2-4 Survey result of the Mantri deposit area

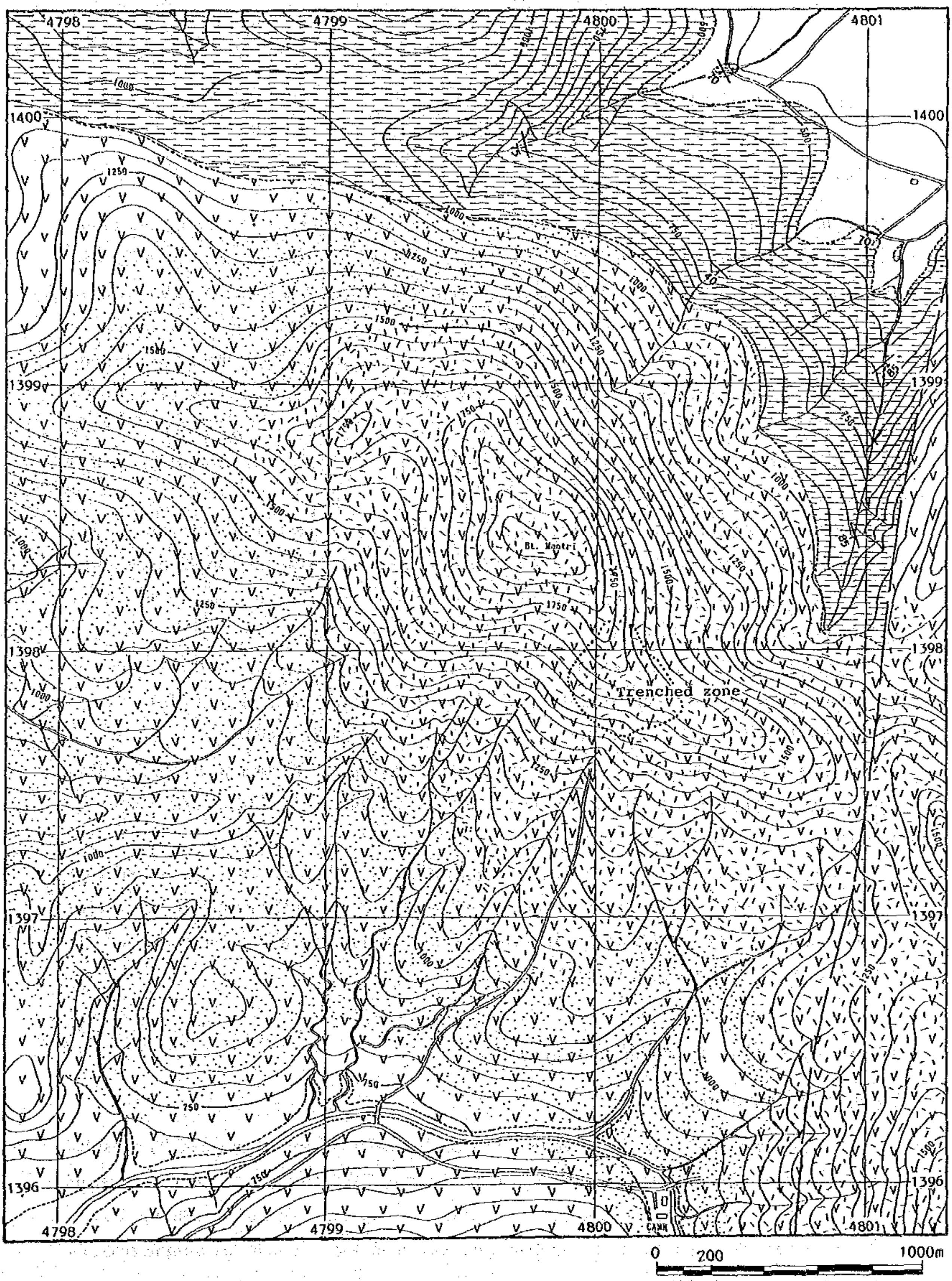
2-4-1 Geology and ore deposits

This area is underlain by Kalumpang Formation (P_4Kg), deposited during Oligocene through middle Miocene, and Pliestocene andesite lavas covering the P_4Kg. Dacite has been reported to be present in some portion (Heng, Y.E., 1985). However, volcanic lavas distributed in this area are all thought to be andesite lavas because quartz phenocrysts are not present in those rocks, though those rocks are too argillized and bleached to be identified. Geologic map of this area is shown in Fig. II-2-21.

Kalumpang Formation is distributed in the northeast portion of the area, comprizing andesite tuff breccias, andesite lapilli tuff, tuffaceous sandstones, tuffaceous mudstones and so on. Near the contact with andesite lavas above mentioned, they are silicified and disseminated with pyrites. In a part of the mudstone, siliceous nodules are found and primary pyrite is concentrated in the nodules. Andesite lavas predominate in the area from the center to the south of the area, unconformably covering Kalumpang Formation. The andesite lavas are significantly altered and bleached by hydrothermal process. The alteration includes silicification, argillization, bleaching and general dissemination of pyrite. Though rocks do not crop out in wide area, silicification and argillization was confirmed 500 m to the south of Mantri Mountain and the argillization was observed around the silicification and argillization. A large amount of limonite as a weathered product is observed around the mineralized zone. In the flat land in the northeast and the south of the area, alluvium dominates and some parts of the area are utilized for agriculture.

Kalumpang Formation generally strikes NW and dips southeast. In the easternmost part of Kalumpang Formation, the formation variably strikes, thus fault trending NNE was presumed to be present. The structure of the andesite was not revealed enough. In the mineralized zone to the south of Mantri Mountain number of fractures trending E can be found.

The mineralized zone of this area, which was found by the soil geochemical survey carried out by Zamia SDN. BHD. is situated approximately 500 m to the east of Mantri Mountain. The anomaous zone, defined by over 0.2 ppm Au, detected by the soil geochemical survey is 500 m by 200 m. In this anomalous zone, 7 trenches were cut so far to reveal mineralization by bulldozer. In the mineralized zone opened by the trench, silicified and argillized andesite is brecciated and in the matrix of the breccias quartz veinlets, limonite and goethite are observed. In some parts with higher grade, andesite is significantly brecciated and a large number of quartz veinlets occur irregularly. The mineralized zone is in general composed of network of clay-quartz veinlets in the breccias of altered andesite. This mineralized zone is considered to accompany base metals as well. However, no sulfide minerals except pyrite can be observed on the surface due to the significant weathering. No quartz veins on a large scale were found so far. Same type of mineralization was found in the neighbouring area to the southeast of this area, being surveyed



Alluvium
Andesite
Kalumpang Formation
Silicified zone
Argillized zone
Fault

Fig. II-2-21 Geologic map of the Mantri deposit area by trenching in the present time.

2-4-2 Sampling

Samples including stream sediments, soil and pan concentrates, were taken from along drainages in the northeast and in the south of the area. Some soil samples were taken in and around the mineralized zone. For the survey, topographic maps on a scale of 1:10,000 were utilized as same as in the other areas, which were enlarged from the topographic maps on a scale of 1:50,000. The locations of some drainages and hill tops are different from the actual state on the maps. The area is mostly occupied by secondary jungles except for northern part utilized for plantation. The locations of the samples are plotted on Fig. II-2-22. At the location numbers from 1 to 71 soil samples were taken near the stream sediment sample points. Stream sediment and soil samples were described in Appendix 4 and 5.

Three kind of stream sediments were collected at each sample location as same as in other areas. At some sample locations in the upper reaches of drainages, sediments on the bank of the drainages were not discriminated from sediments on the edge of the drainages, because of the prominent water flow due to the rain.

Soil samples were taken from three horizones of the soil profile as described before on the other areas. Soil is thick in this area though it is thicker in Bidu Bidu Hill area. B horizon is much thicker than A horizon. Soil samples were collected by hand auger 1 m long.

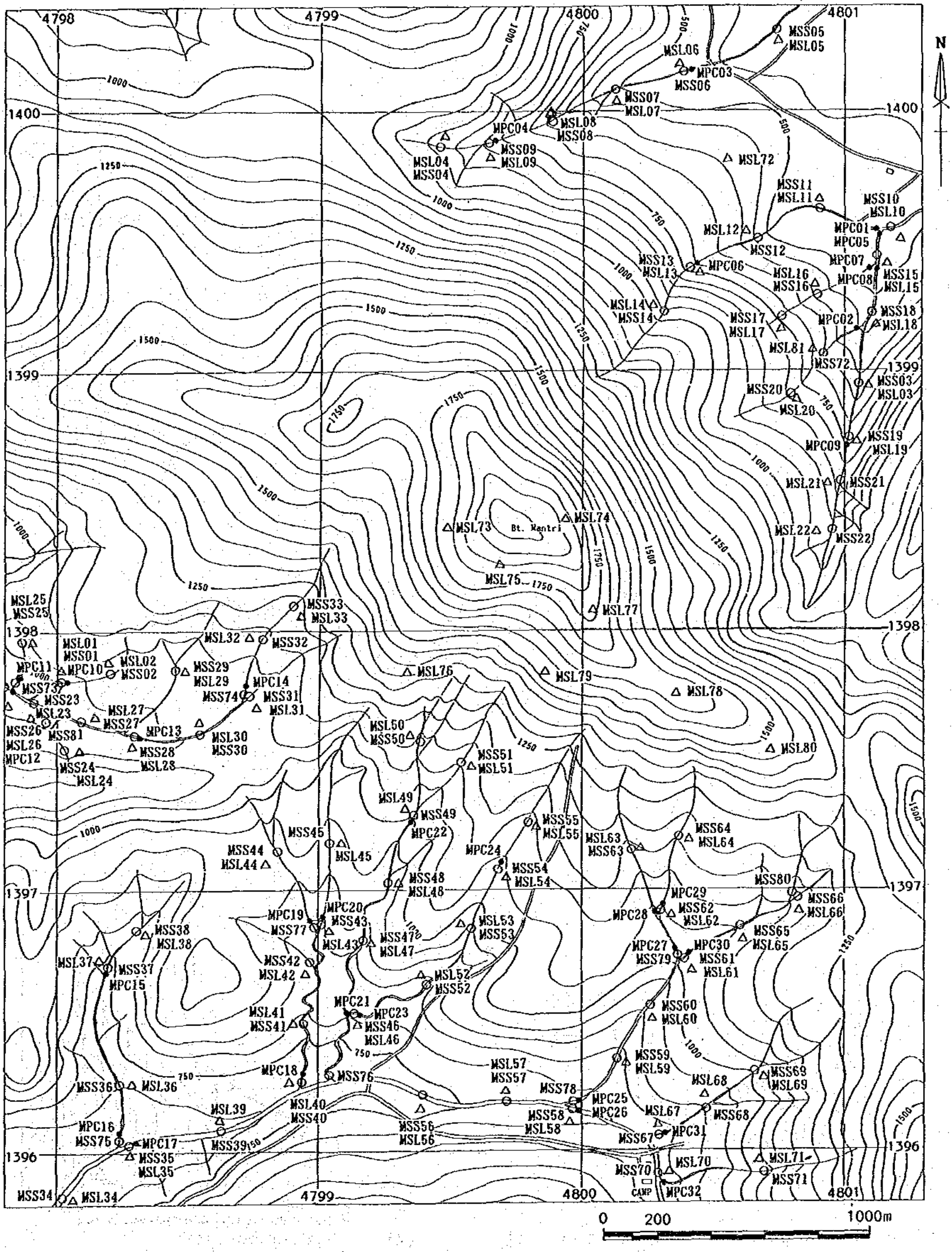
Pan concentrates were uniformly collected from the entire area. Wooden pans were utilized for collecting samples. It took approximately 1 hour to collect the pan concentrates at each point. Gold dusts were observed in some of the samples.

Samples for laboratorial studies, including thin section observation, polished section observation, polished thin section observation and powder X ray diffractometry, were also collected from the area in addition to the geochemical samples. Location of samples for the laboratorial studies are shown in Fig. II-2-23.

2-4-3 Stream sediment geochemical survey

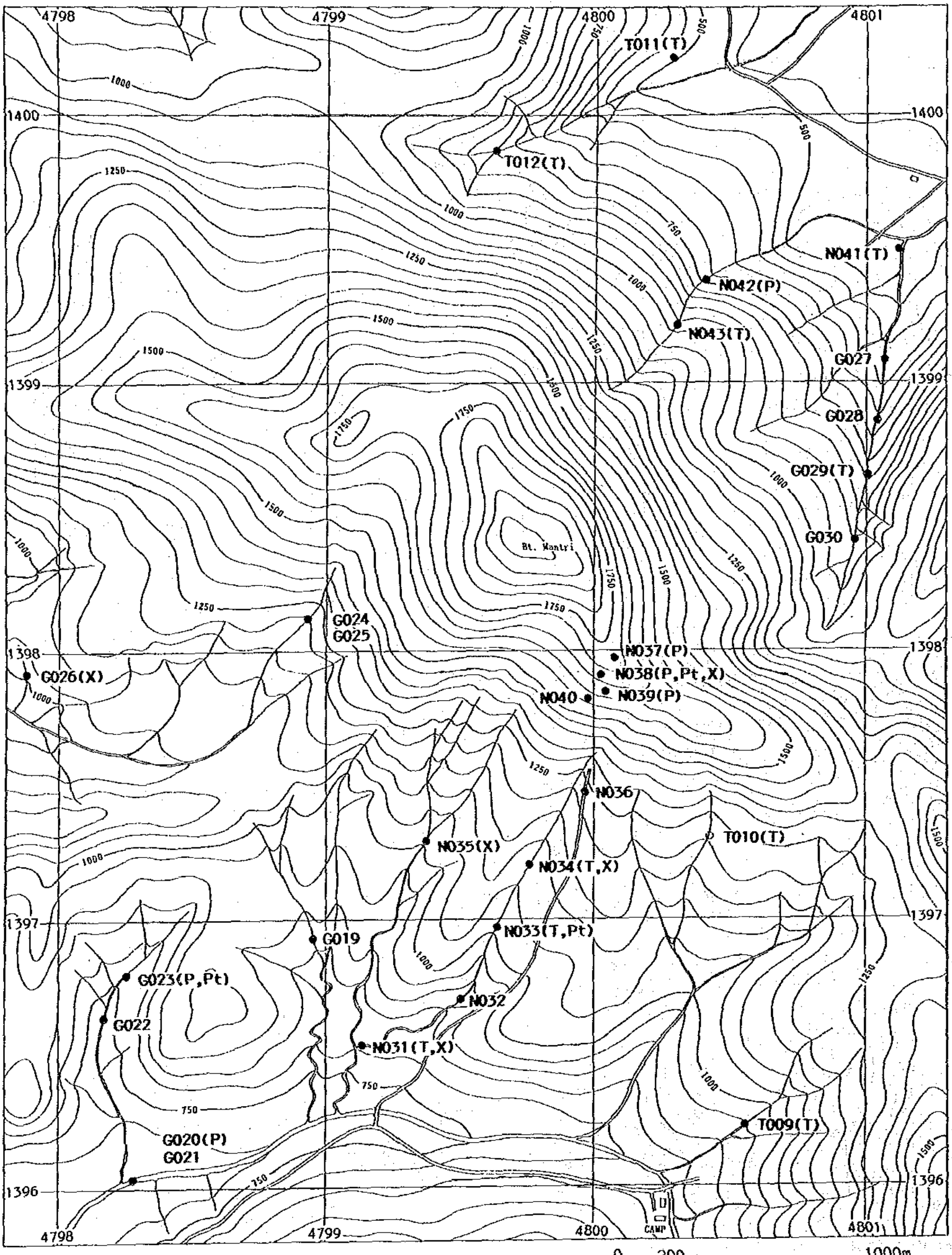
(1) pathfinder elements

The samples were analyzed for 19 elements as described before on the other areas. The results of the statistical treatment of the samples are summarized in Table II-2-32. Analytical values of Ag, Hg, Sn and W were all below each detection limit. Analytical value of Mo, Sb and Pt are mostly below each detection limit. Geometric mean values of each element are summarized as follows;



MSS: stream sediment sample **MSL**: soil sample **MPC**: pan concentrate sample

Fig. II-2-22 Location map of geochemical samples in the Mantri deposit area



N014; sample number **(T)**; thin section **(P)**; polished section

(Pt); polished thin section **(X)**; x-ray diffraction analyses **(E)**; EPMA analyses

Fig. II-2-23 Location map of samples for laboratorial studies in the Mantri deposit area

Table II-2-32 Statistics of stream sediment geochemical survey in the Mantri deposit area

Element	Samples collected at bank (A)						Sample collected at edge of stream (B)						Sample collected at middle of stream (C)					
	B.D.L. (%) *1	Unit	Maximum value	Minimum value	Mean*2 value	S.D. *3	B.D.L. (%) *1	Unit	Maximum value	Minimum value	Mean*2 value	S.D. *3	B.D.L. (%) *1	Unit	Maximum value	Minimum value	Mean*2 value	S.D. *3
Ag	100.0	ppm	<0.5	<0.5	-	0.000	100.0	ppm	<0.5	<0.5	-	0.000	100.0	ppm	<0.5	<0.5	-	0.000
As	18.5	ppm	99	< 5	17.4	0.251	6.2	ppm	115	< 5	29.9	0.146	1.2	ppm	101	< 5	35.6	0.270
Au	1.2	ppb	6000	< 2	81.4	0.955	13.6	ppb	6700	< 2	69.8	1.280	6.2	ppb	4200	< 2	74.3	1.060
Co	4.9	ppm	40	< 1	10.7	0.152	2.5	ppm	35	< 1	10.9	0.097	2.5	ppm	48	< 1	12.3	0.334
Cr	0	ppm	829	51	118.5	0.047	0	ppm	3599	55	114.2	0.056	0	ppm	2525	61	110.5	0.219
Cu	0	ppm	310	12	58.9	0.076	0	ppm	201	20	63.3	0.074	0	ppm	211	20	65.9	0.267
Fe	0	%	16.28	2.46	6.952	0.021	0	%	13.40	3.16	6.989	0.015	0	%	18.09	3.40	7.996	0.154
Hg	100.0	ppm	< 1	< 1	-	0.000	100.0	ppm	< 1	< 1	-	0.000	100.0	ppm	< 1	< 1	-	0.000
Mn	0	ppm	6470	165	1504.6	0.111	0	ppm	3697	203	1507.8	0.096	0	ppm	4332	268	1619.8	0.293
Mo	97.5	ppm	1	< 1	-	0.002	100.0	ppm	< 1	< 1	-	0.000	90.1	ppm	2	< 1	0.6	0.163
Ni	0	ppm	242	6	18.1	0.082	0	ppm	1024	5	17.7	0.116	0	ppm	737	4	16.9	0.351
Pb	1.2	ppm	825	< 2	115.1	0.365	2.5	ppm	989	< 2	118.5	0.410	1.2	ppm	854	< 2	121.7	0.606
Pt	49.4	ppb	10	< 5	5.0	0.092	98.8	ppb	5	< 5	2.5	0.001	75.3	ppb	10	< 5	3.5	0.268
S	0	%	1.682	0.018	0.051	0.099	0	%	3.948	0.022	0.078	0.166	0	%	5.289	0.014	0.092	0.522
Sb	95.1	ppm	9	< 5	2.6	0.011	71.6	ppm	15	< 5	3.5	0.052	88.9	ppm	9	< 5	2.8	0.128
Sn	100.0	ppm	< 1	< 1	-	0.000	100.0	ppm	< 1	< 1	-	0.000	100.0	ppm	< 1	< 1	-	0.000
U	0	ppm	2.2	1.0	1.64	0.004	0	ppm	2.2	1.2	1.62	0.004	0	ppm	2.2	1.0	1.64	0.070
W	100.0	ppm	< 10	< 10	-	0.000	100.0	ppm	< 10	< 10	-	0.000	100.0	ppm	< 10	< 10	-	0.000
Zn	0	ppm	1043	31	219.8	0.104	0	ppm	873	43	261.0	0.099	0	ppm	838	49	272.5	0.291

*1: below detection limit *2: geometric mean *3: standard deviation

Elements with higher mean values on sample A: Au, Cr, Ni, Pt, U

Elements with higher mean values on sample B: Sb

Elements with higher mean values on sample C: As, Co, Cu, Fe, Mn, Mo, Pb, S, U, Zn

There are a number of elements with higher mean values on sample A and C. Mean values of As, Co, Cu, Fe, Mn, Pb, S and Zn increase in order of sample A, B and C. On the other hand, mean values of Cr and Ni decrease in order of sample A, B and C. Samples in series B mostly have intermediate mean values among the three sample series.

Correlation matrixes on each sample series are shown in Table II-2-33. Elements in sample series B have higher correlations. Pairs of elements with higher correlation coefficients, defined by 0.500 and more than that, on sample series B are as follows;

As-Cu, As-Pb, Au-Cu, Au-Pb, Co-Mn, Cr-Ni, Cu-Mn, Cu-Pb, Cu-Zn, Mn-Pb, Mn-Zn, Pb-Zn

As, Au, Cu, Pb and Zn have higher correlation coefficients with each other. They are closely related with the deposit in this area.

