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IRON BLOW GEOPHYSICAL SURVEY, NT 1960

by

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SUMMARY

A geophysical survey was made in the area of the Iron Blow mine, Northern Territory, using self-potential, electromagnetic (Turam), and magnetic methods.

Two Turam anomalies of interest were located. In addition, an interesting magnetic anomaly was found.

One Turam anomaly is thought to be related to a known pyritic body. The other confirms geophysical work done some years previously.

It is recommended that the second Turam anomaly and the magnetic anomaly be tested by drilling.

1. INTRODUCTION

This Record describes geophysical work done around the Iron Blow mine, Northern Territory during November 1960. The Iron Blow mine is situated about two miles south of Grove Hill Station on the North Australian Railway. Plate 1 shows a locality map of the area. The mine was worked in the early days of the Northern Territory as a gold mine, being apparently a very good producer for some years until about 1907. Subsequently it changed hands several times and was finally abandoned in 1914. Extensive underground workings and an open-cut remain in the area.

Reports indicating that the mine still contains about 33,000 tons of workable ore came to the attention of officers of the Northern Territory Mines Branch who intend to verify this by means of diamond drilling in the area. They requested geophysical assistance to decide the position of the drill site. Geophysical surveys had already been made over the Iron Blow area by the Aerial, Geological, and Geophysical Survey of Northern Australia (Rayner and Nye, 1937). It was decided to extend this previous work to test for possible extensions of the known lode, and to use the Turam and magnetic methods, which had not been used in this area previously.

2. GEOLOGY

Detailed mapping of the area was done by Mines Branch geologists at the same time as the geophysical surveying, and a report is being prepared by them.

The mine area occurs on a hill of Precambrian rocks surrounded by recent alluvium. The rocks have a general northerly strike and dip steeply to the east. A shear zone, striking slightly west of north, extends up the hill from its south-eastern end for about 300 ft before disappearing. The lode material appears to be associated with this shear zone.

The known lode consists of two lenses, one slightly north of the other, each about 100 ft long and 20 to 30 ft wide. These lenses are elongated in the northerly direction, and also dip steeply to the east.

The original outcrop, after which the mine was named, was a gossan capping on the northern lens. This outcrop has been removed, and a small open-cut now marks the area. Extensive dumps cover the south-eastern part of the hill, and numerous shafts lead down into the old workings which are now filled with water and are inaccessible.

The sulphide content of the ore material is high; considerable pyrite is in evidence on the dumps, and it was reasonable to suppose that geophysical surveys would give useful information on the area.

3. OPERATIONS

A grid was surveyed over the area around the Iron Blow mine. This grid consisted of a baseline in a northerly direction about 800 ft east of the mine, and a series of traverses at 100-ft intervals, extending 1200 ft west from the baseline. The traverses were numbered consecutively towards the north, and each traverse was pegged at 50-ft intervals along its length. Plates 2 to 5 show the positions of the various mine shafts in relation to the grid.

4. GEOPHYSICAL METHODS

Three separate methods, viz. self-potential, electromagnetic (Turam), and magnetic were used on this area.

Self-potential

This method, which depends on the oxidation of sulphides, was used because the orebody is known to contain pyrite. The process of oxidation is an electrochemical one, and it causes spontaneous potential-differences to occur throughout the region affected by oxidation. In general, a portion of a shallow orebody will project above the naturally occurring groundwater table, thus allowing atmospheric oxygen and the water to oxidise any sulphide present. Electrochemical potentials can then be set up. The currents generated by these potentials may reach as far as the ground surface, where they can be detected with a high-impedence voltmeter. It is found that a cathode is formed at the top of an orebody, and thus an orebody may be detected by searching for areas where the surface potential is negative with respect to the surrounding country.

Using the grid as a basis, self-potential measurements were made at 25-ft intervals along each traverse.

Magnetic

The magnetic method makes use of the fact that any magnetic minerals present will produce inhomogeneities in the Earth's magnetic field. Variations in the Earth's magnetic field were measured with a sensitive magnetic balance.

Magnetic measurements were made at 25-ft intervals along the traverses of the grid and also along a traverse that was parallel to, and 850 ft west of, the baseline.

Electromagnetic

The Turam method, which can delineate regions of high conductivity, such as pyritic orebodies was used. A fairly strong alternating electromagnetic field is set up in the area to be surveyed. This field will induce eddy currents in any conducting material present. These eddy currents produce a secondary magnetic field, which will augment the primary magnetic field, thus modifying the distribution of the total field. In this way conducting bodies will cause anomalies in the total field.

