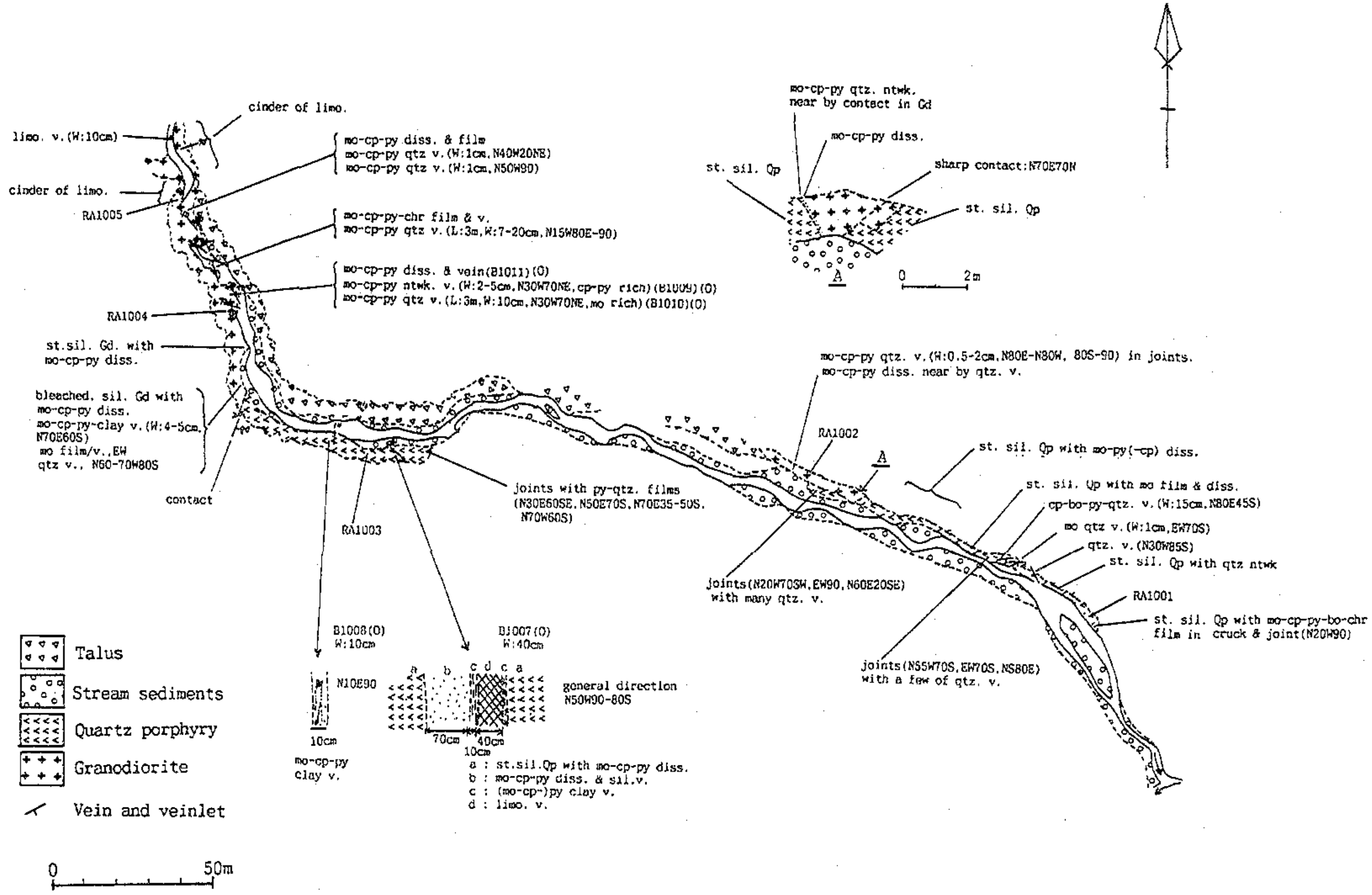


Fig.II–1–4 Sketch of the mineralized outcrop along the Quebrada Limonita

Tab.II–1–3 Mineral assemblages of each alteration zone

Zones / Minerals	Type I-alteration (Dissem.type)		Type II-alteration (Vein type)		Type III-alteration (Acidic alteration)	
	Propylitic	Phyllic	Phyllic	Potassic	A	B
Quartz	———	———	———	———	———	———
Montmorillonite	- - -					
Sericite/Mont.	- - -					
Sericite	- - -	———	———	———	———	———
Chlorite	———	———	- - -	- - -		
Epidote	———					
K-feldspar				———		
Pyrite	- - -	- - -	- - -	- - -		
Kaolinite					- - -	
Halloysite					- - -	

obtained from the Q.La Rica mineralized zone.

The EPMA analysis for high Ag content samples (A1008,A1012 and C1008) was carried out to examine the contents of Cu, Fe, Ag and S. As the results, Ag element was proved to be contained in bornite distinctively, though in small contents.

As regards the sampling method, A1012 was collected by means of channel sampl–ing method. Other vein samples were collected by means of modified channel sampling method similar to the channel sampling. When the samples of ore vein were collected in a form of chip, the number of chips were increased in order to get assay of the mineralized outcrops as averaged correctly as possible.

(3) Type III Alteration

The alteration zone of Type III was divided into two sub–types, Type III A and Type III B.

A silicificated zone of Type III A was observed in an area of 1km east–west and 400 m north–south toward the upper reaches between the Q.Crisocolla and the Q.Cont–roversia. The silicificated zone was composed mainly of stockworky quartz veinlets, only in a part of which quartz vein of 50cm to 1 m in width were recognized in naked eye. Sericite, kaolinite and (halloysite) were identified in addition to quartz by powderly X–ray diffractive analysis method. Ore mineral identified here was chryso–colla generally, though the other ore mineral, cuprite for instanse, was observed in veins which distributed within the Q.Crisocolla minaralized zone.

The alteration zone of Type III B distributed mainly on granodiorite in the south–eastern area. Silicification was recognized in naked–eyes and the quartz–sericite assemblage was recognized by powderly X–ray diffractive analysis method.

Geochemical anormalous zones of Au–Ag were detected partly to scatter within the Type III alteration zone only.

1-2. Geochemical survey

1-2-1. Purpose of geochemical survey

The purpose of the geochemical survey is to clarify the elements related with mineralization and alteration of rocks in this area, and to examine the distribution of the elements.

1-2-2. Method of the geochemical survey

(1) Sampling and preparation of samples

The amount of 305 rock samples at the outcrops in the valleys and on the ridges over the whole area during the geological survey. The average intervals between the sampling points is about 100m. The sampling was not performed in the places where the secondary copper minerals markedly concentrate in the valleys and strongly affe-cted by weathering on the ridges, so, the intervals of the sampling points in such places exceed 100m.

Several small pieces of rocks were collected eithin the area of about 1 to 2 square meters of each sampling outcrop, and total weight of rock sample was over 500 grams each. Geology, type of alteration and hardness, etc. were recorded in each sampling point.

The secondary minerals were eliminated from the samples to make sample be weighed 300 g approximately. After crushing and preparating them individually, 50 g of sample was gathered each by the one fourth method to analize them chemically, and another 50g was also kept each for spare.

(2) Chemical analysis

Chemical analysis was carried out in Geotechnical Laboratory of BEC. The target elements were six (6) such as Cu, Pb, Zn, Au, Ag and Mo for 252 samples and seven (7) such as Total-Cu, Soluble-Cu, Pb, Zn, Au, Ag and Mo for 52 samples.

The method of chemical analysis and the minimum detectable limit for each element are shown on Tab.II-1-4 together with those of stream sediments.

The results of chemical analysis are listed up on Appendix 5.

(3) Data processing

(i) Univariate analysis

Statistic processing of chemical analysis data was carried out with computer. The data less than detectable limit assumed to be a half value of the detectable limit. Samples were processed in the lump for 6 elements except Soluble–Cu. The fundamental statistics are shown on Tab.II–1–5.

Correlation coefficient was calculated in order to clarify the relationship among each element (Tab.II–1–6, and Fig.II–1–5). According to the calculation result, the correlation between Pb and Mo was proved to be moderat, however, no other relationship was distinguished.

Exporatory data analysis(EDA) method, which was proposed by Kurzul,H. (1988), was adopted in order to decide the threshold value to detect the geochemical anorma–lies. Histogram and boxplot were made on the data processed for each component(Fig. II–1–6). According to these data processing, the threshold value was decided to be the value of upper fence and supplemental threshold to be that of upper wisker(Tab. II–1–7).

As regards Soluble–Cu, the ratio to Total Cu is shown on Appendix 5.

(ii) Multivariate analysis

Factor analysis method was applied for examination of the relationship among the elements and mineralization or charactristics of country rock by the chemical analysis data of the samples.

Data was processed with computer by Varimax rotation method. The target were sis (6) elements except Soluble–Cu. As the result, such three factors as 1) Cu–Mo–(Ag), 2) Pb–Zn–(Mo), and 3) Au–Ag were extracted. Factor loading, communality and factor score are all shown on Tab.II–1–8. Factor score, which would indicate how high relationdhip between mineralization and target elements would each sample ob–tain, were allocated on samples individually. The samples, absolute value of factor score more than 1, were extracted and examined which relationship could be expected between the facter score and the geology and/or mineralization in this report.

1–2–3. Results of geochemical survey

(1) Geochemical anormaly in each element

Geochemical anormaly map (Fig.II–1–7) was made by examining of distributions

Tab.II-1-4 Method and detection limits of chemical analyses

Sample media	Elements	Method	Detection limits
Rock	T-Cu	Inductively coupled plasma emission spectrometry	1 ppm
	So-Cu	ditto	1 ppm
	Pb	ditto	1 ppm
	Zn	ditto	1 ppm
	Au	Atomic absorption spectroscopy	1 ppb
	Ag	ditto	0.1 ppm
	Mo	Inductively coupled plasma emission spectrometry	1 ppm
Stream sediment	Cu	Inductively coupled plasma emission spectrometry	1 ppm
	Pb	ditto	1 ppm
	Zn	ditto	1 ppm

Tab.II-1-5 Summary of statistical analysis of rock geochemical data

Geologic units	Elements	Mean	Variance	Standard deviation	Min.	Max.	Mean+2S.D
Gd, Qp & Dp. (N=304)	Cu (ppm)	130.6	0.473	0.688	3.0	16,082.0	3,101.6
	Pb (ppm)	3.6	0.223	0.473	0.5	413.0	31.5
	Zn (ppm)	16.7	0.408	0.639	0.5	1,333.0	316.1
	Au (ppb)	1.2	0.298	0.546	0.5	79.0	14.3
	Ag (ppm)	0.09	0.317	0.563	0.05	12.50	1.26
	Mo (ppm)	1.5	0.431	0.656	0.5	124.0	29.9

Tab.II–1–6 Correlation of six elements of rock geochemical data

	Cu	Pb	Zn	Au	Ag	Mo
Cu	1.000					
Pb	0.254	1.000				
Zn	0.081	0.455	1.000			
Au	0.051	-0.115	-0.322	1.000		
Ag	0.425	0.092	-0.154	0.379	1.000	
Mo	0.330	-0.138	-0.476	0.236	0.318	1.000

Tab.II–1–7 Results of the EDA analysis of rock geochemical data

Elements	Median	L. fence	L. wisker	L. hinge	U. hinge	U. wisker	U. fence
Cu(ppm)	115.0	-322.5	34.0	45.0	290.0	413.0	657.5
Pb(ppm)	3.0	-5.5	2.0	2.0	7.0	10.0	14.5
Zn(ppm)	19.5	-77.0	3.0	4.0	58.0	67.0	139.0
Au(ppb)	0.5	-1.8	0.5	0.5	2.0	3.0	4.3
Ag(ppm)	0.05	0.05	0.05	0.05	0.05	0.20	0.05
Mo(ppm)	0.5	-4.8	0.5	0.5	4.0	7.0	0.3

Tab.II–1–8 Results of factor analysis of rock geochemical data

Elements	Factor			Communality
	1	2	3	
Cu	-0.685	-0.190	0.108	0.4809
Pb	-0.224	-0.636	-0.028	0.4551
Zn	0.098	-0.700	-0.243	0.5591
Au	-0.085	0.209	0.603	0.4142
Ag	-0.476	-0.020	0.503	0.4799
Mo	-0.548	0.447	0.167	0.5273
Contribution	35.20%	40.30%	24.50%	

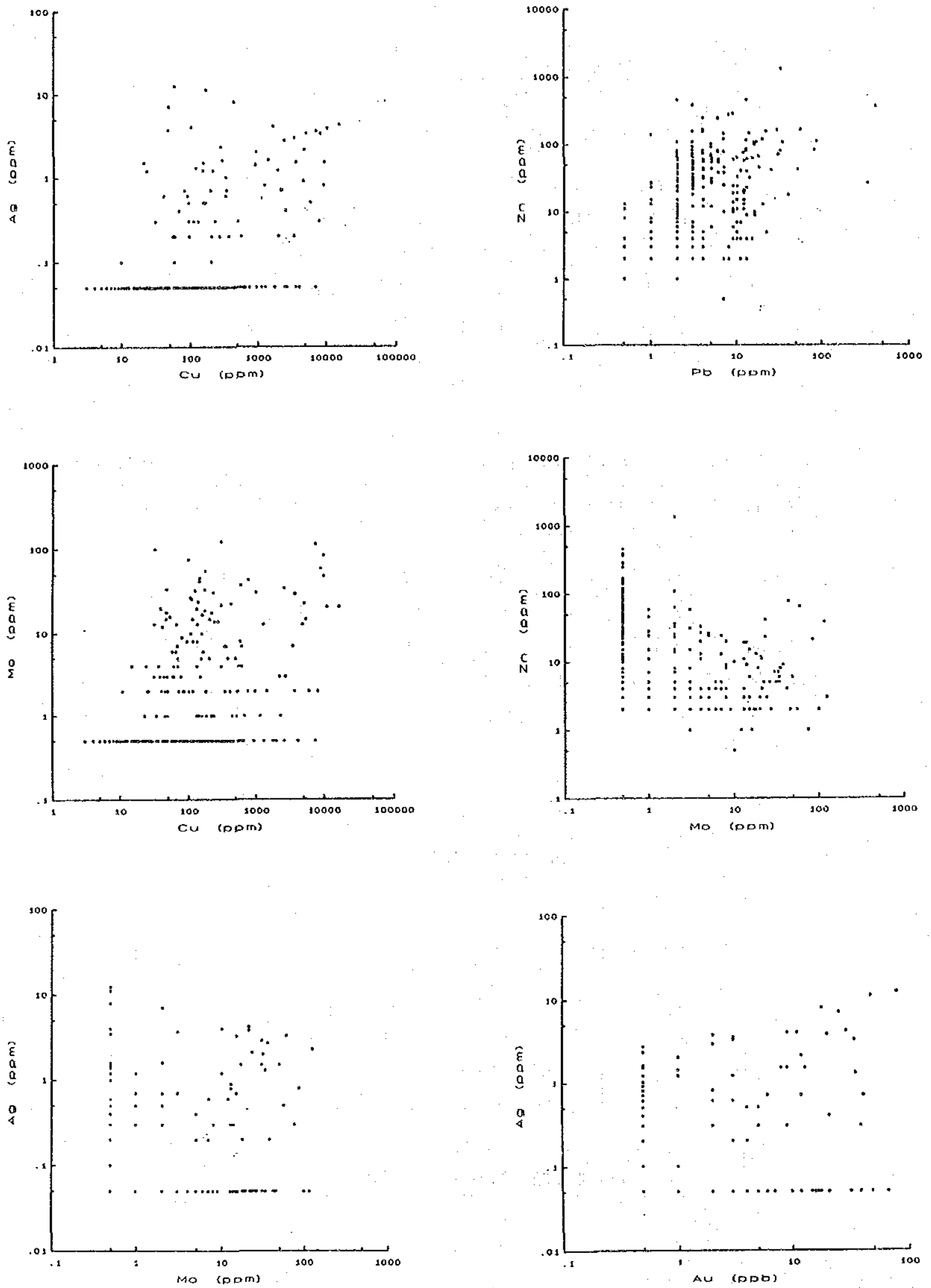


Fig.II–1–5 Correlation diagram between each element

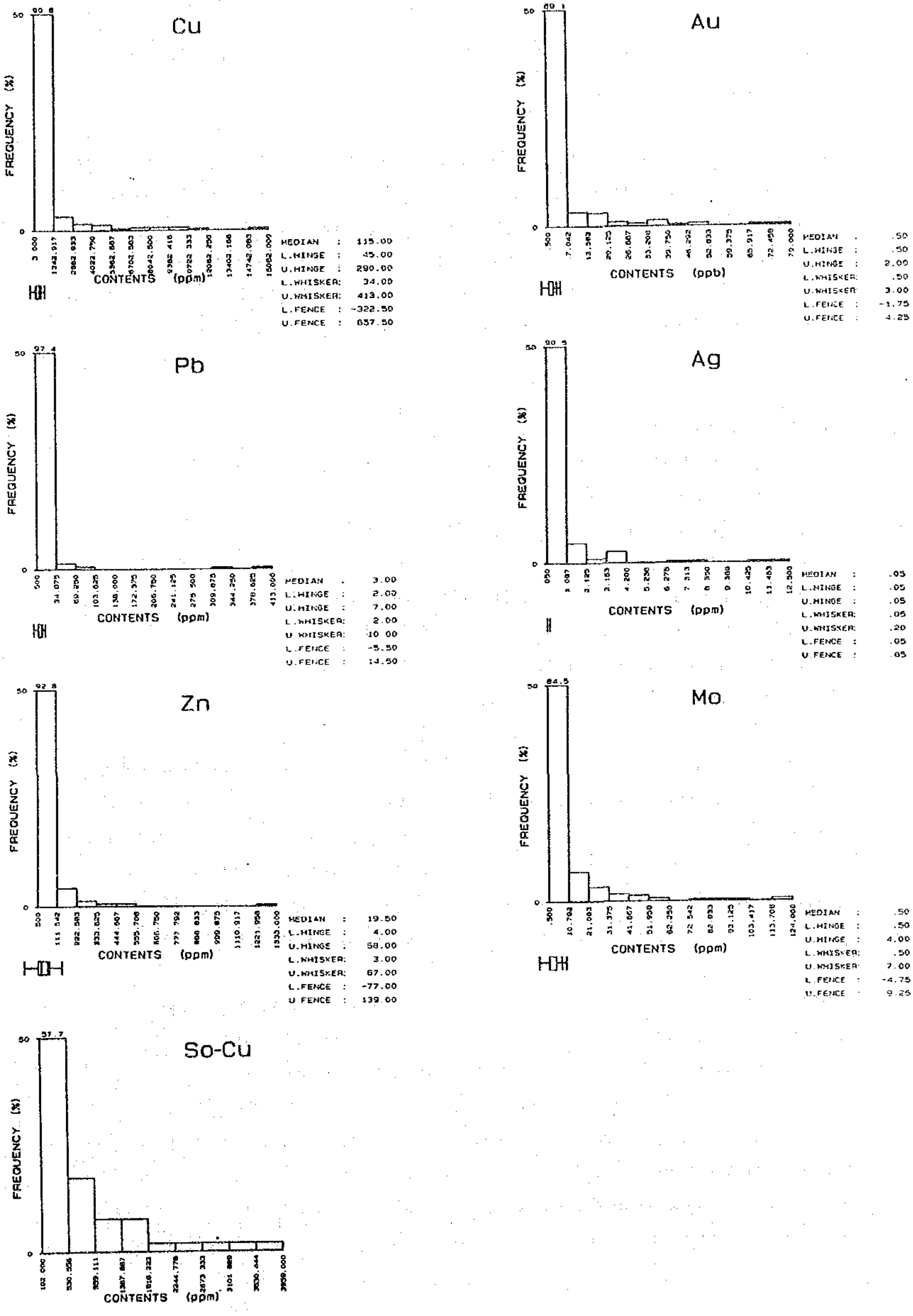


Fig.II–1–6 Histograms and boxplots of seven elements

of such concentration as Cu, Soluble–Cu/Total Cu, Pb, Zn, Au, Ag and Mo with EDA method of univariate analysis.

Copper(Cu): Concentration of copper showed a variation from the minimum value of 3 ppm to the maximum value of 16,082 ppm. The distribution map of high concentration was made as shown inFig.II–1–7 based on the upper fence value (657.5 ppm), upper wisker value (413.0 ppm) and upper hinge value (290.0 ppm). One wide anormalous zone and 6 narrow anormalous zones were detected and delineated with the threshold of upper fence. The narrow zones distributed as surrounding the wide anormalous zone.

