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THE MOUNT HARDY COPPER MINE, NORTHERN TERRITORY.

by

D. J. Grainger

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SUMMARY

This report describes the results of an investigation of the Mount Hardy Copper Mine, which is situated about 200 miles northwest of Alice Springs.

The Mine has been known since the 1930s, and is one of several small copper prospects in the Mount Doreen-Mount Hardy-Yuendumu areas.

Mining operations have been carried out intermittently since 1964 by aboriginal prospectors from Yuendumu Settlement and about 750 tons of secondary copper ore have been broken and stockpiled.

The mine is located in gneisses and schists of the Arunta Complex, which has been intruded by granites in the nearby Mount Doreen and Yuendumu areas.

Mineralization is associated with quartz and pegmatite veins which are conformable with the foliation of the gneisses. Copper minerals found in the veins and in the adjacent gneisses comprise malachite, azurite and chalcocite in the oxidized zone and chalcopyrite in the sulphide zone.

The prospect was trenched and pitted, and seven diamond drill holes, totalling 1,656 feet, were drilled. 190 samples from the ore dump, workings and drill cores were assayed. No zone of secondary sulphide enrichment was found, but native copper was found in two of the drill holes.

The average grade of the top 25 feet of the oxidized zone indicated by systematic chip sampling is about 4% Cu which contrasts with less than 1% Cu for the sulphide zone and indicates enrichment near the surface. Gold, lead and zinc assay values are all very low, but up to 2 ozs per ton of silver are present in some surface samples and up to 1 oz. per ton in some drill cores.

It is conservatively estimated that within 40 feet of the surface there are about 12,000 tons of oxidized ore available for extraction from two main mineralised areas. The grade would be between 3% and 4% Cu.

INTRODUCTION

General

The Mount Hardy Copper Mine is part of the Mount Doreen-Mount Hardy-Yuendumu mineral field located about 200 miles northwest of Alice Springs. The scantily mineralized belt extends eastwards from Mount Doreen for at least 40 miles through the Mount Hardy area and the hills north of Yuendumu Settlement. Over 20 occurrences of mineralization have been discovered within the Mount Hardy-Yuendumu

area; the Mount Hardy Mine seems to be the most promising. Wolfram has been worked near the old Mount Doreen Homestead.

Aboriginal prospectors from Yuendumu Settlement have begun working the oxidized zone of several prospects. Open cutting of the Mount Hardy deposit and stockpiling of the ore had begun before the start of the present investigation. An early attempt at leaching copper ore at the Settlement failed because of the lack of suitable trained personnel, but the process was shown to be feasible.

Location and Access

The Mount Hardy Mine is situated 4 miles east-northeast of Mount Hardy on Mount Doreen pastoral lease and is 17 miles northwest of Yuendumu Settlement (see Plate 2). The western boundary of the Aboriginal Reserve is approximately 2¾ miles east of the mine.

Access is by a bush track of about 7 miles, which leaves the Yuendumu-Old Mount Doreen Homestead graded road 18 miles west of Yuendumu.

Leases and Authorities to Prospect

Mineral leases ML.367H of 40 acres has been taken out over the Mount Hardy Mine area by Yuendumu Native Council. The surrounding area of 432 square miles west from the reserve boundary, except for AP.1563, is held under AP.1722 by Magellan Petroleum (N.T.) Pty Ltd. AP1563 of 16 square miles over an area of west from Mount Hardy is held by T. Jabanardi on behalf of Yuendumu Native Council.

Physiography

The Mount Hardy area consists of low ridges and some areas of high relief separated by extensive flats. The drainage is generally northwards (see Plate 1).

East Point Ridge, (Madigan, 1937) on which the Mount Hardy Mines is located, strikes east-northeast for about 1,000 feet and has its highest point about 70 feet above the extensive lowlands drained by Keridi Creek. To the west, a series of low ridges join East Point to the Gap Range (Kiek, 1941). This range, with a relief of several hundred feet, is broken at the Gap, east of Brown's Mine, by a drainage system trending north from Mount Hardy, and is separated from the Mount Hardy Range by an area of low relief. The Mount Hardy Range itself rises to 2,758 feet and extends eastwards for several miles as a discontinuous line of ridges. Mount Hardy is the highest point in the area.

The prominent rounded Whaleback Hill lies north of the mine and is elongated in an easterly direction. To the north of Whaleback are extensive lowlands and occasional isolated hills.

Atlee Creek drains the western and northern slopes of Mount Hardy, while the eastern slopes and hills to the south provide drainage for the Mount Hardy Creek system which joins Keridi Creek to the northeast of the mine. All these creeks flow only after heavy rain.

Water Supply

There is no permanent water near the Mount Hardy mine; water for domestic and other requirements has to be brought from Yuendumu. For a period of about two months after the heavy rains of early 1967, water could be obtained from a waterhole in Mount Hardy Creek about three-quarters of a mile east of the mine, but this waterhole rapidly became contaminated by cattle. Aboriginals began hand-digging a well in Mount Hardy Creek before the rains, but no further work has been done.

Previous Investigations and Mining

The earliest reference to the deposit is by Madigan (1937). His 'East Point A' probably refers to the present Mount Hardy Mine. He believed it to be a promising reef and suggested the sinking of a prospecting shaft. A sample collected by him assayed 13% Cu and 4% Pb.

Kiek (1941) mapped the mine as Deposit No.1 and located a total of eleven copper bearing reefs. He mapped a prospecting pit on Vein No.8.

A pit (Pit No.2) was later dug on Kiek's Deposit No.1 near the highest point of the ridge and copper staining was exposed. In the 1950s Uranium Development and Prospecting (N.L.) drilled a diamond drill hole about 40 yards north of this pit at a high angle of inclination towards the ridge. No details are known of this hole except that malachite staining is supposed to have been observed at about 80 feet.

Aboriginal prospectors from Yuendumu began work on the deposit in 1964. A number of prospecting pits were dug and a small open cut excavated near the northeastern end of East Point ridge. The ore has been stockpiled at the mine.

Present Investigation

Preliminary work began in late 1966 and was followed by trenching and pitting of the deposit in early 1967. Results of this work were encouraging, and seven diamond drill holes totalling 1,656 feet were subsequently drilled by Mines Branch, Northern Territory Administration (see Appendix II for drill hole logs).

East Point Ridge and a nearby low hill to the southwest were surveyed by plane table at a scale of 60 feet to the inch (see Plate 3). Contours were drawn using an arbitrary datum of 1,000 feet at the southwestern corner post of the lease.

A total of 190 samples from the surface, dump, workings and drill holes were assayed by Mines Branch Laboratory, Darwin, and the Government Battery, Tennant Creek. The results are given in Appendix I.

A Bureau of Mineral Resources geophysical field party carried out Self Potential and Electromagnetic traverses over the Mount Hardy lease in October and November 1967. The results of this work are not yet available.

GENERAL GEOLOGY

General

The rocks of the Mount Hardy area form part of the Arunta Complex. Gneisses and schists of varying composition have been intruded by the Mount Doreen and Yuendumu granites (see Plates 1 and 2). Proterozoic and Palaeozoic sediments of the Ngalia Basin crop out 12 miles south of the mine.

Metamorphic Rocks

A specimen of the country rock from the Mount Hardy Mine has been described by Australian Mineral Development Laboratories as a deformed biotite-muscovite-quartz gneiss. In hand specimen the mica gneiss is medium-grained grey rock which weathers to rusty brown. Porphyroblasts of quartz and feldspar are locally present, and some specimens contain small patches of a white micaceous mineral believed to be sericite.

Diamond drill cores show that quartz and feldspar-rich gneisses alternate with the micaceous gneisses, and both may be locally garnetiferous. Chlorite-rich intervals in the core, less noticeable in outcrop, indicate zones of shearing.

The Gap Range and Whaleback Hill are composed of similar rocks. Micaceous gneisses and mica-quartz gneisses predominate, but there are also thin quartzite and gneissic quartzite bands. Schists are only locally developed.

Igneous Rocks

The metamorphic rocks of the Mount Hardy area have been intruded by several igneous bodies. Of regional interest are the Mount Doreen granite, 7 miles west of the mine, and the granites of Yuendumu Reserve.

Quartz and pegmatite veins up to 600 feet long and 10 to 15 feet wide have been mapped at the Mount Hardy Mine and similar veins are present elsewhere in the area. Two generations of pegmatites and quartz veins have been observed; the younger veins are unmineralized.

The earlier quartz veins are massive, in part ironstained, and tend to be clear. They are locally sheared. The quartz includes occasional films of chlorite and (?) sericite. The earlier pegmatites are composed of graphic intergrowths of felspar and quartz and exhibit a slight degree of fissility, possibly the result of shearing. In general, they are medium to fine grained. During drilling it was recognized that many veins mapped as quartz veins are in fact quartz-cores of pegmatites. The earlier veins tend to be conformable with the foliation of the metamorphic rocks.

The younger quartz and pegmatite veins are unmineralized and generally cut across the foliation of the metamorphic rocks, but were nowhere observed to cut the older veins. The quartz veins are milky white, and do not appear to have suffered any deformation by shearing. The pegmatites are coarse-grained and consist of quartz, felspar and muscovite. Like the younger quartz veins, the later pegmatites are undeformed.

Structure

Regional. The main structural trends of the Mount Hardy area are shown in Plate 1. In the western part of the Gap Range the general strike of the foliation of the steeply dipping rocks is to the south-southeast. East of the Gap, the foliation strike is northeasterly, and in the area of Whaleback Hill and East Point the foliation strikes in a general easterly direction.

Mount Hardy Mine. The general strike of the foliation of the country rocks at the Mount Hardy Mine is 65° magnetic and the dip is steeply (plus 65°) northwards. At the northeastern end of East Point Ridge the main quartz vein curves to the southeast, and the foliation of the gneisses also changes to east or slightly north of east. These changes in strike are thought to indicate an anticline plunging steeply in a northerly direction. Minor folds mapped south of the main vein are tentatively interpreted as drags produced during the formation of the anticline, since the plunges of these minor structures appear to be similar to that of the major anticline.

The dominant strike of joints is approximately northwest and the joints dip steeply to the southwest. A second set of joints strikes to the north and east of north and has moderate to steep dips to the east.

The jointing is later than the copper mineralization and therefore does not affect the distribution of ore, but the younger unmineralized quartz and pegmatite veins strike in a direction similar to that of the main joints, and may represent infillings along joint planes.

In thin section the gneiss constituents have been found to be strongly stressed and contorted. Sericite and chlorite veining of garnets in some hand specimens suggests retrogressive metamorphism resulting from shearing.

Sheared core, and the relative displacement of corresponding rock types between DDH1 and 2, and between DDH3 and 7, indicate that an east-northeast striking shear zone occurs on the north side of the ridge. Sheared chlorite schist exposed in the trench north of No.2 Vein is the surface expression of this shear zone, which dips steeply to the south.

ECONOMIC GEOLOGY

General

The Mount Hardy Mine is one of the many small mineral occurrences in the Mount Doreen-Mount Hardy-Yuendumu wolfram and copper field (see Plate 2). The sparsely mineralized belt extends for more than 40 miles from Wolfram Hill near the old Mount Doreen Homestead, through the Mount Hardy area and the hills north of Yuendumu Settlement, to the Mount Denison road. The belt is 4 to 5 miles wide and is confined to rocks of the Arunta Complex.