Anomalies in the electromagnetic field may be detected in several ways. In the Turam method, two horizontal search coils are placed 50 or 100 ft apart at selected positions covering the area to be prospected. The voltage induced in each coil will be proportional to the magnitude of the alternating electromagnetic field at each place. The ratio of the two voltages is measured with a modified alternating-current bridge, and thus the change in field between the two coils is determined. In addition, the phase difference between the two search coils is measured.

A primary electromagnetic field for Turam measurements was set up by means of a large square loop of wire, carrying an alternating current of about two amperes. The front of this loop was run along the baseline and the rear side was placed about 1800 ft farther away from the mine so that the return current from it would have little effect at the mine site. Turam measurements were then made at 25-ft intervals, the two search coils being 100 feet apart and in line along the traverse. The primary electromagnetic field distribution approximated to that set up by the same current flowing in a long straight conducting wire.

A sufficiently detailed picture of the differential changes caused by anomalies in the alternating magnetic field was found by this method.

5. RESULTS

All measurements were analysed and illustrated as contour plans.

Plate 2 is an equipotential plan of the self-potential measurements.

Plate 3 shows the Turam ratio contours. Plate 4 shows the Turam phase contours with a contour interval of two degrees.

Plate 5 is a contour plan of the vertical magnetic force measurements. Magnetic profiles along two traverses are shown on Plate 6. These profiles are of the vertical component along Traverse 700N and of the horizontal component along Traverse 850W. The maximum in the horizontal-component profile was expected at the northern end of Traverse 850W. It is thought that the reading scale of the magnetometer used for measuring the horizontal component may have been reversed. However, the horizontal-component profile on Plate 6 has been plotted without change of sign.

6. DISCUSSION OF RESULTS

Self-potential

Plate 2 indicates that an area of negative potential occurs in the mine area. The maximum negative value in this area is a little over 150 millivolts, and could normally be attributed to a subsurface sulphide body. However, the old mine dumps contain considerable quantities of oxidising pyritic material which could also cause a negative self-potential anomaly. The close resemblance between the shape of the self-potential anomaly and that of the dumps would suggest that the main self-potential anomaly is due to the oxidation of dump material.

A definite interpretation is difficult owing to the ambiguity introduced by the presence of the dumps.

Turam

Anomalies in ratio and phase were indicated over the mine area. The agreement between the ratio and phase results is quite good. A large area containing Turam anomalies is centred at about 800W and extends from 900N to about 1400N. This area roughly delineates the general position and direction of the known lode. Two anomalies can be recognised within this area.

Anomaly N is centred at 800W/1030N and appears to be on a northern extension of the lode line through the open-cut. This anomaly is probably due to part of the northern orebody which once cropped out where the open-cut is located.

A second anomaly centred near 780W/1200N, has been designated Anomaly E. This anomaly does not appear to correspond with any known feature. Possibly it represents another pyritic body farther north than the two known orebodies. Anomaly E is not considered to be caused by the dump material which, although conductive, is of too limited extent to cause the anomaly.

Old reports on the mine indicate that most of the workings were south of the main shaft. One drive was put in at the 100-ft level in a northerly direction from No.1 North prospecting shaft. However, this drive headed a little west of north and would have missed the source of Anomaly E, especially if the source dips slightly to the east. There seems to have been a short north-westerly drive at the 200-ft level from the main shaft, but it did not go more than about 30 ft, and would also have missed any orebody causing Anomaly E.

Magnetic

Referring to Plate 5, there is a large symmetrical anomaly centred at about 850W/650N and it has been designated Anomaly M.

Calculation of the size and depth of the cause of a magnetic anomaly is possible if a few simple assumptions are made about its shape and composition. Here the assumption of an approximately spherical body seems justified by the symmetry of the anomaly. Moreover, the profiles along two of the traverses (Plate 6) roughly agree with theoretical profiles that would be expected from a spherical body.

Assuming a spherical orebody consisting of a single magnetic pole, the following simple rules can be applied to find the depth to the centre of the orebody:

(1) The vertical magnetic intensity will drop to 1/3 of its maximum value in a distance along the traverse equal to the depth to the centre of the body causing the anomaly. Thus from Plate 6 it is seen that the vertical intensity drops from its maximum value of 2100 gammas to 700 gammas in a distance of about 212 ft. Hence the depth of the centre of the body is about 212 ft.

