ESTADOS UNIDOS MEXICANOS
CONSEJO DE RECURSOS MINERALES

REPORT ON GEOLOGICAL SURVEY OF THE PACHUCA-ZIMAPAN AREA, CENTRAL MEXICO

PHASE Ⅳ

GEOLOGICAL SURVEY

GEOCHEMICAL PROSPECTING

DIAMOND DRILLING

MARCH 1983

JAPAN INTERNATIONAL COOPERATION AGENCY

METAL MINING AGENCY OF JAPAN

GOVERNMENT OF JAPAN

PREFACE

The Government of Japan, in response to the request of the Government of the Estados Unidos Mexicanos, decided to conduct geological survey and other survey works related to ore deposit exploration in order to confirm the potentiality of mineral resources in the Pachuca district of the State of Hidalgo, Mexico, and entrusted its execution to Japan International Cooperation Agency (JICA). The Agency, considering the nature of the works to belong to special field of the investigation of geology and mineral resources, sought the cooperation of the Metal Mining Agency of Japan (MMAJ) to accomplish the task.

Between July 12, 1982 to January 14, 1983, Metal Mining Agency of Japan dispatched a survey team headed by Mr. Motomu Kiyokawa to carried out the Phase IV work of the project.

The survey had been accomplished in close cooperation with the Government of the Estados Unidos Mexicanos and its various authorities.

This report is a compilation of the results of the Phase IV works, and after the completion of the project, a consolidated report will be submitted to the Government of the Estados Unidos Mexicanos.

We wish to express our appreciation to all of the organizations and member who bore the responsibility for the project; the Government of the Estados Unidos Mexicanos, El Consejo de Recursos Minerales (CRM) and other authorities concerned, and the Embassy of Japan in Mexico.

March, 1983

Keisuke Arita
President
Japan International Cooperation Agency

Masayuki Nishiie
President
Metal Mining Agency of Japan

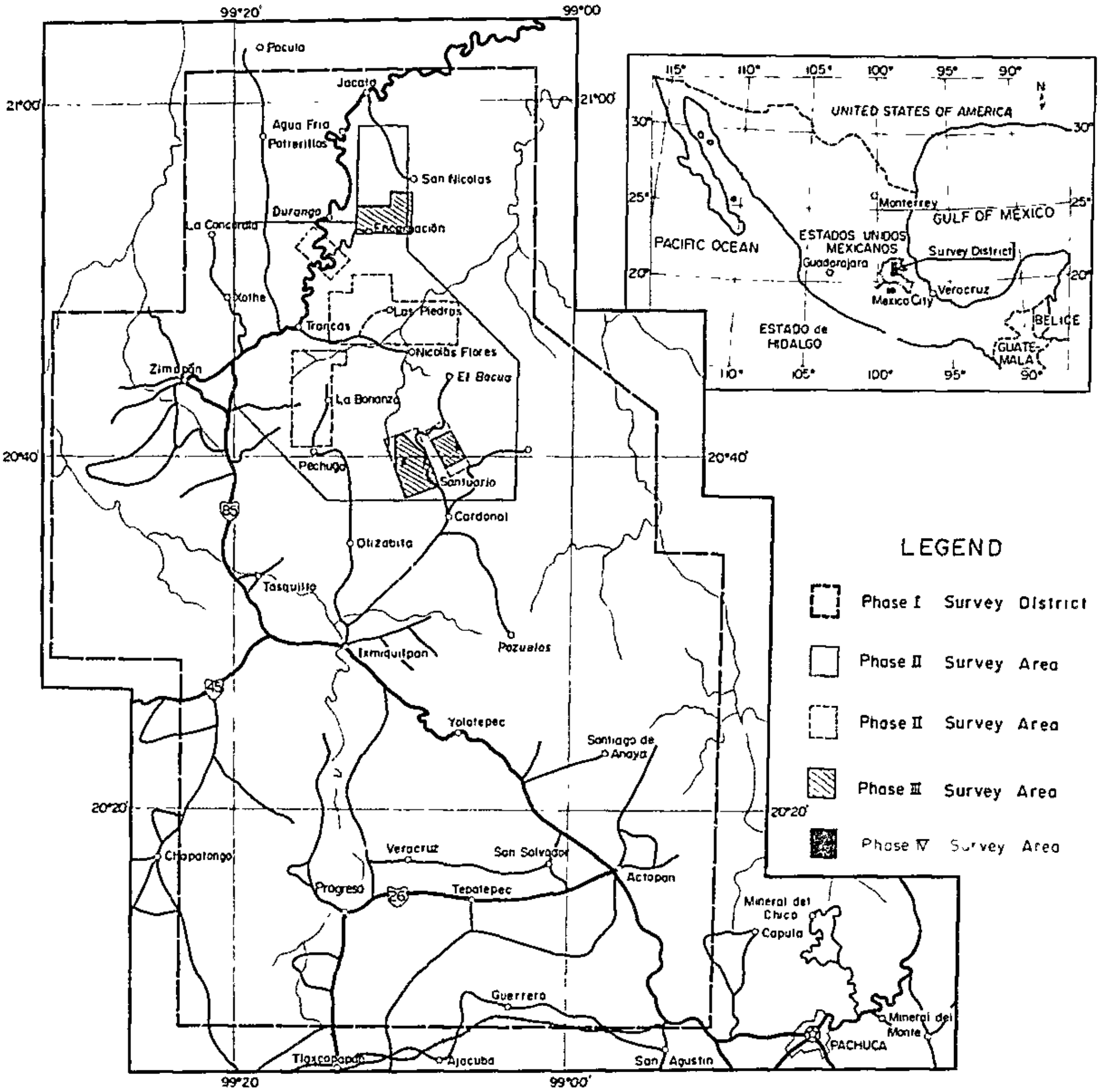

Fig. G-1 Location Map of the Survey District

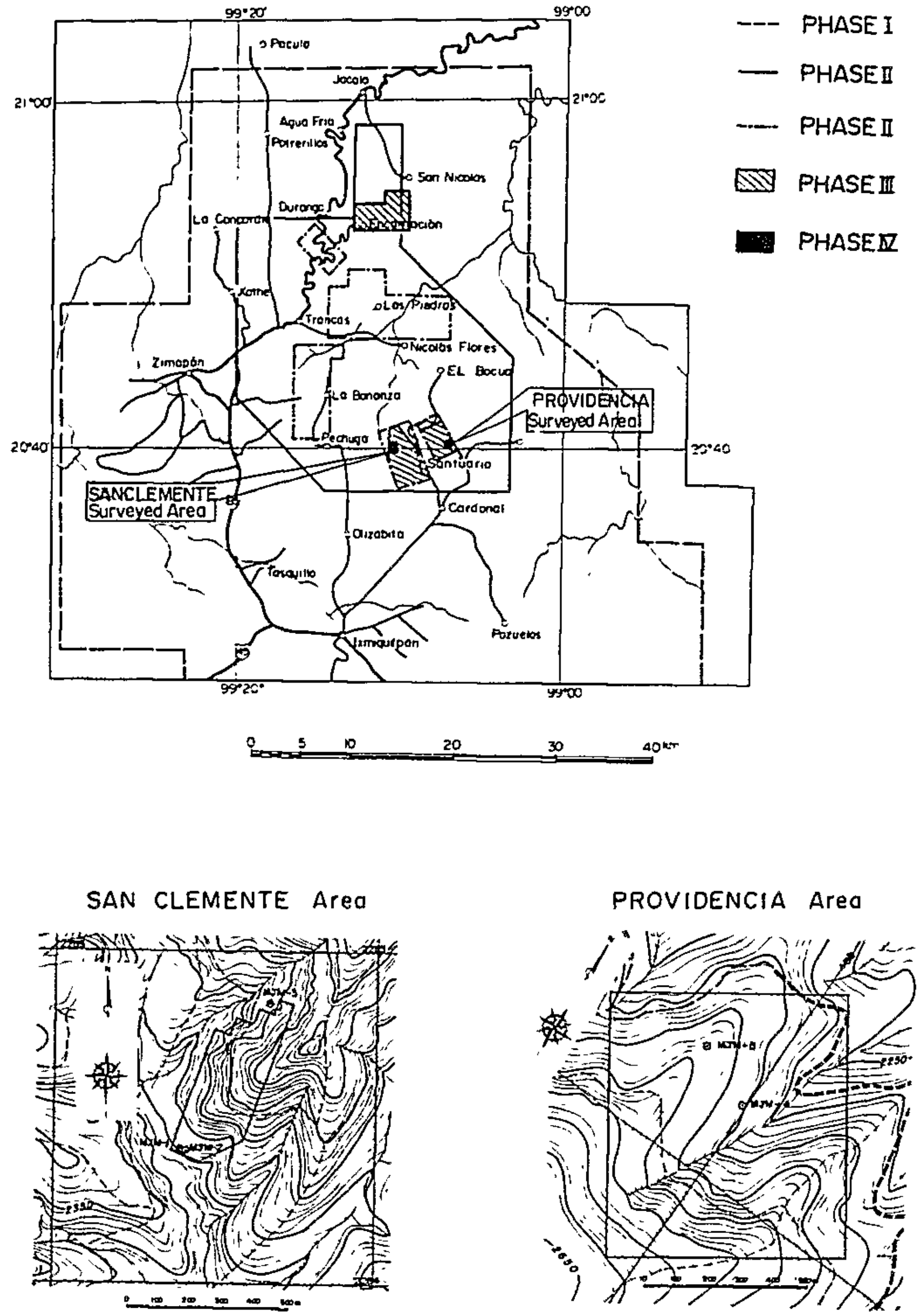

Fig. G-2 Location Map of the Phase Ⅳ Surveyed Area

ABSTRACT

The report is a compilation of the result of the investigation in the fourth phase of the mineral resources development cooperative basic survey in the Pachuca district of the United Mexican States (Estados Unidos Mexicanos).

The main subjects in this phase were to carry out the following surveys for the target areas of the SAN SEVERIANO western mineralized zone (200 m x 400 m) in the SAN CLEMENTE area and of the geochemical and IP anomalous zones (600 m x 800 m) in the central part of the PROVIDENCIA area both of which had been extracted based on the result of survey conducted until the third phase; such as the detailed geological survey and detailed geochemical prospecting by excavating trenches in grid pattern and by continuous sampling of the rock samples along the trenches as well as the drill survey (300 m x 3 holes) in the former area, and the detailed geological survey and the drill survey (300 m x 2 holes) in the latter area. Thus it was intended to obtain a useful policy for the exploration and the development of the mine in the next stage.

A. SAN CLEMENTE Area

(1) Distribution and scale of the Au-geochemically anomalous zones by trench sampling and the relation to the SAN SEVERIANO mineralized zone

The anomalous zones are divided into two groups such as the one distributed concentratedly on a large scale in rhyolite found from the eastern-central part to the northeastern part of the area and the other in a stock-like rhyolite in the southern part of the area. In the former, high grade parts are found in two sections. One of these occupies an area of 15 meters in average width by more than 100 meters in extension, showing an average grade of 1.18 g/t Au, and the other extends for more than 50 meters with the average width of 12 meters, showing an average grade of 1.5 g/t Au.

Some samples showing high assay values among those taken so far in the area between the anomalous zone and the SAN SEVERIANO mine are found to be scattered in that area, and the zone is open, as a whole, toward the SAN SEVERIANO mine. Therefore, the area of 200 m by 400 m sandwiched between the anomalous zone and the SAN SEVERIANO mine can be positioned as an important target of the future exploration.

(2) Relation between Au and Ag anomalous zones

It was made clear in the survey of this phase that the both anomalous zones were not overlapped but distributed in a form of zonal arrangement. Namely, the Au-anomalous zones are distributed in the eastern part of the area to the central part of the rhyolite mass and the Ag- anomalous zones are distributed along around the contact between the ryolite mass and the underlying tuffaceous conglomerate in the surrounding part of the former.

(3) Comparison of the assay values of drill cores with those of the surface samples

The assay values of Au of the drill core were generally low as compared with those of the surface samples. In the MJM-3 hole, however, the assay values of gold from about 200 meters to the bottom was generally high showing the highest value of 1.65 g/t Au. This section is positioned at about 70 meters below the surface, which is rather the shallowest part from the standpoint of the depth. Whereas the bottom of the holes such as MJM-1 and 2 are positioned at the depth of about 160 meters below the surface deeper than the above. Furthermore the two holes were cut through tuffaceous conglomerate near the basement rock underlying the rhyolite mass. On the other hand, disseminated mineralized zones of sphalerite, galena and chalcopyrite are observed in many places of the two holes.

Taking the above facts into account, the comprehensive consideration of the relation between the two modes of distribution of the geochemically anomalous zones of gold and silver, the mineralization of copper, lead and zinc observed in the drill core and the country rocks of each mineralized zone, leads to the conception that the distribution of the mineralized zones of gold and silver and those of copper, lead and zinc suggests a vertical zonal arrangement of the mineralization of the area.

B. PROVIDENCIA Area

(1) Relation between the mineralized zone and the geologic structure

The mineralized zone of the area consists of irregularly massive and partly disseminated ore bodies emplaced along the fracture zones near the faults and fold axes in black flint bearing medium-bedded limestone and the disseminated ore bodies found along the bedding planes of limestone, among which the former is superior to the latter in size as well as in grade. The Mina Providencia mineralized zone is the largest in size and the highest in grade among these mineralized zones.

(2) Grade and size

All the ore bodies found in the area consist of oxide ore. The dimension of individual ore bodies is several tens centimeters to several meters in width and a little more than a dozen meters in extension, while in the Mina Providencia mineralized zone, it extends for about 200 meters with the width of two meters along the fault fracture zone of NNW-SSE system.

The ore grades shown are several percent in lead, several tens percent in zinc, n x 10 - n x 100 g/t in silver and very small content in copper.

(3) <u>The result of the drill survey</u>

As the result of drill survey of the two holes of MJM-4 and 5, the mineralized zones were intersected at six places in the hole MJM-4. Under the microscope, the ore consists of oxide ores mainly of goethite and hematite. The average assay values of the most dominant massive oxide ore found at the depth of 67.00 m - 68.70 m showed 11.87% Pb and 0.68% Zn. Those of oxide ore at 96.72 m - 97.12 m showed 0.13% Pb and 29.16% Zn, and those at 57.85 m - 58.10 m, 1.69% Pb and 1.84% Zn. Those of other oxide ores are less than one percent both in lead and zinc showing a low grade. No notable mineralization was observed in the MJM-5 hole.

The result of surface geological survey and drill survey showed that the mineralized zones formed with close relation to the fracture zones along fault and fold axis. On the other hand, six mineralized parts were intersected in the MJM-4 hole. All these, however, are still in the oxide zone, and the sulfide zone which had been assumed to exist in the depths on the basis of the result of IP electric survey, seems not to have been encountered yet. Therefore, it is desired that the sulfide mineralized zone estimated to exist in the depths of the Mina Providencia mineralized zone might be explored.

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CHAPTER 1

INTRODUCTION

CHAPTER 1 INTRODUCTION

1-1 General Remarks

The mineral resources development collaborative basic survey in Pachuca District of the Estados Unidos Mexicanos was initiated in 1979 as the first year, and this year is the fourth phase of the survey.

The survey in the first year was composed of preparation of the topographical maps of the whole survey district, photogeological interpretation (5,250 km^2) and preliminary geological survey, and was conducted putting emphasis on elucidation of regional geology and the geological structure of the whole district, and also on description of the metallic ore deposits distributed in the district.

As the result, it was concluded as geological policy for future investigation that (1) establishment of stratigraphy of the Cretaceous formations predominated in the district, (2) survey of ore deposits of contact metasomatic to hydrothermal types associated with dioritic to granodioritic intrusive rocks distributed in the northern half of the district, and (3) survey of gold deposit in potash rhyolite in the SAN CLEMENTE area, are to be directed.

Based on the conclusion of the first year, the geological and geochemical surveys were conducted as the second year's works in an area of 750 square kilometer, of the northern part of the district having selected five small areas each of which contain the mineralized zones. These surveys resulted into recommend the mineralized zones to be required of more detailed survey and several subareas in which any mineralized zones were expected to occur. Among those, three areas such as (1) El TEJOCOTE, (2) PROVIDENCIA and (3) SAN CLEMENTE were selected as the most promising areas, and they were the targets of the third year's survey.

As the survey of the third year, the details geological survey, geochemical survey (soil sampling with a definite interval) and electric survey by I.P. method were carried out in the two areas of EL TEJOCOTE and PROVIDENCIA, and the detailed geological survey and geochemical survey (rock sampling with a definite interval) in the SAN CLEMENTE area. As the result, high grade and large scale geochemically anomalous zones, many outcrops of ore deposit and high chargeability anomalies were detected in the PROVIDENCIA area having been in close relationship mutually, and the gold and silver mineralized zone of the SAN CLEMENTE area proved to be of large scale though it was low in grade. Thus it was concluded that it was important in the future to investigate the conditions of ore deposit in the depths in the mineralized zone of the PROVIDENCIA area and that it was necessary for that of SAN CLEMENTE to carry out more detailed exploration.

In the survey of this year, geological survey, vertical diamond drillings were carried out in the PROVIDENCIA area, and detailed geological survey, geochemical survey (by continuous rock samples on the outcrop by trenching) and horizontal diamond drilling were conducted in the SAN CLEMENTE area, on the basis of the conclusion of the third year, which was directed to make clear concretely the guideline for the detailed exploration in future.

The field survey of this year was started on July 12, 1982 and completed on January 14, 1983. The geological survey, and geochemical survey were performed by two Japanese geologists and four Mexican geologists, six in total. The diamond drilling was conducted by the El Consejo de Recursos Minerals (CRM) in technical cooperation of two Japanese drill engineers.

Chemical analysis of the two components of Au and Ag on rock samples taken by geochemical survey was conducted mainly in an assay office in Canada and partly in Japan, analysis of the four components such as Ag, Cu, Pb and Zn of the ore samples at the Ixmiquilpan laboratory of CRM, and that of Au in Japan. The result of these analyses and all the survey data obtained in

the field were investigated, analyzed and arranged in Japan together with the result of laboratory test, and the results were compiled in this report.

1-2 Location and Access

The surveyed areas of this year consist of SAN CLEMENTE and PROVIDENCIA, and the situation and access of each area are shown in the following (Fig. G-1, Table 1-1).

Situation

Table 1-1 Location of the Surveyed Area

	San Clemente Area	Providencia Area
Northern limit	N 20°39'53"	N 20°41'00"
Southern limit	N 20°39'39"	N 20°40'29"
Eastern limit	W 99°09'54"	W 99°06'50"
Western limit	W 99°10'06"	W 99°07'21"
Area	0.08 km^2	0.48 km^2
Total area	0.56 km^2	

Access

The nearest settlement to the SAN CLEMENTE area is San Clemente, and it can be reached by car from Ixmiquilpan where the base camp was set up. There are two routes for access. The one is a paved road running northeastward about 20 kilometers to the Cardonal settlement. From there, a gravel road extends to the north for about 2.5 kilometers to a small settlement, from where a winding gravel road crossing two relatively large creeks branches off westward to terminate at San Clemente at a distance of about four kilometers.

The other is to take a route from Olivo located along the above paved road about 11 kilometers from Ixmiquilpan northward to reach the San Miguel settlement. From there the same winding gravel road can be used toward San Clemente.

Because the road condition of the latter course is poorer than the former and the road is narrow, it is recommended to use the former.

The survey area is situated about 500 meters to the east of the end of the road, and it requires to go on foot to reach there across a valley.

To reach to the PROVIDENCIA area, a paved road leads northeastward from Ixmiquilpan to Cardonal for about 20 kilometers as mentioned above. At the crossroad along the gravel road about two kilometers to the north of Cardonal, a gravel road branches off toward the east to reach the Yonthe settlement at the distance of about 4.5 kilometers. A rough gravel road runs from the settlement to the eastern end of the survey area of this year for about 10 kilometers, which is left in very bad condition, and it takes about 30 minutes to run through the road.

1-3 Survey Works and Examinations

Table 1-2 and Table 1-3 show the quantities of various works and laboratory examinations.

Table 1-2 Kind of Works

Survey Area	Kind of the Works	Area (km^2)	No. of Sample	Length (m)
SAN CLEMENTE	Detailed geological survey	0.08		
	Geochemical prospecting:			
	(extension of trenching line)			3,500
	(line channel-sampling along trench)		725	
	Diamond drilling (wire-line)			
	(three horizontal holes by 300 m each)			900
	(core sample for chemical analysis)		300	
PROVIDENCIA	Detailed geological survey	0.48		
	Diamond drilling (wire-line)			
	(two vertical holes by 300 each)			600

Table 1-3 Laboratory Examinations

Type of Examination	Number of Sample		Analized Elements
	Geological and geochemical surveys	Drill holes	
Chemical analysis of geochemical sample	725	300	Au .... 1025 Ag 1025
Check analysis	10	10	Au, Ag 40
Whole rock analysis	40	10	5.0 x 17 = 850
Chemical analysis of minor element	8	-	(Au, Ag, Cu, Pb, Zn, Te, Sb, As, Bi, Mo, Fe, S) 104
Microscopy of rock thin section	15	7	-
Microscopy of ore polished section	25	16	-
EPMA analysis	25 points		-

1-4 Members

The members engaged in conference for the survey plan and those participated in the survey of this phase are as follows:

Members

Conference for the survey program (May, 1982)	
Japanese mission	Mexican counterparts
Metal Mining Agency of Japan (MMAJ) Shozo Sawaya (Head of the mission, MMAJ) Nobuhisa Nakajima (MMAJ) Kenjiro Takehata (MMAJ, Mexico office) Motomu Kiyokawa (Sumiko Consultants)	El Consejo de Recursos Minerales (CRM) Guillermo P. Salas (Director General del CRM) Jose L. Lee Moreno (Gerencia de Estudios Especiales) Gustavo Camacho Ortega (Gerencia de Estudios Especiales) Raul Cruz Rios (Gerencia de Estudios Especiales)
Field Survey (12 July, 1982 to 14 January, 1983) Geological survey, geochemical prospecting and diamond drilling	
Japanese mission	Mexican counterparts
Motomu Kiyokawa (Head of the mission, geologist) Yasunori Yoshioka (Drilling engineer) Kiyoharu Nakashima (Geologist) Akihiko Murase (Drilling engineer)	Panfilo Snachez Alvarado (Jefe de la oficina de Ixmiquilpan, Ingeniero geologo) Meliton Figueroa Palacios (Ingeniero geologo) Luis Tarcisio Arteaga Pineda (Ingeniero geologo) Victor Manuel Luna Castillo (Ingeniero geologo) Lucio Perez Colin (Supervisor de perforación)

1-5 Acknowledgments

We wish to express our appreciation of guidance and contribution to the survey of this time of Mr. Akira Hirayama and Dr. Tetsuro Urabe who were working for CRM dispatched from JICA as specialists. We are much indebted to Professor Yukitoshi Urashima of Kagoshima University for his guidance to identification of ore minerals by polished section and EPMA.

CHAPTER 2

SAN CLEMENTE AREA

CHAPTER 2 SAN CLEMENTE AREA

2-1 Details and Aims of Survey

During the regional geological survey of the first year, gold mineralization was observed in a part of rhyolitic rocks in which small scale exploration by hand had been being carried out.

The occurrence of gold of the mine is different from the ordinary vein type deposit, showing neither notable silicification nor hydrothermal alteration. Gold occurs along irregular tiny cracks in relatively fresh rhyolite as fine grains of electrum which contains about 75 percent of gold and about 25 percent of silver. The occurrence might be called a kind of network dissemination type. The eight rock samples taken from every part of the rhyolitic rocks of the area showed the assay value of gold to be considered geochemically anomalous (JICA and MMAJ, 1980).

As the result of the second year's survey, the rhyolitic rocks of the area were divided into four rock facies such as rhyolitic lava, rhyolitic tuff breccia, compact rhyolite seemed to be a lava dome, and dyke, and it was made clear that content of the rock forming components varies with the change of rock facies and that the gold mineralization was closely related to the activity of compact rhyolite. At the same time, the occurrence of several A-class gold anomalies (more than 1.16 ppm Au) were confirmed in the complex.

In the survey of the third year, detailed geological survey and geochemical prospecting (rock sampling by 50-meter spacing) were conducted for the three small target areas which contained the geochemically anomalous zones detected in the second year.

As the result of the survey, it was made clear that a mineralized zone extending in east-west direction including the San Severiano mine is more preponderant than others in size and grade. Furthermore, it was concluded that the mineralized zone was divided into two portions of the eastern and

the western parts, and especially that the western part was promising.

In the survey of this year, a detailed geological survey was carried out based on the conclusion of the survey of the third year by having excavated the continuous trenches in a pattern of grid line-spacing, and geochemical prospecting was made by rock samples taken by line-channel sampling on the surface outcrops along the trenches.

In addition, three horizontal drill holes (900 meters in total) were cut toward the depths of the mineralized zone. All these were directed to make an evaluation of the mineralized zone of the area and to obtain the data for investigating the values of exploration in future.

