2-3 Pirca Area

2-3-1 Geology

The Pirca Area in the southwest part of the first year's survey area, extends westwards from the Pirca village approximately 15 km south of the Pausa, and covers on area of 90 km^2 (Fig. G-2). This area was divided into two subareas, the Pirca Eastern Area (48 km^2) and the Pirca Western Area (42 km^2), with an intention to carry out surveys more in details in the eastern area than in the western area. A geological map and geological sections are prepared with a scale of 1/10,000 (PL.5 and 6) for the Pirca Eastern Area and with a scale of 1/25,000 (PL.9 and 10) for Pirca Western Area. Of these plates, the geological maps with a reduced scale were shown in Fig. 2-5 and Fig. 2-6, together with a schematic stratigraphic section of the Pirca Area as a whole in Fig. 2-7.

Geological environment of the general region including the Pirca Area, as shown in the first year's geological map (Fig. 1-1) and in the schematic columnar sections (Fig. 1-2), is represented by the Jurassic Chocolate volcanics distributing from east to southeast of the Pirca village, and the Cretaceous intrusions forming the coastal batholith to the south. The area distributed by these rocks forms a sharp precipitous terrain. Lacking the Cretaceous sedimentary sequences, the Tertiary volcanics directly covers the Chocolate volcanics and the coastal batholith with unconformities.

The Quaternary volcanics unconformably overlying all of these form gentle relieves extending westwards from the precipitous terrain. The Pirca Area is situated in the region mainly distributed by the Tertiary and Quaternary volcanics.

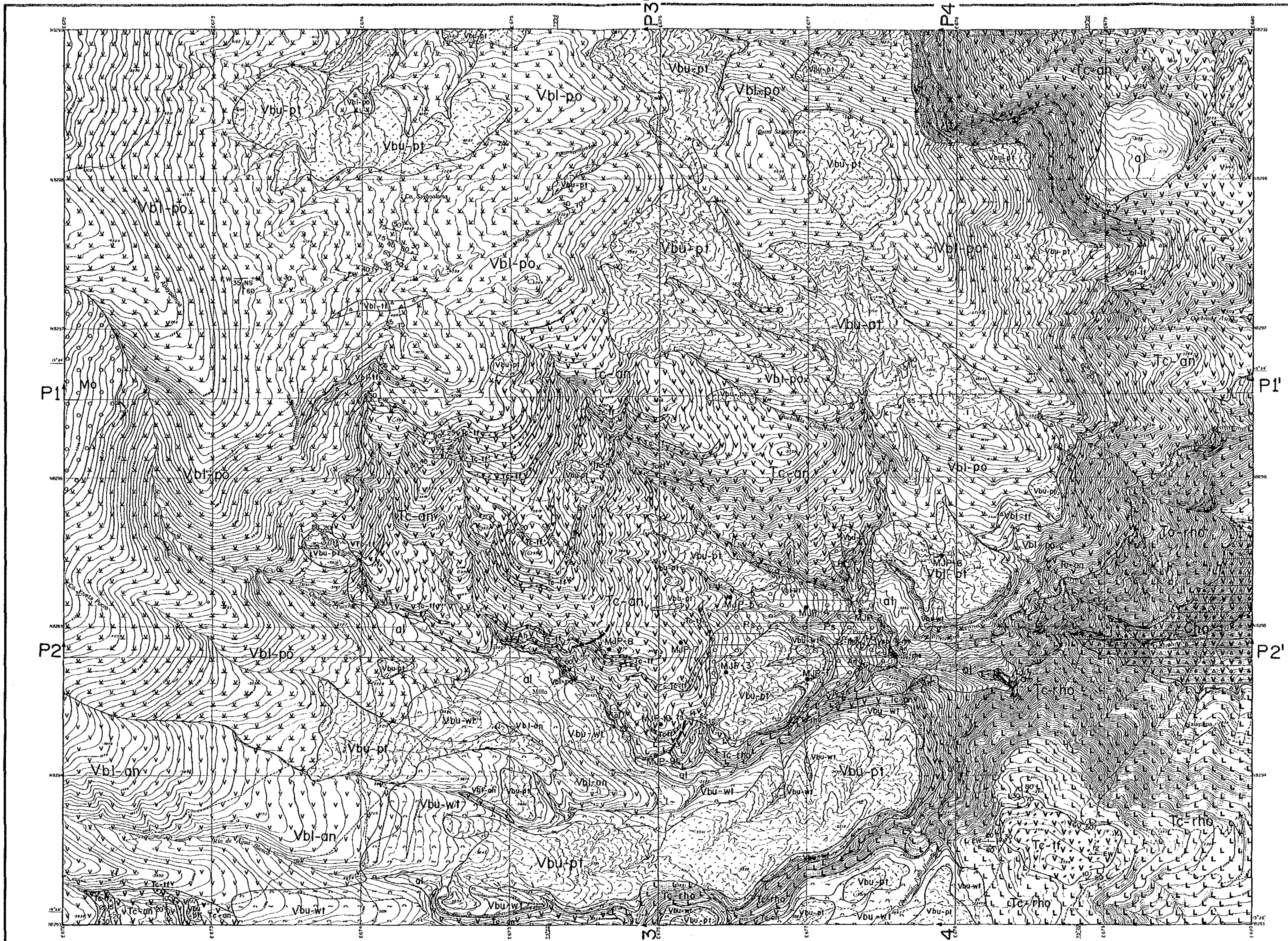
The stratigraphic sequences of the area are composed in stratigraphically ascending order of the Jurassic Chocolate volcanics at the bottom, the Tertiary Tacaza Formation (TC), the Quaternary system comprising the Pirca sediments (PS), the Upper and Lower Barroso Formations (Vbu, Vbl), Moraine (Mo) of the Pleistocene and the Pausa volcanic sediments (Vsp) and alluvium (al) of the Holocene. There are also distributed by minor hornblende andesite dikes.

[1] Jurassic System

The Jurassic system consists of the Chocolate volcanics (Cho).

<u>Distribution</u>

The Chocolate volcanics are distributed in the precipitous terrains lower than 2,700 m to 2,850 m in elevations along the Nauquipa valley running through the eastern end of the eastern area and extend eastwards beyond the eastern boundary


P3'
P4'
P1
P1'
P2
P2'
P3
P4
Vbu-pt
Vbl-po
Tc-an
Vbl-an
Vbu-wt
Vbl-tf
Tc-tf
Tc-rho
Vbl-pt
Mo
al
Ps
MJP-3
MJP-5
MJP-6
MJP-7
MJP-8
Millo


