DEPARTMENT OF MINES AND ENERGY

SOUTH AUSTRALIA

Rept.Bk.No. 80/49

REFRACTION SURVEY, NORTHWEST MULGATHING TROUGH

GEOLOGICAL SURVEY

by

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D.M. No. 192/77

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ABSTRACT

The Mulgathing Trough, a narrow, possibly fault-bounded trough in crystalline basement, has been previously investigated from north of Tarcoola to near the western edge of the TARCOOLA 1:250 000 sheet by seismic refraction and gravity surveys and drilling.

Refraction work further to the northwest in 1979 shows that the trough splits and shallows with one branch ending abruptly against shallow basement. The other branch may also end against shallow basement twenty kilometres further north, or may continue towards Indooroopilly Outstation.

Shallow basement over a negative gravity anomaly southwest of the Mulgathing Trough suggests that the anomaly is caused by intra-basement density contrasts.

INTRODUCTION

Seismic surveys on the TARCOOLA 1:250 000 sheet in 1974 mapped the Mulgathing Trough from north of Tarcoola to near Charcott Bore (Nelson, 1975a, 1975b, 1976); see also Figure 1 of this report. A negative gravity anomaly coincides with this trough and continues westward onto northeast BARTON where it broadens into a regional negative anomaly (outlined by hatching on Figure 2).

In March 1979 a Departmental seismic crew carried out further exploration of this area with two objectives:

1. To map the Mulgathing Trough to the northwest of Charcott Bore and investigate any possible connection with the Tallaringa Trough.
2. To find out if the regional negative gravity anomaly on northeast BARTON is caused by a sedimentary basin, and if so, whether it is connected to the Mulgathing Trough.

The three week programme of continuous refraction profiling covered about fifty kilometres along station tracks and fence lines. Figure 1 shows the position of the seismic lines, including those of 1974, and the interpreted Mulgathing Trough in relation to the local geography.

GEOLOGY
(contributed by S.J. Daly and G.M. Pitt)

The oldest rocks exposed on the BARTON 1:250 000 map sheet area are part of the Archaean to early Proterozoic Mulgathing Complex (Daly et al., 1978). These rocks, originally sedimentary, were subjected to granulite facies metamorphism between 2500 and 2300 Ma. The Mulgathing Complex is predominantly yellowish weathering, pinkish quartz-feldspar gneiss containing subordinate biotite and garnet. These gneisses are well to poorly layered and grade into massive well-foliated concordant and non-foliated discordant granitoids, pegmatitic in part.

After uplift and erosion younger sediments correlated with the Hutchison Group were deposited east and north of Tarcoola. These sediments were subjected to amphibolite facies metamorphism during the Kimban Orogeny (1800-1600 Ma). This event also partly retrogressed the Mulgathing Complex which was intruded by associated granites. No Hutchison Group metasediments are known to outcrop on the northern portion of BARTON, although foliated syntectonic granites associated with the Kimban Orogeny outcrop at Mobing Rock Hole and at Lake Bring.

Correlation of seismic refractors with crystalline basement rocks in the Arckaringa Basin (Townsend, 1971; Milton, 1972) suggests that a high speed refractor of velocity 5.5 to 5.9 km/s should be recorded over northeast BARTON. A refractor of 5.9 km/s velocity was mapped over the Mulgathing Trough on TARCOOLA (Nelson, 1976), although drilling has not been deep enough to confirm its identification with crystalline basement.

Permian sediments are preserved in the central portion of the Mulgathing Trough on TARCOOLA. The Boorthanna Formation is predominantly fine to very fine marine quartz sand with thin grey to black siltstone horizons and boulder beds. The Stuart Range Formation is a poorly layered carbonaceous mudstone with abundant micaceous partings, probably deposited in a non-marine environment. Previous experience suggests that these sediments will have refraction velocities of 2.7 to 3.2 km/s (Milton, 1972; Nelson, 1976). This has been confirmed by drilling in the eastern Mulgathing Trough.

Thin kaolinitic quartz sands, correlated with the Algebuckina Sandstone, outcrop over a greater part of northeast BARTON. A thicker section of kaolinitic sands is present in the central portion of the Mulgathing Trough and is therefore likely to overlie the Permian in the northwest Mulgathing Trough.

Poorly sorted gravels interlayered with clayey carbonaceous sands, correlated with the Eocene Pidinga Formation, are likely to occur in meandering channels (Pitt et al., 1978) super-imposed on the Precambrian, Permian and Mesozoic topography.

