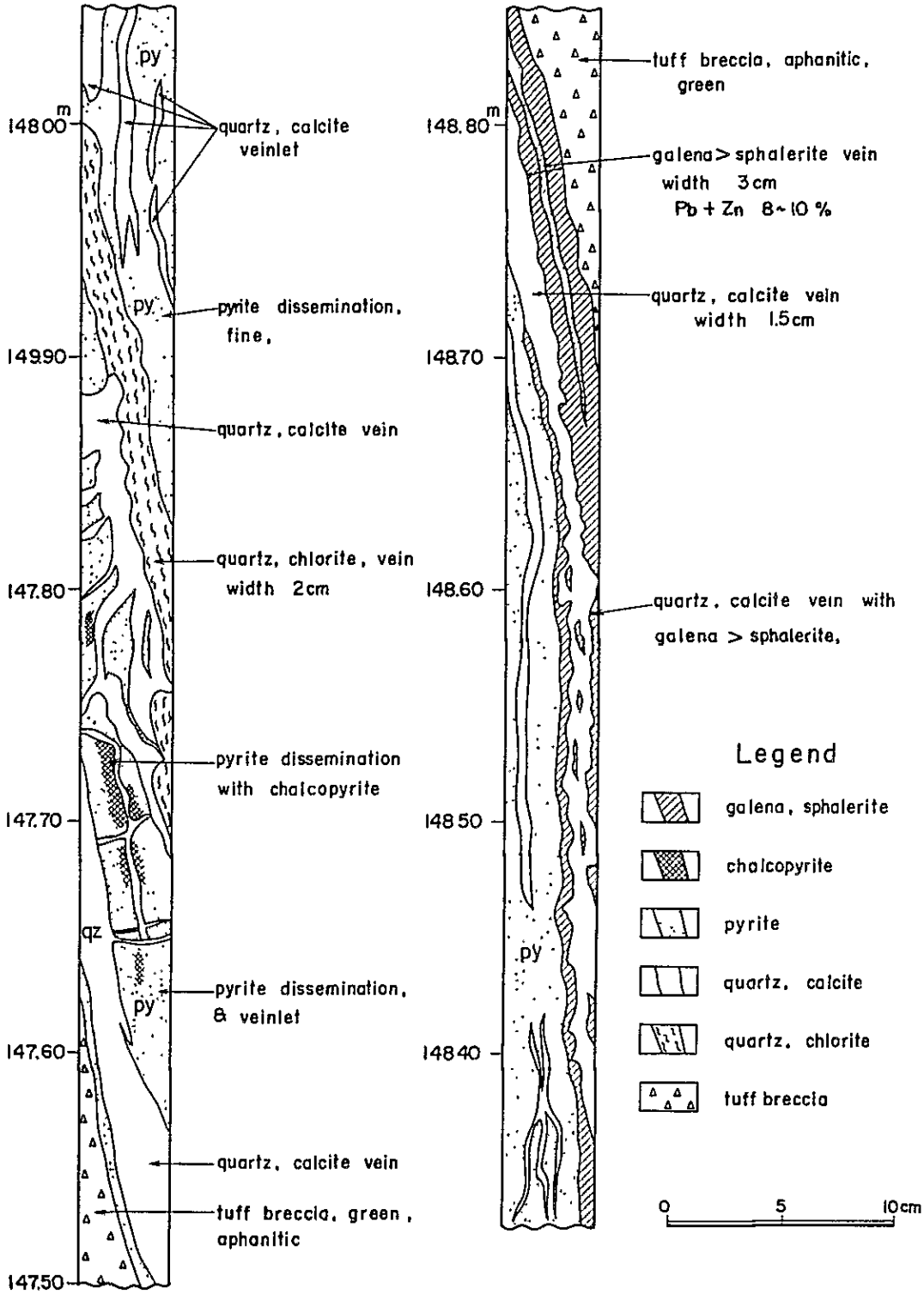
Fig. I-2. Geological sketch of mineral indication in the drill hole No.53-3 (depth 147.50m ~ 148.80m)



3-2-4 Hole No. 53-4 (500.5 m vertical)

(1) Rocks

Down to the depth of 6 m, weathered soil is found. Metamorphosed tuff is recognized from 6 m to 188.8 m of the depth, with two layers of tuff breccia. Schistosity develops well. Further down to the depth of 247 m, welded tuff partly containing insertions of tuff is seen, and the core from there to the bottom comprises alternation of tuff and tuff breccia, with the insertion of banded grey micrograined tuffaceous shale at the depth from 467.6 m to 480 m. Also along 3 m of the length at the depth from 495 m, younger andesitic porphyrite is observed.

(2) Alteration

Sericitization is remarkable all through the core, especially it is intense from the surface to the depth of 250 m. Silicification becomes stronger downwards. Argillization is intense in rather shallow part as at the depth of 150 m. Fracture zones along 3 to 4 m of the length are recognized at the depth of 360 m and 480 m, which are composed of grey clay zone.

(3) Mineralization

In the metamorphosed white tuff at the depth between 90 m and 92 m, dissemination zone of sphalerite and tetrahedrite containing Au 0.76 g/t and Zn 1.84% has been found. In the ore veins contained in the white medium grained metamorphosed tuff at the depth between 108 m and 110 m, chalcocite, chalcopyrite and pyrite are observed, the assay result of which reveals Cu 1.59 % and Zn 0.10 %. The core from 436 m to 486 m of the depth contains comparatively higher grade of zinc, as much as Zn 0.11% in average. This mineralization is found to occur along faults in the alternation of tuff and tuff breccia overlying shale.

3-2-5 Hole No. 53-5 (400.8 m, vertical)

(1) Rocks

Surface soil is down to the depth of 3 m. A dyke of dacitic porphyry is seen at the depth from 3 m to 59.4 m, containing tuffs. This dyke is medium grained, grey to greyish brown aphanitic rock, with less joints. From the depth of 59.4 m to the bottom, the core comprises alternation of tuff and tuff breccia, partly containing welded tuff. Drykes of dacitic porphyry appear along the length of 5 to 6 m at the depth of about 100 m and about 115 m, intruding tuff breccia. Remarkable fracture zones are observed at the depth of 186 m, 247 m, 271 m and 378 m, respectively along 3 to 5 m of th e core length. They are composed mainly of breccias and clays partly associated with limonite. Schistosity is notably seen in wavy form in the tuff at the depth from 160 m to 240 m and from 340 m to the bottom.

(2) Alteration

Silicification, sericitization and argillization are recognized all through the core. Especially, in the part of dacitic porphyry, silicification is remarkable. Intense sericitization is observed notably in the tuff breccia at the depth from 60 m to 100 m and in the tuff at the depth from 345 m to the bottom. The parts where intense argillization is seen are from 190 m to 245 m and from 60 m to 100 m of the depth.

(3) Mineralization

Pyritization is recognized weakly all through the cores. No notable mineralization of copper, lead, zinc etc, nor any part containing high grade of gold have been found. Also, sulphide minerals usually associated with veinlets and fracture zones are not recognized. Mineralization in relation to the dacitic porphyry has not been recognized.

3-2-6 Hole No. 53-6 (300.3 m, vertical)

(1) Rocks

White fine grained aphanitic limestone is seen from the surface to the depth of 121.5 m. This limestone is moderately hard, indistinctly bedded and partly contains oolitic texture. From the depth of 121.5 m to 187.1 m, the core comprises metamorphosed welded tuff, which is grey to dark grey, brecciated or porphyritic, medium grained rock. The boundary to the limestone is an inclined place of 40° to 50°, and comprises a zone along 7 m of the core length where calcite veinlets are developed in network in the aggregate of hematite, chlorite and epidote. It is thought that this is the zone composed of the alteration minerals occuring along the unconformable plane. The part of the core from the depth of 127.1 m to the bottom is composed of metamorphosed andesite partly with the inserted tuff breccia. The metamorphosed andesite is greenish grey porphyritic rock. The groundmass is variable in grain sizes and comprises layers of fine grained part and coares grained part. Phenocrysts are mainly feldspar. The rock is generally aphanitic. Fracture zone is comparatively rare, though there is a fractured andesite at around the depth of 253 m.

(2) Alteration

No skarnization has been recognized in the limestone. It is notable that remarkable chloritization is found in the metamorphic andesite, while silicification and argillization are only slightly recognized in this andesite.

(3) Mineralization

Pyrite has been recognized slightly along the boundary between the limestone and the metamorphosed pyroclastic rocks, but assay result shows not metal element content.

3-2-7 Hole No. 53-7 (300.5 m, vertical)

(1) Rocks

Weathered soil is there down to the depth of 9 m, and from there to the depth of 27.7 m, the core comprises skarnized part composed mainly of garnet (andradite). The part from 27.7 m to 37.0m of the depth is constituted by grey medium grained granodiorite, and the part from 37.0 to 96.2 m of the depth comprises mixture of limestone and skarnized zone. The skarnized zone forms granular and moderately hard mass, and is composed of garnet in the upper part and of garnet and actinolite inthe lower part, while the limestone is whitish grey aphanitic, non-bedded massive rock. The core of the depth from 96.2 m to 115.0 m comprises granite porphyry partly containing skarnized part. The granite porphyry is grey, medium to coarse grained granular rock, containing much of chlorite and feldspar. Along the upper part of the granite porphyry, skarnized portion of epidote has been formed.

Metamorphosed welded tuff has been observed from the depth of 115.0 to 154.1, and further down to the depth of 249.0 m the core comprises alternation of metamorphosed tuff breccia, welded tuff and metamorphosed andesite into which three dykes of diorite porphyrite 4 m to 7 m wide along the core length are seen to have intruded. Dark grey medium grained porphyritic porphyrite is found from 249.0 m to 264.5 m of the depth, which is notably fractured. Further down to the depth of 288.7 m from 264.5 m, there is greyish brown, fine to medium grained dioritic porphyrite with phenocrysts of feldspar, which is obseved to have intruded the metamorphosed andesite.

Limestone appears along 3 m of the core length between 288.7 m and 291.7 m of the depth. This limestone is pale yellow fine grained crystalline limestone, and as it is intensely altered, estimation of age of the formation is difficult. To the depth of 294.7 m from 291.7 m, there is grey granular

tuff, and after remarkable fracture zone along 5 m of the core length, dioritic porphyrite occurs down to the bottom.

Viewing generally, skarnized parts are recognized along the contact zones between limestone and granodioritic porphyry or granite porphyry, and below such parts composition of lithofacies is metamorphosed tuff breccia, welded tuff and porphyrites.

(2) Alteration

The skarnized portion found from the surface to the depth of 105.0 m is composed mainly of garnet in the upper part and mainly of epidote in the lower part. It is possible to elucidate that this is the skarnized zone occurred along the boundary area between limestone and metamorphosed tuff breccia. The skarnized portion down to the depth of 93 m below surface is composed mainly of garnet (andradite) and the green to yellowish green skarnized mass of radial actinolite several mm to 5 cm inlength is recognized to be inserted in the middle part and in the lower part. The garnet forms medium grained, rather hard, granular aggregate, yellowish brown to yellowish grey in color, containing abundant magnetite partly associated with pyrite and chalcopyrite. Epidotization is recognized slightly around the margin of the granodioritic porphyry, while chloritization is observed faintly in the skarnized portion down to the depth of 93 m.

Intense epidotization and chloritization are recognized in the granite porphyry zone. In the pyroclastic rocks, moderate grade of silicification, epidotization and chloritization has been observed and also alteration to form potash feldspar is recognized in the metamorphosed welded tuff. Around the dyke of the porphyrite at the depth of about 260 m, fracture zone develops and another remarkable fracture zone is recognized along 5 m of the core length down from the depth of 290 m.

(3) Mineralization

In the skarnized portion to the depth of 105 m below the surface, mineralization mainly of copper and iron minerals but partly associated with lead and zinc minerals has been recognized. Actinolite skarn mass is generally associated with copper and zinc minerals, while garnet skarn mass usually contains of mineralization obtained in this drill hole are as follows;

The garnet skarn mass from 68 m to 70 m of the depth;

Cu 0.35 %

The garnet skarn mass from 80 m to 82 m to the depth;

Cu 0.09%, Zn 0.68%

The actinolite skarn mass from 86 m to 88 m of the depth;

Cu 0.68 %

The actinolite skarn mass from 90 m to 92 m of the depth;

Cu 1.21 %

Ore minerals are chalcopyrite, sphalerite, magnetite as well as the copper-oxide minerals as covellite and malachite.

3-2-8 Hole No. 53-8 (301.0 m, vertical)

(1) Rocks

Talus sediments containing cobbles of Tertiary volcanic rocks are composing the core from the surface to the depth of 18.1 m. The core from 18.1 m to 156.9 m of the depth comprises dark green medium grained metamorphosed andesite containing phenocrysts of feldspar. To the bottom down from the depth of 156.9 m, alternation of metamorphosed tuff, welded tuff, tuff breccia and metamorphosed andesite has been found, though a dyke of hornblende pyroxene andesite is seen to have intruded them along 1.5 m down from the depth of 199.6 m in addition to the existence of medium to coarse grained light grey mass of granodiorite along 15 m of the core length down

from the depth of 285 m to the bottom.

Fracture zones carrying grey colored breccias about 5 m wide along the core length are found in the metamorphosed andesite, at the depth of about 230 m and about 240 m.

(2) Alteration

Calcitization, epidotization and chloritization are recognized all through the cores. Chloritization is especially remarkable. Silicification is recognized intensely in the part from the depth of 174.2 m to the bottom. Weak hematitization is found in the part from the depth of 20 m to 110 m.

(3) Mineralization

Almost no pyritization has been found, and no remarkable mineralization of chalcopyrite and other ore minerals has been recognized.

Chapter 4 Mineral Indications caught by the Drilling

4-1 Mineral Indications of the Drill Cores

4-1-1 Vueltas del Rio Sector (Refer to PL. II-6, PL. II-7)

1) Indications of copper mineralization confirmed by the diamond drilling are of the following five points;

Hole No.	Depth(m)	Length(m)	Assay results			
			Cu(%)	Zn(%)	Au(g/t)	Ag(g/t)
53-1	96- 98	2	1.28	0.12	-	-
53-1	98-100	2	0.18	-	-	-
53-2	173-174	1	5.94	-	97	80
53-3	104-126	22	0.22	-	-	-
53-4	108-110	2	1.59	0.10	-	-

The mineralized parts are composed of concentration of clay veinlets or calcite veinlets 5 to 10 cm wide, carrying chalcopyrite and pyrite occasionally associated with sphalerite and galena. Sometimes they have some disseminated parts with them.

In the networks of calcite veinlets found at the depth of 106 m of the drill hole No. 53-3, as well as in the networks at the depth of 124 m of the same hole, irregular dot-like association of anhedral chalcopyrite crystals, 0.2 to 0.5 mm often up to 1 mm in diameter, and euhedral pyrite with less amount of sphalerite has been observed. Also, at the depth of 115 m of the same hole, cubic crystals of pyrite and irregular shaped porous chalcopyrite are recognized in quartz vein. At the depth of 124 m of the same drill hole of No. 53-3, euhedral pyrite and irregular shaped chlcopyrite are found along cracks in quartz vein. In the vein at the depth of 148 m of the same hole, paragenesis of pyrite, chalcopyrite, galena, sphalerite and electrum is recognized, where chalcopyrite and

other minerals have filled the space amidst the medium to coarse grained (0.2 to 0.5 mm in diameter) euhedral pyrite. The electrum is associated with galena and appears as dots 0.1 to 0.2 mm in diameter. By the EPMA analysis, it has been confirmed that gold is distributed in dots, forming electrum with silver, along the margin of galena, as well as in the inner part of galena. (Refer to Table I-8, Table of the Results and photomicrographs of X-ray Microanalysis)

Paragenesis of euhedral pyrite, porous chalcopyrite, sphalerite and tetrahedrite has been recognized in the indication of gold copper mineralization found at the depth of 173 m of the drill hole No. 53-2. There, tetrahedrite is contained in irregular shapes in chalcopyrite and pyrite. Also, in the indication of copper mineralization at the depth of 97 m of the drill hole No. 53-1, it is observed that chalcopyrite is associated in irregular shapes along the marginal part of pyrite.

The country rocks containing mineralization are mostly metamorphosed tuff breccia, though occasionally tuff. As for the relation to alteration, the mineralization is found mostly in argillized zone, though generally the parts of mineralization are intensely or moderately sericitized. There is no notable relation of the mineralization to the geological structure. The four drill holes of No. 52-1, No. 52-2, No. 52-3 and No. 52-4, all of which were completed in the last year, are located in the central part of the Vueltas del Rio sector, and the vicinity is composed of metamorphosed tuff, tuff breccia, metamorphosed andesite, green tuff and others. They are extensively altered by sericitization, argillization and carbonatization, but no notable mineralization has been recognized associated with such alteration. There is little difference structurally and lithologically between the geology of the area including last year's drill holes and that of the area where drilling was completed

in the present year, except for the following points; ---- compared to the geology of the area including the drill holes completed in this year, that of the area of last year's drilling can be said to be situated in the northern side of the geochemical gold high anomaly, and to include much more of such rocks as schistosity develops well, which means the rocks are mostly metamorphosed tuffs, in addition that the less amount of limonitization has been found, to mention about alteration.

