2-1-3 Data analyses

In addition to the details for the coming regional geochemical survey, several analytical methods were tested to clarify suitable data analyses methods for the regional geochemical survey.

Two kind of data analyses including single element analysis and multi element analysis are generally used for the geochemical data analyses. These two analytical methods were also applied for the data analyses in this survey.

There are two different methods to delineate the threshold value in the single element analysis. One is Lepeltier method (Lepeltier C., 1969) or Sinclair method (Sinclair A. J., 1974). Based on the hypothesis that the distribution of element forms log normal distribution pattern, the threshold value is delineated in these two methods. Other is EDA method or b + 2S.D. (b: backrround value, S.D.: standard deviation). These methods can delineate the threshold value without the hypothesis. In addition to these methods, trend surface analysis is also one of the method of single element analyses. The Lepeltier method, EDA method and b + 2S.D. method were applied and examined in this survey.

The multi element analysis methods include cluster analyses, discriminant analyses, principal component analyses and factor analyses. Among these analytical methods, cluster analyses and factor analyses were used and examined in this survey. All these data analyses were made using computer.

2-2 Survey results of the Nungkok deposit area

2-2-1 Geology and ore deposits

The Nungkok area is underlain by Crocker Formation, which was deposited in Eocene through Oligocene, and small granodiorite bodies intruding the formation. Quarternary Pinosuk Gravels, which is composed of sand and gravel, widely covers Crocker Formation in the west of the survey area. Terrace deposits are distributed on a small scale along the Kadamaian River in the southwest of the area. According to Collennette P., 1958, and GSM, 1985, Trusmadi Formation (P1Ts), which is principally composed of phyllite and shale of Paleocene through Eocene, predominates in the eastern half of the area, and it is in fault contact with Crocker Formation, and the fault trends N-S. However, this survey disclosed the sedimentary rocks in this area to be Crocker Formation from the facts that most outcrops are composed of same sandstone as the one of Crocker Formation, the fault trending N-S was not be detected in the field. Geochemical samples were taken from the area where is underlain by sandstone. Therefore, the analytical values can be handled without considering the difference of the geology. The geology of the area is shown in Fig. II-2-1.

Crocker Formation is widely distributed in this ore deposit area. The formation is principally composed of gray wellsorted massive sandstone and partly intercalates thin beds of shale and siltstone. Pleistcene Pinosuk Gravels covers Crocker Formation in a lower land in the western to southern portion of the area. Pinosuk Gravels is a sand and gravel bed which comprises unconsolidated rounded conglomerate and sand. The gravels characteristically include granites and ultrabasic rocks. The granite in the gravels are the same as the one composing the Mt. Kinabalu in a characteristic point of view. Small terraces are formed along rivers in the western part of the area and terrace deposit can be seen there.

Granodiorite intruded on a small scale in the western slope of the Mt. Nungkok. This intrusive rock is closely related with porphyry copper deposits, which are known in this area. The intrusive rock is 700 m by 400 m in size depend on the previous survey. The sandstone of Crocker Formation is widely silicified around the intrusive rock.

Crocker Formation strikes NW-SE and dips west in the southern portion, strikes NE-SW and dips east in the central portion and strikes NW-SE and dips west in the northern part of the area. From the facts on the strikes and dips described above and from the topographical features in this area, each two portions, southern-central and central-northern portions, are in fault contact with each other. The faults are supposed to trend NE.

Nungkok porphyry type copper-molybdenum deposit occurs in the granodiorite and the surrounding sandstone. According to the previous drilling, 27 holes and 4,116 m in total, the mineralized zone is 915 m by 366 m in size and the ore grade is reported as 0.18 to 0.56% Cu, 0.003 to 0.051% Mo, 0.6 g/t and less than that of Au, and 0.8 to 9.0 g/t Ag. The deposit is currently

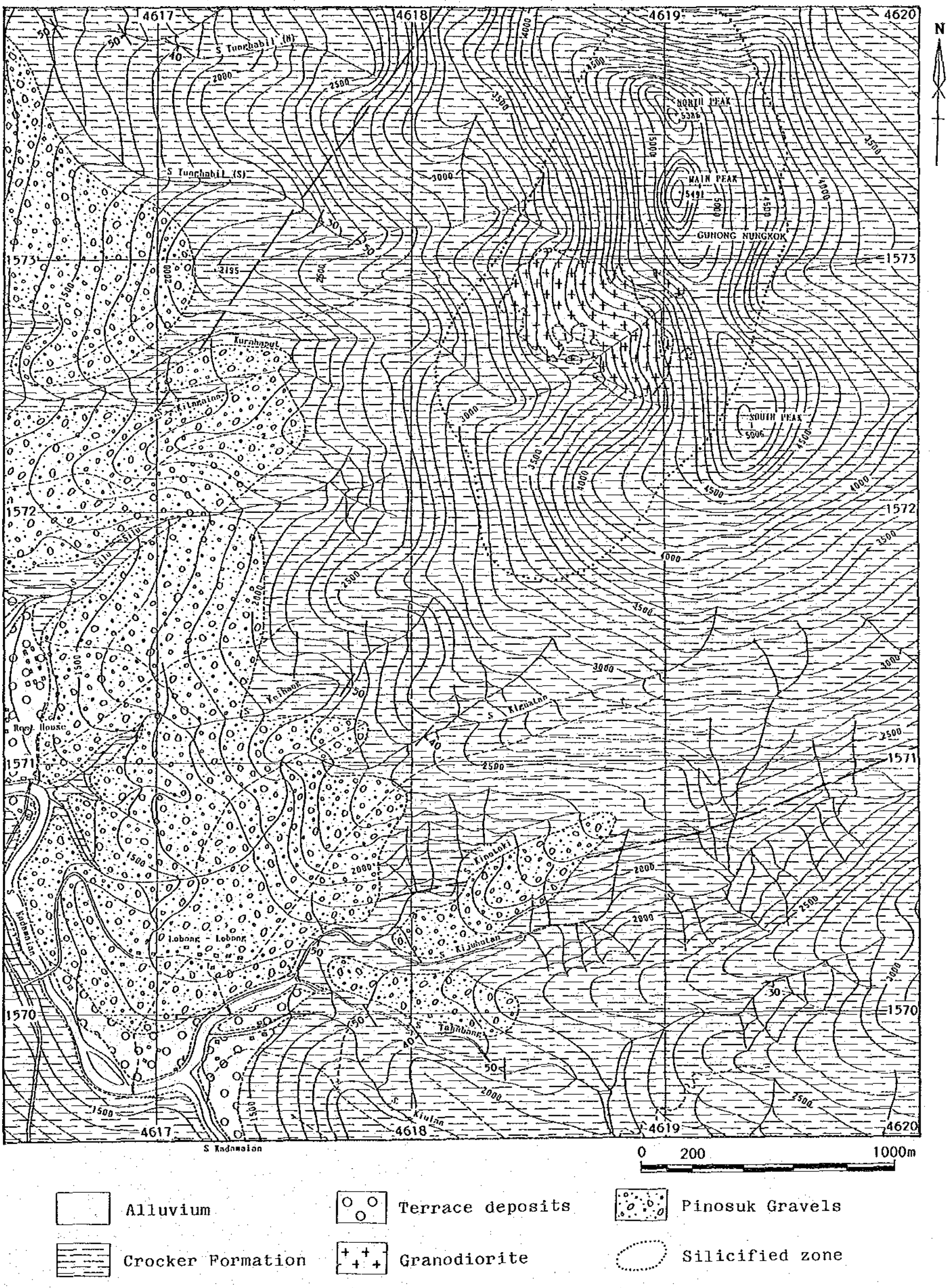


Fig. II-2-1 Geologic map of the Nungkok deposit area understood uneconomical from the viewpoint of the grade and the locality.

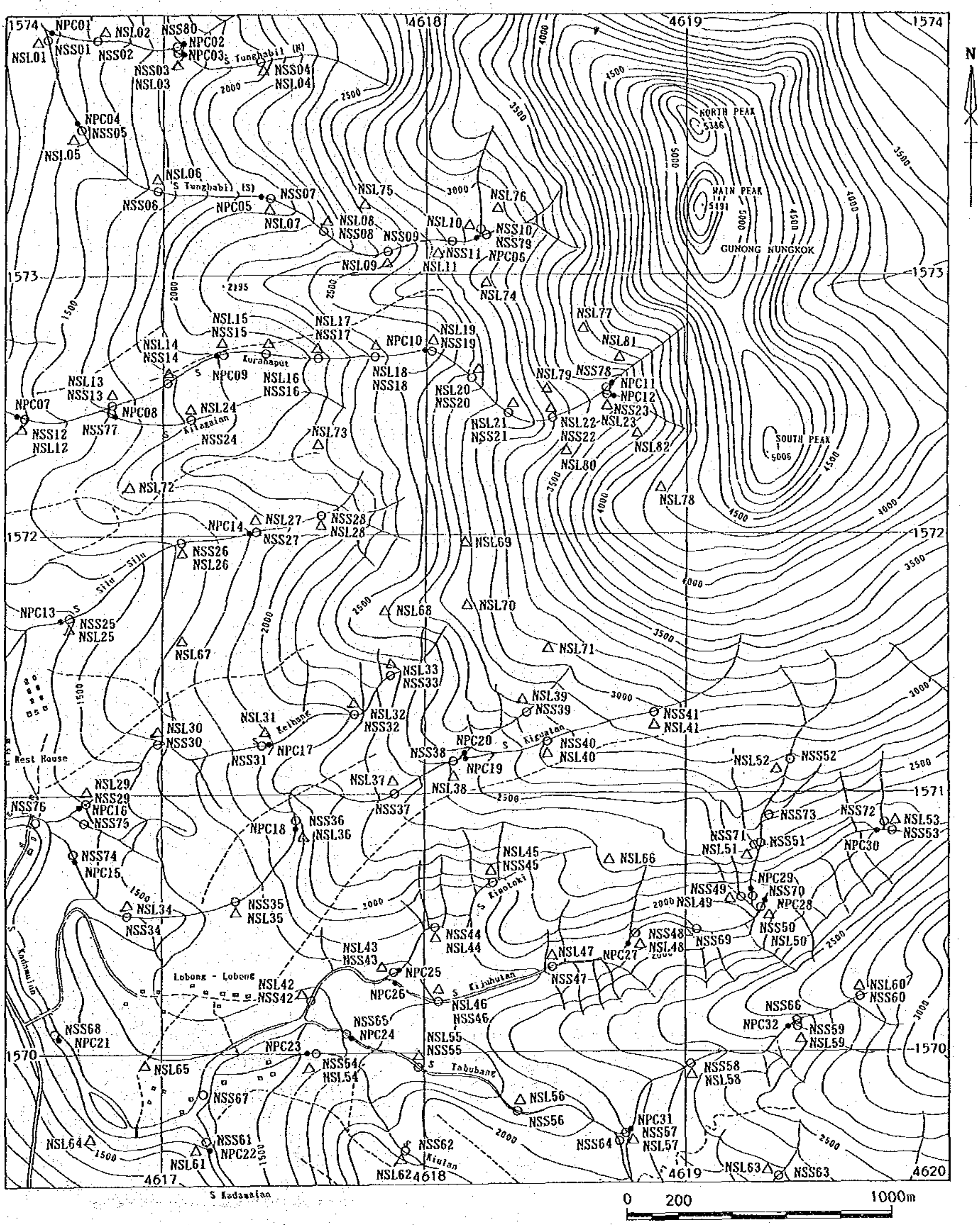
2-2-2 Sampling

Geochemical samples of stream sediments, soil and pan concentrates were mainly taken along the rivers, which flow down west in the area from the west side to the southern portion of the Mt. Nungkok. In the gently undulated area from the west to the south of the area, upland rice plants, cocoa and rubber are planted on the hillside. On each stream sediment sampling site, UPM coordinates of the locaiton, geology of the point, current velocity of the stream, color of the sample, grain size of the sample and so on were described as shown in Appendix 4. On each soil sample location, the coordinates of the sampling point, geology of the area, depth from where the sample was taken, soil profile, characteristics of the sample and vegetation in the sample location were described as shown in Appendix 5. The sample locations are plotted on Fig. II-2-2. At the sample locations, from number 1 to number 63, soil samples were taken near stream sediment sample location.

Three stream sediment samples were taken at one locality as described in 2-2-1. Topography of this area is steep and in the upper part of the stream, stream sediment was not always well deposited at the side of the drainage. Therefore, some sample location, A, of the bank of the river was not well discriminated from the sample location, B, of the edge of the stream.

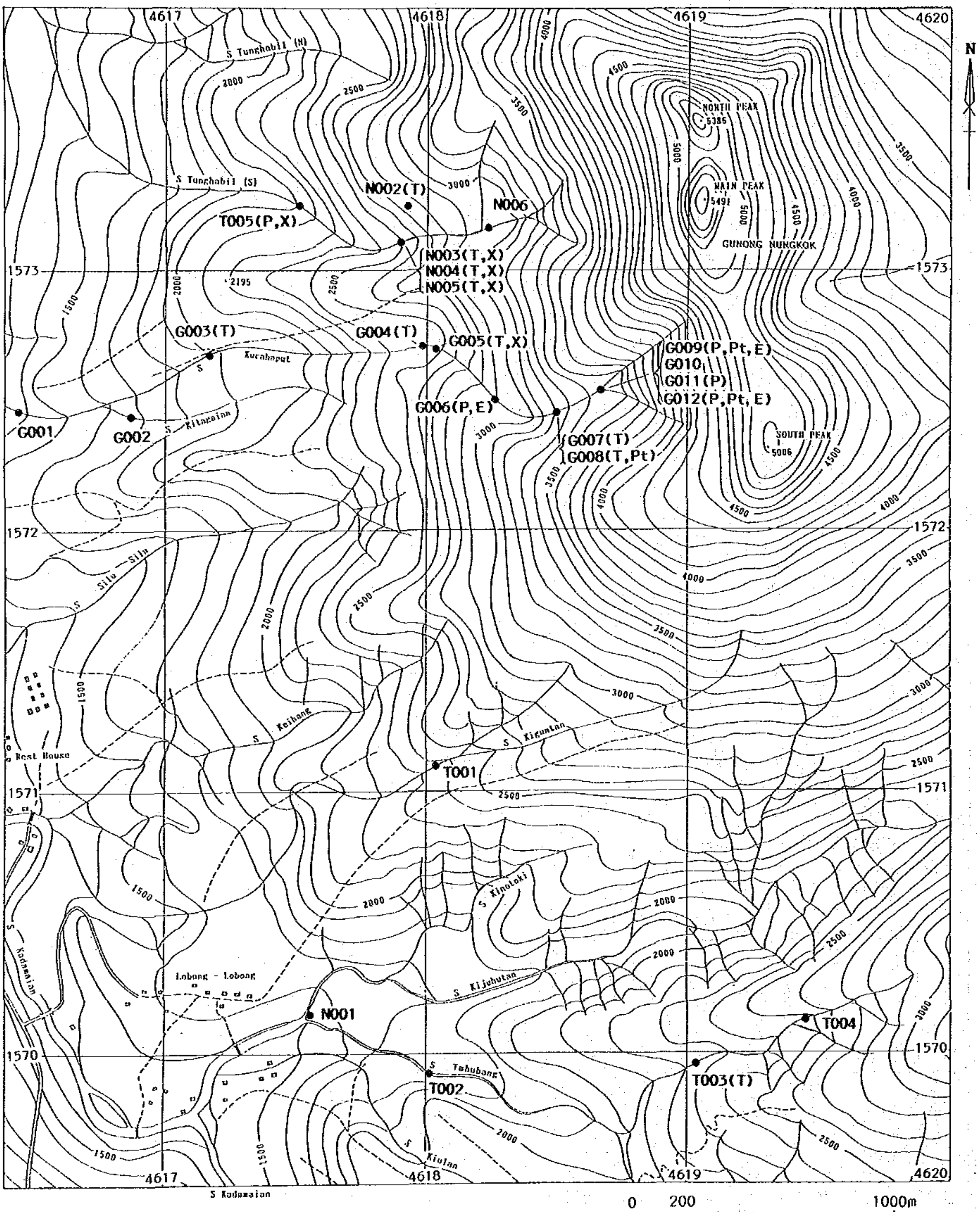
Three soil samples were taken at one locality as described 2-1-1. Soil samples with the number from 64 to the end were mostly taken near the Nungkok deposit with the purpose of disclosing geochemical characteristics of the mineralized zone. Sampling points were decided in order to avoid the influence of stream flow and landsliding. Soil samples were taken by hand auger. B horizon of the soil was well developed compared to A horizon. The location of the pan concentrate sampling was decided in order to obtain the general geochemical trend of the area. The samples were taken by using wooden pan. At many points, one or two hours were spent to collect the pan concentrate, black sands. Maximum of two hours were spent for the sampling.

In addition to the geochemical samples, samples for laboratorial studies, thin section observation, polished section observation, polished thin section observation and X-ray powder diffractometry, were collected in the same area. The locations of the samples for laboratorial studies are shown in Fig. II-2-3. At the mineralized zone, the samples were partly taken from floats because the place was strongly weathered.



NSS: stream sediment sample NSL: soil sample NPC: pan concentrate sample

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



G005; sample number (T); thin section (P); polished section

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

Fig. II-2-3 Location map of samples for laboratorial studies in the Nungkok deposit area

2-2-3 Stream sediment geochemical survey

(1) Tracer elements

Chemical analyses of the samples were executed for 19 elements. The analytical data were statistically treated. The results of the treatment is shown in Table II-2-3. As shown in this table, analytical values of Ag, Hg, Pt and Sn were mostly less than their detection limits.

Stream sediments were taken at three points on one location. The points are bank of the river, represented by A, edge of the river, represented by B, center of the river, represented by C. The relations between tracer elements and the samples taken from these different portions were summarized as the following as the result of the statistical treatment.

Elements with high geometric mean values on sample A;

Co, Mo (2 elements)

Elements with high geometric mean values on sample B;

As, Au, Cr, Mo, Pt, Sb, Sn, U, W (9 elements)

Elements with high geometric mean values on sample C;

Cu, Fe, Mo, Ni, Pb, S, Zn (7 elements)

Because of the higher analytical values of sample B, it is thought the sample B is most effective for the geochemical exploration in the point of view of the elemental concentration.

Correlation matrixes among analytical elements on each sample point, A, B and C, are shown in Table II-2-4. The samples taken at the point B generally have higher correlation coefficients on many elements. Pairs of elements with higher correlation coefficient, 0.600 and more than that, are as the following;

As-Au, As-Mn, As-W, Au-Cu, Au-W, Co-Cr, Co-Fe, Co-Mn, Co-Ni, Co-Sb, Co-Zn, Cr-Fe, Cr-Mn, Cr-Ni, Cr-Pb, Cr-Sb, Cr-U, Cr-Zn, Cu-S, Cu-W, Fe-Mn, Fe-Ni, Fe-Sb, Fe-U, Fe-Zn, Mn-Ni, Mn-Sb, Mn-U, Mo-W, Ni-Sb, Ni-U, Ni-Zn, Sb-U, Sb-Zn, U-Zn

From the above, it is understood that Co, Cr, Fe, Mn, Ni, Sb and Zn tend to have higher correlations with other elements.

(2) Single element analyses

Three methods were applied for geochemical analyses to compare the effectiveness. They are EDA method, Lepeltier method and b + 2S.D. method. Histograms of analytical values on each element and cumulative frequency distribution diagrams used for the determination of the threshold of analytical values on each element by the method of Lepeltier are shown in Appendix 9. The threshold values determined by above mentioned methods and so on are shown in Tabel II-2-5. The followings are the characteristics of the results analysed by those methods;

Table II-2-3 Statistics of stream sediment geochemical survey in the Nungkok 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	53.8	ppm	103	< 5	9.0	0.378	35.0	ppm	114	< 5	11.8	0.390	40.0	ppm	92	< 5	11.1	0.149
Au	37.5	ppb	610	< 2	11.0	0.782	18.8	ppb	1600	< 2	16.0	0.875	42.5	ppb	1600	< 2	11.6	0.754
Co	0	ppm	46	2	7.0	0.358	8.8	ppm	42	< 1	5.4	0.454	10.0	ppm	35	< 1	5.3	0.204
Cr	0	ppm	2363	130	320.0	0.293	0	ppm	3485	105	335.4	0.339	0	ppm	2607	115	333.9	0.110
Cu	0	ppm	910	6	42.6	0.637	0	ppm	1005	5	56.1	0.728	0	ppm	1232	7	66.1	0.540
Fe	0	%	7.15	0.61	2.104	0.264	0	%	8.24	0.74	2.401	0.269	0	%	8.40	0.92	2.429	0.063
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	1248	67	251.1	0.357	0	ppm	1351	61	241.4	0.353	0	ppm	1426	23	245.1	0.131
Mo	66.3	ppm	27	< 1	1.6	0.388	67.5	ppm	19	< 1	1.8	0.409	66.3	ppm	26	< 1	1.8	0.157
Ni	0	ppm	481	10	32.3	0.470	0	ppm	503	10	40.3	0.496	0	ppm	522	12	45.8	0.223
Pb	22.5	ppm	36	< 2	5.3	0.318	21.3	ppm	59	< 2	5.2	0.380	30.0	ppm	109	< 2	5.4	0.184
Pt	100.0	ppb	< 5	< 5	-	0.000	92.5	ppb	10	< 5	5.3	0.080	98.8	ppb	5	< 5	-	0.001
S	0	%	0.090	0.009	0.016	0.189	0	%	0.127	0.008	0.020	0.265	0	%	0.131	0.010	0.028	0.075
Sb	85.0	ppm	12	< 5	5.4	0.084	80.0	ppm	13	< 5	5.5	0.095	85.0	ppm	10	< 5	5.3	0.005
Sn	100.0	ppm	< 1	< 1	-	0.000	97.5	ppm	5	< 1	1.0	0.085	100.0	ppm	< 1	< 1	-	0.000
U	0	ppm	9.4	1.2	1.98	0.189	0	ppm	18.2	1.2	2.19	0.265	0	ppm	16.6	1.2	1.94	0.060
W	73.8	ppm	108	< 10	14.1	0.306	60.0	ppm	267	< 10	17.7	0.391	61.3	ppm	168	< 10	16.8	0.132
Zn	0	ppm	111	7	28.9	0.277	0	ppm	151	13	34.2	0.269	0	ppm	146	15	36.4	0.062

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

Table II-2-4 Coorelation matrix of elements for stream sediments in the Nungkok deposit area

Nungkok
Stream sediments (A)

	As	Au	Co	Cr	Cu	Fe	Mn	Mo	Ni	Pb	S	Sb	U	W	Zn
As	1.000														
Au	.685	1.000													
Co	-.265	-.088	1.000												
Cr	-.222	-.013	.707	1.000											
Cu	.728	.667	-.002	.106	1.000										
Fe	.043	.098	.815	.690	.326	1.000									
Mn	-.526	-.328	.813	.585	-.220	.707	1.000								
Mo	.751	.546	-.246	-.118	.861	.080	-.468	1.000							
Ni	-.421	-.192	.806	.783	-.176	.755	.758	-.396	1.000						
Pb	-.301	-.194	.222	.233	-.101	.203	.357	-.224	.307	1.000					
S	.286	.412	.426	.385	.622	.565	.149	.475	.314	.114	1.000				
Sb	-.255	-.229	.486	.426	-.023	.515	.549	-.208	.466	.212	.120	1.000			
U	-.363	-.327	.624	.524	-.123	.682	.739	-.287	.651	.334	.217	.633	1.000		
W	.654	.465	-.013	.083	.756	.267	-.253	.845	-.162	-.081	.533	-.024	.031	1.000	
Zn	-.335	-.166	.878	.692	-.048	.876	.863	-.270	.883	.296	.416	.494	.717	-.049	1.000

Nungkok
Stream sediments (B)

	As	Au	Co	Cr	Cu	Fe	Mn	Mo	Ni	Pb	Pt	S	Sb	Sn	U	W	Zn
As	1.000																
Au	.630	1.000															
Co	-.275	.007	1.000														
Cr	-.483	-.179	.605	1.000													
Cu	.624	.679	.149	.045	1.000												
Fe	-.098	.121	.730	.774	.408	1.000											
Mn	-.623	-.301	.773	.757	-.159	.705	1.000										
Mo	.738	.543	-.124	-.245	.834	.115	-.446	1.000									
Ni	-.443	-.118	.819	.864	.073	.857	.863	-.212	1.000								
Pb	-.363	-.090	.394	.524	-.011	.448	.525	-.098	.544	1.000							
Pt	-.224	-.166	-.148	-.010	-.275	-.209	-.060	-.185	-.098	-.019	1.000						
S	.402	.357	.304	.128	.743	.442	.053	.626	.228	.049	-.264	1.000					
Sb	-.458	-.185	.618	.663	-.071	.647	.751	-.272	.726	.513	-.139	.053	1.000				
Sn	-.177	-.172	.140	.089	-.072	.129	.195	-.101	.120	.057	-.044	-.057	.225	1.000			
U	-.408	-.024	.544	.765	.043	.718	.715	-.240	.739	.580	-.136	.041	.736	.133	1.000		
W	.609	.570	.026	.008	.810	.304	-.231	.871	.035	.130	-.205	.578	-.081	-.112	.080	1.000	
Zn	-.402	-.146	.847	.796	.090	.875	.907	-.185	.919	.510	-.122	.301	.719	.166	.671	-.004	1.000

Nungkok
Stream sediments (C)

	As	Au	Co	Cr	Cu	Fe	Mn	Mo	Ni	Pb	S	Sb	U	W	Zn
As	1.000														
Au	.617	1.000													
Co	-.235	-.147	1.000												
Cr	-.518	-.241	.692	1.000											
Cu	.668	.498	.215	.048	1.000										
Fe	-.085	-.061	.773	.750	.434	1.000									
Mn	-.550	-.355	.688	.781	-.122	.718	1.000								
Mo	.746	.395	-.010	-.239	.886	.143	-.393	1.000							
Ni	-.544	-.322	.764	.897	-.092	.715	.808	-.354	1.000						
Pb	-.365	-.127	.401	.613	-.036	.404	.561	-.213	.515	1.000					
S	.592	.467	.188	.040	.914	.334	-.144	.863	-.092	-.021	1.000				
Sb	-.375	-.177	.568	.672	.033	.617	.640	-.215	.646	.446	-.033	1.000			
U	-.289	-.032	.536	.738	.158	.724	.651	-.133	.603	.503	.080	.549	1.000		
W	.638	.361	.069	-.017	.825	.269	-.225	.852	-.176	.034	.772	-.087	.100	1.000	
Zn	-.356	-.220	.842	.807	.154	.846	.829	-.129	.863	.542	.142	.631	.656	.006	1.000

Table II-2-5 Threshold values obtained by each analytical method for stream sediment geochemical survey in the Nungkok 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	5.0	23.0	27.5	4	82	2.5	62.4	10.0	31.0	47.5	10	81	2.5	93.9	8.0	30.0	50.0	8	79	2.5	86.8
Au	ppb	6.0	74.0	107.0	7	195	7.5	523.0	7.0	150.0	227.0	9	540	5.5	1063.6	5.0	100.0	127.0	6	205	10.5	809.4
Co	ppm	6.0	18.0	24.0	6	12	25.0	36.6	5.5	19.0	15.5	6	13	23.0	52.0	5.0	21.0	18.0	5	14	22.0	50.5
Cr	ppm	264.0	442.0	565.5	190	815	13.0	1236.3	258.5	678.0	666.5	280	835	15.5	1596.0	266.5	635.0	964.0	270	780	16.5	1541.9
Cu	ppm	30.0	269.0	273.0	31	120	25.0	802.7	37.5	501.0	667.0	41	175	30.0	1603.4	39.0	632.0	921.5	56	370	25.0	1950.7
Fe	%	1.88	3.86	5.86	1.95	3.10	30.0	7.09	2.30	5.12	5.84	2.40	3.90	23.5	8.29	2.38	4.88	5.78	2.38	4.05	21.5	7.74
Hg	ppm	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mn	ppm	196.5	742.0	1160.5	205	385	34.0	1297.3	184.5	733.0	642.0	195	495	24.5	1280.3	209.0	743.0	690.0	200	475	24.5	1295.2
Mo	ppm	1.0	3.0	3.5	0.4	11	4.0	10.4	1.0	5.0	6.0	0.5	16	2.5	13.3	1.0	5.0	6.0	0.9	14	2.5	12.9
Ni	ppm	22.0	85.0	104.0	23	89	21.0	281.2	27.0	172.0	108.0	26	110	21.5	395.3	29.0	239.0	140.0	32	107	24.0	402.2
Pb	ppm	6.0	11.0	19.5	6	14	7.5	30.9	5.5	9.0	17.0	5	19	9.5	37.8	4.5	11.0	19.5	5	26	9.0	51.3
Pt	ppb	—	—	—	—	—	—	—	5.0	5.0	5.0	—	—	—	5.8	—	—	—	—	—	—	—
S	%	0.014	0.021	0.031	0.015	0.041	5.0	0.037	0.019	0.031	0.052	0.020	0.066	5.5	0.069	0.025	0.056	0.078	0.025	0.044	24.0	0.098
Sb	ppm	5.0	5.0	5.0	2	13	2.5	7.0	5.0	5.0	5.0	4	12	2.5	8.3	5.0	5.0	5.0	2	10	2.5	6.5
Sn	ppm	—	—	—	—	—	—	—	1.0	1.0	1.0	< 0.1	2	2.5	1.0	—	—	—	—	—	—	—
U	ppm	1.80	2.40	3.40	1.9	4.1	9.0	4.73	1.80	2.8	3.9	1.9	5.5	11.0	7.41	1.70	2.40	3.40	1.9	4.2	10.5	5.98
W	ppm	10.0	18.0	10.0	2	90	2.5	59.0	10.0	41.0	47.5	6	185	2.5	125.4	10.0	39.0	37.5	6	150	2.5	103.5
Zn	ppm	24.5	58.0	73.0	26	54	19.5	103.4	29.5	71.0	70.5	29	53	24.0	118.1	31.5	63.0	67.5	31	58	22.5	114.4

*1: Background *2: Threshold

1) According to the EDA method, suitable threshold values were not detected in case that the numbers of the samples with analytical values of detection limit and more than that were limited. The value of the Upper Fence sometimes exceed the maximum analytical value.