The wide anormalous zone

1) The area from the upper reaches of the Rio Junin to the Q. Verde

The narrow anormalous zone

2) The upper reaches of the branch of Rio Junin
3) Around the Q.Limonite mineralized zone
4) Upper reaches of the Q.Limonita mineralized zone
5) The area of the upper most reaches of Q.Verde
6) The area of the upper most reaches of Q.Controversia
7) Around the Q.Controversia mineralized zone

The anormalous zone of 1) includes 16,082ppm as maximum and 30 sampling points. The anormalous zone of 2) includes a point of 4,916ppm. The anormalous zone of 3) includes 4,196ppm as maximum and 4 sampling points. The anormalous zone of 4) includes one point of 7,435ppm. The anormalous zone of 5) includes two points of 958ppm and 674ppm. The anormalous zone of 6) includes one point of 3,414ppm. The anormalous zone of 7) includes one point of 8,069ppm and 4 sampling points.

Soluble–Cu/Total Cu: This value shows the ratio of copper oxides and copper sulfates. The high value shows to include much amount of oxide minerals and sulfate minarals, consequently less amount of sulfide minerals. As shown in Fig.II–1–7(2), much amount of sulfide minerals were distributed in the Q.Limonita mineralized zone, the upper reaches of Q.Limonita mineralized zone, the Q.Verde mineralized zone and the Q.Controversia mineralized zone. Less amount of sulfide minerals were recognized only to be disseminated in the part of Q.Junin mineralized zone and around the area of the zones mentioned above. These facts reflected the superficial characteristics of mineralized zone.

Lead(Pb): The variation of lead concentration showed from under 1ppm, which was the minimum detectable limit, to 413ppm as maximum. The distribution map of high concentration was made based on the value of upper fence (14.5 ppm), upper wisker (10.0 ppm) and upper hinge (7.0 ppm) as shown in Fig.II–2–7(3).

The major 7 anormalous zones were recognized as areas delineated with the threshold value of the upper fence.

1) Four (4) areas along Q.Limonita and on the ridge (including the Q.Limonita, the Upper reach of Q.Limonita, the Cerro Junin mineralized zones)
2) One area in the upper reaches of the branch of the lower Rio Junin and on the ridge
3) Two (2) areas in the upper reaches of the branch of the lower Rio Junin and on the ridge
4) One area from the lower reaches of Rio Junin to the ridge of the left side bank
5) Two (2) areas in the lower reaches of Q.Controversia
6) One area in the upper reaches of Q.Controversia
7) One area in the upper reaches of Q.La Rica

The area of 1) includes 337 ppm as maximum and 10 sampling points. The area of 2) includes 2 sampling points of 57 ppm and 37 ppm. The area of 3) includes 88 ppm as maximum and 4 sampling points. The area of 4) includes 413 ppm as maximum and 4 sampling points. The area of 5) includes 2 sampling points of 16 ppm and 17 ppm. The area of 6) includes one sampling point of 16 ppm. The area of 7) includes 22 ppm as maximum and 3 sampling points.

Zinc(Zn): The variation of Zinc concentration showed from under 1 ppm, which was the minimum detactable limit, to 1,333 ppm as mximum (Fig.II–2–7(4)). The distribution map of high concentration was made based on the value of upper fence (58.0 ppm), upper wisker (139.6 ppm) and upper hinge (67.0 ppm) as shown in Fig.II–2–7(4).

The four (4) major anormalous zones were recognized as areas delineated with the threshold of the upper fence in the following areas:

1) Three (3) sampling points along the Q.Limonita
2) Two (2) areas in the upper reaches of the upper branch of the Rio Junin

3) Two (2) areas in the lower reaches of the lower branch of the Rio Junin and on its ridge
4) One area between the lower reaches of the Rio Junin and the left side bank of the Rio Junin

Area 1) includes such three sampling points as 165 ppm, 157 ppm and 146 ppm. Area 2) includes 1,333 ppm and 165 ppm. Area 3) includes an area of 452 ppm as maximum and 4 sampling points, and another area of 156 ppm sampling point. Area 4) includes 461 ppm as maximum and 5 sampling points.

Gold(Au): The concentration of gold varied from under 1 ppb, which was the minimum detectable limit, to 79 ppb as maximum. The distribution map of high concentration was made based on the value of upper fence (4.25 ppb), upper wisker (3.00 ppb) and upper hinge (2.00ppb) as shown in Fig.II–2–7(5).

The anormalous zones, which were delineated with the threshold of upper wisker, showed complicated distribution as shown in the figure. The anormalous zones can be divided into two distributional areas macroscopically.

1) Six (6) areas from the juncture area of the Rio Junin and the Q.Limonita to the Q.Controversia and/or the Q.La Rica
2) Surrounding areas of the area 1) mentioned above

Area 1) includes 49 ppb as maximum and 16 sampling points. Area 2) includes 79 ppb as maximum and 27 sampling points.

Silver(Ag): The concentration of silver varied from under 1.0 ppm, which was the minimum detectalbe limit, to 12.5 ppm as maximum. The distribution map of high concentration was made based on the value of upper wisker (0.20 ppm) as shown in Fig.II–2–7(6).

The anormalous zone with the threshold of upper wisker, showed the complicated distribution. The anormalous zone can be divided into two distributional areas macroscopically.

1) The area from the Q.Verde to the juncture of the Q.Controversia and the Q.La Rica
2) The surrounding areas of the area 1) mentioned above

The area 1) includes 4.0 ppm as maximum and 37 sampling points. The area 2) includes 12.5 ppm as maximum and 20 sampling points.

Molybdenum(Mo): The concentration of molybdenum varied from under 1 ppm, which was the minimum detectable limit, to 124 ppm as maximum. The distribution map of high concentration was made based on the value of upper fence (9.3 ppm), upper wisker (7.0 ppm) and upper hinge (4.0 ppm) as shown in Fig.II–2–7(7).

Five (5) anormalous zones, which were delineated with the threshold of the upper fence value, were recognized. One anormalous zone was wide and showed approximate U shape openned toward the north, and the other four areas were narrow.

The wide anormalous zone of U shape is the following:

1) The area extending over the Q.Verde, the upper reaches of the Rio Junin, the middle reaches of the Q.Controversia, the Q.La Rica and the Q.El Copo (including the mineralized zones of the Q.Verde, Rio Junin, Q.Controvercia, Q.La Rica

The narrow anormalous zones are as follows:

2) The area of the middle reaches of the Rio Junin
3) The area of the Q.Limonita mineralized zone
4) The area of the upper most reaches of the Q.Verde
5) The ridge of the upper most reaches of the Q.Controversia

The anormalous zone 1) includes 124 ppm as maximum and 42 sampling points. The anormalous zone 2) includes a sampling point of 117 ppm. The anormalous zone 3) includes 44 ppm as maximum and 2 sampling points. The anormalous zone 4) includes 31 ppm as maximum and 2 sampling points. The anormalous zone 5) includes one sampling point of 13 ppm.

(2) The results of factor analysis

The following three factors were extracted by factor analysis of Varimax rotation method in multivariate analysis.

The first factor : Cu–Mo–(Ag)
The second factor: Pb–Zn–(Mo)
The third factor : Au–Ag

(i) The first factor: Cu–Mo–(Ag)

The distribution map of negative high factor score less than –1,000 is shown in Fig.II–2–8(1). The distribution areas of negative high score are as follows:

One is delineated as an area to be extended widely from south to north and the other eight (8) to be limited in narrow areas.

The wide distribution area with negative high factor score.

1) The area extending over the Q.Verde, the upper reaches of the Rio Junin and the juncture of Q.Controversia and Q.Rica (including the mineralized zones of the Q.Verde,Rio Junin and Q.Controvercia)

The narrow distribution area with the high factor score.

2) Two (2) areas in the area of the upper reaches of the Rio Junin
3) Two (2) areas in the Q.Limonita and the upper reach of the Q.Limonita mineralized zones
4) One area in the Q.Crisocolla mineralized zone
5) One area in the Q.El Copo
6) One area in the Q.Rica mineralized zone
7) One area in the upper most reaches of the Q.Controversia

(ii) The second factor: Pb–Zn–(Mo)

The distribution map of negative high factor score less than –1.000 is shown in Fig.II–2–8(2).

Fifteen (15) narrow distribution areas of negative high factor score are recognized to be scattered from sothe to north in the western part of the survey area.

1) Four (4) areas along the Rio Junin
2) Two (2) areas in the branch of the lower Rio Junin
3) Two (2) areas in the branch and the ridge of the upper reaches of the Rio Junin
4) Four (4) areas in the Q.Limonita and the Q.Escalera
5) one area in the ridge of the upper most reaches of the Q.Verde

These areas scattered as surrounding the western margin of the first factor distribution area.

(iii) The third factor: Au–Ag

The distribution map of positive high factor score more than +1.000 is shown in Fig.II–2–8(3).

Twenty seven (27) narrow distribution areas of positive high factor score are recognized to be scattered over the whole survey area.

The areas concentrated in comparatively with the third facter is the area between the left side of the upper Rio Junin and the middle reaches of the Q.Controversia, which includes 8 sampling points.

1–3 Drilling survey

1–3–1 Purpose of drilling survey

The ourpose of the drilling survey is to clarify the correlation between geological structure and mineralizing condition of the Q.Limonita mineralized zone in the Central Zone of Junin area, which mineralized zone was investigated with detailed geological survey and geochemical exploration (Fig.II–1–9).

1–3–2 Details of drilling survey

(1) Location

The Q.Limonita mineralized zone, where drilling survey was carried out, situates in the western part of Central Zone of Junin area. The drilling site of MJJ–1 was selected on a steep ridge, the altitution of which is about 2,100 m above see level.

The position of MJJ–1 was decided taking into the consideration on the result of geological survey, distribution of mineralized zones, topography around, and accesibility with heavy drilling machine.

(2) Outline of rilling work

For this work, main drilling machine and equipments including mud pumps were brought in from Japan, and a part of drilling tools, bits, lods and mud materials were also imported from Japan. Other supplemental materials were accomodated from INEMIN. Drilling work was conducted from December 4,1991 to 18 of the same month. The model of drilling machine adopted was the Longyear Model L–24. Works for site preparation and equipment dismantling were proceeded on a daytime shift only.

Drilling work was carried out, as a rule, for 24 hours a day. Wireline process

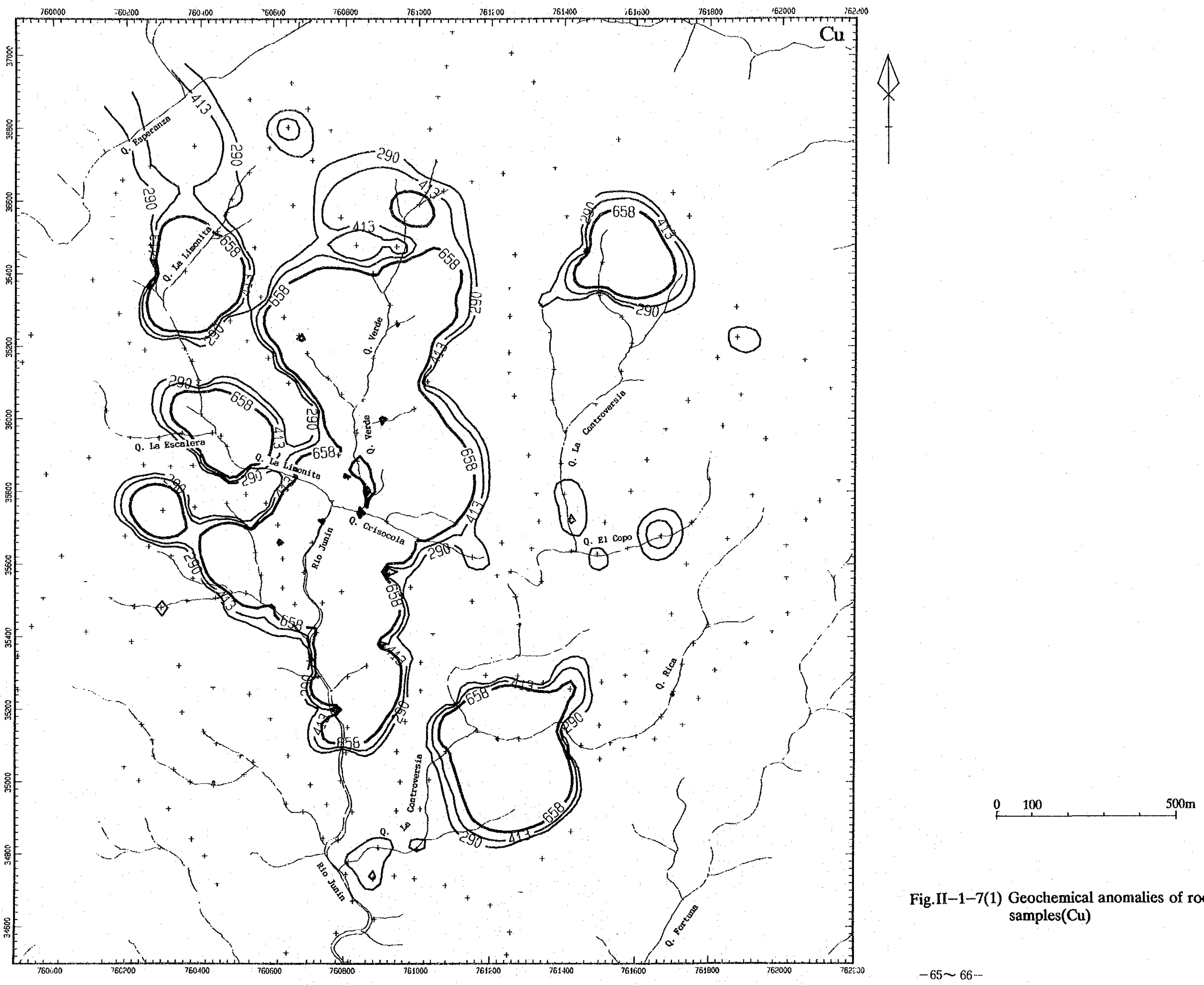
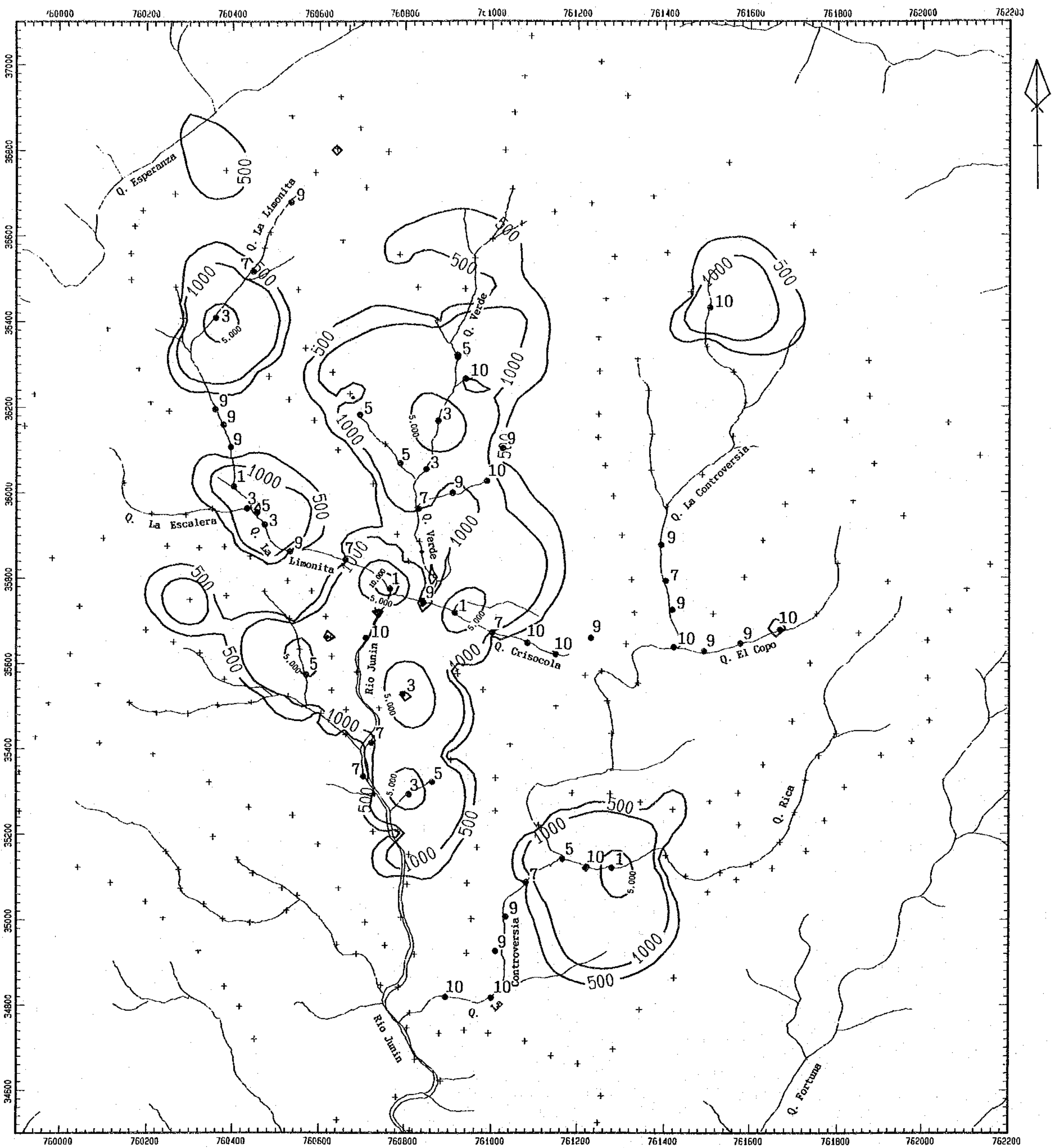


Fig.II–1–7(1) Geochemical anomalies of rock samples(Cu)



REGEND

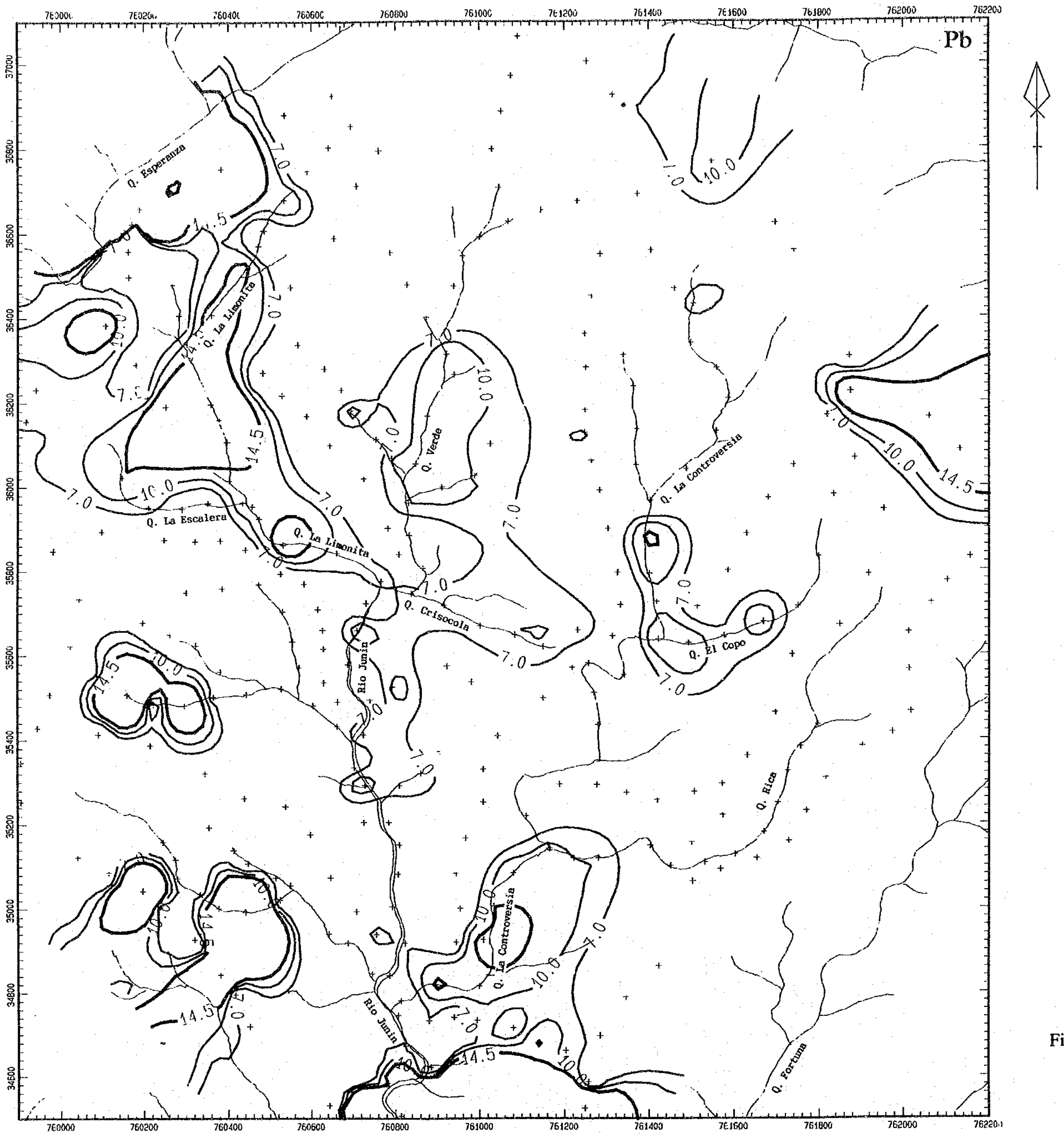
1 : R < 10
3 :10< R < 30
5 :30< R < 50
7 :50< R < 70
9 :70< R < 90
10 :90< R <100

R=((So-Cu)/(T-Cu))x100

T-Cu : total copper,
So-Cu : soluble copper.

