DEPARTMENT OF NATIONAL RESOURCES

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

Record 1977/28

TENNANT CREEK GROUND GEOPHYSICAL SURVEY NORTHERN TERRITORY, 1969

by

J.P. Williams, I.G. Hone, P.J. Gillespie,
E.C.E. Sedmik and J.E.F. Gardener

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SUMMARY

The Bureau of Mineral Resources (BMR) made ground geophysical surveys in the Tennant Creek area from May to July, 1969, to investigate anomalies detected previously by BMR aeromagnetic surveys in the Aeromagnetic Ridge area and in Area A. A traverse of the 1958 BMR ground magnetic survey in BMR Area No. 3 was reoccupied and extended to compare results with the results from the other areas surveyed.

Magnetic, geological and drilling results indicate that most of the magnetic anomalies in the areas surveyed are due to magnetite-bearing Warramunga Group rocks. Some anomalies, however, are shown to be associated with ironstone lodes.

Recommendations for six diamond-drill holes were made to the Mines Branch, Northern Territory Administration, in August, 1970. Two of these holes have been drilled. The drilling recommendations have been reviewed and recommendations are made for more detailed surveys before further drilling for ironstone bodies is undertaken.

Gravity surveys were made along five traverses in the Aeromagnetic Ridge area and along one traverse in BMR Area No. 3. The profiles are too complex for quantitative interpretation.

1. INTRODUCTION

The Bureau of Mineral Resources (BMR) made ground geophysical surveys in the Tennant Creek area, N.T. from May to July 1969 to investigate anomalies detected by BMR airborne surveys in the Aeromagnetic Ridge area (Milsom & Finney, 1965) and in Area A (Shelley & Browne-Cooper, 1967). Ground surveys were also made along a traverse over the Comet anomaly south of the Aeromagnetic Ridge area, and a traverse of the 1958 BMR ground magnetic survey in BMR Area No. 3 (O'Connor & Daly, 1962) was reoccupied and extended to compare results with those from the Aeromagnetic Ridge area. The areas surveyed and their locations in relation to other survey areas are shown in Plate 1. The Aeromagnetic Ridge survey area and Area A were in Government Reserves. The traverse surveyed in BMR Area No. 3 was in an Authority to Prospect held by Australian Development No Liability.

Geophysicists who took part in the survey were J.P. Williams (party leader from 1 May to 30 June), E.C.E. Sedmik (party leader from 1 July to 31 July) and I.K. Godfrey. The surveying was commenced by W. Knowles of the Department of the Interior, and continued from 16 June by D. England from T.S. McKeown, Sydney.

Interpretation of results was by J.P. Williams, I.G. Hone and P.J. Gillespie. The drilling recommendations were made by E.C.E. Sedmik.

2. GEOLOGY

Most of the Tennant Creek area is underlain by shale, siltstone, and greywacke of the Warramunga Group (Lower Proterozoic) which have undergone moderate to severe folding and shearing. These sediments have been intruded by several varieties of granite, adamellite, and quartz-feldspar porphyry and also by quartz-magnetite and quartz-hematite lodes, jasper lenses, quartz reefs, and by diorite, dolerite, and lamprophyre dykes. The gold and sulphide orebodies in the area are confined to the Warramunga Group, and their distribution is influenced by structure and lithology. Most of the known occurrences are closely associated with quartz-magnetite and quartz-hematite lodes, but major shear zones with only minor ironstones may also be important loci for mineralization. The ironstones and the gold and sulphide orebodies are thought to be genetically related to the quartz-feldspar porphyry intrusions (Crohn & Oldershaw, 1965).

The Aeromagnetic Ridge area and Area A are underlain by Warramunga Group sediments. BMR Area No. 3 is thought to be underlain by metamorphosed equivalents of Warramunga Group sediments.

3. GEOPHYSICAL METHODS

All traverses were surveyed using a McPhar M700 vertical field fluxgate magnetometer. Traverses on which anomalies considered to be possible drilling targets were found were resurveyed using the M700 with a horizontal field fluxgate magnetometer attachment to obtain additional information, and an ABEM vertical field torsion magnetometer to obtain greater precision. Station spacing was 100 ft on all traverses. The field and computation procedures used were the same as those used by Haigh in the 1967 Tennant Creek survey (Haigh, 1969).

Gravity readings were made on five traverses in the Aeromagnetic Ridge area and on the traverse surveyed in BMR Area No. 3. The instrument used was Sharpe No. 145. For the calculation of Bouguer anomalies, 2.6 g/cm^3 was used as an average rock density which was the same value as used in 1967. The field and computation procedures were also those used in 1967 and described by Haigh (1969).

The methods of interpretation of magnetic results are described by Haig (1969) and involved the comparison of field profiles with standard curves for infinite dykes (Gay, 1963), finite dykes (Haigh & Smith, 1975) and spheres (Haigh, 1972).

4. RESULTS - AEROMAGNETIC RIDGE AREA

The traverses surveyed in this area are shown in Plate 2 superimposed on the total magnetic intensity contours from the 1964 airborne survey (Milsom & Finney, 1965). The anomalies selected for detailed investigation are shown in Plate 2 as AR1 to AR13 and DW1 to DW3. All traverses were surveyed with magnetics and traverses 2000 E, 3200 E, 4400 E, 9600 E and 12 700 E were surveyed with gravity.

TABLE 1

RECOMMENDED DIAMOND-DRILL HOLES

Hole	Anomaly	Position of target	Depth of target	Position of collar	Inclination	Direction	Approx. length of hole	Suspected source
DDH 14	AR2	7000W/5050N	600 ft	7000W/4700N	-60°	Grid N	800 ft	Ironstone
DDH 15	AR12	24000E/3900N	700 ft	24000E/4300N	-60°	Grid S	1000 ft	"
DDH 16	AR6	3200E/700N	1800 ft	3200E/350S	-60°	Grid N	2400 ft	"
DDH 17	A5	600W/650N	650 ft	600W/1200N	-50°	Grid S	1000 ft	"
DDH 18	A5	800W/720N	700 ft	800W/315N	-60°	Grid N	1000 ft	"
DDH 19	Comet	12700E/3750S	700 ft	12700E/3080S	-45°	Grid S	1000 ft	"

Note: DDH 14 and DDH 17 have been drilled (see Appendix).

The majority of magnetic profiles were too complex for quantitative interpretation. Consequently Plate 3 only shows the magnetic results where the fit between theoretical and field curves is satisfactory. In each case the thick infinite dyke model (Gay, 1963) gave the most satisfactory curve fit and was the most realistic geological model. The gravity survey results are shown in Plate 4.

Magnetic results

Anomaly AR2. The vertical and horizontal magnetic field curves on Traverse 7000 W were used for interpretation. The relatively narrow, near-surface source of the anomaly indicates the possible presence of an ironstone body. A drill hole as shown in Plate 3 and Table 1 was recommended to investigate the source of the anomaly and was subsequently drilled (see Appendix for drilling results). The results of the drilling indicate that the source of the magnetic anomaly AR2 is disseminated magnetite in Warramunga Group sediments. However a small ironstone lode was intercepted at depth.

Anomaly AR6. This anomaly strikes at about 60° and a local grid was pegged with traverses at 330°. Difficulty was experienced in finding a reasonable fit to the profiles. The best fit obtained was for the vertical field curve on Traverse 3200 E (local grid) as shown in Plate 3. A drill hole (Plate 3 and Table 1) has been recommended to investigate the source of the anomaly. The anomaly is about 1 km east of the Burnt Shirt area and may be due to an ironstone body similar to those previously located in the Burnt Shirt area.

Anomaly DW1. The vertical and horizontal magnetic field curves on Traverse 9600 E were used for interpretation. The wide deep body interpreted as the source (Plate 3) cannot be an ironstone lode. Diamond drilling in 1967 by the Mines Branch, Northern Territory Administration, showed that the source of anomaly AR9, about 3 km east of DW1, is disseminated magnetite in Warramunga Group rocks, and the source of DW1 is also likely to be disseminated magnetite.