2) According to the method of Lepeltier, the distribution of analytical values of some elements such as Cu and S on the histograms is thought to be composed of two different kinds of distributions. A distribution with higher values is interpreted to show the mineralization. Same kind of distributions are seen on the histograms of the values of Co, Cr and Mn. Thus, by this method, geology and/or mineralization and the results of the analyses are easily correlated.

3) The thresholds decided by the equation, the mean plus double standard deviations, should be theoretically 2.5% of the values determined by the method of Lepeltier. However, when the distribution is not the lognormal one, the values are not the theoretical ones. Thus, this method is only to be used for the instruction.

For the determination of the threshold by EDA method, the values of Upper Fence were taken. However, in case that the maximum analytical value of each element is less than the value of the Upper Fence, the values of the Upper Whisker were taken. The distribution of analytical values of the samples taken from the point B are shown in Appendix 10. In this diagram the values are divided into three parts, threshold value and more than that, from threshold to median and less than median values. The trends and the characteristics of the distribution of elements are as follows;

As : Anomalous points with values of detection limit and higher than that are distributed along the river flowed out from Nungkok deposit and its siliceous zone. Therefore, the relation of the anomalous points with the deposit can be recognized.

Au : The distribution of the anomalous points are as same as those of As. The relation between the distribution and the deposit is also pointed out. But, the anomalous points are distributed rather lower portion of the stream.

Co : Anomalous points are mainly distributed in the southern part of the area, and the relation with the deposit is not pointed out. This Co anomalous points are thought to be related with ultra-basic rocks in the upper part of the river.

Cr : The distribution of the anomalous points have the same trend as the ones of Co. The distribution is not related with the deposits.

Cu : Anomalous points were detected along the river flowing out from the Nungkok deposit. Thus, the anomalous points zone was related with the deposit. The anomalous points can be detected as far as 1.5 km to the downstream from the deposit.

Fe : Anomalous points can be detected on the river in the south and are distributed as same as the ones of Co and Cr.

Mn : Anomalous points of Mn have the same trend as Fe, and is not related with deposit.

Mo : Anomalous points are detected on the river flowing out from the Nungkok deposit same as Cu. The anomalous points are related with the deposit. The anomalous points can be detected as far as 2 km to the downstream from the Nungkok deposit.

Ni : The anomalous points are distributed in the south of the survey area as the ones of Co, Cr, Fe and Mn. They are not related to the deposits.

Pb : Anomalous points are detected on the river in the south of the area. The relation of the anomalous points with deposit is not confirmed.

S : Anomalous points are only distributed near the Nungkok deposit and are closely related with the deposit.

U : Anomalous points have the same trend of the one of Pb in the south of the survey area.

W : Anomalous points were detected only on the river flowing out of the Nungkok deposit and related with the deposit.

Zn : Anomalous points were only detected on the river in the south of the river same as the one of Co, Cr, Ni, and Mn.

From the distribution trends above mentioned, six elements, As, Au, Cu, Mo, S and W, were to be usefull as pathfinder elements. The other elements are thought to reflect the geology of the area and in the upper streams of the area.

(3) Multi element analyses

Cluster analysis was applied in order to understand the relations among elements as a multi element analysis. The result of the analysis is shown in Fig. II-2-4. As can be seen on this dendrogram, the clusters composed of Mo-W-Cu-S-As-Au and Fe-Zn-Ni-Mn-Cr-Co are clearly distinguished either in the samples of A, B or C. The former cluster is related to the Nungkok deposit due to the composed elements, the latter cluster is thought to be related with the background of the area.

Factor analysis was applied for the samples of A, B and C, as well. The result of the analysis is shown in Table II-2-6. As shown in the table, the samples of B, which were taken from the side of the river, have higher communalities than the other samples, A and B, thus the samples of B are realized more effective for the geochemical exploration. On the other hand, the factors found out from the samples of B have a strong relation to each composing element compared to the other

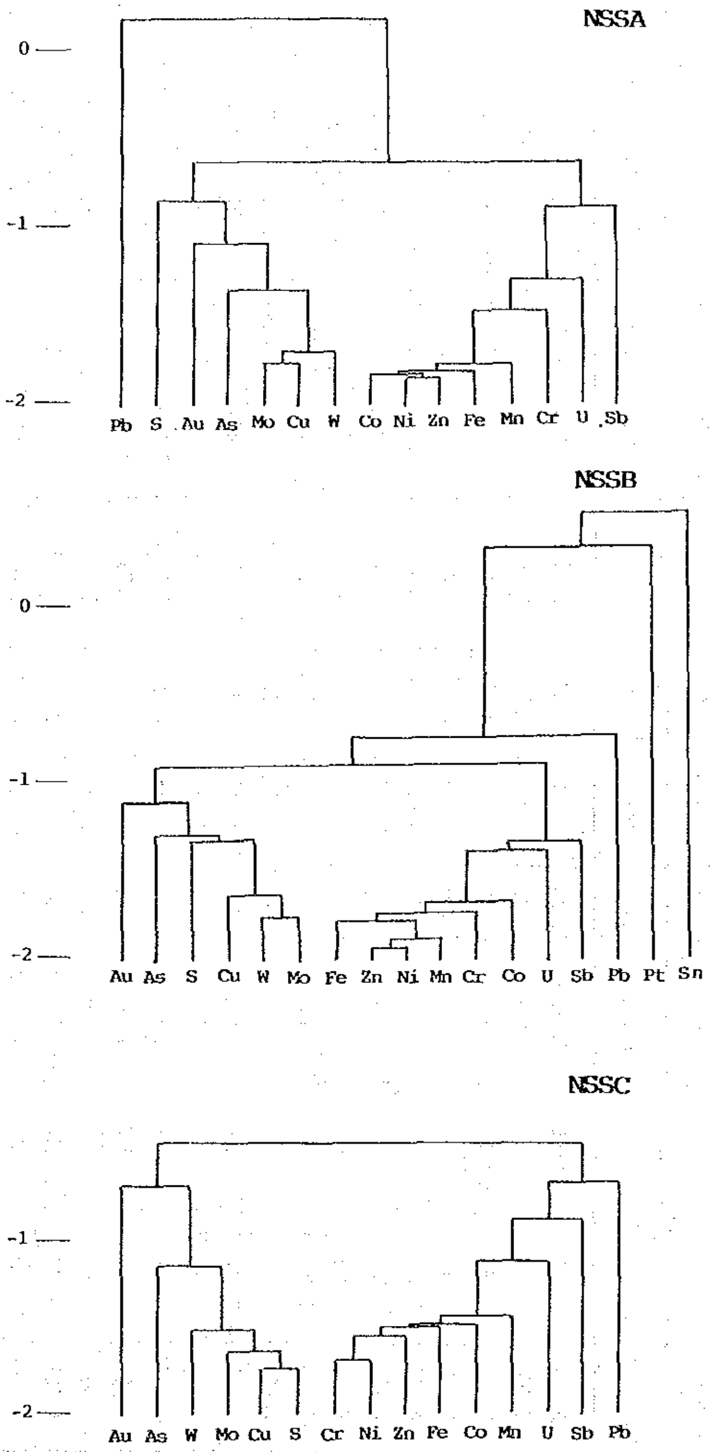


Fig. II-2-4 Dendrogram of elements for stream sediments in the Nungkok deposit area

Table II-2-6 Results of factor analyses for stream sediments in the Nungkok 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	0.217	0.755	-0.123	-0.371	0.7821	0.426	0.698	0.185	-0.279	0.7824	0.356	-0.682	-0.252	-0.364	0.7878
Au	-0.022	0.636	-0.364	-0.330	0.6490	0.077	0.606	0.027	-0.538	0.6958	0.171	-0.399	-0.009	-0.675	0.6436
Co	-0.914	-0.027	0.104	0.081	0.8557	-0.823	0.060	0.047	-0.086	0.8437	-0.864	-0.110	-0.056	0.065	0.8143
Cr	-0.769	0.063	0.086	0.090	0.7831	-0.885	-0.056	-0.079	0.133	0.8866	-0.859	0.060	0.360	0.116	0.8873
Cu	-0.061	0.024	-0.052	-0.097	0.8698	-0.111	0.915	0.088	-0.156	0.8815	-0.168	-0.929	-0.080	-0.218	0.9456
Fe	-0.877	0.308	0.234	0.057	0.9271	-0.880	0.328	0.025	-0.041	0.9118	-0.891	-0.295	-0.026	0.023	0.9014
Mn	-0.797	-0.288	0.267	0.248	0.8788	-0.887	-0.266	-0.083	0.072	0.9208	-0.847	0.241	0.150	0.148	0.8225
Mo	0.231	0.911	-0.029	-0.066	0.8890	0.221	0.928	-0.051	0.044	0.9141	0.155	-0.947	-0.127	-0.013	0.9379
Ni	-0.886	-0.193	0.064	0.166	0.8989	-0.961	-0.005	-0.057	0.053	0.9327	-0.885	0.199	0.162	0.145	0.8885
Pb	-0.225	-0.101	0.066	0.489	0.3048	-0.536	-0.008	-0.536	0.063	0.5787	-0.498	0.065	0.583	0.023	0.5934
Pt	–	–	–	–	–	0.093	-0.264	-0.060	0.192	0.2326	–	–	–	–	–
S	-0.454	0.629	-0.155	0.165	0.6425	-0.249	0.754	0.188	0.126	0.7162	-0.112	-0.907	0.023	-0.174	0.8871
Sb	-0.462	-0.065	0.606	0.046	0.5885	-0.733	-0.138	-0.238	-0.044	0.7443	-0.716	0.104	0.111	0.024	0.5585
Sn	–	–	–	–	–	-0.108	-0.100	-0.020	0.086	0.1736	–	–	–	–	–
U	-0.617	-0.086	0.533	0.297	0.7613	-0.772	-0.056	-0.306	-0.168	0.8109	-0.729	-0.029	0.250	-0.096	0.7327
W	0.037	0.891	0.149	0.062	0.8287	-0.019	0.897	-0.248	-0.063	0.8860	0.016	-0.905	0.129	-0.012	0.8516
Zn	-0.921	-0.059	0.141	0.212	0.9205	-0.944	0.021	0.018	0.106	0.9491	-0.928	-0.034	0.100	0.094	0.8939
F.C.*1	46.8 %	35.3 %	8.7 %	6.7 %	–	51.2 %	32.7 %	4.7 %	4.2 %	–	50.7 %	34.9 %	5.8 %	6.1 %	–

*1: factor contribution

samples, A and C. The factors found out from the samples of B and the elements closely related with the factors are as follows;

Factor 1 : Co-Cr-Fe-Mn-Ni-U-Zn

Factor 2 : As-Cu-Mo-S-W

Factor 3 : Pb

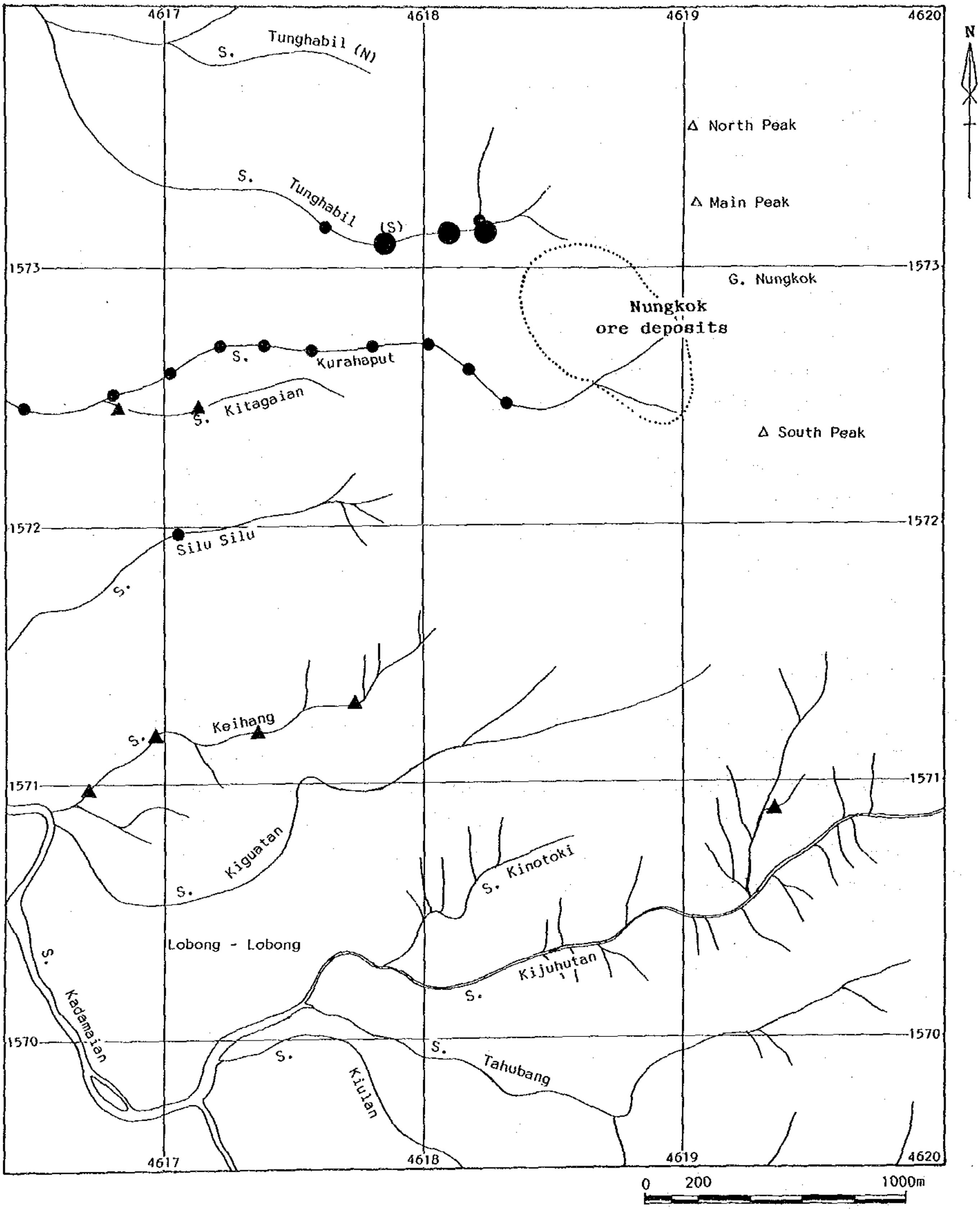
Factor 4 : Au

Factor 1, 2 and 3 have negative factor loadings of related elements. Factor 2 has a same characteristics as that of Nungkok deposit in a view of the composing elements, and is presumed to be of the mineralization. Factor 1 is supposed to be of a ultrabasic rock, judging from the composing elements.

The sample locations with higher factor scores of factors 1 and 2 are shown in Fig. II-2-5. As clearly can be seen in the figure, Factor 2 defines the mineralization of the Nungkok deposit. Thus, the factor analysis is surely effective for the geochemical survey. In addition, according to this factor analysis, the sample of B is better than the samples of A and C for the delineation of the mineralization.

(4) Summary of analyses

Compilation map showing the distribution of anomalous points detected by EDA method is presented as Fig. II-2-6. Six elements, Au, As, Cu, Mo, S and W are selected as effective pathfinders in and around ore deposit. The detected anomalous points are distributed untill 1.5 km down stream from the deposit, that is, wide area is affected by the mineralization. Anomalous points of the elements such as Co, Cr, Fe, Mn, Ni, Pb, U and Zn are all representing the background, and do not delineate the mineralization.



● ≧2.000 factor 2 factor score 2.000>● ≧1.000 factor 2 factor score

▲ ≧1.000 factor 1 factor score (Sample collected at edge of stream (B))

Fig. II-2-5 Distribution map of factor 1 factor score for stream sediments in the Nungkok deposit area

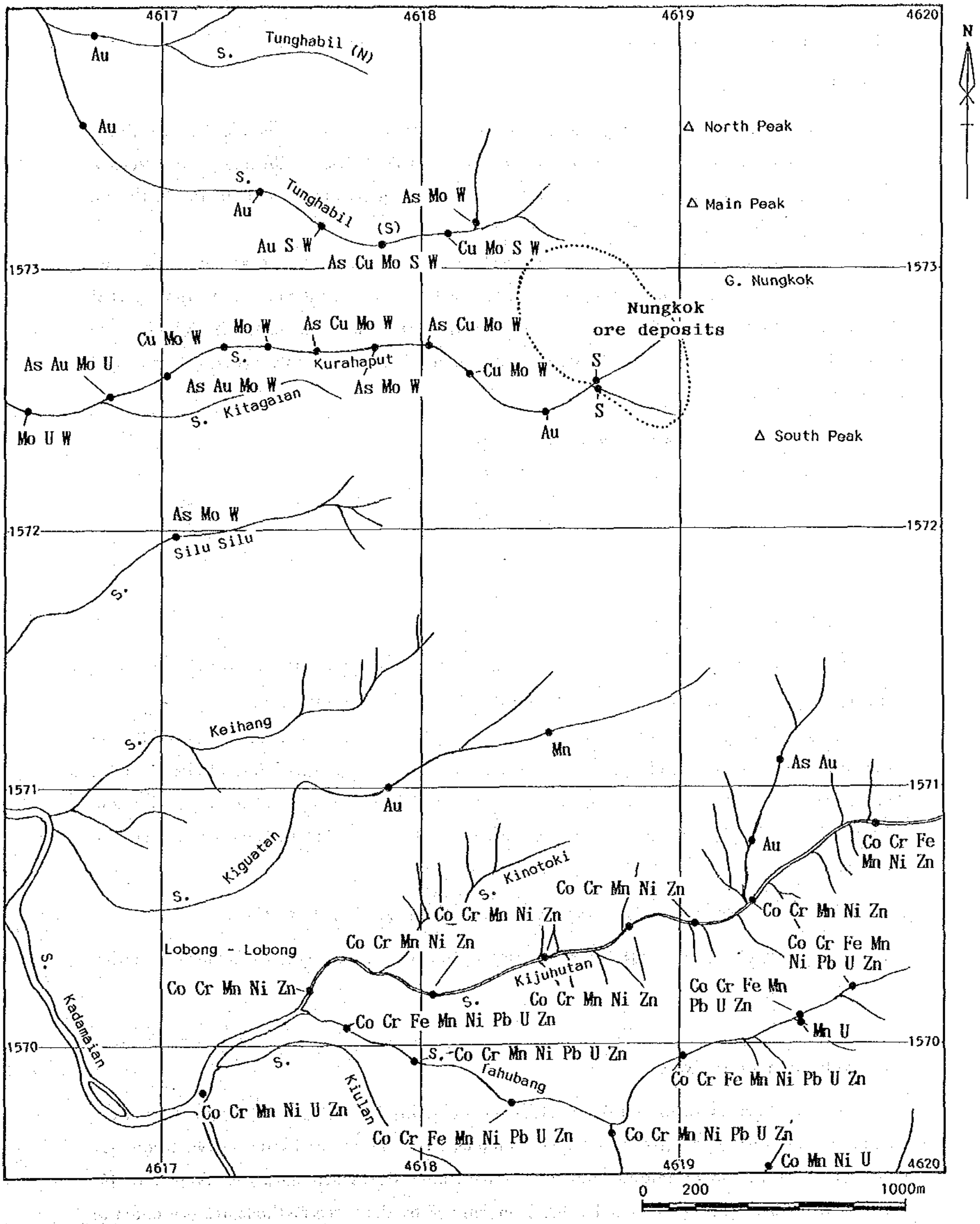


Fig. II-2-6 Interpretation map of stream sediment geochemical survey in the Nungkok deposit area

2-2-4 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 listed in Table II-2-7. The analytical values of Ag, Hg were all below their detection limits. Furthermore, analytical values of Mo, Pt, Sb, Sn and W were also in large part below their detection limits.

Soil samples were taken from three horizons of the soil profile at one sampling location. Sample series A were taken from the A horizon, sample series B were taken from the upper part of the horizon B and the sample series C were taken from the lower part of the horizon B. The geometric means of the analytical values calculated on each kind of sample have a general trend described as follows.

Elements with higher mean values on sample A:
Au, Cr, Cu, Mn, Na, Ni, Pb, Pt, Sb, Sn, Sr, Zn

Elements with higher mean values on sample B:
Co, Fe, Mo, W

Elements with higher mean values on sample C:
As, K, Rb, U

The elements of samples A generally have the highest mean values. However, the histograms of the elemental analytical values of the sample B are not making smooth lines.

Correlation matrixes among elements of each sample series are presented in Table II-2-8. The correlation among elements of sample A are generally lower than those of the samples B and C. The correlations between elements of the sample B and C have about the same trend. Pairs of elements in the sample series B with higher correlation coefficients, 0.600 and more than that, are as follows;

As-Au, As-Mo, Au-Cu, Cr-Ni, Cu-Mo, Cu-W, Fe-U, K-Rb, Mn-Zn, Mo-W, Na-Sr

Elements closely related with mineralization in this area generally have higher correlation with each other.