N
Holocene
Pleistocene
Quaternary
Miocene
Tertiary
Jurassic

Fig. 2-5
Area

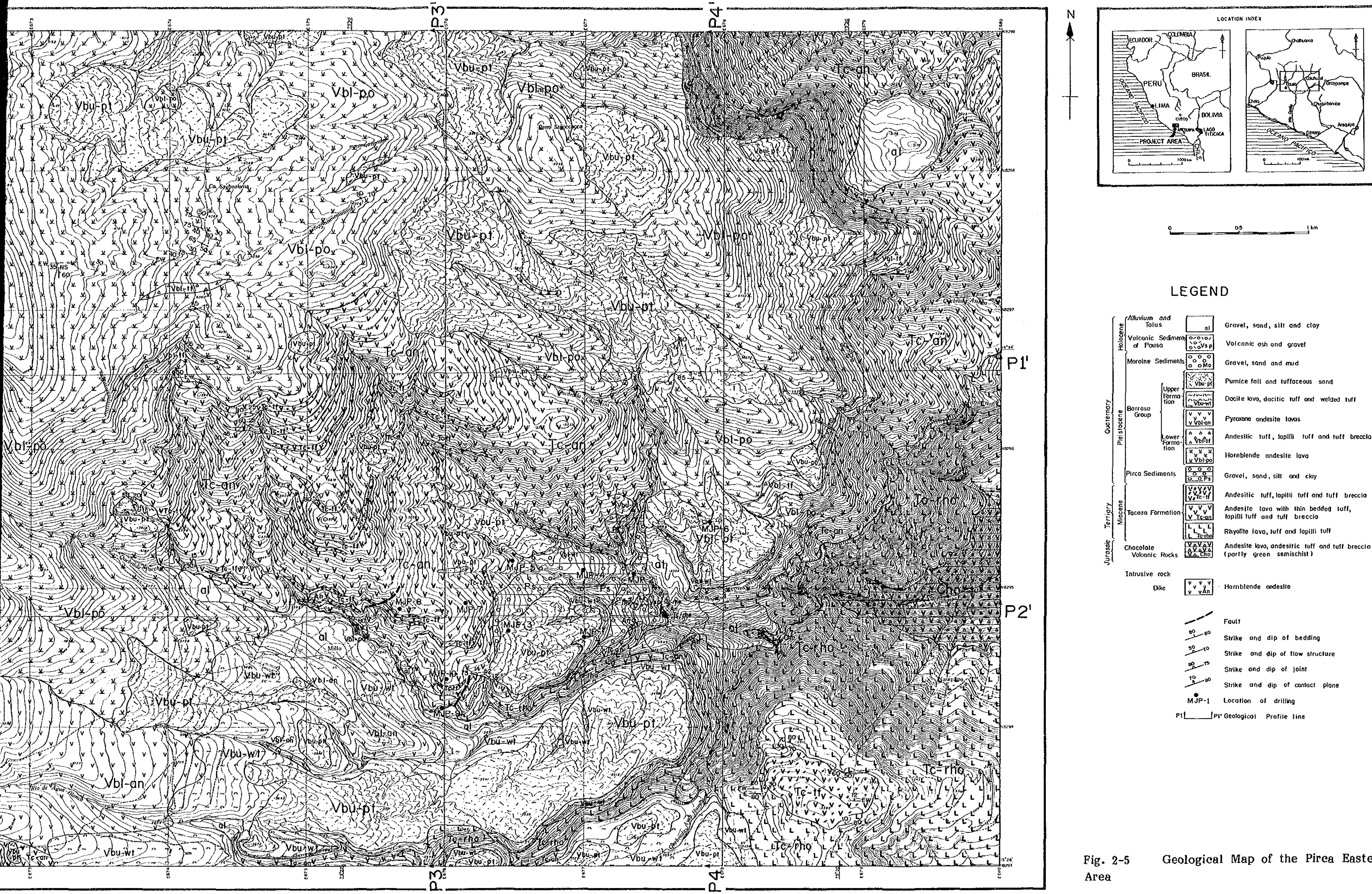


Fig. 2-5 Geological Map of the Pirca Eastern Area

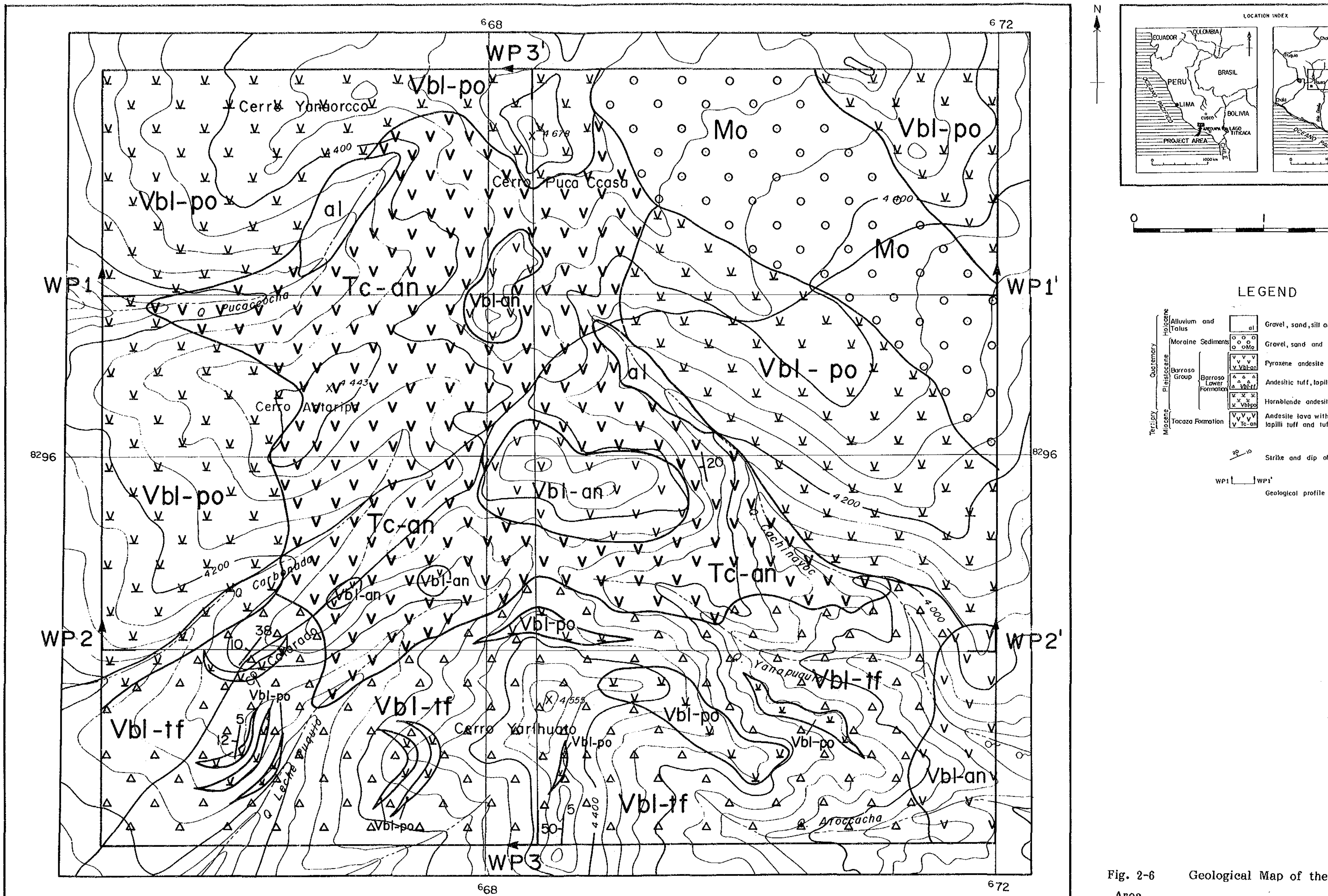


Fig. 2-6 Geological Map of the
Area

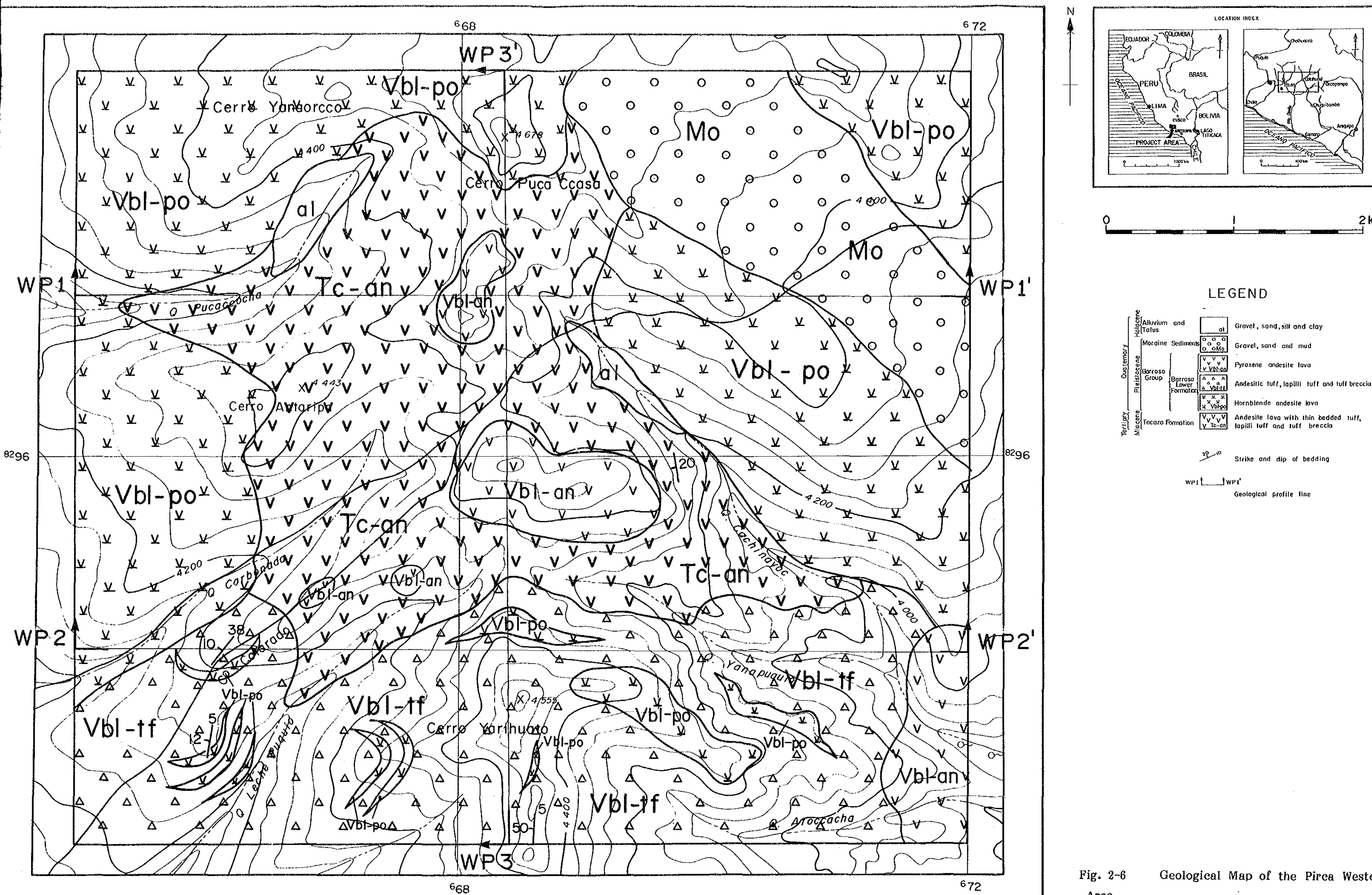
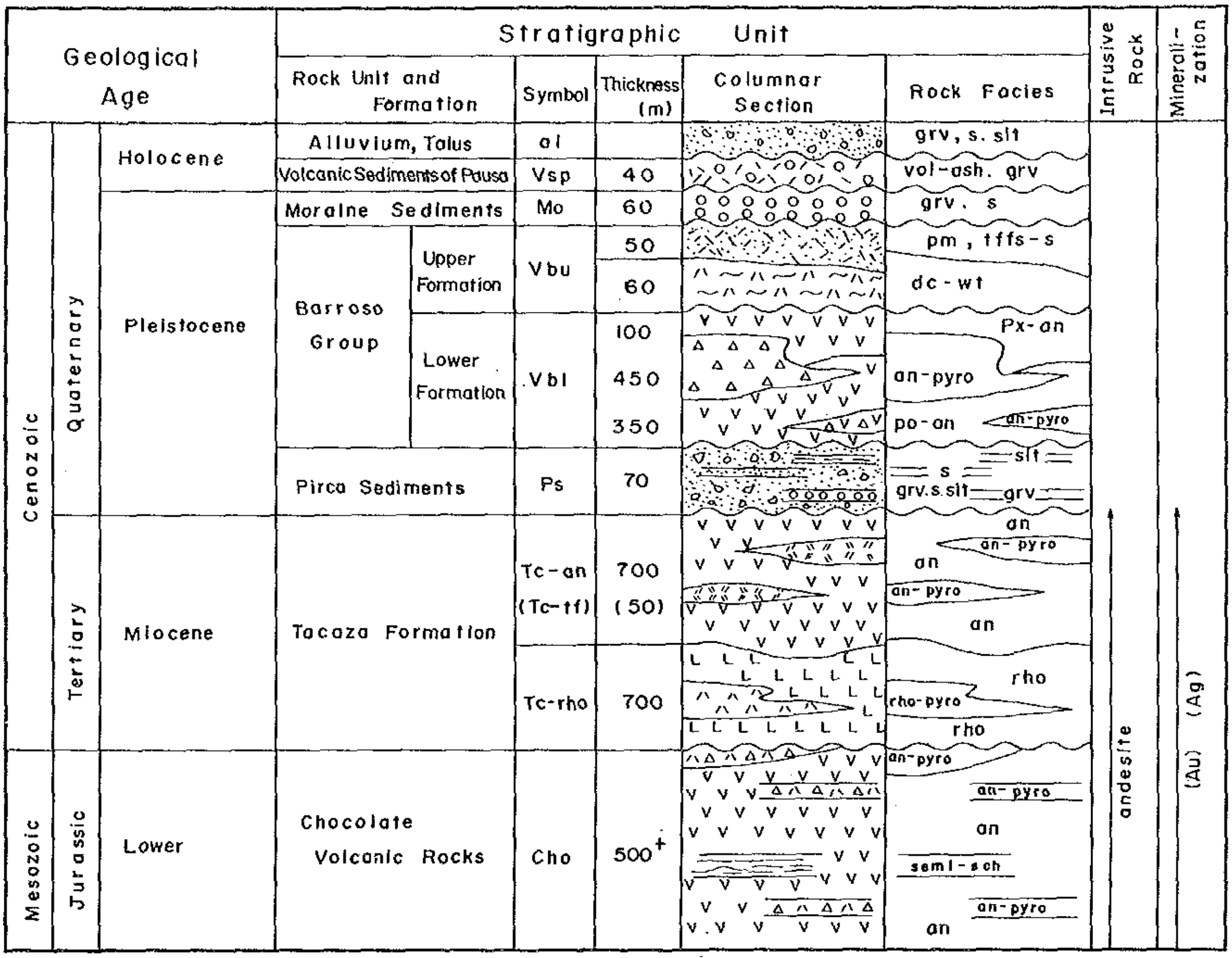


Fig. 2-6 Geological Map of the Pirca Western Area



Abbreviation

an -------- andesite
an-pyro -----andesitic pyroclastic rocks
semi-sch ---- semischist
rho -------- rhyolite
rho-pyro ----- rhyolitic pyroclastic rocks
grv -------- gravel
s --------- sand
slt -------- silt
po-an ------ porphyritic andesite
px-an ------ pyroxene andesite
dc-wt ----- dacitic welded tuff
pm -------- pumice
tffs-s ----- tuffaceous sand
vol-ash -----volcanic ash

Fig. 2-7 Stratigraphic Column of the Pirca Area of the survey area.

Lithology

The volcanics consist of andesitic tuff breccia and tuff with varying colors of green, grayish green or dark grayish brown. These rocks have undergone strong chloritization and epidotization due to regional metamorphisms, locally accompanied by a green or dark green semischist having weak schistosity.

Thickness

The total thickness of the volcanics is unknown without exposure of the bottom of the sequence but may be estimated to exceed 500 m in this area.

Stratigraphy

The volcanic rocks form the lower most sequence in the area, which has been correlated to an early Jurassic system in its stratigraphic position according to the explanatory notes for the Pausa and the Caraveli Geologic Maps, though no firm evidence has been given to-date.

[2] Tertiary System

The Tacaza Formation (Tc), the only Tertiary system in the Pirca area, is divided into the lower member composed of rhyolites and rhyolitic tuffs (Tc-rho) and the upper member dominated by andesitic lavas (Tc-an) interbedded with layers of andesitic tuffs and tuff breccias (Tc-tf).

Distribution

Rhyolites and rhyolitic tuffs (Tc-rho) of the lower member occupy slopes of the both sides of the Nauquipa valley above 2,700 m to 2,850 m and below 3,200 m to 3,350 m in elevations, and form precipitous terrain in the southeastern part of the Pirca Eastern Area. Distributions of these rocks, continuing westwards, form narrow belts along the stream bottoms of the Paccha and the Agua Blanca, the upstreams of the Nauquipa Valley.

The upper member dominated by andesitic lavas (Tc-an) in the Pirca Eastern Area is distributed in an area extending northwards from steep slopes along the Asinga valley running in the northeastern part, in an approximately 3.5 km long and 2.5 km wide area in the directions of E-W and N-S respectively in the central part, and also in limited areas along streams in the southwestern end of the area. A distribution of the same member in the Pirca western area is found in an approximately 4 km long and 3.5 km wide area in the directions of N-W and E-W respectively, extending northwestwards from the central part of the area.

The andesitic tuffs and tuff breccias, interbedded layers or lenses in the andesite lavas of the upper member, are mapped as an independent geologic unit only in the Pirca Eastern Area.

Lithology

The rhyolites and rhyolitic tuffs (Tc-rho) of the lower member are generally light brown to brownish gray, locally brown or grayish white on outcrops and consist of massive rhyolites and tuffs of the same composition, characteristically containing quartz grains of 1 to 3 mm in grain sizes.

The lower member was intersected in the deeper sections than 18.40 m, 3.80 m, and 81.10 m of the drill holes MJP-2, MJP-9 and MJP-10 respectively, drilled in this year's drilling campaign. These drill intersections consist of whitegray massive rhyolite tuffs and lapilli tuffs, in which quartz phenocrysts and rhyolite fragments (0.5 to 3.0 cm) are distinctively observed with the naked eye.

A sample taken at the depth of 78.40 m of the drill hole MJP-9 consists of light grayish white rhyolitic lapilli tuffs which contain rhyolitic fragments of several mm in sizes and corroded quartz and feldspar grains up to 7 mm but no exotic rock fragments under microscope.

Its groundmass is composed of rhyolitic tuffaceous materials completely altered to sericite-quartz-(albite) and disseminated by euhedral pyrite.

Brownish stains feature outcrops of the rocks of this type due to oxidation of pyrite.

The upper member of the Tacaza Formation consists mainly of altered andesitic lavas, propylitized as a whole, locally interbedded with tuff breccias or tuffs of the same composition. The tuff breccias and tuffs with sizeable thickness are mapped as an independent geologic unit in the Pirca Eastern Area but minor occurrences are included in the upper unit.

The altered andesitic lavas are massive rocks with variable colors such as light grayish green, green, dark greenish gray, brown, purplish gray and so forth. A sample of light grayish green andesite, showing a porphyritic texture under microscope, contains phenocrysts of plagioclase (0.5 to 1.0 mm) and mafic minerals (0.5 to 1 mm) in a groundmass consisting of plagioclase (ca. 0.2 mm) and interstitial glass. Both the phenocrysts and groundmass were highly altered; plagioclase is altered to epidote and albite, all of mafic minerals to chlorite and glass to chlorite and albite. The alteration mineral assemblage is chlorite-albite-epidote and typically of propylitization.

A drill core piece at the depth of around 67.35 m in the hole MJP-10 is a dark gray, hard massive rock megascopically showing a porphyritic texture and a fresh outlook as a whole though plagioclase phenocrysts are clouded. A microscopic observation of this sample, showing a porphyritic texture, identified phenocrysts of euhedral plagioclase with An 48 - 60% and of augite and hyperthene, both altered to chlorite and calcite, in a hyalopilitic or pilotaxitic groundmass consisting of microcrystalline plagioclase and chloritized glass.

The andesitic tuffs and tuff breccias (Tc-tf) are green, brown and purplish brown in colors. A drill core piece of light green lapilli tuff taken from the depth of 99.35 m of the hole MJP-7 contains, under microscope, angular fragments of altered andesite (0.2 cm to 2.0 cm) in a matrix consisting fine rock fragments of the same composition, plagioclase fragments and andesitic tuffaceous materials. Both the fragments and the matrix are intensively chloritized and epidotized, and a mortary quartz albite alteration is observed in the matrix.

Alternating beds of tuffs, lapilli tuffs and tuff breccias are commonly observed in outcrops, occasionally interbedded with tuffaceous sandstones.

Thickness

The thickness of the lower rhyolite and rhyolitic tuff member (Tc-rho) and the upper member dominated by andesitic lavas is approximately 700 m each, and accordingly the Tacaza Formation reaches some 1,400 m in its total thickness. Beds of the andesitic tuffs and tuff breccias in the andesitic lavas is estimated to be approximately 50 m thick at their thickest parts.

Stratigraphy

The rhyolites and the rhyolitic tuffs member (Tc-rho) forming the lower part of the Tacaza Formation, having been revealed by this year's survey for the first time unconformably overlies the Chocolate volcanics (Cho) of Jurassic age. The upper member, consisting mainly of andesitic lavas (Tc-an) conformably rests upon the lower member.

The age of volcanic activity which formed the Tacaza Formation (Tc) has not been clarified in the survey area. According to the explanatory notes for the Pausa and Caraveli Geologic Map Areas, dating of the volcanic rocks stratigraphically correlated to the lower part of the Tacaza Formation is said to have given 19.1 Ma (unpublished data) with this result, the volcanic activity is of the early Miocene.

[3] Quaternary System

The Quaternary system comprises Pirca sediments (Ps), the lower (Vbl) and upper (Vbu) formations of Barroso Group, Moraine (Mo), Pausa volcanic sediments (Vsp) and Alluvium (al).

(1) Pirca Sediments (Ps)

Distribution

The Pirca sediments are distributed in an area in the vicinity of the Pirca village located slightly to the southeast of the centre of the Pirca eastern area.

Lithology

The Pirca sediments, having deposited around the Pirca village, consist mainly of sandstones and conglomerates partly interbedded with thin layers of tuffaceous sandstones and siltstones.

Their colors are generally light yellowish gray with local varieties of tan brown, brown and light brown.

The sediments are weakly consolidated and ill-sorted as a whole, and show slumping-like appearances in places.

The conglomerates contain angular or subangular rock fragments of variable sizes, usually of 50 cm or less in diameter.

The fragments are of rocks derived from the Tertiary Tacaza Formation (Tc-an and Tc-tf), highly silicified rocks, white altered rocks and vein-quartz, but no fragments of the quaternary volcanics are contained. The Pirca sediments have been intersected in the four drill holes MJP-1, 2, 3 and 4 in this year's drilling campaign.

Thickness

The Pirca sediments is estimated at approximately 70 m in thickness at the thickest part.

Stratigraphy

The Pirca sediments, unconformably overlying the Tacaza Formation, is presume to have deposited in a basin with a limited extent.

The age of their deposition has not been established, but they have possibly deposited earlier than the volcanism which has formed the Barroso Group.

(2) Barroso Group

The Barroso Group is divided into the lower and the upper Barroso Formations.

a) Lower Barroso Formation

This formation is lithologically divided into the porphyritic andesite (Vbl-po), the andesitic pyroclastics (Vbl-tf) and the pyroxene andesite (Vbl-an) members.

Distribution

This formation, overlying the Tacaza Formation (Tc), is distributed in the northern and the western parts of the Pirca Eastern Area and, further extending to the Pirca Western Area, occupies an extensive area except the central portion of the Pirca Western Area.

While the porphyritic andesite (Vbl-po) is predominated in the Pirca area as a whole, the andesitic pyroclastics (Vbl-tf) have limited distributions, being interlayered with the porphyritic andesite (Vbl-po), in the eastern part and slightly to the northwest of the central part of the Pirca Eastern Area, and also occupy a relatively wide area in the southern half of the Pirca Western Area. The pyroxene andesite (Vbl-an) is rather broadly distributed in the vicinity of Agua Blanca and extends further westwards into the Pirca Western Area. In addition, small distributions are located on or near the tops of ridges in the northern and the central parts of the Pirca western area.

Lithology

The porphyritic andesite (Vbl-po), being light gray, light purplish gray or dark purplish gray in colors, and massive and porous in appearances, consists of hornblende andesite lavas which characteristically contain phenocrysts of plogioclase (3 mm - 6 mm) and brown hornblende (3 mm $\pm$). Under microscope, the andesite, being porphyritic in texture, contain phenocrysts of plagioclase, hornblende and augite in a fresh hyalopilitic groundmass. The plagioclase phenocrysts (1 mm - 3 mm) are euhedral and tabular in shape and has An-compositions ranging from 48 to 60%. The hornblende phenocrysts (0.5 mm - 3 mm) are euhedral and lath-shaped, and brown to yellowish brown in color. The augite phenocrysts (0.5 mm - 1 mm), being minor in amount, are euhedral and gramular. The groundmass is composed of glass, plagioclase, augite, hornblende and opaques, no devitrification is observed in the groundmass.

