(4) Classification of Anomalous Values

According to the results of the statistical treatment as above, samples are classed into 3 ranks for each indicator element; the high-background rank is defined by the values equal to or larger than M + σ and less than M + 2σ, the B-class anomaly by the values equal to or larger than M + 2σ and less than M + 3σ, and the A-class anomaly by the value equal to or larger than M + 3σ. Geochemical anomaly maps (PL.13, (1) - (6)) were prepared separately for each indicator element.

The threshold values defining the ranks for each indicator element are listed in Table 3-5, together with the number of samples for each rank.

Table 3-5 Classification of Anomalous Values in the Marcabamba Area

Element (unit)	High-background value	B-grade anomalous value	A-grade anomalous value	Threshold value
	M + σ ≤ <M + 2σ	M+2σ ≤ <M+3σ	M+3σ≤	
Au (ppb)	18.2≤ <73.0 47 samples	73.0≤ <292.1 17 samples	292.1≤ 11 sample	73.0
Ag (ppm)	0.42≤ <1.15 27 samples	1.15≤ <3.18 13 samples	3.18≤ 16 samples	1.15
As (ppm)	23.8≤ <72.9 54 samples	72.9≤ <223.4 8 samples	223.4≤ 8 samples	72.9
Cu (ppm)	45.1≤ <72.5 55 samples	72.5≤ <116.7 12 samples	116.7≤ 6 samples	72.5
Pb (ppm)	33.5≤ <83.9 31 samples	83.9≤ <210.4 5 samples	210.4≤ 10 samples	83.9
Zn (ppm)	109.6≤ 174.6 43 samples	174.6≤ <278.4 10 samples	278.4≤ 5 samples	174.6

3-2-2 Principal Component Analysis

(1) Standard Statistical Values

Values of the indicator elements are standardized for the principal component analysis based on the standard statistical values in the univariate analysis.

The results of the principal component analysis are shown in Table 3-6.

A variance of the standardized values of the 6 indicator elements is expressed in a transformed orthogonal co-ordinate system having 6 principal component axes, the first through the sixth. The eigen values and the cumulative contribution ratios as in Table 3-6 indicate that the variances of the first through the third principal components account for 83% of the total variance in the characteristic

Table 3-6 Results of Principal Components Analysis in the Marcabamba Area

Principal component	Eigen value	Principal contribu-tion ratio	Cumulative contribu-tion ratio		Au	Ag	As	Cu	Pb	Zn
1st	3.522	0.587	0.59	Eigenvector	0.421	0.436	0.414	0.378	0.425	0.371
				Factor loading	0.791	0.819	0.777	0.710	0.797	0.695
				Contribution ratio of characteristic value	0.625	0.670	0.604	0.505	0.635	0.484
2nd	0.931	0.155	0.74	Eigenvector	-0.274	-0.344	-0.278	0.579	-0.151	0.609
				Factor loading	-0.265	-0.332	-0.268	0.559	-0.146	0.588
				Contribution ratio of characteristic value	0.070	0.110	0.072	0.312	0.021	0.346
3rd	0.508	0.085	0.83	Eigenvector	0.660	0.211	-0.342	0.054	-0.630	0.051
				Factor loading	0.470	0.150	-0.244	0.039	-0.449	0.037
				Contribution ratio of characteristic value	0.221	0.023	0.060	0.002	0.202	0.001
4th	0.443	0.074	0.90	Eigenvector	0.077	-0.381	0.708	0.313	-0.426	-0.261
				Factor loading	0.051	-0.254	0.471	0.208	-0.283	-0.174
				Contribution ratio of characteristic value	0.003	0.064	0.222	0.043	0.080	0.030
5th	0.331	0.055	0.96	Eigenvector	0.015	0.083	-0.339	0.636	0.230	-0.649
				Factor loading	0.009	0.048	-0.195	0.366	0.132	-0.373
				Contribution ratio of characteristic value	0.000	0.002	0.038	0.134	0.017	0.139
6th	0.246	0.044	1.00	Eigenvector	-0.553	0.704	0.134	0.127	-0.406	-0.012
				Factor loading	-0.284	0.362	0.069	0.065	-0.209	-0.006
				Contribution ratio of characteristic value	0.081	0.131	0.005	0.004	0.044	0.000

Table 3-7 Statistical Values of Scores in the Marcabamba Area

Principal component	Maximum	Minimum	Mean (M)	Standard diviation (σ)	− Anomaly ≤M − 2σ	Background	+ Anomaly M + 2σ≤
Z_1	13.81	-5.25	0	1.88	≤ − 3.75 5 samples	-3.75 < < 3.75	3.75≤ 20 samples
Z_2	3.88	-5.12	0	0.97	≤ − 1.93 21 samples	-1.93 < < 1.93	1.93≤ 10 samples
Z_3	3.69	-3.18	0	0.71	≤ − 1.43 9 samples	-1.43 < < 1.43	1.43≤ 27 samples

space. In particular, the contribution ratio of the first principal component is 59% and substantially high.

Cumulative contribution ratios of the characteristic values included in the first through the third principal component range between 70 and 90%. Therefore, the first through the third principal component has been examined in this interpretation.

Standard statistical values are calculated for scores of each sample for the first, the second and the third principal components, and are shown in Table 3-7.

With using these statistical values, samples are classed for the 3 principal components into 5 groups and the geochemical anomaly maps by the principal component analysis are prepared based on this classification (PLs.14, (1) - (3)).

(2) Interpretation of Principal Components

① The First Principal Component

Eigen vectors and factor loadings of the first principal component are positive and large for all of the 6 indicator elements, in particular for the 4 elements Au, Ag, As and Pb. The contribution ratios of the characteristic values are high in Ag. Pb, Au and As in descending order and relatively low in Cu and Zn. The combined contribution ratio of Au, Ag, As and Pb, being very substantial, accounts for 72% of the first principal component and for 42% of the total variance.

Taking the correlation coefficients between the indicator elements into account, it may be interpreted that the first principal component indicates concentration of the elements, Au, Ag, As and Pb in association with Cu and Zn to some extent.

With positive values both in eigen values and factor loadings, positive values in scores are indicatives of mineralization.

② The Second Principal Component

The eigen vectors and the factor loadings of the second principal component are positive and large for Cu and Zn, and negative for Au, Ag, As and Pb. The contribution ratios of Cu and Zn account for 71% of the second principal component and for 15% of the total variance. Positive values in scores indicate concentration only in Cu and Zn. Of the four elements, Au, Ag, As and Pb, Pb is the smallest in the contribution ratio of its characteristic value at 0.021. The combined contribution ratio of Au, Ag and As accounts for 27% of the second principal component and for 4% of the total variance. Negative scores may indicate concentration of Au, Ag and As without Cu and Zn association.

③ The Third Principal Component

The eigen values and factor loadings are positive for Au, Ag, Cu and Zn. Those for Au, in particular, are high and those for Cu and Zn are low. Those for Pb and As are negative and their absolute values are larger for Pb than for As. The contribution ratio of the characteristic value for Au is the largest at 0.221, and accounts for 44% of the third principal component and for 4% of the total variance.

Positive scores may indicate concentration in Au (and Ag) without Pb association and negative scores may indicate concentration in Pb (and As) without Au association.

Relationships between factor loadings of the first, the second and the third principal components for the indicator elements are plotted on correlation dispersion diagrams (Fig. 3-3).

The correlation between the factor loadings in the first (Z_1) and the second (Z_2) principal components apparently separates the indicator elements into the Au-Ag-As-Pb group and the Cu-Zn group. The 6 indicator elements have nearly equal positive factor loadings in the first principal component but are separated into the positive factor loading group (Cu and Zn) and the negative factor loading group (Au, Ag, As and Pb) in the second principal component.

The correlations between the factor loadings in the first (Z_1) and the third (Z_3) principal components and between those in the second (Z_2) and the third (Z_3) principal components indicate that the 6 indicator elements can be grouped into 3 combinations; the Au-Ag, the Cu-Zn and the Pb-Zn.

Accordingly, it may be possible to distinguish geochemical anomalies indicating concentration mainly of Au-Ag, mainly of Cu-Zn and mainly of Pb-As.

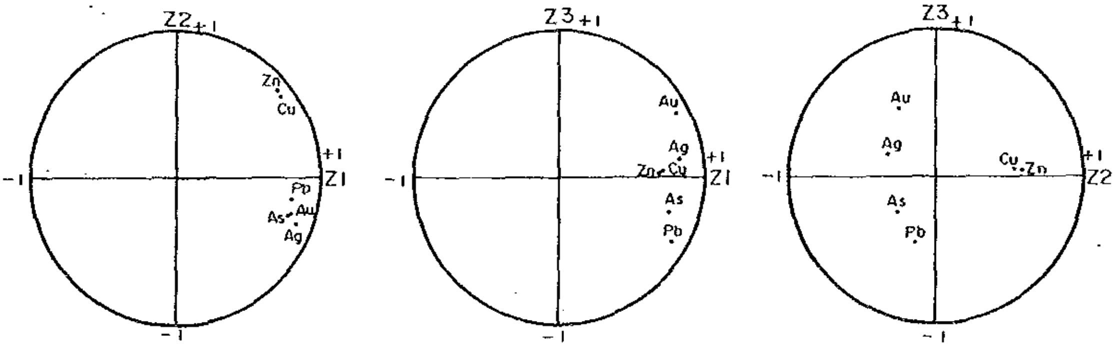
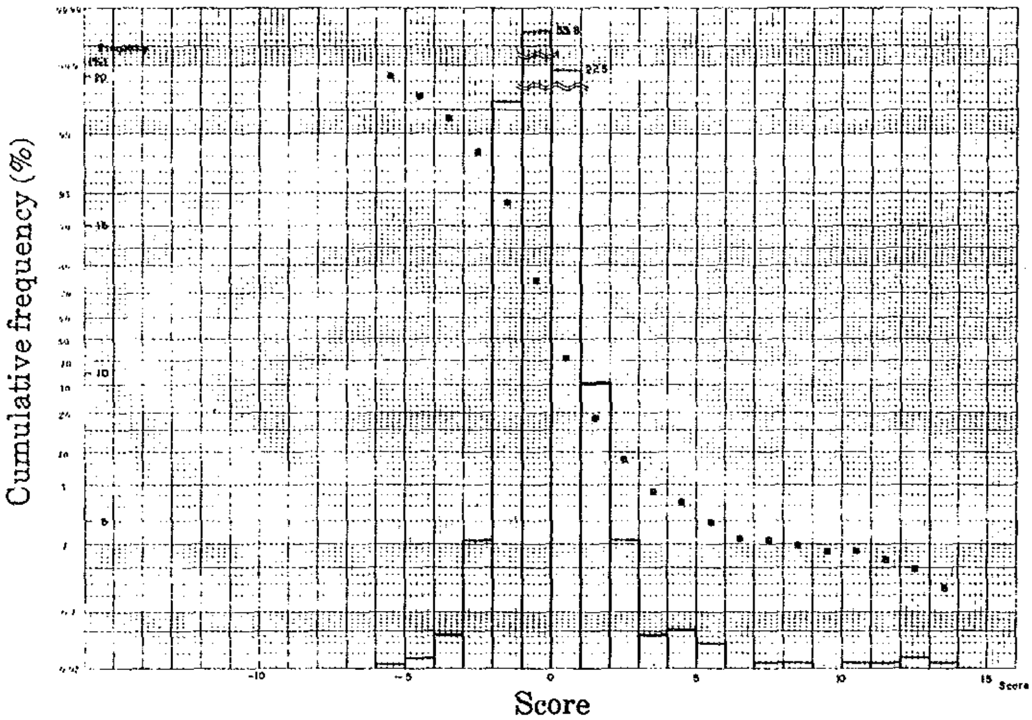
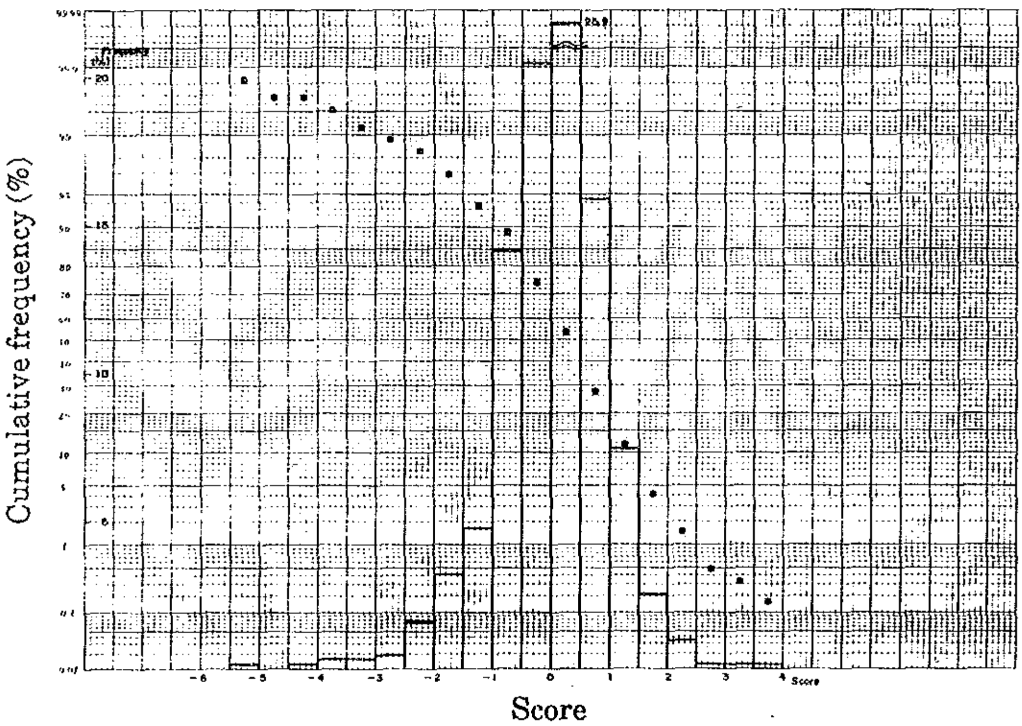


Fig. 3-3 Unrotated Factor Loadings for the Marcabamba Area

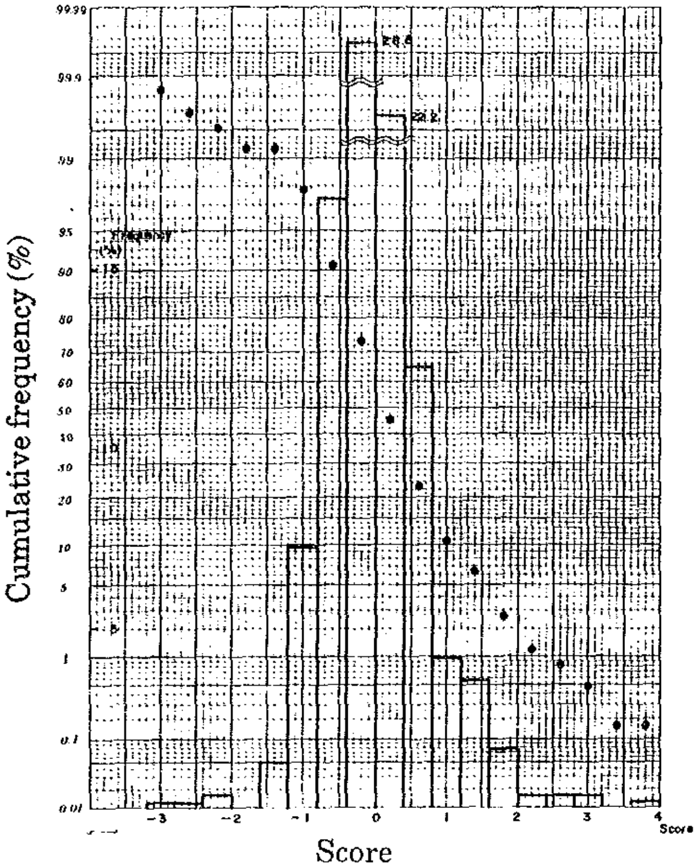


(1) First Principal Component



(2) Second Principal Component

Fig. 3-4 Histograms and Cumulative Frequency Diagrams of First, Second and Third Principal Components of the Marcabamba Area (1-3)



(3) Third Principal Component

Fig. 3-4 Continued

(3) Frequency, Cumulative Frequency and Threshold of Scores

Frequencies and cumulative frequencies of scores for the first, the second and the third principal components are illustrated in Figs. 3-4, (1) - (3).

The positive and negative inflection points in the cumulative frequency curves correspond nearly to the values M $\pm$ 2σ in the three principal components. The threshold values and the numbers of positively and negatively anomalous samples are shown in Table 3-8. The Geochemical Anomaly Maps (PL.14, (1) -(3)) by the principal components analysis are prepared by classifying samples according to these threshold values.

Table 3-8 Classification of Principal Component Scores in the Marcabamba Area

Principal component	-Anomaly $\leq M - 2\sigma$	Background $M - 2\sigma < \ < M + 2\sigma$	+Anomaly $M + 2\sigma \leq$	Threshold value
Z_1	≤-3.75 5 samples	-3.75< <3.75	3.75≤ 20 samples	±3.75
Z_2	≤-1.93 21 samples	-1.93< <1.93	1.93≤ 10 samples	±1.93
Z_3	≤-1.43 9 samples	-1.43< <1.43	1.43≤ 27 samples	±1.43

3-2-3 Geochemical Anomaly

Geochemical Anomaly in Univariate Analysis

Geochemical anomalous zones are defined on the basis of the following criteria with taking account of anomalous values in the indicator elements and correlation co-efficients between the elements above the 5% significance level.

"Anomaly zones" are defined by anomalous values in two or more correlating indicator elements at a single locality or at two or more adjacent localities. Anomalies in a single indicator element are called merely "Anomalies".

The "Anomalous zones" and the "Anomalies", selected on the basis of the above criteria, are shown on the Geochemical Interpretation Map (PL.15).

There are recognized 12 anomalous zones in the Marcabamba area, namely Colpar-A, -B, -C, Huanca Huanca-A, -B, -C, Vilcar, Machancha, Colta, Maracamalta, Tayaloma and Soncota. Their names, locations, distributions, and anomalous elements are summarized in Table 3-9.

Geochemical Anomaly in Principal Component Analysis

Geochemical anomalies in scores for each of the first, the second and the third principal components are combined together and shown in the Geochemical Interpretation Map of Principal Component Anomaly (PL.16).

Scores which are, positive in the first and the third principal components, and negative in the second principal component represent Au-Ag mineralization. Scores, positive both in the first and the second principal component represent Cu-Zn mineralizaton. Pb mineralization is associated with Au-Ag mineralization in the first principal component and is indicated by negative anomalies in the third principal component.

Those geochemical anomalies in the principal components which are associated with anomalies defined by the univariate analysis are added to Table 3-9.

Combined Geochemical Anomaly

The Geochemical Interpretation Map (Fig. 5-1, PL.34) is prepared by combining anomalies in the principal components and the anomalous zones defined by the univariate analysis. The principal component anomalies appear to coinside broadly with the anomalous zones of the univariate analysis.

The anomalous zones, which superimpose the positive anomaly in the first principal component having the largest contribution ratio of the three principal components, are Colpar-A, -B, -C, Huanca Huanca-A, -B, -C, Machancha, Marcamalta, Tayaloma and Soncota. Of these 9 anomalous zones, five anomalous zones, Colpar-A, -B, Machancha, Marcamalta and Soncota has higher potentials in Au-Ag mineralization, taking account of sizes of the anomalous zones and strength of anomalous values.

Table 3-9 List of Geochemical Anomaly Zones in the Marcabamba Area

Name of anomaly zone	Location	Scale (km)	Univariate analysis						Principal components analysis						Remarks (Mineralization)
			Au	Ag	As	Cu	Pb	Zn	+ anomaly			- anomaly			
									Z_1	Z_2	Z_3	Z_1	Z_2	Z_3	
Colpar A	Colpar, in the north of the Marcabamba area	0.6 x 0.7	AA	AA	AA	AA	AA	AA	++		(+)		(-)		Au - Ag, Pb - Cu, Zn mainly Au - Ag
B	Approx. 0.8 km SE of Colpar	0.4 x 0.9	A	A	A	A	A	A	+				(-)		
C	Approx. 1 km NE of Colpar	0.15 x 0.3	B	A							+				Au - Ag
Huanca Huanca A	Aprox. 1 km north of Huanca Huanca	0.15 x 0.25				B	A	B	+					(-)	Pb > Cu, Zn
B	Aprox. 0.8 km north of Huanca Huanca	0.15 x 0.2		B	B			B	+						Ag - Zn
C	Approx. 0.6 km NWN of Huanca Huanca	0.15 x 0.2		B		B	A	B	+						Pb > Cu, Zn
Vilcar	Approx. 1 km SE of Vilcar	0.2 x 0.2			B	B									Cu
Machancha	Approx. 0.5 km north of Co. Machancha	0.2 x 0.8	A	A	A				+				-		Au - Ag
Colta	Approx. 1 km WSW of Colta	0.2 x 0.4	BB								+				Au
Marcamalata	Marcamalata, in the SE of the Marcabamba area	0.5 x 1.1	A	AA	A	A	AA		++		(+)		--	--	Au - Ag, Pb - Cu
Tayaloma	Approx. 0.8 km E of Marcamalata	0.15 x 0.4		B			B	BB	+						Ag, Pb - Zn
Soncota	Co. Soncota	0.4 x 0.9	AA	A					+		+		(-)		Au - Ag

(Note)

Univariate Analysis

- AA: Three or more samples having a value of anomaly A ($\geq M + 3\sigma$)
- A: One or two samples having a value of anomaly A
- BB: Two or more sample having a value of anomaly B ($M + 3\sigma > \geq M + 2\sigma$)
- B: One sample having a value of anomaly B.

Principal Components Analysis

- ++: Three or more samples having a score of + anomaly ($\geq M + 2\sigma$)
- +: One or two samples having a score of + anomaly
- --: Three or more samples having a score of - anomaly ($\geq M - 2\sigma$)
- -: One or two samples having a score of - anomaly
- (): Partly

3-2-4 Geochemical Anomaly in Relation with Alteration and Mineralization

The Interpretation Map of the Marcabamba Area (Fig. 5-1, PL.34) is prepared by combining the anomalous zones and anomalies in soil geochemistry with the alteration-mineralization zones located by the geological survey. Of the 5 major geochemically anomalous zones, the Colpar-A, the Marcabamba and the Soncota zones superimpose the alteration-mineralization zones.

Characters of the presumable mineralization zones for the geochemically anomalous zones are compared with those of the existing alteration-mineralization zones as presented in Table 3-10. The anomalous zones do not present any conspicuous signs of mineralization on outcrops, while some of soil samples in these zones yielded 10 to 100 times higher values in the 6 indicator elements than mineralized rock samples. Presumable reasons for this are that there could be hidden mineralized zones with high concentration in the indicator elements, if not of large sizes, or that materials containing significant amount of these elements may have been transport along steep slopes and concentrated at foot-hills.

Colpar-A Anomalous Zones: Au-Ag-Pb mineralization may be expected in association with Cu-Zn mineralization.

High values detected in some soil samples range from 1.4 to 2.4 g/t Au, from 72 to over 100 g/t Ag, from 0.02 to 0.05% Cu, from 0.2 to 0.5% Pb and from 0.05 to 0.1% Zn, while mineralized rock samples indicated 0.3 to 0.4 g/t Au, 7 to 39 g/t Ag, upto 0.01% Cu, upto 0.2% Pb and upto 0.01% Zn. Since the soil sample with high Au-Ag values were collected at the bottoms of steep slopes, the expected source of the Au-Ag mineralization may be located somewhat at higher elevation on the slopes. Although, Pb values are slightly anomalous, Cu-Pb-Zn mineralization is regarded generally of secondary importance.

Coplar-B Anomalous Zone: As in the Coplar-A zone, Au-Ag-Pb mineralization may be expected in association with Cu-Zn mineralization. Though only in one soil sample, very high values are detected such as more than 10 g/t Au, 72 g/t Ag, 0.02% Cu, 0.6% Pb and 0.3% Zn. No mineralized outcrops are observed at the locality of this particular sample but it may be expected that Au-Ag mineralization be hidden by soil cover in the vicinity.

Machancha Anomalous Zone: Au-Ag mineralization may be expected according to the results of the soil geochemistry. Values in Au and Ag in soil samples range from 0.4 to 0.5 g/t and from 4 to 6 g/t respectively, which are lower than those in the soil samples of the Coplar-A and -B zones. Though no mineralized outcrops have been located in this anomalous zones, Au-Ag mineralization trending in the E-W direction may be expected.

Marcamalta Anomalous Zone: Au-Ag-Pb and Cu mineralization may be expected according to the results of the soil geochemistry. Values of the indicator elements in soil samples range from 0.1 to 3.3 g/t Au, from 7 to more than 100 g/t Ag, from less than 0.01% to 0.02% Cu and from 0.1 to 1% Pb, while a mineralized rock sample yielded values of less than 0.7 g/t Au, 86.5 g/t Ag, less than 0.01% Cu and 0.08% Pb. This anomalous zones appears to be relatively broad in its extent and mineralization hidden by soil cover may be presumed in part of the zone.

Soncota Anomalous Zone: Au-Ag mineralization may be expected according to the results of the soil geochemistry. Higher values in Au and Ag in soil samples range from 1.2 to 4.9 g/t and from 4 to 6 g/t respectively, while two mineralized rock samples yielded values as low as 0.7 g/t Au and 2 to 3 g/t Ag. Mineralization with higher grades in Au and Ag may be expected though its size would be insignificant judging from indistinctive occurrences of the mineralized outcrops.

Table 3-10 Comparison of Geochemical Anomaly Zones with Mineralization Zones in the Marcabamba Area

Geochemical anomaly zone		Results of geological survey	
Name	Mineralization, assumed by geochemical anomaly	Characteristic of mineralization	Characteristic of alteration
Colpar A	Au - Ag, Pb - Cu, Zn	Au - Ag in silicified zone with quartz veinlets (Au: 0.41 g/t, Ag 39.3 g/t)	Hydrothermal alteration (mainly silicification), Qz+Kf+(Ser) (contamination of iron oxides)
Colpar B	Au - Ag, Pb - Cu, Zn	Lack of outcrops	
Machancha	Au - Ag	Lack of outcrops	
Marcamalata	Au - Ag, Pb - Cu	Ag in silicified rock (Au: <0.07 g/t, Ag: 86.5 g/t)	Hydrothermal alteration (mainly silicification), Qz+(Jar) (contamination of iron oxides)
soncota	Au - Ag	Au - Ag in silicified zone with dissemination of pyrite (Au: 0.07 g/t, Ag: 2.8 g/t)	Hydrothermal alteration (argillization and silicification) Qz + Kf + (Gyp) + (Mn)

Abbreviations:
Qz: quartz, Kf: K-feldsper
Ser: sericite, Jar: Jarosite
Gyp: gypsum, Mn: montmorillonite

3-3 Exploration Results in the Pirca Area

The statistical data treatment has been made for a combined population of samples in the Pirca eastern area and the Pirca western area. However, maps and figures have been prepared separately for the two areas.