(2) Single element analysis

Three analytical methods were applied for the soil analytical values in the same way of the statistical analyses of the stream sediment samples. Histograms and cumulative frequency distribution curves on individual elements and sample series are shown on Appendix 11. Statistical values, such as threshold values, determined by the three methods are presented in Table II-2-9. The characteristics of the analytical results among the three methods have about a same trend as the one on stream sediment samples. The histograms of individual element of

Table II-2-7 Statistics of soil geochemical survey in the Nungkok 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	<0.5	<0.5	—	—	100.0	ppm	<0.5	<0.5	—	—	100.0	ppm	<0.5	<0.5	—	—
As	46.3	ppm	225	< 5	8.0	0.562	36.6	ppm	220	< 5	9.8	0.572	28.0	ppm	243	< 5	11.1	0.551
Au	28.0	ppb	230	< 2	6.2	0.667	34.1	ppb	176	< 2	5.6	0.706	30.5	ppb	190	< 2	5.6	0.695
Co	3.7	ppm	33	< 1	8.7	0.360	1.2	ppm	34	< 1	9.8	0.330	4.9	ppm	38	< 1	8.7	0.403
Cr	0	ppm	1048	61	232.8	0.261	0	ppm	1028	30	112.3	0.348	0	ppm	572	36	80.9	0.245
Cu	0	ppm	2806	16	94.2	0.635	0	ppm	2730	12	89.3	0.710	0	ppm	2909	12	86.2	0.715
Fe	0	%	5.96	2.25	3.45	0.097	0	%	6.13	2.09	3.68	0.099	0	%	5.65	1.91	3.600	0.098
Hg	100.0	ppm	< 1	< 1	—	—	100.0	ppm	< 1	< 1	—	—	100.0	ppm	< 1	< 1	—	—
K	0	%	2.61	0.22	0.825	0.191	0	%	3.06	0.32	0.973	0.169	0	%	3.28	0.36	0.998	0.176
Mn	0	ppm	2179	32	489.5	0.412	0	ppm	1761	30	475.1	0.388	0	ppm	1761	36	456.1	0.419
Mo	76.8	ppm	23	< 1	0.9	0.464	63.4	ppm	28	< 1	1.1	0.515	76.8	ppm	31	< 1	0.9	0.506
Na	0	%	1.03	0.05	0.14	0.280	0	%	0.95	0.05	0.128	0.327	0	ppm	1.00	0.05	0.137	0.310
Ni	0	ppm	341	20	83.6	0.261	0	ppm	308	19	50.1	0.313	0	ppm	373	11	33.9	0.311
Pb	20.7	ppm	32	< 2	6.5	0.478	20.7	ppm	107	< 2	5.4	0.464	59.8	ppm	12	< 2	2.1	0.402
Pt	80.5	ppb	10	< 5	3.3	0.240	98.8	ppb	10	< 5	2.5	0.066	90.2	ppb	10	< 5	2.7	0.140
Rb	0	ppm	262	33	120.0	0.164	0	ppm	279	46	128.8	0.150	0	ppm	297	51	133.4	0.155
S	0	%	0.123	0.025	0.061	0.129	0	%	0.112	0.028	0.056	0.119	0	%	0.093	0.025	0.045	0.152
Sb	80.5	ppm	11	< 5	3.1	0.191	87.8	ppm	10	< 5	2.8	0.139	96.3	ppm	9	< 5	2.6	0.102
Sn	96.3	ppm	11	< 1	0.6	0.224	96.3	ppm	7	< 1	0.5	0.184	100.0	ppm	< 1	< 1	—	—
Sr	0	ppm	134	7	31.7	0.258	0	ppm	131	7	29.7	0.267	0	ppm	129	1	26.2	0.320
U	0	ppm	4.2	1.8	2.49	0.071	0	ppm	4.4	1.8	2.68	0.075	0	ppm	4.4	2.0	2.74	0.069
W	85.4	ppm	75	< 10	6.2	0.243	82.9	ppm	61	< 10	6.5	0.268	84.1	ppm	55	< 10	6.4	0.257
Zn	0	ppm	89	19	52.3	0.135	0	ppm	95	20	51.4	0.138	0	ppm	81	17	46.7	0.145

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

Table II-2-8 Coorelation matrix of elements for soil in the Nungkok deposit area

Nungkok Soil (A)

	As	Au	Co	Cr	Cu	Fe	K	Mn	Mo	Na	Ni	Pb	Pt	Rb	S	Sb	Sn	Sr	U	W	Zn
As	1.000																				
Au	.592	1.000																			
Co	-.214	.037	1.000																		
Cr	-.180	-.030	.336	1.000																	
Cu	.394	.629	.134	.243	1.000																
Fe	.122	.135	.277	.354	.208	1.000															
K	-.066	.122	.574	.017	.080	.398	1.000														
Mn	-.318	-.132	.716	.039	-.231	-.024	.451	1.000													
Mo	.567	.516	-.101	.056	.712	-.016	-.126	-.268	1.000												
Na	-.056	.269	.559	.272	.462	.407	.665	.276	.178	1.000											
Ni	-.190	-.034	.465	.960	.265	.438	.185	.135	.033	.356	1.000										
Pb	-.185	-.465	.112	.319	-.244	-.063	-.021	.294	-.088	-.103	.303	1.000									
Pt	-.076	.030	.064	-.190	-.232	-.089	-.043	.137	-.185	-.071	-.186	-.059	1.000								
Rb	-.239	-.257	.447	-.020	-.515	.294	.728	.552	-.553	.154	.077	.167	.124	1.000							
S	.214	.299	.112	.149	.362	.185	-.054	-.003	.290	.311	.143	-.090	-.151	-.244	1.000						
Sb	-.090	-.061	.268	.217	.059	.305	.130	.227	-.050	.399	.259	.141	-.074	.057	.435	1.000					
Sn	.051	.045	-.194	-.130	-.140	.046	.050	-.094	-.097	-.109	-.179	.018	-.093	.097	.074	-.005	1.000				
Sr	-.091	.053	.564	.154	.299	.139	.560	.543	.120	.758	.263	.080	-.136	.209	.348	.450	-.065	1.000			
U	-.032	.069	.127	.181	.091	.581	.262	-.011	-.131	.264	.227	-.052	-.019	.186	.034	.237	.067	.074	1.000		
W	.592	.430	-.205	.103	.598	.050	-.241	-.355	.854	.074	.048	-.061	-.100	-.598	-.211	-.101	-.073	-.033	-.097	1.000	
Zn	-.411	-.199	.536	.241	-.165	.260	.625	.609	-.294	.455	.332	.251	-.029	.622	.027	.176	.002	.477	.113	-.312	1.000

Nungkok Soil (B)

	As	Au	Co	Cr	Cu	Fe	K	Mn	Mo	Na	Ni	Pb	Pt	Rb	S	Sb	Sn	Sr	U	W	Zn
As	1.000																				
Au	.793	1.000																			
Co	-.231	-.008	1.000																		
Cr	.005	.113	.359	1.000																	
Cu	.544	.734	.083	.236	1.000																
Fe	.112	.239	.324	.318	.108	1.000															
K	.030	.098	.576	.117	.160	.481	1.000														
Mn	-.473	-.362	.735	.115	-.272	.021	.339	1.000													
Mo	.600	.557	-.129	.096	.743	-.060	-.063	-.307	1.000												
Na	.027	.302	.532	.355	.531	.354	.579	.217	.186	1.000											
Ni	-.141	.018	.520	.878	.109	.502	.228	.262	-.030	.442	1.000										
Pb	-.363	-.423	.207	.086	-.467	.074	.087	.443	-.258	-.052	.270	1.000									
Pt	-.116	-.024	.030	-.159	-.127	-.130	-.164	.045	-.070	-.089	-.114	.084	1.000								
Rb	-.209	-.267	.457	.028	-.470	.472	.707	.472	-.502	.040	.189	.315	-.150	1.000							
S	.143	.381	.152	.359	.489	.057	-.026	.081	.242	.369	.214	-.213	-.170	-.272	1.000						
Sb	.019	.155	.135	.223	.232	.224	.127	.069	.149	.436	.287	.074	-.040	-.051	.262	1.000					
Sn	-.025	.078	.092	.009	-.036	.242	.035	.034	-.119	.033	.045	-.044	-.021	.082	.037	.088	1.000				
Sr	-.169	.095	.547	.216	.410	.132	.436	.451	.192	.788	.300	.048	-.039	.015	.302	.456	.036	1.000			
U	.042	.146	.193	.155	.056	.655	.337	.021	-.129	.244	.289	.006	.028	.365	-.014	.098	.170	.131	1.000		
W	.583	.507	-.207	.103	.680	-.085	-.121	-.394	.835	.156	-.044	-.296	-.047	-.542	.218	.105	-.080	.118	-.112	1.000	
Zn	-.454	-.374	.512	.189	-.244	.196	.454	.672	-.288	.345	.336	.511	-.039	.491	-.006	.087	-.042	.417	.172	-.321	1.000

Nungkok Soil (C)

	As	Au	Co	Cr	Cu	Fe	K	Mn	Mo	Na	Ni	Pb	Pt	Rb	S	Sb	Sr	U	W	Zn
As	1.000																			
Au	.692	1.000																		
Co	-.153	.004	1.000																	
Cr	-.293	-.141	.444	1.000																
Cu	.510	.748	.043	-.069	1.000															
Fe	.125	.273	.409	.576	.184	1.000														
K	.029	.166	.597	.267	.213	.531	1.000													
Mn	-.320	-.345	.741	.223	-.316	.040	.344	1.000												
Mo	.641	.533	-.122	-.197	.738	.010	-.011	-.305	1.000											
Na	-.009	.327	.493	.423	.526	.389	.588	.172	.226	1.000										
Ni	-.255	-.057	.590	.921	-.023	.660	.401	.334	-.190	.503	1.000									
Pb	-.216	-.413	.311	.187	-.301	-.103	-.014	.438	-.101	-.058	.199	1.000								
Pt	-.021	.014	.067	.114	-.144	.086	.137	.028	-.130	.108	.138	-.101	1.000							
Rb	-.155	-.200	.517	.283	-.378	.504	.751	.467	-.424	.094	.394	.128	.192	1.000						
S	.332	.456	.153	-.135	.625	-.042	.007	.062	.473	.293	-.118	-.052	-.191	-.305	1.000					
Sb	-.044	.052	.071	.138	.134	.147	.154	-.025	.067	.276	.162	-.061	-.050	.005	.072	1.000				
Sr	-.048	.175	.482	.269	.419	.203	.430	.394	.223	.729	.352	.056	.028	.050	.299	.254	1.000			
U	-.011	.144	.233	.443	.057	.617	.348	-.029	-.102	.212	.489	-.068	.068	.386	-.132	.112	.070	1.000		
W	.593	.488	-.202	-.128	.654	.012	-.101	-.365	.877	.127	-.159	-.125	-.106	-.480	.399	.092	.136	-.010	1.000	
Zn	-.313	-.313	.660	.381	-.232	.176	.530	.752	-.261	.321	.443	.351	-.027	.557	-.086	-.066	.396	.028	-.318	1.000

Table II-2-9 Threshold values obtained by each analytical method for soil geochemical survey in the Nungkok 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	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
As	ppm	6.0	30.0	47.5	6	125	2.5	106.5	9.0	36.0	55.0	9	120	2.5	135.7	10.0	37.0	52.5	10	98	4.0	139.9
Au	ppb	4.0	34.0	52.0	6	78	5.5	133.8	4.0	34.0	52.0	6	72	6.5	145.5	4.0	30.0	62.0	6	83	5.5	136.7
Co	ppm	10.0	16.0	24.5	9	30	2.5	45.7	11.0	18.0	28.5	11	30	2.5	44.7	10.0	17.0	24.5	10	17	19.5	55.4
Cr	ppm	201.5	388.0	602.0	200	345	27.0	775.6	86.0	274.0	459.0	150	480	2.5	556.9	68.5	105.0	133.0	71	165	13.0	249.6
Cu	ppm	54.5	513.0	581.5	58	250	27.0	1758.1	52.0	681.0	574.0	58	320	25.0	2348.1	41.0	650.0	611.5	48	305	25.0	2316.4
Fe	%	3.44	4.15	5.72	3.4	5.5	2.5	5.38	3.73	4.32	5.88	3.8	5.8	2.5	5.80	3.52	4.54	5.51	3.7	5.7	2.5	5.66
Hg	ppm	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
K	%	0.84	1.17	1.62	0.86	1.50	8.0	1.99	0.95	1.34	2.05	1.0	1.7	10.0	2.12	0.95	1.35	2.06	1.0	1.5	15.0	2.24
Mn	ppm	598.0	1062.0	2080.5	590	1900	2.5	3270.7	603.5	1021.0	2068.0	610	1500	2.5	2835.8	583.0	1016.0	1995.5	585	1150	9.0	3136.8
Mo	ppm	1.0	2.0	1.0	< 1	11	4.0	7.3	1.0	3.0	3.5	< 1	8	10.0	11.3	1.0	3.0	1.0	1	12	5.0	9.3
Na	%	0.12	0.25	0.43	0.13	0.57	2.5	0.52	0.10	0.27	0.47	0.10	0.62	2.5	0.58	0.11	0.28	0.43	0.12	0.55	2.5	0.57
Ni	ppm	73.0	138.0	243.5	79	240	6.5	278.2	43.0	99.0	162.0	43	210	5.5	211.6	28.5	42.0	64.5	31	102	10.5	142.2
Pb	ppm	9.0	16.0	33.0	9	24	7.0	58.9	6.5	13.0	25.5	7	26	3.0	45.7	2.0	6.0	9.5	1	12	2.5	13.1
Pt	ppb	5.0	5.0	5.0	—	—	—	9.9	5.0	5.0	5.0	—	—	—	3.5	5.0	5.0	5.0	—	—	—	5.2
Rb	ppm	120.5	165.0	241.5	118	240	2.5	255.0	133.5	175.0	253.0	130	250	2.5	257.1	133.5	182.0	254.5	135	270	2.5	272.9
S	%	0.060	0.079	0.109	0.06	0.11	2.5	0.111	0.053	0.069	0.095	0.06	0.10	2.5	0.097	0.045	0.063	0.102	0.04	0.09	2.5	0.090
Sb	ppm	5.0	5.0	5.0	1	10	2.5	7.4	5.0	5.0	5.0	1	9	2.5	5.3	5.0	5.0	5.0	2	9	2.5	4.2
Sn	ppm	1.0	1.0	1.0	< 1	10	2.5	1.5	1.0	1.0	1.0	< 1	6	2.5	1.3	—	—	84.5	—	—	—	—
Sr	ppm	31.5	51.0	83.0	32	97	2.5	103.8	29.0	52.0	82.5	30	103	2.5	101.2	28.0	49.0	84.5	28	79	2.5	114.4
U	ppm	2.40	2.80	3.7	2.6	3.7	2.5	3.5	2.60	3.00	3.40	2.7	4.1	2.5	3.80	2.80	3.00	3.90	2.8	3.1	16.0	3.76
W	ppm	10.0	10.0	10.0	2	38	2.5	18.9	10.0	10.0	10.0	3	58	2.5	22.3	10.0	10.0	10.0	3	35	3.5	20.9
Zn	ppm	52.5	70.0	100.5	54	83	2.5	97.2	53.0	68.0	97.0	51	81	5.0	97.0	48.0	63.0	88.0	48	75	2.5	91.2

*1: Background *2: Threshold

sample A are more random than those of samples B and C. This means that to statistically treat the analytical values and to determine the threshold values, the elements of the sample B and C are more valid than those of the sample A.

Elementary distribution maps were drawn in three categories, threshold value and more than that, Median to threshold value and less than Median. Threshold values are Upper Fence or Upper Whisker determined by the EDA method. Median is also determined by the EDA method. The elemental concentration of the sample B were utilized to draw the maps. The distribution maps are presented in Appendix 12. The characteristics of the distribution of the elemental concentration are described below;

As : Anomalous and higher concentrated values are distributed around the Nungkok deposit, being closely related to the deposit.

Au : Anomalous values are distributed around the silicified zone surrounding the Nungkok deposit, being presumed to be closely related to the deposit as well.

Co : Anomalous points are mainly distributed in the south of the area. Relatively higher values are distributed around the Nungkok deposit as well.

Cr : Concentrated values are distributed as those of Co. Anomalous values are in the northwestern part of the area.

Cu : Anomalous points are concentrated around the Nungkok deposit, being closely related to the deposit. The distribution of the anomalous points expand to 1.0 km outside of the siliceous zone surrounding the Nungkok deposit.

Fe : Higher values are characteristic of the survey area, not having distinct distribution trend.

K : Anomalous and higher concentrated values were detected in the southern part of the survey area and around the Nungkok deposit. Higher concentrations in the deposit area and in the southern part of the area suggest the enrichment by the mineralization and the relation to the geology of that area respectively.

Mn : Higher concentrated values are distributed from the west to the south of the area. The deposit area is characteristic of lower than Median values.

Mo : Anomalous points are centered around the Nungkok deposit, being closely related to the deposit. The anomalous points are distributed to 1.0 km outside of the silicified zone surrounding the Nungkok deposit.

Na : Anomalous and higher concentrated values are distributed around the Nungkok deposit and in the southeast part of the area. These distribution suggest they are related to the mineralization.

Ni : Anomalous points can be seen in the south of the area. The Nungkok deposit and the surrounding area are characterized of lower concentration.

Pb : The deposit area is characterized of lower concentration. Higher concentration do not have a general trend to be distributed.

Rb : Anomalous points and points with higher analytical values are mainly distributed in the southeast part, having a possible trend to be related to the geology of the area.

S : Anomalous points are distributed around the Nungkok deposit, being related to the deposit.

Sr : Anomalous and higher values are distributed on the Nungkok deposit and in the south of the area. Around the deposit is characterized of lower concentration.

U : Anomalous points are mainly distributed in the southeast part of the area, not being related to the deposit.

Zn : The survey area is wholly characterized of higher values. However, the area surrounding the deposit is characterized of more or less lower values like Sr.

From the above mentioned, at least As, Au, Cu, Mo and S are successfully utilized for pathfinder elements. Co, K, Na, Sr and Zn are possibly available for pathfinder elements. Mn, Ni and Pb, which have a negative relationship with the mineralization, are possibly effective for the pathfinders.

(3) Multi element analysis

Cluster and factor analytical methods were applied for the multi elements analyses in the same way for the stream sediment analysis. The results of the cluster analysis and factor analysis are presented in Fig. II-2-7 and Table II-2-10 respectively. The elemental clusters of As-Au-Cu-Mo-W and As-Au-Cu-Mo-S-W were found on the sample series B and C respectively as a result of the cluster analysis. The clusters of elements are thought to be related to the mineralization. Same clusters of elements were found in case of the cluster analysis on the stream sediment samples as well. This analysis suggests that As, Au, Cu, Mo, S and W are available for pathfinder elements. Groups of elements, Co-Mn-Zn and Cr-Ni, are also found as other clusters from all sample series, elements in the cluster being also thought to be closely related to each other.

The samples in sample series B are in general have higher communality than those of samples in series B and C as shown in Table II-2-10, having furthermore higher relationship among their factors and elements. Results of the factor analysis suggests that samples of series B are most effective as the pathfinders. Groups of elements of sample series B listed below are related to the factors described on the left side.

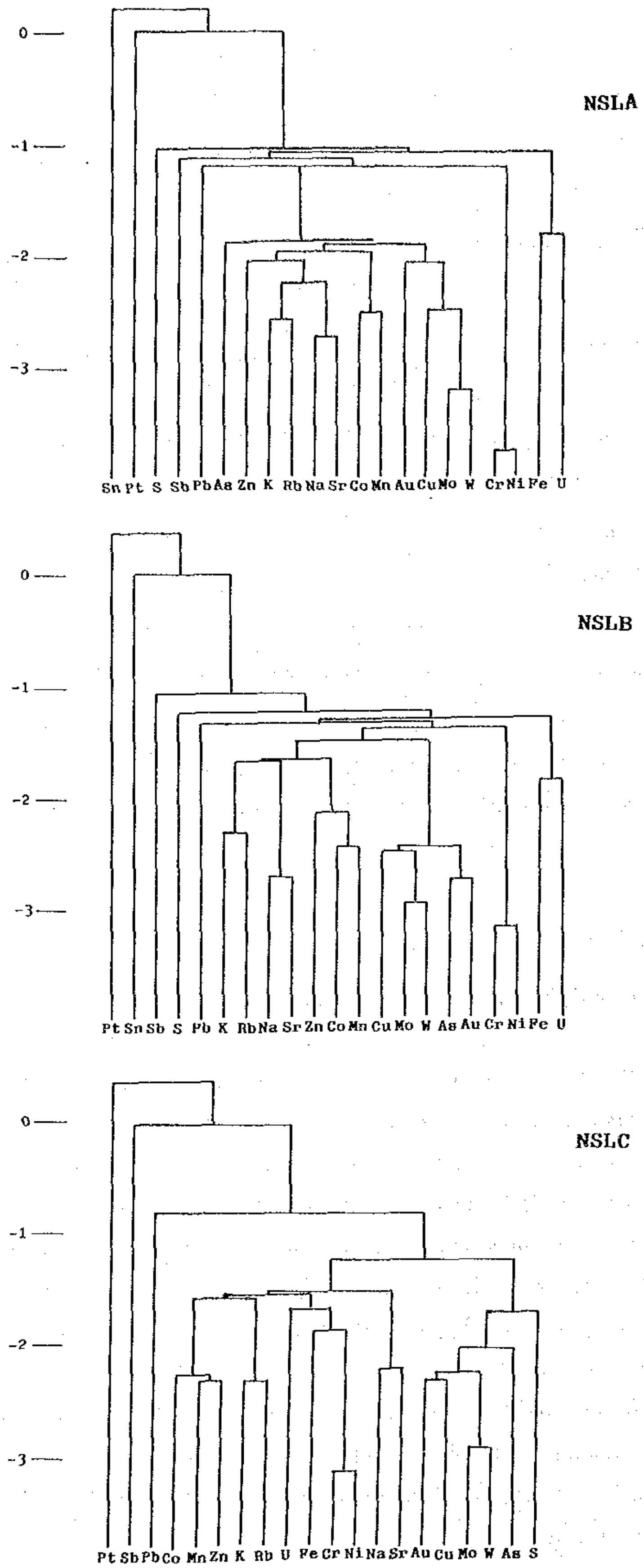


Fig. II-2-7 Dendrogram of elements for soil in the Nungkok deposit area

Table II-2-10 Results of factor analyses for soil in the Nungkok 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	0.156	0.697	0.243	-0.137	0.5934	0.794	-0.210	0.159	0.063	0.7869	0.188	0.678	-0.129	0.068	0.6949
Au	-0.047	0.633	0.037	-0.155	0.6420	0.742	0.054	0.268	-0.017	0.8182	0.284	0.486	-0.142	-0.080	0.7944
Co	-0.757	-0.076	-0.342	-0.014	0.7183	-0.070	0.224	0.175	-0.249	0.7850	-0.735	-0.071	-0.220	-0.319	0.7896
Cr	-0.058	0.042	-0.888	-0.242	0.9405	0.072	0.146	0.072	-0.904	0.8910	-0.223	-0.141	0.046	-0.865	0.9078
Cu	-0.020	0.706	-0.296	-0.039	0.7806	0.730	0.414	-0.014	-0.092	0.8506	0.169	0.593	0.071	-0.030	0.8524
Fe	-0.201	0.107	-0.189	-0.731	0.6429	0.065	0.109	0.765	-0.250	0.7206	-0.043	0.111	-0.446	-0.685	0.7195
K	-0.815	0.013	0.043	-0.360	0.8041	0.061	0.216	0.392	0.095	0.8029	-0.377	0.076	-0.712	-0.190	0.8291
Mn	-0.758	-0.267	-0.024	0.205	0.7106	-0.339	0.136	-0.081	-0.101	0.8061	-0.861	-0.246	-0.067	-0.007	0.8089
Mo	0.094	0.895	-0.075	0.171	0.8672	0.862	0.199	-0.206	-0.047	0.8432	0.091	0.894	0.165	0.094	0.9006
Na	-0.617	0.201	-0.213	-0.210	0.7772	0.191	0.730	0.194	-0.163	0.8218	-0.205	0.119	-0.154	-0.272	0.7946
Ni	-0.193	0.026	-0.885	-0.276	0.9676	-0.038	0.218	0.259	-0.856	0.9106	-0.318	-0.129	-0.081	-0.855	0.9341
Pb	-0.118	-0.152	-0.185	0.105	0.4998	-0.300	-0.022	-0.007	-0.182	0.5073	-0.533	-0.030	0.215	-0.070	0.4263
Pt	-0.056	-0.163	0.089	0.099	0.1233	-0.043	-0.022	0.008	0.114	0.1708	0.064	-0.113	-0.229	-0.080	0.0808
Rb	-0.655	-0.417	0.161	-0.335	0.8446	-0.354	-0.207	0.457	0.053	0.8351	-0.416	-0.227	-0.741	-0.245	0.8549
S	-0.012	0.255	-0.023	-0.062	0.4433	0.207	0.321	-0.093	-0.295	0.4539	-0.148	0.349	0.292	0.110	0.6106
Sb	-0.173	-0.111	-0.073	-0.181	0.4875	0.069	0.539	0.146	-0.168	0.3471	0.078	0.030	-0.039	-0.106	0.1567
Sn	0.073	-0.027	0.290	-0.209	0.1554	-0.082	0.033	0.305	-0.001	0.1466	–	–	–	–	–
Sr	-0.683	0.096	-0.071	0.071	0.7966	0.088	0.791	-0.004	-0.044	0.8342	-0.381	0.121	-0.026	-0.070	0.7270
U	-0.061	-0.078	-0.079	-0.668	0.4892	0.000	0.116	0.757	-0.074	0.5997	0.087	0.016	-0.363	-0.616	0.5210
W	0.222	0.864	-0.101	0.090	0.8239	0.824	0.181	-0.195	-0.058	0.8075	0.185	0.883	0.207	-0.002	0.8751
Zn	-0.705	-0.248	-0.133	-0.131	0.6388	-0.316	0.248	0.045	-0.137	0.6653	-0.789	-0.170	-0.224	-0.106	0.7520
F.C.*1	27.7 %	25.0 %	15.4 %	12.0 %	–	25.6 %	15.0 %	13.7 %	7.5 %	–	21.9 %	21.3 %	13.0 %	19.0 %	–

*1: factor contribution

Factor 1 : As-Au-Cu-Mo-W

Factor 2 : Na-Sb-Sr

Factor 3 : Fe-Rb-U

Factor 4 : Cr-Ni

The factor 4 has a negative relationship with the related elements on the right side. Elements related to the factor 1 include elements characterized by the mineralization of the Nungkok deposit. Therefore, the fact described above suggest that factor 1 is related to the mineralization of this area.

The points with higher factor scores to the factor 1 are plotted on Fig. II-2-8. The points with higher factor scores are distributed along the Kurahaput and Tunghabil Rivers, suggesting the definit relationship with the mineralization. The result of this factor analysis suggest that this method is practical for the soil geochemical survey. Furthermore, this analytical result revealed that elements related to the factor 1 are all effective pathfinders.

(4) Relations between stream sediments and soil

Soil samples, location numbers 1 to 63, 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 : 0.662,	Au : 0.327,	Co : 0.330,	Cr : 0.157,	Cu : 0.769
Fe : 0.548,	Mn : 0.338,	Mo : 0.635	Ni : 0.549,	Pb : 0.252,
Pt : −0.041,	S : 0.386,	Sb : 0.307,	Sn : −0.031,	U : 0.442,
W : 0.569,	Zn : 0.528			

This result suggests that As, Cu and Mo are highly correlated between two sample types, being directly related with the deposit.

(5) Summary of analyses

The distribution of the anomalous values of all elements detected by EDA method are shown in Fig. II-2-9. The anomalous points of As, Au, Cu and Mo are centered around the Nungkok deposit, being closely related to the deposit. These anomalous points are extensively distributed down to 1.5 km west of the deposit.

2-2-5 Pan concentrate geochemical survey

(1) Pathfinder elements

Pan concentrates collected in this area were analysed for 33 elements. The data of the statistical treatments for the analytical values, Appendix 8, are shown in Table II-2-11.

