DEPARTMENT OF MINES AND ENERGY
SOUTH AUSTRALIA

Rept. Bk. No. 80/106

GEOPHYSICAL SURVEYS OF THE ARCKARINGA BASIN RELATED TO PETROLEUM EXPLORATION

GEOLOGICAL SURVEY

By

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D.M.E. No. 574/80

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ABSTRACT

The Department of Mines and Energy and private exploration companies have carried out geophysical investigations in the Arckaringa Basin since 1961 using magnetic, gravity, and seismic methods. Areas of significant sedimentary thicknesses have been found in the Boorthanna, Phillipson, Wallira, Tallaringa, Mt. Willoughby, and Wintinna Troughs. These troughs contain rocks of Permian, ?Devonian, and Cambrian age below the Mesozoic cover of the Great Artesian Basin.

INTRODUCTION

The Arckaringa Basin is a Permian basin underlying the Mesozoic rocks of the Great Artesian Basin in northern South Australia, west of the Peake and Denison Ranges. In deeper parts of the basin, the Permian rocks are underlain by Devonian and/or ?Cambrian sediments. Elsewhere, the Permian rocks lie directly on crystalline basement.

The position and approximate boundaries of the Arckaringa Basin are shown on Figure 1.

SUMMARY OF GEOPHYSICAL EXPLORATION

Geophysical exploration of the Arckaringa Basin began in 1961 with an airborne magnetometer survey by Aero Services Corporation (Delhi Petroleum Ltd, 1961). This indicated the presence of basement troughs west of Oodnadatta and along the western side of the Peake and Denison Ranges.

In late 1963, this Department began investigations in the Arckaringa Basin with seismic surveys along the Oodnadatta - Mount Willoughby road and near Mount Toondina. This continued in 1964 with reflection and refraction work around Mount Toondina

(Moorcroft, 1964) during which the Cootanoorina structure was mapped (Figure 2). Later in the year, refraction depth probes were shot along the Stuart Highway at 10 km intervals from Welbourn Hill to Coober Pedy (Milton, 1964a) and from Coober Pedy to Anna Creek (Milton, 1964b). Spread lengths of 4800 and 7200 feet were used (approximately 1.5 and 2.2 km respectively). Although basement was mapped at less than 300 metres over most of this survey, deeper troughs were discovered north of Mount Willoughby and west of Anna Creek (see figure 1).

A reconnaissance aeromagnetic survey was conducted over the Officer Basin and western Arckaringa Basin in 1964/65 by Adastra Hunting Geophysics Pty Ltd (Exoil Pty Ltd, 1965). The area between this survey and that conducted for Delhi in 1961 was covered by Geophysical Resources Development Co. in 1968. Surveys by the Bureau of Mineral Resources and Geometrics International Corp. for the S.A. Dept of Mines covered the southern and southwestern part of the area (see figure 3).

Regional gravity surveys (see figure 4) of the basin were begun in 1967 with a survey of the southwestern part of OODNADATTA 1:250 000 sheet. Another survey in 1968 covered WARRINA, MURLOOCOPPIE, the southern half of WINTINNA, and the northern halves of BILLAKALINA and COOBER PEDY (Hall and Townsend, 1971). The rest of the Arckaringa Basin was covered in 1969 (Gerdes and Taylor, 1969). Stations were spaced on a nominal 6.5 km square grid in each case.

A more detailed survey was carried out over the southwestern Arckaringa Basin in 1979 to improve knowledge of the Tallaringa Trough and the Karari Fault zone. Gravity stations were established over a 110 by 45 km grid at a station spacing of 2.5 km.

These surveys confirmed the troughs discovered by the aeromagnetic and early seismic surveys and also suggested others north of Coober Pedy (Karkaro anomaly) and southwest of Coober Pedy (Lake Phillipson and Wallira anomalies).