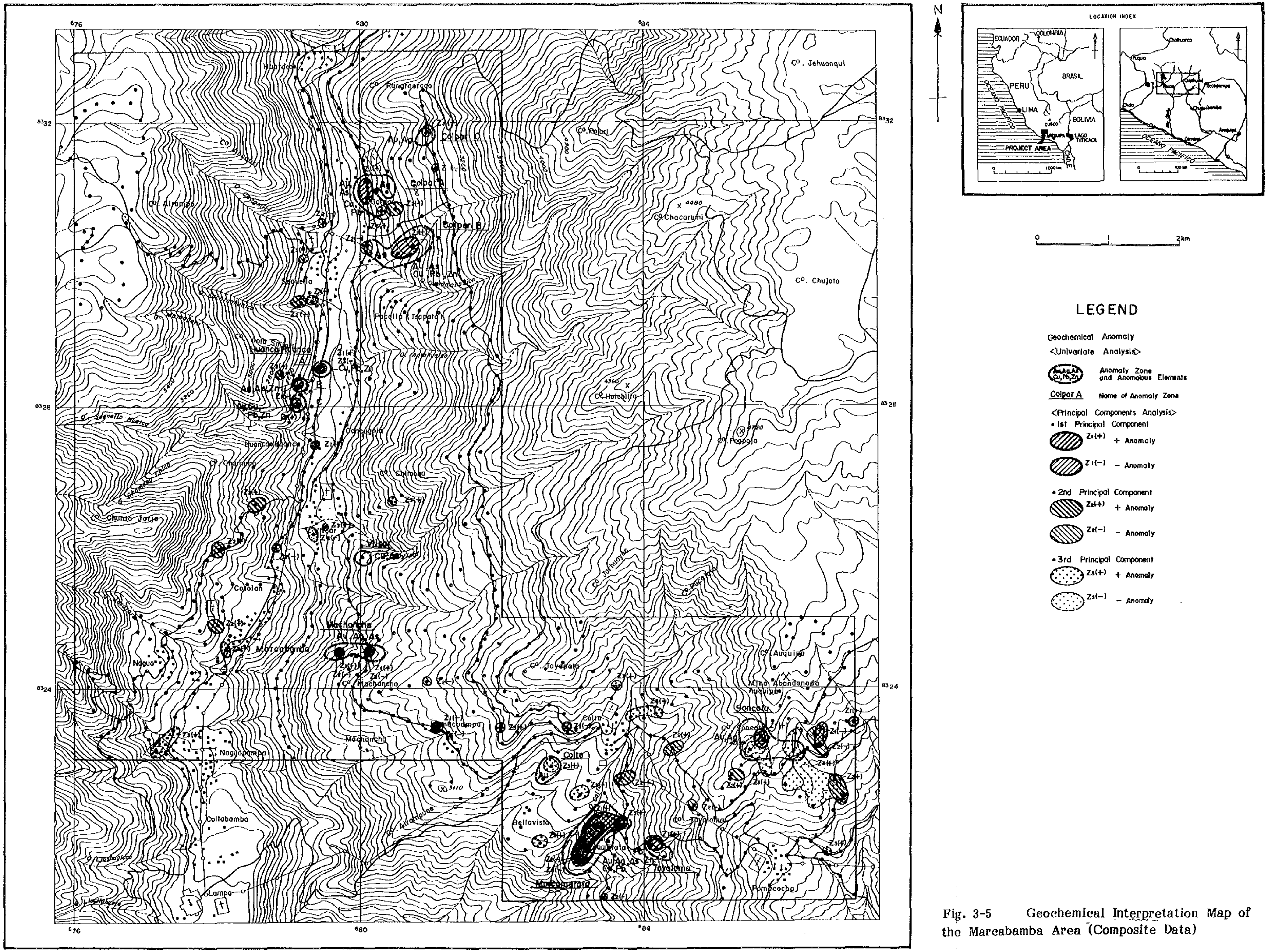


Fig. 3-5 Geochemical Interpretation Map of the Marcabamba Area (Composite Data)

3-3-1 Univariate Analysis

(1) Standard Statistical Values

Standard statistical values for the each indicator elements are shown in Table 3-11.

Table 3-11 Statistical Values of Indicator Elements in the Pirca 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-I sample	W-I sample
Au (ppb)	79	1	0.23	0.33	1.7	3.6	7.8	16.7	4	2	4
Ag (ppm)	0.5	0.1	-0.1	0.04	0.10	0.11	0.12	0.13	0.07	0.04	0.05
As (ppm)	780	1	0.75	0.44	5.6	15.3	41.7	113.9	1.8	0.8	2.4
Cu (ppm)	218	8	1.64	0.16	43.9	62.8	89.8	128.4	55	13	110
Pb (ppm)	137	1	0.72	0.30	5.3	10.6	21.1	42.1	13	49	8
Zn (ppm)	600	1	1.78	0.19	59.8	93.5	146.1	228.4	70	45	82

Means and maximum values are considerably lower than those in the Marcabamba area, particularly means of Au and Ag, and maximum values of all the 6 indicator elements.

(2) Correlations between the Indicator Elements

Correlation co-efficients between the indicator elements on a longalithmic scale are shown in Table 3-12 and correlation variance are illustrated in Fig. 3-6, (1) - (15).

The correlation co-efficients are generally low as seen in Table 3-12, and then the correlations between all combinations of the 6 elements are indistinctive.

Combinations of correlated 2 elements with positive correlation co-efficients exceeding the 5% significance level are, Au-Cu, Cu-Zn, As-Pb, Au-As, Au-Pb, Au-Ag, As-Cu, Cu-Pb, and Ag-Cu. The combinations of Au-Zn, As-Zn and Pb-Zn are negatively correlated with the correlation co-efficients exceeding the 5% significant level.

Au is weakly correlated in positive manner with the 4 indicator elements excluding Zn. Ag is also weakly correlated in positive manner with Cu beside Au. Zn is weakly correlated in positive manner with Cu but in negative manner with As, Au and Pb. Cu is weakly correlated in positive manner with the other 5 elements. With the general weak correlations between all combinations of the indicator elements, superimposition of anomalies in two or more elements may be unlikely, and it would be very difficult to characterize presumable mineralization and to distinguish geochemical anomalies in their natures.

Table 3-12 Correlation Coefficients between the 6 Elements in the Pirca Area

Element	Au	Ag	As	Cu	Pb	Zn
Au	1.0					
Ag	0.125	1.0				
As	0.154	0.034	1.0			
Cu	0.250	0.094	0.125	1.0		
Pb	0.145	0.023	0.166	0.121	1.0	
Zn	-0.066	-0.003	-0.281	0.174	-0.067	1.0

Note: The 5% significance level is 0.052.

(3) Frequency, Cumulative Frequency and Threshold

Frequencies and cumulative frequencies of the indicator elements Au, Ag, As, Cu, Pb, and Zn are plotted on log-probability diagrams as shown in Fig. 3-7, (1) - (6).

The following characteristics are observed in the sample population of each indicator element in these figures.

A: The number of samples with values less than 1 ppb is 843 and accounts for 59.9% of the total number 1408. The number of samples with values exceeding the mean (1.7 ppb) decreases with increasing values, and values exceeding 10 ppb disperse in a broad range. An inflection point of the cumulative frequency curve is obscured. The threshold value is determined at M + 2σ or 7.8 ppb. The number of samples with values exceeding the threshold value is 73.

Ag: The number of samples with values less than 0.1 ppm is 1395 and accounts for 99.1% of the total number 1408. With this considerable proportion of the number of samples with values less than the detection limit, the frequency distribution is very much biased. The number of samples with values exceeding the mean 0.10 ppm is 13 and accounts for only 0.9% of the total number of samples. The threshold value is calculated at 0.12 ppm for M +

2σ. As the detection limit is 0.1 ppm, practically samples with values equal to or more than 0.2 ppm are regarded anomalous.

As: The frequency distribution is typically of log-normal with slight dispersion in the higher value side.
The cumulative frequency curve starts deviating from a linear distribution at the value of 20 ppm towards the higher value side and is inflexed at 60 to 70 ppm towards the higher value side. One or more anomolous population may be included beyond the value of the inflection point. The threshold value is determined at $M + 2\sigma$ or 41.7 ppm. The number of samples with values exceeding the threshold value is 43.

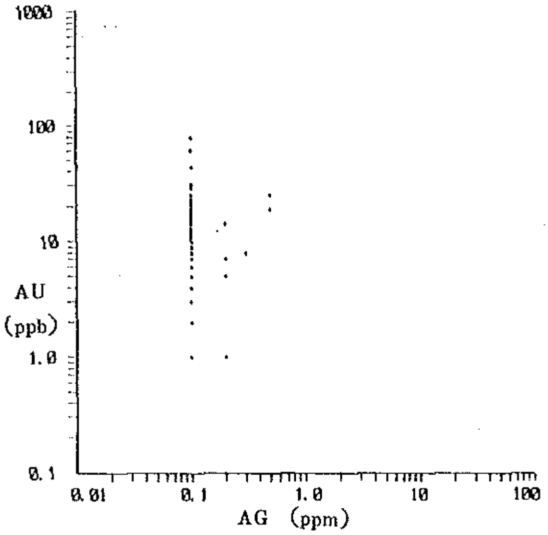
Cu: The frequency curve indicates a relatively typical log-normal distribution with a positive skewness. The cumulative frequency curve is inflexed at around 100 ppm toward the higher value side. The threshold value, is determined at $M + 2\sigma$ or 89.8 ppm which is reasonably closed to the value 100 ppm at the inflection point. The number of samples with values exceeding the threshold value is 34.

Pb: The frequency distribution is more or less of log-normal but indicate a negative skewness. The cumulative frequency curve is inflexed at a point between 20 and 25 ppm. The threshold value is determined at $M + 2\sigma$ or 21.1 ppm and nearly coincide with the value at the inflection point. The number of samples with value exceeding the threshold value is 16.

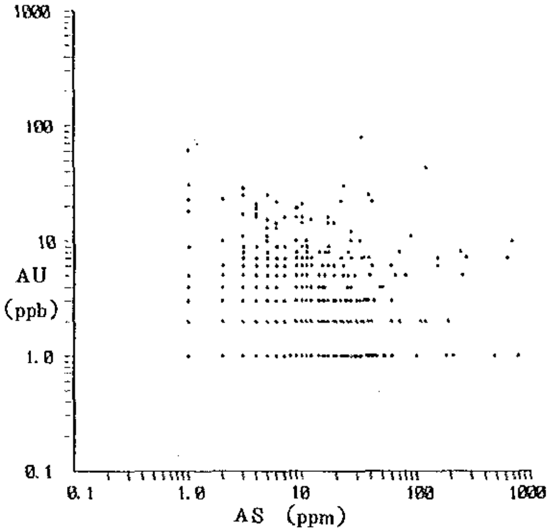
Zn: The frequency distribution is typically of log-normal with a slight dispersions towards both the higher and the lower value sides. The cumulative frequency curve is inflexed at around 150 ppm towards the higher value side. The threshold value is determined at $M + 2\sigma$ or 146.1 ppm and nearly coincides with the value at the inflection point. The number of sample with values exceeding the threshold value is 10.

(4) Classification of Anomalous Values

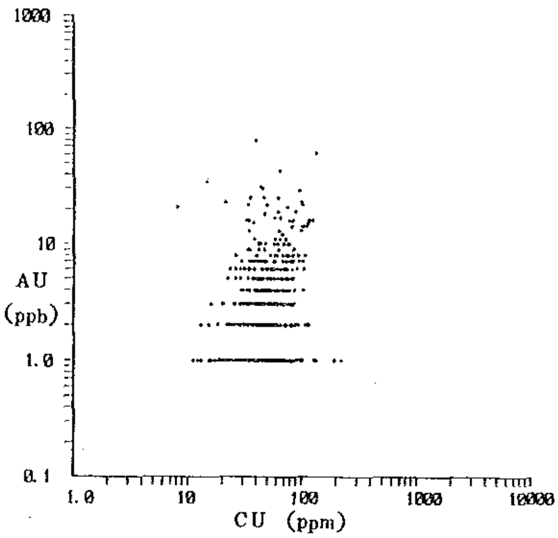
According to the results of the statistical treatment as above, samples are classed into 3 ranks for each indicator element; the high background is defined by the values equal to or larger than $M + \sigma$ and less than $M + 2\sigma$, the B-class anomaly by the values equal to or larger than $M + 2\sigma$ and less than $M + 3\sigma$, and the A-class anomaly by the values equal to or larger than $M + 3\sigma$. Geochemical maps were separately prepared for each indicator element for the Pirca Eastern (PL.18, (1) - (6) and the Pirca Western (PL.23, (1) - (6)) Areas. The threshold values and the numbers of samples for each rank are listed in Table 3-13.



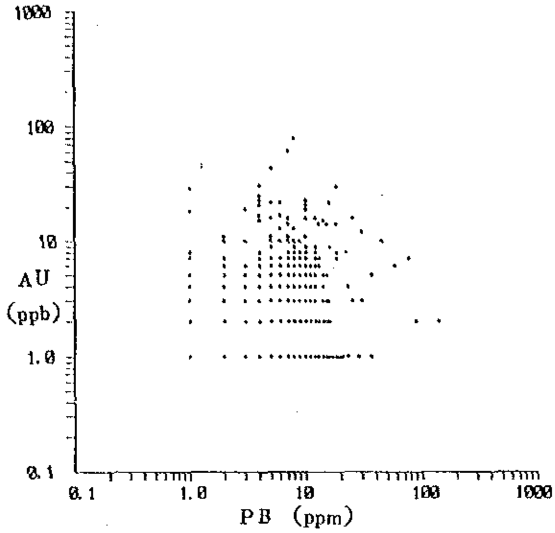
(1) Au-Ag



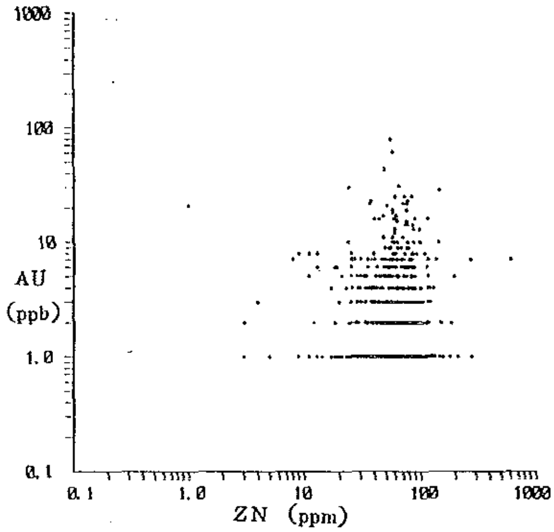
(2) Au-As



(3) Au-Cu

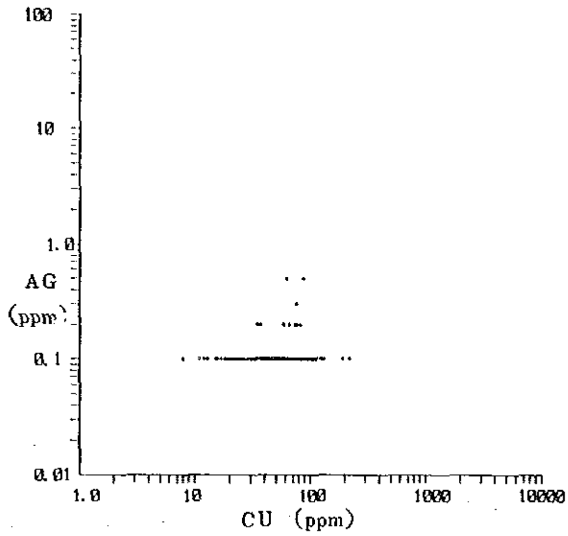


(4) Au-Pb

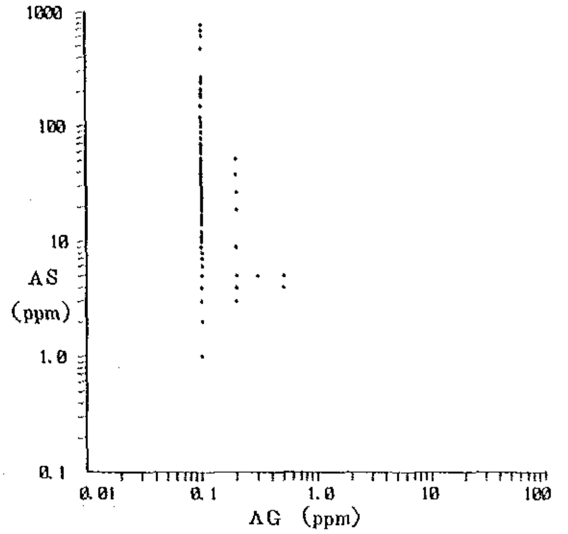


(5) Au-Zn

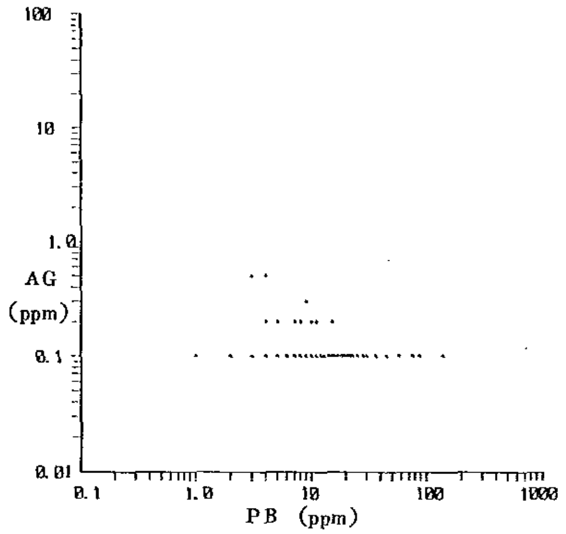
Fig. 3-6 Correlations Between Indicator Elements, Pirca Area (1-15)



