andean trend in NW-SE changes to NE-SW trending.

It was concluded by second year survey that the alteration and quartz zones in Chontali, where this year survey was conducted, occur on the secondary branched NW-SE fissure zone developed between the regional NE-SW systems. As a result of microscopic observation for drill cores taken through last year survey, it is concluded that the tectonic movement has continued even after the formation of quartz vein, because quartz grains in quartz vein and in fracture zone extended from the quartz vein commonly show wavy extinction. As fracture zone is in large scale and continuous, and a large-scaled quartz vein is pinched out (MJPJ-2) or branched (MJPJ-4) in fracture zone, it is assumed that quartz vein is developed in fracture zone controlled by the structure of fracture zone (unidentified up to now). In other words, quartz vein could not be vertical but tend to plunge, and if it is the case, the mineralization zone or enriched part in it could also have a plunge.

The plunge is generally inferred to be controlled by the intersection of quartz vein with crossing fissure and/or deflection of quartz vein itself.
It is verified in this year survey at MJPC-5 and 6 of last year drilling sites, that quartz vein show the plunge of N30° W, 61°, and S57° W, 85° and S53° W, 18°. The former value represents the crossing of quartz vein with fissure, while the latter two represent deflection of the vein. Taking above shown results and the grade of samples from outcrops as well as the results of last year drilling survey into consideration, it can be concluded that quartz vein and mineralization zone in it plunge steeply southward. Namely the mineralization zone is distinctly controlled by the deflection of quartz vein.

As ore minerals containing such valuable metals as gold, silver, zinc, copper, lead and so on are closely associated with each other, the mineralization environment is inferred to be xenothermal. It is worthy of note that the alteration is characterized by the occurrence of carbonate minerals suggesting the neutral to alkaline environment and that the minerals are composed mainly of such heavy metals as Fe, Mn, Mg and so on.

4-2 Potentiality of Ore Deposits

The Pachapiriana area contains numerous geochemical anomalous zones with using the stream sediments which were previously sampled by INGEMMET in the "Proyecto Geoquimico del Norte" and the "Proyecto Integral Chinchipe". Semi-detailed geological survey has been continued to implement up to last year to find out to what origin these anomalies were attributed. As a result, obvious mineralized alteration suspected as the origin of the anomary was verified in the backland of the rivers where geochemical anomaly is marked. Therefore, we can conclude that the geochemical anomaly of stream sediments extracted by INGEMMET suggests an existence of mineralized indications.

While no economical ore deposits have been found in surveyed area as yet, the follow-up study of the aforementioned "Proyectos" verified that the existence of La Granja ore deposits and Canariaco ore deposits. In addition, it is reported that a stratiform gold deposit and an epithermal gold deposit have been found in the northern part of this survey area by the "Proyecto Integral Chinchipe: Cordillela del Condor" which is currently under way. It is certain that the area contains promising mineralized area.

Detailed geological survey, which was conducted in the second year for the Chontali alteration zone extracted in the first year survey, has confirmed the existence of predominant silicified alteration zone with abundant quartz veins and veinlets. Moreover, the geophysical survey confirmed a three-dimensional distribution of mineralized alteration zones with quartz veins. Drilling survey performed in the third year has confirmed the underground fracture zone in large scale (yet unidentified on the surface) and native gold is extracted from the quartz vein in the zone, therefore it becomes more certain that the area contains promising mineralized area.

Meanwhile, it is clarified through this year detailed sampling of quartz veins at outcrop in the area the change in ore-grade tends to be comparatively intense and the highest value confirmed this year is as high as Au 56.23 g/t. Thus, it is possible to extract the high grade mineralization zone (enriched part) when the plunge of the mineralization zone is clarified more in detail.

4-3 Relation between Geochemical Anomaly and Mineralization

Geochemical anomalies obtained up to last year's geochemical survey on rock sample was assumed to be classified into indication of mineralized alteration and horizons. The latter is inferred to correspond to the anomalous values in Salas Group in the Chontali area found by geochemical survey of the first year. Meanwhile, it is clarified by geochemical survey conducted in Jehuamarca last year that zinc anomaly exists along the andesitic sheet in the southwestern part, suggesting the close connection of geochemical anomaly with a specific rock. In this connection, andesite itself contains zinc as high as 5045 ppm (two specimens, arithmetic mean).

Geochemical anomalies suggesting the existence of mineralized alteration zone are the main ones among the anomalies distributed in the surveyed area and can be classified into the following two types. One is closely connected with epithermal mineralized alteration, in which gold anomaly tends to be distributed in the central part and silver, lead and silver anomalies surround it in order outward. Another type suggests the existence of mesothermal mineralized alteration zone where copper anomaly tends to be distributed in the central part, and zinc and lead anomalies surround it in order outward. The former type is represented by the mineralized alteration zones in Jehuamarca and Chontali, and the latter by the mineralized zone in San Felipe.

CHAPTER 5 CONCLUSION AND RECOMMENDATION

5-1 Conclusion

In the Chontali area, secondary fissure system trending NE-SW and NW-SE develop branched from regional fault system in acidic pyroclastic rocks. Mineralization is concluded to progress through the fissure systems.

It is interpreted that the larger fissure zone of NW-SE system is the place of mineralized alteration which is limited on its expanse by NE-SW regional fault system.

The plunges ,inferred, of quartz vein had been estimated in some way, and mineralization zone can be assumed based on the results of geological travers and drilling to be dipped southward steeply on the quartz veins. Therefore the site of mineralization zone is intensely affected by a plunge accompanied with deflection of quartz veins.

Mineralization is intense, for native gold grain was observed under microscope in the third year and high grade part with a grade of 56.23 g/t Au was extracted through the surface survey this year. The homogenization temperature of fluid inclusion in quartz veins of the alteration zones range from 92 to 274℃. Only one sample gives the temperature of the most adequate for gold mineralization (180 to 230℃) and another shows high value of 274℃. Except for those two, estimated values show the lower temperature condition ranging from 92 to 160℃.

All above things and the results of past years' survey considered, it can be concluded that gold ore deposit is possible to exist deep underground, more than 200m depth from the surface, in the survey area.

5-2 Recommendation

It is confirmed that a high grade gold ore deposit is possible to exist in the Chontali area where this year survey was conducted. It can be assumed however, that inferred gold mineralization zone plunges intensely affected by the deflection of quartz vein.

When the full scale survey will be resumed in the Chontali area, the following three points must be emphasized to extract the actual mineralization zone.

1. Detailed sampling to confirm the grade

To confirm the grade of quartz vein at outcrop, channel sampling in every 2 to 5m should be conducted. This allows to clarify horizontal mineralization condition, and to assume the three dimensional mineralization condition for enriched mineralization part by taking the structure of quartz vein into consideration.

2. Horizontal panel drilling

Drilling must be conducted towards the mineralization zone expected by the above-shown survey at more than two holes to confirm its horizontal extent and mineralization condition deep underground at more than 200m depth from the surface. It is advisable if three holes, one towards the center of the expected mineralization zone and the other two towards both sides of the center, will be drilled as one unit.

3. Vertical panel drilling

Drilling must be conducted also deep underground to confirm the extension towards the direction of plunge expected by surface survey and drilling shown above, and then three-dimensional mineralization could be confirmed.

PART II PARTICULARS

CHAPTER 1 GEOLOGICAL SURVEY

1-1 Purpose and Procedure of the Survey

The Chontali area concerns the zones where anomalies were extracted through geochemical survey using stream sediments by INGEMMET as a part of the "Proyecto Integral Chincipe".

The first year survey included a semi-detailed survey combined with a geochemical survey over a total area of 300 km2 in the northern part of the anomalous zones developed in the area. Through the survey, confirmed were a mineralized alteration zone including numerous quartz veins and overlapping geochemical anomalies of gold and silver.

During the second year survey, detailed geological survey combined with geochemical survey was conducted over a total area of 42 km2 including the extracted geochemical anomalous zone. Geophysical survey using CMSAT method (35 km2) was conducted in the northern part of area where semi-detailed geological survey was performed. As a result of these surveys, it is confirmed that quartz vein exists in a silicified-argillized alteration zone and which was represented as low resistivity zone. A swarm of quartz veins loated at the center of the alteration zone corresponds a rise of resistivity basement extracted as high resistivity zones. Moreover, a high grade part is confirmed in quartz vein in which values are as high as 16.15 g/t Au and 12.95 g/t Ag at the outcrop.

During the third year phase, gravity survey was performed in the area where geophysical survey using CSAMT method was also conducted (33km2). Drilling was conducted by vertically fan-shaped method, in which two holes were drilled at each of three sites and total hole length reached 1332.51m. As a result of the gravity survey, it is confirmed that the high density basement is extracted almost coinciding with resistivity basement. Just above this high density basement, a shallow high density zones were extracted and they almost coincide with zones of dense quartz vein occurrence. It is suggested by drilling that the high density zones of the central part of the alteration zones are closely related with carbonitization rich in Mn, Fe and Mg. Quartz vein extracted by drilling exists in breccia (fracture) zone and it is suggested that quartz vein could tend to have plunge as it is pinched out or branched within the fracture zone.