0 500m

Fig.II–1–7(2) Geochemical anomalies of rock samples(Soluble–Cu/Total–Cu)



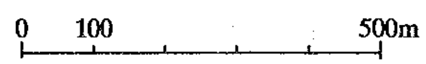


Fig.II–1–7(3) Geochemical anomalies of rock samples(Pb)

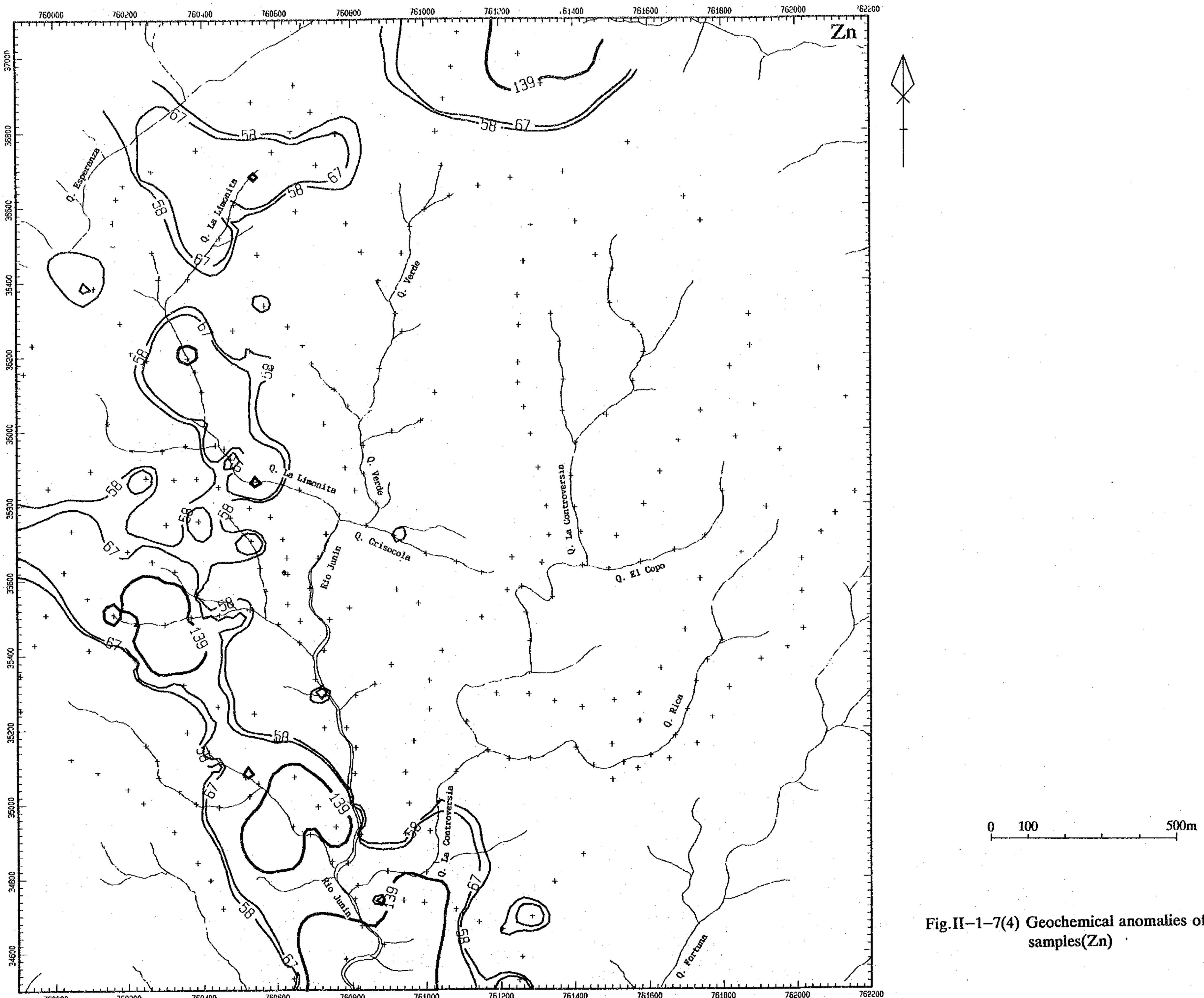


Fig.II−1−7(4) Geochemical anomalies of rock samples(Zn)

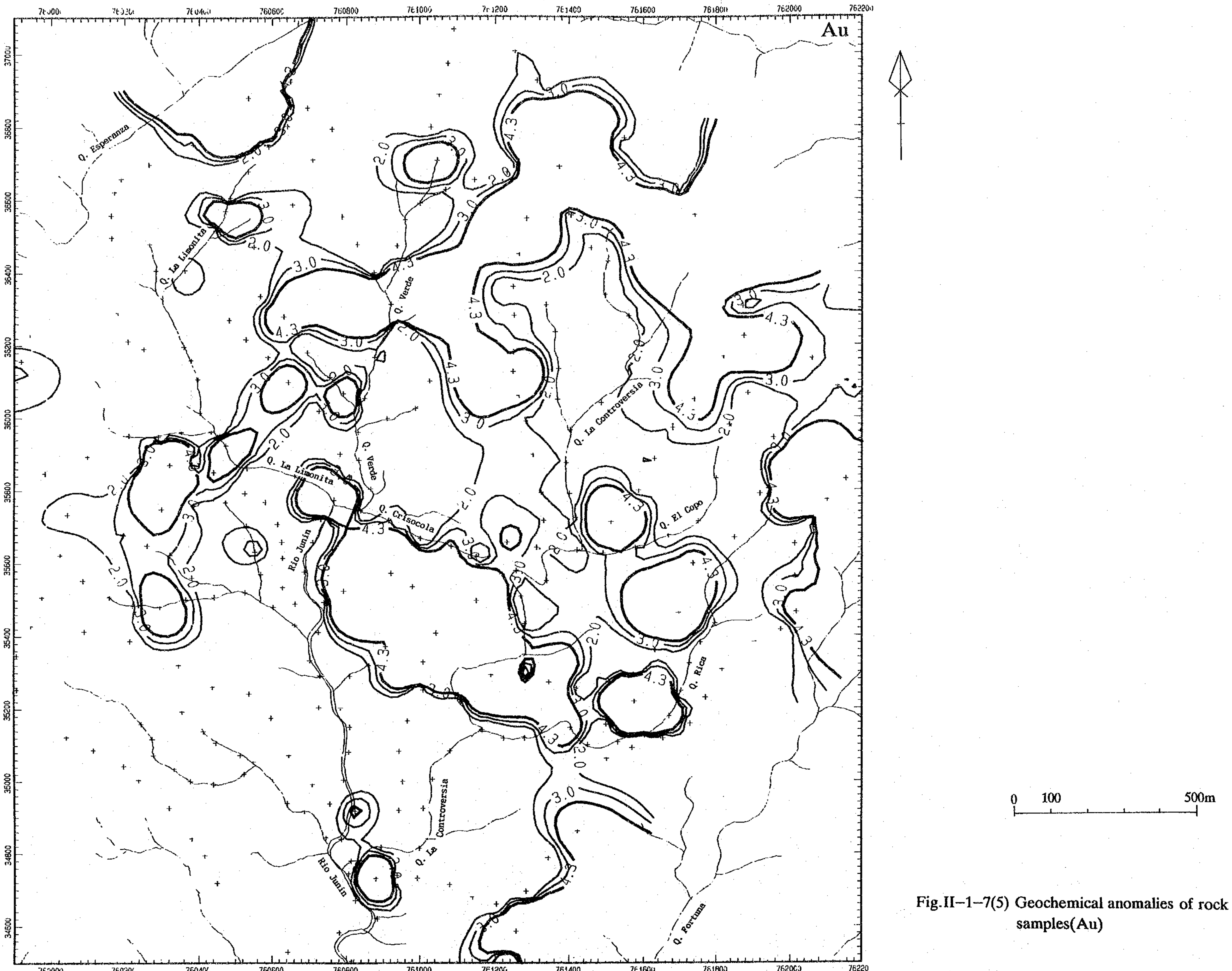
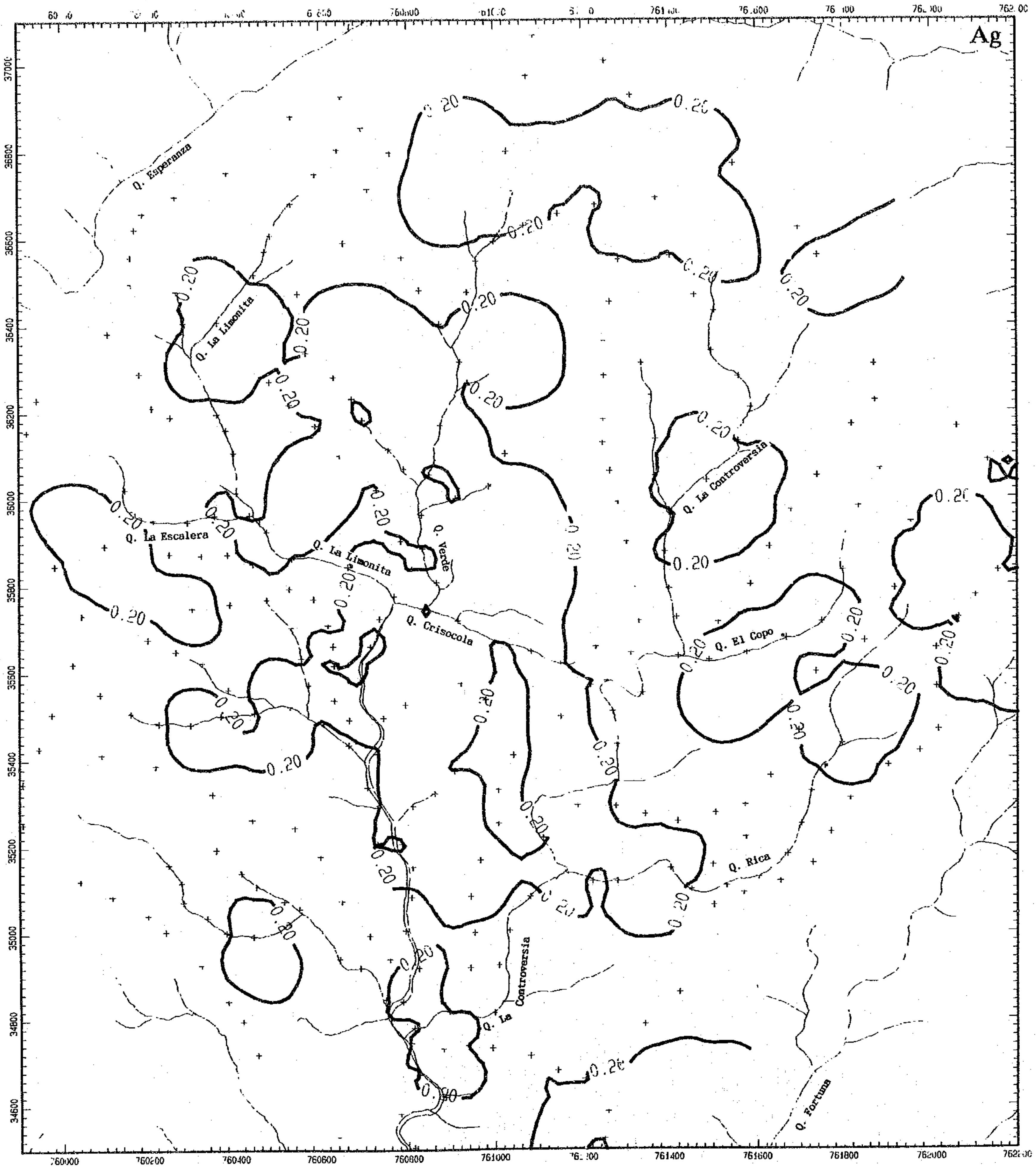


Fig.II-1-7(5) Geochemical anomalies of rock samples(Au)



0 100 500m

Fig.II–1–7(6) Geochemical anomalies of rock samples(Ag)

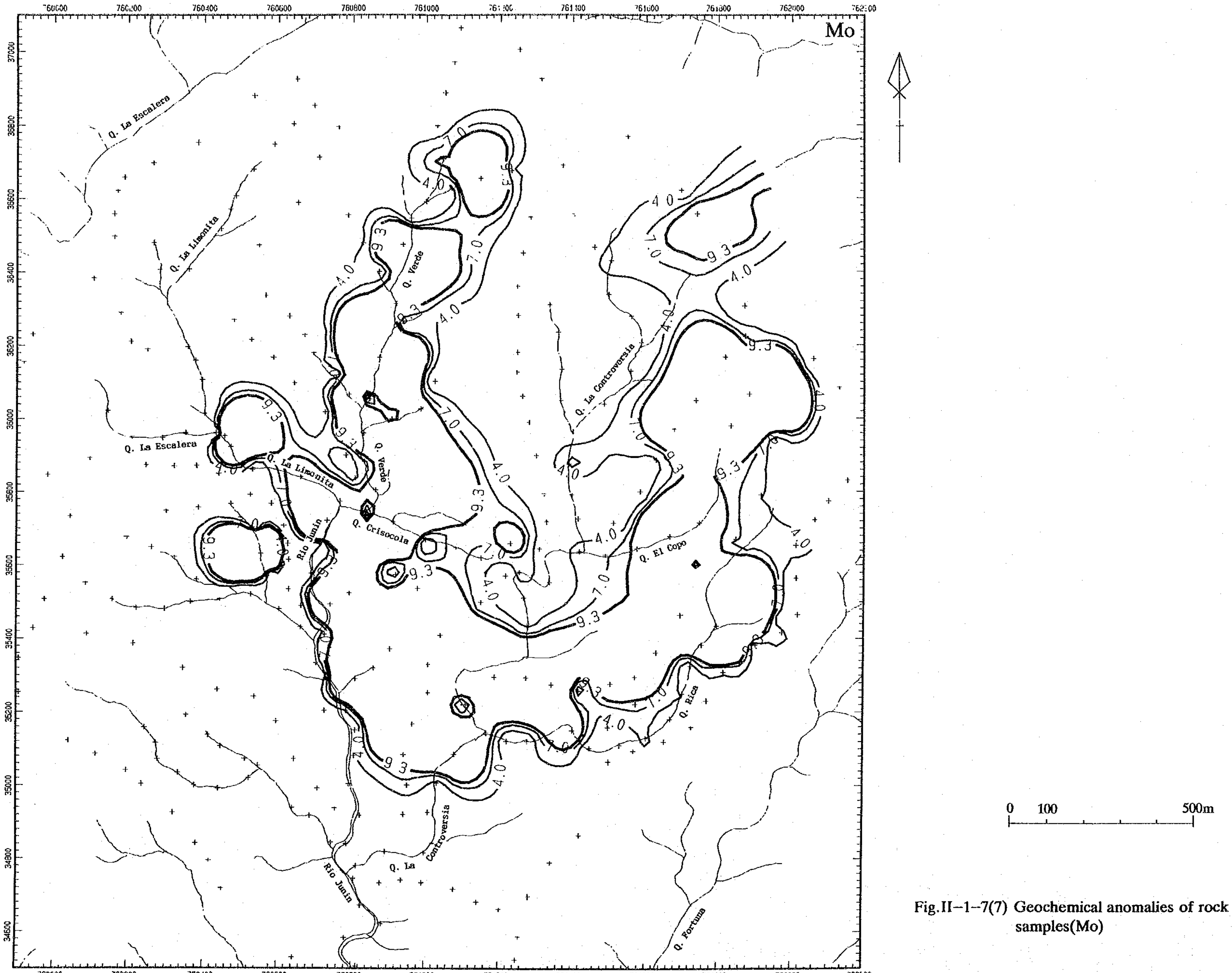


Fig.II-1-7(7) Geochemical anomalies of rock samples(Mo)

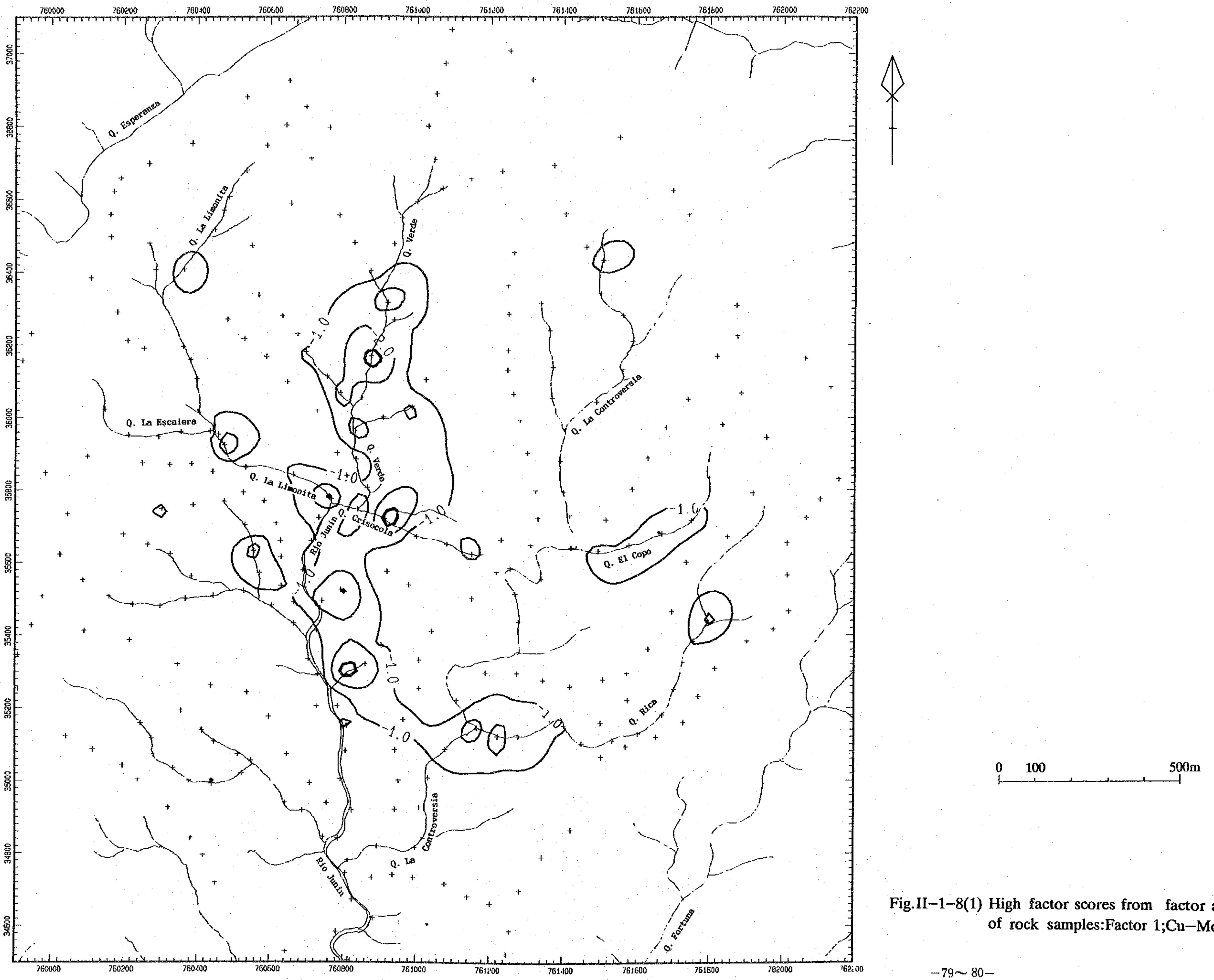


Fig.II–1–8(1) High factor scores from factor analysis of rock samples:Factor 1;Cu–Mo–(Ag)

