2-7 Area E

2-7-1 Geology and mineralization

(1) Survey area

Based on the regional geochemical survey results, this area was selected as the potential area of gold copper deposits. A soil geochemical survey was carried out in this area.

This area is situated at a central part of Semporna area, 30 km north of Tawau. This area is situated along Sungai Langein which is a tributary of the upper most stream of Sungai Kalumpang.

The survey area is flat in the northern part. The central to southern part show steep volcanic topography and the elevation at the southern end is approximately 1,000 m. The survey area is entirely covered with secondary forest.

(2) Geology

This area is situated at the western marginal part of volcanic belt in Semporna Peninsular. Geology in Area E consists of Kuamut formation (P_4Km) of Oligocene to middle Miocene in age and andesitic volcanic rocks (An_1) of Pliocene. Geologic map is shown in Fig. II-2-22.

The Kuamut formation is distributed in the northern part of the area and consists of light greenish gray siliceous shale and light brown tuffaceous siltstone. The siliceous shale intercalates thin tuff and siltstone beds. Andesitic volcanic rocks occurs in the central to southern part of the area and consists of andesite lava and andesitic tuff breccia. Observation results of thin section (M602) indicate strong chloritization in the volcanic rocks.

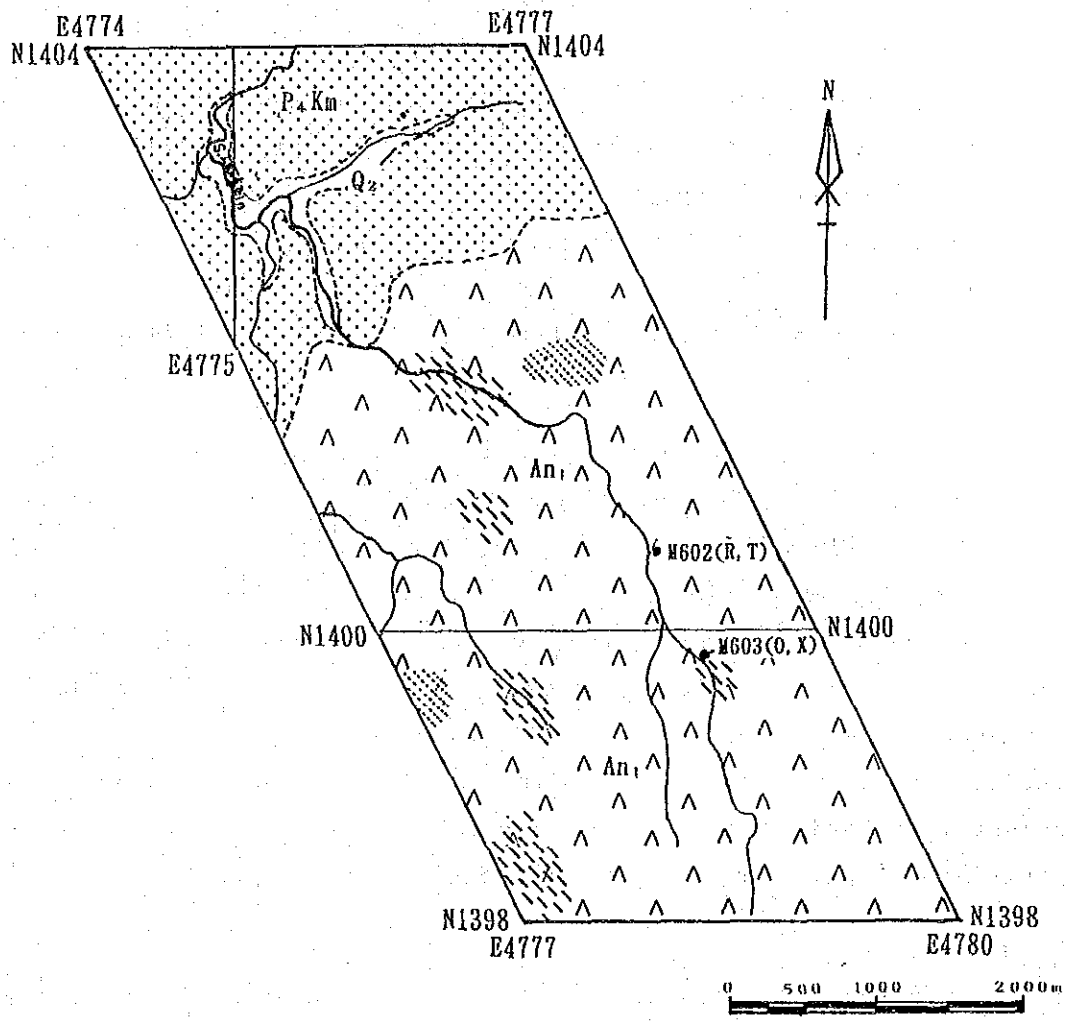
(2) Mineralization

Silicified and argillized zones with pyrite dissemination are found in andesitic volcanic rocks. Silicified zones are found in some places from central to southern part of the area. In these silicified zones, limonite and fine-grained pyrite disseminations are recognized. One samples (M603) collected from the mineralized zone was assayed but the result were not attractive. This sample shows only slightly higher value of S (1.90 %).

2-7-2 Soil geochemical survey

(1) Sampling

Soil samples were adopted as the sample media in this survey. Locations of the samples are shown in Fig. II-2-23 and list of sample are given in Appendix 33.



Recent — Q_2 — Riverine alluvium.

Pliocene — An_1 — Andesite and its pyroclastics.

Oligocene-Middle Miocene — P_4Km — Kuamut Formation: shale and tuffaceous siltstone.

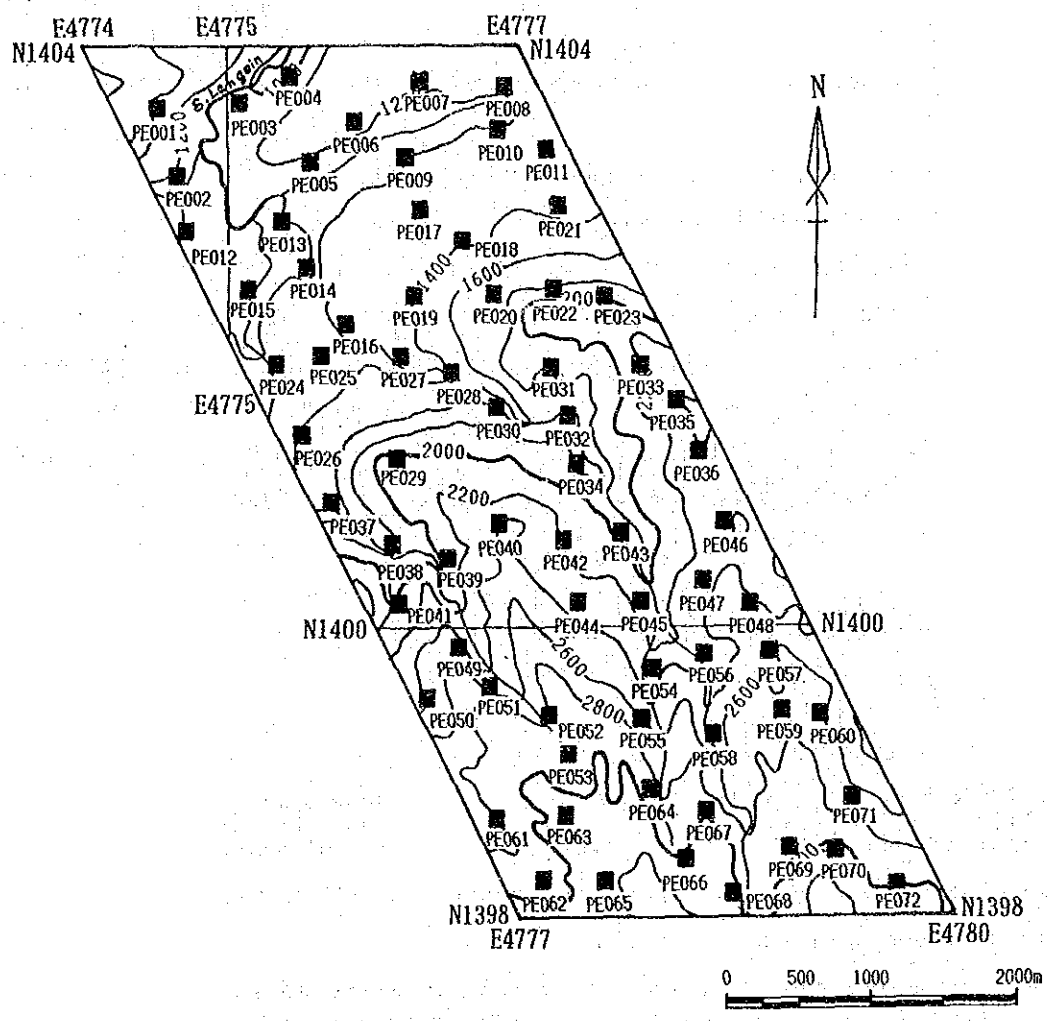
Silicified zone with weak pyrite dissemination.

Argillized zone

• Location of sample for laboratorial studies and sample number.

(O);Ore assaying,
(R);Geochemical analysis,
(T);Thin section,
(X);X-ray diffraction analysis.

Fig. II-2-22 Geologic map of Area E



■ Location of soil sample and sample number
PE045

Fig. II-2-23 Location map of geochemical samples in Area E

After drying up these samples, -80 mesh fraction samples were prepared for the sample of chemical analyses.

(2) Statistical data treatment

Analytical results are shown in Appendix 34. These analytical results were input in computer and statistically treated. The statistics calculated are given in Table II-2-18.

The calculated geometric means give following tendencies comparing with other areas.

Elements indicating higher value: Ba, Pb.

Element indicating lower value: Cr, Ni, Sb, Zn.

In order to clarify the relationship between the elements, correlation coefficient was also calculated. As the results, following pair of element give comparatively good (correlation coefficient: more than 0.500) correlations.

As-Mo, As-Pb, As-S, As-Sr, As-Ti, As-U, As-W, Co-Mg, Co-Mn, Co-Zn, Cr-Ni, Hg-Ti, K-Mg, K-Na, K-Ni, Mg-Mn, Mg-Zn, Mo-Pb, Mo-S, Mo-Ti, Mo-U, Mo-W, Pb-S, Pb-Sr, Pb-Ti, Pb-U, Pb-W, S-Sr, S-Ti, S-U, S-W, Sb-Sr, Ti-U, Ti-W, U-W.

The elments including As, Mo, Pb, S, Ti, U and W give good correlation among them. This tendency is different compare to the survey results for Segama area (Area A, B, C and D).

(3) Single element analysis

Based on the results of statistical data treatment, the threshold values were determined using EDA method. Distribution maps of each element were prepared (Appendix 35) using the values delineated by EDA method. Distribution of each element is summarized as following;

As: High value and anomalous zones are concentrated in the southeastern part of the area and the maximum value (6,683 ppm) is significantly high. This zone is situated in altered andesite.

Au: High value and anomalous zones are scattered. The sample indicated the maximum value (181 ppb) is situated in Kuamut formation ar the north.

Ba: high value and anomalous zones are found in the area of altered zones of andesite.

Co: High value zones are found in the western half of the area. No distinct relationship between the high value zone and geology are recognized.

Cr: High value and anomalous zones are restricted in the area of Kuamut formation at the north.

Cu: High value and anomalous zones are found southern and north western parts of the area zones. The significant anomalous zone is situated at the south

Table II-2-18 Statistics of soil geochemical survey in Area E

Element	Statistics						EDA method*3		
	Below detection limit (%)	Maximum value	Minimum value	Mean*1 value (b)	Standard deviation	b + 2S.D. *2	Median	Upper Wisker	Upper Fence
As (ppm)	51.4	6,682	< 1	2.6	0.957	210.5	0.5	14.0	894.4
Au (ppb)	70.8	181	< 1	0.8	0.458	6.7	0.5	1.0	2.8
Ba (ppm)	—	1,274	1	118.2	0.279	426.3	102.5	206.0	558.1
Co (ppm)	1.4	58	< 1	14.0	0.408	91.6	17.0	29.0	—
Cr (ppm)	—	129	30	47.2	0.193	114.7	44.5	71.0	—
Cu (ppm)	—	117	11	43.1	0.183	100.3	45.0	59.0	—
Hg (ppb)	—	254	< 10	78.1	0.251	248.0	77.0	137.0	—
K (%)	2.8	1.04	< 0.01	0.110	0.597	1.727	0.125	0.430	—
Mg (%)	—	1.27	0.31	0.344	0.356	1.776	0.380	0.690	—
Mn (ppm)	51.4	2,917	< 5	31.4	1.227	8,916.2	2.5	830.0	—
Mo (ppm)	54.2	12	< 1	1.0	0.362	5.1	0.5	2.0	—
Na (%)	—	0.59	< 0.01	0.166	0.273	0.583	0.160	0.250	—
Ni (ppm)	—	71	12	17.7	0.206	45.7	17.0	28.0	61.0
Pb (ppm)	43.1	1,253	< 2	3.5	0.636	65.7	3.5	8.0	129.6
S (%)	—	0.428	0.004	0.023	0.279	0.085	0.024	0.034	0.111
Sb (ppm)	8.3	16.0	< 0.2	2.98	0.606	48.71	5.20	8.00	—
Sr (ppm)	—	299	1	23.6	0.412	157.5	22.5	59.0	—
Ti (%)	—	2.90	0.02	0.722	0.152	1.457	0.730	0.930	1.992
U (ppm)	—	5.2	< 0.2	1.83	0.167	3.96	1.80	2.40	3.55
W (ppm)	95.8	21	< 2	1.1	0.178	2.5	1.0	1.0	1.0
Zn (ppm)	—	84	32	58.5	0.102	93.7	59.5	73.0	—

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

eastern part of the area.

Hg: High value and anomalous zones are found in the south and north marginal parts of the area.

K : High value zones are found in the area of Kuamut formation at the north.

Mg: High value zones are found in the western half of the area. The distribution tendencies area similar to the distribution of Co.

Mn: No clear distribution tendencies are recognized.

Mo: High value zones are found in the central part of the area. The distribution tendency is similar to the distribution of As.

Na: High value zones are also found in the central part of the area. Relationship between the value and geology is not clear.

Ni: High value zones are distributed northern part of the area where Kuamut formation occurs.

Pb: High value and anomalous zones are found in the northern and southern parts of the area. The most significant anomalous zone is recognized in the anomalous zones of As and Mo.

S : High value zones are concentrated in the southern part of the area. These zones are mostly situated in the altered zones.

Sb: High value zones are found in the central part of the area. The anomalous zones are mostly found in the altered zones.

Sr: High value zones are found in the central part of the area. No clear relationship between the distribution and the geology is recognized.

Ti: High value zones are distributed in the south. Relationship with the geology is not clear.

U : High value zones are found in the south. No relationship with the sedimentary rocks is recognized.

W : High value zones are situated in the anomalous zones of As, Mo and Pb.

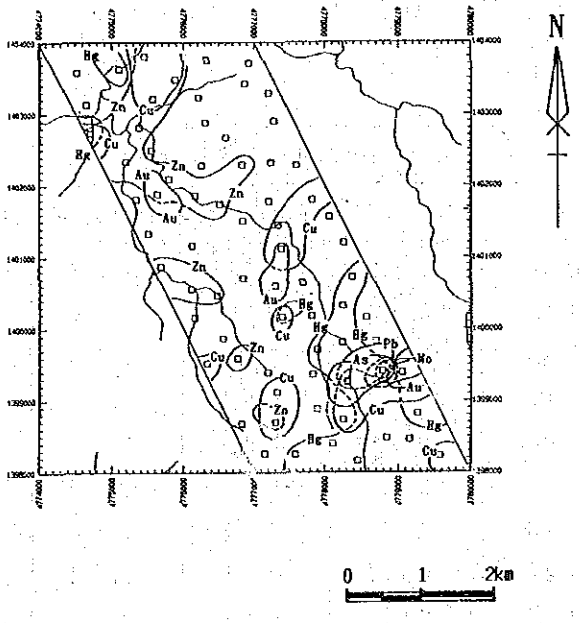
Zn: High value zones are found from western to northern parts of the area and show similar distribution tendencies of Co and Mg. No clear relationship between the distribution and geology is recognized.

According to the distribution maps, the elements which are possibly useful for the survey in this area were selected and anomaly map (Fig. II-2-24) of these elements was prepared. As shown on this map, anomalous zones of As, Au, Cu, Mo and Pb are overlaped in a limited area at south eastern part of the area and this zone is significant anomalous zone.

(4) Multi element analysis

Factor analysis was adopted as the multi element analysis in this survey. The results of factor analysis are given in Table II-2-19. The relationship between the elements and factors are as following;

Factor 1 : (As)-(Au)-Cu-Mo-S-Ti.



As	>	894.4 ppm	Hg	>	137.0 ppb	S	>	0.111 %
Au	>	2.8 ppb	Mo	>	5.1 ppm	Zn	>	73.0 ppm
Cu	>	59.0 ppm	Pb	>	129.6 ppm			

Fig. II-2-24 Distribution map of geochemical anomalous zones in Area E

Table II-2-19 Results of factor analyses for soil samples in Area E

Element	Factor loading (Varimax rotation)					Communality
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	
As	0.480	-0.119	-0.013	0.298	0.589	0.6804
Au	0.473	-0.036	-0.004	-0.006	0.055	0.2281
Ba	0.074	0.801	-0.023	-0.223	0.063	0.7005
Co	-0.167	0.114	-0.066	-0.867	-0.143	0.8176
Cr	-0.013	0.018	0.827	0.261	0.092	0.7612
Cu	0.513	-0.019	-0.367	-0.440	-0.222	0.6412
Hg	0.492	-0.254	-0.293	0.234	0.168	0.4751
K	-0.462	0.574	0.400	-0.112	0.144	0.7362
Mg	-0.332	0.370	0.186	-0.575	0.211	0.6575
Mn	-0.220	0.449	-0.003	-0.678	0.126	0.7257
Mo	0.670	0.102	-0.013	0.107	0.168	0.4992
Na	0.164	0.627	-0.172	-0.390	-0.242	0.6606
Ni	-0.217	0.090	0.807	-0.221	-0.050	0.7580
Pb	0.320	0.037	0.037	0.220	0.762	0.7347
S	0.703	0.339	-0.230	0.164	0.066	0.6936
Sb	0.049	0.306	0.054	-0.199	0.497	0.3858
Sr	0.037	0.795	0.196	0.014	0.196	0.7101
Ti	0.771	-0.101	-0.136	0.123	0.230	0.6908
U	0.460	0.116	0.095	0.538	0.096	0.5335
W	0.434	0.201	-0.026	0.357	0.381	0.5024
Zn	0.036	0.224	0.061	-0.882	-0.176	0.8647
F.C.*1	25.9 %	20.6 %	14.2 %	26.4 %	12.9 %	—

*1: Factor contribution

Factor 2 : Ba-K-(Mn)-Na-Sr.

