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RECORDS.

1962/39

THE PUMKUNA COPPER--GOLD PROSPECT BOUGAINVILLE ISLAND, TERRITORY OF PAPUA AND NEW GUINEA.

by

J.E. Thompson.

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SUMMARY

The Pumkuna lode in mountainous central Bougainville was mined for gold on a small scale throughout the 1930's. The prospect was abandoned in 1941 at the onset of the Japanese invasion and has not been worked since.

The lode is a quartz vein, ranging from a few inches to two feet in width, in microgranodiorite which is overlain by volcanic agglomerate containing both basaltic and andesitic components. Chalcopyrite and bornite in the lode have weathered to produce green staining of soluble copper salts in the old underground workings. Chalcopyrite, bornite, chalcocite, covellite, magnetite and molybdenite were observed in small stringers in the surrounding country rock.

The lode crops out on the steep valley slope north of Pung'gana Creek. It can be traced at the surface for about 150 feet and has been mined at shallow depth by a drive about 100 feet long. The total length of the lode at the surface and in the drive is about the same as the outcrop length mapped in 1936, indicating that much of the lode was mined from the surface.

The lode strikes north-west and dips to the north-east at 30° to 60°. In all faces of the underground workings the lode is only a few inches wide and faulted. At the time of abandonment ore reserves were apparently low. It is estimated that only about 600 tons of ore remain between the drive and the surface. The grade of the ore is not known with any certainty but individual assays from samples taken before 1936 suggest an average grade between 15 dwts and 1 oz. gold per ton.

The Pumkuna lode is not an attractive gold prospect under present conditions.

The extent of copper mineralization in the vicinity of the Pumkuna lode is unknown. However, chalcopyrite-bearing stringers and boulders are common. Copper mineralization is also associated with gold lodes at Kupei and Moroni nearby in a similar geological environment. Reconnaissance geochemical prospecting for copper using trace molybdenum in stream sediments as an indicator might indicate areas of copper concentration worthy of closer attention as copper and possibly gold prospects.

INTRODUCTION

Early in 1960, attention was drawn to the Pumkuna lode in central Bougainville by part-time prospector, Michael Morgan, engineer of Kieta and Rabaul, who forwarded specimens of rich copper-gold ore to the Division of Mines in Port Moresby. In correspondence Mr. Morgan stated that the specimens had not been taken from previously known mine workings.

HISTORY

Gold and copper mineralization has been known on Bougainville at least since 1930, when the Kieta Goldfield was proclaimed. During the early 1930's three principal areas were prospected, namely, Kupei at 3600 feet above sea level on the steep north-eastern fall of the Crown Prince Range overlooking Arawa Bay; Pumkuna at 2300 feet above sea level about three miles south of Kupei and on the south-western fall of the Range; and Moroni, also on the south-western fall, near the head of the Kavarong River.

In 1936, the Kieta Goldfield was examined by N.H. Fisher, then geologist for the New Guinea Administration. His unpublished report (Fisher, 1936), which is the only available account of pre-war mining on Bougainville, is the source of information on pre-war mining at Kupei, Pumkuna and Moroni used throughout this report.

Total recorded gold production from Bougainville has been 2282 fine ounces. Annual production is shown in the accompanying table.

GOLD PRODUCTION - BOUGAINVILLE ISLAND

Year	Gold Fine oz.	Value £
1935	45	
1936	113	
1937	598	
1938	487	
1939	297	19,497
1940	217	
1941	32	
1942 - 1948	no production	
1949	166	
1950	126	1,880
1951	95	1,469
1952	78	1,214
1953	6	94
1954	15	240
1955	5	80
1956 - 1958	no production	-
1959	2	36
Total	2,282 oz.	£24,510

Peak production was attained during the years 1937 and 1938, that is, subsequent to Fisher's examination of the field. The relative contributions of Kupei, Pumkuna and Moroni to production after 1936 are not known, but Kupei was the principal producer.

