Appendix 26

Flight record of heliborne geophysical survey

Flight Record (FY1990) No. 1

Date	Weather	Flight Line-km	Reference
Dec.12	Rain	0.0	From Kota Kinabalu to Ranau
Dec.13	Cloudy/Fine	108.5	Start Kinabalu Flight
Dec.14	Cloudy/Rain	0.0	
Dec.15	Rain	0.0	
Dec.16	Rain	0.0	
Dec.17	Rain/Cloudy	56.2	
Dec.18	Cloudy/Rain	0.0	
Dec.19	Fog	175.0	
Dec.20	Rain/Cloudy	212.0	
Dec.21	Fog/Fine	211.0	
Dec.22	Fog	189.0	
Dec.23	Fog	108.0	
Dec.24	Fog	86.5	
Dec.25	Fog/Rain	100.0	
Dec.26	Fog	0.0	
Dec.27	Fog/Rain	0.0	
Dec.28	Rain	0.0	
Dec.29	Fog/Fine	119.0	
Dec.30	Rain	0.0	
Dec.31	Fog	105.5	
Jan. 1	Fog	0.0	
Jan. 2	Fog	124.6	
Jan. 3	Fog	0.0	
Jan. 4	Fog	0.0	
Jan. 5	Fog	0.0	
Jan. 6	Fog	30.0	Complete Kinabalu Flight
Jan. 7	Cloudy	0.0	Ranau ⇨Kota Kinabalu ⇨Tawau Tawau
Jan. 8	Cloudy	0.0	Helicopter Check
Jan. 9	Fine	0.0	- do -
Jan.10	Cloudy	0.0	- do -
Jan.11	Cloudy	0.0	- do -
Jan.12	Fine	206.5	Start Semporna Flight
Jan.13	Cloudy	354.0	
Jan.14	Fine	350.5	
Jan.15	Fine	379.5	
Sub Total		2,915.8	
Total		2,915.8	

Flight Record (FY1990) No. 2

Date	Weather	Flight Line-km	Reference
Jan.16	Fine	354.0	
Jan.17	Fine	354.0	
Jan.18	Cloudy	295.0	
Jan.19	Rain	0.0	
Jan.20	Cloudy/Rain	118.0	
Jan.21	Cloudy	177.0	
Jan.22	Fine	434.8	
Jan.23	Rain/Fine	253.0	
Jan.24	Rain	0.0	
Jan.25	Rain	0.0	
Jan.26	Rain	0.0	
Jan.27	Rain	0.0	
Jan.28	Cloudy/Rain	0.0	
Jan.29	Rain	0.0	
Jan.30	Rain	0.0	
Jan.31	Rain	0.0	
Feb. 1	Rain	0.0	
Feb. 2	Cloudy	0.0	
Feb. 3	Cloudy	102.0	
Feb. 4	Rain	0.0	
Feb. 5	Fine	289.0	
Feb. 6	Fine	305.0	
Feb. 7	Cloudy	10.0	
Feb. 8	Fine	238.0	Complete Semporna Flight
Feb. 9	Cloudy	0.0	Tawau ⇨Segama
Feb.10	Fine	0.0	Helicopter check
Feb.11	Cloudy	0.0	- do - Tawau
Feb.12	Cloudy	188.7	Start Segama Flight
Feb.13	Cloudy	273.0	
Feb.14	Cloudy	104.1	
Feb.15	Cloudy	134.8	
Feb.16	Cloudy	69.4	
Feb.17	Cloudy	101.1	
Feb.18	Cloudy	296.6	
Feb.19	Rain	0.0	
Sub Total		4,097.5	
Total		7,013.3	

Flight Record (FY1990) No. 3

Date	Weather	Flight Line-km	Reference
Feb.20	Rain	0.0	
Feb.21	Cloudy	33.7	
Feb.22	Cloudy	235.9	
Feb.23	Cloudy	293.3	
Feb.24	Cloudy	69.4	
Feb.25	Cloudy	69.4	
Feb.26	Cloudy	69.4	
Feb.27	Fine	208.2	
Feb.28	Cloudy	138.8	
Mar. 1	Cloudy	0.0	Helicopter Check
Mar. 2	Cloudy	0.0	- do -
Mar. 3	Cloudy	0.0	- do -
Mar. 4	Fine	0.0	- do -
Mar. 5	Fine	269.6	
Mar. 6	Cloudy	337.0	
Mar. 7	Cloudy	50.0	
Mar. 8	Cloudy	150.0	
Mar. 9	Cloudy	200.0	
Mar.10	Cloudy	200.0	
Mar.11	Cloudy	300.0	
Mar.12	Fog/Fine	101.1	
Mar.13	Fine	303.3	
Mar.14	Cloudy	134.8	
Mar.15	Cloudy	337.6	
Mar.16	Fog/Cloudy	134.8	
Mar.17	Fog/Cloudy	101.1	
Mar.18	Fog/Cloudy	268.2	
Mar.19	Fog/Rain	180.0	Complete Segama Flight
Mar.20	Rain		Segama⇨Kota Kinabalu
Sub Total		4,185.6	
Total		10,919.0	

Flight Record (FY1991) No. 1

Date	Weather	Flight Line-km	Reference
Sep.24	Rain		Kota Kinabalu to Kundasang
Sep.25	Rain	0.0	Start Labuk/Southern Kinabalu Flight
Sep.26	Rain	0.0	
Sep.27	Fine/Rain	111.1	
Sep.28	Fine/Rain	111.1	
Sep.29	Fine/Rain	111.1	
Sep.30	Fog/Fine/Rain	156.4	
Oct.01	Fog/Rain	0.0	
Oct.02	Fine/Rain	144.2	
Oct.03	Rain	0.0	
Oct.04	Fine/Rain	251.7	
Oct.05	Rain	0.0	
Oct.06	Rain	0.0	
Oct.07	Fine	216.7	
Oct.08	Fine	103.8	
Oct.09	Fog/Rain	0.0	
Oct.10	Rain	0.0	
Oct.11	Cloudy	0.0	
Oct.12	Fine	311.4	
Oct.13	Fine	311.4	
Oct.14	Fine	311.4	
Oct.15	Fine	207.6	
Oct.16	Fine	186.7	
Oct.17	Fine	103.8	
Oct.18	Fine	203.4	
Oct.19	Fine	292.6	
Oct.20	Rain	0.0	
Oct.21		---	Helicopter 100hr Check
Oct.22		---	- do -
Oct.23	Fine	231.7	
Oct.24	Fine	279.1	
Oct.25	Fine	408.0	
Oct.26	Rain·Haze	0.0	Waiting for rain & haze
Oct.27	Rain·Haze	0.0	- do -
Sub Total		4,053.2	
Total		4,053.2	

Flight Record (FY1991) No. 2

Date	Weather	Flight Line-km	Reference
Oct.28	Fine	383.1	
Oct.29	Fine	389.6	
Oct.30	Fine	434.2	
Oct.31	Rain·Haze	0.0	Waiting for Rain & Haze
Nov.01	Fine	488.7	
Nov.02	Fine	118.4	
Nov.03	Fine	192.5	
Nov.04	Rain	0.0	
Nov.05	Fine	570.9	
Nov.06	Rain	0.0	
Nov.07	Fine	299.2	
Nov.08	Rain	0.0	Helicopter: 50hr Check
Nov.09	Fine	149.5	
Nov.10	Rain	0.0	
Nov.11	Fine	337.0	
Nov.12	Cloudy	0.0	
Nov.13	Rain	0.0	
Nov.14	Rain	0.0	
Nov.15	Fine	151.6	
Nov.16	Fine	133.3	
Nov.17	Fine	207.4	
Nov.18	Rain	0.0	
Nov.19	Rain	0.0	
Nov.20	Fine	92.8	Start Northern Kinabalu Flight
Nov.21	Rain	0.0	
Nov.22	Cloudy	0.0	
Nov.23	Rain	0.0	
Nov.24	Cloudy	0.0	
Nov.25	Fine	444.8	
Nov.26	Fine	444.8	
Nov.27	Fine	333.6	
Nov.28	Fine	444.8	
Nov.29	Cloudy	0.0	
Nov.30	Rain	0.0	
Sub Total		5,616.2	
Total		9,669.4	

Flight Record (FY1991) No. 3

Date	Weather	Flight Line-km	Reference
Dec.01	Rain	0.0	
Dec.02	Fine	0.0	Halt for poor GPS signal
Dec.03	Rain	0.0	
Dec.04	Fog	0.0	
Dec.05	Fog	0.0	
Dec.06	Fog	0.0	
Dec.07	Fine	111.2	
Dec.08	Rain	0.0	
Dec.09	Cloudy	0.0	
Dec.10	Rain	0.0	
Dec.11	Fine	137.1	
Dec.12	Cloudy	0.0	Test Flight(Second System)
Dec.13	Rain	0.0	
Dec.14	Rain	0.0	
Dec.15	Rain	0.0	First System: 300hr Check
Dec.16	Fine	277.5	
Dec.17	Fine	27.7	Poor GPS Signal
Dec.18	Rain	0.0	
Dec.19	Fine	336.8	
Dec.20	Fine	374.5	
Dec.21	Fine	353.1	
Dec.22	Rain	0.0	Finish First System 300hr Check
Dec.23	Rain	0.0	
Dec.24	Rain	0.0	
Dec.25	Rain	0.0	
Dec.26	Rain	0.0	
Dec.27	Rain	0.0	
Dec.28	Fine	463.5	
Dec.29	Fine	146.75	
Dec.30	Fine	186.25	
Dec.31	Fine	620.75	
Jan.01	Rain	0.0	
Jan.02	Rain	0.0	
Jan.03	Rain	0.0	
Sub Total		3,121.15	
Total		12,790.55	

Flight Record (FY1991) No. 4

Date	Weather	Flight Line-km	Reference
Jan.04	Fine	63.0	
Jan.05		----	Move to Northern Semporna
Jan.06	Rain	0.0	Start Northern Semporna Flight
Jan.07	Fine	643.0	
Jan.08	Fog	1,043.8	
Jan.09	Fog	843.4	
Jan.10	Fine	444.3	Finish Northern Semporna Flight
Jan.11		----	
Jan.12	Rain	0.0	Restart Southern & Northern Kinabalu
Jan.13	Rain	0.0	
Jan.14	Fine	332.4	
Jan.15	Rain	0.0	
Jan.16	Rain	0.0	
Jan.17	Fine	234.0	
Jan.18	Fine	242.0	Finish Norhtern Kinabalu Flight
Jan.19	Rain	0.0	
Jan.20	Fine/Cloudy	18.0	Finish Southern Kinabalu Flight
Jan.21			Demobilization
Sub Total		3,868.85	
Total		16,659.4	

Appendix 27

In-situ magnetic susceptibility and radiometric activity

Ser. No.	Location No.	Area *1	Geologic unit	Lithology	Total Count (cps)	K+U+Th (cps)	U+Th (cps)	Th (cps)	κ ($\times 10^{-3}$SI)	Remarks
1	SG-09	C	P_4Km	Sandstone	88.7	2.29	1.49	0.74	0.17	
2	SG-27	C	P_4Km	Sandstone	80.3	2.03	1.40	0.55	0.07	
3	SG-29	C	P_4Km	Sandstone	50.8	1.43	0.83	0.44	0.30	
4	SG-26	C	P_4Km	Basaltic Lava	32.6	0.96	0.82	0.62	28.4	
5	SG-28	C	P_4Km	Tuff. Sandstone	67.8	1.72	1.05	0.67	2.92	
6	SP-28	D	P_4Kg	Limestone	17.7	0.90	0.70	0.60	0.04	
7	SP-21	D	P_4Kg	Tuff	33.8	1.36	1.01	0.82	7.87	
8	SP-22	D	P_4Kg	Tuff	33.8	1.36	1.01	0.82	17.1	
9	LB-07	B	P_4Gr	Sandstone	96.0	1.95	1.31	0.59	0.36	
10	LB-08	B	P_4Gr	Sandstone	100.	2.34	1.56	0.71	0.29	
11	KB-02	A	P_2Cr	Sandstone	73.2	2.31	1.25	0.81	0.12	
12	KB-05	A	P_2Cr	Sandstone	92.1	2.34	1.43	0.70	0.13	
13	KB-07	A	P_2Cr	Sandstone	107.	2.76	1.69	0.52	0.17	
14	KB-16	A	P_2Cr	Sandstone	115.	3.23	1.60	0.84	0.10	
15	KB-17	A	P_1Ts	Sandstone	119.	3.33	1.81	0.77	0.22	
16	KB-18	A	P_1Ts	Sandstone	195.	5.11	2.39	0.84	0.16	
17	KB-20	A	P_1Ts	Sandstone	148.	4.40	1.98	0.94	0.14	
18	KB-21	A	P_1Ts	Sandstone	105.	3.15	1.87	1.10	0.08	
19	KB-22	A	P_1Ts	Sandstone	128.	4.01	2.36	0.92	0.12	
20	KB-23	A	P_1Ts	Sandstone	140.	4.22	2.23	0.82	0.12	
21	KB-24	A	P_1Ts	Sandstone	118.	3.96	2.04	0.77	0.15	
22	KB-30	A	P_1Ts	Sandstone	158.	4.64	2.45	0.87	0.13	
23	KB-31	A	P_1Ts	Shale	168.	5.14	2.43	0.89	0.27	
24	KB-32	A	P_1Ts	Shale	184.	5.12	2.13	0.80	0.19	
25	KB-33	A	P_1Ts	Shale	159.	4.14	2.14	0.91	0.23	

