CHAPTER 5 Colpar Area

5-1 Geology and Geological Structures

The major part of the Colpar is occupied by the Tacaza Formation (Tc) of Miocene age of Tertiary, which is overlain by the Alpabamba Formation (Al). The Quarternary Formations comprising Pausa volcano-sedimentaries (Vsp) and alluvials (al) are localized in their distribution (Fig. II-23 and II-24).

Tacaza Formation (Tc)

The Formation consists mainly of andesite lavas and andesitic pyroclastics (Tc-an). The andesite lavas are generally purple brown to dark grey colored and compact rocks with a porphyritic texture. The andesitic pyroclastics comprise tuffbreccias, lapilli tuffs and tuffs which generally look light green due to ubiquitous alteration.

In addition to the above two rock types, dacitic pyroclastics are also interbedded with andestic pyroclastics and are composed of dacitic tuffs and lapilli tuffs, including angular essential fragments in part. These rocks, being light green in color and compact, contain characteristically quartz fragments and light green lenticular patches (3 cm or less in long axes).

The thickness of the Tacaza Formation, the bottom of which is not exposed, is unknown but is estimated to exceed 800 m in this area. The stratigraphic relation between the Tacaza Formation and the underlying formation is also unknown.

According to the explanatory notes for the Caraveli and the Pausa Geologic Maps, the volcanic activity of the Tacaza Formation and its equivalents have taken place in early Miocene.

Alpabamba Formation (Al)

This Formation is observed at elevations high than 3,050 m above sea level near the eastern edge of this area and comprises light grey or light purplish grey rhyolite lavas and pyroclastics containing phenocrysts of quartz, plagioclase and biotite.

Flow structures are observed in places.

Dacitic lavas with notable flow structure are locally interbedded with the rhyolite lavas and pyroclastics.

The age of the volcanic activity of the Alpabamba Formation is believe to be of middle to late Miocene.

The Quarternary Formations

The Quarternary Formations are sporadically distributed with limited extentions along Rio Huanca Huanca and comprise the Pausa volcano-sediments (Vsp), and alluvials (al) which are further subdivided into fluvial terrace deposits (al-t), talus deposits (al-d), and river gravels (al-sd).

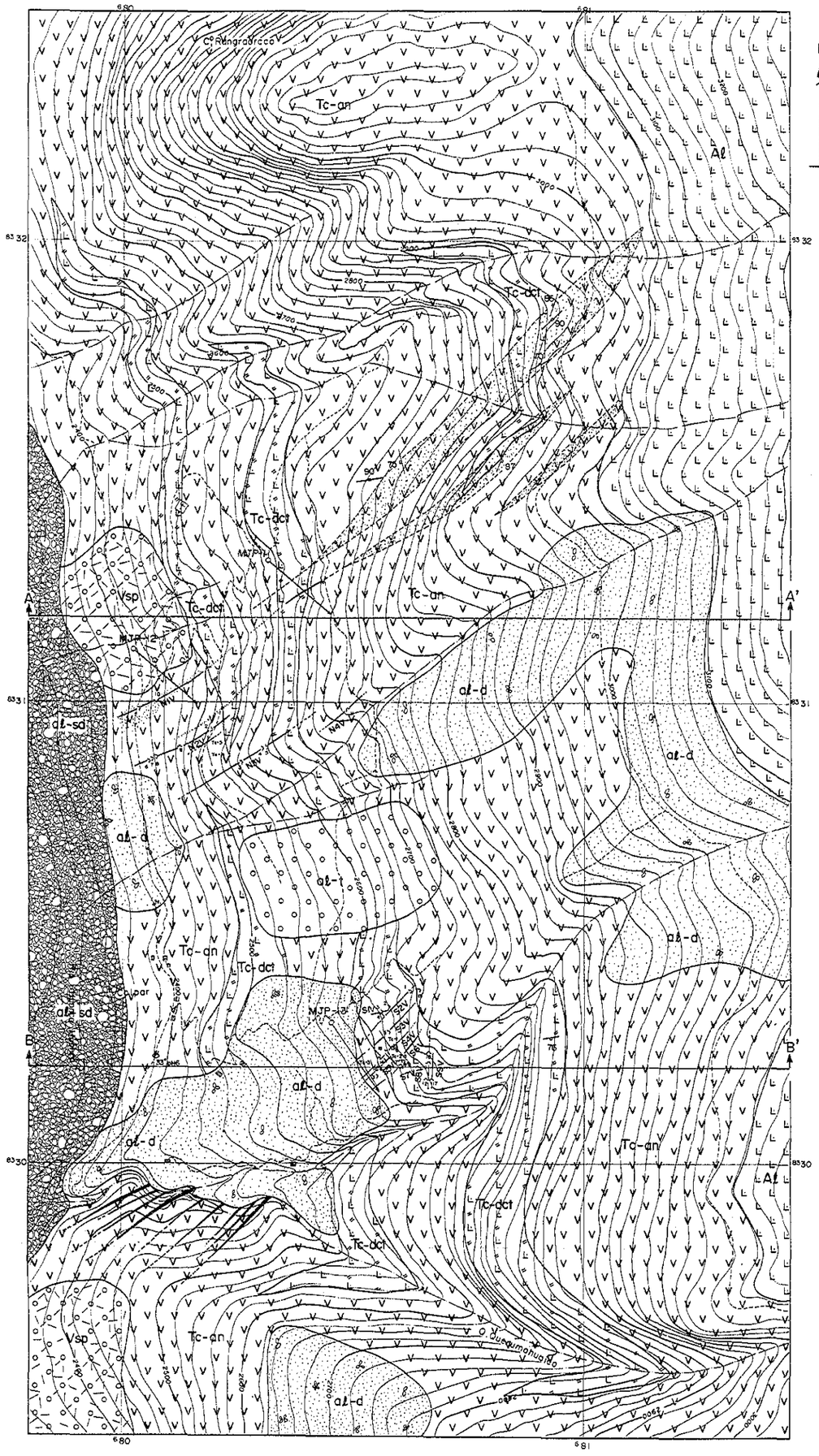
The Pausa volcano-sediments, grey to greyish white in color, are unconsolidated or semiconsolidated sedimentary rocks consisting of alternations of tuffaceous silts, sands and gravels.

Of the alluvials, fluvial terrace deposits and river gravels consist of sand and gravel layers containing abundant rounded or subrounded cobles and boulders.

The talus deposits contain abundant angular boulders in sandy soil.

Structure

Neither prominent fault nor folding structure has been observed in this area. NE-SW trending joints or fractures with steep dips are most well developed with sub-ordinate occurrences of NW-SE or N-S trending joints.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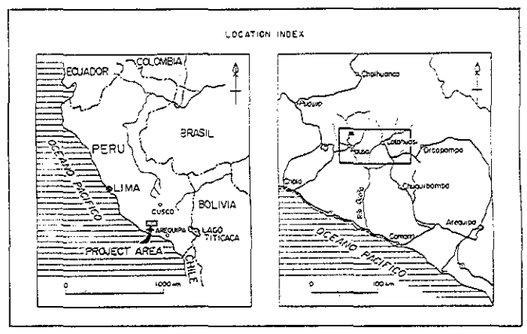
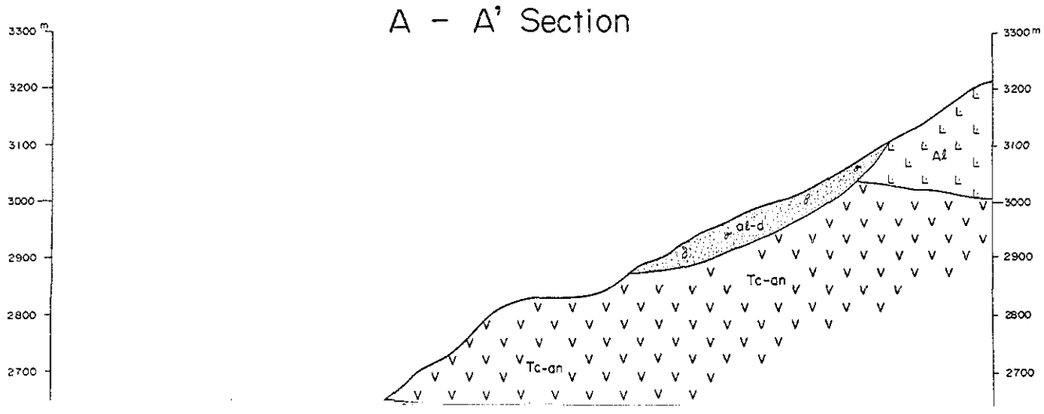

LOCATION INDEX
ECUADOR
COLOMBIA
BRASIL
PERU
OCEANO PACIFICO
LIMA
CUSCO
BOLIVIA
AREQUIPA
LAGO TITICACA
PROJECT AREA
CHILE
Chahuanca
Orcopampa
Caylloma
Chuquibamba
Arequipa
Camaná
OCEANO PACIFICO

A - A' Section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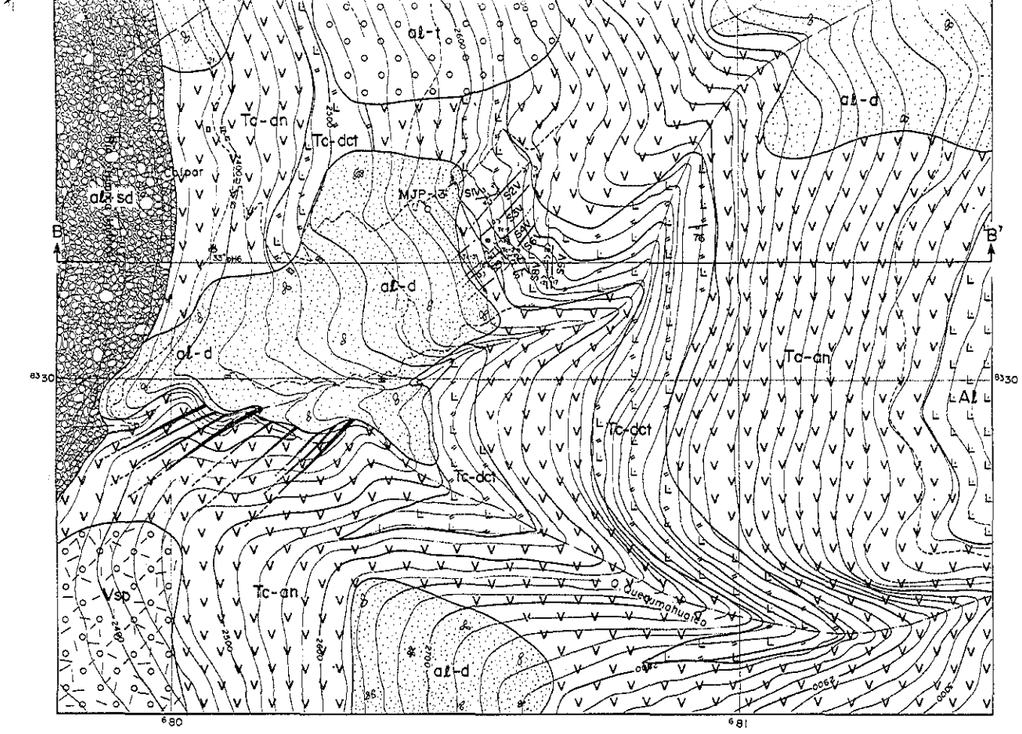
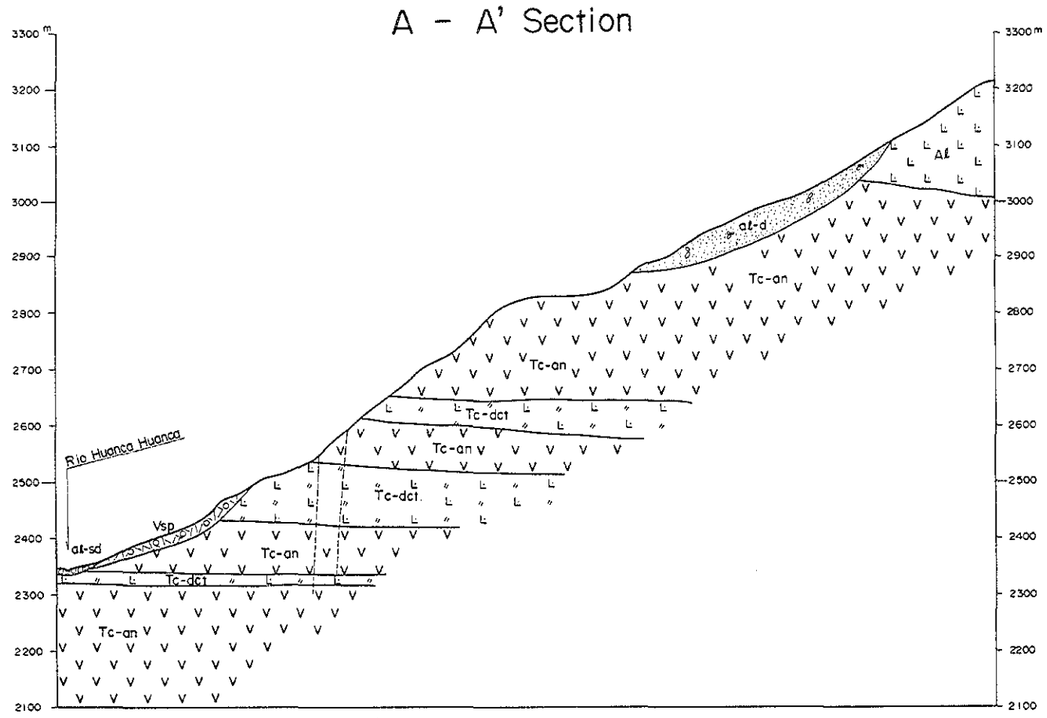
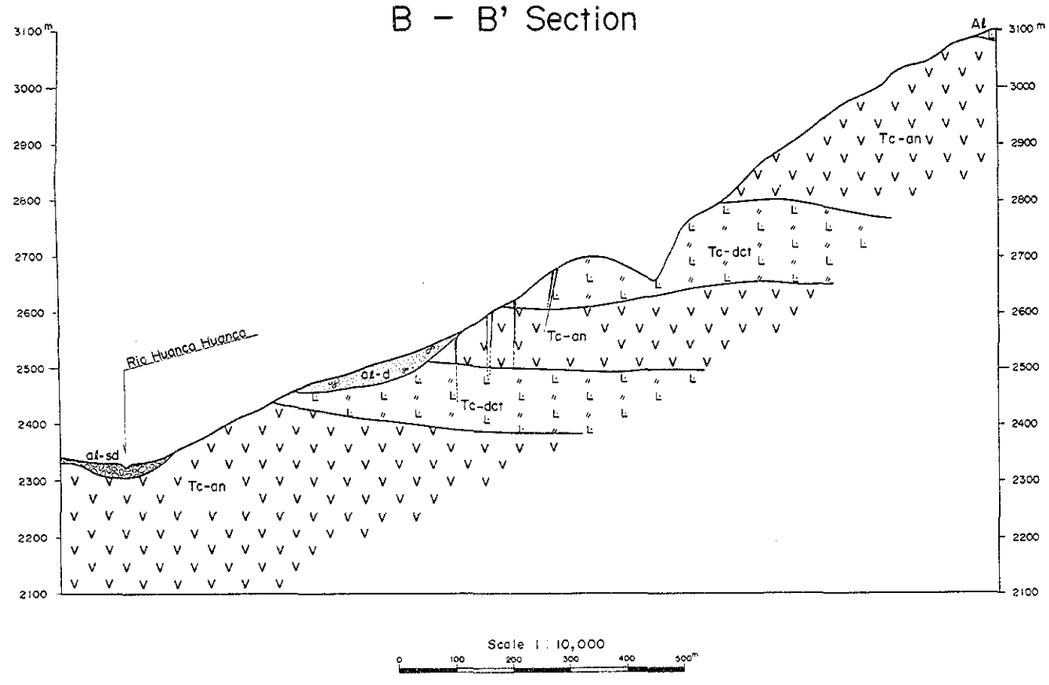


A - A' Section



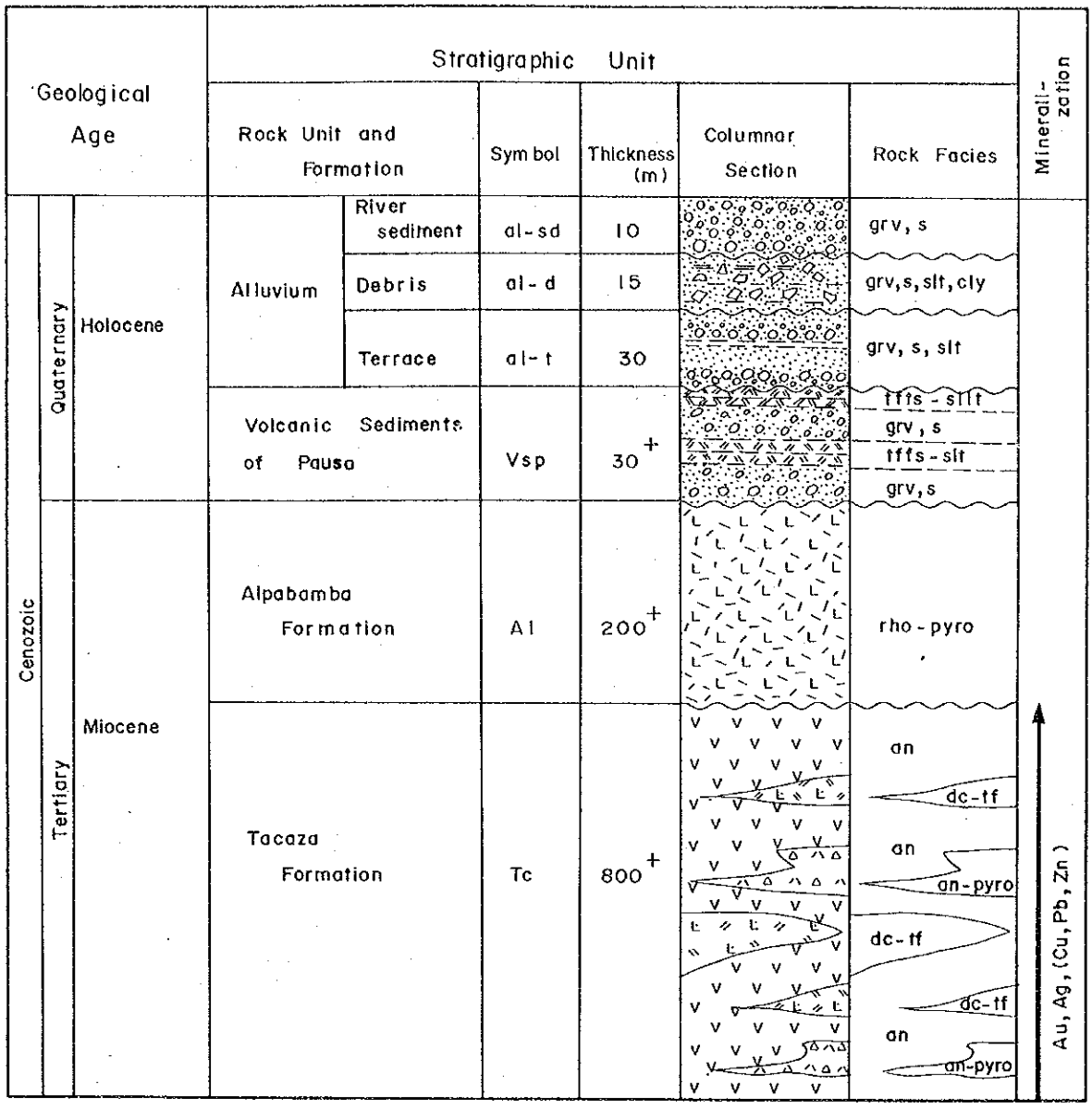
B - B' Section



LEGEND

- Quaternary
  - Holocene
    - Alluvium
      - River sediments (gravel, sand)
      - Debris (gravel, sand silt, clay)
      - Terrace (gravel, sand, silt)
    - Volcanic Sediment of Pausa — Tuffaceous silt, sand, gravel
- Tertiary
  - Miocene
    - Alpabamba Formation — Rhyolitic pyroclastic rocks
    - Tacaza Formation
      - Dacitic Pyroclastic rocks
      - Andesite lava and andesitic pyroclastic rocks
- Strike and dip of joint
- Old tunnel
- Trenching site
- Drilling site
- Mineralization zone (Au, Ag)
- Silicification zone with iron oxides

Fig. II-2 Geological Map and Section of the Colpar Area



Abbreviation

grv-----gravel , s ----- sand , slt-----silt,

cly-----clay , tffs-slt----tuffaceous silt,

rho-pyro-----rhyolitic pyroclastic rocks,

an-----andesite lava, dc-tf-----dacitic tuff,

an-pyro----andesitic pyroclastic rocks,

Fig. II-24 Stratigraphic Column of the Colpar Area

5-2 Mineralization and Alteration

The mineralization and alteration zones are hosted by the Tacaza Formation of Tertiary age and located in four places in this area; these are the northern mineralized zone in the central west, the northern silicified zone in the central north, the southern mineralized zone in the central south and the Quebrada Querumahuaico alteration zone in the south west of the area (Fig. II-25).