The fourth year survey was conducted in order to verify the distribution and structure of quartz vein and to determine the direction of its plunge. The purpose was also to verify the distribution of grade in quartz vein at outcrops and mineralized conditions. As a result of the survey, drawn up were route maps on the scale of 1/2,000 and distribution map of quartz vein on the scale of 1/5,000. The survey was carried out along measuring lines, which were drawn using string tape (100 m) and pocket compasses, to confirm the locality of quartz vein. If a quartz vein was extracted, outcrop sketching on the scale of 1/500 and channel sampling were conducted at measuring points in every 10m along the measuring line. Measuring lines were closed with each other, except for a part of northern survey area. The revision of error of closure was made in terms of horizontal distance.

As there exist no triangulation station nearby, the altitude was measured based on that at the center of the quartz vein outcrop situated in MJPC-3 and -4 sites of last year survey. The altitude of the center was measured on the topographical map on the scale of 1/25000 published by IGN (Instituto Geologico Nacional). The revision of error of closure was made in terms of relative height. Topographical map was compiled using such data as those of the second year which could be confirm the starting point of measuring and be connected with this year data and those between the drilling sites of the third year. Topographical map was drawn for the areas lacking of measuring data in the use of aerophotos on the scale of almost 1/60,000 to confirm the direction of valley and ridge. Unsurveyed quartz veins were indicated, taking topography into consideration, based on the results of detailed geological survey of the second year.

Ore samples were analyzed at Chemex Labs Ltd. in Canada.

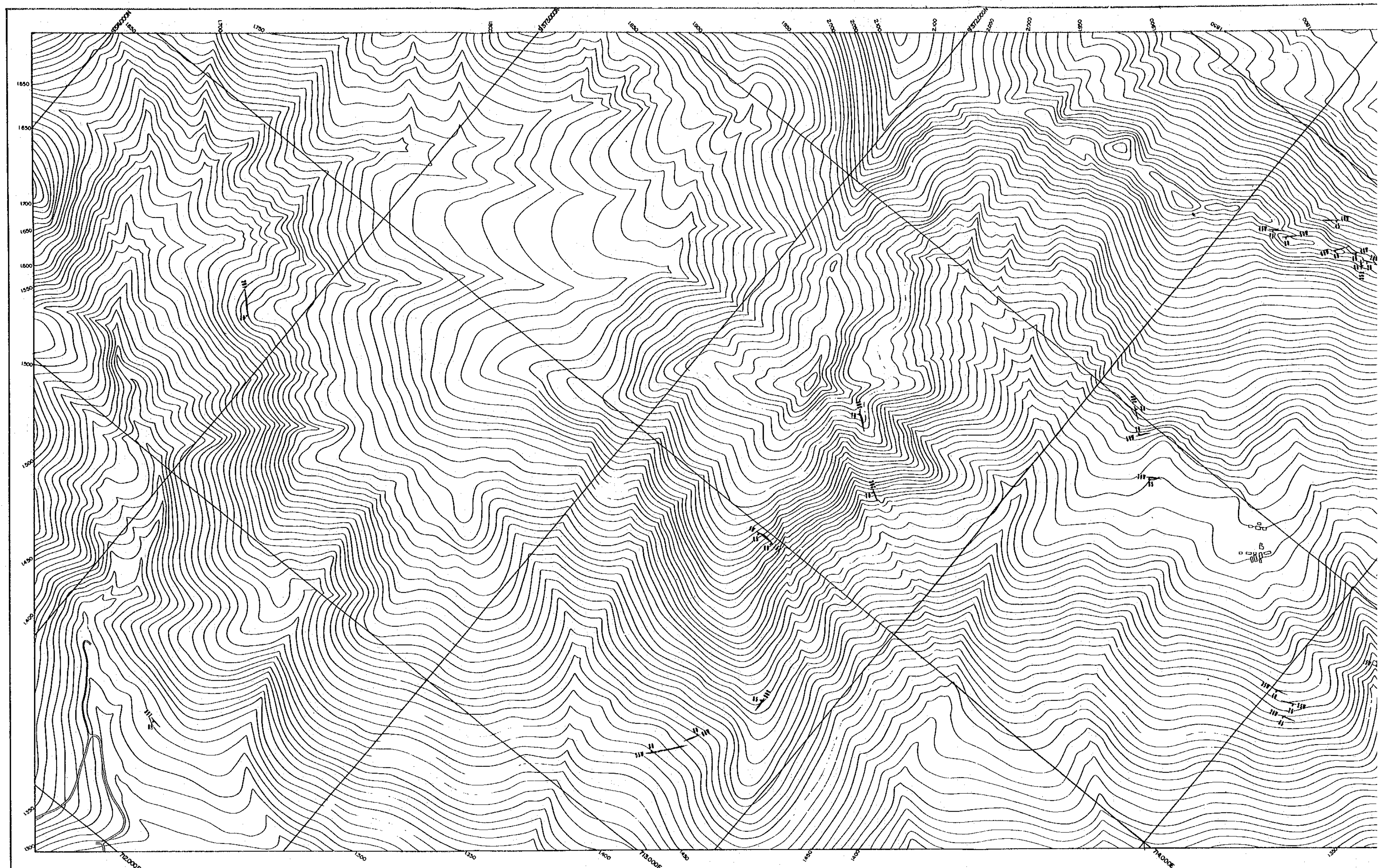
1-2 Survey Result

The distribution of quartz vein outcrops is shown in Fig. II-1 and is characterized by concentration on the slope close to the apex of gravity basement, especially from eastern to the southern slopes and from southeastern to southern slopes where quartz vein develops towards lower altitude.

Strike of quartz vein is dominant in the direction of NW-SE and rarely of NE-SW. The former direction coincides with that of gravity basement and the latter with that of dominant fissure system verified through the second year survey. If the rise of gravity basement can reflect the intrusion structure of basement granitic rocks, it is inferred that quartz vein has been formed along the extension fracture associated with the granite intrusion.

Quartz vein is up to 8m in width and 200m in length of strike side, averaging 2 to 3m in width and 50 to 100m in length. The vein develops almost always closely associated with each other as parallel vein of echeron type. The plunge of quartz vein is inferred to be controlled by the intersection of quartz vein with crossing fissure and/or deflection of quartz vein itself. An example of the evidences verified in this year survey are shown in Apx. 7-1. The vein is found at MJPC-7 and 8 of last year survey. The plunge of crossing of a fissure (N10° E, 75° W) with a quartz vein (N45° W, 85° NE) is estimated by stereographic projection to be N40° W, 61° . While the plunge of deflection is estimated to be 57° W, 85° at the crossing of N25° W, 85° SW and N55° W, 80° SW, and N53° E 18° at the crossing of N55° W 80° SW and N50° W, 85° NE.