The andesitic pyroclastics (Vbl-tf) comprise gray to purplish gray tuff breccias and volcanic breccias which contain fragments of porphyritic andesite, ordinarily with sizes of 5 to 10 cm, but rarely include large blocks up to 2 m in diameter. The matrix looks like unconsolidated or semiconsolidated sands in appearances, and is composed of fine fragments of hornblende andesite, and of coarse grained volcanic ashes.

The pyroxene andesite (Vbl-an) is gray, dark gray or light brownish gray in colors, and massive and compact.

Under, microscope, it is porphyritic or glomeroporphyritic in texture and contains phenocrysts of plagioclase (0.5 mm - 1.0 mm), augite, hornblende in a hyalopilitic or pilotaxitic groundmass.

The groundmass consists of glass and microlites of plagioclase, augite and hornblende.

Being included in part of the pyroxene andesite, the unaltered olivine basalt contains phenocrysts of plagioclase, augite, hyperthene, olivine and opaques in a groundmass consisting of glass and microlites of the same minerals as the phenocrysts.

Thickness

Being composed of volcanic rocks, the thickness of the formation is variable from place to place but the maximum thickness of each member is estimated to be approximately 350 m for the porphyritic andesite (Vbl-po), approximately 100 m and 450 m for the andesitic pyroclastics (Vbl-tf) in the Pirca Eastern Area and in the Pirca Western Area respectively, and approximately 300 m for the pyroxene andesite (Vbl-an).

Stratigraphy

This formation overlies the Tacaza Formation unconformably dating of a hornblende andesite sample collected from a formation equivalent to this formation in the first year's survey, yielded 1.30 $\pm$ 0.11 Ma which is correlated to the Pleistocene. According the explanatory notes of the Pausa and Caraveli Geologic Maps, the dated formation is correlated to late Pliocene or Pleistocene age. The formation in the Pirca Area may also well be correlated to the same age.

b) Upper Barroso Formation

This formation is lithologically divided into two members; the dacitic tuffs and welded tuffs (Vbu-wt), and the pumice fall deposits and tuffaceous sandstones (Vbu-pt).

Distribution

This formation is distributed only in the Pirca Eastern Area. The dacitic tuff and welded tuff member (Vbu-wt) forms belts along the right bank of the Paccha creek and along the Agua Blanca creek in the south, and small patches on steep slopes to the northeast and the southwest of the Pirca village.

The pumice fall deposits and tuffaceous sandstones (Vbu-pt) are distributed in several-tens localities, forming irregular shapes with variable extents, along ridges or gentle mountain slopes in the north-central part to the southern part of the southern part of the Pirca Eastern Area.

Lithology

The dacitic tuffs and welded tuffs (Vbu-wt) are light brownish gray, light gray or gray in colors, and indicate massive or platey appearances with prominent flow structures.

They usually contain flattened or elongated pumice fragments (0.5 cm - 2.0

cm) rarely with exotic andesite fragments (2 cm or less).

Under microscope, broken pieces of such minerals as plagioclase (0.5 mm - 3 mm), quartz (0.5 mm - 0.8 mm) and biotite (0.5 mm - 3 mm) are observed in a glassy groundmass with a minor amount of microlites of plagioclase, quartz and biotite.

The pumice fall deposits and tuffaceous sandstones (Vbu-pt) are unconsolidated sediments consisting of white or grayish white pumices (ordinarily 5 cm or less) and grayish white tuffaceous sands. Altenating beds of finer and coarser facies consisting of fall pumices, subrounded pumices and tuffaceous sands are observed in outcrops along creeks, which may suggest a part of this formation to have deposited under water.

Thickness

The maximum thickness is estimated at approximately 60 m for the dacitic tuffs and welded tuffs member (Vbu-wt), and at approximately 50 m for the pumice fall deposits and tuffaceous sandstones member (Vbu-pt).

Stratigraphy

The dacitic and welded tuff member changes gradually upwards into the pumice fall and tuffaceous sand member.

The formation unconformably overlies the Tacaza Formation (Tc), the Pirca sediments (Ps) and the lower Barroso Formation (Vbl).

The age of the volcanic activity which formed this formation has not been precisely established but may be of the late Pleistocene, taking the age of the lower Barroso Formation into account.

(3) Moraine

Distribution

The Moraine is distributed on gentle slopes of the northeastern mountains in the Pirca Western Area and its southeastern continuation skirts along the eastern edge of the Pirca Eastern Area.

Lithology

The Moraine is composed of sands and gravels transported by glaciers. The gravels are angular, subrounded or rounded in parts, and consist mainly of the porphyritic andesite of the lower Barroso Formation. The sands and the matrix of the gravels are composed of pebbles and coarse sands of the same composition as the gravels.

Thickness

The Moraine is estimated at approximately 60 m in thickness at its thickest part.

Stratigraphy

The Moraine unconformably overlies a part of the andesitic lava dominant member (Tc-an) of the Tacaza Formation and the porphyritic andesite (Vb1-po) of the lower Barroso Formation.

It is a glacial deposit which may have been formed in a glacial period towoards the end of the Pleistocene.

(4) Pausa Volcanic Sediments (Vsp)

Distribution

The Pausa volcanic sediments are distributed in a very area along a creak 200 m east of the Pirca village in the Pirca Eastern Area.

Lithology

The volcanic sediments is mainly composed of alternating beds of light grey or white tuffs, tuffaceous sandstones and siltstones interbedded partly with thin layers of pebbles, and very weakly consolidated.

Thickness

The top of the volcanic-sediments having been eroded out, the total thickness cannot be estimated, the volcanic sediments of around 40 m thick appear to be left at his location.

Stratigraphy

The volcanic sediments unconformably overlie the rhyolitie tuff (Tc-rho) of the Tacaza Formation and the Pirca sediments (Ps).

(5) Alluvials (al)

In the Pirca Eastern Area, relatively broad distributions of the Alluvials are observed in the vicinity of Millo along the Paccha river running westward in the south central part of the area, in an area to the east of Pirca village where the Nauquipa creek branches into several smaller creeks, and the precipitous area in the northeastern end of the area.

Limited distributions are located along the Agua Blanca creek in the southern part of the Pirca Western Area, and in the vicinities of the upstreams of the Cachinayoc and the Pucaccocha creeks in the Pirca Western Area.

Lithology

The Alluvials distributed along rivers and creeks are composed of angular or subround cobbles and gravels, sand and silts.

Talus deposits are developed on the slopes to the east of the Pirca village and contain angular boulders, cobbles and gravels togother with sands, silts and cloys.

The Alluvials at the north eastern end of the Pirca Eastern Area form landslide and collapsed deposits containing large blocks of rocks.

Thickness

Thickness of the Alluvials are estimated at approximately 40 m at the thickest for the alluvial deposits along rivers and streams and the talus deposits, and at approximately 60 m at the thickest for the landslide and collapsed deposits.

(4) Instrusive Rocks

There are small dikes of hornblende andesite (An) only in the Pirca Eastern Area.

Distribution

The hornblende andesite dikes intrude the Tacaza Formation at one locality to the north of Millo, and at three localities to the southeast of the Pirca village. No dikes of this kind have been recongnized in the Pirca Western Area.

Lithology

The hornblende andesite is dark grey or blackish grey in colors, and massive and compact. It contains phenocrysts (1 mm $\pm$) of plagioclase and hornblende.

Occurrences and Age of Intrusion

The hornblende andesite dikes, trending a E-W, NE-SW or NW-SE direction, intrude the andesitic lavas (Tc-an) and rhyolitic tuffs (Tc-rho) of the Tacaza Formation.

The age of the intrusion has not been established but may be assumed to be the middle to late Miocene because of unaltered of the hornblende andesite.

2-3-2 Geological structures

No prominent tectonic element has been recognized in the Pirca Area.

In the Pirca Eastern Area, the Tacaza Formation appears to have been deformed subject to the Andean Orogeny (at the waining stage of the orogeny?). The beddings of the formation strike in the direction of E-W and dip 10° to 15° to N.

Faults have been recognized at three localities, one trending NW-SE along the Paccha creek in the vicinity of Millo, another trending NE-SW on the slope to the northeast of Millo and the third also trending NE-SW on the slope approximately 1 km southeast of Millo. Magnitudes of dislocation by these faults appear to be small, possibility within ranges of several tens of meters.

No Notable structural features has been recognized in the Pirca Western Area.

2-3-3 Alteration and Mineralization

A number of alteration zones of variable size have been observed in the Pirca Area (Figs. 2-8, 2-9, PLs.7, 11).

However, the mineralization of this area is generally weak and no mineralized zone has ever been exploited though several localities have been explored by means of trenching.

Of Samples collected from outcrops in the Pirca Eastern and Western Areas, 70 samples were submitted for X-ray diffraction analysis, 2 samples for microscopic observation of polished sections to identify are minerals, and 27 samples for chemical analysis. The results of these analyses and observation are shown in the Appendices 4, 8 and 6 attached to the end of this report.

(1) Distribution of the Alteration and Mineralization Zones

Most of the alteration zones are located in areas distributed by the andesitic lavas (Tc-an) and the andesitic tuffs (Tc-an) of the Tacaza Formation (Tc), and a few in areas distributed by the rhyolitic tuffs (Tc-rho) of the same formation.

No primary alteration or mineralization has been recognized in the Quaternary system, though fragments of altered or silicified rocks are contained in the Pirca sediments, the lowermost formation of the Quaternary.

Distributions, sizes and modes of occurrences of the major alteration and mineralization zones are summerized in Table 2-3. Seven major alteration zones, PE-1 through PE-7 are recognized in the Pirca Eastern Area, and three, PW-1 through PW-3, in the Pirca Western Area.

(2) Outline of the Alteration and Mineralization Zones

Three types of alteration are classified by the field observation: one dominated by silicification, another characterized both by silicification and argillization and the third dominated by argillization (Figs 2-7, 2-8, PLs.7, 11).

The alteration dominated by silification forms light brown to grey colored and strongly silicified outcrops occassionally accompanied, by discontinuous quarts veinlets. This type of alteration is typified by a mineral assemblage of quarts or quarts and ¶-cristobalite-kaolinite. The alteration zones of this type have been located in parts of the PE-3, PE-4, and the PE-5 alteration zones in the Pirca Eastern Area and in parts of the PW-1 and the PW-2 alteration zones in the Pirca Western Area.

The alteration characterized both by silicifiation and argillization forms brown to yellowish brown colored outcrops due to iron oxide stains, consisting of mixture of silicified and argillized portions. The argillized portion is composed mainly of quartz and alunite, accompanied by dickite in places in the Pirca Eastern Area, and by α-cristobalite in the Pirca Western Area. The silicified portion is composed of quartz-(Kaolinite) and a small amount of montmorillonite.

This type of the alteration occupies the whole areas of the zones PE-1 and PE-2, and parts of the zones PE-3, PE-4 and PE-5 excluding the parts subject to the alteration dominated by silicification, in the Pirca Eastern Area, and the whole of the zone PW-3 and most parts of the zone PW-2 in the Pirca Western Area.

The alteration dominated by argillization forms outcrops exhibiting variable colors such as brown, yellowish brown, light grey, white and so forth.

This type of the alteration are recognized in the zones PE-6 and PE-7 in the Pirca Eastern Area, and generally represented by an alteration mineral assemblage of quarts-montmorillonite-(Kaolinite), occassionally accompanied by pyrophyllite, jarosite and chlorite. In the Pirca Western Area, 8 small zones of the alteration of this type are identified and generally characterized by an alteration mineral assemblage of quartz-¶cristobalite-alunite.

The zones PW-1 and PW-3 in the Pirca Western Area include the Au-Ag mineralization associated with the alteration dominated by silicification and the accompanying quarts veinlets.

No or very little evidences of the Au-Ag mineralization have been recognized in the Pirca Eastern Area. There is none at all in respect to the Cu-Pb-Zn mineralization. Pyritization is the only megascopically identified mineralization in the Pirca Easter Area.

(3) Description of Individual Alteration-Mineralization Zones

Under this section, the alteration-mineralization zones are, for the purpose of description, categorized into the following 7 groups according to the types of alteration; they are a) PE-1, b) PE-2, c) PE-3, PE-4 and PE-5, d) PE-6 and PE-7, for the Pirca Eastern Area, e) PW-1, f) PW-2, and g) PW-3 for the Pirca Western Area.

The analytical results of the samples of each alteration-mineralization zone are shown in Table 2-4.

a) PE-1 Alteration Zone

This zone is located on the left bank of the Paccha creek approximately 0.8 km southeast of Millo and occupies and are extending for approximately 0.5 km in the E-W direction with a width of approximately 0.3 km, where the rhyolitic tuffs of the Tacaza Formation are distributed.

The alteration zone comprises zones of silicification and argillization. The silicifiation zones, being resistant to erosion form projecting outcrops with widths of 10 m or less. The silicified outcrops are arranged in parallel with each other and accompanied by vein-like zones of intensive silicification with widths of 1.5 m or less and by quartz veins.

The argillization of variable degree is developed in zones between the silicified zones. The argillized outcrops are variable in colors showing light grey, yellowich grey, and brown appearances.

A sketch of an altered outcrop in the southwestern part of the PE-1 zone is shown in Fig. 2-10. As soon in the sketch, the intensively silicified zones and quartz veins change there widths within a range 1.5 m or less, and generally strike in the E-W direction and dip steeply to the north or to the south.

A minor fault trending NNE-SSW is located in the centre of the PE-1 zone, and cut-accross the alteration zones, the trends of which is changed into the NW-SE direction in the southeastern side of the fault.

Alteration mineral assemblages are quartz-sericite-(kaolinite)-(alunite) in the white argillized zones, and quart-(sericite)-(kaolinite) in the silicified zones. Zones of weak alteration in the eastern part of the PE-1 zone contain montmorillonite and chlorite.

Chemical analysis of 4 samples of strongly silicified rocks and quartz yielded very low Au and Ag values with the maxima of 0.07 g/t Au and 2.8 g/t Ag.

No mineralization of Au, Ag, Cu, Pb or Zn has been recognized in the PE-1 zone, though brown iron-oxide staining and pyrite dissemination are prominent in outcrops.

Weak geochemical anomalies in Au and As are located in association with the PE-1 alteration zone, and 2 holes, MJP-9 and 10, were drilled to verify the anomalies.

The results will be mentioned in the later chapters, 3 and 4.

b) PE-2 Alteration Zone

The PE-2 alteration zone is located on the top of a mountain approximately 0.5 km northeast of Millo and occupies an area extending for approximately 0.3 km along a ridge in the E-W direction with a width of approximately 0.1 km, where the altered andesitic lavas (Tc-an) of the Tacaza Formation are distributed.

The alteration zone comprises zones of silicification and argillizaion. Intensively silicified rocks with variable widths crop out continually and are surrounded by brown or white colored argillization. The continuation of the silicified outcrops strikes in the direction of approximately N80°W and appears to dip 75°-85° to the north though not difinitive.

The western end of the series of the silicified outcrops is cross cut by a minor fault trending NW-SE, and possible dislocated continuation can be traced for approximately 0.5 km further westwards.

Though no sample from the PE-2 alteration zone has been submitted for X-ray diffraction analysis, a main alteration mineral assemblage is pressumed to be quartz-(sericite)-(kaolinite), judging the results of X-ray diffraction analysis for samples from the possible western continuation of the PE-2 zone and from the PE-1 zone.

Chemical analysis of the sample from a strongly silicified outcrop yielded values of less than 0.07 g/t Au and 4.7 g/t Ag which suggest a sign of Ag mineralization.

Irregular lenses or veins of reddish brown iron-oxides are concentration in strongly silicified outcrops in a part of the PE-2 alteration zone. A hole MJP-8 was drilled to verify these outcrops in the depth, the result of which will be mentioned in the Chapter 4.

c) PE-3, PE-4 and PE-5 Alteration Zones

The alteration zones of PE-3, PE-4 and PE-5 occupy broad areas distributed by the altered andesitic lavas (Tc-an) and the andesitic volcanic breccias (Tc-tf) of the Tocaza Formation.