2) Indications of gold mineralization caught by the drilling are as follows;

Hole No.	Depth(m)	Length(m)	Assay Results				
			Au(g/t)	Ag(g/t)	Cu(%)	Pb(%)	Zn(%)
a) 53-2	6- 8	2	44	-	-	-	-
b) 53-2	173-174	1	97	80	5.94	-	0.19
c) 53-3	46- 48	2	3.34	-	-	-	1.85
d) 53-3	68- 70	2	3.72	-	-	0.15	0.48
e) 53-3	146-150	4	1.3	-	-	0.19	1.78

The indications of gold mineralization are found mainly in the metamorphosed tuff breccia, though partly in the tuff as is the case of copper mineralization. They are in many cases along the boundary of the separated lithofacies. As for alteration, the mineralization is seen in such zones as those intensely sericitized and argillized. These indications of gold mineralization are located, in small distance, south of the limit of the geochemical gold high anomaly. The relation of these indications to the geological structure is not certain.

3) Indications of zinc mineralization confirmed by the drilling are as follows;

Hole No.	Depth(m)	Length(m)	Assay Results
a) 53-1	6- 16	10	Zn 0.15 % in average
b) 53-2	6- 32	32	Zn 0.11 % in average
c) 53-3	40- 84	44	Zn 0.22 % in average
d) 53-3	46- 48	2	Zn 1.85 %, Au 3.34 g/t
e) 53-3	146-150	4	Zn 1.78 %, Au 1.3 g/t
f) 53-4	90- 92	2	Zn 1.84 %, Au 0.76 g/t
g) 53-4	436-486	50	Zn 0.11 % in average

These indications of zinc mineralization are found mainly in the metamorphosed tuff, metamorphosed welded tuff and metamorphosed tuff breccia. Also, these indications are associated sometimes with intense sericitization, sometimes with carbonatization and with argillization. There seems to be no definite relation between alteration and such indications of zinc mineralization. Under microscope (Table I-2, sample No. 4090), paragenesis of pyrite, sphalerite, tetrahedrite and chalcopyrite has been recognized in a sample collected at the depth of 90 m of the drill hole No. 53-4. There, pyrite appears in granular form, replacing tetrahedrite and sphalerite partly. Sphalerite micro-crystals are also found contained in tetrahedrite in dots-like forms, while chalcopyrite contains irregular grains of tetrahedrite.

4-1-2 Minitas Sector

1) Indications of skarnization confirmed by the drilling are as follows;

Aggregates of skarn minerals of hematite, chlorite and epidote are found associated with calcite veinlets along the contact zone between limestone and underlying metamorphosed welded tuff, along the core length of 7 m down from the depth of 121 m of the drill hole No. 53-6, though only slight mineralization has been recognized.

Another skarnized portion has been found along 90 m of the core length from the depth of 6 m to 96 m of the drill hole No. 53-7, where skarnized zones containing quartz, calcite, dolomite and chlorite in addition to garnet, actinolite and epidote are recognized with the insertions of limestone and granite porphyry. Ore minerals are chalcopyrite, sphalerite, galena, magnetite as well as pyrite, hematite, siderite and copper-oxide minerals.

2) Indications of copper mineralization confirmed by the drilling are as follows;

Hole No.	Depth(m)	Length(m)	Skarn mineral	Assay Results
53-7	68-70	2	andradite	Cu 0.35 %
53-7	80-82	2	andradite	Cu 0.09 %, Zn 0.68%
53-7	86-88	2	actinolite	Cu 0.68 %
53-7	90-92	2	actinolite	Cu 1.21 %

Under microscope (Table I-2, sample No. 7087), paragenesis of pyrite and chalcopyrite with less amount of hematite has been recognized in the indication of copper iron mineralization froun at the depth of 87 m of the drill hole No. 53-7, where euhedral pyrite has been replaced by chalcopyrite in micro-grained crystals. Also, the indication of copper iron mineralization found at the depth of 91 m of the same hole of No. 53-7 is composed of chalcopyrite, magnetite and hematite, in addition to chalcocite which occurs in the space amidst the aforesaid ore minerals and along the marginal part of such minerals. Hematite is recognized in foliated form to have filled irregularly the space amidst the magnetite grains, while chalcopyrite is seen to have filled the cracks and the cleavages found in magnetite grains. (Refer to Table I-2, Sample No. 7091).

4-1-3 Summary of the Mineralization, in Relation to Appraisal

Characteristics of the indications of mineralization found in the Vueltas del Rio sector are summarized as follows;

a) Many indications of mineralization mainly of copper and gold with some zinc, silver and lead ore minerals have been discovered.

b) They are vein type, network type and disseminated type mineralization, found mostly in the metamorphosed tuff breccia as well as in the metamorphosed tuff. (Mineralization is less found in the part where apparent schistosity develops well).

c) The mineralization has been recognized mostly in the intensely sericitized parts, though it is associated with argillization and with silicification.

d) The mineralization has been found much in the beds, in which fractures are developed to a certain degree, and also in the parts where variation of lithofacies has been recognized, though the relation of the mineralization to fractures and lithological structures is not certain in detail.

e) The actual relation of the mineralization to the dykes such as dacitic porphyry, quartz porphyry and younger andesite has not been confirmed. Its relation to the extensive geological structure has been left uncertain.

f) The depth of the mineralized parts has been turned out to be mostly in the shallow part down to 150 m below surface, which shows that most of the mineralization is contained in the surface oxidation zone and in the secondary enrichment zone.

Characteristics of the indications of mineralization found in the Minitas sector are summarized as follows;

a) Along the contact zones between limestones and metamorphosed igneous rocks, only such skarnized portions as composed of chlorite and epidote can be found, and only slight mineralization has been recognized associated with such skarnized portions.

b) Skarnized portions composed of garnet and actinolite are observed to be associated with copper, lead and zinc mineralization, along the contact zones between limestones and granite porphyry. However, copper mineralization covering whole skarnized portion or extending outwards to the margin of the skarnized portion has not been recognized, which is similar in characteristics to the mineralization found in the Macutalo area.

c) Extensive and high grade mineralization can not be expected in a single unit of limestone or metamorphosed igneous rocks.

d) The condition to form skarn type ore deposits in this area is thought to be the combination of granite porphyry and limestone in addition to the development of fracture zones or fault zones of the directions of NW-SE, WNW-ESE and E-W.

4-2 Relation of the Geology of the Drill Cores to the Geological Structure

4-2-1 Vueltas del Rio Sector

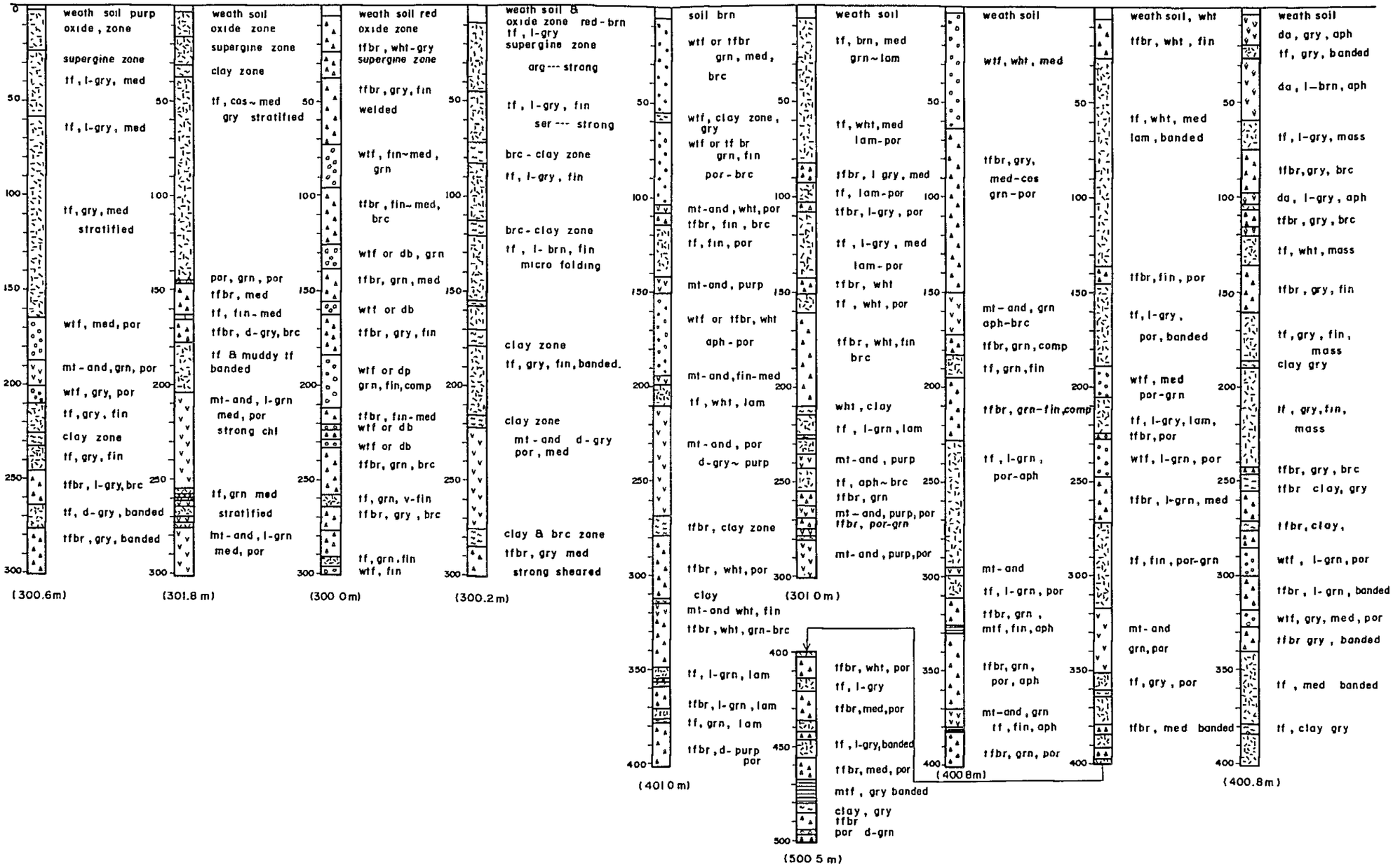
a) The outline of the geology in this area has been illustrated on the profile (Refer to Pl. I-5), by the information of the surface geology and by the data obtained through the drilling carried out in the present year, in addition to the results of the re-logging of the cores from the drill holes performed in the last year. (Refer to Fig. I-3)

Through the consideration in the way to take the metamorphosed andesite to be a key bed, though it is extremely difficult to correlate the stratigraphical units of each drill hole like tuff breccia etc., it has been confirmed by the diamond drilling that a synclinorium is recognized in this area, with the axis of the direction of east-west. The drill holes No. 53-3 and No. 53-2, located in the southern part of this area, are positioned in the area occupied by east-west trending metamorphosed tuff breccia and metamorphosed tuff,

Fig. I-3 SAMMARY OF CORE LOG IN THE VUELTAS DEL RIO SECTOR

(No.52-1 ~ No.52-4)
1977 year

(No.53-1 ~ No.53-5)
1978 year



Symbol &
Origina Rc

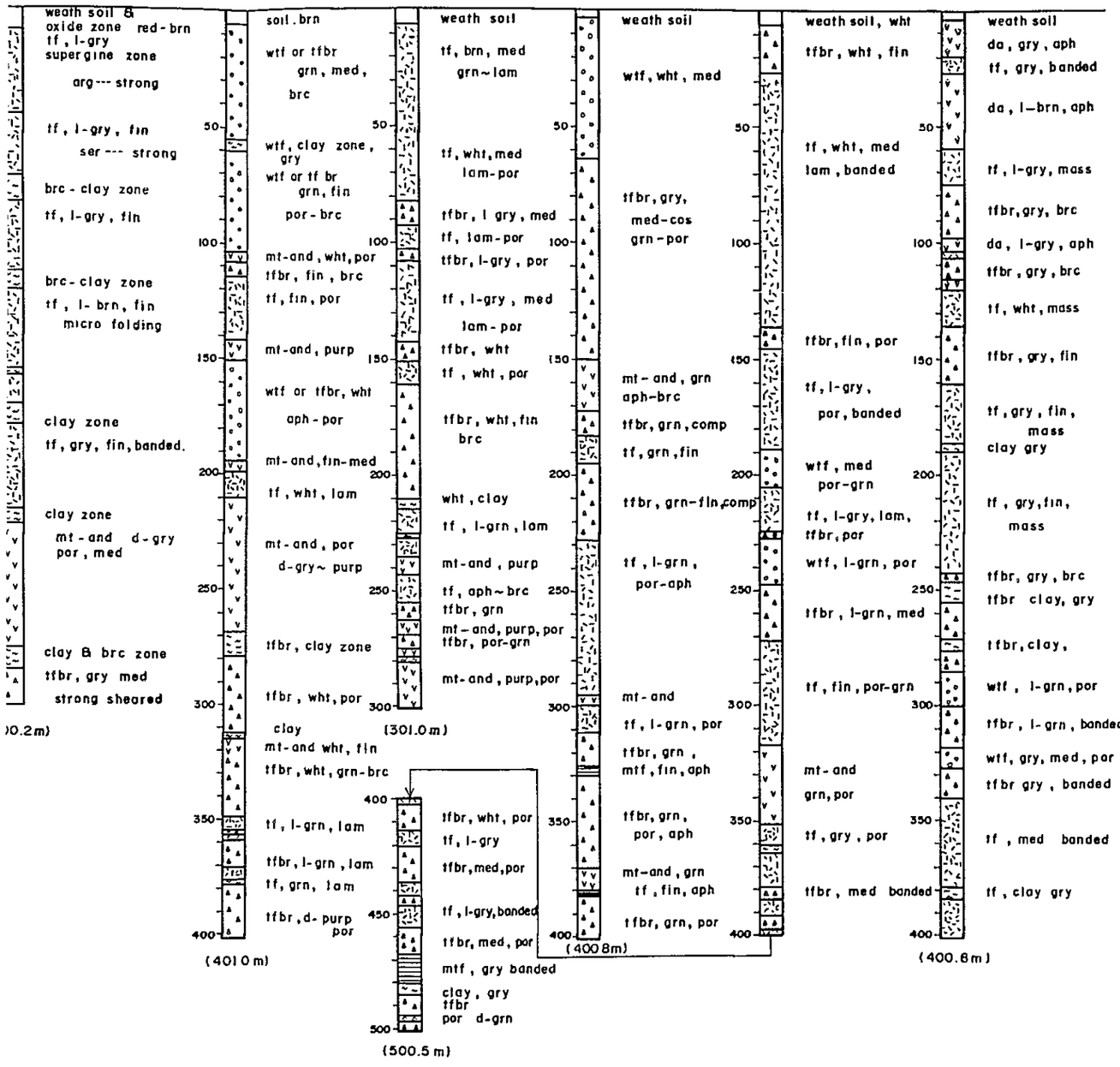
Texture

Grain si

RY OF CORE LOG IN THE VUELTAS DEL RIO SECTOR

(No.53-1 ~ No.53-5)

1978 year



INDEX

Symbol & Origina Rock

	soil	soil
	mt-and	meta andesite
	tf	tuff
	tfbr	tuffbreccia
	wtf	welded tuff
	cht mtf	chert & muddy tuff
	db	diabase
	por	porphyrite
	da	dacite porphyry
		clay zone

Texture

aph	aphanitic
band	banded
brc	brecciated
grn	granular
lam	lamella
por	porphyritic

Grain size

v-fin	very fine
fin	fine
med	medium
cos	coarse

Phenocryst

cal	calcite
chl	chlorite
cly	clay
fd	feldspar
hb	hornblende
qz	quartz

Color

d	dark
l	light
blk	black
brn	brown
grn	green
gry	grey
purp	purple
wht	white
yel	yellow

0 40 80 120 160 200m

with the insertions of metamorphosed andesite, which are dipping to the north. This metamorphosed andesite, though it appears in the drill hole No. 53-4 located in the north, with the change of dipping, that is, to the south, is seen again dipping to the north in further northern area. The metamorphosed andesite is recognized to be existing in the northern area beyond the location of the drill hole No. 53-5. All of the above evidences will compose the elucidation, without any conflict, that there is a synclinorium in this area.

b) Remarkable faults and fractures are recognized in the lower parts of the metamorphosed andesite and also in the lower part of the fine grained tuffaceous shale, and no notable faults or fractures have been found in the metamorphosed tuff and in the tuff breccias.

c) As for alteration, remarkable argillization and sericitization are recognized well, but they are rarely found at the depth. Intense sericitization has been found in the shallow part down to the depth of 200 m below surface. So is the case of the argillization. Generally the oxidation zone reaches the depth of over ten meters to several ten meters while alteration zone white in color by argillization, carbonatization and sericitization is recognized to extend generally as deeply as 150 m, which is thought to be supergene alteration zone.