As for the alteration relationship between quartz vein and its country rocks, it has been referred in first and second year survey that quartz vein exists in silicified and silicified-argillized alteration zones. Through the X-ray diffraction analysis, it is verified that kaoline is sometimes associated with quartz in the quartz vein concentration zone near the apex of Hualatan west. It suggests that quartz vein was formed under acidic environment. In the eastern part gypsum(Apx. 4, 5; T1601) is found filling the fissure of country rock in which halotrichite is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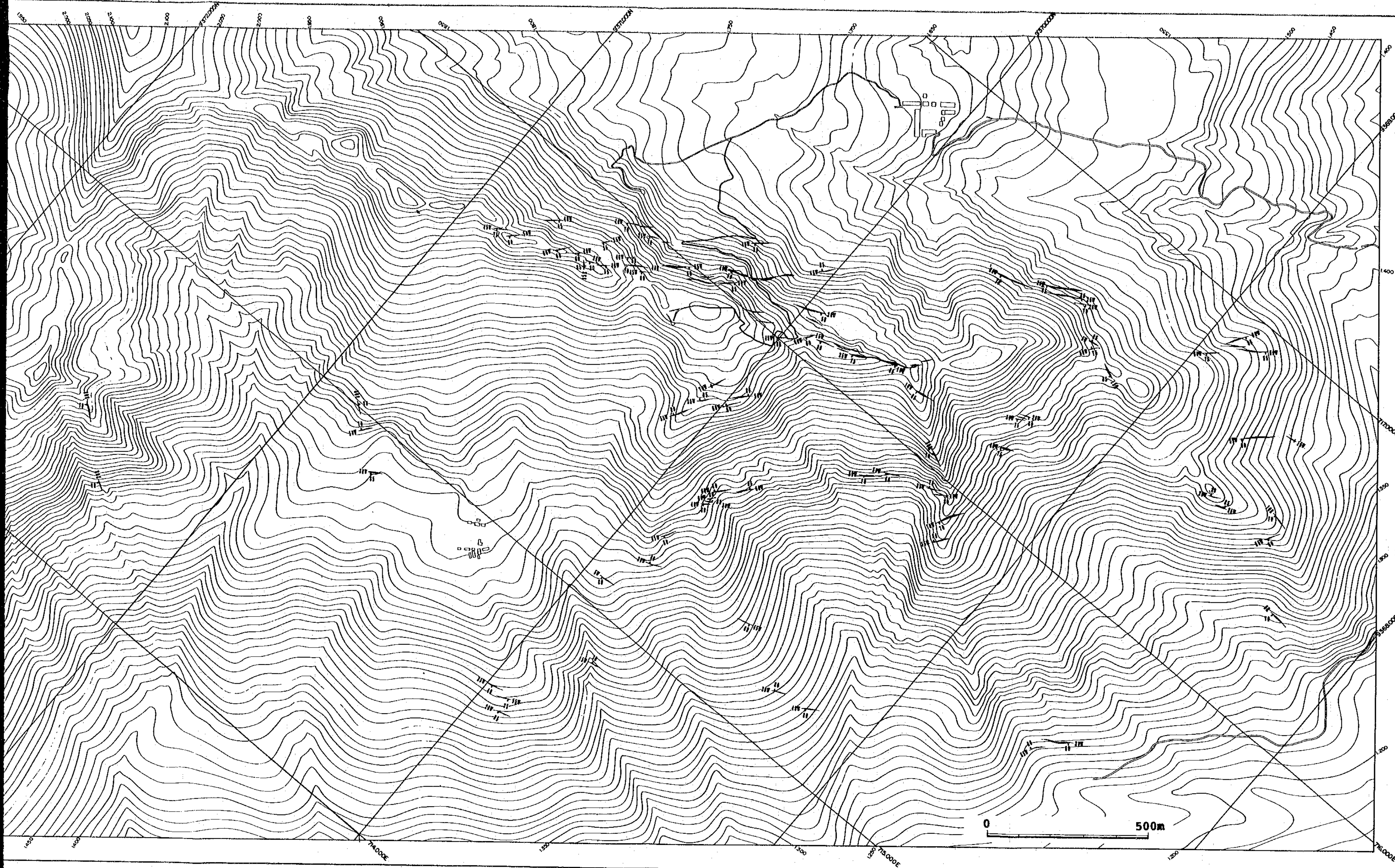
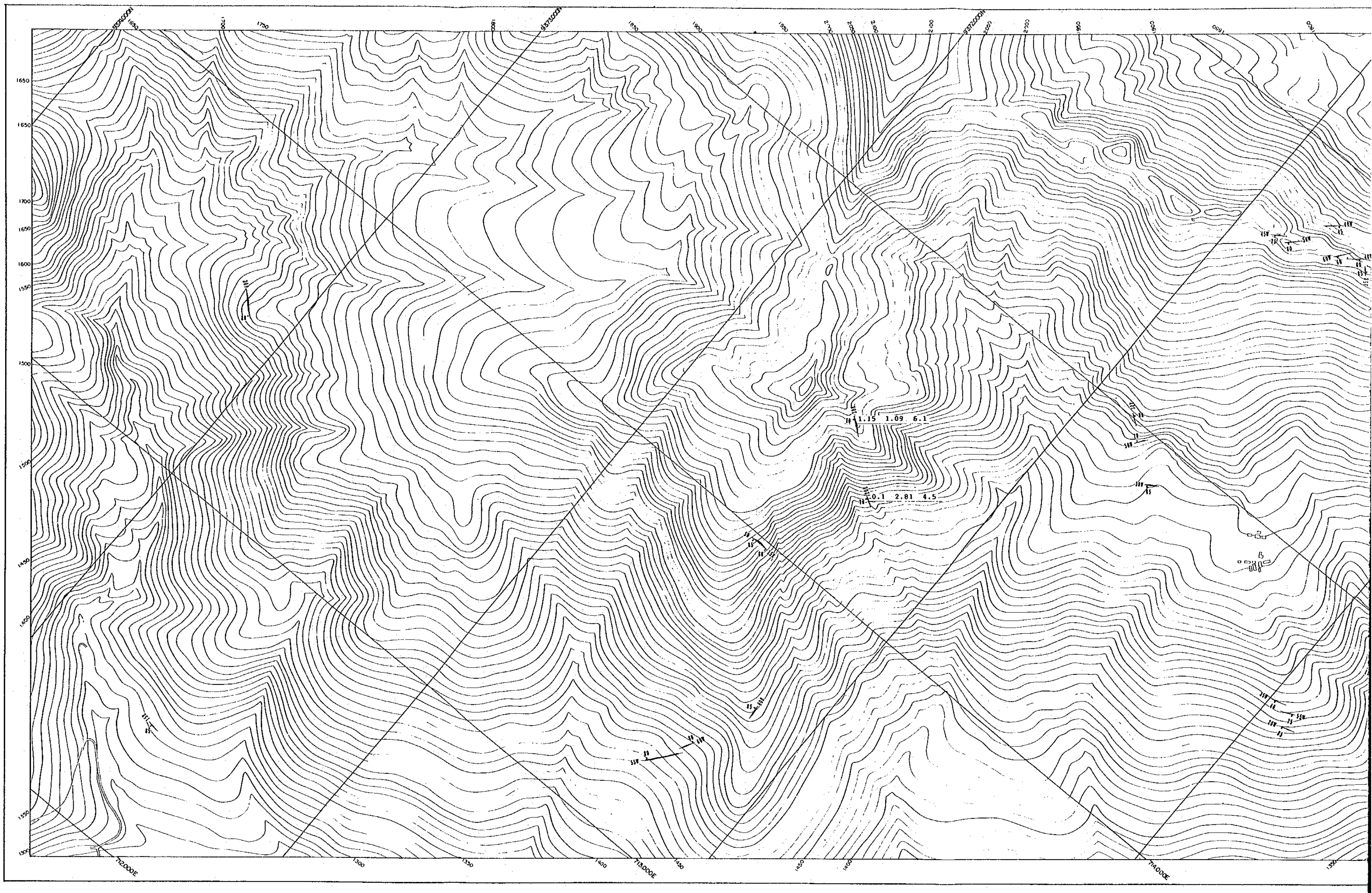