The PE-3 alteration zone is located approximately 1.3 km north of the Pirca village and extend northwestwards for approximately 1.5 km. The area of the alteration zone is approximately 1.4 km long in the E-W" direction and approximately 0.5 km wide in the N-S direction.

The PE-4 alteration zone, possibly the western continuation of the PE-3, occupies an area approximately 1.4 km long in the E-W direction and approximately 0.6 km wide in the N-S direction.

The PE-5 alteration zone, to the southwest of the PE-4 zone, is located from approximately 0.7 km to 2.2 km north northwest of Millo and an area elongated in the NW-SE direction with a length of 1.5 km and a width of 0.5 km.

These alteration zones are characterized by mixture of silicification and argillization but partly include zones dominated by silicification.

The silicification-argillization zones exhibit variable colors such as brown, reddish brown, yellowich grey and grayish white, and are characterized by complex intermixture of silicified and argillized portions.

Strongly silicified portions form lenticular outcrops or zones of abundant boulder floats. On the other hand, in portions of prominent argillization, a very little floats of rocks are found, and creeks and v-shaped valleys of small scales are well-developed.

These alteration zones of large scales trend generally in the E-W direction a whole, but, unlike in the PE-1 and the PE-2 alteration zones, there have been observed no quartz veins nor prominent trends of intensively altered zones.

Silicification dominant alteration occupies a relatively broad area in the western part of the PE-3 zone, and also forms 2 separate zones in the PE-4 zone and 3 separate zones in the PE-5 zone. The zones dominated by silicification consist mainly of intensively silicified rocks with light brownish grey to grey colors and are partly accompanied by networks of quartz veinlets but contain no prominent quartz veins.

An alteration mineral assemblage of quartz-alunite is prominent in the intensively argillized zones, and assemblages of quartz only, α-cristobalite-kaolinite-alunite, and quartz-potash feldspar-α-cristobalite are common in the intensively silicified zones, according to the results of X-ray diffraction analysis of samples taken from there alteration zones.

Mineralization is very weak in general. A sample taken from an intensively altered outcrop in the PE-4 alteration zone contained 6.8 g/t Ag, and another sample collected in the southeastern and of the PE-5 yielded a value of 12.0 g/t Ag. These analytical results suggest a possibility of Ag mineralization but no evidences of other mineralization have been recognized except for pyritization.

d) PE-6 and PE-7 Alteration Zones

The PE-6 alteration zone is located in on area extending from 0.9 km to 1.5 km northwest of Millo.

The PE-7 alteration zone is located 0.3 km to the north of Millo and forms a narrow belt continuing southeastwards for approximately 1 km along the Paccha creek.

Both the alteration zone are dominated by argillization showing brown, light brown and yellowish brown colors.

Differences in degrees of alteration strength produce alteration bands in altered rocks. These alteration bands trend in the E-W direction in general. Neither prominent silicification zones nor quartz veins have been recognized in association with these alteration zones.

X-ray diffraction analysis of samples collected in there alteration zones identified a main alteration mineral assemblage of quartz-montmorillonite accompanied by kaolinite, sericite and/or jarosite. An assemblage of quartz-kaolinite-pyrophyllite is also identified in a sample taken from a partially silicified outcrop.

Chemical analysis of samples of argillized or silicified rocks gave very low values in any elements of interest. A value of 8.0 g/t Ag was ditected in a sample of argillized ad pyrite-disseminated rocks, which had been collected in the central part of the PE-7 alteration zone. This is the only sign of Ag mineralization found in these alteration zones.

e) PW-1 Alteration Zone

The PW-1 alteration zone, dominated by silicification, occupies an area extending northeastwards from the Antaripa mountain along a ridge for approximately 1.5 km with a width of approximately 0.3 km, where the Tacaza Formation, showing a light brown color due to weak pervasive alteration, is distributed.

This alteration zone comprises intensively altered, porous rocks showing grey, dard gray and partly light brown colors. The rocks megascopicaly appear to be composed only of quartz, and their original textures are completely obliterated due to alteration. Quartz veinlets with dark gray bands crosscut a part of the silicified zone but are discontinuous.

Quartz is the only alteration mineral identified in most samples of sicilified rocks by X-ray diffraction analysis. An alteration mineral assemblage of quartz-(cristobalite)-(alunite) is found only in one sample.

A quartz vein network with a dark gray color is associated with a silicified outcrop located in the southeastern part of the PW-1 alteration zone. A sample of the network yielded values of 6.65 g/t Au and 10.0 g/t Ag which would be a notable sign of Au-Ag mineralization.

A polished section of the sample has been examined under microscope. Minuite particles showing a dark gray color in quartz are identified as concentration of fine grained pyrite. However, no Au and/or Ag minerals have been recognized in association with quartz.

f) PW-2 Alteration Zone

The PW-2 alteration zone occupies an area extending for 2.5 km with a width of 0.3 km along the best bank of the upstream of the Cachinayoc river flowing in the eastern part of the Pirca Western Area, where the andesitic volcanic breccias of the Tacaza Formation are distributed.

The alteration zone comprises intermixtures of zones of silicification and argillization showing a brown or reddish brown color due to iron-oxide stains.

Intensively silicified portions are locally observed but are limited in extent and indicate no prominent trends.

X-ray diffraction analysis identified an alteration mineral assemblage of quartz-cristobalite-alunite in a sample collected in the north eastern part of the alteration zone, and an assemblage of potash feldspar - (halloysite) - (montmorillonite) - (alunite) in a sample colled in the southeastern part.

Alteration disseminated by pyrite or showing a brown color due to oxidation of pyrite has been recognized in the PW-2 zone. however, intensively silicified zones or quartz veins which may have potentials for Au-Ag mineralizaion, have not been located.

g) PW-3 Alteration Zone

The PW-3 alteration zone occupies a 0.5 km long and 0.15 km wide area located to the felt bank of the Carbonada creek flowing in the southwestern part of the Pirca Western Area, where the andesitic volcanic breccias of the Tacaza Formation are distributed.

The alteration zone, consisting of silicification and argillization has not been well-studied due to its limited exposures.

X-ray diffraction analysis of a sample taken from a silicified outcrop identified an alteration mineral assemblage of quartz-(halloysite). The sample, having yielded values of 0.89 g/t Au and 7.0 g/t Ag, indicated a sign of weak Au-Ag mineralization.

h) Other Alteration Zones

Other than described above, a number of alteration zones of small sizes area located in the Pirca area. Some of then area not marked in the maps presented with this report. However, neither significant alteration-mineralization zones nor prominent quartz veins are associated with these alteration zones.

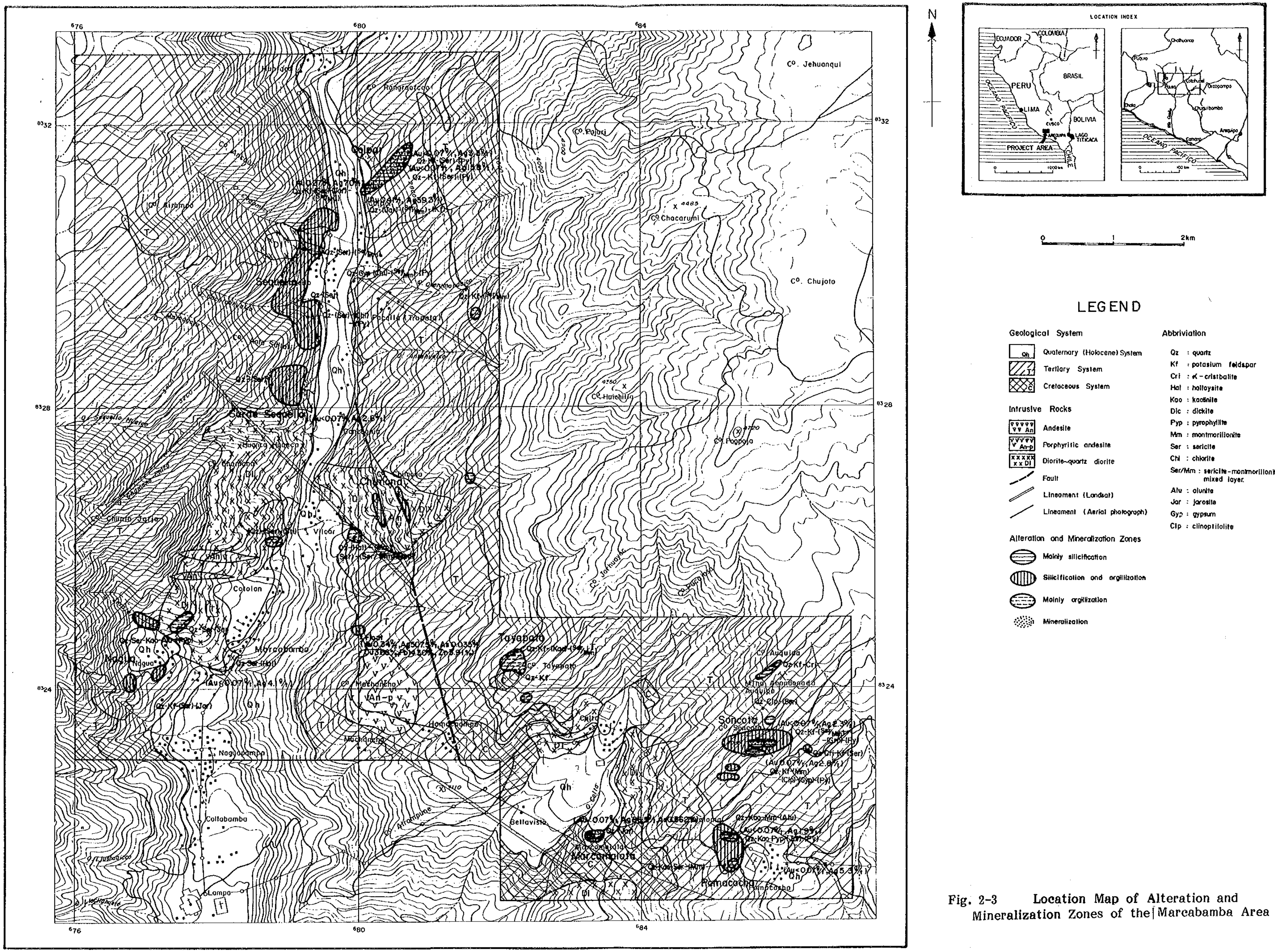
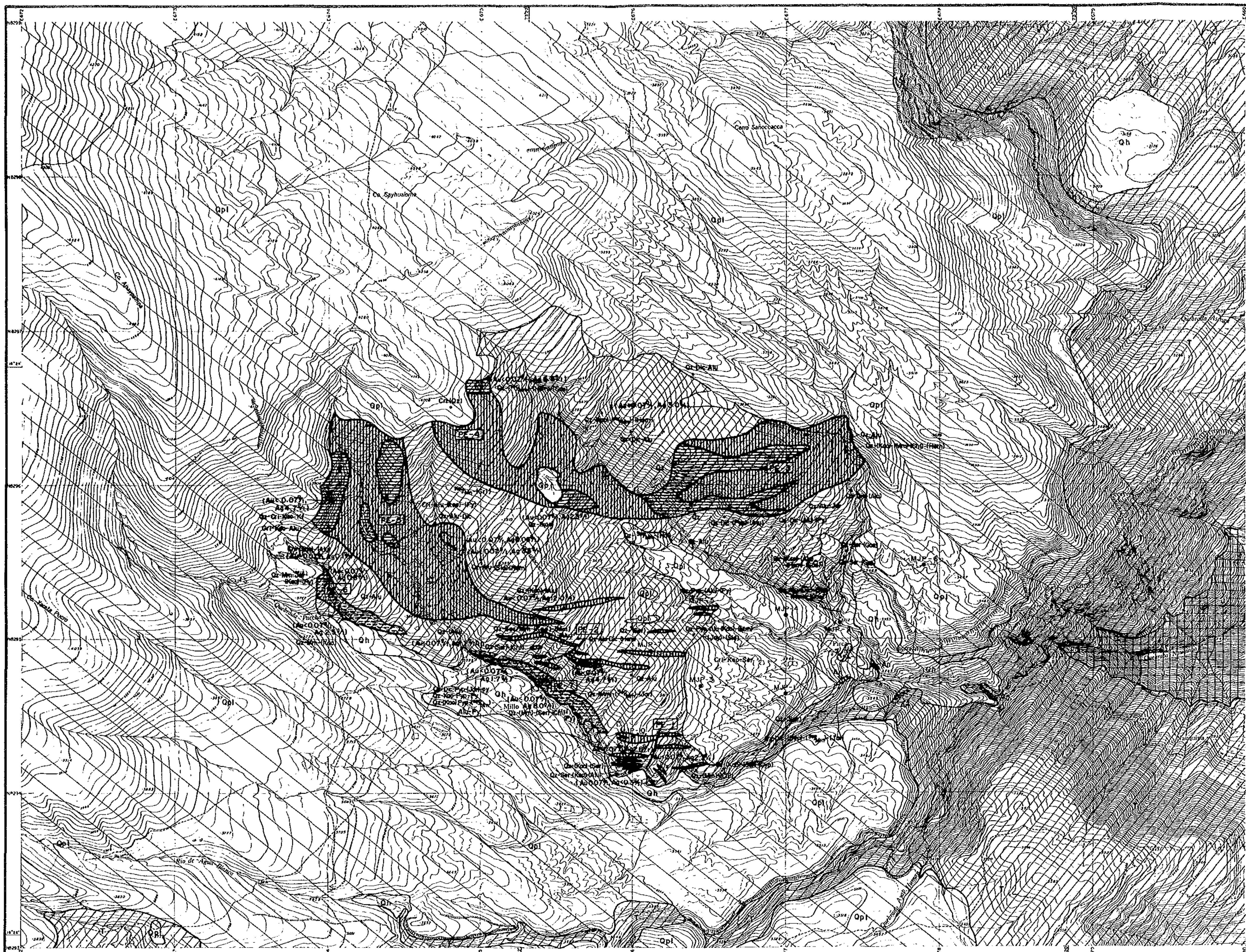


Fig. 2-3 Location Map of Alteration and Mineralization Zones of the Marcabamba Area

