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THE GEOLOGY OF THE PEDIRKA BASIN

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DEPARTMENT OF MINES
SOUTH AUSTRALIA

THE GEOLOGY AND HYDROCARBON POTENTIAL OF THE PEDIRKA BASIN

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NOTE

Owing to the considerable dependence of this work on petroleum exploration well data, the operating company and full title of each well will be omitted from the text in order to reduce unnecessary repitition. The names of the wells and operating companies are given below.

French Petroleum Company (Australia)	:	Mokari No. 1
		Mt. Crispe No. 1
		Poonarunna No. 1
		Purni No. 1
		Witcherrie No. 1
Amerada Petroleum Corporation of Australia Ltd.	:	Hale River No. 1
		McDills No. 1

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ABSTRACT

The Pedirka is a Permian infrabasin beneath the western Great Artesian Basin. It lies mainly in the central north of South Australia and the southeast of the Northern Territory but a small part may also extend into Queensland. Much of the eastern Pedirka Basin underlies the Simpson Desert.

The whole of the basin has been covered by aeromagnetic and gravity surveys which, in conjunction with the results of seismic work and exploration drilling, have revealed the existence of two major subdivisions within the basin. The roughly north-south McDills Trend separates an area of thick Lower Palaeozoic sediments in the west from an area of thin Lower Palaeozoic but thicker Permian and Mesozoic sediments to the east.

The Pedirka Basin displays a maximum development of the Permian to the east of the wells drilled. The glacigene sediments of the Crown Point Formation are present over wide areas of the basin. The overlying Purni Formation is less widespread but, where present, the sands, shales and coals may be well over 300 m in their thickest developments. The lithology of the Purni Formation is similar to that of the gas-bearing formations of the Cooper Basin and structures suitable for trapping hydrocarbons are developed in the Permian in the eastern Pedirka Basin. A Triassic caprock could be present in this region.

The western sub-basin, beneath the Pedirka Basin, contains large thicknesses of Lower Palaeozoic and possibly Proterozoic sediments. Sedimentation in this area may have been continuous with that in the Amadeus Basin during parts of the Palaeozoic. Cambrian carbonates and shales, Ordovician sands and Devonian terrestrial sands, shales and conglomerates have been reported from some of the wells. Several formations are considered to contain as much hydrocarbon potential as the Permian rocks.

Mesozoic strata unconformably overlie all Palaeozoic rocks in the area. The Mesozoic sediments increase in thickness in an easterly direction.

The whole region was affected by the Alice Springs Orogeny which developed generally gentle structures in the pre-Permian strata and caused syndepositional movements during the Permian.

Six petroleum exploration wells have been drilled to date. No shows of hydrocarbons were encountered but large areas of the Pedirka Basin remain to be explored and several interesting structures which have been outlined remain untested to date.

INTRODUCTION

The name Pedirka was first used by Canaple and Smith (1965) to describe the southwestern Permian sub-basin within the area presently under study. The name is derived from a small railway siding at the Hamilton River on the railway north from Oodnadatta. Sprigg (1962) named the eastern Permian sub-basin the Simpson Desert Basin. McDills 1 and its associated seismic work have proved that the Permian is continuous over the McDills Trend. Wopfner (1972) extended the term Pedirka Basin to cover the entire Permian depositional area within that part of South Australia. The Pedirka is, by definition, a Permian basin and this study includes its extension into the Northern Territory and Queensland. In this text the two pre-Permian depressions, which are part of the Warburton Basin (Wopfner, 1972), will be informally referred to as the western and eastern sub-basins.

The Pedirka is an infrabasin beneath the western parts of the Great Artesian Basin and the Permian sediments are overlain nearly entirely by the Mesozoic strata of the younger basin.

The Pedirka Basin covers an area of approximately

185 000 sq km. It is contained mainly in the central north of South Australia and the southeastern Northern Territory; and a small area possibly extends into southwestern Queensland beyond the limit shown on Fig. 1. This map shows the location of the basin within Australia and its relation to other known Permian deposits.

At the time of writing (January, 1973) petroleum exploration within the basin is believed to be at a standstill. Figure 2 shows the petroleum exploration titles held at various times in the basin and its surrounding areas. The most recent activity has been the Three Corners Seismic and Gravity Survey conducted by Beach Petroleum (1971) in OP 177 during the latter part of 1971. This and the Vamgas Mt. Ross Seismic Survey (Vamgas, 1970), are the only exploration to have been carried out in the basin since 1966 when the French Petroleum Company (Australia) Ltd. (henceforth called FPC(A)) ceased operating in [redacted] its farmout from Delhi and Santos (see Fig. 2), and Amerada drilled Hale River 1, the second and last well within the Northern Territory part of the basin (Amerada, 1966). A total of six petroleum exploration wells have been drilled in the basin. All were dry. Nevertheless, geophysical data suggest that there may be large areas of virtually unknown prospective strata and that older sediments, as well as the Permian, should be considered in future exploration.

GEOMORPHOLOGY AND CLIMATE

A major part of the land surface overlying the Pedirka Basin is composed of the north-northwesterly trending sand dunes of the Simpson Desert (Fig. 3). The desert covers all of the central and eastern areas of the basin and it is only to the west of the railway line in the Northern Territory and west of the Finke River in South Australia, that the scenery changes. West of the Simpson Desert the gently undulating plateaux rise from 250 m above sea level (a.s.l.) around Pedirka to over 500 m a.s.l. in the northwest. The only noteworthy hills in the region are the Black Hill Range which are just outside the northwestern limit of the basin (Fig. 3) and represent the surface outcrop of an ancient Proterozoic ridge.

The main drainage system of dry watercourses is provided by the Finke River and its tributaries the Stevenson and Hamilton Rivers, all of which in flood flow into the northern end of Lake Eyre. The Todd, Hale and Hay Rivers flow into the northern parts of the desert, but do not cross it into South Australia.

The basin underlies some of the most arid country in Australia. Most places within the region can expect between 5 and 6 cm only of rain a year. Daily maximum temperatures frequently exceed 40°C during the summer months and can fall below 0°C during the winter nights.

The area is remote from Australia's main centres of population. Port Augusta (Fig. 1) is the nearest port (750 km) and Adelaide the closest capital city (1050 km). Land access to the Pedirka Basin is from the north and south. The Stuart Highway

(Fig. 3) runs just west of the area and it is 3 200 km from Darwin south to Port Augusta (Fig. 1). Alice Springs, which lies just outside the northwestern border of the basin (Fig. 1), is the largest centre of population in the region. South of Alice Springs the Stuart Highway is mainly unsealed and can be untrafficable in wet weather. The railway from Adelaide to Alice Springs runs east of the road and passes through Oodnadatta, on the south-western limit of the basin, 960 km from Adelaide (Fig. 3). Access into the western parts of the basin, west of the Finke River, is relatively easy for four-wheel-drive vehicles and a number of tracks are available. Tracks of variable quality circumnavigate the Simpson Desert but very few actually enter the desert area. The best one is that to the Andado Homestead, 100 km east of Finke (Fig. 3). Possibly the best routes to take into the desert would be those pioneered by the seismic teams over the last ten years. These tracks will often be aligned roughly north-south, owing to the dune trends, but a few east-west ones also exist. Travel within the desert is hazardous at all times of the year and there are very few native water wells.

