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Record No. 1970 / 1

Geophysical Investigation of the eastern margin of the Rum Jungle Complex, Northern Territory 1967

by

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CONTENTS

ILLUSTRATIONS

SUMMARY

A gravity survey supplemented by ground magnetic and radiometric work was conducted in an area east of Rum Jungle to study the behaviour of the contact between the Rum Jungle Complex and the surrounding metasediments.

The Rum Jungle Complex is related to a large gravity low. The contact between the Complex and the metasediments appears to dip to the east at about 20 degrees. In this area the sediments above the Complex have a thickness of the order of 1500 metres.

A gravity high near the Complex/metasediment contact appears to be due to a non-magnetic amphibolite.

1. INTRODUCTION

In 1967 the Geophysical Branch of the Bureau of Mineral Resources (BMR) conducted a gravity survey over part of the eastern portion of the Rum Jungle Complex and the Rum Jungle East area near Batchelor, Northern Territory. The location of traverses is shown in Plate 1. The aim of the survey was to investigate the granite/metasediment contact at depth.

The gravity field work was carried out from 16 August to 4 November by J.P. Williams (geophysicist) and C. Braybrook (geophysical assistant). Most of the traverses were pegged and levelled by licensed surveyors Timbs and Britten under contract to the Department of the Interior, but some surveying was also carried out by the gravity party (see Appendix 1). Two traverses were also surveyed in the L3 area to determine whether the gravity results could aid interpretation of existing geophysical data.

One hundred and fifty hand specimens were collected for density determinations (see Chapter 4) and, in addition, some follow-up ground magnetic and radiometric work was undertaken. Details of geochemical work conducted by BMR in the area near the granite complex are given in Appendix 3.

2. GEOLOGY

The area considered in this Record extends from the eastern margin of the Rum Jungle granite to the Stuart Highway and is bounded by Coomalie Creek to the south and the old Woodcutters Track to the north. Apart from some Cainozoic deposits, the rocks are all Precambrian. Interest in the Rum Jungle area is due mainly to deposits of uranium ores and certain base metals found in one of the Proterozoic formations (the Golden Dyke Formation).

The regional geology of the area is shown in Plate 1. The detailed map (Plate 3) is based on the work of Dodson and Shatwell (1965), Semple (1968), South (1967), and the writer. Plate 2 illustrates the division of the Rum Jungle granite into the units recognised by Rhodes (1965).

The general geology of the area has been described by Williams (1963), Dodson and Shatwell (1965), Rhodes (1965) and Semple (1968). The following description is based largely on these sources, but, in places, is supplemented by the writer's observations.

Rhodes (1965) states that the Rum Jungle Complex consists of at least six major rock units which he describes in detail. Listed in order of decreasing age these are: schists and gneisses, granite gneiss, metadiorite, coarse granite, large feldspar granite, and leucocratic granite (Plate 2). The leucocratic granite is obviously intrusive into all members of the Complex, but no member of the Complex intruded the metasediments (Rhodes, op. cit., p.9).

The oldest rocks in the area covered by the present investigation are probably the banded ironstones (referred to as B.I.F.). These appear as small outcrops, apparently resting on the Rum Jungle Complex; and occasionally as inclusions in the Complex. It is possible that the B.I.F. belongs to the schist and gneiss unit.

The metasediments occurring in the survey area are, in order of decreasing age:

1. Beestons Formation
2. Celia Dolomite
3. Crater Formation
4. Coomalie Dolomite
5. Golden Dyke Formation

5a. Acacia Gap Tongue

In general most members of the formations crop out in the survey area, but exposures are poor and it is not possible to determine the relative importance of some of the rock types.

The major outcrop of the Beestons Formation lies between 124S/96W and 141S/108W and is about 800 feet across at its widest point (a T-shaped outcrop just north-east of this is shown as Beestons Formation in Plate 1, but is actually B.I.F.). It dips steeply to the south-east. This outcrop is mainly greywacke (with a coarse sandstone texture) and contains at least one bed of pebble conglomerate. There are numerous small outcrops of arkose which, as far as can be determined in hand specimen, have a mineral composition similar to the granite gneisses. In fact the main criterion for distinguishing between arkose and weathered granite and gneiss is the occasional presence of rounded pebbles in the arkose. A specimen of schist found at 169S/103W may be a siltstone of the Beestons Formation, but it was too weathered for definite identification.

The Celia Dolomite is represented only by small outcrops of silicified dolomite and dolomitic breccia, and is presumed to be lithologically similar to the Coomalie Dolomite.

Good exposures of the Crater Formation are found as erosion-resistant ridges. The most consistent members are quartz greywacke and fine pebble conglomerate. These are described by Semple (1968).

Semple (1968) has distinguished the Coomalie Dolomite from the Crater Formation by a quartzite bed called the Coomalie quartzite. Scattered outcrops of silicified dolomite and dolomitic breccia are also present. Most of the area mapped as Coomalie Dolomite is covered by recent deposits, but almost 300 feet of dolomite was intersected in DDH 67/11 in the L3 area.

The Golden Dyke Formation is of interest because in places it contains economic mineralisation near its contact with the Coomalie Dolomite. Exposure of this Formation is poor, but most of the dominant lithologies (grey shale, siltstone, and breccia) were observed in the field. Amphibolite is also present but was revealed only by auger drilling.

The Acacia Gap Tongue forms a prominent N-S ridge in the eastern half of the area (Plates 1 and 3), and represents the most resistant member of a N-S trending syncline. It consists mainly of pyritic sandstone, but a siltstone crops out at 28W on Traverses 72S and 120S (Plate 3) and apparently forms the core of the syncline.

Members of the Rum Jungle Complex and the younger sediments are intersected by numerous quartz-tourmaline veins; the source of these is not apparent.

Williams (1963) divides the structural history of the area into three main phases. The first stage was gentle folding of the Rum Jungle Complex and sediments and is evident only in the Coomalie Creek area. The second stage of folding was more intense and caused a marked uplift of the whole area. The axes of these two fold systems were approximately horizontal and at right angles (Williams, op. cit., p.54). The third phase of folding was about a vertical axis and completed the doming of the Complex. The Giants Reef Fault was a product of this folding.

Rhodes (1965) has likened this domed Complex to the mantled gneiss domes of Finland (Eskola, 1948), but states that the late kinematic leucocratic granite of Rum Jungle was emplaced before the metasediments were deposited. This means its intrusion could not have caused the uplift during the second phase of folding.

However, several problems exist and were brought to the writer's notice by the comments of field geologists who have recently worked in the area and from his own observations. Because they are largely untested opinions they are listed without references.

1. There is still some feeling that the Rum Jungle granite has, at least partly, been responsible for metamorphism and metasomatism in metasediments.

2. Assuming that Williams' (1963) structural theory is correct, there must be an upraised mass, presumably granitic, beneath the dome. According to Rhodes (1965) this cannot be the leucocratic granite, so another source must be found.

3. Some of the formations show considerable lensing so that apparently different formations may have been deposited at the same time.

4. Auger drilling during the 1967 field season revealed a mass of amphibolite (field name) in an area previously mapped as Rum Jungle Complex (undifferentiated) by Rhodes (1965). It completely surrounds the outcrops of Beestons greywacke (Plate 3). The airborne magnetic survey (Browne-Cooper, in prep.) suggests that this amphibolite is non-magnetic. The geochemical results are similar to those encountered in amphibolites of the Golden Dyke Formation in the Rum Jungle East area (Semple, pers. comm.) indicating that the amphibolite is probably derived from a sedimentary rock. A thin section revealed that the rock contains about 80 percent amphibole which in places shows minor chloritisation. Iron stained mica (possibly biotite) and quartz are the other major components. The amphiboles are frequently bent and the quartz shows strain effects. The quartz also reveals relict bedding. Accessory minerals are apatite and sphene. The rock is considered to be of sedimentary origin and although referred to as amphibolite in this report it is to be understood that the term implies a quartz biotite amphibole rock. Although the amphibolite is included in the Rum Jungle Complex (Plate 3) its relationship to the adjoining outcrop of Beestons Formation is not clear. A small outcrop of green (chloritic?) schist was found just south-west of the Beestons greywacke. It has near-vertical, north-trending foliation. If this schist is considered to be derived from a siltstone in the Beestons Formation, the relationship of the amphibolite, which resembles this schist, to the Beestons Formation would need careful study. There is a remote possibility that the amphibolite belongs to the Golden Dyke Formation, which would be of interest because of the additional possibilities for mineralisation.

