1-4 Preliminary Works of Mercury Gas Geochemistry and Biogeochemistry

(1) Mercury Gas Geochemistry

Mercury contents in gas from soil were measured using portable-type mercury analyzer. The instrument adopted was the Mercury Sniffer model PM-1A of Nippon Instruments Corp. The methodology is gold amalgamation, as was already explained in the first phase report. Detection limit is 0.01 nanograms. Upper limit is 100 nanograms.

Holes of 45 mm in diameter and 50 cm deep were dug using hand auger. PVC tube was then inserted to the depth of about 40 cm. Mouth of the hole was sealed.

Gas of 1.2 liters in soil was sucked out from the hole, and analyzed at the point. Fifty measurements were made. The sample line tested for mercury measurements was running roughly east-west about 2 km long, and crosscutting to one of the major quartz veins in the Batuisi prospect (same line as plant leaf sampling). The average interval of the holes was 50 m along the line. While in the vicinity of the vein (within 35 m radius), holes were dug much closer -- about 10 m apart from each other. Location map of the mercury gas measurements is shown in Fig.2-6. Results of mercury contents in soil gas are listed in a table in the same figure.

The results of mercury contents in soil gas were examined together with the analytical results of soil geochemistry.

The correlation coefficients between mercury content in soil gas and analytical value of soil geochemistry were calculated for 11 geochemical elements. Correlation coefficient of less than 7 % was returned from the combination of Hg (nanogram) in soil gas and Hg (ppm) in soil. No significant correlation has been observed between Hg in soil gas and any other elements in soil.

Fig.2-8 shows the geochemical profiles along the survey line schematically. An Au anomalous zone of about 200 m wide is clearly shown in the profile. Anomalies of Cu, Pb and Zn, though vague, appear within and around the Au anomaly. However, neither Hg in soil gas nor Hg in soil has shown any associated behaviour.

(2) Plant Leaf Biogeochemistry

Test sampling of plant leaves for biogeochemistry was carried out in the Batuisi prospect along the same sampling line as mercury gas measurements. Samples were collected from ten locations, positioned within a radius of 20 meters from the soil sampled holes. Four out of ten locations were set very close to the vein (within 50 m), two moderately close to the vein (100 to 150 m), and remaining four locations far from the vein (700 to 900 m).

Six kinds of grass leaves were collected this time. Two belong to a fernery order -- Kadak and Potok. One is a cogan grass -- Tille. The other three are herbs -- Reubombo, Lito and Tilutilu. The sample list is shown in Table 2-10. Stems and stalks were taken off. Only leaves were selected, washed by river water and dried under the sun. Dried leaves of about 100 grams were sent to Chemex Labs Ltd. for analysis. Seven elements were analyzed; Au, As, Sb, Cu, Pb, Zn and Ba. The analytical methods and the limits of detection are shown in Table 2-9. Results of chemical analysis were listed in the first phase report.

The results were disappointing. Most of the plant leaf samples showed quite low level of metallic element concentration. The maximum value of Au in leaves, for example, is only 0.8 ppb (28-⑥, Tilutilu). Any significant concentration of metallic elements in plant leaves has not been detected. Fig.2-9 shows the schematic profiles of Au and some basemetal elements in plant leaves. Geometric mean of the analytical values is applied for the representative value of each point in the profiles. Line of the profiles is the same as in the mercury gas geochemistry.

Table 2-9 Methods of Analysis and Limits of Detection of Plant Leaf Samples

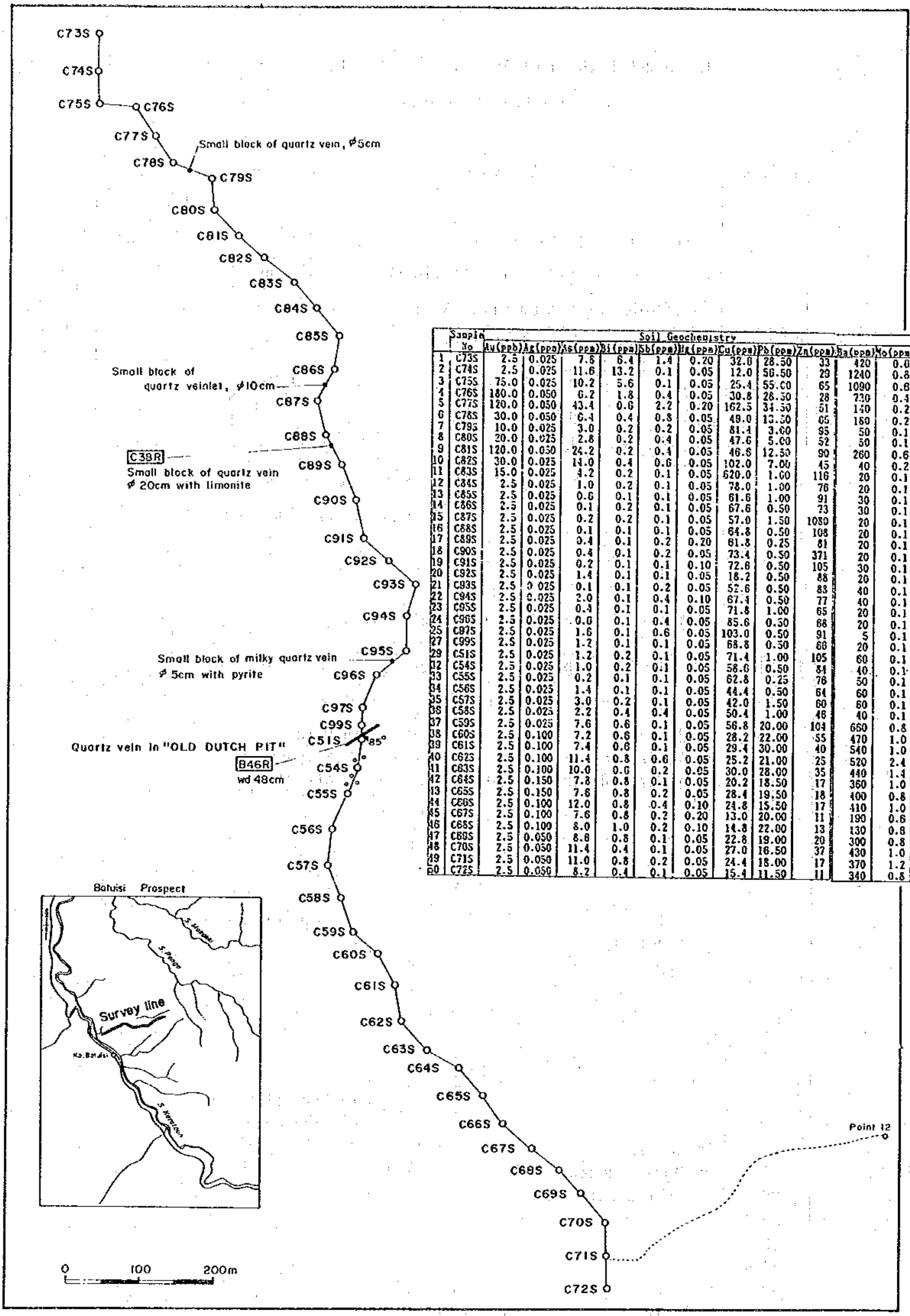
Element	Methods of Analysis	Detection Limit	Upper Limit
Au	Fire assay with NAA finish	0.2 ppb	1 ppm
As	Aqua regia hydride with NAA finish	10 ppb	0.01 %
Sb	$HCl/KClO_3$ extraction with NAA finish	5 ppb	0.01 %
Cu	Nitric aqua regia with AA finish	1 ppm	1 %
Pb	ditto	1 ppm	1 %
Zn	ditto	1 ppm	1 %
Ba	Total digestion with AA finish	10 ppm	1 %

※ NAA means Neutron Activation Analysis
AA means Atomic Absorption Method

Table 2-10 Sample List of Plant Leaves

Sample No.	Name of Samples	Sample No.	Name of Samples
3-① 25-① 28-① 30-① 32-① 34-①	ln:Reubombo sn:Asteraceae eupatorium inulifolium	6-④ 8-④ 23-④ 49-④	ln:Potok sn:Polypodiaceae dryopteris sp.
3-② 6-② 8-② 23-② 25-② 28-② 30-② 32-② 34-② 49-②	ln:Tille sn:Poaceae imperata cylindrica	3-⑤ 6-⑤ 8-⑤ 23-⑤ 25-⑤ 28-⑤ 30-⑤ 32-⑤ 34-⑤ 49-⑤	ln:Lito sn:Schizaeaceae lygodium palmatum
3-③ 6-③ 8-③ 23-③ 25-③ 28-③ 30-③ 32-③ 34-③ 49-③	ln:Kadak sn:Dovalliaceae nephiolepis sp.	3-⑥ 6-⑥ 8-⑥ 23-⑥ 25-⑥ 28-⑥ 30-⑥ 32-⑥ 34-⑥ 49-⑥	ln:Tilutilu sn:Taecaceae tacea pulmata

※1 ln=local name, sn=scientific name
※2 The first two digits of sample number show the hole number. The last digit (①~⑥) shows the kind of plant.



	Sample No	Soil Geochemistry											Hg Gas Mes
		Au(ppb)	Ag(ppm)	As(ppm)	Bi(ppm)	Sb(ppm)	Hg(ppm)	Cu(ppm)	Pb(ppm)	Zn(ppm)	Ba(ppm)	Mo(ppm)	Hg(nanogr)
1	C73S	2.5	0.025	7.6	6.4	1.4	0.20	32.6	28.50	33	420	0.0	0.10
2	C74S	2.5	0.025	11.6	13.2	0.1	0.05	12.0	56.50	29	1240	0.8	0.08
3	C75S	75.0	0.025	10.2	5.6	0.1	0.05	25.4	55.00	65	1090	0.8	0.08
4	C76S	180.0	0.050	6.2	1.8	0.4	0.05	30.8	28.50	28	730	0.4	0.07
5	C77S	120.0	0.050	43.4	0.6	2.2	0.20	162.5	34.50	51	140	0.2	0.07
6	C78S	30.0	0.050	6.4	0.4	0.8	0.05	49.0	13.50	65	160	0.2	0.07
7	C79S	10.0	0.025	3.0	0.2	0.2	0.05	81.4	3.00	95	50	0.1	0.07
8	C80S	20.0	0.025	2.8	0.2	0.4	0.05	47.6	5.00	52	50	0.1	0.05
9	C81S	120.0	0.050	24.2	0.2	0.4	0.05	46.8	12.50	90	260	0.6	0.06
10	C82S	30.0	0.025	14.0	0.4	0.6	0.05	102.0	7.00	45	40	0.2	0.05
11	C83S	15.0	0.025	4.2	0.2	0.1	0.05	620.0	1.00	116	20	0.1	0.06
12	C84S	2.5	0.025	1.0	0.2	0.1	0.05	78.0	1.00	76	20	0.1	0.05
13	C85S	2.5	0.025	0.6	0.1	0.1	0.05	61.6	1.00	91	30	0.1	0.04
14	C86S	2.5	0.025	0.1	0.2	0.1	0.05	67.6	0.50	73	30	0.1	0.05
15	C87S	2.5	0.025	0.2	0.2	0.1	0.05	57.0	1.50	1080	20	0.1	0.04
16	C88S	2.5	0.025	0.1	0.1	0.1	0.05	64.8	0.50	108	20	0.1	0.03
17	C89S	2.5	0.025	0.4	0.1	0.2	0.20	61.8	0.25	81	20	0.1	0.05
18	C90S	2.5	0.025	0.4	0.1	0.2	0.05	73.4	0.50	371	20	0.1	0.04
19	C91S	2.5	0.025	0.2	0.1	0.1	0.10	72.6	0.50	105	30	0.1	0.05
20	C92S	2.5	0.025	1.4	0.1	0.1	0.05	18.2	0.50	88	20	0.1	0.04
21	C93S	2.5	0.025	0.1	0.1	0.2	0.05	52.6	0.50	83	40	0.1	0.05
22	C94S	2.5	0.025	2.0	0.1	0.4	0.10	67.4	0.50	77	40	0.1	0.04
23	C95S	2.5	0.025	0.4	0.1	0.1	0.05	71.8	1.00	65	20	0.1	0.03
24	C96S	2.5	0.025	0.0	0.1	0.4	0.05	85.6	0.50	68	20	0.1	0.04
25	C97S	2.5	0.025	1.6	0.1	0.6	0.05	103.0	0.50	91	5	0.1	0.04
27	C99S	2.5	0.025	1.2	0.1	0.1	0.05	68.8	0.50	68	20	0.1	0.04
29	C51S	2.5	0.025	1.2	0.2	0.1	0.05	71.4	1.00	105	60	0.1	0.09
32	C54S	2.5	0.025	1.0	0.2	0.1	0.05	58.6	0.50	84	40	0.1	0.09
33	C55S	2.5	0.025	0.2	0.1	0.1	0.05	62.8	0.25	76	50	0.1	0.08
34	C56S	2.5	0.025	1.4	0.1	0.1	0.05	44.4	0.50	64	60	0.1	0.08
35	C57S	2.5	0.025	3.0	0.2	0.1	0.05	42.0	1.50	60	60	0.1	0.08
36	C58S	2.5	0.025	2.2	0.4	0.4	0.05	50.4	1.00	48	40	0.1	0.08
37	C59S	2.5	0.025	7.6	0.6	0.1	0.05	56.8	20.00	104	660	0.8	0.08
38	C60S	2.5	0.100	7.2	0.6	0.1	0.05	28.2	22.00	55	470	1.0	0.08
39	C61S	2.5	0.100	7.4	0.6	0.1	0.05	29.4	30.00	40	540	1.0	0.07
40	C62S	2.5	0.100	11.4	0.8	0.6	0.05	25.2	21.00	25	520	2.4	0.07
41	C63S	2.5	0.100	10.0	0.6	0.2	0.05	30.0	28.00	35	440	1.4	0.07
42	C64S	2.5	0.150	7.8	0.8	0.1	0.05	20.2	18.50	17	360	1.0	0.06
43	C65S	2.5	0.150	7.8	0.8	0.2	0.05	28.4	19.50	18	400	0.8	0.08
44	C66S	2.5	0.100	12.0	0.8	0.4	0.10	24.8	15.50	17	410	1.0	0.04
45	C67S	2.5	0.100	7.6	0.8	0.2	0.20	13.0	20.00	11	190	0.6	0.06
46	C68S	2.5	0.100	8.0	1.0	0.2	0.10	14.8	22.00	13	130	0.8	0.04
47	C69S	2.5	0.050	8.8	0.8	0.1	0.05	22.8	19.00	20	300	0.8	0.04
48	C70S	2.5	0.050	11.4	0.4	0.1	0.05	27.0	16.50	37	430	1.0	0.02
49	C71S	2.5	0.050	11.0	0.8	0.2	0.05	24.4	18.00	17	370	1.2	0.04
50	C72S	2.5	0.050	8.2	0.4	0.1	0.05	15.4	11.50	11	340	0.8	0.03

Fig.2-6 Location Map of Soil Samples and Mercury Gas Measurements at the NW of S. Tarawa

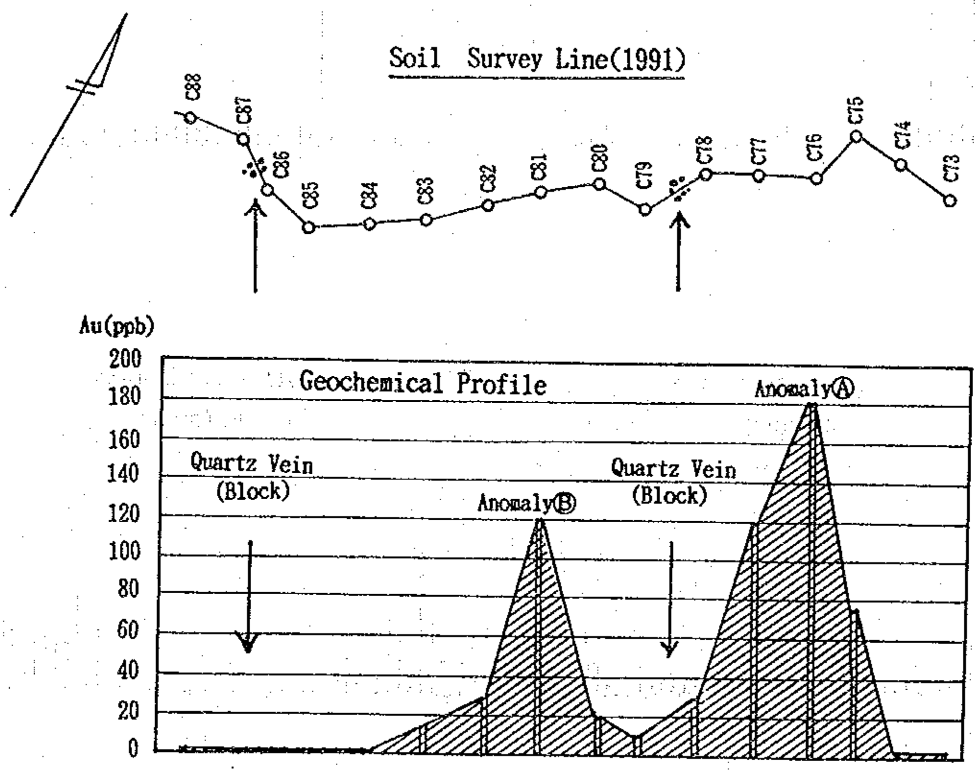


Fig.2-7 Geochemical Profile along the Survey Line at the NW of S. Tarawa

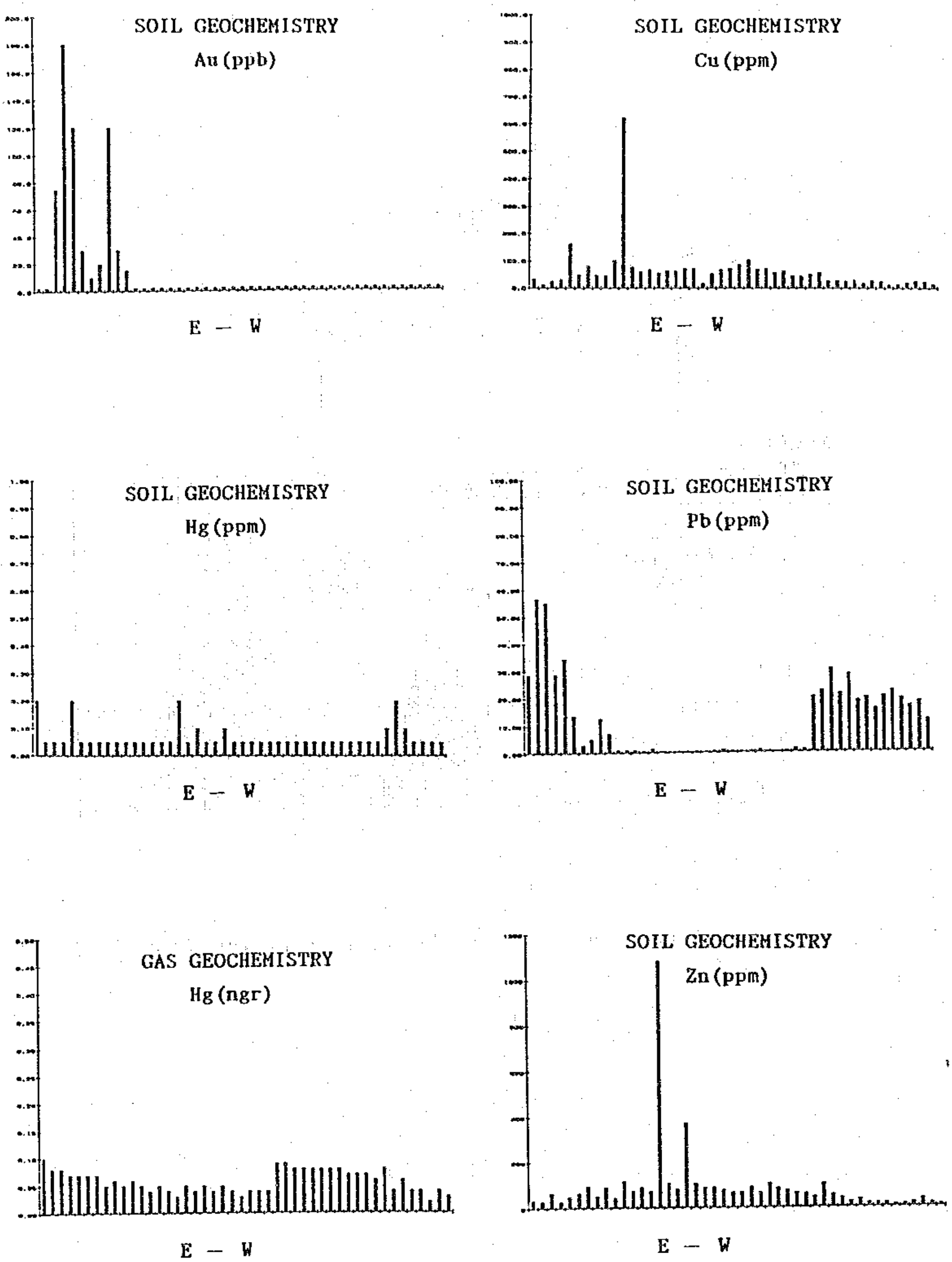
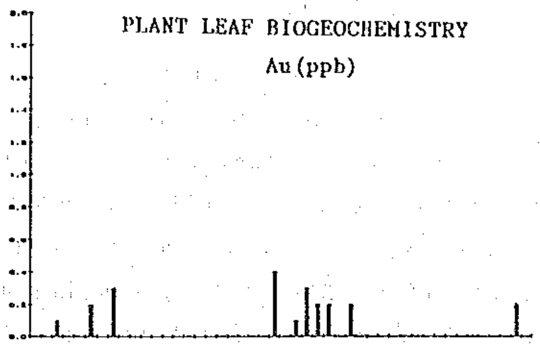
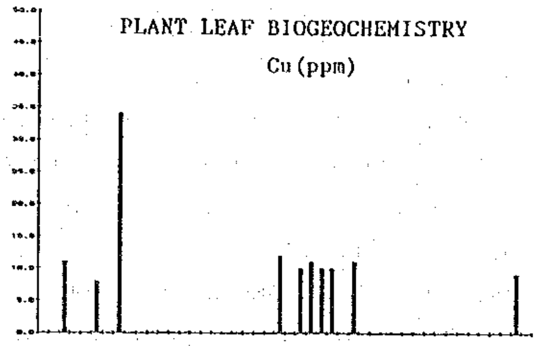
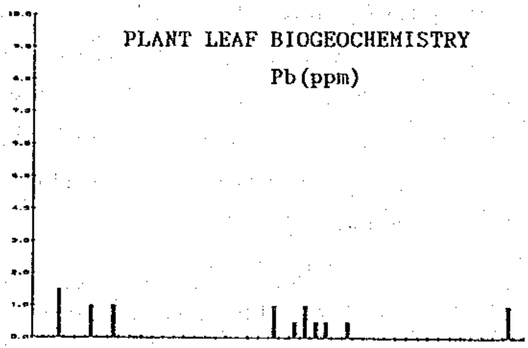


Fig.2-8 Schematic Geochemical Profile along the Soil Line at the NW of S. Tarawa







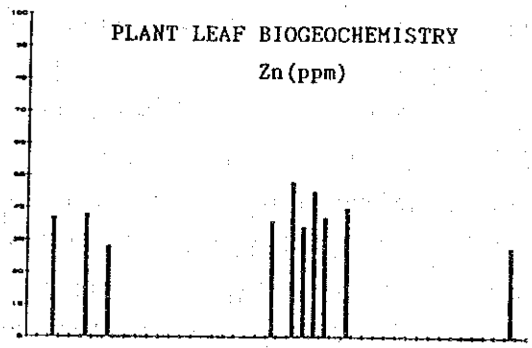


Fig.2-9 Schematic Biogeochemical Profile along the Soil Line at the NW of S. Tarawa

1-5 Summary and Conclusions of Geochemical Exploration in the First Phase

(1) Regional geochemical exploration

On the basis of the result of regional geochemical exploration by means of stream sediment sampling, six areas came to light as the potential mineralized areas. The results of panning prospecting and geological survey were the other points to have been considered in the evaluation. Semi-detailed survey was undertaken in two of the areas -- Batuisi and Bau -- during the exploration programme in 1991. Among the remaining four areas, S. Lebutang and Kariango appeared to be interesting prospects of gold and basemetal mineralization.