Factor 3 : Cr-Ni.

Factor 4 : Co-Mg-Mn-Zn.

Factor 5 : As-Pb-(Sb).

Among these factors, factor 4 has negative relationship with the elements. Judging from the relationship between the factor and the elements, factor 1, 4 and have may related to mineralization. Consequently, a distribution map (Fig. II-2-25) of factor scores of these three factors were prepared using different colors for each factor. The relationship between the color and the factor are as following;

Factor 1 : red Factor 4 : blue Factor 5 : yellow

Distribution tendencies for these factors are summarized as following;

Factor 1: High factor score zones are found at the south eastern part of the area where anomalous zones are overlaped.

Factor 4: High factor score zones are found in the western part of the area and no relationship with the geology is recognized.

Factor 5: High factor score zones are found in the south eastern part of the area where high factor scores of factor are distributed. The high factor score zone is also found in the northern part.

According to the results of the factor analyses, the area with overlapping of factor 1 and 5 high factor score zones is interpreted as potential area.

2-8 A r e a F

2-8-1 Geology and mineralization

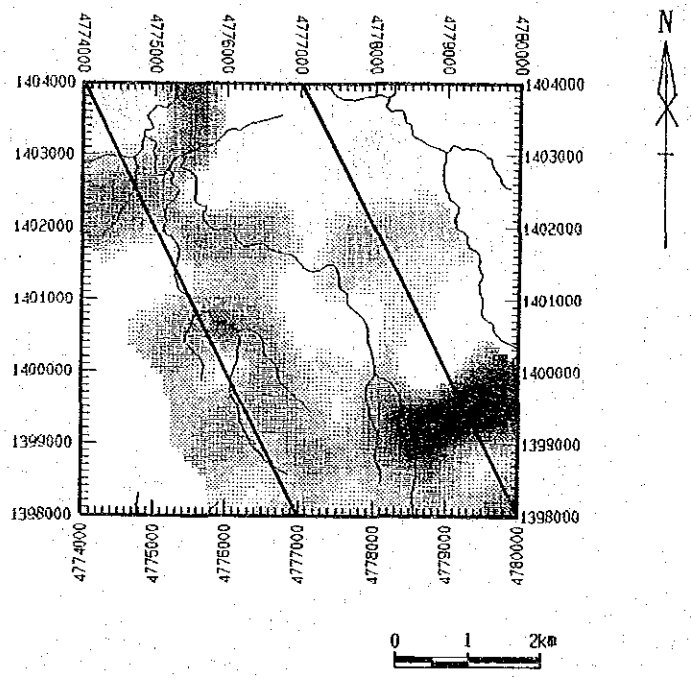
(1) Survey area

Based on the result of regional geochemical survey in Phase II, this area was selected as a potential area of gold ore deposits. Soil geochemical surveys were adopted for the survey in this area.

Area F is situated approximately 20 km north of Tawau in the central south part of Semporna area. The central part of the area is hilly topography and is used for plantation. The northern part of the area indicates comparatively steep topography of volcanics. Upper stream of Sungai Tawau is situated at the north of the area.

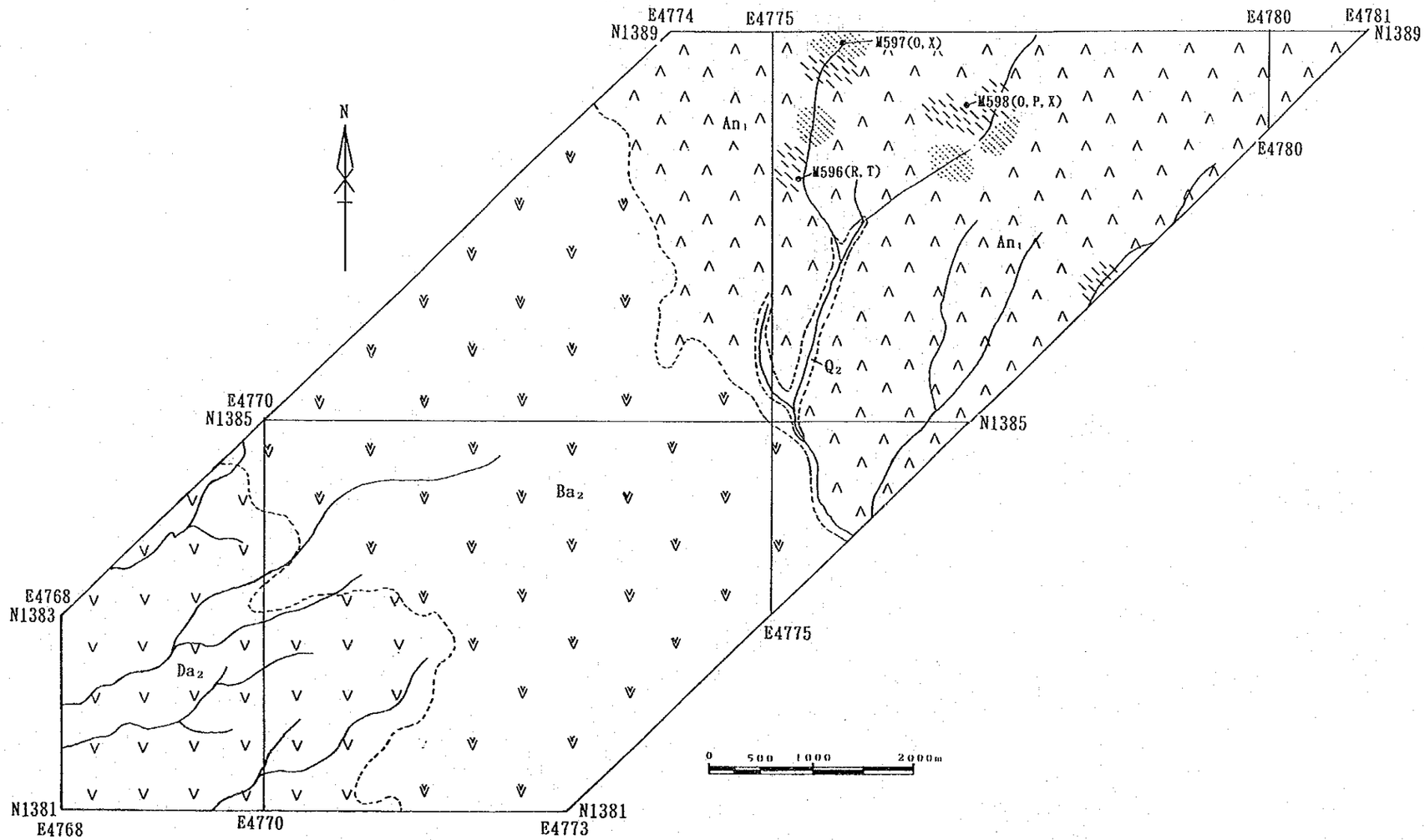
(2) Geology

Area F is situated at the western marginal part of the volcanic belt in Semporna peninsular. Geology of this area consists of Pliocene volcanic rocks (An_1) and Pleistocene volcanics (Da_2 and Ba_2). The geologic map of this area is shown in Fig. II-2-26.



Factor 1 factor score: Red Factor 4 factor score: Blue
Factor 5 factor score: Yellow

Fig. II-2-25 Distribution map of factor scores in Area E



Recent — Q_2 — Riverine alluvium.

Pleistocene — Ba_2 — Olivin basalt.

Pleistocene — Da_2 — Dacite and its pyroclastics.

Pliocene — An_1 — Andesite and its pyroclastics.

Silicified zone.

Argillized zone.

• Location of sample for laboratorial studies and sample number.
(O);Ore assaying, (P);Polished section,
(R);Geochemical analysis, (T);Thin section,
(X);X-ray diffraction analysis.

Fig. II-2-26 Geologic map of Area F

Pliocene volcanic rocks (An_1) consist of andesite lava and andesitic pyroclastic rocks and are distributed in the north eastern part of the area. Observation results of thin section (Table II-2-2) indicate that the andesite lava is hornblende pyroxene andesite. Silicified and argillized zones are found within this andesite lavas. Pleistocene dacite and dacitic pyroclastics (Da_2) occur in the south western part of the area. Basalt lavas (Ba_2) are found over andesitic and dacitic rocks in the central part of the area. This basalt is olivine basalt.

Alluvium (Q_2) is found along rivers.

No significant fault systems are recognized in this area.

(3) Mineralization

Silicified and argillized zones with pyrite dissemination are recognized in the area of Pliocene andesite. Within altered zone, hot spring is recognized and the surroundings are strongly argillized.

2-8-2 Soil geochemical survey

(1) Sampling

Soil samples were collected in this survey. Locations of the soil samples are shown in Fig. II-2-27. List of samples collected in this srvey are shown in Appendix 36. After drying up these samples, -80 mesh fraction samples were collected and chemical analyses were conducted for these fraction samples.

(2) Statistic data treatment

The analytical results of soil samples are shown in Appendix 37. The results were input in computer and the data were statistically treated. The statistics calculated are given in Table II-2-20.

The calculated geometric means give following tendencies comparing with other areas.

Elements indicating higher value: AS, Hg, Mo, S, Ti, Ui.

Element indicating lower value: K, Mg, Na, Sr.

In order to clarify the relationship between the elements, correlation coefficient was also calculated. As the results, following pair of element give comparatively good (correlation coefficient: more than 0.500) correlations.

As-Ab, As-Sr, AS-W, Au-Zn, Ba-Co, Ba-Mn, Ba-Ni, Co-Cr, Co-Cu, Co-Mn, Co-Ni, Co-Ti, Co-U(-), Cr-Ni, Cr-Ti, Cr-U(-), Cu-Ni, Cu-U(-), Cu-Zn, Hg-Sb, K-Mg, Mn-Ni, Ni-Ti, Ni-U(-), Pb-Sr, Pb-W, S-Sr, Ti-U(-).

Among the elments, Au and Zn characteristically indicate high correlation coefficient (0.903).

Table II-2-20 Statistics of soil geochemical survey in Area F

Element	Statistics						EDA method*3		
	Below detection limit (%)	Maximum value	Minimum value	Mean*1 value (b)	Standard deviation	b + 2S.D. *2	Median	Upper Wisker	Upper Fence
As (ppm)	41.8	597	< 1	3.9	0.860	206.1	5.0	24.0	—
Au (ppb)	85.2	185	< 1	0.6	0.315	2.7	0.5	0.5	0.5
Ba (ppm)	—	1,065	14	88.8	0.439	670.5	76.5	238.0	—
Co (ppm)	7.4	92	< 1	10.8	0.602	—	10.5	50.0	—
Cr (ppm)	—	402	12	88.9	0.444	—	72.5	279.0	—
Cu (ppm)	—	100	15	43.3	0.176	97.6	47.0	63.0	—
Hg (ppb)	—	735	34	138.5	0.209	362.4	137.0	202.0	455.7
K (%)	4.1	1.29	< 0.01	0.045	0.475	0.403	0.040	0.100	0.640
Mg (%)	—	0.87	0.01	0.105	0.390	0.634	0.090	0.220	1.407
Mn (ppm)	62.3	8,171	< 5	26.8	1.372	—	2.5	1,513.0	—
Mo (ppm)	12.3	7	< 1	2.0	0.299	—	2.0	3.0	5.5
Na (%)	—	30.12	0.02	0.106	0.309	0.441	0.100	0.140	0.329
Ni (ppm)	0.8	239	< 1	34.5	0.538	—	21.5	144.0	—
Pb (ppm)	73.8	234	< 2	1.8	0.511	19.4	1.0	5.0	5.7
S (%)	—	0.721	0.012	0.039	0.280	0.140	0.035	0.055	0.149
Sb (ppm)	4.9	55.7	< 0.2	4.75	0.501	47.75	6.10	10.70	—
Sr (ppm)	—	527	2	16.2	0.504	165.0	14.0	37.0	217.9
Ti (%)	—	2.77	0.34	1.150	0.203	—	1.110	1.920	—
U (ppm)	—	4.2	1.0	2.12	0.152	—	2.00	3.00	—
W (ppm)	93.4	11	< 2	1.1	0.163	2.3	1.0	1.0	1.0
Zn (ppm)	—	1,423	16	68.7	0.293	264.6	58.5	128.0	552.0

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

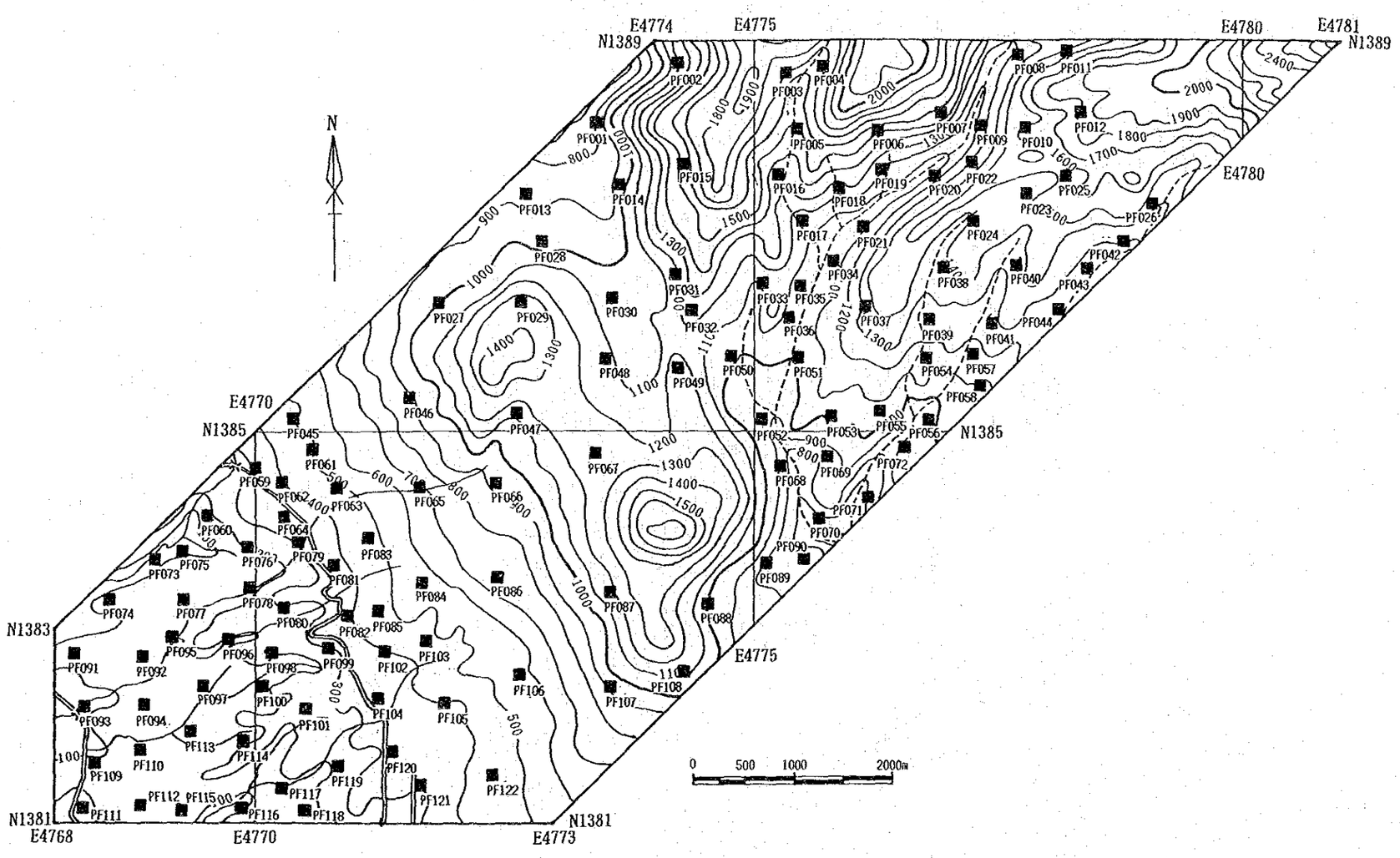


Fig. II-2-27 Location map of geochemical samples in Area F

(3) Single element analysis

Based on the results of statistical data treatment, the threshold values were determined using EDA method. Distribution maps of each element were prepared (Appendix 38) using the ranks delineated by EDA method. Distribution of each element is summarized as following;

As: High value and anomalous zones are concentrated in the northern and southern part of the area. Significant anomalous zones are found in the northern part of the area.

Au: Anomalous zones are scattered in the northern and southern marginal parts of the area. The sample with the maximum value (185 ppb) is situated at the southern marginal part of the area.

Ba: High value zones are found in the eastern part of the area. Relationship between the distribution and geology is not clear.

Co: High value zones are found in the central to the southern part of the area. The high value zones are mostly found in the area of basaltic rocks.

Cr: High value and anomalous zones are restricted in the area of basalt.

Cu: High value zones are found in the eastern and southern parts of the area. The zones in the eastern part are found in the area of altered zone of andesitic rocks. The zones in the south are found in the area of basalt.

Hg: High value and anomalous zones are found from the central to northern part of the area. Significant anomalous zones are situated around the altered zones in andesitic rocks.

K : High value zones show similar distribution tendencies of Hg. Anomalous zones are found in the area of andesite at the north.

Mg: High value zones are found in the northern part of the area where andesite occurs. The area of basalt is situated in the low value zone.

Mn: High value zones are found in the southern part of the area. The distribution has no clear relationship with the geology.

Mo: Lowh value zones are found in the central part of the area where basalt is distributed. Anomalous samples are concentrated in the northern part of the area where altered andesite occurs.

Na: High value zones are distributed northern and south western parts of the area. These zones are mostly occurs in the area of andesite and dacite.

Ni: High value zones are restricted in the area of basalt.

Pb: High value and anomalous zones are found in the northern and southern parts of the area. The conspicuous anomalous zones are correspond to the altered zones in andesite.

S : High value and anomalous zones are found in the altered zones of andesite.

Sb: High value zones are found along the boundary between basalt and dacite in the south. Other high value samples are scattered.

Sr: High value and anomalous zones are found in and around the altered zones of andesite.

Ti: The distribution tendencies are similar to Sb. High value zones are found in the vicinity of the boundary between basalt and dacite.

U : High value zones are restricted in the area of andesite and dacite. Low value zones are found in the area of basalt.

W : Because of low value (maximum value; 11 ppm), no clear distribution tendencies are recognized.

Zn: High value zones are found in the area of basalt.

In above description, high value mean the value more than the value of Upper Wisker. Based on the distribution of each element, the elements possibly related to mineralization and/or alteration were selected and an anomalous map (Fig. II-2-28) was prepared. As shown on this map, anomalous zones of these elements are found in the altered zone of andesite.

