accompanied by the ores of copper, lead, zinc, etc. in outcrops.

5-2-4 Pagar Gunung Mineralization Zone - Patahajang Alteration Zone

(a) Pagar Gunung Mineralization Zone

The Pagar Gunung mineralization zone located at the south-west edge of the survey area lies on the ridge of the upper reaches of the Si Ambok River 1,100 m above sea level. It requires 3 hours to travel from Kotanopan to Pagar Gunung. After a 30 minute drive from Kotanopan to Simpang Tolang there is an 8 km walk on mountain roads to Pagar Gunung.

For a 200 m stretch east to west along the ore deposits 6 adits have been developed. According to the information of the present inhabitants there, some exploration and a little mining was carried out during the period from 1942 - 1944, but the conditions of that operation are unknown.

Metosomatic ore deposits are emplaced around the contact area of Muara Sipongi granodiorite and limestone (accompanied by sandstone and shale). In places there are also disseminated ore deposits and ore viens which filled in fissures. (Fig. III-23, Fig. III-24)

1. Adit No. 1 (Fig. III-25)

This adit is dug approximately 2.5 m to a N 60° E direction. The ore deposit is 5 m wide, intercalated with a 2 m width of gangue rock of limestone and shale, having a strike of N 55° E, and a dip of 40° SE. Following along the hanging wall of limestone a rich ore deposit approximately 1 m wide, contains massive charcopyrite, galena, and sphalerite. The ores are Cu 0.13%, Pb 3.84%, and Zn 4.83% in grade. Under a microscope (DR 129, 131, 132, 133) it is primarily lead and sphalerite, with chalcopyrite dot scattered in the sphalerite. As a secondary mineral a little convelline can be seen.

2. Adit No. 2

This adit is about 10 m below Adit No. 1 and is dug underneath the ore deposit of adit No. 1. However, because the adit has caved in details are unknown.

3. Adit No. 3 (Fig. III-26)

This adit is located 40 m east of Adit No. 1. At adit entrance there is limonite gossen and at the foot wall a roughly 80 m wide ore deposit of galena and limonite accompanying clay. The ore grades are Cu 0.06%, Pb 3.42%, and Zn 1.20%. According to information from the local inhabitants there was extensive digging in this mine; however, because it has completely caved in the conditions are unknown.

4. Adit No. 4

This aidt lies about 30 m east of Adit No. 3 in swampy ground. Around the adit there is massive ore of sphalerite and galena with analyzied values of Cu 0.12%, Pb 8.33%, and Zn 7.94% (Fig. III-24).

5. Adits No. 5 and No. 6

These lie 200 m east of Adit No. 1 with their entrances along the north-south flow of the river.

In Adit No. 5 there is a 1 m wide fault of strike N 10° W, dip 90° ± filled by an oxidized vein in the limonite in which massive galena, sphalerite and pyrite ore is found. The massive ore's analyzed values are Cu 0.14%, Pb 8.93%, and Zn 7.49%.

Adit No. 6 lies 15 m north of Adit No. 5. The ore deposit of strike 90° E, dip 25° S has a 2 m wide mineralized core made up of layers arranged from the bottom up abounding in pyrite, then sphalerite, with disseminated galena and pyrite. Under a microscope (DR 140, 141, 142) primarily chalcopyrite, sphalerite, and galena appear, with some arsenopyrite and pyrrhotite. The average analyzed values for the rich ore vein of width 150 cm are Cu 0.14%, Pb 4.47%, and Zn 5.53%. (Fig. II-27)

The Pagar Grunung ore deposit is in parts made up of veins which have filled in faults but, overall it is distributed in the contact area of granitoid rock and limestone - shale strata, the upper part of the ore deposit, or in intercalated recrystallized limestone. In the ore deposit these are accompanied at times by skarn mineral (DR 120) make up of hedenbergite, actionolite, and epidote; there is often also calcite present as gangue mineral. The ore deposit shows massive and bedded form accompanied by sphalerite, galena, and pyrrhotite; in addition, the exsolution relation of sphalerite and chalcopyrite can be observed. From these it is very possible that it is a pyrometasomatic ore deposit.

(b) Patahajang Mineralized Zone (Fig. III-28)

A clay zone accompanied by disseminated pyrite is scattered over 150 m along the road that follows the Pungkut River near the village of Patahajang. According to the results of an X ray analysis (DR 68) this argillization zone is made up of sericite and chlorite. According to a survey of this area carried out by the Directorate of Mineral Resources, boulders of skarn accompanied by sphalerite and galena were discovered.

(c) Air Mandagang Pyrite Disseminated Zone

There is a strongly silicified zone accompanied by pyrite on the upper reaches of the Mandagung River, a tributary of the Pungkut River located about 1.5 km north of the village of Patahajang. A number of veinlets with sericite and quartz are distributed.

(d) Simpang Pining Mineralized Zone

Boulders with quartz veinlets (width 3-5 cm) accompanied by pyrite were observed at the Simpan Pining tributary in between the Patahajang argillization zone and the Pagar Gunung mineralized zone. Placer gold grains were discovered in the panning survey. Though faint, mineralizations were found in between the Pagar Gunung mineralized zone and the Patahajang variation zone, but a detailed survey has not been conducted yet.

5-2-5 Others

(a) Si Lopo Mineralized Zone

In the area near the junction of the Cubadak River and its tributary the Si Lopo River on the road from Ranjau Batu (Batas) to Limau Manis, a 1 cm wide vein of massive chalcopyrite sphalerite, and galena ore deposit was observed embedded in Patahajang siliceous rock, calcareous siliceous rock, and sandstone strata. The vein strikes N 60° W and dips 70° SW. Under a microscope (AR 86) it is made up of chalcopyrite and sphalerite, with the chalcopyrite dots scattered in the sphalerite. The analyzed values were Cu 0.47%, Pb 0.79% and Zn 0.84% (Fig. III-29).

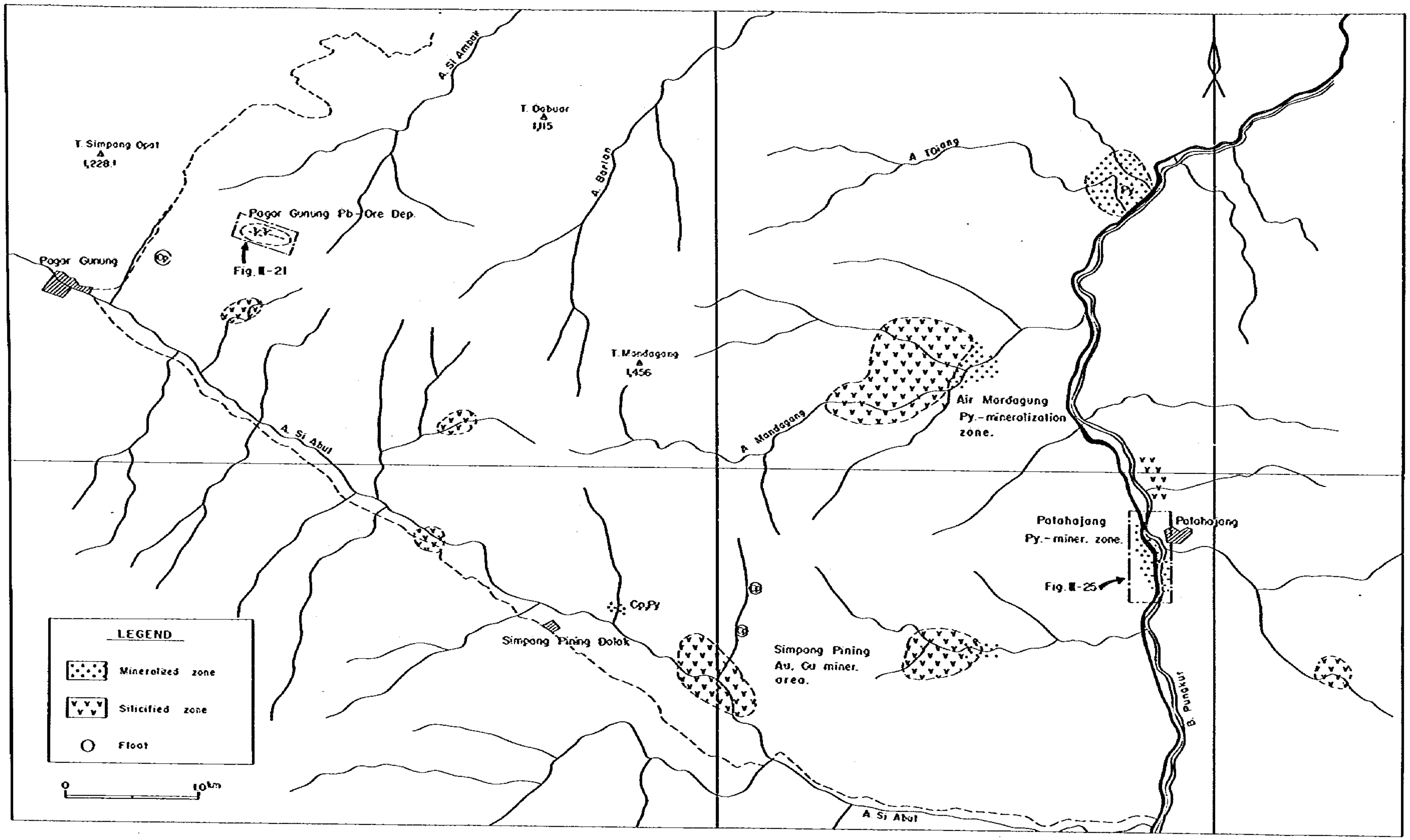


Fig III-23 Location Map of Mineralization in Pagar Gunung and Patahajang

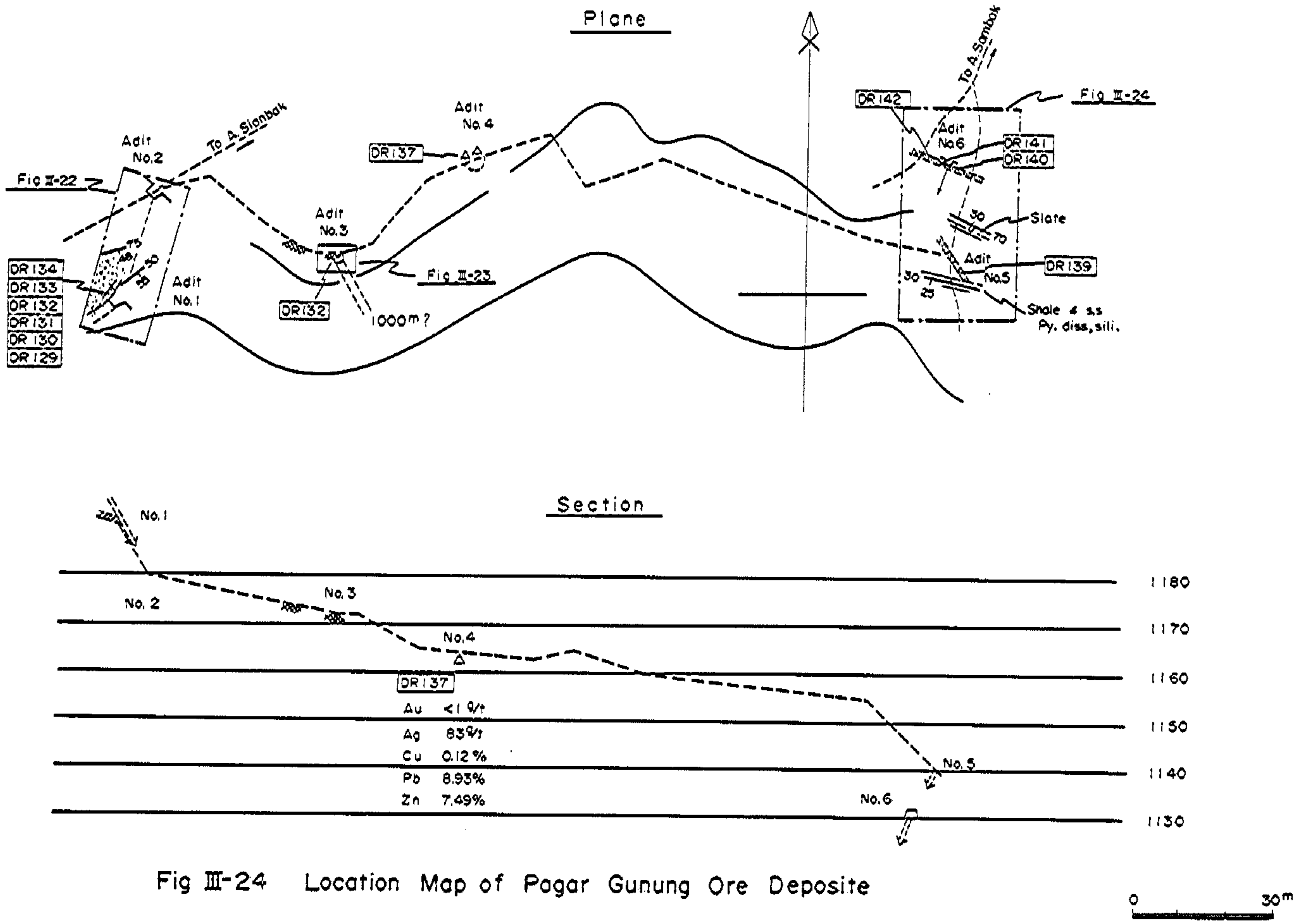
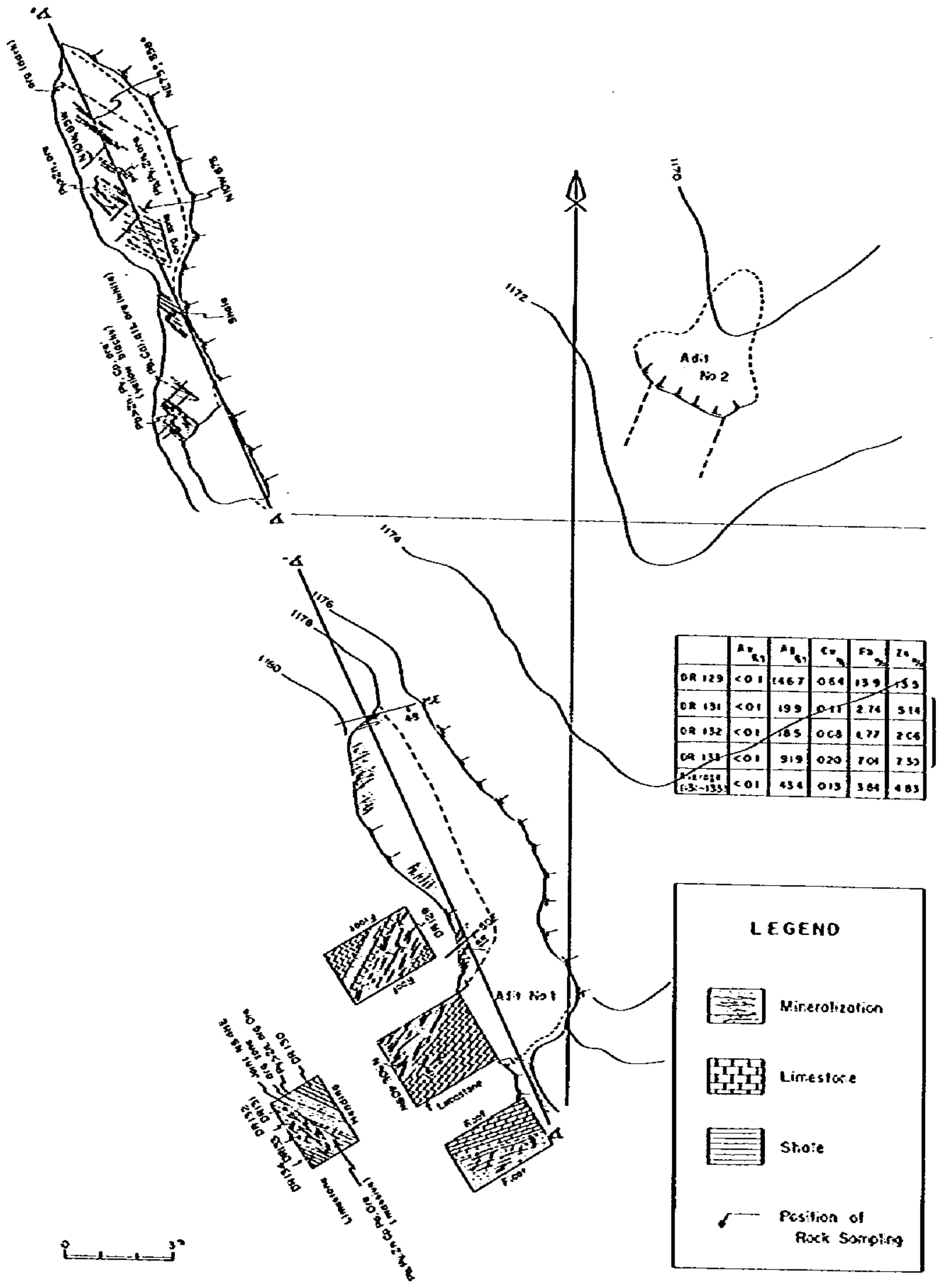


Fig III-24 Location Map of Pagar Gunung Ore Deposite



	Au g/t	Ag g/t	Cu %	Pb %	Zn %
DR 129	<0.1	1467	0.64	13.9	15.5
DR 131	<0.1	199	0.11	2.74	5.14
DR 132	<0.1	185	0.08	1.77	2.06
DR 133	<0.1	919	0.20	7.01	7.35
Average (131~133)	<0.1	434	0.13	3.84	4.83

Fig II-25 Sketch Map of Adit No1 and No2, Pager Gunung

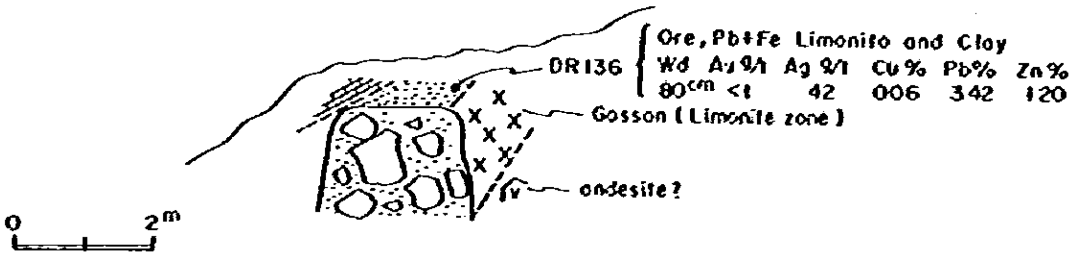
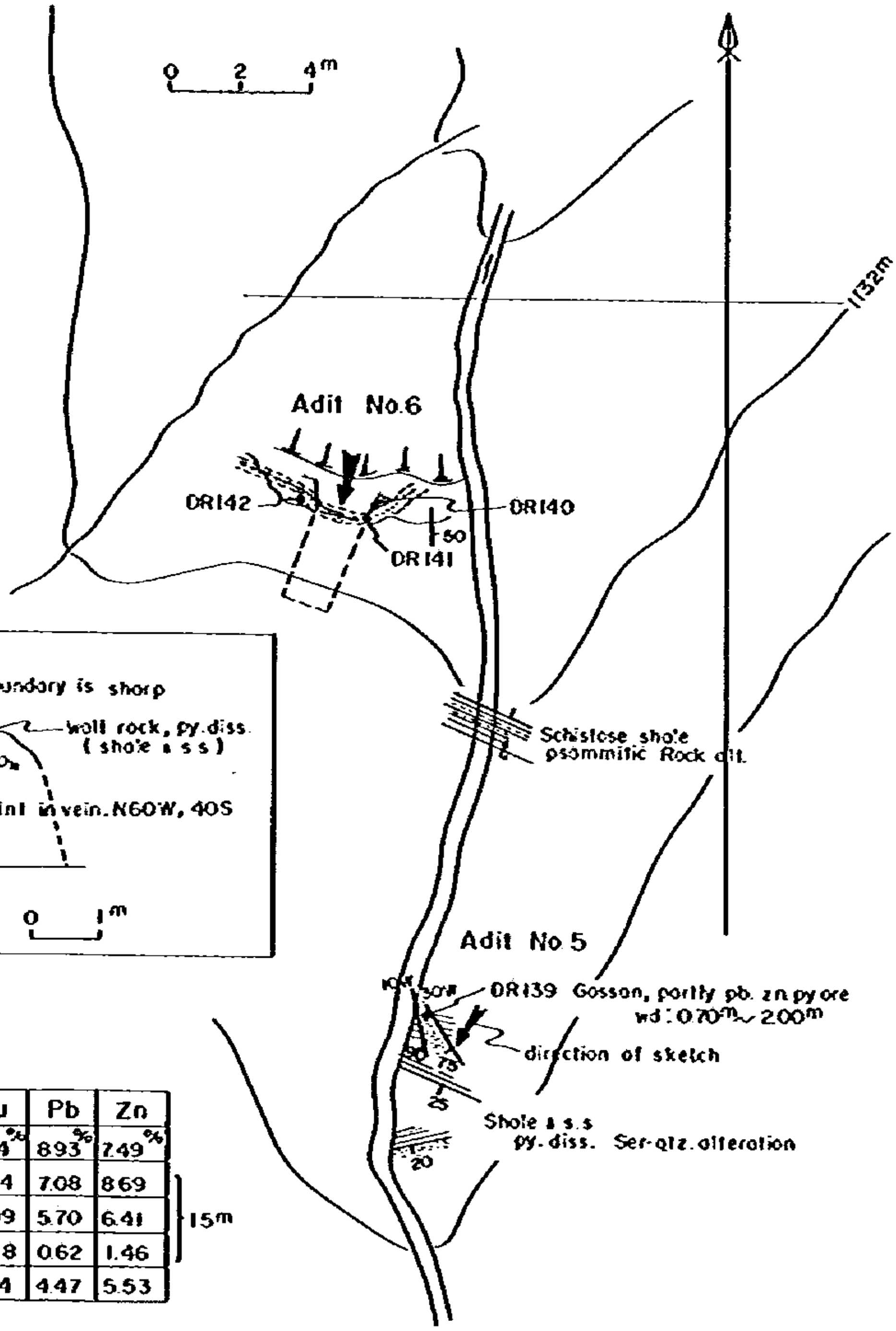
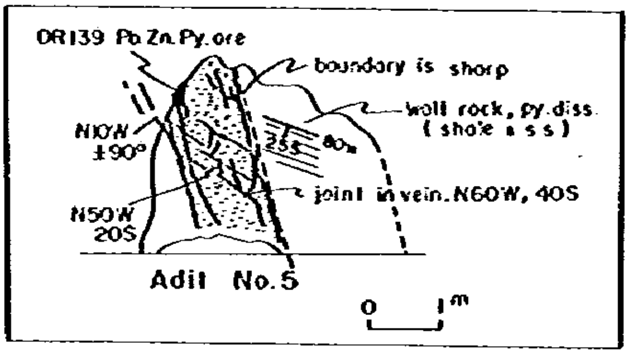


Fig Ⅲ-26 Sketch Map of Adit No.3





Sample No.	Au	Ag	Cu	Pb	Zn
DR 139	< 1 g/t	83.0 g/t	0.14 %	8.93 %	7.49 %
140	0.4	77.1	0.24	7.08	8.69
141	0.2	64.2	0.09	5.70	6.41
142	<0.1	4.8	0.08	0.62	1.46
Average (140~142)	0.2	48.7	0.14	4.47	5.53

1.5m (140~142)

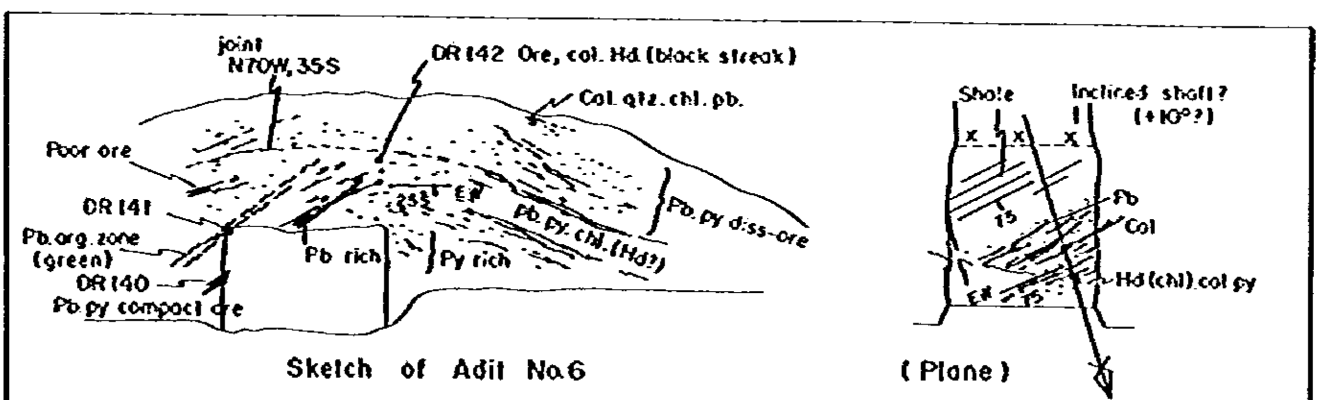
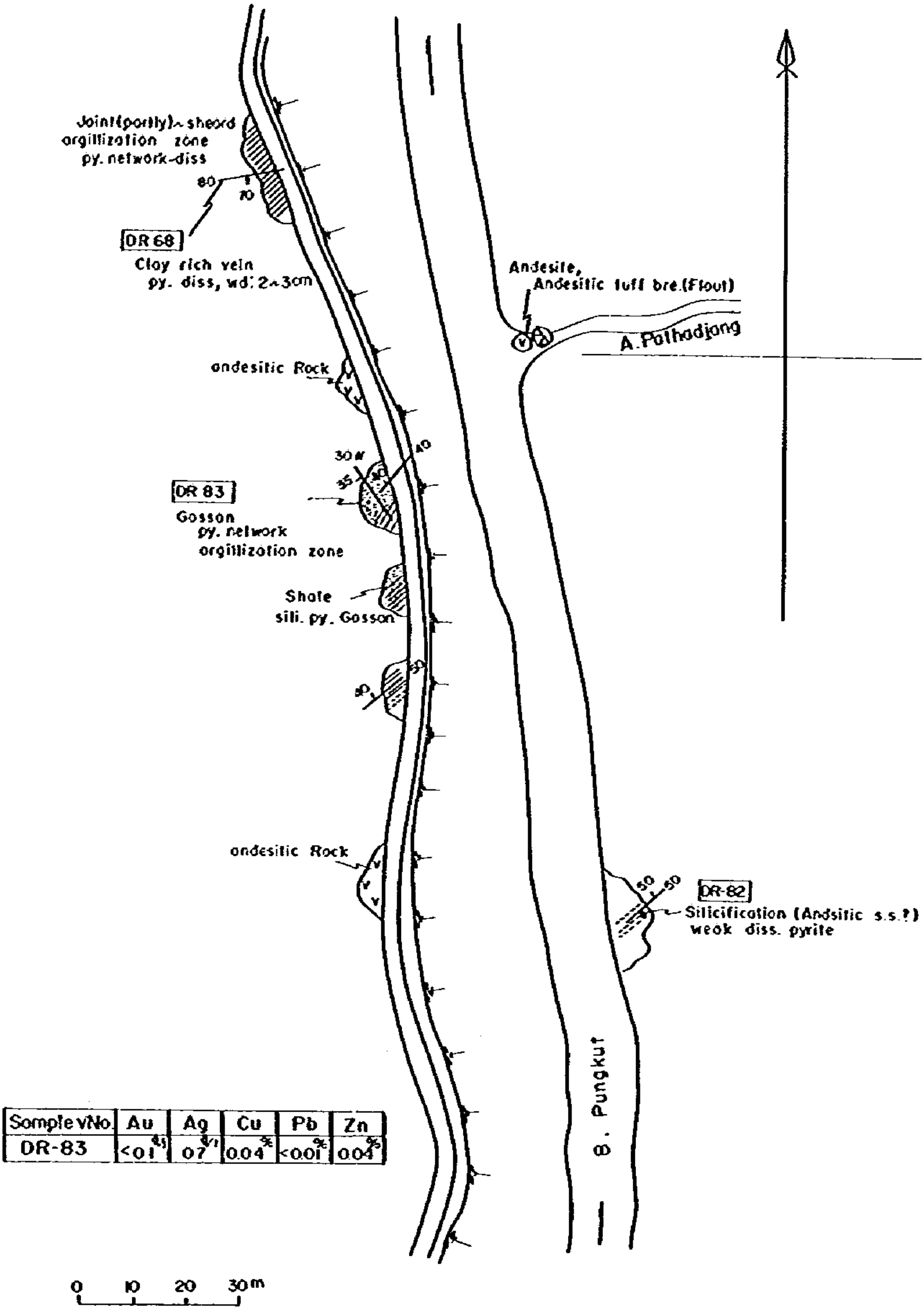
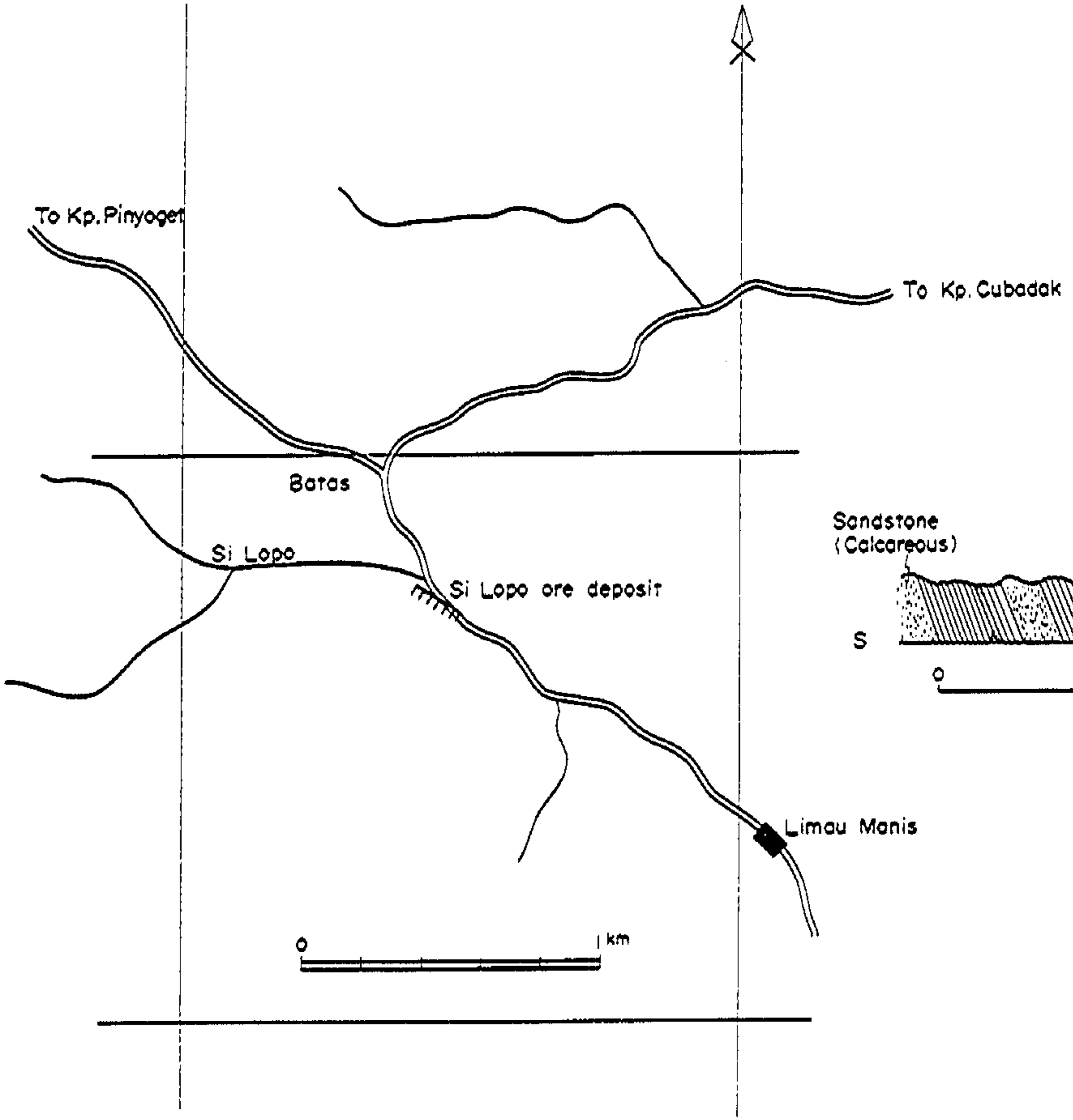


Fig III-27 Sketch Map of Adit No.5 and No.6, Pagar Gunung



Sample No.	Au	Ag	Cu	Pb	Zn
DR-83	<0.1 g/t	0.7 g/t	0.04 %	<0.01 %	0.04 %

Fig III-28 Mineralized Zone of Patahajang Area



	Wd	Au	Ag	Lu	Pb	Zn
	cm	g/t	g/t	%	%	%
AR-86	1	< 0.1	4.1	0.47	0.79	0.84

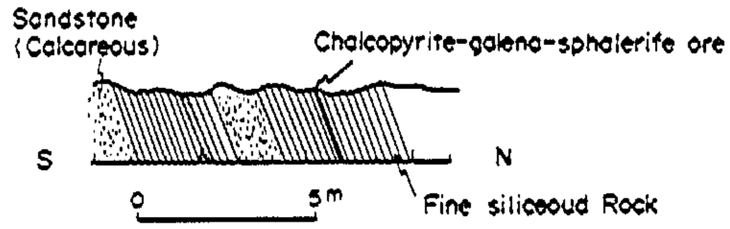


Fig III-29 Location and sketch Map of Si Lopo Ore Deposit

CHAPTER 6 GEOCHEMICAL SURVEY

6-1 Data Collection

A geochemical survey was carried out in parallel with the geological study. The geochemical survey samples of stream sediments were gathered using an 80 mesh sieve. Samples were taken upstream on the tributary from where it joined the main river at 2 sites per 1 km of the route covered by the geological survey. The samples were dried in the sun at the base camp and divided in two for analysis by both the Japanese and Indonesians.

