DEPARTMENT OF MINES
SOUTH AUSTRALIA

# PROGRESS REPORT ON GEOPHYSICAL SURVEY IN E.L. 157, MULGATHING AREA.

by

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REPT.BK.NO. 75/5
D.M. NO. E.L. 157
G.S. NO. 5546

JANUARY 16TH, 1975

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## INTRODUCTION

Five geophysical traverses were made within the area covered by E.L. 157 (see Plan No. S11160) at the request of Uranerz (Australia) Pty. Ltd. Their object was to locate and outline the shape and depth of a paleo-channel lying within basement, the existence of which had been inferred from previous drilling information (see the reports on E.L. 48 by Nissho-Iwai Co. (Aust.) Pty. Ltd., held on open file by the South Australian Department of Mines - Envelope 2390.

## GEOLOGY

Acid metamorphic rocks of probably Lower Proterozoic age form basement in the area: these appear to be predominantly granite gneisses, although outcrop is sparse.

The paleo-channel inferred from the Nissho-Iwai drilling has been filled by a black mudstone, palynological examination of which indicates "abundant spores of early Permian Age" (W.K. Harris (1973) - report in S.A. Department of Mines envelope 2390, on E.L. 48).

Tertiary sediments (white sandstones and siltstones) overly unconformably both basement and Permian rocks. A thin silcrete duricrust has developed over much of the area.

## GEOPHYSICAL METHODS USED

The five traverses were made along lines selected by Uranerz. These cross an elongated gravity low on the Bureau of Mineral Resources 1:250 000 Bouguer gravity map (see Plan No. S11162) which is thought to

be an expression of the paleo-channel. An inspection of aeromagnetic maps of the area shows that the channel may be delineated similarly by use of these. A north-easterly trending linear feature passing through Durkin in the north-west of the leased area appears on both the regional gravity and the aeromagnetic maps, obscuring to some extent the channel anomalies. This may be caused either by a deep-seated structure within basement or by a change in basement rock type.

The seismic refraction technique was used on all five lines. Gravity readings were made on lines 2, 4 and 5. See Plan No. S11161 for locations of the traverses.

1. Seismic refraction

a. Instrumentation

Texas Instrument Co. 7000B 24-channel recording seismograph interfaced with a Geospace R1801 electrostatic camera using paper speed of 50 cms/second.

Filters: low-cut - out;
high-cut - type L, 57 hz.

Amplifiers were tested regularly in parallel using an oscillatory signal to check for uniformity in amplitude and phase response. Regular checks were also made on instrumental noise.

Radio time breaks were used (2 140 kHz).

b. Geophone layout

Originally it was thought that the paleo-channel would be no more than 150 metres deep and that good results would be obtained by arranging the geophones 61 metres (200 feet) apart in line along the traverse, firing a shot in the centre of the spread, then moving the geophone spread one quarter of its length along the traverse, firing another shot at spread centre, and so on.

In this way it was felt that overlapping basement refractions from forward and reverse shots would be obtained and thence a detailed outline of the basement profile.

However, it soon became clear that basement lay at depths of 300 metres or more in the centre of the channel and we were forced to fire shots at both ends of the basic spread and then move it one half of its length at a time. Even by adopting this procedure refractions from basement in the deeper parts of the channel were obtained only on the last few traces of each records. However, overlapping arrivals were available to give good resolution on the Tertiary-Permian interface.

A Gemco drilling rig mounted on the back of a Land Rover utility was to have been used to place the shots at depths of at least 5 metres, but the hard silcrete layer common through out the area prevented the drill from penetrating to any significant depth. Use of the rig was abandoned and near-surface shots consisting of two 1.5 kg sticks of AN60 gelignite were used. The resulting records are of mediocre quality but neverthless give the required information at minimum cost.

c. Recording techniques

The silcrete layer presents a special problem as it forms a high-speed layer overlying lower velocity material. Now, according to optical ray theory, this should form a velocity inversion resulting in overestimates in depths. However, ray path theory does not hold where the high-speed layer becomes very thin in relation to the seismic wavelength: refraction arrivals from such thin layers show a relatively rapid amplitude decay with decreasing frequency (Lavergne, 1966; Poley & Nooteboom, 1966).