Anomaly AR13. This is a small irregular anomaly north of anomaly DW1, at about 6000 N on Traverse 9600 E (Plate 3). No satisfactory interpretation was obtained for this anomaly.

Anomaly AR12. This is a low-amplitude anomaly from which a complex residual due to the main Aeromagnetic Ridge anomaly was removed. The anomaly is probably caused by an irregular body. However, the vertical magnetic profile has been interpreted to be due to a relatively thin body dipping north as shown in Plate 3. This narrow anomaly may be due to an ironstone body, and a drill hole as shown in Plate 3 and Table 1 has been recommended to investigate the source.

Anomaly AR11. This anomaly was interpreted to be caused by a steeply dipping wide body of low susceptibility as shown in Plate 3. The anomaly source is probably disseminated magnetite in the country rock and similar to the source of AR9.

Anomaly DW2. The vertical and horizontal magnetic field profiles on Traverse 4400 E were interpreted as shown in Plate 3 to give a wide body dipping south. The anomaly source is considered to be disseminated magnetite in the country rock and similar to the source of AR9.

Anomaly AR4 and Anomaly AR9. These two anomalies (Plate 2) were drilled by Mines Branch, Northern Territory Administration, in 1968 and 1967 respectively, following a ground magnetic survey made in 1967 by the Mines Branch. Hence no quantitative interpretation of the 1969 magnetic survey results was made.

The drill hole at anomaly AR4 (referred to as anomaly No. 6 by Mines Branch) was designed to intersect an ironstone body at a downhole depth of 340 ft. The whole length of the drill hole (840 ft) was in a shale/greywacke sequence of the Warramunga Group. There was a small, quartz-hematite vein at 520 ft. The base of oxidation was 200 ft (Willis, 1972).

The drill hole at anomaly AR9 (anomaly No. 13 of Mines Branch) was designed to intersect the anomaly source at 900 ft below the surface. The hole was drilled to 942 ft at 80°. Rocks intersected consisted of an interbedded sequence of slate and greywacke of the Warramunga Group. Disseminated magnetite was present from 350 ft to the bottom of the hole (Willis, 1972).

Gravity results

The gravity results from the Aeromagnetic Ridge area are shown in Plate 4. The profiles show localized short-wavelength anomalies superimposed on a regional trend of values increasing to the south. The significance of this trend can only be determined from a regional gravity survey.

An interpretation of the gravity profiles with model dimensions indicated by the magnetic interpretations and density contrasts consistent with disseminated magnetite in country rock was precluded by the complexity of the gravity profiles and the strong regional gradient.

5. RESULTS - COMET ANOMALY

Prior to the 1969 survey, the Mines Branch, Northern Territory Administration, made a ground magnetic survey in 1966 in the area of the Comet anomaly (Plate 2) and drilled two diamond-drill holes in 1967. These two holes and the ironstone body, about 30 ft wide, intersected by them are shown in Plate 5.

The drilling results have been described by Tapp & Taube (1968) and summarized by Willis (1972). The holes intersected greywacke and shale of the Warramunga Group. An ironstone lode crops out as shown in Plate 5. The outcrop consists of crystalline hematite/martite with up to 50% quartz. The lode intersection in DDH 2 at a vertical depth of 250 ft is similar. The intersection in DDH 1 at a vertical depth of 450 ft consists chiefly of magnetite with up to 50% chlorite. Zones of shearing and alteration are apparent on either side of the lode intersections.

The diamond drilling shows that the magnetic anomaly is caused by a downward extension of the cropping out ironstone. The sediments are intensely weathered to about 200 ft and lightly oxidized to about 400 ft, but the depth at which the ironstone changes from mainly hematite to mainly magnetite is not known (Tapp & Taube, 1968, p. 41). The magnetic field profile obtained in the 1969 survey was interpreted to be due to a spherical body of radius 300 ft and depth to centre of 700 ft. This interpretation indicates that the lode continues downwards beneath the intersection in DDH 2, and a diamond-drill hole as shown in Plate 5 and Table 1 has been recommended to investigate the anomaly source at 700 ft depth.

The gravity profile over the Comet magnetic anomaly is shown in Plate 4. A model based on the narrow (30 ft) ironstone lode intersected by the drilling does not produce a profile compatible with the field profile. The profile in Plate 4 appears to be due to an irregular source much wider than the ironstone lode. It is possible that the low-amplitude short-wavelength anomaly at about 3800 S is due to the lode, but the profile is too complex for quantitative interpretation.

6. RESULTS - AREA A

Part of the aeromagnetic contour map from the 1967 survey (Shelley & Browne-Cooper, 1967) is shown in Plate 6 with the ground traverses superimposed.

Anomaly A3. Vertical and horizontal magnetic field readings were made but the profiles obtained were too complex for interpretation.

Anomaly A5. This anomaly was surveyed in 1967 but the traverses were not extended far enough south to give profiles suitable for quantitative interpretation. Traverse 600 W was extended and additional traverses were pegged. The resultant grid is shown in Plate 6. The profiles used for interpretation are shown in Plate 7. Anomaly A5 is interpreted to be due to a steeply-dipping, near-surface source. Two diamond-drill holes as shown in Plate 7 and Table 1 were recommended to investigate the source since it appeared to have the general form of an ironstone lode. One hole (DDH 17) was subsequently drilled to test this anomaly (see Appendix for drilling results). The results of the drilling indicate that the source of magnetic anomaly A5 is disseminated magnetite in Warramunga Group sediments.

7. RESULTS - BMR AREA NO. 3

Traverse 20 500 W of O'Connor & Daly (1962) was reoccupied and extended. The traverse location is shown in Plate 1.

Traverse 20 500 W passes through the centre of anomaly 1, Area 3, of O'Connor & Daly (1962). The anomaly is elliptical with the long axis in the direction of the main magnetic zone in the area. The anomaly was interpreted to be from a spherical body, 185 ft radius, centred at a depth of 535 ft below 4600 N on Traverse 20 500 W.

O'Connor & Daly (1962) recommended a diamond-drill hole to investigate the source of the anomaly, and DDH 161 was subsequently drilled by Australian Development No Liability. The results (Plate 8) showed that the anomaly is due to a sequence of magnetite-bearing rocks, mostly gneiss, which are probably metamorphosed Warramunga Group sediments. Plate 8 also shows the centre of the spherical body interpreted by O'Connor & Daly (1962) using the interpretation method described by Daly (1957).

The 1969 data are shown in Plate 9. Three interpretations using the 1969 and earlier data are shown in Plates 8 and 9. These are an infinite dyke dipping steeply south with the centre of its top face at 4670 N at a depth of 250 ft (Pl. 9) and a sphere and a thin finite dyke in the positions shown in Plate 8. The position of the magnetic rocks intersected by DDH 161 is compatible with each interpretation. The susceptibility of magnetic rocks from DDH 161 tested in the laboratory varies from about 0.0002 to 0.1 c.g.s. units compared with the susceptibility of 0.018 c.g.s. units assumed in the interpretation.

The gravity profile along Traverse 20 500 W (Plate 9) shows a change of slope at the position of the magnetic anomaly. It is not possible to determine the significance of this change of slope from this single traverse.

8. CONCLUSIONS AND RECOMMENDATIONS

Widespread magnetite-bearing rocks appear to be the sources of the majority of the magnetic anomalies in the areas surveyed.

Diamond drilling in the Aeromagnetic Ridge area has shown that anomaly AR9 is due to disseminated magnetite in rocks of the Warramunga Group. The large bodies interpreted to be the sources of anomalies AR6, AR11, DW1 and DW2 (Plate 3) are consistent with sources which are magnetite-bearing country rock, and it seems that most of the anomalies in the Aeromagnetic Ridge area are due to concentration of magnetite in the country rock. This conclusion is supported by the drilling of anomaly AR2 which intersected disseminated magnetite in Warramunga Group rocks as well as a narrow ironstone lode.