The Kupei lode is a lenticular concentration of fractured quartz veins containing interstitial chalcopyrite, bornite and gold within a feldspar-hornblende porphyry which is overlain by a volcanic agglomerate with porphyry components. The lode is elliptical in plan, has an outcrop length of 230 feet and a maximum width of 106 feet. At the time of Fisher's inspection the lode had been intersected on three adit levels but on the lowest level, about 220 feet below outcrop, it was represented by a narrow zone of slightly mineralized porphyry containing only few small gold-bearing quartz stringers. Fisher estimated that about 7,400 tons of easily mined gold ore were available. A reliable estimate of the grade of this ore could not be made, but production figures indicate an average grade between 8 and 10 dwts per ton. The Bougainville production from 1936 to 1941 suggests that about a third of the ore reserve estimated by Fisher had been consumed by 1941. There is no record of production from the Kupei mine after the war.

At Pumkuna, Fisher mapped the outcrop of a well-defined quartz-gold lode containing chalcopyrite and bornite over 231 feet. The average width of the lode was between 20 and 24 inches and its estimated average grade was 15 dwts to 1 oz gold per ton. In 1936, underground development at Pumkuna was restricted to a short drive at creek level at the south-eastern end of the outcrop. Recent mapping by the writer indicated that much of the original lode outcrop as mapped by Fisher has since been removed and that the lode was subsequently intersected at shallow depth by a 50 foot adit and followed for about 100 feet by a drive from this adit. This work was done before the evacuation in 1941.

At Moroni, eluvial gold occurs over a large area near the crest of the Crown Prince Range on its south-western fall, near the contact of porphyry with overlying agglomerate, but up to 1936 no definite lode had been located.

The flats of the lower reaches of the Kavarong River were tested by drilling as possible gold dredging areas in 1937 and again about 1953, apparently with poor results.

For a few years after the war, a syndicate comprising R. Watson, now of Lae, R. Doyle of Lahang Plantation near Sohano and others, won a small quantity of alluvial gold from near Atamo on the north-eastern fall of the Crown Prince Range and Karato on the opposite fall (see Plate 1A). Mr. Doyle could not recall seeing copper minerals in these areas.

Small parcels of alluvial gold were won from several localities in the Crown Prince Range by Messrs. Hetherington and Gleeson, prospectors, between 1949 and 1954, but as far as is known they made no important new finds.

Mr. M. Morgan, Mr. E. Tull and other residents of Kieta have, during the past few years, made short prospecting trips to the known gold-bearing areas, but they have won very little gold.

There is no record of any serious testing of the copper mineralization which commonly is associated with the gold in this region.

THE PUMKUNA LODE

Access and Climate

The Pumkuna lode crops out on the steep northern flank of the valley of Pung'gana Creek, an eastern headwater tributary of the Kavarong River which joins the south-westerly flowing Jaba River. The prospect, about 2300 to 2500 feet above sea level, is deeply enclosed within mountains up to 4500 feet above sea level. Rainfall is high; probably of the order of 150 to 200 inches per year and morning mists are common. Clouds usually accumulate around the mountain peaks, but, even on cloud-free days, sunshine penetrates to the valley floor only between 10 a.m. and 3 p.m. Nights in the prospect area are cold and day temperatures are mild.

That small part of the steep hill slope which has been disturbed by former mining operations is now thickly covered with low, dense, secondary bracken. The rest of the area is covered by thick, perpetually wet, rain-forest.

The prospect adjoins a walking track between Moroni and Guava villages which is kept clear by local villagers for the use of patrolling Administration officers.

Access from the coast to the Pumkuna prospect is extremely difficult and the only means of transporting supplies and equipment to the area is by porterage. The pre-war feats of transporting heavy equipment and regular supplies from the north-eastern coast by the use of native carriers could not be repeated nowadays because of the changed attitude of natives towards this type of work. Even on a short visit to the area, arrangements for native carriers should be made well in advance and the services of the mountain people from the Guava area should be sought in preference to villagers from Moroni; the coastal inhabitants understandably object to carrying supplies in the rugged mountains.

