Geology Asholabe Mineral Field
Prt Moresby - Area of P.N.G.

for L.M. Gross
AN EVALUATION OF THE LALOKI AND MT. DIAMOND DEPOSITS AND LOCAL GEOCHEMICAL EXPLORATION
ASTROLABE MINERAL FIELD
PAPUA

for

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Consulting Geologists and Engineers.
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SUMMARY

Property and Location

Prospecting Authority 27(P) was granted to Mr. Lionel M. Gross of 13 Russell Street, Toorak, Victoria during July, 1968, for a period of two years. This Prospecting Authority covers 200 square miles of the Astrolabe Mineral Field in the central district of the Territory of Papua.

Two of the principal copper prospects located within the Prospecting Authority are the Laloki deposit and the Mount Diamond Prospect. These copper sulphide occurrences are located 19 and 22 miles respectively from Port Moresby in youthful topography adjacent to the Sogeri Plateau. The climate of the area is tropical with a distinct rainy season.

History and Previous Work

Production from the Astrolabe Copper Field commenced in 1906 from numerous small mines. Total production of copper ores has been approximately 85,000 tons, with three significant producers: Laloki - 40,000 tons, Dubuna - 20,000 tons, and Sapphire-Moresby King - 17,000 tons. A geophysical survey was conducted by the Bureau of Mineral Resources to locate additional prospects in 1949-1950. Following these investigations, a diamond drilling programme on the Laloki deposit was undertaken by the Administration and Enterprise Exploration Company Pty. Ltd. in 1960-61. This programme established that the largest known occurrence, the Laloki deposit, was of limited size. A total of 5,572 feet of drilling in thirteen holes was completed, with three holes obtaining four sulphide intersections.
Programme Organisation

The purpose of the programme currently reported on was as follows: (i) produce fresh samples of Laloki ore for metallurgical testing, (ii) establish a reliable estimate of the tonnage and grade of the Laloki deposit, (iii) make a preliminary evaluation of the Mount Diamond Prospect by carrying out a limited diamond drilling programme, and (iv) concurrently carrying out an exploratory programme of soil geochemistry with associated magnetometer surveys in the most favourable areas adjacent to the Laloki deposit and in the Ruby-Mount Diamond-Dubuna area.

Field operations were supervised by geologist, L. Geitans, who arrived in Port Moresby on August 18th, 1968, with field technician, J. Malloch. The drilling operations commenced on August 30th and terminated on March 17th, 1969. The geologist departed Port Moresby on December 20th to reduce supervision expenditure and J. Malloch was left to supervise the remaining drilling and complete the geophysical exploration programme.

Due to the limited footage, remote location and other factors, it was not possible to arrange for a contractor to undertake the diamond drilling programme with his own equipment on a fixed quote basis. Therefore, arrangements were made to rent government equipment through the Mines Department in Port Moresby in addition to supplying some new drilling supplies from Australia. An arrangement was entered into with a contract drilling organisation to supply one or two competent drillers on a monthly fee basis. Native offsiders worked with these drillers. Many difficulties were encountered during the drilling programme which resulted in very slow average progress.

Contract surveyors were hired to lay out the control grids in the Laloki and Mount Diamond areas and to put in all line work required for the geochemical exploration programme.

Geology and Mineralization

The copper deposits are located within the Port Moresby Beds which are a sequence of folded Eocene mudstones and shales with calcareous and cherty varieties. The intrusive Sadowa Gabbro of Oligocene age invariably outcrops close by these deposits and at the Laloki deposit, is known to underlie the sulphide zone at a depth of only 250 feet.
The sulphide deposits vary in size from several thousand tons to approximately 300,000 tons, and are generally lenticular in form and composed of almost massive sulphide. Pyrite, marcasite and chalcopyrite are the principal sulphide minerals present.

**Laloki Deposit**

A total of 1,024 feet was drilled in seven holes during the programme. One hole was abandoned and five of the six remaining holes obtained significant sulphide intersections. Detailed sampling in the old open cut was also completed. Sample results from drill intersections and surface samples, in addition to three previous drill intersections, were integrated with all available underground information from previous development work to produce a comprehensive set of maps and sections representing the Laloki sulphide deposit (Maps Nos. 12, 12A, 13 and Sections 14 to 20).

The Laloki deposit has a curved lenticular form and is located on the limb of a fold. The deposit is approximately 525 feet long by 260 feet wide, over a vertical height of 180 feet. The southeast portion of the sulphide zone is exposed at surface and dips 60 to 40 degrees to the northwest. Below the 137 level the deposit flattens considerably and is flat-lying in places. True widths vary up to 55 feet in the thicker steep-dipping portions of the deposit, but 15 to 25 feet is a common thickness in the lower portion.

A total of 306,000 long tons, grading 5.16% copper has been drill-indicated. Approximately 180,000 tons of this amount has been proven by underground development work. The above tonnage represents the current reserves, after allowing for the mining of 40,500 tons of ore recorded from this deposit, both from underground and open cut operations. An additional 6,000 tons of probable ore is indicated, grading 5.06% copper. At the northwest end of the orebody, approximately 6,000 tons of possible ore may be present, grading 3.94% copper. On incomplete assay results, a gold content of at least 2.6 dwts. gold and roughly 0.5 oz. silver per short ton is indicated.
Further drilling or underground development may extend these reserves to the northeast by a maximum of an additional 20,000 tons.

A preliminary calculation for an open pit outline has shown that approximately 40% of the ore reserves could be extracted by this method, with an average 38 degree pit angle and an overburden plus waste to undiluted ore ratio of 10.9:1. Underground mining could proceed through a portal established near the base of the open pit. The fractured country rock should be rippable and hence readily mined in an open cut. *Important consideration in mining engineering.*

Soil geochemistry has indicated a moderate copper anomaly southwest of the Laloki deposit which a previous exploration drive on the 137 level had approached.

Mount Diamond Prospect

This Prospect is located in a hillside and has been explored by a series of adits covering a 164-foot vertical range. No mining has been recorded but a massive sulphide zone is present with a possible strike length in excess of 200 feet. The sulphide zone assayed 4.4% copper over a 30-foot horizontal width and dipped into the hillside at approximately 40 degrees. A geophysical survey had indicated good correlation between the known sulphide zone and the magnetics. A self-potential survey indicated the possibility of a considerable strike extension. No previous drilling had been done on this prospect.

Three holes totalling 980 feet were drilled down-dip from the deposit. However, the best intersection obtained in hole D-3 was only 2.2 feet of 2.8% copper. The failure of the drilling to intersect significant sulphides eliminated the immediate down-dip extension possibilities of the Mount Diamond deposit but left the strike extension to the west untested. A structural interpretation has been made of the deposit which indicates that the mineralization is contained on an anticlinal structure. The massive sulphide zone terminates abruptly down-dip on the north limb of the anticline, but tails off into weak sulphide stringers within a pyritic shale on the strongly oxidised south limb. An extension in this direction has also been tested with negative results by the lower adit. Maps 9, 10 and 11 show the geology, underground sampling results, and drill sections.
Probable ore reserves at the Mount Diamond deposit are approximately 29,000 long tons (of which approximately 50% could be considered developed ore reserves at the present time) at a grade between 2.8% and 4.5% copper. The range in copper values shown is attributable to a 2.8% copper result having been obtained from 1968-69 underground sampling, compared with sampling on two previous occasions which has indicated grades of 4.3% and 4.6% copper. Although the surface crust was removed during sampling, it is believed that copper values have been leached from adit walls during the last few decades and the resulting samples are therefore not necessarily representative. Further testing by percussion drilling could definitely establish the correct grade and better define the width of the mineralization in several areas.

The mining of this small deposit as a supplementary source of ore could be achieved by lengthening the lowest adit and mining the deposit as a single stope.

Ruby-Mount Diamond Area Exploration

A regional soil sampling programme over a three-mile length of the most favourable area for additional copper mineralization was undertaken. The Dubuna deposit was located within this zone. A total of approximately 500 soil samples were taken during the survey, which represented approximately 104,000 line feet of coverage. Approximately 25% of this work represented surveys carried out in the general Lalokki area. Line spacing was at 800-foot intervals, with anomalous zones defined at 400 and 200 foot intervals. Soil samples were taken at the soil/rock interface by hand augering.

Background values in the Port Moresby Beds averaged 150 ppm copper. Anomalies were outlined by 500, 1000 and 2000 copper contours, with a maximum value of 6,000 ppm copper having been obtained (0.6%). A combined strike length of 3,500 feet on the 1000 ppm contour is present in five anomalies. Several of these anomalies are thought to represent sulphides. A weak magnetic profile is present with most anomalies. However, while adding validity to the anomalies, it must be observed that magnetic association is not a definite indicator of sulphides. Geochemical maps Nos. 3, 4A and 4B outline the soil geochemistry results, and maps 5 to 8 depict the magnetic profiles associated with these anomalies.
Metallurgical Testing

Previous metallurgical test results indicated that further research to improve the recovery and grade of copper concentrates by flotation methods was warranted. Also, the mining history of these deposits indicated that research in the handling of ores and concentrates is warranted. Such test work is of extreme importance in establishing the feasibility of mining the Laloki deposit.

This work is under the direction of Keith Turner, Melbourne Mining Consultant, who has directed the work being done by the C.S.I.R.O. in Melbourne.

Sulphide drill core for testing was thoroughly dried, wrapped in double plastic bags in 1-foot lengths and then shipped air freight to Australia. This procedure greatly reduced the possibility of oxidation which would unfavourably affect the flotation test results. Cores from hole L-2 and L-3 totalling 243 lbs. was shipped during September-October, 1968; split core and sample reject material totalling 188 lbs. from holes L-5 and L-7 was shipped from Perth in April, 1969. In the latter case, the core was logged, split and assayed in Perth prior to shipment to the C.S.I.R.O. in Melbourne.
II CONCLUSIONS

1. At 300,000 tons of minimum 5% undiluted copper ore, the Laloki deposit is of sufficient interest to warrant further investigation. Such investigation would take the form of a feasibility report and related test work to establish the viability of an independent mining operation on this deposit.

2. Metallurgical test work currently being carried out by the C.S.I.R.O. should form a very important part of the feasibility information required. However, the importance of this work and the value of the sample made available for this work cannot be stressed too much. Representative sample material should be retained, if at all possible, for further test work by other reliable independent laboratories.

3. The Mount Diamond deposit has been adequately tested to determine its tonnage potential. At 29,000 long tons of ore, this deposit is relatively small, although still open for possible extension to the west. Ore from this deposit could only serve to add additional tonnage to be treated, presumably at a mill established near the Laloki deposit. Such ore would be relatively more expensive, due to the capital costs involved in extracting the ore and necessary trucking charges.

   It may be appropriate at some future time to better define the Mount Diamond deposit by underground drilling using long hole percussion and/or diamond drilling methods. This would establish the ore limits, accurate widths, and a reliable grade for this deposit. All of this work can be readily accomplished from existing mine openings.

4. Valid geochemical anomalies are present in the Ruby-Mount Diamond line of workings. However, further exploration work should be deferred on these anomalies until encouraging results from metallurgical testing currently in progress on Laloki ore have been reported. Even then, it may be wise to defer such exploration expenditure if sufficient tonnage is available to establish an operating mine at Laloki.
Although valid, further exploration work should include ground electromagnetic surveys of the Turam type which are expected to work successfully in this area. However, it is imperative that test loops be run over known deposits first. Drilling of the best anomalies would then follow.

5. Should additional ore reserves be required in the immediate Laloki vicinity, then consideration should be given to testing the geochemical anomaly located immediately to the southwest of the main deposit.

6. Geochemical exploration would appear to be a valid exploration method for establishing additional potential in the Astrolabe Copper Field.

7. A review of all drilling information available suggests that significant zones of low grade copper mineralization are not present in the vicinity of sulphide deposits. Only very limited fringe copper mineralization has been recorded adjacent to the discrete sulphide deposits tested.

III RECOMMENDATIONS

1. A preliminary feasibility study to establish the viability of mining the Laloki deposit is required. The possible economics of this operation were set forward in our letter of December 12th, 1968. It was stressed at that time that information regarding the grade and recovery of concentrates produced from Laloki copper ore was of prime importance. The final report by the C.S.I.R.O. on current metallurgical testing will form a valuable source of information for feasibility studies. However, further test work may be required.
2. Although valid geochemical anomalies have been located which, on further testing, may establish additional reserves, it is recommended that no further exploration work be undertaken until feasibility studies have been completed on the Laloki deposit.

3. Further metallurgical test work may be required at a future date. Ideally, sample material should be representative fresh sulphides which could be made available in larger lots. Further diamond drilling for this purpose at the Laloki deposit is not recommended.

Alternative sources of sample material are (i) underground samples from the Laloki deposit following dewatering and limited rehabilitation of the No. 1 or No. 2 air shafts or (ii) the sinking of a small pilot shaft in the Laloki open cut. Due to the unknown costs and problems associated with entering the old mine workings, the sinking of a pilot shaft is recommended.

This future programme would cost approximately $15,000 for sample collection and shipment. This figure does not include metallurgical testing charges.

### Cost of Recommended Programme

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<tr>
<td>1. Preliminary Feasibility Study</td>
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<tr>
<td>2. Additional metallurgical testing on available sample material</td>
<td>3,000</td>
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<tr>
<td>Contingency</td>
<td>2,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>$10,000</strong></td>
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Property and Location

Prospecting Authority 27(P) was granted to Mr. Lionel M. Gross of 13 Russell Street, Toorak, Victoria during July, 1968 for a period of two years. This Prospecting Authority covers 200 square miles of the Astrolabe Mineral Field in the Central District of the Territory of Papua and is defined as follows: commencing from Pyramid Point (50.7 miles south-east of Port Moresby and on the coast) thence north for 20 miles, thence east for 10 miles, thence south for 20 miles thence west for 10 miles to Pyramid Point (see Maps Nos. 1 and 2).

It has been reported that all mining leases on individual properties within the area of P. A. 27(P) have expired.

The location of two of the more important prospects where diamond drilling was undertaken is described. The Laloki Mine is located 1.4 miles southeast of the 17 mile peg on the Sogeri Road, a total of 18.8 road miles from Port Moresby. The mine workings are on the north bank of Simpson Creek at an elevation of 1150 feet above sea level. The Mount Diamond Prospect is located 3.1 miles south of the Laloki Mine approximately 0.8 miles northeast of Maiberi Village, and a total of 21.5 road miles from Port Moresby. The mine workings are on the north bank of Maiberi Creek at an elevation of approximately 350 feet above sea level.

Access and Topography

Access to the Laloki Mine from Port Moresby is via the all-weather, unsealed Sogeri Road for 17 miles, then by bush track for approximately 1.8 miles to the mine workings. This track was made during past mining operations and was regraded for the commencement of the drilling programme. Sections of this road are difficult to negotiate during wet weather. In dry weather the road is passable by 2-wheel drive vehicles.
Access to the Mount Diamond Prospect from Port Moresby is via the Rigo Road for approximately 17 miles, then along a branch road which partly follows the former Dubuna Mine railway, then through Chapman's Farm for approximately 4.5 miles. The last mile of this road was bulldozed to provide access to the prospect for diamond drilling operations and this section of the road is accessible only by 4-wheel drive vehicles. The old Rigo Road from near Illawarra Farm on the Soperi Road (14 miles from Port Moresby) to the present Rigo Road near Chapman's Farm is seldom used but in dry conditions it provides rapid access from the Laloki Mine to the Mount Diamond Prospect.

Topographically, the area is youthful with the gently undulating Soperi Plateau terminating on its western and southwestern margins in steep cliffs which are known as the Astrolabe Range. The Plateau is drained and partly dissected by the Laloki River and its tributaries, the waters of which have been dammed for hydro-electric power development. The northern part of the area is drained by the Goldie and Hiwick Rivers and their tributaries. In the southern portion of the area, the foothills of the Astrolabe Range rapidly grade into gentle relief and coastal or alluvial plains.

The mineral occurrences are located in the foothills of the Astrolabe Range on the western and southwestern margins of the Soperi Plateau.

Rapid run-offs follow wet season rains. In the vicinity of the Laloki deposit, Sapphire Creek maintains a meagre flow during the dry season and Simpson Creek only flows during the wet season. Maiberi Creek, near the Mount Diamond prospect, maintains a permanent flow.

Climate and Vegetation

The climate in the area is tropical with high relative humidity. Seasonal variations are governed by heavy rains during the wet season.

In the dry season, between May and October, the climate is controlled by the southeast trade winds and the mean maximum temperature in Port Moresby is 80 to 85 degrees Fahrenheit with a relative humidity of 60 to 65 percent. During the wet season from November to April the climate is controlled by the northwest trade winds and the mean maximum temperature is 85 to 90 degrees Fahrenheit with a noticeable increase in relative humidity.
Rainfall typically increases with altitude but no figures have been recorded for the Laloki Mine area. The following ten-year average rainfall figures have been recorded: Port Moresby - 36.82 inches; 15-mile peg on the Sogeri Road - 56.07 inches; Rhoanna - 85.66 inches and at Koitaki on the Sogeri Plateau - 112.20 inches. It is expected that the average annual rainfall at Laloki would be approximately 60 inches.

