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1961/49

DIAMOND DRILLING AT THE LALOKI MINE

Progress Report to 17th February, 1961.

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CONTENTS

ILLUSTRATIONS

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SUMMARY

This report concerns the results of diamond drilling, up to February 1961, at the Laloki copper-gold mine, near Port Moresby. Drilling totalled 4,860 feet in eleven drill holes, and was undertaken by the Administration and Enterprise Exploration Pty. Ltd., using two Mindrill E1000 drills.

The Laloki orebody is a lens of massive fine-grained sulphides enclosed in fine-grained, partly calcareous sediments of the Eriama Series. Drilling has defined the lateral limits of the lode, except to the south-east, and has shown that the lode grades laterally from massive sulphides up to 20 feet thick into pyritic pug and then into weakly pyritic shale. That part of the lode revealed in the old mine workings dipped generally at about 45° to the north and north-west. To the north the lode flattens then rises so that the probable dip near the northern margin is about 15° to the south.

Copper content varies between 2.3% and 10.9%, zinc between 0.3% and 25.2%, gold between 0.2 and 28.8 dwts. per ton, and silver between 0.07 and 2.63 ozs. per ton. Mineralization is generally associated with black shale and consistently occurs within ten feet of a distinctive grey and red lutite marker bed; this indicates that the lode is stratigraphically controlled. Some pyrite is syngenetic and some has been introduced by solutions emanating from the gabbro. Chalcopyrite, sphalerite and calcite were emplaced during shearing, either by solutions emanating from the gabbro or by concentration from the sediments. Massive sulphide encountered at shallow depth in drill hole SC3 ~~are~~ is thought to be a faulted segment of the main lode but it is difficult to find a likely position and attitude for the hypothetical fault.

The country rock comprises fine-grained, partly calcareous sediments of the Eriama Series, in which lutite and shale and a sedimentary shale-lutite breccia predominate. Other sediments are greywacke, chert and rare tuff.

"Gabbro" occurs consistently 250 to 275 feet below the lode. Some regard the gabbro as an extrusive volcanic member of the sedimentary sequence, citing its constant stratigraphic position and the presence of pillow structures as evidence. Others believe that the gabbro is intrusive, a sill in this instance, and cite as evidence the marginal finer grain of the gabbro, the induration of sediments near the contact, and the introduction of zeolite, epidote and pyrite into the sediments.

At least two more holes will be drilled, one to define the south-eastern margin of the lode and the other to check for recurrence of the lode to the west. Surface mapping of the grey and red lutite marker is recommended as a guide to any subsequent drilling.

INTRODUCTION

This report summarises the results of diamond drilling on the Laloki Mine, near Port Moresby, from commencement on 9th June, 1959, to temporary cessation on 17th February, 1961.

Drilling totalled 4,860 feet in eleven drill holes numbered SC1 to SC11; the deepest hole, SC7, reached 552'9". Two Mindrill E1000 drills were used, one operated by the Administration driller, Mr.A.A.Heyne, and the other by Enterprise Exploration drillers, Messrs. W.C.Wingrave and P.Gaydon. Drill holes SC1, SC2, SC3, SC4, SC6, and SC9 were drilled by the Administration, and SC5, SC7, SC8, SC10, and SC11 by Enterprise.

In each hole except SC1 the drillers commenced with NM bits and reduced to BM and AM at depth if necessary. Core barrels with split inner tube were used throughout except in hole SC1, and recovery was generally between 90% and 100%, rarely dropping as low as 50% where the smaller bits were in use. The first 130 feet of hole SC1 were drilled with a BX bit and a double tube rigid core barrel; in this section recovery was only about 20%.

Drill hole sites were selected by Mr. J.E. Thompson, then Senior Resident Geologist, Port Moresby, and Mr. C.L.Knight, Chief Geologist, Exploration, of Enterprise Exploration, in conference. Drilling was supervised in the field by Mr. Thompson, with occasional visits by Mr. Knight. Cores were logged at different times by Mr. Thompson and Messrs. J.F.Ivanac, P.W.Pritchard, and H.L.Davies, of the B.M.R. resident staff, and were examined periodically by Mr. Knight. It is unfortunate that it was not possible for one geologist to log all cores; this was due to movements of the resident staff occasioned by leave, transfer, or other investigations.

Drill hole sites were initially located by chain and compass and were later tied in by triangulation, using plane-table and telescopic alidade. Mr.F.Witcher of Enterprise Exploration made a plane-table survey of the area south of the open-cut and plotted the geology as exposed in the creek beds.

DATA FROM PREVIOUS INVESTIGATIONS

The Laloki orebody is a lens of massive fine-grained sulphides enclosed in fine-grained, partly calcareous sediments of the Eriama Series. About 41,400 tons of ore have been extracted from open-cut and underground workings on the Laloki Mine; copper content was about 4.5% and gold content about 2.6 dwts. per ton, (Hooper, 1941). Nearby "gabbro" is thought to be intrusive but is regarded by some as a volcanic member of the sedimentary sequence.

The most comprehensive account of the regional geology is contained in a report by R.N.Spratt (1957). Results of geomagnetic surveys are discussed by Tate (1951) and Knight (1959). Mine geology and history are discussed by Fisher (1940), Hooper (1941) and King (1950).

This report is solely concerned with new information revealed by the current drilling programme.

RESULTS OF CURRENT DRILLING PROGRAMME

Lateral limits of lode.

Drill holes SC5, SC7, SC9, SC10 and SC11 intersected little or no mineralisation. It is inferred that these holes are very near the limits of the lode and thus the western, northern and north-eastern limits of the lode are known. The southern limit of the lode is known from surface evidence so that only the south-eastern limit remains undefined.