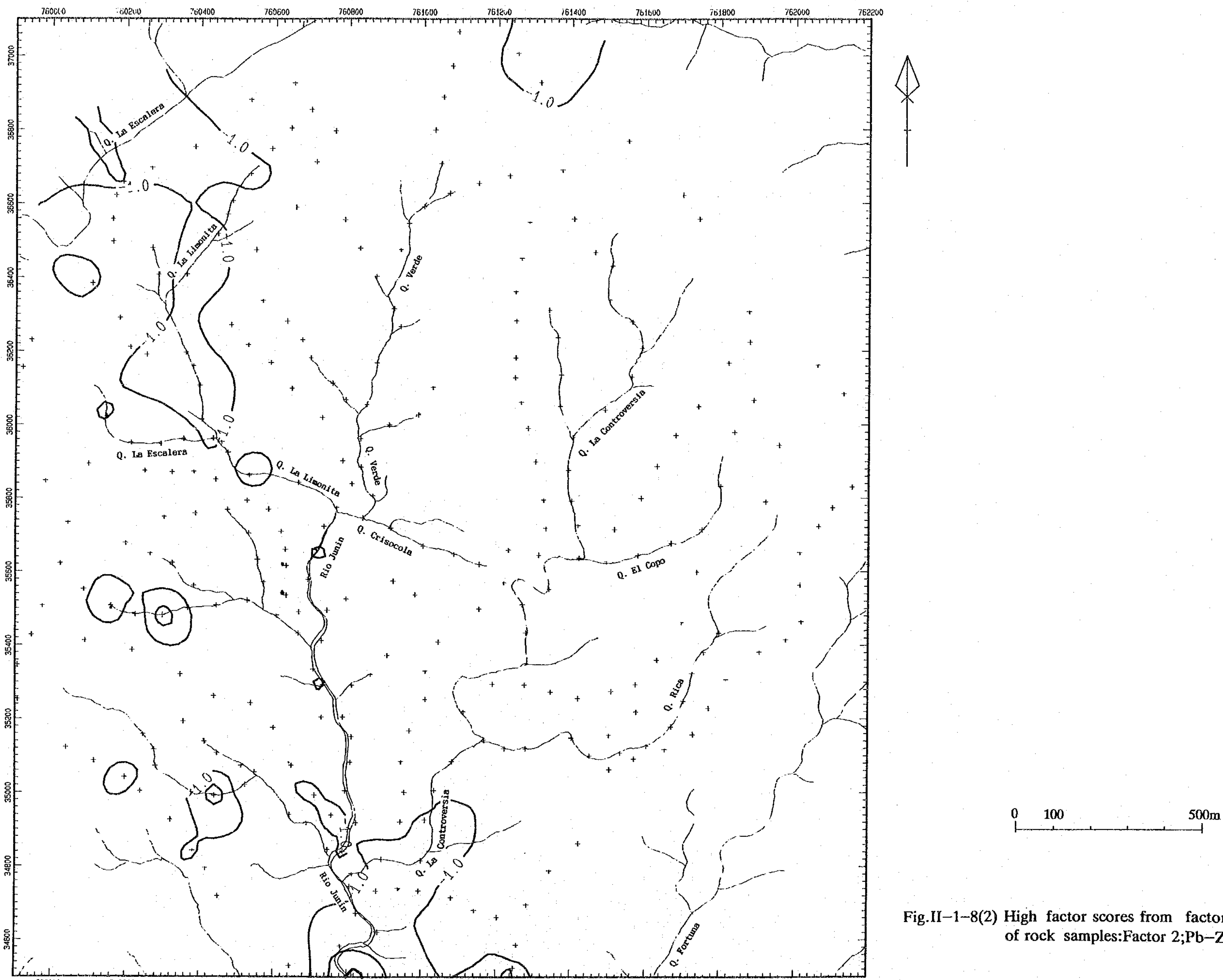


Fig.II–1–8(2) High factor scores from factor analysis of rock samples:Factor 2;Pb–Zn

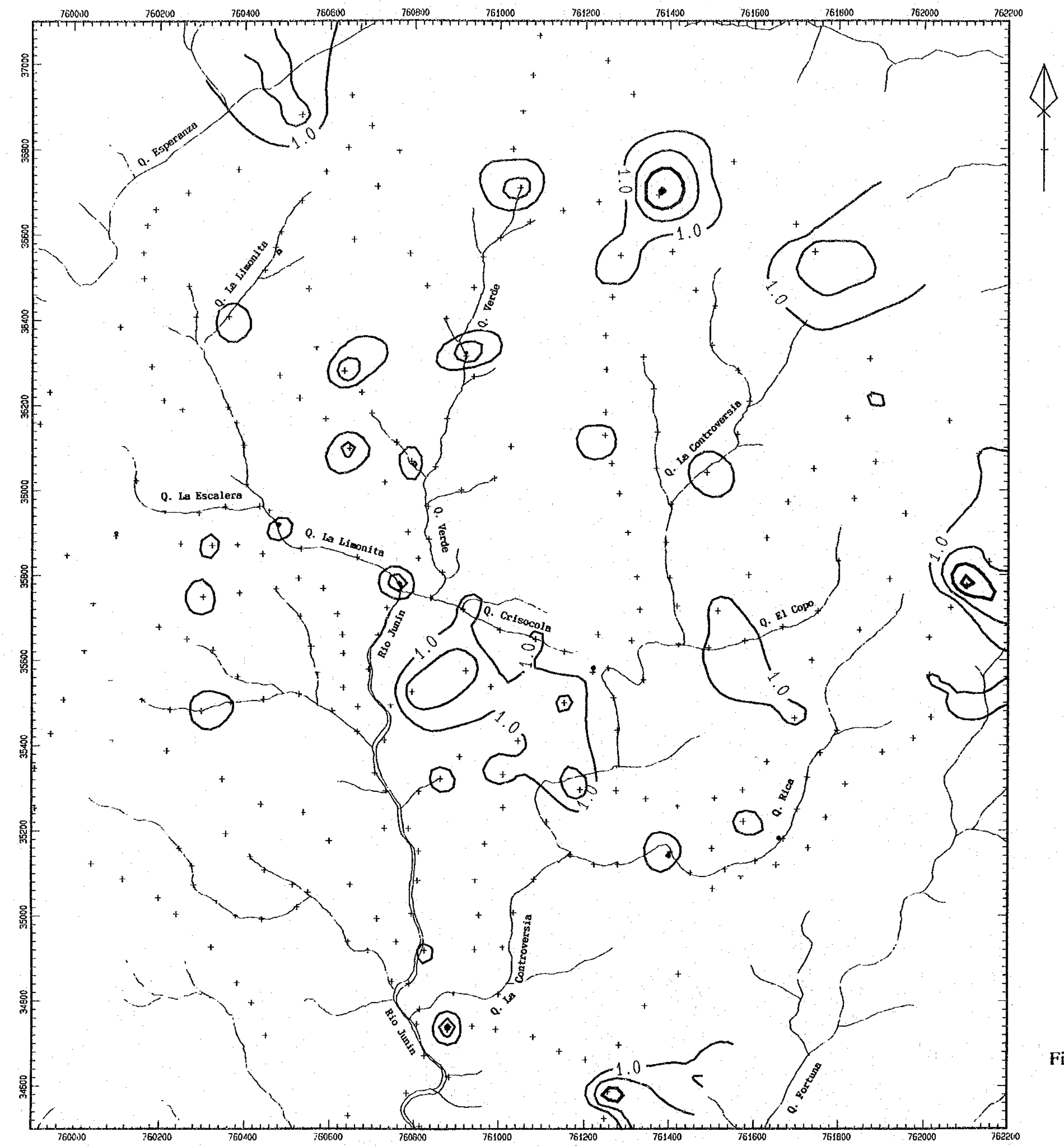


Fig.II−1−8(3) High factor scores from factor analysis of rock samples:Factor 3;Au−Ag

was adopted to maximize recovery of drill cores and efficiency of other works. Through the drilling survey, required were apropriate camp facilities for laborers.

Drilling performance of the hole is listed on Tab.II–1–9.

(3) Transportation and preparation of drilling site

All the machines, equipments and materials were transported to Chalguayacu Alto, which is the terminal of the road and the entrance for Junin. A " Site Storage House" was to be built on the mountaintop of Cerro Junin (2,280 m ASL) which is about the midway between drill hole sites, MJJ–1 and MJJ–2. A part of the " Site Storage House" was also utilized as dormitory foe laborers.

Heavy machinaries were decomposed and shouldered basically from Chalguayacu Alto to the Drilling site. Other lighter equipments and materials were delivered from Chalguayacu Alto to the " Site Storage House" on horseback in case that the heavy cargo were able to be sub–divided. All of the cargo were shouldered between the " Site Storage House and the drilling site. Every existing narrow and snaky road was amplified and adjusted. In the interior part of the mountain, the transporta–tion road was to be built in time.

Water required for drilling work was supplied with water pipeline (1 to 1/2 inch poly–ethylene pipe) by pumping up from Q.Escalera where a tentative water dam was facilitated.

(4) Drilling work

Actual drilling work is shown in Fig.II–1–11, the progress of drilling work for MJJ–1 is shown on Tab.II–1–10, and the drilling equipments and consumed mate–rials are listed on Tab.II–1–11.

Detailed work of MJJ–1 was as follows:

0 to 11.50 m

(Hole diameter 101 mm, with NQ–NU casing down to the depth of 11.50 m)

To drill surface soil and gravel layers, 101 mm metal bits and diamond shoe were used with bentonito mud water. When reached the country rock at 11.50 m, NQ–Nu casing was inserted.

11.50 to 58.40 m

(Hole diameter 77.5 mm of NQWL: NQ–NU casing to 12.50 m and BW casing to 58.40m)

Through NQWL process, drilling was conducted using bentonite and TK–60B with

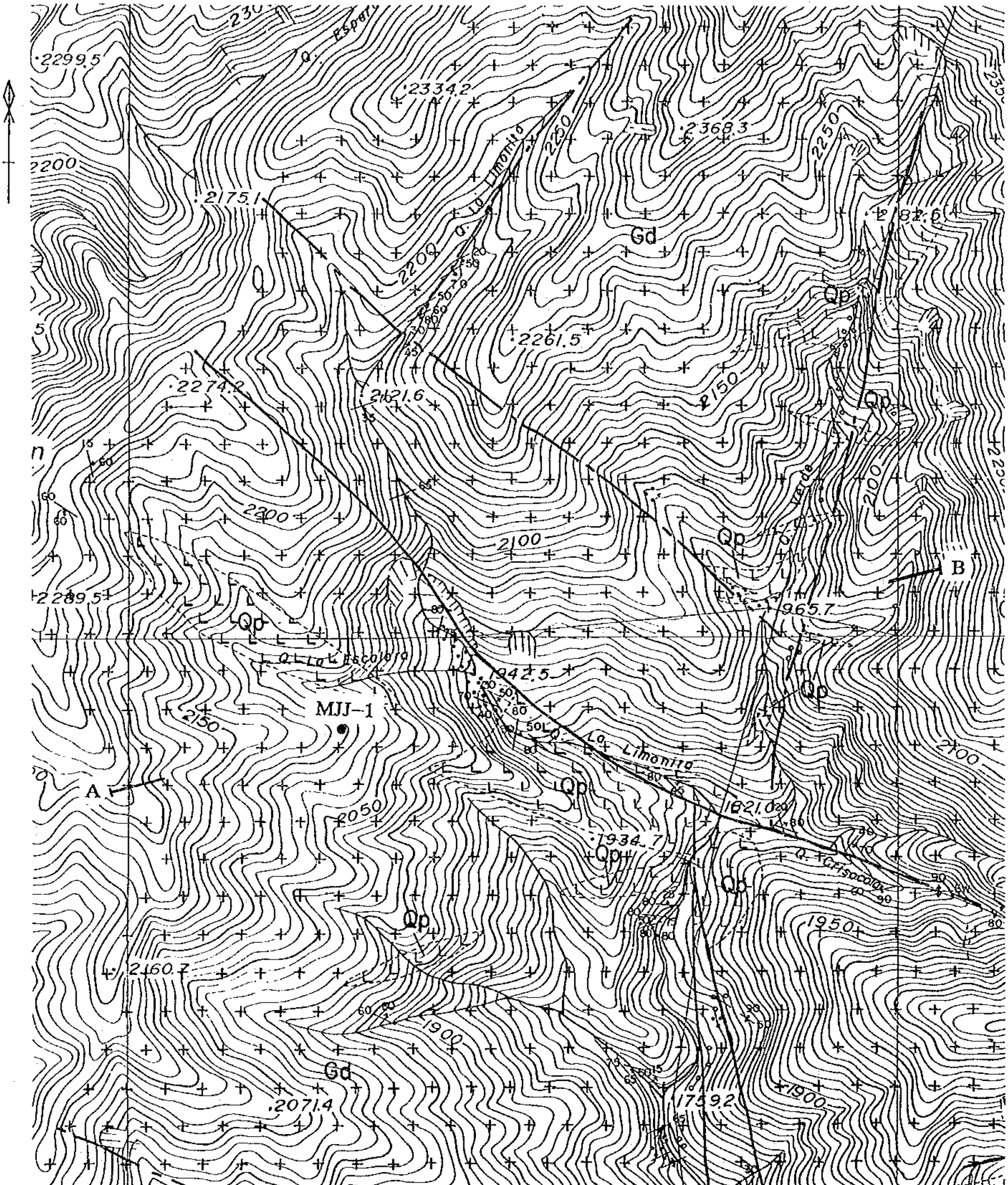


Fig.II–1–9 Location and geologic map of the drill hole MJJ–1

Tab.II-1-9 Generalized drilling results

Drill Hole NO	Machine Type	Drilling Period	Drilled Length	Core		Number of Drilling Shift			Drilling speed		Remarks
				Length	Recovery	Drilling	Preparation & Removing	Total	m/shift*	m/shift**	
MJJ-1	L-24	Dec.4, 1991 ~ Dec.16, 1991	151.50 m	133.50 m	95.4 %	31	44	75	2.02	4.89	

Note * Drilled Length per one shift covering total works operated

** Drilled Length per one shift covering net drilling operation

MJJ-1 were drilled by 3 shift/day (8 hours/shift)

Tab.II-1-10 Summary record of drilling activities(MJJ-1)

		Periods			Number of Days	Actual Working Days	Pay off	Total Number of Workers
Drilling Period	Preparation	Nov· 4·1991～Dec· 3·1991			30	30	-	1893
	Drilling	Dec· 4·1991～Dec·16·1991			13	13	-	444
	Removing	Dec·17·1991～Dec·31·1991			15	15	-	570
	Total	Nov· 4·1991～Dec·31·1991			58	58	-	2907
Drilling Length	Planned Length	150m	Overburden	11.5m	Core Recovery for Each 50m Section			
	Increase or Decrease in Length	+1.50m	Core Length	133.50m	Depth(m)	Section(m)	Core Length(m)	Core Recovery(%)
	Drilled Length	151.50m	Core Recovery	95.4%	11.50～ 58.20	46.70	40.40	86.5
Working Time	Drilling	127° 50′	49.9%	12.6%	58.20～105.40	46.20	47.00	99.6
	Accompanying Works	128° 10′	50.1%	12.7%	105.40～151.50	46.10	46.10	100.0
	Repairing	0°	-	-				
	Sub Total	256°	100 %	25.3%	Drilling Efficiency			
	Preparation	156°		15.4%	151.50 / 13	[Total Length / Drilling Days]		11.65m/Day
	Moving	88°		8.7%	151.50 / 58	[Total Length / Total Working Days]		2.61m/Day
	Others	512°		50.6%	444 / 151.50	[Net Drilling Workers / Total Length]		293mens/Day
	Grand Total	1012°		100 %	2907 / 151.50	[Net Drilling Workers / Total Length]		19.19mens/Day
Inserted Casing Pipe	Pipe size & Inserted Length	Inserted Length / Drilled Length ×100		Recovery of Casing Pipe	Remarks			
	NQ-NUCP 12.5m	8.3 %		100 %				
	BWCP 58.40m	38.5 %		100 %				

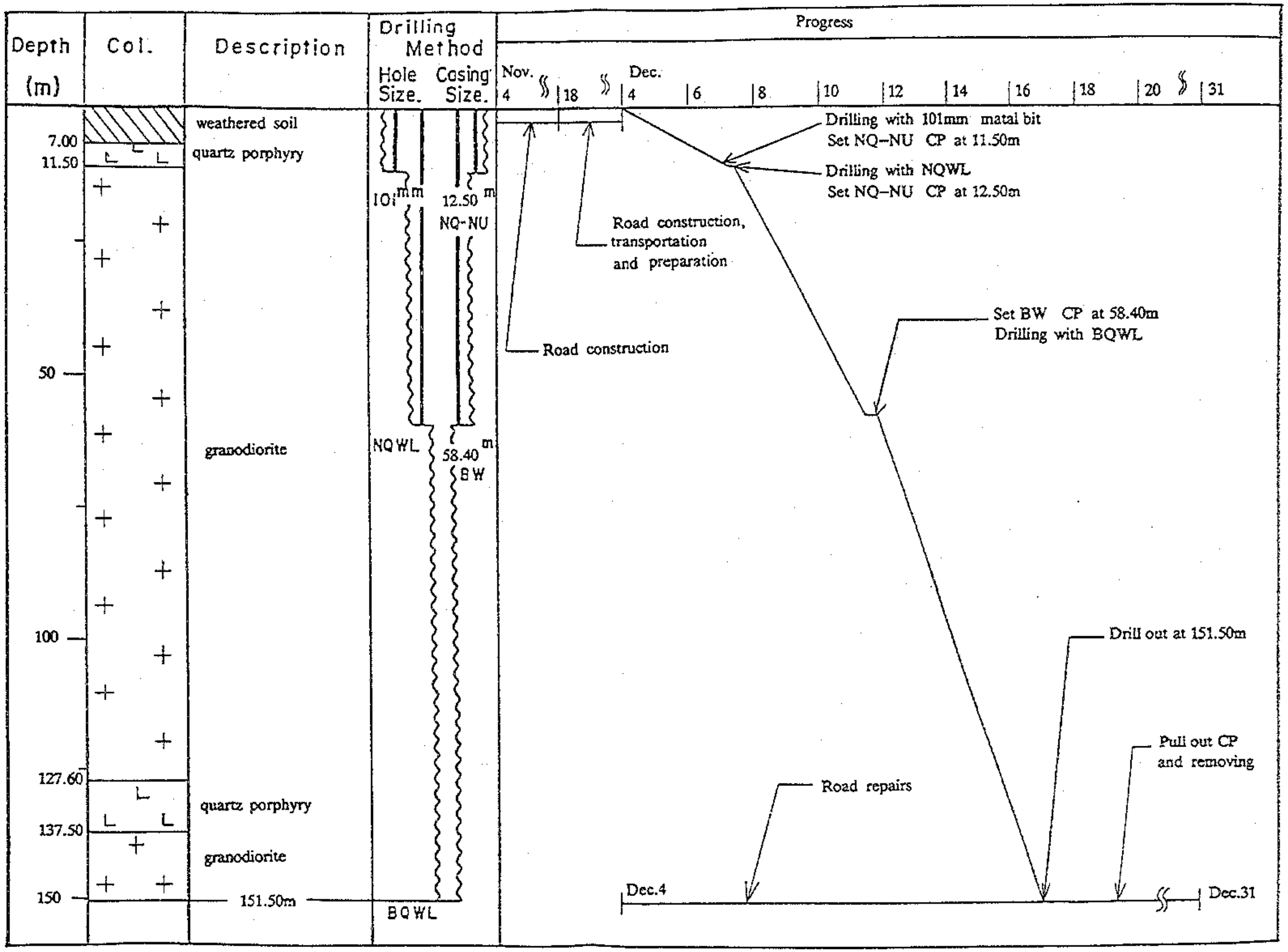


Fig.II–1–10 Progress record of hole MJJ–1

Tab.II-1-11 Drilling equipments and consumed materials

A.Drilling equipment

Article	Model	Specification	Quantity
Drilling Machine	L-24	Maker:Longyear Capacity:BQ WL 120m Dimensions: Height 1370mm Length 1200mm Weight(without Power Unit) : 435 Kg	1 set
Diesel Engine	NFD-10	Maker:YANMAR Horse Power:10HP/2600rpm	1 set
Drilling Pump	NAS-2	Maker:TONE Piston Diameter 63mm Stroke 67mm MAX Capacity 45ℓ/min MAX Pressure 37Kg/cm² Weight(Without Power Unit) : 190 Kg	1 set
Diesel Engine	NFAD-5	Maker:YANMAR Horse Power:5.5HP/2600rpm	1 set
Water Supply Pump	MS-1503	Maker:MARUYAMA Piston Diameter 47mm Stroke 36mm MAX Capacity 150ℓ/min MAX Pressure 30Kg/cm² Weight(Without Power Unit) : 40.8 Kg	2 set
Diesel Engine	MFD-10	Maker:YANMAR Horse Power:10HP/2600rpm	2 set
Wireline Hoist	WLH-S	Maker:Longyear Hoisting Capacity 250m	1 set
Diesel Engine	NS-40C	Maker:YANMAR Horse Power:5HP/2400rpm	1 set
Mixer	Jet Type	Run by Drilling Pump	1 set
Drill Rod		NQWL (3.00m/joint) BQWL (3.00m/joint) NQ-NU(2.50m/joint) BW (2.80m/joint)	89 joint 150 joint 18 joint 98 joint

B. Consumed Materials

Article	Specification	Unit	Quantity
			MJJ-1
Light oil	Engine	ℓ	1115
Cement	40 Kg/Sx	Sx	10
Bentonite	25 Kg/Sx	Sx	90
Libonite	20 Kg/Sx	Sx	6
C·M·C	10 Kg/Sx	Kg	80
TK60B	20 Kg/Sx	Sx	2

C. Consumed Bit

Hole No. / Bit Type		MJJ-1	
		Drilled Length	Quantity
101mm Single	Metal Bit	11.50 m	7 PCS
	Diamond shoe	11.50	1
NQWL	Diamond Bit	58.40	3
	Diamond Reamer	58.40	2
BQWL	Diamond Bit	93.10	7
	Diamond Reamer	93.10	3

fresh water. Lithology was hard (siliceous) granodiorite accompanied with stringers and networks of quartz, epidote, and chlorite. Drillimg work faced a difficulty because drill hole intersected fracture zone. Circulating mud water was lost completely at 16.40 m in depth. The " Telstop" was adopted to recover the condition then NQ–NU casing pips were insertws.