The Department of Mines resumed seismic investigation of the Arckaringa Basin in 1968 in the area west of the Peake and Denison Ranges. This survey confirmed the existence of a basement trough (the Boorthanna Trough - see figure 1) indicated by the 1961 aeromagnetic survey and the 1963/64 seismic surveys. Two structural highs were mapped in detail, one near the Coober Pedy - Anna Creek road and the other west of the Duff Creek railway siding (the Warrangarrana structure, later the site of the exploration well Weedina No. 1 - see figure 2). Some experimental work late in the year north of Mount Willoughby confirmed the existence of the trough indicated by the 1964 refraction work and the 1968 regional gravity survey.

The Karkaro, Phillipson, and Wallira gravity anomalies were investigated by seismic reflection and refraction surveys in 1969. This work confirmed the Phillipson and Wallira troughs but down-graded the Karkaro 'trough' to a shallow depression in crystalline basement; stratigraphic drilling (Karkaro No. 1) confirmed this. Further gravity readings showed that the Karkaro gravity anomaly was of lower amplitude than had been originally thought, the original values probably being caused by errors in barometric elevations used to reduce the gravity readings to datum.

North of Wintinna homestead, a high speed refractor was mapped which was much shallower than the depth to basement interpreted from aeromagnetic data and of a significantly higher velocity than that recorded from crystalline basement in other parts of the Arckaringa Basin. Milton (1972) suggested

that these results indicated a basement trough containing high-density carbonates. Further refraction work late in 1970 strengthened this interpretation and led to the drilling of Mount Willoughby No. 1 which confirmed it and suggested a possible connection with the carbonates in the Boorthanna Trough.

The 1970 seismic season began with refraction work south-west of the Wallira Trough where the 1969 regional gravity survey had indicated a broader and deeper extension of the Wallira Trough. Results of the seismic survey suggested that this was not the case, the axis of the trough (the Tallaringa Trough) being displaced to the north of the gravity anomaly. A strati graphic well, Wallira West No. 1, entered Cambrian Observatory Hill Beds below Stuart Range and Boorthanna Formation rocks of the Arckaringa Basin (Milton, 1973; Townsend, 1976).

Pexa Oil N.L. contracted two seismic surveys in the Boorthanna Trough in 1970 (United Geophysical Corp., 1970a, 1970b). These surveys extended the known trough to the northwest (but did not indicate the boundaries in this direction) and provided a little more detail on the Warrangarrana structure before the drilling of Weedina No. 1.

The Department of Mines carried out an experimental seismic survey in 1971 using Geoflex (Milton, 1971). This was the first use in Australia of Geoflex as an energy source for seismic refraction work. Data were recorded at six areas in the Arckaringa Basin, generally over earlier seismic lines; data quality was generally at least as good as that from the earlier surveys and was obtained with lower operating costs.

A refraction and reflection survey in 1974 (Milton, 1974) west of Wallira West No. 1 strengthened the probability of this being an area of overlap of the Permian Arckaringa Basin and the lower Palaeozoic Officer Basin. However, Wilkinson No. 1,

drilled in 1978, entered Cambrian Observatory Hill Beds beneath Tertiary Pidinga Formation indicating a possible south-western boundary of the Arckaringa Basin between Wallira West and Wilkinson (see figure 1).

Gravity readings were taken along seismic lines as a matter of routine from 1968, and had previously been made on some of the 1964 lines. These results were integrated with those from the regional gravity surveys of 1967, 1968, and 1969.

While the surveys described in this report were related to petroleum exploration, many private companies have carried out detailed geophysical surveys since the early 1960's as part of mineral exploration programmes, usually using magnetic, electrical, and gravity methods. A discussion of this work will be the subject of a later report.