Dense rain forest vegetation is prolific along the water courses and the gullies in the foothills. Jungle growth commences at the higher altitudes which receive more rain. The lowlands, foothill ridges and upper slopes support scant stunted cabbage leaf eucalypts, kangaroo grass and a variety of minor associated ferns. Kunai grass up to 7 feet tall is developed locally.

Scope of Work and Personnel

The programme undertaken followed the recommendations of a report by Watts, Griffis and McOuat (Australia) Pty. Ltd. entitled "Diamond Drilling and Exploration Proposals, Astrolabe Mineral Field, Papua."

This report was submitted on August 11, 1968, following a trip to the property and study of information by Mr. W. A. Brook.

The main objectives of the programme currently reported on were as follows:

(i) to produce a reliable estimate of the tonnage and grade of the Laloki deposit by diamond drilling and record review,

(ii) to produce representative samples of Laloki ore for metallurgical testing,

(iii) to make a preliminary evaluation of the Mount Diamond prospect by limited diamond drilling with concurrent inspection and sampling of underground workings,

(iv) to complete an exploratory geochemical soil sampling programme with associated magnetometer surveys in the Mount Diamond-Dubuna area.
Field operations were supervised by geologist L. Geidans who arrived in Port Moresby on August 18th with field technician J. Malloch. Drilling operations commenced on August 30th, 1968 and terminated on March 17th, 1969. L. Geidans left Port Moresby on December 20th, 1968. J. Malloch completed the geochemical and geophysical exploration programme on February 7th and then assisted with diamond drilling till job completion.

Geologists W. Brook and D. Cheeseman provided project supervision with the latter visiting the property from September 23th to 29th.

History and Previous Work

The history of the Astrolabe Copper Field has been adequately summarized by Yates and Ferranti (1965) on pages 46 to 48 of their Bureau of Mineral Resources Report as follows:

"On December 21, 1906, an area of 1,000 square miles was proclaimed the "Astrolabe Copper Field". Two reward claims of 160 acres each, the Hector and the Astrolabe (now known as Federal Flag), were granted and applications for four prospecting leases were submitted. By 1909, the Dubuna, Elvina, Federal Flag, Hector, Laloki, Mount Diamond, Paree, and Sapphire Creek lodes had been discovered and partly developed. Extensive testing and proving at the Laloki mine was carried out by the British New Guinea Development Coy. Small parcels of rich oxidised copper ore were exported, mainly from the Hector and Federal Flag mines. The Dubuna mine began production of rich oxidized ore in 1910, and was the source of most of the ore exported up to June 1912. About the same time, both the Dubuna and Laloki mines were taken over by the Great Fitzroy Mines Limited. G. C. Klug (1912) recommended an expenditure of £56,000 to develop these leases in order to ship 2,000 to 3,000 tons of ore per month for treatment in Australia. It is understood that the first ore shipped caught fire on the voyage.

Erle Huntley in 1917 recommended an expenditure of £130,000 to build an aerial ropeway and railway to transport ore from the Laloki and Dubuna mines to Bootless Inlet for smelting and conversion.

In 1919, the Astrolabe Copper field was enlarged to 2,040 square miles to include copper mineralization found several years previously at Mount Louis near Rigo, and renamed the Astrolabe Mineral Field. Samples of iron ore for use as pigment, and 10 tons
of copper ore, were exported from Mount Louis in 1920, but although prospecting continued intermittently, no further ore was produced.

New Guinea Copper Mines Limited took over the Laloki and Dubuna mines in 1920, with the intention of shipping ore to Port Kembla for smelting. However, spontaneous combustion of ore in the ship's holds made it necessary to resume the project proposed by Huntley. The aerial ropeway, railway line and smelter were completed in 1923 but smelting problems were immediately encountered and full production did not commence till 1925. Because of fire in the Laloki and, later, in the Dubuna mines, open cut mining commenced, and new smelting problems were introduced. These problems were not satisfactorily overcome, and the low price of copper at the time caused New Guinea Copper Mines Limited to cease operations in the latter half of 1926. This company had extracted 32,000 tons of ore from the Laloki mine since 1920.

The closing of the Laloki and Dubuna mines marked the end of activity on the field. Except for a little interest shown in the area as a goldfield in the early 1930's there was no major activity until 1936 when Mandated Alluvials N. L. acquired the Sapphire and Moresby King mines. A smelter was erected at Sapphire Creek and between 1938 and 1940, 21,007 tons of oxide and sulphide ores were treated, yielding 6,989 ozs. of gold, 17,522 ozs. of silver and 268.7 tons of copper.

George A. More inspected the Laloki mine in 1940, to examine the possibility of smelting ore from this mine when reserves at the Moresby King and Sapphire mines were exhausted. A loan of £10,000 was obtained from the Commonwealth Government and the company commenced to install a sintering plant, and reopen the underground workings at the Laloki mine. R. Pitman Hooper (1941) and N.H. Fisher (1941) reported on the Laloki, Moresby King and Sapphire mines. However, because of the Japanese invasion, the company was forced to suspend operations in January 1942 before the new mining and smelting plant was ready for use.

From 1938 to January 1942, 16,953 tons of oxide and 10,438 tons of sulphide ore were mined, which yielded 1,498.5 tons of matte, containing 8,842 ozs. of gold, 22,880 ozs. of silver and 361.2 tons of copper.

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After the Second World War, Mandated Alluvials attempted to rehabilitate the mines by reconstructing the mining and smelting plant, together with roads and bridges. All the areas of interest within 5 miles of the Laloki mine were acquired in 1948, and at the request of the company the Bureau of Mineral Resources conducted a geophysical survey of the prospects in 1949-1950 (Tate, 1951). Because of an offer of free inspection of the leases, the Zinc Corporation Ltd. made a thorough examination of all mines and prospects (King, 1950). K.R. Glasson (1954) reported to Mandated Alluvials on the prospects of the field, and R.N. Spratt (1957) mapped the geology of the Laloki-Dubuna area for Consolidated Zinc Pty. Ltd.

As a result of these investigations, diamond drilling at the Laloki mine was undertaken in 1960 by the Administration and Enterprise Exploration Co. Pty. Ltd. (for Consolidated Zinc Pty. Ltd.). The limits of the ore body were outlined but no additional ore reserves were found.

Drilling by the Administration at the Hector mine in 1957, the Dubuna mine in 1963-64, and the Ventura prospect in 1964, failed to reveal any economic mineralization."

By 1968 all the tenements were abandoned and Mr. L.M. Gross secured the Prospecting Authority over most of the prospects of the Astrolabe Mineral Field.

In July and August, 1968, Watts, Griffis and McQuat (Australia) Pty. Ltd. prepared a report for L.M. Gross of Melbourne. This report detailed test work required on the Laloki and Mount Diamond occurrences and areas favourable for geochemical soil exploration.

**Diamond Drilling Organization**

Due to the limited footage, remote location and slow rate of drilling previously recorded, it was not possible to arrange for an Australian drilling contractor to undertake the diamond drilling programme on a fixed quote basis. Also, the commencement date for drilling coincided with the busy exploration season in Australia and contractors' rigs and related equipment were not available to be transported to Port Moresby. This situation left no alternative and arrangements were made to rent a used drill rig in Papua and provide experienced drillers through a Perth-based drilling contractor.
A trailer-mounted Mindrill F-30 rig with hydraulic head and some miscellaneous drilling equipment, including a tripod and pump, were hired from the Mines Division of the Department of Lands, Surveys and Mines at Port Moresby. The required equipment which was not locally available was purchased in Australia and shipped to Papua. An arrangement was made with the Mines Department whereby the hire charges for the rig would be debited against drilling equipment purchased in Australia which was transferred to the Mines Department at the completion of the programme. A second drill rig, a Mindrill F-6 with a screw feed head, was briefly introduced for short hole drilling during the later part of the programme. However, very poor core recovery attributable to the screw feed head resulted in the removal of this drill.

Two experienced European drillers working 10-hour shifts six days per week were provided by Inspiration Drilling (Australia) Pty. Ltd. on a fixed monthly fee basis. A local native driller from the Mines Department was temporarily employed. Post Christmas drilling was done on a single shift basis under the direction of driller-foreman, R. MacDonald, an experienced Canadian. The two or three drill offiders per shift were all native, having little or no experience. Some of these natives were Mines Department employees and some were hired directly. During the last weeks of the drilling programme, field assistant J. Malloch acted in the capacity of drill offider.

Arrangements were made for Arman and Larmer, a local surveying company, to arrange and direct contract bulldozing of access tracks and drill site pads at Laloki and Mount Diamond.

Initially, three holes were drilled at the Laloki deposit before the drill was transferred to the Mount Diamond prospect. This move was required since the onset of the rainy season was imminent and it would not have been possible to position or service a drill rig in the hilly Mount Diamond area with slippery tracks. Also, access track preparation work and possible drill sites would have washed away to a large degree by heavy downpours. Following the completion of 3 holes at Mount Diamond, the F-30 rig was moved back to Laloki to complete two additional holes. Another short hole had been drilled by the native driller using the F-6 rig but the core recovery was very disappointing.
Holes were drilled N size with both NMLC and Mindrill NMS core barrels being used. Core recovery was fair to poor in the country rocks but generally good in most of the sulphide intersections. The NMS core barrels proved to be the most suitable. B size equipment was also available with casing and core barrels should the need to reduce hole size have occurred. However, where ever possible NX casing was reamed or the hole cemented to overcome problems and maintain the larger size core.

The rate of drilling was discouraging and well below anticipated levels. Two major equipment breakdowns lost a total of 43 operating shifts until parts were obtained and repairs effected. A total of 22 calendar days were involved in the move to the Mount Diamond area, return move to Laloki and the Christmas holiday period. Of the remaining 142 calendar days, representing 195 effective working shifts, an average of 9.6 feet per shift was drilled for a total of 1874 feet. This total does not include hole L-4, 130 feet in length, which was drilled entirely by the native driller. The best performance was in the Mount Diamond area where the rock was less broken and the worst performance was during the second phase of drilling at Laloki during the wet season.

Although the European drillers were considered quite competent, working conditions and operating problems greatly reduced their effectiveness. Some of the problems encountered are listed below: native drill offsiders, difficulties with rented drill equipment, water shortages and pumping problems, very broken rock conditions which resulted in short runs and frequent cementing, heavy sulphide sludge causing core barrels to stick in hole due to inadequate pressure pump capacity, deep casing reaming and constant difficulty in extracting casing with hydraulic jacks, washing away of hole walls which permitted casing to unscrew through vibration, and so on.

No doubt drilling performance could be considerably improved by a competent contractor using his own equipment and personnel, and being prepared to overcome some of the genuinely difficult drilling conditions which exist.
V. GENERAL GEOLOGY

Introduction

The area of the Prospecting Authority contains three major rock groups: the Port Moresby Beds of Eocene age, the Astrolabe Agglomerate of Pliocene age and the Sadowa Gabbro of Oligocene age. The Port Moresby Beds are the most important economically as they contain all the significant copper deposits. These beds have been intruded by the Sadowa Gabbro and the Astrolabe Agglomerate unconformably overlies both the gabbro and the Port Moresby Beds. The following table lists the various rock groups with ages and relationships as proposed by Yates and Ferranti (1965):

STRATIGRAPHIC TABLE OF ASTROLABE MINERAL FIELD

Recent
- Alluvium, Scree
- Ararabu Conglomerate

Pleistocene

UNCONFORMITY

Pliocene
- Kwikila Agglomerate
- Astrolabe Agglomerate

UNCONFORMITY

Middle and Upper Miocene
- Siro Conglomerate
- Gidobada Limestone

Lower Miocene
- Dokuna Tuff
- Bootless Inlet Limestone

UNCONFORMITY

Oligocene
- Sadowa Gabbro (Intrusion)

Eocene
- Port Moresby Beds

UNCONFORMITY

Upper Cretaceous
- Bogoro Limestone

Lithology

As no time was spent in regional geological mapping, the following sections are summarized from Yates and Ferranti (1965):
Port Moresby Beds

Two lithological facies can be distinguished in the Port Moresby Beds: a lutite or fine grained detrital facies and a chert facies. The lutite facies are confined almost entirely to the Astrolabe Mineral Field and grade into the chert facies to the south. The lutite facies generally varies in colour from grey to green with reddish banded calcareous members or calclutites. Calcite veins are common and bedding is not well developed. Slates are developed in places and range in colour from black, grey and green to red. A red to pink massive calclutite or impure limestone occurs as small scattered lenses. At Laloki a red and grey calclutite and lutite breccia occur below the sulphide zone. Some dark red tuffaceous beds have been found at Laloki and Dubuna.

The chert facies occurs between Bootless Inlet and Rigo. These beds are characterised by the presence of chert bands and nodules with interbeds of fossiliferous limestone and a small content of clastic material.

Sadowa Gabbro

In the Astrolabe area the gabbro is coarse-grained with finer dolerite varieties being confined to the margins. The primary minerals are plagioclase (predominantly labradorite), clinopyroxene, hornblende, olivine, orthopyroxene, quartz, magnetite, ilmenite, pyrite, apatite and sphene. Secondary minerals include uralitic amphibole, red and brown hornblende and chlorite.

The batholith intrudes the Port Moresby Beds but does not appear to intrude lower Miocene rocks. The Sadowa Gabbro is therefore considered to be Oligocene age.

Metamorphic effects on the intruded Port Moresby Beds are restricted to local, narrow calc-silicate hornfels aureoles.

The Sadowa Gabbro outcrops over approximately 50 percent of the area between the Sogeri Road and Mount Diamond and is considered to underly the exposed Port Moresby Beds.
Siro Conglomerate

This rock type occurs north of the Laloki River as unconsolidated fluviatile conglomerate with minor interbeds of fine grained sandstone and siltstone. It is separated by unconformities from both the Sadowa Gabbro and the Astrolabe Agglomerate.

Astrolabe Agglomerate

This rock occupies the whole of the Sogeri Plateau and the Astrolabe Range. It does not outcrop in the area between the Sogeri Road and Mount Diamond but large talus blocks of the agglomerate are not uncommon. It varies in thickness from 400 to 800 feet and is a coarsely stratified, dark grey volcanic agglomerate with relatively uniform lithology and minor tuff bands. Fragments are mainly sub-rounded, vesicular or massive basalt in a tuff matrix. The framework is more or less continuous.

Structure

All the rocks within the area have been affected to a varying degree by several episodes of tectonic activity resulting in folding and faulting. The rocks most affected are the Port Moresby Beds which have been tightly folded along generally north to northwest trending axes with the formation usually dipping steeply to the east or northeast. The predominant east dips indicate that overturned isoclinal folding may be developed. However, the large variation in dip and strike readings indicate a considerable irregularity in fold patterns and numerous plunge reversals. Slumping or cross-folding has contributed to numerous examples of this divergence from original strike. No well developed cleavage is evident and folds have probably developed by bedding plane slip.

The attitude of the sedimentary sequences is difficult to establish because of the absence of marker beds and reliable evidence of bedding. It is further obscured by tectonic structures.
The contact between the Sadowa Gabbro and the sediments is usually concordant, ranging from horizontal to vertical, although cross-cutting gabbro apophyses and dolerite dykes have been observed. Some of the folding and faults within the Port Moresby Beds may have been developed in response to stress fields set up by the gabbro intrusion.

Several north-trending lineaments have been interpreted as transcurrent faults. No faults have been found in rocks younger than the Sadowa Gabbro. On a small scale the Port Moresby Beds show numerous faults of unknown displacement and an intense jointing with locally developed cleavage.

Following the folding of the Port Moresby Beds, the subsequent tectonic movements have been relatively mild, resulting in uplift, and some faulting and gentle folding of the Astrolabe Agglomerate into broad and shallow northwest trending syncline.

Mineralization

Sulphide mineralization is restricted to the Port Moresby Beds on the west and southwestern side of the Astrolabe Range. It is not known whether the sulphide deposits belong to any specific stratigraphic horizon within this sedimentary sequence due to intensive deformation, poor exposure and correlation difficulties. Mineralization is usually indicated by gossans and occasionally by creek exposures of sulphides. Thomas (1962) considers that two sulphide horizons occur within the Port Moresby Beds.

The copper deposits generally occur near the gabbro but no significant copper mineralization has thus far been located in the gabbro itself. Only minor copper mineralization has been located in the chert facies of the Port Moresby Beds; the argillaceous and calcareous members are the normal host rocks.