Patches of copper mineralization occur throughout the area, but seldom amount to more than stainings. In the 1930s wolfram was mined at Wolfram Hill. A little galena occurs with copper about 2¾ miles northeast of Mount Hardy, and silver has been detected in assays from both lead and copper minerals from several localities in the Mount Hardy area.

The surface expressions of copper mineralization are similar throughout the Mount Hardy-Yuendumu area. Quartz and pegmatite veins and adjacent gneisses and schists are stained with malachite and some azurite. The malachite forms thin intergranular films in the veins, and films and veinlets in the country rocks. Rosettes of malachite crystals occur at some localities. Boxworks after sulphides are rare, and gossans and ironstainings are poorly developed. No primary sulphides have been identified at the surface or in any of the excavations, but drilling at the Mount Hardy Mine has proved pyrite and chalcopyrite at depth.

Copper mineralization is usually indicated on the surface by the presence of a 'copper plant', a member of the family Goodenicea (Animal Industries Branch Botanist, Alice Springs, personal communication) which appears to be restricted to soils having a high copper content. This plant is used by the aboriginals from Yuendumu as a guide to copper occurrences.

Mount Hardy Copper Mine

General. The mine is the most important deposit so far investigated in the Mount Hardy-Yuendumu area. Workings are at the eastern end of East Point Ridge which extends for about 1,000 feet in a southwesterly direction and has a steep drop at the northeastern end (see Plate 3). The highest point on the ridge is more than 70 feet above the level of the surrounding low ground. A valley separates the ridge from a low rise in the southwestern portion of the lease.

There are nine concordant veins or systems of veins at the mine, of which eight are mineralized. In addition, numerous younger unmineralized quartz and pegmatite veins cut across the foliation of the gneisses.

The prospect was mapped at a scale of 60 feet to the inch, and additional geological data were obtained by trenching, pitting and examination of diamond drill cores. The deposit has been known for about 30 years and during this time a limited amount of investigation and prospecting has been carried out. Aboriginals from Yuendumu settlement have been mining the oxidized zone of the deposit intermittently since 1964 and have stockpiled about 750 tons of ore. A representative collection of samples from the dump yielded 4% copper, which corresponds closely to the average grade of the secondary ore throughout the Mine area. There are reserves of several thousand tons of secondary ore available for small scale mining.

Description of the Main Veins (see Plate 3)

No.1 Vein follows the summit of East Point Ridge. It has been mapped as a quartz vein, but it is pegmatitic in parts. The vein is over 600 feet long and up to 15 feet wide. It is conformable with the gneisses.

At the surface the vein itself is only mineralized near Pit No.2 and at the northeastern end of the vein, but adjacent gneisses are veined with quartz stringers and stained with malachite along much of the length of the vein. This mineralization in the gneisses is confined to the southern side of the vein, except near the open cut and Pit No.2, where the gneisses on both sides of the vein are mineralized. Malachite is the main copper mineral contained in No.1 Vein, but azurite and chalcocite are also present.

No.2 Vein lies to the north of No.1 Vein, and is 380 feet long and up to 15 feet wide. At its southwestern end it is a quartz vein, but for the remainder of its length it is a pegmatite-aplite vein composed mainly of graphic intergrowths of quartz and feldspar. Mineralization (chiefly malachite) is exposed where the vein is cut by a trench and also in the open cut.

No.3 Vein to the west of the summit of the ridge is a quartz vein, believed to be the core of a complex quartz-pegmatite vein, and is mineralized only over a small length.

No.4 Vein is a small, heavily mineralized quartz vein 60 feet long and about 2 feet wide. It occurs to the south of No.1 Vein and east of the summit of the ridge. Rosettes of malachite crystals occur in the vein and adjacent gneisses.

No.5 Vein may be a westerly extension of No.1 Vein. It is 170 feet long and up to 25 feet wide. No mineralization was observed.

No.6 Vein consists of a group of mineralized quartz and pegmatite/aplite veins south of No.5 vein and on the northern side of a shallow drainage channel. The veins have been mapped as isolated occurrences, but may be continuous with each other. Several lie outside the boundary of ML.367H.

The following veins are exposed on the low hill in the southwest corner of the lease.

No.7 Vein is a quartz vein 100 feet long and up to 15 feet wide. Malachite staining is weakly developed and some of the nearby gneisses are slightly mineralized.

No.8 Vein is a quartz vein near the top of the rise northwest of No.7 Vein. It is 20 feet long and 3 feet wide, lying alongside a small pegmatite. The quartz vein is strongly mineralized with malachite and there is some chalcocite present.

No.9 Vein consists of a line of quartz boulders north of No. 8 Vein, on the northern flank of the hill. Copper mineralization has been exposed in a number of shallow pits dug along this line.

Mineralization

Mineralization is associated with the quartz and pegmatite veins. Diamond drilling proved that primary sulphides (chalcopyrite and pyrite) occur at depth and form thin stringers and clots in the veins and, more rarely, in the country rock. No massive concentrations of primary sulphides have been intersected at Mount Hardy.

Above the water table the chalcopyrite has been oxidized to the carbonates malachite and azurite. In the vicinity of the open cut at Mount Hardy the copper carbonates have been proved to persist for at least 50 feet below the present floor level, and to have impregnated the gneisses up to a distance of 15 feet from the veins.

No zone of secondary sulphide enrichment was discovered during drilling at Mount Hardy. However, in several cores sooty chalcocite has partly replaced the chalcopyrite, and native copper was noted in DDH3 and DDH7 in the zone of oxidation. The native copper is disseminated in quartz veins, particularly as films around the grains.

Prospecting and Development

Previous Work. The open cut is located at the northeastern end of East Point Ridge and has been excavated in No.1 and No.2 veins and associated gneisses. It is semi-circular, with a diameter of about 40 feet and a maximum depth of about 22 feet. It is estimated that about 750 tons of ore have been taken from the open cut and now form the main ore dump. This is the main area worked by the aboriginals.

No.1 and No.2 Veins are both mineralized in the open cut, but most of the ore has been obtained from the gneisses which have been mineralized for a distance of about 15 feet from the hanging-wall of No.1 Vein. These gneisses are permeated by quartz veinlets and contain malachite and some azurite and chalcocite.

Pit No.1 has been excavated by aboriginal workers in the mineralized gneisses on the hanging-wall side of No.1 Vein at the northeastern extremity of the vein. The pit is 35 feet by 10 feet by 5 feet. Ore taken from this excavation forms the small dumps to the north and east of the pit. Malachite, chalcocite and azurite are present.

Pit No.2 is near the southwestern end of No.1 Vein and is 70 feet west of the summit of the ridge. It was dug after the visit by Kiek (1941). The excavation is about 25 feet by 12 feet, and about 10 feet deep towards the eastern end. It extends through No.1 Vein, which is mineralized, and into the mineralized gneisses on its footwall side. The gneisses are strongly veined with quartz and are mineralized with malachite and some azurite and chalcocite.

Pit No.3, 15 feet by 7 feet by 5 feet in extent, was dug by aboriginals on No.4 Vein. The quartz vein is strongly mineralized with malachite but the adjacent gneisses are only weakly mineralized. Rosettes of malachite crystals are common in the quartz vein.

In addition to the larger excavations, a number of small test pits have been dug on No.8 vein (prior to 1941), on No.9 Vein, and in the area west of the main ore dump. Some mineralization is exposed in the pits on both the veins, and in one of the pits near the ore dump.

In the 1950s, Uranium Development Pty Ltd (N.L.) began diamond drilling at the Mount Hardy Mine, but the hole was abandoned. It is located 160 feet northwest of Pit No.2 and was drilled at a steep angle towards the pit. No other details are available.

Present Investigation

1. Trenching

At the beginning of the investigation it was decided to trench the Mount Hardy deposit to determine whether there was mineralization between the open cut and Pit No.2. Aboriginals from Yuendumu accordingly dug a trench across the ridge at right angles to the strike of the foliation in the gneiss. It is 110 feet southwest of the open cut, and is 245 feet long, up to 6 feet wide and 3 to 4 feet deep, and extends from near the track on the north side of the hill to about 60 feet south-southeast of No.1 Vein.

Patchy mineralization is exposed in No.2 Vein, and stronger mineralization in a 15-foot section of gneiss between No.1 and No.2 veins. A narrow, rich mineralized zone is also present south of No. 1 Vein.

2. Pitting.

Pits were dug in the trench on the mineralized gneiss between No.1 and No.2 Veins, and on the narrow rich zone south of No.1 Vein.

Pit No.4, between No.1 and No.2 Veins, is up to 10 feet deep. Gneiss veined with quartz contains malachite mineralization over a width of 15 feet. A fine-grained pegmatite vein, 4 feet wide, exposed at the northern end of the pit, is unmineralized.

Pit No.5 was dug to a depth of 6 feet on the mineralized zone south of No.1 Vein. Malachite staining is present over a thickness of about 12 inches in gneiss and quartz veinlets. A band of malachite, ¼ inch thick, fills an open fracture in the gneiss.

3. Diamond Drilling.

Seven holes totalling 1,656 feet were drilled by Mines Branch, Northern Territory Administration (see Appendix II for drill logs, and Figs 3, 4 and 5 for sections).

DDH1 and DDH2 were drilled to test for primary sulphide mineralization below the open cut. In DDH1, No.1 Vein was not intersected, and only minor amounts of chalcopyrite and pyrite were present in No.2 Vein and associated rocks. In DDH2, No.2 Vein is unmineralized, and only a weak zone of oxide mineralization was intersected.

No evidence of secondary sulphide enrichment was obtained from these holes, so it was decided to site DDH3 to investigate the possibility of secondary enrichment below Pit No.2. In this hole, the main mineralized zone was intersected at an inclined depth of 125 feet and had a width of 24 feet, measured along the hole. The principal mineral is malachite, but chalcocite is also present and films of native copper around quartz grains indicate enrichment in a 9 foot section of core. Chalcopyrite is partly replaced by sooty chalcocite.

DDH4 and DDH5 were drilled down the foliation of the mineralized gneiss in the open cut to determine the depth of oxidized ore. DDH4 passed through intermittent copper carbonates for over 50 feet until a steepening of the dip of the rocks caused it to intersect No.2 Vein, which is not mineralized at this point. DDH5, drilled at a steeper angle to avoid No.2 Vein, intersected only minor mineralization.

DDH6 was drilled about halfway between DDH2 and DDH3 to investigate the downward extension of surface mineralization in No.2 Vein and in Pit Nos 3, 4 and 5. Patches of malachite and azurite are present at depths corresponding to No.1 Vein and Pit No.4, and in addition chalcopyrite and pyrite are present over a core length of 11 feet in quartz and aplite veins and in the country rock. A little galena was observed in a pegmatite 1 foot wide near the bottom of the hole. These primary sulphides cannot be correlated with any occurrences of mineralization at the surface.

DDH7 was drilled to investigate primary mineralization below the zone of native copper in DDH3. Four mineralized zones were intersected between 190 and 405 feet, the largest extending for about 20 feet along the drill hole. Native copper, chalcocite, malachite and chalcopyrite are present in the uppermost zone, and chalcopyrite and pyrite in the others. Mineralization is present in quartz and pegmatite veins, and as disseminations and stringers in the country rock gneisses.

Assay Results

A total of 190 samples were assayed. Of these 16 were surface samples and the remainder were split diamond drill cores, usually in one foot lengths, and sludge samples.