58.40 to 151.50 m

(Hole diameter 59.56 mm of BQWL)

Through BQWL process, drilling was conducted with mud water of TK–60B and fresh water. Lithology was hard compact granodiorite mainly with intrusive dike of quartz porphyry. Through the entire cores, recognized are dissemination and/or stringers of Pyrite generally, and thin vein or stringers filled with quartz, chlorite and epidote. The hole was completed at the depth of 151.50 m.

(5) Examination of drill cores

The MJJ–1 drill core was examined simultaneously with operation at the drilling site and Chalguayacu Alto or Garcia Moreno.

Results of this examination were compiled in columner section (Appendix 7) and geologic section (Fig.II–1–11). Drill cores were split with diamond cutter after completing the drill hole. One half of them was taken as test samples and the other was left for duplication.

1–3–3 Results of drilling survey

MJJ–1

1) Location, Inclination and Depth

Location : Latitude 35.880 N; Longitude 760.220 E; Altitution +2,105 m ASL

Inclination : –90 degrees

Depth : 151.50 m

2) Objectives

The objectives of MJJ–1 was to confirm the extension westwards of Q.Limonita mineralized zone and the existence of secondary copper minerals (Chrysocolla, Cuprite, Chalcocite, etc.) at the depth of Q. Limonita level (approximate 2,000 m ASL), and then to consider the relationship between granodiorite and quartz porphyry which is expected to be associated with mineralization, and to considerfurther the signif–

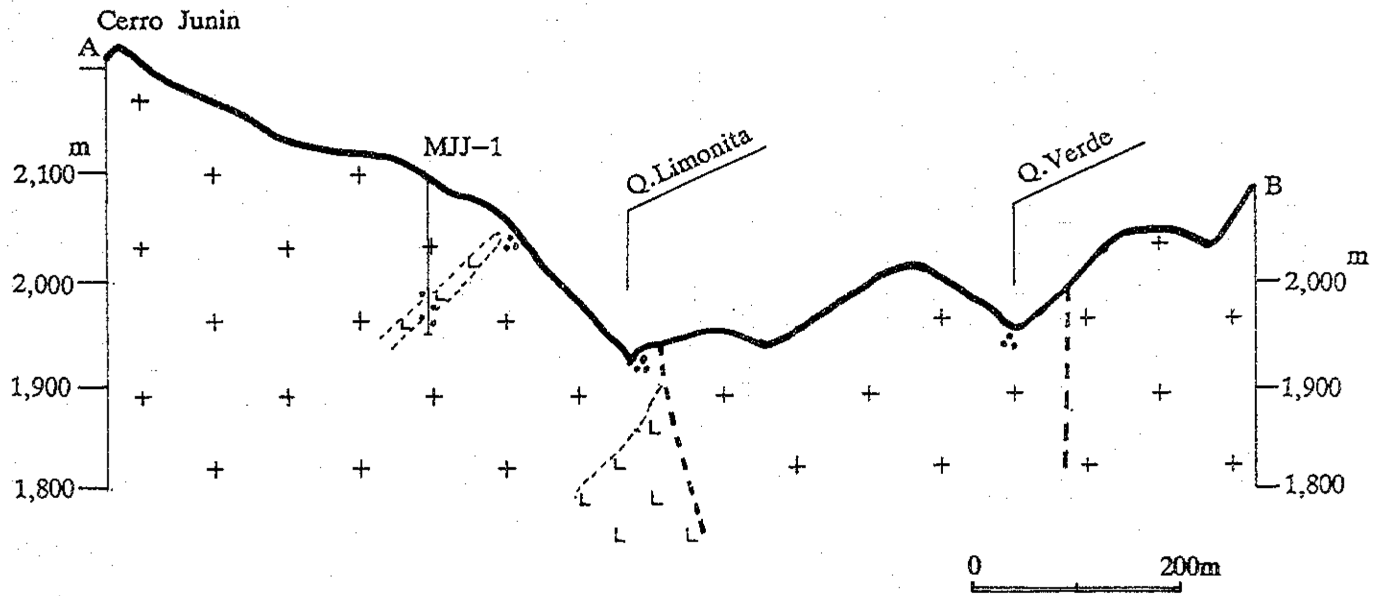


Fig.II–1–11 Geologic profile of the drill hole MJJ–1 icance of faults and lineaments on the process of exploration.

3) Geology and mineralization of MJJ–1

0.00 to 7.00 m	Light yellowish to light pinkish clay; includes quartz porphyry fragments
7.00 to 12.00	Quartz porphyry (weathered)
12.00 to 31.80	Granodiorite; moderate to strong argillization; epidotization › sericitization
31.80 to 41.60	Granodiorite; epidotization; fine Pyrite film
41.60 to 49.90	Granodiorite; strong argillization; epidotization; limonite dissemination through the core
49.90 to 54.60	Granodiorite; moderate silicification; epidotization › chloritization; fine Pyrite film
54.60 to 127.60	Granodiorite; strong silicification; chloritization › epidotization; dissemination and film of Pyrite–Chalcopyrite–(bornite)
127.60 to 137.50	Pale grayish green quartz porphyry (dike); moderate to strong silicification; chloritization; dissemination of Pyrite–Chalcopyrite
137.50 to 151.50	Granodiorite; moderate to strong silicification; chloritization and epidotization; dissemination of Pyrite–Chalcopyrite
	At the depth of 151.50 m drill hole was completed.

As the result of drilling survey the Q. Limonita mineralized zone was confirmed to extend toward the drill hole site MJJ–1, though intensity of mineralization seem–ed to be decrease westwards. The mineralization recognized within quartz porphyry dike between 127 m and 137 m in depth and its vicinity was proved to be more intens–ive comparatively than any other part of the hole. This fact was harmonized with the mineral occurrence obseved in the Q. Limonita minera–lized zone.

The mineral assemblage, furthermore, on the drill hole cores was concluded to be Pyrite–chalcopyrite mainly, which were accompanied with secondary minerals such as Cuprite, Chalcocite, Bornite and Hematite sporadically.

White argillization and epidotization were common characteristically near the surface, while silicification and chloritization were dominated at the depth. The powderly X–ray diffractive analysis revealed a quartz–chlorite–sericite assemblage which was corresponded to the phyllic alteration zone.

Taking the result of the drill hole core examination and geological investigat– ion, and the powderly X–ray diffractive analysis into account, the hole MJJ–1 was concidered to have intersected the western margin of the Q.Limonita mineralized zone though intensity of mineralization was comparatively weak, because the core deeper than 120 m, where phyllic alteration zone was identified by powderly X–ray diffract– ive analysis, was predominat on silicification and chloritization even to the nakid eyes.

1–4. Discussion

The metallogenetic process of above three mineralized and alteration zones are considered as follows: The trend of granodiorite batholith(Aquela–Nanegal batholith) is the N–S or NNE–SSW directions which is the same of the direction of Andes as a large structure. The distinguished direction of NE–SW and NW–SE of the lineaments is medium scaled structure. They are considered to be conjugate set. And, these three structures are presumed to have existed as a basement structure for quratz–diabase magma which rose through the structures and formed stocks.

The Central Zone of Junin area is considered to be a place where these structural and igneous activity concentrated. The radius lineament develops from the area of the juncture of Q.Limonita and Q.Crisocolla. These fractures can be considered to have been the weak structure, and which have been intruded by porphyry accompnied with ore solution. By the mineralization and alteration of Type I together with Type II which occured in this unique place, each type of ore deposit was formed (Type I and II are considered to be porphyry–copper type).

The mineralization was finished by the acidic hydrothermal alteration of Type III in the final stage. After that, the secondary copper minerals are crystallized by the local circulation of ground water, however, oxidation zone or the zone of secondary enrichment are presumed not to be formed, because of extreme shortage of pyrite. (however, the zone of secondary enrichment was formed in Q.Crisocolla mineralized zone, because the leaching progressed along the fault).

By the structural analysis of the fractures Type II and III, the thrust from the deeper part of Q.Verde toward the surface is presumed.

The type of mineralization, classification of alteration and the result of geochemical survey of each mineralized zone are shown on Tab.II–1–12.

Taking the result of the drill hole core examination and geological investigation, and the powderly X–ray diffractive analysis into account, the Hole MJJ–1 was considered to have intersected the western margin of the Q.Limonita mineralized zone though intensity of mineralization was comparatively weak, because the core deeper than 120 m, where phyllic alteration zone was proved by X–ray analysis, was predominant on silicification and chloritization even to the nakid eyes.

Tab.II-1-12 Summary of each mineralized zone

Mineralized and alteration zones	Mineralized type					Alteration zoning pattern						Geochemical anomaly					
	I	II		III		I		II		III		Cu	Mo	Pb	Zn	Au	Ag
		A	B	A	B	Prop	Phyl	Phyl	Pota	A	B						
Q. Limonita miner. zone	◎	◎	◎	–	–	○	◎	–	○	–	–	◎	◎	○	○	●	●
Q. Verde miner. zone	◎	–	–	–	–	○	◎	–	–	–	–	◎	◎	○		●	●
Rio Junin miner. zone	○	–	◎	–	–	○	◎	◎	○	–	–	◎	◎	o	–	–	●
Up. reach of Q. Limonita miner. zone	–	◎	–	–	–	●	–	◎	–	–	–	◎	–	◎	◎	●	●
Q. Crisocola miner. zone	–	◎	–	◎	–	●	–	○?	–	◎	–	●	○	o	–	●	●
Q. Crisocola-Q. Controversia alter. zone	–	–	●	◎	–	–	–	–	–	◎	–	–	○	○	–	●	●
Q. Controversia miner. zone	○	◎	◎	–	–	○	◎	◎	–	–	–	◎	◎	○	–	–	●
Q. Rica miner. zone	o	–	○	–	–	◎	–	○	–	–	–	–	○	–	–	–	●
Cerro Junin miner. zone	–	–	o	–	–	–	–	○	–	–	–	●	–	◎	○	●	–
Southeast-East alter. zone	–	–	●	–	◎	–	●	–	–	–	◎	–	●	○	–	●	●

◎>○>o>●>–

Chapter 2 Surrounding Zone of Junin area

Semi-detailed geological survey, geochemical survey (stream sediment) were carried out in an area of 35 km^2 for Phase I survey.

2-1 Geological survey

2-1-1 Purpose and method of survey

The purpose of the survey is to study the geology of the Surrounding Zone of Junin area in order to clarify the ore-bearing circumstances. The important objectives of the survey is to clarify the relationship between geological structure and mineralization/alteration in this area, and to clarify the outerward expanse of known promissive mineralized zones found in the Central Zone up to the Surrounding Zone of Junin area.

Before the survey, the new map on a scale of one to ten thousand was made based on the existing aerial photographs, and route map was also made based on this new map. The survey routes were decided with careful examination of the existing data. Aerial photographs were fully used in this survey. During this route survey, stream sediments were sampled in the main stream and their branches for geochemical survey.

Geological plan map is shown in Fig.II-2-1 and Pl.II-2-1 and geological profile is shown in Pl.II-2-2. The generalized columnar section is shown in Fig.II-2-2.

The samples for various analysis and tests were collected after due consideration. The sampling points are shown in Pl.II-1-3. The results of the analysis and the tests are described in this report and also listed up on appendix.

2-1-2 Geology and geological structure

Geology of this area mainly consists of granodiorite(Gd) which forms batholith, and diabase-porphyry(Dp) and quartz-porphyry(Qp) both of which intrude into the batholith as stocks.

(1) Granodiorite(Gd)

Granodiorite forms Apuela-Nanegal batholith which distibutes almostly through the survey area. This rock shows medium grained, dotted pattern of hornblendes and biotites. The granodiorite batholith includes mafic tuff of Macuchi Formation and it's hornfels as xenolith in the upper reaches of Rio Chalguayacu and the lower reaches of Q.Esperanza in the western part of the area.

The microscopic observation of typical rock is as follows(Appendix 1);

Granodiorite(D1015)
Location: Q.Esperanza
Texture : subhedral granular
Main and accessory minerals: plagioclase› quartz› K–feldspar› biotite› hornblende, allanite, apatite, zircon, opaque minerals
Altered minerals: chlorite

Biotites are slightly altered to chlorite.

(2) Diabase–porphyry(Dp)

Diabase–porphyry distributes in two areas, in the central part and the south–eastern part of the Surrounding Zone. The rock intrudes into granodiorite batholith and forms stocks with about 0.5 km and 1 km in diameter, respectively.

The microscopic observation of typical rock is as follows(Appendix 1);

Diabase–porphyry(E1026)
Location: Q.Fortuna
Texture : porphyritic
Phenocryst : plagioclase› quartz› biotite› opaque mineral
Groundmass : plagioclase› quartz› K–feldspar
Altered minerals: quartz› sericite› chlorite› K–feldspar› epidote› limonite

Almost all the biotites are altered to chlorite. Plagioclases of phenocryst and groundmass is replaced by sericite and chlorite.

(3) Quartz–porphyry(Qp)

Quartz–porphyry distributes in the lower reaches of Rio Chalgualyacu and Q.Esperanza in the western part of the survey area, in the lower reach of Q.Cristal and the upper reaches of the branch of Q.Cristal in the eastern part of the area and in the upper reaches of Q.Fortuna and the middle reaches of the branch of Q.Fortuna in the southeastern part of the area. The rock intrudes into granodiorite batholith and diabase–porphyry stock, and forms stock of 10m in width and dyke of 100m in width, respectively. Referring to the distribution of quartz–porphyry in the Central Zone of Junin area, there are comparatively abundant intrusions of quartz–porphyry

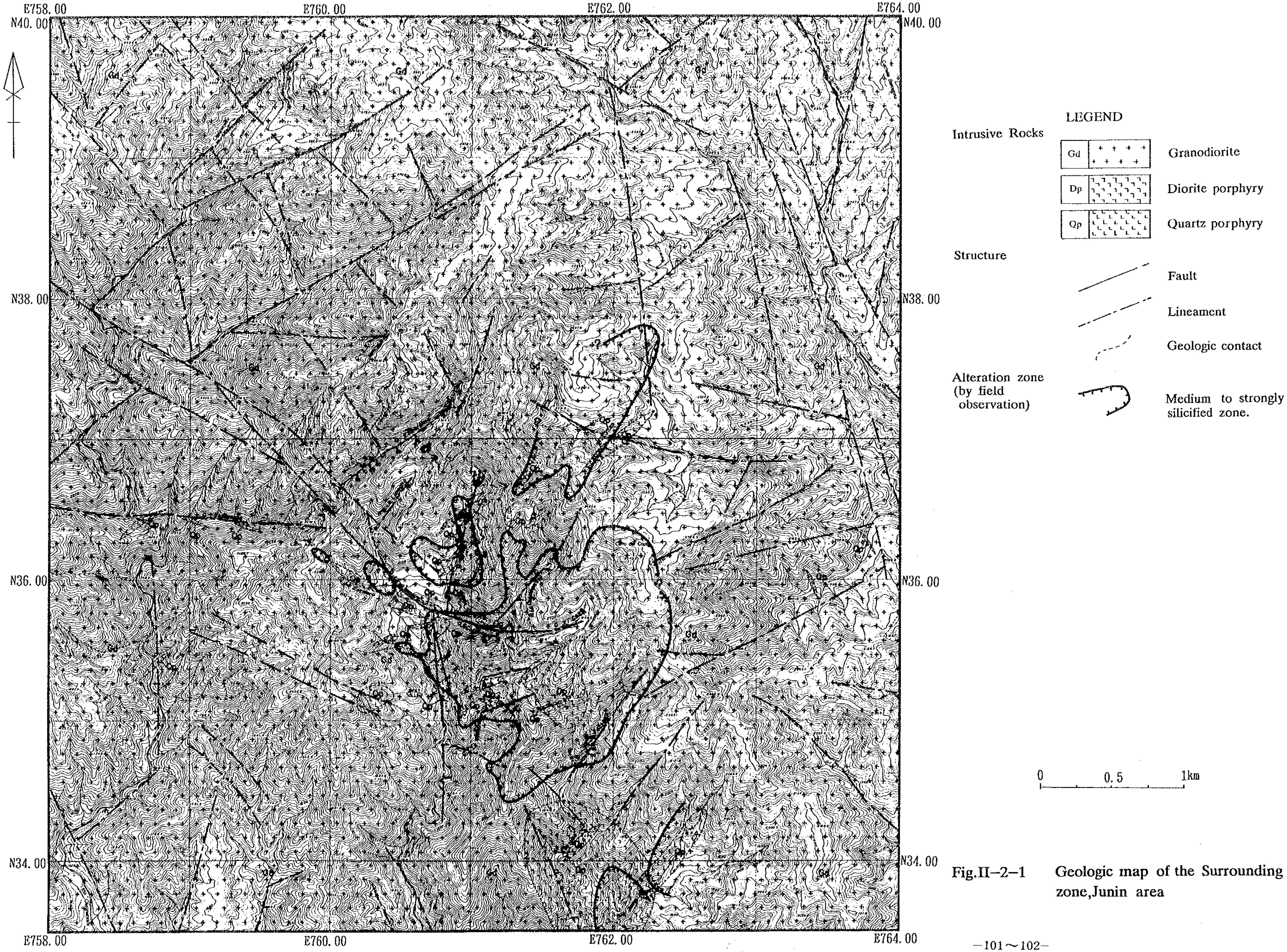


Fig.II–2–1 Geologic map of the Surrounding zone,Junin area

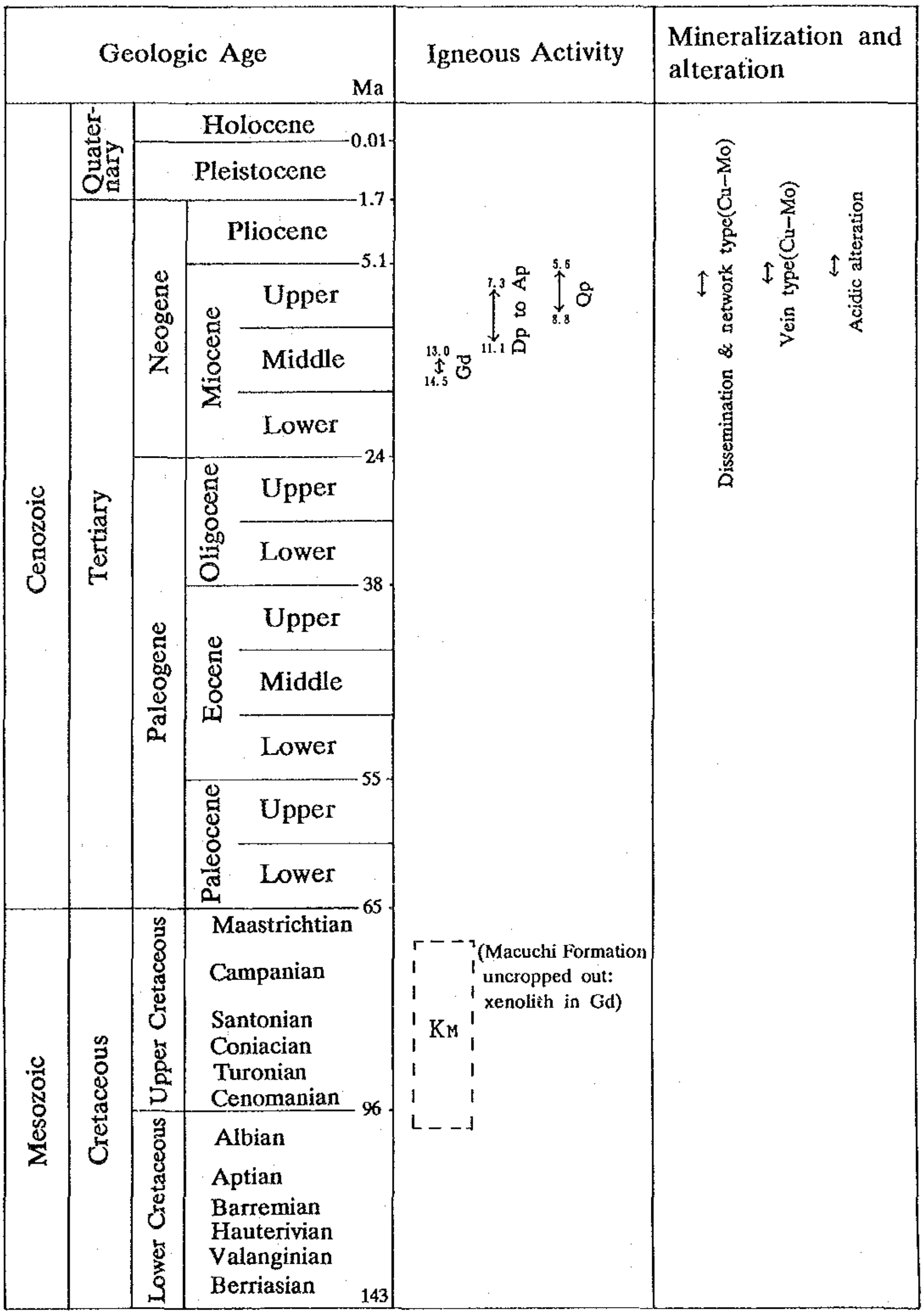


Fig.II–2–2 Generalized columnar section of the Junin and Cuellaje areas concentrating around the juncture of Rio Junin, Q.Limonita and Q.Crisocolla, only a few intrusions of quartz–porphyry are, however, distributed outwards.

