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DEPARTMENT OF MINES
SOUTH AUSTRALIA

GEOLOGICAL SURVEY
GEOPHYSICAL SECTION

Report on

GRAVITY AND MAGNETIC TRAVERSES OVER AEOMAGNETIC ANOMALY, HD. CARINA, NEAR MINNIPA, EYRE PENINSULA

by

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Geophysicists

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16th June, 1959

Department of Mines
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SUMMARY

An aeromagnetic anomaly near Minnipa, Eyre Peninsula, called the Inkster anomaly was revealed by aerial survey and has now been investigated on the ground with vertical magnetometer and gravimeter. The results imply the presence, at less than 400 feet below the surface of a zone or rocks slightly more dense than those surrounding the area, and the occurrence of magnetic material, probably in the denser rocks. A drilling programme to test the anomaly has been recommended.

INTRODUCTION:

The Bureau of Mineral Resources conducted airborne magnetometer surveys in 1953-55 over Upper Eyre Peninsula, and revealed a number of geomagnetic anomalies.

An intense anomaly was disclosed 10 miles WSW of Minnipa, a town 400 miles from Adelaide on the Eyre Highway.

The purpose of the survey reported here was to establish ground gravimeter and magnetometer stations, thus detailing the magnetic anomaly and detecting any accompanying gravity high.

The anomaly covers an area of approximately 15 square miles near the common boundary of the Inkster and Minnipa one mile sheets, centred in Section 40, Hundred of Carina. Its extent can be seen on the locality plan S2026, which shows part of County Robinson.

Access to the area is gained by means of a bush track running west from the Minnipa-Mt.Damper road, five miles south of Minnipa.

Field work was commenced in October, 1958 and completed in February 1959. At first, survey lines were cut with axes through the thick scrub which covers most of the area, but progress was so slow that the Departmental bulldozer was used for the major part of the clearing. In all, the surveying and levelling which was done by J. Erkelens took 8 weeks and the geophysical observation, 4 weeks.

PREVIOUS GEOPHYSICAL WORK

The only previous geophysical work on record is the aerial survey mentioned above, which was conducted by the Bureau of Mineral Resources. Aeromagnetic contour plans are available both on 1" = 4 miles and 1" = 1 mile. The present is the first ground survey over one of the larger Eyre Peninsula anomalies, those at Cowell and Port Neill being much smaller in extent.

GEOLOGY:

The land over which this survey was run is very gently undulating, the variation in elevation between highest andlowest points on the surveyed lines being about 70 feet. There are flats of red and brown soil between sand ridges, with limestone at the surface in places. Aerial photographs show that these dunes have a marked NW-SE trend, and so are roughly at r ight angles to the traverses.

There is no detailed information on subsurface geology in the Inkster area. In his report No. 47/148, J.F. Hayball, Geologist, records a search through bore information with the idea of ascertaining the depth of the post-Mesozoic cover. He makes a number of general comments, pointing out that the western extremities of the B.M.R. upper Eyre Peninsula sheet reveal a vast extent of aeolianite (Pleistocene calcareous sands) thickest in the cliffs at the West, and thinning Easterly and inland. Further east the cover is Recent sands, clays, and alluvium. The occurrence of inliers of Archaean granite throughout the area suggest its being the bedrock, but the aeromagnetic anomalies suggest a local variation in the nature of this bedrock or the occurrence of anomalous rocks between the bedrock and the post-Mesozoic cover. The latter possibility is less likely in view of the relative thinness of the cover.

Summarizing, Hayball suggests that inland the cover would generally be less than 100 feet, but that it must be regarded as possible that Tertiary basins similar to one in the vicinity of Cummins, Eyre Peninsula, could extend to the north and contain 300 - 500 feet of sediments.

METHODS USED:

The first line of the grid, 20000N, designed to intersect the anomaly at its peak was laid out by theodolite and tape as a continuation of an old track (See LocalityPlan S2026). Subsequently, further lines, 2000 feet apart, were laid out, two to the north of 20000N and five to the south, joined by a baseline at 20000E and all 20,000 feet long except 10000N, which extends only as far west as 5000E.