Fig. II-1 Distribution of Quartz Vein in the Chontali Area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0.1 2.81 4.5
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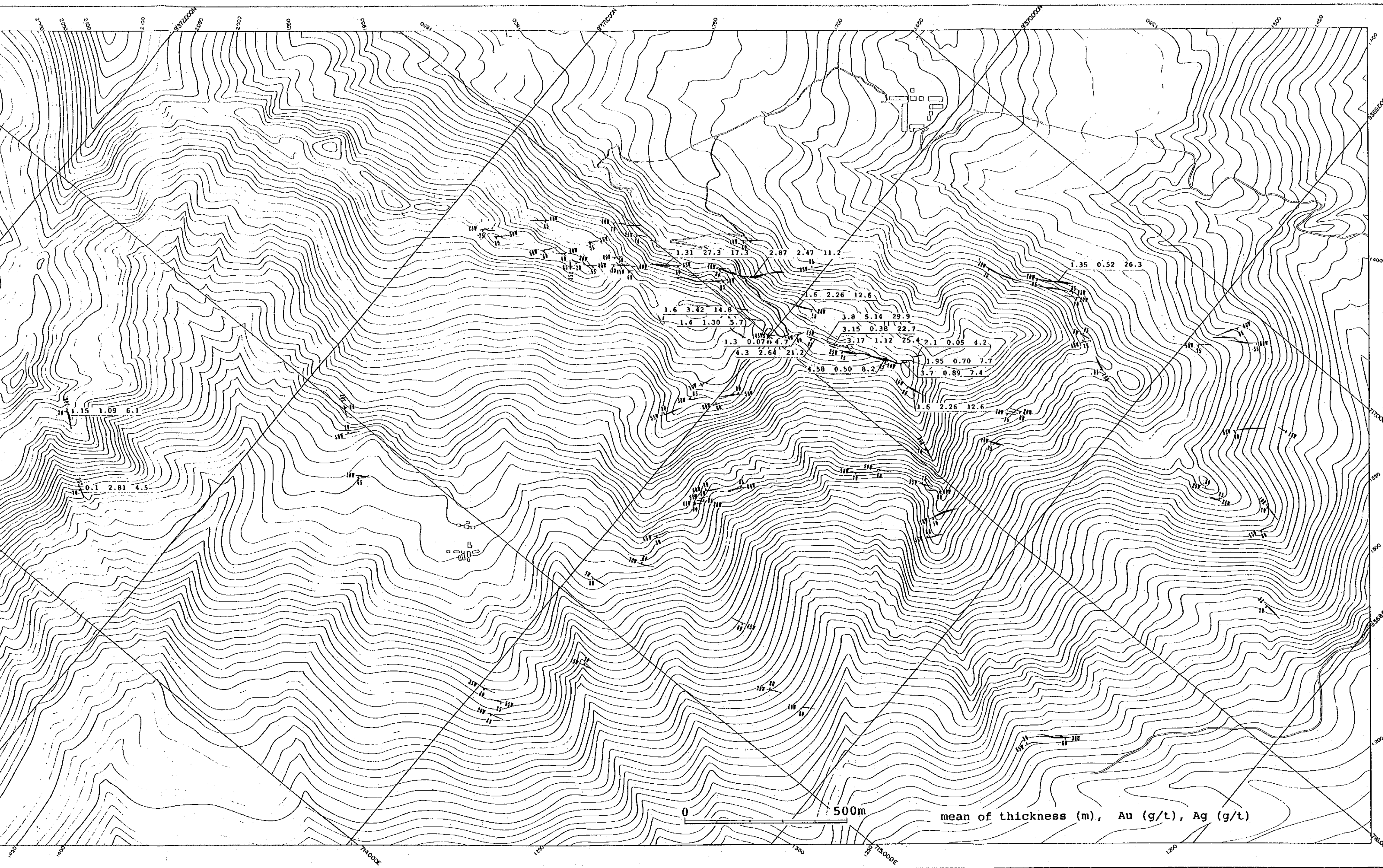
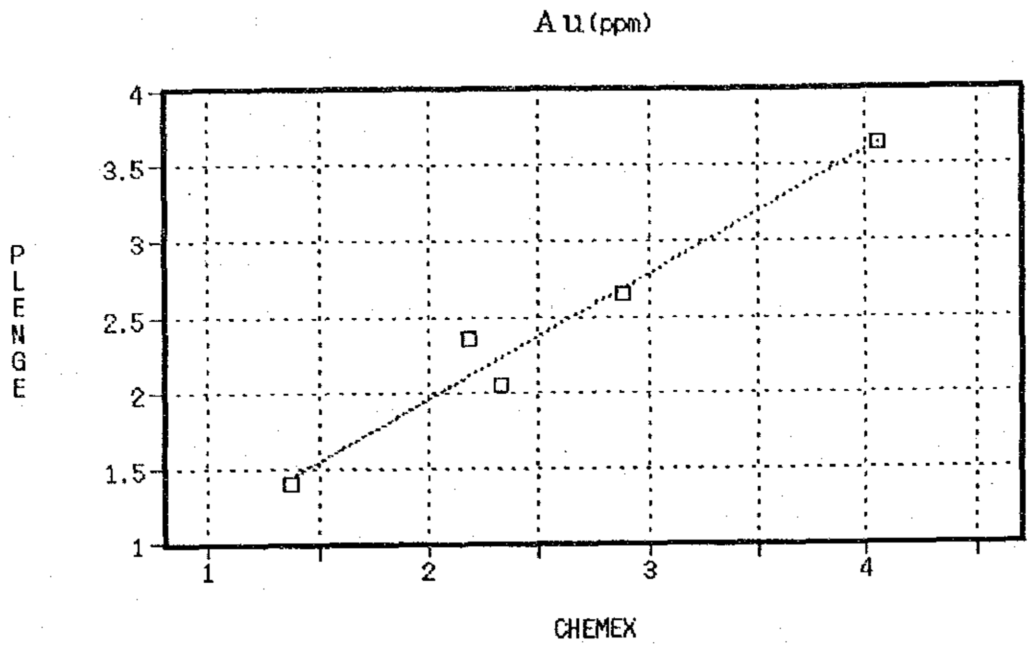


Fig. II - 2 Assay Results of Quartz Vein in the Chontali Area



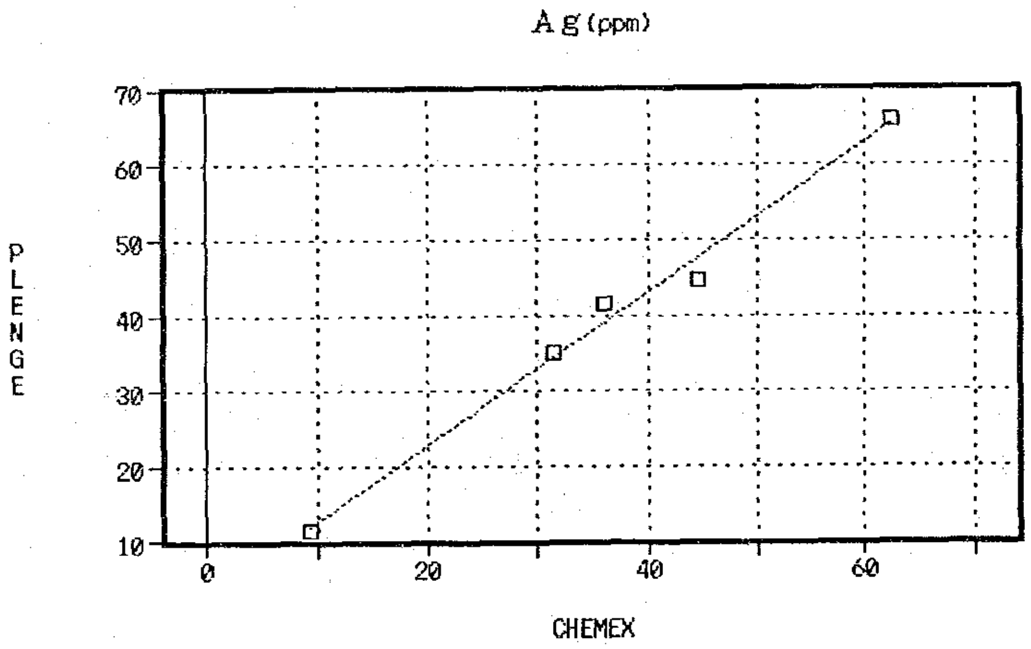
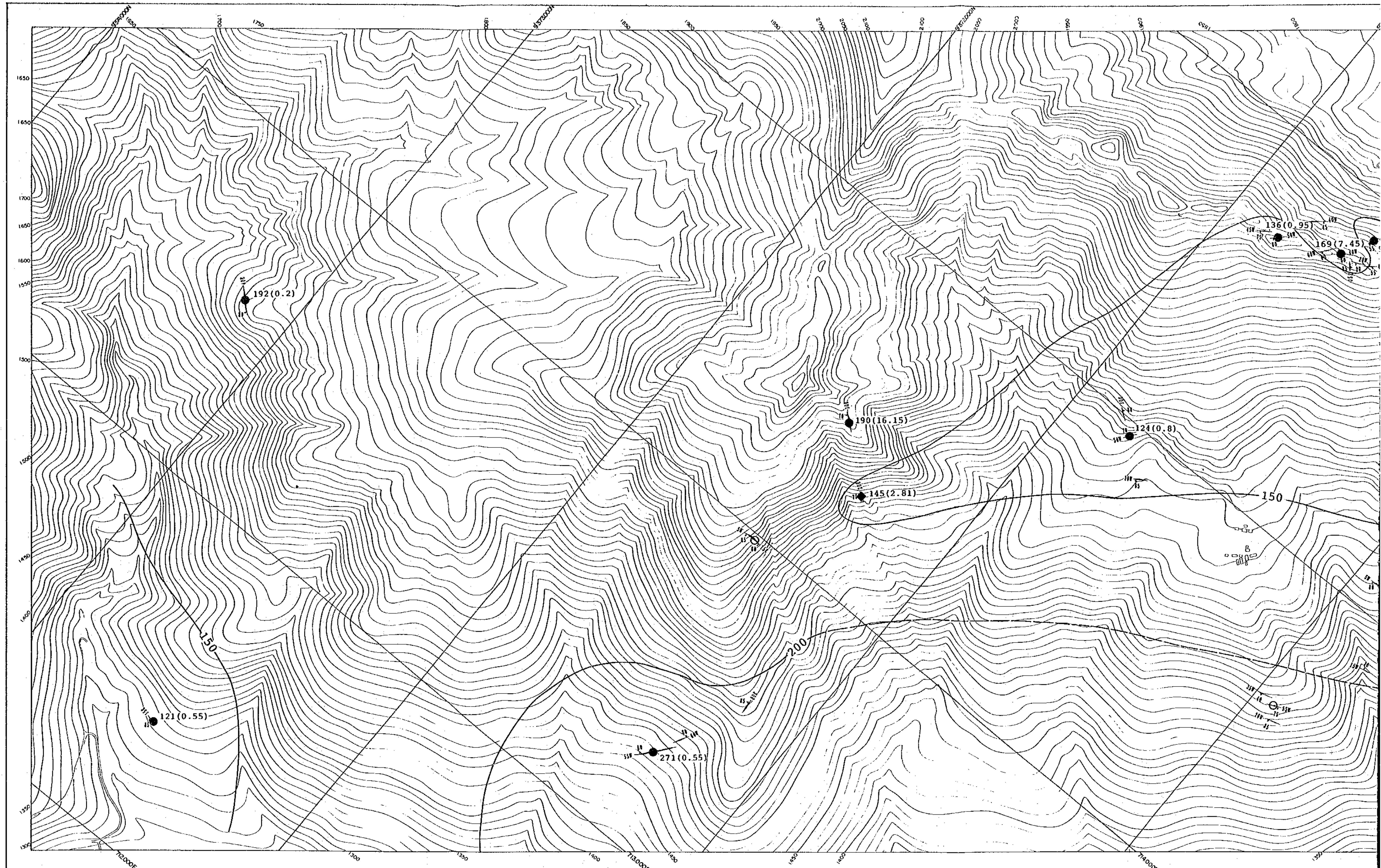