Regular scheduled air flights are available daily to Alice Springs and Oodnadatta from Darwin and Adelaide, which in turn have national and international connections.

Table I

History of Petroleum Exploration in the Pedirka Basin*

1959	Delhi-Santos took out OEL 20/21 (now PEL 5/6).
1961	Aeromagnetic survey flown by Aero Service Corp. for Delhi-Santos (OEL 20/21).
1962	Simpson Desert Seismic Survey by Geoseismic for Beach Petroleum (OP 45).
1963	March: Farmout agreement between Delhi-Santos and FPC(A) (OEL 20/21).
	March-July: Pedirka Seismic Survey by CGG for FPC(A) (OEL 20/21).
	August-November: Dalhousie Gravity Survey by Wongela for FPC(A) (OEL 20/21).
	October: Witcherrie 1 drilled by FPC(A) (OEL 20/21).
	December: Purni 1 drilled by FPC(A) (OEL 20/21).
	December-January 1964: re-interpretation of aeromagnetic data by CGG for FPC(A) (OEL 20/21).
1964	Dakota and Anacoora Bores Seismic Survey by Geoseismic for Beach Petroleum (OP 57).
	April-July: Kallakoopah Seismic and Gravity Survey by United Geophysical for FPC(A) (OEL 20/21).
	December-April 1965: Poolowanna Seismic and Gravity Survey by CGG for FPC(A) (OEL 20/21).
1965	May-October: McDills 1 drilled by Amerada under a farmout from Beach Petroleum (OP 57).
	June-October: continuation of Poolowanna Survey.

1966 February-March: Emery Seismic Survey by CGG for FPC(A) (OEL 20/21).

April-May: Mt. Crispe 1 drilled by FPC(A) (OEL 20/21).

April-June: Perlanna Seismic and Gravity Survey by CGG for Australian Aquitaine Petroleum (OP 36).

June: Mokari 1 drilled by FPC(A) (OEL 20/21).

September: Simpson Desert "A" Seismic Survey by Austral Geo-Prospectors for Amerada (OP 57).

October-November: Hale River 1 drilled by Amerada (OP 57).

1969 Farmout agreement between Delhi-Santos and Vamgas N.L. (PEL 5/6).

1970 Mt. Ross Seismic Survey by United Geophysical for Vamgas (PEL 5/6).

1971 Vamgas N.L. relinquished Mt. Ross farm-in area.

Beach Petroleum Three Corners Seismic and Gravity Survey (OP 177) by Geosurveys.

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*License areas shown on Fig. 2.

HISTORY OF EXPLORATION

Table I shows the record of exploration work within the Pedirka Basin and Figure 2 the Petroleum Exploration and Development Titles held at 1st October, 1972. The South Australian portion of the basin is covered by P.E.L.'s 5 and 6 (originally OEL 20 and 21, and changed in 1969), which are held by Delhi-Santos. The area east of 134° was farmed out to the French Petroleum Company (now Total Exploration) between 1963 and 1966 and the area to the west of 135° was held by Vamgas N.L. under another later farmout agreement.

Beach Petroleum hold O.P. 177 which covers the major part of the basin within the Northern Territory; it was once farmed out to the Amerada Petroleum Corporation. The northeastern corner of the Pedirka Basin is at present held by Reef Oil N.L. under O.P. 172.

Drilling ceased in 1966 with the completion of a sixth dry hole within the basin (Hale River 1). Virtually no exploration work has been carried out since then.

FPC(A) covered fully their South Australian farmout area with an airborne gravity survey (FPC(A), 1964a) and a re-interpretation of aeromagnetic data (Laherrere & Drayton, 1965). A gravity plan of the State, at 1:1 000 000, has been produced by the South Australian Mines Department and a similar aeromagnetic plan is nearing publication. The Northern Territory and western Queensland have been similarly covered by the BMR. An adequate picture of these geophysical data is therefore available to assist with future exploration.

Most of the deeper part of the Pedirka Basin (see Fig. 5) has been covered moderately well by at least reconnaissance seismic surveys (Fig. 4). The four surveys conducted for FPC(A),(FPC(A) 1963, 1964b, 1966a & b; Drayton, 1967) covered 2 440 line km and the Vamgas (1970) Mt. Ross Survey 320 km in a total area of approximately 65 000 sq km. Figures are not available for the surveys conducted in the Northern Territory. The seismic data available to date have enabled several potential target structures to be outlined and four wells have been drilled in South Australia and two in the Northern Territory. Much more seismic coverage is needed in large areas of the northern parts of the basin and also smaller areas along the western and eastern margins. This information is required to outline the limits of the Permian subcrop, to delineate possible pinchout zones and to define structures which could warrant further investigation.

The first of the six petroleum wells drilled in the basin was Witcherrie 1. It was drilled by FPC(A) late in 1963 in order to adjust the Mesozoic and Upper Palaeozoic seismic markers already known from the preliminary surveys. It was also proposed to identify the Palaeozoic formations. The well was located down-dip on a fault-bounded structure. Witcherrie 1 achieved its objective in that it identified over 900 m of possibly Devonian and Ordovician beneath the thin Permian strata and found a good reservoir in the ?Finke Group (Magnier, 1964a). No petroleum drilling targets were prognosed for the well and it was purely a stratigraphic test.

Purni 1 was drilled immediately following Witcherrie 1 and, like the latter, was a stratigraphic test only. No total depth was fixed before drilling - it was to be decided during the drilling of whatever Palaeozoic strata were encountered. Purni 1 was drilled 45 km ENE of Witcherrie 1, just into the Simpson Desert, and was located to test Palaeozoic sediments which geophysical work had shown to have different seismic characteristics from those in the Witcherrie area (Magnier, 1964b). Purni 1 encountered far thicker and more complete Mesozoic (over 1 300 m) and Permian (375 m) sections than Witcherrie 1 and intersected ?Lower Ordovician shales beneath the Permian. No Devonian was present in the well and drilling ceased in the ?Ordovician strata. Good Permian porosities were encountered in this well but no hydrocarbon shows were recorded.

Following the drilling of these wells, Magnier (1964b) suggested that FPC(A) concentrate future exploration on Permian targets - partly as a result of the two abovementioned stratigraphic tests and partly as a result of commercial gas flows at Gidgealpa 2 in the Cooper Basin in 1964.

Amerada's first well, McDills 1, was drilled in the Northern Territory north of the French wells during the winter of 1965 (Amerada, 1965). It was ~~sighted~~ sited on the top of a closed Permian structure which had been located from seismic surveys. The well intersected approximately 700 m of Mesozoic strata, nearly 200 m of Permian, over 1 700 m of thick possibly Devonian rocks and bottomed in Lower Cambrian dolomites. This well was the first deep test in the Simpson Desert and, although no shows were found, it demonstrated the possibilities for thick Lower Palaeozoic sections within the basin and disclosed a Permian section thinner than was anticipated.

Following further seismic surveys (Table I) and a critical re-evaluation of all data, FPC(A) decided to drill two more wells. Mt. Crispe 1 was drilled 30 km west of Witcherrie 1 and 100 km southwest of McDills 1 (Jacque, 1966a). This well was drilled during April and May 1966 on the flank of a surface structure (the Dalhousie Anticline) which also had been defined by seismic data. As expected, the Mesozoic and Permian sections were thinner than those to the east - approximately 450 m of Mesozoic and only 19 m of lowermost Permian. The Devonian strata were entirely missing from Mt. Crispe 1 and the 300 m of ?Ordovician and 900 m of Cambrian sediments were considered disappointing as prospective hydrocarbon reservoirs (Jacque, 1966a).