Assays were made by the Government Battery, Tennant Creek for copper and by Mines Branch Laboratory, Darwin for copper, lead, zinc, silver and gold. The results are given in Appendix I. Values for lead and zinc are extremely low, and values for gold rarely rise above trace amounts. Silver values of up to 1 oz/ton in core samples and nearly 2 ozs/ton in surface samples are significant, as corresponding lead values are low. This suggests that the silver is present not in association with galena, but possibly in copper minerals such as tetrahedrite or enargite, which may have been mistakenly identified as chalcocite.

Representative chip samples and random grab samples taken from the open cut and pits agree fairly closely in copper content, yielding an average grade of about 4% Cu, which is similar to the average grade obtained for a number of samples from the main ore dump. The ore in this dump has been obtained from the open cut and has not been upgraded by handpicking.

Copper values in the zone of secondary enrichment in DDH3 (122-148 feet down-hole depth) range from 0.02 to 5.7%, but the average values agree fairly well with the surface value. For example an interval of 7 feet of core between 135 and 142 feet gave an average value of 3.7% Cu.

In comparison, values from the primary sulphide zone are much lower and rarely rise above 1% Cu.

This difference in values between surface samples and samples of drill cores from the primary sulphide zone indicates that enrichment in the oxidised zone is important. The enrichment is due to the oxidation of chalcopyrite to copper carbonates and secondary sulphides, and to the concentration of these secondary copper minerals near the surface by groundwater movement.

Tonnage

The most promising areas for exploitation of oxidized ore are in the vicinity of the open cut and near Pit No.2.

1. Open Cut. In the area between the trench and the open cut it is estimated that there are at least 3,600 tons of ore available for extraction to a depth of 25 feet below the ground surface, assuming an average width of 15 feet for the mineralized zone.

However, drilling has shown that copper carbonates are present to a vertical depth of at least 45 feet below the present level of the floor of the open cut, and it may therefore be estimated that an additional 5,500 tons of about 3% Cu ore are present to a depth of about 40 feet below the floor of the open cut in the area between the open cut and the trench.

2. Pit No.2. In this area an estimated 2,100 tons of ore of about 4% Cu are present south of No.1 vein, giving a width of mineralized gneiss of 20 feet to a depth of at least 25 feet below ground surface. No estimate has been made of ore reserves below this depth because of lack of information.

An extension along strike of the two main areas of oxidized ore is possible, but only low assay results have been recorded in the oxidized zone in DDH6.

About 750 tons of ore averaging about 4% Cu have been broken and stockpiled.

Small amounts of ore may possibly be extracted from the other known mineralized zones at the Mount Hardy Mine, but no estimates of tonnage or grade can be made for these.

Only in DDH7 is there an appreciable intersection of primary sulphides. Intermittent mineralization occurs over a core length of 90 feet (between 290 feet and 380 feet inclined depth), but assay values are very low (rarely more than 1% Cu). Because of the lack of information, no estimate of the possible tonnage of primary sulphide ore in the mine area has been attempted.

CONCLUSIONS

The investigation of the Mount Hardy Copper Mine has shown that:

1. Numerous small patches of copper mineralization occur on the Mount Hardy lease, but there are two main ore zones:

Area 1. - in the vicinity of the open cut, especially the mineralized gneiss between the trench and the open cut on the north side of No.1 Vein.

Area 2. - mineralized gneiss south of No.1 Vein in the vicinity of Pit No.2.

2. Ore reserves of about 12,000 tons are made up as follows:-

		Area 1.	Area 2
Broken	:	750 tons of 4% Cu.	
Probable to depth of 25 feet below present ground surface	:	3,600 tons of 4% Cu.	2,100 tons of 4% Cu.
Probable to depth of 40 feet below floor of present opencut	:	5,500 tons of 3% Cu.	
Possible	:	Extension along strike.	Ore below 25 foot depth and extensions along strike

3. Mineralization is associated with quartz and pegmatite/aplite veins, but the bulk of the copper mineralization is contained in the adjacent gneisses.

4. Primary sulphides are present as stringers and disseminations in the quartz and pegmatite/aplite veins, and more rarely in the associated gneisses. No massive concentrations of sulphides have been found at the Mount Hardy Mine.

5. Above the water table, chalcopyrite has been altered to malachite and minor azurite which have stained the gneisses adjacent to the veins. Chalcocite is present throughout the oxidized zone as a replacement of chalcopyrite.

6. Malachite staining at the surface tends to give an exaggerated impression of the amount of primary sulphides present at depth, as thin stringers and disseminations of chalcopyrite can result in considerable malachite staining. Copper enrichment in the oxidized zone, particularly near the surface, resulted from the conversion of chalcopyrite to copper carbonates, followed by concentration by groundwater movement.

7. No important zone of secondary enrichment at depth has been proved at the Mount Hardy Mine. Chalcocite is found throughout the oxidized zone, and the only indication of enrichment is the presence of minor amounts of native copper.

8. Leaching tests carried out by the Mines Branch Laboratory, Darwin, on ore from Mount Hardy indicate that with an average grade of 3% Cu and 50% extraction, a return of about $13 per ton of ore treated is possible. This value is based on a copper price of $1,150 per ton, and a cost of acid of $76 per ton. Similar tests carried out on ore from Jervois Range, 170 miles northeast of Alice Springs, suggest that finer crushing of the Mount Hardy ore may give improved extraction.

RECOMMENDATIONS

It is recommended that a feasibility study be made of the Yuendumu copper leaching project on the basis of the reserves of oxidized ore being about 12,000 tons of 3% to 4% Cu.

Further diamond drilling may be recommended when the results of the geophysical survey carried out in October and November 1967 are available.

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APPENDIX I

ASSAY RESULTS *

DDH I

Sample No.	Interval			Results				
F52/12-25				Cu. %	Pb. %	Zn. %	Ag. dwts/	Au. ton
(1)	171'3"	-	171'9"	0.005	nil	0.006	nil	tr
(2)	171'9"	-	172'3"	0.405	nil	0.007	nil	0.9
(3)	172'3"	-	172'9"	0.005	nil	0.005	nil	tr
(4)	191'6"	-	192'		Sample missing			
(5)	192'	-	192'6"	0.05	nil	0.002	nil	tr
(6)	192'6"	-	193'	1.00	nil	0.008	nil	tr
(7)	193'	-	193'6"	9.00	nil	0.021	nil	tr
(8)	193'6"	-	194'	0.125	nil	0.007	nil	tr
(9)	194'	-	194'6"	0.040	Nil	0.005	nil	tr
(18)	220'	-	221'	0.005	nil	0.005	nil	tr
(19)	221'	-	222'	0.01	nil	0.005	nil	tr
(20)	222'	-	223'	0.01	nil	0.002	nil	tr
(21)	223'	-	224'	0.005	nil	0.004	nil	tr
(22)	224'	-	225'	0.005	nil	0.002	nil	tr
(23)	225'	-	226'	0.01	nil	0.0015	nil	tr
(24)	226'	-	227'	0.01	nil	0.001	nil	tr
(25)	227'	-	228'	0.01	nil	0.001	nil	tr
(26)	228'	-	229'	0.015	nil	0.001	nil	tr
(27)	229'	-	230'	0.010	nil	tr	nil	tr
(28)	230'	-	231'	0.03	nil	0.0015	nil	tr
(29)	231'	-	232'	0.035	nil	0.0015	nil	tr
(30)	232'	-	233'	0.03	nil	0.001	nil	tr
(31)	233'	-	234'	0.025	nil	0.001	nil	tr
(32)	234'	-	235'	0.015	nil	0.001	nil	tr
(33)	235'	-	236'	0.005	nil	0.0025	nil	tr
(34)	236'	-	237'	0.005	nil	0.004	nil	tr
(35)	237'	-	238'	0.005	nil	0.002	nil	tr

* Assays by Mines Branch Laboratories, Darwin unless otherwise stated.

DDH 3

Sample No.	Interval	Results				
F52/12-25		Cu. %	Pb. %	Zn. %	Ag. dwts/ ton	Au.
(36)	122' - 123'	0.45	tr	0.014	nil	tr
(37)	123' - 124'	0.13	tr	0.007	nil	tr
(38)	124' - 125'	0.16	tr	0.010	nil	tr
(39)	125' - 126'	0.68	tr	0.020	5.0	tr
(40)	126' - 127'	0.77	0.01	0.031	1.0	0.1
(41)	127' - 128'	0.07	tr	0.049	tr	tr
(42)	128' - 129'	0.02	0.02	0.080	2.0	0.2
(43)	129' - 130'	0.34	tr	0.019	nil	tr
(44)	130' - 131'	1.12	0.05	0.026	nil	tr
(45)	131' - 132'	0.57	0.03	0.031	tr	tr
(46)	132' - 133'	0.17	tr	0.017	3.0	tr
(47)	133' - 134'	0.60	0.02	0.010	1.0	0.2
(48)	134' - 135'	0.22	0.03	0.008	nil	0.2
(49)	135' - 136'	3.3	0.03	0.024	12.0	0.5
(50)	136' - 137'	5.7	tr	0.018	15.0	0.3
(51)	137' - 138'	4.3	tr	0.045	18.0	0.5
(52)	138' - 139'	4.9	tr	0.060	10.0	0.6
(53)	139' - 140'	4.1	tr	0.029	5.0	0.2
(54)	140' - 141'	1.72	tr	0.023	1.0	0.1
(55)	141' - 142'	1.58	tr	0.037	5.0	0.5
(56)	142' - 143'	0.31	tr	0.024	nil	0.3
(57)	143' - 144'	0.08	0.01	0.018	nil	tr
(58)	144' - 145'	1.07	0.01	0.038	nil	0.1
(59)	145' - 146'	1.55	nil	0.054	1.0	0.6
(60)	146' - 147'	0.31	nil	0.017	nil	tr
(61)	147' - 148'	0.16	nil	0.010	nil	tr

DDH 4

Sample No.	Interval	Results				
		Cu. %	Pb. %	Zn. %	Ag. dwts/ton	Au. dwts/ton
F52/12-25						
(62)	25' - 26'	2.2	0.01	tr	1.0	tr
(63)	26' - 27'	0.95	nil	tr	nil	tr
(64)	27' - 28'	0.87	nil	tr	nil	tr
(65)	28' - 29'	0.70	nil	0.001	nil	tr
(66)	29' - 30'	0.95	nil	0.001	nil	tr
(67)	30' - 31'	0.62	nil	0.001	nil	0.4
(68)	31' - 32'	3.0	nil	0.001	8.0	tr
(69)	32' - 33'	0.88	nil	0.001	nil	tr
(70)	33' - 34'	0.62	nil	0.001	nil	0.2
(71)	34' - 35'	0.95	nil	0.001	nil	tr
(72)	35' - 36'	11.00	nil	0.001	20.0	tr
(73)	36' - 37'	11.4	nil	0.001	10.0	tr
(74)	37' - 38'	6.4	nil	0.001	8.0	tr
(75)	38' - 39'	2.5	nil	0.001	1.0	tr
(76)	39' - 40'	1.2	nil	0.02	nil	tr
(77)	40' - 41'	0.55	nil	0.001	nil	tr
(78)	41' - 42'	0.49	nil	0.002	nil	tr
(79)	42' - 43'	0.35	nil	0.001	nil	tr
(80)	43' - 44'	0.19	nil	0.001	nil	tr
(81)	44' - 45'	0.33	nil	0.001	nil	tr
(82)	45' - 46'	0.31	Nil	0.001	nil	tr
(83)	46' - 47'	0.86	nil	0.001	nil	tr
(84)	47' - 48'	2.3	nil	0.001	nil	tr
(85)	48' - 49'	3.7	nil	0.001	tr	tr
(86)	49' - 50'	0.96	nil	0.001	tr	tr
(87)	50' - 51'	2.6	nil	0.001	2.0	tr
(88)	51' - 52'	5.5	nil	0.001	2.0	0.5
(89)	52' - 53'	0.96	nil	0.001	nil	tr
(90)	53' - 54'	0.78	nil	0.001	nil	tr
(91)	54' - 55'	0.52	nil	0.001	nil	tr
(92)	55' - 56'	2.5	nil	0.001	nil	tr
(93)	56' - 57'	1.6	nil	0.001	nil	tr
(94)	57' - 58'	0.5	nil	0.001	nil	tr
(95)	58' - 59'	0.29'	nil	0.001	nil	tr