*1 A; Kinabalu area B; Labuk area C; Segama area D; Semporna area

Ser. No.	Location No.	Area *1	Geologic unit	Lithology	Total Count (cps)	K+U+Th (cps)	U+Th (cps)	Th (cps)	κ (x 10^{-3}SI)	Remarks
26	KB-34	A	P_1Ts	Philite	184.	5.12	2.49	1.07	0.21	
27	KB-35	A	P_1Ts	Philite	189.	5.42	2.87	1.12	0.25	
28	KB-36	A	P_1Ts	Philite	201.	5.99	2.44	1.12	0.11	
29	KB-37	A	P_1Ts	Philite	180.	4.89	2.47	1.03	0.21	
30	KB-38	A	P_1Ts	Philite	222.	5.82	3.01	0.92	0.33	
31	KB-39	A	P_1Ts	Philite	148.	4.48	2.13	1.03	0.12	
32	KB-40	A	P_1Ts	Philite	169.	4.73	2.67	1.13	0.20	
33	KB-41	A	P_1Ts	Philite	209.	5.13	2.65	0.81	0.10	
34	SG-05	C	KpCs	Basalt	9.23	0.86	0.70	0.65	6.55	
35	SG-06	C	KpCs	Basalt	9.03	0.88	0.83	0.62	0.51	
36	LB-01	B	KpCs	Basalt	14.2	0.96	0.84	0.57	4.57	
37	LB-02	B	KpCs	Basalt	21.8	1.23	0.75	0.53	14.0	
38	LB-03	B	KpCs	Basalt	11.4	0.75	0.77	0.53	21.1	
39	LB-06	B	KpCs	Basalt	16.3	0.75	0.88	0.77	13.6	
40	SG-07	C	KpCs	Chert	23.7	0.94	0.70	0.64	0.16	
41	SG-08	C	KpCs	Chert	14.6	1.03	0.73	0.71	2.48	
42	LB-05	B	KpCs	Chert	20.8	1.02	0.98	0.75	0.08	
43	SG-22	C	KpCs	Sandstone	100.	3.15	1.70	0.70	0.23	
44	SG-24	C	KpCs	Sandstone	92.2	2.61	1.51	0.80	0.14	
45	SG-25	C	KpCs	Sandstone	95.4	2.99	1.67	0.67	0.13	
46	SG-31	C	KMb	Limestone	11.7	0.41	0.37	0.24	0.03	
47	SP-04	D	I_5	Basalt	78.2	2.05	1.14	0.49	1.51	
48	SP-05	D	I_5	Basalt	55.5	2.00	1.27	0.78	5.34	
49	SP-06	D	I_5	Basalt	83.8	2.45	1.47	0.75	9.77	
50	SP-19	D	I_5	Basalt	77.4	3.15	1.49	0.82	6.24	

*1 A; Kinabalu area B; Labuk area C; Segama area D; Semporna area

Ser. No.	Location No.	Area *1	Geologic unit	Lithology	Total Count (cps)	K+U+Th (cps)	U+Th (cps)	Th (cps)	κ (x 10^{-3}SI)	Remarks
51	SP-16	D	I_5	Dacite	74.7	2.37	1.56	0.83	0.17	
52	SP-17	D	I_5	Dacite	94.5	3.03	1.63	0.81	31.4	
53	SP-18	D	I_5	Dacite	115.	3.47	1.45	0.60	27.1	
54	SP-01	D	I_3	Microdiorite	111.	3.33	1.92	0.82	35.9	
55	SP-02	D	I_3	Microdiorite	95.5	2.87	1.50	0.82	31.1	
56	SP-03	D	I_3	Microdiorite	149.	3.65	1.79	0.80	31.0	
57	SP-07	D	I_3	Andesite	72.1	2.47	1.45	0.65	14.4	
58	SP-10	D	I_3	Andesite	111.	2.37	1.25	0.65	18.4	
59	SP-11	D	I_3	Andesite	83.9	2.23	1.51	0.82	16.3	
60	SP-12	D	I_3	Andesite	74.5	2.29	1.38	0.57	0.10	
61	SP-13	D	I_3	Andesite	65.1	1.75	1.06	0.68	24.5	
62	SP-14	D	I_3	Andesite	89.3	1.98	1.37	0.61	27.4	
63	SP-20	D	I_3	Andesite	53.6	2.06	1.19	0.75	14.4	
64	SP-24	D	I_3	Andesite	56.0	2.64	1.17	0.81	10.8	
65	SP-25	D	I_3	Andesite	134.	3.95	2.17	0.99	18.7	
66	SP-27	D	I_3	Andesite	93.4	2.05	1.29	0.76	4.59	
67	SP-08	D	I_3	Agglomerate	73.2	2.45	1.45	0.83	16.2	
68	SP-09	D	I_3	Agglomerate	72.7	2.28	1.31	0.77	7.10	
69	SP-26	D	I_3	Andesite	91.9	1.97	1.27	0.61	12.6	
70	KB-03	A	I_2	Granodiorite	173.	4.38	2.28	0.83	1.51	
71	KB-04	A	I_2	Granodiorite	176.	4.42	1.97	0.80	1.67	
72	KB-10	A	I_2	Adamellite	283.	5.38	2.97	0.80	1.16	
73	KB-13	A	I_2	Adamellite	140.	3.81	1.99	1.32	0.83	Ore
74	KB-14	A	I_2	Adamellite	242.	7.29	2.84	1.12	2.63	Ore
75	KB-15	A	I_2	Adamellite	162.	4.42	2.19	1.07	0.33	

*1 A; Kinabalu area B; Labuk area C; Segama area D; Semporna area

Ser. No.	Location No.	Area *1	Geologic unit	Lithology	Total Count (cps)	K+U+Th (cps)	U+Th (cps)	Th (cps)	κ (x 10^{-3}SI)	Remarks
76	MM-06	A	I_2	Adamellite	132.	3.98	1.80	1.04	31.4	Ore
77	MM-07	A	I_2	Adamellite	137.	4.29	2.13	0.97	3.12	Ore
78	MM-08	A	I_2	Adamellite	208.	5.79	2.45	0.98	1.23	Ore
79	KB-11	A	I_2	Biotite Hornfels	193.	5.28	1.90	1.10	34.0	Ore
80	MM-04	A	I_2	Biotite Hornfels	216.	6.02	2.15	0.94	19.3	Ore
81	MM-05	A	I_2	Biotite Hornfels	191.	5.55	2.17	0.88	2.97	Ore
82	SG-01	C	I_1	Serpentinite	4.90	0.83	0.66	0.59	96.5	
83	SG-02	C	I_1	Serpentinite	4.97	0.95	0.75	0.71	24.9	
84	SG-03	C	I_1	Serpentinite	6.00	0.97	0.81	0.61	28.2	
85	SG-04	C	I_1	Serpentinite	4.03	0.67	0.61	0.53	1.89	
86	SG-23	C	I_1	Serpentinite	11.3	0.90	0.78	0.75	23.1	
87	KB-06	A	I_1	Serpentinite	13.6	0.77	0.86	0.74	5.83	
88	KB-08	A	I_1	Serpentinite	6.70	0.90	0.84	0.72	23.0	
89	KB-09	A	I_1	Serpentinite	13.8	0.89	0.85	0.73	15.0	
90	KB-12	A	I_1	Serpentinite	41.0	1.49	0.88	0.67	26.2	Ore
91	LB-04	B	I_1	Serpentinite	8.50	0.81	0.71	0.74	16.2	
92	LB-09	B	I_1	Serpentinite	6.00	0.82	0.64	0.65	21.1	
93	LB-10	B	I_1	Serpentinite	6.80	0.62	0.68	0.68	8.60	
94	LB-11	B	I_1	Serpentinite	7.20	0.79	0.75	0.72	10.3	
95	MM-10	A	I_1	Serpentinite	80.1	2.96	0.77	0.57	23.7	Ore
96	SG-18	C	I_1	Gabbro	5.50	0.88	0.77	0.63	163.	
97	SG-19	C	I_1	Gsbbro	5.00	0.79	0.69	0.71	34.6	
98	SG-20	C	I_1	Gabbro	7.80	0.98	0.77	0.65	0.60	
99	SG-21	C	I_1	Gabbro	36.5	1.35	0.91	0.70	4.47	
100	SG-10	C	Cb	Schist	11.2	1.00	0.77	0.61	0.34	

*1 A; Kinabalu area B; Labuk area C; Segama area D; Semporna area

Ser. No.	Location No.	Area *1	Geologic unit	Lithology	Total Count (cps)	K+U+Th (cps)	U+Th (cps)	Th (cps)	κ (x 10^{-3}SI)	Remarks
101	SG-15	C	Cb	Schist	18.8	1.09	0.93	0.77	1.05	
102	SG-16	C	Cb	Schist	17.7	1.02	0.92	0.82	0.52	
103	SG-14	C	Cb	Gneiss	14.6	1.01	0.75	0.82	2.28	
104	SG-17	C	Cb	Gneiss	45.0	1.33	1.06	0.76	0.47	
105	SG-11	C	Cb	Amphibolite	48.0	1.75	1.35	0.63	0.64	
106	SG-12	C	Cb	Amphibolite	17.8	1.09	0.89	0.73	11.0	

*1 A; Kinabalu area B; Labuk area C; Segama area D; Semporna area

Appendix 28

Laboratory magnetic susceptibility and radiometric activity for the Segama and Semporna areas

Labotratory magnetic susceptibility and radiometric activity of the Segama area (1)