Fig.2-2 shows the distribution of regional geochemical gold anomalies in the northern part of the survey area (1991). Au anomalies of stream sediment samples, and gold occurrences in pan concentrates were integrated in the map. A sizable amount of geochemical anomalies was discovered at S. Lebutang. Moreover values of the Au anomalies were distinctive in the prospect. A considerable amount of Au anomalies were also found in the Kariango area. Those two prospects were picked up for the further exploration. It was recommended that semi-detailed level of works comprising geological survey, panning prospecting and soil survey be carried out in the S. Lebutang and Kariango prospects in the next phase programme.

(2) Semi-detailed geochemical exploration

Regarding the results of the semi-detailed geochemical exploration -- panning prospecting and soil survey -- in Batuisi and Bau, several significant anomalous zones were delineated from the integrated examination with the results of geological survey. The major target zones for the further exploration were: the upper reaches of S. Tarawa and the lower reaches of S. Malela in the Batuisi prospect, and the eastern anomalous zone and the western anomalous zone in the Bau prospect.

Figs. 2-4 and 2-5 show the distribution of indications of gold mineralization in the Batuisi and Bau prospects. Inferred mineralized zones were outlined based on the distribution of quartz veins/floats and geochemical anomalies. Detailed geological survey and geochemical exploration comprising soil survey and rock-chip sampling were recommended in the two prospects in the next phase programme. For the purpose of elucidating the nature and characteristics of gold mineralization in this area, continuous sampling in trenches and/or drill cores could be useful in the most remarkable zones such as the upper reaches of S. Tarawa and the lower reaches of S. Malela.

Chapter 2 Batuisi Prospect

2-1 Outline of the Prospect

The Batuisi prospect is located between S. Karataun and the upper reaches of S. Pongo in the northwestern part of the survey area. The altitude of S. Karataun is 150 m above sea level (at the bridge of Kp. Batuisi). A high ridge of more than 600 m extends northwestward in the prospect. The prospect lies geologically among the area of metasediments of the Latimojong Formation. The Mamasa granite batholith occurs at the southeastern area adjacent to the prospect. Dacite lava and volcanic breccia of the Barupu Tuffs occur at the high elevations. The distribution of these young volcanics forms very steep ridges.

Semi-detailed geological survey, panning prospecting and reconnaissance soil survey were conducted for the area covering approximately 50 km^2 last year. Positive geological and geochemical results was returned in the first phase survey, although assaying on some of the quartz veins were disappointing. Two remarkable Au anomalous zones of soil samples were caught. One was distinctive Au soil anomaly at the hill northwest of the upper reaches of S. Tarawa. Another zone was found at the middle reaches of S. Malela. Several other anomalous zones were delineated in the prospect as well. Those zones were composed of Au soil anomalies, panning and stream sediment anomalies, and occurrence of quartz veins/stockworks. The strike direction of each zone was interpreted to be NNW from the trend of quartz veins.

On the basis of the results of the first phase exploration, the central part was picked up for the detailed survey area. It consisted of about 15 km^2. The works in this phase were composed of detailed geological survey, grid soil survey, geochemical rock-chip sampling and shallow trenching. A small scale drilling programme for the reconnaissance purpose was carried out at the hill northwest of the upper reaches of S. Tarawa.

2-2 Geological Survey

(1) Survey method

Detailed geological survey was undertaken together with grid soil survey and geochemical rock-chip sampling in the Batuisi prospect. A base camp was settled in Kp. Batuisi for geological survey. A series of flying camps were also employed for a period of one to two weeks. A 1:5,000 scale route map was produced on the last year's map through grid surveying (200 m x 50 m) with fifty meter tape and a Brunton-type compass. Major outcrops of quartz veins and trenches were studied in much details (sketches of 1:50 to 1:200 scale were drawn).

During the field work, geology and the degree of hydrothermal alteration were surveyed, and samples for assaying and laboratory studies were collected at every major outcrop and quartz float zone. The degree of alteration was carefully judged and recorded on the field note by geologist on the basis of the following criteria:

① Silicification;
S)trong, M)oderate, W)eak, N)one
② Chloritization;
S)trong, M)oderate, W)eak, N)one
③ Pyritization;
S)trong, M)oderate, W)eak, N)one

Other features of mineralization and hydrothermal alteration such as sulphide dissemination, clay alteration and quartz networking were also checked in the survey.

The results of the geological survey were compiled on a 1:10,000 scale geological map. Alteration map was produced and examined as well. A total of 75 km of survey length was achieved, and 80 ore samples were collected. Numbers of samples for polished sections and X-ray powder analysis were 5 and 4 respectively this year.

(2) Geology and geologic structure

Latimojong Formation (Kl) : The major part of the prospect consists of shale, siltstone, tuffaceous shale, andesite and dolerite of the Latimojong Formation.

Shale and siltstone commonly show dark grey to brown massive appearance. Some part of shale is weakly metamorphosed, and shows phyllitic features. The trend of shale and siltstone changes variously. In the broad scale, they have a general strike direction of N-S to NW and W dip. Generally speaking, the lower part of the sedimentary facies consists of shale, and the upper part of siltstone.

Andesite to basic lava facies occurs at the upper reaches of S. Tarawa and at the middle reaches of S. Malela. It is slightly metamorphosed and some part shows doleritic texture. The volcanic facies of the Latimojong Formation overlies on the sedimentary facies in the Batuisi prospect. The transitional zone is composed of the alternation of tuffaceous shale, shale/siltstone and lava.

Barupu Tuffs (Qt) : Andesite to dacite lava and volcanic breccia are developed at the high-altitude (about 600 m above sea level) in the prospect. These young volcanics of the Barupu Tuffs occur on the ridge between S. Karataun and S. Pongo. They form very steep, sometimes inaccesible topography.

Intrusive rocks : Small stocks of diorite and andesite dykes were observed in the prospect as for intrusive rocks. A stock of diorite occurs in shale at the middle reaches of S. Tarawa. It is chemically diorite to granodiorite, and is composed of plagioclase, orthoclase, biotite, quartz and hornblende. Diorite stocks were also found at the area between S. Pongo and S. Makaliki. They show an elongation of the NW direction in common.

Several small dikes of andesite are intruded within shale at the area along S. Karataun. Most of them are hornblende andesite, and some are biotite andesite.

The Batuisi prospect is situated structurally at the western flank of an anticlinorium. The Mamasa granite batholith is exposed at the southeastern area adjacent to the prospect. The granite crypto-batholith is supposed to lie beneath the prospect area as well.

Two groups of faults -- E-W and NW-SE -- were recognized within the prospect. Faults of the E-W direction occur at S. Malela and S. Bone. Faults of the NW-SE occur at S. Bone. The latter is crosscut by the former.

(3) Mineralization and hydrothermal alteration

Extensive development of quartz veins and quartz stockworks was observed at the middle reaches of S. Tarawa, the upper reaches of S. Tarawa and the middle reaches of S. Malela.

More than 20 quartz veins were counted at the middle reaches of S. Tarawa and its branch creeks. They show massive features of up to 2.8 m wide. Their strike direction changes variously. The most common trend is NNW with steep E dip. N-S and NW systems are the next major trend. The quartz at the middle reaches of S. Tarawa generally contains a small amount of sulphide minerals such as chalcopyrite, pyrite, arsenopyrite and sphalerite. Gold grade of quartz veins is generally very low. Shale and siltstone adjacent to quartz veins are strongly silicified. A moderate degree of chloritization was observed in the country rock near quartz veins. These quartz veins extend to the northwest and to the southeast. At the hill between S. Tarawa and S. Bone, a couple of massive quartz vein of 50 cm in width were observed at the "Old Dutch Pit" site (Fig. 2-10). The northwestern extension of these quartz veins was traced to the middle reaches of S. Bone. The southeastern extension was caught at the middle reaches of S. Tarawa.

A group of quartz veins/stockworks is developed at the upper reaches of S. Tarawa and the upper reaches of S. Bone. Quartz of this group generally shows white to light grey color, translucent with resin-like brightness. The width is from a few centimeters to 70 cm. Each vein shows various trends, however they have gentle dipping and stockwork nature in common. The major trends recognized in this area are NNW and N-S~NNE. They crop out sporadically at the upper reaches of S. Tarawa and the upper reaches of S. Bone. Many flocks of quartz floats and gravels are distributed at the hill between the two creeks. They were interpreted to be the surface exposures of quartz of this group. Pyrite dissemination was observed in quartz. Some quartz samples of this group showed a significant value of gold from the geochemical point of view as listed in Table 2-15. Alteration in the surrounding rock is not so distinctive. Moderate silicification and weak chloritization were observed in this area during the field survey. This group of quartz veins/stockworks later became the main target of trenching and drilling exploration in the Batuisi prospect.

Gold mineralization was recognized in andesite and black shale at S. Malela. Andesite is crosscut by quartz veins, which are white, massive, and medium to coarse grain with pyrite and chalcopyrite. They have widths ranging from 10 cm up to 3 m. Andesite is also crosscut by quartz stockwork system. Quartz veinlets are developed in black shale as well. The trend of quartz veins changes variously. The dominant direction is NNW at S. Malela. Quartz veins were caught at the branch creeks of S. Pongo through the detailed geological survey this year. Two kinds of vein systems were distinguished at the area -- NNE with W dip and E-W with N dip.

Vein quartz in S. Tarawa, S. Bone and S. Malela commonly shows massive appearance. Petrographic study has indicated characteristic features of those quartz. It sometimes shows clastic (cataclastic) texture. Massive vein quartz is fractured. It is filled by microcrystalline quartz. Chlorite, clay minerals and opaque ore minerals were observed in fractures of the massive quartz. One of the opaque ore minerals which are associated with the later stage quartz is fine grain pyrite. It is partly oxidized to iron oxide mineral (limonite). Aduralia was recognized to be associated with quartz in some massive quartz vein under the microscope. Calcite and anhydrite veinlets were observed to crosscut quartz vein in some cases.

Some characteristic association of sulphide minerals was observed in quartz stockwork at S. Malela. It is composed of pyrite, arsenopyrite, chalcopyrite and bornite. Pyrite is partly replaced by iron oxide (limonite), and chalcopyrite is replaced by covelline and malachite. The results of ore microscopy are listed in Table 2-12.

Silicification, chloritization and sericitization were distinguished through the X-ray powder diffraction analysis as for the wall rock alteration associated with quartz veining/stockworking. The results are shown in Table 2-13.

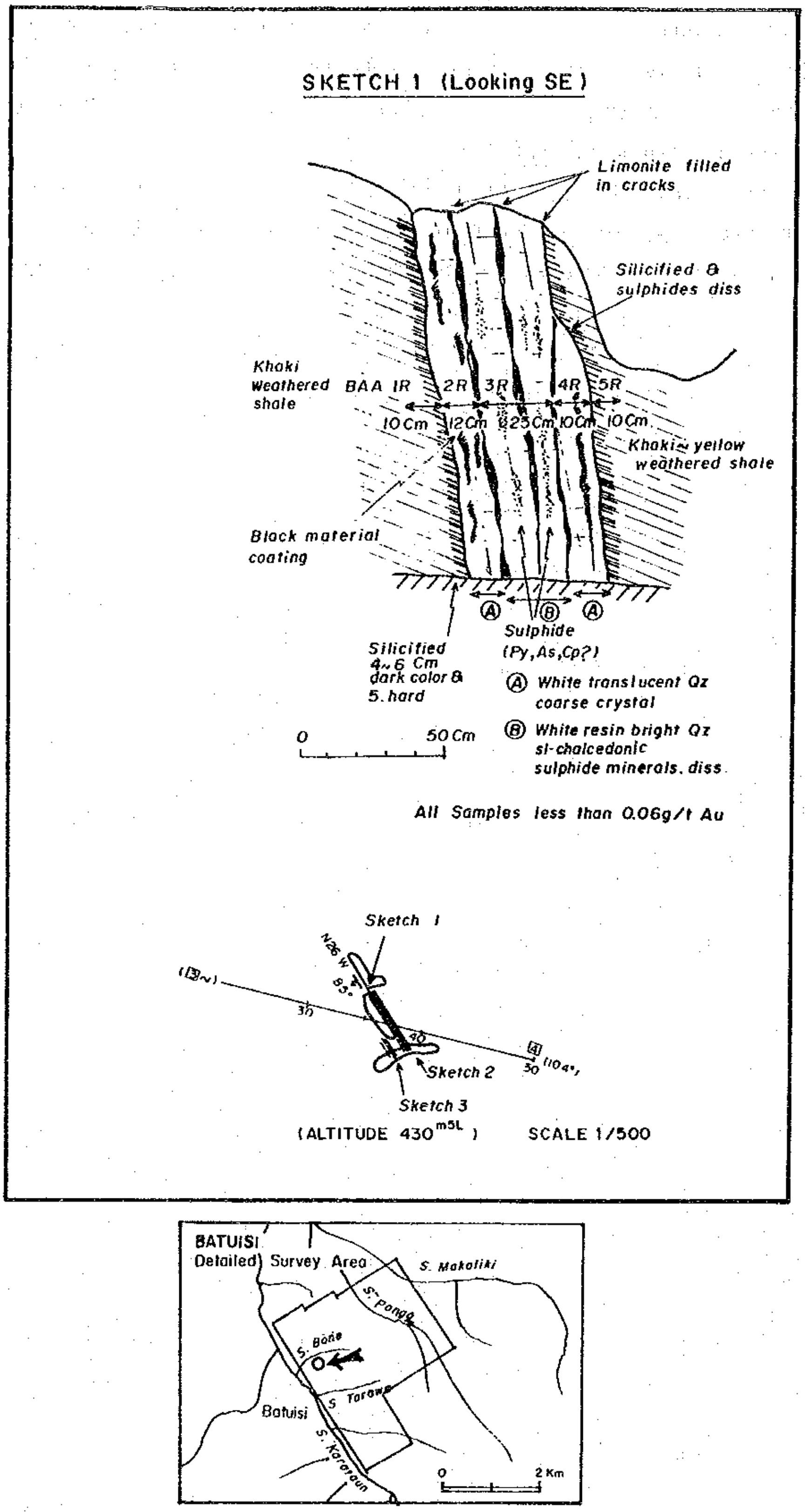
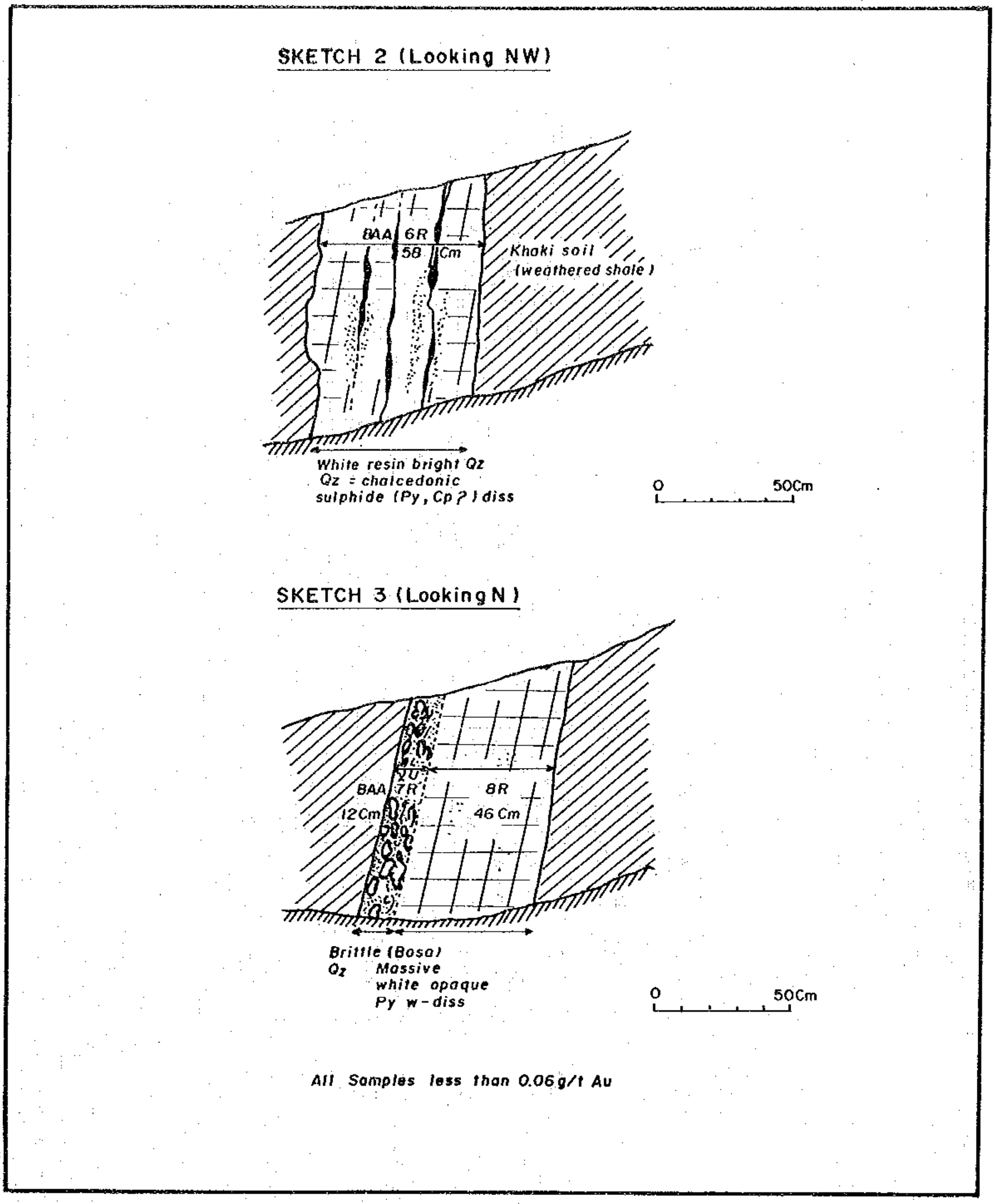


Fig.2-10 Sketch Showing the Occurrence of Quartz Vein at the Old Dutch Pit (1)



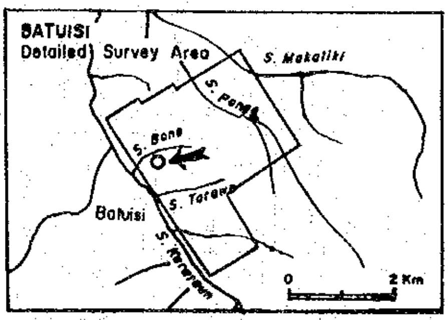


Fig.2-10 Sketch Showing the Occurrence of Quartz Vein at the Old Dutch Pit (2)

Table 2-11 Results of Microscopic Observation of Thin Sections

Sample No.	Locality	Rock Name	Formation	Texture	Phenocryst/Crystal Fragment									Groundmas/Matrix						Alteration
					Qz	Kf	Pl	Bi	Hb	Px	Ol	Ep	Op	Qz	Kf	Pl	Hb	Px	Gl	
	【S. LEBUTANG】																			
LEB1T	S. Lebutang	Trachy andesite	Kv	Hol(fine)	•	△	△		●			•	•							Pl→Kf•Hb→Ch, Py diss(w)
LEB2T	S. Lebutang	Microdiorite	Tmg	Hypd-gr.			●		●	△		•	•			△				Pl•Hb→Ch•Se
LEB3T	S. Lebutang	Phyllite	Kls	Clastic	○			●					•			•				CH, Qz-veinlet
LEB4T	S. Lebutang	Siltstone	Kls	Clastic	○		△	○					•			•				Ch, Qz-veinlets, Py diss
LEB5T	S. Lebutang	Granite	Tmg	Hypd-gr.	△	●	•	△	△	•										Kf•Pl→Ch•Se
LEB8T	S. Lebutang	Andesite	Kv	Porphyritic			○		△	•			•			○				Pl•Hb→Ch•Se
LEC12T	S. Peko	Qz•Ep vein	-	Fractured	●							○	•							
LED12T	S. Petangunan	Dacite	Qt	Porphyritic	△		●		△	△			•			○	•	•		Pl→Ch
LED14T	S. Petangunan	Andesite	Klv_1	Brecciated			○			△						△			•	Pl•Px→Se•Ca
LED24T	S. Petangunan	Tuff breccia	Klv_2	Clastic		△	○			△		•		•		△				Pl→Ch
LED26T	S. Piku	Granite	Tmg	Hol-gr.	△	●	•	•	△				•							Kf→Ch•Se
LED28T	S. Malolo	Andesite	Qt	Porphyritic			●		○	○			•			○	•	•		Px•Hb→Ch
	【KARIANGO】																			
KAD1T	S. Uroh	Tuffaceous sandstone	Tmb_3	Clastic	•	•	○					•	•			•				
KAD3T	S. Uroh	Andesite	Tv	Porphyritic			●	△	•				•			○				Pl•Hb→Se•Ch
KAD8T	S. Kariango	Granodiorite	Tmg	Porphyritic			●	△	•	•				•		○				Pl→Qz•Se•Ca, Px•Hb→Ch, sili.
KAD12T	S. Uroh	Andesite	Tmv	Brecciated			○	•		•						△			•	Pl→Se•Ch
KAG2T	S. Ruruh	Diorite porphyry	Tmd	Porphyritic			△			○			•			○		•		Px•Pl→Ch•Ca
KAH7T	S. Kanan	Granodiorite	Tmg	Porphyritic			●	△		△			•			○	•	•		Pl→Se•Ch•Ca, silicified
KAH9T	S. Kanan	Granodiorite	Tmg	Porphyritic			○					•	•	•	△	○				Pl→Se•Ca
	【BAU】																			
BAC16T	S. Salubongi	Qz vein	-		●	△							•							Kf→Se, Qz-veinlet

Abundance of Minerals : ●;Abundant, ○;Common, △;Rare, •;Trace
Abbreviations
Formation Names: Kl;Latimojong For., Tmb;Beropa Tuffs, Qt;Barupu Tuffs, Tmg;Mamasa granite, Tmd;Diorite, Kv;Andesitic volcanic neck, Tv;Andesite(dyke)
Texture : Hol;Holocrystalline, Hypd-gr;Hypidiomorphic-granular
Minerals : Qz;Quartz, Kf;Potash feldspar, Pl;Plagioclase, Bi;Biotite, Hb;Hornblende, Px;Pyroxene, Ol;Olivine, Ep;Epidote, Op;Opaque Minerals, Gl;Glass, Ch;Chlorite, Se;Sericite, Ca;Carbonates

Table 2-12 Results of Ore Microscopy

Sample No.	Locality	Minerals Py	As	Cp	Sp	Ga	Bn	Cv	Io	Remarks
	Batuisi									
BAA53K	S.Tarawa	△	•	•	•				•	Quartz float
BAA62K	T-2, 79m	•							•	Quartz vein (Wd=12cm)
BAA75K	S.Bone	△	•	•				•	•	Quartz vein (Wd=75cm)
BAA99K	T-6, 22m	•	•	•	•			•	•	Quartz vein (Wd=24cm)
BAA103K	T-5, 47m	△		•				•	•	Quartz vein (Wd=32cm)
BTB17K	S.Kayulalong	•		•				•	•	Qz fl. Io composed of hematite & limonite
										Sulphide vein crosscut by qz vein
BTC43K	S.Bone	•	•	•				•	•	Quartz float
BTF16K	S.Malela	•	•	○			•	•	△	Qz stockwk (Wd=20cm). Trace of malachite
	Bau									
BAB2K	S.Balimbing	△	•	•		•	•	•	•	Qz veinlet (Wd=9cm). Trace of chalcocite
BAB5K	S.Mariku			•					•	Quartz-epidote float
BAB18K	S.Balimbing	△	•	•					•	Sulphide dissemination in shale
BAB19K	S.Balimbing	•		•					•	Sulphide veinlet in diorite
BAC8K	S.Salole	•	•	•						Silicified andesite. Py disseminated
BAC16K	S.Salubongi	•	•	•	•					Quartz vein (Wd=10cm)
BAC17K	S.Salubongi	•		•					•	Quartz vein (Wd=15cm)
	S.Lebutang									
LEB11K	S.Taroto	•							•	Andesite boulder. Py disseminated
LEB17K	S.Taroto	•		•					•	Sulphide vein (Wd=35cm)
LEB25K	S.Lebutang	•		•				•	•	Sulphide dissemination near qz vein
LEC13K	S.Peko	△	•	•	•					Quartz vein (Wd=50cm)
LEF1K	S.Lebutang	○	○	•						Pyrite ore float
LEG11K	S.Peko	•		•	•			•		Pyrite veinlet/network
	Kariango									
KAB2K	S.Suluan	•							△	Py netwk.Io composed of hematite & limonite
KAB8K	S.Suluan								•	Pyrite network
KAB9K	S.Suluan	•							△	Gossan fl.Io composed of limo & specularite
KAB10K	S.Saluan	△							•	Silicified zone near quartz vein