(4) Multi element analysis

Factor analysis was adopted as the multi element analysis in this survey. The results of facter analysis are given in Table II-2-21. The relationship between the elements and facters are as following;

Factor 1 : (Co)-Cr-(Mn)-Ni-Zn
Factor 2 : K-Mg-Na
Factor 3 : As-Pb-S-Sr-W
Factor 4 : Au-Cu
Factor 5 : Ba-Co

Among these factors, factor 1 has negative relationship with the related elements. Judging from the relationship between the factor and the elements, factor 1 and 2 have related with basalt. Factor 3 and 4 have relation with mineralization and/or alteration. Factor 5 shows no clear relationship. Among these factors, three factors such as factor 1, 3 and 4 were selected and distribution map (Fig. II-2-29) of factor scores were prepared using different colors for each factor. The relationship between the color and the factor are as following;

Factor 1 : blue Factor 3 : yellow Factor 4 : red

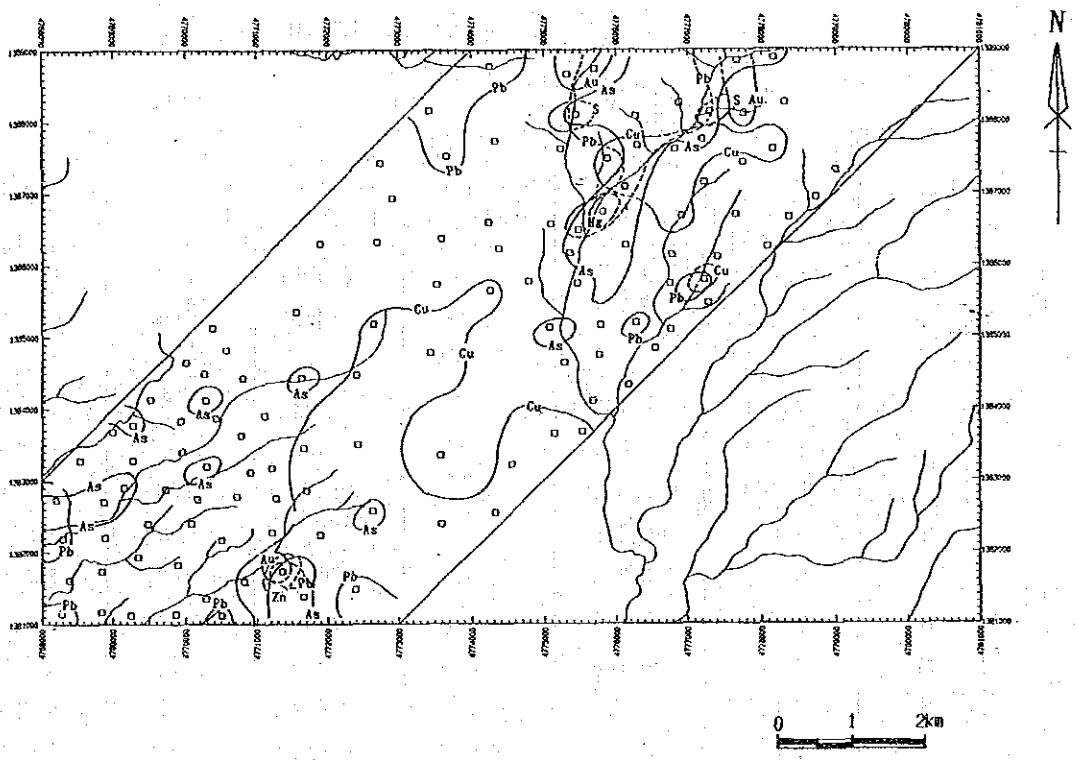
Distribution tendencies of these factor scores are summarized as following;

Factor 1: High factor score zones are found in the area of basalt.

Factor 3: High factor score zones are well correspond to the altered zones in andesite.

Factor 4: High factor score zones are found in and around the high factor score zones of factor 3. Conspicuous high factor score zone is found in a limited area at the southern marginal part.

According to the results of the factor analyses, the altered zones of andesite in the north and the high factor 3 factor score zone in the southern marginal parts are interpreted as potential area.



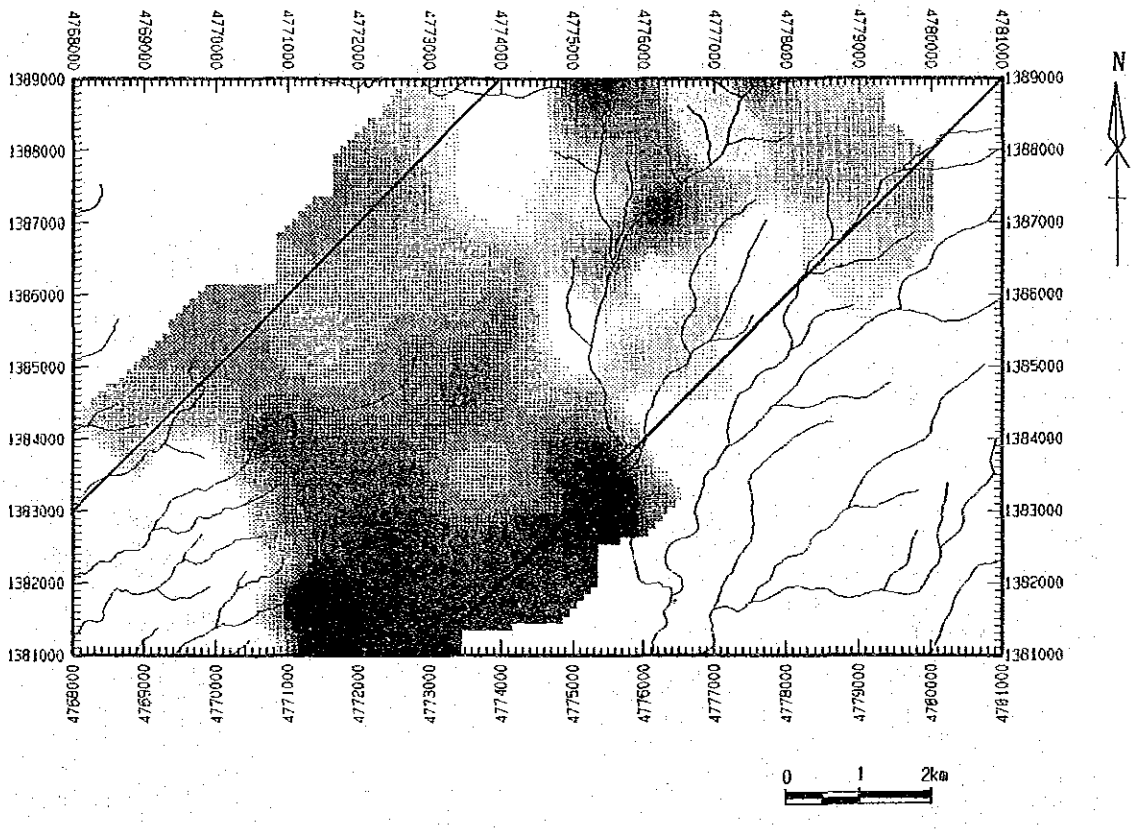
As	> 24.0 ppm	Hg	> 455.7 ppb	Zn	> 552.0 ppm
Au	> 2.7 ppb	Pb	> 5.7 ppm		
Cu	> 63.0 ppm	S	> 0.149 %		

Fig. II-2-28 Distribution map of geochemical anomalous zones in Area F

Table II-2-21 Results of factor analyses for soil samples in Area F

Element	Factor loading (Varimax rotation)					Communality
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	
As	0.141	0.072	0.580	0.028	-0.287	0.4448
Au	0.121	0.121	0.268	0.455	-0.023	0.3082
Ba	-0.266	0.163	0.426	0.271	0.605	0.7180
Co	-0.521	0.140	-0.157	0.062	0.671	0.7702
Cr	-0.964	-0.019	-0.136	-0.081	0.002	0.9553
Cu	-0.409	0.029	-0.061	0.577	0.369	0.6411
Hg	-0.474	-0.396	0.187	0.387	0.032	0.5673
K	-0.110	0.553	0.317	0.167	0.424	0.6264
Mg	0.285	0.505	0.126	0.231	0.475	0.6312
Mn	-0.517	0.103	0.057	0.020	0.711	0.7880
Mo	-0.051	-0.127	0.254	0.037	-0.370	0.2213
Na	-0.048	0.522	-0.091	0.018	0.092	0.2916
Ni	-0.917	0.070	-0.233	0.071	0.198	0.9448
Pb	0.224	-0.049	0.682	0.145	0.108	0.5496
S	-0.335	-0.132	0.574	0.157	-0.125	0.4993
Sb	-0.444	-0.078	0.234	-0.063	0.100	0.2719
Sr	0.043	0.254	0.767	0.039	0.123	0.6716
Ti	-0.876	-0.228	-0.163	-0.164	-0.022	0.8736
U	0.720	-0.209	0.017	-0.243	-0.207	0.6648
W	0.128	-0.264	0.503	-0.014	0.010	0.3399
Zn	-0.819	0.182	-0.160	0.328	0.273	0.9113
F.C.*1	41.3 %	10.9 %	21.0 %	8.7 %	18.1 %	—

*1: Factor contribution



Factor 1 factor score: Blue Factor 3 factor score: Yellow
Factor 4 factor score: Red

Fig. II-2-29 Distribution map of factor scores in Area F

2-9 Area G

2-9-1 Geology and mineralization

(1) Survey area

Based on the regional geochemical survey results, this area was selected as the potential area of gold deposits. A soil geochemical survey was carried out in this area.

This area is situated at 15 km east of Tawau.

The eastern and western parts show hilly topography and the central to southern part is flat area. The main river system in Area G is Sungai Apas in the center of the area.

The survey area is mostly covered with plantation of cocoa, oil palm and rubber except the western part of the area where is ocuppied with mountainous topography.

(2) Geology

This area is situated at the south western part of volcanic belt in Semporna Peninsular. Geology in Area G consists of volcanics and pyroclastics of Pliocene to Pleistocene. Geologic map is shown in Fig. II-2-30.

Pliocene volcanics (An_1) consist of hornblende andesite and augite-hypersthene andesite and are distributed from western to southern part of the area. A small stock of granodiorite porphyry is found in the southern part of the area and is possibly Pliocene in age. Pleistocene volcanics occur in the northern part of the area and consist of dacite (Da_2) and hypersthene andesite (An_2). The area of these volcanics shows volcanic topography. From the central to eastern part of the area, tuff, sand, silt and volcanic ash are widely distributed. These sediments are strongly weathered and are mostly consist of dacitic pyroclastics possibly Pleistocene in age.

Hornblende andesite show dark gray in color and phenocrysts of hornblende and plagioclase of 1 mm in diameter are observed. Augite-hypersthene andesite is also dark gray and phenocrysts of 1mm in diameter are observed. Dacite is gray in color and fine-grained quartz, plagioclase and hornblende are observed as the phenocrysts. Hypersthene andesite shows porous texture.

Alluvium (Q_2) are fond along river and caost and silica sand beds are situated in alluvium at the southern part of the area.

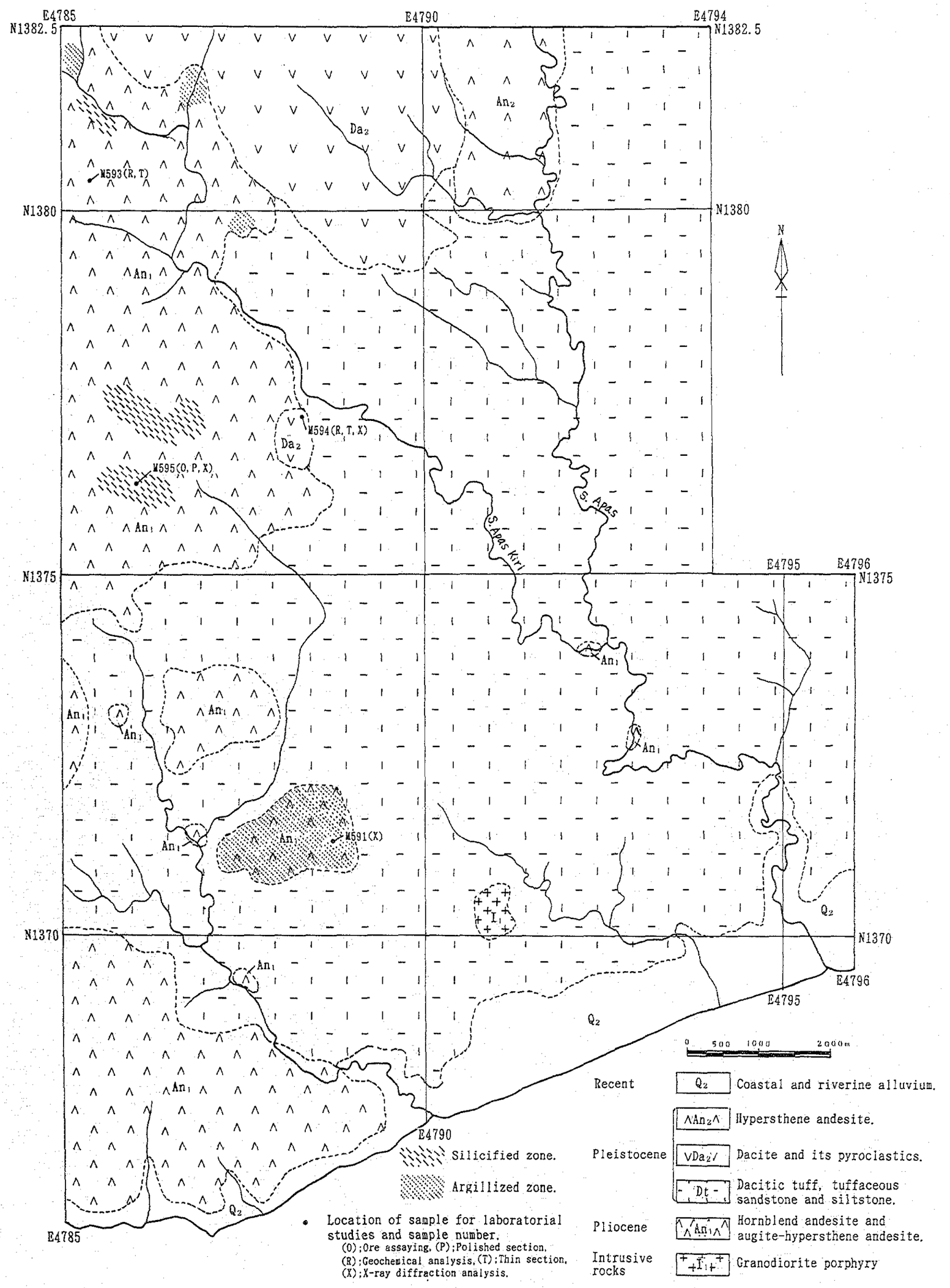


Fig. II-2-30 Geologic map of Area G

(2) Mineralization

Strongly silicified and argillized zones are found in augite-hypersthene andesite. Weak pyrite disseminations are recognized in this altered zone. The most significant silicified zones are found in the mounainous part at the north western part of the area. The extensions of these silicified zones are from several tens meters to several hundred meters. These altered zones are brecciated and limonite is recognized along the fractures. Significant argillized zones are found in the north western and southern parts of the area. The most significant argillized zone is situated at the south covering wide area.

2-9-2 Soil geochemical survey

(1) Sampling

Soil samples were adopted as the sample media in this survey, Locations of the samples are shown in Fig. II-2-31 and list of sample are given in Appendix 39. After drying up these samples, -80 mesh fraction samples were prepared for the sample of chemical analyses.

(2) Statistical data treatment

Analytical rsults are shown in Appendix 40. These analytical results were input in computer and statistically treated. The statistics caluculated are given in Table II-2-22.

The calculated geometric means give following tendencies comparing with other areas.

Elements indicating higher value: As, Ba, Hg, Pb, S, Ti, U.

Element indicating lower value: Co, Cu, Mg, Mn, Sb, Zn.

In order to clarify the relationship between the elements, correlation coefficient was also calculated. As the results, following pair of element give comparatively good (correlation coefficient: more than 0.500) correlations.

Ba-K, Ba-Sr, Co-Cu, Co-Mn, Co-Zn, Cr-Ni, Cu-Na, Cu-Zn, K-Mg, K-Na
K-Sr, Mg-Sr, Mg-Zn, Na-Zn.

Among the elments including Co, Cu, Na and Zn give good correlation each other. These elements may have some relationship with mineralization.