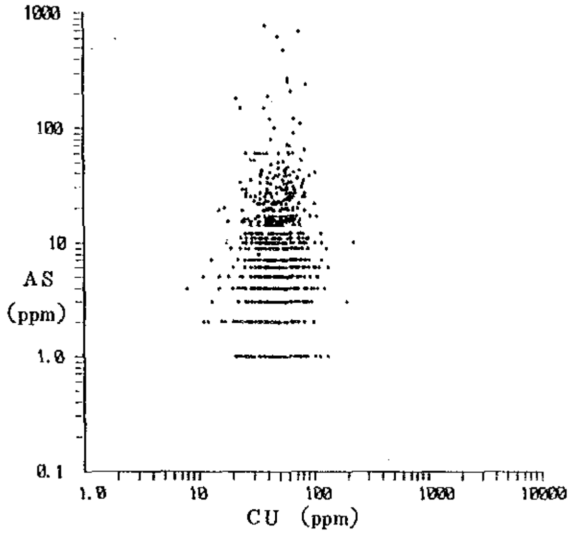
(6) Ag-Cu



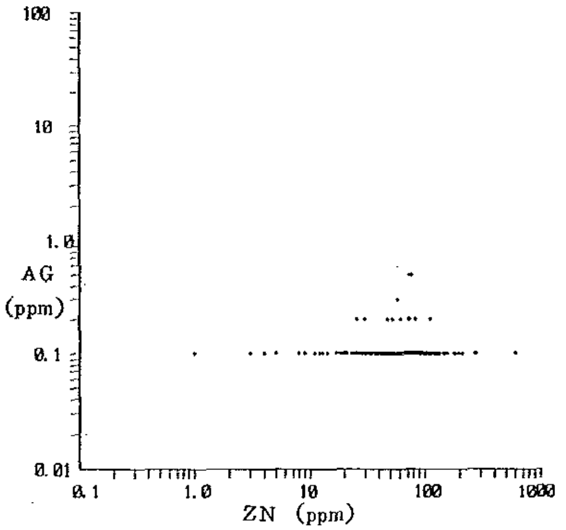
(9) As-Ag



(7) Ag-pb

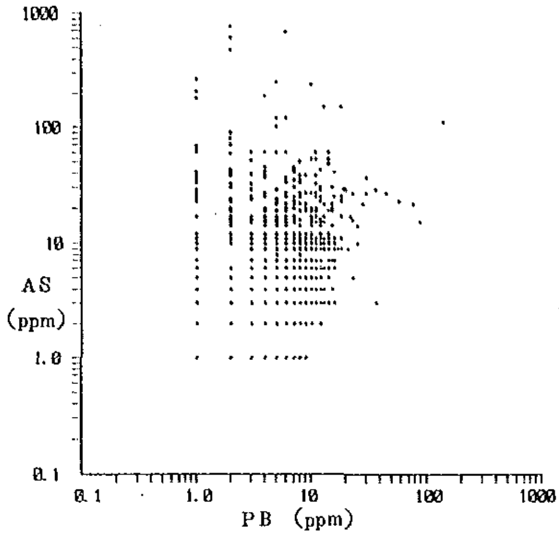


(10)As-Cu

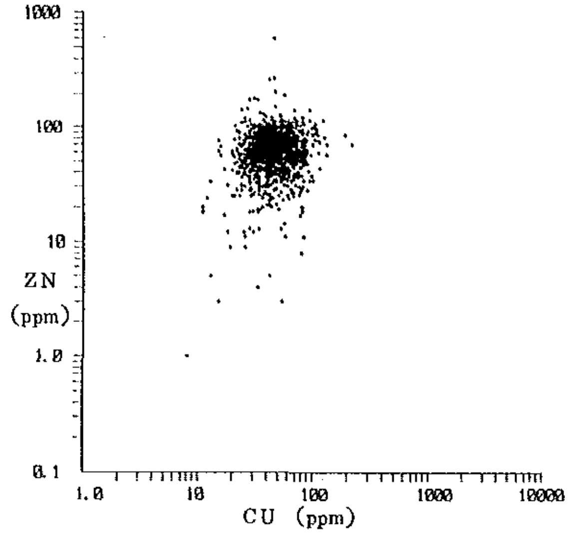


(8) Ag-Zn

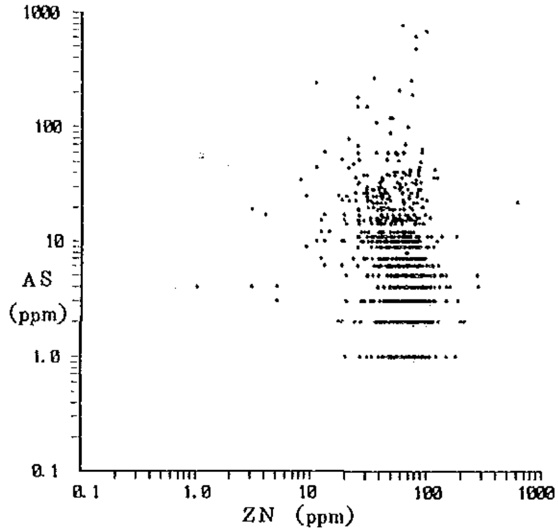
Fig. 3-6 Continued



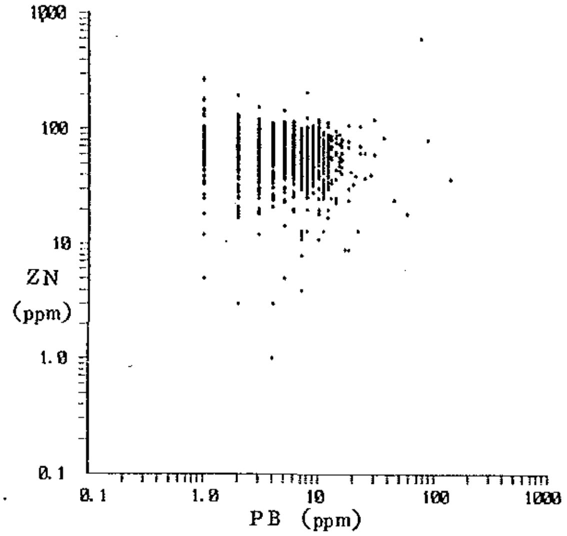
(11)As-Pb



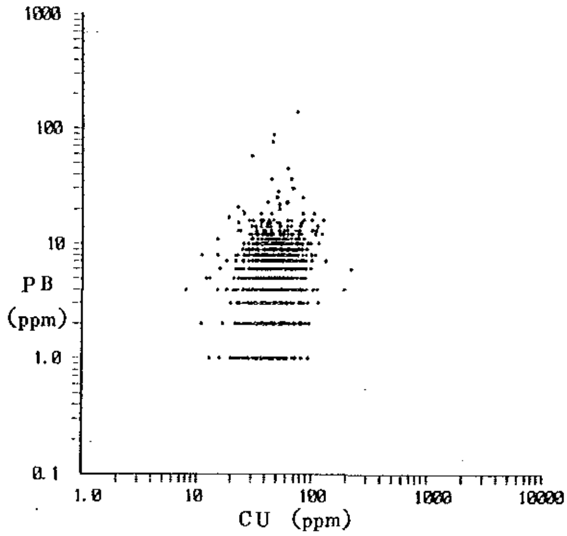
(14)Zn-Cu



(12)As-Zn

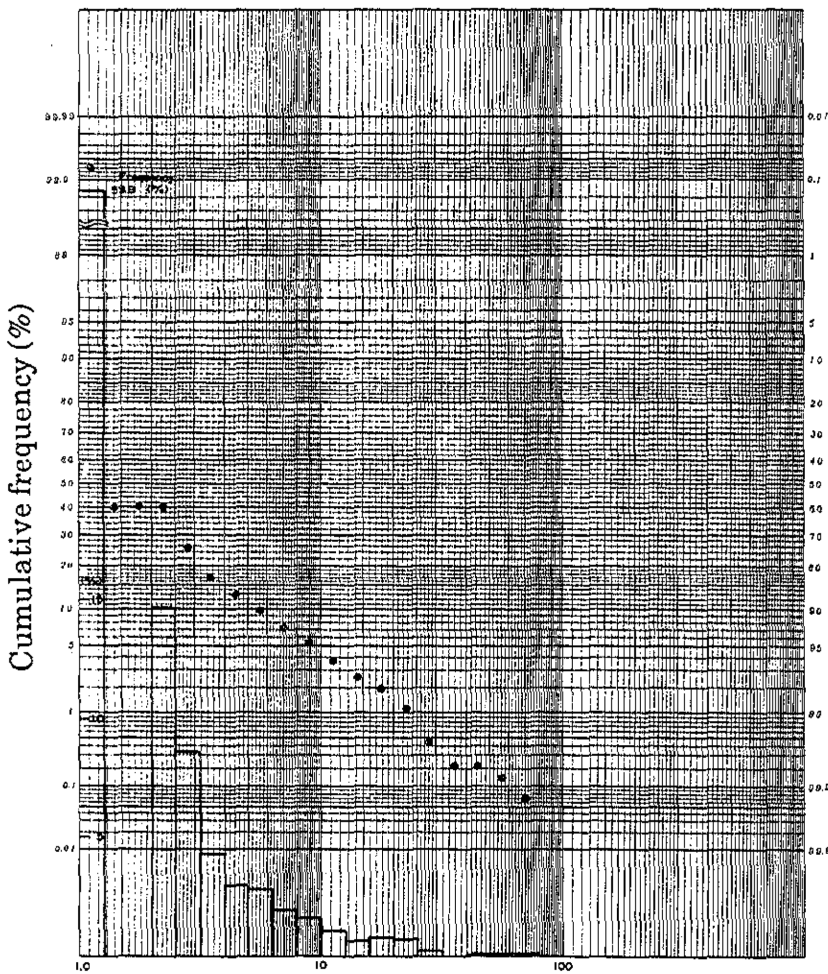


(15)Zn-Pb

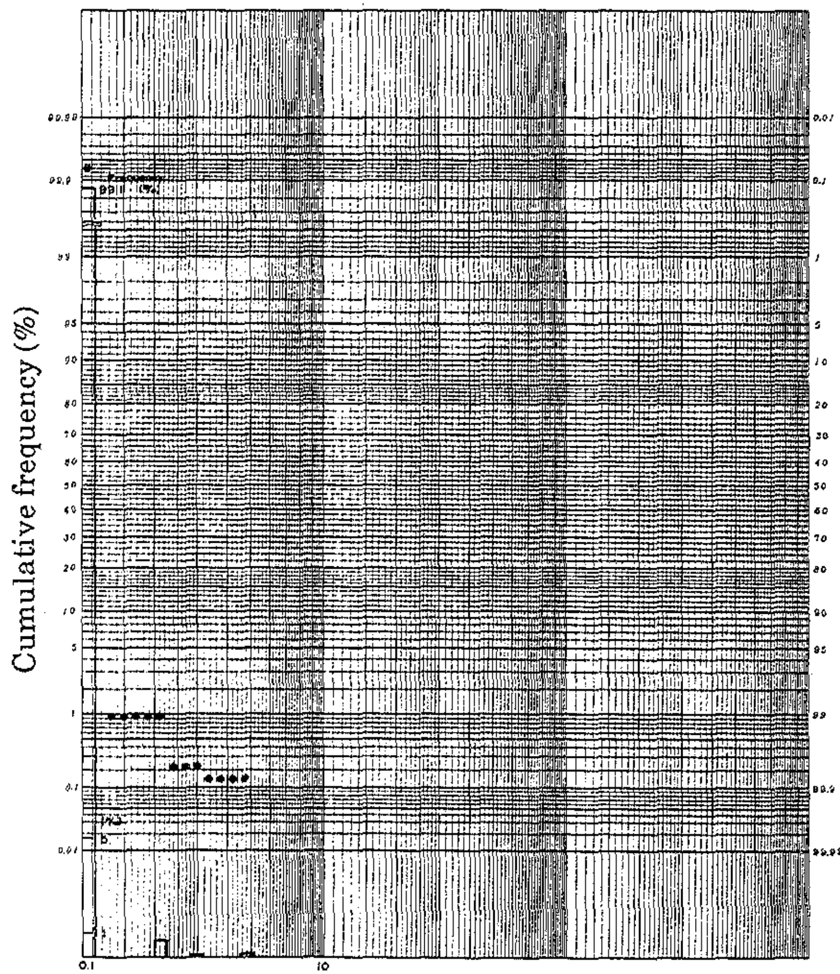


(13)Pb-Cu

Fig. 3-6 Continued

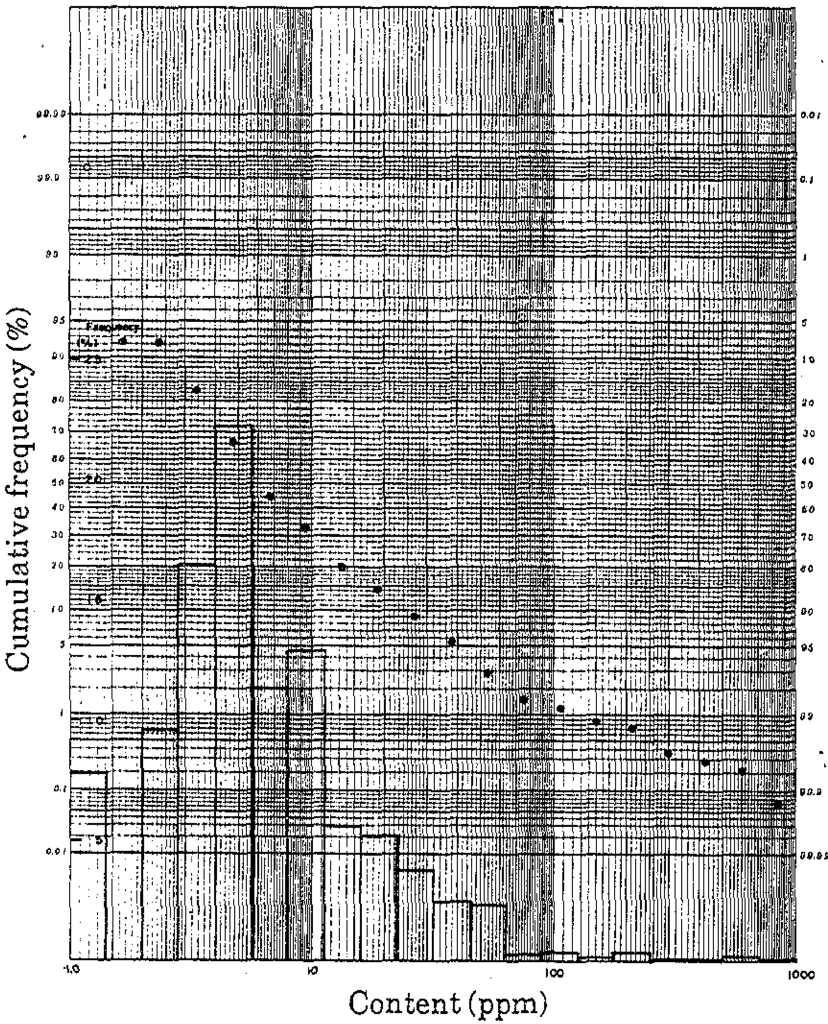


Content (ppb)
(1) Au

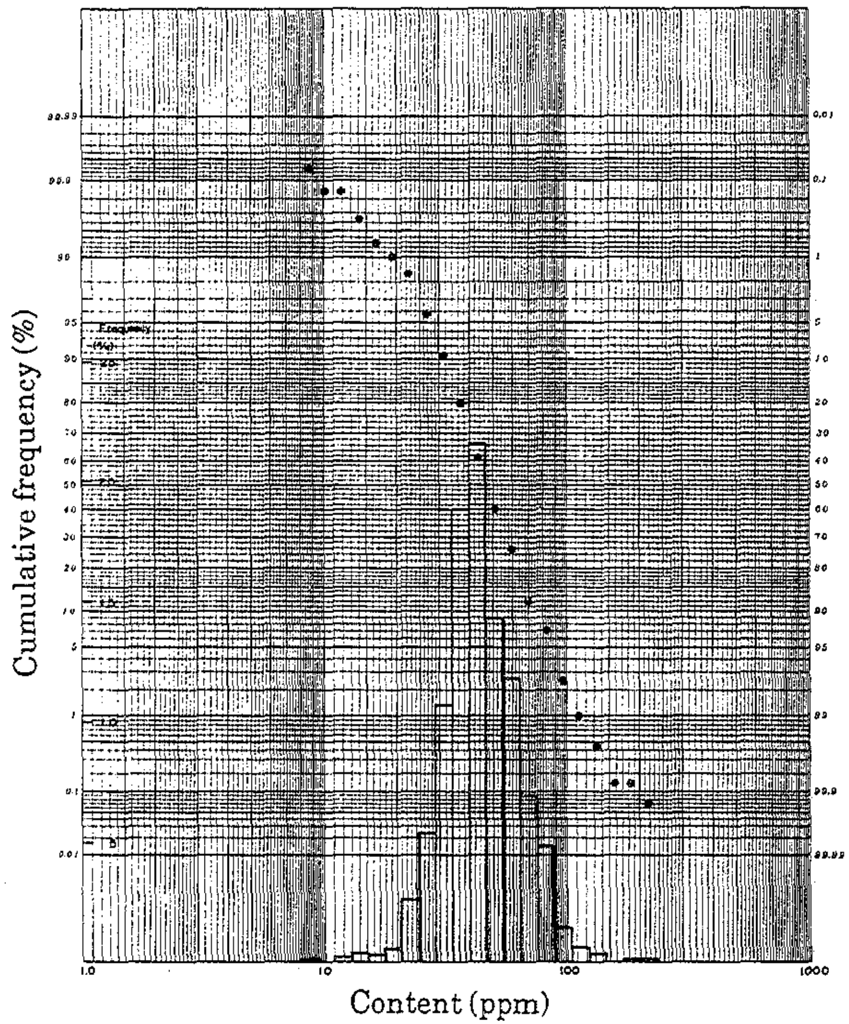


Content (ppm)
(2) Ag

Fig. 3-7 Histograms and Cumulative Frequency Diagrams (Au, Ag, As, Cu, Pb, Zn) of the Pirca Area (1-6)

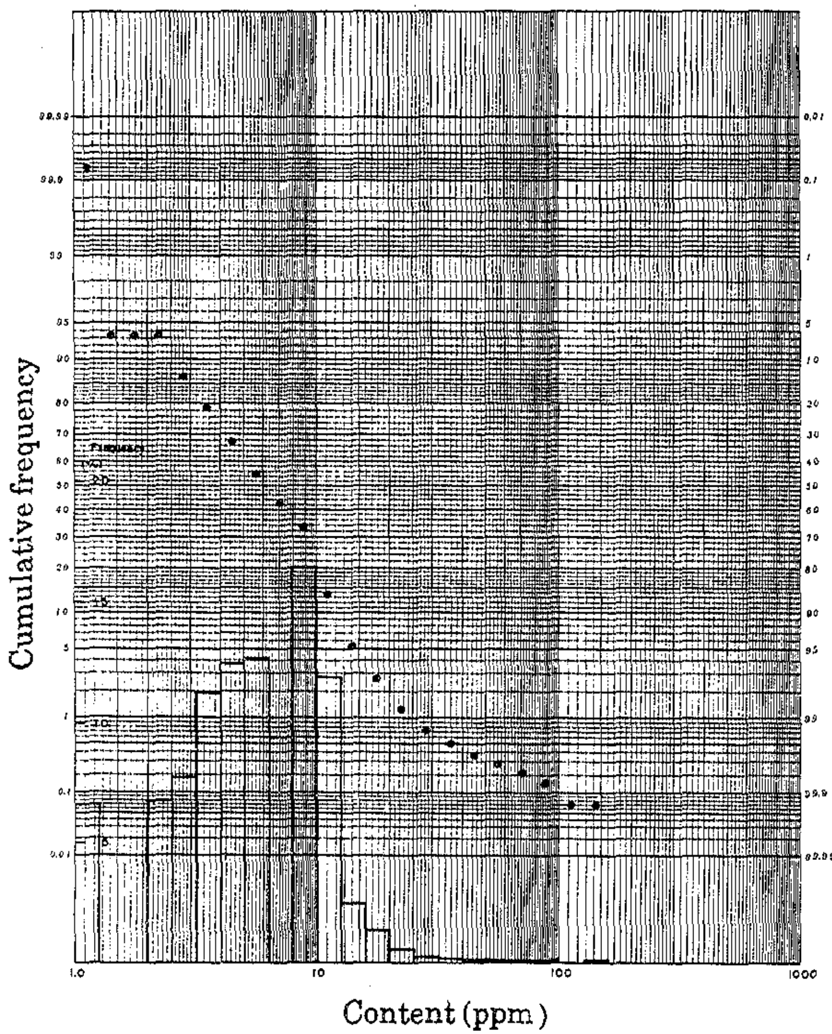


(3) As

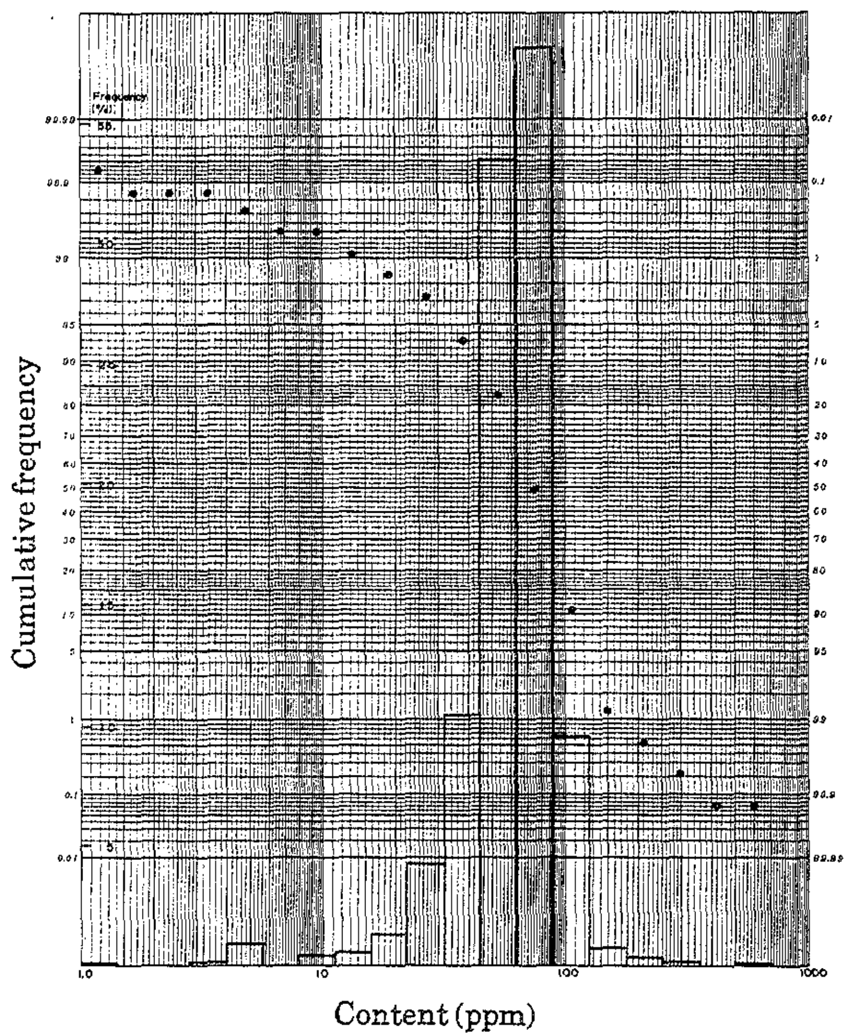


(4) Cu

Fig. 3-7 Continued



(5) Pb



(6) Zn

Fig. 3-7 Continued

Table 3-13 Classification of Anomalous Values in the Pirca Area

Element (unit)	High-background value	B-grade anomalous value	A-grade anomalous value	Threshold value
	M + σ ≦ <M + 2σ	M+2σ≦ <M+3σ	M+3σ≦	
Au (ppb)	3.6≦ <7.8 167 samples	7.8≦ <16.7 52 samples	16.7≦ 21 samples	7.8
Ag (ppm)	0.11≦ <0.12 0 samples	0.12≦ <0.13 0 samples	0.13≦ 13 samples	0.12
As (ppm)	15.3≦ <41.7 159 samples	41.7≦ <113.9 29 samples	113.9≦ 14 samples	41.7
Cu (ppm)	62.8≦ <89.8 185 samples	89.8≦ <128.4 30 samples	128.4≦ 4 samples	89.8
Pb (ppm)	10.6≦ <21.1 143 samples	21.1≦ <42.1≦ 11 samples	42.1≦ 5 samples	21.1
Zn (ppm)	93.5≦ <146.1 110 samples	146.1≦ <228.4 7 samples	228.4≦ 3 samples	146.1

3-3-2 Principal Component Analysis

(1) Standard Statistical Values

Values of the indicator elements are standarized for the principal component analysis based on the standard statistical values in the univariate analysis.

The results of the principal component analysis are shown in Table 3-14.

The eigen values and the cumulative contribution ratios as in Table 3-13 indicate that the variance of the first through the third principal components accounts for 63% of the total variance in the characteristic space. The cumulative contribution ratios of the characteristic values for the first through the third principal components are 48% for Au, 86% for Ag, 58% for As, 66% for Cu, 46% for Pb and 75% for Zn, and vary significantly depending on the elements. The first through the third principal components are mainly taken into account for the geochemical interpretation. The fourth and fifth principal components will be mentioned in the later section (3-3-3) since they appear to indicate geochemical characteristies in some cases.

Scores of samples are calculated for the first through third principal components and their standard statistical values are shown in Table 3-15. The scores are classified on the basis of these statistical values. The geochemical anomaly maps in the principal components are separately prepared for the Pirca Eastern (PLs.19, (1) - (3)) and the Pirca Western (PLs.24 (1) -(3)) Areas.

Table 3-14 Results of Principal Components Analysis in the Pirca Area

Principal component	Eigen value	Principal contribution ratio	Cumulative contribution ratio		Au	Ag	As	Cu	Pb	Zn
1st	1.549	0.258	0.26	Eigenvector	0.525	0.240	0.508	0.411	0.423	-0.245
				Factor loading	0.654	0.299	0.633	0.512	0.526	-0.305
				Contribution ratio of characteristic value	0.428	0.090	0.400	0.262	0.277	0.093
2nd	1.266	0.211	0.47	Eigenvector	0.198	0.223	-0.371	0.532	-0.039	0.699
				Factor loading	0.223	0.251	-0.417	0.598	-0.044	0.787
				Contribution ratio of characteristic value	0.050	0.063	0.174	0.358	0.002	0.619
3rd	0.976	0.163	0.63	Eigenvector	0.078	0.852	-0.064	-0.198	-0.430	-0.202
				Factor loading	0.077	0.841	-0.063	-0.195	-0.425	-0.199
				Contribution ratio of characteristic value	0.006	0.708	0.004	0.038	0.180	0.040
4th	0.853	0.142	0.77	Eigenvector	-0.277	0.360	-0.263	-0.293	0.794	0.091
				Factor loading	-0.256	0.333	-0.243	-0.270	0.733	0.084
				Contribution ratio of characteristic value	0.066	0.111	0.059	0.073	0.537	0.007
5th	0.769	0.128	0.90	Eigenvector	0.733	-0.193	-0.530	-0.335	0.064	-0.169
				Factor loading	0.643	-0.169	-0.465	-0.294	0.056	-0.148
				Contribution ratio of characteristic value	0.413	0.029	0.216	0.086	0.003	0.022
6th	0.587	0.098	1.00	Eigenvector	0.254	0.015	0.500	-0.558	-0.028	0.611
				Factor loading	0.195	0.011	0.383	-0.427	-0.022	0.468
				Contribution ratio of characteristic value	0.038	0.000	0.147	0.183	0.000	0.219

Table 3-15 Statistical Values of Principal Component Scores in the Pirca Area

Principal component	Maximum	Minimum	Mean (M)	Standard diviation	− Anomaly ≦M − 2σ	Background	+ Anomaly M + 2σ≦
Z_1	6.25	-3.39	0	1.24	≦ − 2.49 17 samples	-2.49 < < 2.49	2.49≦ 54 samples
Z_2	6.22	-8.16	0	1.12	≦ − 2.25 47 samples	-2.25 < < 2.25	2.25≦ 24 samples
Z_3	15.55	-2.74	0	0.99	≦ − 1.98 3 samples	-1.98 < < 1.98	1.98≦ 16 samples

(2) Interpretation of Principal Components

① First Principal Component

Eigen vectors and factor loadings of the first principal component are positive for Au, Ag, As, Cu and Pb, and negative for Zn. Au, As, Cu and Pb have relatively large eigen vectors and factor loadings. The contribution ratios of the characteristic values decrease in the order of Au, As, Pb and Zn. The contributions of Ag and Zn are minimal. The first principal component accounts for 26% or approximately one quarter of the total variance. With taking account of the correlation co-efficients between the indicator elements, positive scores in the first principal components may indicate concentration in Au, As, Cu and (Pb), and negative scores, concentration in Zn.

② Second Principal Component

The eigen vectors and the factor loadings of the second principal components are positive and large in Zn and Cu, and negative in As. The contribution ratios of the characteristic values are large in Zn, subordinate in Cu and very small in As. The second principal component accounts for 21% of the total variance, which is lower than that of the first principal component. With taking account of the correlation co-efficients between the indicator elements, positive scores in the second principal component may indicate Cu concentration accompanied by Zn, and negative scores may indicate As concentration.

③ Third Principal Component

The eigen values and the factor loadings in the third principal component are positive and high in Ag, and negative in Pb with relatively high absolute numbers. The contribution ratios of the characteristic values are high in Ag and subordinate in Pb. Positive scores in the third principal component may indicate Ag concentration and negative scores may indicate Pb concentration. The third principal component accounts for 16% of the total variance.

④ Fourth Principal Component

The eigen values and the factor loadings are positive in Pb and Ag (particularly in Pb), and negative in Au, As and Cu. Accordingly, positive scores may indicate Pb concentration in association with Ag, and negative scores may indicate concentration in Au, As, and Cu.

⑤ Fifth Principal Component

The eigen values and the factor loadings are positive in Au and negative mainly in As. Positive scores may indicate concentration only in Au and negative scores may indicate concentration mainly in As.

Relationships between the factor loadings of the first, second and the third principal components for the indicator elements are plotted on correlation diagrams (Fig. 3-8).

The correlation between the factor loadings of the first and the second principal components separates the indicator elements into 3 groups; one includes Au, Cu and Ag, another Pb and As, the third Zn. The correlation between the factor loadings of the first and third principal components separates the indicator elements into 4 groups; one includes Au and As, another Cu and Pb, the third Ag, and the fourth Zn. The correlation between the factor loadings of the second and the third principal components appears to indicate an affinity between Cu and Zn. However, the other 4 elements appear to be independent to each other on the correlation diagram.

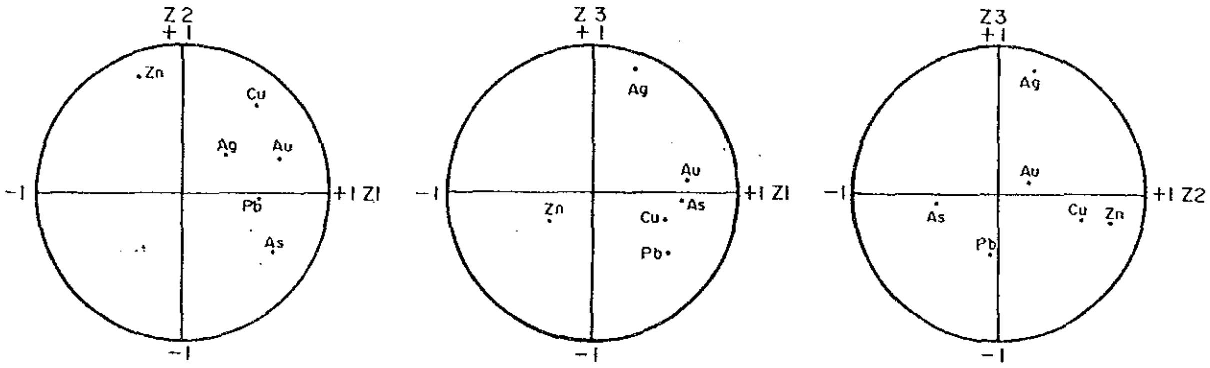


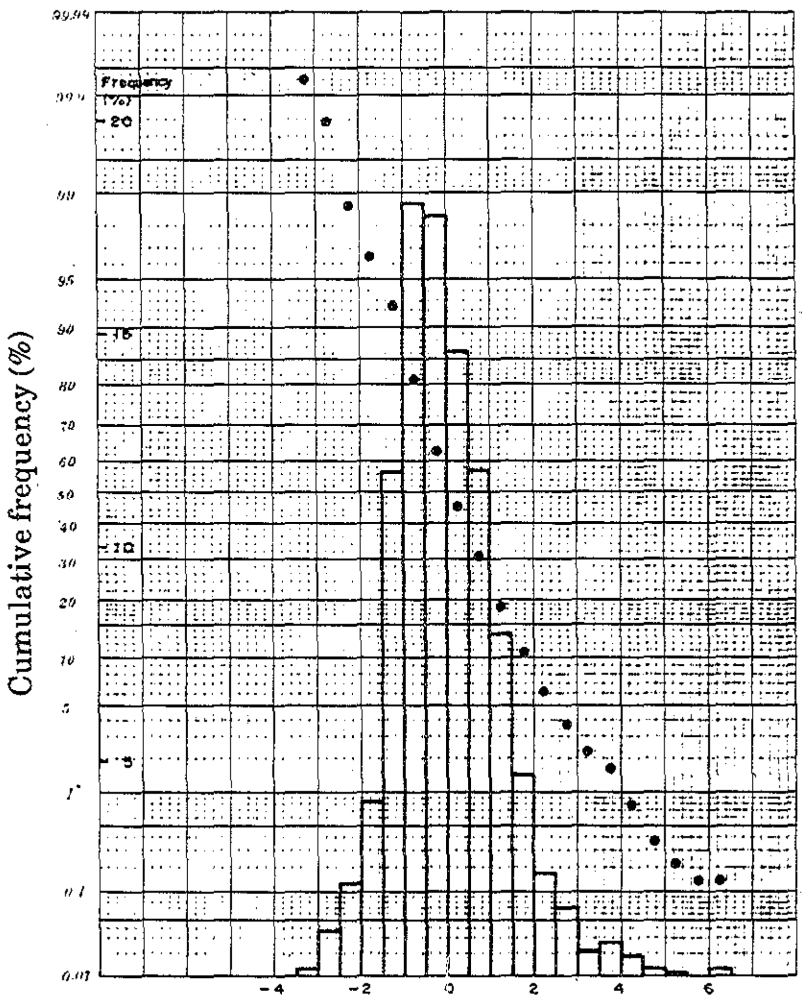
Fig. 3-8 Unrotated Factor Loadings of the Pirca Area

(3) Frequency, Cumulative Frequency and Threshold Value of Scores

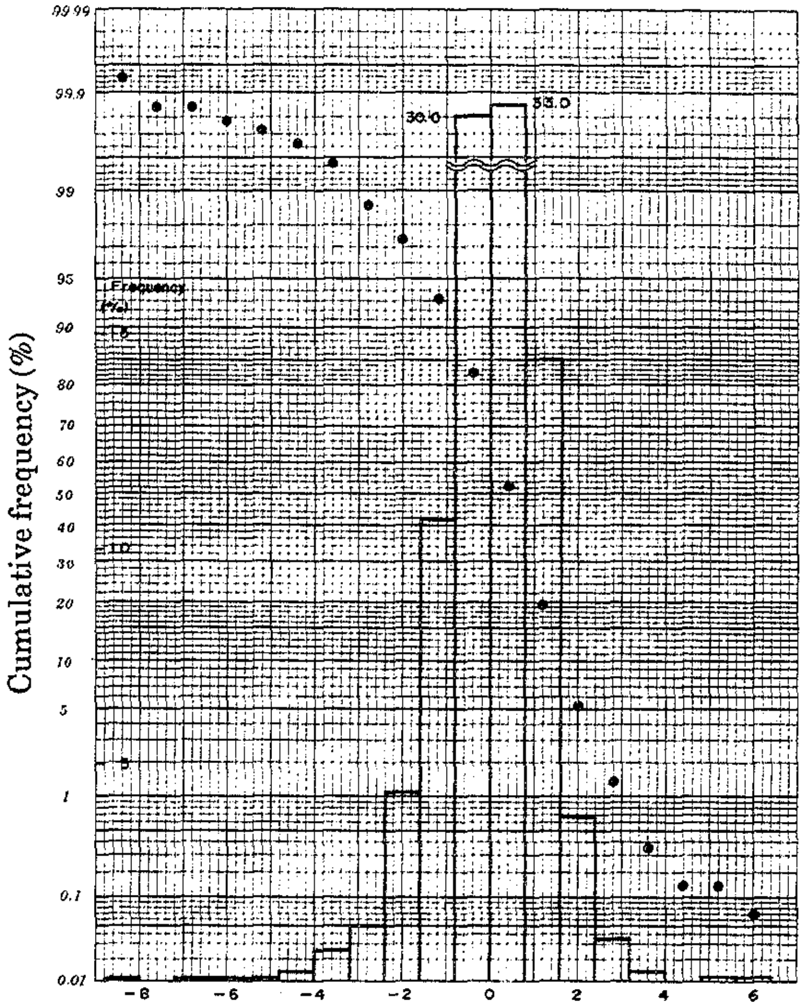
Frequency and cumulative frequency distributions of scores for the first, the second and the third principal components are illustrated in Fig. 3-7, (1) - (3).