Elevations were obtained by level and staff, but no tie was made to a point of known height. All elevations are given above an arbitrary base.

Vertical magnetic intensity was measured with Watts vertical force variometers nos. 60565 and 61939, and a station was repeated every two hours approximately so that corrections could be applied for diurnal variation.

Gravity readings were taken with Worden gravimeter no. 204. To determine drift traverses were read in sections of about 6000 feet, the centre station of each section being read 3 times at about 45 minute intervals during the traversing of that section. No tie was made to an established gravity station but again, an arbitrary datum has been chosen.

RESULTS:

Profiles of vertical magnetic intensity and Bouguer anomaly are shown in plans 59-75 and 59-76. In the magnetic case, corrections for diurnal variation have been applied, but no geographic correction is warranted. In correcting gravity values for elevation a combined Bouguer and free air corresponds to a density of 2.7 gm/cc. for rocks above sea level. In the profiles, a small apparent regional increase in gravity values from West to East has been noticed. There is a similar increase from North to South. The approximate result of subtracting this effect has been calculated, but it has been found that considering the magnitude of the gravity anomaly, neither the positions of the highs, nor the directional trends are affected and there is, therefore, nothing to be gained by evaluating this effect with any accuracy.

A local magnetic anomaly having values of vertical magnetic intensity as high as 8000 gammas on the line 16000N and being extremely broad ($\geq$ 15000 feet) has been observed. It diminishes in magnitude to 2000 gammas on lines 10000N and 24000N, and in the circumstances it was considered uneconomical to pursue the anomaly further.

Coincident with the magnetic disturbance there is a high broad gravity anomaly rising from 4 milligals on 10000N to 11-12 milligals on 14000N, 16000M and 18000N and diminishing to 5 milligals on 24000N.

INTERPRETATION:

A magnetic anomaly of this magnitude implies the presence of magnetite-bearing rocks and possibly a general concentration of iron minerals, many of which can be magnetic in certain circumstances. Although it is impossible to estimate the amount of magnetite present, H. Haalck (Jakosky, p.211) has derived a classification of anomalies from a large number of recorded cases, and in his scheme the Inkster anomaly falls into class 2 (anomalies of 1,000 - 10,000 gammas) which are most often due to extensive masses of volcanic or crystalline rock rich in magnetite but very rarely of economic importance.

It is also significant that this anomaly is of the order of those near Cowell where drilling has revealed magnetite widely disseminated in a rock of low grade.

On the line 16000N there are three fairly distinct peaks, while the other profiles exhibit less distinct peaks, with no apparent line up. However, when a plot of positions of magnetic peaks is considered in conjunction with a similar plot of gravity highs some correlation is possible, the two plots showing parallel directional trends. The trend is grid N-S at the southern end, but north of 16000N it swings sharply and runs grid NW-SE. Although this trend is indicated by broad, indistinct peaks, such a marked variation in direction may well be significant and it is likely that it reduces the possibility of the anomaly being related to regularly bedded rocks, where persistence of strike would be expected.

Even on the profile along 16000N the peaks are too indistinct to interpret quantitatively with any accuracy. It seems reasonable to assume that they are the result of magnetic properties of a number of bodies, and cannot be resolved into a small number of simple curves. Such resolution is necessary for analysis. In the case of Port Neill, the magnetic peaks were very well defined and by considering the sources of the anomaly as vertical, tabular, vertically polarized bodies of infinite extent in the direction of the strike depths to the upper pole (which can be considered for practical purposes as the top of the body, the other pole being at infinite depth) can be estimated reasonably. This was done, and agreed well with observed depths. However, in the present case, although resolution of the profile is virtually impossible, it can be said that on resolution, the component curves would be sharper than those on the original profile and so a limiting depth may be derived from the half-widths of the peaks on the original profiles. It is estimated thus that depth to the disturbing material will be less than 400 feet which agrees with the estimate given by J.F. Hayball in his report on subsurface geology.