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J. McG. HALL

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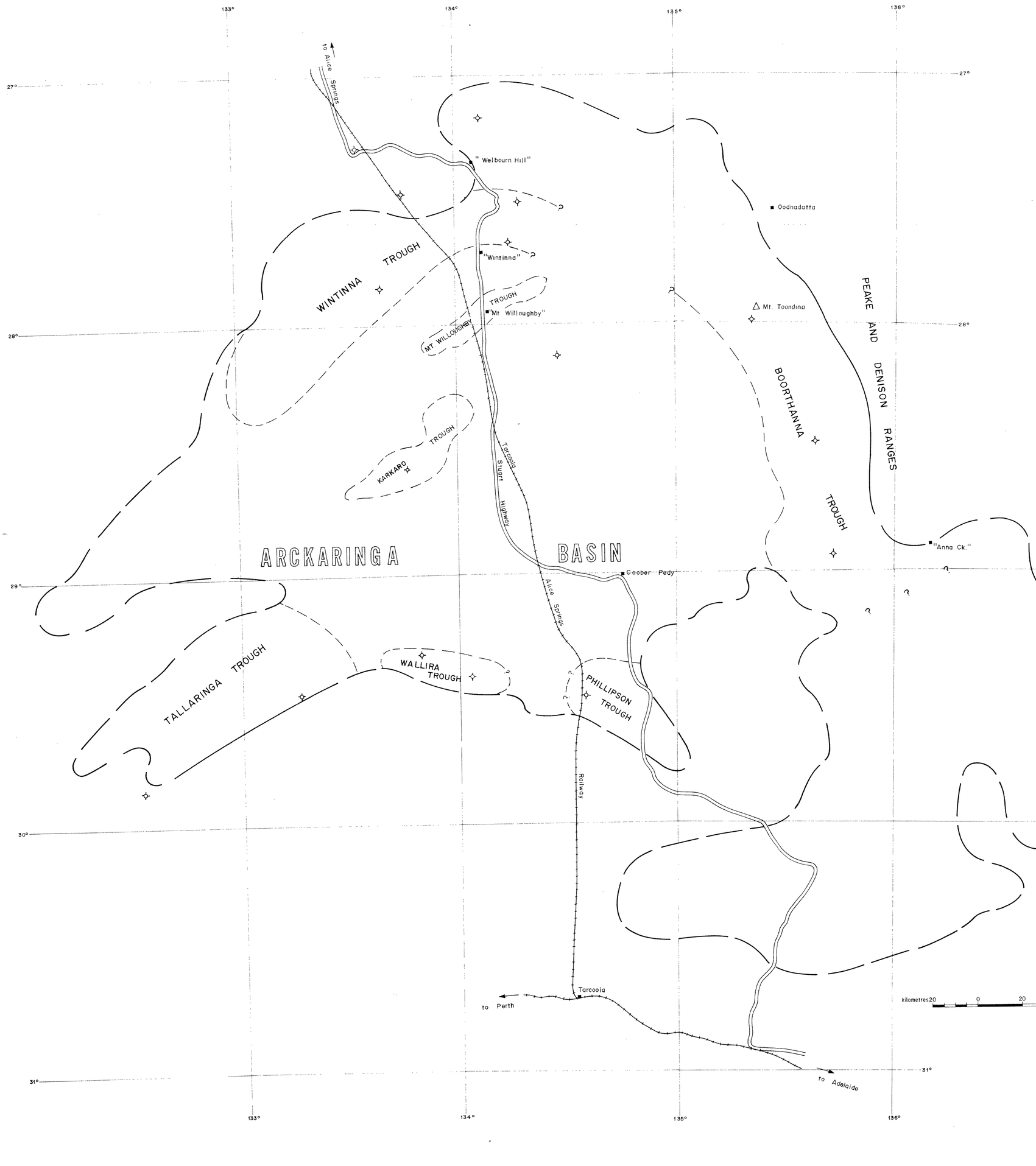
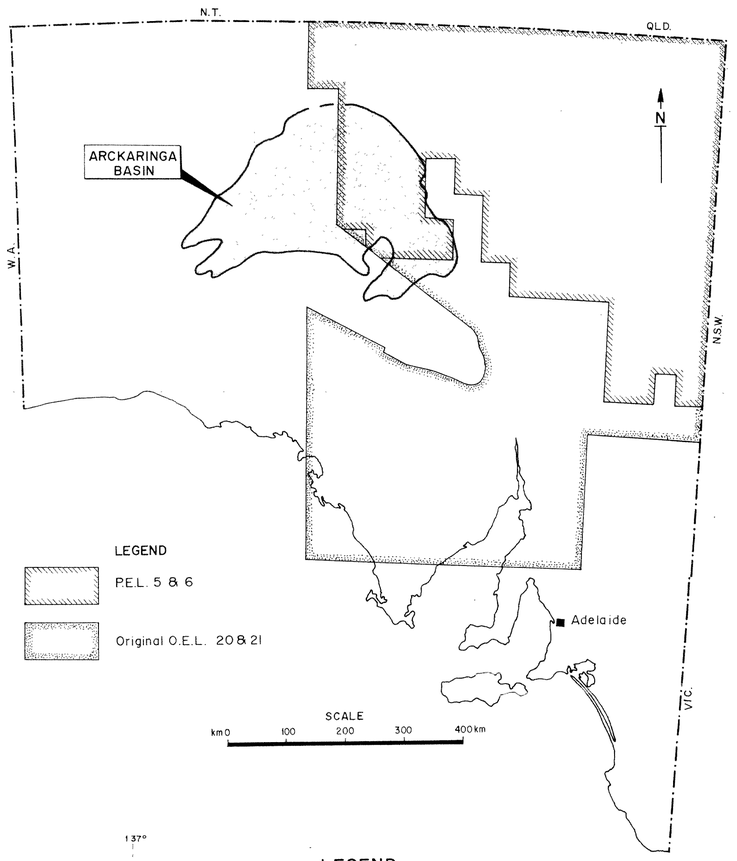
ARCKARINGA BASIN