Because the ore deposits distributed in this area contain gold, copper, zinc and lead, Au, Ag, Cu, Pb, Zn, and As were analysed as pathfinder elements, and, expecting that a porphyry copper type ore deposit exists, Mo has been added.

All together 540 samples were collected, but to make the sample densities uniform those with high densities were eliminated leaving 500 samples which were provided for anlysis.

6-2 Data Processing and Interpretation

In processing the results of the analysis they were first standardized through logarithmic conversion, then a histogram of cumulative frequency distribution was prepared, mean values and standard deviation calculated, and threshold value (1) ($M + \sigma$) and threshold value (2) ($M + 2\sigma$) charted. (Fig. III-30, 31, 32).

(a) Correlation of Components

The search for the coefficients of the components for Au, Ag, Cu, Pb, Zn, As, and Mo is outlined in Table III-5. Besides obtaining the correlation between Pb - Ag, Zn - Ag, and Zn - Pb, As was seen with coefficients of Cu, Pb, Zn, Ag, etc. Au was not observed with the coefficients of any other elements.

Table III-5 The List of Coefficients of Correlation between each Component on Geochemical Prospecting

	Ag	Cu	Pb	Zn	Mo	As
Au	0.1828	0.2896	△0.0203	0.0893	0.0774	0.2999
Ag		0.2340	0.5458	0.6260	0.1581	0.4262
Cu			0.0694	0.3738	0.2282	0.4513
Pb				0.5984	0.1515	0.4807
Zn					0.2274	0.4747
Mo						0.3231
As						

Table III-6 Background deviation and Threshold value

(Population: 500)

	Background value (M)	Standard deviation (a)	M + a	M + 2a
Au	8 (ppb)	0.8102	53	344
Ag	0 (ppm)	0.2381	0.2	0.4
Cu	28 (ppm)	0.4119	72	187
Pb	9 (ppm)	0.5335	31	108
Zn	96 (ppm)	0.2965	139	374
Mo	1 (ppm)	0.1988	2	3
As	14 (ppm)	0.3957	34	85

(b) Anomalous Areas

The histograms for Cu, Zn, Pb, and As showed regular logarthmic distribution but histograms of the analyzed values of Au, Ag, and Mo showed distribution of many low values. The calculated mean values, standard deviations, and threshold value (1) ($M + \sigma$) and threshold value (2) ($M + 2\sigma$) are shown in Table III-6. (PLII-3, PLII-4)

Each element in the Muara Sipongi area shows a special distribution depending on the form of the mineralized zone it is contained in.

(1) Pagar Gunung Mineralized Zone - Patahajang Variation Zone

The Cu, Zn, and Pb class 1 anomalous area overlaps the Pagar Gunung ore deposit area and the Patahajang argillization zone where they are found respectively. The Zn and Pb class 2 anomalous area is spread widely, covering the Pagar Gunung ore deposit area and the Patahajang argillization zone. Ag and As show a correlation with Cu, Pb, and Zn, and these anomalous areas are found over almost all of both areas. (As does not extend to the Patahajang zone.) In contrast Au has almost no anomalous areas in this area. The distribution conditions of these anomalous areas of the geochemical survey reflect that the Pagar Gunung ore deposit area is a copper, lead, and zinc mineralization with no accompanying gold. (PLIII-3,4)

(2) Subun-Subun Mineralization Zone - Bt Pionggu Mineralization Zone

Based on existing knowledge, the Cu class 2 anomalous area is distributed in a small section of this area. In contrast to this, the Au anomalous area is spread widely in this mineralization zone. It is shown clearly that a special characteristic of this mineralization zone is that it is accompanied by gold. However, the Zn, Pb, As, etc., anomalous areas are hardly observed at all.

(3) Others

The anomalous area observed in the area of the village of Pinyoge, east of Muara Sipongi is based on skarn on the northern margin of the Muara Sipong granitoid rocks in the upper reaches of the Halili River. Also the Au and Zn anomalous areas observed on the Si Bubungan tributary of the Cubadak River appear to indicate the mineralization of quartz veins accompanied by malachite of M. Batung meta-andesite found in this area. (PL III-3, 4)

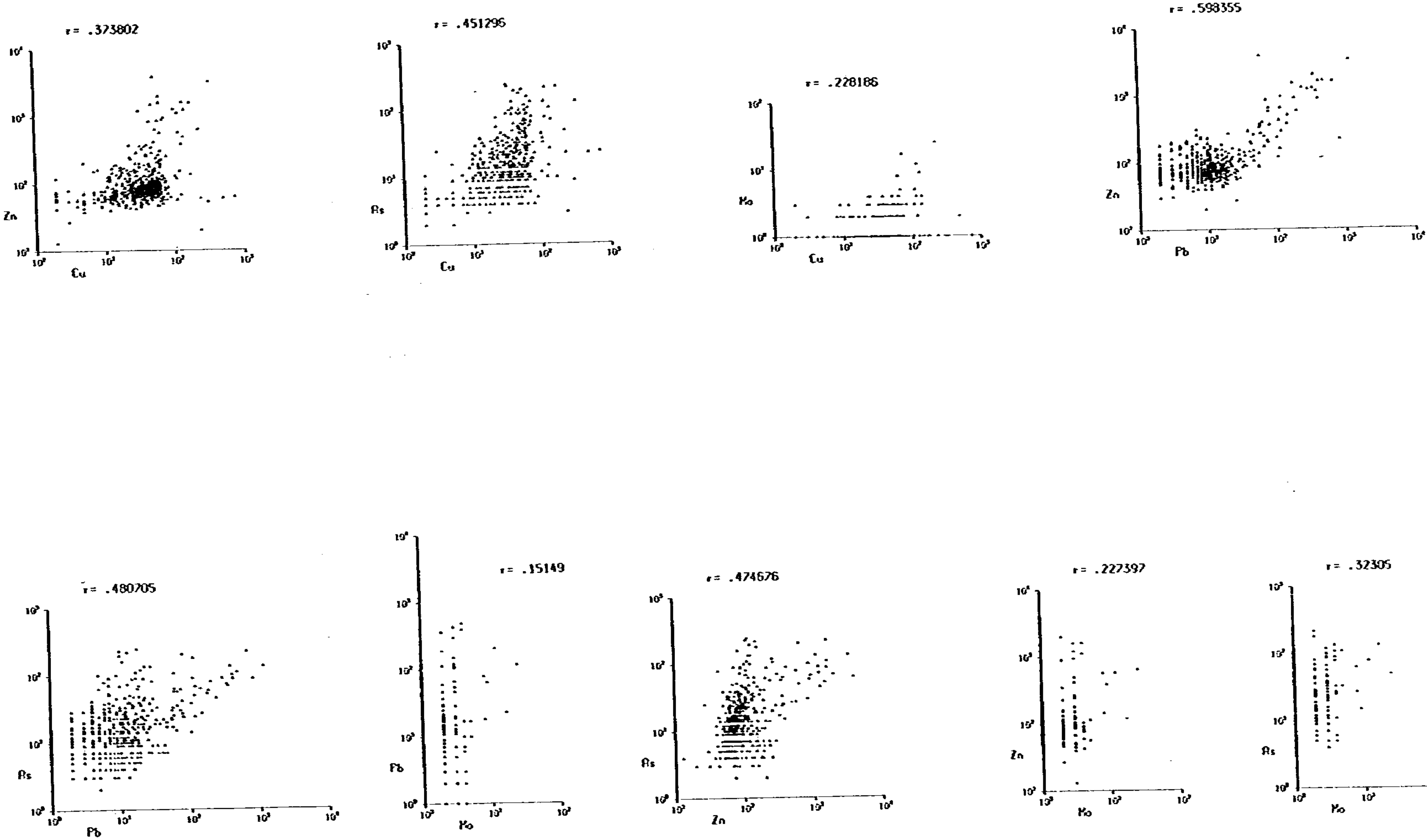


Fig. III-30 Coefficient of Correlation of the Geochemical Samples in Muara Sipongi Area (1)

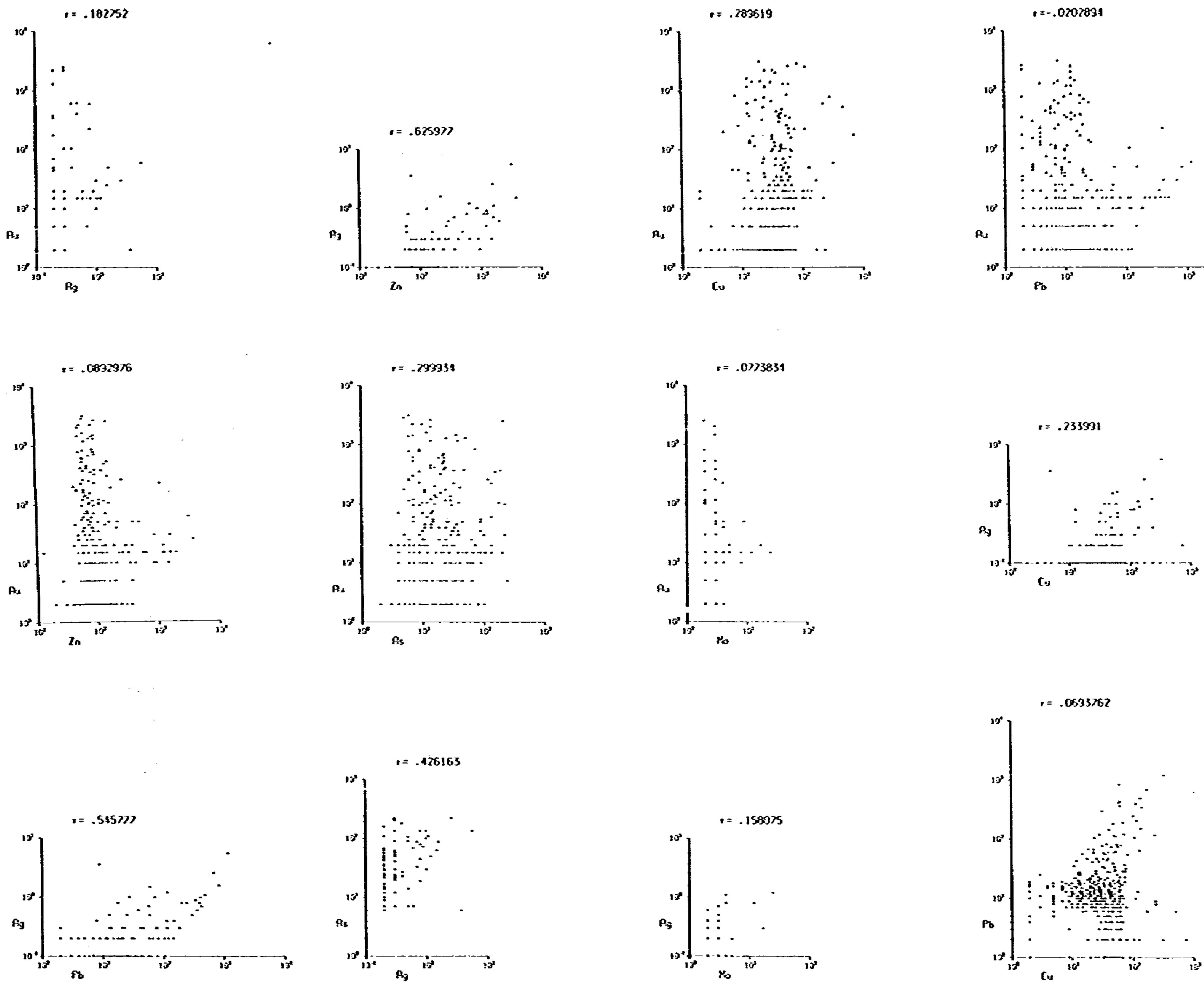


Fig. III-30 Coefficient of Correlation of the Geochemical Samples in Muara Sipongi Area (2)

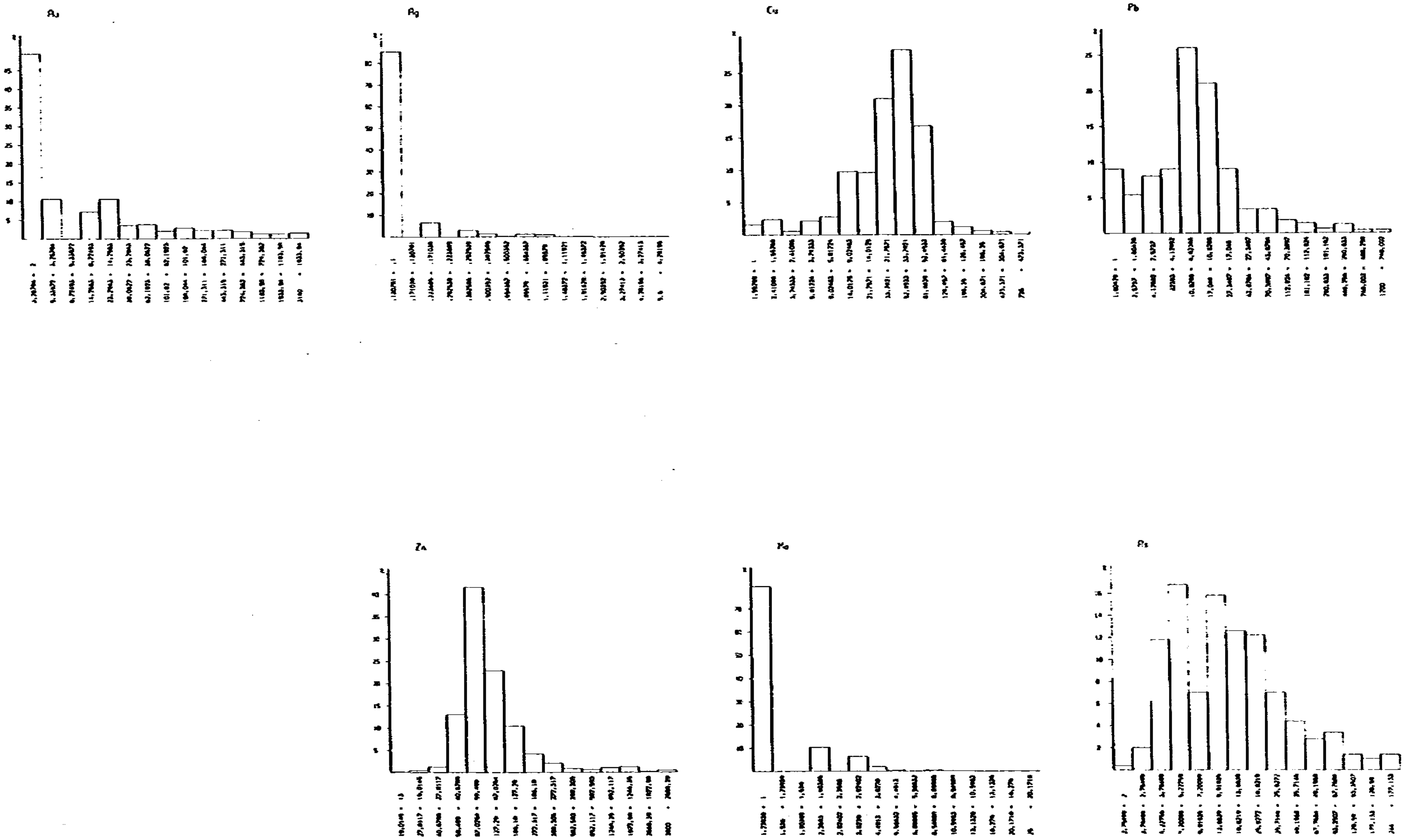


Fig. III-31 Histogram of Geochemical Analysis in Huara Sipongi Area

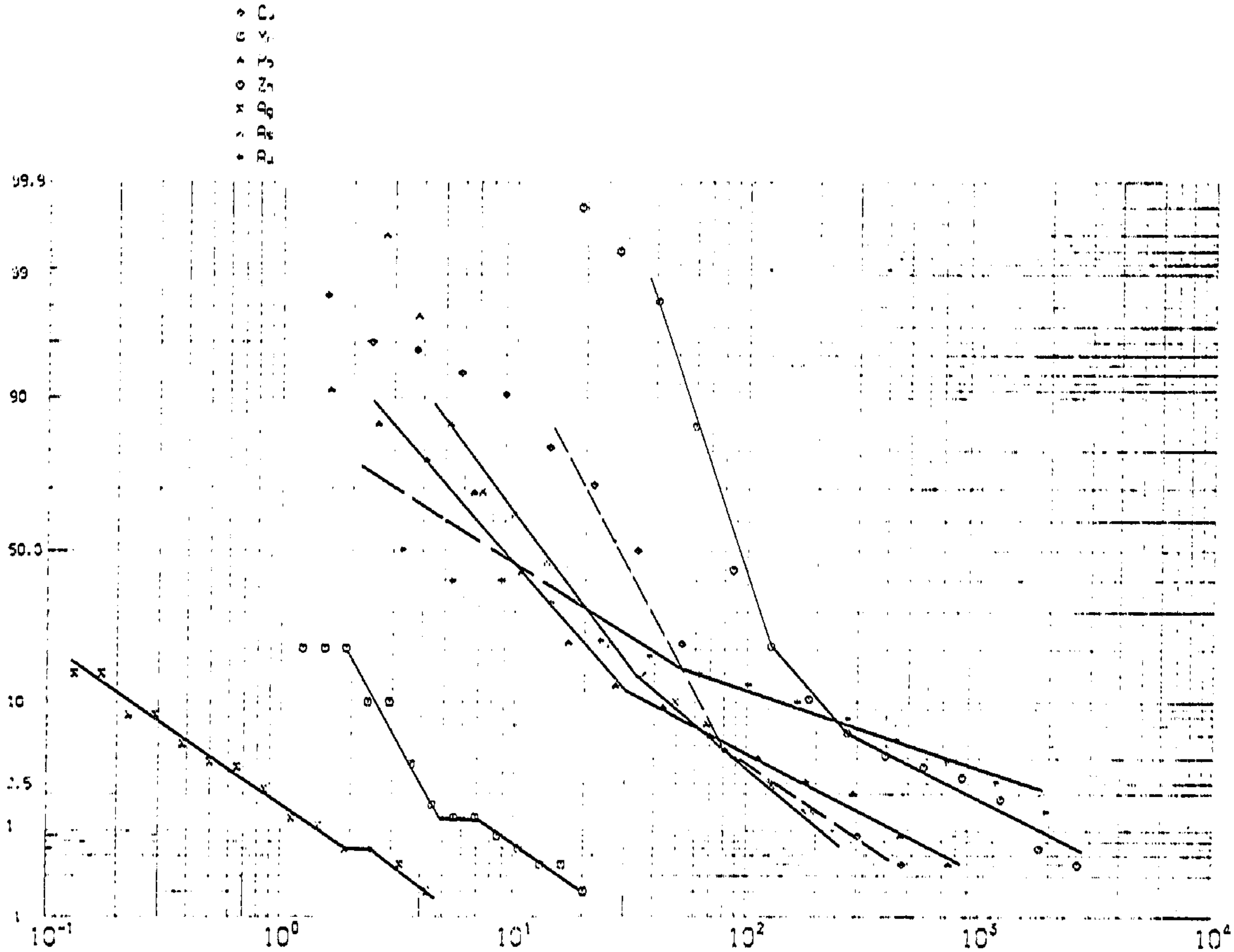


Fig. III-32 Cumulative frequency distribution in Muara Sipongi Area

CHAPTER 7 PLACER GOLD SURVEY

7-1 Survey Objectives and Methods

It was known from old data that the Subun-Subun and Bt Pionggu ore deposits distributed in the study area were accompanied by gold. Because of this, the pursuit of new ore deposits was carried out through a geochemical investigation of the stream sediment conducted in parallel with a study of placer gold in river bed sediments.

The study procedures were to first gather two 20 liter plastic buckets of river bed sediments from each geochemical sampling site, then using a wooden bowl 40 cm to 50 cm in diameter, to pan the sediments and sort out the gold grains, then lastly to count the gold grains. The amounts of gold extracted from each site were divided into five classes; 1 - 3 grains, 4 - 6 grains, 7 - 10 grains, 11 - 32 grains and over 33 grains, then plotted on a map of the area. The results from the 520 sampling sites are shown in III-4. Ideally, a comparison between the number of gold grains found and their size would be considered; however, because most of the gold grains collected were very fine, the number of grains found was simply plotted on a map of the area.

7-2 Results and Analysis

The area in which placer gold was found to be distributed was the Bt Pionggu mineralization zone, concentrating on the southeast extension of the zone, extending over the Kota Lambak area, upper Si Gerunggung River area, and the Subun-Subun mineralization zone. There was also some placer gold grain found on the upper Si Bubungen River, a tributary of the Cubadah River which is thought of as the southeast extension of this mineralization zone. There were other scattered findings including 2 sites on the S. Pungkut that produced large quantities of placer gold grains.

Taking a general view of the distribution of gold grains, that gold which is distributed over in the Si Ayu skarn zone, the Bt Bionggu mineralization zone, the Suban Suban mineralization zone, and the Si Bububgan River mineralization zone shows the connection between the results of the geochemical investigation and the Muara Sipongi mineralization zone.

Except for a few sites, almost no placer gold was found in the Pagan-Patahajang mineralization zone. The low grade of gold containing ore shown by the results of analysis on ore from this zone reflects the low content of placer gold in this area.

7-3 Electron Probe Minoanalyzer Test

Analysis based on the electron probe microanalyzer was conducted with the aim of finding the ratio of gold and silver and inclusions of trace elements contained in gold grains collected through panning. In order to investigate whether the form of the ore deposit and the trace elements found there have any special characteristics a comparison was carried out between the placer gold of the Muara Sipong area found in sphalerite·galena ore deposits, and the placer gold (Hong Muisan ore deposit West Kalimantan) distributed in the area of gold·silver·chalcopyrite·molybdenite ore deposits. Samples used were, 4 from Muara Sipongi (MA-1, BP 152, BP 153, and Fp 241), and 1 from west Kalimantan (Hong Muisan).

The analysis of gold and silver is shown in Table III-7.

The placer gold from west Kalimantan contained gold (68.2%) and silver (26.9%). In contrast, except for B 152 (Au 68.4%, Ag 27.3%) the samples from Muara Sipongi contained a high percentage of gold. Especially the samples taken at Si Botung (Au 99%) were almost pure gold. Because the results of an electron image taken of gold and silver to find the distribution pattern of gold and silver in the placer gold showed them to be uniformly distributed, the placer gold from west Kalimantan and Muara Sipongi is electrum. Furthermore, an examination was carried out based on the ratings of the trace components. No element with special mineralized characteristics were found in either area.

Table III-7: Microprobe Analysis of Gold and Silver in Placer Gold
(Muara Sipongi Area and West Kalimantan)

Element \ Location \ Sample No.	MA-1	BT-152	BP-153	FP-245	CA-1
	Si Botung M. Sipongi	M. Sipongi	M. Sipongi	M. Sipongi	W. Kalimantan
Ag	0.8	27.3	7.8	3.4	26.9
Au	99.0	68.4	90.7	95.6	68.9
Total	99.8	95.7	98.7	99.0	95.6

Appendix III-1 Assay Results of Geochemical and Panning Samples in Muara Sipongi Area

(1)

Serial No.	Sample No.	Location River or Creek	Assay Results Au ppb	Ag ppm	Cu ppm	Pb ppm	Zn ppm	Mo ppm	As ppm	Sn ppm	Number of Gold Grain F.C	M.C	C.C
541	As) Ap) 122	A. Malili	<5	0.1	36	7	130	3	14	10	1		
542	" 123	do	<5	0.1	73	37	88	2	19	N	1		
543	" 124	do	<5	0.1	32	1	118	2	11	5			
544	" 125	do	530	0.1	24	1	155	3	7	N			
545	" 126	do	<5	0.1	36	1	96	2	11	N			
546	" 127	do	<5	0.1	27	1	150	1	6	20			
547	" 128	do	<5	0.1	33	1	105	3	16	40			
548	" 129	do	<5	0.1	39	6	73	2	9	5			
549	" 130	do	70	0.1	38	7	90	3	14	20			
550	" 131	do	<5	0.1	170	6	138	1	10	20			
551	" 132	do	<5	0.1	36	3	70	2	9	20			
552	" 133	do	<5	0.1	27	1	52	1	10	5			
553	" 134	do	<5	0.1	27	1	75	2	7	20			
554	" 135	do	5	0.1	82	55	88	3	23	20			
555	" 136	do	5	0.1	58	20	75	2	19	N			
556	" 137	do	15	0.1	108	107	120	3	38	N			
557	" 138	do	20	0.1	110	10	57	5	33	N			
558	" 139	do	350	0.1	45	2	85	2	9	20			
559	" 140	do	<5	0.1	34	1	90	2	10	5			
560	" 141	do	670	0.1	33	7	78	1	22	N			
561	" 142	do	30	0.1	35	1	50	3	39	N			
562	" 143	do	115	0.1	37	1	88	3	24	20			
563	" 144	A. Cubadak	<5	0.1	35	8	100	1	17	N			
564	" 145	do	10	0.1	53	4	168	1	10	20			
565	" 146	do	<5	0.1	38	6	130	1	9	5			
566	" 147	A. Bobuguan	<5	0.1	78	7	255	1	4	10			
567	" 149	do	20	0.1	58	1	85	1	7	N			
568	" 150	do	5	0.1	38	44	190	1	7	N			
569	" 151	do	<5	0.1	43	5	195	1	6	N			
570	" 152	do	300	0.1	44	3	155	1	7	20			
571	" 153	do	<5	0.1	13	9	168	1	6	N			
572	" 154	do	1415	0.2	32	1	88	1	6	10	3		
573	" 155	do	50	0.1	52	3	160	1	7	20	2		

Fc: fine Grain Color < 1/2 mm, Mc: Medium Grain Color 1/2 ~ 1 mm,
Cc: Coarse Grain Color > 1 mm

Serial No.	Sample No.	Location	Assay Results								Number of Gold Grain		
		River or Creek	Au ppb	Ag ppm	Cu ppm	Pb ppm	Zn ppm	Mo ppm	As ppm	Sn ppm	F.C	M.C	C.C
574	As) Ap 156	A. Bobuguan	<5	0.1	46	4	90	2	36	N			
575	" 157	do	20	0.1	57	1	95	1	9	N			
576	" 158	do	95	0.1	32	1	93	1	9	10			
577	" 159	do	10	0.1	52	1	95	1	7	N			
578	" 160	do	<5	0.2	40	4	163	1	6	N			
579	" 161	do	30	0.1	49	1	64	2	5	N			
580	" 162	do	20	0.1	48	1	57	1	6	20			
581	" 163	do	60	0.1	54	1	62	1	7	N			
582	" 164	do	25	0.1	68	1	50	1	6	N			
583	" 165	do	15	0.1	42	1	57	1	6	20			
584	" 166	do	5	0.1	50	9	105	1	23	5			
585	" 167	do	<5	0.1	60	16	95	1	48	5			
586	" 168	A. Silopo	155	0.1	33	3	80	1	20	N			
587	" 169	do	<5	0.1	52	7	100	1	23	5			
588	" 170	do	10	0.1	26	5	50	2	24	N			
589	" 171	do	<5	0.1	47	7	82	1	12	20			
590	" 172	do	<5	0.1	57	3	115	1	17	N			
591	" 173	do	5	0.1	52	5	98	1	11	5			
592	" 174	do	<5	0.1	75	29	110	2	81	N			
593	" 175	do	5	0.1	35	4	68	1	17	N			
594	" 176	A. Cubadak	<5	0.1	40	4	88	1	20	N			
595	" 177	do	<5	0.1	50	12	97	3	46	N			
596	" 178	do	<5	0.1	40	8	85	2	36	5			
597	" 180	do	<5	0.1	32	2	87	3	22	N			
598	" 181	do	5	0.1	3	25	27	2	25	N			
599	" 182	do	45	0.1	9	3	45	3	14	N			
600	" 183	do	<5	0.1	50	29	153	3	9	N			
601	" 184	do	<5	0.1	27	8	105	1	4	N			
602	" 186	do	<5	0.1	32	6	178	1	4	N			
603	" 187	do	<5	0.1	13	10	145	1	19	N			
604	" 188	do	<5	0.1	17	8	130	1	3	N			
605	" 189	do	40	0.1	24	10	88	1	19	5			
606	" 190	do	<5	0.1	43	13	75	1	15	5			

Serial No.	Sample No.	Location	Assay Results								Number of Gold Grain		
		River or Creek	Au ppb	Ag ppm	Cu ppm	Pb ppm	Zn ppm	Mo ppm	As ppm	Sn ppm	F.C	M.C	C.C
607	As Ap) 191	A. Cubadak	<5	0.1	23	6	43	4	79	10			
608	" 192	do	<5	0.1	29	9	80	1	15	N			
609	" 193	do	<5	0.1	36	5	128	3	101	N			
610	" 194	do	<5	0.1	30	2	75	1	22	10			
611	" 195	A. Ranyah	1435	0.1	16	8	51	1	7	5			
612	" 196	do	3160	0.1	21	8	65	1	6	10	7	11	
613	" 198	do	<5	0.1	21	9	65	1	11	20	1		
614	" 199	do	<5	0.1	13	17	50	1	6	5			
615	" 200	do	<5	0.1	19	10	75	1	10	5			
616	" 201	do	<5	0.1	23	10	73	1	9	10			
617	" 202	do	<5	0.1	5	6	38	1	4	10			
618	" 203	do	<5	0.1	20	19	48	1	9	5			
619	" 204	do	<5	0.1	7	15	60	1	4	10			
620	" 205	do	<5	0.1	18	12	75	1	10	10			
621	" 206	do	5	0.1	15	13	69	1	5	20			
622	" 207	do	<5	0.1	9	9	46	1	5	N			
623	" 208	do	5	0.1	25	29	58	1	9	10			
624	" 209	do	<5	0.1	25	26	56	1	7	200			
625	" 210	do	<5	0.1	12	22	66	1	16	10			
626	" 211	do	<5	0.1	14	18	75	1	17	10			
627	Bs Bp) 126	A Buris	15	0.1	80	2	71	1	9	N			
628	" 127	do	20	0.1	125	2	68	1	10	N			
629	" 128	do	5	0.1	40	6	80	1	15	N			
630	" 129	do	10	0.1	45	7	80	1	11	N			
631	" 130	do	<5	0.1	9	9	55	1	4	N		1	
632	" 132	do	<5	0.1	23	9	110	1	15	5			
633	" 133	do	<5	0.1	18	14	100	1	9	N	1		
634	" 134	do	35	0.1	65	2	60	1	10	N			
635	" 135	do	120	0.1	48	6	112	1	7	N			
636	" 136	do	5	0.1	55	6	103	1	15	N			
637	" 137	do	5	0.1	45	6	85	1	7	N			2
638	" 138	do	5	0.1	28	16	130	1	35	10			
639	" 139	do	5	0.2	38	5	88	1	7	N			

Serial No.	Sample No.	Location River or Creek	Au ppb	Ag ppm	Cu ppm	Pb ppm	Zn ppm	Mo ppm	As ppm	Sn ppm	Number of Gold Grain F.C	H.C	C.C
640	Bs) Bp) 140	A. Buris	5	0.1	26	11	100	1	12	N			
641	" 141	do	250	0.1	9	1	78	1	6	N			
642	" 142	do	<5	0.1	10	8	78	1	10	N			
643	" 143	A. Lamane	<5	0.1	21	11	160	1	19	N			
644	" 144	do	10	0.1	22	7	107	1	7	40	1		
645	" 145	do	320	0.1	23	13	98	1	20	N		1	
646	" 146	do	5	0.1	21	16	110	1	22	20			
647	" 147	do	30	0.1	13	27	75	1	38	N			
648	" 148	do	<5	0.1	19	10	85	1	23	N			
649	" 149	do	5	0.1	20	11	75	1	20	N			
650	" 150	do	<5	0.1	18	8	93	1	17	N			
651	" 151	A. Gerunagung	35	0.1	46	6	87	1	38	N	1		
652	" 152	do	100	0.1	34	10	110	1	230	N	60		1
653	" 153	do	20	0.1	103	2	130	1	12	N			
654	" 154	do	70	0.1	24	10	73	1	14	N	4		
655	" 155	do	25	0.1	42	13	80	1	19	N			
656	" 156	do	40	0.1	24	9	82	1	11	N			
657	" 157	do	5	0.1	27	14	158	2	10	N	1		
658	" 158	do	2530	0.3	120	13	155	2	220	N	15		
659	" 159	do	40	0.1	24	10	85	4	33	20			
660	" 160	do	10	0.1	14	13	78	2	14	N			
661	" 161	do	370	0.1	14	15	63	1	33	N			
662	" 162	do	1180	0.1	13	13	65	1	39	N	1		
663	" 163	do	<5	0.1	15	12	55	1	12	N			
664	" 164	do	<5	0.1	12	7	53	2	7	10			
665	" 165	Simpangna Baso	10	0.1	45	4	73	1	33	N			
666	" 166	Near Tandjung Ala	15	0.1	42	1	50	1	12	N			
667	" 167	North of A. Gulgur	<5	0.1	15	8	75	1	14	N			
668	" 168	do	15	0.1	30	14	130	1	6	N			
669	" 169	Near Bt Tamjang	25	0.1	40	7	87	1	24	N			
670	" 170	do	105	0.1	55	7	77	1	39	N	3		
671	" 171	Near Kota Lambah	<5	0.1	52	7	100	2	14	N			
672	" 172	Near Tandjung Alai	10	0.1	40	1	65	1	7	N			

