the compact rhyolite. In these mineralized portions, pyrite, sphalerite and galena are of principal ore minerals, and chalcopyrite, tetrahedrite, magnetite, hematite, goethite are of accessories.

Analytical results of samples from these portions show very low contents of gold although there are slightly observed a tendency of increase in silver contents than other parts of the drilling core.

It is seemed to be attributed to a nature of zonal arrangement of gold-silver-copper.lead.zinc in the mineralization.

5-4 Silver Mineralization (Ref. Fig. 7-1)

Excepting the sample from C-1 tunnel, grade of silver is generally low in the gold mineralized zone, and silver is slightly accompanied with gold-mineralization. But in a case of the sulfosalts as major ore mineral, contents of silver ought to increase and it is reasonable that a ratio of silver to gold reaches around fifty to one as same as an example of the sample from the C-1 tunnel. As a result of the trench channel-sampling in the forth phase, it is observed that geochemically anomalous zone of silver is zonally arranged outside border of those of gold in the Western zone.

5-5 Hydrothermal Alteration

Silicification and argillization as hydrothermal alteration, and supergene oxidation are partly observed in the mineralized zone. The results of whole rock analysis and microscopy of rock thin section show that the compact rhyolite is weakly silicified on an average although the rock is primarily siliceous. Irregular quartz veinlets in network form are observed partly, and these veinlets form rarely network vein with less than 20 centimeters in width. Silicification is more remarkablly observed in the drilling core sample than those of the trenches on the surface.

Supergene oxidation is developed along cracks and fissures in the compact rhyolite where film-like precipitations of iron oxides are invariably recognized and peripheries of these cracks and fissures have brown-colored halo of iron oxides.

It was made clear that there is a considerable correspondence in comparison with both distributions of the geochemically anomlous zones of gold and the oxidized zones. It is considered that gold mineralization is rather controlled by fracture and joint systems than the supergene oxidation.

Argillization are recognized mainly in some parts of oxidized zone on a small scale and also along fractures, fault and shear zone. Within these types of argillized parts, gold contents of a type along fractures show rather high values frequently, and so the argillized parts of this type is one of the important mineral indication for exploration work.

5-6 Fracture Pattern

Fracture system (mainly joint) observed in the mineralized zone, are of three types as follows:

A type: E-W N70°E, 70°SE~90° and 80°NW

B type: N5°E N15°W, 70°NE~90° and 80°SW 90°

C type: E-W N65°W, 80°NE ~ 90°

In these systems, directions of A and C types have a fair correspondence with the arrangement of the mineralized zones and fault system in the Western zone.

5-7 A Comparison of Gold and Silver Contents between Surface Rock Sample and Drilling Core Sample

Gold contents of the drilling core samples from MJH-1, 2 and 3 of the forth phase survey, are rather low in average, but the samples in the length from 200 meters to 300 meters of MJH-3 drilling show exceptionally high values such as 1.65 g/t in maximum. This part corresponds to the position of 70 meters beneath the Central zone of the surface.

On the other hand, MJM-1 and 2 drillings are volcanostratigraphically situated in a depth passing mainly through the tuffaceous conglomerate formation which underlain the rhyolite. Although gold contents is fairly low, copper-lead-zinc mineralizations are clearly recognized. The fact is completely different from the surface on the mineralization.

Taking the relation to geochemically anomalous zones between gold and silver, and copper-lead-zinc mineralization in the drilling cores into account, it is considered that various mineralizations in this area show a tendency of vertically zonal arrangement such as gold mineralization in the upper part, silver mineralization in the peripheries of the former in the compact rhyolite, and copper-lead-zinc mineralization in the tuffaceous conglomerate around the base of the rhyolite. And the fact is one of important data for next step exploration.

CHAPTER 6 MINERALIZED ZONE OF THE PROVIDENCIA AREA

6-1 General Remarks

The PROVIDENCIA area is structurally positioned at the place where it is put between the two axial planes of a couple of overfolding anticline and syncline on a large scale.

Geology of the area is composed mainly of black flint, sandstone, calcarenite and marl layers alternating fine to medium-bedded limestone (Kdf Member) of the El Doctor Formation which shows a facies of flysh type sequence, and small dykes of basalt and rhyolite intruded into the former.

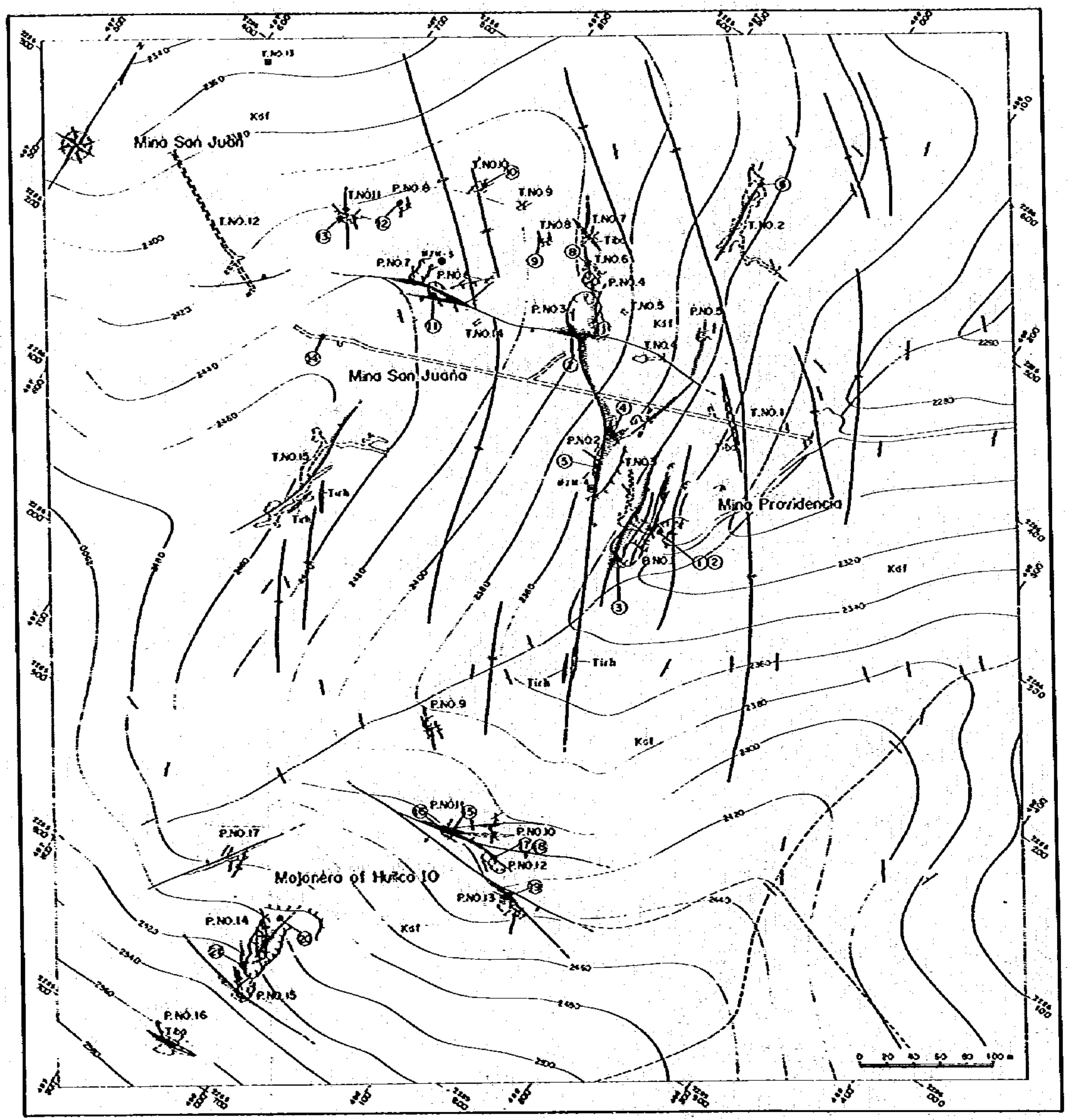
Reflecting the regional geological-structure, there is observed many of small-scale folding structures, sheared zone along axes of foldings and faults in the El Doctor Formation.

Ore deposit recognized in this area, is of two types such as irregular-massive, breccia and dissemination forms in faults and sheared zones, and dissemination-manto form along bedding planes of the Kdf Member.

In both of them, the former is more important in a scale and grade of ore than the latter.

The silver bearing lead and zinc mineralized zones are observed as the outcrops of the ore deposits scattered in the Kdf Member within an ellipse-shaped extent having the major axis of about 1,000 meters long extending in N-S and the minor axis of about 700 meters in length.

In those of the ore deposits, large-scale and important ones are of the Mina Providencia, Mina San Juana and Mina San Juan which located in the north-western side of a dry creek running down from the southern west to the northern east in the central part of the area, and Mojonera of Huilco 10 situated on the southern side of the creek (ref. Fig. 6-1).



LEGEND

Altered augite basalt

Rhyolite

Kdf Alternation of medium bedded limestone, thin bedded calcarenite and black flint band

Strike and dip of strata

Fault

Anticlinal axis

Synclinal axis

Overturned anticlinal axis

Overturned synclinal axis

Oxide ore

Tunnel

Open pit

⊙ MJM-4 Diamond drilling site and number

●—① Sample Location and number

Chemical Analysis of Ore Samples

Ser No.	Sample No.	Metal Contents				
		Au g/t	Ag g/t	Cu %	Pb %	Zn %
1	KP-1PM	0.01	11	0.01	6.06	0.52
2	KP-2PM	—	10	0.03	2.56	2.63
3	KP-3PM	—	13	0.08	1.38	41.78
4	KP-4M	0.01	19	0.01	0.94	32.87
5	VL-6PM	<0.01	12	0.02	1.18	7.61
6	VL-11PM	—	7	Tr	7.90	1.91
7	KP-6M	0.03	21	0.05	8.80	33.39
8	VL-8PM	—	10	0.01	6.66	0.90
9	VL-3PM	<0.01	14	0.02	0.55	44.78
10	KP-8PM	—	18	0.01	10.28	25.71
11	KP-9PM	—	8	0.04	0.24	43.25
12	VL-2PM	0.03	3	0.01	0.06	0.72
13	VL-5PM	—	4	Tr	0.04	37.77
14	OH-1M	—	3	0.01	0.01	0.22
15	NP-5M	<0.01	6	0.02	1.98	4.65
16	NP-7M	—	7	0.02	1.93	3.97
17	NP-9M	—	5	Tr	0.93	23.76
18	NP-10PM	<0.01	3	Tr	0.91	6.41
19	NP-8M	—	4	0.02	1.33	2.62
20	NP-3PM	0.01	8	0.01	1.63	4.08
21	NP-2M	0.05	15	0.01	2.34	18.96

Tr : Trace — : Not assayed

Fig. 6-1 Geological Sketch of the PROVIDENCIA Mineralized Area

Table 6-1 List of Mines, Prospects and Ore Showings in the PROVIDENCIA Area

Name of Mine	Pit and funnel No.	Mode of occurence	Principal ore mineral	Scale of ore body	General trend of ore body	Reference·Sample
				width,length		
Mina Providencia	P No.1	massive and dissemination	hematite, goethite	4m± , 25m±	N20°W	KP-1PM, KP-2M
	P No.1 T No.3	massive and dissemination	goethite	1m± , 45m±	N10°W	KP-3PM
	T No.2	brecciated ore and dissemination	hematite, cerussite	0.7± 60m±	NS	VL-11P
	T No.5	dissemination	goethite	1m- , 5±	N40°W	
	P No.2	brecciated ore, dissemination and partly massive ore along the fault	hematite,goethite	2m±, 200m±	N30°W	KP-4M, KP-5P, VL-aM
	P No.3					KP-6M, KP-7T,
	P No.4					VL-8PM
	T No.6					KP-11T
	T No.7					KP-11T
	T No.8	massive and dissemination	Mn-mineral, henimorphite	0.3m±, 15m±	N30°E	VL-3PM
	T No.9	calcite vein network	goethite	0.5m±, —	—	
	P No.5	dissemination	goethite	0.5m±, 15m±	N20°W	
Mina San Juana	P No.6	massive and dissemination	heminorphite,hematite	1.5m-, 60m±	N80°E	KP-9PM, KP-10T
	P No.7	ore along the fault				
	P No.8	dissemination	hematite, goethite	1m- , 10m±	N10°E	VL-2PM
	T NO.10	dissemination	heminorphite, goethite, hematite	1m- . 10m-	N50°E	KP-8PM
	T No.11	massive and dissemination	Mn-mineral	0.5m±, 15m±	N70°E	VL-5PM
	T No.14	dissemination	goethite, hematite	0.3m±, 3m±	N10°E	
	T No.15	brecciated ore and dissemination	goethite, hematite	1.5m±, 70m±	NS	
Mina San Juan	T No.12	calcite vein with iron oxides	goethite, hematite	0.3m, 2m±	N35°E	
Mojonera of Huilco 10	P No.10	massive and brecciated ore	goethite, hematite	0.3m-, 15m±	N45°W	
	P No.11	massive and brecciated ore	goethite, hematite	1.0m±, 30m±	N70°E	NP-5M, NP-6P, NP-7M
	P No.12	massive and dissemination	goethite, hematite	0.85m-, 10m±	N60°W	NP-9M, NP-10PM
	P No.13	brecciated ore and massive	goethite, hematite	0.75m, 10m±	N80°E	NP-8M
	P No.14	massive (stocked ore)	hematite, goethite, barite	? ?	?	NP-2M, NP-3PM, NP-4P
	P No.15	massive	goethite, hematite	2m±, 10m±	N80°W	
	P No.16	massive	goethite, hematite	1m± 10m±	N80°E	
	P No.17	brecciated ore	goethite, hematite	1m±, 30m±	N35°E	

