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GEOPHYSICAL SURVEY AT THE MOUNT FARRELL MINE, TULLAH, TASMANIA.

by

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ABSTRACT

A geophysical survey, using electromagnetic and self-potential methods, was made over an area about 7,000 feet in length and ranging from 1,500 feet to 2,500 feet in width, in the Mt. Farrell Mining Field.

Results of the survey indicate that the area surveyed cannot be regarded as very favourable for further exploration for shallow ore bodies. Weak indications were found to the east of the Farrell lode, but they are probably not caused by lead mineralisation. Somewhat more promising indications were obtained in the northern part of the area, corresponding to the northern extension of the Farrell lode, and in the southern part of the area, probably corresponding to the Central Farrell lode. It is suggested that, if further exploration is to be done, it be concentrated on these two indications.

1. INTRODUCTION

The geophysical survey described in this report was requested by the Mount Farrell Mining Company which is the only company actively mining in the Mount Farrell field. The request was made through the Tasmanian Mines Department. J. Horvath, a Senior Geophysicist of the Bureau of Mineral Resources studied the available information about the property ahd, after inspecting it, recommended that a geophysical survey be made.

Mining operations in the Mount Farrell field were started in 1899 and it appears from available reports that prospecting and exploitation of the field have not been continuous. It is possible, having regard to the irregular nature and smallness of the ore-bodies that prospecting and mine development have missed valuable mineralisation.

Mineralisation at the site of the present Farrell mine was discovered in 1933 and the mine has been worked, with occasional cessation of operations, until the present date. No major developmental work was done between 1940 and 1945. Surface drilling to the north of the mine did not locate any additional ores but it is likely that the targets chosen do not lie along the main lode. At the time of the survey, mining of ore in sight was proceeding but the life expectancy of the mine appeared to be very limited. The need for discovering further ore deposits was urgent and it was considered likely that a geophysical survey would assist in this respect.

The survey was made by geophysicists K.H.Tate (party leader) and E.Sedmik, assisted by a surveyor (T.Austin) from the Department of the Interior. Some casual helpers were supplied by the mining company and others were engaged by the field party. The survey commenced in February, 1957 and ended in April, 1957. A preliminary report on the survey was prepared by Tate (1957) and distributed to interested parties in August, 1957.

2. GEOLOGY

The geology of the area has been studied by various officers of the Geological Survey of Tasmania. The most comprehensive report is that by Ward (1908) and a later report was written by Nye (1931). Ward's report, which includes a geological map, also refers to earlier investigations by W.H. Twelvetrees and G.A. Waller.

The most recent geological report is that by Henderson (1945), who examined the field in 1941, and the following summary of the geology is taken from his report.

The structural trend in the area is north-south. The geological section is that of the western limb of an overturned syncline and the sequence of rocks from west to east is as follows:-

(i) A thick series of beds, misnamed locally as "felsites", consisting of lavas with interbedded breccias, agglomerates, tuffs and sediments.

(ii) The Farrell slate series of approximately 1,500 feet thickness, consisting of black slates and tuffs with occasional tongues of sheared intrusive porphyries (sericitic schist). The main Farrell fault, a high-angle overthrust fault with wich the silver-lead ore bodies are associated, occurs at the western boundary between the slates and tuffs and the "felsite" series.

(iii) Approximately 1,000 feet of an older conglomerate series with fragments of slate in a tuffaceous matrix. This formation apparently overlies the slates conformably. Occasional pebbles of the red quartzite from the West Coast Range Conglomerate are included near the top of the series.

(iv) A disconformity, or even an unconformity, divides the older conglomerate from the West Coast Range Conglomerate which forms the main mass of Mount Farrell.

The age of the mine rocks is uncertain but is is tentatively placed as Middle Cambrian. The rocks have been intruded by a granite massif, which is probably Devonian, and the ore bodies are associated with the intrusive porphyries whichhave risen along pre-existing lines of weakness. The main line of weakness is on the western margin of the Farrell slates and is the course of the Farrell lode. The chief mines along this line of lode are the abandoned North Mount Farrell mine, which is located near the present mill, and the Farrell mine, which is at present being worked. The Farrell mine is situated on lease No. 11065M and is in the area formerly known as the Mackintosh lease, No. 3221/93M. The position of the Farrell main shaft is shown on Plate 2.

Well-defined quartz veins occur in the area east of the Farrell lode. The quartz veins were formed earlier than the lead veins and are barren except where the lead veins intersect them. For the most part the quartz veins are approximately parallel to the lead veins.