Ser. No.	Sample No.	UTM Coordinates X (km)	UTM Coordinates Y (Km)	1:50,000 Topographic Sheet	Sample Location	Radiometric Activity (CPS) T.C.	Radiometric Activity (CPS) K+U+Th	Radiometric Activity (CPS) U+Th	Radiometric Activity (CPS) Th	Magnetic Susceptibility ($x10^{-6}$ CGSemu)	Lithology	Geolo. Unit
1	G056	1428.45	4723.85	Gunong Moritok	S. Imbak	4.51	0.69	0.54	0.36	64	sandstone	P_4Km
2	K053	1437.30	4728.75	G. Moritok	S. Imbak	0.55	0.85	0.51	0.33	273	granodiorite	Ub
3	K054	1437.30	4728.75	G. Moritok	S. Imbak	3.11	0.01	0.29	0.26	111	sandstone	P_4Km
4	K055	1437.30	4728.75	G. Moritok	S. Imbak	2.91	0.72	0.68	0.30	68	sandstone	P_4Km
5	J052	1432.90	4749.40	Ulu Segama	S. Segama	3.66	0.50	0.68	0.37	2450	sheared ultramafic	Ub
6	P040	1433.45	4766.90	S. Ulu Bole	S. Beruang	4.78	0.64	0.46	0.12	667	amphybolite	Cb
7	P041	1434.40	4766.95	S. Ulu Bole	S. Beruang	4.97	0.26	0.37	0.34	5968	gneiss	Cb
8	K031	1432.90	4767.75	S. Ulu Bole	S. Beruang	1.17	0.63	0.40	0.43	110	amphibolite	Cb
9	J031	1437.70	4771.45	S. Ulu Bole	S. Ulu Bole	2.07	0.88	0.34	0.53	1099	schist	Cb
10	J032	1437.90	4771.80	S. Ulu Bole	S. Ulu Bole	3.97	0.54	0.23	0.35	84	granodiorite	Cb
11	J014	1435.45	4776.70	S. Ulu Bole	S. Ulu Bole	1.93	0.89	0.69	0.47	306	schist	Cb
12	J027	1435.10	4782.25	S. Ulu Bole	S. Ulu Bole	1.75	0.37	0.10	0.35	841	gabbro	Ub
13	N012	1437.05	4783.30	S. Ulu Bole	S. Juak	2.29	0.24	0.64	0.04	179	sandstone	KPCs
14	J021	1437.50	4784.05	S. Ulu Bole	S. Juak	3.28	0.84	0.57	0.24	1096	basalt	KPCs
15	N013	1434.85	4786.65	S. Ulu Bole	-	8.59	0.88	0.50	0.40	72	chert	KPCs
16	P072	1446.70	4718.60	G. Moritok	S. Kuamut	1.31	0.22	0.79	0.49	300	volcanic breccia	KPCs
17	J057	1444.25	4720.10	G. Moritok	S. Imbak	3.13	0.63	0.84	0.00	272	sandstone	KPCs
18	N086	1445.20	4738.65	Ulu Segama	S. Karangon	7.24	0.00	0.48	0.21	63	sandstone	P_4Km
19	N088	1445.25	4737.90	Ulu Segama	S. Karangon	6.87	0.63	0.23	0.44	58	shale	P_4Km
20	N084	1445.70	4739.40	Ulu Segama	S. Karangon	4.22	0.57	0.49	0.24	1302	dolerite	Ub
21	N089	1446.40	4737.30	Ulu Segama	S. Karangon	5.26	1.58	1.07	0.44	1026	dolerite	Ub
22	N093	1442.70	4743.45	Ulu Segama	S. Danum	1.41	0.49	0.86	0.61	77	sandstone	P_4Km
23	N095	1442.70	4744.65	Ulu Segama	S. Danum	1.64	0.84	0.43	0.14	54	sandstone	P_4Km
24	N094	1442.65	4744.85	Ulu Segama	S. Danum	2.28	0.77	0.57	0.41	72	chert	KPCs
25	P055	1442.40	4752.10	Ulu Segama	S. Segama	4.76	0.32	0.78	0.15	2555	basic rock	Ub
26	G039	1442.50	4765.00	S. Ulu Bole	S. Segama	2.50	0.93	0.17	0.39	786	chl. dolerite	Cb
27	K035	1440.50	4765.70	S. Ulu Bole	S. Segama	1.42	0.89	0.26	0.20	1593	diorite	Cb
28	N110	1449.60	4776.65	S. Ulu Bole	S. Bole	0.92	0.38	0.16	0.22	174	peridotite	Ub
29	N111	1449.60	4776.65	S. Ulu Bole	S. Bole	3.74	0.30	0.59	0.45	4935	gabbro	Ub
30	J024	1445.10	4784.65	S. Ulu Bole	S. Juak	3.03	0.52	0.51	0.38	2401	peridotite	Ub

Labotratory magnetic susceptibility and radiometric activity of the Segama area (2)

Ser. No.	Sample No.	UTM Coordinates X (km)	UTM Coordinates Y (Km)	1:50,000 Topographic Sheet	Sample Location	Radiometric Activity (CPS) T.C.	K+U+Th	U+Th	Th	Magnetic Susceptibility ($x10^{-6}$ CGSemu)	Lithology	Geolo. Unit
31	Y021	1448.30	4784.75	S. Ulu Bole	S. Kawag	0.59	0.59	0.28	0.39	2432	sheared peridotite	Ub
32	Y020	1447.55	4786.15	S. Ulu Bole	S. Kawag	5.95	1.06	0.17	0.52	3897	granodiorite	Cb
33	K041	1450.60	4740.10	Ulu Segama	S. Malubuk	2.71	0.50	0.43	0.23	1068	gabbro	Ub
34	Y032	1450.00	4767.95	S. Ulu Bole	S. Segama	5.60	1.01	0.17	0.41	83	sandstone	P_4Km
35	Y037	1450.85	4770.75	S. Ulu Bole	-	4.65	0.09	0.31	0.32	53	chert	KPCs
36	N112	1450.35	4773.75	S. Ulu Bole	S. Bole	4.32	0.24	0.54	0.51	856	sandstone	P_4Km
37	N113	1450.35	4773.75	S. Ulu Bole	S. Bole	1.33	0.43	0.43	0.32	88	sandstone	P_4Km
38	N106	1450.90	4783.00	S. Ulu Bole	S. Kawag	4.38	0.78	0.12	0.17	922	green schist	Cb
39	N105	1450.80	4783.25	S. Ulu Bole	S. Kawag	2.91	0.84	0.52	0.06	98	phyllite	Cb
40	K043	1451.30	4737.70	Ulu Segama	S. Malubuk	2.35	0.85	0.54	0.33	4603	basalt	KPCs
41	K040	1451.25	4739.55	Ulu Segama	S. Malubuk	5.00	0.13	0.52	0.25	495	gabbro	Ub
42	Y035	1451.00	4770.40	S. Ulu Bole	-	5.37	0.41	0.35	0.51	67	sandstone	P_4Km
43	N109	1451.35	4782.70	S. Ulu Bole	S. Kawag	0.77	0.77	0.57	0.43	6122	ultramafic rock	Ub
44	N108	1451.10	4782.90	S. Ulu Bole	S. Kawag	1.98	1.53	0.44	0.44	2391	amphibolite	Cb
45	N107	1451.00	4783.00	S. Ulu Bole	S. Kawag	4.21	0.10	0.46	0.34	766	amphibolite	Cb
46	N104	1452.65	4746.60	S. Malua	S. Berseh	1.65	0.60	0.55	0.22	344	dolerite	Ub
47	N103	1452.80	4746.75	S. Malua	S. Berseh	3.57	0.94	0.31	0.55	348	gabbro	Ub
48	N101	1452.70	4747.75	S. Malua	S. Berseh	0.38	0.97	0.30	0.21	1477	siliceous shale	KPCs
49	N099	1452.60	4751.40	S. Malua	S. Berseh	4.03	0.59	0.48	0.08	2434	gabbro	Ub
50	N102	1453.00	4746.25	S. Malua	S. Berseh	2.86	0.22	0.27	0.61	1107	siliceous shale	KPCs
51	J037	1453.70	4781.05	S. Bole	S. Kawag	2.83	0.80	0.39	0.20	2490	gneiss	Cb
52	G053	1454.50	4733.35	S. Malua	S. Malubuk	2.45	0.67	0.63	0.41	66	sandstone	KPCs

Labotratory magnetic susceptibility and radiometric activity of the Semporna area (1)

Ser. No.	Sample No.	UTM Coordinates X (km)	UTM Coordinates Y (Km)	1:50,000 Topographic Sheet	Sample Location	Radiometric Activity (CPS) T.C.	K+U+Th	U+Th	Th	Magnetic Susceptibility ($\times 10^{-6}$ CGSemu)	Lithology	Geolo. Unit
1	M060	1417.24	4717.72	Sungai Tiagau	S. Gukuam	7.10	1.09	0.46	0.57	61	shale	P_4Kl
2	M061	1423.10	4722.05	Sungai Tiagau	—	4.71	0.73	0.76	0.02	71	sandstone	P_4Km
3	H058	1404.10	4724.70	Sungai Tiagau	S. Mawing	2.80	0.94	0.55	0.26	70	siltstone	P_4Kl
4	H048	1420.22	4747.45	S. Umas Umas	S. Muntai	6.35	0.70	0.24	0.12	58	sandstone	P_4Km
5	M041	1418.30	4739.87	S. Umas Umas	S. Gumbal	6.17	0.50	0.21	0.39	99	meta-gabbro	Ub
6	H060	1401.15	4744.22	S. Umas Umas	S. Gukuam	4.08	1.00	0.80	0.32	89	conglomerate	P_4Km
7	M018	1413.55	4769.50	S. Tingkayu	S. Binuang	1.16	0.57	0.38	0.25	51	tuffaceous s.s.	P_4Km
8	M015	1407.95	4767.83	S. Tingkayu	S. Merotai B	6.36	0.50	0.71	0.69	55	sandstone	P_4Km
9	M022	1405.34	4766.50	S. Tingkayu	S. Merotai B	5.91	0.89	0.22	0.51	3341	tuffaceous s.s.	P_4Km
10	M023	1400.90	4768.90	S. Tingkayu	S. Merotai B	1.83	1.04	0.37	0.50	772	mudstone	P_4Km
11	M033	1398.20	4767.85	S. Tingkayu	S. Merotai B	5.91	0.50	0.27	0.27	402	mudstone	P_4Km
12	M034	1398.06	4768.32	S. Tingkayu	S. Merotai B	4.07	0.86	0.26	0.16	4497	andesite	I_1
13	B052	1420.80	4770.55	S. Tingkayu	S. Tingkayu	5.89	0.79	0.32	0.41	53	sandstone	P_4Km
14	H039	1420.02	4778.70	S. Tingkayu	S. Tingkayu	2.96	0.16	0.25	0.05	90	sandstone	P_4Km
15	M021	1411.33	4775.50	S. Tingkayu	S. Binuang	4.14	1.18	0.11	0.43	63	fine sandstone	P_4Km
16	M009	1393.70	4774.70	Tawau North	S. Merotai B	4.98	0.60	0.51	0.24	4503	andesite	I_1
17	M006	1391.00	4774.40	Tawau North	S. Merotai K	7.21	0.56	0.11	0.14	43	altered andesite	I_1
18	B007	1388.45	4773.55	Tawau North	—	4.45	0.46	0.32	0.08	2205	basalt	I_2
19	T061	1384.20	4770.45	Tawau North	S. Merotai K	2.78	0.06	0.77	0.50	557	basalt	I_2
20	B004	1385.65	4779.80	Tawau North	S. Tawau	3.30	0.96	0.56	0.25	1632	coarse tuff	I_1
21	H042	1420.38	4786.40	S. Tingkayu	S. Tingkayu	2.34	0.62	1.03	0.40	3107	green rock	KPCs
22	M030	1412.25	4786.30	S. Tingkayu	S. Kalumpang	3.37	0.59	0.00	0.52	1934	tuffaceous s.s.	P_4Kg
23	M031	1405.89	4787.05	S. Tingkayu	S. Malati	3.86	0.95	0.31	0.25	62	tuffaceous s.s.	P_4Km
24	M032	1405.08	4786.05	S. Tingkayu	S. Malati	0.00	0.62	0.15	0.13	1388	andesite	I_1
25	T060	1392.10	4783.56	Tawau North	S. Balung	3.77	0.70	0.47	0.46	3494	andesite	I_1
26	H011	1382.05	4784.80	Tawau North	S. Apas Kiri	5.80	1.37	0.69	0.35	2487	andesite	I_2
27	T049	1381.58	4788.37	Apas-Balang	S. Apas	5.61	0.55	0.00	0.38	2167	andesite	I_2
28	H025	1418.90	4798.55	Mostyn	S. Tingkayu	3.65	0.74	0.25	0.71	352	basalt	I_2
29	T065	1411.55	4794.98	Mostyn	S. Kalumpang	0.47	0.59	0.39	0.44	86	siltstone	P_4Kg
30	T066	1408.63	4797.80	Mostyn	S. Kalumpang	0.59	0.23	0.42	0.36	1386	coarse sandstone	P_4Kg

Labotratory magnetic susceptibility and radiometric activity of the Semporna area (2)