On this inspection, access to Pumkuna was achieved by chartered launch from Kieta to Rorawana, thence by a good track and using Rorawana carriers, to Korpei where the night was spent in the Government rest house. On the following morning, using carriers from Korpei and the nearby village of Pakia, the Crown Prince Range was crossed after a steep climb up to a saddle about 3500 feet above sea level. At Moroni on the south-western fall, carriers were changed. The Pumkuna prospect was reached late in the afternoon after a half hour walk from Moroni.

It is possible to make this journey in one day, but the overnight stop is strongly recommended so that the steep climb up to the divide on the Crown Prince Range can be tackled after a good rest and during the cool of the morning.

There is a more direct route from Pumkuna to Kieta by way of Guava village and the Kupei mine which is regularly traversed by natives in one day, but which, from all accounts, is very difficult going.

The transport of heavy mining equipment over the routes described above would be impractical and only the incentive of very large returns could justify large scale development of a prospect in this area. Should the Kupei-Pumkuna-Moroni area be considered as a large scale porphyry copper prospect with by-product gold and other minerals only then could serious appraisal of the access problem be justified. In this case the use of aerial rope-ways from mineralized areas in the mountains inland from Arawa Bay to the coastal flats would seem the most feasible method of transport, though the source of power for operating such a system is not readily apparent. Approach from the north-eastern coast would be preferable to an approach from the south-western coast, not only because of the shorter direct distance but because of the advantage of natural harbours on the north-eastern coast at Arawa and at Kieta.

In the improbable event of the Pumkuna lode being developed as a gold producer without support from Kupei then road access from many possible airstrip sites on the lower Kavarong River might be considered. Such airstrip sites could be linked to vehicle tracks maintained by the Administration and the Roman Catholic Mission which lead to a beach landing point near the mouth of the Jaba River and to Buin.

Geological Environment.

The present investigation can add little to the observations of Fisher (1936) as most of the prospect area has been covered by thick secondary growth since pre-war abandonment and much of the steep hillslope made unstable by surface mining operations has since been further disturbed by successive small landslips.

The host rock of the quartzose lode is a medium-grained leucocratic intrusive rock (?microgranodiorite) which is darker in colour away ffom the main lode. The darker phase of the intrusive rock about 800 feet upstream from the Pumkuna lode is notably less quartzose than the main lode and contains more chalcopyrite, bornite, covellite, magnetite and molybdenite. This mineralization occurs in at least three widely separated fracture fillings up to 9" wide with no wall-rock alteration. Although gold assays up to 2 ozs per ton have been obtained on specimens from these veins they are individually too small for profitable mining. It was from one such vein that Mr. Morgan's specimen containing a high copper and gold content was obtained.

Volcanic agglomerate and breccia with components similar to the host rock of the Pumkuna lode and some vesicular basaltic components bonded with a fine fragmental matrix were seen as boulders in Pung'gana Creek and as talus accumulations near the mineralized area.

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The relationship of the agglomerate to the intrusive rock could not be determined from outcrop but similarity of components of the agglomerate to the intrusive rock which contains the Pumkuna lode suggests that the agglomerate is the younger. A similar relationship for "porphyry" and agglomerate was observed by Fisher in the Kupei area and adopted by him for the Pumkuna area. However, exposures at Pumkuna are so poor and topographic relief so abrupt that detailed surface mapping and probably drilling would be necessary to determine the true relationship.

At Moroni, Fisher noted a gradational contact between "porphyry" and agglomerate through a transitional "porphyry" boulder zone. This contact was silicified, pyritized and contained bornite, sphalerite and gold, with gold more particularly on the agglomerate side.

Thus it appears that mineralization is younger than the deposition of the volcanic agglomerate.

The fineness of gold in the region ranges from 830 at Kupei to 946 at Pumkuna. This is anomalously high fineness for gold associated Tertiary volcanic rocks or high-level intrusives in the Territory of Papua and New Guinea (Fisher, 1945) but there seems little doubt that the intrusive rock, the agglomerate and the mineralization are co-magmatic members of a complex volcanic pile now deeply eroded to form the crest of the Crown Prince Range in the mineralized area. The age of this volcanic pile is unknown but the low-angled easterly regional dip of agglomerates near Kieta indicates little tectonic deformation which suggests no great antiquity. An Upper Tertiary age is therefore proposed tentatively.