A total of 39 copper showings have been prospected and worked to varying degrees; several unworked copper prospects have also been noted during surveys by the Bureau of Mineral Resources. The deposits are lenticular in shape and appear conformable with their enclosing envelope of contorted sediments. The deposits vary downwards in size from a maximum of 500 feet long by 300 feet by 10 to 40 feet thick. Dip attitudes are highly variable.
No wall rock alteration has been observed but post ore faulting is common in many deposits.

The typical copper deposits contain approximately 90 percent massive sulphides by weight (or roughly 76 percent by volume). Copper mineralization is present principally in the form of chalcopyrite with minor bornite and chalcocite(?). Other sulphide and metallic minerals present in order of abundance are pyrite, marcasite, sphalerite, magnetite, galena and arsenopyrite. Non-metallic gangue minerals are chalcedony, calcite, chlorite and talc in addition to sedimentary inclusions.
VI  LALOKI DEPOSIT

History and Previous Work

Leases covering the Laloki copper deposit were acquired during the period 1907 to 1912 by the British New Guinea Development Company. These leases were transferred to Great Fitzroy Mines Limited in 1914 and to the New Guinea Copper Mines Limited in 1917. The latter company sank the vertical "old mine shaft" to the 137 level, where subsequent development work included a regular pattern of cross-cuts off exploratory drives and a connecting adit. Total ore production after development work in 1917 is reported at 2,060 long tons.

A mine fire in 1924 prevented further underground mining and the ensuing open cut operations were terminated by a landslide in 1926 which closed the mine. Total recorded production to 1926 is recorded at 34,698 long tons of ore.

Open cut mining activities were resumed in 1939 by Mandated Alluvials N.L. Consideration was being given to further underground mining in the partially accessible openings when all operations were suspended in January, 1942, due to the Japanese invasion. Production by Mandated Alluvials to July 31, 1941 is reported at 5,790 tons of copper ore in bringing the total production to 40,488 long tons.

In 1949, Mandated Alluvials N.L. acquired additional leases and requested the Bureau of Mineral Resources to conduct surveys over the mineralized area of the Astrolabe Mineral Field. The results of these surveys indicated additional ore potential.

Between 1959 and 1961, the Zinc Corporation, through a subsidiary exploration company and with the support of the Administration of Papua-New Guinea, completed an exploratory diamond drilling programme involving 5,572 feet in thirteen holes on the Laloki deposit. The dip and strike potential of this deposit were assessed and it was established that the tonnage potential of the Laloki deposit was limited and confined to the drilled area.

In 1968, all leases were permitted to lapse and Mr. L.M. Gross acquired control of the Laloki deposit through P.A. No. 27(P).
Field Observations:

Two distinct varieties of turbots are observed here:
1. A calcareous type or calcilutite / biomicrite to micrite to dol.
2. A fissile and shale type.

The grading is from impure limestone micritic to biomicritic then to siltstone which are becoming silicious to sandstone and shale which occur as carbonaceous shale in places.
Lithology

The Laloki copper deposit is located within the Port Moresby Beds. The Sadowa Gabbro outcrops on surface approximately 250 feet north of the most northernly portion of the sulphide ore body. Also, the Sadowa Gabbro was encountered in previous diamond drilling at a depth of 250 to 275 feet below the footwall of the sulphide deposit. Drilling indicated that the members of the Port Moresby Beds encountered during drilling were highly fractured, with a maximum core length of a few inches having been obtained. Surface outcrops are very limited and mostly restricted to creek beds, road cuts, and exposures in the old open cut. The variations of the Port Moresby Bed sedimentary sequence encountered in the diamond drilling are described in more detail below:

The lutites or mudstones were generally dark grey to grey-green in colour with rare maroon to brownish bands. One such band, termed the "marker horizon", was several feet thick with a banded or mottled appearance in which individual bands reach a maximum thickness of approximately 1/4 inch. Two distinct varieties of lutites are recognized: calcareous members or calcilutites which grade into impure limestone, and non-calcareous members, which are more fissile and grade into shale. Random calcite veinlets varying from wisps to 1/4 inch in thickness were widespread. Field correlation of these beds is not generally possible unless drilling is on a close-spaced pattern. Some tuff content was undoubtedly present in some of the lutites and a tuffaceous grewacke was described.

Bands of distinctive jet black, fissile shale were recognized and commonly contained slickensided surfaces of a chloritic and/or graphitic nature. These shale bands were very soft (could be crumpled in the hand), non-calcareous and frequently pyritic to varying degrees. Shale bands are commonly associated with sulphide mineralization and correlation between individual bands may be possible.

A lutite breccia containing grey and maroon angular to subrounded fragments up to 1½ inches, set in a fine grained matrix, was also described. In places the breccia fragments were sufficiently small to impart a sandy appearance. In origin, this breccia may be a sedimentary or collapse breccia and/or a tectonic breccia formed during folding and faulting.

A pyritic pug or clay is commonly present on the periphery or extensions of the sulphide ore zone.
Structure

Exposures of the Port Moresby Beds in Simpson Creek indicate an approximate east-west strike with a dip varying from 40 to 60 degrees to the north. Cliff exposures above the open cut area, indicate a swing in the strike to the northeast, (Plan No. 12). The outline of the orebody on the 137 level (Plan No. 13), agrees with this strikeswing and with the dip which progressively becomes northwesterly. Below the 137 level the orebody flattens and becomes almost horizontal in places. Since all information to date has indicated that the sulphide orebody is generally conformable with the enclosing sediments, one limb of a fold structure has effectively been outlined.

From drilling and outcrop information, it would appear that the folded sequence of Port Moresby Beds is relatively thin and is resting on or enclosed by the Sadowa Gabbro. The intrusion of this large sill-like body may be the cause of some of the fold structures, brecciation and small displacement faults recorded.

Evidence indicates that the sediments immediately enclosing the massive sulphide deposit are highly sheared and chloritic, and locally contorted. No apparent alteration of the wall rocks has occurred. The same is observed in the Buns Peak Formation.

Mineralization

The Laloki deposit is comprised of fine grained almost massive sulphide which was relatively competent for drilling purposes. Pyrite, marcasite and chalcopyrite are the most common sulphides. However, substantial amounts of sphalerite are also present. Detailed descriptions of grain size and relationships between the sulphides are described under the section entitled "Mineragraphy".

The average chemical composition of assays from the 137 foot level is recorded as follows: 4.67% Cu, 51.98% Fe, 39.97% S, 4.8% SiO₂, 2.8 dwts. Au and 10.8 dwts. Ag per long ton. Average zinc assays have been omitted.

Detailed sampling from some drill holes and surface outcrops has indicated that 30 to 35 percent of the sulphide orebody probably contains richer chalcopyrite bands. These bands seem preferentially oriented to the hanging wall side of the deposit, starting within several feet of the contact. Examples of this copper concentration are as follows:
hole L-4 contained 20 feet of 7.1% Cu, hole L-5 contained 25 feet of 9.5% Cu with values up to 14%, hole L-7 contained 11 feet of 6.5% Cu, surface sampling indicated zones of 6.6% and 5.3% copper over a total of 16.5 feet. Detailed information as to the distribution of the copper over a width of the deposit is not available for the other drill holes but the majority of hole L-7 assayed 7.8% Cu which must have included some very rich sections. The chalcopyrite content of most of these richer zones is readily recognized. One example of a high grade copper band near the footwall contact was indicated in hole L-5 where 14% Cu was intersected. Most of the remaining sulphide appears to carry from 2 to 3.5% Cu on the average.

Mineragraphy

Polished sections of Laloki sulphide have been studied in detail by Pontifex (1935) indicating the grain size and interrelationships of the various types of sulphide present. A sedimentary origin by colloidal precipitation is inferred. The report by Pontifex is condensed below:

Pyrite and marcasite are the most common iron sulphides; pyrite is generally dominant with marcasite generally rimming the pyrite. These minerals form subhedral and euhedral grains of two principal grain sizes with average sizes of 0.01mm. and 0.2 mm. The pyrite bands are intergrown with sphalerite and chalcopyrite. In most sections pyrite forms composite grains with chalcopyrite, pyrite and minor galena. Some of the pyrite shows a spheroidal character with concentric inner rings enclosing silica and, in places, sphalerite.

Chalcopyrite occurs in masses and grains in gangue filling or partly filling interstices in pyrite aggregates. In some places it occurs alone and elsewhere it is combined with other sulphides where it forms complex colloform and graphic intergrowths with sphalerite and galena. The chalcopyrite occurs in botryoidal, colloform, subhedral and brecciated masses which are intimately associated with sphalerite and minor galena.

The botryoidal masses have an average size of 0.15mm. and show scalloped margins. They are made up of an amorphous admixture of copper and zinc sulphides which, in some places, contain accessory lead sulphide. Sphalerite is the dominant component and is riddled by extremely fine veinlets and blebs of chalcopyrite; these have a random distribution and they give the sphalerite a brassy veneer.
In some masses these minerals form concentric colloform layers and chalcopyrite also forms radial structures in sphalerite. Galena occurs as blebs in the centre of some masses and as narrow concentric bands near the outer margins of others.

These masses occur in areas which grade imperceptibly into zones made up of chalcopyrite which, in turn, contain various types of sphalerite intergrowths. Here, chalcopyrite shows an incipient crystalline form and sphalerite has segregated into colloform bands and graphic and emulsion type intergrowths in chalcopyrite. In some grains, sphalerite and minor galena form a narrow marginal rim which indicates that they have diffused from the main body of the grain to the outer margins.

Between this zone and adjacent to the barytes gangue subhedral chalcopyrite which is virtually free of inclusions, is surrounded by relatively wide margins of sphalerite. This appears to be an advanced stage of segregation of the two minerals from the intergrowth stage mentioned above. The interface between sphalerite and barytes typically has a reniform shape and minor, narrow bands of galena are intergrown around the outer margin of some sphalerite.

The limbs of small folds in the Laloki ore are made up of a roughly consistent sequence of bands of these various chalcopyrite-sphalerite combinations. The core of the fold consists of barytes and a section away from this, progressively intersects zones of decreasing degrees of segregation of the copper and zinc sulphides. The band farthest away from the core consists of fine euhedral, subhedral and spheroidal pyrite.

Development and Nature of the Orebody

The original surface expression of the Laloki deposit was a 20-foot by 30-foot outcrop of gossanous sulphide, in the present open cut location. Subsequent underground development, particularly on the 137 level, further delineated the sulphide deposit over a 500-foot length. A series of vertical and inclined winzes sunk from the 137 level intersected the northwesterly dipping footwall and gave indications of down-dip potential. The 198 level was driven north from one winze but did not reach the No. 1 air shaft.
The underground workings were not visited during the field programme for the following reasons: shaft rehabilitation was required; provision of ventilation and other unknown problems were associated with access through one of two shafts; the 137 level adit was inaccessible, having reportedly been blasted in several locations before the Japanese invasion. In the latter instance, limited bulldozing at the collapsed adit portal location released a moderate water flow.

Previous open cut mining had reached the 87-foot bench before work terminated. Although the old open cut is largely filled with debris, it was possible to thoroughly sample two sulphide outcrops within the pit outline. Details regarding open cut and underground mining are shown on Plan No. 13.

The strike and dip potential of the Laloki deposit was tested during the period 1959 to 1961 when thirteen diamond drill holes totalling 5,572 feet were drilled. Three holes obtained four significant intersections of copper-bearing sulphides with one intersection being stratigraphically related to the main deposit. Some other holes intersected a "pyritic pug" or weak sulphide mineralization in sediments, both of which are interpreted as a marginal phase of the main sulphide lense. This exploratory drilling definitely established the lenticular nature and limited size of the main deposit.

A detailed interpretation of the orebody taking all information into account, including the drilling results of the 1968-69 programme, indicates that the sulphide body has a horizontal extent of approximately 525 feet along strike by 270 feet across strike and is present over a vertical range of approximately 180 feet. In shape, the orebody is a folded lense in two directions with the upper portion of the orebody being located on the curving limb of a fold. True thicknesses vary from 55 feet in the thicker upper portion, which has a dip of 60 to 40 degrees, to 15 to 20 feet on the gently dipping to flat lower northwestern portion of the orebody. The minimum drill hole thickness recorded is 4 feet in hole SC-1.

Irregularities were reported in the nature of the footwall during mining and development on the 137 level. Minor faults and folds apparently caused some dislocations of the orebody. However, the hanging wall was reported to be fairly regular on the 137 level.
Diamond Drilling

A total of 1,024 feet was drilled during the 1968-69 season in seven holes on the Laloki deposit. One hole was abandoned and five of the remaining six holes obtained sulphide intersections. Non-core drilling accounted for 264 feet and core drilling for 760 feet of the total footage. Drilling occurred over two periods, from August 30th to October 10th, 1968, and from November 28th, 1968 to March 17th, 1969. Details regarding the organisation and performance of the drilling programme are contained in the Introduction under the heading of "Diamond Drilling Organisation".

The purpose of the diamond drilling programme was (i) to provide fresh sulphide material for metallurgical testing and (ii) provide additional sulphide intersections which would permit an accurate tonnage and grade calculation to be made.

Drill core from four of the intersections was shipped to Melbourne for metallurgical testing. Very poor core recovery was obtained in the remaining intersection and no sample was forwarded.

The holes were located within the main portion of the sulphide body which had previously not been drilled, and this necessarily involved some risk with encountering underground workings. Two of the five drill intersections did in fact encounter underground workings which were successfully cased through in one instance, but caused the hole to be abandoned in the second case (hole L-5). Drill hole locations and details are shown on Maps Nos. 12, 13 and Sections 14 to 20.

It was observed that the plotting of the first three diamond drill holes at Laloki appeared to place the intersections approximately 10 feet higher than they should be when plotted on the mine sections. Also, hole L-2 intersected a mine opening which would be equivalent to the 137 foot level, with an approximate 10-foot adjustment required. This suggested that the elevation of the surface information (diamond drill hole collars, etc.) were not consistent with the underground adit information. Detailed surveys by Arman & Larmer correctly established the difference in elevation between the collars of air shaft No. 1 and No. 2. Since air shaft No. 2 is located close to the 137 level adit (72.6 feet above the rails), this established that the elevation of the 137 level was approximately 1,072 feet. A difference in elevation of approximately 93 feet was indicated by the surveyors versus an approximate 105 feet indicated
on an old longitudinal section showing air shaft No. 1 and noting that its collar elevation was 1,238 feet. It has been concluded that a drafting error occurred in placing the collar of the No. 1 air shaft too high above the 137 level. This had the net result of leaving the collar elevations for all the drill holes unchanged (No. 1 air shaft was elevation reference), but effectively increasing the vertical separation between the drill hole intersections and the 137 level adit. This has increased the ore reserves available below the 137 level.

Geochemical Exploration

Part of the regional geochemical programme of soil sampling was conducted in the Laloki-Sapphire King-Merrie England area. A total of approximately 27,500 line feet was surveyed at 100-foot intervals in this area. This represented approximately 25% of the overall geochemical programme.

Zones of contamination were identified near the 137 level adit portal and old trucking road.

Only one significant anomaly resulted from this survey. This anomaly is located immediately to the southwest of the Laloki deposit and is of moderate to strong intensity. The anomaly is over 400 feet long on the 1000 ppm copper contour with maximum values reaching 3800 ppm copper. This anomaly is exactly in line with an old exploration drive in a south-westerly direction from the 137 level adit. Shears containing weak copper mineralization were probably followed underground. Unfortunately the driving did not proceed sufficiently far and only touched on the outside of the anomaly which is shown on Map No. 3. A reasonable magnetic correlation is associated with this anomaly as indicated on Map No. 5.

This anomaly is considered particularly important and of a high priority, due to its proximity to the Laloki deposit. Should additional tonnage reserves be required in the Laloki area, then this anomaly should receive first consideration for further drilling. An electromagnetic survey should be conducted prior to drilling.
Ore Reserves

The following tonnage and grade have been calculated for ore remaining in the Laloki deposit:

Definite Ore:

<table>
<thead>
<tr>
<th>Level</th>
<th>Tonnage</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above 137</td>
<td>123,600</td>
<td>4.50% Cu</td>
</tr>
<tr>
<td>Below 137</td>
<td>182,300</td>
<td>5.61% Cu</td>
</tr>
<tr>
<td>Total</td>
<td>305,900</td>
<td>5.16% Cu</td>
</tr>
</tbody>
</table>

Probable Ore:

<table>
<thead>
<tr>
<th>Level</th>
<th>Tonnage</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 137</td>
<td>6,100</td>
<td>5.06% Cu</td>
</tr>
</tbody>
</table>

Possible Ore:

<table>
<thead>
<tr>
<th>Level</th>
<th>Tonnage</th>
<th>Grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Below 137</td>
<td>6,300</td>
<td>3.94% Cu</td>
</tr>
</tbody>
</table>

The above ore categories represent drill-indicated ore with a minimum of 180,000 long tons of the definite ore having been confirmed by development work.