Ser. No.	Sample No.	UTM Coordinates X (km)	UTM Coordinates Y (Km)	1:50,000 Topographic Sheet	Sample Location	Radiometric Activity (CPS) T.C.	K+U+Th	U+Th	Th	Magnetic Susceptibility ($\times 10^{-6}$ CGSemu)	Lithology	Geolo. Unit
31	T034	1399.35	4790.95	Mostyn	S. Mantri	6.67	0.61	0.55	0.53	2984	andesite w/pyrite	I_1
32	T033	1396.65	4790.55	Mostyn	S. Mantri	3.35	0.78	0.96	0.42	73	altered rock w/py	I_1
33	T010	1392.95	4792.46	Apas-Balang	S. Balung	3.58	0.60	0.58	0.21	2798	medium tuff	I_1
34	T009	1392.92	4793.59	Apas-Balang	S. Balung	7.94	1.21	0.71	0.84	3451	andesite	I_1
35	T012	1390.44	4796.70	Apas-Balang	S. Balung	1.54	0.68	0.45	0.11	81	dacite	I_1
36	H026	1417.62	4808.30	Mostyn	S. Metarid	3.20	0.62	0.34	0.28	124	basalt	I_2
37	H022	1410.70	4806.87	Mostyn	S. Limau	4.05	0.86	0.09	0.47	2095	coarse tuff	P_4Kg
38	H015	1405.62	4803.94	Mostyn	S. Kalumpang	4.07	1.15	0.36	0.48	3217	micro-diorite	I_1
39	H013	1399.90	4806.95	Mostyn	S. Pang B.	4.19	0.84	0.15	0.36	1344	sandstone	P_4Kg
40	H003	1390.90	4801.75	Apas-Balang	S. Balung	7.40	0.36	0.71	0.18	986	medium tuff	I_1
41	H001	1387.94	4803.56	Apas-Balang	S. Balung	6.93	0.80	0.28	0.15	378	altered andesite	I_1
42	H027	1414.67	4814.16	Mostyn	S. Atas	2.09	0.32	0.35	0.22	699	chert	KPCS
43	H012	1402.25	4813.00	Mostyn	S. Kalumpang	3.77	0.41	0.43	0.30	1601	lapilli tuff	P_4Kg
44	S003	1393.04	4820.15	Kalumpang	—	2.77	0.83	0.36	0.33	1272	basalt	I_2
45	T016	1390.50	4821.02	Kalumpang	S. Kalumpang	4.73	0.71	0.10	0.17	3275	andesite	I_2
46	S005	1388.84	4828.62	Kalumpang	S. Gading G.	4.80	1.75	0.79	0.21	746	micro-diorite	I_1
47	T045	1397.92	4835.27	P.Timbun Mata	—	5.29	0.72	0.53	0.11	2316	micro-diorite	I_1
48	T032	1388.74	4835.56	Kalumpang	—	9.83	0.66	0.26	0.63	69	fine tuff	I_1
49	T031	1388.05	4834.88	Kalumpang	—	3.92	0.00	0.89	0.47	722	andesite	I_1
50	T027	1380.65	4831.42	Kalumpang	—	2.94	0.94	0.27	0.13	25	alt. and. (gossan)	I_1

Appendix 29

Satellite image analysis using TM data for the Kinabalu/Labuk area

1. Data used

One scene of TM data taken by the Landsat launched by NASA, USA was processed to generating the image. The details of the data and the aerial coverage of the TM data are shown in Table 1 and Fig. 1 respectively. The range of wave length and the characteristics of each band of the Landsat TM data are shown in Table 2.

2. Image generation

In this survey, two kinds of images including false color and principal component compressed images were generated using CCT(computer compatible tape).

(1) Generation of false color image

The false color images were generated using the band 2 (blue), band 3 (green) and band 4 (red). Contrast stretch processing were used for these images in order to interpret the images easly. The images are shown in Fig. 2.

(2) Generation of principal component compressed images

The principal component analysis is the method to compress the variance of the original data into limited number of components. The principal component compression method is the method integrating the principal component analysis, and can generate four components in one image.

The processing method of this principal component compression is as follows;

① Conducting the principal component analysis.

② Compressing the principal components obtained using following fomula;

$$CPC_{n-1}(x, y) = PC_1(x, y) * PC_n(x, y)$$

$$n = 2, \cdots 6$$

CPC_{n-1} : (n-1)-th principal component compression data at (x, y)

PC_1 : first principal component data at (x, y)

PC_n : n-th principal component data at (x, y)

③ Coloring obtained three principal component compression (CPC_1, CPC_2 and CPC_3) with red, green and blue respectively.

The results of the principal component analysis in this survey are given in Table 3. In this processing, first, second and third principal component compression data which were calculated from first to fourth principal component, were used to

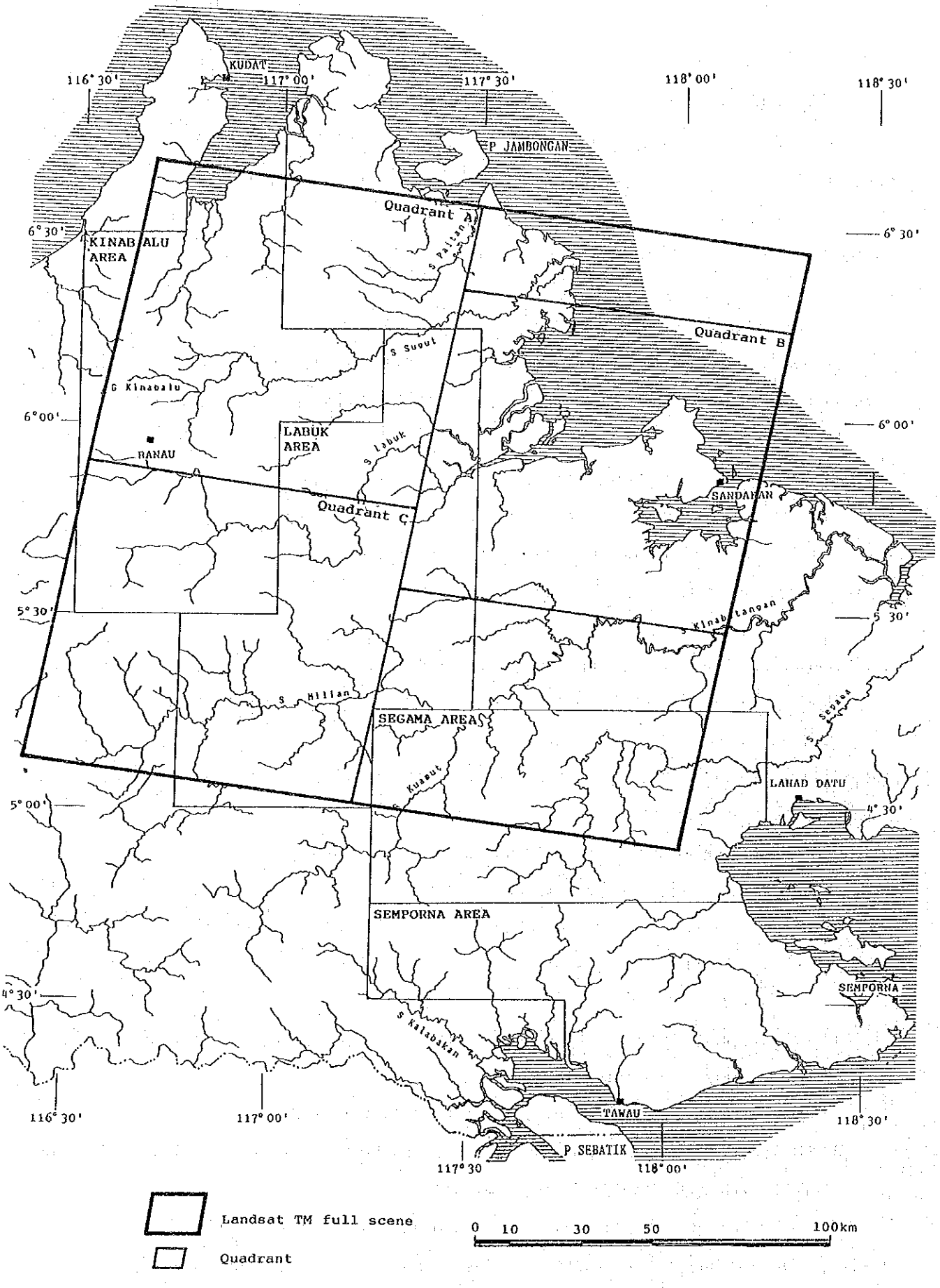


Fig. 1 Index map of Landsat TM data

Table 1 List of Landsat data used

Path	Row	Date	ID number	Cloud cover	Sun azimuth	Sun elevation
117	056	07/10/89	520460 -1513400	1124	108.8 °	56.4 °

Table 2 Band characteristics of Landsat TM data

Band	Wave length	Band characteristics
Band 1	0.45 ~ 0.52 μm	water body penetration, differentiation soil from vegetation.
Band 2	0.52 ~ 0.60 μm	usefull for vigor assessment of vegetation.
Band 3	0.63 ~ 0.69 μm	chlorophyll absorption band.
Band 4	0.76 ~ 0.90 μm	usefull for determining biomass content.
Band 5	1.55 ~ 1.76 μm	indicative of moisture content of vegetation and soil.
Band 6	10.40 ~ 12.50 μm	thermal infrared band
Band 7	2.08 ~ 2.35 μm	discriminating rock types, hydrothermal mapping.

Table 3 Result of principal component analysis

Principal component		1 st	2 nd	3 rd	4 th	5 th	6 th
Band	Band 1	0.50	-0.33	-0.29	-0.69	-0.27	-0.09
	Band 2	0.32	-0.17	-0.15	0.20	0.15	0.89
	Band 3	0.49	-0.37	-0.14	0.66	0.00	-0.41
	Band 4	0.31	0.77	-0.54	0.04	0.12	-0.08
	Band 5	0.48	0.36	0.70	0.03	-0.38	0.07
	Band 7	0.28	-0.02	0.31	-0.24	0.86	-0.14
Contribution		79.47	16.16	3.08	0.97	0.22	0.09
Cumulative contribut.		79.47	95.63	98.71	99.69	99.91	100.00