Poley and Nooteboom (1966) provide data which show that this attenuation is greatest when the thickness/wavelength ratio is less than 0.3. It was found that by using a high-cut filter with a 3 dB value of 57 Hz and a slope of 12 dB/octave (type L on the 7000B system) the refractions from the silcrete layer were attenuated below general noise levels beyond a horizontal distance of 30 metres.

## 2. Gravity

### a. Instrumentation

La Coste and Romberg gravity meter; serial no. LRG-212.

| Calibration factor | Date |
|---|---|
| 1.0582 mgals/division | 30.10.74 |
| 1.0581 mgals/division | 17.12.74 |

### b. Control base station

Both elevations and gravity values were tied to Department of Lands BM4528 on the Commonwealth Hill road which has been assigned the following values:

elevation - 155.694 metres A.S.L.

observed gravity - 979 300.30 mgals.

### c. Drift control

Tie stations were established at intervals along each traverse such that the time taken to read gravity values at stations in between would be not more than one hour. Linear gravity drift was assumed between tie stations.

### d. Base network control

A series of readings were made to tie the ends of traverses together and to form a network for control purposes. The resulting loop misclosure diagram was adjusted by a least squares method (Smith, 1951) to distribute errors. Average loop misclosure was 0.07 dial divisions.

### e. Horizontal control

Stations were established at 122 metre intervals along each traverse by placing a peg at every second geophone station on the seismic traverses.

Control was maintained by referring the ends of lines and stations in between to known points on 1:47 520 base maps of the area. Latitudes for the various stations were derived from these maps.

f. Accuracy

Observed gravity accurate to 0.01 mgals.

Elevation considered accurate to 3 cms (equivalent to 0.01 mgals).

Latitude accurate to 10 metres (0.01 mgals).

Therefore the data are considered accurate to $((0.01)^2 + (0.01)^2 + (0.01)^2)^{\frac{1}{2}} = 0.02$ mgals.

g. Reduction of data

Data were reduced according to standard formulae (vide Grant and West, 1966, pp 238-239). Thus the latitude, free-air and elevation corrections were applied. No topographic corrections have been made as topographic relief is slight.

A density of 1.9 gms/cc was assumed in applying the elevation and is borne out by the following information from core taken from Uranerz drill hole No. 18 on Line 5.

| Rock type | Depth | Dry Bulk Density | Wet Bulk Density |
|---|---|---|---|
| Permian mudstone | 76 m | 1.77 | 1.88 |
| " " | 259 m | 2.07 | 2.27 |

## FURTHER DETAILS

1. Personnel

R. G. Nelson (Geophysicist) - 5.11.74 to 26.11.74

B. A. C. Brice (staff field assistant) - 4.11.74 to 26.11.74

J. Davis (field assistant) - 4.11.74 to 26.11.74

M. Ross (field assistant) - 4.11.74 to 16.11.74

2. Seismic coverage

| Line | Distance (km) |
|---|---|
| 1A | 2.8 |
| 1B | 5.0 |
| 1C | 1.3 |
| 2 | 5.0 |
| 2A | 2.7 |

| Line | Distance (km) |
|---|---|
| 2B | 2.1 |
| 3 | 11.6 |
| 4 | 10.1 |
| 5 | 9.8 |
| Total | 50.4 |

3. Gravity coverage

| Line | Distance (km) |
|---|---|
| 2 | 5.0 |
| 2A | 2.7 |
| 2B | 2.1 |
| 4 | 10.1 |
| 5 | 9.8 |
| Total | 29.7 |

Altogether 250 stations were occupied.