(2) Single element analysis

Three analytical methods were applied and compared with each other as in the other two areas. Histograms and cumulative frequency distribution curves are drawn on each element and sample series as shown in Appendix 17. Statistical values calculated by means of three methods are presented in Table II-2-34. The statistical treatments suggest the followings;

1) Analytical values of Mo, Pt and Sb are largely less than each detection limit, then adequate threshold values such as Upper Fence values were not found by EDA method.

2) On Au, Cu, Pb and S, two populations of analytical values were confirmed on their cumulative frequency distribution curves by Lepeltier method. One population with higher values are considered to represent the mineralization.

3) The analytical values of Pb are remarkably high. Even the values of background are high enough to be normally managed as anomalous values. By the method of Lepeltier, the values lower than the background value were detected as threshold value.

Upper Fence values determined by EDA method were applied as threshold values as in the other two areas. Because the samples of the sample series B have intermediate analytical values for whole elements among the three sample series A, B and C, anomalous points and points with higher values of the samples of sample B were plotted on the distribution map. The values plotted on the distribution map were determined by EDA method. The distribution of principal elements with higher values are plotted on Appendix 18 and summarized as follows;

Table II-2-33 Coorelation matrix of elements for stream sediments in the Mantri deposit area

Mantri
Stream Sediment (A)

	As	Au	Co	Cr	Cu	Fe	Mn	Ni	Pb	Pt	S	Sb	U	Zn
As	1.000													
Au	.421	1.000												
Co	.042	.141	1.000											
Cr	-.030	.117	.257	1.000										
Cu	.743	.521	.146	-.078	1.000									
Fe	.306	.525	.363	-.118	.527	1.000								
Mn	.292	.369	.744	.162	.450	.397	1.000							
Ni	-.035	.123	.370	.775	.078	-.001	.286	1.000						
Pb	.548	.497	.223	-.104	.662	.319	.560	-.040	1.000					
Pt	-.404	-.316	.181	.096	-.399	-.220	-.043	.115	-.318	1.000				
S	.214	.165	-.257	-.270	.247	.358	-.341	-.218	.122	-.263	1.000			
Sb	.146	.180	.029	-.116	.249	.227	.128	-.073	.126	-.138	.203	1.000		
U	.116	.003	-.190	-.190	-.009	-.035	-.151	-.148	.040	-.081	.047	-.059	1.000	
Zn	.438	.469	.515	.009	.573	.451	.769	.194	.809	-.200	.002	.145	.021	1.000

Mantri
Stream sediments (B)

	As	Au	Co	Cr	Cu	Fe	Mn	Ni	Pb	S	Sb	U	Zn
As	1.000												
Au	.436	1.000											
Co	-.180	.045	1.000										
Cr	-.064	.223	.344	1.000									
Cu	.573	.510	.051	.165	1.000								
Fe	.032	.425	.394	.134	.413	1.000							
Mn	.258	.311	.637	.229	.576	.548	1.000						
Ni	-.193	.115	.553	.828	.185	.202	.485	1.000					
Pb	.577	.532	.035	.299	.735	.315	.517	.197	1.000				
S	-.154	.237	-.236	-.021	.050	.340	-.337	-.189	.017	1.000			
Sb	.137	.336	.005	.341	.307	.301	.112	.161	.260	.163	1.000		
U	-.020	-.006	.066	.052	-.155	-.102	-.164	-.063	.028	.189	-.049	1.000	
Zn	.417	.531	.383	.327	.687	.466	.784	.373	.829	-.105	.171	.003	1.000

Mantri
Stream sediments (C)

	As	Au	Co	Cr	Cu	Fe	Mn	Mo	Ni	Pb	Pt	S	Sb	U	Zn
As	1.000														
Au	.450	1.000													
Co	-.064	-.040	1.000												
Cr	-.259	-.034	.258	1.000											
Cu	.692	.442	.005	.043	1.000										
Fe	.215	.357	.262	-.125	.343	1.000									
Mn	.448	.422	.503	.142	.566	.370	1.000								
Mo	.016	-.152	-.160	-.072	-.100	-.185	-.244	1.000							
Ni	-.258	-.085	.489	.828	.028	-.196	.370	-.084	1.000						
Pb	.588	.551	-.017	.103	.688	.206	.600	-.233	.052	1.000					
Pt	-.006	.013	-.044	-.091	-.072	.127	.027	-.183	-.174	.192	1.000				
S	-.033	.074	-.078	-.301	.024	.517	-.347	.038	-.501	-.166	.110	1.000			
Sb	-.267	-.116	.189	.501	-.132	-.177	.047	-.110	.438	-.066	-.111	-.219	1.000		
U	-.019	-.070	-.034	-.253	-.161	.007	-.166	-.022	-.282	.044	.238	.190	-.137	1.000	
Zn	.474	.634	.273	.138	.630	.357	.786	-.263	.246	.801	.164	-.134	-.070	.043	1.000

Table II-2-34 Threshold values obtained by each analytical method for stream sediment geochemical survey in the Mantri deposit area

	Unit	Sample collected at bank (A)							Sample collected at edge of stream (B)							Sample collected at middle of stream (C)						
		E.D.A. method			Lepeltier method			m + 2S.D	E.D.A. method			Lepeltier method			m + 2S.D	E.D.A. method			Lepeltier method			m + 2S.D
		Median	Upper Wisker	Upper Fence	B.G.*1 value	T.H.*2 value	%		Median	Upper Wisker	Upper Fence	B.G.*1 value	T.H.*2 value	%		Median	Upper Wisker	Upper Fence	B.G.*1 value	T.H.*2 value	%	
Ag	ppm	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
As	ppm	23.0	50.0	90.0	25	92	2.5	175.0	36.0	55.0	91.0	38	98	2.5	173.7	38.0	58.0	99.0	39	101	2.5	123.2
Au	ppb	110.0	730.0	1241.0	100	165	44.5	7320.1	100.0	910.0	1413.0	110	170	45.5	12776.3	110.0	830.0	1366.0	115	220	37.0	9812.1
Co	ppm	13.0	18.0	29.0	13	19	15.5	64.3	13.0	18.0	30.5	13	29	2.5	45.9	14.0	20.0	30.0	15	35	2.5	57.3
Cr	ppm	106.0	171.0	257.0	110	210	10.0	322.6	105.0	142.0	205.5	108	165	11.5	340.9	99.0	141.0	202.5	103	175	11.5	302.4
Cu	ppm	58.0	98.0	158.5	59	115	15.5	209.5	63.0	119.0	213.5	63	86	36.0	221.0	65.0	123.0	197.5	63	96	29.0	225.2
Fe	%	6.96	9.54	12.99	7.2	11.5	2.5	13.51	7.18	8.62	12.02	7.0	9.2	16.0	12.39	7.45	10.46	15.04	8.1	13.5	11.5	16.27
Hg	ppm	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mn	ppm	1646.0	2987.0	5112.5	1850	4000	5.0	6987.3	1746.0	2752.0	4755.5	1880	3850	2.5	6271.6	1781.0	2869.0	4934.5	1910	4100	2.5	6232.0
Mo	ppm	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1.0	1.0	1.0	—	—	—	1.2
Ni	ppm	16.0	26.0	43.5	18	68	5.5	67.5	15.0	30.0	51.0	18	57	4.5	84.9	16.0	27.0	42.5	16	41	7.5	85.1
Pb	ppm	173.0	325.0	670.0	182	128	59.0	1858.1	175.0	387.0	686.5	185	135	59.0	2263.6	197.0	363.0	671.0	195	170	53.0	1985.5
Pt	ppb	10.0	10.0	17.5	—	—	—	20.3	—	—	—	—	—	—	—	5.0	10.0	5.0	—	—	—	11.7
S	%	0.045	0.081	0.149	0.05	0.14	6.5	0.215	0.058	0.164	0.223	0.06	0.13	21.0	0.512	0.067	0.241	0.380	0.07	0.56	9.0	1.016
Sb	ppm	5.0	5.0	5.0	2	8	2.5	4.3	5.0	7.0	7.5	5	11	2.5	10.0	5.0	5.0	5.0	1	9	2.5	5.0
Sn	ppm	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
U	ppm	1.60	1.80	2.40	1.8	2.2	2.5	2.20	1.60	1.80	2.40	1.8	2.2	2.5	2.19	1.60	1.80	2.40	1.8	2.3	2.5	2.26
W	ppm	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Zn	ppm	251.0	387.0	644.5	250	630	6.0	970.7	313.0	466.0	850.0	305	650	3.5	1114.7	330.0	462.0	868.5	315	620	5.0	1041.7

*1: Background *2: Threshold

As : Anomalous points are distributed in the southeastern part of the area. Points with higher analytical values are located in the north and in the south of the Mantri deposit, being related to the deposit.

Au : Anomalous points are mainly distributed in the north and in the south of the central part of the Mantri deposit, being considered to be closely related with the deposit.

Co : Anomalous points are distributed in the south of the area. They are not related with the deposit.

Cr : Anomalous points are distributed as that of Co, not being related with the deposit.

Cu : Points with higher values are distributed in the north and in the south of the deposit, being related with the deposit. The distribution tendency is as same as that of As.

Fe : Points with higher values are mainly located in the south of the Mantri deposit. They are not definitely related with the deposit.

Mn : Points with higher values are distributed in the east of the area. The distribution pattern is same as that of Co. They are scarcely related with the deposit.

Ni : Anomalous points are found in the south of the area. Points with lower values are located near the deposit. No relationship between anomalous values and the deposit was detected.

Pb : Anomalous points and points with higher values are distributed around the Mantri deposit, being closely related with the deposit.

S : Points with higher values and anomalous points are distributed in the southernmost part and in the western part of the area. The Mantri deposit is characteristic of lower concentration.

Sb : Anomalous points are distributed in the south of the area. They are not related with the deposit.

U : Points with higher values are scattered in the entire area. No distribution trend was defined.

Zn : Anomalous points are distributed around the Mantri deposit, being related with the deposit.

Judging from the distribution of anomalous points and points with higher values and their relation with the deposit, As, Au, Cu, Pb and Zn are considered to be effective for the pathfinders. S is possibly utilized as pathfinder as well, because the distribution of points with lower values of S correspond to the location of the deposit.

(3) Multi elements analysis

Cluster analysis and factor analysis methods were applied as multi element analysis as in the other areas. The results of cluster analysis and factor analysis are presented in Fig. II-2-24 and Table II-2-35 respectively.

The results of cluster analysis are quite variable depending on the sample series. As, Co, Cu, Mn, Pb and Zn are as a whole related with each other. Cr and Ni form different cluster in every sample series.

The relationships between factors detected and elements related to the factors on the sample B and C are similar with each other. On the other hand, relationship between factors detected on the sample A and elements related to the factors does not correspond with the results of single element analysis. Furthermore, amount of contribution of each factor detected is low. The communality of each element of sample B is higher than that of sample C. Thus, from the result of cluster analyses, sample series B are most useful for the geochemical survey. Factors detected on the sample B and the elements closely related to the factors are as follows;

Factor 1 : As-Au-Cu-Pb-Zn-(Mn)

Factor 2 : Cr-NI

Factor 3 : S-(Fe)

Factor 4 : Co-Fe-Mn-(Zn)

Factors 3 and 4 have negative relations with the related elements. Judging from the factors detected and the elements closely related with the factors, factor 1 is considered to be related to the mineralization in this area. The distribution of the points with higher factor scores of factors 1 and 2 is presented in Fig. II-2-25. On the figure, Factor 1 definitely located the mineralized zone. Thus sample B and this analytical method were effectively applied.

(4) Summary of analysis

Anomalous points for every element determined by EDA method are shown in Fig. II-2-26. Anomalous points of Au, Sb and Pb were detected around the deposit. Therefore, these elements are effectively utilized as pathfinders. Anomalous points of Au and Sb are widely distributed down to 2 km from the Mantri deposit. Such a wide area defined by the distribution of anomalous point of Au and Sb correspond to the area defined by the mineralization of alteration.

2-4-4 Soil geochemical survey

(1) Pathfinder elements

Soil samples collected from the survey area were analysed for 23 elements. The results of statistical treatment of the analytical values were presented in Table II-2-36. Analytical values of Hg and W were below their detection limits. Furthermore the majorities of the analytical

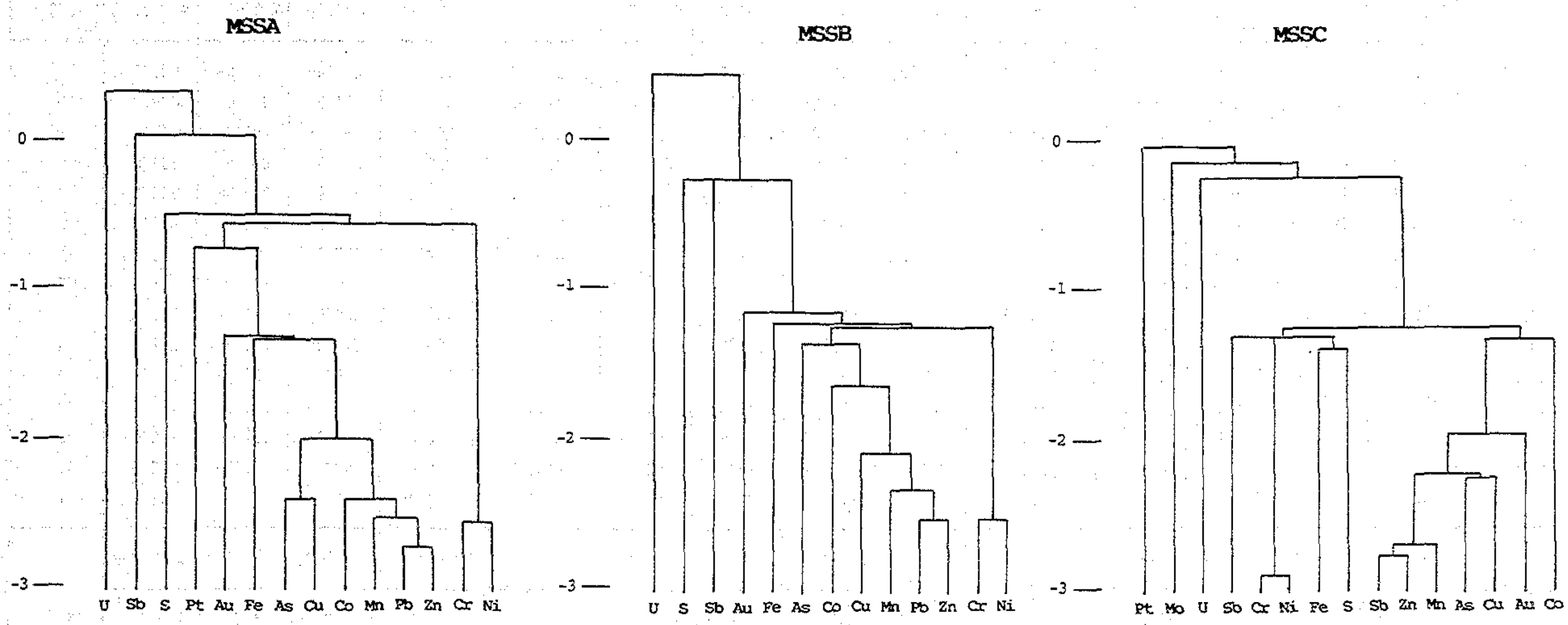
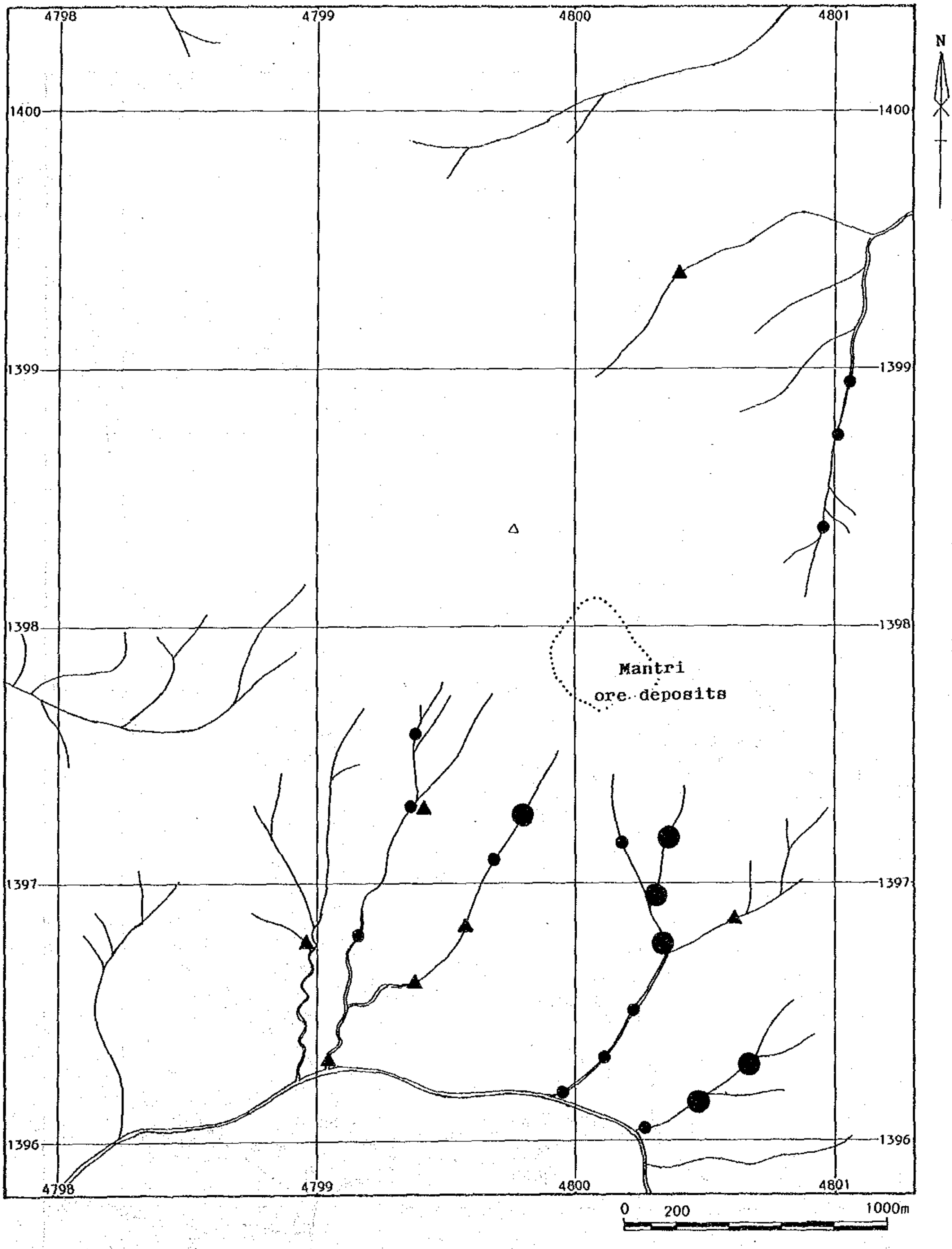


Fig. II-2-24 Dendrogram of elements for stream sediments in the Mantri deposit area

Table II-2-35 Results of factor analyses for stream sediments in the Mantri deposit area

Element	Sample collected at bank (A)					Sample collected at edge of stream (B)					Sample collected at middle of stream (C)				
	Factor loadings (Varimax rotation)				Communality	Factor loadings (Varimax rotation)				Communality	Factor loadings (Varimax rotation)				Communality
	Factor 1	Factor 2	Factor 3	Factor 4		Factor 1	Factor 2	Factor 3	Factor 4		Factor 1	Factor 2	Factor 3	Factor 4	
As	0.783	0.011	0.081	-0.209	0.7518	0.741	-0.164	0.142	0.116	0.6103	0.727	0.372	0.048	0.010	0.6945
Au	0.240	-0.194	0.045	-0.466	0.5076	0.596	0.089	-0.377	-0.148	0.5271	0.682	0.007	-0.219	0.020	0.5174
Co	-0.063	-0.191	-0.744	-0.016	0.7665	-0.102	0.361	0.140	-0.714	0.6704	-0.006	-0.227	-0.067	-0.714	0.5660
Cr	0.011	-0.869	-0.122	0.161	0.7963	0.134	0.917	-0.127	-0.041	0.8758	0.053	-0.896	0.093	-0.081	0.8343
Cu	0.644	-0.020	-0.039	-0.419	0.7786	0.806	0.054	-0.098	-0.242	0.7212	0.813	0.044	-0.105	-0.057	0.7172
Fe	0.127	0.029	-0.242	-0.655	0.6063	0.252	0.032	-0.466	-0.617	0.6617	0.313	0.123	-0.642	-0.311	0.6302
Mn	0.188	-0.122	-0.577	0.008	0.8568	0.459	0.201	0.238	-0.768	0.8972	0.663	-0.085	0.127	-0.642	0.8754
Mo	—	—	—	—	—	—	—	—	—	—	-0.166	0.149	0.067	0.185	0.1959
Ni	-0.006	-0.839	-0.220	0.077	0.7680	0.020	0.855	0.088	-0.349	0.8622	0.026	-0.761	0.313	-0.418	0.8817
Pb	0.360	0.083	0.097	-0.137	0.8228	0.877	0.178	-0.047	-0.121	0.8178	0.871	-0.063	0.121	0.009	0.8491
Pt	-0.358	-0.026	-0.298	0.303	0.3377	—	—	—	—	—	0.049	0.075	-0.054	0.014	0.2652
S	0.102	0.159	0.278	-0.553	0.4266	-0.022	-0.109	-0.665	0.091	0.4632	-0.104	0.248	-0.719	0.136	0.6169
Sb	0.118	0.087	-0.090	-0.352	0.1551	0.276	0.243	-0.381	-0.013	0.2802	-0.130	-0.578	0.107	-0.067	0.3684
U	0.060	0.159	0.261	0.063	0.1036	-0.059	0.044	-0.115	0.103	0.0293	-0.096	0.228	-0.031	0.059	0.2614
Zn	0.213	-0.043	-0.203	-0.157	0.8475	0.734	0.230	0.050	-0.495	0.8391	0.815	-0.111	0.007	-0.337	0.8611
F.C.*1	17.3 %	19.0 %	15.4 %	17.2 %	—	39.3 %	23.5 %	13.3 %	23.9 %	—	40.3 %	22.9 %	12.6 %	15.1 %	—