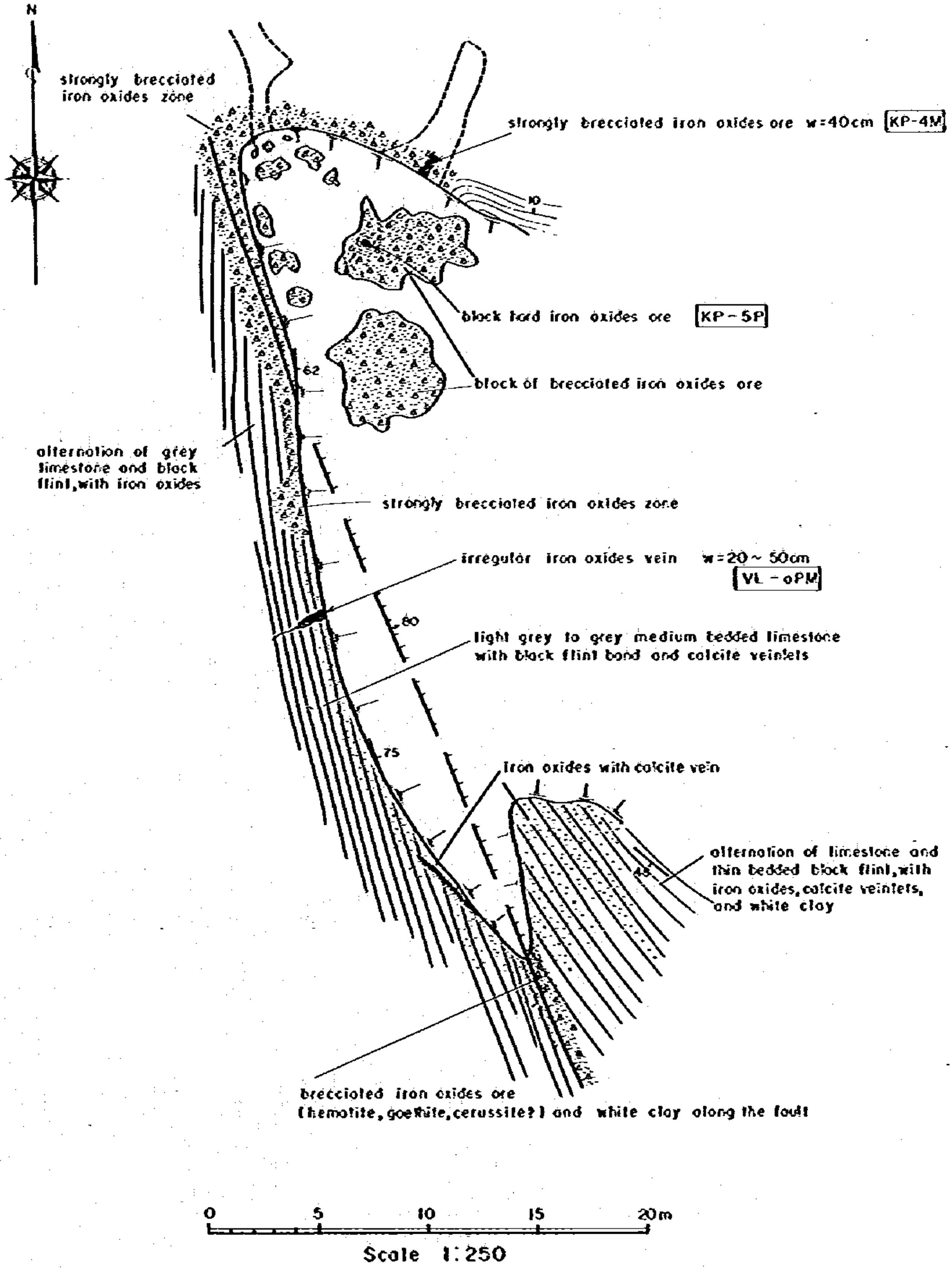


Fig.6-2 Geological Sketch of No.2 Open Pit of the PROVIDENCIA Area

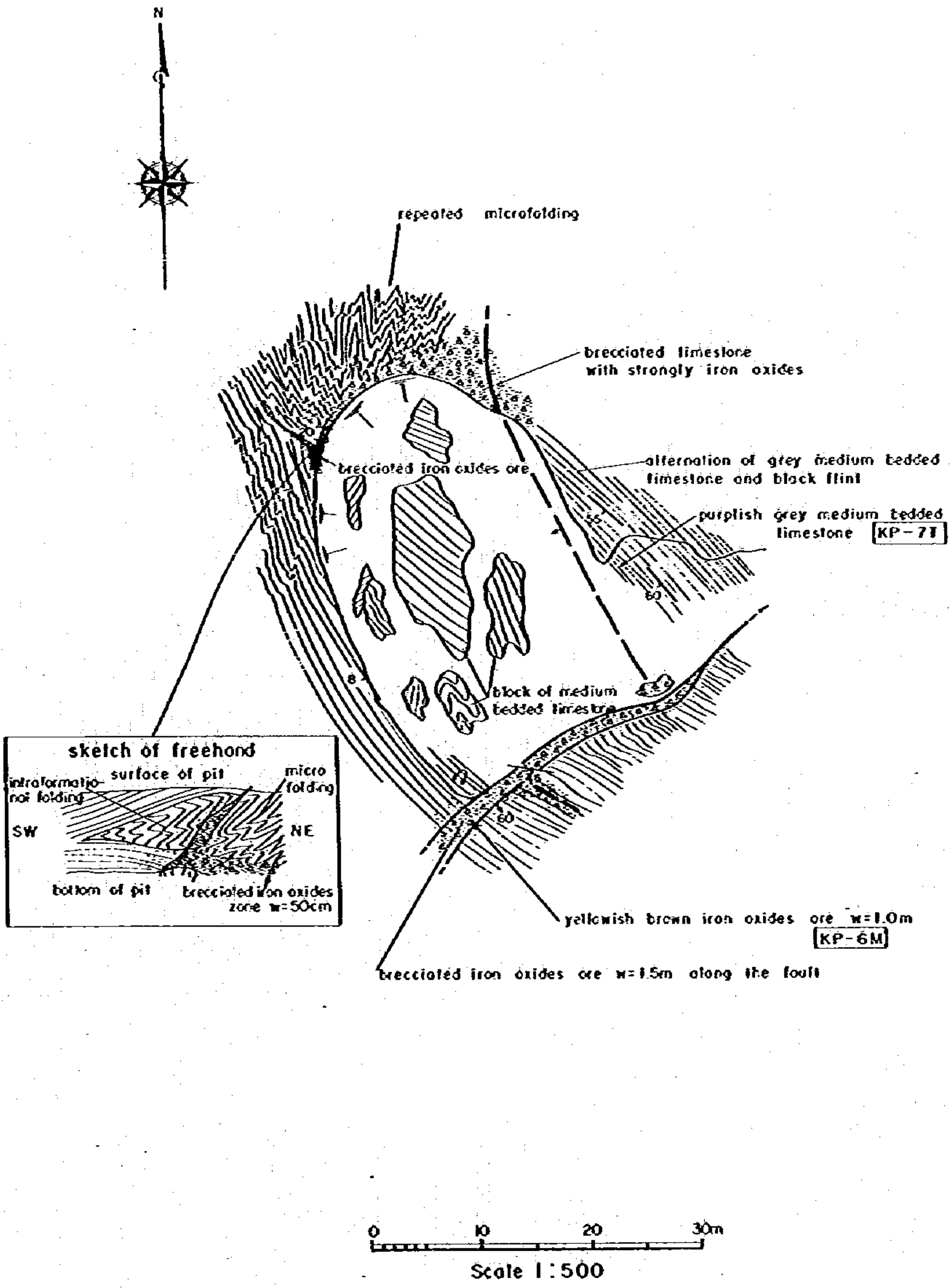


Fig.6-3 Geological Sketch of No.3 Open Pit of the PROVIDENCIA Area

6-2 Scale of Ore Body and Ore Grade (Ref. Fig. 7-2)

Almost all the ore deposits consist of oxide ores except only one outcrop of sulfide ore contained in quartz vein. The dimensions of ore deposit seem to have been approximately several tens centimeters to several meters by several tens to hundred meters (ref. Table 6-1).

The ore body which continues north-northwestward from P. No. 2 to T. No. 7 is and oxide ore body composed of brecciated, disseminated and massive ore emplaced along the fault fracture zone of NNW-SSE system. The ore body is the largest in scale among the ore bodies in this area, and continues for about 200 meters along the fault with about 2 meters in width (ref. Fig. 6-2, 6-3).

The mineralized zone has generally been highly oxidized to form brown gossan. Beside it, many network veinlets of calcite and partly network veins of quartz are observed. The hydrothermal alteration of the county rock, however, is weak in general, and recrystallization can scarecely be observed in the country rock.

The assay results of ore samples show the metal contents such as Pb n%, Ag n~nx 100 g/t, Zn nx10%, with a very small amount of copper.

6-3 Mode of Occurrence of Ore Mineral

The ore mineral consist mainly of iron oxides such as limonite, hematite and goethite associated with jarosite, smithsonite, calamine and cerussite. These ore minerals of lead and zinc, however, are complicatedly mixed in iron oxides and jarosite as tiny crystals, so that it is very hard to discern these minerals with naked eye. Under the microscope, these ore minerals of lead and zinc are associated with iron oxides minerals showing botryoidal and zonal structures.

6-4 Geochemical and IP Anomalies (ref. Fig. 7-2)

Geochemical prospecting of stream sediments sample was carried out with those indicator elements as silver, lead and copper, in the second phase. After the data processing by the graphical method (Lepeltier, 1969), the following geochemical-classifications were prepared (ref. Table 6-2).

Table 6-2 Statistical Classification of Geochemical Element (stream sediments) of phase II

Ag Anomaly (ppm)	Cu Anomaly (ppm)	Pb Anomaly (ppm)
A-class ≥ 2.9	A-class ≥ 1.148	A-class ≥ 1.072
-------- M + 2σ ---------	-------- M + 2σ -------	-------- M + 2σ --------
2.9 > B-class ≥ 1.7	1,148 > B-class ≥ 417	1,072 > B-class ≥ 372
----- skew point --------	-------- median -------	-------- median --------
1.7 > C-class ≥ 1.2	417 > C-class ≥ 95	372 > C-class ≥ 135
-------- M + σ ----------	-------- M + σ --------	-------- M + σ ---------
1.2>D-high background≥0.7	95>D-high background≥49	135>D-high background≥58
---------- M ------------	---------- M ----------	---------- M -----------

As the results, A-class Ag and Pb anomalies were detected on a large scale in all principal creeks of the Providencia mountain mass (7 systems on the northeastern side and 5 systems on the southwestern side).

Considering the results of geochemical prospecting of the second phase, an area for the exploration works of the third phase, was extracted in the central part of the PROVIDENCIA area. Geochemical soil samples were taken with at intervals of 100 meters on the IP electric survey lines (200 meters line-spacing) in the third phase. Three elements of copper, silver and lead were determined as the indicators same as the previous phase. Data processing was also same as the previous phase. The results are summerized as follows:

Table 6-3 Statistical Classification of Geochemical Element (soil sample) of phase Ⅲ

Ag Anomaly (ppm)	Cu Anomaly (ppm)	Pb Anomaly (ppm)
		AA-class ≧ 2,570
		------ Skew point -----
A-class ≧ 6.6	A-class ≧ 141	2,570 > A-class ≧ 923
----- Skew point -----	----- Skew point -----	-------- M + σ ------
6.6 > B-class ≧ 3.2	141 > B-class ≧ 83	923 > B-class ≧ 457
----- Skew point -----	----- M + σ -------	------ Skew point -----
3.2 > C-class ≧ 2.0	83 > C-class ≧ 50	457 > C-class ≧ 302
---------- M ---------	--------- M ----------	----------- M ---------

As the results, 9 points of AA-class and 12 points of A-class anomalies were detected in the mineralized zone. Within these points, 5 points of AA-class showed the values of 1.4% to 9.8% Pb and others showed 0.3% to 0.4% Pb.

Although the reason why such high grade as good as ore grade will partly be attributed to the waste ore remained at the old mine workings and test pits, it is considered that one of the principal mineralization of this area is lead. And also Ag anomalous zone is well consistent with the distribution of Pb anomalies though small in scale.

The IP electric survey was conducted in parallel with the geochemical survey in the same area. As the results, a high-chargeability anomalous zone in irregular ellipse-shape, was detected in the eastern central part of the mineralized zone which corresponds topographycally to a little bit of upper side position than those of geochemical anomalies. As the results of the simulation analysis in the depth of 100 m, 200 m and 300 m, it can be said that the IP anomalous zone has a tendency to become stronger with the depth having an extent of 300 m by 500 m.

It suggests that the causative body of IP anomaly is possibly continued in a depth having an irregular chimney-form.