FIELD PROCEDURES AND COMPUTATIONS

Continuous profiling with 24-channel refraction spreads 1.8 km long was carried out over most of the area except for some spreads of 1.2 km on GP79A and GP79J (see appendix for details). Where increasing seismic travel times indicated a deepening of the high speed refractor, spreads were shot with 50 per cent overlap for continuous sub-surface coverage of this refractor. Weathering shots at the centre of each spread provided information on the near-surface low velocity layers. Charges of up to 16 kg of AN60 gelignite were used as the energy source, detonated near the surface or in shot-holes up to ten metres deep.

Energy arrival times were plotted against distance from the shot. Depths to the shallow and intermediate refractors were calculated from the weathering spread data using plane layer theory (Telford et. al., 1976). Approximate depths to the high speed refractor were also calculated in this way and the initial results used to calculate an average velocity from the surface to the high speed refractor along each profile. Final high speed refractor profiles were then calculated using a method described by Hawkins (1961). The time-distance graphs are stored in the Geophysics Section with the basic data (field records, survey data, computation sheets).

RESULTS AND INTERPRETATION

Cross-sections of all the profiles are included in this report as Figure 3. Figure 4 is a contour plan of the high speed refractor, including the section from Charcott Bore to Traverse 5 of Nelson (1975b).

Three refractors were recorded below the surface layer over the survey area, although only the high speed layer was present everywhere:

1. A refractor of velocity about 1.5 km/s was recorded intermittently at very shallow depths (5 to 15 metres) and with a wide range of values (.8 to 2 km/s). In some places at least it may be a water table.
2. An intermediate refractor was recorded on lines GP79D and GP79F. On GP79D this refractor occurs where the basement dips sharply into two troughs and has an average velocity of 2.7 km/s (5 samples, standard deviation s = .3 km/s). Previous experience in the Arckaringa Basin and in the eastern part of the Mulgathing Trough suggests that this is Lower Permian Stuart Range Formation (Milton, 1972; Nelson, 1976). This refractor was also recorded in basement depressions on GP79F,

but is much nearer the surface than on GP79D. Its velocity here is lower at 2.4 km/s, but this may be due to weathering.

3. The deepest refractor, which was recorded on all lines, has an average velocity of 5.7 km/s (34 samples, s = .6 km/s) and is interpreted as crystalline basement (see Milton, 1972, page 70).

West of Charcott Bore the Mulgathing Trough splits into two, both parts being recorded on line GP79F and, more prominently, on GP79D. The southern branch ends against shallow basement between GP79D and GP79C where basement is less than ninety metres deep. The northern branch may continue northwest towards Indooroopilly and/or Lamont Bore on TALLARINGA, or alternatively, could also end against shallow basement south of Lake Anthony (Fig. 4). Both branches of the trough on BARTON appear to contain sediments of the Stuart Range Formation.

Southwest of Lochaline Bore, a broad negative gravity anomaly had suggested the presence of a sedimentary basin. However, the basement refractor was mapped on lines GP79A and GP79J less than seventy metres below the surface. The gravity anomaly must be caused by density variations within the crystalline basement.

CONCLUSIONS AND RECOMMENDATIONS

The two objectives of the survey have been only partially achieved:

1. Northwest of Charcott Bore the Mulgathing Trough splits into two shallower troughs which have been mapped as far as line GP79D. Results on the GP79 lines C, E, J, and A have shown that the Mulgathing Trough does not connect with the Tallaringa Trough via the southern branch - this ends against shallow basement near Lochaline Bore. The northern branch may also end

against shallow basement south of Lake Anthony, or it may continue north-northwest towards Indooroopilly and/or Lamont Bore. Results of earlier refraction work (Milton, 1973) make a connection with the Tallaringa Trough in this direction unlikely.

2. Refraction results indicate shallow basement at the centre of the negative gravity anomaly on northeast BARTON. Also, granite gneiss outcrops at three places over the area covered by the anomaly (Fig. 4). The surface and sub-surface occurrence of crystalline basement indicates that the gravity anomaly is caused by intra-basement density variations.

If the results of drilling by Uranerz (Aust.) Pty Ltd (Dewhurst, 1975; Fig. 1 of this report) and the S.A.D.M.E. Konkaby wells in the eastern part of the Mulgathing Trough give grounds for further investigation, the next phase of exploration of the western parts of the Trough should be drilling. One or two holes should be drilled to basement on line GP79D at shot-points 212 and/or 245 (Figs. 3 and 4). The probable formation intersections at each site are shown below. Depths are in metres relative to surface.