It is obvious that the relationship of the Rum Jungle Complex to the metasediments is not straightforward. Drilling at Manton Dam (Rattigan, 1957) showed that the granite contact has a dip of 75° for the first 400 feet, but there is no information beyond this depth. It should be noted however that this dip is similar to the dip of the sediments near the contact, suggesting that the beds were folded with the granite.

3. DESCRIPTION OF THE GRAVITY METHOD

The gravity observations were made with a Sharpe gravity meter (No. 145). The gravity datum was bench mark 51 (Stuart Highway, BM 51) as in 1966 (Duckworth, Farrow & Gardener, 1968). The observed gravity value of BM 51 was taken as zero. The field observations were controlled by hourly drift checks. Individual sets of drift checks (normally of half a day's duration) were also tied to BM 51. A typical series of readings would be observed in the following order: BM 51, 40W, 41W,.......60W, 40W, 60W, 61W,.....80W, 60W, 81W........100W, 80W, BM51... In general the meter behaved satisfactorily, but occasional steep drifts, e.g. 0.5 milligals per hour, were encountered. In such cases the field readings were repeated.

After the drift corrections were made, the readings were converted to observed gravity values in milligals using the calibration constant of the meter, in this case 0.10651 milligals per scale division. The latitude corrections were made using a factor of 0.0108 milligals per hundred feet north and south of BM 51. The latitude of BM 51 was taken as 12° 56.5'.

Combined free-air and Bouguer corrections were applied to all stations. Initially a density value of 2.3 g/cm^3 was used for these reductions as in 1966, but the final results were computed for densities of 1.9, 2.0, 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.67, 2.9 g/cm^3. These results were obtained using a computing programme, METGRAV, developed in the Metalliferous Section of BMR.

Station interval along traverse was 100 feet for most of the area. Some of the 1966 gravity results are included in this report and were recomputed by the METGRAV programme. Survey details are listed in Appendix 1.

4. DISCUSSION OF DENSITY

A knowledge of the density of the rocks in the area is required if quantitative interpretation is to be attempted. One hundred and thirty-nine hand specimens were collected for density determinations in Canberra, and 231 specimens of drill core from the eastern part of the area (L5 area) were measured by the Darwin Uranium Group. The density of one auger chip sample of amphibolite was also measured. The results are presented in Appendixes 4 and 5

These density data were supplemented by analytical methods of density determination. Nettleton's method (Parasnis, 1962) involves the computation of Bouguer anomalies for several density values; the most suitable density value is that for which the Bouguer anomaly shows the least correlation with topography. On Traverse 168S (Plate 6) the profile for a density of 2.6 g/cm^3 shows the least relationship to the topographic high due to the Acacia Gap Tongue.

Another method involves the plotting of observed gravity values against elevation. The slope of the line gives a combined free-air and Bouguer correction from which the density can be deduced. This method gave a density value of 2.55 g/cm^3; it is really a variation of Nettleton's, but is more sensitive to small changes in topography. The limitations of these methods are discussed by Williams (1965).

The average dry density of the hand specimens was 2.52 g/cm^3 (Appendix 4)* The average value weighted according to the amount of each formation cropping out along the traverse (i.e. areal distribution) was 2.55 g/cm^3. These results suggest that a density of 2.5-2.6 g/cm^3 is most suitable for reduction of field data.

The density selected for reductions (2.6 g/cm^3) need not be the same as the mean formational densities which are required for detailed interpretation. It is not even necessary to have absolute densities; density contrasts relative to one formation in the area are sufficient. If the weathering in the area is uniform the contrasts from the dry densities (i.e. of weathered rock) would be sufficient. However, weathering does not appear to be uniform in this area. It may be argued that the wet density values would be preferred because of the proximity of the water table to the surface.

The best information on formational densities is usually obtained from measurements of diamond-drill cores of unweathered rock. Density determinations were made on slate and siltstone (Golden Dyke Formation) and dolomite (Coomalie Dolomite) from diamond drill holes in the L3 and L5 areas and on amphibolite core samples from Mount Fitch. The results (Appendix 5) suggest a density of 2.77 g/cm^3 for Golden Dyke Formation, 2.79 g/cm^3 for amphibolite, and 2.93 g/cm^3 for Coomalie Dolomite. These values (excluding amphibolite) are in good agreement with measurements made in the Embayment area (Langron, 1956).

It is obvious that one cannot give absolute values for all the formational densities from the data available. This problem is discussed further in the section in interpretation, but an accurate solution would be aided by more measurements of drill cores if these become available.

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* Excluding the B.I.F. specimens

5. INTERPRETATION OF RESULTS

The results are presented as Bouguer anomaly profiles for a density of 2.6 g/cm^3 (Plate 4) from which the contour map (Plate 5) has been drawn. The profiles show a general decrease in gravity values towards the west; ~~this is revealed more clearly by the contour map (Plate 5) has been drawn. The profiles show a general decrease in gravity values towards the west~~; this is revealed more clearly by the contour map. Between about 100W and the eastern boundary of the area there is a distinct NNE trend in the anomaly pattern. West of 100W the gravity values decrease with a SW trend except where this is obscured by the closed gravity high centered at 110W/150S.

The Bouguer anomaly profiles for 11 different densities for Traverse 168S are presented in Plate 6. The only noticeable difference in shape is over the ridge of the Acacia Gap Tongue. This set of profiles is representative of the area in so far as different density values affect the reductions.

Granitic masses are normally associated with gravity lows. Comparison of the gravity contour map (Plate 5) and the geological map (Plate 3) suggests that the low gravity values are related to the Rum Jungle Complex. This in turn suggests that the densities of surface samples (Appendix 4), which indicate that the Complex has a higher density than the sediments, are not representative of the respective lithologies at depth. This is borne out by the densities of borehole samples, which show that some sediments have much higher densities at depth. The smaller variations on the profiles appear to be related to near-surface effects such as differential weathering of the various rock types.

Because the magnitude of the gravity low assumed to be due to the Complex is large compared with the near-surface effects, these effects can be largely ignored in a study of the behaviour of the Complex/sediment contact. The problem resolves to a two-body case which assumes that the Complex and sediments have uniform but different densities. A further assumption is that the sediments can be approximated by a simple shape such as a wedge.

The behaviour of the Complex/sediment contact can now be studied by comparing theoretical gravity profiles due to various wedge-shaped masses with the observed gravity profiles. The theoretical cases that show the best agreement with the observed results and present a reasonable geological picture would be considered to provide the most likely explanation of the gravity results. Apart from the fact that there is no unique solution to any gravity profile the limitations of this technique are normally due to lack of geological control and density data on the various rock types. A study of the anomalies due to wedges of different kinds was undertaken with the aid of a BMR gravity integrator (type J02), with which the vertical gravitational effect of any two-dimensional body can be computed (Olbrich, 1966). This investigation will not be discussed in detail.

With the exception of amphibolite, surface samples of Rum Jungle Complex rocks show little variation in density (Appendix 4). Over the Complex the Bouguer anomaly profiles (Plate 4) generally show no variation in slope that could be due to variations in the Complex (an exception is the amphibolite on Traverses 120S and 168S.) There are variations in the Bouguer anomaly profiles over the different sediments, but as these are generally small the sediments can be treated as a single unit in a preliminary study of the Complex/sediment contact.

The next problem is to estimate the density contast between the Complex and the sediments. It is assumed that densities measured on drill cores give the best available information for unweathered rocks. There are no drill hole density measurements on Rum Jungle Complex rocks, but the denisty of fresh granite rarely exceeds 2.67 g/cm^3 and the density of most members of the Complex probably lies between 2.6 and 2.67 g/cm^3.

The drill core measurements from the Golden Dyke Formation (2.77 g/cm^3) and Coomalie Dolomite (2.93 g/cm^3) suggest density contrasts with the Complex of 0.10 and 0.26 g/cm^3 respectively. It appears likely that the density contrast between the Complex and the metasediments lies between these two values.