6-5 Considerations

After a synthetical consideration of the results of various survey mentioned above, two vertical diamond drillings with 300 meters each, namely MJM-4 and 5, were carried out in the final phase to obtain informations of ore bodies in a depth at the Mina Providencia zone and Mina San Juana zone. The MJM-4 drilling cut some oxide ores at 6 portions in such depth as 67.00 m to 68.70 m (Pb 11.87%, Zn 0.68% in average), 96.72 m to 97.12 m (Pb 0.13%, Zn 29.16% in average), 57.85 m to 58.15 m (Pb 1,69%, Zn 1.84% in average) and other three portions with low grade of ore.

In the MJM-5 drilling, no remarkable mineralization is observed. In comparison with arrangements of the geochemically anomalous zones and IP high-chargeability zone on the surface to the results of the two diamond drillings in the depth, mutual relations with them are summerized as follows:

(1) The results of drillings are consistent with the geochemically anomalous zone because of that the MJM-4 is situated within the anomalous zone but MJM-5 is outside of the anomalus zone.

(2) In both drillings of MJM-4 and 5, possible causative bodies which correspond to the IP anomaly, have not been recognized yet. It is presumed that the causative bodies such as intrusive rocks or mineralized zone are latent in more deeper part.

(3) The drilling cores show that drilling portions of the mineralized zones are still situated in oxidized and/or leached parts.

Taking all the results of the drillings and surveys into account, it is considered that main target for future exploration is sulfide ore zone which presumed to be in a depth under the principal mineralized zone of the surface.

CHAPTER 7 CONCLUSION AND RECOMMENDATION

7-1 Conclusion

The project was conducted in Pachuca District (5,250 km^2) in the State of Hidalgo in the central part of Mexico in order to make clear the potentiality of mineral resources by investigating geology, geologic structure, igneous activity, mineralization and the relation between them.

The following surveys were carried out every year successively, such as photogeological interpretation and geological survey (preliminary survey) in 1979 (Phase I), geological survey (semi-detailed), geochemical prospecting (stream sediments sample) and geological survey (detailed) in 1980 (Phase II), geological survey (detailed), geochemical prospecting (soil and rock samples) and geophysical survey (IP method) in 1981 (Phase III) and geological survey (detailed), geochemical survey (rock) and diamond drilling in 1982 (Phase IV).

As the result, the basic information regarding the geology and the ore deposits in the district and at the same time, the interesting characteristics on each mineralized zone have been grasped. The result can be summarized as follows.

I. Geology and Geologic Structure

The surveyed district can be divided, on the standpoint of geologic structure, into the following parts: the northern part, the central part and the southeastern part contained within the Sierra Madre Oriental zone; the central-western part and the southwestern part contained in the Younger Volcanic zone.

The Sierra Madre Oriental zone corresponds to the southeastern extension of the Rocky Mountain Range which is positioned as the forefront of the Alpine Orogenic belt extending from the northern part to the central part of the North American Continent. On the other hand, the Younger Volcanic zone is distributed in the direction of E-W cutting the Sierra Madre Oriental zone and the main geologic structures parallel to the zone, and forms a field of intense volcanic activity continued at present.

Reflecting the background of these geologic structure, the following formations are distributed in the northern part, the central part and the southern part of the district from the base upward: the Las Trancas Formation (Jts, Jtc and Jtl Members) which is correlated to Titonian of the latest Jurassic to Neocomian of the earliest Cretaceous; the El Doctor Formation (Kdl, Kdf and Kds Members) which belongs to Albian of the middle Early Cretaceous to Turonian of the upper Late Cretaceous; the Mendez Formation (Kms) which belongs to Turonian to Campanian of the uppermost Late Cretaceous. Although the Las Trancas Formation and the Mendez Formation are pelitic, the El Doctor Formation consists mainly of limestone.

In these pre-Tertiary formations, a couple of overfold anticlinal and syclinal structures on a large scale, and other many small folds have been formed, resulting in to make the geologic structure very complicated. The geologic structure of the district, however, has an appearance of monoclinic structure because this couple of overfold anticlinal and synclinal structure has the axes striking northwesterly and the axial planes dipping toward the west. The actual state is that these form a overfold structure in which the part sandwiched between the two axial planes shows a reverse stratigraphical relation.

On the other hand, the Tertiary volcanic rocks are widely distributed in the central-western part and the southwestern part of the district. Among these, the important ones are the potash rhyolites which belong to Trhy2, forming the SAN CLEMENTE mountain mass in the central part of the district overlying basalt which belongs to Tbal. The time of activity of the rocks shown by the K-Ar dating is 26.5 ± 1.3 Ma, showing the latest Oligocene. The rocks are rich in potasium or sodium, and considered to have a close relation with the gold mineralization, which is one of the main targets of survey.

The main intrusive rocks distributed in the district are quartzdioritic rocks (Tidi) and diorite porphyry (Tidp). Others are small dykes of volcanic rocks.

Quartzdioritic rocks show a form of irregular stock, and the distribution of which is concentrated in the northern part of the district showing a tendency to be arranged in a certain direction. This trend is concordant with the two systems of direction of the main faults observed in the district.

The rocks mainly intruded into the El Doctor Formation which consists of calcareous rocks and have an effect of contact metamorphism associated with mineralization on the formation, and it is significant in the sense that it controlled the distribution of the ore deposits. Their K-Ar ages show about 47 Ma, corresponding to middle Eocene.

Diorite porphyry (Tidp) is distributed in a form of small stock or dyke and has an effect of contact metamorphism on the calcareous rocks intruded by the former. It is also important as the rocks in the above. Its K-Ar ages show 31.1 ± 1.6 Ma, showing the time of activity in middle Oligocene.

II. Mineralized zone

(1) It was made clear that the following three types of mineralization occur in the surveyed district.

A. Contact metasomatic mineralized zone [Fe-Cu-(Pb-Zn-Ag-Au) type]:

These are concentratedly distributed in the northern part of the district accompanied with diorite bodies. The typical examples are the mineralized zones such as EL TEJOCOTE, ENCARNACION, EL ZAPOTE, DOS DE EL AGUILA, SAN JOSE DEL ORO and LAS PIEDRAS.

B. Hydrothermal type deposit [Pb-Ag(Zn-Acu-Cu) type] emplaced in the form of irregular massive - manto - vein in the calcareous rocks of the distant surrounding area of the intrusive body or adjacent surrounding area of the intrusive body of diorite porphyry (Tidp) (typical examples are PECHUGA, PROVIDENCIA and TEJOCOTE).

C. Hydrothermal type gold deposit found in potash rhyolites which form the SAN CLEMENTE mountain mass in the central part of the district (typical example is the San Serveriano mine in the area).

(2) Among the mineralized zones above mentioned, the areas to be worthy of note are the PROVIDENCIA area where the hydrothermal deposit [Pb-Ag(Zn-Au-Cu) type] is expected and the SAN CLEMENTE area where the hydrothermal type gold ore deposit is expected.

PROVIDENCIA Area

The mineralized zones are observed in the Black Flint Bearing Medium Bedded Limestone Member of the El Doctor Formation and they show a hydrothermal type occurrence emplaced along the fold axes trending northwesterly and the fault fractures of NNW-SSE system as well as ENE-WSW system.

The unit ore bodies show irregularly massive, brecciated and disseminated forms. Ores are all composed of oxides ores mainly of goethite and hematite, in which calamine, smithsonite and cerussite are contained.

The highest values of lead and zinc shown in the local samples taken from the ore deposit in the area are 10.28% Pb and 44.78% Zn, showing considerably high grades.

Geophysical survey (IP method) and geochemical prospecting carried out in the area revealed as an excellently overlapped anomalous domains. As the result of drill survey, the mineralized zones were intersected at six places. All these, however, are shown to be the massive oxides ore, and it was made clear that the oxides zone still continued to the depth of 300 meters.

SAN CLEMENTE Area

The gold mineralization shows an occurrence of so-called "network dissemination type" in which minute grains of electrum containing about 25 percent of silver are found along the irregular fine cracks in relatively fresh rhyolite accompanied with no remarkable silicification and hydrothermal alteration different from those of ordinary gold ore deposits.

It was made clear as the result of geochemical prospecting (rock sampling) that the mineralization is fairly preponderant in an area to the west of the SAN SEVERIANO mine. Geological survey (trench survey) and drill survey were conducted in the area (200 m x 400 m) which contains the anomalous zones of high values.

Among the samples taken for every five-meter section along the whole length of trench (3,625 m), 10 samples showed the values of more than 1 g/t Au, while the highest one is 7.9 g/t.

On the other hand, the result of drill survey showed that the gold mineralization in the depths was inferior to that on the surface. However, since dissemination of chalcopyrite, sphalerite and galena is observed in the drill core, it is considered that though gold and silver are dominant on the surface and in the shallow part, they become inferior in the depth, and copper, lead and zinc become superior instead, showing a vertical zonal arrangement.

(3) The COLORADO area and the El ZAPOTE - LAS PIEDRAS area are worthy of note as the areas of interest in which occurrence of the contact metasomatic type deposits is expected.

COLORADO Area (partly overlapped with the DOS DE EL AGUILA area)

An intermittent occurrence of skarn zones is found at the contact between the Massive Limestone Member (Kdl) of the El Doctor Formation and a small stock-like diorite body (Tidi) which intruded into the former, and the skarn zone is accompanied with mineralization.

Two mines such as Dos de El Aguila and Esmeralda are situated in the northwestern part of the area. The main mineralized skarn zones are found on both sides of the intrusive body. On the eastern side, the zone extends for about 260 meters with the width of 20 - 40 meters. On the western side, a zone of almost the similar size is observed. Magnetite, galena, sphalerite, chalcopyrite and pyrite are disseminated in gangue minerals consisting mainly of garnet.

The assay result of the samples taken from these zones showed the values such as 0.2 - 2.7 g/t Au, 4 - 140 g/t Ag, 0.0 n - 14.49% Cu, 0.04 - 1.59% Pb and 1 - 1.62% Zn, showing few of those samples of high content. At the same time, the extension of the known mineralized zone can not be much expected.

However, because a lead anomalous zone of moderate degree has been detected at the northeastern end of the area by geochemical prospecting (stream sediments), because of the occurrence of an intrusive body on the ridge on the southern side, and because of occurrence of the mines such as La Luz, San Antonio and Bonanza, a possibility of existence of any mineralized zone other than the known ore deposits in an area from the above lead anomalous zone to the La Luz mine would have been remained.

EL ZAPOTE - LAS PIEDRAS Area

Lenticular ore deposits, the main components of which consist of iron and copper, accompanied with lead, zinc, gold and silver, are scattered in the skarn zones found at the contact between the diorite intrusive rock and limestone of the El Doctor Formation. Eleven mines are concentrated there for exploration and development of these deposits, and the area is called the El Zapote mining area, among which only four mines are in operation at present.

The skarn zones mainly consist of fine-grained garnet skarn and are distributed along the intrusive body having a width from 30 meters to 150 meters. The ore bodies are intermittently distributed in the skarn zones, and dimension of a unit body is 5 - 10 meters in width, 100 meters in strike length and 70 - 130 meters in shoot length. Two kinds of ore are found: the one is dominant in magnetite with dissemination of chalcopyrite and other sulfide minerals, and the other consists of massive sulfides. Both ores are characteristically accompanied with gold and silver, and especially the latter is high in their content.

The assay values of ore from those mines such as IGNACIO ZARAGOZA, SAN JOSE DEL ORO, TRINIDAD and LOS GALLOS which produce the ore belonging to the latter are 1.4 - 43.4 g/t Au, 9.3 - 313.9 g/t Ag and 0.77 - 23.70% Cu. The main components of the ore are gold, silver and copper, with accessory amount of lead and zinc.

The central part of the El Zapote mineralized zone has been explored and developed to a considerable degree, and very small room is remained for future exploration.

A geochemically anomalous zone mainly of Ag component has been detected in the northern half of the El Zapote intrusive body, especially in the limestone terrain to the west of SAN JOSE DEL ORO, and a possibility of existence of any latent skarn zone is indicated. Furthermore, a skarn zone as wide as 80 meters has been found in the surrounding area of the Las Piedras intrusive body, and at the same time, geochemical anomaly of Ag component has been detected there. Thus a possibility of occurrence of any mineralized zone is remained in these two areas since they have the favorable conditions for ore emplacement almost similar to that of the EL ZAPOTE area.

7-2 Recommendation (ref. Fig. 7-1, 7-2)

While the project in the Pachuca District is to be finalized by the survey of this phase, the following investigations are recommended to be conducted in the two areas if Mexican side has the intention to continue the survey in future.

(1) SAN CLEMENTE Area

The exploration should be directed in future to the target at a place higher than 2,350 meters above sea level since the gold and silver mineralization is preponderant on the surface and in a superficial part.

For this purpose, the following measures are recommended.

At first, survey by trench is to be conducted in an area (200 m x 400 m) between the San Severiano mine and the eastern limit of the surveyed area of the fourth phase. After confirmation of the distribution of gold and silver on the surface, ore reserve and grade should be confirmed by short drillings of about 50 to 100 meters deep at a regular interval in the area of high content of gold and silver including the surveyed area of the fourth phase.

(2) PROVIDENCIA Area

As the result of survey so far conducted, it was made clear that the oxides ore still continues at the depth of 300 meters below the surface.

It is recommended, therefore, firstly to grasp any sulfide mineralized zone by drilling in order to confirm the conditions of ore deposit together with to investigate the extensity of the sulfide ore body in a depth.