Of the four mineralization and alteration zones, the northern and the southern mineralized zone are prominent.

A total of 11 abandoned old workings were located in the northern mineralized zone where 4 mineralized veins had been worked in the underground. A total of 18 old workings were located in the southern mineralized zone, where 9 mineralized veins, had been worked in the underground (Fig. II-26, II-27 and Table II-23).

All the mineralized veins of both the zones consist of quartz veins, quartz vein networks and silicified zones along fractures with the NE-SW trend most predominated in the general area.

The mineralization is of gold and silver associated with copper, lead and/or zinc in places and of epithermal origin.

The identified ore minerals are electrum, argentite, polybasite, pearceite, galena, sphalerite, pyrite, hematite, limonite and ferro-manganese minerals.

Silicification is the most predominated alteration in association with occasional argillization.

An ordinary clay mineral assemblage associated with the mineralization is quartz-potash felospar-sericte with or without chlorite.

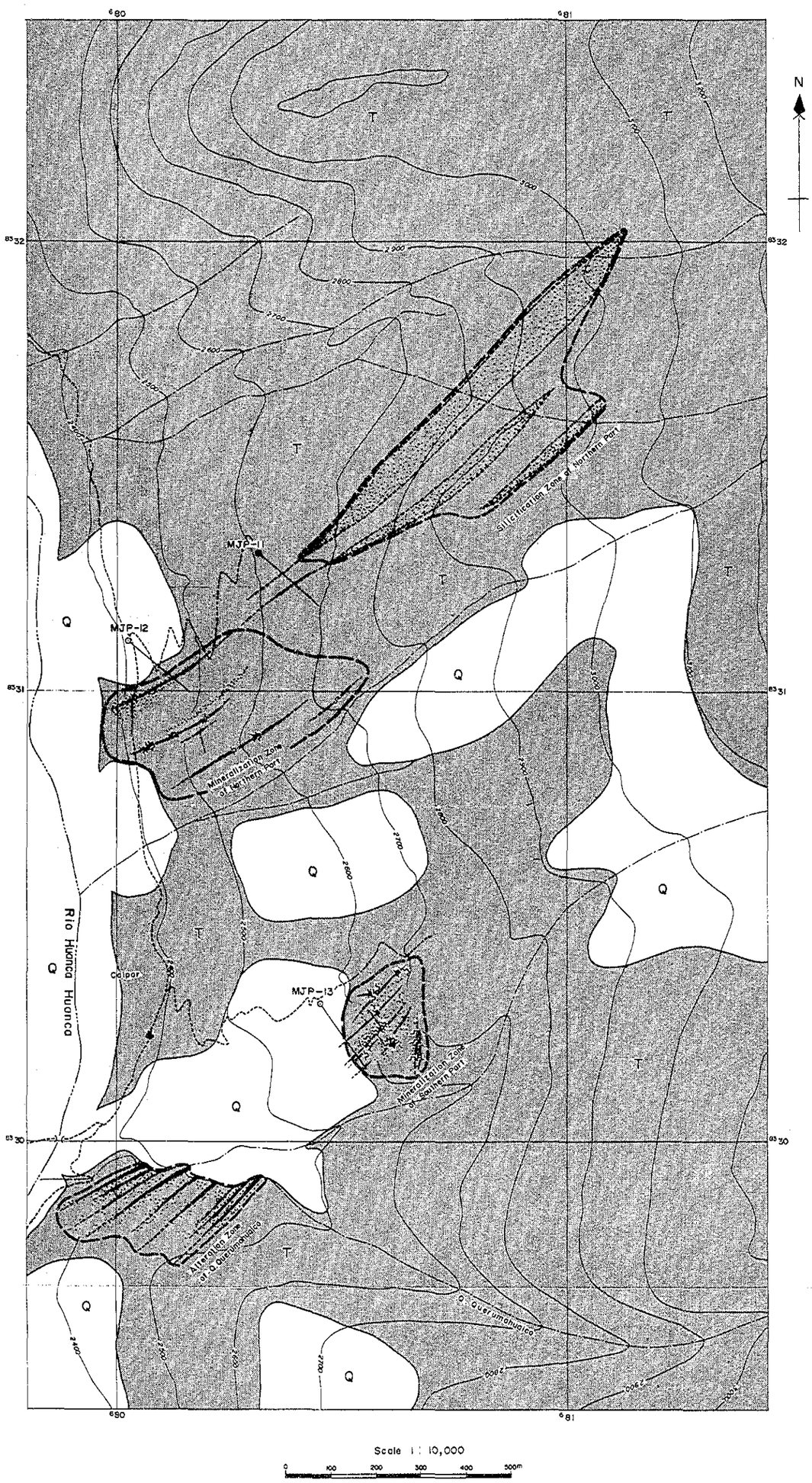
Examples of assay results of mineralized samples are 5.97 g/t Au and 640 g/t Ag for a width of 1 m in the N3 vein, 20.1 g/t Au and 1,200 g/t Ag for a width of 0.3 m in the S7 vein both in the northern mineralized zone, and

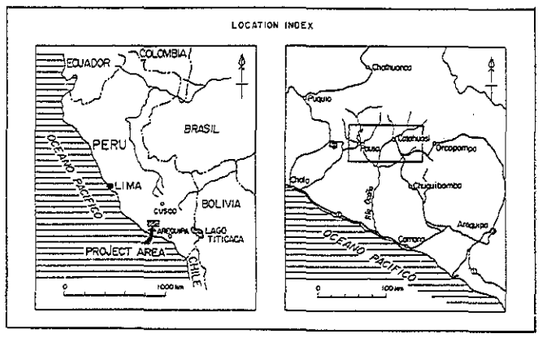
21.5 g/t Au and 410 g/t Ag for a width 0.15 m in the S3 vein in the southern mineralized zone. Silver values tend to be high in comparison with gold values.

The major mineralized veins are summarized in Table II-22 together with their sizes, assay results of collected samples, and brief description of their occurrences.

Table II-22 Important Mineralized Vain in the Colpar Area

Name of Mineralized Zone	Vein №	Probable length of Vein (m)	Direction	Probable width (m)	Tunnel №	Sample width № (m)	Assay Results		Description of Mineralization
			Strike Dip				Au g/t	Ag g/t	
Mineralized Zone of Northern part	N1V	600	N50° ~60° E, 70° ~80° NW	0.5~1.2	N1, 10	MN-11 spot (phase II)	0.41	39.3	silicified and argilized rock with iron oxides
	N2V	200	N60° ~80° E, 80° ~90° NW	0.2~0.7	N-2, 6, 7, 8, 9	N-6-4 0.5	0.89	390	sheared zone with brown iron oxides and a little quartz vein
	N3V	300	N45° ~60° E, 80° ~90° SE	0.35~1.5	N-3, 4, 5	N-3-3 1.0	5.97	640	strongly silicified rock with quartz veinlet
Mineralized Zone of Southern part	S2V	120	N50° E, 75° ~90° SE	0.3~0.5	SN-1, 4	Mz-16 0.3	3.36	142	quartz vein with pyrite mangan oxides and iron oxides
	S3V	200	N40° ~45° E, 80° ~90° SE	0.1~0.5	SN-5	S-5-5 0.15 S-5-6 0.2	21.50 11.10	410 890	brown clay and altered rock of sheared zone
	S4V	150	N45° E, 80° ~86° NW	0.1~0.5	SN-6, 6', 6", 18	S-6-1 0.1	10.10	540	brown and black clay along sheared zone
	S5V	100	N45° E, 70° NW	0.4~1.0	SN-16	S16-1 0.4	14.50	90.0	brown clay with iron oxides along many joint
	S6V	50	N35° E, 90°	0.4~0.8	SN-7, 8	Mz-12 0.45	0.14	10.5	strongly altered rock with iron oxides
	S7V	10	N55° E, ?	0.1~0.3 network	SN-9	Mz-11 0.30	20.10	1200	strongly silicified vein network with *shalerite galena and pyrite*





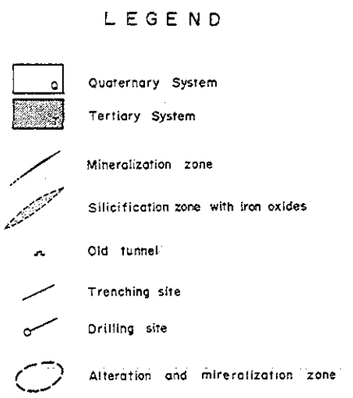
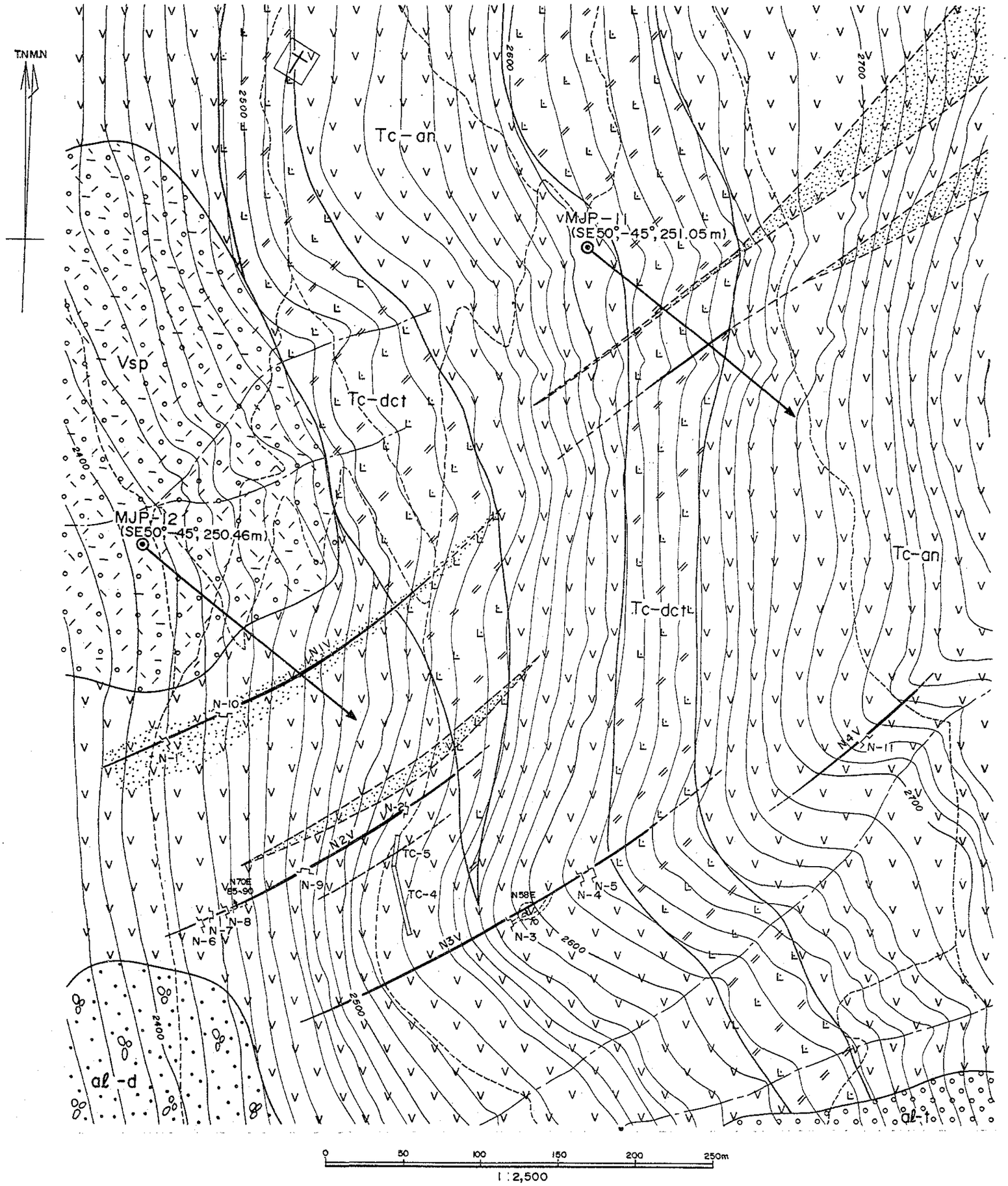


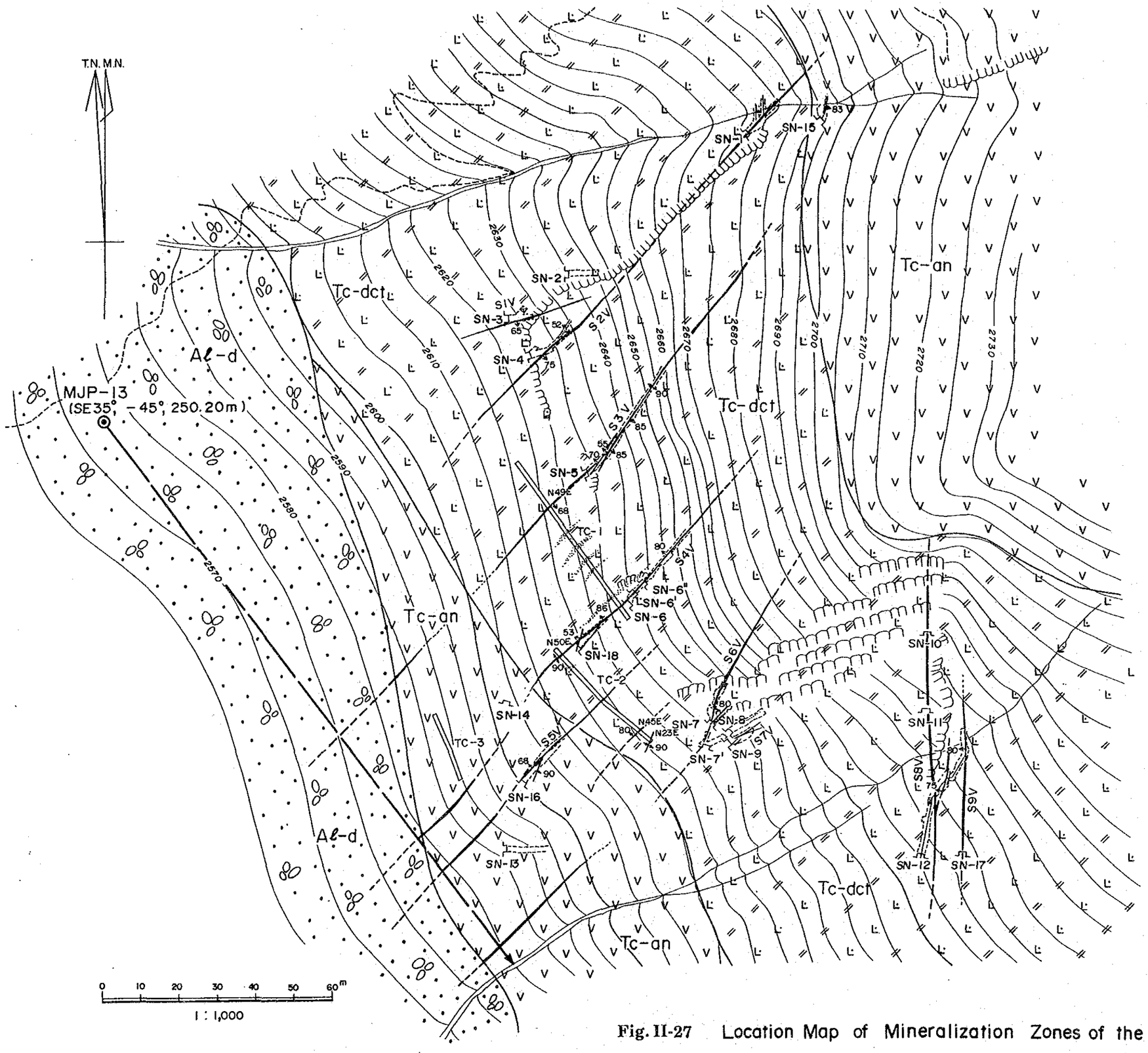
Fig. II-25 Location Map of Alteration and Mineralization Zone of the Colpar Area



LEGEND

- al-d — Debris (gravel, sand, silt)
- al-t — Terrace (gravel, sand, silt, clay)
- Vsp — Tuffaceous silt, sand, gravel
- Tc-dct — Dacitic pyroclastic rocks
- Tc-an — Andesite lava and andesitic pyroclastic rocks.
- 85 — Quartz vein and silicified zone
- Iron oxides zone
- 80 — Joint with iron oxides and clay
- Drilling site
- Trenching site
- Tunnel

Fig. II-26 Location Map of Mineralization Zones of the Northern Part of the Colpar Area



LEGEND

- Aℓ-d — Debris (gravel, sand, silt, clay)
- Tc-dct — Dacitic pyroclastic rocks
- Tc-an — Andesite lava and andesitic pyroclastic rocks.
- Quartz vein and silicified zone
- Iron oxides zone
- Joint with iron oxides and clay
- Drilling site
- Trenching site
- Tunnel

Fig. II-27 Location Map of Mineralization Zones of the Southern Part of the Colpar Area