Abundance of Minerals: ○;Common, △;Rare, •;Trace
Abbreviation : Py;Pyrite, As;Arsenopyrite, Cp;Chalcopyrite
Sp;Sphalerite, Ga;Galena, Bn;Bornite
Cv;Covelline, Io;Iron Oxide

Table2-13 Results of X-ray Diffraction Analysis (1/2)

No.	Sample No.	Altered Rock	Rock unit	Location	Clay Mineral							Sulfate m.			Carbonate			Silicate			Feld.		Miscellaneous m.					
					Mo	Ch	Se	Mu	Ka	Ha	Mx	Al	Gy	Ja	Ca	Ak	Si	Cr	Tr	Qz	Pl	Kf	Py	Go	He	Im	Ho	At
				【Batuisi】																								
1	BAA1X	Footwall(shale) of Qz vein	Kl	Old Dutch Pit		○														◎	o							
2	BAA5X	Hangingwall(shale) of Qz vein	Kl	Old Dutch Pit		o														◎	◎							
3	BAA59X	Qz stockwork in andesite	-	T-2, 78.0m					○									o		◎					●?			
4	BAA78X	Qz stockwork	-	T-1, 23.5-27.0m		o										●				◎				●?				
5	BAA82X	Qz stockwork	-	T-2, 76.3-79.7m					○											◎					●			
6	BAA83X	Qz stockwork	-	T-3, 36.7-40.0m					o											◎		●?						●?
7	BAA87X	Andesite	Kl	T-4, 77.7-78.7m			o		●											◎								o
8	BAA96X	Silicified zone	-	T-4, 112.0m		●														◎	○							
9	I44X	Qz vein in andesite	-	T-4, 107.5m																◎	●?							
10	I45X	Silicified zone in andesite	-	T-4, 112.0m																◎	○							
11	I47X	Silicified zone in andesite	-	T-4, 117.5m																◎		●?	●?					
12	BTC2X	Qz stockwork	-	T-1, 18.5m					o											○								o
				【Bau】																								
13	BAB1X	Brown, soft saprolite	Kv	S.Balimbing	○				●											○	◎							
14	BAB2X	Qz-vein with calcite	-	S.Balimbing											o	◎				○								
15	BAB4X	Brown, soft, limonitic	Kv	S.Mariku																○				o	o			
16	BAB6X	Qz-vein, Py-diss	-	S.Balimbing					o						●?	◎				◎	o							
17	BAC95X	Silicified dyke rock	Tmd	S.Bau			o		●							○				◎	○		●					
18	BAC16X	Qz vein	-	S.Salubongi			●								○					◎								
19	BAD8X	Qz vein in andesite	Kl	S.Belopi		○									o					○	○	●?					●?	
20	BAF1X	Altered, silicified rock	Kl	S.Balimbing	○				●											○	○							
21	BAF2X	Brown, soft saprolite	Kl	S.Balimbing	●				o											◎	◎							
22	BAF3X	Brown, limonitic	Kl	S.Balimbing	○				●											○	◎							
23	BAE1X	Qz-veinlet in white rock	-	S.Lipak			○		o											◎	○		●					

Abbreviations: ◎:Abundant, ○:Common, ∘:Few, ●:Rare, Mo:Montmorillonite, Ch:Chlorite, Se:Sericite, Mu:Muscovite, Ka:Kaoline, Mx:Mixed layer, Ha:Halloysite, Al:Alunite, Gy:Gypsum, Ja:Jarosite, Ca:Calcite, Ak:Ankerite, Si:Siderite, Cr: α-Cristobalite, Tr:Tridymite, Qz:Quartz, Pl:Plagioclase, Kf:Potash feldspar, Py:Pyrite, Go:Goethite, He:Hematite, Im:Ilmenite, Ho:Hornblende, At:Anatase,

Table2-13 Results of X-ray Diffraction Analysis (2/2)

No.	Sample No.	Altered Rock	Rock unit	Location	Clay Mineral							Sulfate m.			Carbonate			Silicate			Feld.		Miscellaneous m.					
					Mo	Ch	Se	Mu	Ka	Ha	Mx	Al	Gy	Ja	Ca	Ak	Si	Cr	Tr	Qz	Pl	Kf	Py	Go	He	Im	Ho	At
				【Lebutang】																								
24	LEB1X	Argillaceous andesite	Kv	S. Taroto		○															○						◎	
25	LEB5X	Saprolite/alluvial	Kv	S. Taroto					o			●?								○		○				●?		
26	LEB17X	Wall rock of shear zone	Kv	S. Taroto		○														o	○						◎	
27	LEC1X	Wall rock of qz-cal vein	Kv	S. Peko		○															◎	o					○	
28	LEC6X	Country rock of bedded Py	Kv	S. Talang		○														○	◎							
29	LED5X	Wall rock of quartz vein	Klv	S. Penaseang		○									○					◎	◎							
30	LEG11X	Altered porphyritic dacite	Kv	S. Peko		◎															○		o					
				【Kariango】																								
31	KAB1X	White argillaceous tuff	Tmbl	S. Suluang					o											◎								
32	KAB2X	Pale green argillaceous tuff	Tmbl	S. Suluang			o				o									◎								
33	KAB9X	Gossan	-	S. Suluang																◎					o			

Abbreviations: ◎:Abundant, ○:Common, o:Few, ●:Rare, Mo:Montmorillonite, Ch:Chlorite, Se:Sericite, Mu:Muscovite, Ka:Kaoline, Mx:Mixed layer, Ha:Halloysite, Al:Alunite, Gy:Gypsum, Ja:Jarosite, Ca:Calcite, Ak:Ankerite, Si:Siderite, Cr:α-Cristobalite, Tr:Tridymite, Qz:Quartz, Pl:Plagioclase, Kf:Potash feldspar, Py:Pyrite, Go:Goethite, He:Hematite, Im:Ilmenite, Ho:Hornblende, At:Anatase,

Table 2-14 Methods of Analysis and Limits of Detection for Ore Assay

Element	Methods of Analysis	Detection Limit	Upper Limit
Au	Fire assay with AA finish	0.06 g/t	600 g/t
Ag	Nitric aqua regia with ICP-AES finish	2 g/t	500 g/t
Cu	ditto	0.001 %	2.50 %
Pb	ditto	0.001 %	2.50 %
Zn	ditto	0.001 %	2.50 %
Fe	ditto	0.01 %	50 %

※ AA means Atomic Absorption Method
※ Chemical analysis conducted by Chemex Labs Ltd.

Table 2-15 Assay Results of Ore Samples in the Batuisi Prospect (1)

Sample No.	Width (cm)	Au (g/t)	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)	Fe (%)	Sample type and locality
BAA2A	12	<0.06	2	0.077	0.001	0.148	4.99	Qz vein, Old Dutch Pit
BAA7A	12	<0.06	<2	0.003	<0.001	0.007	4.92	Qz vein, Old Dutch Pit
BAA32A	5	0.19	2	0.014	0.004	0.010	11.70	Qz veinlet, T-1, 5.4m
BAA35A	25	0.19	<2	0.003	<0.001	0.001	0.87	Qz vein, T-1, 32.0m
BAA59A	42	<0.06	<2	0.015	0.003	0.007	4.97	Qz stockwork, T-2, 78.0m
BAA62A	12	<0.06	<2	0.019	0.002	0.010	5.32	Qz vein, T-2, 78.0m
BAA63A	230	0.12	<2	0.038	0.004	0.011	5.97	Qz stockwork, T-1, 23.7m
BAA64A	15	0.12	<2	0.028	0.003	0.008	4.15	Qz vein, T-1, 25.0m
BAA66A	200	0.09	<2	0.081	0.004	0.014	5.22	Qz stockwork, T-1, 24.0m
BAA68A	80*	0.53	<2	0.065	<0.001	0.025	4.12	Qz vein, S.Bone
BAA72A	200	<0.06	2	0.009	0.001	0.007	5.60	Qz stockwork, T-3, 37.0m
BAA77A	330	0.16	2	0.027	0.001	0.012	5.97	Qz stockwork, T-1, 17.2m
BAA79A	320	1.52	<2	0.024	0.002	0.011	7.98	Qz stockwork, T-1, 30.4m
BAA81A	200	<0.06	<2	0.016	0.002	0.006	5.96	Qz stockwork, T-2, 26.5m
BAA83A	330	<0.06	2	0.012	0.002	0.009	7.32	Qz stockwork, T-3, 36.7m
BAA84A	300	<0.06	2	0.005	0.002	0.007	4.93	Qz stockwork, T-3, 48.5m
BAA85A	16	<0.06	<2	0.009	0.004	0.008	5.08	Qz vein, T-4, 77.2m
BAA94A	28	<0.06	<2	0.153	0.001	0.025	5.36	Qz vein, T-4, 91.6m
BAA96A	200	0.72	<2	0.008	0.002	0.008	3.59	Sili zone, T-4, 111.0m
BAA99A	24	<0.06	2	0.045	0.002	0.014	4.95	Qz vein, T-6, 22.0m
BTB6A	--	0.19	16	>3.00	0.001	0.041	6.04	Qz float, N2, 22-23
BTB12A	--	<0.06	<2	0.088	<0.001	0.025	7.78	Qz float, N1, 12-13
BTB17A	--	0.16	8	1.735	<0.001	0.031	3.80	Qz float, S2, 10-11
BTB19A	20	<0.06	<2	0.147	0.001	0.063	5.29	Shear zone, S2, 10-11
BTB20A	60	<0.06	<2	0.037	<0.001	0.017	5.34	Qz vein, S2, 10-11
BTB22A	15	<0.06	2	0.511	<0.001	0.012	1.60	Qz vein, S2, 10-11
BTB23A	--	<0.06	2	0.558	<0.001	0.571	5.05	Qz float, S4, 3-4
BTB34A	--	<0.06	4	0.659	0.001	0.123	8.76	Sili float, S3, 21-22
BTB35A	--	0.16	4	0.232	<0.001	0.041	10.80	Qz float, S3, 24-25
BTB38A	40	<0.06	<2	0.039	<0.001	0.013	6.14	Qz vein, S3, 33-34
BTB45A	--	<0.06	6	0.956	0.001	0.023	3.31	Qz float, S4, 30-31
BTB54A	--	0.22	22	1.570	<0.001	0.100	9.85	Qz float, NS0, 23-24
BTC3A	50	<0.06	<2	0.041	0.001	0.780	6.38	Qz vein, N16, 7-8
BTK8A	7	1.34	8	1.460	0.002	1.255	13.00	Qz-Py-Cp vein, S.Tarawa

Table 2-15 Assay Results of Ore Samples in the Batuisi Prospect (2)

Sample No.	Width (cm)	Au (g/t)	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)	Fe (%)	Sample type and locality
BTK25bA	50	<0.06	2	0.527	<0.001	0.205	1.86	Qz vein, S.Kayulalong
BTK26A	200+	<0.06	4	0.926	0.002	0.061	3.13	Qz vein, S.Kayulalong
BTK27A	100+	<0.06	2	0.594	0.001	0.041	2.11	Qz vein, S.Kayulalong
BTF14A	--	<0.06	2	0.022	<0.001	0.010	6.76	Qz stockwork, S.Malela
BTF16A	70	<0.06	6	1.215	0.001	0.027	3.25	Qz stockwork, S.Malela
BTF18A	35	<0.06	2	0.501	0.001	0.008	1.82	Qz vein, N2, 47-48
BTF18rA	40	<0.06	2	0.023	0.002	0.002	2.60	Qz vein, N4, 44-45
BTF20A	--	<0.06	2	0.587	0.001	0.009	2.04	Qz float, N4-6, 48-49
BTF22A	15	<0.06	<2	0.020	<0.001	0.142	7.56	Qz vein, NS0-N2, 42-43
BTF25A	10	<0.06	4	0.446	0.001	0.009	1.39	Qz vein, NS0, 42-43
BTG1A	--	<0.06	2	0.004	0.001	0.007	6.13	Qz veinlet, N4, 49-50
BTG7A	--	0.40	8	1.740	<0.001	0.032	4.35	Qz float, N4-6, 50-51
BTH36A	15	<0.06	2	0.010	0.001	0.007	4.79	Qz stockwork, S.Batupapan
BTH39A	20	<0.06	<2	0.007	0.001	0.010	6.05	Sili rock, S.Batupapan

2-3 Grid Soil Survey

(1) Sampling and chemical analysis

Detailed soil sampling was carried out for the entire 15 km^2 area in the Batuisi prospect. Soil samples were taken from the B-layer of residual soil at a depth of 40 to 80 cm from the surface using hand-auger. Sample lines were set systematically at line spacing of 200 m and sample intervals of 50 m. The base line, which was orientated at 54 degree (N54°E), was set up through surveying with transit and fifty-meter tape.

The sampling was carried out generally by a team composed of one geologist, one surveyor and several field hands. While a hole was dug and a soil sample was picked up by surveyor, the observation of samples was made and it was recorded on the field note by geologist. The record form for soil samples consisted of the following descriptions:

① Location (grid coordinates)
② Sample number
③ Sample type (residual, talus, alluvial or cultivated)
④ Site topography (hill top, slope, base of slope, valley floor or level)
⑤ Horizon (A, BF, BT, BM or C)
⑥ Depth
⑦ Color
⑧ Texture (organic, sandy, silty, clay or gravel)
⑨ Coarse fragment (lithic fragment, quartz, pisolite or others)
⑩ Bedrock.

Soil samples were air-dried at the base camp, then crashed to -80 mesh. Chemical analysis was conducted at Chemex Labs Ltd. of Canada for eight elements; Au, Ag, As, Sb, Hg, Cu, Pb and Zn. The analytical details are given in Table 2-16. A total of 1,514 soil samples was collected and provided for chemical analysis this year in the prospect.

(2) Statistical data processing

On the assumption that the distribution of geochemical data shows a close approximation to logarithmic normal distribution, natural logarithmic conversion of the respective analytical values was adopted in the statistical data processing. When an analytical value was less than the detection limit, a value half of the lower limit was substituted in the calculation.

At first, statistical properties of geochemical data were checked. Basic statistical figures were calculated. Distribution histograms of each element were drawn out. Correlation coefficients among eight elements were examined. Then principal components analysis was practiced for extracting some statistically efficient combinations of elements.

Basic statistical figures

The proportion of samples with values less than the lower detection limit to the total population is significantly high for Au and Sb. Elements such as Ag, As, Hg and basemetals show a distribution of close-to-normal. Whereas Au and Sb show an L-shape distribution. The basic statistical figures are listed in Table 2-17.

Table 2-18 shows the matrix of correlation coefficients among eight elements. Some kinds of correlation, though weak, were recognized between Ag-As, As-Pb and Cu-Zn.

Principal components analysis

Two principal components were picked up on the basis of the eigenvalues more than 1.0. Values of the eigenvector, factor loading, proportion and cumulative proportion were calculated for the two principal components. The results were shown in Table 2-19.

① The first principal component: Values of the factor loadings more than 0.5 were obtained for Au, As, Sb, Hg, Cu and Zn. The proportion of the first principal component is 0.31. It is indicative that the first principal component has some association with the behaviour of Au and the other five basemetal elements.

② The second principal component: This component is positively correlated to only Cu.

The results of those analyses indicate the possibility of statistically significant correspondence among Au and some of the basemetal elements.

(3) Anomalies of soil geochemistry

The threshold values were determined automatically through the calculation of ① the mean value of each element plus a value of the standard deviation, and ② the mean value plus twice the standard deviation. Values of each sample were expressed by one of three kinds of symbols on the map. The soil anomaly maps drawn for each element are attached in appendices.

Three major anomalies and several minor anomalies of Au were distinguished in the prospect. Anomalies of Cu and Zn almost overlap on the Au anomalies. It is possible to explain this conformability by the mineral association of auriferous quartz veins/stockworks. The mode of distribution of the other elements such as As and Hg, whose weak correlation to Au were indicated through the principal components analysis, is different from that of Au.
Those anomalies are located within an area of 2,500 m (NE-SW) × 1,500 m (NW-SE) centered at the tondoratte (top of the ridge).

Upper reaches of S. Tarawa

An outstanding Au anomaly appeared at the area extending over the upper reaches of S. Tarawa and the upper reaches of S. Bone. It forms an irregular shaped area of approximately 1,000 m (E-W) × 500 m (N-S). The core zone (Au>37 ppb) is 400 m × 400 m. The soil anomaly found at the hill NW of S. Tarawa in 1991 is located inside this zone. The maximum value is 1,340 ppb Au. This anomaly is correlated to the area where the intensive quartz stockworking was found. Anomalies of Cu and Zn were also recognized at this area. The tondoratte area is excluded in the anomaly, because the original geochemical condition has been disturbed by the slash-and-burn farming.

S. Malela

A narrow and long anomaly was caught along S. Malela. It is correlated to the area of intensive quartz veining.

A distinctive Au anomaly was found at the area between S. Malela and S. Pongo. It spreads over an area of approximately 500 m (E-W) × 400 m (N-S). It is composed of significant Au anomalies up to 708 ppb. Anomalies of Cu and Zn also appear at this area.

Middle reaches of S. Bone

A group of Au anomalies was caught at the area extending over the middle reaches of S. Tarawa and the middle reaches of S. Bone. It has an area of approximately 600 m (E-W) × 400 m (N-S). Several quartz veins including the one at the Old Dutch Pit are located within this anomaly.

Middle reaches of S. Tarawa

Several Au anomalies were detected at the middle reaches of S. Tarawa. They are roughly correlated to the occurrences of quartz veins. Those anomalies are sporadic and generally composed of low level Au values.

Table 2-16 Methods of Analysis and Limits of Detection of Soil Samples

Element	Methods of Analysis	Detection Limit	Upper Limit
Au	Fire assay with NAA finish	1 ppb	10 ppm
Ag	$HCl/KClO_3$ extract'n with ICP-AES fin	0.02 ppm	0.02 %
As	ditto	0.2 ppm	0.5 %
Sb	ditto	0.2 ppm	0.1 %
Hg	HNO_3/HCl cold vapour with AA finish	10 ppb	0.01 %
Cu	$HCl/KClO_3$ extract'n with ICP-AES fin	0.2 ppm	0.5 %
Pb	ditto	0.5 ppm	0.5 %
Zn	ditto	1 ppm	0.5 %

※ AA means Atomic Absorption Method

※ NAA means Neutron Activation Method

Table 2-17 Basic Statistics of Soil Samples

	Au (ppb)	Ag (ppm)	As (ppm)	Sb (ppm)	Hg (ppb)	Cu (ppm)	Pb (ppm)	Zn (ppm)
Log Mean (M)	2.1	0.05	4.2	0.2	57.6	30.8	9.6	66.8
Max Value	1340	0.50	71.0	12.8	1500	838	77.5	1185
Min Value	<1	<0.02	<0.2	<0.2	10	2.0	<0.5	10
Std Dev (σ)	0.6	0.34	0.5	0.4	0.2	0.4	0.6	0.2
M+σ	8.8	0.10	13.1	0.5	92.9	74.1	38.3	107.6
M+2σ	37.7	0.22	40.6	1.3	149.8	178.1	153.3	173.4
No of Samples less D Lmt %	36.0	7.0	1.7	44.2	0	0	1.5	0

※ Number of Samples = 1,514

Table 2-18 Correlation Matrix of Soil Samples

	Au	Ag	As	Sb	Hg	Cu	Pb	Zn
Au	1.00	0.09	0.15	0.46	0.16	0.36	-0.14	0.20
Ag		1.00	0.52	0.11	0.33	-0.02	0.42	0.08
As			1.00	0.33	0.42	0.04	0.55	0.04
Sb				1.00	0.31	0.43	-0.04	0.26
Hg					1.00	0.17	0.28	0.07
Cu						1.00	-0.53	0.67
Pb							1.00	-0.28
Zn								1.00

Table 2-19 Results of Principal Components Analysis of Soil Samples

	1		2	
	Eigen-vector	Factor Loading	Eigen-vector	Factor Loading
Au	0.379	0.600	0.128	0.196
Ag	0.273	0.432	-0.384	-0.588
As	0.353	0.559	-0.422	-0.646
Sb	0.470	0.745	0.056	0.085
Hg	0.358	0.568	-0.257	-0.392
Cu	0.425	0.673	0.394	0.603
Pb	0.008	0.012	-0.585	-0.894
Zn	0.358	0.567	0.302	0.461
Eigen	2.510		2.338	
Prop	0.314		0.292	
Cum Pr	0.314		0.606	

2-4 Geochemical Rock-chip Sampling

(1) Sampling and chemical analysis

Geochemical rock-chip sampling was conducted during the detailed geological survey in the Batuisi prospect. The samples were collected from most of the outcrops of quartz veins, mineralized/altered rocks and major quartz float zones within the prospect.

The observation for the degree of alteration was recorded on the field note by geologist during the survey. The description was made on the same criteria as in geological survey (refer to the previous section). A total of 214 rock-chip samples was collected in the prospect.

Geochemical rock-chip samples were provided for chemical analysis. The analysis was conducted at Chemex Labs Ltd. for eight elements; Au, Ag, As, Sb, Hg, Cu, Pb and Zn. The analytical details are shown in Table 2-20. The major results of analysis are shown in Table 2-21.

(2) Statistical data processing

The same methods and procedures as in soil samples were adopted in the data processing of rock-chip samples.

(3) Anomalies of rock-chip geochemistry

The sampling points are not sufficiently distributed for contour analysis. Therefore the rock-chip geochemistry was examined together with the results of ore assay samples and soil geochemistry. Several significant anomalies of Au were caught from the results of rock-chip sampling. Anomalies of Ag, Cu and Zn are intimately associated with Au anomalies.

Upper reaches of S. Tarawa

There are many outcrops of quartz veins and quartz float zones within and around this area. Some of them showed anomalous values of Au (up to 300 ppb), Ag (up to 9.58 ppm) and Cu (up to 4,250 ppm).

S. Malela

Anomalous values of Ag, Cu and Zn were obtained from silicified rocks and quartz floats in the soil anomaly stretching between S. Malela and S. Pongo.

Middle reaches of S. Bone

Au anomalies up to 1,685 ppb were returned from quartz floats at the middle reaches of S. Bone. Pyrite, limonite and malachite were observed in those quartz samples. An anomalous value of Au (172 ppb) was also obtained from the sub-outcrop of quartz vein extending from the Old Dutch Pit.

Middle reaches of S. Tarawa

Anomalous values of Au (227 ppb), Ag (9.40 ppm) and Cu (3,760 ppm) were found from a quartz float zone at S. Kayulalang.

An anomalous value of Au (127 ppb) was obtained from the outcrop of quartz vein at the middle reaches of S. Tarawa. It is only 100 m downstream from the outcrop of quartz vein from which a significant assay value of Au (1.34 g/t) was returned.