Coincident with the magnetic disturbance occurs the broad gravity anomaly described above. This implies the presence of a mass of rock having a specific gravity greater than the surrounding rocks. Gravimetrically there are an infinite number of possible causes of the anomaly ranging from bodies having an S.G. approaching that of magnetite (approx. 5) or associated iron minerals to a very much larger body making only a small density contrast with the surrounding rocks. In considering the likely conditions three things must be considered namely:-

(1) the class of the magnetic anomaly, which is probably too low to indicate a discrete body or bodies approaching magnetite in composition. (Haalck's classification suggests the anomaly caused by such a body of size approaching economic importance to be of the order n x 10,000 gammas when n=1,2...20)

(2) the irregularity of the magnetic profiles which show a number of poorly defined peaks suggesting the uneven distribution of the magnetic material in its host rock.

(3) the results of drilling at Cowell where similar anomalies were found to be due possibly to a large zone of rocks which did actually contain magnetite in bands of irregular width, but which themselves provided a density contrast (about 0.4 gsm/cc) with the country rock sufficient to be a possible cause of the gravity anomaly.

It seems most likely therefore, that at Carina there exists a large zone of rocks of S.G. greater than those surrounding it by about 0.5 and that contained in this zone, which is possibly one of basic concentration in the bedrock, there are irregular occurrences of magnetite. It is not possible from the results to predict the state of dissemination of the magnetite. If the drilling programme recommended below is carried out, more accurate appraisals of the possible conditions will be made as specific gravities of the rock types come to hand. It will then be possible to estimate the extent of the magnetite bearing zone and the tonnages involved.

It has been calculated regarding the anomalous mass as a regular geometric form that the depth to its centre of gravity is of the order of 4-5000 feet. This implies a great depth extent, and favours the theory that a widespread zone of more basic rocks is responsible for the gravity anomaly.

It has also been calculated that a very large body, density contrast 0.5 gm/cc could possibly cause the gravity anomaly but such a calculation is dependent on the profile of surface of bedrock which will also be disclosed by the drilling programme.

CONCLUSIONS:

It is concluded that there is probably present a very large zone (15,000 ft x 15,000 ft approximately) of rocks having an S.G. of about 3.2 and that associated with this zone, which may be one of the basic concentration in the bedrock, are irregular occurrences of magnetic minerals - probably largely

magnetite. The depth below surface of the magnetic material is less than 400 feet and the zone of denser material apparently has a large depth extent.

RECOMMENDATIONS:

It is recommended that a programme of drilling be carried out to test

(1) the depth to bedrock

(2) the nature of the bedrock directly below the stations showing peak magnetic values.

(3) the nature of the bedrock at a point clear of the magnetic peaks but within the magnetically disturbed area.

(4) the nature of the bedrock outside the magnetically disturbed area.

These holes will be relatively shallow and will take only short samples of the bedrock and it is also recommended that a deeper diamond drill hole (approx. 1000 feet) be drilled to test the variation in bedrock composition with depth, and thus the possibility of the gravity anomaly here, and in other similar areas being due largely to basic differentiation in the basement.

Calculations will be made on the amount of magnetite present and the extent and economic importance of the anomalous zone as results come to hand.