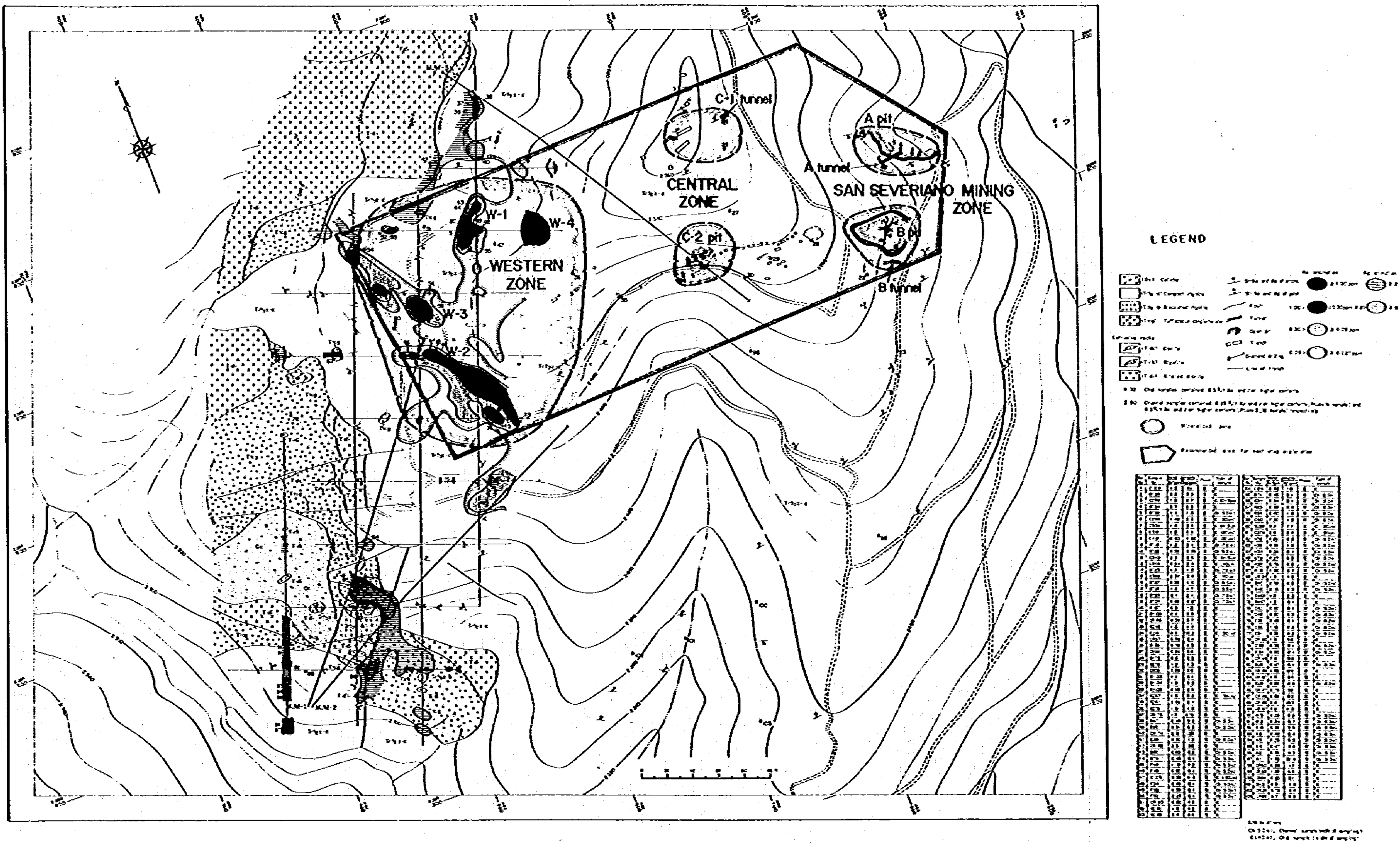
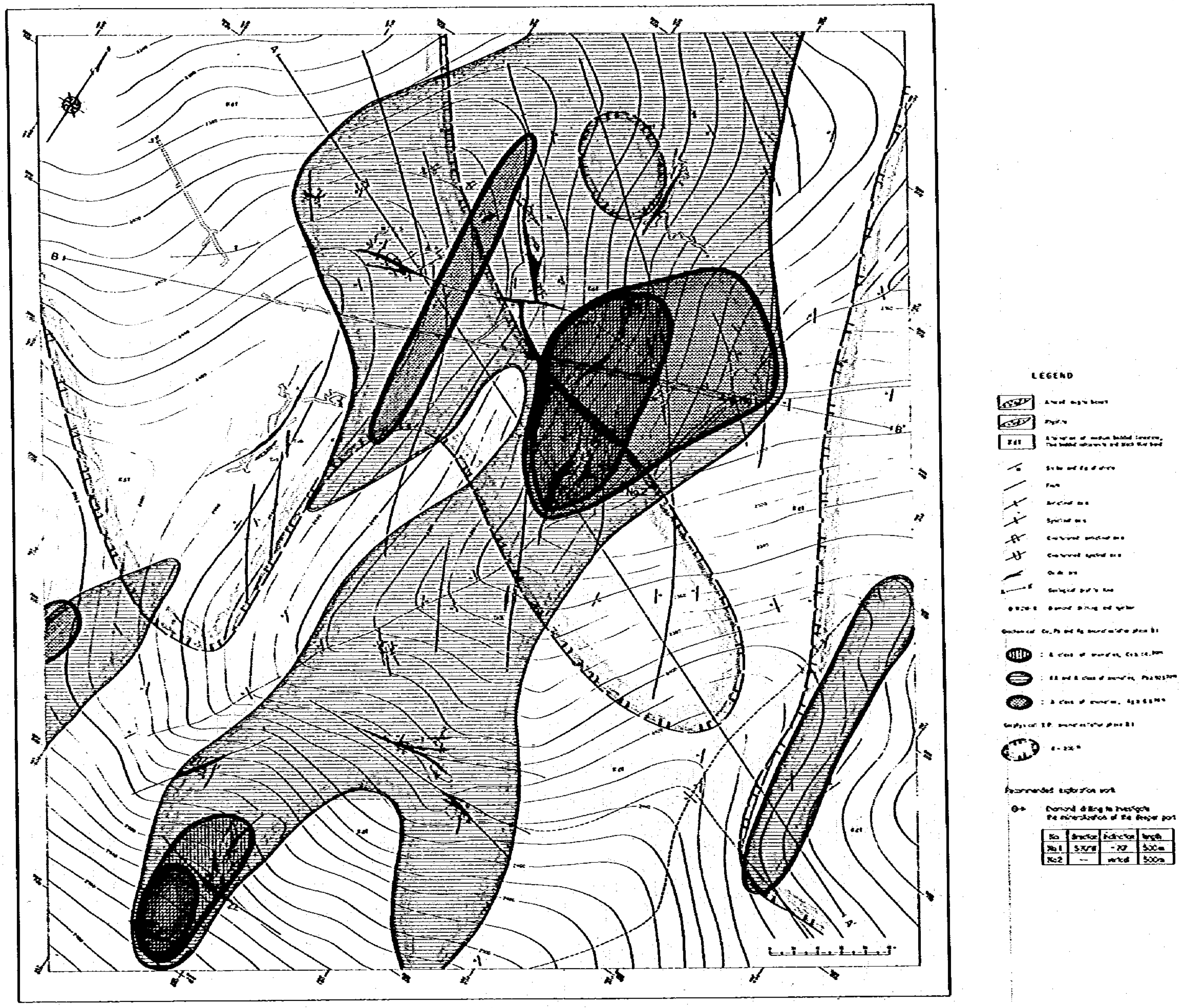


Fig.7-1 Interpretation Map of the SAN SEVERIANO Mining Area, SAN CLEMENTE



No.	Direction	Inclination	length
No.1	S70°W	-70°	500m
No.2	—	vertical	500m

Fig.7-2 Interpretation Map of the PROVIDENCIA Mining Area, PROVIDENCIA

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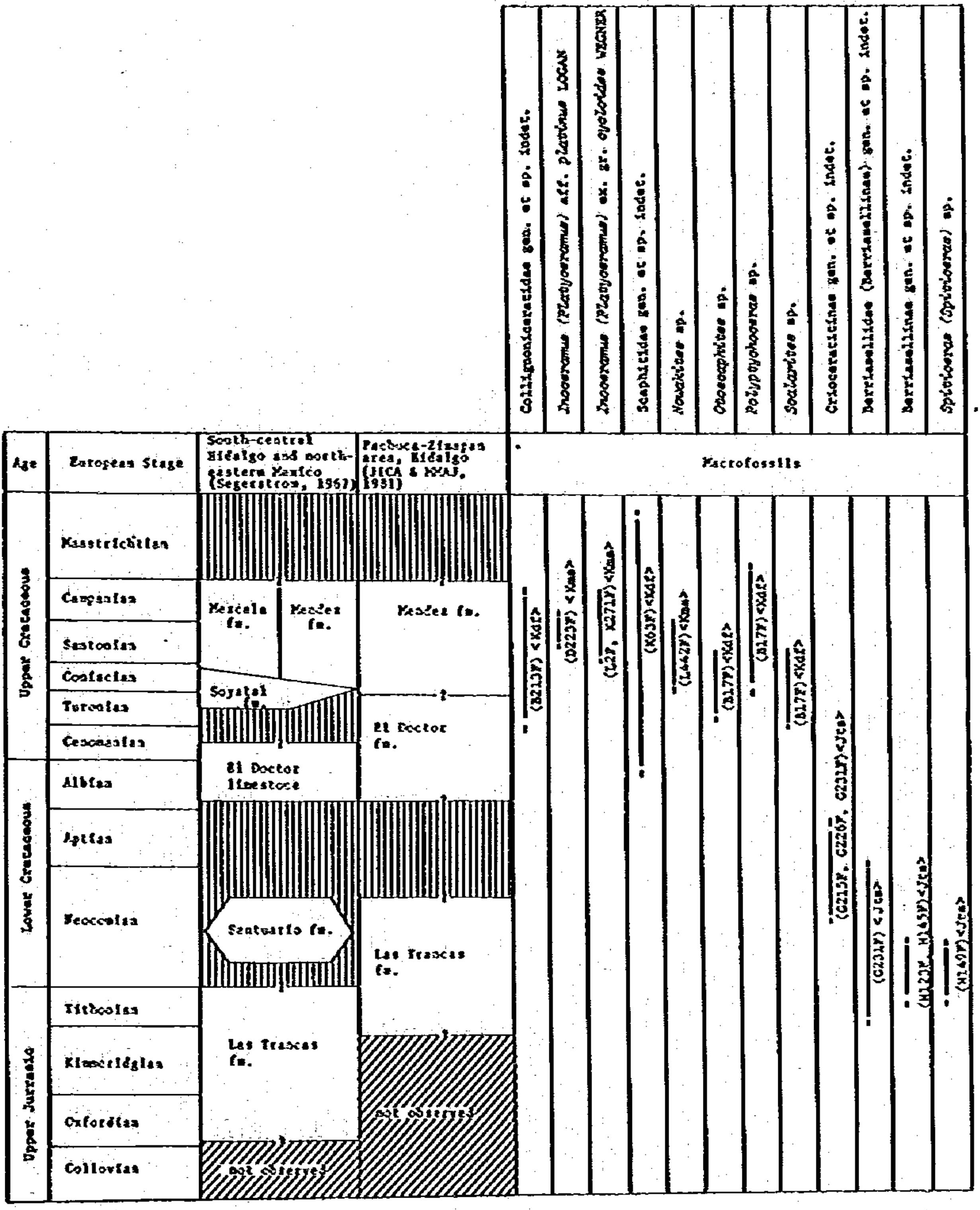
APPENDICES

Apx. 1 Identified Macrofossils

(Identified by Dr. K. TANAKA)