## DISCUSSION OF RESULTS

1. Seismic refraction

Sections were drawn in the field to aid in the drilling programme. These were made from spot depth estimates. Further reduction and interpretation of the data is underway and it is expected that greater resolution will be achieved. The channel is at least 300 metres deep.

The general distribution of velocities within the various rock types is tabled below.

| Rock type | Velocity | Remarks |
|---|---|---|
| Sandy soil | 330-450 m/s | Up to 2 m thick; information from short weathering spreads. |
| Silcrete | 2 000-2 700 m/s | Weathering spreads |
| Tertiary sandstones and siltstones | 1 000-1 700 m/s | |
| Permian mudstone | 2 040 m/s | 1 860 m/s on basin margins; |

| Rock type | Velocity | Remarks |
|---|---|---|
| | | 2 130 m/s in deeper sections. |
| Beneath Permian mudstone (type unknown) | 2 870 m/s | Possibly weathered basement; could also be lower member in Permo-Carboniferous Series - see comments below. |
| Crystalline basement | 5 600 m/s | |

Comments:

The 2 870 m/s refractor below the Permian mudstone was not noted in the original field interpretation, but revealed itself in an overall appraisal of the results of the traverses studied in detail so far.

The closest available seismic studies for the purpose of comparison are from the Arckaringa Basin over 100 km to the north-east. Typical velocities here are:

| Age | Velocity |
|---|---|
| Lower Cretaceous | c.2 200 m/s |
| Top of Permian | c.2 500 m/s |
| Unit 1 - Lower Permian (top of Stuart Range Formation) | c.2 900 m/s |
| Unit 2 - Lower Permian (near base of Boorthanna Fm.) | c.3 200 m/s with occasional 4 100 m/s |
| Crystalline basement | c.5 600 m/s |

A correlation of ages with seismic velocities for the Mulgathing data would equate the mudstone with either the Lower Cretaceous or the top of the Permian sequence, and the refractor below the mudstone (2 870 m/s) with Unit 1 of the Lower Permian. Crystalline basement at 5 900 m/s is probably not significantly different from the 5 600 m/s basement in the Arckaringa Basin. The fact that the mudstone has been identified as Lower Permian indicates possible different depositional environments, depth of burial, and compaction and lithification processes.

If the 2 870 m/s refractor exists, it will make depth estimates to basement in the centre of the channel substantially greater.

Seismic refraction appears to have outlined the paleo-channel quite well.

2. Gravity

Bouguer gravity values have been calculated and plotted for each of the traverses made. Each traverse shows a distinct gravity low with steep sides which is undoubtedly associated with the channel itself.

Further work to be undertaken involves removal of the regional effects and then estimating depths from the residual gravity profiles. Possibly a density vs. depth relationship may have to be derived to give a more accurate picture of basement depths than the simple assumption of fixed density contrast would give.