2-2 Location, Town and Village, Topography and Vegetation

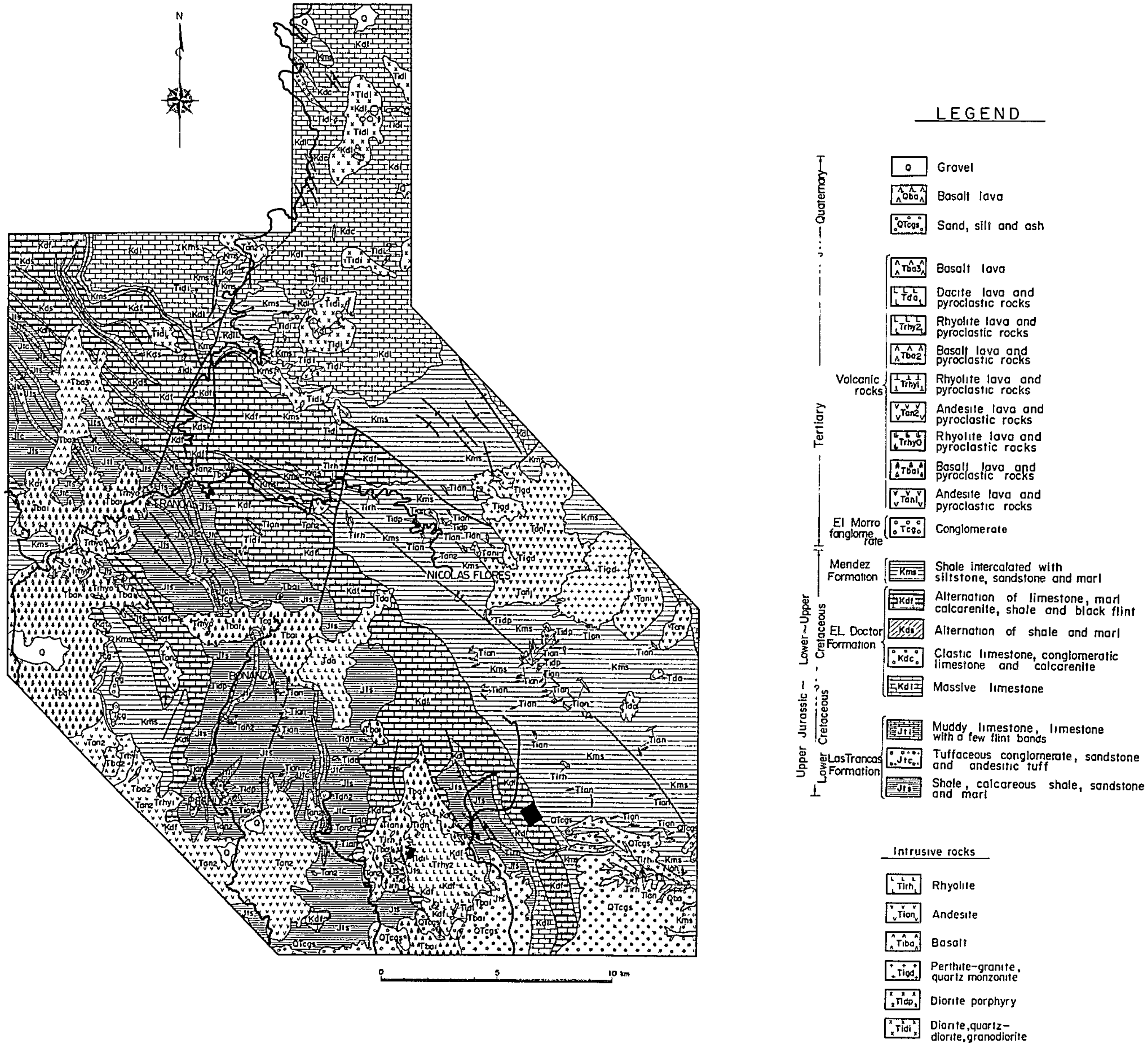
The area is situated about 21 kilometers to the north-northeast of Ixmiquilpan City and occupies an area of 0.08 km^2 with the width of 200 meters and the extension of 400 meters in north-northeast direction. The nearest village is San Clemente about one kilometers to the west on the outside of the area, which is a small settlement consisting of several tens houses.

A relatively flat ridge with an altitude of 2,560 meters is found on the adjacent northeastern side of the area. On the southwestern side, a river flows southwestward and a tributary flows into it on the north-western side of the area. Thus the area occupies the steep slopes surrounded by these ridges and creeks.

Shrubs grow thick in the part close to the ridge, while the other part is sparcely wooded by mixture of shrub, cactus and agave in general.

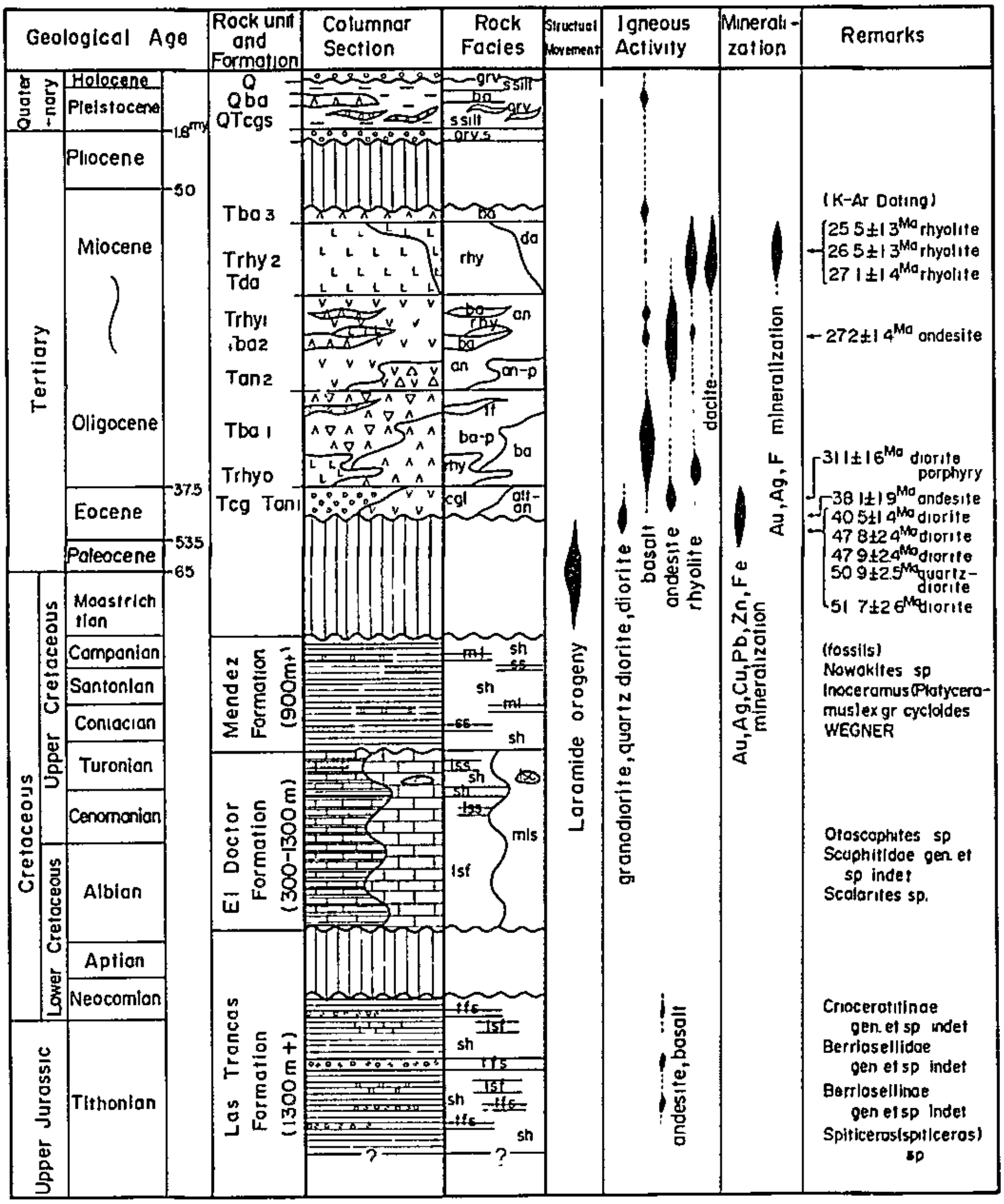
2-3 Geology

The survey area of this year is of very narrow occupying an area of 0.08 km^2 in the central western part of the surveyed area of the third year, located in the southern part of the area surveyed in the second year (Fig. 2-1 and Fig. 2-3).



Survey area of phase Ⅳ

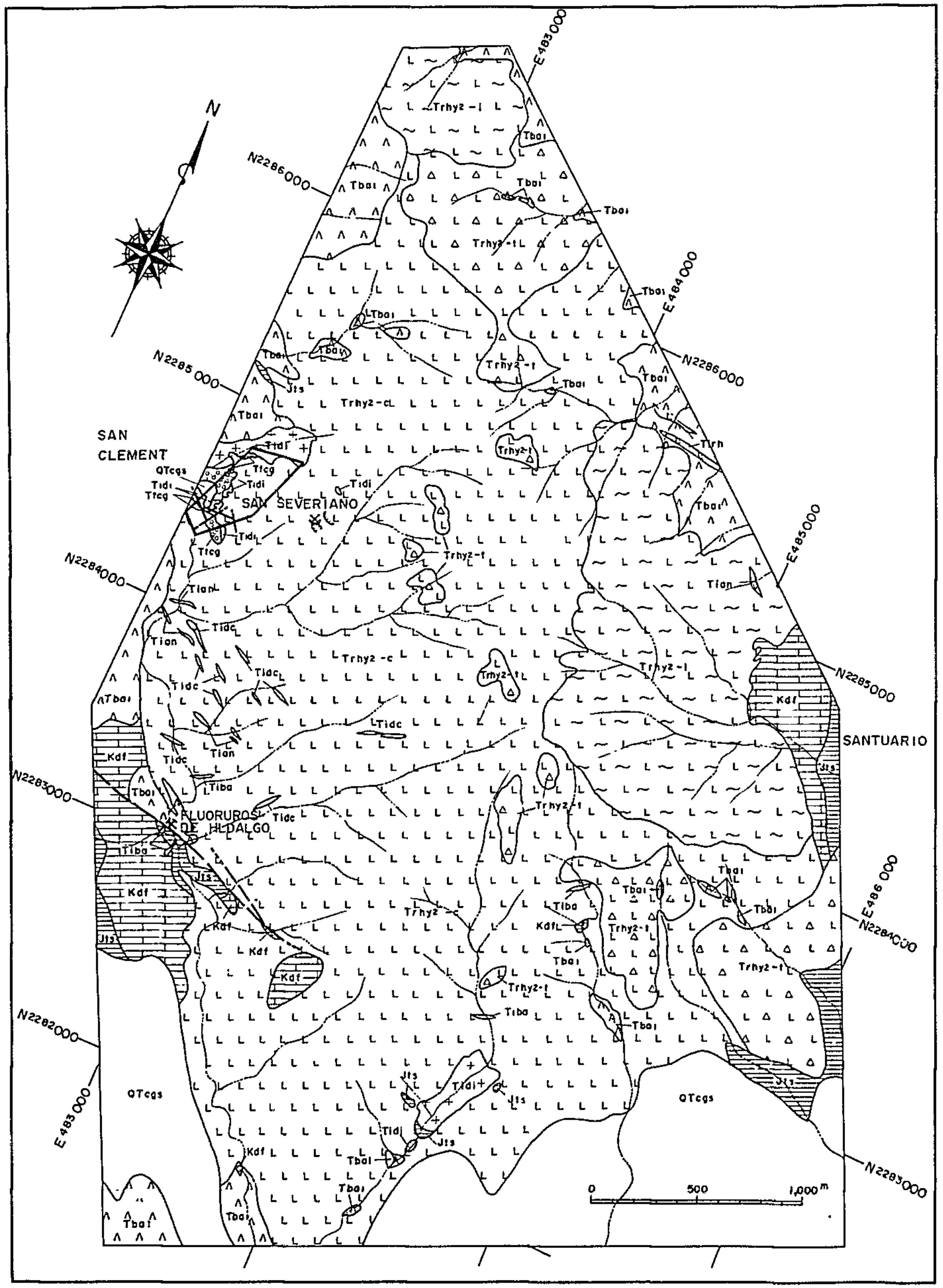
Fig. 2-1 Geological Map of the Phase Ⅱ Survey District



Abbreviations

grv	gravel	alt	altered
s	sand	ml	marl
silt	silt	sh	shale
ba	basalt	ss	sandstone
rhy	rhyolite	lsc	clastic limestone, limestone conglomerate
da	dacite	lss	calcarenite
an	andesite	lsf	thin to medium-bedded limestone with black flint
p	pyroclastic rocks	mls	massive limestone
tf	tuff	tfs	tuffaceous sandstone, conglomerate, tuff
cgl	conglomerate		

Fig. 2-2 Generalized Stratigraphic Column of the Phase II Survey District
(after JICA and MMAJ 1981)



LEGEND

Quaternary		(QTcgs)	Sand, silt and ash
Tertiary		(Trhyz-l)	Banded rhyolite lava
		(Trhyz-t)	Rhyolitic tuff breccia
		(Trhyz-c)	Compact rhyolite
		(Ttcg)	Conglomerate
		(Tbai)	Basalt lava and pyroclastic rocks
El Doctor Formation		(Kdf)	Alternation of limestone, marl, calcarenite, shale and black flint
Las Trancas Formation		(Jts)	Alternation of shale, calcareous shale, sandstone and marl

Intrusive rocks

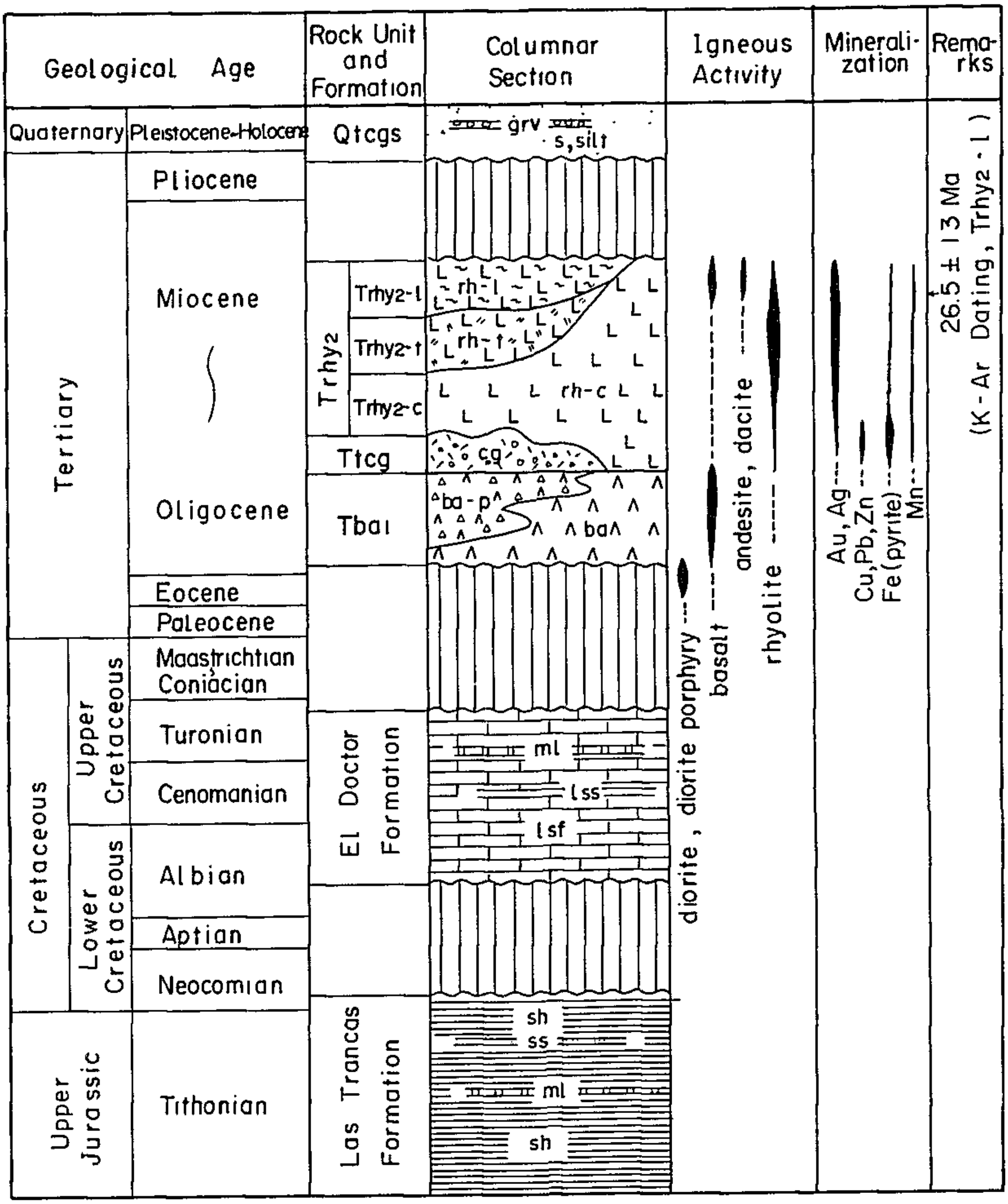
	(Tirh)	Rhyolite
	(Tidc)	Dacite
	(Tian)	Andesite
	(Tiba)	Basalt and dolerite
	(Tidi)	Diorite

Fault

Geochemical prospecting area of Phase IV

Fig. 2-3

Geological Map of the Phase III Surveyed Area, SAN CLEMENTE
(modified from Phase II)



Abbreviations

grv	gravel	lsf	limestone with black flint	Zn	zinc
s	sand	ml	marl	Fe	iron
silt	silt	lss	calcarenite	Mn	mangan
rh-l	banded rhyolite lava	ss	sandstone		
rh-t	rhyolitic tuff breccia	sh	shale		
rh-c	compact rhyolite	Au	gold		
cg	conglomerate	Ag	silver		
p	pyroclastic rocks	Cu	copper		
ba	basalt	Pb	lead		

Fig.2-4 Stratigraphic Column of the Phase III Surveyed Area, SAN CLEMENTE
(modified from Phase II)

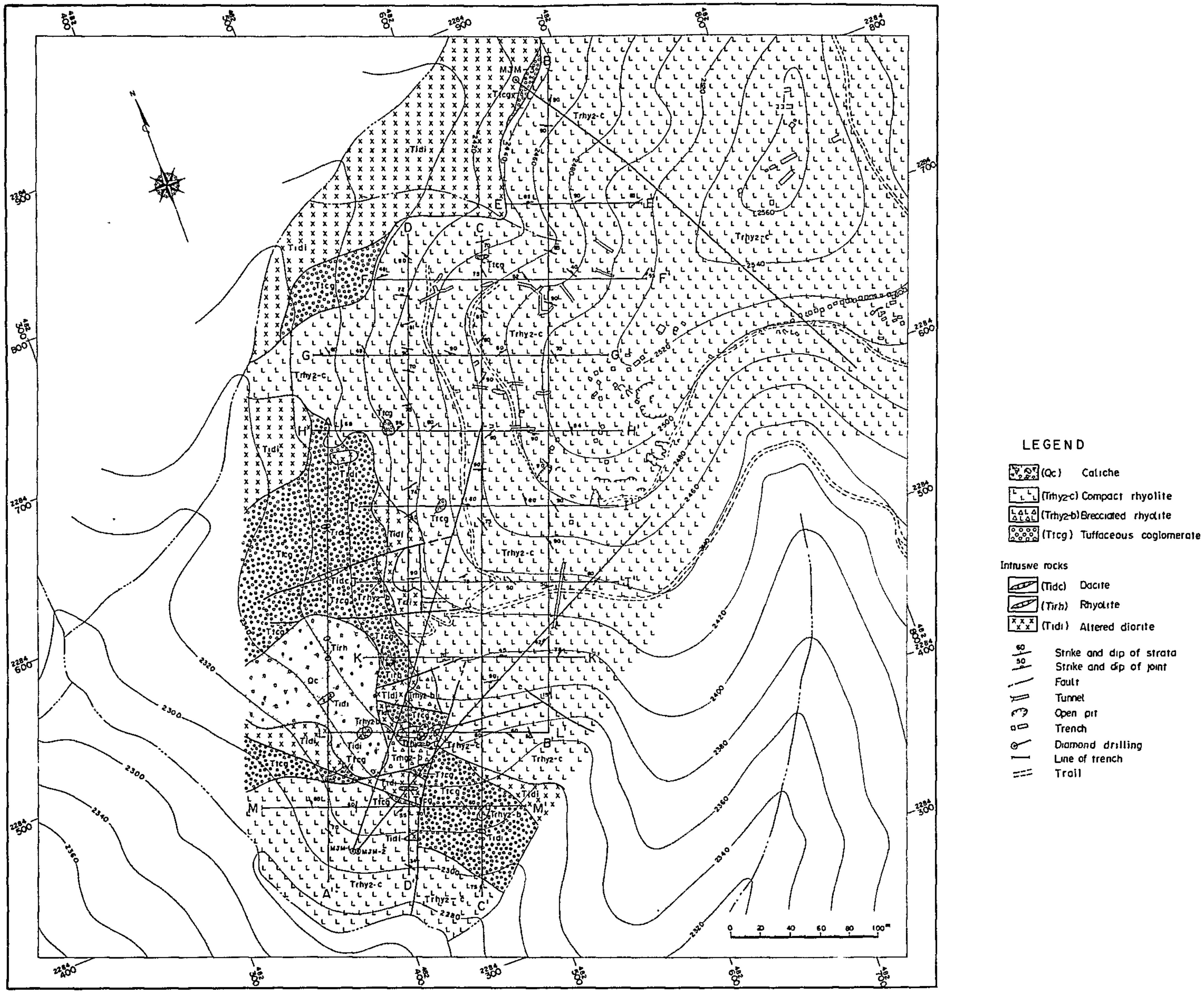
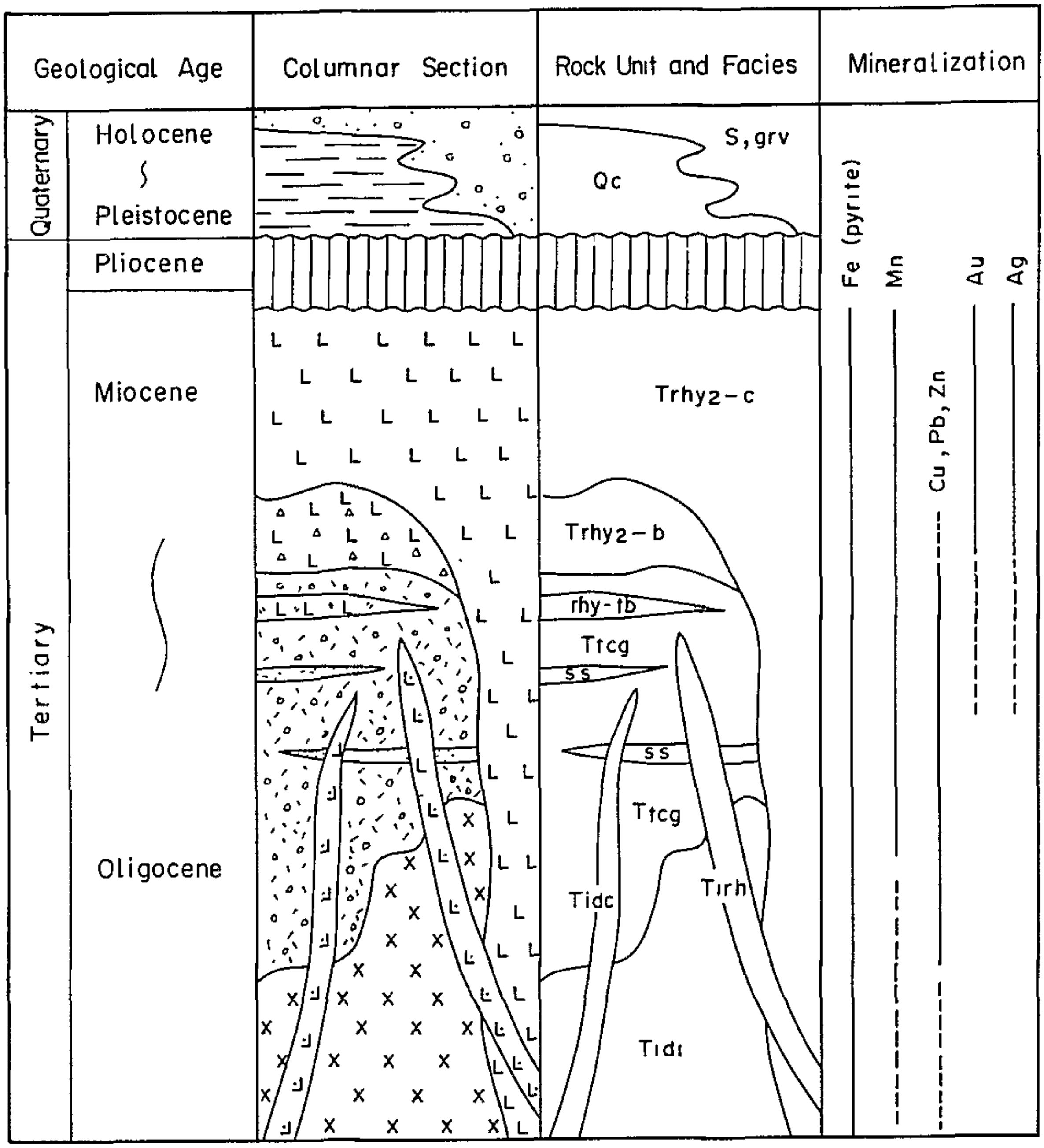


Fig. 2-5 Geological Map of the SAN CLEMENTE Area



Abbreviations

Qc : caliche
Trhy2-c : compact rhyolite
Trhy2-b : brecciated rhyolite
Ttcg : tuffaceous conglomerate
Tirh : rhyolite dike
Tidc : dacite dike
Tidi : altered diorite

s : sand
grv : gravel
rhy-tb : rhyolitic tuff breccia
s.s : sandstone

Fe : iron
Mn : mangan
Cu : copper
Pb : lead
Zn : zinc
Au : gold
Ag : silver

Fig. 2-6 Stratigraphic Column of the SAN CLEMENTE Area

The geological map of the semi-detailed survey in the second year (Fig. 2-1) and a geological columnar section (Fig. 2-2) are annexed to show the geological position of the area in the regional geology. Regional geology around the area consists of sedimentary rocks of Jurassic to Cretaceous, and Tertiary intrusive rocks and volcanic rocks which intrude or cover the sedimentary rocks.

