I–24). The Gunung Krian – Gunung Badug area coincides with the area where most old mine workings for Au and Sb are located. The other two areas are therefore, considered important and merit further exploration work for possible Au and Sb mineralization.

1–3 Mineralization

Many old mine workings mainly for Au and Sb are located in the Jambusan – Tai Parit area and Tai Ton area. Most of the worked ore deposits are found around the acidic intrusive stocks and in the limestone area to the west of the NNE-SSW trending intrusive alignment. Part of these ore deposits can still be observed. During the Phase II survey, 15 old mine workings were investigated in detail and several mineral showings some newly discovered, were studied and described. The locations of the old workings and mineral showings are shown in Map I–25.

1–3–1 Old Mine Working

15 old mine workings – Gunung Krian, Gunung Bau, Gunung Arong Bakit A and B, Gunung Tai Ton, Tai Ton B, Gunung Saburan, Bidi, Rumoh, Saburan, Jambusan East, Bidi South, Gunung Nanui and Gunung Jabul, West Batu Bekajang and Gunung Tongga were investigated in detail during the Phase II survey.

Gunung Krian Ore Deposit

The deposit consisting of at least three veins is located on the NNE trending spur of Gunung Krian, about 1.2 km to the southwest SW of Bau Town (grid reference oZ 1640 5520) (Fig. I–5). The area is easily accessible from Bau town. The deposit was worked by the Liew Nyan Foo Gold Mining Company between 1950 and 1978, producing about 50 kg of gold. At about the same time the Kwei Fah Mining Company worked part of the deposit. All the workings are probably abandoned and their entrances covered with bush.

Geology and Mineralization. The area is underlain by the Bau Limestone cut by a few NW and NE trending intrusive dikes. The limestone had been largely metamorphosed to marble by the acidic intrusive stocks of Gunung Kolong Bau and Gunung Juala. Each of the three main veins is a composite of many quartz and/or quartz-calcite veinlets trending NW-SE. The old workings No. 1, No. 2 and No. 9 extracted ore from the northern vein, No. 4 and No. 5 from the central vein, and No. 8 and possibly No. 7 extracted ore from the southern vein (Fig. I–6).

Working No. 1 located on the top of the northern part of Gunung Krian NNE trending spur, is the largest working of the northern vein and it is about 80 m above sea level. The vein of about 4 m wide and 20 m in length, strikes N55°W and dips above 70°S. It consists of a network of

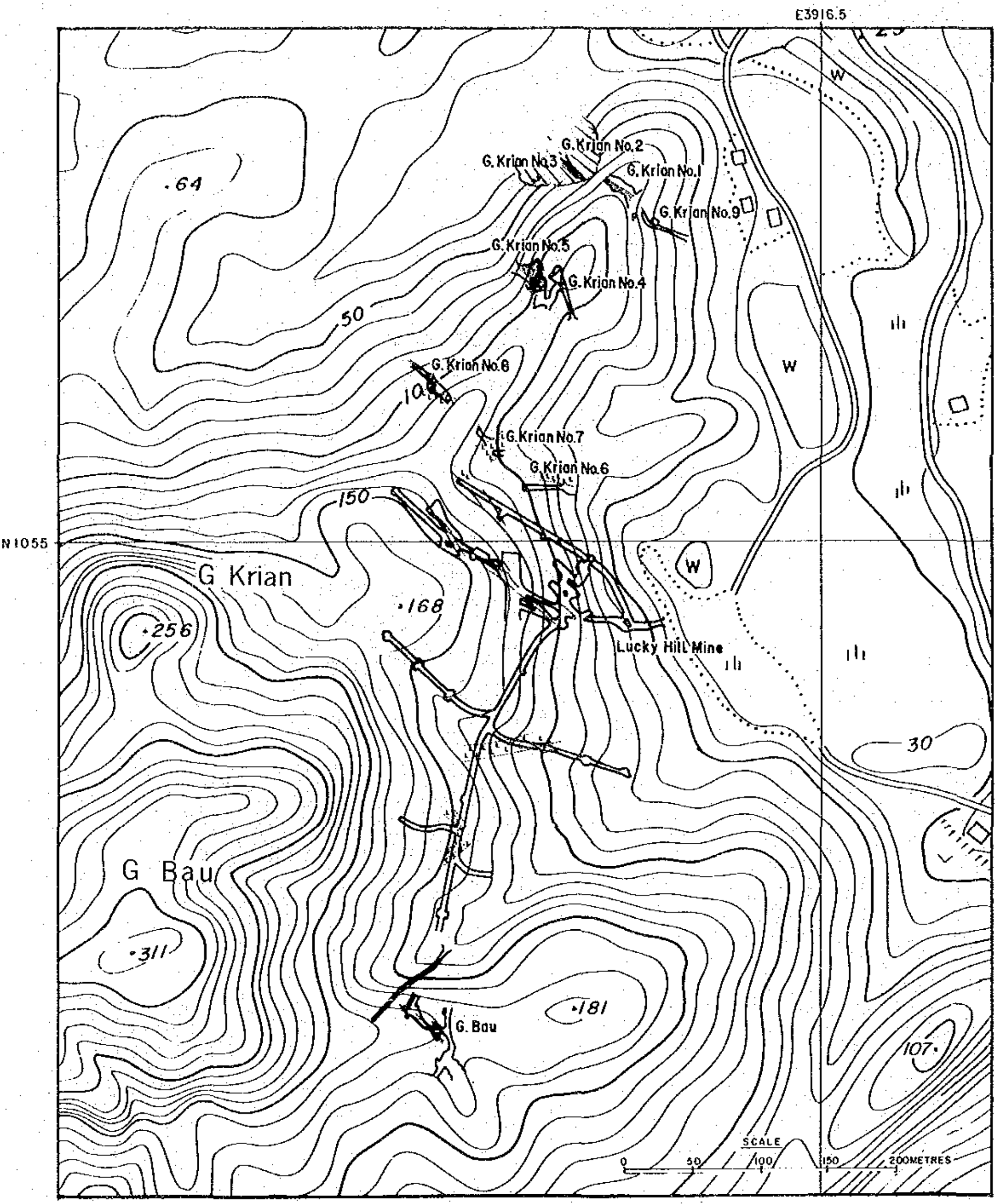

Fig. I-5 Location Map of Old Mine Workings around Gunung Krian and Gunung Bau

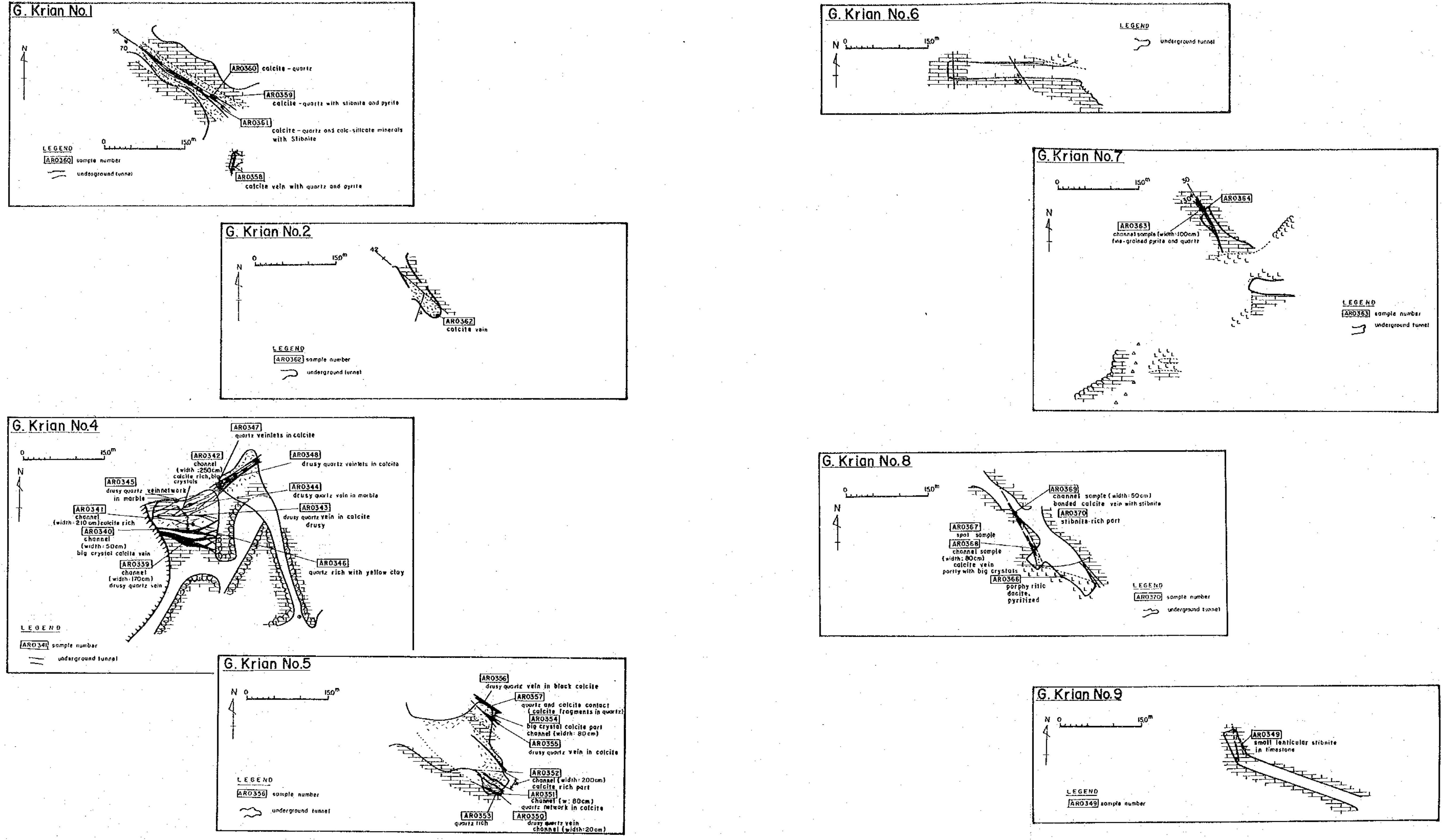

Fig. I-6 Gunung Krian Old Mine Workings (No.1, 2, 4, 5, 6, 7, 8 and 9) quartz veinlets which are probably the later phase of mineralization. Stibnite and native arsenic are occasionally observed in the quartz veinlets. Analytical results of three spot samples of calcite with quartz veinlets gave 6.30 to 9.17 g/t Au and 19.1 to 79.5 g/t Ag. The No. 2 working probably extracted ore from the northwestern extension of the northern vein. The working is about 14 m in length and is situated at about 50 m above sea level. Here the vein consists of a network of calcite veinlets with no observable quartz or ore minerals. The analytical results of a spot sample gave 20.0 g/t Au and 12.6 g/t Ag. Working No. 9 of about 20 m long is situated southeast of Working No. 1. This working was probably undertaken in order to locate the south eastern extension of the northern vein. The vein in this working is a quartz-calcite vein with some stibnite. Analytical results of a spot sample show 2.33 g/t Au and 3.2 g/t Ag.

Working No. 4 is the main working of the central vein. It is located in a small hill at an elevation of about 100 m. Here the vein consists of a network of quartz-calcite veinlets in limestone and marble. The total width of the vein is about 10 m. The average Au value over 6.8 m of this vein is 1.17 g/t and Ag 4.0 g/t. Working No. 5 is about 70 m above sea level, just below Working No. 4. The vein in this working strikes N50°–60°W with a dip ranging from 60°N to 70°N. The width of the vein is about 15 m, but this include blocks of country rock in the centre of the vein. The vein is dominantly of calcite with a few quartz veinlets. The average gold value is 0.13 g/t and Ag 0.6 g/t. These values are based on the analytical results of divided channel sample. In one spot sample of quartz veinlets the analytical value shows Au 23.00 g/t and Ag 20.2 g/t.

Working No. 8 is the main working of the southern vein. It is located on the northwestern slope of a small hill, with an elevation of about 85 m above sea level. The vein strikes 30°W, with nearly vertical dip. The vein width varies from a few cm to 80 cm and consists of calcite, occasionally as coarse crystals, and rarely containing small acicular stibnite. Analytical results of a 50 cm channel sample of the banded calcite vein about 10 m from the entrance of the adit, shows a Au value of 26.25 g/t and Ag 292.7 g/t. 8 m further inside the adit, an 80 cm channel sample of the vein with large calcite crystals gave values of Au 0.80 g/t and Ag 8.8 g/t. Working No. 7 is a trench of about 8 m long located at the southeastern slope of a hill at an elevation of 105 m above sea level. The vein which is probably an extension of the southern vein consists of a network of quartz veinlets with rare pyrite disseminations. Analytical results of a channel sample from northwestern end of the trench shows only trace Au and Ag.

It may be concluded that the Au and Ag grades of the Gunung Krian ore deposit are generally low with only a few places showing high Au and Ag contents. Selective mining on a small scale of the higher grade portions may however be feasible.

Gunung Bau Ore Deposit

The deposit is located about 1.5 km S of Bau town (grid reference oZ 1645 5475) (Fig. I–5) and is easily accessible. The deposit was mined by the Ban Lee Gold Mining Company sometime between 1948 and 1959. The area is presently in the mining lease area belonging to the Luckyhill Mining Sendirian Berhad.

Geology and Mineralization. The area is underlain by marble of the Bau Limestone. The deposit was worked by means of adits. In one adit two parallel calc-silicate veins can still be observed extending for about 20 m to the top of the eastern spur of Gunung Bau (Fig. I–7). The upper vein contain wollastonite, epidote, garnet and some stibnite. The analytical results of a 90 cm channel sample gave 0.20 g/t Au and 0.20 g/t Ag. The lower vein contain epidote and wollastonite. The analytical results of two channel samples of 50 cm sampling widths from the hanging wall near the western entrance and the southern end of the adit gave 1.43 g/t Au and 0.9 g/t Ag, and 3.50 g/t Au and 1.4 g/t Ag respectively. A channel sample with sampling width of 100 cm from the lower vein in another adit 3 m higher, contains 21.0 g/t Au and 36.4 g/t Ag. A shear zone (?) at the western part of the adit strikes N35°E. Neither vein appear to extend further west beyond the shear zone.

Gunung Arong Bakit A Ore Deposit

The deposit consists of 3 veins located E of Gunung Arong Bakit about 2 km SW of Bau town (grid reference oZ 1590 5444) (Fig. I–8). The base of Gunung Arong Bakit is accessible by gravel road from Bau town passing by Luckyhill Mine. The northern and the southern most veins were worked by the Kwei Fah Mining Company in 1964. The middle vein was worked by the Ban Lee Gold Mining Company in the 1950's. All the workings were abandoned and the path leading to the entrances are bush-covered.

Geology and Mineralization. All the three workings are in marble of the Bau Limestone (Fig. I–9). Gunung Juala intrusive is located just south of the deposit.

The vein of Working No. 1 at the southern slope, is about 190 m above the sea level and consists of mainly wollastonite and quartz, and some epidote and garnet. The vein strikes N30W, dips 40°S and is 1.60 m wide. At the footwall side, networks of quartz and wollastonite veinlets were observed. The analytical results of channel sampling across the vein gave 3.79 g/t Au and 0.7 g/t Ag.

Working No. 2 is located on a cliff about 230 m above the sea level at the eastern slope of Gunung Arong Bakit. The ore worked consisted of a calcite vein containing native arsenic, stibnite and magnetite, and striking N20°E.

Working No. 3 is very small and it is located at the top of the spur trending NE from Gu-

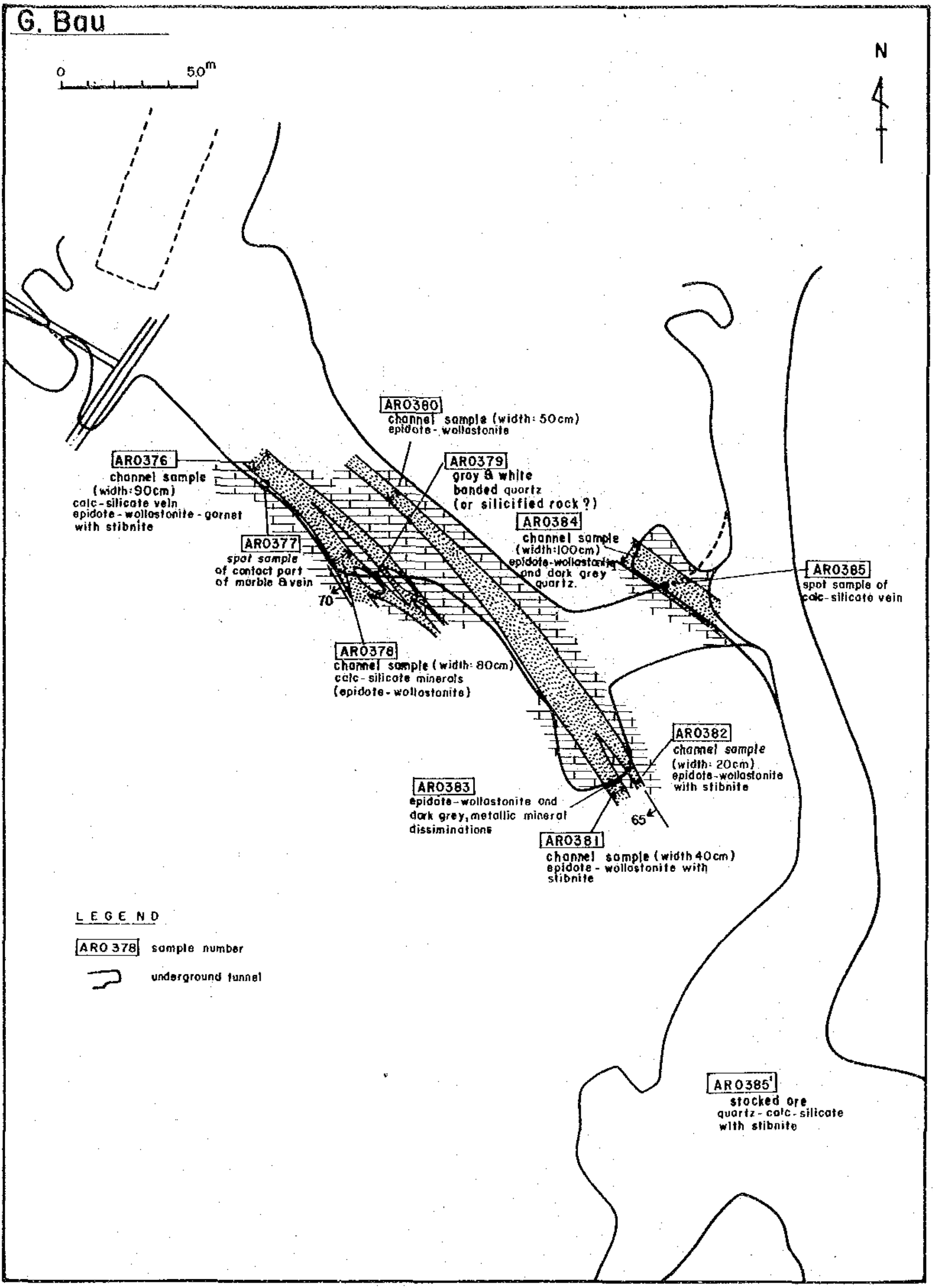

Fig. I-7 Gunung Bau Old Mine Workings

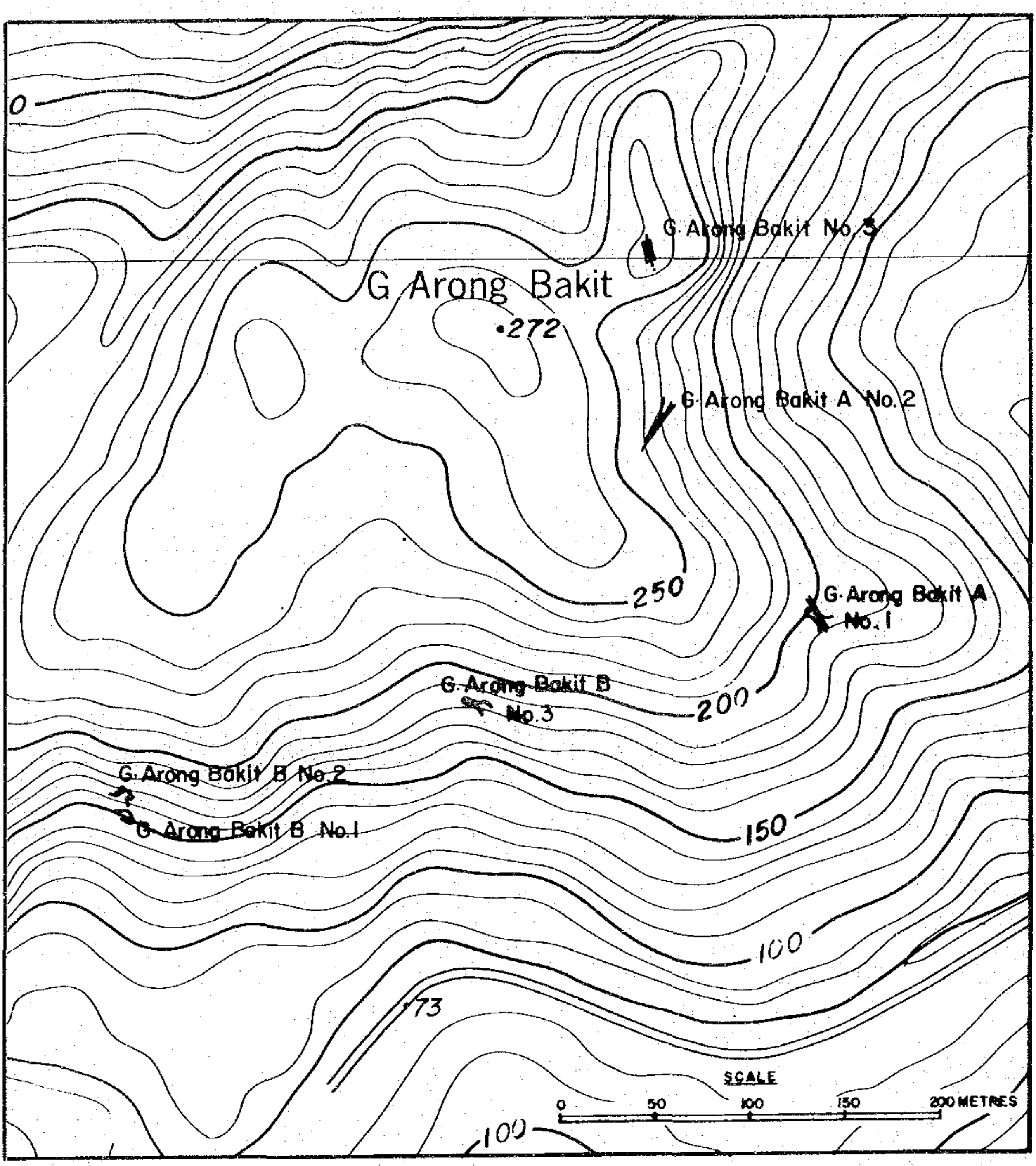

Fig. I-8 Location Map of Old Mine Workings around Gunung Arong Bakit

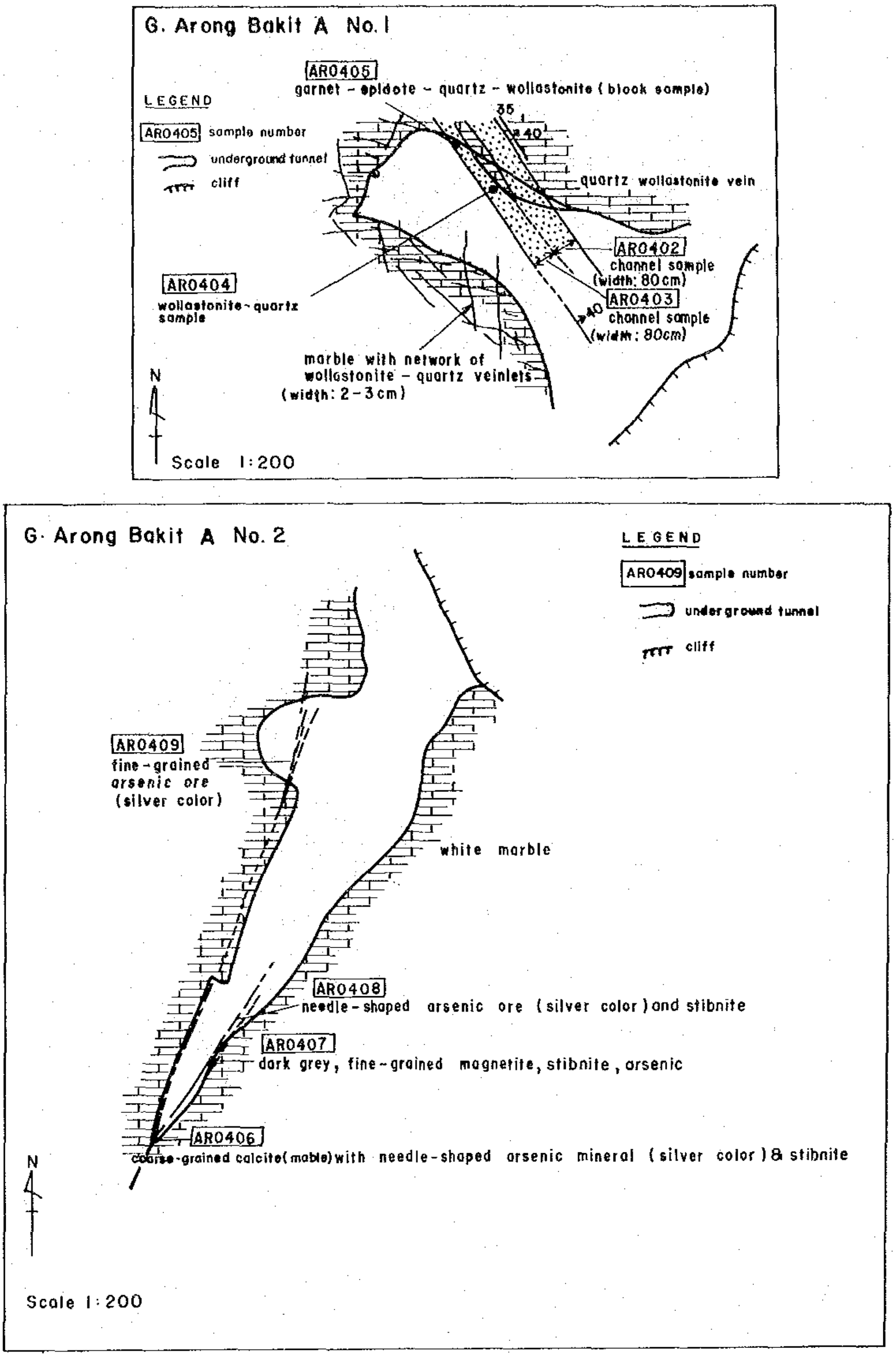

Fig. I-9 Gunung Arong Bakit A Old Mine Workings nung Arong Bakit about 260 m above sea level. The vein strikes NNW and consists of mainly calc-silicate and calcite veinlets with some gossan.

Gunung Arong Bakit B Ore Deposit

The Gunung Arong Bakit B ore deposit comprises three veins found in three old workings located in the southern cliff slope of Gunung Arong Bakit. It is about 1.3 km S of Bau town (grid reference oZ 1569 5426) (Fig. I–8) and is accessible by a gravel road to as far as base of the cliff. The deposit was mined by the Kwei Fah Mining Company sometime during the 1960's. The previous working had left two small underground excavations. The area is at present under the prospecting right of Gladioli Sendirian Berhad.

Working No. 1 is situated at an elevation of about 150 m. Working No. 2 is about 160 m above sea level, just above Working No. 1. Working No. 3 old is about 180 m above sea level and about 150 m ENE of Workings No. 1 and No. 2.

Geology and Mineralization. The workings are in marble of the Bau Limestone (Fig. I–10). The Gunung Juala intrusive is located just to the south.

Working No. 1 is in a vein of calcite, quartz and wollastonite. The vein is about 4 m wide and 8 m along strike. The hanging wall consists of marble but the footwall is not exposed. Calcite is found in the hanging wall side while the footwall side contains mainly quartz and wollastonite. The analytical results of a channel sample over 2 m of the calcite part gave 0.50 g/t Au and 3.7 g/t Ag. The result from the quartz-wollastonite part shows Au 3.16 g/t while Ag 18.4 g/t.