JANUARY 16TH, 1975
RGN:TJB

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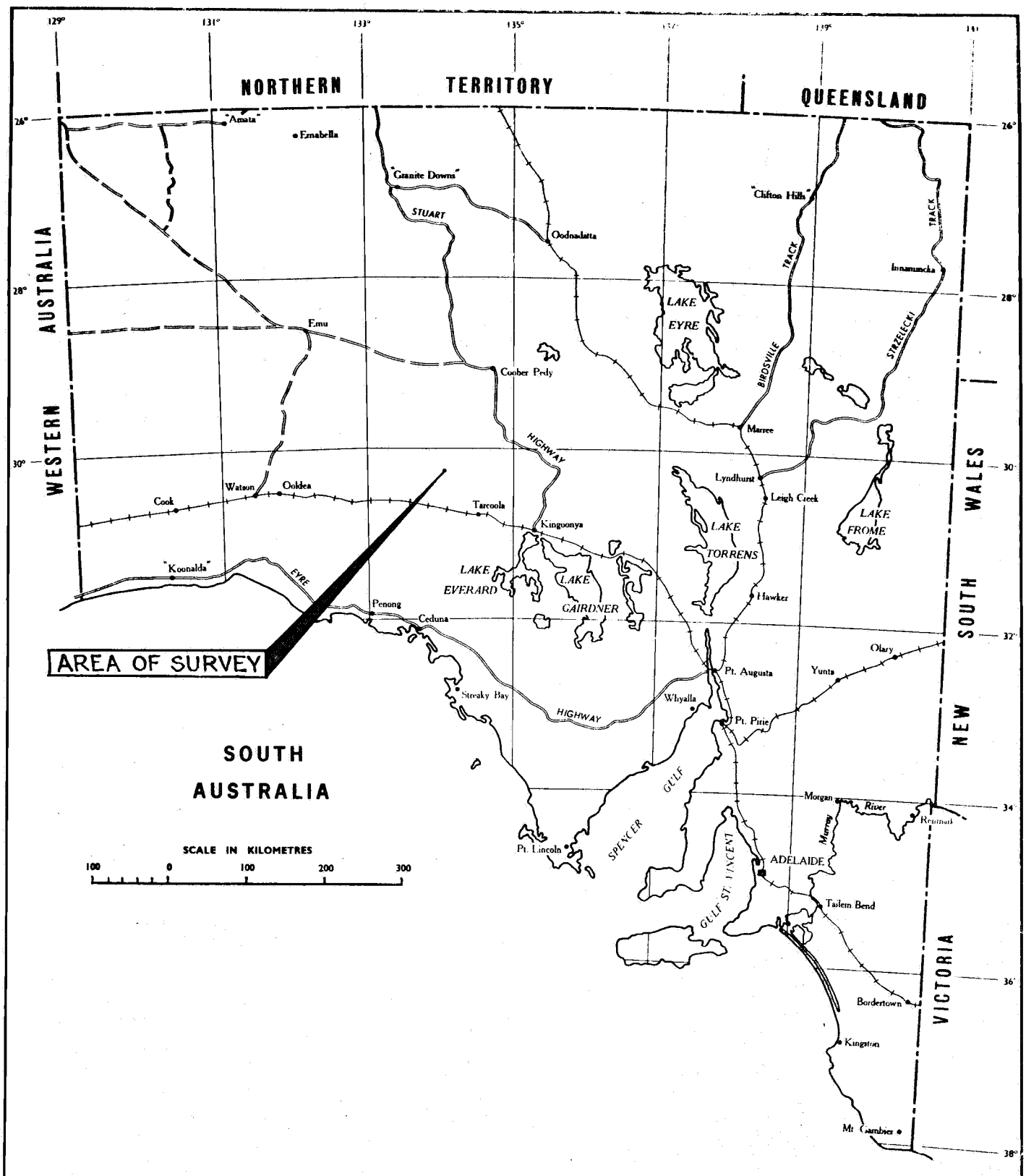
SMITH, A.E., 1951. Graphic adjustment by least squares. Geophysics, 26: 222-227.