Mokari 1 was drilled on a seismically defined structure by FPC(A) during June 1966 and was planned with a Permian target in mind. The three earlier wells and their associated geophysical surveys led FPC(A) to expect a thicker Permian section to the east and a thinner or absent Lower Palaeozoic section (Jacque, 1966b). The well intersected over 1 700 m of Mesozoic sediments, over 450 m of Permian and bottomed in shales which were given a Lower Ordovician age by radio-active dating. The section was identical to that in Purni 1 (Magnier, 1964b) but was thicker in each formation. No significant hydrocarbon shows were encountered and the Permian strata were considered by FPC(A) to have no good reservoirs. The well was completed as an artesian water well.

Amerada's Hale River 1 was drilled in the desert 90 km northeast of McDills 1 during October and November 1966. It was drilled to test a large pre-Permian anticline which had been identified by seismic methods. The target zones were in the pre-Permian formations but the Palaeozoic section was found to be much thinner than anticipated (Amerada, 1966) and contained only 120 m of Permian and 56 m of sediments which may belong to the Permian or Finke Group. All other Palaeozoic formations were absent. Good porosities were encountered in some Jurassic and Permian sands but no hydrocarbon shows were found.

Four water bores have also yielded information on Permian strata and associated microflora. They occur close to the western outcrop areas in the Finke River region and are recorded by Evans (1964) and Rochow (1965).

The six petroleum wells, despite a density of less than 1 in 30 000 sq km, have given much useful stratigraphic information and have identified the thick pre-Permian strata which were unknown ten years ago and still remain virtually untested.

At this stage in the exploration of the basin, all activity is at a standstill and future plans for the deeper parts of the basin possibly could be best directed towards detailed seismic work of previously delineated structures followed up by exploration drilling. A close study of the gravity and aeromagnetic data would assist in identifying areas with possibly thick sediments and future drilling should concentrate on all of the Palaeozoic section rather than just the Permian. In the western areas, particularly closer to the Amadeus Basin, there are good possibilities that the Ordovician and Devonian sandstones and Cambrian sands and limestones of the Warburton depositional area will provide suitable reservoir rocks in both structural and stratigraphic traps. The Permian sediments have been shown to thicken eastwards and recent work (Beach Petroleum, 1971; Williams, 1973) suggests that Triassic caprocks (cf. the Cooper Basin) may be present in the eastern parts of the basin. Fig. 23 shows three possible interpretations of the thicker Permian section in the eastern parts of the basin. Further details of this are given on page 37. The thicker members of the Purni Formation could be developed similarly to those of the Lower Permian in the Cooper Basin and therefore contain adequate reservoir sands and source beds of coal.

Further possibilities for Permian stratigraphic traps exist around the margins of the basin and in the southern parts (see FPC(A) Kallakoopah Survey). Only a minimum amount of seismic work should be necessary to locate pinchouts prior to exploration drilling.

A number of purely stratigraphic wells could also be of great advantage in long-term exploration of the basin and information on the sediments between the Arckaringa and Pedirka Basins would be one of the first targets. The northern region, overlying the Arunta Block, warrants much more investigation. Initially a few shallow stratigraphic wells should be drilled to establish the presence of Permian and maybe older sediments.

PREVIOUS LITERATURE

General.

Very little published literature relates directly to the Pedirka Basin. Some major contributions have been presented by Sprigg (1963), Canaple and Smith (1965), Laherrere and Drayton (1965), Rochow (1965) and Wopfner (1972). Most of the unpublished work is in the form of company reports on geophysical and drilling work and nearly all of it is available on open file at the South Australian Department of Mines.

Surface Mapping.

Surface mapping of the Northern Territory part of the basin is nearly complete. The Finke (Wells, 1969), Hale River (Shaw, 1968), McDills (Stewart, 1968) and Rodinga (Cook, 1969) 1:250 000 geological sheets have been published by the Bureau of Mineral Resources (B.M.R.) with accompanying explanatory notes and the Simpson Desert North and South sheets are in preparation. Preliminary geological sheets for the Dalhousie and Poolowanna areas have been published by the South Australian Department of Mines and the latter sheet also has an unpublished set of explanatory notes (Williams & Youngs, 1972). The Abminga sheet is in preparation. F.P.C.(A) company geologists carried out field mapping on the Dalhousie sheet and around the Finke River in the Northern Territory during the early part of their farmout agreement (Cooper *et al.*, 1964).

Exploration.

Well completion reports for the six petroleum exploration wells are not published but five of them are available at the South Australian Department of Mines, (Amerada, 1965; Jacque, 1966a & b; Magnier, 1964a & b).

A summary of the geophysical work carried out by FPC(A) in the South Australian portion of the basin was published by Laherrere and Drayton (1965). The only other published material covers the Northern Territory; seismic results are given by Moss (1962), gravity by Langron (1962) and aeromagnetic by Quilty and Milsom (1964). The remaining geophysical reports are available on open file at the South Australian Department of Mines. Seismic results in PEL's 5 and 6 are given by FPC(A) (1963, 1964b, 1966a & b), Drayton (1967) and Vamgas (1970). Hall (1968), Krieg (1967) and Stadter (1972) present unpublished seismic contour maps of the Great Artesian Basin within South Australia and revised metric editions of the former two are in preparation at the present time. Seismic survey results from the Simpson Desert in the Northern Territory are given by Beach Petroleum (1965, 1967, 1970 & 1971). The only large-scale gravity survey was carried out by FPC(A) (1964). Interpretations of airborne magnetic surveys are given by Delhi (1961a & b, 1962) and Laherrere and Drayton (1965).

No work has been published as a complete study of the Pedirka Basin. Parkin (1969) presents a small amount of information on the basin. Wells *et al.* (1966b & 1970) extend their studies of the Palaeozoic Amadeus Basin into the northwestern parts of the Pedirka, Wopfner *et al.* (1970) discuss the Mesozoic rocks of this part of the Great Artesian Basin and Smith (1967) describes briefly the Permian outcrops of the northern margin.

THE BASIN LIMITS

Very little definitive information is available concerning the limits of the Pedirka Basin (Fig. 5). The estimation of an areal extent of 185 000 sq km is therefore very approximate. Exploration has been nearly entirely confined to the central part of the basin but it is believed that the Permian strata extend farther in nearly all directions and will still offer prospective exploration targets. In the west the underlying sediments are Lower Palaeozoic in age. In the east the thicker Mesozoic strata will be underlain by Permian and Triassic sediments much thicker than those found in the west which are, in turn, underlain by possibly thin Lower Palaeozoics.

The northern limit of the basin has been placed around the outcrops of ?Permian glacial deposits of the Tarlton Formation (Smith, 1967). These strata, which outcrop in scattered small areas along the northern edge of the Simpson Desert, are overlain by sediments of Upper Triassic-Lower Jurassic age (Smith, 1967) and are very similar to those at Crown Point in the Northern Territory (Wopfner, *pers. comm.*) which have been described by many authors, including Wells *et al.* (1970).