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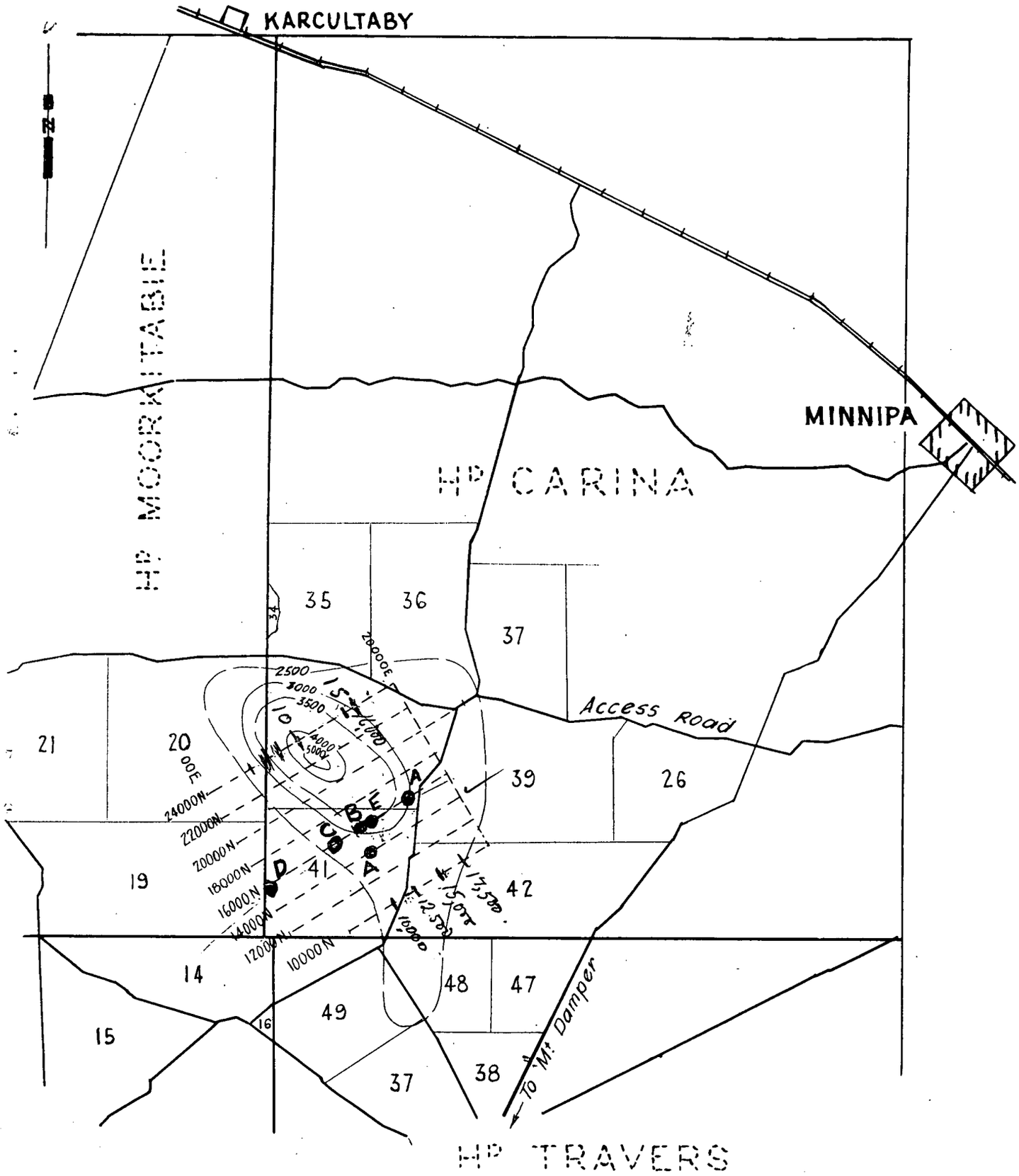
GEOPHYSICISTS

IHMcM:EM:CERF
16/6/59



SCALE

MILE 1 ½ 0 1 2 3 4 5 MILES

Aeromagnetic contours (in gammas) 2500 3000

Surveyed traverses

To accompany report by I.H.McMutrie.

S.A. DEPARTMENT OF MINES					
Approved	Passed	Drn.	INKSTER AEROMAGNETIC ANOMALY LOCALITY PLAN	D.M.	Scale 2 miles to 1in.
		Tcd. M.B.L.		Req.	S 2026
		Ckd.			
Director		Exd.			Date 23-3-59 | Dg14/15