Table II −23 List of Mineralization Zones of the Colpar Area

Name of Mineralization Zone	Mineralization			Tunnels			Assay results				description
	Name of Vein	Probable length of Vein	Strike and dip of Vein	Tunnel No.	Length of tunnel	Condition of tunnel	Sample No.	Width m	Au g/t	Ag g/t	
Mineralization Zone of Northern Part	N1V	600m±	N50° ~60° E? · 70° ~80° NW	N−1	8m+	inclined shaft	—	—	—	—	silicified and argillized rock with brown iron oxides
				N−10	?	shaft	—	—	—	—	siclicified rock with iron oxides
	N2V	200m±	N60° ~80° E·80° ~90° NW	N−2	?	shaft	—	—	—	—	network of iron oxides
				N−6	30m+	inclined shaft	N6−4	0.5	0.89	390	brown to darkbrown sheared zone with brown iron oxides clay and a little quartz veinlet
				N−7	12m+	inclined shaft	Mz−37	0.3	0.82	205	
				N−8	13m	inclined shaft	N8−2	0.5	0.89	178	
				N−9	?	shaft	—	—	—	—	
	N3V	300m±	N45° ~60° E · 80° ~90° SE	N−3	33m+	inclined shaft	N3−1	0.5	0.07	18.0	quartz vein with breccia of alfered rock
							N3−3	1.0	5.97	640	strongly silicified andesitic tuff breccia with quartz veinlet
							N3−5	0.3	0.75	86.0	strongly silicified with zone with quartz veinlet
				N−4, N−5	?	cave−in of the tunnel	—	—	—	—	
	N4V	50m±	N50° E · 50° ~70° NW	N−11	19m	inclined shaft	—	—	—	—	argillized zone along crack with iron oxides and mangane oxides (w=0.07m)
Mineralization Zone of Southern Part	S1V	10m+	N80° E · 65° SE	SN−3	5m	drift and shaft	Mz−24	0.25	1.17	55.0	sheared zone with quartz veinlets, iron oxides and clay
	S2V	120m+	N50° E · 75° ~90° SE	SN−1	12m+	inclined shaft	Mz−17	0.5	0.41	33.0	brown argillized and silicified zone with quartz veinlet along crack
				SN−4	27m+	inclined shaft	Mz−16	0.3	3.36	142.0	quartz vein with crystal pyrite, black mineral and iron oxides
	S3V	200m±	N40° ~45° E · 80° ~90° SE	SN−5	34m+	inclined shaft	S5−5	0.15	21.50	410	brown to dark brown clay along sheared zone
							S5−6	0.2	11.10	890	brown clay (w=3cm) and sheared zone (w=17cm)
				TC−1 (trench)	—	——	TC−1−2	0.2	0.69	71.0	gray strong silicified altered rock with quartz vein network
	S4V	150m±	N45° E · 80° ~86° NW	SN6, 6′, 6″	30m+	inclined shaft	S6−1	0.1	10.10	540	brown and black clay along sheared zone
				SN−18	10m+	inclined shaft	Mz−34	1.2	0.48	22.5	white grey hard silicified altered rock with iron oxides
							Mz−35	0.3	1.23	18.5	white grey strongly altered zone
	S5V	100m±	N45° E · 70° NW	SN−16	12m+	inclined shaft	S16−1	0.4	14.50	90.0	brown clay with iron oxides along joint
							S16−2	0.8	0.82	43.0	strongly altered rock along sheared zone
	S6V	50m+	N35° E · 90°	SN−7	12m+	inclined shaft	Mz−12	0.45	0.14	10.5	light grey strongly silicified altered rock
				SN−8	11m	inclined shaft	Mz−10	0.45	0.55	31.5	silicified altered rock with limonite stain
	S7V	10m+	N55° E · ?	SN−9	10m	inclined shaft	Mz−11	0.3	20.10	1200	strong silicified vein network with sphalcrite galeepa and pyrite
	S8V	60m+	NS · 75° ~80° W	S12	38.5m	inclined shaft	—	—	—	—	sheard zone with iron oxides
				SN10, SN11	?	cave−in of the tunnel	—	—	—	—	iron oxides along crack
	S9V	30m+	NS · 80° W	S12	38.5m	inclined shaft	S12−1	0.6	1.85	108.0	sheared zone with quartz veinlet along joint

5-3 Drilling Result

In the Colpar, 3 holes with depths of approximately 250 m were drilled; two in the northern mineralized zone and one in the southern mineralized zone. Mineralized intersections in these holes are summarized in Table II-25 together with other particulars of the holes.

Three holes (each 250 m long) were drilled in the Colpar, two holes, MJP-11 and 12, in the northern mineralized zone, and one hole, MJP-13, in the southern mineralized zone (Fig. II-28, II-29).

The drilling operation was performed by using two machines, Long Year 44 and 38 with adopting a wireline method. The operation performance of each hole is shown in Fig. II-30.

Each of the 3 holes penetrated several mineralized sections. The description of the mineralized intersections are summarized in Table II-24..

The geological section is prepared for each of the three holes in Fig. II-31 II-32, II-33 and II-34. The assay results and occurrences of the mineralized intersections are tabulated in Table II-25.

The MJP-11 was drilled in the northeastern extension of the northern mineralized zone and intersected the northeastern extension of the N1 vein at depth. The intersection is 5.20 m wide in core length including the associated alteration. Assay results of a 0.35 m portion of the intersection indicated 0.41 g/t Au, 104 g/t Ag, 0.34% Cu and 2.96% Pb. The mineralization is dominated by Ag and Pb.

The hole MJP-12 was drilled in the northern mineralized zone and intersected the N1 vein with a core length of 3.20 m, N2 vein with a core length of 10.0 m, both including the associated silicification zones and also minor parallel quartz veins. Assay results of the intersections of the N1 and N2 veins were low for all the analyzed elements. However, a quartz vein intersected at the depth between 75.40 and 75.60 m yielded 3.54 g/t Au and 705 g/t Ag, and a part of a silicified zone indicated 13.10 g/t Au and 360 g/t Ag at the depth between 189.0 and 189.30 m.

This hole was too short to reach the N3 vein, which was the best mineralized vein of all on the surface in the northern mineralized zone.

The hole MJP-13 was drilled in the southwestern extension of the southern mineralized zone and intersected the S3, S4 and S5 veins. The intersection of the S3 vein was 0.65 m in core length including zones of intensive silicification and that of the combined S4 and S5 veins reached 7.10 m including associated alteration zones.

An intersection at the depth between 201.14 and 201.30 m, which was correlated to a part of the S4 vein, indicated assay values of 5.04 g/t Au, 45.0 g/t Ag, 0.79% Cu, 1.37% Pb and 1.30% Zn. The Au-Ag mineralization is apparently associated with Cu, Pb and Zn.

Identified ore minerals are electrum, argentite, polybasite, galena, sphalerite and limonite, and associated alteration minerals are generally quartz, potash feldspar and sericite with or without chlorite.

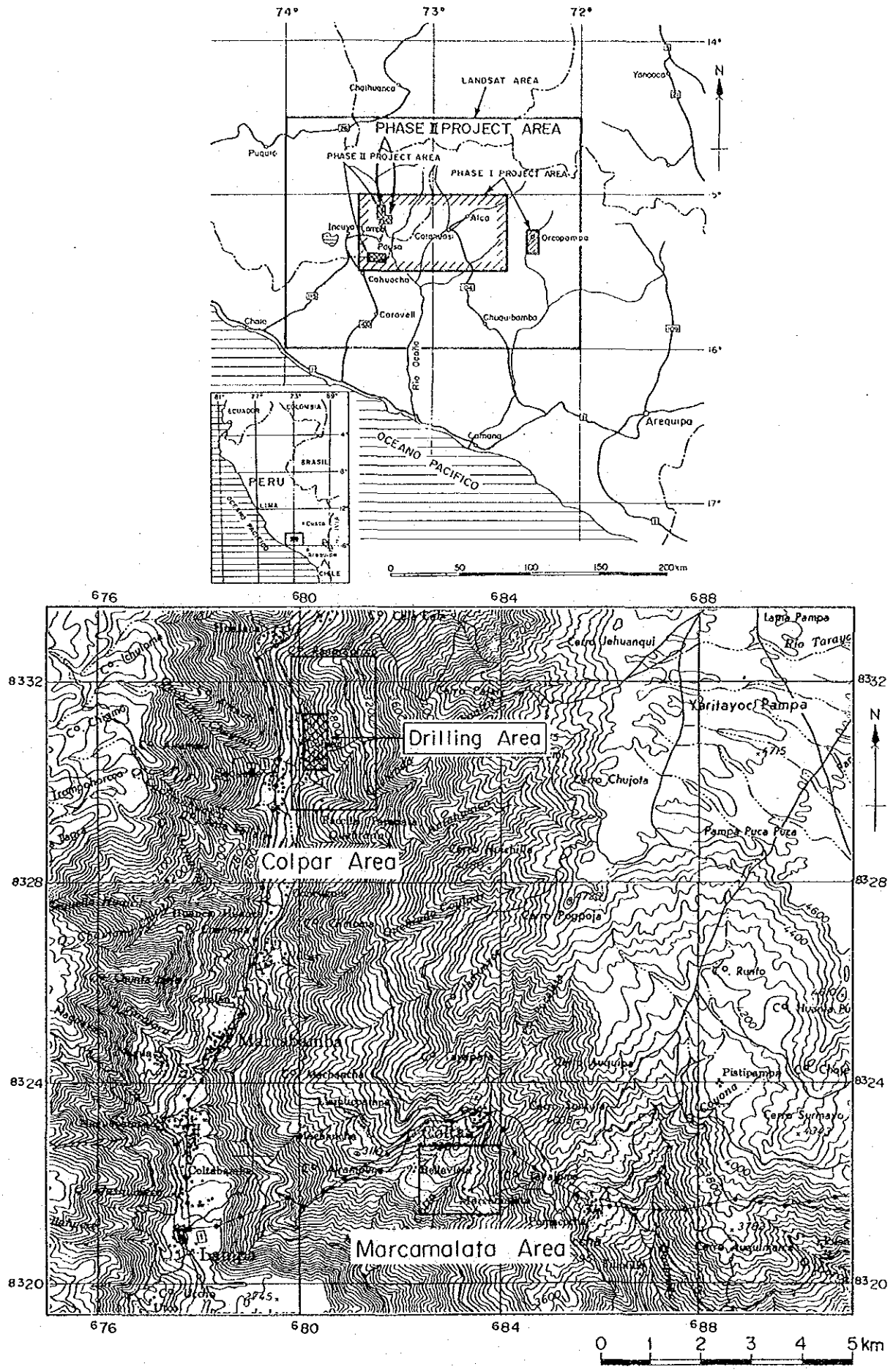


Fig. II-28 Location Map of the Drilling Sites

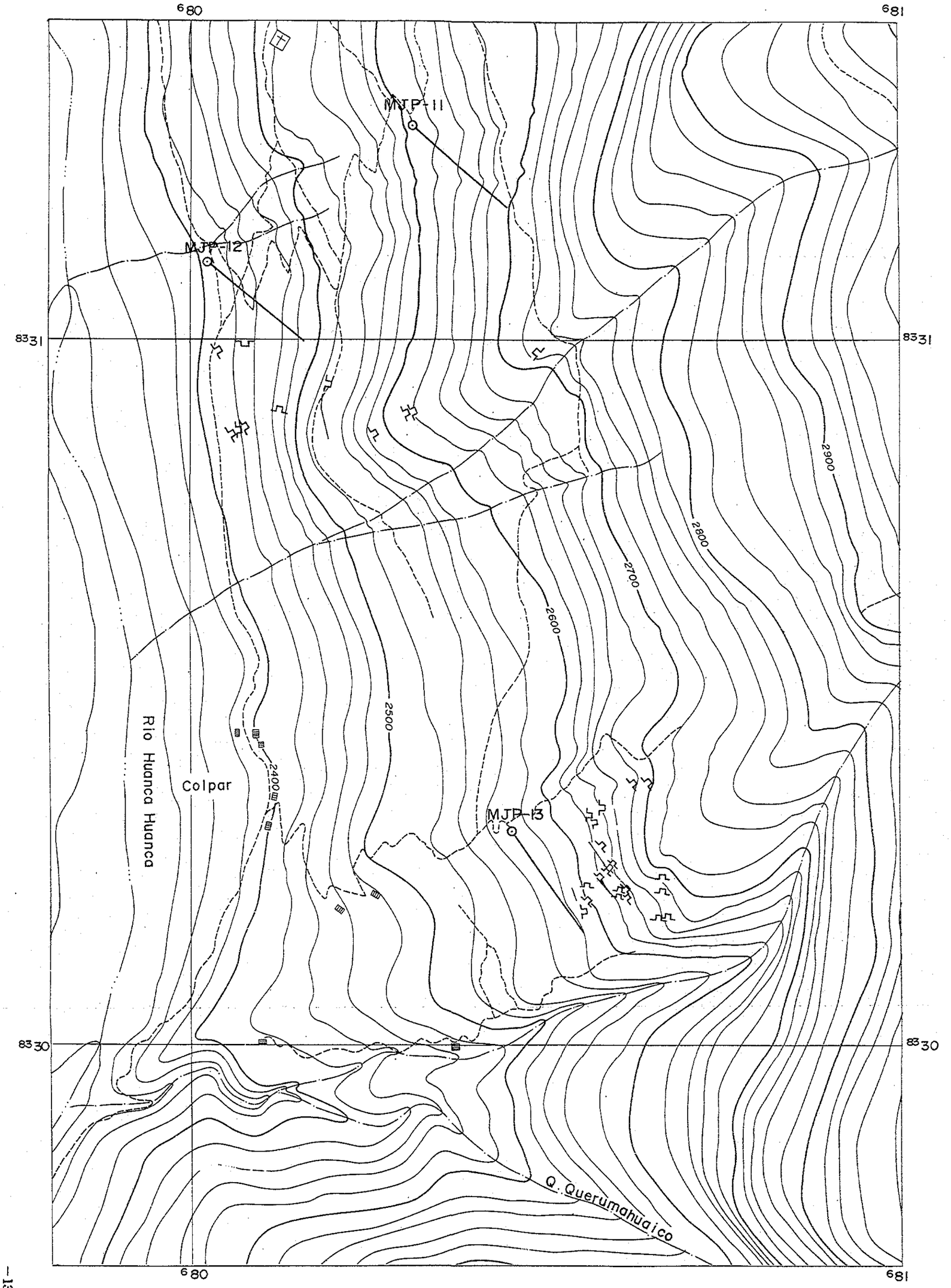


Fig.II-29 Location Map of the Drilling Sites in the Colpar Area

Scale 1 : 5,000

0 100 200 300 400 500m

Table II-24 Important Mineralized Zones and Vein in Drilling Holes of the Colpar Area

Name of Mineralized Zone	Drilling No.	Depth of Mineralized Zone (m)	Apparent width (m)	Name of Vein	Depth of Sampling (m)	Apparent width (m)	Assay Results Au g/t	Ag g/t	Cu %	Pb %	Zn %	Description of Mineralization
Mineralized Zone of Northern Part	MJP-11	117.00~122.20	5.20	NIV								silicified rock and quartz vein network with disseminated of py. 119.35~120.70m : disseminated Cp, Sp, Ga, Py
					119.35~119.70	0.35	0.41	104.0	0.34	2.96	0.01	(grey quartz vein with breccia of silicified rock and disseminated Cp, Sp, Ga, Py)
	MJP-12	75.40~76.80	1.40	–	75.40~75.60	0.20	3.54	705	–	–	–	(quartz vein (w=0.13m) with Cp, Sp, Ga)
		111.50~114.70	3.20	NIV								(strongly silicified rock with quartz vein (w=1.0)
					111.92~112.52	0.60	0.07	56.5	<0.01	0.01	0.10	(strong silicified rock)
					112.95~114.50	1.55	0.21	22.3	<0.01	<0.01	0.06	(quartz vein silicified rock)
		176.45~195.10	18.65	–								medium to strong silicified zone 186.30~193.70m (w=7.40m) : spot and lense of black mineral in silicified rock.
					189.00~189.30	0.30	13.10	360	–	–	–	(silicified rock with black lenticular vein)
		211.20~221.20	10.0	N2V								strongly silicified rock and quartz vein (w=1.7m) with disseminated py rite
					212.55~212.75	0.20	0.46	7.3	–	–	–	(black quartz vein)
Mineralized Zone of Southern Part	MJP-13	156.90~157.55	0.65	S3V	156.90~157.55	0.65	<0.07	3.6	–	–	–	(quartz vein network)
		198.70~205.80	7.10									strongly silicified rock with quartz vein (w=0.16m, w=0.70m)
				–	199.45~199.60	0.15	2.33	8.0	0.03	0.33	0.48	(silicified rock with Cp, Sp, Ga
				S4V	201.14~201.30	0.16	5.04	45.0	0.79	1.37	1.30	(quartz vein network with Cp, Sp, Ga
				S5V	203.50~204.20	0.70	0.21	18.0	0.18	0.86	1.62	(quartz vein network with Cp, Sp, Ga