The grade has been calculated from drill hole intersections and surface sampling results. The grade above the 137 level compares very favourably with a projection by Hooper (1941). Similarly, the grade of the 87-foot bench in the open cut at 3.68% copper compared identically with Hooper's figures. The improvement in grade below the 137 level has been largely brought about by two wide diamond drill core intersections which yielded high grade ore.

Both tonnage and grade have been adjusted from original calculations to take into account the previous mining of 40,500 tons in this deposit.

Details regarding the composition of all drill intersections used in calculating the grade of this deposit are listed in Appendix II and III at the back of this report. Details of the tonnage and grade calculation itself are listed in Appendix Iv at the back of this report.

The tonnage for the deposit has been calculated in three separate manners, with two of them showing in Appendix Iv. The most conservative of these calculations has been used for tonnage purposes. The volumes attached to the polygonal net calculation have been used to provide a more accurately calculated grade.

Maps and sections Nos. 12 to 20 detail the Laloki Deposit.
Mining Considerations

A preliminary estimate of ore available by open cut mining has been made with outlines shown on Plans and Sections Nos. 12 to 20.

Open Pit Data

Waste Rock Nature - highly fractured sediments which could be mined by bulldozers with rippers. Drilling and blasting costs, if required, should be minor per cubic yard.

Pit Angle - the soft broken rock, valley setting and relatively heavy rainfall call for a safe wall angle of 38 degrees. Benches have not been indicated on plans yet but smaller benches of the order of 30 foot width and 22 foot height would appear suitable.

Volumes - a total volume including ore of 535,000 cubic yards is indicated. Of this total, 45,000 cubic yards would be undiluted ore (1,213,000 cubic feet).

Detailed allowances for previously mined ore and much cross checking has not yet been completed but this figure represents approximately 40% of the Laloki ore reserves.

Ratio - Overburden plus waste to undiluted ore equals 10.9:1. This ratio will be further reduced when approximately 7 percent wall rock dilution is allowed for during open cut mining.

Underground Mining

Ore which is not mined through the open pit will be no more than 30 feet below the pit floor elevation. Down dip development will reach a maximum of 150 feet and strike development a maximum of 350 feet. Gradients from horizontal to 20 percent will be experienced on the footwall outline. Backs will average approximately 15 feet and vary from 6 feet to 35 feet.

It would appear that relatively cheap trackless mining operating through a safe portal established in the pit wall at the base of the open pit would be a suitable mining method. Previous reports about the ore having a tendency to fall when widths of over 15 feet are exposed should receive full consideration.
History and Previous Work

The first mining lease over the Mount Diamond Prospect was granted in December, 1907. A series of exploratory adits, shafts and connecting crosscuts, succeeded in locating a massive sulphide occurrence with a maximum horizontal width of approximately 30 feet, over a 200-foot strike length and a vertical height of 45 feet.

No stoping was done at the property and the only production recorded is a shipment of development ore in July, 1912, (Carne - 1912).

The area has been previously investigated by various companies interested in the Astrolabe Mineral Field, but only cursory examinations have been carried out.

During 1949 to 1950, the Bureau of Mineral Resources carried out a geophysical survey over the prospect, which indicated "strong, well defined, magnetic and self-potential anomalies", (Yates & Ferranti - 1965). Other authors have indicated that the Mount Diamond Prospect warranted further exploration and was a "tangible drilling prospect", (Thomas - 1962).

Lithology and Mineralization

Exposure in the Mount Diamond area is poor and knowledge of the lithology and structure has been gained from isolated outcrops, road cuts, drill core and underground workings.

The local geology includes members of the Port Moresby Beds, including argillites, lutites and minor shale, in addition to exposures of the Sadowa Gabbro.

The argillites are grey to pale greenish grey in colour with occasional lenses of dark grey shales. The argillites are indurated with occasional fissile sections, and siliceous zones tend to approach the composition of chert. Indistinct banding in shades of grey is common, with bands varying from 1/8 inch to one inch. The lutites
are similar in colour to the argillites but are generally softer and less competent and contain elongated chert nodules up to 9 inches in width. Calcereous faciess and calcite veining are rare in the local sedimentary sequence.

The Sadowa Gabbro outcrops extensively about one-quarter of a mile to the north and northeast of the prospect. Also, a small gabbro outlier is located only 500 feet south of the main sulphide zone.

The sulphide mineralization occurs within the Port Moresby Bed sequence and there is evidence to suggest that a second minor sulphide horizon is present 60 to 70 feet stratigraphically above the main zone. The upper horizon was weakly indicated in the diamond drilling and is present in gossanous form in adit "R". The lower horizon or main sulphide zone appears to vary in thickness with a maximum horizontal width of approximately 30 feet. Minor zones of weak copper mineralization most probably representing disseminated chalcopyrite in pyritic argillites, flank the sulphide zones. Values range from 0.2 to 0.5 percent copper in these sections.

The massive sulphide appears identical with the Laloki-type sulphide in nature and composition. The sulphide is fine grained and primarily composed of pyrite, marcasite, chalcopyrite, with minor pyrrhotite and magnetite. Oxidation of the sulphide mineralization resulting in gossan or gossanous sulphide has reached a depth of 50 to 60 feet in most places. Some sections of the mineralized zone are thought to be comprised of sulphide stringers within pyritic argillites in which oxidation has proceeded to a greater degree than in the very massive sulphide zone. In the latter, oxidation is evident for several inches below a limonitic crust in underground exposure. Brecciated zones within the sulphide have caused the sulphide to weather into nodular form on a scale of several inches to several feet. Intervening zones tend to be represented by soft, black, powdery or pugy material underground.

Underground sampling of massive sulphides indicated copper values ranging from 1 to 7 percent, with frequent values in the range of 2 to 3.5 percent. Average weighted assays from the 238 level indicated an average grade of 2.8% copper. Precious metal assays are not currently available over this zone. Previous underground sampling by Carne (1912) over an oblique 41 foot section of the main sulphide zone, indicated an average sulphide composition of 4.3% Cu, 0.93% Zn, 39.9% Fe, 28.1% S, 13.8% SiO₂, and 1.1 dwts. Au and 6.0 dwts. Ag per long ton. Sampling by Thomas (1962) indicated
an average of 4.65% Cu, 2.75 dwts. Au, and 0.5 ozs. Ag per long ton over the same zone. Osborne also sampled the upper tunnel (adit "Q") and obtained an assay of 2.9% Cu. The reduction in copper content between the 1968 sampling and previous sampling of the main sulphide zone may be attributable to solution leaching which has impoverished the copper values in the immediate proximity of the adit walls.

Structure and Interpretation

A study of all information from the 1968 drilling, underground sampling and geological mapping and reference to significant old records, has resulted in a general structural interpretation for the Mount Diamond Prospect. The resulting folded structure is shown on Plan No. 10 and accompanying sections on Drawing No. 11. Complete explanatory notes accompany these plans. Reference to these plans will reveal that the massive sulphide zone is located on an anticlinal fold with the mineralization stopping abruptly on the north-dipping limb but tailing off into a weaker zone of sulphide stringers within a pyritic argillaceous zone on the south-dipping limb. The crest of the anticline and most of the south limb are generally sufficiently close to surface to have had the mineralized zone rendered gossanous to varying degrees with the resulting impoverishment of copper values. Of the three holes drilled down dip from the main sulphide zone to the north, only one yielded slight indications of the presence of this zone.

In detail, the structure is undoubtedly complex. Brecciated zones developed during folding, post ore faults of relatively minor displacement, fold irregularities including drag fold structures, and the possibility of cross-folding have all contributed to the structural complexity.

On the basis of limited rock attitude data, the interpreted fold sequence repeats itself to the north and south of the mineralized area.

The pattern of underground testing and development which followed the finding of surface gossans in the Mount Diamond area is of interest. Apparently, adit "A" was first driven to a length of 180 feet and passed through the main sulphide zone at that horizon.
Subsequently a shaft was sunk approximately 90 feet east of the original sulphide intersection with the hanging wall contact of the massive sulphide zone having been intersected at a vertical depth of 80 feet. The shaft was then inclined and followed the sulphide contact down to the horizon of the original adit where it was subsequently connected. Adit "Q", 38 feet higher than adit "A" and approximately 100 feet west along strike, also intersected the sulphide zone but failed to establish the horizontal width of the sulphide in this area. This work succeeded in indicating a sulphide occurrence over a strike length of approximately 200 feet, a vertical extent of 45 feet and the maximum horizontal width of approximately 30 feet. Other adits have yielded additional information. Adit "B" to the east, intersected the south-dipping limb of the structure in an oxidised environment. Adit "C" presumably intersected the tail end of the peripheral weak zone of mineralization surrounding the main sulphide zone. Adit "P", 38 feet above the original adit "A", intersected highly gossanous material near the crest of the anticline but may have intersected better sulphides further into the hill in areas which are now inaccessible. Two small adits, "S" and "R", at a somewhat higher elevation, indicated another gossanous zone which most probably represents a parallel mineralized horizon. Finally, adit "U", at an elevation of 147 feet with its portal being located near Maiberi Creek, was driven for a length of 300 feet at which point it branched out into a Y, proceeding approximately 50 feet on each branch. This adit was obviously the latest development work and it is not known why the drive was not continued further. The south-dipping limb of the mineralized zone would have been encountered in adit "U", however no mineralization was observed.

Underground Mapping and Sampling

The portal position of all adits in the Mount Diamond area were tied into the survey grid by the local contract survey company, Arman & Larmer, using a transit. Underground workings were surveyed with tape, prismatic compass and clinometer. Since it was found that the proximity of sulphides affected the compass readings, turning points in drives were measured by a change in compass direction with clinometer checks. The resulting plan of underground workings shows considerable variation from plans previously recorded for this prospect.
Underground conditions were far from ideal for working. The humid, foul air which contained varying degrees of hydrogen disulphide gas from decomposed bat droppings was somewhat dangerous and as a result, the work proceeded slowly with intervals of fresh air outside. Other obstacles were varying numbers of bats which were extremely dense in adit "U" and water which was up to 3 feet deep in places.

Almost all of the adit walls were in a state of oxidation and decomposition, being covered with several inches of thick limonitic crust, both massive and cellular, which obscured the lithology and structure. Immediately beneath this layer, a leached pale zone was present. Undoubtedly copper values have been leached from sulphides and redeposited along solution planes, etc. In adit "A", a zone of hydrous iron stalactites is present, which may represent a more permeable sheared zone. Several of the crosscuts and changes in direction of the adits are probably due to the old miners following iron-enriched and copper-stained shears in the hope that sulphide would be encountered.

Due to the conditions mentioned above, the quality and reliability of the information which was recorded is not as good as desired, but a larger programme of slashing the walls to a greater depth to obtain more reliable information was not warranted or possible within the scheduled field programme. Structural information is shown on Map No. 12.

The Mount Diamond workings have been previously mapped and reported on by other authors as follows: Carne (1912), King (1950), Glasson (1954) and Thomas (1962).

Underground sampling was undertaken, generally on both walls of the adits. In order to remove contaminating surface material, holes were dug into the walls at approximate 3-foot centres and sample material was collected at an average depth of approximately 6 inches. Sampling was generally at a height of about 4½ feet above the adit floor. Unfortunately, the system of sampling employed resulted in an average of 6 inches sample length for every three feet of adit advance. However, sampling on both walls has effectively increased the sampled length. Bad working conditions, lack of co-operation with the native labour and time requirements were the main considerations for not adopting a more complete sampling procedure. However, the results of the sampling are considered to be quite valid over larger areas where the results of samples have been averaged.
Some sulphide present in a flat-lying position or exposed only on the back in some adits was inadvertently not sampled. However, this sulphide was mapped and has been correlated with the general interpretation of the deposit.

It was observed that considerable copper staining was present along fissures in adit "B" without any sulphide having been recognized. It is possible that the copper values recorded were entirely due to solution deposition along fault planes and/or that all signs of original thin sulphide stringers thought to be present have been oxidised into gossanous form.

Diamond Drilling

Arrangements for the bulldozing of access tracks and drill pads were made by W. Brook. The contract surveyors, Arman & Larmer, were responsible for carrying out this work which was located in very hilly terrain.

The diamond drilling programme at the Mount Diamond Prospect commenced on October 17th and terminated on December 16th, 1968. The rig and equipment were moved off the hill and down the steep access track just in advance of the seasonal rains which would have made this a difficult task.

A total of three holes were drilled during the programme, totalling 980 feet. Of this total, 702 feet was cored and 278 feet was drilled non-core. All three holes were drilled from the same location with two being on the same line and one oblique hole.

Hole D-1 was designed to intersect the north-dipping sulphide lode approximately 150 to 180 feet down-dip. This hole was drilled at 87 degrees and the target area was expected between 250 and 320 feet. The hole was terminated at 361 feet when no sulphides had been encountered.

Hole D-2 was drilled up-dip from D-1 at an angle of 65 degrees to the south. This hole was designed to intersect roughly half-way between D-1 and the known sulphide occurrence in adit "A". This hole was terminated at 329 feet without any intersection.
The next drill target was located approximately 100 feet east and somewhat below the elevation of the sulphide in adit "A". This target also coincided with the eastern portion of the magnetic anomaly over the sulphide zone. The hole was drilled at a flat angle of 41\(\frac{1}{2}\) degrees with non-coring for 170 feet. The following is a list of sulphide intersections obtained at Mount Diamond (all hole D-3):

- From 190.0 to 195.5 = 5.5 feet of 0.25% Cu (10% sulphide)
- From 195.5 to 195.8 = 0.3 feet of 4.0% Cu
- From 214.0 to 216.0 = 2.0 feet of 0.2% Cu
- From 238.0 to 240.0 = 2.0 feet of 0.27% Cu (2% sulphide)
- From 241.8 to 244.0 = 2.2 feet of 2.6% Cu

Ore Potential

Probable ore reserves at the Mount Diamond deposit are approximately 29,000 long tons at a grade between 2.8% and 4.5% copper.

The range in copper values shown is attributable to an average weighted copper assay of 2.8% having been obtained from the 1968-69 underground sampling, compared with sampling on two previous occasions which has indicated grades of 4.3% and 4.65% copper. Although the surface crust was removed during sampling, it is believed that copper values have been leached from adit walls during the last few decades and the resulting samples are therefore not necessarily representative. Further testing by percussion drilling could definitely establish the correct grade and better define the width of the mineralization in several areas.

Of the probable 29,000 long tons indicated above, approximately 50% of this tonnage could be considered as proven ore through development work.

Underground sampling results were averaged in the sulphide zone from sampling on both walls of the adits. These averages were then calculated together on an area basis to provide an average grade of 2.8% copper.

According to the interpretation projected on Map No. 10 and the accompanying Sections, the upward projection of the sulphide zone is gossanous, which limits the zone of copper values, and the diamond drill intersections limit the down-dip projection.
Projection below adit "A" was 50 feet down-dip or one-half the distance to Hole D-2 on Section 10, 100 East. Projection on Section 10, 200 East where Hole D-3 passed immediately below the projected sulphide zone was approximately 25 feet.

Strike projection to the east of the sulphide zone is considered highly improbable but the deposit is open to the west. There is a suggestion that the sulphide zone has thinned in a westerly direction but this must be confirmed by test drilling from surface or underground. No significant magnetic anomaly is located to the west to support this projection.

The following calculations were used to arrive at the probable tonnage of the Mount Diamond Prospect:

<table>
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<tr>
<th>Sections</th>
<th>Dimensions</th>
<th>Area</th>
<th>Length</th>
<th>Volume</th>
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<tr>
<td></td>
<td>feet</td>
<td>sq. ft.</td>
<td>feet</td>
<td>cu. ft.</td>
</tr>
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<td>800</td>
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<td>15' x 60'</td>
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<tr>
<td>Total Cubic Feet</td>
<td></td>
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<td>287,500</td>
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</table>

Tonnage Factor = 10.0 cubic feet/long ton

Ore tonnage = \[
\frac{287,500}{10.0} = 28,750 \text{ long tons}
\]

OR approximately 29,000 long tons
History and Previous Work

The main producer in the area has been the Dubuna Mine. Yates and Ferranti (1965) conclude that total production has been 20,000 tons and that underground reserves amount to 25,000 tons. Two other prospects, the Ruby and Pari, have been opened up by shafts and adits but no ore has been shipped and no reserves developed.

The Bureau of Mineral Resources conducted a magnetic and self-potential survey over the Dubuna and Pari Prospects in 1949 and 1950 (Tate 1951). This survey located magnetic and self-potential effects which could be attributed to sulphide mineralization at both the Dubuna and Pari Prospects, but magnetic results were difficult to interpret and it was considered that the self-potential method was not really effective in the area.

Geology

Mapping by the Bureau of Mineral Resources shows that Port Moresby Beds trend northwesterly from the Pari Prospects through to the Dubuna and Ruby Prospects. The Port Moresby Beds are bounded on the east and west by the Sadowa Gabbro which also underlies the Port Moresby Beds. This corridor of the Port Moresby Beds varies from 1200 to 3000 feet wide.