*1: factor contribution



● ≧1.200 factor 1 factor score　　1.200> ● ≧0.800 factor 1 factor score

▲ ≧1.000 factor 2 factor score　　(Sample collected at edge of stream(B))

Fig. II-2-25　Distribution map of factor 1 factor score for stream sediments in the Mantri deposit area

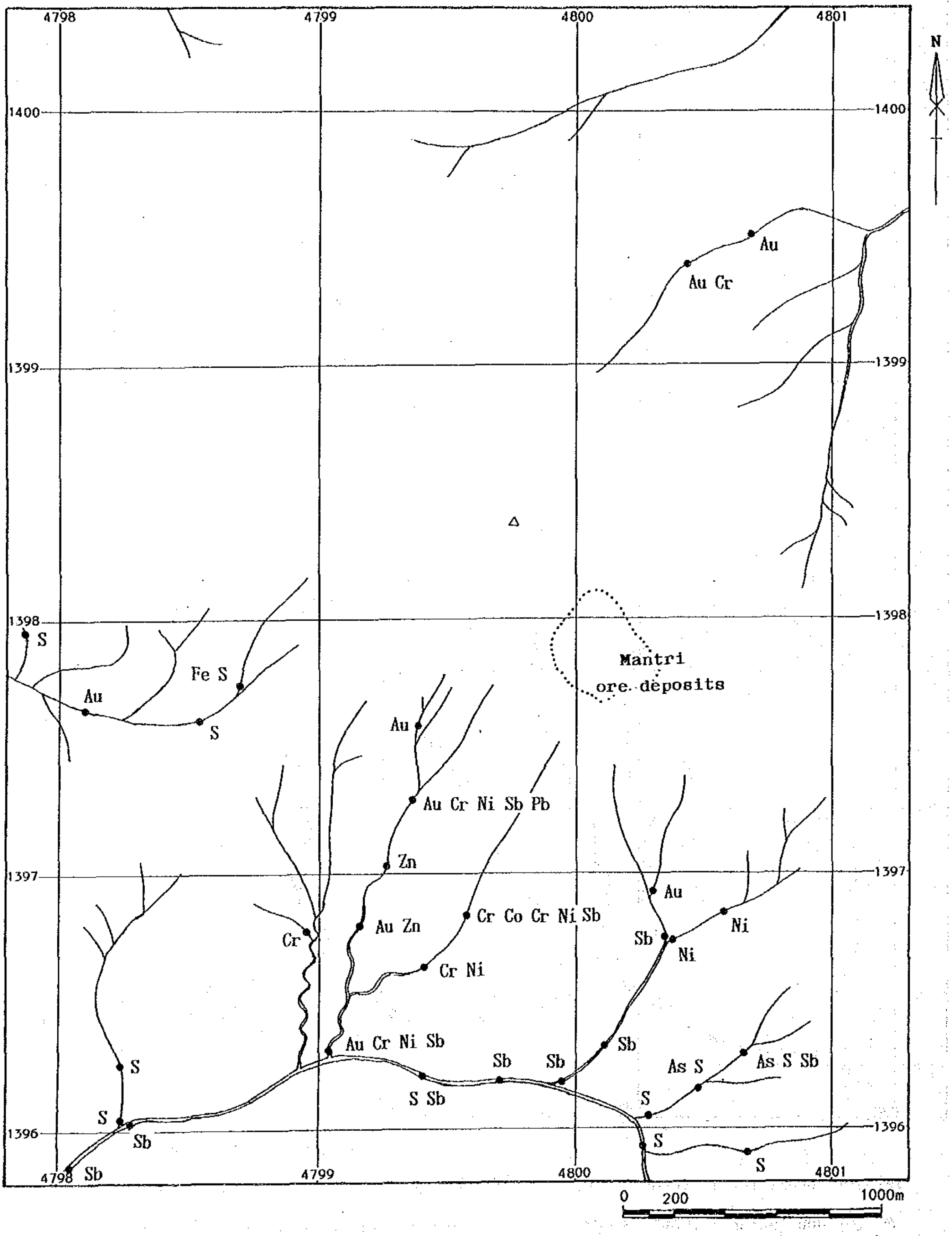


Fig. II-2-26 Interpretation map of stream sediment geochemical survey in the Mantri deposit area

Table II-2-36 Statistics of soil geochemical survey in the Mantri deposit area

Element	Zone A (A)						Upper part of zone B (B)						Lower part of zone B (C)					
	B.D.L. (%) *1	Unit	Maximum value	Minimum value	Mean*2 value	S.D. *3	B.D.L. (%) *1	Unit	Maximum value	Minimum value	Mean*2 value	S.D. *3	B.D.L. (%) *1	Unit	Maximum value	Minimum value	Mean*2 value	S.D. *3
Ag	100.0	ppm	0.6	<0.5	0.25	0.042	100.0	ppm	<0.5	<0.5	—	—	100.0	ppm	<0.5	<0.5	—	—
As	3.7	ppm	131	< 5	24.3	0.317	3.7	ppm	262	< 5	27.3	0.336	1.2	ppm	245	< 5	27.1	0.286
Au	8.6	ppb	260	< 2	11.5	0.529	8.6	ppb	170	< 2	11.3	0.526	6.2	ppb	500	< 2	13.7	0.532
Co	11.1	ppm	39	< 1	8.8	0.573	14.8	ppm	43	< 1	7.5	0.630	8.6	ppm	38	< 1	9.6	0.550
Cr	0	ppm	406	11	39.8	0.250	0	ppm	79	< 14	30.9	0.189	0	ppm	73	10	31.4	0.183
Cu	0	ppm	244	11	51.4	0.276	0	ppm	335	13	56.0	0.271	0	ppm	354	15	62.1	0.275
Fe	0	%	9.79	2.25	5.171	0.136	0	%	10.37	2.52	5.809	0.120	0	%	10.96	2.81	6.166	0.124
Hg	100.0	ppm	1	< 1	—	—	100.0	ppm	< 1	< 1	—	—	100.0	ppm	< 1	< 1	—	—
K	0	%	1.95	0.03	0.298	0.327	0	%	1.98	0.05	0.383	0.318	0	%	1.75	0.09	0.393	0.307
Mn	0	ppm	7351	111	1126.4	0.544	0	ppm	7499	123	932.8	0.536	0	ppm	7132	112	913.2	0.517
Mo	75.3	ppm	3	< 1	0.6	0.222	97.5	ppm	2	< 1	0.5	0.074	85.2	ppm	3	< 1	0.6	0.171
Na	0	%	0.16	0.04	0.067	0.108	0	%	0.18	0.05	0.079	0.107	0	%	0.18	0.05	0.088	0.103
Ni	0	ppm	214	3	13.0	0.323	7.4	ppm	43	< 1	7.6	0.465	9.9	ppm	39	< 1	7.0	0.504
Pb	3.7	ppm	3448	< 2	80.7	0.732	4.9	ppm	4048	< 2	87.9	0.708	13.6	ppm	3530	< 2	77.7	0.876
Pt	70.4	ppb	10	< 5	5.8	0.172	87.7	ppb	5	< 5	—	—	85.2	ppb	10	< 5	5.2	0.125
Rb	0	ppm	223	9	69.5	0.279	0	ppm	249	11	78.5	0.279	0	ppm	352	24	85.3	0.267
S	0	%	0.112	0.020	0.042	0.149	0	%	0.104	0.014	0.033	0.168	0	%	0.098	0.013	0.033	0.184
Sb	98.8	ppm	8	< 5	2.5	0.056	100.0	ppm	< 5	< 5	—	—	97.5	ppm	9	< 5	2.5	0.062
Sn	98.8	ppm	1	< 1	—	—	97.5	ppm	6	< 1	0.5	0.147	100.0	ppm	< 1	< 1	—	—
Sr	0	ppm	277	5	23.2	0.302	0	ppm	356	6	22.0	0.282	0	ppm	389	5	21.8	0.281
U	0	ppm	4.8	0.4	1.45	0.126	0	ppm	2.4	0.4	1.52	0.124	0	ppm	2.4	0.4	1.5	0.123
W	100.0	ppm	< 10	< 10	—	—	100.0	ppm	< 10	< 10	—	—	100.0	ppm	< 10	< 10	—	—
Zn	0	ppm	1248	23	147.1	0.377	0	ppm	1148	32	161.8	0.376	0	ppm	1389	23	170.9	0.379

*1: below detection limit *2: geometric mean *3: standard deviation values of Ag, Mo, Pt, Sb and Sn were below their detection limits as well.

Soil samples were collected from three horizones of the soil profile at one sampling location as same as described before. The geometric mean of the analytical values calculated on each sample series have a general trend described as follows:

Elements with higher mean values on sample A: Ag, Cr, Mn, Mo, Ni, Pt, S, Sr
Elements with higher mean values on sample B: As, Pb, Sn, U
Elements with higher mean values on sample C: Au, Co, Cu, Fe, K, Na, Rb, Zn

Some elements of sample series A and C have higher mean values. Elements of sample series B have intermediate mean values.

Correlation matrixes among elements of individual sample series are presented in Table II-2-37. The correlation among elements of sample B have in general highest correlation. Pairs of elements in the sample series B with higher correlation coefficients, 0.500 and more than that, are as follows;

As-Au, As-Cu, As-Pb, Au-Cu, Au-Pb, Co-Mn, Co-Ni, Co-Zn, Cr-Ni, Cu-Fe, Cu-Pb, K-Rb, Mn-Ni, Mn-Zn

Elements such as As, Au, Cu and Pb, supposed to be related with the mineralization of this area, have higher correlation with each other. That suggests intence mineralization in this area.

(2) **Single element analysis**

Three analytical methods were applied to statistically treat the soil analytical values in the same way in the other two areas. Histograms and cumulative frequency distribution curves on individual elements and sample series are shown in Appendix 19. Statistical values such as threshold values determined by the three methods are presented in Table II-2-38. The followings are pointed out;

1) Analytical values of Ag, Mo, Sb and Sn were below their detection limits and the values of Median, Upper Whisker and Upper Fence determined by EDA method came out with the same value. Therefore, no threshold values were detected.

2) The cumulative frequency distribution curves suggest that two populations of distribution are recognized and the population with higher values is of possible mineralization.

3) The threshold values determined by the equation b+2S.D. are highest among the three methods, being not to be utilized as threshold values anymore.

The elemental concentration of sample B are divided into three categories, at the boundaries of Upper Fence and Median values determined by EDA methods, to plot on the maps. The distribution of elemental concentration is shown in Appendix 20. The characteristics of the distribution are described below;

Table II-2-37 Coorelation matrix of elements for soil in the Mantri deposit area

Mantri Soil (A)

	Ag	As	Au	Co	Cr	Cu	Fe	K	Mn	Mo	Na	Ni	Pb	Pt	Rb	S	Sb	Sr	U	Zn
Ag	1.000																			
As	-.244	1.000																		
Au	-.162	.351	1.000																	
Co	.051	-.093	-.051	1.000																
Cr	.093	-.043	-.052	.162	1.000															
Cu	-.176	.264	.583	.193	.077	1.000														
Fe	-.150	.140	.280	.305	-.054	.645	1.000													
K	-.009	.212	.060	.197	.068	.077	-.052	1.000												
Mn	.047	.007	.135	.835	.145	.333	.234	.295	1.000											
Mo	-.057	.217	.030	-.338	-.019	-.128	.031	-.031	-.291	1.000										
Na	-.133	-.183	-.134	.273	-.068	.204	.387	.320	.280	.005	1.000									
Ni	.116	-.089	-.094	.319	.724	.107	-.026	.098	.335	-.128	.152	1.000								
Pb	-.163	.338	.547	.189	-.021	.550	.169	.311	.448	-.271	-.027	-.011	1.000							
Pt	-.241	.327	-.041	-.046	-.105	.007	.097	.058	-.075	.102	-.051	-.179	.148	1.000						
Rb	.027	.259	.071	.176	.109	.016	-.159	.966	.267	-.019	.152	.098	.317	.019	1.000					
S	-.004	.049	.327	.001	.230	.316	.250	-.166	.173	.155	.036	.001	.207	-.089	-.224	1.000				
Sb	-.013	.260	.161	.089	.036	.089	-.079	.107	.150	-.057	.018	.146	.251	-.044	.141	.159	1.000			
Sr	.100	-.050	-.113	.190	.151	-.255	-.190	.043	.245	.079	.138	.075	-.112	-.094	.009	.321	.130	1.000		
U	.083	.128	-.123	-.131	.067	-.285	-.445	.145	-.172	.020	-.390	.072	-.045	.023	.245	-.266	.124	-.004	1.000	
Zn	-.120	.222	.317	.574	.098	.493	.320	.385	.763	-.245	.250	.259	.752	.156	.352	.119	.227	.019	-.220	1.000

Mantri Soil (B)

	As	Au	Co	Cr	Cu	Fe	K	Mn	Mo	Na	Ni	Pb	Rb	S	Sn	Sr	U	Zn
As	1.000																	
Au	.577	1.000																
Co	-.193	-.023	1.000															
Cr	-.225	-.171	.315	1.000														
Cu	.598	.697	.120	-.051	1.000													
Fe	.221	.477	.266	-.078	.614	1.000												
K	-.030	.044	.129	.227	.114	-.091	1.000											
Mn	-.006	.070	.840	.226	.260	.245	.296	1.000										
Mo	-.059	.034	-.138	-.092	-.119	-.326	.080	-.217	1.000									
Na	-.162	-.043	.260	.134	.240	.304	.295	.394	-.073	1.000								
Ni	-.200	-.156	.632	.739	.091	-.023	.175	.549	.022	.265	1.000							
Pb	.518	.561	.257	-.030	.509	.108	.306	.479	-.089	.072	.158	1.000						
Rb	-.002	.078	.141	.305	.133	-.136	.969	.300	.080	.213	.219	.359	1.000					
S	.452	.390	-.074	-.345	.362	.475	-.247	.073	-.145	-.015	-.289	.155	-.336	1.000				
Sn	.007	-.014	.112	.173	.158	-.047	.192	.191	-.024	.188	.154	.136	.199	.002	1.000			
Sr	-.109	-.188	.139	.211	-.217	-.155	.119	.183	-.180	.053	.117	-.053	.027	.252	.191	1.000		
U	-.127	-.178	-.055	.276	-.219	-.382	.206	-.142	.049	-.261	.058	-.148	.268	-.426	.094	.145	1.000	
Zn	.258	.311	.611	.058	.435	.290	.292	.801	-.206	.352	.381	.739	.301	.085	.218	.007	-.262	1.000

Mantri Soil (C)

	As	Au	Co	Cr	Cu	Fe	K	Mn	Mo	Na	Ni	Pb	Pt	Rb	S	Sb	Sr	U	Zn
As	1.000																		
Au	.289	1.000																	
Co	-.056	.096	1.000																
Cr	-.024	-.046	.363	1.000															
Cu	.427	.612	.227	-.042	1.000														
Fe	.074	.333	.275	.036	.527	1.000													
K	.170	.075	-.043	.061	-.002	-.182	1.000												
Mn	.151	.190	.814	.148	.295	.201	.247	1.000											
Mo	.026	.059	-.168	-.154	.071	-.187	-.187	-.254	1.000										
Na	-.094	-.016	.084	-.095	.223	.315	.337	.219	-.153	1.000									
Ni	-.180	-.041	.719	.636	.066	.046	-.064	.503	-.123	.132	1.000								
Pb	.534	.514	.319	.027	.555	.185	.164	.480	.079	-.024	.101	1.000							
Pt	.231	.319	-.146	-.261	.362	.268	-.135	.021	-.046	.005	-.186	.279	1.000						
Rb	.224	.098	-.020	.142	.005	-.220	.970	.255	-.130	.192	-.025	.238	-.153	1.000					
S	.285	.387	-.143	-.257	.397	.440	-.256	-.031	.163	.013	-.382	.259	-.394	-.296	1.000				
Sb	.018	.267	.082	.013	.177	.123	.080	.143	-.043	-.043	.035	.076	-.013	.096	.015	1.000			
Sr	-.111	-.014	.139	.222	-.204	-.187	.152	.108	.038	-.001	.016	-.054	-.258	.116	.169	-.007	1.000		
U	.036	.041	.002	.363	-.144	-.247	.174	-.150	-.010	-.230	.157	-.152	-.307	.216	-.383	.111	.112	1.000	
Zn	.300	.293	.572	.131	.423	.283	.198	.806	-.220	.213	.456	.729	.169	.217	.029	.108	-.007	-.224	1.000

Table II-2-38 Threshold values obtained by each analytical method for soil geochemical survey in the Mantri deposit area

	Unit	Zone A (A)							Upper part of zone B (B)							Lower part of zone B (C)						
		E.D.A. method			Lepeltier method			m + 2S.D	E.D.A. method			Lepeltier method			m + 2S.D	E.D.A. method			Lepeltier method			m + 2S.D
		Median	Upper Wisker	Upper Fence	B.G.*1 value	T.H.*2 value	%		Median	Upper Wisker	Upper Fence	B.G.*1 value	T.H.*2 value	%		Median	Upper Wisker	Upper Fence	B.G.*1 value	T.H.*2 value	%	
Ag	ppm	0.50	0.50	0.50	—	—	—	0.31	—	—	—	—	—	—	—	—	—	—	—	—	—	—
As	ppm	28.0	41.0	64.0	29	71	2.5	104.7	32.0	48.0	81.5	34	63	4.0	127.8	28.0	40.0	65.0	30	52	7.5	100.9
Au	ppb	12.0	30.0	64.0	12	115	5.0	131.8	10.0	32.0	54.0	12	77	9.0	127.1	14.0	30.0	51.0	14	51	15.0	158.3
Co	ppm	16.0	25.0	53.0	17	34	2.5	123.5	13.0	25.0	55.5	14	39	2.5	135.4	17.0	26.0	52.5	16	37	2.5	120.3
Cr	ppm	37.0	60.0	93.5	39	100	5.0	126.0	28.0	47.0	74.5	32	73	2.5	73.6	31.0	45.0	69.0	32	68	2.5	72.9
Cu	ppm	49.0	76.0	124.0	51	135	10.0	182.9	56.0	82.0	137.5	55	89	20.0	194.9	63.0	97.0	159.0	62	115	13.5	220.0
Fe	%	5.35	6.64	9.49	5.3	8.1	7.5	9.67	5.95	7.10	9.81	6.1	9.8	2.5	10.08	6.34	7.47	10.58	6.2	8.9	11.0	10.91
Hg	ppm	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
K	%	0.33	0.60	0.96	0.33	0.99	2.5	1.35	0.44	0.72	1.21	0.43	1.10	6.0	1.66	0.43	0.75	1.23	0.41	103	3.5	1.61
Mn	ppm	1830.0	3370.0	6456.5	1800	6300	2.5	13780.3	1116.0	2737.0	5774.0	1250	6200	2.5	11031.4	1061.0	2583.0	5131.5	1050	6300	2.5	9886.7
Mo	ppm	1.0	1.0	1.0	< 1	4	2.5	1.8	1.0	1.0	1.0	< 1	1	2.5	0.7	1.0	1.0	1.0	< 1	3	2.5	1.3
Na	%	0.07	0.08	0.11	0.07	0.10	6.5	0.11	0.08	0.10	0.12	0.08	0.11	10.0	0.13	0.09	0.10	0.15	0.08	0.12	9.0	0.14
Ni	ppm	12.0	25.0	39.5	14	52	2.5	57.4	9.0	17.0	27.5	9	38	2.5	64.5	9.0	18.0	31.5	9	30	5.5	70.7
Pb	ppm	117.0	281.0	474.5	115	790	3.0	2346.2	122.0	291.0	530.0	135	420	10.0	2285.3	139.0	305.0	574.5	140	570	8.0	4393.5
Pt	ppb	5.0	10.0	17.5	8	17	2.5	12.9	—	—	—	—	—	—	—	5.0	5.0	5.0	7	12	2.5	9.2
Rb	ppm	80.0	128.0	199.0	71	190	2.5	250.8	87.0	137.0	212.5	87	215	2.5	283.3	92.0	147.0	247.0	93	250	2.5	292.0
S	%	0.041	0.055	0.081	0.04	0.08	7.0	0.084	0.032	0.042	0.062	0.032	0.048	17.0	0.071	0.032	0.048	0.074	0.033	0.082	2.5	0.077
Sb	ppm	5.0	5.0	5.0	—	—	—	3.3	—	—	—	—	—	—	—	—	—	—	—	—	—	3.4
Sn	ppm	—	—	—	—	—	—	—	1.0	1.0	1.0	< 1	3	2.5	1.0	5.0	5.0	5.0	—	—	—	—
Sr	ppm	23.0	43.0	76.5	23	71	3.0	93.5	20.0	38.0	59.0	22	64	2.5	80.5	21.0	37.0	62.5	22	48	6.0	79.8
U	ppm	1.40	1.80	1.90	1.6	2.3	3.0	2.60	1.60	2.00	2.40	1.7	2.4	2.5	2.69	1.60	1.80	2.40	1.6	2.4	2.5	2.67
W	ppm	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Zn	ppm	163.0	260.0	469.0	165	430	11.5	836.5	167.0	304.0	545.0	170	710	2.5	913.7	177.0	322.0	604.5	180	420	17.5	977.8

*1: Background *2: Threshold

As : Higher concentration points are mainly distributed in the Mantri deposit and surrounding silicified area, being closely related to the deposit.