The inflection points of the cumulative frequency curves for the three principal components are reasonably close to the threshold values determined at $M \pm 2\sigma$ on the basis of the standard statistical values of scores. Therefore, the threshold values at the $M \pm 2\sigma$ are adopted for all the three principal component. Table 3-16 is a list showing the threshold values and the numbers of samples belonging to the classes defined by the threshold values.

Scores equal to or higher than $M + 2\sigma$ are regarded positively anomalous and those equal to or less than $M - 2\sigma$ negatively anomalous. Distributions of positive and negative anomalies are illustrated in PL.19, (1) - (3).

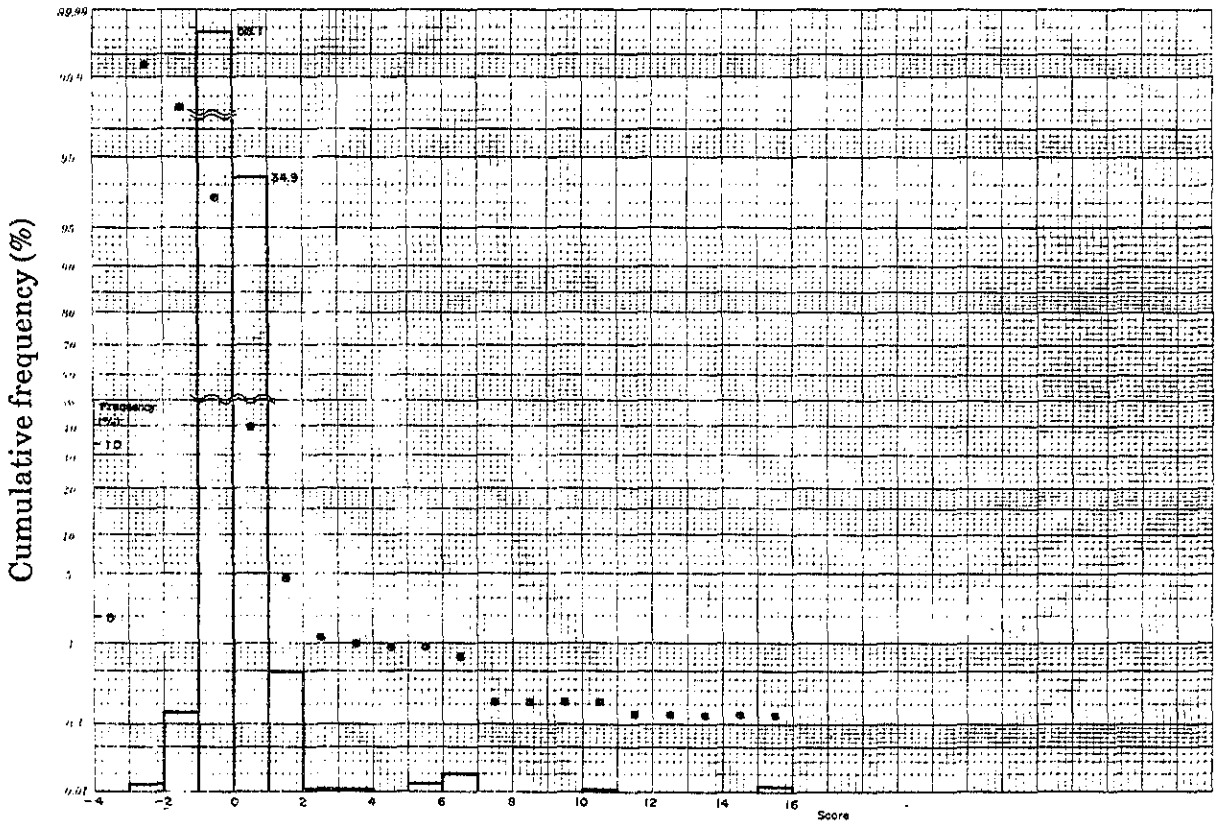


(1) First Principal Component



(2) Second Principal Component

Fig. 3-9 Histograms and Cumulative Frequency Diagrams of First, Second and Third Principal Components of the Pirca Area (1-3)



Score

(3) Third Principal Component

Fig. 3-9 Continued

Table 3-16 Classification of Principal Components Scores in the Pirca Area

Principal component	-Anomaly ≦M - 2σ	Background M - 2σ< <M + 2σ	+Anomaly M + 2σ≦	Threshold value
Z_1	≦-2.49 17 samples	-2.49< <2.49	2.49≦ 54 samples	±2.49
Z_2	≦-2.25 47 samples	-2.25< <2.25	2.25≦ 24 samples	±2.25
Z_3	≦-1.98 3 samples	-1.98< <1.98	1.98≦ 16 samples	±1.98

3-3-3 Geochemical Anomalies

Geochemical Anomalies in Univariate Analysis:

Geochemical anomalous zones are defined on the basis of the same criteria as in the Marcabamba area. The anomalous zones and anomalies by the univariate analysis are shown on the Geochemical Interpretation Maps separately for the Pirca Eastern (PL.20) and the Pirca Western (PL.25) Areas.

The total number of 24 anomalous zones PE-A through PE-X are located in the Pirca Eastern Area and 9 anomalous zones PW-A through PW-I in the Pirca Western Area.

These anomalous zone are listed in Table 3-17, with their names, approximate locations, distributions and anomalous elements.

Geochemical Anomaly by principal component analysis:

Geochemical anomalies in scores for each of the first, the second and the third principal components are compounded and shown in the Geochemical Interpretation Maps of Principal Component Anomaly separately for the Pirca Eastern (PL.21) and the Pirca Western (PL.26) Areas.

Positive anomalies in the first and third principal components may indicate Au-Ag mineralization.

The geochemically anomalous zones in the univeriate analysis are listed in Table 3-17, together with the geochemical anomalies in the principal component analysis. Anomalies in the forth and fifth principal components are also listed in Table 3-17. Positive anomalies in the first, the second and the third, principal components superimpose each other in the vicinity of Co. Antaripa. However, the anomalous zone is not listed in Table 3-17, because it is limited in its extent.

Table 3-17 List of Geochemical Anomaly Zones in the Pirca Area

Area	Name of anomaly zone	Location	Scale (km)	Univariate analysis						Principal components analysis								Remarks (mineralization)
										+ anomaly			- anomaly					
				Au	Ag	As	Cu	Pb	Zn	Z_1	Z_2	Z_3	Z_1	Z_2	Z_3	Z_4	Z_5	
Pirca Eastern Area	PE-A	2.0 km NE of Pirca	0.1 x 0.2	A			B			(+)							(+)	Au
	PE-B	1.5 Km NE of Pirca	0.1 x 0.4	A			B			(+)							+	Au (+Cu)
	PE-C	1.0 km NE of Pirca	0.1 x 0.3	BB			B			(+)	(+)							Au-Cu
	PE-D	1.6 km NNE of Pirca	0.15 x 0.25	B	A					+	+	+				+		Au-Ag, Cu-Zn
	PE-E	1.5 km N of Pirca	0.07 x 0.15	B				B		+								Au-Pb
	PE-F	1.2 km N of Pirca	0.2 x 0.5	BB	A		B	B		++	(+)	(+)				(+)		Au-Ag-Cu-Pb
	PE-G	0.8 km NNE of Pirca	0.25 x 0.3	A	A		B			+	+	+				+	(-)	Au-Ag, Cu (+Pb)
	PE-H	0.3 km N of Pirca	0.5 x 0.7	B		AA				++						-	(-)	Au-As
	PE-I	0.3 km WNW of Pirca	0.1 x 0.2	BB												(-)		(Au)
	PE-J	1.0 km NW of Pirca	0.2 x 0.75	A						+							++	Au
	PE-K	0.2 km S of Pirca	0.15 x 0.25	A		B				(+)								(Au)
	PE-L	0.5 km S of Pirca	0.15 x 0.2	A			B				+					-	+	Au-Cu
	PE-M	0.8 km SSW of Pirca	0.1 x 0.8	BB			B				+					(-)	(+)	Au-Cu
	PE-N	1.0 km S of Pirca	0.1 x 0.3	BB			BB			(+)	(+)							Au-Cu
	PE-O	1.3 km SSW of Pirca	0.3 x 0.4	A	A					+	+	+				(+)		Au-Ag, (Cu-Zn)
	PE-P	1.5 km SW of Pirca	0.1 x 0.4	BB			BB			+	+							Au-Cu (+Ag)
	PE-Q	1.1 km W of Pirca	0.1 x 0.3	BB	A						+	+				(+) (-)	(-)	Ag, Cu
	PE-R	1.5 km W of Pirca	0.25 x 0.8	A		AA				++				(-)		--		Au-As
	PE-S	1.3 km WSW of Pirca	0.1 x 0.75			BB								(-)		--	-	As
	PE-T	1.5 km WSW of Pirca	0.15 x 0.3	B		A	BB			+				(-)				Au-As-Cu
	PE-U	1.8 km SW of Pirca	0.1 x 0.35						A		(+)		(-)			(-)		Zn
	PE-V	2.5 km WNW of Pirca	0.15 x 0.3			B		A		+					(-)	+		Pb-As
	PE-W	2.5 km WNW of Pirca	0.2 x 0.55			BB		A	A		(+)			(-)	(-)	+		Pb-As, Zn
	PE-X	2.5 km W of Pirca	0.3 x 0.7			BB				(+)		(+)		(-)		(+)	-	As, Ag
Pirca Western Area	PW-A	W of C°. Puca Ccasa	0.15 x 0.2	B				B		+				-				Au-Pb
	PW-B	S of C°. Puca Ccasa	0.2 x 0.25	A			B			+								Au-Cu
	PW-C	S of C°. Puca Ccasa	0.15 x 0.4				BB											Cu
	PW-D	E of C°. Antaripa	0.25 x 0.25	B			B	A		+								Au-Cu-Pb
	PW-E	S of C°. Puca Ccasa	0.15 x 0.35					A		+				-		+		Pb (+Au)
	PW-F	C°. Colarado	0.25 x 0.6		A		B			++		+				+	-	Ag-Cu (+As)
	PW-G	NE of C°. Yarihuato	0.25 x 0.4				A				+							Cu
	PW-H	S of C°. Yarihuato	0.2 x 0.2	A			A			+	+						+	Au-Cu
	PW-I	Q. Atoccacha	0.25 x 0.4				B											Cu

(Note)

Univariate Analysis
- AA: Three or more samples having a value of anomaly A (≥M + 3σ)
- A: One or two samples having a value of anomaly A
- BB: Two or more sample having a value of anomaly B (M + 3σ > ≥M + 2σ)
- B: One sample having a value of anomaly B.

Principal Components Analysis
- ++: Three or more samples having a score of + anomaly (≥M + 2σ)
- +: One or two samples having a score of + anomaly
- --: Three or more samples having a score of - anomaly (≤M - 2σ)
- -: One or two samples having a score of - anomaly
- (): Partly

Combined geochemical anomaly:

The Geochemical Interpretation Maps for the Pirca Eastern (Fig. 3-8, PL.22) and the Pirca Western (Fig. 3-9, PL.27) Areas are prepared by combining anomalies in the principal components and anomalous zones in the univariate analysis. In many cases, anomalies in the principal components coincide with the anomalous zones by the univariate analysis. There are some geochemically anomalous zones with strong (A) or very strong (AA) intensities, which are superimposed by anomalies in two or more principal components. These anomalous zones are regarded relatively intensive. There are 7 anomalous zones of this type in the Pirca Eastern Area, namely PE-D, PE-F, PE-G, PE-H, PE-O, PE-Q and PE-R. In addition, PE-J and PE-T are regarded relatively intensive. The anomalous zones PW-F, PW-H, PW-B and PW-D are relatively intensive in the Pirca Western Area.

In general, however, the means, the threshold values and the maximum values are apparently lower in the Pirca Area than in the Marcabamba Area, as shown in Table 3-18.

Table 3-18 Comparison of the Pirca Area with the Marcabamba Area on Abundance of Indicator Elements

Area		Au (ppb)	Ag (ppm)	As (ppm)	Cu (ppm)	Pb (ppm)	Zn (ppm)
Pirca	Mean	1.7	0.10	5.6	43.9	10.6	59.8
	Threshold	7.8	0.12	41.7	89.8	21.1	146.1
	Maximum	79	0.5	780	218	137	600
Marcabamba	Mean	4.6	0.15	7.8	28.0	13.4	68.7
	Threshold	73.0	1.15	72.9	72.5	83.9	174.6
	Maximum	>10,000	>100	>10,000	570	>10,000	2,750

3-3-4 Geochemical Anomaly in Relation With Alteration and Mineralization

In Interpretation Map of the Pirca Eastern Area (Fig. 5-2, PL.32) and of the Pirca Western Area (Fig. 5-3, PL.33) are prepared by combining the anomalous zones and the anomalies in soil geochemistry with the alteration-mineralization zones located by the geological survey.

Characters of the presumable mineralization for the selected geochemically anomalous zones are compared with those of existing mineralization and/or alteration zones as summerized in Table 3-10. The numbers of the anomalous zones selected for this study are 13 in the Pirca Eastern Area and 4 in the Pirca Western Area.

As the results of this study, there are some discrepancies between the mineralization presumed for the geochemically anomalous zones and the existing mineralization and alteration zones; they are 1) geochemically anomalous zones without signs of alteration or mineralization (PE-D, PE-G, PE-H, PE-O, PW-H), 2) weak Ag mineralization zones without notable geochemical signatures (PE-R, PE-T, PE-V, PE-W), 3) geochemically anomalous zones for Au without recognition of Au mineralization by the geological survey (PE-A, PE-O, PW-D, PW-H), 4) weak mineralization zone without geochmeically anomalous values, 5) the significant Au-Ag mineralization zone PW-1 (6.5 g/t Au, 10.0 g/t Ag) only with minimal geochemical values. The reasons for these discrepancies would be that soil sections are incomplete at most of sample localities due to poor development of soils, and that mineralization itself is weak in the whole area and very much localized.

In the Pirca Area, relatively promising targets of geochemically anomalous zones are PE-F, PE-G, PE-J, PE-Q, PE-R, PE-T and PW-F. Of these, PE-Q, PE-R and PE-T, with higher priority than the other anomalous zones, were examined by drilling with a length of approximately 100 m for each hole. However, the drilling results failed to indicate any signs of promising ore deposits or mineralization in association with these anomalous zones. Accordingly, no significant mineralization may be expected in association with the other anomalous zones of lower priority.

Table 3-19 Comparison of the Geochemical Anomaly Zones with Mineralization Zones in the Pirca Area

Area	Geochemical anomaly zone		Results of geological survey	
	Name of anomaly zone	Mineralization, assumed by geochemical anomaly	Characteristics of mineralization	Characteristics of alteration
Pirca Eastern Area	PE-D	Au-Ag, Cu-Zn	Not observed	Not observed
	PE-F	Au-Ag, Cu-Pb	"	Partly PE-3 Alteration zone: Hydrothermal alteration (silicification + argillization) Qz + Alu + (Mn) + (Ser).
	PE-G	Au-Ag, Cu (+Pb)	"	Not observed
	PE-H	Au-As	"	Weak argillization
	PE-J	Au	"	Partly, PE-3 alteration zone: Hydrothermal alteration (silicification + argillization) Qz + Alu + (Mn) + (Ser)
	PE-O	Au-Ag, (Cu-Zn)	"	Not observed
	PE-Q	Ag, Cu	"	"
	PE-R	Au-As	(Ag: 4.7 g/t, As: 0.003%)	PE-2 alteration zone: Hydrothermal alteration (silicification + argillization Qz + Alu + (Mn) + (Ser)
	PE-S	As	Not observed	PE-1 alteration zone: Hydrothermal alteration Qz + Ser + (Kao) + (Alu)
	PE-T	Au, As, Cu	(Ag: 7.8 g/t, As: 0.002% Pb: 0.01%, Zn: 0.01%)	PE-1 alteration zone: Hydrothermal alteration Qz + Ser + (Kao) + (Alu)
	PE-V	Pb-As	Au: < 0.07 g/t, Ag: 6.8 g/t	PE-4 alteration zone } Hydrothermal alteration Qz, Qz + Kao, Qz + Cri + Kao Qz + Alu, Qz + Alu + Jar
	PE-W	Pb-As, Zn	Au: 0.07 g/t, Ag: 3.3 g/t, As: 0.022%	PE-5 alteration zone } (as above)
	PE-X	As, Ag	Not observed	PE-5 alteration zone } (as above)
Pirca Western Area	PW-B	Au-Cu	Not observed	Argillization
	PW-D	Au-Cu-Pb	Lack of outcrops	Lack of outcrops
	PW-F	Ag-Cu (+As)	Not observed	Argillization (Cri + Kao + Alu)
	PW-H	Au-Cu	"	Not observed

Abbreviations: Qz: quartz, Alu: alunite, Mn: montmorillonite, Ser: sericite, Kao: Kaolinite, Cri: cristobalite, Jar: jarosite

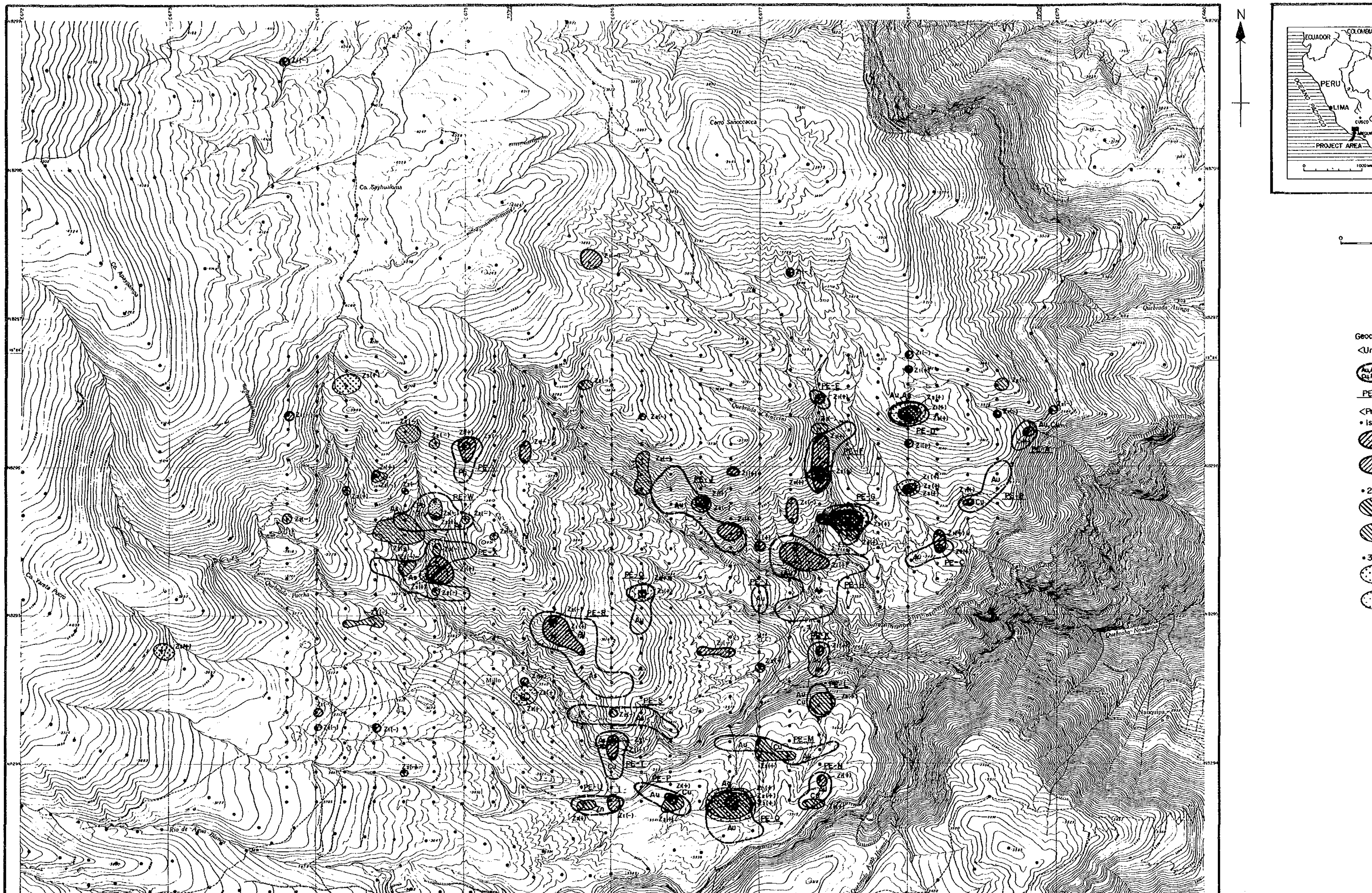
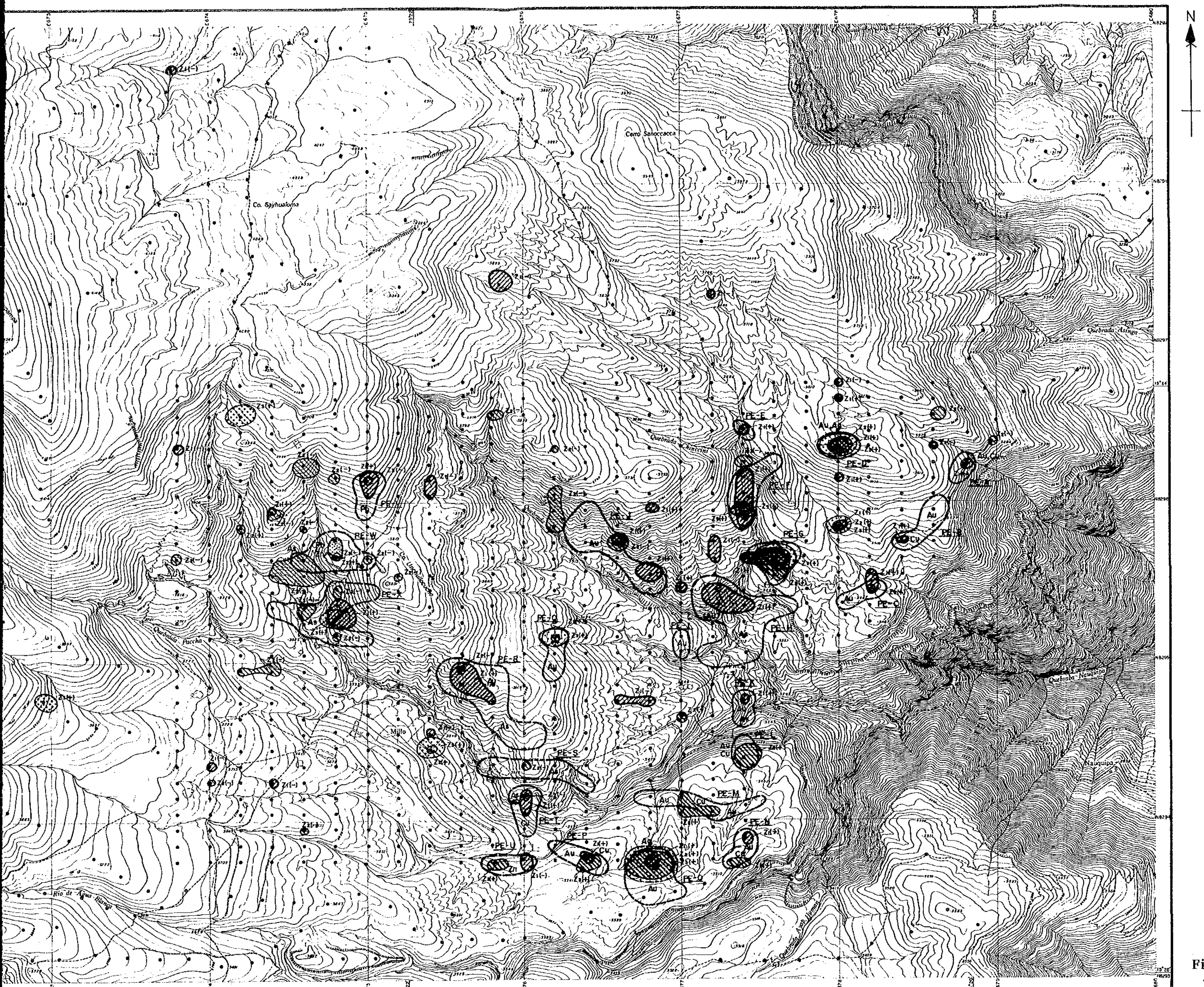
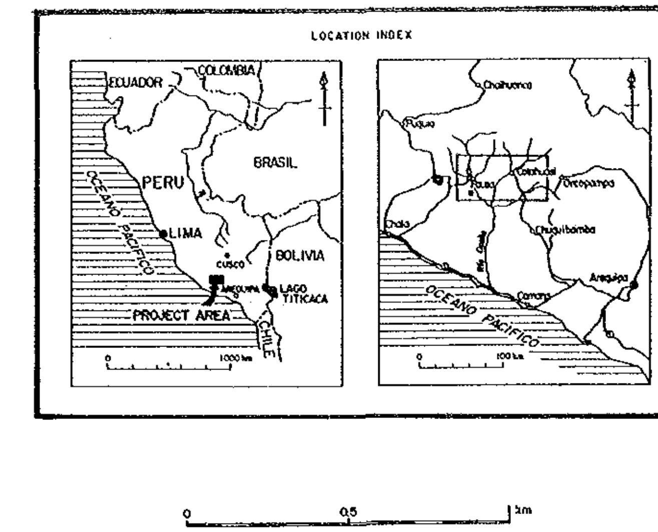