Working No. 2 is about 10 m above Working No. 1. The vein in this working strikes N45°W and dips 10°NE and has a width of more than 2 m. It consists of a hard and a brittle zone. The hard zone contains quartz and wollastonite accompanied by a little malachite dissemination. The brittle zone contains besides quartz and wollastonite, also calcite. The analytical results of channel samples of each zone are as follows:

Sample Number	Zone	Sampling Width m	Au Value g/t	Ag Value g/t
AR0419	Hard	2.20	123.90	58.9
AR0420	Brittle	1.30	1.20	5.5
AR0421	Hard	0.50	26.00	34.00
AR0422	Brittle	1.00	0.10	0.39

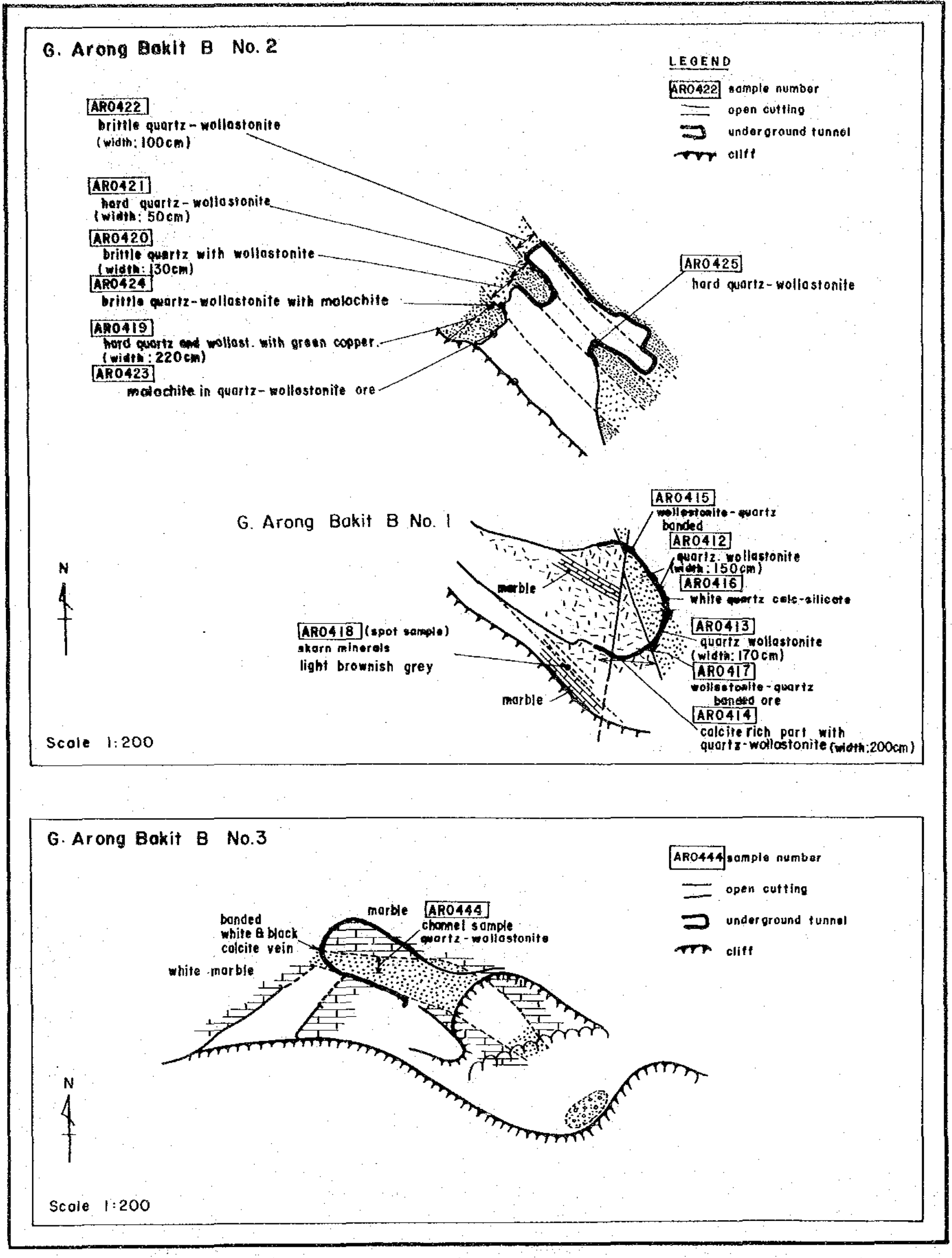

Fig. I -10 Gunung Arong Bakit B Old Mine Workings

The results show that the hard zone has higher Au and Ag values. The analytical results of one spot sample with some malachite disseminations from the hard zone gave 1197.00 g/t Au and 973.8 g/t Ag. Microscopic study of this sample shows some Au to be associated with chalcopyrite and tetrahedrite, and some occurring as free gold in the gangue. The Au colour is dark yellow suggesting the ratio Ag/Au to be 1/4 to 1/9. The Ag value from analysis is however, high suggesting that Ag may be also present as Ag-rich tetrahedrite.

Working No. 3 with an elevation of about 180 m is located about 200 m E of Working No. 2. The vein strikes N70°W and dips 60°N, and has a width of about 1.5 m. It consists of calcite, wollastonite and quartz. The analytical result of a channel sample of a part of the vein shows 1.17 g/t Au and 0.5 g/t Ag.

Gunung Tai Ton Ore Deposit

Gunung Tai Ton deposit consists of calcite veins with quartz veinlets observed in some of the five old workings. The deposit is about 1.5 km to the southeast of Tai Ton village (grid reference oZ 1475 5333) (Fig. I–11) is accessible by a gravel road from Bau town. The deposit was worked by the Tai Ton Gold Mining Syndicate sometime during the 1950's. The ore was extracted from quartz-calcite veins. The area is presently part of the mining lease area awarded to the Priority Trading Sendirian Berhad.

Geology and Mineralization. The old workings are found in the Bau Limestone (Fig I–12). The veins in the old workings, comprise mainly calcite with small amount of quartz veinlets and gossanised clay.

Working No. 1 is located on the northern slope of Gunung Tai Ton, at an elevation of 135 m. The vein strikes N20° – 55°W with a vertical dip and a width of between 2 to 10 m. Gossanised clay filled irregular cracks found in the calcite vein. In some places the gossanised clay is abundantly found and calcite occurs only as segregated fragments in it. Analytical results of 2 channel samples at the end of the tunnel, one with a sampling width of 3 m of calcite, quartz veinlets and clay gave 20.67 g/t Au and 37.8 g/t Ag, and the other with a sampling width of 2.6 m gave only trace values for both Au and As.

Working No. 2 is a pit, located NE of Gunung Tai Ton, at an elevation of 205 m. The vein strikes N20°W but the dip is not clear. The vein width is 10 m and comprises calcite veinlet network with clay. The analytical results of a channel sample with a sampling width of 100 cm gave 10.50 g/t Au and 31.0 g/t Ag.

Working No. 3, E of Gunung Tai Ton, is located at an elevation of 210 m. Reddish brown clay filled parallel joints trending N15°W developed in the limestone. Analytical results of some of the clay shows values of 1.00 g/t Au and 1.5 g/t Ag.

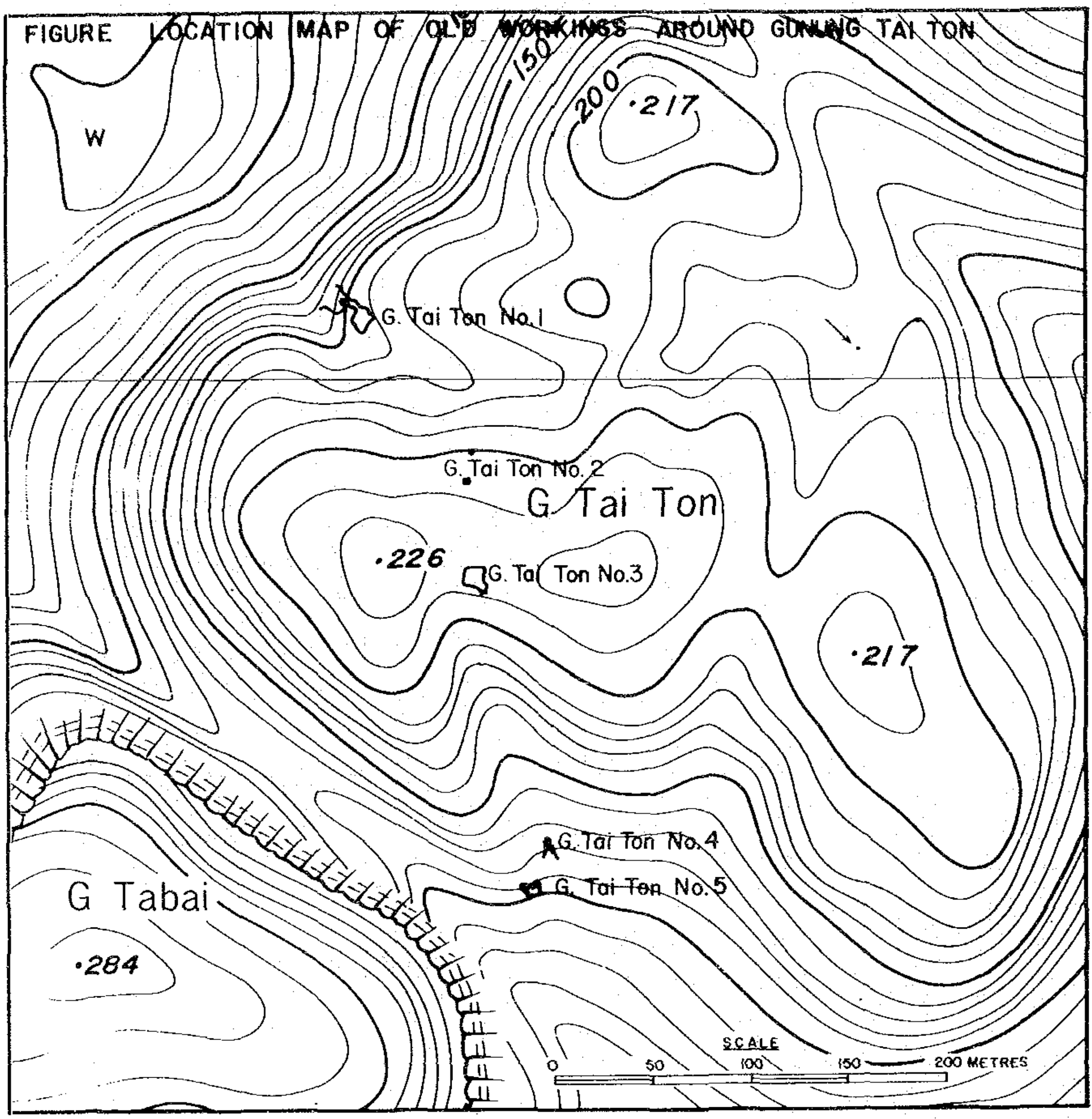

Fig. I-11 Location Map of Old Mine Workings around Gunung Tai Ton

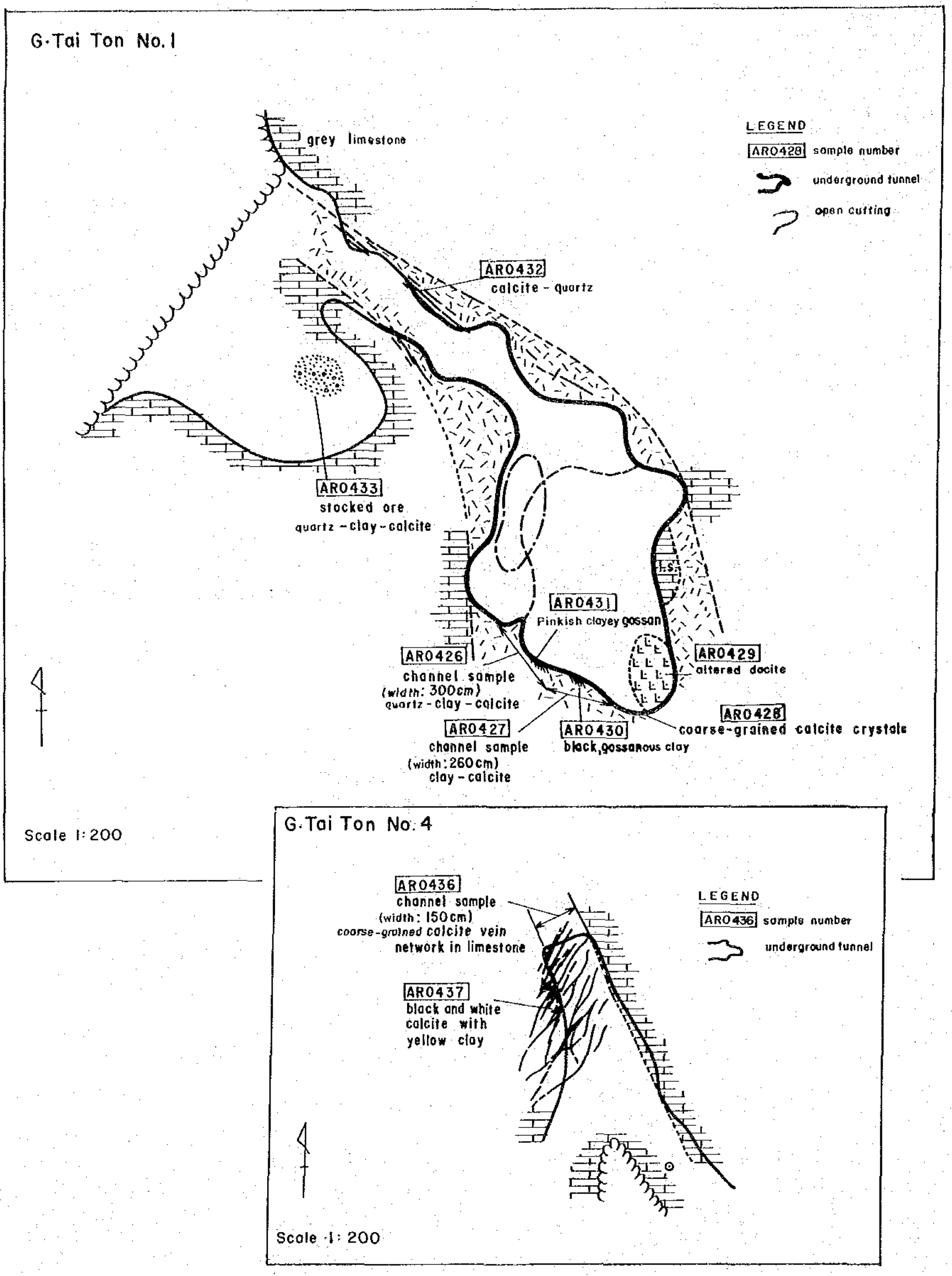

Fig. I -12 Gunung Tai Ton Old Mine Workings

Working No. 4, south of Gunung Tai Ton, is at an elevation of 120 m. The vein comprises a network of mainly calcite with some quartz veinlets. Coarse calcite crystals are also found in the calcite network zone. Analytical results of channel sample of 150 cm sampling width from the network zone shows 7.50 g/t Au and 5.3 g/t Ag.

Located just below working No. 4 is working No. 5. This working is situated at an elevation of about 100 m. The vein at the working cannot be observed but an ore stock pile contains fragments of quartz-calcite vein. The quartz occurs as well developed pyramidal crystals in vugs. Analytical results of a sample from the ore stock pile shows 27.0 g/t Au and 14.2 g/t Ag.

Tai Ton B Deposit

Tai Ton B ore deposit consists of a big calcite vein found in one old working tunnel. The entrance of the tunnel is located about 800 m S of the Tai Ton village (grid reference oZ 1362 5409) and is accessible by a gravel road from Bau town. The tunnel was formally a cave. The deposit was mined by the Tai Ton Gold Mining Syndicate from 1931 to 1954. The ore was extracted from the quartz-calcite vein found emplaced along a NE-SW trending fracture in the limestone. The area is now part of the mining lease area awarded to the Priority Trading Sendirian Berhad. The previous working left a cave-like excavation measuring about 5 m wide and about 350 m along the strike direction. The thick calcite vein with coarse calcite crystals can still be observed on the floor and sometimes on the wall and roof of this underground working.

Geology and Mineralization. The vein was emplaced along a NE-SW fracture in the Bau Limestone (Fig. I–13). An acidic dyke is found near an old dressing plant just N of the vein. The vein strikes N45°W and dips 40° to 80°NE, with width measuring 2 to 6 m and a strike extension of more than 350 m. In the hanging wall, about 170 m from the tunnel entrance, drusy quartz veinlets forming a network filled the interstitial spaces between the coarse calcite crystals in the vein. Dark grey, fine-grained quartz also form lenses containing small amount of stibnite. Dark brownish grey, gossanised clay containing calcite fragments is also found in cracks and joints which develop irregularly mainly in the calcite vein. 13 samples were analysed and divided into groups as shown below:

(i) Calcite vein: values of Au vary from trace to 0.10 g/t and Ag trace to 0.1 g/t.

(ii) Calcite vein with drusy quartz veinlets: values of Au vary from 1.33 g/t to 11.25 g/t and Ag 1.6 g/t to 28.6 g/t.

(iii) Gossanised clay with calcite fragments: values of Au vary from 15.83 g/t to 18.00 g/t and Ag 14.7 g/t to 24.3 g/t.

(iv) Dark grey fine-grained quartz with stibnite: values of Au vary from 9.20 g/t to 36.70 g/t and Ag 1.9 g/t to 39.6 g/t.

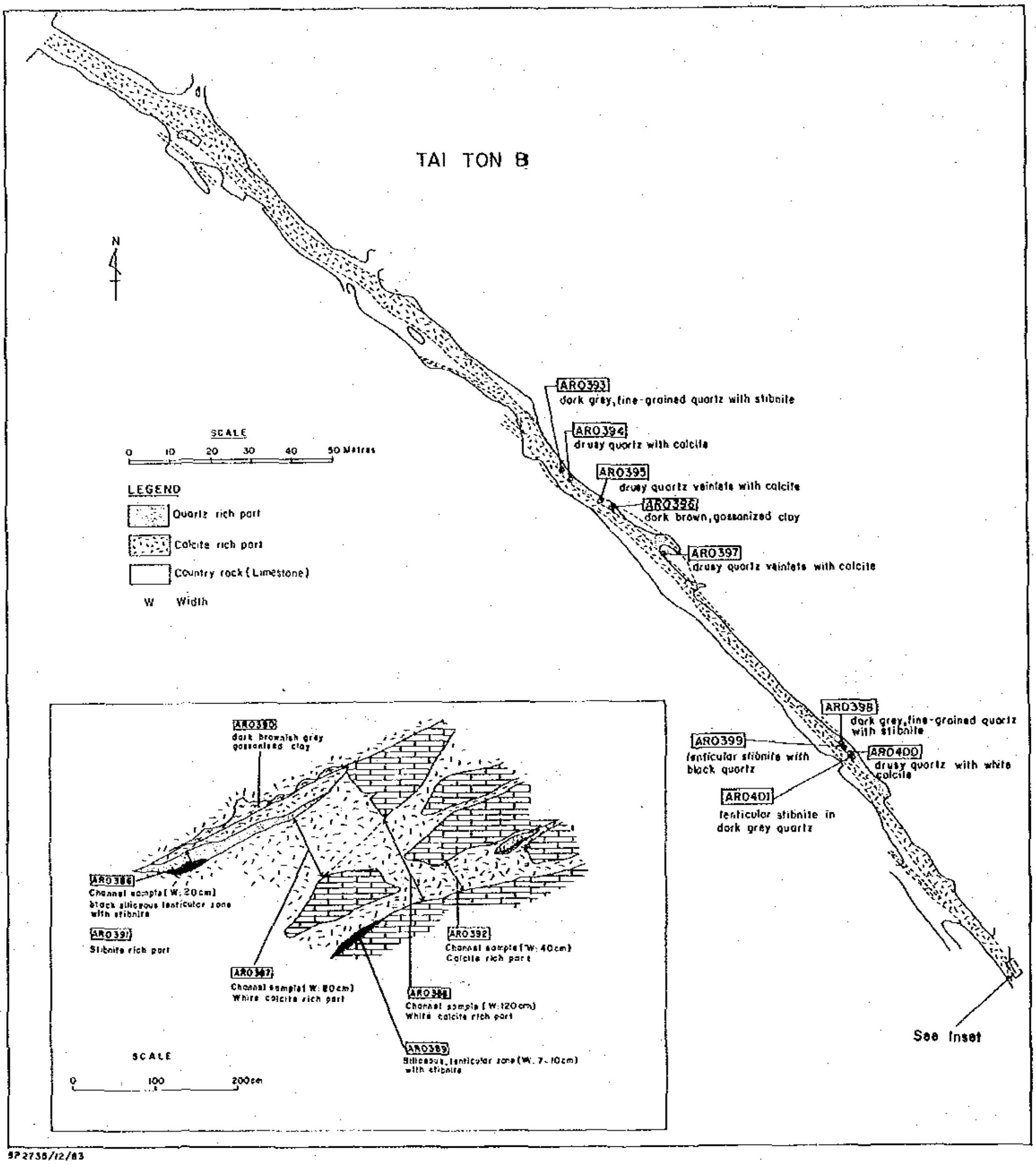

Fig. I-13 Tai Ton B Ore Deposit

Gunung Saburan Ore Deposit

The Gunung Saburan ore deposit consists of two veins observed in two old workings located at the northeastern and southern sides of Gunung Saburan, (grid reference oZ 1530 5400 and oZ 1532 5375) (Fig. I–14). The deposit is accessible by foot path from the Gunung Arong Bakit B ore deposit which is accessible by a gravel road from Bau town. During 1948 to 1959, the ore deposit was mined by the Ban Lee Gold Mining Company. The working at the northeastern side left a cave-like excavation measuring about 1 m by 2 m wide and about 3 m long while the other working left a shallow excavation of about 10 m wide.

Geology and Mineralization. The two workings are located in Bau Limestone which had been metamorphosed to marble by the nearby Gunung Juala intrusive.

Working No. 1 located on the northeastern side of Gunung Saburan, is a tunnel of about 20 m long striking S55°W. At the end of the tunnel, irregular shaped calcite veins can be observed. The veins are cut by lenticular quartz-wollastonite veins. The analytical results of the quartz-wollastonite veins gave 1.50 g/t Au and 0.29 g/t Ag. Stibnite is not observed in situ but is found in some fragments of the quartz-wollastonite ore stock pile in the tunnel. This means that the stibnite has been mined out. Analytical values of Au and Ag in one of the sample from one of the stocked ore are trace.

Working No. 2 located on the southern side of Gunung Saburan, consists of two sets of quartz-wollastonite vein networks trending N45°W and N75°W, and dipping 40°N and 40° 50°S respectively. Both veins contain some stibnite. A channel sample from near the entrance of the tunnel, with a sampling width of 160 cm, contains 12.00 g/t Au and 104.0 g/t Ag. Another channel sample with a sampling width of 60 cm from the end of the tunnel contains 3.83 g/t Au and 2.6 g/t. One sample of banded quartz from the same location studied under the microscope *contains native arsenic, arsenopyrite, boulangerite and sphalerite. A few specks of tetrahedrite* and electrum were also observed.

Bidi Ore Deposit

The deposit was formerly named the Kusa ore deposit in the Phase I report. The deposit is located near the Bidi Bazaar (grid reference oZ 1387 5248) and is accessible by a gravel road from Bau town. The area was first mined by Jong Kuet Syn Mining Company during the 1960's. In the 1970's, the mining right over the area was taken over by the Kusa Mining Sendirian Berhad. Both companies were mainly mining for gold but the kusa Mining Sendirian Berhad, in addition also extract antimony. The previous workings left some small and shallow opencasts. The area is presently still under the mining rights of the Kusa Mining Sendirian Berhad but due mainly to the high amount of arsenic present in the ore, the operation had stopped.

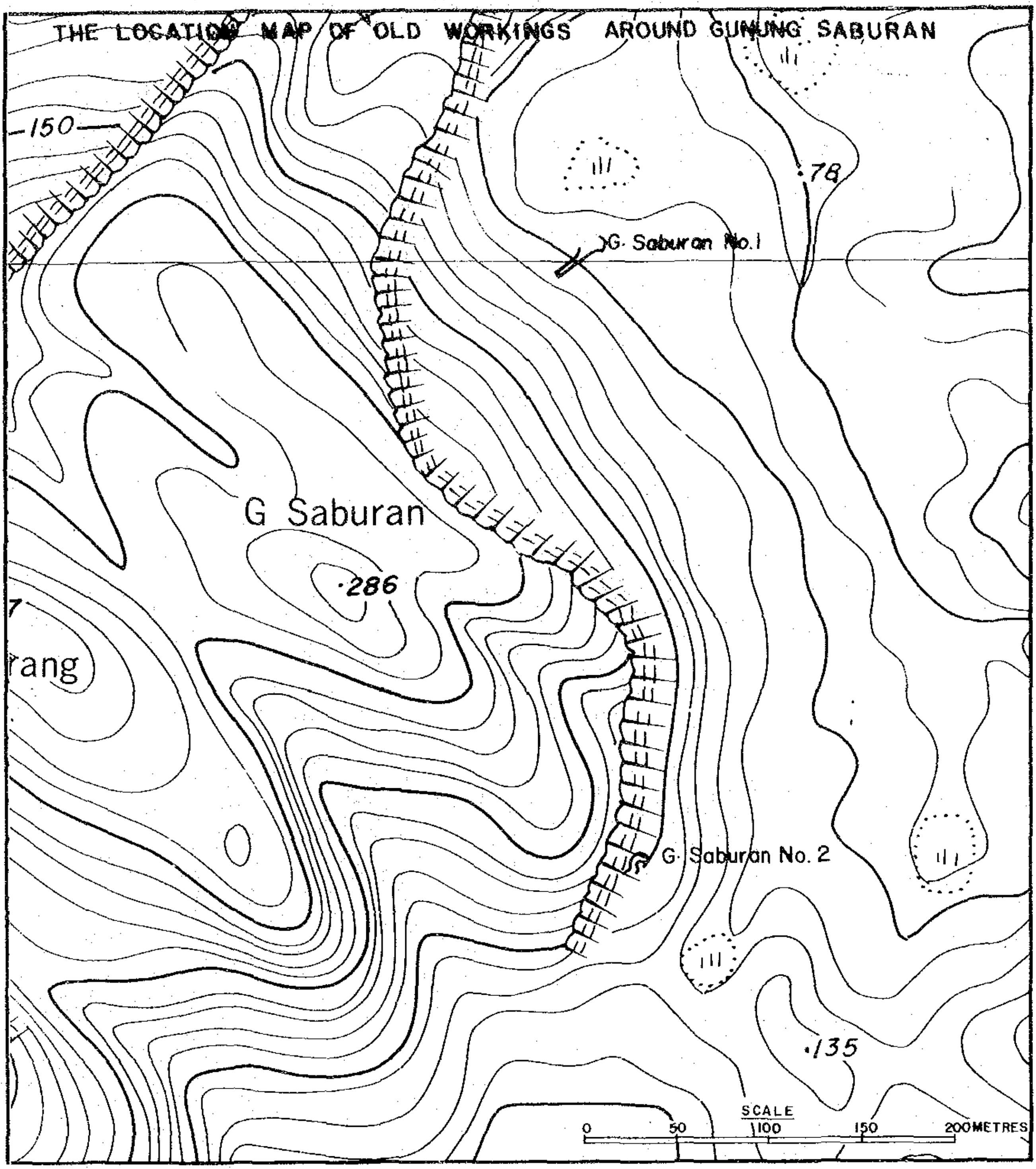

Fig. I -14 Location Map of Old Mine Workings around Gunung Saburan

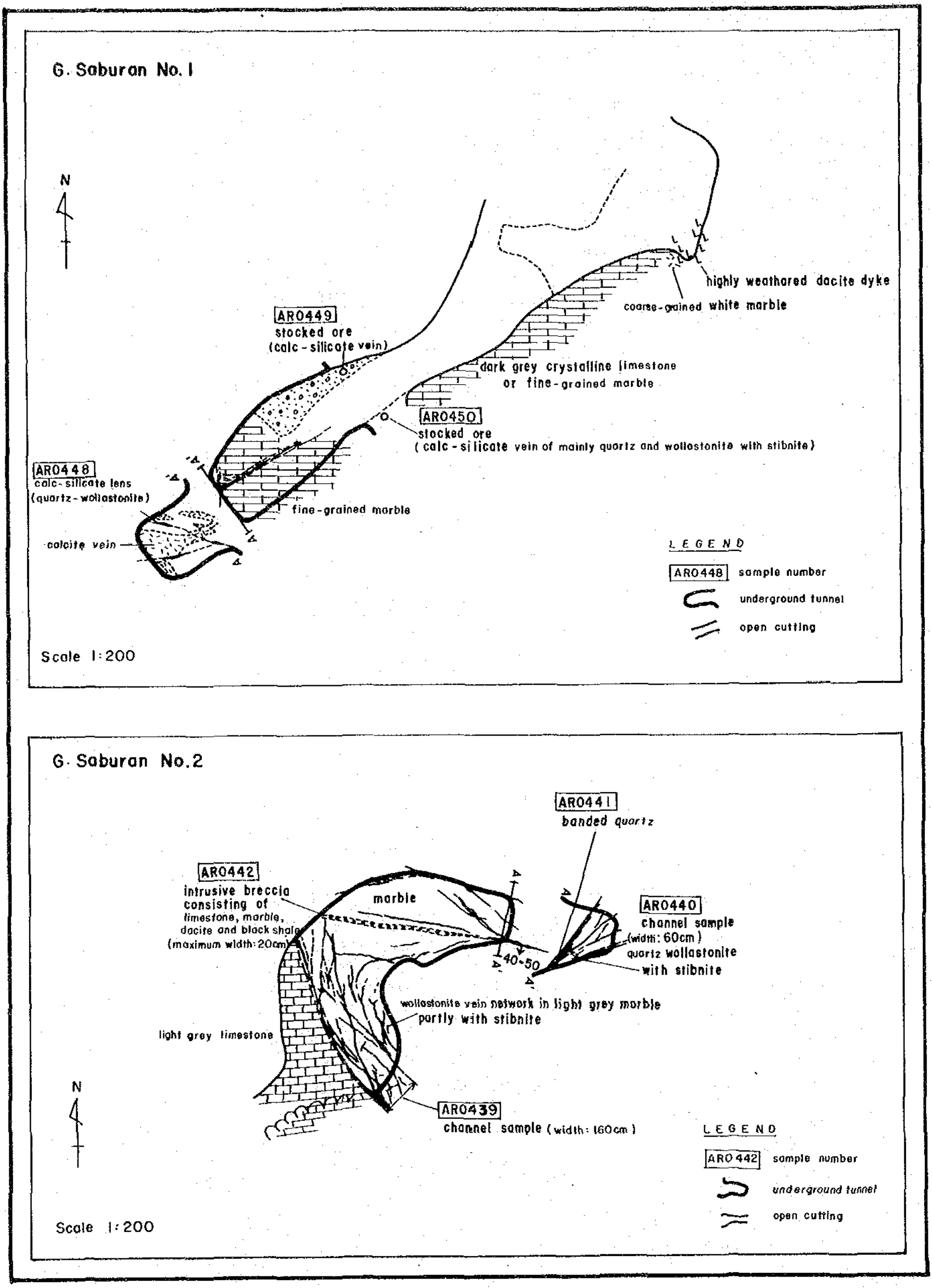

Fig. I -15 Gunung Saburan Old Mine Workings

Geology and Mineralization. The area is underlain by the Bau Limestone faulted against the Pedawan Formation on the eastern side by a NNE trending fault almost parallel to the Bidi-Krokong road. To the south, part of an acidic dike trending WNW can be observed. The old workings are flooded and thus it was not possible to study the deposit in detail. As may be inferred from the exposed part of the calcite vein, the shape and arrangement of the mining pools, the trend of the calcite veinlets in the surrounding area, microscope study of some samples and the analytical results of the high grade ore from the old ore stock pile, the deposit consists of a fissure filling quartz-calcite vein trending nearly NS and NW. The part of the vein mined out containing stibnite and gold. Abundant native arsenic can also be observed in the ore stock pile together with stibnite. Analytical results of a channel sample with a sampling width of 130 cm of the quartz-calcite vein containing small amounts of stibnite and native arsenic gave very low Au and Ag. Analytical results of two samples from the old ore stock pile however, show values of 20.0 and 74.4 g/t Au and 211.0 and 272.0 g/t Ag.