Au : Anomalous points and points with higher values are centered around the Mantri deposit, being closely related with the deposit.

Co : Lower concentration is a trend around the Mantri deposit. Points with higher concentration are dispersed.

Cr : Lower concentration is characteristic of the deposit area like Co. Points with higher values are in general distributed in the area of Kalumpang Formation in the north of the survey area.

Fe : Anomalous points are extensively distributed from the central part to the southern part of the survey area, not being distinctly related to the deposit. The area of Kalumpang Formation is characteristic of lower concentration.

K : Points with higher concentration are dispersed, not being related to the mineralization.

Mn : Points with lower concentration can be recognized around the deposit. No characteristical distribution was detected.

Na : Anomalous points are limited in the area of Kalumpang Formation. The values have a trend to become slightly higher near the deposit.

Ni : The distribution patterns are the same as those of Co and Cr. The deposit area is characteristic of lower concentration.

Pb : Anomalous points are locally distributed near the deposit, and points with higher concentration are also centered around the deposit. This element is most closely related with the deposit.

Rb : Anomalous points and points with higher concentration are dispersed and not related with the deposit.

S : Anomalous points and points with higher concentration are near the deposit. Lower concentration is characteristic of argillized zone and the area of Kalumpang Formation.

U : The distribution of the anomalous points are limited inside the area of Kalumpang Formation, not being related to the deposit.

Zn : Anomalous points are distributed in the west side and the northeast side of the deposit, not being related to the deposit.

The result described above suggests that five elements of As, Au, Cu, Pb and S are effective pathfinders. Furthermore, Sr is also possibly utilized for pathfinder element because it has a negative relationship with the deposit.

(3) Multi element analysis

Cluster and factor analytical methods were applied for the multi element analysis as in the other two areas. The results of the cluster analysis and factor analysis are presented in Fig. II-2-27 and Table II-2-39 respectively.

The elemental clusters of Au-Cu-Fe, Co-Mn-Zn-Pb and K-Rb were found on the individual sample series. The cluster Au-Cu-Fe is considered to represent the mineralization of this area, elements of this cluster being effective pathfinders.

Factor 2 was detected to be closely related to As, Au, Cu and Pb on sample A and B by factor analysis. These related elements suggest that factor 2 is the one representing the mineralization of this area. Factor analysis on the elements of sample C did not found any factors distinctly related to the mineralization of this area. The elements of the factor 2 on sample B have a higher factor loadings and higher communalities than those on sample A. Therefore, the samples B is thought to be useful. Groups of elements of sample B listed below are related to the factors described on the left side.

Factor 1 : Co-Mn-Pb-Zn
Factor 2 : As-Au-Cu-Pb
Factor 3 : K-Rb
Factor 4 : Fe

The factors 2 and 4 have negative relationships with the related elements on the left side. Distribution of the points with higher factor scores to the factor 2 are shown in Fig. II-2-28. The distribution of the points with higher factor scores to the factor 2 is apparently corresponds to the zone of mineralization including altered zone. Therefore, the result suggests the method of factor analysis to be useful in this area.

(4) Relations between stream sediment and soil samples

Soil samples, location numbers 1 to 71, were collected near the stream sediment sample locations. To reveal the relationship between analytical values of stream sediment and soil, correlation coefficients were calculated for individual elements.

As : 0.511,	Au : 0.519,	Co : 0.399,	Cr : 0.446,	Cu : 0.638,
Fe : 0.360,	Mn : 0.590,	Ni : 0.509,	Pb : 0.814,	S : 0.424,
U : -0.085,	Zn : 0.723			

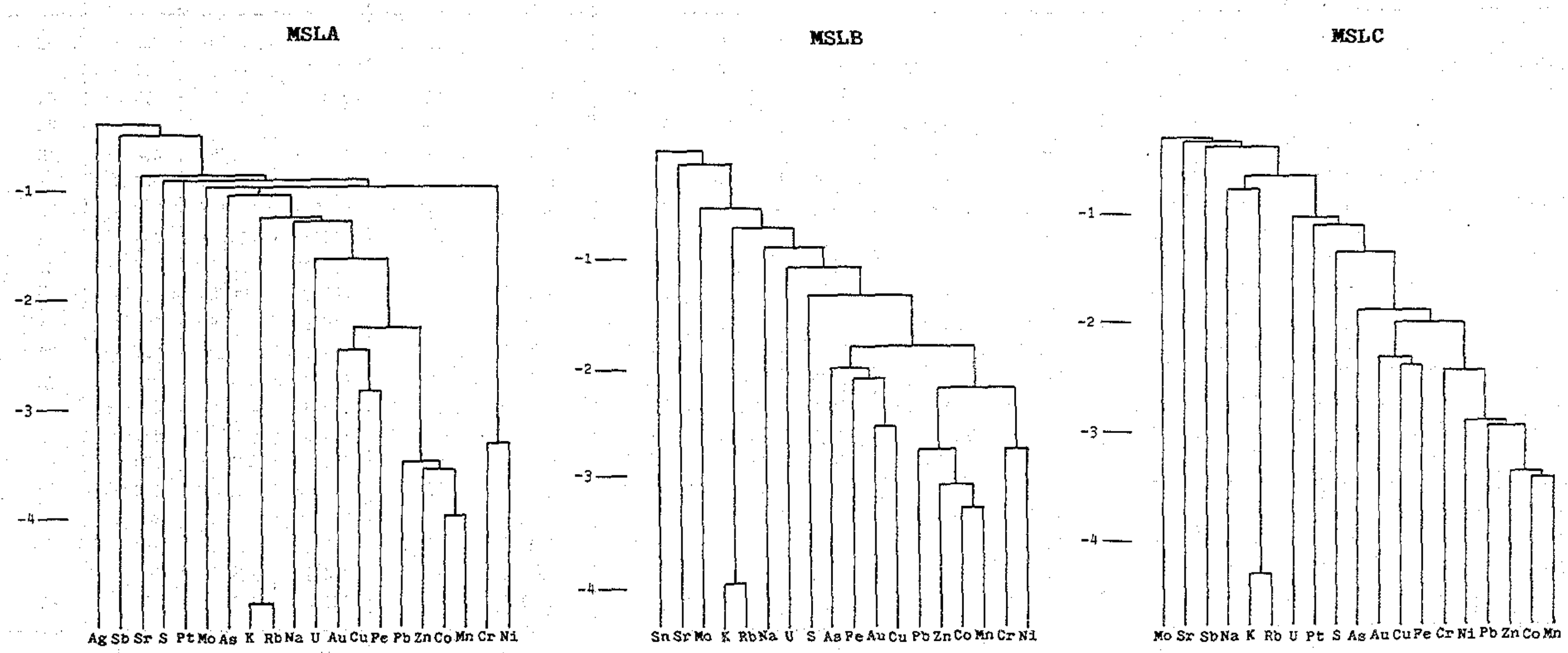
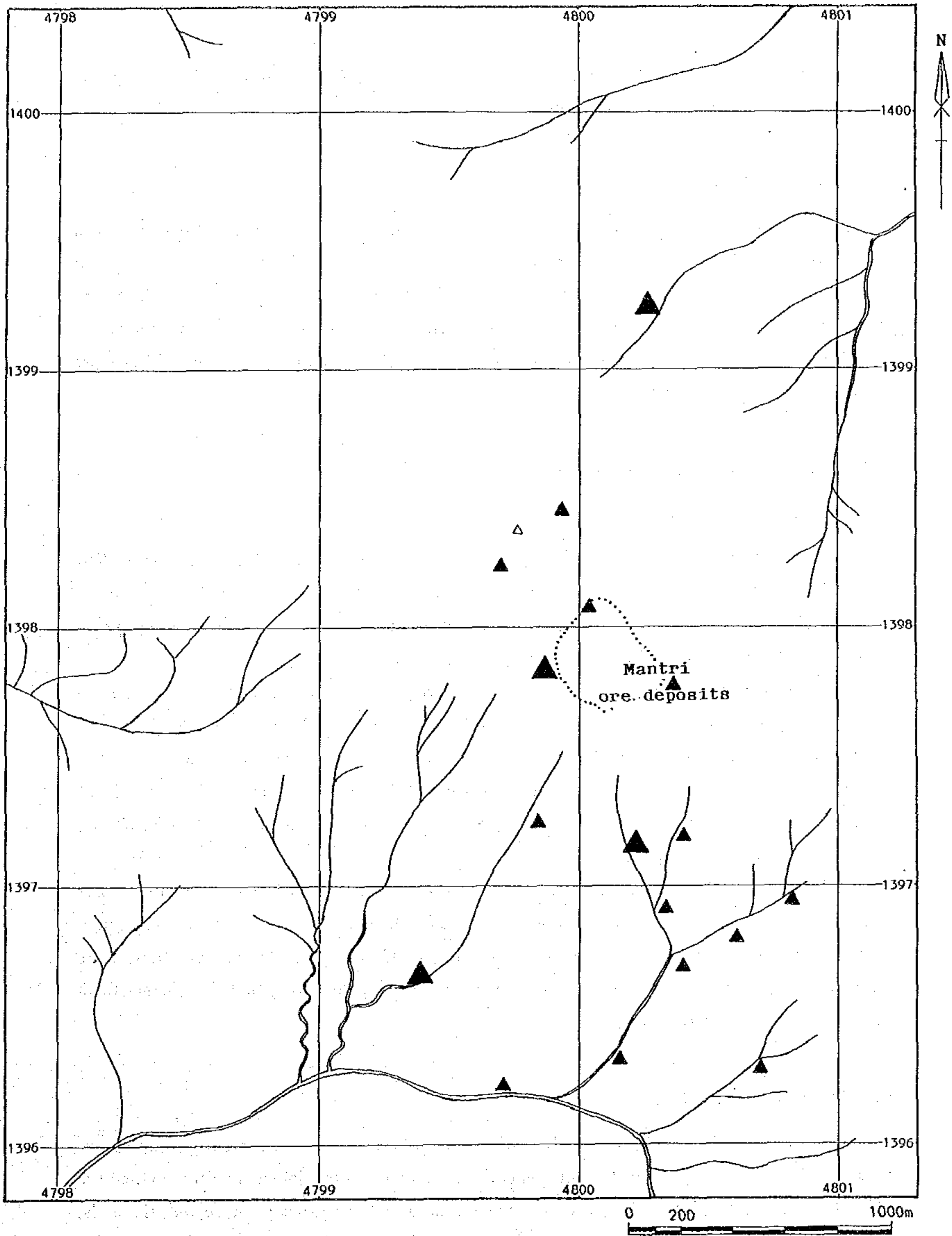


Fig. II-2-27 Dendrogram of elements for soil in the Mantri deposit area

Table II-2-39 Results of factor analyses for soil in the Mantri deposit area

Element	Sample collected at bank (A)					Sample collected at edge of stream (B)					Sample collected at middle of stream (C)				
	Factor loadings (Varimax rotation)				Communality	Factor loadings (Varimax rotation)				Communality	Factor loadings (Varimax rotation)				Communality
	Factor 1	Factor 2	Factor 3	Factor 4		Factor 1	Factor 2	Factor 3	Factor 4		Factor 1	Factor 2	Factor 3	Factor 4	
Ag	0.036	0.242	-0.135	-0.166	0.1313	—	—	—	—	—	—	—	—	—	—
As	-0.208	-0.552	0.083	-0.076	0.3795	-0.025	-0.779	-0.037	0.063	0.6454	0.138	-0.363	-0.265	-0.133	0.4825
Au	0.065	-0.739	0.031	0.105	0.5635	0.027	-0.809	0.026	-0.177	0.7077	0.097	-0.111	-0.069	-0.027	0.5916
Co	-0.132	0.092	-0.155	0.267	0.7770	0.793	0.105	-0.011	-0.199	0.7935	0.828	0.185	0.158	0.285	0.8565
Cr	-0.037	-0.033	-0.845	-0.051	0.7336	0.093	0.120	0.167	0.047	0.7717	0.228	0.020	0.017	0.717	0.5840
Cu	0.056	-0.633	-0.140	0.478	0.7229	0.126	-0.754	0.087	-0.420	0.7767	0.234	0.114	0.029	-0.112	0.7173
Fe	0.105	-0.279	0.001	0.750	0.6843	0.092	-0.373	-0.141	-0.724	0.7002	0.133	0.489	0.277	-0.111	0.6957
K	-0.969	-0.113	-0.026	0.035	0.9674	0.122	-0.016	0.975	-0.019	0.9706	0.048	0.209	-0.968	0.054	0.9981
Mn	-0.190	-0.157	-0.147	0.244	0.8706	0.856	-0.055	0.173	-0.205	0.8861	0.867	0.181	-0.163	-0.010	0.8388
Mo	-0.063	-0.039	0.041	0.092	0.3264	-0.104	0.061	0.086	0.194	0.2152	-0.163	-0.336	0.119	-0.096	0.1791
Na	-0.269	0.165	-0.012	0.590	0.4745	0.268	0.108	0.257	-0.503	0.4114	0.122	0.553	-0.183	-0.161	0.3834
Ni	-0.083	0.069	-0.820	0.007	0.7416	0.499	0.106	0.066	-0.039	0.7804	0.604	0.192	0.159	0.579	0.7720
Pb	-0.160	-0.751	0.068	-0.022	0.7826	0.528	-0.650	0.246	0.132	0.7864	0.557	-0.328	-0.214	-0.172	0.7841
Pt	-0.098	-0.180	0.206	0.009	0.1190	—	—	—	—	—	0.020	-0.022	0.102	-0.381	0.3851
Rb	-0.948	-0.146	-0.056	-0.149	0.9596	0.142	-0.081	0.951	0.082	0.9696	0.085	0.052	-0.966	0.147	0.9695
S	0.231	-0.341	-0.140	0.246	0.4643	-0.038	-0.412	-0.266	-0.285	0.5906	-0.076	-0.067	0.239	-0.477	0.5984
Sb	-0.092	-0.286	-0.071	-0.153	0.1894	—	—	—	—	—	0.018	0.046	-0.065	0.144	0.1034
Sn	—	—	—	—	—	0.118	-0.055	0.211	0.009	0.1348	—	—	—	—	—
Sr	-0.049	0.134	-0.064	-0.022	0.4186	0.057	0.152	0.062	0.112	0.3726	0.057	-0.069	-0.079	0.073	0.3564
U	-0.178	0.029	-0.073	-0.521	0.4351	-0.199	0.129	0.226	0.445	0.3996	-0.172	-0.188	-0.178	0.596	0.4560
Zn	-0.272	-0.482	-0.081	0.243	0.7976	0.810	-0.348	0.201	-0.158	0.8470	0.862	0.067	-0.163	-0.083	0.8675
F.C.[*1]	19.5 %	22.0 %	13.6 %	16.3 %	—	23.4 %	23.7 %	19.5 %	12.4 %	—	26.7 %	9.7 %	20.0 %	15.7 %	—

*1: factor contribution



▲ ≦-1.200 factor 2 factor score   -1.200 ≦ ▲ ≦-0.800 factor 2 factor score

Fig. II-2-28 Distribution map of factor 1 factor score for soil in the Mantri deposit area

This result suggests that individual elements, especially Cu, Pb and Zn, have a highly correlation between the two sample medias.

(5) Summary of analyses

The distribution of the anomalous values of all elements detected by EDA method are shown in Fig. II-2-29. This figure shows that the anomalous points of Au, Cu, Pb and S are centered around the deposit and these elements are effective pathfinder elements. Judging from the distribution of these elements, the extension of the anomalous zones are limited within the areas, which enclose the mineralized zone and are bounded by the lines 1.5 km, 0.5 km and 1.0 km apart from the mineralization zone.

2-4-5 Pan concentrate geochemical survey

(1) Pathfinder elements

Pan concentrate samples collected in this survey area were analysed for 33 elements. The data of the statistical treatments for the analytical values, Appendix 8, are presented in Table II-2-40. Analytical values of Ge are all below the detection limit. Further, majorities of analytical values of Pt, Re, Se and Ta are below their detection limits as well.

The concentration of Au, Fe, Mn, Mo, Pb, S, Sn and Zn is higher than those of stream sediment samples. Especially the concentration of Au and Pb is significantly high. On the contrary, the concentration of As, Ni, Sb and U is lower than those of stream sediment samples. The concentration of Co, Cr, Cu and Pt is more or less the same as those of stream sediments. Thus, the analytical values of individual elements of the pan concentrates are not so different from those of the stream sediment samples.

Correlation matrixes among analytical values are shown in Table II-2-41. This matrix suggests that elements in samples from Mantri deposit area generally have a higher correlation with each other than those from Bidu Bidu Hill area, and lower correlation than those from Nungkok deposit area, on the contrary. Group of elements Ba-Cu-Mn-Pb-Sb is characteristic of higher correlation with each other.