Pyrite or chalcopyrite–pyrite dissemination is observed near the boundary area of this rock and intruded rock.

The microscopic observation of typical rock is as follows(Appendix 1);

Quartz–porphyry(E1027)
Location: Q.Fortuna
Texture : porphyritic
Phenocryst : plagioclase› quartz› biotite› opaque minerals,
Groundmass : quartz› plagioclase› K–feldspar
Altered minerals: sericite› chlorite› epidote› calcite› limonite

Almost all the biotites are strongly altered to chlorite. Plagioclases of phenocryst and groundmass are replaced by calcite, sericite and chlorite.

The chemical analysis of bulk rock, chemical variation diagrams of these three kinds of rocks such as Normative Quartz–Orthoclase–Plagioclase Diagram, ACF Diagram and SiO_2–(Fe^{3+}/Fe^{2+}) Diagram, are shown on Tab.II–1–1 and in Fig.II–1–2, respectively. As the result, except C1027, the rock is classified in granodiorite, and except D1028, the rock is classified in Type I. All the rocks are classified in magnetite series.

Isotope age determination with K–Ar method was carried out for granodiorite (C1022) which forms Apuela–Nanegal batholith, diabase–porphyry(E1026) and quartz–porphyry(E1027) which form stock(mineral dating for C1022 and bulk dating for other two samples). As the results, the ages are 14.5+ 1.0Ma, 7.3+ 0.3Ma and 6.1+ 0.2Ma were obtained(Tab.II–1–2). The age of batholith was defined to be from post–Eocene on the current study to limited epoch of the middle of Miocene of Tertiary Period. The age of the porphyries was to be late of Miocene of Tertiary Period.

(4) Geological Structure

Lineaments develop as the conspicuous geological structure in this survey area. The lineaments were extracted by the analysis of aerial photographs on a scale of one to sixty thousand, and were drawn in geological plan map (Fig,II–2–1 and Pl.II–2–1).

The comparatively long and distinct lineaments in this area were developed with the direction of NNW–SSE in the north–eastern to the eastern area, lineaments with the direction of ENE–WSW were developed in the north–western area, lineaments with the direction of WNW–ESE were developed in the central to the western areas and in the south–western area, lineaments with the direction of E–W were developed in the southern and the southwestern part of the Central Zone of Junin area. In addition to them, radial lineaments with the direction of NW–SW, N–S, E–W and NNE–SSW which run from the area around the juncture of Rio Junin, Q.Limonita and Q.Crisocolla as the center of the radiating.

The faults which were confirmed to exist are as follows; The faults of the direction of NW–SE to EW were distributed in Q.Limonita to Q.Crisocolla, faults of the direction of N–S were along Rio Junin and faults of the direction of ENE–WSW and NW–SW were in Q.Controversia. These faults were the same to the part of the lineament in the Central Zone of Junin area, so, other lineaments would be possible to be faults.

2–1–3 Mineralization and alteration

Q.Esperanza mineralized zone, Q.Fortuna mineralized zone and the branch of Q.Cristal silicificated zone were considered to be possible of ore deposit in this area.

(1) Q.Esperanza mineralized zone

This mineralized zone is adjacent to outside of the north–western end of the Central Zone of Junin area where is the north–western extension of the mineralized zone of the upper reaches Q.Limonita and also situates in the upper reaches of Q.Esperanza of the branch of RioChalguayacu. The scale observed was about 1km along Q.Esperanza.

The country rock of this mineralized zone is generally weak chloritizated medium grained hornblende–biotite–granodiorite. Hornblende and biotite are slightly altered to epidote and chlorite. Plagioclase is slightly replaced by sericite. However, the rock is generally fresh.

This mineralized zone belongs to Type II which is definedin the Central Zone, and consists of two types of veins: ore is vein rich in sulfide minerals(Type II A) and the other is quartz vein with a few sulfide minerals(Type II B).

Two ore veins were observed in the lower reaches of Q.Esperanza to be rich in sulfide minerals and to have the width of 40 cm and 60 cm. The strike of them is N70W and the inclination vertical. The other veins observed in the short distance from the fomer vein mentioned above show the width between 60 cm and 1.6 cm, the strike between N70E and N60E and the inclination vertical. The directions of these veins are oblique slightly to the direction of Q.Esperanza. The quartz vein which locates in the upper most reaches is 1.6 m in width, and has the strike of N40E and the vertical inclination. These directions and positions of veins are thought to be in harmony with those of the lineaments extracted as NW–SE and NE–SW around Q.Esperanza.

By the microscopic observation of the polished section of the samples collected in the vein of the strike of N70E to N60E(D1019,D1022 and D1023), the ore minerals consist of pyrite and chalcopyrite mainly, in addition to them, of tetrahedrite. Quartz is observed to be principal gangue mineral.

The alteration along the vein are silicification and argillization mainly, the width of alteration zone is about 2 m to 3 m. Quartz and sericite are recognized as altered minerals (Appendix 3).

As the result of chemical analysis, the grade of ore sample(D1021) obtained from the vein of N70W strike is as follows; 0.6g/t Au, 784.0g/t Ag, 20.97%, Cu, 0.01% Pb and 0.28% Zn (Appendix 4). The grades of ore samples(D1022 and D1026) of the vein with strike of N70E to N60E are as follows; 13.9g/t to 156.7g/t Ag, 11.07% Cu, under 0.03% Pb and under 0.07% Zn. The grade of ore sample(D1027) of the quartz vein with strike of N40E is as follows; 12.1g/t Ag, 0.34% Cu, under 0.01% Pb and 0.01% Zn.

(2) Q.Fortuna mineralized zone

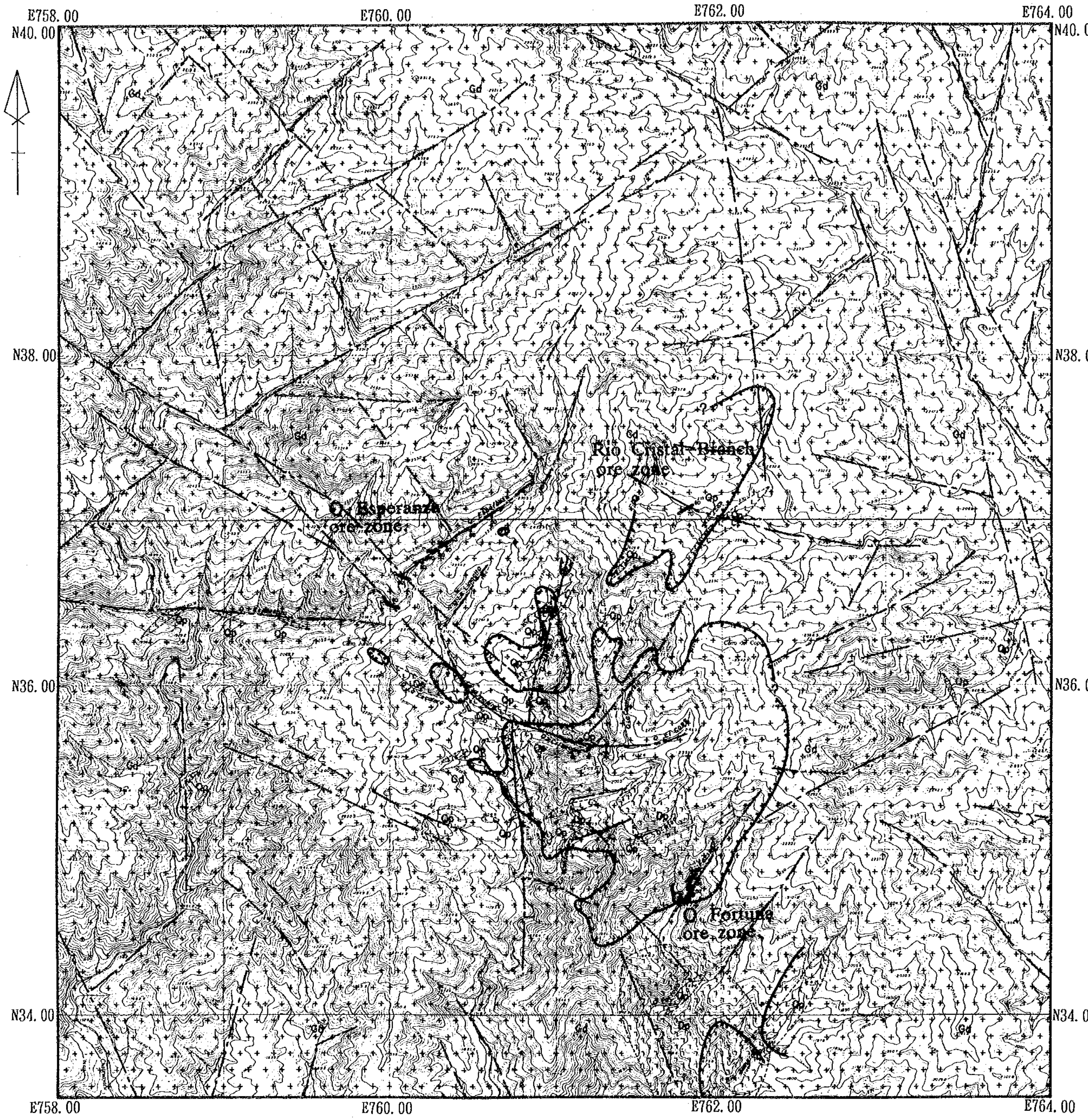
The Fortuna mineralized zone is adjacent to outside of the south–western end of the central zone of Junin area where is in the upper reaches of Q.Fortuna of the branch of Rio Zumarraga. The scale is about 100m along Q.Fortuna.

The country rock of this mineralized zone consists of strongly silicificated medium grained hornblende–biotite–granodiorite and quartz–porphyry.

This mineralized zone belongs to Type I and Type IIA which are defined in the Central Zone.

Type I consists of strongly silicificated granodiorite and impregnation and stockwork of pyrite–(chalcopyrite)–(tetrahedrite)–(cuprite)–(chalcocite) in quartz–porphyry.

Type IIA consists of ore vein rich in sulfide mineral(pyrite and chalcopyrite). Three ore veins are confirmed, one of them with 10cm in width has the strike of N15W and the dip of 60E, and is in harmony with the lineament of the direction of NW–SE.



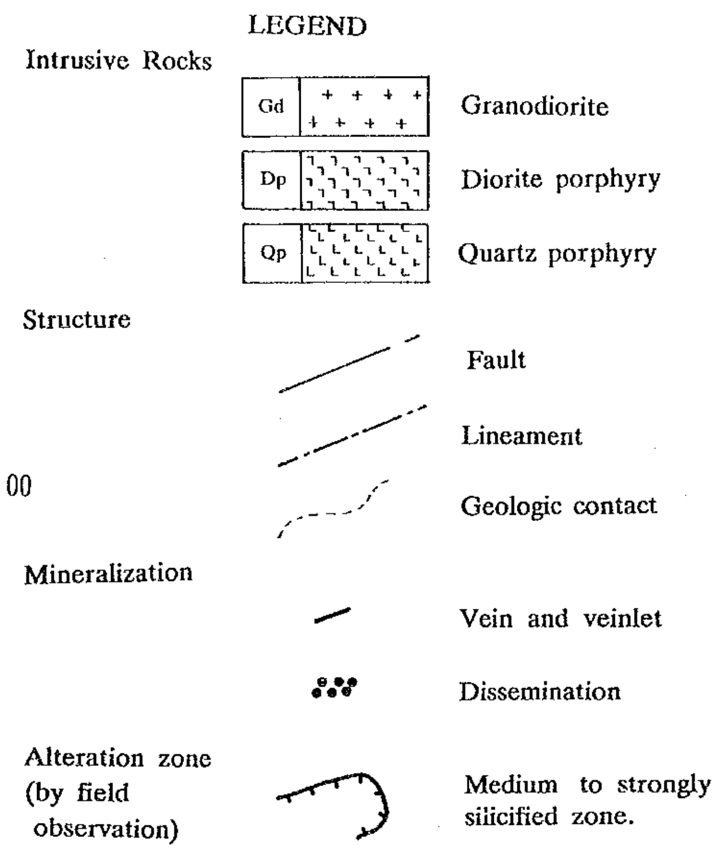


Fig.II-2-3 Mineralized and alteration zone map of the Surrounding zone, Junin area

The other two ore veins locate in the upper reaches have 10cm and 40cm in width, and the strikes are N35E and N50E, and the dips are 50E and 45E, respectively. They locate on the lineament of the NNE–SSW direction.

Granodiorite(E1021, E1022 and E1025) affected the mineralization of dissemination and stockwork mainly includes quartz and sericite as altered minerals.

Quartz and sericite are observed around the vein as altered minerals which associated vein type mineralizaation (E1020 and E1024).

By chemical analysis, the grades of the dissemination and stockwork vein are as follows: 8.3g/t to 1.1g/t Ag, 2.68 to 0.33% Cu and 0.09% or under Mo for dissemination; and under 0.2g/t Au, 3.5g/t to 1.8g/t Ag and 1.26 to 0.37% Cu.

(3) Alteration zone of the branch of Q.Cristal

The branch of Q.Cristal mineralized zone is adjacent to outside of the north–eastern end of the Central Zone of Junin area where is in the upper reaches of the branch of Q.Cristal. The scale is about 1km in the NE–SW direction and more than 0.5 km in the NW–SE direction.

The country rock of this mineralized zone consists of medium grained hornblende –biotite–granodiorite and quartz–porphyry which affected by moderate silicification and weak argillization. Dissemination of pyrite and film of limonite are recognized.

Silicificated granodiorite (D1040 and D1043) are thought to be included in phyllic alteration zone which is composed of quartz and sericite.

By the chemical analysis, the grade of a silicificated boulder (D1044) collected in silicification zone is as follows: 0.7g/t Au, 11.7% Ag, 0.22% Cu, 0.02% Pb, 0.02% Zn and 0.01% Mo.

(4) Other mineralized zone

In addition to above mineralized zones, small scale of dissemination zone of chalcopyrite–pyrite is observed in middle reaches of branch of Q.Cristal.

As the result of chemical analysis, the grade of ore sample obtained from the dissemination zone is as follows: 24.8g/t Ag and 1.10% Cu.

2–2. Geochemical survey

2–2–1. Purpose of survey

The purpose of survey with stream sediments is to clarify the expanse of known mineralization to outerward and to find out potential areas for ore deposits, especially for porphyry–copper deposit.

2–2–2. Method of the survey

(1) Sampling and preparation

The total of 305 samples of stream sediments were collected(Fig.II–2–5 and Pl.II–1–4). Although the average density of sampling is 8 to 9 samples/km^2, the actual density made slightly high in the central part of this area. The samples were collected at the upper stream side of the juncture of two or more rivers where the samplesof stream may not be affected by the other river. At the sampling point, where sands directly deposited upon the exposed basement rock and heavy minerals concentrate also, stream sediments were sampled with a sieve. Sand passed through a sieve should be the size under #30 mesh. Such sands were adopted for chemical analysis. The collected samples were divided by one fourth method, and 50g was for laboratory and another 50g was kept for spare. At the sampling point, recorded were such information as geological features, order of the river, width of the stream, current velocity and general grain size of stream sediments.

(2) Chemical analysis

Chemical analysis was carried out in Geotechnical Laboratory of BEC. The target elements were three elements of Cu, Pb and Zn.

The method of chemical analysis and the detectable limit for each element are shown on Tab.II–1–4. The results of chemical analysis are shown on Appendix 6.

(3) Data processing

The chemical analysis data was input in computer and statistic processing was carried out. The data under detectable limit was assumed to be half value of the detectable limit. Fundamental statistics is shown on Tab.II–2–1.

Correlation coefficiency was calculated(Tab.II–2–2) in order to find out the relationship among the target elements and then was made scatter diagram of correlation (Fig.II–2–4).

EDA method mentioned already was adopted to define the threshold value for detecting anormaly.

The histogram and boxplot (Fig.II–2–5) for each component was made. With these data, threshold value and supplementary threshold value were defined to be the value of upper fence and upper wisker, respectively(Tab.II–2–3).

2–2–3. Result of prospecting

(1) Geochemical anormaly for each element

Concentration of Cu, Pb and Zn was examined by EDA method of univariate analy–sis and then geochemical anormaly plans were made.

Copper(Cu): The concentration of copper varied from 5 ppm as minimum to 2,823 ppm as maximum. The value of upper hinge(227.0 ppm) by EDA method was adopted as the threshold and the value of upper wisker (9.5 ppm) was the supplementary threshold to detect the anormalous zone of the target elements. The anormalous zones were shown in the distribution map of high concentration(Fig.II–2–6(1)).

The anormalous zones over 227 ppm of copper were delineated the following 4 places:

Zone 1) Q.Esperanza

Zone 2) Rio Junin

Zone 3) Q.Fortuna

Zone 4) A branch of Rio Cristal

The anormalous zone 1) distributed only in the main stream of Q.Esperanza, and the concentration was 227 ppm to 641 ppm. The anormalous zone 2) also distributed only in the main stream, the concentration was 1,861 ppm to 2,194 ppm which was markedly high value. The anormalous zone 3) distributed in three places. One was in the lower reaches of the main stream, the other was in the middle reaches of the eastern branch, the rest was in the upper reaches of the western two branches. The concentration was 279 ppm to 917 ppm. The anormalous zone 4) distributed in the main stream and its branches. The concentration was 300 ppm to 2,828 ppm which was considered to be fairly high value, and to show the tendency that the concentration becomes higher to the upper stream ward.