The behaviour of various wedges (representing sediments) was then studied with the integrator. The longest traverse, 120S, was chosen for the initial work. The results are shown in Plate 7. Wedges such as the one shown were computed for various density contrasts (0.1, 0.2, 0.25 g/cm^3) and various dips (10°, 20°). The thickness of the wedge was controlled by the density contrast and the amplitude of the Bouguer anomaly.

Although the theoretical profiles for these postulated wedges showed reasonable agreement with the observed gravity profile, the position of the surface contacts of the wedges had to be placed near 160W whereas it is actually at 86W. It became obvious that the effect of the amphibolite had to be considered. Assuming a density contrast of 0.22 g/cm^3 between the amphibolite and the Complex, the effect of a trapezium-shaped block of amphibolite (Plate 7) was then added to the effect of the sediment wedge dipping at 20° (density contrast 0.2 g/cm^3). The combined effect is shown in Plate 7, and the resulting curve shows quite reasonable agreement with the Bouguer anomaly profile of Traverse 120S. However, because the density contrast between amphibolite and Complex is nearly the same as between the sediments and Complex, the dip of the sediment/amphibolite contact could be steeper than indicated. For this reason a study was made of Traverse 240S where no amphibolite is known. The best result is also shown in Plate 7. Again a wedge of 20° dip and 0.2 g/cm^3 density contrast appeared to provide the best fit, although here the traverse is short. Matching of the profiles due to wedges of steeper dip would require the surface contact to be farther east than it actually is (about 124W); for example, a wedge with a 90° dipping contact would require that the contact be near 65W.

Although wedges of density contrast 0.1 and 0.25 g/cm^3 and dips of 10^o as well as 20^o showed some agreement with the Bouguer anomalies on these traverses the sections shown in Plate 7 provided the best agreement. It should be noted that a decrease in density contrast requires a corresponding increase in thickness of sediments to maintain the amplitude equal to that of the observed anomaly.

The assumed shape of the amphibolite may appear controversial because the western boundary of the amphibolite is controlled by the Giants Reef Fault which apparently is near-vertical. However, both the fault and the amphibolite cut Traverse 120S obliquely. The JO2 integrator can only accept two-dimensional sections, so the apparent thinning of the amphibolite to the west can be explained as a simulation of the side effect of the body cutting the traverse at an angle. Such an explanation makes it impossible to estimate the dip of the sediments near the amphibolite, but the results on Traverse 240S tend to support the postulated shallow dip on Traverse 120S.

The true density contrast between the amphibolite and the Rum Jungle Complex is difficult to determine. The borehole samples were of amphibolite in the Golden Dyke Formation and it is possible that the contrast is much higher than assumed above, in which case the block would have to be smaller. However, since there is a density contrast of 0.02 g/cm^3 between amphibolite and Golden Dyke Formation, the value selected (0.22 g/cm^3) was considered reasonable.

The theoretical profiles (Plate 7) are based on the assumption that the small variations east of the respective contacts are due to minor variations in the nature of the lithologies. These variations appear to be due mainly to weathering effects in the various sediments.

There is good correlation between the Celia Dolomite and a small gravity low which extends through most of the area (see Plates 3, 5 & 6). The Coomalie Dolomite is related to another low, although in places the low embraces the contact of two formations, e.g. the Coomalie Dolomite/Golden Dyke contact at 168S/44W (Plate 6).

Small gravity highs on Traverse 120S at 0 and 20E may be related to amphibolites inferred from airborne magnetic work (Browne-Cooper, in prep.). However, amphibolites were not recorded on this traverse by auger drilling (Dodson & Shatwell, 1965).

The amphibolite referred to in Plate 7 crops out between 100W and 120W on Traverse 144S. This amphibolite is non-magnetic (Plate 8) and has a reasonably high density. The associated gravity high may be emphasised by the weathering of the adjacent sediments. Thus, although the auger chip sample appeared weathered, its density (2.82 g/cm^3) is considerably higher than the densities of the surrounding rocks (Appendix 4). The geochemical results suggest it is similar to the Golden Dyke amphibolites in the Rum Jungle East area. However, it appears to be of much larger extent than these other amphibolites, and this may account for the prominence of the gravity anomaly.

In 1967, Traverse 120S was observed only as far west as 220W. This traverse was extended westwards for eight miles in the 1968 field season, and the eastern portion of the profile has been included in Plate 7. The 1968 results will be treated in a report being prepared by J.E.F. Gardener on the 1968 Rum Jungle work, but they appear to be consistent with the above interpretation.

Traverses 46E and 58E in the L3 area show small gravity highs at 45N and 50N respectively (Plate 4). These highs are approximately at the contact of the Coomalie Dolomite and Golden Dyke Formation.

The electromagnetic anomaly on 46E (Duckworth et al., 1968) is located at 49N. The drilling results (DDH 67/11 and DDH 67/15) suggest that this anomaly is related to the Golden Dyke/ Coomalie Dolomite contact which, at 49N, is about 175 feet deep. Neither hole encountered significant mineralisation. The gravity high is farther south and does not seem to be related to the electromagnetic anomaly but, as in the L5 area, is probably due to variations in weathering.

The radiometric work revealed an anomaly of seven times background between 113W and 138W on Traverse 120S. This does not appear to correspond to any significant gravity anomaly but would appear to arise from a source in the leucocratic granite (Plate 2). This anomaly should be investigated further.

6. CONCLUSIONS

The gravity results suggest that the Rum Jungle Complex dips under the metasediments at an angle of about 20° to the east. This is based on the theoretical profiles computed for Traverses 120S and 240S. Density measurements indicated contrast of 0.2 g/cm^3 between the Complex and the metasediments; on this basis it appears that the maximum depth of sediments in the area studied is of the order of 1500 metres.

The closed gravity high between 120S/107W and 168S/130W is apparently due to a non-magnetic amphibolite of relatively high density. This anomaly complicates the interpretation of the gravity results along Traverse 120S, and any further studies of the Complex/ sediment contact should be confined to areas devoid of amphibolite.

Smaller variations of the Bouguer anomaly values are apparently due to differential surface weathering in the sediments and in places, perhaps, to small bodies of amphibolite.

The radiometric anomaly on Traverse 120S extending from 113W to 138W requires further investigation to determine its cause.

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APPENDIX 1.

DETAILS OF GRAVITY STATIONS READ

(a) Grid surveying by Timbs and Britten

Traverse	72S	from	100W	to	40E	at 100 ft intervals
Traverse	120S	"	220W	to	8E	" " "
Traverse	168S	"	90W	to	16E	" " "
Traverse	192S	"	154W	to	16E	" " "
Traverse	216S	"	90W	to	16E	" " "
Traverse	240S	"	166W	to	80W	" " "

(b) Grid surveying by J.P. Williams.

Traverse	72S	from	130W	to	100W	at 200 ft intervals
Traverse	144S	"	120W	to	90W	" " "
Traverse	168S	"	130W	to	90W	" " "
Traverse	216S	"	"	to	"	" " "
Traverse	108W	"	120S	to	168S	" " "
Traverse	130W	"	168S	to	192S	" " "

Reconnaissance from 168S/130W at 321° for 3400 ft at 200-ft intervals

Reconnaissance - 13 stations at approx. 500-ft intervals (Plate 3)

(c) Gravity data of Duckworth (1966)

Traverse	72S	from	86E	to	40E	at 100-ft intervals
Traverse	120S	"	75E	to	8E	" " "
Traverse	92S	"	48E	to	16E	" " "
Traverse	216S	"	45E	to	16E	" " "
Traverse	240S	"	42E	to	80W	" " "

APPENDIX 2

DETAILS OF MAGNETIC AND RADIOMETRIC STATIONS READ

(a) Traverse surveyed by ABEM Vertical Force Torsion Magnetometer.

Traverse	120S	from 70W	to	114W	at	200-ft intervals
Traverse	144S	from 90W	to	120W	at	" " "
Traverse	168S	from 90W	to	130W	at	" " "
Traverse	108W	from 120S	to	168S	at	" " "

Reconnaissance from 168S/130W for 1400 ft bearing 321°

No anomalies other than those shown by the airborne survey (Browne-Cooper, in prep.) were recorded.

(b) Traverses surveyed by ratemeter.