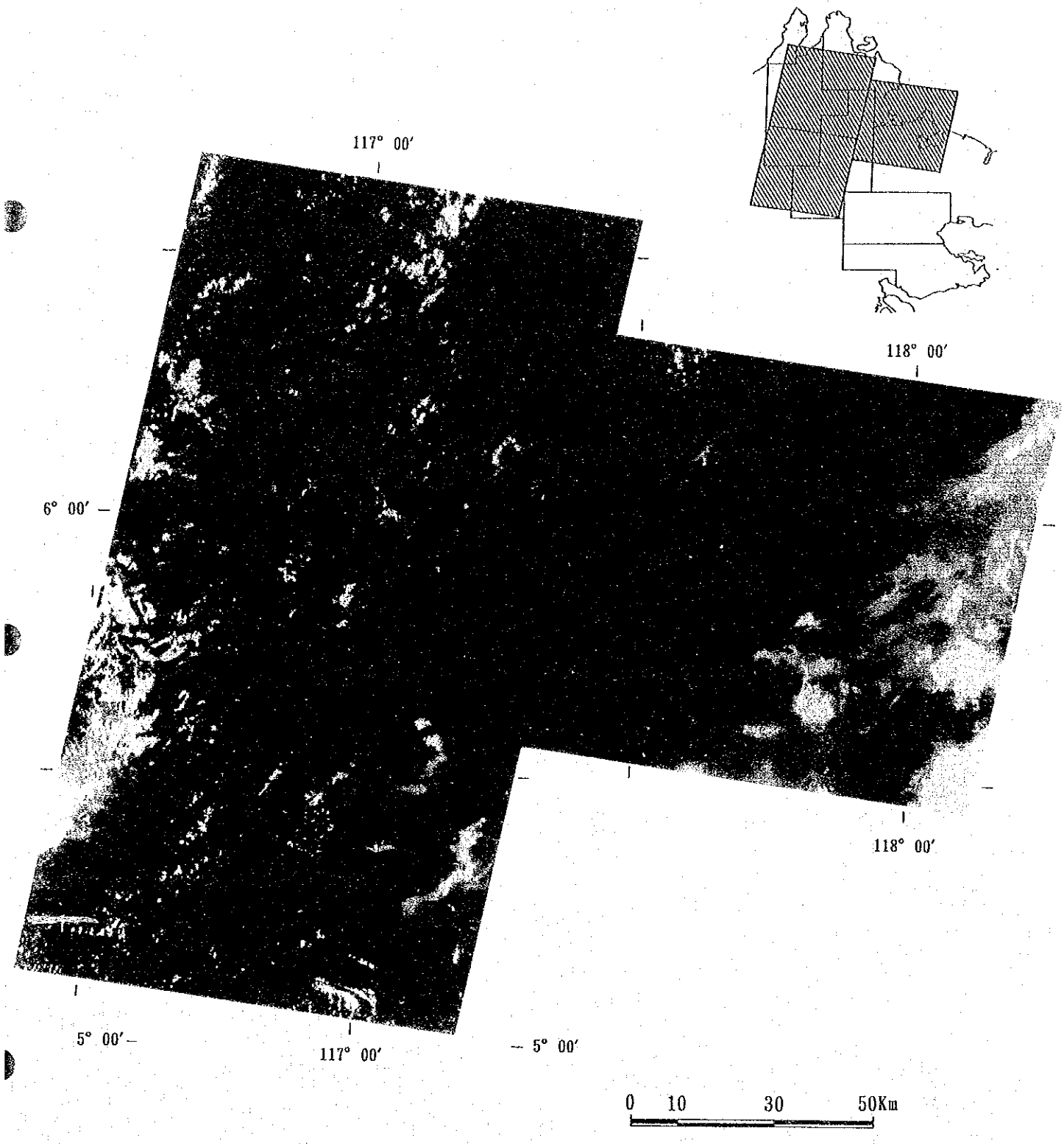


Fig. 2 Landat TM false color image of the Kinabalu and Labuk areas

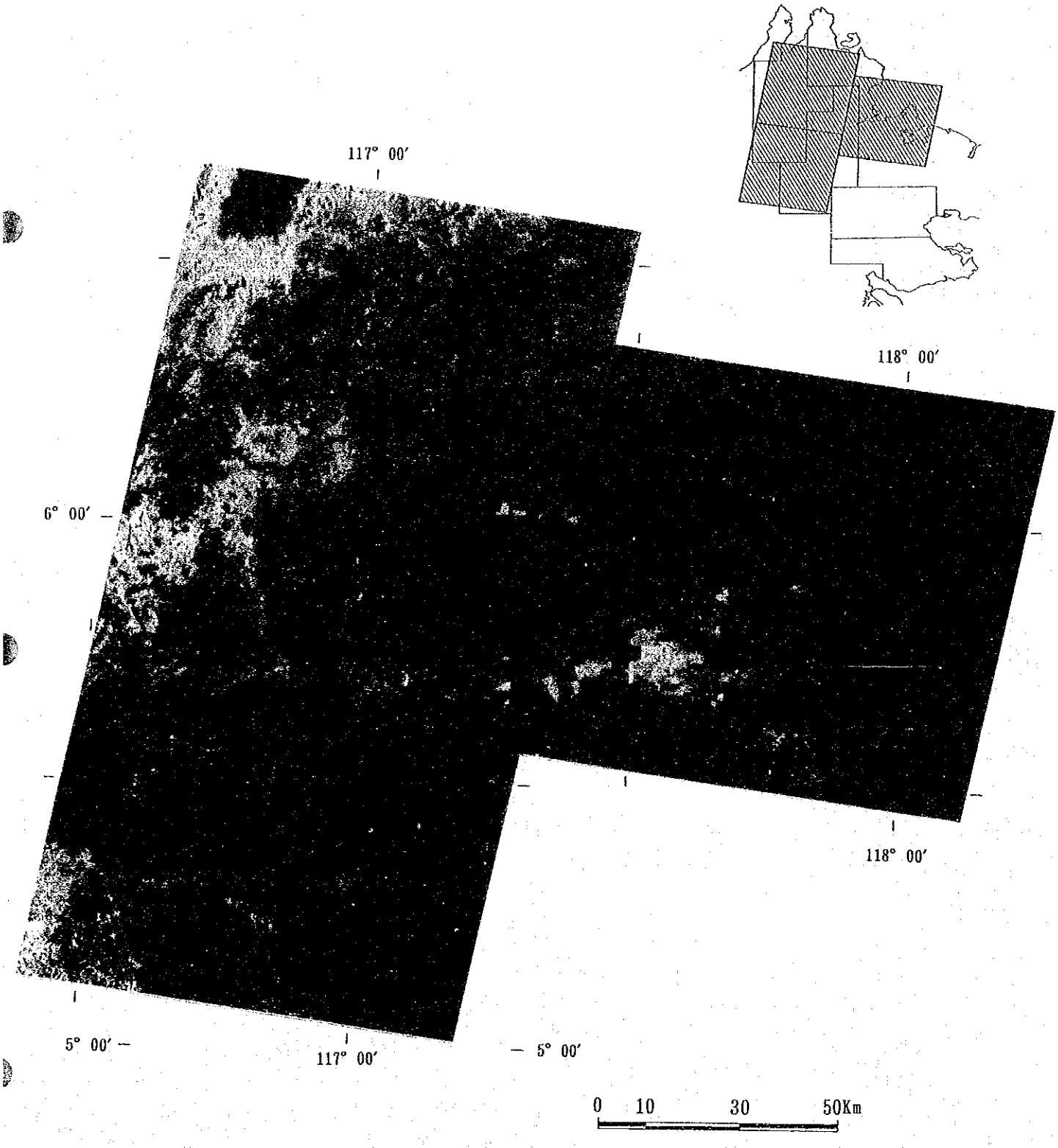


Fig. 3 Landat TM PC compressed image of the Kinabalu and Labuk areas

generate the image. As the results, more than 99 % of original TM data were expressed on the image. The band 6 is extruded from this processing because of different ground resolution. The principal component compression image generated is shown in Fig. 3.

(3) Generated image

List of the images generated and interpreted in this survey are shown in Table 4.

Table 4 List of generated Landsat TM images

Type of image	P - R	Scene size	Scale
False color image	117-056	Quadrant (A)	1:100,000
False color image	117-056	Quadrant (B)	1:100,000
False color image	117-056	Quadrant (C)	1:100,000
PC compressed image	117-056	Quadrant (A)	1:100,000
PC compressed image	117-056	Quadrant (B)	1:100,000
PC compressed image	117-056	Quadrant (C)	1:100,000

PC: principal component

3. Lithologic classification

Fifteen geologic unit were classified in the area by this photogeologic interpretation. The interpretation chart and the interpretation result are shown in Table 5 and Fig. 4 respectively.

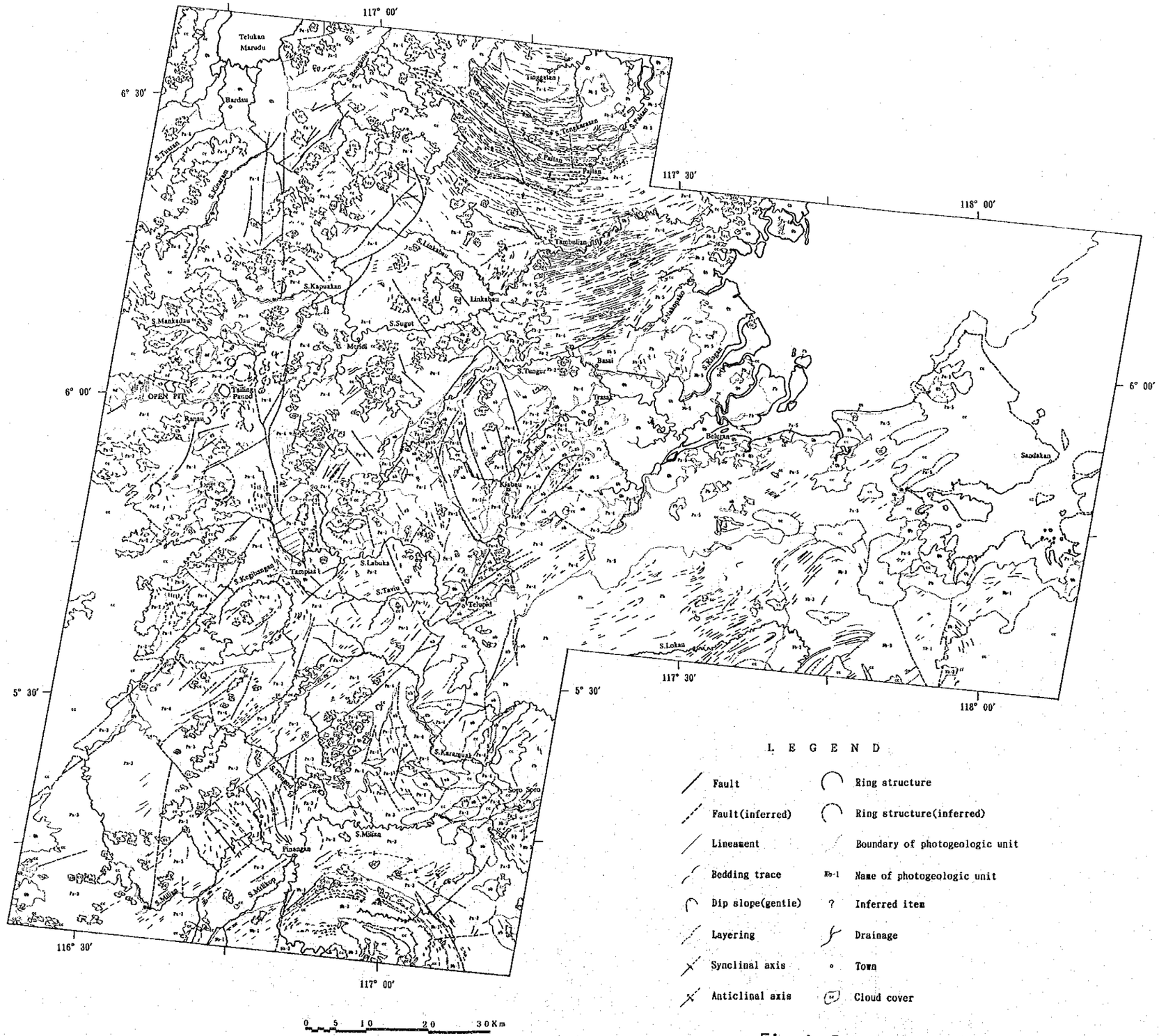
Distributions and characteristics of each geologic unit are given below. The classified units in this interpretation are basecally same as the results of interpretation for the MSS images in the previous survey, and a few new geologic units are discriminated in this interpretation.

(1) Sedimentary rocks

Unit Pa-1 This unit is widely distributed over the area between central and west parts of the Labuk area and it is closely associated by Unit ub. Variable topographic features, relatively rough to intermediate, within the unit indicates that resistance against erosion is not uniform through out the area. This unit corresponds to Chert-Spilite formation (KPCs) mainly consisting of chert, basalt and spilite.

Table 5 Photogeologic interpretation chart

Units	Color		Drainage		Morphological expression					Vegetation	Comparison with existing data
	False color	PC compressed	Pattern	Density	Rock resistance	Cross section of vallay & ridge	Texture	Bedding or schistosity	Lineament		
Qb	dark red to red	purple and creamy yellow	anastomotic	high	very low	– / –	very smooth	–	–	dense	recent alluvial clay, sand
Qa	dark red	light gray	subparallel	high	low	⌣ / ⌒	rough	–	–	dense	terrace clay, sand, gravel
Nb-5	dark red	brown and pale orange	parallel	very high	moderate	V / ∧	intermediate	well bedded	low	very dense	sandstone
Nb-3	dark red	brown and purple	annular	moderate to high	moderate	V / ∧	intermediate	well bedded	low	very dense	mudstone, siltstone
Nb-2	red	orange	dendritic	high	very high	V / ∧	very rough	poorly bedded	low	very dense	calcareous sandstone
Nb-1	dark red	brown	trellis	moderate	low to moderate	V / ∧	smooth to intermediate	bedded	low	very dense	sandstone, mudstone
Pb	dark red	brown	trellis	high	low	⌣ / ⌒	smooth	well bedded	very low	very dense	sandstone, shale
Pa-5	red	pale red	dendritic	high	low	⌣ / ⌒	smooth	bedded	low	very dense	mudstone, slump breccia
Pa-4	red to dark red	brown, orange and pale red	dendritic, trellis	very high	moderate to high	V / ∧	rough to intermediate	well bedded locally	low	very dense	alternation beds of sandstone and shale
Pa-3	dark red	brown	dendritic	moderate	moderate	V / ∧	rough and smooth	bedded	low	very dense	mudstone
Pa-2	red	pale red	dendritic	high	very high	V / ∧	very high	poorly bedded	low	very dense	shale, phyllite
Pa-1	red	pale red and dark red	dendritic, trellis	high to moderate	high to moderate	V / ∧	rough to intermediate	bedded locally	low	very dense	chert, spilite
ad	dark red	dark gray	subdendritic	high	very high	V / ∧	rough	–	moderate	very dense	adamellite
gb	dark red	dark gray and dark red	subdendritic	moderate	moderate	⌣ / ⌒	rough	poorly layered	low	very dense	gabbro, dolerite
ub	dark brown	dark purple	dendritic	high	very high to moderate	V / ∧	rough to very rough	poorly layered	moderate	very dense	peridotite



L E G E N D

Fault		Ring structure	
Fault(inferred)		Ring structure(inferred)	
Lineament		Boundary of photogeologic unit	
Bedding trace	Kb-1	Name of photogeologic unit	
Dip slope(gentle)	?	Inferred item	
Layering		Drainage	
Synclinal axis	∘	Town	
Anticlinal axis		Cloud cover	

Fig. 4 Interpretation map of Landsat TM images in the Kinabalu and Labuk areas

Unit Pa-2 Tis unit is distributed in southwest vicinity of the Kinabalu area. A high resistance of this unit is reflected by very rough topography. The unit shows characteristics siilar to those of Unit Pa-4, however, resistivity is different between them. This can be explained either by contemporaneous hetorotopic facies relation between them or by a lithologic variation within a formation. This unit corresponds to Trusumadi formation (P_1Ts), consisting of shale and phyllite.