Lead(Pb): The concentration of lead varied from under 1 ppm, which was the minimum detactable limit, to 24 ppm as maximum. The anormalous zones detected with the

Tab.II-2-1 Summary of statistical analysis of stream sediment geochemical data

Geologic units	Elements	Mean	Variance	Standard deviation	Min.	Max.	Mean+2S.D
Gd, Qp	Cu (ppm)	44.7	0.455	0.675	5.0	2,828.0	999.9
& Dp.	Pb (ppm)	3.2	0.084	0.289	0.5	24.0	12.1
(N=160)	Zn (ppm)	31.1	0.107	0.327	11.0	701.0	140.1

Tab.II-2-2 Correlation of three elements of stream sediment geochemical data

	Cu	Pb	Zn
Cu	1.000		
Pb	0.438	1.000	
Zn	0.577	0.782	1.000

Tab.II-2-3 Results of the EDA analysis of stream sediment geochemical data

Elements	Median	L.fence	L.wisker	L.hinge	U.hinge	U.wisker	U.fence
Cu(ppm)	27.5	-117.0	11.0	12.0	98.0	219.0	227.0
Pb(ppm)	3.0	-2.5	2.0	2.0	5.0	5.0	9.5
Zn(ppm)	24.0	-12.5	17.0	19.0	40.0	54.0	71.5

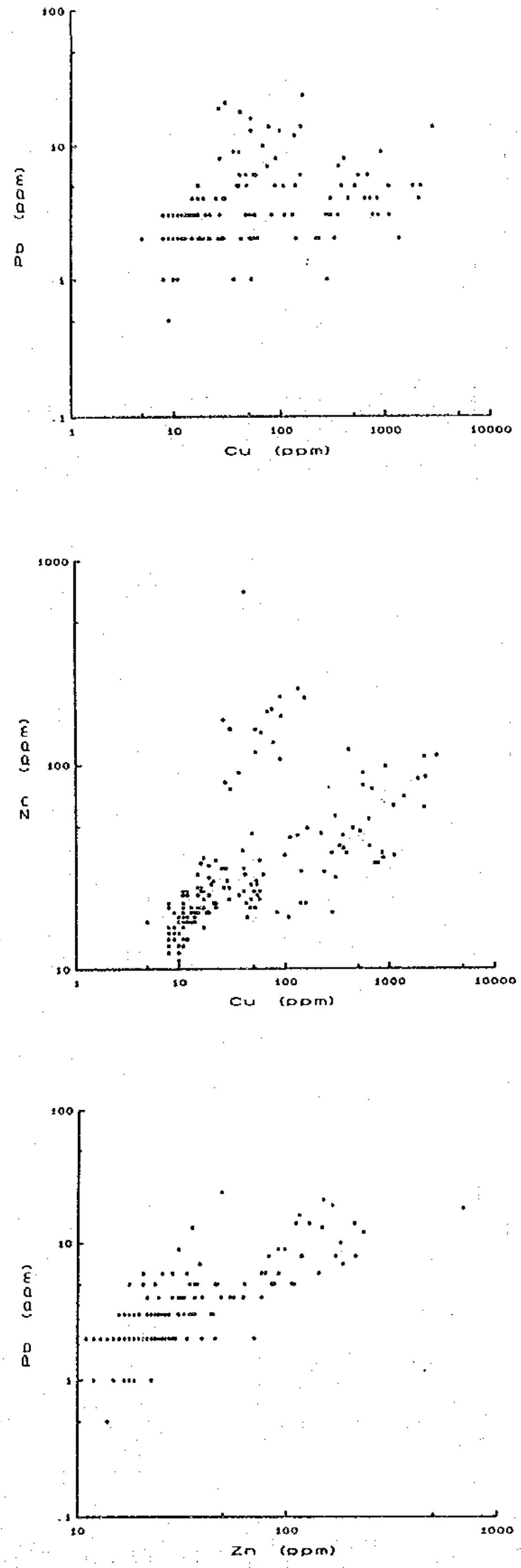


Fig.II–2–4 Correlation diagram between each element

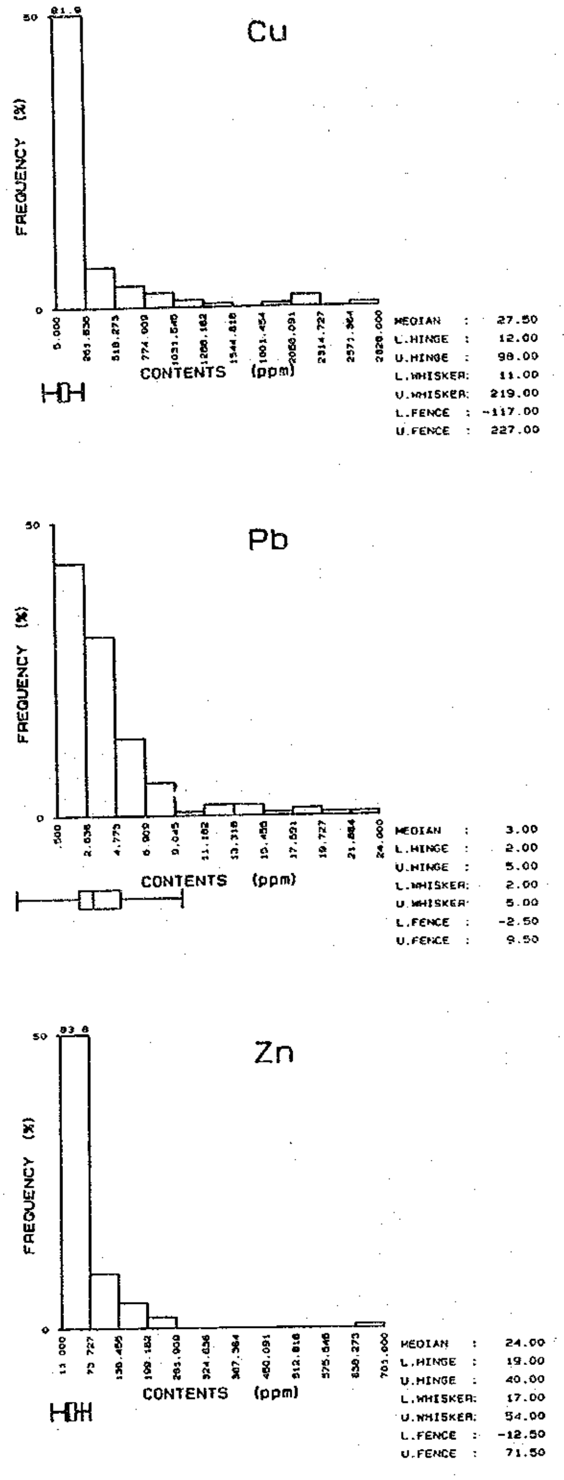


Fig.II--2--5 Histograms and boxplots for three elements

threshold of upper hinge (9.5 ppm) and supplementary threshold of upper wisker (5.0 ppm) were shown in the distribution map of high concentration (Fig.II–2–6(2)).

The anormalous zones over 9.5 ppm were delineated in the following six places:

Zone 1) A branch 1 km west of the Rio Junin

Zone 2) Rio Junin

Zone 3) Rio Zumarraga

Zone 4) Q.Fortuna

Zone 5) Rio Cristal

Zone 6) A branch of Rio Cristal

The anormalous zone 1) distributed in two places in the main stream, and the concentration was 13 ppm to 24 ppm. The anormalous zone 2) distributed in one place of the main stream and the concentration was 13 ppm. The anormalous zone 3) distributed in four places in the main stream and one place in the branch, and the concentration was 14 ppm to 21 ppm. The anormalous zone 4) distributed in one place in the western branch of the lower main stream, and the concentration was 18 ppm. The anormalous zone 5) distributed in two places in the main stream, and the concentration was 10 ppm to 12 ppm. The anormalous zone 6) distributed in one place in the branch of the upper main stream, and the concentration was 14 ppm.

Zinc(Zn): The concentration of zinc varied from under 11 ppm, which was the minimum detectable limit, to 701 ppm as maximum. The anormalous zones were shown in the distribution map of high concentration, which was detected with the threshold of upper hinge(71.5 ppm) and supplementary thresold of upper wisker(54.0 ppm) as shown in Fig.II–2–6(3).

The anormalous zones over 9.5 ppm were delineated in the following six places:

Zone 1) Rio Junin

Zone 2) Rio Zumarraga

Zone 3) Q.Fortuna

Zone 4) Q.Del Cerro Peiad

Zone 5) Rio Cristal

Zone 6) A branch of Rio Cristal

The anormalous zone 1) distributed in three places in the main stream and one place in the western branch of the middle main stream, and the concentration was 85 ppm to 148 ppm. The anormalous zone 2) distributed in six places in the main stream and its branches, and the concentration was 91 ppm to 221 ppm. The anormalous zone 3) distributed in three places in the lower reaches of the main stream and its bran–

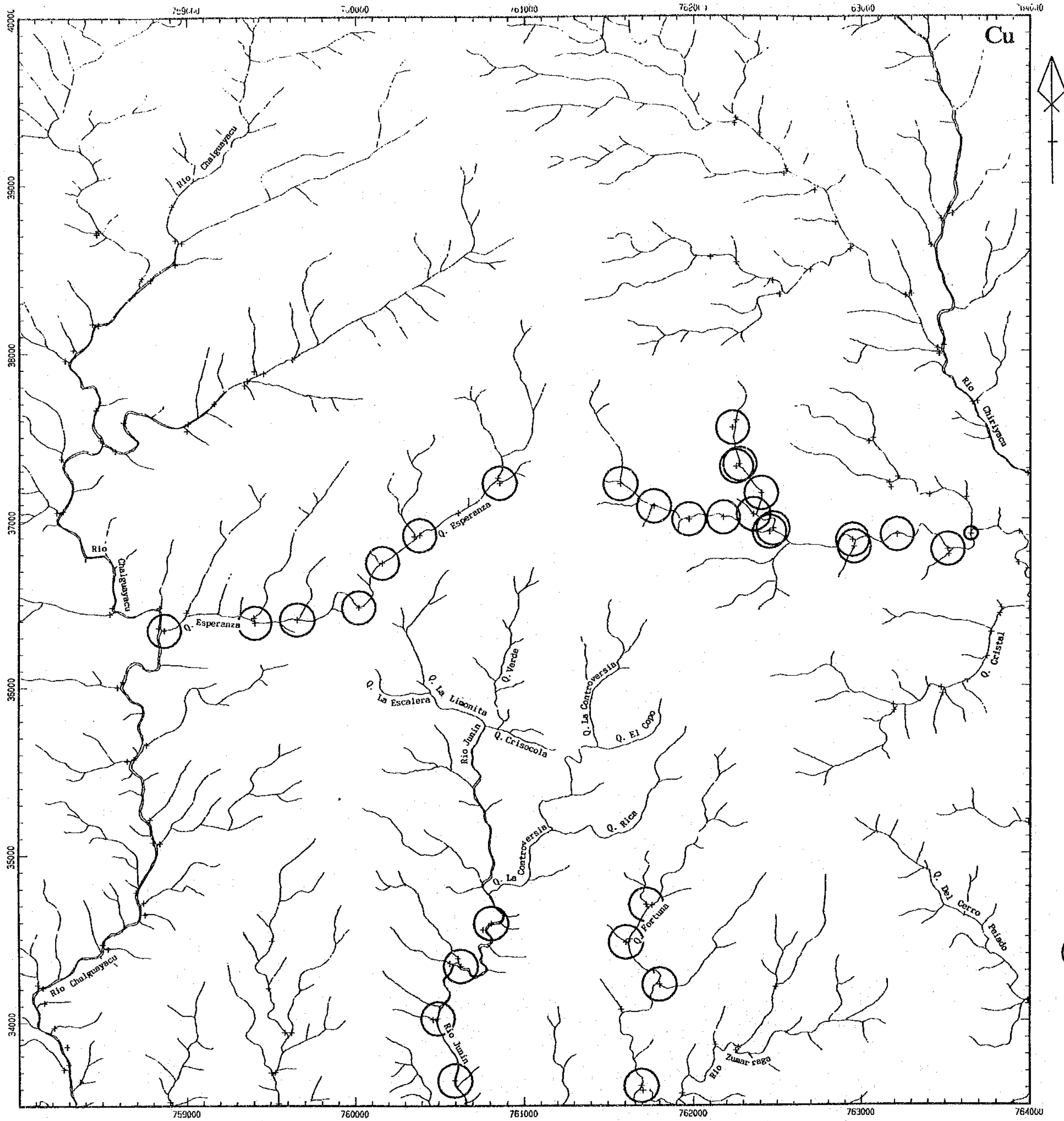
ches, and the concentration was 91 ppm to 701 ppm. The anormalous zone 4) distributed in one place in the lower reaches of the main stream, and the concentration was 82 ppm. The anormalous zone 5) distributed in eight places in the main stream and its branches, and the concentration was 76 ppm to 234 ppm. The anormalous zone 6) distributed in four places in the upper main stream, and the concentration was 76 ppm to 111 ppm.

2–3 Consideration

There were three mineralized alteration zones in the Surrounding Zone, which extended from the Central Zone of Junin area.

Q.Esperanza mineralized zone consisted of ore vein classified into Type II which was defined in the Central Zone. Q.Fortuna mineralized zone consisted of dissemination of Type I and of ore vein of Type II. In the alteration zone of the Rio Cristal, recognized were the phyllic alteration zone which were corresponded to type I defined in the Central Zone and the boulder which was considered to be of TypeII.

The geochemical anormalous zones of Cu–Pb–Zn elements were detected for the stream sediments in these three mineralized and alteration zones.



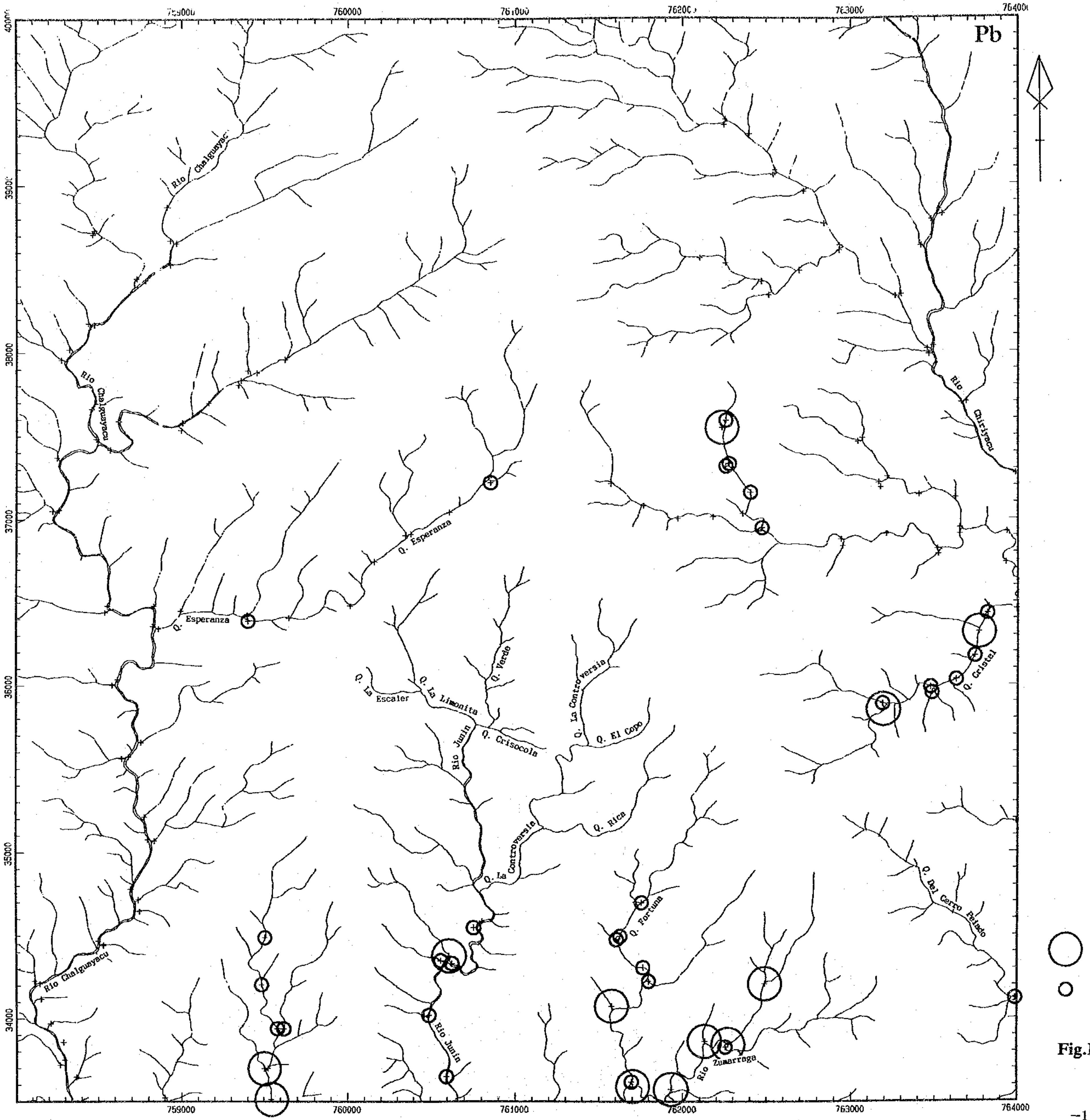
0 0.5 1km

LEGEND

○ 227.0 < Cu(ppm)

○ 219.0 < Cu(ppm) < 227.0

Fig.II–2–6(1) Geochemical anomalies of stream sediment samples(Cu)



0 0.5 1km

LEGEND

○ 9.5 < Pb(ppm)

○ 5.0 < Pb(ppm) < 9.5

Fig.II-2-6(2) Geochemical anomalies of stream sediment samples(Pb)

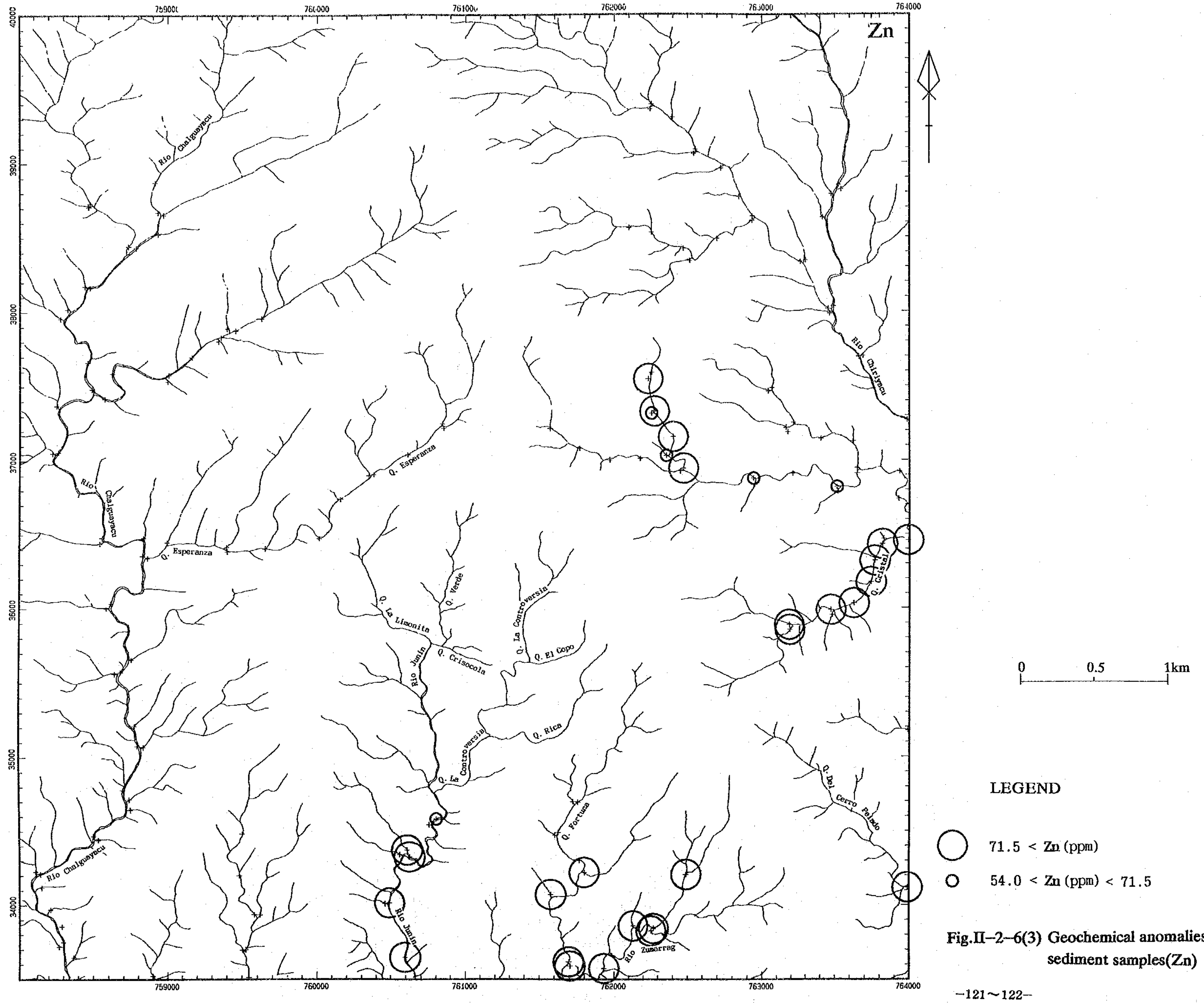


Fig.II-2-6(3) Geochemical anomalies of stream sediment samples(Zn)

Chapter 3 Cuellaje Area

Regional geological survey was carried out in an area of 34 km^2 for Phase I survey.

3–1 Geological survey

3–1–1 Purpose and method of survey

The purpose of survey is to clarify the outline of geology and geological structure and to summarize the characteristics of known possible occurrence of ore deposit.