The intrusive rocks consist of diorite stocks which intrudes into the sedimentary rocks of the uppermost Jurassic and Cretaceous and is covered by basaltic rocks and rhyolitic rocks in the western part of the area and on the west, and small dyke rocks which intrude into the basaltic rocks and rhyolitic rocks (Fig. 2-1 and 2-3).

The main area of survey of this year is positioned in the western end of the extent covered by the rhyolitic rocks among those geologic circumstances mentioned above.

The sedimentary rocks of uppermost Jurassic to Cretaceous are absent in the area. A stock-shaped altered diorite (Tidi) intruded in early to middle Oligocene, forms the basement of the area. Unconformably overlying it, tuffaceous conglomerate (Ttcg), brecciated rhyolite (Trhy2-b) and compact rhyolite (Trhy2-c) of the late Oligocene overlap each other. Small dykes of dacite (Tidc) and rhyolite (Tirh) intrude into the above. Caliche (Qc), a Quaternary deposit, is also found in the area (Fig. 2-5 and 2-6).

(1) Altered diorite (Tidi)

Although it is an intrusive rock, it is described in the first place since it forms the base of the area.

Two modes of distribution of the rock are seen in the area; the one shows a relatively wide distribution in the northern part of the area, while the other show a small distribution being splitted into 14 bodies from the western part to the southern part.

The rocks of the northern part are found along the southeastern slope of a tributary which flows down toward southwest in the northwestern end of the area.

The rocks scattered from the western part to the southern part are mainly distributed in the following places: from the western end of the H trench, toward the west, from the crossing of the D and I trenches to the southwestern side of it, from the crossing of the D and L trenches to the northern side of it, northern side of the crossing of the D and M trenches, from the western end of the L trench to the western side of it, and at the eastern end of the M trench. The others are small in scale.

The three horizontal drill holes bored on this time showed the intersections of the rock in many places.

In the MJM-1 hole in the southern part, the intersections were observed at 67.50 m - 98.20 m, 101.50 m - 122.22 m, 206.1 m - 246.85 m and at other five places. In the MJM-2 hole in the southern part, the rock is observed at 108.72 m - 117.65 m and other two places.

In the MJM-3 hole in the northern part, the rock exposed on the surface at the drill station continues from the collar to the depth of 4.50 m, and beyond that point, no intersection was encountered.

The rock at the surface outcrop is weathered in general and shows a facies of soft rock with tints of dark brown or dark greenish grey by oxidation of mafic minerals.

The rock shown by drill core is fine to medium-grained holocrystalline altered diorite showing green to dark green color.

Microscopic observation of the rock samples taken from the drill core shows that it is medium-grained holocrystalline rock consisting mainly of plagioclase, hornblende and augite with accessory mineral of apatite. It is generally strongly altered to have produced abundant secondary minerals.

Plagioclase is oligoclase to andesine one to two milimeters long. Inside of the crystals is cloudy with fine clay minerals produced by alteration, and the crystal form has been disturbed.

Though hornblende displays long prismatic crystal form 0.5 to one milimeter wide and less than four milimeters long, the crystal form has been disturbed, and the most part has been altered to chlorite.

The whole part of augite has been altered to chlorite or epidote, and only the pseudomorph can be observed.

Other secondary minerals to be observed are calcite, titanite and opaque minerals.

Although direct contact of the rock with the underlying formations has not been observed in the surveyed area of this year, an outcrop where the rock intrudes into the sedimentary rocks of uppermost Jurassic, can be observed along the main stream flowing down south-southeastward in the outside of the area.

Although the radiometric dating has not been made directly on the rock samples obtained from the area, the result of K-Ar dating of the dioritic rocks of the PECHUGA area about nine kilometers to the west-northwest of the area measured in the survey of the second year, showed the value of 31.1 ± 1.6 Ma. Because of close resemblance of the rock to diorite of the area, it is assumed that the time of intrusion of diorite of the area, would have been in early to middle Oligocene.

(2) Tuffaceous conglomerate (Ttcg)

The rock shows two modes of distribution. The one is those with relatively wide distribution in the central western end and in the southern part of the area. The other is those with a narrow distribution being splitted into nine places from northeastern part to the southwestern part of the area.

The rock in the central western end occurs in irregular shape with an extent of approximately 90 m x 180 m from the north end of the A trench to the southwest and the south of it. In the southern part, it is distributed within an extent of approximately 60 m x 80 m in the vicinity of the crossing of the C and M trenches.

Beside these, the occurrence is known at the northwestern end of the area, at the western end of the F trench, at the windows in rhyolite at the H and I trenches, and other five small exposures in the area of diorite and in its vicinity in the southwestern part of the area.

The intersections of the rock in the three drill holes are as follows. In the MJM-1 hole in the southern part, the rock is observed mainly at 59.65 m - 67.50 m, 122.22 m - 161.00 m, 174.7 m - 188.68 m, 298.25 m - 300.10 m (the bottom of the hole). In the MJM-2 hole, it is observed mainly at 51.20 m - 70.33 m, 78.00 m - 108.72 m, 117.65 m - 181.10 m, 181.65 m - 193.00 m and 224.20 m - 232.70 m. In the MJM-3 hole, it is observed at 4.50 m - 10.65 m.

The rock is generally of dark grey to grey, but it markedly varies according to the kinds of pebbles contained in conglomerate. The rock is partly interbedded with tuffaceous sandstone, tuffaceous granule conglomerate, rhyolitic tuff and tuff breccia. Since these intercalatory lamina are of thin layers less than two meters thick and are poor in their continuity, they were included in tuffaceous conglomerate in a bundle in the geological map.

Among the tuffaceous conglomeratic rock, that of the central western end of the area represents the best the characteristic of the rock, generally showing dark grey or dark greenish grey color.

The pebbles which constitute the rock mainly consist of subangular, subround and round pebbles of green altered diorite and grey rhyolite two to five centimeters in diameter, and small pebbles of black shale, brown

andesite and basalt 0.5 to one centimeter across are partly contained. The matrix consists of fine grains of rocks of the same source as the pebbles and slightly argillaceous tuffaceous-materials. In terms of proportion of the kinds of pebbles, it tends to be more abundant in pebbles of altered diorite at the base close to the altered diorite mass and to be abundant in those of rhyolite in the place more apart from the base. Pebbles of black shale are relatively more abundantly contained in the western part of the K trench.

The rock widely spread in the southern part which is highly altered and weathered, showing brown and soft rock facies. The most abundant pebbles contained in the rock consist of subangular to subround pebbles of rhyolite two to five centimeters across, and those of brown or brownish green altered diorite and small amount of pebbles of black shale are also found. The matrix consists of grains of the same source as the pebble and the brown material.

The tuffaceous conglomerate observed in the drill core shows greyish white to dark grey color. The kinds of pebbles and the matrix are similar to those found on the surface.

Tuffaceous conglomerate is intercalated with tuffaceous sandstone at the western end of the K trench and at the eastern end of the M trench. Alternating beds of tuffaceous sandstone and tuffaceous conglomerate are found in drill cores from the MJM-1 hole at three places between 122.22 m and 131.45 m and those from the MJM-2 hole at 97.30 m - 98.92 m and 179.65 m - 193.00 m.

Tuffaceous conglomerate is interstratified with rhyolitic tuff breccia and tuff in the southern part of the area. In addition, it is observed in the MJM-1 hole at the depth of 161.90 m - 174.70 m, in the MJM-2 hole at 193.00 m - 209.55 m, 213.60 m - 216.45 m and 219.10 - 221.60 m, and in the MJM-3 hole at 10.65 - 16.50 m.

The rock consists mainly of white to greyish white rhyolite breccia partly containing small amount of rock fragment of black shale. The matrix is composed of small rock fragments of rhyolite and tuffaceous material.

Tuffaceous conglomerate overlies unconformably the lower altered diorite, and from the kinds of pebbles and the intercalated layers in the rock, it is assumed that the sedimentation of the rock took place in the early stage of activity of rhyolite described later, and that the time of it was late Oligocene.

(3) Brecciated rhyolite (Trhy2-b)

In addition to the four separate distribution of the rock at the crossing of the D and L trenches in the southern part of the area, it is found at the crossing of the C and M trenches.

In the drill core, it is observed in the MJM-1 hole at 188.68 m - 199.45 m and 252.30 m - 290.30 m.

Although the rock shows greyish white to greyish brown color on the surface, white to greyish white color are shown in the drill core. The rock consist of breccias of rhyolite containing phenocrysts of quartz and feldspar. The interstices of the breccias are filled with small breccias of rhyolite, quartz, feldspar and white or brown clay.

The rock unconformably overlies the lower altered diorite and tuffaceous conglomerate.

(4) Compact rhyolite (Trhy2-c)

The rock unit is the target of the survey of this year, and is widely spread occupying the most part of the area. Two distributions of exposure are found. The one shows a wide distribution on the east of the area having an extent of about 150 meters in E-W direction and about 400 meters in N-S direction. The other is found at the southwestern end of the area with the extension of about 180 meters in the northwest direction

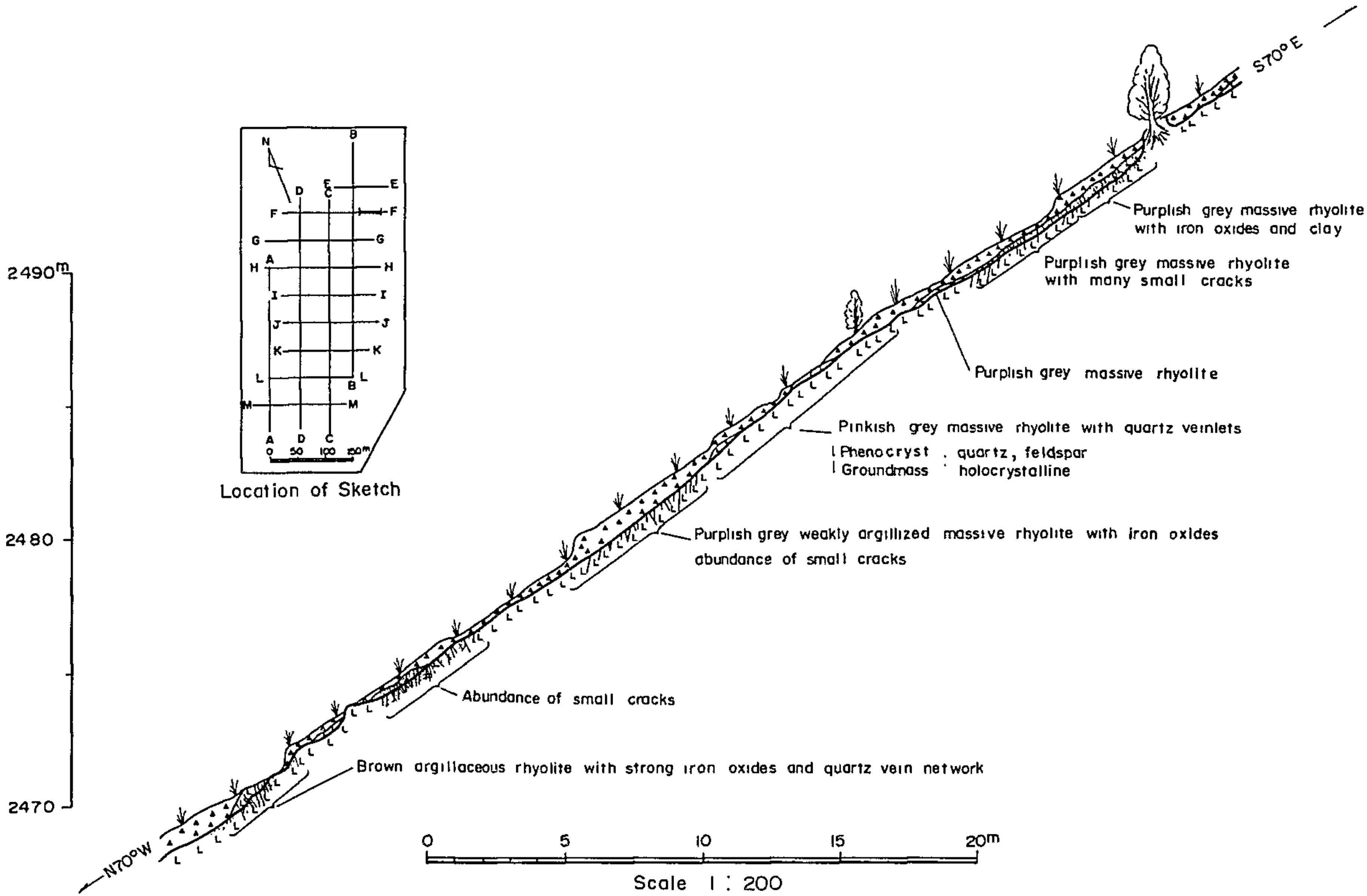


Fig.2-7 Geological Sketch of F – Trench.

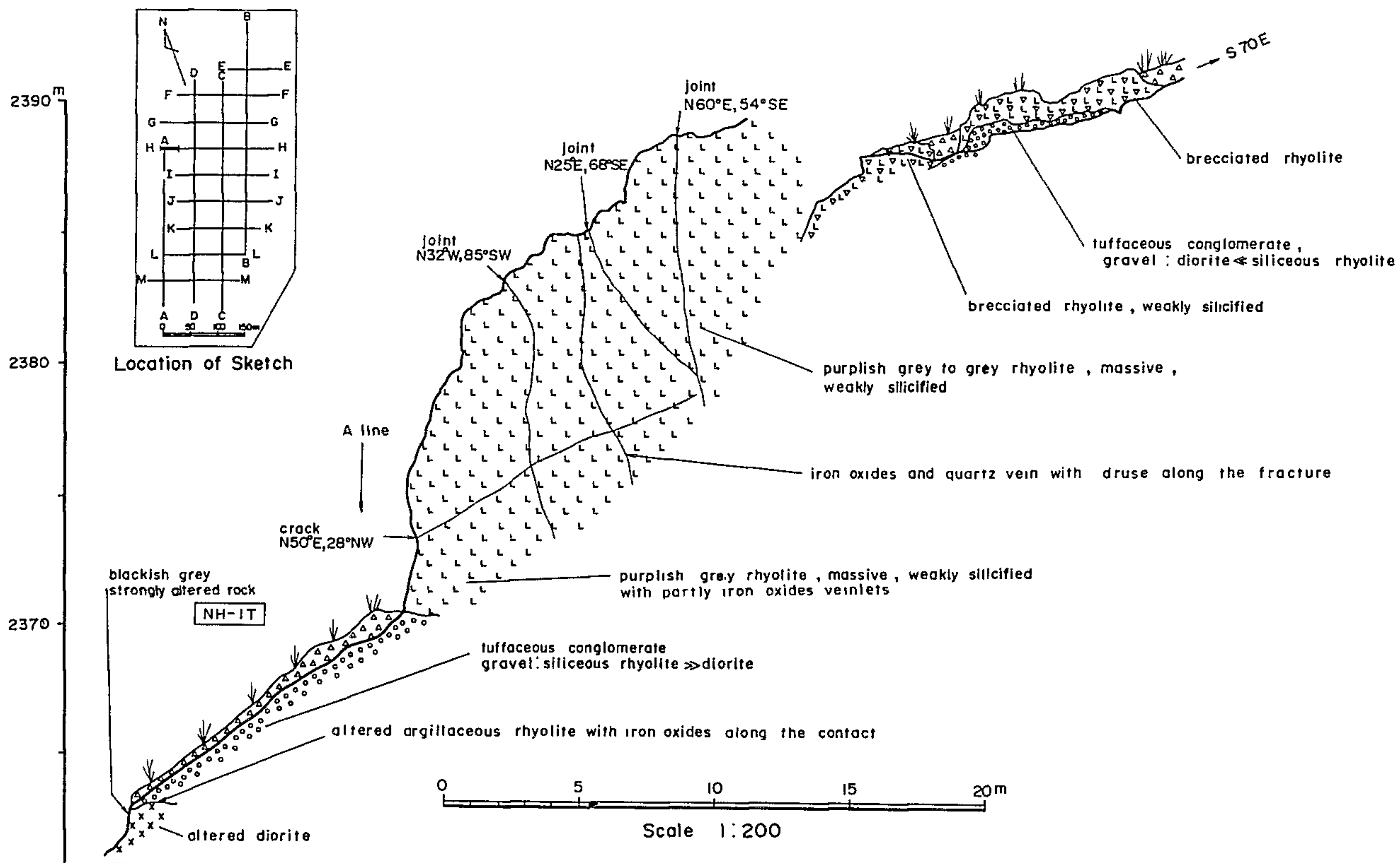


Fig. 2-8 Geological Sketch of H−Trench (western part)

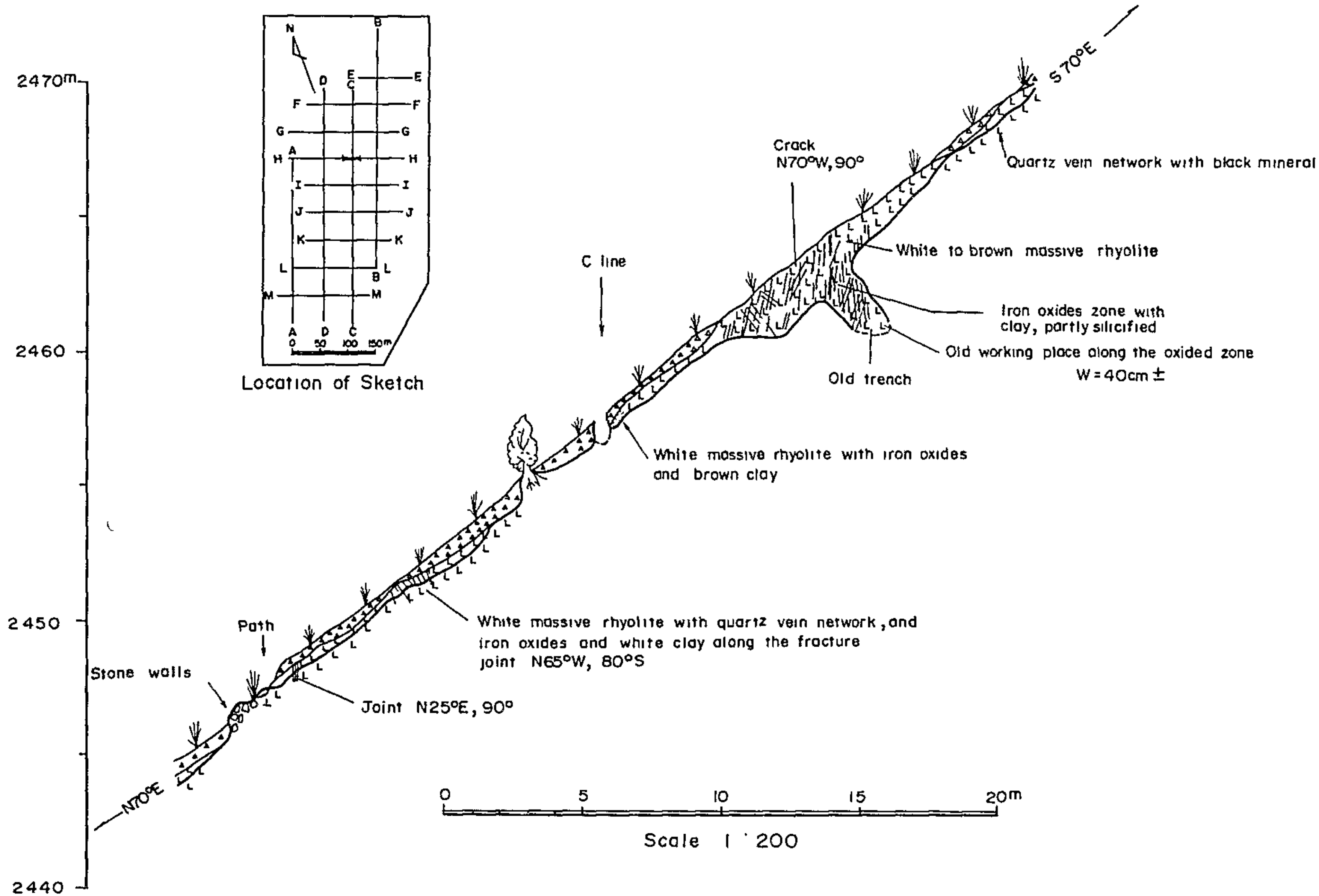


Fig.2-9 Geological Sketch of H-Trench (central part)