(2) The distance between the maximum and minimum values of the horizontal intensity is 1.4 times the depth to the centre of the body causing the anomaly. The location of the minimum horizontal intensity due to a body at depth is obscured owing to superimposition of a smaller anomaly on the main anomaly (Plate 6). If the dotted line is taken as an approximation to the main anomaly, the distance between maximum and minimum is about 300 ft, giving a depth of 213 ft to the centre of the body causing the anomaly.

The above assumption of a single magnetic pole leads to a simple analysis of the results. However, a more reasonable and accurate assumption is that the sphere is uniformly magnetised in the direction of the magnetic dip in the area. For this case Daly (1959) has fully explained an analysis which is more complex than the simple rules quoted above. The result from the vertical intensity measurements gives a depth of 280 ft, and from the horizontal intensity measurements, a depth of 250 ft to the centre of the body. This analysis also provides an estimation of the diameter of the orebody, if an assumption is made of the magnetic susceptibility of the material. Choosing 10^{-1} c.g.s. units, which is approximately the same as for other magnetic materials found in the Northern Territory, then the diameter is found to be about 150 ft, both from the horizontal and the vertical measurements.

It is difficult to make any definite statement about the cause of Anomaly M because this anomaly is centred over the alluvium and no geological evidence is available. Attention is drawn to the small anomaly along 850W, between 700N and 1200N, superimposed on the main horizontal-component anomaly shown on Plate 6. Over this section the traverse passes very close to the edge of the open-cut. Possibly this minor anomaly is caused by the remnant of a larger body that has been diminished owing to removal of part of the body by open-cut operations. Therefore, the cause of Anomaly M may be similar to the original northern orebody, and may possibly be a southern extension of the lode.

Another explanation may be that Anomaly M is due to amphibolites similar to those which cause magnetic anomalies elsewhere in the Brocks Creek district. However, the nearest known amphibolites are about two miles from the mine.

7. CONCLUSIONS AND RECOMMENDATIONS

In the present survey the Turam method indicated a broad, roughly north-striking conductive zone extending through the mine area. This agrees with previous geophysical results of the Aerial, Geological, and Geological Survey of Northern Australia. Two specific areas of higher conductivity have been delineated within the broad zone. In one of these, Anomaly N appears to be related to the known northern lens of the lode. In the other, Anomaly E is not identifiable with the known portion of the lode, and may represent a hitherto-unknown northern extension. As far as can be ascertained from the reports, this possible northern extension was not intersected by any of the old mine workings.

The report (Rayner and Nye, 1937) of the previous geophysical work does not contain sufficient detail to indicate whether this work also specifically delineated Anomaly E. However, it is notable that the previously-recommended drill hole would have been identical with one sited to test Anomaly E. Accordingly, the same recommendation for drilling is made here, viz. a 300 to 400-ft hole, commencing at 1200N/650W, bearing west, and inclined at about 60 degrees.