Fig. 3-10 Geochemi
the Pirca Eastern Ar





LEGEND

Geochemical Anomaly
<Univariate Analysis>

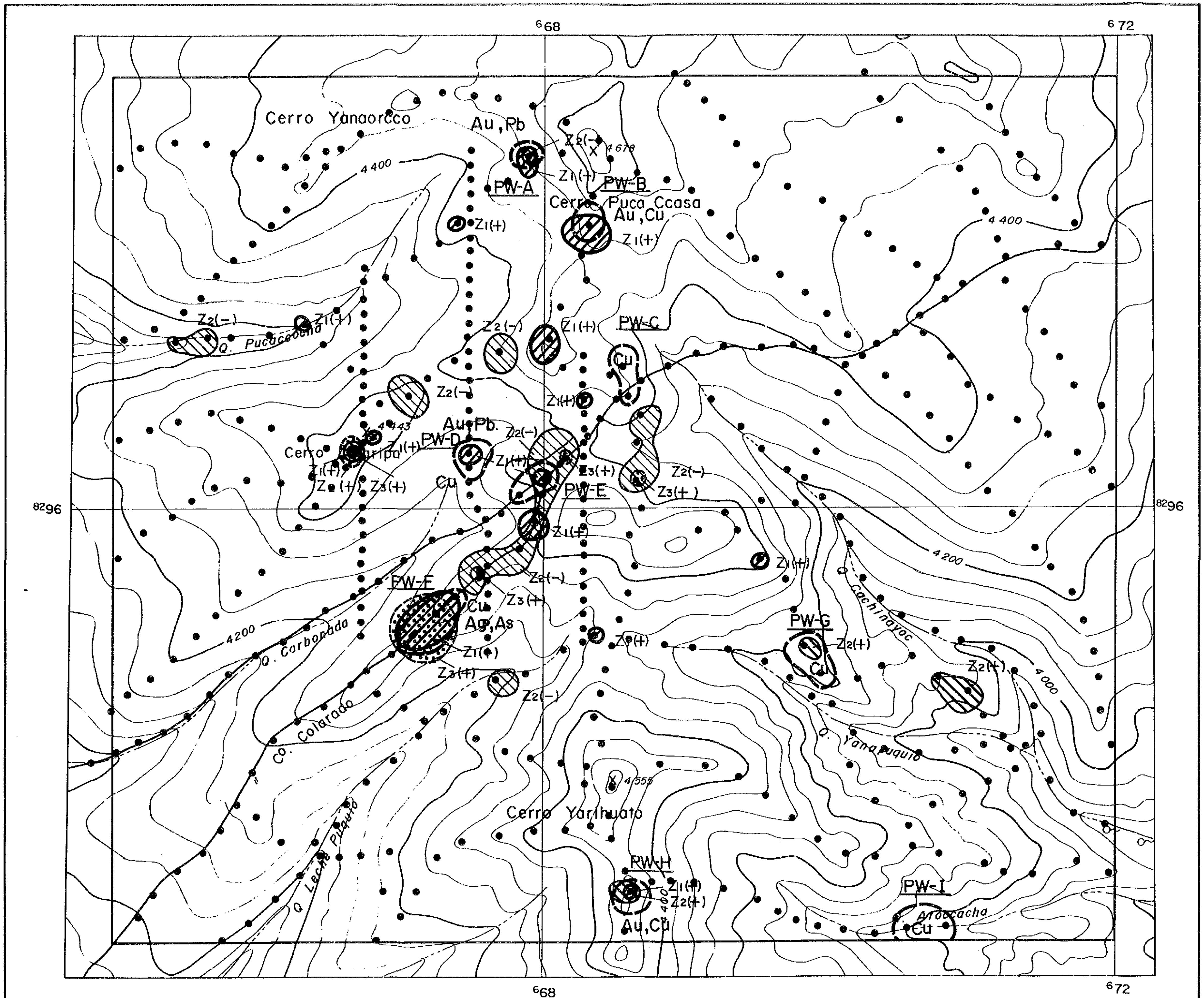
Anomaly Zone and Anomalous Elements

PE-A Name of Anomaly Zone

<Principal Components Analysis>

- 1st Principal Component
  - Z1(+) + Anomaly
  - Z1(−) − Anomaly
- 2nd Principal Component
  - Z2(+) + Anomaly
  - Z2(−) − Anomaly
- 3rd Principal Component
  - Z3(+) + Anomaly
  - Z3(−) − Anomaly

Fig. 3-10 Geochemical Interpretation Map of the Pirca Eastern Area (Composite Data)



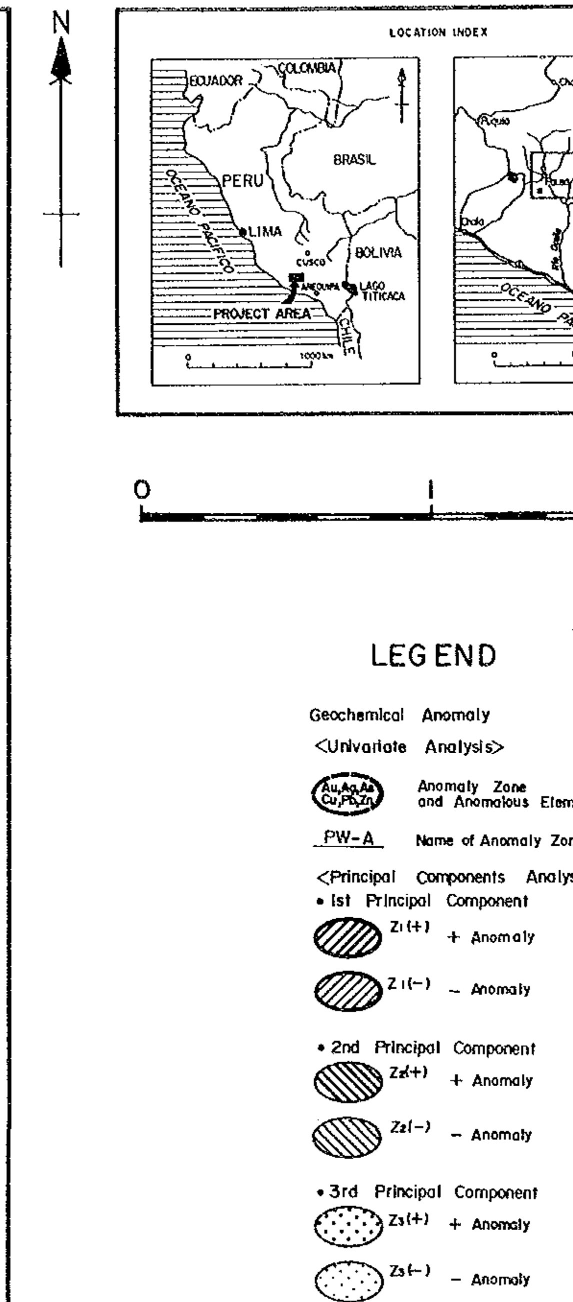
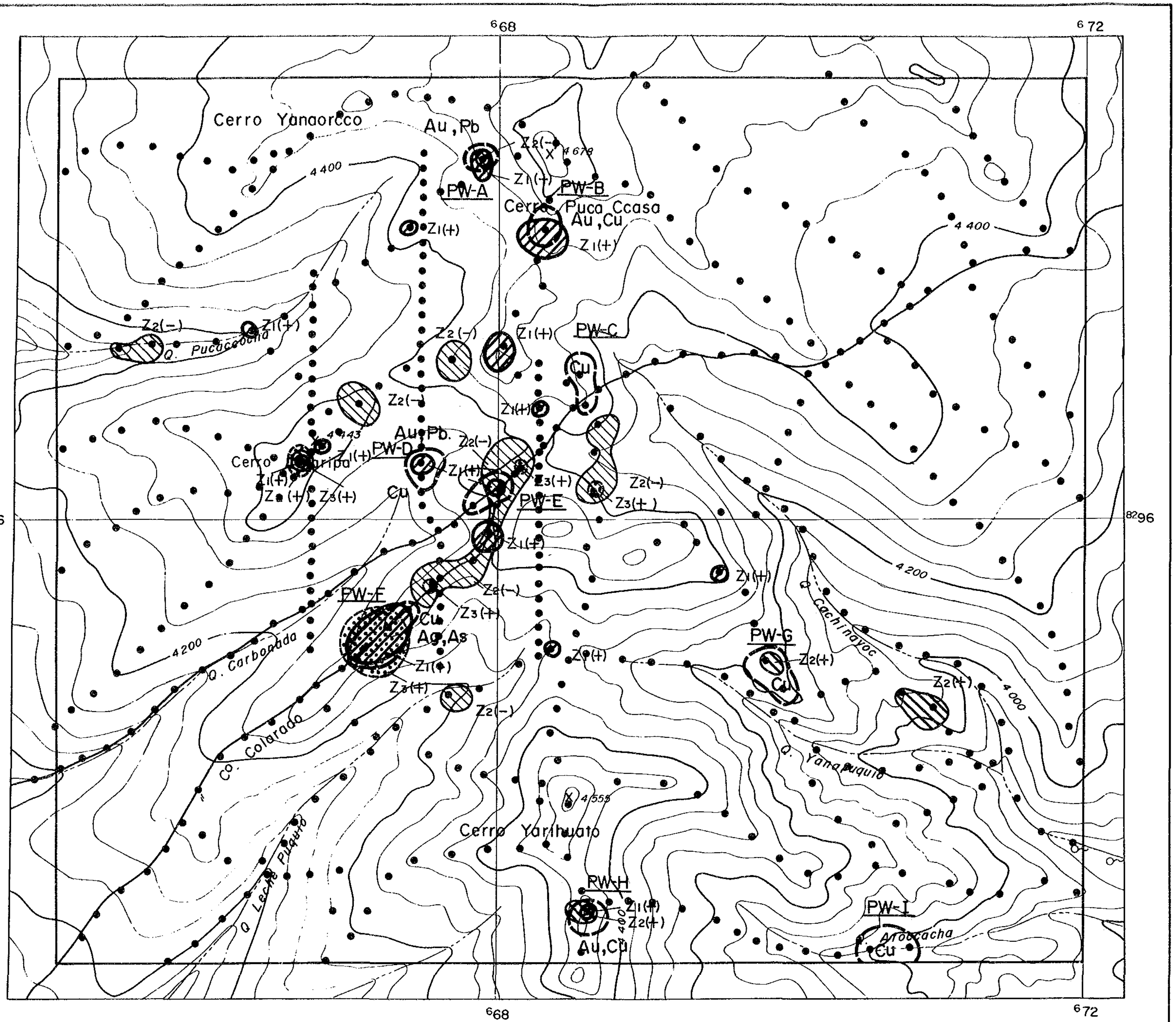
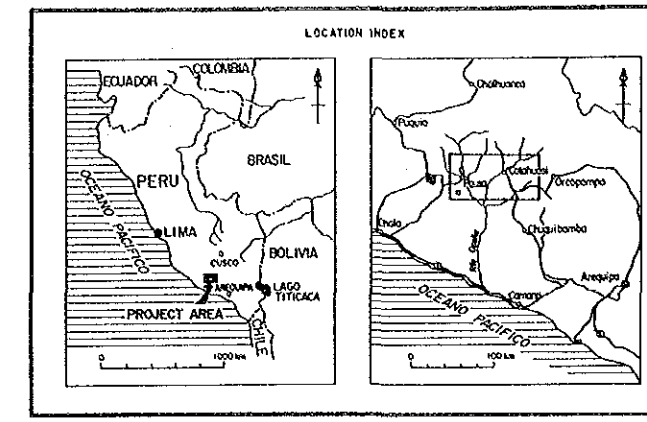


Fig. 3-11 Geochemical Interpretati
the Pirca Western Area





0 1 2 km

LEGEND

Geochemical Anomaly

<Univariate Analysis>

Au,Ag,As Cu,Pb,Zn — Anomaly Zone and Anomalous Elements

PW-A — Name of Anomaly Zone

<Principal Components Analysis>

- 1st Principal Component
  - Z1(+) + Anomaly
  - Z1(−) − Anomaly
- 2nd Principal Component
  - Z2(+) + Anomaly
  - Z2(−) − Anomaly
- 3rd Principal Component
  - Z3(+) + Anomaly
  - Z3(−) − Anomaly

Fig. 3-11 Geochemical Interpretation Map of the Pirca Western Area

CHAPTER 4 DRILLING EXPLORATION

CHAPTER 4 DRILLING EXPLORATION

4-1 Outline

The drilling survey of this year aimed at making clear of the geological condition and grasping of the occurrence of ore deposit in the Cotahuasi area of Peru and the vertical drilling of ten holes (MJP-1 - 10) were operated (Fig. 4-1, and Table 4-1).

The drilling operation was conducted by GEOTEC S.A. using two drilling machines for 88 days from July 20, 1986 to October 15, 1986. Its details are shown below:

Name of machine	ACKER		BBS-1	
	Period	Days	Period	Days
Carrying-in	July 20 - Aug. 21	33	July 20 - Aug. 9	21
Drilling	Aug. 22 - Oct. 15	55	Aug. 10 - Oct. 15	67
Total	July 20 - Oct. 15	88	July 20 - Oct. 15	88

(Digging includes transfer and installation.)

The lodgings of GEOTEC S.A. were installed at Pirca village (for drilling of MJP-1 - 6) and at Millo village (for drilling of MJP-7 - 10). The distances from these lodgings to each site are one for 5 to 30 minutes on foot.

The number of persons of GEOTEC S.A. was as follows;

Field supervisor	1 person
Field sub-supervisor	1 person
Boring engineer	4 persons
Boring assistant	8 persons
Driver	1 person
Cook	1 person
Cook assistant	1 person
Laborer for transfer-installation and miscellaneous works	Many persons

The drilling team was organized in four groups and each group comprised a boring engineer and two assistants under control of one field supervisor and one sub-supervisor.

The drilling work was operated using two drilling machines under 1 or 3 shifts system.

4-2 Drilling Method and Machines

Main rock types to be excavated were tuff and andesite, and existence of some cracks in those rocks and silicification and argillization in and around the mineralization zones were predicted to be encountered. By reason of these, two stages of wire line tools of NX and BX were prepared. For drilling machines, ACKER made by ACKERDRILL and BBS-1 made by BOYLESBROSDRILLING were selected.

For drilling pumps, BEAN ROYAL 425 and 420 made by JOHN-BEANDIVISION were adopted.

For drilling mud, bentonite was used in the most part for the purpose to improve drill bit life and core extraction and to protect wall of holes.

The drilling machines, drilling pumps and other machinery and tools used are shown in Table 4-2, the details of supplies used in Table 4-4 and the diamond bit used in Table 4-5 (1) - (5).

4-3 Drilling Works

4-3-1 Transportation and Transfer of Machines and Setting of Pipes

The machine parts and materials were transported from the warehouse of GEOTEC S.A. located in Lima to the terminal of the road (Kawacho) through No. 1 National Highway and No. 100 Departmental Roadway, from that place to Pirca Village, carried by manpower and asses. The number of days needed to carry-in those equipment and materials to the MJP-1 and MJP-2 drillsites were 33 and 21 days respectively.

Transfer and installation of machines were worked mainly by manpower and self-moving of the drilling machines after the construction of road.

Water for drilling was taken from nearby creeks by a pump through one inch pipes.

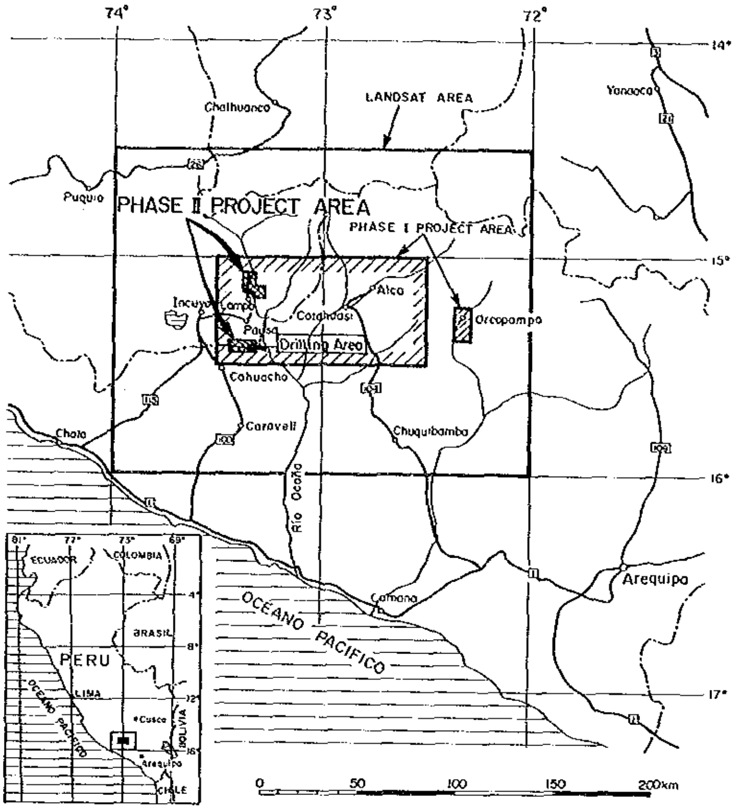
4-3-2 Drilling Operation

The details of drilling by each hole are shown in the following tables and figures: the summary of works (Table 5-5 (1) to (19)), the progress of works (Fig. 4-2 (1) to (10)), and the results of drilling (Table 4-6).

(1) MJP-1 Hole

0 - 8.60 m: Sand, dacitic welded tuff

NC-WL diamond bit was used to dig up to 4.00 m and a 90 mm casing was inserted.



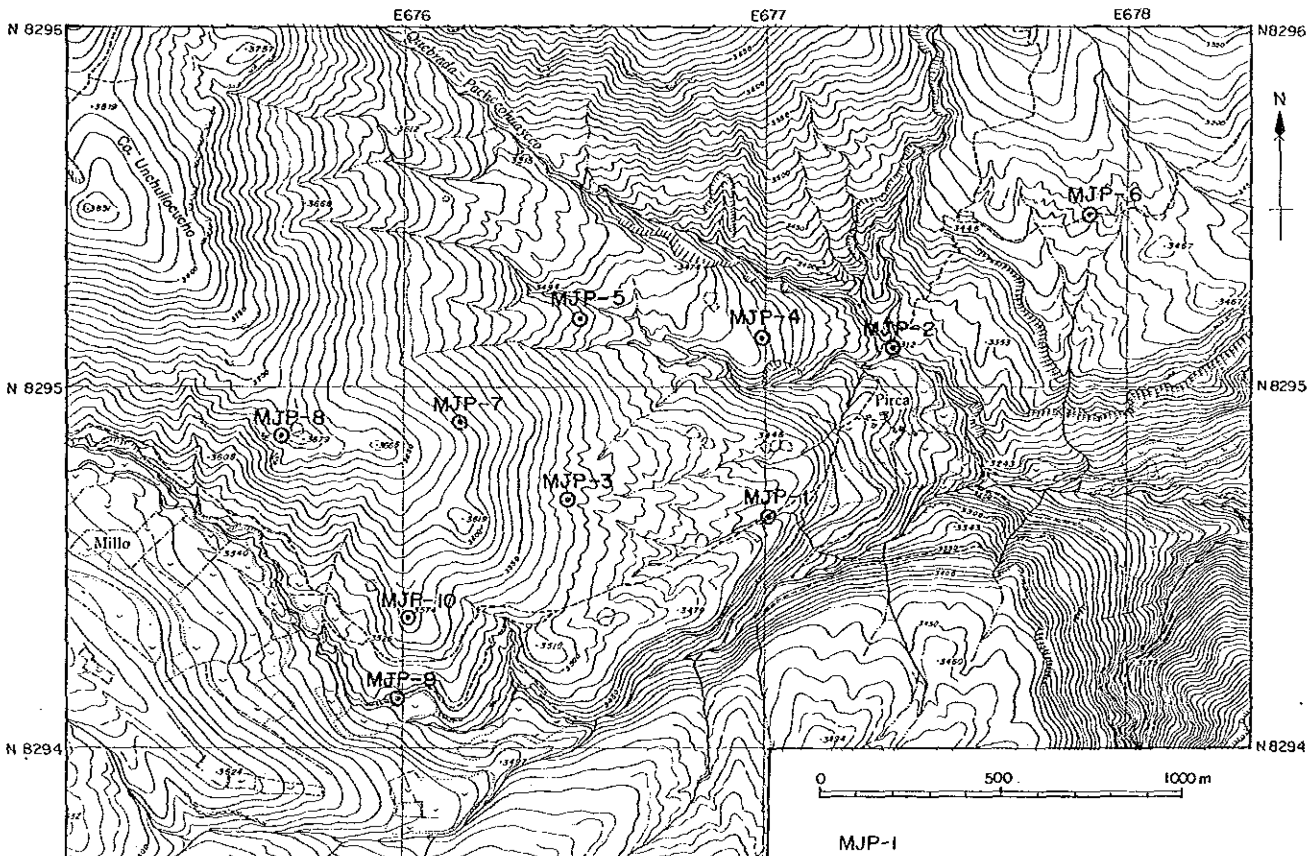


Fig. 4-1 Location Map of Drilling Sites

Table 4-1 Generalized Drilling Results

Drill Hole No.	Type of Machine	Drilling Period	Length (m)	Core Recovery (%)	Location of Drill Hole		Elevation (m)
					Longitude	Latitude	
MJP-1	Acker	22th∿28th Aug. '86	100.80	98.3	N8'294,638.2	E677,006.7	3,441.1
MJP-2	BBS-1	10th∿21th Aug. '86	100.00	98.0	N8'295,108.1	E677,352.5	3,309.0
MJP-3	Acker	13th∿20th Sep. '86	100.00	99.4	N8'294,686.8	E676,456.1	3,512.5
MJP-4	BBS-1	17th∿23th Sep. '86	100.00	99.1	N8'295,133.7	E676,988.3	3,416.0
MJP-5	Acker	4th ∿ 8th Sep. '86	100.10	98.6	N8'295,191.2	E676,479.9	3,480.4
MJP-6	BBS-1	27th Aug. ∿ 12th Sep. '86	100.80	73.0	N8'295,480.0	E677,892.0	3,452.0
MJP-7	Acker	5th ∿ 12th Oct. '86	100.00	99.4	N8'294,901.1	E676,151.7	3,598.5
MJP-8	Acker	25th Sep. ∿ 2th Oct. '86	100.20	98.8	N8'294.865.9	E675,655.6	3,673.4
MJP-9	BBS-1	7th ∿ 13th Oct. '86	100.00	99.7	N8'294,132.0	E675.986.5	3,491.3
MJP-10	BBS-1	27th Sep. ∿ 4th Oct. '86	100.00	98.3	N8'294,354.5	E676,013.2	3,572.0

Table 4-2 Drilling Equipment

Article	Model	Specification	Quantity
Drilling machine	Model "BBS-1" (BOYLES BROS)	Capacity: NX 152 m, BX 165 m Inner diameter of spindle: 50 mm Spindle speed: 1,000 rpm Weight: 600 kg	1 set
Drilling machine	Model "ACKER" (ACKER DRILL)	Capacity: NX 130 m, BX 170 m Inner diameter of spindle: 50 mm Spindle speed: 1,300 rpm Weight: 652 kg	1 set
Motor	TJD (TELEDYNE WISCONSIN MOTOR)	Gasoline engine: 4 cycle Revolution: 1,800 rpm Related power: 32 PS	2 sets
Drilling pump	BEAN ROYAL 425 (BEAN ROYAL)	Type: 3 cylinders-single acting Capacity (max): 105 ℓ/min Pressure (max): 35 kg/cm^2	2 sets
Motor	TJD (TELEDYNE WISCONSIN MOTOR)	Gasoline engine: 4 cycle Revolution: 1,800 rpm Related power: 32 PS	2 sets
Water-supply pump	BEAN ROYAL 435 (BEAN ROYAL)	Type: 3 cylinders-single acting Capacity (max): 170 ℓ/min Pressure (max): 45 kg/cm^2	2 sets
Motor	TJD (TELEDYNE WISCONSIN MOTOR)	Gasoline engine: 4 cycle Revolution: 1,800 rpm Related power: 32 PS	2 sets
Wire line hoist		Attached to drilling machine	2 sets
Derrick		Pipe structural derrick (vertical)	2 sets
Derrick		Maximum load capacity: 3 t Effective length of pull rod: 3 m	2 sets
Generator	392 (MILWAUKEE WISCONSIN MOTOR)	Gasoline engine: 4 cycle Revolution: 3,600 rpm Related power: 10 PS	2 sets
Drill rod	Wire line rod	NC 15 m NX 60 m BX 110 m	× 2
Water tank		0.4 m^3 2 sets 0.2 m^3 4 sets	× 2

Table 4-3 Consumed Materials: MJP-1 - MJP-10

Article	Specification	Unit	Quantity										
			MJP-1	MJP-2	MJP-3	MJP-4	MJP-5	MJP-6	MJP-7	MJP-8	MJP-9	MJP-10	Total
Gasoline	Drilling machine & drilling pump water pump	ℓ	1,780	3,050	2,020	1,650	1,270	4,830	2,170	2,000	1,700	2,030	22,500
Gasoline	Truck & jeep	ℓ											15,400
Engine oil	Drilling machine & drilling pump	ℓ	20	25	20	20	20	40	30	25	25	25	250
Cylinder oil Gear oil	Drilling machine & drilling pump	ℓ	50	50	55	55							210
Grease		kg	10		10			30		10		10	70
Bentonite		kg	875	400	425	575	450	1,000	550	550	275	550	5,650
Cement		sx	4	4	6	4	4	12	1	2	1	3	41
CMC		kg	3		9	11	9	16	11	11	6	12	88
Diamond bit	NC	pcs	1	1									2
	NX	pcs	2	1	1	1		1		1	1		8
	BX	pcs		1	1	1	2		1		1	1	8
Diamond reaming shell	NC	pcs											
	NX	pcs	1	1									2
	BX	pcs		1			1					1	3
Core barrel	NC	pcs	1	1									2
	NX	pcs	1	1									2
	BX	pcs	1	1				1					3
Drill rod	NC	m	15	15									30
	NX	m	60	60									120
	BX	m	110	110									220
Core lifter	NC	pcs											8
	NX	pcs	2	2	1	1	1	3	2	1	1	1	15
	BX	pcs	0	2	2	1	1	3	1	2	2	1	15
Core lifter case	NC	pcs											
	NX	pcs											20
	BX	pcs											18
Chuck piece		pcs	1	1						1		1	4
Wire	4 mm	m	110	110									220
	12 mm	m	10	10									20
Lost circulation materials		kg											