DDH 6

Sample No.	Interval	Results				
F52/12-25		Cu. %	Pb. %	Zn. %	Ag. dwts/	Au. ton
(98)	50' - 51'	0.037	nil	0.007	nil	
(99)	51' - 52'	0.067	0.01	0.006	nil	
(100)	52' - 53'	0.185	nil	0.006	nil	
(101)	53' - 54'	0.475	nil	0.002	nil	
(102)	54' - 55'	0.65	nil	0.005	nil	tr
(103)	55' - 56'	0.51	nil	0.003	nil	tr
(104)	56' - 57'	0.68	nil	0.005	nil	tr
(105)	57' - 58'	0.14	nil	0.001	nil	tr
(106)	58' - 59'	0.125	nil	0.006	nil	tr
(107)	59' - 60'	0.76	nil	0.006	tr	tr
(108)	60' - 61'	0.425	nil	0.007	tr	tr
(109)	61' - 62'	0.57	nil	0.012	nil	tr
(110)	62' - 63'	0.16	nil	0.007	nil	tr
(111)	63' - 64'	0.52	nil	0.014	nil	tr
(112)	64' - 65'	0.28	nil	0.010	nil	tr
(112A)	89' - 90'	0.18	nil	0.007	nil	tr
(113)	90' - 91'	0.48	nil	0.017	nil	tr
(114)	91' - 92'	0.37	nil	0.010	nil	tr
(115)	92' - 93'	1.4	nil	0.010	2.0	tr
(116)	93' - 94'	0.35	nil	0.005	tr	tr
(117)	94' - 95'	0.25	nil	0.009	nil	tr
(118)	95' - 96'	0.27	nil	0.016	nil	tr
(119)	96' - 97'	0.11	nil	0.007	nil	tr
(120)	97' - 98'	0.185	nil	0.012	nil	tr
(121)	98' - 99'	0.20	nil	0.015	nil	tr
(122)	99' - 100'	0.18	nil	0.014	nil	tr
(123)	100' - 101'	0.34	nil	0.011	nil	tr
(124)	101' - 102'	0.18	0.01	0.012	nil	tr
(125)	102' - 103'	0.65	tr	0.016	tr	tr
(126)	103' - 104'	1.6	tr	0.011	tr	tr
(127)	104' - 105'	0.43	nil	0.010	nil	tr
(128)	105' - 106'	0.10	nil	0.006	nil	tr
(129)	265' - 266'	0.04	tr	0.020	nil	tr
(130)	266' - 267'	0.025	tr	0.018	nil	tr
(131)	267' - 268'	0.01	tr	0.017	tr	tr
(132)	268' - 269'	0.03	nil	0.013	tr	tr
(133)	269' - 274'	0.66	nil	0.020	tr	tr
(134)	274' - 275'	0.04	nil	0.005	nil	tr
(135)	275' - 276'	0.03	nil	0.007	nil	tr
(136)	sludge 247' - 265'	0.01	nil	0.008	nil	tr
(137)	sludge 265' - 274'	0.40	0.01	0.020	tr	tr
(138)	sludge 274' - 289'	0.10	tr	0.013	nil	tr

DDH7

Sample No.	Interval	Results	
F52/12-25		Cu. %	Ag dwts/ton
(139)	197' - 198'	0.05	Nil
(140)	198' - 199'	0.37	"
(141)	199' - 200'	0.52	"
(142)	200' - 201'	0.26	"
(143)	201' - 202'	0.02	"
(144)	202' - 203'	0.41	"
(145)	203' - 204'	0.36	"
(146)	204' - 205'	0.27	"
(147)	205' - 206'	1.00	"
(148)	293' - 294'	0.02	"
(149)	294' - 295'	0.46	"
(150)	295' - 296'	1.02	"
(151)	296' - 297'	1.00	"
(152)	297' - 298'	0.36	"
(153)	298' - 299'	0.24	"
(154)	299' - 300'	0.75	"
(155)	300' - 301'	0.17	"
(156)	301' - 302'	0.24	"
(157)	302' - 303'	0.04	"
(158)	303' - 304'	0.15	"
(159)	304' - 305'	0.50	"
(160)	305' - 306'	0.42	"
(161)	306' - 307'	0.35	"
(162)	307' - 308'	0.24	"
(163)	308' - 309'	0.20	"
(164)	309' - 310'	0.95	"
(165)	310' - 311'	0.37	"
(166)	311' - 312'	0.36	"
(167)	312' - 313'	4.80	1 oz.
(168)	313' - 314'	0.05	Nil
(169)	329' - 330'	0.68	"
(170)	330' - 331'	0.12	"
(171)	331' - 332'	0.13	"
(172)	332' - 333'	5.00	15
(173)	333' - 334'	0.54	tr
(174)	334' - 335'	0.17	Nil
(175)	335' - 336'	Nil	"
(176)	398' - 399'	0.05	"
(177)	399' - 400'	0.43	"
(178)	400' - 401'	0.47	"
(179)	401' - 402'	0.58	"
(180)	402' - 403'	0.18	"
(181)	403' - 404'	0.07	"
(182)	404' - 405'	0.02	"

Sample No.		Results				
		Cu. %	Pb. %	Zn. %	Ag. dwts/ton	Au. dwts/ton
Samples from main ore dump:						
F52/12-25	(E)	3.80	nil	0.008	tr.	tr.
	(F)	3.00	nil	0.007	tr.	tr.
	(14)	4.3	assayed by Tennant Creek Battery			
	(15)	5.4				
Chip samples from open cut:						
F52/12-25	(A)	6.60	0.03	0.24	12.0	0.08
	(B)	3.20	nil	0.0145	nil	tr.
	(C)	4.75	nil	0.0095	nil	tr.
	(D)	4.25	nil	0.0085	tr.	tr.
Sample of ? cuprite from open cut:						
F52/12-25	(96)	7.7				
Chip samples from pits:						
Pit No.2						
F52/12-25	(16)	3.3				
	(17)	5.6				
Pit No.4						
F52/12-25	(10)	2.4	assayed by Tennant Creek Battery			
	(11)	4.7				
Pit No.5						
F52/12-25	(12)	8.7				
	(13)	25.2				
Pit on No.8 Vein						
F52/12-25	(97)	6.9	0.01	0.068	32.0	0.1

APPENDIX II

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT: MT. HARDY COPPER MINE, YUENDUMU, N.T. REMARKS: M.L. 367 H

HOLE No.: D.D.H.1 CO-ORDINATES: 4655 2405 131°35'00"E 22°06'30"S R.L. GROUND: 983 ft (ARBITRARY DATUM)

LOCATION: NEAR EAST END OF EAST POINT RIDGE, NORTH OF OPEN CUT ANGLE FROM HORIZONTAL: 50° DIRECTION: 165° mag.

DESCRIPTION OF CORE	R.L. / CASING	DEPTH / SIZE OF CORE	LOG	CUT & CORE RECOVERY %	SAMPLES	REMARKS	ASSAYS
Core broken. Friable schistose rock		10'		20		Poor core recovery	(figures in brackets = true width)
Core fractured. Mica gneiss. "Clots" of sericite. A few carbonate stringers and quartz veins. Foliation approximately vertical				95			
Core broken. Quartzo-feldspathic gneiss with some mica. Foliation approximately vertical.		40'		77			
				100			
Sheared kaolinised pegmatite		73' 78'					
		88'		90			
Sheared kaolinised pegmatite				100			
Mica gneiss garnetiferous in part. Numerous fracture zones and quartz veins. Foliation steeply inclined to north.				77			
		150'					
Mica gneiss with numerous quartz and pegmatite veins. Core often sheared, broken and chloritic especially 170'–200'. Foliation approximately 65° towards north.				72		From 170'–225' a little py. and ? arsenopy. especially on chloritic foliation planes.	
				100		At 170', 190', 205' quartz veins up to 6" thick carry py. and cpy.	171'3"–172'9" av. = 0.138% Cu
				100			192–194'6" (2.2') av. = 2.04% Cu
Quartz-feldspar-mica pegmatite		225' 235'		No.2 Vein		229'–232' a little py. and cpy.	225'–235' (8.6') av. = 0.019% Cu
Mica gneiss, biotite-rich above 260', becoming more muscovite-rich below. Foliation approximately vertical. A few thin quartz and pegmatite veins.				100			
				100			
				100			
				100			
		310'				T. D.	

DRILL No.: TYPE: DRILLER: S. BERGER COMMENCED: COMPLETED:

EXPLANATION: CASING IN HOLE DURING DRILLING

REFERENCES

HEAD OFFICE: LOGGED BY: D.J. GRAINGER DRAWN BY: D.J. GRAINGER CHECKED BY: SHEET 1 OF 1 DRAWING No.:

60130 To accompany Record 1968/100 F52/A12/33(1)

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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT. MT. HARDY COPPER MINE, YUENDUMU, N.T. REMARKS. ML 367 H

HOLE No. DDH 2 CO-ORDINATES 4655 240 S. 131°55'00"E 22°06'30"S. R.L. GROUND 990 ft (ARBITRARY DATUM)

LOCATION 120 ft. NORTH OF OPEN CUT ANGLE FROM HORIZONTAL 50° DIRECTION 153° mag.

DESCRIPTION OF CORE	R.L. / CASING	DEPTH / SIZE OF CORE	LOG	LIFT & CORE RECOVERY %	SAMPLES	REMARKS	ASSAYS
Core broken and sheared. Quartzo-feldspathic gneiss with muscovite and chlorite rich intervals. Some garnets. Foliation approximately 60° to S.		30'		86			
Sheared muscovite-chlorite gneiss. Some ? garnets. Foliation approximately vertical		50'		100			
Mica gneiss with quartz veining.		64'		95			
Kaolinitic pegmatite		67'					
Mica gneiss with quartz veining. Foliation about 80° to north				100		77'-78' malachite and azurite stained quartz veins.	
		98'		100			
Graphic pegmatite				No. 2 Vein			
Mica gneiss with occasional quartz veins				100			
				100			
		145'				T.D.	

DRILL NO. .....
TYPE .....
DRILLER S. BERGER
COMMENCED .....
COMPLETED .....

EXPLANATION

CASING IN HOLE DURING DRILLING

REFERENCES

HEAD OFFICE

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DRAWN BY D.J. GRAINGER
CHECKED BY .....
SHEET 2 OF 2
DRAWING NO. .....