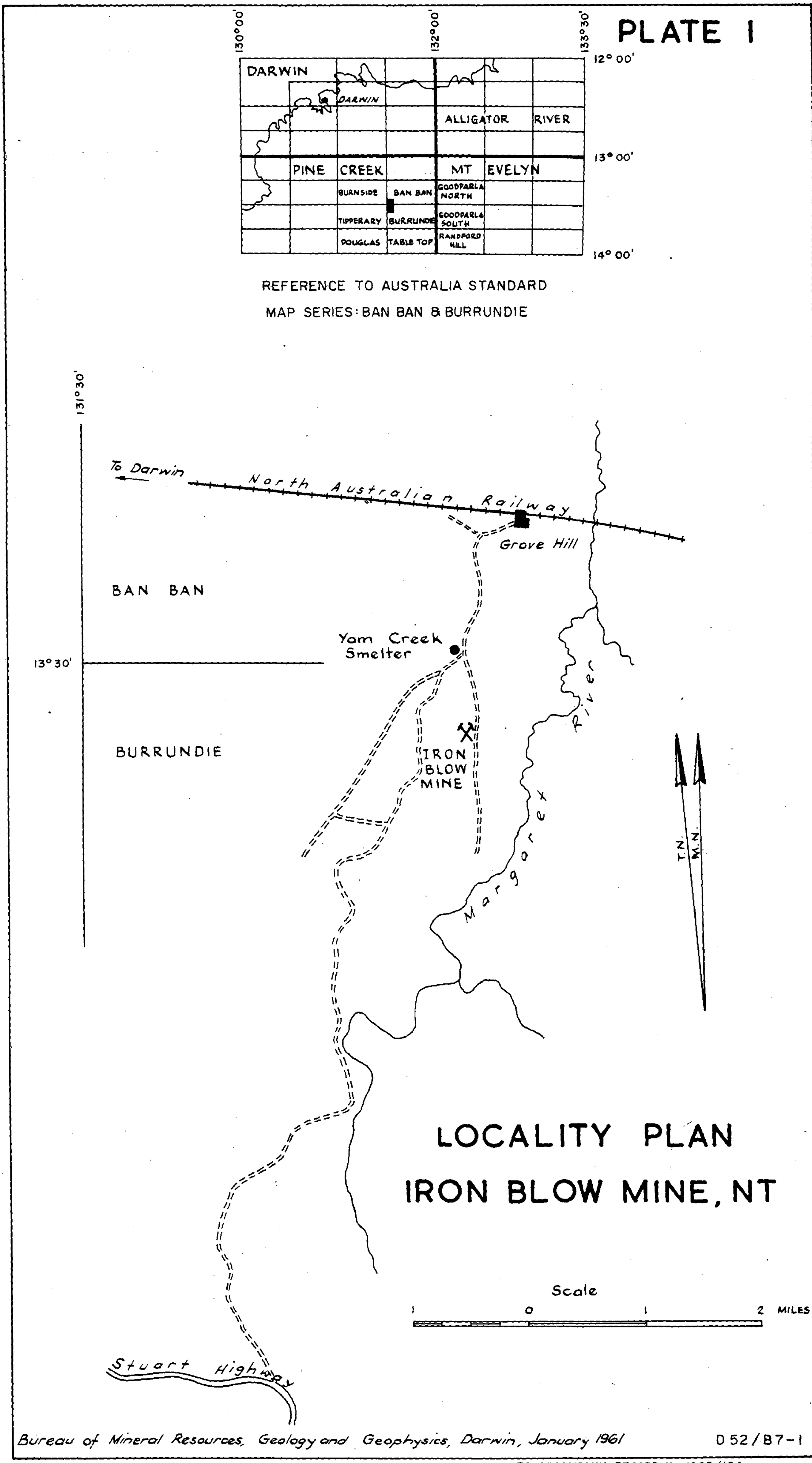
The present work has also delineated the magnetic anomaly M south of the known orebody and centred at 650N/850W. This anomaly is probably due to a magnetic body about 150 ft across, the centre being about 250 ft below the alluvium cover.

Assuming that a magnetic anomaly existed over the original mine outcrop, it is possible that Anomaly M is caused by a similar pyritic body. Therefore, Anomaly M is also recommended for testing by drilling. The best site would probably be at 650N/625W, with a 400-ft hole bearing west and depressed about 52 degrees.

8. REFERENCES

DALY, J.	1957	Magnetic prospecting at Tennant Creek, Northern Territory 1935-37. Bur. Min. Resour. Aust. Bull. 44
HOSSFELD, P.S.	1937	Geological report on the Iron Blow area, Pine Creek district. AGGSNA Report Northern Territory No. 14
RAYNER, J.M. and NYE, P.B.	1937	Geophysical report on the Iron Blow area, Pine Creek district. AGGSNA Report Northern Territory No. 13

PLATE I



LOCALITY PLAN
IRON BLOW MINE, NT

Bureau of Mineral Resources, Geology and Geophysics, Darwin, January 1961 D 52/B7-1

TO ACCOMPANY RECORD No. 1962/184

PLATE 2

SELF-POTENTIAL CONTOURS

IRON BLOW MINE, N T

GEOPHYSICAL SURVEY, NOVEMBER 1960

Contour Interval : 25 millivolts

Mine Shafts shown : ⊠

Scale

100 50 0 100 200 FT

Bureau of Mineral Resources, Geology and Geophysics,
Darwin February 1961

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TO ACCOMPANY RECORD No. 1962/184

PLATE 3

TURAM RATIO CONTOURS

IRON BLOW MINE, NT

GEOPHYSICAL SURVEY, NOVEMBER 1960.