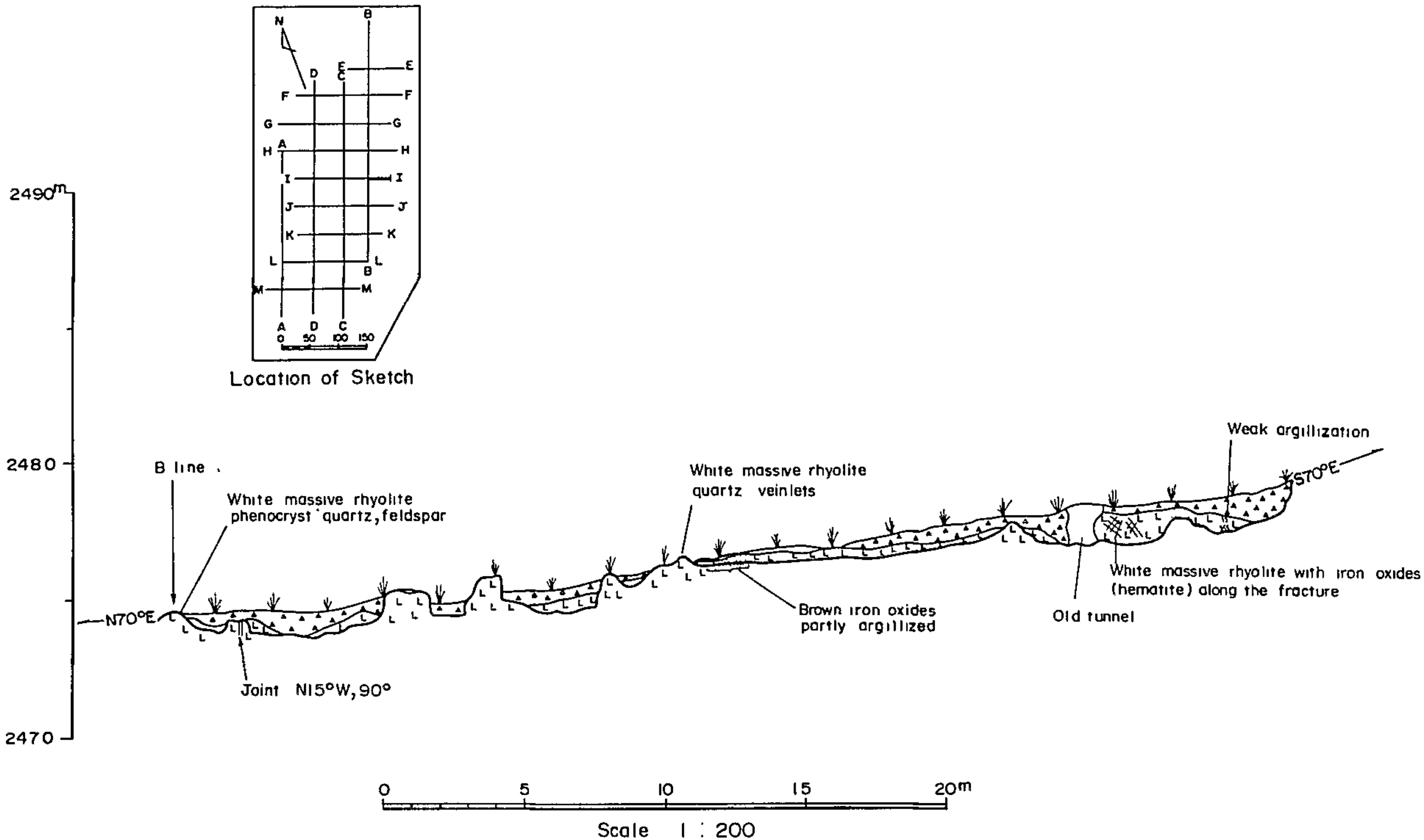


Fig.2-10 Geological Sketch of I-Trench

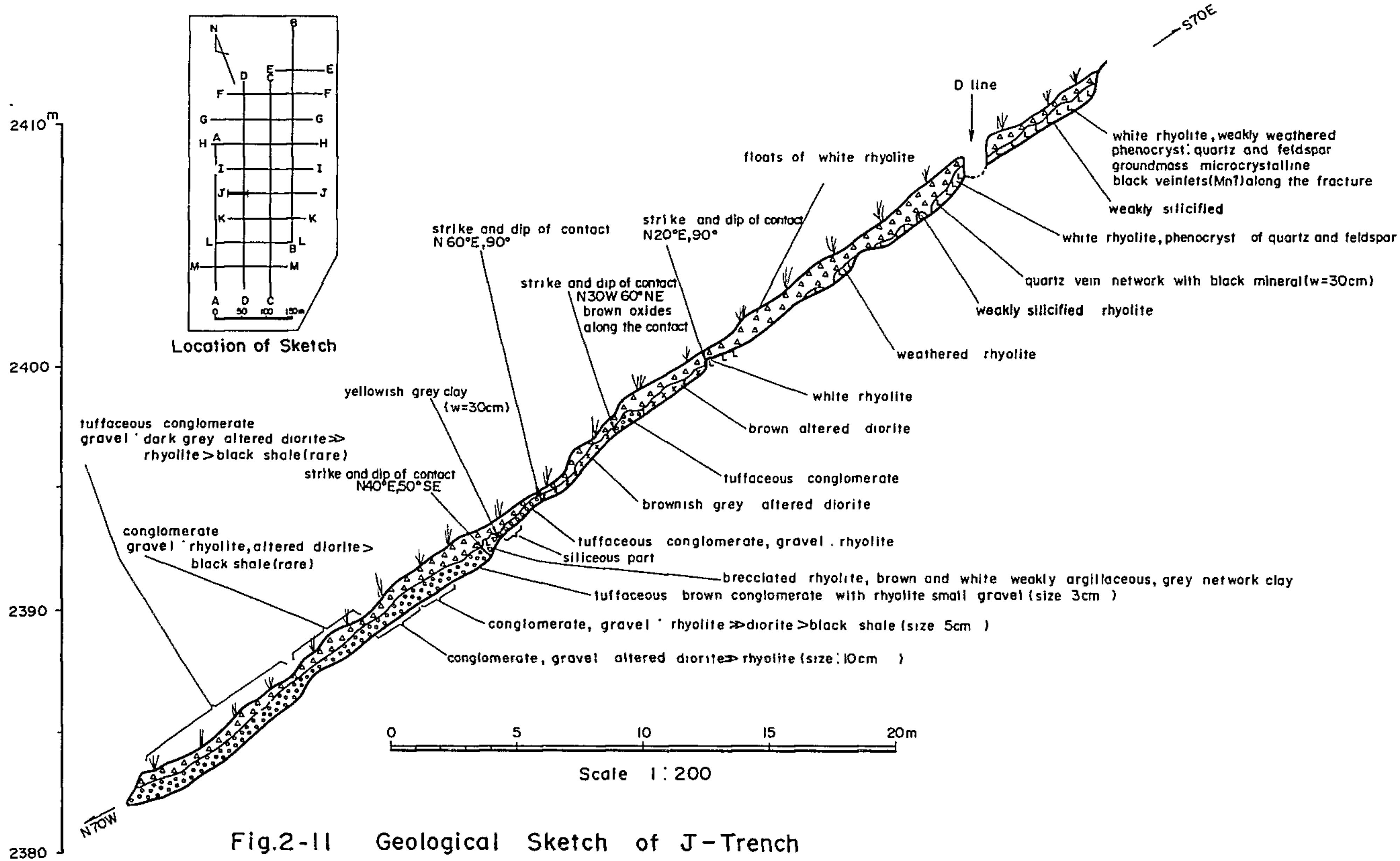


Fig.2-11 Geological Sketch of J-Trench

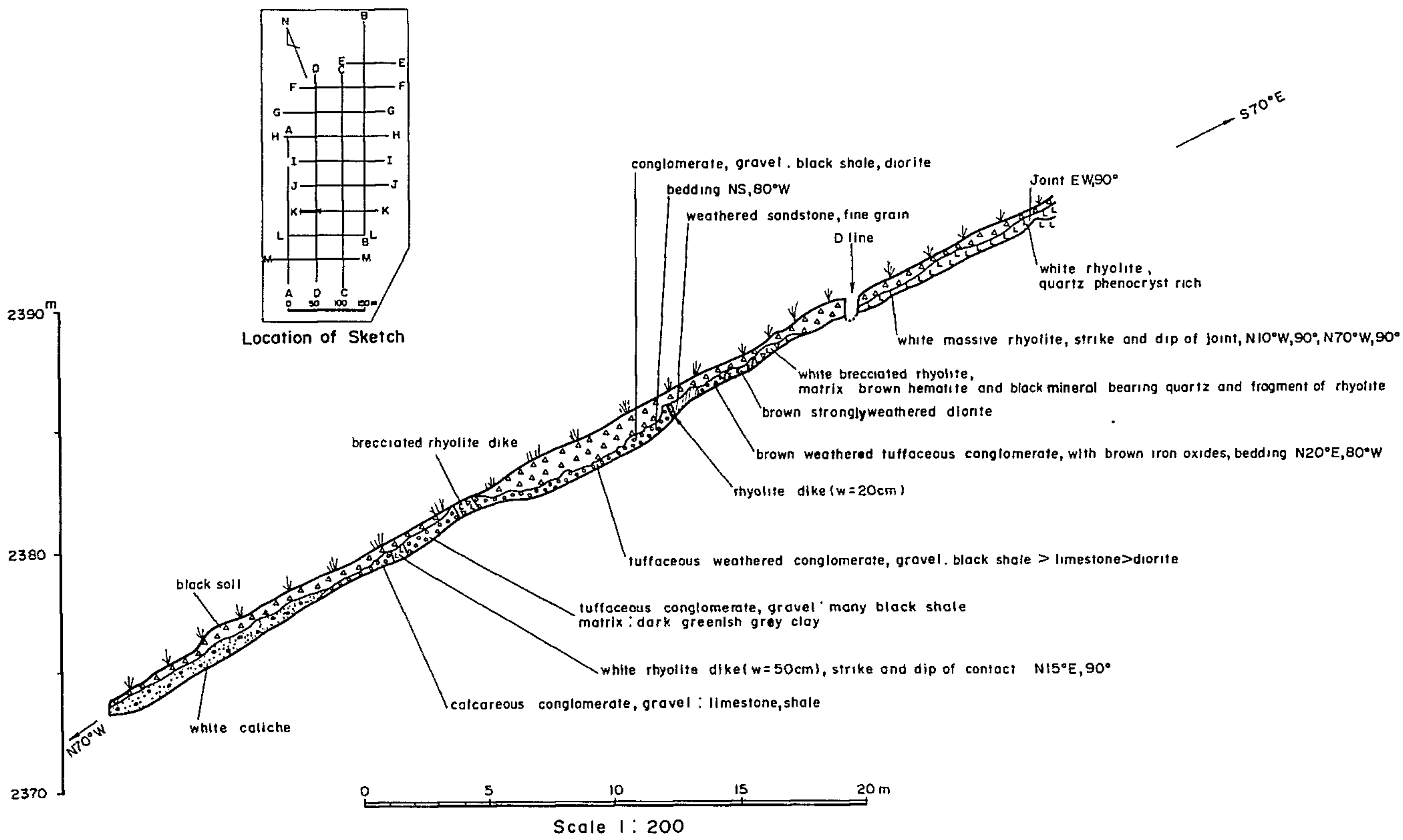


Fig.2-12 Geological Sketch of K-Trench(western part)

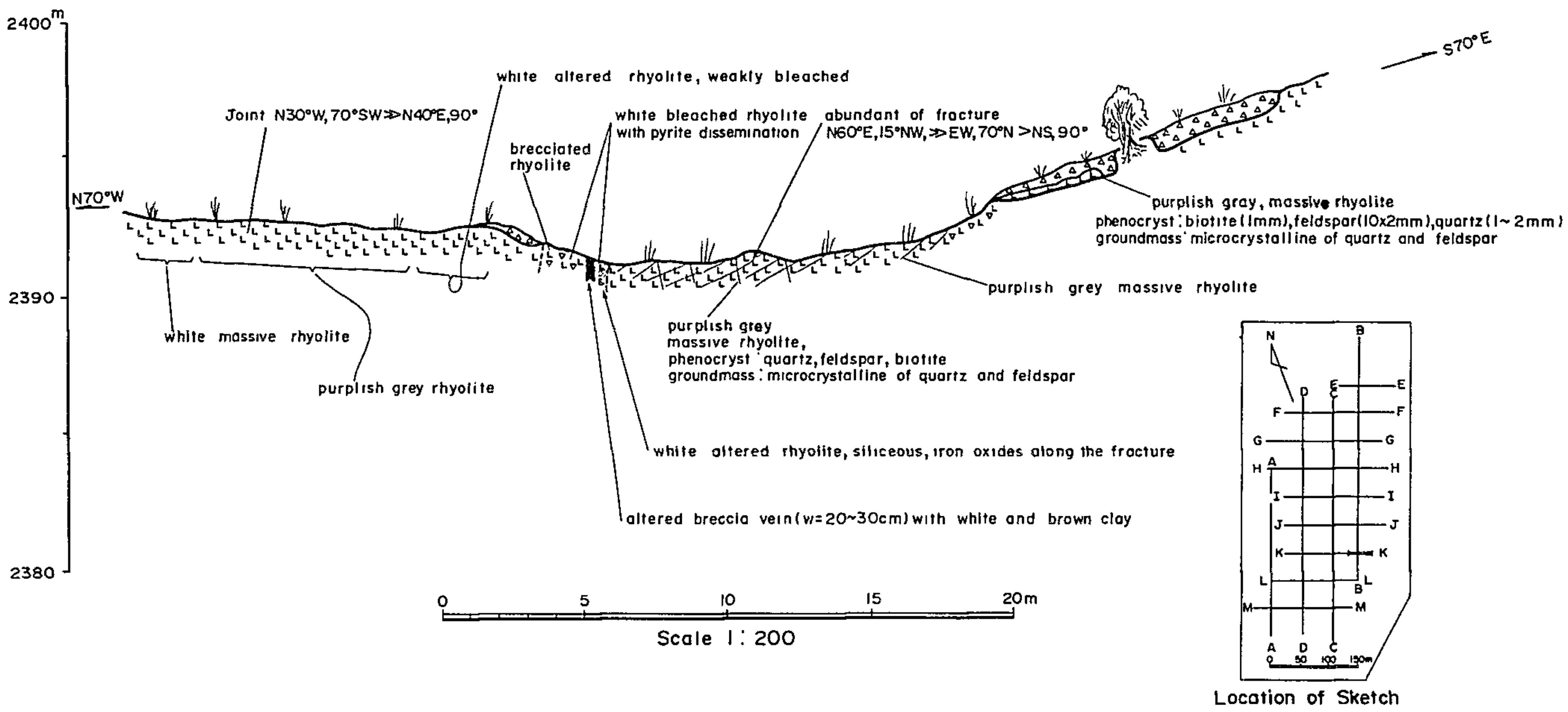


Fig.2-13 Geological Sketch of K-Trench (eastern part)

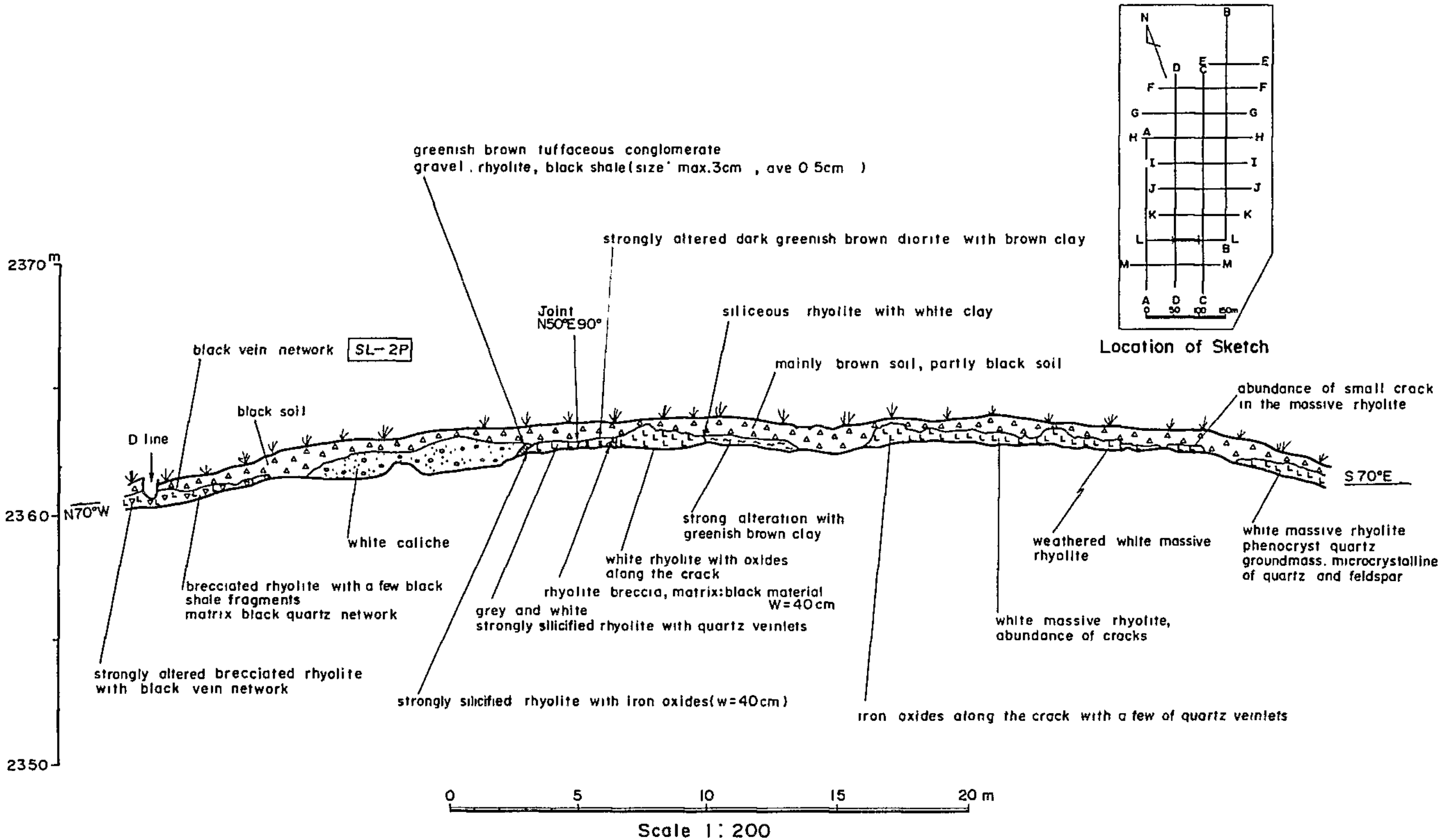
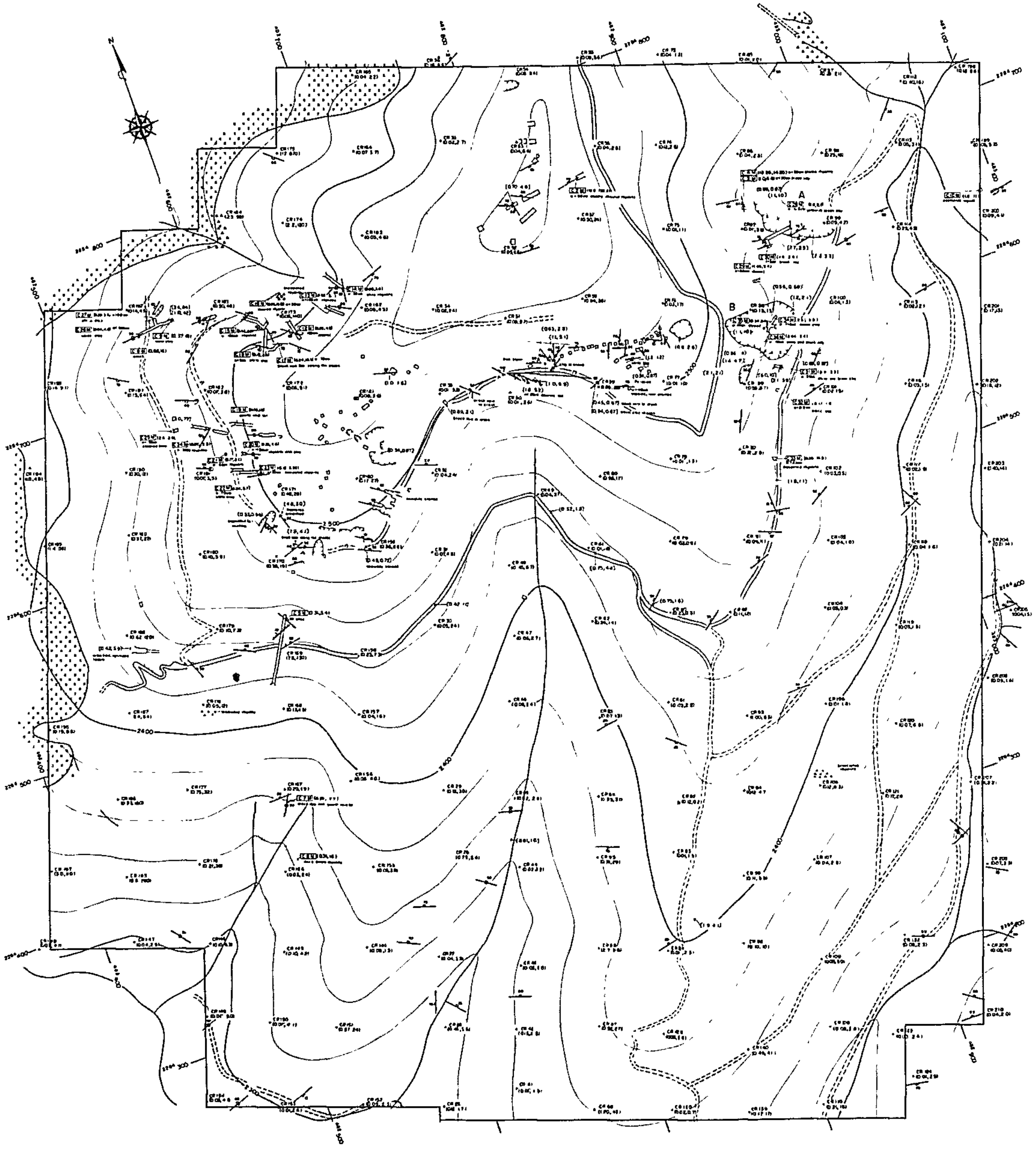


Fig.2-14 Geological Sketch of L-Trench



LEGEND

- Compact rhyolite
- Diorite porphyry
- Brecciated rhyolite
- Oxidation zone
- Fault
- Joint
- Adit
- Open pit
- Trench and pit
- CR 25 — Geochemical rock sample
- C7M — Sample of ore
- (0.35,3.5) Analytical results of Au g/t, Ag g/t (1982)
- (035,35) Analytical results of Au g/t, Ag g/t (1981)

Fig. 2-15 Geological Sketch of the San Severiano Mine, SAN CLEMENTE (after JICA and MMAJ 1982)

and the width of about 100 meters. These distributions are positioned at the western end of the rhyolite complex which forms the main mass to the east of the area.

The rock is observed in the drill core from the MJM-1 hole at 0 m - 59.65 m, the MJM-2 hole at 0 m - 51.20 m and 232.70 m - 300.20 m (the bottom), and in MJM-3 hole at 16.50 m - 300.50 m (the bottom).

Although the rock shows locally pale purple to pale pink color, it generally shows pale grey to white color, and is a massive and compact rhyolite containing characteristically the phenocrysts of quartz and feldspar.

Under the microscope, the rock shows the porphyritic structure with the phenocrysts of quartz, oligoclase, small amount of anorthoclase and very small amount of biotite.

Quartz phenocryst shows a corroded anhedral crystal form one to two milimeters across. Oligoclase displays euhedral and anhedral crystal forms one to three milimeters across sometimes showing glomeroporphyritic texture. These were generally subject to weak alteration to show a cloudy appearance, and microlitic sericite has been produced in the crystal. Mantle of anorthoclase is sometimes observed at the periphery of oligoclase. Anorthoclase is one to two milimeters in size and is contained in small amount. Myrmekite has been produced at the part of mantle, and microlitic sericite and kaoline are also observed inside the crystal.

The matrix consists of microlites of quartz, oligoclase and anorthoclase and is holocrystalline.

Small amount of apatite and opaque minerals are observed as accessory minerals. Sericite and kaoline are observed as secondary minerals produced in feldspars, and chlorite is partly found.

Rarely, quartz veinlts (less than one milimeter wide) of poor continuity cut irregularly the rock.

In order to investigate the chemical composition of rhyolite of the area, whole rock analyses were made on 50 rock samples in total, of which 40 samples were taken from the surface and 10 from the drill core (Apx. 6). From the result of analysis of these samples, it is indicated that the mean values of each chemical composition of the rock (Table 2-1) has such characteristics of higher SiO_2 and Na_2O contents as compared with those of ordinary rhyolite of Daly, R.A. (1933), though other components show low values. That is, while each content of SiO_2 and Na_2O in ordinary rhyolite are 72.82% and 3.38% respectively, the rhyolite on the surface of the area shows 79.35% SiO_2 and 4.16% Na_2O respectively, and that of drill core shows 77.82% SiO_2 and 5.67% Na_2O.

Among the chemical compositions showing low values, K_2O is especially conspicuous. Contrary to the K_2O content of 4.46% in ordinary rhyolite, that of the surface of the area shows 1.40% and that of the drill core 0.86%.