No.	Sample No.	Coordinates E	Coordinates N	Stratigraphic unit	Ancyloceratidae gen. et sp. indet.	Berriasellinae gen. et sp. indet.	Berriasellidae (Berriasellinae) gen. et sp. indet.	Collignoniceratidae gen. et sp. indet.	Crioceratitinae gen. et sp. indet.	Sauvagesiinae gen. et sp. indet.	Scaphitidae gen. et sp. indet.	Anahamulina sp.	Nowakites sp.	Otoscaphites sp.	Polyptychoceras sp.	Scaphites sp.	Spiticeras (Spiticeras) sp.	Ammonoidea	Coiled ammonite	Uncoiled ammonite	Inoceramus (?Platyceramus) aff. Platinus LOGAN	Inoceramus (Platyceramus) ex. gr. cycloides WEGNER	Monopleuridae gen. et sp. indet.	Radiolitidae gen. et sp. indet.	Caprinula sp.	Inoceramus sp.	Radiolites sp.	Sauvagesia sp.	Titanosarcolites sp.	Bivalvia	Rudistid	Nerinea sp.	Gastropoda	indeterminable fossil	trace fossil (feeding burrow)
					Ammonite																Pelecypods											Gastropoda			
1	B 10F	468750	2308750	Kdl						○															?		○		?			○			
2	B 17F	466831	2309025	Kdf	○									?	○				○									○							
3	B 20F	466055	2308725	Kdl																○										○			○		
4	B 22F	465595	2308015	Kdf																												○			
5	B 26F	475035	2308025	Kdl																															
6	B 50F	474225	2308520	Kdl																				○								○			
7	B 51F	475105	2307725	Kdl																			○									○			
8	B151F	469160	2302625	Jtf														○																	
9	B213F	466392	2306847	Kdf				○										○																	
10	B324F	474380	2306805	Kdl																											○				
11	B325F	474145	2307530	Kdl																				○											
12	B326F	473210	2304680	Kdf										?					○																
13	B328F	473245	2306620	Kdl																											○	?			
14	B329F	466896	2305500	Kdl																														?	
15	D 2F	478465	2300127	Jts																														○	
16	D 20F	473580	2298294	Jts																										○					
17	D 28F	475570	2301425	Kdf																										○					
18	D 31F	473395	2302045	Kdf																														○	
19	D 50F	469845	2301945	Jts																										○					
20	D214F	466710	2296846	Jts																										○					
21	D218F	475178	2297950	Kdf												○																			
22	D223F	478210	2299011	Kss																	○														
23	E 8F	463030	2295569	Kdf																															○
24	E301F	479929	2301650	Kdf																														○	
25	G 27F	478382	2296793	Kdf																														○	
26	G215F	472580	2294842	Jts					○																										
27	G226F	474407	2293352	Jts					○									○																	
28	G231F	474481	2296080	Jts			○																												
29	G307F	474262	2291187	Jts																														○	
30	G346F	470902	2290282	Kss																										○					
31	H123F	472973	2296020	Jts		○																													
32	H145F	475320	2292808	Jts			○																												
33	H149F	475380	2292775	Jts													○																		
34	H306F	494923	2283978	Kdf														○																	
35	I 8F	486617	2285018	Kdf																						?									
36	K 63F	486603	2285677	Kdl							?																								
37	K195F	486056	2286403	Jts																														○	
38	K271F	487500	2286108	Kms																		○													
39	K276F	487888	2285877	Kdf											○																				
40	K410F	484995	2285924	Jts																															○
41	L 2F	488257	2281488	Kms																		○													
42	L 3F	488310	2281532	Kss																						?				○					
43	L 30F	490052	2289480	Kss																														○	
44	L203F	491728	2286250	Kss																															○
45	L307F	488416	2286126	Kss																														○	
46	L304F	488467	2285352	Kdf																															
47	L442F	493026	2283946	Kss								○	○																						

Apx. 2 Stratigraphic Correlation of the Jurassic and Cretaceous Systems by the Identified Macrofossils



( ); sample number
< >; Simbol name of the formation
—; range of leading fossil

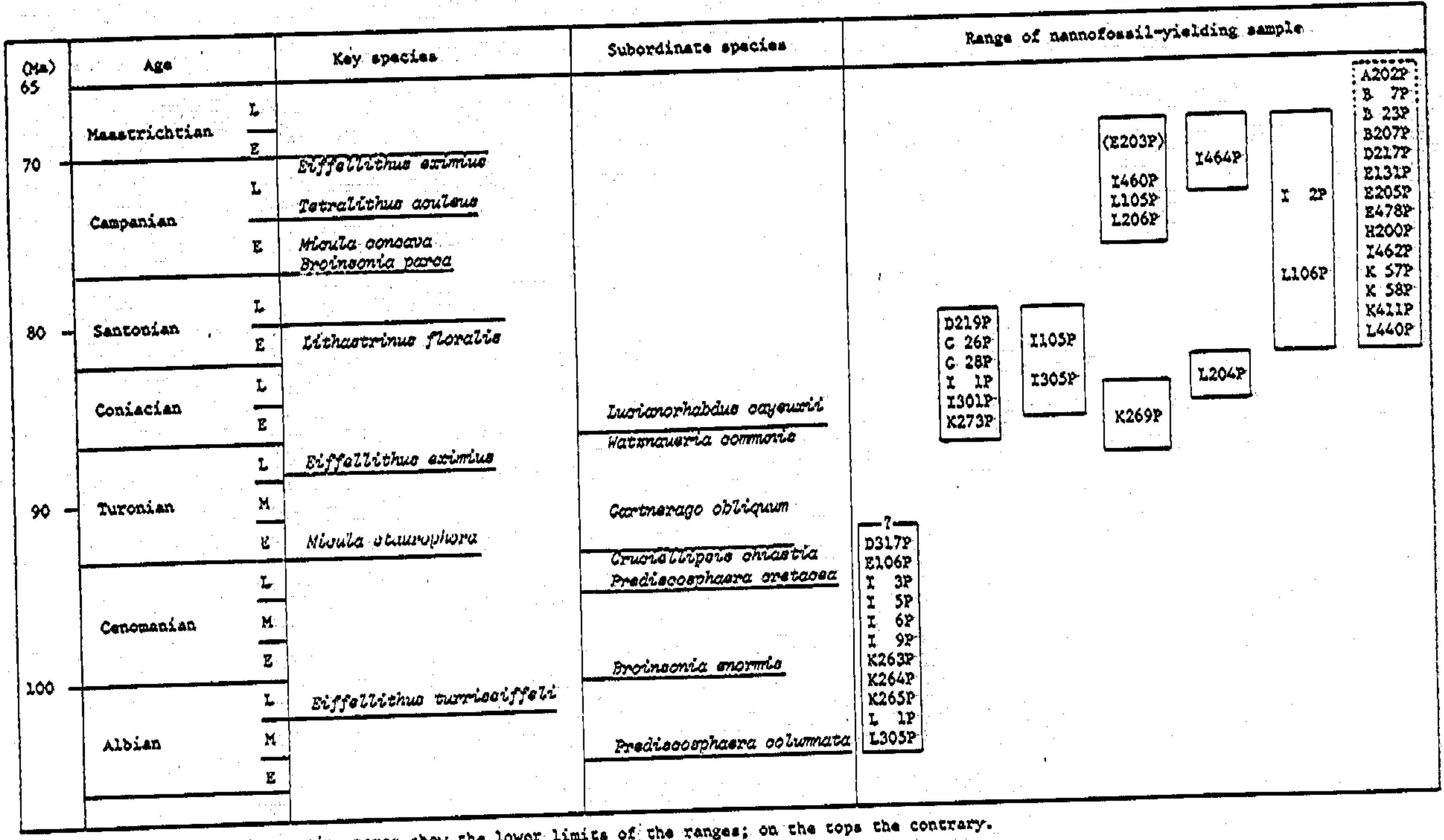
Apx. 3 Identified Nannofossils

(Identified by Dr. H. OKADA)

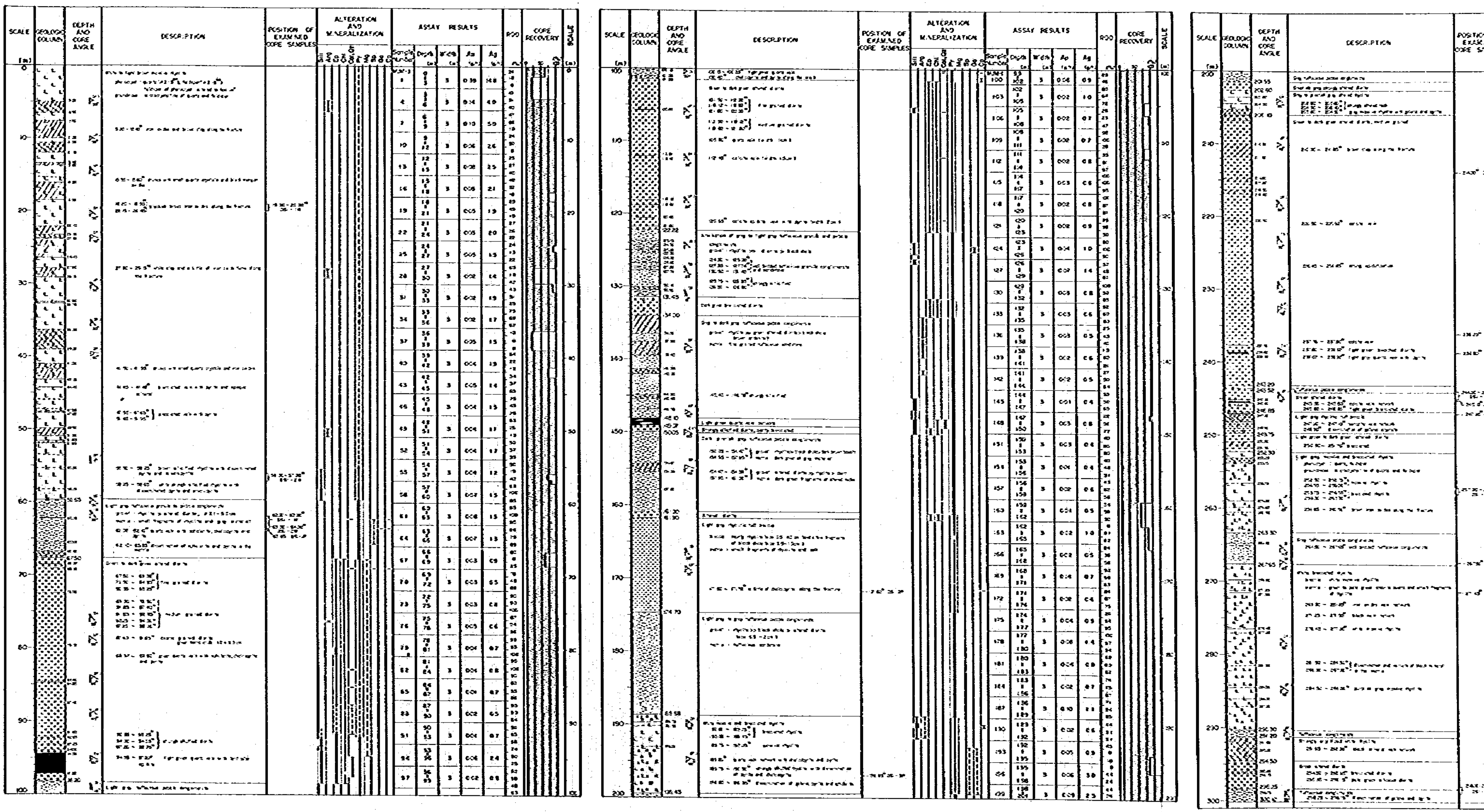
No.	Sample No.	Coordinates		Strati-graphic unit	*	Braarudosphaera africana	Broinsonia enormis	Broinsonia parca	Chiastozygus litterarius	Cretarhabdus crenulatus	Cribrosphaerella ehrenbergii	Cruciellipsis chiastia	Eiffellithus eximius	Eiffellithus turriseiffeli	Gartnerago obliquum	Gartnerago striatum	Kamptnerius magnificus	Lithastrinus floralis	Lucianorhabdus cayeuxii	Micula concava	Micula staurophora	Parhabdolithus angustus	Parhabdolithus embergeri	Prediscosphaera columnata	Prediscosphaera cretacea	Prediscosphaera spinosa	Tetralithus aculeus	Tranolithus orionatus	Watznaueria barnesae	Watznaueria communis	Zygodiscus diplogrammus
		E	N																												
1	A202P	479200	2317759	Kas	F-P					○				○							○	○			○				○		
2	B 7P	476592	2305099	"	F-P					○											?								○		
3	B 23P	474716	2308102	"	F-P																?								○		○
4	B207P	470142	2304300	Kdf	C-P																○								○		
5	D217P	474055	2293800	"	F-P																○								○		
6	D219P	477913	2300538	Kas	F-P													○			○			○					○		
7	D317P	477281	2300652	"	C-P									○				○											○		○
8	E106P	480319	2297947	"	F-P									○															○		
9	E131P	483312	2300174	"	F-P									○							?								○		
10	E203P	479350	2297782	"	F-P															?	?								○		
11	E205P	479559	2297355	"	F-P	○				○				○							○								○		○
12	E478P	482325	2293110	"	F-P																○								○		
13	G 26P	477822	2295883	Kdf	F-P													?			?								○		
14	G 28P	477332	2295930	"	F-P																		○						○	○	
15	H200P	497208	2289450	Kas	F-P	○								○							○		○						○		
16	I 1P	498531	2289852	"	F-P					○				○				?			?	○	○		○				○		○
17	I 2P	488036	2289826	"	C-M	○	○		○	○			○	○											○			○	○		○
18	I 3P	487639	2289553	"	F-P					○				○				○								○		○	○		
19	I 5P	487012	2289390	"	C-P					○				○				○						○				○	○	○	
20	I 6P	486719	2288702	Kdf	F-P					○				○									○					○	○		
21	I 9P	486772	2287852	"	C-M					○		○		○				○						○		○		○	○	○	○
22	I105P	493503	2291153	Kas	C-P		○			○			○	○				○	○		○				○				○		
23	I301P	492818	2288342	"	F-M					○				○				?			○	○							○		
24	I305P	492752	2292289	"	C-M					○			○	○				○			○	○			○				○		○
25	I450P	494335	2290902	"	A-M	○		○		○	○		○	○	○		○		○		○				○			○	○		○
26	I462P	492887	2289858	"	F-P									○							○				○				○		
27	I454P	492534	2292451	"	C-M		○			○	○		○	○					○	○	○	○					○		○		○
28	K 57P	487488	2286459	Kdf	F-P	○								○							○	○	○						○		
29	K 58P	487345	2287067	"	F-P	○															○								○		
30	K263P	486953	2287543	"	C-M					○		?		○				○						○				○	○	○	○
31	K264P	487190	2287500	"	F-P					○								○											○		
32	K265P	487581	2287357	"	F-P					○		○						○						○					○		
33	K259P	487903	2287453	Kas	C-P					○				○				○			○			○	○			○	○	○	
34	K273P	488055	2287100	"	F-P									○				?			○								○		
35	K511P	495977	2285976	Jcs	C-P	○															○								○		
36	L 1P	488108	2287471	Kas	F-P					○				○										○					○		
37	L105P	493717	2281707	"	C-M					○			○	○							○				○				○		○
38	L106P	493810	2281537	"	F-P					○			○	○							○								○		
39	L204P	492500	2285345	"	C-P					○			○	○		○	○				○							○	○		
40	L266P	493568	2286037	"	C-M		○			○	○		○	○						○	○	○			○		○		○		
41	L305P	493217	2285137	"	C-M					○		○		○				○						○				○	○	○	
42	L450P	493879	2293651	"	F-M					○				○							○								○		

* abundance - preservation F; frequent, A; abundant, C; common, M; moderate, P; poor.