In Area A, anomaly A5 was considered to be due to an ironstone body, but diamond drilling (see Appendix) has since shown that it is due to magnetite concentrations in Warramunga Group sediments which probably occur as a roof pendant in a granitic complex.

In BMR Area No. 3 drilling has shown that the anomaly on Traverse 20 500 W is due to magnetite-bearing rocks which are the metamorphic equivalents of Warramunga Group sediments.

The gravity profiles are too complex and the traverse are too widely spaced for quantitative interpretation. A detailed gravity survey would be necessary on each magnetic anomaly to determine if an ironstone lode is present.

The diamond-drilling recommendations for the Aeromagnetic Ridge area and Area A in Table 1 were given to the Mines Branch, Northern Territory Administration, in August, 1970. Since then a large amount of geological data have become available and the recommendations made in 1970 need reviewing.

Anomaly AR6 was interpreted to be due to a wide body which is probably disseminated magnetite in country rock. Thus recommended hole DDH 16 is probably not warranted. However, the northwest corner of the Aeromagnetic Ridge area is known to contain ironstone bodies as shown by drilling at AR2 and the Burnt Shirt. Hence the area of anomaly AR6 could be considered for a more detailed survey than was made in 1969 with the objective of searching for anomalies due to hidden ironstone bodies.

Anomaly AR12 was interpreted to be due to a narrow shallow-dipping body which could possibly be an ironstone body. A more detailed survey than was made in 1969 could also be made in this area to reassess the anomaly before further consideration is given to drilling DDH 15.

DDH 17 at anomaly A5 in Area A showed the source of the anomaly to be concentrations of disseminated magnetite and no further drilling is warranted at A5.

DDH 19 was recommended to test for the continuation of the Comet ironstone lode at depth interpreted from magnetic data. On economic grounds this drilling does not now seem warranted.

9. REFERENCES

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APPENDIX

DIAMOND-DRILLING RESULTS

Aeromagnetic Ridge, Anomaly AR2

DDH 14 was sited at 7000W/4800N with depression 62° and direction grid north. Drilling started in September 1971 and finished in May 1972. The results are described by Willis (1972).

Porphyry was intersected from 42 ft to 151 ft and an interbedded greywacke-shale sequence belonging to the Warramunga Group was intersected from 151 ft to the total depth (950 ft). A quartz-magnetite lode was intersected between 816 ft and 851 ft at a vertical depth of 700 ft below 5250 N. The rocks adjacent to the lode are sheared and chloritic. Disseminated magnetite is present from 580 ft to 950 ft (Willis, 1972).

Correlation of the geological log of the hole and surface geology indicates the lode is almost vertical. The depth of oxidation is about 325 ft. The body interpreted from the magnetic results is not the narrow (35 ft intersection, 25 ft true thickness) lode intersected; the magnetic anomaly is considered to be due to disseminated magnetite in the Warramunga Group sediments.

The porphyry intersected in DDH 14 is probably part of a large body of porphyry underlying the area. Porphyry crops out 1200 ft south of the drill hole and half a mile to the west, and was also intersected in DDH 1 in the Burnt Shirt area (Willis, 1972).

Area A, Anomaly A5

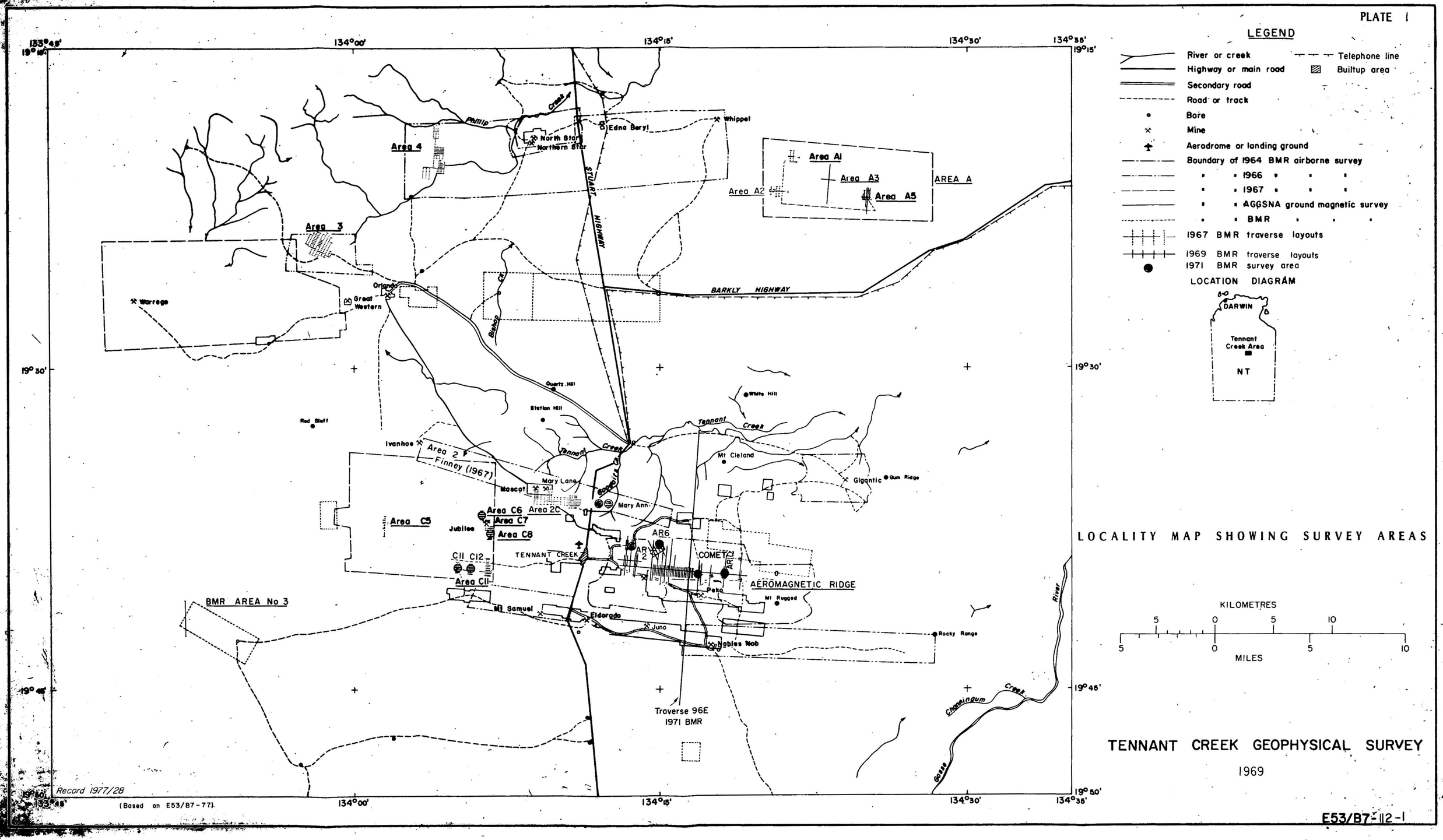
One diamond-drill hole designated DDH 17 was drilled as recommended at 600W/1200N with collar depressed 50° on a bearing of 180°. Length of the hole was 971 ft. Drilling started in August 1970 and finished in June 1971. The results are described by Daly (1971).

Above 247 ft, quartz-feldspar porphyry is the dominant rock, and intrudes fine-grained sandstone of the Warramunga Group. From 247 ft to the end of the hole at 971 ft, the entire sequence consists of sandstone which has been recrystallized; the rocks are highly magnetic with 5% to 15% magnetite. The magnetic anomaly is probably caused by magnetite disseminated throughout a large sequence of recrystallized and metasomatized sedimentary rocks of the Warramunga Group.