Eastwards from the Pari Prospect the rock types are dominantly Port Moresby Beds with apophyses of Sadowa Gabbro protruding in places. Dip and strike readings indicate that a major strike change hinges on the Pari Prospect with northwest trends to the north of Pari and easterly trends to the east of Pari.

Regional Geochemical Survey

A total of approximately 500 soil samples were taken during the survey over a continued strike length of 3 miles. These samples represented the coverage of 104,000 line-feet with 27,500 line-feet located in the Laloki area and 76,500 line-feet in the Mount Diamond Dubuna area.

Lines for geochemical traverses were laid in by Arman and Larmer, surveyors of Port Moresby, using a theodolite and stadia.
Samples were taken by a hand auger from the soil/bedrock interface where possible and were analysed by Sampey Exploration Services of Perth for total copper, lead, zinc and silver by atomic absorption spectrophotometry. Samples were screened to minus 80 mesh and the finer fraction analysed. Initial sample analyses were undertaken at the laboratory of the Mines Department in Port Moresby, using an atomic absorption unit. However, as these results proved to be unreliable, all samples were channeled through Perth. As a result of this early work, some samples were lost or destroyed in the Mines Department. Where important, these samples were recollected in the field.

Initial sample traverses were at a separation of 800 feet with a sample interval of 100 feet. Where significant results were located, the traverse separation was closed to 400 feet and subsequently to 200 feet, if necessary.

The average copper background value in soil developed over the Port Moresby Beds is approximately 150 ppm. Silver, lead and zinc values generally show little variation although in the zones of high copper, the zinc values tend to become anomalous. The maximum copper value located in the soil was 6,000 ppm from Line 3800 North. This value is part of an anomalous trend southwards from the Dubuna Prospect. Generally the copper anomalies form a sensible pattern with a predominantly northwesterly trend, particularly between the Dubuna and Pari Prospects. In the area between Pari and Mount Diamond, and slightly to the north, the anomalies are not particularly linear and may represent folded sequences in the Port Moresby Beds.

Most of the known prospects are contaminated by mining and orientation surveys are valueless. The Pari Prospect is one of the few in the area on which an orientation survey could be conducted and values up to 2100 ppm copper were obtained over this known sulphide occurrence. Using this as a general measure of the value of other anomalies, it is considered that those anomalies with values in excess of 2,000 ppm copper could represent sulphide mineralization.

**Magnetometer Survey**

Zones of significant geochemical anomalies were surveyed magnetically with a Sharpe MF-1 fluxgate magnetometer. Readings were taken every 50 feet along the soil sample traverses. Diurnal variations were checked and found not to exceed 20 gammas.
The magnetic survey did not locate continuous anomalies which could be definitely attributed to the same source as the copper anomalies. Discussions were held with Mr. B. Dochery of Seigel Associates Australasia, who considers that the anomalies represent very shallow sources, probably less than 50 feet and that they may reflect the effect of oriented magnetic particles within the Port Moresby Beds. Mr. Dochery considers that much more detail magnetic work would be necessary in order to provide sufficient meaningful data. The effect of the underlying gabbro with its potential apophyses makes interpretation more difficult and uncertain. Work by the Bureau of Mineral Resources indicated that most of the sulphides and the Sadowa Gabbro are weakly magnetic while the Port Moresby Beds are relatively non-magnetic.

In a few instances, notably geochemical anomalies G-3, G-4 and G-5, it appears that the associated magnetic anomaly could be attributed to the same source as the geochemical anomaly. However, these magnetic anomalies have little strike extension.

The most significant geochemical anomalies are G-5 and G-6 which extend southwards from the Dubun Workings for a combined distance of 2400 feet.

Discussion of Geochemical Anomalies

Anomaly G1

Geochemical anomaly G1 extends in a bowed fashion from Line 400 North to 600 North and has a total length of 600 feet within the 1000 ppm. copper contour. The maximum value in this anomaly is 2100 ppm copper at Line 400 North. Magnetic trend M1 has a length of 200 feet and strikes parallel to the baseline at an azimuth of 340 degrees between Lines 400 and 600 North. This magnetic trend is coincident with the geochemical anomaly at Line 400 North and is of weak intensity. The area covered by this geochemical anomaly includes the Pari Workings which located minor copper sulphides.

Anomaly G2

Geochemical anomaly G2 strikes parallel to the baseline from Line 1000 North to Line 1200 North. The maximum value in this anomaly of 2600 ppm copper occurs at Line 1200 North. The anomaly has a length of 400 feet within the 500 ppm copper contour.
Anomaly G3

Geochemical anomaly G3 extends from Line 1600 North to Line 2600 North and strikes approximately due north over a length of 1200 feet on the 500 ppm copper contour. Maximum values in this anomaly are 2600 and 2900 ppm copper at Lines 2000 and 2400 North respectively. From 1800 North to 2000 North, the geochemical anomaly is coincident with magnetic trend M3, which extends from Line 1800 North to Line 2400 North and is of weak to moderate intensity. At 2000 North, M3 parts with G3 and strikes in a northwesterly direction. From 2400 North to 2600 North, the geochemical anomaly is closely paralleled by magnetic trend M3A, with a maximum lateral offset of 10 feet. M3A is of moderate to strong intensity.

Anomaly G4

Geochemical anomaly G4 extends from Line 2000 North to Line 3200 North and strikes parallel to the baseline with a length of 1000 feet on the 1000 ppm copper contour. A maximum value of 2300 ppm copper occurs at Lines 2800 and 3000 North. G4 is closely paralleled throughout its extent by a weak magnetic trend, M4, with a maximum lateral offset of 100 feet. This geochemical anomaly is probably the southern continuation of anomaly G6.

Anomaly G5

Geochemical anomaly, G5, extends from Line 2200 North to Line 2400 North, but has its maximum development along Line 2400 North where it is coincident with a magnetic plateau. It has a length of 600 feet within the 1000 ppm copper contour. A maximum value of 2400 ppm copper occurs at 2200 North at the south end of the anomaly. A magnetic anomaly extends from the northern end of G5 to Line 2800 North.

Anomaly G6

The strongest geochemical anomaly, G6, extends from Line 3600 North to Line 4400 North, and trends parallel to the baseline at an azimuth of approximately 340 degrees with a length of 900 feet within the 1000 ppm copper contour.
Anomaly G6 lies immediately south of the Dubuna workings and has maximum values of 5000 and 4000 ppm copper at Lines 3800 and 4000 North respectively. A weak magnetic trend, M6, extends from Line 3600 North to Line 4000 North and is offset 100 to 200 feet to the east of anomaly G6. A gossan centred on Line 4400 North is coincidental with anomaly G6, and is more or less continuous with the Dubuna mineralization. A self-potential anomaly is associated with the northern end of anomaly G6. Small pits and costeans have been sunk on G6 and Tate (1951) reports a sulphide occurrence, presumably near Line 4000 North. A strong, isolated magnetic anomaly occurs in the vicinity of G6, at 550 East on Line 3600 North. This is the most significant copper anomaly located and it most probably represents sulphide mineralization.

Anomaly G7

Geochemical anomaly G7 extends from Line 1600 North to Line 2400 North. The 1000 ppm contour has a length of 400 feet and a width of 250 feet. The maximum value is 1500 ppm copper. This anomaly is located 750 feet northwest of the Mount Diamond mineralization.
Previous Work

Previous testing has included flotation tests on tailings from the Laloki deposit (Stillwell - 1942), Report No. 235; test work on the treatment of gold-copper ore from the Laloki Mine by Hart & Dunkin (1942), Investigation No. 233, Melbourne University Ore Assessing Laboratory; and most recently by Blaskett and Dunkin (1948) who did further flotation tests on gold-copper ore from the Laloki Mine, Investigation No. 349, Metallurgical Laboratory, University of Melbourne. Roberts (1960) and Pontifex (1965) have studied drill core specimens from the Laloki deposit and from several deposits in the Astrolabe Mineral Field respectively to determine the relationship between the sulphide minerals present. A summary of Pontifex' mineralogical investigation of Laloki ore is presented on page 26 under the heading "Mineralography".

Generally, the Laloki ore has been found to be very fine grained with intergrowth relationships between pyrite, marcasite, chalcopyrite and sphalerite on varying scales. This has called for fine grinding to release the chalcopyrite during flotation. Previous grinds of 90% minus 200 mesh have been used but even then composite particles containing chalcopyrite have been present.

The best test result previously recorded (Blaskett & Dunkin - 1948), Investigation No. 349, Test No. 447, obtained a 70.6% recovery with a 14.05% copper concentrate grade. The head grade for this sample was 2.7% copper and the sample is believed to have come from the open cut where a higher degree of oxidation may have been present in the ore than at lower levels.

Blaskett (1948), stated that a 75% recovery with a 15% concentrate was the best that could be expected with the sample material that had been provided up to that time. Possibly less oxidised sample material which would be more representative of the deeper ore in the Laloki deposit could improve further on these suggested upper limits.
Sample Material

Split core and sample reject material totalling 188 pounds from Holes L-5 and L-7 were shipped from Perth to the C.S.I.R.O. in Melbourne in early April, 1969. The approximate grade of the samples was 7.2% copper in Hole L-5 and 3.8% copper in Hole L-7. Core from these holes had been air freighted from Port Moresby and was logged, split and assayed in Perth prior to shipment to the C.S.I.R.O. in Melbourne. All samples were thoroughly dried and then doubly sealed in plastic bags to reduce oxidation.

It was recommended in a covering letter that the minus quarter inch crushed reject material be used first in test work, rather than the remaining one-half of the split drill core.

Drill core from Holes L-2 and L-3 weighing 243 pounds was shipped from Port Moresby directly to Melbourne during September-October, 1968 at the urgent request of Mr. K. Turner. This resulted in the core being despatched without having been split or assayed. All drill core was supplied in 1-foot lengths in doubly sealed plastic bags which were clearly labelled. Core was shipped by alternate feet in two separate lots from Port Moresby in case of loss during transit.

Unfortunately, no assaying of individual sections of Holes L-2 and L-3 occurred in Melbourne and all of the core from each hole was bulked to produce two samples, Lots A and B. Copies of drill logs describing the nature of the sulphide intersection with footage intervals had been provided to the C.S.I.R.O. through Mr. Turner.

Reporting

The direction of the metallurgical testing programme has been provided by Mr. H.K. Turner, Melbourne Mining Consultant, who has been in liaison with the C.S.I.R.O. representatives in Melbourne. No information on the current testing programme is included in this report. A separate report covering test work to date will be issued by the C.S.I.R.O.
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**APPENDIX 1**

**DIAMOND DRILLING DATA SHEET**

**1968-69 PROGRAMME**

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<td>85W</td>
</tr>
<tr>
<td>L-3</td>
<td>Laloki</td>
<td>F30</td>
<td>23. 9.68</td>
<td>10.10.68</td>
<td>235S</td>
<td>24W</td>
</tr>
<tr>
<td>L-4</td>
<td>Laloki</td>
<td>F6</td>
<td>28.11.68</td>
<td>5. 1.69</td>
<td>347S</td>
<td>141W</td>
</tr>
<tr>
<td>L-5</td>
<td>Laloki</td>
<td>F30</td>
<td>2. 1.69</td>
<td>8. 3.69</td>
<td>68S</td>
<td>111E</td>
</tr>
<tr>
<td>L-6</td>
<td>Laloki</td>
<td>F6</td>
<td>23. 1.69</td>
<td>17. 3.69</td>
<td>352S</td>
<td>54W</td>
</tr>
<tr>
<td>L-7</td>
<td>Laloki</td>
<td>F30</td>
<td></td>
<td></td>
<td>355S</td>
<td>55W</td>
</tr>
</tbody>
</table>

**Total** Laloki = 5 holes (effective)

|       | Mt. Diamond | F30 | 17.10.68 | 7.11.68 | 9658S | 10115E | 404 | 165 | 87 | 333 | 28 | 361 |        |
|       | Mt. Diamond | F30 | 15.11.68 | 28.11.68 | 9660S | 10115E | 404 | 165 | 65 | 249 | 80 | 329 |        |
|       | Mt. Diamond | F30 | 6.12.68  | 16.12.68  | 9661S | 10117E | 404 | 136 | 41.5 | 120 | 170 | 290 |        |

**Total** Mt. Diamond = 3 holes

|       | Grand Total |      |         |         |       |       |     |     |     | 1462 | 542 | 2004 |        |

50
# APPENDIX II

**DIAMOND DRILLING DATA AND INTERSECTIONS**

**1959-61 PROGRAMME AT LALOKI**

## SURVEY DATA

<table>
<thead>
<tr>
<th>Hole No.</th>
<th>Co-ordinates</th>
<th>Elevation (R. L.)</th>
<th>Azimuth</th>
<th>Angle</th>
<th>Length feet</th>
<th>Elevation Marker Bed</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC- 1</td>
<td>79W 103S</td>
<td>1222</td>
<td>-</td>
<td>90</td>
<td>400</td>
<td>1024</td>
</tr>
<tr>
<td>SC- 2</td>
<td>240W 145S</td>
<td>1179</td>
<td>156M</td>
<td>70</td>
<td>455</td>
<td>1032</td>
</tr>
<tr>
<td>SC- 3</td>
<td>7E 25S</td>
<td>1240</td>
<td>162M</td>
<td>80</td>
<td>270</td>
<td>1200-1014</td>
</tr>
<tr>
<td>SC- 4</td>
<td>118E 130N</td>
<td>1255</td>
<td>180M</td>
<td>60</td>
<td>301</td>
<td>95 est.</td>
</tr>
<tr>
<td>SC- 5</td>
<td>379W 180S</td>
<td>1157</td>
<td>157M</td>
<td>60</td>
<td>482</td>
<td>993</td>
</tr>
<tr>
<td>SC- 6</td>
<td>118E 130N</td>
<td>1255</td>
<td>-</td>
<td>90</td>
<td>508</td>
<td>938</td>
</tr>
<tr>
<td>SC- 7</td>
<td>28W 115N</td>
<td>1242</td>
<td>-</td>
<td>90</td>
<td>553</td>
<td>957</td>
</tr>
<tr>
<td>SC- 8</td>
<td>265E 94N</td>
<td>1295</td>
<td>-</td>
<td>90</td>
<td>551</td>
<td>1011</td>
</tr>
<tr>
<td>SC- 9</td>
<td>360E 304N</td>
<td>1325</td>
<td>-</td>
<td>90</td>
<td>497</td>
<td>-</td>
</tr>
<tr>
<td>SC-10</td>
<td>506E 190N</td>
<td>1332</td>
<td>-</td>
<td>90</td>
<td>511</td>
<td>953</td>
</tr>
<tr>
<td>SC-11</td>
<td>397E 97N</td>
<td>1315</td>
<td>-</td>
<td>90</td>
<td>533</td>
<td>1017</td>
</tr>
<tr>
<td>SC-12</td>
<td>328E 45S</td>
<td>1319</td>
<td>-</td>
<td>90</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>SC-13</td>
<td>452E 402S</td>
<td>1158</td>
<td>-</td>
<td>90</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
## APPENDIX II
### INTERSECTION DATA
(continued)

<table>
<thead>
<tr>
<th>Hole No.</th>
<th>From ft.</th>
<th>To ft.</th>
<th>Length ft.</th>
<th>Cu%</th>
<th>Zn%</th>
<th>Au</th>
<th>Ag</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC - 1</td>
<td>184.9</td>
<td>197.3</td>
<td>12.4</td>
<td>2.3</td>
<td>25.2</td>
<td>28.8</td>
<td>2.63</td>
<td>Py, cpy, sp &amp; qtz.</td>
</tr>
<tr>
<td>SC - 2</td>
<td>153.0</td>
<td>166.3</td>
<td>13.3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Zones py, pug.</td>
</tr>
<tr>
<td>SC - 3</td>
<td>20.5</td>
<td>28.0</td>
<td>7.5</td>
<td>10.9</td>
<td>4.0</td>
<td>3.7</td>
<td>0.7</td>
<td>Mass. py, cpy with some shale.</td>
</tr>
<tr>
<td>SC - 3</td>
<td>206.0</td>
<td>224.0</td>
<td>18.0</td>
<td>3.1</td>
<td>0.8</td>
<td>1.2</td>
<td>1.8</td>
<td>Mass py and cpy.</td>
</tr>
<tr>
<td>SC - 4</td>
<td>267.0</td>
<td>289.2</td>
<td>22.2</td>
<td>4.8</td>
<td>0.3</td>
<td>0.2</td>
<td>0.7</td>
<td>&quot; &quot; &amp; pyr.</td>
</tr>
<tr>
<td>SC - 5</td>
<td>208.7</td>
<td>220.0</td>
<td>12.3</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Rare py blebs.</td>
</tr>
<tr>
<td>SC - 6</td>
<td>308.0</td>
<td>309.0</td>
<td>1.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Py, cpy in pug.</td>
</tr>
<tr>
<td>SC - 6</td>
<td>349.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Py, cpy, strg.</td>
</tr>
<tr>
<td>SC - 7</td>
<td>155.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Py in bx.</td>
</tr>
<tr>
<td>SC - 7</td>
<td>276.6</td>
<td>276.6</td>
<td>0.2</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Py pug.</td>
</tr>
<tr>
<td>SC - 8</td>
<td>262.2</td>
<td>263.0</td>
<td>0.8</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Mass. py and cpy.</td>
</tr>
<tr>
<td>SC - 8</td>
<td>268.0</td>
<td>284.0</td>
<td>16.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Py, pug and mass.</td>
</tr>
<tr>
<td>SC - 9</td>
<td>432.0</td>
<td>433.0</td>
<td>1.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>sulph. (2 feet)</td>
</tr>
<tr>
<td>SC-10</td>
<td>331.7</td>
<td>376.7</td>
<td>45.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Py, pug.</td>
</tr>
<tr>
<td>SC-11</td>
<td>268.0</td>
<td>296.0</td>
<td>28.0</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>Weakly pyritic</td>
</tr>
</tbody>
</table>

*Note: it is assumed that Au values are in dwts/long ton and Ag values are in ozs./long ton.