Serial No.	Sample No.	Location	Assay Results								Number of Gold Grain		
		River or Creek	Au ppb	Ag ppm	Cu ppm	Pb ppm	Zn ppm	Mo ppm	As ppm	Sn ppm	F.C	M.C	C.C
673	Bs Bp) 173	A. Galugur	1465	0.1	22	15	95	3	36	N	3		
674	" 174	do	<5	0.1	9	11	45	1	5	N			
675	" 175	do	<5	0.1	10	13	63	2	23	N			
676	" 176	do	<5	0.1	10	12	58	1	16	N			
677	" 177	do	40	0.1	13	20	63	1	24	N	5		1
678	" 178	do	1630	0.1	13	13	63	1	12	N	1	1	
679	" 179	do	140	0.1	14	25	68	1	16	N			
680	" 180	A. Sipangi	10	0.1	38	6	73	1	29	N			
681	" 181	do	<5	0.1	40	5	55	1	19	20			
682	" 182	A. Batu Tungal	<5	0.1	38	8	58	1	12	N		2	
683	" 183	do	<5	0.1	64	4	55	1	7	N			
684	" 184	do	10	0.1	35	7	72	1	12	N	1		
685	" 185	Simpang Tinggo	<5	0.2	60	4	63	1	15	10			
686	" 186	Simpang Ata-Ata	260	0.1	60	20	268	3	120	20	1		
687	" 187	A. Sipangi	<5	0.1	45	4	135	1	10	10			
688	" 188	do	115	0.1	45	7	133	1	29	N	1		
689	" 189	do	<5	0.1	63	10	230	1	7	N	1		
690	" 190	do	<5	0.1	56	8	240	1	6	N			
691	" 191	do	40	0.1	57	5	210	1	14	N	1		
692	" 192	do	<5	0.1	40	2	116	1	16	N			
693	" 193	do	490	0.1	49	6	140	1	22	N			
694	" 194	do	<5	0.1	32	9	72	2	27	N			
695	" 195	do	<5	0.1	40	3	65	2	15	N			
696	" 196	Simpang Nangatan	410	0.1	45	6	72	1	24	N	4	1	1
697	" 197	do	<5	0.1	35	2	50	1	5	N			
698	" 198	do	1310	0.2	52	7	80	1	51	N	3		
699	" 199	do	380	0.2	56	19	122	3	48	N	3		
700	" 200	do	100	0.1	66	1	75	2	16	N	4		
701	" 201	do	105	0.3	47	2	78	2	12	10	7		
702	" 202	A. Balangae	<5	0.2	43	5	72	2	6	N	1		
703	" 203	Simpanganob	<5	0.1	44	3	68	3	5	N			
704	" 204	Near Pinang	10	0.1	48	2	135	1	6	10			
705	" 205	do	<5	0.1	54	1	155	3	7	N			

Serial No.	Sample No.	Location	Assay Results								Number of Gold Grain		
		River or Creek	Au ppb	Ag ppm	Cu ppm	Pb ppm	Zn ppm	Mo ppm	As ppm	Sn ppm	F.C	M.C	C.C
706	Bs, Bp) 206	Near Pinang	50	0.1	50	1	80	4	25	N			
707	" 207	do	<5	0.1	45	2	180	3	11	5	1		
708	" 208	A. Godis Route	<5	0.1	12	8	115	2	14	N			
709	" 209	do	<5	0.1	43	4	90	2	29	N	15		
710	" 210	do	10	0.1	62	6	105	4	27	N			
711	" 211	do	<5	0.1	37	2	60	4	11	N			
712	" 212	do	2040	0.1	39	13	52	3	14	N	4	2	
713	" 213	do	<5	0.1	60	1	47	2	7	N			
714	" 214	do	<5	0.1	47	1	60	2	10	N	2		
715	" 215	do	<5	0.1	50	1	75	1	11	N			
716	" 216	do	<5	0.1	58	1	47	1	6	5			
717	" 217	do	<5	0.1	45	12	100	2	25	N	1		
718	Cs, Cp) 99	A. Si Binail	<5	0.1	55	25	78	2	11	N			
719	" 101	do	<5	0.1	50	18	80	2	11	N			
720	" 102	do	<5	0.1	45	13	73	1	10	20			
721	" 103	do	<5	0.1	42	13	86	1	14	N			
722	" 104	A. Asaha Godong	<5	0.1	12	11	59	1	5	10			
723	" 105	do	<5	0.1	19	10	65	1	12	5			
724	" 106	do	<5	0.1	15	7	50	1	7	10			
725	" 107	do	<5	0.1	5	11	53	1	5	10			
726	" 108	do	<5	0.1	8	7	58	1	4	5			
727	" 109	do	<5	0.1	3	11	55	1	5	5			
728	" 110	do	<5	0.1	2	17	57	1	5	N			
729	" 111	do	<5	0.1	40	1	70	1	10	N			
730	" 112	do	<5	0.1	25	6	65	1	6	N			
731	" 113	A. Si Binail	<5	0.1	34	3	82	1	15	N			
732	" 114	do	<5	0.1	24	7	78	1	5	N			
733	" 115	do	<5	0.1	78	32	85	1	19	N			
734	" 116	do	<5	0.1	27	11	88	1	17	10			
735	" 117	do	<5	0.1	18	2	52	1	4	N			
736	" 118	do	<5	0.1	17	8	73	1	7	5			
737	" 119	do	<5	0.1	60	7	100	1	15	N			
738	" 122	do	<5	0.1	15	10	80	1	7	10			

Serial No.	Sample No.	Location River or Creek	Assay Results Au ppb	Ag ppm	Cu ppm	Pb ppm	Zn ppm	Mo ppm	As ppm	Sn ppm	Number of Gold Grain F.C	H.C	C.C
739	(Cs, Cp) 123	A. Si Binail	<5	0.1	15	6	66	1	10	5			
740	" 124	do	<5	0.1	30	11	90	1	17	5			
741	" 125	do	<5	0.1	17	6	160	1	14	10			
742	" 126	do	<5	0.1	10	7	65	1	5	N			
743	" 127	do	<5	0.1	13	8	60	1	6	5			
744	" 128	do	<5	0.1	13	7	65	1	6	5			
745	" 129	do	<5	0.1	33	6	75	1	9	N			
746	" 131	A. Bandung	<5	0.1	18	8	55	1	4	5			
747	" 132	do	<5	0.1	15	10	65	1	5	N			
748	" 133	do	<5	0.1	25	10	73	1	5	5			
749	" 134	do	<5	0.1	12	16	128	1	4	5			
750	" 135	do	<5	0.1	20	13	88	1	5	N			
751	" 137	A. Si Binail	5	0.1	62	23	88	1	22	5			
752	" 138	do	5	0.1	42	12	88	3	33	N	1		
753	" 141	A. Lakapah	<5	0.1	25	17	75	1	11	20			
754	" 143	do	<5	0.1	27	18	78	1	11	N			
755	" 144	do	5	0.1	34	16	78	1	20	10			
756	" 145	do	<5	0.1	28	15	78	2	10	10			
757	" 146	do	<5	0.1	29	15	82	1	11	10			
758	" 147	do	<5	0.2	22	18	80	1	14	N			
759	" 148	do	10	0.1	23	15	73	1	9	N			
760	" 149	do	5	0.1	35	10	70	1	12	N			
761	" 150	A. Sironggur	<5	0.1	22	15	70	1	7	10			
762	" 151	do	<5	0.1	20	15	68	1	9	5			
763	" 152	do	<5	0.1	14	12	57	1	6	10			
764	" 153	do	<5	0.1	14	18	60	1	10	5			
765	" 154	do	<5	0.1	27	20	85	1	9	10			
766	" 155	do	5	0.1	24	14	75	1	7	20			
767	" 156	do	<5	0.1	30	13	72	1	9	10			
768	" 157	A. Baun	5	0.1	62	1	80	1	7	N			
769	" 160	A. Kao	<5	0.1	30	12	73	1	6	N			
770	" 161	do	<5	0.1	26	9	58	1	9	N			
771	" 162	A. Bayu	<5	0.1	62	1	82	1	9	5			

Serial No.	Sample No.	Location	Assay Results								Number of Gold Grain		
		River or Creek	Au ppb	Ag ppm	Cu ppm	Pb ppm	Zn ppm	Mo ppm	As ppm	Sn ppm	F.C	M.C	C.C
772	Cs) Cp) 163	A. Lakapah	5	0.2	33	9	70	1	12	10			
773	" 164	do	<5	0.1	28	9	63	1	10	5			
774	" 165	A. cu BADAK	<5	0.1	30	11	88	1	15	10			
775	" 167	do	<5	0.1	36	7	82	1	12	N			
776	" 168	do	<5	0.1	30	9	72	1	9	10			
777	" 170	do	<5	0.1	30	8	82	1	12	5			
778	" 171	do	<5	0.1	33	6	93	1	22	N			
779	" 172	A. Silago	<5	0.1	12	10	65	1	6	N			
780	" 174	Si Misun	<5	0.1	12	10	110	1	5	N			
781	" 175	A. Cubadak	<5	0.1	14	10	62	1	6	N			
782	" 176	do	5	0.1	25	8	67	1	10	N			
783	Ds) Dp) 174	A. Patahadjung	10	0.3	57	75	210	1	61	N			
784	" 175	do	5	0.2	41	145	375	1	63	N			
785	" 176	do	<5	0.1	24	17	82	1	22	N			
786	" 177	do	45	0.2	48	20	138	1	36	N			
787	" 178	Si Mangambat	<5	0.1	12	43	120	1	9	N			
788	" 179	do	<5	0.1	12	15	60	1	5	N			
789	" 180	do	<5	0.1	5	8	50	1	4	N			
790	" 181	do	10	0.1	11	35	125	1	7	N			
791	" 182	do	<5	0.2	24	105	235	1	14	10			
792	" 183	do	<5	0.3	29	119	290	1	24	5			
793	" 184	do	15	0.8	118	205	580	12	79	N			
794	" 185	do	15	1.2	230	118	640	25	50	N			
795	" 186	A. Si Kladi	15	0.1	2	1	13	3	4	10			
796	" 187	do	860	0.1	59	13	90	1	73	N			
797	" 188	do	20	0.1	55	4	88	1	30	N			
793	" 189	do	15	0.1	73	19	105	2	69	N			
799	" 190	do	10	0.1	44	11	110	1	23	N			
800	" 191	do	10	0.1	60	9	105	1	29	N			
801	" 192	do	35	0.1	62	6	105	1	32	N	1	1	1
802	" 193	do	1300	0.1	63	4	94	1	25	N			
803	" 194	do	50	0.1	60	9	105	1	45	10			
804	" 195	A. Madangang	225	0.8	115	395	1130	4	135	N			

Serial No.	Sample No.	Location	Assay Results								Number of Gold Grain		
		River or Creek	Au ppb	Ag ppm	Cu ppm	Pb ppm	Zn ppm	Mo ppm	As ppm	Sn ppm	F.C	M.C	C.C
805	Ds Dp) 196	A. Madangang	10	0.3	70	190	900	2	59	N			
806	" 197	do	15	1.1	137	490	1630	4	110	5			
807	" 198	do	15	0.7	63	430	1600	3	88	5			
808	" 199	do	10	0.2	73	121	950	3	67	N			
809	" 200	do	15	0.6	63	365	2000	2	69	N			
810	" 201	do	10	0.3	49	180	1500	1	53	50			
811	" 202	do	20	0.1	15	56	135	1	30	10			
812	" 203	do	<5	0.1	1	9	40	1	9	N			
813	" 204	A. Mandagang	50	1.6	62	840	220	1	88	10			
814	" 205	do	30	1.0	60	415	880	1	101	N			
815	" 206	do	15	1.0	39	28	130	1	135	N			
816	" 207	do	15	0.5	40	60	270	1	107	20			
817	" 208	do	105	0.4	50	114	160	2	180	10			
818	" 209	do	10	0.1	62	14	118	1	39	N			
819	" 210	A. Pungkt	5	0.2	20	21	66	1	24	N			
820	" 211	do	<5	0.1	12	11	40	3	12	N			
821	" 212	do	50	0.4	138	151	500	3	27	N			
822	" 213	do	50	0.1	130	64	390	9	15	10			
823	" 214	do	<5	0.1	1	2	30	1	5	5			
824	" 215	do	<5	0.1	18	47	148	1	20	N			
825	" 216	do	<5	0.1	1	5	43	1	4	N			
826	" 217	do	<5	0.1	1	7	40	1	6	N			
827	" 218	do	<5	0.1	1	3	83	1	3	N			
828	" 219	do	5	0.1	13	11	52	2	11	N			
829	" 220	do	<5	0.1	1	3	31	1	3	10			
830	" 221	A. Lan	<5	0.1	2	16	75	1	11	10			
831	" 222	do	<5	0.1	1	4	85	1	7	N			
832	" 223	do	<5	0.1	5	6	70	1	9	5			
833	" 224	do	<5	0.1	1	1	90	1	4	N			
834	" 225	do	<5	0.1	2	5	70	1	3	N			
835	" 226	do	<5	0.1	2	13	120	1	5	5			
836	" 227	do	<5	0.1	12	10	58	1	15	N			
837	" 228	do	35	0.1	39	22	93	1	88	N			

Serial No.	Sample No.	Location River or Creek	Assay Results Au ppb	Ag ppm	Cu ppm	Pb ppm	Zn ppm	Mo ppm	As ppm	Sn ppm	Number of Gold Grain F.C	M.C	C.C
838	Ds Dp) 229	A. Lan	5	0.1	24	19	85	1	39	N			
839	" 230	do	<5	3.6	5	9	72	1	6	N			
840	" 231	do	780	0.1	25	10	93	1	6	N			
841	" 232	do	<5	0.1	5	5	205	1	2	30			
842	" 233	do	<5	0.1	7	19	70	1	5	N			
843	" 234	do	10	0.1	60	18	145	8	63	N			
844	" 235	do	<5	0.1	2	19	55	1	6	N			
845	" 236	do	<5	0.2	15	15	70	1	17	N			
846	" 237	do	5	0.1	14	10	190	1	5	20			
847	" 238	do	<5	0.1	8	13	160	1	3	N			
848	" 239	do	<5	0.1	2	5	75	1	3	N			
849	" 240	do	45	0.1	7	9	75	1	11	N			
850	" 241	do	20	0.1	2	2	67	1	3	N			
851	" 242	do	20	0.1	15	7	190	1	4	N			
852	" 243	do	<5	0.1	2	4	73	1	3	N			
853	" 244	do	<5	0.1	3	7	80	1	4	5			
854	" 245	do	<5	0.1	7	16	155	1	11	N			
855	" 246	A. Pungkt	<5	0.1	26	6	65	1	4	N			
856	" 247	do	<5	0.1	2	5	42	1	3	N			
857	" 248	do	<5	0.1	13	8	68	1	5	N			
858	" 249	do	<5	0.1	2	1	73	1	2	N			
859	" 250	A. Si Abuk	10	0.1	20	11	120	1	23	10			
860	" 251	do	15	0.1	57	10	113	1	69	N			
861	" 252	do	15	0.1	50	9	105	1	100	N			
862	" 253	do	10	0.1	59	11	118	2	27	20			
863	" 254	do	15	0.1	65	17	92	4	90	10			
864	" 255	do	<5	0.1	15	8	98	1	7	N			
865	" 256	do	<5	0.1	10	11	65	1	4	N			
866	" 257	Simpang Pining	20	0.3	73	23	120	17	135	5			
867	" 258	do	15	0.2	67	17	115	5	110	10			
868	" 259	do	5	0.1	49	7	120	1	15	N			
869	" 260	do	15	0.1	50	15	90	3	88	5			
870	" 261	do	<5	0.1	20	16	85	1	12	20			

Serial No.	Sample No.	Location	Assay Results								Number of Gold Grain		
		River or Creek	Au ppb	Ag ppm	Cu ppm	Pb ppm	Zn ppm	Mo ppm	As ppm	Sn ppm	F.C	M.C	C.C
871	Ds) Dp) 262	Simpang Pining	<5	0.1	16	11	123	1	9	N			
872	" 263	Pager Gunung	<5	0.1	14	9	68	1	9	N			
873	" 264	do	<5	0.1	11	12	90	1	11	N			
874	" 265	do	<5	0.1	28	13	150	1	5	N			
875	" 266	do	<5	0.1	17	11	175	1	4	N			
876	" 267	do	<5	0.1	5	10	70	1	9	N			
877	" 268	do	<5	0.1	2	10	60	1	7	N			
878	" 270	do	<5	0.1	23	10	135	1	9	N			
879	" 272	do	370	0.1	43	10	128	1	195	N			
880	" 273	do	<5	0.1	44	16	185	1	19	5			
881	" 274	do	<5	0.1	14	17	80	1	9	5			
882	" 275	do	5	0.1	48	7	105	1	30	20			
883	" 276	A. Si Aul	115	0.1	17	11	133	2	6	5			
884	" 277	do	15	0.1	62	5	120	1	63	10			
885	" 278	do	190	0.1	63	4	178	1	41	N			
886	" 279	do	15	0.1	61	7	145	1	53	5			
887	" 280	do	5	0.1	63	3	200	1	11	10			
888	" 281	do	<5	0.1	64	3	195	1	29	20			
889	" 282	A. Si Aabul	20	0.1	64	7	310	1	71	10			
890	Es 82 Ep 124	A. Karuntang	10	0.1	47	8	75	1	12	N			1
891	Es 83 Ep 125	do	15	0.1	17	14	60	1	9	N			
892	Es 84 Ep 126	do	5	0.1	32	10	63	1	20	N			
893	Es 85 Ep 127	Simpang dutar	<5	0.1	9	17	68	2	7	N			
894	Es 86 Ep 128	do	410	0.5	13	13	58	1	14	N	20	1	
895	Es 87 Ep 129	do	600	0.8	13	18	63	1	19	N	2	3	
896	Es 88 Ep 130	A. M. Batung	<5	0.1	22	24	70	1	14	N	1	1	
897	Es 89 Ep 131	do	<5	0.1	4	15	56	1	5	N			
898	Es 90 Ep 132	do	<5	0.1	4	16	46	1	5	N			
899	Es 91 Ep 133	do	170	0.1	16	18	48	2	11	N			
900	Es 92 Ep 134	do	<5	0.1	20	22	88	1	19	N		4	
901	Es 93 Ep 135	do	<5	0.1	5	18	56	1	5	N			
902	Es 94 Ep 136	do	5	0.1	26	47	105	2	17	N			
903	Es 95 Ep 137	do	<5	0.1	20	12	73	2	27	N			

Serial No.	Sample No.	Location	Assay Results								Number of Gold Grain		
		River or Creek	Au ppb	Ag ppm	Cu ppm	Pb ppm	Zn ppm	Mo ppm	As ppm	Sn ppm	F.C	H.C	C.C
904	Es 96 Ep 138	Simpang Satu Lamo	5	0.1	10	18	62	2	19	N	1		
905	Es 97 Ep 139	do	200	0.1	5	16	43	1	16	N	13		
906	Es 98 Ep 140	do	15	0.1	11	16	60	1	22	N	5		
907	Es 99	do	615	0.5	13	25	60	1	7	N			
908	Es 100 Ep 141	do	5	0.1	7	14	53	1	11	N	1		
909	Es 101 Ep 142	do	130	0.1	14	27	74	1	17	N	2		
910	Es 102 Ep 143	Simpang dutar	<5	0.2	10	15	55	1	9	N			
911	Ep 144	do									6	1	
912	Es 103 Ep 145	do	815	0.1	8	18	62	2	9	N	2		
913	Es 104 Ep 146	A. Tabur	600	0.4	235	8	60	1	23	200	5		
914	Es 105 Ep 147	do	175	0.2	735	2	63	1	24	N		1	
915	Es 106 Ep 148	do	225	0.1	78	7	58	1	33	N	3		
916	Es 107 Ep 149	do	35	0.1	25	10	60	1	30	N	2	1	
917	Es 108 Ep 150	do	30	0.1	46	2	66	1	9	5	1		
918	Es 109 Ep 151	do	525	0.1	500	6	60	2	23	N			
919	Es 110 Ep 152	Simpang Mangampo	350	0.2	66	11	84	1	160	N	32		
920	Es 111 Ep 153	do	<5	0.1	30	4	63	1	22	N	65	8	
921	Es 112 Ep 154	do	55	0.1	46	7	73	1	90	N	9		
922	Es 113 Ep 155	do	450	0.1	40	5	73	1	14	5	10	1	
923	Es 114 Ep 156	do	135	0.1	36	4	65	1	29	5	12	1	
924	Es 115 Ep 157	A. H. Batung	1175	0.1	26	11	67	1	14	20	12		
925	Es 116 Ep 158	do	120	0.1	46	4	61	1	14	N	6		
926	Es 117 Ep 159	do	55	0.1	37	3	57	1	15	N	11		
927	Es 118 Ep 160	do	415	0.1	48	7	58	1	16	N	5		
928	Es 119	A. Tabur	780	0.1	305	2	53	1	9	N			
929	Es 120 Ep 161	A. H. Batung	30	0.1	59	2	66	1	29	N	1		
930	Es 121 Ep 162	do	<5	0.1	53	1	70	1	15	10			
931	Es 122 Ep 163	do	260	0.1	57	8	63	1	6	N	9		
932	Es 123 Ep 164	do	160	0.1	68	4	63	1	11	20	4		
933	Es 124 Ep 165	do	20	0.1	28	3	42	1	5	N			
934	Es 125 Ep 166	do	<5	0.1	235	9	20	1	3	N			
935	Es 126 Ep 167	do	95	0.1	70	10	58	1	30	60			
936	Es 127 Ep 168	A. Gadis	<5	0.1	18	14	70	1	10	N			

Serial No.	Sample No.	Location River or Creek	Assay Results Au ppb	Ag ppm	Cu ppm	Pb ppm	Zn ppm	Mo ppm	As ppm	Sn ppm	Number of Gold Grain F.C	M.C	C.C
937	Es 128 Ep 169	A. Gadis	<5	0.1	68	29	130	3	30	N			
938	Es 129 Ep 170	do	<5	0.1	52	3	93	4	5	40		1	
939	Es 130 Ep 171	do	<5	0.1	33	1	52	1	6	N			
940	Es 131 Ep 172	do	<5	0.1	43	17	92	1	27	N			
941	Es 132 Ep 173	do	5	0.1	40	12	80	1	23	50			
942	Es 133 Ep 174	A. Si Luak	<5	0.1	28	5	62	1	12	N			
943	Es 134 Ep 175	do	<5	0.1	37	5	85	1	17	N			
944	Es 135 Ep 176	do	<5	0.1	30	7	67	1	16	N			
945	Es 136 Ep 177	A. Diambu	<5	0.1	33	5	45	1	5	N			
946	Es 137 Ep 178	do	<5	0.1	43	6	66	1	6	5			
947	Es 138 Ep 179	do	<5	0.1	28	3	42	1	6	20			
948	Es 139 Ep 180	do	<5	0.1	20	1	44	1	4	30			
949	Es 140 Ep 181	A. Si Latung	5	0.1	33	18	118	1	244	10			
950	Es 141 Ep 182	do	5	0.2	30	22	112	2	43	5			
951	Es 142 Ep 183	do	<5	0.1	35	21	103	1	17	N			
952	Es 143 Ep 184	do	<5	0.1	36	56	85	1	22	N			
953	Es 144 Ep 185	do	<5	0.1	21	7	62	1	15	N			
954	Ep 186	do											
955	Es 146	do	<5	0.1	27	23	162	1	46	40			
956	Es 147 Ep 187	do	<5	0.1	25	6	100	1	7	1000			
957	Ep 188	do											
958	Es 149 Ep 189	do	5	0.1	40	13	90	1	15	20			
959	Es 150 Ep 190	do	<5	0.1	27	11	63	1	11	N			
960	Es 151 Ep 191	A. Gadis	<5	0.1	28	11	67	1	11	40			
961	Es 152 Ep 192	do	<5	0.1	25	7	77	4	6	80			
962	Es 153 Ep 193	do	<5	0.2	43	11	98	1	10	40			
963	Es 154 Ep 194	do	<5	0.3	40	14	70	1	50	N			
964	Es) Ep) 200	Si Ambak	10	0.2	35	12	83	1	29	N			
965	" 201	do	5	0.3	28	42	200	1	22	N			
966	" 202	do	20	0.2	35	33	103	1	22	N			
967	" 203	do	10	0.3	32	78	200	1	41	N			
968	" 204	do	10	0.2	19	67	170	1	35	N			
969	" 205	do	15	0.1	35	57	330	1	17	N			

Serial No.	Sample No.	Location River or Creek	Assay Results Au ppb	Ag ppm	Cu ppm	Pb ppm	Zn ppm	Mo ppm	As ppm	Sn ppm	Number of Gold Grain F.C	M.C	C.C
970	Fs, Fp) 206	Si Ambak	<5	0.2	38	82	360	1	24	N			
971	" 207	do	20	0.2	23	59	375	1	25	N			
972	" 208	do	20	0.1	50	34	142	1	33	N			
973	" 209	do	15	0.3	55	80	640	1	205	N			
974	" 210	do	20	0.9	145	345	1250	1	73	N			
975	" 211	do	15	0.8	103	245	1280	1	45	N			
976	" 212	do	30	2.6	175	690	1600	1	225	N			
977	" 213	do	60	5.6	335	1200	3300	1	135	N			
978	" 214	do	10	1.0	45	74	845	1	30	N			
979	" 215	do	20	0.6	48	39	290	1	7	N			
980	" 216	do	25	1.5	53	61	3900	1	63	N			
981	" 217	do	5	0.7	33	58	365	1	33	N			
982	" 218	do	<5	0.1	60	8	68	1	7	N			
983	" 219	do	15	0.1	57	2	73	1	6	N			
984	" 220	do	10	0.1	70	4	63	1	10	N			
985	" 221	do	15	0.1	67	8	230	2	6	N			
986	" 222	do	10	0.1	40	17	90	1	14	5			
987	" 223	do	175	0.1	33	2	48	1	5	5			
988	" 224	do	385	0.1	43	18	98	1	23	N			
989	" 225	do	5	0.1	35	10	65	1	14	N			
990	" 226	do	25	0.1	36	8	70	1	10	5			
991	" 227	do	<5	0.1	35	9	70	1	11	5			
992	" 228	do	60	0.1	23	12	83	1	12	N			
993	" 229	Barlan	<5	0.1	13	8	65	1	19	10			
994	" 230	do	<5	0.1	15	11	73	1	10	N			
995	" 231	do	<5	0.2	11	22	112	1	30	N			
996	" 232	do	700	0.1	18	21	95	1	23	N			
997	" 233	do	<5	0.3	29	21	105	1	30	N			
998	" 234	do	15	0.5	32	300	1220	3	90	N			
999	" 235	do	5	0.2	52	30	110	2	45	N			
1000	" 236	do	<5	0.2	23	67	245	3	57	N			
1001	" 237	do	15	0.1	64	79	570	8	27	N			
1002	" 238	do	15	0.3	40	47	260	3	20	5			

Serial No.	Sample No.	Location	Assay Results								Number of Gold Grain		
		River or Creek	Au ppb	Ag ppm	Cu ppm	Pb ppm	Zn ppm	Mo ppm	As ppm	Sn ppm	F.C	H.C	C.C
1003	Fs) Fp) 239	Barlan	10	0.3	53	112	420	3	90	N			
1004	" 240	do	10	0.1	48	60	350	2	57	5			
1005	" 241	do	<5	0.1	26	9	66	1	7	5			
1006	" 242	do	<5	0.2	30	12	83	1	6	N			
1007	" 243	do	<5	0.1	47	11	75	1	10	N			
1008	" 244	do	20	0.1	52	7	63	1	11	N			
1009	" 245	Si Aju	70	0.2	50	1	65	1	10	20	34	3	
1010	" 246	do	2240	0.2	26	2	56	1	10	5			
1011	" 247	do	2250	0.3	35	2	86	1	7	N			
1012	" 248	do	5	0.1	48	1	72	1	4	20			
1013	" 249	do	10	0.1	46	1	73	1	4	N			
1014	" 250	do	15	0.1	40	1	95	1	7	20			
1015	" 251	do	2660	0.1	63	2	98	1	14	10			
1016	" 252	do	230	0.1	63	4	95	1	9	10			
1017	" 253	do	2880	0.1	88	1	63	1	5	N			
1018	" 254	do	105	0.1	55	7	110	1	10	N			
1019	" 255	do	75	0.1	65	5	70	1	15	N			
1020	" 256	B. Pungkut	15	0.1	30	9	63	1	12	N			
1021	" 257	do	10	0.1	58	3	72	1	12	N			
1022	" 258	do	95	0.1	44	1	88	1	7	5			
1023	" 259	do	10	0.2	60	2	85	1	7	N			
1024	" 260	do	5	0.1	40	7	75	1	10	N			
1025	" 261	do	5	0.1	73	2	80	1	17	N			
1026	" 262	Tolang	<5	0.1	25	9	97	1	6	N			
1027	" 263	do	<5	0.1	13	7	85	1	12	N			
1028	" 265	do	<5	0.1	47	9	95	1	7	N			
1029	" 266	do	<5	0.1	52	7	90	1	23	N			
1030	" 267	do	<5	0.1	52	8	78	1	4	5			
1031	" 268	do	<5	0.1	34	10	58	1	7	N			
1032	" 269	do	<5	0.1	32	34	90	1	9	N			
1033	" 270	do	<5	0.1	43	28	103	1	7	N			
1034	" 271	do	5	0.1	34	17	92	1	6	5			
1035	" 272	do	5	0.1	44	8	70	1	5	N			

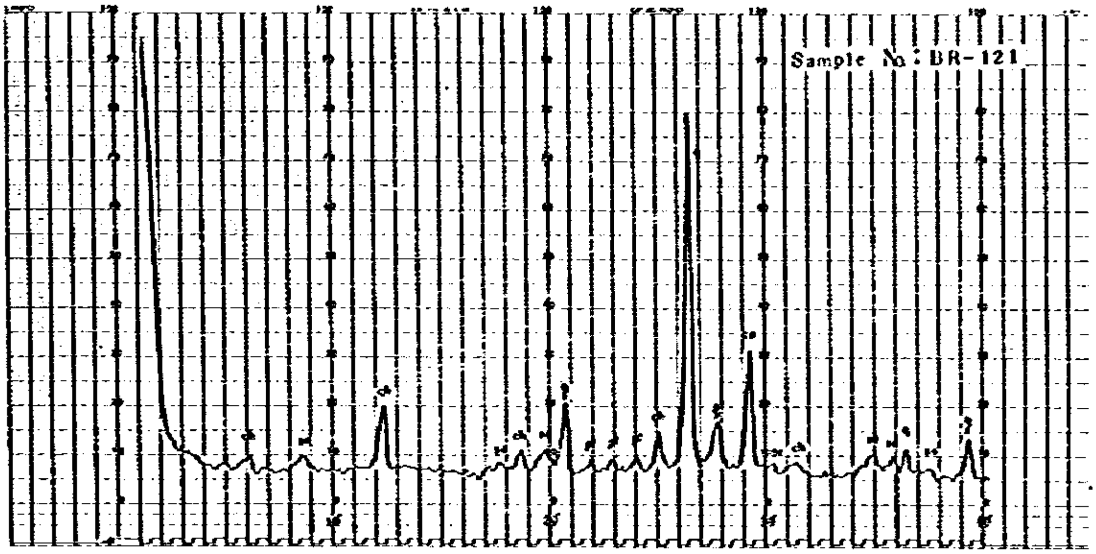
Serial No.	Sample No.	Location River or Creek	Assay Results Au ppb	Ag ppm	Cu ppm	Pb ppm	Zn ppm	Mo ppm	As ppm	Sn ppm	Number of Gold Grain F.C	M.C	C.C
1036	Fs) Fp) 273	Tolang	15	0.1	22	41	145	1	7	N			
1037	" 274	do	5	0.1	23	19	120	1	7	N			
1038	" 275	do	<5	0.1	33	47	123	1	7	5			
1039	" 276	do	<5	0.1	36	10	107	1	5	10			
1040	" 277	do	<5	0.1	30	10	155	1	5	N			
1041	" 278	do	5	0.1	63	4	70	1	4	20			
1042	" 279	do	25	0.1	29	9	112	1	11	5			
1043	" 280	do	70	0.1	50	10	140	1	4	N			