Permian rocks were absent from those wells to the south and east of the Pedirka Basin which are shown on Fig. 5. The eastern boundary of the basin has been drawn purely tentatively and without any seismic control. The Birdsville Track Ridge has limited Permian deposition on its western flank but the exact limits are unknown.

The Kallakoopah Seismic Survey (FPC(A), 1964b) obtained good results from a Permian reflector in the northern half of the survey area (Fig. 4). The report suggested they were derived from coal beds. The quality of reflections deteriorated southwards, towards Poonarunna 1, and it is possible that the coals gradually disappear in this direction. Permian strata may well be present farther south than the boundary shown, as Poonarunna 1 was drilled on a structural "high" which was bald of Permian (Magnier & Cooper, 1964) and at least one stratigraphic well is required in this region.

The southeastern limits of the Pedirka Basin, as shown on Fig. 5, lie beyond the limits of the Kallakoopah Seismic Survey (FPC(A), 1964b) and have been drawn with the cooperation of gravity and aeromagnetic data in the area. The southwestern area, south of Oodnadatta 1, has been drawn on the results of South Australian Mines Department seismic work which has found the Permian to be very thin or absent in this area. To the northwest of Oodnadatta 1, there may be thin sediments over the Bitchera Ridge (Figs. 6 & 7), connecting the Pedirka and Arckaringa Basins.

The western margin of the basin passes close to the Eringa Trough (Figs. 6 & 7), near Mt. Crispe 1, and is then located from the Permian outcrops near the Finke River. Northeast of the outcrops, the Arunta Block is known to be close to the surface but it is postulated that thin Permian sediments may overly it and thereby connect the Crown Point outcrops with those in the Georgina Basin.

THE BASIN STRUCTURE

The broad structural elements within the basin can best be described by reference to the aeromagnetic (Figs. 6 & 7) and gravity (Fig. 8) plans for the basin and its environs.

Fig. 6 shows the original interpretation of depths to magnetic basement which was carried out by Aero-Service for Delhi-Santos (Delhi, 1961a & b, 1962) and Fig. 7 shows the later interpretation of the same data by C.G.G. for FPC(A). These two plans were presented by Laherrere and Drayton (1965) who concluded that an average of the two probably gives the best indication of depths to the magnetic basement as defined by seismic surveys. The two interpretations have been included in this study to demonstrate the regional trends and positions of the structural features.

The major trends within the Pedirka Basin are aligned northwest and southeast. The northwesterly lines are associated with the older Proterozoic structures in the region. The Peake and Denison Ranges outcrop to the south of the Pedirka Basin and their influence on the aeromagnetic and gravity patterns is clearly seen in Figs. 6, 7 & 8. This trend dies out along the southwestern edge of the western sub-basin where the latitudinal lines of the Musgrave Block (Bitchera Ridge; Devine & Youngs, 1973) and Amadeus Basin exert their influence over the western margins of the basin (Figs. 6 & 7). These east-west trends possibly exist at depth into the western Pedirka Basin but are overlain by the predominant north-northeasterly lines which cover nearly the entire area.

The gravity data (Fig. 8) clearly show a northeasterly pattern of anomalies running through the McDills 1 well and towards the Arunta Block which underlies the northern part of the basin (Fig. 5). In South Australia, the McDills Trend appears to change direction and run northwesterly close to Witcherrie 1 - this suggests that in this part of the basin it may be associated with the Peake and Denison Ranges trend.

The McDills Trend divides the Pedirka Basin into the two Palaeozoic sub-basins which are centred along the Northern Territory - South Australian border. The Permian in the western one was named the Pedirka Basin by Canaple and Smith (1965) and is clearly demonstrated by geophysical methods in the area of Mt. Crispe 1. It is believed that the sub-basin contains thick Lower Palaeozoic sediments as well as Permian. The eastern sub-basin has been called the Simpson Desert Basin (Sprigg, 1962) and represents an area of gentler gravity anomalies (Fig. 8) and probably shallower depths to the magnetic basement (Figs. 6 & 7). A very deep northeasterly trending sub-basin is present close to the southeastern margin of the Pedirka Basin and is accompanied by a negative gravity anomaly (Fig. 8) - it is interpreted as being 5 500 m deep by Aero-Service (Fig. 6). This sub-basin abuts on to the Birdsville Track Ridge and has a shallower lobe extending southwards towards Poonarunna 1.

As mentioned earlier in this report, the two Palaeozoic sub-basins will be referred to informally as western and eastern.

The northern parts of the basin have a generally shallower basement and the surface of the Arunta Block gradually rises towards the northern margin of the Pedirka Basin. The McDills Gravity Platform is an area of gentle, small gravity anomalies and moderately deep aeromagnetic basement to the north of the deeper sub-basins mentioned earlier (Figs. 6 & 8). A small northeasterly aligned depression is located on the edge of the McDills Gravity Platform close to Malcolm's Bore (Fig. 6) and is accompanied by a negative gravity anomaly (Fig. 8).

Figs. 9, 10, 11 and 12 show structure contour plans which have been derived from seismic data.

Five seismic reflectors have been recognised in the basin and they are defined as follows:

- C - top of Cadna-owie Formation (Cretaceous)
- P - top of Permian
- Pi - base of Upper Member, Purni Formation
- Z - base of Permian or Mesozoic, if Permian is absent
- D - base of Devonian, where present.

The C, P and Z definitions are in use by the South Austrlian Mines Department. Unfortunately, FPC(A), Vamgas and Beach Petroleum frequently lapsed from this terminology and care must be taken to distinguish between the companies' P, P1, P2 and Z for each of their surveys. It is found that P and Z do not always correspond to the above definitions and that P, P1 and P2 change levels between surveys.

Fig. 9 represents the unconformity surface onto which the Devonian (D) and later sediments were deposited. It shows a definite northeasterly alignment of faults and of the Eringa Trough (Devine and Youngs, 1973). The area east of the McDills Trend displays gentler structures and less precise trends, particularly to the south of the Devonian limits and the information suggests that some deep Palaeozoic basins could be preserved in the Northern Territory north of Purni 1 and Mokari 1 (Fig. 14). The base of the Permian ("Z" horizon) (Fig. 10), is similar to the lower surface and shows the substantial infilling of the troughs which occurred during the Devonian (Fig. 13). The throws of the faults are similar at both levels.

The "P" structure contour plan (Fig. 11) covers much of the explored parts of the Pedirka Basin. In the South Australian portion, the trends are similar to those for the two lower horizons but display gentler structures and occur at shallower depths. The structure in the Northern Territory demonstrates the continuation of the strong northeasterly trends from the Eringa Trough into the area west of McDills 1. Data for this part are scarce but it is believed that the unknown structure on Fig. 11 is a trough downfaulted to the west of the McDills Trend. As in the South Australian portion, the structures in the remaining part of the Northern Territory are less clearly aligned but the contours indicate that the basin could be deeper between Hale River 1 and McDills 1. Recent work by Beach (1971) has identified several features in the area north of Purni 1 and Mokari 1, they are not shown in Fig. 11. Throws of the faults are generally less than 300 m.

The basal Cretaceous "C" plan shows the structure of the Cadna-owie Formation (Fig. 12). The same general pattern of faults and structures has continued up the sequence from the underlying strata but structures are noticeably less severe and the influence of faulting is greatly reduced (Figs. 13 & 14). Fault F2 is not present at this level (Fig. 12).