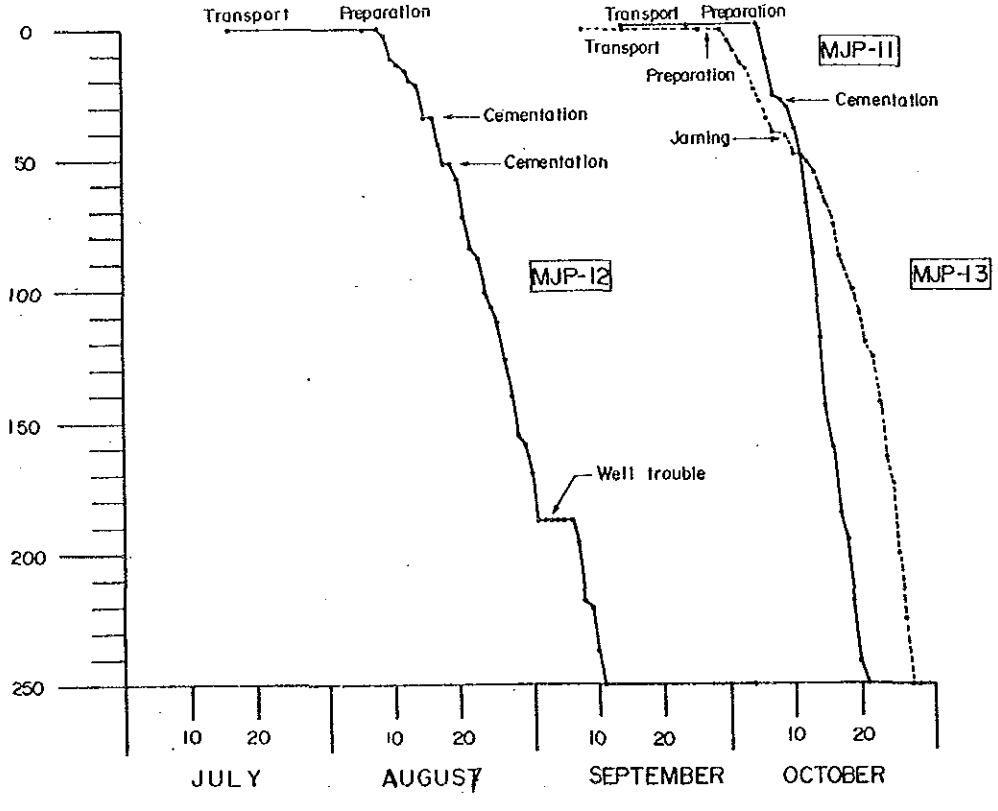


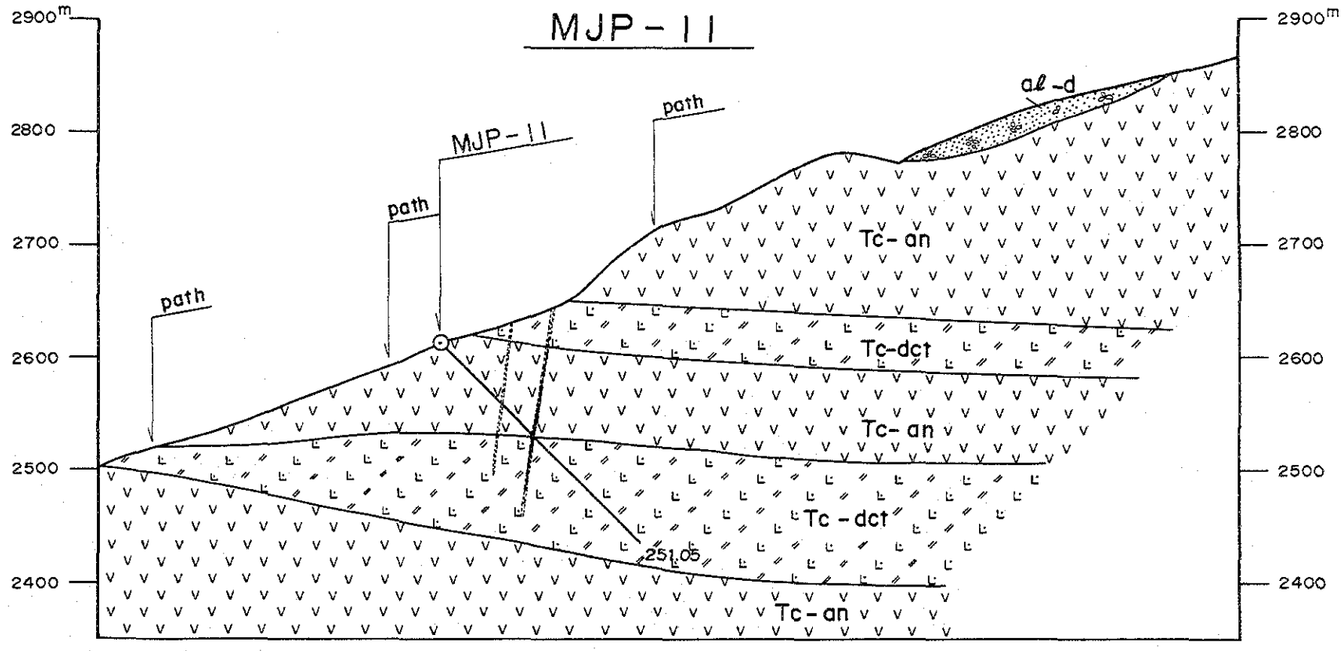
Fig. II-30 Drilling Progress of the Colpar Area (MJP-11~13)

Table. II −25 Mineralization Zones of Drilling Holes in the Colpar Area

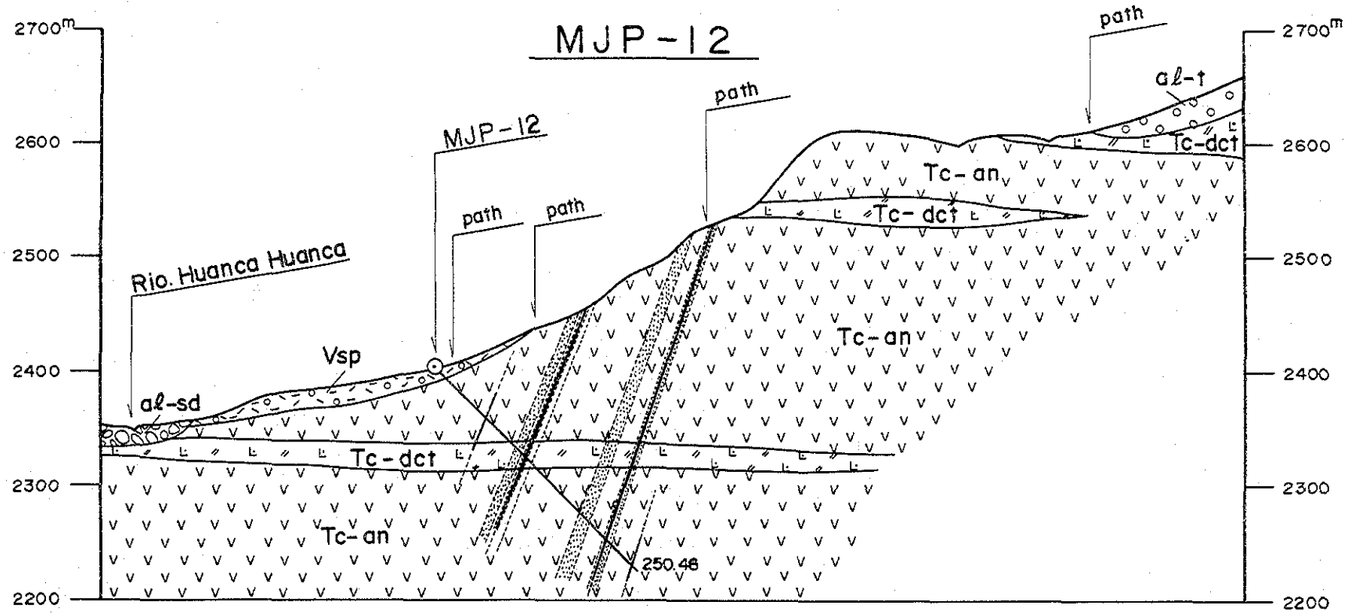
Name of Mineralization Zone	Number of Drilling	Depth of Alteration and Mineralization Zone (m)	Width (m)	Name of Vein	Alteration and Mineralization Depth (m)	Alteration and Mineralization width (m)	Description
Mineralization Zone of Northern Part	MJP−11	75.60 ~ 76.50	0.9				• light grey altered andesite with lenticular pyrite vein and partly calcite vein
		117.00 ~ 122.20	5.20		117.00 ~ 118.80	1.80	• grey to light grey bleached altered andesite with dissemination of pyrite
					118.80 ~ 119.35	0.55	• light grey strongly silicified rock.
				※N1V	119.35 ~ 120.95	1.60	• dark grey quartz vein and very strong silicified rock with quartz winlet network and dissemination of Cp, Ga. 〔119.35~119.70m (0.35m) Au 0.41g/t, Ag 104.0g/t, Cu 0.34%, Pb 2.96%〕
					120.95 ~ 122.20	1.25	• light grey strongly silicified rock
	MJP−12	63.80 ~ 65.67	1.87				• grey to light grey strong silicified rock with dissemination of pyrite and quartz vein (w=0.13m)
		75.40 ~ 76.80	1.40	※			• light grey strongly silicified rock with quartz vein 〔75.40~75.60m (0.20m) Au 3.54g/t, Ag 705g/t〕
		88.00 ~ 88.08	0.08				• grey quartz vein
		88.67 ~ 88.75	0.08				• grey quartz vein
		100.50 ~ 108.20	7.70				• white grey strongly silicified rock
		111.50 ~ 114.70	3.20	N1V	111.50 ~ 112.95	1.45	• light grey strongly silicified rock with black mineral (Ag, Mn, Sp, Py) • 〔111.92~112.52m (0.60m) Au 0.07g/t, Ag 56.5g/t〕
					112.95 ~ 113.95	1.00	• dark grey quartz vein with blackmineral (Ag, Mn, Py)
					113.95 ~ 114.70	0.75	• light grey strong silicified rock with black mineral (Sp, Ag?)
		119.80 ~ 123.30	3.50				• light grey strongly silicified rock with black veinlet network and dissemination of pyrite
		176.45 ~ 195.10	18.65		176.45 ~ 186.30	9.85	• light grey medium to strongly silicified andesitic tuff, bleached
				※	186.30 ~ 193.70	7.40	• light grey strongly silicified rock with black dots and lenticular vein of black mineral (Sp, Mg, Py, Mn?) 〔189.00~189.30m (0.30m) Au 13.10g/t, Ag 360g/t〕
					193.70 ~ 193.80	0.10	• quartz−chlorite vein with black mineral
					193.80 ~ 195.10	1.30	• light grey strongly silicified rock
		211.20 ~ 221.20	10.00		211.20 ~ 212.30	1.10	• white grey strongly silicified andesitic tuff with dots of black mineral (Py?)
				N2V	212.30 ~ 214.00	1.70	• dark grey to grey quartz vein with black mineral (Py?) 〔212.55~212.75m (0.20m) Au 0.48g/t, Ag 7.3g/t〕
					214.00 ~ 221.20	7.20	• white grey strongly silicified andesitic tuff with black veinlets and dots
		246.58 ~ 246.78	0.20				• grey quartz−feldspar vein
		247.70 ~ 248.40	0.70				• white quartz vein network
Mineralization Zone of Southern Part	MJP−13	156.90 ~ 157.55	0.65	S3V			• dark grey strongly altered rock with white quartz veinlets network and grey clay
		198.70 ~ 205.80	7.10		198.70 ~ 201.14	2.44	• white grey strongly altered rock with dissemination of pyrite
				※S4V	201.14 ~ 201.30	0.16	• white quartz vein network with Sp, Ga, Cp, Py 〔201.14~201.30m (0.16m) Au 5.04g/t, Ag45.0g/t, Cu 0.79%, Pb 1.37%, Zn 1.30%〕
					201.30 ~ 203.50	2.20	• white grey strongly altered rock
				S5V	203.50 ~ 204.20	0.70	• white grey strongly altered rock with dissemination and veinlets of Sp, Cp, Ga, Py
					204.20 ~ 205.80	1.60	• white grey strongly altered rock with dissemination of pyrite
		225.00 ~ 227.40	2.40	S6V?			• light grey altered dacitic tuff with dissemination of pyrite and black fine vein

Abbreviations. Cp : chalcopyrite, Sp : Sphalerite, Ga : galena, Py : pyrite, Mg : magnetite, Mn : mangan Au : gold, Ag : silver,
※ : strongly mineralization zone

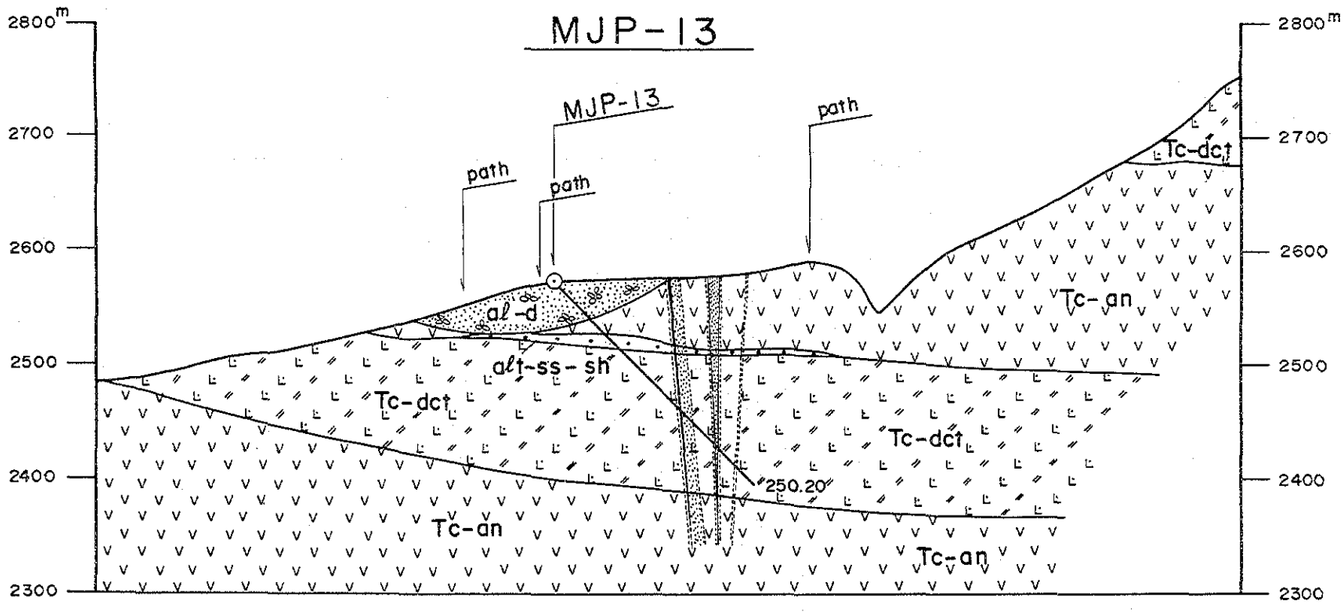
MJP - 11



MJP - 12



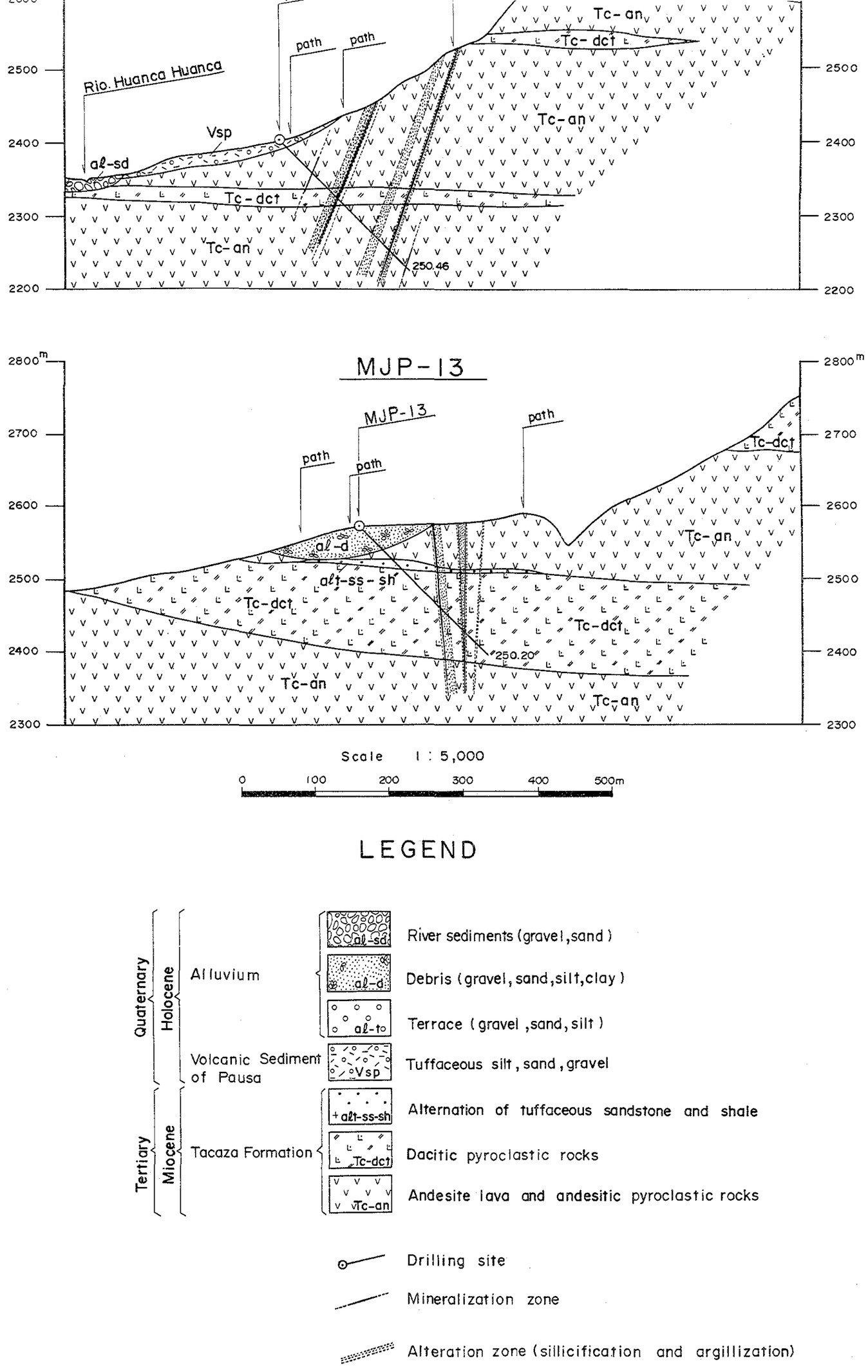
MJP - 13



Scale 1 : 5,000

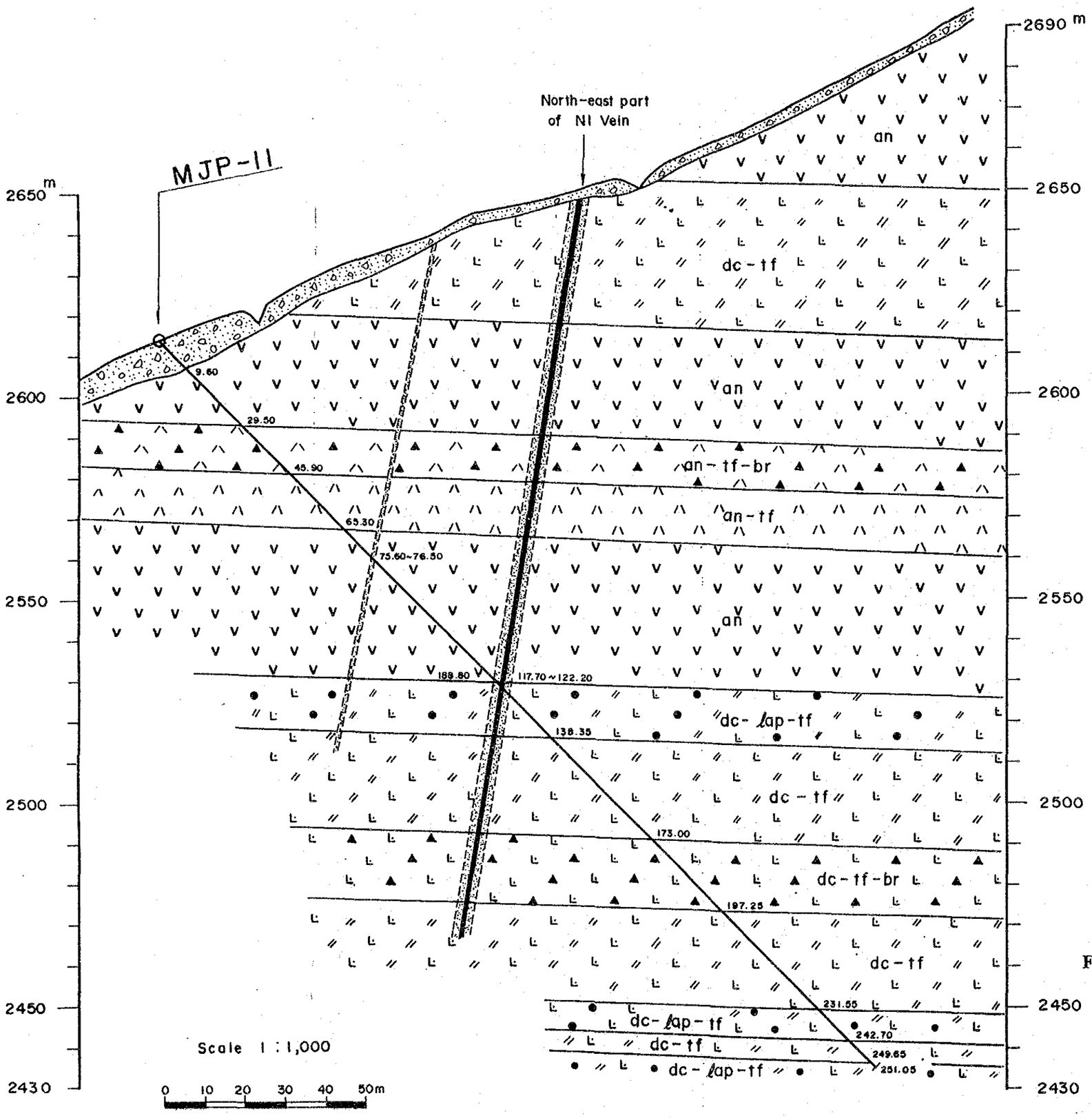
0 100 200 300 400 500m

LEGEND



LEGEND

Fig. II-31 Geological Section of the Drilling Holes (MJP-11,12,13) in the Colpar Area (scale 1:5,000)