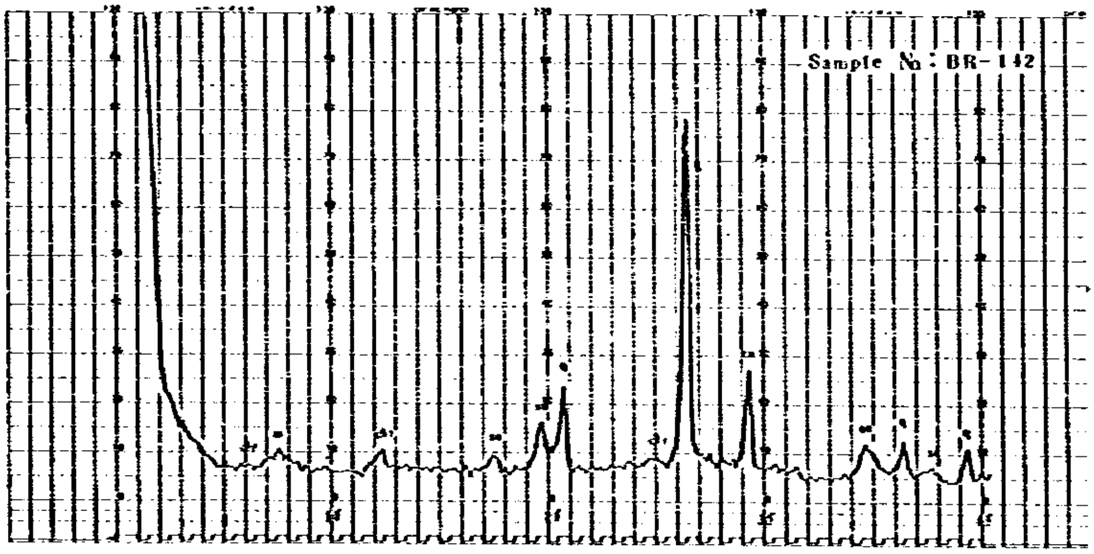
Appendix III-2 List of X-ray diffractive analysis, Muara Sipongi area

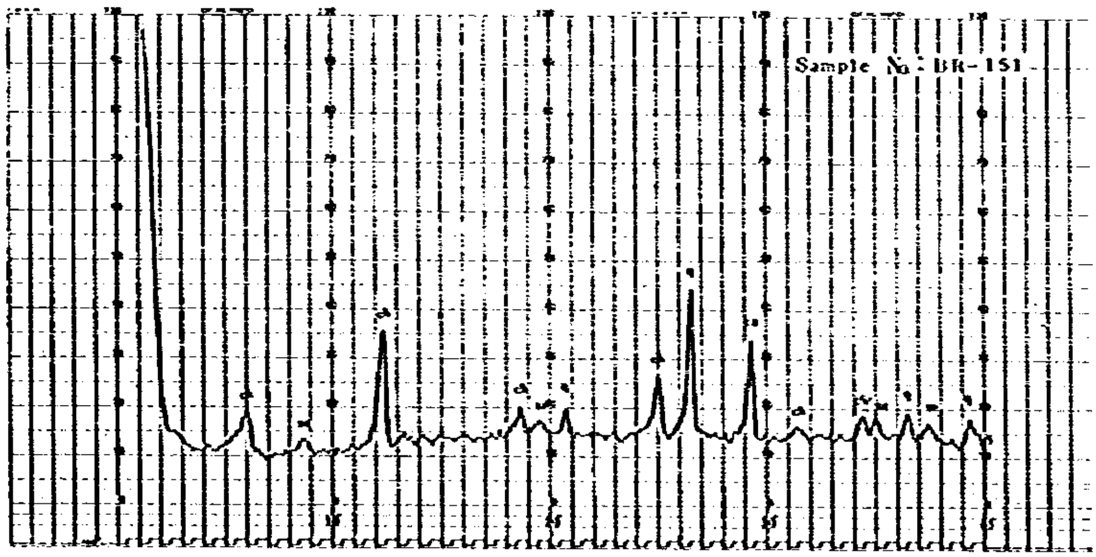
Sample No.	Location	Minerals										Remarks
		qz	Se	ch	Kao	m	Ca	pl	py	ha		
BR-121		◎	o	o			o					
BR-142		◎	o	o		o ?	o					
BR-151		○	o	○			○					
BR-194		○	o	o								
BR-228		○	o	o			o		o ?			
CR-68		◎	o		o			o				
DR-68		○	o	o								
DR-135		○	o	○					o			
ER-160		○	o	o			o		o			
ER-195		○	o									
FR-201		○	o	o				o				
FR-210		◎	o	o				○	o	o		

Condition

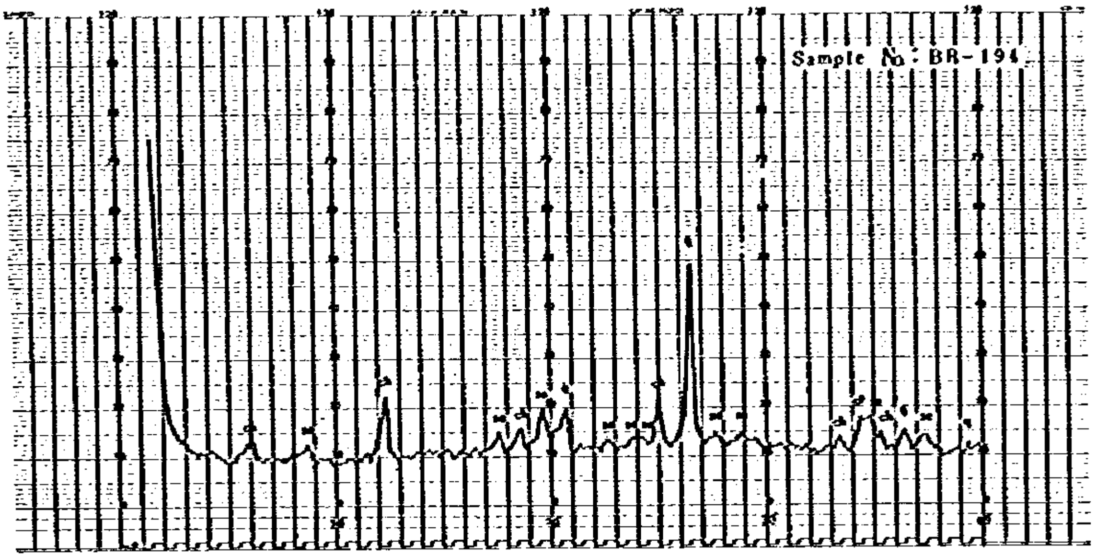
Target	Cu	Divergency slit	1°	qz :	quartz	Ca :	Calcite
Filter	Ni	Receiving slit	0.5 mm	Se :	Sericite	Pl :	Plagioclase
Voltage	30 kV	Scatter slit	1°	ch :	chrolite	Py :	Pyrite
Current	15 mA	Chart speed	4 cm/min	Kao:	Kaoline	ha :	halloysite
Sending speed	4°/min	Full scale	800 cps	m :	montmorillonite		
Time constant	2 sec						

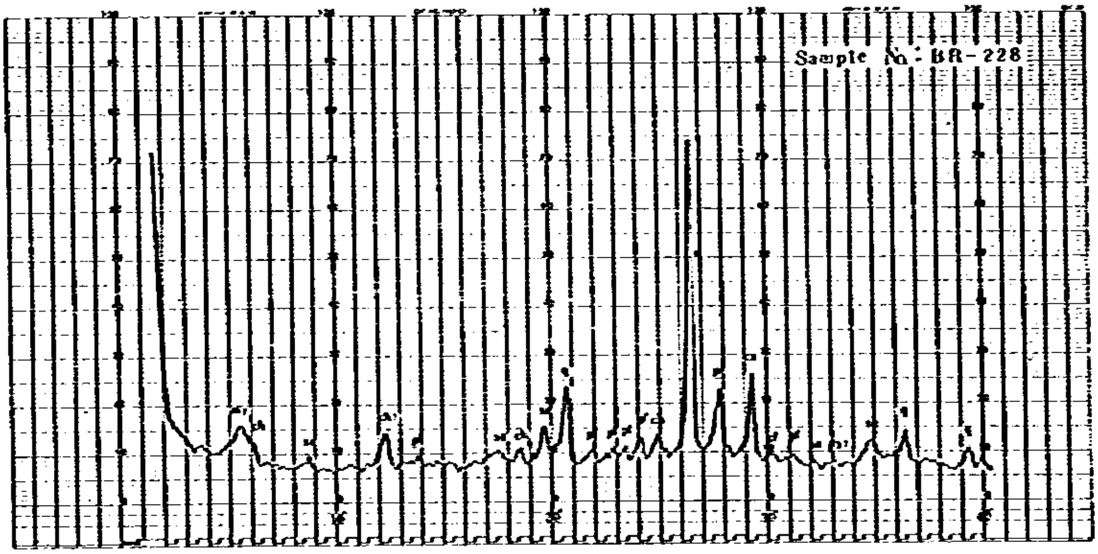




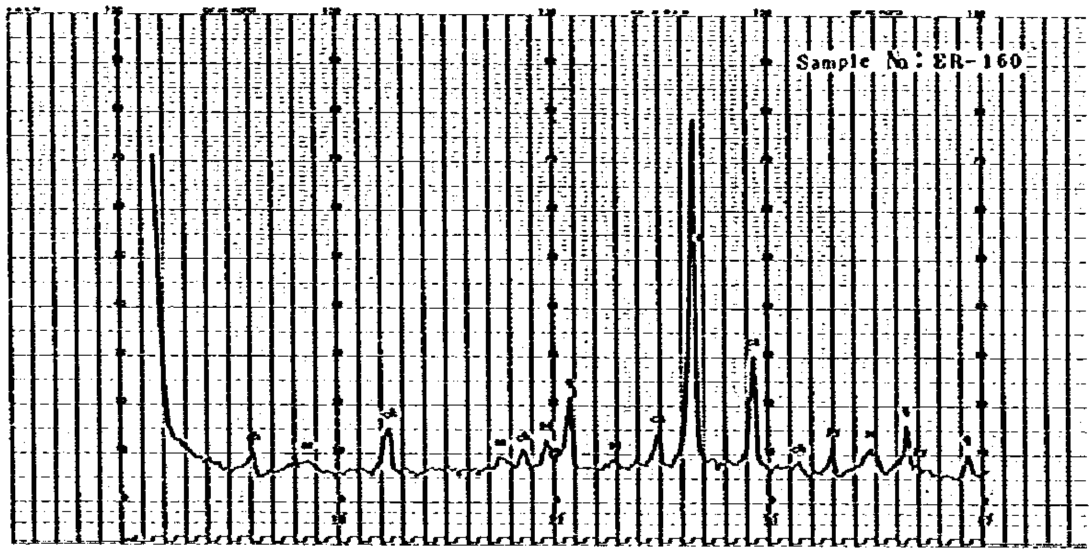


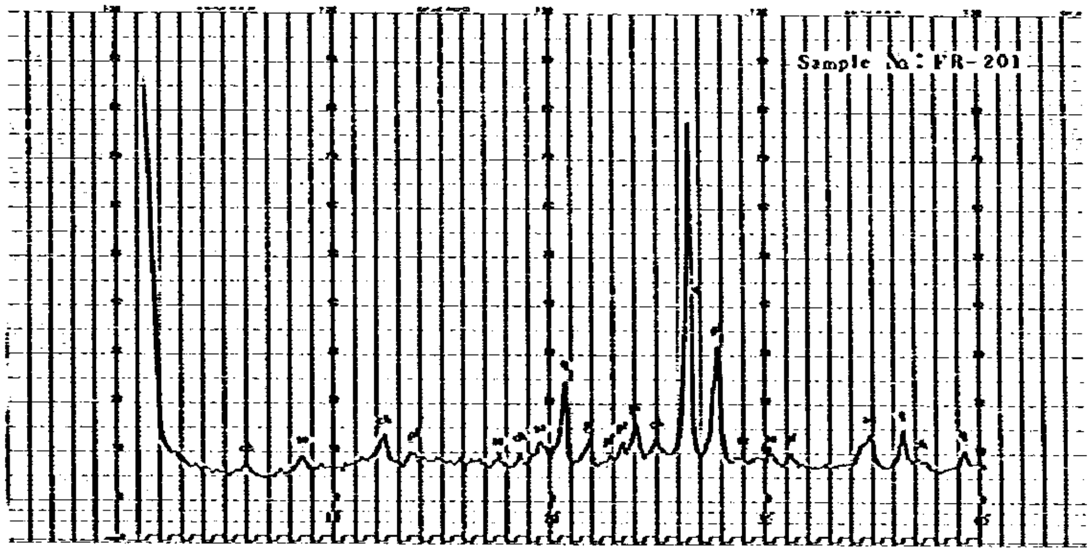
Appendix III-2 Charts and List of X-Ray Diffractive Analysis in Muara Sipongi Area (1)



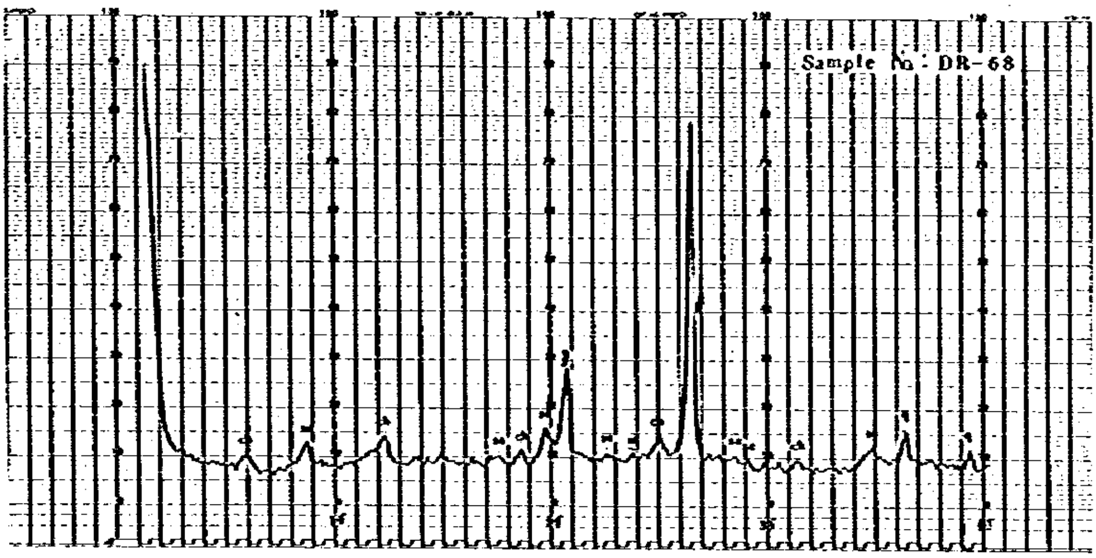


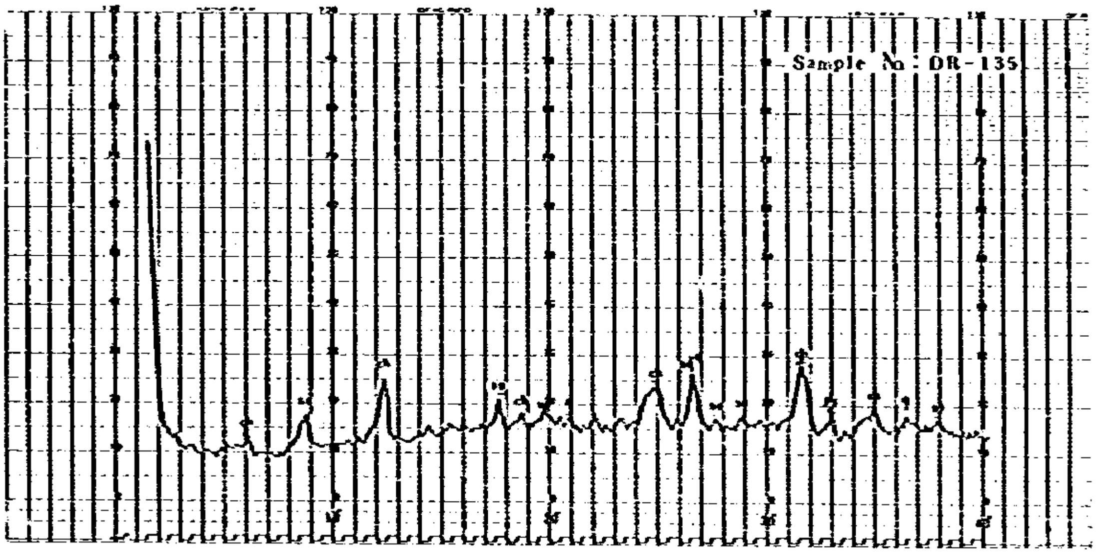
Appendix III-2 Charts and List of X-Ray Diffractive Analysis in Muara Sipongi Area (2)





Appendix III-2 Charts and List of X-Ray Diffractive Analysis in Muara Sipongi Area (3)





Appendix III-2 Charts and List of X-Ray Diffractive Analysis in Muara Sipongi Area (4)

Appendix III-3-(1) Microscopic Observation of Thin Section in Muara Sipongi Area

Sample No.	Rock Name	Texture	Fragment/Grain										Groundmass/Matrix											Secondary Mineral													Remarks
			Q	k-f	pl	Bt	Hb	Au	Hy	Ol	Op	Lith	Q	Si	k-f	Pl	Bt	Hb	Cpx	Opx	Ol	Op		Q	Si	Cc	Ser	Chl	Kao	Bt	Act	Epi	Tau	Op	Py		
S	Ranya Formation																																				
AR 107	Meta quartzose sandstone		◎		●																			○			○										Silicification
B	Batung Meta-Andesite																																				
AR 58	Meta Andesite	Porph			◎						○					◎										○	●	◎				○					
AR 63	"	Porph			◎	?	?				○		o			○											○	◎				◎					
AR 68	"	"			◎						○					○											○	◎				◎					
AR 83	"	(Porph)	●		◎																			o		○	○	○				●		○			Hard alteration
AR 99	"	(Porph)			◎											○								o			◎									cloy	
BR 104	Andesite	Porph			◎	o	o				○					◎						o					○	○									
BR 136	Meta Andesite	(Porph)			◎		●	●			○					◎											○	○									
BR 212	"	"			◎						○													●		○		○				○					
BR 226	"	(Porph)			○						o													◎				○				●					
CR 52	"	"			◎						o																◎	◎						○			
ER 116	"	"			○						○					○										○		○				◎					
ER 169	"	"					◎				○		○			○						○						○				●					
ER 178	"	"			○		◎									○											○	○									
ER 189	"	"			◎		◎				●																○	○				●					
FR 218	"	"	●		◎	●						○	○			○							glass	○													Silicification
FR 220	"	"			◎		○				o			○		○											○	○				●		o			

Porph: Porphyritic Gradio: Granodiorite Pyrocras: Pyroclastic Qzdio: Quartz diorite Hol crys: Hollo crystal

◎ Abundant ○ Common ● Rare

Sample No.	Rock Name	Texture	Fragment/Grain										Groundmass/Matrix											Secondary Mineral													Remarks
			Q	K-f	pl	Bt	Hb	Au	Hy	Ol	Op	Lith	Q	Si	K-f	Pl	Bt	Hb	Cpx	Opx	Ol	Op		Q	Si	Cc	Ser	Chl	Kao	Bt	Act	Epi	Lau	Op	Py		
FR240	Andesitic tuff	Pyrocras.			○						○	And		○		○						○				●						○					
Patahajan Formation																																					
AR 87	Tuffaceous slate	Pyrocras	○		○																						○	○			○	◎					
BR 174	Sericite quartz schist	Schist																						◎			Mus ◎							o			
Dacitic tuff																																					
DR 98	Dacitic tuff	Pyrocrys	○		◎	○					○	○										o	glass														
ER 129B	"	"	○									○																									
ER 132	"	"	○		○							And.											glass														Lithic tuff
Tertiary Andesite																																					
CR 48	Andesite	Porph	○		◎			●			o					◎						o				o		o									
Muarassipongi Granitoid Rocks																																					
AR 51	Gra dio	Holcrys	◎	●	◎		◎				o																○	○				o					
AR 100	"	"	◎	o	◎	○	○				o													○		◎		○				o					
AR 117	"	"	◎	●	◎																			o		o	o	◎						○			
BR 185	Qz dio	"	◎		◎	○	○																				o	o				●		o			
BR 192	"	"	◎		◎						○															o		○				◎					

Sample No.	Rock Name	Texture	Fragment/Grain Q	k-f	pl	Bt	Hb	Au	Hy	Ol	Op	Lith	Groundmass/Matrix Q	Si	k-f	Pl	Bt	Hb	Cpx	Opx	Ol	Op	Secondary Mineral Q	Si	Cc	Ser	Chl	Xad	Bt	Act	Epi	Tau	Op	Py	Remarks
BR 213	Gra dio	Holcrys	◎	o	◎	o	o				○															○	○								
ED 2	Qz dio	"	o		◎	●	◎				○														●	○	○								
ED 3	Qz dio	"	o		◎	○	○				○															○	○				●				
ER 222	Gr dio	"	◎	●	◎	◎	◎																			○	○				●				
FR 223	Gr dio	"	◎	o	◎	o																					○				●				
FR 226	Gr dio	"	◎	o	◎	●	○				○															o	o								
FR 237	Qz dio	"	o		◎	●	○				○															o	o				●				
FR 248	Gr dio	"	◎	●	◎	●	●																			◎	o						o		sericitization
Bt Ruruk Raru Granite																																			
AR 105	Gr dio	Porph hol	◎	o	◎	●	o																		◎	o	o				●				
AR 55	"	"	◎	◎	◎	●																				o	o				●				

Appendix III-4 Microscopic Observation of Polished Section of Muara Sipongi

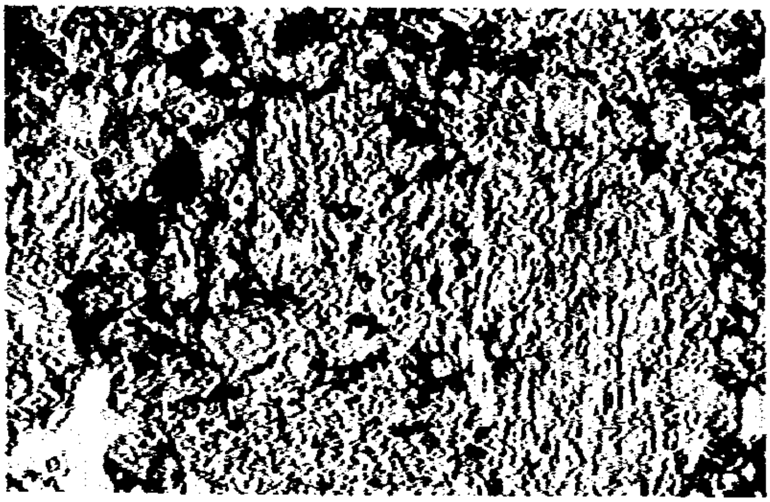
Sample No.	Location	Occurrance	Mineral											Remarks
			CP	Ga	Sph	CC	Bo	Cov	Py	Pyr	Asr	Mf	He	
AR 86	S. Silopo.	Vein	○	o	◎	●								Chalcopyrite dot in sphalerite
BR 201	Subun Subun Adit	Massive	◎					●						Mesh texture
BR 202	" "	"										◎	◎	
BR 203	" "	"	○			o	o	o						
BR 206	" "	"										◎	◎	
DR * 19	Pagar Gunung	"	o	○	◎				◎					Chalcopyrite dot in sphalerite
DR 120	" "	"	o	o	◎				○					" "
DR 129	" "	"	o	○	◎				◎					" "
DR 131	Pagar Gunung Adit	"	●	o	○		●	●	○					
DR 132	" "	"	o	○	◎				○					
DR 133	" "	"	o	○	○				◎					Dissemination
DR 140	" "	"	o	○	○				◎					Massive, dissemination
DR 141	" "	"	●	o	○				◎	?	o			Mesh, dissemination
DR 142	" "	"	●	●					◎	?				Dissemination
ER 175	Bt Pionggu, Adit	"	●		○			●	◎					Mesh, dissemination
ER 200	"	"	●		○				◎	◎				Massive
ER 208A	"	"	○	●	●		o	●	●					Massive, dissemination
ER 209	"	"	o		○			o	○			o		Mesh, dissemination
ER 210	"	"	o	●	○				○					Massive
*ER 232	"	Skarn	o		o				○					Skarn mineral (garnet, vesuvianite, calcite)
*FR 242	"	Skarn	o		o				○					Clinopyroxene, quartz, chlorite

Cp: Chalcopyrite
Ga: Galena
Sph: Sphalerite
Asp: Arsenopyrite
Cov: Covelline
Py: Pyrite
Pyr: Pyrrhotite
Mt: Magnetite
He: Hematite
Bo: Bornite

◎ : Abundant ○ : Common o : Present ● : Rare ?: Probably * polished thin section

Sample No.	Rock Name	Skarn Mineral					Other Mineral				Ore Mineral				
		Gar	Ves	Cpx	Wal	Ep	Cal	Qz	Se	Ch	Apq	Py	Cp	Sph	
AR 56	Garnet Skarn	◎				●		o	o						Contact zone of granodiorite and limostone
BR 203	Epidoto Skarn					◎		◎		o	o				Subun-Subun Mineralization area
DR 120	Hedenbergite Skarn			◎				o							Cpx: hedenbargite, Pagar Gunung Mineralization
ER 206	Garnet Skarn	◎	o	o		o		o							G. Pionggu mineralization area
ER 208B	C. Pyroxene Skarn			◎	○		o	o					o		"
FR 231	Garnet-Wallst Skarn	○	◎		◎			o							
FR 232	Garnet Skarn	◎	○									o	o	o	
FR 233	Garnet Skarn	◎	◎												Hornblende
FR 235	Epidote Skarn	o				◎	o	o							
FR 236	Garnet Skarn	◎		○		o									
FR 242	C. Pyroxene Skarn			◎			o					o	o	o	
FR 243	C. Pyroxene Skarn			○			o								Hornblend, sphane
FR 244	Garnet Wallst Skarn	◎			○	o									
FR 245	Garnet Skarn	◎				o	o			o					
FR 246	Epidote Skarn			o		◎		o			o				

Gar: Carnet　Cal: Calcite　Opq: Opaque Mineral　Ves: Vesubianite　Qz: Quartz　Py: Pyroxene
Cpx: Clinopyroxene　Se: Sericite　Cp: Chalcopyroxene　Wal: Wallastonite　Ch: Chlorite　Sph: Sphalerite　Ep: Epidote



Sample No.: BR-212

Location : Piong

Rock Name : Meta-Andesite
(Formation)

pl: pseudomorph of plagioclase
io: iron oxide

open nicol

0 0.5 mm

Sample No.: BR-212

Location : Piong

Rock Name : Meta-Andesite

epi: epidote

cross nicol

0 0.5 mm

Sample No.: CR-48

Location : Paninggarahan

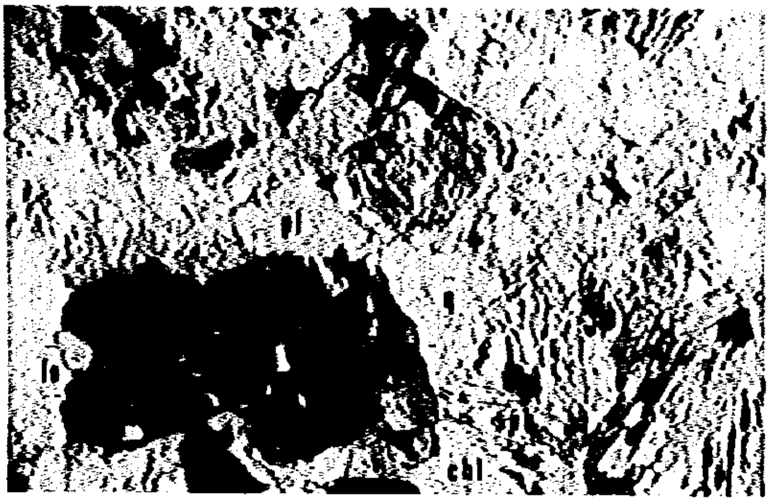
Rock Name : Andesite
(Tertiary)

pl: plagioclase

open nicol

0 0.5 mm

Appendix III - 5 Photographs of Microscopic Observation of Thin Section and Polish section, Muara Sipongi Area



Sample No.: ED-3

Location : Simpang Mangampo

Rock Name : M.Sipongi quartz diorite

q : quartz
pl : plagioclase
chl: chlorite
sph: sphane
io : iron oxide

open nicol

0 0.5 mm

Sample No.: ER-132

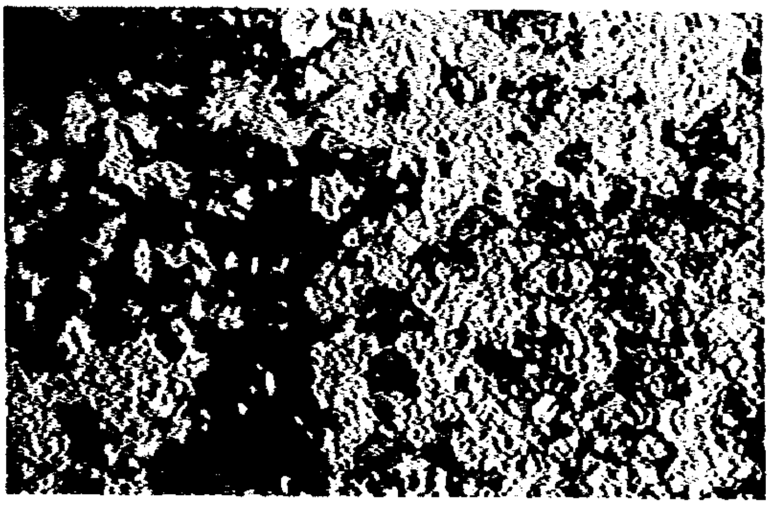
Location : Simpang Katalo

Rock name : Dacitic Tuff (Tertiary)

RF: rock fragment (altered andesite)

open nicol

0 0.5 mm



Sample No.: FR-244

Location : Pungkut River

Rock Name : Wollastonite skarn

w : wollastonite
ga: garnet

open nicol

0 0.5 mm

Sample No.: FR-245

Location : Pungkut River

Rock Name : Garnet skarn

ga : garnet
epi: epidote

open nicol

0 0.5 mm

Sample No.: BR-203

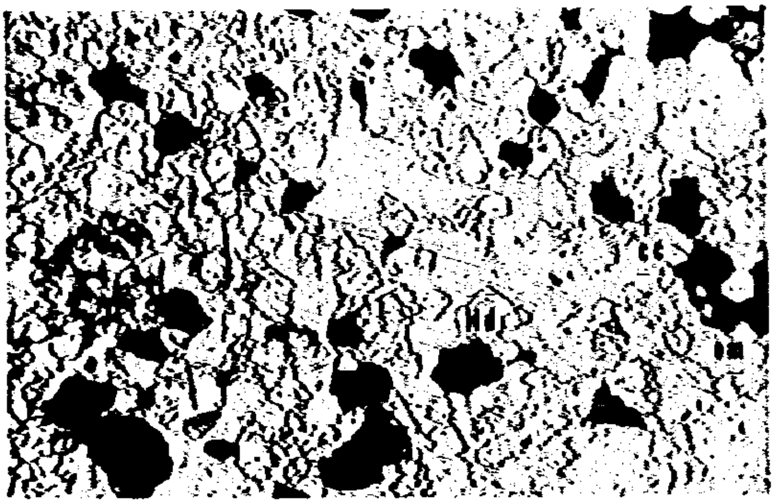
Location : Subun-Subun

Rock Name : Epidote skarn

epi: epidote
q : quartz

open nicol

0 0.5 mm



Sample No.: ER-208

Location : Bt Pionggu

Rock Name : Clinopyroxene skarn

hd: Clinopyroxene (hedenbergite)
cc: calcite
om: ore mineral (sulphide)

open nicol

0 0.5 mm

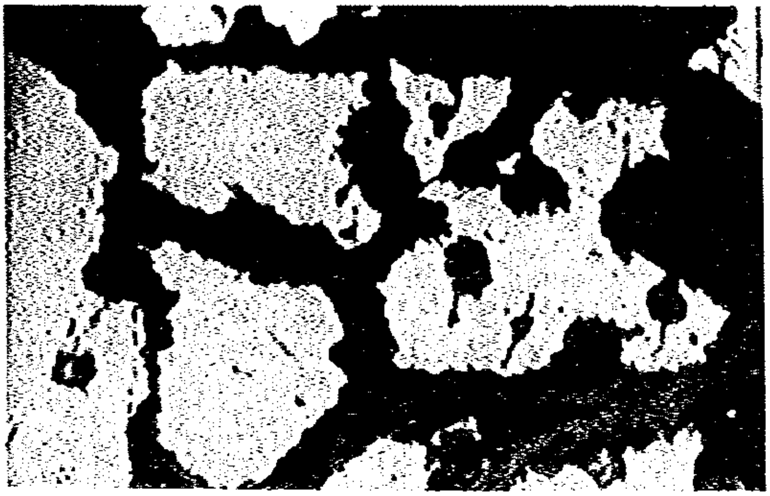
Sample No.: AR-86

Location : South of Batas (S.Silopo)