Table 2-4 Chemical Analyses of Altered Rock and Ore Samples of the Pirca Area

Name of Alteration Zone		Sample No.	Co-ordinates		Au g/t	Ag g/t	As %	Cu %	Pb %	Zn %	Remarks
			E (km)	N (km)							
Pirca Eastern Area	PE-1	PMV-2	676.2	8294.2	<0.07	2.3	0.004	<0.01	<0.01	<0.01	quartz vein (w = 0.80 m)
		PK-6	676.0	8294.2	<0.07	2.8	0.002	<0.01	0.01	0.01	strong siliceous rock
		PK-39	675.9	8294.1	0.07	<0.3	0.005	<0.01	<0.01	<0.01	strong siliceous rock (quartz vein?)
		PK-42	676.3	8294.2	<0.07	<0.3	<0.001	<0.01	<0.01	<0.01	quartz vein (w : 0.45 m)
	PE-2	PV-16	675.5	8294.8	<0.07	4.7	0.003	<0.01	<0.01	<0.01	siliceous rock
	PE-4	PK-30	675.0	8296.6	<0.07	6.8	0.005	<0.01	0.01	0.01	siliceous rock
		Pm-25	675.4	8295.8	<0.07	2.5	0.002	<0.01	<0.01	<0.01	"
	PE-5	Pm-13	674.0	8295.9	<0.07	4.7	0.004	<0.01	<0.01	<0.01	argillaceous rock with pyrite
		Pm-24	675.4	8295.2	<0.07	12.0	0.001	<0.01	0.01	0.01	"
		PZ-14	674.8	8295.6	0.07	3.3	0.022	<0.01	<0.01	<0.01	siliceous rock with limonite stains
		PZ-15	674.8	8295.6	<0.07	0.3	0.006	<0.01	<0.01	<0.01	"
	PE-6	Pm-9	674.1	8295.2	<0.07	2.5	0.022	<0.01	<0.01	<0.01	white argillaceous rock
		Pm-10	674.0	8295.4	<0.07	0.8	0.040	<0.01	<0.01	<0.01	"
		Pm-11	674.0	8295.5	<0.07	1.0	0.002	<0.01	<0.01	<0.01	siliceous rock
	PE-7	PK-25	675.1	8294.8	<0.07	1.7	0.011	0.01	<0.01	0.01	siliceous rock (quartz vein?)
		Pm-20	675.4	8294.7	<0.07	8.0	0.028	<0.01	0.01	0.02	argillaceous rock with pyrite
	Others	Pm-2	673.8	8294.1	<0.07	0.8	0.002	<0.01	<0.01	<0.01	massive quartz (float)
		PZ-6	675.8	8296.5	<0.07	3.0	0.008	<0.01	<0.01	<0.01	altered rock with iron oxides
		PZ-12	674.8	8295.0	<0.07	1.7	0.001	<0.01	<0.01	<0.01	calcedonic quartz (float)
Pirca Western Area	PW-1	PN-31	667.5	8297.1	<0.07	1.9	0.002	<0.01	<0.01	<0.01	siliceous rock
		PV-21	666.6	8296.6	<0.07	1.0	0.002	<0.01	<0.01	<0.01	"
		WG-2	667.0	8296.8	6.65	10.0	0.006	<0.01	0.02	0.01	grey quartz vein
		WPK-1	666.8	8296.5	0.17	<0.3	<0.001	<0.01	<0.01	<0.01	strong siliceous rock
		WPZ-6	666.4	8296.0	0.14	2.3	0.007	<0.01	<0.01	<0.01	white siliceous rock
	PW-3	WG-1	666.8	8295.3	0.89	7.0	0.009	<0.01	0.04	0.01	siliceous rock
		WPZ-10	666.5	8295.3	<0.07	<0.3	0.001	<0.01	<0.01	<0.01	strong siliceous rock
	Others	PN-24	667.7	8295.7	<0.07	<0.3	0.008	<0.01	<0.01	<0.01	siliceous rock



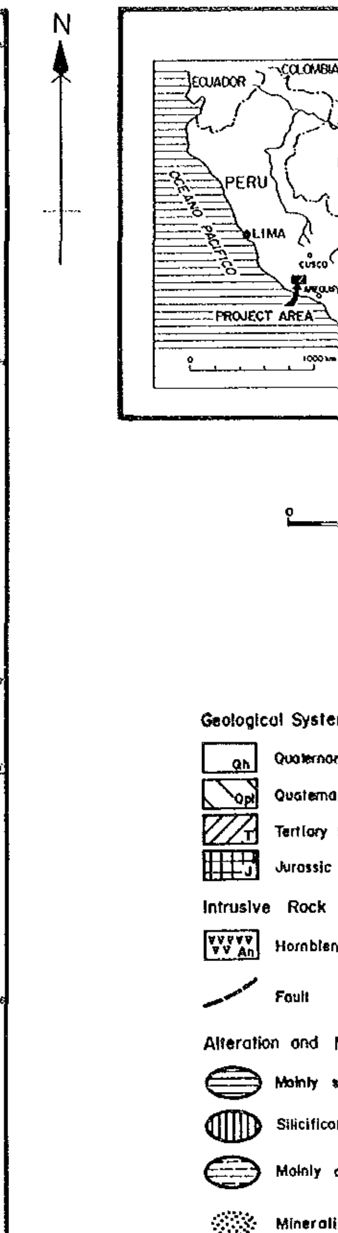
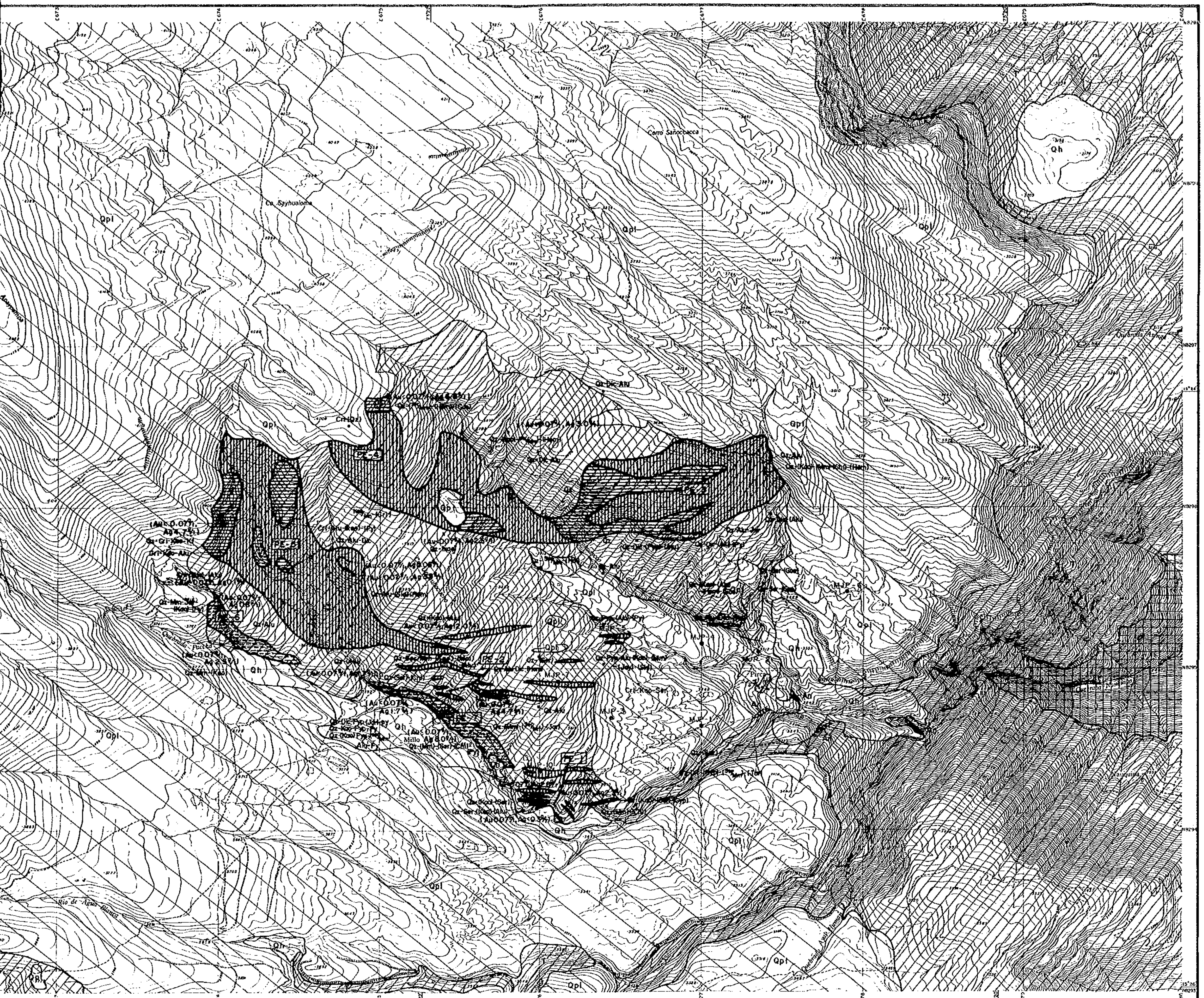
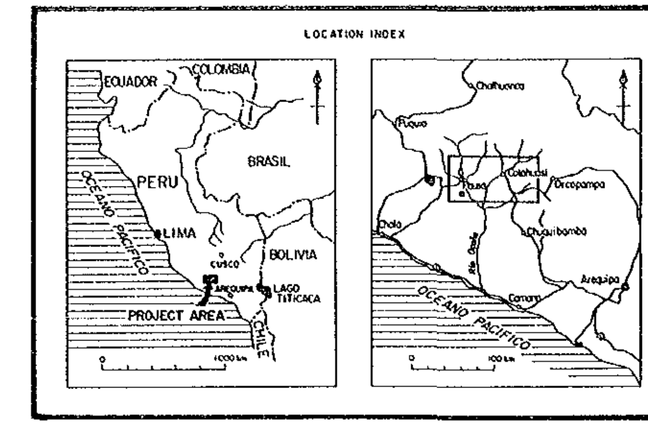


Fig. 2-8 Location
Mineralization Zones





0 0.5 1 km

LEGEND

Geological System

- Qh — Quaternary (Holocene) System
- Qpl — Quaternary (Pleistocene) System
- T — Tertiary System
- J — Jurassic System

Intrusive Rock

- An — Hornblende andesite
- Fault

Alteration and Mineralization Zones

- Mainly silisification
- Silicification and argilization
- Mainly argilization
- Mineralization

Abbriviatiom

- Qz : quartz
- Kf : potasium feldsper
- Cri : α-cristbalite
- Hal : halloysite
- Kao : kaolinite
- Dic : dickite
- Pyp : pyrophyllite
- Mm : montmorillonite
- Ser : sericite
- Chl : chlorite
- Kao/Mm : kaolinite-montmorillonite mixed layer
- Ser/Mm : sericite-montmorillonite mixed layer
- Alu : alunite
- Jar : jarosite
- Gyp : gypsum
- Py : pyrite
- Hem : hematite
- Goe : goethite

Fig. 2-8 Location Map of Alteration and Mineralization Zones of the Pirca Eastern Area

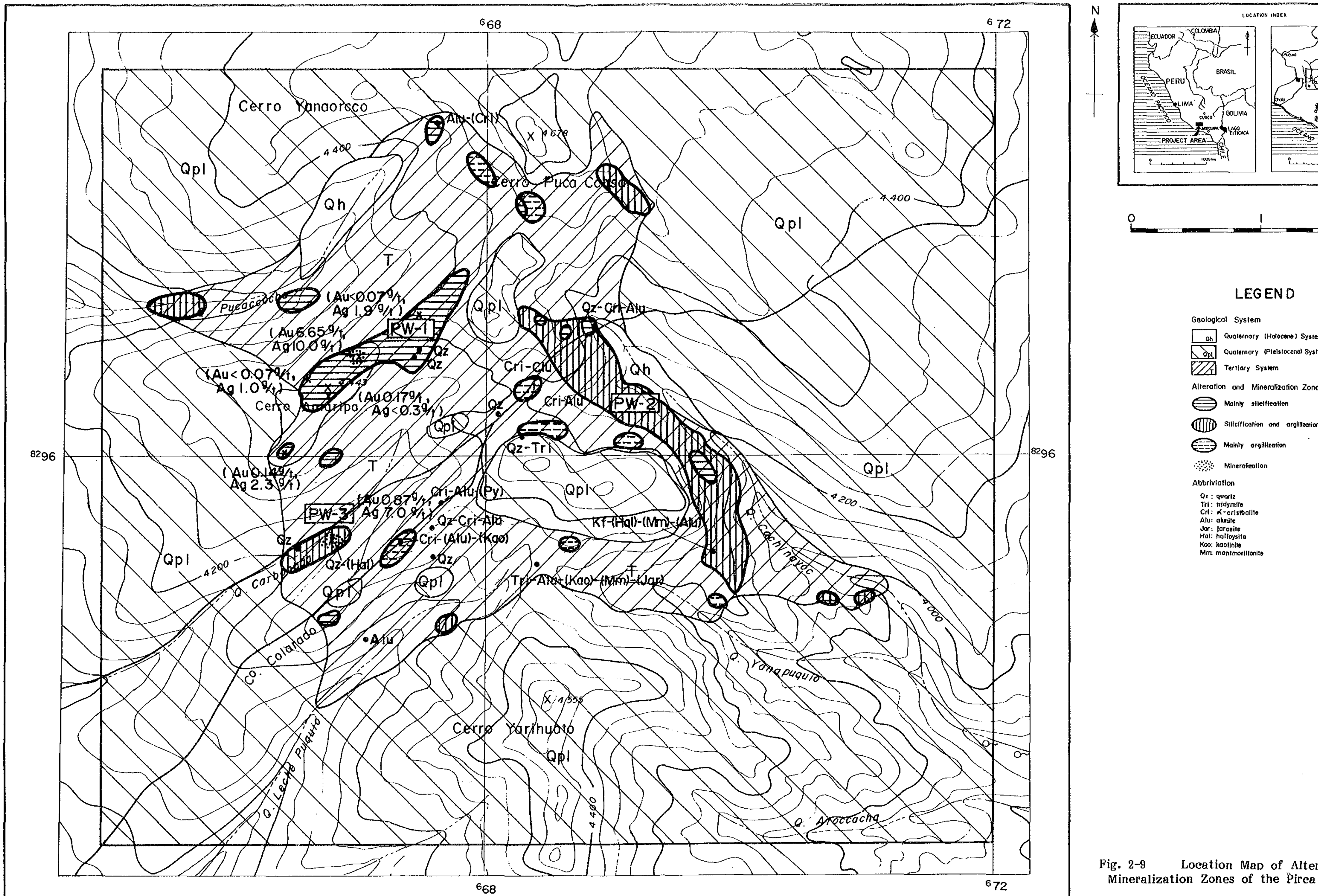
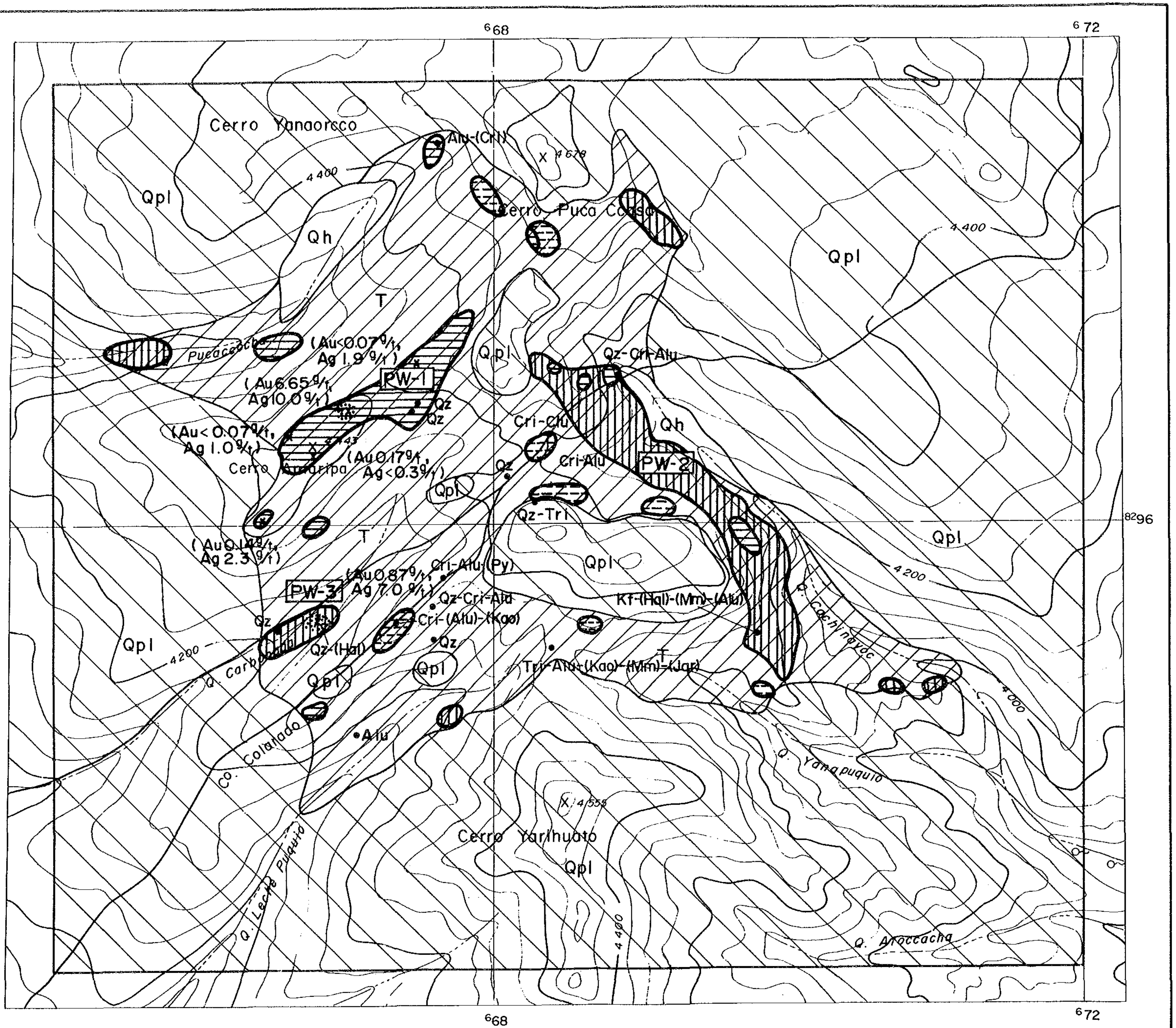
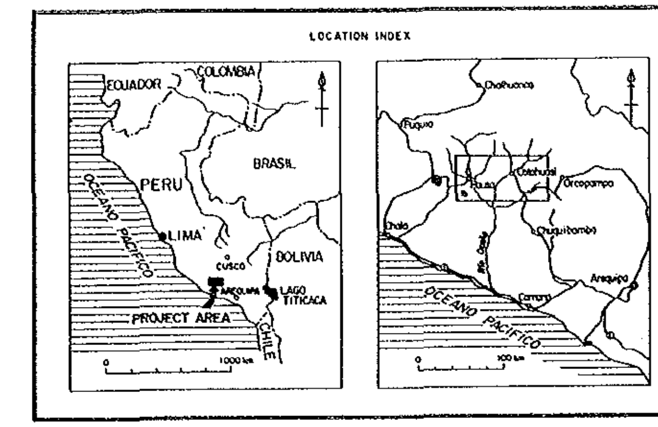