4-2-2 Minitas Sector (Refer to Fig. I-4)

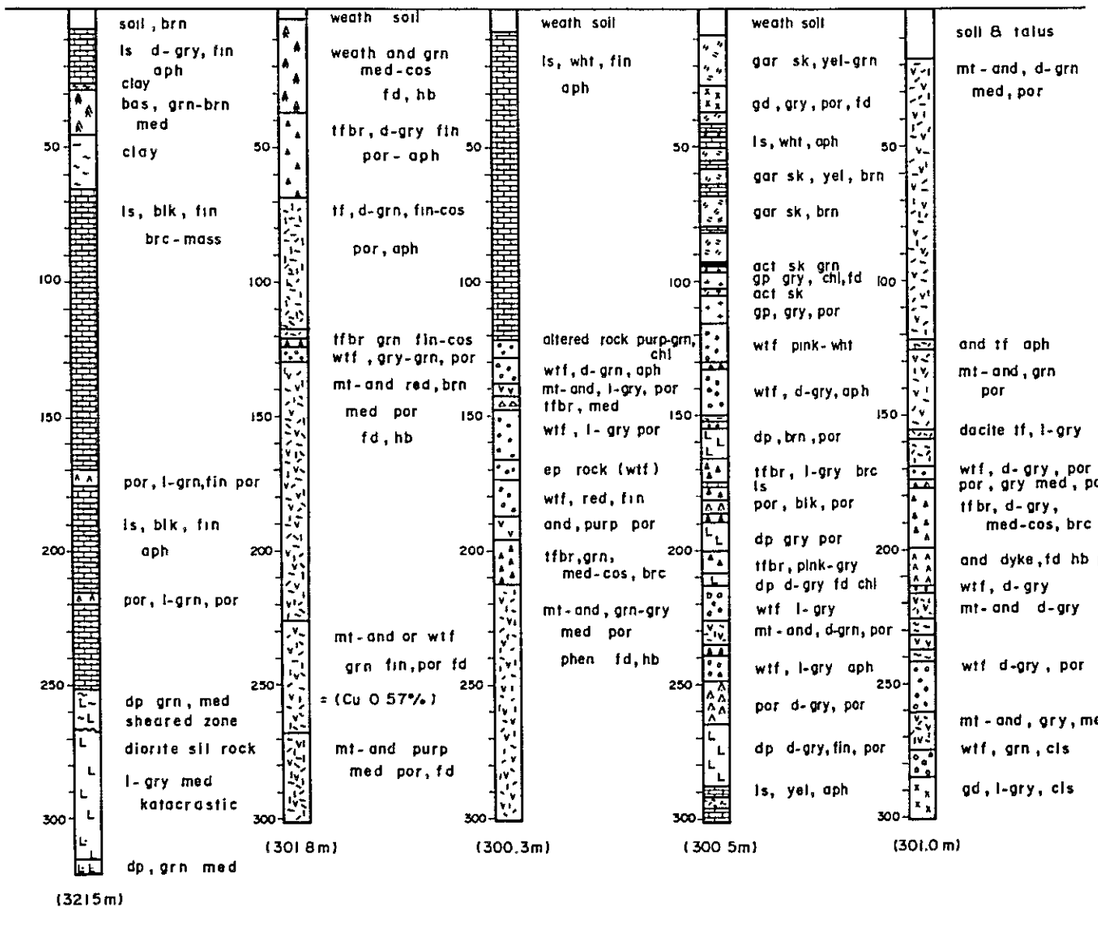
a) Precise subdivision of the metamorphosed igneous rocks into metamorphosed andesite, metamorphosed welded tuff metamorphosed tuff breccia, dioritic porphyrite and others was performed and their mutual relation has been analysed. It is impossible to presume the structural relation of the geology of the drill holes due to the distance of the holes one another.

b) Igneous rocks are classified into the rocks metamorphosed older volcanic rocks and the rocks dykes of granite porphyry accompanying skarn

Fig.I-4 SUMMARY OF CORE LOG IN THE MINITAS SECTOR

(No.52-5 ~ No.52-6)　　No.53-6 ~ No.53-8

1977 year　　1978 year



INDEX

Symbol & Original Rock

soil wth	soil & weathered rock	
bas	basalt	
ls	limestone	
tf	tuff	
mt and	mata andesite	
wtf	welded tuff	
tfbr	tuffbreccia	
and	andesite	
por	porphyrite	
dp	diorite porphyry	
gp	granite porphyry	
gd	granodiorite	
sk	skarn	
	clay zone	

Color

d	dark
l	light
blk	black
brn	brown
grn	green
gry	grey
purp	purple
wht	white
yel	yellow

Remark

act	actinolite
and	andesite
bas	basalt
brc	breccia
ep	epidote
gar	garnet

Texture

aph	aphanitic
brc	brecciated
cls	cataclastic
coll	colloid
grn	granular
por	porphyritic
sac	saccharoidal

Grain size

vfin	very fine
fin	fine
med	medium
cos	coarse

Phenocryst

chl	chlorite
fd	feldspar
hb	hornblende
px	pyroxene
qz	quartz

0　40　80　120　160　200m

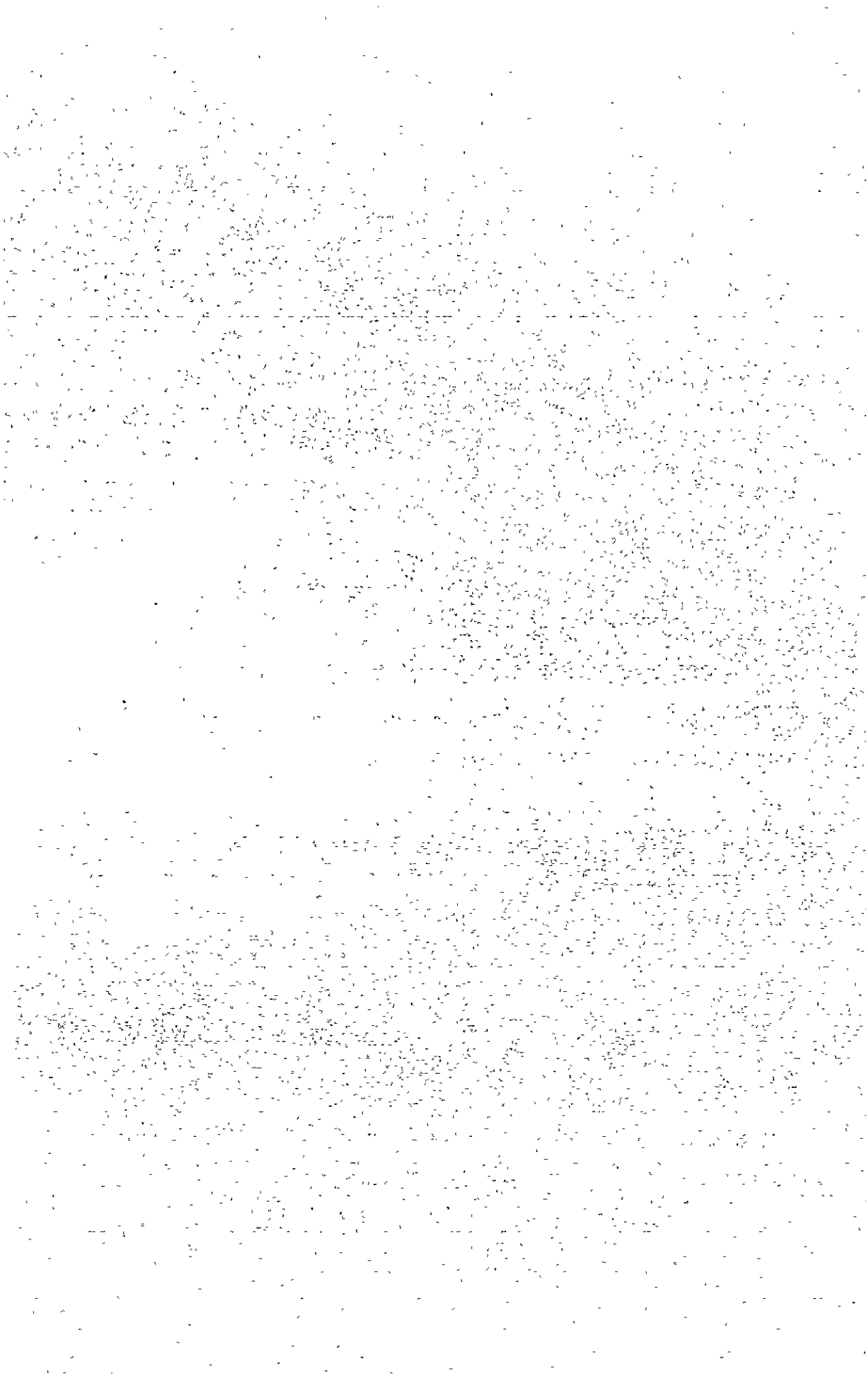
minerals, and the rocks which carries no skarnization or is uncertain whether it carries skarnization or not, such as dioritic porphyry. (Younger andesite is ommitted)

The period of activity of the latter is estimated to be older than the sedimentation of the Atima Formation, but it has not been confirmed with evidence.

c) In the lower part of the drill cores, containing skarnized portion and the portion intruded by the granite porphyry as is the case of the drill hole No. 53-7, there are many other dykes such as those of dioritic porphyry. However, dykes are rare in and around the drill hole composed of the cores constituted by such metamorphosed igneous rocks as those without any relation to the mineralization, as well as in the area where the metamorphosed igneous rocks are monotonously in contact with limestone. This evidence would show the facts that the structurally complicated area at present might have been unstable through the geological age, having tendency easily to form the block to be mobilized by tectonic movement, and that such structurally unstable area might have supplied favorable place in the past for the selective emplacement of mineralization.

d) The limestone which appeared along 3 m of the core length at the depth of about 290 m of the drill hole No. 53-7 is yellow micritic limestone, and it is too difficult to determine whether it belongs to the Atima Formation or to the Paleozoic metamorphic rocks. If it would belong to the Atima Formation, it is thought that the evidence would show the result of the transition of the Atima Formation to appear in the lower part by a supposed tectonic fault existing around the drill hole No. 53-7. Also, if it would be the limestone contained in the Paleozoic metamorphic rocks, it is thought that the metamorphosed igneous rocks would have caught and brought this block of the older limestones up to that part seen at present, but in this latter case it might be thought to be natural that xenolithes

of such Paleozoic rocks as black schists or mica schists could be found near there or that some surface exposures of the metamorphic rocks could be found in the vicinity area. In any way, further study will be expected to determine the geological position of this limestone.



APPENDICES

PART I GEOLOGICAL SURVEY

Table I—1 List of rock samples

(1)

Sample No.	Location (Sector)	Rock name	Thin Section	Polished Section	EPMA	X-ray	Remarks
0201	Vueltas del Rio	Quartz porphyry	○				
0202	"	Quartz porphyry	○				
0203	"	Quartz porphyry	○				
0204	"	Tuff breccia	○				
1601	"	Altered andesite	○				
62102	"	Cristal vitric tuff	○				
62201	"	Meta tuff (breccia)	○				
62205	"	Silicified tuff	○				
70010	"	Carbonatized tuff	○				
70011	"	Silicified tuff	○				
70012	"	Silicified rock (tuff)	○				
70306	"	Silicified tuff	○				
71201	"	Silicified tuff	○				
71502	"	Andesite	○				
71504	"	Tuff breccia	○				
0504	Laguna Seca	Liparite	○				

Sample No.	Location (Sector)	Rock name	Thin Section	Polished Section	EPMA	X-ray	Remarks
0514	Laguna Seca	Porphyrite	○				
80808	"	Silicified tuff (?)	○				
80903	"	Porphyrite	○				
81102	"	Granodiorite porphyry	○				
81105	"	Welded tuff (?)	○				
81406	"	Porphyrite	○				
0401	Minitas	Porphyritic granodiorite	○				
2202	"	Tuff breccia	○				
2205	"	Altered andesite	○				
2206	"	Aplitic rock	○				
71705	"	Fe-altered rock	○			○	No. 53-7 SSE 250 m
71803	"	(Altered) andesite	○				
71902	"	Coarse granodiorite	○				
72807	"	Silicified rock with Cu-Veins	○	○			Qda. Minitas outcrop
80205	"	Iron ore		○		○	No. 53-7 Skarn outcrop
80306	"	Iron ore	○	○		○	Macutalo outcrop
1901	Pueblo Nuevo	Garnet skarn	○				
1902	"	Altered andesite	○				

Sample No.	Location (Sector)	Rock name	Thin Section	Polished Section	EPMA	X-ray	Remarks
81806	Pueblo Nuevo	Granodiorite	○				
81810	"	Altered andesite	○				
81901	"	Limestone with Cu ore				○	Santa Ines old pit
82405	"	Conglomerate	○				
82409	"	Fe-Cu-Zn ore		○		○	Santo Domingo old pit
82601	"	Carbonaceous conglomerate	○				
82905	"	Porphyrite	○				
90601	"	Granite porphyry	○				
1026	Vueltas del Rio DDH. No 53-1	Tuff breccia	○				
1050	"	Tuff				○	
1068	"	Tuff breccia	○				
1095	"	Tuff breccia	○				
1097	"	Fe-Cu-Zn ore		○		○	No. 53-1 depth 97m, width 10 cm ccp, py vein
1161	"	Tuff (?)	○				
1246	"	Welded tuff	○				
1371	"	(Welded ?) tuff	○				
1386	"	Tuff	○				

Sample No.	Location (Sector)	Rock name	Thin Section	Polished Section	EPMA	X-ray	Remarks
2050	Vueltas del Rio DDH. No 53-2	Tuff				○	
2085	"	Silicified tuff	○				
2128	"	Silicified tuff	○				
2173	"	Tuff breccia	○	○		○	X-ray diffraction 2173A tuff breccia 2173B cp, py ore
2256	"	Tuff breccia	○				
2276	"	Altered andesite	○				
3020	Vueltas del Rio DDH. No 53-3	Welded tuff				○	
3050	"	Welded tuff				○	
3057	"	Welded tuff				○	
3106	"	Tuff breccia		○			
3115	"	Tuff breccia	○	○			
3124	"	Tuff breccia	○	○			No. 53-3 depth 124 m, cp, py, diss
3148	"	Tuff breccia with Pb-Cu ore		○	○		No. 53-3 depth 148 m, cp, gn, sp, py vein
3167	"	Tuff breccia	○				
3211	"	Tuff breccia	○				
3340	"	Tuff breccia	○				
3360	"	Tuff breccia	○				

Sample No.	Location (Sector)	Rock name	Thin Section	Polished Section	EPMA	X-ray	Remarks
4068	Vueltas del Rio DDH. No 53-4	Tuff				○	
4083	"	Silicified tuff	○			○	
4090	"	Tuff		○		○	No. 53-4 depth 90 m, sp, cp, veinlet
4152	"	Tuff of Altered andesite	○				
4221	"	Tuff	○				
4283	"	Silicified tuff	○				
4332	"	Tuff breccia	○				
4340	"	Tuff breccia	○				
4440	"	Tuff	○				
4475	"	Tuff	○				
4495	"	Porphyrite	○				
5007	Vueltas del Rio DDH. No 53-5	Dacite porphyry				○	
5050	"	Dacite porphyry				○	
5056	"	Dacite porphyry				○	
5072	"	Dacite porphyry				○	
5098	"	Pyrite vein	○	○		○	No. 53-5 depth 98 m, py vein
5101	"	Silicified rock	○				
5128	"	Tuff	○				

Sample No.	Location (Sector)	Rock name	Thin Section	Polished Section	EPMA	X-ray	Remarks
5160	Vueltas del Rio DDH. No 53-5	Silicified tuff	○				
5291	"	Altered tuff breccia	○				
5318	"	Tuff	○				
5397	"	Altered tuff	○				
5400	"	Tuff	○				
6111	Minitas DDH. No 53-6	Crystalline limestone	○				
6122	"	Tuff breccia (?)	○				
6172	"	Epidote skarn	○				
6191	"	Andesite	○				
6218	"	Andesite	○				
6274	"	Porphyrite	○				
7082	Minitas DDH. No 53-7	Garnet skarn	○			○	No. 53-7 depth 82 m gar sk with cp, mela, mg
7087	"	Garnet actinolite skarn	○	○			
7091	"	Garnet skarn	○	○		○	No. 53-7 depth 91 m gar act sk with cp, sp, mg
7095	"	Epidote fluorite skarn	○			○	No. 53-7 depth 95 m ep sk
7110	"	Porphyritic granodiorite	○				
7113	"	Epidote skarn	○			○	
7115	"	Epidote skarn	○				

Sample No.	Location (Sector)	Rock name	Thin Section	Polished Section	EPMA	X-ray	Remarks
7152	Minitas DDH. No 53-7	Porphyrite	○				
7156	"	Porphyritic diorite	○				
7163	"	Altered andesite	○				
7242	"	Altered andesite	○				
7283	"	Meta andesite	○				
8115	Minitas DDH. No 53-8	Meta andesite	○				
8167	"	Altered andesite	○				
8185	"	Tuff breccia	○				
8255	"	Meta andesite	○				
8300	"	Granodiorite	○				
							Au : gold
							cp : chalcopyrite
							diss : dissemination
							ep : epidote
							gar : garnet
							gn : galena
							mg : magnetite
							mala : malachite
							sk : skarn
							sp : sphalerite
							py : pyrite

Table I—2 Microscopic observations

(1) Thin sections of rock samples, Vueltas del Rio, Laguna Seca, Minitas and Pueblo Nuevo Sector

(2) Thin sections of drill cores, Vueltas del Rio and Minitas Sector

(3) Polished sections of ore minerals, Vueltas del Rio, Minitas and Pueblo Nuevo sector

(1) Thin sections of rock samples, Laguna Seca, Minitas, and Pueblo Nuevo Sector

(1)

Sample No.	Location	Formation	Rock Name	Microscopic Observation
0201	Vueltas del Rio Qda. Las Minas	Intrusive rock	Quartz-porphyry	The rock shows porphyritic texture with calcite vein (0.2 mm in width). Phenocrystic minerals are quartz, plagioclase and K-feldspar. Mafic minerals cannot be found in the specimen. Quartz shows corroded form and up to 1 mm in size. Plagioclase shows subhedral and moderately affected by carbonatization and sericitization. K-feldspar shows subhedral and Carlsbad twinning. The grained size of feldspars is up to 0.5 mm. Matrix is composed of fine grained (0.02 mm) felsic mineral and secondary sericite. In places, calcite in vein is suffered of iron-alteration.
0202	Vueltas del Rio Qda. Las Minas	Intrusive rock	Quartz-porphyry	This is porphyritic in texture and mainly composed of quartz, plagioclase, K-feldspar and secondary chlorite. Quartz shows corroded form and weakly wavy extinction. (up to 2.0 mm in size). Plagioclase shows subhedral and albite twinning. K-feldspar shows subhedral and Carlsbad twinning. The feldspars are weakly affected by carbonatization and sericitization, and up to 1.0 mm in length. Chlorite, by which biotite might be replaced, shows lath-like form and is accompanied by magnetite. Matrix is composed of fine grained (0.02 mm) felsic mineral and moderately affected by chloritization. In places, acicular plagioclase is found Other accessory mineral is fine grained apatite.
0203	Vueltas del Rio Qda. Las Minas	Intrusive rock	Quartz-porphyry	The rock shows porphyritic texture. Phenocrystic minerals are quartz, plagioclase and K-feldspar. Mafic mineral cannot be found and may be replaced by carbonates. Quartz (up to 1.5 mm) shows corroded form and wavy extinction. Plagioclase is subhedral (up to 1.0 mm) and shows albite twinning. K-feldspar is subhedral to anhedral in form (up to 1.0 mm) and shows Carlsbad twinning. Matrix is composed of fine grained (0.02 mm) felsic mineral and suffered of very weak chloritization. Other accessory minerals are apatite, sphene and opaque minerals.
0204	Vueltas del Rio Qda. Las Minas	Vueltas del Rio Formation	Meta tuff-breccia	It has many porphyritic fragments. Matrix is composed of fine grained (0.01 mm) recrystallized felsic minerals. In part the boundary between fragment and matrix is not clear. Porphyritic fragments are suffered of chloritization and carbonatization in fragments by fragments. The size is about 50 mm to 0.2 mm. Crystal fragments as plagioclase and quartz occur in parts about 0.2 mm in size. Matrix is holocrystalline and made of fine felsic minerals and opaque minerals.