Fig. II - 3

Correlation of Assay Results between PLENGE and CHEMEX

Table II-1 Correlation of Assay Results between PLENGE and CHEMEX

Drill No.	Depth (m)	Sample Length (m)	Assay Result			
			PLENGE		CHEMEX	
			Au(g/t)	Ag(g/t)	Au(g/t)	Ag(g/t)
MJPC-1	52.45 - 52.75	0.30	3.65	11.5	4.05	9.3
	131.9 - 133.8	1.90	2.65	35.0	2.88	31.5
MJPC-2	193.5 - 194.15	0.65	1.40	41.5	1.37	36.0
MJPC-3	203.5 - 204.5	1.0	2.35	44.5	2.19	44.6
MJPC-5	121.45 - 122.6	1.15	2.05	66.0	2.33	62.4


192(0.2)
190(16.15)
124(0.8)
145(2.81)
136(0.95)
169(7.45)
121(0.55)
271(0.55)
150
150
200
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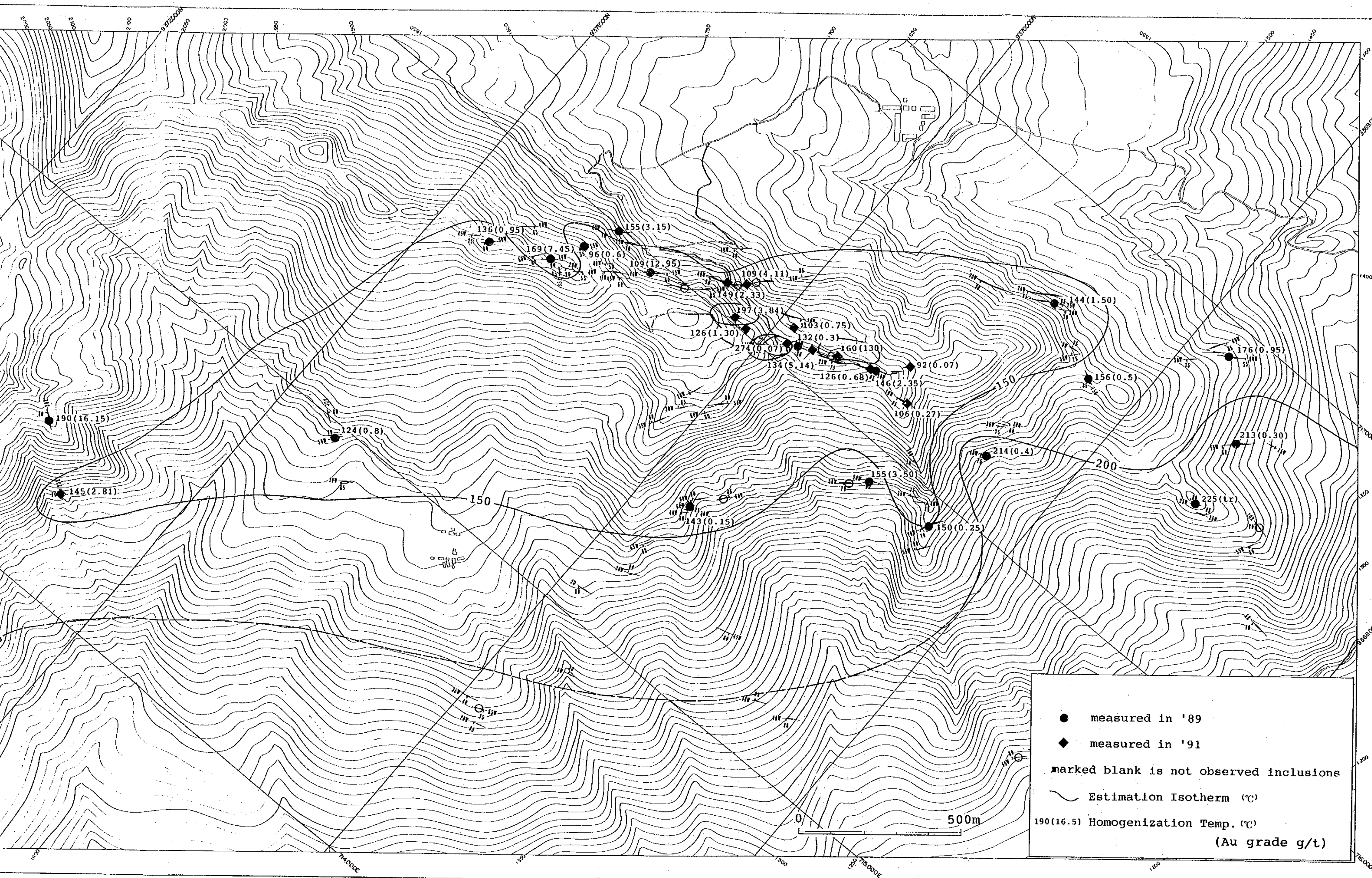


Fig. II - 4 Distribution of Fluid Inclusion Homogenization Temperature of Quartz Vein in the Chontali Area

detected. Therefore acidic environment has been maintained until under relatively lower temperature. As carbonate minerals which were often found in drill cores of last year survey, calcite (Apx. 4, 5; T1204, T1205) is observed in the surface sample from eastern fringe but no carbonates with heavy metal can not be found.

Analyzed results for quartz vein are shown in Apx. 6 and Pl. 3. Averaged value is also given in Apx. 6 and its distribution is shown in Fig. II-2.

The results of cross check between PLENGE and CHEMEX analyses are shown in Table II-1 and Fig. II-3. Both analyses are relatively in good correlation, considering that the compositions of Au and Ag tend to change at every locality. The correlation coefficients for Au and Ag are 0.967 and 0.989 respectively. Analyzed result of Au by CHEMEX tends to be rather lower for low-graded samples and higher for high-graded ones than those by PLENGE. Date of Ag by PLENGE are always higher than those by CHEMEX.

The regression equations are as follows:

Au $Y_{Au}=0.8225144\,X_{Au} + 0.3110729$

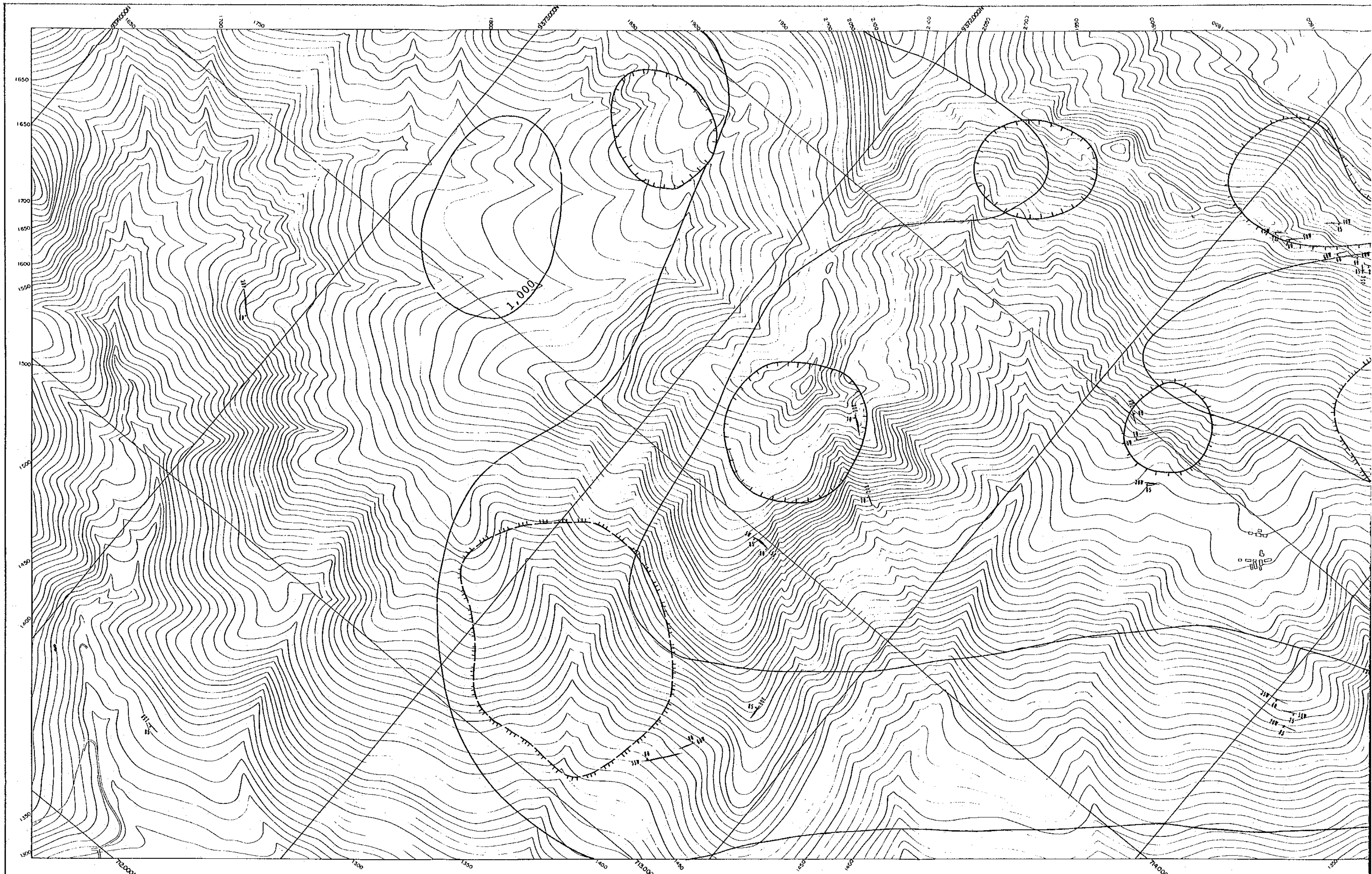
Ag $Y_{Ag}=1.0056742\,X_{Ag} + 2.7314151$