Thickness of the lode.

Massive sulphide lode 18 to 19 feet thick was intersected in holes SC3 and SC4. Massive sulphide was also intersected high in SC3 (seven feet), in SC1 (four feet), and in SC8 (one and two feet). In holes SC1 and SC8 the massive lode is intercalated in up to 16 feet of pyritic pug.

Pyritic pug was intersected in holes SC2 (total two feet), SC6 (one foot), SC7 (one foot), and SC9 (one foot).

Weakly pyritic zones were encountered in holes SC10 and SC11.

All of the above intersections are thought to represent the Laloki lode and it is consequently inferred that the lode grades laterally from massive sulphides up to 20 feet thick, into pyritic pug and then to weakly pyritic shale. Hole SC5 did not reveal any evidence of the lode.

Attitude of the lode.

That part of the Laloki orebody revealed in the mine workings had an overall dip of about 45° to the north and north-west. Drilling has shown that, to the north, the western part of the lode flattens and then rises so that the probable dip near the northern margin is about 15° to the south.

Grade of the lode.

Assay results from only the first four holes are known at the time of writing; these show great variation in the composition of the lode. Copper content is between 2.3% and 4.8% except in the upper lode in SC3 where it is 10.9%. Zinc content is below 1% in SC4 and in the lower lode in SC3, but is 4% in the upper lode in SC3 and a surprising 25.2% in SC1. Gold content is between 0.2 and 3.7 dwts. per ton except in hole SC1 where it is 28.8 dwts. per ton. Silver content is between ~~0.2~~ 0.01 and 2.63 ozs. per ton.

Lithology of country rock.

*The predominant sediments are fine-grained shale and lutite and these, in various forms, constitute more than 95% of the core. Red-brown (ferruginous) shale and light grey or green grey (non-ferruginous) lutite predominate; these may be calcareous or non-calcareous. There is no visible difference between the calcareous and non-calcareous members, except where the red-brown shale is fissile and breaks into platy fragments with polished surfaces: this fissile shale is invariably non-calcareous.

The red-brown shale and the grey lutite may occur separately as massive beds up to five feet thick, but more commonly they form a breccia, with angular or sub-rounded fragments of both types set in a matrix of finer breccia and greywacke or, less commonly, of the red-brown shale. The fragments may be up to 3" in diameter but are normally ½" to 1". The finer breccia and greywacke are made up of the same components. This is the common "red and grey breccia" of the core logs. In some cases the breccia is completely grey.

Another important rock type is black shale which is commonly fissile and invariably non-calcareous. This is commonly associated with fine-grained greywacke, the two occurring as alternate laminae or as parts of the one graded bed. Mineralisation is generally associated with the fissile black shale.

Rare white or light grey chert occurs scattered throughout the section but is consistently well developed immediately above the gabbro-sediment contact, where it is 20 to 40 feet thick. The grey chert looks like silicified grey lutite and commonly shows the breccia fabric peculiar to lutite. Silicification is also suggested by the vague outlines of breccia components in the chert and by gradations from chert showing breccia fabric to massive chert.

A thin bed of tuffaceous greywacke was intersected in holes SC2 and SC3 and this is described in detail in Appendix I. It consists of grains of brown to black basaltic? glass?, minor shale, rare plagioclase, quartz, hornblende, carbonate and apatite, all cemented by zeophyllite which comprises 50% of the rock.

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* The difference between "shale" and "lutite", as the terms are used here and in core logs, is that the lutite is harder, appears more lithified and less friable. The shale may be massive or fissile, whereas the lutite is always massive. Red-brown lutite is rare and there is no light grey shale.

Fine calcite stringers are common throughout the core except in the black shale and associated fine greywacke. These may derive from low-grade metamorphism of the gabbro but, as they do not become more prevalent near the gabbro, probably derive from the original lime content of the sediments.

Deposition probably took place on a low-angle offshore slope flanking a landmass of subdued topography.

Origin of the breccia.

The fairly uniform composition of the breccia and its recurrence throughout the sedimentary sequence argue against fault origin. It may have originated through the different responses to tectonic stress of the competent lutite and the less competent shale: under folding stress the lutite might be expected to shatter and the shale to flow around the lutite fragments. However, as noted above, both lutite and shale form component fragments in the breccia and the matrix is rarely pure shale but is, rather, a finer breccia or greywacke. Furthermore there are few or no signs of flowage in the shale.

The favoured hypothesis is that the breccia is purely sedimentary and originated from the slumping of partly lithified sediments. The slump hypothesis is supported by the occurrence of slump structures in hole SC9.

Stratigraphic correlation.

In February, 1961, Mr. Knight found a marker bed which occurs within ten feet of the footwall of the Laloki orebody (or the ore horizon as indicated by pyritic zones) in all drill holes except SC9. This was a most significant observation as it proves conclusively that mineralization is stratigraphically controlled. The marker bed is a grey lutite with red (probably ferruginous) lutite laminae which have gradational contacts with the grey lutite.

Failure of other geologists to note the marker bed is attributed to the fact that no less than four geologists were engaged, at different times, in logging the core. Not until Mr. Knight's visit was all the core laid out and examined at the one time by one person. Had the marker been noted earlier in the programme many hundreds of feet of drilling would have been saved.

The thin tuff bed noted in holes SC2 and SC3 occurs within eight feet of lode footwall but was not intersected in any of the other drill holes.

Gabbro was intersected in holes SC2, SC5, and SC7, and in each case, it was overlain by grey chert or hardened lutite, some of which showed breccia fabric. Holes SC6 and SC11 intersected the same rock but were not pushed through to gabbro. This bed occurs 230 to 250 feet below lode footwall, and the gabbro, where intersected, occurs 250 to 275 feet below lode footwall.