The main fracture in a complex system of parallel fractures along the line of weakness consists of a fault and a crushed zone of crumpled and contorted slates and intercalated tuffs in which the metallic minerals galena, sphalerite, chalcopyrite and pyrite occur, together with siderite and quartz.

All the workable deposits are in, or along, fissures and nearly all are along faults of appreciable throw. Most of the faults of the system show some mineralisation but none are mineralised for the whole of their length. In many places the lodes are sheeted zones instead of single fractures filled with ore.

The ore occurs in shoots and the lode fracture is often traceable by a seam of pug and by the development of siderite on one or both sides in the slates beyond the present limits of stoping. The ore-shoots pitch to the south and make and pinch out along the course of the lode.

The main fracture system in which the ore-shoots occur is fairly persistent but the ore-shoots are not. Henderson attributes the irregularity of the ore-shoots to irregular development on two sets of shears.

3. THE PROBLEM.

The chief lead deposits on the field are found along the Farrell line of lode. It was considered that there was a possibility of locating similar lines of lode parallel to the Farrell lode. The problem resolved itself into finding narrow, steeply-dipping, lead ore-bodies with which are associated pyrite and chalcopyrite. The electrical conductivity of galena, pyrite and chalcopyrite is much higher than that of the host rock and if they occur in sufficient quantities, can be found by electrical methods of prospecting.

For such a problem, the electromagnetic (Turam) and self-potential methods of survey are commonly used. The electromagnetic method locates conducting bodies and the conductivity may be due to a variety of causes such as lead ore-bodies, pyrite bodies barren of lead mineralisation, and geological formations containing abundant graphite and/or pyrite. It is not possible to determine from the results which of these is responsible for the anomalies. The self-potential method likewise gives anomalies from a variety of causes. The interpretation of the results of electrical surveys has therefore to rely largely on geological probability and subsequent testing.

The magnetic method was tested on selected traverses and some soil samples were taken for geochemical testing.

In considering the scope for further prospecting in the Mount Farrell area, Henderson (1945) recommended exploration for :-

(1) Extensions along the strike of developed deposits.

(2) Fractures and veins in the walls of developed deposits.

(3) Extensions in depth of developed deposits.

(4) Undiscovered lodes.

Recommendations (2) and (3) above were not considered to be within the scope of the geophysical survey, which was made over the northern extension of the Farrell mine and the area east of the lode line. The 2,000 feet of lode line between the Farrell and Mount Farrell Mines was omitted as it is largely unsuitable for electrical survey because of the presence of rails, pipes and other miscellaneous material likely to cause electrical disturbances. The area surveyed is shown on Plate 2.

4. THE GEOPHYSICAL SURVEY.

A. GENERAL.

The survey party first tested its equipment on the traverses prepared and surveyed under the direction of the Mine Manager, Mr. R. Midson.

On the arrival of the surveyor, the existing grid was extended. As geophysical indications were discovered, the area of survey was modified accordingly. The complete layout of traverses is shown on Plate 2. Surveying conditions in much of the area, particularly in the southern part, were very difficult owing to the dense cover of "horizontal" scrub or to steep slopes.

Geophysical work was concentrated first in the area east of the Farrell lode line. Certain traverses were then surveyed over the northern extension of the Farrell lode and these were followed by traverses over extensions of the grid to the south.

B. THE ELECTROMAGNETIC (TURAM) SURVEY.

(a) Method.

When an alternating current field is applied to a large area of ground containing buried conductors in otherwise homogeneous ground, the primary field is modified by the secondary electromagnetic field arising from currents induced in the conductors. This secondary field is out of phase with the primary field and the resultant of primary and secondary fields differs in phase and magnitude from the primary field. By using induction coils in an alternating current bridge network, it is possible to measure the phase differences as well as the variations in magnitude of the resultant field. Various arrangements of equipment have been designed for this purpose.

That used in the Turam method has two coils at constant separation to measure the ratio between the field strengths and the phase difference between the coils. The measurements made are indicative of the presence of any buried conductor within range. The method is well suited to the location of mineralised bodies which contain minerals of high electrical conductivity. Readings are taken at various distances along traverses placed at right angles to a long cable which carries a 440-or 880-cycle current of approximately one ampere at 240 volts. The ratios of field strength and phase difference between the coils for the unmodified primary field can be calculated and are considered in interpreting the results of a survey. Well-defined departures from the normal field are called anomalies and an explanation of their cause is sought in terms of geological factors.