Steeply dipping, grey, bedded marl was seen at a creek crossing on the north-eastern fall of the Crown Prince Range between Pakia and Moroni villages. These marls appeared unfossiliferous but their steep dip suggests that they are older than the volcanic agglomerate on the crest of the range. A limestone boulder with diagnostic Lower Miocene "e" stage large foraminifera was collected by A.K.M. Edwards in 1951 from the Wakunai River on the route from Numa Numa to Mount Balbi and described by Crespin (1951). It is possible that the steeply dipping marl mentioned above may also be of Lower Miocene age.

Active and recently active vulcanism on Bougainville is expressed by the volcanic cones of Mount Balbi (9000 feet) which dominates the northern half of the island, Mount Bagana (6560 feet) an active vent on the south-western flank of the Crown Prince Range near the centre of the island, and the complex of eroded cones including Mount Takuam (7385 feet) and Mount Taroka (7240 feet) which dominate the southern half of the island. The pyroclastic products from this vulcanism are only loosely compacted and cannot be mistaken for the older, well lithified pyroclastics in the mineralized areas.

In brief, the Crown Prince Range is composed of Lower Miocene marine sediments including limestone and bedded marl which have been folded, and, after a period of erosion, subjected to severe andesitic and basaltic vulcanism with the accumulation of large pyroclastic piles which were later intruded by numerous volcanic plugs and near-surface intrusives ranging in composition from granodiorite to quartz diorite.

In the Kupei-Pumkana-Moroni area the margins of these plugs and intrusives have been favourable sites for quartz, copper, iron and gold mineralization introduced at a late stage in the volcanic cycle. Subsequent uplift and erosion has exhumed the Miocene marine sediments, exposed volcanic necks and intrusives and has isolated remnant agglomerate outlier cappings to form the rugged Crown Prince Range to which large Recent volcanic mountains have been accreted.

(The occurrence of ultramafic pebbles in streams draining the southern end of the Crown Prince Range (Thompson, 1961) suggests that deeply penetrating faulting may have preceded the earlier vulcanism but, as this area has not been closely examined, further deduction is not possible.)

Lode Dimensions and Disposition (Plate 1c)

The outcrop of the lode mapped by Fisher (1936) was described thus :-

..."a fissure vein fairly consistent in thickness and composition over an exposed length of 231 feet. Width varies up to 44 inches and averages between 20 and 24 inches. Dip is from 40° to 65° to the north-east and the direction of the lode on the surface is 57° west of north".

This description does not quite fit the present-day outcrop which must have been modified by mining after Fisher's visit. The lode outcrop could be traced discontinuously for about 140 feet and the width of massive quartz ranged up to 18 inches. The strike and dip of the lode conform with that recorded by Fisher. Thus it appears that the thickest parts of the lode outcrop were removed.

At the time of Fisher's inspection, the short drive from creek level at the south-eastern end of the lode outcrop was the only attempt to follow the main lode underground. Later an adit was driven beneath the lode outcrop apparently on the 1 foot wide near-vertical quartz vein mentioned by Fisher at the western end of the lode and striking across it. This vein terminated against post-mineralization faults within a short distance of the portal. The adit was driven about 60 feet where it encountered a lode with strike and direction of dip comparable with that of the exposed lode but its correlation with the outcrop requires an unnatural projection of the surface dip which may be explained by downhill movement of the surface with adjustments along fault planes observed in the adit.

The main lode was followed to the north-west for 70 feet where it terminated against a cross fault and to the south-east where there is minor displacement by post-ore faulting. At both faces in the drive the quartz lode was only about six inches wide and apparently not sufficiently rich to warrant underground search for the displaced portions. Along strike the lode width is irregular, with bulges up to 2 feet 6 inches wide but averaging about 1 foot. The extent to which gold mineralization extended beyond the limits of the quartz lode into surrounding wall rock has not been checked by assay but except for a few small stringers the wall rock looks barren although it is stained pale green in places by the impregnation by soluble copper salts.

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The short drives at the south-eastern end of the lode also indicate irregular width and faulting complications which discouraged further work.