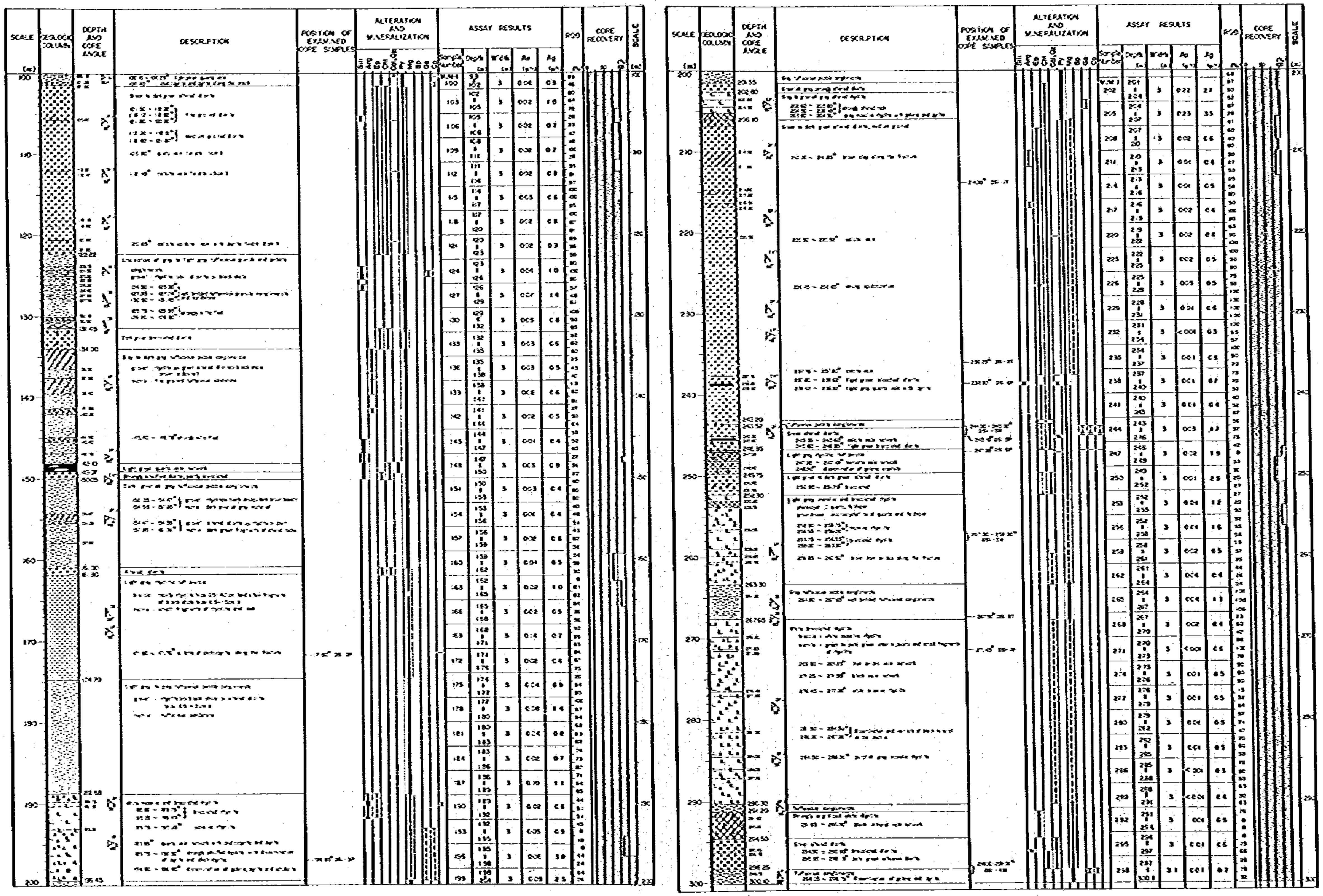
Apx. 4 Age Determination by the Identified Nannofossils



Bar lines under the species names show the lower limits of the ranges; on the tops the contrary.



Apx. 5 Geological Log of



DRILL No	MJM-1	
DRILL SITE	Coordinate	Altitude
	N 2254407	2537 m
	E 282329	
DIRECTION	N 45°E	
INCLINATION	0°	
LENGTH	300.10 m	

ABBREVIATIONS

(F) : Fracture
(V) : Vein
(B) : Bedding
Sili : Silicification
Arg : Argillization
Ep : Epidotization
Chl : Chloritization
Cal,Qz : Calcite and Quartz vein
Py : Pyrite
Mg : Magnetite
Sp : Sphalerite
Ga : Galena
Cp : Chalcopyrite
T : Thin section
P : Polished section
M : Chemical analysis of ore
W : Chemical analysis of whole-rock

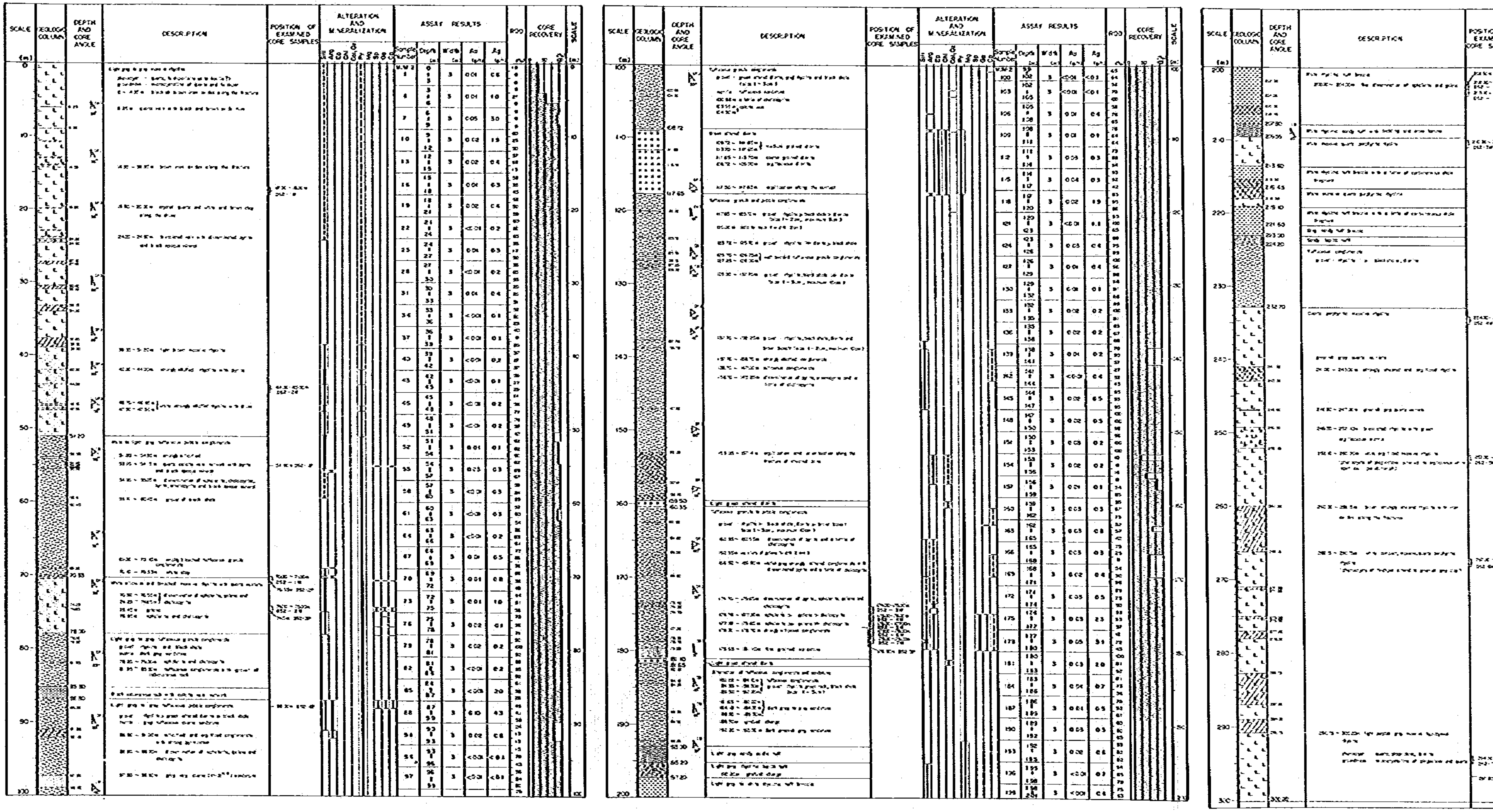
SYMBOL

━━ Vein
XXXX Brecciated vein
▨ Silicification
- - - - Druse
▨ Sheared zone
▨ Strongly sheared zone
▨ Brecciation

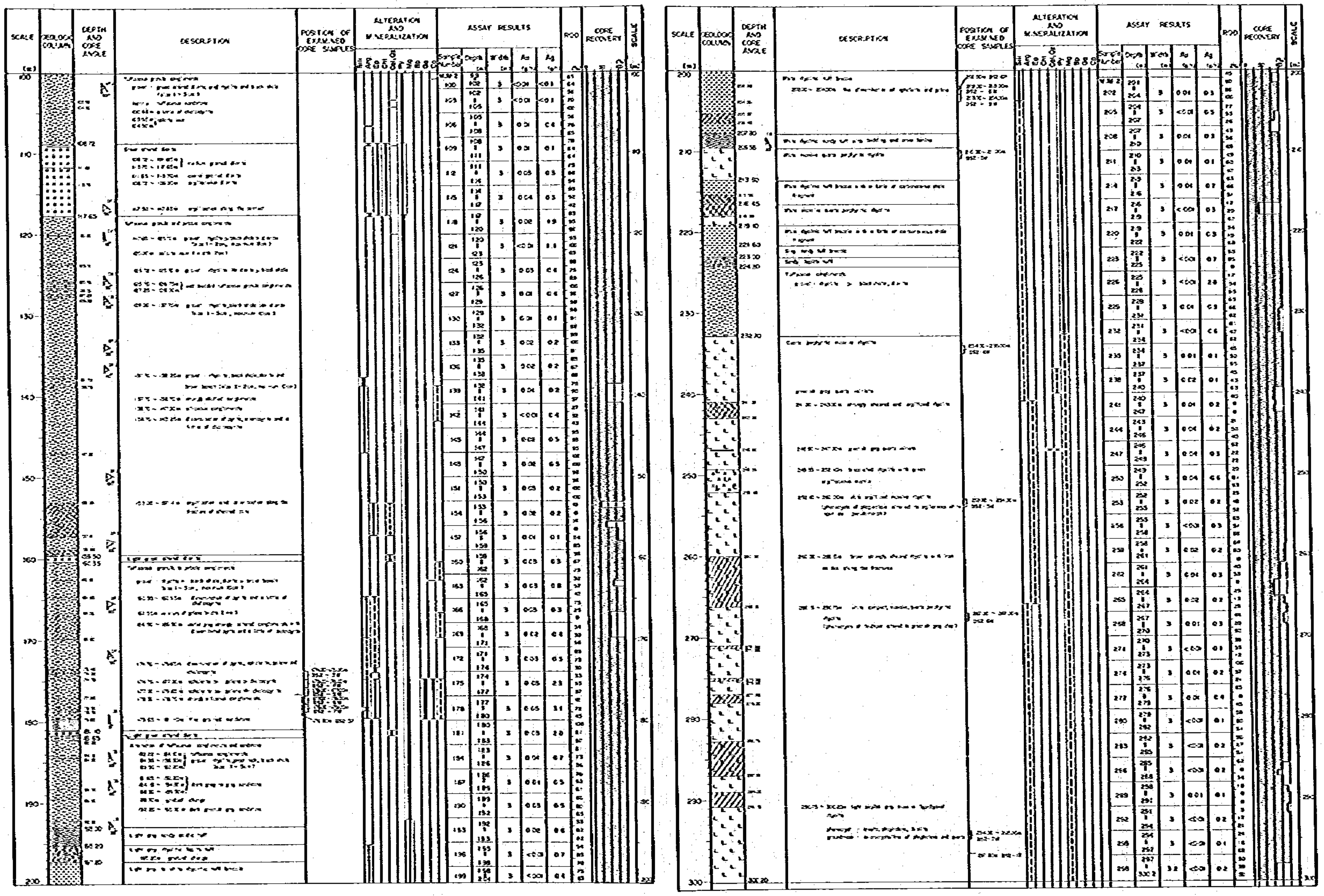
ALTERATION AND MINERALIZATION GRADE

━━ Strong
—— Medium
- - - Weak

Apx. 5 Geological Log of Diamond Drilling Hole in the SAN CLEMENTE Area (MJM-1)