MJP-11

Grand level : 2613.9m
Direction : SE 50°
Angle : -45°
Depth : 251.05m

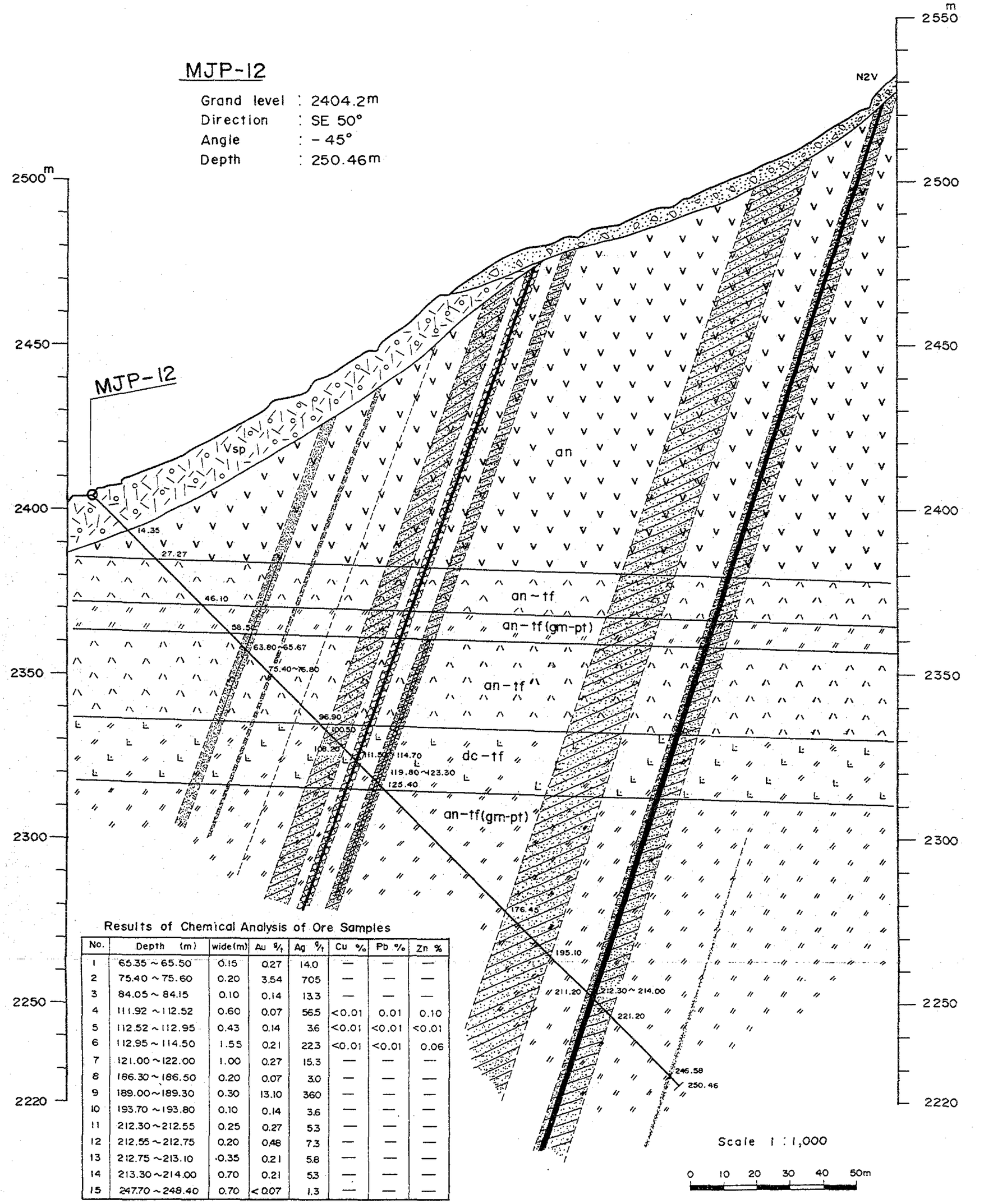
Results of Chemical Analysis of Ore Samples

No.	Depth (m)	wide(m)	Au %	Ag %	Cu %	Pb %	Zn %
1	119.35~119.70	0.35	0.41	104.0	0.34	2.96	0.01
2	119.70~120.10	0.40	0.14	32.3	0.08	0.29	<0.01
3	120.10~120.95	0.85	0.14	28.3	0.03	0.17	0.02

Fig. II-32 Geological Section of Drilling Hole MJP-11 in the Colpar Area

MJP-12

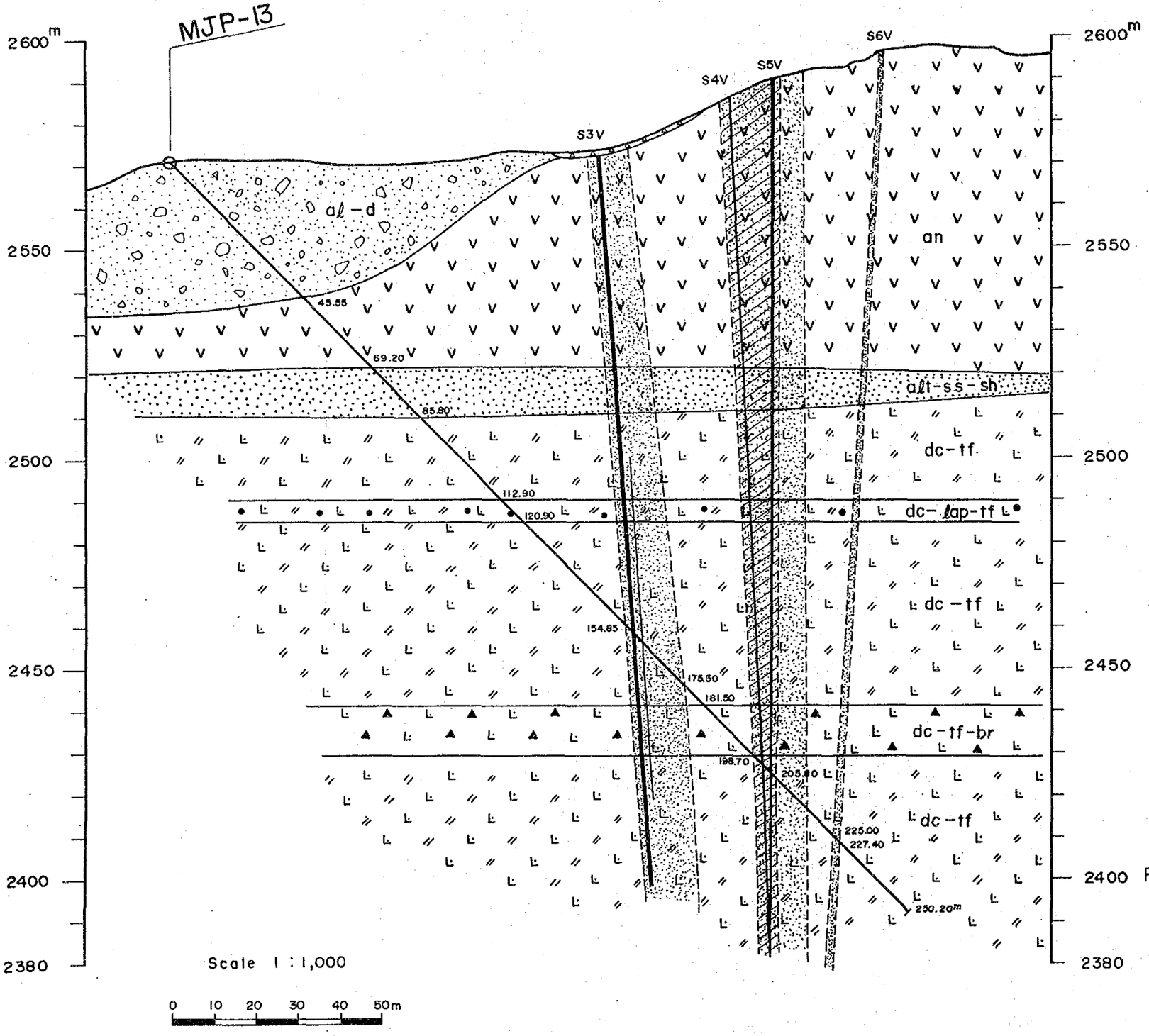
Grand level : 2404.2m
Direction : SE 50°
Angle : -45°
Depth : 250.46m



Results of Chemical Analysis of Ore Samples

No.	Depth (m)	wide(m)	Au g/t	Ag g/t	Cu %	Pb %	Zn %
1	65.35 ~ 65.50	0.15	0.27	14.0	—	—	—
2	75.40 ~ 75.60	0.20	3.54	705	—	—	—
3	84.05 ~ 84.15	0.10	0.14	13.3	—	—	—
4	111.92 ~ 112.52	0.60	0.07	56.5	<0.01	0.01	0.10
5	112.52 ~ 112.95	0.43	0.14	3.6	<0.01	<0.01	<0.01
6	112.95 ~ 114.50	1.55	0.21	22.3	<0.01	<0.01	0.06
7	121.00 ~ 122.00	1.00	0.27	15.3	—	—	—
8	186.30 ~ 186.50	0.20	0.07	3.0	—	—	—
9	189.00 ~ 189.30	0.30	13.10	360	—	—	—
10	193.70 ~ 193.80	0.10	0.14	3.6	—	—	—
11	212.30 ~ 212.55	0.25	0.27	5.3	—	—	—
12	212.55 ~ 212.75	0.20	0.48	7.3	—	—	—
13	212.75 ~ 213.10	0.35	0.21	5.8	—	—	—
14	213.30 ~ 214.00	0.70	0.21	5.3	—	—	—
15	247.70 ~ 248.40	0.70	< 0.07	1.3	—	—	—

Fig. II-33 Geological Section of Drilling Hole MJP-12 in the Colpar Area



MJP-13

Grand level : 2571.3 m
Direction : SE 35°
Angle : −45°
Depth : 250.20 m

▪Results of Chemical Analysis of Ore Samples

No.	Depth (m)	wide (m)	Au g/t	Ag g/t	Cu %	Pb %	Zn %
1	156.90 ~ 157.55	0.65	<0.07	3.6	—	—	—
2	199.45 ~ 199.60	0.15	2.33	8.0	0.03	0.33	0.48
3	199.60 ~ 200.60	1.00	0.27	1.9	<0.01	0.06	0.03
4	200.60 ~ 201.14	0.54	0.48	6.3	0.06	0.14	0.29
5	201.14 ~ 201.30	0.16	5.04	45.0	0.79	1.37	1.30
6	201.30 ~ 202.05	0.75	<0.07	2.3	<0.01	0.03	0.07
7	202.05 ~ 202.75	0.70	0.07	4.1	0.03	0.04	0.13
8	202.75 ~ 203.50	0.75	<0.07	5.0	0.06	0.12	0.14
9	203.50 ~ 204.20	0.70	0.21	18.0	0.18	0.86	1.62
10	204.20 ~ 205.05	0.85	<0.07	1.3	<0.01	0.01	0.02

Fig.II-34 Geological Section of Drilling Hole MJP-13 in the Colpar Area

5-4 Summary of the Results in the Colpar

The two mineralized zones, the northern and the southern mineralized zones, hosted by the Tacaza Formation of Tertiary age, have been outlined in the area; 4 veins have been identified in the former and 9 veins in the latter.

All of the 4 veins in the northern and most of the 9 veins of the southern mineralized zones are associated with fractures trending NE-SW which is a major structural trend in the area. There have been observed variable occurrences of the veins, such as quartz veins, quartz vein networks and silicified fracture zones (Fig. II-25).

Major Au and Ag minerals are electrum, argentite polybasite and pearceite associated with galena, sphalerite, chalcopyrite and pyrite. Electrum contains about 52% Au and 48% Ag.

The alteration mineral assemblage is quartz-potash feldspar (aduralia)-sericite with or without chlorite in general.

The above features of the mineralization and alteration suggest that the veins are of epithermal origin.

A surface sample of the N3 vein in the northern mineralized zone yielded values of 5.79 g/t Au and 640 g/t Ag for a width of 1 m across the vein.

The hole MJP-11 in the northern mineralized zone intersected the N1 vein for a core length of 0.35 m, the sample of which was assayed at 0.41 g/t Au, 104 g/t Ag, 0.34% Cu, 2.96% Pb and 0.01% Zn.

The other hole MJP-12 in the same zone intersected a number of quartz veins, and intensively silicified zones, of which the veins correlated to the N1 and N2 veins were low in Au and Ag values. However, a quartz vein for a core length of 0.20 m yielded 3.54 g/t Au and 705 g/t Ag and an intensively silicified zone for a core length of 0.30 m indicated 13.10 g/t Au and 360 g/t Ag.

The surface indications and the drill intersections suggest that the N1 vein may extend for approximately 600 m along strike.

The northern silicified zone, being located to the northeast of the northern mineralized zone, may form a continuous mineralization-alteration zone incorporated with the northern mineralization. The mineralization-ateration zone is estimated to be as extensive as 1.5 km long and 0.3 km wide.

In the southern mineralized zone, notable mineralization occurs in the S3 vein, a sample of which indicated 21.5 g/t Au and 410 g/t Ag for a width of 0.15 m, and in the S7 vein, a sample of which indicated 20.10 g/t Au and 1200 g/t Ag for a width of 0.30 m.

The hole MJP-13 in this mineralized zone intersected the S3, S4 and S5 veins, of which the S-4 vein gave assay results of 5.04 g/t Au, 45.0 g/t Ag, 0.79% Cu, 1.37% Pb and 1.30% Zn.

An alteration zone associated with weak Au and Ag mineralization is located to the southwest of the southern mineralized zone. A scree covered area separates the alteration zone from the mineralized zone and the two zones may be incorporated in a continuous mineralization-alteration zone more than 0.9 km long with a width of approximately 0.2 km.

A number of abandoned old workings, which had been unrecognized for years, were located in association with the two mineralization-alteration zone as above described during the 3rd year's campaign.

The two zones provide substantial areas for exploration of Au-Ag mineralization and may be expected to include Au-Ag deposits of commercial grades and sizes.

CHAPTER 6 MARCAMALATA AREA

6-1 Geology and Geological Structues

The geology of this area comprises the Hualhuani (Yu) and the Murco (Mu) formation of Cretaceous age, which are unconformably overlain by the Tacaza (Tc) formation of Tertiary age, and the Lampa volcanics (Vla) and alluvials (al) of Quarternary age. Accha stocks (Di) intrudes the Cretaceous and Tertiary Formations (Fig. II-35, II-36).

Hualhuani Formation (Yu)

This formation, being distributed from the centre to the south of the area, consists mainly of grey to light grey, fine to medium grained arkosic sandstones (Yu-ss) and grey to dark grey shales (Yu-sh). The thickness of the formation has been estimate at 300 m or more.

The formation is correlated to the upper Yura group and is believed to have deposited during the early Neocom stage of the late Cretaceous.

Murco Formation (Mu)

This formation, being distributed to the east of the Hualhuani Formation, consists mainly of light brown to purplish brown shales interbedded with thin layers of sandstones. Its thickness is estimated to exceed 200 m. The formation, conformably overlying the Hualhuani Formation, has been correlated to the late Neocom stage.

Tacaza Formation (Tc)

This Formation consists of dacitic lavas distributed in a limited area near the northern end and andesitic pyroclastics distributed in the eastern part of the area.

The formation spreads towards the east of the area and has a thickness more than 200 m.

The volcanic activity which extruded these volcanic materials is believed to be of the Miocene age of Tertiary.

Lampa Volcanics (Vla)

Being widely distributed in the northwestern part of the area, the volcanics consist of dark grey or purplish grey, porous basaltic andesite, andesite and pyroclastics of similar compositions. The thickness of the volcanics reaches approximately 100 m at its thickest part. The age of the volcanic activity which brought these volcanic materials has been estimated at an early Holocene.

Alluvials (al)

Alluvials are widely distributed in the central and northwestern part of this areas and consist of talus deposits containing abundant large boulders of dacite and andesite.

Accha Stocks (Di)

The stocks have been located at three places in the northeastern, southeastern and southwestern part of the area and consist of light grey to grey, holocrystalline quartz diorite. They intruded the Tacaza and the lower formations.

The age of the intrusion is estimated to be Miocene of Tertiary age.

Geological Structures

A NNW-SSE trending fault has been assumed, running from the central west to the south of the area.

The amount of dislocation by the fault is not well known but has been estimated at approximately 120 m vertically. The western block of the fault is relatively downthrown against the eastern block.

NE-SW trending joints are most well developed in the formations of Tertiary or earlier, with subordinate E-W and NW-SE trending joints.