Ores : chalcopyrite dots in sphalerite

sp: sphalerite
cp: chalcopyrite

0 0.2 mm



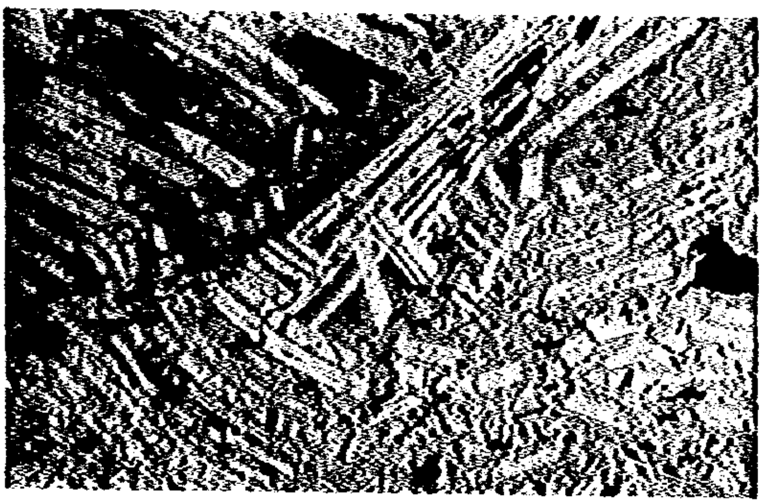
Sample No.: BR-201

Location : Subun-subun

Ores : chalcopyrite and covelline

Covelline distributed around chalcopyrite

0 0.2 mm

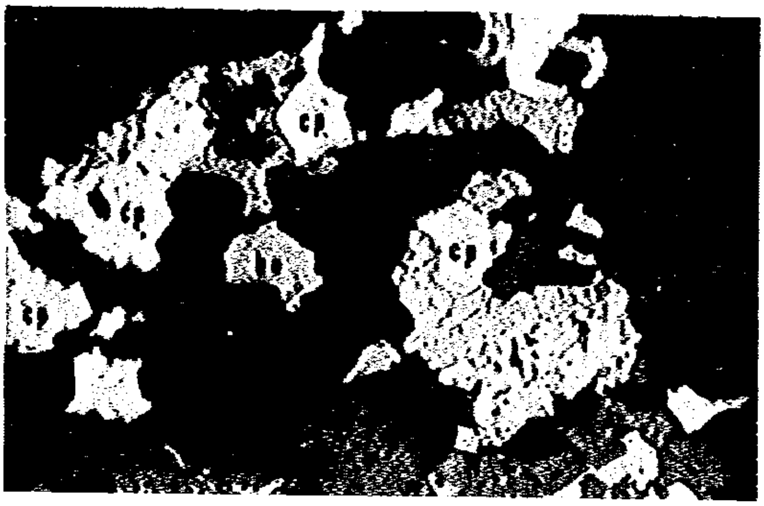


Sample No.: BR-202

Location : Subun-subun outcrop

Ores : Magnetite and hematite

0 0.2 mm



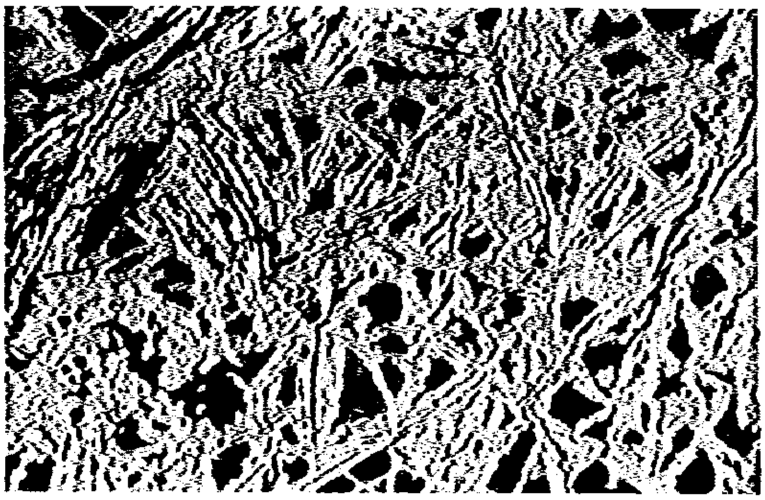
Sample No.: BR-203

Location : Subun-subun

Ores : Chalcopyrite and bornite

cp: chalcopyrite
bo: bornite

0 0.2 mm

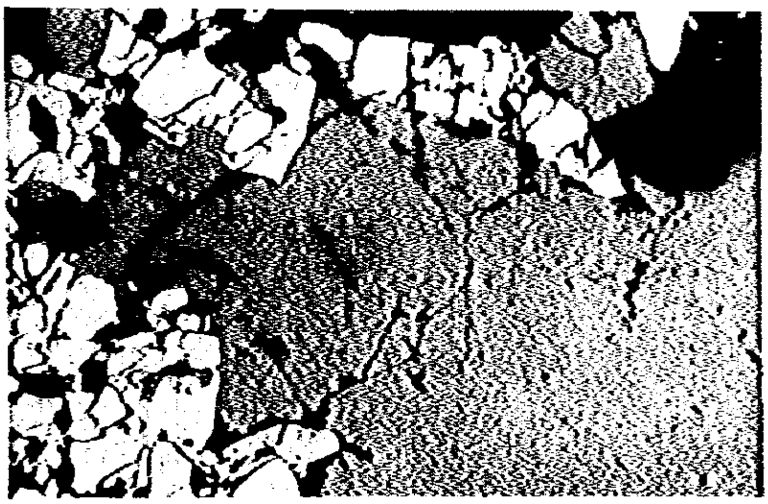


Sample No.: BR-206

Location : Subun-subun

Ores : Magnetite and hematite

0 0.2 mm

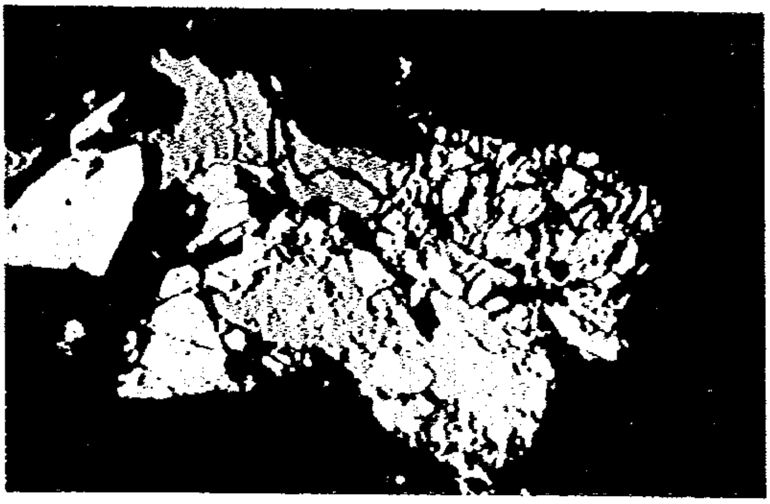


Sample No.: ER-175

Location : Bt Pionggu Adit

Ores : Chalcopyrite dot in sphalerite

0 0.2 mm

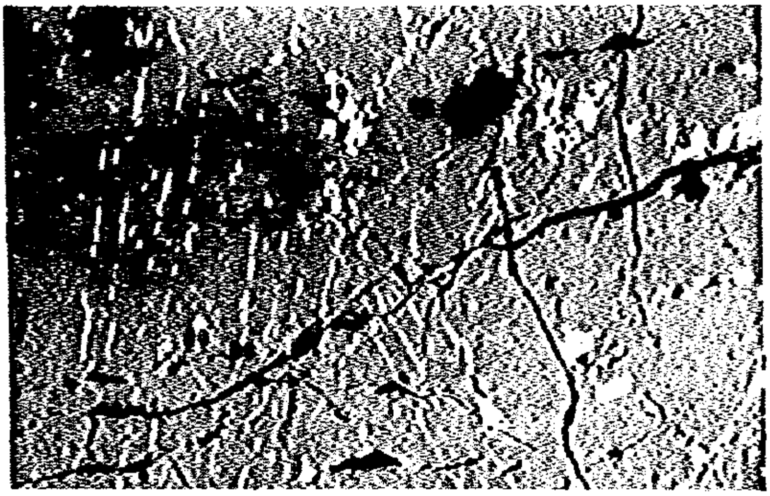


Sample No.: ER-175

Location : Bt Pionggu Adit

Ores : Sphalerite and pyrite

0 0.2 mm



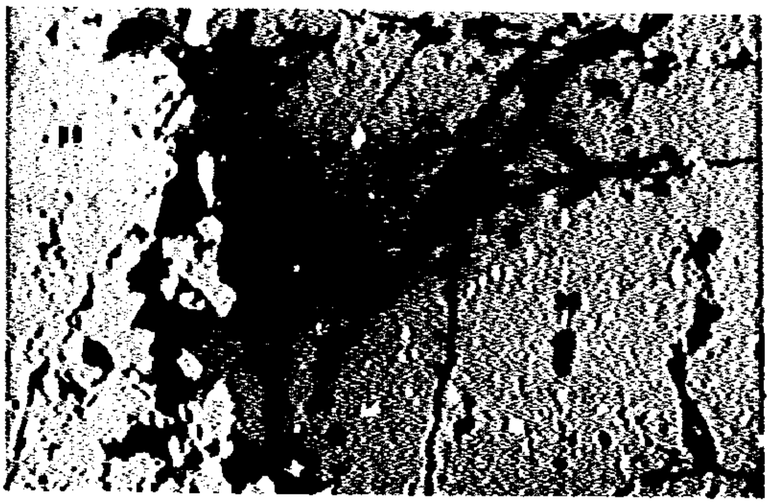
Sample No.: ER-200

Location : Bt Pionggu Adit 1

Ores : Pyrrhotite lammerae in sphalerite

po: pyrrhotite
sp: sphalerite

0 0.2 mm



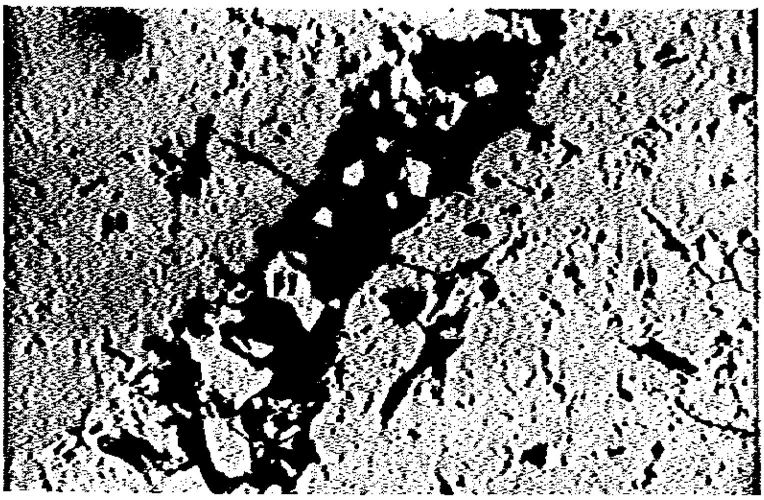
Sample No.: ER-200

Location : Bt Pionggu Adit 1

Ores : Pyrrhotite and chalcopyrite dot in sphalerite

po: pyrrhotite
cp: chalcopyrite
sp: sphalerite

0 0.2 mm



Sample No.: ER-200

Location : Bt Pionggu
Adit 1

Ores : Pyrrhotite and chalcopyrite in pyrite

po: pyrrhotite
cp: chalcopyrite
py: pyrite

0 0.2 mm

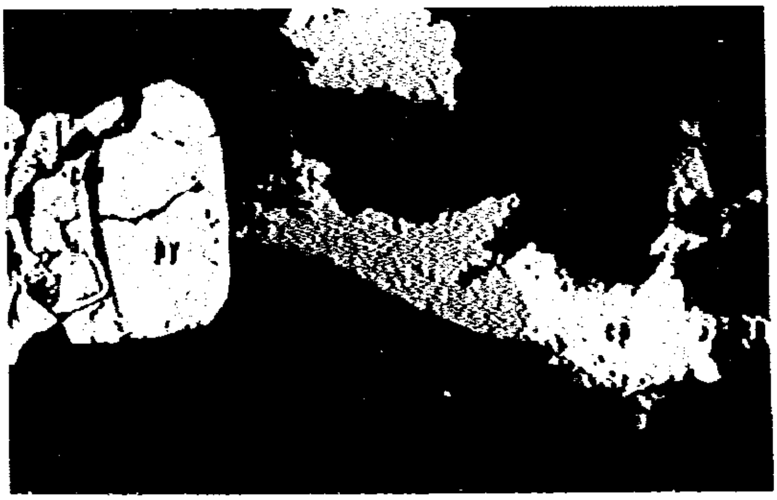
Sample No.: 208A

Location : Bt pionggu

Ores : Chalcopyrite and bornite. Bornite shows lattice texture

cp: chalcopyrite
Bo: bornite

0 0.2 mm



Sample No.: ER-209

Location : Bt Pionggu
Adit A

Ores : Pyrite, covelline and chalcopyrite

cp : chalcopyrite
cov: covelliné
py : pyrite

0 0.2 mm

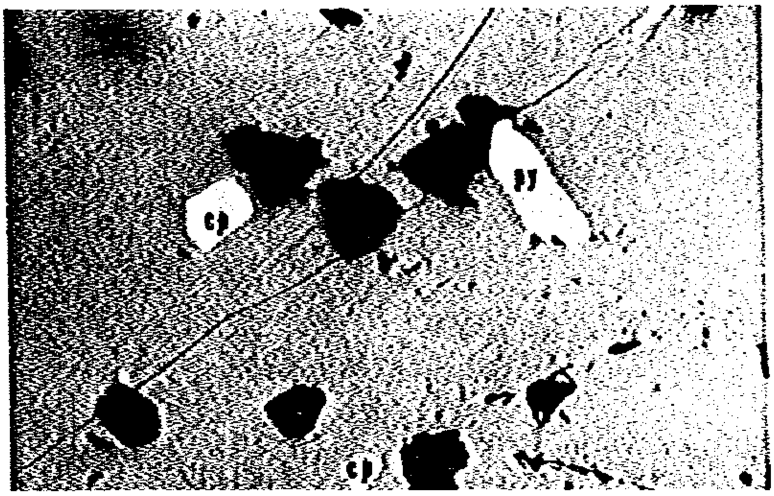
Sample No.: ER-209

Location : Bt Pionggu
Adit A

Ores : Pyrite,
chalcopyrite
and magnetite

mt: magnetite
py: pyrite
ch: chalcopyrite

0 0.2 mm



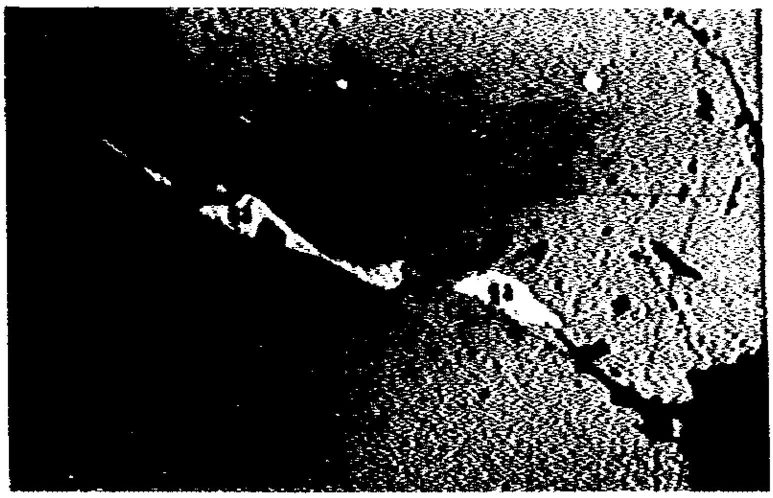
Sample No.: ER-210

Location : Bt Pionggu
Adit A

Ores : Pyrite and
chalcopyrite

py: pyrite
cp: chalcopyrite

0 0.2 mm



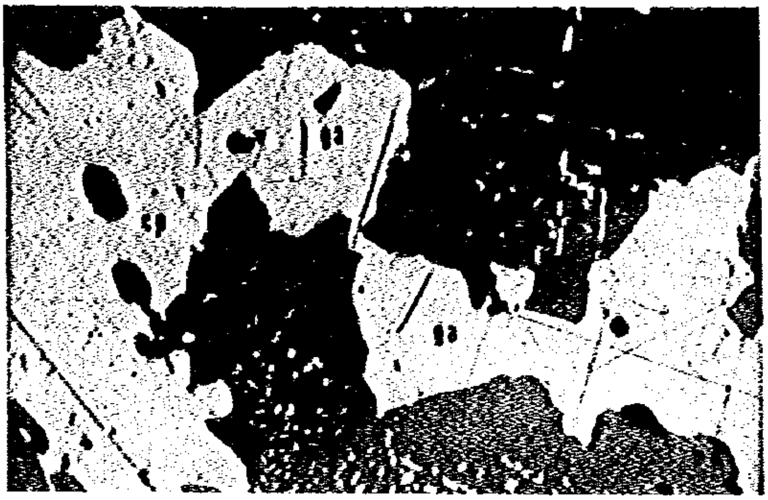
Sample No.: ER-210

Location : Bt Pionggu Adit

Ores : Galena veinlet
and chalcopyrite
dot in sphalerite

ga: galena
cp: chalcopyrite
sp: sphalerite

0 0.2 mm



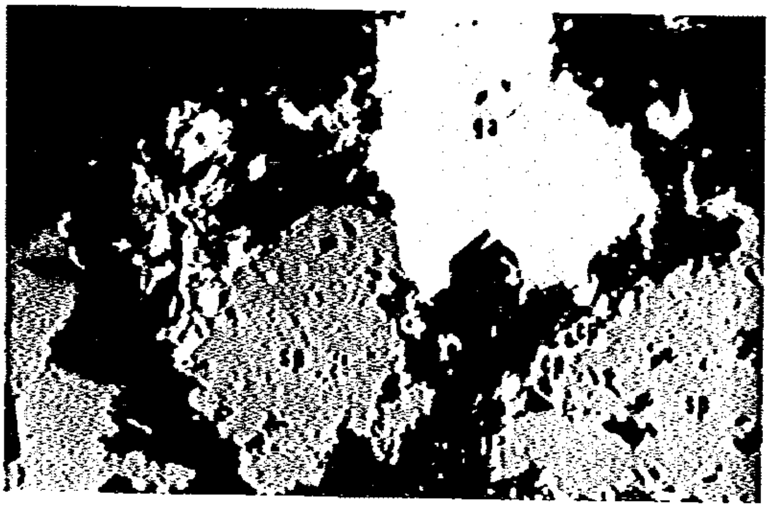
Sample No.: DR-119

Location : Pagar Gunung (outcrop)

Ores : Chalcopyrite and Galena

cp: chalcopyrite
ga: galena

0 0.2 mm



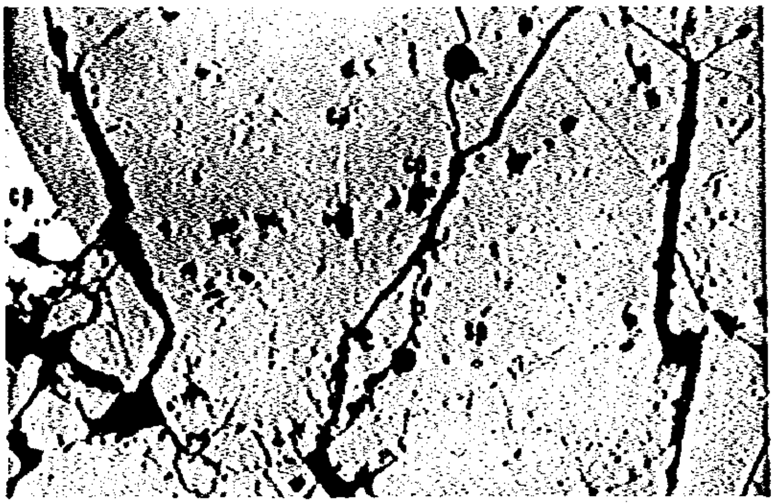
Sample No.: DR-120

Location : Pagar Gunung (outcrop)

Ores : Chalcopyrite, galena and sphalerite

cp: chalcopyrite
ga: galena
sp: sphalerite

0 0.2 mm



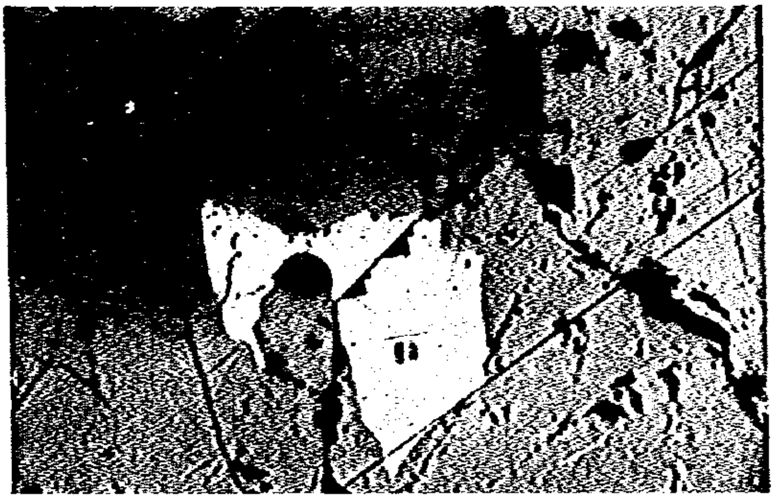
Sample No.: DR-129

Location : Pagar Gunung Adit No. 1

Ores : Chalcopyritespot in sphalerite

cp: chalcopyrite
sp: sphalerite

0 0.2 mm



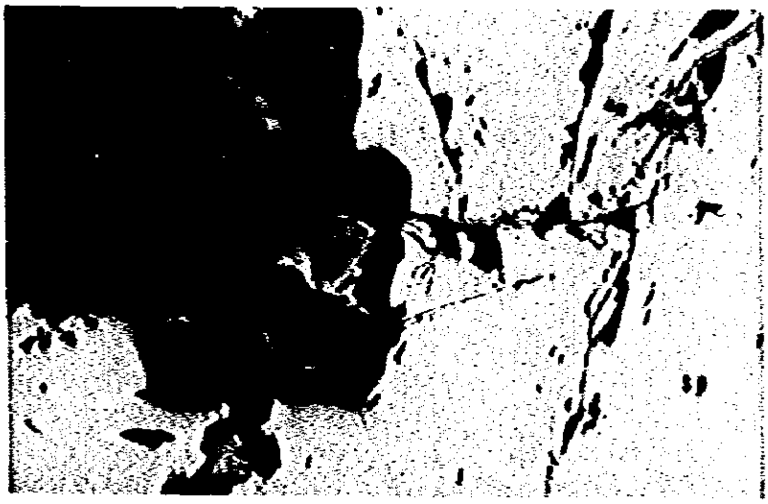
Sample No.: DR-129

Location : Pagar Gunung
Adit No. 1

Ores : Galena and
chalcopyrite dots
in sphalerite

cp: chalcopyrite
ga: galena
sp: sphalerite

0 0.2 mm



Sample No.: DR-131

Location : Pagar Gunung
Adit No. 1

Ores : Sphalerite and
covelline

sp : sphalerite
cov: covelline

0 0.2 mm

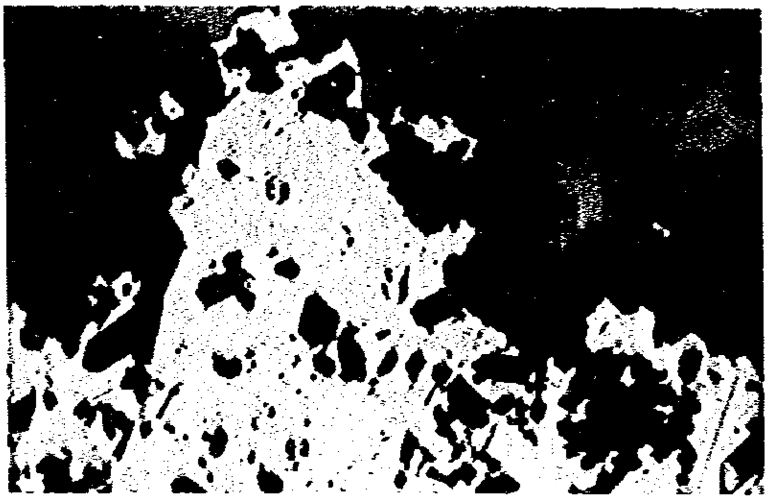
Sample No.: DR-132

Location : Pagar Gunung
Adit No. 1

Ores : Sphalerite and
chalcopyrite,
and pyrite vein

cp: chalcopyrite
sp: sphalerite
py: pyrite

0 0.2 mm



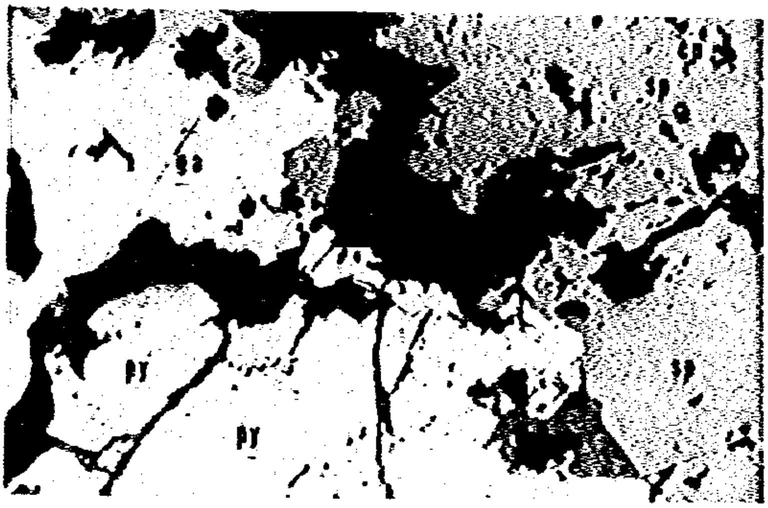
Sample No.: DR-133

Location : Pagar Gunung
Adit No. 1

Ores : Sphalerite, galena and chalcopyrite

sp: sphalerite
ga: galena
cp: chalcopyrite

0 0.2 mm



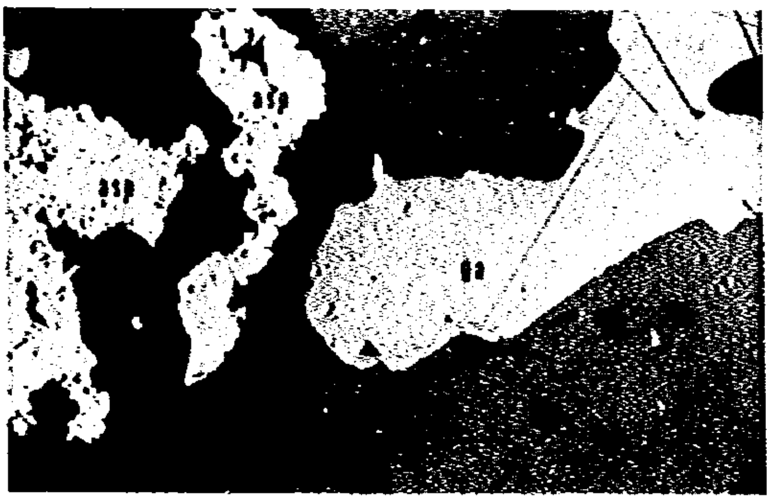
Sample No.: DR-140

Location : Pagar Gunung
Adit No. 6

Ores : Pyrite, sphalerite and chalcopyrite

py: pyrite
sp: sphalerite
ga: galena

0 0.2 mm



Sample No.: DR-141

Location : Pagar Gunung
Adit No. 6

Ores : Arsenopyrite and small amount of chalcopyrite

asp: arsenopyrite
sp : sphalerite
ga : galena
cp : chalcopyrite

0 0.2 mm

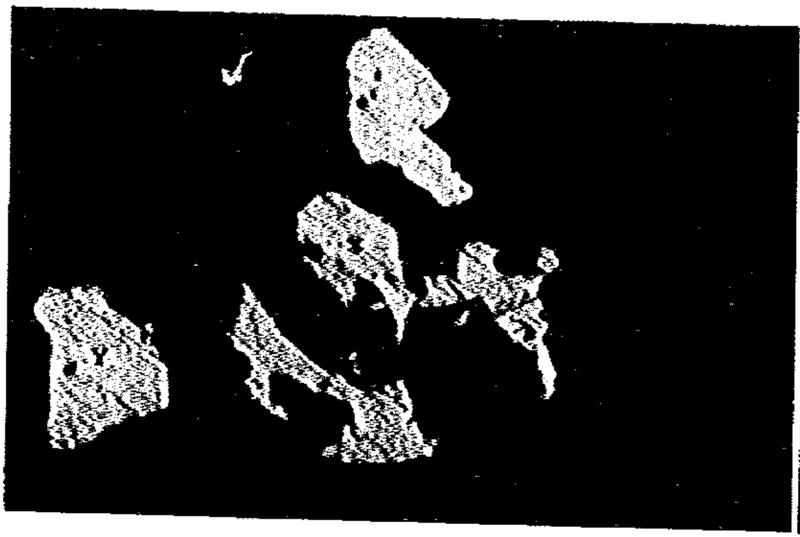
Sample No.: DR-142

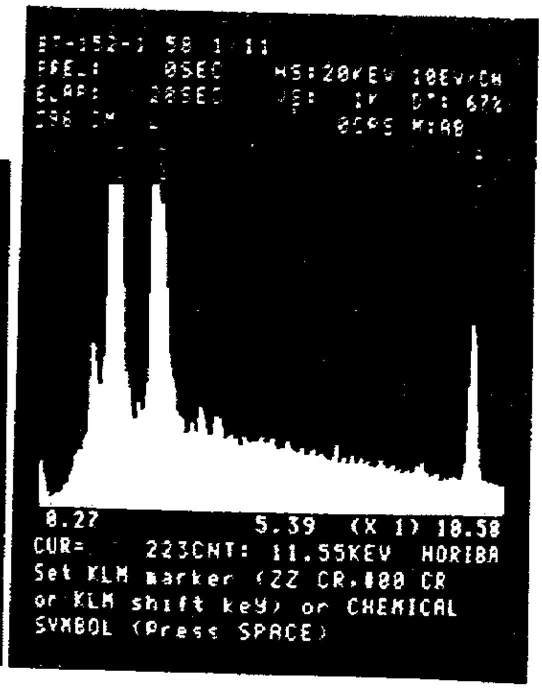
Location : Pagar Gunung
Adit No. 6

Ores : Pyrite, galena and
pyrrhotite

py: pyrite
ga: galena
po: pyrrhotite

0 0.2 mm



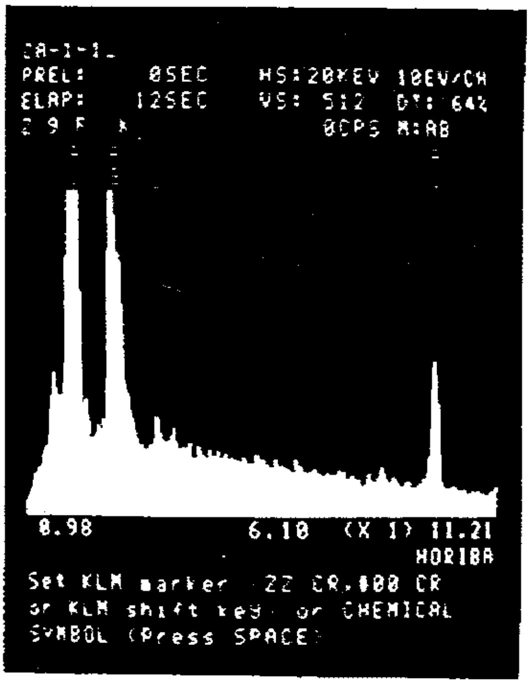


0 0.4 mm

Gold grains

Peak of Au and Ag

Sample BP-152



0 0.4 mm

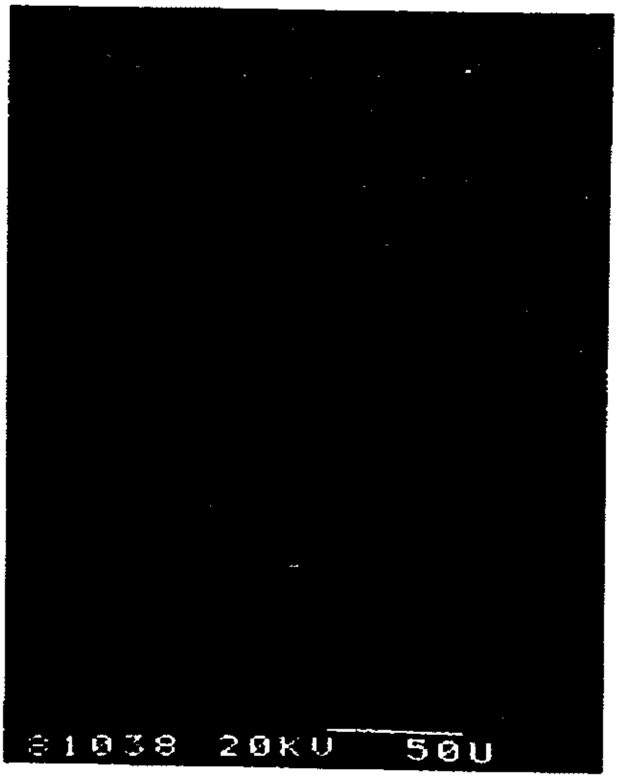
Gold grains

Peak of Au and Ag

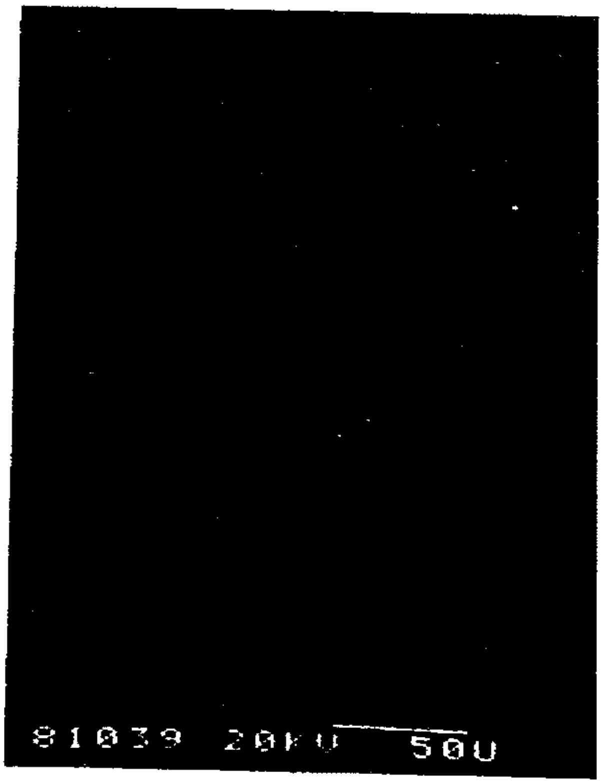
Sample of Hong Muisan of West Kalimantan