(2) Single element analysis

The results of EDA analysis for the analytical values of pan concentrate samples are presented in Table II-2-40. The distribution of the anomalous points detected by the method are plotted on Fig. II-2-30. This figure shows that the area of the deposit is characteristic of the anomalies of Ba. Ga was also detected near the deposit. However, the concentration of Ga is considered to be significantly influenced by the weathering, because the element has high

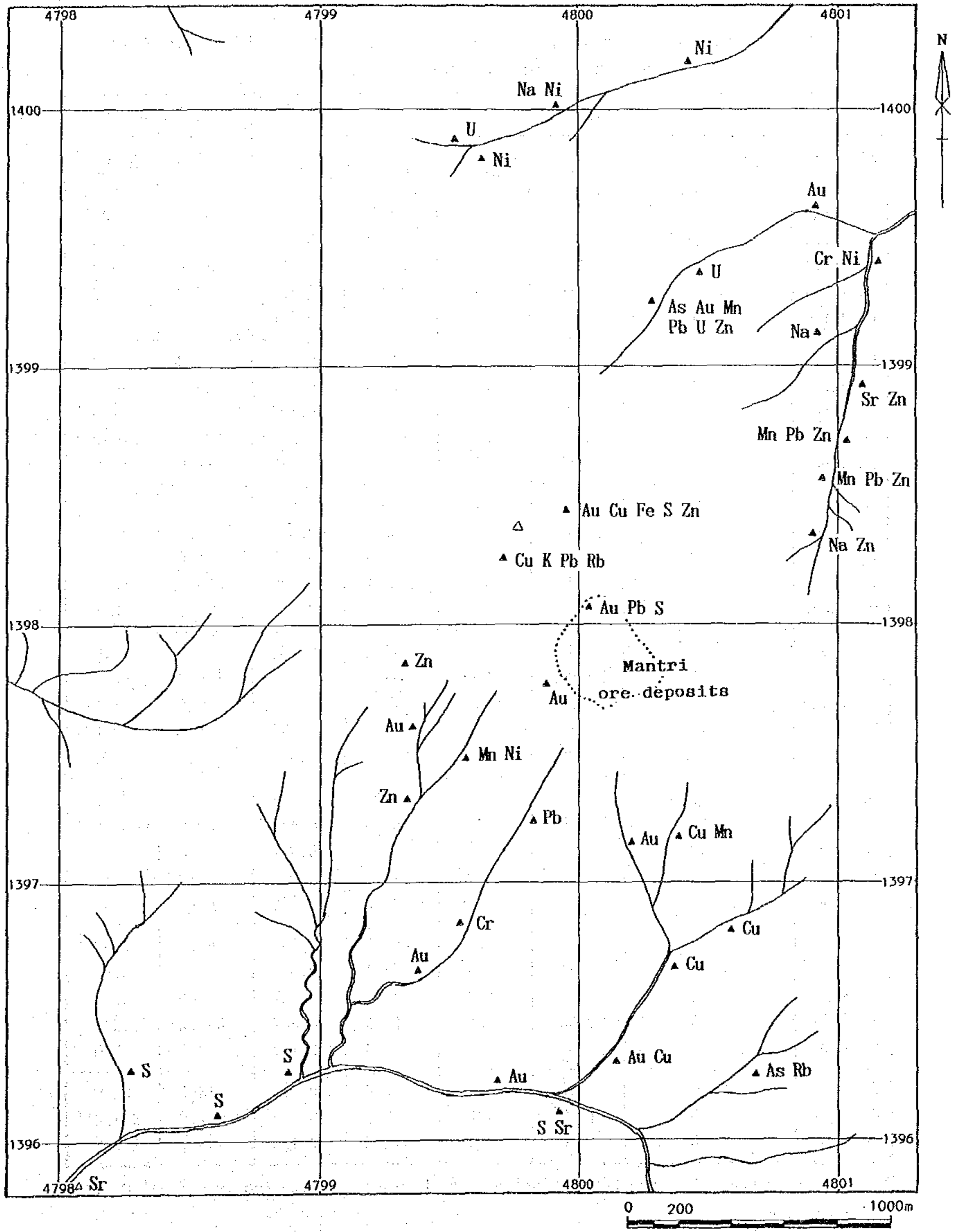


Fig. II-2-29 Interpretation map of soil geochemical survey in the Mantri deposit area

Table II-2-40 Statistics and thresholds of pan concentrate geochemical survey in the Mantri deposit area

Statistics						EDA method*3	
Element	Below detection limit (%)	Maximum value	Minimum value	Mean*1 value	S.D. *2	Median	Upper Fence
Ag (ppm)	59	12.0	< 0.5	0.47	0.423	0.50	1.00*4
As (ppm)	0	76	3	18.8	0.417	23.0	48.0
Au (ppb)	0	> 10000	6	568.4	1.003	980.0	6850.0
Ba (ppm)	0	1250	70	224.3	0.321	180.0	655.0
Ce (ppm)	0	58	8	25.5	0.165	26.0	42.0
Co (ppm)	6	36	< 1	10.9	0.422	14.0	34.0
Cr (ppm)	0	630	16	129.1	0.373	140.5	376.0
Cu (ppm)	13	421	< 1	30.9	0.846	35.0	397.5
Fe (%)	0	> 25.00	5.76	13.06	0.228	13.55	24.40*4
Ga (ppm)	0	17	7	11.1	0.113	11.5	13.0*4
Ge (ppm)	100	< 5	< 5	—	—	—	—
Hg (ppb)	0	880	30	89.3	0.329	85.0	225.0
La (ppm)	0	20	4	10.2	0.159	11.0	18.0
Mn (ppm)	0	7290	350	2782.0	0.294	3060.0	4910.0*4
Mo (ppm)	34	9	< 1	1.3	0.387	1.0	3.5
Ni (ppm)	0	43	1	13.4	0.356	15.5	36.0
Pb (ppb)	0	1700	18	247.8	0.525	310.0	1293.0
Pt (ppm)	84	100	< 5	3.1	0.294	5.0	5.0
Re (ppm)	78	15	< 1	0.8	0.392	1.0	2.0*4
S (%)	0	7.900	0.027	0.172	0.623	0.166	0.696
Sb (ppm)	0	7.4	0.4	2.37	0.334	2.90	6.30
Se (ppm)	84	3.6	< 0.2	0.15	0.431	0.20	0.20
Sn (ppm)	59	4	< 2	2.2	0.087	2.0	3.0*4
Ta (ppm)	97	2.0	< 2.0	—	—	—	—
Te (ppm)	6	2.75	< 0.10	0.73	0.388	0.85	2.75
Th (ppm)	0	8.0	2.0	5.03	0.142	5.00	7.00*4
Ti (%)	0	9.01	0.34	2.31	0.359	2.84	8.59
U (ppm)	0	2.2	0.8	1.41	0.117	1.40	2.20
V (ppm)	0	2700	108	601.9	0.382	638.0	2149.5
W (ppm)	3	7	< 2	3.4	0.157	3.5	5.5
Y (ppm)	0	30	7	16.0	0.135	16.0	29.0
Zn (ppm)	0	1140	100	469.7	0.279	527.0	844.0*4
Zr (ppm)	0	310	91	121.7	0.125	110.0	142.5

*1: geometric mean *2: standard deviation *3: Exploratory Data Analysis (Kurzl H., 1988)

*4: Upper Wisker

Table II-2-41 Coorelation matrix of elements for pan concentrates in the Mantri deposit area

	Ag	As	Au	Ba	Ce	Co	Cr	Cu	Fe	Ga	Hg	La	Mn	Mo	Ni	Pb	Pt	Re	S	Sb	Se	Sn	Te	Th	Ti	U	V	W	Y	Zn	Zr
Ag	1.000																														
As	.159	1.000																													
Au	.432	.364	1.000																												
Ba	.166	.581	.333	1.000																											
Ce	-.264	.175	.161	.121	1.000																										
Co	-.220	.220	.033	.282	.251	1.000																									
Cr	.309	.174	.410	.252	.063	.095	1.000																								
Cu	.201	.820	.243	.571	.116	.273	.037	1.000																							
Fe	.441	-.437	.304	-.077	-.277	-.063	.079	-.327	1.000																						
Ga	.442	-.334	.243	-.019	.069	.093	.185	-.195	.798	1.000																					
Hg	.236	-.032	.172	-.159	.144	.069	-.265	-.074	.443	.523	1.000																				
La	-.343	.231	-.007	-.091	.848	.198	-.113	.143	-.493	-.222	.129	1.000																			
Mn	.425	.307	.577	.555	.300	.170	.529	.326	.389	.602	.154	-.050	1.000																		
Mo	.321	.615	.487	.558	.087	.323	.185	.569	.144	.184	.296	.055	.475	1.000																	
Ni	.360	.068	.429	.275	.316	.167	.806	.017	.290	.546	-.017	-.033	.785	.175	1.000																
Pb	.325	.637	.435	.681	.089	.185	.327	.674	.029	.115	-.204	-.078	.674	.516	.392	1.000															
Pt	.250	.072	.131	-.076	.132	.154	.090	.073	-.057	-.129	-.084	.132	-.083	-.229	.047	.085	1.000														
Re	.134	-.029	.207	.156	.115	.288	-.076	-.041	.299	.383	.508	.021	.170	.438	.048	-.080	-.147	1.000													
S	-.008	-.185	.074	-.238	.162	.203	-.293	-.248	.495	.494	.823	.127	.090	.179	-.030	-.154	-.067	.448	1.000												
Sb	.458	.612	.647	.552	.098	.065	-.021	.591	.201	.166	.293	.005	.481	.691	.050	.664	.065	.189	.168	1.000											
Se	-.133	.244	.035	-.011	.406	.127	-.256	.089	-.094	.015	.530	.477	-.075	.292	-.169	-.130	-.125	.216	.450	.223	1.000										
Sn	.060	-.217	.110	-.270	-.049	.266	.190	-.103	.523	.470	.167	-.083	.236	.098	.192	.109	.186	.029	.330	.010	-.080	1.000									
Te	.360	.442	.517	.312	.229	-.037	-.127	.394	.112	.115	.378	.102	.256	.479	.004	.423	.123	.237	.289	.774	.343	-.169	1.000								
Th	-.395	.302	-.040	.090	.468	.254	-.278	.205	-.415	-.333	-.078	.585	-.242	.060	-.333	.125	.212	-.221	.056	.231	.441	-.100	.337	1.000							
Ti	.342	-.469	.350	-.202	-.140	-.172	.060	-.509	.831	.683	.572	-.309	.245	.062	.215	-.172	-.041	.301	.621	.188	.007	.412	.137	-.316	1.000						
U	.042	.067	.288	-.002	.024	-.154	-.350	.031	.260	.144	.374	.127	-.028	.360	-.319	.075	-.139	.045	.439	.475	.306	.131	.412	.398	.426	1.000					
V	.476	-.439	.363	-.077	-.175	-.102	.195	-.391	.923	.806	.494	-.400	.444	.126	.413	-.045	-.065	.298	.495	.173	-.105	.442	.054	-.493	.922	.224	1.000				
W	.177	.066	.457	.081	-.204	.133	-.028	.086	.313	.072	.243	-.227	.101	.200	-.052	.132	.293	.118	.267	.400	-.158	.191	.246	.001	.471	.350	.377	1.000			
Y	-.116	.679	.128	.473	.399	.062	-.053	.586	-.527	-.359	-.158	.485	.170	.337	-.126	.422	-.036	-.167	-.322	.435	.190	-.243	.276	.542	-.491	.230	-.538	-.013	1.000		
Zn	.386	.193	.449	.441	.105	.025	.296	.276	.501	.604	.084	-.185	.840	.337	.561	.789	-.040	.043	.167	.545	-.175	.352	.328	-.109	.316	.153	.466	.158	.080	1.000	
Zr	.339	-.142	.116	-.161	-.160	.103	.170	-.173	.340	.347	.113	-.237	.032	.211	.141	.094	.285	.223	.279	.134	.044	.408	.172	-.025	.360	.155	.303	.179	-.319	.138	1.000

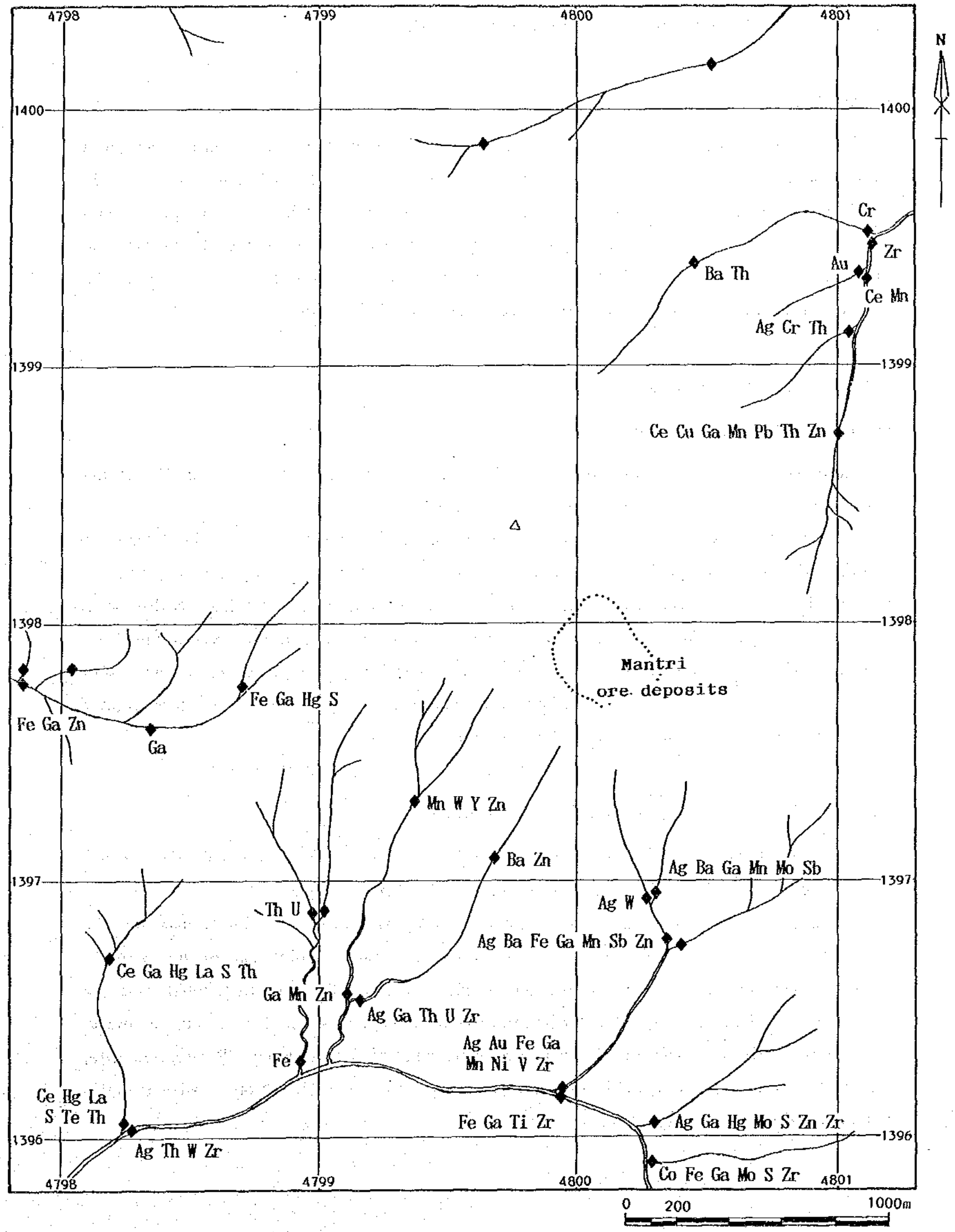


Fig. II-2-30 Interpretation map of pan concentrate survey in the Mantri deposit area correlation with Fe as can be seen in the correlation matrix.

(3) QME analysis

Data of QME analysis for pan concentrate samples collected from this area are presented in Table II-2-42. Magnetite, ilmenite, leucoxene, goethite, quartz and plagioclase were identified in all samples. Pyrite, clinozoisite and enstatite were also identified in many samples. Gold particles were observed in ten samples, scattering throughout the area. No distribution trend of gold could be detected. Minorities of spinel, rutil, hematite, chalcopyrite, olivine, amphibole, epidote, zircon, anataze, calcite and manganese oxide were also identified.

2-4-6 Laboratorial studies

(1) Thin section observation

Samples for thin section observation were taken from clastic rocks of Kalumpang Formation and andesite lavas. The observations were presented in Table II-2-43.

The observations verified that andesite which was determined to be pyroxene andesite is significantly silicified and chloritized, and accompanied with calcite in many samples. Epidote and sericite were observed as altered minerals as well. Samples taken from Kalumpang Formation were identified to be tuff and tuffaceous rocks comprising same altered minerals as andesite. This fact revealed that alteration, which accompanies mineralization, expands into Kalumpang Formation. However, Kalumpang Formation is thought to be more or less slightly altered compared to the andesite due to the observable montmorillonite.

(2) Polished section and polished thin section observation

Five and three samples were collected for polished section and polished thin section observations respectively. The observations were listed in Table II-2-44.

Three polished section samples were taken from the trench dug on the Mantri deposit. Hematite and goethite, and pyrite were observed on three samples and on one sample respectively. Gold was not observable on each sample. Sample N042 is a pyrite taken from inside the silicified mudstone, being verified to be composed of only pyrite by the observation. On quartz vein sample G020 only pyrite is observable by polished section observation. Pyrite, hematite, goethite with quartz and minor chlorite, zeolite and carbonate minerals were observed on samples by polished thin section observation.

Table II-2-42 Results of qualitative mineral examination of pan concentrates in the Mantri deposit area

Mineral Names \ Sample Number	MPC 01	MPC 02	MPC 03	MPC 04	MPC 05	MPC 06	MPC 07	MPC 08	MPC 09	MPC 10	MPC 11	MPC 12	MPC 13	MPC 14	MPC 15	MPC 16
Maagnetite	2.7	2.3	6.1	8.6	1.8	5.4	1.4	2.3	0.3	0.3	1.3	44.6	29.5	44.7	5.1	3.4
Native Gold		Tr					Tr	Tr				Tr			Tr	Tr
Spinel	Tr	Tr	Tr	Tr	Tr	Tr	Tr	Tr	Tr						Tr	
Ilmenite	2.4	1.4	6.8	0.9	0.7	1.1	0.6	1.0	0.3	0.2	0.6	10.8	7.1	13.2	2.8	4.5
Rntile		Tr	Tr				Tr					Tr				
Leucoxene	2.1	2.4	1.0	0.6	1.7	2.9	0.6	0.9	Tr	0.3	8.4	7.2	1.2	1.9	13.8	13.0
Pyrite			Tr	Tr					Tr	Tr	0.2	Tr	Tr	17.0	Tr	0.1
Goethite	9.3	5.7	1.9	4.0	7.2	11.9	10.0	11.0	12.2	2.5	11.8	6.0	15.3	5.6	22.8	18.6
Hematite	Tr		Tr				Tr	Tr						Tr		
Chalcopyrite									Tr							
Olivine			Tr													
Amphibole		Tr		Tr	Tr											
Clinozoisite		Tr	Tr	Tr	Tr	Tr	Tr	Tr		Tr		Tr	Tr	Tr		
Epidote	Tr						Tr									
Zircon	Tr	Tr	Tr	Tr	Tr			Tr	Tr	Tr						Tr
Enstatite	0.3	0.1	Tr	0.3	Tr	Tr	Tr	Tr		Tr		Tr	Tr	Tr	Tr	Tr
Anatase	Tr	Tr														
Quartz	16.7	17.6	50.5	25.7	31.0	19.7	21.9	28.0	17.4	14.5	11.7	4.7	7.0	2.6	6.7	14.9
Plagioclase	66.9	70.5	33.7	60.0	57.6	59.0	65.6	56.8	69.7	82.2	66.0	26.3	39.9	15.4	48.8	44.5
Calcite																
MnO_2								Tr	Tr							

Mineral Names \ Sample Number	MPC 17	MPC 18	MPC 19	MPC 20	MPC 21	MPC 22	MPC 23	MPC 24	MPC 25	MPC 26	MPC 27	MPC 28	MPC 29	MPC 30	MPC 31	MPC 32
Maagnetite	14.9	38.0	9.2	7.0	30.9	8.8	15.0	18.1	63.0	28.2	36.5	11.0	16.8	9.9	23.5	27.9
Native Gold					Tr				Tr		Tr		Tr			
Spinel					Tr	Tr			Tr					Tr		
Ilmenite	17.4	5.8	1.0	1.1	3.3	1.4	2.3	0.9	7.5	55.0	2.9	2.6	1.3	0.5	15.2	11.5
Rntile																
Leucoxene	10.0	4.6	8.3	4.5	4.9	2.8	7.1	7.7	1.9	1.2	2.1	1.3	1.5	2.5	2.2	1.6
Pyrite	Tr		Tr	Tr	Tr	Tr	Tr		Tr	Tr	Tr	Tr	Tr	Tr	Tr	Tr
Goethite	19.0	12.8	11.3	16.9	24.3	23.3	19.0	17.2	9.4	4.9	24.4	22.1	15.3	13.5	19.5	18.3
Hematite	2.5		Tr		Tr			Tr		Tr	Tr			Tr	6.5	21.0
Chalcopyrite																
Olivine														Tr		
Amphibole							Tr		Tr				Tr	Tr	Tr	
Clinozoisite			Tr		Tr	Tr	Tr	Tr	Tr		Tr		Tr	Tr	Tr	Tr
Epidote	Tr						Tr			Tr						
Zircon				Tr	Tr	Tr									Tr	
Enstatite	1.0	Tr	Tr	Tr	Tr	Tr			Tr	Tr	Tr	Tr			Tr	Tr
Anatase																
Quartz	14.1	7.8	14.0	10.6	7.3	15.9	8.5	11.2	5.5	5.4	8.5	12.6	16.3	18.4	13.2	9.9
Plagioclase	21.1	31.0	56.2	69.9	29.3	47.8	48.1	44.9	12.7	5.3	25.6	50.4	48.8	55.2	19.9	9.8
Calcite																Tr
MnO_2									Tr							

Table II-2-43 Observation results of thin sections collected in the Mantri deposit area

Sample No.	Location	Descriptions	Texture	Frag		Grains and phenocrysts					Matrix and groundmass					Secondary minerals									Remarks
				Andesite	Pumice	Quartz	Plagioclase	Clinopyroxene	Orthpyroxene	Opaque minerals	Tuff	Silt	Plagioclase	Clinopyroxene	Glass	Quartz	Chlorite	Epidote	Albite	Calcite	Opaque minerals	Montmorillonite	Sericite	Illite	
N031	South part	Dark green pyroxene andesite.	Porphyritic				◎	◯	○				◎			◯	◯	•		◯	•				
N033	South part	Strongly silicified tuff breccia with pyrite diss.	Pyroclastic													◎	◯			◯	◯		◯		
N034	South of Bt. Mantri	Dark gray andesite with pyrite diss. Silicified.	Porphyritic				◎						◎			◎	◯			◯	○				
N041	Northeast corner	Pale green tuffaceous sandstone, weathered.	Clastic			◯	◎					◎					◯	•				◎		◯	
N043	Northeast of Bt. Mantri	Greenish gray altered rock pyrite diss., silicified.	Porphyritic													◎	◯		◎	◯			○		
T009	Camp area	Greenish gray andesite	Porphyritic				◎	◯	○	•			◯	○	◎	○	◯	•							
T010	Southeast of Bt. Mantri	Greenish gray andesite with weak pyrite diss.	Porphyritic				◯						◎	◯			◎	○	◎	◯	○				
T011	North part	Greenish gray andesitic lapilli tuff.	Pyroclastic	◎	◯	◯	◯			•	◯						◯	◯		◯	•				
T012	North part	Light gray tuffaceous sandstone.	Clastic		•	◯	◯			•	◎						○			◯		◯			Fossil
G023	Southwest part	Gray andesite, strongly silicified & pyrite diss.	Porphyritic				◎	◯	○	•			◯		◯	◯	○	•		○	•				

◎: abundant ◯: common ○: little •: rare

Table II-2-44 Observation results of polished and polished thin sections collected in the Mantri deposit area

	Sample No.	Location	Descriptions	Texture	Observed minerals								Remarks
					Pyrite	Hematite	Goethite	Gangue minerals	Quartz	Chlorite	Zeolite	Carbonate minerals	
Polished section	N037	Trench	Quartz veinlet with limonite and goethite.	Disseminations	●	●	○	◎					Weathered
	N038	Trench	Silicified rock with quartz, limonite & goethite.	–		●	◎	◎					Weathered
	N039	Trench	Silicified & argillized rock with limo.-goethite-hematite	–		●	○	◎					Weathered
	N042	Northeast part	Black silicified mudstone with fine-grained pyrite	Disseminations	○			◎					Euhedral and fine-grained pyrite.
	G020	Southwest corner	Strongly silicified rock with pyrite/quartz·jasper	Vein	∘			◎					Euhedral pyrite. Float.
Polished thin s.	N033	South of Bt. Mantri	Strongly silicified rock with intense pyrite diss.	Disseminations	○				◎	∘		○	
	N038	Trench	Quartz veinlet with limonite & goethite in sili. rock	Veinlet & disseminations		○	○		◎				Weathered
	G023	Southwest Part	Gray silicified andesite with pyrite disseminations	Disseminations	○				◎		●		Float

◎: abundant ○: common ∘: little ●: rare

(3) X-ray diffractometry

Five samples were taken from andesite and mineralized zone and presented for the X-ray diffraction to reveal the relationships between the mineralization and the alteration. The result of the diffraction was shown in Table II-2-45.