Part of the Tennant Creek Granite Complex probably occurs in close proximity. The closest outcrop is approximately 4 miles to the west of anomaly A5. However, the aeromagnetic pattern indicates that granite probably occurs close to the surface about 3 miles west of anomaly A5 and possibly 1½ to 2 miles north of anomaly A5.

The diamond-drilling results are in accord with the suggestion that the ridge of high magnetic values in Area A is due to magnetite concentrations in a roof pendant of Warramunga Group sediments within the Tennant Creek Granite Complex (Daly, 1971).

PLATE I

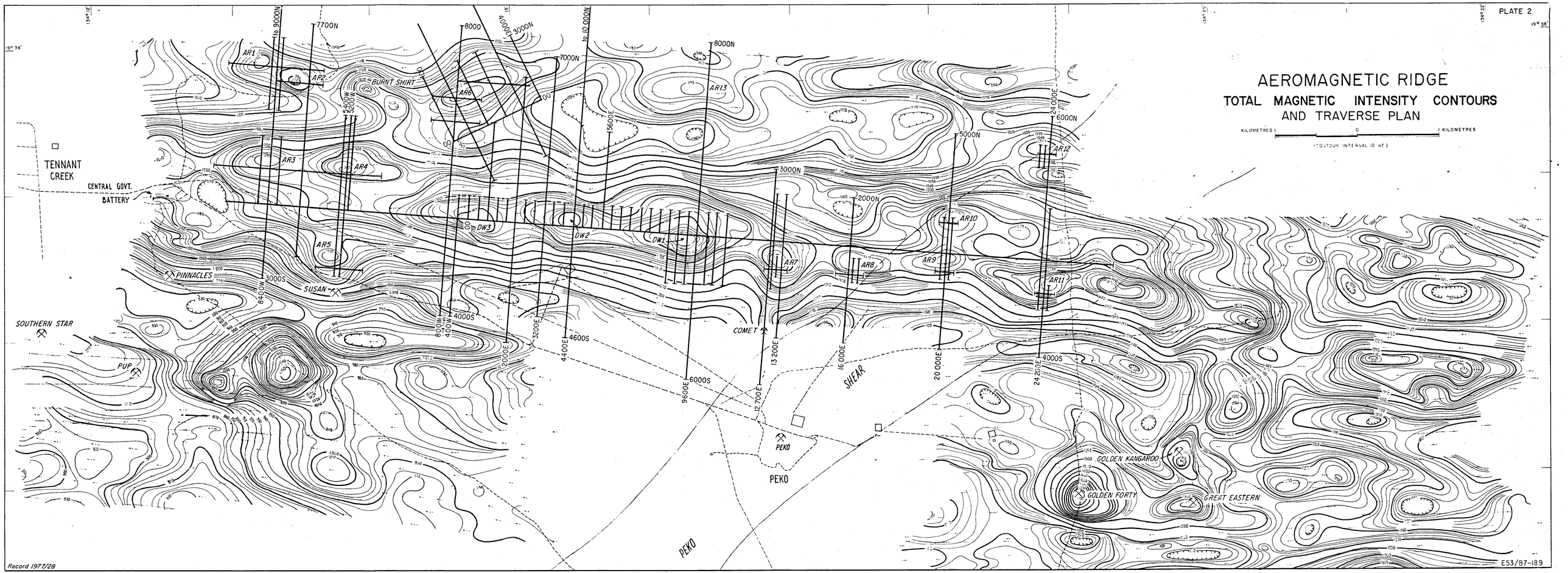

LEGEND
River or creek
Telephone line
Highway or main road
Builtup area
Secondary road
Road or track
Bore
Mine
Aerodrome or landing ground
Boundary of 1964 BMR airborne survey
1966
1967
AGGSNA ground magnetic survey
BMR
1967 BMR traverse layouts
1969 BMR traverse layouts
1971 BMR survey area
LOCATION DIAGRAM
DARWIN
Tennant Creek Area
NT
LOCALITY MAP SHOWING SURVEY AREAS
KILOMETRES
MILES
TENNANT CREEK GEOPHYSICAL SURVEY
1969
133°45'
134°00'
134°15'
134°30'
134°35'
19°15'
19°30'
19°45'
19°50'
Area 4
Area 3
Area A1
Area A2
Area A3
Area A5
AREA A
Area 2
Finney (1967)
Area C5
Area C6
Area 2C
Area C7
Area C8
Area C11
C11 C12
BMR AREA No 3
Phillip Creek
North Star
Northern Star
Edna Beryl
Whippet
STUART HIGHWAY
BARKLY HIGHWAY
Warrego
Orlando
Great Western
Bishop Pt
Quartz Hill
Station Hill
Red Bluff
Ivanhoe
Tennant Creek
Mt Cleland
White Hill
Gigantic
Gum Ridge
Mascot
Mary Lane
Mary Ann
Jubilee
TENNANT CREEK
AR6
AR2
AR1
COMET
Peko
AEROMAGNETIC RIDGE
Mt Rugged
Mt Samuel
Eldorado
Juno
Nobles Nob
Rocky Range
Traverse 96E
1971 BMR
Chomingum Creek
Gosse River
Record 1977/28
(Based on E53/B7-77)
E53/B7-12-1

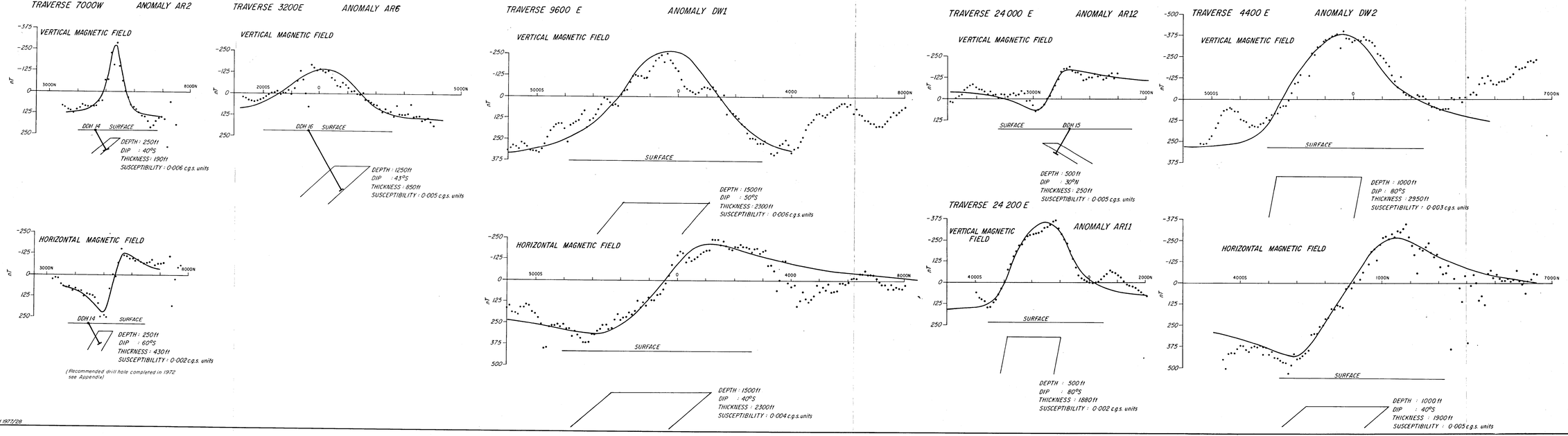
AEROMAGNETIC RIDGE

TOTAL MAGNETIC INTENSITY CONTOURS AND TRAVERSE PLAN

KILOMETRES 1 0 1 KILOMETRES

(CONTOUR INTERVAL 10 nT)