Traverse	120S	from 60W	to	220W	at	100-ft intervals
Traverse	144S	from 90W	to	120W	at	" " "
Traverse	168S	from 90W	to	130W	at	" " "
Traverse	192S	from 90W	to	154W	at	" " "
Traverse	216S	from 90W	to	130W	at	" " "
Traverse	108W	from 120S	to	168S	at	" " "
Traverse	130W	from 168S	to	192S	at	" " "

Reconnaissance from 168S/130W for 1400 ft bearing 321°

APPENDIX 3

GEOCHEMICAL RESULTS

The geochemical sampling method is described by Semple (1968). The geological mapping based on this auger drilling is shown in Plate 3. The analyses made by AMDEL (1967) indicate that the amphibolite (Plate 3) has an average of 130 ppm copper and nickel as opposed to a background ranging from 10 to 60 ppm.

The detailed results are as follows.

APPENDIX 3 (c) cont.

Sample No.	Co-ordinates		Cu	Pb	Zn	Co	Ni	mR/h	Depth
67124800	108W	142S	200	70	120	60	100	003	17'
1		140	165	15	120	85	250	003	11'
2		144	100	30	130	40	100	002	14'
3		146	100	25	110	50	70	003	13'
4		148	50	25	100	50	160	003	23'
5		150	190	20	90	55	130	003	23'
6		152	190	25	210	55	160	003	17'
7		154	120	30	130	55	130	003	23'
8		156	115	35	110	55	130	005	23'
9		158	135	20	80	55	130	005	23'
10		160	160	20	110	65	140	005	29'
1		162	190	25	100	80	130	005	29'
2		164	90	25	90	30	65	004	35'
3		166	30	15	15	5	25	006	12'
67124814	108W	168	55	80	40	5	25	009	17'
67124815	168S	110W	20	10	10	-5	15	007	11'
6		112	20	15	10	5	10	004	6'
7		114	15	25	10	-5	5	006	6'
8		116	20	55	5	-5	-5	005	8'
9		118	20	45	20	-5	-5	006	11'
20		120	70	25	100	35	50	004	16'
1		122	45	20	100	55	70	004	17'
2		124	135	20	100	55	130	004	29'
3		126	150	20	50	35	85	004	7'
4		128	45	50	20	25	60	005	6'
5		130	125	25	70	35	110	004	5'
6	166.5S	131	40	45	20	80	55	004	6'
7	165S	132.2W	95	15	60	35	120	004	20'
8	163S	133W	170	25	90	30	110	002	17'
9	161	134	250	30	120	50	100	003	23'
30	160	136	165	30	60	40	80	003	23'
1	158	137	145	25	70	40	100	003	23'
2	157.5	138	120	25	90	30	100	003	23'
3	155	140	120	30	100	55	150	-	29'

APPENDIX 3 (c) cont.

Sample No.	Co-ordinates		Cu	Pb	Zn	Co	Ni	mR/h	Depth
4	154	141	50	30	110	70	150	003	23'
5	152	142	90	30	90	60	170	006	17'
67124836	150S	143W	120	30	160	65	150	003	17'
67124837	144S	120W	80	15	50	30	90	003	17'
8		118	120	20	40	50	130	003	11'
9		116	130	20	70	50	120	003	17'
40		114	115	25	50	40	130	004	17'
1		112	100	25	100	55	120	004	23'
2		110	170	25	100	50	100	002	23'
3		106	170	110	120	60	180	003	17'
4		104	100	50	45	70	140	003	6'
5		102	140	25	110	55	110	004	23'
6		100	115	20	140	55	65	003	23'
7		98	130	25	110	55	110	003	23'
8		96	150	20	85	55	110	002	23'
9		94	110	25	150	55	90	002	11'
50		92	110	25	120	70	370	004	17'
67124851	144S	90W	10	15	5	-5	15	010	11'
67124852	130W	170S	100	20	60	30	80	006	11'
3		172	50	15	30	25	60	004	11'
4		174	10	15	15	5	10	004	6'
5		176	10	25	20	-5	5	004	6'
6		178	30	30	20	20	50	006	6'
7		180	130	25	120	50	150	005	11'
8		182	25	20	30	10	25	004	11'
67124859	130W	184S	15	10	20	-5	10	No log sheet	
67124860	108W	136S	290	15	150	290	65	002	11'
1		132S	65	50	80	65	35	003	11'
2		128S	35	15	30	40	30	003	11'
3		124S	75	10	100	85	40	004	23'
4	120S	108W	30	5	55	35	20	No log sheet	
5	120S	104W	200	30	180	65	70	002	23'
6	120S	100W	110	5	70	85	50	002	17'

APPENDIX 3 (c) cont.

Sample No.	Co-ordinates		Cu	Pb	Zn	Co	Ni	mR/h	Depth
7		96W	80	5	50	75	50	002	17'
8		92W	100	-5	100	115	65	002	17'
69		88W	15	-5	20	15	15	006	17'
67124870	120S	84W	20	10	20	40	25	-	3'

APPENDIX 4

DENSITY MEASUREMENTS ON HAND SPECIMENS

Type (No. of specimens)	Av. dry density, g/cm3	Av. wet density, g/cm3
Banded Ironstone (B.I.F.) (7)	3.31	3.34
Rum Jungle Complex (40)	2.61	2.64
Beestons Formation (12)	2.51	2.55
Celia Dolomite (7)	2.41	2.52
Crater Formation (15)	2.52	2.58
Coomalie Dolomite (17)	2.53	2.51
Plo/Pld transition bed (2)	2.25	2.41
Golden Dyke Formation (26)	2.45	2.52
Acacia Gap Tongue (13)	2.43	2.50
Total (139)	2.56	2.60
Total less BIF (133)	2.52	2.56
Weighted (area) total	2.55	2.59

$$\text{Dry Density} = \frac{\text{Dry weight}}{\text{Wet weight-wet weight in water}}$$

$$\text{Wet density} = \frac{\text{Wet weight}}{\text{Wet weight - wet weight in water.}}$$

Details of density values are given in the following tables.

Formation	Name	Dry density Av.	Dry density Range	Wet density Av.	Wet density Range
Banded iron Formation (7)	Banded ironstone (7)	3.31	2.65-4.39	3.44	2.67-4.50
Rum Jungle Complex (40)	Coarse Feldspar Granite (4)	2.64	2.58-2.71	2.65	2.62-2.73
	Coarse Granite (1)	2.62	2.62	2.63	2.63
	Medium Granite (5)	2.62	2.61-2.64	2.64	2.63-2.69
	Metadiorite (2)	2.75	2.72-2.77	2.78	2.77-2.78
	Leucocratic granite (3)	2.61	2.60-2.61	2.64	2.63-2.64
	Granite Gneiss (4)	2.61	2.55-2.65	2.62	2.59-2.66
	Gneiss (9)	2.67	2.58-3.05	2.72	2.62-3.07
	Schist (5)	2.51	2.36-2.71	2.64	2.50-2.81
	Undiff. Schist, Gneiss etc. (7)	2.55	2.11-2.67	2.58	2.15-2.68
Beestons Form. (12)	Arkose (3)	2.58	2.53-2.62	2.61	2.58-2.64
	Sandstone (4)	2.54	2.38-2.63	2.58	2.47-2.65
	Qtz Greywacke (5)	2.44	2.37-2.50	2.50	2.43-2.55
Celia Dolomite (7)	Silicified Breccia Dolomite (4)	2.38	2.16-2.59	2.52	2.37-2.66
	Silicified Dolomite (3)	2.45	2.41-2.52	2.53	2.48-2.58
Crater Form. (15)	Qtz Greywacke (10)	2.51	2.33-2.81	2.58	2.52-2.93
	Greywacke (5)	2.54	2.44-2.56	2.57	2.49-2.69
Coomalie Dolomite (17)	Coomalie Qtzite (4)	2.56	2.55-2.60	2.59	2.56-2.62