On the sample N038, which was taken from the trench dug in the intense alteration zone in the area, quartz, kaolinite, hematite and pyrite were identified. Kaolinite is characteristic of the sample. Samples N035 and G026 which were intensely argillized characteristically include quartz and sericite. In these samples plagioclase thoroughly or almost disappeared. Sample N034 is slightly altered and still include plagioclases. Sample N031 is most slightly altered among the samples and is revealed to be slightly chloritized.

Table II-2-45 Results of X-ray diffraction analyses in the Mantri deposit area

Sample No.	Location	Descriptions	Detected minerals								Remarks
			Quartz	Plageoclase	Diopside	Chlorite	Sericite	Kaolinite	Hematite	Pyrite	
N031	South part	Dark green pyroxene andesite. Weakly altered.	◎	◯	○	•					
N034	South of Bt.Mantri	Dark green silicified andesite with pyrite diss.	◎	◯		○				•	
N035	South of Bt.Mantri	Strongly argillized andesite with pyrite diss.	◎	•		○	○			○	
N038	Trench	Silicified, brecciated & mineralized zone	◎					•	○	•	Weathered
G026	West part	Gray argillized andesite with pyrite disseminations	◎				○			○	

◎ : abundant ◯ : moderate ○ : few • : rare

2-5 Overall discussion for the survey results

2-5-1 Sample media

Three sample medias including stream sediments, soil and pan concentrates were adopted for this survey as the sample media. In case of stream sediments and soil samples, three different samples were collected at each sampling site, in order to clarify the most suitable sampling position.

(1) Stream sediment sample

The stream sediment samples was collected from three different positions at each sampling site. These three positions are bank (sample A), edge of stream (sample B) and middle of stream (C). Analytical results for these three kind of samples in the each orientation geochemical survey area are summarized as follows:

<u>Nungkok deposit area</u>

As the results of the statistical data treatment, sample B gave higher geometric mean values in general. The elements in sample B also indicate higher correlation coefficient each other. Results of factor analysis indicate that the factors delineated by sample B have more close relationship with the elements, and clearly delineate factor which is thought to be mineralization. These results conclude that the sample B is better for the survey comparing with samples A and C.

<u>Bidu Bidu Hill deposit area</u>

Results of data treatment gave comparatively higher geometric mean values of elements for sample B. Sample A has higher correlation coefficient among the elements. Distribution of factor scores for sample B clearly delineates the existing ore deposits. These results suggest that the sample B is better than the samples A and C.

<u>Mantri deposit area</u>

Results of statistical data treatment indicate that elements have higher geometric means in sample A or C, and the mean values of sample B are mostly in the middle. Factors delineated from sample A are not correspond to the results of single element analyses. Samples B and C gave similar results in the factor analyses and ore deposit area was clearly delineated by these samples. Between these two kind of samples, sample B gave higher values of communality in the factor analyses comparing with the values of sample C. These results suggest no significant difference between the sample B and C, but the sample B is slightly better than the sample C.

Based on these results for three survey areas, mentioned above, the sample collected at the edge of stream (B) is thought to be the best, and the sample should be taken at this sampling point in the coming regional geochemical survey.

(2) Soil sample

In order to select optimum sampling points, three kind of samples from different sampling points were collected in this survey. These points area horizon A (sample A), upper part of horizon B (sample B) and lower part of horizon B (sample C). Results obtained from each survey area are summarized as follows:

Nungkok deposit area

Comparing with the geometric mean for each element, more elements have higher concentration in the sample A. However, in case of sample A, distribution pattern of element tend to have irregular shape on the cumulative frequency graph compare to the distribution patterns of the samples B and C. The samples B and C gave higher correlation coefficients among the elements than those of sample A. As the results of cluster analysis, cluster which is thought to be related to the mineralization was delineated only from the samples B and C. Factor analysis for the sample B give higher communality values comparing with other two kind of samples. These results suggest the sample B is better than other samples.

Bidu Bidu Hill deposit area

Comparing with the geometric mean for each element, no tendency can be observed for these three kind of samples and only some differences are found for the elements. Samples B and C have more close correlation among the elements, comparing with the correlation of the sample A. As the results of factor analysis, the factor which has close relation to mineralization in this area was delineated only from the samples B and C, and the elements indicating the mineralization in sample B have more close relation with the factor than sample C. These results suggest that the sample B is the best among these three kind of samples in a geochemical survey.

Mantri deposit area

As the results of statistical data treatment, sample A or C show higher geometric means of elements, and sample B give mostly middle values. Among the elements, sample B has more close correlation. Results of factor analysis delineated factors which are thought to be mineralization only from samples A and B. Between two factors related to mineralization, the factor of sample B shows more close relation with the elements and the elements have higher communality values. Judging from these results, sample B is thought to be the best among these three kind of samples.

The survey results for these three orientation survey areas indicated that the sample B is the most suitable sample for soil geochemical survey in this area. Because soil of horizon A in this project area is limited in general, and it is difficult to sample soil of same nature in the survey. Therefore, soil sample of the horizon A is thought to be not suitable for the soil geochemical survey in this area. The concentrations of some elements for the samples of the Bidu Bidu Hill deposit area show significant difference between the samples collected along stream and the samples collected at the hill. This may come from the different nature at the sampling site. Therefore, it is quite important to select the sampling site in order to collect the samples with same nature.

(3) **Pan concentrate sample**

In this survey, 32 samples from each survey area totaling 96 samples were collected and analysed. Results of the statistical treatment for the samples collected from the Nungkok deposit area, geometric means of most elements indicated higher values than the elements of stream sediments. In case of the samples in the Bidu Bidu Hill deposit area, a half of elements show higher geometric means and remaining elements are lower comparing with the geometric means of the stream sediment sample in the area. The samples collected in the Mantri area show similar tendency of geometric means to the samples in the Bidu Bidu Hill area.

Results of the qualitative mineral examination (QME) clarified significant differences of mineral composition among the survey area. Most pan concentrates sampled in the Nungkok deposit area contain no black sand. On the other hand, the pan concentrates sampled in the Bidu Bidu Hill deposit area, mostly consist of black sand. Time required for the sampling is also significantly different among the survey areas. Because of these differences due to the sampling site, results of chemical analyses for pan concentrates are not suitable for treating statistically, and the anomalous zone delineated by the data analyses may have errors. The elements which were chemically analysed for both of stream sediments and pan concentrates show that the results of data analyses for stream sediments give better results than those for pan concentrates.

(4) **Applicability and distance of influence**

As the results of this survey, it was confirmed that three kind of the sample medias used in this survey are applicable to delineate mineralized zones. However, each sample media has different characteristics, and therefore selection of sample media should be made on the basis of the purpose of the survey.

As the results of the stream sediment geochemical survey, anomalous samples were delineated 1.5 km a way from the Nungkok ore deposits, several hundred meter away from the Bidu Bidu Hill ore deposits and 2.0 km away from Mantri ore deposits. The distances of influence from the ore deposits are significantly long except the Bidu Bidu Hill ore deposit which is blind ore deposits, and therefore the stream sediment sample is thought to be suitable for the regional geochemical survey in this area. However, these three ore deposits surveyed are the most significant and large in scale in this project area, therefore, sampling site should be located adopting 1 km as the distance of influence in the planning of a regional geochemical survey.

The results of soil geochemical survey confirmed 1.5 km of distance of influence in the Nungkok deposit area and 1.0 km in the Bidu Bidu Hill and Mantri deposit areas. The distances of influence of soil samples are shorter than those of stream sediment samples in general, and the anomalous soil samples are found mostly in the mineralization zone. Therefore, soil geochemical survey is suitable for a detailed geochemical survey in a limited area. The ore deposits investigated in this survey are significant in this project area, and therefore, 500 m ore less should be applied for the distance of influence in case to locate sampling site in a soil geochemical survey in this project area.

A geochemical survey using pan concentrates is convenient and applicable method to carry out the survey in a limited area or for special minerals. However, if this survey carry out together with a stream sediment survey, it is not necessary to conduct chemical analyses for the pan concentrates and the pan concentrate survey should be limited to clarify the mineral composition of the survey area.

2-5-2 Pathfinder elements

In this survey, 19 elements for stream sediments, 23 elements for soil and 33 elements for pan concentrates were chemically analysed. Judging from the results of data analyses, following elements were delineated as useful pathfinder elements for the survey in this project area.

Stream sediments sample

Nungkok deposit area: As, Au, Cu, Mo, S, W

Bidu Bidu Hill deposit area: Au, Cu, Mn, Pb, U

Mantri deposit area: As, Au, Cu,Pb, Zn

Soil sample

Nungkok deposit area:	As, Au, Cu, Mo, S, W
Bidu Bidu Hill deposit area:	Au, Cu, S, U
Mantri deposit area:	As, Au, Cu,Pb, S

Pan concentrate sample

Nungkok deposit area:	Au, Cu, Mo, S, Se, W
Bidu Bidu Hill deposit area:	-
Mantri deposit area:	Ba

As the results of this survey, the pathfinder elements delineated from the stream sediment survey are quite similar to those from soil survey. On the whole, following 10 elements are thought to be the useful pathfinder elements for the geochemical survey in this project area.

As, Au, Cu, Mn, Mo, Pb, S, U, W, Zn

Among these elements, two elements of Mn and U have close relation with the host rocks of the Bidu Bidu Hill deposit area, and also these element themselves are the target elements for the survey in this project area.

Results of pan concentrate survey in the Mantri deposit area confirmed close relation between the concentration of Ba and the mineralization. Therefore, Ba is thought to be a useful pathfinder element for the survey of Au-Ag mineralization. Because of the geologic setting of the project area, potentiality of chromite ore deposits related to ultra-basic rocks are thought to be high. It is useful to apply Cr as the pathfinder element in the regional stream sediment survey. In this case, chemical analysis of Cr should be made by percentage, because many samples in this survey indicated more than the detection limit (10,000 ppm).

2-5-3 Data analyses

In this survey, single element and multi element analysis method were examined and these analytical methods gave good results. The methods of data analyses should be selected depending on geology of the survey area, type of mineralization, coverage of survey area and sample media used. Consequently, results of the field survey are also very important for selecting the analytical method. However, each method also has limitation, and then at least one single element analysis and one multi element analysis methods should be applied for the data analyses.

2-5-4 Fieldwork in the regional geochemical survey

Judging from the results of this survey and the data analyses, followings can be pointed out for the coming regional survey.

① The sample density of 2 km^2/sample is ideal for the regional stream sediment survey. However, because longer distance of influence are expected for topographically flat area, 4 km^2/sample is enough sample density in the flat area.

② In case of above mentioned sample density, it is better to collect the stream sediment samples from the first or second stream.

③ The Project area is entirely covered with 1/50,000 in scale topographic map sheet. But the accuracy of the maps are limited and the contour lines in flat areas are not clear. Therefore, it is better to use aerial photographs together with the topographic map sheet. In some areas, it is also necessary to use Global Positioning System in order to confirm the exact sampling location.

Chapter 3 Heliborne geophysical survey

3-1 Methodology and work amounts

The heliborne geophysical survey, consisting of aero-magnetics and aero-radiometrics, is being carried out in the selected areas of the Kinabalu, Labuk, Segama and Semporna areas where known mineral occurrences are mostly situated, in order to clarify the distribution of magnetic and radiometric rocks and to observe anomalies caused by massive sulfide ore deposits and mineralizations. Coverage of these four areas is about 8,000 km^2. The location of these four areas are shown in Fig. 1. And, in-situ measurements of magnetic susceptibilities and radiometric intensities are also being made for the typical 16 kinds of rocks and ores distributed within the survey area. Field operation of the heliborne geophysical survey was done by Aerodat Ltd., Canada, and started at November 13, 1990. Survey flight is being done now and will be finished till the middle of March, 1991.

Specifications of the survey are as follows:

① Method	Heliborne geophysical survey
② Items	Total intensity of geomagnetic field Radiometric intensity (γ-ray; U, Th, K, and Total count)
③ Flight level	150 metres ±30 metres above ground level (AGL)
④ Line spacing	Traverse line 500 metres Tie line 10 kilometres
⑤ Direction of traverse line	
	E-W Kinabalu and Labuk areas N-S Segama and Semporna areas Flight plan maps are shown in Fig. II-3-1.
⑥ Total line length	15,473 km
⑦ Navigation	Combination of INS (Inertia Navigation System), Rador Navigation and GPS (Global Positionary System) Navigation
⑧ Instruments used	Instruments used and those specifications are shown in Table II-3-1.

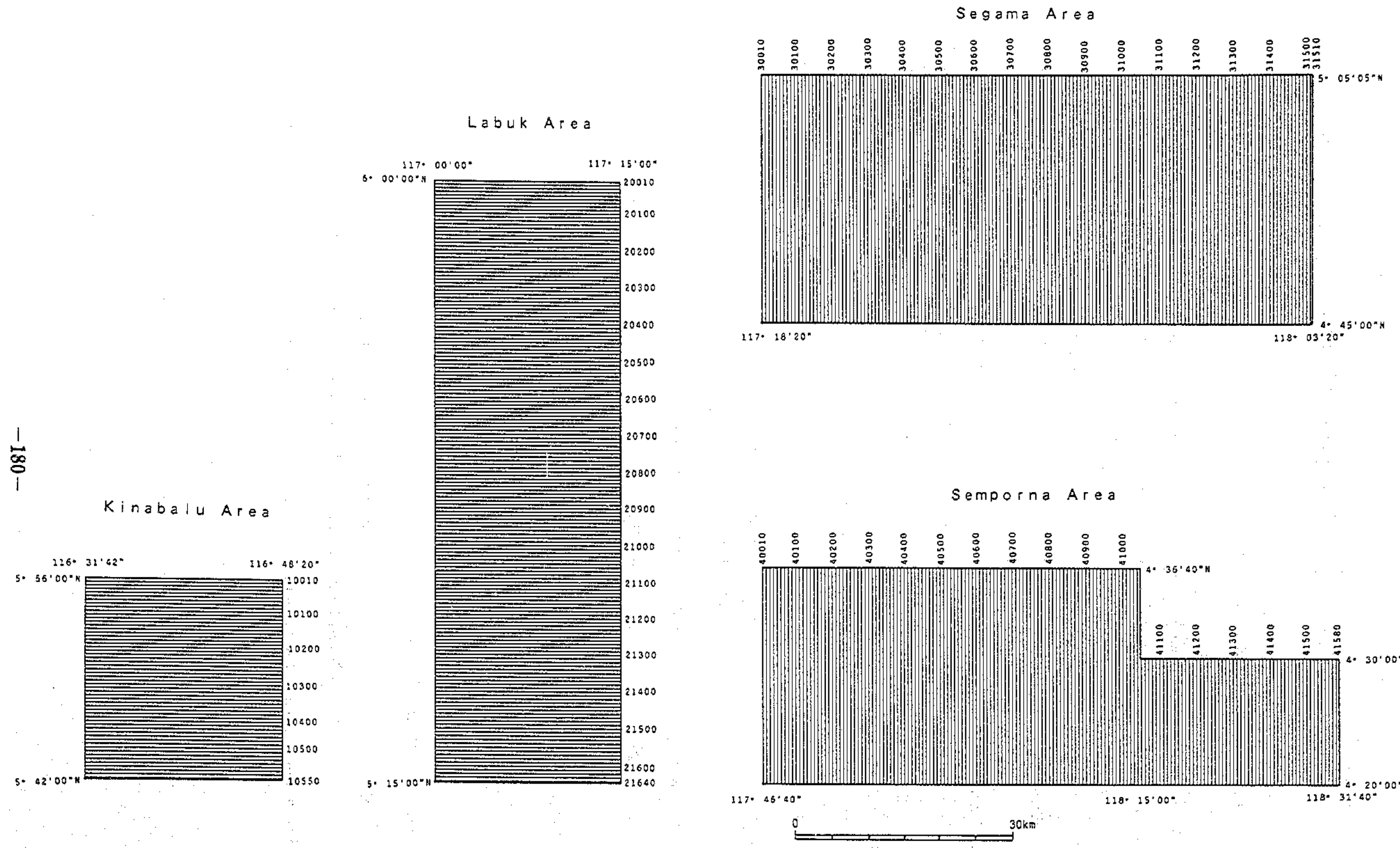


Fig. II-3-1 Flight plan map of heliborne geophysical survey

Table II-3-1 Specifications of instruments for heliborne geophysical survey

Name	Model	Manufacturer(Country)	Specifications
Airborne Magnetometer Cesium Magnetometer Sensor	HSM2 V1W2321H8	IFG/Aerodat(Canada) Scintrex(Canada)	Resolution; 0.001 nT Sensitivity; 0.005 nT, Range; 20,000 - 100,000 nT
Spectrometer	Pgam6000/ Pgam6100/ Pgam6500	Picodas Group (Canada)	Crystal volume; 32.7ℓ (downward), 4.1ℓ (upward) Crystal resolution; >12 %, Range; 0.1 - 3.0 meV/256 ch, 0.1 photopeak resolution Window; / Lower Limit / Higher Limit Bi(upward) 1138 1154 Total(upward) 1034 1233 Tl208(downward) 201 233 Bi214(downward) 138 154 K40(downward) 113 129 Total(downward) 034 233
Data Acquisition System/ Graphic Recorder	DGR33	RMS Instruments Ltd. (Canada)	Analog Inputs; 32, Analog Input Range; ±10V, Chart Resolution; 4x4 dots/mm, Chart Sensitivity; 10 mV/cm to 10 V/cm Interface; RS-232-C x 4 ports Data Sample Rate; 10/sec Event Markers, Manual Fiducial Mark 5/sec Magnetometer, Navigation 1/sec Spectrometer
Cartridge Tape Recorder	TCR12	RMS Instruments Ltd. (Canada)	Recording Density; 6400 BPI Recording Capacity; 11.7 MBytes
Station Magnetometer	M234	Barringer Research (Canada)	Sampling Rate; 1 sec, Resolution; 0.1 nT Accuracy; 0.5 nT, Range; 20,000 - 90,000 nT
Radar Navigator	PNAV2001	Picodas Group (Canada)	Resolution; 0.5 m
GPS Receiver	TANS12017-10	Trimble(U.S.A.)	Accuracy; ±10 m
Barometric Altimeter	1241M	Rosemount(U.S.A.)	Relative Accuracy; ±7 ft, Resolution; ±10 ft
Radar Altimeter	KRA-10A	King(U.S.A.)	Range; 40 - 2,500 ft, Resolution; 5 ft, Accuracy; 5 %
Flight Path Recorder	AG2400 DXC101 DXF40A	Panasonic(Japan) Sony(Japan) Sony(Japan)	VHS style Video-Recorder in NTS format Video Camera Video Monitor
Helicopter	TwinStar AS355F2	Aerospatial(France)	Type; Twin-engine turbine(Allison 250-C20F) Size; 10.3 ft(H)x 42.5 ft(L)x 8.3 ft(W) Main Rotor Diameter; 35.1 ft, Useful Load; 2,928 lb(1,212 Kg)

Part III Conclusions and Recommendations

Chapter 1 Conclusions

Three survey methods including satellite image analyses, orientation geochemical survey for three ore deposit areas and heliborne geophysical survey were adopted in this survey. These survey results are conclusively summarized as follows:

(1) Satellite image analyses

Images generated by Landsat MSS data were used in this survey. This survey including ground truth was carried out for the entire project area and following conclusions were obtained in this survey.

① Distribution of geologic units delineated by the satellite image analyses correspond mostly to existing geologic maps. But some part show differences between them, and these parts are better to be investigated in the future.

② Small in scale ring structures delineated in around Ranau in the Kinabalu area have close relation with intrusives. Because pyrite disseminations are observed in these intrusives, attention should be payed for the ring structure in the future exploration.