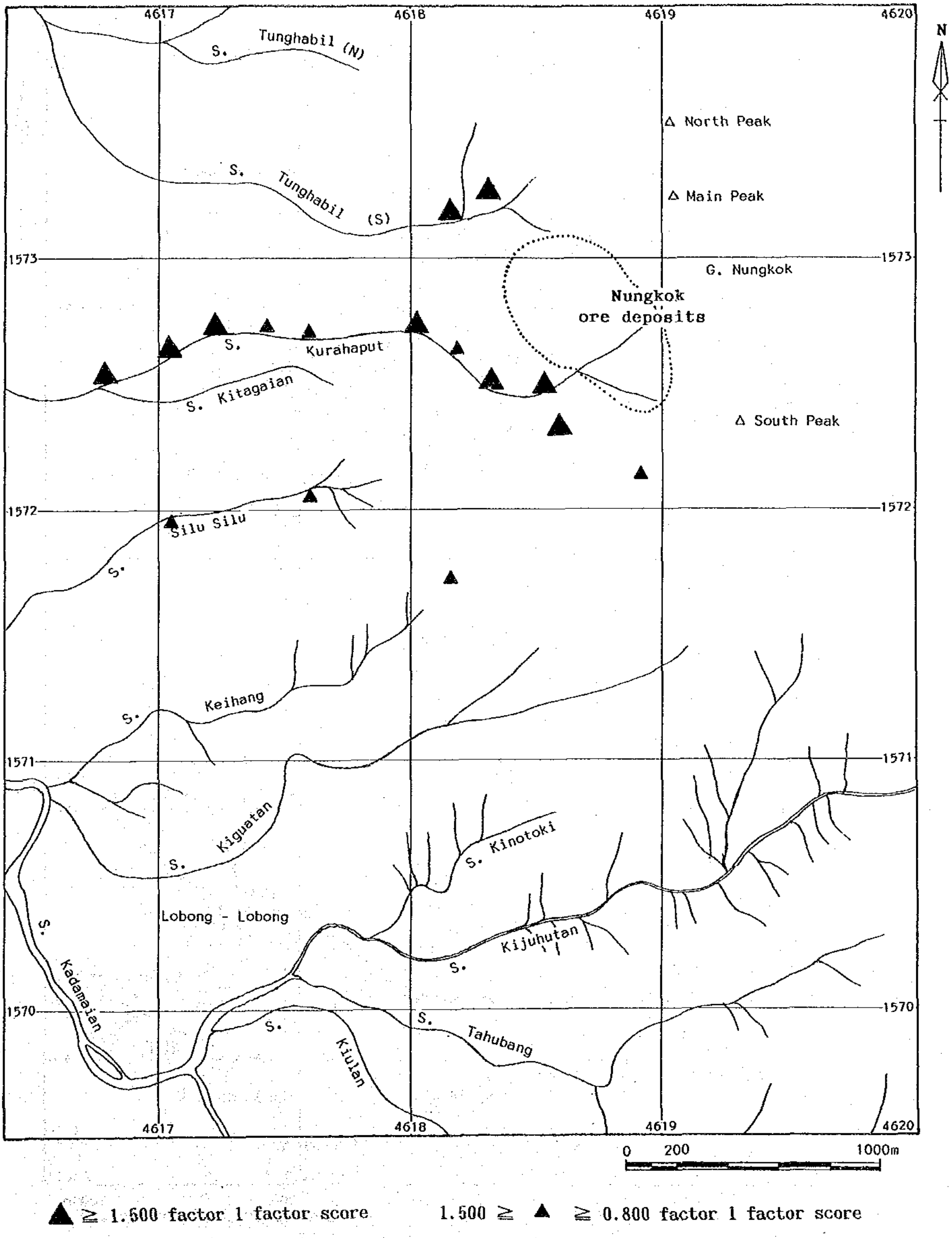


Fig. II-2-8 Distribution map of factor 1 factor score for soil in the Nungkok deposit area

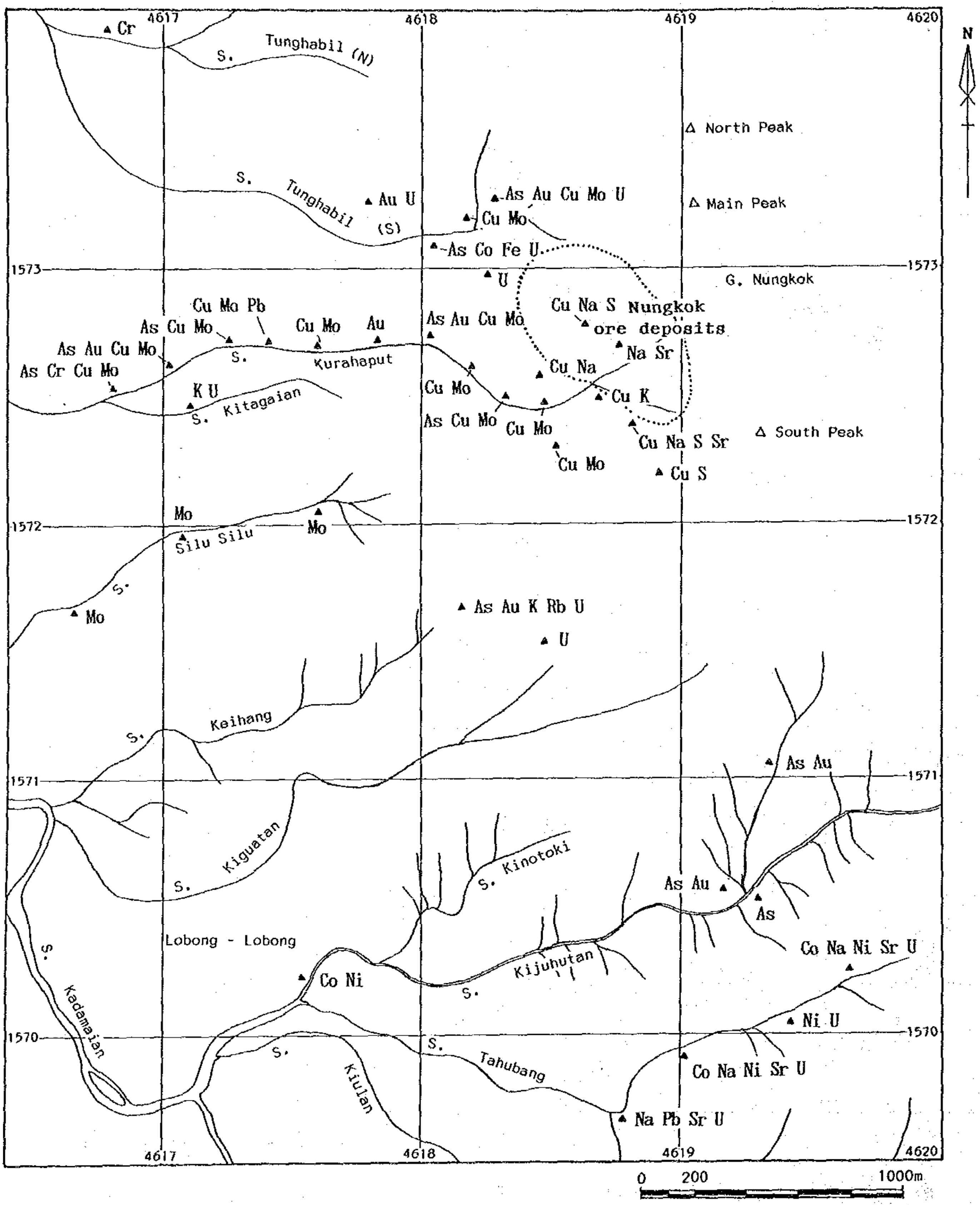


Fig. II-2-9 Interpretation map of soil geochemical survey in the Nungkok deposit area

Table II-2-11 Statistics and thresholds of pan concentrate geochemical survey in the Nungkok 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)	88	1.0	< 0.5	0.28	0.135	0.50	0.50
As (ppm)	0	170	1	13.0	0.652	18.0	104.0
Au (ppb)	19	1000	< 2	17.4	0.941	20.0	297.0
Ba (ppm)	0	610	20	109.7	0.330	110.0	360.0
Ce (ppm)	0	800	24	87.5	0.381	76.0	204.0
Co (ppm)	0	95	1	7.0	0.583	5.0	20.5
Cr (ppm)	0 (13 %[*4])	> 10000	127	480.0	0.731	196.0	1498.5
Cu (ppm)	0	1900	1	66.1	0.950	57.5	1054.0
Fe (%)	0	20.10	0.46	2.65	0.500	1.98	13.22
Ga (ppm)	0	12	1	3.9	0.327	4.0	9.0[*5]
Ge (ppm)	100	< 5	< 5	—	—	—	—
Hg (ppb)	0	820	20	51.1	0.365	40.0	105.0
La (ppm)	0	416	15	43.3	0.371	35.0	99.0
Mn (ppm)	0	2950	45	225.2	0.573	140.0	1692.5
Mo (ppm)	41	19	< 1	1.6	0.551	1.0	11.0
Ni (ppm)	0	1070	3	21.6	0.871	7.5	112.5
Pb (ppm)	0	206	2	9.9	0.479	9.0	34.0
Pt (ppb)	72	60	< 5	4.9	0.511	5.0	30.0[*5]
Re (ppm)	69	4	< 1	0.8	0.303	1.0	3.5
S (%)	0	0.398	0.016	0.048	0.419	0.039	0.178
Sb (ppm)	13	1.8	< 0.2	0.50	0.400	0.60	1.20[*5]
Se (ppm)	75	4.2	< 0.2	0.19	0.521	0.20	0.80[*5]
Sn (ppm)	0	3	2	2.1	0.052	2.0	2.0
Ta (ppm)	88	8.0	< 2.0	1.23	0.247	2.00	2.00
Te (ppm)	0	1.70	0.10	0.21	0.339	0.25	0.48
Th (ppm)	0	146.0	2.0	8.2	0.450	6.0	24.0
Ti (%)	0	1.56	0.08	0.21	0.354	0.16	0.52
U (ppm)	0	16.2	0.6	1.99	0.356	1.60	3.70
V (ppm)	0	631	10	56.2	0.548	52.5	290.5
W (ppm)	6	525	< 2	19.6	0.794	16.5	156.5
Y (ppm)	0	49	5	11.3	0.284	9.5	32.0
Zn (ppm)	0	376	8	34.5	0.515	21.0	69.0
Zr (ppm)	0	3880	165	359.1	0.311	302.5	702.5

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

*4: above detection limit *5: Upper Wisker

Analytical values of Ag, Ge, Pt, Re and Ta are largely below their detection limits. Individual element except for Mn and Ni of pan concentrate in general have higher analytical values than those of stream sediments.

Correlation matrixes among analytical values are shown in Table II-2-12. This matrix shows that Co, Cr, La, Mn, Ni, Th and Y have higher correlations with each other. As, Cu, Mo, S, Se and W, supposed to be related with the mineralization, have higher correlation with each other as well.

(2) Single element analysis

Though there are some obstacles to statistically treat the analytical values such as minority of the samples and the random sampling method, EDA method was applied to reveal a general trend of elemental distribution and the their relationship with the deposit as well. The results of the analysis are shown in Table II-2-11. The distribution of elemental concentration detected by the method are shown in Fig. II-2-10. The figure shows that anomalous points of Au, Cu, Mo, S, Se and W are distributed near the Nungkok deposit, being related closely related to the deposit. The anomalous elements, supposed not to be related to the deposit, are mostly distributed in the south of the survey area, having the same trend of that of stream sediments.

(3) QME analysis

Majority of pan concentrate samples do not contain black sand. That was confirmed by recognition of large amount of quartz by QME analysis. The results of QME analysis are presented in Table II-2-13. In samples taken from the Tunghabil and Krahaput Rivers which are flowing down from the Nungkok deposit, pyrite, chalcopyrite, bornite and marcasite with major goethite were identified. Biotite was identified in the samples taken from the upper reaches of the Kurahaput River, being originated from granodiorite genetically related to the Nungkok deposit. The samples collected in the southeastern part of the area are characterized of chromite, suggesting the relationship with ultrabasic rocks distributed in the upper reaches of the area. This distribution pattern of chromite was detected by stream sediment geochemical survey as well. The samples collected in this area include amphiboles and olivines in relatively large amount.

2-2-6 Laboratorial studies

(1) Thin section observation

Ten samples were collected for thin section observation from sandstone of Crocked Formation, extensively distributed in this area, and granodiorite which intruded Crocked Formation and is closely related to the mineralization in this area. The observations were described in

Table II-2-12 Coorelation matrix of elements for pan concentrates in the Nungkok deposit area

	Ag	As	Au	Ba	Ce	Co	Cr	Cu
Ag	1.000							
As	.203	1.000						
Au	.185	.639	1.000					
Ba	.227	.465	.065	1.000				
Ce	.729	.371	.291	.495	1.000			
Co	.618	.493	.411	.528	.813	1.000		
Cr	.645	.169	.150	.343	.773	.902	1.000	
Cu	.263	.812	.472	.480	.385	.304	-.011	1.000
Fe	.606	.554	.462	.479	.837	.949	.848	.396
Ga	.451	.477	.374	.626	.738	.737	.649	.415
Hg	-.238	.037	.188	-.023	.161	-.001	-.025	.058
La	.770	.361	.299	.468	.977	.788	.746	.424
Mn	.626	.200	.206	.492	.793	.902	.903	.085
Mo	.405	.651	.432	.349	.607	.513	.295	.762
Ni	.650	.251	.173	.413	.772	.921	.987	.057
Pb	.715	.356	.228	.433	.632	.700	.631	.321
Pt	.597	.266	.081	.425	.666	.821	.882	.140
Re	.199	.198	-.057	.607	.369	.574	.587	-.038
S	.274	.803	.535	.526	.488	.525	.225	.804
Sb	.033	.881	.616	.449	.292	.509	.209	.617
Se	-.192	.569	.307	.152	.043	-.047	-.330	.679
Sn	-.114	-.017	.396	-.274	-.085	.068	.012	-.098
Ta	.674	-.122	.199	-.027	.655	.515	.629	-.039
Te	-.039	.506	.477	.127	.007	.159	-.040	.373
Th	.780	.281	.295	.483	.960	.817	.803	.305
Ti	.658	.136	.284	.330	.827	.848	.883	.016
U	.696	.170	.269	.316	.883	.741	.742	.195
V	.608	.410	.425	.505	.852	.894	.815	.319
W	.254	.736	.549	.191	.389	.301	.021	.838
Y	.642	.459	.270	.637	.901	.843	.768	.456
Zn	.655	.352	.326	.472	.786	.956	.939	.162
Zr	.036	-.033	.150	-.043	.387	.264	.255	-.103

	Fe	Ga	Hg	La	Mn	Mo	Ni	Pb	Pt	Re
Fe	1.000									
Ga	.784	1.000								
Hg	.150	.233	1.000							
La	.827	.706	.178	1.000						
Mn	.860	.682	.050	.789	1.000					
Mo	.645	.520	.069	.637	.345	1.000				
Ni	.867	.706	-.049	.749	.912	.336	1.000			
Pb	.673	.412	-.313	.679	.720	.441	.659	1.000		
Pt	.725	.565	-.273	.626	.736	.267	.883	.628	1.000	
Re	.454	.563	-.082	.340	.597	-.041	.647	.384	.548	1.000
S	.608	.554	.290	.515	.334	.733	.277	.292	.236	.157
Sb	.559	.440	.151	.242	.234	.439	.266	.315	.300	.218
Se	.110	.136	.285	.062	-.237	.691	-.285	-.140	-.314	-.271
Sn	.110	-.061	.114	-.029	.032	.106	-.019	.013	-.187	-.101
Ta	.584	.380	.045	.713	.646	.384	.583	.581	.378	.072
Te	.136	.016	-.165	.026	-.031	.221	-.034	.176	.058	-.010
Th	.838	.728	.100	.972	.853	.547	.805	.726	.673	.399
Ti	.853	.627	.162	.837	.914	.394	.865	.655	.655	.429
U	.795	.642	.236	.921	.820	.535	.732	.652	.495	.335
V	.949	.773	.225	.854	.889	.604	.824	.654	.659	.398
W	.421	.252	.092	.448	.096	.826	.067	.337	.013	-.151
Y	.872	.847	.204	.914	.833	.605	.805	.661	.685	.504
Zn	.925	.716	-.008	.776	.917	.416	.950	.716	.860	.560
Zr	.358	.155	.659	.420	.388	.171	.221	.096	-.080	.068

	S	Sb	Se	Sn	Ta	Te	Th	Ti	U	V	W	Y	Zn	Zr
S	1.000													
Sb	.669	1.000												
Se	.671	.417	1.000											
Sn	.025	.031	.098	1.000										
Ta	.013	-.178	-.201	.279	1.000									
Te	.420	.437	.234	.468	-.168	1.000								
Th	.411	.213	-.079	.003	.749	-.001	1.000							
Ti	.292	.158	-.212	.143	.803	-.067	.890	1.000						
U	.364	.118	-.030	.187	.840	-.046	.933	.907	1.000					
V	.580	.420	.066	.097	.656	.067	.832	.921	.848	1.000				
W	.685	.499	.695	.124	.199	.345	.312	.150	.328	.331	1.000			
Y	.575	.405	.076	-.096	.546	.009	.903	.795	.834	.885	.360	1.000		
Zn	.422	.393	-.186	.045	.578	.096	.834	.900	.752	.914	.152	.830	1.000	
Zr	.174	.044	.067	.299	.421	-.126	.404	.530	.606	.440	.153	.347	.257	1.000

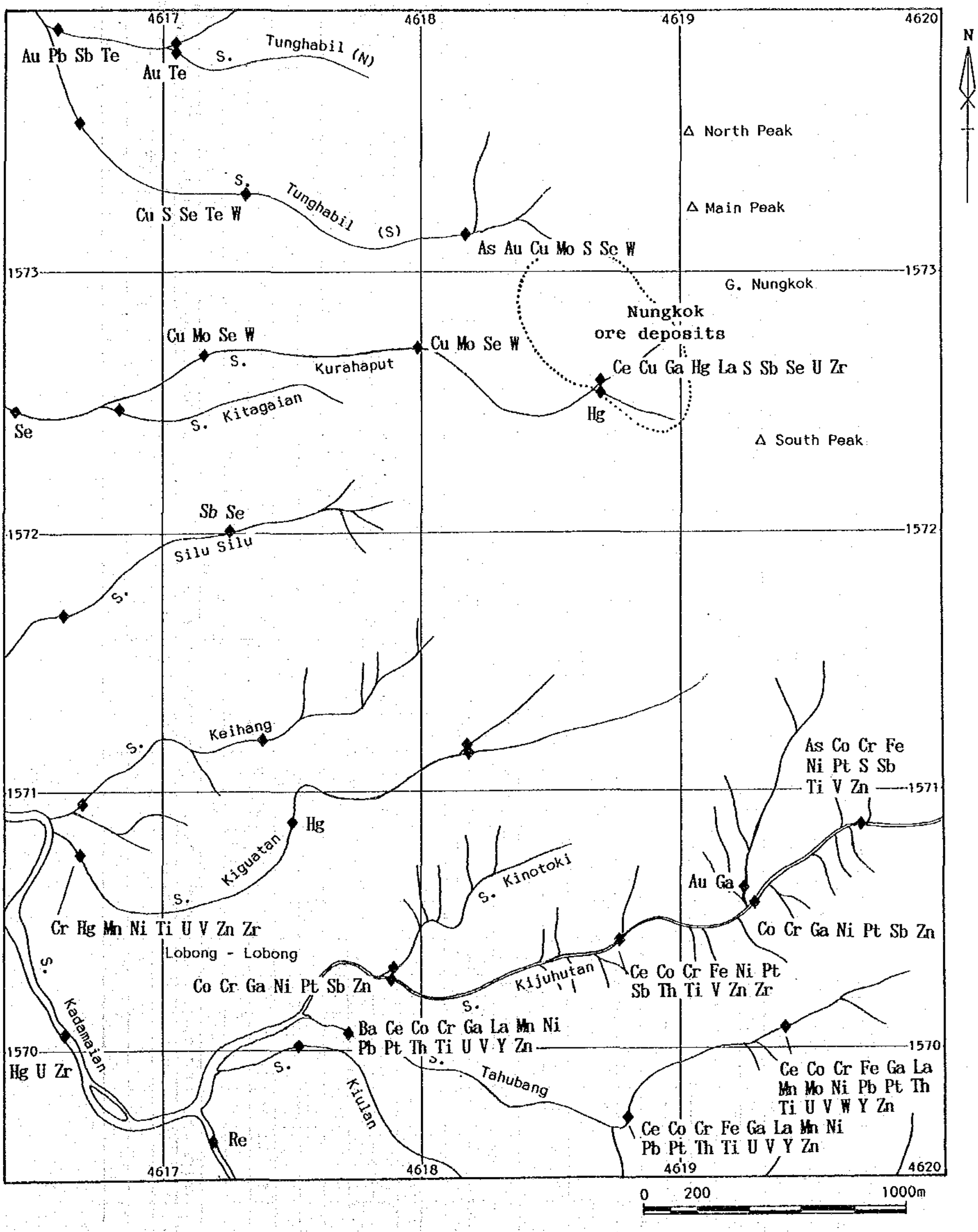


Fig. II-2-10 Interpretation map of pan concentrate survey in the Nungkok deposit area

Table II-2-13 Results of qualitative mineral examination of pan concentrates in the Nungkok deposit area

Mineral Names \ Sample Number	NPC 01	NPC 02	NPC 03	NPC 04	NPC 05	NPC 06	NPC 07	NPC 08	NPC 09	NPC 10	NPC 11	NPC 12	NPC 13	NPC 14	NPC 15	NPC 16
Magnetite	Tr	Tr	Tr	0.7	0.9	0.9	0.7	Tr	2.8	0.7	5.6	0.7	Tr	Tr	20.4	Tr
Native Gold																
Chromite																
Spinel				Tr	Tr			Tr					Tr			
Ilmenite															9.6	
Rutile						0.1	Tr	Tr	Tr	Tr	Tr			Tr	Tr	Tr
Brookite			Tr						Tr	Tr						
Titanite										Tr	Tr	Tr			Tr	
Leucoxene	Tr	0.1	0.1	Tr	Tr		0.1	0.2	Tr						Tr	0.1
Pyrite				Tr	Tr	Tr	Tr		Tr	Tr	0.3	Tr	Tr			Tr
Goethite	2.6	1.0	2.0	1.0	3.9	4.3	2.5	0.1	4.8	3.8	0.9	0.4	3.1	4.3	Tr	0.3
Hematite	Tr	Tr	Tr	Tr	Tr	Tr	Tr		Tr				Tr			Tr
Chalcopyrite					Tr	Tr	Tr		Tr	Tr	Tr	Tr	Tr			
Bornite							Tr		Tr				Tr			
Pyroxene	Tr														Tr	
Amphibole	Tr			0.1	0.2	0.2	0.1		0.3	0.7	4.8	2.2			Tr	
Clinozoisite	Tr		Tr	Tr	Tr	Tr	Tr		Tr	Tr				Tr	Tr	
Epidote																
Tourmaline	Tr	0.1	Tr			Tr	Tr	0.1					Tr			Tr
Garnet																
Zircon	Tr	0.1	Tr	Tr	Tr	Tr	Tr	0.1	Tr	Tr	Tr	Tr	Tr		0.2	Tr
Anatase			Tr			Tr			Tr	Tr						
Malachite											Tr					
Quartz	95.9	97.3	96.4	96.7	93.6	93.1	95.2	98.0	90.7	93.4	87.1	91.9	95.4	94.3	68.7	98.2
Plagioclase	1.5	1.5	1.5	1.5	1.4	1.4	1.4	1.5	1.4	1.4	1.3	4.8	1.5	1.4	1.1	1.5
Biotite							Tr			Tr	Tr	Tr				
Clastics																

Mineral Names \ Sample Number	NPC 17	NPC 18	NPC 19	NPC 20	NPC 21	NPC 22	NPC 23	NPC 24	NPC 25	NPC 26	NPC 27	NPC 28	NPC 29	NPC 30	NPC 31	NPC 32
Magnetite	Tr	Tr	Tr	0.2	1.6	Tr	0.4	21.9	Tr	9.0	34.5	1.7	Tr	29.7	28.3	40.4
Native Gold		Tr														
Chromite								Tr			1.0	Tr	Tr	0.7	2.8	3.0
Spinel		Tr	Tr	Tr	Tr	Tr	Tr	Tr		Tr						
Ilmenite								Tr	Tr		Tr					
Rutile					Tr		Tr									
Brookite		Tr	Tr	Tr	Tr											
Titanite																
Leucoxene	0.1	0.1	Tr	Tr			Tr		Tr							
Pyrite			Tr					Tr				Tr		Tr	Tr	Tr
Goethite	0.2	1.4	0.4	1.5	1.4	1.8	Tr	Tr	1.8	1.0	Tr	1.3	1.9	0.8	Tr	Tr
Hematite		Tr														
Chalcopyrite																Tr
Bornite																
Pyroxene			Tr													
Amphibole					2.8	Tr	2.1	28.5	Tr	2.0	8.4	5.5	Tr	11.8	27.0	26.3
Clinozoisite		0.1		Tr	Tr		Tr	Tr			0.9	2.7		1.2	0.9	0.9
Epidote		Tr	Tr													
Tourmaline	Tr	0.1	Tr	Tr	Tr		Tr		Tr		Tr	Tr	Tr			
Garnet									Tr	Tr	Tr			Tr	Tr	0.3
Zircon	Tr	Tr	Tr	Tr	2.4	Tr	Tr		Tr	Tr	Tr	Tr	Tr	Tr	Tr	Tr
Anatase		0.1		Tr	Tr								Tr	Tr		
Malachite															Tr	Tr
Quartz	96.7	96.3	97.6	96.3	90.0	74.0	95.5	39.0	96.2	31.0	21.4	28.0	93.2	55.0	36.9	27.6
Plagioclase	3.0	2.0	2.0	2.0	1.8	Tr	2.0	10.6	2.0	13.0	9.5	4.0	4.9	3.0	4.1	1.5
Biotite								Tr								
Clastics						24.2				51.0	18.7	49.1				

Table II-2-14.

The sandstone includes chlorite partly accompanied by kaolinite, quartz and silicite as secondary minerals. These minerals are supposed to be mainly formed by mineralization. The granodiorite includes phenocrysts of quartz, plagioclase, potash feldspar, biotite and amphibole.

(2) Polished section and polished thin section observation

Samples for polished section and polished thin section observation were collected from the Nungkok deposit. The samples and observations are described in Table II-2-15.

Chalcopyrite, sphalerite, pyrrhotite, pyrite and magnetite were identified on the thin sections made from the sample taken from the Nungkok deposit. The majority of the pyrites identified are secondary ones changed from pyrrhotites. The polished thin section observations suggest that the Nungkok deposit was formed by the mineralization in the granodiorite and the sandstone. Sample, number G012, is a chlomite float picked up at the creek near the Nungkok deposit. In this sample abundant chlomite is observable. However, Cr was analysed low as can be seen in Appendix 3.

(3) X-ray diffraction analyses

Five samples were presented for the powder X-ray diffraction. The result of the test was shown in Table II-2-16.

Clay minerals such as chlorite, sericite and kaolinite were identified. Their diffraction patterns are not so strong that alteration of the samples is understood to be rather slight. Amphiboles were identified in samples N004 and N005 by thin section observation, but not by X-ray diffraction because the samples are not abundant in amphiboles. Other rock forming minerals than amphibole were identified by both thin section observation and X-ray diffraction.

(4) EPMA analysis

Three samples out of the polished samples described above were presented for quantitative analyses by EPMA method. The analyses were executed at one point on individual samples. The results of the EPMA analyses are presented in Table II-2-17.

Two points on chalcopyrite and one point on magnetite were analysed. Magnetite was analysed on sample G012 instead of chromite, because no chrome was detected by qualitative analysis, though chrome was intended to be analysed. The analyses suggested that chalcopyrite has theoretical composition.