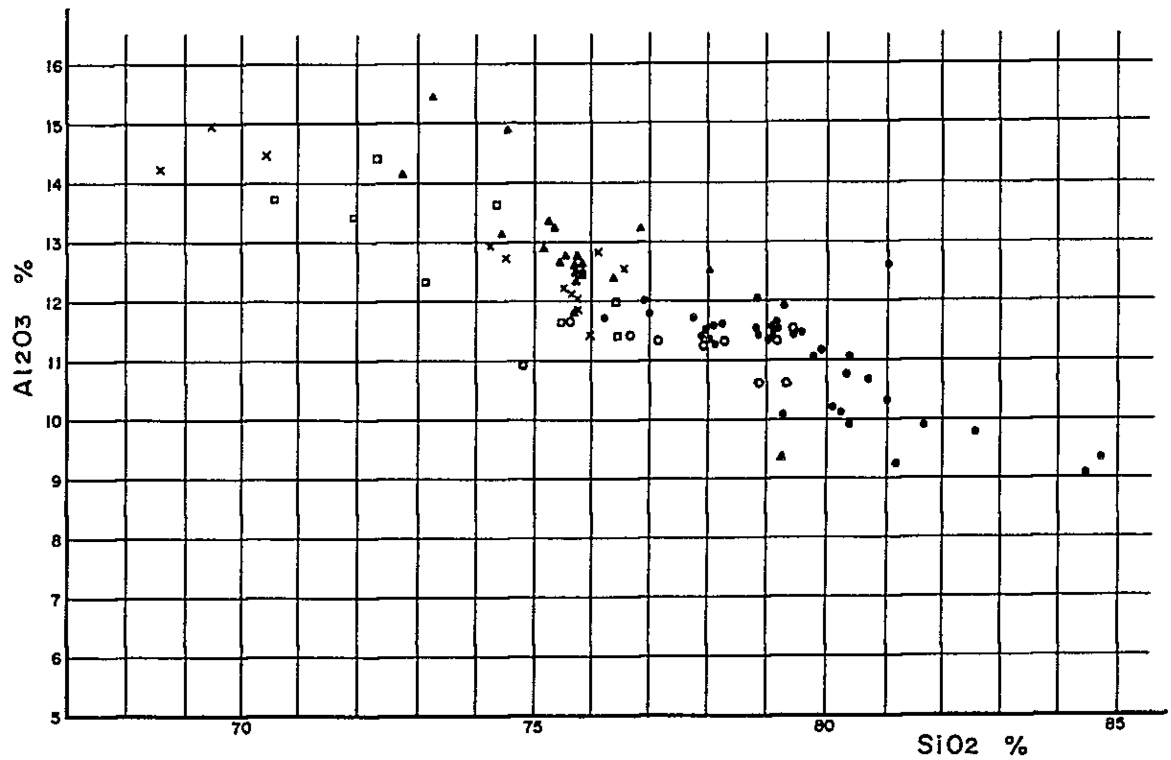
Table 2-1 Average Chemical Composition of Compact Rhyolite

	Average value of 22 samples (Phase II survey area) weight%	Average value of 10 samples (Phase IV Drilling core) weight %	Average value of 40 samples (Phase IV surface) weight %
SiO_2	75.77	77.82	79.35
TiO_2	0.09	0.07	0.08
Al_2O_3	12.85	11.20	11.05
Total Fe(asFeO)	1.17	0.98	0.85
MgO	0.12	0.15	0.10
CaO	0.16	0.94	0.11
Na_2O	3.47	5.67	4.16
K_2O	4.28	0.86	1.40

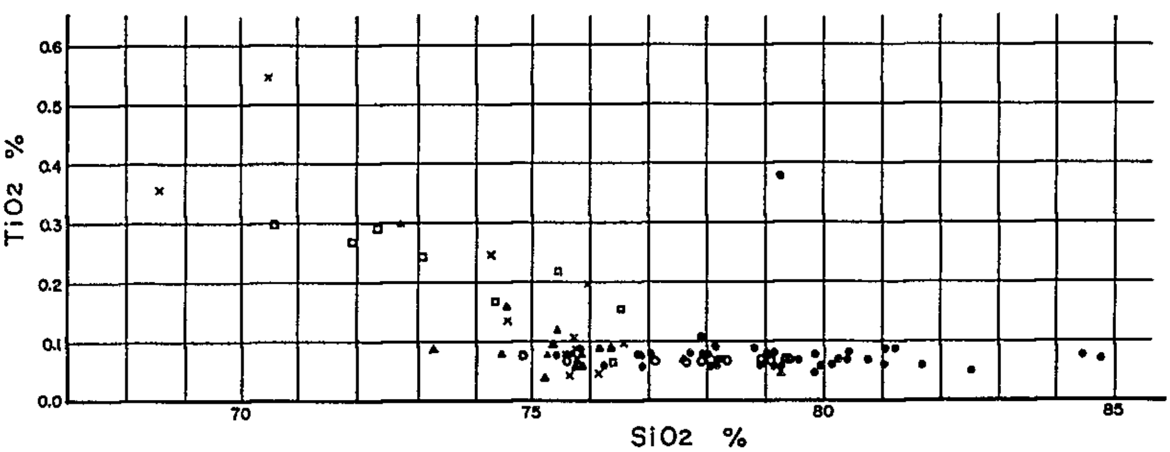
Fig. 2-16 Variation Diagram for the San Clemente Rhyolitic Rocks (weight percent SiO_2 – weight percent Al_2O_3, TiO_2, MgO, CaO, T.Fe, K_2O, Na_2O and K_2O – Na_2O Correlation Diagram)

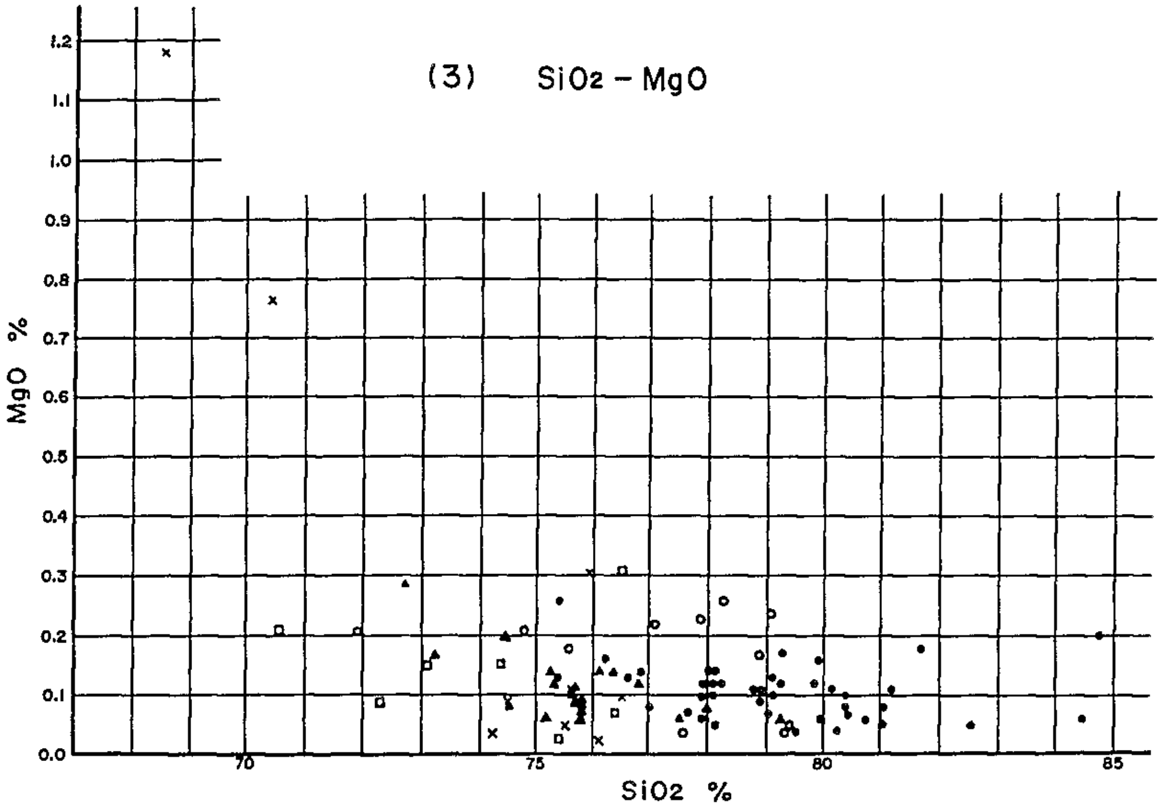
▲	Compact rhyolite Phase II
●	Compact rhyolite Phase IV
o	Compact rhyolite Phase IV (Drilling-core)
□	Banded rhyolite Phase II
×	Rhyolitic tuff breccia Phase II

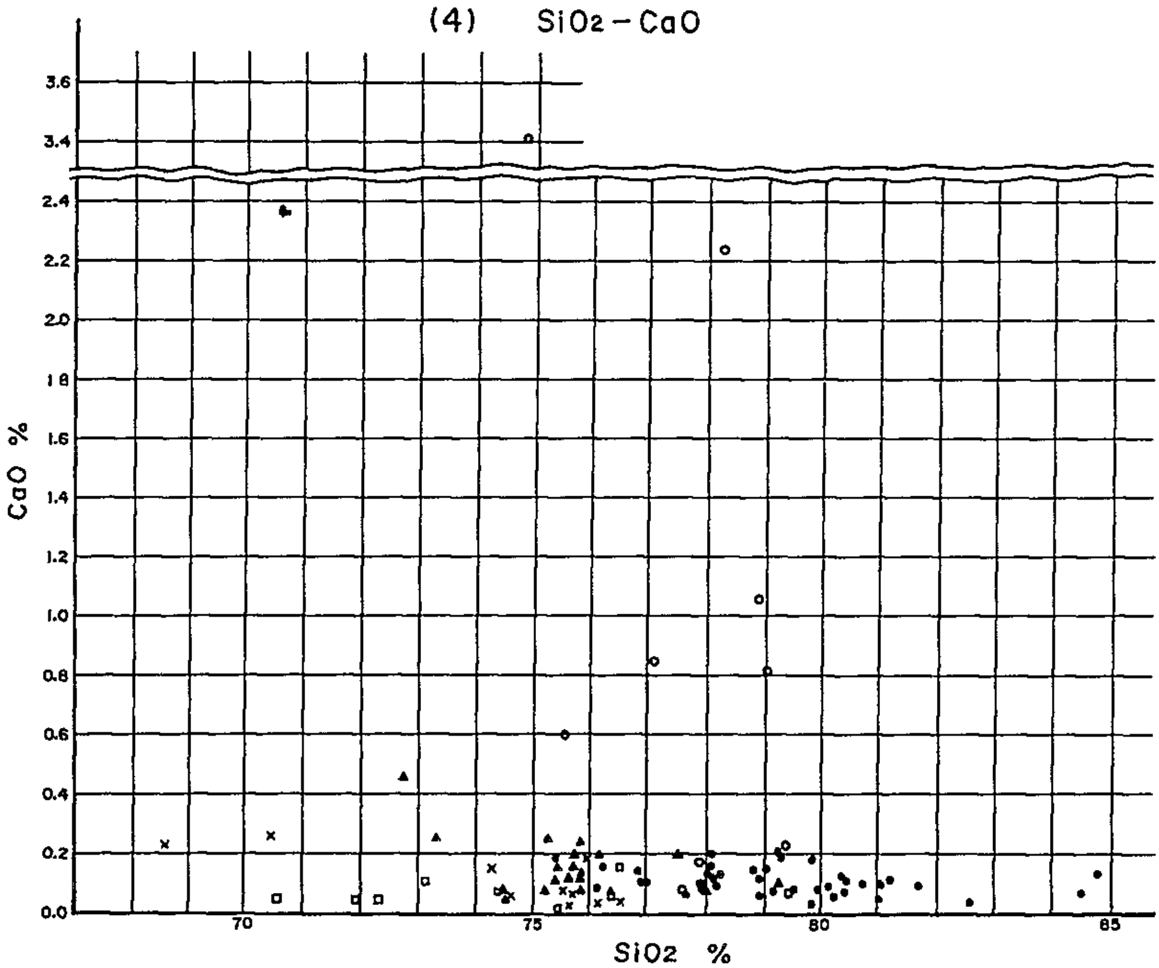
(1) SiO_2 – Al_2O_3



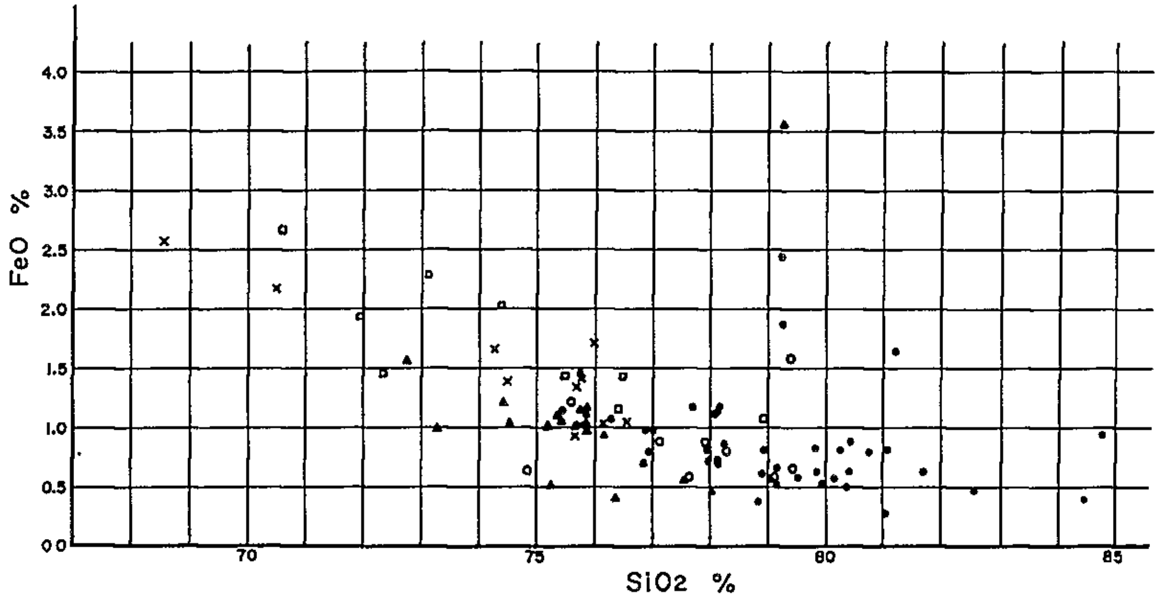
(2) SiO_2 – TiO_2



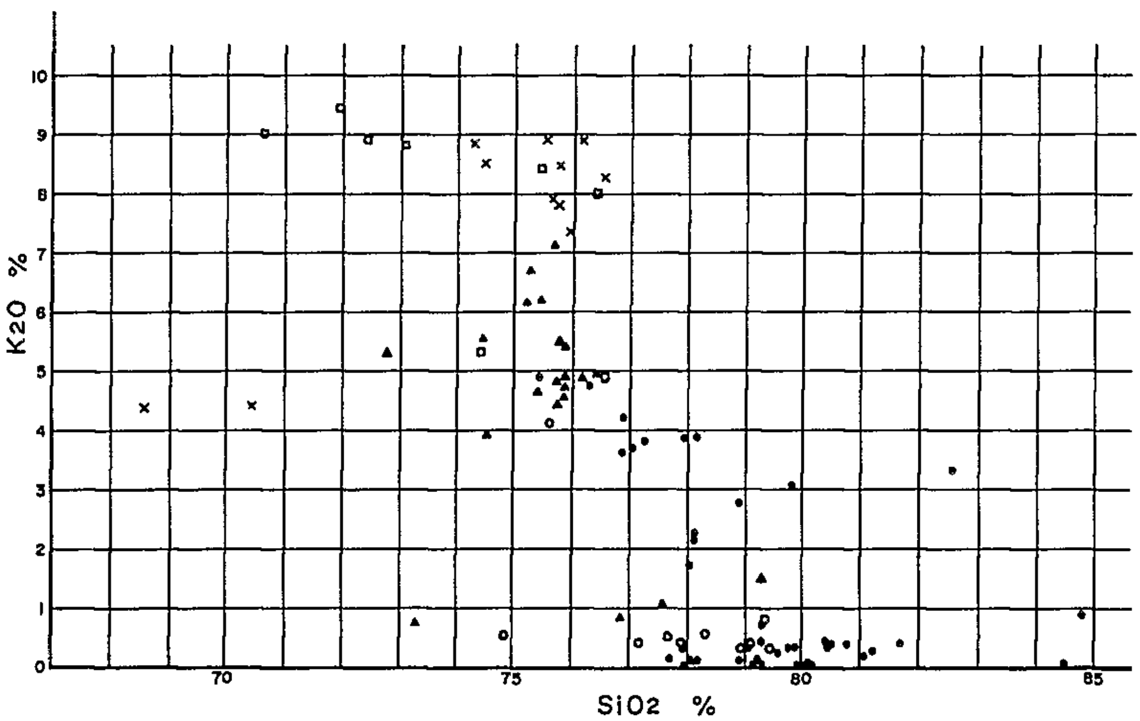

(3) SiO2 - MgO
MgO %
1.2
1.1
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
70
75
80
85
SiO2 %


(4) SiO2 - CaO
CaO %
3.6
3.4
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
70
75
80
85
SiO2 %

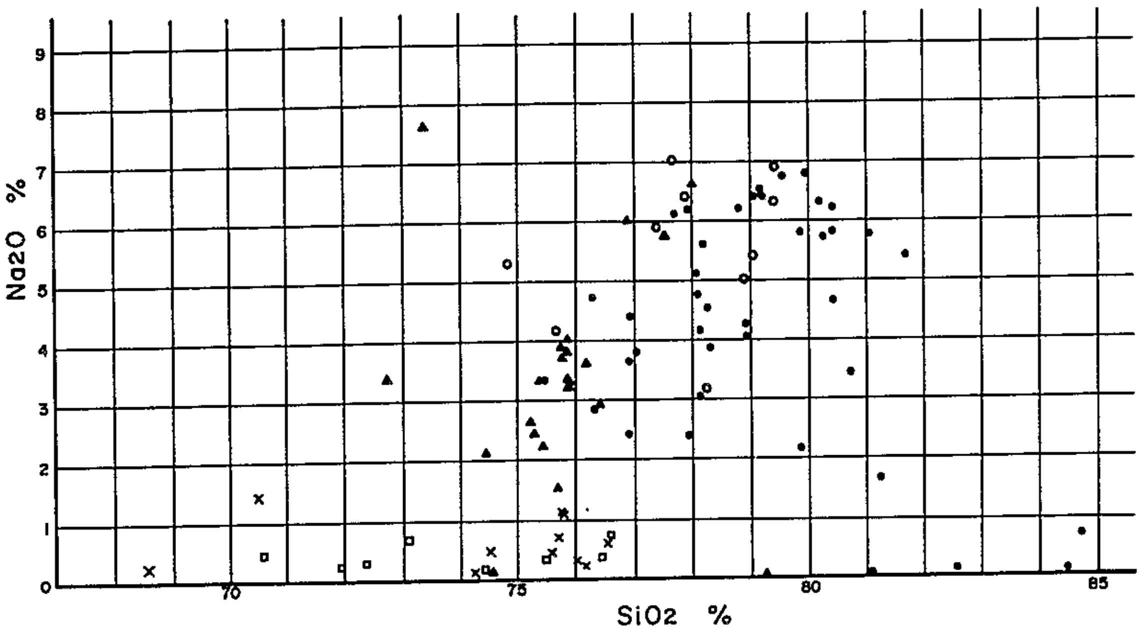
(5) SiO_2 – T. Fe (as FeO)



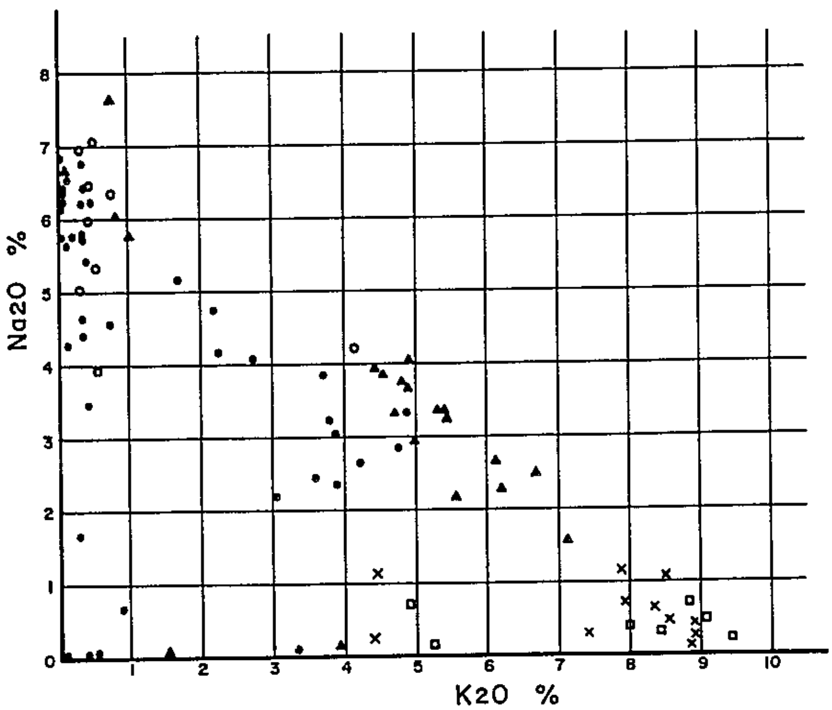
(6) SiO_2 – K_2O



(7) $SiO_2 - Na_2O$



(8) $K_2O - Na_2O$



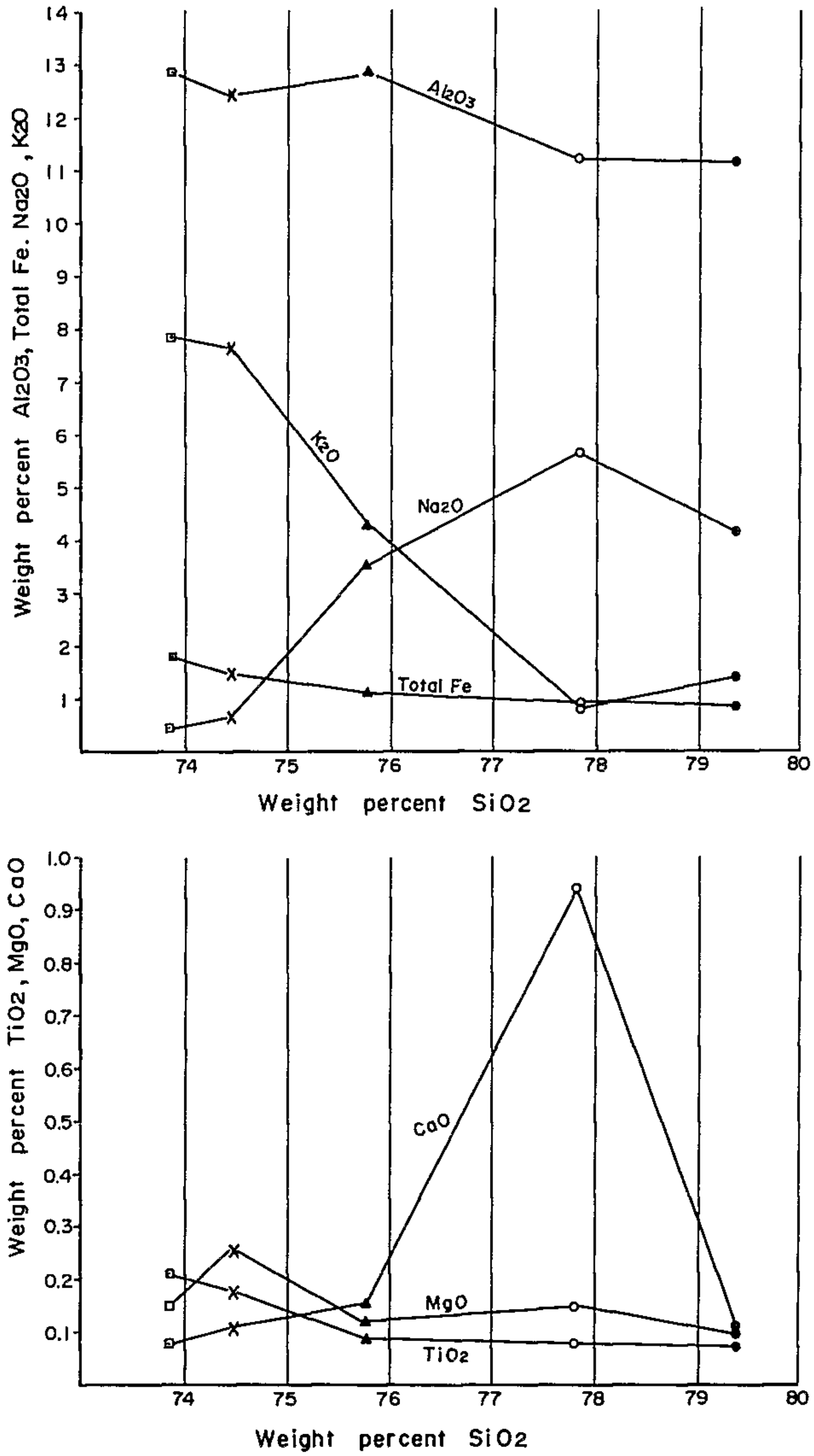


Fig. 2-17 Variation Diagram for the San Clemente Rhyolitic Rocks by Their Average Chemical Compositions

- ● Compact rhyolite
- ○ Compact rhyolite (Drilling-Core)
- ▲ Compact rhyolite
- □ Banded rhyolite
- × Rhyolitic tuff breccia

(▲, □, ×: after JICA and MMAJ (1981))

In the survey of the second year, investigation of the main rock forming components of the rhyolite mass was made on the whole rhyolite mass which is broadly distributed on the east including the area. Since the area is positioned in the zone of distribution of compact rhyolite of the rhyolite mass, a chemical composition variation diagram of eight components (Fig. 2-16) and a variation diagram of mean values of these chemical compositions (Fig. 2-17) were produced in order to make relative investigation between the chemical compositions of the compact rhyolite of the second year and those of the compact rhyolite of this area. Although in the variation diagrams (Fig. 2-16 and Fig. 2-17), chemical composition of bandded rhyolite and rhyolitic tuff were shown for the reference, only those of compact rhyolite are discussed here. The result is compiled as follows.

① Although most of the SiO_2 contents of samples in the second year are concentrated within the range between 75.20% and 76.39%, those of the samples of the area are concentrated within the range between 76.88% and 81.21%, showing high values of SiO_2 component.

② Content of $A\ell_2O_3$ and T. Fe (as FeO) show a tendency to decrease gradually with increase of SiO_2 content (Fig. 2-16-(1), (5)). Therefore, contents of both components of the samples of this year are low as compared with those of the second year.

③ Contents of TiO_2, MgO and CaO do not show any great difference between those of this year and the second year on the surface, but the samples in the depths taken from the drill core show high values in CaO content (Fig. 2-16-(2), (3), (4)).

④ As to K_2O content, contrary to concentration of the values of samples of the second year within the range between 4.47% and 7.13%, most of those of samples of this year are concentrated below 0.73%,

and the remains are dispersed in the range from 1.74% to 4.90%, showing low content as a whole (Fig. 2-16-(6)).

⑤ Na_2O content shows a tendency to gradually increase to the point of about 80.5% SiO_2, which suddenly decrease over that point (Fig. 2-16-(7)).

As shown in Fig. 2-16-(8), correlation between the contents of K_2O and Na_2O can not be recognized only from the samples of this year, because most of the samples of rhyolite of the area show the values of less than 0.91% in K_2O, and because the Na_2O contents are concentrated within the range between 4.25% and 7.07%. When taking, however, a wide view of the relation between both components including those of the samples of the second year, it can be said that correlation between them is shown that Na_2O content increases with decrease of K_2O content.

The zone covered with rhyolite in the area is included in the geochemically anomalous zone confirmed as the result of geochemical survey of the second and the third years, so that it is considered that the SiO_2 content of rhyolite of the area shows an unusually high values, since SiO_2 component was supplied by silicification associated with the mineralization which formed the above anomalous zones.

It is, therefore, considered that contents variation of rock forming components described in the clauses such as (2), (4), (5) and (6) would have been caused by this increase of SiO_2 content.

High values of CaO content shown in the depth as compared with that of the surface mentioned in the clause (3) will be attributed to leaching by weathering on the surface of oligoclase which contains CaO.

The time of activity of the rock seems to be almost contemporaneous with the rhyolite lava distributed on the east of the area, which is shown to be of 26.5 ± 1.3 Ma as the result of K-Ar dating.

(5) Intrusive rocks

Intrusive rocks distributed in the area are altered diorite (Tidi) rhyolite (Tirh) and dacite (Tidc). Among these, description of diorite has been made in the previous section, because it forms the basement of the area, so that it will be omitted here.

Rhyolite (Tirh):

The rock is exposed as small dykes at four places in the southwestern part of the area and at one locality in the southern part.