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CD130 To accompany Record 1968/100

F52/A12/33(2)

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT: MT. HARDY COPPER MINE, YUENDUMU, N.T. REMARKS: ML 367 H

HOLE No.: DDH 3 CO-ORDINATES: 4955 2405 131°35'00"E 22°06'30"S R.L. GROUND: 1015 ft (ARBITRARY DATUM)

LOCATION: 120 ft NORTH WEST OF PIT No. 2 ANGLE FROM HORIZONTAL: 45° DIRECTION: 142° mag

DESCRIPTION OF CORE	R.L. / CASING	DEPTH / SIZE OF CORE	LOG	LIFT & CORE RECOVERY %	SAMPLES	REMARKS	ASSAYS
Broken quartz vein. Biotite gneiss inclusions							(figures in brackets = true width)
Biotite schist. Foliation 85° to south		10'		66			
Friable weathered mica pegmatite. Graphic intergrowth of quartz and feldspar		14'			No. 2 Vein		
Mica gneiss. Foliation 70° to north. Thin quartz and pegmatite veins parallel to foliation and also cross-cutting		28'		100		29' malachite staining quartz fragments.	
Broken quartz vein (partly pegmatitic)		52'			No. 3 Vein		
Mica gneiss. Foliation 75° to north		59'		100			
Mica gneiss with quartz and pegmatite veins.		68'		92			
Quartz vein		88'					
Mica gneiss and schist		92'		95			
Quartz vein with inclusions of mica gneiss and schist. Vugs in veins partly filled with limonite. Box works present.		96'		100	No. 1 Vein	96'–122' a little malachite. Below 122' malachite increases. Malachite mainly in quartz but schist also stained. Mal. rosettes. Native Cu. in qtz. 133'–142' Mal. Cpy. replaced by chalcocite in quartz veins. Mal. chalcocite 149'–152' in quartz veins.	122'–148' (24·5') av. = 1·37% Cu 135'–142' (6·5') av. = 3·7% Cu.
Qtzo-feld.-mica gneiss. Thin quartz veins		142'		100			
Qtzo-feld. mica schist. Foliation vertical. Irregular qtz. veining.		149'					
Mica gneiss. Foliation 75° to north. A few thin quartz veins. Intervals of augen gneiss, banded gneiss, and sericite "clots" aligned parallel to foliation		162'		100		A little malachite in quartz veins.	
Mica gneiss and schist (rusty). Quartz veins		191'		100			
Mica gneiss. Quartz veining.		195'					
Mica gneiss. A few quartz veins.		200'		100		Mal. chalcocite in quartz.	
		207'				T.D.	

DRILL NO.:
TYPE:
DRILLER: S. BERGER
COMMENCED:
COMPLETED:

EXPLANATION

CASING IN HOLE DURING DRILLING

REFERENCES

HEAD OFFICE

LOGGED BY: D.J. GRAINGER
DRAWN BY: D.J. GRAINGER
CHECKED BY:
SHEET 3 OF 7
DRAWING NO.:

GD130 To accompany Record 1968/100 F52/A12/32/2

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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT. MT. HARDY COPPER MINE, YUENDUMU, N.T. REMARKS. ML 367 H

HOLE No. D.D.H. 4 CO-ORDINATES 4655 2405 131° 35' 00" E. 22° 06' 30" S R.L. GROUND 994 ft (ARBITRARY DATUM)

LOCATION OPEN CUT. DRILLED DOWN MINERALISED OUTCROP ANGLE FROM HORIZONTAL 65° DIRECTION 335° MAG

DESCRIPTION OF CORE	R.L. / CASING	DEPTH / SIZE OF CORE	LOG	LIFT & CORE RECOVERY %	SAMPLES	REMARKS	ASSAYS
Core broken. Quartz veining in mica schist		11'				Mal. in quartz veins	(figures in brackets = true width)
Mica gneiss and schist. Quartz veins.		16'		80			
Broken kaolinised pegmatite		18'				Mal. az. chalcocite in quartz	
Quartz veins with inclusions of mica & chlorite schist		29'					
Ortho-feld. mica-chlorite schist. Qtz. veins.		35'		100		Mal. az. in qtz. veins.	25'-59' (6')
Quartz veins		39'				Mal. chalcocite. ? cpy.	av = 2·05% Cu.
Mica gneiss, garnetiferous. Thin quartz veins.		48'					
Quartz vein		54'				Mal. az. chalc. ? cpy.	
Mica gneiss with quartz veins.		58'		90		Mal. chalc. in quartz veins	
Kaolinised pegmatite, slightly foliated. Graphic and coarse grained. Pale pink garnets in aplite and foliated zones.				No. 2 Vein 100			
		90'				T.D.	

DRILL NO. .....
TYPE .....
DRILLER S. BERGER
COMMENCED .....
COMPLETED .....

EXPLANATION

CASING IN HOLE DURING DRILLING

REFERENCES

HEAD OFFICE

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DRAWN BY D.J. GRAINGER
CHECKED BY .....
SHEET 4 OF 7
DRAWING NO. .....

GD130

To accompany Record 1968/100

F52/A12/33(4)

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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT MT. HARDY COPPER MINE, YUENDUMU, N.T. REMARKS Ml 367 H

HOLE No. DDH 5 CO-ORDINATES 4655240S 131°35'00"E 22°06'30"S R.L. GROUND 994 ft. (ARBITRARY DATUM)

LOCATION OPEN CUT. DRILLED DOWN. MINERALISED OUTCROP ANGLE FROM HORIZONTAL 75° DIRECTION 335° mag.

DESCRIPTION OF CORE	R.L. CASING	DEPTH SIZE OF CORE	LOG	LIST & CORE RECOVERY %	SAMPLES	REMARKS	ASSAYS
No core				0			
Quartz vein		17' 20'				Mal. chalcocite	
Mica gneiss with a few thin quartz veins.		30'		80		A little mal. in quartz veins	
Quartz veins		33'				A little mal.	
Friable kaolinised pegmatite slightly foliated. Some gneissic aplite. Occasional quartz veins		51' 55'		100		A little mal. in quartz veins.	
Aplitic gneiss. Quartz veining.							
Pegmatite and gneissic aplite		68' 72		85			
Quartz veining.							
Pegmatite and gneissic aplite with occasional quartz veins.		96'		95			
Mica gneiss with quartz veins.		105'					
Mica gneiss		110		100		T.D.	

DRILL NO. .....
TYPE .....
DRILLER S. BERGER
COMMENCED .....
COMPLETED .....

EXPLANATION

CASING IN HOLE DURING DRILLING

REFERENCES

HEAD OFFICE

LOGGED BY D.J. GRAINGER
DRAWN BY D.J. GRAINGER
CHECKED BY .....
SHEET 5 OF 7
DRAWING NO. .....

To accompany Record 1968/100

E52/A12/33(6)

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BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT MT. HARDY COPPER MINE, YUENDUMU, N.T. REMARKS ML 367 H

HOLE No. DDH 6 CO-ORDINATES 455 240S 131°35'00"E 22°06'30"S R.L. GROUND 1004 ft (ARBITRARY DATUM)

LOCATION APPROXIMATELY 180 ft SOUTH-WEST OF DDH 2 ANGLE FROM HORIZONTAL 45° DIRECTION 153° mag.

DESCRIPTION OF CORE	R.L. / CASING	DEPTH / SIZE OF CORE	LOG	LIFT & CORE RECOVERY %	SAMPLES	REMARKS	ASSAYS
Coarse mica gneiss with sericite "clots". Occasional thin quartz veins. Foliation at 75° to north.				77			(figures in brackets = true width)
Sheared quartz vein. Foliation vertical.		30' 38'		87			
Quartz veining in mica gneiss.							
Quartz vein. Massive from 49'–61'. Copper minerals stain quartz and form stringers		48' 65'		100 No.2 Vein		54'–65' Mal. azurite	54'–65' (10') av. = 0.45% Cu
Mica gneiss with quartz veins. Grey gneiss with sericite "clots".				100		A little mal. in quartz veins.	
Quartz veins with mica gneiss.		88'		100		Mal. az. in quartz veins.	90'–105' (13.5') av. = 0.46% Cu.
Mica gneiss with quartz veining. Shearing and brecciation.		108'		100		Mal. az. in quartz veins and sheared intervals.	
Quartz veins. Shearing and brecciation.		134' 138'		No.1 Vein 100		Mal. az.	
Massive mica gneiss. Sericite above 149'. Poor foliation at 80° to north. A few thin quartz veins.				100		A little mal. in quartz veins.	
Quartz veining in mica gneiss. Core fractured and chloritic		162' 171'					
Grey mica gneiss. Foliation about 70° to N. Sheared graphic pegmatite. Some sericite.		178' 180'		87			
Mica gneiss with much sericite. Foliation about 65° to north. 201'–202' Mica pegmatite		200' 201' 202'		90			
Core broken. Chloritic [illegible] ? shear zone		226' 230'				Poor core recovery.	
Mica gneiss. Garnets [illegible] 231' Foliation about 75° to north. Core broken and sericite-rich.							
Massive mica gneiss. Vertical foliation.		250' 260'		73			
Garnet mica chlorite gneiss and schist.						A little py, cpy.	
Core broken. Mica gneiss. Quartz, aplite veins.		269' 274'				Py, cpy. in gneiss and quartz	269'–274' (4.5') av. = 0.48% Cu
Massive mica gneiss. A few thin quartz veins. Muscovite below 275'						Some py, cpy. in quartz veins.	
Mica pegmatite		290'		100		Galena in pegmatite.	
Massive mica gneiss. Foliation 75° to north		309'		33		T.D.	

DRILL NO. ..... TYPE	EXPLANATION: CASING IN HOLE DURING DRILLING	HEAD OFFICE: LOGGED BY D.J. GRAINGER; DRAWN BY D.J. GRAINGER; CHECKED BY .....
DRILLER S. BERGER; COMMENCED ..... COMPLETED	REFERENCES	SHEET 6 OF 7; DRAWING NO. .....

GO130 To accompany Record 1968/100 F52/A12/23/5

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

GEOLOGICAL LOG OF DRILL HOLE

PROJECT MT. HARDY COPPER MINE, YUENDUMU, N.T. REMARKS ML. 367 H

HOLE No. DDH 1 CO-ORDINATES 4655240S 131°35'00"E 22°06'30"S R.L. GROUND 997ft (ARBITRARY DATUM)

LOCATION 310ft. NORTH-WEST OF PIT No. 2. ANGLE FROM HORIZONTAL 50° DIRECTION 147° mag.