LEGEND

- Railway
- Stuart Highway
- Stratigraphic well. (For names, see figure 2)
- Arckaringa Basin boundary
- Internal Sub-basins

FIG. 1

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA

ARCKARINGA BASIN
GEOPHYSICAL EXPLORATION

LOCALITY MAP

COMPILED	J.H.
DRAWN	S.R.
DATE	22/8/80
CHECKED	
for C.D.O.	DATE
SCALE	1:1 000 000 reduced to 1:6 250 000 approx.
PLAN NUMBER	80-569

2/18

133°
134°
135°
136°
137°
28°
29°
30°

Coongra No. 1
Byilkaoora No.1
Maria No.1
Lambina No.1
Mt. Willoughby No. 1
Manya No.1
Cootanoorina No.1
Mt. Furner No. 1
Weedina No. 1
Karkaro No. 1
Boorthanna No. 1
Wallira No.2
Wallira No.1
Wallira West No.1
Lake Phillipson Bore
Wilkinson No. 1

ARCKARINGA BASIN

LEGEND

S.A. Dept. of Mines and Energy.
1963, 1964.
1968
1969
1970
1972
1974
United Geophysical Corp.
1970

SCALE
kilometres 20 0 20 40 60 80 100 kilometres

FIG. 2

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA

ARCKARINGA BASIN GEOPHYSICAL EXPLORATION

SEISMIC TRAVERSES

COMPILED	J.H.
DRAWN	S.R.
DATE	26/8/80
CHECKED	
for C.D.O. DATE	15/10/80
SCALE	1:1000 000
PLAN NUMBER	80-570

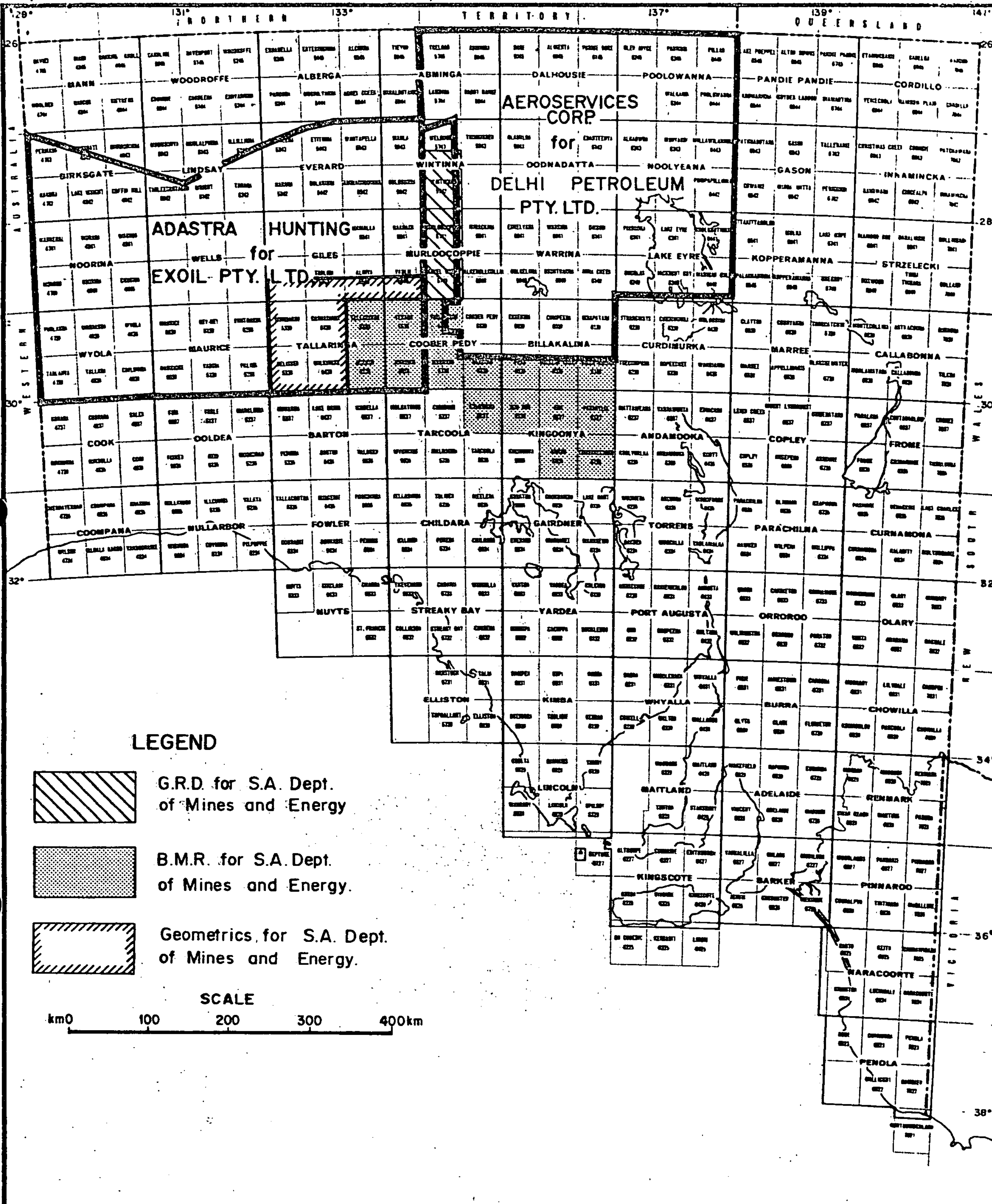


FIG. 3

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED J. H.	for C.D.O. 15/1/81 DATE
ARCKARINGA BASIN GEOPHYSICAL EXPLORATION AREAS COVERED BY AEROMAGNETIC SURVEYS	DRAWN S.R.	SCALE 1: 6300 000 approx
	DATE 18-8-80	PLAN NUMBER
	CHECKED	S15003