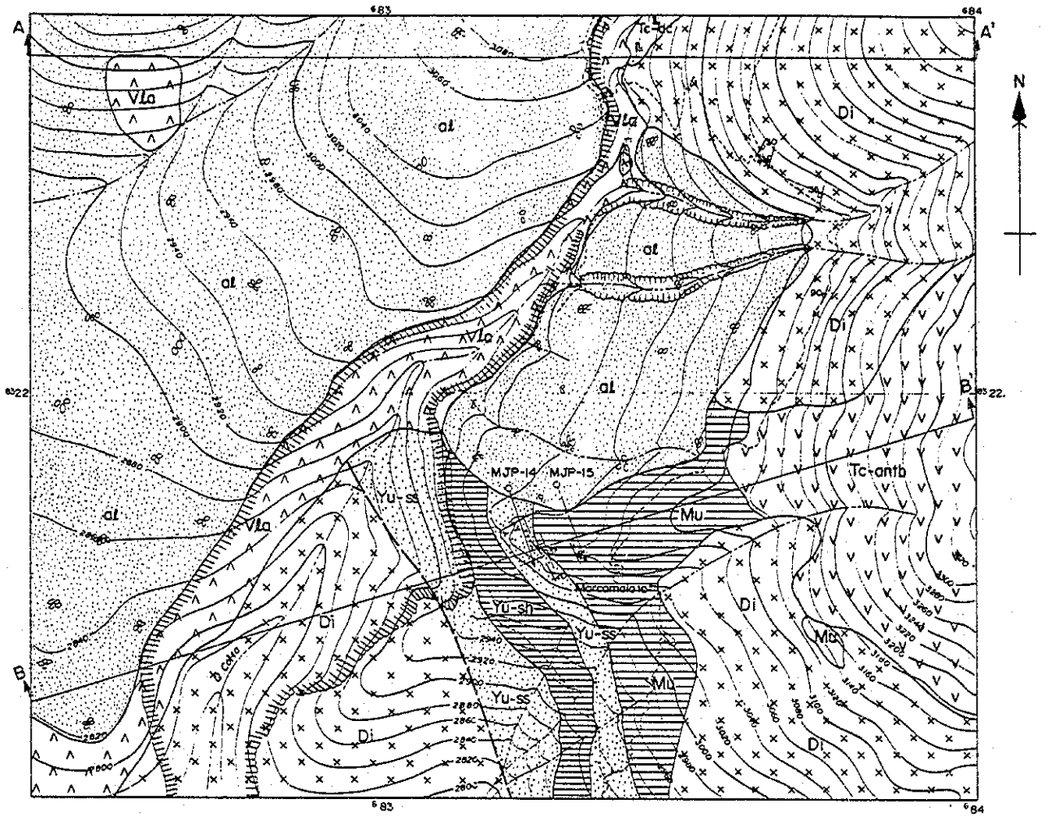
6-2 Mineralization and Alteration

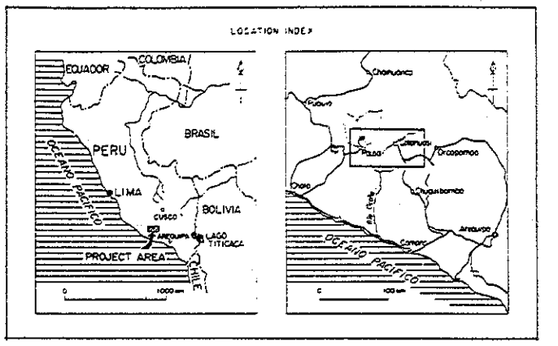
The mineralization and alteration occurs in the sedimentary rocks of the Hualhuani and the Murco Formations of Cretaceous, and is found along a ridge running in the central southern part of the area (Fig. II-37, II-38).

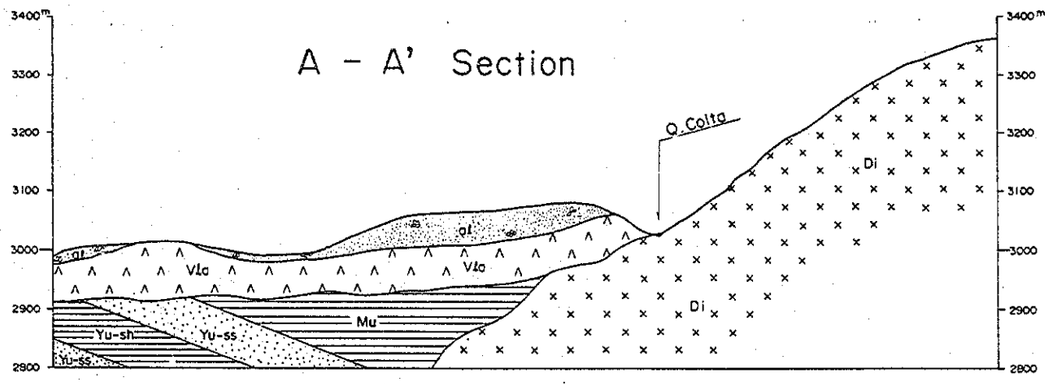
The mineralization consists of quartz veins or quartz vein networks in association with silicification along fractures or fractured zones, occasionally carrying some values of Au and Ag and is believed to be of epithermal origin.

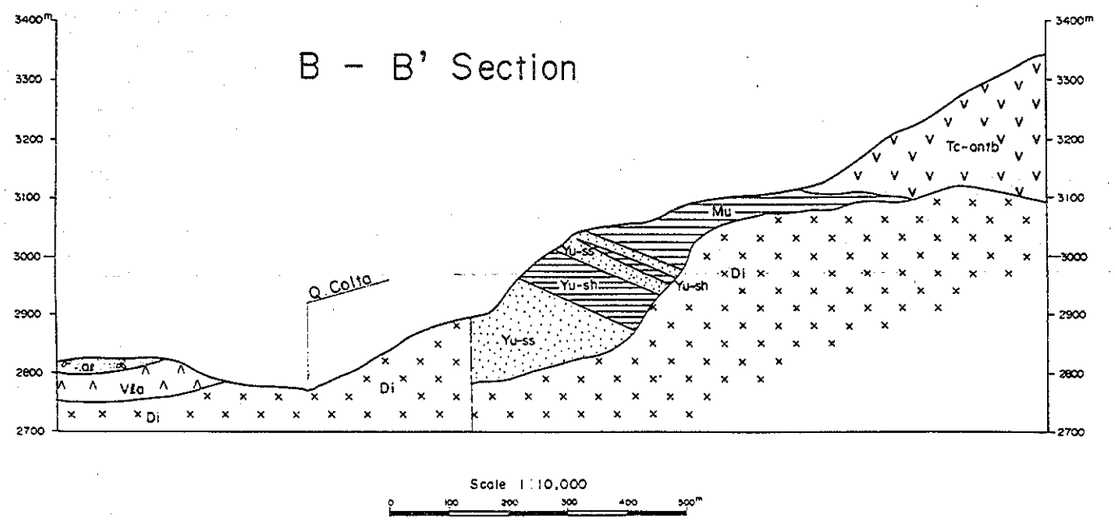
The most prominent vein occurs in the abandoned old working SM-2 and is hosted by arkosic sandstones of the Hualhuani formation. A sample from the vein along brown colored oxidized fractures indicated values of 1.99 g/t Au and 440 g/t Ag, which suggested high silver mineralization.

Samples from other abandoned old workings yielded some Au and Ag values as well.









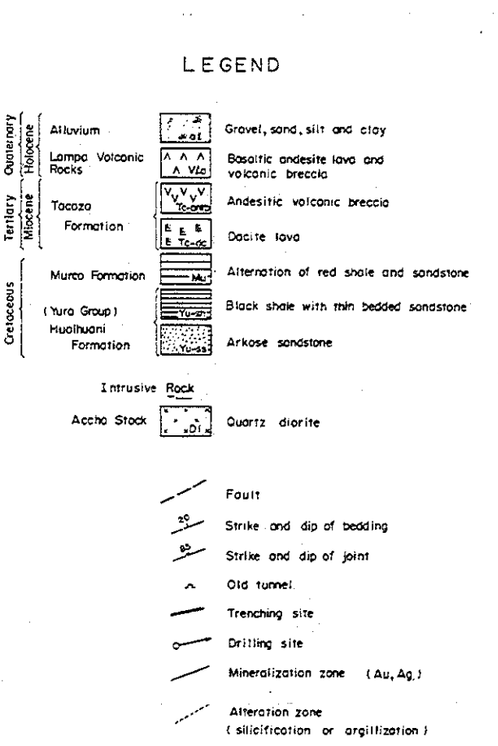
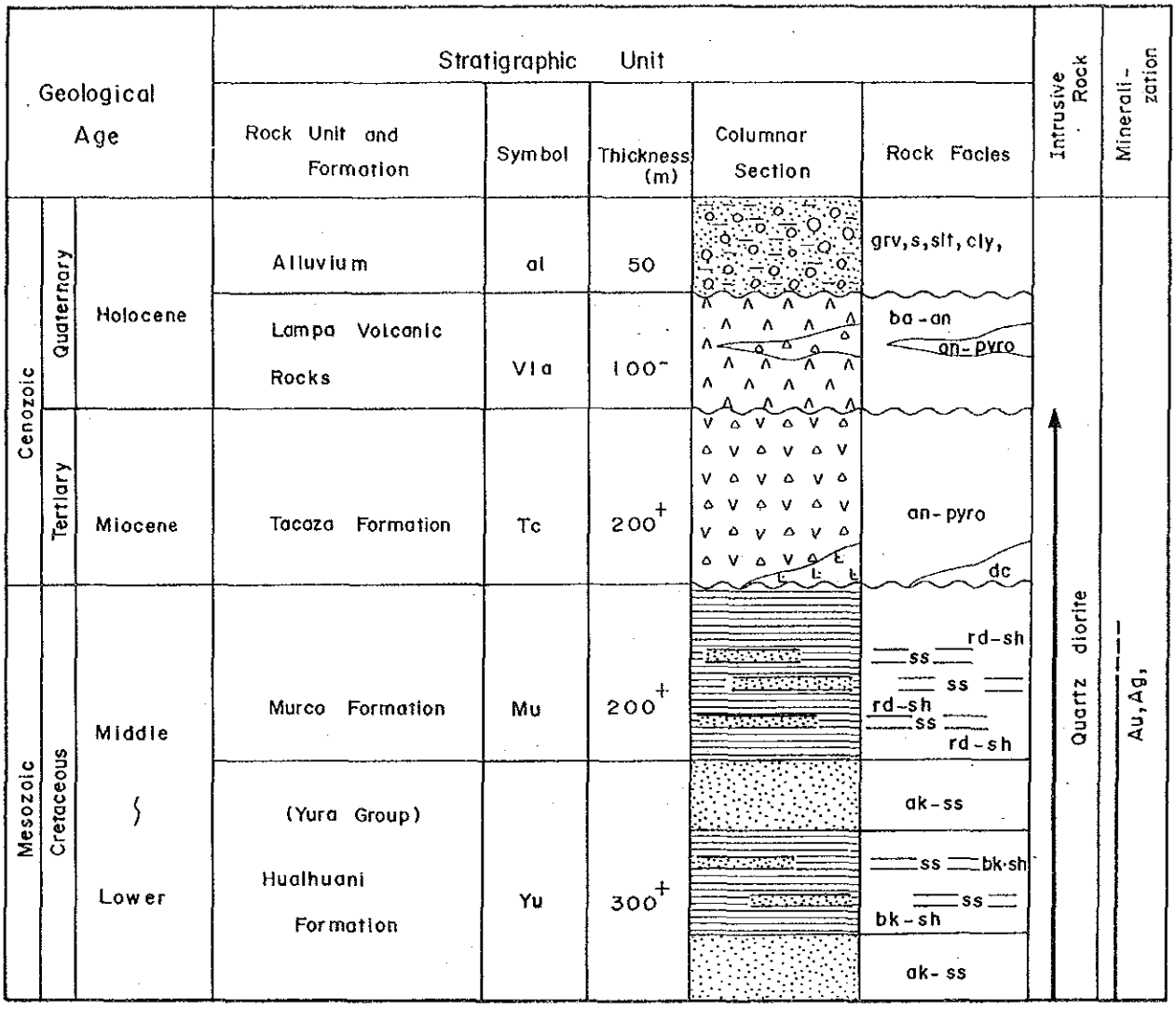


Fig. II-35 Geological Map and Section of the Marcamalata Area



Abbreviation

grv-----gravel , s----- sand , slt-----silt , cly----clay,

ba-an-----basaltic andesite, an-pyro-----andesitic pyroclastic rocks,

dc-----dacite, rd-sh-----red shale, ss-----sandstone,

ak-ss----- arkose sandstone , bk-sh -----black shale,

Fig. II-36 Stratigraphic Column of the Marcamalata Area

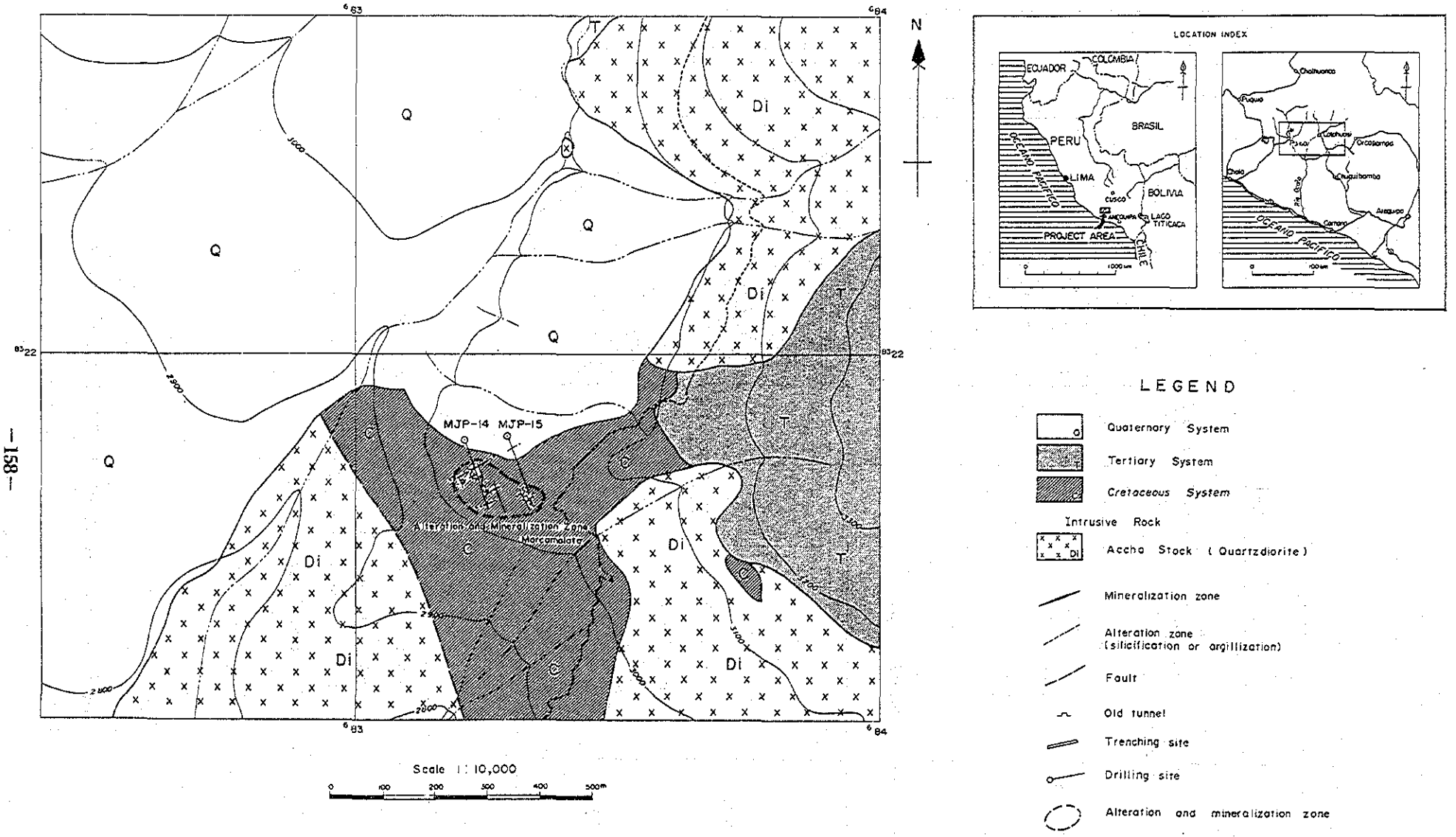
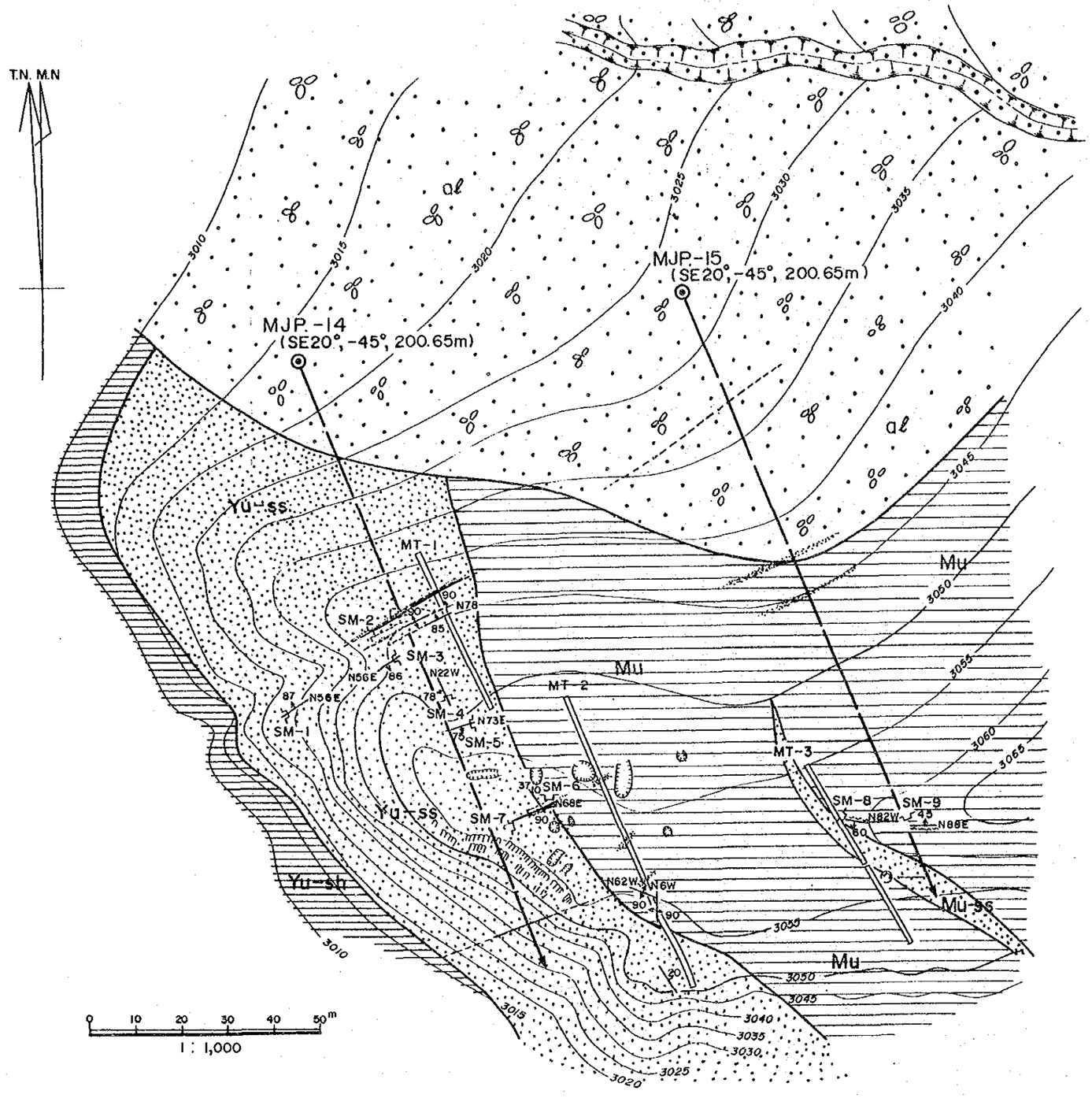


Fig. II-37 Location Map of Alteration and Mineralization Zone of the Marcamalata Area



LEGEND

- Gravel, sand, silt and clay
- Sandstone
- Alternation of redshale and sandstone
- Black shale with thin bedded sandstone
- Arkose sandstone

- Silicified zone with iron oxides
- Iron oxides zone
- Joint with iron oxides and clay
- Drilling site
- Trenching site
- Tunnel
- Exploration pit

Fig. II-38 Location Map of Mineralization Zones of the Marcamalata Area.