Sample No.	Location	Formation	Rock Name	Microscopic Observation
1601	Vueltas del Rio No 53-5 NWW 650 m	Vueltas del Rio Formation	Altered andesite	This is porphyritic in texture and composed mainly of plagioclase. Mafic minerals are perfectly replaced by chlorite. Plogioclase shows euhedral to subhedral and albite twinning. The grained size is up to 2.0 mm and about An 35 in content. Plagioclase is affected by strong carbonatization and chloritization along the clacks of crystal. Matrix is composed of lath shaped plagioclase (up to 0.2 mm), fine opaque minerals and chloritized glass.
62102	Vueltas del Rio El Coyol	Vueltas del Rio Formation	Crystal vitric tuff	The rock is all over affected by strong chloritization and slight sericitization. It is composed of phenocrystic plagioclase and chloritized glass. Plagioclase shows subhedral and is strongly suffered of chloritization and sericitization (up to 1.5 mm). Matrix is made of chloritized glass and fine grained opaque minerals.
62201	Vueltas del Rio Qda. Las Minas	Vueltas del Rio Formation	Meta tuff (breccia)	This is holocrystalline rock but is thought to be recrystallized. In parts, porphyrite fragment-like texture can be observed. In porphyrite fragment, porphyritic plagioclase (up to 1.0 mm) and lath shaped plagioclase (about 0.05 mm) are observed with fine magnetite. The boundary between fragment and matrix is not clear. Matrix is composed of fine grained (0.02 mm) felsic minerals and suffered of moderate sericitization and chloritization.
62205	Vueltas del Rio Qda. Las Minas	Vueltas del Rio Formation	Silicified tuff	The rock is composed of quartz, carbonate, sericite, opaque minerals and a few amount of layered structure. Quartz shows anhedral and very fine grain (0.01 mm). Sericite shows fine acicular form and layered structure. Euhedral carbonate is scattered in the sample and up to 0.05 mm. Also, opaque minerals are scattered and it may be pyrite.
70010	Vueltas del Rio DDH. No 53-5 NW 700 m	Vueltas del Rio Formation	Carbonatized tuff	The rock is composed of quartz, feldspars, carbonate, sericite and chlorite. It is suffered of strong carbonatization and weak sericitization. Texture is not clear by the strong alteration. All of minerals shows anhedral and very fine grained size (0.02 mm). A few amount of opaque minerals occure.
70011	Vueltas del Rio DDH. No 53-5 NWW 500 m	Intrusive rock (?)	Silicified tuff	This is composed of anhedral fine grained felsic minerals, acicular sericite and iron oxide (hematite). The grained size of crystals are about 0.01 ~ 0.03 mm. In parts, layered structure of sericite aggregate is found as patched form. It suggests to be tuff fragment originally. Then, the rock may be silicified tuff or tuff breccia.

Sample No.	Location	Formation	Rock Name	Microscopic Observation
70012	Vueltas del Rio DDH. No 53-5 NWW 800 m	Intrusive rock (?)	Silicified rock (tuff)	The rock shows granular texture and composed of quartz and sericite. It is affected by strong silicification and sericitization. So, it is difficult to judge the original rock. The grained size of quartz is very changeable from 0.01 mm to 0.1 mm. In parts, medium grained crystals quartz show aggregated form, and it may be tuff fragments, originally. Sericite shows acicular and aggragated form.
70306	Vueltas del Rio DDH. No. 53-5 NEE 400 m	Vueltas del Rio Formation	Silicified tuff	The rock is affected by strong sericitization and silicification. Original rock may be the same as the above mentional No. 70011. But, sericitization is stronger than the above, and sericite shows acicular form and layered structure. Crystal size of all minerals is up to 0.03 mm. Other accessory mineral is dispersed opaque mineral.
71201	Vueltas del Rio DDH. No 53-5 NE 400 m	Intrusive rock (?)	Silicified tuff	This is the same mineral assemblage and texture as the above mentioned No. 70306. Layered structure is clearer than the above. So, it may be originally tuff and has been suffered of silicification and sericitization.
71502	Vueltas del Rio Qda. Las Minas	Intrusive rock	Andesite	This is porphyritic in texture and mainly composed of plagioclase (euhedral to anhedral, 1.0 x 0.3 - 0.2 x 0.1 mm), secondary calcite (subhedral to anhedral, 2.3 x 2.0 - 0.2 x 0.1 mm) and groundmass. Plagioclase shows Carsbad and Albite twinning. In parts, the inside of phenocrystic plagioclase grains are suffered of chloritization and carbonatization. The groundmass shows weakly fluidal texture and is composed of acicular plagioclase (up to 0.1 mm) and fine grained quartz (up to 0.1 x 0.05 mm). Matrix suffered of moderate chloritization. Opaque mineral (perhaps iron oxides) are dispersed in the rock.
71504	Vueltas del Rio Qda. Las Minas	Vueltad del Rio Formation	Tuff breccia	It has many porphyritic fragments. Matrix is composed of very fine grained (0.01 mm) recrystallized felsic minerals. In parts, the boundary between fragment and matrix is not clear. Porphyrite fragments are suffered of strong chloritization and carbonatization, which are mainly composed of euhedral plagioclase (up to 0.5 mm). They occurs as angular and irregular shape and is about 3.0 x 3.0 mm to 1.0 x 1.0 mm in general size.
0504	Laguna Seca Laguna Seca NEE 1000 m	Intrusive rock	Liparite	This rock shows weak fluidal texture. It is composed of abundant fine grained quartz, K-feldspar and a small amount of plagioclase. Phenocrystic quartz occurs as anhedral crystal and is about 0.15 x 0.10 mm to 0.07 x 0.05 mm in size. Subhedral K-feldspar (0.18 x 0.03 mm - 0.05 x 0.02 mm) shows Carlsbad twinning and is suffered of weak sericitization. Slight apatite is observed as accessory minerals. Two bands which consists of fine grained iron oxide (hematite ?) is recognized in this specimen.

Sample No.	Location	Formation	Rock Name	Microscopic Observation
0514	Laguna Seca Laguna Seca NWW 550 m	Vueltas del Rio Formation	Porphyrite	It shows porphyritic texture and mainly composed of lath-shaped plagioclase. Euhedral plagioclase is about 2.3 x 0.5 mm - 0.7 x 0.2 mm in size and mostly altered to carbonates and sericite. Matrix is composed of fine grained quartz and felsic minerals and suffered of strong sericitization and carbonatization. Oxide iron minerals are dispersed in the rock. Intense alterations of this rock are sericitization and carbonatization.
80808	Laguna Seca Laguna Seca NW 820 m	Vueltas del Rio Formation (?)	Silicified tuff	This rock is composed of anhedral quartz, subhedral plagioclase and several rock fragments of andesite. Phenocrystic plagioclase (2.0 x 0.7 mm - 0.6 x 0.2 mm) which is mostly crashed shows Carlsbad and albite twinning and is suffered of carbonatization. Andesitic fragments are mostly composed of lath-shaped plagioclase (euhedral to subhedral, 0.2 mm - 0.05 mm) and affected by strong chloritization. Matrix is mainly composed of abundant anhedral quartz and fine grained felsic minerals, and is also weakly suffered of carbonatization.
80903	Laguna Seca Laguna Seca NWW 650 m	Vueltas del Rio Formation	Porphyrite	This rock is porphyritic in texture and mainly composed of large grained plagioclase. Phenocrystic plagioclase (2.3 x 1.0 mm - 0.5 x 0.4 mm) shows albite twinning and is mostly altered to chlorite and corbonates. Matrix is affected by strong chloritization and moderate carbonatization So in which lath-shaped plagioclase and fine grained anhedral quartz are only recognized.
81102	Laguna Seca Laguna Seca E 750 m	Intrusive rock	Granodiorite porphyry	This shows porphyritic texture and mainly composed of euhedral to subhedral plagioclase, subhedral K-feldspar and quartz. Phenocrystic plagioclase (2.3 x 2.0 mm - 0.4 x 0.2 mm) shows albite twinning and mostly altered to carbonates and sericite. Matrix shows granular texture and consist of anhedral fine grained quartz and lath-shaped plagioclase. In which carbonatization and sericitization are also observed.
81105	Laguna Seca Laguna Seca E 950 m	Vueltas del Rio Formation	Welded tuff	The rock is composed of chips of quartz and plagioclase, two kind of rock fragments and chloritized glass. Rock fragments are consisted of andesite and granodiorite. In parts, the boundary between fragment and matrix is not clear. Phenocrystic plagioclase associated with andesite fragment shows flow structure. Matrix is mainly composed of fine grained felsic minerals and anhedral chlorite by alteration. Other accessory minerals are a small amount of apatite and iron oxide mineral.

Sample No.	Location	Formation	Rock Name	Microscopic Observation
81406	Laguna Seca Laguna Seca NNW 450 m	Intrusive rock	Porphyrite	This rock shows porphyritic texture and mainly composed of euhedral to subhedral plagioclase and fine grained biotite by alteration. Phenocrystic plagioclase (1.2 x 0.5 mm - 0.5 x 0.1 mm) is mostly altered chlorite and carbonates. Matrix is composed of anhedral fine grained quartz and mostly replaced by chlorite and carbonates. It may be thought that carbonatization is a later alteration than chloritization. Because in several grains chlorite is replaced by carbonates.
0401	Minitas Macutalo	Intrusive rock	Porphyritic granodiorite	It shows porphyritic and granular in texture. It is composed of plagioclase, quartz and a small amount of K-feldspar. Epidote and chlorite are also observed as secondary minerals. Phenocrystic plagioclase shows euhedral to subhedral crystal and is about 2.5 x 2.0 mm ~ 0.5 x 0.2 mm in size. It shows Carlsbad and albite twinning and affected by sericitization, chloritization and epidotization. Mafic minerals perfectly altered to epidote and chlorite. For example, biotite is replaced by chlorite. Phenocrystic quartz is crashed and becomes to aggregate of small grains of quartz. Groundmass is composed of felsic mineral, quartz and feldspars. Intense alteration of this rock is epidotization.
2202	Minitas Qda. Minitas DDH. No 53-6 SEE 350 m	Minitas Formation	Tuff breccia	It has many andesite fragments. They are about 3.0 x 2.5 mm to 0.6 x 0.4 mm in size. It contains coarse grained euhedral to subhedral plagioclase crystals (2.0 x 1.0 mm - 0.3 x 0.2 mm, An 45) with andesite fragments. They shows Carlsbad twinning and are affected by carbonatization and sericitization. Matrix is composed of felsic minerals and mostly altered to carbonates and chlorite. Fine grained iron minerals are dispersed in the matrix. A small amount of epidote crystal is also observed as accessory minerals.
2205	Minitas Qda. Minitas DDH. No 53-6 S 400 m	Minitas Formation	Altered andesite	This shows porphyritic texture and mainly composed of euhedral to subhedral plagioclase and rare pyroxene altered perfectly by carbonatization and chloritization. Plagioclase is about 4.5 x 2.0 mm to 1.8 x 0.8 mm in general size and also affected by carbonatization, sericitization and epidotization. Matrix is composed of lath-shaped plagioclase and a small amount of anhedral quartz. Plagioclase in the matrix shows fluidal texture. Fine grained iron minerals are dispersed and glass replaced by chlorite occurs in the matrix.

Sample No.	Location	Formation	Rock Name	Microscopic Observation
2206	Minitas Qda. Minitas	Intrusive rock	Aplitic rock	The rock shows granular texture and composed of anhedral quartz, plagioclase and K-feldspar. It may be crashed and recrystallized, so it has two groups of crystal grained size, 0.7 - 0.2 mm and 0.03 - 0.02 mm. Plagioclase shows albite and Carlsbad twinning and is weakly affected by carbonatization and sericitization. While K-feldspar occurs as subhedral crystal and in which it is observed the perthite texture. Mirmekitic texture between quartz and feldspars is recognized. Calcite veinlets are abundant.
71705	Minitas DDH. No 52-6 NNE 200 m	Atima Formation	Fe-altered rock	This rock is composed of frameworks of iron mineral (hematite), aggregate of quartz and radial acicular secondary zeolites. It is very difficult to presume the original rock for the altered rock.
71803	Minitas DDH. No 53-8 N 300 m	Intrusive rock	(Altered) andesite	It shows porphyritic texture. Phenocrysts are plagioclase and augite. Euhedral to subhedral plagioclase (1.8 x 0.5 mm - 0.6 x 0.3 mm, An 45) shows albite twinning and is affected by strong sericitization and chloritization. Augite occure as euhedral to subhedral crystals and are about 1.0 x 1.0 mm to 0.4 x 0.2 mm in size. They are mostly replaced by chlorite and epidote. Matrix is composed of lath-shaped plazioclase, anhedral quartz, fine grained magnetite and altered pyroxene. Matrix shows weak flow texture and is affected by chloritization and iron-alteration.
71902	Minitas DDH. No 53-8 N 300 m	Intrusive rock	Coarse granodiorite	The rock shows granular texture. Mafic minerals are perfectly altered to chlorite and epidote. Main constituent minerals are quartz, plagioclase and K-feldspar. Euhedral to subhedral plagioclase (3.0 x 1.0 mm - 0.6 x 0.3 mm in size) shows albite twinning and zonal structure. It is affected by carbonatization, chloritization and eqidotization. Anhedral quartz (0.9 x 0.6 mm - 0.2 x 0.2 mm in size) shows mirmekitic texture with feldspars. This rock is abundant in epidote associated with a few sphene.
72807	Minitas Qda. Minitas	Atima Formation	Silicified rock with Cu-veins	In this specimen veinlets of azurite and malachite are megascopically observed. Under the microscope it is mainly composed of fine grained recrystallized quartz, up to 10 microns. Cu-crystal veinlets (0.5 mm - 0.05 mm in width) are recognized in the rock. They are composed of bluish azurite, greenish malachite and light bluish chrysocolla. Other accessory minerals are iron oxide minerals and chlorite.

Sample No.	Location	Formation	Rock Name	Microscopic Observation
80306	Minitas Macutalo	Atima Formation	Magnetite ore	It is mainly composed of garnet, magnetite and quartz. Euhedral to subhedral magnetites occur as cube and columnar crystals (0.2 x 0.1 mm - 0.05 x 0.05 mm in size). Euhedral garnet (1.0 x 0.7 mm - 0.1 x 0.1 mm in size) is pele greenish color in thin section and has weak birefrigence. Matrix is mainly composed of aggregated anhedral quartz and mostly altered to sericite and chlorite. Intense alteration of this rock is sericitization. A small amount of calcite is observed as accessory mineral.
1901	Pueblo Nuevo Esperanza SEE 650 m	Atima Formation	Garnet skarn	It is mainly composed of anhedral calcite and euhedral to subhedral garnet. Anhedral calcite (0.2 x 0.2 mm - 0.1 x 0.1 mm in size) fills interstitially small grains of garnet and is affected by weak sericitization. Garnet (0.4 x 0.4 mm - 0.05 x 0.05 mm in general size) is colorless in thin section under one nicol and partly altered to sericite. In parts, some lath-shaped plagioclases with porphyritic texture is observed under one nicol, but it does not have birefringence. It may be replaced by garnet. So it is thought the original rock of this specimen is andesite. A small amount of chlorite is also observed as secondary mineral.
1902	Pueblo Nuevo Esperanza S 150 m	Minitas Formation	Altered andesite	This is porphyritic in texture and mainly composed of plagioclase. Phenocrystic plagioclase (2.0 x 0.5 mm - 0.5 x 0.2 mm in size) shows albite twinning and mostly altered to carbonate, sericite and epidote. Groundmass is composed of lath-shaped plagioclase (0.1 x 0.03 mm in general size) and very fine grained felsic mineral. It shows flow texture in the matrix, which is affected by chloritization and epidotization. Other accessory mineral is iron oxide minerals.
81806	Pueblo Nuevo Las Crucitas SEE 650 m	Intrusive rock	Granodiorite	It shows holocrystalline and granular texture. Main constituent minerals are euhedral to subhedral plagioclase (2.5 x 1.2 mm - 0.5 x 0.3 mm in size), anhedral quartz (1.5 x 1.5 mm - 0.6 x 0.4 mm) and subhedral K-feldspar (1.7 x 1.5 mm - 0.7 x 0.3 mm). Mafic minerals are rare. Euhedral to subhedral plagioclases show albite twinning and are moderately affected by sericitization and chloritization. While fine grained quartz and plagioclase (0.3 mm - 0.1 mm) are also observed with coarse grained euhedral to anhedral crystals of quartz and feldspars. Other accessory minerals are a small amount of apatite and zircon.