Rumoh Ore Deposit

The Rumoh ore deposit is located at about 6 km SW of Bau town and 300 m NW of the Bidi bazaar (grid reference oZ 1430 5282). The area is accessible by gravel road from Bau town (Fig. I–16). The Rumoh Gold Mining Company mined the area during the period, 1949 to the 1970's, and between 1949 and 1964, the mine obtained about 165 kg of gold from about 36,000 t of crude ore by cyanidation. The workings were concentrated in three main underground tunnels with strikes generally trending in a northeasterly direction. The area is presently under the Syarikat Tabai Sendirian Berhad. The company had already completed prospecting the area and is now preparing the access roads to the old underground workings before actual mining can be carried out. The company has also constructed cement vats for use in the ore treatment by cyanidation.

Geology and Mineralization. The Rumoh ore deposit consists mainly of epithermal, Au and Ag-bearing quartz-calcite veins which have been worked by three underground tunnels, Level No. 1, No. 2 and No. 3 (Maps I–26 – I–29). The veins occur on the W slope of the Gunung Badug limestone hill which is a faulted block of the Bau Limestone. The Tai Parit Fault lies just west of the underground tunnels. On its eastern side, the limestone hill is faulted against the Pedawan Formation. The nearest intrusive rocks are two quartz porphyry dikes located about 400 m to the N and 450 m to the NE. The intrusive stock of Gunung Juala is about 1 km to the NE.

Past mining followed the strikes of the veins which formed caves and coincide with prominent NW joints in the limestone. The Tai Parit fault though not mineralized, was apparently important as a channel for mineralizing solutions which eventually formed veins in fissures in the

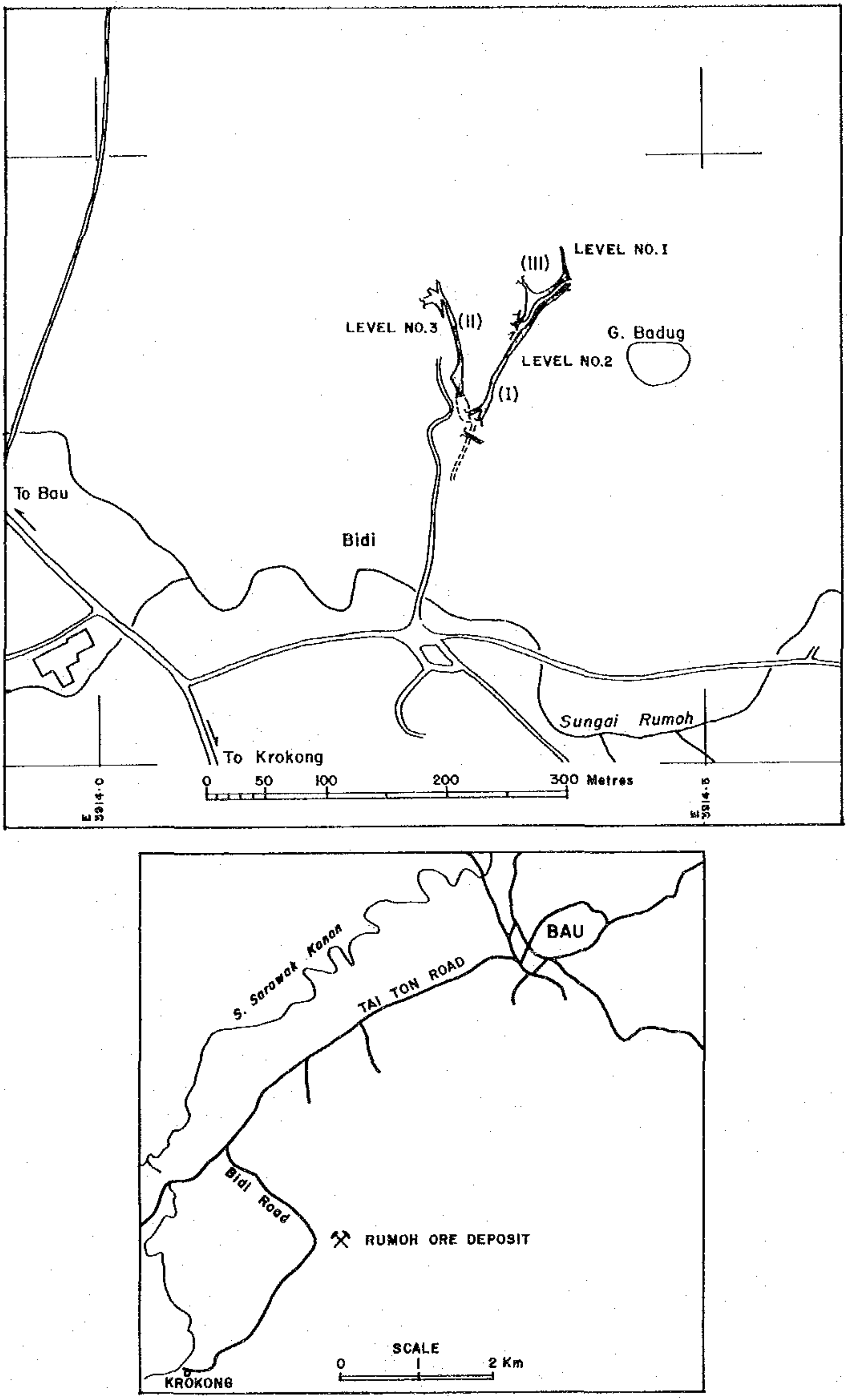

Fig. I -16 Location Map of Rumoh Ore Deposit limestone and in parts replacing the limestone. These veins as may be observed in the underground workings are highly irregular in shape and continuity. They are mainly lenticular but at places chambered with widths reaching 5 m. The veins are composed chiefly of large white and black calcite crystals and manganese oxides. Rare quartz and ore minerals including native arsenic, arsenopyrite, stibnite, malachite, azurite and sphalerite are also observed in the veins.

Analytical results of samples collected from the underground workings are shown in Table I–2.

The following observations may be made from the work done in the area:

i) Based on the analysed samples, the overall average Au and Ag contents are slightly too low for economic exploitation but selective mining of the higher grade parts should be feasible.

ii) The area offers good potential for finding similar new ore veins and extensions to known ones. This would require intensive sampling and shallow drilling.

iii) The ore samples from Level No. 2 show higher Au content than those from the other levels.

iv) The calcite vein with large black calcite crystals from Level No. 2 show the highest gold content. Veins of the other levels are generally low though megascopically they appear similar.

v) Au and Ag values for both the calcite vein with gossanous clay and calcite veinlets which gave high values in the Saburan ore deposit, are low in the Rumoh area.

Saburan Ore Deposit

The Saburan ore deposit is located 2 km SW of Bau town (grid reference oZ 1520 5435). The area is linked to Bau town by gravel road. The ore deposit was mined sporadically for gold by the Saburan Gold Mining Company between 1947 and 1964. During the operation, approximately 14,000 t of crude ores were treated by the cyanidation process producing a total of about 109 kg of gold. The ore was extracted mainly from irregular quartz-calcite veins in underground workings. Ten abandoned underground workings are found scattered over the area (Fig. I–17). Two long cement vats with a total capacity of about 3,000 t are located near the old mine site and are still in perfect condition. The area is presently under the mining rights of Southern Gold Mining Development Sendirian Berhad.

Geology and Mineralization. The area is underlain by the Bau Limestone of greyish white and black, argillaceous limestone, intercalated in places with calcareous sandstone. Strikes of beds vary from NW to NE with dips of 20° to 30° in the NW and SE directions. The formation is intruded by several quartz porphyry dikes with NE, NW and EW trends. These dikes are sericitized and silicified and are mostly apophyses of the Gunung Juala intrusive of quartz porphyry located about 300 m SE of Saburan. The Tai Parit fault cut across the old mine area and this

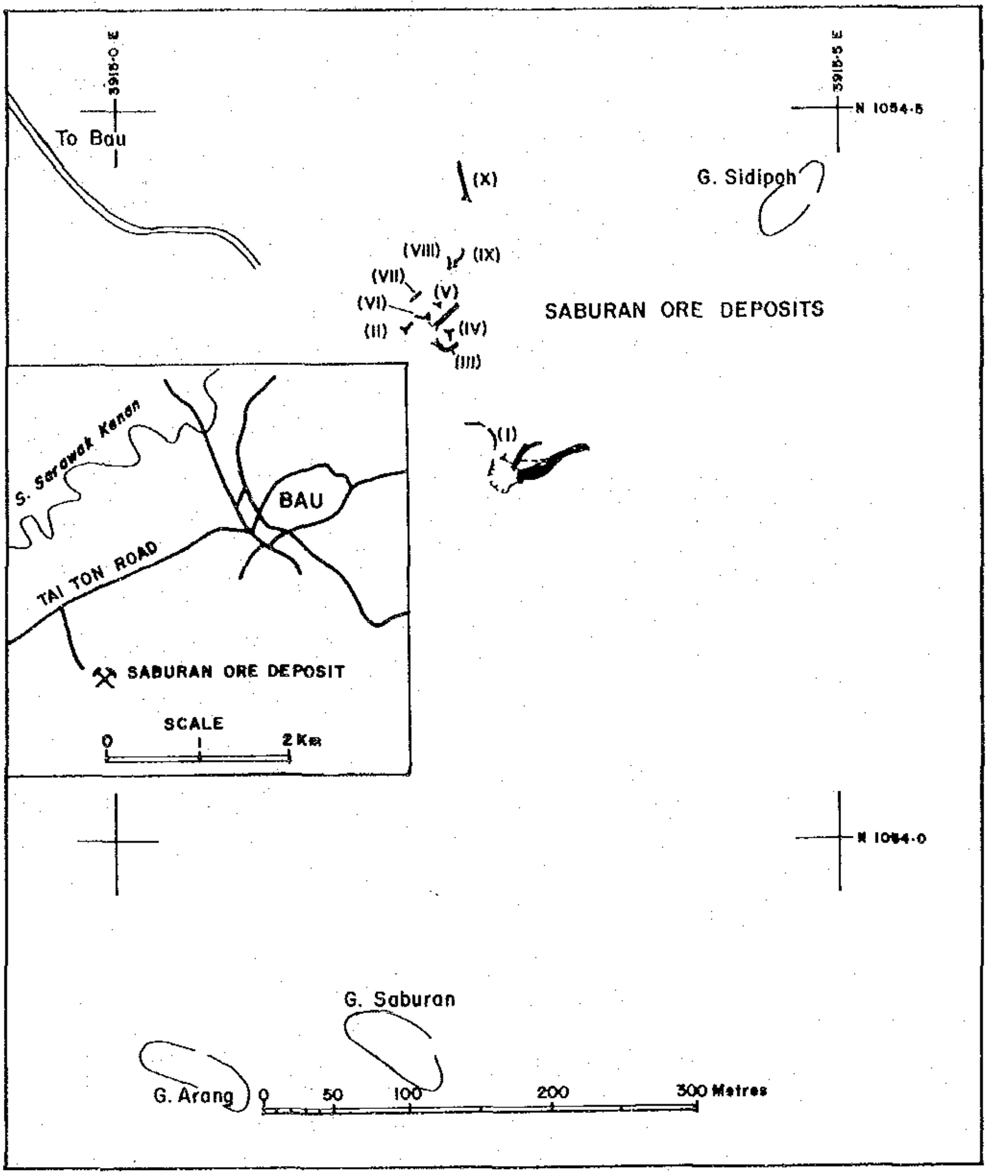

Fig. I-17 Location Map of Saburan Ore Deposit structure and the intrusives are closely related to the mineralization in the area.

Ten small old workings mainly underground adits are found in the area, the longest being about 20 m (Maps I–30 – I–33). The mined ore deposit consists of many small quartz-calcite and calcite veins of the epithermal type emplaced in fissures, joints and along the bedding planes in the limestone with strikes of NW, NS, NE and EW. The mineralized veins of old workings II, III, V, VI, VII and VIII were emplaced along bedding planes striking N45°W and dipping 25°NE to 30°SW. IX and X show steeply dipping veins of 75°E and 65°SW and strikes of NS and N20°W. The main vein vein of old working I is steeply dipping at 65°SE with a strike of N60°E. Smaller veins with a strike of N80°E and dips of 20° to 30°SE parallel to the limestone bedding plane branch out from the main vein. The main vein is cut by a quartz porphyry dike at level No. 1 and No. 2 of this old working.

The mineralized veins are generally lenticular in shape with varying lateral and down dip extents. Ore minerals including pyrite, arsenopyrite, realgar and orpiment are observed in only *level No. 1 of old working I. They are megascopically not seen in the other old workings.* Quartz is commonly detected by X-Ray Diffraction in samples of limestone with calcite veinlets.

Results of samples collected from the various workings are given in Table I–1.

Other spot samples collected gave the following results:

Sample Description/ Sample No.	Location	Au g/t	Ag g/t	As %	Remarks
Argillaceous *limestone* Phase	Old Working I, *Level No. 1*	77.6	8.1	1.53	Sample AR0098 collected during
"	"	0.8	10.6	0.27	Sample YR0001 collected during Phase II
BR 0367	"	22.50	1.4	NA	Collected during Phase II from stockpile
BR 0368	"	tr	tr	NA	
BR 0369	"	29.50	6.8	NA	

NA – not analysed tr – trace

Table I - 1 Analytical Results of Samples from the Saburan Ore Deposit

Sample Description	Location	Number of Channel Samples	Average Sampling Width cm	Weighted Average Grade	
				Au g/t	Ag g/t
Fault breccia	Old Working VIII	1	20	1.63	4.9
Gossanous clay with fracture	Old Working I Level No. 2	3	45	2.25	1.4
Calcite vein, calcite veinlets and calcite vein network in black argillaceous limestone	Old Working I Level No. 1	9	148	11.91	4.9
	Old Working I Level No. 2	9	110	1.42	1.9
	Old Workings II, III, V, VII, IX	6	85	3.69	4.9
		Sub total = 24	118	6.749	3.8
Calcite vein with gossanous clay	Old Working I Level No. 1	3	30	0.68	0.1
	Old Working I Level No. 2	5	15	21.53	38.7
		Sub total = 8	20	10.16	17.5
Calcite vein with large white calcite crystals and some large black calcite crystals	Old Working I Level No. 2	2	110	4.40	2.9
	Old Workings VI, VIII, X	3	120	1.60	1.6
		Sub total = 5	116	2.66	2.0
All samples from Old Working I described above	Old Working I Level No. 1	12	119	11.21	4.6
	Old Working I Level No. 2	19	70	3.09	4.1
		Sub total = 31	89	7.29	4.4
All samples described above	Old Working I	31	89	7.29	4.4
	Old Workings II, III, V, VI, VII, VIII, IX, X	10	89	2.89	3.6
	Total	41	89	6.20	4.1

Table I -2 Analytical Results of Samples from the Rumoh Ore Deposit

Sample Description	Location	No. of Channel Samples	Average Sampling Width cm	Weighted Average	
				Au g/t	Ag g/t
Calcite veinlets and calcite veinlet network in limestone	Level No. 2	3	110	1.85	1.0
Calcite vein with gossanous clay	Level No. 2	1	100	tr	tr
	Level No. 3	1	50	tr	tr
		Sub total = 2	75	tr	tr
Black calcite-quartz vein	Level No. 2	4	27	2.29	14.2
	Level No. 3	2	200	1.29	5.4
		Sub total = 6	85	1.50	8.1
Calcite vein with large white calcite crystals and some large black calcite crystals	Level No. 1	4	140	0.15	0.8
	Level No. 2	5	122	4.20	10.1
		Sub total = 9	130	2.25	5.9
Calcite vein with large black calcite crystals and some large white calcite crystals	Level No. 1	4	130	2.30	6.1
	Level No. 2	6	61	21.08	19.1
	Level No. 3	1	100	0.10	0.5
		Sub total = 11	90	9.09	10.5
All samples described above	Level No. 1	8	135	1.18	3.3
	Level No. 2	19	80	7.38	10.0
	Level No. 3	4	137	0.95	4.0
		Total = 31	101	4.13	6.1

tr -- trace

Based on the present investigation and the analytical results, the following observations may be made:

i) The area has good potential for further mining. Further exploratory work including intensive rock sampling and drilling is required to estimate the ore grade and reserve available.

ii) The average ore grade of all the old workings based on the samples analysed, is 6.20 g/t Au and 4.1 g/t Ag. This grade is slightly too low for underground operation. Selective mining of higher grade ore should however be profitably undertaken.

iii) Average grade of Old Working I, Level No. 1 is higher than those of the other old workings.

iv) Calcite vein, calcite veinlets and calcite vein network in black, argillaceous limestone of Old Working I, Level No. 1 show comparatively higher Au content.

v) Au content of calcite veins though megascopically similar, varies from place to place.

vi) Calcite veins containing sulphide ore minerals gave high values for Au of 9.50 to 21.58 g/t.

vii) Au content of gossanuous clay in fractures in low.

viii) Ag content is generally low except for samples from the Old Working I, Level No. 1.

Jambusan East Ore Deposits

The deposits are located about 6 km E of Bau town and just N and NE of the Jambusan bazaar (grid reference oZ 2190 5527) (Fig. I–18). They are accessible by a gravel road from the Jambusan bazaar which is also accessible by a gravel road from the Bau town. The area was mined during the early half of the 1800's and sporadically in the 1900's for antimony and gold. The ore was mined by opencast and it occurred mainly as residual ore in the crevices of the limestone flats. All the opencasts are flooded and this together with the thick secondary vegetation make field observations very difficult. A few of the old workings are presently held under the mining lease of the Negara Mining Sendirian Berhad.

Geology and Mineralization. The area is underlain by the Bau Limestone, the Pedawan Formation of intercalated shale and sandstone and a few argillized dacite dikes. The limestone formed flats covered by a thin layer of alluvium and the Pedawan low undulating hills. The Pedawan is highly tectonized with strike trends varying from N70°E to N70°W and dips ranging from 15°SW to 70°NW. Near the sites of old mining pools, shale of the formation also appears phyllitic and altered by silicification.

Eleven small, abandoned mining pools worked previously for gold and stibnite, are found north and northeast of the Jambusan bazaar.

The deposits were mined for gold and stibnite and are of the epithermal vein type. They

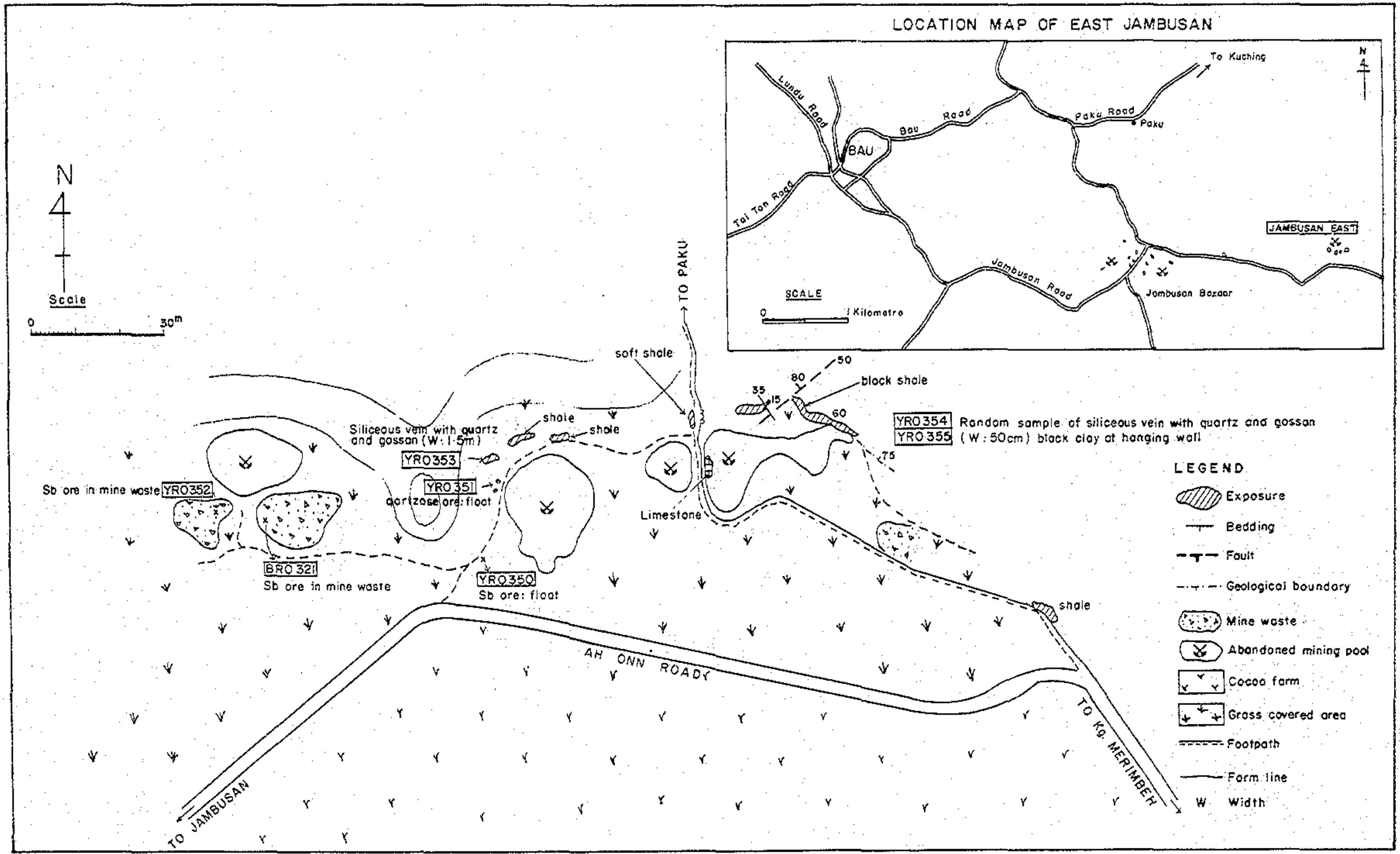

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Fig. I-18 Jambusan East Ore Deposits

may be broadly grouped as those occurring in the limestone flats and those at the limestone – shale and sandstone contact. Seven are found in the former area and four at the contact which generally strike EW. Locally, exposures at one old working show the contact striking N65°W and dipping 70°NE. Silicified shale with common quartz veins are also commonly observed near the contact. Some fragments from mine waste contain quartz, stibnite and pyrite, and rare arsenopyrite, realgar, calcite and clay minerals. Two mine waste piles estimated at 200 t occur near the western old mine pit. Samples collected from the waste and two exposures at this site show that gold is associated mainly with silicification and that stibnite-rich ore only gave low gold values (below).

Sample No.	Sample Description	Sampling Width cm	Au g/t	Ag g/t	Sb %
YR 0347	Stibnite ore (waste)	Spot	tr	tr	NA
YR 0350	Stibnite ore (waste)	Spot	tr	tr	14.61
YR 0351	Quartz vein (waste)	Spot	1.17	2.3	NA
YR 0352	Stibnite ore (waste)	Spot	0.4	0.4	8.08
YR 0353	Gossanous, clayey rock with quartz veinlets (exposure)	150	0.63	3.0	NA
YR 0354	"	100	3.90	2.5	"

NA – not analysed tr – trace

Records of productions from the old workings located near the limestone-shale and sandstone contact are given in Table I–3.

It appears that most of the higher grade ore had been mined out though the possibility of finding new workable deposits along the limestone - shale/sandstone contact and in the limestone flats cannot be ruled out.

Bidi South Ore Deposit

The deposit is located about 6 km SW of Bau town and 0.5 km SSW of Bidi bazaar (reference oZ 1380 5214) (Map I–34). It lies on the western side of the Bau-Krokong road which is the main access road to the area. The deposit was first mined by the Borneo Company between 1900 and 1911. From 1946 to 1952 the area was worked by the Associated Mines (Borneo)

Table I-3 Record of Production, Jambusan East Ore Deposits

Pit Location	Year Worked	Approximate Production tonne	Ore Grade	Depth of Pit m	Remarks
West abandoned mining pool	1871 by Borneo Co.	–	–	–	Ore incline, open pit
	1943 by Japanese				Ore horizontal, open pit
	1964 by local Chinese	6	Sb 40%	4	Ore horizontal, open pit
〃	1965 by Singaporean	5	Sb 30%	5	Ore incline, open pit
	1970 by Chung Pah Hing Mining Co.	8	Sb 30%	5.5	Ore incline, open pit
〃	1972 by Negara Co.	100	Sb 30%	6	Ore horizontal, open pit and underground mining
Central abandoned mining pool	1871 by Borneo Co.			4	
	1936 by Ngien Soon Gold Mine		Au, grade unknown		Ore incline, open pit
East abandoned mining pool	1871 by Borneo Co.		–	3	Ore incline, open pit
	1943 by Japanese		–	5	Ore horizontal, open pit
	1964 by Local Chinese	4	40%	–	Ore horizontal, open pit
〃	1965 by Singaporean	1	30%	6	Ore horizontal, open pit
	1970 by Chung Pah Hing Mining Co.	5	30%	8	Ore horizontal, open pit
〃	1970 by Negara Co.	60	40%	15	Ore horizontal, open pit

Limited. The area was again mined during the 1960's and 1970's by the Nam Loong Gold Mining Company and the Ng Kui Hung Gold Mining Company. The latter was later taken over by the Ng Khin Siong Gold Mining Company. All the small opencasts are presently flooded making field observation difficult. The area now belongs to the Gunung Wang Mining Sendirian Berhad which is currently pumping water out of the flooded opencasts.

Geology and Mineralization. The area is underlain by the Bau Limestone which is steeply faulted against shale and sandstone of the Pedawan Formation. A few thin, altered dacite and quartz porphyry dikes intruded the area at the sites of the old mining pools. From what can be observed, the ore deposit consisted of quartz-calcite veins with NE to EW strikes associated with a N60°E fault dipping 65°SE. The mineralized quartz-calcite veins contain clay and ore minerals including arsenopyrite, realgar, stibnite, malachite, and pyrite (Map I–34).

Analytical results of samples collected from the area are shown in Table I–4.

High gold values are obtained from samples of the mineralized/quartz-calcite veins. These and the gold content of the dike rock suggest further prospecting should be concentrated in the vicinity of the dikes and the main N60E fault.

Gunung Nanui and Gunung Jabul Ore Deposits

The deposits are located on the western and southern slopes of Gunung Nanui and Gunung Jabul about 5 km SW of Bau town and 900 m N of the Bidi bazaar (grid reference oZ 1405 5355 and oZ 1524 5340) (Map I–35 & I–36). The deposits are accessible by gravel road from Bau town. They were mined in the past by the Ng Kui Hiung Gold Mining Company. An underground working is located on the western slope of Gunung Nanui and two on the southern slope of Gunung Jabul. All of these underground workings especially those on the southern side of Gunung Jabul are difficult to reach due to the rugged terrain and thick vegetation. They are presently under the mining lease area awarded to the Gunung Wang Mining Sendirian Berhad.

Geology and Mineralization. Hills and flats of limestone of the Bau Limestone underlie the area. NW joints are very prominent in the limestone which is intruded by an argillized and silicified quartz porphyry dike, an apophysis of the Gunung Juala intrusive located about 800 m E of the area. The dike with a strike of N40°E and a dip of 85°NW cuts obliquely the NW joint pattern.