2/18

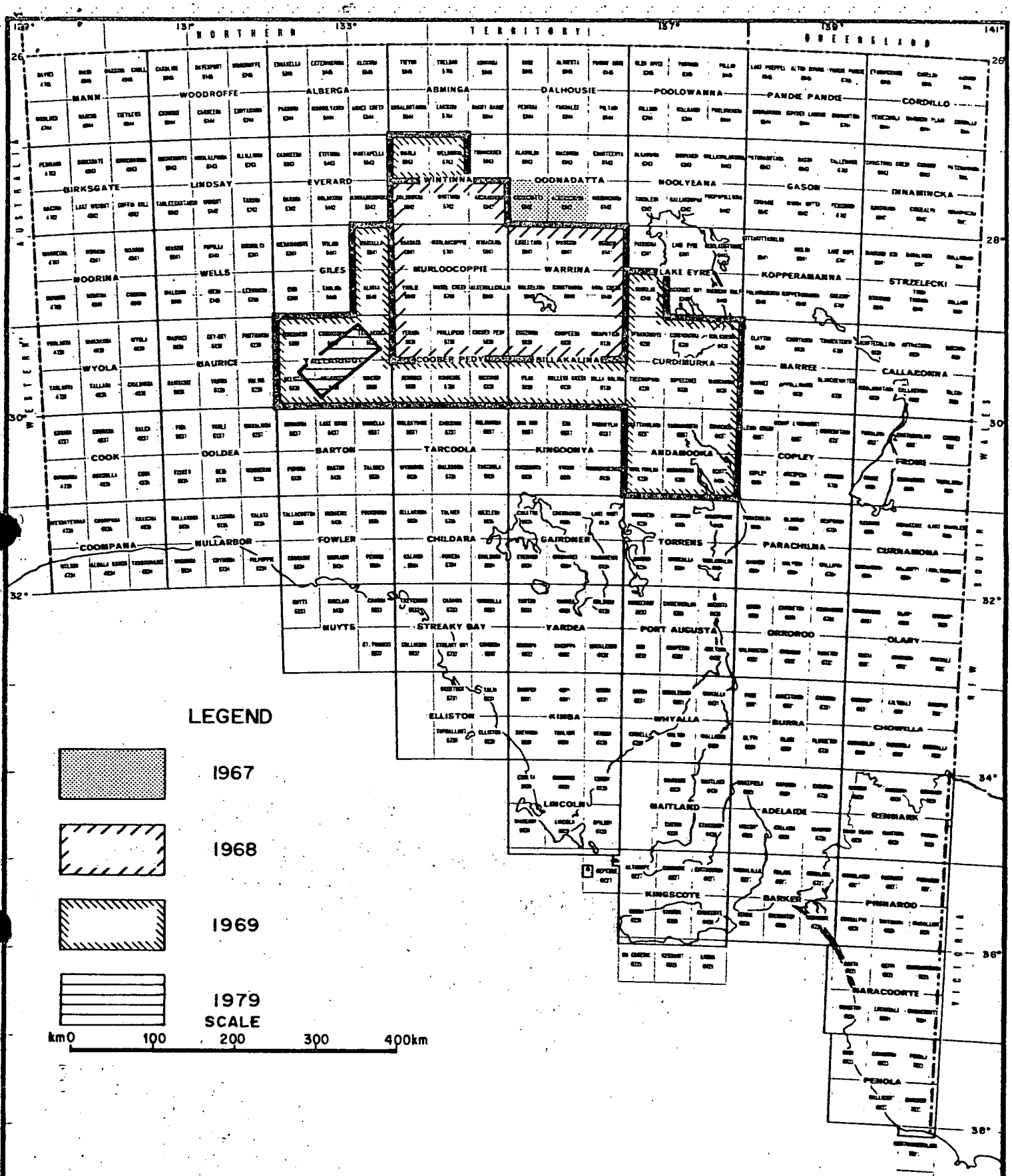


FIG. 4

DEPARTMENT OF MINES AND ENERGY SOUTH AUSTRALIA	COMPILED J.H.	C.D.O. DATE 15/1/81
ARCKARINGA BASIN GEOPHYSICAL EXPLORATION AREAS COVERED BY REGIONAL GRAVITY SURVEYS	DRAWN S.R.	SCALE 1: 6 300 000 approx.
	DATE 19/8/80	PLAN NUMBER S15004
	CHECKED	

2118