Sample No.	Location	Formation	Rock Name	Microscopic Observation
81810	Pueblo Nuevo Santa Ines NEE 600 m	Intrusive rock	Altered andesite	It shows porphyritic texture and mainly composed of euhedral to subhedral plagioclase. Phenocrystic plagioclase (2.0 x 2.0 mm - 0.7 x 0.3 mm in size) shows albite and Carlsbad twinning and is affected by strong carbonatization moderate sericitization and chloritization. In parts, it is perfectely altered to carbonates. Matrix shows flow texture and is mainly composed of lath-shaped plagioclase (100 x 20 microns - 40 x 10 microns) and very fine grained quartz. Matrix is also suffered of chloritization.
82405	Pueblo Nuevo Santa Ines W 400 m	Atima Formation	Conglomerate	This is composed of many fragments of coarse grained quartz and plagioclase, three kinds of rock fragments and alteration minerals. Fragments of quartz (1.2 x 0.8 mm - 0.5 x 0.3 mm in size) occur as anhedral crystal and some of which has veinlets of calcite. Rock fragments consist of andesite, granite and sandstone. Andesite fragments (1.5 x 1.2 mm - 0.6 x 0.4 mm) consist of lath-shaped plagioclase and fine grained felsic minerals and are affected by carbonatization, while granite fragments (9.0 x 8.0 mm in maximum size) show granular texture and composed of quartz, K-feldspar and a small amount of plagioclase. They are suffered of carbonatization and epidotization. Matrix is composed of fine grained quartz and felsic minerals.
82601	Pueblo Nuevo Esperanza SEE 500 m	Atima Fortion	Carbonaceous Conglomerate	This is made of many fragments of carbonates, andesite and porphyrite. The fragments are rounded and up to 3 mm in size. Some carbonaceous fragments are made of single crystal of carbonates and the others are aggregate of carbonates. Andesite fragments are composed of phenocrystic euhedral plagioclase and fine lath-shaped plagioclase. It is affected by carbonatization. Matrix is perfectly altered to carbonates. Then the boundary between fragment and matrix is sometimes not clear.
82905	Pueblo Nuevo Santo Domingo NEE 1000 m	Intrusive rock	Porphyrite	The rock shows porphyritic texture. Phenocrystic minerals are plagioclase and clino-pyroxene. Phenocrystic plagioclase (2.0 x 0.4 mm - 0.5 x 0.2 mm in size) shows euhedral crystal and suffered of argillization. Euhedral to subhedral clino-pyroxene (2.0 x 1.0 m - 0.4 x 0.3 mm in size) shows secter twinning and is considerably altered to amphibole. Matrix is composed of lath-shaped plagioclase, fine grained felsic mineral and anhedral quartz. Other accessory minerals are epidote and apatite.

Sample No.	Location	Formation	Rock Name	Microscopic Observation
90601	Pueblo Nuevo Las Crusitas SEE 600 m	Intrusive rock	Granite porphyry	It shows porphyritic texture and mainly composed of euhedral to subhedral plagioclase (7.0 x 2.5 mm - 0.6 x 0.2 mm), anhedral quartz (2.5 x 2.3 mm - 0.5 x 0.4 mm) and subhedral K-feldspar (2.0 x 2.0 mm - 1.5 x 0.5 mm). Phenocrystic plagioclase shows albite twinning and is suffered of weak sericitization. While K-feldspar shows Carlsbad twinning. Matrix shows granular texture and mainly composed of quartz, K-feldspar and plagioclase. In parts, it is affected by weak chloritization. Other accessory mineral is iron oxide mineral.

(2) Thin sections of drill cores, Vueltas del Rio and Minitas Sector

(1)

Sample No.	Location	Formation	Rock Name	Microscopic Observation
1026	Vueltas del Rio No. 53-1 Depth 26 m	Vueltas del Rio Formation	Tuff breccia	If is mainly composed of many andesite fragments and euhedral to subhedral plagioclase. In these fragments phenocrystic plagioclase shows Carlsbad and albite twinning and is suffered of weak sericitization. Matrix of the fragment is composed of anhedral quartz and mostly altered to chlorite. While euhedral to subhedral plagioclase (2.3 x 0.5 mm - 0.7 x 0.2 mm) is perfectly altered to carbonates and sericite.
1068	Vueltas del Rio No. 53-1 Depth 68 m	Vueltas del Rio Formation	Tuff breccia	This rock is mainly composed of fragments of quartz and plagioclase and several andesite fragments. Subhedral plagioclase (2.3 x 0.4 mm - 0.6 x 0.2 mm) is perfectly replaced by carbonates and sericite. Andesite fragments consist of lath-shaped plagioclase and are affected by intense chloritization and carbonatization. Matrix is composed of fine grained felsic minerals, anhedral quartz and chloritized glass. Other accessory mineral is dispersed opaque mineral.
1095	Vueltas del Rio No. 53-1 Depth 95 m	Vueltas del Rio Formation	Tuff breccia	This rock is not clear in texture because of intense sericitization and carbonatization. It is composed of anhedral quartz, euhedral to subhedral plagioclase and rock fragments. Plagioclase (0.6 x 0.2 mm - 0.3 x 0.1 mm) is perfectly altered to sericite and carbonates. Matrix is composed of fine grained quartz and felsic minerals. Glass is replaced by sericite and chlorite.
1161	Vueltad del Rio No. 53-1 Depth 161 m	Vueltad del Rio Formation	Tuff (?)	This rock is not clear in texture, because it is affected by intense carbonatization and sericitization. It is composed of anhedral aggregated quartz and fine grained felsic minerals. Other accessory minerals are apatite and zircon.
1246	Vueltas del Rio No. 53-1 Depth 246 m	Vueltas del Rio Formation	Welded tuff	It is mainly composed of subhedral plagioclase and anhedral quartz. Plagioclase (1.0 x 0.9 mm - 0.3 x 0.05 mm) shows Carlsbad twinning and mostly altered to carbonates and sericite. Matrix is composed of lath-shaped plagioclase and fine grained anhedral quartz. In which the flow texture is recognized. It is also suffered of intense sericitization and carbonatization.
1371	Vueltas del Rio No. 53-1 Depth 371 m	Vueltas del Rio Formation	Welded tuff (?)	This rock shows flow structure and consists of anhedral quartz and rock fragment. Mafic minerals and plagioclase may be perfectly altered to carbonates and sericite. Intense alterations of this rock are sericitization and carbonatization. Other accessory mineral is dispersed opaque mineral (may be pyrite).

Sample No.	Location	Formation	Rock Name	Microscopic Observation
1386	Vueltas del Rio No. 53-1 Depth 386 m	Vueltas del Rio Formation	Tuff	This rock shows weak flow texture and is composed of subhedral plagioclase, anhedral quartz and calcite by alteration. Plagioclase (1.2 x 0.3 mm - 0.5 x 0.2 mm) shows weakly albite twinning and mostly altered to carbonates and chlorite. Matrix is five grained anhedral quartz and aggregated felsic mineral and is suffered of intense carbonatization. Glass is mostly replaced by chlorite. Oxidized iron minerals are dispersed in the rock.
2085	Vueltas del Rio No. 53-2 Depth 85 m	Vueltas del Rio Formation	Silicified tuff	The rock is composed of quartz, carbonate, sericite and a few amount of felsic minerals. In parts, sericite crystals show layered structure. Quartz shows anhedral and very fine grain (50 microns to 30 microns in size). Sericite shows fine acicular form and layered structure. Euhedral to subhedral carbonate is scattered in the sample and is about 0.8 x 0.4 mm to 0.1 x 0.05 mm in size. Also, euhedral sphene is scattered as accessory mineral.
2128	Vueltas del Rio No. 53-2 Depth 128 m	Vueltas del Rio Formation	Silicified tuff	It is composed of quartz, anhedral fine grained felsic minerals, carbonate and acicular sericite. In parts, sericite crystals show layered structure. It is affected by strong silicification and sericitization. So, it is difficult to judge the original rock. Quartz crystals consist of two groups in grained size. One of them is about 0.5 x 0.3 mm to 0.3 x 0.1 mm and the other is about 50 microns to 20 microns. The later shows aggregated form. Other accessory minerals are sphene and oxidized iron minerals.
2173	Vueltas del Rio No. 53-2 Depth 173 m	Vueltas del Rio Formation	Tuff breccia	The rock is composed of anhedral fine grained felsic minerals, carbonate, sericite and rock fragments. Rock fragment mainly consists of anhedral fine grained quartz (up to 50 microns), which shows aggregated form. In parts, the boundary between fragment and matrix is not clear. Euhedral to anhedral crystal of carbonate is scattered in the rock and is about 1.0 x 0.7 mm to 0.1 x 0.1 mm in size. The layered structure of sericite is found as patched form. It suggests to be tuff fragment, originally.
2256	Vueltas del Rio No. 53-2 Depth 256 m	Vueltas del Rio Formation	Tuff breccia	It has many andesite fragments. Matrix is composed of fine grained felsic minerals, anhedral quartz and a few amount of plagioclase. In parts, the boundary between fragment and matrix is not clear. Andesite fragments are mainly composed of lath-shaped plagioclase (0.5 x 0.2 mm - 0.1 x 0.05 mm), which shows albite and Carlsbad twinning, and is suffered of carbonatization. Matrix of the fragment is mostly replaced by chlorite. Glass is perfectly altered to chlorite. Other accessory mineral is dispersed opaque mineral.

Sample No.	Location	Formation	Rock Name	Microscopic Observation
2276	Vueltas del Rio No. 53-2 Depth 276 m	Vueltas del Rio Formation	Altered andesite	The rock is porphyritic in texture and mainly composed of lath-shaped plagioclase and a small amount of anhedral quartz. Phenocrystic plagioclase (1.5 x 0.4 mm - 0.5 x 0.1 mm in size) shows euhedral to subhedral crystal and mostly altered to carbonate, chlorite and sericite. Matrix is composed of anhedral fine grained quartz and affected by intense sericitization and carbonatization. Abundant oxidized iron minerals are dispersed in the rock.
3115	Vueltas del Rio No. 53-3 Depth 115 m	Vueltad del Rio Formation	Tuff breccia	It has many porphyrite fragments. Matrix is composed of fine grained (up to 20 microns) recrystallized felsic minerals. Porphyrite fragments mainly consist of lath-shaped plagioclase (0.2 mm - 0.1 mm) and are suffered of sericitization and carbonatization. Crystal fragments as quartz and plagioclase occur in parts about 0.3 mm to 0.1 mm in size. Matrix is holocrystalline and made of fine felsic minerals and opaque minerals. It is suffered of intense carbonatization.
3124	Vueltas del Rio No. 53-3 Depth 124 m	Vueltas del Rio Formation	Tuff breccia	A few andesite fragments are recognized in the rock. It is composed of anhedral quartz (0.8 x 0.3 mm - 0.2 x 0.05 mm), very fine grained (up to 30 microns) felsic mineral, carbonate and rock fragment. Andesite fragments are composed of lath-shaped plagioclase and mostly altered to chlorite, quartz and carbonate. A few veins which consist of anhedral medium grained (0.6 mm to 0.4 mm) quartz and calcite are found in the rock. Matrix is composed of fine grained quartz and opaque minerals and affected by intense chloritization.
3167	Vueltas del Rio No. 53-3 Depth 167 m	Vueltas del Rio Formation	Tuff breccia	It has many porphyrite fragments. Matrix is composed of fine grained quartz, lath-shaped plagioclase and felsic minerals. Porphyrite fragments mainly consist of euhedral plagioclase (0.3 mm to 0.2 mm) which shows Carlsbad twinning, and are moderately suffered of chloritization and carbonatization. Crystal fragments as quartz and plagioclase occur in parts about 0.05 mm in size. Matrix is affected by intense chloritization and carbonatization. Anhedral carbonates are scattered in the sample and is about 1.0 x 0.3 mm to 0.4 x 0.1 mm in size. Also, abundant fine grained opaque minerals are scattered.
3211	Vueltas del Rio No. 53-3 Depth 211 m	Vueltas del Rio Formation	Tuff breccia	It has many porphyrite fragments. Matrix is composed of quartz and fine grained felsic mineral. Porphyrite fragments which consist of lath-shaped plagioclase (up to 0.3 mm) are about 2.3 x 0.8 mm to 0.7 x 0.5 mm in size and affected by strong sericitization and carbonatization. While, matrix is affected by intense sericitization and carbonatization. Glass is perfectly replaced by chlorite. Other accessory minerals are biotite (0.6 mm to 0.3 mm in size) and opaque minerals.

Sample No.	Location	Formation	Rock Name	Microscopic Observation
3340	Vueltas del Rio No. 53-3 Depth 340 m	Vueltas del Rio Formation	Tuff breccia	It has many andesite fragments. Matrix is composed of anhedral quartz and subhedral to anhedral calcite by alteration. In andesite fragment, phenocrystic plagioclase (2.0 x 1.5 mm to 0.6 x 0.2 mm) and lath-shaped plagioclase (about 0.2 mm) are observed with fine oxidized iron mineral and the former is mostly altered to sericite, carbonate and chlorite. Mafic mineral is perfectly altered to carbonate without lath-shaped plagioclase, groundmass are perfectly replaced by chlorite. In which lath-shaped plagioclase shows flow texture. While matrix is also suffered of intense chloritization and carbonatization.
3360	Vueltas del Rio No. 53-3 Depth 360 m	Vueltas del Rio Formation	Tuff breccia	The rock has many andesite fragments. These fragments are composed of phenocrystic plagioclase (1.5 x 0.4 mm to 0.4 x 0.1 mm) and lath-shaped plagioclase (about 0.2 mm). Phenocrystic plagioclase shows albite and Carlsbad twinning and is suffered of chloritization and carbonatization. Groundmass is composed of lath-shaped plagioclase and a little of anhedral quartz and mostly altered to chlorite with opaque mineral. Matrix consists of anhedral quartz and fine grained felsic mineral and is also suffered of intense chloritization.
4083	Vueltas del Rio No. 53-4 Depth 83 m	Vueltas del Rio Formation	Silicified tuff	The rock is composed of aggregated quartz, acicular sericite, very fine grained felsic mineral and opaque minerals. Quartz crystal is about 0.07 mm and shows aggregated form. Originally it may be tuff fragment. Sericite aggregate shows layered structure, in parts which is found as patched form. Opaque minerals are scattered in the sample and it may be pyrite.
4152	Vueltas del Rio No. 53-4 Depth 152 m	Vueltas del Rio Formation	Tuff or Altered andesite	The rock is composed of quartz, feldspars, sericite and opaque minerals. It is affected by strong sericitization. In parts, euhedral crystals like plagioclase (about 1.0 x 0.6 mm) is found in the sample, but they are perfectly altered to sericite aggregate. All of minerals show anhedral and very fine grained size (0.04 mm in general size). Sericite aggregate also shows layered structure as above No. 4083.
4221	Vueltas del Rio No. 53-4 Depth 221 m	Vueltas del Rio Formation	Tuff	The rock shows layered structure by sericite aggregate associated with opaque minerals (may be pyrite). It is composed of quartz, sericite, carbonate, very fine grained felsic mineral and opaque minerals. It is suffered of intense sericitization and carbonitization. So, mafic mineral and plagioclase may be perfectly altered to sericite and carbonate. Abundant opaque minerals are scattered in the sample.

Sample No.	Location	Formation	Rock Name	Microscopic Observation
4283	Vueltas del Rio No. 53-4 Depth 283 m	Vueltas del Rio Formation	Silicified tuff	It is composed of quartz, carbonate, felsic mineral and sericite. Quartz-calcite vein is found in the rock, which is about 0.5 cm in width and consist of anhedral crystal of quartz and calcite. It is suffered of sericitization and carbonatization in the sample. In parts, sericite aggregate is found as patched form. It suggests to be tuff fragment, originally. Then the rock may be silicified tuff or tuff breccia.
4332	Vueltas del Rio No. 53-4 Depth 332 m	Vueltas del Rio Formation	Tuff breccia	The rock is composed of plagioclase, quartz, felsic mineral and rock fragment. Crystal fragments as quartz and plagioclase occur about 2.0 mm to 0.5 mm in size. Euhedral to subhedral plagioclase shows albite twinning and is suffered of carbonatization and sericitization. Rock fragments consist of andesite. It is mainly composed of phenocrystic plagioclase, lathe-shaped plagioclase and a small amount of quartz. The groundmass is suffered of chloritization and carbonatization. While matrix is composed of anhedral quartz and fine grained felsic mineral, and modelately affected by sericitization and carbonatization. Glass is perfectly altered to chlorite.
4340	Vueltas del Rio No. 53-4 Depth 340 m	Vueltas del Rio Formation	Tuff breccia	It has many rock fragments of andesite and porphyrite. The rock is composed of plagioclase, quartz, felsic mineral and opaque minerals. Rock fragments consist of porphyritic plagioclase and lath-shaped plagioclase, and in parts show fluidal texture. Both phenocryst and groundmass are suffured of chloritization and carbonatization. Plagioclase clearly show Carlsbad and albite twinning. While the boundary between fragment and matrix is not clear. Crystal fragments as quartz and plagioclase occur in parts about 2.0 mm to 0.3 mm in size. Matrix which shows holocrysalline is made of fine grained (about 0.04 mm) felsic minerals and suffered of moderate chloritization. Almost a few calcite veinlets are observed.
4440	Vueltas del Rio No. 53-4 Depth 440 m	Vueltas del Rio Formation	Tuff	The rock is composed of quartz, sericite, carbonate and opaque minerals. There is little plagioclase in the rock. Crystal fragments of quartz occur about 2.0 mm to 0.5 mm in size. In parts, aggregate mass of acicular sericite is found is patched form. It suggets to be tuff fragment, originally. Matrix is composed of fine grained felsic mineral and a little of anhedral quartz, and is affected by sericitization and carbonatization. Opaque minerals are disseminated in the rock.