Table II-2-14 Observation results of thin sections collected in the Nungkok deposit area

Sample No.	Location	Descriptions	Texture	Grains and minerals							Matrix, groundmass & accessary					Secondary minerals										Remarks
				Quartz	Plagioclase	K-feldspar	Muscovite	Biotite	Hornblende	Opaque minerals	Silt	Allanite	Apatite	Zircon	Sphene	Prehnite	Calcite	Illite	Kaolinite	Opaque minerals	Chlorite	Montmorillonite	Quartz	Epidote	Sericite	
N002	West of G. Nungkok	Gray Sandstone. Pyrite diss.	Clastic	◎	○	○					◯					○				○	○					
N003	S. Tunghabil	Gray sandstone.	Clastic	◎	◯	◯	○	○			◯						○			•	•					
N004	S. Tunghabil	Porphyritic granodiorite with quartz stringer.	Porphyritic	◎	◎	◯		○	○	•		•	•	•	•											Float
N005	S. Tunghabil	Hornblende granodiorite	Porphyritic	◯	◎	◯		○	○	•		•	•	•	•											Float
T003	S. Tahubang	Gray massive sandstone, weakly silicified.	Clastic	◎	◯	○		•			◎						•	○	○		◯		◯			
G003	S. Kurahaput	Gray massive sandstone, weakly silicified.	Clastic	◎	◯						◯						◯	○			○	•				
G004	S. Kurahaput	Dark brownish gray hard mudstone.	Clastic															◎	◎	○						
G005	S. Kurahaput	Whitish gray sandstone with quartz.	Clastic	◎	◯			○			◎								◯		○		◎			
G007	S. Kurahaput	Light gray sandstone, silicified & mineralized.	Clastic	◎	◯						◎										○		◯	○	○	
G008	S. Kurahaput	Gray microgranodiorite with pyrite. Porphyritic.	Porphyritic	◎	◎	◯		◯		•																Float

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

Table II-2-15 Observation results of polished and polished thin sections collected in the Nungkok deposit area

	Sample No.	Location	Descriptions	Texture	Chalcopyrite	Covellite	Sphalerite	Pyrrhotite	Pyrite	Magnetite	Chromite	Gangue minerals	Quartz	Plageoclase	Biotite	Hornblende	Apatite	Leucoxene	Albite	Chlorite	Epidote	Serpentine	Carbonate minerals	Remarks
Polished section	T005	S. Tunghabil	Silicified rock with pyrite/ chlorite veinlet	Veinlet	•				◎			◎												Secondary py. Float
Polished section	G006	S. Kurahaput	Silicified rock with pyrite veinlt	Veinlet & disseminations	•		•	○	○			◎												Secondary py. Float
Polished section	G009	S. Kurahaput	Granodiorite with pyrite chalcopyrite disseminations	Veinlet & disseminations	○				○			◎												Secondary py.
Polished section	G011	S. Kurahaput	Granodiorite with pyrite-chalcopyrite stringer	Veinlet & disseminations	•			•	•	•		◎												
Polished section	G012	S. Kurahaput	Disseminated chromite	disseminations	•						◎	◎												Float
Polished thin s.	G008	S. Kurahaput	Micr-granodiorite with with pyrite disseminations	Holocryst.	○				•				◎	◯	◯		•	•	•	○			•	Secondary py. Float
Polished thin s.	G009	S. Kurahaput	Silicified sandstone with pyrite, chalcopyrite diss.	Clastic	•	•			•				◎			○				○	○			
Polished thin s.	G012	S. Kurahaput	Disseminated chromite	—							◎		◯			◎				•		•		Float

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

Table II-2-16 Results of X-ray diffraction analyses in the Nungkok deposit area

Sample No.	Location	Descriptions	Detected minerals										Remarks
			Quartz	Plagioclase	K-feldspar	Hornblende	Calcite	Biotite	Chlorite	Sericite	Kaolinite	Pyrite	
N003	S. Tunghabil	Gray massive sandstone	◎	◯			○		•	•			
N004	S. Tunghabil	Porphyritic granodiorite silicified	◎	◎	○			◯	•				Float
N005	S. Tunghabil	Granodiorite with pyrite disseminations	◎	◎	○			◯					Float
T005	S. Tunghabil	Silicified rock with pyrite/chlorite veinlet	◎	•	○	○			•			•	
G005	S. Kurahaput	Silicified & argillized rock with quartz string.	◎								•	•	

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

Table II-2-17 Results of EPMA in the orientation geochemical survey areas

Ser. No.	Sample No.	Descriptions	Cu %	Fe %	S %	Zn %	O %	Remarks
1	G006	Chalcopyrite	34.01	29.63	34.36	—	—	Ningkok deposit area
2	G009	Chalcopyrite	34.11	30.35	33.93	—	—	Nungkok deposit area
3	G012	Magnetite	—	71.73	—	—	29.06	Ningkok deposit area
4	N021	Chalcopyrite	33.56	30.05	34.36	—	—	Bidu Bidu Hill deposit area
5	N022	Sphalerite	5.54	10.26	32.34	52.12	1.02	Bidu Bidu Hill deposit area
6		Sphalerite	10.82	9.62	33.03	46.66	0.81	
7		Chalcopyrite	34.36	29.91	34.55	—	—	
8	N024	Chalcopyrite	34.40	29.65	34.30	—	—	Bidu Bidu Hill deposit area

2-3 Survey results of the Bidu Bidu Hill deposit area

2-3-1 Geology and ore deposits

This area is dominated by Chert-Spilite Formation and fine grained gabro and ultra-basic rock. Chert-Spilite Formation was deposited in Cretaceous through Eocene, the gabro and ultra-basic rock intruded into the formation. The low land in the north of the area is dominated by Quarternary sand and gravels. Geologic structures are rather complicated. Several faults and thrust faults can be recognized. This area is predominated by soil, thus outcrops are limited. Geologic map is shown in Fig. II-2-11.

Chert-Spilite Formation is mainly composed of basaltic pillow lavas locally intercalated with sandstone, massive lavas and pillow breccias. According to the drilling into the Bidu Bidu Hill deposit in the northern part of the area, red mudstone is intercalated in the formation. The basaltic pillow lavas is strongly chloritized, being green, and locally accompanying pyrite disseminations.

Fine grained gabro is distributed on a small scale from the center to the west of the area. The gabbro is dark green doleritic crystalline rock. It is thought to have supplyed pillow lavas in this area.

Ultra-basic rocks are distributed in the north and in the south of the area. Drilling into the Bidu Bidu Hill deposit confirmed the ultra-basic rock on a small scale as well. These ultra-basic rocks are all serpentinized. They are mostly originated from harzbergite. The relation between the ultra-basic rock and Chert-Spilite Formation is not defined yet. However, the formation is presumed to be in fault contact with the ultra-basic rock in the northern part, and in thrust contact with the ultra-basic rock in the eastern part of the area. Small ultra-basic bodies near the deposit and in the south of the area are supposed to be intrusive rocks. Their relation with Chert-Spilite Formation is not disclosed yet.

Chert-Spilite Formation is presumed to strike NW-SE due to the strike of sandstone and the shape of the ore deposit. Chert-Spilite Formation distributed in the center and the south of the area corresponds to the footwall of the Bidu Bidu Hill deposit due to the NE dip of the sandstone and the ore deposit. From the lithological distribution, faults trending NE, NW and N-S are infered in the area. The ultra-basic rock is presumed to have thrusted up on Chert-Spilite Formation from the distribution of the ultra-basic rocks and the surrounding topography.

In the Bidu Bidu Hill deposit, 3.6 million tons of ore with the grade of 3.6% Cu, 1 to 2 g/t Au and 8 to 15 g/t Ag were confirmed by the drilling, 171 holes and approximately 40,000 m in total. The ore is reported to be mainly composed of massive ore and be partly accompanied by stockwork ore. The profile of the ore deposit is composed of basalt lavas, altered basalt, mineralized zone, altered basalt, red mudstone and basalt lavas from the bottom to the top, and the mineralized zone is intercalated in the altered basalts. The massive ore is generally fine grained, having colloform and framboidal textures. Ore minerals are mainly composed of pyrite and chalcopyrite. They are

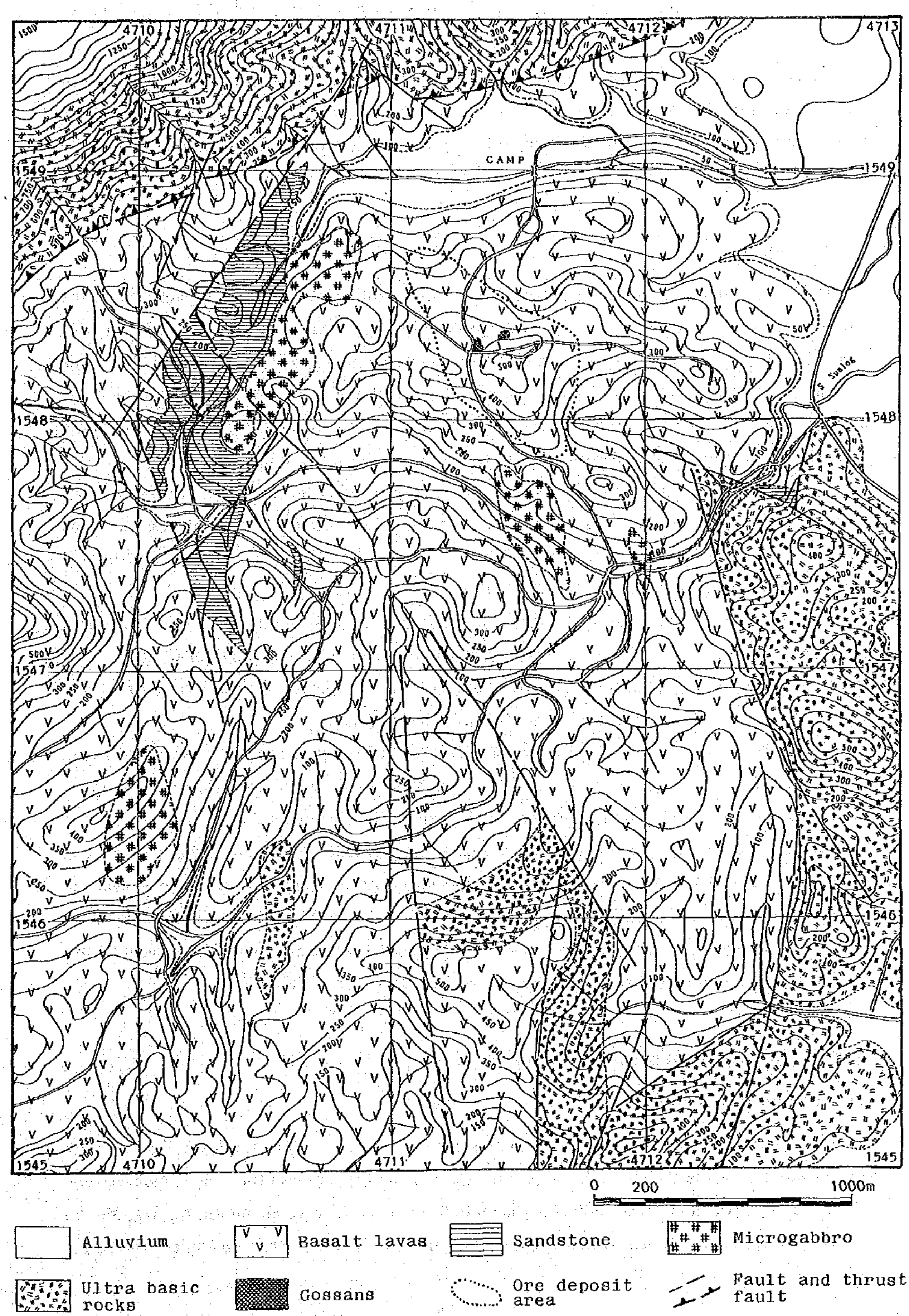


Fig. II-2-11 Geologic map of the Bidu Bidu Hill deposit area secondarily enriched by chalcocite and bornite near the surface. The deposit is thought to be a Cyprus type massive sulfide deposit due to the morphology, host rock, ore features and ore forming minerals. The outcrops of the deposit is completely gossanized, large amount of limonite and goethite are observed there.

2-3-2 Sampling

The area is flat and soil is well developed. Soil samples were uniformely sampled in the survey area except for the area of the Bidu Bidu Hill deposit where the sample density was slightly higher. This area is mostly composed of secondary jungle, and there are many dirt roads used for the log transportation. Stream sediment and soil samples are listed in Appendixes 4 and 5. Locations of the stream sediments and soils are shown in Fig. II-2-12. Soil samples with the sample location number 1 to 66 were taken near the stream sediment sample location.

The stream sediment sample locations were easily decided because the drainages were uniformely distributed. And the sampling were purposefully carried out. However, in some portions a large amount of soil flowed down into the drainages due to the existence of the dirt roads and the sample may include the dirt.

Soil is very well developed in this area. C horizon of the soil could scarcely be recognized during the sampling. At one location, three samples were taken at the points without influence of stream and landsliding as done in the Nungkok area. The samples with the location numbers after 67 were mostly taken from the area of Chert-Spilite Formation.

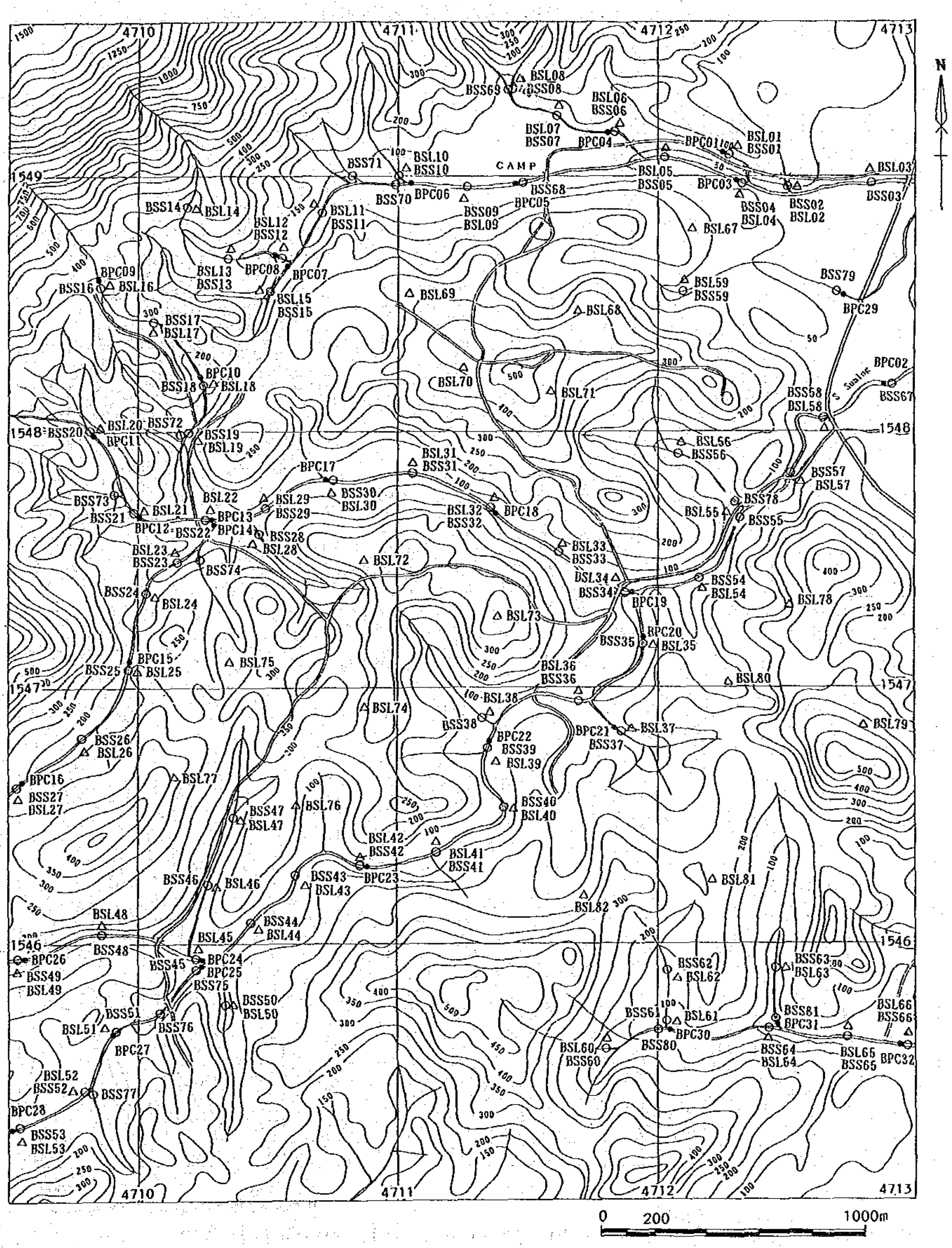
Pan concentrate samples were uniformely taken from the entire area. Stream sediment in this area are rich in heavy minerals, especially magnetite and chromite, and was easily sampled. Chemical analyses and QME analyses were carried out for these samples.

Samples for laboratorial studies were also taken in order to disclose the geology and mineralization. The studies include thin section observation, polished section observation, polished thin section observation, X-ray diffractometry and EPMA analysis. The samples were taken from the drilling cores of the Bidu Bidu Hill deposit due to the bad condition of the outcrops. The location of the samples for the laboratorial studies are shown in Fig. II-2-13.

2-3-3 Stream sediment geochemical survey

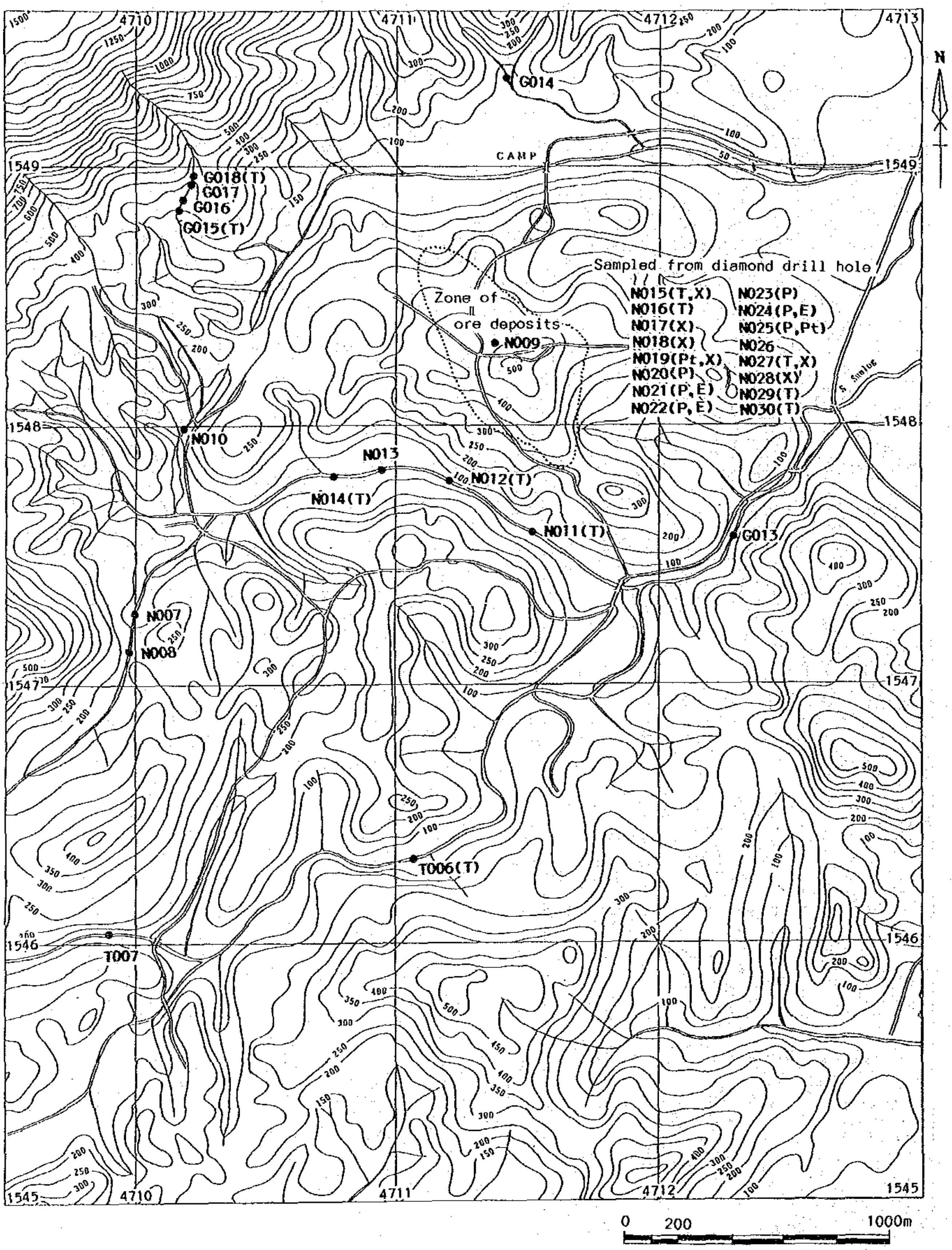
(1) Pathfinder elements

Series of the samples A, B and C were analysed for 19 elements. The samples A, B and C were taken from the bank of the river, the edge of the stream and the center of the stream respectively. The statistics of the analytical values is shown in Table II-2-18. Five elements, Ag, Hg, Mo, Sn and W, do not have analytical values because they are less than the detection limits. Cr did not



BSS; stream sediment sample BSL: soil sample BPC: pan concentrate sample

Fig. II-2-12 Location map of geochemical samples in the Bidu Bidu Hill deposit area



G023; sample number (T); thin section (P); polished section

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

Fig. II-2-13 Location map of samples for laboratorial studies in the Bidu Bidu Hill deposit area

Table II-2-18 Statistics of stream sediment geochemical survey in the Bidu Bidu Hill 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	100.0	ppm	< 5	< 5	-	0.000	98.8	ppm	5	< 5	-	0.033	93.8	ppm	24	< 5	2.7	0.180
Au	72.8	ppb	380	< 2	1.8	0.521	56.8	ppb	280	< 2	3.1	0.692	66.7	ppb	220	< 2	3.0	0.703
Co	0	ppm	568	34	122.7	0.217	0	ppm	313	39	122.3	0.188	0	ppm	333	34	116.0	0.187
Cr	86.4*3	ppm	>10000	715	-	0.257	87.7*3	ppm	>10000	948	-	0.236	86.4*3	ppm	>10000	615	-	0.259
Cu	0	ppm	294	12	48.9	0.306	0	ppm	376	20	53.5	0.293	0	ppm	401	13	57.4	0.324
Fe	0	%	15.85	6.08	11.614	0.088	0	%	16.19	7.10	11.757	0.081	0	%	16.26	7.46	11.690	0.079
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	>10000	1481	2952.8	0.153	0	ppm	>10000	1569	2901.7	0.155	0	ppm	8575	1388	2875.4	0.154
Mo	100.0	ppm	< 1	< 1	-	0.000	100.0	ppm	< 1	< 1	-	0.000	100.0	ppm	< 1	< 1	-	0.000
Ni	0	ppm	3339	86	682.5	0.347	0	ppm	2998	94	726.2	0.341	0	ppm	2729	77	640.1	0.350
Pb	79.0	ppm	428?	2	1.7	0.490	91.4	ppm	47	< 2	1.3	0.350	75.3	ppm	26	< 2	1.6	0.382
Pt	98.8	ppb	40	< 5	2.6	0.134	98.3	ppb	5	< 5	2.5	0.033	90.1	ppb	15	< 5	2.8	0.201
S	0	%	0.090	0.012	0.025	0.155	0	%	0.192	0.017	0.030	0.175	0	%	0.141	0.008	0.029	0.207
Sb	82.7	ppm	13	< 5	3.0	0.195	91.4	ppm	8	< 5	2.7	0.114	100.0	ppm	< 5	< 5	-	0.000
Sn	100.0	ppm	< 1	< 1	-	0.000	100.0	ppm	< 1	< 1	-	0.000	100.0	ppm	< 1	< 1	-	0.000
U	44.4	ppm	1.6	<0.2	0.20	0.339	44.4	ppm	1.6	<0.2	0.20	0.332	43.2	ppm	1.8	<0.2	0.20	0.321
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	844	82	364.2	0.267	0	ppm	888	79	376.5	0.255	0	ppm	841	80	346.5	0.243

*1: below detection limit *2: geometric mean *3: standard deviation *4: above detection limit detected in most of the samples due to more than the detection limit as well.

The concentration of the elements in the samples A, B and C are summalized as follows;

Elements with higher analytical mean values in sample A: Co, Mn, Pb, Sb
Elements with higher analytical mean values in sample B: Au, Fe, Ni, S, Zn
Elements with higher analytical mean values in sample C: Cu, Pt

Form the above, sample B have general tendency to have higher concentration of elements than other sample series as the Nungkok deposit area.

The correlation matrixes on each sample is shown in Table II-2-19. Each element is well correlated on sample A. The paires of samples correlated with each other with more than 0.500 of correlation coefficient on sample A are as follows;

Co-Fe, Co-Ni, Co-Sb, Co-Zn, Cr-Ni, Cr-Sb, Fe-Ni, Fe-Zn, Mn-U, Ni-Sb, Ni-Zn, Sb-Zn

Elements such as Co, Fe, Ni, Sb and Zn have stronger correlation with each other.

(2) **Single element analysis**

To decide geochemical anomalies, EDA method, Lepeltire method and the calculation of geometric mean plus twice of standard deviation were applied. Histograms for each element and cumulative frequency distribution curves, which were used to decide the thresholds by Lepeltire method, are shown in Appendix 13. The statistical data obtained by these three methods are listed in Table II-2-20. The analytical results by means of these three methods are summarized as follows;

1) By the EDA method, the values of Median, Upper whisker and Upper Fence of elements Pb and Sb became the same, because the values of those elements were mostly less than their detection limits. On Cr, those three values were the same due to the same reason.

2) By the Lepeltire method, two populations of analytical values were recognized in the cumulative frequency distribution curve of Cu and S. The higher population of distribution should show mineralization.

3) By the calculation of geometric mean plus twice of standard deviation, the anomalous values are the highest among the three methods. This means that if this value is applied for the threshold, anomalous points are less than thos decided by other methods.