The dyke rock is observed in the drill core of the MJM-1 hole at the section from 202.6 m to 206.10 m and the MJM-2 hole at the section from 70.33 m to 78.00 m.

The rhyolite dyke shows greyish white to white color, which is very similar to that of compact rhyolite spreading broadly in the area. The dyke observed in the MJM-1 hole shows grey to pale greenish grey color and is highly altered. It seems to be due to the association of sulfide minerals and chlorite. The trend of intrusion of the dyke shows approximately N-S direction.

The time of intrusion of the rock is assumed to be almost contemporaneous with compact rhyolite because of its close resemblance of appearance to that rock.

Dacite (Tidc):

The rock has intruded into tuffaceous conglomerate in the western part of the area on a small scale along the fault of E-W system. The rock displays brown color due to weathering, on which cloudy plagioclase can be clearly observed by the naked eye and small amount of quartz grains are also found.

Because it was confirmed by the third year's survey that a dyke of the same appearance with this rock penetrated the compact rhyolite, the rock can be said to have intruded after the activity of rhyolite of the area.

Caliche (Qc):

Caliche is distributed in the southwestern part of the area with an extent of about 100 meters in E-W and about 110 meters in N-S unconformably overlying the lower formations. It is semi-consolidated material white to greyish white in color, and markedly effervesces with dilute hydrochloric acid. It is assumed to have deposited in Quaternary and the thickness is about three meters.

2-4 Geologic Structure

Consideration of the geologic history and the geologic structure of the area leads to the following interpretation.

The diorite intruded into the sedimentary rocks uppermost Jurassic to Cretaceous periods in early to middle Oligocene formed the basement of the area having been subjected to the successive errosion. In the late Oligocene, activity of rhyolitic rocks commenced on the east of the area, and a part of released rhyolitic-tuff and rhyolite was transported to the area, which was deposited in the depression formed on the eroded surface of diorite, forming tuffaceous conglomerate.

In the later stage of sedimentation of the conglomerate, the activity of rhyolite on the east of the area became active, and the area was subjected to the influence of it. In association with the activity, compact rhyolite of the area unconformably overlay the lower formation, and almost simultaneously the fault structure developed in the southern part of the area, having resulted complicately to the formations into blocks.

Among the fault structures, those of E-W system is most conspicuous, and in addition, the faults of NE-SW and NW-SE systems are also observed. The faults of E-W system have been cut by those of NE-SW and NW-SE systems.

From the fracture zones and fault clay zones observed in the drill cores from the holes in the southern part of the area, some faults structures can be estimated. Those of relatively large scale ones are observed in the MJM-1

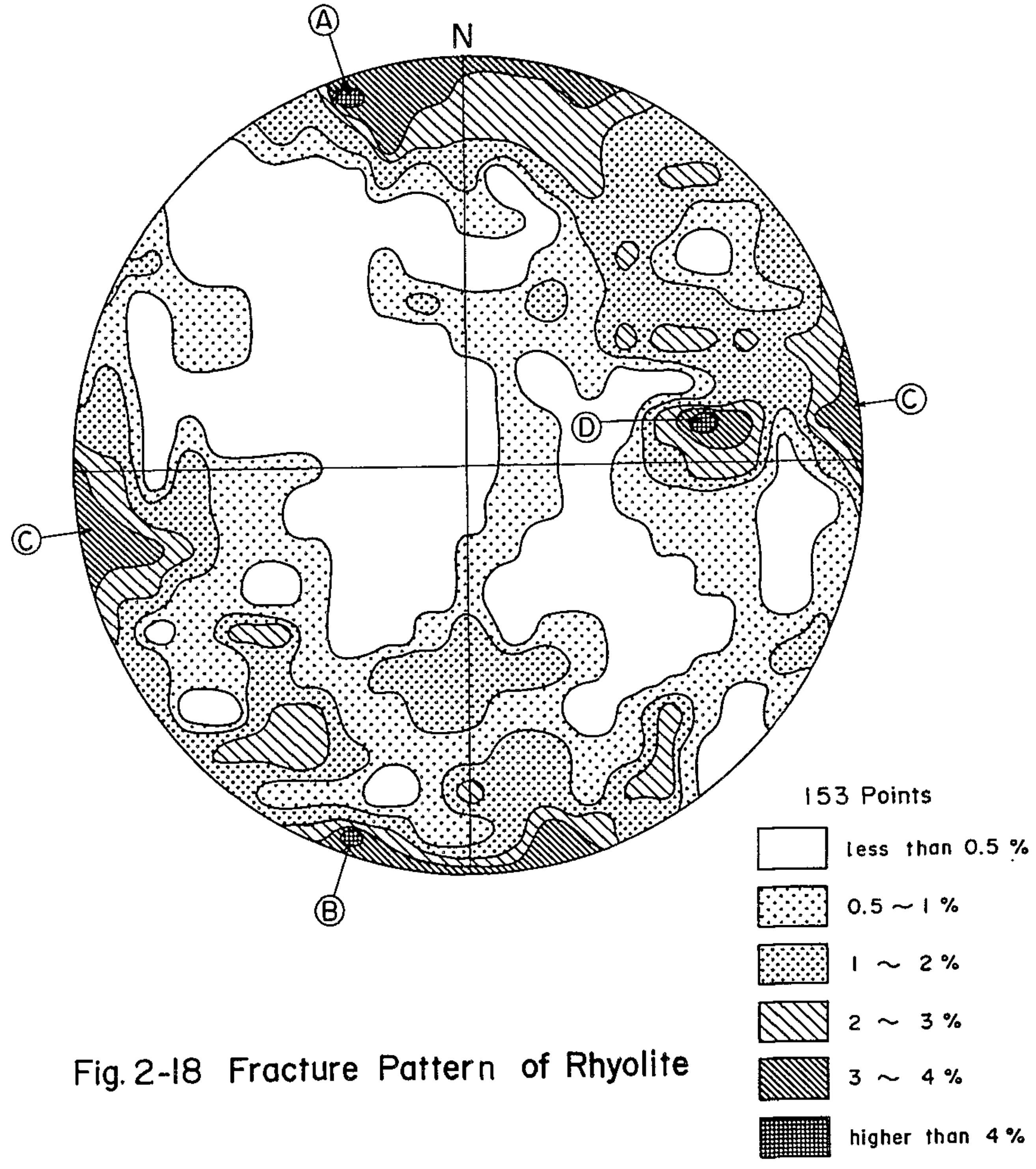
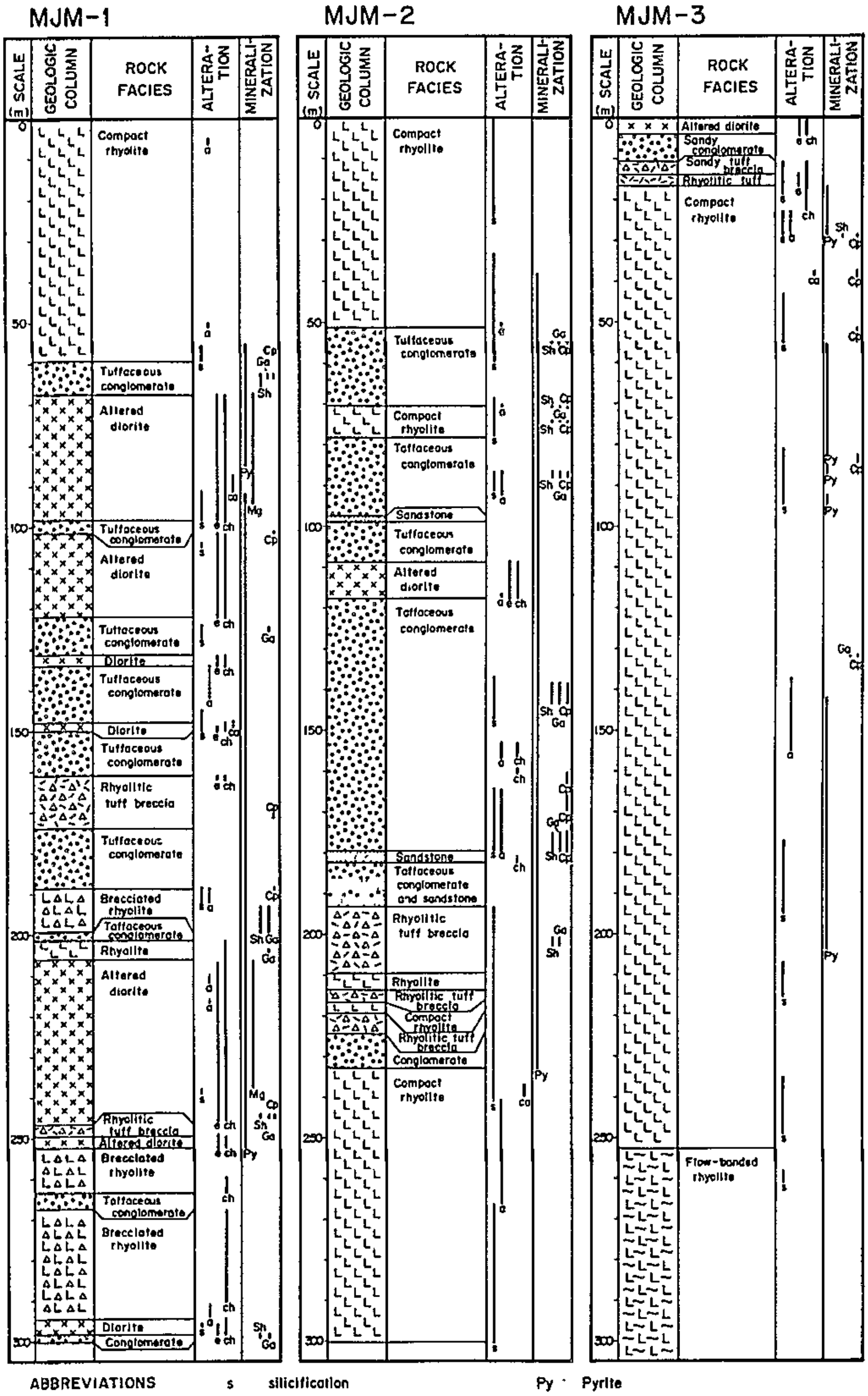


Fig. 2-18 Fracture Pattern of Rhyolite



ABBREVIATIONS			
s	silicification	Py	Pyrite
a	argillization	Mg	Magnetite
e	epidotization	Sh	Sphalerite
ch	chloritization	Ga	Galena
ca	carbonitization, calcite vein and quartz vein	Cp	Chalcopyrite

Fig. 2-19 Summary of Geological Core Logs of the MJM-1, MJM-2 and MJM-3 Drilling Holes, SAN CLEMENTE

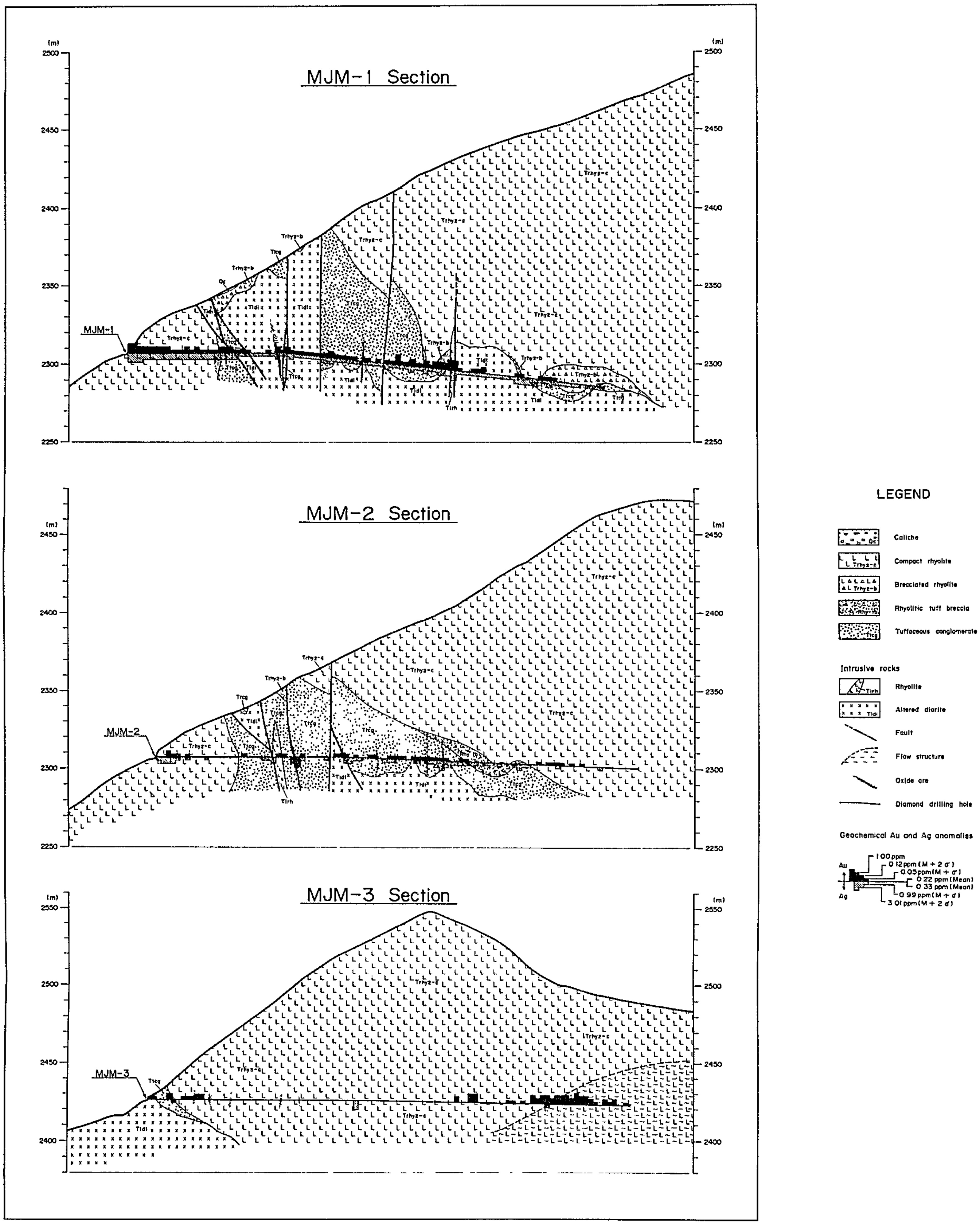


Fig. 2-20 Geological Profiles by Drilling Holes

hole at seven places and in the MJM-2 hole at four places.

Down throw of the largest one is estimated to be more than 80 meters from the assumption based on the geological section prepared by the drill sections (Fig. 2-20).

Many joints and fractures are observed in compact rhyolite of the area. Since these fracture systems are closely related to the gold and silver mineralization, the strikes and dips of the joints and fractures measured on this time at 153 points, were projected to the Schmidt net to investigate the trends (Fig. 2-18).

As the result, it has been known that the fracture systems of the following four directions are predominant in the rhyolite.

System A: EW - N70°E, 70°SE - 90 and EW - N70°E, 80°NW - 90°

System B: EW - N65°W, 80°NE - 90° and EW - N65°W, 80°SW - 90°

System C: N5°E - N15°W, 70°NE - 90° and N5°E - 15°W, 80°SW - 90

System D: N5° - 15°W, 45° - 60°SW

Among these fissure systems, combinations of A and C systems are remarkably observed in the field, having a character of conjugate joint.

The D system is almost consistent with the C system in the trend, but the dip is unilateral and gentle.

The trends of A and B systems are almost consistent with those of the fault of E-W system, and it also shows a tendency to be consistent with the trend of extension of the brown oxidized zone which extends along the fracture in rhyolite.

2-5 Alteration and Mineralization

The area is situated in the western part of a series of the gold and silver mineralized zone including the San Severiano mine, and a trace of exploration in the past by tunneling and trenching on a small scale is found in the area (Fig. 2-15).

Among the matters obtained as the result of investigation of this year,

the result of geochemical survey is described in Section 2-6 and that of drill survey in Section 2-7. Therefore, the mineralization and alteration observed by the detailed geological survey is described in this section.

The alteration related to mineralization are observed of silification, oxidation and argillization, etc. on the surface.

Among these, in respect with silicification, the whole rock mass of rhyolite has been subject to the influence of it, so that it is difficult to discriminate it as silicified zone from other part. The oxidation and argillization, however, are notably observed locally, which were demarcated as oxidized zone and argillized zone (Fig. 2-24). Pyritization is markedly observed in the terrain of altered diorite and tuffaceous conglomerate.

Silicification in rhyolite

Although the whole rock mass of rhyolite presents an appearance of white color having been subjected to weak silicification throughout the rock, no place has been found in the field to discriminate the highly silicified zone from other part of the rock. It is considered, moreover, that the whole rock mass has been subjected to a weak silicification, because it is often observed that very fine quartz veinlets (less than one milimeter wide) of poor continuity penetrate the rhyolite and because SiO_2 content in the rock is very high as mentioned in Section 2-4.

It is rarely observed that network quartz veins of poor continuity less than 20 centimeters wide and quartz veinlets less than five milimeters wide partly cut the rock.

A brecciated quartz vein accompanied with white clay penetrates the rhyolite in the direction of N70°E in the D-trench at 25 meters to the south of the intersection of H and D-trenches. The assay grades of a smaple (KD-1) taken from that vein showed 0.02 g/t Au and 0.2 g/t Ag. Those of a sample (SHQ-1) taken from a brecciated and highly silicified part in the H-trench at 17 meters to the east of the intersection of H and D-trenches showed 0.10 g/t Au and 1.0 g/t Ag. Both of these are low in grade.

The result of microscopy of the polished section of a sample (SC-3P) taken from the network quartz vein in the C-trench at 19 meters to the south of the intersection of the C and G- trenches showed scattering fine crystal aggregate of hematite 2 x 10 μ in size and goethite dissemination in the gangue minerals (mainly quartz). Other trace minerals such as Pb-Ba-Mn minerals (coronadite-hollandite system) and hausmannite (approx. 75% MnO, 9% FeO)? are also observed.

The result of microscopy of other samples of rhyolite and quartz veins showed that pyrite, marcasite, sphalerite and rutile were contained in a very small amount beside goethite and hematite, but no gold and silver minerales were confirmed. Electrum was, however, observed in the sample taken from the oxidized zone, which will be described in the clause of oxidation.

Among the assay result of the geochemical samples taken by linear-channel sampling for each interval of five meters, the highest gold content is shown by the sample C-80, such as 7.9 g/t Au and 1.5 g/t Ag. The sample C-80 is the average sample of those taken from the five meter-interval from 10 to 15 meters toward the south along the C-trench from the intersection of the C and G-trenches. The rhyolite exposed there is similar to that commonly observed in the surrounding area, in which no particular alteration is observed. Beside it, the samples which showed the gold grade of more than 1 g/t are found at nine places. Since these samples were taken in the oxidized zone, the description will be made in the next clause of oxidation.

Oxidation and argillization in rhyolite

Oxidation in rhyolite is found conspicuously along the crack in the rock, and gradually declines in the surrounding part in a form of dissemination. The part having especially been subject to strong oxidation was shown in Fig. 2-24 as the oxidized zone. The oxidation is also observed along the crack even in the outside part of the oxidized zone.

Argillization is observed in the oxidized zone, along the crack and partly in rhyolite itself, and in addition, along the fault.

The extent of oxidized zone in rhyolite is mainly divided into four areas from A to D (Fig. 2-24). Among these, the oxidized zone of A and B form almost parallel two lines in the northern half of the area, both extending in the E-W direction for about 170 meters with an irregular form of variable width of 30 to 70 meters. The oxidized zones of C and D are found separately on the northeastern side and the southwestern side in the southern half of the area, the former extending in the E-W direction for about 100 meters with the width of 60 meters, and the latter almost in the N-S direction for about 70 meters with the width of 50 meters. Further, other small oxidized zones are found in three places.

The main mineral in the oxidized zone consist of reddish brown to brown goethite and hematite concentrated especially along the crack.

Electrum was observed in the sample of oxidized zone taken in this survey. A highly oxidized part 20 centimeters wide is found in the E-trench at 35 meters to the east of the intersection of the B and E-trenches on the northwestern side of the A oxidized zone.

The result of microscopy of a sample (NE-1P) taken from that part is as follows.

The main minerals are goethite and hematite, and minor minerals are electrum, pyrite and rutile. Three grains of electrum have crystallized in a druse, the diameter of the grains being about 5 μ. Quantitative analysis of these electrum grains by EPMA showed the values such as 76.3% - 77.0% Au and 21.8% - 23.2% Ag (weight percent).

The outcrop which contained the said electrum is included in the geochemical sample No. E-20, and the assay grade of E-20 showed 0.30 g/t Au and 1.3 g/t Ag.

Most of the samples taken on this time which contain gold of more than 1 g/t, are included in the eastern half of the oxidized zones belonging to A and B; in the A-oxidized zone, three samples (F-32, F-44 and F-46) in the central part and at the western end of the F-trench. No. F-46 showed

the highest content among these with the values such as 6.6 g/t Au and 0.1 g/t Ag. It was sampled between 50 m and 55 m along the F-trench to the east of the intersection of the B and F trenches, where many cracks are found, the gossan of iron oxide is observed along them. Similarly, in the parts other two samples were taken, gossan of iron oxide is found along numerous cracks.

In the B-oxidized zone, the samples from four places showed the gold content of more than 1 g/t, and these are the sample (H-35) approximately in the central part of the H-trench, the two samples (B-45 and B-47) in the central part of the B-trench which is put between the H and I trenches and the one (I-36) in the western part of the I-trench. Among these, the highest content of gold, 4.35 g/t Au and 1.9 g/t Ag, was shown by the sample H-35. In that place, the cracks accompanied with the gossan of iron oxides occurs abundantly in rhyolite. The two samples in the B-trench showed the gold contents of 2.15 g/t and 2.7 g/t respectively, and the sample taken in the survey of the third year in a prospecting tunnel on a small scale about 10 meters to the east of the above trench showed the gold and silver contents of 4.8 g/t Au and 28 g/t Ag respectively.

In the oxidized zones of C and D, no sample was found to be more than 1 g/t in gold content. A sample (A-1) at the southern end of the A-trench which is close to the D-oxidized zone showed the gold and silver contents of 1.60 g/t Au and 35.4 g/t Ag respectively, showing high content of silver. Only a weak contamination of iron oxide is found in this place along the crack in rhyolite.

Argillization is notably observed in a part of the oxidized zone, the extent of which was demarcated as the argillized zone. It shows a distribution on a small scale in the oxidized zones of A, B and C. The areas of distribution of these are at the intersection of B and F trenches in the A-oxidized zone, the western part of the I-trench in the B-oxidized zone and the central part of the C-trench put between K and L trenches in the C-oxidiz-

ed zone, and all these are small in scale.

The argillized zone observed in these three areas is accompanied with brown and white clay along the crack, and rhyolite in the adjacent area of the crack has been slightly argillized to become soft. The clay minerals observed in the argillized zone consist of kaoline and montmorillonite.

The argillized zone at the southern end of the B-trench on the east of the C-oxidized zone is found along a fault fracture zone (three meters wide) of NW-SE system and consists mainly of white clay accompanied with brown clay.

Among these argillized zones, those at the southern end of the B-trench are accompanied with iron oxide and high in gold content, which leads to the assumption that there is some relation with the gold mineralization.

In the survey of the third phase, qualitative analysis by EPMA was carried out on the minor elements of black minerals obtained by sluicing of samples which showed high contents of gold and silver. The result showed that the heavy minerals were complex sulfosalts containing various kinds of minor elements (MMAJ and JICA 1982).

In this year, accordingly, eight rhyolite samples taken from the places where the rhyolite would show a relatively high content of gold and silver were analyzed for minor elements, and the relation between the minor elements and contents of gold and silver was investigated.

Table 2-2 shows the assay result of minor elements and Fig. 2-21 the relation between the gold and silver contents.

The relation between the contents of gold and silver and those of minor elements are shown in Fig. 2-22 and Fig. 2-23 respectively.

In the relation between Au and Ag components, relatively good correlation was shown that the content of Ag component increases with the increase of that of Au component (Fig. 2-21).

No correlation was shown between the content of Au component and those of other elements (Fig. 2-22).

Table2—2 Minor Elements of Rhyolite

Element / Sample No.	Au ppm	Ag ppm	Cu ppm	Pb ppm	Zn ppm	Te ppm	Sb ppm	As ppm	Se ppm	Bi ppm	Mo ppm	Fe %	S ppm
SQ−1E	0.74	23.5	20	61	320	0.1	1.2	4	<2	0.4	1	0.33	140
SQ−2E	0.22	10.0	45	105	230	0.1	0.8	4	<2	0.1	1	0.46	115
SQ−3E	0.21	9.2	48	77	430	0.1	3.0	7	<2	0.2	1	1.00	400
SQ−4E	0.11	4.5	13	31	23	0.2	1.4	7	<2	0.2	1	0.48	55
SQ−5E	0.15	5.7	23	275	218	0.2	2.0	3	<2	0.1	1	0.72	55
SQ−6E	0.48	11.8	62	200	90	0.4	2.0	6	<2	0.2	1	0.95	55
SQ−7E	0.18	6.5	10	225	148	0.1	1.0	6	<2	0.3	1	0.40	115
SQ−8E	0.43	8.2	9	118	275	0.2	1.4	7	<2	0.4	1	0.65	115

Although the positive correlation is observed between the content of Ag component and that of Cu component that the Cu content increases with content of Ag and those of other minor elements (Fig. 2-23).