The picture construed from the mapping is one of a small marginal mine which, while on average width and grade ore, may have yielded small profits but which could not tide over lean periods when width and/or grade dropped below average nor could it support underground probing for displaced lode segments. Thus it appears that the mine was abandoned primarily because of the lack of ore reserves and not because of the war threat.

The underground workings are not timbered but there have been no serious collapses and the workings are completely accessible, though very wet from surface drainage moving along the fractured quartz lode system. This water has leached the copper sulphides in the lode and pale green and pale blue copper salts encrust the walls and roof in some sections of the cross-cut and drive. Green algal slime which is also prevalent may be mistaken for copper staining. In places the slightly weathered microgranodiorite wall rock is very pale green from the impregnation of copper salts which selectively stain the slightly weathered feldspars.

The mine is inhabited by a colony of bats which may cause some alarm on first entry but which soon disperse.

Lode Mineralization and Tenor.

The main lode is white, fractured quartz containing chalcopyrite and bornite which appear to have followed the quartz, in some instances occupying the central portion of the lode. The copper minerals are localized within the lode but show no relationship to faulting. The small north-easterly striking quartz lode on which the main adit was driven shows only limonite staining.

No unweathered specimens suitable for mineragraphic examination could be obtained either from the outcrop of the main lode or from the underground workings. The small quartzose veins about 800 feet upstream from the main lode, had a central band of copper-iron sulphide minerals, magnetitie and molybdenite.

A mineragraphic description by G.Greaves* of two specimens (P436a and P436b) from this locality is appended. He recognized, in order of decreasing abundance, the copper minerals, bornite, chalcopyrite, chalcocite, covellite and minor digenite and noted ex-solution lamellae of chalcopyrite in bornite.

A specimen of ore from the Old Kupei mine was also examined and described by Greaves (Appendix I, specimen P437). The Kupei ore and the specimens from near Pumkuna show marked mineragraphic similarity and indicate a comparable, if not a common, genesis.

No samples were taken for assay from the Pumkuna lode because of extensive leaching and contamination by copper salts. From information available in 1936, Fisher estimated that the main Pumkuna lode contained from 15 dwts to 1 oz gold per ton. The fineness of the Pumkuna gold produced before 1936 ranged from 904 to 946.

* Bureau of Mineral Resources mineragraphic laboratory.

The only ore reserve that can be calculated with any degree of confidence is that block between the underground workings and the surface. Assuming a connection through average width ore (1.2 feet) between the two workings, this block contains about 600 tons of quartz lode material which, for the most part, is considerably less than minimum stoping and driving width.

The lode cannot be confidently projected beyond any of the faces in the underground workings and in all faces the lode is less than average width.

The narrow quartz chalcopyrite fracture fillings in (?)quartz diorite which crop out in the bed of Pung'gana Creek upstream from the main lode, are too small to support a mining operation even though specimens taken from the veins may give high assays for both copper and gold.

Green staining of the country rock was seen not only in the immediate vicinity of the known lode but also on many stream boulders and in the boulders of some talus accumulations downstream from the exposed lode. This staining was seen in both agglomerate and microgranodiorite. In the agglomerate, malachite occurs in small round voids which look like vesicules but are more probably spaces left after selective removal by weathering of a particular mineral. In the microgranodiorite, a faint green colouration has selectively stained slightly weathered feldspar but, except for very minor chalcopyrite in accessory magnetite, no copper minerals could be identified microscopically. It would appear that this staining has come from leaching of copper minerals nearby.

Method of Treatment of ore from pre-war mining.

The Pumkuna mine was not being worked at the time of Fisher's visit in 1936.

The remains of a small ball mill were found on an alluvial flat on the left bank of the Pung'gana Creek opposite the main adit, and about a hundred feet from the creek (presumably above flood level.) Ore and mullock were probably trucked out of the main adit; the ore hand-picked and the mullock dumped on the right bank of the creek. The selected ore must have been transported to the opposite bank by a "flying fox", put through the ball mill and the gold concentrated from the crushings by some crude gravity method followed by amalgamation. It is indeed surprising that even such a rudimentary treatment plant could have been established in this remote area when it is considered that all equipment was carried from the north-eastern coast over a rugged 4000 feet range by native labour. Under present day labour conditions, this feat could not be repeated; some other means of transportation would have to be found.