Before the survey, the base of route map on a scale of one to ten thousand was made by enlargement of the existing topographical map on a scale of one to fifty thousand along the route decided by the consideration of the existing data.

The results of survey are summarized in the geological plan map (Pl.II–3–1) and geological section (Pl.II–3–2) drawn on a scale of one to ten thousand. The reduced geological map is shown in Fig.II–3–1, the generalized columnar section in Fig.II–2–2, and the sampling position in Fig.II–3–2.

3–1–2. Geology and geological structure

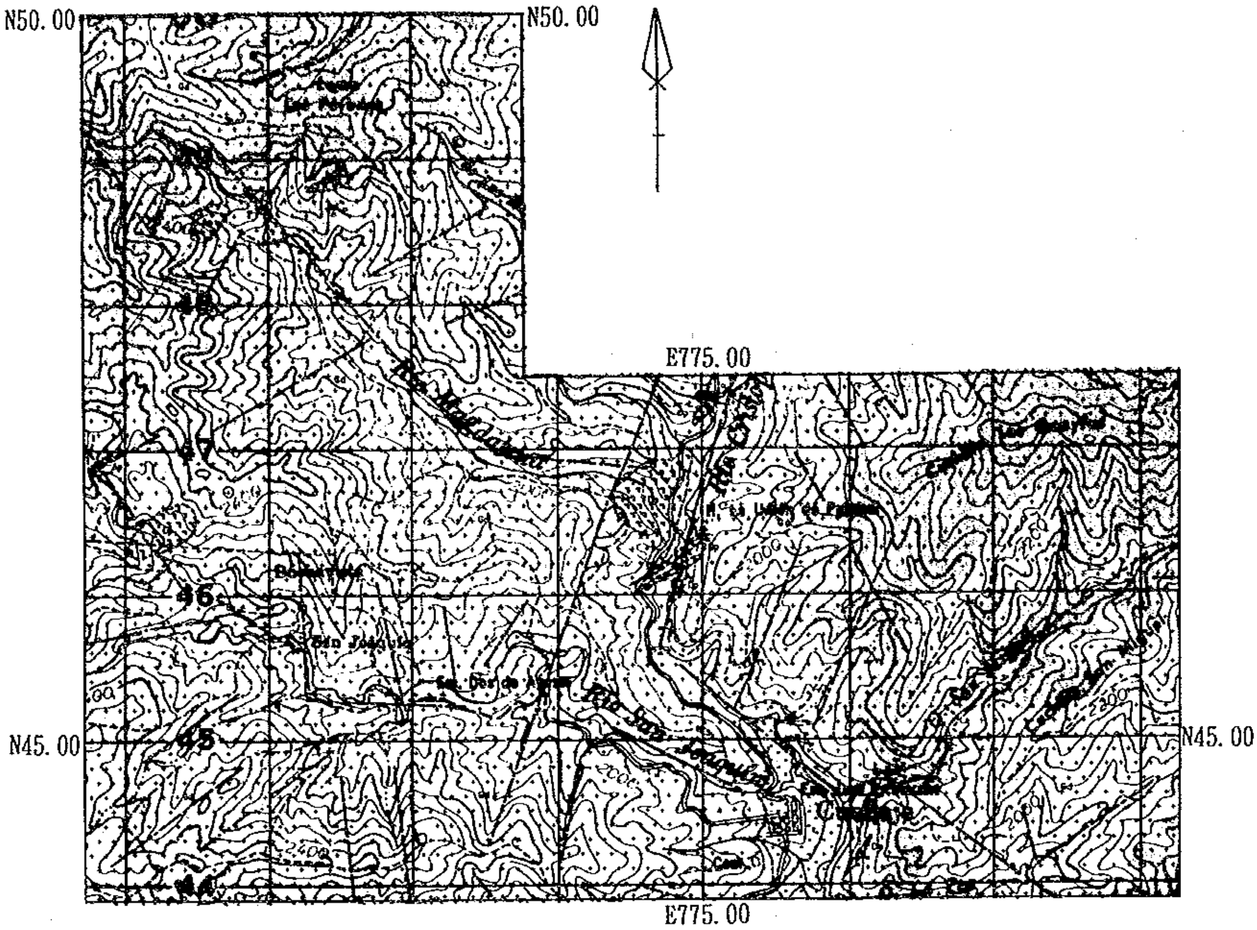
The geology of this area consists of granodiorite mainly which forms batholith as the same one distributed in Junin area, stock to dyke of andesitic–porphyry(Ap) and diabase–porphyry(Dp) which intrude into granodiorite, and dyke of quartz–porphyry(Qp).

(1) Granodiorite(Gd)

The Granodiorite shows greyish color and is medium grained, and includes biotite› hornblende as colored minerals. The rock is generally the same as that of Junin area, though spme rock body is observed to contain few hornblende partly.

The microscopic observation of typical rock is the following (Appendix 1);

Granodiorite(C1033)
Location: Rio Cristopamba
Texture :subhedral granuar
Main and accessory minerals : plagioclase› quartz› K–feldspar› biotite› hornblende› apatite, allamite, Zircon, sphane, opaque minerals
Altered minerals: chlorite, epidote

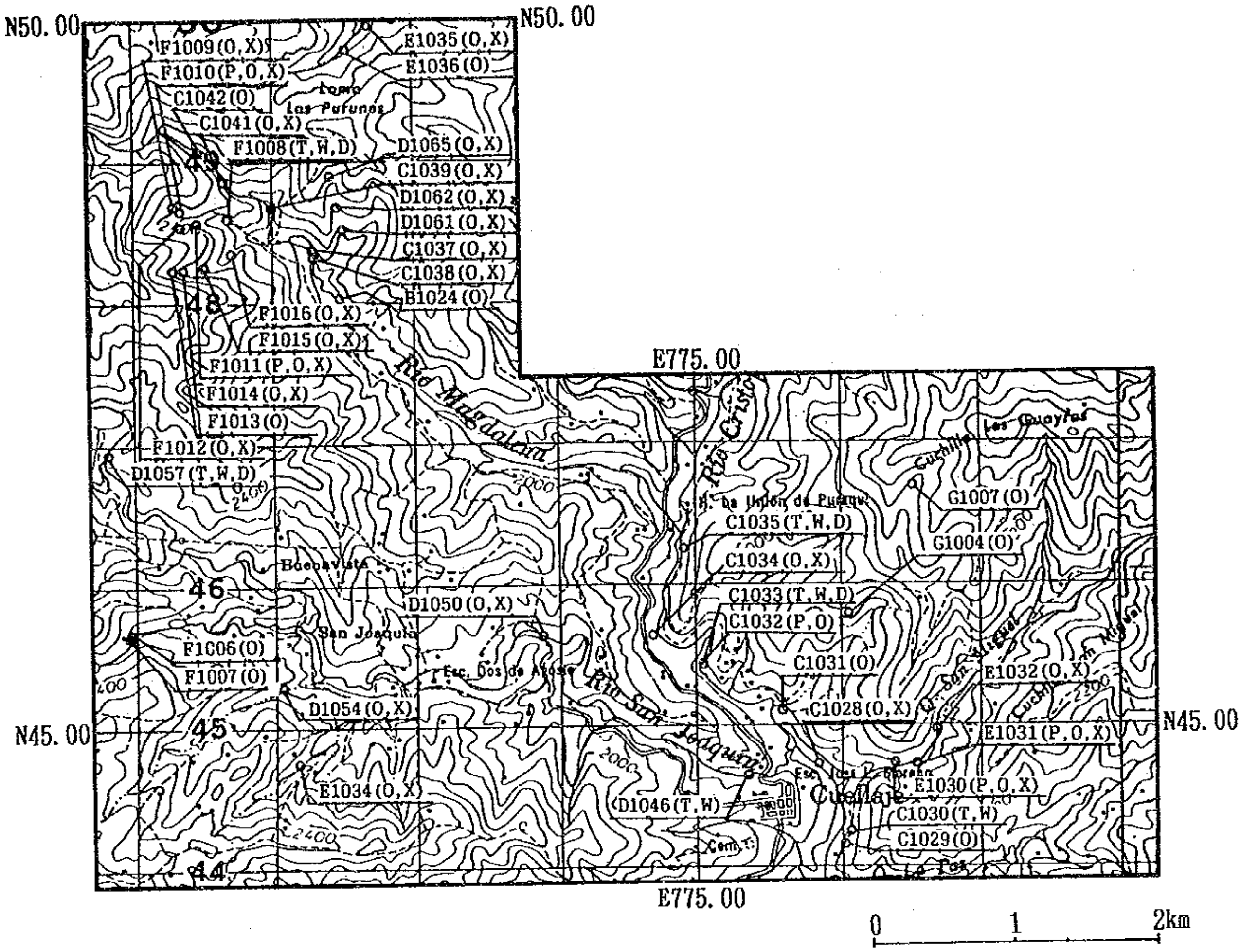


LEGEND

Terrace Deposit	t	Gravel, sand and mud.
Intrusive Rocks		
	Gd	Granodiorite
	Dp	Diorite porphyry
	Ap	Andesite porphyry
	Qp	Quartz porphyry
Structure		
		Lineament
		Geologic contact

0 1 2km

Fig.II–3–1 Geologic map of the Cuellaje area



• Sample point

T : Thin section
X : X–ray diffraction analysis
D : K–Ar dationg
W : Whole rock analysis
P : Polished section
O : Ore analysis

Fig.II–3–2 Location of samples for laboratory tests

Biotites are slightly altered to chlorite.

(2) Andesite–porphyry(Ap)

Andesite–porphyry distributes along the branch of Rio Magdalena in the north–western area and in the upper reaches of Rio Joaquin in the western area. In the former area, the elliptical distribution of approximately 160 x 90m is shown in the center of the Rio Magdalena mineralized zone. The rock shows feltic and includes plagioclase phenocrysts. In the latter area, the rock forms dyke, and includes plagioclase phenocrysts of several millimeters in greenish glassy groundmass.

The microscopic observation of typical rock is as follows (Appendix 1);

Quartz–porphyry(F1008)
Location: the branch of Rio Magdalena
Texture : porphyritic
Phenocryst: plagioclase› quartz› hornblende› biotite› opaque minerals
Groundmass: glass› plagioclase› quartz
Altered minerals: quartz› sericite› chlorite

The biotites are altered slightly to chlorite. Plagioclases of phenocryst and ground mass are replaced by sericite and chlorite.

(3) Diabase–porphry(Dp)

Diabase–porphry distributes comparatively wide in the central area of 400 x 250 m along Rio Cristopamba, and also distributes as small dykes with the ENE–NNE direction along the branch of the north–west, Q.San Joaquin in the western area and the south–eastern part of Cuellaje village. The rock along Q.Cristopamba is markedly affected by weathering. As the rock which occurs like dyke is similar to andesitic–porphyry, it's groundmass is much holocrystalline and granular. Some part gradually changes to granodiorite in the northern part outside the survey area.

The microscopic observation of typical rock is as follows (Appendix 1);

Diabase–porphry(C1030)
Location: the south–east of Coellaje village
Texture : porphyritic
Phenocryst: plagioclase› hornblende
Groundmass: plagioclase› quartz› hornblende› opaque minerals

Altered minerals: quartze

(4) Quartz–porphyry(Qp)

Quartz–porphyry occurs as the dyke with the direction of NE–SW and the scale of 300 m x 20 m in the central part of the area where the juncture of Q. Cristopamba and Q.Magdalena.
The rock is white color and dense, and includes quartz phenocrysts of 1 to 2mm in diameter in glassy groundmass.

The microscopic observation of typical rock is as follows (Appendix 1);

Quartz–porphry(C1035)
Location: Rio Cristopamba
Texture : porphyritic
Phenocryst: quartz› hornblende
Groundmass: quartz› plagioclase› biotite› opaque minerals

The result of the chemical analysis of bulk rock of these four kinds of rocks are illustrated in chemical variation diagrams such as (FeO" /MgO)–SiO_2 Diagram, (FeO" /MgO)–FeO" Diagram, Normative Quartz–Orthoclase–Plagioclase Triangle Diagram, ACF Diagram and SiO_2–(Fe^{3+}/Fe^{2+}) Diagram, as shown on Tab.II–1–1 and in Fig.II–1–2. As the result, these rocks are classified in calc–alkaline rock series, in granodiorite chemical composition, I–Type and magnetite series respectively.

Isotope age determination with K–Ar method was carried out for granodiorite (C1033), andesitic–porphyry(D1057,F1008) and quartz–porphyry(C1035): (the dating of the mineral for C1033 and the dating of the rock for the others). The results are 13.0+ 0.6Ma for granodiorite, 8.8+ 0.4Ma for quartz–porphyry (Tab.II–1–2).

These ages shows upper Miocene of Tertiary Period.

(5) Geological structure

The lineaments with the directions of NNE–SSW and NW–SE are conspicuous, and lineaments with N–S and E–W are also developed. The E–W lineament is supposed to acommpany ore veins as described later.

3–1–3 Mineralization and alteration

In Cuellaje area, in addition to the vein deposit(Type II in Junin area) along Q.Cristopamba near Cuellaje village known as a potential area of ore deposit, two mineralized zones, which were composed of dissemination deposit (Type I in Junin area) were confirmed by this survey: one in the upper reaches of Rio Magdalena in the northwestern area and the other along Q.San Miguel in the southeastern area as shown in Fig.II–3–3.

(1) Type I Mineralization and alteration

The mineralized and alteration zone is observed in the upper reaches of Rio Magdalena in the northwestern area (the Magdalena minaralized zone) and around Q.San Miguel in the southeastern area (the Q.San Miguel mineralized zone).

Dissemination to film deposit of chalcopyrite and pyrite with small amount of bornite and chalcocite are observed in four places along the river within the section of 100 to 200 m around the center of andesitic–porphyry stock in the Rio Magdalena mineralized zone. Molybdenite stockwork is observed in the central part of the stock.

By X–ray diffraction method, the zonal structure which consists of the mineral composition of K–feldspar in the center, sericite–chlorite around the center and chlorite–calcite in the outer rim, is identified.

By the chemical analysis of ore samples, the grade of the Rio Magdalena minera–lized zone is as follows : Cu 1.66%, Mo 0.11% and Ag 5.2g/t. The scale of the zone and Ag content is comparable to those of the Central Zone of Junin. Chalcopyrite and pyrite dissemination and film with a small amount of chrysocolla are observed with–in the 30 m section in the lower reaches of Q.San Miguel in the Q.San Miguel minera–lized zone. The alteration of country rock is weak chloritization and silicificat–ion. Furthermore weak mineralization of pyrite, chalcopyrite and cuprite is recogn–ized 2km north of this area. Where the alteration of country rock is silicification. No sericite was identified by X–ray diffraction method.

(2) Type II Mineralization and alteration

Mineralized zone of Type II is recognized at nine places(Rio Cristopamba miner–alized zone) within the section of 9km along Rio Cristopamba near Cuellaje village, mineralized zones of Type I are also observed around the Rio Magdalena mineralized zone and Q.San Miguel mineralized zone. The occurrences of these mineralized zones are generally composed of veinlet to film of chrysocolla–limonite, partly of chalco–

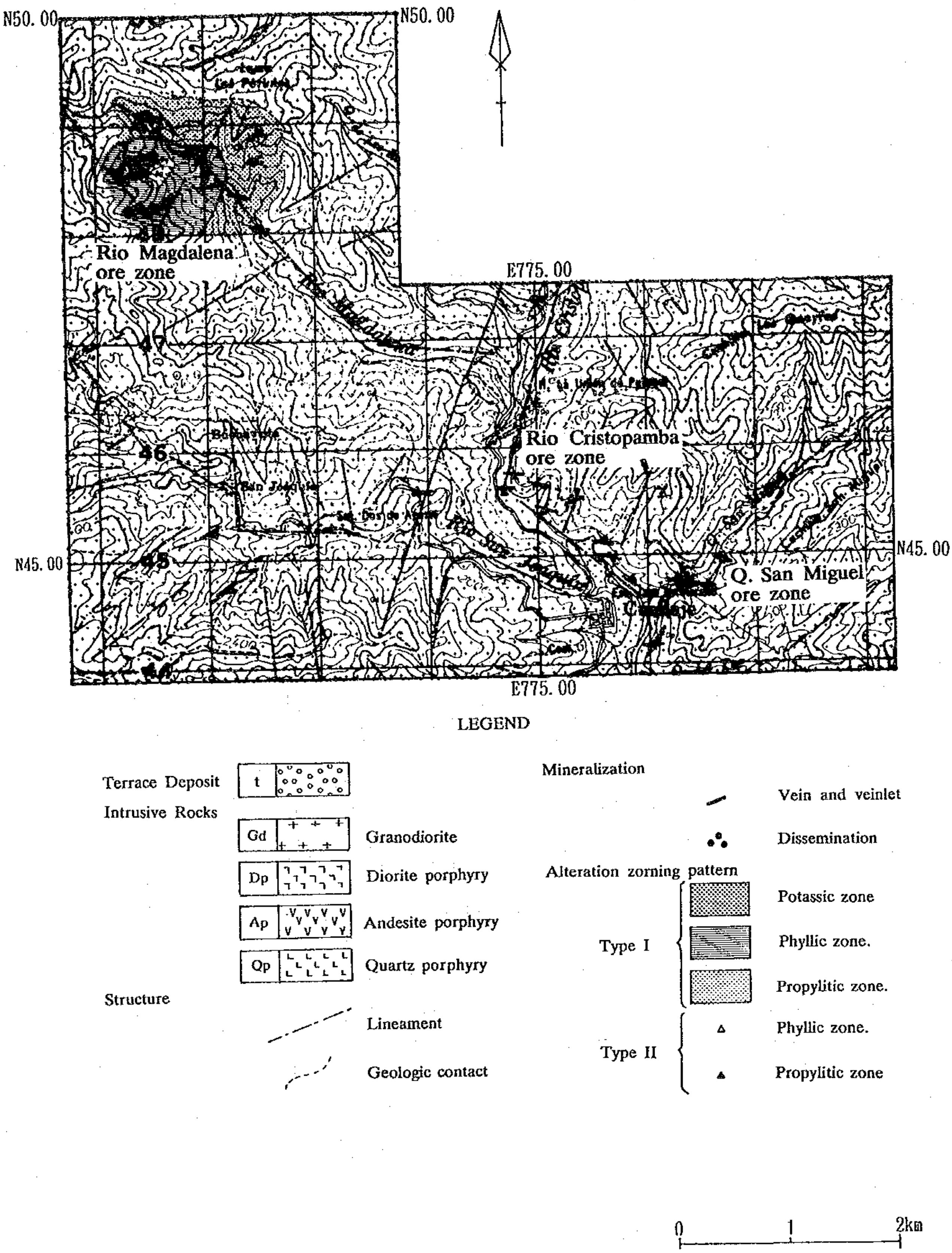


Fig.II–3–3 Mineralized and alteration zone map of the Cuellaje area

pyrite–bornite–chalcocite–quartz vein. Their direction is approxi– mately E–W.

Addition to these, there are veinlet to film of chrysocolla–limonite along Q.San Joaquin.

The mineral assemblages identified by X–ray diffraction method are sericite–chlorite inner part and chlorite–calcite outer part as the alteration of the country rocks in the vicinity of veins.

The grades of ore samples of the RioCristopamba and the Q. San Miguel minerali–zed zones were as follows : 0.1g/t Au, Ag 36.5g/t Ag 1.43% Cu and 0.02% Zn for the Rio Cristopamba mineralized zone (C1029), 6.3g/t Ag, 6.97% Cu and 0.13% Mo for rio Cristopamba mineralized zone (C1032) and 0.4g/t Au, 36.5g/t Ag, 7.98% Cu, 0.01% Zn and 0.03% Mo for the Q.San Miguel mineralized zone (E1031).

The difference between this area and Junin area is as follows; In this area, andesitic–porphyry distributes in the center of Typr I and quartz–porphyry distri–butes around Type II, on the other hand, quartz–porphyry distributes in association with Type I and diabase–porphyry distributes around Type II.

3–2 Consideration

Stockwork deposits distribute in the center, dissemination deposits around them and vein deposits in the outer rim in the Rio Magdalena mineralized zone. The miner al assemblage of altered minerals is differentiated as the change of the mineralizat ion types: K–feldspar zone, sericite–chlorite zone and chlorite–calcite zone in outw ard order. These zonal assemblages coinside with potassic alteration zone, phyllic a lteration zone and propylitic alteration zone of general porphyry–copper deposit. The zoning of mineralization is also coinside markedly with that of general prophyry–copper deposit.

The scale of the mineralization and Cu content in this area are resemble to those of the Central Zone of Junin area.

From the viewpoint of zonal structure of porphyry–copper deposit,the Q.San Miguel mineralized zone is presumed to exist in inner part, and the Rio Cristopamba mineralized zone in outer part laterally. The center of the mineralization is, furthermore, expected to be in deeper part vertically.