(b) Results.

The Turam survey, using a frequency of 880 cycles/sec, located anomalies from buried conductors in three areas on the surveyed grid. For reference, these are called Indications A, B and C; their positions are shown on the phase-difference contour plan (Plate 4) and on Plate 2. Each is described separately below :-

Indication "A"

When the grid was extended to cover the northern extension of the Farrell line of lode, large Turam phase anomalies were found on each traverse surveyed (see Plate 3). A line joining the point on each traverse where the phase difference between Turam coils is greatest has a consistent northerly strike. It is clear that the effect is in line with the known Farrell lode and it is reasonable to assume that it arises from a northern extension of the lode. The indication is continuous from traverse 700N to traverse 2300N, but its magnitude varies from traverse to traverse.

It was stated in Section 3 that such anomalies may be attributed to one or more of several causes. It is clear from the geology that any ore-bodies mined in the past were irregular in shape and discontinuous. Indication "A" cannot therefore be regarded as likely to be caused by a large continuous ore-body which is persistent in strike.

The indication can, however, be regarded as being the cumulative effect of the following factors:-

1. The electrical effect from a dipping zone of fractures along a persistent fault line (the Farrell Lode). The effect arises chiefly from the mineralised waters along the fracture zone.

2. The occurrence throughout the zone, and in adjacent Farrell slate formations, of disseminated pyrite. This is reported in the literature and was observed by the field party.

3. The occurrence of black slates. The slates have not usually been termed graphitic but they could contain appreciable quantities of graphite.

4. The occurrence of intermittent bands or shoots of sulphide minerals.

It is considered that factors (1) and (2) above are responsible for the major part of the anomaly. As far as (3) is concerned, it is not likely, in a fractured zone where crumpling and folding occur as described by Henderson, that a thin black (or graphitic) slate bed would occur as a persistent formation. Further, the thickness of individual formations of black slate beds is often greater than 50 feet and usually more than 50 per cent of the intersection of any of the holes drilled in the Farrell Slates. The slates appear to be too wide to be the cause of the electrical anomalies located.

The occurrence of veins of sulphide minerals has been reported in drilling results and there is a possibility that small valuable shoots occur along the line of Indication "A". Whatever factor or combination of factors causes the anomaly it can be inferred that the feature dips steeply.

The most important result of the Turam survey in the northern part of the area over Indication "A" is that the continuous fault or shear zone which is most favourable to deposition of ore-bodies has been accurately mapped from the Farrell Mine to the northern boundary of the lease and test drilling can therefore be concentrated on the most suitable locations.

Indication "B"

Indication "B" occurs in the southern part of the area surveyed and is a strong Turam phase anomaly extending from 1600S/500W to, and probably south of, 4400S/950W. The indication is strongest from traverse 2400S to traverse 4400S. It is persistent in strike and appears to be a continuous feature. It is caused by a narrow, steeply dipping conductor and is considered to be very similar to Indication "A".

The main difference is that, as far as is known, no mineralisation of economic value has been proved in the area of Indication "B". There is no record of the occurrence of lead at any of the openings made by prospectors. One tunnel was seen at 4100S/975W. Material on the dump indicated that a contact of slates and a massive rock had been intersected and there was some pyrite. Nearby was another opening in the bank of a creek on the same pyritic lode.

The line of lode is probably that marked by Henderson on his plan as the Central Farrell lode. The Turam survey located and determined its extent, and the results should enable test-drilling of the lode to be carried out economically.

Indication "C".

This line of Turam phase anomalies is in the eastern part of the area surveyed and extends from traverse 980S, where the strike is northerly, to traverse 2006N, where the strike is north-westerly.

The line of indication is continuous between 200N and 2006N; the phase anomalies are very weak but definite. Two possible causes may be suggested -

(1) A fracture zone containing weak mineralisation.

(2) A feature connected with a contact between Farrell slates and conglomerates.

The area in which this indication occurs is very unfavourable for geological mapping and it is not known whether the positions of the Central Farrell line of lode, and the contact between Farrell slates and conglomerates, as shown by Henderson have been precisely determined. In the circumstances it appears possible that indication "C" may be connected with either of these. However, as the indication is weak, testing of it cannot be recommended.

Other minor Turam phase anomalies which are shown on the plan are too weak to be of interest.

C. THE SELF-POTENTIAL SURVEY.

(a) Method.

Sulphide bodies which are so placed in the ground that portion of the body is in a state of active oxidation are the source of natural or self-potentials. The self-potential method can be used to locate them by taking potential measurements on the surface.