Table 4-4 Results of Bit Works: MJP-1 ~ MJP-10

MJP-1

Item		Depth (m): 0 - 8.60	8.60 ∿ 100.80	
Circulating water		Bentonite mud	Bentonite mud	
Change bit		NC 0	NX 1	
Pump	Pressure (kg/cm^2)	0	5 ∿ 7	
	Suction volume (ℓ/min)	60	60	
	Output volume (ℓ/min)	0 ∿ 60	0	
Bit	Load (kg)	100 - 200	800 ∿ 1000	
	Speed (rpm)	100	200 ∿ 250	
Core recovery (%)		100	98.2	

MJP-2

Item		Depth (m): 0 ∿ 6.50	6.50 ∿ 72.90	72.90 ∿ 100.00
Circulating water		Bentonite mud	Bentonite mud	Bentonite mud
Change bit		NC 1	NX 1	BX 1
Pump	Pressure (kg/cm^2)	0 ∿ 2	0 ∿ 5	5 ∿ 8
	Suction volume (ℓ/min)	70	60	50
	Output volume (ℓ/min)	70	60	50
Bit	Load (kg)	50 ∿ 100	500 ∿ 600	500 ∿ 600
	Speed (rpm)	100	200 ∿ 250	200 ∿ 250
Core recovery (%)		79.5	96.9	100

Table 4-4 Continued

MJP-3

Item \ Depth (m)		0.00 ∿ 4.10	4.10 ∿ 54.50	54.50 ∿ 100.00
Circulating water		Bentonite mud	Bentonite mud	Bentonite mud
Change bit		NC 0	NX 1	BX 1
Pump	Pressure (kg/cm^2)	0 ∿ 2	0 ∿ 5	7 ∿ 10
	Suction volume (ℓ/min)	70	60	50
	Output volume (ℓ/min)	70	0 ∿ 60	0 ∿ 50
Bit	Load (kg)	50 ∿ 100	500 ∿ 1000	800 ∿ 1000
	Speed (rpm)	100	200 ∿ 250	200 ∿ 250
Core recovery (%)		91.5	100	99.3

MJP-4

Item \ Depth (m)		0.00 ∿ 4.20	4.20 ∿ 51.75	51.75 ∿ 100.00
Circulating water		Bentonite mud	Bentonite mud	Bentonite mud
Change bit		NC 0	NX 1	BX 1
Pump	Pressure (kg/cm^2)	0 ∿ 2	2 ∿ 4	4 ∿ 7
	Suction volume (ℓ/min)	70	60	50
	Output volume (ℓ/min)	70	60	50
Bit	Load (kg)	50 ∿ 100	500 ∿ 600	500 ∿ 600
	Speed (rpm)	100	200 ∿ 250	200 ∿ 250
Core recovery (%)		100.0	98.5	99.6

Table 4-4 Continued

MJP-5

Item \ Depth (m)		0.00 ∿ 5.50	5.50 ∿ 56.25	56.25 ∿ 100.10
Circulating water		Bentonite mud	Bentonite mud	Bentonite mud
Change bit		NC 0	NX 1	BX 2
Pump	Pressure (kg/cm^2)	0 ∿ 2	0 ∿ 7	10
	Suction volume (ℓ/min)	70	60	50
	Output volume (ℓ/min)	70	60	50
Bit	Load (kg)	50 ∿ 100	500 ∿ 1000	800 ∿ 1000
	Speed (rpm)	100	200 ∿ 250	200 ∿ 250
Core recovery (%)		100	98.9	97.9

MJP-6

Item \ Depth (m)		0 ∿ 11.0	11.00 ∿ 50.65	50.65 ∿ 100.80
Circulating water		Bentonite mud	Bentonite mud	Bentonite mud
Change bit		NC 0	NX 1	BX 0
Pump	Pressure (kg/cm^2)	0 ∿ 2	0	0
	Suction volume (ℓ/min)	70	60	50
	Output volume (ℓ/min)	0	0	0
Bit	Load (kg)	50 ∿ 100	500 ∿ 600	500 ∿ 600
	Speed (rpm)	100	200 ∿ 250	200 ∿ 250
Core recovery (%)		91.8	54.7	83.4

Table 4-4 Continued

MJP-7

Item \ Depth (m)		0.00 ∿ 3.50	3.50 ∿ 55.20	55.20 ∿ 100.00
Circulating water		Bentonite mud	Bentonite mud	Bentonite mud
Change bit		NC 0	NX 0	BX 1
Pump	Pressure (kg/cm^2)	0 ∿ 2	0 ∿ 7	0 ∿ 13
	Suction volume (ℓ/min)	70	60	50
	Output volume (ℓ/min)	70	60	0 ∿ 50
Bit	Load (kg)	50 ∿ 100	500 ∿ 600	1000 ∿ 1200
	Speed (rpm)	100	200 ∿ 250	200 ∿ 250
Core recovery (%)		100	100	98.7

MJP-8

Item \ Depth (m)		0.00 ∿ 12.25	12.25 ∿ 59.70	59.70 ∿ 100.20
Circulating water		Bentonite mud	Bentonite mud	Bentonite mud
Change bit		NC 0	NX 1	BX 0
Pump	Pressure (kg/cm^2)	0 ∿ 2	0 ∿ 7	0 ∿ 14
	Suction volume (ℓ/min)	70	60	50
	Output volume (ℓ/min)	0 ∿ 70	0 ∿ 60	0 ∿ 50
Bit	Load (kg)	50 ∿ 100	500 ∿ 600	1000 ∿ 1200
	Speed (rpm)	100	200 ∿ 250	200 ∿ 250
Core recovery (%)		97.6	98.4	99.5

Table 4-4 Continued

MJP-9

Item \ Depth (m)		0.00 ∿ 3.70	3.70 ∿ 46.55	46.55 ∿ 100.00
Circulating water		Bentonite mud	Bentonite mud	Bentonite mud
Change bit		NC 0	NX 1	BX 0
Pump	Pressure (kg/cm^2)	0 ∿ 2	0 ∿ 5	5 ∿ 7
	Suction volume (ℓ/min)	70	60	60
	Output volume (ℓ/min)	0 ∿ 70	60	60
Bit	Load (kg)	50 ∿ 100	500 ∿ 600	500 ∿ 600
	Speed (rpm)	100	200 ∿ 250	200 ∿ 250
Core recovery (%)		91.9	99.9	100.0

MJP-10

Item \ Depth (m)		0.00 ∿ 4.20	4.20 ∿ 56.20	56.20 ∿ 100.00
Circulating water		Bentonite mud	Bentonite mud	Bentonite mud
Change bit		NC 0	NX 0	BX 1
Pump	Pressure (kg/cm^2)	0 ∿ 2	0	5 ∿ 7
	Suction volume (ℓ/min)	70	60	60
	Output volume (ℓ/min)	70	0 ∿ 60	30 ∿ 60
Bit	Load (kg)	50 ∿ 100	500 ∿ 600	500 ∿ 600
	Speed (rpm)	100	200 ∿ 250	200 ∿ 250
Core recovery (%)		100	99.7	96.5

After the insertion, digging was continued using a NX-WL diamond bit, but it became very difficult by continuous lost circulation of water and breaking of walls. For this countermeasure, the casing was extended to 8.60 m to take as a mouth pipe.

The rate of core recovery in this section was 100%.

8.60 - 100.80 m: Dacitic welded tuff, sand and gravel layers

The digging was done using NX-WL diamond bits, in 60 lit./minute of water supply, 200 - 300 rpm of bit rotation and 800 - 1000 kg of bit load.

The rocks were composed of middle hard dacitic welded tuff until 43.55 m and soft sand and gravel layers after that.

In the drilling operation lost circulation of all water happened in a depth of about 13.00 m but the digging was continued as it was. In the sand and gravel layers, however, breaking of bore hole became heavy and the resistance in the hole increased. As a measure against this, grease was applied on the rods to reduce the resistance in the hole.

The digging work was finished at the depth of 100.80 m.

The core recovery in this section was 98.2%.

(2) MJP-2 Hole

0 - 6.50 m: Sand, silt, clay

The digging was done using NC-WL diamond bits and a 90 m casing was inserted to take as a mouth pipe.

The core recovery in this section was 79.5%.

6.50 - 72.90 m: Sand, silt, clay, rhyolitic tuff

The digging was done using NX-WL diamond bits in 60 lit./minute of water supply, 250 - 300 rpm of bit rotation and 500 - 600 kg of bit load.

The rocks in the section were composed of sand, silt and clay up to 43.55 m and rhyolitic tuff of medium hard rock after that depth.

The digging was done smoothly without any trouble in the section in a complete circuration of mud water and a good discharging of slime.

During the digging, some trouble occurred on the drilling machine and was repaired by a mechanic called from Lima.

When the digging arrived to 72.90 m, 73 mm casings were inserted to the bottom of the bore.

The core recovery in this section was 96.9%.

72.90 - 100.00 m: Rhyolitic tuff

The digging was done using BX-WL diamond bits in 50 lit./minute of water supply, 250 - 300 rpm of bit rotation and 500 - 600 kg of bit load.

The rock was a middle hard rock composed of rhyolitic tuff and the core was recovered in a rod shape.

The digging was done smoothly in a complete circuration of mud water and a good discharging of slime.

The digging work was finished at 100.00 m of the predetermined depth.

The core recovery in this section was 100%.

(3) MJP-3 Hole

0 - 4.10 m: Sand, pumice

The digging was done using a NX-XL diamond bit to 4.10 m and the bore was expanded further by a NC-WL diamond bit. After that, a 90 mm casing was inserted to take as a mouth pipe.

The core recovery in this section was 91.5%.

4.10 - 54.50 m: Sand, gravel, andesite

The digging was done using NX-WL diamond bits in 60 lit/minute of water supply, 250 - 300 rpm of bit rotation and 500 - 1000 kg of bit load.

The rocks in this section were composed of sand mixed with gravels up to 16.40 m and andesite of medium hard rock after that depth. The andesite section was shared throughout and had many cracks.

In the drilling operation, lost circulation started at the depth of near 20 m (discharge quantity: 50%) and the bore was digged to 28.40 m without recovery, but the resistance in the bore increased more and more by lost circulation and collapse of the wall. For a measure of this, cementing was done by rod injection method.

After the hardening of cement, cement cutting and digging were done using the NX-WL diamond bit and the cementing effect prevented the lost circulation and collapse of the wall, so the bore was digged smoothly. When the digging arrived to 54.50 m, 73 mm casings were inserted to the bottom of the bore.

The core recovery in this section was 100%.

54.50 - 100.00 m: Andesite, andesitic tuff

The digging was done using BX-WL diamond bits in 50 lit./minute of water supply, 250 - 300 rpm of bit rotation and 800 - 1000 kg of bit load.

The rock was a middle hard rock composed of andesite and andesitic tuff with cracks throughbut the section. The section from 96.30 to 96.60 m was quartz vein and from 98.80 to 99.20 m was a strongly silicified rocks.

Although the core was clogged by cracks and lost circulation occurred at near 99 m, the digging was done smoothly without any trouble in the bore.

The digging work was finished at the predetermined depth of 100.00 m.

The core recovery in this section was 99.3%.

(4) MJP-4 Hole

0 - 4.20 m: Gravel, sand, silt

The digging was done using a NX-WL diamond bit and the bore was expanded furthermore by a NC-WL diamond bit. After the expansion of the bore, a 90 mm casing was inserted to take as a mouth pipe.

The core recovery in this section was 100.0%.

4.20 - 51.75 m: Gravel, sand, silt, andesite, andesitic tuff breccia

The digging was done using NX-WL diamond bits in 50 lit./minute of water supply, 150 rpm of bit rotation and 500 - 600 kg of bit load.

This section was composed of gravel, sand and silt up to 34.55 m, and andesite and medium hard andesitic tuff breccia after that depth.

The mud water was circulated completely but the section of gravel, sand and silt was soft and clayey. Recovery of core was tried to increase through reduction of the rod rotation and the quantity of water supply. When arrived to 51.75 m, 73 mm casings were inserted to the bottom of the bore.

The core recovery in this section was 98.5%.

51.75 - 100.00 m: Andesite

The digging was done using BX-WL diamond bits in 50 lit./minute of water supply, 250 - 300 rpm of bit rotation and 500 - 600 kg of bit load.

This section was composed of medium hard andesite with cracks.

The digging was done smoothly without any trouble under complete circuration of mud water.

The digging work was finished at the predetermined depth of 100.00 m.

The core recovery in this section was 99.6%.

(5) MJP-5 Hole

0 - 5.50 m: Clayey soil

The digging was done using a NX-WL diamond bit to 5.50 m and then the bore was expanded by a NC-WL diamond bit. After the expansion, a 90 mm casing was inserted to take as a mouth pipe.

The core recovery in this section was 100.0%.

5.50 - 56.25 m: Clayey soil, andesite

The digging was done using NX-WL diamond bits in 60 lit./minute of water supply, 250 - 300 rpm of bit rotation and 500 - 1000 kg of bit load.

This section was composed of soft or medium hard andesite with cracks. In the section between 22.70 and 44.85 m iron oxide occurs in cracks and between 44.85 and 54.40 m pyrite dissemination exists considerably.

The digging was done smoothly without any trouble under complete circulation of mud water. At the depth of 56.25 m, 73 mm casings were inserted to the bottom of the bore.

The core recovery in this section was 98.9%.

56.25 - 100.10 m: Andesite, strongly silicified rock

The digging was done using BX-WL diamond bits in 50 lit./minute of water supply, 250 to 300 rpm of bit rotation and 800 to 1000 kg of bit load.

This section is composed of medium hard andesite and strongly silicified rock with abundant cracks. The section between 61.90 m and 83.30 m has strong pyrite dissemination, between 83.30 m and 95.35 m is composed of silicified rock and between 95.35 m and 97.80 is composed of gray porous quartz vein.

The digging was done smoothly without any trouble under complete circuration of mud water.

The digging work was finished at the depth of 100.10 m.

The core recovery in this section was 97.9%

(6) MJP-6 Hole

0 - 11.00 m: Talus deposit, andesite

The digging was done up to 4.00 using a NC-WL diamond bit and a 90 mm casing was inserted. After the insertion of the casing, the digging was further done using a NX-WL diamond bit, but it became very hard due to lost circulation of all water and breaking of the wall. As a countermeasure against this, a 90 mm casing was inserted up to 11.00 m to take as a mouth pipe.

The core recovery in this section was 91.8%.

11.00 - 50.65 m: Andesite, andesitic volcanic breccia

The digging was done using NX-WL diamond bits in 60 lit./minute of water supply, 100 to 200 rpm of bit rotation and 500 to 600 kg of bit load.

This section is composed of andesite, and andesitic volcanic breccia tuff breccia to (very loose because of unconsolidated to semiconsolidated and partly sandy matrix composed of andesitic ash). Collapse of wall and lost circulation of all water happened at the depth of 15.05 m and for the measure of it cementing was executed. But the lost circulation did not recover. The digging was continued in unrecovered condition, but vibration of rods became strong causing collapse of wall and increasement of resistance of the bore. As a measure of it, lifting and falling of rods were repeated, to down the broken material of the wall on the bottom of the bore and grease was applied on the rods to reduce the resistance of the bore.

But, jamming trouble of rods due to collapse of wall happened at the depths of 47.90 m, 48.55 m, 49.15 m and 50.65 m. As the recovering work of the trouble, recovery work of rods by weight hammer and cementing were executed. After digging up to 50.65 m, 73 mm casings were inserted.

The unconsolidated sandy part in this section could not be recovered, though nonwater drilling method was applied and a special core catcher was used to improve the core recovery. The core recovery in this section was 54.7%.

50.65 - 100.80 m: Andesite, andesitic volcanic breccia to tuff breccia

The digging was done using a BX-WL diamond bit on 50 lit./minute of water supply, 100 to 200 rpm of bit rotation and 500 to 600 kg of bit load.

This section is composed of andesite and andesitic volcanic breccia to tuff breccia (loose, same as those of upper section).

In drilling this section, lost circulation of all water and collapse of the wall happened at the depth of 62.60 m. As a countermeasure against it, cementing was carried out but the lost circulation was not recovered though the collapse of wall was prevented.

The digging was continued up to 100.80 m under lost circulation of all mud water. After that jamming of the rod caused at 57.00 m during lifting of the rod. As a countermeasure of it, hitting of the monkane and inside-tapping were operated but the rod of 9 m and the outer tube was impossible to recover.

Also the 73 mm casing could not be recovered.

The core recovery in this section was 83.4%.

(7) MJP-8 Hole

0 - 3.50 m: White argillized rocks

The digging was done using a NX-WL diamond bit up to 3.50 m and the bore was expanded by a NC-WL diamond bit. After the expansion, a 90 mm casing was inserted to take as a mouth pipe.

The core recovery in this section was 100%.

3.50 - 55.20 m: White argillized rock, andesite

The digging was done using a NX-WL diamond bit in 60 lit./minute of water supply, 250 to 300 rpm of bit rotation and 1000 to 1200 kg of bit load.

This section is composed of medium hard white argillized rock and andesite with cracks. The sections between 22.40 and 34.70 m and between 45.00 and 49.50 m are composed of argillized alteration zone.

Although core clogging was remarkable because of many cracks, the digging was smoothly done without any trouble under complete circulation of mud water. When the digging arrived to 55.20 m, 73 mm casings were inserted to the bottom of the bore.

The core recovery was 100% in this section.

55.20 - 100.00 m: Andesite, andesitic tuff

The digging was done using BX-WL diamond bits in 50 lit./minute of water supply, 250 to 300 rpm of bit rotation and 1000 to 1200 kg of bit load.

This section is composed of medium hard andesite and andesitic tuff. The sections between 57.90 m and 67.00 m and between 73.30 m to 76.40 m were argillized alteration zone.

The digging was continued under lost circulation of all mud water occurred at 72.30 m, but collapse of wall became strong and the resistance of bore increased. As a countermeasure against it, cementing was carried out by rod injection method.

After the cementing, the digging was continued up to 100.00 m and the work was finished.

The core recovery in this section was 98.7%.

(8) MJP-8 Hole

0 - 12.25 m: Strongly argillized alterated rock

The digging was done using a NX-WL diamond bit up to 12.25 m and the bore was expanded by a NC-WL diamond bit. After the expansion, a 90 mm casing was inserted to take as a mouth pipe.

This section is composed of strongly argillized alterated rock, and the sections between 7.55 m and 8.75 m and between 9.90 m and 10.45 m are composed of brown massive iron oxide and between 9.10 m and 9.90 m silicified rock.

The core recovery in this section was 97.6%.

12.25 - 59.70 m: Strongly argillized altered rock, andesite, andesitic tuff breccia

The digging was done using NX-WL diamond bits in 60 lit./minute of water supply, 250 to 300 rpm of bit rotation and 1000 to 1200 kg of bit load.

This section is composed of medium hard strongly argillized altered rock, andesite and andesitic tuff breccia with cracks, and quartz vein occurs in 46.85 to 46.95 m. In drilling this section, lost circulation of all mud water continued and the resistance of the bore increased. As a countermeasure against this, 73 mm casings were inserted to 59.70 m. The core recovery in this section was 98.4%.

59.70 - 100.20 m: Andesite, andesitic tuff breccia

The digging was done using a BX-WL diamond bit in 50 lit./minute of water supply, 250 to 300 rpm of bit rotation and 1000 to 1200 kg of bit load.

This section is composed of medium hard andesite and andesitic tuff breccia.

The digging was smoothly done without any trouble, though lost circulation occurred at 93 m.

The digging work was finished at the depth of 100.20 m.

The core recovery in this section was 99.5%.

(9) MJP-9 Hole

0 - 3.70 m: Talus deposit, strongly altered rock

The digging was done using a NX-WL diamond bit and the bore was expanded by a NC-WL diamond bit. After the expansion, 90 mm casings were inserted to take as a mouth pipe.

The rocks between 1.50 m and 3.70 m are composed of heavy silicified rocks and lost circulation occurred in the depth of 2.40 m.

The core recovery was 91.90%.

3.70 - 46.55 m: Strongly altered rock, rhyolitic tuff

The digging was done using a NX-WL diamond bit in 60 lit./minute of water supply, 250 to 300 rpm of bit rotation and 500 to 600 kg of bit load.

This section is composed of strongly altered rock and medium hard rhyolitic tuff which was extracted in lod-shape core and strongly silicified rock occurring in the depth between 3.70 m and 14.90 m.

In drilling, lost circulation and collapse of wall occurred in the strongly altered part and the digging became very hard. As a countermeasure against it, cementing was carried out by rod injection method. As the result, mud water circulated completely and the lost circulation stopped.

The more deeper section than 14.90 m was composed of steady rhyolitic tuff and the digging was done smoothly without any trouble.

When the digging arrived to 46.55 m, 73 mm casings were inserted to the bottom of the bore.

The core recovery in this section was 99.9%.

46.55 - 100.00 m: Rhyolitic tuff

The digging was done using a BX-WL diamond bit in 60 lit./minute of water supply, 250 to 300 rpm of bit revolution and 500 to 600 kg of bit load.

This section is composed medium hard rhyolitic tuff, and a strongly silicified zone and a quartz vein occur in the section of 74.65 to 76.00 m and 76.60 to 77.00 m respectively.

The digging was done smoothly under complete circulation of mud water without any trouble.

The digging work was finished at the predetermined depth of 100.00 m.

The core recovery in this section was 100.00%.

(10) MJP-10 Hole

0 - 4.20 m: Strongly silicified rock

The digging was done using a NX-WL diamond bit up to 4.20 m and the bore was expanded by a NC-WL diamond bit. After the expansion, a 90 mm casing was inserted to take as a mouth pipe.

The core recovery in this section was 100%.

4.20 - 56.20 m: Strongly altered rock, altered andesite, andesitic tuff

The digging was done using a NX-WL diamond bit in 60 lit./minute of water supply, 250 to 300 rpm of bit rotation and 500 to 600 kg of bit load.

This section is composed of medium hard strongly altered rock, altered andesite and andesitic tuff, and the sections between 4.20 m and 26.70 m and between 50.40 m to 53.15 m are argillized altered zone.

In drilling lost circulation and collapse of wall occurred in the strongly altered part and the resistance of the bore increased. As a countermeasure against it, cementing was done by rod injection method. As the result, mud water circulated and the collapse of wall stopped. Then lost circulation happened again at the depth of 27.00 m but collapse of wall did not occur, so the digging work was continued.

When the digging arrived to 56.20 m, 73 mm casings were inserted.

The core recovery in this section was 99.7%.

Table 4-5 (1) Summary of Drilling Results: MJP1

	Item	Working Period	Item of Working Period			Total Number of Workers
		Period	Number of Days	Actual Working Days	No Working Days	
Working period	Preparation	10th Aug.'86-21st Aug.'86	12 day	12 day	0 day	392 man
	Drilling	22nd Aug.'86-28th Aug.'86	7	Drilling 7	0	80
				Trouble 0	0	0
	* Dismounting	29th Aug.'86-2nd Sep.'86	5	3	2	96
	Total	10th Aug.'86-2nd Sep.'86	24	22	2	568

Drilling length, etc.			
Planned length	100.00 m	Over burden	0 m
Increase or de-crease in length	0.80 m	Core length	99.10 m
Length drilled	100.80 m	Core recovery	98.3 %

Core recovery for each 100 m section		
Depth of hole	Section	Total
0 - 100 m	98.3%	98.3%
100 - 200		
200 - 300		

	Item	Time	%	%
Working time	Drilling	74°00'	51.4%	27.2%
	Hoisting & lowering rod, casing	70°00'	48.6	25.7
	Repairing	0°00'	0	0
	Sub total	144°00'	100.0	52.9
	Preparations	96°00'		35.3
	* Dismounting	32°00'		11.8
		0°00'		
	Others	0°00'		
	Total	272°00'		100.0

Drilling efficiency		
Total drilling length/ Working period	14.4	m/day
Total drilling length/ Net working days	14.4	m/day
Total drilling length/ Net drilling days	14.4	m/day
Total drilling workers/ Total drilling length	0.79	man/m
Remarks		

	Pipe size & inserted length (m)	Inserted length / Drilling length ×100(%)	Recovery of casing pipe (%)
Inserting casing pipe	90mm 8.60m	8.5	100

Table 4-5 (2) Summary of Drilling Results: MJP2

	Item	Working Period	Item of Working Period			Total Number of Workers
		Period	Number of Days	Actual Working Days	No Working Days	
Working period	Preparation	3rd Aug.'86 - 9th Aug.'86	7	7	0	42
	Drilling	10th Aug.'86-21st Aug.'86	12	Drilling 10	0	83
				Trouble 2	0	16
	* Dismounting	22nd Aug.'86-25th Aug.'86	4	4	0	127
	Total	3rd Aug.'86-25th Aug.'86	23	23	0	268

Drilling length, etc.