Appendix III - 6 Microprobe Test of Placer Golds, Muara Sipongi Area and West Kalimantan

Photograph of Electron Microscope of Gold Grain

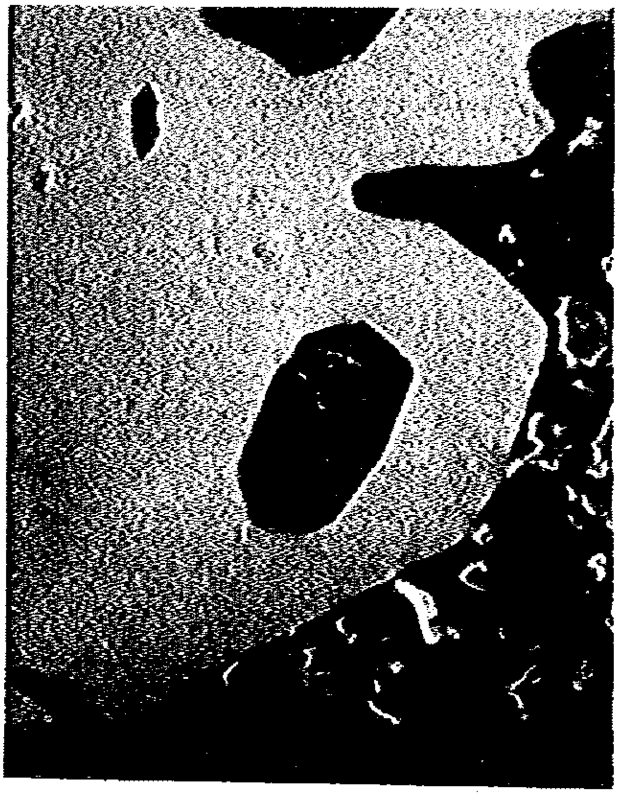


AuLα
Gold Distribution

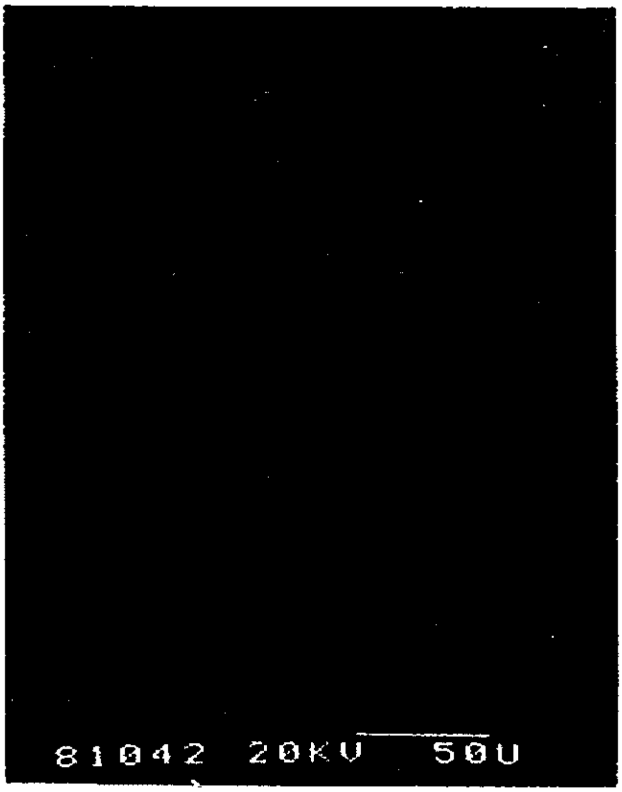


AgLα
Silver Distribution

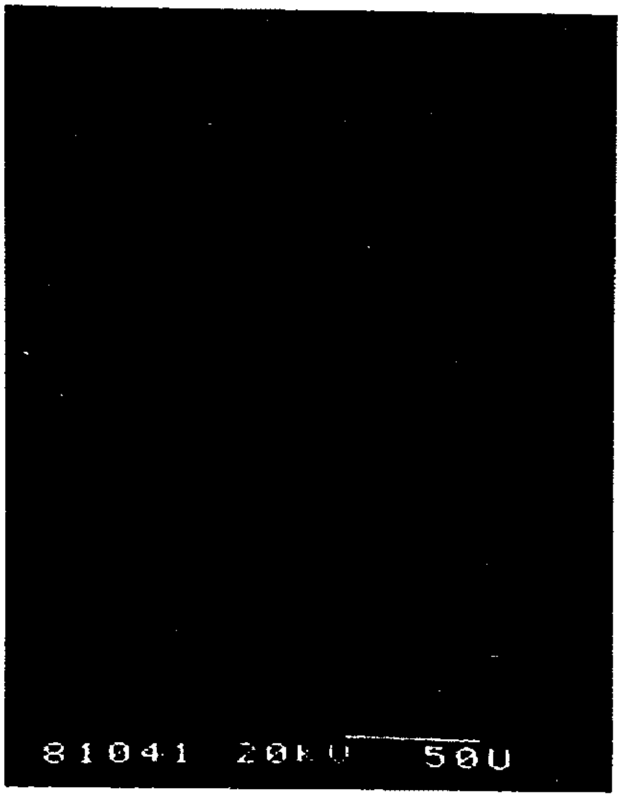
Appendix III - 7 Microprobe Image of Gold (BP-152) Muara Sipongi



Photograph of Electron Microscope of Gold Grain



AuLα
Gold Distribution



AgLα
Silver Distribution

Appendix III - 8 Microprobe Image of Gold (Hong Muisan) West Kalimantan

PART FOUR

PASAMAN AREA

CHAPTER 1 OUTLINE

1-1 Purpose of the Survey

This survey was undertaken to make clear the characteristics of ultrabasic rock distributed in this area, to investigate the cumulating condition of the ultrabasic rock, geological structure, the stage of crystallization of chromite that accompanies the ultrabasic rock, and its location within the rock, and the resource possibilities of this chromite.

1-2 Survey Methods and Quantities

(1) Geological Survey

Since ultrabasic rocks are distributed in the southern part of the study area, in keeping with the study objectives, the geological survey was carried out centering on this area. A photogeological interpretation was applied for a compilation of the geology of the entire area, using airphotos (apx. 1/100,000). A 1/20,000 scale topographical map was brought in the field for this survey and a geological map of scale 1/40,000 was compiled. The survey route of the survey area was in total 103 kilometers.

(2) Chromite Placer Survey

In order to pursue the chromite deposits accompanying the ultrabasic rock, in parallel with the geological survey, a survey was carried out of the chromite placer found among the heavy minerals extracted by panning the river sediments. Panning was conducted along the surveyed rivers at approximately 2 sites per kilometer. Test samples were handled at the Directorate of Mineral Resources in Bandung, concentrating on the chromite.

(3) Other Items

An examination was carried out on ultrabasic rock and chromite. For the study's investigation, microscopic examinations of rock

(25 samples), ore (12 samples), whole rock chemical analysis of 15 rock samples, and ore analysis of 2 samples were conducted. Also, in order to determine the lithography of the ultrabasic rock, electron probe microanalysis was done on the olivine, pyroxene and chromite which it contained.

CHAPTER 2 GEOLOGY

2-1 General Geology

The geology of the study area is made up of the Cretaceous Woyla Group and ultrabasic rock consisting of pelitic schist (or slate and phyllite), green schist, green rock, and limestone. There is also a dorelite dike, and in the extreme southeast section a distribution of Quaternary pyroclastic rock which came from the Talumau Volcano. (PL IV-1)

The generalized stratigraphy, geological structure, and igneous activities in the survey area are summarized in Fig. IV-1.

2-2 Geology

2-2-1 Woyla Group

The Woyla Group distributed in this area consists primarily of sedimentary rock, made up of pelitic rock, limestone, marl, and the green rocks consisting of pyroclastic green schist, green phyllite, and green rock metamorphosed from the basic lava, and pyrocrastic rocks.

(a) Sedimentary Rocks

Distribution: These rocks are distributed widely from the northern to the central part of the survey area. The survey centered on the two rivers Sarigawan River and Simpang Koruh that intersect the general geology perpendicularly. The results showed primarily weakly metamorphosed slate, phyllite, and pelitic limestone, as well as some siliceous schist (sandstone), and limestone.

Rock facies: The pelitic rock formed ranged widely from weakly metamorphosed phyllite to pelitic schist (BR-33), and is yeilded

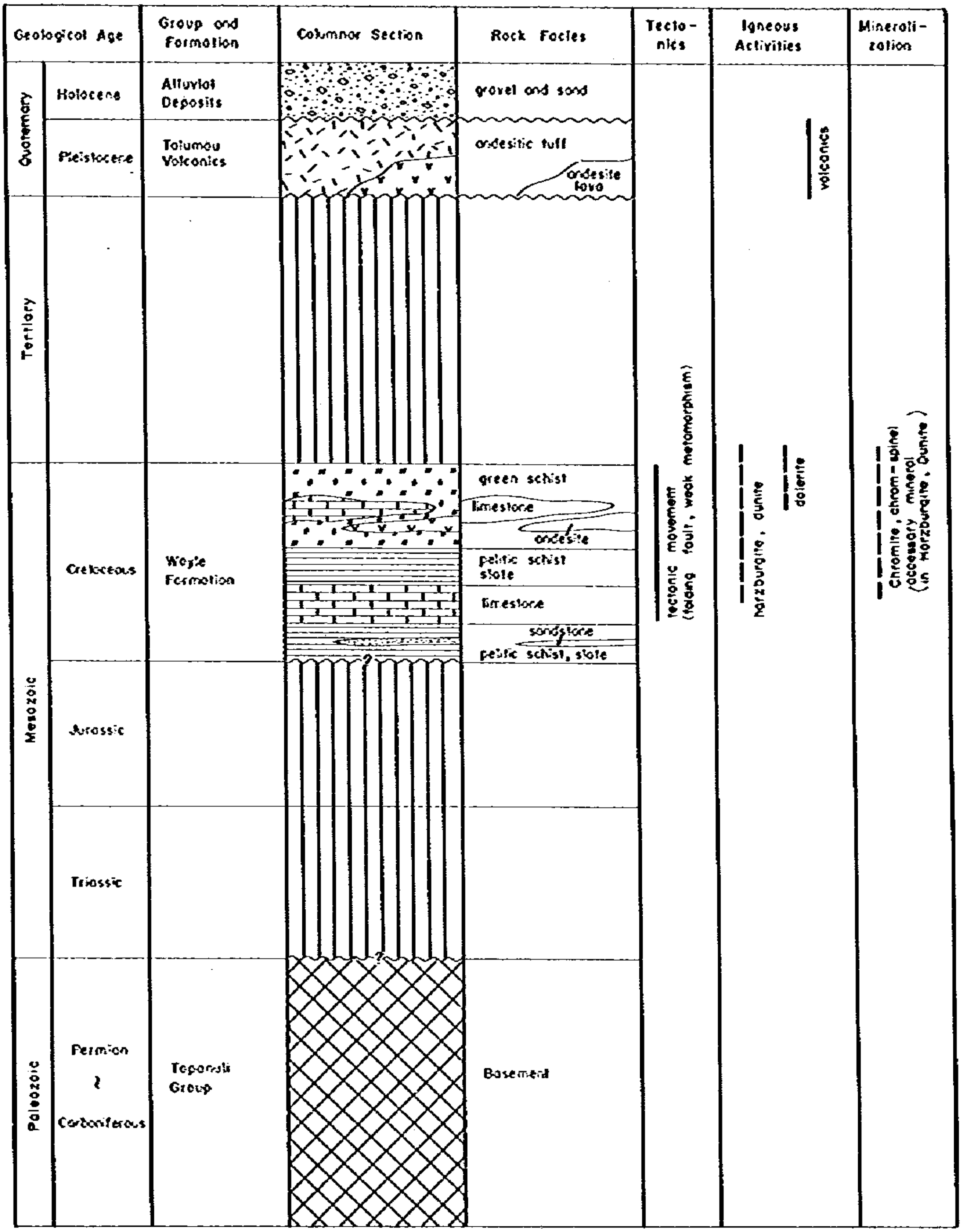


Fig. IV-1 Generalized Stratigraphy of Pasaman Area quartz and sericite with schistose texture under microscopic examination. In contrast to the low metamorphosed phyllite and slate which are primary all along the Saligawan River route, the Simpang Koruh River route, with large mass ultrabasic rock, has widely distributed pelitic schist which tends to show slightly strong metamorphism.

Limestone is found in the pelitic rock strata and also with green schist. It consists of white limestone and marl. Narrow veinlets of calcite usually fill cracks where the limestone has been fractured.

Geological structure: The pelitic rock strata strikes N 70°W, dips 70°NE or SW. The limestone has great resistance against erosion, in comparison with pelitic rock. In photo-geological interpretation the limestone strata showed high mountains and lenticular form.

(b) Green Rock

Distribution: Pale green colored green phyllite and green schist having good schistosity or phyllitic texture are distributed in the area from the Saligawan River to the Simpang Koruh River. Also pale green to gray-green colored green rocks are distributed along the southeast boundary of the ultrabasic rock body.

Rock facies: Generally the pale green to gray green colored green schist stratam are obvious, but sometimes the strata are weakly metamorphosed green phyllite. Under a microscope (BR-48) it shows clearly the schistose texture, showing mineral arrangement. The rock forming minerals consist of sericite, chlorite, quartz, and so on. Also some rocks contain epidote and actinolite.

Geological structures: In massive green rock, pynoxene altered into epidote and actinolite chlorite and altered plagioclase phenocrysts is embedded in a groundmass of clay minerals and altered pyroxene. Under microscopic observation (ER 74), it seems that the rock is pyroxene andesite lava. The Woyla Group has received tectonic movement from the prevalence of the kink bands recognizable in green schist, the cracks and fissures in the limestone, regional metamorphism, and a folding structure. Green schist distributed in the southeast part has good graded bedding. Through an interpretation of the graded bedding from the syncline structure becomes clear.

Stratigraphic correlation: This strata has been correlated with the Cretaceous system by an Indonesian-British cooperative survey.

2-2-2 Ultrabasic Rock

Distribution: The ultrabasic rock distributed in the south part of the survey area is 5 km in width extending 8 km, elongating northwest. Another two small lenticular ultrabasic rocks of about one km in width are distributed at the upper reaches of the Saligawan River and Simpang Koruh Rivers. The distribution of these ultrabasic rocks, especially the northern bodies, was compiled through photographic interpretation.

Rock facies: The ultrabasic rock is homogeneous massive periodotite. Under a microscope it is fresh harzburgite composed of 70% - 90% olivine, 10% - 30% orthopyroxene, and small amounts of clinopyroxene (less than 5%). Also, dunite (BR-57) consisting mostly of olivine occupies a small part of the the harzburgite. The olivine has undergone serpentinization along cracks in it. Orthopyroxene shows a partial bent, indicating probably tectonic fabric. In outcrops faint foliation showing mineral arrangement is observable. The ultrabasic rock distributed in the upper reaches of the Saligawan River has almost all been serpentinized and become serpentine.

Geological structure: The peridotite body along the Lintjik River has obviously been sheared. In field observation brecciated rocks are included in the sheared rock. The breccias are widely ranged in size, from several cm to large outcrop size. The part that was sheared has been almost completely serpentinized showing a green and pale green colored serpentine pattern. In sheared parts where the many shear planes have occured and slickensides are recognizable. The general strike and dip of this shear plane is N 70°W 40°NE. From aerial photograph interpretation eroded parts of peridotite can be observed as the lowlands along the Lintjik River which flows through this ultrabasic rock, indicating the advanced erosion along the sheared zone. From the absence of accidental fragments in the sheared zone it can be interpreted that the ultrabasic rock was sheared and crushed in the process of accretion into its present position.

Accretion period: According to interpretation of tectonic movement in Sumatra by the cooperative survey of the Indonesian-British team, during the Cretaceous period, a marginal basin was formed by spreading in a back arc. Then after the deposition of the Woyla Group the marginal basin was closed again by subduction from the west side. When the marginal basin was being closed, ultrabasic rock was accreted into the Woyla Group. Pasaman ultrabasic rock was also accreted from the mantle layer during this period.

2-2-3 Dolerite Dike

In the southeast of the survey area north of the village of Kapur Putih there is a dolerite dike where the ultrabasic rock and the Woyla Group contact. Under a microscope phenocrysts of pyroxene in the groundmass made up of plagioclase and orthopyroxene can be observed.

2-2-4 Quateranary Talumau Tuff Formation

In the southeast extreme of the survey area a little andesite tuff is distributed. This tuff overlies the Woyla Group and is effusive tuff of the Talumau Volcano.

2-2-5 Quateranary System

Downstream in the main flow area of streams and rivers sediments of unsolidified pebbles and sand are distributed.

CHAPTER 3 GEOCHEMISTRY OF ULTRABASIC ROCK VARIETIES

3-1 Chemical Composition of Ultrabasic Rocks

A whole rock chemical analysis was carried out on 15 samples taken from the ultrabasic rock at predetermined sites to provide an even distribution, in order to examine the chemical composition of this rock. The breakdown was; 13 incidents of harzburgite, 1 of dunite, and 1 of dolerite. These results are shown in Tables IV-1, IV-2.

3-2 Chemical Composition of Rock Forming Minerals in Ultrabasic Rock

Analysis using an electron probe microanalyzer was carried out to detect the chemical composition of rock forming minerals of the ultrabasic rock (peridotite) distributed in this area, namely olivine, orthopyroxene, clinopyroxene, and the chromite (chrome spinel) that accompanies them as accessory minerals. At the same time 4 samples of olivine and pyroxene, and 9 of chromite were selected, polished thin sections prepared, and lithological observation was conducted. Under the microscope one sample (D-57) was dunite while the other eight were all harzbargite. References to the analysis examples of harzburgite and dunite (Coleman 1977) are listed. The main components of SiO_2, FeO, MgO, NiO, and Cr_2O_3 show similar values to the Pasaman harzburgite and dunite.

(a) Olivine

Olivine found in harzburgite is Fo_{91-92}, that found in dunite is Fo 94 with the latter abounding in Forsterite (Table IV-3). Further, it is said that olivine is harzburgite is the so called tectonite ultrabasic rock Fo_{90-92} (Green 1973), or the accumulate type ultrabasic rock Fo_{90-80} (Coleman 1977). If the survey area harzburgite is selected from these it is of the tectonite type.

Table IV-1 Chemical Composition of Ultra Basic Rock in Pasaman Area (A)

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Sample No.	BR-38	BR-74	BR-76	DR-36	DR-40	DR-41	DR-45	DR-50	DR-54	ER-61	ER-67	ER-111	FR-107	DR-57	FR-101
	Location	S.Kanan	Branch of A.Lincjik	Branch of A.Lincjik	Branch of A.Lincjik	Branch of A.Lincjik	A.Lincjik	G.Tongar	Branch of A.Lincjik	G.Tongar	B.Pasaman	Branch of B.Pasaman	A.Lumpa-tan	S.Sangan	Branch of A.Lincjik	A.Karata putih
	Rock Name	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Dunite	Dolerite
Chemical Composition	SiO_2 %	43.54	42.76	41.83	42.45	43.01	43.49	41.68	40.75	42.25	42.24	42.34	43.01	42.93	36.95	50.76
	Al_2O_3 %	0.89	0.11	0.40	0.22	0.80	1.05	0.10	0.40	0.13	0.93	0.67	0.58	0.97	0.03	10.31
	CaO %	1.21	0.82	0.87	0.85	1.37	2.17	0.97	2.16	0.73	2.36	1.75	0.99	2.19	0.23	10.55
	MgO %	39.91	42.82	42.16	41.92	40.34	37.84	39.66	40.11	40.66	38.88	37.97	39.53	37.08	43.97	9.26
	Na_2O %	0.11	0.03	0.03	0.02	0.02	0.43	0.01	0.02	0.02	0.09	0.30	0.01	0.10	0.03	1.37
	K_2O %	0.02	0.02	0.03	0.02	0.02	0.01	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.03	3.30
	Fe_2O_3 %	0.99	1.91	1.38	0.94	0.74	0.78	1.63	1.54	1.62	0.82	0.92	0.86	1.87	2.50	3.71
	FeO %	6.77	5.76	6.41	6.98	6.77	6.34	6.19	6.19	6.05	7.20	6.62	6.62	6.05	3.38	6.41
	MnO %	0.15	0.13	0.13	0.15	0.14	0.14	0.14	0.17	0.14	0.16	0.13	0.13	0.13	0.08	0.18
	TiO_2 %	0.01	0.01	0.05	0.01	0.02	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.01	0.08	0.35
	P_2O_5 %	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.33
	BaO %	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.07
	LOI %	3.19	4.72	3.96	2.38	2.83	3.72	5.44	5.07	4.64	2.94	3.98	2.22	4.25	10.85	2.26
	Total	96.82	99.12	97.29	95.97	96.09	96.01	95.88	96.48	96.31	95.7	94.74	94.01	95.63	98.17	98.86
	Cr ppm	1280	1220	1440	1140	1920	3400	1080	2000	1260	2900	1840	1560	3200	345	560
	Ni ppm	1930	1950	2000	2050	1900	1720	1950	1880	1780	1900	1830	1800	1650	2300	143
	V ppm	75	50	50	50	25	50	25	50	25	75	25	25	75	25	325
	Co ppm	96	92	90	97	88	80	93	87	79	85	80	80	82	86	18
	Pt ppb	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50
	Pd ppb	<10	<10	<10	<10	<10	<10	10	<10	<10	10	<10	<10	10	<10	10
	Au ppb	5	75	20	230	55	35	25	15	550	550	30	750	55	1050	5
	MgO/MgO+FeO	0.85	0.88	0.87	0.86	0.86	0.86	0.87	0.87	0.87	0.84	0.85	0.86	0.86	0.93	0.59

Table IV-2 Chemical Composition of Ultra Basic Rock in Pasaman Area (B)

	1	2	3	4	5	6	7	8	9	10	11	12	13		(1)	(2)	14	(1)
Sample No.	BR-38	BR-74	BR-76	DR-36	DR-40	DR-41	DR-45	DR-50	DR-54	ER-61	ER-67	ER-111	FR-107	Average	USGS	New-Caledonia	DR-57	USGS
Location	S.Kanan	Branch of A.Lintjik	Branch of A.Lintjik	Branch of A.Lintjik	Branch of A.Lintjik	A.Lintjik	G.Tangar	Branch of A.Lintjik	G.Tangar	B.Pasaman	Branch of B.Pasaman	A.Lumpa-tan	S.Sangan				Branch of A.Lintjik	
Rock Name	Harzburgite	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Harzb.	Dunite	Dunite
SiO_2	46.30	45.11	44.62	45.16	45.88	46.77	45.89	44.34	45.90	45.23	46.41	46.64	46.65	45.76	44.0	43.9	42.17	40.5
TiO_2	0.01	0.01	0.05	0.01	0.02	0.01	0.01	0.02	0.02	0.02	0.01	0.01	0.01	0.02	0.016	0.07	0.09	0.013
Al_2O_3	0.95	0.12	0.43	0.23	0.85	1.23	0.11	0.44	0.14	1.00	0.73	0.63	1.05	0.61	0.78	1.1	0.03	0.24
Fe_2O_3	1.05	2.01	1.47	1.00	0.79	0.84	1.79	1.68	1.76	0.88	1.01	0.93	2.03	1.33	3.00	1.3	2.85	1.21
FeO	7.20	6.08	6.84	7.43	7.22	6.82	6.82	6.73	6.57	7.71	7.26	7.18	6.57	6.96	5.50	6.8	3.86	7.23
MnO	0.16	0.14	0.14	0.16	0.15	0.15	0.15	0.18	0.15	0.17	0.14	0.14	0.14	0.15	0.13	0.01	0.09	0.11
MgO	42.44	45.17	44.97	44.60	43.03	40.70	43.67	43.64	44.17	41.63	41.67	42.86	40.29	42.99	45.3	45.2	50.18	49.80
CaO	1.29	0.86	0.93	0.90	1.46	2.33	10.7	2.35	0.79	2.53	1.92	1.07	2.38	2.27	0.5	0.59	0.26	0.15
Na_2O	0.12	0.03	0.03	0.02	0.02	0.46	0.01	0.02	0.02	0.10	0.33	0.01	0.11	0.10	0.006	0.13	0.03	0.007
K_2O	0.02	0.02	0.03	0.02	0.02	0.01	0.02	0.02	0.02	0.03	0.02	0.02	0.02	0.02	0.004	0.01	0.03	0.0012
Cr_2O_3	0.20	0.19	0.22	0.18	0.30	0.54	0.18	0.32	0.20	0.45	0.30	0.25	0.51	0.30	0.42	0.41	0.33	0.58
NiO	0.27	0.26	0.27	0.28	0.26	0.24	0.28	0.26	0.25	0.26	0.25	0.25	0.23	0.26	0.31	0.54	0.06	0.29
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
MgO/MgO+FeO	0.85	0.88	0.87	0.86	0.86	0.86	0.86	0.87	0.87	0.84	0.85	0.86	0.86	0.86	0.89	0.87	0.93	0.87

LOI: Deleted from analysis and then normalized

(1) Cazadero, Pecli U.S.G.S. standard from Coleman 1977.

(2) New Caledonia 4 Harzburgite, Rodgers (1975) from Coleman 1977.

Table IV-3 Electron Microprobe Analysis of Olivine, Pasaman Area

Element \ Sample No.	DR-36		DR-40		DR-50		ER-111		DR-57	
SiO_2	40.84%	40.94%	40.66%	40.52%	40.78%	40.76%	40.69%	40.99%	41.72%	41.38%
Al_2O_3	0.02	0.00	0.01	0.02		0.01				0.00
TiO_2	0.00	0.01			0.00	0.04	0.01		0.03	0.00
FeO	8.70	8.45	8.81	8.97	8.06	8.36	7.79	8.12	6.13	6.10
MnO	0.13	0.16	0.07	0.14	0.16	0.18	0.14	0.12	0.05	0.11
MgO	50.11	50.41	50.39	50.39	50.74	50.80	50.57	50.49	52.84	52.02
CaO	0.03	0.02		0.03	0.00		0.01	0.01	0.08	0.10
Na_2O		0.00		0.02	0.01		0.01	0.00	0.00	0.00
K_2O	0.00		0.00	0.00	0.00	0.01				
NiO	0.37	0.33	0.42	0.44	0.45	0.47	0.37	0.43	0.44	0.43
Cr_2O_3			0.00	0.02	0.00	0.00		0.01	0.06	0.01
V_2O_3		0.00	0.02	0.01			0.03	0.00		
Total	100.20	100.32	100.40	100.56	100.19	100.64	99.63	100.17	101.36	100.17
Oxygen =	4									
Si	0.995	0.995	0.990	0.987	0.992	0.989	0.994	..997	0.994	0.997
Al	0.001	0.000	0.000	0.001		0.000				0.000
Ti	0.000	0.000			0.000	0.001	0.000		0.000	0.000
Fe	0.177	0.172	0.179	0.183	0.164	0.170	0.159	0.165	0.122	0.123
Mn	0.003	0.003	0.001	0.003	0.003	0.004	0.003	0.003	0.001	0.002
Mg	1.821	1.827	1.829	1.829	1.840	1.837	1.841	1.830	1.876	1.869
Ca	0.001	0.001		0.001	0.000		0.000	0.000	0.002	0.003
Na		0.000		0.001	0.000		0.000	0.000	0.000	0.000
K	0.000		0.000	0.000	0.000	0.000				
Ni	0.007	0.006	0.008	0.009	0.009	0.009	0.007	0.008	0.008	0.008
Cr			0.000	0.000	0.000	0.000		0.000	0.001	0.000
V		0.000	0.000	0.000			0.001	0.000		
Total	3.004	3.005	3.010	3.013	3.008	3.010	3.006	3.003	3.005	3.003
Fe/Fe+Mg	0.089	0.086	0.089	0.091	0.082	0.084	0.080	0.083	0.061	0.062
Forsterite content	91	91	91	91	92	92	92	92	94	94

Table IV-4 Electron Microprobe Analysis of Orthpyroxene, Pasaman Area

Sample No. / Element	DR-36		DR-40		DR-50		ER-111	
SiO_2	56.50%	56.26%	55.84%	56.45%	56.13%	56.52%	56.53%	56.66%
Al_2O_3	1.95	1.91	2.38	1.89	2.20	2.32	2.38	2.57
TiO_2	0.01	0.00	0.00	0.05	0.02	0.03	0.01	0.05
FeO	5.71	5.54	5.59	5.61	5.56	5.84	5.62	5.35
MnO	0.19	0.17	0.09	0.14	0.13	0.11	0.13	0.18
MgO	34.40	34.24	34.17	34.51	34.46	34.55	34.74	34.27
CaO	0.74	0.65	0.49	0.41	0.63	0.51	0.55	1.39
Na_2O	0.02	0.03	0.01	0.00	0.02	0.00	0.02	
K_2O	0.01			0.00	0.01	0.02	0.02	0.01
NiO	0.13	0.08	0.12	0.08	0.03	0.10	0.11	0.10
Cr_2O_3	0.76	0.72	0.48	0.33	0.44	0.31	0.59	0.73
V_2O_3	0.04	0.00	0.00	0.02	0.05			0.03
Total	100.46	99.61	99.16	99.49	99.67	100.29	100.70	101.34
Oxygen =	6							
Si	1.942	1.947	1.939	1.952	1.940	1.942	1.935	1.930
Al	0.079	0.078	0.097	0.077	0.090	0.094	0.096	0.103
Ti	0.000	0.000	0.000	0.001	0.001	0.001	0.000	0.001
Fe	0.164	0.160	0.162	0.162	0.161	0.168	0.161	0.152
Mn	0.006	0.005	0.003	0.004	0.004	0.003	0.004	0.005
Mg	1.763	1.766	1.769	1.779	1.775	1.769	1.773	1.740
Ca	0.027	0.024	0.018	0.015	0.023	0.019	0.020	0.051
Na	0.001	0.002	0.001	0.000	0.001	0.000	0.001	
K	0.000			0.000	0.000	0.001	0.001	0.000
Ni	0.004	0.002	0.003	0.002	0.001	0.003	0.003	0.003
Cr	0.021	0.020	0.013	0.009	0.012	0.008	0.016	0.020
V	0.001	0.000	0.000	0.001	0.001			0.001
Total	4.008	4.005	4.006	4.003	4.009	4.007	4.010	4.007
Fe/Fe+Mg	0.085	0.083	0.084	0.084	0.083	0.087	0.083	0.081
$K \frac{opx-cpx}{Fe-Mg}$	1.22	1.44	1.60	1.48	1.32	1.39	1.35	1.45
Temperature C°	815	710	650	690	760	730	750	700
	760		675		745		725	