(b) Results.

The results of the self-potential measurements are shown as contours on Plate 5. Not all traverses were surveyed by the self-potential method; it was used after the Turam survey to see if the bodies causing Truam anomalies also caused self-potential anomalies. A large area in the northern part of the grid and a smaller area in the southern part were surveyed. The two areas were surveyed with separate base-stations and the base-stations were not tied together. In a few places, self-potential measurements were made on traverses which were not surveyed by the Turam method.

Self-potential anomalies along Turam Indication "A".

On the northern extension of the Farrell lode, some of the self-potential measurements made were on traverses 500N and 600N, which cross the surface projection of existing underground workings (Plate 2). An anomaly of approximately 250 millivolts was recorded there. This anomaly terminates, at its northern end, on traverse 600N; north of this there is a strong self-potential anomaly of approximately 200 to 300 millivolts between traverses 800N and 1525N. This is a persistent anomaly which has the same strike as, but is slightly east of, the Turam anomaly. This is consistent with a westerly dip of the lode because the S.P. anomaly should arise from a shallower part of the body than the Turam anomaly. The plan position of the electromagnetic anomaly is thus displaced down-dip from that of the self-potential anomaly

Other self-potential anomalies along the line of Turam Indication "A" are not of any special significance. There may be traces of mineralisation at each locality but it is doubtful if such local anomalies provide targets for drilling.

Self-Potential anomalies along Turam Indication "B".

Some significant anomalies occur along the line of Turam Indication "B", especially at the points 2400S/675W, 3400S/850W, 3603S/875W, 4000S/900W and 4400S/875W. The strike of the line of the self-potential anomalies is parallel to that of the line of Turam Indication "B" but the negative centres occur about 50 feet west of the line of Turam Indication "B". This fact would ordinarily lead to the conclusion that the body causing both Turam and self-potential anomalies dips to the east. In this particular case however, the anomalies occur on steep slopes and the position of the self-potential anomaly is likely to be displaced down-slope from a position directly over the body causing the anomaly. It is therefore possible to conclude only that the same body causes both self-potential and Turam anomalies; its dip cannot be specified.

Other self-potential anomalies.

The self-potential anomalies along the line of Turam Indication "C" and in other parts of the area surveyed are not sufficiently well-defined to warrant close study.

5. GEOCHEMICAL RESULTS

Several soil samples were taken to test for the presence of lead or copper in amounts greater than normal. The samples were taken with a hand auger along traverses where geophysical indications were discovered.

Samples from portions of three traverses were tested at the Bureau's Geophysical Laboratory in Melbourne using the dithizone method.

The samples from traverses 1100N (1200W to 1600W) and 2400S (600W to 1100W) showed no lead or copper values above average, but the samples from traverse 4400S showed slightly higher lead values at 925W and 950W, the values gradually decreasing down slope. The higher lead values coincide with Turam Indication "B" and point to the possibility that lead mineralisation may be in part the cause of the indication.

6. CONCLUSIONS AND RECOMMENDATIONS.

It is considered that the survey results enable the course of the Farrell and Central Farrell lodes to be followed with sufficient precision for testing. However, they do not suggest that any particular portions of the lodes are likely to contain valuable deposits of sulphide minerals. If testing is desired, it is recommended that a series of holes be drilled from the western side of each indication to test the ground at shallow depth (say 50 feet). In order to minimise the chance of missing an ore shoot, the distance between holes should not exceed 100 feet.

Trenching had commenced at the close of the geophysical survey, and a trench started at 1300N/1450W located a crushed zone in slates containing pyrite at about 1300N/1500W. The completion of such trenches along the lines of Indications "A" and "B" should yield valuable information.