Apx. 6 Geological Log of



DRILL No	MJM - 2	
DRILL SITE	Coordinate	Altitude
	N 2254406	2307 m
	E 432362	
DIRECTION	N50°E	
INCLINATION	0°	
LENGTH	300.20 m	

ABBREVIATIONS

- (F) : Fracture
- (V) : Vein
- (B) : Bedding
- Si : Silicification
- Ag : Argillization
- Ep : Epidotization
- Cl : Chloritization
- Cal,Qz : Calcite and Quartz vein
- Py : Pyrite
- Mg : Magnetite
- Sp : Sphalerite
- Ga : Galena
- Cp : Chalcopyrite
- T : Thin section
- P : Polished section
- M : Chemical analysis of ore
- W : Chemical analysis of whole-rock

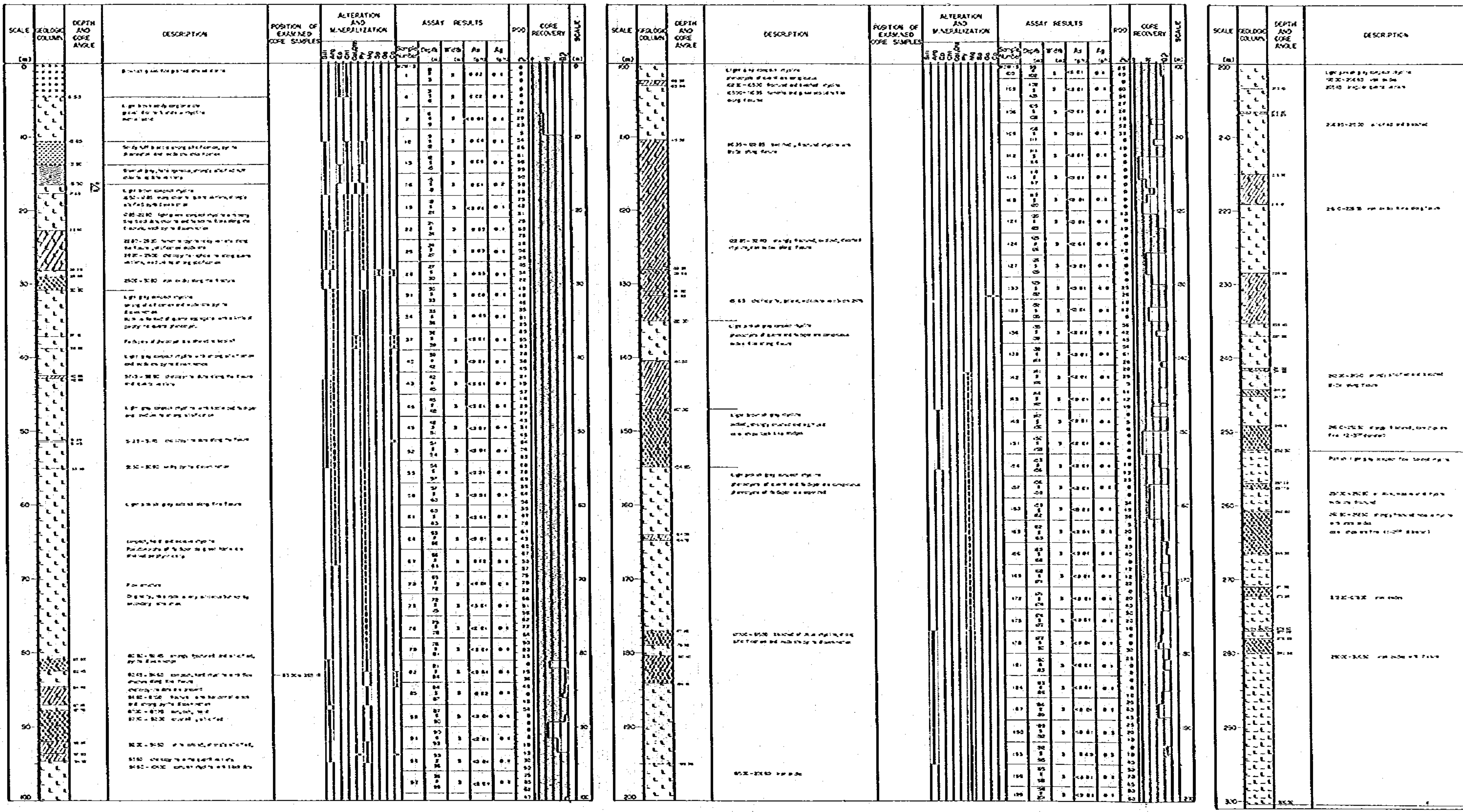
SYMBOL

- ―― Vein
- xxxx Brecciated vein
- ⁚⁚⁚⁚ Silicification
- ···· Druse
- //// Sheared zone
- ▨ Strongly sheared zone
- ⁛ Brecciation

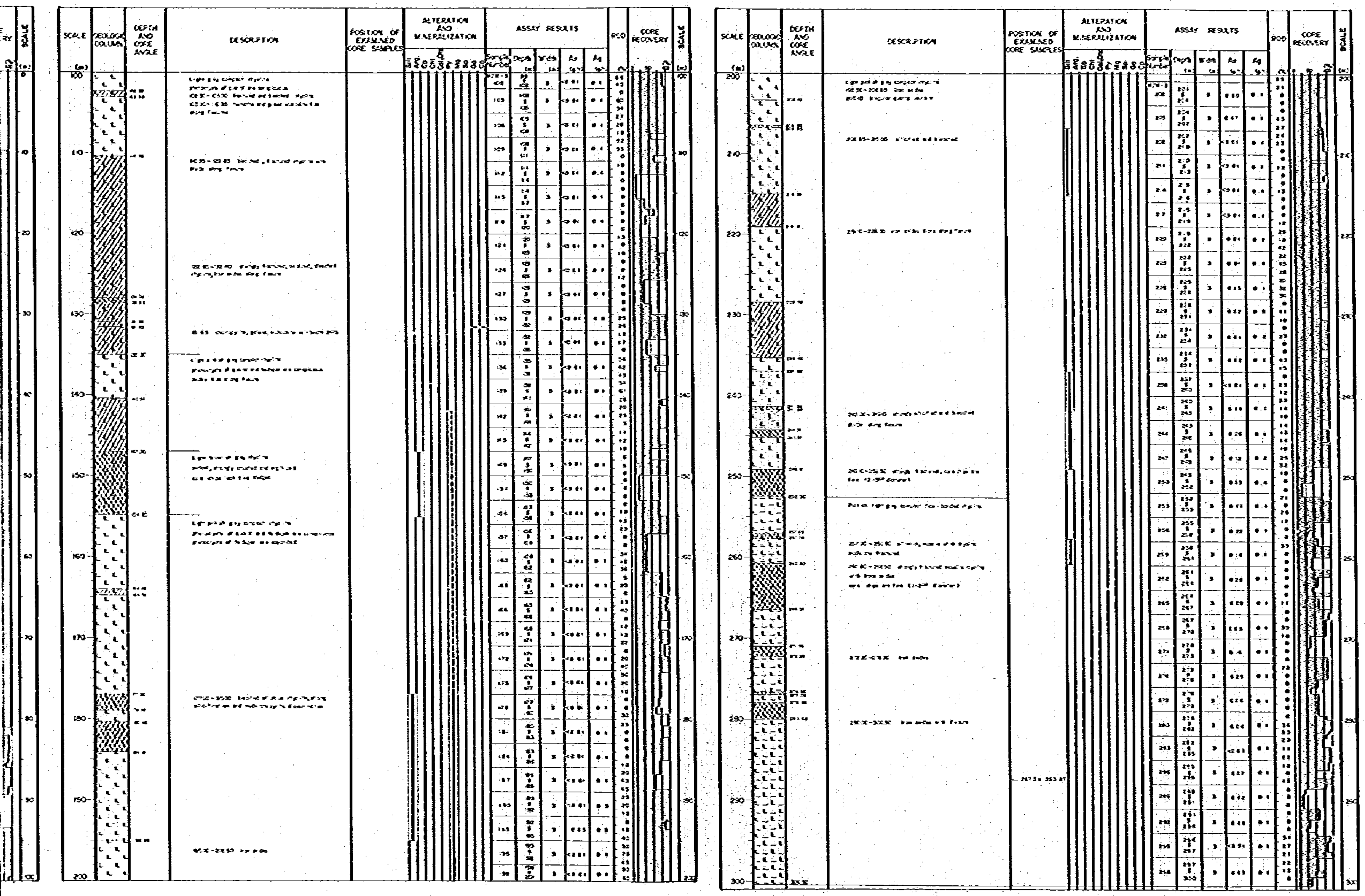
ALTERATION AND MINERALIZATION GRADE

- ━━ Strong
- ―― Medium
- - - - Weak

Apx. 6 Geological Log of Diamond Drilling Hole in the SAN CLEMENTE Area (MJM-2)



Apx. 7 Geological Log



DRILL No	MJM - 3	
DRILL SITE	Coordinate	Altitude
	N 2264845 E 432663	2426 m
DIRECTION	S 43°E	
INCLINATION	0°	
LENGTH	300. 50 m	

ABBREVIATIONS

(F) : Fracture
(V) : Vein
(B) : Bedding
Sil : Silicification
Arg : Argillization
Ep : Epidotization
Chl : Chloritization
Cal,Qz : Calcite and Quartz vein
Py : Pyrite
Mg : Magnetite
Sp : Sphalerite
Gn : Galena
Cp : Chalcopyrite
T : Thin section
P : Polished section
M : Chemical analysis of ore
W : Chemical analysis of whole rock

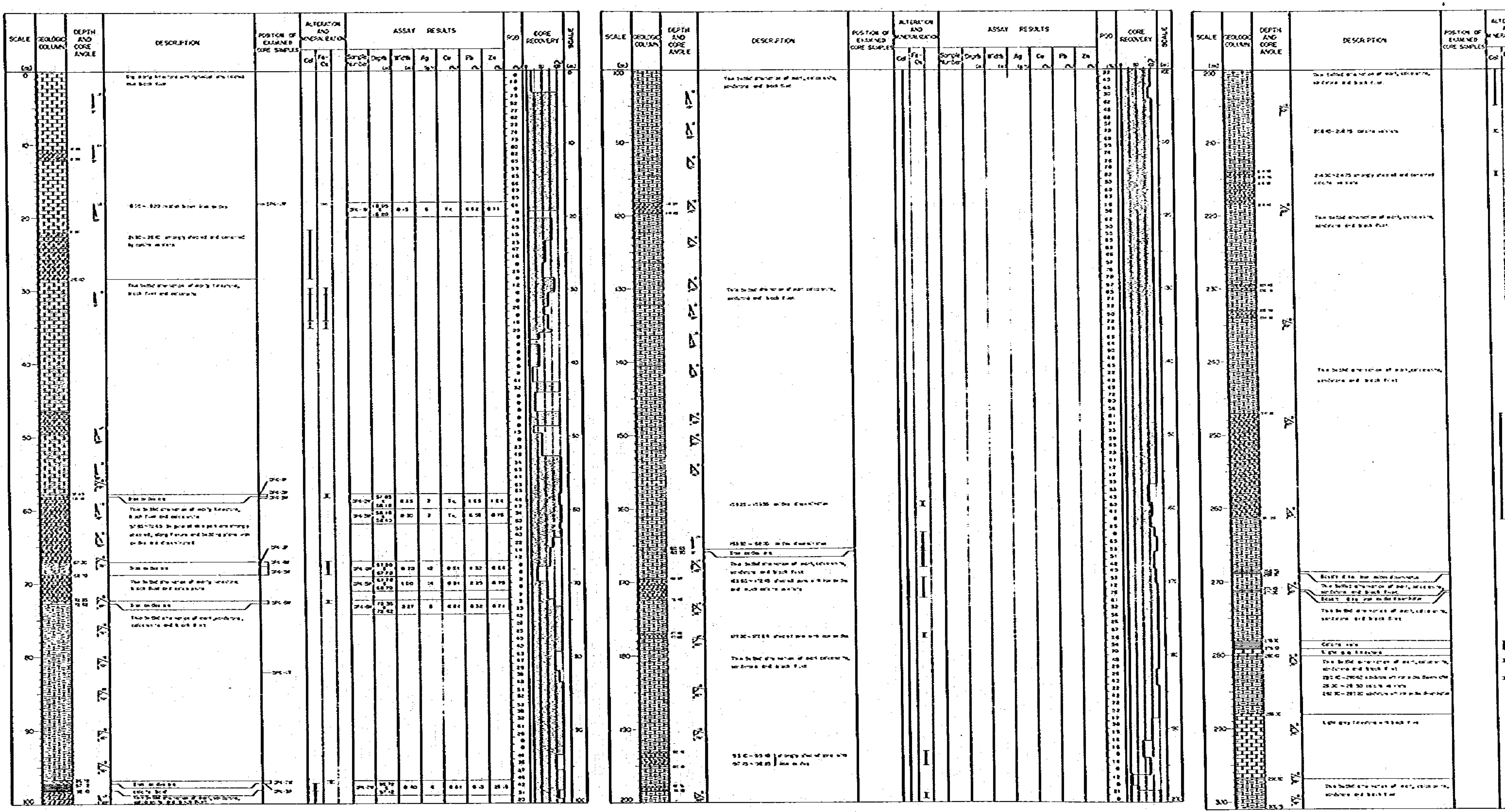
SYMBOL

━ Vein
▨ Brecciated vein
▨ Silicification
▨ Druse
▨ Sheared zone
▨ Strongly sheared zone
▨ Brecciation