Unit Pa-3 The unit is distributed over the area between south part of the Labuk area and northwest part of the Segama area. It, typically, shows very undulated, rough texture except in northwest part of the Segama area where it shows a relatively flat topography. The characteristics of the Unit Pa-3 are similar to those of Unit Pa-4. The unit corresponds to mudstone dominant Sapulut formation (KPSp).

Unit Pa-4 This unit, characterized by rough topography and dendritic drainage pattern, occupies a wide area, from the Kinabalu area to the Labuk area. In north part of the survey area, a continuous bedding plane with changing trend, NW-SW to E-W, and a characteristic lattice drainage pattern are observed. This unit corresponds to Crocker formation (P_2Cr) composed of flysh-type sandstone.

Unit Pb This unit is distributed in east part of the Labuk area and characterized by a relatively flat topography. A low resistance of the unit resulted in a formation of lattice drainage pattern in the area. The unit correspond to Kulapis formation (P_2Ks), consisting of red calcareous sandstone and shale, and it has unconformable boundaries with underlying and overlying formations.

Unit Nb-1 The unit has a restricted distribution in northwest part of the Segama area, and it is characterized by rather undulated, flat topography and clear beddings. It is conformably overlain by Unit Nb-3. The unit is correspond to Labang formation (P_3Lb) and Kuamut formation (P_4Km), both of which are mainly composed of sandstone and mudstone.

Unit Nb-2 This unit, characterized by a very rough topography, occupies a small area in the east part of the Kinabalu area. Although the topographic

features easily separate this unit from other surrounding unit, its stratigraphic relations with other units are not known from interpretation of the images. The unit correspond to the limestone-dominant Kudat formation (P_3Kb).

Unit Nb-3 The unit, showing clear bedding and questa, is distributed in the south part of the Labuk area. An annular drainage system, reflecting geologic structure of the area, is a characteristic drainage system of the unit. The unit correspond to Tanjong formation (N_2Tj) composed of mudstone and siltstone.

Unit Nb-5 This unit occupies a restricted area in northeast part of the Labuk area. An annular drainage system, reflecting geologic structure of the area, is a characteristic drainage system of the unit. The unit corresponds to Bongaya formation (N_4By) composed of sandstone.

Unit Qa The unit is found on slopes of mountains in the northeast of Ranau, Kinabalu area. It shows a relatively rough texture of low resistance. The unit corresponds to Pinosuk Gravels of glacier deposits.

Unit Qb The unit is distributed along coast lines and main drainages. It shows very flat topography and very low resistance. A drainage pattern of the unit is anastomotic and its density increases close to coast lines.

(2) Intrusive rocks

Unit ub This unit is widespread in the Labuk area and it shows scattering distribution around Ranau of the Kinabalu area. Very rough topography is a characteristic feature of the unit, however, it shows a intermediate roughness in certain part of the unit and locally layered structure is observed. It shows a characteristic tone on the images, dark brown on false color images and dark purple on principal component compressed images. The unit corresponds to the ultrabasic rocks of Cretaceous to early Tertiary.

Unit gb This unit is distributed in northwest and southwest of Telupid in the Labuk area and in southeast of Ranau in the Kinabalu area. It is

characterized by a topography of intermediate roughness and relatively rounded ridge pattern. a layered structure is, locally, observed. The unit corresponds to the gabbro and dolerite of Cretaceous to early Tertiary.

Unit ad A scattered distribution of the unit is found in north of Ranau in the Kinabalu area. It is characterized by a rough topography and a dark tones. A few lineaments are locally found. The unit is correspond to the adamellite intrusive bodies of middle to late Tertiary.

4. Geologic structure

Based on the results of this interpretation, a geologic structure map is illustrated as shown in Fig. 5. The geologic structure in the surcey area is summerized as follows:

(1) Kinabalu and Labuk areas

Geologic structure in the Kinabalu area is characterized by general trends of NW-SE and E-W which is observed in the area of unit Pa-4. This geologic unit is widely found in the north and central parts of this area. The geologic structure of this unit consists of synclinal and anticlinal structures, and strike-slip faults. The faults trending NW-SE, NE-SW and N-S cutting the general trends are also found in the image and forms complicated structure in the area. This geologic structure is not found in the west part of the Kinabalu area, and is bounded by faults trending N-S which occurs from Bandau to 10 km east of Ranau. This fault system is significant one and forms fault zone. This fault zone separate the Kinabalu area and each side shows completely different geologic structure.

In the Labuk area, the unit ub is distributed in north and central parts of the area, the unit Pa-1 occurs from the central to west part of the area with a direction of NE-SW, and the unit Nb-3 unconformably covers these units. These distributions give complicated structure in this area. General trend of NE-SW is dominated in the north and central parts of the area where units ub and Pa-1 are distributed. In these parts, fault systems of NE-SW, N-S and NW-SE are also observed. In the south part of the area, basin structure is observed in the area

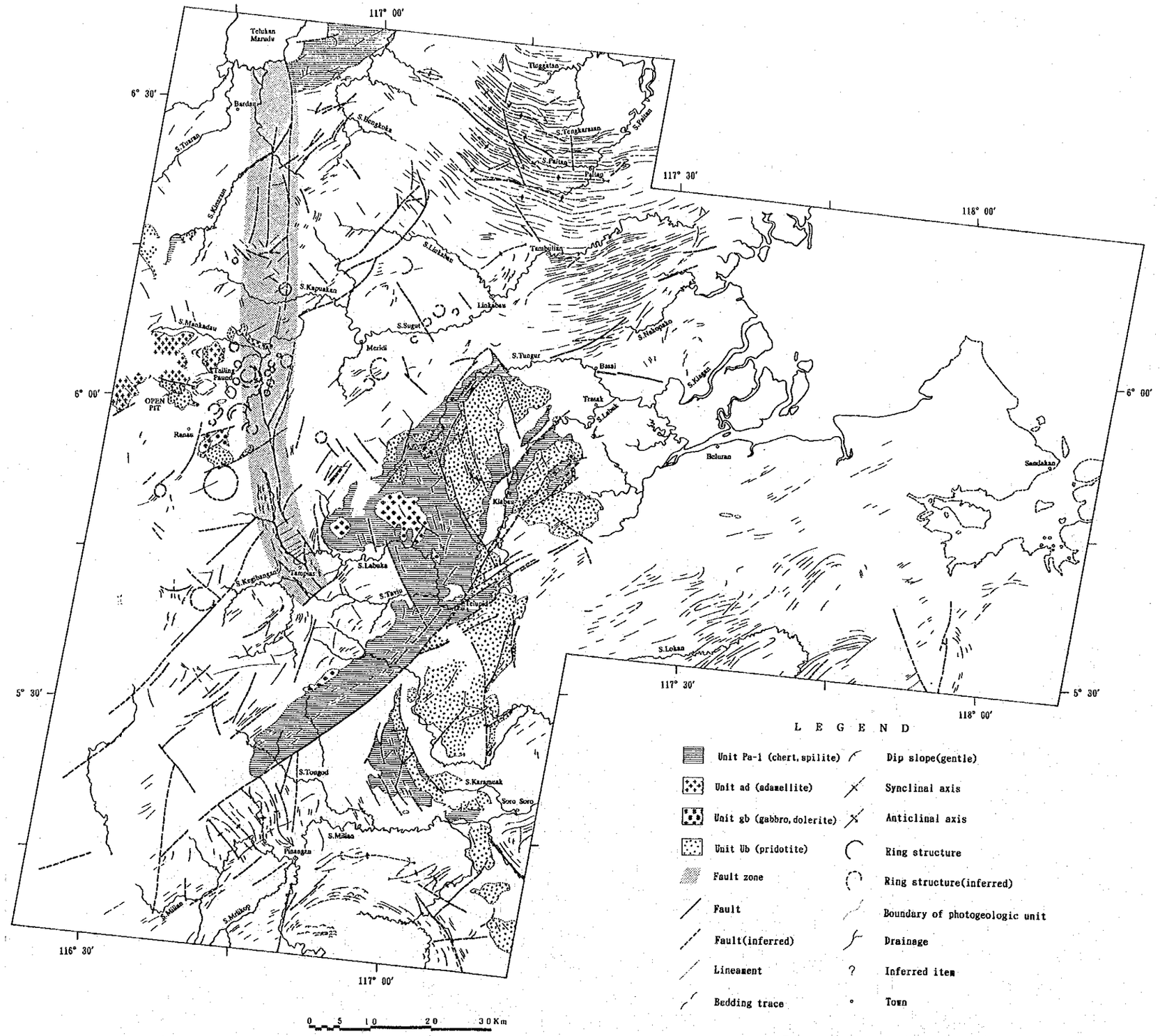


Fig. 5 Interpretation map of geologic structure in the Kinabalu and Labuk areas

where geologic unit Nb-3 occurs. This structure continuing further south, outside of the survey area, is gentle and 10 km in diameter. The unit Nb-3 unconformably covers the undelain units and shows different geologic structure to the underlain units. Consequently, this basin structure is thought to be formed in later stage compare to the structure observed in the north and central parts of the area.

(2) Ranau and the surroundings

A significant fault trending N-S is found approximately 10 km east of Ranau. This fault separated the area to different geologic settings. Mineral deposits represented by Mamut mine is found in the west side of this fault and no mineral deposits is known in the east side of this fault. The Mamut mine area is in the area of unit Pa-4 and shows complicate structure because of intruded or emplaced rocks, such as adamellite and ultra-basic rocks, corresponding to the geologic units of ad and ub. Many ring structures, several km to 10 km in diameter, are found in the area of unit Pa-4. Existing geologic maps indicate that some of the ring structure corresponds to the granodiorite stocks, and these ring structures characteristically align along the N-S trending fault. Although intrusives are not observed in some ring structures, these ring structures are possibly retated to subsurface intrusive bodies. Units ad and ub are not recognized at east side of this N-S trending fault, and only faults and lineaments are found within the unit Pa-4.

(3) Bidu Bidu Hill and the surroundings

Fault system trending NW-SE is dominated in the Bidu Bidu Hill area. Among these fault, shape of the fault and distribution of geologic units suggest that the fault bounding the unit ub and Pa-1 is thrust fault. This characteristic futures are also found along Labuk river where widely coverd by alluvium. Faults trending NNW-SSE are also found in the area of unit ub. NW-SE trending lineaments are observed in the Bidu Bidu Hill ore deposit area where situated in a area of unit Pa-1. Geologic unit corresponding to microgabbro due to existing geologic map, is discriminated on the image in this area. Although the unit ub shows rough and massive topography in general, layered structure trending NE-SW is observed in limited area at the east of the Bidu Bidu Hill ore deposit.

5. Discussion

As the results of this interpretation, followings can be pointed out.

(1) Data used and images generated

① Because the ground resolution of TM data is 30 m, TM data give more usefull data comparing to MSS data which resolution is 80 m. Consequently, it is better to use TM date for the important area, such as ore deposit area, in order to carry out more accurate interpretation, if adequate data are available.