The top of Permian and basal Cretaceous plans (Figs. 11 & 12) both display east-west trends and steeper gradients in the area of Hale River 1 and to the west of it. This is probably influenced by the relatively shallow-lying Arunta Block and marks the northern margin of thicker Permian deposition in that area.

The structural features which have been detected at the seismic horizons are discernible in the modern topography. Most of the surface features within the basin are obscured by the Simpson Desert but the area west of the Finke River has been mapped by Cooper *et al.* (1964). The Emery Range and Dalhousie Anticline (Fig. 16) are surface expressions of part of the McDills Trend and fault F1 runs through the middle of the eroded anticline.

Some faults in the region are moving at the present time. Recent earthquake data suggest that fault F6, which marks the eastern limit of the thick Permian coal beds (Drayton, 1967),

TABLE II: WELL DATA AND FORMATION TOPS

Well Name	HALE RIVER 1	McDILLS 1	MOKARI 1	MOUNT CRISPE 1	PURNI 1	WITCHERRIE 1
Latitude	25°15'48"S	25°43'50"S	26°19'06"S	26°26'43"S	26°17'10"S	26°22'20"S
Longitude	136°43'36"E	135°47'25"E	136°26'22"E	135°22'36"E	136°05'35"E	135°39'10"E
K.B. m a.s.l.	125	126	68	131	78	87
	FORMATION TOPS IN METRES; BELOW S.L.					
TERTIARY & HOLOCENE	SFCE	SFCE	SFCE	SFCE	SFCE	SFCE
CRETACEOUS:	+64	+105	111	+122	38	+72
CADNA-OWIE FMN "C"	715	312	1124	54	903	191
JURASSIC	750	337	1172	81	946	229
PERMIAN: PURNI FMN "P"	1144	591	1735	-	1339	468
CROWN POINT FMN	-	784	2085	315	1620	471
DEVONIAN: IDRACOWRA SST	-	?856	-	-	-	-
HORSESHOE BEND SH	?1260	?1030	-	-	-	?568
LANGRA FMN	-	1066	-	-	-	?710
POLLY CONGLOMERATE	-	1642	-	-	-	?906
MEREENIE SST	-	2036	-	-	-	-
ORDOVICIAN	-	?2377	?2186 TD=2318	?334	?1708 TD=1797	?1083 TD=1378
CAMBRIAN	-	2625 TD=3080	-	647 TD=1590	-	-
PROTEROZOIC	?1309 TD=1507	-	-	-	-	-

is aligned with other faults to the southeast and that it has moved during this century (Youngs & Wopfner, 1972). It runs in a northwesterly direction and is therefore associated with the older tectonics of the region.

STRATIGRAPHY

General

The Pedirka Basin is, by definition, Permian in age and the present day area of the basin contains sediments ranging in age from Permian to Holocene. Three of the wells (Mt. Crispe 1, Mokari 1 and McDills 1) have identified Lower Palaeozoic strata and the other three intersected sediments which can reasonably be presumed to be Palaeozoic in age (Table II). The Pedirka Basin is possibly underlain by large thicknesses of Palaeozoic strata, particularly in the western parts of the basin (Fig. 16).

The Permian and younger rocks are entirely sedimentary in origin and contain some non-detrital minerals e.g. pyrite in the Purni Formation and glauconite in the Rumbalara Shale. In many places the sequence is capped by a silcrete layer which crosses stratigraphic boundaries and represents the result of an ancient stable landscape which underwent deep weathering (Wopfner & Twidale, 1967).

The clastic sediments range from shales through to conglomerates and diamictites. The Rumbalara Shale is predominantly a dark grey mudstone. Shales were also intersected in the Purni and Crown Point Formations. Sands occur at intervals throughout the Permian to Holocene sequence and include the De Souza

Sandstone and the glacigene sands of the Crown Point Formation. Conglomerates are found in the basal Purni Formation and also in the underlying Crown Point Formation. The Crown Point sediments also contain diamictites in the subsurface occurrences but none have been recorded from the outcrops in the Northern Territory. Carbonates do not constitute a major lithology in the Pedirka Basin and no large sequences have been intersected in the Permian to Holocene strata. The silcrete forms a solid, impermeable layer of quartz.

Potential reservoir and cap rocks occur throughout the sequence. The Permian sands are interbedded with shales and coals, the former of which could provide cap rocks and the latter source beds for hydrocarbons. This is the case in the Cooper Basin to the east. The Jurassic sands provide excellent reservoir conditions and the overlying Cretaceous shales and silts could act as cap rocks. Thin lignitic beds in the continental Jurassic sequence and marine shales in the Cretaceous are possible source beds for hydrocarbons.

Interpreted environments for the deposition of the Pedirka Basin sediments suggest that much of the sequence has been deposited under terrestrial conditions. The lowermost Permian sediments were deposited in a glacial to periglacial environment and the overlying Purni Formation and De Souza Sandstone in terrestrial conditions. The Cretaceous sediments were deposited under increasingly marine conditions and a return to a terrestrial environment occurred during the deposition of the uppermost Cretaceous formation (Winton). The Tertiary and younger sediments, including the silcrete, are all terrestrial (Fig. 15).

Maximum sedimentary thicknesses have been recorded in Mokari 1 (the most southeasterly well) where 1 077 m of Cretaceous, 563 m of Jurassic and 451 m of Permian strata were intersected. As mentioned previously, seismic work suggests that these sections are increasing in an easterly direction.

Dips increase with the age of the sediments but in the Permian and younger strata they are very small to horizontal. Structures within the Mesozoic rocks are broad and contours on the base of the Cretaceous ("C" horizon, Fig. 12) trend approximately north-south. The Permian structures are naturally less gentle but still tend to align north-south ("P" horizon, Fig. 11). The base of the Permian ("Z" horizon, Fig. 10) represents the pre-Permian unconformity and is more complex than the two higher structure contour maps.

Unconformities occur at the base and top of the Permian, at the top of the Cretaceous and at several stages throughout the Precambrian and Lower Palaeozoic.

The Pedirka Basin is bordered by the Amadeus Basin in the northwest and the Officer Basin in the southwest (Fig. 5). Both of these are filled with sediments ranging in age from Adelaidean to possibly Devonian or Carboniferous (Krieg, 1969; Wells *et al.*, 1970) and it is probable that at times sedimentation may have been laterally continuous from the Amadeus to the Officer by way of the future Pedirka Basin.

The Officer Basin is virtually unknown and has not produced any commercial quantities of hydrocarbons to date. The Amadeus Basin has been well documented (e.g. Wells *et al.*, 1970) and is producing gas from the Ordovician Pacoota and Stairway Sandstones at the Palm Valley and Mereenie Gas Fields. In the light of this knowledge, the pre-Permian sequence of the Pedirka Basin frequently has been interpreted as representing a lateral continuation of the Amadeus sediments and this study will continue to describe the pre-Permian with an emphasis on this area.

Pre-Devonian

Figure 15 gives a brief description of the pre-Finke Group strata that occur in the Amadeus Basin (Wells *et al.*, 1970).

The Archaean Arunta Complex underlies the northern part of the Pedirka Basin and was possibly penetrated in the base of Hale River 1 (Amerada, 1966). The basement here consisted of volcanics and volcanic conglomerates.