Formation	Name	Dry density Av.	Dry density Range	Wet density Av.	Wet density Range
	Silicified Dolomite (4)	2.33	2.18-2.47	2.40	2.30-2.50
	Tremolite Schist (2)	2.49	2.48-2.50	2.56	2.55-2.56
	Silic. Dolomitic Breccia (7)	2.63	2.33-3.79	2.77	2.50-4.05
Transition Bed (2)	Shale and calcilutite (2)	2.25	1.97-2.53	2.41	2.16-2.66
Golden Dyke Formation (27)	Grey shale (11)	2.51	2.26-2.67	2.56	2.31-2.83
	Quartz Siltstone (8)	2.43	2.14-2.61	2.48	2.41-2.60
	Dolomitic Marl (3)	2.37	2.03-2.61	2.46	2.15-2.65
	Dolomite Slump Breccia (4)	2.41	2.26-2.61	2.51	2.34-4.67
Acacia Gap Tongue (13)	Qtz sandstone (pyritic) (10)	2.47	2.22-2.59	2.52	2.34-2.68
	Siltstone (3)	2.32	2.06-2.47	2.42	2.24-2.62

APPENDIX 5

DENSITY MEASUREMENTS ON DRILL CORES

(by Darwin Uranium Group)

Type (No. of specimens)	Density, g/cm^3
Weathered slate (21)	2.01
Unweathered slate (168)	2.77
Total slate (189)	2.69
Mineralised slate (42)	4.31
Siltstone (5)	2.52
Dolomite (31)	2.93
Amphibolite (7)	2.79

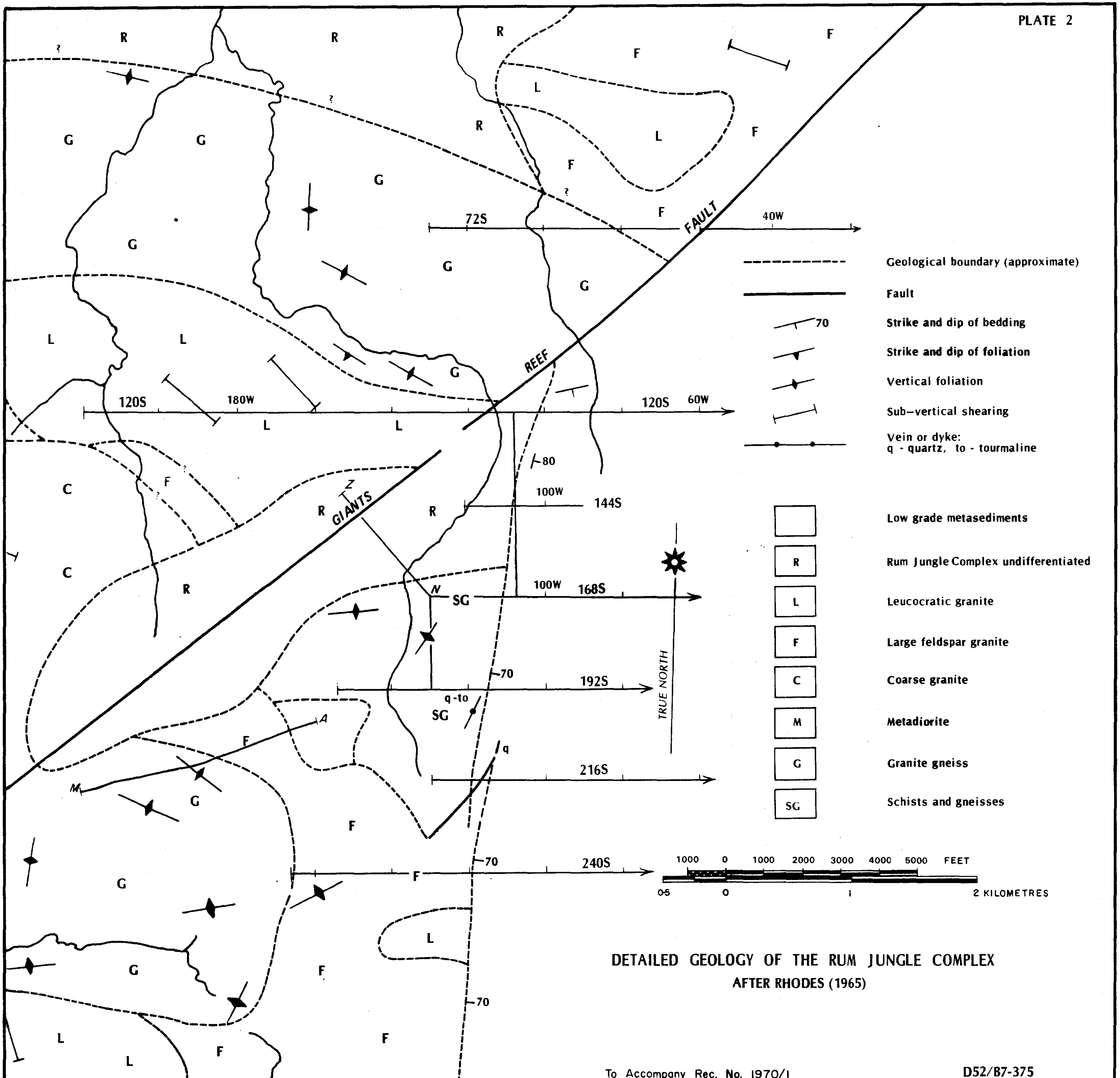
$$\text{Density} = \frac{\text{Dry weight}}{\text{Volume displaced in water}}$$

Auger chip density measurements

Amphibolite (1) dry density = 2.82 g/cm^3
(144S, 108W)


PLATE 1
GEOLOGICAL LEGEND
QUATERNARY
Alluvium
UPPER PROTEROZOIC
TOLMER GROUP
BULDIVA SANDSTONE
DEPOT CREEK SANDSTONE MEMBER
Quartz sandstone, with lenses of haematite-rich breccia and lenses of quartz pebble conglomerate
LOWER PROTEROZOIC
AGICONDIAN SYSTEM
RUM JUNGLE GRANITE COMPLEX (see text)
Basic intrusives
FINNISS RIVER GROUP
BURRELL CREEK FORMATION
Siltstone, greywacke siltstone, greywacke, quartz greywacke
GOODPARLA GROUP
GOLDEN DYKE FORMATION
Quartz siltstone and carbonaceous siltstone, in places pyritic
MASSON FORMATION
ACACIA GAP TONGUE
Quartz greywacke, quartz sandstone, pyritic and silicified in places; pyritic, carbonaceous siltstone, siltstone
BATCHELOR GROUP
COOMALIE DOLOMITE
Silicified and metamorphosed dolomite
CRATER FORMATION
Quartz greywacke, greywacke, arkose, fine and pebble conglomerate, siltstone
CELIA DOLOMITE
Algal dolomite, in places silicified and metamorphosed, silicified dolomitic breccia, tremolite schist
BEESTONS FORMATION
Arkose, greywacke, siltstone, conglomerate, arkosic conglomerate, white friable quartz sandstone
Geological boundary
Dip and strike of strata
Trend lines
Established synclinal trough - position accurate
Established synclinal trough - concealed; position approximate
Plunge of syncline
Plunge of anticline
Established fault - position accurate
Established fault - position approximate
Established fault - concealed
Probable fault
Quartz vein
Quartz-tourmaline vein
Fossil locality
67/15 Diamond drill hole
GEOLOGY AFTER RUM JUNGLE DISTRICT
SPECIAL SHEET, 1:63,360, 1960 EDITION
TOPOGRAPHICAL LEGEND
Geophysical Traverse
Highway
Road or track
River or creek
Railway with station and siding
Mine or prospect
Open cut
Dump
Transmission line
Dam
FOG BAY
DARWIN
ALLIGATOR RIVER
SURVEY AREA
D52
D53
E52
E53
LOCALITY MAP
REFERENCE TO AUSTRALIA 1:250,000 STANDARD MAP SERIES
MILES
KILOMETRES
RUM JUNGLE EAST NT, 1967
LOCALITY MAP AND REGIONAL GEOLOGY
TO ACCOMPANY RECORD No 1970/
D52/B7-374
Mt Fitch
Mt Burton
Dolerite Ridge
Area 55
Rum Jungle Siding
Rum Jungle Creek
Rum Jungle Creek South
Flynns
Castlemaine Hill
Laterites
BATCHELOR
BATCHELOR AIRFIELD
Crater Hill
Browns
Whites
Whites Extended
Dysons
WOODCUTTERS L5 PROSPECT
WEST TRACK
L3 AREA
COOMALIE AIRFIELD
STUART
HIGHWAY
Finniss
River
East
Branch
South
Coomalie
Creek