CONCLUSIONS

Difficult access conditions would make any mining venture in the Pumkuna area very costly. The Pumkuna lode as seen from outcrop and the old underground workings is much too small for consideration as a gold-mining prospect under present access and labour conditions.

Underground mapping has indicated that, contrary to popular rumour, the mine was abandoned primarily because of shortage of ore and not because of the Japanese advance.

In none of the underground faces is the lode wider than 1 foot and at both ends of the main drive the lode is displaced along faults. There is insufficient ore in sight to justify re-opening the mine even on a small scale.

From a regional aspect, the Kupei-Pumkuna-Moroni area is a province of copper/gold mineralization which warrants reconnaissance investigation. The rugged topography, dense forest cover and paucity of outcrop severely limit coverage by conventional surface mapping methods. The most fruitful method of mineral exploration would be by geochemical survey, using either stream sediment or stream water analyses. The known association of molybdenite with the ore would be of value in tracing the copper mineralization geochemically. Geochemical methods based on molybdenum dispersion in stream sediments have been successfully applied by the Kennecott Copper Corporation in the search for "porphyry" copper deposits in mountainous British Columbia (G.F. Joklik, pers. comm.).

In such an investigation stream sediment sampling and field mapping of available outcrop could proceed concurrently. The area of particular interest for copper mineralization is the northern fall of the Crown Prince Range from Atamo to the foothills behind Kieta; about 80 square miles with a high density drainage pattern.

On a broader scale, the entire Crown Prince Range, about 250 square miles, is worthy of reconnaissance surface mapping and reconnaissance sampling and analysis of stream sediments to determine whether the Kupei-Moroni-Pumkuna area is the only province of copper mineralization.

The difficulties of access to the mineralized areas of the Crown Prince Range could possibly be borne by a large scale copper - goldmining operation but for small operators interested only in gold the area is not attractive.

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APPENDIX I

MINERAGRAPHIC DESCRIPTION OF THREE SPECIMENS OF COPPER ORE FROM BOUGAINVILLE, NEW GUINEA.

by

G. Greaves.

Following are descriptions of three specimens of copper ore from Bougainville. These were submitted by J.E. Thompson.

P436b - Pung'gana Creek near Pumkuna lode, headwaters of Jaba Creek, Bougainville.

The hand specimen consists of a massive, fine-grained, grey rock intersected by a green-stained brecciated quartz vein which in turn encloses a brassy yellow and black sulphide vein about 0.5 cm. wide.

Sulphides form roughly 30% of the specimen. Of these, chalcopyrite forms over 50%, bornite 40%, and chalcocite and covellite 10%.

Inclusions of quartz, hydrous iron oxides and malachite up to 1 m.m. long are found in the sulphide vein, and fracture fillings of these minerals up to 0.2 m.m. wide, also cut the vein.

The chalcopyrite has numerous elongated inclusions of bornite up to 6 m.m. long; these are generally parallel to the margins of the vein.

Some bornite grains have exsolution lamellae of chalcopyrite in the (111) planes. Peripheral alteration of bornite to covellite has proceeded along two crystallographic directions. Bornite has been altered to chalcocite and covellite to a greater extent than has chalcopyrite.

The green colouration in the quartz vein is due to malachite. Hydrous iron oxides and small amounts of magnetite, chalcopyrite and bornite are also present. The chalcopyrite occurs both as irregular inclusions in magnetite and as separate grains marginally altered to covellite. The bornite is partly altered to chalcocite and subordinate covellite.

P436 a - same locality as P436 b.

The hand specimen is massive and consists of equidimensional grains of black sulphide, quartz, smaller grains of brassy yellow sulphide, and interstitial green oxidation products.

Sulphides form roughly 30% of the specimen. Of these, bornite forms about 65%, chalcopyrite 20%, and chalcocite and minor digenite and covellite 15%. The textures are similar to those of specimen P436 b.