DESCRIPTION OF CORE	R.L. / CASING	DEPTH / SIZE OF CORE	LOG	LIST & CORE RECOVERY %	SAMPLES	REMARKS	ASSAYS
Coarse grained mica gneiss. Porphyroblastic. Foliation 70° to north.				93			(figures in brackets = true width)
Banded mica gneiss. Porphyroblasts of sericite after feldspar		18'					
		34'		95			
Massive mica gneiss. Poorly banded. Foliation about 65° to north. A few sericite porphyroblasts. Carbonate on some joint planes.				100			
				100			
				100			
Mica gneiss with quartz veining.		105'		100		114'-115' Mal. staining.	
Mica gneiss. Foliation about 70° to north. Shearing at 130'. Massive and poorly foliated elsewhere.				93			
				75			
				100			
Quartz vein. Chlorite streaks.		179'					
Mica gneiss strongly veined with quartz		181'					
Sheared quartz vein. Chlorite streaks. Some mica gneiss intervals		192'			?	198'-200' native Cu as filling and stringers in gneiss. 200'-205' chalc. cpy.	198'-206' (6.5') av. = 0.36% Cu.
Pegmatite. Pink garnets. Sheared at 213'		205'		No. 2 Vein			
Mica gneiss. Foliation 80° to north		213'		100			
Sheared foliated pegmatite. Pink garnets especially in sheared zones.		217'		No. 3 Vein	?	220' a little cpy.	
		228'					
Mica gneiss veined with quartz. Core fractured 250'-253'. Sheared and muscovite-rich.				100		232' cpy in 4" quartz vein 237' mal in 6" quartz vein	
Quartz vein				89		trace of cpy.	
		261'					
Quartz vein, foliated and sheared. A little mica gneiss.				100		Py, cpy. At 266' native Cu, mal, chalc. cuprite over 4"	
		282'		No. 1 Vein	?		
Quartz vein foliated, sheared, chloritic. Pink garnets in occasional gneiss intervals.				100		294'-302' cpy, py in qtz. and gneiss.	294'-302' (6.5') av. 0.53% Cu.
		302'					
Mica gneiss with some quartz veining. Gneiss mica and chlorite-rich. Foliation 75° to north.						Cpy. py in gneiss and quartz veins esp. near 313'.	309'-313' (3.2') av. = 1.62% Cu.
		313'					
Mica gneiss. Foliation about 80° to north. Quartz veining and shearing 324'-327'				100		315' cpy in 6" quartz vein.	
		330'					
Broken, sheared, chloritic gneiss. Qtz. veins. Silicified. Sericite, chlorite		334'				Cpy, py. in quartz veins. Cpy, py. in qtz vein 335'	329'-334' (4.0') av. = 1.29% Cu.
Well foliated mica gneiss. Intervals of broken sericite-rich gneiss. Foliation 80° to north.				95		350' cpy in quartz vein.	
		352'					
Mica gneiss massive. Sheared intervals. Occasional quartz veins.				87		370' cpy. in quartz vein.	
graphic pegmatite.		376'					
Massive mica gneiss. Sericite-rich 378'-381' Poor foliation 75° to north.		378'		89			
Sheared chloritic garnet schist. Qtz. veins.		399'				Cpy, py. in qtz. and schist.	399'-403' (3.25') av. = 0.41% Cu.
		405'		100			
Massive mica gneiss. Foliation about 80° to north. Occasional zones of sheared sericite-rich gneiss Core broken 464'-466' and sheared, brecciated quartz veins. At 480' poor foliation at 55° to north.				100			
				90			
				100		T.D.	
		484'					

DRILL NO. .....

TYPE .....

DRILLER S. BERGER

COMMENCED .....

COMPLETED .....

EXPLANATION

CASING IN HOLE DURING DRILLING

REFERENCES

HEAD OFFICE

LOGGED BY D.J. GRAINGER

DRAWN BY D.J. GRAINGER

CHECKED BY .....

SHEET 7 OF 7

DRAWING NO. .....

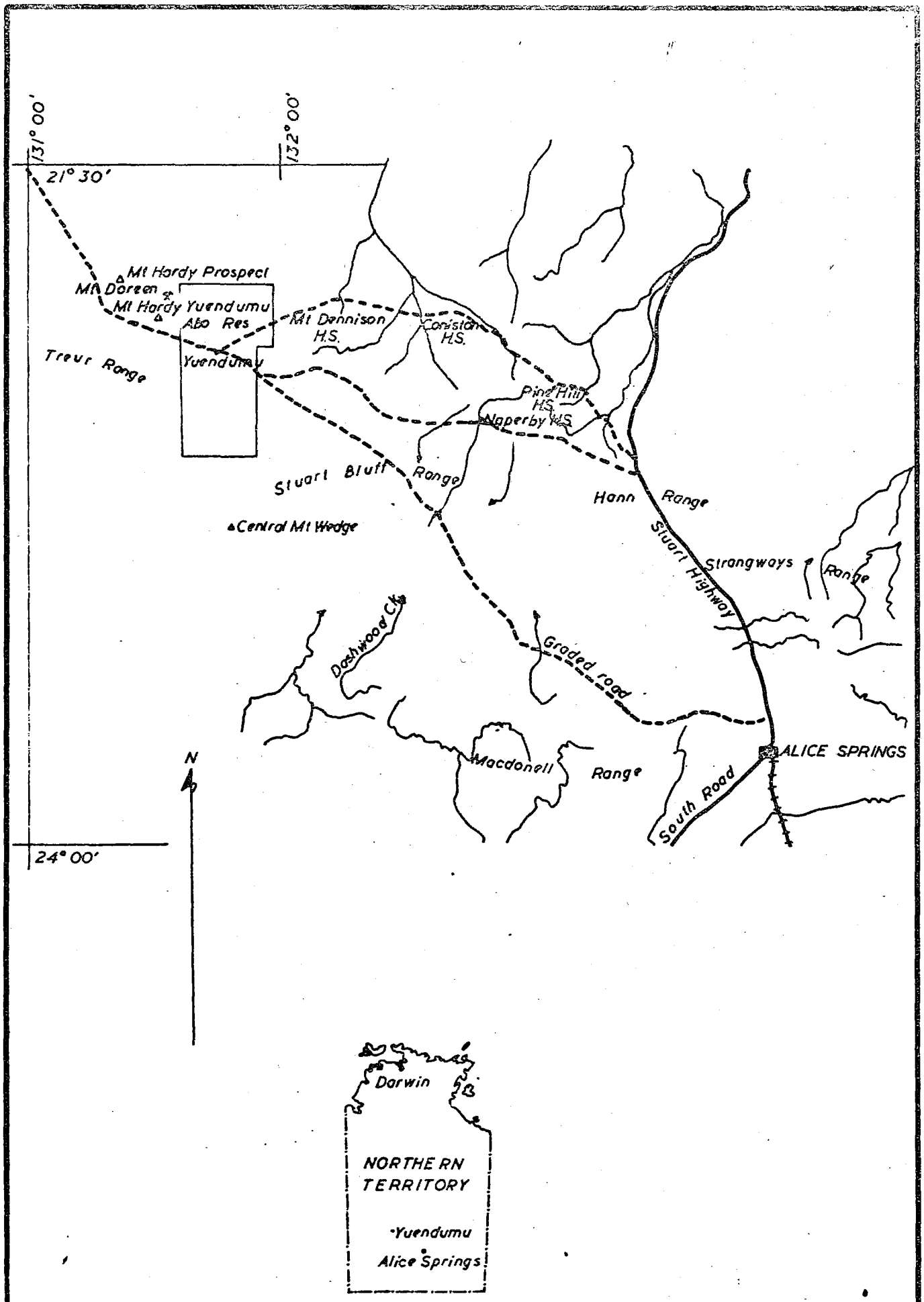
60/50

To accompany Record 1968/100

F52/A12/33(7)

G68/25

29



LOCALITY MAP OF THE YUENDUMU AREA

10 0 20 50 Miles

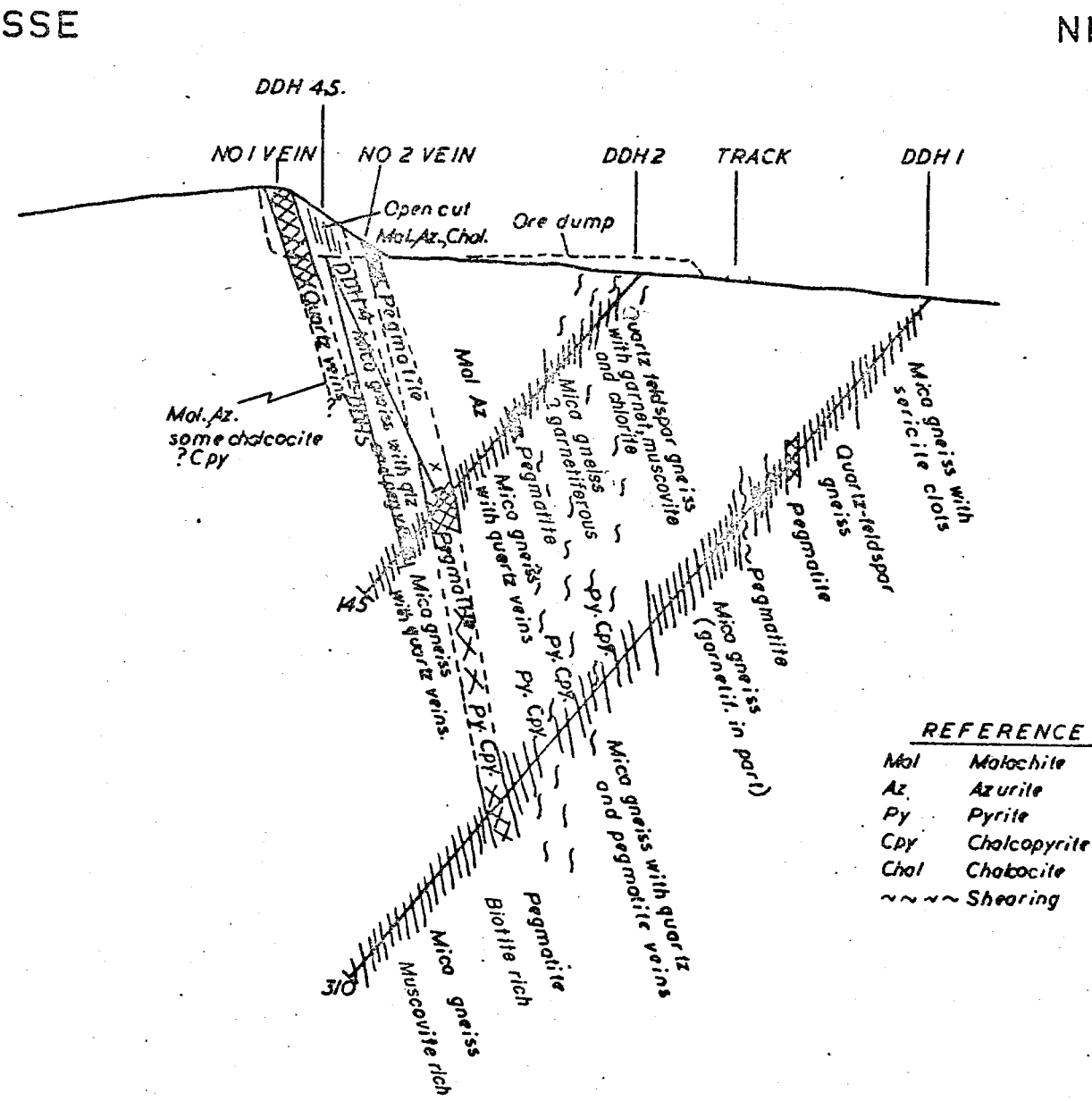
SCALE

To accompany Record 1968/100

COMPILED BY RESIDENT GEOLOGICAL SECTION

F52/A12/26

FIG. 1.



AVERAGE ASSAYS

INTERVAL	TRUE WIDTH	% COPPER
	DDH. 1	
192'-194·5'	2·2'	2·04
225'-235'	8·6'	0·02
	DDH. 4	
25'-59'	6'	2·05

DIAMOND DRILL HOLES 1,2,4,5.