	GP79D212	GP79D245
Permian (Stuart Range Formation)	95	65
Crystalline basement	300	240

JMcGH:ZV

J. McG. Hall

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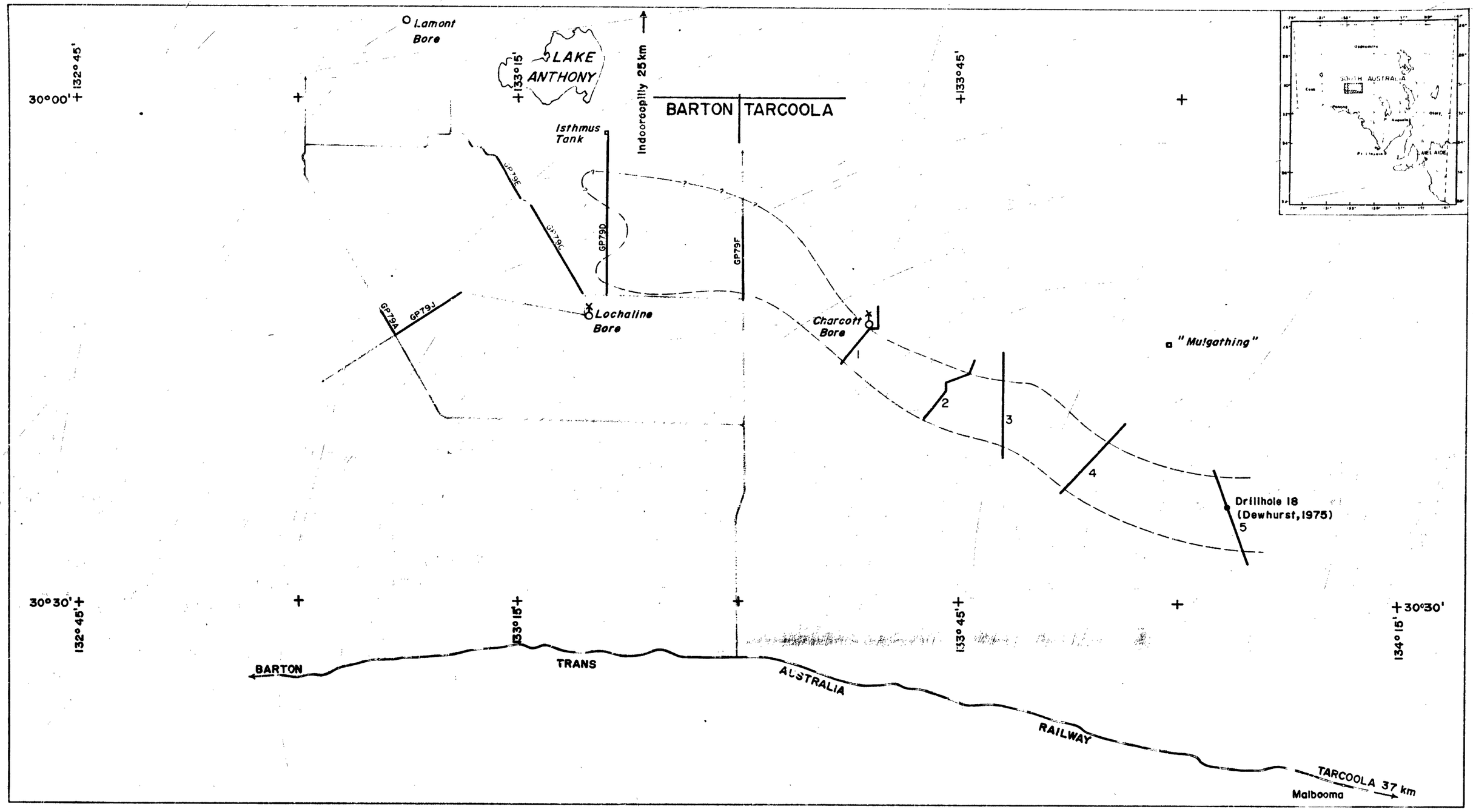
APPENDIX - SHOOTING STATISTICS AND VELOCITIES

	spread length (metres)	geophone spacing (metres)	shot depth (metres)	explosive charge (kilogrammes)	velocity (km/s)
6-cable spreads	1800	75	3-10	3.2-16	
4-cable spreads	1200	50	.5-1	12.8-16	
weathering spreads	600	25	.5-10	.4-1.6	
sub-weathering layer					.8-2.0
intermediate layer					1.8-3.2
high speed layer					4.5-6.2



Seismic line 1979..... GP79C

Seismic line 1974..... 2

Outline of Mulgathing Trough.....