Table 2-20 Methods of Analysis and Limits of Detection of Geochemical Rock-chip Samples

Element	Methods of Analysis	Detection Limit	Upper Limit
Au	Fire assay with NAA finish	1 ppb	10 ppm
Ag	$HCl/KClO_3$ extract'n with ICP-AES fin	0.02 ppm	0.02 %
As	ditto	0.2 ppm	0.5 %
Sb	ditto	0.2 ppm	0.1 %
Hg	HNO_3/HCl cold vapour with AA finish	10 ppb	0.01 %
Cu	$HCl/KClO_3$ extract'n with ICP-AES fin	0.2 ppm	0.5 %
Pb	ditto	0.5 ppm	0.5 %
Zn	ditto	1 ppm	0.5 %

※ AA means Atomic Absorption Method

※ NAA means Neutron Activation Method

Table 2-21 Analytical Results of Geochemical Rock-chip Samples in the Batuisi Prospect

Sample No.	Au (ppb)	Ag (ppm)	As (ppm)	Sb (ppm)	Hg (ppb)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Sample type and locality
BAA42Q	172	0.28	5.4	<0.2	820	543	19.0	2190	Qz float, S.Bone(J1)
BTB17Q	227	9.40	33.4	<0.2	460	3760	3.5	280	Qz float, S2,10-11
BTB34Q	16	4.32	19.6	<0.2	420	4310	2.5	993	Sili float, S3,21-22
BTB45Q	11	3.10	20.0	<0.2	70	4340	2.0	161	Qz float, S4,30-31
BTB54Q	300	9.58	532	3.8	1700	4250	9.0	973	Qz float, NS0,23-24
BTC43Q	1685	1.14	11.4	0.2	50	2050	1.0	105	Qz float, N3,18-19
BTC44Q	207	0.22	4.2	0.2	30	359	0.5	130	Qz float, N3,19-20
BTD36Q	127	0.04	353	1.8	10	37.2	1.8	17	Qz vein, S.Tarawa
BTF13Q	4	1.42	20.8	<0.2	740	4320	1.0	1805	Sili rock, N3,46-47
BTG24Q	59	0.24	12	<2	<1000	3290	<2	6740	Qz float, N4,46-47
BTH9Q	3	2.56	24.0	76.2	100	108.0	4.5	13	Qz float, N1,52-53
BAA1T	146	0.02	20.6	0.8	80	56.2	25.0	110	T-1,0.4-4.0m
BAA2T	109	0.02	25.4	1.0	80	56.6	31.0	84	T-1,4.0-8.0m
BAA3T	154	0.02	21.8	0.8	70	57.4	25.0	77	T-1,8.0-12.0m
BAA4T	368	0.06	20.2	1.2	70	96.4	20.0	70	T-1,12.0-16.0m
BAA5T	246	0.02	44.4	1.4	80	140.0	25.0	100	T-1,16.0-20.0m
BAA6T	184	0.02	40.8	1.6	100	187.0	34.5	117	T-1,20.0-24.0m
BAA7T	163	0.02	44.4	1.6	110	398	85.0	120	T-1,24.0-28.0m
BAA8T	570	0.08	108.5	1.6	130	170.0	50.0	95	T-1,28.0-32.0m
BAA9T	987	<0.02	164.0	1.6	120	115.0	26.5	54	T-1,32.0-36.0m
BAA10T	494	0.02	106.0	3.2	160	153.0	46.0	77	T-1,36.0-40.0m
BAA11T	118	0.02	28.6	3.4	130	188.0	48.0	79	T-1,40.0-44.2m
BAA12T	133	<0.02	40.0	5.2	150	152.5	40.0	79	T-2,0.35-4.0m
BAA13T	139	0.02	28.6	3.8	170	163.0	33.0	65	T-2,4.0-8.0m
I36T	479	0.08	108.0	1.0	100	73.2	20.5	90	T-4,108.0-111.0m
I37T	1165	0.20	291	1.4	90	110.5	9.5	185	T-4,111.0-113.0m
I38T	386	0.02	205	0.6	90	126.0	11.5	205	T-4,113.0-115.0m

Table 2-22 Basic Statistics of Rock-chip Samples

	Au (ppb)	Ag (ppm)	As (ppm)	Sb (ppm)	Hg (ppb)	Cu (ppm)	Pb (ppm)	Zn (ppm)
Log Mean (M)	4.3	0.03	5.7	0.3	59.9	84.5	2.4	86.1
Max Value	1685	9.58	532	149.5	2000	4340	95	6740
Min Value	<1	<0.02	<0.2	<0.2	10	3.2	<0.5	3
Std Dev (σ)	0.8	0.61	0.6	0.6	0.4	0.5	0.8	0.5
M+σ	25.8	0.14	23.7	1.2	160.9	284.4	14.7	273.0
M+2σ	153.6	0.56	98.2	4.5	431.7	957.6	88.6	865.7
No of Samples less D Lmt %	29.9	25.3	1.5	61.7	0	0	16.0	0

※ Number of Samples = 324

Table 2-23 Correlation Matrix of Rock-chip Samples

	Au	Ag	As	Sb	Hg	Cu	Pb	Zn
Au	1.00	0.19	0.64	0.42	0.43	0.35	0.56	0.27
Ag		1.00	0.25	0.03	0.39	0.61	-0.01	0.26
As			1.00	0.57	0.38	0.31	0.58	0.14
Sb				1.00	0.36	0.08	0.46	-0.15
Hg					1.00	0.40	0.53	0.44
Cu						1.00	0.02	0.52
Pb							1.00	0.17
Zn								1.00

Table 2-24 Results of Principal Components Analysis of Rock-chip Samples

	1		2	
	Eigen-vector	Factor Loading	Eigen-vector	Factor Loading
Au	0.424	0.781	-0.139	-0.185
Ag	0.258	0.474	0.446	0.595
As	0.426	0.785	-0.228	-0.304
Sb	0.307	0.566	-0.422	-0.562
Hg	0.415	0.764	0.093	0.124
Cu	0.321	0.591	0.478	0.638
Pb	0.373	0.687	-0.353	-0.470
Zn	0.252	0.464	0.436	0.582
Eigen	3.393		1.779	
Prop	0.424		0.222	
Cum Pr	0.424		0.646	

2-5 Trenching

(1) Survey method

Six lines of shallow trenches (costeans) were excavated by hand-digging in the Batuisi prospect this year. The total length is 438.0 m. Trenches were dug at the two most significant Au anomalous zones of soil samples -- at the hill NW of S. Tarawa and at the northern side of S. Bone. They aimed at; ① getting a series of continuous samples for weathered bed-rock geochemistry, and ② examining the mode of occurrence of gold in quartz vein and adjoining alteration zone. Details of the trenches are listed in the following table:

Trench No.	Locality	Eleva-tion	Azimuth	Length	No. of Samples
T-1	Hill	560 m	40 °	43.8 m	11 pcs
T-2	Northwest	565	43	99.3	25
T-3	of S. Tarawa	600	44	47.7	13
T-4		555	51/44	120.8	29
T-5	N of S. Bone	480	44/60	95.6	23
T-6		470	56	30.8	8
Total				438.0	109

One side of trench walls was sketched by geologist at a scale of 1:100. The observation of vein quartz was made based on the following description criteria:

① Color
② Clearness (transparent, translucent, opaque or milky)
③ Glossiness (chalcedonic, resin bright or glossy)
④ Grain size (fine, medium, coarse or crystalline)
⑤ Texture (massive, fine banded, banded, granular or brecciated)
⑥ Appearance (compact, hard, vuggy or brittle)
⑦ Inclusions
⑧ Sulphides

When met a clay vein, its color, texture, softness (touch) and the degree of sulphide dissemination were observed and recorded on the field note.

Weathered bedrock samples were taken from trenches for analysis of geochemical level. A total of 109 samples was collected from trenches. Samples of quartz veins and adjoining alteration zones were taken for ore assaying.

Chip samples from some of quartz veins were provided for fluid inclusion study. Samples of quartz veins and altered rocks were provided for X-ray diffraction analysis. Numbers of samples for ore assaying, fluid inclusion study, ore microscopy and X-ray analysis were 44, 27, 3 and 8 respectively.

(2) Results of trenching

Geologic profile

Trenches were dug by worker's hand. The depths are from 1.6 m to 2.8 m. The geologic profile is composed of soil layer and near surface weathered bedrock. Gravel zone (colluvium) occurs in the surface soil in some part of the trenches T-2 and T-3.

Soil layer consists of brown to khaki residual soil. It corresponds to the A- and B-layer of brown soil in the pedological classification. The A-layer is poorly developed in this area. The soil layer extends 20 to 60 cm below the surface.

Gravel zone was observed in the profiles in some part of T-2 and T-3. The zone is composed of various kinds of rock gravels -- shale/siltstone, dolerite, andesite, dacite (of the Barupu Tuffs), vein quartz -- and soil. They show from rounded (typical to andesite and dacite) to angular features (typical to quartz). The size varies from a few centimeters up to 1 m (=boulder size). Fragments of vein quartz sometimes occur at the bottom of the gravel zone. The gravel zone was interpreted to be the talus deposit. The source of gravels could be the topographic high near the present location. The distance from the source to the place of accumulation is not likely to be so far, probably less than a few hundred meters, judging from the topography. One of the soil anomalies (180 ppb Au at C-76 in the 1991 survey) has been found to be located within the gravel zone in T-2.

Weathered bedrock occurs below the soil and/or gravel layer. It is saprolite, and its original bedrock texture is kept. The geology in this area consists of shale, siltstone, tuffaceous shale and andesite of the Latimojong Formation. Saprolite shows brown to reddish brown color. Some part of the weathered bedrock, especially one which is close to the mineralized zone, shows limonitic. Weathering was observed pervasively in the trench profiles. Saprolite sometimes shows reddish lateritic property. Quartz veins in saprolite are broken and sugary. Pyrite is oxidized into limonite. It is only identical as a relict.

Mineralization

Quartz veins and quartz stockworks were caught in several locations in trenches.

In T-1, three zones of intense quartz veining were found. Those are; 17.2 ~ 20.5 m (3.3 m in zone width), 23.5 ~ 27.0 m (3.5 m in zone width), and 30.4 ~ 33.6 m (3.2 m in zone width). Quartz veins and stockworks are developed in reddish brown strongly weathered andesite and tuffaceous shale. Quartz is generally white to light grey color with resin bright tint. Each quartz vein has lensy-shape, from a few centimeters up to 65 cm in width. They show gentle dipping and network/stockwork structure. Pyrite, most of it changed into limonite, is sometimes weakly disseminated in quartz veins. Saprolite adjacent to the lenticular quartz is silicified, and shows weak foliation. The plane of foliation is almost pararell to the quartz vein. A careful observation suggested that the foliation was the product of shearing. Thin fractures of millimeters thickness are often developed in the sheared saprolite. The fractures are filled by limonite (probably after pyrite) and quartz. The occurrence of quartz stockwork in T-1 is shown in Fig.2-11.

In T-2, also three zones of quartz veining were found. The most significant one was caught at 76.3 ~ 79.7 m (3.4 m in zone width). Quartz veins (up to 38 cm in width) occur in mottled saprolite of yellowish to reddish brown color below gravel zone. Quartz shows white color with resin brightness. It contains pyrite dissemination. Saprolite around quartz veins exhibits strongly limonitic features as observed in T-1. Quartz veins show NNW strike direction and dip E at 40 ~ 60°. Sketch of this zone is shown in Fig.2-12.

Two zones of quartz veining -- 36.7 ~ 40.0 m (3.3 m in zone width) and 48.5 ~ 51.5 m (3.0 m in zone width) -- were distinguished in T-3. Quartz shows lensy-shape of up to 42 cm in width. It has white color with slightly brownish tint. The surrounding rock is reddish brown limonitic saprolite (same as in T-1 and T-2). This zone crops out at the creek (the uppermost reaches of S. Bone) 20 m north of the trench.

T-4 was dug in the boundary between shale and andesite. The lower part of the trench profile consists of shale (partly tuffaceous). Andesite lava flow occurs over the shale member. Four distinctive quartz veins and one intensively silicified zone were caught between 75 m and the end of T-4 trench (121m). White quartz veins of up to 28 cm wide occur in brown to reddish brown mottled saprolite. Quartz veins strike NW-SE. Three of them dip NE. Whereas one dips SW. A silicified zone develops at the NE end of the trench over 10 m. It consists of light grey strongly silicified rock (originally shale) and white to light grey quartz stockworks. Limonite veinlets of a few millimeters thick was observed in the silicified matrix.

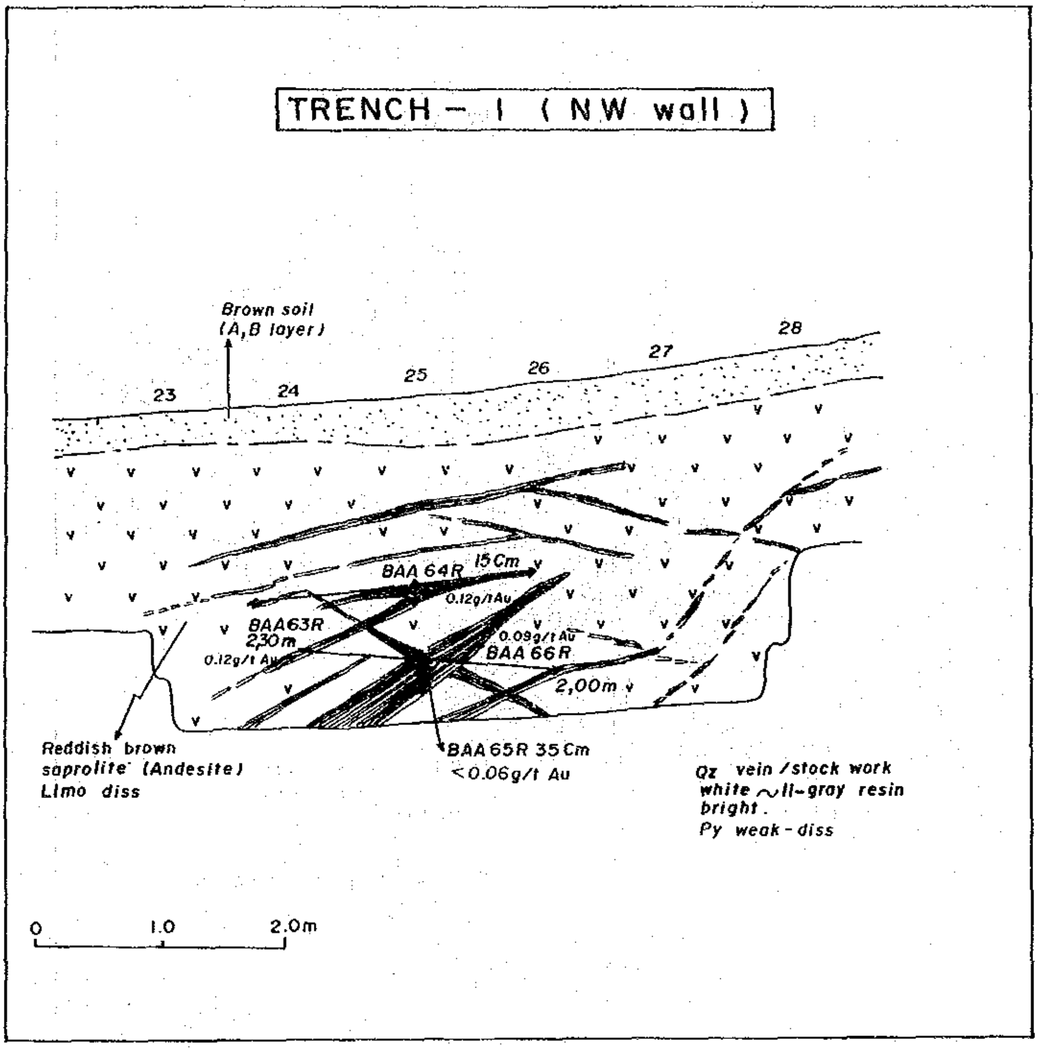
Two lines of trenches, T-5 and T-6, were dug at the northern flank of S. Bone. Both trenches were aimed at catching the northern extension of a significant quartz vein outcrop at the north of S. Bone. The quartz vein, observed at the outcrop and in the trenches, is massive up to 230 cm wide. Pyrite of fine grain is strongly disseminated in some part of the vein. It strikes N to NNE, and dips W at 28 ~ 41°. The surrounding shale (black or dark grey) is partly silicified. This quartz vein is traced up to 150 m along the strike direction.

The occurrence of gold in quartz veins/stockworks was first recognized through panning examination. Bucketsful of samples from trenches were crashed and panned out at the site. Samples were collected from various parts of the geologic profiles. Gold grains were returned from some of the panned samples. This examination has revealed several characteristic features concerning the mode of occurrence of gold: ① Gold is fairly coarse -- up to 500 microns in diameter. ② Gold is closely associated with pyrite and limonite. ③ Gold is not only carried by quartz veins, but also found in the host rock adjacent to the quartz veins. Some of gold grains were discovered from the strongly limonitic saprolite in the quartz stockwork zone. Those features were later confirmed by assaying and laboratory test. Some of the significant assay results of samples from trenches are shown in Table 2-15.

Under the ore microscope, a quartz sample from quartz stockwork in T-2 shows that very fine pyrite is disseminated. The pyrite is almost replaced by iron oxide. The other quartz samples from quartz veins in T-5 and T-6 show that a small amount of pyrite, arsenopyrite, chalcopyrite and sphalerite are contained. Covelline and iron oxide (limonite) were also observed in the quartz under the microscope.

One of the representative quartz of quartz veins/stockworks was examined petrographically. The sample was taken from a quartz vein at around 79 m in T-2. The thin section shows clastic texture. Quartz is medium grain (up to 2 mm in diameter). The vein quartz is fractured. The cracks are filled by fine grained quartz and opaque ore minerals (probably limonite).

X-ray diffraction analysis indicates that the alteration assemblage is mainly composed of quartz, chlorite, sericite and carbonates. Kaoline, which was often observed in trenches, is interpreted as the product of strong weathering.



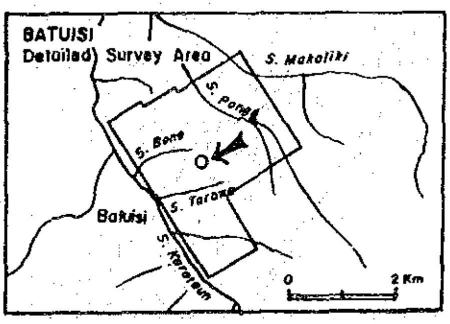
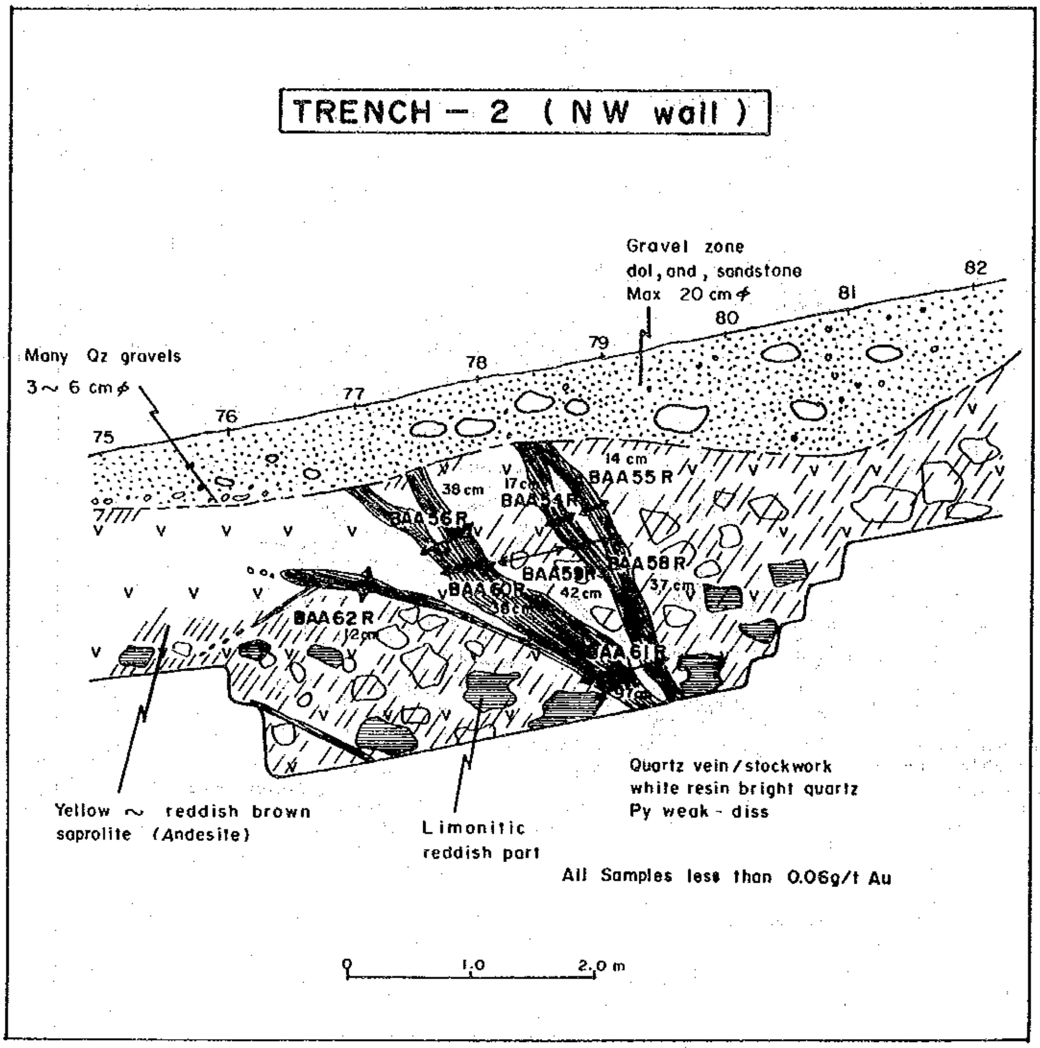


Fig.2-11 Sketch Showing the Occurrence of Quartz Stockwork in T-1



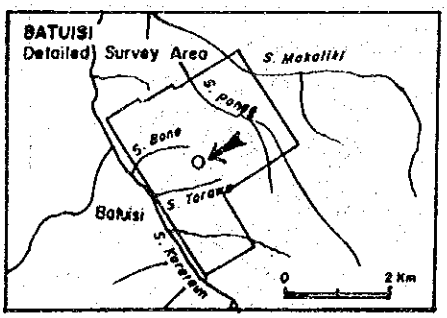


Fig.2-12 Sketch Showing the Occurrence of Quartz Stockwork in T-2

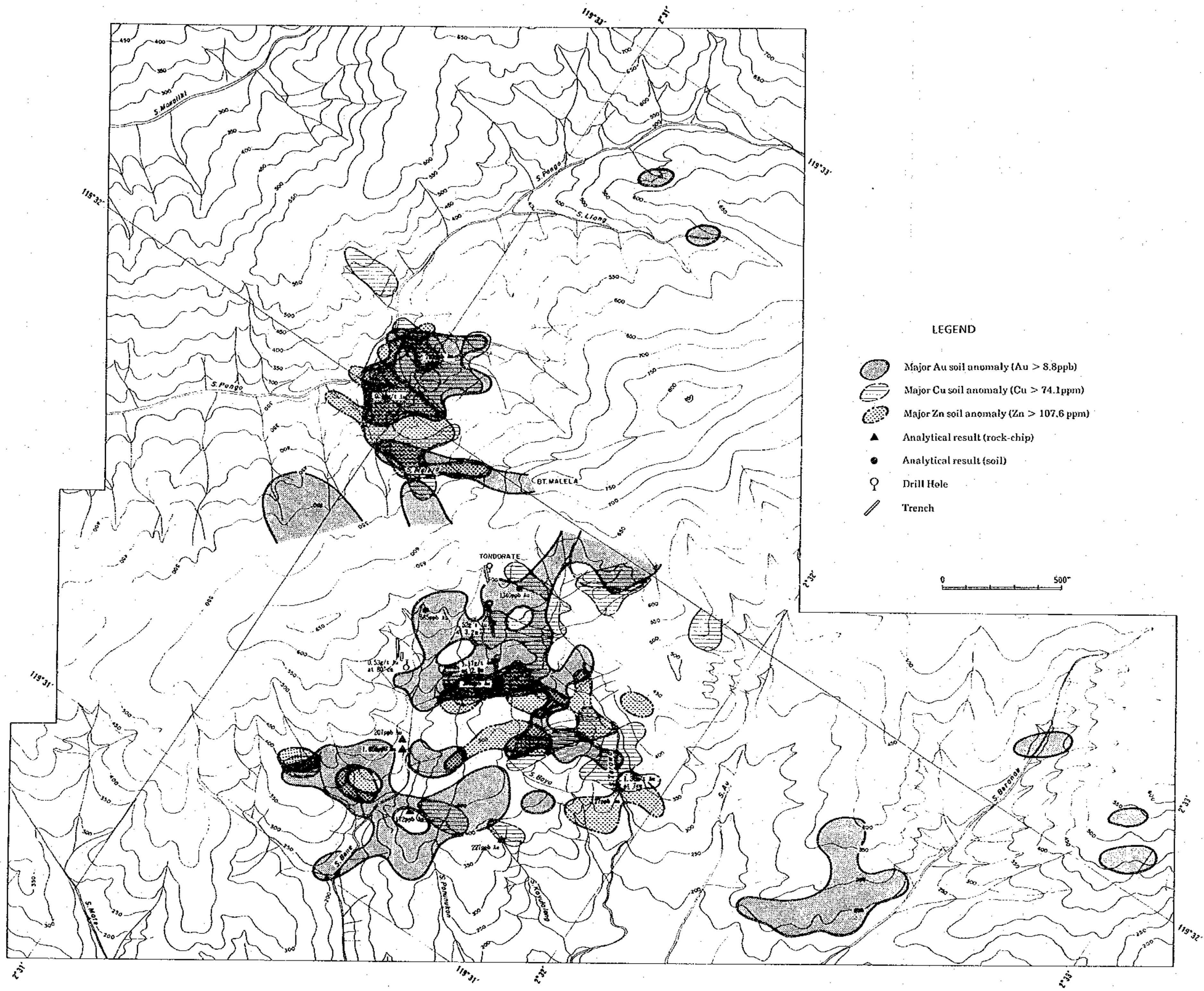


Fig.2-13 Anomalies of Soil and Rock-chip Geochemistry in the Batuisi Prospect

2-6 Fluid Inclusion Study

(1) Methodology

Quartz chips were collected, and provided for fluid inclusion study. A total of 144 chips was sampled this year in the Batuisi prospect. The breakdown was; 90 from outcrops and floats, 27 from trenches, and remaining 27 from drill cores. Additional four chips from the S. Lebutang prospect were tested under the heating-stage.