MT HARDY AREA

0 50 100 FEET

SCALE

To accompany Record 1968/100

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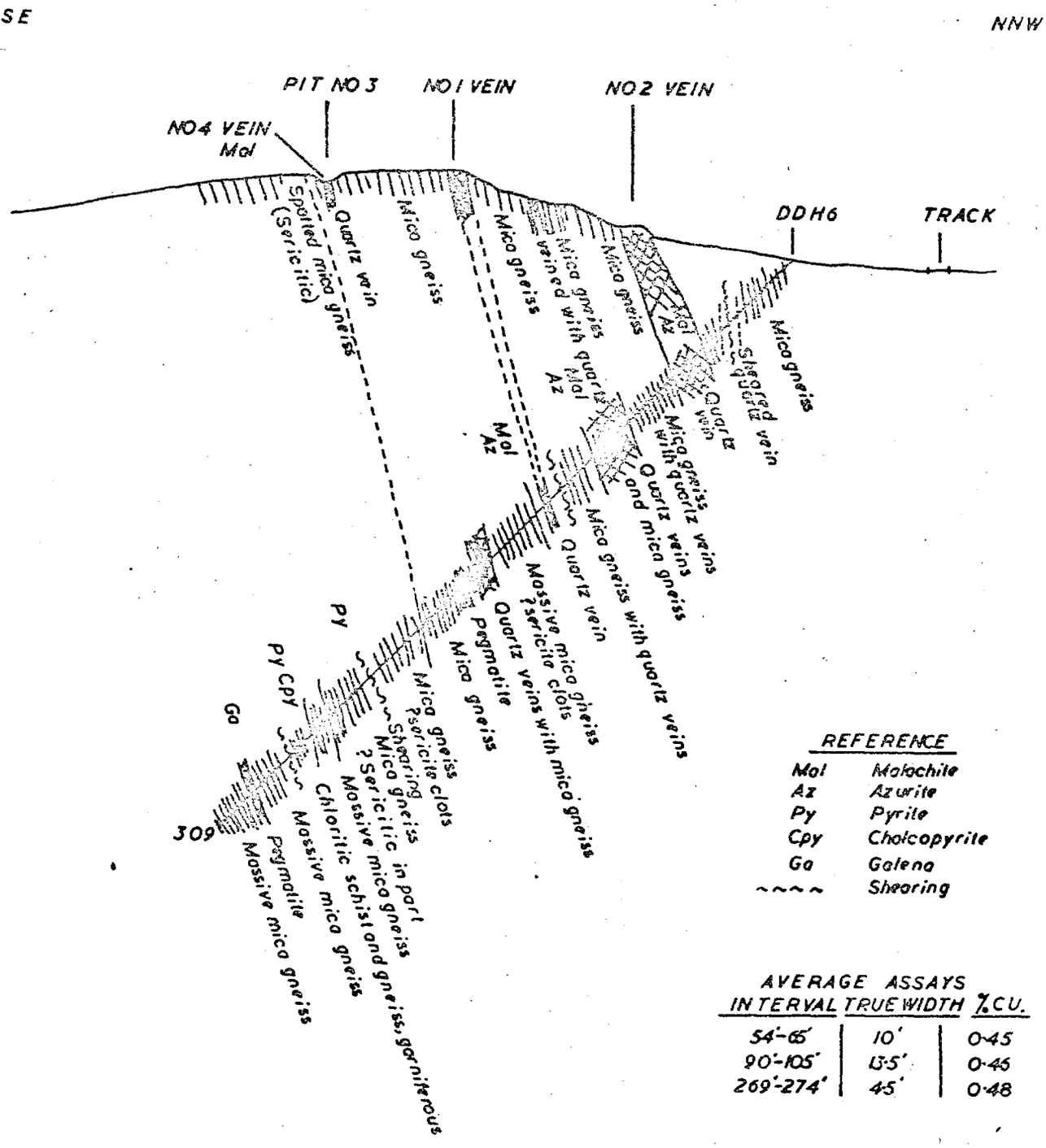
DRAWN BY MINES BRANCH DRAUGHTING OFFICE DARWIN APRIL 1968

F 52/A12/27

G68/13E

FIG. 2



AVERAGE ASSAYS

INTERVAL	TRUE WIDTH	% CU.
54'-65'	10'	0·45
90'-105'	13·5'	0·46
269'-274'	4·5'	0·48

DIAMOND DRILL HOLE No 6
MT HARDY AREA

0 50 100 FEET
SCALE

To accompany Record 1968/100

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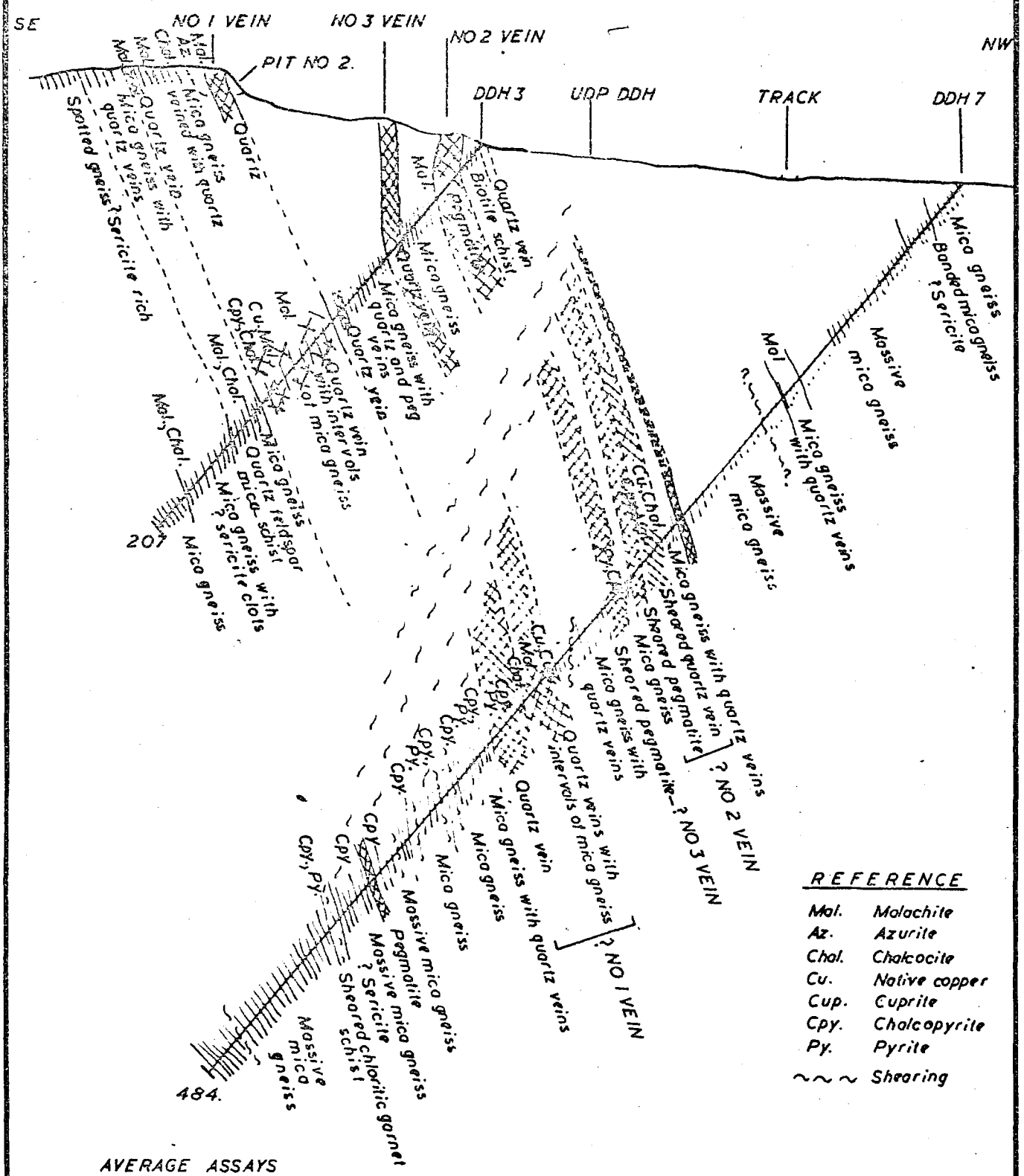
F52/A12/28

GGS/MAE



AVERAGE ASSAYS
DDH 3

INTERVAL	TRUE WIDTH	% COPPER
122'-148'	24·5'	1·37
135'-142'	6·5'	3·7
	DDH 7	
198'-206'	6·5'	0·36
294'-302'	6·5'	0·53
309'-313'	3·2'	1·62
329'-334'	4·0'	1·29
399'-403'	3·25'	0·41

DIAMOND DRILL HOLES 3, 7.

MT HARDY AREA

0 50 100 FEET
SCALE

F52/A12/29

G68/15E

To accompany Record 1968/100
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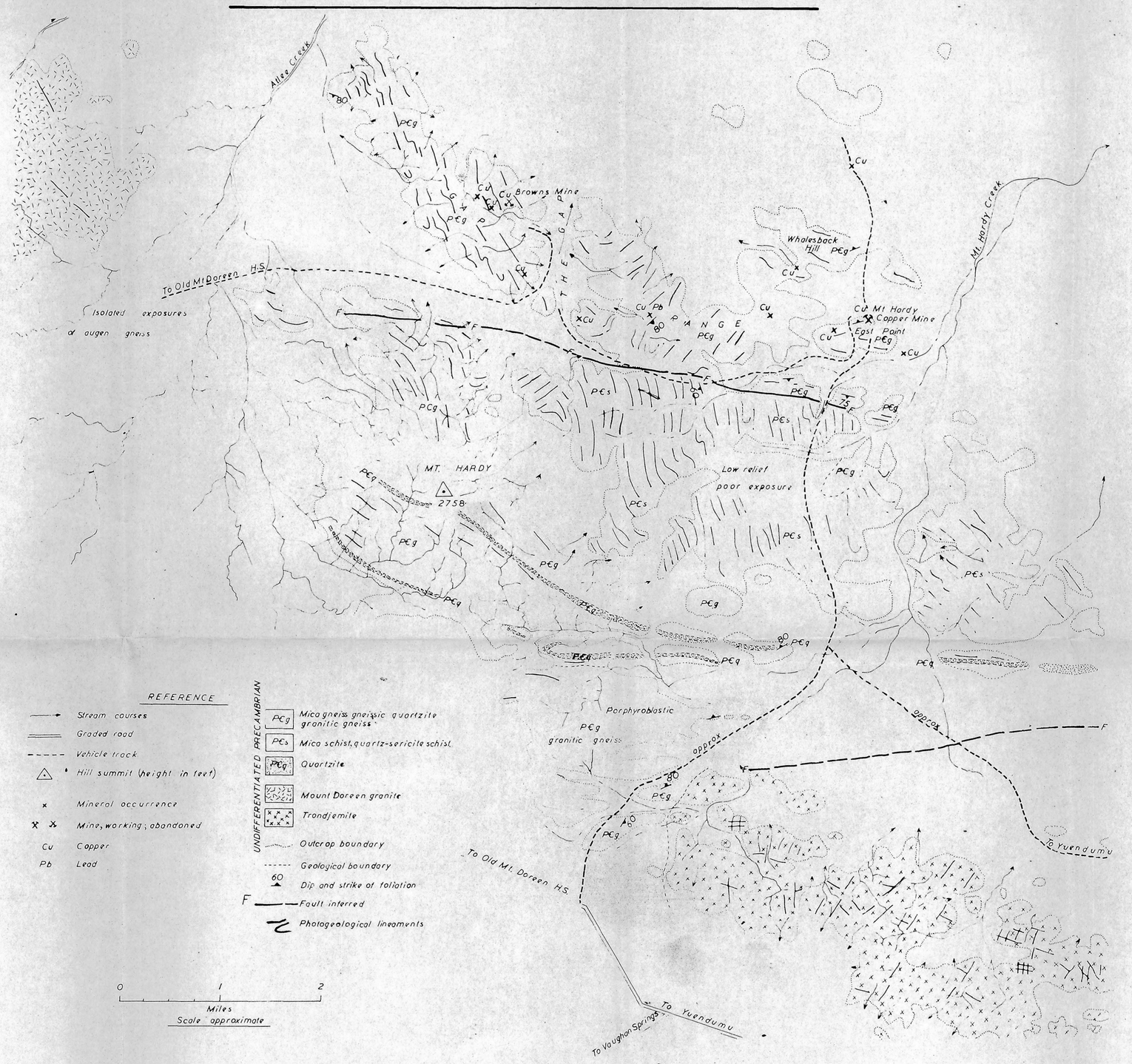
GEOLOGY OF THE MOUNT HARDY AREA
From photogeology and field work



GEOLOGY DERIVED FROM PHOTOGEOLOGICAL INTERPRETATION AND FIELD WORK.