Attempts to correlate other beds have failed, possibly because the sequence is disturbed by irregular tongues and lenses of breccia.

Nature of the "gabbro".

There is some controversy as to whether the "gabbro" is of intrusive or extrusive origin. Most writers have regarded it as a pluton in which the Eriama sediments occur as roof pendants.

Spratt's (1957) survey represents the most detailed mapping of the area and he has concluded that the gabbro is intrusive, citing as evidence the generally finer grain of the gabbro near its margins. However he points out that the gabbro-sediment contact is generally conformable with bedding in the overlying sediments.

Spheroidal structures in weathered gabbro exposed near the Mandated Alluvials smelter might be interpreted as pillow structures or as spheroidal weathering of homogeneous gabbro.

Mr. Thompson regards the gabbro as intrusive and notes that, although Spratt's (ibid.) map shows "distinct parallelism of the strike of the sediments and their outcropping contact with the gabbro ...... the dips in the sediments are inconsistent, generally steep, and rarely conforming with the surface of the 'gabbro'" (Thompson, 1959).

Both arguments have gained some strength from the drilling results. Near the contact zeolite, epidote and pyrite have been introduced into the sediments and the sediments are hardened; this suggests an intrusive relationship (see Appendix I). The constant stratigraphic position of the gabbro might suggest extrusive origin.

It seems most likely that the gabbro in the vicinity of the Laloki Mine is a sill, possibly emplaced before folding.

Upper lode in SC3.

An exciting anomaly is the occurrence of a massive sulphide lode, with high copper content, at shallow depth in hole SC3. This was thought to represent a separate orebody but the occurrence of the grey and red lutite marker seven feet below the footwall suggests that it is a part of the Laloki orebody. If this is so it must have been faulted into its present position, but examination of all data has not revealed a likely position and attitude for the fault.

The attitude of this "upper lode" is not known. Presumably it was not intersected in the air-shaft, a vertical shaft 30 feet to the north, and shallow costeaning has not revealed any lateral extension.

Syngenetic or epigenetic sulphides?

Pyrite which forms the cores of small interstitial blebs of epidotite in sediments near the gabbro contact is almost certainly epigenetic and probably derives from hydrothermal solutions emanating from the gabbro. Pyrite which occurs as component grains and fragments in greywacke at 233 feet in hole SC3 and at 155 feet in hole SC7 is almost certainly syngenetic and derives from the source area of the sediments or from the re-working of pyrite precipitated ?organically elsewhere on the sea floor. Chalcopyrite, sphalerite and calcite associated with the pyrite fragment at 155 feet in hole SC7 have almost certainly been introduced during a late stage of the shearing which affects most of the sediments (see Appendix II). This opinion is based on the observation that lens-like twinning characteristically produced by only light stress is preserved in the chalcopyrite.

In summary syngenetic pyrite was deposited with the sediments but some pyrite was also introduced in solutions emanating from the gabbro. During subsequent shearing, chalcopyrite, sphalerite and calcite were introduced into a favourable bed either in solutions emanating from the gabbro or by concentration from the surrounding sediments.

FUTURE INVESTIGATION

It has been agreed that the south-eastern limit of the orebody should be defined. This might be accomplished by one drill hole, the proposed SC12. Another hole will be drilled west of the orebody "on the projection of the midline of the mineralisation" (Knight, 1961). Both these holes could be abandoned when they intersect the grey and red lutite marker bed.

Should both these holes fail to intersect strong mineralisation the Laloki orebody will have been defined as a shallow-dipping lens of limited lateral extent. However it is possible that the lode will "make" again, probably in the same stratigraphic horizon, and with this in mind, it might be worthwhile to trace the outcrop of the marker bed to the westward. (To the east it is concealed by boulders and scree of younger agglomerate.) Such mapping might reveal a likely site for a "wildcat" hole, somewhere between the Laloki and Merrie England mines, as suggested by Thompson (1959, para.10).

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Appendix I

The Petrography of Five Specimens from the Laloki Mine, Port Moresby, T.P.N.G.

by

W. R. Morgan.

Introduction. The five specimens were obtained by J.E. Thompson and H.L. Davies from D.D.H. M 83 SC2, Laloki Mine, Port Moresby. The specimen numbers and their depths in the hole are listed as follows :-

P.421 - 170 feet
P.422 - 347 feet
P.423 - 436 feet, 9 inches
P.424 - 439 feet, 9 inches
P.425 - 455 feet.

The reason for this report is to decide whether or not the basic igneous rock represented by specimens P.424 and P.425 is intruded into the sedimentary rocks represented by P.421, P.422, and P.423.

Petrography.

P.421, slide number 5390

The hand specimen is a fine- to medium-grained, greyish-buff apparent sandstone. On one of the specimen's surfaces a thin layer of more coarse grit containing sub-angular to sub-rounded grains is present.

The thin section presents rather serious difficulties in mineral identification. The rock appears to consist mostly of angular to sub-angular, sometimes shard-shaped grains of brown to black (?)basaltic (?)glass. Some grains contain this (?)glass in laminated intergrowth with a mineral that is pleochroic from almost-colourless to purplish-blue ((?)soda-amphibole). Quite commonly, the (?)glass has a rim of a reddish-brown, anisotropic and sometimes fibrous mineral. Rounder grains composed of masses of minute flakes of green nontronite are present. Some grains of two other unidentified minerals were noted: one is a reddish-brown anisotropic mineral with fairly high relief; the other is a greenish-brown isotropic mineral with high relief. Grains composed of fine-grained shale were observed. Rare grains of plagioclase, quartz, green hornblende, carbonate, and apatite are present.