Y: grade analyzed by PLENGE

X: grade analyzed by CHEMEX

The highest value detected through this year survey is Au 56.23 g/t (H1504) and the sample was collected from quartz vein which was the object of drilling at MJPC-3 and -4 last year. The distribution of grade in quartz veins is shown in Apx. 7. There seems to exist no distinct tendency in the distribution but those distributed in the fringe tends to be relatively higher-graded in the northwestern margin of each outcrop.

The results of homogenization temperature for quartz veins and their spatial distribution are shown in Apx. 3 and Fig. II-4 respectively. The results are generally in harmony with those by second year survey, but it is remarkable that relatively higher part than 150℃ is confirmed in the summit area where low temperature part was inferred to develop through the second year survey.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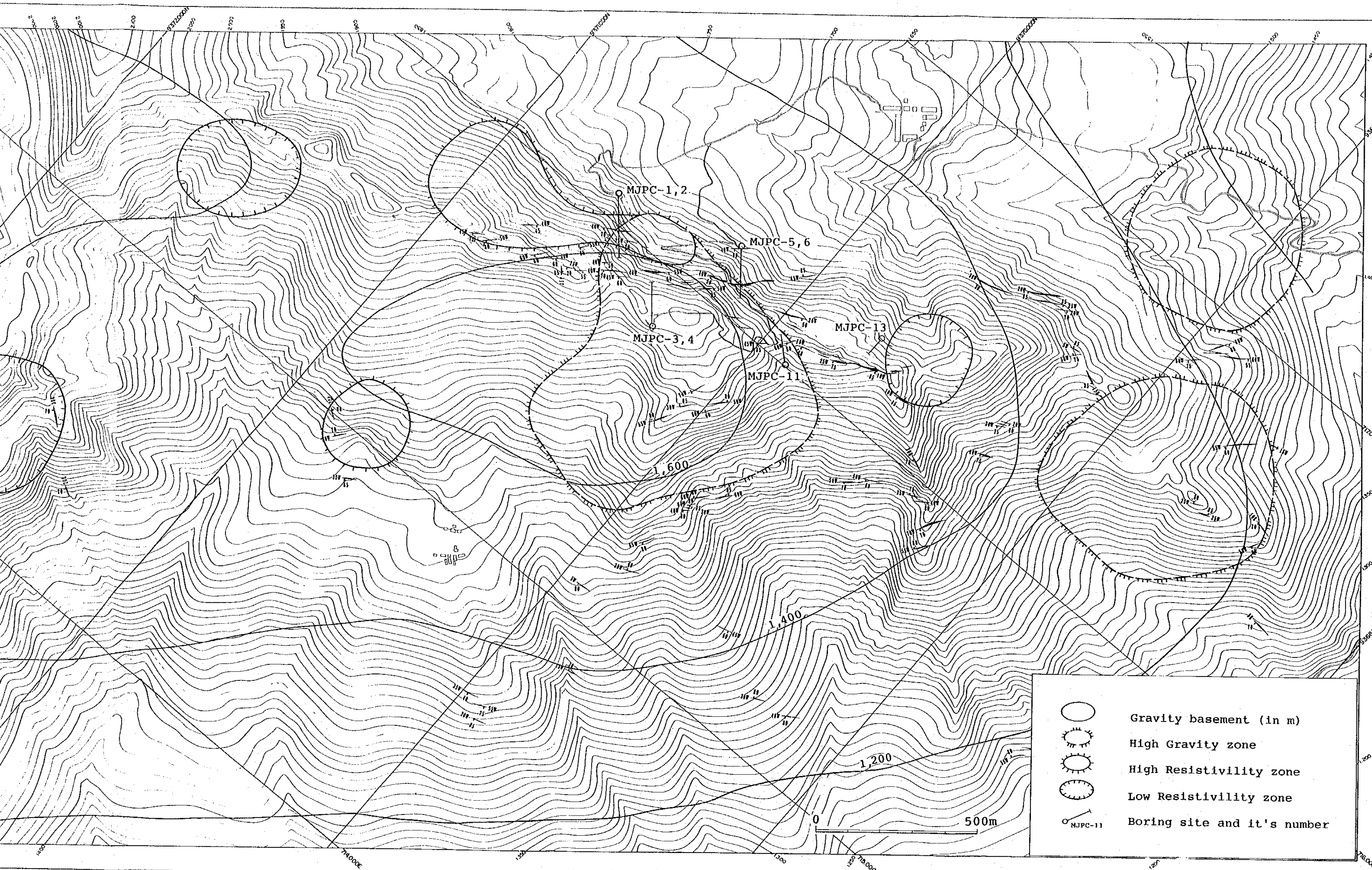

Fig. II - 5 Location of the Drillings with showing Geophysical Survey Results in the Chontali Area

CHAPTER 2 DRILLING SURVEY

2-1 Purpose of the Drilling

As described in the previous chapter, quartz vein in the survey area exists in breccia (fracture) zone and it is suggested that quartz vein could tend to have plunge as it is pinched out or branched within the fracture zone. Therefore, drilling was conducted in order to verify the plunge of quartz vein and mineralized zone and/or enriched part by comparing the grade of surface outcrops with that of drilling core.

2-2 Drilling Operation

2-2-1 Outline of the Survey

Diamond drilling was performed taking the local drilling company into employment, under the direction of the drilling engineer, who stayed during the operation. Drilling was conducted using two set of rigs, model L-44 with maximum capacity of up to 1060m (BQ).

Operations were conducted in three shifts of 8 hours each under the direction of a foreman. A party of each shift is constituted by one local foreman and five operators. The wire-line method was adopted as well as using a bit at least larger than NX to get high core recovery and high operation efficiency.

Drilling covers 31 days, from June 30 to July 30, 1991 and amount of the drilling at each hole is as follows:

Boring hole	Hole length(m)	Core length(m)	Core recovery(%)
MJPC-11	145.3	143.25	98.6%
MJPC-13	75.4	73.95	98.1%

2-2-2 Drilling

1) Transportation of rigs and materials

Drilling rigs and materials were transported from Lima to Puente Blanca by big trucks, from Puente Blanca to Las Penas by medium-sized trucks, from Las Penas to Huaratan by small trucks and four-wheels driving mini-trucks, and from Huaratan to the drilling sites by cows, horses and by human power.

2) Construction of hauling routes and drill site preparation

Repair work of road from Las Penas to Huaratan and to existing drilling sites, construction of routes and drill site preparation was performed by human power.

3) Setting up

Setting up of rigs and drilling operations was made in the order of hole number MJPC-11 and -13.

4) Water transportation

Water sprung out from MJPC-5 and 6 holes which were drilled last year was once deposited and transported using hoses of 1 inch in diameter and pumps. Preparing for a period of water shortage, water from a stream, north of Huaratan, was transported to the deposit using hoses of 1 inch in diameter and pumps.

5) Driiling operation (Apx. 8-1)

(i) MJPC-11 direction 42° inclination -50°

Period	from July 11 to July 30, 1991
Hole length	150.0 m
Core length	143.25 m
Core recovery	98.6 %

0.00-100.5m

Drilling was performed using NC-WL diamond bit with bentonite mud water until 100.5m. Between 10.25 to 19.45m, rocks were fractured and destroyed and all mud water was lost, and HQ diamond bit was used to extend the hole and HW casing pipe was set until 20.95m. Between 60.3 to 64.7m, wall were destroyed and all mud water was lost and cementation was performed. Failed to stop the lost, and the drilling was continued after injecting grease. After reaching 100.5m, NW casing pipe was set. The rock is altered tuff.