(3) Single element analysis

Based on the results of statistical data treatment, the threshold values were determined using EDA method. Distribution maps of each element were prepared (Appendix 41) using the values delineated by EDA method. Distribution of each element is summarized as following;

Table II-2-22 Statistics of soil geochemical survey in Area G

Element	Statistics						EDA method*3		
	Below detection limit (%)	Maximum value	Minimum value	Mean*1 value (b)	Standard deviation	b + 2S.D. *2	Median	Upper Wisker	Upper Fence
As (ppm)	28.4	1,615	< 1	5.4	0.755	177.3	9.0	24.0	—
Au (ppb)	88.5	170	< 1	0.6	0.312	2.6	0.5	0.5	0.5
Ba (ppm)	—	1,680	13	93.2	0.467	800.7	76.0	218.0	1,021.7
Co (ppm)	7.4	106	< 1	7.8	0.531	90.1	8.0	24.0	—
Cr (ppm)	—	1,025	7	62.9	0.346	309.4	49.0	148.0	296.0
Cu (ppm)	—	165	3	18.8	0.260	62.3	20.0	31.0	96.6
Hg (ppb)	0.3	3,278	< 10	100.3	0.314	425.8	97.0	169.0	518.6
K (%)	—	1.78	0.02	0.118	0.420	0.816	0.090	0.310	—
Mg (%)	0.9	1.24	< 0.01	0.122	0.484	1.135	0.120	0.390	—
Mn (ppm)	59.0	7,363	< 5	19.8	1.159	4,099.1	2.5	580.0	—
Mo (ppm)	28.9	13	< 1	1.4	0.337	6.5	2.0	3.0	—
Na (%)	—	0.79	0.04	0.140	0.280	0.509	0.140	0.240	0.748
Ni (ppm)	0.5	593	< 1	17.7	0.448	139.0	15.0	44.0	167.7
Pb (ppm)	47.2	96	< 2	3.1	0.505	31.3	3.0	11.0	—
S (%)	—	0.822	0.020	0.059	0.189	0.141	0.056	0.083	0.178
Sb (ppm)	10.3	44.2	< 0.2	2.95	0.602	47.12	4.4	7.8	44.1
Sr (ppm)	—	388	3	29.2	0.340	140.1	29.0	56.0	182.9
Ti (%)	—	5.15	0.26	0.836	0.176	1.879	0.860	1.150	2.368
U (ppm)	—	5.6	0.8	2.67	0.137	5.03	2.80	3.40	—
W (ppm)	90.7	37	< 2	1.1	0.183	2.6	1.0	1.0	1.0
Zn (ppm)	—	199	1	30.3	0.290	115.1	33.0	52.0	146.8

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

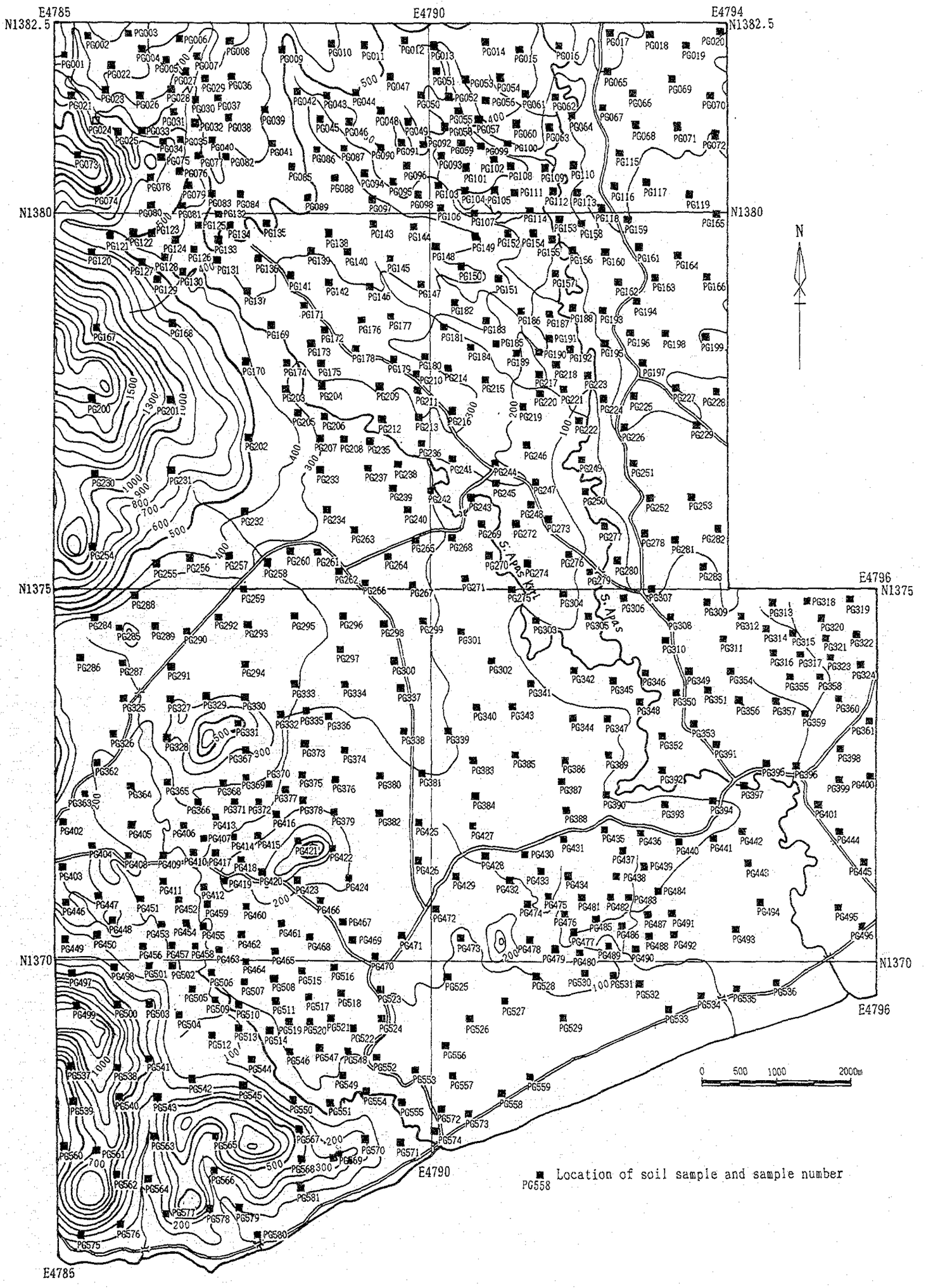


Fig. II-2-31 Location map of geochemical samples in Area G

As: High value and anomalous zones are found in the north western marginal part and southern part of the area. Significant anomalous zones are found in and around the altered zone and the granodiorite stock.

Au: Anomalous zones are found at the western margin of altered zone in the south western part of the area and around the granodiorite stock. Orther anomalous zones are scattered.

Ba: high value and anomalou zones are found in the northern part of the area where dacite occurs. High value zone of small in scale are scattered in the western to south western part of the area.

Co: High value and anomalous zones are scattered in the marginal part of the area where andesite is distributed.

Cr: Main high value and anomalous zones are found in a E-W trending zone with a width of approximately 2 km in the central part of the area. Othe small in scale anomalous zones are found in the north western and south western marginal parts of the area.

Cu: High value zones show no conspicuous distribution tendencies and are scattered in the northern and south western parts of the area.

Hg: High value and anomalous zones are concentrated at the altered zone and the west of the altered zone in the south western part. Hg shows close relationship with alteration.

K : High value zones are found in and around the altered zone and the granodiorite stock in the south western and southern parts of the area. Other high value zones are scattered.

Mg: Low value zones are found in the central part of the area.

Mn: High value zones are scattered along the coast line in the south western to southern part of the area.

Mo: High value and anomalous zones are scattered in and around the granodiorite stock. But the values are low.

Na: High value zones are found in the northern, south western and southern parts of the area. The central part is low value zone.

Ni: High value zones are distributed in the central part with a E-W direction. The distribution has similar distribution tendencies of Cr.

Pb: High value zones are scattered in the central part and show no clear distribution tendencies.

S : High value zones are scattered from the northern to eastern part of the area. The distribution tendencies are not so clear.

Sb: High value zones are scattered over the area. No clear distribution tendencies are recognized.

Sr: The most significant high value zones are found around the altered zone in the south western part of the area. Other high value zones are scattered in the northern, eastern and southern parts of the area.

Ti: High value zones are distributed from the north to the east of the area. Other small in scale high value zones are scattered from the western to

southern part of the area.

U : High value zones are distributed from northern to eastern part of the area and low value zones are distributed from the western to southern part of the area.

W : High value zones are situated in the central part of the area with a direction of E-W. Distribution tendencies are similar to Cr and Ni.

Zn: High value zones are found from northern to eastern part and southwestern marginal part. The distribution is similar to the distribution of Cu and Co.

According to the distribution maps, the elements which are possibly useful for the survey in this area were selected and anomaly map (Fig. II-2-32) of these elements was prepared. As shown on this map, anomalous zones are concentrated in and around the altered zone and the granodiorite stock. These areas may be promising.

(4) Multi element analysis

Factor analysis was adopted as the multi element analysis in this survey. The results of factor analysis are given in Table II-2-23. The relationship between the elements and factors are as following;

Factor 1 : (As)-Ba-K-Mg-Sr.
Factor 2 : (Ba)-Co-Cu-Mg-Mn-Na-Zn.
Factor 3 : Cr-Ni-(S).
Factor 4 : (MN)-Sb-(Sr).
Factor 5 : (Mo)-(U).
Factor 6 : Hg.

Among these factors, factor 2, 4, 5 and 6 have negative relationship with the elements. The elements indicating by ( ) show comparatively weak relation with the elements.

Judging from the relationship between the factor and the elements, factor 1 and 2 may related to mineralization. And factor 6 has relation with alteration. Consequently, a distribution map (Fig. II-2-33) of factor scores of these three factors were prepared using different colors for each factor. The relationship between the color and the factor are as following;

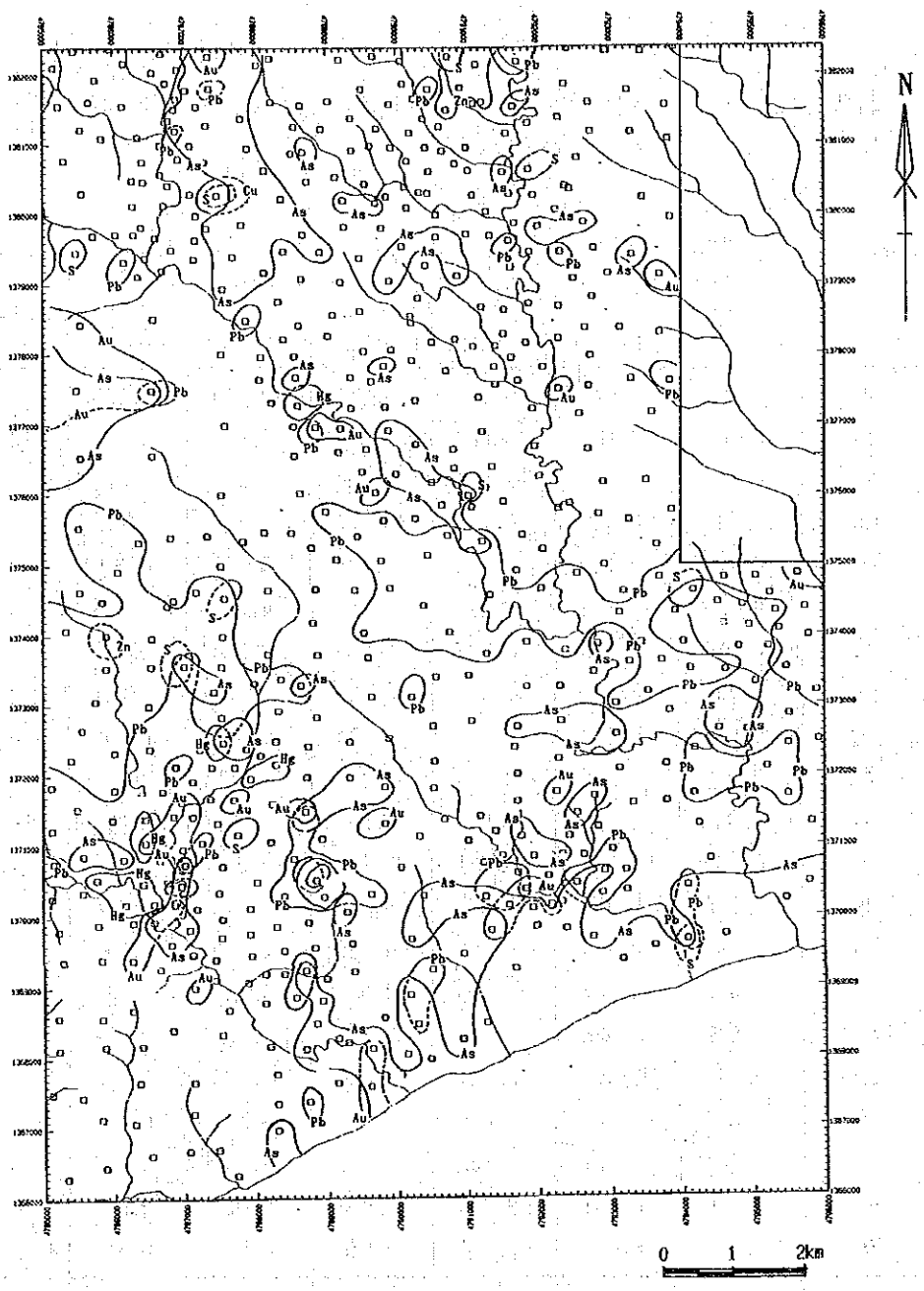
Factor 1 : red Factor 2 : blue Factor 6 : yellow

Distribution tendencies for these factors are summarized as following;

Factor 1: High factor score zones are found in the area of altered andesite at north western part and altered zone at the south western part of the area. High score zones are also found along the coast and around the granodiorite stock.

Factor 2: High factor score zones are found in the northern and south western parts of the area where andesite occurs.

Factor 6: High factor score zones give similar distribution tendencies of



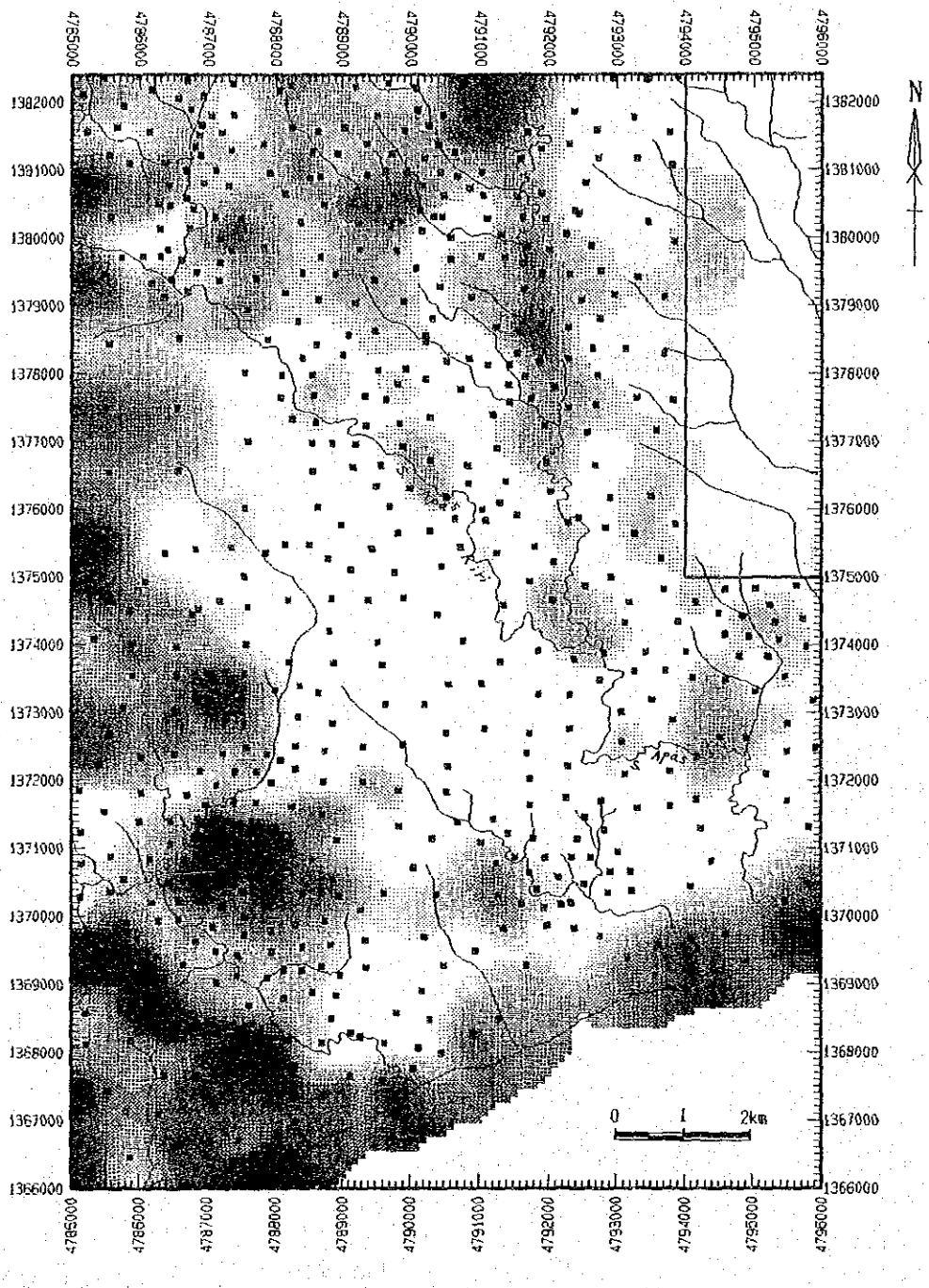
As >	24.0 ppm	Hg >	518.6 ppb	Zn >	146.8 ppm
Au >	2.6 ppb	Pb >	11.0 ppm		
Cu >	96.6 ppm	S >	0.178 %		

Fig. II-2-32 Distribution map of geochemical anomalous zones in Area G

Table II-2-23 Results of factor analyses for soil samples in Area G

Element	Factor loading (Varimax rotation)						Communality
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	
As	0.422	0.041	-0.031	-0.014	-0.149	-0.025	0.2042
Au	0.203	0.168	-0.063	-0.079	0.028	-0.183	0.1140
Ba	0.573	-0.458	-0.076	-0.350	-0.128	0.071	0.6874
Co	-0.147	-0.762	0.144	-0.196	0.236	0.212	0.7618
Cr	-0.102	-0.114	0.897	-0.128	-0.045	0.129	0.8639
Cu	0.055	-0.794	0.286	0.203	-0.084	-0.174	0.7932
Hg	0.036	0.015	-0.030	-0.005	-0.074	-0.505	0.2624
K	0.759	-0.471	-0.074	-0.033	0.168	0.021	0.8330
Mg	0.541	-0.559	-0.008	-0.094	0.341	-0.098	0.7392
Mn	0.036	-0.524	-0.010	-0.406	0.428	0.246	0.6854
Mo	-0.009	0.015	0.051	0.088	-0.446	-0.033	0.2108
Na	0.344	-0.703	-0.041	0.148	-0.205	-0.168	0.7064
Ni	-0.059	-0.304	0.862	-0.046	0.012	0.224	0.8905
Pb	0.057	0.184	0.292	-0.396	0.178	0.347	0.4318
S	0.017	-0.257	0.416	-0.026	-0.328	-0.235	0.4028
Sb	0.072	0.026	0.079	-0.512	0.064	-0.023	0.2794
Sr	0.647	-0.072	0.031	-0.460	0.099	-0.075	0.6516
Ti	-0.627	-0.261	0.040	-0.168	-0.337	0.080	0.6104
U	-0.414	0.107	-0.023	0.049	-0.435	0.407	0.5409
W	-0.020	0.043	0.246	-0.063	-0.051	0.321	0.1723
Zn	-0.042	-0.876	0.241	0.028	-0.007	-0.018	0.8290
F.C.*1	22.0 %	32.7 %	17.6 %	9.4 %	9.7%	8.5 %	—

*1: Factor contribution



Factor 1 factor score: Red Factor 2 factor score: Blue
Factor 6 factor score: Yellow

Fig. II-2-33 Distribution map of factor scores in Area G

Factor 1 and are mostly found in the altered zone of andesite.

According to the results of the factor analyses, the area with overlapping of factor 1 and 6 high factor score zones is interpreted as the potential area. These are in and/or around altered zone of andesite.

2-10 Area H

2-10-1 Geology and mineralization

(1) Survey area

Based on the result of regional geochemical survey in Phase II, this area was selected as a potential area of gold ore deposits. Soil geochemical surveys were adopted for the survey in this area.