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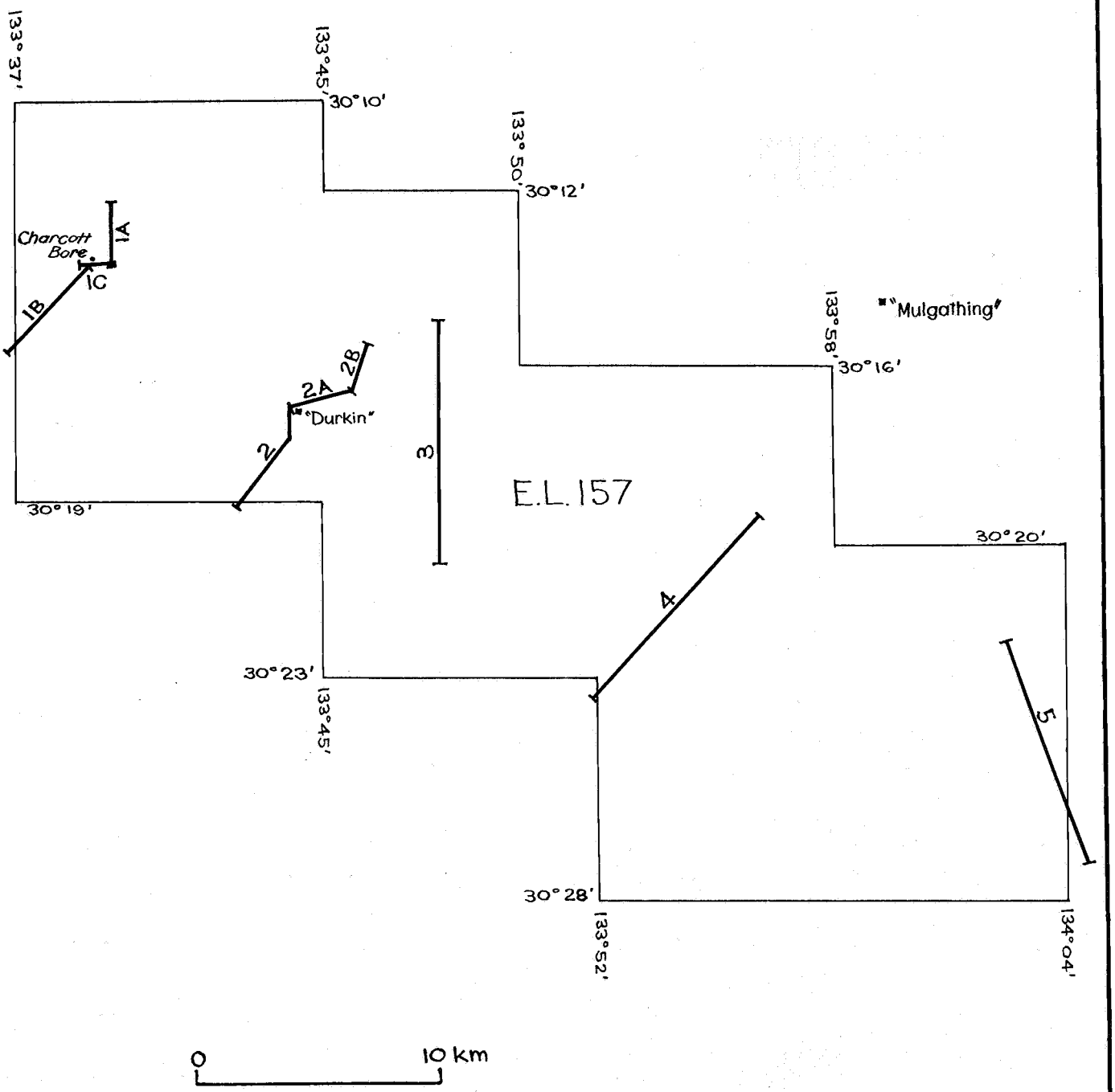
| Compiled. R.G.N. | MULGATHING GEOPHYSICAL SURVEY | Date: JAN 1975 |
| Drn. A.F. Ckd. | E.L. 157 | Drg. No. S11160 |
| | LOCALITY PLAN | |