Planned Length	100.00 m	Over burden	3.90 m
Increase or de-crease in length	0.00 m	Core length	97.95 m
Length drilled	100.00 m	Core recovery	98.0%

Core recovery for each 100 m section

Depth of hole	Section	Total
0 - 100 m	98 %	98 %
100 - 200 m		
200 - 300 m		

	Item			
Working time	Drilling	102°20'	55.6%	37.3%
	Hoisting & lowering rod, casing	55°10'	30.0	20.2
	Repairing	26°30'	14.4	9.7
	Sub total	184°00'	100.0	67.2
	Preparations	56°00'		20.4
	* Dismounting	34°00'		12.4
	Others			
	Total	274°00'		100.0

Drilling efficiency

Total drilling length/ Working period	8.3 m/day
Total drilling length/ Net working days	8.3 m/day
Total drilling length/ Net drilling days	10 m/day
Total drilling workers/ Total drilling length	0.83 man/m

Remarks

	Pipe size & inserted length (m)	Inserted length / Drilling length x100(%)	Recovery of casing pipe (%)
Inserting casing pipe	90mmx6.50m	6.5	100
	73mmx72.90m	72.9	100

Table 4-5 (3) Summary of Drilling Results: MJP3

	Item	Working Period	Item of Working Period			Total Number of Workers
		Period	Number of Days	Actual Working Days	No Working Days	
Working period	Preparation	12th Sep.'86 - 12th Sep.'86	1	1	0	31
	Drilling	13th Sep.'86-20th Sep.'86	8	Drilling 8	0	199
				Trouble	0	
	* Dismounting	21st Sep.'86-23rd Sep.'86	3	3	0	123
	Total	12th Sep.'86-23rd Sep.'86	12	12	0	353

Drilling length, etc.			
Planned length	100.00 m	Over burden	0 m
Increase or decrease in length	0.00 m	Core length	99.35m
Length drilled	100.00 m	Core recovery	99.4%

Core recovery for each 100 m section: Depth of hole	Section	Total
0 - 100 m	99.4%	99.4%
100 - 200 m		
200 - 300 m		

	Item	Time		
Working time	Drilling	80°30'	47.4%	36.6%
	Hoisting & lowering rod, casing	62°30'	36.8	28.4
	Repairing	27°00'	15.8	12.3
	Sub total	170°00'	100.0	77.3
	Preparations	18°00'		8.2
	* Dismounting	32°00'		14.5
	Others			
	Total	220°00'		100.0

Drilling efficiency	
Total drilling length/ Working period	12.50 m/day
Total drilling length/ Net working days	12.50 m/day
Total drilling length/ Net drilling days	12.50 m/day
Total drilling workers/ Total drilling length	1.99 man/m

Remarks

Inserting casing pipe	Pipe size & inserted length (m)	Inserted length / Drilling length ×100(%)	Recovery of casing pipe (%)
	90mmx4.10m	4.1	100
	73mmx54.50m	54.5	100

Table 4-5 (4) Summary of Drilling Results: MJP4

Item		Working Period	Item of Working Period			Total Number of Workers
		Period	Number of Days	Actual Working Days	No Working Days	
Working period	Preparation	17th Sep.'86 - 16th Sep.'86	0.5	0.5	0	30
	Drilling	17th Sep.'86-23rd Sep.'86	6.5	Drilling 6.5	0	81
				Trouble 0	0	0
	* Dismounting	24th Sep.'86-25th Sep.'86	2	2	0	54
	Total	17th Sep.'86-25th Sep.'86	9	9	0	165

Drilling length, etc.

Planned length	100.00 m	Over burden	0 m
Increase or de-crease in length	0.00 m	Core length	99.10 m
Length drilled		Core recovery	99.1 %

Core recovery for each 100 m section

Depth of hole	Section	Total
0 - 100 m	99.1%	99.1%
100 - 200 m		
200 - 300 m		

Working time

Drilling	81°40'	56.3%	48.0%
Hoisting & lowering rod, casing	63°20'	43.7	37.3
Repairing			
Sub total	145°00'	100.0	85.3
Preparations	7°00'		4.1
* Dismounting	18°00'		10.6
Others			
Total	170°00'		100.0

Drilling efficiency

Total drilling length/ Working period	15.4 m/day
Total drilling length/ Net working days	15.4 m/day
Total drilling length/ Net drilling days	15.4 m/day
Total drilling workers/ Total drilling length	0.81 man/m

Inserting casing pipe

Pipe size & inserted length (m)	Inserted length / Drilling length ×100(%)	Recovery of casing pipe (%)
90mmx4.20m	4.2%	100
73 x51.75	51.8	100

Remarks

Table 4-5 (5) Summary of Drilling Results: MJP5

	Item	Working Period: Period	Item of Working Period: Number of Days	Actual Working Days	No Working Days	Total Number of Workers
Working period	Preparation	3rd Sep.'86 - 3rd Sep.'86	1	1	0	30
	Drilling	4th Sep.'86 - 8th Sep.'86	5	Drilling 5	0	90
				Trouble 0	0	
	* Dismounting	9th Sep.'86 -11th Sep.'86	3	3	0	93
	Total	3rd Sep.'86 -11th Sep.'86	9	9	0	213

Drilling length, etc.

Planned length	100.00 m	Over burden	1.90 m
Increase or decrease in length	0.10 m	Core length	98.65 m
Length drilled	100.10 m	Core recovery	98.6%

Core recovery for each 100 m section

Depth of hole	Section	Total
0 - 100 m	99 %	99 %
100 - 200 m		
200 - 300 m		

	Item			
Working time	Drilling	60°20'	53.9%	37.7%
	Hoisting & lowering rod, casing	51°40'	46.1	32.3
	Repairing			
	Sub total	112°00'	100.0	70.0
	Preparations	12°00'		7.5
	* Dismounting	36°00'		22.5
	Others			
	Total	160°00'		100.0

Drilling efficiency

Total drilling length/ Working period	20.02 m/day
Total drilling length/ Net working days	20.02 m/day
Total drilling length/ Net drilling days	20.02 m/day
Total drilling workers/ Total drilling length	0.90 man/m

	Pipe size & inserted length (m)	Inserted length / Drilling length ×100(%)	Recovery of casing pipe (%)
Inserting casing pipe	90mmx5.50m	5.5	100
	73mmx56.25m	56.2	100

Remarks

Table 4-5 (6) Summary of Drilling Results: MJP6

Item		Working Period	Item of Working Period			Total Number of Workers
		Period	Number of Days	Actual Working Days	No Working Days	
Working period	Preparation	26th Aug.'86 - 26th Aug.'86	1	1	0	44
	Drilling	27th Aug.'86-14th Sep.'86	19	Drilling 11	1	118
				Trouble 7	0	90
	* Dismounting	15th Sep.'86-16th Sep.'86	2	2	0	84
	Total	26th Aug.'86-16th Sep.'86	22	21	1	336

Drilling length, etc.			
Planned length	100.00 m	Over burden	7.05 m
Increase or de-crease in length	0.80 m	Core length	73.65 m
Length drilled	100.80 m	Core recovery	73.0%

Core recovery for each 100 m section		
Depth of hole	Section	Total
0 - 100 m	73%	73%
100 - 200 m		
200 - 300 m		

	Drilling	113°40'	25.7%	24.3%
	Hoisting & lowering rod, casing	105°20'	23.8	22.6
Working time	Repairing	223°00'	50.5	47.7
	Sub total	442°00'	100.0	94.6
	Preparations	18°00'		3.9
	* Dismounting	7°00'		1.5
	Others			
	Total	467°00'		100.0

Drilling efficiency		
Total drilling length/ Working period	5.31	m/day
Total drilling length/ Net working days	5.60	m/day
Total drilling length/ Net drilling days	9.16	m/day
Total drilling workers/ Total drilling length	1.17	man/m

Remarks

Inserting casing pipe	Pipe size & inserted length (m)	Inserted length / Drilling length ×100(%)	Recovery of casing pipe (%)
	90mmx11m	10.9	100
	73 x50.65	50.2	54.9

Table 4-5 (7) Summary of Drilling Results: MJP7

	Item	Working Period	Item of Working Period				Total Number of Workers
		Period	Number of Days	Actual Working Days		No Working Days	
Working period	Preparation	4th Oct.'86 - 4th Oct.'86	1	1		0	42
	Drilling	5th Oct.'86 -12th Oct.'86	8	Drilling	7	0	108
				Trouble	1	0	22
	* Dismounting	13th Oct.'86-15th Oct.'86	3	3		0	72
	Total	4th Oct.'86 -15th Oct.'86	12	12		0	244

Drilling length, etc.			
Planned length	100.00 m	Over burden	0 m
Increase or de-crease in length	0.00 m	Core length	99.40 m
Length drilled	100.00 m	Core recovery	99.4%

Core recovery for each 100 m section		
Depth of hole	Section	Total
0 - 100 m	99.4%	99.4%
100 - 200 m		
200 - 300 m		

Working time	Drilling	88°30'	49.2%	41.8%
	Hoisting & lowering rod, casing	43°30'	24.2	20.5
	Repairing	48°00'	26.6	22.6
	Sub total	180°00'	100.0	84.9
	Preparations	10°00'		4.7
	* Dismounting	22°00'		10.4
	Others			
	Total	212°00'		100.0

Drilling efficiency		
Total drilling length/ Working period	12.50	m/day
Total drilling length/ Net working days	12.50	m/day
Total drilling length/ Net drilling days	14.3	m/day
Total drilling workers/ Total drilling length	1.08	man/m

Remarks

Inserting casing pipe	Pipe size & inserted length (m)	Inserted length / Drilling length ×100(%)	Recovery of casing pipe (%)
	90mmx3.50m	3.5	100
	73mmx55.20m	55.2	100

Table 4-5 (8) Summary of Drilling Results: MJP8

	Item	Working Period	Item of Working Period			Total Number of Workers
		Period	Number of Days	Actual Working Days	No Working Days	
Working period	Preparation	24th Sep.'86 - 24th Sep.'86	1	1	0	42
	Drilling	25th Sep.'86-2nd Oct.'86	8	Drilling 8	0	165
				Trouble 0	0	
	* Dismounting	3rd Oct.'86 - th	1	1	0	42
	Total	24th Sep.'86-3rd Oct.'86	10	10	0	249

Drilling length, etc.			
Planned length	100.00 m	Over burden	0 m
Increase or decrease in length	0.20 m	Core length	98.95 m
Length drilled	100.20 m	Core recovery	98.8%

Core recovery for each 100 m section		
Depth of hole	Section	Total
0 - 100 m	98.8%	98.8%
100 - 200 m		
200 - 300 m		

	Drilling	83°10'	49.2%	41.6%
	Hoisting & lowering rod, casing	72°50'	43.1	36.4
	Repairing	13°00'	7.7	6.5
Working time	Sub total	169°00'	100.0	84.5
	Preparations	19°00'		9.5
	* Dismounting	12°00'		6.0
	Others			
	Total	200°00'		100.0

Drilling efficiency	
Total drilling length/ Working period	12.53 m/day
Total drilling length/ Net working days	12.53 m/day
Total drilling length/ Net drilling days	12.53 m/day
Total drilling workers/ Total drilling length	1.65 man/m

Remarks

Inserting casing pipe	Pipe size & inserted length (m)	Inserted length / Drilling length ×100(%)	Recovery of casing pipe (%)
	90mmx12.25m	12.2	100
	73mmx59.70m	59.6	100

Table 4-5 (9) Summary of Drilling Results: MJP9

	Item	Working Period	Item of Working Period			Total Number of Workers
		Period	Number of Days	Actual Working Days	No Working Days	
Working period	Preparation	6th Oct.'86 - 6th Oct.'86	1	1	0	42
	Drilling	7th Oct.'86 -13th Oct.'86	7	Drilling 7	0	148
				Trouble 0	0	
	* Dismounting	14th Oct.'86-15th Oct.'86	2	2	0	48
	Total	6th Oct.'86 -15th Oct.'86	10	10	0	238

Drilling length, etc.			
Planned length	100.00 m	Over burden	1.5 m
Increase or decrease in length	0.00 m	Core length	99.65 m
Length drilled	100.00 m	Core recovery	99.7%

Core recovery for each 100 m section		
Depth of hole	Section	Total
0 - 100 m	99.7%	99.7%
100 - 200 m		
200 - 300 m		

	Item	Time	%	%
	Drilling	76°20'	50.2%	42.4%
	Hoisting & lowering rod, casing	55°40'	36.6	30.9
Working time	Repairing	20°00'	13.2	11.1
	Sub total	152°00'	100.0	84.4
	Preparations	6°00'		3.3
	* Dismounting	22°00'		12.3
	Others			
	Total	180°00'		100.0

Drilling efficiency		
Total drilling length/ Working period	14.29	m/day
Total drilling length/ Net working days	14.29	m/day
Total drilling length/ Net drilling days	14.29	m/day
Total drilling workers/ Total drilling length	1.48	man/m

Remarks

Inserting casing pipe	Pipe size & inserted length (m)	Inserted length / Drilling length ×100(%)	Recovery of casing pipe (%)
	90mmx3.70m	3.7	100
	73 x46.55	46.6	100

Table 4-5 (10) Summary of Drilling Results: MJP10

	Item	Working Period Period	Item of Working Period Number of Days	Actual Working Days	No Working Days	Total Number of Workers
Working period	Preparation	26th Sep.'86 - 26th Sep.'86	1	1	0	42
	Drilling	27th Sep.'86-4th Oct.'86	8	Drilling 8	0	180
				Trouble	0	0
	* Dismounting	5th Oct.'86 - th	1	1	0	27
	Total	26th Sep.'86-5th Oct.'86	10	10	0	249

Drilling length, etc.

Planned length	100.00 m	Over burden	0 m
Increase or decrease in length	0.00 m	Core length	98.30 m
Length drilled	100.00 m	Core recovery	98.3%

Core recovery for each 100 m section

Depth of hole	Section	Total
0 - 100 m	98.3%	98.3%
100 - 200 m		
200 - 300 m		

Working time

	Item	Time		
	Drilling	88°40'	49.8%	42.6%
	Hoisting & lowering rod, casing	72°20'	40.6	34.8
Working time	Repairing	17°00'	9.6	8.2
	Sub total	178°00'	100.0	85.6
	Preparations	13°00'		6.2
	* Dismounting	17°00'		8.2
	Others			
	Total	208°00'		100.0

Drilling efficiency

Total drilling length/ Working period	12.5 m/day
Total drilling length/ Net working days	12.5 m/day
Total drilling length/ Net drilling days	12.5 m/day
Total drilling workers/ Total drilling length	1.8 man/m

Inserting casing pipe

Pipe size & inserted length (m)	Inserted length / Drilling length ×100(%)	Recovery of casing pipe (%)
90mmx4.20	4.2	100
73mmx56.20m	56.2	100

Remarks

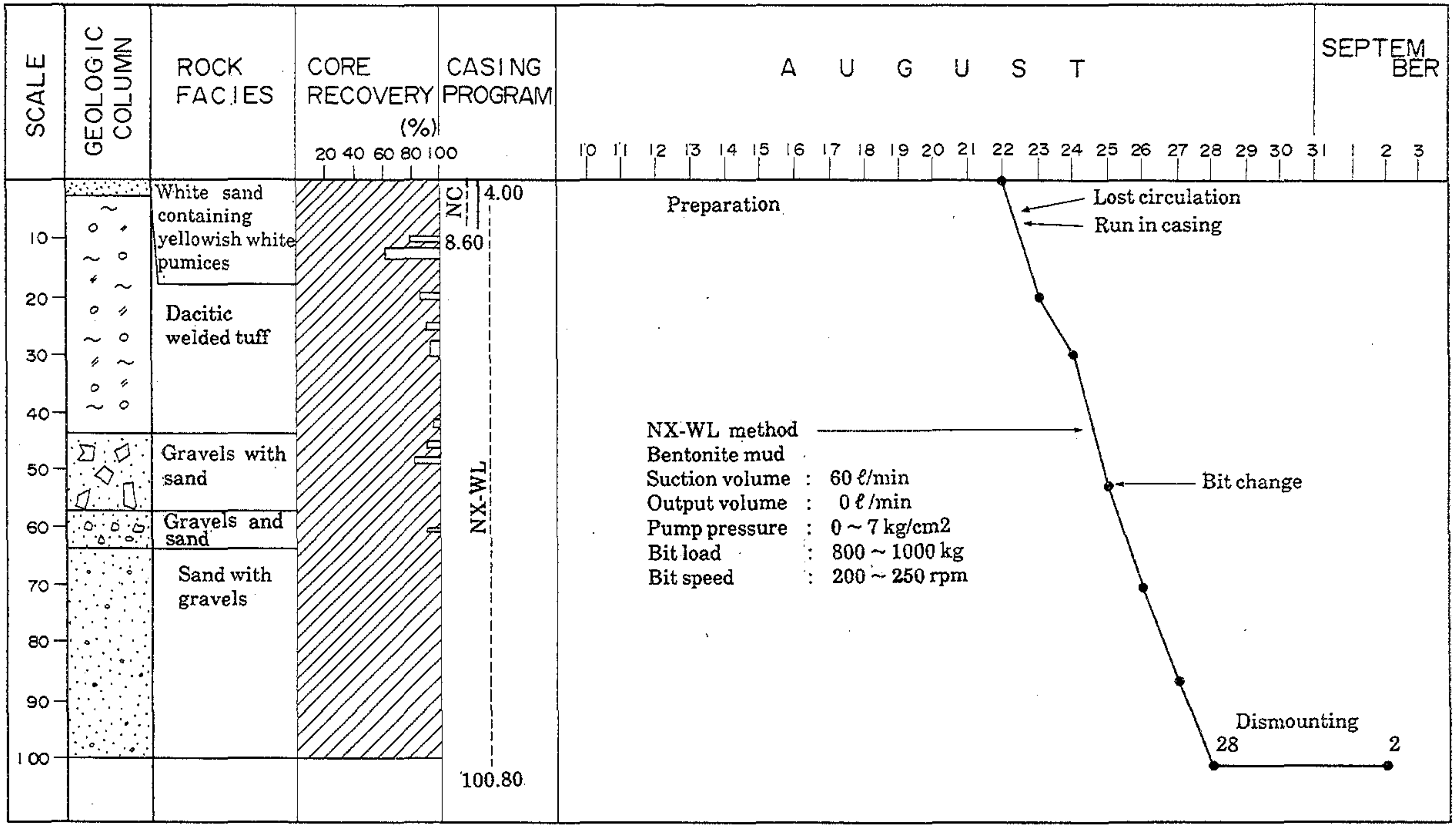


Fig. 4-2 (1) Drilling Progress of the Pirca Area (MJP- 1)

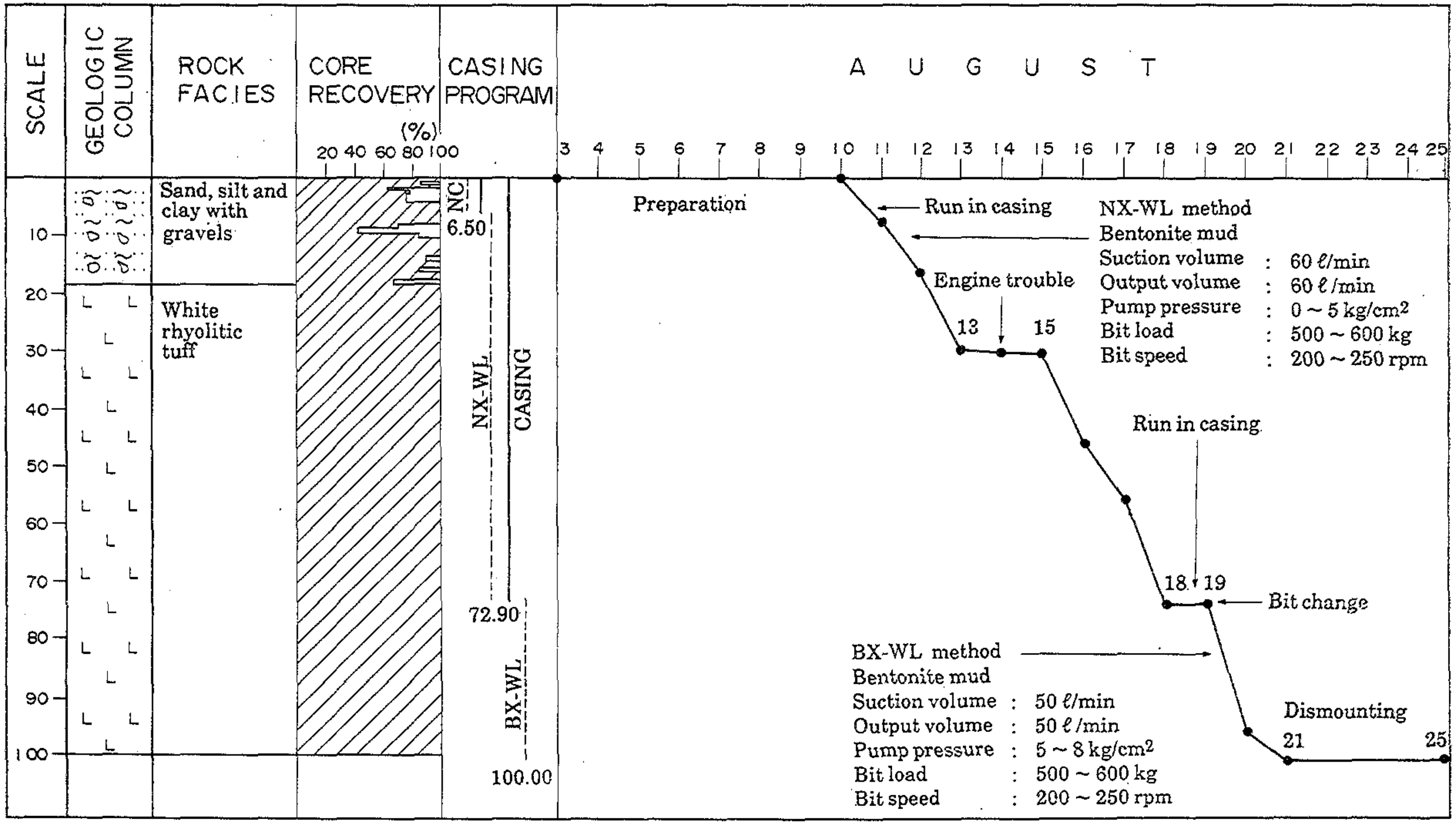


Fig. 4-2 (2) Drilling Progress of the Pirca Area (MJP- 2)

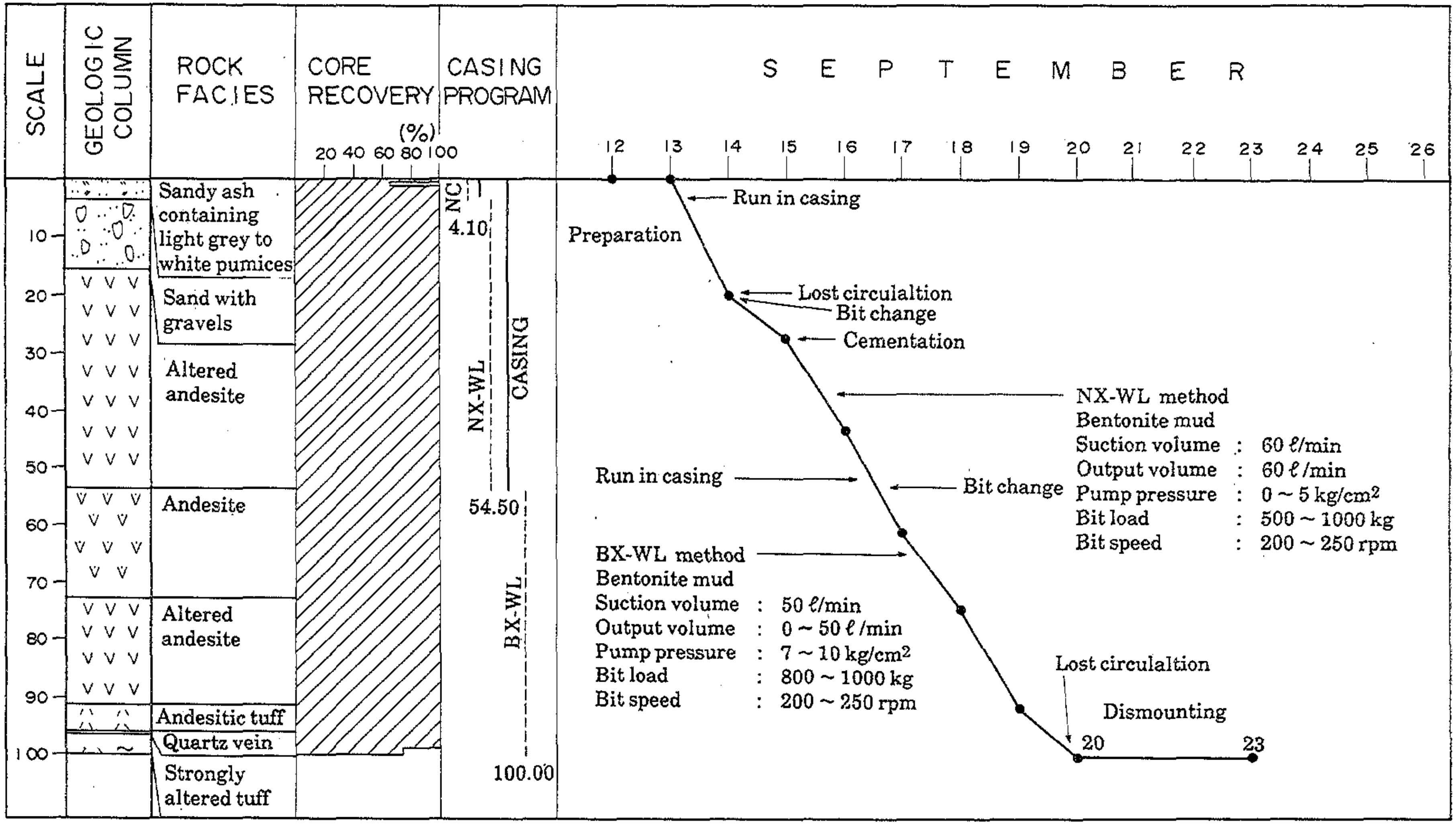


Fig. 4-2 (3) Drilling Progress of the Pirca Area (MJP- 3)

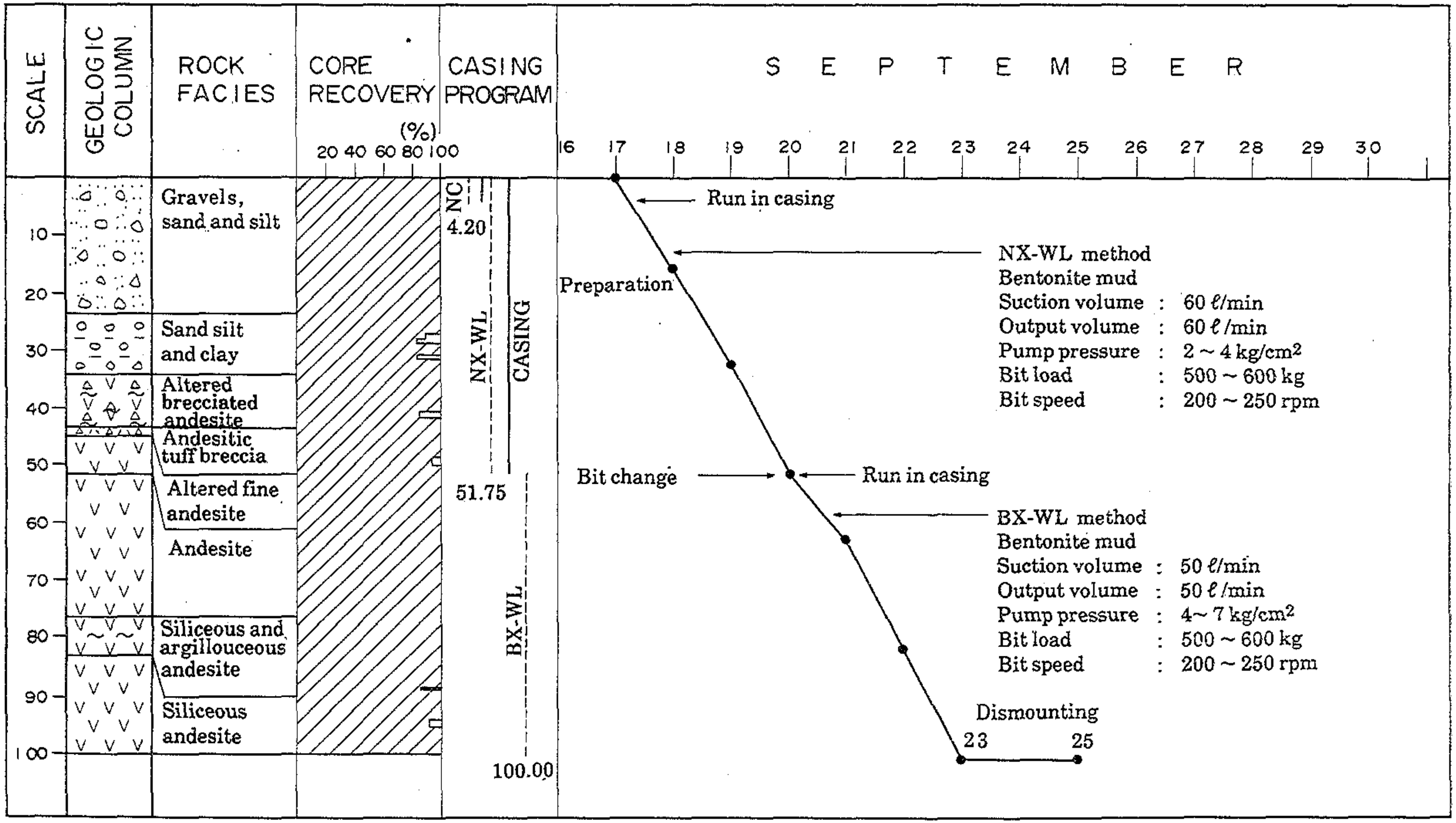


Fig. 4-2 (4) Drilling Progress of the Pirca Area (MJP-4)