Gunung Nanui. The deposit of this old working was mined by opencast for about 80 m along its strike length. It consists of an Au-bearing, quartz-calcite vein with a strike of N20°E and a dip varying from 20° to 70° NW. The width of the vein pinches and swells reaching a maximum of more than 15 m at one place. Subsidiary calcite veinlets branches off the main vein at a few places (Map I–35). The vein composes predominantly large white calcite crystals, and

Table I-4 Analytical Results of Samples, Bidi South Ore Deposit

Sample Number	Sampling Width cm	Sample Description	Au g/t	Ag g/t	Sb %
BR 0485	30	Quartz-calcite vein with arsenopyrite, pyrite, realgar, stibnite and malachite	31.90	12.3	0.71
BR 0486	Spot	Dacite dike	1.50	5.3	–
BR 0487	Spot	Ore from mine waste. Quartz-calcite vein with arsenopyrite and stibnite	5.70	27.4	0.27
* AR 0061-a	Spot	Quartz-calcite vein with stibnite from mine waste.	69.6	29.1	1.36
* AR 0061-b		Quartz-calcite vein with stibnite and arsenic minerals from mine waste	20.4	29.8	1.78

* Collected during Phase I work

sporadic patches of large black calcite crystals associated with manganese oxide and gossanous clay. Quartz and ore minerals are megascopically not observable. Samples of the vein gave the following analytical results:

Sample No.	Sampling Width cm	Au g/t	Ag g/t	Remarks
BR 0450	120	0.86	1.2	Calcite vein of large white calcite crystals
BR 0451	100	tr	tr	"
BR 0452	150	4.00	2.5	"
BR 0453	100	2.30	14.2	Calcite vein of large black calcite crystals
Weighted Average	117	1.98	4.1	

tr – trace

The results show that the Au content of the vein is very low and even selective mining may not be feasible.

Gunung Jabul. The deposit of the two old workings I and II of Gunung Jabul consists of an Au-bearing quartz-calcite vein with a strike of N40°W and a dip of 45° to 70°NE emplaced in a joint in limestone (Map I–36). At old working I, the vein is a composite of several smaller calcite veins which are composed of mainly large white calcite crystals and sporadic patches of large black calcite crystals. The vein was mined by underground drifts with a total length of about 50 m and a small winze sunk at one place along a drift. Analysis of a few samples of the vein gave the following results:

Sample No.	Sampling Width cm	Au g/t	Ag g/t	Remarks
BR 0488	50	tr	tr	Calcite vein of large white calcite crystals.
BR 0489	120	1.20	0.8	"
BR 0490	100	tr	tr	"
Weighted Average	90	0.52	0.3	

The mineralized vein at old working II was mined by drifting for about 15 m along its strike. The vein is composed chiefly of large white calcite crystals and at one place large black calcite crystals with manganese oxide stain. Analysis of three samples gave the following results:

Sample No.	Sampling Width cm	Au g/t	Ag g/t	Remarks
BR 0454	80	0.60	1.5	Calcite vein of large white calcite crystals.
BR 0455	120	1.50	1.4	Calcite vein of large white and black calcite crystals.
BR 0456	120	1.67	5.3	"
Weighted Average	106	1.33	2.8	

A few samples of calcite veinlets in limestone from a few old prospecting pits in the limestone flat area SW of Gunung Nanui and Gunung Jabul were also analysed but gave only trace values for Au and Ag.

All the analytical results from the area may be classified as shown below:

Sample Description	Location	Average No. of Samples	Sampling Width cm	Weighted Average	
				Au g/t	Ag g/t
Calcite veinlets in limestone	Limestone flat SW of G. Nanui and G. Jabul	2	90	tr	tr
Calcite vein of large white calcite crystals and some large black calcite crystals	G. Nanui old working	3	123	1.98	2.4
	G. Jabul old working I	3	90	0.51	0.3
	G. Jabul old working II	3	106	1.33	2.8
		Sub total = 9	106	1.32	2.9
Calcite vein of large black calcite crystals	G. Nanui old working	1	100	2.30	14.2
		Total = 12	103	1.21	2.3

tr – trace

Though samples analysed are few, they indicate in conjunction with field observations that the Gunung Nanui and Gunung Jabul old workings offer little potential for further mining and that any extensions of the known veins would probably be also low in Au grade.

West Batu Bekajang Ore Deposit

The deposit is located on the western edge of Batu Bekajang lake just SW of Bau town (grid reference oZ 1715 5510) (Fig. I–19). The area was first mined by the Borneo Company in the early 1900's and forms part of the mined-out deposit which is presently the Batu Berkajang Lake. From 1955 to 1979 the area was part of the Bukit Young Mine mining area. In both cases, mining was confined to the surface. The area is now part of the mining lease belonging to Bukit Lintang Enterprise Sendirian Berhad. The company had completed its prospecting work which included some shallow drilling. Mining is expected to commence soon.

Geology and Mineralization. The deposit consists of epithermal quartz and quartz-calcite veins occurring in the Bau Limestone, shale and intercalated sandstone of the Pedawan Formation and at the contact of these two formations. The limestone is poorly bedded with strike of N5°W to N60°W and dips of 5° to 10°SW. It is overlain conformably by the Pedawan Formation which is observed on the western part of the lake to have suffered some degree of argillization, silicification and pyritization as a result of the intrusion of a few porphyry dikes. These dikes are apophyses of the Gunung Bekajang intrusive located just W of the lake. Mineralizing solutions apparently migrated along the boundaries of the dikes until they reached the relatively impermeable shale of the Pedawan. Deposition occurred at the shale-limestone contact and also formed quartz and quartz-calcite veinlets in the limestone and the overlying shale of the Pedawan. The main deposit of Batu Bekajang Lake at the contact appears to have been mined out but there is a good possibility that it may extend further laterally.

This is indicated by quartz and calcite-quartz veinlets occurring in altered shale, parallel to the bedding which may be seen in outcrops on the western side of the lake (Fig. I–20). The veinlets contain pyrite, galena, sphalerite, chalcopyrite, arsenopyrite, stibnite and clay minerals. Silicified shale near the contact with the dike rock also contains disseminated pyrite and some galena. Samples collected from the outcrops gave the following analytical results:

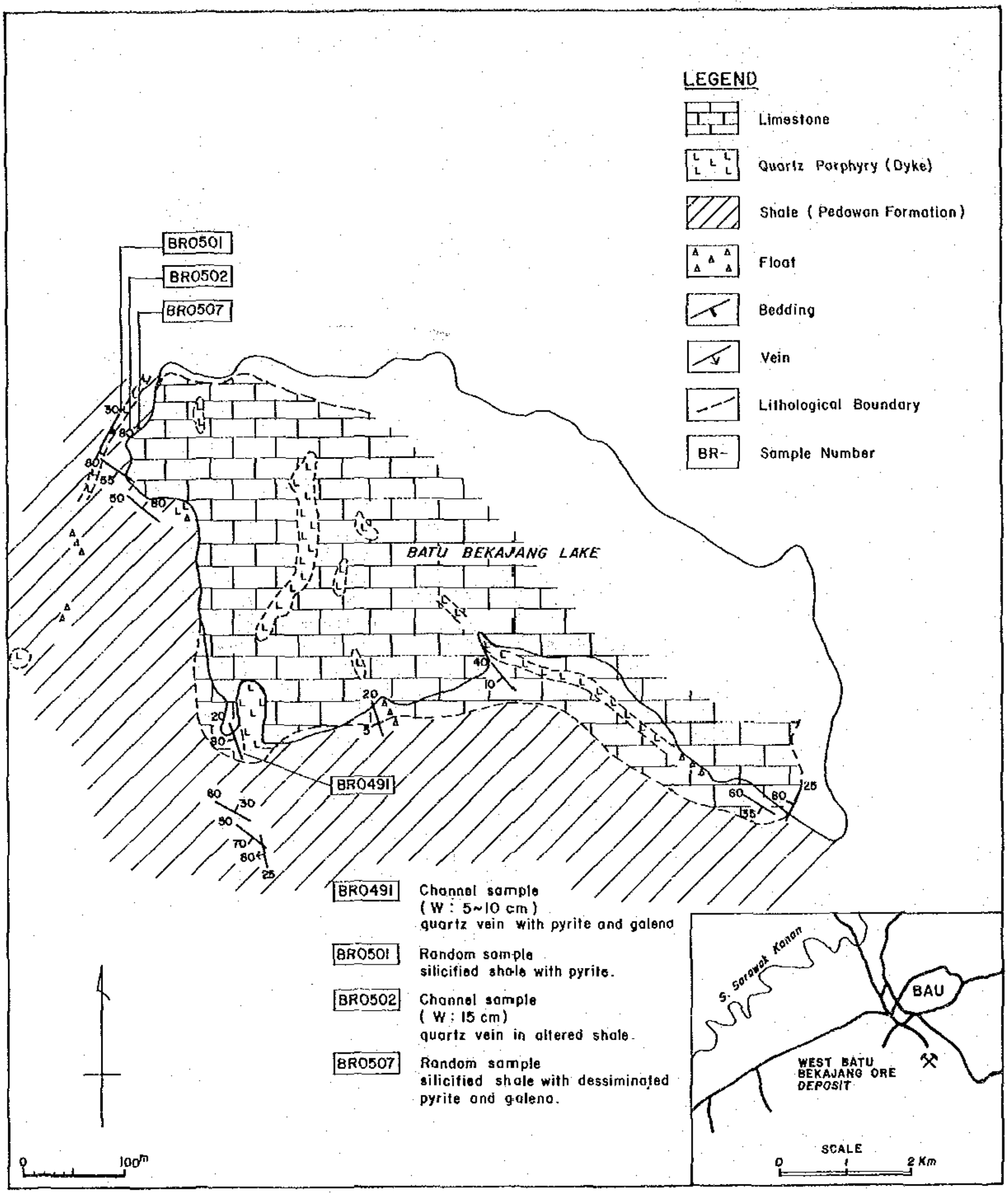

Fig. I-19 West Batu Bekajang Ore Deposit

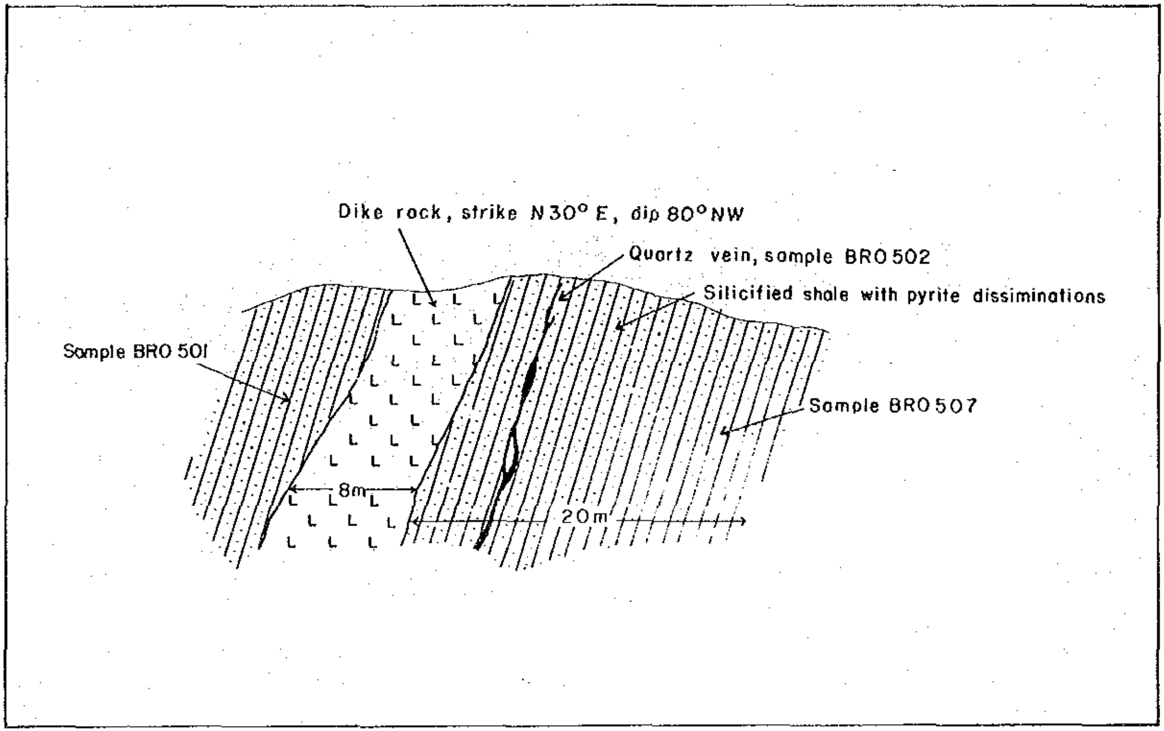

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Fig. I-20 Outcrop, West of Batu Bekajang Lake

	Sample No.	Sample Description	Sampling Width cm	Au g/t	Ag g/t	Sb %	As %	Cu %	Pb %	Zn %
Phase II	BR 0491	Quartz vein with pyrite and galena	5	1.00	157.1	NA	NA	0.05	9.32	2.83
	BR 0501	Silicified shale with pyrite	Spot sample	2.40	12.0	NA	NA	0.01	0.08	0.05
	BR 0502	Quartz vein in altered shale	15	0.50	0.7	NA	NA	NA	NA	NA
	BR 0507	Silicified shale with pyrite and some galena	Spot sample	6.00	42.2	NA	NA	0.07	0.43	0.90
Phase I	–	Quartz-calcite vein with stibnite	2	33.2	85.0	0.33	3.98	NA	NA	NA

NA = not analysed

The work done suggests that the main deposit at the limestone-shale contact may extend laterally in the vicinity of dikes.

Gunung Tongga Ore Deposit

The deposit consists of a massive sulphide vein, located about 3 km S of Bau town (grid reference oZ 1590 5310) (Fig. I–21). The area is accessible by a gravel road from Bau town. The vein was mined for its gold content in the past on a small scale leaving behind a cave like excavation trending in a northeasterly direction. In 1962, the Malayan Miners Limited prospected the deposit, but the result indicated only a limited ore reserve. In the early 1970s, the Kalimantan Enterprises Sendirian Berhad which presently holds the mining rights over the area drilled three holes in the vicinity of the vein. Only one intersected the mineralized vein, 240 cm in width indicating that the vein was apparently not extensive. The same company also drove a short adit to intersect the vein from the side of the hill. Two stockpiles of ore estimated at 120 t may still be seen outside the entrance of the adit.

Geology and Mineralization. The deposit is a small, epithermal vein of massive sulphides with a strike of N40°E to N60°E and steeply dipping at 70°SE to 80°NW. The vein is emplaced

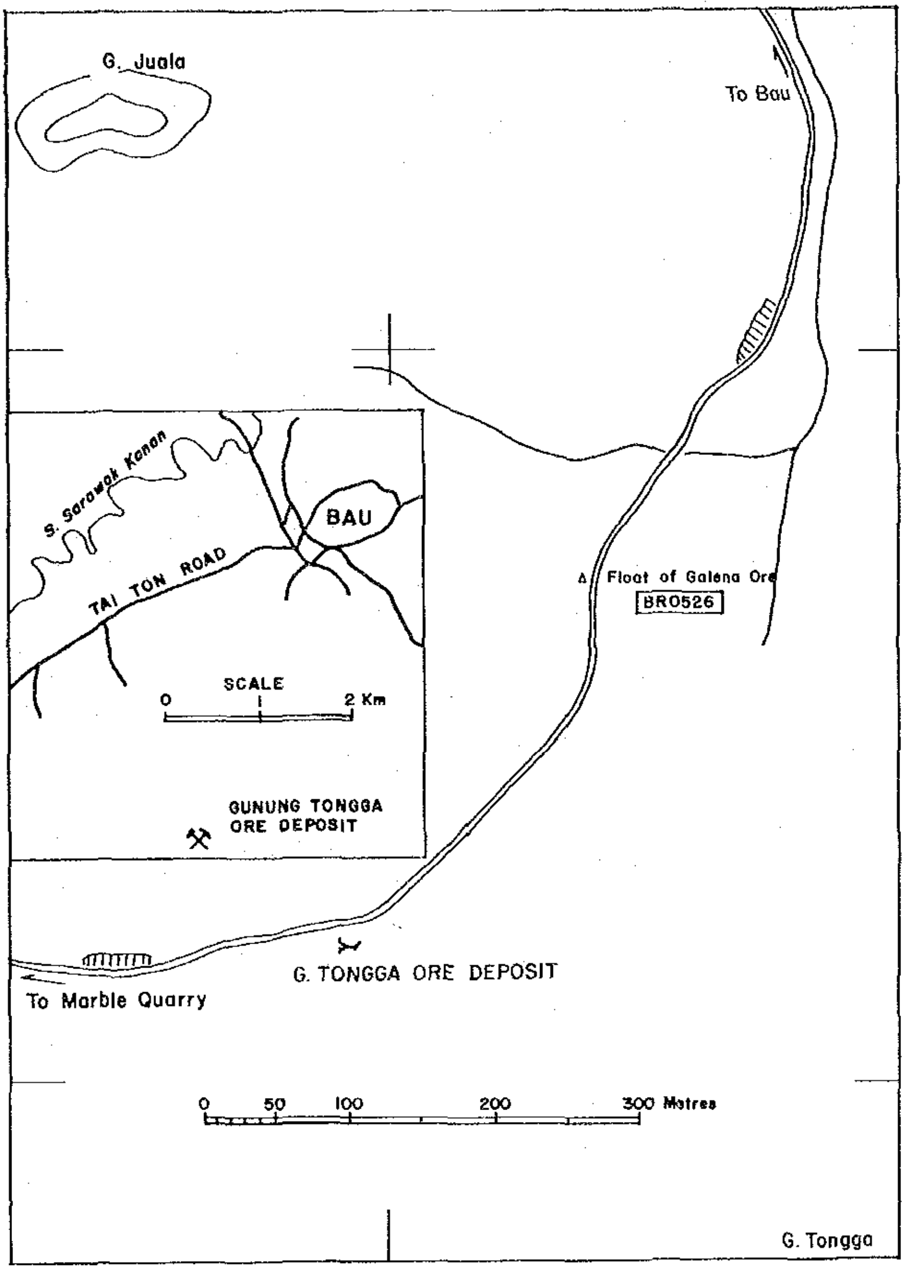

Fig. I-21 Location Map of Gunung Tongga Ore Deposit in marble on the west side of Gunung Tongga just adjacent to the southern contact of the Gunung Juala intrusive (Map I–37). The vein is composed mainly of galena, pyrite and arsenopyrite, and minor sphalerite, chalcopyrite, marcasite, calcite, quartz, boulangerite, bournonite and bornite. Analysis of samples collected from the vein and stockpile gave results as shown in Table I–5.

From the analytical results and field observation, it appears that though Au and Ag contents are erratically high and Pb and Zn contents are appreciable, the vein however is apparently not extensive to merit much importance. Gold extraction by the usual cyanidation method would also be difficult in view of the high sulphide contents. Direct export of the ore to overseas smelting may however be feasible.

Gunung Siriung Mineralized Occurrence

The occurrence is located about 2 km S of Bau town (grid reference oZ 1618 5398) and is accessible by gravel road from the town passing by the Luckyhill mine (Fig. I–22). The occurrence on the southern side of Gunung Siriung was prospected for gold by local prospectors. The site was excavated following the strike direction of a coarse calcite vein which is presently still observable. The occurrence lies within the mining lease area of Kalimantan Enterprises Sendirian Berhad.

Geology and Mineralization. The mineralized occurrence is found at the southern side of a limestone hill near a quartz porphyry dike, W of the Gunung Juala intrusive. The occurrence consists of an irregular coarse calcite vein with a general strike of N5°E and a dip of 30°SE emplaced along the bedding plane of the limestone (Map I–37). The vein is composed predominantly of large white and some black calcite crystals. Samples of the vein analysed, gave the following results:

Sample Number	Sampling Width cm	Sample Description	Au g/t	Ag g/t
BR 0402	60	Gossanous large crystal calcite vein	3.60	1.1
BR 0403	100	"	1.00	1.1
BR 0404	Spot sample	Calcite vein	1.13	0.4
BR 0405	10	Gossanous calcite vein	2.20	1.1

The mineralized vein is not extensive and the gold content low and hence, offers little prospect for mining.

Table I-5 Analytical Results of Samples from the Gunung Tongga Ore Deposit

	Sample No.	Sample Description	Sampling Width cm	Au g/t	Ag g/t	Cu %	Pb %	Zn %	Sb %	As %
Phase II	BR 0387	Ore – Galena, sphalerite, pyrite, chalcopyrite, quartz and calcite	10	7.50	102.8	0.33	8.34	5.19	NA	NA
	BR 0389	Gossan	80	1.25	3.2	NA	NA	NA	NA	NA
	BR 0390	Gossanous clay	8	2.20	2.7	NA	NA	NA	NA	NA
	BR 0391	Ore – galena, chalcopyrite, pyrite and gossan	15	19.25	117.9	NA	NA	NA	NA	NA
	BR 0392	Large white calcite crystals	50	tr	tr	NA	NA	NA	NA	NA
	BR 0393	Gossanous clay in calcite	100	18.75	119.4	NA	NA	NA	NA	NA
	BR 0394	Ore – galena, sphalerite, chalcopyrite, pyrite, arsenopyrite, quartz and calcite.	30	21.10	158.0	0.52	15.20	8.86	NA	NA
Previous Analysis	AR 0032-a	Ore – galena, sphalerite	Spot sample	7.0	268.0	1.54	5.39	4.25	0.46	NA
	AR 0032-c	Ore – pyrite, arsenopyrite	Spot sample	3.3	129.0	0.64	2.62	1.20	0.26	14.28
	AR 0032-d	Ore – galena, sphalerite, calcite	Spot sample	20.0	84.3	0.24	4.05	7.90	tr	NA
	GSMS	Ore – galena, pyrite	Spot sample	3.1	136.8	0.26	1.04	3.20	0.07	1.96

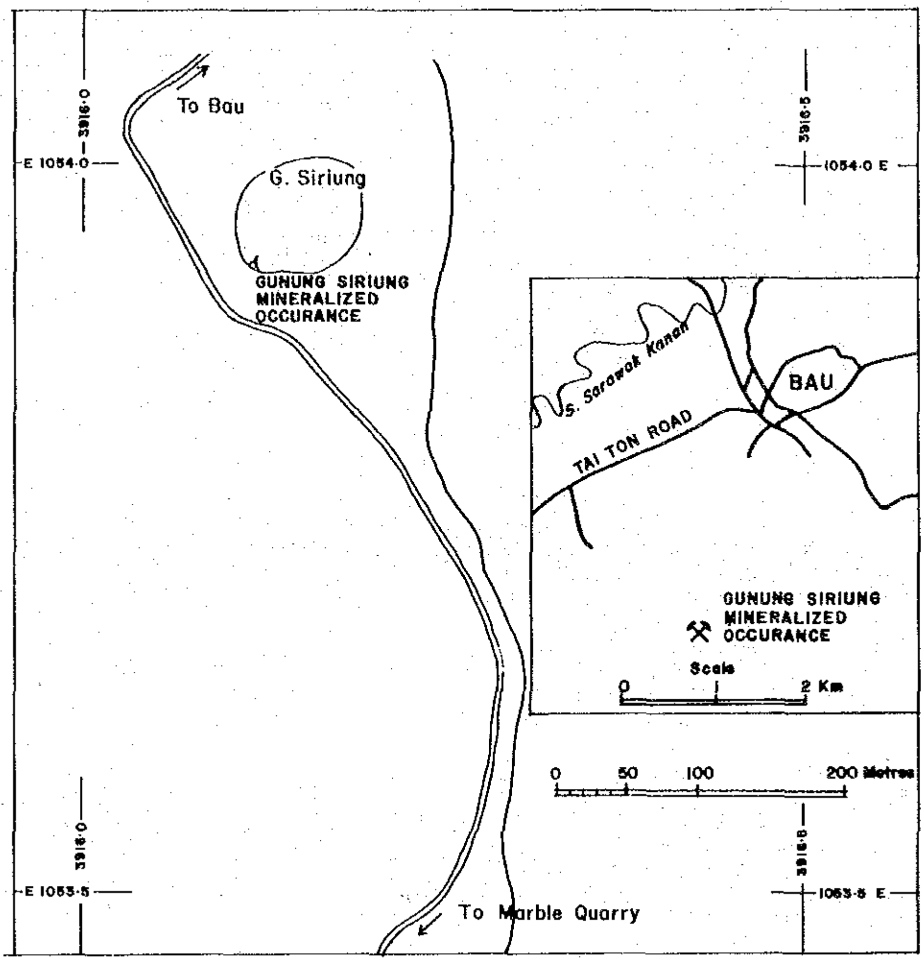

Fig. I-22 Location Map of Gunung Siriung Mineralized Occurrence

1–3–2 Mineral Showing

Calcite veinlets in limestone are commonly observed in this area (Map I–25). Most of the veinlets are probably derived from the limestone. It is difficult to differentiate these veinlets from those hydrothermally formed. The following two calcite veins are probably related to hydrothermally formed veins:

(1) Calcite vein to the South of Bukit Tongga. Outcrop of calcite vein trending N40°E and dipping 85°SE is observed on the northern slope of the limestone hill about 300 m to the southeast of Bukit Tongga. The vein is lenticular with maximum width of about 1.3 m consisting of large calcite crystals similar to that of Tai Ton B vein, but with no quartz veinlets. The analytical results of sample from the vein show Au as trace, Ag 7.1 ppm, Sb 1.6 ppm, Cu 5 ppm, Pb 5.6 ppm and Zn 3 ppm.

(2) Calcite vein to the North of Gunung Engkuyong. Calcite vein trending N20°E dipping nearly 90° is observed about 300 m to the north of Gunung Engkuyong, in a limestone hill. The maximum width of the vein is 1.2 m and it is exposed for 4 m along strike. The vein consists of large calcite crystals. Analytical results of the sample from the vein shows Au as trace, Ag 6.0 ppm, Sb 37.8 ppm, Cu 12 ppm, Pb 52 ppm and Zn 42 ppm.

Along the approximate boundary of the Pedawan Formation and the Bau Limestone trending nearly EW to the west of Kampung Seromah, in the southeast part of the area, floats of gossan are observed. The source of the floats is not observed probably due to thick overburden.

1–4 Discussion

Mineralogical Classification of the Known Gold-Antimoney Ore Deposit

The main ore deposits known in the area may be mineralogically classified into two groups based on whether or not native arsenic is present. Ore deposits with native arsenic are found mainly in the Tai Ton, Saburan, Rumoh, Bidi and Bidi South areas. The deposits are mainly calcite vein with some quartz veinlets. Ore minerals, though generally not abundant, consists chiefly of native arsenic, arsenopyrite and stibnite. Ore deposits without native arsenic may be further divided into 2 subgroups based on whether the principal gangue mineral is calcite or wollastonite. The Gunung Krian, Gunung Tai Ton and the main part of the Lucky Hill A ore deposits belong to the subgroup with calcite as the main gangue mineral. They are mainly calcite veins with some quartz veinlets. The ore minerals are mainly stibnite and arsenopyrite with subordinate amount of sphalerite, rare galena, chalcopyrite and a variety of antimony minerals. The Gunung Bau, Gunung Arong Bakit A and B, the lower part of Lucky Hill A and Lucky Hill B belong to the other subgroup with wollastonite as the principal gangue mineral. Ore minerals of Gunung Bau consist of stibnite and arsenopyrite, Arong Bakit A of arsenopyrite, stibnite and berthierite and Arong Bakit B of tetrahedrite, chalcopyrite and native gold. A common ore mineral assemblage is not recognized in this sub-group but the higher content of Au and Ag such as that found at Gunung Arong Bakit B is characteristic of the ore deposits in this sub-group.

Relationship Between Gangue Minerals of Ore Veins and the Country Rock

Most of the known gold-antimony deposits are found in limestone or marble in this area. The deposits at Gunung Bau, Gunung Arong Bakit A and B and Lucky Hill B, with wollastonite as the principal gangue mineral, are found in marble, whereas deposits at Saburan, Rumoh, Gunung Tai Ton, Tai Ton B and Gunung Krian, with calcite as the principal gangue mineral, are found in limestone. It is therefore obvious that distance from the main intrusives determines the type of gangue mineral and the host rock.

Gold and Silver Grades of Ore Deposits

In order to study the relationship between Au and Ag grades and the type of ore veins, 146 ore samples from the various old mine workings were classified into 6 groups based on their mineralogical content. Each group was further classified into 4 subgroups based on the analytical results (Fig. I–23).

The figure shows that most of the samples collected from ore veins with calc-silicate gangue minerals contain the highest average Au grade (more than 10 g/t), followed by samples collected of dominantly quartz veins. More than 90% of the samples collected from only calcite veins contain low Au (less than 5 g/t).

A number of ore samples in which gold or electrum were observed under the microscope were also counted and classified according to the sample types. 4 of the 5 samples in which gold or electrum were observed are calc-silicate ore of mainly quartz and wollastonite. One sample is of a quartz vein. This indicates clearly that high gold contents are obtained mostly from ore veins with calc-silicate gangue minerals.

Fig. I–24 shows 150 analytical values for Au and Ag, greater than detection limits, plotted on logarithmic graph. The ratio of Ag/Au is approximately one. Although the occurrence of silver mineral is not observed except for electrum, silver is probably also contained in tetrahedrite and other minerals.