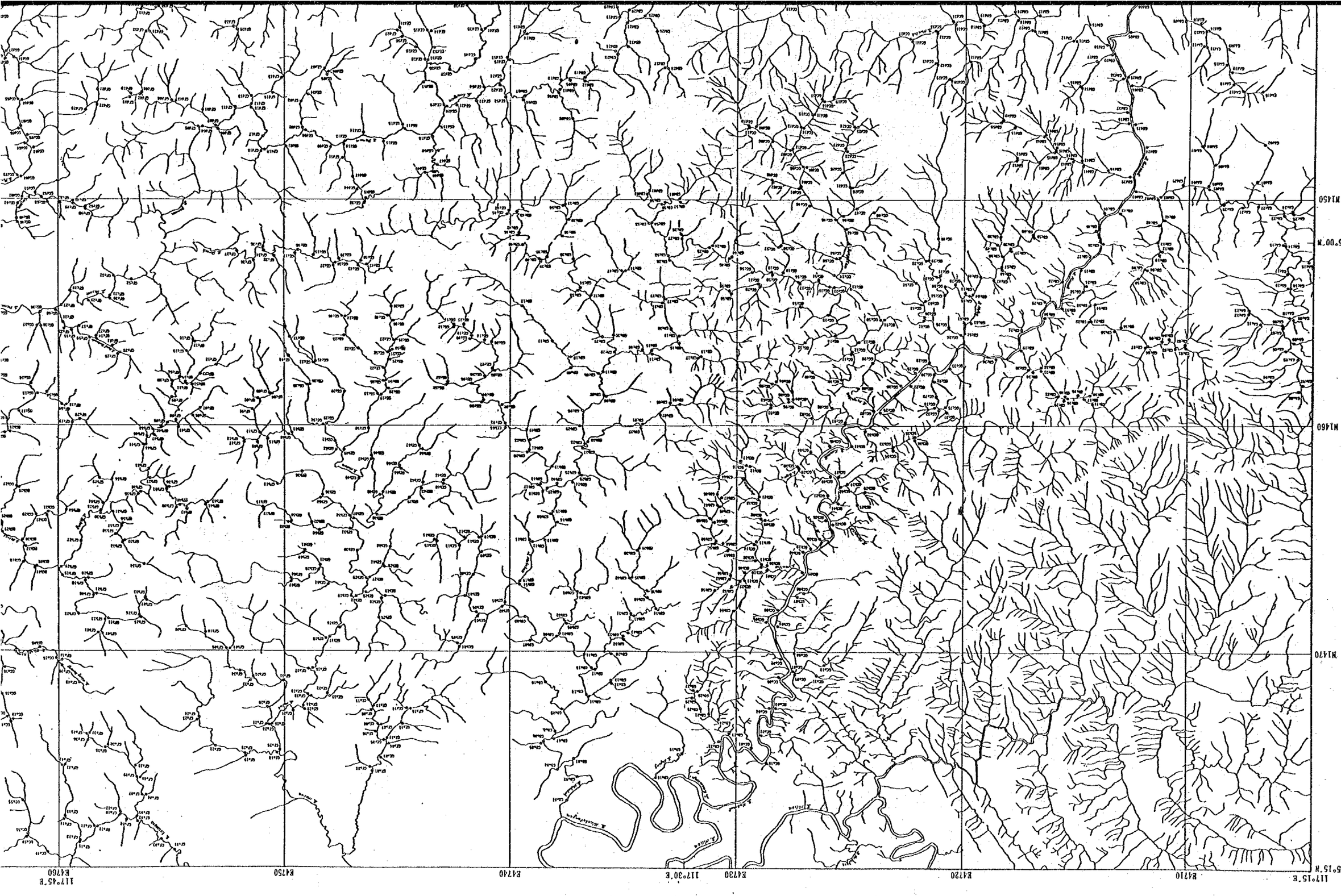
② The principal component compressed images generated in this survey have not only spectral data but also topographic data. Six bands were used for the generation of this image. Consequently, this image is quite usefull for photogeologic interpretation.

(2) Results of interpretation

① Fault zone in a direction of N-S was deliniated at the east of Ranau in this interpretation of images. This fault zone possibly play important role for the geology and mineralization in the area. A ground truth survey should be carried out in this area to understand the geology more clearly.

② Ring structures deliniated in the Ranau area suggest existance of intrusive bodies. As the results of Phase I survey, mineralization was recognized in these intrusive bodies. Consequently, the ring structure is quite important for further exploration work in this area.

③ The area along Labuk river was deliniated as the area showing similar geologic setting of Bidu Bidu Hill ore deposit area. It is better to carry out geologic survey in the Labuk river area in order to clarify the relationsip between the geology and mineralization.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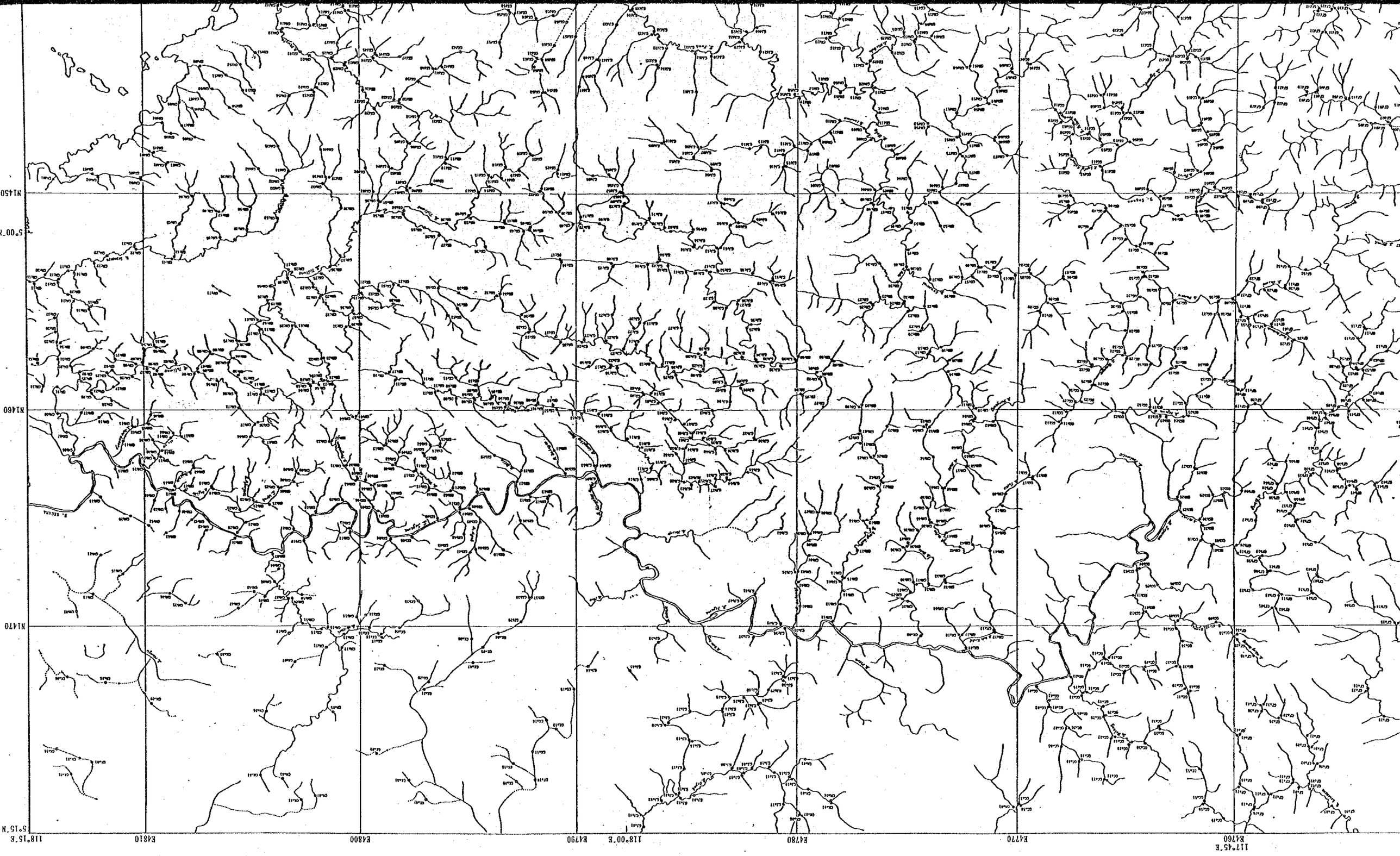
5°00'N
M1470
5°15'N
E4710
E4720
E4730
117°30'E
E4740
E4750
E4760
117°45'E

E4780 E4770 E4760 E4750 E4740 E4730 20

117°45'E 117°30'E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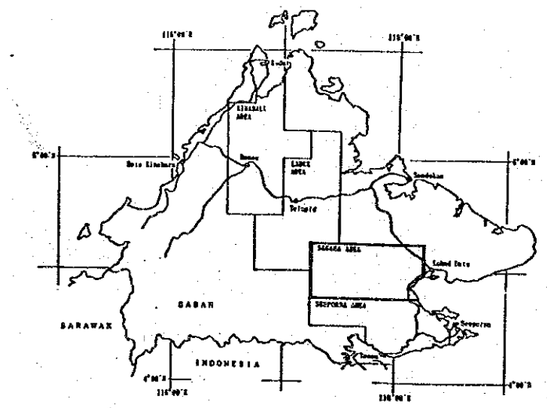
N1470
5°15'N
E4760
E4770
E4780
E4790
E4800
E4810
117°45'E
118°00'E
118°15'E

Plate II-1-1

MINERAL EXPLORATION:
SUPRA-REGIONAL SURVEY IN
CENTRAL SABAH, MALAYSIA
PHASE II

LOCATION MAP OF STREAM SEDIMENT GEOCHEMICAL SAMPLES IN THE SEGAMA AREA

Scale 1:100,000



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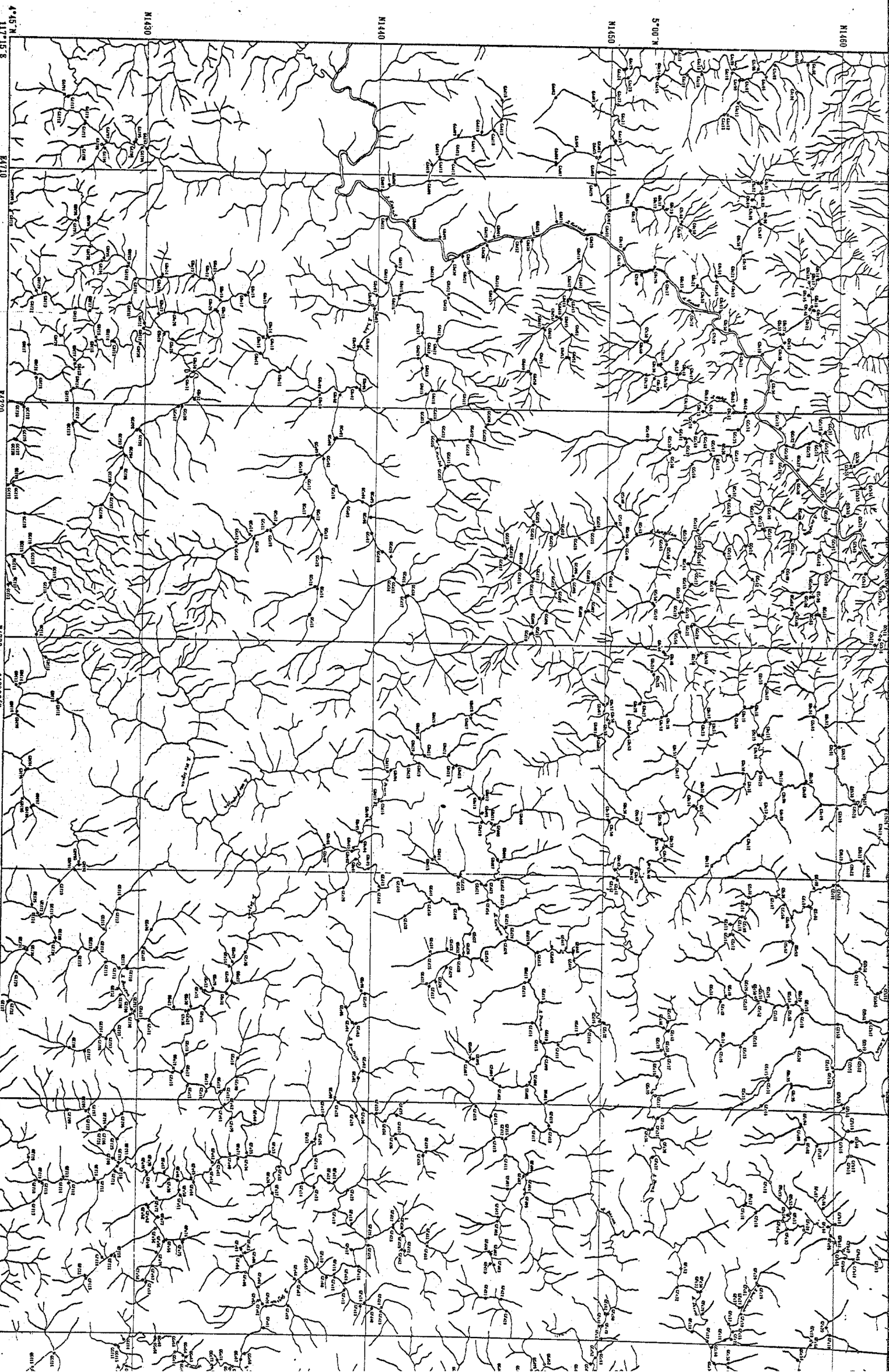
FEBRUARY, 1992

E4780 118°00'E E4790 E4800 E4810 118°15'E
5°15'N
N1470
N1460
5°00'N
N1450

L E G E N D

- • Location of stream sediment sample
- GNb20 Sample number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E4760
117°30' E
117°45' E