Coil Separation : 100 ft
Frequency : 440 c/s
Contour Interval : ·02

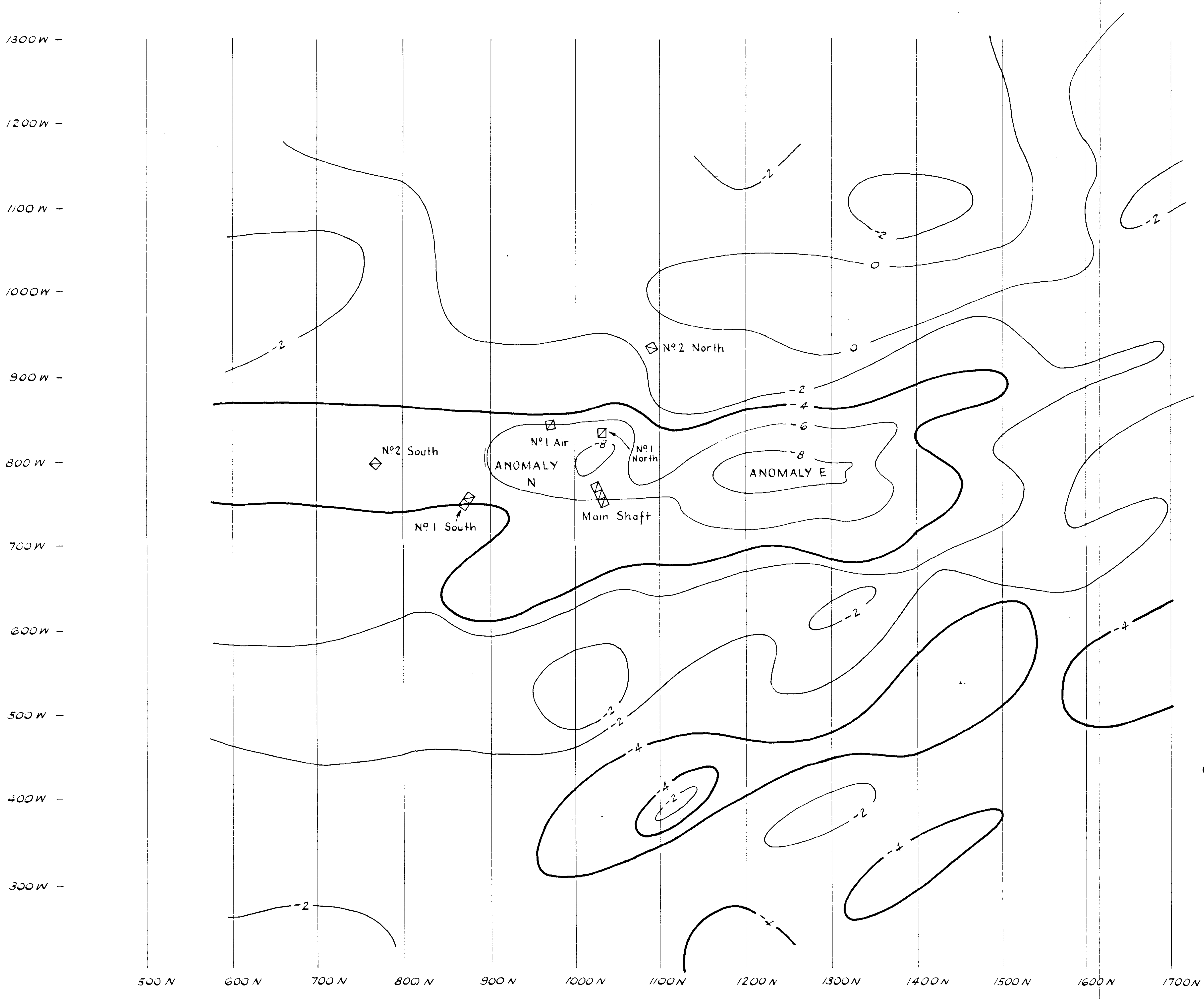
Mine Shafts shown ☒

Bureau of Mineral Resources, Geology and Geophysics,
Darwin February 1961

D 52/B 7 – 3

TO ACCOMPANY RECORD No 1962/184

PLATE 4



TURAM PHASE CONTOURS

IRON BLOW MINE NT

GEOPHYSICAL SURVEY, NOVEMBER 1960

Coil Separation : 100 ft