Area H is situated approximately 60 km northeast of Tawau in the eastern part of Semporna area. Sungai Sipit run for east in the central part of the area. The southern part of the area is hilly topography but other parts are flat. The survey area is mostly used as plantation of cocoa and oil pahm.

Only few outcrops are recognized in this area along road except southern marginal part of the area.

(2) Geology

Area H is situated at the north eastern marginal part of the volcanic belt in Semporna peninsular. Geology of this area mainly consists of Oligocene to middle Miocene Kalumpang formation (P_4Kg) and volcanic rocks (An_1) of Pliocene. The geologic map of this area is shown in Fig. II-2-34.

Kalumpang formation (P_4Kg) is distributed over the area except southern part and consists of gray siltstone, tuffaceous siltstone and pale green fine-grained tuff. The strike is NWN-SES and dips to south. At the north eastern part of the area, chert bed crops out. This chert may belong to Chert-Spilite formation (Csch) of Cretaceous to Eocene in age.

Andesite (An_1) is distributed at the south and consists of andesite lava and andesitic tuff breccia. Phenocrysts of plagioclase, pyroxene and hornblende are recognized in this andesite.

No significant fault systems are recognized in this area.

(3) Mineralization

Because of limited outcrops, mineralized and/or altered zone was not confirmed. An altered zone with pyrite disseminations was confirmed at 500 m outside from the southern end of this area. This mineralized zone is one of the

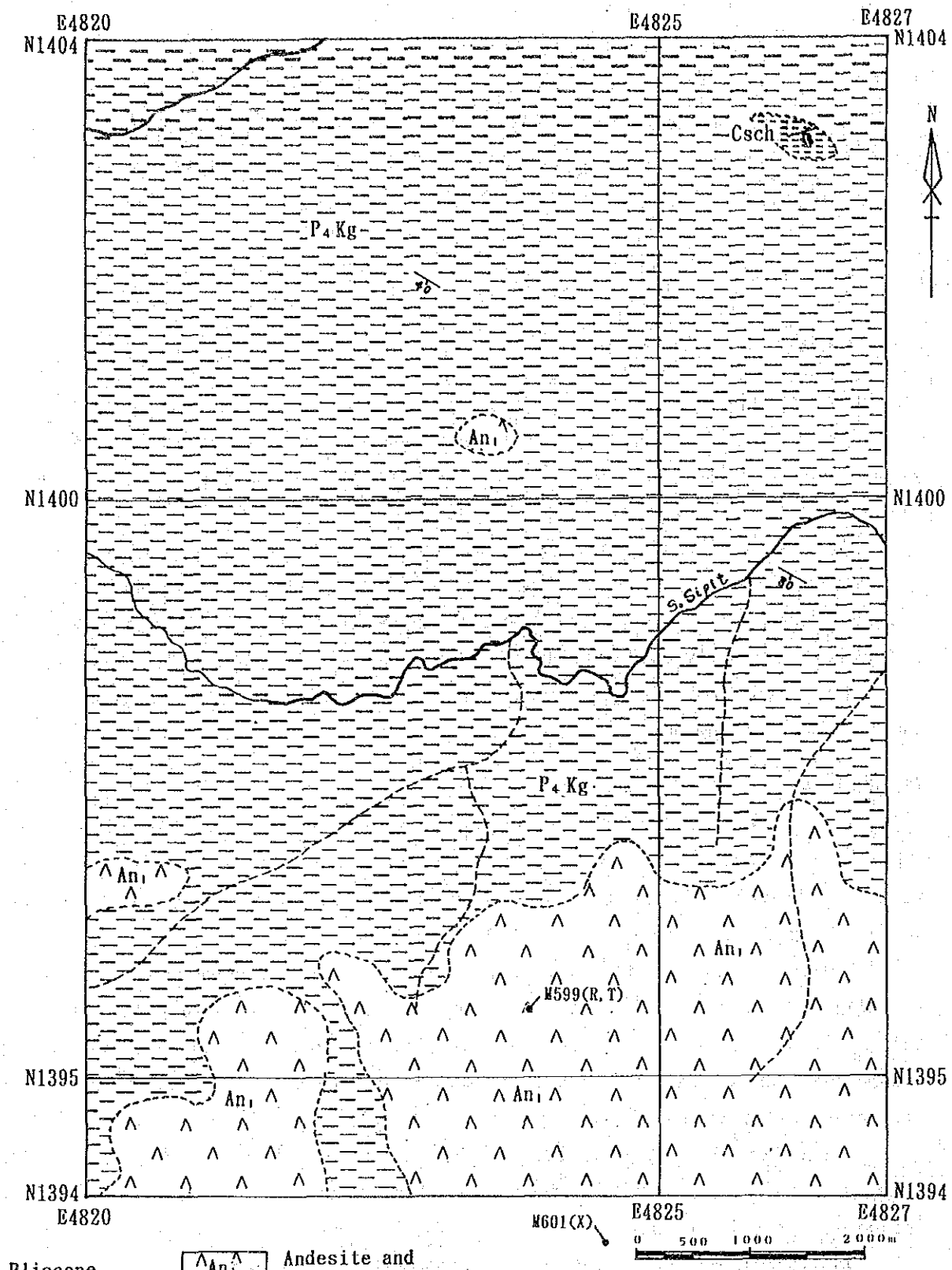


Fig. II-2-34 Geologic map of Area H

mineralized zone in Nagos area where exploration has been conducted by private sector.

2-10-2 Soil geochemical survey

(1) Sampling

Soil samples were collected in this survey. Locations of the soil samples are shown in Fig. II-2-35. List of samples collected in this srvey are shown in Appendix 42. After drying up these samples, -80 mesh fraction samples were collected and chemical analyses were conducted for these fraction samples.

(2) Statistic data treatment

The analytical results of soil samples are shown in Appendix 43. The results were input in computer and the data were statistically treated. The statistics calculated are shown in Table II-2-24.

The calculated geometric means give following tendencies comparing with other areas.

Elements indicating higher value: Mo.

Element indicating lower value: Co, Cr, Mn, Na, Ni, S, Sb, Sr, Zn.

In order to clarify the relationship between the elements, correlation coefficient was also calculated. As the results, following pair of element give comparatively good (correlation coefficient: more than 0.500) correlations.

Ba-Co, Ba-Cu, Ba-Mg, Ba-Na, Ba-Sr, Ba-U(-), Ba-Zn, Co-Cu, Co-Mg, Co-Mn, Co-Na, Co-U(-), Co-Zn, Cr-Ni, Cu-K, Cu-Mg, Cu-Na, Cu-Ni, Cu-U(-), Cu-Zn, K-Mg, K-Na, K-Ni, K-Sr, K-Zn, Mg-Na, Mg-Ni, Mg-Sr, Mg-Zn, MnU(-) Na-Sr, Na-U(-), Na-Zn, Ni-Zn, S-Zn.

Among the elments, Ba characteristically indicate good correlation with other elements.

(3) Single element analysis

Based on the results of statistical data treatment, the threshold values were determined using EDA method. Distribution maps of each element were prepared (Appendix 44) using the ranks delineated by EDA method. Distribution of each element is summarized as following;

As: High value and anomalous zones are found in the area of Kalumpang formation.

Au: High value and anomalous zones are scattered and the values (maximum value: 36 ppb) are low.

Ba: High value and anomalous zones are concentrated in the area of andesite at the south.

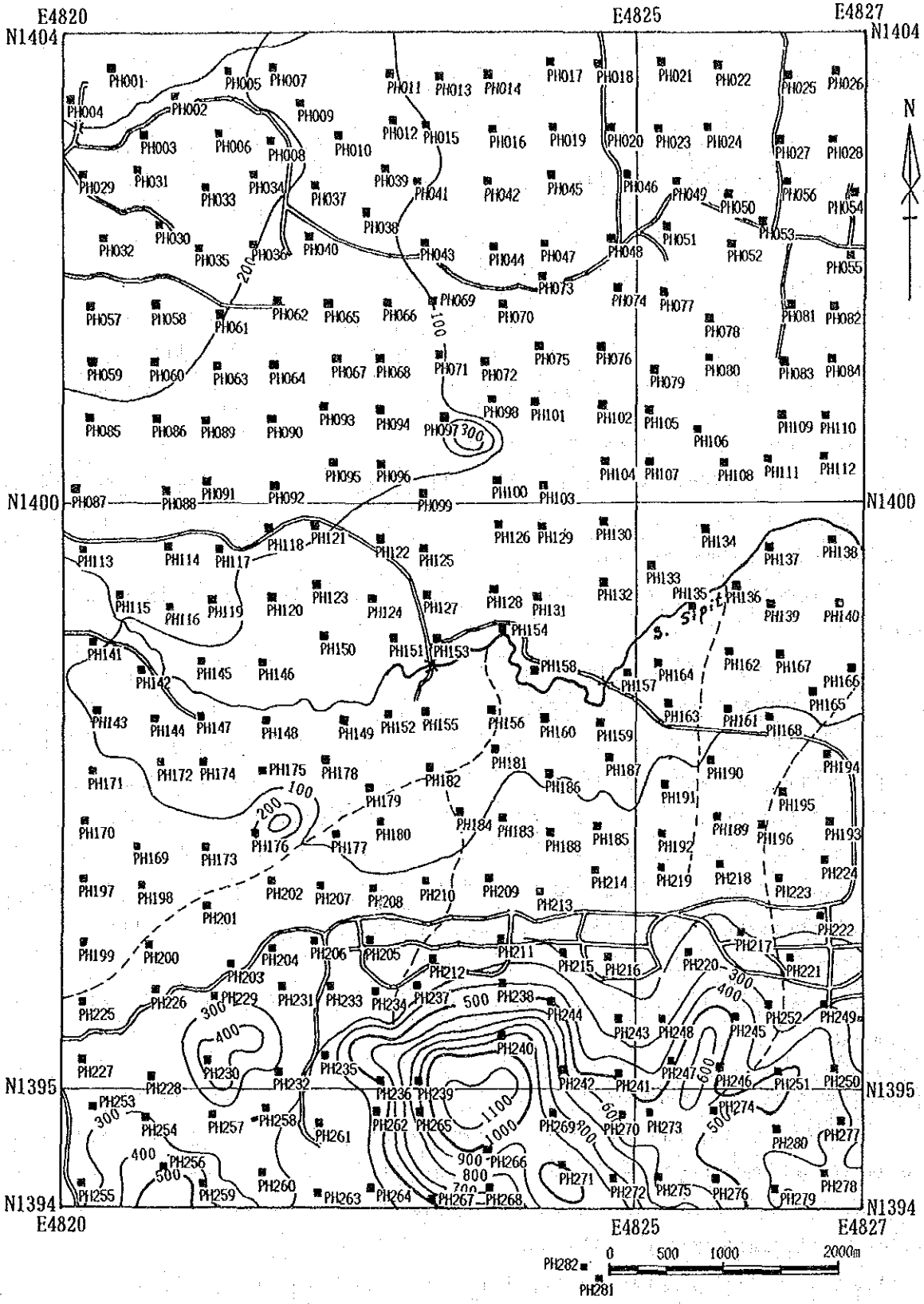


Fig. II-2-35 Location map of geochemical samples in Area H

Table II-2-24 Statistics of soil geochemical survey in Area H

Element	Statistics						EDA method*3		
	Below detection limit (%)	Maximum value	Minimum value	Mean*1 value (b)	Standard deviation	b + 2S.D. *2	Median	Upper Wisker	Upper Fence
As (ppm)	48.9	55	< 1	1.9	0.627	34.8	1.0	10.0	—
Au (ppb)	85.8	36	< 1	0.6	0.259	2.0	0.5	0.5	0.5
Ba (ppm)	—	1,447	12	84.8	0.505	867.6	66.5	151.0	760.8
Co (ppm)	27.0	197	< 1	3.7	0.717	100.2	3.0	24.0	—
Cr (ppm)	—	1,248	3	47.9	0.338	227.6	48.0	79.0	210.6
Cu (ppm)	0.4	226	< 1	12.9	0.522	143.3	15.0	43.0	—
Hg (ppb)	—	1,059	14	71.4	0.205	183.7	66.5	105.0	216.2
K (%)	11.3	1.79	< 0.01	0.098	0.733	—	0.125	0.560	—
Mg (%)	3.2	2.10	< 0.01	0.148	0.585	—	0.190	0.450	—
Mn (ppm)	58.2	9,308	< 5	19.9	1.177	4,499.8	2.5	731.0	—
Mo (ppm)	27.7	18	< 1	1.7	0.392	10.1	2.0	4.0	—
Na (%)	5.3	1.78	< 0.01	0.052	0.556	0.679	0.050	0.190	1.764
Ni (ppm)	2.8	2,191	< 1	9.9	0.498	98.2	10.0	20.0	106.6
Pb (ppm)	64.5	60	< 2	1.8	0.380	10.3	1.0	5.0	32.0
S (%)	—	0.255	0.008	0.019	0.208	0.049	0.017	0.025	0.054
Sb (ppm)	18.8	17.1	< 0.2	1.67	0.690	—	2.80	6.60	—
Sr (ppm)	—	302	2	20.5	0.332	94.7	18.0	37.0	139.3
Ti (%)	—	1.44	0.19	0.591	0.146	1.159	0.595	0.830	1.365
U (ppm)	3.2	5.8	< 0.2	1.40	0.333	—	1.80	2.20	4.33
W (ppm)	98.6	4	< 2	1.0	0.052	1.3	1.0	1.0	1.0
Zn (ppm)	—	2,134	3	33.8	0.408	220.6	38.0	73.0	532.2

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

Co: High value zones are mostly found in the area of andesite at the south.

Cr: High value zones are restricted in the area of Kalumpang formation.

Cu: High value and anomalous zones are found in the area of andesite at the south and in the area of Chert-Spilite formation at north eastern part.

Hg: High value and anomalous zones are scattered and no relationship with the geology is recognized.

K : High value zones are distributed with a NW-SE direction at the north. This direction is the same to the strike of Kalumpang formation.

Mg: High value zones are found in the northern and southern parts of the area No clear relationship is recognized between the distribution and the geology.

Mn: High value zones are found in the southern part of the area where andesite occurs.

Mo: High value zones are found in the central part of the area. Lowh value zones No clear relationship is recognized between the distribution and the geology.

Na: High value zones are mostly found in the south part of the area where andesite occurs.

Ni: High value zones are restricted in and around the area of Chert-Spilite formation at the north.

Pb: Comparatively high value zones are found in the area of Chert-Spilite formation. No clear relationship with geology is found.

S : High value and anomalous zones are found in the areas of Chert-Spilite at the north formation and andesite at the south.

Sb: High value zones are restricted in the south where andesite occurs.

Sr: High value zones are found in the southern and northern parts of the area. Relationship with the geology is not clear.

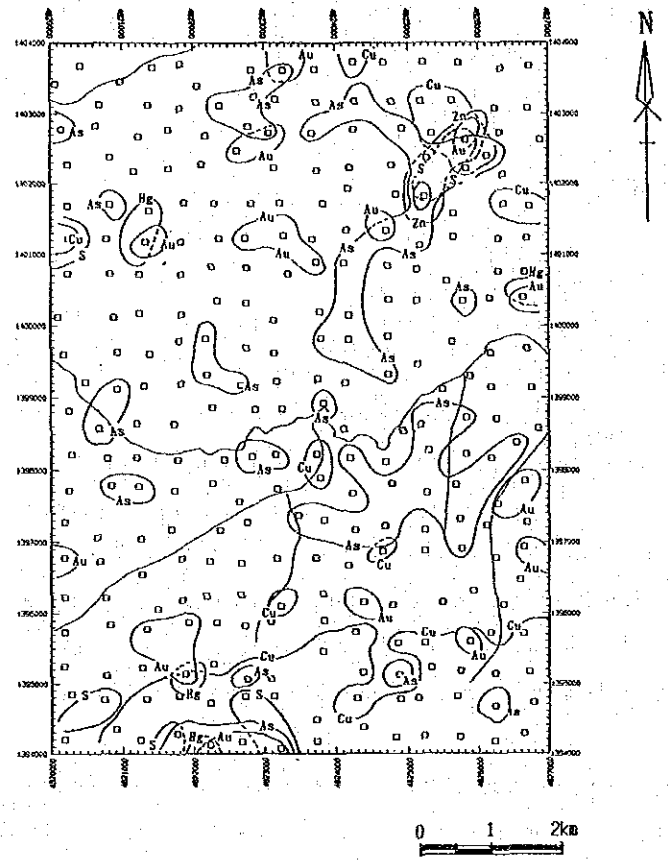
Ti: High value zones are found in the southern half of the area. Relationship with the geology is not clear.

U : High value and anomalous zones are restricted in the area of Kalumpang formation.

W : Because of low value (maximum value; 11 ppm), no clear distribution tendencies are recognized.

Zn: High value and anomalous zones are found in the area of Chert-spilite formation ar the north and in the area of andesite at the south.

In above description, high value means the value more than Upper Wisker. Based on the distribution of each element, the elements possibly related to mineralization and/or alteration were selected and an anomalous map (Fig. II-2-36) was prepared. As shown on this map, anomalous zones of these elements are found in the area of Chert-Spilite formation at the north and southern marginal part of the area.



As	>	10.0 ppm	Hg	>	216.2 ppb
Au	>	2.0 ppb	S	>	0.054 %
Cu	>	43.0 ppm	Zn	>	532.2 ppm

Fig. II-2-36 Distribution map of geochemical anomalous zones in Area H

(4) Multi element analysis

Factor analysis was adopted as the multi element analysis in this survey. The results of factor analysis are given in Table II-2-25. The relationship between the elements and factors are as following;

Factor 1 : Ba-Co-Cu-Mg-Na-Zn
Factor 2 : Hg-Mo-Ti
Factor 3 : Cr-Ni
Factor 4 : (Au)-(Au)
Factor 5 : (Pb)

Among these factors, factor 1, 2 and 5 have negative relationship with the related elements.

Judging from the relationship between the factor and the elements, factor 1 and 4 possibly relates with mineralization. Factor 2 has relation with alteration. These three factors such as factor 1, 2 and 4 were selected and distribution map (Fig. II-2-37) of factor scores were prepared using different colors for each factor. The relationship between the color and the factor are as following;

Factor 1 : blue Factor 2 : yellow Factor 4 : red

Distribution tendencies of factor scores for these factors are summarized as following;

Factor 1: High factor score zones are found in the area of andesite.

Factor 2: High factor score zones are well correspond to the area of Kalumpang formation.