Table IV-5 Electron Microprobe Analysis of Clinopyroxene, Pasaman Area

Sample No. / Element	DR-36				DR-40		DR-50		ER-111	
SiO_2	53.90%	52.12%	54.45%	54.17%	54.39%	53.96%	54.22%	54.18%	54.22%	54.02%
Al_2O_3	2.00	1.70	1.80	2.02	1.72	2.00	2.30	2.37	1.97	2.58
TiO_2	0.04	0.04	0.03	0.01	0.06	0.04	0.05	0.07	0.08	0.05
FeO	2.39	2.23	1.96	2.19	1.82	1.95	2.18	2.13	2.12	2.02
MnO	0.10	0.05	0.11	0.11	0.09	0.08	0.09	0.07	0.09	0.10
MgO	17.69	19.85	17.49	17.58	17.78	17.75	17.80	17.49	17.63	18.75
CaO	23.51	20.68	24.37	24.09	24.62	24.36	23.55	24.16	24.17	23.02
Na_2O	0.23	0.20	0.19	0.21	0.08	0.10	0.01	0.04	0.10	0.12
K_2O	0.01		0.01	0.00		0.01			0.03	0.01
NiO	0.08		0.05	0.03	0.01	0.01	0.10	0.10	0.05	0.05
Cr_2O_3	0.83	0.77	0.76	0.86	0.38	0.52	0.51	0.58	0.66	0.98
V_2O_3	0.02	0.00	0.05	0.02	0.01	0.05	0.02	0.02	0.03	0.02
Total	100.79	97.64	101.27	101.29	100.96	100.81	100.84	101.21	101.14	101.73
Oxygen =	6									
Si	1.944	1.929	1.953	1.945	1.955	1.944	1.948	1.943	1.948	1.924
Al	0.085	0.074	0.076	0.085	0.073	0.085	0.097	0.100	0.083	0.108
Ti	0.001	0.001	0.001	0.000	0.002	0.001	0.001	0.002	0.002	0.001
Fe	0.072	0.069	0.059	0.066	0.055	0.059	0.065	0.064	0.064	0.060
Mn	0.003	0.001	0.003	0.003	0.003	0.002	0.003	0.002	0.003	0.003
Mg	0.951	1.095	0.936	0.941	0.953	0.953	0.954	0.935	0.944	0.996
Ca	0.909	0.820	0.937	0.927	0.948	0.940	0.907	0.929	0.930	0.878
Na	0.016	0.014	0.013	0.015	0.006	0.007	0.001	0.003	0.007	0.008
K	0.001		0.000	0.000		0.001			0.001	0.001
Ni	0.002		0.001	0.001	0.000	0.000	0.003	0.003	0.001	0.001
Cr	0.024	0.022	0.021	0.025	0.011	0.015	0.015	0.016	0.019	0.028
V	0.000	0.000	0.001	0.001	0.000	0.001	0.000	0.000	0.001	0.001
Total	4.008	4.028	4.003	4.007	4.005	4.008	3.994	3.998	4.003	4.010
Fe/Fe+Mg	0.070	0.059	0.059	0.065	0.054	0.058	0.064	0.064	0.063	0.057

Table IV-6 Electron Microprobe Analysis of Chromite, Pasaman Area

Element \ Sample No.	DR-36		DR-40		DR-50		ER-111		DR-57		DR-41		DR-45		FR-105		DR-54	
SiO_2	0.05	0.04	0.04	0.05	0.07	0.11	0.05	0.05	0.04	0.05	0.07	0.04	0.11	0.08	0.02	0.03	0.06	0.05
Al_2O_3	27.23	22.82	36.62	36.58	41.24	35.94	30.22	30.05	17.72	17.83	33.18	35.19	19.21	18.80	30.53	32.01	20.61	20.59
TiO_2	0.08	0.06	0.06	0.03		0.02	0.09	0.06	0.14	0.16		0.09	0.06	0.08	0.04	0.05	0.08	0.09
Fe_2O_3																		
FeO	19.10	19.98	15.60	15.27	15.36	16.10	16.07	15.82	15.80	15.72	15.85	15.68	22.23	21.30	15.51	15.45	18.70	18.09
MnO	0.19	0.26	0.18	0.14	0.18	0.19	0.14	0.17	0.31	0.22	0.18	0.19	0.36	0.34	0.18	0.16	0.28	0.24
MgO	13.17	11.66	15.25	15.22	15.42	14.92	14.43	14.36	13.81	14.11	14.81	15.13	9.21	9.57	14.32	14.54	11.66	11.64
CaO		0.02		0.00	0.04		0.00	0.00		0.02	0.02		0.02	0.01		0.01	0.01	0.00
Na_2O	0.02	0.00	0.01			0.00	0.00	0.04			0.01	0.03	0.01			0.00	0.00	
K_2O	0.01	0.01		0.01	0.02	0.02	0.00		0.00			0.01	0.01	0.02		0.01		0.01
NiO	0.10	0.06	0.19	0.18	0.10	0.12	0.10	0.09	0.09	0.14	0.21	0.28	0.14	0.15	0.17	0.15	0.17	0.18
Cr_2O_3	39.63	44.07	31.91	32.37	27.17	32.43	38.12	39.48	51.63	51.69	35.11	33.61	47.04	48.52	38.60	37.75	47.87	47.72
V_2O_3	0.27	0.26	0.17	0.17	0.20	0.18	0.18	0.15	0.13	0.14	0.14	0.22	0.31	0.32	0.16	0.15	0.24	0.27
Total	99.85	99.22	100.04	100.02	99.80	100.03	99.41	100.27	99.68	100.10	99.58	100.46	98.70	99.19	99.53	100.32	99.66	98.89
Oxygen =	4												4					
Si	0.001	0.001	0.001	0.001	0.002	0.003	0.001	0.001	0.001	0.002	0.002	0.001	0.004	0.003	0.001	0.001	0.002	0.002
Al	0.976	0.844	1.241	1.239	1.373	1.224	1.061	1.048	0.657	0.657	1.148	1.197	0.735	0.715	1.069	1.105	0.764	0.768
Ti	0.002	0.001	0.001	0.001		0.000	0.002	0.001	0.003	0.004		0.002	0.001	0.002	0.001	0.001	0.002	0.002
Fe_2O_3																		
Fe	0.486	0.524	0.375	0.367	0.363	0.389	0.401	0.391	0.416	0.411	0.389	0.378	0.604	0.575	0.385	0.378	0.492	0.479
Mn	0.005	0.007	0.004	0.003	0.004	0.005	0.004	0.004	0.008	0.006	0.005	0.005	0.010	0.009	0.005	0.004	0.007	0.007
Mg	0.597	0.545	0.654	0.653	0.649	0.643	0.641	0.633	0.648	0.658	0.648	0.651	0.446	0.460	0.634	0.635	0.547	0.549
Ca		0.001		0.000	0.001		0.000	0.000		0.001	0.001		0.001	0.000		0.000	0.000	0.000
Na	0.001	0.000	0.001			0.000	0.000	0.002			0.001	0.002	0.001			0.000	0.000	
K	0.000	0.000		0.000	0.001	0.001	0.000		0.000			0.000	0.000	0.001		0.000		0.000
Ni	0.002	0.001	0.004	0.004	0.002	0.003	0.002	0.002	0.002	0.004	0.005	0.006	0.004	0.004	0.004	0.004	0.004	0.005
Cr	0.953	1.093	0.726	0.736	0.607	0.741	0.898	0.923	1.284	1.279	0.815	0.767	1.207	1.238	0.907	0.874	1.191	1.194
V	0.006	0.007	0.004	0.004	0.005	0.004	0.004	0.003	0.003	0.004	0.003	0.005	0.008	0.008	0.004	0.004	0.006	0.007
Total	3.030	3.026	3.012	3.009	3.006	3.012	3.015	3.011	3.023	3.025	3.015	3.014	3.020	3.015	3.009	3.007	3.016	3.012
Fe/Fe+Mg	0.449	0.490	0.365	0.360	0.359	0.377	0.384	0.382	0.391	0.385	0.375	0.36	0.575	0.555	0.378	0.373	0.474	0.466
Fe/Fe+Al	1.999					0.001	3.019	3.021	3.019		76.000	82.00	1.999					0.001

Table IV-7 Characteristic of Ultramafic rock

	Upper mantle origin	Cummulative rock origin
Rock	lherzolite, harzburgite peridotite-websterite, websterite (dunite) (wehrlite) no gradual variation between Peridotite and Pynoxenite	Peridotite-clinopyroxenite Pxroxenite wehrlite hurzburgite lhrzolite (peridofite-websterite) (websterite) gradual variation from Peridotite to Pyroxenite, and also to mafic rock
Rock-forming Minerals	Olivine Onthopynoxene Clinopxroxone chromespinel (pargasite) (plagioclase)	Clinopyroxene Olivine Orthopyroxene chromespinel spinel, (Kaersutite) (Ti-phlogepite) (parnet)
Texture	tectonite texture, recrystalization texture, exsolution texture	Cummulative texture, exsolution texture, (tectonite texture) (catacrasfic texture)
Chenical Composition of Rock-forming Mineral		
Olivine	Fo 92 ∿ 87	Fo 90 ∿ 65
Opx	En 91 ∿ 87 poor content of Ti, Ca, Al	En 90 ∿ 75 rich content of Ti, Ca, Al, Fe
Cpx	rich content of Cr, Mg and poor content of Ti, Al	rich content of Ti, Al, Fe poor content of Cr
Spinel	rich content of Cr, Al	rich content of Fe, Al poor content of Cr

( ): rare rock, nineral and texture

from Chikyu Kagaku Vol. 3 Iwanami Shoten p.56 (K. Aoki)

(b) Orthopyroxene, Clinopyroxene

According to the analysis results of orthopyroxene its component is En $_{91-92}$ (Table IV-4, 5). A geothermometer was used to calculate the partition of iron and magnesia in orthopyroxene and clinopyroxene (Mori and Banno 1973). According to this calculation is 1.22 - 1.60 which converted to $K \frac{OPX-CPX}{Fe-Mg}$ degrees celsius is 650°C to 750°C. This value is practically the same for harzburgite accreted in tectonic zones throughout the world. Further, in this connection the comparisons of the iron, magnesia, and lime in orthopyroxene are projected onto a triangle diagram shown in Fig. IV-31.

(c) Chromite, Chromium Spinel

The results of the analysis of the 9 samples of the chromite or chrome spinel found usually as an accessory mineral in harzburgite and dunite are shown in Table IV-6. In general, the chromium mineral accompanying harzburgite as an accessory abounds in Al_2O_3 but is low in Cr_2O_3, and is the so-called chromium spinel. The chromium mineral accompanying the harzburgite in this area also is high in Al_2O_3 20% - 40% but relatively low in Cr_2O_3 27% - 47%. In this range it should be labelled chromium spinel. The chromite accompanying dunite is Al_2O_3 17%, Cr_2O_3 51% so it should be labelled chromite. For reference a triangle diagram of Cr_2O_3 : Al_2O_3 : (Mg, Fe)O is shown in Figure IV-2. When prospecting for chromite ore as a natural resource, dunite rather than harzburgite should be sought out. In reference to the chromitite resources of the world, chromitite is usually emplaced in dunite, but is rarely embedded in harzburgite.

3-3 Division of Trace Minerals

There is vanagium (25 ppm - 75 ppm) and cobalt (79 ppm - 97 ppm) in the harzburgite, without any unusual contents. Platinum was less than 50 ppb in the harzburgite.

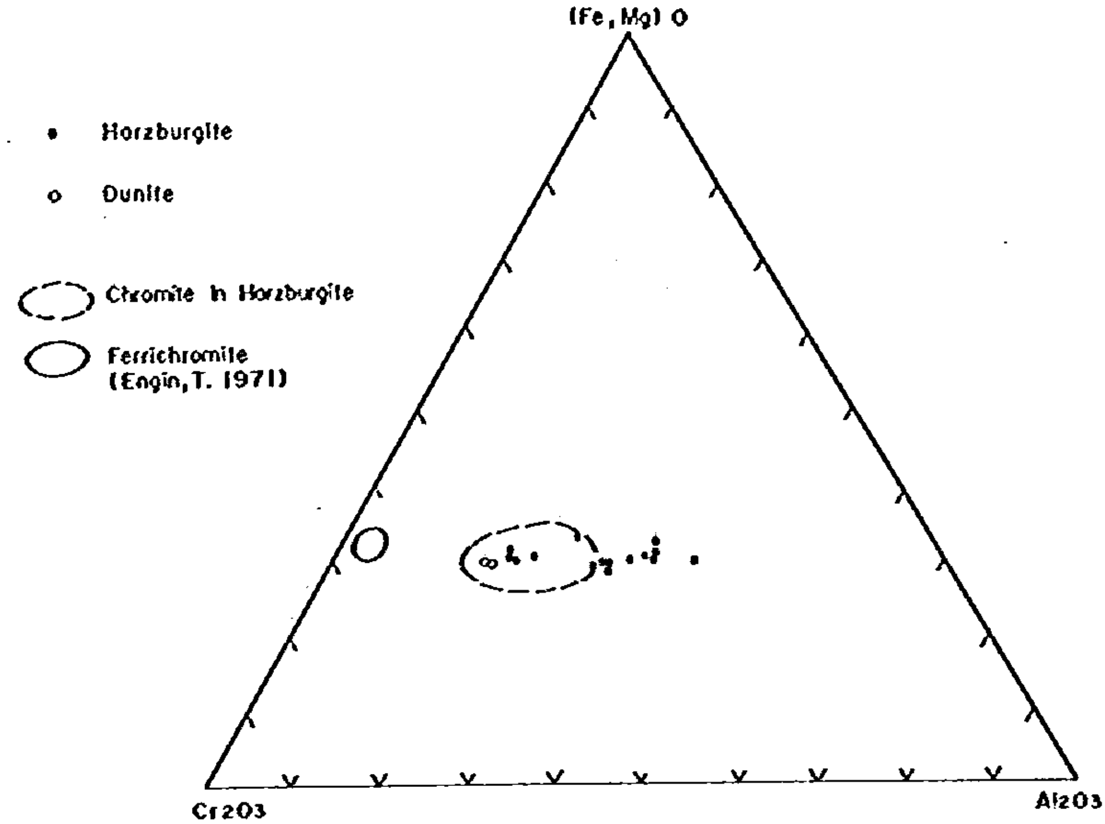


Fig. IV-2 Composition of Chrom-Spinel in Pasaman Harzburgite and Dunite

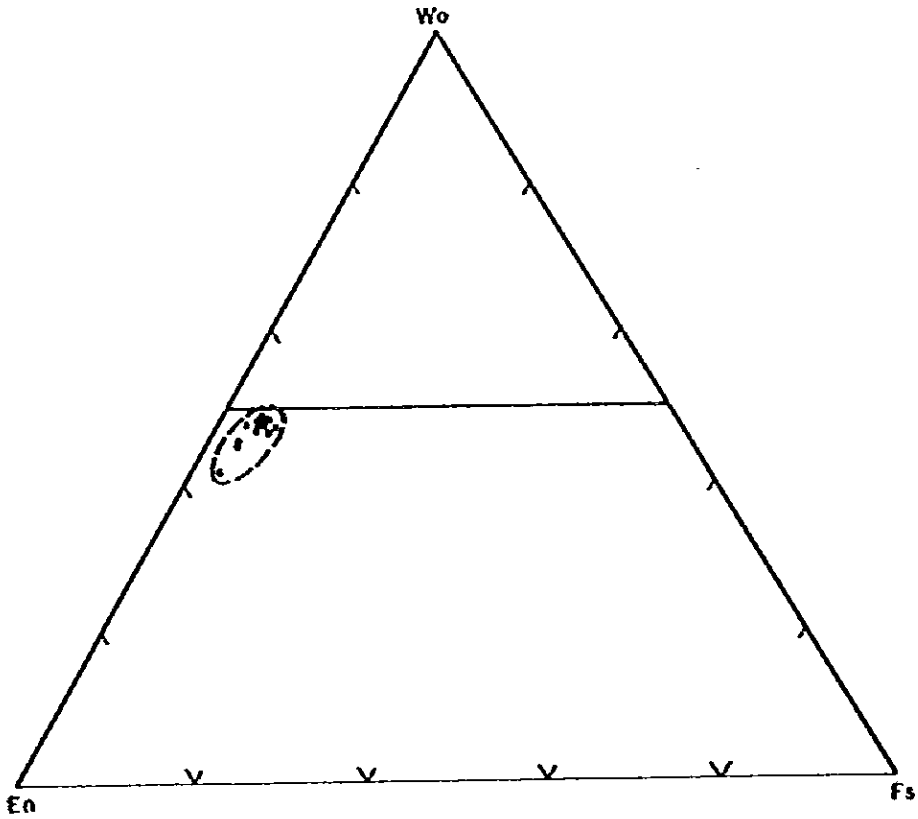


Fig. IV-3 Composition of Clino-pyroxenes in the Harzburgite of Pasaman Area

CHAPTER 4 GEOLOGICAL STRUCTURE

In the northwest part of this area there is the Cretaceous System Woyla Group mad up of pelitic schist slate, siliceous schist sandstone, limestone, and green schist green rock. In the southeast primarily harzburgite accompanied by a very little dunite is distributed. Both are divided by a fault running north-south.

(a) Central - Northwest Part

All Members of the Formation are distributed in a zone having the direction of roughly N45°W. The strike of the strata is virtually the same. Referring to the geological survey result of the main route the Formation of this area was compiled by photo-geological interpretation.

The strata of each area repeatedly appear so it can be concluded that there is a repetitive folding structure. The green schist, green rocks-limestone of the Woyla Group's upper strata and limestone in pelitic schist strata are distributed topographically in high altitude areas (mountain ridges etc.), occupying the synclines and anticlines of the folding structure. The lower strata of the Woyla Group are generally distributed in low altitude areas due to their low resistance based on the erosion of peritic schist and slate. The ultrabasic rock distributed in the east has a dip in the northeast direction of lenticular shape. Where it contacts with the Woyla Group, faults are sometimes observed. An analysis based on interpretation of aero-photogeology and the conditions of strata distribution shows the lineament assumed to be a fault showed two lines with the strike of N50°W and one line with strike N20°W.

(b) Southeast Area

This area is largely made up of ultrabasic rock, the Woyla Group's sedimentary rock, volcanic rock, and metamorphic rock barely distributed in the surrounding ultrabasic rock. The grading structure of green andesitic pyroclastic rocks confirms that the Woyla Group distributed along the east of the ultrabasic rock has a synclinal structure with a fold axis of N50° - 60°W.

The ultrabasic rock is made up of massive masses of harzburgite, and moreover, flow structure was not observed; therefore the structure of the harzburgite mass could not be analyzed. At the margin with the Woyla Group there are numerous crushed areas; it sppears both contact by faulting (direction N-S, N20°E, N20°W, E-W).

Within the ultrabasic rock area along the Lintjik River there is an obvious sheared zone. Sheared plane striking N70°E and dipping 40°NW and a large amount of sheared breccia were observed.

Joints and shears in the rock are frequent north of the Lintjik River in the direction with strike N60°W and dip 35°NE and prevalent in the south in the direction with strike N60°W and dip 40° - 70°NE.

From the structure and metamorphism of these Woyla Group rocks, and the previously described characteristics of the ultrabasic rock, it appears that Pasaman ultrabasic rock (harzburgite) is tectonite type periodotite which has accreted in the tectonic zone, and that from the overall structure the rock is distributed in the direction of N60° - 70°W, 40°NE.

CHAPTER 5 CHROMITE PLACER SURVEY

5-1 Survey Method

In parallel with the geological survey heavy minerals were gathered from riverbed sediments from 2 sites per km on the survey route on the main river and tributaries.

For collecting samples 2 full 20 liter plastic buckets of stream sand were gathered, then by panning using a wooden pan (approx. diameter 50 cm), heavy minerals were collected. Sorting of the chromite (chromite and chrome spinel) of these samples was carried out by the staff at the Bandung (Directorate of Mineral Resources). First the magnetic minerals were removed by using a hand magnet and an isodynamic, then using a binocular microscope the chromium ore was separated out and the number of chromium ore grains was counted. In cases when there are large quantities of over 200 grains a rough estimate of the quantity appears.

The number of grans from 1 to 1000 was divided into 5 classes in logarithmic intervals; 0 - 25 grains, 26 - 64 grains, 65 - 160 grains, 161 - 410 grains, 411 - 1000 grains. The result based on this classification was plotted on a map. (PL IV-2).

5-2 Data Processing and Results

There are large quantities of chromium ore in the harzburgite in the southeast survey area. Chrome spinel (Cr_2O_3 27% - 44%, Al_2O_3 22% - 35%) as an accessory mineral to harzburgite is universally observed, the mineral content being over 1%. It is assumed that this placer ore is chromium spinel derived from Harzburgite. It is thought that the placer ore in the Saligavan River is derived from the incidental chrome spinel derived from ultrabasic rock upstream.

CHAPTER 6 MINERALIZATION

The Pasaman ultrabasic rock is primarily harzburgite. In this survey a distribution of chromite in which chromite is concentrated was not found. The analyzed values of rock (BR-75) found in the field that was thought to have concentrations of chromite showed low a grade of Cr_2O_3 0.57%. (Table IV-8)

In the panning study chrome ore was gathered from the stream bed sediments within the harzburgite distribution area, but harzburgite usually contains Cr_2O_3 0.2% - 0.5%, resulting in whole rock chemical analysis. From the universal inclusion of chromium spinel as an accessory mineral, with values of Cr_2O_3 27% - 44%, Al_2O_3 22% - 35% as confirmed by electron probe microanalyzer, it appears that the chromium ore placer is a concentration of accessory mineral chromium spinel in the harzburgite.

Since, as was previously stated, the Pasaman area ultrabasic rock is primarily harzburgite with a little accompanying dunite, it appears there is little possibility of finding minable chromitite resources.

Table IV-8 List of Assay Results of Ore Samples in Pasaman Area

Sample No.	Location	Assay Results					
		Cr_2O_3	MgO	Al_2O_3	SiO_2	FeO	Pt
		%	%	%	%	%	ppb
BR-51	Simpang kiri	0.02	3.70	12.90	59.94	5.58	<50
BR-75	Sigapuk	0.57	0.29	3.60	7.15	0.47	<50

Pasaman

(1)

Serial No.	Sample No.	Location River or Creek	Assay Results							Number of Chromite
1044	Ap 96	Saligavan								29
1045	" 97	do								34
1046	" 98	do								14
1047	" 99	do								7500
1048	" 100	do								20
1049	" 101	do								
1050	" 102	do								
1051	" 103	do								28
1052	" 104	do								31
1053	" 105	do								
1054	" 106	do								28
1055	" 107	do								7500
1056	" 108	do								7200
1057	" 109	do								28
1058	" 110	do								7500
1059	" 111	do								
1060	" 112	do								
1061	" 113	do								
1062	" 114	do								
1063	" 115	do								20
1064	" 116	do								28
1065	" 117	do								
1066	" 118	do								10
1067	" 119	East of Saligavan								25
1068	" 120	do								
1069	" 121	West of Saligavan								20
1070	Bp 97	Simpang Kanan								7500
1071	" 98	do								7500
1072	" 99	do								7500
1073	" 100	do								7500
1074	" 101	do								7500
1075	" 102	do								22
1076	" 103	do								±286

Serial No.	Sample No.	Location River or Creek	Assay Results							Number of Chromite
1077	Bp 104	Simpang Kanan								7250
1078	" 105	do								18
1079	" 106	do								10
1080	" 107	do								9
1081	" 108	do								22
1082	" 109	do								24
1083	" 110	do								8
1084	" 111	do								12
1085	" 112	do								
1086	" 113	do								
1087	" 114	do								
1088	" 115	do								
1089	" 116	A. Lintjik								7500
1090	" 117	do								7500
1091	" 118	do								7500
1092	" 119	do								7500
1093	" 120	do								7500
1094	" 121	do								7500
1095	" 122	do								7500
1096	" 123	do								7500
1097	" 124	Simpang Kanan								
1098	" 125	do								
1099	Cp 78	A. Kawai								
1100	" 79	do								
1101	" 80	do								
1102	" 81	do								
1103	" 82	A. Simpang Kurah								
1104	" 83	do								
1105	" 84	do								
1106	" 85	do								
1107	" 86	do								
1108	" 87	do								
1109	" 88	A. Kiawai								

Serial No.	Sample No.	Location River or Creek	Assay Results							Number of Chromite
1110	Cp 89	A. Kiavai								10
1111	" 90	A. Sinpang Kuruh								29
1112	" 91	do								7
1113	" 92	do								25
1114	" 93	do								
1115	" 94	do								10
1116	" 95	A. Tiavi								
1117	" 96	do								
1118	" 97	do								
1119	" 98	A. Tiogar								
1120	Dp 134	A. Lintjik								7500
1121	" 135	do								7500
1122	" 136	do								
1123	" 137	do								7500
1124	" 138	do								7500
1125	" 139	do								7500
1126	" 140	do								7500
1127	" 141	do								7500
1128	" 142	do								7500
1129	" 143	do								7500
1130	" 144	do								7500
1131	" 145	do								7500
1132	" 146	do								7500
1133	" 147	do								7500
1134	" 148	do								7500
1135	" 149	do								7500
1136	" 150	do								7500
1137	" 151	do								7500
1138	" 152	do								71000
1139	" 153	do								7500
1140	" 154	do								7500
1141	" 155	do								71000
1142	" 156	do								71000

Serial No.	Sample No.	Location River or Creek	Assay Results							Number of Chromite
1143	Dp 157	A. Lintjik								7500
1144	" 158	do								7500
1145	" 159	do								7500
1146	" 160	do								7500
1147	" 161	do								71000
1148	" 162	do								7500
1149	" 163	do								7500
1150	" 164	do								11
1151	" 165	do								6
1152	" 166	do								20
1153	" 167	do								
1154	" 168	do								
1155	" 169	do								15
1156	" 170	do								18
1157	" 171	do								10
1158	" 172	do								7500
1159	" 173	do								11
1160	Ep 82	A. Pasaman								
1161	" 83	do								
1162	" 84	do								
1163	" 85	do								
1164	" 86	do								
1165	" 87	do								
1166	" 88	do								
1167	" 89	G. Si Gapuk								15
1168	" 90	do								
1169	" 91	do								300
1170	" 92	do								7500
1171	" 93	do								
1172	" 94	do								
1173	" 95	A. Pasaman								
1174	" 96	do								
1175	" 97	Lubuk Karang Putih								

Serial No.	Sample No.	Location River or Creek	Assay Results							Number of Chromite
1176	Ep 98	Simpang Kiri								18
1177	" 99	do								20
1178	" 100	do								
1179	" 101	do								
1180	" 102	do								8
1181	" 103	do								
1182	" 104	do								
1183	" 105	do								
1184	" 106	do								
1185	" 107	do								
1186	" 108	do								
1187	" 109	do								
1188	" 110	do								16
1189	" 111	do								7500
1190	" 112	do								20
1191	" 113	do								40
1192	" 114	do								
1193	" 115	do								
1194	" 116	do								
1195	" 117	do								
1196	" 118	A. Pasaman								
1197	" 119	do								30
1198	" 120	do								7500
1199	" 121	A. Lumpatan								7500
1200	" 122	do								
1201	" 123	do								
1202	Fp 100	Karsik Putik								
1203	" 101	do								7500
1204	" 102	do								64
1205	" 103	Batang Kenbar								
1206	" 104	do								7500
1207	" 105	do								80
1208	" 106	Karsik Putik								10

Serial No.	Sample No.	Location River or Creek	Assay Results							Number of Chromite
1209	Fp 107	Karsik Putik								20
1210	" 108	Tinggam								
1211	" 109	Tanger								
1212	" 110	do								20
1213	" 111	do								7500
1214	" 112	do								
1215	" 113	do								
1216	" 114	do								
1217	" 115	do								
1218	" 116	do								
1219	" 117	Si Sangan								
1220	" 118	do								
1221	" 119	do								
1222	" 120	do								
1223	" 121	do								
1224	" 122	do								10
1225	" 123	do								10

Appendix IV-2 Microscopic Observation of Thin Section in Pasaman

(1)

Sample No.	Rock Name	Texture	Fragment/Grain										Groundmass/Matrix											Secondary Mineral													Remarks
			Q	K-f	pl	Bt	Hb	Au	Hy	Ol	Op		Q	Si	K-f	Pl	Bt	Hb	Cpx	Opx	Ol	Op		Q	Si	Cc	Ser	Chl	Kad	Bt	Act	Epi	Tau	Op	Py	Serp	
Woyla Formation																																					
AR 26	Calcareous slate	Slate	◎								○	cc ◎																									
AR 32	"	"	○									cc ◎												○										○			
AR 36	Lime stone		◎									cc ◎																									graphite
AR 44	Andositic tuff (schist)	Pyrocrys			◎			○				cc ○				○						○									○	◎					
AR 46	Clacareous schist	Schist																																			
AR 49	Sericte-quartz schist	"			◎						◎	Lith cc												◎			○										
BR 33	Pelitic schist	"										Zoisite?															◎										
BR 48	Green schist	"			◎																			◎			◎	○									
BR 50	Pelitic schist				○								◎											◎			◎	○									
BR 83	Pelitic schist																							◎			◎							○			
BR 89	Pelitic schist				○																						○							○			
BR 96	Tuff sandstone	S.S.	◎		○						○																	◎									
Ultrabasic Rock								(cpx)	(opx)																												
AR-42	Serpentine	Hol-crys						•		•	○																○		◎							◎	
BR 74	Harzburgite	Hol-crys						•	○	◎	○	Cr spi																									
BR 76	"	"							○	◎	○	"																									
ER 61	"	"						○	○	◎	○	"																									
ER 67	"	"									•	"																			○			○		○	

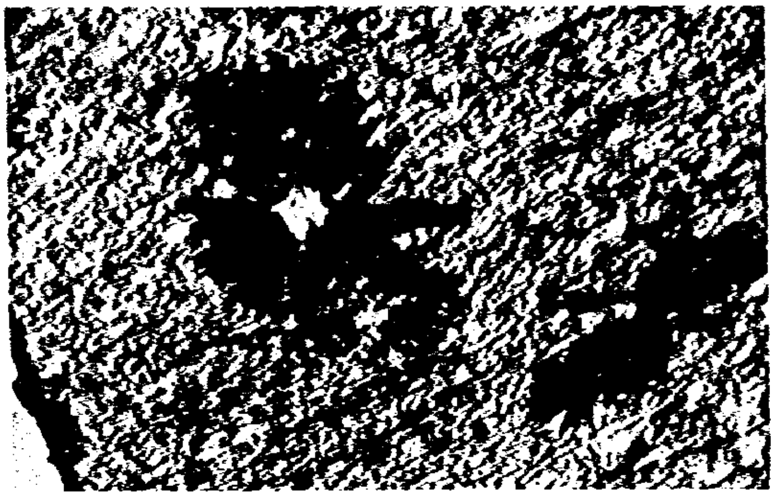
C.c: Calcite
Lith: Lithic
Serp: Serpentine
Pyrocrs: Pyrocrastic
Hol-crys: Hollo crystal
Porph: Porphyritic
Cr spi: Chromium spinel

◎ Abundant ○ Common • Rare

Sample No.	Rock Name	Texture	Fragment/Grain										Groundmass/Matrix											Secondary Mineral													Remarks
			Q	k-f	pl	Bt	Hb	Au	Hy	Ol	Op		Q	Si	k-f	Pl	Bt	Hb	Cpx	Opx	Ol	Op		Q	Si	Cc	Ser	Chl	Kao	Bt	Act	Epi	Tau	Op	Py	Serp	
FR 106	Serpentine (Harzburgite)	Hol-crys						cpx	opx ○	○	o	Cr spi																						○			
FR 107	Harzburgite	"							○	◎	o	"																									
FR 36	"	"							○	◎	o	"																								○	
DR 40	"	"						●	●	◎	o	"																								○	
DR 41	"	"						●	○	◎		"																								o	
DR 45	"	"							●	◎		"																								o	
DR 50	"	"							o	◎		"																								o	
DR 54	"	"						●	o	◎		"																								o	
DR 57	Dunite	"							●	◎		Chromite																								o	
FR 111	Harzburgite	"						o	●	◎		Cr Spi																								o	
FR 105	"	"						●	o	◎		"																								o	
Dyke Rock								Au																													
AR 29	Meta Basalt	Porph			○											○								○				○			●	○					
ER 74	Meta Diabase	Diab.			◎						○													○				◎				◎					
FR 101	Dolerite	Porph						◎								◎			○			○										○					

Appendix IV-3 Microscopic Observation of Polished Thin Section in Pasaman Area

Sample No	Description
DR-36 DR-40 DR-41 DR-45 DR-50 DR-54 ER-111 FR-105	Chromium minerals are sporadically distributed in harzburgitol as accessory minerals. as a resule ot microprobe microanalysis, the mineral is identified chromium Spinel
DR-57	Chromite is contained in dunite as accessory mineral



Sample No.: BR-33
Location : Simpang Kanan River
Rock Name : Pelitic Schist
(Woyla Formation)

Sericite and quartz

open nicol

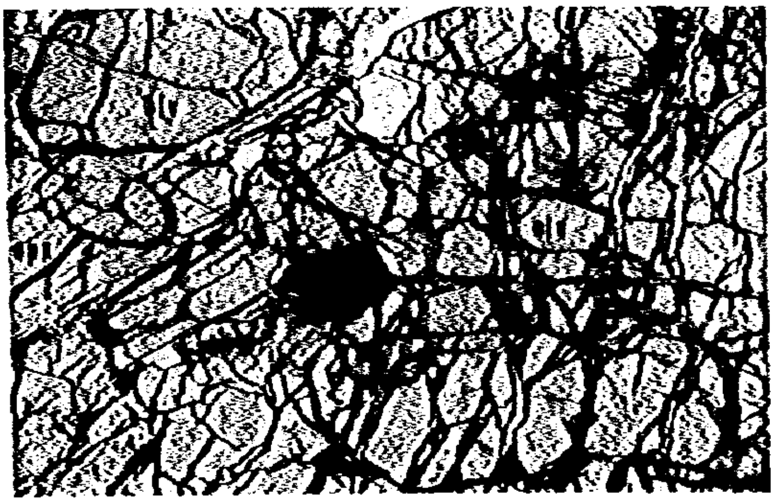
0 0.5 mm

Sample No.: BR-48
Location : Simpang Kanan River
Rock Name : Green schist

pl : plagioclase
chl: chlorite

open nicol

0 0.5 mm



Sample No.: BR-76
Location : G.Gapuk
Rock Name : Harzburgite

olv: olivine
opx: orthopyroxene

cross nicol

0 0.5 mm

Appendix IV - 4 Photographs of Microscopic Observation of Thin Section and Polished Section, Pasaman Area

Sample No.: FR-101

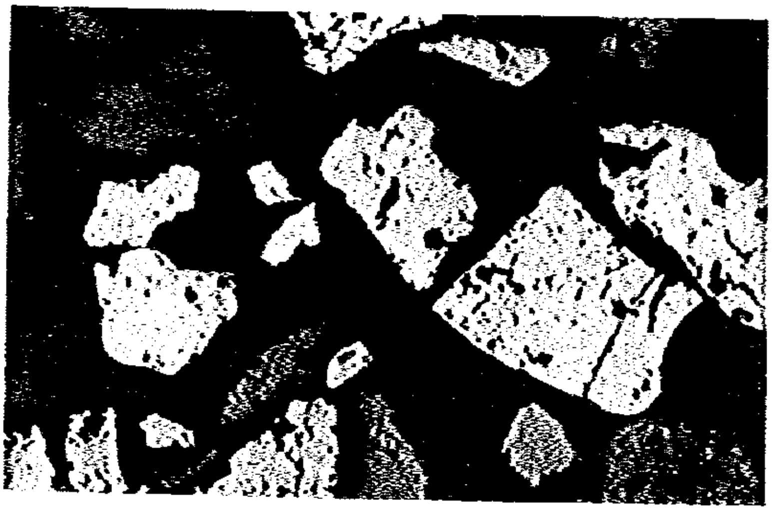
Location : Karata Putih

Rock Name : Dolerite

Aug: augite
Epi: epidote

open nicol

0 0.5 mm



Sample No. : Panning DP-160

Location : Branch of Lintjik River

Sample Name: Chromium Spinel

0 0.2 mm

PART FIVE

CONCLUSIONS

CHAPTER 1 COMPREHENSIVE STUDY

This year's survey involved a preliminary detailed survey of the Hatapang Area, which contains tin and tungsten ores (geological, geochemical, and tin and tungsten placer ore surveys; survey area: 169 km^2); a reconnaissance survey of the Muara Sipongi Area, which contains gold, silver, copper, lead and zinc ore deposits (geological, geochemical, and placer gold surveys; survey area: 400 km^2); and a reconnaissance survey of the Pasaman Area, focusing on chromite (geological, geochemical, and chromite placer ore surveys; survey area: 200 km^2). The survey yielded much new information and material on the geology and ore deposits of each area, in addition to clarifying the relationship between ore deposits and geology, geological structure, and igneous activity. The following is a summary of the results of the survey for each area studied.