Gossanised Auriferous Clay

The old workings of Tai Ton B, Rumoh, Nam Loong A (investigated in Phase I), Saburan and some others which have apparently been mined out on a large scale are found in limestone caves. Gossanised auriferous clay filling irregular cracks and joints in the calcite veins and country

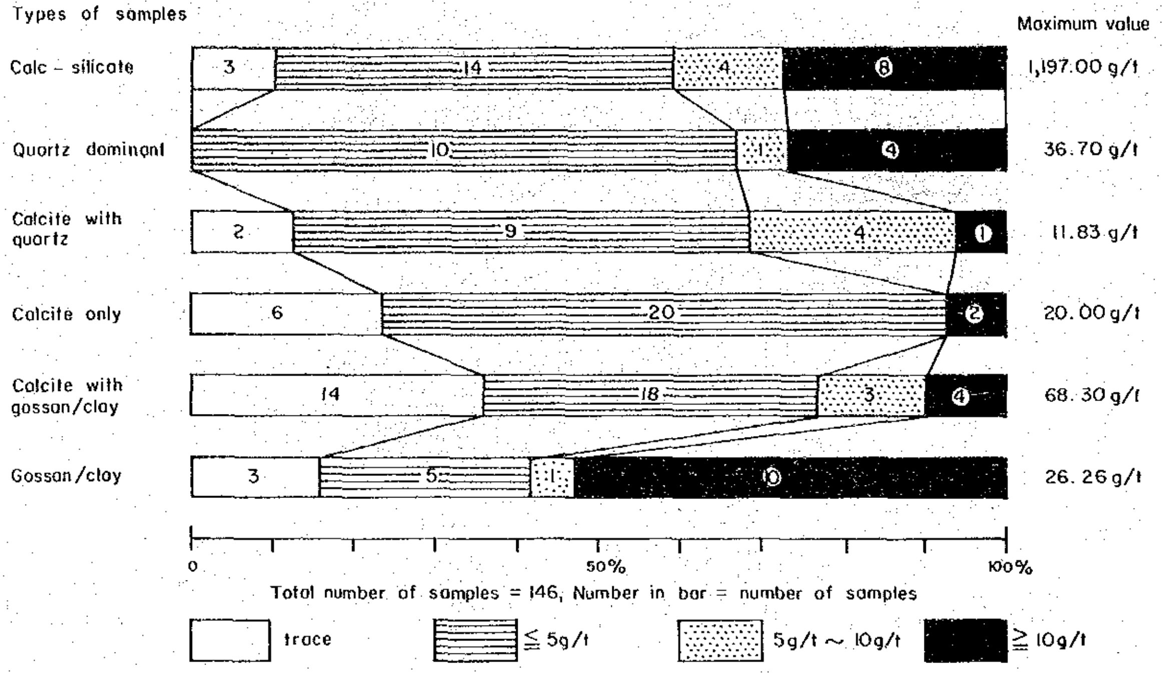

Fig. I-23 Au Contents in Various Types of Samples

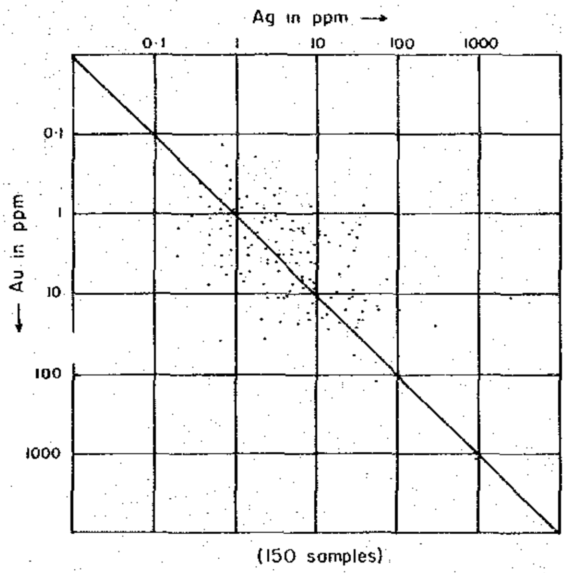

Fig. I-24 Variation of Au/Ag Contents in Ore Samples rock in caves were mined out for gold. From Fig. I–23, it is obvious that the gossanised clay is of two types, namely the high grade clay, with more than 10 g/t of Au, and the low grade clay with less than 5 g/t of Au. Only a few are of intermediate grade, with Au values between 5 g/t and 10 g/t.

The results of chemical analysis and X-ray diffractive analysis of clay ore collected from some old workings may be tabulated as follows:

Sample No.	Au (g/t)	Ag (g/t)	Minerals detected by X-ray diffraction
AR 0369	26.25	292.7	(A) Quartz, (C) Montomorillonite, (R) Ferritungstite, (R) Calcite, (R) Mixed layered minerals
AR 0390	15.83	24.3	(A) Quartz, (C) Calcite, (R) Montmorillonite, (R) Ferritungstite, (R) Kaolin
AR 0430	13.00	9.8	(A) Quartz, (R) Calcite
AR 0431	17.50	7.9	(A) Quartz
AR 0435	1.00	1.5	(A) Calcite, (R) Quartz, (R) Chlorite, (R) Gypsum

(A) = abundant, (C) = common, (R) = rare or little

Samples with a high Au grade such as AR0369, AR0390, AR0340 and AR0341 consist mainly of quartz while those with low Au grade such as AR 0345 contains very little quartz. Thus it appears that gold is related to quartz in the gossanised clay and not to the clay minerals. The origin of gossanized auriferous clay is schematically depicted in Fig. I–25 of the Tai Ton B ore deposit.

The adit is presumed to be in a limestone cave because of the presence of stalactites in the adit. The Au contents of the pure calcite vein which makes up most of the vein in the adit are quite low. On the other hand, Au contents of drusy quartz veinlets and calcite vein with quartz veinlets in the adit are mostly high. Gossanised clay with high Au content is present in all types.

The following is a hypothetical process of the formation of gossanised clay:–

(1) Rain water dissolved the exposed limestone country rocks and calcite vein. Quartz veinlets which may be accompanied by a little adularia, montmorillonite, and possibly scheelite in the calcite vein were also subjected to weathering and subsequently altered to clay and sand (adularia → kaolin, quartz → sand and scheelite → ferritungstite).

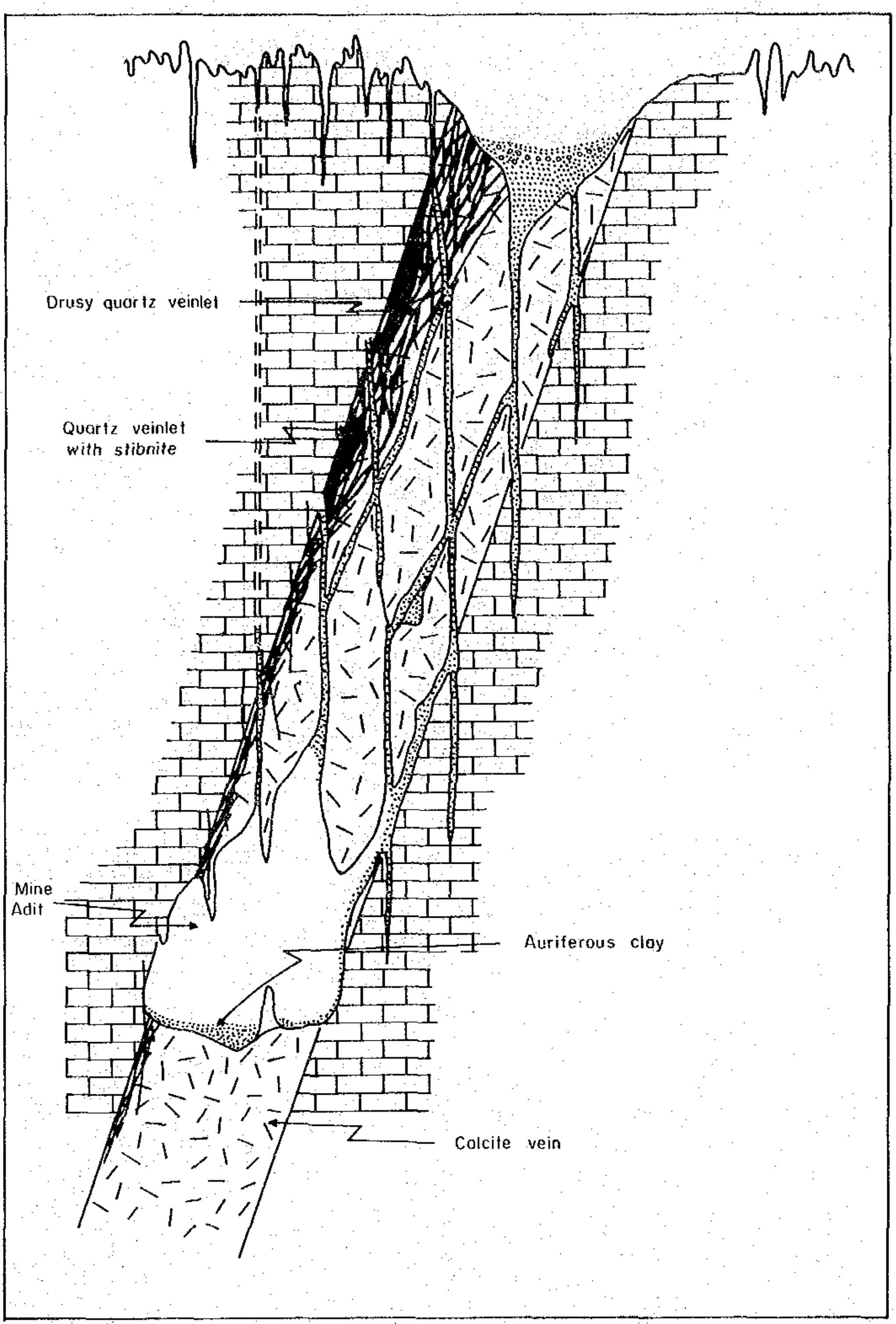

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Fig. I-25 Schematic Section of Tai Ton B Old Mine Adit

(2) Rain water permeated into cracks dissolving both the calcite vein and limestone and formed large openings and the cave. The gossanised clay comprising quartz grains, clay and other materials was transported below and deposited in the cave. Dolines which developed on the surface, may play a part in concentrating gold grains in the gossanised clay. High Au grade clay probably originated from the weathering of the ore vein and Au was concentrated in the process. On the other hand, low Au grade clay probably mainly originated from barren limestone.

Even though the average Au grade of gossanised clay in many old workings is high, it is not economically mineable on a large scale as the total clay reserve is small. Gossanised clay should be useful in prospecting as it can be used as an indicator of the existence of primary Au deposits.

Relationship between Ore Deposit and Geological Structure

As mentioned earlier the Tai Parit area may be structurally divided into two parts, a northwestern part and the southeastern part. Most of the known ore deposits are found in the northwestern part and few in the southeastern part. The distribution of ore deposits was most probably controlled mainly by NE-SW trending structure (faults and folds) which characterize the northwestern part.

The NE-SW trending parallel faults probably acted as channel ways for the ore-solution, even though most of the mineralized veins strike NW-SE as is observed in Lucky Hill, Gunung Krian, Gunung Bau, Gunung Arong Bakit B, Gunung Tai Ton, Tai Ton B and Saburan. The veins filled open fractures which were formed concurrently with the NW-SE trending faults created by a compressional stress trending NW-SE.

Relationship between Geochemical Trend Surface and Geological Structure

Comparing the 11 trend surface maps for Au, Ag, As, Sb, Cu, Pb, Zn, Mo, Mn, Fe and Hg contents in limestone samples, a general low metal zone (showing low values for most of the metal elements) of about 1 km in width trending NE from Gunung Ropih intrusive becomes apparent. The low metal zone nearly coincides with the boundary between the northwestern part and the southeastern part divided based on the geological structure. The Ag trend surface in particular, high in the southeast and low in the northwest, reflects the difference between these two structural domains.

Relationship between Geochemical Anomaly Surfaces and Mineralization

Superimposition of the anomaly surface maps for As, Sb, Hg and Mn shows good overlapping of the 'high anomalies' in these areas: the Gunung Krian – Gunung Badug area, the Gunung Batu area and the Kampung Seromah North Area. As most known old mine workings for Au and Sb are located in the Gunung Krian – Gunung Badug area, it is therefore considered that the other two areas have good potentials for possible Au and Sb mineralization.

CHAPTER 2 GUNUNG ROPIH – GUNUNG JUALA AREA

The area includes the intrusive stocks of Gunung Ropih and Gunung Juala where massive sulphide veins are known to occur and indications of disseminated copper and molybdenum mineralization found during Phase I work. Geochemical stream sediments sampling also showed that the area is geochemically anomalous for mainly Cu, Pb, Mo, Sb, W, Au and As. In order to investigate further the extent of the mineralization and the anomaly, a geochemical soil survey and detailed geological survey were conducted in the area.

2–1 Geological Survey

2–1–1 Geology

Gunung Ropih and Gunung Juala are two acidic stocks of Late Neogene age intruded into the Bau Limestone. The northern stock of Gunung Juala with a maximum elevation of 262 m covers an area of approximately 1 km^2. Many dikes mainly with NE and NW trends radiate out from the intrusive into the limestone country rock. On the southern slope, patches of hornfels and marble are found as roof pendants. These are presumably partially assimilated remnants of the Pedawan Formation and the Bau Limestone (Fig. I–26). The southern stock of Gunung Ropih with a maximum elevation of 221 m covers an area of approximately 0.6 km^2. Its contact with the limestone country rock is very irregular. Many dikes diverge outwards from the intrusive. A few small marble roof pendants were also found on the southern slope of the intrusive.

The intrusive stocks are composed of quartz porphyry and based on chemical analysis, are granodioritic in composition. Because of extensive alteration, deep weathering and the lack of outcrops, it was not possible to determine accurately the original compositions of the intrusives. Dike rocks appear to be similar in composition to the intrusives but are generally more altered and weathered. The emplacement of the intrusives might have been controlled by the intersections of the main NNE and NW faults and the dikes by NE and NW faults.

The intruded Bau Limestone is composed of mainly massive, grey to dark grey, relatively pure limestone. The limestone is unevenly recrystallized to marble. Marble is widely developed to the north and south of Gunung Juala and to the south of the Gunung Ropih intrusive but not to the east of both intrusives.

2–1–2 Alteration

Alteration of the intrusives is extensive but because of deep weathering and the lack of outcrops, the pattern of alteration zoning cannot be conclusively delineated. Alteration recognisa-

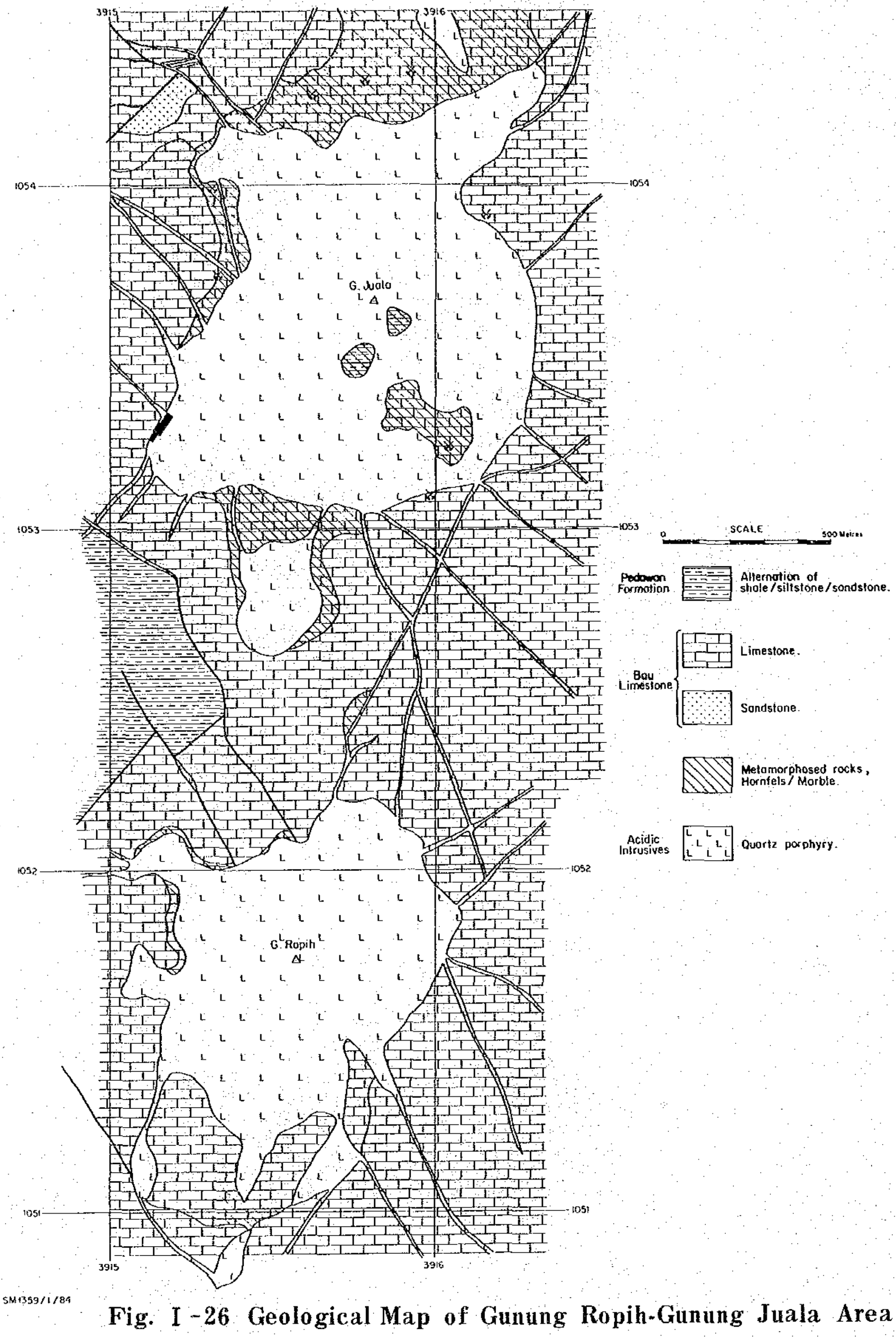

Fig. I-26 Geological Map of Gunung Ropih-Gunung Juala Area ble in mainly floats of the intrusives include silicification, sericitization, K-alteration and chloritization (Fig. I–27, Appendix 4). *Silicification is particularly common in the southern part of* Gunung Ropih where it is observed as network of quartz veinlets in floats. Some white, highly silicified intrusive floats show a banded, porous and sugary texture. Sericitization as is evident in thin section and in x-ray diffraction analysis is also widespread in both stocks. Similarly, chloritization appears to be widespread and is observable in thin section to have affected the mafic minerals. K-alteration is reflected in the higher K_2O content of the rocks and in thin sections of particularly samples from the Gunung Ropih intrusive where K-felspar is observed to have partly replaced plagioclase in quartz veinlets. Actinolite partially replacing hornblende and rare grossularite, and wollastonite are also observed in thin sections of a few samples.

2–1–3 Chemical Composition of Intrusives

In order to examine whether the intrusive stocks of Gunung Ropih and Gunung Juala with their associated Pb-Zn and Cu-Mo mineralizations, can be differentiated from the other Tertiary intrusive stocks of the Bau Area, 20 rock samples from the various stocks were analysed for their major elements. The locations of these samples are shown in Fig. I–28 and their chemical composions and CIPW norms in Table I–6.

The QPA diagram of the normative quartz, plagioclase and orthoclase shows that most of the samples plot as an aggregate near the central part of the granodiorite field (Fig. I–29). Sample from the Gunung Ropih and Gunung Juala stocks (No. 13–20) plot slightly away from this main group and in the quartz-rich granitoids, adamellite and quartz monzodiorite fields. This is possibly due to the types and degree of alteration which affected the Gunung Ropih and Gunung Juala stocks. The ACF diagram also shown that the rocks of these two stocks plot somewhat away from the main group (Fig. I–30). This vague separation may also be seen from the variation diagrams of K_2O, CaO and SiO_2 plotted against the solidification index, MgO x 100/(MgO + Fe_2O_3 + FeO + Na_2O + K_2O) (Fig. I–31). The plot of CaO against the solidifica*tion index shows most of the Gunung Ropih and Gunung Juala samples have higher CaO contents* which may possibly caused by assimilation of the limestone country rock as suggested in the Phase I report.

By discriminant analysis using the 11 oxides of the major elements for all the samples analysed, a more apparent separation of the intrusive stocks into two groups was achieved: the Gunung Ropih and Gunung Juala group and the group comprising the rest of the analysed Tertiary intrusive stocks of the Bau area. As shown in Figure I–32, all samples from the Gunung Ropih and Gunung Juala stocks have negative discriminant scores whereas the rest positive. The

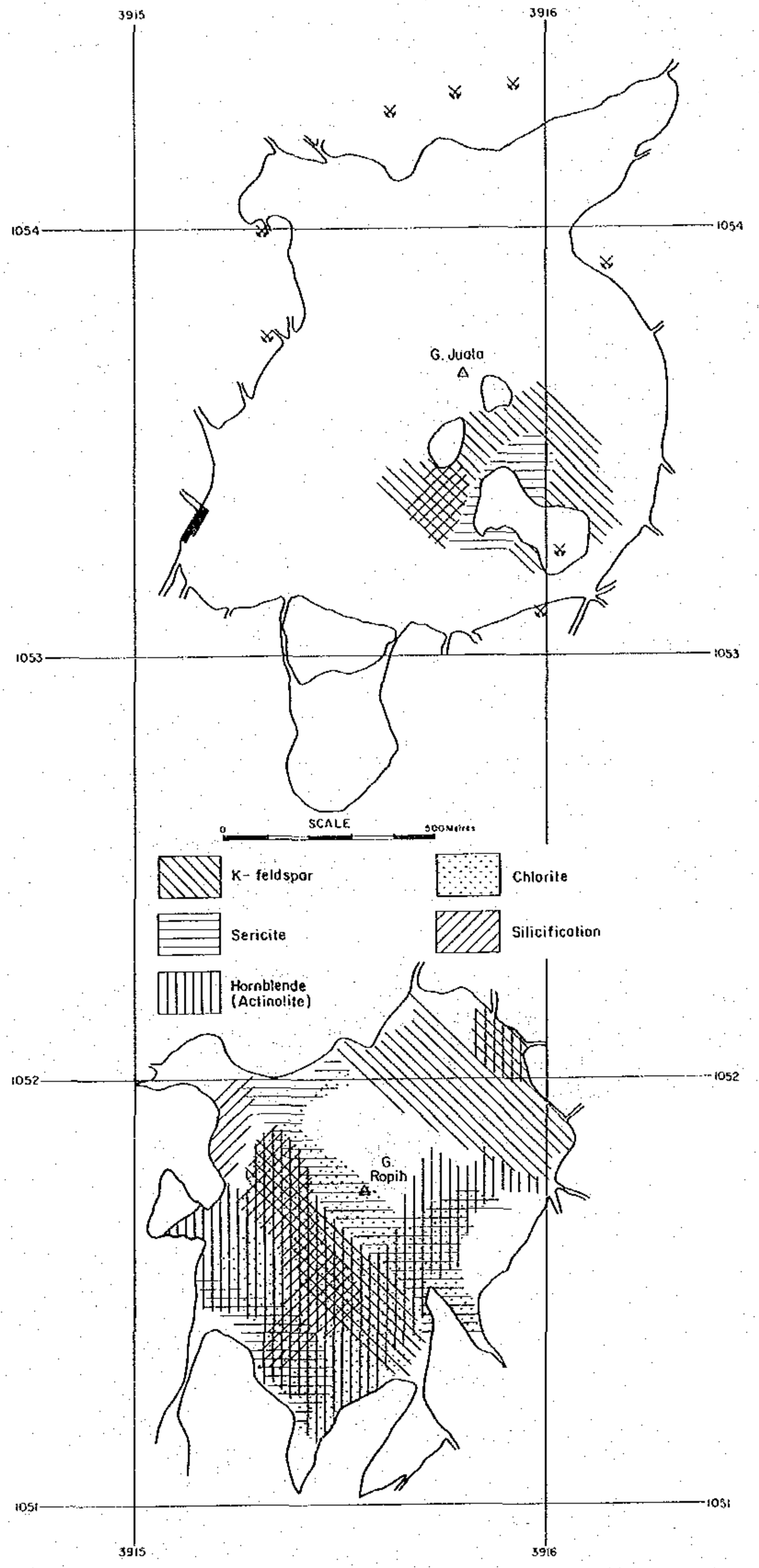

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Fig. I -27 Distribution of Alteration Minerals, Gunung Ropih-Gunung Juala Area

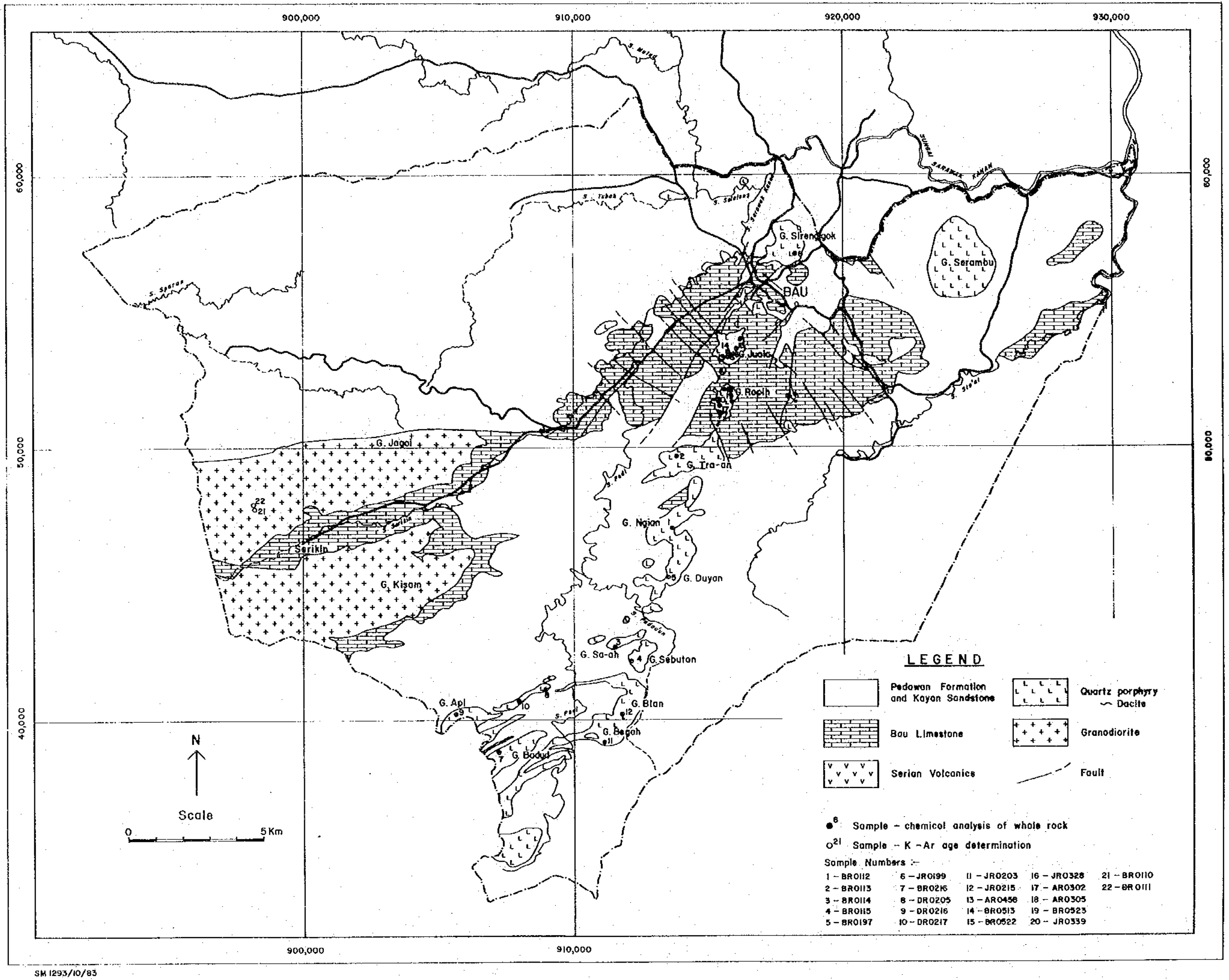

Fig. I-28 Location Map of Rock Samples for Chemical Analysis and K-Ar Age Determination.