The observation of quartz chips was made in the field according to the description criteria explained in the previous section. The observation of fluid inclusions under the microscope was undertaken in the laboratory. The morphological observation of fluid inclusions may yield an important information regarding the environment under which fluid inclusions and their host minerals were formed. Therefore, it is better to conduct a careful work before going into thermometric study. General process of the microscopic observation consisted of the following contents:

① Distinction between primary/pseudosecondary inclusions and secondary ones
② Observation of size, shape and surface smoothness
③ Estimation of filling degrees (approximate liquid to vapour volumetric ratios of inclusions)
④ Identification of solid crystal in inclusions when exists
⑤ Search for any evidence indicating fluid boiling phenomena

Most of the important samples were micro-photographed on the microscopic observation.

Measurements of homogenization temperature of liquid-gas and polyphase inclusions were made with the heating-stage (Linkam model TH-600) under the microscope. The measurement was made only for primary and pseudosecondary inclusions. Twenty measurements for each sample were made in average, and the result was statistically processed. An arithmetic mean was adopted as the representative value for each sample. The standard deviation among the values of homogenization temperature in each sample was checked. The result of homogenization temperature measurements was plotted on the map and examined geologically.

(2) Results of the study

Measurements of homogenization temperature were rather difficult because most of the fluid inclusions in quartz chips were very fine. Fluid inclusions of larger than 10 microns in diameter were seldom, if ever, found. As a result of this fine nature of fluid inclusions, 96 samples out of 148 have been measured in total under the heating-stage. The results of the measurements are listed in Table 2-25.

Morphology of fluid inclusion

The number of fluid inclusions which was investigated under the microscope amounted to nearly two thousand. Ninty-eight percents of them are liquid-rich two-phase inclusions. Gas-rich two-phase inclusions are less than 2 % of them. The actual percentage of gas inclusions may probably be much less. The possibility of miss-identification still exists despite of the careful observation. Because fluid inclusions are three-dimensional objects which are being observed in only two dimensions, inclusions having consistent liquid-to-gas ratios may appear to have variable phase ratios.
This result may indicate that the boiling of fluid has never occurred during the formation of quartz vein in the Batuisi prospect.

Polyphase inclusions were found in 9 samples. Five of them are stockwork quartz from the upper reaches of S. Tarawa and the upper reaches of S. Bone. Halite and some opaque ore minerals were distinguished as daughter minerals. One of the opaque minerals is probably pyrite.

Homogenization temperature

Values of homogenization temperature of each fluid inclusion are distributed from 180°C up to 320°C. Most of them are settled within a range of 200 ~ 280°C.

Mean values of homogenization temperature of samples which showed a significant value of gold (for example; BAA68F=0.53 g/t, BD4-7F=0.37 g/t) range from 210°C to 260°C.

The comparison of homogenization temperature between massive quartz and stockwork quartz was made. Histograms of the temperature measurements were drawn in two categories as shown in Fig.2-14. The peak temperature of frequency distribution is 240 ~ 250°C for the stockwork type quartz. Whereas that is 250 ~ 260°C for the massive type quartz. The difference is small.

Fig.2-15 shows the lateral distribution of homogenization temperature (arithmetic mean) of each sample. Any significant tendency is not recognizable on this map, even if the altitude difference among the sample localities is considered.

Table 2-25 Results of Fluid Inclusion Study (1)

	Sample	Locality	n	Ave	SD	Remarks
1	BAA2F	Tarawa·Bone area	NA			
2	BAA3F		32	234	17.03	Gas Incl (+)
3	BAA4F		20	249	16.48	
4	BAA9F		16	235	24.78	Gas Incl (+)
5	BAA14F		17	241	17.24	
6	BAA18F		NA			
7	BAA19F		18	250	6.27	
8	BAA21F		26	249	19.60	Poly Incl (+)
9	BAA22F		3	274	5.44	Gas Incl (+)
10	BAA24F		14	235	42.69	Poly Incl (+), Gas Incl (+)
11	BAA27F		9	208	12.56	
12	BAA30F		30	245	20.24	Poly Incl (+), Gas Incl (+)
13	BAA47F		20	227	15.66	
14	BAA49F		NA			
15	BAA51F		24	230	25.88	
16	BAA52F		23	230	16.44	Gas Incl (+)
17	BAA67F		NA			
18	BAA68F		13	262	10.99	
19	BAA88F		NA			
20	BAA92F		17	276	16.24	Poly Incl (+)
21	BTB2F		10	216	20.85	
22	BTB3F		NA			
23	BTB4F		5	269	10.48	
24	BTB6F		6	206	18.79	
25	BTB8F		7	268	13.05	
26	BTB9F		21	271	16.04	
27	BTB10F		20	217	11.19	
28	BTB11F		NA			
29	BTB13F		15	246	7.70	
30	BTB15F		NA			
31	BTB16F		NA			
32	BTB17F		21	233	11.08	
33	BTB18F		NA			
34	BTB21F		13	191	9.63	
35	BTB22F		12	223	18.03	
36	BTB25F		NA			
37	BTB26F		23	236	18.77	
38	BTB27F		NA			
39	BTB30F		NA			
40	BTB31F		20	274	14.24	
41	BTB32F		NA			
42	BTB33F		30	252	10.54	
43	BTB35F		18	250	15.60	
44	BTB36F		NA			
45	BTB37F		23	224	32.31	Gas Incl (+)
46	BTB38F		NA			
47	BTB39F		9	255	10.89	
48	BTB40F		12	229	16.76	
49	BTB41F		NA			
50	BTB43F		22	244	20.22	

Table 2-25 Results of Fluid Inclusion Study (2)

	Sample	Locality	n	Ave	SD	Remarks
51	BTB44F	Tarawa·Bone Area	14	250	22.94	
52	BTB45F		NA			
53	BTB46F		20	228	13.20	
54	BTB47F		NA			
55	BTB48F		16	220	14.97	Poly Incl(+)
56	BTB50F		32	229	16.38	
57	BTB51F		NA			
58	BTB56F		NA			
59	BTC1F		NA			
60	BTK7F		18	241	15.31	
61	BTK8F		NA			
62	BTK9F		16	244	14.07	
63	BTK10F		NA			
64	BTK20F		21	236	14.66	
65	BTK22F		NA			
66	BTK24F		14	269	12.45	Poly Incl(+)
67	BTK25F		24	275	13.57	
68	BTK26F		NA			
69	BTK27F		29	262	22.56	
70	BTK28F		32	263	17.58	
71	BTK29F		NA			
72	BTK30F		21	247	17.06	
73	BTK32F		NA			
74	BTK33F		23	247	20.75	
75	BTF19F	Pongo·Malela area	12	221	25.55	Gas Incl(+)
76	BTF20F		25	271	21.91	Poly Incl(+), Gas Incl(+)
77	BTF21F		NA			
78	BTF22F		13	260	25.21	Poly Incl(+), Gas Incl(+)
79	BTF23F		14	264	12.78	
80	BTF24F		NA			
81	BTF25F		17	270	15.09	
82	BTF26F		10	261	12.43	
83	BTG2F		20	248	14.79	
84	BTG3F		NA			
85	BTG5F		14	224	11.87	
86	BTG6F		33	220	11.32	
87	T13F		NA			
88	T16F		NA			
89	T26F		NA			
90	T35F		18	216	30.40	
91	BAA33F	T-1	NA			
92	BAA34F	T-1	6	218	15.66	Poly Incl(+)
93	BAA35F	T-1	13	250	16.16	
94	BAA37F	T-2	6	209	7.07	
95	BAA38F	T-2	35	236	29.13	Gas Incl(+)
96	BAA39F	T-2	11	238	26.77	
97	BAA43F	T-2	NA			
98	BAA54F	T-2	NA			
99	BAA56F	T-2	23	207	13.83	
100	BAA58F	T-2	28	252	15.95	

Table.2-25 **Results of Fluid Inclusion Study (3)**

	Sample	Locality	n	Ave	SD	Remarks
101	BAA63F	T-1	19	252	22.10	Gas Incl(+)
102	BAA64F	T-1	NA			
103	BAA65F	T-1	11	266	9.96	
104	BAA66F	T-1	NA			
105	BAA69F	T-3	29	243	12.12	
106	BAA70F	T-3	NA			
107	BAA71F	T-3	26	253	13.16	
108	BAA84F	T-3	17	245	9.39	
109	BAA85F	T-4	42	245	10.74	
110	BAA86F	T-4	14	284	16.53	
111	BAA94F	T-4	13	255	15.80	
112	BAA98F	T-5	12	206	14.06	
113	BAA99F	T-6	21	209	13.65	
114	I42F	T-4	NA			
115	I44F	T-4	NA			
116	I46F	T-4	NA			
117	I48F	T-4	25	267	13.63	
118	BD1-6F	MJT-1, 30.72m	31	224	32.79	
119	BD1-17F	MJT-1, 60.27m	NA			
120	BD1-21F	MJT-1, 68.85m	21	237	11.96	
121	BD1-24F	MJT-1, 72.00m	23	236	16.82	
122	BD1-27F	MJT-1, 73.30m	NA			
123	BD1-29F	MJT-1, 75.10m	NA			
124	BD2-8F	MJT-2, 14.50m	28	225	15.02	
125	BD2-17F	MJT-2, 19.45m	17	214	13.19	
126	BD2-20F	MJT-2, 21.15m	NA			
127	BD2-23F	MJT-2, 35.06m	31	255	10.99	
128	BD2-28F	MJT-2, 48.95m	13	186	6.13	
129	BD2-33F	MJT-2, 59.45m	NA			
130	BD3-3F	MJT-3, 12.80m	NA			
131	BD3-4F	MJT-3, 13.90m	28	247	13.03	
132	BD3-7F	MJT-3, 25.50m	NA			
133	BD3-9F	MJT-3, 27.50m	NA			
134	BD3-12F	MJT-3, 51.30m	10	242	10.01	
135	BD3-17F	MJT-3, 80.05m	NA			
136	BD4-7F	MJT-4, 14.05m	28	235	14.55	
137	BD4-11F	MJT-4, 53.70m	24	238	18.92	
138	BD4-13F	MJT-4, 54.40m	19	211	11.52	
139	BD4-17F	MJT-4, 56.90m	20	224	13.40	
140	BD4-21F	MJT-4, 61.10m	22	229	17.84	
141	BD4-23F	MJT-4, 63.80m	24	238	13.59	
142	BD4-25F	MJT-4, 79.30m	13	222	12.36	
143	BD5-4F	MJT-5, 48.70m	22	220	13.65	
144	BD5-6F	MJT-5, 49.40m	15	189	13.08	
145	LEB3F	S. Taroto	30	286	20.49	
146	LEB10F	S. Taroto	21	264	18.81	Gas Incl(+)
147	LEB20F	S. Taroto	6	278	13.17	
148	LEC15F	S. Peko	33	243	14.41	