The grains are cemented by (?)zeophyllite, which makes up about 50% of the rock. It is a colourless mineral which forms partly coalesced, sub-radial fibres, and has a low to moderate birefringence, a refractive index of 1.56-1.57, and is uniaxial negative. Small amounts of sericite are intergrown with the (?)zeophyllite. Commonly, a thin rim of a colourless anisotropic mineral with a negative refringence, surrounds the grains of basaltic (?)glass: this mineral may be fluorite or opal.

P.422, slide number 5391

In hand specimen the rock is a dull, dark purplish-brown breccia containing coarse sub-angular and angular fragments that range up to 1.5 cm. in size. The fragments and matrix are composed of fine-grained material that reacts with dilute HCl, showing that calcite is present. Irregular veins of calcite cut the rock.

In thin section, coarse angular to sub-angular fragments are seen to be enclosed in a fine-grained matrix. The matrix grains range between 0.004 mm. and 0.024 mm. in size, and consist of fairly abundant calcite, very minor amounts of quartz, more rare grains of pale green chlorite, and very rare grains of plagioclase; all these grains are enclosed in extremely fine-grained hydrated iron oxide dust. In places, the iron oxide dust becomes so thick that it has the appearance of forming irregular veins cutting the matrix.

Many of the fragments are commonly formed of calcilutite and slightly silty calcilutite. Some fragments contain hydrated iron oxide dust; in others, this dust is absent. Rarer small fragments are composed of aggregates of fine flakes of pale green, nearly isotropic chlorite whose refractive index is only slightly above that of quartz.

Thick irregular veins cutting the rock contain coarse granular calcite and rare lamellar barytes.

The rock is a veined ferruginous calcilutite breccia.

P.423, slide number 5392

Like sample P.422, the hand specimen is a breccia. The main differences are that it is light grey, and that the matrix and fragments are only slightly softer than steel. Application of dilute HCl shows that calcite is present in both the matrix and fragments. Calcite veins are present, but they are thinner and less common that in P.422.

In the thin section the texture is seen to be similar to that of P.422. Most of the fragments are composed of calcilutite and silty calcilutite: others are composed of aggregates of fine-grained flakes of very pale green chlorite. The calcilutite fragments contain granules of apparent leucoxene, and rare small cavities occupied by fine flakes of chlorite.

The matrix is formed of fine-grained granular calcite, (?)leucoxene, and quartz, and of fine, anhedral chlorite flakes.

Thin veins cut the rock, and are composed of calcite and zeolite, the minerals occurring singly in some, and together with yellow epidote in others. Small aggregates of irregular grains of pyrites and zeolite are clustered in places in the rock. These aggregates are not confined to the fragments, but also occur in the matrix.

The zeolite in both the veins and the aggregates forms fine-grained intergrowths of sub-tabular crystals that have oblique extinction: it is possibly laumontite.

The rock is a veined calcilutite breccia.

P.424, slide number 5393

The hand specimen is of a dark grey, fine- to medium-grained basic igneous rock.

In thin section, the rock is seen to consist almost entirely of zeolites and actinolitic hornblende, with small amounts of black iron ore. Its texture, viewed in ordinary light, gives the impression of being doleritic. The intersecting sub-tabular laths of felspar are represented by zeolite, and are sub-ophitically intergrown with anhedral to subhedral crystals of green actinolitic hornblende that probably pseudomorphs pyroxene. Black iron ore forms anhedral grains that are commonly associated with actinolitic hornblende.

The specimen is cut by one or two irregular zones of crushed rock composed of sub-angular grains of zeolite and actinolitic hornblende embedded in a fine-grained matrix of these minerals. Several veins of zeolite also cut the rock.

The main zeolite replacing feldspar appears to be analcite, although some (?)thompsonite and (?)laumontite are also present. Veins composed of analcite are cut by later veins containing (?)thompsonite and (?)laumontite.

A visual estimation of the percentages of minerals present is:- zeolites: 50, actinolitic hornblende: 45, black iron ore: 5. The rock is a zeolitized and uralitized dolerite.

P.425, slide number 5394.

The hand specimen is a dark grey, fine- to medium-grained basic igneous rock that is cut by several thin irregular veins of zeolite.

In thin section, the rock is seen to be composed of zeolites, actinolite, oligoclase, augite and black iron ore. The rock's texture is fine- to medium-grained and doleritic. Much of the feldspar is replaced by analcite and (?)thompsonite. In places, (?)thompsonite forms masses of small, radially fibrous crystals which almost obliterate the pre-existing texture. Commonly, the zeolites are clouded by alteration products. The laths of feldspar are sub-ophitically enclosed by sub-prismatic, colourless augite, much of which is now replaced by pale green, fibro-prismatic actinolite. Irregular grains of black iron ore are often associated with actinolite.

Some veins of fibrous (?)thompsonite cut the rock. One of these is seen to be cut by a fault along which a thin crushed zone is present.

The rock is a partly zeolitized and uralitized oligoclase dolerite.

Comments. Specimens P.424 and P.425 are uralitized and zeolitized dolerites; no chilling effects were observed in P.424. Specimens P.422 and P.423 are calcareous breccias. The main difference between the two specimens is the presence of hydrated iron oxide dust in P.422, and its absence in P.423. No hornfelsing of P.423 was noted. Both specimens are cut by veins. In P.422 the veins contain calcite and small amounts of barytes. The veins in P.423 contain zeolite, calcite, and epidote: this specimen, on Mr. Thompson's evidence, occurs very close to the contact with the dolerite. Bearing in mind that the dolerite is extensively zeolitized, it seems likely that the zeolite and epidote in the veins are derived from the dolerite. From this, it is probable that the dolerite intrudes the breccia.