Sample No.	Location	Formation	Rock Name	Microscopic Observation
4475	Vueltas del Rio No. 53-4 Depth 475 m	Vueltas del Rio Formation	Tuff	The rock is affected by strong sericitization and moderate carbonatization. It is composed of felsic mineral, quartz acicular sericite and carbonate. Original rock may be the same as the above mentioned No. 4440. But, sericitization is weaker than the above, and crystal fragments of quartz occure about 0.4 mm in size. Other accessory minerals are dispersed sphene and opaque minerals.
4495	Vueltas del Rio No. 53-4 Depth 495 m	Intrusive rock	Porphyrite	The rock is porphyritic in texture and mainly composed of plagioclase, acicular hornblende, quartz and calcite. Plagioclase (about 1.0 x 0.2 mm in general size) shows subhedral crystal and is suffered of sericitization and carbonatization. Hornblende (0.6 mm to 0.2 mm in size) is brown to dark brown in color and partly affected by chloritization. Matrix is mainly composed of andedral quartz, feldspars and apatite, and affected by chloritization. Other accessory mineral is dispersed opaque mineral.
5098	Vueltas del Rio No. 53-5 Depth 98 m	Vueltas del Rio Formation	Pyrite vein	It consists of idiomorphic pyrite and aggregated mass of one. Interstices of pyrite crystals are filled up by anhedral quartz and calcite. Idiomorphic pyrites occur about 3.5 x 2.0 mm to 0.1 x 0.1 mm in size. In parts, quartz and calcite are suffered of sericitization.
5101	Vueltas del Rio No. 53-5 Depth 101 m	Intrusive rock	Silicified rock	The rock is mainly composed of fine grained quartz and sericite. It is affected by strong silicification and sericitization. So, it is difficult to judge the original rock. The grain size of quartz is about 0.03 mm to 0.01 mm. Sericite aggregate consists of acicular crystals and is partly found as pathed form. Several veinlets of quartz are observed in the rock. Also, opaque minerals are scattered.
5128	Vueltas del Rio No. 53-5 Depth 128 m	Vueltas del Rio Formation	Tuff	The rock is composed of quartz, sericite, felsic mineral and a small amount of glass. It is affected by strong sericitization, so mafic mineral is not observed. The grain size of quartz is chageable from 0.2 mm to 0.02 mm. In parts, medium grained crystals of quartz show aggregate form, and it may be tuff fragments, originally. Sericite shows acicular and aggregated form. Other accessory mineral is sphene.
5160	Vueltas del Rio No. 53-5 Depth 160 m	Vueltas del Rio Formation	Silicified tuff	It is mainly composed of quartz, felsic mineral and sericite. The rock is affected by strong silicification and sericitization. Original rock may be the same as the above mentioned No. 5128. But, silicification is stronger than the above. Sericite shows acicular form and layered structure. While medium grained (about 0.2 mm to 0.1 mm in size) crystals of quartz show partly aggregate form. Other accessory mineral is dispersed opaque mineral.

Sample No.	Location	Formation	Rock Name	Microscopic Observation
5291	Vueltas del Rio No. 53-5 Depth 291 m	Vueltas del Rio Formation	Altered tuff breccia	This is affected by intense chloritization, sericitization and silicification, so texture is not clear. There is three type of fragment. One is fine grained (0.02 mm) quartz aggregate. The second one is fine acicular sericite aggragate. The third one is chloritized fragment, which shows andesitic texture in parts. Opaque minerals are dispersed in the rock.
5318	Vueltas del Rio No. 53-5 Depth 318 m	Vueltas del Rio Formation	Tuff	The rock is composed of quartz, chlorite and sericite. Porphyritic minerals and rock fragment are perfectly altered to chlorite, quartz and sericite. Quartz crystals show anhedral one and are affected by strong sericitization. So, texture is not clear and it is difficult to judge the original-rock. Also, matrix is composed of quartz and mostly altered to chlorite and sericite. Glass is perfectly replaced by chlorite. Opaque minerals are scattered in the rock.
5397	Vueltas del Rio No. 53-5 Depth 397 m	Vueltas del Rio Formation	Altered tuff	This is affected by intense chloritization, sericitization and silicification, so texture is not clear. There are three types of fragments. One is fine acicular sericite aggregate. The second one is chloritized fragment. The third one consist of fine grained (up to 0.1 mm) quartz aggregate and chloritized one, which shows andestic texture in parts. Fine grained opaque minerals are dispersed in the rock.
5400	Vueltas del Rio No. 53-5 Depth 400 m	Vueltas del Rio Formation	Tuff	This is affected by intense sericitization and silicification, so texture is not clear. This is composed of quartz and sericite. Opaque minerals are dispersed in the rock. Intense alteration of this rock is sericitization. Sericite shows acicular form and layered structure. In parts, layered structure of sericite aggregate is found as patched form. It suggest to be tuff fragment originally.
6111	Minitas No. 53-6 Depth 111 m	Atima Formation	Crystalline limestone	It is composed of anhedral calcite. Porphyritic calcites occure about 0.6 x 0.3 mm to 0.2 x 0.1 mm is size, and matrix is up to 0.04 mm. Fine grained calcite veinlet occurs in the rock.
6122	Minitas No. 53-6 Depth 122 m	Minitas Formation	Tuff breccia (?)	This is affected by intense carbonatization and chloritization, so texture is not clear. It is composed of calcite and chlorite by alteration and fine grained felsic minerals, plagioclase and quartz. In plases, there look like andesite fragments. Oxidized iron minerals are dispersed in the rock.
6172	Minitas No. 53-6 Depth 172 m	Minitas Formation	Epidote skarn	It is composed of abundant epidote, calcite, opaque minerals and sericite. Epidote crystals which show euhedral to subhedral form (up to 0.4 mm) are pale green to yellowish green in color and its extinction is nearly parallel in elongate sections. Anhedral crystals of calcite and sericite fill up interstitions between epidote and opaque mineral.

Sample No.	Location	Formation	Rock Name	Microscopic Observation
6191	Minitas No. 53-6 Depth 191 m	Minitas Formation	Andesite	The rock shows porphyritic texture and consists mainly of plagioclase. Phenocrystic plagioclase (euhedral to subhedral, 4.3 x 2.0 mm to 0.8 x 0.3 mm in size), shows albite twinning and affected by sericitization and carbonatization. Some plagioclase include apatite. Matrix is composed of lath-shaped plagioclase, fine grained quartz and chlorite. Iron minerals are mostly altered to hematite and limonite. Calcite veinlets occur 50 microns in width.
6218	Minitas No. 53-6 Depth 218 m	Minitas Formation	Andesite	The rock is porphyritic in texture and consists of plagioclase. Mafic minerals are perfectly altered to calcite, epidote and opaque minerals. Phenocrystic plagioclase shows euhedral to anhedral and albite twinning, up to 4.0 mm. It is affected by chloritization and sericitization. Matrix is composed of lath-shaped plagioclase, fine grained dispersed magnetite and glass. They show flow texture and spotted altered chlorite.
6274	Minitas No. 53-6 Depth 274 m	Minitas Formation	Porphyrite	The rock is porphyritic in texture and grain size is bigger than other andestic rocks. It is mainly composed of plagioclase. Phenocrystic plagioclase (about 2.3 x 1.0 mm to 0.6 x 0.2 mm in size) shows euhedral to subhedral and albite twinning. It is affected by chloritization and carbonatization. Mafic mineral is perfectly replaced by carbonates, chlorite and epidote. Plogioclase in matrix shows euhedral and Carlsbad twinning, up to 0.2 mm. Glass in matrix is perfectly altered to chlorite. Iron minerals are dispersed in the rock.
7082	Minitas No. 53-7 Depth 82 m	Atima Formation	Garnet skarn	It is composed of garnet, calcite, quartz and iron-oxide. Euhedral garnet (about 1.5 x 1.0 mm to 0.2 x 0.2 mm in size) shows slightly anisotropism and zonal structure. Garnet is cracked in parts and cemented by quartz and calcite. Anhedral quartz shows wavy extinction. Iron oxide occurs in cracks of the other crystals.
7087	Minitas No. 53-7 Depth 87 m	Atima Formation	Garnet-actinolite skarn	Main constituent minerals are garnet actinolite and opaque minerals. Euhedral to subhedral garnet (1.5 x 1.0 mm to 0.4 x 0.2 mm in size) shows slightly anisotropism and zonal structure, and coexists with radiated acicular wollastonite, in parts. Actinolite occurs in columner to acicular, and is replaced by calcite in parts. Small amounts of epidote occurs with garnet and actinolite. Quartz and calcite cements the cracks of garnet. Anhedral to subhedral opaque minerals, up to 2.0 mm, occurs in aggregated.

Sample No.	Location	Formation	Rock Name	Microscopic Observation
7091	Minitas No. 53-7 Depth 91 mm	Atima Formation	Garnet skarn	Main constituent minerals are garnet, calcite and opaque minerals. Subhedral to anhedral garnet show isotropic and pale green in colour. Some calcite is large crystal, up to 3.0 mm and some fine one occurs in the cracks of garnet and opaque minerals. Subhedral quartz occurs beside the opaque minerals. Opaque minerals are pyrite and hematite.
7095	Minitas No. 53-7 Depth 95 m	Atima Formation	Epidote-fluorite skarn	Main constituent minerals are epidote, calcite and fluorite. Epidote crystal (about 0.6 x 0.3 mm to 0.2 x 0.2 mm in size) shows subhedral to anhedral and pale green to brownish green in clolour. Anhedral calcite and fluorite cement the interstices of epidote aggregate.
7110	Minitas No. 53-7 Depth 110 m	Intrusive rock	Porphyritic granodiorite	This is prophyritic in texture and mainly composed of plagioclase. Phenocrystic plagioclase (about 2.0 x 0.5 mm to 0.5 x 0.2 mm in size) is euhedral to subhedral and shows albite twinning, and affected by sericitization and carbonatization. Hornblende is mostly replaced by calcite and epidote. Groundmass is composed of small grained quartz and feldspars. It is moderately suffered chloritization and carbonatization.
7113	Minitas No. 53-7 Depth 113 m	Atima Formation	Epidote skarn	Main constituent minerals are epidote, quartz and opaque minerals. Epidote (about 1.0 mm to 0.05 mm in size) is euhedral to subhedral and pale greento colurless. Quartz, chlorite and rare calcite cement epidote aggregate. Opaque minerals, up to 2.0 mm, show euhedral to subhedral and are scattered in the rock. They may be pyrite.
7115	Minitas No. 53-7 Depth 115m	Atima Forma-	Epidote skarn	This shows the same mineral assemblages as the above No. 7113. Epidote is smaller grain size, up to 0.2 mm, and calcite is much more than the above. Also, pyrite is disseminated in the rock.
7152	Minitas No. 53-7 Depth 152 m	Minitas Formation	Porphyrite	This is porphyritic in texture and mainly composed of plagioclase. Phenocrystic plagioclase (about 2.0 x 1.0 mm to 0.9 x 0.4 mm in size) shows euhedral to subhedral and is affected by carbonatization and sericitization. Mafic minerals are perfectly altered to cabonate, epidote and chlorite. Matrix is composed of lath-shaped plagioclase (up to 0.2 mm) and chlorite by alteration. Fine grained calcite veins are observed in the rock.

Sample No.	Location	Formation	Rock Name	Microscopic Observation
7156	Minitas No. 53-7 Depth 156 m	Intrusive rock	Porphyritic diorite or porphyrite	The rock shows porphyritic texture and composed mainly of plagioclase. Phenocrystic plagioclase (about 3.5 x 1.8 mm to 0.5 x 0.3 mm in size) is euhedral to subhedral and is affected by sericitization, carbonatization and slight epidotization. Mafic minerals are perfectly replaced by epidote, chlorite and carbonates. Groundmass is composed of quartz aggregate, feldspars and chlorite. Other accessory mineral is fine grained apatite.
7163	Minitas No. 53-7 Depth 163 m	Minitas Formation	Altered andesite	The rock shows porphyritic texture and matrix shows fluidal texture. Phenocrystic plagioclase (about 2.3 x 1.0 mm to 0.8 x 0.2 mm in size) is euhedral to subhedral and is affected by sericitization, carbonatization, slight chloritization and slight epidotization. Mafic mineral is perfectly replaced by epidote, carbonates and chlorite. Matrix is composed of lath-shaped plagiochase (up to 0.2 mm), scattered iron-oxide mineral and chlorite by alteration.
7242	Minitas No. 53-7 Depth 242 m	Minitas Formation	Altered andesite	The rock shows clearly fluidal texture. In phenocrystic mineral it is affected by intense epidotization. Specially, mafic minerals are perfectly replaced by epidote (up to 0.2 mm, pale green aggregate) and a small amount of sphene. Phenocrystic plagioclase (about 0.6 x 0.3 mm to 0.2 x 0.1 mm in size) is also suffered of epidotization. Matrix is composed of lath-shaped plagioclase (up to 0.2 mm), small grained epidote aggregate and chlorite.
7283	Minitas No. 53-7 Depth 283 m	Minitas Formation	Meta andesite	It shows porphyritic texture. Phenocrystic plagioclose (about 1.5 x 0.5 m to 0.4 x 0.1 mm in size) is euhedral to subhedral and moderotely suffered of sericitization,chloritization and carbonatization. Mafic minerals are perfectly replaced by carbonates, chlorite, epidote and iron-oxides. Matrix is composed of plagioclase microlite, quartz aggregate, chlorite and iron-oxide.
8115	Minitas No. 53-8 Depth 115 m	Minitas Formation	Meta andesite	The rock shows nearly same texture and mineral assemblage as the above No. 7283, but grain size of materix is a little bigger and carbonatization is more intense. It has calcite veinlets.
8167	Minitas No. 53-8 Depth 167m	Minitas Formation	Altered andesite	The rock shows porphyritic and fluidal texture and mainly composed of plagioclase. Phenocrystic plagioclase (about 2.5 x 1.0 mm to 0.3 x 0.1 mm in size) is euhedral to subhedral and affected by strong sericitization, chloritization and iron alteration. Rare augite is subhedral and mostly replaced by chlorite, carbonates and iron oxide. Matrix is composed of fine grained lath-shaped plagioclase (up to 0.05 mm) and iron mineral.

Sample No.	Location	Formation	Rock Name	Microscopic Observation
8185	Minitas No. 53-8 Depth 185 m	Minitas Formation	Tuff breccia	It is composed of many medium grained andesite fregments. Andesite fragments are suffered of intense carbonatization. Phenocrystic plagioclase (about 2.0 x 0.5 mm to 0.5 x 0.2 mm in size) is perfectly altered to carbonate, sericite and fine grained quartz aggregate. Matrix is composed of fine grained quartz aggregate and lath-shaped plagioclase (up to 0.05 mm). Zeolite spots occur in places.
8255	Minitas No. 53-8 Depth 255 m	Minitas Formation	Mata andesite	The rock shows porphyritic texture and is composed of plagioclase and a small amount of quartz. Phenocrystic plagioclase (about 2.0 x 0.4 mm to 0.5 x 0.1 mm in size) shows enhedral to subhedral and is affected by chloritization, sericitization and slight carbonatization. There is a small fragment is the rock, which is mainly composed of anhedral albite (up to 0.1 mm), clinopyroxene (euhedral, up to 0.1 mm), carbonates and opaque mineral. It may be skarn-fragment. Matrix is mainly composed of lath-shaped plagioclase and suffered of chloritization.
8300	Minitas No. 53-8 Depth 300m	Intrusive rock	Granodiorite	The rock shows granular texture. Mafic minerals are perfectly altered to chlorite and calcite. Main constituent minerals are quartz, plagioclase and K-feldspar. Subhedral plagioclase (about 3.0 x 2.0 mm to 0.4 x 0.3 mm) shows albite twinning and is affected by sericitization, slight chloritization and carbonatization. Anhedral quartz shows mirmekitic texture with feldspar. In parts, K-feldspar show microcline and perthite texture. Opaque mineral associated with chlorite is scattered.