Frequency : 440 c/s
Contour Interval : 2

Mine Shafts shown ⊠

Scale
100 50 0 100 200 FT

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D 52/B 7— 4

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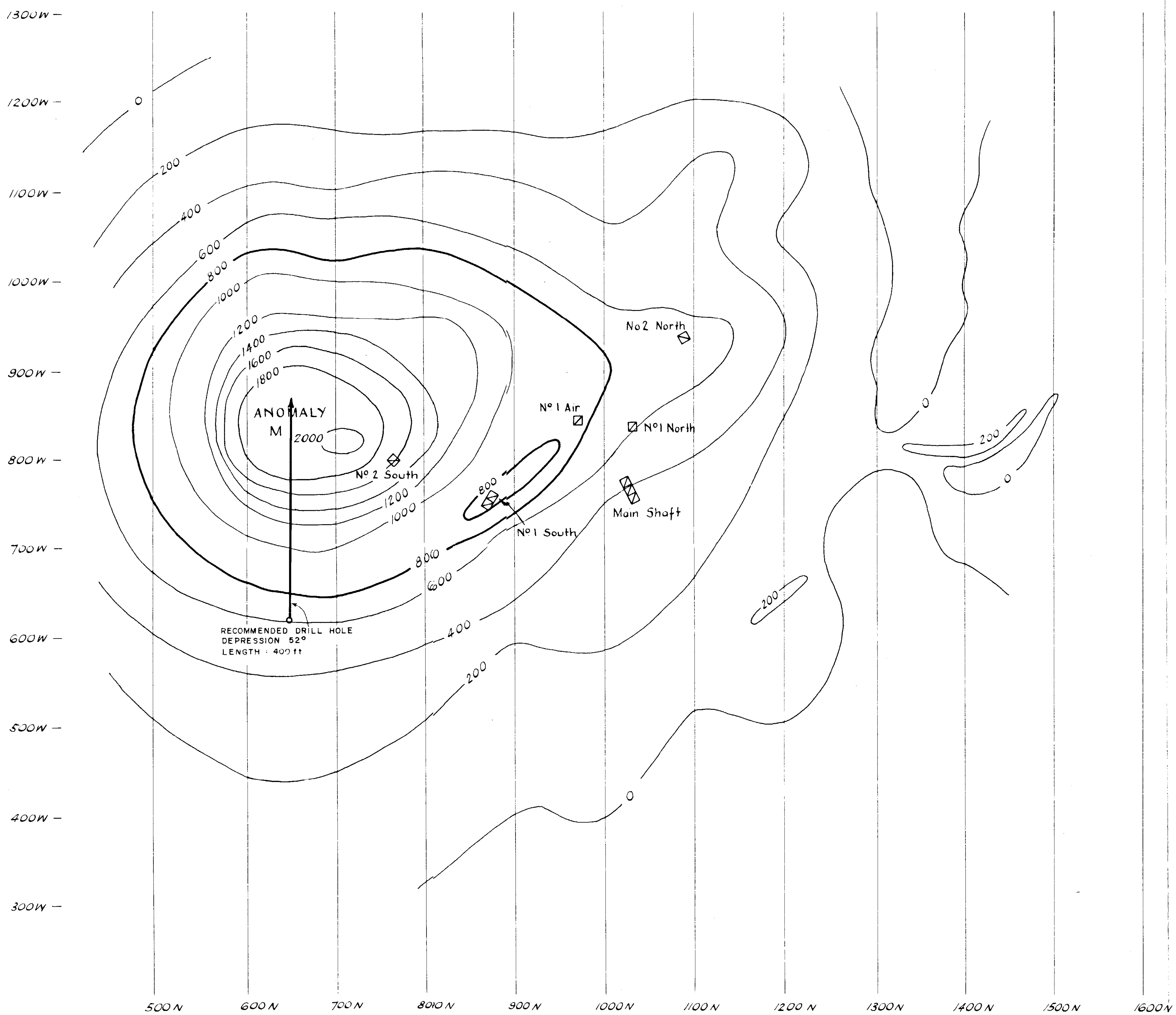
PLATE 5



VERTICAL MAGNETIC FORCE (Z) CONTOURS

IRON BLOW MINE NT

GEOPHYSICAL SURVEY, NOVEMBER 1960.