Abbreviations: n;number of measured f-inclusions
NA;homo-temp not available
Ave;arithmetic mean of homo-temp (°C)
SD;standard deviation (°C)

```
                      0         5         10        15        20 %
                      |_________|_________|_________|_________|
 180<= T <190         XXXXXXXX
 190<= T <200         XXXXXX
 200<= T <210         XXXXXXXXXXXX
 210<= T <220         XXXXXXXXXXXXXXXX
 220<= T <230         XXXXXXXXXXXXXXXXXXXXXXXXX
 230<= T <240         XXXXXXXXXXXXXXXXXXXXXXXX
 240<= T <250         XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 250<= T <260         XXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 260<= T <270         XXXXXXXXXXXXXXXXXXXXXX
 270<= T <280         XXXXXXXXXXXXXXX
 280<= T <290         XXXXXXX
 290<= T <300         X
 300<= T <310         X
 310<= T <320         X
 320<= T <330

Whole Data (1,765 Fluid Inclusions)

 180<= T <190         XXXXXXXXX
 190<= T <200         XXXXXX
 200<= T <210         XXXXXXXXXXXXXX
 210<= T <220         XXXXXXXXXXXXXX
 220<= T <230         XXXXXXXXXXXXXXXXXXXXXXXXXX
 230<= T <240         XXXXXXXXXXXXXXXXXXXXXXXX
 240<= T <250         XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 250<= T <260         XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 260<= T <270         XXXXXXXXXXXXXXXXXXXXXX
 270<= T <280         XXXXXXXXXXX
 280<= T <290         XXXXXX
 290<= T <300         X
 300<= T <310         X
 310<= T <320         X
 320<= T <330

Stockwork Type (953 Fluid Inclusions)

 180<= T <190         XXXXXXX
 190<= T <200         XXXXXX
 200<= T <210         XXXXXXXXXX
 210<= T <220         XXXXXXXXXXXXXXXXXXX
 220<= T <230         XXXXXXXXXXXXXXXXXXXXXXXX
 230<= T <240         XXXXXXXXXXXXXXXXXXXXXXXX
 240<= T <250         XXXXXXXXXXXXXXXXXXXXXXXXXXX
 250<= T <260         XXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 260<= T <270         XXXXXXXXXXXXXXXXXXXXXX
 270<= T <280         XXXXXXXXXXXXXXXXXXX
 280<= T <290         XXXXXXXX
 290<= T <300         XX
 300<= T <310         X
 310<= T <320
 320<= T <330

Massive Type (812 Fluid Inclusions)
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Fig.2-14 Histogram of Homogenization Temperature of Fluid Inclusions

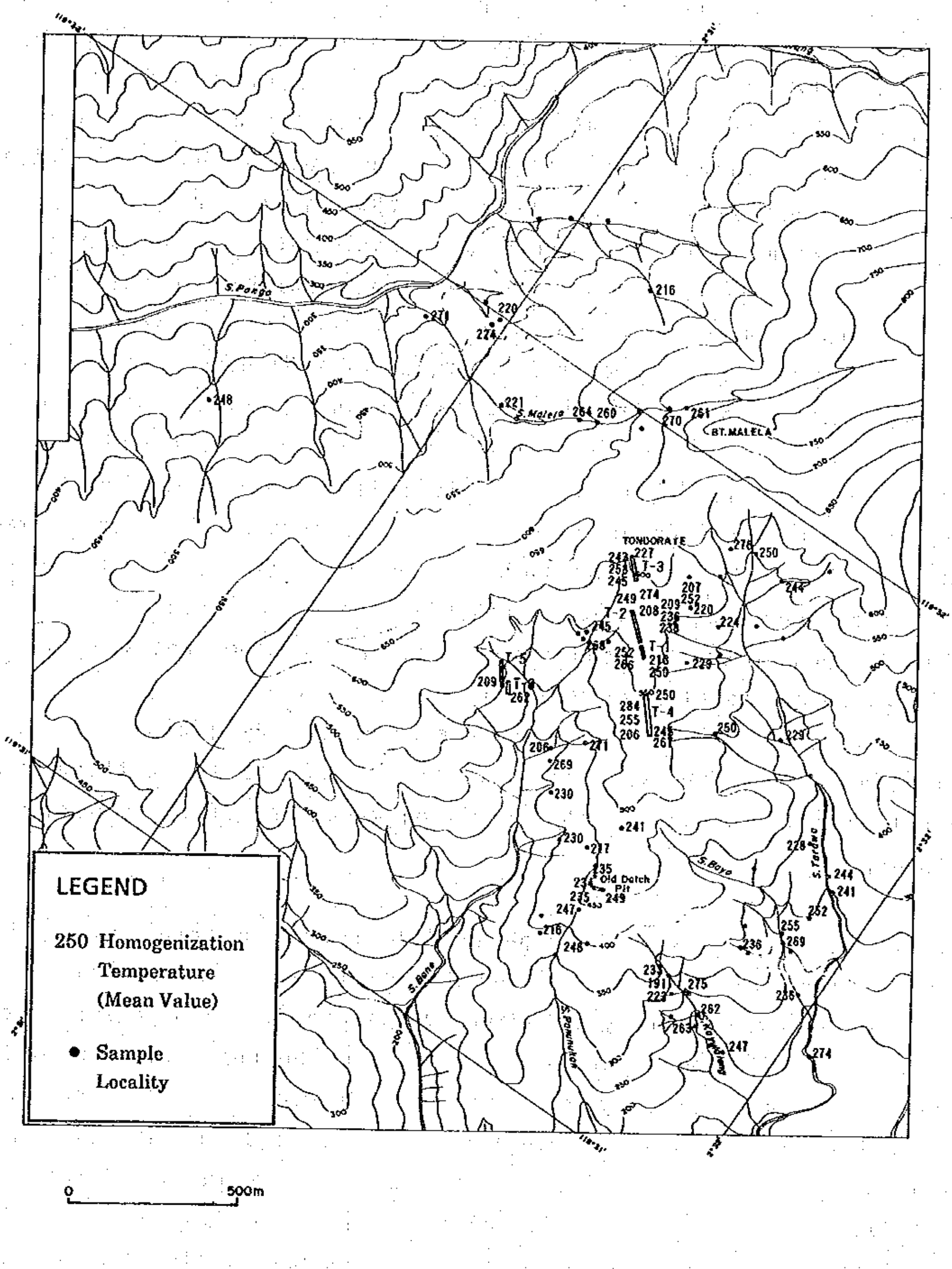


Fig.2-15 Map Showing the Distribution of Mean Values of Homogenization Temperature of Fluid Inclusions

2-7 Discussions

Auriferous quartz veins and quartz stockworks are hosted by the alernating beds of shale, siltstone, tuff and andesite of the Cretaceous Latimojong Formation in the Batuisi prospect. The prospect is situated structurally on the western flank of an anticlinorium which was interpreted to be formed by the emplacement of the Mamasa granite. The inferred principal direction of the compressional stress field generated by the emplacement of granite batholith is NNE to N-S on the regional scale (refer to the Phase I Report). Whereas the most dominant direction of vein systems is NNW in the prospect. It is not consistent with the regional structure. Despite this, the other geologic evidences indicate some connection between the formation of vein systems and granite intrusion. Diorite stocks are distributed in the vicinity of quartz veining/stockworking zone, commonly showing the NW～NNW direction of elongation. They are assumed to be affiliated from the Mamasa granite. Thus the fissure pattern is interpreted to be formed under the local compressional stress field of the NNW direction which was occurred in this partcular area by the granite intrusion. The NNW system of quartz vein is interpreted to be formed as a normal fault in the direction of the compression. Two systems of N-S～NNE and NW～WNW probably correspond to the synthetic-antithetic strike-slip faults also formed simultaneously by the compression. The E-W system, not so common in the prospect, may be a kind of reverse fault.
The actual stress-strain field is three-dimensional. An upward component of the compression must be taken into consideration. One of the matters which are difficult to find an answer is the formation mechanism of the stockwork system of gentle dip.

Two styles of quartz and sulphide mineralization were distinguished at three areas. More than 20 massive quartz veins were counted at the middle reaches of S. Tarawa. A group of quartz veins and quartz stockworks occurs at the area between the upper reaches S. Tarawa and the upper reaches of S. Bone. This area is characterized by the extensive development of quartz stockwork systems which were confirmed through the trenching exploration. Massive quartz veins were also caught at the area between S. Pongo and S. Malela. Quartz stockwork systems are associated with quartz veins at S. Malela.

Significant gold values were obtained from outcrops, floats, rock-chips and trench samples. An assay result of 1.34 g/t Au at 7 cm in width was obtained from a quartz vein at the middle reaches of S. Tarawa. A quartz rock-chip of 1,685 ppb Au was detected at the middle reaches of S. Bone. A value of 0.53 g/t at 80^{+} cm in width was returned from the outcrop of a massive quartz vein at the north of S. Bone. The best result of channel samples in trenches is 1.52 g/t Au at 3.2m in sampling width. A value of 0.40 g/t Au was obtained from a quartz float zone at the S. Pongo area. These quartz samples commonly contain a small amount of sulphide minerals such as pyrite and chalcopyrite and their oxidized spacies. Traces of arsenopyrite, shalerite and bornite were also found in quartz veins. Strong silicification and moderate chloritization are associated with quartz veining.

Three distinctive Au anomalies and several minor anomalies were delineated from grid soil survey and rock-chip geochemistry. The major anomalies are located at; ① the upper reaches of S Tarawa, ② S. Malela, and ③ the middle reaches of S. Bone. These anomalies are distributed within an area of 2,500 m (NE-SW) × 1,500 m (NW-SE) centered at the top of the ridge. They are composed of significant Au values of soil samples. Au values more than 100 ppb were obtained from more than 20 samples. The maximum value is 1,340 ppb Au at the anomaly ①. Anomalies of Cu and Zn almost overlap on the Au anomalies. The geochemical anomalies are well correlated to the areas where the intensive quartz veins/stockworks were found. The geochemical features of each anomaly can be explained by the geologic evidences.

The systematic study of fluid inclusion has revealed some interesting features of mineralization in the prospect.

Measurements of homogenization temperature of fluid inclusions of quartz range from 180°C to 320°C.
The temperature range of fluid inclusions in this area is slightly higher than the typical Neogene Tertiary epithermal auriferous quartz veins in Japan. It is rather similar to mesothermal gold-quartz veins such as the Oya deposit in northern Japan. Temperature range of epithermal veins was summarized to be 180 ~ 240°C. That of mesothermal veins was estimated to be higher (Enjoji & Takenouchi, 1976). This result may indicate that the auriferous quartz veins were formed under mesothermal conditions in the Batuisi prospect. The negative evidence of fluid boiling also suggests that the veins were formed not under the near-surface conditions. This kind of ore deposit tends to show a big fluctuation of gold grade. This nature needs to be considered in the evaluation of mineralization.

Chapter 3 Bau Prospect

3-1 Outline of the Prospect

The Bau prospect is located along S. Salole and its tributaries in the central northern part of the survey area. The area, situated in one of the most inland part of the central western Sulawesi, is surrounded by steep hills and mountains of more than 1,000 m above sea level. Altitudes of the prospect are in the proximity between 460 m (at the bridge of S. Salole) and 1,000 m. Access from the outer world is very difficult.

The geology of the prospect is composed mainly of black shale, andesite and dolerite of the Latimojong Formation. The prospect is structurally located on the eastern wing of the regional anticlinorium which is interpreted to be formed by the emplacement of the Mamasa granite batholith. Small stocks and dykes of granitic rocks occur in the Latimojong Formation.

Semi-detailed exploration comprising geological survey, panning prospecting and reconnaissance soil survey was carried out for the area covering approximately 50 km^2 in the first phase. As a result of the exploration, several mineralized zones were delineated within the prospect. Those zones are composed of outcrops of quartz veins and alteration zones (mainly pyrite dissemination), panning and stream sediment anomalies, and Au soil anomalies. The eastern anomalous zone, running from Kp. Bau down to the junction of S. Salole and S. Belopi, is characterized by the development of quartz veins and veinlets with a small amount of sulphide minerals. The western anomalous zone, running along the lower reaches of S. Salole and S. Balimbing, is tracked by the sporadic occurrence of gold anomalies in either pan concentrates or stream sediment samples. The distribution of quartz floats and pyrite dissemination was also recognized in the zone. The strike direction of each zone was interpreted to be almost NNW from the arrangement of mineral showings.

Based on the results of the first phase exploration, the western part was selected for the further exploration area. The area was about 15 km^2. Detailed exploration was conducted in the second phase. It was composed of geological survey, soil survey and geochemical rock-chip sampling.

3-2 Geological Survey

(1) Survey method

Detailed geological survey was carried out together with soil survey and geochemical rock-chip sampling in the Bau prospect. A base camp was set up at Kp. Bau. Flying camp survey was also utilized together with base camp. The survey was carried out along creeks and ridge lines. The sampling points were tried to be distributed uniformly. However some of the survey points were slightly offset from the proper position because of the steep topography. A 1:10,000 scale route map was produced. The results of the geological survey were compiled on a 1:10,000 scale geological map. A total of 50 km was traversed, and 27 ore samples were collected. Numbers of samples for polished sections and X-ray powder analysis were 7 and 11 respectively this year.

(2) Geology and geologic structure

Latimojong Formation (Klv) : It consists of shale, andesite lava, andesitic tuff and dolerite. Shale is widely distributed in the Bau prospect. Color of this rock is dark grey to black. It shows massive texture in general. Slatey cleavage was recognized only in the vicinity of fault. It was observed at the contact of shale and granite intrusive bodies that the indurated shale became much darker and showed resin brightness due to the maturation of organic matters.

Andesite lava shows propylitic features. Hyaloclastic texture was often recognized in the peripheral zone of the extension. This rock sometimes contains shale units, and it was interpreted as an effusive facies on the sea floor.

Fine tuff and lapilli tuff occur in the prospect. These pyroclastic units are interbedded within the alternation of black shale and andesite.

Dolerite crops out almost covering the southern half of the prospect. This rock unit often shows intrusive nature. It has steep contact with black shale and andesite in some part. The host rocks are intensively indurated. Silicification and pyritization were observed in the host rocks near the contact.

Intrusive rocks : Several small stocks and sills of granodiorite and diorite are distributed in the northern part of the prospect.

The sedimentary and pyroclastic sequences of the Latimojong Formation generally strike NW-SE and dip W at 20 to 40°. The intrusive bodies are arranged in the NW-SE direction at the north of S. Salole.

Several faults were inferred to exist in the southern part of the prospect. They exhibit a spatial arrangement enclosing dolerite mass.

(3) Mineralization and hydrothermal alteration

Two styles of mineralization and associated alteration were distinguished in the Bau prospect. One is fissure filling quartz mineralization accompanied with a small amount of sulphide minerals, and another is the pyrite dissemination near the intrusive bodies.

Quartz veins in the prospect can be divided into two groups on the basis of their strike-dip patterns; NNW-SSE system with dipping E, and NE system with dipping SE or NW. The width of quartz veins ranges 1 cm up to nearly 2 m for the both systems. However the majority is less than 30 cm in width.

Sulphide minerals are frequently associated with the NE system. They occur as disseminated fine grains in quartz. Quartz veins of the NNW system tend to contain a very small amount of sulphides. Pyrite, arsenopyrite and chalcopyrite were observed in common. Sphalerite and galena were also observed in some quartz samples. Bornite was found in quartz samples from S. Balimbing. It was observed at S. Salubongi that the quartz vein of the NE system was crosscut by NNW system. Fig.2-16 is the sketch showing the situation of crosscutting relation. Quartz vein which contains a small amount of sulphide minerals carrys some gold. The best result returned from assay samples is 2.18 g/t Au at 10 cm (BAC17A).

The gangue minerals identified in the field are quartz, chlorite, montmorillonite and sericite. The wall rock alteration of quartz vein is dominated by silicification, chloritization and carbonitization.

Pyrite dissemination was observed within diorite intrusives. Black shale intruded by igneous bodies is affected by pyritization and silicification. The occurrence of pyrite dissemination was found mainly at the northern part of the prospect. This is spatially correlated to the distribution of gold anomalies outlined through the geochemical survey (stream sediments and panning) in the first phase. It suggests that the pyrite dissemination is the source of low level gold anomalies in the prospect.

3-3 Soil Survey

(1) Sampling and chemical analysis

Detailed soil sampling was conducted for the entire 15 km^2 area in the Bau prospect. Soil samples were taken from the B-layer of residual soil at depths of 40 to 70 cm from the surface using hand-auger. The sampling points were set along creeks and ridge lines in order to be uniformly arranged as much as possible within the topographic restriction.

Methods of soil sampling and chemical analysis were the same as in the Batuisi prospect. A total of 506 soil samples was collected this year.

(2) Statistical data processing

The same methods and procedures as in the Batuisi prospect were adopted in the data processing of soil samples in the Bau prospect.

(3) Anomalies of soil geochemistry

Although anomalous values of a certain level (up to 165 ppb Au) have been obtained in the prospect, they are isolated each other. Any important correlation has not been recognized between Au and the other basemetal elements through the statistical analysis.

Some of the significant anomalies are explained as follows.

S. Salubongi

From the junction of S. Salole and S. Belopi up to the middle reaches of S. Salubongi, several anomalous Au values (up to 22 ppb) were obtained. They are roughly correlated with the occurrences of quartz veins which contain pyrite and chalcopyrite. They are distributed sporadically.

Western side of S. Belopi

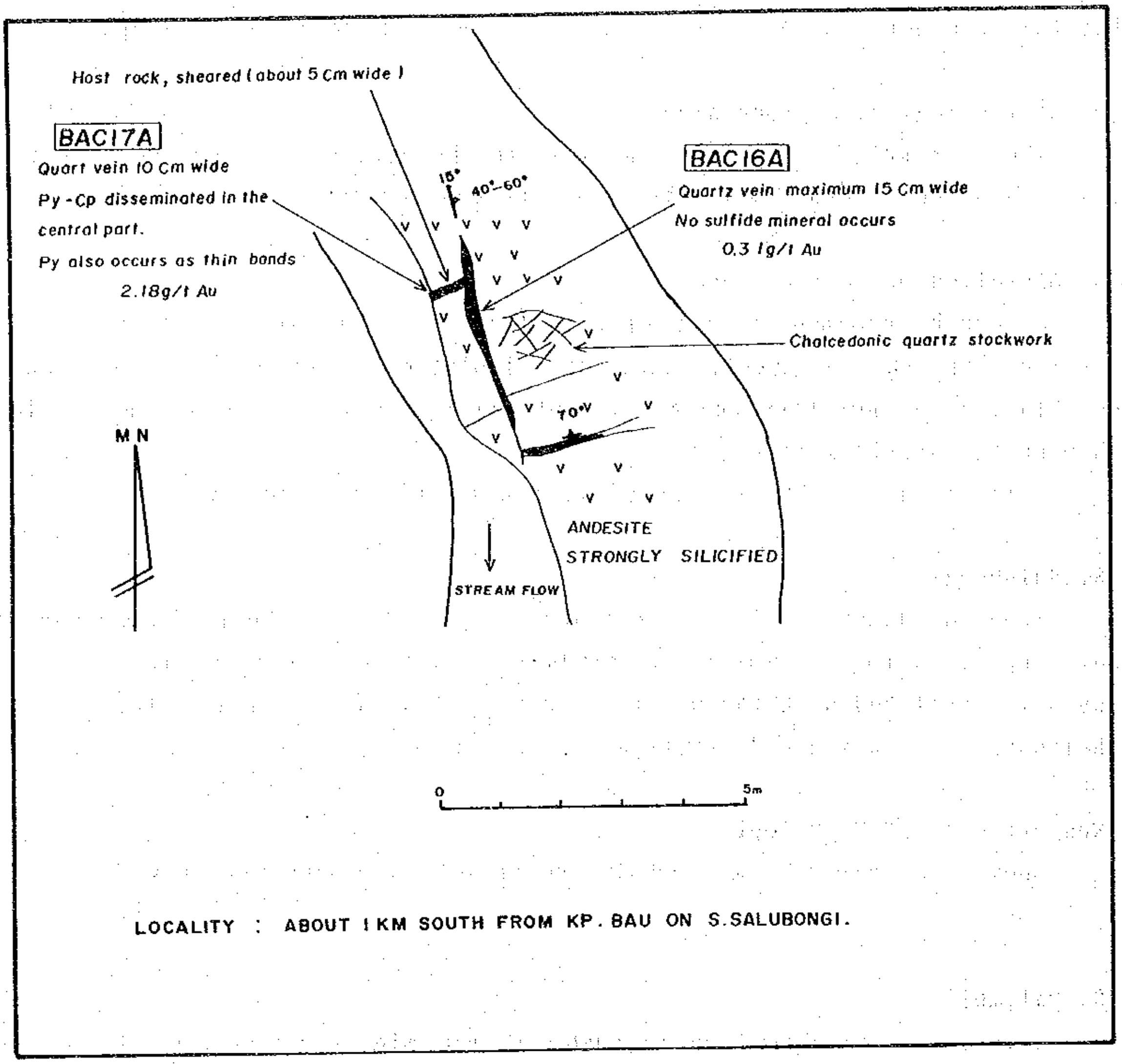
Anomalous values of Cu and Zn are densely arranged at the western side of S. Belopi.

S. Balimbing

Several Au anomalies were caught at the middle reaches of S. Balimbing. The biggest one (about 1 km long) was found within massive andesite. It is an Au anomaly up to 64 ppb.

Lower reaches of S. Salole

Several Au anomalous values were found along the lower reaches of S. Salole. They occur sporadically. As anomalies are associated with them. They are roughly correlated with pyrite dissemination within black shale.



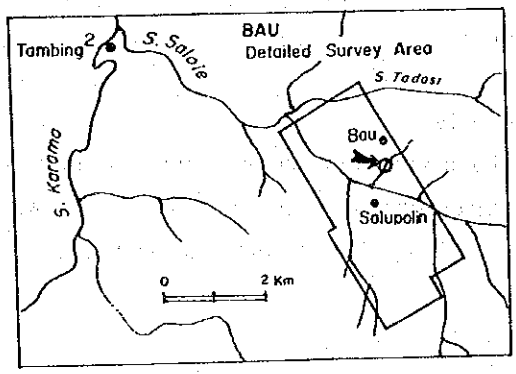


Fig.2-16 Sketch Showing the Crosscutting of Quartz Veins at S. Salubongi

Table 2-26 Assay Results of Ore Samples in the Bau, S. Lebutang, and Kariango Prospects

Sample No.	Width (cm)	Au (g/t)	Ag (g/t)	Cu (%)	Pb (%)	Zn (%)	Fe (%)	Sample type and locality
								Bau
BAB2A	9	0.09	10	0.032	0.056	0.101	8.15	Qz veinlet, S.Patoso
BAB4A	7	0.37	26	0.330	0.007	0.304	38.40	Limo veinlet, S.Wariku
BAB9A	--	0.25	<2	0.010	<0.001	0.006	7.24	Limo diss, S.Salole
BAC16A	15	0.31	2	0.048	<0.001	0.202	1.64	Qz vein, S.Salubongi
BAC17A	10	2.18	2	0.096	<0.001	0.001	0.81	Qz vein, S.Salubongi
BAC93A	--	<0.06	<2	0.003	0.006	0.008	6.03	Sili rock, S.Tadasi
BAD2A	--	<0.06	2	0.016	<0.001	0.010	5.69	Sili rock, S.Beropi
BAD8A	--	<0.06	2	0.004	<0.001	0.008	9.00	Qz float, S.Belopi
BAH3A	70	0.40	4	0.371	<0.001	0.017	7.23	Qz vein, Gn.Salupolin
								S.Lebutang
LEB5A	--	<0.06	<2	0.007	0.003	0.013	12.75	Qz float, S.Lebutang
LEB6A	--	<0.06	2	0.006	0.001	0.009	11.30	Andesite boulder, S.Taroto
LEB7A	--	<0.06	2	0.011	<0.001	0.007	9.72	Andesite boulder, S.Taroto
LEB11A	--	<0.06	2	0.001	<0.001	0.006	8.43	Andesite boulder, S.Taroto
LEB13A	5	<0.06	<2	0.001	0.001	0.009	9.10	Qz veinlet, S.Taroto
LEB17A	35	<0.06	2	0.011	<0.001	0.018	9.14	Shear zone, S.Taroto
LEB21A	5	<0.06	2	0.016	<0.001	0.009	10.35	Limo veinlet, S.Taroto
LEB22A	7	<0.06	4	0.011	0.001	0.015	14.40	Qz veinlet, S.Taroto
LEC9A	3	<0.06	2	0.045	0.001	0.042	4.71	Qz veinlet, S.Peko
LEC10A	2	<0.06	2	0.047	0.001	0.153	9.83	Qz veinlet, S.Peko
LEC11A	5	<0.06	2	0.066	<0.001	0.061	8.49	Sili andesite, S.Peko
LEC18A	--	<0.06	2	0.004	0.001	0.017	9.34	Shear zone, S.Peko
LED5A	2	<0.06	2	0.010	0.001	0.013	7.94	Qz veinlet, S.Penasean
LED32A	--	<0.06	4	0.866	<0.001	0.005	1.11	Qz float, S.Lelating
LEF1A	--	<0.06	4	0.129	0.001	0.013	24.30	Py float, S.Lelating
LEG12A	--	0.09	6	0.626	0.002	0.016	33.10	Py veinlet, S.Peko
								Kariango
KAB2A	--	<0.06	4	0.006	0.003	0.057	42.30	Limo diss, S.Ledan
KAB3A	--	<0.06	2	0.003	0.001	0.068	47.30	Limo diss, S.Ledan
KAB9A	--	<0.06	2	0.001	<0.001	0.002	8.02	Limo float, S.Suluan
KAB10A	10	<0.06	2	0.008	<0.001	0.019	7.72	Shear zone, S.Suluan
KAB11A	--	<0.06	2	0.008	0.001	0.017	14.35	Sili zone, Jl.Kariango
KAF2A	--	<0.06	10	0.027	<0.001	0.005	11.50	Limo network, S.Uroh

※ Details of assaying same as in Table 2-14

Table 2-27 Analytical Results of Geochemical Rock-chip Samples in the Bau Prospect

Sample No.	Au (ppb)	Ag (ppm)	As (ppm)	Sb (ppm)	Hg (ppb)	Cu (ppm)	Pb (ppm)	Zn (ppm)	Sample type and locality
BAC16R	260	0.34	5.8	<0.2	600	398	5.0	1350	Qz vein, S.Salubongi
BAC17R	5340	0.92	7.4	1.2	40	1230	<0.5	13	Qz vein, S.Salubongi
BAD30R	4	0.94	3.4	<0.2	60	3810	0.5	52	And, S.Tendanmetang
BAH3R	162	0.20	7.4	<0.2	170	835	0.5	56	Qz vein, Gn.Salupolin

3-4 Geochemical Rock-chip Sampling

(1) Sampling and chemical analysis

Geochemical rock-chip sampling was conducted during the detailed geological survey in the Bau prospect. The samples were gathered from most of the outcrops of quartz veins, mineralized and altered rocks, and quartz float zones within the prospect. The description of samples was recorded in the same manner as in the Batuisi prospect. Geochemical rock-chip samples were treated and analyzed in the same method as in the Batuisi prospect as well. A total of 104 samples was collected and provided for chemical analysis this year.

(2) Statistical data processing

The same methods and procedures as in the Batuisi prospect were adopted in the data processing of geochemical rock-chip samples in the Bau prospect.

(3) Anomalies of rock-chip geochemistry

There are many outcrops and float zones in the prospect. However, anomalous values have been returned from only limited rock-chip samples.

S. Salubongi

Significant Au values were obtained from quartz veins at S. Salubongi. Anomalous values of Cu, Zn, and Ag were also detected in these samples. Au, Ag, and basemetal anomalies are sporadically distributed along the area from the junction of S. Salole and S. Belopi up to Kp. Bau.

Lower reaches of S. Salole

Anomalous values of low level Au were found at the lower reaches of S. Salole. They correspond to the pyrite mineralization associated with dioritic intrusives.

3-5 Discussions

Two styles of mineralization were distinguished in the Bau prospect.

Quartz veins and veinlets occur at the eastern and southern part of the prospect. They contain a small amount of sulphide minerals. Some of the quartz veins showed a significant level of gold (up to 2.18 g/t Au). Outcrops of quartz veins and veinlets were counted more than ten localities within the prospect. They seem to be discontinuous. Several Au and Cu anomalies of soil samples were caught in the area. Each soil anomaly is of rather low level and sporadic. The gold mineralization of this style has no sign of extensive development.

Pyrite dissemination was caught in black shale near the contact of dioritic intrusives at the northern part of the prospect. Assay results of samples were discouraging. Au anomalies of soil and rock-chip samples were ditected nearby. But most of them are of low level and patchy.

Chapter 4 S. Lebutang Prospect

4-1 Outline of the Prospect

The S. Lebutang prospect is located along S. Lebutang and its tributaries -- S. Petangunan, S. Lelating, S. Talodo and S. Taroto. It lies just between the Batuisi prospect and the Bau prospect. There is only one little village called Kp. Petangunan at the western corner of the prospect. Major part of the prospect consists of ragged hills and steep mountains. Access to the prospect is most difficult. The prospect is geologically situated within the distribution of metasediments of the Cretaceous Latimojong Formation. It is immediately north of the Mamasa granite.

During the regional survey last year, significant indications of gold mineralization were caught in the prospect. A series of strong Au anomalies of stream sediments was obtained from the prospect. Some distinctive gold anomalies of pan concentrate were also detected in the prospect.