LEGEND

- • FIELD DATA
- THEORETICAL CURVE FOR A THICK INFINITE DYKE
- DDH RECOMMENDED DIAMOND-DRILL HOLE
- INTERPRETED BODY

NOTE : Magnetic values are based on arbitrary datum

AEROMAGNETIC RIDGE
MAGNETIC PROFILES AND INTERPRETATION

E53/B7-190

Record 1977/28

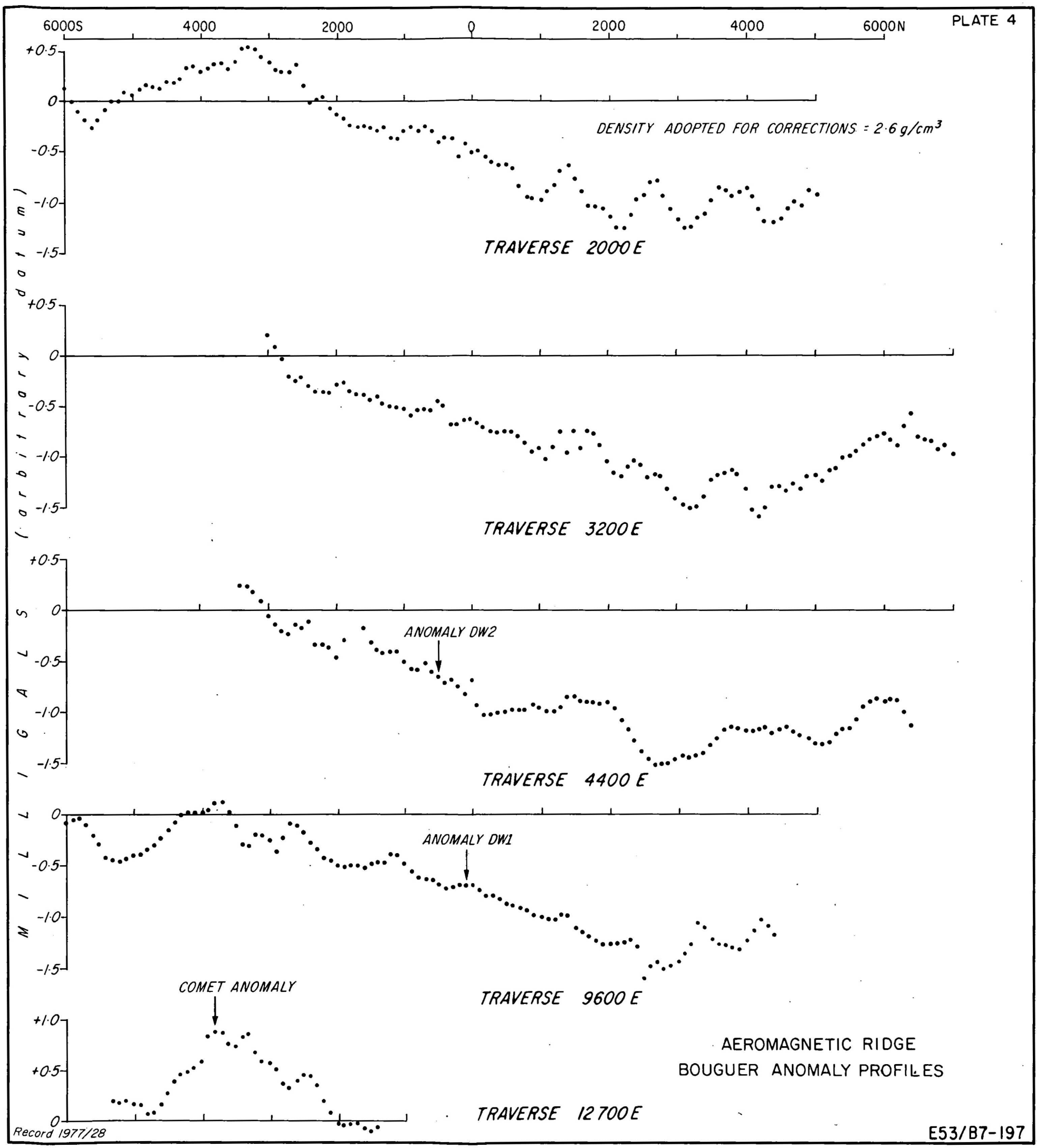
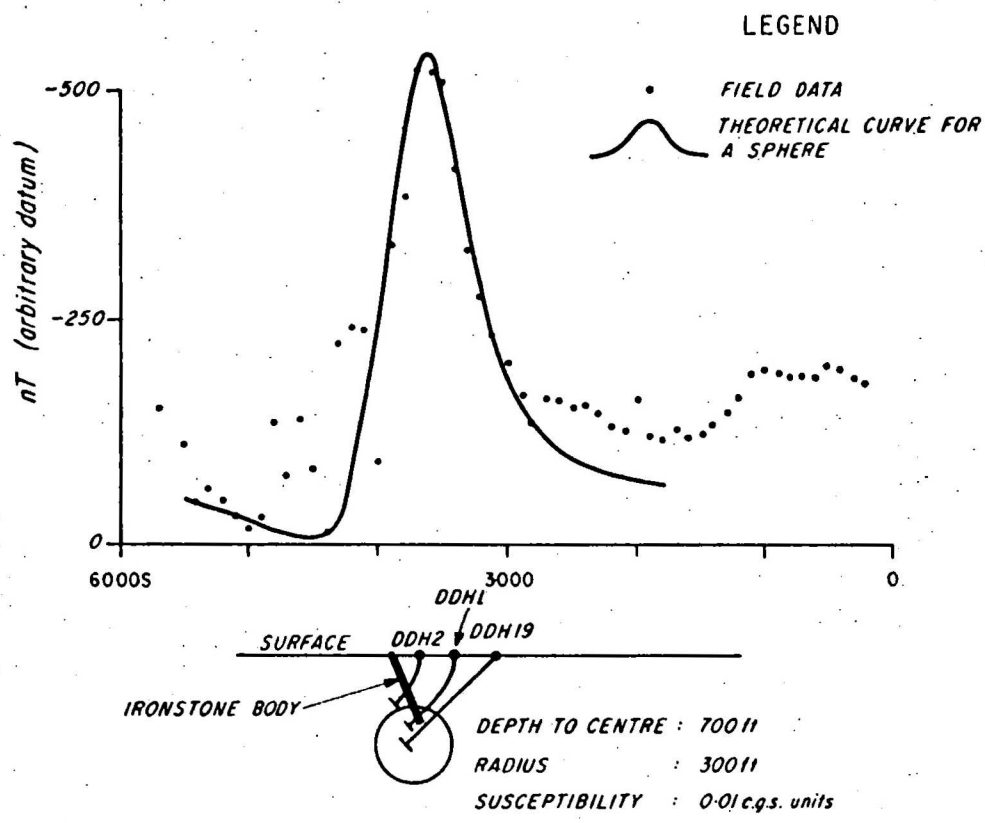