To decide the threshold values by means of EDA method, the values of Upper Fence were basically applied as in the Nungkok area. Analytical values of the sample B are generally higher than those of sample A and C. The distribution of the main elements of the sample B is shown in Appendix 14. The values shown in the map are devided into three categories, threshold value and more than that, from the threshold down to Median value and below Median value. The tendency and characteristics of the elemental distribution are as follows;

Table II-2-19 Coorelation matrix of elements for stream sediments in the Bidu Bidu Hill deposit area

Bidu Bidu Hill
Stream sediments (A)

	Au	Co	Cr	Cu	Fe	Mn	Ni	Pb	Pt	S	Sb	U	Zn
Au	1.000												
Co	.076	1.000											
Cr	.133	.647	1.000										
Cu	.438	-.290	-.042	1.000									
Fe	.222	.654	.487	-.059	1.000								
Mn	.338	.178	-.038	.353	.320	1.000							
Ni	.030	.921	.728	-.318	.547	-.045	1.000						
Pb	.172	.104	-.028	.157	.205	.466	.042	1.000					
Pt	-.055	.030	.038	-.120	.071	-.094	.055	.178	1.000				
S	-.084	-.167	.059	.172	.036	-.027	-.144	.251	.078	1.000			
Sb	-.023	-.514	-.685	.195	-.246	.064	-.608	.172	-.050	.095	1.000		
U	.339	-.093	-.244	.249	-.090	.526	-.139	.374	-.103	-.216	.219	1.000	
Zn	.001	.806	.740	-.416	.631	-.092	.815	-.082	.075	-.121	-.591	-.240	1.000

Bidu Bidu Hill
Stream sediments (B)

	Au	Co	Cr	Cu	Fe	Mn	Ni	Pb	S	Sb	U	Zn
Au	1.000											
Co	.019	1.000										
Cr	.019	.682	1.000									
Cu	.284	-.383	-.025	1.000								
Fe	.023	.462	.411	.021	1.000							
Mn	.257	-.076	-.019	.392	.302	1.000						
Ni	.067	.886	.585	-.399	.265	-.204	1.000					
Pb	-.024	-.215	-.034	.171	.009	.470	-.234	1.000				
S	-.066	-.296	-.049	.286	-.002	-.097	-.305	-.010	1.000			
Sb	.020	-.399	-.483	.045	-.315	.072	-.446	.111	-.010	1.000		
U	.211	-.166	.001	.421	.082	.499	-.079	.226	-.179	-.086	1.000	
Zn	-.048	.783	.756	-.364	.567	-.163	.683	-.239	-.116	-.433	-.187	1.000

Bidu Bidu Hill
Stream sediments (C)

	As	Au	Co	Cr	Cu	Fe	Mn	Ni	Pb	Pt	S	U	Zn
As	1.000												
Au	-.042	1.000											
Co	-.277	.036	1.000										
Cr	-.161	.103	.644	1.000									
Cu	.140	.180	-.252	.032	1.000								
Fe	-.197	-.066	.521	.453	.181	1.000							
Mn	.133	.204	.081	.060	.405	.359	1.000						
Ni	-.321	.058	.953	.666	-.322	.461	-.047	1.000					
Pb	.155	.112	-.067	-.008	.121	.095	.417	-.064	1.000				
Pt	.091	.091	.266	.103	.005	-.002	.119	.244	-.010	1.000			
S	-.084	-.148	-.355	-.089	.237	-.196	-.149	-.286	.011	-.059	1.000		
U	.293	.246	-.080	-.034	.334	-.059	.541	-.132	.372	.142	-.118	1.000	
Zn	-.385	.072	.742	.771	-.263	.588	-.034	.730	-.134	.073	-.195	-.252	1.000

Table II-2-20 Threshold values obtained by each analytical method for stream sediment geochemical survey in the Bidu Bidu Hill 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	—	—	—	—	—	—	—	—	—	—	—	—	—	—	5.0	5.0	5.0	1	16	2.5	6.4
Au	ppb	2.0	4.0	2.0	1	31	3.5	19.7	2.0	16.0	22.0	1	78	4.0	75.3	2.0	16.0	12.0	2	85	5.0	77.3
Co	ppm	137.0	176.0	288.0	140	265	3.0	333.9	138.0	170.0	275.0	140	230	2.5	290.6	127.0	159.0	219.0	128	215	4.0	274.9
Cr	ppm	10000	10000	10000	—	—	—	26822.7	10000	10000	10000	—	—	—	24705.9	10000	10000	10000	—	—	—	26989.5
Cu	ppm	54.0	85.0	140.5	52	140	7.0	200.2	49.0	87.0	142.0	53	190	7.0	206.5	58.0	104.0	150.5	58	208	7.0	255.1
Fe	%	11.93	14.03	18.27	12.0	16.0	2.5	17.42	11.97	13.90	18.29	12.0	16.0	2.5	17.04	12.03	13.84	18.34	12.3	16.0	2.5	16.8
Hg	ppm	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mn	ppm	2849.0	3700.0	5057.0	2980	3950	16.0	5986.3	2708.0	3628.0	4841.0	2880	4000	12.5	5925.1	2741.0	3722.0	5168.0	2900	4450	14.5	5846.5
Mo	ppm	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Ni	ppm	801.0	1327.0	2087.0	800	1280	21.0	3374.6	853.0	1405.0	2336.0	810	1150	26.0	3489.6	740.0	1095.0	1724.5	750	1180	20.0	3206.2
Pb	ppm	2.0	3.0	2.0	< 1	27	2.5	16.0	2.0	2.0	2.0	< 1	24	2.5	6.3	2.0	4.0	2.0	2	13	5.5	9.2
Pt	ppb	5.0	5.0	5.0	—	—	—	4.8	—	—	—	—	—	—	—	5.0	5.0	5.0	—	—	—	7.0
S	%	0.023	0.033	0.042	0.023	0.051	5.2	0.051	0.028	0.038	0.057	0.030	0.066	4.9	0.068	0.027	0.038	0.051	0.027	0.074	6.0	0.076
Sb	ppm	5.0	5.0	5.0	3	12	2.5	7.5	5.0	5.0	5.0	1	7	2.5	4.6	—	—	—	—	—	—	—
Sn	ppm	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
U	ppm	0.20	0.40	0.70	0.2	0.6	14.5	0.97	0.20	0.40	0.70	0.2	1.3	2.5	0.94	0.20	0.40	0.70	0.2	0.9	2.5	0.90
W	ppm	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Zn	ppm	422.0	572.0	991.5	430	620	17.0	1243.5	418.0	599.0	971.5	400	445	45.0	1216.3	397.0	495.0	749.0	390	580	15.5	1062.4

*1: Background *2: Threshold

Au : Anomalous points are principally distributed along the drainages surrounding the Bidu Bidu Hill deposit, being related with the deposit.

Co : Higher concentration points have a general tendency to be distributed along the drainages in the northernmost and in the eastern part of the area. This distribution suggests the relation with the ultra-basic rocks.

Cu : Anomalous points were detected in the drainages in the south side of the Bidu Bidu Hill deposit and in the southwestern part of the area. The anomalous points in the southside of Bidu Bidu Hill deposit is related to the deposit and those in the southwestern part of the area is related to the mineral showing of Southwest Sualog prospect about 800 m upperstream.

Fe : No apparent tendency was detected in the distribution. However, anomalous points were rather detected in the samples taken from the flat area.

Mn: Anomalous and higher concentration points were detected in the central western to central part of the area, being closely relatd to the distribution of the sedimentary rocks of Chert-Spilite Formation.

Ni : Anomalous points were detected in the eastern and the northern parts of the area, corresponding to the distribution of the ultra-basic rocks.

S : The area in and around the Bidu Bidu Hill deposit is characteristic of low concentration. Anomalous points in the southwestern portion of the area are supposed to be influenced by vein-type Southwest Sualog prospect, which is different from the Bidu Bidu Hill deposit.

U : No apparent tendency was detected in the distribution. The distribution of anomalous points correspond to the distribution of the sedimentary rocks of Chert-Spilite Formation.

Zn : No distribution tendency was recognized. Higher concentration was detected near the Bidu Bidu Hill deposit.

The distribution of anomalous points and points with higher concentration of each element is not clearly corresponded to the location of the deposit, because the Bidu Bidu Hill deposit is conceiled. However, Au and Cu are thought to be available for pathfinders. The distribution of Co, Mn, Ni and U corresponds to the geology of this area. The distribution of Cr reflects the geology of this area, though the analytical values of a number of samples are more than the upper detection limit.

(3) Multi elements analysis

The results of the Cluster analysis for the stream sediments is shown in Fig. II-2-14. Two clusters of the elements were identified in the dendrograms. They are Co-Cr-Fe-Ni-Sb-Zn and Cu-Mn-Pb-U. Au and S are not closely related with the other elements. Judging from the elements composing each cluster, the cluster of Co-Cr-Fe-Ni-Sb-Zn and the other cluster are presumed to correspond to the background and mineralization respectively.

The results of the factor analysis for the stream sediments are shown in Table II-2-21. Factor 4 of the sample series A is related to Au and Cu, which is possibly the factor representing a mineralization. Factor 2 of the sample B is related to Cu, Mn, Pb and U. The factor 2 is presumably connected to the mineralization, judging from both the Cluster and Factor analyses. Points having higher factor scores of factor 1 and 2 on the sample series B are shown in Fig. II-2-15. Points having higher factor scores of factor 2 are distributed in the area surrounding the Bidu Bidu Hill deposit, that points out the relation between the factor 2 and the mineralization. Cu, Mn, Pb and U were related to the factor 2 on sample C, which have a tendency to be distributed as the sample B.

The rate of contribution of the factors, which are presumed to be related to the mineralization, are approximately as low as 20% as shown in the result of the factor analysis. This may be because the deposit is conceiled, therefore prominent mineralization could not be detected on the surface. According to the result of the analysis, the factor analysis is thought to be effective even for some blind deposit.

(4) Summary of analyses

The distribution of the anomalous points detected by the EDA method were plotted on Fig. II-2-16. Au and Cu anomalous points were detected near the Bidu Bidu Hill deposit. That suggests the relationship between these elements and the deposit. The anomalous point defined is expanded to some 100 m outside of the deposit. Limited area is interpreted to be affected by the mineralization. Cu anomalies detected in the southwestern edge of the area is interpreted to be affected by the mineralization of Southwest Sualog prospect situated in the upper reaches of the anomalies.

2-3-4 Soil geochemical survey

(1) Pathfinder elements

Soil samples were chemically analysed for 23 elements. The result of the statistical treatment of the analytical data is shown in Table II-2-22. Analytical values of Ag and Hg are all below the detection limit. Analytical values of As, Mo, Pb, Sb, Sn and W were mostly below the detection limits as well.

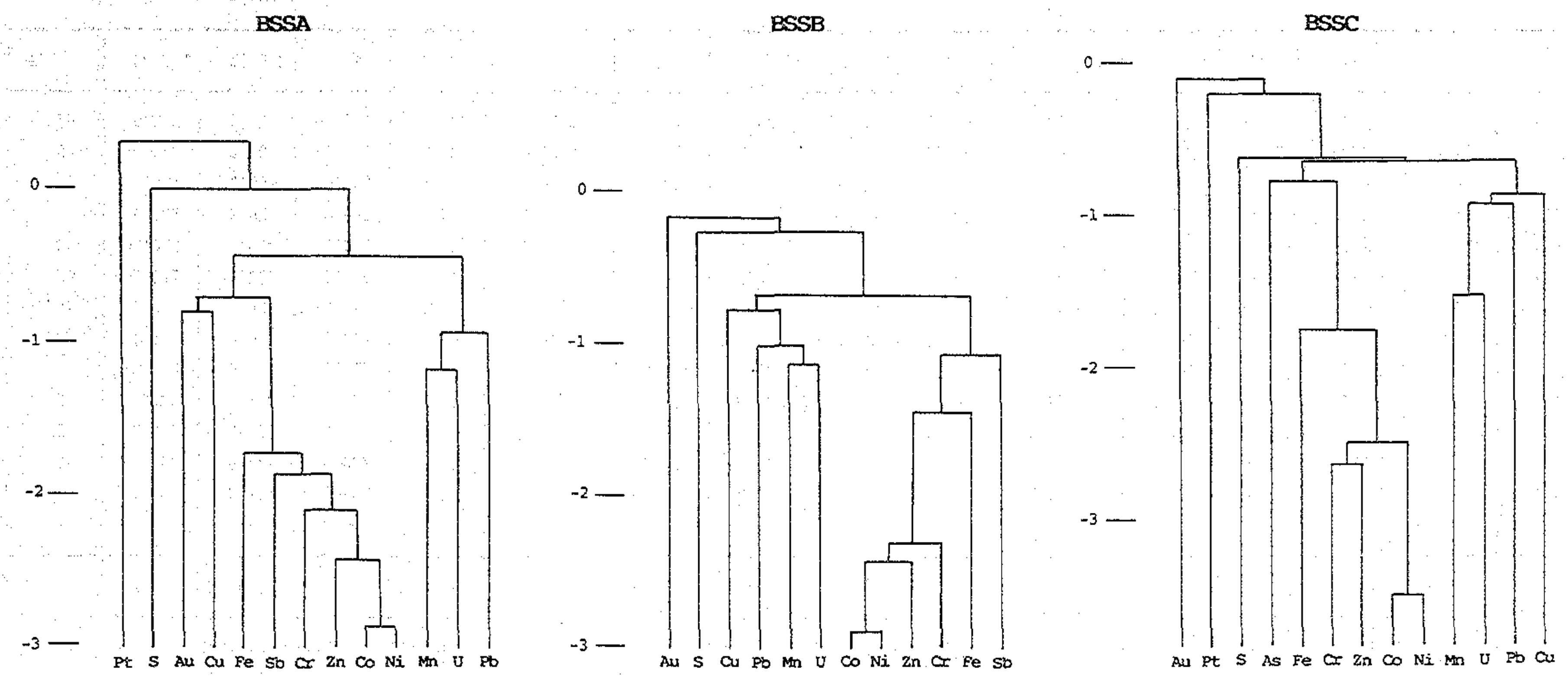
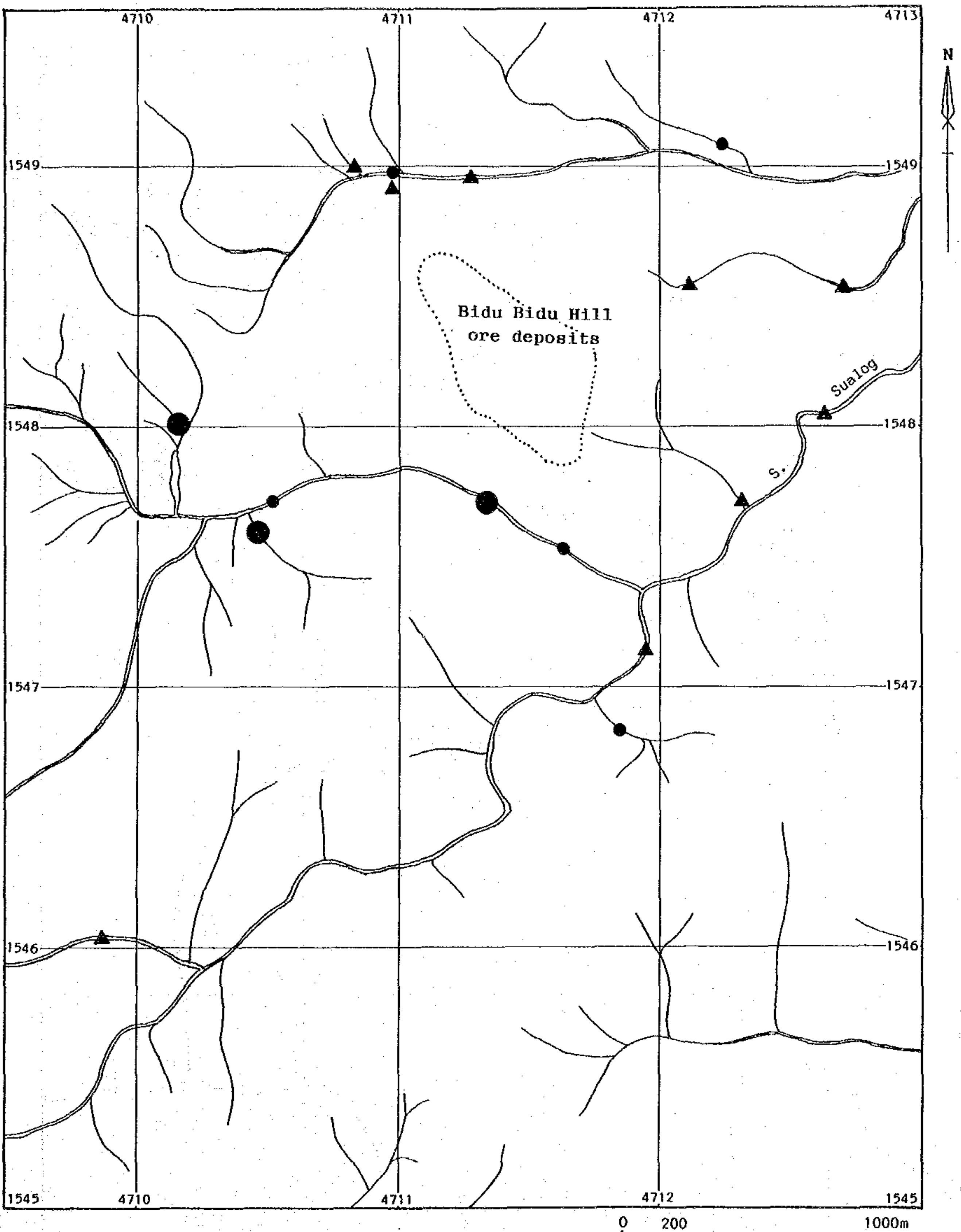


Fig. II-2-14 Dendrogram of elements for stream sediments in the Bidu Bidu Hill deposit area

Table II-2-21 Results of factor analyses for stream sediments in the Bidu Bidu Hill 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	—	—	—	—	—	—	—	—	—	—	0.356	0.252	0.020	-0.373	0.3544
Au	-0.126	0.312	-0.133	-0.547	0.4304	0.038	0.319	0.134	-0.335	0.2330	-0.051	0.199	-0.022	-0.048	0.2814
Co	-0.905	0.224	-0.092	0.202	0.9181	-0.930	0.056	0.178	0.046	0.9013	-0.840	-0.041	-0.432	-0.231	0.9479
Cr	-0.830	-0.186	0.134	-0.218	0.7892	-0.750	0.282	-0.239	-0.033	0.7004	-0.827	0.007	0.136	-0.156	0.7415
Cu	0.229	0.201	0.088	-0.649	0.5213	0.393	0.502	-0.253	-0.257	0.5363	0.051	0.480	0.483	-0.014	0.4698
Fe	-0.664	0.326	0.211	-0.022	0.5924	-0.477	0.427	-0.232	0.231	0.5167	-0.663	0.347	-0.042	0.206	0.6656
Mn	-0.056	0.688	-0.057	-0.314	0.5778	0.200	0.723	0.133	0.168	0.6084	-0.098	0.778	-0.011	-0.044	0.6225
Ni	-0.918	0.030	-0.085	0.191	0.8878	-0.875	-0.027	0.297	-0.176	0.8845	-0.831	-0.167	-0.400	-0.220	0.9317
Pb	-0.012	0.635	0.318	-0.054	0.5071	0.268	0.411	0.097	0.399	0.4094	0.065	0.521	-0.059	-0.009	0.2844
Pt	-0.055	0.034	0.263	0.166	0.1012	—	—	—	—	—	-0.128	0.044	-0.073	-0.438	0.2222
S	0.088	-0.024	0.555	-0.107	0.3281	0.209	-0.063	-0.548	-0.047	0.3500	0.147	-0.142	0.535	0.074	0.3357
Sb	0.688	0.305	0.105	0.111	0.5901	0.511	-0.177	0.214	0.180	0.3711	—	—	—	—	—
U	0.188	0.605	-0.352	-0.211	0.5695	0.181	0.628	0.194	-0.194	0.5023	0.159	0.627	-0.016	-0.302	0.5783
Zn	-0.887	-0.082	-0.016	0.214	0.8403	-0.887	0.034	-0.165	0.113	0.8273	-0.869	-0.150	-0.141	0.117	0.8145
F.C.*1	54.5 %	21.9 %	9.4 %	14.2 %	—	47.3 %	17.4 %	17.4 %	18.0 %	—	48.1 %	24.8 %	12.6 %	8.5 %	—

*1: factor contribution



● ≧2.000 factor 2 factor score 2.000>● ≧1.000 factor 2 factor score

▲ ≦-0.800 factor 1 factor score (Sample collected at edge of stream(B))

Fig. II-2-15 Distribution map of factor 1 factor score for stream sediments in the Bidu Bidu Hill deposit area

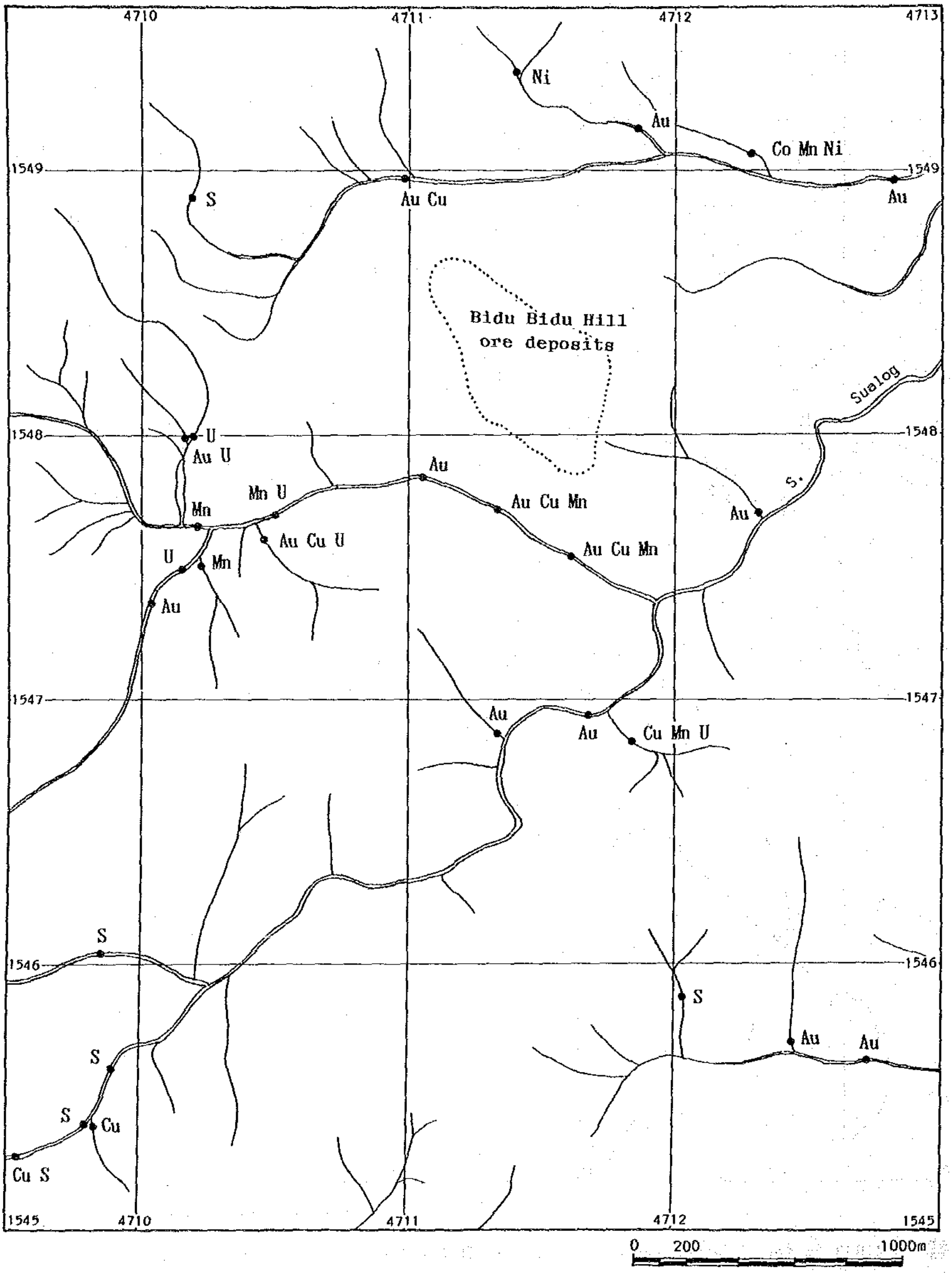


Fig. II-2-16 Interpretation map of stream sediment geochemical survey in the Bidu Bidu Hill deposit area

Table II-2-22 Statistics of soil geochemical survey in the Bidu Bidu Hill 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	<0.5	<0.5	—	—	100.0	ppm	<0.5	<0.5	—	—	100.0	ppm	0.5	<0.5	—	—
As	89.0	ppm	32	< 5	3.1	0.260	89.0	ppm	33	< 5	2.9	0.211	87.8	ppm	38	< 5	3.0	0.222
Au	0	ppb	170	4	5.1	0.268	14.6	ppb	140	< 2	4.2	0.383	54.9	ppb	130	< 2	2.3	0.507
Co	0	ppm	730	23	132.2	0.319	0	ppm	695	31	150.2	0.336	0	ppm	742	31	145.5	0.364
Cr	0	ppm	>10000	248	2057.0	0.562	0	ppm	>10000	228	2342.8	0.550	0	ppm	>10000	171	1972.3	0.577
Cu	0	ppm	819	34	93.1	0.258	0	ppm	743	39	107.8	0.248	0	ppm	742	39	108.8	0.268
Fe	0	%	21.89	5.44	10.611	0.105	0	%	22.41	4.22	11.867	0.112	0	%	22.04	3.73	11.935	0.128
Hg	100.0	ppm	< 1	< 1	—	—	100.0	ppm	< 1	< 1	—	—	100.0	ppm	< 1	< 1	—	—
K	29.3	%	0.54	<0.01	0.024	0.580	22.0	%	1.11	<0.01	0.030	0.596	24.4	%	0.81	<0.01	0.027	0.612
Mn	0	ppm	>10000	1097	3546.7	0.229	0	ppm	>10000	460	3528.7	0.266	0	ppm	>10000	395	3380.1	0.286
Mo	98.8	ppm	1	< 1	—	—	98.8	ppm	1	< 1	—	—	100.0	ppm	< 1	< 1	—	—
Na	0	%	2.05	0.05	0.188	0.357	0	%	2.18	0.06	0.198	0.351	0	%	1.61	0.05	0.199	0.329
Ni	0	ppm	3717	87	622.1	0.516	0	ppm	4717	97	778.6	0.506	0	ppm	5660	94	798.3	0.535
Pb	80.5	ppm	32	< 2	1.5	0.387	81.7	ppm	38	< 2	1.5	0.399	76.8	ppm	57	< 2	1.6	0.421
Pt	0	ppb	30	10	10.2	0.062	25.6	ppb	60	< 5	7.3	0.295	85.4	ppb	15	< 5	3.1	0.220
Rb	1.2	ppm	86	1	6.8	0.349	0	ppm	137	2	8.5	0.308	0	ppm	99	2	8.0	0.336
S	0	%	0.119	0.025	0.043	0.125	0	%	0.098	0.020	0.034	0.113	0	%	0.086	0.014	0.029	0.133
Sb	82.9	ppm	13	< 5	3.0	0.176	89.0	ppm	11	< 5	2.8	0.157	93.9	ppm	9	< 5	2.7	0.108
Sn	100.0	ppm	< 1	< 1	—	—	96.3	ppm	17	< 1	0.6	0.229	63.4	ppm	15	< 1	1.1	0.466
Sr	0	ppm	166	3	23.1	0.356	0	ppm	354	2	20.5	0.377	0	ppm	455	2	17.0	0.397
U	29.3	ppm	1.8	<0.2	0.28	0.372	28.0	ppm	2.6	<0.2	0.29	0.376	29.3	ppm	2.4	<0.2	0.28	0.374
W	100.0	ppm	< 10	< 10	—	—	100.0	ppm	< 10	< 10	—	—	98.8	ppm	11	< 10	5.0	0.038
Zn	0	ppm	497	53	117.7	0.178	0	ppm	503	58	126.3	0.178	0	ppm	439	52	126.7	0.179

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

Three samples were taken at one location as same as described before on the samples of the Nungkok deposit area. Geometrical means calculated on the analytical values of three sample series, A, B and C, are summarized as follows.

Elements with higher mean values on the sample A: As, Au, Mn, Pt, S, Sb, Sr

Elements with higher mean values on the sample B: Co, Cr, K, Mo, Rb, U

Elements with higher mean values on the sample C: Cu, Fe, Na, Ni, Pb, Sn, Zn

The mean values of Au, Mn, S, Sb and Sr are getting lower in order of A, B, C. On the other hand, the values of Cu, Na and Ni are getting higher in order of A, B, C.

Correlation matrixes among each element is showin in Table II-2-23. Elements of sample series B and C have stronger correlation with each other than those of sample series A. Pairs of elements having higher correlation coefficient, 0.6000 and more than that, on the sample series B are as follows;

Co-Cr, Co-Mn, Co-Ni, Co-Zn, Cr-Ni, Cr-Zn, Fe-Sr, K-Rb, Na-Sr, Ni-Zn

Among the above elements, Co, Cr, Ni and Zn have a stronger correlation with each other, which are closely related to the geology of this area.

(2) Single element analysis

EDA method, Lepeltire method and the method of calculating the geometric mean plus twice of standard deviation were applied to determine the threshold values. Histograms and cumulative frequency distribution curves on each element and sample series are shown in Appendix 15. The statistic values determined by the three methods are listed in Table II-2-24. Followings are pointed out by these methods.

1) Analytical values of As, Pb, Sb and W are mostly less than the detection limits. Therefore, the values of Median, Upper whisker and Upper Fence have the same values by means of the EDA method.

2) Two populations of analytical values are distinguished in the cumulative frequency distribution curves by means of Lepeltier method.

3) The values determined by the calculation of mean plus twice of standard deviation are mostly higher than those determined by other methods.