No proven Proterozoic strata have been reported in wells in the Pedirka Basin. The basal formation in Purni 1 was assigned a Proterozoic age purely on a lithological comparison with shales in the Amadeus Basin. Similar shales in the nearby Mokari 1 were indicated to be Ordovician by radio-active dating. The shales of similar lithology in Purni 1 could have a similar age. The dating method used by Amdel was K-Ar on a whole-rock sample and is therefore open to question. That data may document an Ordovician orogenic event rather than the age of deposition of the sediment (Evans, *pers. comm.*). Wopfner (*in* Parkin, 1969) reports a confirmed Lower Ordovician age for steeply-dipping, dark shales under the Cooper Basin to the east.

McDills 1 intersected over 450 m of rocks showing lithological similarities to the Todd River Dolomites. These dolomites occur in the Amadeus Basin as part of the Cambrian Pertaoorrta Group. The rocks in McDills 1 (Amerada, 1965) were correlated on lithological and palaeontological grounds - Lower Cambrian brachiopoda were found in the cores. Mt. Crispe 1 intersected nearly 1 000 m in a monotonous sequence of sandstones, siltstones and occasional dolomites (Jacque, 1966a). These strata also have been tentatively correlated with the Cambrian Pertaoorrta Group, purely on lithological grounds.

The Ordovician Larapinta Group in the Amadeus Basin is subdivided into five alternating sandstone and siltstone sequences (see Fig. 15; Wells *et al.*, 1970). The two lowermost units are not present in the subsurface of the southeastern Amadeus Basin but the overlying three are present. The lowermost of the three, the Stairway Sandstone, is considered to have possible lateral extensions into the Pedirka Basin. Mt. Crispe 1 and Witcherrie 1 intersected hard, pink and white quartzitic sandstones which contained red and green clay interbeds. In Mt. Crispe 1 these silts contained Ordovician brachiopoda, so these two subcrops together with an unnamed indurated sandstone in McDills 1 (Amerada 1965) are tentatively correlated with the Stairway Sandstone. As mentioned earlier (p.11) the hard, dense, grey shales intersected at the bottom of Mokari 1 have been radioactively dated as Lower Ordovician and it is possible that these and the lithologically similar ones in Purni 1 may be lateral extensions of those under the Cooper Basin and fine-grained lateral equivalents of the widespread Stairway Sandstone.

The Mereenie Sandstone attains thicknesses of over 600 m in the southeastern parts of the Amadeus Basin and the subsurface occurrences are believed to extend to the Black Hill Range (Fig. 3). There is every possibility therefore that the sandstone extends into the subsurface of the Pedirka Basin. It is likely that the

341 m of red-brown to white sandstone beneath the Polly Conglomerate in McDills 1 (Amerada, 1965) is a lateral extension of the Mereenie Sandstone although no definitive evidence is available. The lowermost Devonian units in Witcherrie 1 (Units I & II in Magnier, 1964a; Cooper *et al.* 1964) (see Fig. 15) could possibly be Mereenie Sandstone. The two units have a combined thickness of 338 m and although the text descriptions do not suggest any correlation with the Mereenie Sandstone (Magnier, 1964a), the core descriptions clearly identify red and white, medium to coarse sands with massive cross-bedding. Units I and II as mapped by Cooper *et al.*, (1964) are directly correlatable with the two lowest formations of the Finke Group. It is therefore believed that they may have been incorrectly identified in Witcherrie 1 and that the Units I and II in the well are really possibly Mereenie Sandstone.

Devono-Carboniferous (?) - *The Finke Group*

The Finke Group is equivalent in time to at least a large part of the Pertnjara Group of the Amadeus Basin (Wells *et al.*, 1970; Jones, 1972). It outcrops only along the southeastern limits of the Amadeus Basin (Wells *et al.*, 1970) and is known also from a few waterbores.

The group has been divided into four formations which are, from the base to the top:- the Polly Conglomerate, Langra Formation, Horseshoe Bend Shale and Idracowra Sandstone.

The Finke Group's position in the southeastern Amadeus Basin allows the possibility that it extends into the Pedirka Basin. Formations of the group have been suggested to underlie the Permian strata in Witcherrie 1, McDills 1, Hale River 1 and bore G 53/6-143. The three remaining wells in the basin were drilled deep enough to intersect Finke Group sediments if they had been present. The absence of these strata in Mt. Crispe 1, Mokari 1 and Purni 1 is due either to non-deposition or erosion. The answer to this question is important in determining the structural history of the area and requires further study.

The Polly Conglomerate, as defined, is a polymictic conglomerate with pebbles, cobbles and boulders derived from igneous, metamorphic and sedimentary sources which vary locally within the southeastern Amadeus Basin. In McDills 1 394 m of conglomerate with some interbedded sandstone and shale layers were intersected. The conglomerate contains granite, marble, shale and other fragments up to 8 cm long in a matrix of buff to red, subangular, fine to coarse sandstone (Amerada, 1965).

The strata intersected in McDills 1 may reasonably well be directly correlated with the Polly Conglomerate because of their lithological similarities with those of the type section (Wells *et al.*, 1966 & 1970) and their stratigraphic position within the pre-Permian sequence in the well. Also, McDills 1 is relatively close to the Amadeus Basin.

Cooper *et al.* (1964) named the sands and conglomeratic layers of Witcherrie 1 as Unit II of the Finke Group - the present study has revealed that this unit's stratigraphic position and lithology may suggest a tentative correlation with either the Mereenie Sandstone or Polly Conglomerate, rather than the Langra Formation.

The Langra Formation (Wells *et al.*, 1966) is the most widespread of the Finke Group formations in the Amadeus Basin. It is described as predominantly a sandstone formation (150 m thick at Horseshoe Bend) which can be divided into three units. The lowermost is a poorly-sorted, cross-bedded, pale sandstone with conglomeratic to silty interbeds; the middle unit is a red siltstone and the top one a fine-grained sandstone.

McDills 1 intersected 528 m of porous, cross-bedded sandstones which were conglomeratic at the base and calcareous at the top. Grey-green shale interbeds were encountered throughout the section. Witcherrie 1 intersected 142 m of coarse, grey sands with red-green silty layers and argillaceous cement. The presence of the sands and conglomerates above the presumed Polly Conglomerate in McDills 1 suggests that they are lateral rock extensions of the Langra Formation. The sediments in Witcherrie 1 are more difficult to identify. Their position is above the probable Mereenie Sandstone and/or Polly Conglomerate and beneath the Permian. The known wider distribution of the Langra Formation farther north has resulted in these strata, which were named Unit III, (Horseshoe Bend Shale) by Magnier (1964a), to be correlated with the Langra Formation. This unit may also contain some of the overlying Horseshoe Bend Shale.

The uppermost unit of the Finke Group in Witcherrie 1 may represent an interdigitating of the Langra Formation and Horseshoe Bend Shale. The lithology encountered (Magnier, 1964a) suggests that the sediments most probably are Langra Formation with interdigitating of the red and green shales of the Horseshoe Bend Shale.

The Horseshoe Bend Shale of the Amadeus Basin (Wells *et al.*, 1966) rests conformably on the Langra Formation. In the type section at the Finke River, it is a series of red and green shales and siltstones which contain abundant biotite, ripple marks, mud cracks and gypsum.

McDills 1 intersected 85 m of red, brown and green biotitic shales and siltstones which are slightly calcareous at the base (Amerada, 1965). Their lithology is very similar to that at the type section and suggests they can fairly certainly be called Horseshoe Bend Shale. Water bore G 53/6-143 (Fig. 5) bottomed in 12 m of brown, biotitic siltstones which have been interpreted as Horseshoe Bend Shale (Evans, 1964).