Fig. 2-9 Location Map of Altera
Mineralization Zones of the Pirca





LEGEND

Geological System

- Qh — Quaternary (Holocene) System
- Qpl — Quaternary (Pleistocene) System
- Tertiary System

Alteration and Mineralization Zones

- Mainly silicification
- Silicification and argillization
- Mainly argillization
- Mineralization

Abbriviation

Qz : quartz
Tri : tridymite
Cri : α-cristobalite
Alu: alunite
Jar: jarosite
Hal: halloysite
Kao: kaolinite
Mm: montmorillonite

Fig. 2-9 Location Map of Alteration and Mineralization Zones of the Pirca Western Area

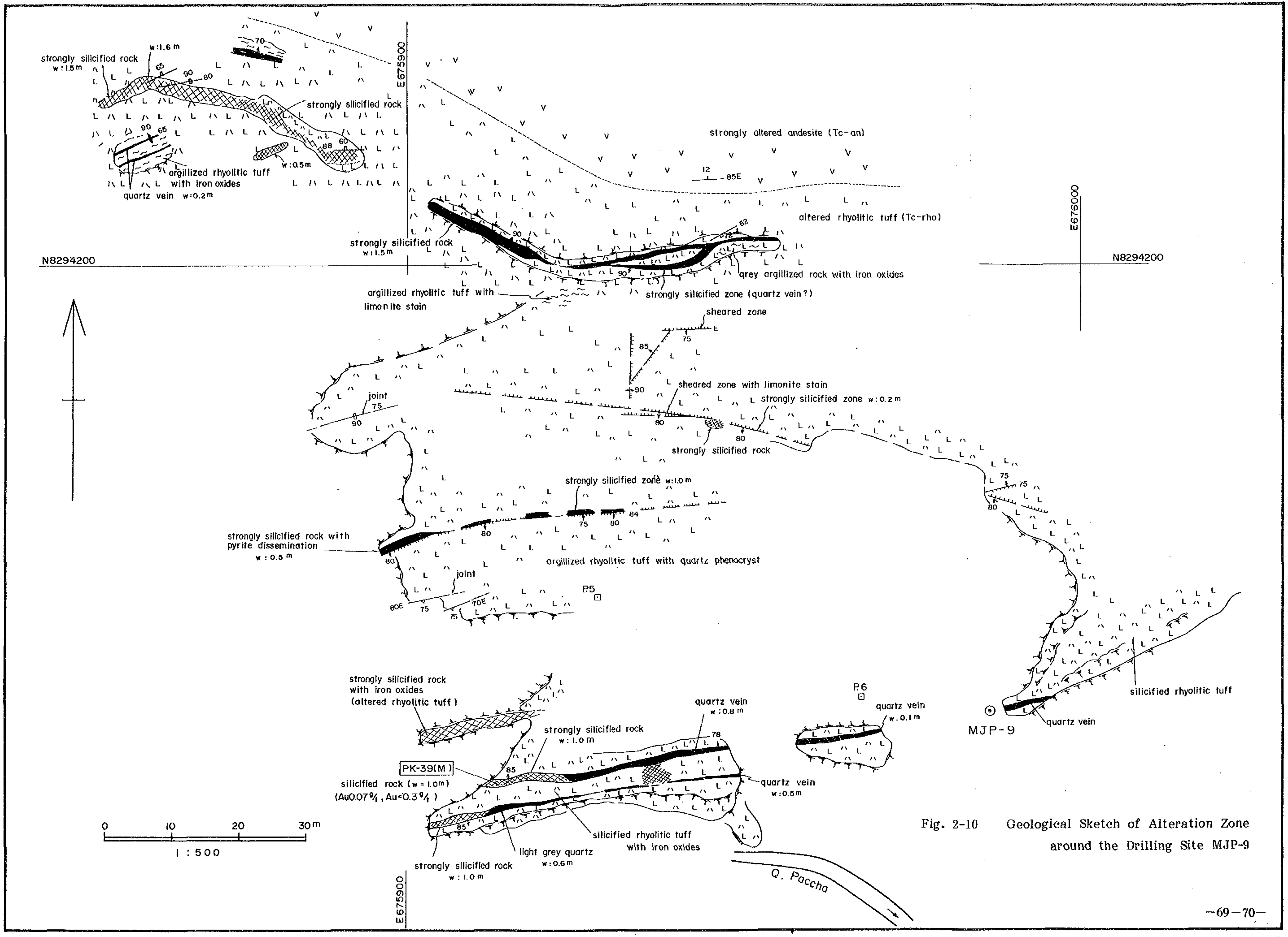


Fig. 2-10 Geological Sketch of Alteration Zone around the Drilling Site MJP-9

CHAPTER 3 GEOCHEMICAL EXPLORATION

CHAPTER 3 GEOCHEMICAL EXPLORATION

In this year's survey, a geochemical soil sampling for the survey area was conducted and collected samples were analized for 6 indicator elements such as Au, Ag, As, Cu, Pb and Zn.

3-1 Sampling and Analytical Procedures

Sampling, sample preparation, analytical methods and data-analysis are described in this section.

3-1-1 Sampling Procedures and Number of Samples

Soil samples were taken from B-horizon of soil layers and approximately 50 grams of a minus 80 mesh fraction of each sample after sieving were submitted for chemical analysis.

Sample locations were decided on a lectiangular grid system in the alteration zones of the Pirca area (the Pirca alteration zones and the Sara Sara south alteration zones) and on a ridge-and-spur system in other parts of the survey areas than these zones.

The rectiangular grid system was controlled by using a packet compus and a chain.

Sampling patterns and the number of collected samples for the 3 survey areas listed in Table 3-1. The total number of soil samples collected is 2.028.

Table 3-1 Sampling Patterns and Number of Samples in Each Area

Area	Part of the Area	Sampling Pattern			Number of Samples	
		Pattern	Route	Interval		
Marcabamba Area	Whole Area	Ridge-and-Spur	Along roads and paths Along ridges	200 - 250 m	620	
Pirca Eastern Area	Pirca Altera-tion Zone	Rectiangular Grit	Along N-S traverse lines	Line spacing: 200 m Interval: 100 m	680	1408
	Marginal Zone	Ridge-and-Spurt	Along small paths and ridges	200 - 250 m	272	
Pirca Western Area	S. of Sara Sara Altera-tion Zone	Rectiangular Grit	Along N-S traverse lines	Line Spacing: 700-800 m Interval: 100 m	83	
	Whole Area	Ridge-and-Spur	Along small paths and ridges	200 - 250 m	373	

3-1-2 Sample Preparation and Analytical Procedure

Each collected sample was dried and sieved at the base camp and divided into 2 portions; one for chemical analysis and the other as a duplicate.

The samples for chemical analysis, after having been classified, arranged and recorded, were sent by air to CHEMEX LABS LTD. in Vancouver, B.C., Canada, via Lima, Peru, for chemical analysis.

These samples were analized for the 6 indicator elements, Au, Ag, As, Cu, Pb and Zn at CHEMEX LABS LTD.

Au was determined by a neutron-activation analysis. An atomic absorption spectrometory was applied for determining other 5 elements, Ag, As, Cu, Pb and Zn.

The analytical methods were outlined in Table 3-2.

The lower detection limits for the elements were 1 ppb for Au, 0.1 ppm for Ag and 1 ppm for As, Cu, Pb and Zn, and the upper detection limits were 10,000 ppb for Au, 100 ppm for Ag, and 10,000 ppm for As, Cu, Pb and Zn.

Table 3-2 Method of Chemical Analayses (by CHEMEX LABS LTD.)

GOLD A 10 gram sample is fused in litharge, carbonate and silicious flux. The resulting lead button containing any gold in the sample is cupelled in a muffle furnace to produce a precious metals bead. Sample beads, plus standard and blank beads are irradiated in a thermal neutron flux. The gamma emissions of the irradiated beads are counted utilizing a Ge (Li) detector and quantified for gold. The detection limit for a 10 gram sample is 1 ug/kg (ppb).
ARSENIC A 1.0 gram sample is digested with a mixture of perchloric and nitric acid to strong fumes of perchloric acid. The digested solution is diluted to volume and mixed. An aloquot of the digested is acidified, reduced with KI and mixed. A portion of the reduced solution is converted to arsine with NaBH4 and the arsenic content determined using flameless atomic absorption. The detection limit is of 1 ppm.
SILVER A 1.0 gram portion of sample is digested in conc. perchloric-nitric acid (HC104-HN03) for approx. 2 hours. The digested sample is cooled and made up to 25 mls. with distilled water. The solution is mixed and solids are allowed to settle. Silver is determined by atomic absorption technique using background correlation on analysis. The detection limit is of 0.1 ppm.
Copper, Lead, Zinc A 1.0 gram portion of sample is weighed into a calibrated test chube. The sample is digested using hot 70% perchloric acid and concentrated nitric acid. Digestion time is two hours. Sample solutions are homogenized and allowed to settle before being analyzed by atomic absorption procedures. Detection limits using Varian atomic absorption unit are as follows : Copper - 1 ppm Lead - 1 ppm Zinc - 1 ppm

3-1-3 Data Analysis

Analytical data, being separately treated for the Marcabamba area and the Pirca area (further subdivided into the Pirca Eastern and Western areas), were statistically examined by using univariate analysis and principal component analysis.

The theoretical backgrounds for these statistical methods and the definitions of threshold values have been described in the first year survey report.

Numbers of samples collected were 620 in the Marcabamba area and 1408 in the Pirca area. Those values below the lower detection limit were treated as equal to the lower detection limits and those above the upper limit as equal to the upper detection limits.

3-2 Exploration Results in the Marcabamba Area

3-2-1 Univariate Analysis

(1) Standard Statistical Values

Standard statistical values for the indicator elements are shown in Table 3-3, together with the crustal abundances and USGS standards G-1 and W-1.

Table 3-3 Statistical Values of Indicator Elements in the Marcabamba Area

Element (unit)	Maximum value	Minimum value	Logarithmic base		Values of classification				Abundance		
			Mean (M)	Standard diviation (σ)	M	M + σ	M + 2σ	M + 3σ	Crust	G-1 sample	W-1 sample
Au (ppb)	10,000	1	0.66	0.60	4.6	18.2	73.0	292.1	4	2	4
Ag (ppm)	100	0.1	-0.82	0.44	0.15	0.42	1.15	3.18	0.07	0.04	0.05
As (ppm)	10,000	1	0.89	0.49	7.8	23.8	72.9	223.4	1.8	0.8	2.4
Cu (ppm)	570	4	1.45	0.21	28.0	45.1	72.5	116.7	55	13	110
Pb (ppm)	10,000	1	1.13	0.40	13.4	33.5	83.9	210.4	13	49	8
Zn (ppm)	2,750	4	1.84	0.20	68.7	109.6	174.6	278.4	70	45	82

(2) Correlations between the Indicator Elements

Correlation co-efficients between the indicator elements on logalithmic scale are shown in Table 3-3 and correlation variances are illustrated in Figs. 3-1, (1) - (15).

All of the correlation co-efficients are positive and exceed the 5% significance level. Combinations of correlated 2 elements are, in descending order of the correlation co-efficients, Au-Ag, Cu-Zn, As-Pb, Ag-As, Au-Pb, Zn-Pb, Pb-Cu, As-Cu, Ag-Zn, Au-Zn, Ag-Cu, Ag-Zn, Au-Zn, Ag-Cu and As-Zn. Of these combinations, Au-Ag and Cu-Zn are prominently high in their correlation co-efficients.

According to the above results, there appear to be two groups of samples; one group is characterized by Au, Ag, As and Pb values, and another by Cu and Zn values. Positive correlation between the indicator elements are observed within each of these groups, and therefore some of samples belonging to one group may also belong to the other group.

Table 3-4 Correlation Coefficients between the 6 Elements in the Marcabamba Area

Element	Au	Ag	As	Cu	Pb	Zn
Au	1.0					
Ag	0.690	1.0				
As	0.573	0.584	1.0			
Cu	0.427	0.390	0.424	1.0		
Pb	0.504	0.636	0.594	0.443	1.0	
Zn	0.401	0.404	0.364	0.651	0.453	1.0

Note: The 5% significance level is 0.079.

(3) Frequency, Cumulative Frequency and Threshold

Frequencies and cumulative frequencies of the indicator elements are plotted on log-probability diagrams as shown in Figs. 3-2, (1) - (6).

The following characteristics are observed in the sample population for each indicator elements as illustrated in the figures.

Au: The number of samples with values less than 1 ppb is 146 and accounts for 23.5% of the total 620 samples.

In the frequency diagram, values exceeding the mean vary in considerable ranges.

The cumulative frequency curve indicates its inflection point at around 40 ppb. The threshold value is determined at M + 2σ or 73.0 ppb which is higher than the value at the inflection point.

The number of samples exceeding the threshold value is 28.

Ag: The number of samples less than 0.1 ppm accounts for 76.5% of the total number of samples. The frequency curve is somewhat biased toward the lower value side. The cumulative frequency curve appears to be inflexed at 1.3 ppm towards the higher value side, and one or more anomalous populations may be included beyond this value.

The threshold value, being determined at M + 2σ or 1.15 ppm, nearly corresponds to the value at the inflection point.

The number of samples exceeding the threshold value is 28.

As: The frequency curve indicates more or less a typical log-normal distribution, with a little dispension in high value samples. The cumulative frequency curve is inflexed at around 60 to 70 ppm towards the higher value side and appears to include one or more anomalous populations with peak values beyond the inflection point.

The threshold value, being determined at M + 2σ or 72.9 mm, nearly corresponds to the value at the inflection point.

The number of samples exceeding the threshold value is 16.

Cu: The frequency curve indicates a typical log-normal distribution with a slight dispersion in high value samples. The cumulative frequency curve has two inflection points at around 60 ppm and 100 ppm, changing its trends towards the higher value side.

The threshold value, being determined at M + 2σ or 72.5 ppm, is relatively close to the value of the lower inflection point at 60 ppm.

The number of samples exceeding the threshold value is 18.

Pb: The frequency curve indicates more or less a typical log-normal distribution with relatively notable dispersions both in the higher and lower value sides, in comparison with the frequency curve for Cu. The cumulative frequency curve has two inflection points at around 40 ppm and 120 ppm, changing its trend to the higher value side.