1:250 000 Sheet names..... BARTON

Kilometres 5 0 5 10 15 20 25

Fig. 1

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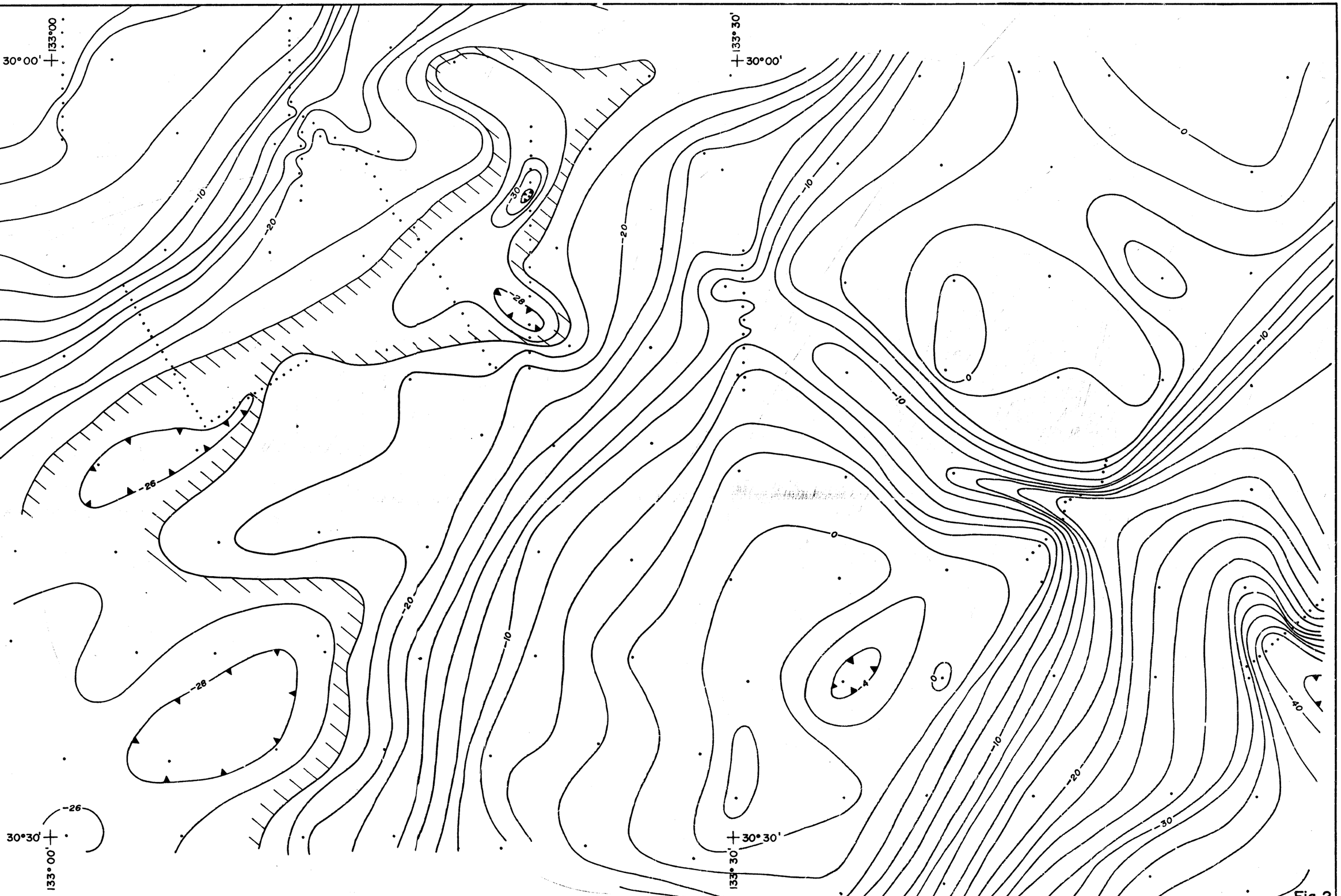
SOUTH AUSTRALIA

NORTHWEST MULGATHING TROUGH
REFRACTION SURVEY
LOCALITY PLAN

COMPILED	J. HALL
DRAWN	M. B.
DATE	30-4-80
CHECKED	
	27/6/80
	DATE
SCALE	As Shown
PLAN NUMBER	80-227

JOB 1882



Contour interval ..... 2 milligals
Gravity Datum ..... mean sea level
Gravity station .....
Regional gravity anomaly .....