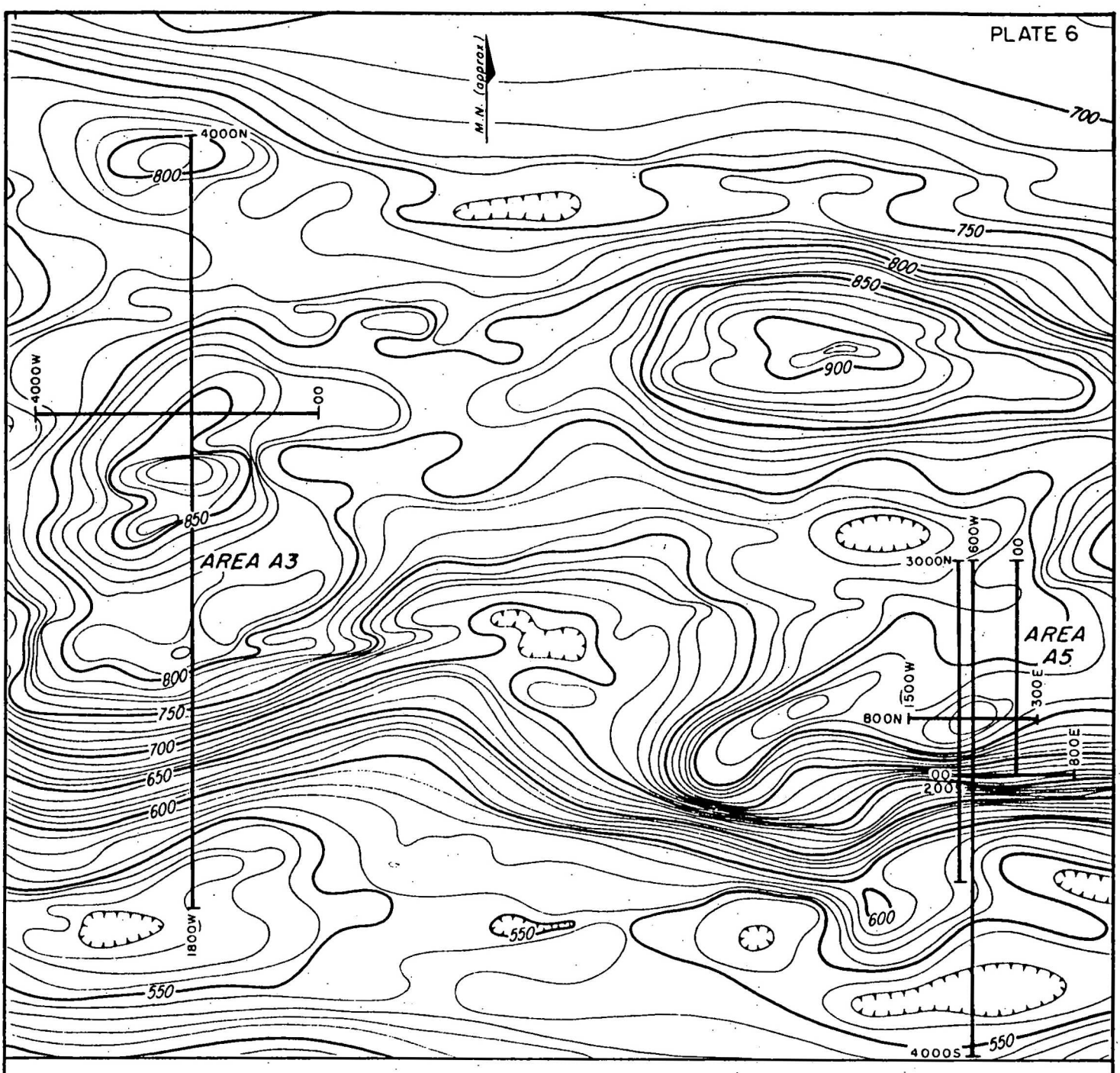
PLATE 4
6000S
4000
2000
0
2000
4000
6000N
+0·5
0
-0·5
-1·0
-1·5
MILLIGALS (arbitrary datum)
DENSITY ADOPTED FOR CORRECTIONS = 2·6 g/cm³
TRAVERSE 2000 E
TRAVERSE 3200 E
ANOMALY DW2
TRAVERSE 4400 E
ANOMALY DW1
TRAVERSE 9600 E
COMET ANOMALY
+1·0
TRAVERSE 12700 E
AEROMAGNETIC RIDGE
BOUGUER ANOMALY PROFILES
Record 1977/28
E53/B7-197