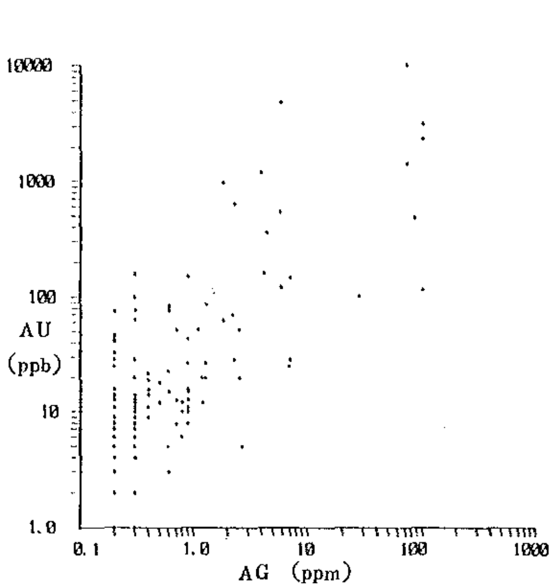
The threshold value, being determined at M + 2σ or 83.9 ppm, is much higher than the value of the first inflection point at 40 ppm.

The number of samples exceeding the threshold value is 15.

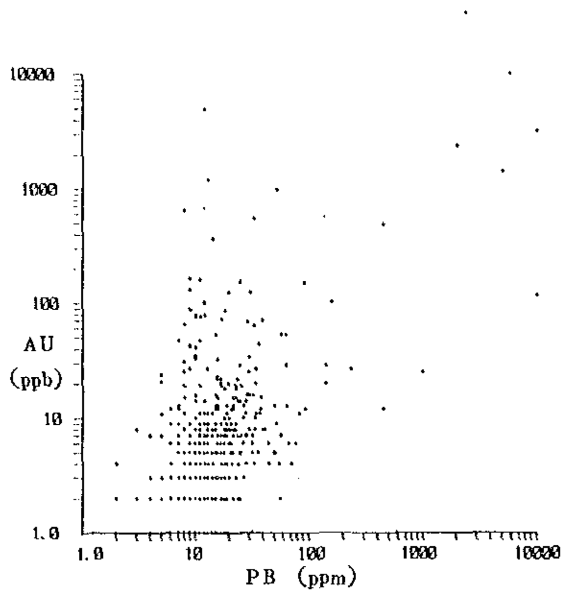
Zn: The frequency curve indicates a typical log-normal distribution as in the cases for Cu and Pb. The cumulative frequency curve has an inflection point between 180 and 200 ppm, and changes its trend towards the higher value side beyond this point.

The threshold value, being determined at M + 2σ or 174.66 ppm, nearly corresponds to the value at the inflection point.

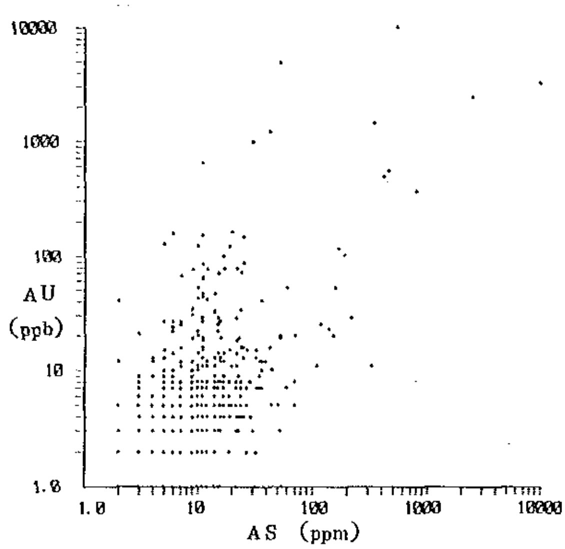
The number of samples exceeding the threshold value is 15.



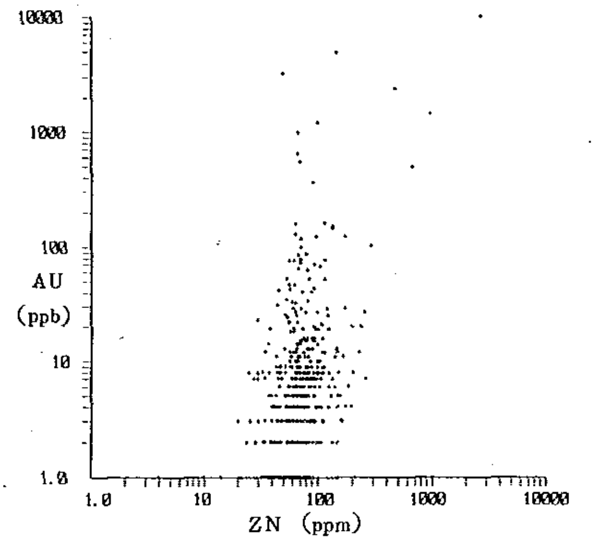
(1) Au-Ag



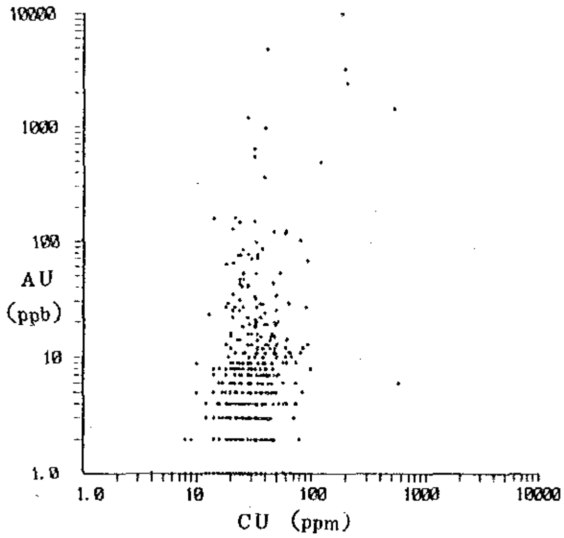
(4) Au-Pb



(2) Au-As

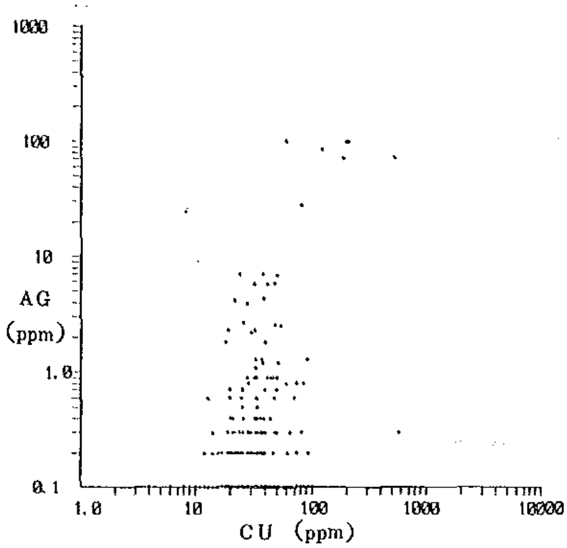


(5) Au-Zn

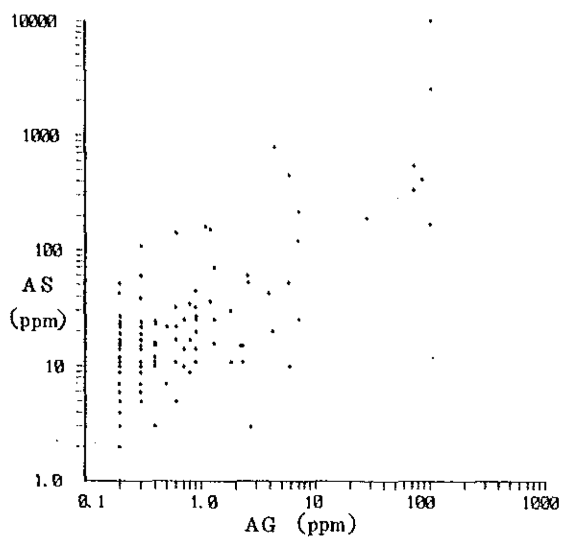


(3) Au-Cu

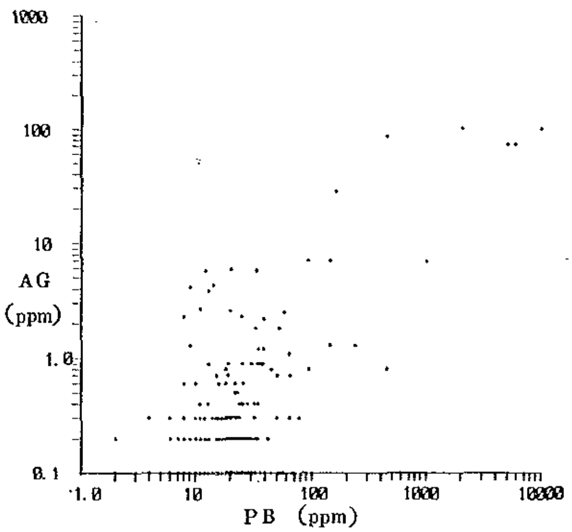
Fig. 3-1 Correlations Between Indicator Elements, Marcabamba Area (1-15)