Table I-6 Chemical Composition and CIPW Norms

Sample No.	BR0112	BR0113	BR0114	BR0115	JR0197	JR0199	BR0216	DR0205	DR0216	DR0217	JR0203	JR0215	AR0302	AR0305	AR0458	BR0513	BR0522	BR0523	JR0328	JR0339
SiO_2	74.96	69.42	70.55	65.12	69.63	65.29	69.91	68.20	71.82	78.45	62.32	68.37	66.68	65.80	67.73	66.28	66.43	67.49	67.92	73.29
TiO_2	0.41	0.38	0.38	0.33	0.40	0.33	0.29	0.49	0.29	0.10	0.32	0.31	0.44	0.47	0.44	0.47	0.42	0.47	0.50	0.43
Al_2O_3	13.63	14.51	13.94	14.30	13.37	13.41	13.83	14.90	13.94	13.08	13.90	13.09	14.61	14.84	13.25	13.58	13.68	14.12	14.14	11.27
Fe_2O_3	2.13	0.49	1.23	0.64	1.13	0.19	1.20	2.76	1.04	0.07	0.14	0.19	2.13	2.10	1.50	0.20	0.74	1.67	0.51	1.20
FeO	0.27	1.99	1.39	2.19	1.45	2.06	1.20	0.67	1.07	0.31	2.33	2.39	0.86	0.40	1.07	2.52	1.79	0.53	2.19	1.07
MnO	0.05	0.05	0.04	0.05	0.05	0.05	0.04	0.04	0.04	0.01	0.05	0.04	0.04	0.08	0.05	0.06	0.04	0.06	0.08	0.05
MgO	0.49	1.21	0.97	1.15	1.00	1.10	0.70	1.42	0.69	0.13	1.31	0.80	1.23	1.18	1.18	1.09	1.22	1.28	1.21	1.30
CaO	0.09	3.71	3.49	4.32	3.15	4.02	3.35	3.63	2.98	0.03	3.62	3.32	4.18	5.55	4.16	3.44	3.73	4.64	4.17	3.93
Na_2O	0.40	4.04	4.16	3.72	4.08	3.27	3.78	3.98	4.14	0.52	2.67	3.90	4.28	4.12	4.00	4.48	3.60	3.70	3.76	3.15
K_2O	4.43	1.96	2.31	1.23	2.06	1.27	2.31	1.96	1.92	2.43	2.55	1.27	2.29	3.97	4.15	2.68	2.15	3.90	2.35	2.35
P_2O_5	0.05	0.09	0.11	0.10	0.10	0.09	0.08	0.10	0.06	0.02	0.10	0.09	0.09	0.11	0.10	0.10	0.10	0.13	0.10	0.11
BaO	0.05	0.05	0.04	0.03	0.02	0.03	0.04	0.03	0.04	0.04	0.03	0.02	0.04	0.06	0.05	0.04	0.03	0.06	0.04	0.03
Ig. Loss.	4.25	1.45	1.80	6.34	4.89	7.42	1.84	2.71	0.90	3.78	5.94	3.64	0.70	0.41	0.70	1.62	5.27	1.22	1.81	1.31
TOTAL	101.21	99.35	100.41	99.52	101.33	98.53	98.57	100.89	98.43	98.97	95.28	97.43	97.57	99.09	98.38	96.56	99.20	99.27	98.38	99.49
q	54.86	28.13	29.31	27.14	30.14	30.21	31.16	28.00	32.44	65.73	25.88	31.34	23.82	16.85	21.16	21.10	27.44	22.08	26.33	37.72
c	8.10	–	–	–	–	–	–	–	–	9.56	0.39	–	–	–	–	–	–	–	–	–
or	26.18	11.58	13.65	7.27	12.17	7.51	13.65	11.58	11.35	14.36	15.07	7.51	13.58	23.46	24.53	15.84	12.71	23.05	13.89	13.89
ab	3.38	34.19	35.20	31.48	34.52	27.67	31.99	33.68	35.03	4.40	22.59	33.00	36.22	34.86	33.85	37.91	30.46	31.31	31.82	26.65
an	0.20	15.67	12.54	18.69	12.08	18.16	13.95	17.00	13.78	0.09	17.35	14.46	13.89	10.27	5.94	9.03	14.82	10.40	15.04	9.67
wo	–	–	–	–	–	–	–	–	–	–	–	–	–	3.55	2.42	–	–	1.27	–	–
diwo	–	0.93	1.72	0.90	1.22	0.52	0.93	0.17	0.28	–	–	0.61	2.64	3.40	3.48	3.11	1.29	3.69	2.11	3.83
dien	–	0.48	1.13	0.43	0.78	0.24	0.60	0.15	0.19	–	–	0.22	2.28	2.94	2.94	1.30	0.74	3.19	1.05	3.05
difs	–	0.43	0.46	0.45	0.36	0.28	0.28	–	0.08	–	–	0.41	–	–	0.09	1.82	0.50	–	1.02	0.34
hyen	1.22	2.54	1.28	2.44	1.71	2.50	1.15	3.39	1.53	0.32	3.26	1.78	0.78	–	–	1.41	2.30	–	1.96	0.19
hyfs	–	2.28	0.52	2.59	0.80	2.90	0.53	–	0.62	0.36	3.73	3.38	–	–	–	1.98	1.56	–	1.90	0.02
mt	–	0.71	1.78	0.93	1.64	0.28	1.74	0.87	1.51	0.10	0.20	0.28	1.63	0.19	2.17	0.29	1.07	0.54	0.74	1.74
hm	2.13	–	–	–	–	–	–	2.16	–	–	–	–	1.01	1.97	–	–	–	1.30	–	–
il	0.68	0.72	0.72	0.63	0.76	0.63	0.55	0.93	0.55	0.19	0.61	0.59	0.84	0.89	0.84	0.89	0.80	0.89	0.95	0.82
ru	0.05	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
ap	0.12	0.21	0.25	0.23	0.23	0.21	0.19	0.23	0.14	0.05	0.23	0.21	0.21	0.25	0.23	0.23	0.23	0.30	0.23	0.25
TOTAL	96.93	97.87	98.58	93.16	96.43	91.09	96.71	98.16	97.50	95.16	89.32	93.78	96.84	98.64	97.65	94.91	93.91	98.01	97.04	98.16

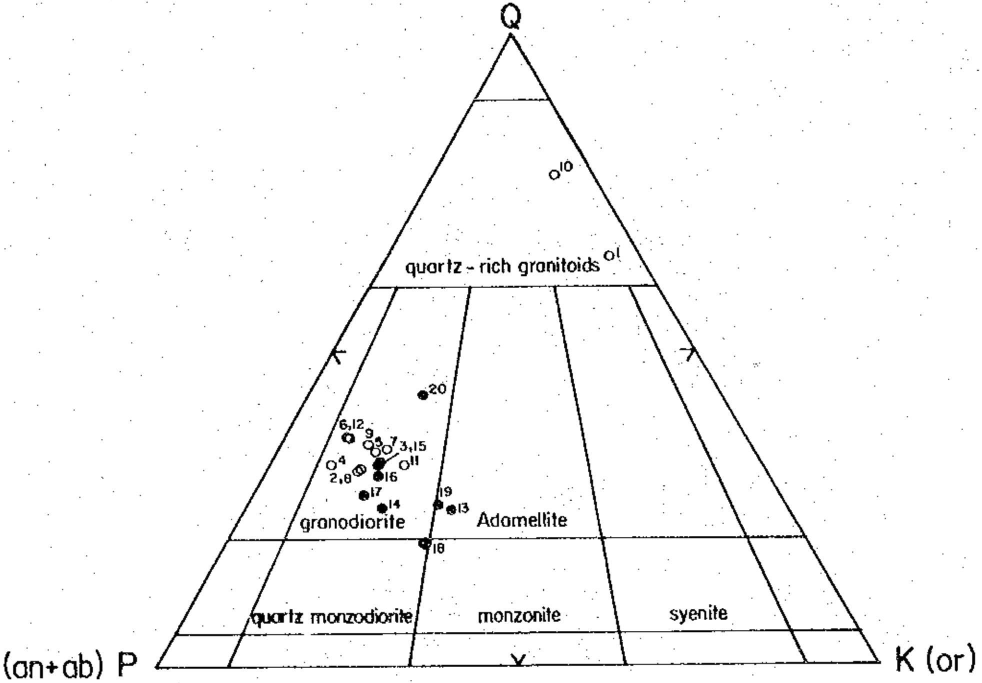

Fig. I -29 QPA Diagram

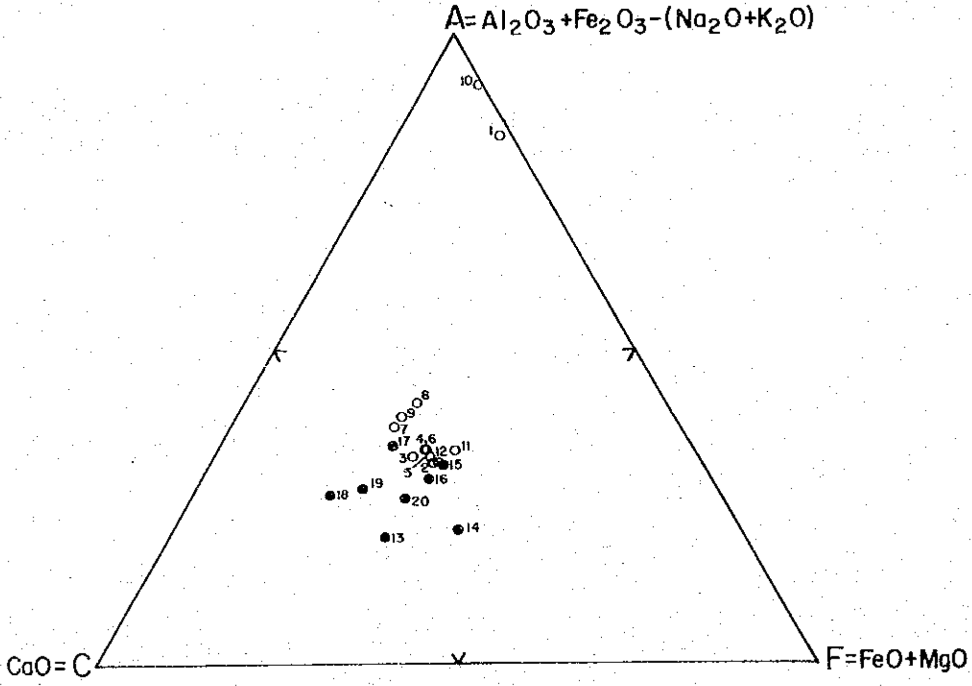

Fig. I -30 ACF Diagram

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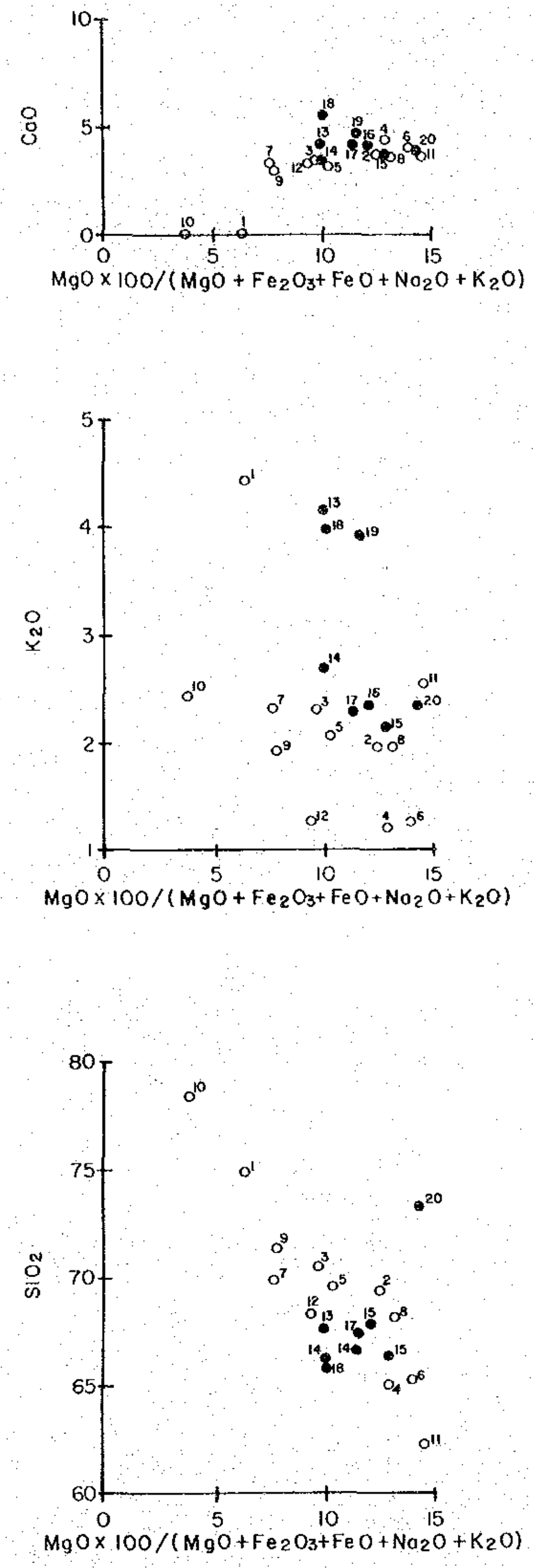

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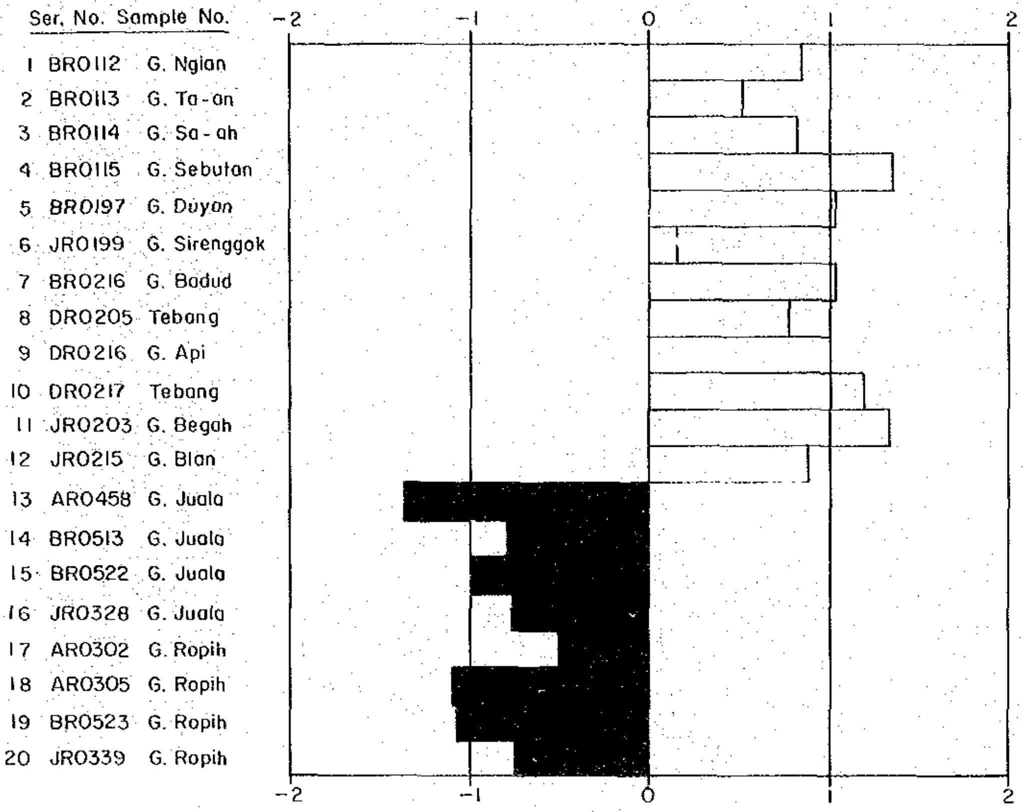
Fig. I-31 Variation Diagrams of CaO, MgO and SiO_2 Versus Solidification Index



Discriminant Function $Z = -0.62966 + 0.01222X_1 + (-24144963)\,X_2 + 0.13873X_3$
$+ 1.66889X_4 + 0.83735X_5 + 67.40468X + 2.47812X_7$
$+ (-1.51230X_8) + 0.50305X_9 + (-0.30297)\,X_{10} + 31.92704X_{11}$

Where $X_1, \dots X_{11}$ are analysed
Values in % of SiO_2, TiO_2, Al_2O_3,
Fe_2O_3, FeO, MnO, MgO, CaO,
Na_2O, K_2O and P_2O_5

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Fig. I-32 Result of Discriminant Analysis discriminant function Z used for the calculation of the discriminant score of each sample is shown in the same figure. Its validity of discriminating between the two groups of stocks should be tested further with more samples before it may be used on unknown samples.

2–2 Geochemical Survey

A geochemical soil survey was carried out over approximately 1.6 km^2 of the Gunung Ropih – Gunung Juala area of approximately 1.6 km^2 as a follow-up to the stream sediment anomaly and favourable geological observations obtained over the area during Phase I work.

2–2–1 Sampling and Analysis

1019 soil samples, each weighing about 300 g were collected in polythene bags from the B horizon using steel gouge augers along previously cut and measured lines. The lines were oriented E-W and spaced 100 m and 50 m apart. The sampling interval along each line was 25 m. At each sampling point relevant data pertaining to the sample and the sample site such as sample depth, sample composition, colour, soil transportation, slope information, parent material, relief, possible source of contamination and type of vegetation were also recorded in a standard field coding form. The samples were dried, crushed, rolled and quartered, and sieved to -80 mesh. About 20 g of each sieved sample was sent to the Bishimetal Exploration Company, Japan, to be analysed for Au, Ag, Cu, Pb, Zn and Mo. Au was analysed by atomic absorption spectrometry and the other elements by the inductively coupled argon plasma emission spectrophotometer. The analytical procedure is as shown in Appendix 1.

2–2–2 Data Treatment

Simple statistical analysis, factor analysis and trend analysis of the analytical data were carried out with the help of a desk top computer, the NEC PC -8800. The simple statistical method of Sinclair (1974) was adopted to separate anomalous population(s) from the background population for each element. Factor analysis was undertaken to extract factors that may be related to different types of mineralization and to obtain factor scores for each sample. Trend analysis was carried out using analytical data from only the Gunung Ropih area for the purpose of identifying significant anomaly targets.

Simple Statistical Analysis

From the cumulative probability plots of the 6 analysed elements, partitioning as described by Sinclair (1974) was used to separate the anomalous from the background populations (Fig.

I–33). The statistical parameters derived are as shown in Table I–7. Au, Ag and Zn show biomodal distributions, Cu and Pb three population distributions and Mo an unimodal distribution. For mixed populations, the lowest value population for each element was considered the background population. The statistical parameters $\bar{x}$, $\bar{x}$ + s, $\bar{x}$ + 2s and $\bar{x}$ + 3s of the background populations read off directly from the plots, were used for contouring the geochemical data over the area. Values equal or greater than $\bar{x}$ + 2s are considered anomalous.

Factor Analysis

The technique of factor analysis basically involves establishing from a larger set of variables, a smaller number of provisional variables called factors each of which represents a relation between various closely associated variables of the larger set. In our case, from the six variables, Cu, Pb, Zn, Mo, Au and Ag, 3 factors, 1, 2, and 3 were computed. Each sample was also quantified in terms of its factor score for factor 1, 2 and 3, each score representing the degree of association the sample has to the factor. As the analytical values have already been standardized before factor analysis was performed, a factor score of zero is approximately equivalent to the mean ($\bar{x}$), a factor score of one to mean plus one standard deviation ($\bar{x}$ + s) and a factor score of two to mean plus two standard deviations ($\bar{x}$ + 2s). This may be shown by treating the factor scores for each factor using the same method of Sinclair described earlier. Using these parameters, factor score distributions for the samples were contoured as shown in Fig. I–34.

Trend Analysis

The treatment described before for the limestone samples of the Jambusan – Tai Parit area was also used on the analytical data for the soil samples from the Gunung Ropih area. Selection of the cell and section sizes for the six elements analysed is shown in Fig. I–35.

2–2–3 Results of Data Treatment

Simple Statistical Analysis

The distributions of the six elements analysed based on the derived statistical parameters are displayed on 1:10,000 scale maps (Figs. I–36, I–37).

Gold (Au). Anomalous values of equal or greater than $\bar{x}$ + 2s (0.10 ppm) which represent about 8% of the data are concentrated as small anomalies around the margins of both of the intrusive stocks of Gunung Juala and Gunung Ropih. The largest concentration with 21 anomalous values, the highest being 0.85 ppm, covers about 60,000 m^2 at the NW end of the Gunung Juala intrusive. Another anomalous area covering about 20,000 m^2 and represented by 5 anomalous values, the highest being 1.64 ppm, is located at its NE end. 3 anomalous values of 0.83 ppm, 0.68 ppm and 0.29 ppm at the SW corner are attributed to contamination from an old ore-

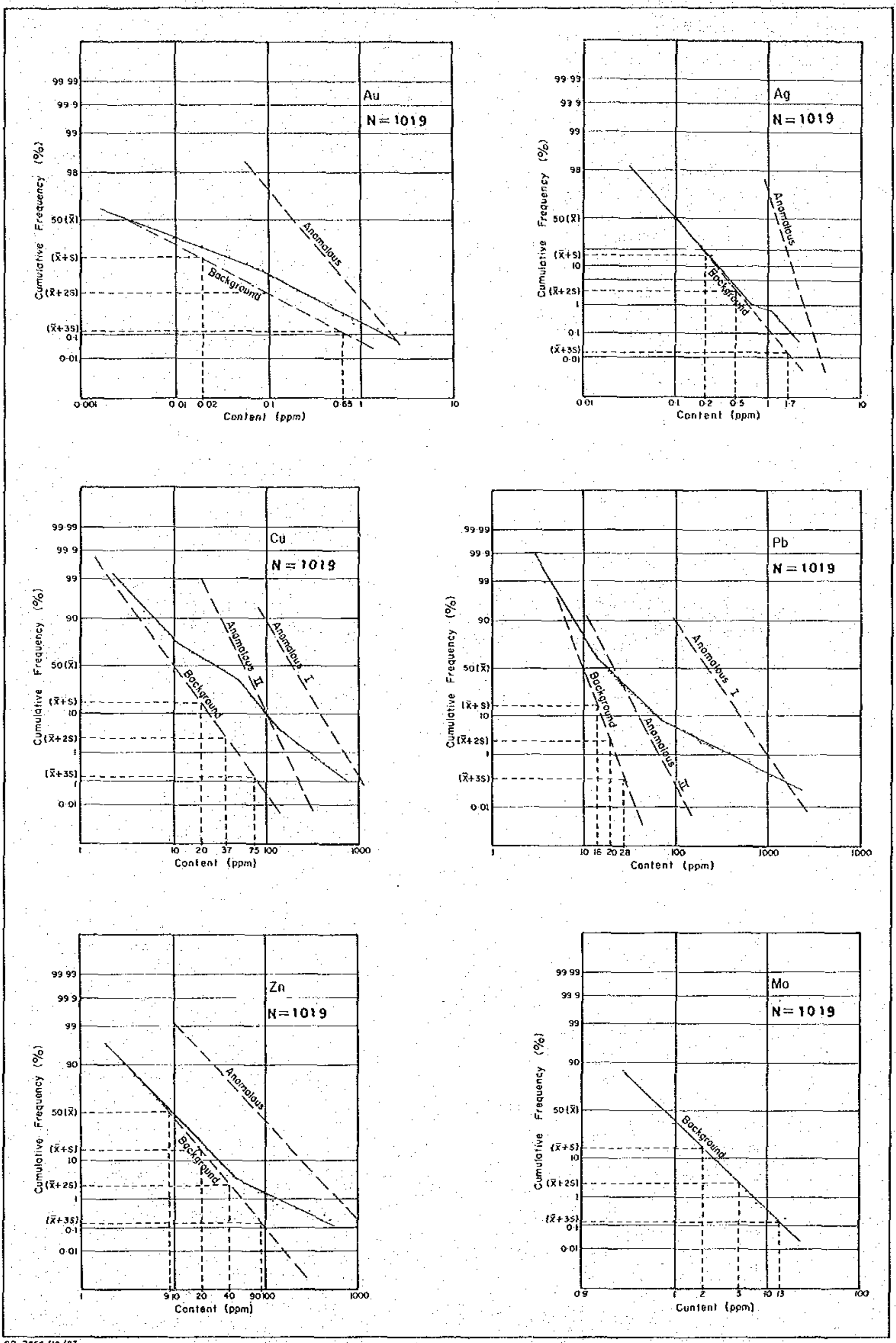

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Fig. I-33 Cumulative Probability Plots, Soil Samples,
Gunung Ropih-Gunung Juala Area