(3) Polished sections of ore minerals, Vueltas del Rio, Minitas and Pueblo Nuevo Sector

(1)

Sample No.	Location	Formation	Rock Name	Microscopic Observation
72807	Minitas Qda. Minitas	Atima Formation	Copper ore	The specimen consists of malachite, azurite and goethite. Malachite and azurite occur in irregular shape and filling the interstices of gangue minerals. Geothite shows colloform texture and associates with malachite and azurite.
80205	Minitas No. 53-7 N 50m	Atima Formation	Iron ore	The specimen consists of mainly magetite and a small amount of hematite. Magnetite is sometimes brecciated and parthy replaced by hematite.
80306	Minitas Macutalo	Atima Formation	Iron ore	Main constituent mineral is magnetite. Magnetite is brecciated and sometimes accompanied with a small amount of hematite.
82409	Pueblo Nuevo Santo Domingo	Atima Formation	Fe-Cu-Zn ore	The speciemen consists of hematite, chalcopyrite, goethite, sphalerite, phyrite and galena, and among them hematite is the most abundant. Hematite crystales occur in aggregate. Goethite occurs in intinate association with chalcopyrite margin. Sphalerite occurs in irregular shaped crystal associated with pyrite and chalcopyrite.
1097	Vueltas del Rio No. 53-1 Depth 97 m	Vueltas del Rio Formation	Fe-Cu-Zn ore	The specimen consists of mostly pyrite and chalcopyrite. Pyrite occurs as idiomorphic or subidimorphic crystals, chalcopyrite sometimes occurs as veinlets filling the interstices of pyrite crystals, in which a small drops of sphalerite are found.
2173	Vueltas del Rio No. 53-2 Depth 173 m	Vueltas del Rio Formation	Fe-Cu-Zn ore	The speciemen consists of idiomorphic pyrite, chalcopyrite, tetrahedrite and sphalerite, among them sphalerite is the smallest amount. In place, chalcopyrite and tetrahedrite cements the intersitices of pyrite. Tetrahedrite is coexsisted with chalcopyrite and pyrite intimately.
3106	Vueltas del Rio No. 53-3 Depth 106 m	Vueltas del Rio Formation	Cu-Pb-Zn ore	In megascopicaly, it shows network texture of chalcopyrite and quartz veinlets. Under the microscope, it is composed of pyrite and chalcopyrite. Pyrite occurs as idiomorphic cube crystals of 200 to 100 microns in general size. Chalcopyrite occurs in irregular shape and fills up the interstices of pyrite and gangue minerals. The grain size of chalcopyrite is up to 500 microns. A small amount of galena and sphalerite associated with pyrite and chalcopyrite is also recognized as accessory minerals.

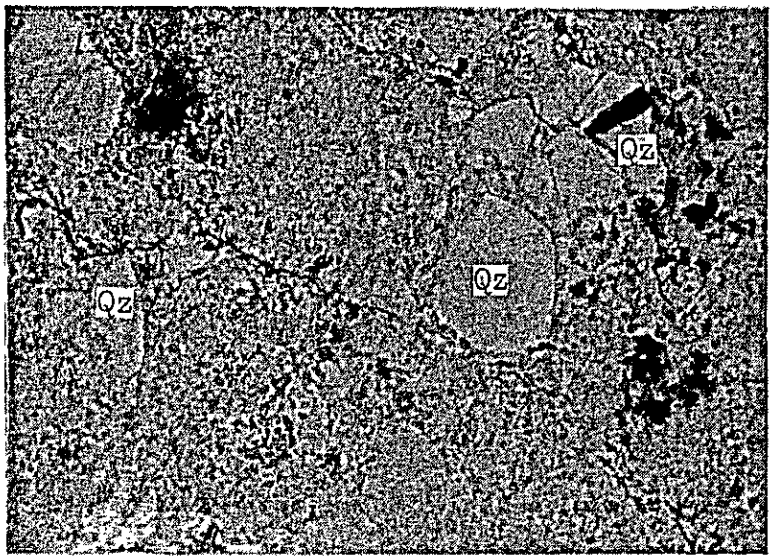
Sample No.	Location	Formation	Rock Name	Microscopic Observation
3115	Vueltas del Rio No. 53-3 Depth 115 m	Vueltas del Rio Formation	Cu-Fe ore	The specimen consists of mainly pyrite and chalcopyrite. Pyrite occurs as idiomorphic cube crystal. Chalcopyrite occurs in quartz vein.
3124	Vueltas del Rio No. 53-3 Depth 124 m	Vueltas del Rio Formation	Fe-Cu ore	The vein, 0.5 cm in width, mainly composed of pyrite and chalcopyrite is found megascopically on the polished surface of the specimen. In quartz vein, smallgrains of pyrite and chalcopyrite are disseminated. Under the microscope, it is composed of pyrite, chalcopyrite and a small amount of sphalerite. Pyrite occurs as idiomorphic crystals of 0.5 x 0.5 mm to 0.02 x 0.02 mm in general size and closely associated with chalcopyrite. In parts, pyrite is replaced by chalcopyrite.
4090	Vueltas del Rio No. 53-5 Depth 98 m	Vueltas del Rio Formation	Fe-Zn-Cu ore	The specimen consists of pyrite, sphalerite, tetrahedrite and chalcopyrite. Chalcopyrite contains an irregular small grains of tetrahedrite, while inparts tetrahedrite also contains many small pyrite and sphalerite crystals. Then they show very intimate intergrowth texture.
5098	Vueltas del Rio No. 53-5 Depth 98 m	Vueltas del Rio Formation	Fe-Cu ore	The specimen is mainly composed of idimorphic pyrite crystals and chalcopyrite. Chalcopyrite occurs in filling the interstices of pyrite and contains a small amount of sphalerite.
7087	Minitas No. 53-5 Depth 87 m	Atima Formation	Fe-Cu ore	The specimen consists of pyrite, chalcopyrite and a small amount of hematite. In places, chalcopyrite occurs in filling the interstices of pyrite.
7091	Minitas No. 53-7 Depth 91 m	Atima Formation	Cu-Fe ore	Main constituent minerals ore chalcopyrite, magnetite, hematite and chalcocite. Chalcocite occurs as secondary mineral in filling the interstices of chalcopyrite and the margin of its crystal. Hematite also occurs in filling the interstices of magnetite, and is thought to be secondary minerals from the occurence.

Table I—3 Photomicrographs

Mineral and metal abbreviations

An	Andesite	Hb	Hornblende
Ap	Apatite	Il	Ilmenite
Au	Augite	Mg	Magnetite
Bi	Biotite	Mc	Malachite
Ca	Calcite	Mu	Muscovite
Cc	Chalcocite	Op	Opaque mineral
Cp	Chalcopyrite	Or	K-feldspar
Ch	Chlorite	Py	Pyrite
Cr	Chrysocolla	Qz	Quartz
Dio	Diopside	Se	Sericite
Ep	Epidote	Sp	Sphalerite
Fl	Fluorite	Sh	Sphene
Gn	Galena	Td	Tetrahedrite
G	Gangue	Ze	Zeolite
Ga	Garnet		
Gt	Goethite		
Hm	Hematite		

Thin Sections



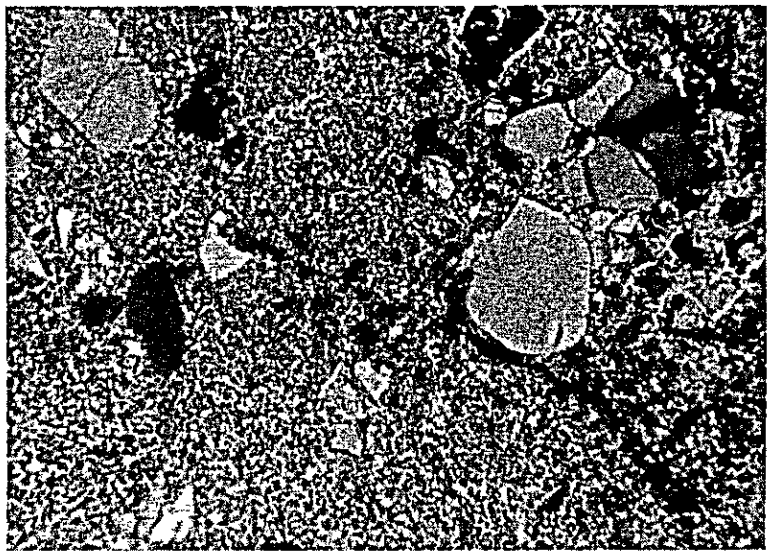
Sample No. 0201

Rock name:

Quartz porphyry

Open nicol

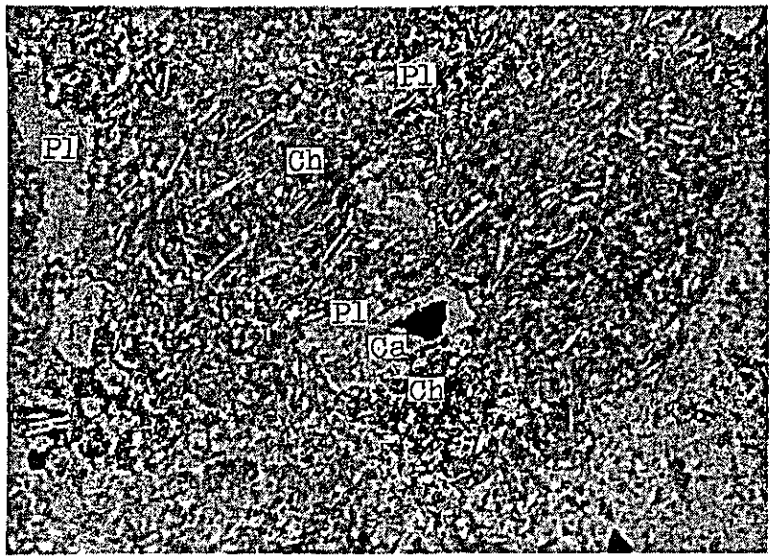
1 mm



Sample No. 0201

Crossed nicols

1 mm



Sample No. 0204

Rock name:

Tuff breccia

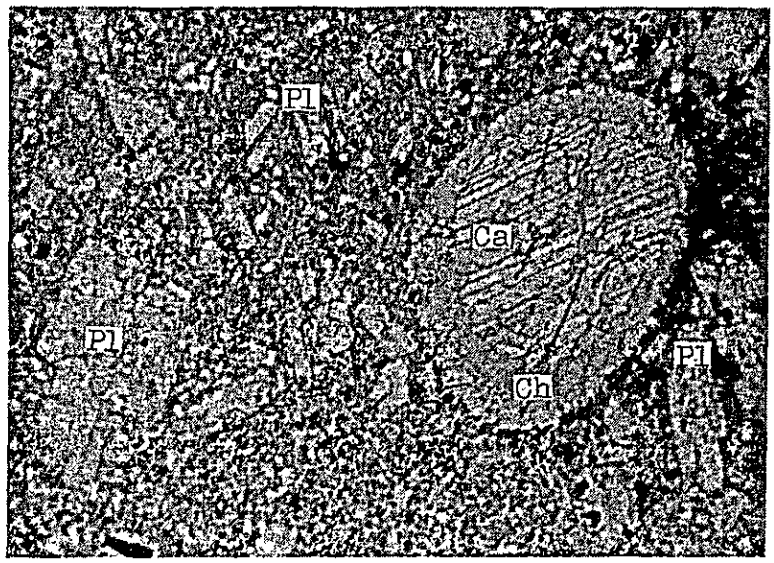
Open nicol

1 mm

Sample No. 0204

Crossed nicols

1 mm



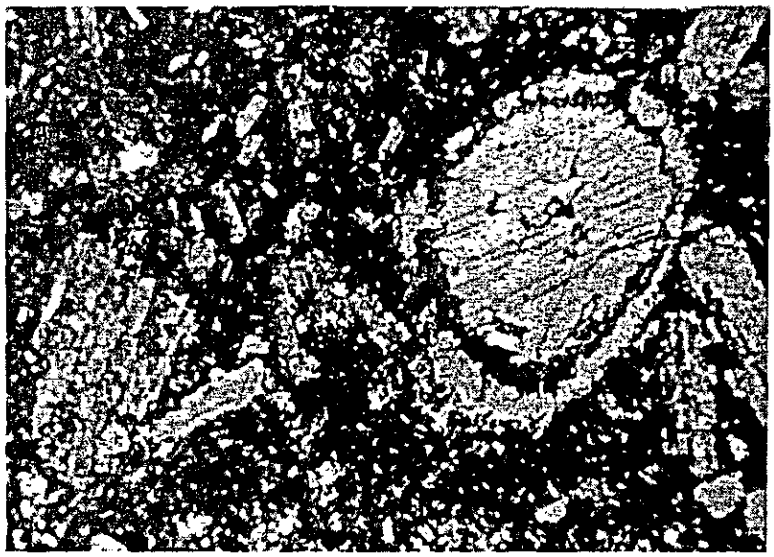
Sample No. 1601

Rock name:

Altered andesite

Open nicol

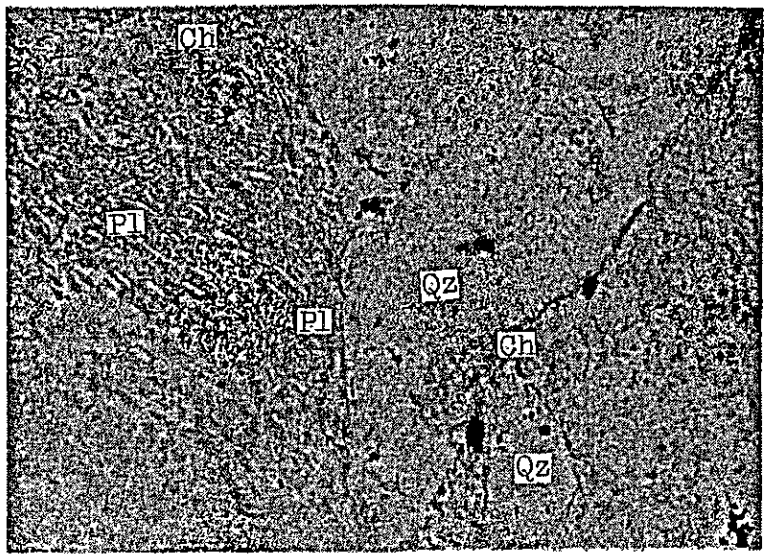
1 mm



Sample No. 1601

Crossed nicols

1 mm



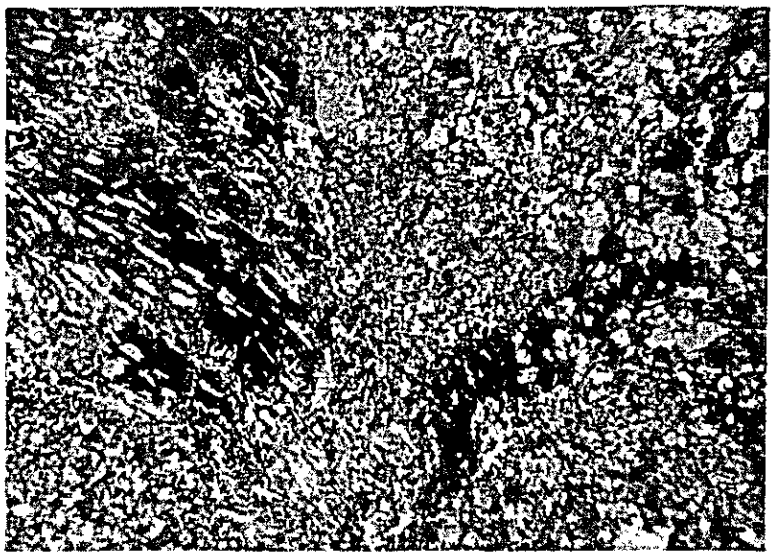
Sample No. 81105

Rock name:

Welded tuff

Open nicol

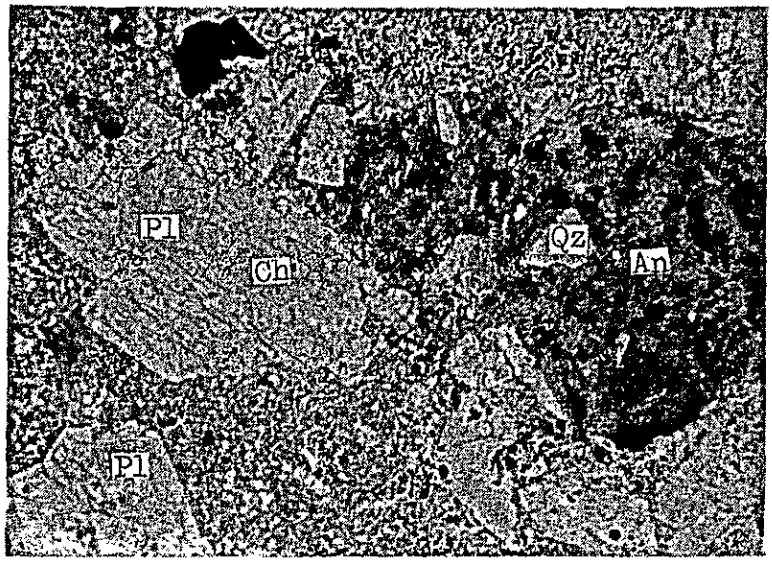
1 mm



Sample No. 81105

Crossed nicols

1 mm



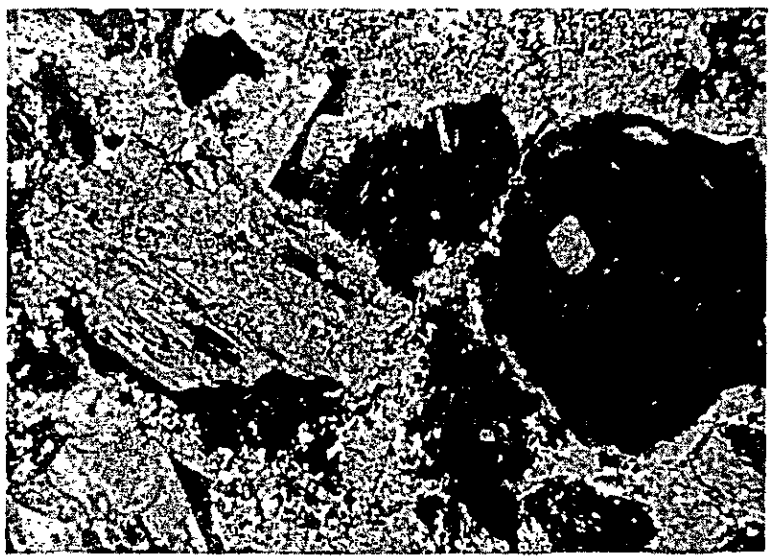
Sample No. 2202

Rock name:

Tuff breccia

Open nicol

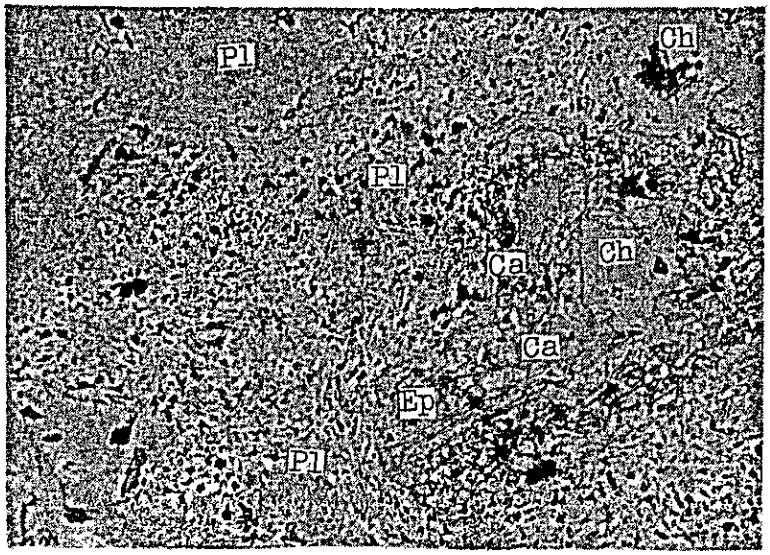
1 mm



Sample No. 2202

Crossed nicols

1 mm



Sample No. 2205

Rock name:

Altered andesite

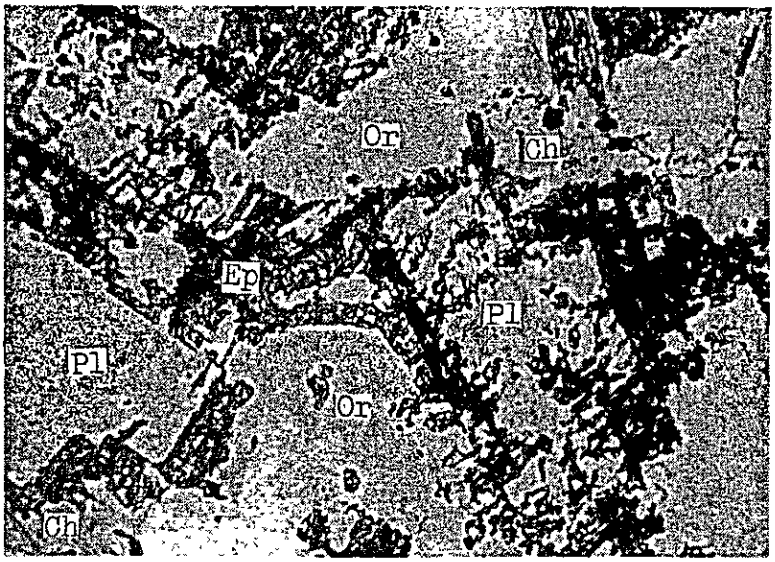
Open nicol

1 mm

Sample No. 2205

Crossed nicols

1 mm



Sample No. 71902

Rock name:

Granodiorite

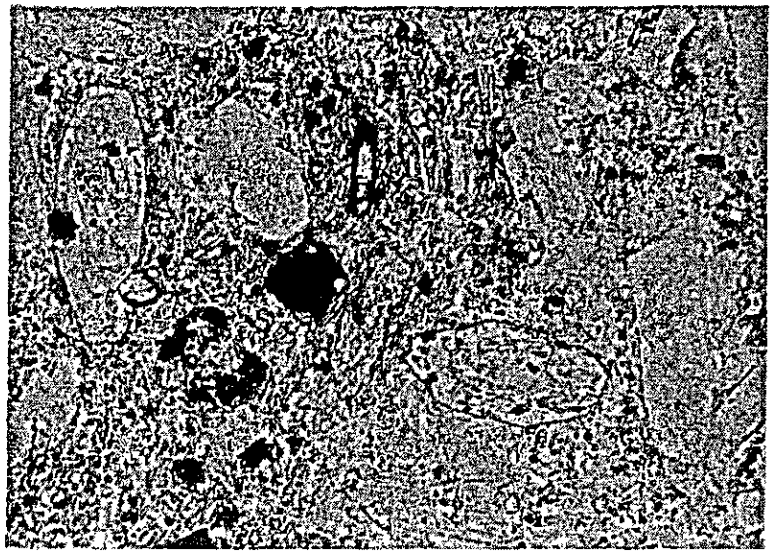
Open nicol

1 mm

Sample No. 71902

Crossed nicols

1 mm



Sample No. 81810

Rock name:

Altered andesite

Open nicol

1 mm

Sample No. 81810

Crossed nicols

1 mm

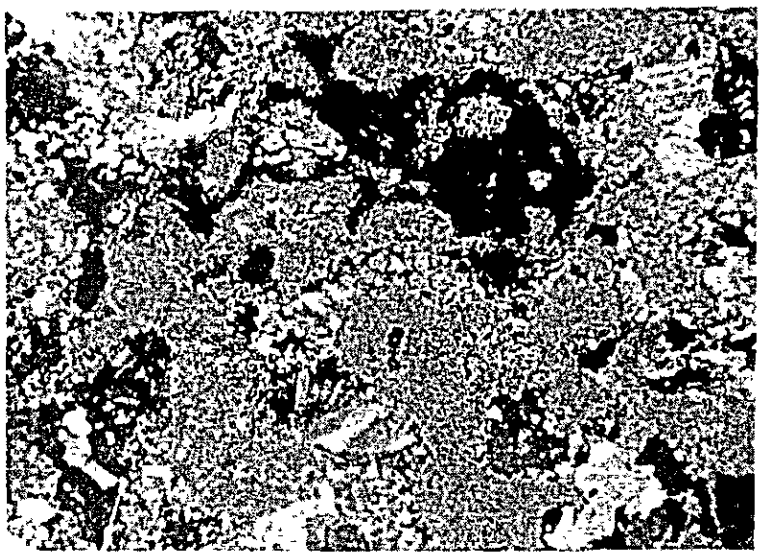
Sample No. 82601

Rock name:

Carbonaceous conglomerate

Open nicol

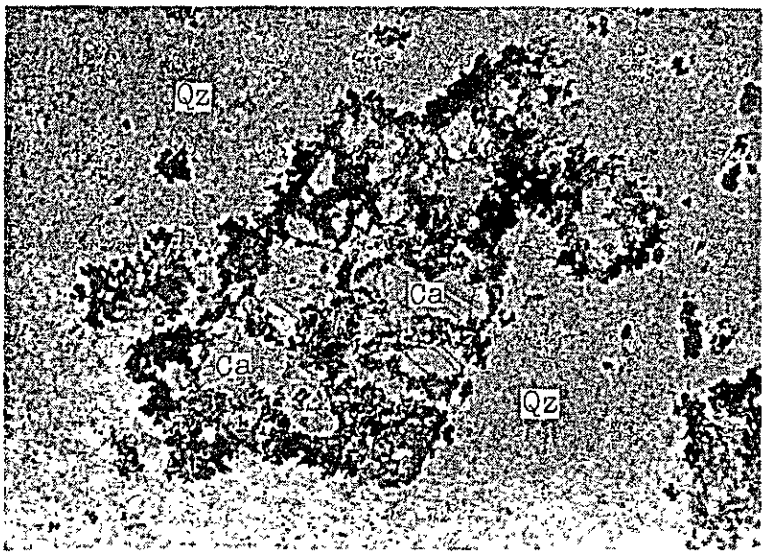
1 mm



Sample No. 82601

Crossed nicols

1 mm



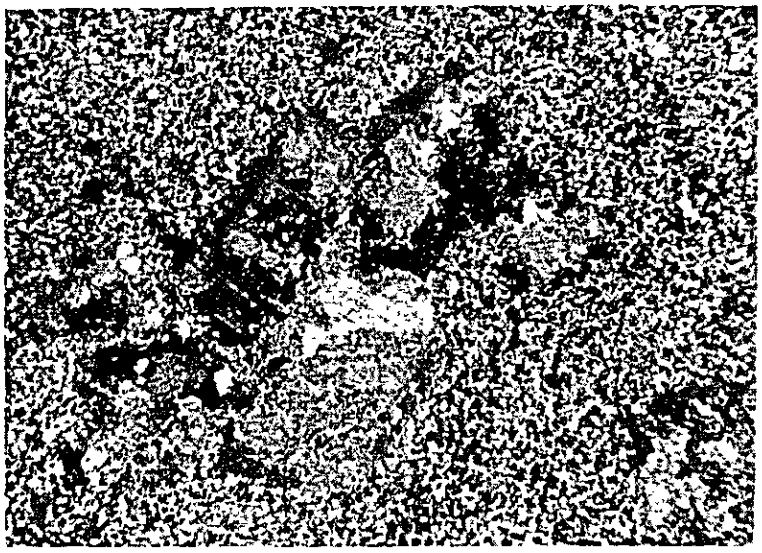
Sample No. 1161

Rock name:

Tuff

Open nicol

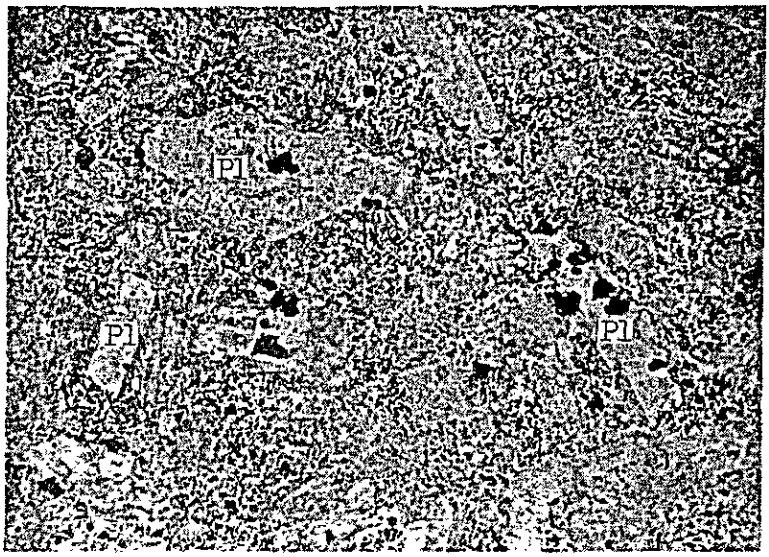
1 mm



Sample No. 1161

Crossed nicols

1 mm



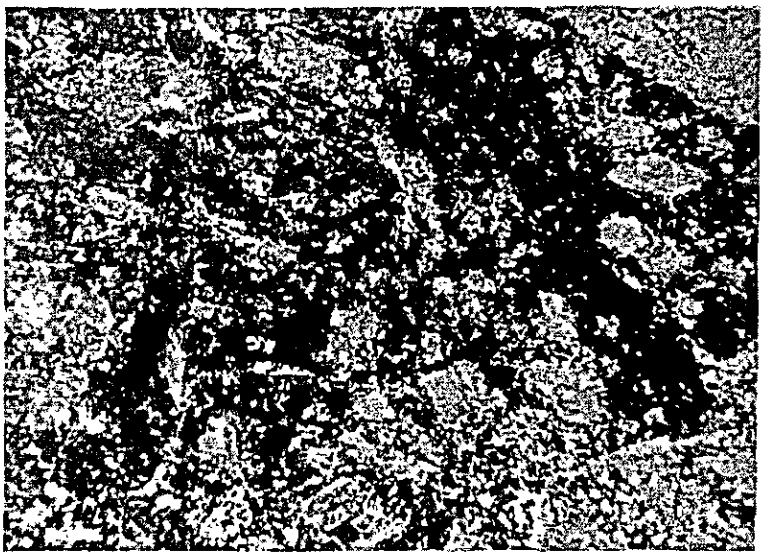
Sample No. 2276

Rock name:

Altered andesite

Open nicol

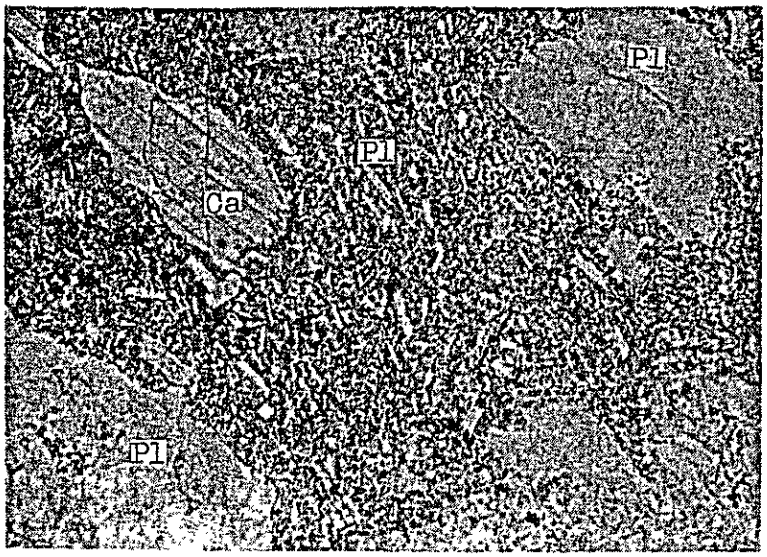
1 mm



Sample No. 2276

Crossed nicols

1 mm



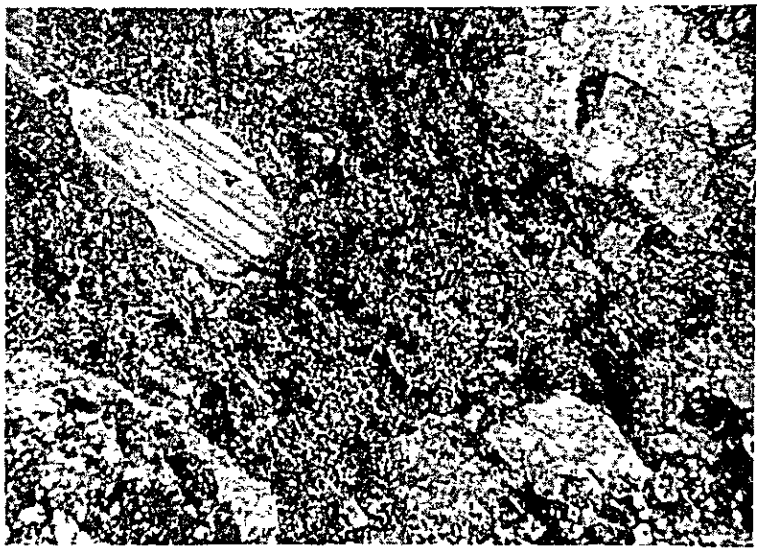
Sample No. 3340

Rock name:

Tuff breccia

Open nicol

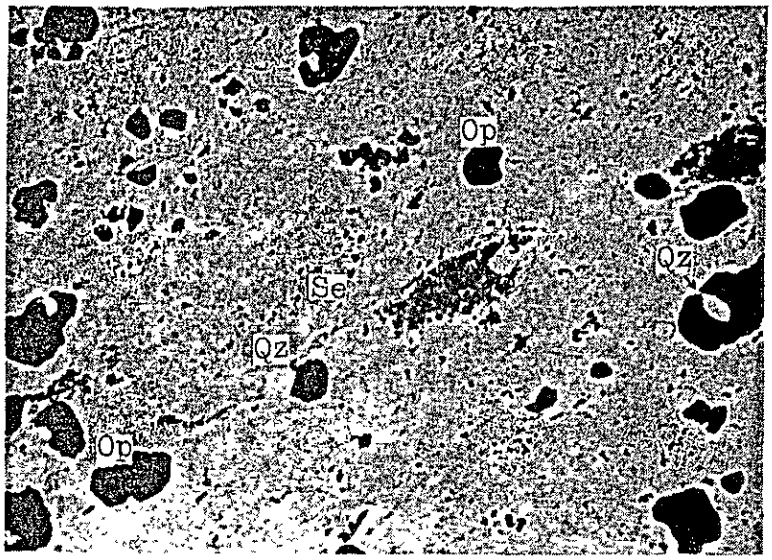
1 mm



Sample No. 3340

Crossed nicols

1 mm



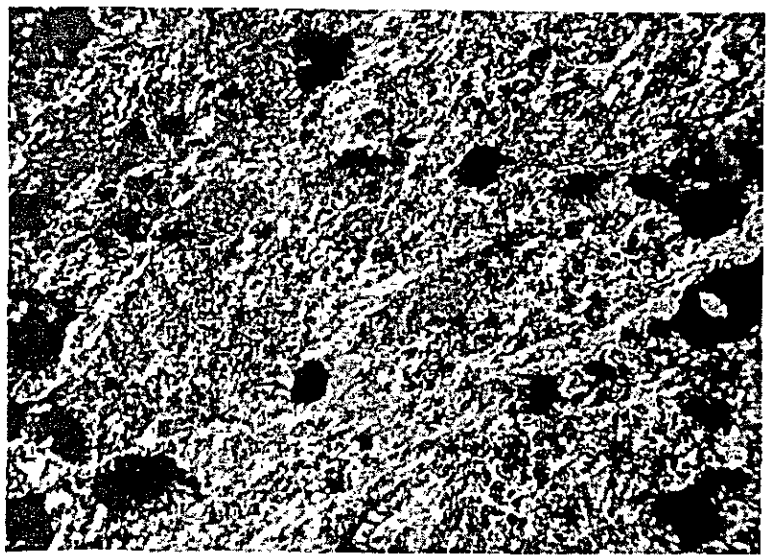
Sample No. 4221

Rock name:

Tuff

Open nicol

1 mm



Sample No. 4221

Crossed nicols

1 mm