In Hale River 1, 56 m of shales with interbedded sands and underlying sands were intersected between basement and Permian sediments (Fig. 18). Their correlation is ambiguous. They could be Permian sediments (Purni Formation) or Devonian - Carboniferous in age (Finke Group). As at Witcherrie 1 (mentioned above), the lithologies allow at least three possible Devonian interpretations to be made. They may represent the siltier facies of the middle section of the Langra Formation overlying the sandier lower division, a generally sandier facies of the Horseshoe Bend Shale, or thin marginal accumulations of both of the two above formations. Fig. 18 shows the interpretation of Finke Group strata between 1378 m and 1434 m. Fig. 17 suggests that this interval could also possibly be correlated with the Middle Member of the Purni Formation (see page35).

The Idracowra Sandstone (Wells *et al.*, 1966) outcrops in a small area along the Finke River. It consists of 60 m of medium to fine, kaolinitic sandstones which are generally well sorted (Wells *et al.*, 1970). It disconformably overlies the Horseshoe Bend Shale.

McDills 1 intersected 174 m of grey-white, fine to coarse sandstones overlying the probable Horseshoe Bend Shale. The sediments have been interpreted as lateral representatives of the Idracowra Sandstone (Amerada, 1965).

No fossils have been found in the formations of the Finke Group. The Pertnjara and Finke Groups are found interfingering in their outcrops in the southeastern Amadeus Basin (Stewart, 1968; Wells *et al.*, 1970) and both directly overlie the Mereenie Sandstone. The Finke Group has been tentatively assigned a middle Devonian to early Carboniferous age by Jones (1972) who suggests that at any given time two or three of the Pertnjara and Finke Group formations were being deposited and that they therefore possibly represent lateral facies variations.

Permo-(Carboniferous?) - Crown Point and Purni Formations.

The Permian and ?Upper Carboniferous strata of the Pedirka Basin have been divided into two formations. These are the lowermost Crown Point Formation and the overlying Purni Formation, which is possibly disconformable on the Crown Point Formation. Both the Crown Point and Purni Formations outcrop along the basin margins.

One further minor occurrence of Permian rocks is reported by Quinlan and Forman (1968) who described 31 m of Upper Permian sandy clays overlying the Arunta Complex in a water bore (F 53/13-224) on the west of the Hermannsburg Sheet. No outcrops are known and this occurrence is presumed to be an isolated patch of Upper Permian sediments in a basement pocket. Older sediments outcrop extensively in this area and in the region towards the Finke River outcrops.

The Permian correlations made in this study are purely tentative and alternative ones may well be possible. Further drilling is required to increase the present knowledge of Permian and older strata.

Workers in the Northern Territory have placed all Lower Permian sediments into the Crown Point Formation, whereas FPC(A) identified an overlying, non-glacial formation which they informally named the Purni Formation (Jacque, 1966b). In this study an attempt has been made to identify the possible Purni Formation sediments within the Northern Territory wells and bores.

The Crown Point Formation, at its outcrop sections in the Northern Territory, consists of a series of diamictites (Flint *et al.*, 1960a & b), pebbly sandstones and clays which are at least 50 m thick (Crowell and Frakes, 1971). Some of the boulders, cobbles and pebbles show evidence of glacial striae but in general the evidence for glaciation is weak and restricted to the lower levels of the outcrops.

Throughout the Finke River outcrop area of the Northern Territory, the diamictites are overlain by sandstones and silts. These sands are white, fine to medium grained, well sorted and kaolinitic. The clays and silts are vari-coloured, micaceous and generally sandy. The sands overlying the glacigene sediments display convolute and contorted bedding, slumping, climbing-ripple laminae and many other features resulting from deposition in a fluviatile environment (Crowell & Frakes, 1971; Chewings, 1914; David & Howchin, 1924; McKee, 1966). See Plates 1, 2 and 3.

Diamictites have been recorded from wells and bores in the Pedirka Basin. McDills 1 penetrated 71 m of "conglomerate" composed of chert and metamorphic pebbles in a shale matrix (Amerada, 1965). The four South Australian wells reported up to 101 m (Mokari 1 and Witcherrie 1) of quartzite, limestone and dolomite pebbles and cobbles in a grey-green shale matrix. In all cases the diamictite layers are interbedded with sands and clays (see Appendix I) (Jacque, 1966a & b; Magnier, 1964a & b). Two of the water bores (G 53/6-120 and G 53/6-143) probably contain the glacial Crown Point Formation. Evans (1964) presents lithological logs of the bores where the strata are represented by diamictites, sands and clays. Malcolm's Bore probably contains 83 m of similar glacigene sediments (Rochow, 1965). Fig. 19 shows sand-shale ratios and isopachs for the Crown Point Formation within part of its possible subcrop area. Sand percentages are greatest at Mt. Crispe 1 and decrease towards the north. Limits of the formation are uncertain and possible extensions could occur in several directions.

An area of glacigene outcrops occurs along the possible northern margin of the Pedirka Basin (Fig. 5) at the edge of the Georgina Basin. Smith (1967) reports outcrops of the Tarlton Formation (Condon & Smith, 1959) which are composed of a basal pebbly layer and an upper shale layer. The latter was found to contain Upper Triassic-Lower Jurassic plant remains and Smith has therefore placed the whole sequence within the Mesozoic. Wopfner (*pers. comm.*) believes the lower conglomeratic beds are comparable with those of the true glacial Crown Point Formation in the Northern Territory. The lower levels of the Tarlton Formation outcrops have therefore been included in the suggested area of Permian deposition.

As in the Finke River outcrops, the diamictites and associated sediments are overlain by conglomerates, sands, shales and, higher in the subsurface sequence, coals. The whole sequence of the Purni Formation is similar to that of the Patchawarra Formation in the Cooper Basin (Kapel, 1972). The lower levels of the formation are predominantly grey, fissile, carbonaceous shale with a few sand and conglomerate layers (Lower Member) (see Appendix II) and, particularly in Mokari 1, the Middle Member is a medium grained to conglomeratic, grey sandstone (Figs. 20 & 21). The Upper Member is a series of generally thinly interbedded sands, shales and coals with the latter increasing in prominence upwards (Fig. 22). Throughout the Purni Formation the sands are well-sorted, kaolinitic and sometimes compact and argillaceous.

The three members of the Purni Formation were intersected in McDills 1; Here the sequence is sandier than that in the southern wells and shale occurs only in the Upper Member. The three members were also intersected in Purni 1 and Mokari 1. Witcherrie 1 contained approximately 3 m of sands and shales (see Appendix II) above the glacigene sediments and Hale River 1 intersected 109 m of sands, coals and shales and a further 56 m of possible Purni Formation beneath them (Figs. 17 & 18) (see page 30). The four water bores in the Northern Territory intersected a series of vari-coloured shales, silts and kaolinitic sands which, although originally interpreted as being part of the Crown Point Formation, are fairly certainly part of the overlying Purni Formation and do not display any characteristics of glacial sediments (Evans, 1964; Rochow, 1965).

There are three reasons for believing that the Crown Point Formation in the Northern Territory is overlain by sediments of the Purni Formation and that the whole sequence is not glacial.