These results seem to show that the relation between the contents of gold and silver and those of other minor elements has not been discerned because of a small number of the samples and because of relatively low contents of gold and silver.

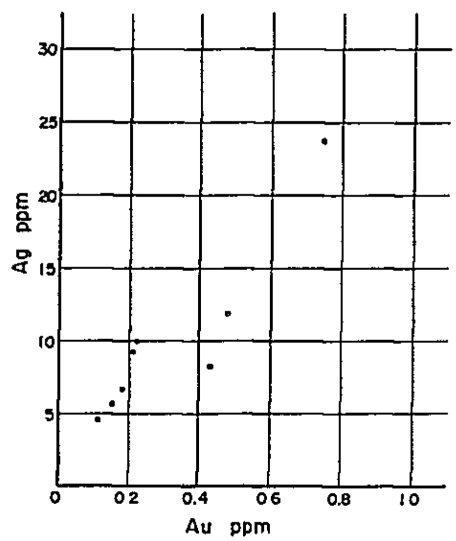


Fig.2—21 Au-Ag Contents Diagram of Rhyolite (by8 samples from rhyolite)

Mineralization in altered diorite and tuffaceous conglomerate

Pyrite dissemination by pyritization is generally observed in the

diorite and tuffaceous conglomerate of the area. Especially the pyrite dissemination is notably observed in the matrix of tuffaceous conglomerate distributed widely in the southern part, and dissemination of sphalerite and galena in addition to pyrite is observed in the matrix of conglomerate exposed in the M-trench at 13 meters to the west of the intersection of C and M trenches.

The relation between the mineralization and alteration observed on the surface and the content of gold and silver, and the relation between these and the geology of the drill holes will be described in the section (2-7) of consideration.

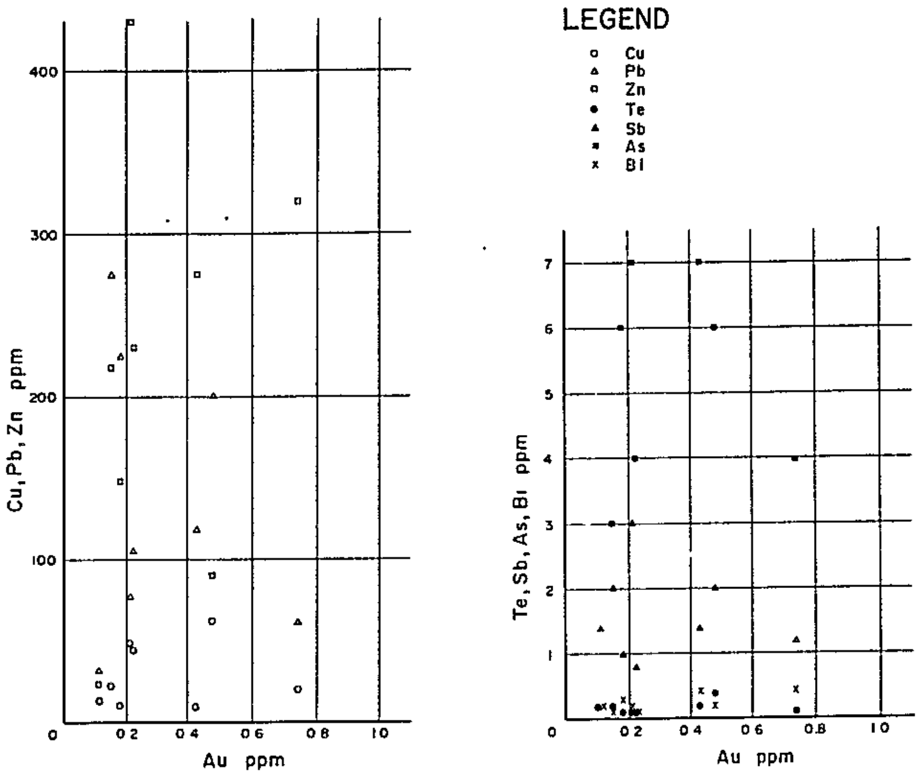


Fig. 2-22 Au – Cu, Pb, Zn, Te, Sb, As, Bi Contents Diagram of Rhyolite
(by 8 samples from rhyolite)

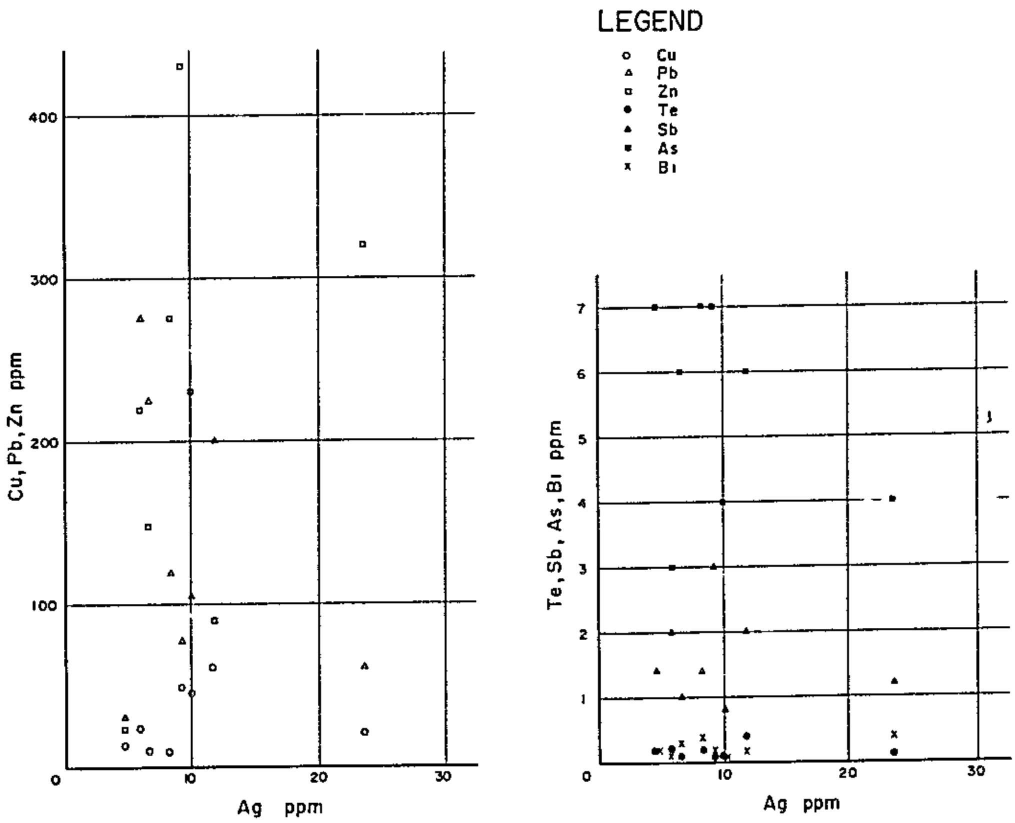


Fig. 2-23 Ag – Cu, Pb, Zn, Te, Sb, As, Bi Contents Diagram of Rhyolite
(by 8 samples from rhyolite)

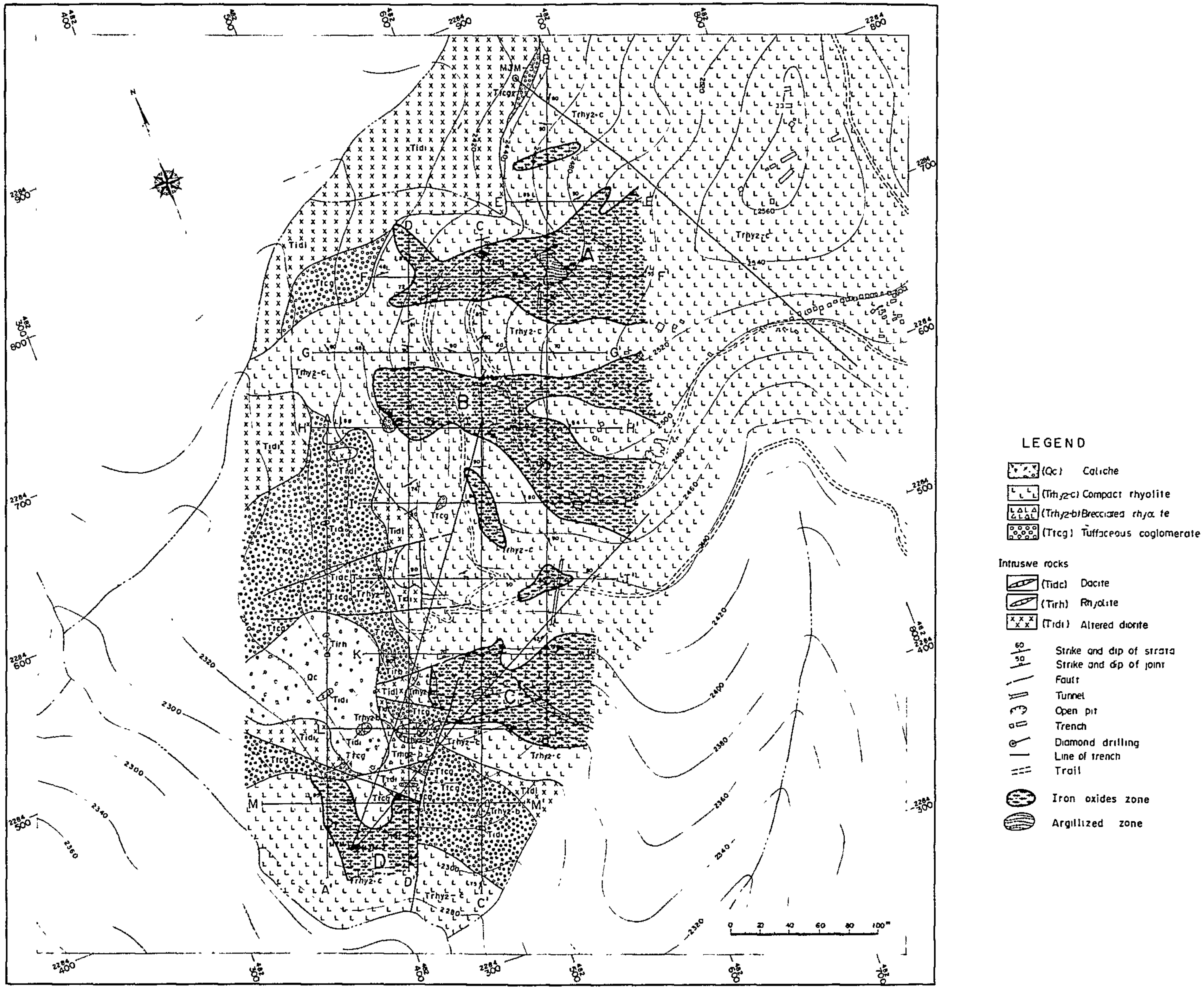


Fig.2-24 Alteration Zone of the Rhyolite

2-6 Geochemical Prospecting

2-6-1 Outline

Geochemical prospecting by rock sampling was conducted in the SAN CLEMENTE area in order to detect the gold and silver mineralized zone from the second phase to the third phase, and a considerably favorable results were obtained. At the same time, the target area of survey was narrowed down. Although these results were favorable, however, they were based on the analytical values of chip samples taken from the outcrops apart from each other, so that the conditions of mineralization for the areas lying between sampled points have remained unclear.

Therefore, the geochemical prospecting of this phase was carried out to make clear the variation of gold and silver contents continuously and quantitatively in the rocks exposed on the surface in the small target area of 200 m x 400 m which is contained in the western part of the SAN SEVERIANO mineralized zone considered to be the most premising as the result of the previous survey.

For this purpose, the next methods were used (Fig. 2-25).

(1) Excavation of the continuous trenches down to the bed rock in a grid pattern of 50-meter line-spacing to cover the whole area of survey. This work resulted in to expose continuously the bed rock by removing the overburden, float and scree.

(2) Observation and description of the mineralization on the rock exposed, and channel sampling to connect the trenches together.

(3) Chemical analysis of the samples on gold and silver, and interpretation of the assay result.

2-6-2 Configuration of Trench Line and Sampling (Fig. 2-25)

Partly preceded by lumbering, handy survey by transit and pegging, excavation of trenches followed consecutively and in parallel. The excavation was carried out by about sixty local residents from the nearby San

Clemente settlement and the adjacent villages by hands using pick and shovel.

The surveyed area is situated on the mountain slope having the maximum difference of height of about 200 meters between the lowest and the highest points in the area with relatively steep slope of 25° to 35°.

The overburden is 40 to 60 centimeters thick in the upper part and sometimes more than one meter thick in the lower part, which forced to require a considerable heavy hand labor.

The survey lines were set up at a distance of about 50 meters with four parallel lines in the direction of N20°E - S20°W such as A, B, C and D, and nine parallel lines in the direction of N70°W - S70°E perpendicular to the aboves such as E, F, G, H, I, J, K, L and M.

Chisel and hammer were used for sampling. Sampling was made as in usual channel sampling, by cutting the channel with roughly a definite width to obtain rock chips for sample. Rock samples were packed in a bag for each one meter interval to send every day to CRM office in Ixmiquilpan after the end of day-shift, where it was rearranged and stored. Finally, the one-meter sample was crushed and reduced. Five consecutive samples were evenly mixed and prepared to make assay sample (for example, from the initial point to 5-meter point of A-line). Thus, the gold and silver contents of one assay sample represent the average values for five meter-interval of the trench.

Table 2-3 shows the extension of trench lines and number of the geochemical rock samples.

Table 2-3 Extension of Trench Lines and Number of Geochemical Rock Samples

Trench Line	Extension (m)	No. of Samples for Chemical Analysis
A	290	58
B	525	105
C	500	100
D	475	95
E	135	27
F	245	49
G	260	52
H	270	54
I	205	41
J	200	40
K	160	32
L	160	32
M	200	40
Trench total: 13 lines	3,625	725
Rock chip sampling: 8 points		8
	3,625	733

2-6-3 Sample Preparation and Chemical Analysis

The rock samples taken for each one-meter interval and packed in the bag were crushed by a small-size jaw crusher at the sample preparation room of CRM office in Ixmiquilpan to under 8 mm size, then split into two parts by a reducer. The reduced five consecutive samples were mixed and made homogeneous, and the sample for analysis of about 200 grams for each was made up by splitting of several times.

Most of the final samples were sent to CHEMEX LABS LTD. in Canada. A part of the duplicate samples were sent to the Besshi assay laboratory in Japan.

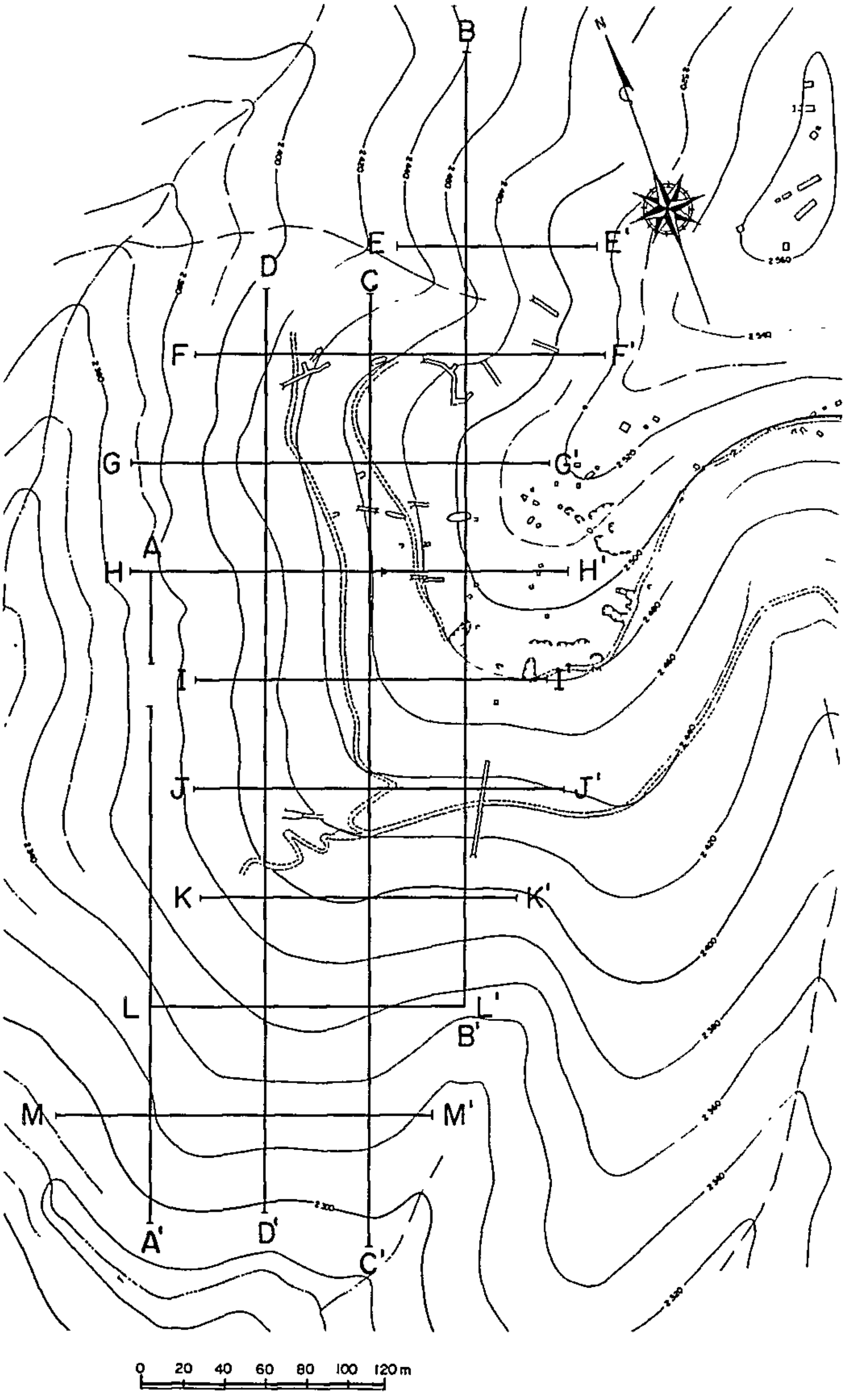


Fig. 2 - 25 The Configuration of Trench Lines for Geological and Geochemical Surveys

The outline of analytical procedure is shown in Appendix 11.

The both laboratories carried out the analysis at the detection limits such as 0.01 ppm for gold and 0.1 ppm for silver. The results of analysis are shown in the Appendix 9.

2-6-4 Data processing

The surveyed area is a terrain of gold and silver geochemically anomalous zone narrowed down by the geochemical prospectings conducted in the second and the third phases. These results of geochemical prospecting carried out for two years, however, were based on the rock samples obtained from the rock exposures scattered separately in the area, and they were not based on such linear channel samples obtained from the continuous rock exposure as those in the survey of this year.

At the first glance of the assay values of gold and silver obtained this time, it became clear that many samples below the detection limit were obtained. Accordingly, the assay values of 733 samples were converted to logarithm, which were classified into 21 classes logarithmically at regular intervals. These were statistically calculated for frequency distribution and cumulative frequency distribution. Thus the values shown in Table 2-4 were obtained.

Cumulative frequency distribution graph was prepared by plotting these values on logarithm probability paper, by which the statistic distribution character was investigated. The calculation was all made in logarithm and finally converted to antilogarithm.

Table 2-4 Statistical Summary of Au and Ag Contents

	Au	Ag
No. of samples	733	733
Maximum contents (ppm)	7.90	35.4
Minimum contents (ppm)	<0.01	<0.1
No. of trace data	404 (55% of the total)	385 (52.5% of the total)
Mean	log. -1.6597=0.022 ppm	log. -0.6497=0.224 ppm
Standard deviation (σ)	log. 0.5115	log. 0.4857
Mean + σ	0.071 ppm	0.686 ppm
Mean + 2σ	0.231 ppm	2.098 ppm

The results are compiled as follows (Fig. 2-26).

Au component

The cumulative frequency distribution of the population which has the values obtained by the calculation such as Mean = 0.022 ppm, M + σ = 0.071 ppm and M + 2σ = 0.231 ppm, should be theoretically expressed by the broken line in the case of a logarithmic normal distribution. The actual distribution shown by a solid line has a more gentle inclination, and intersects with the former at the vicinity of 0.09 ppm, greatly extending to the high content side. Moreover, it rises up sharply below 0.01 ppm on the low content side. Such difference indicates that the distribution of the population has a stretch in a form of the base of a mountain on the high content side as compared with the logarithmic normal distribution type, namely it indicates that the population contains high grade side anomaly which suggests the mineralization.

On the other hand, on the low-grade side below 0.09 ppm, a tendency is shown that the rate of increase is smaller than that of logarithmic type. However, because the detection limit is below 0.01 ppm and because the trace data below the limit of detection are plotted for the reasons of convenience

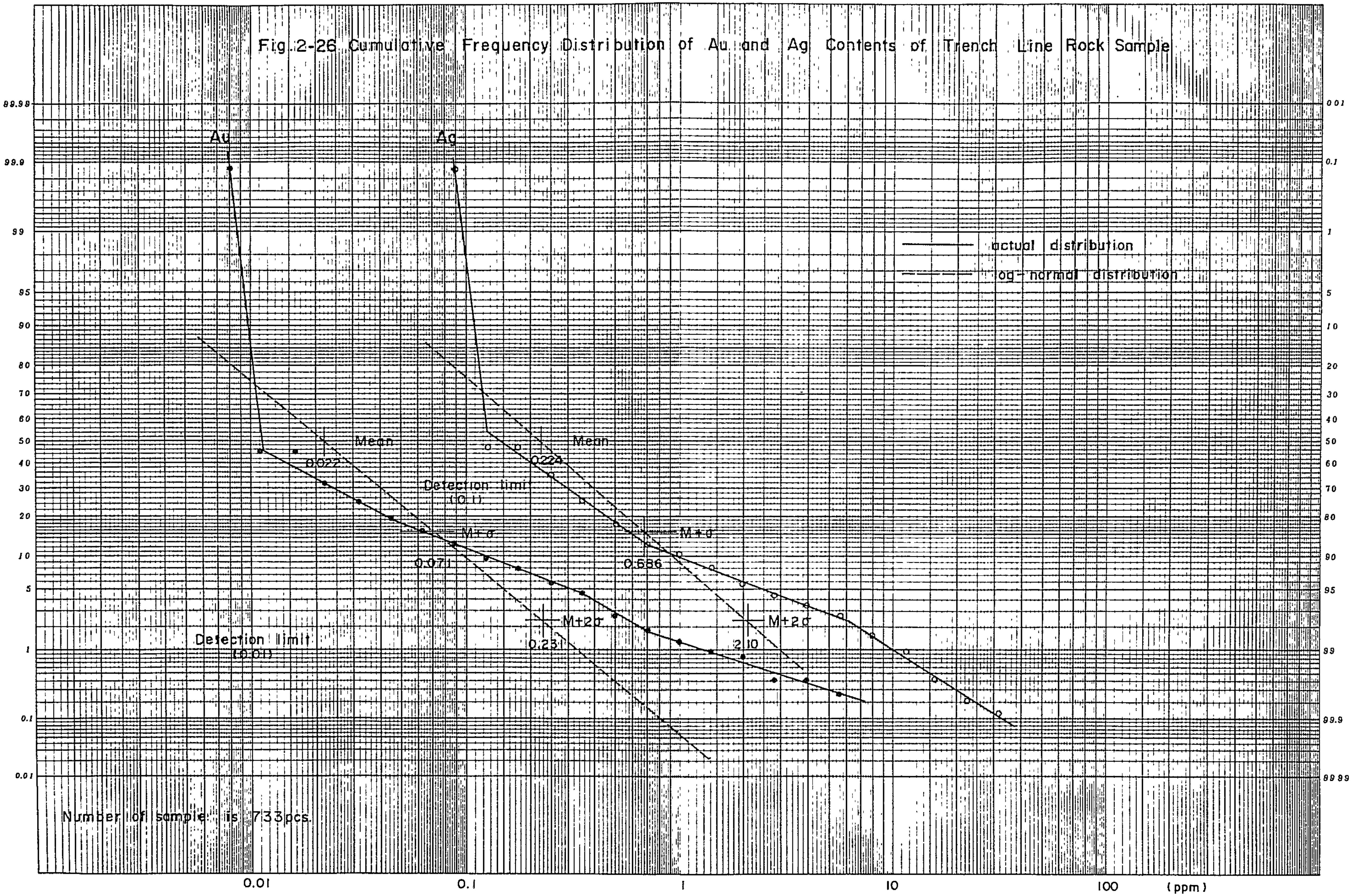


Fig.2-26 Cumulative Frequency Distribution of Au and Ag Contents of Trench Line Rock Sample
Au
Ag
actual distribution
log-normal distribution
Mean
0.022
Mean
0.224
Detection limit
(0.1)
M+σ
0.071
M+σ
0.686
M+2σ
0.231
M+2σ
2.10
Detection limit
(0.01)
Number of sample is 733pcs.
99.98
99.9
99
95
90
80
70
60
50
40
30
20
10
5
1
0.1
0.01
0.01
0.1
1
5
10
20
30
40
50
60
70
80
90
95
99
99.9
99.99
0.01
0.1
1
10
100
(ppm)

on the point of 0.008 ppm collectively, it can not be made clear what tendency would be shown on the low-grade side below that point.