As mentioned before, specimen P.421 presents serious difficulties in mineral identification; the description I have given is the result of long and arduous discussion between Mr. Dallwitz and myself. At the moment we would call the rock a tuff or resorted tuff, but we are by no means sure. We would like some more of this material, in order to carry out more detailed mineralogical and chemical work ourselves.

(W.R. MORGAN)
Geologist, Grade 1

Appendix II

Examination of a Drill Core Specimen from the Laloki Copper Prospect. New Guinea.

by

W.M.B. Roberts.

The specimen, No. P.433, is from 155 feet in the D.D.H. SC7 from the Laloki copper prospect, New Guinea. The country rock consists of sub-angular to rounded fragments of a shaly material ranging up to 4.5 mm. in length. The components of the fragments themselves are extremely fine-grained; as a result quartz and sericite are the only minerals which can be positively identified. A brown staining, probably iron oxide is apparent in all fragments.

That the rock has been subjected to severe shearing stress is evident from the strong fracture pattern, and, in places, fairly intense brecciation. The whole rock is marked by extensive introduction of calcite, effectively recementing the fragments, but without any obvious signs of having replaced them.

The sulphides identified in the rock are: pyrite, chalcopyrite, marcasite, sphalerite, and some ? cubanite, in that order of abundance.

The pyrite has been strongly fractured, in places almost pulverised, by severe shearing; it forms irregular masses and subhedral crystals which are moulded and re-cemented by chalcopyrite and calcite. The chalcopyrite is characterised by a lamellar twinning, the individual lamellae having a lens-like form, indicative of a stress which has been imposed upon the grains after, or at a late stage in, their deposition. The chalcopyrite also has a spongy appearance in many places, due to an almost myrmekitic intergrowth of chalcopyrite and calcite. There is no doubt that this mineral is replacing pyrite; it preserves the outlines of partly replaced grains and masses, in places preserving traces of the pyrite fracture pattern. A structure clearly showing the replacement process may be seen in the accompanying photo; a mineral remaining from the original rock, having a perfect (III) cleavage, has been replaced along this cleavage by invading chalcopyrite, the remainder of the mineral clearly preserving its original outline. Marcasite forms irregular intergrowths with pyrite, mainly as chain-like masses composed of small evenly-sized grains.

Sphalerite is always associated with chalcopyrite, forming irregular areas, frequently as rims on isolated pyrite grains.

What is thought to be cubanite, is an orange-brown mineral formed along fractures in two of the chalcopyrite areas. Although similar in appearance to bornite, it is clearly distinguished from bornite by its intense anisotropism.

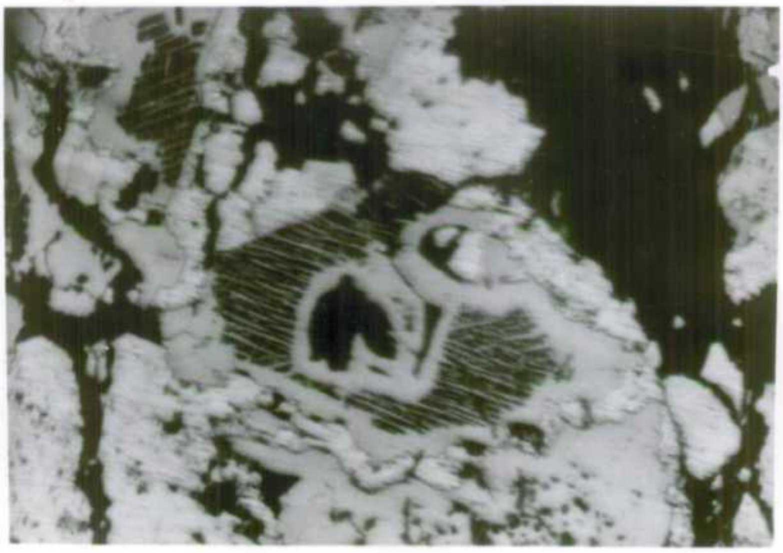
The only gangue mineral is calcite. A qualitative X-ray spectrographic analysis showed the metallic elements in the rock to be: Fe, Cu, Zn, Mn, As and traces of cobalt, in that order of abundance.

Conclusions.

The pyrite, which forms the bulk of the sulphide portion of the rock, shows evidence of having been very strongly sheared; in places it has been almost pulverised by the shearing action. It must therefore have been deposited before the introduction of the gangue, for, if it had followed the calcite, the relatively large quantity of this latter mineral would have, by flowage under pressure, protected the pyrite from at least the more drastic effects of the shearing. The fairly sharp break between the pyrite mass and the brecciated country rock would indicate that the pyrite was present, before the shearing took place. If it were introduced subsequently it would have been injected along the multitude of fractures opened in the country rock whereas its outlines are quite sharp and only calcite has been introduced in these areas. An area of intense shearing roughly 0.5 mm. in width in the country rocks follows the boundary of the pyrite at a distance of approximately 0.5 mm. from it, probably due to compression of the rock against the fairly unyielding pyrite.

Some movement has continued in the rock subsequent to the deposition of the copper-zinc sulphides, - the lens-like lamellar twins in the chalcopyrite grains, and the extensive twinning of the calcite are evidence of a post-depositional stress.

In conclusion it can be stated with reasonable certainty that the pyrite in this rock was present prior to the shearing and the consequent introduction of copper-zinc sulphides. It is not possible to say whether this pyrite is of sedimentary origin.