E4730

117°30'E

E4740

E4750

E4760

117°45'E

E4770

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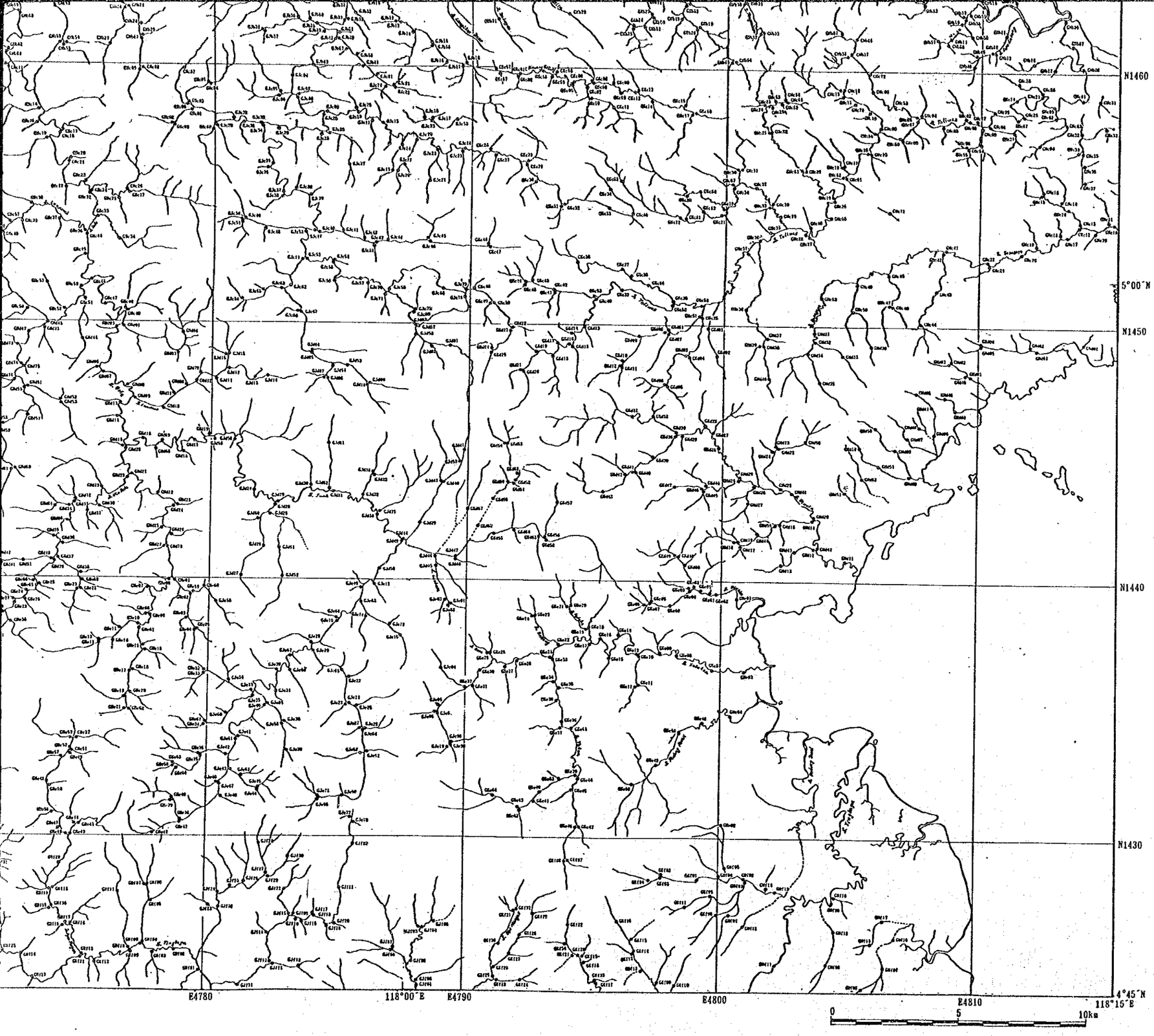
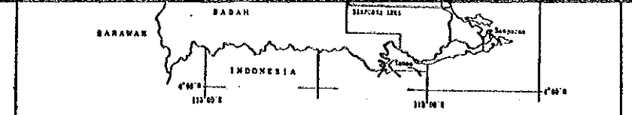
10km





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METAL MINING AGENCY OF JAPAN

FEBRUARY, 1992

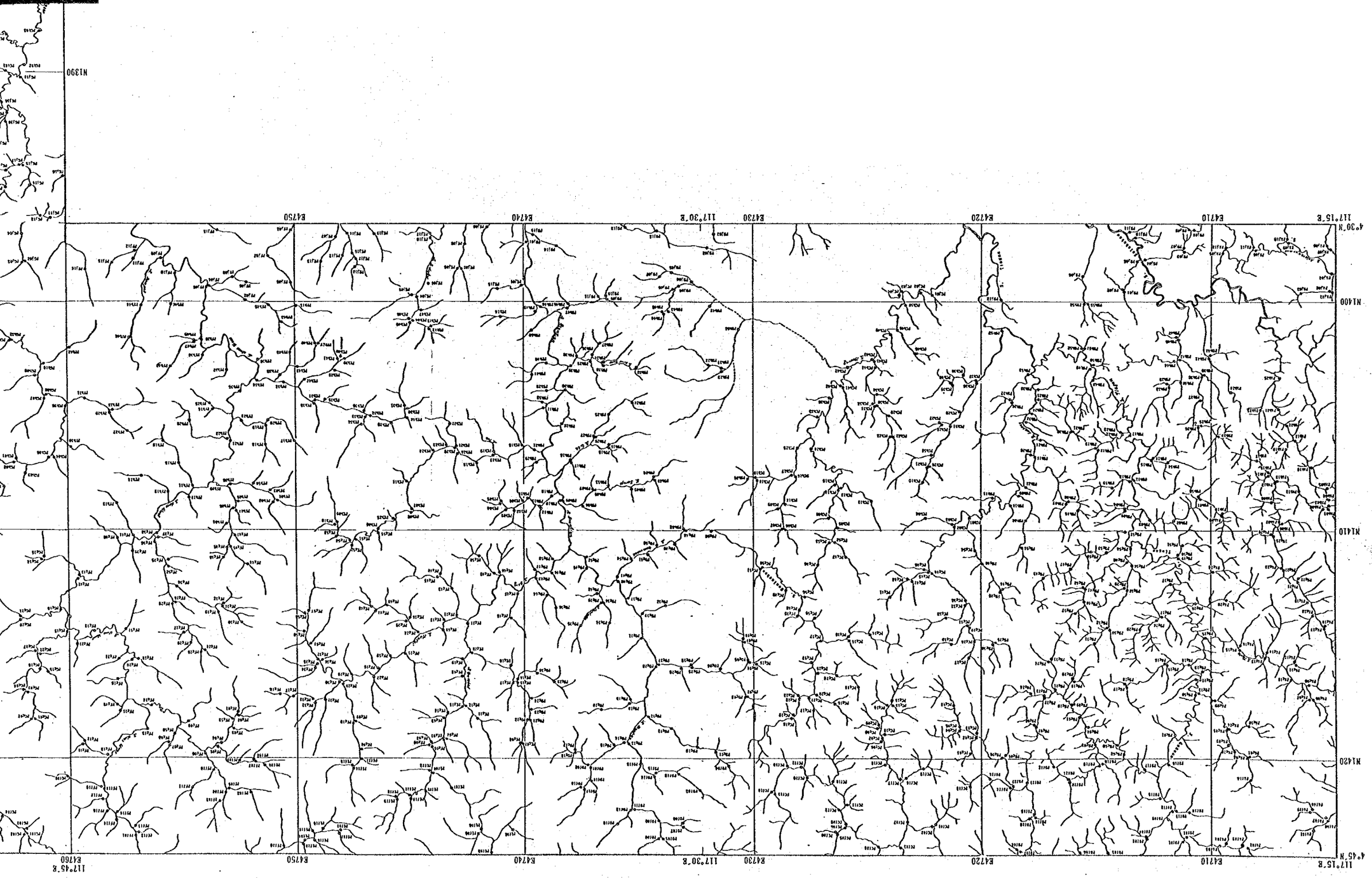
L E G E N D

• Location of stream sediment sample

GNb20 Sample number

117°15´E 117°30´E 117°45´E 118°00´E 118°15´E

				5°15´N
KUAMUT	SUNGAI MALUA	SUNGAI BOLE	MANSULI	
				5°00´N
GUNONG MORITOK	ULU SEGAMA	SUNGAI ULU BOLE	SILAM	
				4°45´N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49°30'N
N1400
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N1420
49°45'N
117°15'E
E4710
E4720
E4730
117°30'E
E4740
E4750
117°45'E

N1390

E4740

E4750

117°30'E

E4730

E4740

E4750

E4760

117°45'E

E4770

E4780

118°00'E

E4790

117°45´E
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118°00´E
E4790
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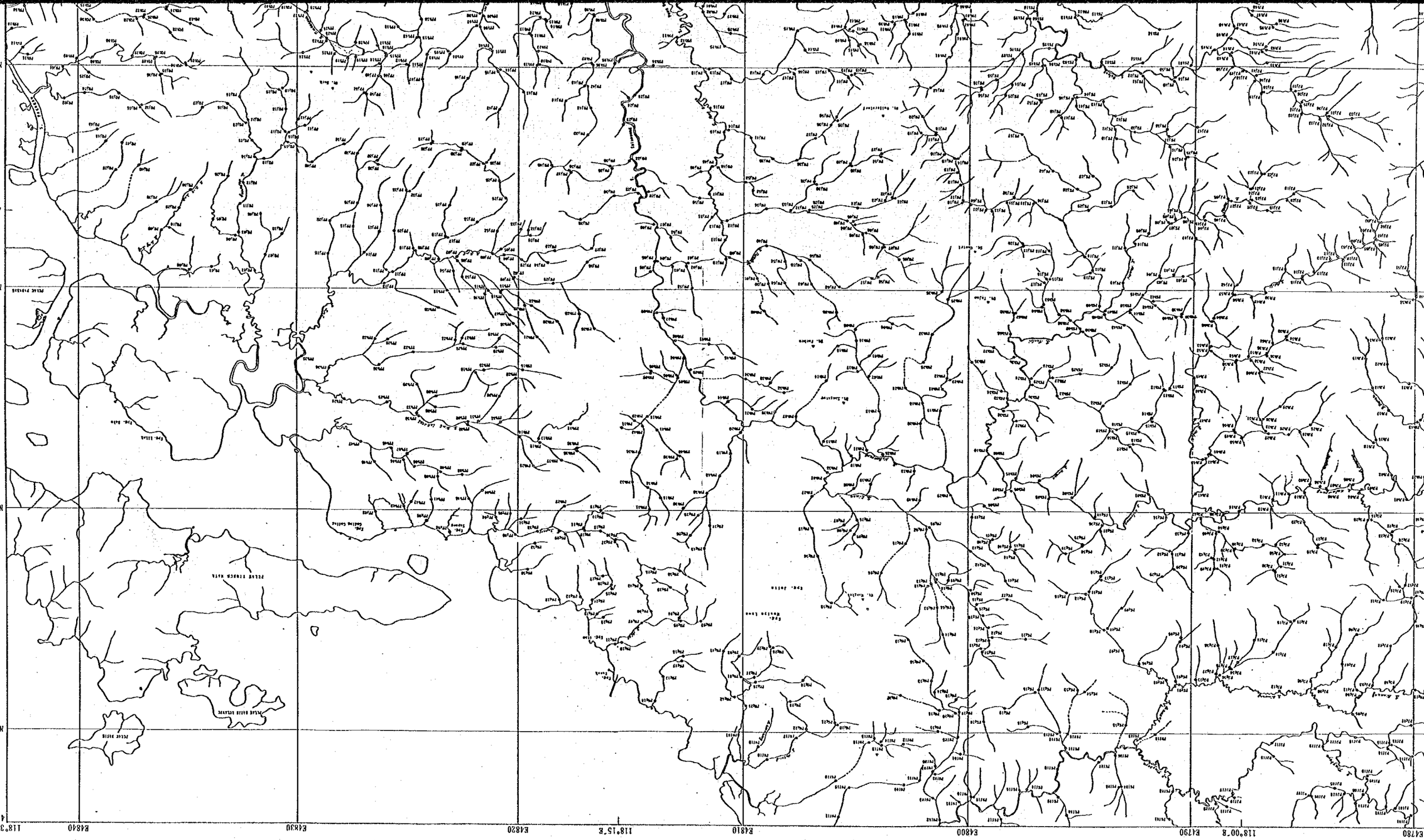
E4810
118°15´E
E4820
N1390


118°30'E
E4840
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E4800
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118°00'E
E4780
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N14
4°4