Because the target area for survey is an area extracted as a geochemically anomalous zone based on the surveys of the second and the third phases, and because the points showing the high grade have been partly confirmed in the area, the statistical data on Au content is geochemically very high as compared with that of other areas. That is, the remaining 329 samples when excluded 404 samples having the values below the detection limit (0.01 ppm), are considered to have geochemically anomalous values.

For classification of these values in accordance with the grade of abnormality, the values of the four points in the logarithmic normal type cumulative frequency distribution such as Mean, M + σ, M + 2σ and 1 ppm were adopted as parameters. Moreover, although the Au content of each sample of the population shows the average value of the 5-meter interval in the trench, a similar statistical process was applied by calculating the three-points running mean values. In this case, it is advantageous in that a more wide range of tendency of distribution of geochemical anomaly can be observed, because a running mean value represents the average grade of the 15-meter interval (Fig. 2-29, 2-30).

Ag component

In regard to the Ag component, the frequency distribution showed a tendency almost similar to that of the Au component. Accordingly, a similar statistical process to that of the Au component was applied, and the values of Mean, M + σ and M + 2σ in the logarithmic normal type cumulative frequency distribution was adopted for the classification (Fig. 2-31, 2-32). These statistical classification are shown lumped together in the following table (Table 2-5).

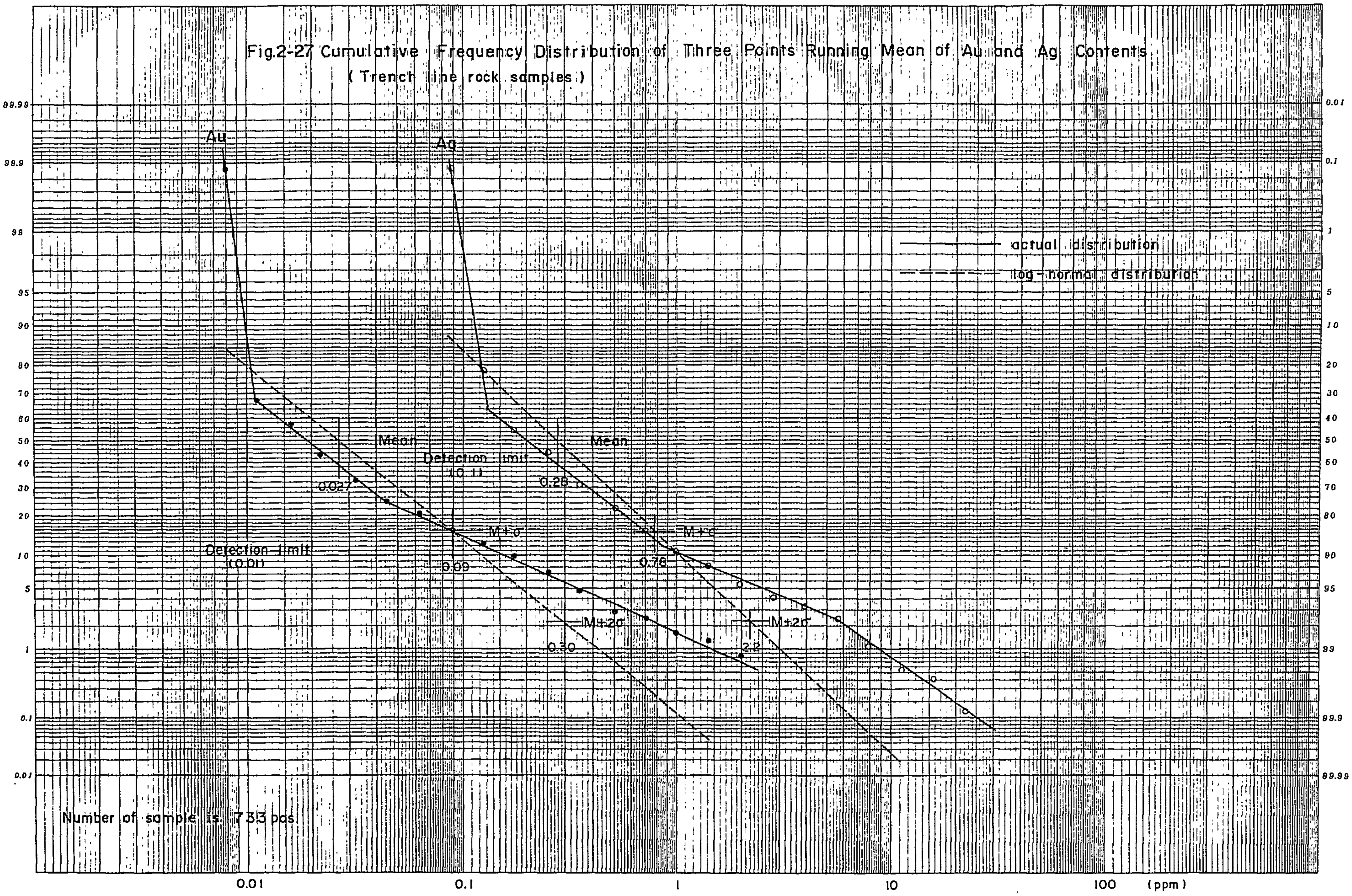
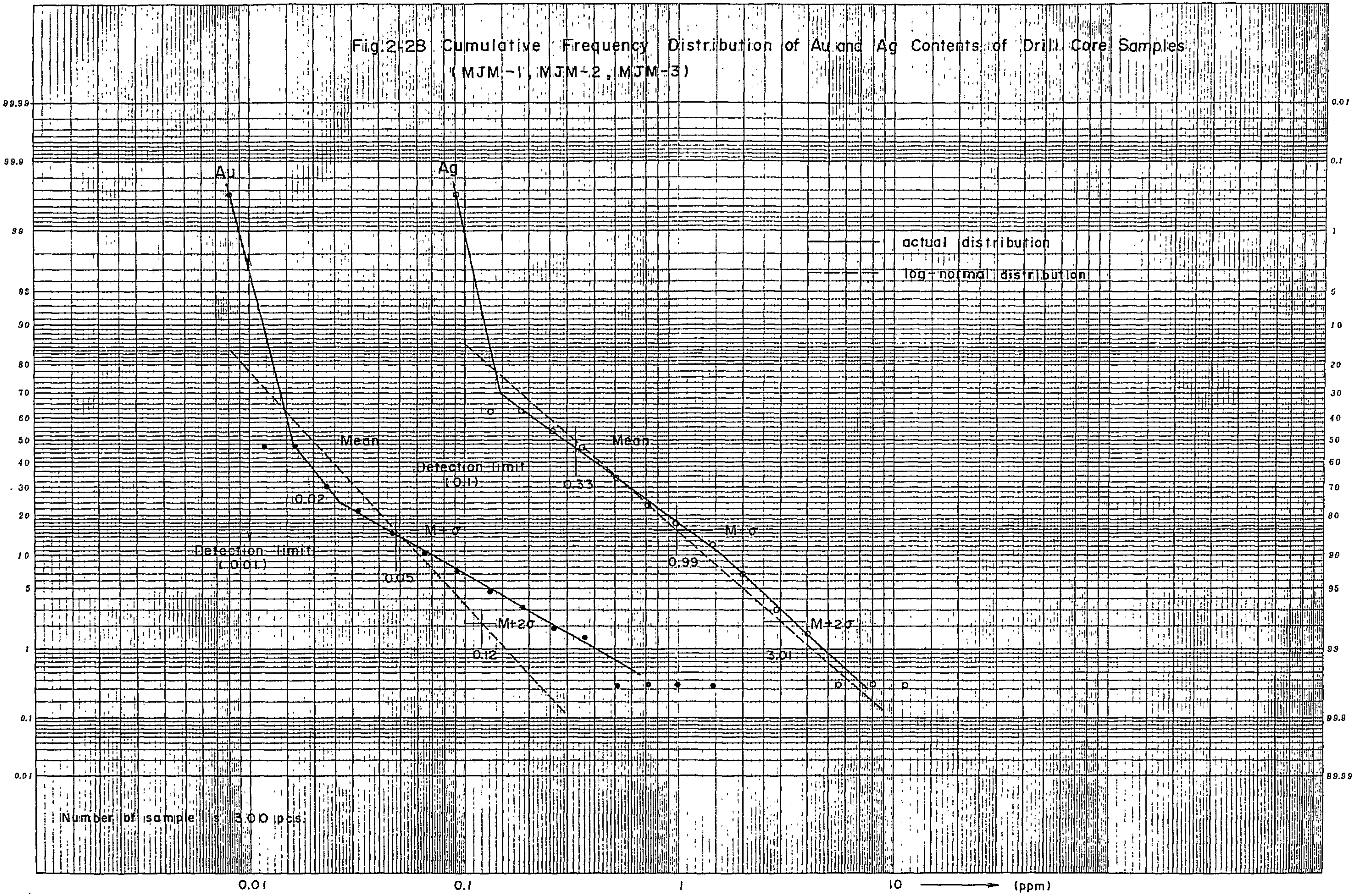
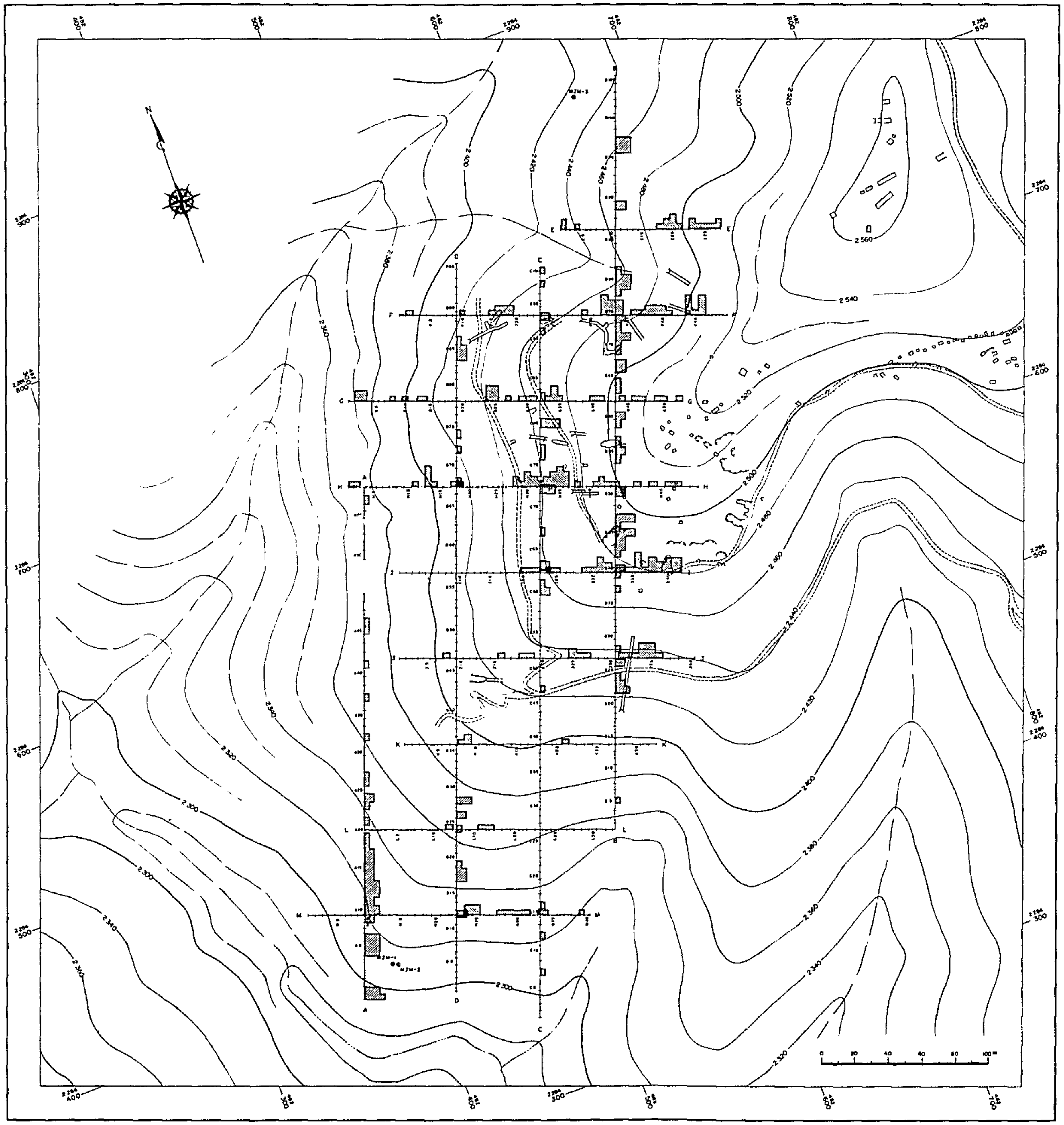


Fig.2-27 Cumulative Frequency Distribution of Three Points Running Mean of Au and Ag Contents
(Trench line rock samples)
Au
Ag
actual distribution
log-normal distribution
Mean
Mean
Detection limit (0.1)
Detection limit (0.01)
0.027
0.28
M+σ
M+σ
0.09
0.78
M+2σ
M+2σ
0.30
2.2
Number of sample is 733 pcs
0.01
0.1
1
10
100
(ppm)
99.99
99.9
99
95
90
80
70
60
50
40
30
20
10
5
1
0.1
0.01

Fig.2-28 Cumulative Frequency Distribution of Au and Ag Contents of Drill Core Samples
(MJM-1, MJM-2, MJM-3)





LEGEND

Au - Contets

1.00ppm
0.231ppm(M + 2σ)
0.071ppm(M + σ)
0.022ppm(Mean)

Fig.2-29 Geochemical Au Distribution of the Trench Lines

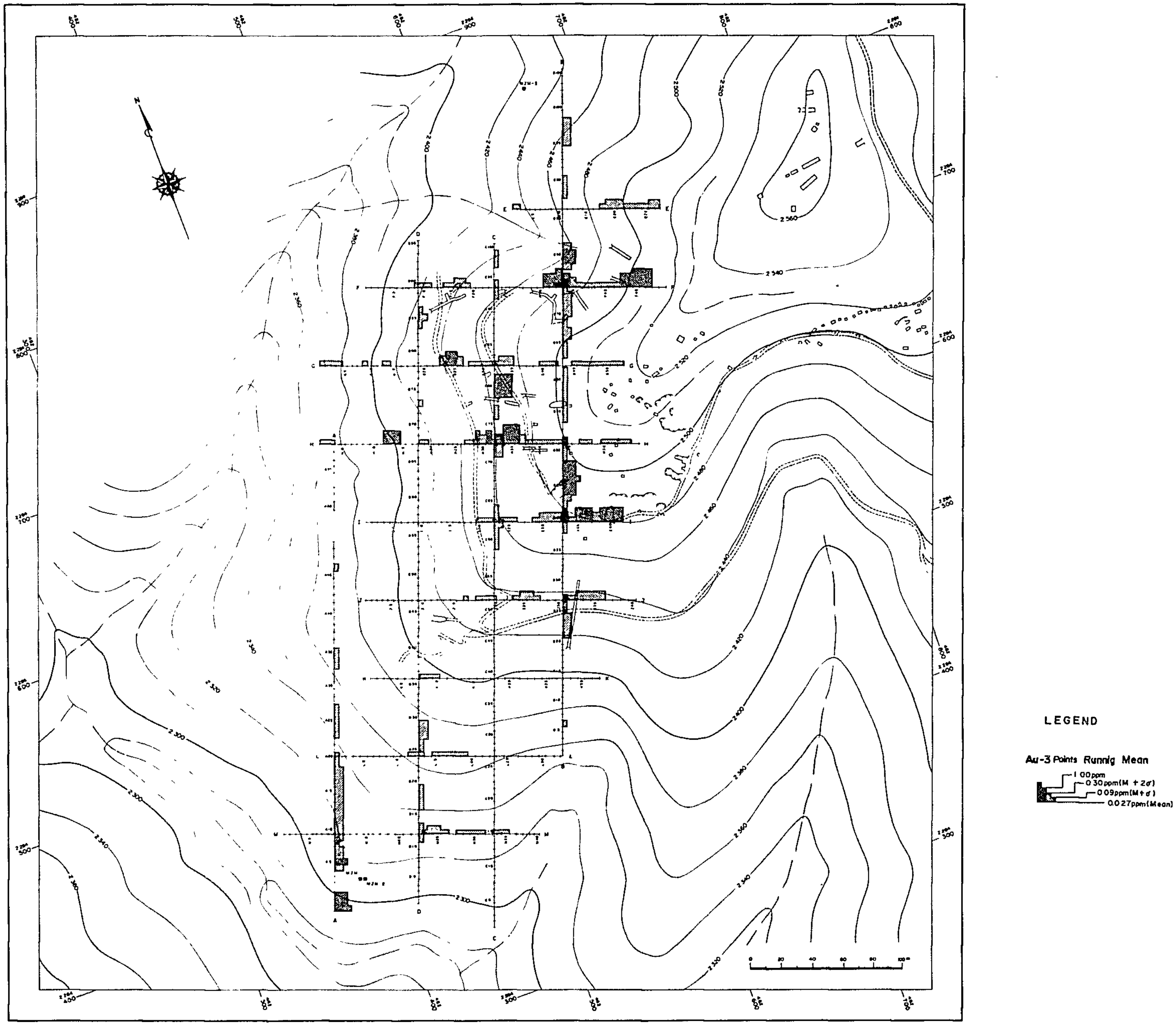
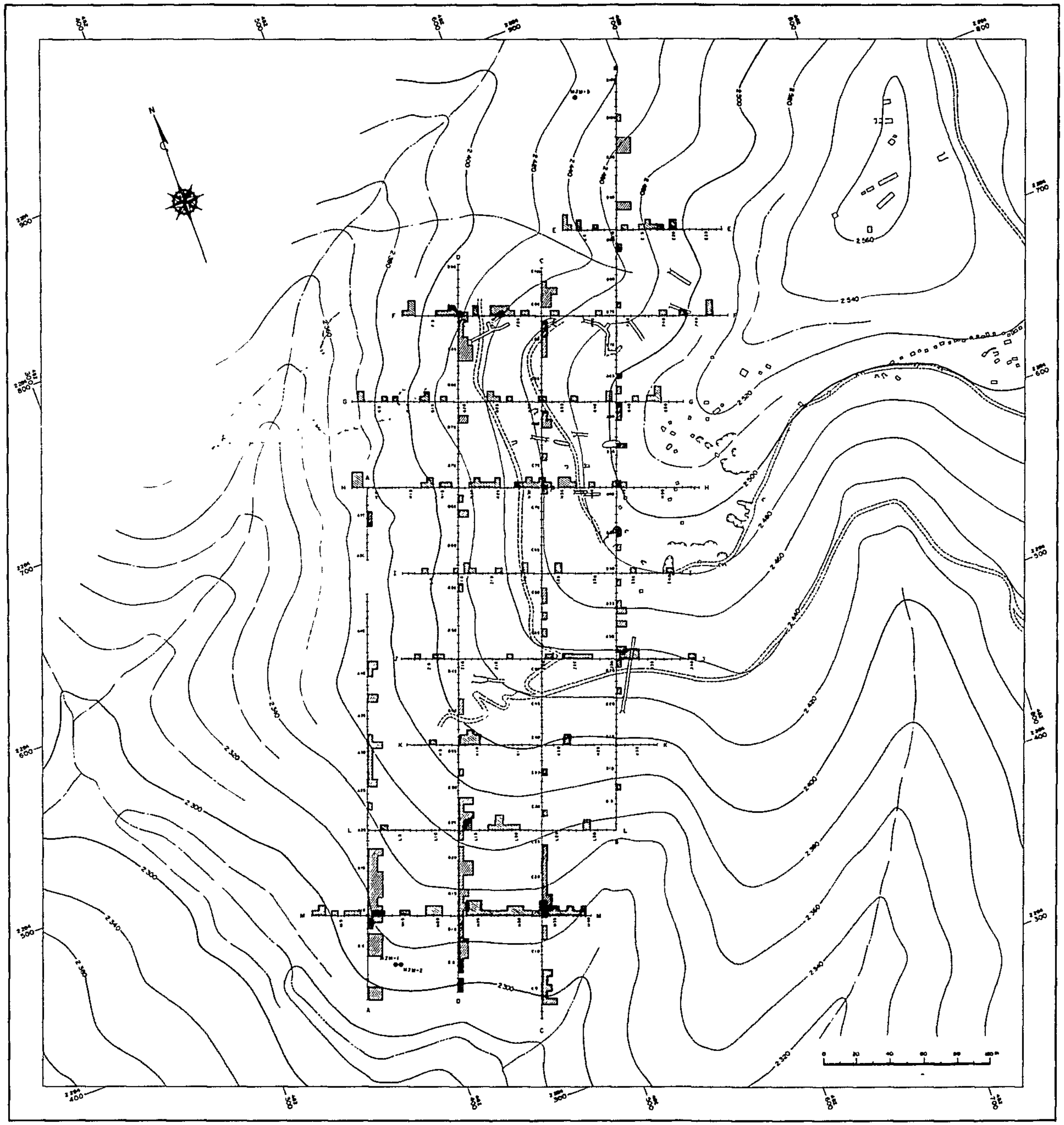


Fig.2-30 Geochemical Au Distribution of the Trench Lines by Three Points Running Mean Values



LEGEND

Ag – Contets

2.10ppm (M + 2σ)
0.686ppm (M + σ)
0.224ppm (Mean)

Fig. 2-31 Geochemical Ag Distribution of the Trench Lines

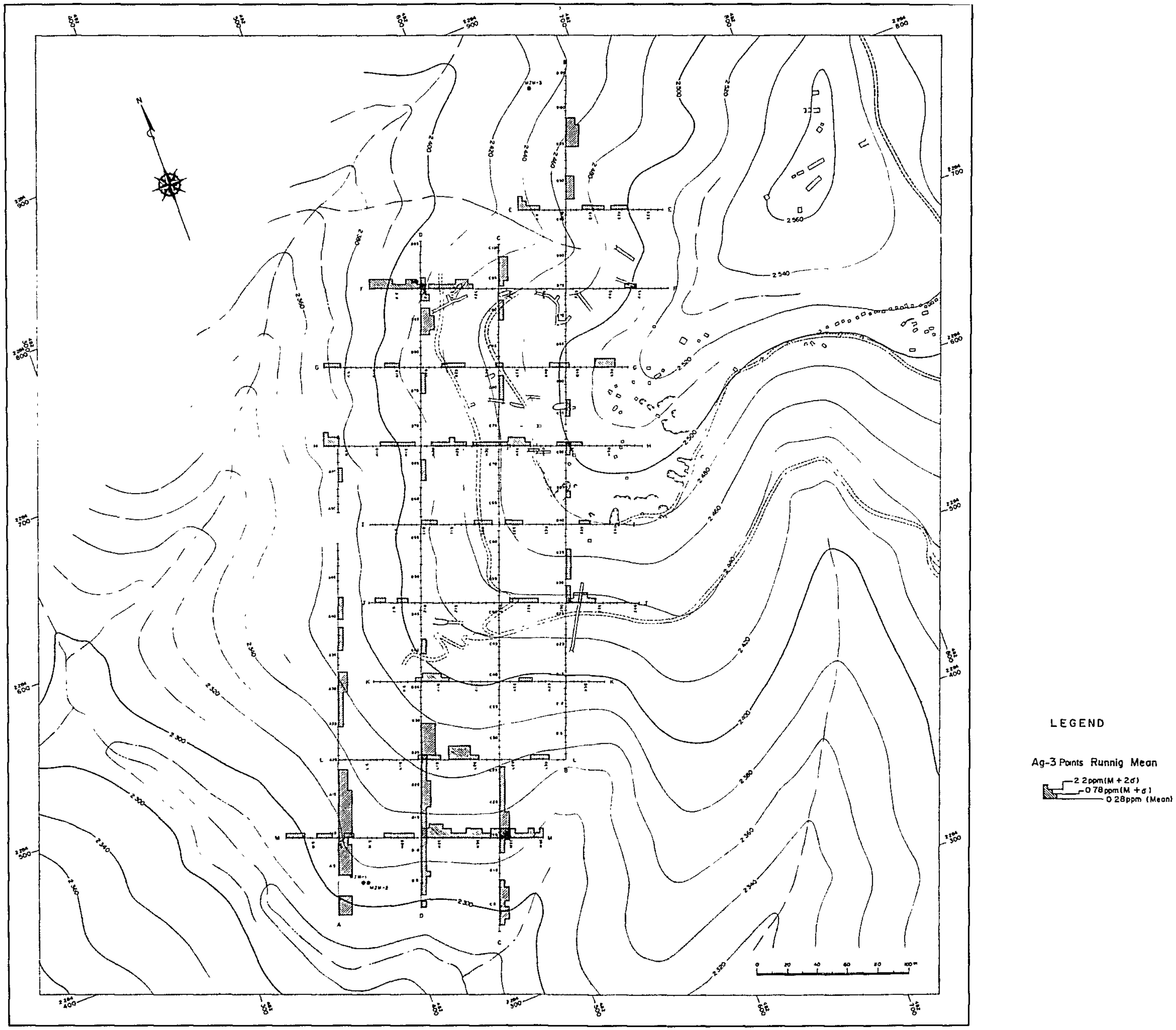


Fig.2-32 Geochemical Ag Distribution of the Trench Lines by Three Points Running Mean Values