Replacement of a mineral, along the (III) cleavage, by chalcopyrite. The outline of the original mineral is clearly preserved. Chalcopyrite mid-grey, pyrite-marcasite intergrowth light grey, calcite gangue black (X400).

W.M.B. ROBERTS.

12.10.60.

Plate I

Laloki Mine

SUMMARY OF DRILLING RESULTS

To 17.2.1961

D.D.H. No	R.L. Collar	Length	R.L. Bottom	Angle	Azimuth	Mineralization: Footage	Mineralization: R.Ls.	Assay: Cu %	Assay: Zn %	Assay: Au dwts/ton	Assay: Ag ozs/ton	Description	R.L. Marker - laminated red + grey lutite.	R.L. Gabbro	Remarks.
sc 1	1222'	400'	822'	Vertical	—	184'10½" - 197'4"	1025' - 1037'						1112'-1124'		
							1031' - 1035'	2.3	25.2	28.8	2.63	Pug c 3'9½" lens of fine-grained banded py, cpy, sp, qts.			
sc 2	1179'	455'	751'	70°	156° M.	153' - 154' 161' - 162' 166' - 166'4"	1036' - 1037' 1027' - 1028' 1023'					Pyritic pug	1022' - 1032'	766'	
						175' - 175'9"	1014' - 1015'					Pyritic greywacke			
sc 3	1240'	270'	970'	80°	162° M.	20'6" - 28'	1213' - 1220'	10.9	4.0	3.7	0.7	Massive py - cpy except 20'9" - 22'8" which is sheared black shale	1186' - 1200'		
						206' - 224'	1019' - 1037'	3.1	0.8	1.2	1.8	Massive py, cpy and magnetite	1012' - 1014'		
sc 4	1255'	301'	995'	60°	180° M	267' - 289'3"	1005' - 1024'	4.8	0.3	0.2	0.07	Massive py, cpy, pyrr., and magnetite except 268'3" - 269'11" - talc c minor pyrite.	Estimated 380' - 385'		
sc 5	1157'	482'	739'	60°	157° M	208'8" 213' - 220'	977' 967' - 973'					Rare pyrite blebs.	976' - 993'	760'	Ore horizon not intersected.
sc 6	1255'	508'	747'	Vertical	—	308' - 309' 349'	946' - 947' 906'					Py, cpy, magnetite in pug. Py, cpy, magnetite stringer	928' - 938'	Short dist. below 747'	
sc 7	1242'	552'9"	689'	Vertical	—	155' 276'1" - 276'10"	1087' 965' - 966'					Pyrite components in breccia. Pyritic pug.	937' - 957'	691	
sc 8	1295'	351'	944'	Vertical	—	262'3" - 263' 268' - 284'	1032' - 1033' 1011' - 1027'					Massive py + cpy Pyritic pug with massive sulphide 277' - 279'	999' - 1011'		
sc 9	1325'	496'6"	828'6"	Vertical	—	432' - 433'	892' - 893'					Pyritic pug.			Marker not seen.
sc 10	1332'	511'	821'	Vertical	—	332' - 376'9"	955' - 1000'					Weakly pyritic.	942' - 953'		
sc 11	1315'	532'6"	782'	Vertical	—	268' - 296'	1019' - 1047'					Weakly pyritic	1008' - 1017'	Short dist. below 782'	