BASE MAP PREPARED FROM UNCONTROLLED AIR PHOTOS, RESIDENT GEOLOGIST'S OFFICE, ALICE SPRINGS.

To accompany Record 1968/100

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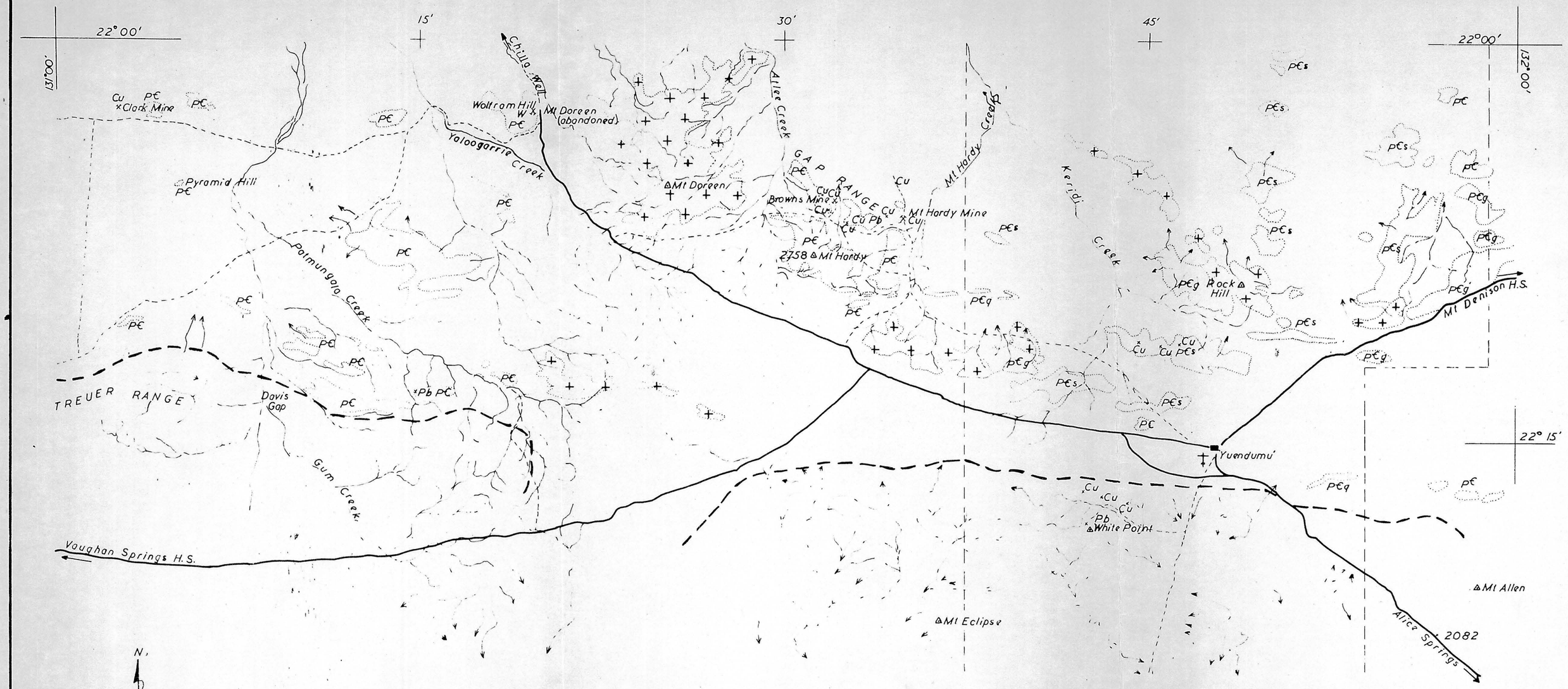
F52/A12/30

G68/16C



MT. DOREEN — MT. HARDY — YUENDUMU MINERAL FIELD

5 0 5 10 Miles

SCALE - 1:250,000

REFERENCE

- Stream Courses
- Graded road
- Vehicle track
- Hill summit; spot height (elevation in feet)
- Airstrip
- Boundary of Yuendumu Aboriginal Reserve
- Geological boundary
- Northern limit of Ngalia Basin
- pЄ Undifferentiated Precambrian rocks
- pЄg Precambrian gneisses
- pЄs Precambrian schists
- pЄq Precambrian quartzites
- Granite
- Mine
- Mine abandoned
- Mineral ocurrence
- Cu Copper
- Pb Lead
- W Wolfram

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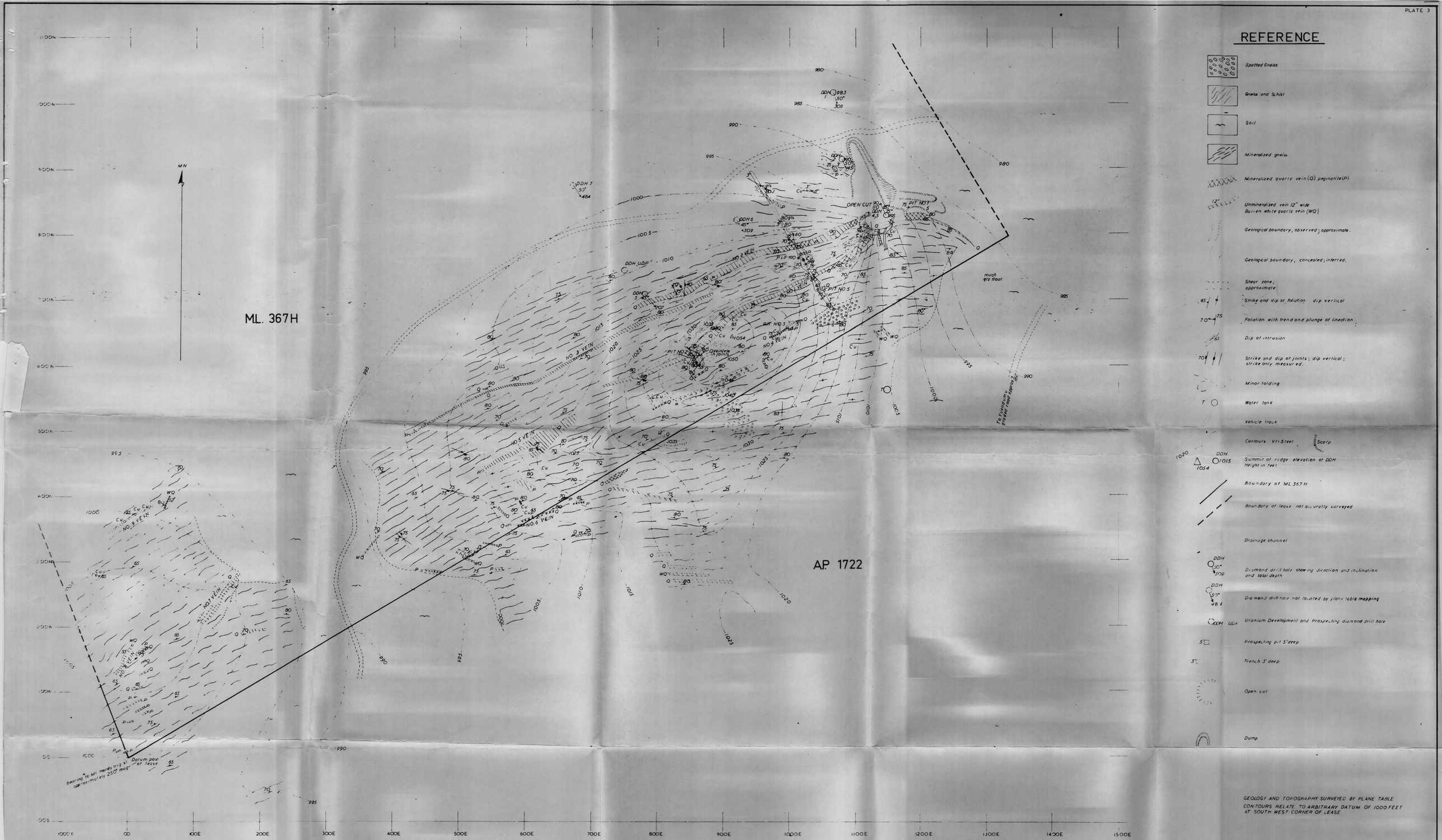
DRAWN BY MINES BRANCH DRAUGHTING OFFICE
DARWIN MARCH 1968

To accompany Record 1968/100

F52/A12/31

G68/17D



MOUNT HARDY
GEOLOGY and TOPOGRAPHY

SURVEYED BY D.J.GRAINGER MARCH-APRIL 1967.

100 50 0 100 200 FEET

SCALE

REFERENCE

- Spotted Gneiss
- Gneiss and Schist
- Soil
- Mineralized gneiss
- Mineralized quartz vein (Q) pegmatite (P)
- Unmineralized vein 12" wide. Barren white quartz vein (WQ)
- Geological boundary, observed; approximate.
- Geological boundary, concealed; inferred.
- Shear zone; approximate
- 65 Strike and dip of foliation dip vertical
- 70 75 Foliation with trend and plunge of lineation
- 65 Dip of intrusion
- 70 Strike and dip of joints; dip vertical; strike only measured.
- Minor folding
- T Water tank
- Vehicle track
- Contours VI-Steel. Scarp
- 1020 DDH 1015 1054 Summit of ridge elevation of DDH Height in feet
- Boundary of ML 367 H
- Boundary of lease not accurately surveyed
- Drainage channel
- DDH 50° 309 Diamond drill hole showing direction and inclination and total depth
- DDH 50° 48.4 Diamond drill hole not located by plane table mapping
- DDH UD.4 Uranium Development and Prospecting diamond drill hole
- 5 Prospecting pit 5' deep
- 3 Trench 3' deep
- Open cut
- Dump

GEOLOGY AND TOPOGRAPHY SURVEYED BY PLANE TABLE
CONTOURS RELATE TO ARBITRARY DATUM OF 1000 FEET AT SOUTH WEST CORNER OF LEASE

COMPILED BY RESIDENT GEOLOGICAL SECTION. DRAWN BY MINES BRANCH DRAUGHTING OFFICE, DARWIN, MARCH 1968. To accompany Record 1968/100

F52/A12/32

G68/18B