The occurrence of quartz floats was observed in several localities. Those quartz floats often contain pyrite and chlorite. At the upper reaches of S. Taroto, strong pyrite dissemination was found in altered andesitic rock. Old alluvial diggings were located in the area, and a quartz float zone with some limonite lay nearby.

Semi-detailed geological survey, panning prospecting and reconnaissance soil survey were carried out for the area of approximately 60 km^2 this year.

4-2 Geological Survey

(1) Survey method

Semi-detailed geological survey was carried out along with panning prospecting and soil sampling in the S. Lebutang prospect. The field survey was conducted mostly by flying camping, because there was very few people living in the area. A 1:10,000 route map was produced. The results of survey were compiled on a 1:25,000 map. The total length of traverses was more than 100 km. Ore samples for assaying, ore samples for polished sections, rock samples for thin sections and altered rock samples for X-ray powder analysis amounted to 37, 6, 12 and 7 respectively this year.

(2) Geology and geologic structure

Geology of the S. Lebutang prospect is composed of shale, tuff and andesite of the Latimojong Formation, and dacitic volcanic rocks of the Barupu Tuffs. Granite and andesite dykes are intruded into the Latimojong Formation.

Latimojong Formation : The upper members of the Latimojong Formation (Kls and Klv) occur in the prospect.

The Kls member is dominated by grey to black shale which is interbedded with thin layers of grey fine sandstone (greywacke). It is developed at the middle to the lower reaches of S. Lebutang, S. Talodo and S. Lelating. Shale shows grey to black color. The well-bedded shale is brittle to be broken into flaky fragments. Whereas the massive unit sometimes exhibits very hard nature. Some part of the shale is metamorphosed into phyllite and biotite schist at the upper reaches of S. Lebutang. The Mamasa granite batholith lies close to the southern rim of the metamorphosed zone. Shale adjacent to the contact with andesite stock (described below) is indurated and silicified. It is accompanied with weak pyrite dissemination.

The Klv member consists of the alternating beds of shale, andesite lava and andesitic pyroclastic rocks. This member outcrops mainly at the north of S. Petangunan striking NE-SW and dipping NW gently. Andesite lava shows green color. Four units of lavas were counted. Their thickness ranges from 50 to 250 m. Andesitic pyroclastic rocks consist mainly of pale green to green coarse-grained tuff and tuff breccia. Thin layers of sandy or fine tuff occur within them in some place.

Andesite intrusive body, possibly stock, occupies the southern part of the area stretching from the south of S. Talodo to S. Lelating. The outline of this body shows an ellipse of 2.7 km (N-S) × 6 km (E-W). Andesite is massive, compact and hard, and shows green to greenish grey color. Intensive silicification was recognized in this body. Pyrite dissemination and epidotization were observed in some part of the rock.

Barupu Tuffs (Qt) : Several rock units were distinguished.

Grey coarse-grained dacite. This is characterized by coarse feldspar and biotite crystals. The rock unit occurs mainly at Gn. Tammapupu.

Dacite containing megacrysts of feldspars. Outcrops of this unit are limited to the west and the south of S. Lelating.

Alternation of coarse tuff, fine tuff and volcanic breccia. It is distributed at the upper reaches of S. Talodo.

Greenish grey andesitic rocks (agglomerate and lava) lie at the ridge over 600 m above sea level in the northern side of S. Petangunan.

Congromerate occurs at S. Lelating over 900 m in altitude. It appears to overlie granite body. It sometimes contains rounded fragments of shale, granite and andesite.

Intrusive rocks : Granite (Tgm) and andesite dykes occur in the prospect.

Two stocks of granite were recognized. One occurs at the area over 1,200 m above sea level along S. Lebutang. Biotite, amphibole, and megacryst of feldspar were observed as phenocryst. Another granite body outcrops at S. Piku -- the tributary of S. Lelating. The phenocryst consists of feldspar, biotite, amphibole and quartz.

Andesite dykes from 10 to 150 m wide occur within the pyroclastic units of the Latimojong Formation at the north of S. Talodo. The younger andesite is green to pale greenish grey. It shows compact appearance.

The stratigraphically top member of the Latimojong Formation, Klv which lies in the northern part of the prospect, strikes NE-SW and dips NW gently. In the area from the central to the eastern and the western parts, Kls member (the second from the top) of the Latimojong Formation is widespread in the form of surrounding Klv. From the central to the southern parts is broadly intruded by andesite body which is elongated in the E-W direction.

The Mamasa granite batholith lies to the south of the prospect. The effect of granite emplacement was recognized at the surrounding zone in the Latimojong Formation as the heat conduction from the granite.

Three faults were identified in the prospect. Two faults, striking N70-80°E, were interpreted to have moved after andesite intrusion.

(3) Mineralization and hydrothermal alteration

A total of more than thirty quartz veins and limonite veinlets was counted in the prospect. Most of them are thin veins of 1 to 50 cm in width. Quartz veins are generally composed of fine-grained white to milky quartz. They are usually massive and show no particular inner structure. Some of the quartz veins accompany a small amount of white clay and calcite. Sulphide minerals were found in two styles. One is pyrite-chalcopyrite dissemination occurring in the wall rock adjacent to quartz veins. Another is limonite (probably after pyrite) filling shears and/or fractures which crosscut quartz veins.

Three areas have been highlighted for the development of quartz veins; S. Petangunan, S. Talodo and S. Taroto.

At S. Petangunan, quartz veinlets of 1 to 5 cm wide occur in andesite lava, andesitic pyroclastic rocks, and shale of the Latimojong Formation. Veins are divided into two groups in terms of their strike direction; N10-55°E, and N10-15°W. Both systems were interpreted as tension fracture filling. Any sulphide mineral has yet been found in this locality.

Two groups of veins -- N20-50°E and N5-30°W -- were recognized at the southern slope of S. Talodo. This zone lies along the northern rim of andesite stock. Quartz veins of this zone accompany weak dissemination of pyrite and chalcopyrite. The host rocks, comprising shale and andesite, are totally silicified. Epidotization and pyritization were recognized in some part.

At S. Taroto and the upper reaches of S. Peko, quartz-pyrite mineralization which was probably controlled by shear zones was found. This zone lies at the eastern part of andesite stock. Many quartz float zones are spread over the place. The width of quartz veins ranges from a few centimeters to 35 cm. The host rock is altered by silicification and pyritization. Pyrite and chalcopyrite were found in shears/fractures. Four quartz chips from this area were provided to the fluid inclusion study. The range of homogenization temperature of each fluid inclusion is slightly higher (220 ~ 320°C) than that of in the Batuisi prospect.

S. Taroto is a once-active pan mining place in the prospect. Gold is recovered from the following geological situation.

Steep slopes and floors of the creek are widely covered by andesite talus deposit. It consists of gravel to boulder size subangular fragments of andesite. Surface of the fragments is coated by limonite. Interspace of the fragments is filled with sand-sized particles of andesite and brown soil. The lower part of the fragment zone gradually changes into weathered andesite. Andesite is strongly silicified and moderately chloritized. Dissemination and stringer of pyrite were observed in andesite.

Gold was detected in both andesite fragments and interspace soil at this locality. It was assumed that gold was associated with pyrite mineralization within andesite.

The surface indications of mineralization are distributed within an area of nearly 1,200 m (N-S) × 500 m (E-W) along S. Taroto and S. Peko.

Sulphide minerals identified under the microscope are pyrite, arsenopyrite, chalcopyrite and sphalerite. Pyrite is replaced by iron oxide (limonite). Chalcopyrite is partly replaced by covelline.

The major alteration minerals associated with the mineralization are quartz and chlorite in the S. Lebutang prospect.

4-3 Panning Prospecting

(1) Sampling and heavy minerals analysis

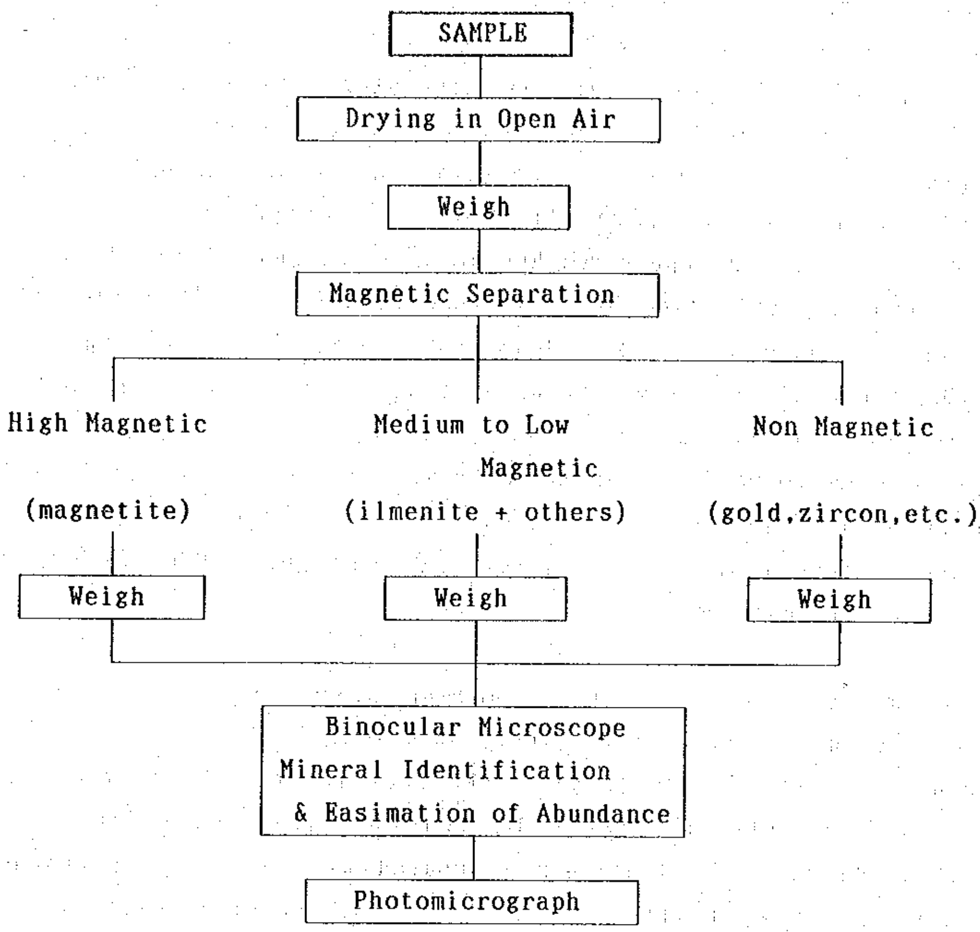


Fig.2-17 Flow Chart of Gold and Heavy Mineral Analysis

Panning prospecting was carried out in the S. Lebutang prospect.

Pan concentrate samples were collected from trap sites in the active drainage channels. A bucketful of sand and gravel which was about 2 liters was gathered and carefully panned out. A panned sample of about 5 grams was obtained finally at every point. Fineness and number of gold grains were measured, and heavy mineral composition was examined roughly by loupe in the field and carefully under the microscope in the laboratory.

The procedures of gold and heavy minerals analysis were illustrated in Fig.2-17. One hundred and twenty-six panned samples were checked in the S. Lebutang prospect.

(2) Results of microscopic observation

Gold was detected in 9 samples in the S. Lebutang prospect. It is composed of fine to very fine carat gold of up to 500 microns in diameter. The major heavy minerals observed in pan concentrates are; garnet, epidote, zircon, ilmenite, pyrite and iron oxide. Corundum, rutile and barite were identified at a few places.

(3) Anomalies of panning prospecting

Among 9 localities where gold was detected in pan concentrates, 8 are located along S. Taroto and its branch creeks. The other one, which was detected in S. Kanan, is located about 1 km south-southeast of S. Taroto. Those localities are arranged within a narrow zone running approximately in the N-S direction.

4-4 Soil Survey

(1) Sampling and chemical analysis

Semi-detailed soil sampling was conducted in the S. Lebutang prospect. Samples were taken from the B-layer of residual soil using hand-auger. The sampling points were arranged along creeks and ridge lines in the prospect.

The same methods of sample treatment and chemical analysis as in the Batuisi prospect were applied. A total of 606 soil samples was collected this year. It corresponds to the sampling density of nearly 10 samples per 1 km^2.

(2) Statistical data processing

The same methods and procedures as in the Batuisi prospect were adopted in the data processing of soil samples in the S. Lebutang prospect.

(3) Anomalies of soil geochemistry

Several Au anomalies were distinguished in the S. Lebutang prospect. Any significant correlation has not been recognized between Au and the other basemetal elements.

S. Taroto

A distinctive soil anomaly (up to 90 ppb Au) was caught along S. Taroto. It extends in the N-S direction over 1,200 m to the upper reaches of S. Peko. It roughly coincides with both the areas of pyrite mineralization and Au anomaly of pan concentrate.

A small anomaly was found at S. Kanan where gold was detected in pan concentrate. It is situated at the south-southeastern extension of the Au anomaly at S. Taroto.

S. Talodo Basisi

This anomaly is located about 2 km north of the S. Taroto anomaly. It is composed of several sampling points of low level Au values (up to 22 ppb) arranging in the NNW-SSE direction. Three anomalies -- S. Taroto, S. Kanan and S. Talodo Basisi -- are distributed along a line extending over 4 km.

S. Pamonde

Anomalous values of Au were obtained from soil samples at S. Pamonde (a branch creek of S. Talodo). It roughly overlaps on the area of quartz float zones.

Middle reaches of S. Lebutang

Several anomalous values of Au in soil samples were obtained at the middle reaches of S. Lebutang. It is sporadic, and is composed of low level Au values up to 23 ppb.

4-5 Discussions

The characteristic features of gold mineralization at S. Taroto in the S. Lebutang prospect are summarized as follows:

① Gold mineralization was found mainly in massive andesite of the Latimojong Formation.

② Gold is intimately associated with pyrite dissemination or stringers which is accompanied with strong silicification.

③ It is overprinted on the zones of intensive quartz veinning which are probably controlled by shear zones.

These features are somehow unique compared with the mineralization in the Batuisi prospect.

Geochemical anomalies were also detected in this area. According to the soil survey, a series of Au anomalies of moderate to low degrees are arranged approximately in the direction of N-S from S. Kanan through S. Taroto and S. Peko up to S. Talodo Basisi. The geochemical features clearly suggest that the mineralization was controlled by a fracuture of N-S system.

The surface indications are thus extensive. However the assay result of ore samples was disappointing. It shows some possibility that it is rather a low grade gold mineralization associated with pyrite dissemination along shear zones. The detailes has not been fully investigated.

Several other outcrops of quartz veins and geochemical anomalies were found in the S. Lebutang prospect. They are of small scale and sporadic.

Chapter 5 Kariango Prospect

5-1 Outline of the Prospect

The Kariango prospect is located to the northeast of the Bau prospect, and is at the area along the lower reaches of S. Uroh. The geology is different from the other three prospects. It consists of the strata of the middle to the upper Miocene series. The southern half is composed of andesitic tuff and siltstone of the Beropa Tuffs. Dacitic tuff and lava of the Barupu Tuffs cover at the high altitude in the prospect. Whereas in the northern half, a thick sequence of sandstone and black shale of the Toraja Formation crops out on the surface.

During the regional survey in 1991, several Au anomalies of stream sediments were detected at the north of Kp. Kariango. Anomalies of Cu, Pb, Zn, and Ag were scattered to some extent in the area. No indication of mineralization on the surface, however, was found in the area. The area has not been fully traversed at all.

Semi-detailed survey area of approximately 40 km^2 was picked up. Geological survey, panning prospecting and reconnaissance soil survey were conducted in the prospect this year.

5-2 Geological Survey

(1) Survey method

Semi-detailed geological survey was carried out in the Kariango prospect. The field survey was conducted by a combination system of base camping in Kp. Kariango and flying camping. The route map was prepared at a scale of 1:10,000. The results of survey were compiled on a 1:25,000 geological map. Traverses of more than 70 km were made. Numbers of ore samples for assaying, ore samples'for polished sections, rock sampies for thin sections, and altered rock samples for X-ray powder analysis were 13, 4, 7 and 3 respectively this year.

(2) Geology and geologic structure

The prospect is underlain by the Toraja Formation, the Beropa Tuffs, and the Barupu Tuffs in ascending order. The lower two sequences are intruded by diorite, andesite and gabbroic rock.

Toraja Formation (Tet) : This formation outcrops along S. Kariango and S. Kanan. The eastern edge of the exposure is bounded with the upper member of the Beropa Tuffs by a NNW-SSE fault. The western and the northern limits of the exposure are contacted with the middle member of the Beropa Tuffs by a N-S fault at the west and a NE-SW fault at the north respectively.

The formation consists mainly of sandstone. It is dark grey well sorted rock, and is interbedded with thin layers of black shale.

Beropa Tuffs (Tmb) : The Beropa Tuffs is subdivided into three members; the lower (Tmb_1), the middle (Tmb_2) and the upper member (Tmb_3).

The lower member is the sequence mainly composed of greenish grey andesitic tuff and grey siltstone. It occurs along S. Suluan stretching in the N-S direction. The andesitic tuff changes their facies from lapilli tuff to tuff breccia. Tuff breccia appears at the south of S. Kariango. Whereas fine tuff and lapilli tuff dominate in the area around S. Ledan and S. Suluan.

The middle member is exposed within a zone extending from Kp. Poyahaang to the west of S. Uroh with the strike direction of NNW-SSE. It is a sedimentary sequence comprising tuff, grey mudstone and siltstone. The middle member gradually changes into the upper member.

The upper member occurs in the eastern area with the strike direction of NNE-SSW. It consists mainly of sandstone and siltstone. They are interbedded with andesitic tuff and lava.

Barupu Tuffs (Qt) : It is composed of dacitic tuff (the upper member) and dacite (the lower member). They lie on the high plain covering from Kp. Ledan to Kp. Beroppa. The other distribution was observed at Gn. Lemo which was situated near the junction of S. Suluan and S. Uroh.

Intrusive rocks : Intrusive rocks of gabbro, diorite and andesite were distinguished in the prospect.

Gabbroic rock occurs at S. Uroh and S. Ruruh. They are stocks extending in the directions of NNE-SSW, N-S and NNW-SSE. They are arranged along the inferred faults.

Several stocks of diorite are exposed at S. Uroh. They extend mainly in the NNE-SSW direction. The diorite stocks are lined up along faults.

Andesite dykes occur at the middle reaches of S. Suluan and the upper reaches of S. Ledan. They show the elongated form of N-S.

The Toraja Formation has the unconformable relationship to the overlying strata within the prospect. The contact between them is bounded by faults.

An anticlinal structure with NNE-SSW axis was recognized in the Toraja Formation. The structure does not extend to the overlying rocks. Therefore it was interpreted that the Toraja Formation had the deformation structure formed before the deposition of the Beropa Tuffs. The Beropa Tuffs has been deformed to show a gentle anticlinal structure or a flexure whose axis lies near S. Suluan trending in the N-S direction. Consequently the either sides from the axis show the monoclinal structure striking N-S. The Beropa Tuffs in the northeastern area, however, changes to the structure with striking E-W and dipping N.

Several faults were observed in the prospect. They strike N-S to NNW-SSE. Most of the intrusive rocks occur along these faults.

(3) Mineralization and hydrothermal alteration

Any significant mineralization has yet been recognized in the Kariango prospect, except a minor occurrence of iron oxide. There is a small limonite network near the hilltop east of S. Suluan. It occurs within the lower member of the Beropa Tuffs. The network zone has the N-S elongation of 300 m × 20 m. Pyrite is almost replaced by iron oxide minerals such as limonite, specularite and hematite. Magnetite was observed in this zone.

5-3 Panning prospecting

(1) Sampling and heavy minerals analysis

Panning prospecting was carried out in the Kariango prospect. The same methods for pan concentrate sampling and sample processing as in the S. Lebutang prospect were taken in the prospect.

Eighty panned samples were collected and processed for gold and heavy minerals analysis this year.

(2) Results of microscopic observation

Gold was detected in only one sample in the Kariango prospect this year. It is very fine carat gold. The major heavy minerals observed in pan concentrates are; garnet, epidote, zircon, ilmenite, pyrite and iron oxide. Cinnabar, corundum and marcasite were found in one locality each.

(3) Anomalies of panning prospecting

The only one place where gold was detected in pan concentrates is located near the junction of S. Uroh and S. Kariango. There is no other anomaly in the prospect.

5-4 Soil Survey

(1) Sampling and chemical analysis

Soil survey for reconnaissance purpose was conducted in the Kariango prospect. Samples were taken from the B-layer of residual soil using hand-auger. The sampling points were arranged along creeks and ridge lines in the prospect.

The same methods of sample treatment and chemical analysis as in the Batuisi prospect were applied in the Kariango prospect. A total of 404 soil samples was collected this year. It corresponds to the sampling density of approximately 10 samples per 1 km^2.

(2) Statistical data processing

The same methods and procedures as in the Batuisi prospect were adopted in the data processing of soil samples in the Kariango prospect.

(3) Anomalies of soil geochemistry

One broad Au anomaly and one small anomaly were obtained in the prospect. Any significant correlation has not been distinguished between Au and the other basemetal elements.

Southwestern side of S. Uroh

A broad Au anomaly was obtained at the southwestern side of the middle reaches of S. Uroh. It is composed of low level Au values of up to 17 ppb. It has an area of 1,500 m (N-S) × 1,000 m (E-W). This anomaly is situated at the downstream side of the limonite network zone in the Beropa Tuffs (Tmb_1).

Lower reaches of S. Kariango

This is a small Au anomaly (up to 12 ppb). It is located near the anomaly of pan concentrate.

5-5 Discussions

A small limonite network zone was found in andesitic tuff of the Beropa Tuffs near the hilltop east of S. Suluan. A low level Au anomaly of soil samples was obtained at the downstream side of the limonite zone. It is assumed that the pyrite mineralization in the Beropa Tuffs carries a very low level of gold. Any significant result has not been obtained from ore assaying.

Chapter 6 Drilling

6-1 Outline of Drilling

A small scale diamond drilling programme for reconnaissance purpose was planned at the upper reaches of S. Tarawa in the Batuisi prospect. The drilling area was situated over the most significant soil anomalous zone which was discovered during the preliminary soil survey in 1991. The geology around the drill sites was composed of shale and andesite of the Latimojong Formation. Only small blocks of quartz float were observed on the surface. As was already explained in the previous chapter (Chapter 2), six lines of shallow trenches were excavated in the anomalous zone at the early stage of the current field work. Several indications of gold mineralization, such as occurrence of quartz veins/stockworks and silicified zones, were caught in the trenches. The targets of drilling were discussed on the basis of the result of trenching, then locations of drill holes were selected.