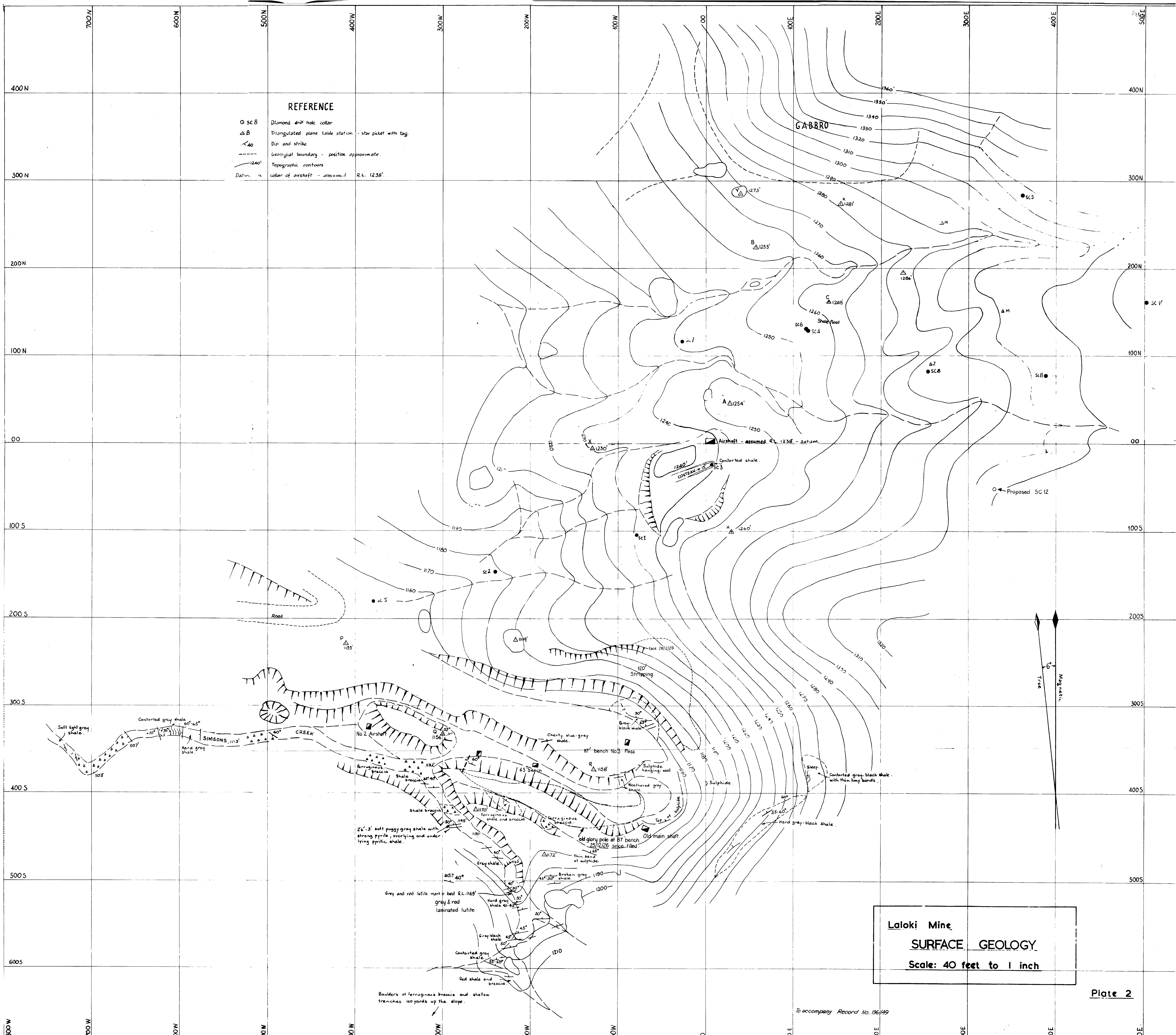
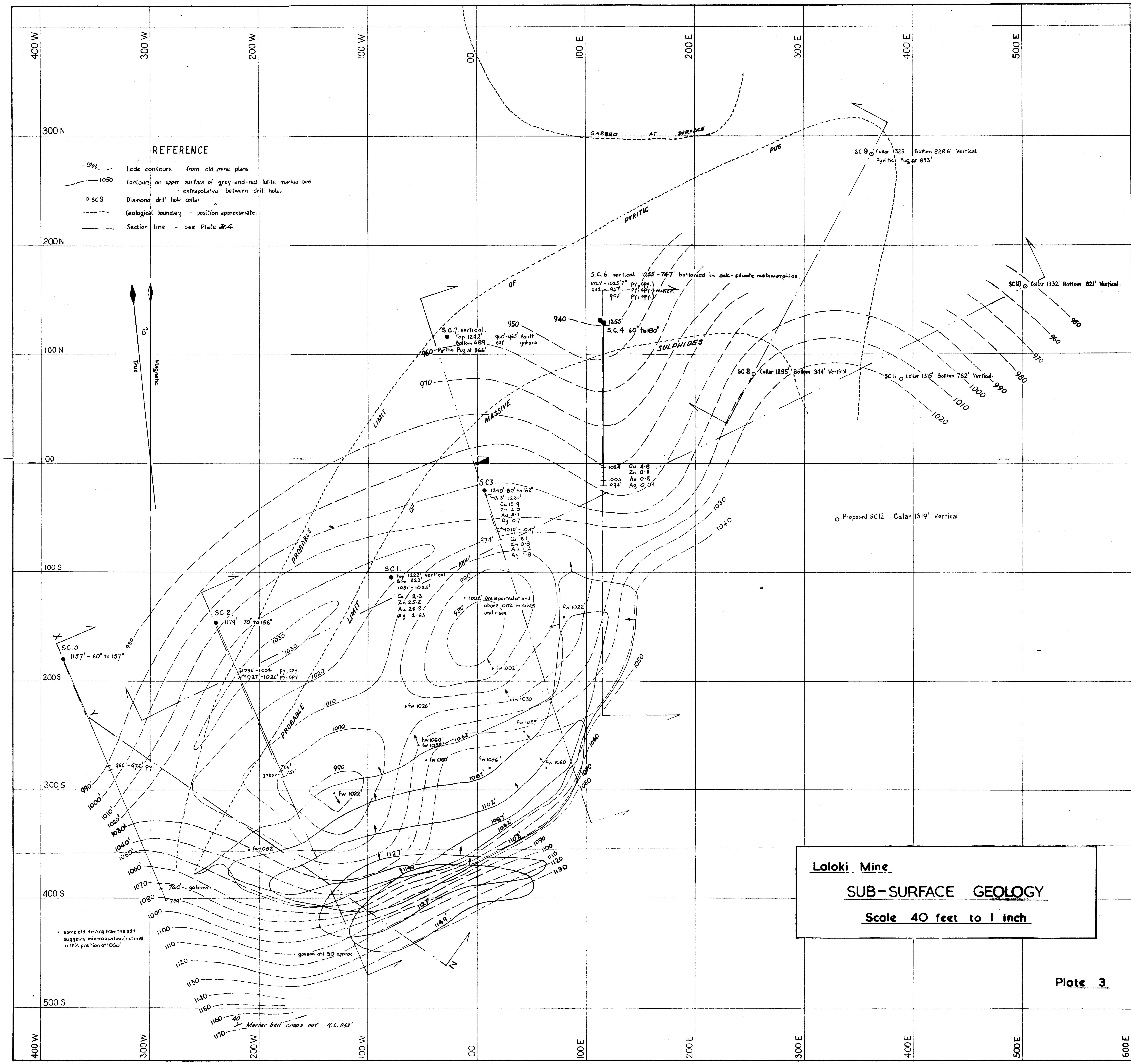


Plate 2

To accompany Record No. 1961/49

Bureau of Mineral Resources, Geology & Geophysics June, 1961.