RESULTS OF FACTOR ANALYSIS

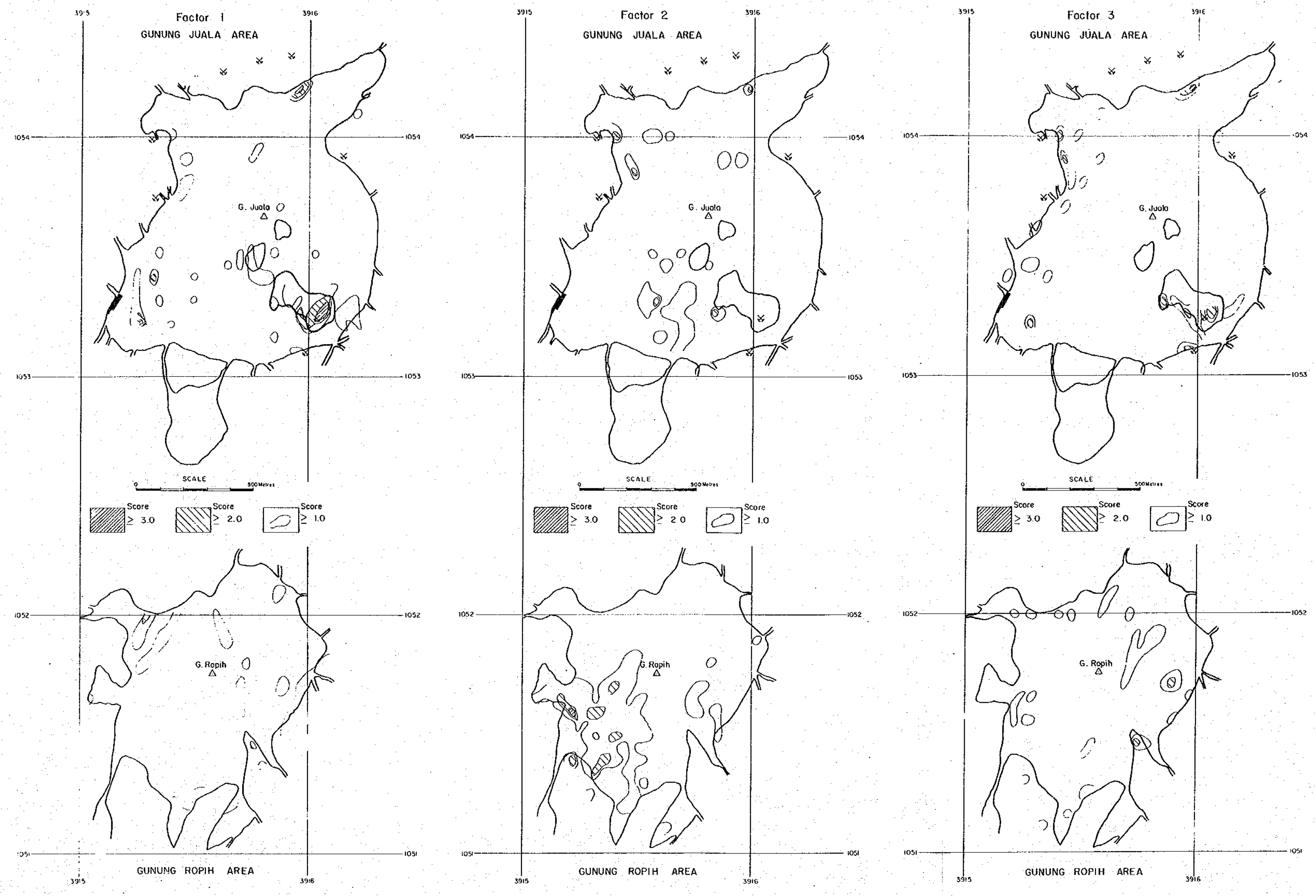

Fig. I-34 Results of Factor Analysis, Gunung Ropih-Gunung Juala Area

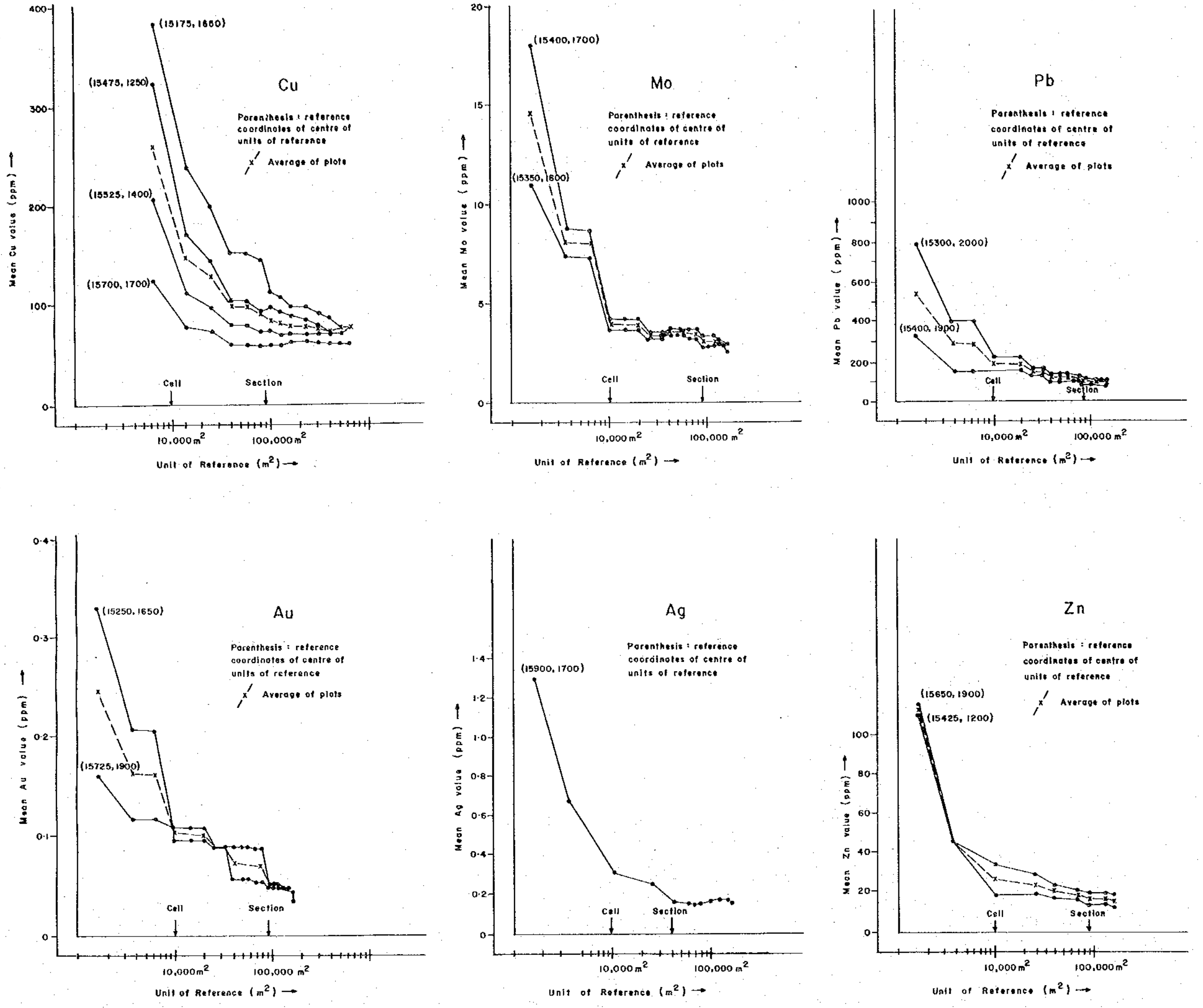

Fig. I-35 Selection of Cell and Section Sizes, Gunung Ropih

RESULTS OF GEOCHEMICAL SOIL SURVEY, Au, Ag AND Cu, GUNUNG ROPIH – GUNUNG JUALA AREA

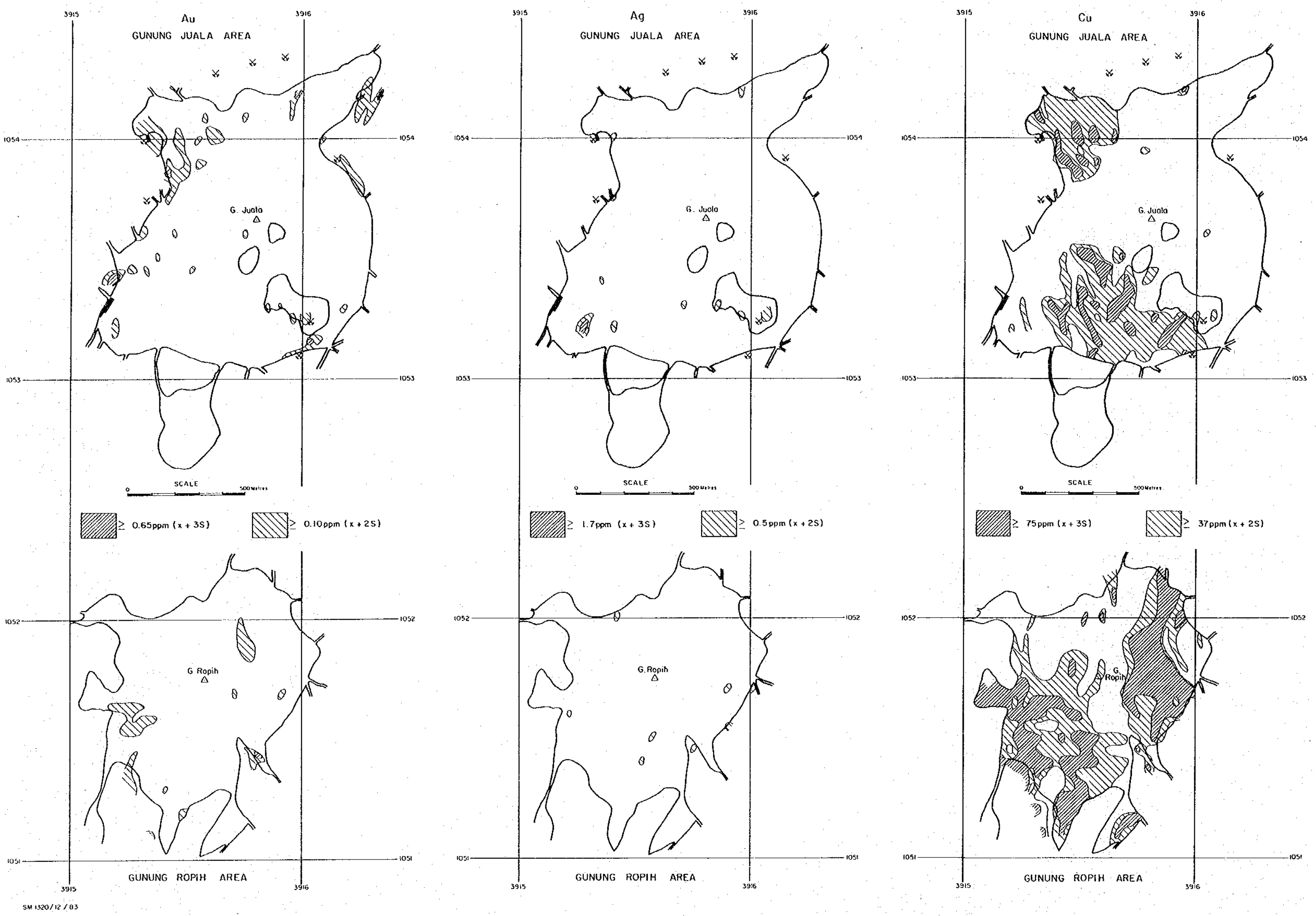

Fig. I-36 Results of Geochemical Soil Survey, Au, Ag and Cu
Gunung Ropih-Gunung Juala Area

RESULTS OF GEOCHEMICAL SOIL SURVEY, Pb, Zn AND Mo, GUNUNG ROPIH - GUNUNG JUALA AREA

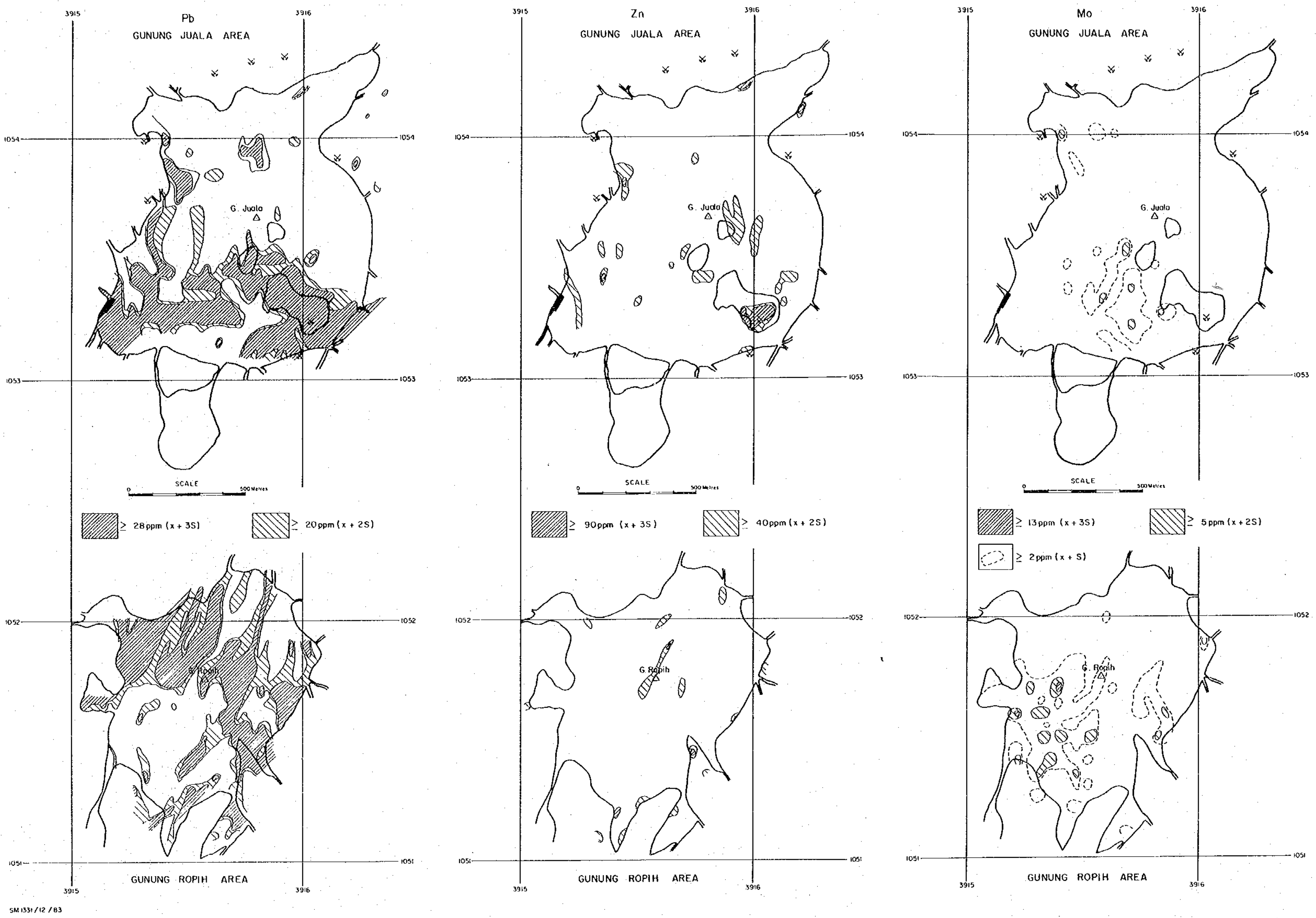

Fig. I-37 Results of Geochemical Soil Survey, Pb, Zn and Mo Gunung Ropih-Gunung Juala Area dressing plant. In the Gunung Ropih area, an anomalous area of about 23,000 m^2 represented by 14 anomalous values, the highest being 0.33 ppm, shows up at the W margin of the intrusive.

Silver (Ag). Anomalous values equal or greater than $\bar{x} + 2s$ (0.5 ppm) account for about 2.5% of the data. They are erratically distributed also along the margins of the intrusives. The maximum value of 3.1 ppm is probably attributable to contamination from an old ore-dressing plant located about 150 m SE of the sample.

Copper (Cu). Anomalous values of equal or greater than $\bar{x} + 2s$ (37 ppm) make up for about 45% of the data. Four large anomalies, two at the NW and S sides of Gunung Juala and the other two at the SW and E side of Gunung Ropih show up. The NW anomaly of Gunung Juala occupies an area of about 100,000 m^2 and is represented by 41 anomalous values including 15 values of greater than $\bar{x} + 3s$ (75 ppm). The highest value obtained is 852 ppm. The S anomaly occupies an area of about 200,000 m^2 and is represented by 130 anomalous values including 39 greater than $\bar{x} + 3s$ and a maximum value of 170 ppm. The SW anomaly of Gunung Ropih covers an area of about 250,000 m^2, almost half the size of the stock and is represented by 176 anomalous values including 84 greater than $\bar{x} + 3s$. The highest value is 768 ppm. The E anomaly is represented by 81 anomalous values including 51 greater than $\bar{x} + 3s$ and occupies an area of about 100,000 m^2.

Lead (Pb). Anomalous values of equal or greater than $\bar{x} + 2s$ (20 ppm) account for about 45% of the data. In the Gunung Juala intrusive an anomaly in the southern part is delineated, with a coverage of about 300,000 m^2 and a EW to NNW trend. In the Gunung Ropih intrusive, the anomaly is very extensive covering an area of about 400,000 m^2 over almost the entire stock except for the SW part. The highly anomalous parts of the anomaly (greater than $\bar{x} + 3s$) have a pronounced NNE trend.

Zinc (Zn). Anomalous values of equal or greater than $\bar{x} + 2s$ (40 ppm) which account for 6% of the data show up as small anomalies scattered mainly over the S part of the Gunung Juala intrusive, and the N and SE parts of the Gunung Ropih intrusive stocks. The largest of these, is located at the SE part of Gunung Juala with 9 anomalous values, including 7 greater than $\bar{x} + 3s$. The highest values of 451 and 551 ppm in the Gunung Juala intrusive is located near an excess road and are attributed to contamination from mining activities.

Molybdenum (Mo). Anomalous values of equal or greater than $\bar{x} + 2s$ (5 ppm) account for 2.5% of the data and they form clusters of small anomalies in the SE part of Gunung Juala and in the SW and E parts of Gunung Ropih. The largest concentration shows up in the SW part of Gunung Ropih and is represented by 19 anomalous values including 2 greater than $x + 3s$. The highest value is 18 ppm.

Factor Analysis

Results of the factor analysis are shown in Tables I–8, I–9 and Fig. I–34.

Factor 1 has high loadings of more than 0.6 for Zn and Pb, and accounts for 39.3% of the data variability. It also has a relatively high loading of 0.255 for Ag. The factor is clearly related to Pb – Zn enrichment or mineralization such as the known Gunung Tongga massive sulphide vein of chiefly galena and sphalerite located south of Gunung Juala.

Factor 2 has high loadings of more than 0.7 for Cu and Mo and accounts for 41.8% of the data variability. The factor is related to Cu – Mo enrichment or mineralization as observed in the southern part of Gunung Ropih where disseminated molybdenite and chalcopyrite occur.

Factor 3 has high loadings of more than 0.45 for Au and Ag, 0.342 for Pb and 0.236 for Cu and accounts for 22.5% of the data variability. This factor may be mainly related to the vein type Au – Sb mineralization known around the margins of the intrusives. Relatively high loadings for Pb and Cu may also be related to such veins which have been observed in cases to carry also minor amounts of boulangerite, bournonite, tetrahedrite and chalcopyrite.

The distributions of the computed factor scores for the three factors for all samples show the following features:

Factor 1 Scores. Scores of equal or greater than +1 show up as small groups of mainly single sample, around the margins of the intrusives. The largest group is in the SE part of Gunung Juala where 9 samples scored equal or greater than +1. The distribution of the higher scores for this factor generally correlates well with the anomalous distributions of Pb and Zn.

Factor 2 Scores. In general, the distribution of factor 2 scores of equal or greater than +1 also correlate well with the anomalous distributions of Cu and Mo. The largest concentration of high scores is in the SW part of the Gunung Ropih intrusive where 12 samples scored equal or greater than +1.

Factor 3 Scores. The distribution of the higher scores of factor 3 is correlatable with the distributions of the anomalous values of Au and Ag. Scores of equal or greater than +1 show up as mainly single sample scores around the margins of the intrusives.

Trend Analysis.

From the anomaly surface maps of the six elements of the Gunung Ropih area, it can be seen that the anomaly highs also show the same elemental associations as inferred from factor analysis (Figs. I–38 ~ I–43).

Cu and Mo. Cu and Mo anomalies coincide approximately with one another, the main ones being in the SW and E of Gunung Ropih. Cu anomalies have wider dispersion. The two very high Cu anomalies in the SW near the margin of the intrusive possibly reflect either supergene,

Table I-7 Statistical Parameters of Metal Content in Soil Samples, Gunung Ropih-Gunung Juala

Element	Population	Proportion (%)	Nos. of Samples used in Statistical Treatment	x (ppm)	$x+s$ (ppm)	$x+2s$ (ppm)	$x+3s$ (ppm)
Au	Anomalous	8	82	0.20	0.43	0.93	2.1
	Background	92	937	–	0.02	0.10	0.65
Ag	Anomalous	0.9	9	1.3	1.7	2.2	3.6
	Background	99.1	1010	0.1	0.2	0.5	1.7
Cu	Anomalous	5	51	200	340	600	1000
	Background I	50	509	57	90	130	220
	Background II	45	459	10	20	37	75
Pb	Anomalous	6	61	220	420	800	1600
	Background I	54	550	22	35	57	93
	Background II	40	408	10	16	20	28
Zn	Anomalous	4	41	83	200	450	1100
	Background	96	978	9	20	40	90
Mo	Anomalous	–	–	–	–	–	–
	Background	100	1019	< 1	2	5	13

Table I-8 Correlation Matrix of 6 Elements

	Au	Ag	Cu	Pb	Zn	Mo
Au	1.000					
Ag	0.219	1.000				
Cu	0.176	0.193	1.000			
Pb	0.221	0.324	0.235	1.000		
Zn	0.051	0.215	-0.029	0.528	1.000	
Mo	0.044	0.056	0.570	-0.074	-0.217	1.000

Table I-9 Factor Loading after Varimax Rotation

		Factor 1	Factor 2	Factor 3	Communality
Element	Au	0.056	0.073	0.459	0.219
	Ag	0.255	0.098	0.466	0.292
	Cu	0.099	0.734	0.236	0.605
	Pb	0.667	0.073	0.342	0.567
	Zn	0.725	-0.141	0.080	0.551
	Mo	-0.167	0.753	0.022	0.595
Factor Contribution		1.076	1.146	0.608	
Data Variation		39.3%	41.8%	22.2%	

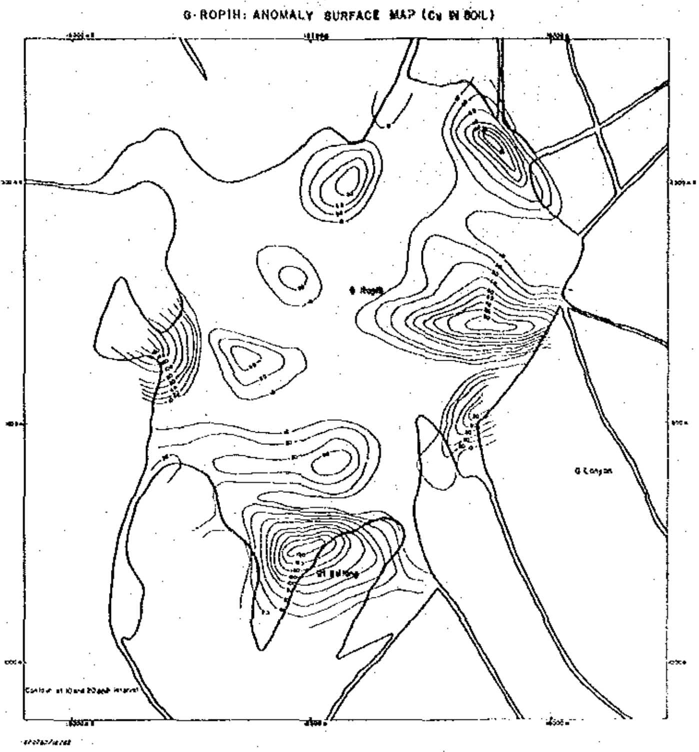

Fig. I-38 Gunung Ropih, Anomaly Surface Map (Cu in Soil)

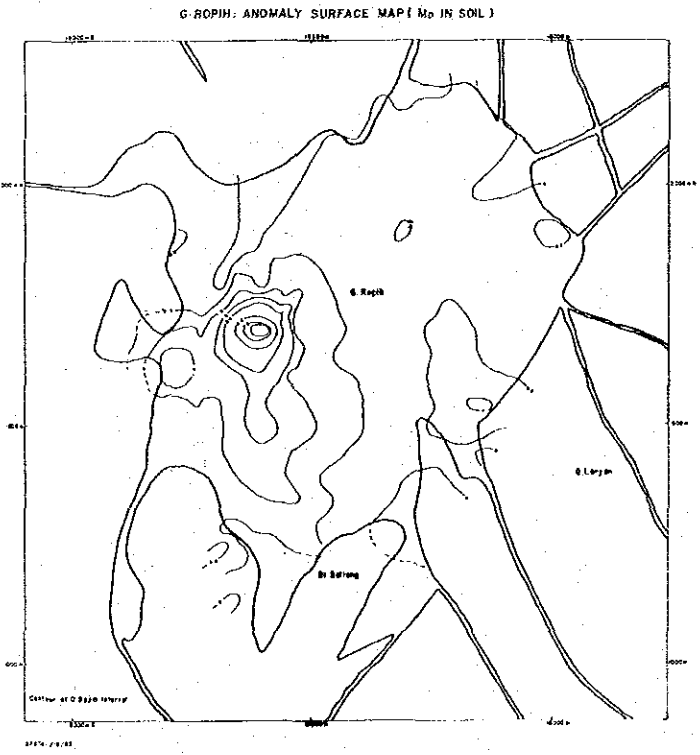

Fig. I-39 Gunung Ropih, Anomaly Surface Map (Mo in Soil)

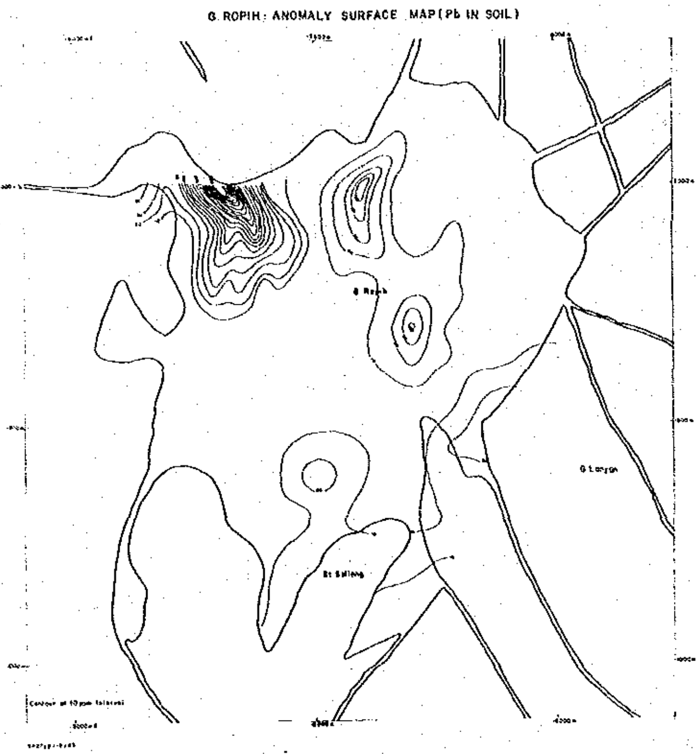

Fig. I -40 Gunung Ropih, Anomaly Surface Map (Pb in Soil)

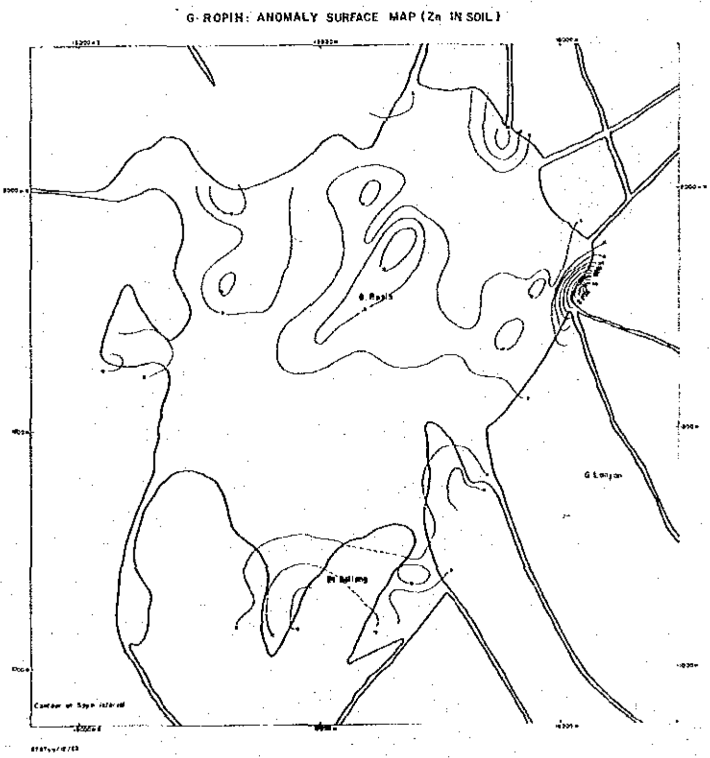

Fig. I -41 Gunung Ropih, Anomaly Surface Map (Zn in Soil)

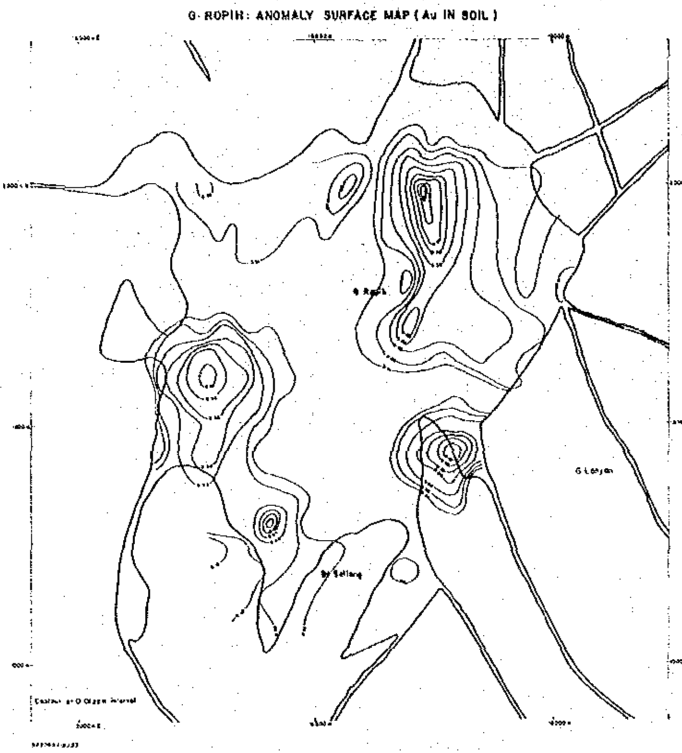

Fig. I -42 Gunung Ropih, Anomaly Surface Map (Au in Soil)

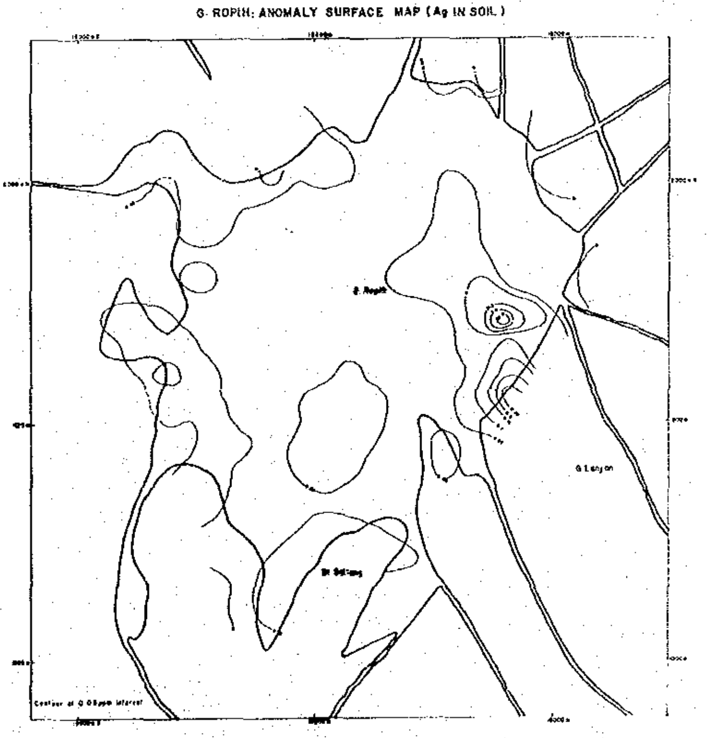

Fig. I -43 Gunung Ropih, Anomaly Surface Map (Ag in Soil) hydromorphically transported Cu enrichment or possibly vein type mineralization. Mo anomalies are smaller and probably more indicative of hypogene mineralization.

Pb and Zn. Anomalies for Pb and Zn are located mostly around the contact of the intrusive with limestone and they are generally well correlated. An anomalous area for these elements to the NE overlaps partly with the Cu anomaly to the east.

Au and Ag. Au and Ag anomalies are also mainly concentrated towards the margin of the intrusive. The anomalous area towards the NE partly overlaps with the Pb and Zn and Cu anomalies. Near the SW contact margin, Au and Ag anomalies partly overlap Cu and Mo anomalies.

2–3 Mineralization

Several old mine workings for gold are known to exist in the Gunung Ropih – Gunung Juala area. They are located in limestone around the margin of the Gunung Juala intrusive. The area had also been heavily prospected in the past for gold by local prospectors chiefly by means of pitting around the peripheries of the intrusives. The locations of the old mine workings and mineral showings located during the present survey are shown in Fig. I–44. Detailed description of the mineralization of the old workings within the Gunung Ropih – Gunung Juala have been described earlier. The mineralization is mainly in the form of small calcite-quartz, massive sulphide and calc-silicate veins which are gold bearing.

Cu – Mo mineral showings associated with network of quartz veinlets in the Gunung Ropih intrusive and floats of massive pyrite in a stream draining the southern part of the intrusive were discovered during the Phase I work. Follow-up geological mapping along grid lines located abundant altered mineralized floats with network of quartz veinlets in the SW slope of Gunung Ropih. Abundant floats of barren quartz veinlets network and altered quartz porphyry with barren quartz veinlets are also widespread in the southern part of the area.