1-1 Hatapang Area

1-1-1 Igneous Activity

In the Hatapang Area, Hatapang granite covering an area of 6 km EW and 8 km NS is found intruded in the Permian - Carboniferous system Hatapang Sedimentary Formation (Bohorok Formation), where it has brought about hornfels alteration. Hatapang granite is coarse-grained biotite granite containing feldspar phenocrysts; toward the western margin the fedspar phenocrysts become fewer and give way to equi-granular, medium-grained biotite granite. Fine-grained two mica granite is intruded in the Hatapang porphyritic granite at its northeastern margin, irregularly or as dikes.

The chemical composition of Hatapang granites including fine two mica granite is about 75% SiO_2 and $\pm$ 8% $Na_2O + K_2O$; the differentiation index (D.I.) is about 95%, indicating an extremely high degree of differentiation and chemical composition that resembles the mean grade of general tin-bearing granites. The absolute age of the Hatapang granite was determined by the K-Ar method to be 78 - 65 Ma, indicating the later Cretaceous period. These characteristics are similar to those of the Phuket zone, a Cretaceous tin granite zone situated at the westernmost margin of the Thai-Malaysia-Indonesia tin mineralization zone. The Hatapang granite is located at the southern extension of this zone.

The tin content of the fine-grained two mica granite, which intruded as later-stage Hatapang granite, is 10 - 98 ppm. This is a high value in comparison with that for porphyritic biotite granite (1 - 7 ppm) and suggests that it was the fine-grained two mica granite which brought tin mineralizations in this area.

1-1-2 Mineralization Zones

The geological survey revealed the distribution of many quartz veins in the Batu Jongjong area at the eastern margin of the Hatapang granite, around the Hatapang River at its northern border, and in their tributary basins; intrusions of fine-grained two mica granite are also present in these areas, irregularly or as dikes. While no significant outcrops of tin or tungsten ore deposits were discovered in this survey, the geochemical survey of stream sediment and the survey of cassiterite and tungsten ore placers obtained by panning yielded results which agreed with those for the above-mentioned areas and indicated the distribution of anomalous areas.

The parts of the Hatapang Area considered most likely to have tin mineralizations are the eastern and northern marginal areas of the Hatapang granite.

1-2-2 Mineralizations

To the south of the Muara Sipongi granitoid rock intrusion which extends well WNW are arranged (from east to west along this direction) the Subun-Subun mineralization zone, the Bt Pionggu mineralization zone, and the Si Ayu skarn zone. The Pagar Gunung mineralization zone and Patahajang alteration zone are also distributed in the southwestern part of the survey area.

The former zones are gold-bearing copper, zinc, and lead ore deposits, having characteristic form in accordance with the condition of their emplacement. When emplacing in meta-andesite, for example, mineralizations are deposits of gold-bearing copper, lead, and zinc quartz veins which have filled in fissures; parts of the Subun-Subun deposit and the eastern Bt Pionggu mineralization zone are classified into this fissure-filling form. When emplacing in limestone, mineralizations take the form of skarn zones accompanying chalcopyrite (magnetite) deposits with skarn body or in crystalline limestone; the upper zone Subun-Subun ore deposits, the western Bt Pionggu mineralization zone, and the Si Ayu skarn zone are grouped into this type.

The Pagar Gunung ore deposits consist of massive lead and zinc ore. No granitoid outcrop or contact areas are observable at surface level, but the deposits contain skarn, and there is a strong probability of skarn-type metasomatic deposits. Additionally, skarn boulders were observed in Patahajang, situated in the eastern extension of the Pagar Gunung ore deposits.

1-2-3 Relationship between Mineralization Zones and the Placer Gold and Geochemical Surveys

The results of placer gold surveys conducted by panning the major rivers revealed the distribution of placer gold over an area extending from the Bt Pionggu mineralization zone through the Subun-Subun mineralization zone. Areas containing such

1-2 Muara Sipongi Area

1-2-1 Geological Characteristics

The geology of this area can be summarized as follows.

(1) Permian-Carboniferous system quartz arenite strata (S. Ranya Formation) form the basement. The Formation is correlative to the Kluet Formation Tapanuli Group.

(2) Next follows the M. Batung Meta-andesite Formation, composed mainly of andesite lava, and the Patahajang Formation sedimentation composed of limestone, sandstone, mudstone, and siliceous tuff. These Formations are both correlative to the Silungkang Formation of the Peusangan Group Permian-Carboniferous system.

(3) Muara Sipongi granitoid rock intrusion

The Muara Sipongi granitoid rocks intruded during the Jurassic period, according to the results of age determination by the K-Ar method. At the time of the Muara Sipongi granitoid rock intrusion, there was a geological structure extending in a WNW direction, and the M. Batung Meta-andesite Formation and the Patahajang Formation were formed by the synclinal and anticlinal structures, and the fissures which accompanied that tectonic movement in that geological structure.

Muara Sipongi granitoid rocks range from granodiorite to quartz diorite and diorite, and with respect to differentiation belong to the calc-alkalic rock series. Mineralizations in the area occurred during this period, accompanied by tectonic movement and igneous activity.

(4) Tertiary Dacitic Tuff Formation

This unconformably overlies older rock at the southern margin of the survey area; dacitic tuff is widely distributed.

mineralization zones were clearly indicated.

According to the geochemical survey, anomalous areas containing a preponderance of copper, lead, and zinc were identified in the Patahajang alteration zone - Pagar Gunung lead and zinc ore deposit zone. In contrast, the Subun-Subun and Bt Pionggu ore deposit zone contains many anomalous areas of gold.

The mineralization characteristics of the two mineralization zones described above thus brought contrasting results for each zone in the placer gold and geochemical surveys.

1-3 Pasaman Area

In the Pasaman Area is the Cretaceous Woyla Group which is composed of pelitic schist - phyllite; greenschist - green phyllite; and limestone, and associated with ultrabasic rocks. The Woyla Group has been weakly metamorphosed and folded, forming a folding structure.

The ultrabasic rock body is massive and extends over an area 5 km in width and 8 km NS. The northern extension is cut by a fault and continues further as a lenticular small ultrabasic rock body.

The ultrabasic rock is comparatively fresh and is composed of 70 - 90% olivine, 10 - 30% orthopyroxene, small quantities of clinopyroxene and chrome mineral (less than 5%). It is classified as harzburgite.

Olivine contained in harzburgite is Fo_{91-92} while orthopyroxene is En_{91-92}. The generating temperature of the harzburgite has been determined at 650° - 750°C by means of the calculation of the distribution of iron and magnesia between the orthopyroxene and clinopyroxene under an equilibrium relation. In addition, from an examination of tectonic fabric (which, while weak, was found to exist), the geological structure of the Woyla Group, and other factors, this ultrabasic rock is determined to be harzburgite in the category of tectonite-type peridotite, of mantle origin, produced in the tectonic zone.

Under the electron probe microanalyzer the chrome ore accompanying the harzburgite was found to be composed of 27 - 47% Cr_2O_3 as opposed to 40 - 20% Al_2O_3, this high value of Al_2O_3 showing it to belong to chrome spinel rather than chromite. A mineral very similar to chromite is found in small, local distributions of dunite; this is composed of 50% or more Cr_2O_3 and 17% or less Al_2O_3; nearly chromite.

Little dunite is found in Pasaman ultrabasic rock composed of harzburgite, nor are there any observed accumulative-type ultrabasic rocks such as wehrlite or gabbro, leading to the conclusion that there is very little possibility that chromite ore (chromatite) can be economically mined in the area.

CHAPTER 2 CONCLUSIONS AND RECOMMENDATION FOR THE SECOND PHASE

2-1 Conclusions

2-1-1 Hatapang Area

The Hatapang granite in this area is composed of coarse-grained porphyritic biotite granite, medium-grained biotite granite, and later intrusions of fine-grained two mica granite. The granite as a whole was found to be adamellitic, and its geochemical and physical characteristics extremely similar in type to granites generally accompanied by tin ore deposits. The presence of fine-grained two mica granite is a particular indicator of granites bringing tin mineralizations, and granite of this type is distributed at the northern margin (upper reaches of the Hatapang River and its tributaries) and the eastern margin (lower reaches of the Batu Jongjong River) of the stock. Its tin content (10 - 98 ppm) is comparatively higher than that of other ordinary types of granite.

Panning revealed the location of concentrations of cassiterite, while the geochemical survey determined the location of anomalous areas of tin, tungsten, and fluorine as well as distribution areas of many quartz veins. These distribution areas, too, are well consistent with areas in which two mica granite is distributed. The survey thus revealed the northern and eastern margins of the Hatapang granite stock to be centers of tin and tungsten mineralization. Moreover, while the Island of Sumatra had been held to be an extension of Thai-Malaysian tin and tungsten zones, the actualities had not been fully understood. This survey, however, confirmed the existence of a southern extension of the Phuket tin zone situated at the westernmost margin of the Sumatra tin and tungsten zone. The possibility therefore emerges that tin ore deposits exist in other granitoid regions of Sumatra and are not limited to those in the Hatapang Area.

2-1-2 Muara Sipongi Area

This area features widely distributed granitoid rocks which intruded during the Jurassic period and extend from WNW through SSE. The following two zones of mineralization were found to accompany this igneous activity. In the central region, in the Palaeozoic system Patahajang Formation and the H. Batung Meta-andesite Formation distributed along the southern side of the granitoid rocks, the Subun-Subun mineralization zone, the Bt Pionggu mineralization zone, and the Si Ayu skarn zone are found emplaced along with granitoid rocks. Mineralization zones are also found in the southwestern region, where the Pagar Gunung mineralization zone and the Patahajang alteration zone are contained within the Patahajang Formation in the southern part of the granitoid rock. In the central mineralization zone, when the host rock is andesite the ore deposits found are fissure-filling gold, silver, copper, lead, and zinc ore deposits, while skarn-type copper and magnetic ore deposits are found when the host rock is limestone. In the southwestern mineralization zones, the ore deposits found are skarn-type massive lead and zinc ore deposits. In the Pagar Gunung mineralization zone in particular, ore outcrops have been confirmed extending over some 200 m, although intermittently (ore grade Ag, 20 - 90 g/t; Cu, 0.1 - 0.6%; Pb 3 - 7%, Zn, 5 - 9%). The placer gold survey revealed practically consistent distributions of placer gold in the central mineralization zones and clarified the extent of the mineralization zones. And, through the geochemical survey, anomalous areas with a consistent preponderance of copper, lead, and zinc were identified in the western mineralization zones. The anomalous areas of gold were found to be located in the central area, the results thereby conforming satisfactorily with those obtained from the placer gold survey.

2-1-3 Pasaman Area

The ultrabasic rock distributed in this area is composed almost entirely of harzburgite, with an extremely minute distribution of dunite. The equilibrium temperature, determined from the distribution of Fe and Mg in clinopyroxene and orthopyroxene, is 650° - 750°, indicating the temperature at the upper mantle. The ultrabasic rock distributed in Sumatra forms a part of the ophiolite, and is considered to have been accreted to Sumatra when the island was closed off by the marginal sea during the later Cretaceous period. The harzburgite distributed in this area is also considered to form a part of the ophiolite and to be mantle residual (tectonite). Ultrabasic rock which is the host rock to chrome ore deposits is generally of the cumulate type of dunite - wehrlite formed by the crystallization differentiation of basic magma; with few exceptions, there are no know chromite ore deposits (chromitite) of economic value within the harzburgite itself. Indications of chromite dissemination have been observed in parts of this area's ultrabasic rock, and chromite has also been collected throughout the rock body by means of panning, but almost all of this is thought to be chromium spinel which accompanied the harzburgite.

2-2 Recommendation for the Second Phase

2-2-1 Hatapang Area

The survey conducted this year resulted in the discovery of promising tin and tungsten mineralization zones in the northern and eastern borders of the Hatapang Granite Formation. The next phase of the survey should focus on gaining a broader understanding of the character of the mineralizations in this region and on selecting areas with favorable ore deposits by conducting detailed geological surveys and detailed chemical surveys of the soil; other more thorough surveys by means of trenting and other methods should be carried out when warranted.

2-2-2 Muara Sipongi Area

This year's survey revealed the Muara Sipongi Area mineralizations to consist of mineralization zones of gold, silver, copper, lead, and zinc in the central region which was revealed to manifest the characteristics of a concentrated placer gold area by the geochemical survey, which identified traces of gold, and by panning; and mineralization zones of silver, lead, and zinc in the southwest which the geochemical survey showed to possess indications of silver, lead, and zinc. The southwestern Pagar Gunning mineralization zone is considered to be a particularly promising zone for ore deposits, judging from all data gathered thus far. The next phase should focus on conducting a detailed geological survey and a geochemical survey of an area some 20 km^2 centering on the mineralization zone in order to gain a more thorough understanding of the geological structure and the mineralizations. These surveys should be supplemented with geophysical and drilling surveys intended to provide more information on the scale and grade of the ore deposits. It was recommended from indications gathered not only from a surface geological survey of the mineralization zone but also from gold indications obtained from the geochemical survey that, while the value of further prospecting is also recognized, survey activities should be concentrated on the Pagar Gunung mineralization zone.

2-2-3 Pasaman Area

Some indications of chromite are contained locally in the ultrabasic rock of the region, but those that exhibit possibilities of developing into economically valuable chrome ore deposits are extremely few. The area was determined not to be worthwhile for future prospecting.

Table IV-7 Characteristic of Ultramafic Rock

	Upper mantle origine	Cummulative rock origin
Rock	lherzolite, harzburgite periodite - websterite, websterite (dunite) (wehrlite) no gradual variation between Peridotite and Pynoxenite	Periodite-clinopyroxenite pyroxenite wehrlite harzburgite lhrzolite (peridofite-websterite) (websterite) gradual variation from Peridotite to Pyroxenite, and also to mafic rock
Rock forming minerals	olivine orthopynoxene clinopxroxone chrome-spinel (pargasite) (plagioclase)	clinopyroxene olivine orthopyroxene chromespinel spinel, (kaersutite) (Ti-phlogopite) (garnet)
Texture	tectonite texture, recrystalization texture, exsolution texture	cummulative texture, exsolution texture, (tectonite texture) (catacrasfic texture)
Chemical composition of rock forming mineral		
Olivine	Fo 92 - 87	Fo 90 - 65
Opx	En 91 - 87 poor content of Ti Ca Al	En 90 - 75 rich content of Ti Ca Al Fe
Cpx	rich content of Cr Mg and poor content of Ti Al	rich content of Ti Al Fe poor content of Cr
Spinel	rich content of Cr Al	rich content of Fe, Al poor content of Cr

from Chikyu Kagaku vol. 3 Iwanami Shoten p56 (K. Aoki)

( ): rare rock, mineral and texture

Appendix I-1 List of Rock and Ore Samples Tested

Abbreviation

Rock

Dio	:	Diorite
Gr	:	Granite
Gradio	:	Granodiorite
Por-Gr	:	Porphyritic Granite
Apl	:	Aplite
And	:	Andesite
Bas	:	Basalt
Lim	:	Limestone
Ss	:	Sandstone
Silt	:	Siltstone
Tf	:	Tuff
Sch	:	Schist

Mineral

Qtz	:	Quartz
Bt	:	Biotite
horn	:	Hornblende
Cpx	:	Clinopyroxene
Cal	:	Calcite
Ser	:	Sericite
Epi	:	Epidote
Ga	:	Garnet
Chl	:	Chlorite
harz	:	Harzbarzite
Mal	:	Malachite
Cp	:	Chalcopyrite
Spha	:	Sphalerite
Mag	:	Magnetite
Pb	:	Galena
Py	:	Pyrite

Texture

Mass	:	Massive
arg	:	Argillaceous
Sili	:	Siliceous
Meta	:	Metamorphic

Appendix I-1 List of Rock and Ore Samples Tested

Hatapang Area

(1)

Sample No.	Rock Name	Thin Section	Polished Section	X-Ray Analysis	K-Ar Dating	Chemical Analysis: Whole Composition	Chemical Analysis: Ore
AR-1	Gr	o					
AR-6	Aplite	o			o	o	
AR-10	Gr	o				o	
AR-13	Bt-Horn	o					
AR-15	Pebbly-silt	o					o
AR-16	Gr					o	
AR-17	Gr					o	
AR-24	Two-mica-Gr	o				o	
BR-4	Por-Gr					o	
BR-5	Hor-Ss	o					
BR-6	And	o					
BR-7	Silt	o					
BR-8	Bt-Horn	o					
BR-16	Por-Gr					o	
BR-18	Por-Gr	o				o	
BR-20	Apl-Gr					o	
BR-21	Bt-Horn	o					
BR-22	Apl-Gr					o	
BR-24	Two-mica-Gr	o				o	
CR-4	Qtz-V		o				o
CR-7	Por-Gr	o			o	o	
CR-11	Gr	o				o	
CR-13	Gr					o	
CR-14	Qtz-V		o				o
CR-18	Sill-Gr					o	
CR-20	Gr	o				o	
CR-21	Gr					o	
CR-24	Gr					o	
DR-6	Pabbly-silt	o					
DR-8	Sh						
DR-10	Por-Gr	o				o	
DR-11	Qtz(Ore)		o				o
DR-15	Qtz-V		o				o
DR-16	Qtz-V		o				o

Hatapang Area

Sample No.	Rock Name	Thin Section	Polished Section	X-Ray Analysis	K-Ar Dating	Chemical Analysis	
						Whole Composition	Ore
DR-18	And	o					
DR-19	Gr	o				o	
DR-20	Qtz-V		o	o			o
DR-21	Qtz-V		o				o
DR-22	Silt	o					
DR-24	Qtz-Mica			o			
DR-25	Gr	o				o	
DR-26	Qtz-V		o	o			o
DR-27	sh		o	o			o
DR-29	Qtz-V						o
DR-31	Silt	o					
ED-1	Gr	o			o	o	
ER-15	Por	o				o	
ER-18	Meta Qtzite	o					
ER-45	Bt-Gr					o	
ER-46	And	o					
ER-50	Bt-Gr	o				o	
ER-55	Bt-Gr					o	
ER-57	Bt-Gr	o				o	
ER-58	Bt-Gr					o	
FR-4	Hor	o					
FR-5	Horm	o					
FR-11	clay			o			
FR-14	Gr	o				o	
FR-16	Gr					o	
FR-20-2	Gr	o				o	

Muara Sipongi Area (3)

Sample No.	Rock Name	Thin Section	Polished Section	X-Ray Analysis	K-Ar Dating	Chemical Analysis: Whole Composition	Chemical Analysis: Ore
AR-51	Gradio	o				o	
AR-55	Gradio					o	
AR-56	Garnet skarn	o					
AR-58	Meta-And	o					
AR-63	do	o					
AR-66	Meta-And						
AR-68	Meta-And	o					
AR-77	Gradio	o				o	
AR-83	Meta-And	o					
AR-86	Spha-vein		o				o
AR-87	Tuff-slate	o					
AR-99	Meta-And	o					
AR-100	Gradio	o				o	
AR-105	Gradio	o				o	
AR-107	quartzose Ss	o					
BR-104	And	o					
BR-117	Gradio	o					
BR-121	Clay			o			
BR-136	Meta-And	o					
BR-142	Clay			o			
BR-145	Por						
BR-151	Clay			o			
BR-174	ser-qtz-schist	o					
BR-185	Gradio	o				o	
BR-192	Gradio	o				o	
BR-194	And			o			
BR-201	Mass-Cp		o				o
BR-202	Mag-Cp		o				o
BR-203	skarn (Epidoto)	o	o				o
BR-206	Mag-mal		o				o
BR-212	And (Meta)	o					
BR-213	hb-bt gradio	o			o	o	
BR-226	Meta-And	o					
BR-228	Clay			o			

Muara Sipongi Area

Sample No.	Rock Name	Thin Section	Polished Section	X-Ray Analysis	K-Ar Dating	Chemical Analysis Whole Composition	Chemical Analysis Ore
CR-48	And	o					
CR-52	Meta-And	o					
CR-55	Gr	o					
CR-68	arg-silt-R			o			
DR-68	Py-Ore			o			
DR-83	Ore(py only)						o
DR-84	Qtz-dio					o	
DR-98	Dacitic tuff	o					
DR-119	Ore		o				o
DR-120	Ore + skarn	o	o				o
DR-129	Ore (rich)		o				o
DR-131	Ore		o				o
DR-132	Pb-cal-Ore		o				o
DR-133	Mass-Ore		o				o
DR-135	clay			o			
DR-136	poor ore						o
DR-137	Ore						o
DR-139	Ore						o
DR-140	Pb-Py-Ore		o				o
DR-141	Ore		o				o
DR-142	Ore		o				o
ED-2	Qz-dio	o				o	
ED-3	Qz-dio	o			o	o	
ER-116	Meta-And	o					
ER-129B	Dacitic tuff	o					
ER-132	do	o					
ER-160	clay			o			
ER-169	Meta-And	o					
ER-175	diss-ore		o				o
ER-178	Meta-And	o					
ER-189	Meta-And	o					
ER-195	clay						
ER-200	Ore		o				o
ER-206	Lim(skarn)	o					

Muara Sipongi Area

Sample No.	Rock Name	Thin Section	Polished Section	X-Ray Analysis	K-Ar Dating	Chemical Analysis	
						Whole Composition	Ore
ER-208A	skarn + ore		o				o
ER-208B	skarn + ore		o				
ER-209	Ore		o				o
ER-210	Ore		o				
ER-222	Gradio	o				o	
ER-233	Qtz-dio					o	
ER-237	Hb-Qtz-dio					o	
FR-201	Gr			o			
FR-208	Gradio					o	
FR-210	Gr-R						
FR-215	Meta-And	o					
FR-218	Meta-And	o					
FR-220	do	o					
FR-223	Gradio	o					
FR-226	Gradio	o			o	o	
FR-229	Gradio					o	
FR-231	Cpx-skarn	o					
FR-232	Cpx+Ga skarn		o				o
FR-233	Cpx-skarn	o					
FR-235	Ep skarn	o					
FR-236	Cpx+Ga skarn	o					
FR-237	Gradio	o				o	
FR-240	And-tuff	o					
FR-242	Cpx-skarn, Ore		o				o
FR-243	Cpx-skarn	o				o	
FR-244	Cpx-skarn	o					
FR-245	Ga+Cpx skarn	o					
FR-246	Mt-ore;skarn	o					
FR-248	Gradio	o				o	
FR-252	Qtz-Sch	o					

Sample No.	Rock Name	Thin Section	Polished Section	X-Ray Micro Analysis			K-Ar Dating	Chemical Analysis	
				ch	ol	py		Whole Composition	Ore
AR-26	Slate	o							
AR-29	Met-Basalt	o							
AR-32	Slate	o							
AR-36	Limestone	o							
AR-42	Serpentine	o							
AR-44	Andistic tuff	o							
AR-46	Cal-schist	o							
AR-49	se-qz-schist	o							
BR-31	pel (Py)		o						
BR-33	pel-sch	o							
BR-38	harz							o	
BR-48	chl-sch	o							
BR-50	pel-sch	o							
BR-51	Cp								o
BR-74	harz	o						o	
BR-75	mag-hem		o						o
BR-76	harz	o						o	
BR-83	Pelitic schist	o							
DR-36	harz		o	o	o	o		o	
DR-37-2	harz								
DR-40	harz		o	o	o	o		o	
DR-41	harz		o	o				o	
DR-45	harz		o	o				o	
DR-50	harz		o	o	o	o		o	
DR-54	harz		o	o				o	
DR-57	Dunite		o	o	o			o	
ER-59	Dio	o							
ER-61	harz	o						o	
ER-67	harz	o						o	
ER-70	slate								
ER-74	Meta-Diabase	o							
ER-81	Basalt	o							
ER-88	Tf	o							
ER-90	Tf-Sandstone	o							

ch: chroaite ol: olivine Py: pyroxene

Pasaman Area

Sample No.	Rock Name	Thin Section	Polished Section	X-Ray Micro Analysis			K-Ar Dating	Chemical Analysis	
				ch	ol	py		Whole Composition	Ore
ER-111	harz		o	o	o	o		o	
FR-101	Dolerite	o						o	
FR-105	harz		o	o					
FR-106	harz	o							
FR-107	harz	o						o	

REFERENCES

1. Aoki K. (1978); Petrology of Upper Mantle, Igneous Rock and its Genesis, Chikyu Kagaku (Geoscience) Vol. 3 41 - 86 (Iwanami Shoten) (in Japanese)

2. Aramaki S. et al (1972); Chemical Composition of Japanese Granites Part 2 Variation Trends and Average Composition. Jour. Gel. Soc. of Japan Vol. 78, No. 1, p. 39 - 49

3. Aramaki S. (1978); Origine of Felsic Magma Igneous and its Genesis Chikyu Kagaku (Geoscience) Vol. 3 138 - 150 (Iwanami Shoten) (in Japanese)

4. Bemmelen R. W. (1970); Geology of Indonesia 2 vols. Martinus Nijinhoff The Hague (2nd ed.)

5. Ben-Avraham, Z. (1978); The Evolution of Marginal Basin and Adjacent Shelves in East and South Asia, Tectonophysics 45, p. 269 - 288

6. Cameron N. R. et al (1980); The Geological Evolution of Northern Sumatra. Ninth Indonesian Petroleum Association Convention

7. Clark M. C. G. et al (1982); Geological Map of the Pematangsiantar Quadrangle Sumatra (1/250,000) Geological Research and Development Center, Indonesia

8. Clark M. C. G. & Surjono (1982); Primary Tungsten Occurences in Sumatra and the Indonesian Tin Islands, Bull. Directorate of Mineral Resaurces Indonesia No. 5 bul. Vol. 1

9. Coleman R. L. (1977); Ophiolite, Springer - Verlag, Berlin

10. Dickey J. S. Jr. (1975); A Hypothesis of Origin for Podiform Chromite Deposits, Geoch. et Cosmochim. Vol. 39 1061 - 1074

11. Geochemical Study Group (1975); Hand Book of Geochemical Exploration (in Japanese) Mining and Metallugical Institute of Japan

12. Hamilton W. (1978); Tectonic Map of the Indonesian Region United State Geological Survey

13. Hamilton W, (1979); Tectonics of the Indonesia Region, USGS Prof. Rep. 1078

14. Hoskins K. F. G. (1979); Tin Distribution Patterns, Geol. Soc. Malaysia, Bull. Vol. 11 Dec. 1 - 70

15. Hutchison C. S. (1973); Tectonic Evolution of Sundaland: A Phanerozoic Synthesis
Geol. Soc. Malaysia, Bulletin 6, July, p. 61 - 86

16. Hutchison C. S. (1975); Ophiolite in South Asia
Bulletin of Geological Society of America, Vol. 86, 797 - 806

17. Ishihara, S. (1977); The Magnetite-series and Ilmenite-series Granitic Rocks, Mining Geology 27, No. 145, p. 293 - 305

18. Ishihara S. et al (1979); The Magnetite-series and Ilmenite-series Granitoids and Their Bearing of Tin Mineralization Particularly of the Malay Peninsular region
Geol. Soc. Malaysia Bull. Vol. 11, Dec. 103 - 110

19. Ishihara, S. et al (1980); Grainites and Sn-W Deposites of Peninsular Thailand, Mining Geology Special Issue No. 8

20. IUGS (1973); Plutonic Rocks, Classification and Nomenclature Recommended by the IUGS, Subcommission on the Systematics of Igneous Rocks. Geotimes Oct. 1973.

21. Katili J.A. (1967); On the Occurrence of Large Transcurrent Fault in Sumatra, Indonesia Jour. of Geoscience, Osaka City University Vol. 10 Art 1 - 1 5 - 17

22. Katili J.A. (1969); Permian Volcanism and its Relation to the Tectonic Development of Sumatra, Bull. Volcanologique XXXIII-2, p. 530 - 540

23. Katili J.A. (1970); Naplet Structure and Transcurrent Faults in Sumatra, Bull. National Institute of Geology and Mining Bandung vol. 3 no. 1 11 - 28

24. Katili J.A. (1973); Geochronology of West Indonesia and its Implication on Late Techtonics
Tectonophysics 19, p. 195 - 212

25. Katili, J.A. (1973); Plate Tectonics and its Significance in the Search Mineral Deposits in Western Indonesia
CCOP Technical Bulletin Vol. 7

26. Katili, J.A. and Hartono, H. M. S. (1979); Van Bemmelen Contributions to the Growth of Geotectonics and the Present State of Earth-Science Research in Indonesia, Geologie Mijinbouw Vol. 58 (2), p. 107 - 116

27. Katili, J. A. (1981); Geology of South Asia with Paticular Reference to the South China Sea Bull. of the Geological Research and Development Center of Indonesia No. 4, March 1981, p. 1 - 12

28. Mitchell A. H. G. (1979); Rift-Subduction-and Collision-Related Tin Belts, Geol. Soc. Malaysia, Bull. Vol. 11, Dec. p. 81 - 102

29. Mori T. and Banno S. (1973); Petrology of Peridotite and Garnet Clinopyroxenite of Mt. Higashi Akaishi Mass, Central Shikoku, Japan (Subsolidus Relation of Anhydrous Phase. Contr. Mineral & Petrol. 41 301 - 323

30. OMRDC (1971); Summary Report on the Survey of Sumatra No. 5 Block (umpublished)

31. Page B. G. N. (1981); The Serpentinites of Northern Sumatra Bull. Directorate of Mineral Resources Indonesia No. 3 Vol. 1 103 - 113

32. Prime, H. N. A. et al (1975); Isotope Geochronology in the Indonesian Tin Belt Geol. Mijinbouw 54, p. 61 - 70

33. Rock N. M. S., A. Djunuddin and et al (1980); Geology of the Natal Teluk Dalam (Part) Quadrangles DMR/IGS Northern Sumatra Project (unpublish)

34. Rocksalagora, W. and Djumhani (1971); Metallic Mineral Deposits of Indonesia, XII Pacific Science Congress

35. Silitonga P. H., Kastowo (1975); Geological Map of Solok Quadrangle, Sumatra Direktorat Geologi, Indonesia

36. Takahashi, M. and et al (1980); Magnetite Series/Ilmenite Series vs I-Type/S-Type Granitoids Mining Geology Special Issue No. 8

37. Taylor D. and Hutchison C. C. (1978); Pattern of Mineralization in Sourth Asia. Their Relationship to Broad Scale Geological Features and the Relevance of Plate Tectonics Concepts to their Understanding. Eleventh Commonwealth Mining and Metallurgical Congress

38. Tsusue, A. and Ishihara, S. (1974); The Iron-Titanium Oxide in the Granitic Rocks of Southwest Japan Mining Geology, Vol. 24, p. 13 - 30