100.5-145.3 m

Drilling was performed using NX-WL diamond bit with bentonite mud water. Until reaching the bottom, loss of mud water was not stopped and the drilling was continued after injecting grease. The rock is altered tuff. Quartz vein was confirmed in 138.0-140.15m.

(ii) MJPC-13 direction 271 inclination -30°

period	from July 22 to July 30, 1991
hole length	75.4 m
core length	73.95 m
core recovery	98.1 %

0.00-75.4 m

Drilling was performed using NC-WL diamond bit with bentonite mud water until 75.4m. Between 3.5 to 9.95m, rocks were broken loose and mud water was lost. Then it came the soft zone and the rocks were intensely destroyed and HW casing shoe was used to extend the hole and HW casing pipe was set until 26.6m. At 62.8m, all mud water was lost, failed to stop the lost, and the drilling was continued after injecting grease until reaching 75.4m. The rock is altered tuff.

2-3 Result of Drilling

During the drilling, the survey was suspended for security, thus the observation of drilling cores could not be conducted. However the geological drilling log (Apx.8) was made based upon the data on drilling procedure by the drilling company, on surface observation and on observation by counterparts.

Geological outline of each hole is as follows:

1) MJPC-11 (Location 9'369,898N, 716,007E)

m m	
0 - 23.9	Weathered lapilli tuff with limonite
23.9 - 54.45	Argillized-silicified lapilli tuff
54.45- 60.3	Silicified lapilli tuff
60.3 - 91.15	Argillized-silicified lapilli tuff

Between 74.95 and 80.85m rocks were intensely destroyed and the extention of quartz vein cropping out on the surface was missed(?).

91.15-109.35	Silicified lapilli tuff
109.35-117.4	Argillized-silicified lapilli tuff
117.4 -138.0	Silicified lapilli tuff
138.0 -140.15	Quartz vein mineralized by sulfides
140.15-145.3	Silicified lapilli tuff

2)MJPC-13 (Location 9'369,726N, 716,257E)

m m	
0 - 53.2	Weathered lapilli tuff with limonite
53.2 - 66.45	Weathered lapilli tuff
66.45- 75.4	Silicified lapilli tuff

The relationship between quartz vein extracted at MJPC-11 and surface outcrop is shown in Fig. II-6. At the northernmost outcrop quartz vein has horizontal width, almost same as that of 1.88m extracted by drilling. If it is assumed that both veins coincides with each other, the plunge of the quartz vein is estimated to be S85° W, 70° .

Quartz vein extracted at MJPC-11 is distinctly mineralized by sulfides. Main constituent of sulfides is pyrite with lesser amount of chalcopyrite and sphalerite. The counterpart in Peru reported the existence of tetrahedrite. Therefore it is possible that the area has undergone gold-silver mineralization.

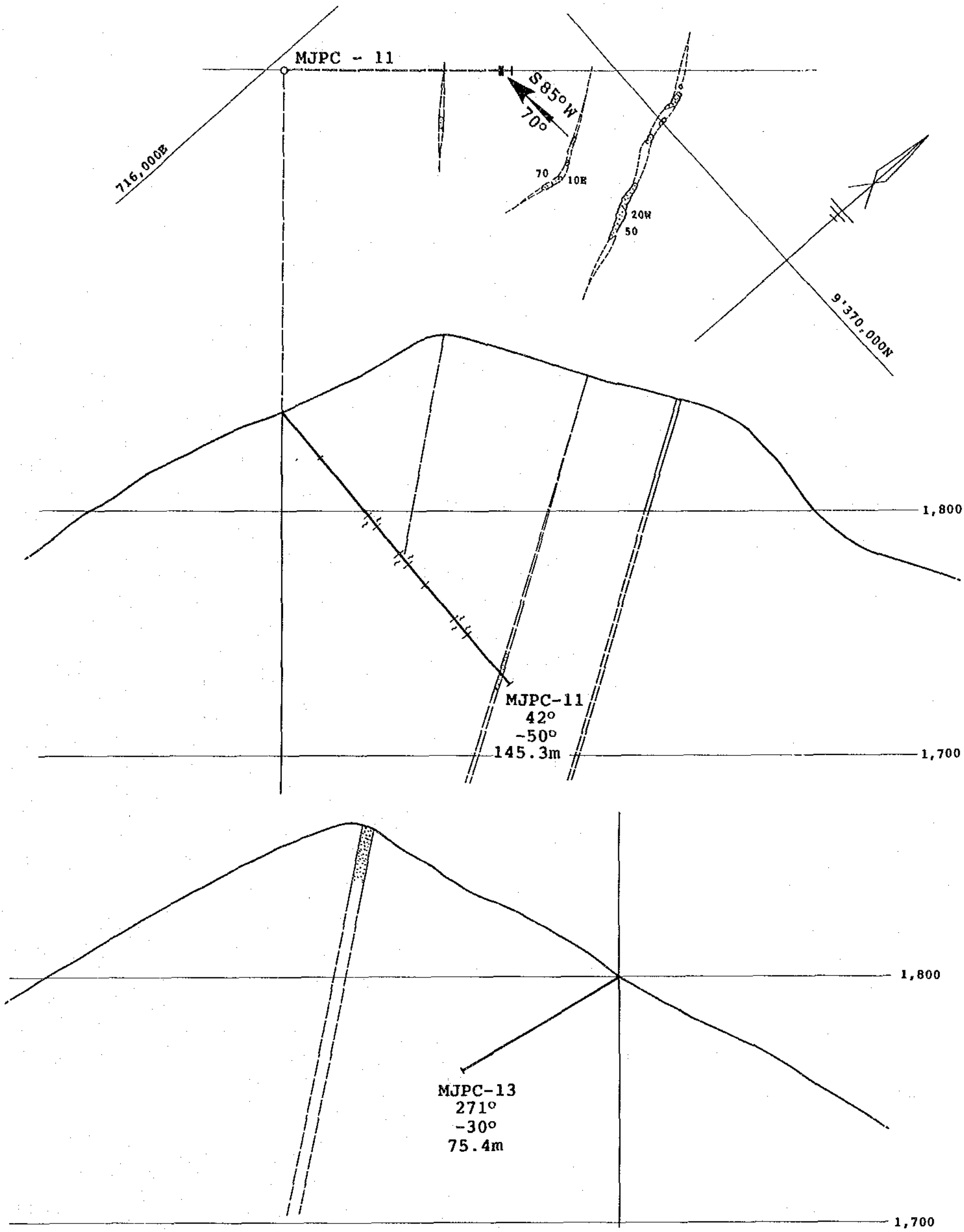

Fig. II -6

Generalized Profiles of the Drillings in the Chontali Area

PART III CONCLUSION AND RECOMMENDATION

CHAPTER 1 CONCLUSION

It is clarified, through this year survey in Chontali area, that subordinate fissure systems trending NE-SW and NW-SE branched from regional fissure system in acidic pyroclastic rocks. Mineralization was taken place through the fissure systems.

It is concluded that alteration-mineralization occurs along the relatively large-scaled NW-SE fissure zone developed between the regional NE-SW fault system in Oyotún Volcanics correlatable to Jurassic. The fissure zone, although unclear on the surface, is extracted as distinct breccia zone in drilling cores and quartz grain in it microscopically shows distinct wavy extinction, therefore it is assumable that the tectonic movement which is represented after formation of quartz vein. The basement structure inferred by the resistivity survey clarified, through the gravity survey, that the gravity basement has higher density of 2.8 g/cm3. The value is higher than that of inferred basement granitic rocks. It, therefore, may well be said that basement granitic rocks have undergone carbonitization rich in heavy metal to make the density higher, as observed in drill core. Carbonitized alteration zone was also confirmed on the surface in the southwestern part (western foot of the hill) close to the granitic body.

The plunge of quartz vein expected to exist was confirmed in the drill hole of MJPC-11. Namely quartz vein, although the outcrop is unclear on the surface right above the vein in MJPC-11, with the horizontal width of 1.88m was intersected by drilling of MJPC-11. At the northernmost outcrop quartz vein has horizontal width almost same as that intersected by drilling. If it is assumed that quartz vein on the surface continues to that intersected by drilling, the plunge of the quartz vein is estimated to be S85° W, 70° . The plunge was also estimated by detailed sketch at outcrop. Intersection of quartz vein and crossing fissure and of deflection are estimated by stereographic projection to be N30° W, 61° , and 57° W, 85° and N53° E, 18° respectively. Summarizing above results, grade of outcrop and last year results of drilling, it can be assumed that the mineralization zone dips (has plunge) steeply southward, and therefore intensely affected by the deflection of quartz vein.

Native gold is confirmed by microscopic observation last year and high grade part with a grade of 56.23 g/t Au was extracted through the surface survey this year. Moreover ore minerals containing such metals as silver, copper, zinc and lead are closely associated with each other in drill cores. The mineralization environment, therefore, is assumed to be xenothermal.