③ Many ring structures were also confirmed other than the Kinabalu area, it is important to clarify the relationship between the ring structure and mineralization for the future exploration work in this area.

④ Results of the ground truth indicate that establishment of the stratigraphy for Chert-Spilite Formation and ultra-basic rocks is quite important for the exploration work of the Cyprus type massive sulfide deposits and chromite deposits.

⑤ The assay results of lateritic soil samples show significant concentration of nickel (best one, 0.86%). The lateritic soil covers wide area in the area of ultra-basic rocks, the lateritic soil should be investigated to clarify the potentiality of nickel deposits in this project area.

(2) Orientation geochemical survey

Orientation geochemical survey was carried out in three known ore deposit areas in order to determine the optimum method for the regional geochemical survey in next phase (Phase II). Conclusions obtained in this survey are as follows:

① Edge of stream is optimum sampling point for geochemical sample of stream sediments.

② Soil sample collected from the upper part of horizon B is the optimum sample for soil geochemical survey in this area.

③ Most pathfinder elements in pan concentrates show higher concentration than these elements in stream sediments. Nature of pan concentrate depend on the geology of the survey area, and it is very difficult to collect samples with similar nature. Therefore, chemical analyses are not necessary for pan concentrates if stream sediments samples are collected in the same area.

④ However, the pan concentrate survey is applicable and useful for the survey in the limited area or for the survey of specified minerals.

⑤ Based on the results of stream sediment and soil surveys, useful pathfinder elements in this project area are 12 elements including As, Au, Ba Cr, Cu, Mn, Mo, Pb, S, U, W and Zn.

⑥ According to the special relationship between geochemical anomalous sample and the known ore deposits, the sample density should be at least 4 km^2/sample and 1 km^2/sample for stream sediments and soil samples respectively. The optimum sample densities are thought to be 2 km^2/sample for stream sediments and 0.5 km^2/sample for soil samples. However, in the flat area, 4 km^2/sample is enough sample density because of wider distance of influence in the flat area.

⑦ Based on above mentioned sample densities, stream sediments should be used for regional geochemical survey, and soil survey should be used for detailed survey in a limited area.

⑧ The methods of data analyses should depend on the geology in the survey area, type of ore deposit expected, kind of sample media used etc., but at least one method of single element analyses and one method of multi element analyses should be applied for the data analyses.

The entire project area is covered by 1/50,000 topographic map sheets, but the aquracy of the map sheets are low, and streams and contour are not clear in some flat areas. In order to locate the sample point on the map, the aerial photo should be used in the regional geochemical survey. Furthermore, it is necessary to use Global Positioning System in some part of the area to confirm the sampling point.

(3) Heliborne geophysical survey

This survey includes aero-magnetics and aero-radiometrics and data analyses will be made in next phase. Results of satellite image analyses should be referred in the data analyses of this heliborne survey.

Chapter 2 Recommendations for Phase II survey

The regional geochemical survey is planned in Phase II for the Kinabalu and Labuk areas. Recommendable survey methods for this survey are as follows:

① Stream sediments should be used for the sample media in this survey, and the sample should be collected from the edge of stream. Sampling site should be selected from the first or second order stream.

② The sample density in this survey should be 2 km^2/sample except flat areas. The sample density of 4 km^2/sample should be adopted for the flat area.

③ Twelve elements including As, Au, Ba, Cr, Cu, Mn, Mo, Pb, S, U, W and Zn should be applied as the pathfinder elements for this survey.

In addition to this regional geochemical survey, a reconnaissance soil geochemical survey in the area of ultra-basic rocks (approximately 600 km^2) should be carried out in order to clarify the potentiality of lateritic nickel deposits. The details are as follows:

① The soil sample should be collected in the area of ultra-basic rocks. The sampling point should be at the top of the horizon B.

② The sample density should be 3 km^2/sample.

③ The pathfinder elements for this survey should be Al, Co, Fe and Ni.

Fieldwork for these survey should be carried out by following manner.

① Topographic map of 1/50,000 in scale and aerial photograph should be used to confirm the location of the sample site.

② Global Positioning System should be used in the area where it is difficult to confirm the sampling site in the topographic map sheet or aerial photograph.

③ During the fieldwork for the regional geochemical survey, geologic check survey should be carried out for the area where satellite image analyses give different geology to the existing geologic map sheets.

④ If new mineral showings are discovered during the regional geochemical survey, the occurrences should be described.

Sample density for the coming regional geochemical survey and the survey areas for the reconnaissance soil survey in the Kinabalu and Labuk areas are shown in Fig. I-3. Details for the regional geochemical survey in the Segama and Semporna areas should be decided on the basis of this survey and coming regional survey results.

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Appendices

APPENDICES

Appendix 1

Results of chemical analyses for whole rock samples

Sample No.	SiO₂ %	TiO₂ %	Al₂O₃ %	Fe₂O₃ %	FeO %	MnO %	MgO %	CaO %	Na₂O %	K₂O %	P₂O₅ %	L.O.I %	Ag ppm	As ppm	Au ppb	Co ppm	Cr ppm	Cu ppm	Hg ppm	Mo ppm	Ni ppm	Pb ppm	S %	Sb ppm	U ppm	W ppm	Zn ppm
N094	49.87	0.55	19.67	3.87	4.62	0.18	4.54	9.37	4.01	0.41	0.05	2.36	<0.5	< 5	< 5	25	49	52	< 1	< 1	14	< 2	.116	< 5	<0.2	14	35
N115	73.56	0.27	12.67	3.66	0.39	0.06	0.31	1.75	5.10	0.03	0.02	1.70	<0.5	< 5	< 5	< 1	57	6	< 1	2	8	< 2	.336	< 5	1.0	<10	22
G014	41.83	0.13	3.44	4.39	4.10	0.13	33.68	2.70	0.11	0.02	0.01	8.67	<0.5	< 5	25	90	714	44	< 1	< 1	1905	< 2	.173	< 5	<0.2	25	< 1
N061	44.31	0.14	2.77	2.02	6.28	0.13	38.00	2.86	0.19	0.01	<0.01	2.57	<0.5	< 5	< 5	107	745	32	< 1	< 1	1887	< 2	.034	< 5	<0.2	111	< 1
N067	39.62	0.04	1.41	5.35	2.43	0.11	35.78	2.24	0.02	0.01	<0.01	12.29	<0.5	< 5	< 5	93	544	23	< 1	< 1	1821	< 2	.046	< 5	<0.2	13	< 1
N069	41.17	0.14	2.93	4.37	3.56	0.12	35.27	2.92	0.19	0.02	<0.01	8.50	<0.5	< 5	< 5	95	568	27	< 1	< 1	1691	< 2	.043	< 5	<0.2	29	< 1
N072	40.53	<0.01	1.12	7.71	0.13	0.12	35.50	0.82	0.03	0.01	<0.01	13.53	<0.5	< 5	< 5	110	1035	12	< 1	< 1	2023	< 2	.015	< 5	<0.2	<10	< 1
N054	39.50	0.01	1.19	7.75	0.51	0.10	35.31	0.02	0.01	0.01	<0.01	15.01	<0.5	< 5	< 5	111	1101	16	< 1	< 1	2129	< 2	.014	< 5	<0.2	<10	< 1
N079	38.97	<0.01	0.51	6.95	0.90	0.11	39.99	0.51	0.02	0.01	<0.01	11.43	<0.5	< 5	< 5	101	679	10	< 1	< 1	2211	< 2	.013	< 5	<0.2	20	< 1
N095	40.48	0.02	1.67	6.27	1.61	0.11	36.20	1.84	0.06	0.02	<0.01	11.04	<0.5	< 5	< 5	99	849	14	< 1	< 1	1885	< 2	.025	< 5	<0.2	<10	< 1
N119	40.01	0.02	1.33	3.80	3.98	0.11	38.58	1.58	0.02	0.01	<0.01	10.25	<0.5	< 5	< 5	100	797	6	< 1	< 1	1890	< 2	.034	< 5	<0.2	<10	< 1
N062	52.41	1.12	13.58	3.60	7.11	0.19	6.65	8.74	2.83	0.07	0.10	3.06	<0.5	< 5	< 5	40	70	23	< 1	< 1	68	< 2	.112	< 5	<0.2	78	44
N071	48.36	0.98	15.25	2.52	7.11	0.17	9.01	9.39	2.81	0.27	0.09	3.39	<0.5	< 5	< 5	44	147	59	< 1	< 1	117	< 2	.163	< 5	<0.2	43	23
N077	46.65	0.36	18.56	3.16	10.45	0.18	6.14	12.53	0.45	0.07	<0.01	0.73	<0.5	< 5	35	55	27	235	< 1	< 1	58	< 2	.070	< 5	<0.2	72	54
N101	44.49	0.18	17.47	0.71	3.20	0.08	11.39	15.86	2.63	0.11	<0.01	3.18	<0.5	< 5	< 5	30	259	6	< 1	< 1	292	< 2	.074	< 5	<0.2	22	< 1
N103	49.12	0.18	17.25	0.83	4.10	0.12	11.11	13.59	1.58	0.01	<0.01	1.47	<0.5	< 5	< 5	35	160	55	< 1	< 1	236	< 2	.112	< 5	<0.2	40	< 1
N117	46.74	0.12	17.20	0.66	2.43	0.07	9.34	18.16	1.10	0.30	<0.01	3.60	<0.5	< 5	< 5	29	182	67	< 1	< 1	191	< 2	.084	< 5	<0.2	38	< 1
N120	45.27	2.75	14.01	8.06	8.79	0.27	5.54	10.78	2.85	0.07	0.24	0.62	<0.5	< 5	< 5	44	53	61	< 1	< 1	24	< 2	.208	< 5	<0.2	29	90
N121	47.16	1.34	15.26	3.63	6.73	0.18	8.82	12.77	2.04	0.03	0.11	1.34	<0.5	< 5	< 5	46	168	57	< 1	< 1	74	< 2	.085	< 5	<0.2	45	41
T007	47.67	1.10	14.76	6.05	3.07	0.18	8.52	6.88	3.96	0.67	0.09	6.49	<0.5	< 5	< 5	38	110	60	< 1	< 1	87	< 2	.046	10	<0.2	11	36
N065	54.92	0.81	13.77	3.15	4.17	0.12	5.22	11.56	1.20	0.01	0.07	4.50	<0.5	< 5	< 5	32	98	40	< 1	< 1	74	< 2	.168	< 5	0.2	91	33
N076	50.94	0.98	12.77	5.60	4.43	0.17	7.19	7.54	4.05	0.03	0.06	5.55	<0.5	< 5	< 5	52	243	76	< 1	< 1	302	< 2	.100	< 5	<0.2	40	52
N080	49.00	1.82	14.84	5.56	7.05	0.20	4.52	8.58	2.43	0.07	0.14	5.50	<0.5	< 5	< 5	39	20	33	< 1	< 1	14	< 2	.211	< 5	0.2	26	70
N081	47.73	1.24	14.82	6.99	2.24	0.21	5.32	14.07	1.54	0.24	0.11	5.10	<0.5	< 5	< 5	33	107	42	< 1	< 1	56	< 2	.088	< 5	<0.2	110	39
N096	49.57	0.88	15.04	3.79	6.09	0.15	4.99	7.89	3.24	0.21	0.09	7.50	<0.5	< 5	< 5	29	72	88	< 1	< 1	38	< 2	.043	< 5	0.2	<10	55
N097	49.17	1.29	14.25	3.25	7.37	0.17	7.01	9.63	3.45	0.03	0.10	3.53	<0.5	< 5	< 5	38	78	51	< 1	< 1	50	< 2	.181	< 5	<0.2	<10	50
N098	49.15	1.51	14.73	3.40	5.71	0.16	6.92	10.77	3.26	0.22	0.19	3.39	<0.5	< 5	< 5	39	173	48	< 1	< 1	106	< 2	.058	< 5	<0.2	<10	41
N099	49.02	0.97	14.66	2.82	5.78	0.16	7.24	9.04	2.47	0.20	0.10	6.75	<0.5	< 5	< 5	38	129	76	< 1	< 1	69	< 2	.285	< 5	0.2	<10	63
N100	44.08	1.23	13.53	3.20	4.75	0.11	5.19	15.88	1.99	0.15	0.14	9.13	<0.5	< 5	< 5	32	129	44	< 1	< 1	113	< 2	.106	< 5	0.4	<10	41
N102	46.86	1.10	13.46	4.13	4.75	0.15	7.03	12.05	3.21	0.20	0.09	6.33	<0.5	< 5	< 5	39	153	62	< 1	< 1	93	< 2	.066	< 5	<0.2	<10	39
N104	50.30	1.09	13.36	4.25	5.39	0.14	7.00	9.95	3.26	0.06	0.10	4.73	<0.5	< 5	< 5	41	87	54	< 1	< 1	61	< 2	.054	< 5	<0.2	<10	24
N116	49.01	0.80	13.02	2.75	4.36	0.13	6.20	12.77	3.97	0.22	0.07	5.80	<0.5	< 5	< 5	34	203	48	< 1	< 1	76	< 2	.360	< 5	0.4	11	32
N106	54.36	2.17	14.51	2.46	9.49	0.15	5.38	7.26	3.32	0.26	0.15	0.11	<0.5	< 5	< 5	38	141	49	< 1	< 1	120	< 2	.053	< 5	0.4	22	91
N107	51.61	0.82	17.99	3.89	5.52	0.19	4.07	4.01	5.58	1.22	0.20	4.29	<0.5	< 5	< 5	22	25	19	< 1	< 1	3	< 2	.039	< 5	1.0	<10	64
N108	60.71	1.21	18.23	5.52	0.51	<0.01	0.22	0.41	5.91	0.52	0.01	6.00	<0.5	23	< 5	4	24	36	< 1	< 1	3	< 2	.218	< 5	0.8	<10	19
N109	51.09	0.88	17.26	3.12	5.52	0.17	6.64	9.45	2.36	0.70	0.17	1.97	<0.5	< 5	< 5	34	134	50	< 1	< 1	134	< 2	.051	< 5	0.8	18	43
N110	63.55	0.73	23.52	1.10	0.13	0.01	0.10	0.21	0.03	0.03	0.19	9.82	<0.5	10	< 5	2	38	3	< 1	2	5	< 2	.131	< 5	1.6	<10	7
N111	53.60	0.75	18.54	2.67	6.03	0.18	4.22	9.68	2.01	0.97	0.12	0.72	<0.5	< 5	< 5	30	43	40	< 1	< 1	23	< 2	.059	< 5	1.0	41	63
N114	62.00	0.43	15.88	2.19	1.80	0.11	1.56	4.36	3.07	3.32	0.19	4.95	<0.5	< 5	< 5	12	19	12	< 1	2	9	< 2	.031	< 5	2.6	13	49
N112	72.52	0.35	13.06	1.63	1.03	0.03	0.62	1.45	4.17	3.21	0.05	1.27	<0.5	6	< 5	11	43	8	< 1	2	14	< 2	.017	6	2.6	68	46
N113	46.32	0.81	18.86	2.85	6.21	0.16	4.84	10.08	1.88	0.40	0.09	6.87	<0.5	< 5	< 5	30	36	51	< 1	< 1	19	< 2	.148	< 5	0.4	<10	47
N050	59.89	0.58	15.62	2.16	3.65	0.12	2.54	6.18	3.01	3.04	0.25	2.44	<0.5	< 5	< 5	26	679	45	< 1	< 1	258	21	.066	< 5	3.0	152	53
N051	61.48	0.63	13.77	1.44	4.36	0.10	3.85	4.45	2.17	4.15	0.25	2.77	<0.5	< 5	< 5	24	76	34	< 1	< 1	19	< 2	.085	6	3.2	99	49
N052	63.65	0.61	14.75	1.46	3.85	0.10	2.37	3.72	2.65	3.94	0.24	2.27	<0.5	8	< 5	12	46	13	< 1	< 1	11	3	.027	< 5	2.8	92	53
N053	62.21	0.63	14.68	2.07	3.59	0.11	3.11	4.67	2.45	3.96	0.24	1.70	<0.5	5	< 5	24	43	18	< 1	< 1	14	4	.030	5	2.2	230	53
N057	59.54	0.68	15.82	3.15	3.33	0.17	3.28	5.50	2.47	2.70	0.18	2.66	<0.5	< 5	< 5	23	56	53	< 1	< 1	23	< 2	.035	< 5	1.6	89	55
N058	62.80	0.60	14.22	0.83	4.62	0.10	3.21	4.41	2.76	4.59	0.27	1.13	<0.5	9	< 5	54	73	7	< 1	< 1	14	< 2	.079	6	3.0	341	46
N063	60.97	0.57	15.39	1.14	4.23	0.12	2.53	4.17	2.35	2.64	0.19	5.00	<0.5	7	30	19	41	58	< 1	< 1	13	< 2	.209	< 5	2.0	86	56
N090	64.52	0.49	13.93	1.56	3.46	0.11	2.22	5.00	2.91	4.49	0.24	0.58	<0.5	< 5	< 5	25	82	44	< 1	< 1	13	3	.071	< 5	5.0	180	44
N092	58.89	0.65	14.82	2.03	5.07	0.15	3.32	6.71	3.04	4.15	0.38	0.39	<0.5	< 5	10	30	90	92	< 1	< 1	22	< 2	.121	8	4.6	115	45
N017	42.77	0.47	10.33	23.30	0.96	1.32	4.15	1.64	0.38	1.73	0.13	12.13	<0.5	50	265	43	110	1378	< 1	< 1	219	8	.057	22	1.4	<10	560

Appendix 2

Results of Norm calculation

Sample No	N094	N115	G014	N061	N067	N069	N072	N054
q	0.00	40.52	0.00	0.00	0.00	0.00	0.00	0.00
c	0.00	1.14	0.00	0.00	0.00	0.00	0.00	1.37
or	2.48	0.18	0.12	0.00	0.00	0.12	0.06	0.00
ab	34.95	44.09	1.02	1.69	0.17	1.78	0.25	0.00
an	35.47	8.75	9.77	6.91	4.33	7.81	3.38	0.10
ne	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ac	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ns	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ks	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
wo	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
diwo	5.04	0.00	2.07	3.25	3.52	3.38	0.56	0.00
dien	3.31	0.00	1.72	2.60	3.03	2.85	0.48	0.00
difs	1.38	0.00	0.08	0.27	0.01	0.10	0.00	0.00
hyen	4.79	0.80	35.13	23.34	33.78	27.25	47.64	52.06
hyfs	2.00	0.00	1.64	2.43	0.07	0.92	0.00	0.00
olfo	2.48	0.00	39.11	50.42	45.99	46.75	38.34	36.55
olfa	1.14	0.00	2.02	5.79	0.10	1.75	0.00	0.00
mt	5.77	0.67	7.03	3.03	8.92	6.99	0.93	2.29
hm	0.00	3.28	0.00	0.00	0.00	0.00	8.33	7.60
il	1.08	0.53	0.27	0.27	0.09	0.28	0.00	0.02
tn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
pf	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
rn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ap	0.12	0.05	0.02	0.00	0.00	0.02	0.00	0.00
cc	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
pr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	100.01	100.00	99.99	99.99	100.00	100.00	99.98	99.99
* or	3.40	0.33	1.08	0.00	0.00	1.22	1.60	0.00
* ab	47.94	83.16	9.31	19.68	3.76	18.31	6.87	0.00
* an	48.66	16.50	89.60	80.32	96.24	80.48	91.53	100.00
* wo	30.52	0.00	5.08	10.19	8.70	9.80	1.14	0.00
* en	49.00	100.00	90.67	81.34	91.12	87.24	98.86	100.00
* fs	20.48	0.00	4.24	8.47	0.18	2.96	0.00	0.00
* fo	68.47	0.00	95.09	89.70	99.79	96.40	100.00	100.00
* fa	31.53	0.00	4.91	10.30	0.21	3.60	0.00	0.00
C.I.	27.10	5.32	89.09	91.40	95.50	90.29	96.30	98.53
D.I.	37.43	84.79	1.13	1.69	0.17	1.90	0.31	0.00
T.FeO	8.34	3.77	8.89	8.37	8.32	8.30	8.22	8.86
O.I.	1.20	0.11	0.93	3.11	0.45	0.82	0.02	0.07
A.I.	39.44	17.22	8.23	6.24	3.56	7.12	2.76	3.01
S.I.	26.59	3.43	80.46	82.10	83.14	82.01	83.33	82.52
F.M.I.	1.79	11.77	0.24	0.21	0.20	0.21	0.20	0.21
A	25.91	56.19	0.30	0.42	0.04	0.49	0.08	0.00
M	26.59	3.43	80.46	82.10	83.14	82.01	83.33	82.52
F	47.50	40.38	19.24	17.49	16.82	17.51	16.59	17.48
Na2O	0.067	0.084	0.002	0.003	0.000	0.003	0.000	0.000
K2O	0.004	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Al2O3	0.199	0.127	0.037	0.028	0.016	0.032	0.013	0.014