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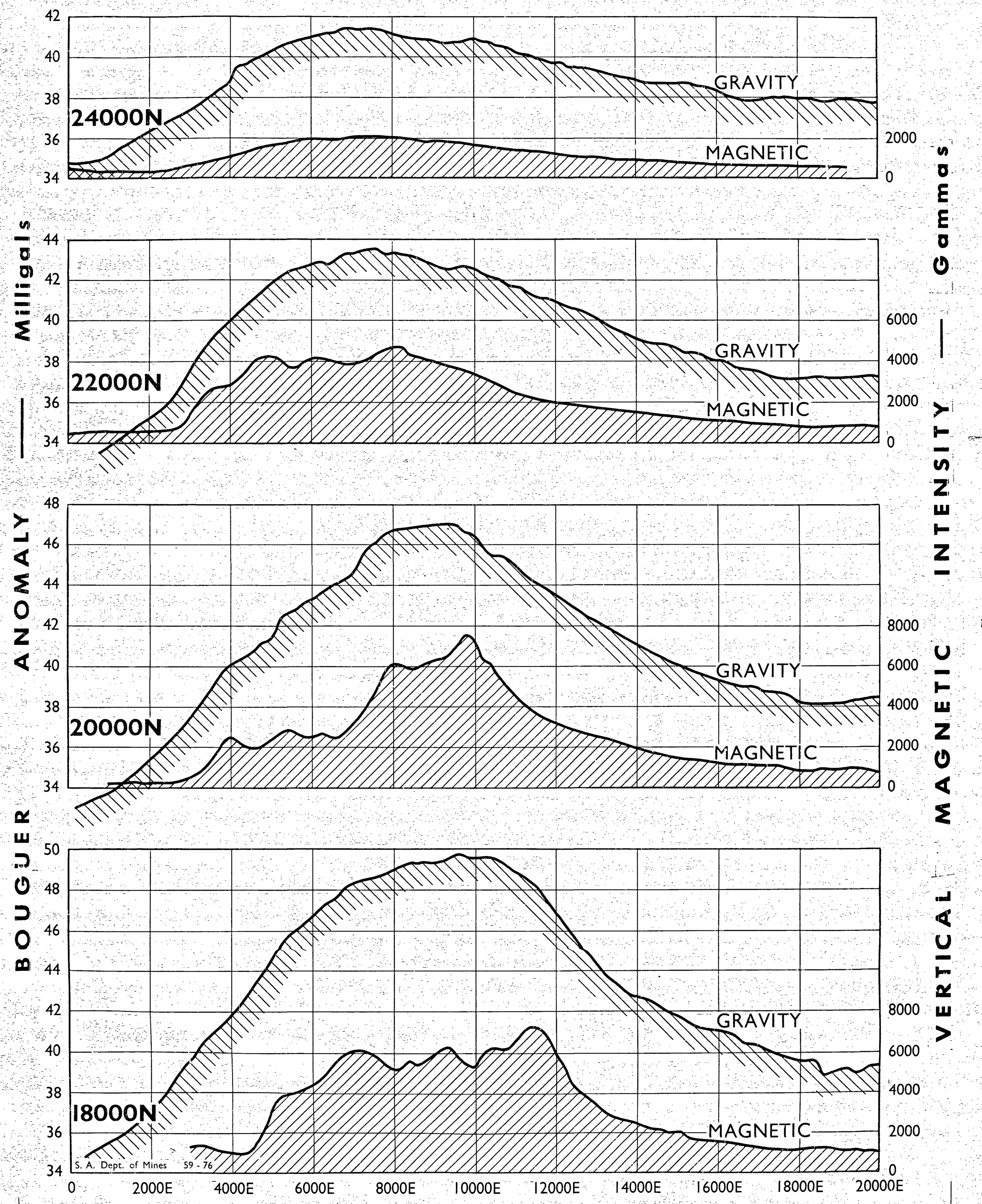

Reduce to 5½ inches

Inkster Aeromagnetic Anomaly. Profiles of Bouguer Anomaly + Vertical Magnetic Intensity on 18000N – 24000N inclusive

Director of Mines	Drn. C.F. / Chk. / Passed /	59-76/4 P&M/15(50) Date: 21-1-1960

BOUGUER ANOMALY — Milligals

VERTICAL MAGNETIC INTENSITY — Gammas

Reduce to 7½ inches