DDH 1,2 DIAMOND-DRILL HOLES

DDH 19 RECOMMENDED DIAMOND-DRILL HOLE

COMET PROSPECT TRAVERSE 12 700E
VERTICAL MAGNETIC PROFILE, INTERPRETATION,
AND DRILLING RESULTS



METRES

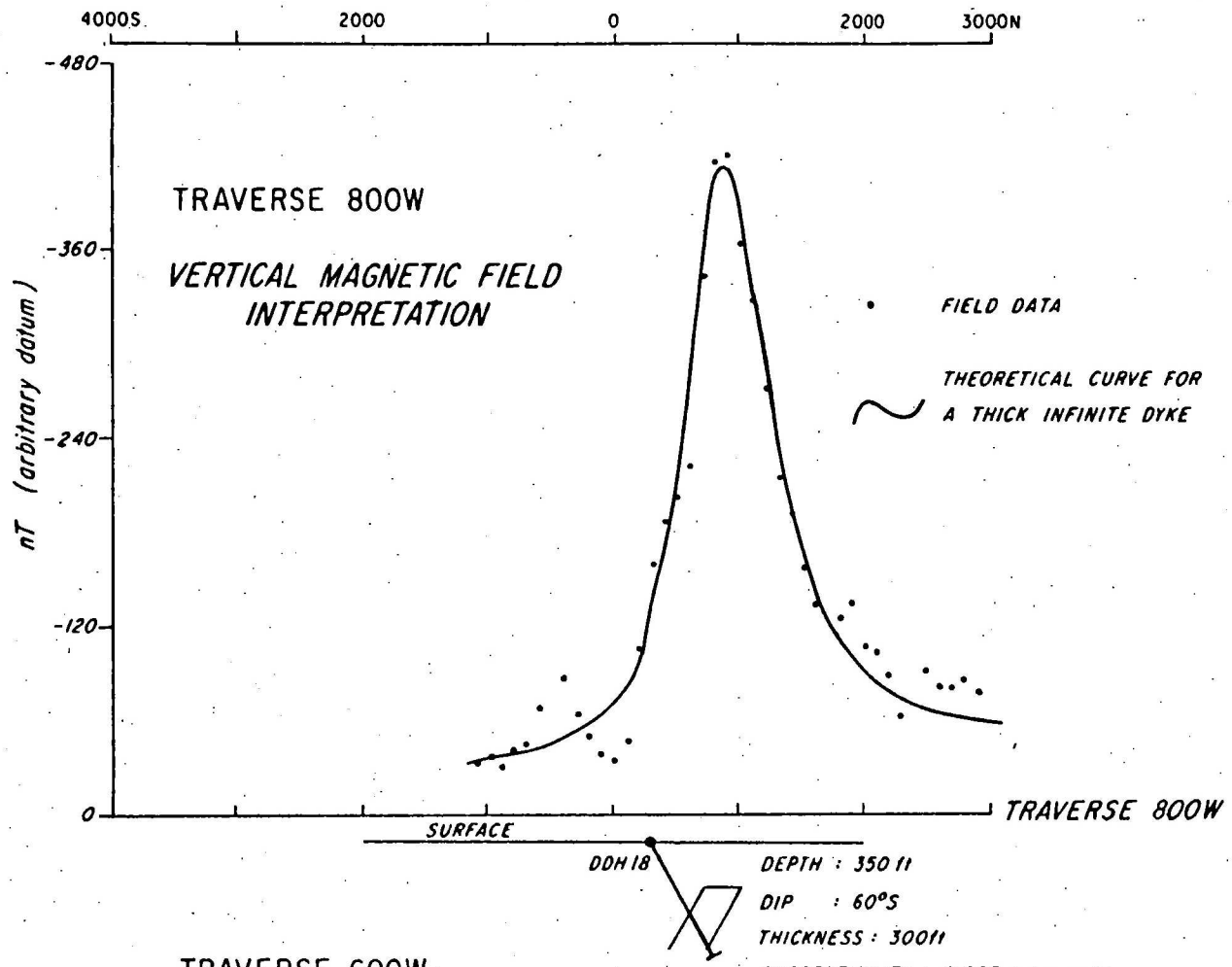
500 0 500 1000 1500

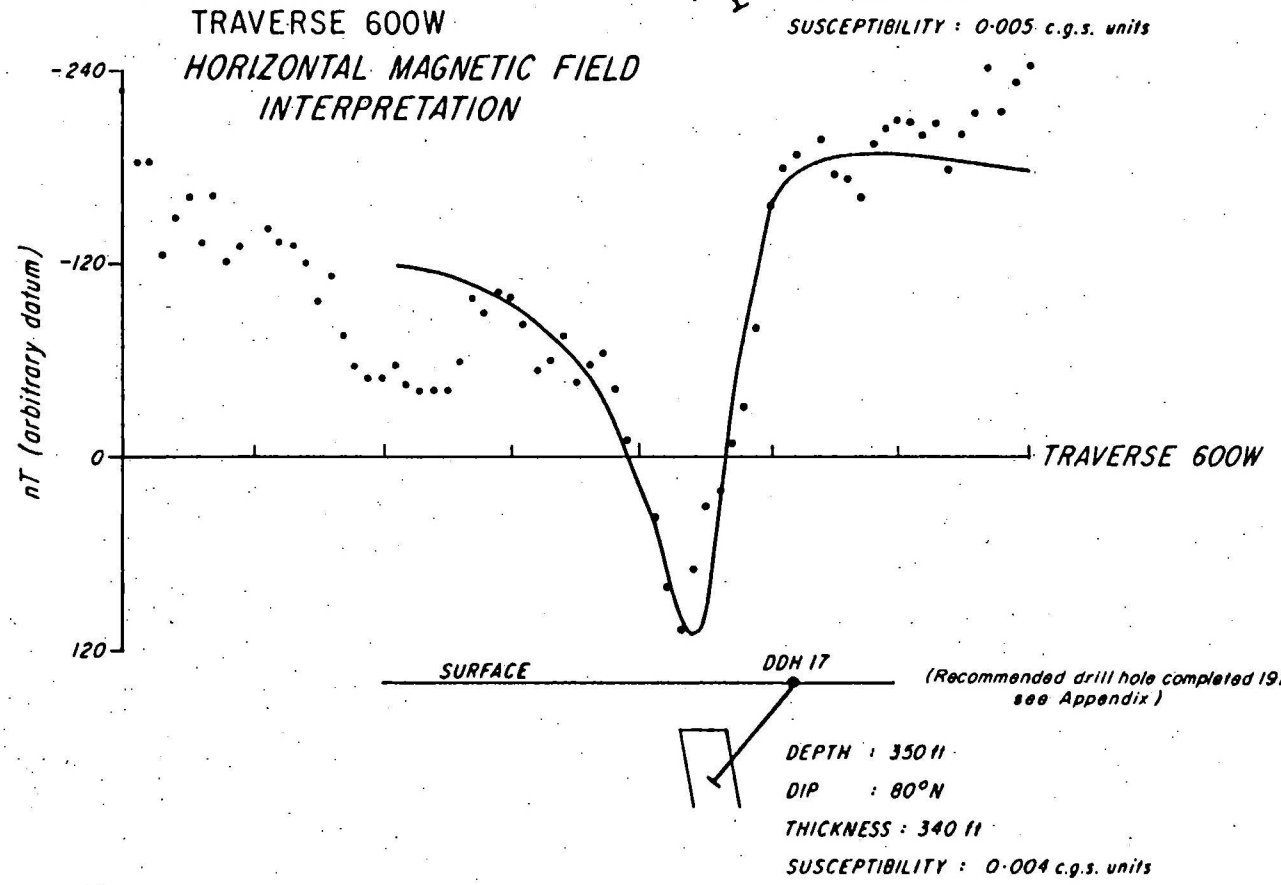
CONTOUR INTERVAL 10nT

AREA A

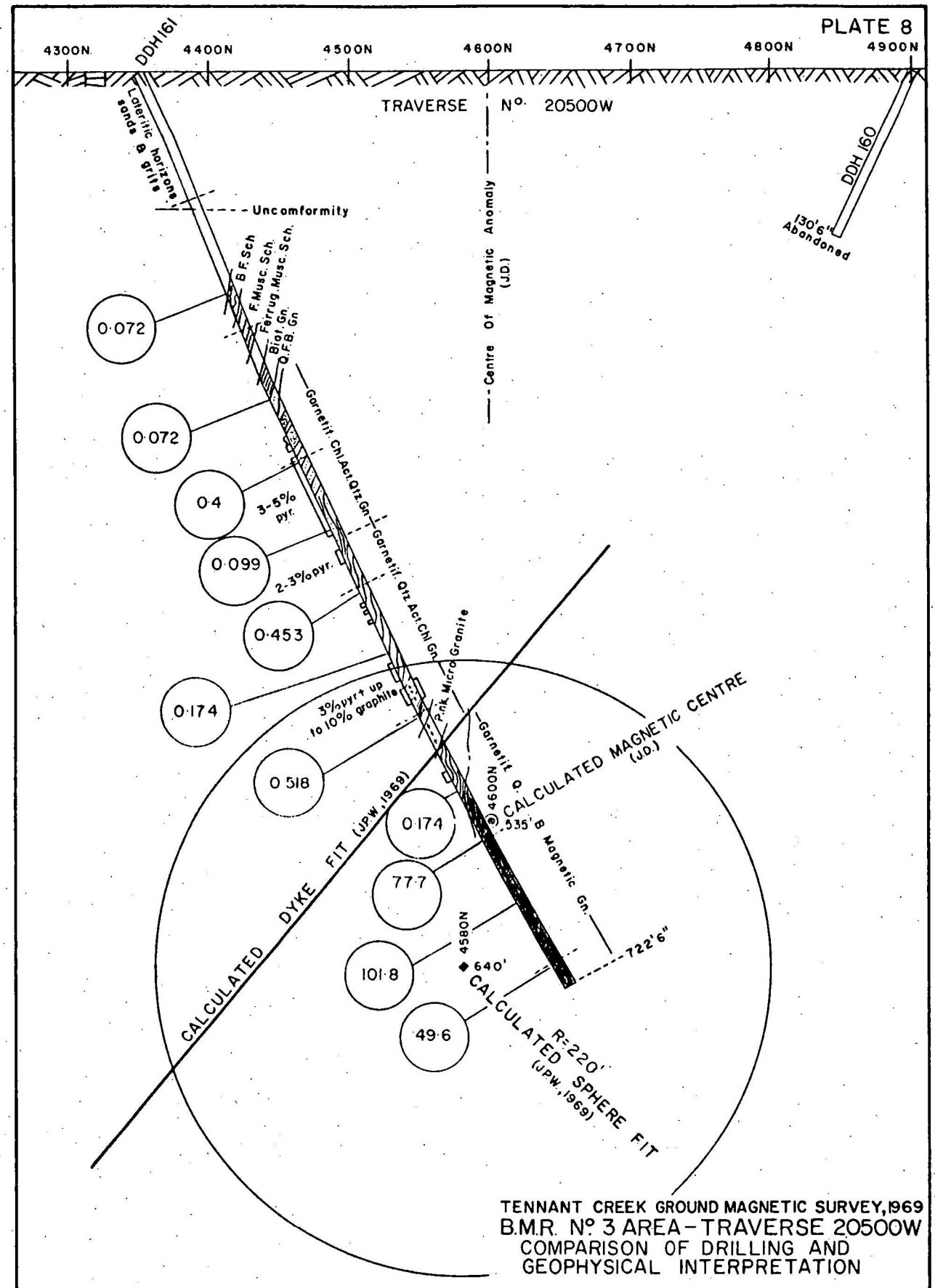
TOTAL MAGNETIC INTENSITY CONTOURS

AND TRAVERSE PLAN





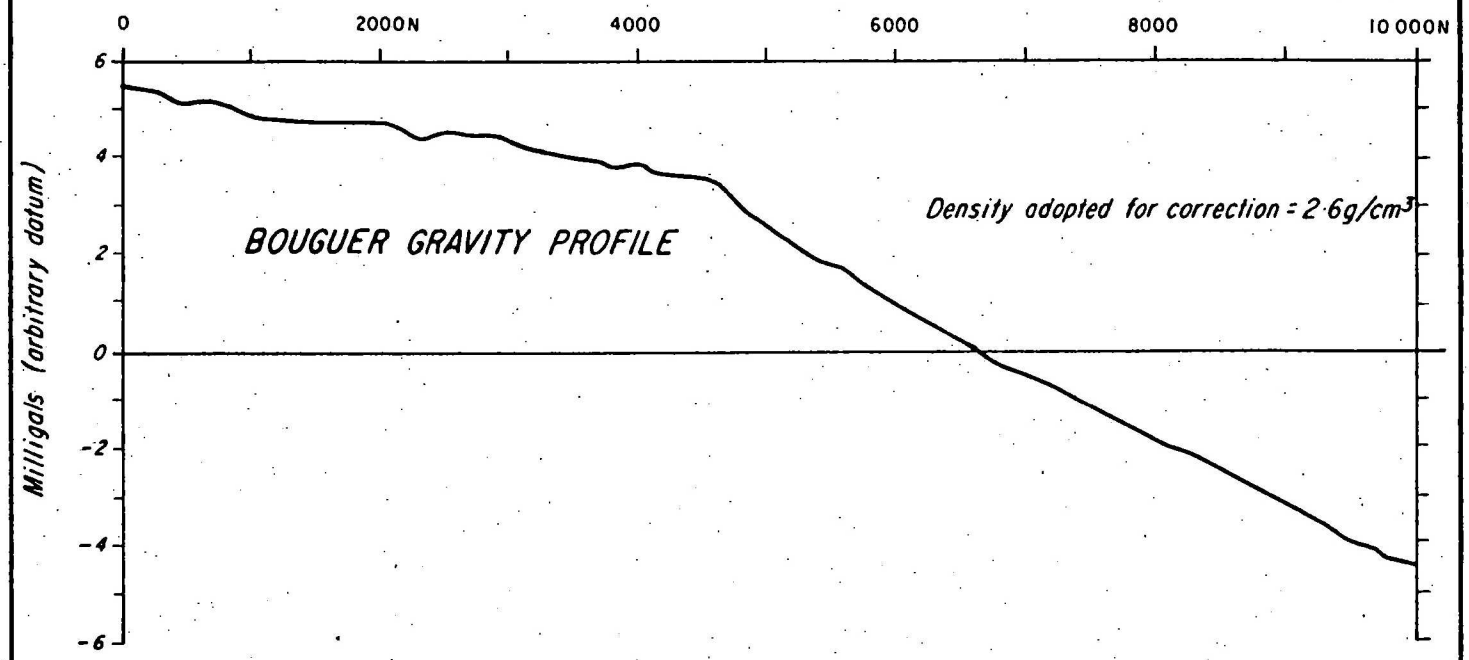