PLATE 2



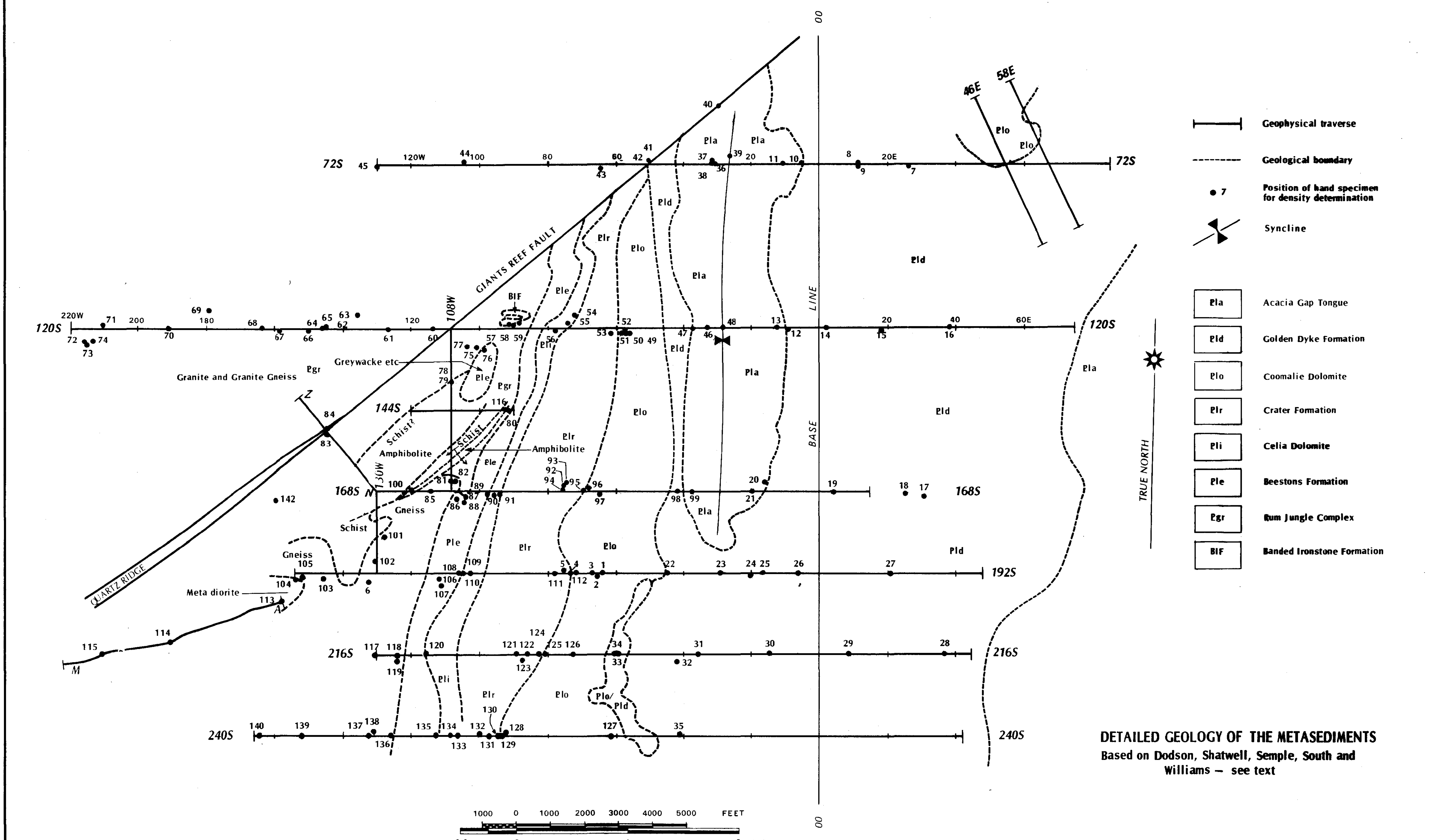
DETAILED GEOLOGY OF THE RUM JUNGLE COMPLEX

AFTER RHODES (1965)

To Accompany Rec. No. 1970/1

D52/B7-375

PLATE 3

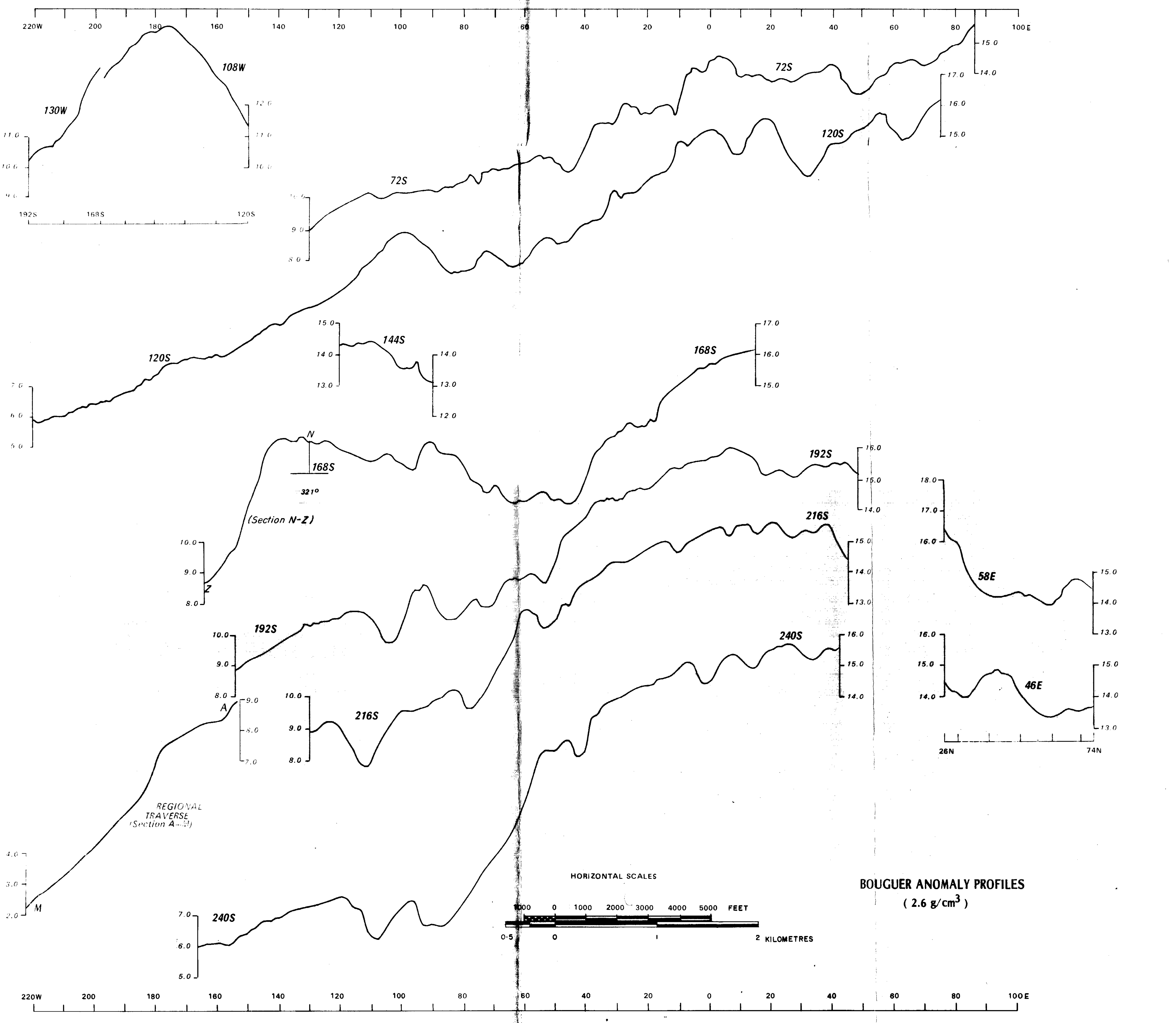


DETAILED GEOLOGY OF THE METASEDIMENTS
Based on Dodson, Shatwell, Semple, South and Williams – see text