The mineralized floats contain malachite, chalcopyrite, molybdenite and pyrite as disseminations in the quartz veinlets and within the altered intrusive rock itself. Chalcopyrite and pyrite occur as disseminations of about 0.02 mm across in the quartz veinlets and in the quartz porphyry rock which is commonly so highly silicified and sericitized that the original texture has been completely obliterated. Some floats still retain the original porphyritic texture though they have been intensely altered. Molybdenite occurs as disseminations with pyrite and with or without chalcopyrite in quartz veinlets and in mainly quartz porphyry which appears to be less altered. Molybdenite also occurs as aggregate of up to 5 mm across. Malachite was found in floats with quartz veinlets and chalcopyrite disseminations mainly in the lower part of the slope. These have

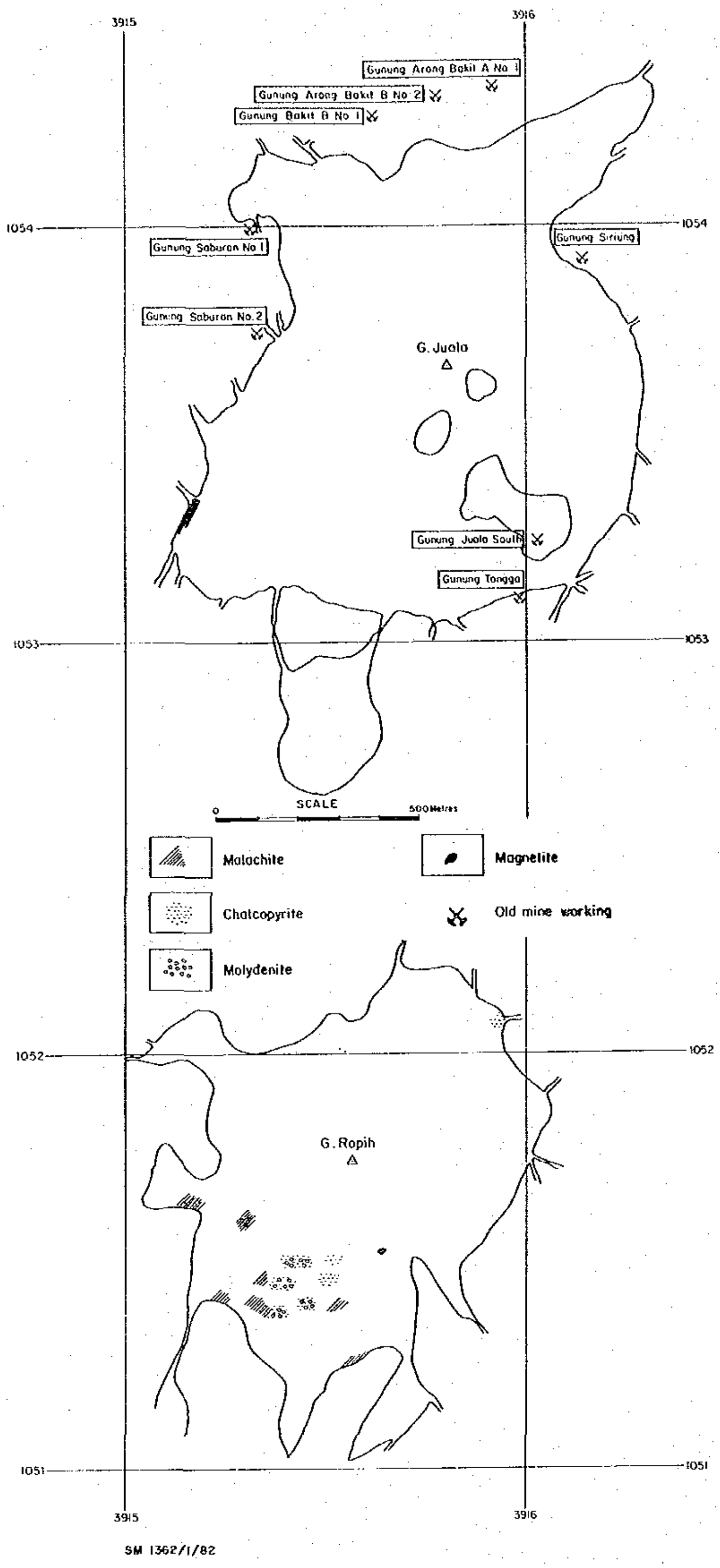

Fig. I-44 Old Mine Workings and Mineral Showings, Gunung Ropih-Gunung Juala Area been so intensely altered and weathered such that the original porphyritic texture is not observable. Chlorite is seen to accompany most of the quartz veinlets. A few magnetite cobbles were also found in the southern part of Gunung Ropih.

Analytical results of some samples of the mineralized floats are shown below:

Sample No.	Au (g/t)	Ag (g/t)	Cu (%)	Mo (%)
AR0301	tr	tr	0.07	0.012
AR0371	tr	tr	0.04	0.004
AR0374	tr	tr	0.08	tr
AR0460	0.10	0.3	0.12	0.004
AR0464	tr	tr	0.09	0.003
AR0465	0.20	0.4	0.15	0.005
AR0470	tr	tr	0.01	tr
JR0339	0.10	0.5	0.23	0.008
JR0340	tr	tr	0.03	0.010
JR0343	0.20	1.3	0.08	0.002
JR0346	tr	tr	0.05	0.009
JR0351	tr	tr	0.14	0.001
Average	0.05	0.2	0.09	0.005

2–4 Discussion

Zonation of Metal Distribution

From the distribution patterns of the elements analysed, factor analysis and trend analysis, three zones of metal enrichments may be approximately delineated in each intrusive. An approximately nearer central zone of Cu-Mo enrichment overlapped marginally by zones of Pb-Zn and Au-Ag enrichments. A simple concentric zonation however, cannot be deduced.

Hydrothermal Alteration

Silicification and sericitization are the most prominent types of alteration in the area. K-alteration is probably weak as secondary biotite is not observed though K-felspar is seen in quartz veinlets. This weak K-alteration and the extensive silicification particularly in the form of network of quartz veinlets with disseminated chalcopyrite and molybdenite in the southern part of Gunung Ropih coincide with the Mo anomalies of the soil samples. Chloritization and sericitization though widespread are difficult to determine because of deep weathering. The presence of skarn minerals in some intrusive samples including actinolite, grossularite and wollastonite indicates contamination by the limestone country rock and little erosion of the original intrusives.

Cu – Mo Mineralization, Gunung Ropih Area

As suggested by the Cu and Mo anomalies, factor analysis, trend analysis, the presence of abundant mineralized floats and alteration, the SW slope of the Gunung Ropih intrusive is the most promising part of the area investigated for disseminated Cu – Mo deposit mineralization of economic grade.

Mineralized floats with network of quartz veinlets and disseminated chalcopyrite and molybdenite are abundantly found on the SW slope of Gunung Ropih. Many from the upper part of the slope are not accompanied by malachite or gossan and these may represent the original hypogene mineralization. The mean grades of 6 samples of these floats analysed are 0.1% Cu and 0.007% Mo. Although the number of samples analysed are insufficient, the results indicate that Cu – Mo mineralization at the surface of this area is generally low compared with the typical porphyry copper mineralization.

Secondary Enrichment, Gunung Ropih Area

According to Ishihara (1974), the following factors are important in determining whether secondary enrichment exists – initial Cu grade, amount of pyrite, country rock type, alteration mineral, structure and reaction time.

A pyrite to copper sulphide ratio of more than 5 is necessary for the development of secondary Cu enrichment. It is estimated from field observations and microscopic examination that the ratio of pyrite to chalcopyrite in the Gunung Ropih area is only about 1.

No suitable structure such as faults or fracture zones which allow for the permeation of acidic waters is so far recognised in the intrusive. Furthermore, the neutralizing limestone environment is not favourable for the formation of acidic waters.

The unfavourable conditions discussed together with a low initial copper grade of the inferred hypogene mineralization, indicate little possibility of any secondary enrichment of some scale to have developed in the area investigated.

Mineralization at Depth, Gunung Ropih Area

As the mineralized area of the Gunung Ropih intrusive has been subjected to only very little erosion, it is possible that the superficially observed Cu – Mo mineralization corresponds to only the crest of a deeper and larger mineralized body; abundant floats of barren quartz veinlets also appear to suggest such a possibility.

It is concluded that the southwestern part of the Gunung Ropih intrusive has the best potential for Cu – Mo mineralization of possible economic grade at depth. The area to the east also merit further exploration.

CHAPTER 3 GUNUNG API – SUNGAI PUTEH AREA

As a follow-up of the anomalous areas of Gunung Api and Sungai Puteh delineated by the Phase I work, a detailed geochemical survey by means of stream sediment and panned sampling was carried out over the Gunung Api – Sungai Puteh area covering an area of about 25 km^2. The routes traversed which normally follow streams were also geologically mapped.

3–1 Geological Survey

3–1–1 Geology

The Gunung Api – Sungai Puteh area is underlain by the Pedawan Formation and Tertiary acidic intrusives (Fig. I–45).

The Pedawan Formation consists predominantly of an alternating sequence of shale, mudstone, siltstone and sandstone with individual beds ranging in thickness mostly from a few cm to a few tens of cm. In the SE part of the surveyed area, an alternating sequence of calcareous mudstone, siltstone and sandstone, and lenses of argillaceous limestone predominates. The calcareous sequence exhibits a smoother weathering surface and can be easily identified with the help of dilute HCl acid. Carbonaceous material sometimes occurs as laminae in the fine grained sandstone or/and siltstone. Generally, the Pedawan Formation in the area is poorly fossiliferous and no direct fossil evidence indicative of its age was found. Based on regional lithological correlation, the Formation in the area is considered to be middle to Late Cretaceous in age.

Analysis of samples from the intrusives in the area shows that they are granodioritic in composition. The Gunung Begah – Gunung Blan intrusive is the southern most stock of the NNE trending series of aligned intrusive stocks in the Bau Area. Non-bedded tuff and tuff-breccia occurring on the northern and southern slopes of the intrusive testify to its partially explosive nature. On the other hand, the Gunung Api and Gunung Badud intrusive fall outside the NNE alignment. They are similar in composition but appear fresher and coarser grained. Silicification and sericitization which are pervasive in the Gunung Begah – Gunung Blan intrusive are not observed. Highly altered dikes of a similar composition are encountered in many places varying from a few m to a few hundreds of m thick. The dominant strike trend of these dikes is ENE which is concordant with the general trend of the Pedawan Formation.

3–1–2 *Metamorphism and Alteration*

The shale, siltstone and sandstone around the Gunung Begah – Gunung Blan intrusive, especially along Sungai Bong Penyup, are weakly metamorphosed. Generally, the Pedawan For-

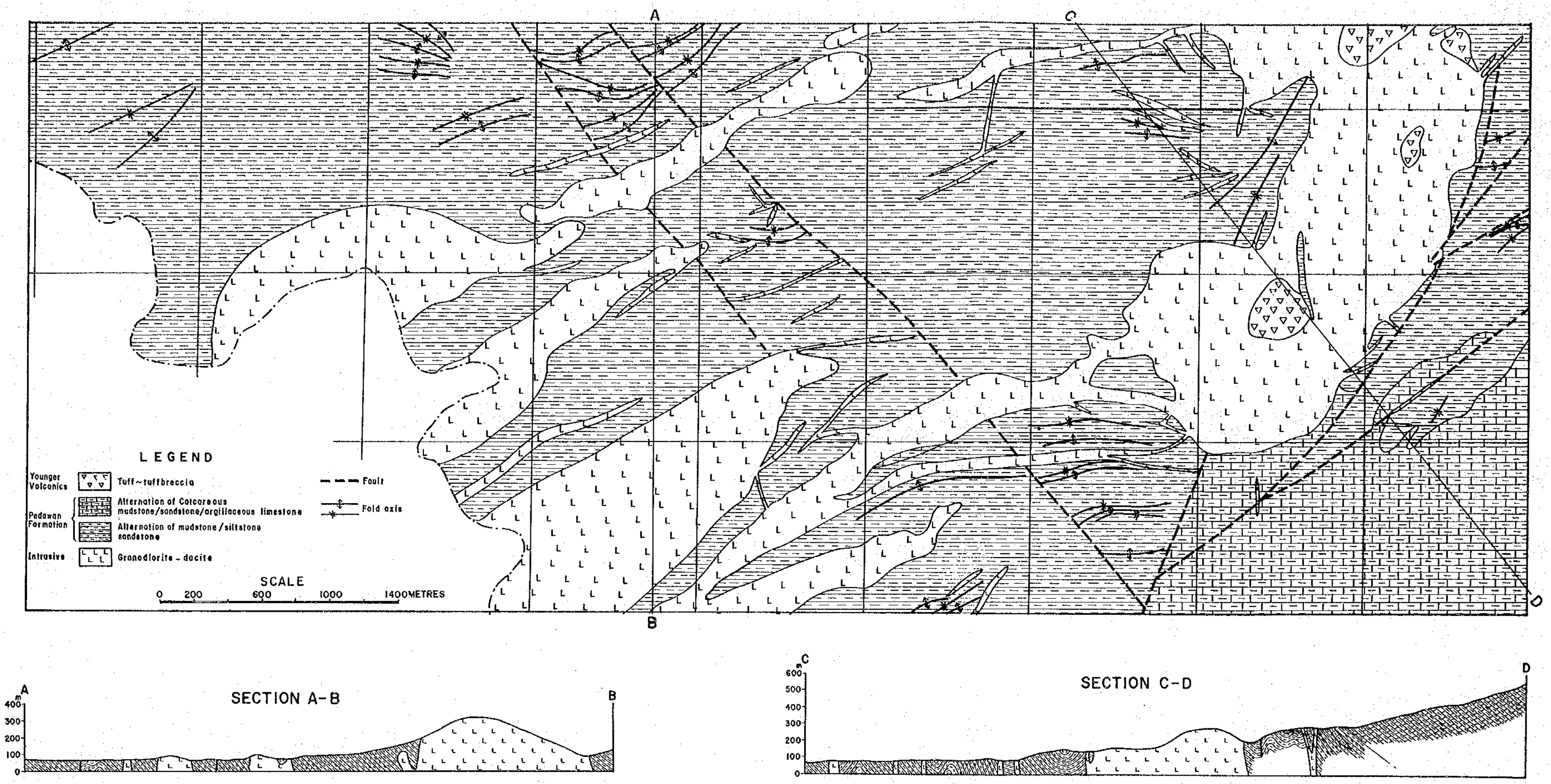

Fig. I-45 Geological Map of Gunung Api-Sungai Puteh Area (1:25,000) mation is not altered but local silicification, epidotization and sericitization are observed near large dikes. The Gunung Begah – Gunung Blan intrusive is highly silicified with common quartz veinlets and mafic minerals altered to epidote and chlorite in places. Sericitization is also widespread. In constrast, the Gunung Api and Gunung Badud intrusives are quite fresh. Most of the dikes are highly sericitized and kaolinized.

3–1–3 Geological Structure

The main structures observed in the area are folds and faults occurring in the Pedawan Formation, and the elongation trends of the acidic intrusive stocks and dikes. Folding of the Pedawan Formation is characterized by common small folds with their axes trending ENE concordant with the regional trend of the formation. In the central part of the surveyed area, 2 NW trending faults are clearly apparent. Radiating faults with NNE to NE trends are observed along the Ulu Sungai Pedau-un. The boundary of the eastern margin of the Gunung Begah – Gunung Blan intrusive body appears to have been controlled by a NNE trending fault. The elongation trends of Gunung Api and Gunung Badud intrusives are concordant with the general strike trend of the Pedawan Formation. Most of the dykes also take after this trend.

3–2 *Geochemical Survey*

A total of 255 stream sediment and 212 panned concentrate samples were collected from the Gunung Api – Sungai Puteh Area (Map I–39).

Stream sediment samples were analysed for 10 elements: Au, Ag, Cu, Pb, Zn, As, Sb, Hg, Mo and W. The results were treated statistically with the help of a desk top computer and plotted on 1:25,000 drainage maps of the surveyed area (Maps I–40 ~ I–49).

Gold grains were separated from the panned concentrate samples and weighed. The corresponding recalculated Au grades were then plotted on a similar map of the area (Map I–50).

3–2–1 Stream Sediment Sampling

Sampling and Analysis

A total of 255 stream samples were collected mainly from first order streams resulting in a sampling density of 10.2 samples per km^2. At each preselected site, about 20 g of -80 mesh, wet sieved, stream sediment sample was taken in a polythene bag. The samples were air dried and analysed by the laboratory of the Geological Survey of Malaysia, Sarawak for Au, Ag, Cu, Pb, Zn, As, Sb, Hg, Mo and W. The analytical procedures are similar to those used during Phase I work and shown in Appendix 1.

Data Treatment

The analytical results were tabulated and statistically treated in a similar manner as was carried out during Phase I. The statistical parameters $\bar{x}$, $\bar{x}$ + s, $\bar{x}$ + 2s, and $\bar{x}$ + 3s for the background populations of all the elements were obtained from cumulative probability plots and tabulated as shown in Table I–10.

Distribution of Elements

Generally no distinct anomalies can be delineated in the area. Anomalous values for most of the elements appear to be mostly singly scattered and the occurrence of a few clusters of anomalous values is apparently related to the altered intrusives. The area had not been heavily prospected in the past such that the main possible source of contamination is shifting agriculture.

Gold (Au). The Distribution of gold in stream sediments is illustrated on Map I–40. About 5% of the values are above the threshold value of $\bar{x}$ + 2s (0.375 ppm). There are 6 highly anomalous samples with values greater than $\bar{x}$ + 3s (0.64 ppm). These values range from 0.8 ppm to 2.4 ppm.

1 anomalous sample occurs in each of the upper tributaries of both Sungai Pelandok and Sungai Nguyu draining the Pedawan Formation. In the upper tributary of Sungai Sinyi which drains altered intrusive bodies, there are 2 highly anomalous samples. 1 highly anomalous sample occurs at the right tributary of Sungai Sebuluh with the source draining both altered intrusive and the Pedawan Formation. Along Ulu Sungai Pedau-un, 1 highly anomalous sample occurs in one of the tributaries draining the northeastern slope of Gunung Begah and 1 anomalous value in Sungai Seripoh draining the Pedawan Formation. From upper Sungai Pedi, there are several anomalous samples and highly anomalous samples; 1 highly anomalous sample occurs in the tributary of Sungai Bayan draining altered intrusive, 1 in the tributary of Sungai Bong draining the Pedawan Formation and small altered intrusive dikes and 3 anomalous samples in the tributaries of Sungai Bong Penyup partly draining altered intrusives and the Pedawan Formation. Towards the source of Sungai Sepan which drains altered intrusive, there is 1 anomalous sample.

Generally, there are 3 areas with anomalous Au values: the Sungai Sebuluh – Sungai Sinyi, Sungai Bayan – Sungai Bong – Sungai Bong Penyup and the Sungai Sepan – Sungai Maling areas.

Silver (Ag). The distribution of silver in stream sediments is illustrated in Map I–41. About 9.4% of the 255 samples analysed are above the threshold value of 4.6 ppm. 4 samples have values greater than 15.5 ppm ($\bar{x}$ + 3s) ranging from 37.7 to 55.9 ppm.

In Ulu Sungai Pedau-un which drain the Pedawan Formation and altered intrusive, 3 samples are anomalous and 1 highly anomalous. 1 sample from the tributary of Sungai Serijer draining the northern slope of Gunung Penam is anomalous. From Sungai Bong which drains the Pedawan

Table I-10 Statistical Parameters of Metal Contents in Stream Sediments, Gunung Api-Sungai Puteh Area

Element	Population	Proportion (%)	Nos. of Samples used in Statistical Treatment	x (ppm)	$x + s$ (ppm)	$x + 2s$ (ppm)	$x + 3s$ (ppm)
Au	Anomalous	4.5	11	0.51	0.8	1.25	2.0
	Background	95.5	240	0.145	0.23	0.375	0.64
Ag	Anomalous	8.0	20	5.6	6.8	8.3	10.0
	Background	92.0	227	0.41	1.35	4.6	15.5
Cu	Anomalous	–	–	–	–	–	–
	Background	100	249	15.0	22.2	28.2	36.2
Pb	Anomalous	–	–	–	–	–	–
	Background	100	252	13.7	18.7	23.7	28.7
Zn	Anomalous	–	–	–	–	–	–
	Background	100	252	56.1	80.5	104.5	128.5
As	Anomalous	3.5	9	64	68	72	76
	Background	96.5	245	8	19.6	48	124
Sb	Anomalous	23.5	59	5.5	7.6	10.6	14.7
	Background	76.5	194	1.95	4.7	11.7	28.2
Hg	Anomalous	–	–	–	–	–	–
	Background	100	252	22.5	70.0	212	664
Mo	Anomalous	6.5	16	5.2	5.9	6.8	7.8
	Background	93.5	237	0.8	2.2	6.0	16.5
W	Anomalous	19.5	49	15	21	30	44
	Background	80.5	204	2.1	7.4	25	87

Formation and altered dykes, 2 samples are anomalous. 2 samples from the upper tributary of Sungai Bong Penyup draining altered intrusive, are highly anomalous and 2 samples from the lower tributaries of Sungai Bayan draining altered intrusive bodies are also highly anomalous samples. 2 anomalous samples occur in the western tributaries of Sungai Awan draining the altered Gunung Badud intrusive and further down stream, 1 in the tributary of Sungai Pedi. 6 samples from Ulu Sungai Sebuluh and its tributaries which drain mainly altered intrusive bodies are anomalous. Further down stream, 1 anomalous sample occurs in the left tributary of Sungai Sebuluh draining altered intrusive and 2 anomalous samples in Sungai Pelandok draining silicified Pedawan Formation. 3 samples north of Kampong Gumbang gave anomalous values.

The anomalous samples can be grouped into 3 areas: the Sungai Sebuluh, Upper Sungai Pedi and Ulu Sungai Pedau-un areas.

Copper (Cu). The distribution of copper in stream sediments is illustrated in Map I–42. About 5.9% of the samples are above the threshold value of 28.2 ppm. There are 6 highly anomalous samples (above 36.2 ppm) with values ranging from 49 ppm to 64 ppm.

Most of the anomalous and highly anomalous samples are located to the east of Sungai Pedi. West of Sungai Pedi, 2 anomalous samples are from the tributaries of Sungai Pedi draining altered intrusive and the Pedawan Formation, 1 highly anomalous sample from the tributary of Sungai Sebuluh draining the eastern slope of the Gunung Jemois intrusive and 1 anomalous sample from the source of Sungai Odong, draining slightly metamorphosed Pedawan Formation north of Kampong Gumbang. East of Sungai Pedi, 6 samples are anomalous and 5 highly anomalous: 2 highly anomalous and 2 anomalous samples are from the upper part of Sungai Puteh draining altered intrusive, a highly anomalous sample from the source of Sungai Keloi draining altered intrusive, 1 highly anomalous sample from the tributary of Sungai Bong Penyup draining altered intrusives, 1 anomalous sample from the tributary of Sungai Bong draining the Pedawan Formation and altered intrusive dyke, and 1 highly anomalous sample and 1 anomalous sample from Sungai Batuh and Sungai Bekuh draining the Pedawan Formation and altered intrusive dykes. In the easternmost part of the area, two tributaries of Ulu Sungai Pedau-un have 1 anomalous sample each, both draining the Pedawan Formation.

In general, only the area just east of Sungai Pedi particularly in upper reaches of Sungai Puteh around Gunung Begah is weakly anomalous for Cu.

Lead (Pb). The distribution of lead in stream sediments is illustrated in Map I–43. About 4.3% of the 255 samples analysed are above the threshold value of 23.7 ppm. 3 samples are greater than $\bar{x} + 3s$ (28.7 ppm), ranging from 29 ppm to 40 ppm.

2 samples from the streams north of Kampong Gumbang draining slightly metamorphosed Pedawan Formation are anomalous. 1 highly anomalous and 1 anomalous samples are from the tributary of Sungai Sebuluh draining the Pedawan Formation and altered intrusive dykes, and 1 anomalous sample from Ulu Sungai Sebuluh draining altered intrusives and the Pedawan Formation. 1 highly anomalous and 2 anomalous samples occur at the source of Sungai Puteh draining altered intrusive. 1 sample from the source of the tributary of Sungai Bong draining the Pedawan Formation is highly anomalous. 1 sample from the tributary of Sungai Bayan draining altered intrusive is anomalous and 1 from Sungai Sundang draining the Pedawan Formation is also anomalous.

Generally, anomalous values are erratically scattered over the surveyed area with only a small cluster in the upper Sungai Puteh area.

Zinc (Zn). The distribution of zinc in stream sediments is illustrated in Map I–44. About 4.3% of the 255 samples analysed are above the threshold value of 104.5 ppm. 3 samples have values higher than $\bar{x} + 3s$, ranging from 145 ppm to 162 ppm.

2 samples from the sourve of the tributary of Sungai Grong draining the northern slope of Gunung Jemois are highly anomalous. Further up stream from the junction of the tributary. 1 sample is anomalous. 1 sample from the upper tributary of Sungai Bong Penyup draining the Pedawan Formation is anomalous. Two tributaries of Ulu Sungai Pedau-un show an anomalous and a highly anomalous sample. In the south western part of the surveyed area, only 3 samples are anomalous, 2 from the tributaries of Ulu Sungai Sebuluh and 1 from the source of Sungai Odong tributary.

Arsenic (As). The distribution of arsenic in stream sediments is illustrated in Map I–45. About 3.5% of the 255 samples analysed are above the threshold value of 48 ppm. None of the samples is highly anomalous.

2 samples from the left tributary and 1 from the right tributary of Ulu Sungai Pedau-un draining the Pedawan Formation and the eastern slope of the altered Gunung Begah intrusive are anomalous. Sungai Sepan draining the western slope of the Gunung Penam intrusive has 3 anomalous values. 1 sample each from the tributary of Ulu Sungai Sebuluh and the tributary of Sungai Bong Penyup both draining altered intrusives are anomalous.

Antimony (Sb). The distribution of antimony in stream sediments is illustrated in Map I–46. Only 2 of the 255 samples analysed are above the threshold value of 11.7 ppm. 1 sample is highly anomalous with a value of 31.8 ppm.

The highly anomalous sample occurs in a tributary of Sungai Awan draining the eastern slope of the Gunung Badud intrusive and an anomalous sample in the tributary of Sungai Grong draining the Pedawan Formation.

Mercury (Hg). The distribution of mercury in stream sediments is illustrated in Map I–47. Only about 3.5% of the 255 samples analysed are above the threshold value of 212 ppb. 1 sample is highly anomalous with a value of 667 ppb.

From Sungai Sebuluh draining altered intrusives and the Pedawan Formation 5 samples are anomalous. 3 anomalous samples and 1 highly anomalous samples are from the tributaries of Ulu Sungai Pedau-un.

Two areas may be delineated as areas with anomalous values of Hg; the Sungai Sebuluh and Sungai Seripoh – Sungai Jugan areas.

Molybdenum (Mo). The distribution of molybdenum in stream sediments is illustrated in Map I–48. 5 of the 255 samples analysed are above the threshold value of 6 ppm. None of the samples shows highly anomalous values.

1 anomalous sample was collected from the stream just south of Kampung Gumbang draining the northern slope of the Gunung Api intrusive. The tributary of Sungai Grong and the tributary of Sungai Pedi both draining the Pedawan Formation have 1 anomalous sample each. From the upper part of Sungai Puteh draining the western slope of Gunung Begah, 2 samples are anomalous.

In the area surveyed only the upper part of Sungai Puteh may be considered to be mildly anomalous for molybdenum.

Tungsten (W). The distribution of tungsten in stream sediments is illustrated in Map I–49. 5 of the 255 samples analysed are above the threshold value of 25 ppm. None of the sample shows highly anomalous values.

1 sample from Sungai Odong draining slightly metamorphosed Pedawan Formation is anomalous. From Sungai Sinyi draining altered intrusives and the Pedawan Formation, 2 samples are anomalous. 1 anomalous sample was collected from the tributary of Sungai Sebuluh draining the western slope of the altered Gunung Jemois intrusive. 1 anomalous sample is from the source of Sungai Bong Penyup draining the Pedawan Formation.

3–2–2 Panned Concentrate Sampling

Sampling of heavy minerals in stream sediments were undertaken by hand panning, mainly for the purpose of prospecting for gold. Gold was physically detected in more panned concentrate samples than chemically in stream sediment samples. This is possibly because of the particulate nature of dispersion of gold and the small amount of sample used in analysis. In cases where gold is chemically detected but not physically as gold grains in the panned concentrate samples, gold probably exists as very fine particle which were washed away during panning or is intergrown in other minerals.

The gold grains were separated from the panned concentrate samples and weighed. From these results the gold grades in g/t of sediments were calculated.

Sampling and Laboratory Procedures

At most stream sediment sample sites, panned concentrate samples were also collected by hand panning with the wooden dulang from known volumes of sediments. A total of 212 panned concentrate samples were collected over the surveyed area giving a sampling density of 8.48 samples per km^2. The actual field procedure is the same as that used during the Phase I work.

In the laboratory, samples containing gold were further panned and the gold manually separated under the binocular microscope after drying. The gold grains were then weighed. Samples were also bromoformed and the heavy fractions subjected to a rapid examination under the binocular microscope.

Data Treatment

Knowing the original volumes of stream sediments panned and using an estimated s.g. of 1.46 for the stream sediments, the gold grade for each gold-containing sample was calculated in g/t of stream sediments. The results were then plotted on a 1:25,000 drainage map of the surveyed area using symbols to denote 5 classes of gold grade: no gold detected, $> 0 - < 0.1$ g/t, $\geqslant 0.1 - < 0.1 - < 0.5$ g/t, $\geqslant 0.5 - < 1.0$ g/t and $\geqslant 1.0$ g/t.

Distribution of Gold Grains

The distribution of gold grains in panned concentrate samples is shown in Map I–50. Out of the 212 panned concentrate samples collected, gold was detected in 32 (15.09%) samples. From the tributaries of Sungai Pedi, 12 samples contain gold grains: 1 sample from a stream just north of Kampung Tringos Baharu contains 0.292 g/t, 1 from Sungai Matung 1.890 g/t and others have values ranging from 0.014 g/t to 0.068 g/t. 1 sample from a stream just southwest of Pangkalan Tebang contain 0.376 g/t. 18 samples from Sungai Sebuluh and its tributaries contain gold grains; 2 samples from Sungai Pad draining slightly silicified Pedawan Formation contain 0.130 g/t and 0.268 g/t, 1 from the tributary of Sungai Sinyi 0.411 g/t, 1 sample from Sungai Sinyi contain 0.663 g/t and others have values between 0 g/t and 1 g/t.

Generally two areas are considered to be significant for gold: the Sungai Pad – Sungai Sinyi and Sungai Matung areas.