AREA A — ANOMALY 5
MAGNETIC PROFILES AND INTERPRETATION

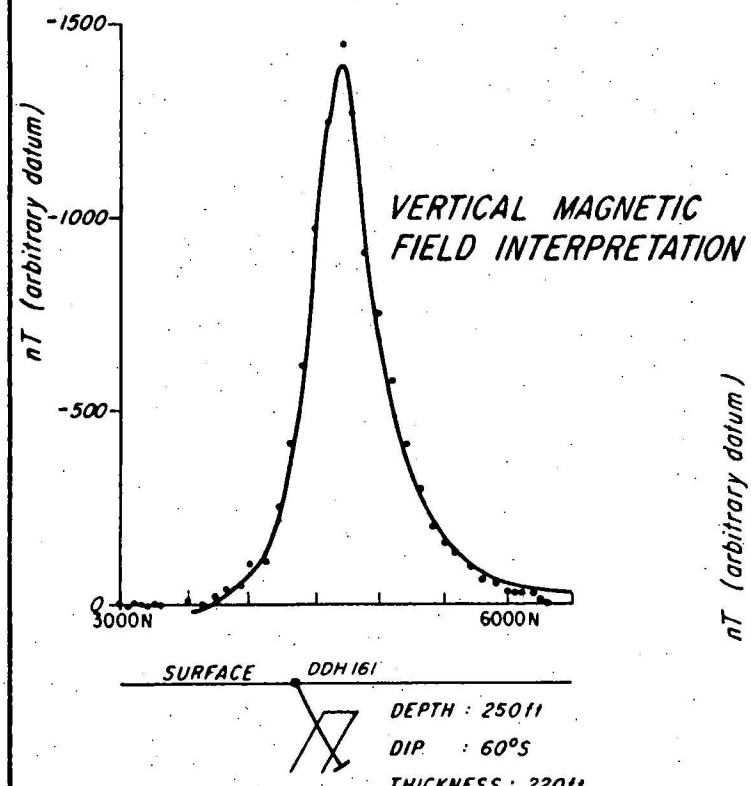


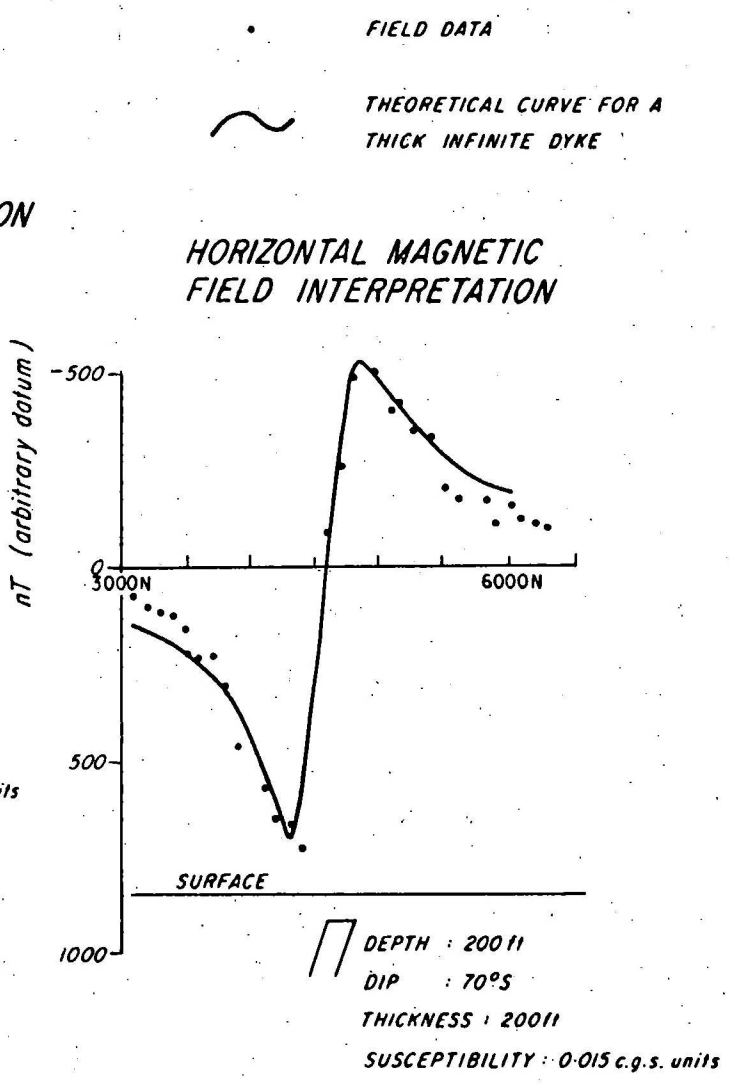
TENNANT CREEK GROUND MAGNETIC SURVEY, 1969
B.M.R. No. 3 AREA – TRAVERSE 20500W
COMPARISON OF DRILLING AND GEOPHYSICAL INTERPRETATION

MAGNETIC SUSCEPTIBILTY VALUES in 10^{-3} c.g.s units

SCALE: 100 FEET TO AN INCH







BMR AREA N°3 — TRAVERSE 20500W
GRAVITY PROFILE AND MAGNETIC PROFILES