Sample No	N117	N120	N121	T007	N065	N076	N080	N081
q	0.00	1.02	0.00	0.00	20.12	4.24	10.54	8.38
c	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
or	1.83	0.41	0.18	4.25	0.06	0.18	0.41	1.48
ab	4.58	24.45	17.60	36.05	10.66	36.55	21.83	13.79
an	42.78	25.57	33.03	22.08	33.85	17.68	31.19	34.73
ne	2.75	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ac	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ns	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ks	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
wo	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
diwo	21.27	11.33	12.88	5.84	10.88	9.11	5.44	16.02
dien	16.32	7.54	8.84	5.04	7.64	7.20	3.39	13.84
difs	2.70	2.96	3.00	0.00	2.32	0.88	1.72	0.00
hyen	0.00	6.46	8.45	9.54	6.03	11.90	8.56	0.18
hyfs	0.00	2.62	2.87	0.00	1.89	1.49	4.43	0.00
olfo	5.53	0.00	3.57	5.79	0.00	0.00	0.00	0.00
olfa	1.01	0.00	1.34	0.00	0.00	0.00	0.00	0.00
mt	1.00	11.85	5.36	7.83	4.81	8.66	8.55	4.55
hm	0.00	0.00	0.00	1.11	0.00	0.00	0.00	4.26
il	0.23	5.30	2.60	2.24	1.61	1.99	3.67	2.49
tn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
pf	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
rn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ap	0.00	0.56	0.25	0.23	0.16	0.14	0.35	0.28
cc	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
pr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	99.99	100.07	99.99	100.00	100.05	100.03	100.08	100.00
* or	3.72	0.82	0.35	6.82	0.13	0.33	0.77	2.85
* ab	9.30	48.49	34.64	57.78	23.82	67.18	40.86	27.59
* an	86.97	50.69	65.01	35.40	75.95	32.50	58.37	69.46
* wo	52.78	36.66	35.72	28.58	37.83	29.78	23.10	53.32
* en	40.51	45.28	47.98	71.42	47.52	62.48	50.78	46.68
* fs	6.70	18.06	16.30	0.00	14.65	7.74	26.12	0.00
* fo	84.58	0.00	72.75	100.00	0.00	0.00	0.00	0.00
* fa	15.42	0.00	27.25	0.00	0.00	0.00	0.00	0.00
C.I.	48.06	48.58	49.19	37.62	35.35	41.36	36.08	41.62
D.I.	6.41	25.89	17.78	40.30	30.84	40.97	32.78	23.65
T.FeO	3.15	16.26	10.19	9.16	7.38	10.09	12.79	9.03
O.I.	3.67	1.09	1.85	0.51	1.32	0.79	1.27	0.32
A.I.	36.79	30.94	32.36	30.96	25.06	25.07	30.28	31.05
S.I.	67.87	22.62	42.23	39.34	38.83	34.69	23.72	34.04
F.M.I.	0.32	2.89	1.13	1.00	1.34	1.32	2.66	1.60
A	10.13	11.92	9.91	21.37	8.98	19.67	13.09	11.37
M	67.87	22.62	42.23	39.34	38.83	34.69	23.72	34.04
F	22.00	65.46	47.86	39.29	52.18	45.64	63.19	54.59
Na2O	0.018	0.047	0.034	0.069	0.020	0.070	0.042	0.026
K2O	0.003	0.001	0.000	0.008	0.000	0.000	0.001	0.003
Al2O3	0.175	0.139	0.153	0.156	0.142	0.134	0.154	0.154

Sample No	N096	N097	N098	N099	N100	N102	N104	N116
q	5.94	0.00	0.00	4.60	0.00	0.00	3.44	0.00
c	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
or	1.36	0.18	1.36	1.30	1.00	1.24	0.35	1.42
ab	29.79	30.46	28.77	22.59	17.43	28.79	29.11	29.37
an	28.16	24.38	25.92	30.64	30.52	23.38	22.80	18.23
ne	0.00	0.00	0.00	0.00	0.64	0.22	0.00	3.62
ac	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ns	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ks	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
wo	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
diwo	5.74	10.39	11.87	7.16	2.56	16.79	11.89	20.53
dien	3.50	6.44	8.26	4.78	0.00	12.47	8.48	14.44
difs	1.93	3.33	2.63	1.85	0.00	2.89	2.36	4.34
hyen	10.03	9.88	9.28	14.72	0.00	0.00	9.90	0.00
hyfs	5.64	5.11	2.96	5.80	0.00	0.00	2.83	0.00
olfo	0.00	1.34	0.30	0.00	0.00	4.46	0.00	1.49
olfa	0.00	0.76	0.10	0.00	0.00	1.06	0.00	0.49
mt	5.97	4.93	5.13	4.42	5.15	6.44	6.50	4.28
hm	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
il	1.82	2.56	2.98	1.99	2.58	2.24	2.18	1.63
tn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
pf	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
rn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ap	0.23	0.23	0.46	0.25	0.37	0.23	0.25	0.19
cc	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
pr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	100.11	100.00	100.02	100.12	60.27	100.00	100.08	100.02
* or	2.29	0.32	2.43	2.38	2.05	2.32	0.68	2.89
* ab	50.22	55.37	51.33	41.43	35.60	53.90	55.70	59.92
* an	47.48	44.31	46.24	56.19	62.35	43.77	43.63	37.19
* wo	21.39	29.54	33.93	20.88	100.00	52.56	33.53	52.23
* en	50.39	46.44	50.11	56.83	0.00	39.02	51.85	36.74
* fs	28.21	24.02	15.96	22.29	0.00	8.41	14.62	11.04
* fo	0.00	63.69	74.01	0.00	0.00	80.80	0.00	75.13
* fa	0.00	36.31	25.99	0.00	0.00	19.20	0.00	24.87
C.I.	34.83	44.98	43.97	40.94	17.70	46.38	44.35	47.37
D.I.	37.08	30.64	30.13	28.50	18.43	30.03	32.90	30.79
T.FeO	10.33	10.76	9.14	8.99	8.45	9.11	9.71	7.32
O.I.	1.61	2.26	1.68	2.05	1.48	1.15	1.27	1.58
A.I.	30.34	28.99	29.97	29.91	30.69	28.73	26.57	26.56
S.I.	27.84	33.72	36.09	39.72	34.69	37.20	35.84	36.00
F.M.I.	1.90	1.47	1.27	1.15	1.47	1.20	1.32	1.10
A	19.22	16.72	18.17	14.66	14.30	18.01	17.00	24.36
M	27.84	33.72	36.09	39.72	34.69	37.20	35.84	36.00
F	52.94	49.56	45.73	45.62	51.01	44.80	47.16	39.65
Na2O	0.057	0.058	0.055	0.043	0.035	0.056	0.056	0.069
K2O	0.002	0.000	0.002	0.002	0.002	0.002	0.001	0.003
Al2O3	0.160	0.146	0.150	0.156	0.147	0.142	0.138	0.137

Sample No	N106	N107	N108	N109	N111	N112	N050	N051
q	7.81	0.00	24.81	4.67	9.83	32.70	14.91	17.32
c	0.00	0.71	7.74	0.00	0.00	0.21	0.00	0.00
or	1.54	7.56	3.31	4.25	5.79	19.32	18.50	25.35
ab	28.26	49.67	53.65	20.48	17.26	35.96	26.23	19.04
an	24.02	19.58	2.12	35.39	39.16	7.02	20.77	16.11
ne	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ac	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ns	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ks	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
wo	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
diwo	4.68	0.00	0.00	4.87	3.62	0.00	3.81	2.09
dien	2.40	0.00	0.00	3.25	1.98	0.00	2.20	1.23
difs	2.16	0.00	0.00	1.26	1.50	0.00	1.44	0.76
hyen	11.08	5.03	0.60	13.74	8.65	1.57	4.33	8.69
hyfs	10.17	2.93	0.00	5.43	6.68	0.02	2.91	5.49
olfo	0.00	3.95	0.00	0.00	0.00	0.00	0.00	0.00
olfa	0.00	2.54	0.00	0.00	0.00	0.00	0.00	0.00
mt	3.58	5.93	0.00	4.64	3.91	2.41	3.23	2.16
hm	0.00	0.00	5.92	0.00	0.00	0.00	0.00	0.00
il	4.14	1.63	2.47	1.71	1.44	0.68	1.14	1.23
tn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
pf	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
rn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ap	0.35	0.49	0.02	0.39	0.28	0.12	0.60	0.60
cc	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
pr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	100.19	100.00	100.63	100.09	100.12	100.00	100.07	100.08
* or	2.85	9.85	5.60	7.08	9.31	31.02	28.24	41.90
* ab	52.51	64.68	90.81	34.06	27.74	57.72	40.05	31.47
* an	44.63	25.47	3.58	58.86	62.95	11.26	31.71	26.63
* wo	15.35	0.00	0.00	17.07	16.13	0.00	25.95	11.46
* en	44.19	63.16	100.00	59.49	47.40	98.89	44.41	54.30
* fs	40.45	36.84	0.00	23.44	36.47	1.11	29.64	34.25
* fo	0.00	60.87	0.00	0.00	0.00	0.00	0.00	0.00
* fa	0.00	39.13	0.00	0.00	0.00	0.00	0.00	0.00
C.I.	38.49	22.49	8.95	35.26	28.04	4.79	19.66	22.24
D.I.	37.61	57.23	81.76	29.40	32.88	87.98	59.63	61.71
T.FeO	11.76	9.48	5.88	8.55	8.54	2.54	5.77	5.85
O.I.	3.86	1.42	0.09	1.77	2.26	0.63	1.69	3.03
A.I.	26.69	34.86	30.03	33.78	34.59	18.01	26.09	22.40
S.I.	26.04	20.47	1.84	36.85	26.98	5.89	17.92	24.31
F.M.I.	2.17	2.22	24.49	1.25	2.00	4.04	2.20	1.47
A	17.33	34.19	53.01	16.96	19.08	70.32	42.62	39.95
M	26.04	20.47	1.84	36.85	26.98	5.89	17.92	24.31
F	56.63	45.34	45.15	46.19	53.95	23.79	39.45	35.74
Na2O	0.054	0.095	0.102	0.039	0.033	0.069	0.050	0.038
K2O	0.003	0.014	0.006	0.008	0.010	0.035	0.033	0.046
Al2O3	0.143	0.186	0.192	0.174	0.184	0.131	0.158	0.140

Sample No	N079	N095	N119	N062	N071	N077	N101	N103
q	0.00	0.00	0.00	7.67	0.00	3.36	0.00	0.00
c	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
or	0.00	0.12	0.00	0.41	1.65	0.41	0.65	0.06
ab	0.17	0.59	0.17	24.88	24.79	3.89	-0.01	13.62
an	1.49	4.78	3.98	25.04	29.38	49.11	35.98	40.85
ne	0.00	0.00	0.00	0.00	0.00	0.00	12.56	0.00
ac	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ns	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ks	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
wo	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
diwo	0.58	2.31	2.01	8.06	7.77	5.82	18.74	11.70
dien	0.50	2.00	1.68	4.99	5.05	2.78	14.23	8.52
difs	0.00	0.00	0.08	2.59	2.18	2.96	2.57	2.08
hyen	30.76	36.55	26.14	12.19	10.76	12.74	0.00	11.31
hyfs	0.00	0.00	1.18	6.46	4.64	13.82	0.00	2.77
olfo	57.44	44.57	55.81	0.00	5.31	0.00	10.71	5.91
olfa	0.00	0.00	2.77	0.00	2.52	0.00	2.13	1.59
mt	3.71	6.19	6.16	5.41	3.81	4.65	1.07	1.23
hm	5.34	2.83	0.00	0.00	0.00	0.00	0.00	0.00
il	0.00	0.04	0.04	2.20	1.94	0.70	0.36	0.34
tn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
pf	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
rn	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ap	0.00	0.00	0.00	0.23	0.21	0.00	0.00	0.00
cc	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
pr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	99.99	99.98	100.00	100.14	100.01	100.25	100.01	99.99
* or	0.00	2.15	0.00	0.82	2.96	0.77	1.73	0.11
* ab	10.18	10.78	4.08	49.43	44.41	7.29	-0.01	24.98
* an	89.82	87.07	95.92	49.75	52.63	91.94	98.29	74.91
* wo	1.82	5.66	6.46	23.50	25.55	15.28	52.71	32.15
* en	98.18	94.34	89.51	50.11	52.02	40.71	40.05	54.51
* fs	0.00	0.00	4.04	26.40	22.42	44.02	7.24	13.33
* fo	100.00	100.00	95.26	0.00	67.80	0.00	83.38	78.77
* fa	0.00	0.00	4.74	0.00	32.20	0.00	16.62	21.23
C.I.	98.34	94.50	95.85	42.08	44.18	43.37	49.82	45.46
D.I.	0.17	0.71	0.17	32.96	26.45	7.66	0.64	13.68
T.FeO	8.13	8.21	8.27	10.74	9.78	13.49	4.00	4.95
O.I.	0.13	0.26	1.05	1.98	2.82	3.30	4.50	4.93
A.I.	1.31	4.12	3.33	25.92	31.53	39.78	39.27	35.14
S.I.	84.80	83.17	83.87	33.42	41.96	30.77	63.38	63.32
F.M.I.	0.18	0.20	0.19	1.56	1.04	2.17	0.34	0.44
A	0.04	0.18	0.04	14.58	14.35	2.62	15.24	9.04
M	84.80	83.17	83.87	33.42	41.96	30.77	63.38	63.32
F	15.16	16.65	16.09	52.00	43.69	66.61	21.37	27.64
Na2O	0.000	0.001	0.000	0.047	0.047	0.007	0.044	0.026
K2O	0.000	0.000	0.000	0.001	0.003	0.001	0.001	0.000
Al2O3	0.006	0.019	0.015	0.138	0.156	0.185	0.178	0.173

Sample No	N052	N053	N057	N058	N063	N090	N092
q	20.64	18.34	18.46	14.35	23.60	17.73	7.56
c	0.00	0.00	0.00	0.00	1.64	0.00	0.00
or	23.93	23.93	16.49	27.54	16.55	28.83	24.70
ab	23.02	21.24	21.58	23.69	21.07	24.88	25.89
an	17.17	17.76	24.90	13.10	20.62	11.81	14.68
ne	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ac	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ns	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ks	0.00	0.00	0.00	0.00	0.00	0.00	0.00
wo	0.00	0.00	0.00	0.00	0.00	0.00	0.00
diwo	0.06	1.81	0.85	3.07	0.00	4.87	6.83
dien	0.03	1.12	0.59	1.60	0.00	2.61	3.63
difs	0.03	0.58	0.20	1.39	0.00	2.10	2.99
hyen	6.02	6.80	7.86	6.52	6.68	2.97	4.71
hyfs	5.22	3.61	2.65	5.81	6.59	2.46	3.99
olfo	0.00	0.00	0.00	0.00	0.00	0.00	0.00
olfa	0.00	0.00	0.00	0.00	0.00	0.00	0.00
mt	2.17	3.07	4.71	1.22	1.75	2.29	2.97
hm	0.00	0.00	0.00	0.00	0.00	0.00	0.00
il	1.20	1.22	1.33	1.16	1.14	0.95	1.25
tn	0.00	0.00	0.00	0.00	0.00	0.00	0.00
pf	0.00	0.00	0.00	0.00	0.00	0.00	0.00
rn	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ap	0.58	0.58	0.44	0.63	0.46	0.56	0.88
cc	0.00	0.00	0.00	0.00	0.00	0.00	0.00
pr	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	100.08	100.05	100.05	100.08	100.10	100.07	100.10
* or	37.33	38.03	28.18	42.81	28.41	42.24	37.34
* ab	35.90	33.75	34.27	36.83	36.18	39.17	39.67
* an	26.78	28.22	39.55	20.36	35.41	18.60	22.50
* wo	0.55	12.97	7.01	16.72	0.00	32.45	30.85
* en	53.24	56.90	69.54	44.14	50.32	37.15	37.66
* fs	46.21	30.13	23.46	39.14	49.68	30.40	31.49
* fo	0.00	0.00	0.00	0.00	0.00	0.00	0.00
* fa	0.00	0.00	0.00	0.00	0.00	0.00	0.00
C.I.	15.31	18.78	18.62	21.38	16.61	18.60	27.24
D.I.	67.59	63.51	56.53	65.58	61.22	69.44	58.15
T.FeO	5.31	5.58	6.36	5.45	5.58	4.92	6.95
O.I.	2.64	1.73	1.06	5.58	3.71	2.22	2.49
A.I.	23.17	23.59	26.57	22.65	25.24	21.59	25.17
S.I.	16.75	20.76	22.46	20.17	19.78	15.30	19.09
F.M.I.	2.19	1.75	1.88	1.67	2.08	2.20	2.08
A	46.66	42.83	35.38	46.15	39.04	51.09	41.27
M	16.75	20.78	22.46	20.17	19.78	15.30	19.09
F	36.59	36.41	42.16	33.69	41.18	33.61	39.64
Na2O	0.044	0.040	0.041	0.045	0.040	0.047	0.049
K2O	0.043	0.043	0.030	0.049	0.030	0.048	0.044
Al2O3	0.149	0.147	0.160	0.142	0.160	0.138	0.147

Appendix 3

Results of assaying for ore samples

Ser. No.	Sample No.	Ag ppm	As ppm	Au ppm	Co ppm	Cr ppm	Cu ppm	Fe %	Hg ppb	Mn ppm	Mo ppm	Ni ppm	Pb ppm	Pt ppm	Sb ppm	Sn ppm	U ppm	W ppm	Zn ppm
1	G009	1.3	5	0.17	47	221	7520	3.02	58	476	1	34	11	< 0.09	19	< 1	1.6	726	90
2	G010	0.9	1	0.06	34	251	2540	2.70	41	251	4	62	13	< 0.09	12	< 1	1.6	538	49
3	G012	< 0.1	1	0.06	55	239	280	37.38	27	1310	< 1	98	< 1	< 0.09	19	< 1	1.4	115	169
4	T008	< 0.1	37	< 0.06	59	391	163	8.72	164	467	< 1	98	7	< 0.09	35	< 1	< 0.2	196	4820
5	N009	< 0.1	607	5.07	20	555	3180	56.07	86	1970	141	53	< 1	< 0.09	97	< 1	1.8	13	109
6	N026	7.3	210	1.70	1110	70	53960	38.76	15	108	34	88	47	< 0.09	14	< 1	0.8	139	3210
7	N037	1.6	50	0.71	32	151	686	13.12	270	2010	< 1	23	1360	< 0.09	14	< 1	0.2	457	421
8	N038	0.7	176	0.45	81	158	509	16.05	504	603	< 1	23	525	< 0.09	30	< 1	0.2	317	131
9	N040	3.3	109	3.57	19	192	550	12.96	406	107	< 1	24	1450	< 0.09	14	< 1	0.8	699	36
10	N047	3.1	15	0.91	39	172	6580	5.28	49	389	36	160	42	< 0.09	27	8	2.4	615	223
11	N049	37.0	1330	0.74	47	212	4250	7.35	6070	266	12	72	39600	< 0.09	1910	7	< 0.2	1460	340
12	N060	< 0.1	4	0.06	57	208	18	0.35	238	110	< 1	24	117	< 0.09	10	< 1	0.4	653	< 1
13	N073	< 0.1	1	0.11	79	292	48	4.18	24	983	< 1	316	19	< 0.09	68	< 1	< 0.2	110	1210
14	N074	< 0.1	2	0.09	812	20100	82	39.00	128	5730	< 1	8590	< 1	< 0.09	20	< 1	0.2	< 10	493
15	N078	< 0.1	2	0.34	500	9180	119	33.52	212	4620	< 1	4720	< 1	< 0.09	55	< 1	< 0.2	< 10	1190
16	N082	< 0.1	2	0.11	486	8040	110	32.27	110	7070	< 1	4550	< 1	< 0.09	47	< 1	< 0.2	< 10	1040
17	N084	0.5	246	0.88	188	348	39	14.60	2020	167	< 1	137	142	< 0.09	21	< 1	0.8	343	20
18	N086	0.2	7	0.11	2	340	15	1.16	158	788	< 1	39	83	< 0.09	2	< 1	< 0.2	< 10	2
19	N087	< 0.1	2	0.06	84	250	< 1	0.82	68	481	< 1	25	35	< 0.09	11	< 1	< 0.2	757	< 1
20	N093	0.9	402	0.17	< 1	58	7	0.03	39400	5	< 1	14	2	0.17	641200	< 1	< 0.2	< 10	< 1
21	N105	0.5	4	0.06	57	342	58	7.43	71	2100	< 1	206	15	< 0.09	388	< 1	1.0	< 10	233
22	N118	< 0.1	3	0.06	149	6110	25	14.55	152	2303	< 1	4640	< 1	< 0.09	42	< 1	< 0.2	< 10	153
23	N122	0.2	5	0.06	160	88600	18	14.73	10	2570	3	577	109	< 0.09	62	57	1.8	< 10	1020
24	N123	0.2	1	1.16	220	149700	30	33.28	8	2330	6	352	< 1	< 0.09	33	30	0.2	< 10	562
25	N124	0.2	37	0.06	54	835	122	5.76	234	1010	< 1	148	35	< 0.09	2750	< 1	< 0.2	435	153
26	N125	0.2	2	0.51	44	851	83	5.92	19	1110	< 1	114	6	< 0.09	83	< 1	< 0.2	295	588