### Abbreviations:
- py = pyrite
- cpy = chalcopyrite
- sp = sphalerite
- qtz = quartz
- mass = massive
- bx = breccia
- strg = stringer
- sulph = sulphide.

### Source of Information:
The information presented above is from the Bureau of Mineral Resources, Geology and Geophysics, June 1961 to accompany Record 1961/49 (reference - Plate 1, Laloki Mine, "Summary of Drilling Results to 17.2.61", PNG8C-14).
APPENDIX III.

DRILL HOLE INTERSECTION DETAILS

1968-69 PROGRAMME

The following list details the results of all drill hole intersections for 1968-69, showing significant assays, estimated percent sulphide, assay results (incomplete in part) and weighted average assay values. Other calculations to arrive at grade information is also detailed.

The results of previous drilling are also tabulated.

LALOKI DEPOSIT - 1968-69 DRILLING

Hole L-1

This hole missed the down-dip projection of the Laloki deposit but the horizon was indicated by one inch of chalcopyrite at 109 feet.

Hole L-2

Most of the sulphide intersections in addition to some of the adjacent core for holes L-2 and L-3 was directly air freighted to the C.S.I.R.O. in Melbourne for metallurgical testing. Only bulk assay results were made available to Watts, Griffis and McQuat (Australia) Pty. Ltd. and theoretical grades have been calculated. Drill logs were supplied to the C.S.I.R.O.

In a letter dated April 8, 1969, Mr. G.W. Heyes of the C.S.I.R.O. advised a head assay of 7.9% Cu, 42.3% Fe and 40.9% S covering 171.2 pounds of sample material (sample Nos. 1000 to 1050 inclusive). No sub-division of the sample submitted occurred and assays for separate sections are unfortunately not available. Therefore the following theoretical calculation was made:
## Sample Submitted to C.S.I.R.O.

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>From (feet)</th>
<th>To (feet)</th>
<th>Length (feet)</th>
<th>Recovered (feet)</th>
<th>Est. Sulph.</th>
<th>Est. Cu.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>41.0</td>
<td>42.2</td>
<td>1.2</td>
<td>1.0</td>
<td>100%</td>
<td>15%</td>
</tr>
<tr>
<td>1001</td>
<td>58.0</td>
<td>58.5</td>
<td>0.5</td>
<td>0.5</td>
<td>100%</td>
<td>20%</td>
</tr>
<tr>
<td>1002</td>
<td>62.0</td>
<td>63.0</td>
<td>1.0</td>
<td>1.0</td>
<td>100%</td>
<td>15%</td>
</tr>
<tr>
<td>1003</td>
<td>63.0</td>
<td>63.5</td>
<td>0.5</td>
<td>0.5</td>
<td>100%</td>
<td>15%</td>
</tr>
<tr>
<td>1004-12</td>
<td>65.0</td>
<td>74.0</td>
<td>9.0</td>
<td>9.0</td>
<td>80%</td>
<td>10%</td>
</tr>
<tr>
<td>1013</td>
<td>74.5</td>
<td>77.0</td>
<td>2.5</td>
<td>2.0</td>
<td>80%</td>
<td>? (mush)</td>
</tr>
<tr>
<td>1014-15</td>
<td>84.0</td>
<td>86.5</td>
<td>2.5</td>
<td>1.0</td>
<td>20%</td>
<td>?</td>
</tr>
<tr>
<td>1016-23</td>
<td>86.5</td>
<td>96.0</td>
<td>9.5</td>
<td>8.0</td>
<td>80%</td>
<td>?</td>
</tr>
<tr>
<td>1024</td>
<td>96.0</td>
<td>97.0</td>
<td>1.0</td>
<td>1.0</td>
<td>20%</td>
<td>?</td>
</tr>
<tr>
<td>1025-46</td>
<td>97.0</td>
<td>119.0</td>
<td>22.0</td>
<td>22.0</td>
<td>100%</td>
<td>9%</td>
</tr>
<tr>
<td>1047-50</td>
<td>119.0</td>
<td>123.0</td>
<td>4.0</td>
<td>4.0</td>
<td>100%</td>
<td>?</td>
</tr>
</tbody>
</table>

Total 53.7 50.0 89.2%

Average C.S.I.R.O. grade reported = 7.90% Cu.

Now subtract 1.0 feet (41.0 to 41.2) at estimated 12.8% Cu. to leave an average grade of 7.80% Cu. (referred to as "M" below).

Lower grade sections of the L-2 intersection were assayed separately and are shown below:

### L-2 Intersection:

<table>
<thead>
<tr>
<th>Sample No.</th>
<th>From (feet)</th>
<th>To (feet)</th>
<th>Length (feet)</th>
<th>% Cu</th>
<th>%Zn.</th>
<th>Au</th>
<th>Ag</th>
</tr>
</thead>
<tbody>
<tr>
<td>1786</td>
<td>56.0</td>
<td>58.0</td>
<td>2.0</td>
<td>0.45</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>58.0</td>
<td>58.5</td>
<td>0.5</td>
<td>7.80</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1787</td>
<td>58.5</td>
<td>60.5</td>
<td>2.0</td>
<td>0.80</td>
<td>0.28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1788</td>
<td>60.5</td>
<td>62.0</td>
<td>1.5</td>
<td>2.50</td>
<td>0.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>62.0</td>
<td>63.5</td>
<td>1.5</td>
<td>7.80</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1789</td>
<td>63.5</td>
<td>65.0</td>
<td>1.5</td>
<td>1.90</td>
<td>0.21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>65.0</td>
<td>74.0</td>
<td>9.0</td>
<td>7.80</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>74.0</td>
<td>74.5</td>
<td>9.0</td>
<td>0.5</td>
<td>Nil</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>74.5</td>
<td>77.0</td>
<td>2.5</td>
<td>7.80</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drive*</td>
<td>77.0</td>
<td>84.0</td>
<td>7.0</td>
<td>1.90*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>84.0</td>
<td>123.0</td>
<td>39.0</td>
<td>7.80</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: Au and Ag values are in dwts/short ton.

-54-
Drill Hole Intersections (Results to be plotted on Holes)

Hole L-2 Summary

<table>
<thead>
<tr>
<th>% Sulph.</th>
<th>Cu %</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>41.0 to 42.2 = 1.2 ft.</td>
</tr>
<tr>
<td>2</td>
<td>54.0 to 56.0 = 2.0 ft.</td>
</tr>
<tr>
<td>5</td>
<td>56.0 to 58.0 = 2.0 ft.</td>
</tr>
<tr>
<td>40</td>
<td>58.0 to 65.0 = 7.0 ft.</td>
</tr>
<tr>
<td>75</td>
<td>65.0 to 77.0 = 12.0 ft.</td>
</tr>
<tr>
<td></td>
<td>77.0 to 84.0 = 7.0 ft.</td>
</tr>
<tr>
<td>85</td>
<td>84.0 to 123.0 = 39.0 ft.</td>
</tr>
<tr>
<td>71</td>
<td>58.0 to 123.0 = 65.0 ft.</td>
</tr>
<tr>
<td>78</td>
<td>58.0 to 123.0 = (less drive opening)58.0 ft.</td>
</tr>
</tbody>
</table>

*Note: 20% sulphide was encountered below the drive and 70% sulphide above the drive. On a 20% sulphide content basis, a grade of 1.90% Cu has been projected across the drive.

HOLE L-3

In a letter dated April 8, 1969, Mr. G.W. Heyes of the C.S.I.R.O. advised a head assay of 2.70% Cu, 29.6% Fe and 27.5% S (60% sulphide) covering 71.6 lbs. of sample material (Sample Nos. 1051 to 1079 inclusive). Unfortunately, sample material logged as containing very little sulphides outside of the main intersection was not treated separately, as intended, and only one bulk assay is available. By using information on core recovery, ore density, sulphide concentration and assumed marginal copper grades, it has been possible to arrive at a reasonable theoretical grade for the diluted intersection.

L-3 Calculations

An average specific gravity of 4.0 was recorded for 5 sets of sulphide samples from Hole L-5. These samples averaged an estimated 24.6%chalcopyrite, 1.0% sphalerite and 50.4% pyrite for a total of 76% sulphide. Gangue material contained in these samples was calculated to have a specific gravity of 2.0 equivalent to 125 lbs. per cubic foot. The average ore density of the samples was 9.0 cu. ft. per long ton.
<table>
<thead>
<tr>
<th>From</th>
<th>To</th>
<th>Length</th>
<th>Recovered</th>
<th>Est. % Sulph.</th>
<th>Density S.G.</th>
<th>Rec% by wt.</th>
<th>Cu% Est.</th>
</tr>
</thead>
<tbody>
<tr>
<td>128.0</td>
<td>132.0</td>
<td>4.0</td>
<td>4.0</td>
<td>5.0</td>
<td>2.15</td>
<td>11.2</td>
<td>0.40</td>
</tr>
<tr>
<td>132.0</td>
<td>151.0</td>
<td>19.0</td>
<td>11.0</td>
<td>75</td>
<td>3.98</td>
<td>56.9</td>
<td>4.27</td>
</tr>
<tr>
<td>151.0</td>
<td>156.0</td>
<td>5.0</td>
<td>4.0</td>
<td>20</td>
<td>2.54</td>
<td>13.2</td>
<td>1.50</td>
</tr>
<tr>
<td>156.0</td>
<td>161.0</td>
<td>5.0</td>
<td>7.0</td>
<td>2</td>
<td>2.06</td>
<td>18.7</td>
<td>0.15</td>
</tr>
</tbody>
</table>

*Drill logs indicate the following appropriate distribution:

128.0 - 131.0 = 3.0 feet at 0.15% Cu.
131.0 - 132.0 = 1.0 feet at 1.15% Cu.

L-3 Intersection

<table>
<thead>
<tr>
<th>% Sulph.</th>
<th>From</th>
<th>To</th>
<th>Length</th>
<th>Cu%</th>
<th>Assays</th>
</tr>
</thead>
<tbody>
<tr>
<td>ft.</td>
<td>ft.</td>
<td>ft.</td>
<td></td>
<td></td>
<td>Zn%</td>
</tr>
<tr>
<td>20</td>
<td>131.0</td>
<td>132.0</td>
<td>1.0</td>
<td>1.15</td>
<td></td>
</tr>
<tr>
<td>75</td>
<td>132.0</td>
<td>151.0</td>
<td>19.0</td>
<td>4.27</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>151.0</td>
<td>156.0</td>
<td>5.0</td>
<td>1.50</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>131.0</td>
<td>156.0</td>
<td>25.0</td>
<td>3.59%</td>
<td></td>
</tr>
</tbody>
</table>

Note: Au and Ag values in dwts. per short ton.

C.S.I.R.O. results indicate 2.6 dwts/long ton(?) Au with 2.7% Cu. Other holes have shown gold values distributed into the walls and an average of 3.2 dwts/LT or 2.9 dwts/short ton would appear reasonable with 3.59% Cu.

HOLE L-4

Hole L-4 was drilled by a native driller and intermittent supervision was supplied by a field technician (geologist absent from property). Core recovery was very poor with this drill (crew feed head) and information is mostly based on sludge samples. In most cases the sludge samples assayed higher than the core recovered which would be attributable to (i) the sulphide being preferentially ground away and more resistant rock inclusions being cored, and (ii) contamination from a sulphide zone higher up in the hole. Deeper in the hole sludge sample values progressively decrease over the intersection but some contamination is present.
### L-4 Intersections

<table>
<thead>
<tr>
<th>Sulph.</th>
<th>From ft.</th>
<th>To ft.</th>
<th>Length ft.</th>
<th>Sample</th>
<th>Cu%</th>
<th>Zn%</th>
<th>Au</th>
<th>Ag</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>65</td>
<td>70</td>
<td>5.0</td>
<td>Core 0.5'</td>
<td>2.90</td>
<td>0.50</td>
<td></td>
<td></td>
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<tr>
<td>80</td>
<td>70</td>
<td>75</td>
<td>5.0</td>
<td>Sludge</td>
<td>6.80</td>
<td>0.95</td>
<td></td>
<td></td>
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<td>80</td>
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<td>Sludge</td>
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<td>85</td>
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<td>Sludge</td>
<td>8.40</td>
<td>0.60</td>
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<td></td>
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<td>85</td>
<td>90</td>
<td>5.0</td>
<td>Sludge</td>
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<tr>
<td>80</td>
<td>90</td>
<td>95</td>
<td>5.0</td>
<td>Sludge</td>
<td>5.40</td>
<td>0.70</td>
<td></td>
<td></td>
</tr>
<tr>
<td>90</td>
<td>95</td>
<td>100</td>
<td>5.0</td>
<td>Core 0.5'</td>
<td>0.07</td>
<td>0.01</td>
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<tr>
<td>15?</td>
<td>95</td>
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<td>5.0</td>
<td>Sludge</td>
<td>3.50</td>
<td>0.60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5?</td>
<td>100</td>
<td>105</td>
<td>5.0</td>
<td>Core 0.7'</td>
<td>1.20</td>
<td>1.50</td>
<td></td>
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<tr>
<td>100</td>
<td>105</td>
<td>105</td>
<td>5.0</td>
<td>Sludge</td>
<td>3.40</td>
<td>0.45</td>
<td></td>
<td></td>
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<tr>
<td>15?</td>
<td>105</td>
<td>110</td>
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<td>Core 0.3'</td>
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<td>Sludge</td>
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<td>0.60</td>
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</table>

#### Weighted Averages

- 65 - 70 = 5.0: 2.90, 0.50
- 70 - 90 = 20.0: 7.10, 0.69
- 90 - 110 = 20.0: 1.93, 1.38
- 65 - 110 = 45.0: 4.33, 0.98

*Note: Assays from 90 to 110 feet were combined on the basis of 1 part sludge to 2 parts core values. The resulting average of 4.33% Cu appears acceptable, being higher grade than the open cut average but less than the 137 level average. Also, the high grade band in the upper section of the hole has been detected in other holes and in the open cut sampling. The lower grade for the bottom of the hole reflects lower grade material mentioned by Hooper (1941) at the southwest end of the 137 level.*
HOLE L-5

This intersection was logged, split and analysed in Perth.

<table>
<thead>
<tr>
<th>Sulph.</th>
<th>From (ft.)</th>
<th>To (ft.)</th>
<th>Length (ft.)</th>
<th>Cu%</th>
<th>Zn%</th>
<th>Au</th>
<th>Ag</th>
</tr>
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<tbody>
<tr>
<td>tr.</td>
<td>175 - 184</td>
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<tr>
<td>1</td>
<td>184 - 186</td>
<td>2.0</td>
<td>0.15</td>
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<td>0.24</td>
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<tr>
<td>40</td>
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<td>4.15</td>
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<tr>
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<td>190 - 195</td>
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<tr>
<td>50</td>
<td>195 - 200</td>
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<tr>
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<td>200 - 205</td>
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<td>205 - 210</td>
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<td>0.17</td>
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<tr>
<td>90</td>
<td>210 - 215</td>
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<td>0.95</td>
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<tr>
<td>90</td>
<td>215 - 220</td>
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<tr>
<td>90</td>
<td>220 - 225</td>
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<tr>
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<td>225 - 230</td>
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<td>90</td>
<td>230 - 235</td>
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<td>3.99</td>
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</table>

Note: Au and Ag values are in dwts. per short ton.