To Accompany Rec. No. 1970/1

D52/B7–373

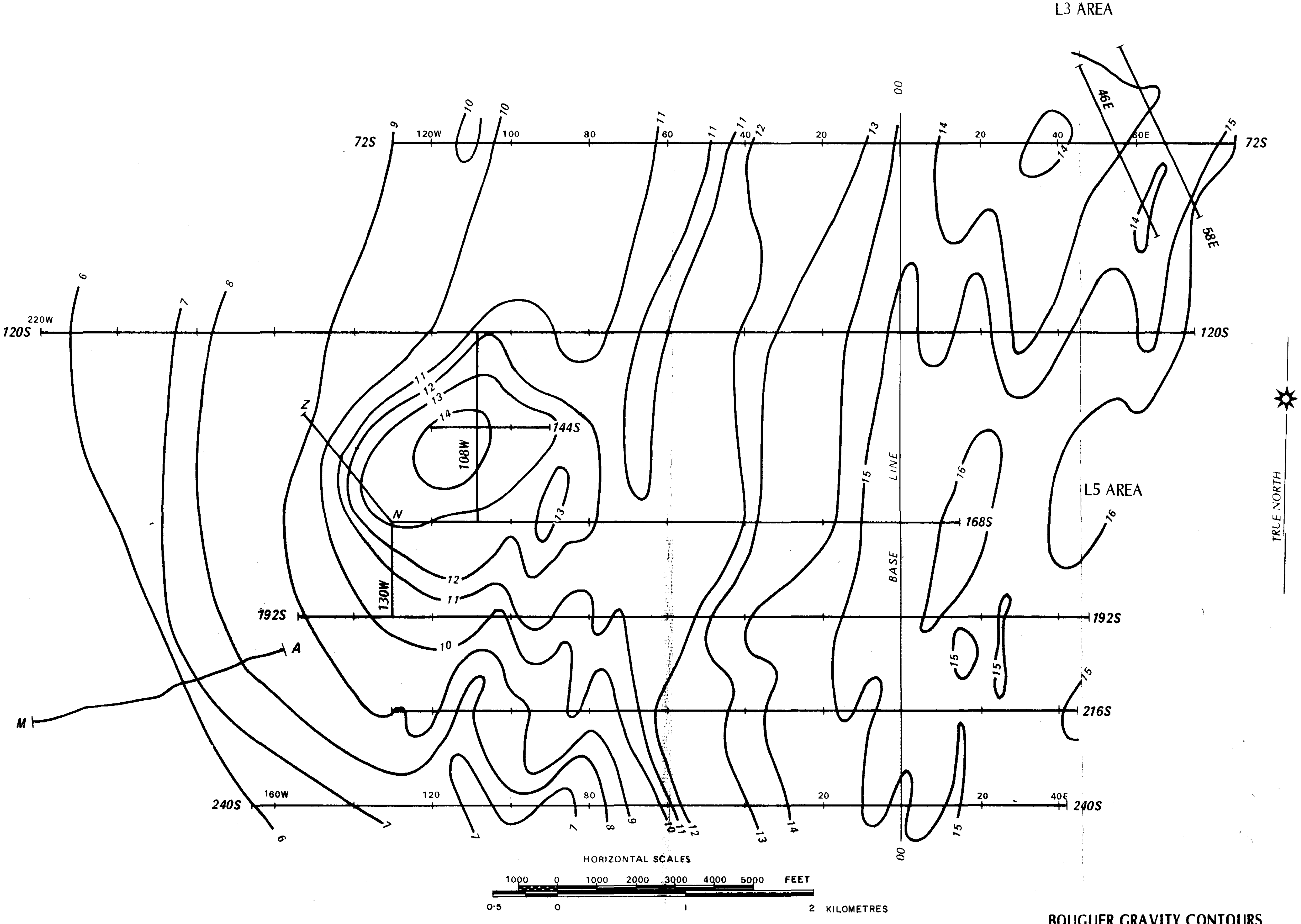
PLATE 4



BOUGUER ANOMALY PROFILES
(2.6 g/cm^3)