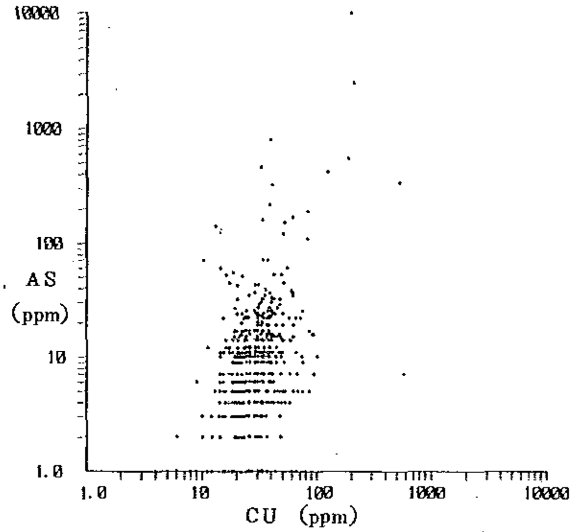
(6) Ag-Cu



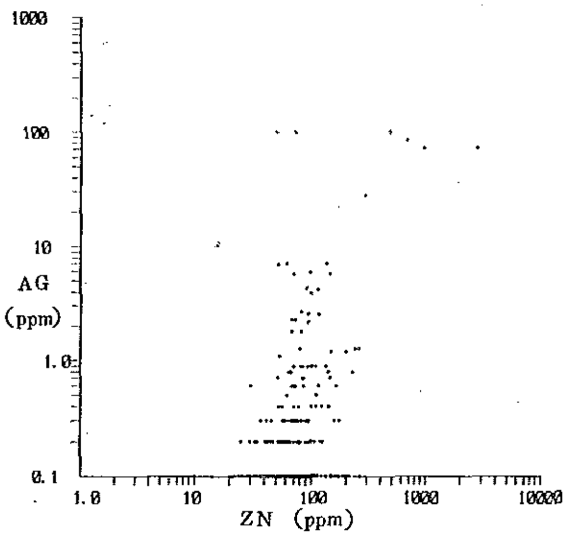
(9) As-Ag



(7) Ag-Pb

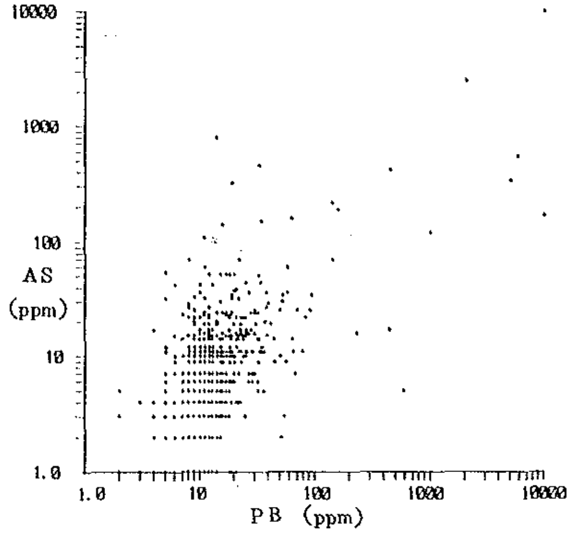


(10)As-Cu

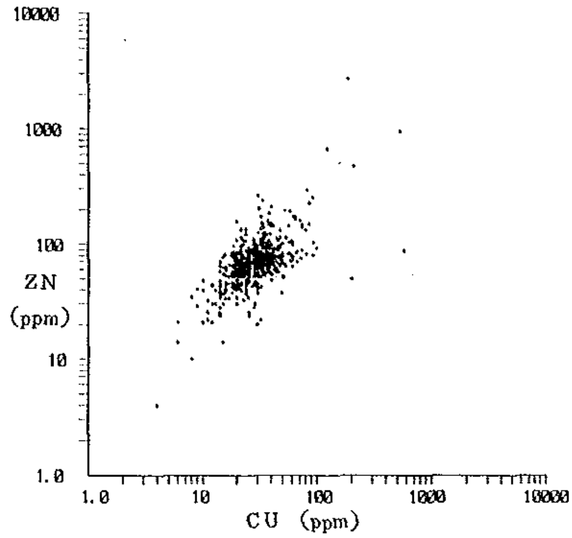


(8) Ag-Zn

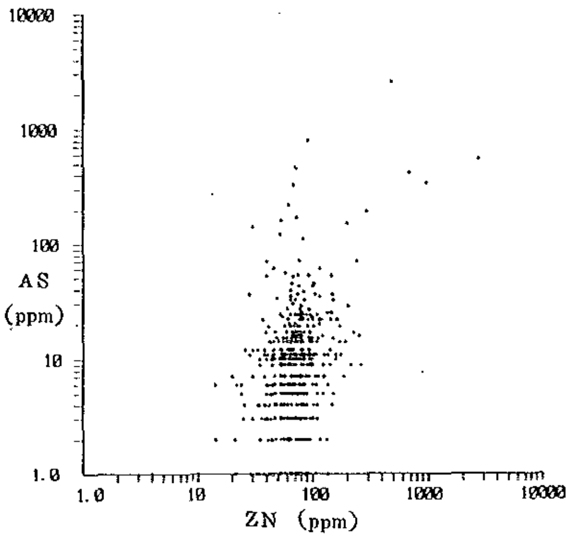
Fig. 3-1 Continued



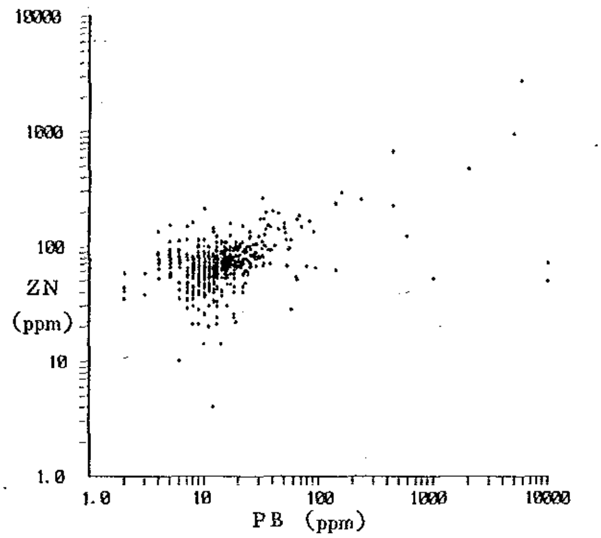
(11)As-Pb



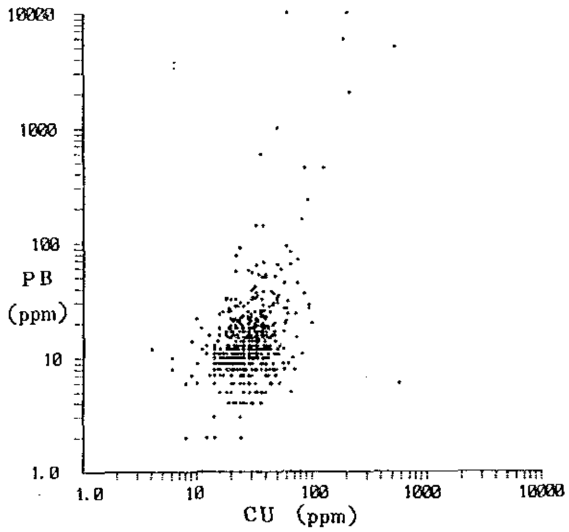
(14)Zn-Cu



(12)As-Zn

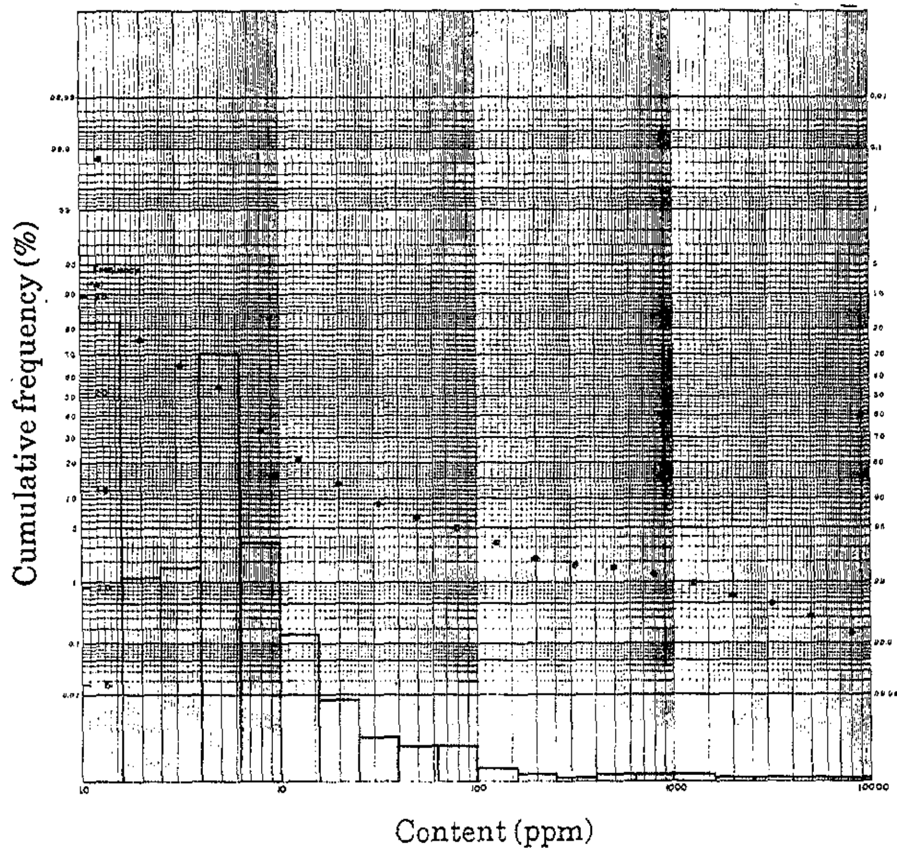


(15)Zn-Pb

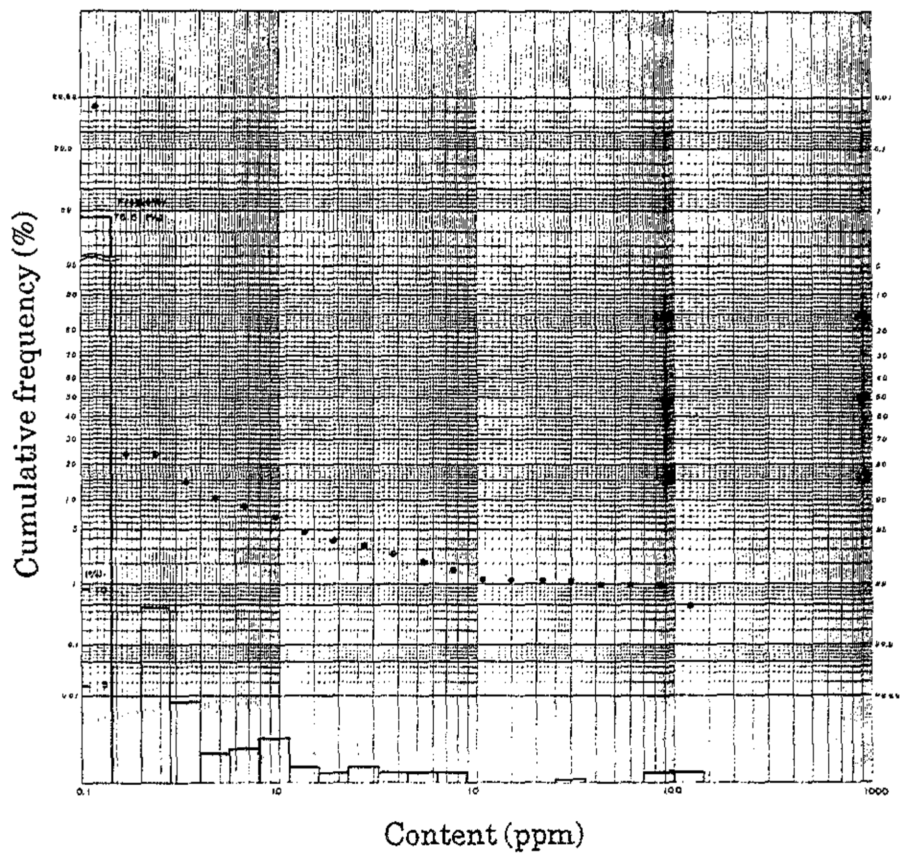


(13)Pb-Cu

Fig. 3-1 Continued

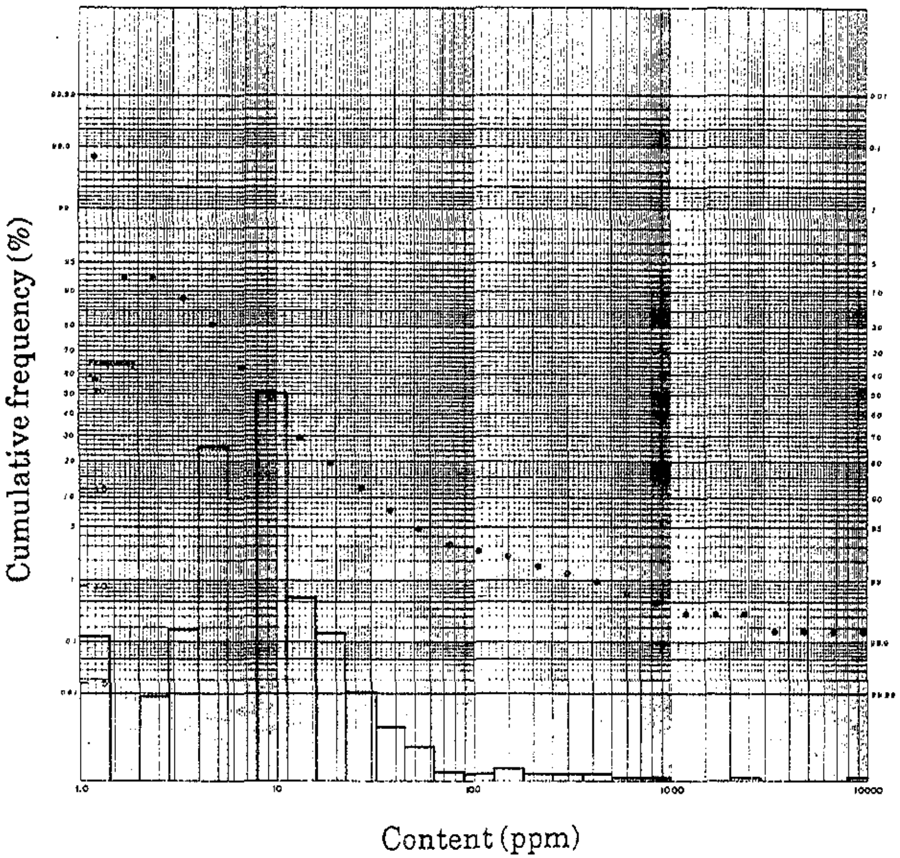


(1) Au

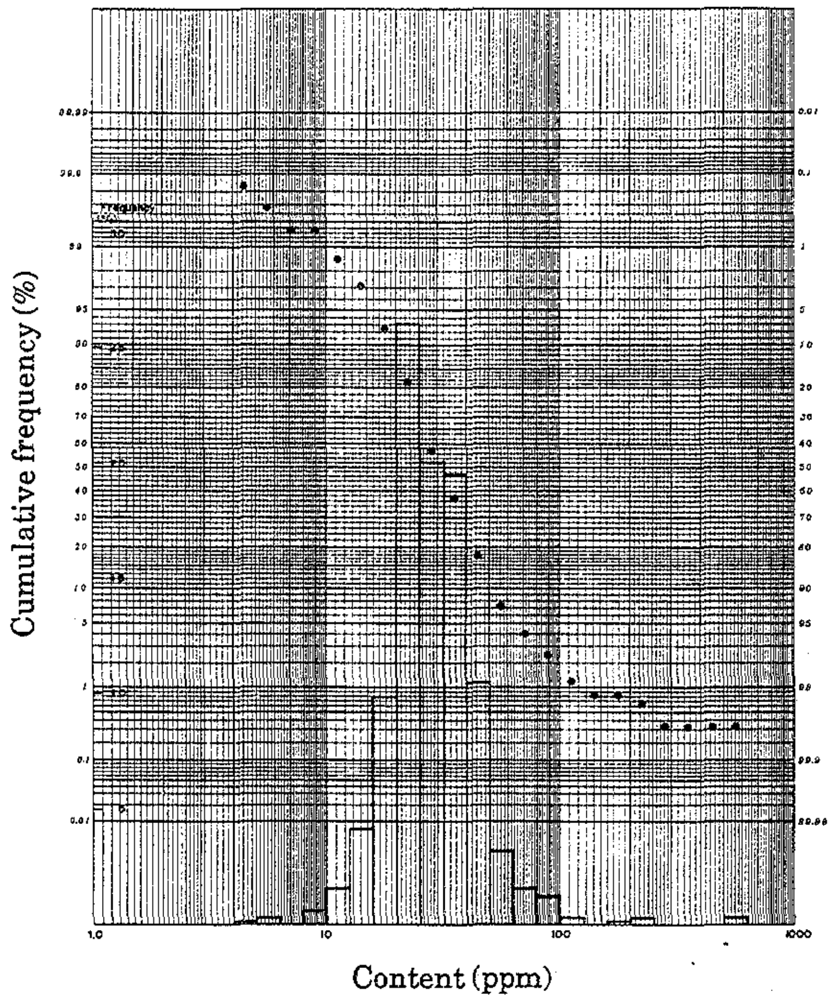


(2) Ag

Fig. 3-2 Histograms and Cumulative Frequency Diagrams (Au, Ag, As, Cu, Pb, Zn) of the Marcabamba Area (1-6)

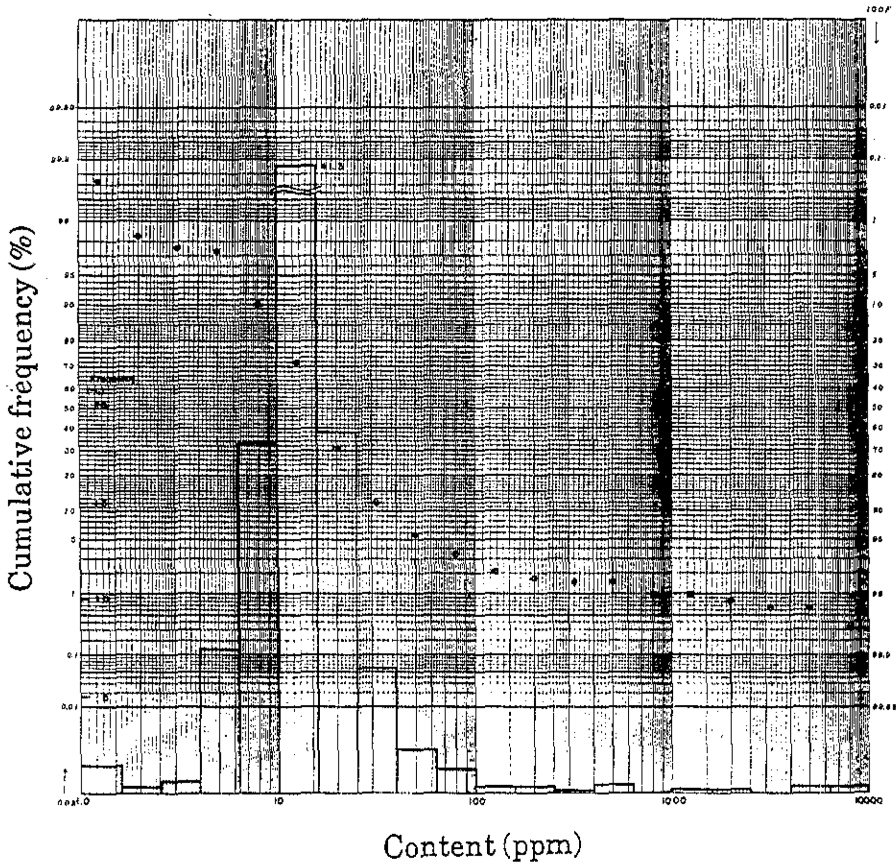


(3) As

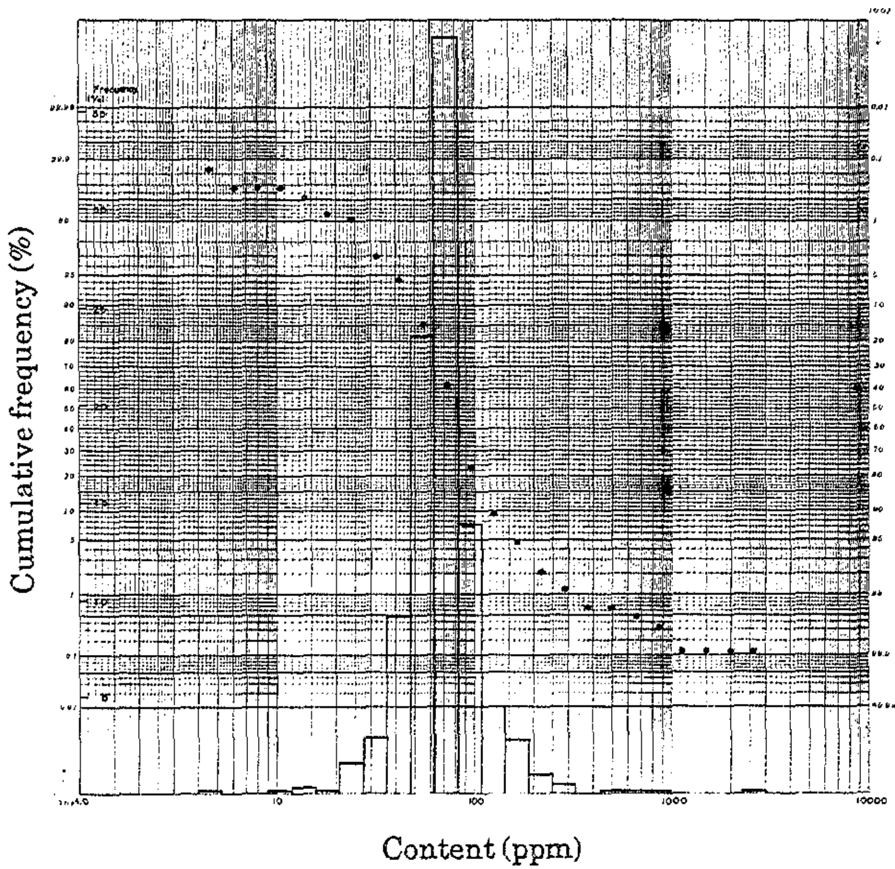


(4) Cu

Fig. 3-2 Continued



(5) Pb



(6) Zn

Fig. 3-2 Continued d