Weighted Averages

\[
\begin{array}{cccc}
186 - 190 & 4.0 & 2.25 & 4.15 & 0.25 & 8.1 \\
190 - 215 & 25.0 & 9.54 & 0.24 & 0.76 & 6.9 \\
215 - 235 & 20.0 & 5.28 & 1.76 & 2.65 & 10.5 \\
186 - 235 & 49.0 & 7.21 & 1.18 & 1.49 & 8.5 \\
\end{array}
\]

Note: This hole was abandoned at 245 feet with mine workings having been encountered at 237 feet. The core band was not recovered and assays for the remaining 2 feet of core are not available. The hole stopped in high grade ore and projection of the intersection average to 245 feet is considered justified. Lead assays vary from trace to 0.01%.
HOLE L-6

Abandoned - see Hole L-7 results.

HOLE L-7

<table>
<thead>
<tr>
<th>Sulph. %</th>
<th>From ft.</th>
<th>To ft.</th>
<th>Length ft.</th>
<th>Cu%</th>
<th>Zn%</th>
<th>Assays</th>
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<td>1.75</td>
<td>4.70</td>
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</tr>
<tr>
<td>85</td>
<td>45</td>
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<td>5.0</td>
<td>2.30</td>
<td>7.00</td>
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<td>95</td>
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<td>6.80</td>
<td>4.00</td>
<td>4.81</td>
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<tr>
<td>?</td>
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<td>0.13</td>
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Note: Au and Ag reported in dwts. per short ton.

Weighted Averages

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<td>72</td>
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<td>3.97</td>
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<p>| | | | | | | |</p>
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<tbody>
<tr>
<td>35</td>
<td>72</td>
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<td>3.77</td>
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</tr>
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<td>3.48</td>
<td>4.59</td>
<td>5.33</td>
<td>11.4</td>
</tr>
</tbody>
</table>

Note: the average core assay of 2.40% Cu (35 to 50 feet) has been applied over the 10-foot zone from 25 to 35 feet where samples from massive sulphide were lost. The lower grade average intersection assays for Zn, Au and Ag were also applied to this zone. The resulting average of 3.48% Cu is considered acceptable and possibly down-graded since it is less than the open cut average, and possibly down-graded. The high zinc assays seem abnormal and are being checked.
APPENDIX IV

LALOKI TONNAGE AND GRADE CALCULATIONS

1. TONNAGE FACTOR

A tonnage factor of 9.0 cubic feet per long ton of ore has been used in the following calculations. Hooper (1941) indicated the average density of 15 open cut samples (somewhat denser than average) was 8.0 cubic feet per long ton. In another report dated May, 1940, a factor between 8 and 9 was mentioned. Limited tests in 1969 on Hole L-5 core indicated a factor of 9.0. In view of the information available, a factor of 9.0 cubic feet per long ton of ore is considered realistic and slightly conservative. This figure was also employed by Hooper (1941).

2. METHODS AND DEFINITIONS

The volume or tonnage calculations have been made in two ways (i) by the section method and (ii) by the polygonal net method. In the polygonal net method, lines perpendicular to the mid points of lines joining the centre of drill hole intersections have been joined to form polygons. These polygons best represent the area of influence for each hole in an irregular drilling pattern and hence are more suitable for grade calculations. Areas in plan have been calculated using a planimeter. Vertical thicknesses have been arrived at by averaging the thickness of ore under the influence of each polygon as shown of the respective drill sections.

-60-
In the section method, areas have been measured above and below the 137 level on each section. Sections have been projected one-half the distance to each other, except at the ends of the deposit. At the northeast end a projection 50 feet beyond the last drill hole has been made; at the southwest end a pyramidal projection to zero area at 34 feet past section 19+00 has been made due to the ore outline and 137 level data. The area of section 18+50 is a composite of section 18+00 and 19+00 below the 1112 elevation to which has been added the area above the 1112 elevation shown on Section 18+00 (actually 18+50).

Ore outlines have taken into consideration all development work on the 137 level, ore outlines from old block diagrams, surface sampling and drill hole intersections.

Ore has been projected between drill holes and all reported occurrences in the 137 level development headings. On the outside of the mineralized zone, mineralization has been projected a maximum of 50 feet beyond drill holes (except SC-1 at 25 feet) or halfway to negative information. Ore outlines have been projected further above the 137 level but more data on the shape and extent of the ore body has been available here.

Ore categories used are as follows: definite ore means drill or development indicated ore within the projected outer limits of the ore zone; probable ore means ore which is included within the general lenticular outline of the deposit but for which insufficient data is available to be definite; possible ore is a projection beyond definite ore outlines where other data inferring further possible ore extension is available.
In the section method, areas have been measured above and below the 137 level on each section. Sections have been projected one-half the distance to each other, except at the ends of the deposit. At the northeast end a projection 50 feet beyond the last drill hole has been made; at the southwest end a pyramidal projection to zero area at 34 feet past section 19+00 has been made due to the ore outline and 137 level data. The area of section 18+50 is a composite of section 18+00 and 19+00 below the 1112 elevation to which has been added the area above the 1112 elevation shown on section 18+00 (actually 18+50).

Ore outlines have taken into consideration all development work on the 137 level, ore outlines from old block diagrams, surface sampling and drill hole intersections.

Ore has been projected between drill holes and all reported occurrences in the 137 level development headings. On the outside of the mineralized zone, mineralization has been projected a maximum of 50 feet beyond drill holes (except SC-1 at 25 feet) or halfway to negative information. Ore outlines have been projected further above the 137 level but more data on the shape and extent of the ore body has been available here.

Ore categories used are as follows: definite ore means drill or development indicated ore within the projected outer limits of the ore zone; probable ore means ore which is included within the general lenticular outline of the deposit but for which insufficient data is available to be available; possible ore is a projection beyond definite ore outlines where other data inferring further possible ore extension is available.
### Tonnage Calculation - Section Method

<table>
<thead>
<tr>
<th>Section</th>
<th>Area in Sq. Feet</th>
<th>Strike Length</th>
<th>Volume Cu. Ft. X 1000</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Above 137L</td>
<td>Between 137L</td>
<td>Total</td>
<td>Above 137L</td>
</tr>
<tr>
<td>Definite Ore</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14+60</td>
<td>-</td>
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<td>2464</td>
<td>90</td>
</tr>
<tr>
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<td>3488</td>
<td>42</td>
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<tr>
<td><strong>Total</strong></td>
<td>-</td>
<td>-</td>
<td>1316.3</td>
<td>1645.0</td>
</tr>
</tbody>
</table>

| Probable Ore |
| 18+00    | -    | 360  | 360  | 100 | -    | 36.0  | 36.0  | Projection to zero at Sec. 19 or equal volume for 50ft. SW. |
| 17+00    | -    | 365  | 365  | 50  | -    | 18.8  | 18.8  | Projection SW only. |
| **Total** | -    | -    | -    | -   |      | 54.8  | 54.8  | |

| Possible Ore |
| 15+40    | -    | 240  | 240  | 70  | -    | 16.8  | 16.8  | |
| 14+60    | -    | 448  | 448  | 90  | -    | 40.3  | 40.3  |
| **Total** | -    | -    | -    | -   |      | 57.1  | 57.1  |

Definite Ore: *Above 137 level* = \( \frac{1,316,300}{9.0} = 146,200 \) long tons

Below 137 level = \( \frac{1,645,000}{9.0} = 182,300 \) long tons

*Total = 330,500 long tons

Probable Ore (below 137 level) = \( \frac{54,800}{9.0} = 6,090 \) long tons

Possible ore (below 137 level) = \( \frac{57,100}{9.0} = 6,300 \) long tons

* Note: Less previously mined tonnage (see part No. 6 for adjustment).
4. Tonnage Calculation - Polygonal Net Method

**Definite Ore**

<table>
<thead>
<tr>
<th>Hole No.</th>
<th>Vertical Thickness</th>
<th>Area</th>
<th>Volume X 1000 cu.ft.</th>
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</thead>
<tbody>
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<td>Above 137</td>
<td>Below 137</td>
<td>Total</td>
</tr>
<tr>
<td>L-4</td>
<td>19.2</td>
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<td>30.0</td>
</tr>
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<tr>
<td>SC-1</td>
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</table>

**Probable Ore**

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<th>Volume X 1000 cu.ft.</th>
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<tbody>
<tr>
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<td>Above 137</td>
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<td>Total</td>
</tr>
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<tr>
<td>L-2</td>
<td>-</td>
<td>11.0</td>
<td>11.0</td>
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<tr>
<td>SC-1</td>
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**Possible Ore**

<table>
<thead>
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<th>Hole No.</th>
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<th>Volume X 1000 cu.ft.</th>
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<td>Above 137</td>
<td>Below 137</td>
<td>Total</td>
</tr>
<tr>
<td>SC-3</td>
<td>-</td>
<td>15&quot;</td>
<td>15&quot;</td>
</tr>
<tr>
<td>SC-4</td>
<td>-</td>
<td>15&quot;</td>
<td>15&quot;</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Definite Ore:  
* above 137 level = \[\frac{1,433,000}{9.0} = 159,200 \text{ long tons}\]  
* below 137 level = \[\frac{1,629,500}{2.0} = 81,475 \text{ long tons}\]  
* Total = 340,200 long tons

Probable Ore: (below 137 level) = 46,600/9.0 = 5,200 long tons

Possible Ore: (below 137 level) = 61,900/9.0 = 6,877 long tons

* Note: Less previously mined tonnage (see part No. 6 for adjustment).
4. **Tonnage Calculation - Polygonal Net Method**

### Definite Ore

<table>
<thead>
<tr>
<th>Hole No.</th>
<th>Vertical Thickness</th>
<th>Area</th>
<th>Volume X 1000 cu. ft.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Above 137</td>
<td>Below 137</td>
<td>Total</td>
</tr>
<tr>
<td>L-4</td>
<td>19.2</td>
<td>10.8</td>
<td>30.0</td>
</tr>
<tr>
<td>L-2</td>
<td>11.4</td>
<td>35.6</td>
<td>47.0</td>
</tr>
<tr>
<td>SC-1</td>
<td>-</td>
<td>6.5</td>
<td>6.5</td>
</tr>
<tr>
<td>SC-3</td>
<td>-</td>
<td>14.0</td>
<td>14.0</td>
</tr>
<tr>
<td>SC-4</td>
<td>-</td>
<td>19.0</td>
<td>19.0</td>
</tr>
<tr>
<td>L-5</td>
<td>10.8</td>
<td>28.2</td>
<td>37.0</td>
</tr>
<tr>
<td>L-3</td>
<td>17.9</td>
<td>6.1</td>
<td>24.0</td>
</tr>
<tr>
<td>L-7</td>
<td>57.4</td>
<td>2.6</td>
<td>60.0</td>
</tr>
<tr>
<td>Surface</td>
<td>42.0</td>
<td>-</td>
<td>42.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Probable Ore

<table>
<thead>
<tr>
<th></th>
<th>-</th>
<th>9.0</th>
<th>9.0</th>
<th>608</th>
<th>-</th>
<th>5.5</th>
<th>5.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>L-2</td>
<td>-</td>
<td>11.0</td>
<td>11.0</td>
<td>1920</td>
<td>-</td>
<td>21.1</td>
<td>21.1</td>
</tr>
<tr>
<td>SC-1</td>
<td>-</td>
<td>5.0</td>
<td>5.0</td>
<td>4000</td>
<td>-</td>
<td>20.0</td>
<td>20.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>46.6</td>
<td>46.6</td>
</tr>
</tbody>
</table>

### Possible Ore

<table>
<thead>
<tr>
<th></th>
<th>-</th>
<th>15&quot;</th>
<th>15&quot;</th>
<th>2080</th>
<th>-</th>
<th>31.2</th>
<th>31.2</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC-3</td>
<td>-</td>
<td>15&quot;</td>
<td>15&quot;</td>
<td>2048</td>
<td>-</td>
<td>30.7</td>
<td>30.7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>61.9</td>
<td>61.9</td>
</tr>
</tbody>
</table>

Definite Ore:  *above 137 level = \( \frac{1,433,000}{9.0} = 159,200 \) long tons  
below 137 level = \( \frac{1,629,500}{9.0} = 181,000 \) long tons  

Probable Ore: (below 137 level) = 46,600/9.0 = 5,200 long tons  
Possible Ore: (below 137 level) = 61,900/9.0 = 6,900 long tons

* Note: Less previously mined tonnage (see part No. 6 for adjustment).
## 5. Grade Calculation - Polygonal Net Method

### DRILL INDICATED ORE - LALOKI DEPOSIT

#### Definite Ore

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>L-4</td>
<td>144.4</td>
<td>4.33</td>
<td>81.2</td>
<td>4.33</td>
<td>225.6</td>
<td>4.33</td>
<td>0.98</td>
<td>25.7</td>
<td>47.0</td>
<td></td>
</tr>
<tr>
<td>L-2</td>
<td>152.5</td>
<td>6.63</td>
<td>476.4</td>
<td>6.63</td>
<td>628.9</td>
<td>6.63</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SC-1</td>
<td>-</td>
<td>-</td>
<td>66.6</td>
<td>2.30</td>
<td>66.6</td>
<td>2.30</td>
<td>25.2</td>
<td>25.7</td>
<td>47.0</td>
<td></td>
</tr>
<tr>
<td>SC-3</td>
<td>-</td>
<td>-</td>
<td>162.1</td>
<td>3.10</td>
<td>162.1</td>
<td>3.10</td>
<td>0.80</td>
<td>1.07</td>
<td>21.4</td>
<td></td>
</tr>
<tr>
<td>SC-4</td>
<td>-</td>
<td>-</td>
<td>246.2</td>
<td>4.80</td>
<td>246.2</td>
<td>4.80</td>
<td>0.30</td>
<td>0.18</td>
<td>0.7</td>
<td></td>
</tr>
<tr>
<td>L-5</td>
<td>188.7</td>
<td>7.21</td>
<td>457.7</td>
<td>7.21</td>
<td>646.4</td>
<td>7.21</td>
<td>1.18</td>
<td>1.49</td>
<td>8.5</td>
<td></td>
</tr>
<tr>
<td>L-3</td>
<td>355.1</td>
<td>3.59</td>
<td>121.0</td>
<td>3.59</td>
<td>476.1</td>
<td>3.59</td>
<td></td>
<td>2.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>L-7</td>
<td>404.1</td>
<td>3.48</td>
<td>18.3</td>
<td>3.48</td>
<td>422.4</td>
<td>3.48</td>
<td>4.59</td>
<td>5.33</td>
<td>11.4</td>
<td></td>
</tr>
<tr>
<td>Surface</td>
<td>188.2</td>
<td>3.68</td>
<td>-</td>
<td>-</td>
<td>188.2</td>
<td>3.68</td>
<td>1.33</td>
<td>4.19</td>
<td>8.73</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1433.0</td>
<td>4.46</td>
<td>1629.5</td>
<td>5.61</td>
<td>3062.5</td>
<td>5.07</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Probable Ore

<table>
<thead>
<tr>
<th>Hole No.</th>
<th>Vol. X 1000 cu. ft.</th>
<th>Cu%</th>
<th>dwts/S.T.</th>
<th>Au</th>
<th>Ag</th>
</tr>
</thead>
<tbody>
<tr>
<td>L-4</td>
<td>5.5</td>
<td>4.33</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>L-2</td>
<td>21.1</td>
<td>6.63</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SC-1</td>
<td>10.0</td>
<td>2.30</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

46.6 4.50 46.6 4.50

1676.1 5.58 3109.1 5.06

#### Possible Ore

<table>
<thead>
<tr>
<th>Hole No.</th>
<th>Vol. X 1000 cu. ft.</th>
<th>Cu%</th>
<th>dwts/S.T.</th>
<th>Au</th>
<th>Ag</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sc-3</td>
<td>31.2</td>
<td>3.10</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SC-4</td>
<td>30.7</td>
<td>4.80</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

61.9 3.94 61.9 3.94

Note: an incomplete assay information, gold values in dwts. per short ton are indicated as follows: without SC-1 = 2.62 dwts; with hole SC-1 = 3.31 dwts.
6. Final Tonnage and Grade Adjustments

Volumes calculated by the section method have been used for tonnage calculation purposes. All tonnage has been calculated without any consideration having been given to underground or open pit mining (i.e. ore outlines have been projected above the current open pit surface - see Section 19+00). Previously mined tonnage totals 40,500 long tons. A maximum of 11,000 tons of this total represents development openings and stoping above and below the 137 level. This leaves 29,500 tons extracted from the open pit.

It is possible to adjust for all ore calculated above the known open cut benches. By subtracting a length of 50 feet of ore on section 18+50 (see section 19+00 outline) above the 1132 elevation, and subtracting 50 feet of ore on section 18+00 above the 1152 elevation, the total remaining tonnage below surface can be calculated. The amount to be subtracted totals 11,600 tons at 3.68% copper.