The results of homogenization temperature of fluid inclusions in quartz veins of the alteration zones range from 92 to 274℃. Only one sample gives the temperature of the most adequate for gold mineralization (180 to 230℃) and another shows high value of 274℃. Except for these two, estimated values suggest the lower temperature condition ranging from 92 to 160℃.

All things considered, it can be concluded that gold ore deposit is possible to exist deep underground, more than 200m depth from the surface, in the survey area.

CHAPTER 2 RECOMMENDATION FOR THE FUTURE SURVEY

It is confirmed that high grade gold ore deposit is possible to exist in Chontali area in which this year survey was conducted. It can be assumed, however, that inferred gold mineralization zone plunges intensely affected by the deflection of quartz vein.

When the full scale survey will be resumed in the Chontali area, the following three points must be emphasized to extract the actual mineralization zone.

1. *Detailed sampling to confirm the grade*

To confirm the grade of quartz vein at outcrop, channel sampling in every 2 to 5m should be conducted. This allows to clarify horizontal mineralization condition, and to assume the three dimensional mineralization condition for enriched mineralization part by taking the structure of quartz vein into consideration.

2. Horizontal panel drilling

Drilling must be conducted towards the mineralization zone expected by the above-shown survey at more than two holes to confirm horizontal development and mineralization condition deep underground at more than 200m depth from the surface. It is advisable if three holes, one towards the center of the expected mineralization zone and the other two towards both sides of the center, will be drilled as one unit.

3. Vertical panel drilling

Drilling must be conducted also deep underground to confirm the extension towards the direction of plunge expected by surface survey and drilling shown above, and the three-dimensional mineralization could be confirmed .

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APPENDIXES

Apx. 1 Microscopic Observations of Thin Section

Apx. 1 Microscopic Observations of Thin Sections

Sample No.	Rock Name	Geol. unit	Texture	Grain/Phenocryst/Main component mineral: Rock fragment	Quartz	Plagio-clase	Biotite	Horn-blende	Matrix/Groundmass/Accessory mineral: Quartz	Plagio-clase	Apatite	Glass	Opaque mineral	Secondary mineral: Quartz	Chlorite	Sericite	Epidote	Clay mineral	Carbo-nate	Rutile	Opaque mineral	Remarks
H0801	Andesitic tuff	Oy	clastic	○ 3×5 →Chl, Ser p.Ep·Op·Rt		△ 0.74×0.9 →Chl	? →Ep, Chl 〔m.	○ 1×1.34 Ser, Pl, crystal〕		◎ 0.02 tabular Z 〔m.crystal〕	• 0.03	• →Chl	△ 0.21×0.27 irregular Hematite		•	△ 0.04	○ 0.1×0.2	•			•	Rock fragments are angular shape as like breccia. An origin of fragments may be from lava flow.
H1401	Andesite	Oy	holocrystal. seriate	• 5×7.5		◎ 1.3×1.9 wZ, T →Ser, Chl, Ep	? →Chl Ser	○ 1.62×2.86 p.Ep·Op			△ 0.1×0.14 granular		△ 0.58×0.74		○	•			• with Chl irregular			Chloritizarion is remarkable. Original texrure is indistinct by alteration. It is not obserbed reaction rimb near the srounding of the rock fragments.
	Rock fragments of H1401	Oy	holocrystal. equigranular			○ 0.5×0.6 →Ser, Chl	→Chl Op	◎ 1.44×4.8 p.Ep·					△ 0.54×0.7		○	•	△ 0.04				△	Original rock may be dioritic one.
T1204	Andesitic tuff	Oy	clastic	○ 8×8 →Chl, Carb	• 0.38×0.5 fragmental	◎ 0.84×1.34 →Ser, Chl, p.Carb	→Chl p.C	○ 0.4×0.82 Op, arb		○ 0.04×0.14 granular	• 0.1×0.12 granular		• 0.11 irregular aggregate		○	△			○		△	Rock fragments is originated lava flow so that ground mass plagioclase is lath shape and shows trachytic texture.
T1301	Silicified breccia	Oy	clastic (breccia)	○ 4×5 →Qz, Ser	◎ 0.6×0.8 w.ext				○				○ 2.4 Hematite Limonite	◎		○						Original texture is destroyed completely. Breccciation is partly obserbed. Quartz in ground mass and in fine veinlets shows wavy extinction but in rather large vein with acompamying hematite, wavy extinction is not recognized.
J2701	Dacitic tuff	Oy	clastic	△ 2.3×3.2	• 0.14×0.16 w.ext	○ 1×2.04 →Ser, Qz			○				• aggregate Limonite	◎		◎				△ 0.03×0.06	△	Original texture is indistinct, but rock fragment-like texrure is observed partly. Quratz crystal in vein gradually changes in diameter larger from the outside (0.2×0.3) to the center (0.64×1.4).

◎:abundant ○:common △:few •:rare 0.38×0.5 : maximum size (mm)

Abbreviations: Carb:Carbonate, Chl:Chlorite, Ep:Epidote, holocrystal.:holocrystalline, m.crystal:micro-crystal (undistinguished), Op:Opaque minerals, Oy:Oyotun volcanics, p.:partly, Pl:Plagioclase, Qz:Quartz, Rt:Rutile, Ser:Sericite, T:twin, w.ext:wavy extinction, wZ:weak zoning, 〔 〕:as inclusion, →:altered to

Apx. 2 Microscopic Photographs of Thin Section

Abbreviations

Ca : carbonate

Chl : chlorite

Ep : epidote

F : rock fragment

Op : opaque mineral

Pl : plagioclase

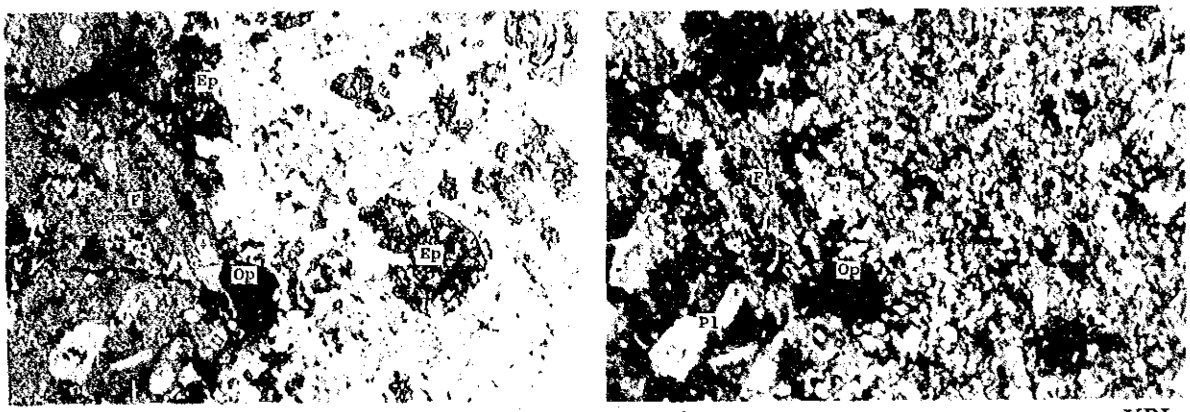
Qz : quartz

Ser : sericite

PPL : plane polarized light

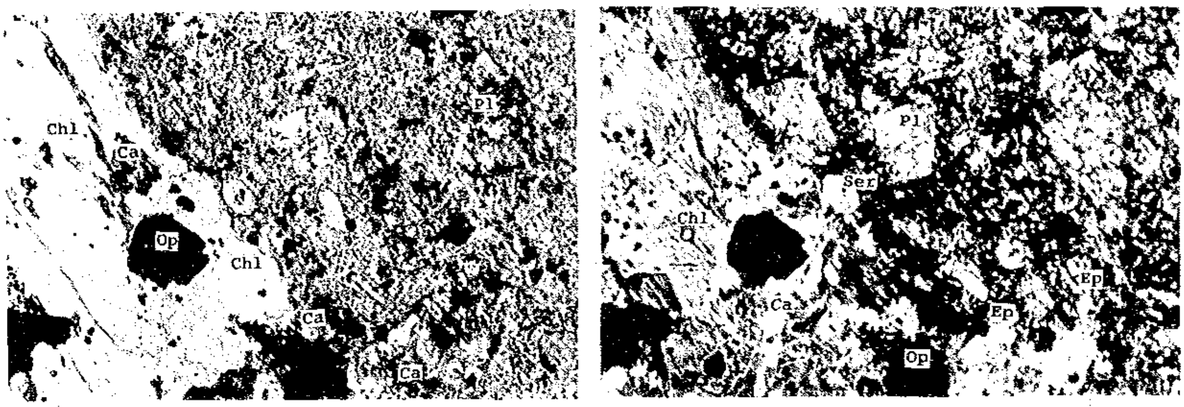
XPL : crossed polarized light

Sample No. H0801, Andesitic tuff



PPL 0 1mm XPL

Sample No. H1401, Andesite and Xenolith



PPL 0 1mm XPL

Sample No. T1204, Andesitic tuff

PPL 0 1mm XPL