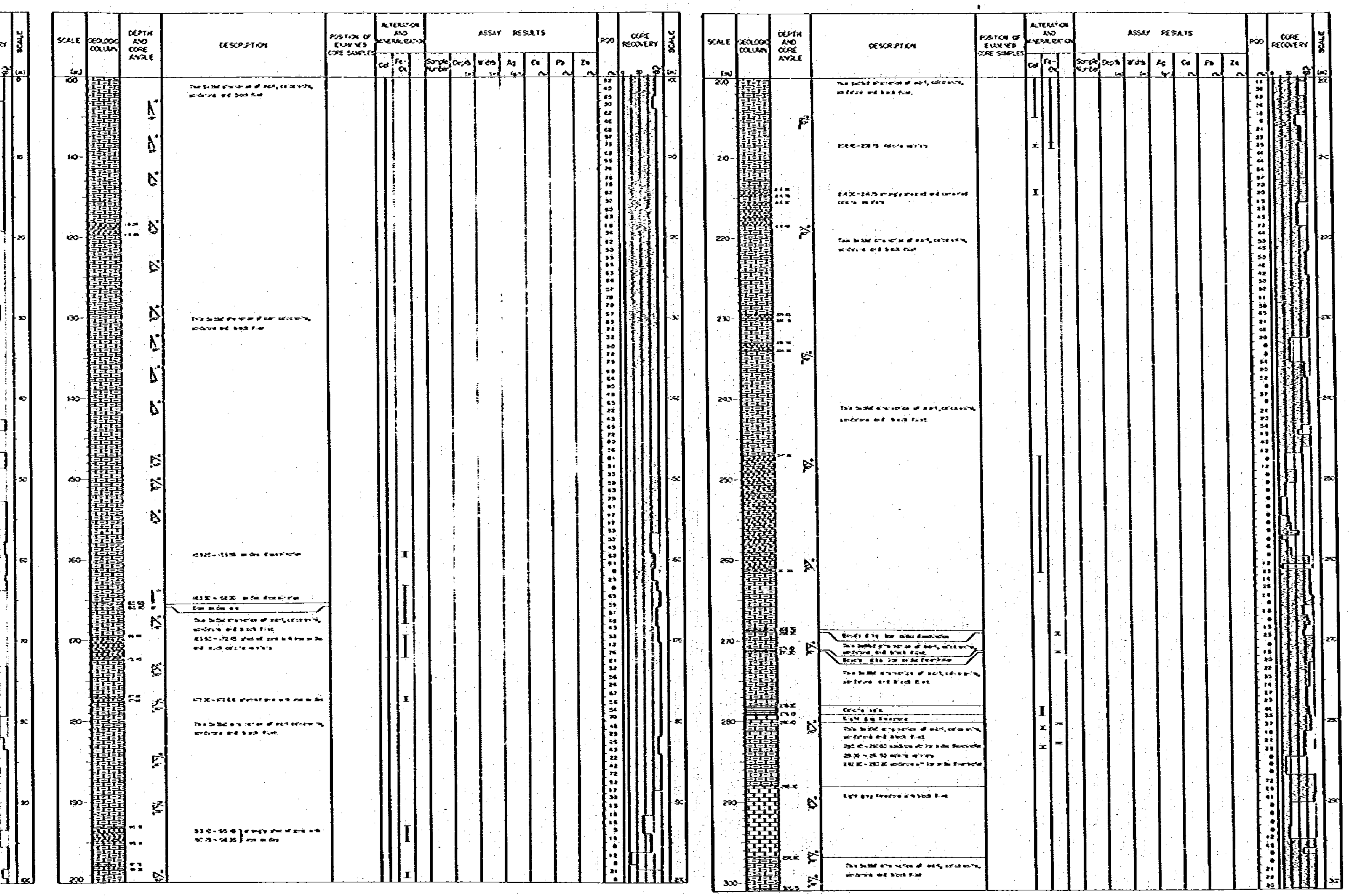
ALTERATION AND MINERALIZATION GRADE

━ Strong
— Medium
- - - Weak

Apx. 7 Geological Log of Diamond Drilling Hole in the SAN CLEMENTE Area (MJM - 3)



Apx. 8 Geological Log of Diamon



DRILL No.	MJM - 4	
DRILL SITE	Coordinate	Altitude
	N 2266245	2357 m
	E 437991	
DIRECTION	—	
INCLINATION	- 90°	
LENGTH	300,75 m	

ABBREVIATIONS

(F) : Fracture
(V) : Vein
(B) : Bedding
Cal : Calcite vein
Fe-Ox : Fe-Oxides

T : Thin section
P : Polished section
M : Chemical analysis of ore

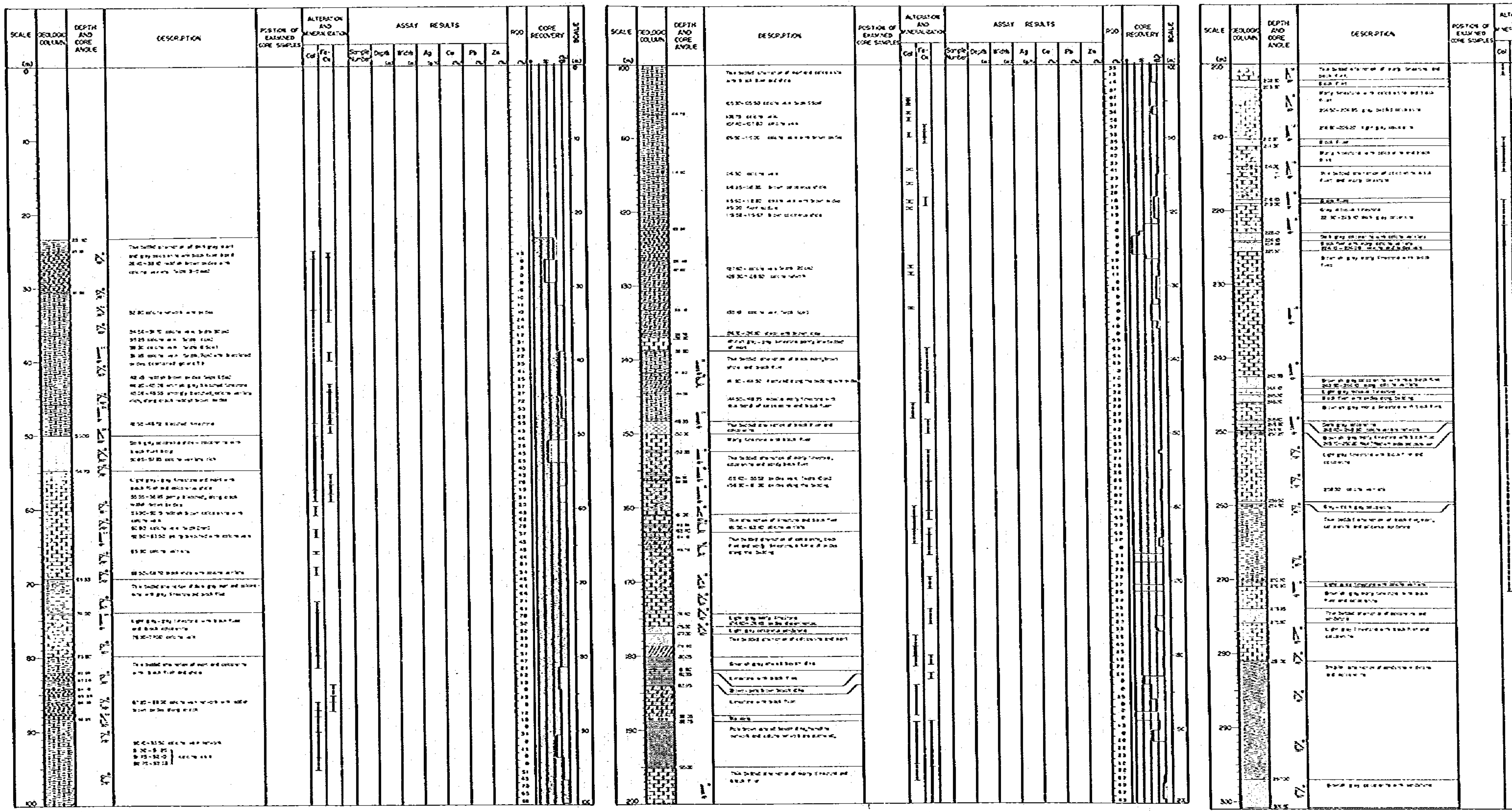
SYMBOL

— Vein
▨ Sheared zone
▩ Strongly sheared zone

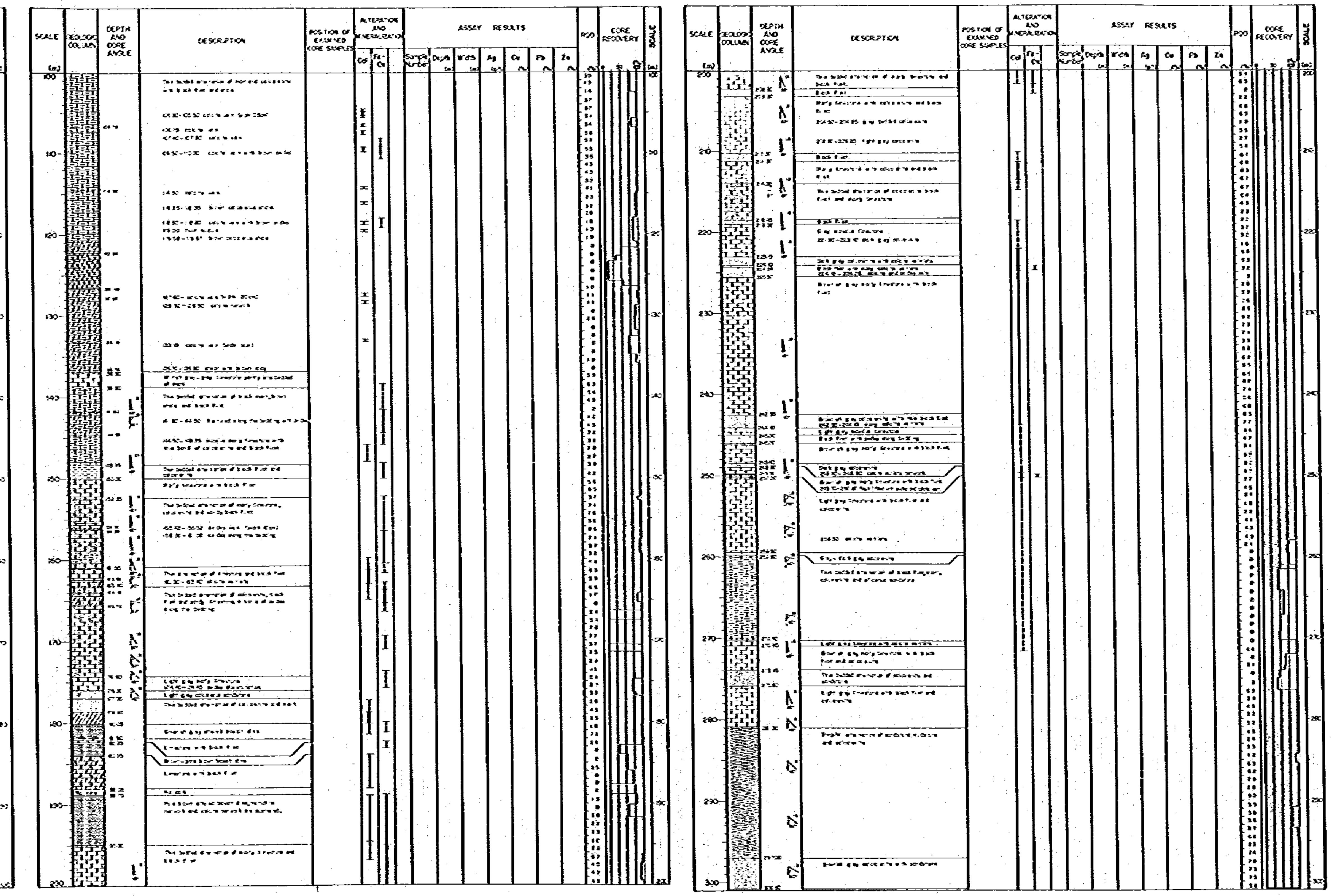
ALTERATION AND MINERALIZATION GRADE

━ Strong
— Medium
---- Weak

Apx. 8 Geological Log of Diamond Drilling Hole in the PROVIDENCIA Area (MJM - 4)



Apx. 9   Geological Log of Di



DRILL No.	MJM-5	
DRILL SITE	Coordinate	Altitude
	N 2286323	2435 m
	E 455502	
DIRECTION	—	
INCLINATION	−90°	
LENGTH	300.80 m	

ABBREVIATIONS

(F) : Fracture
(V) : Vein
(B) : Bedding
Cal : Calcite vein
Fe-Ox : Fe-Oxides

T : Thin section
P : Polished section
M : Chemical analysis of ore

SYMBOL

— Vein
▨ Sheared zone
▩ Strongly sheared zone

ALTERATION AND MINERALIZATION GRADE

━ Strong
— Medium
---- Weak

Apx. 9 Geological Log of Diamond Drilling Hole in the PROVIDENCIA Area (MJM-5)