KILOMETRES
5 0 5 10 15 20 25

Fig. 2

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NORTHWEST MULGATHING TROUGH
REFRACTION SURVEY
BOUGUER ANOMALY MAP

COMPILED	J. HALL		27/6/80 DATE
DRAWN	M. B.	SCALE	As Shown
DATE	1-5-80	PLAN NUMBER	80-228
CHECKED			

JOB 1882

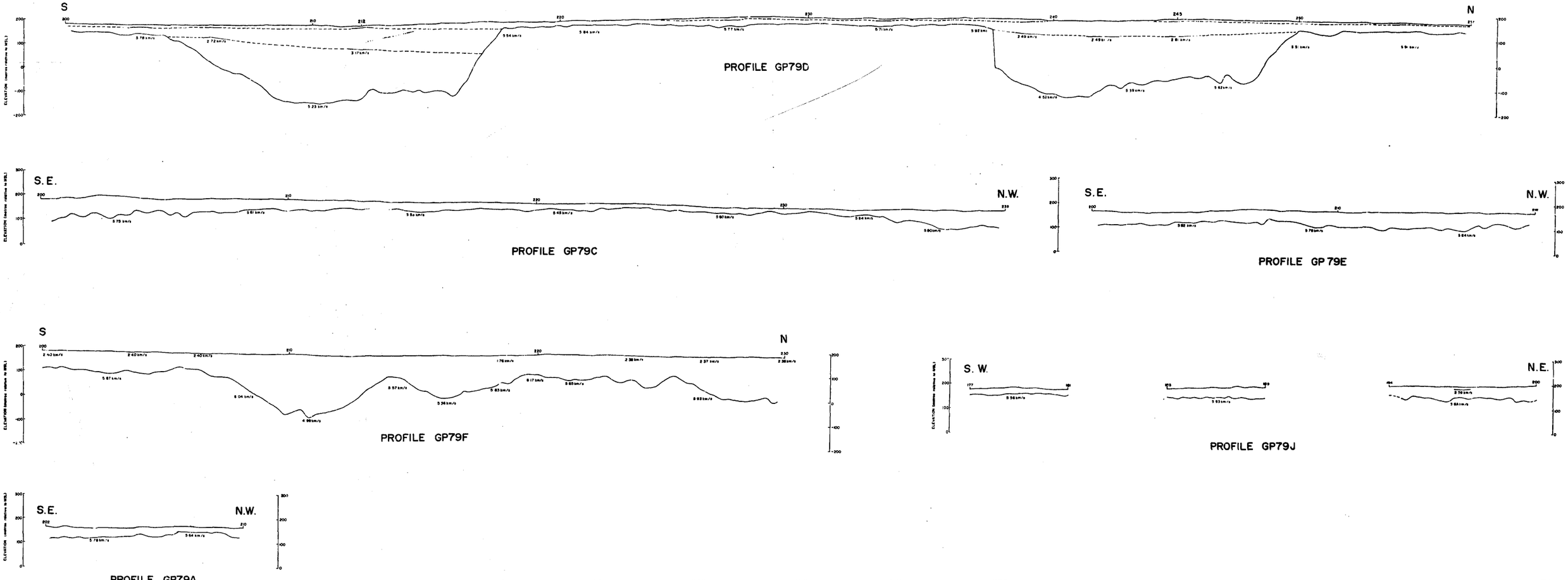

Fig. 3

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED J. HALL		27/6/80 DATE
NORTHWEST MULGATHING TROUGH – REFRACTION SURVEY	DRAWN M.B.	SCALE As Shown	
PROFILES – GP79A, GP79C, GP79D, GP79E, GP79F, GP79J	DATE 2-5-80	PLAN NUMBER 80-229	
	CHECKED		

Job 1662

133° 00'

30° 00'

LAKE ANTHONY

Lamont Bore 15 km

Indooroopilly 25 km

133° 30'

134° 00'

30° 00'

GP79E

GP79D

GP79C

GP79B

GP79A

245

212

× Granite outcrop

× Granite outcrop

× Granite outcrop

Lochaline Bore

Charcott Bore

"Mulgathing"

Vermin Proof Fence

Approximate boundary of area covered by Fig. 2

30° 30'

133° 00'

133° 30'

134° 00'

30° 30'

Datum : Mean Sea Level

Contour interval 50 and 100 metres

1979 seismic lines GP79D

1974 seismic lines ..... ②

5 0 5 10 15 20 Kilometres

Fig. 4

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SOUTH AUSTRALIA

NORTHWEST MULGATHING TROUGH
REFRACTION SURVEY
BASEMENT CONTOURS

COMPILED J.H.	27/6/80 DATE
DRAWN M.B.	SCALE 1 : 250000
DATE 7-5-80	PLAN NUMBER 80-230
CHECKED	

JOB 1882