PNG 8C/15



Laloki Mine

SUB-SURFACE GEOLOGY

Scale 40 feet to 1 inch

Plate 3

Bureau of Mineral Resources, Geology and Geophysics June 1961. To accompany Record 1961/49.

PNG 8c-16

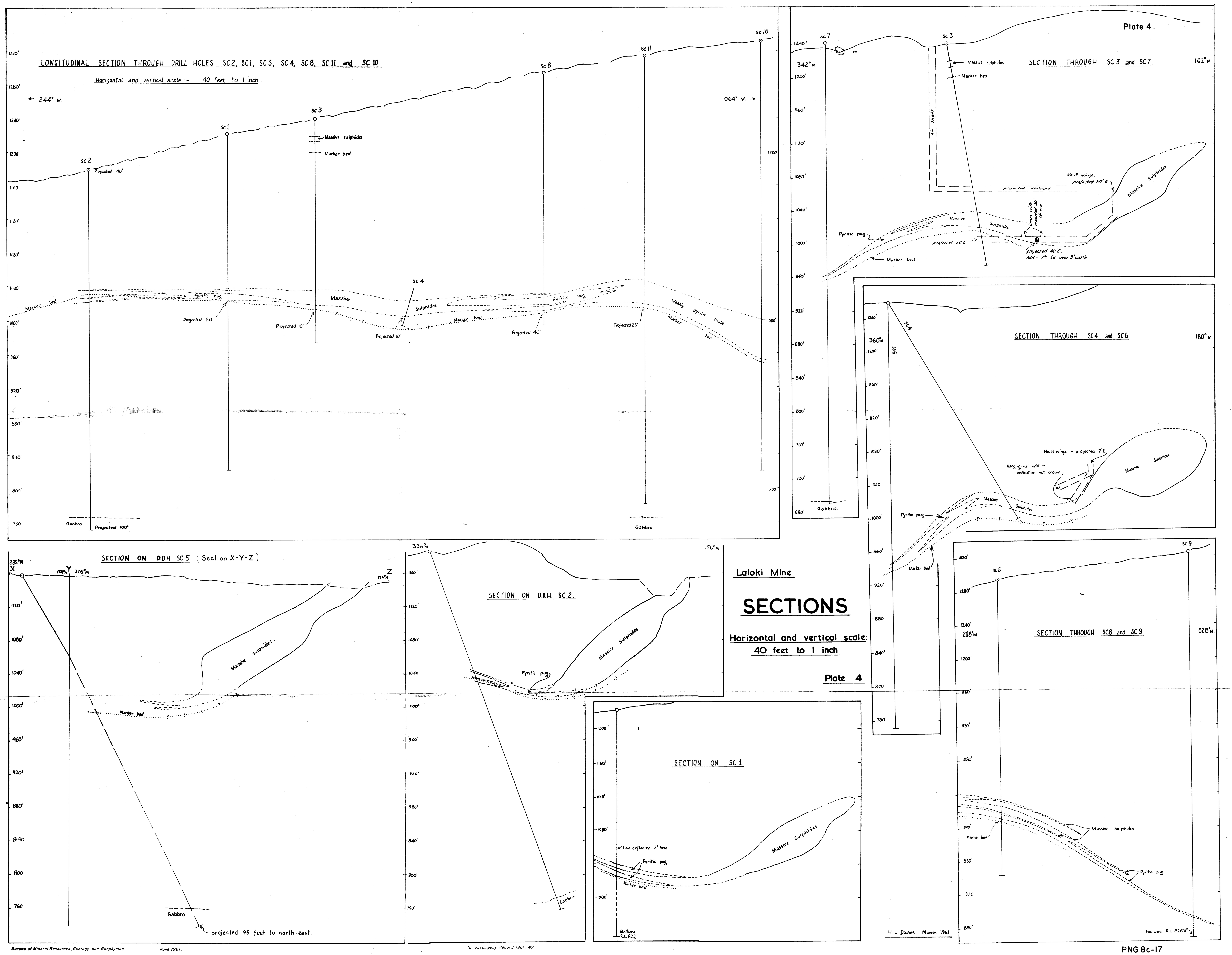


Plate 4.
LONGITUDINAL SECTION THROUGH DRILL HOLES SC2, SC1, SC3, SC4, SC8, SC11 and SC10
Horizontal and vertical scale:- 40 feet to 1 inch.
244° M
064° M
Massive sulphides
Marker bed
Pyritic pug
Weakly pyritic shale
Projected 40'
Projected 20'
Projected 10'
Projected 25'
Projected 100'
Gabbro
SECTION THROUGH SC3 and SC7
342° M
162° M
Air shaft
projected westward
No. 8 winze, projected 20' E.
projected 20' E
projected 40' E.
Adit: 7% Cu over 9' width.
SECTION THROUGH SC4 and SC6
360° M
180° M.
No. 13 winze - projected 12' E.
Hanging-wall adit - inclination not known
SECTION ON D.D.H. SC5 (Section X-Y-Z)
335° M
155° M
305° M
125° M
projected 96 feet to north-east.
SECTION ON D.D.H. SC2.
336° M
156° M
Laloki Mine
SECTIONS
Horizontal and vertical scale: 40 feet to 1 inch
Plate 4
SECTION ON SC1
Hole deflected 2° here
Bottom: R.L. 822'
SECTION THROUGH SC8 and SC9
208° M.
028° M.
Bottom: R.L. 828'6"
H.L. Davies March 1961
Bureau of Mineral Resources, Geology and Geophysics.
June 1961.
To accompany Record 1961/49
PNG 8c-17