The drilling programme was directed toward; ① the lower extension of the surface indications, and ② the lateral extension of the gold anomalous zone. The programme consisted of five inclined holes of 80 m deep each. The total length was 400 m. The target depth was set at 50 m from the surface. Details of each hole are summarized in the following table.

Hole No.	Locality	Grid Coordinates		Eleva-tion	Azimuth	Incli-nation	Hole Length
		N	E				
MJT-1	Hill Northwest of S. Tarawa	55S	1,695E	605 m	235 °	-60 °	80.3 m
MJT-2		55S	1,535E	580	235	-60	80.3
MJT-3		65S	1,440E	560	235	-60	80.3
MJT-4		90S	1,290E	560	235	-60	80.3
MJT-5	N of S. Bone	290N	1,250E	455	55	-60	80.3
Total							401.5 m

A series of drill logs of 1:200 scale were prepared, and the whole drill cores were photographed in color. One hundred and five ore assay samples were obtained. Twenty-seven quartz chips were taken for fluid inclusion study. Twenty polished sections for ore microscopy were produced from the cores. Twenty altered rock and clay samples were examined for X-ray powder analysis.

6-2 Drilling Method, Equipment and Progress

6-2-1 Drilling Method and Equipment

Method

For surface soil and gravel layer (up to 8 m), drilling was done by NW casing shoe (92 mm in diameter) with inserting of NW casing pipes. Weathered bedrock was drilled by conventional drilling method with NX diamond bit (76 mm in diameter) and NX-STH core tube. The weathered bedrock continued down to 20 ~ 30 m deep, and BW casing pipes were inserted in this zone. For the bedrock zone, wireline method was adopted with BQ oversized diamond bit (60 mm in diameter) and BQ-WL core tube. Bentonite mud, lubricant chemical (Mud Oil), and CMC were usually mixed in the circulating drilling water. When the water was lost in the hole where fractures were developed, Tel-Stop and Seaclay (asbestos) were injected to recover the trouble. Borehole cementation was applied when water loss and the collapse of wall happened at the same time.

Equipment

The drilling site was located in the remote place. No vehicle road was available in the area. Transportaion was limited only by horses and labors. Specially made machine and equipment were brought into the operation because of this condition. The drilling machine was YBM-05DA of Yoshida Boring Machines, a special light-weight product of which the maximum weight of the dismantled parts was 55 kg. Other equipment for drilling such as drill rig, drilling pump, mud mixer, etc., was chosen up on the basis of the weight constraint. Specifications of drilling machine and equipment are shown in Table 2-28. Diamond bits and expendable items used during the drilling are listed in Tables 2-29 and 2-30 respectively.

Working system

Drilling operation was carried out by three shifts per day (8 hours per shift), while the appurtenant works, such as rig construction, mobilization and demobilization, were done by one shift per day. A shift crew consisted of one drilling engineer and three workers normally. Additional fourteen workers (round figures) were involved in case of the appurtenant work. A base camp for drilling operation was built near the drilling sites. A series of footpaths was cleared from Kp. Batuisi to the hill-top on which the base camp and drilling sites were located.

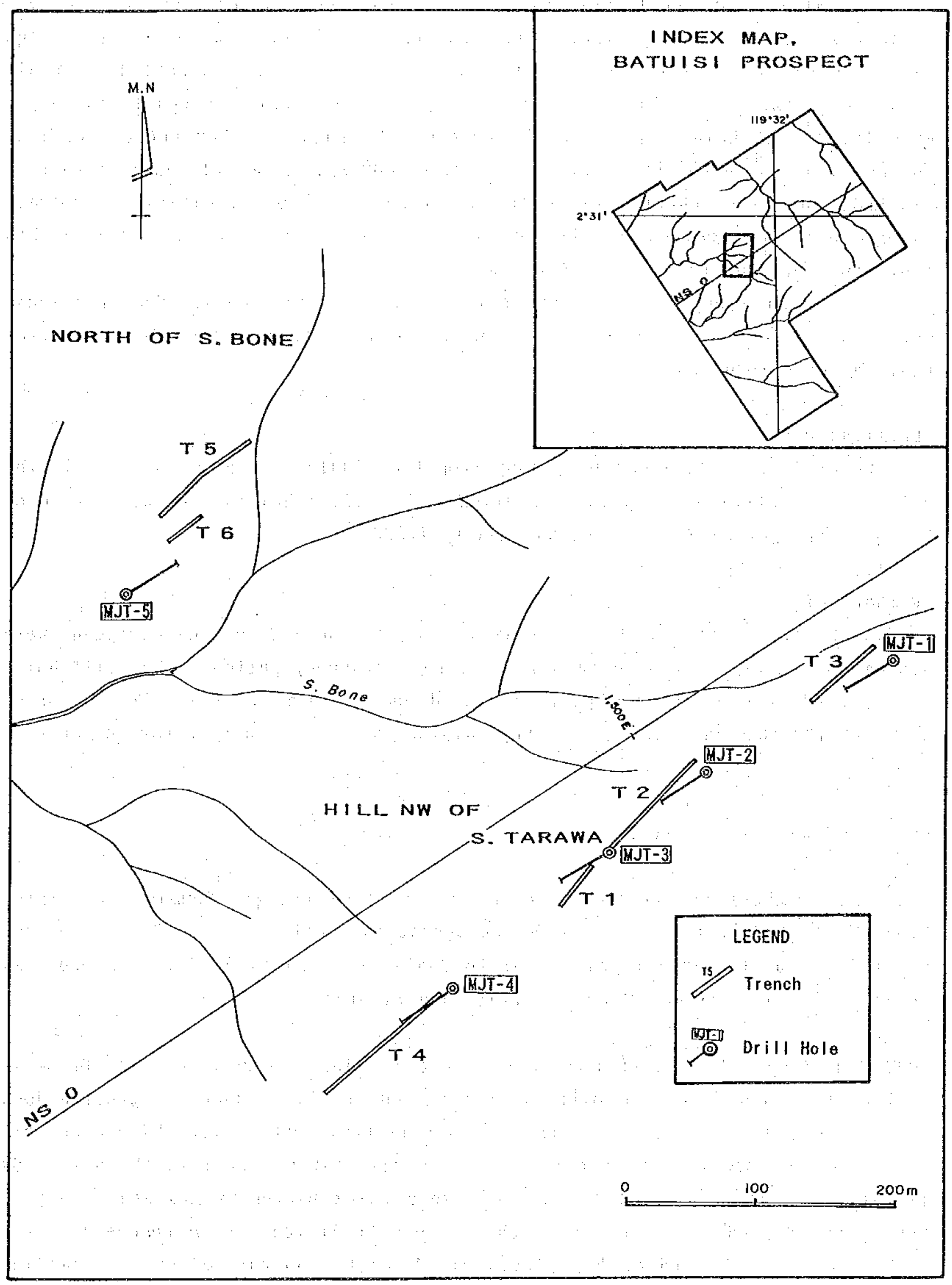


Fig.2-18 Location Map of Drill Holes

Transportation

The machine and equipment were shipped from Yokohama to Ujung Pandang via Surabaya. After landed, they were transported to Tarailu by trucks. The cargoes were once unloaded at Tarailu deposit, unpacked and dismantled for small transportation. Fuel, foods, and camping goods were also gathered to the depo. From Tarailu to Galumpang (about 60 km along S. Karama), they were carried by engine canoe whose loading capacity was up to 600 kg. From Galumpang to Batuisi (16 km), they were carried by horses and labors. From Kp. Batuisi a footpath (short-cut) was constructed up to the drilling site, and the machine and equipment were carried up on labors' back.

Supply for the camp was made at least once in four weeks. Fuel and foods were bought at Ujung Pandang and Mamuju, and were transported along the same route as described above.

Drilling water

Water for drilling was pumped up from the middle reaches of S. Bone to the hill-top. Two stages of pumping station were established for the water head of 300 m. Piping length installed was nearly 1,000 m.

Withdrawal

After the completion of drilling programme, the machine and equipment were stored in the drilling base camp for the next stage operation. The drill holes were capped, and drilling site was cleaned and reclaimed. The drilling cores, of which the half was taken for assay samples, were kept in the storage house.

6-2-2 Progress of Drilling

The progress of each drill hole is described below. Summary of working time (Table 2-31), records of drilling operation (Tables 2-32 to 2-36), records of drilling performance (Tables 2-37 to 2-41), and charts of drilling progress (Figs. 2-19 to 2-23) are shown in tables and figures.

MJT-1 : For surface soil and saprolite zone, drilling was done by NW metal casing shoe, and NW casing pipes were inserted to 10.0 m deep. Saprolite down to 21.0 m deep was drilled by conventional drilling method with NX diamond bit and NX - STH core tube. Some of the water was lost at 7.2 m in the hole. BW casing pipes were inserted to 21.0 m. Very thick bentonite mud and core pack tube were adopted for strongly weathered zone to increase core recovery. From 21.0 m down to the end of hole (80.3 m), drilling was carried out by wireline method with BQ diamond bit and BQ-WL core tube. Bentonite, CMC, Libonite and Mud Oil were mixed with circulating water. The circulating water was lost at 69.6 m in the hole, where massive quartz veins with numerous micro-fractures were developed. Telstop and Seaclay were injected to recover the trouble. The overall core recovery of 99.0 % was achieved in this hole.

MJT-2 : Surface soil and gravel zone are deeply developed down to 8.0 m in MJT-2. Very thick, massive quartz veins were caught at rather shallow horizon (from 9.0 m until 21.3 m) in this hole. Some part of the quartz shows sugary features because of strong weathering. Only quartz fragments of sand size were returned from such a zone. Therefore, low recovery of drill core was produced in this zone. NW casing pipes were inserted to 10.0 m, and BW casing pipes to 20.0 m. The circulating water was lost at 16.0 m, where was right in the middle of the quartz vein. Telstop and Seaclay were injected for this zone. From 20.0 m down to the end of hole (80.3 m), drilling was done by wireline method with BQ diamond bit and BQ-WL core tube. Overall core recovery was 92.3 % in this hole.

MJT-3 : NW casing pipes and BW casing pipes were inserted to 10.0 m and 20.0 m respectively in this drill hole. The circulating water was lost at 12.7 m, where a quartz stockwork zone was developed. Telstop and Seaclay were injected into the circulating water together with bentonite and CMC. From 20.0 m down to the end of hole (80.3m), drilling was done by wireline method with BQ diamond bit. Overall core recovery was almost 100 % in this hole, because of the thoughtful operation of drilling.

MJT-4 : Drilling for surface soil and saprolite zone was undertaken by NW diamond casing shoe, and NW casing pipes were inserted to 6.0 m deep. Saprolite down to 20.0 m deep was drilled by conventional drilling method with NX diamond bit and NX-STH core tube, and BW casing pipes were inserted. From 20.0 m down to the end of hole (80.3 m), drilling was done by wireline method with BQ diamond bit and BQ-WL core tube. Saprolite and black shale are very soft and easy to melt when mixed with water. Therefore drilling operation in these zones were carefully conducted. Poor core recovery has returned from some of these zones. The circulating water was lost at 54.5 m, which was correlated to quartz vein. Telstop and Seaclay were injected to recover the water loss. Overall core recovery was 89.0 % in this hole.

MJT-5 : For the near surface zone to 6.0 m, drilling was made by NW diamond casing shoe, and NW casing pipes were inserted. Numerous fractures were developed in silicified andesite from 6.0 m down to 30.0 m. BW casing pipes were inserted to 19.0 m. However, from 19.0 m to 30.0 m, the collapse of hole wall happened together with the total water loss. These troubles were controlled by inner hole cementation (two times -- at 25.5 m and 30.0 m). Overall core recovery was 95.6 % in this hole.

Table 2-28 Specifications of Drilling Machine and Equipment

Drilling machine ; Model YBM-05DA	1 set
Capacity	110 m (40.5 mm$^{\phi}$) / 50 m (65 mm$^{\phi}$)
Dimensions (L x W x H)	1,040 x 550 x 950 mm
Weight	230 kg (excl engine)
Hoisting capacity	500 kg
Spindle speed	57, 110, 225 rpm
Engine ; Model DY-41B	7.5 ps/1,750 rpm
Drilling pump ; Model MG-5h	1 set
Piston diameter	68 mm
Stroke	60 mm
Capacity	70 ℓ/min (discharge)
Dimensions (L x W x H)	1,630 x 470 x 680 mm
Weight	200 kg (excl engine)
Engine ; Model NFAD7	6.0 ps/2,600 rpm
Water supply pump; Model TA-800	3 sets
Plunger type	3 planger lateral
Capacity	88 ℓ/min (discharge)
Dimensions (L x W x H)	554 x 354 x 424 mm
Weight	29 kg (excl engine)
Engine ; Model LA90ASES	8.0 ps/1,800 rpm
Derrick	1 set
Height	5.5 m
Maximum load capacity	3,000 kg
Mud mixer ; Model MCE-100A	1 set
Capacity	100 ℓ / 800 rpm
Engine ; Model NSA40C	4.5 ps/2,400 rpm
Generator ; Model YDG-3005	2 sets
Capacity	2.7 KVA (100V, 27A)
Generator ; Model YSG-2005	2 sets
Capacity	1.7 KVA (100V, 17A)
Drilling tools	
Drilling rods	40.5 mm 1.5 m x 20 pcs
	BQ-WL 3.0 m x 36 pcs
Casing pipes	NW CP 1.0 m x 10 pcs
	BW CP 1.5 m x 20 pcs
Core tubes	NX-STH 1.5 m x 2 pcs
	BQ-WL 3.0 m x 2 pcs

Table 2-29 Drilling Meterage and Diamond Bit Consumption

Item	Size	Bit No.	Drillig Meterage/Each Bit					Total (m)
			MJT-1	MJT-2	MJT-3	MJT-4	MJT-5	
Diamond Bit	NX	3537889-1	16.00					16.00
		3537889-2		12.00	10.00			22.00
		3537889-3				14.00		14.00
		3537889-4					13.00	13.00
		Total	16.00	12.00	10.00	14.00	13.00	65.00
			Average Drilling Length/Bit 16.25 m					
	BQ	NT303-24	28.00					28.00
		10910	23.70					23.70
		12612	7.60	11.10				18.70
		11848		29.30				29.30
		11849		19.90	5.50			25.40
		11850			30.20			30.20
		11852			24.60			24.60
		11855				26.00		26.00
		11856				20.70		20.70
		11859				13.60	6.50	20.10
		11860					4.50	4.50
		101812					25.20	25.20
		101813					25.10	25.10
		Total	59.30	60.30	60.30	60.30	61.30	301.50
			Average Drilling Length/Bit 23,20 m					
Diamond Casing Shoe	NW	12685	–	–	10.00	6.00	6.00	22.00
		Total	–	–	10.00	6.00	6.00	22.00
			Average Drilling Length/Bit 22.00					

Table 2-30 Consumption of Expendable Items

Expendable Item	Spec	Unit	Consumption					Total Amount
			MJT-1	MJT-2	MJT-3	MJT-4	MJT-5	
Diesel fuel		ℓ	730	660	550	600	720	3,260
Gasoline		ℓ	160	140	140	150	180	770
Hydraulic oil		ℓ	14	10	10	12	20	66
Engine oil		ℓ	3	3	3	3	10	22
Grease		kg	3	3	2	3	10	21
Bentonite		kg	825	575	500	625	650	2,625
CMC		kg	40	23	21	42	31	157
Seaclay		kg	34	31	25	60	10	160
Libonite		kg	18	–	25	40	–	83
Tel-Stop		kg	15	24	23	45	25	132
Mud-Oil		ℓ	20	18	17	30	45	130
Cement		kg	80	80	80	80	480	800
Diamond bit	NX	pcs	1	1	←	1	←	3
Diamond bit	BQ	pcs	3	2	2	3	3	13
Diamond reamer	NX	pcs	1	←	1	←	1	3
Diamond reamer	BQ	pcs	2	1	1	1	1	6
Metal casing shoe	NW	pcs	1	←	–	–	–	1
Diamond casing shoe	NW	pcs	–	–	1	←	←	1
Core barrel assembly	BQ	set	1	←	←	←	←	1
Core lifter	NX	pcs	1	←	←	1	←	2
Core lifter case	NX	pcs	1	←	←	1	←	2
Core lifter	BQ	pcs	2	1	1	2	1	7
Core lifter case	BQ	pcs	1	1	1	1	1	5
Double core tube	NX	pcs	1	←	←	←	←	1
Inner tube	BQ	pcs	1	←	←	1	←	2
Inner tube stabilizer	BQ	pcs	1	←	←	1	←	2
Thrust ball bearing	BQ	pcs	1	1	1	1	1	5
Chack piece	40.5	set	1	←	←	←	←	1
Cylinder liner	MG-5	pcs	1	←	←	←	←	1
Piston rod	MG-5	pcs	1	←	←	←	←	1
Piston rubber	MG-5	pcs	1	1	1	1	←	4
V-packing	MG-5	pcs	1	1	1	1	←	4
Wire line cable		m	200	←	←	←	←	200
Core case	NQ	pcs	3	3	3	3	3	15
Core case	BQ	pcs	6	6	6	6	6	30

Table 2-31 Summary of Working Time

Hole No.	Drilling			Shift		Man Working ※[1]		Working Time ※[2]						
	Bit Size	Drilling Length (m)	Core Length (m)	Drilling Shift (shift)	Total Shift (shift)	Engineer (man)	Worker (man)	Drill-ing (h)	Other Work (h)	Sub-total (h)	Assem-blage (h)	Disman-tlement (h)	Trans-porta-tion (h)	Grand Total (h)
MJT-1	NX/BQ	80.3	79.5	15.0	20.0	36.0	352.0	61.40	66.20	128.00	8.00	8.00	16.00	160.00
MJT-2	NX/BQ	80.3	74.1	15.0	20.0	36.0	273.0	60.20	67.40	128.00	8.00	8.00	16.00	160.00
MJT-3	NX/BQ	80.3	80.3	13.0	16.5	42.0	208.0	53.20	57.40	111.00	8.00	8.00	8.00	135.00
MJT-4	NX/BQ	80.3	71.5	16.0	20.0	44.0	246.0	66.30	66.30	133.00	8.00	4.00	12.00	157.00
MJT-5	NX/BQ	80.3	76.8	23.5	30.5	62.0	410.0	79.00	113.00	192.00	8.00	4.00	40.00	244.00
Total		401.5	382.2	82.5	107.0	220.0	1,489.0	320.50	371.10	692.00	40.00	32.00	92.00	856.00

※[1] Geological logging inclusive

※[2] Site preparation and road constraction exclusive

Table 2-32 Record of Drilling Operation (MJT-1)

Date	Drilling Length (m)			Daily Total (m)		Shift (shift)		Man Working(man)	
	Shift 1	Shift 2	Shift 3	Drill'g	Core L	Drill'g	Total	Eng'er	Worker
Sep30	Preparation								
Oct 1	ditto								
2	Assemblage								
3	5.0	–	–	5.0	5.0				
4	2.1	–	–	2.1	2.1				
5	5.7	–	–	5.7	5.7				
6	7.2	4.0	7.3	18.5	18.5				
7	2.9	5.3	6.5	14.7	14.7				
8	3.0	7.9	3.9	14.8	14.8				
9	6.2	5.7	7.6	19.5	18.7				
10	Take-out CP								
11	Dismantlement					15.0	20.0	36.0	352.0
Total				80.3	79.5	15.0	20.0	36.0	352.0

Table 2-33 Record of Drilling Operation (MJT-2)

Date	Drilling Length (m)			Daily Total (m)		Shift (shift)		Man Working(man)	
	Shift 1	Shift 2	Shift 3	Drill'g	Core L	Drill'g	Total	Eng'er	Worker
Oct12	Transportation								
13	ditto								
14	Assemblage								
15	8.0	–	–	8.0	8.0				
16	4.4	–	–	4.4	2.4				
17	3.3	3.9	1.7	8.9	4.7				
18	9.8	–	–	9.8	9.8				
19	6.1	6.3	7.7	20.1	20.1				
20	5.4	3.8	6.4	15.6	15.6				
21	5.6	3.4	4.5	13.5	13.5				
22	Take-out CP								
23	Dismantlement					15.0	20.0	36.0	273.0
Total				80.3	74.1	15.0	20.0	36.0	273.0

Table 2-34 Record of Drilling Operation (MJT-3)

Date	Drilling Length (m)			Daily Total (m)		Shift (shift)		Man Working(man)	
	Shift 1	Shift 2	Shift 3	Drill'g	Core L	Drill'g	Total	Eng'er	Worker
Oct24	Transportation								
25	Assemblage								
26	7.0	–	–	7.0	7.0				
27	8.6	–	–	8.6	8.6				
28	9.9	–	–	9.9	9.9				
29	5.0	5.1	4.0	14.1	14.1				
30	5.2	5.7	5.2	16.1	16.1				
31	4.0	5.3	6.8	16.1	16.1				
Nov 1	8.5	–	–	8.5	8.5				
2	Take-out CP & Dismantlement								
3	Dismantlement(& Transportation to MJT-4)					13.0	16.5	42.0	208.0
Total				80.3	80.3	13.0	16.5	42.0	208.0

Table 2-35 Record of Drilling Operation (MJT-4)

Date	Drilling Length (m)			Daily Total (m)		Shift (shift)		Man Working(man)	
	Shift 1	Shift 2	Shift 3	Drill'g	Core L	Drill'g	Total	Eng'er	Worker
Nov 3	Transportation (& Dismantlement of MJT-3)								
4	ditto								
5	Assemblage								
6	6.0	–	–	6.0	6.0				
7	8.1	–	–	8.1	8.1				
8	8.7	–	–	8.7	7.3				
9	4.1	3.7	3.2	11.0	10.6				
10	3.6	4.6	3.4	11.6	9.6				
11	4.0	4.1	4.0	12.1	7.1				
12	4.3	4.9	7.5	16.7	16.7				
13	6.1	Take-out CP		6.1	6.1				
14	Dismantlement(& Transportation to MJT-5)					16.0	20.0	44.0	246.0
Total				80.3	71.5	16.0	20.0	44.0	246.0

Table 2-36 Record of Drilling Operation (MJT-5)

Date	Drilling Length (m)			Daily Total (m)		Shift (shift)		Man Working(man)	
	Shift 1	Shift 2	Shift 3	Drill'g	Core L	Drill'g	Total	Eng'er	Worker
Nov14	Transportation(	& Dismantlement			of MJT-4)				
15	ditto								
16	ditto								
17	Assemblage								
18	5.0	1.0	–	6.0	6.0				
19	3.3	2.7	3.5	9.5	9.0				
20	3.2	1.7	3.9	8.8	7.5				
21	1.2	Cementation		1.2	1.2				
22	Cementation			–	–				
23	2.7	1.8	Cement	4.5	3.3				
24	1.6	7.4	7.2	16.2	15.7				
25	3.6	5.4	5.5	14.5	14.5				
26	7.0	8.5	4.1	19.6	19.6				
27	Dismantlement &	Demobilization							
28	Demobilization								
29	Demobilization					23.5	30.5	62.0	410.0
Total				80.3	76.8	23.5	30.5	62.0	410.0

Table 2-37 Record of Drilling Performance (MJT-1)

Operation	Survey Period: Period	Survey Period: Day	Work Day	Off Day	Total Man Day: Engineer	Total Man Day: Worker
Preparation	Sep.30 ～ Oct. 2 ,1992	3.0	3.0	0	9.0	130.0
Drilling	Oct. 3 ～ Oct. 9	7.0	7.0	0	21.0	181.0
Removing	Oct.10 ～ Oct.11	2.0	2.0	0	6.0	41.0
Total		12.0	12.0	0	36.0	352.0

Drilling Length	m		m
Length Planned	80.0	Overburden	0.2
Increase/De- crease in L'th	+ 0.3	Core Length	79.5
Length Drilled	80.3	Core Recovery	% 99.0

Core Recovery of 50 m Hole

Depth of Hole	Core Recovery	Cumulative Core Recovery
0 ～ 50.0 m	100.0	100.0
50.0 ～ 80.3 m	97.4	99.0

Working Hours	h	%	%
Drilling	61.40	48.2	38.6
Other Work	66.20	51.8	41.4
Recovering	—	—	—
Sub-total	128.00	100.0	80.0
Assemblage	8.00		5.0
Dismantlement	8.00		5.0
Water Transportation	—		—
Transportation	16.00		10.0
Grand Total	160.00		100.0

Efficiency of Drilling

Total Length / Total Work Days	6.7 m/day
Total Length / Total Shifts	4.0 m/shift

Drilling Length/Each Bit (m)

Bit Size	NX	BQ	NW
Drilled Length	11.0	59.3	10.0
Core Length	11.0	58.5	10.0

Casing Pipe Inserted

Size	Meterage (m)	Meterage / Drilling Length x 100 (%)	Recovery (%)
NW	10.0	12.5	100.0
BW	21.0	26.2	100.0

Table 2-38 Record of Drilling Performance (MJT-2)

Operation	Survey Period: Period	Survey Period: Day	Work Day	Off Day	Total Man Day: Engineer	Total Man Day: Worker
Preparation	Oct.12 ～ Oct.14,1992	3.0	3.0	0	9.0	59.0
Drilling	Oct.15 ～ Oct.21	7.0	7.0	0	21.0	205.0
Removing	Oct.22 ～ Oct.23	2.0	2.0	0	6.0	39.0
Total		12.0	12.0	0	36.0	273.0

Drilling Length	m		m
Length Planned	80.0	Overburden	8.0
Increase/Decrease in L'th	+ 0.3	Core Length	74.1
Length Drilled	80.3	Core Recovery (%)	92.3

Core Recovery of 50 m Hole: Depth of Hole	Core Recovery	Cumulative Core Recovery
0 ～ 50.0 m	89.9	89.9
50.0 ～ 80.3 m	100.0	92.3

Working Hours	h	%	%
Drilling	60.20	47.1	37.7
Other Work	66.40	52.1	41.7
Recovering	1.00	0.8	0.6
Sub-total	128.00	100.0	80.0
Assemblage	8.00		5.0
Dismantlement	8.00		5.0
Water Transportation	–		–
Transportation	16.00		10.0
Grand Total	160.00		100.0

Efficiency of Drilling

Total Length / Total Work Days	6.7 m/day
Total Length / Total Shifts	4.0 m/shift

Drilling Length/Each Bit (m)

Bit Size	NX	BQ	NW
Drilled Length	10.0	60.3	10.0
Core Length	3.8	60.3	10.0

Casing Pipe Inserted

Size	Meterage (m)	Meterage / Drilling Length x 100 (%)	Recovery (%)
NW	10.0	12.5	100.0
BW	20.0	24.9	70.9

Table 2-39 Record of Drilling Performance (MJT-3)

	Survey Period				Total Man Day	
	Period	Day	Work Day	Off Day	Engineer	Worker
Operation						
Preparation	Oct 24 ~ Oct.25,1992	2.0	2.0	0	8.0	41.0
Drilling	Oct.26 ~ Nov. 1	7.0	7.0	0	28.0	137.0
Removing	Mov. 2 ~ Nov. 3	1.5	1.5	0	6.0	30.0
Total		10.5	10.5	0	42.0	208.0

Drilling Length	m		m
Length Planned	80.0	Overburden	0.6
Increase/Decrease in L'th	+0.3	Core Length	80.3
Length Drilled	80.3	Core Recovery	% 100.0

Core Recovery of 50 m Hole		
Depth of Hole	Core Recovery	Cumulative Core Recovery
0 ~ 50.0 m	100.0	100.0
50.0 ~ 80.3 m	100.0	100.0

Working Hours	h	%	%
Drilling	53.20	48.0	39.5
Other Work	57.40	52.0	42.7
Recovering	—	—	—
Sub-total	111.00	100.0	82.2
Assemblage	8.00		5.9
Dismantlement	8.00		5.9
Water Transportation	—		—
Transportation	8.00		5.9
Grand Total	135.00		100.0

Efficiency of Drilling	
Total Length / Total Work Days	7.6 m/day
Total Length / Total Shifts	4.9 m/shift

Drilling Length/Each Bit (m)			
Bit Size	NX	BQ	NW
Drilled Length	10.0	60.3	10.0
Core Length	10.0	60.3	10.0

Casing Pipe Inserted			
Size	Meterage (m)	Meterage / Drilling Length x 100 (%)	Recovery (%)
NW	10.0	12.5	100.0
BW	20.0	24.9	100.0

Table 2-40 Record of Drilling Performance (MJT-4)

Operation	Survey Period: Period	Survey Period: Day	Work Day	Off Day	Total Man Day: Engineer	Total Man Day: Worker
Preparation	Nov. 3 ~ Nov. 5,1992	2.5	2.5	0	10.0	49.0
Drilling	Nov. 6 ~ Nov. 13	7.5	7.5	0	30.0	182.0
Removing	Nov.13 ~ Nov. 14	1.0	1.0	0	4.0	15.0
Total		11.0	11.0	0	44.0	246.0

Drilling Length	m		m
Length Planned	80.0	Overburden	0.1
Increase/De-crease in L'th	+0.3	Core Length	71.5
Length Drilled	80.3	Core Recovery	% 89.0

Core Recovery of 50 m Hole: Depth of Hole	Core Recovery	Cumulative Core Recovery
0 ~ 50.0 m	91.6	91.6
50.0 ~ 80.3 m	85.7	89.0

Working Hours	h	%	%
Drilling	66.30	50.0	42.4
Other Work	66.30	50.0	42.4
Recovering	–	–	–
Sub-total	133.00	100.0	84.8
Assemblage	8.00		5.1
Dismantlement	4.00		2.5
Water Transportation	–		–
Transportation	12.00		7.6
Grand Total	157.00		100.0

Efficiency of Drilling	
Total Length / Total Work Days	7.3 m/day
Total Length / Total Shifts	4.0 m/shift

Drilling Length/Each Bit (m): Bit Size	NX	BQ	NW
Drilled Length	14.0	60.3	6.0
Core Length	12.6	52.9	6.0

Casing Pipe Inserted

Size	Meterage (m)	Meterage / Drilling Length x 100 (%)	Recovery (%)
NW	6.0	7.5	100.0
BW	20.0	24.9	100.0

Table 2-41 Record of Drilling Performance (MJT-5)

Operation	Survey Period: Period	Survey Period: Day	Work Day	Off Day	Total Man Day: Engineer	Total Man Day: Worker
Preparation	Nov.14 ~ Nov.17,1992	3.5	3.5	0	14.0	135.0
Drilling	Nov.18 ~ Nov.26	9.0	9.0	0	36.0	180.0
Removing	Nov.27 ~ Nov.29	3.0	3.0	0	12.0	95.0
Total		15.5	15.5	0	62.0	410.0

Drilling Length	m		m
Length Planned	80.0	Overburden	0
Increase/Decrease in L'th	+0.3	Core Length	76.8
Length Drilled	80.3	Core Recovery	% 95.6

Core Recovery of 50 m Hole

Depth of Hole	Core Recovery	Cumulative Core Recovery
0 ~ 50.0 m	93.0	93.0
50.0 ~ 80.3 m	100.0	95.6

Working Hours	h	%	%
Drilling	79.00	41.1	32.4
Other Work	77.00	40.1	31.6
Recovering	36.00	18.8	14.7
Sub-total	192.00	100.0	78.7
Assemblage	8.00		3.3
Dismantlement	4.00		1.6
Water Transportation	–		–
Transportation	40.00		16.4
Grand Total	244.00		100.0

Efficiency of Drilling

Total Length / Total Work Days	5.2 m/day
Total Length / Total Shifts	2.6 m/shift

Drilling Length/Each Bit (m)

Bit Size	NX	BQ	NW
Drilled Length	13.0	61.3	6.0
Core Length	11.6	59.2	6.0

Casing Pipe Inserted

Size	Meterage (m)	Meterage / Drilling Length x 100 (%)	Recovery (%)
NW	6.0	7.5	100.0
BW	19.0	23.7	92.6

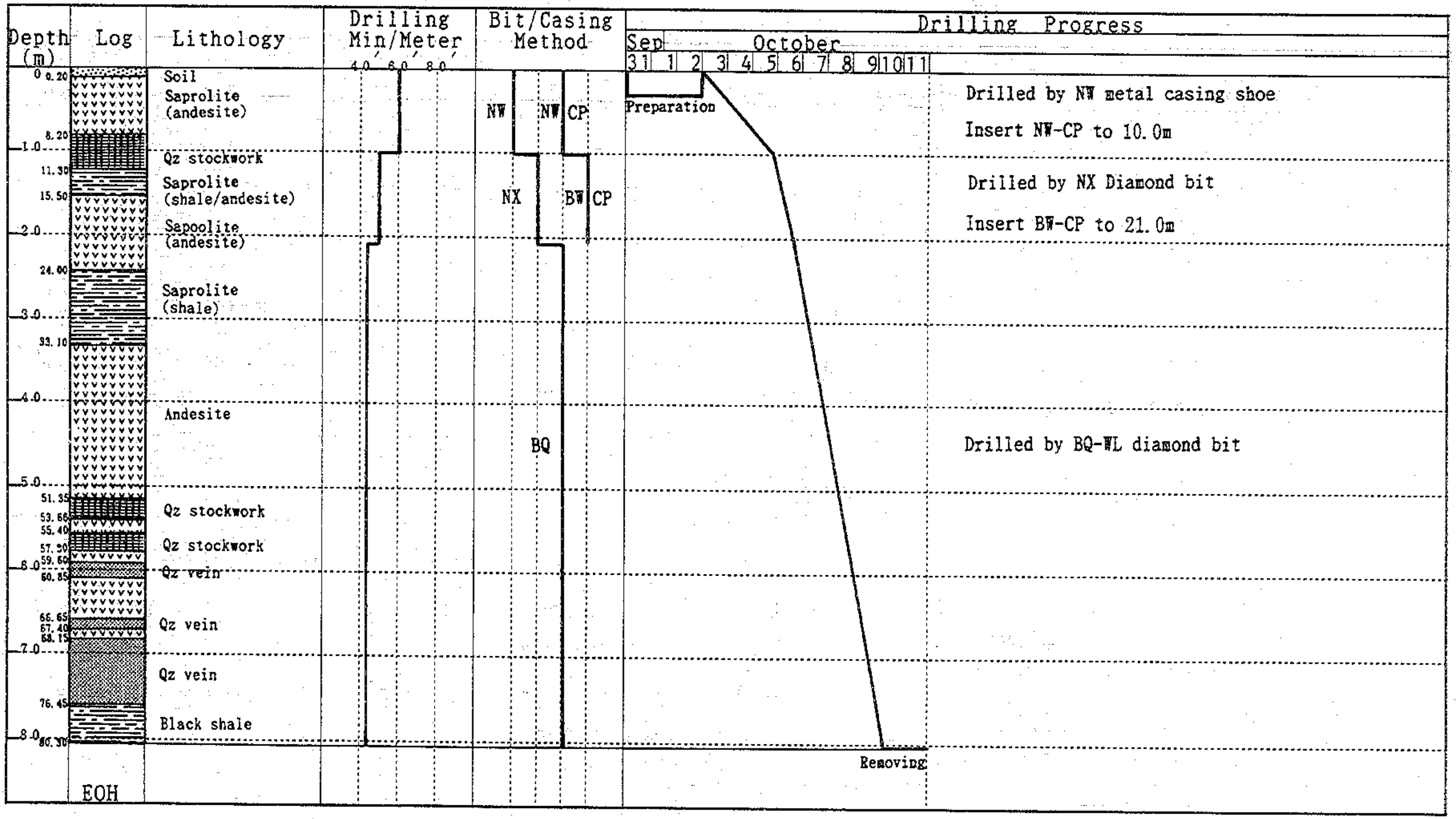


Fig.2-19 Chart of Drilling Progress (MJT-1)