6-3 Drilling Result

Two holes (each 200 m long), MJP-14 and 15, were drilled in the mineralization-alteration zone outlined on the surface. (Fig. II-39, II-40)

The drilling operation was performed by using a machine, Long Year 38 with adopting a wireline method. The operation performance of each hole is shown in Fig. II-41.

The geological section is prepared for each of the two holes, MJP-14 and 15, in the Fig. II-42.

The description of the mineralized intersections are summarized in Table II-26.

The two holes, MJP-14 and -15, drilled to the depth of the mineralized zone, intersected a number of quartz veins, quartz vein networks and intensively silicified zones but with only weak mineralization. The best assay results obtained for drill core samples were as low as 0.07 g/t Au and 3.3 g/t Ag.

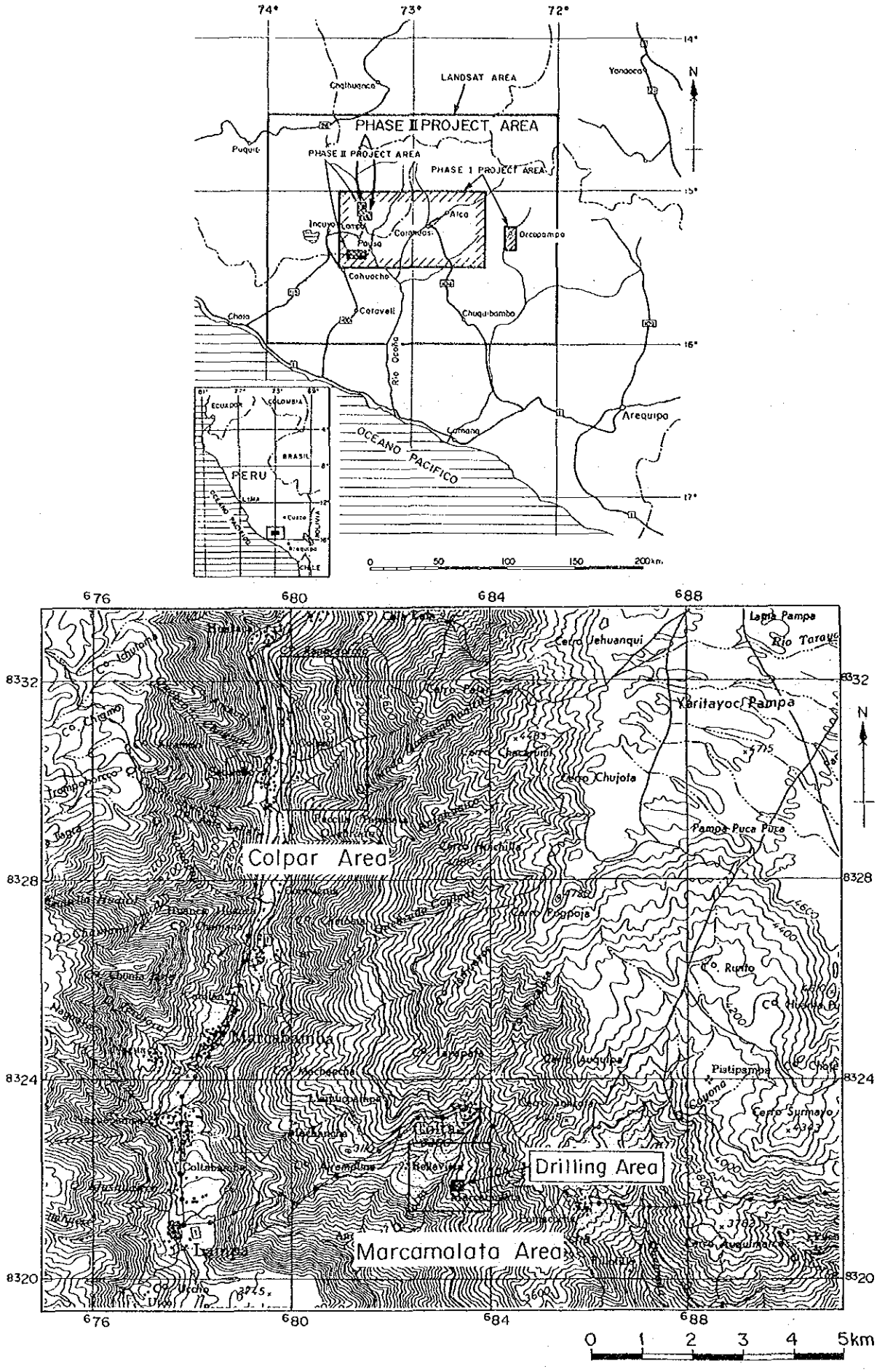


Fig. II-39 Location Map of the Drilling Sites

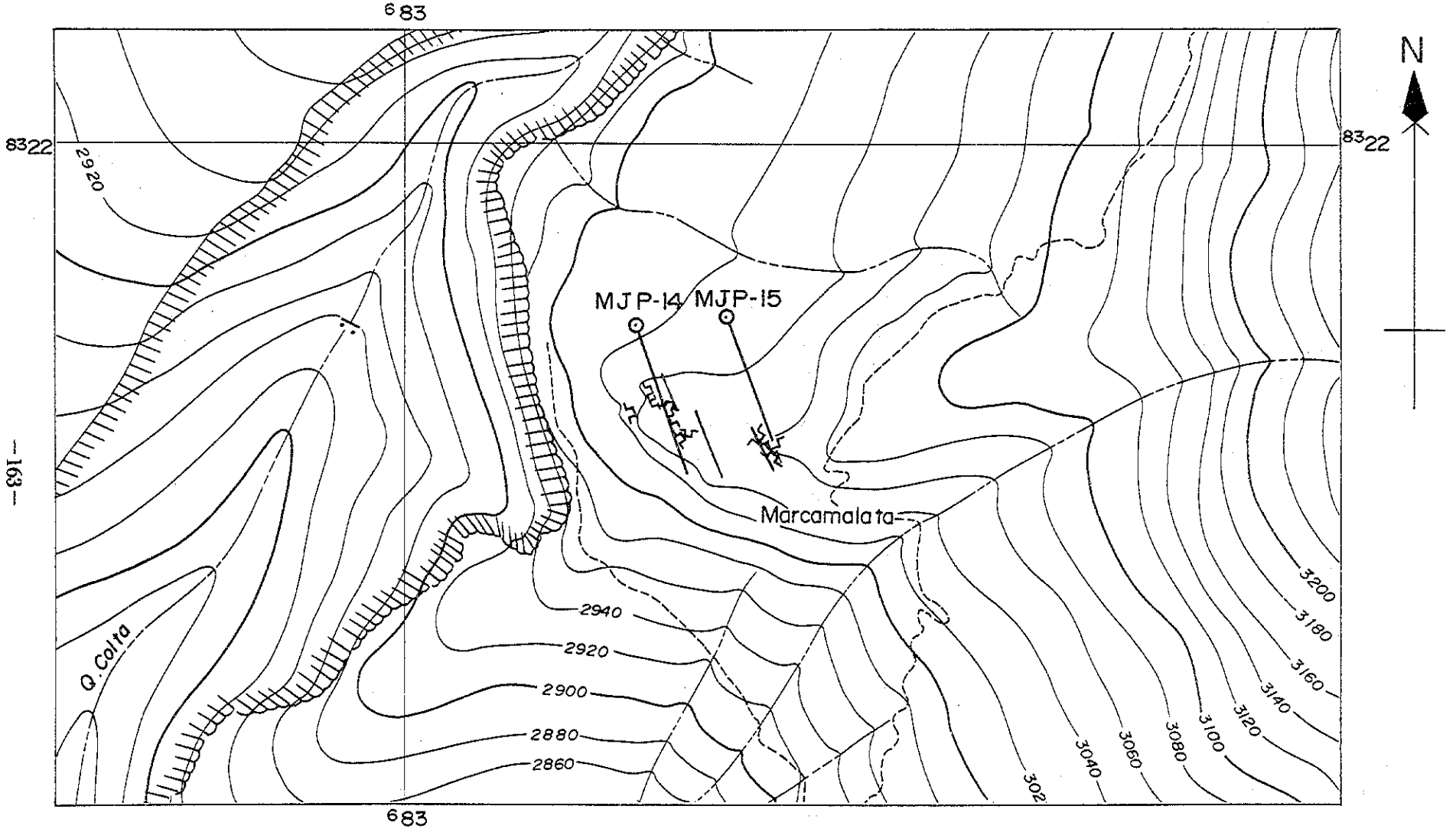


Fig.II-40 Location Map of the Drilling Sites in the Marcamalata Area

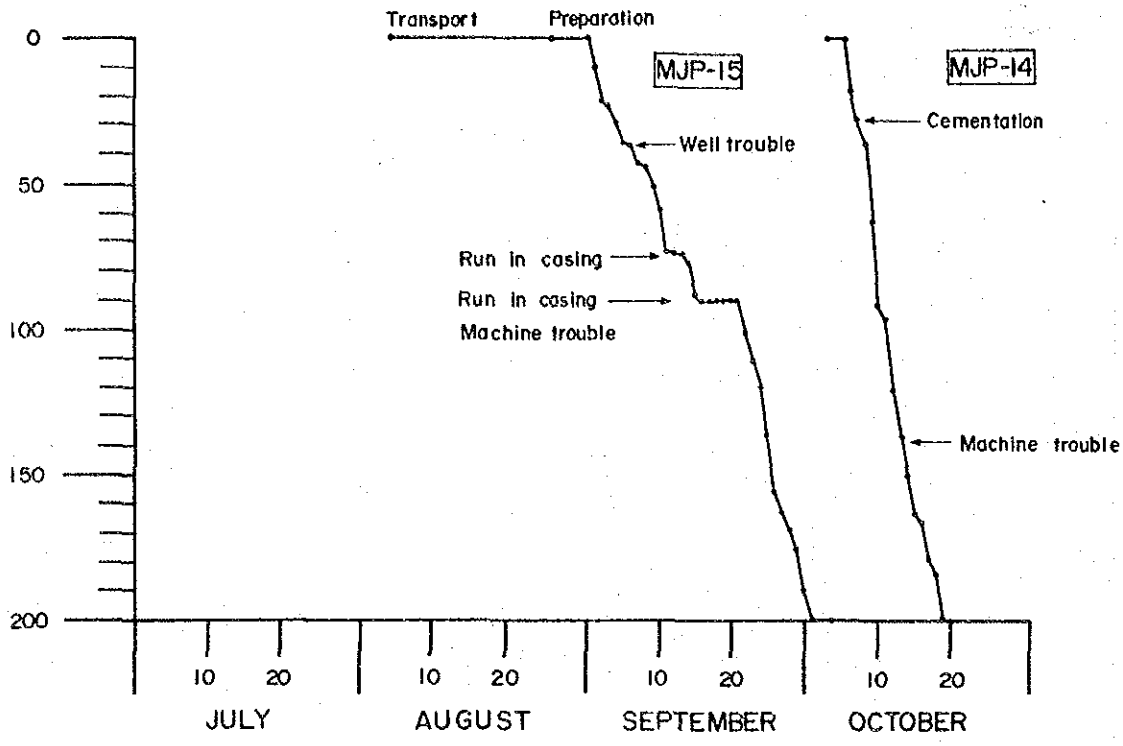


Fig. II-41 Drilling Progress of the Marcamalata Area (MJP-14～15)

Table II −26 Alteration Zones of Drilling Holes in the Marcamalata Area

Name of Mineralization Zone	Number of Drilling	Depth of Alteration Zone (m)	Width of Alteration Zone (m)	Alteration and Quartz vein		Description
				Depth (m)	Width (m)	
Alteration and Mineralization Zone of Marcamalata	MJP−14	8.90～ 12.75	3.85			・light grey quartz vein network
		28.00～ 30.70	2.70			・light grey arkose sandstone with brown to reddish brown iron oxides along many cracks
		164.95～168.85	3.90	164.95～166.40	1.45	・strongly silicified sandstone with quartz vein network and quartz vein (w=10cm)
				166.40～166.55	0.15	・white quartz vein with druse
				166.50～168.85	2.30	・strongly silicified sandstone with quartz vein network
		179.22～179.40	0.18			・white and grey quartz vein
	MJP−15	32.70～ 34.20	1.50			・silicified arkose sandstone with white quartz vein network and black patch of pyrite
		68.35～ 69.55	1.20			・dark grey arkose sandstone with pyrite and black mineral (Mn?)
		82.75～ 83.80	1.05			・arkose sandstone with white quartz vein network
		84.50～ 85.40	0.90			・arkose sandstone with quartz vein and quartz vein network
		92.20～ 93.80	1.60	92.20～93.48	1.28	・strongly silicified sandstone with veinlet and spot of pyrite
				93.48～93.65	0.17	・yellowish brown and reddish brown veinlet network of iron oxides

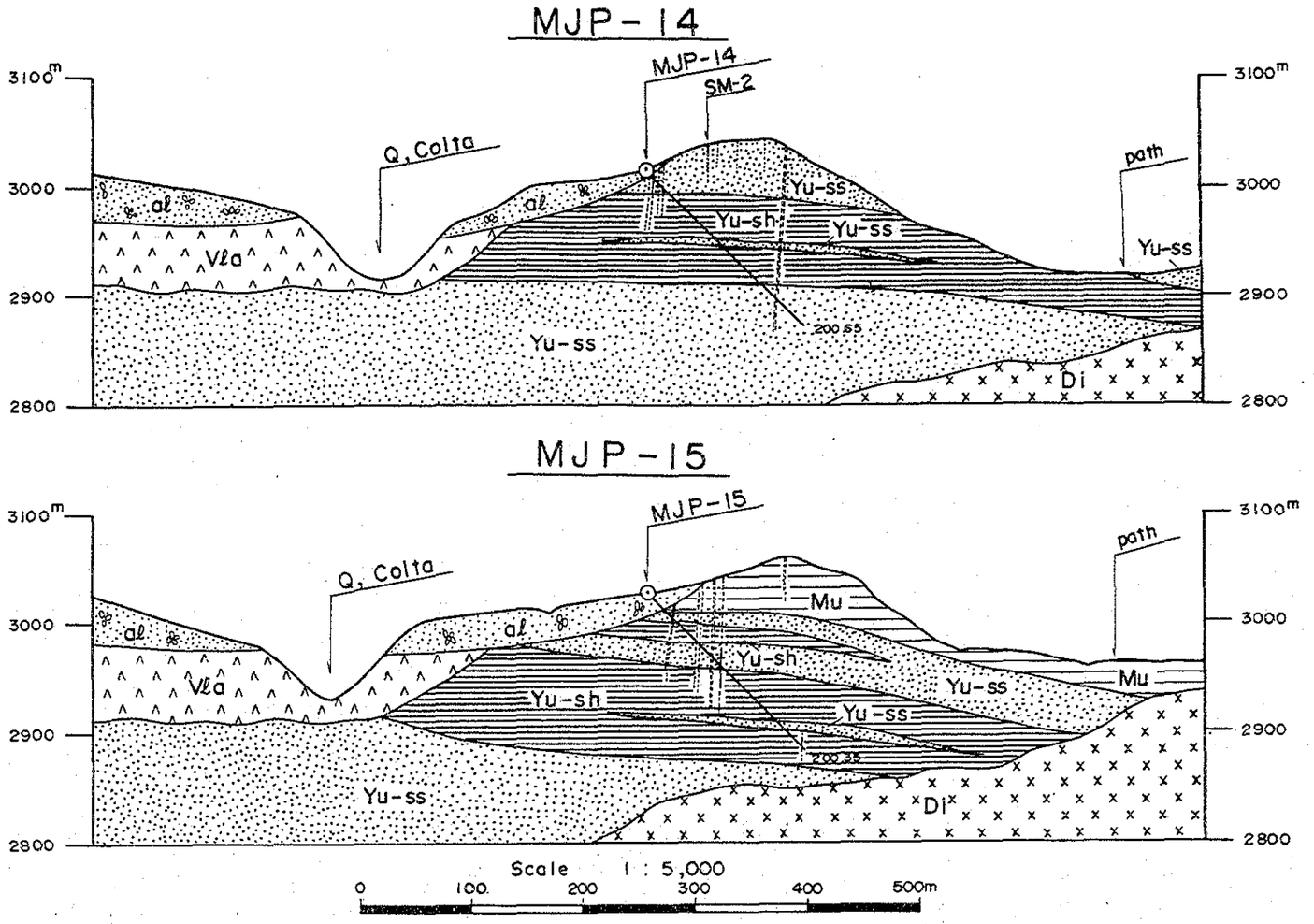
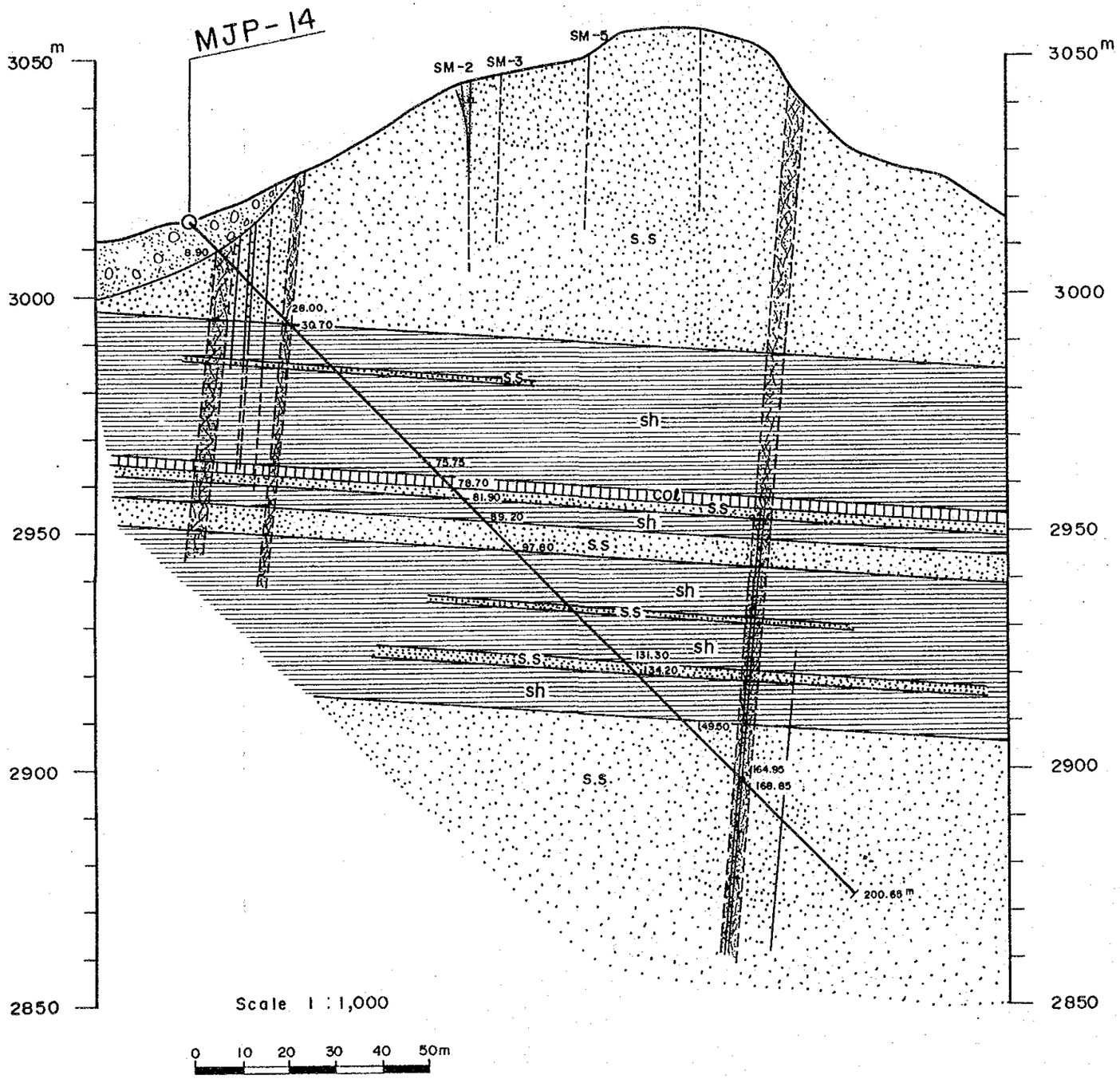