P.F. No. 55850 9942 5637

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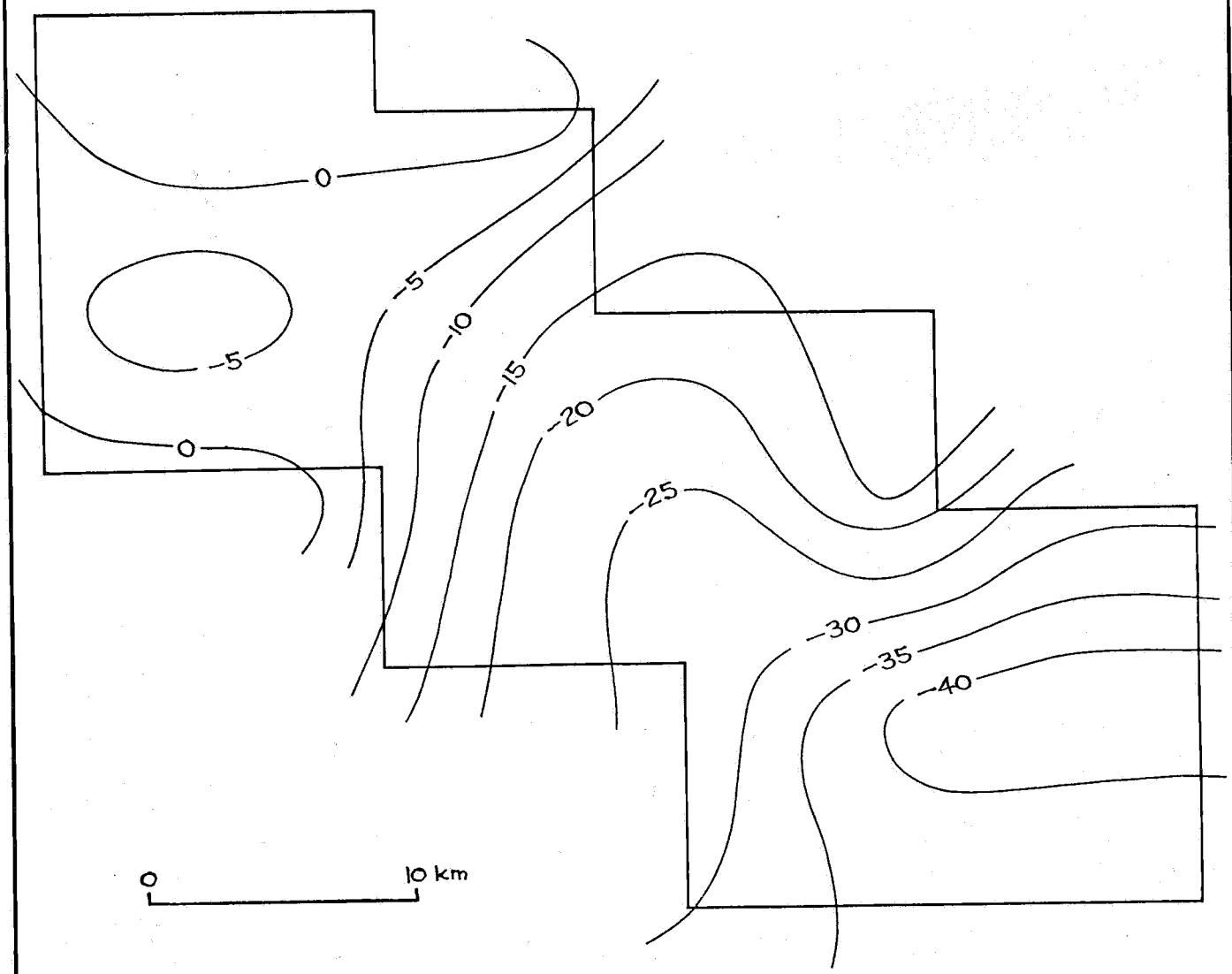
| Drn. A.F. \| Ckd | E.L. 157 | Drg. No. S11161 |
| | LOCATION OF GEOPHYSICAL TRAVERSES | |

IM-- 270 A1810 5637




B.M.R. Regional gravity contours

Assumed density for calculation of bouguer gravity values — 2·2 gm/cc.

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|---|---|---|
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| | REGIONAL GRAVITY CONTOURS | S11162 |

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