To Accompany Rec. No. 1970/1

D52/B7–370

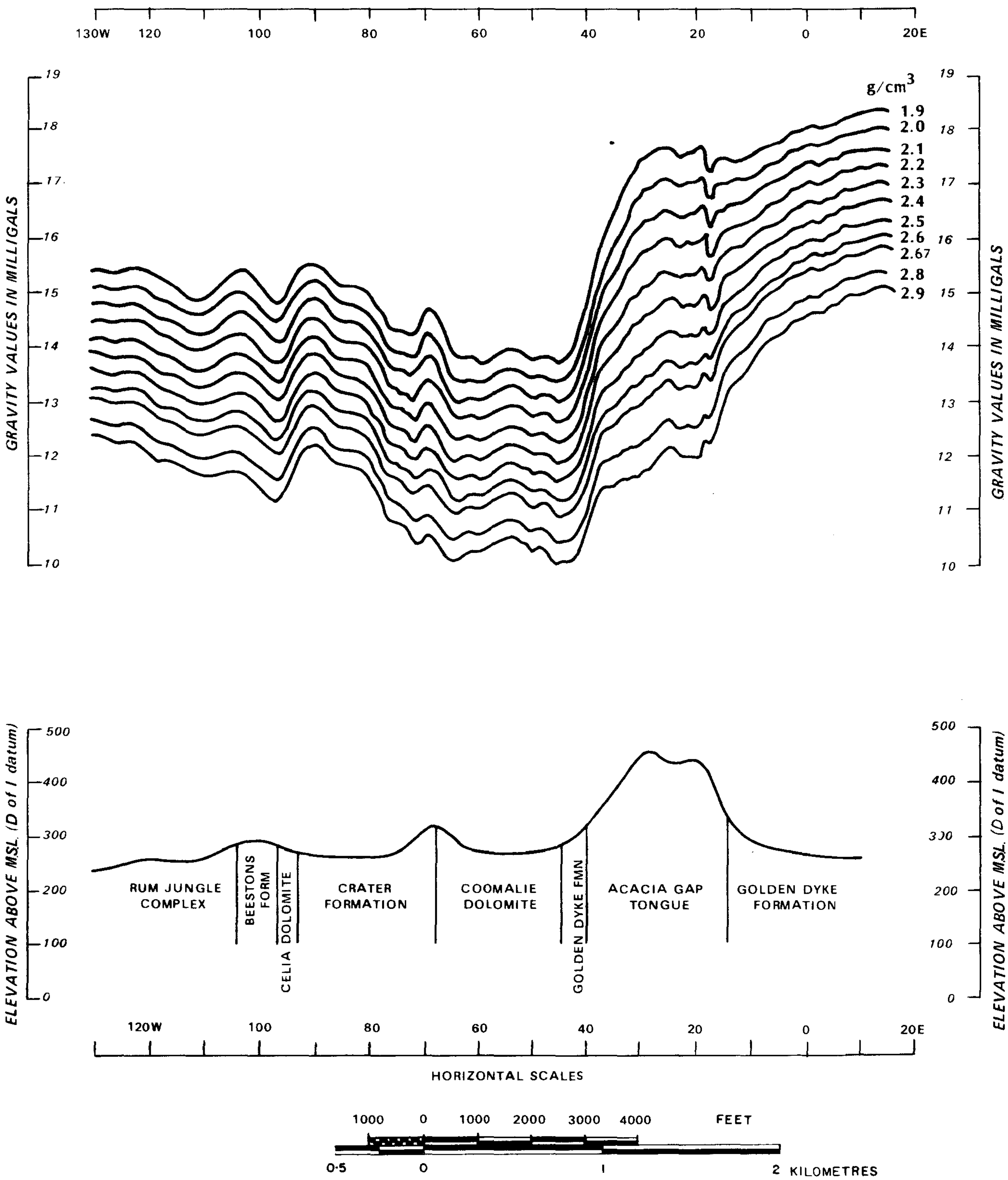


BOUGUER GRAVITY CONTOURS
Density: 2.6 g/cm^3
Contour interval: 1 milligal

To Accompany Rec. No. 1970/1

D52/B7–371

PLATE 6



BOUGUER ANOMALY PROFILES

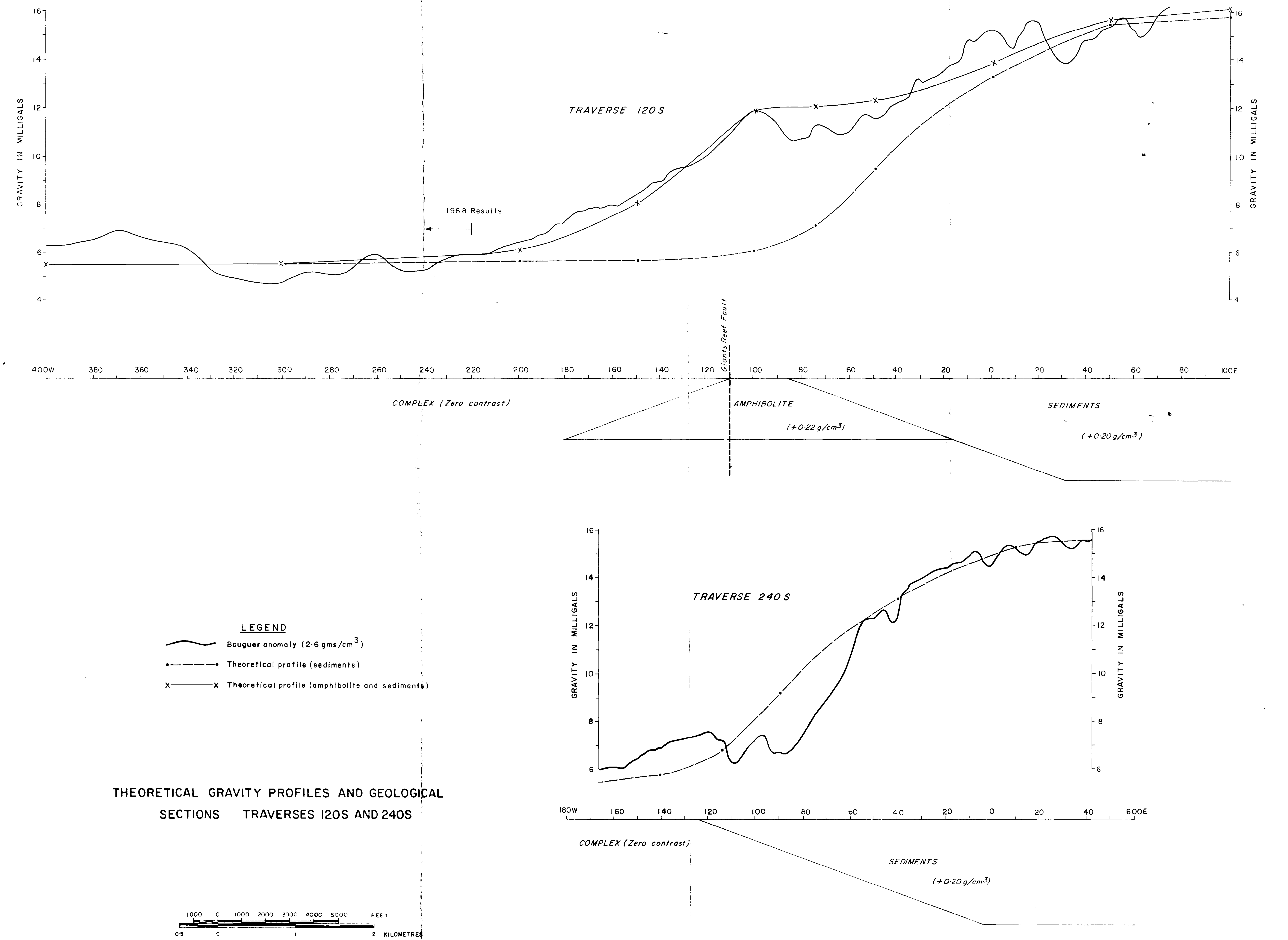
TRAVERSE 168S

(Geology diagrammatic)

To Accompany Rec. No. 1970/1

D52/B7–372

PLATE 7

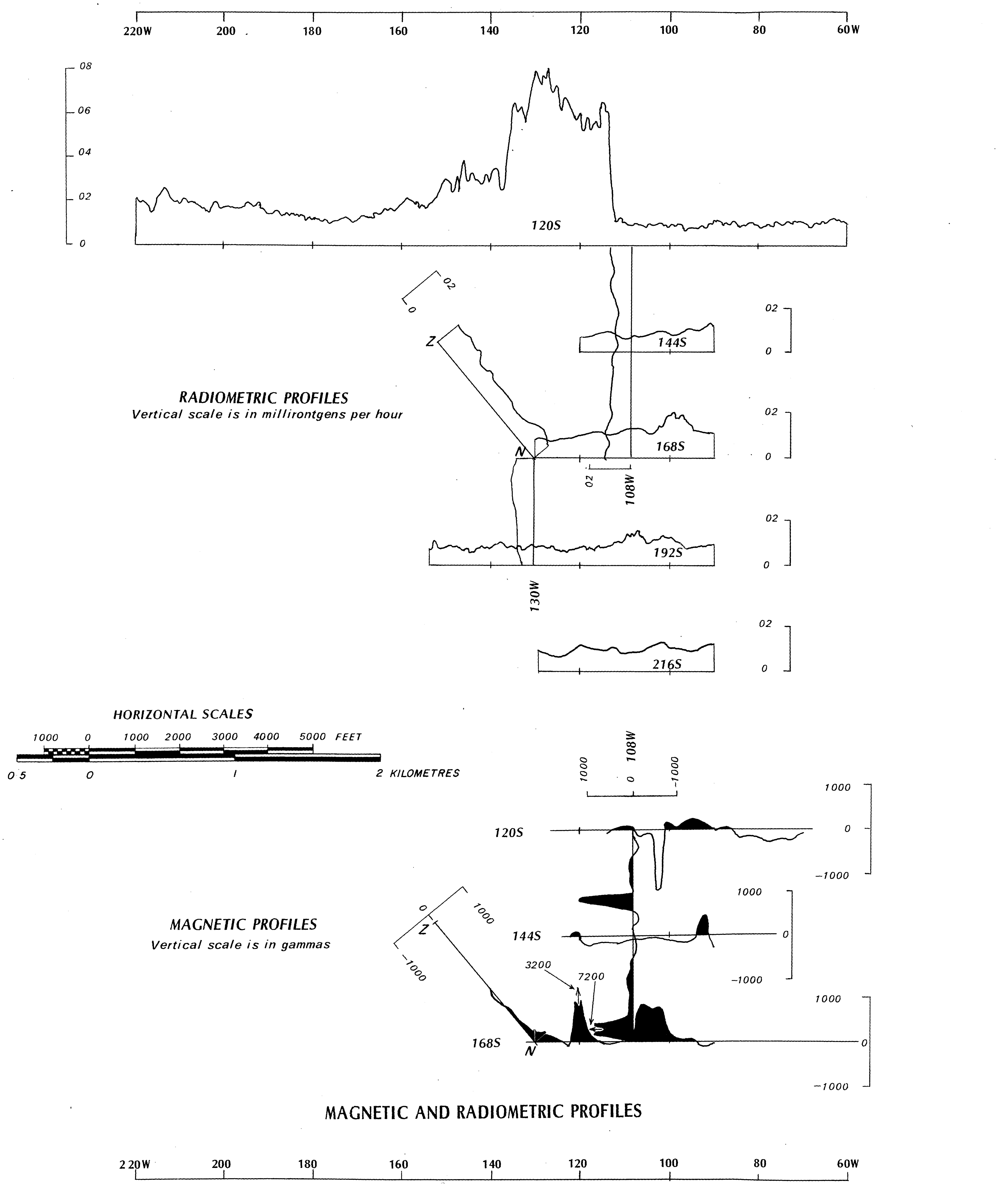


THEORETICAL GRAVITY PROFILES AND GEOLOGICAL SECTIONS TRAVERSES 120S AND 240S

To Accompany Rec. No. 1970/1

D52/B7-448

PLATE 8



MAGNETIC AND RADIOMETRIC PROFILES

To Accompany Rec. No. 1970/1

D52/B7-381