Fig. II-42 Geological Section of the Drilling Holes (MJP-14,15) in the Marcamalata Area (scale 1 : 5,000)



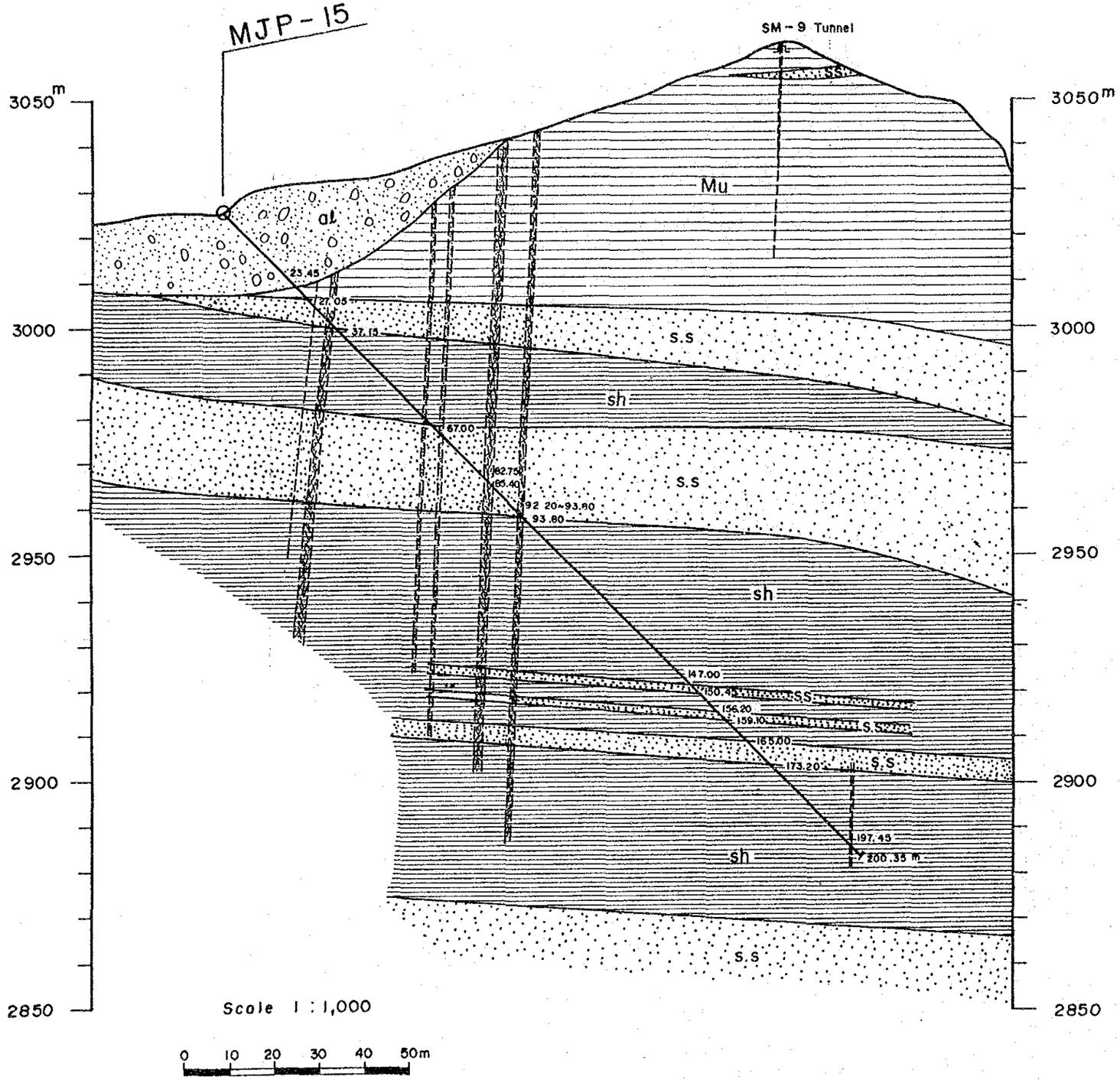
MJP-14

Grand level : 3015.6m
Direction : SE 20°
Angle : - 45°
Depth : 200.65m

Results of Chemical Analysis of Ore Samples

No.	Depth (m)	wide(m)	Au g/t	Ag g/t
1	8.90 ~ 10.15	1.25	< 0.07	2.3
2	10.15 ~ 11.60	1.45	< 0.07	1.9
3	11.60 ~ 12.75	1.15	< 0.07	0.3
4	14.15 ~ 14.25	0.10	< 0.07	<0.3
5	17.40 ~ 17.50	0.10	< 0.07	0.3
6	18.40 ~ 18.47	0.07	< 0.07	0.3
7	23.15 ~ 23.25	0.10	< 0.07	0.5
8	28.50 ~ 29.65	1.15	< 0.07	0.5
9	29.65 ~ 30.70	1.05	< 0.07	3.3
10	115.40 ~ 115.60	0.20	< 0.07	2.5
11	165.30 ~ 165.70	0.40	< 0.07	2.3
12	165.70 ~ 166.55	0.85	< 0.07	2.5
13	167.30 ~ 167.85	0.55	< 0.07	0.5
14	167.85 ~ 168.55	0.70	< 0.07	0.5
15	179.22 ~ 179.40	0.18	0.07	2.5

Fig. II-43 Geological Section of Drilling Hole MJP-14 in the Marcamalata Area



MJP-15

Grand level : 3026.7m
Direction : SE 20°
Angle : −45°
Depth : 200.35m

Results of Chemical Analysis of Ore Samples

No.	Depth (m)	wide(m)	Au g/t	Ag g/t
1	32.70 ~ 33.45	0.75	< 0.07	1.9
2	33.45 ~ 34.20	0.75	< 0.07	1.0
3	35.00 ~ 36.00	1.00	< 0.07	0.3
4	63.70 ~ 64.00	0.30	0.07	0.3
5	68.35 ~ 69.55	1.20	< 0.07	1.3
6	82.75 ~ 83.80	1.05	< 0.07	0.5
7	84.50 ~ 85.00	0.50	< 0.07	0.8
8	92.20 ~ 93.10	0.90	< 0.07	0.3
9	93.10 ~ 93.80	0.70	< 0.07	2.8
10	197.45 ~ 197.80	0.35	< 0.07	1.9

Fig. II-44 Geological Section of Drilling Hole MJP-15 in the Marcamalata Area

6-4 Summary of the Results in the Marcamalata

The mineralization and the alteration in this area are hosted by the Hualhuani or the Murco Formation of Cretaceous age and follow the similar structural trend, NE-SW to that in the Colpar.

Occurrences of the mineralization are also similar to those in the Colpar but without any Au and Ag minerals identified.

The mineralization looks better in sandstones than in shale. The best mineralization was found in association with a vein in the abandoned old workings SM-2, where a sample indicated assay values of 1.99 g/t Au and 440 g/t Ag. However, Au contents of the samples from other old workings were very low occasionally with some Ag values.

The two drill holes MJP-14 and -15 were carried out in the mineralization-alteration zone and intersected a number of quartz veins, quartz vein networks and intensively silicified zones but with only minor values of Au and Ag.

Neither of these holes intersected the extension of the vein in the old working SM-2 at the expected depth.

The mineralization-alteration zone is much smaller in its extension than those of the Colpar and may have a very little potential for mineralization of commercial importance.

PART III CONCLUSION AND RECOMMENDATION

PART III CONCLUSION AND RECOMMENDATION

CHAPTER I CONCLUSION

The exclusive conclusions of the 3 year-project are summarized as follows.

(1) The basement of the project area consists of gneissic granites or diorites of Precambrian age.

The Jurassic and Cretaceous systems, mainly consisting of sedimentary rocks, unconformably overlies the Precambrian basement and are unconformably underlain by volcanic rocks of the Tertiary and the Quarternary systems. Intrusions comprises granitic batholiths or stocks of Cretaceous age, and andesitic and dioritic stocks or dikes of Tertiary age.

(2) Folding and NW-SE or NE-SW trending fault structures are well developed in the Jurassic and the Cretaceous systems as a result of the Andean Orogeny.

NW-SW or NE-SW trending faults are also observed in the Miocene volcanics, particularly the Tacaza formation (Tc).

These structural features are well expressed in the landsat imagery.

(3) Mineralization and alteration occur mainly in the Tacaza formation of Mioceue age or lower formations.

Most of the known deposits in the project area are of Au-Ag vein type and consist of quartz veins, quartz vein networks, or silicified or oxidized fractures.

A pyrometasomatic deposit of a small scale has been located at the contact between a diorite stock and limestones of the Cretaceous Arcurquina formation.

(4) Alteration (Silicification and angillization) zones of sizable seales were outlined in the Pirca area in the course of the 1st year's field work.

However, the 2nd year's geochemical investigation indicated that geochemical anomalies associated with the alteration zones were limited in their extensions and low in values of elements of interest.

The results of the 10 holes of drilling in the eastern Pirca Area intersected intensive alteration zones but with only minor mineralization.

(5) Alteration and mineralization zones were outlined in the Tacaza formation (Tc) of Miocene age and in the Hualhuani (Yu) and the Murco (Mu) formation of the Cretaceous age in the Marcambamba area.

Of a number of the alteration silicification and angillization, and mineralization zones outlined in the course of the 2nd year's investigation, the Colpar and the Marcamalata alteration zones were associated with promising geochemical anomalies.

The 2nd year's work resulted in selection of two target areas, the Colpar (5 km^2) and the Marcamalata (2 km^2), including these alteration zones, for the 3rd year's programme.

(6) A number of abandoned old workings, which had been unknown, were located in the Colpar in the course of the 3rd year's work.

Two mineralized zones, the northern and the southern mineralized zones, were outline in the Miocene Tacaza formation (Tc) by the detailed prospecting with aids of trending.

These mineralized zones include mineralized veins, 4 major veins in the northern zone and 9 in the southern zone, is association with surrounding silicification and minor parallel veins.

All the vein except for two in the southern zone trend in the general direction of NE-SW, and comprise quartz veins, quartz vein network and silicified fracture zones.

Major ore minerals are electrum, argentite, polybasite pearceite, galena, sphalerite and pyrite in association with alteration minerals of quartz-potash feldspar and sericite with or without chlorite.

(7) The N3 vein of the northern vein yielded a surface sample of the best assay results, 5.79 g/t Au and 640 g/t Ag for an 1 m width.

The drill holes, MJP-11 and 12, intersected the N1 and N2 veins but were too short to reach the N3 and N4 veins. The mineralized intersections yielded appreciable values in Au and Ag, which would suggest the mineralized zone to be continuous for a substantial distances.

The northern silicified zone, located to the northeast of the northern mineralized zone, may continue to the northern mineralized zone. If the assumption is true, the incorporated alteration-mineralization zone would form a sizable area approximately 0.3 km wide and 1.5 km long.

(8) In the southern mineralized zone, the S3 and the S7 veins yielded surface samples of high assay values, 21.50 g/t Au and 410 g/t Ag for a 0.15 m width and 20.10 g/t Au and 1200 g/tAg for a 0.3 m width respectively.

The drill hole, MJP-13, intersected the S3, the S4 and S5 veins and the quartz vein network of the S4 vein indicated.

Assay values of 5.04 g/t Au, 45.0 g/t Ag, 0.79% Cu, 1.37% Pb and 1.30% Zn. The mineralization contains appreciable values of Cu, Pb and Zn in addition to Au and Ag, and is considered to be promising.

The southern mineralized zone may continue to the Quabrad Quarmahuaico alteration zone. If the assumption is true, the incorporated alteration-mineralization zone would form a sizable area approximately 0.2 km wide and 0.9 km long.

(9) The mineralization-altration in the Marcamalata occurs in the Cretaceous Hualhuani (Yu) and Murco (Mu) formation and is associated with a minor amount of Ag.

All the observed veins are limited in extensions and discontinuous.

The two holes, having been drilled beneath the surface mineralized veins, intersected a number of quartz veins and quartz vein networks but without mineralization of any values.

(10) In conclusion, the two mineralization-alteration zones, the northern (0.3 km wide and 1.5 km long) and the southern (0.2 km wide and 0.9 km long), seem to be promising judging from the exclusive results of the 3 year work, and would be worthwhile for further exploration.

CHAPTER 2 RECOMMENDATION

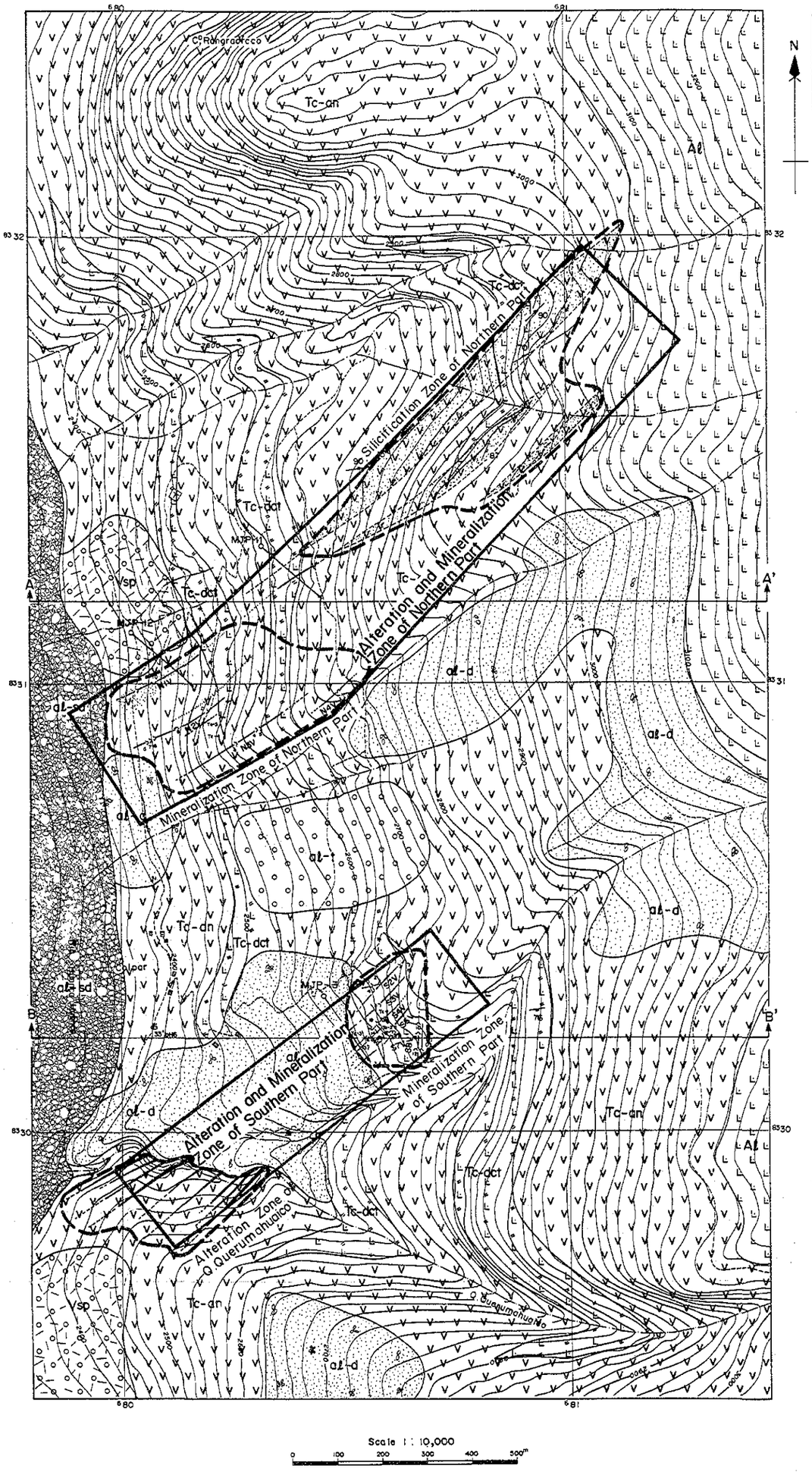
The fiscal year 1987, closing at the end of March, 1988, is the last year of the 3 year technical co-operation project in the Catabuosi area by Japanese Government.

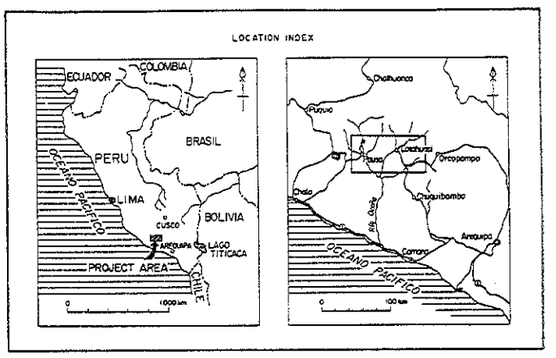
However, the 3 year work for the project have outlined two promising targets for potentially-commercial mineralization in the Colpar, the northern mineralization-aleration zone (0.3 km wide and 1.5 km long) and the southern mineralization-alteration zones (0.2 km wide and 0.9 km long) (Fig. III-1)

It would be recommended that these two zones in the Colpar be followed up by further detailed exploration including diamond core drilling.

Methods and purposes of the recommended work are summarized in the table below.

Method	Purposes
Detailed prospecting	To clarify occurrences, extents, and grades of the mineralization on the surface by investigating further in detail mineralized outcrops and abandoned old workings of the mineralization-alteration zones.
Drilling	To define extents and grades of veins in strike sides and dip sides, and also to explore other veins parallel to the known ones.





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LEGEND

Quaternary	Holocene	Alluvium	River sediments (gravel, sand)
			Debris (gravel, sand silt, clay)
			Terrace (gravel, sand, silt)
		Volcanic Sediment of Pausa	Tuffaceous silt, sand, gravel
Tertiary	Miocene	Alpabamba Formation	Rhyolitic pyroclastic rocks
		Tacaza Formation	Pacific Pyroocksic rocks
			Andesite lava and andesitic pyroclastic rocks

- Strike and dip of joint
- Old tunnel
- Trenching site
- Drilling site
- Mineralization zone (Au, Ag)
- Silicification zone with iron oxides
- Recomended Area

Fig. Ⅲ－1 Interpretation Map of the Colpar Area

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