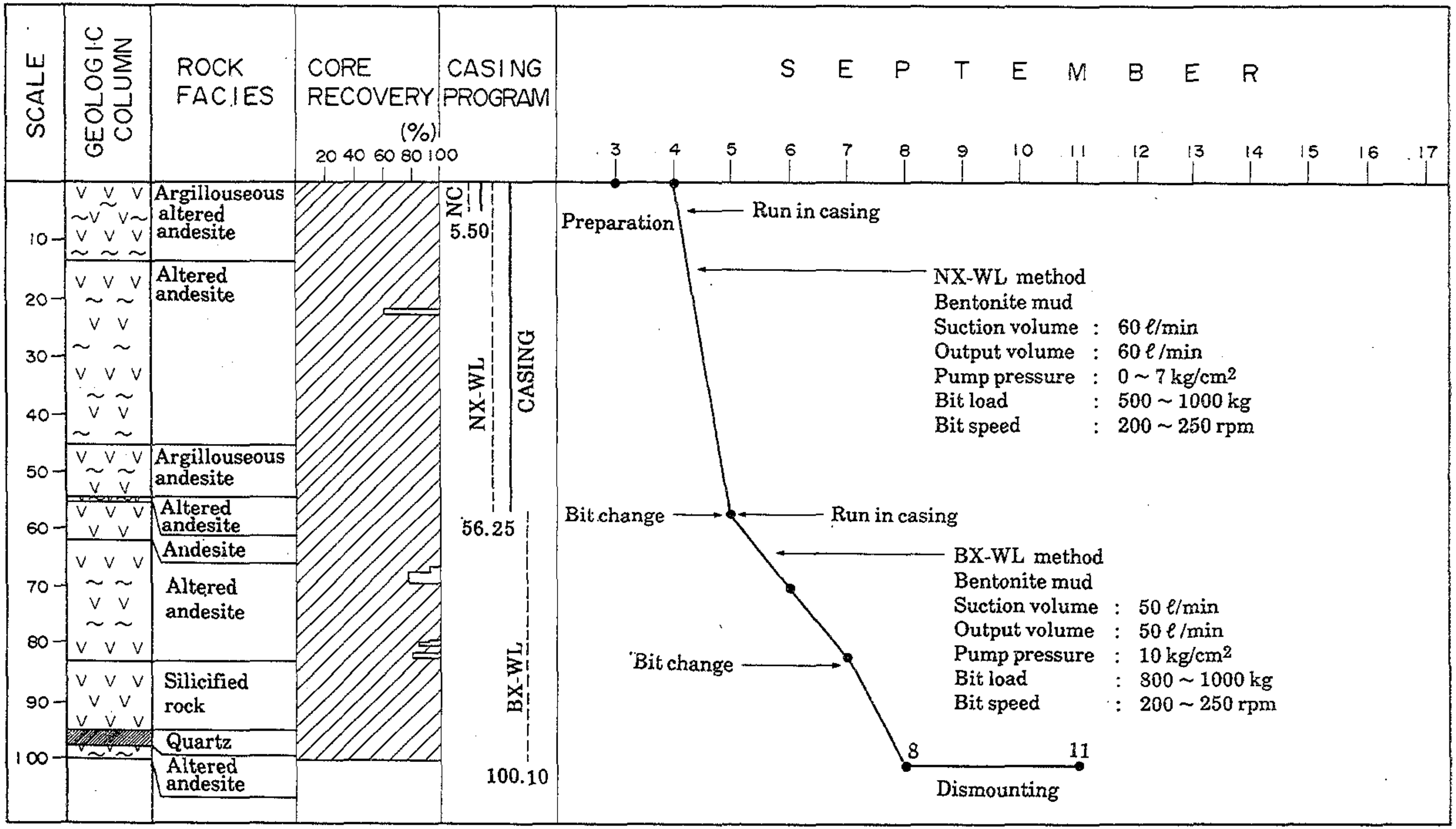


Fig. 4-2 (5) Drilling Progress of the Pirca Area (MJP- 5)

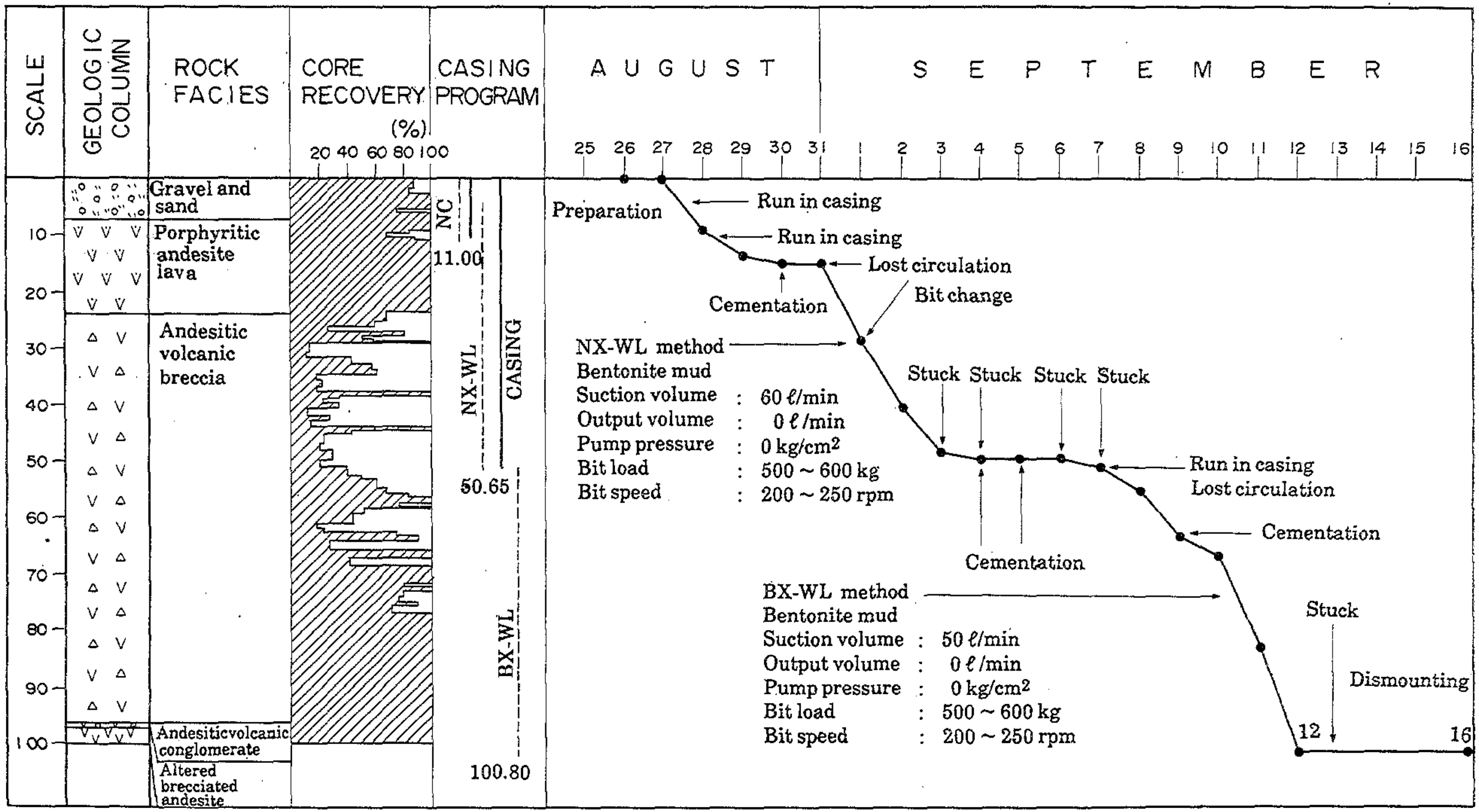


Fig. 4-2 (6) Drilling Progress of the Pirca Area (MJP- 6)

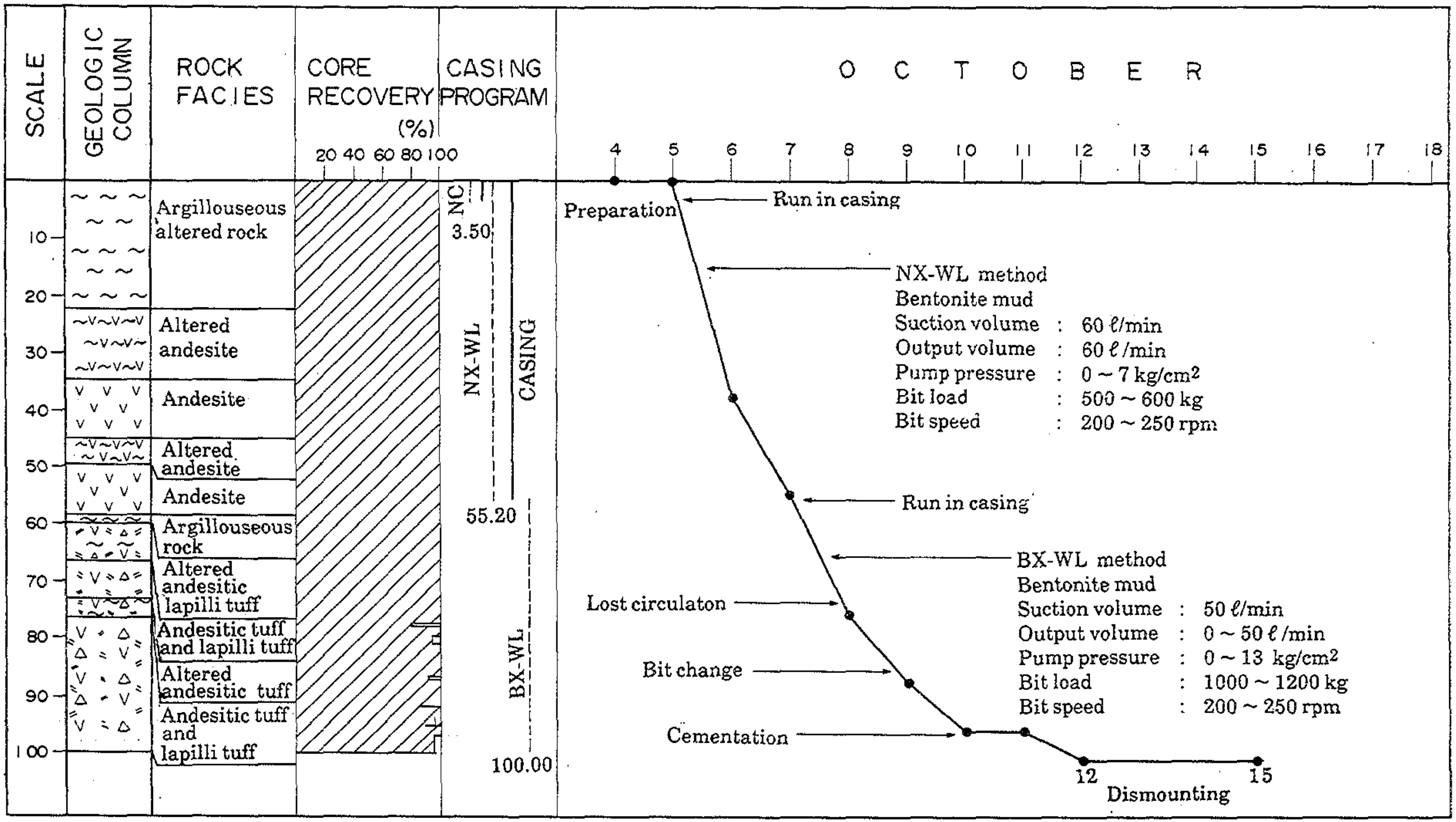


Fig. 4-2 (7) Drilling Progress of the Pirca Area (MJP-7)

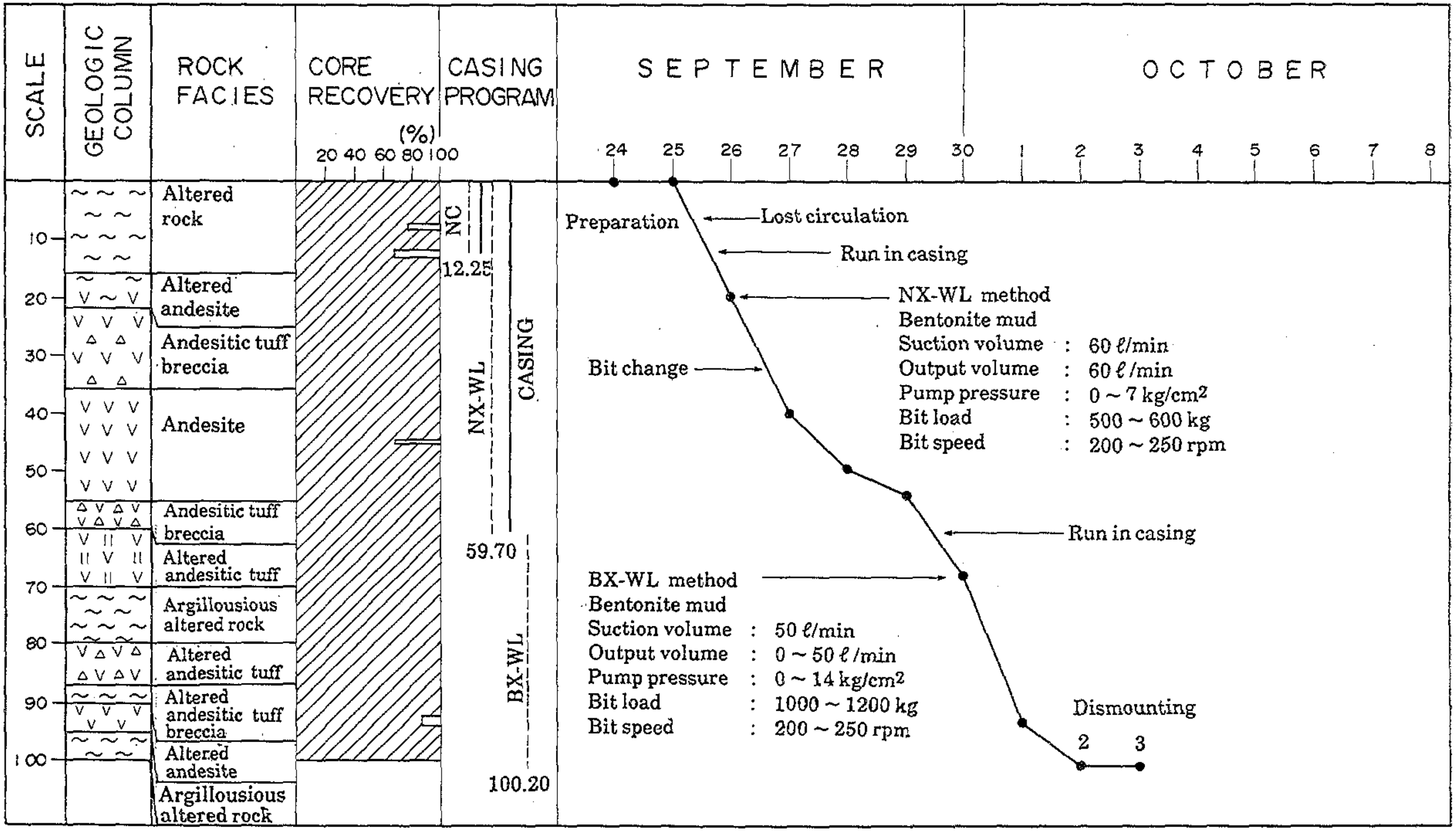


Fig. 4-2 (8) Drilling Progress of the Pirca Area (MJP- 8)

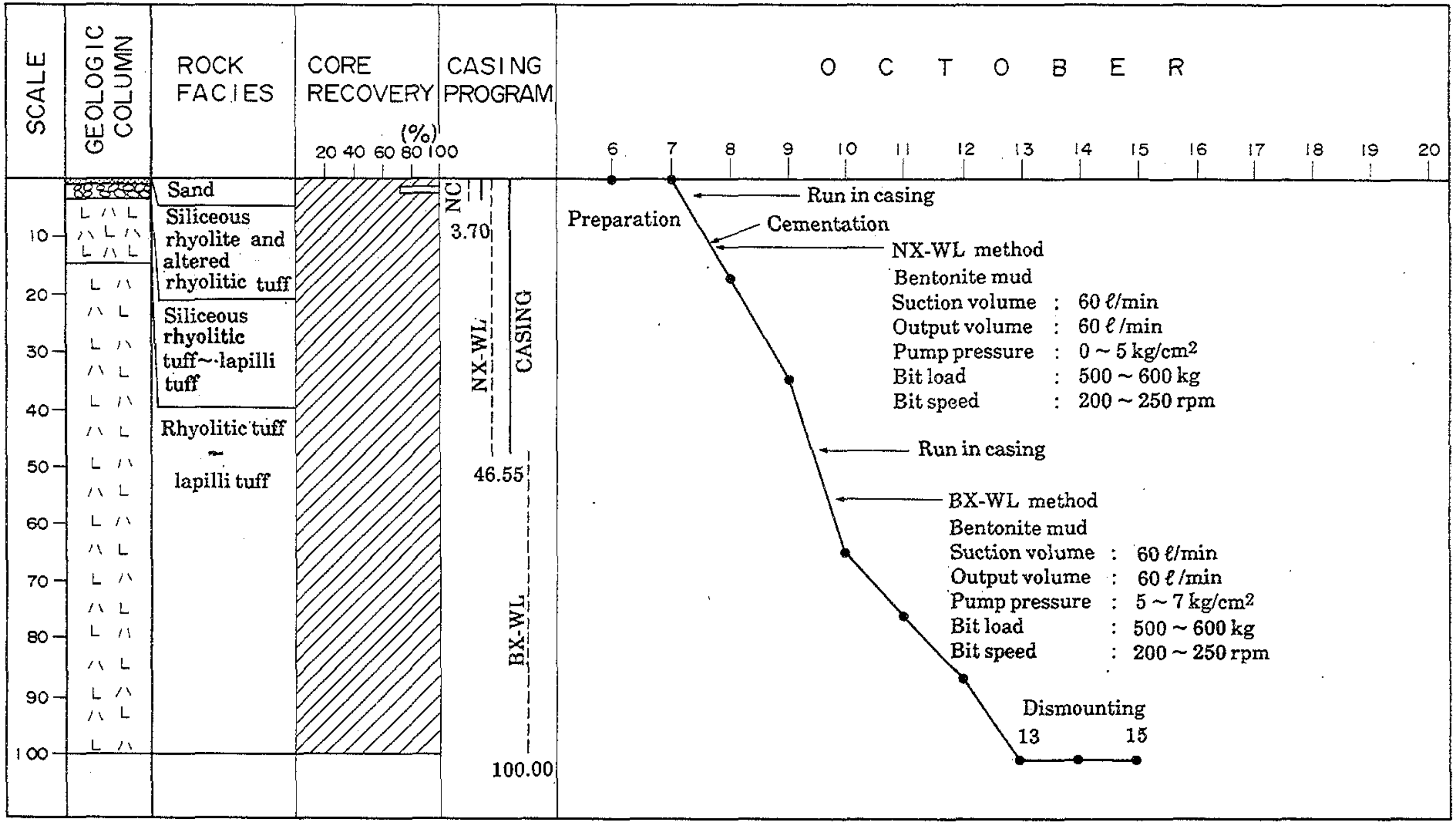


Fig. 4-2 (9) Drilling Progress of the Pirca Area (MJP- 9)

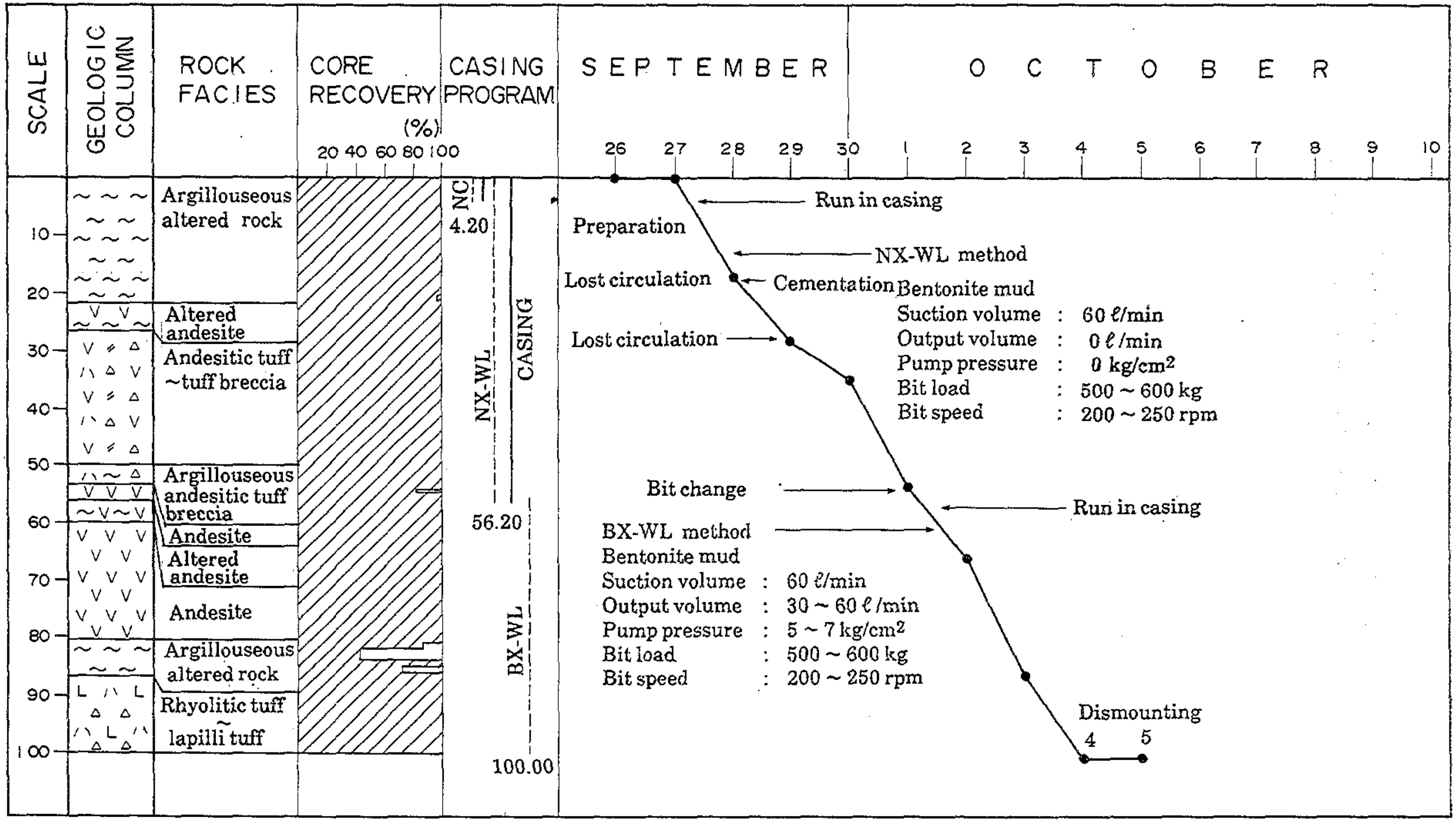


Fig. 4-2(10) Drilling Progress of the Pirca Area (MJP-10)

Table 4-6 Working Time and Efficiency of Drillings

Working Time and Efficiency / Drill Hole No.	Drilling		Hoisting and Lowering Rod, Casing		Repairing		Sub Total		Number of Workers		Length (m)
	Total Time	H/m	Total Time	H/m	Total Time	H/m	Total Time	H/m	Total Number of Workers	Man/m	
MJP-1	74°00'	0.73	70°00'	0.69	0°00'	-	144°00'	1.43	80	0.79	0 - 100.80
MJP-2	102°20'	1.02	55°10'	0.55	26°30'	0.27	184°00'	1.84	99	0.99	0 - 100.00
MJP-3	80°30'	1.24	62°30'	0.63	27°00'	0.27	170°00'	1.70	199	1.99	0 - 100.00
MJP-4	81°40'	0.82	63°20'	0.63	0°00'	-	145°00'	1.45	81	0.81	0 - 100.00
MJP-5	60°20'	0.60	51°40'	0.52	0°00'	-	112°00'	1.12	90	0.90	0 - 100.10
MJP-6	113°40'	1.13	105°20'	1.04	223°00'	2.21	442°00'	4.38	208	2.06	0 - 100.80
MJP-7	88°30'	0.89	43°30'	0.44	48°00'	0.48	180°00'	1.80	130	1.30	0 - 100.00
MJP-8	83°10'	0.83	72°50'	0.73	13°00'	0.13	169°00'	1.69	165	1.65	0 - 100.20
MJP-9	76°20'	0.76	55°40'	0.56	20°00'	0.20	152°00'	1.52	148	1.48	0 - 100.00
MJP-10	88°40'	0.89	72°20'	0.72	17°00'	0.17	178°00'	1.78	180	1.80	0 - 100.00