<table>
<thead>
<tr>
<th>Description</th>
<th>Tonnage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original tonnage above 137 level</td>
<td>146,200</td>
</tr>
<tr>
<td>Less calculated pit outline</td>
<td>11,600</td>
</tr>
<tr>
<td>Less all underground mining</td>
<td>11,000</td>
</tr>
<tr>
<td>Total Remaining</td>
<td>123,600</td>
</tr>
</tbody>
</table>

This figure compares with 119,000 long tons calculated by Hooper (1941) using the same tonnage factor. Since the present ore outlines are based on more information, the larger tonnage is accepted. However, a difference in mined tonnage of 40,500 less 22,600 equals 17,900 long tons. Denser ore than calculated could account for another 2,500 long tons, leaving 15,400 tons. This amount could easily represent mined-out ore which was originally present at a higher elevation and further to the southwest than allowed for in ore shapes and calculation.

<table>
<thead>
<tr>
<th>Description</th>
<th>Tonnage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Definite Ore: above 137 level</td>
<td>123,600</td>
</tr>
<tr>
<td>below 137 level</td>
<td>182,300</td>
</tr>
<tr>
<td>Total</td>
<td>305,900</td>
</tr>
<tr>
<td>Probable Ore: (below 137 level)</td>
<td>6,100</td>
</tr>
<tr>
<td>Possible Ore: (below 137 level)</td>
<td>6,000</td>
</tr>
</tbody>
</table>
Grade calculations have been based on polygonal net areas for greater accuracy. The calculated grade of 4.46% Cu above the 137 level must be adjusted by subtracting 11,600 tons of 3.68% Cu open cut ore. This results in a grade of 4.50% Cu for the remaining 123,600 tons. Underground mining has been about average grade and no further adjustment was required.

**Definite Ore:**

- Above 137 level = 123,600 long tons of 4.50% Cu
- Below 137 level = 182,300 long tons of 5.61% Cu

**Total** = 305,900 long tons of 5.16% Cu.

**Probable Ore:**

Below 137 level = 6,100 long tons of 5.06% Cu

**Possible Ore:**

Below 137 level = 6,300 long tons of 3.94% Cu

Note: Hooper (1941) gave an average level grade of 4.67% Cu on the 137 level, a grade of 3.68% Cu on the 87 foot bench, and a grade of 4.51% Cu for all ore above the 137 level. The comparison with the present grade is excellent. Sampling in the open pit yielded identical average copper values.

Assay information is incomplete and Zn, Au and Ag cannot be fully calculated.
Note: Au and Ag values given in dwts/shorth ton.
AN EVALUATION OF THE LALOKI AND
MT. DIAMOND DEPOSITS AND LOCAL
GEOCHEMICAL EXPLORATION
ASTROLABE MINERAL FIELD
PAPUA

for

L. M. GROSS, ESQ.

D. R. Cheeseman, B.A.Sc., P.Eng.,
Watts, Griffis and McQuat (Aust.) Pty. Ltd.,
Consulting Geologists and Engineers.

Australia
Oct. 23, 1969
The Director,  
Department of Lands, Surveys & Mines  
KONDOBU, PAPUA.

Dear Sir,

Prospecting Authority 27(P) - Territory of Papua & New Guinea

1. Following completion of the diamond drilling programme in February 1970, (as recorded in Report dated 20th February), field work was limited to completion of surveys and study of the area surrounding the Laloki orebody to determine sites for concentrator and stacking stockpiles.

2. Ore dressing tests from bulk samples of diamond drill cores was completed by Kanematsu Brothers with a mill, flow sheet and the general layout of plant.

3. Other studies included water and power survey, with cost of design and costing of all units.

4. A full feasibility study was completed prior to the close of the period.

5. Attached hereto are bore logs for recently completed diamond drilling.

Yours faithfully,

[Signature]

[Date: 11/07/70]
Fundamentals of Russian

The last no motion is the

Success Nature of the

The Complex Nature is the

Anabel and Eliza
<table>
<thead>
<tr>
<th>Depth</th>
<th>Lithology</th>
<th>Description</th>
<th>Per Cent</th>
<th>Notes</th>
</tr>
</thead>
</table>
| 11.5" | Block calcareous mudstone | | 40% | Very fine grained, with some infilling.
| 22" | Sheared breccia | Regular fragments of calcareous mudstone in grey to red-brown matrix. | 55% | Sheared. |
| 25" | Sandstone | Calcareous, grey, f.g. Sandstone | | Bedding and cross-bedding. |
| 33" | Calcareous mudstone | | 85% | |
| 37" | Sheared breccia | | 80% | |
| 37" | Calcareous, white in colour | | 50% | |
| 41" | Massive chalcopyrite and pyrite | | 5% | Little core recovery (sand). |
| 45.9" | Bleached Zone | White, highly altered, sericite and/or talc material | | |
| 58" | Breccia & chalcopyrite | | 100% | |
| 63.2" | Massive chalcopyrite & chalcopyrite | | 100% | |
| 63.2" | Ores | Massive chalcopyrite, minor barite on some fractures. | | |
| 69.4" | Massive, friable whilitish pyrite (marcasite), with irregular patches of chalcopyrite | | 100% | |
| 76" | Block pyritic mudstone | Mudstone, slightly phyllic, minor chalcopyrite. | | 77.4" wood from underground support. |
| 79.6" | Massive, friable pyrite with irregular patches of chalcopyrite | | 100% | |
| 9.96" | Ores | Massive, friable white pyrite and chalcopyrite. | | 100% |
Red and grey mottled and barred argillite & Small amounts of small angular pebbles. Also fine calcite veins. Sharply in 110" to core is intersected by fracture, clinching with polished edges. Limb.<br>Red and grey mottled and barred argillite & Small amounts of small angular pebbles. Also fine calcite veins. Sharply in 110" to core is intersected by fracture, clinching with polished edges. Limb.

Red and grey mottled and barred argillite & Small amounts of small angular pebbles. Also fine calcite veins. Sharply in 110" to core is intersected by fracture, clinching with polished edges. Limb.

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Red and grey mottled and barred argillite & Small amounts of small angular pebbles. Also fine calcite veins. Sharply in 110" to core is intersected by fracture, clinching with polished edges. Limb.
<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Fresh</td>
</tr>
<tr>
<td>0-10</td>
<td>Very fresh</td>
</tr>
<tr>
<td>10</td>
<td>Fresh</td>
</tr>
<tr>
<td>10-20</td>
<td>Fresh</td>
</tr>
<tr>
<td>20</td>
<td>Fresh</td>
</tr>
<tr>
<td>20-30</td>
<td>Fresh</td>
</tr>
<tr>
<td>30</td>
<td>Fresh</td>
</tr>
<tr>
<td>30-40</td>
<td>Fresh</td>
</tr>
<tr>
<td>40</td>
<td>Fresh</td>
</tr>
<tr>
<td>40-50</td>
<td>Fresh</td>
</tr>
<tr>
<td>50</td>
<td>Fresh</td>
</tr>
<tr>
<td>50-60</td>
<td>Fresh</td>
</tr>
<tr>
<td>60</td>
<td>Fresh</td>
</tr>
<tr>
<td>60-70</td>
<td>Fresh</td>
</tr>
<tr>
<td>70</td>
<td>Fresh</td>
</tr>
<tr>
<td>70-80</td>
<td>Fresh</td>
</tr>
<tr>
<td>80</td>
<td>Fresh</td>
</tr>
<tr>
<td>80-90</td>
<td>Fresh</td>
</tr>
<tr>
<td>90</td>
<td>Fresh</td>
</tr>
<tr>
<td>90-100</td>
<td>Fresh</td>
</tr>
</tbody>
</table>

**Lithology:**
- **Gravel:**
  - Angular to subangular, reddish brown to gray, with some fine gravel, more clayey in places.
- **Sandstone:**
  - Light brown to gray, well sorted, fine to medium-grained, cross-bedded, possibly channel filled, possibly contain pebbles.
- **Shale:**
  - Gray to greenish-gray, soft, with occasional thin layers of siltstone or mudstone.
- **Limestone:**
  - Light gray to white, with some fossil fragments and veins of calcite.
- **Dolomite:**
  - White to gray, with occasional thin layers of limestone.

**Mineralogy:**
- **Chlorite:**
  - Occasional, with some fine-grained chlorite, more clayey in places.
- **Quartz:**
  - Abundant, with some fine grains, more clayey in places.
- **Feldspar:**
  - Abundant, with some fine grains, more clayey in places.
- **Carbonate:**
  - Abundant, with some fine grains, more clayey in places.
- **Mica:**
  - Abundant, with some fine grains, more clayey in places.

**Geology:**
- **Faulting:**
  - Well-developed, with some fine fractures, more clayey in places.
- **Jointing:**
  - Abundant, with some fine joints, more clayey in places.

**Other:**
- **Veins:**
  - Occasional, with some fine veins, more clayey in places.
- **Sedimentary Structures:**
  - Well-developed, with some fine sedimentary structures, more clayey in places.

**Scale:**
- 1 inch = 10 feet
February 20, 1970.

The Director,
Department of Lands, Surveys & Mines,
KONEDELOUPAPUA.

Dear Sir,

Prospecting Authority 27(P)
Territory of Papua and New Guinea

Report on Prospecting Operations for the period

During the above period, the second stage
of diamond drilling at the Laloki orebody was completed
this with other work in the field is summarised below.

1. Diamond Drilling. Laloki orebody.

Five vertical holes were completed with a total
footage of 1036'.

Hole LJ No. 1 intersected 61' of ore
" LJ No. 2 " 5' " 
" LJ No. 3 " 20' " 
" LJ No. 4 " 51' of ore
" LJ No. 5 - no intersection - outside of ore limits.
(Copies of logs will be forwarded in due course).

2. Geological mapping of areas around Laloki, extending
to the Diamond Elvina and other sections where anomalies
have been established.

3. Surveying of roads and sites for establishment of operations.

4. Road construction.

5. Ore dressing. C.S.I.R.O. final report received - copy attached.

This programme was completed at the close of the period
drilling and other plant stored at Moresby.

Yours faithfully,
KEITH TURNER & ASSOCIATES

(h. Keith Turner)

[Attached report will be]

Attach - CSIRO final report.
June 17, 1969.

The Director,
Department of Lands, Surveys & Mines,
KONEDOBU, PAPUA.

Dear Sir,

Prospecting Authority - 27(P)

This introduces Messrs. K. Otani of Kanematsu-Gosho (Aust.) Pty. Ltd., and Hiromitsu Nozawa and Shigeaki Hosayama of Nittetsu Mining Company, Limited.

The bearers are interested in visiting the Astrolabe Copper Field and they have my full authority to do so and to look at any records in your Department.

They will also lodge with you a copy of Messrs. Watts, Griffis & McOuat's full report on our exploration programme of the Astrolabe Field. Our letter with further details of the prospecting is being mailed.

Yours faithfully,

(L. M. GROSS.)
June 19, 1969.

PROSPECTING AUTHORITY NO. 27(P).
TERRITORY OF PAPUA & NEW GUINEA.

Statement showing expenditure on the above Authority between the period August 13, 1968 to February 13, 1969.

1. Watts, Griffis & McQuat (Aust.) Pty. Ltd.
   Geological services and supervision (as per copies of their statements) $59,052.31

2. Inspiration Drilling
   Diamond drilling services 18,495.60
   $77,547.91

Attachments.

Copies of statements -
1. Watts, Griffis & McQuat (Aust.) Pty. Ltd.
   covering August 1968 to April 1969.
   (further statements to complete).

2. Inspiration Drilling
   (complete).

H. KEITH TURNER.
L. M. GROSS.  
13 RUSSELL STREET, 
TOORAK, VICTORIA. - 3142. 
June 27, 1969.

The Director, 
Department of Lands, Surveys & Mines, 
KONEDOBU, PAPUA.

Dear Sir,

Prospecting Authority 27(P).

Please be advised that Mr. Alan Blatchford of Placer, who have expressed an interest in the Astrolabe field, will be visiting Moresby towards the end of next week - probably on 3rd or 4th July, and I would be grateful if you would allow him to look at any records in your Department.

He may also visit the field and inspect a number of areas of interest.

Yours faithfully,

(L. M. GROSS)

Minute to
Senior Resident Geologist

For information please. Mr. Blatchford will be directed to your office to examine the records.

Dear Sir,

Prospecting Authority No. 27(P).

With reference to your letter (your ref. 68/535 and 68/536) dated 22nd May, 1969, attached herewith are statutory reports as required under Section 251.

The reports, in duplicate, cover

1. Prospecting operations for the periods
   (b) November 14, 1968 to February 13, 1969.
   (c) February 14, 1969 to May 13, 1969.

   A plan covering the areas investigated is also attached.

2. Statements showing amounts expended in relation to the Authority for the period ended 13th February, 1969.

   I am also forwarding by hand copy of final Reports and Plans etc. by Messrs. Watts, Griffis & McQuat, Geological Consultants. These data record in detail activities to May 1969 in the Authority.

Yours faithfully,

(L. M. GROSS)

Attachments.
June 19, 1969.

PROSPECTING AUTHORITY 27(P).

TERRITORY OF PAPUA & NEW GUINEA.

REPORT ON PROSPECTING OPERATIONS FOR THE PERIOD AUGUST 13, 1968 TO NOVEMBER 13, 1968.

The planned programme in the above Authority commenced on 13th August, 1968, when geological staff of Consultants, Messrs. Watts, Griffiss & McOuart (Aust.) Pty. Limited proceeded as outlined below.

1. Re-establishment of the survey grid over the Laloki area extending outwards.

2. Location of drilling sites at Laloki and firing of R.L.'s etc.

3. General organizing for setting-up of diamond drill rigs, water supply, etc. - drilling at Laloki commenced on 30th August, 1968.

4. Soil sampling - extending outwards from Laloki.

5. Road construction to the Mt. Diamond; surveys and layout of drilling sites.


8. During the period of three months diamond drill holes completed were -

   - Laloki No. 1 157'
   - Laloki No. 2 199'
   - Mt. Diamond No. 1 227'

(Detailed of intersections are contained in Watts, Griffiss & McOuart's reports forwarded to the Mines Department).

Soil samples number 117 taken during the quarter.

...
June 19, 1969.

PROSPECTING AUTHORITY 27(P).

TERRITORY OF PAPUA & NEW GUINEA.

REPORT ON PROSPECTING OPERATIONS FOR THE PERIOD

1. The programme of diamond drilling at Mt. Diamond was completed throughout the period.

2. Soil Sampling extended south to the Dabuna section.

3. Ground magnetometer work commenced in the areas being covered by soil sampling.


5. Soil Sampling extended in the Mt. Diamond area.

H. KEITH TURNER.

PROSPECTING AUTHORITY 27(P).
TERRITORY OF PAPUA & NEW GUINEA.

REPORT ON PROSPECTING OPERATIONS FOR THE PERIOD
FEBRUARY 13, TO MAY 13, 1969.

During the above period operations in terms of
the original programme were completed - a summary of the
items being -

1. Diamond Drilling
   (a) Laloki orebody
      Total of 1024 feet was drilled, one hole was
      abandoned and five of the remaining six holes
      obtained sulphide intersections. Non core
      drilling (of overburden) totalled 260' and
      core drilling 760'.
   (b) Mt. Diamond
      Total of 980' of which 278' was drilled non-core.

2. Geochemical sampling
   (a) Laloki area - one significant anomaly determined.
   (b) Ruby Mt. Diamond - refer to attached plan - seven
       anomalies outlined.

3. Magnetometer Survey
   Zones of significant geochemical anomalies were surveyed
   magnetically. Readings being taken every 50' along the
   soil sample traverses.

4. Field Geology
   Mapping of the areas attached as well as that of the
   Diamond underground workings.

5. Ore dressing research
   All cores of ore intersections from the Laloki orebody
   were shipped to C.S.I.R.O. for test purposes.
5. Ore dressing research (continued)

At the close of this period, work was still in progress. (Final report expected to issue in June, 1969).

Messrs. Watts, Griffis & McQuat (Aust.) Pty. Ltd. report on the programme and all geological maps cover in detail the extent of the work carried out.

A copy of this report has been forwarded to the Director of Lands, Surveys & Mines, Konedobu, Papua.

H. KEITH TURNER.

April 24, 1969

The Director,
Department of Lands, Surveys & Mines
KONEDOKI, PAPUA.

Dear Sir,

PROSPECTING AUTHORITY NO. 1223.

On April 22nd Mr. Rogers, together with members of his staff, accompanied by Mr. J. X., the geologist, visited the area.

Mr. Rogers will probably call on you and this letter gives him an authority to visit and spend the period of time in the field and to examine any Mines Department records relating to the field.

Yours faithfully,

[Signature]
<table>
<thead>
<tr>
<th>Depth</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Massive, friable pyrite and chalcopyrite</td>
</tr>
<tr>
<td>128</td>
<td>Sheared, sheared, brecciated mudstone, slightly calcareous</td>
</tr>
<tr>
<td>131</td>
<td>Red-brown, green and black, slightly calcareous mudstone</td>
</tr>
<tr>
<td>157</td>
<td>Irregular, small out numerous veins of calcite and of a soft white, fibrous mineral (barite? or zeolite? or?)</td>
</tr>
</tbody>
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End of hole.