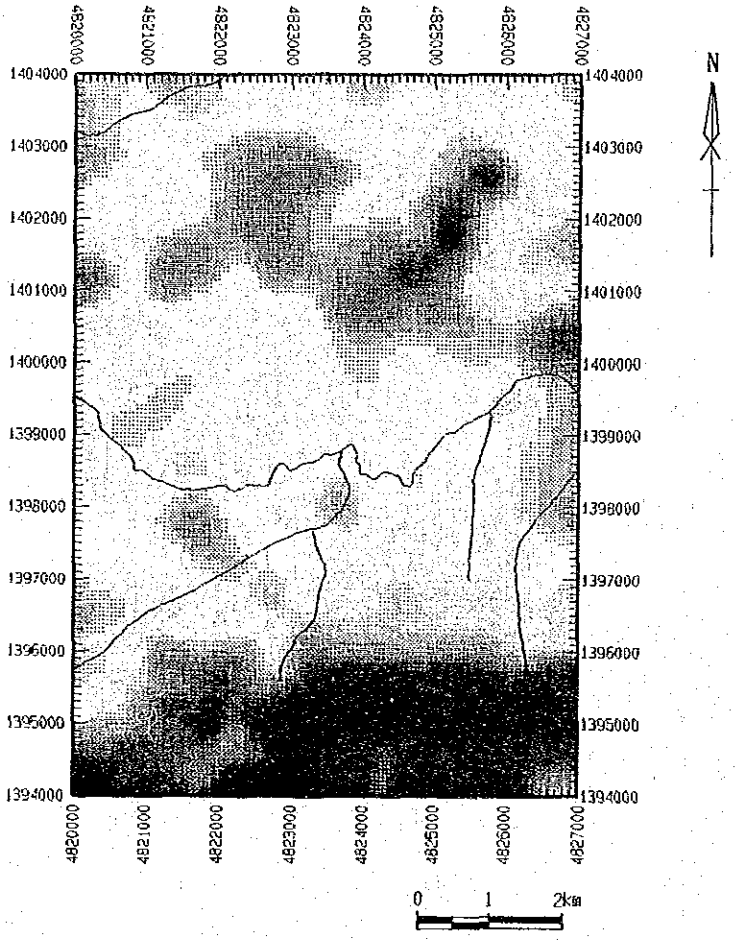
Factor 4: High factor score zones are found in the northern and southern marginal parts of the area.

According to the results of the factor analyses, the high factor score zones of factor 4 are promising.

Table II-2-25 Results of factor analyses for soil samples in Area H

Element	Factor loading (Varimax rotation)					Communality
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	
As	0.145	0.103	0.061	0.373	-0.161	0.2004
Au	-0.089	-0.033	0.027	0.339	0.033	0.1260
Ba	-0.833	0.122	-0.209	0.098	0.106	0.7733
Co	-0.794	-0.127	0.125	-0.287	-0.200	0.7839
Cr	0.140	0.089	0.785	0.149	-0.155	0.6893
Cu	-0.885	-0.011	0.308	0.019	0.070	0.8832
Hg	0.105	-0.509	-0.103	0.251	0.109	0.3550
K	-0.489	0.632	0.335	0.174	0.224	0.8312
Mg	-0.808	0.355	0.205	-0.114	0.251	0.8966
Mn	-0.584	-0.233	-0.096	-0.428	-0.405	0.7520
Mo	0.057	-0.542	-0.053	-0.108	0.126	0.3269
Na	-0.903	0.031	0.071	0.108	0.129	0.8489
Ni	-0.457	0.147	0.725	0.088	-0.185	0.7986
Pb	0.073	0.209	0.190	0.068	-0.506	0.3457
S	-0.502	-0.381	0.095	0.296	-0.240	0.5513
Sb	-0.388	-0.359	-0.142	-0.246	0.040	0.3617
Sr	-0.632	0.409	-0.188	-0.036	-0.005	0.6032
Ti	-0.152	-0.737	-0.035	-0.093	0.041	0.5782
U	0.678	0.244	0.284	0.190	-0.010	0.6359
W	-0.038	0.105	0.107	-0.067	0.041	0.0302
Zn	-0.876	0.081	0.308	0.054	-0.054	0.8745
F.C.*1	53.0 %	18.9 %	14.5 %	7.3 %	6.4 %	—

*1: Factor contribution



Factor 1 factor score: Blue Factor 2 factor score: Yellow
Factor 4 factor score: Red

Fig. II-2-37 Distribution map of factor scores in Area H

Chapter 3 Heliborne geophysical survey

3-1 Outline of survey

Heliborne geophysical surveys, consisting of magnetics and gamma-ray radiometrics, were carried out, in order to clarify the distribution of magnetic and radiometric rocks and to observe magnetic anomalies caused by mineralization and alteration. The areas are shown in Fig. II-3-1.

In 1990 and 1991 fiscal years, the data acquisition work for six areas, Northern Kinabalu, Southern Kinabalu, Labuk, Segama, Nothern Semporna and Southern Semporna, have been carried out. Those locations are shown in Fig.II-3-1. The surveyed areas occupy about 12,250 km^2 in total and the line lengths flown is 27,578.4 line-km in total.

The results of the data analysis and interpretation for the five areas (10,650 km^2 and 21,923.4 line-km in total) of Southern Kinabalu, Labuk, Segama, Northern Semporna and Southern Semporna, were reported in 1991 fiscal year, and in this report the results of the data analysis and interpretation for Northern Kinabalu area (2,700 km^2 and 5,655 line-km) are described.

3-2 Coverage of work

Field operations and data processing of the surveys were done by Aerodat Ltd., Canada. Specifications of the survey are as follows:

① Method Heliborne geophysical survey

② Items Total intensity of geomagnetic field
Gamma-ray radiometrics(U, Th, K, and Total count)

③ Flight level 150± 30 metres terrain clearance
Magnetometer Sensor 150 m terrain clearance
Spectrometer Sensor 180 m terrain clearance

④ Line spacing Traverse line 500 metres
Tie line 10 kilometres

⑤ Direction and length of survey lines

Survey area	Northern Kinabalu	Southern Kinabalu	Labuk	Segama	Northern Semporna	Southern Semporna
Traverse line	E-W			N-S		
Tie line	N-S			E-W		
Line length (km)	5,655.0	4,274.5	4,554.0	5,094.0	3,800.9	4,210.3
Total line length (km)	27,578.4					
Area (km^2)	2,700	2,320	2,300	2,820	1,130	2,080
Total area (km^2)	13,350					

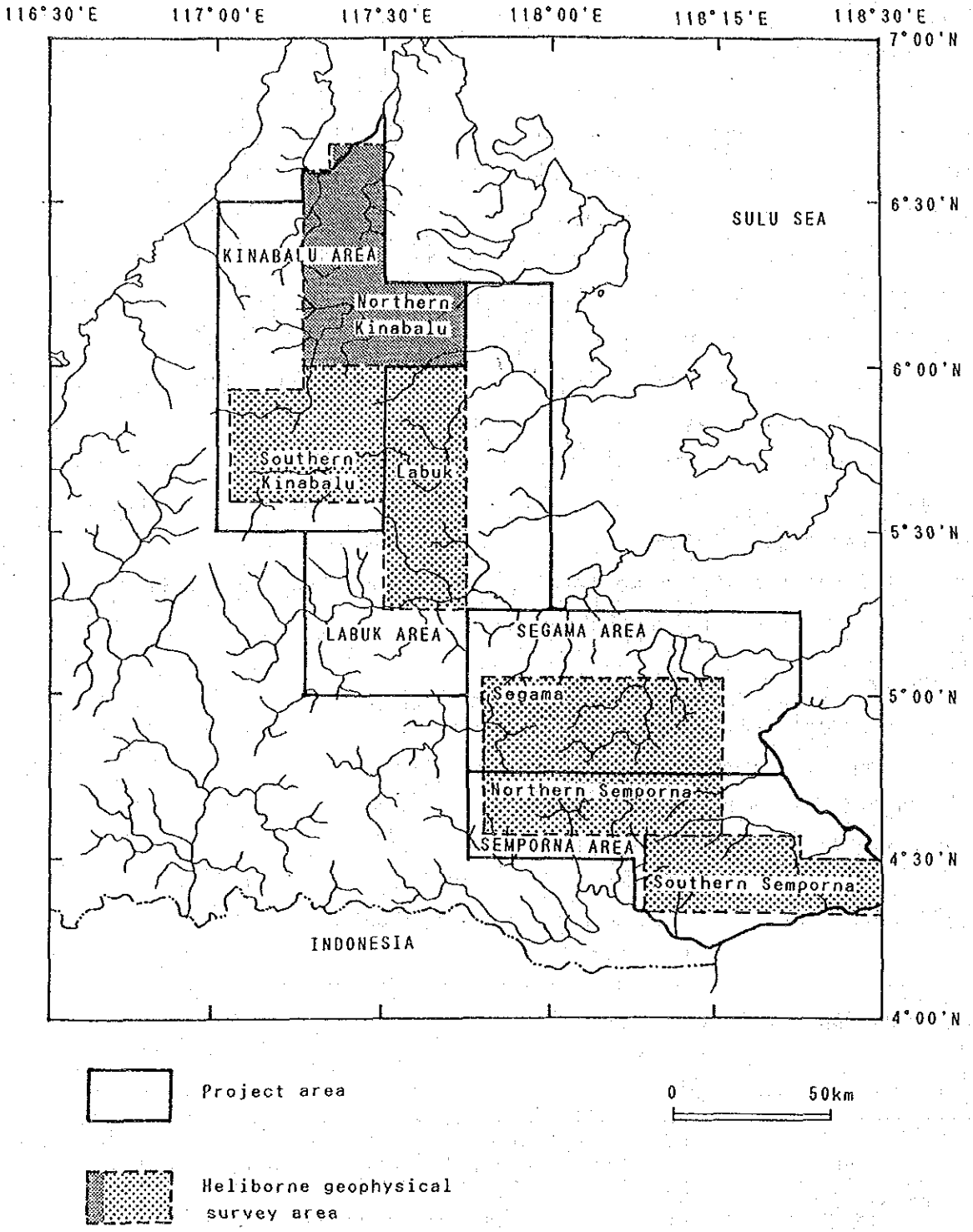


Fig. II-3-1 Location map of the heliborne geophysical survey area

⑥ Equipment Equipment used are shown in Table II-3-1.

⑦ Navigation GPS (Global Positioning System)

⑧ Traverse ground speed Approximately 75 knots(135 km/h)

The geomagnetic field in the general area has a total intensity of about 36,000 nT, an inclination of 6° to 8° south and a declination of 1° east of south.

The methods of the data processing are same for these six areas.

3-3 Results of interpretation

A magnetic anomaly map shows the distribution of highly magnetized rocks and magnetic discontinuity lineaments delineated qualitatively and quantatively from "Total Field Magnetics" maps. As shown in Fig.II-3-2, a magnetic anomaly due to highly magnetized prism model near the equator shows predominant nagative part above a prism and small positive parts at the south and north of a prism, and extends towards east and west. Quality analysis for magnetic anomalies was made taking this characteristics of magnetic anomaly pattern into consideration.

A radiometric anomaly map shows the distribution of high count anomalies of Total Count(T.C.), potassium(K), uranium(U) and thorium(Th) radiomerics, and radiometric discontinuity lineaments delineated qualitatively from "Total Count Radiometric Contours" and "Ternery Map".

(1) Magnetic anomaly map

Total field magnetic map of Northern Kinablu area is shown in Figs.II-3-3, and a magnetic anomaly map of Northern Kinabalu area is shown in Fig.II-3-4.

In the northern part of Northern Kinabalu area, magnetic anomalies of large amplitude and short wave length are aligned in E-W and ENE-WSW directions and form a large-scale low magnetic anomalies trending in an ENE-WSW direction. These anomlies suggest the existence of magnetized bodies near surface, which are bounded at the north and south edges by magnetic discontinuity lineaments trending in E-W and ENE-WSW directions, and divided by N-S trending magnetic discontinuity lineaments. And these causative bodies correspond to the distribution of the Chert-Spilite(KPCs) formation.

In the central part of Northern Kinabalu area, low magnetic anomalies of long wavelength and relatively large amplitude are found at the western side, and a number of small scale magnetic anomalies are distributed entirely. And there are distributed a number of N-S and NW-SE trending magnetic discontinuity lineaments. Low magnetic anomalies at the western side are due to the highly magnetized bodies

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

Name	Model	Manufacturer(Country)	Specifications
Airborne Magnetometer Cesium Magnetometer Sensor	HSM2 V1W2321H8	IFG/Aerodat(Canada) Scintrex(Canada)	Resolution; 0.001 nT Sensitivity; 0.005 nT, Range; 20,000 - 100,000 nT
Spectrometer	Pgam6000/ Pgam6100/ Pgam6500	Picodas Group (canada)	Crystal volume; 32.7ℓ (downward), 4.1ℓ (upward) Crystal resolution; >12 %, Range; 0.1 - 3.0 meV/256 ch, 0.1 photopeak resolution Window; / Lower Limit / Higher Limit Bi(upward) 1138 1154 Total(upward) 1034 1233 T1208(downward) 201 233 Bi214(downward) 138 154 K40(downward) 113 129 Total(downward) 034 233
Data Acquisition System/ Graphic Recorder	DGR33	RMS Instruments Ltd. (Canada)	Analog Inputs; 32, Analog Input Range; ± 10V, Chart Resolution; 4x4 dots/mm, Chart Sensitivity; 10 mV/cm to 10 V/cm Interface; RS-232-C x 4 ports Data Sample Rate; 10/sec Event Markers, Manual Fiducial Mark 5/sec Magnetometer, Navigation 1/sec Spectrometer
Cartridge Tape Recorder	TCR12	RMS Instruments Ltd. (Canada)	Recording Density; 6400 BPI Recording Capacity; 11.7 MBytes
Station Magnetometer	M234	Barringer Research (Canada)	Sampling Rate; 1 sec, Resolution; 0.1 nT Accuracy; 0.5 nT, Range; 20,000 - 90,000 nT
Radar Navigator	PNAV2001	Picodas Group (Canada)	Resolution; 0.5 m
GPS Receiver	TANS12017-10	Trimble(U.S.A.)	Accuracy; ± 10 m
Barometric Altimeter	1241M	Rosemount(U.S.A.)	Relative Accuracy; ± 7 ft, Resolution; ± 10 ft
Radar Altimeter	KRA-10A	King(U.S.A.)	Range; 40 - 2,500 ft, Resolution; 5 ft, Accuracy; 5 %
Flight Path Recorder	AG2400 DXC101 DXF40A	Panasonic(Japan) Sony(Japan) Sony(Japan)	VHS style Video-Recorder in NTS format Video Camera Video Monitor
Helicopter	TwinStar AS355F2	Aerospatial(France)	Type; Twin-engine turbine(Allison 250-C20F) Size; 10.3 ft(H)x 42.5 ft(L)x 8.3 ft(W) Main Rotor Diameter; 35.1 ft, Useful Load; 2,928 lb(1,212 Kg)