The distribution of each element on each samples series were shown in Appendix 16. The analytical values are devided into three categories to be shown on the map, threshold value and more than that, from the threshold value down to median values and below median values, based on the EDA method. The analytical values of sample series B were used to plot on the map, because those values are intermediate among the values calculated by three methods. The distributions of each element have a general tendency and characteristics as described below;

Table II-2-23 Coorelation matrix of elements for soil in the Bidu Bidu Hill deposit area

Bidu Bidu Hill
Soil (A)

	As	Au	Co	Cr	Cu	Fe	K	Mn	Na	Ni	Pb	Pt	Rb	S	Sb	Sr	U	Zn
As	1.000																	
Au	.277	1.000																
Co	-.070	-.129	1.000															
Cr	-.067	-.118	.872	1.000														
Cu	.312	.675	-.256	-.299	1.000													
Fe	.109	.197	.538	.504	.129	1.000												
K	.190	.061	-.344	-.296	.165	-.412	1.000											
Mn	.134	.109	.580	.344	.196	.195	.084	1.000										
Na	-.166	.006	-.210	-.236	.087	-.368	.208	-.186	1.000									
Ni	-.080	-.148	.885	.944	-.331	.546	-.272	.340	-.194	1.000								
Pb	.357	.259	.005	.016	.129	-.104	.324	.431	-.289	.004	1.000							
Pt	-.052	-.063	.291	.158	-.006	.318	-.182	.214	-.147	.170	.077	1.000						
Rb	.266	.106	-.063	.034	.164	-.063	.768	.311	-.280	.035	.573	-.020	1.000					
S	.113	.344	-.336	-.249	.184	-.061	-.172	-.194	-.332	-.293	.143	-.124	-.078	1.000				
Sb	.058	-.027	-.078	-.076	-.123	-.198	.248	-.032	.256	-.051	.072	-.067	.101	-.145	1.000			
Sr	-.087	-.119	-.340	-.384	.051	-.653	.588	-.106	.720	-.368	-.054	-.219	.136	-.297	.238	1.000	17	18
U	.352	.366	.004	.037	.303	.059	.403	.362	-.328	.068	.507	.142	.606	.070	.021	-.214	1.000	
Zn	.001	-.037	.728	.609	.004	.400	-.323	.472	.051	.591	-.074	.159	-.136	-.355	-.111	-.119	-.038	1.000

Bidu Bidu Hill
Soil (B)

	As	Au	Co	Cr	Cu	Fe	K	Mn	Na	Ni	Pb	Pt	Rb	S	Sb	Sn	Sr	U	Zn
As	1.000																		
Au	.134	1.000																	
Co	-.213	.111	1.000																
Cr	-.241	.079	.897	1.000															
Cu	.291	.488	-.191	-.216	1.000														
Fe	-.186	.237	.560	.555	.149	1.000													
K	.283	-.149	-.436	-.369	-.059	-.568	1.000												
Mn	.100	.225	.662	.469	.141	.150	-.151	1.000											
Na	-.182	-.100	-.223	-.190	-.156	-.515	.220	-.103	1.000										
Ni	-.242	.028	.883	.950	-.300	.542	-.302	.420	-.190	1.000									
Pb	.343	.116	.092	.058	.054	-.021	.252	.342	-.247	.088	1.000								
Pt	-.132	.338	.407	.422	-.202	.131	-.048	.224	.174	.419	.011	1.000							
Rb	.387	-.029	-.130	-.056	-.032	-.296	.783	.131	-.205	-.008	.521	-.005	1.000						
S	.123	.433	-.148	-.149	.474	.360	-.312	-.021	-.343	-.194	.028	-.326	-.232	1.000					
Sb	-.069	-.133	-.122	-.168	-.239	-.200	.207	-.068	.338	-.131	.157	.015	.071	-.212	1.000				
Sn	-.062	.001	-.299	-.188	.155	.045	-.163	-.262	-.180	-.226	-.082	-.297	-.141	.108	-.063	1.000	17	18	19
Sr	.005	-.288	-.223	-.221	-.159	-.640	.492	.015	.328	-.200	-.058	.061	.145	-.502	.385	-.295	1.000		
U	.326	.212	.008	.026	.292	-.138	.327	.334	-.366	.031	.397	-.109	.563	.119	-.196	.042	-.152	1.000	
Zn	-.138	.078	.747	.689	.060	.422	-.430	.524	-.050	.651	.008	.195	-.221	-.086	-.228	-.181	-.081	.013	1.000

Bidu Bidu Hill
Soil (C)

	As	Au	Co	Cr	Cu	Fe	K	Mn	Na	Ni	Pb	Pt	Rb	S	Sb	Sn	Sr	U	W	Zn
As	1.000																			
Au	.170	1.000																		
Co	-.050	.039	1.000																	
Cr	-.116	.024	.903	1.000																
Cu	.313	.455	-.140	-.167	1.000															
Fe	.050	.298	.585	.602	.271	1.000														
K	.058	-.058	-.390	-.354	.037	-.439	1.000													
Mn	.093	.120	.694	.514	.131	.228	-.126	1.000												
Na	-.198	-.190	-.285	-.274	-.163	-.532	.140	-.161	1.000											
Ni	-.118	-.019	.896	.991	-.226	.569	-.279	.482	-.267	1.000										
Pb	.269	.314	.150	.096	.262	.106	.219	.430	-.315	.093	1.000									
Pt	-.083	.226	.421	.371	-.148	.356	-.345	.138	-.184	.401	.044	1.000								
Rb	.145	.046	-.132	-.058	-.010	-.208	.825	.072	-.255	-.013	.470	-.158	1.000							
S	.209	.417	-.084	-.030	.351	.367	-.298	.046	-.248	-.172	.036	-.057	-.194	1.000						
Sb	.018	-.149	-.284	-.333	-.189	-.325	.173	-.255	.384	-.329	-.122	-.103	-.023	-.191	1.000					
Sn	-.003	-.192	-.062	-.129	-.181	-.184	-.094	-.006	.025	-.171	-.117	-.193	-.139	-.043	.004	1.000				
Sr	-.075	-.251	-.204	-.230	-.129	-.604	.397	.071	.819	-.215	-.070	-.275	.086	-.356	.466	.055	1.000			
U	.280	.352	.067	.026	.225	-.070	.362	.400	-.399	.053	.506	.019	.580	.072	-.260	-.198	-.154	1.000		
W	-.038	-.080	-.114	-.147	-.093	-.138	.087	-.092	.133	-.151	-.054	-.046	-.020	-.039	.549	.065	.142	-.134	1.000	
Zn	-.088	.053	.729	.684	.087	.433	-.358	.535	-.127	.629	.144	.251	-.194	-.083	-.342	.049	-.078	.008	-.185	1.000

Table II-2-24 Threshold values obtained by each analytical method for soil geochemical survey in the Bidu Bidu Hill 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	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
As	ppm	5.0	5.0	5.0	< 1	29	2.5	10.1	5.0	5.0	5.0	< 1	14	3.0	7.8	5.0	5.0	5.0	< 1	15	2.5	8.3
Au	ppb	4.0	6.0	4.0	2	27	3.0	17.7	4.0	6.0	4.0	6	24	3.5	24.6	2.0	4.0	7.0	2	29	4.0	23.8
Co	ppm	131.0	260.0	490.0	135	550	2.5	574.2	164.0	316.0	557.5	160	490	4.5	706.1	171.0	308.0	617.0	170	590	2.5	778.4
Cr	ppm	3362.5	7097.0	14086	2950	18000	2.5	27421.1	3564.5	8327.0	17949	3300	21000	2.5	29524.1	3068.5	6996.0	15545	3050	19000	2.5	28081.0
Cu	ppm	86.5	146.0	242.0	87	190	13.0	305.7	92.0	162.0	270.0	92	270	9.0	338.3	96.0	179.0	283.0	105	290	6.0	374.4
Fe	%	10.73	12.47	15.98	10.8	16.5	3.5	17.21	12.01	14.60	18.81	12.0	18.0	4.0	19.92	12.45	14.92	18.46	12.5	18.0	4.0	21.48
Hg	ppm	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
K	%	0.03	0.09	0.14	0.03	0.37	2.5	0.35	0.03	0.10	0.19	0.04	0.22	8.0	0.47	0.03	0.10	0.19	0.03	0.54	2.5	0.45
Mn	ppm	3510.0	5743.0	8355.5	3700	7900	8.0	10187.1	3745.0	5561.0	8583.0	3750	7800	7.5	11999.8	4062.5	5353.0	9366.0	3700	11000	2.5	12643.6
Mo	ppm	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Na	%	0.17	0.38	0.74	0.18	0.054	10.5	0.97	0.18	0.41	0.63	0.18	0.71	8.5	1.00	0.17	0.41	0.71	0.17	0.59	11.0	0.91
Ni	ppm	803.5	2137.0	4480.5	645	3300	2.5	6698.2	1011.5	2477.0	4947.5	920	3950	2.5	8016.8	1190.5	2596.0	5275.5	1200	4400	2.5	9372.1
Pb	ppm	2.0	2.0	2.0	< 1	29	2.5	8.9	2.0	2.0	2.0	< 1	29	2.5	9.3	2.0	3.0	2.0	< 1	32	2.5	11.1
Pt	ppb	10.0	10.0	10.0	—	20	2.5	13.6	10.0	10.0	17.5	—	30	2.5	28.2	5.0	5.0	5.0	7	13	2.5	8.5
Rb	ppm	6.0	12.0	19.0	6	26	8.0	34.1	7.0	12.0	18.5	7	83	2.5	35.2	6.0	14.0	22.5	7	34	6.5	37.9
S	%	0.043	0.057	0.079	0.042	0.070	4.5	0.077	0.034	0.038	0.049	0.033	0.042	11.0	0.057	0.028	0.032	0.039	0.028	0.034	15.5	0.053
Sb	ppm	5.0	5.0	5.0	2	11	2.5	6.7	5.0	5.0	5.0	< 1	10	2.5	5.8	5.0	5.0	5.0	1	8	2.5	4.4
Sn	ppm	—	—	—	—	—	—	—	1.0	1.0	1.0	< 1	7	2.5	1.9	1.0	3.0	6.0	< 1	6	9.5	9.1
Sr	ppm	26.0	43.0	73.0	26	75	6.0	118.9	21.0	39.0	71.0	21	72	5.0	116.6	16.5	39.0	74.0	17	29	30.0	105.6
U	ppm	0.20	0.60	1.20	0.4	1.0	9.5	1.55	0.40	0.60	0.70	0.4	1.1	8.0	1.64	0.40	0.60	0.70	0.39	0.61	22.0	1.58
W	ppm	—	—	—	—	—	—	—	—	—	—	—	—	—	—	10.0	10.0	10.0	—	—	—	6.0
Zn	ppm	119.0	155.0	237.0	115	205	7.0	266.7	133.0	176.0	272.0	135	235	3.0	287.1	139.5	174.0	288.0	140	215	4.0	289.0

*1: Background *2: Threshold

Co : Points with higher values are distributed in the area of ultra-basic rocks in the east of the area. In and around the Bidu Bidu Hill deposit lower values are characteristic.

Cr : Anomalous points and points with higher values are distributed along drainages. Samples taken from hillside are characteristic of low values. This distribution tendency is probably related to the thickness of soil.

Cu : Anomalous points and points with higher values are distributed in and around the Bidu Bidu Hill deposit. That points out the close relations with the deposit.

Fe : Anomalous points and points with higher values are sparsely distributed, and no distribution tendency is detected.

K : Points with higher values are distributed in the area of gabro and ultrabasic rocks. In the samples taken from the hillside low values are characteristic.

Mn : Samples taken from the hillside have rather lower values.

Na : Anomalous points and points with higher values are scattered around. No distinctive tendency of distribution is not detected.

Ni : Anomalous points were detected along drainages as same as those of Cr. The distribution may be related to the formation of the soil.

Pt : Higher values are distributed along drainages as Cr and Ni. Samples taken from hillside are characteristic of lower values.

Rb : Higher values and lower values were detected around the Bidu Bidu Hill deposit and near the dposit respectively. Thus negative relation can be recognized between the alteration of mineralization and the concentration of Rb.

S : Anomalous points and points with higher values were detected near the Bidu Bidu Hill deposit. Thus the close relation can be pointed out between them.

Sr : The distribution of the values have a general tendency same as that of Rb. Thus negative relation between them is pointed out here as well.

U : Anomalous points and points with higher values are distributed in and around the Bidu Bidu Hill deposit. However, because the area having higher values is wide, the relation between the distribution and the deposit is not clearly defined.

Zn : Anomalous values were detected along drainages same as those of Cr and Ni.

From the above mentioned, Cu and S are though to be effective as pathfinder elements. Rb and Sr can be used as pathfinder element as well because they have negative relation with the mineralization. The concentration of Cr, Ni and Zn possibly depend on the location of the samples. Therefore, the sampling point should be carefully localized.

(3) Multi element analysis

Cluster and factor analysis methods were applied for the statistical treatment of analytical data of soil samples. The analytical result by means of cluster analysis method is shown in Fig. II-2-17 and the result by means of factor analysis is shown in Table II-2-25.

Two clusters of elements, Co-Cr-Mn-Ni-Zn and Au-Cu, were identified on each sample series by cluster analysis. Judging from this analysis, Au is also supposed to be effective as pathfinder because Cu is related to deposit by means of single element analysis. Sr and Rb are composing one cluster in sample series C, corresponding to the distribution of above mentioned clusters of elements.

According to the cluster analysis and single element analysis, Au, Cu and S are effective as pathfinders. Furthermore, by the cluster analysis some factors closely related to Au, Cu and S were identified on the samples B and C. In the sample A, these elements were separately clustered. Therefore, elements of the sample series B and C are rather effective. The factors, which were defined on sample series B, are more strongly related to those three elements than the factors on sample series C. The factors, which were detected on the sample series B, and the elements strongly related to the factors are as follows;

Factor 1 : Co-Cr-Mn-Ni-Zn

Factor 2 : Fe-Sr

Factor 3 : K-Pb-Rb-U

Factor 4 : Au-Cu-S

The factor 1 and the related elements have a negative relation with each other. Judging from the factors and the related elements, factor 4 is supposed to be the one representing mineralization.

The distribution of the points with higher factor scores of factors 1 and 4 is shown in Fig. II-2-18. The distribution of the points with higher factor scores of factor 4 corresponds to the distribution of the mineralization. Judging from the results above mentioned, factor analysis is effective in this area as well. Points with higher factor scores of factor 4 are distributed along drainages. This situation is aproximately the same as the result of single element analysis.

(4) Relationships between stream sediment and soil samples

Soil samples with the location numbers 1 to 66 were collected near the stream sediment sample location in the Bidu Bidu Hill deposit area. To detect the relationship between the two sample types, elemental correlation coefficients for individual elements were calculated as follows;

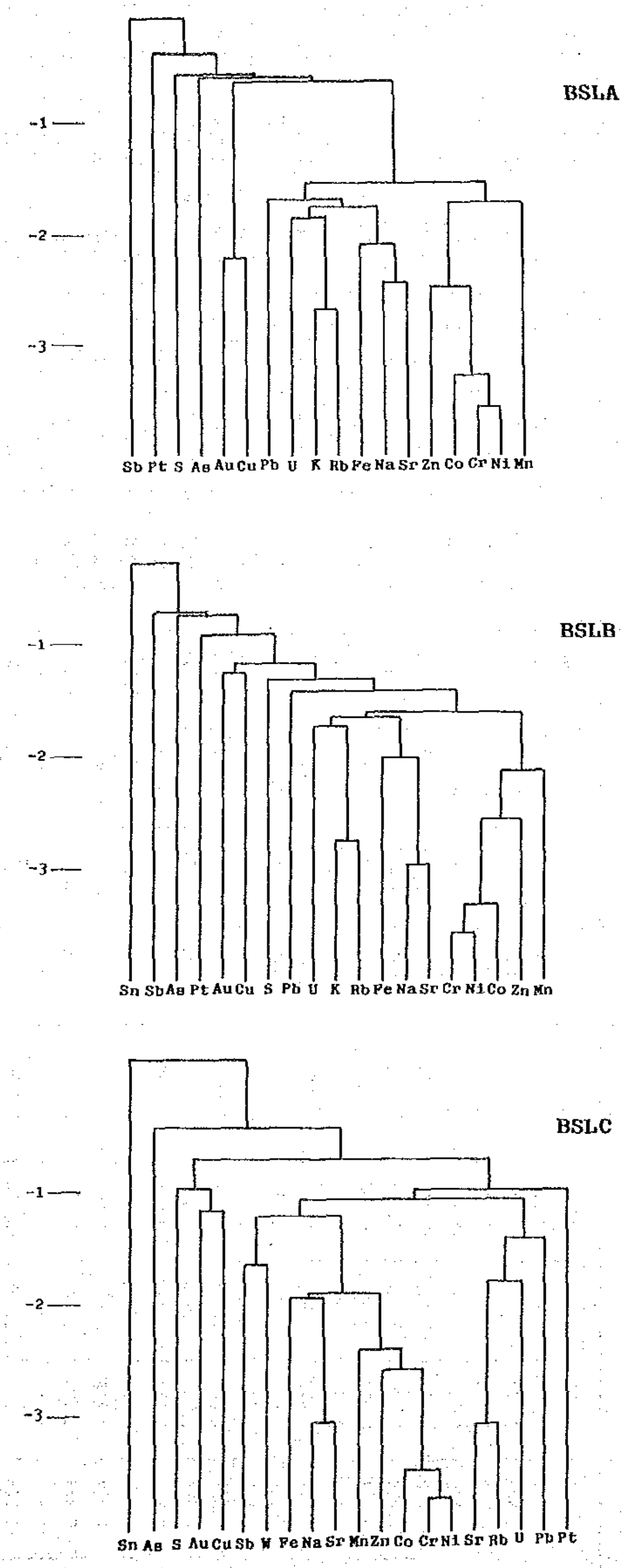
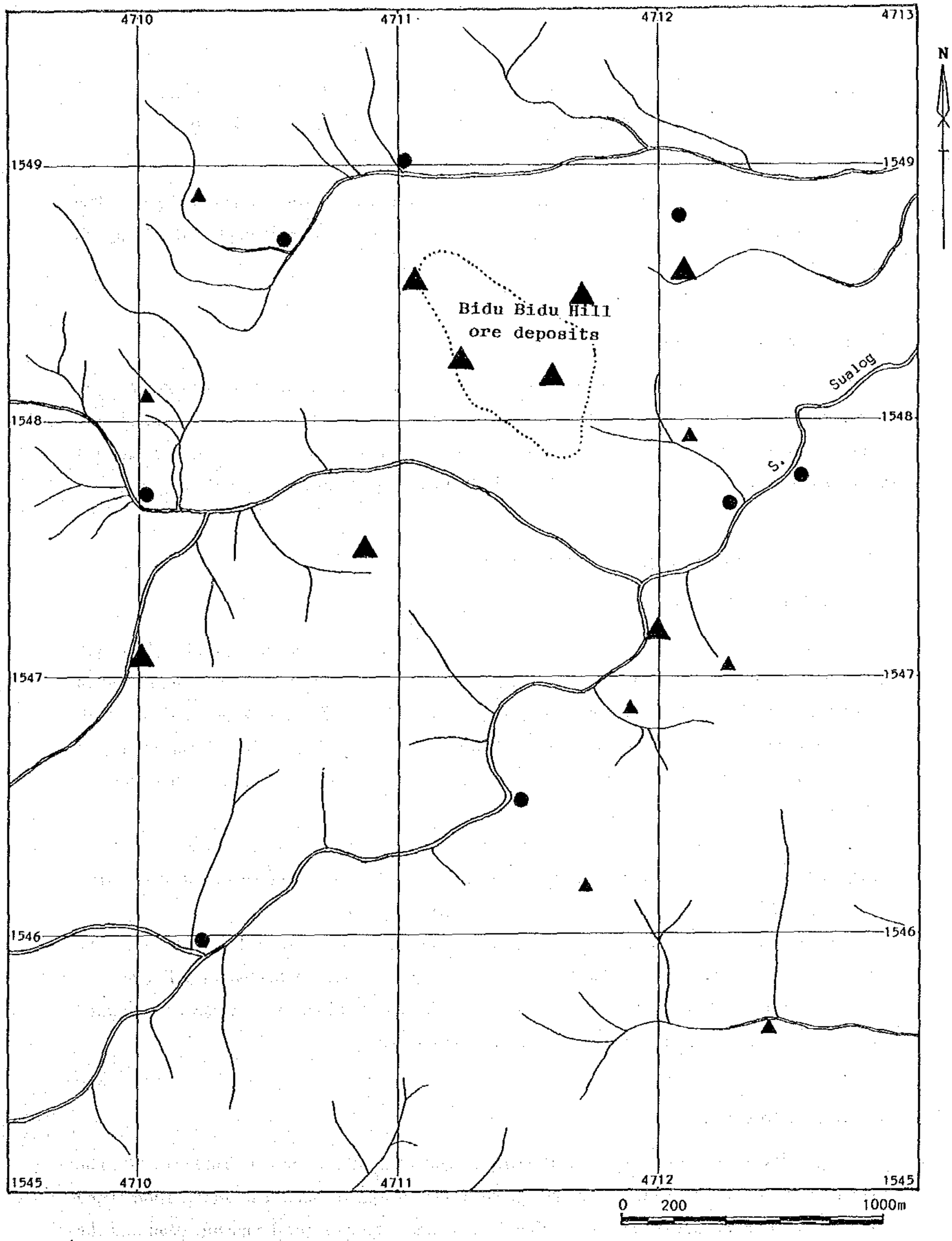


Fig. II-2-17 Dendrogram of elements for soil in the Bidu Bidu Hill deposit area

Table II-2-25 Results of factor analyses for soil in the Bidu Bidu Hill 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	0.021	0.355	-0.094	-0.334	0.2539	0.131	-0.019	0.492	0.261	0.3400	-0.036	-0.200	-0.093	0.404	0.2286
Au	0.034	0.151	-0.123	-0.803	0.7074	-0.078	0.147	0.081	0.647	0.6030	0.039	-0.069	-0.114	0.598	0.5052
Co	-0.906	-0.028	-0.125	0.126	0.9401	-0.923	0.180	-0.068	-0.098	0.9458	0.951	0.049	-0.163	-0.080	0.9486
Cr	-0.934	0.039	-0.179	0.160	0.9378	-0.857	0.242	-0.061	-0.207	0.9168	0.880	0.047	-0.197	-0.198	0.9241
Cu	0.179	0.132	0.045	-0.806	0.7250	0.069	0.108	0.127	0.709	0.5618	-0.067	-0.056	-0.007	0.677	0.4927
Fe	-0.510	-0.076	-0.468	-0.242	0.7144	-0.411	0.631	-0.256	0.137	0.6813	0.470	0.232	-0.495	0.248	0.6868
K	0.250	0.684	0.551	-0.013	0.8601	0.369	-0.412	0.656	-0.229	0.7943	-0.350	-0.775	0.284	-0.143	0.8277
Mn	-0.446	0.373	0.022	-0.153	0.6418	-0.697	-0.100	0.292	0.259	0.6483	0.740	-0.238	0.104	0.282	0.7260
Na	0.073	-0.361	0.783	-0.125	0.7698	0.094	-0.857	-0.316	-0.032	0.8608	-0.182	0.260	0.851	-0.183	0.8696
Ni	-0.938	0.050	-0.148	0.183	0.9553	-0.825	0.243	-0.023	-0.305	0.9283	0.852	-0.021	-0.198	-0.290	0.9500
Pb	-0.006	0.668	-0.103	-0.119	0.6070	-0.119	0.057	0.616	0.058	0.4058	0.237	-0.540	-0.062	0.385	0.5003
Pt	-0.150	0.032	-0.176	0.039	0.2736	-0.323	-0.137	-0.045	-0.033	0.4960	0.341	0.145	-0.211	-0.046	0.3503
Rb	-0.002	0.897	0.129	-0.011	0.8316	0.085	-0.071	0.892	-0.201	0.8572	-0.108	-0.922	-0.044	-0.086	0.8778
S	0.337	0.002	-0.458	-0.218	0.4604	0.149	0.433	-0.073	0.573	0.5516	-0.096	0.212	-0.275	0.553	0.4406
Sb	0.021	0.120	0.305	0.083	0.1392	0.170	-0.334	0.001	-0.207	0.2127	-0.254	0.043	0.303	-0.127	0.6155
Sn	–	–	–	–	–	0.276	0.291	-0.120	0.042	0.2322	-0.038	0.132	-0.006	-0.109	0.2462
Sr	0.262	0.010	0.857	0.055	0.8187	0.053	-0.923	0.039	-0.179	0.8900	-0.054	-0.113	0.891	-0.161	0.8828
U	-0.039	0.705	-0.147	-0.274	0.6043	-0.105	0.134	0.699	0.212	0.5831	0.106	-0.671	-0.127	0.337	0.6099
W	–	–	–	–	–	–	–	–	–	–	-0.082	0.023	0.034	-0.039	0.5400
Zn	-0.726	-0.175	0.093	-0.122	0.7100	-0.838	0.022	-0.145	0.095	0.7440	0.775	0.128	0.028	0.053	0.6708
F.C.*1	32.4 %	22.6 %	19.7 %	14.6 %	–	33.4 %	22.8 %	21.9 %	14.6 %	–	32.7 %	19.7 %	17.2 %	15.0 %	–

*1: factor contribution



▲ ≧ 1.200 factor 4 factor score

1.200 ≧ ▲ ≧ 0.800 factor 4 factor score

● ≦-1.000 factor 1 factor score

Fig. II-2-18 Distribution map of factor 1 factor score for soil in the Bidu Bidu Hill deposit area

Au :	0.238,	Co :	0.583,	Cr :	0.420,	Cu :	0.405,	Fe :	0.390,
Mn :	0.305,	Ni :	0.588,	Pb :	0.508,	S :	0.089,	Sb :	0.346,
U :	0.405,	Zn :	0.486						

Relatively higher correlation was defined on Co, Ni and Pb of the two sample types. The correlation of individual elements is in general not higher than those defined in the Nungkok deposit area.

(5) Summary of analyses

The distribution of anomalous points of all elements detected by EDA method is shown in Fig. II-2-19. Anomalous areas of Cu, S and U were found near the deposit. However, the anomalous points were also detected in the other areas, that suggests they do not have distinct trend. Anomalous zones of Cu and S are limited within the area 1 km outward of the deposit.

2-3-5 Pan concentrate geochemical survey

(1) Pathfinder elements

Pan concentrate samples collected in the area were analysed for 33 elements like Nungkok area. The results of the chemical analyses and the statistical treatments are presented in Appendix 8 and Table II-2-26 respectively. Analytical values of Ag, Ge, Se, Ta and W are all below their detection limits. Majorities of analytical values of As, Au, Ba, Cu, Pt, Sb, Sn, Te, Th and U are below their detection limits as well. Most of Cr has analytical values higher than the detection limit.

Analytical values of Co, Cr, Mo, Pb, Pt and Sb are higher than those of stream sediment samples, the values of Cu, Fe, Mn, Ni, Sb and U are lower than those of stream sediments. The values of S and Zn are about the same as those of stream sediments.

Elemental correlation matrixes of analytical values are presented in Table II-2-27. The correlation coefficients among elements calculated for the samples collected in this area are generally lower than those of Nungkok deposit. Even Au and Cu which are supposed to be related with the deposit do not have correlation with the other elements.