Irregular grains of chalcopyrite up to 3 m.m. long have been altered along grain boundaries and quartz-filled fractures to chalcocite.

Bornite grains up to 7 m.m. diameter have been extensively shattered, and subsequently recemented with quartz. Bornite is considerably altered to chalcocite and covellite along these fracture fillings and around the margins; it also contains inclusions of digenite up to 0.05 m.m. diameter.

Hydrated iron oxides and malachite have formed around the quartz grains and to a lesser extent the sulphide grains.

P437 - Old Kupei Mine, 10 miles S.W. of Kieta, Bougainville.

The hand specimen consists of irregular grains of black and brassy yellow sulphides in quartz.

The sulphides form roughly 10% of the specimen. Of these, chalcopyrite forms about 45%, bornite 50% and covellite and minor chalcocite 5%.

Grains of chalcopyrite up to 2 m.m. in diameter are generally associated with the bornite.

Bornite forms rectangular grains up to 4 m.m. long and exsolution lamellae of chalcopyrite occur in the (111) planes of bornite. Very fine veins of chalcopyrite in some of the bornite grains are just visible at a magnification 1,050 X. Bornite, more so than chalcopyrite, is altered to covellite and chalcocite around the margins and along fracture fillings of quartz. The exsolution - lamellae of chalcopyrite are unaltered, although the enclosing bornite is partly altered to covellite.

Irregular magnetite grains form less than 0.5% of the specimen and have a maximum diameter of 1.6 m.m.

Summary

The sulphides present are bornite, chalcopyrite, chalcocite, covellite and very minor digenite in order of decreasing abundance.

Chalcopyrite and bornite have been fractured and recemented by quartz and supergene alteration to chalcocite and covellite has taken place.

The presence of exsolution lamellae of chalcopyrite in bornite indicates that the temperature of deposition of these two sulphides was greater than 475°C (Schwartz, 1931)*.

The complete absence of pyrite and the presence of minor amounts of magnetite is notable.

Surface weathering of the copper minerals has produced malachite and hydrous iron oxides.

* Schwartz, G.M., 1931 : Econ.Geol., 26, 186-201.

Plate 1

THE PUMKUNA COPPER - GOLD PROSPECT

BOUGAINVILLE ISLAND
NEW GUINEA

154°00′ 154°30′ 155°00′ 155°30′

5°30′ 6°00′ 6°30′ 7°00′

TRUE NORTH 6½° MAG. NORTH

Buka I.

Sohano

BOUGAINVILLE I.

NUMA NUMA

MT. BALBI 9000′

WAKANAI R.

MT. BAGANA 6560′

ATAMO

KARATO

CROWN

KORPEI

KOROWANA

ARAWA BAY

Kieta

KUPEI

PUMKUNA

GUAVA

MORONI

JABA R.

KAVARONG R.

PRINCE

RANGE

MT. TAKUAM 7385′

MT. TAROKA 7240′

EMPRESS AUGUSTA BAY

Buin

FOR DETAIL SEE 1B.

FOR DETAIL SEE 1C

TO GUAVA ¾ hr walk.

A LOCALITY MAP

SCALE 1:100.000

10 5 0 10 20 30 40 Miles.

TO MORONI ½ hr walk.

Pungirunga Ck.

JOINS KAVARONG CK. THENCE JABA R.

T.N 6½° M.N

Pung'gana Creek

Korurupa Ck.

2300′

2700′

B PUNG'GANA CREEK

SCALE

200 0 400 Feet

OLD BALL MILL

Binivan Ck.

CAMP

C THE PUMKUNA LODE AND OLD WORKINGS

SCALE

20 0 40 Feet

TRUE NORTH 6½° MAG. NORTH

PLAN

2370′
2360′
2350′
2340′
2330′
2320′
2310′

LODE 18" to 24" WIDE

Chalcopyrite within lode

B

CU STAIN

2" chalcopyrite stringer

Cu stained wall rock

Quartz with limonite stains

Lode outcrop

Cu staining

Mullock

A

Pung'gana Ck.

● OLD BALL MILL

DIAGRAMMATIC SECTION

A B

Scale

40 0 80 Feet

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