7. REFERENCES

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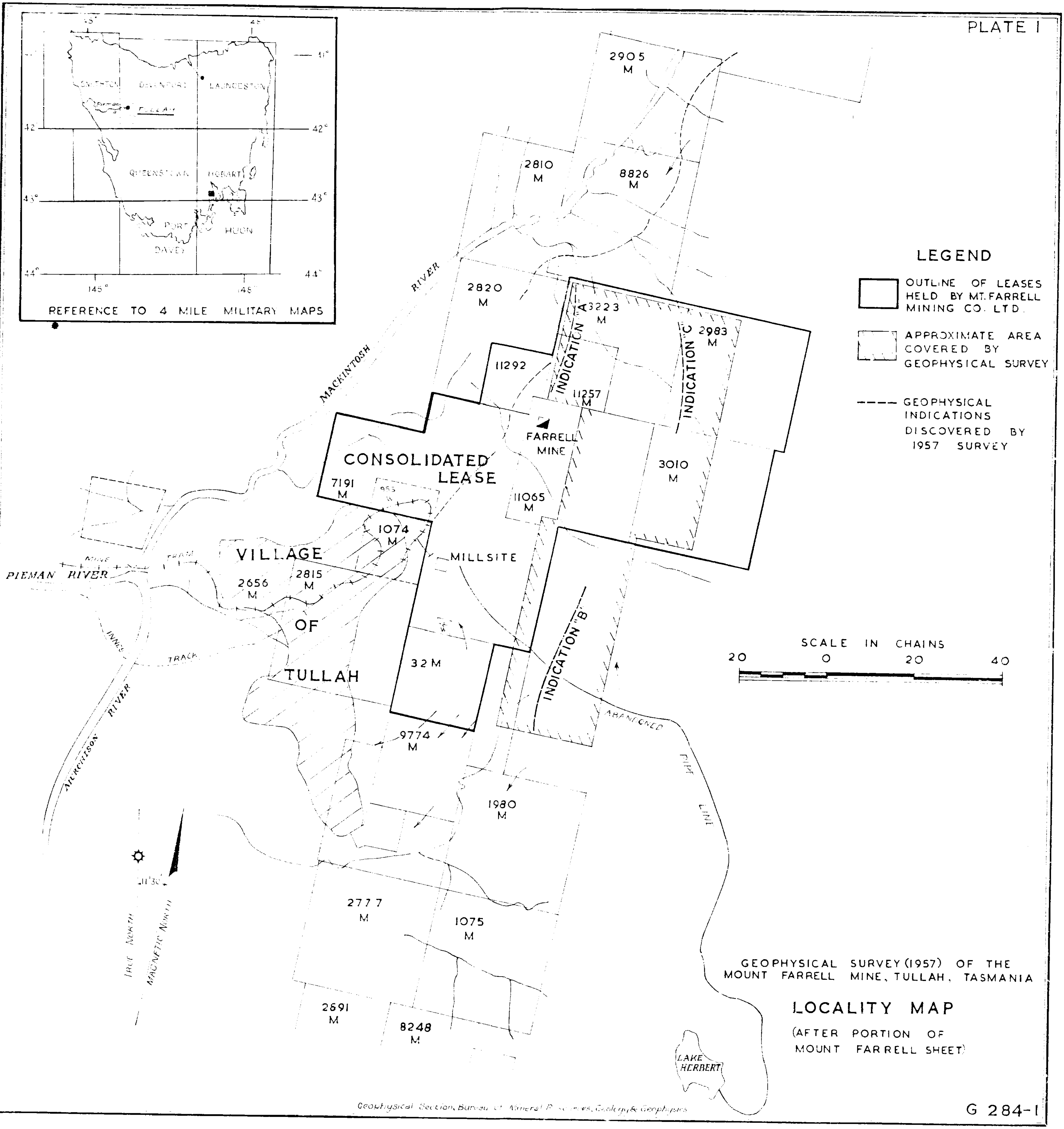
PLATE I



GEOPHYSICAL SURVEY (1957) OF THE MOUNT FARRELL MINE, TULLAH, TASMANIA

LOCALITY MAP

(AFTER PORTION OF MOUNT FARRELL SHEET)

Geophysical Section, Bureau of Mineral Resources, Geology & Geophysics

G 284-1

PLATE 2

GEOPHYSICAL SURVEY AT THE MOUNT FARRELL MINE, TULLAH, TASMANIA.

GEOLOGY, GEOPHYSICAL GRID AND INDICATIONS

GEOPHYSICIST

G 284—2

GEOPHYSICAL SURVEY
AT THE MOUNT FARRELL MINE,

TULLAH, TASMANIA.

TURAM PHASE DIFFERENCE PROFILES

(FREQUENCY 680 CYCLES/SECOND)

GEOPHYSICIST

G 284-3

GEOPHYSICAL SURVEY
AT THE MOUNT FARRELL MINE,

TULLAH, TASMANIA.

TURAM PHASE
DIFFERENCE CONTOURS

(FREQUENCY 880 CYCLES/SECOND)

G 284—4

GEOPHYSICAL SURVEY AT THE MOUNT FARRELL MINE,

TULLAH, TASMANIA.

SELF-POTENTIAL CONTOURS