(2) Single element analysis

The results of the EDA analyses for the pan concentrates are presented in Table II-2-26. The anomalous points detected by this method were shown in Fig. II-2-20. The distribution of the anomalous points did not reveal the relationship between the elemental concentration and the deposit.

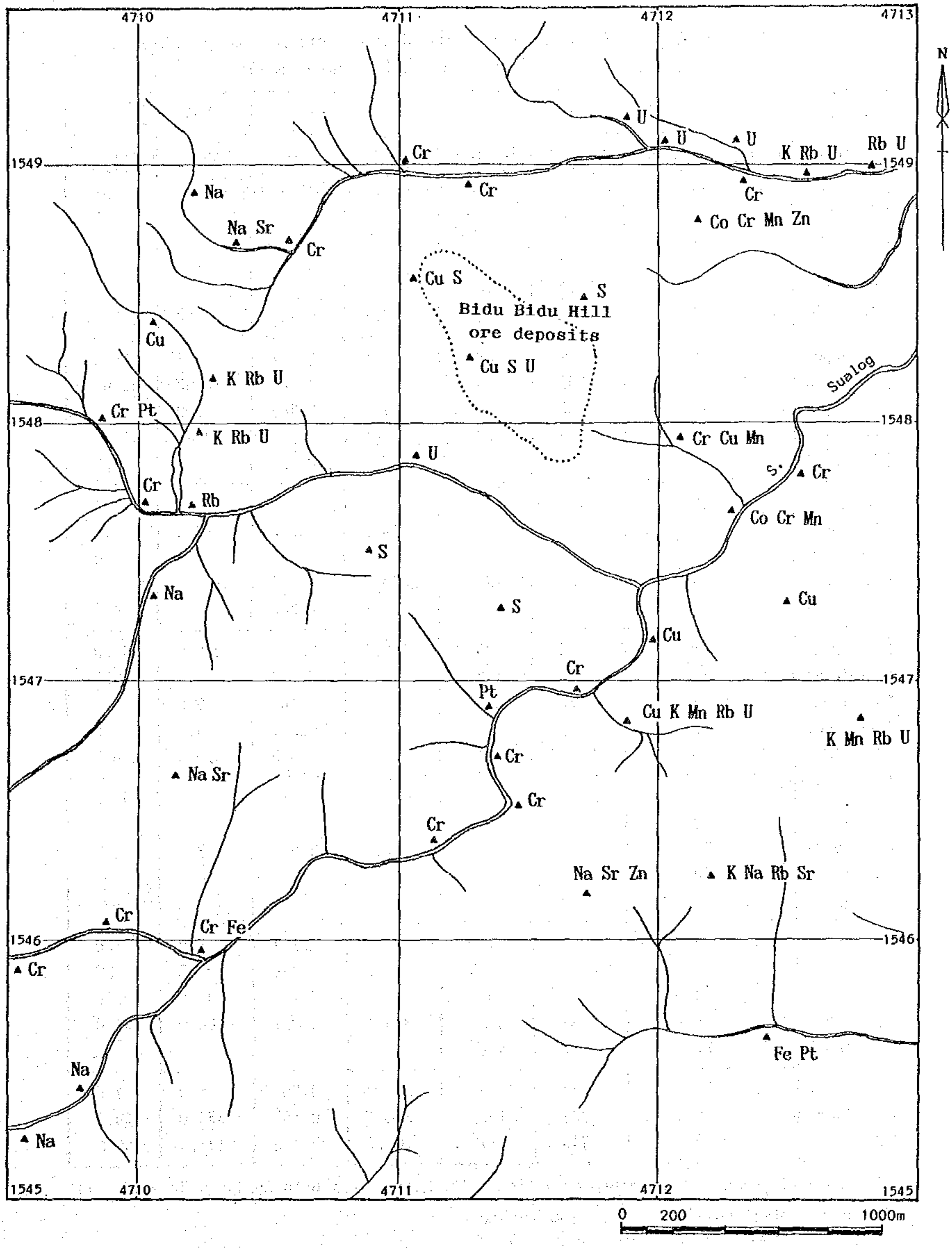


Fig. II-2-19 Interpretation map of soil geochemical survey in the Bidu Bidu Hill deposit area

Table II-2-26 Statistics and thresholds of pan concentrate geochemical survey in the Bidu Bidu Hill 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)	100	< 0.5	< 0.5	—	—	—	—
As (ppm)	75	1	< 1	—	—	—	—
Au (ppb)	78	100	< 2	2.0	0.618	2.0	6.0*5
Ba (ppm)	94	10	< 10	—	—	—	—
Ce (ppm)	56	12	< 2	2.1	0.386	2.0	7.0
Co (ppm)	0	196	67	96.4	0.151	99.0	156.5
Cr (ppm)	0 (94 %*4)	> 10000	2270	—	0.102	10000	10000
Cu (ppm)	72	52	< 1	1.3	0.746	1.0	3.0*5
Fe (%)	0	12.85	4.55	8.44	0.145	9.64	11.15*5
Ga (ppm)	6	23	< 1	7.0	0.330	8.0	12.0
Ge (ppm)	100	< 5	< 5	—	—	—	—
Hg (ppb)	0	120	10	16.1	0.322	10.0	35.0
La (ppm)	56	4	< 1	0.9	0.305	1.0	2.0*5
Mn (ppm)	0	3230	765	2050.0	0.217	2165.0	5055.0
Mo (ppm)	16	5	< 1	2.1	0.315	3.0	4.5
Ni (ppm)	0	915	103	293.0	0.183	303.0	469.0
Pb (ppm)	25	6	< 2	2.5	0.419	2.0	7.0
Pt (ppb)	88	200	< 5	3.6	0.467	5.0	5.0
Re (ppm)	13	14	< 1	2.7	0.367	3.0	7.0
S (%)	0	0.253	0.013	0.031	0.356	0.025	0.079
Sb (ppm)	91	1.0	< 0.2	0.1	0.188	0.20	0.20
Se (ppm)	100	< 0.2	< 0.2	—	—	—	—
Sn (ppm)	97	5	< 2	2.1	0.070	2.0	2.0
Ta (ppm)	100	< 2.0	< 2.0	—	—	—	—
Te (ppm)	88	0.10	< 0.10	—	—	—	—
Th (ppm)	94	2.0	< 1.0	0.53	0.117	1.0	1.0
Ti (%)	0	8.08	0.20	1.8	0.396	2.48	7.29
U (ppm)	84	0.2	< 0.2	0.12	0.165	0.20	0.20
V (ppm)	0	558	239	366.1	0.097	368.0	431.0*5
W (ppm)	100	< 2	< 2	—	—	—	—
Y (ppm)	31	22	< 5	4.9	0.256	5.0	7.5
Zn (ppm)	0	804	108	354.1	0.165	354.0	634.0
Zr (ppm)	0	745	17	167.5	0.375	177.5	407.5

*1: geometric mean *2: standard deviation *3: Exploratory Data Analysis (Kurzl H., 1988)
*4: above detection limit *5: Upper Wisker

Table II-2-27 Coorelation matrix of elements for pan concentrates in the Bidu Bidu Hill deposit area

	Au	Ce	Co	Cr	Cu	Fe	Ga	Hg	La	Mn	Mo	Ni	Pb	Pt	Re	S	Sb	Sn	Th	Ti	U	V	Y	Zn	Zr
Au	1.000																								
Ce	.317	1.000																							
Co	.241	-.298	1.000																						
Cr	.112	-.422	.642	1.000																					
Cu	.057	.206	.133	.123	1.000																				
Fe	-.087	.414	-.072	-.153	.110	1.000																			
Ga	.086	.293	.007	-.009	.031	-.106	1.000																		
Hg	.318	.001	.062	.146	-.112	-.061	.135	1.000																	
La	.211	.959	-.412	-.501	.139	.378	.271	-.051	1.000																
Mn	.066	.576	-.172	-.203	.015	.876	.088	-.013	.538	1.000															
Mo	-.008	-.117	.409	.019	.120	-.223	-.059	-.208	-.124	-.274	1.000														
Ni	.120	-.316	.785	.565	-.003	-.194	.145	.164	-.353	-.322	.210	1.000													
Pb	.082	-.141	.116	.057	-.149	.184	-.053	.384	-.114	.100	-.240	.023	1.000												
Pt	.258	-.106	.036	.076	-.141	-.118	.146	.080	-.146	-.076	.036	-.005	.187	1.000											
Re	-.010	-.298	.428	.458	.237	-.340	-.212	-.108	-.366	-.353	.236	.076	-.079	.109	1.000										
S	-.226	.345	-.245	-.335	.282	.604	-.189	-.109	.320	.493	.008	-.287	.003	-.066	-.254	1.000									
Sb	.032	-.005	.037	.060	.113	.213	-.100	.321	-.005	.073	-.256	.016	.737	-.091	.032	.138	1.000								
Sn	-.090	.357	-.502	-.961	-.099	.095	.000	-.117	.402	.122	-.015	-.454	-.046	-.061	-.367	.220	-.048	1.000							
Th	-.122	-.207	.077	.055	-.134	-.208	.134	-.159	-.188	-.081	.137	.042	.057	-.082	.015	-.258	-.066	-.044	1.000						
Ti	-.102	.350	-.287	-.195	-.093	.864	-.049	.015	.313	.877	-.384	-.413	.181	.012	-.348	.440	.106	.133	-.067	1.000					
U	.330	.406	.174	.085	.073	-.091	.267	.342	.443	.052	-.234	.383	.054	-.129	-.136	-.177	-.009	-.068	-.093	-.154	1.000				
V	-.164	.046	.176	-.032	-.006	.536	-.234	-.270	.049	.369	.253	-.074	.206	.044	-.143	.241	.068	.004	-.063	.431	-.203	1.000			
Y	-.101	.574	-.571	-.566	.197	.482	.071	-.271	.605	.629	-.088	-.668	-.143	-.198	-.241	.409	-.081	.464	.104	.543	-.131	.009	1.000		
Zn	.251	-.308	.914	.637	.078	-.207	.115	.039	-.405	-.191	.510	.713	.009	.019	.384	-.208	-.096	-.569	.193	-.361	.171	.058	-.497	1.000	
Zr	.148	.207	.028	.085	-.248	.443	.101	.284	.176	.615	-.414	.116	.246	.039	-.278	.038	.117	-.089	.186	.608	.234	.053	.180	-.011	1.000

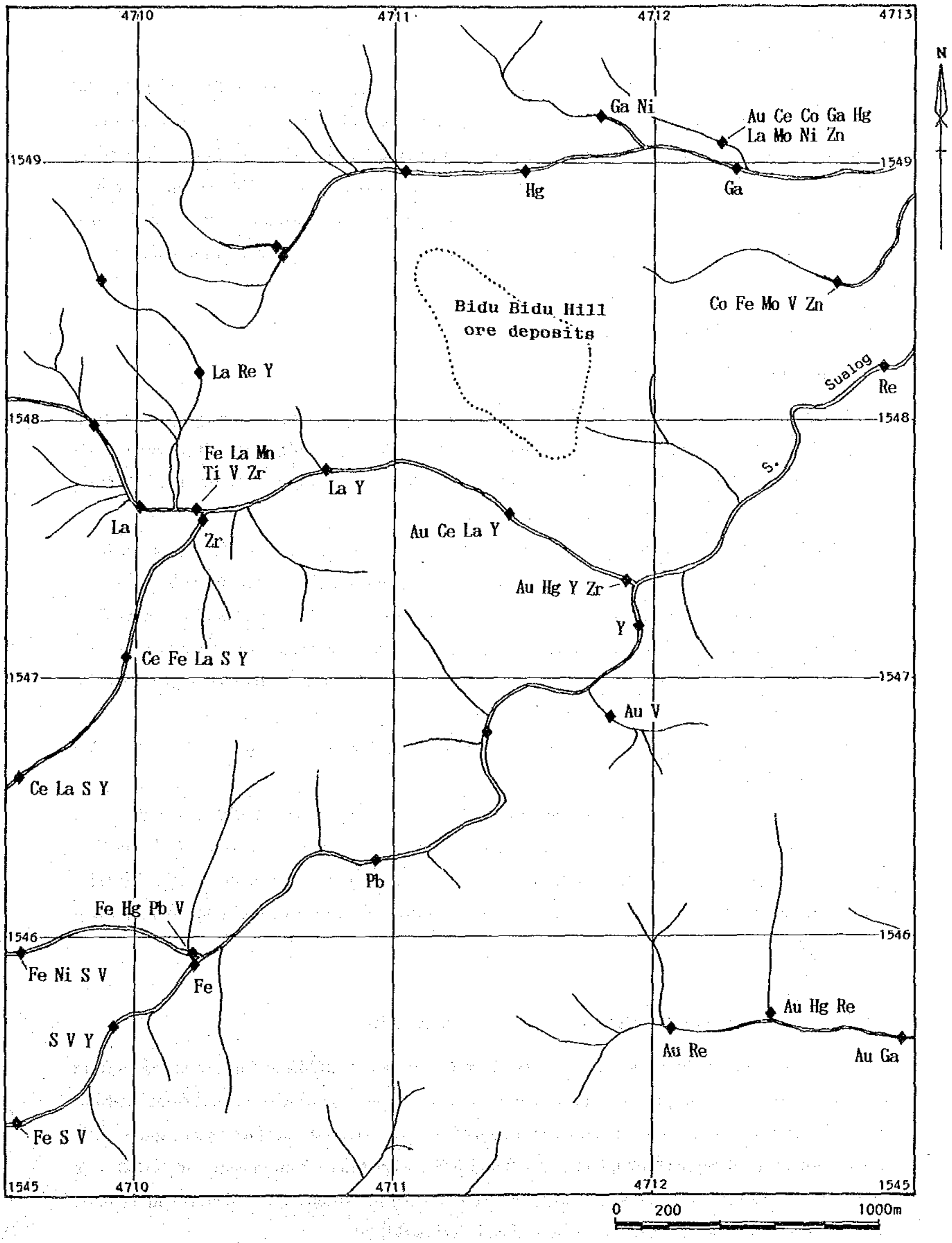


Fig. II-2-20 Interpretation map of pan concentrate survey in the Bidu Bidu Hill deposit area

(3) QME analysis

The result of the QME analysis for the pan concentrate samples is shown in Table II-2-28. The pan concentrate samples are characteristic of large amount of chromite. The samples are black sands and mostly include magnetite, chromite, rutil, goethite, olivine, amphibole, clinozoicite, enstatite, quartz and feldspar. Augite, epidote, garnet and zircon are identified in some samples as well. All samples have approximately the same amount of those minerals described above except for two samples, BPC15 and BPC16, which include less cromite and more amphibole.

2-3-6 Laboratorial studies

(1) Thin section observation

The samples were taken for the thin section observation in this survey area. Five of them were collected from the drilling cores, which were taken from the Bidu Bidu Hill deposit. The result of observation are described in Table II-2-29. The number and the depth of the drilling were shown in the remarks of the table as well.

Samples N015 and G015 are taken from ultra-basic rocks. Sample N015 was taken from serpentinized ultra-basic rock located on the hunging wall of the deposit. The ultra-basic rock is not clearly related to the deposit. Sample G015 was taken from the serpentinized lherzolite. Cumulus structures were observed in the samples. Because the cumulus structure is generally observed in a ultra-basic rock forming ophiolite, the ultra-basic rock in this area is possibly the part of an ophiolite.

Sample N016 was taken from conglomerate situated right on the Bidu Bidu Hill deposit. The rock is chloritized.

Samples other than those described above were taken from basalt intercalated within the Chert-Spilite Formation and from fine grained gabro intruding into the basalt. Rock forming minerals of these rocks are mostly similar, thus these rocks are probably in one series. Chlorite can be observed as a secondary mineral. Therefore the rocks are thought to be generally chloritized.

(2) Polished section and polished thin section observation

Five samples for polished sections and two samples for polished thin sections were taken from the survey area. The samples were all taken from the drilling cores which were cut from the Bidu Bidu Hill deposit, because no mineralized zone could be observed on the surface except some small gossan outcrops. Samples N020, N021, N022 and N024 were taken from massive ore, N025 was taken from stockwork ore and N019 was taken from the argillized zone situated on the uppermost part of the ore. The observations were described in Table II-2-30.

Chalcopyrite, pyrite, sphalerite, marcasite, bornite chalcocite and covellite were identified on

Table II-2-28 Results of qualitative mineral examination of pan concentrates in the Bidu Bidu Hill deposit area

Mineral Names \ Sample Number	BPC 01	BPC 02	BPC 03	BPC 04	BPC 05	BPC 06	BPC 07	BPC 08	BPC 09	BPC 10	BPC 11	BPC 12	BPC 13	BPC 14	BPC 15	BPC 16
Magnetite	4.5	8.2	3.7	5.0	5.2	5.6	5.5	4.2	1.9	1.1	11.7	8.5	7.1	3.5	3.3	3.3
Chromite	75.2	78.7	90.7	81.6	83.0	76.0	84.8	86.9	83.0	46.6	58.0	65.5	79.2	87.6	16.0	Tr
Rutile	Tr	2.7	Tr	0.9	Tr	Tr	Tr	Tr	Tr	1.9	Tr	3.5	5.4	1.9	6.6	Tr
Goethite	Tr	1.8	1.0	1.9	1.9	2.7	0.9	Tr	2.8	23.4	7.1	3.5	2.7	2.8	1.9	Tr
Olivine	Tr	Tr	Tr	Tr	Tr	Tr	Tr	Tr	0.9	2.8	2.2	0.8	Tr	Tr	2.8	4.1
Augite	Tr											4.4	Tr	Tr		
Amphibole	2.5	1.8	0.9	2.8	1.9	1.8	1.9	1.4	1.8	4.7	4.5	2.6	Tr	Tr	14.2	61.2
Clinozoisite	Tr		Tr	Tr	Tr	Tr	Tr	Tr	Tr	2.8	Tr	Tr	Tr	Tr	6.6	2.4
Epidote												Tr				
Garnet				Tr	Tr	Tr	Tr	Tr	Tr	Tr	Tr	Tr	1.3	Tr		
Zircon		Tr	Tr			Tr							Tr	Tr		
Enstatite	8.4	5.4	2.9	6.6	6.5	9.2	4.7	6.6	5.5	11.2	13.4	7.0	2.7	1.9	46.2	12.2
Qnarts	0.1	0.1	0.1	0.1	Tr	0.2	Tr	Tr	0.1	0.2	0.3	0.2	Tr	0.1	0.1	0.7
Plagioclase	9.3	1.4	0.7	1.1	1.5	4.5	2.2	0.9	4.5	5.3	2.8	3.9	1.6	2.2	2.3	16.1

Mineral Names \ Sample Number	BPC 17	BPC 18	BPC 19	BPC 20	BPC 21	BPC 22	BPC 23	BPC 24	BPC 25	BPC 26	BPC 27	BPC 28	BPC 29	BPC 30	BPC 31	BPC 32
Magnetite	8.5	13.3	7.7	1.9	9.9	10.6	12.4	14.3	6.6	17.0	4.5	1.3	4.3	3.8	3.9	4.1
Chromite	78.3	73.7	86.4	94.4	80.6	78.4	76.5	75.4	84.8	73.5	82.7	81.7	87.3	85.2	90.5	82.4
Rutile	Tr	1.7	1.8	1.0	2.7	2.6	1.7	0.8	1.8	1.7	1.8	0.4	4.7	Tr	1.9	0.5
Goethite	2.7	3.4	1.4	0.5	1.3	1.3	2.6	4.2	1.4	3.3	1.4	1.8	1.0	0.9	0.5	0.5
Olivine	Tr	Tr	Tr	Tr	Tr	Tr	Tr	Tr	Tr	Tr	Tr	Tr	Tr	0.5	Tr	Tr
Augite																
Amphibole	Tr	1.7	0.5	Tr	0.4	0.9	1.3	0.7	0.5	0.8	0.5	Tr	Tr	Tr	Tr	Tr
Clinozoisite	0.9	Tr	Tr	Tr	Tr	Tr	Tr	0.8	0.5	Tr	Tr	Tr	Tr	0.9	Tr	Tr
Epidote	Tr	Tr								Tr		Tr				
Garnet	Tr	Tr	Tr		Tr	Tr	Tr	Tr	Tr	Tr	Tr	Tr	Tr	Tr		
Zircon			Tr		Tr	Tr		Tr		Tr						Tr
Enstatite	7.2	4.2	1.8	Tr	4.5	3.5	3.4	2.5	2.8	3.3	5.5	4.4	1.9	5.6	0.9	0.5
Qnarts	0.1	0.2	Tr	0.3	0.1	0.2	0.2	0.1	0.1	Tr	0.4	0.4	0.1	0.4	0.3	0.2
Plagioclase	2.3	1.8	0.4	1.9	0.4	2.5	1.9	1.2	1.5	0.4	3.2	10.0	0.7	2.7	2.0	1.8

Table II-2-29 Observation results of thin sections collected in the Bidu Bidu Hill deposit area

Sample No.	Location	Descriptions	Texture	Fragments				Grains and phenocryst						Matrix & groundmass				Secondary minerals												Remarks (DDH No) (Depth)
				Basalt	Dolerite	Altered rock	Altered gabbro	Plagioclase	Hornblende	Clinopyroxene	Orthopyroxene	Olivine	Opaque minerals	Sand	Silt	Plagioclase	Chromian spinel	Tremolite	Chlorite	Prehnite	Montmorillonite	Quartz	Epidote	Actinolite	Serpentinite	Talc	Calcite	Saponite	Opaque minerals	
N011	South of ore deposit	Dark green micro-gabbro	Ophitic					◎	◎				○						○					•					•	
N012	Ore deposts area	Dark green massive basalt	Intergranular					◎	◎				○																	
N015	Ore deposts area	Dark green chloritized peridotite (HW)	—														•								◎	◎			•	WS88-8 61.60 m
N016	Ore deposts area	Reddish brown conglomerate with rounded material (HW)	Clastic	◎	◎	•								◯	◯				•											WS89-134 45.30 m
N027	Ore deposts area	Dark green chloritized & brecciated basalt (FW)	Clastic			◯	◎							◯	◯				•											WS88-8 85.50 m
N029	Ore deposts area	Light green argillized & brecciated basalt (FW)	Intergranular					◎		◯									•	•							•	•	•	WS88-9 89.70 m
N030	Ore deposts area	Light green fine-grained gabbro with gypsum (HW)	Equigranular					◎	○	◎			•					•						•						WS89-13 90.20 m
T006	S. Sualog	Dark green fine-grained gabbro	Granular & poikilitic					◎	◯	◯	•								○						•					
G015	Northwestern corner	Black lehrzolite	Cumulus							◯	◯	◎					○								◎	◯			○	
G018	Northwestern corner	Dark green weakly sili. basalt with pyrite diss.	Intergranular					◎		◯	○								◎		○	◯	◯						○	

HW: hanging wall rocks. FW: footwall rocks. ◎: abundant ◯: common ○: little •: rare

Table II-2-30 Observation results of polished and polished thin sections collected in the Bidu Bidu Hill deposit area

	Sample No.	Location	Descriptions	Texture	Observed minerals													Remarks (DDH No.) (Depth)
					Chalcopyrite	Bornite	Chalcocite	Covellite	Sphalerite	Pyrite	Marcasite	Gangue minerals	Quartz	Sericite	Chlorite	Carbonate minerals	Montmorillonite	
Polished section	N020	Ore deposit area	Massive and compact sulfide ore.	Massive	∘	◎	○	•		○		•						WS88-8, 78.70 m Secondary enrichment.
	N021	Ore deposit area	Fine-grained pyrite ore.	Massive	•				•	◎	◎	•						WS88-54, 59.60 m Colloform pyrite.
	N022	Ore deposit area	Weakly brecciated compact chalcopyrite-pyrite ore.	Massive	◎				•	○		•						WS89-91, 46.10 m.
	N024	Ore deposit area	Fine-grained pyrite ore with minor chalcopyrite.	Massive	○	○	•			○		∘						WS89-115, 32.50 m. Framboidal pyrite, crushed. Secondary enrichment.
	N025	Ore deposit area	Fine-grained pyrite diss. ore with minor chalcopyrite.	Disseminat.	•					◎		◎						WS89-136, 179.40 m.
Polished thin section	N019	Ore deposit area	Strongly chloritized basalt with pyrite stringer & diss.	Pyroclastics	○				•	◎					◎	○	○	WS89-98, 74.00 m
	N025	Ore deposit area	Fine-grained pyrite diss. ore with minor chalcopyrite.	Disseminat.	•				•	◎			◎	○	○			WS89-136, 179.40 m. Crushed & fractured.

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

the polished sections. These ore minerals are all fine grained. Colloform and/or framboidal textures were very often identified in the pyrites. Thus the ore deposit is thought to be of sedimentary origin.

Prominent chloritization was observed on the polished section of sample N019, which was taken from the uppermost part of the ore deposit. Sericitization and chloritization were observed in the host rock of the stockwork deposit.

(3) X-ray diffraction analyses

Six samples collected in the area were tested by X-ray diffraction as shown in Table II-2-31. The samples were taken from the drilling cores drilled into the Bidu Bidu Hill deposit.

Sample N015, which is of basalt lavas distantly apart from the deposit and corresponded to the hanging wall of ore deposit, is characteristic of kaolinite. In sample N017, which is of sedimentary rock fractured as phyllite and situated on the hanging wall side of the deposit near the deposit, montmorillonite was identified. That suggests that the rock is less strongly altered than the rock situated on the footwall side of the deposit being described later. Sample N018, which is taken from the altered basalt situated right on the deposit, is characteristic of strong chloritization and hematitization. Sample N019 which is taken from the stockwork ore, being a part of the deposit, is thoroughly altered into chlorite. Sample N027 and N028 are taken from the basalt lavas situated on the footwall side of the deposit. In the rocks situated on the footwall side, chlorite and montmorillonite were in general identified except local part with thorough chloritization as described.

(4) EPMA analysis

Three samples, selected from polished section samples based on the observations, were presented for EPMA analysis. Three points on chalcopyrite and two points on sphalerite were analysed by the method. The results of the EPMA analyses are presented in Table II-2-17.

The analytical result suggests that sphalerite was formed in lower temperature condition, because zinc content in the sphalerite is comparatively low. Chalcopyrite has a approximately theoretical composition without any variance.

Table II-2-31 Results of X-ray diffraction analyses in the Bidu Bidu Hill deposit area

Sample No.	Location	Descriptions	Detected minerals													Remarks (DDH No.) (Depth)
			Quartz	Plageoclase	Hornblende	Augite	Calcite	Analcite	Chlorite	Montmorillonite	Kaolinite	Goethite	Hematite	Pyrite	Chalcopyrite	
N015	Ore deposit area (DDH)	Dark green chloritized basalt (H.W.)			◯				○		◯					WS88-8 61.60 m
N017	Ore deposit area (DDH)	Reddish brown phyllitic sediments (H.W.)	◯							○		•				WS89-136 133.90 m
N018	Ore deposit area (DDH)	Strongly chloritized & hematized sheared basalt			◯		◯		◯				○			WS88-8 (HW) 74.10 m
N019	Ore deposit area (DDH)	Stockwork ore							○					○	○	WS89-98 74.00 m
N027	Ore deposit area (DDH)	Dark green chloritized brecciated basalt (F.W.)		○	•	○		○	•	•						WS88-8 85.50 m
N028	Ore deposit area (DDH)	Light green strongly argillized basalt (F.W.)							◎							WS88-10 139.80 m

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