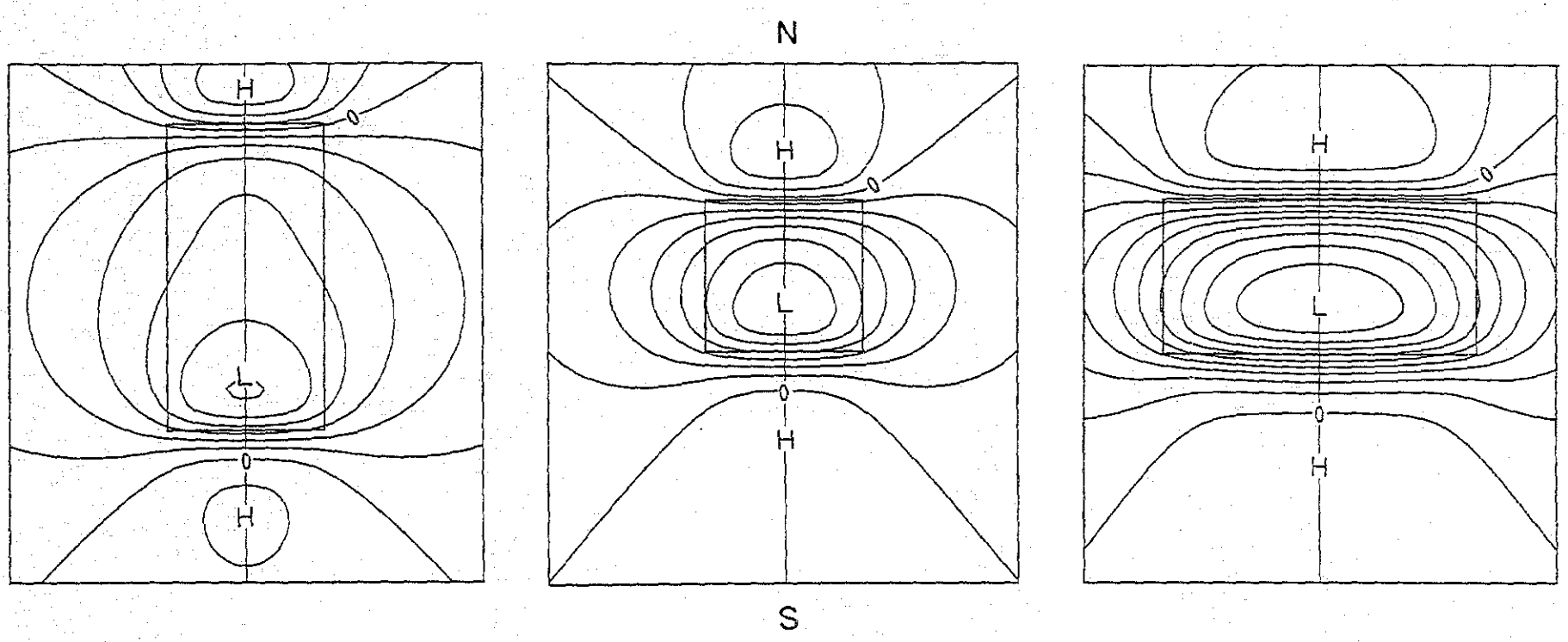


Fig. II-3-2 Theoretical magnetic anomaly due to prism model

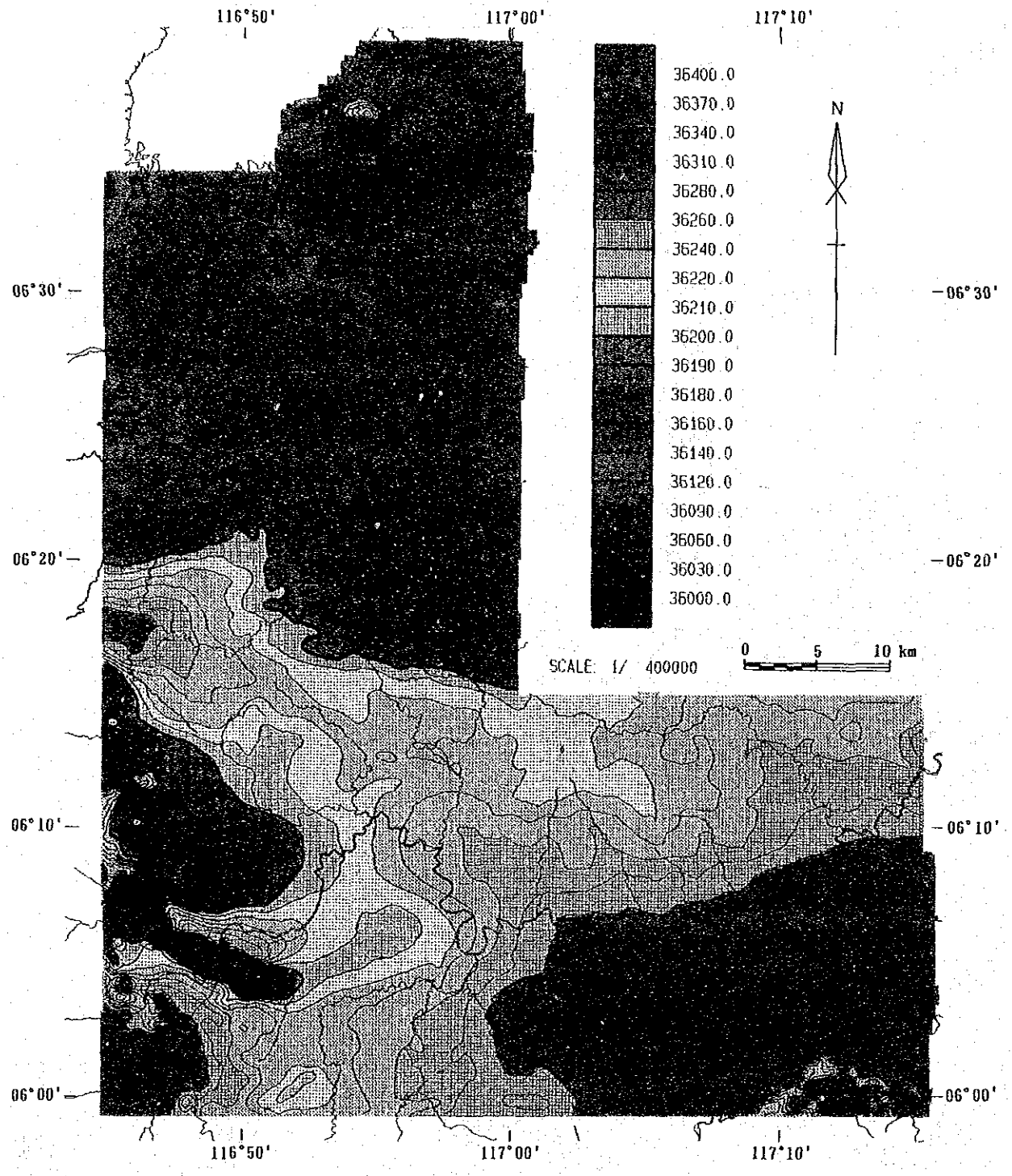


Fig. II-3-3 Total field magnetics of Northern Kinabalu area

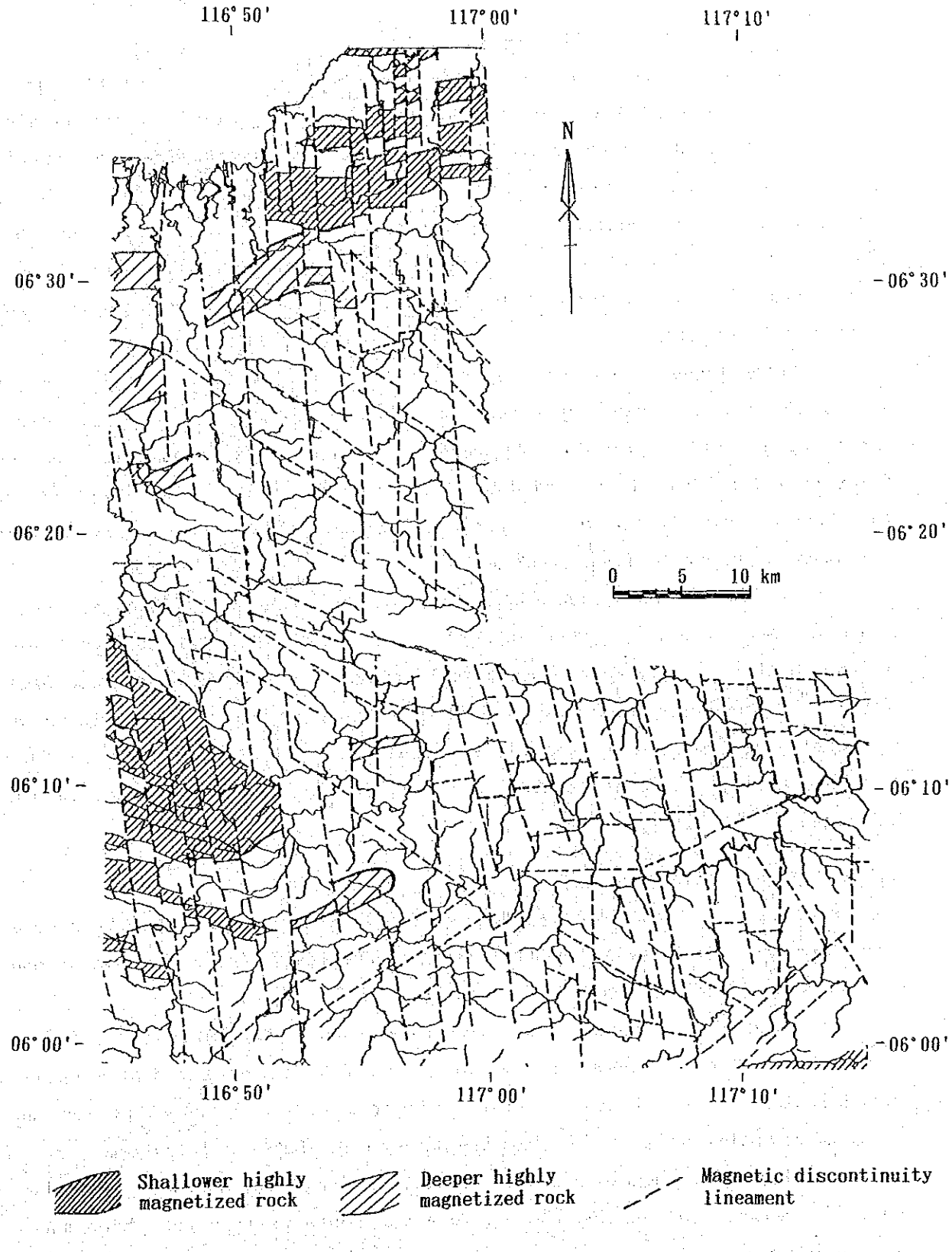


Fig. II-3-4 Magnetic anomaly map of Northern Kinabalu area

such as ultra-basic rocks at the depth.

At the southwestern part of Northern Kinabalu area, there are distributed a number of large-amplitude magnetic anomalies of relatively short wavelength aligning in NW-SE direction, which seem to be caused by the highly magnetized rocks near surface. Those rocks are bounded at the north and south edges by NW-SE trending magnetic discontinuity lineaments and divided into small blocks by N-S trending magnetic discontinuity lineaments. These anomalies are due to ultra-basic rocks, adamellite, granodiorite, basalt and Chert-Spilite (KPCs) near surface and/or at the shallower part.

And high magnetic anomalous zone is found at the east of the above magnetic anomalies, suggesting sediment rocks of low magnetics are dominated. This part shows the similar distribution of magnetic discontinuity lineaments trending in NW-SE to WNW-ESE directions and N-S direction as those at the south western part. And there are distributed NE-SW trending lineaments at the southeastern part which are found at the north of the Labuk area.

In the Kinabalu and Labuk areas, the distribution pattern of magnetic anomalies shows a remarkable difference between three areas, which seems to reflect the differences of geology and/or geological structures of three areas. Low magnetic anomalies of long wavelength are dominated in Northern Kinabalu area and large-scale high magnetic anomalies are distributed predominantly in Southern Kinabalu area, while smale-scale low magnetic anomalies of short wavelength are dominated in the Labuk area.

(2) Radiometric anomaly map

Radiometrics total count contour maps and ternery maps of Northern Kinabalu area, are shown in Figs. II-3-5 and II-3-6, respectively. And a radiometric anomaly map of Northern Kinabalu area is shown in Fig. II-3-7.

In the Northern Kinabalu area, high total count(T.C.) values are found in the whole area. Within these high values, low T.C. zones are found sparsely. Potassium(K) high count zone coincides almost with high total count zone so the total count radiometrics in this area are mainly contributed by potassium.

Very high T.C. anomalous zones are distributed at the southwestern and southeastern parts of the Northern Kinabalu area. South western very-high anomalous zone which shows large contribution of uranium(U) and thorium(Th) is located on low magnetic anomalies due to basalt.

High count anomalies aligned in N-S directions are predominantly distributed

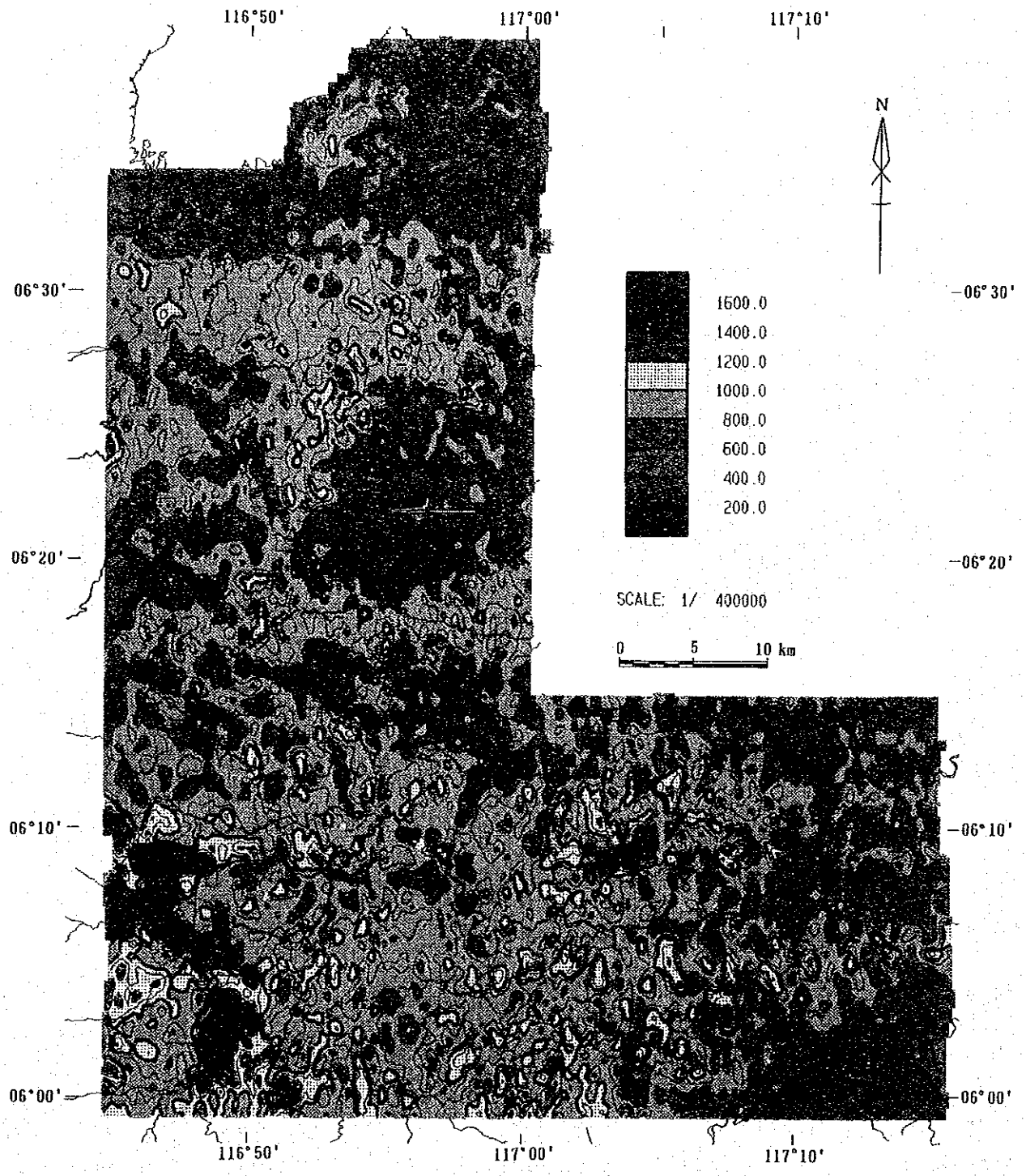


Fig. II-3-5 Radiometric total count of Northern Kinabalu area

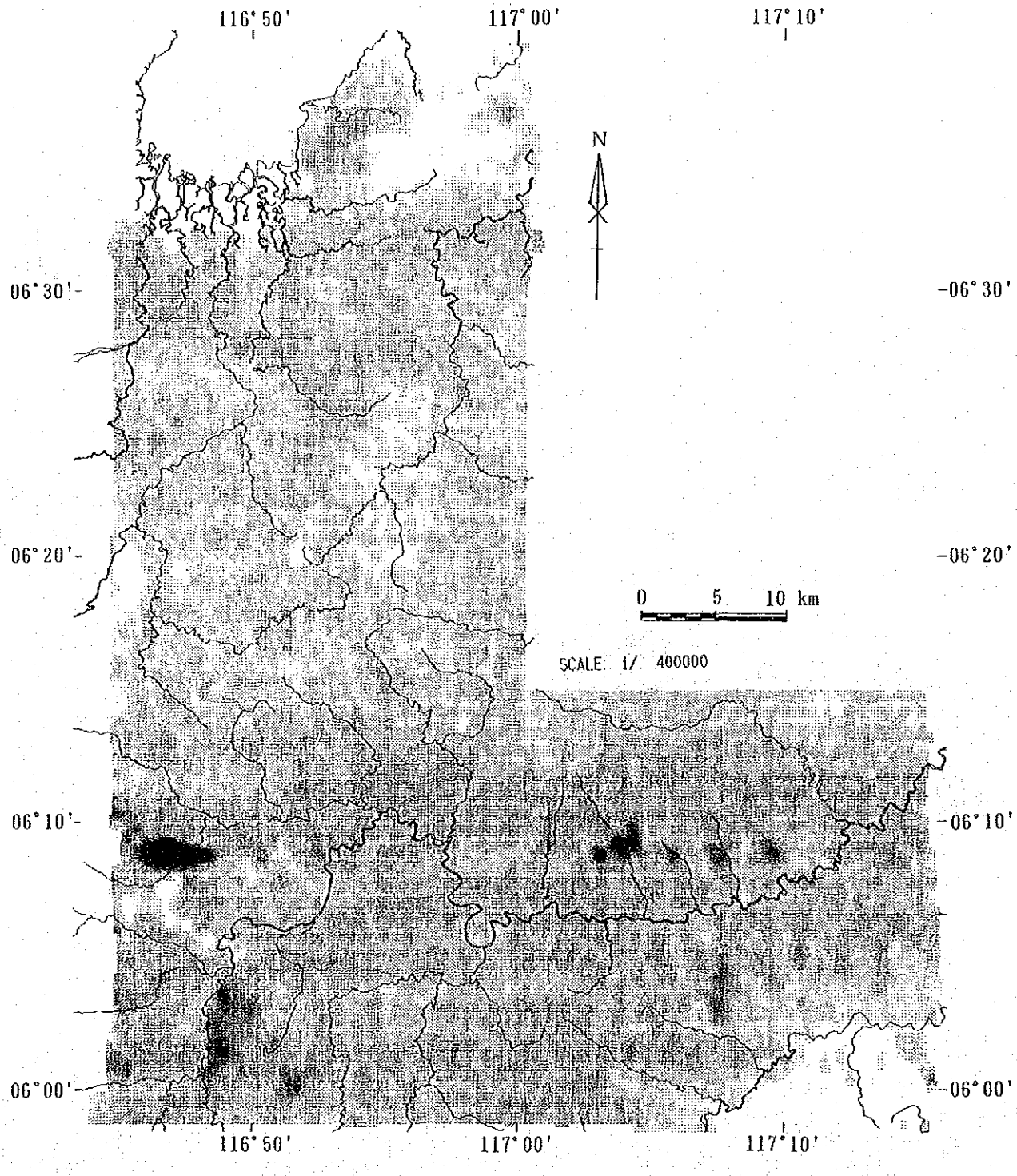


Fig. II-3-6 Radiometric ternery map of Northern Kinabalu area

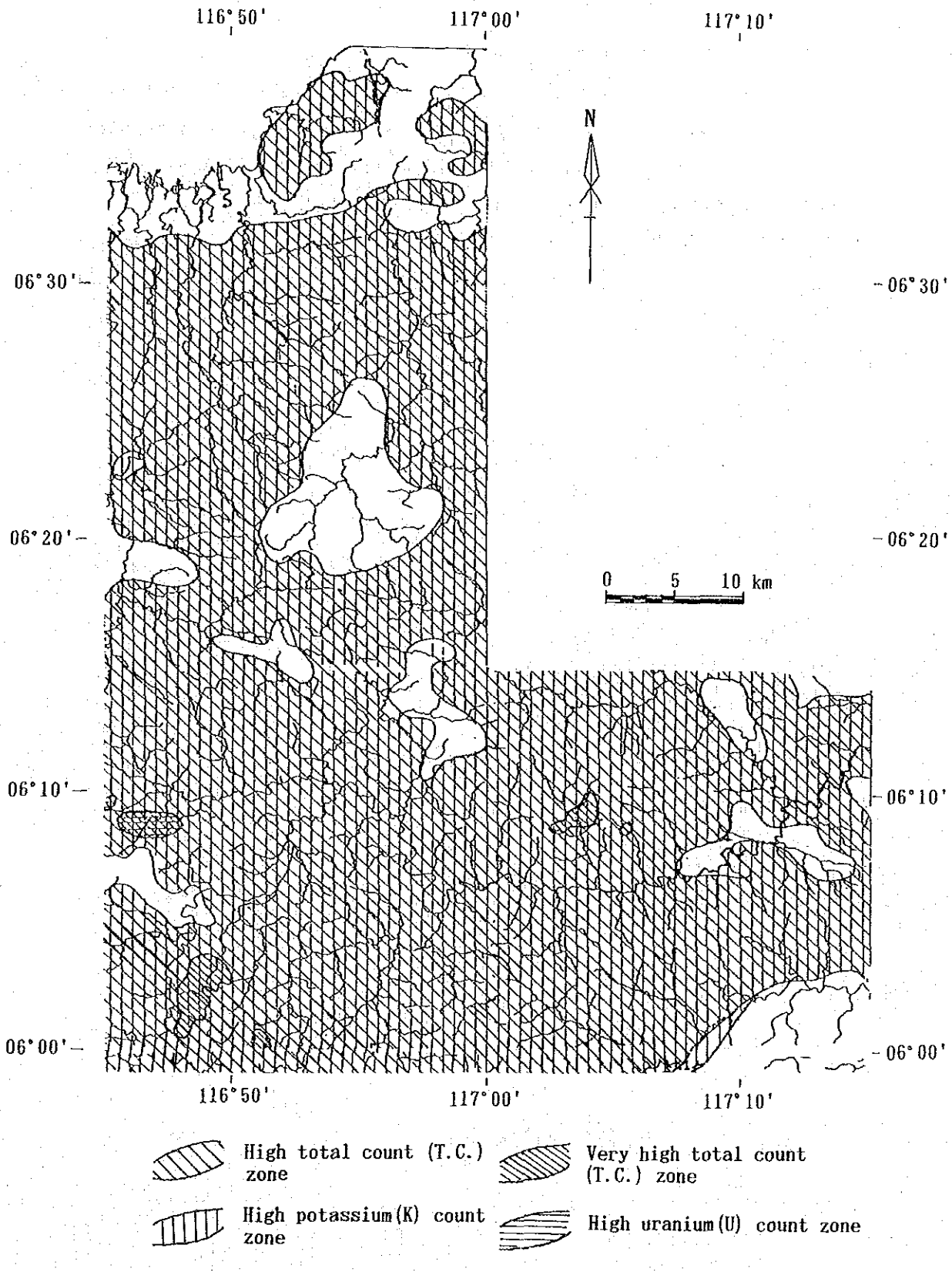


Fig. II-3-7 Radiometric anomaly map of Northern Kinabalu area

and those aligning in NW-SE and NE-SW directions are also found.