Contour Interval : 200 gammas

Mine Shafts shown ☒

Scale 100 50 0 100 200 FT

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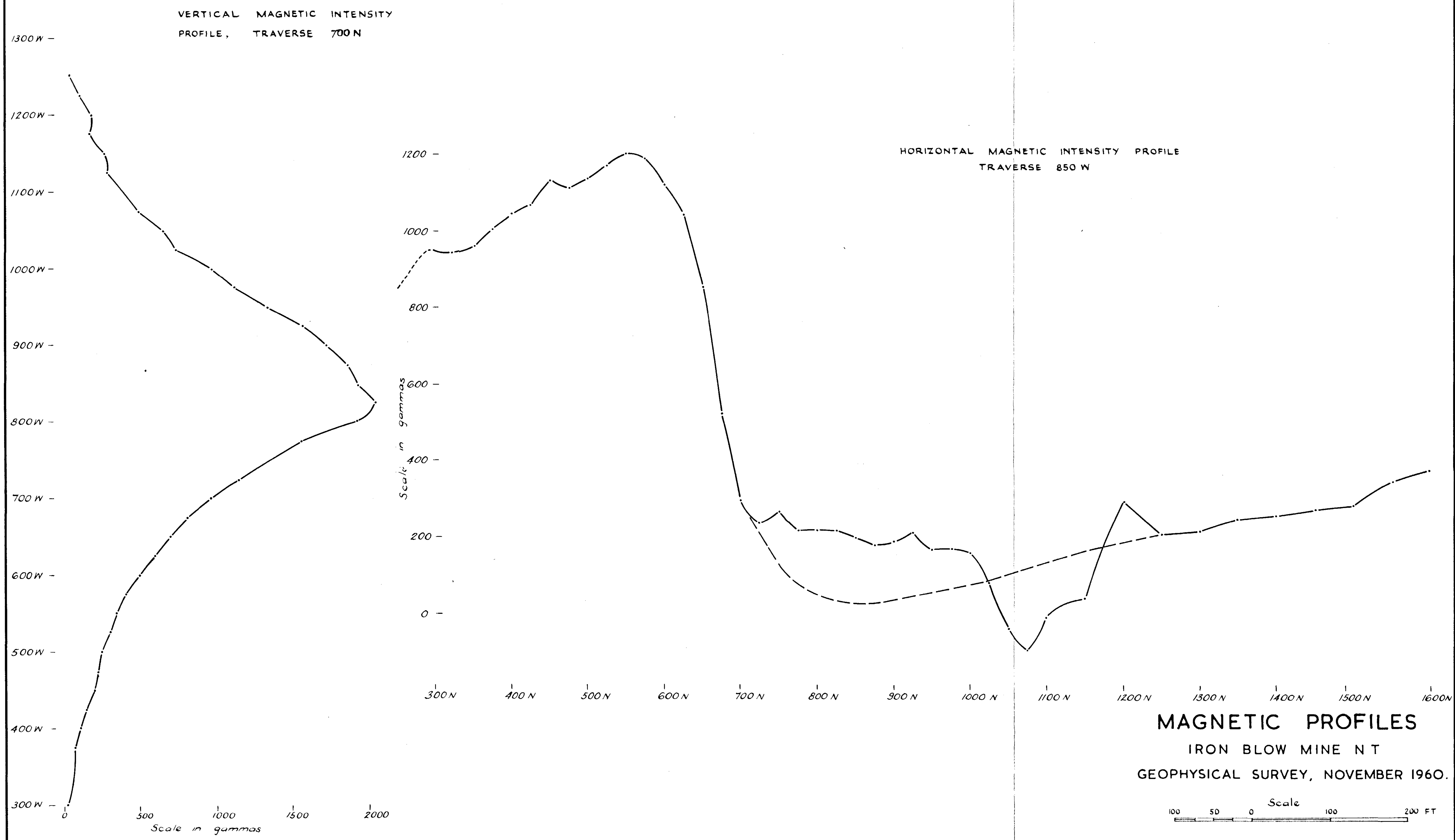
D52/B7-5

TO ACCOMPANY RECORD No. 1962/184

PLATE 6



MAGNETIC PROFILES

IRON BLOW MINE N T

GEOPHYSICAL SURVEY, NOVEMBER 1960.

Scale

100 50 0 100 200 FT

GAMMAS

500 250 0 500 1000

200 100 0 200 400

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Darwin February 1961

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TO ACCOMPANY RECORD No. 1962/184