In Kinabalu and Labuk areas, including the Kinabalu North area, radiometric anomaly distribution shows a similar characteristic pattern as magetic anomaly distribution. That is, high total count radiometric anomalous zone occupies Northern Kinabalu and Southern Kinabalu areas, while low total count radiometrics are dominated and high total count anomalies are isolated in the Labuk area.

Chapter 4 Overall discussion

4-1 Regional geochemical survey

As the results of this survey, distributions of each element well correspond to the geology, and delineated the known mineral showings in Kinabalu and Labuk areas. These facts indicate that the sample medias, sampling density and pathfinder elements applied in this survey are adequate for the regional survey in this area. The survey results are interpreted as following;

(1) Survey results in Kinabalu area

① Among the analyzed elements for stream sediment samples, the maximun value of Cr(59,548 ppm), Hg(14,767), Sb(3,488.0 ppm) and Ti(51.07 %) are significantly high. Especially, the value of Ti is extremely high.

② In the stream sediment survey, correlation coefficient among the elements including Cr, Co, Mg, Mn and Ni are higher than that of other elements. These pairs of elements reflect ultra-basic rocks and Chert-Spilite formation in this area.

③ The distribution maps of Co, Cr, Mg, Mn, Na, Ni, Sb, Ti and Zn in the stream sediment survey indicate that these elements have close relation with ultra-basic and basic rocks. The elements including As, Ba, K, Pb, S, Sr and U show comparatively high values in the area of muddy sedimentary rocks.

④ The stream sediment samples with anomalous(more than threshold value) and high values (more than background plus standard deviation) of Au, Cu, Hg, Mo, Pb, S and Sb are found in the area of Mamut mine and the surroundings. This anomalous zone is quite significant.

⑤ Anomalous and high value stream sediment samples of Au, Cu, K and Pb are found in the down stream of Sungai Sugut. This area is interpreted to have potentiality of copper ore deposits.

⑥ Anomalous and high value stream sediment samples of Au, Cu and Hg are also found in the middle stream of Sungai Sugut. This area is situated on a lineament delineated from satellite image analyses of TM data. This area also has potentiality of copper ore deposits.

⑦ A stream sediment sample collected from the upper stream of Sungai Karamuak, indicated significant high contents of Ti. This area may have potentiality of titanium ore deposits. The minerals in this sample is mostly ilmenite.

⑧ The soil geochemical reconnaissance survey was carried out in the area of ultra-basic rocks to clarify a potentiality of residual laterite deposits. The analytical results show that the maximum value of Ni is 10,797 ppm. This sample is situated 4 km east of Ranau and the contents of Co is also high value (1,212 ppm). This area is interpreted to have potentiality of nickel ore deposit.

(4) Survey results in Labuk area

① Among the elements, the maximun value of Au (6,530 ppb), Cr(117,538 ppm), Hg (24,735 ppb) and Ni(6,778 ppm) give higher values in the stream sediment survey.

② In the sream sediment survey, the correlation coefficient among the elements including Co, Cr, Cu, Mg, Ni and Zn show good correlation each other. U has negative correlation with these elements.

③ According to the distribution maps of each element and of anomalous samples, the anomalous and high content stream sediment samples of Co, Cr, Mg, Mn, Ni, Sb, Zn are found in the area of ultra-basic and basic rocks.

④ The stream sediment samples with more than 1,000 ppb Au (maximum; 6,530 ppb) are concentrated in the area of tributary of Sungai Imbak where Tanjong formation is distributed. Anomalous samples of Hg(24,735 ppb) and Pb are also found in this area. During the survey, small in scale andesite porphyry was confirmed in this area. These facts suggest the potentiality of gold deposit in this area.

⑤ Three anomalous stream sediment samples of Au (maximum 2,900 ppb) are found at the south bank of the middle stream of Sungai Imbak. In this area, a sample with high W (95 ppm) content is confirmed. Some samples with more than 1,000 ppb Hg are scattered in the surroundings. These fact also suggest the potentiality of gold deposit in this area.

⑥ Several stream sediment samples with more than 100 ppb Au (maximum 881 ppb) are concentrated in the lower stream of Sungai Karamuak where Crocker formation is distributed. This area is interpreted to have potentiality of gold deposits.

⑦ The anomalous stream sediment samples of Cu (maximum 608 ppm) are found in the area between Sungai Karamuak and Sungai Milian. This area is situated at the southern vicinity of the lower stream of Sungai Karamuak. This area is potential area of copper deposits.

⑧ Significant anomalous zone of Cr was found in the area of the middle stream of Sungai Karamuak where ultra-basic rocks are observed. Most stream sediment samples in this area show more than 50,000 ppm Cr and the maximum is 101,691 ppm Cr. In this area, samples with high Cu contents (maximum 580 ppm) are also confirmed. The potentiality of chromium or copper deposits in this area seems to be high.

⑨ Extreamly high contents of Cr (maximum 117,538 ppm) are found in the upper stream of Sungai Mailo, south of Telupid, over the area of ultra-basic rocks. According to this fact, the potentiality of chromium deposit is high in this area.

⑩ High and anomalous stream sediment samples of Cu (maximum 212 ppm) are concentrated along Sungai Sugut in the northern part of the area. Samples with higher contents of Au and Ba are also found in this area. This anomalous area extends from the eastern margin of Kinabalu area. This area is interpreted to have potentiality of copper deposit.

⑪ Anomalous zones of the stream sediment geochemical survey clearly delineated Bidu Bidu Hill ore deposit. The maximum value of Cu in this area is 516 ppm, and Au is also comparatively high.

⑫ The soil samples with the maximum value of Ni (10,587 ppm) and of Cr (2,173 ppm) are found at the west of Telupid in the central part of survey area. Thick

lateritic soil over serpentinite is found in this area. This area has potentiality of residual nickel ore deposits.

4-2 Semi-detailed geochemical survey

A semi-detailed geochemical survey was carried out for eight selected areas in Segama and Semporna areas. These areas are selected as the areas with mineral potentiality based on the results of the regional geochemical survey in Phase II. The survey results for these eight areas are summarized as below;

① As the results of soil geochemical survey in Area A, anomalous and high value samples of Cu and Zn are scattered. Pyrite dissemination is confirmed at the upper stream of Sungai Sabahan where Kuamut formation occurs. Analytical results of a sample collected in this mineralized zone, show slightly high values of Cu (107 ppm) and Zn (117 ppm). Observation of a polished section confirmed the existance of minor amounts of chalcopyrite and sphalerite. Judging from these fact, the mineralization in this area is possibly weak.

② In the Area B, soil and stream sediment geochemical surveys were carried out. Because of steep topography, the survey was conducted along streams. As the results of soil geochemical survey, significant anomalous zone of Cu and Zn are confirmed in the central and southwest parts of the area where Chert- Spilite formation crops out. Results of stream sediment geochemical survey also delineated significant anomalous zones in the same parts of the area where anomalous zones of soil are distributed. This promising zones were also clearly delineatede by the results of factor analysis. During the sampling work significant copper mineralization was confirmed in these geochemical anomalous zones. This mineralized zone consists of stockwork and dissemination of sulfide minerals and extends 5 km x 2 km. Assay results for the ore sample collected in this zone give 2.12 % Cu and 3.04 % Zn which are the best. This mineralized zone is also strongly silicified, chloritized and brecciated. These facts suggest that Area B has significant potentiality of copper deposits.

③ Geochemical anomalous zones of Cu in Area C are mainly found in the area of green schist. In the surface survey, sulfide disseminations, mostly pyrite, are confirmed in these anomalous zones. Results of soil geochemical survey delineated a anomalous zone of Cu, Pb, S and Zn in the southern central part of the area. This anomalous zone may reflect some mineralization. Because mineralization in this area is found in the sheared zones of green schist, and distribution of Chert-Spilite formation is limited, potentiality of Cyprus type copper deposits in this area is thought to be low.

④ The geochemical anomalous zones delineated in Area D are small in scale and are scattered and no significant anomalous zones were confirmed. Because of limited distribution of Chert-Spilite formation, potentiality of Cyprus type copper ore deposit is thought to be low.

⑤ In Area E, anomalous zones of As, Au, Cu, Hg, Mo and Pb are overlapped in the southeastern part of the area. Results of a factor analysis also clearly delineated this zone. On the surface, silicified zones are observed in this anomalous zone. These fact suggests the existence of hydrothermal alteration

in this zone. However, significant mineralized zones have not been confirmed on the surface.

⑥ As the results of soil geochemical survey in Area F, anomalous zones of As, Cu, Hg, Pb and S are overlapped in the northern part of the area where andesite and its pyroclastics are observed. In this part, silicified and argillized zones with pyrite dissemination and hot spring are situated. Results of factor analysis also clearly delineated these altered zones. Judging from the relation between altered zone and anomalous elements, this altered zone may have some relation with hot spring activity.

⑦ As the results of soil geochemical survey in Area G, anomalous zones of several elements overlap in the southeastern and southwestern parts of the area. Granodiorite porphyry is found in the southeastern part. The southwestern part is the area of strongly argillized andesite. Anomalous zones of As, Au and Pb overlap in the northwestern part of the area where altered andesite occurs. These anomalous zones were also delineated in the results of factor analysis. The significant mineralized zone has not confirmed in this area. Judging from the geochemical survey results, the potential areas may limited in the altered zones and nearby gronodiorite porphyry stock.

⑧ As the result of soil geochemical survey in Area H, anomalous zones of several elements overlap in the area of Chert-Spilite formation and southern margin of the area where andesite crops out. Other than these two area, anomalous zones are scattered. These two anomalous zones may have some potentiality in this area. But the potentiality seems to be low, because no significant mineralized zones were confirmed on the surface.

4-3 Heliborne geophysical survey

Data analysis and interpretation for Northern Kinabalu area are carried out in this phase. The results are summarized as following;

① N-S trending magnetic discontinuity lineaments are dominated and high-count anomalies are aligned in the N-S direction. This direction of N-S is the same as the strikes of the faults infered by the satellite image analysis, so that these lineaments seems to reflect main geologic structure. And there are distributed magnetic discontinuity lineaments in the directions of NW-SE, NE-SW and ENE-WSW in the entire area.

② High count radiometric zones distributed in the whole area are mainly contributed by potassium.

③ In the northern part, magnetic anomalies of large amplitude and short wavelength aligning in E-W and ENE-WSW directions are due to highly magnetized Chert-Spilite formation near surface, which are bounded at north and south edges by magnetic discontinuity lineaments trending in E-W and ENE-WSW directions and divided by N-S trending magnetic discontinuity lineaments.

④ In the central part, low magnetic anomalies of long wavelength and relatively large amplitude at the western side are due to the highly magnetized ultra-basic rock in the depth.

⑤ At the south western part, a number of large-amplitude magnetic anomalies of

relatively short wavelength aligned in NW-SE direction are caused by the highly magnetized rocks such as ultra-basic rocks, adamelite, granodiorite and Chert-Spilite formation near surface. These highly magnetic rocks are bounded at north and south edges by NW-SE trending magnetic discontinuity lineaments and divided by N-S trending magnetic discontinuity lineaments.

⑥ Very high radiometric anomalous zone showing large contribution of uranium (U) and thorium (Th) is located on low magnetic anomalies caused by Chert-Spilite formation.

Part III Conclusions and recommendations

Chapter 1 Conclusions

A regional geochemical survey was carried out for Kinabalu and Labuk areas. The survey method adopted in this survey is the same as the survey in Segama and Semporna areas of Phase II. A semi-detailed geochemical survey for the selected eight areas was also carried out in this phase. These eight areas are situated in Segama and Semporna areas and are selected as potential areas of mineral resources in the regional survey of Phase II.

The results of regional geochemical survey for Kinabalu and Labuk areas clearly delineated the known mineral showings in these areas. Consequently, the survey methods applied are useful method in this project area.

The results of the stream sediment geochemical survey delineated following promising areas of mineral resources in Kinabalu and Labuk areas.

Kinabalu area: ①lower stream of Sungai Sugut, ② middle stream of Sungai Sugut, ③ east of Ranau and ④ the most upper stream of Sungai Karamuak.

Labuk area : ⑤ tributary of Sungai Imbak, ⑥ middle stream of Sungai Imbak, ⑦ lower stream of Sungai Karamuak, ⑧ middle stream of Sungai Karamuak, ⑨ the area between Sungai Karamuak and Sungai Milian, ⑩ Sungai Mailo area, ⑪ Sungai Sugut area at the north, ⑫ west of Telupid and ⑬ Bidu Bidu Hill deposit area.

Results of the regional geochemical survey for Kinabalu area delineated the Mamut ore deposits as a significant geochemical anomalous zone. The nature of the anomalies in the areas of ① and ② are similar to the nature of the Mamut ore deposits. These two areas may have potentiality of porphyry copper deposits which is the type of the Mamut ore deposits. One lateritic soil sample collected at the east of Ranau(③) show comparatively high value (1.08 %) of Ni. This area has potentiality of residual nickel ore deposit. One stream sediment sample collected in the most upper stream of Sungai Karamuak(④) show significant high value (51.07 %) of Ti. This area may have potentiality of titanium deposits.

Among the promising areas delineated in Labuk area, anomalous zones of Au and Hg are found in three areas of ⑤ tributary of Sungai Imbak, ⑥ middle stream of Sungai Imbak and ⑦ lower stream of Sungai Karamuak. Especially, samples with high values (maximum; 6,530 ppb) of Au are concentrated in the tributary of Sungai Imbak. This area have higher potentiality of gold deposit. The middle stream of Sungai Karamuak(⑧) is the potential area of chromium and copper ore deosits. The

target in the area between Sungai Karamuak and Sungai Milian (⑨) is copper ore deposits. The area along Sungai Mailo (⑩) in the south of Telupid has potentiality of chromium ore deposits because extremely high value (maximum 117,538 ppm) samples were confirmed in this area. The area along Sungai Sugut(⑪) in a northern part has potentiality of copper ore deposits. This potential area extend to Kinabalu area. As the results of soil geochemical survey, lateritic soil samples in the west of Telupid (⑫) indicates high values of Ni (maximum 1.06 %) and Co (maximum 0.22 %). This area has potentiality of residual nickel ore deposits. Anomalous zones are also confirmed in the Bidu Bidu Hill deposit area(⑬) where significant Cyprus type copper deposit is known.

The semi-detailed geochemical survey for eight areas were conducted in Segama and Semporna areas. This survey results delineted significant anomalous zone and confirmed mineralized zones in Area B. This mineralized zone extends 5 km x 2 km and the ore samples collected in this area show 2.12 % Cu and 3.04 % Zn at the best. Other than Area B, weakly mineralized and altered zones were also confirmed. Especially, strongly argillized zones with geochemical anomalies are confirmed in the areas of Area E, Area F and Area G.

The data analyses and interpretation of heliborne geophysical survey for Northern Kinabalu area are conclusively summarized as following;

In the northern part, highly magnetized bodies are expected near surface. These bodies correspond to ultra-basic rocks and Chert-Spilite formation on the surface. In the central part, the highly magnetized ultra-basic rocks are expected in the depth. At the south western part, highly magnetized bodies near surface are divided by NW-SE and N-S trending magnetic discontinuity lineaments.

High count radiometric zones distributed in the entire area are mainly contributed by potassium. In the south western and south eastern parts, a very high radiometric anomalous zone showing large contribution of uranium (U) and thorium (Th) is located on low magnetic anomalies caused by Chert-Spilite formation.

Chapter 2 Recommendations for Phase IV survey

The following survey method are recommendable for the survey in Phase IV on the bases of the survey results of Phase III;

1) The promising areas delineated in this survey cover comparatively wide area and therefore, further exploration work should be carried out in order to delineate exact target zones. Locations of these promissing areas are shown in Fig. I-3. The following survy method should be applied for these areas.

Kinabalu area

① Lower stream of Sungai Sugut	: soil geochemical survey
② Middle stream of Sungai Sugut	: soil geochemical survey
③ East of Ranau	: soil geochemical survey
④ Upper most stream of Sungai Karamuak	: stream sediment geochemical survey

Labuk area

⑤ Tributary of Sungai Imbak	: soil geochemical survey
⑥ Middle stream of Sungai Imbak	: soil geochemical survey
⑦ Lower stream of Sungai Karamuak	: soil geochemical survey
⑧ Middle stream of Sungai Karamuak	: soil geochemical survey
⑨ Area between S. Karamuak and S. Milian	: stream sediment geochemical survey
⑩ Sungai Mailo area	: stream sediment geochemical survey
⑪ Sungai Sugut area	: soil geochemical survey
⑫ West of Telupid	: soil geochemical survey

A preliminary geologic survey also should be carried out for these selected areas. The areas where exploration work have been completed are not included in this recommendation. In the survey for areas ③ and ⑫, situation in the deeper parts should be clarified.

2) The significant mineralized zone in Area B deliniated in the semi-detailed survey, should be investigated geologically in order to clarify the nature of mineralization in detail.

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