(1) In the four South Australian wells and McDills 1, the Crown Point Formation is fairly constant in thickness where the Purni Formation is present above it (Fig. 19). There is no reason why the section thickness should increase rapidly to the west and north (away from the glacial sources) in the water bores and Finke area as it would have to if the Permian strata were all Crown Point Formation.

(2) Balme (*in* Evans, 1964) regards the uppermost Permian in McDills 1 (i.e. Upper Member of Purni Formation) to be older than that in the upper levels of Malcolm's Bore. As the strata in McDills 1 are coaly and clearly non-glacial it is suggested that a large part, possibly 379 m, of the Malcolm's Bore sequence is also part of the Purni Formation.

(3) David and Howchin (1924) suggested that the glacials could be overlain by younger coal-bearing strata to the east and southeast of Yellow Cliff (Fig. 3). This interpretation would enable the Lower and Middle Members of the Purni Formation to be present both at the outcrop sections and in the water bores.

The Crown Point Formation is named after a locality on the Finke River in the Northern Territory. Tate & Watt (1897) were the first writers to recognise the glacial nature of the strata and many later workers including Chewings (1914), David and Howchin (1924) and Ward (1925) described the section at Crown Point. The formation was formally named by Wells *et al.* (1966) and the type section is at One Tree Point (Fig. 3).

The Purni Formation was named after the drilling of Purni 1 (Magnier, 1964b; Jacque, 1966b). The name has not been formalised and the author is unable to find any published reference to it.

The Crown Point Formation is present in all wells and bores except Hale River 1. It is possibly the most extensive of the two Permian formations and is probably continuous from the Northern Territory outcrops through the subsurface occurrences. The formation is similar in lithology to that of the Boorthanna Formation (Unit II) in the Arckaringa Basin (Townsend, 1973) and the Merrimelia Formation in the Cooper Basin. It is not laterally continuous with the latter but may be continuous with the Boorthanna Formation in the nearby Arckaringa Basin (Devine & Youngs, 1973).

The Purni Formation is believed to be present throughout most of the Pedirka Basin and possibly is only absent from Mt. Crispe 1 as a result of erosion. The formation thicknesses increase eastwards, particularly to the east of the McDills Trend (Fig. 23).

The coal-bearing strata of the Upper Purni Formation have been identified by seismic work in much of the South Australian portion of the basin. Records show that these coaly beds thicken, by the addition of younger sediments, eastwards from Mokari 1 and a maximum Permian section of at least 650 m is attained near the area of the SA-NT border at 137°E (Figs. 10 & 11). The seismic records show a gradual decrease in thickness eastwards and southwards from this area and it is possible that the coal beds die out before the edge of the Permian basin (Fig. 23). The seismic records (FPC(A), 1963, 1964b, 1966a & b; Vamgas, 1970) show the possible existence of the older Purni and Crown Point Formations between the limit of the coals and the western basin margins. The stratigraphic interpretation of the Permian rocks at Hale River 1 would suggest that the lowest of the three interpretations shown in Fig. 23 may be correct, at least in the northern parts of the basin. This view would greatly enhance the petroleum prospects of the Permian strata east of the McDills Trend. The middle of the interpretations shown in Fig. 23 is suggested as a further alternative for the northern area. The two interpretations are both considered possible at this stage while the age and stratigraphic correlations of Hale River 1 are uncertain. Mt. Crispe 1 and Witcherrie 1 were drilled in an area with only thin Crown Point Formation and seismic results (FPC(A), 1963 & 1966a; Vamgas, 1970) clearly show the greatly increased Permian section (including coals) to the west away from the influence of the McDills Trend. The Permian strata in this southwestern region thin and possibly also die out fairly rapidly away from the deep Eringa Trough (Vamgas, 1970) but the older non-coaly sediments may extend southwards and into the Arckaringa Basin (Devine & Youngs, 1973).

The Purni Formation is unconformably overlain by Mesozoic strata throughout the basin.

Age and Palynology of Permian

Prior to the commencement of this study, there were little palynological data from wells in the basin. Therefore W.K. Harris (South Australian Geological Survey) was asked to investigate Permian core samples from three of the South Australian wells. His full report is given in Appendix I. Fig. 24 shows a summary of his results and those obtained by Evans (*in* Amerada, 1965; Magnier, 1964b; Jacque, 1966b).

This new work revealed the complete lack of any marine microfossils within the sequence. This means that the marine incursion equivalent to the deposition of Stuart Range Formation (Unit I) in the Arckaringa Basin did not occur here. No microfossils were recovered from the Lower Member sediments but it is believed that they are Artinskian in age and that the whole of the Purni Formation is contained within Stage 3 (Fig. 25).

Figs. 17 and 18 show log correlations for the wells in the Pedirka Basin and, in co-operation with the new palynological dating from Witcherrie 1, Purni 1 and Mokari 1, they add to the evidence suggesting that some of the former Crown Point Formation in McDills 1 and Hale River 1 is in fact Purni Formation.

The Crown Point Formation falls within Stage 2 (Fig. 25) and is not known to extend down into the Carboniferous although there is every possibility that the glacial phase commenced before the Permian (Wells *et al.*, 1970) as a result of the Alice Springs Orogeny.

No reliable palynological data are available from

Malcolm's Bore. Wopfner (*pers. comm.*) reports that no reliable samples were taken during the drilling and that cuttings later submitted to Balme (*in* Evans, 1964) were possibly not from the levels indicated. It seems, however, that Stage 3 Artinskian microfossils were obtained from Malcolm's Bore and also the other water bores.

Environment of Deposition

The depositional environment of the Crown Point Formation is envisaged as being periglacial-shallow marine and/or terrestrial. No glaciated pavements or other direct evidence of glaciation have so far been found in the Pedirka Basin, it is therefore considered that the glaciers existed in highlands to the south (Peake & Denison Ranges), southwest (Musgrave Block) and possibly northwest (Amadeus Basin). The diamictites, sands and shales were deposited as re-worked glacial material in areas immediately surrounding the con-tinental glaciers.

A short period of erosion followed the glacial era before the commencement of the Purni Formation deposition. During this time a marine incursion into the Arckaringa Basin took place and resulted in the deposition of Stuart Range Formation (Townsend, 1973) but appears not to have extended into the Pedirka Basin. Initially, the lower levels of the Purni Formation were deposited under alternating high - and low - velocity regimes (Crowell & Frakes, 1971), possibly resulting from the melting glaciers in the surround-ing highlands. As conditions stabilised, the formation of coal swamps was encouraged and the rhythmic alternations displayed by the Upper Member were developed.

Mesozoic - Holocene

The Mesozoic strata are the aquifers of the Great Artesian Basin and, for this reason, they have been closely studied and different nomenclatures have developed throughout the basin (Fig. 24).

The two southeastern wells in the Pedirka Basin, Purni 1 and Mokari 1, intersected lateral equivalents of the Middle Jurassic Walloon Coal Measures and Gubberamunda Sandstone immediately overlying the Purni Formation (Jacque, 1966b; Magnier, 1964b). These oldest Jurassic sediments are predominantly coarse, well sorted, quartz sandstones with occasional grey-white silty lenses and thin shale bands. The remaining Jurassic strata in the basin are younger. They are the Algebuckina Sandstone (Wopfner *et al.*, 1970) and its extension the De Souza Sandstone. These sediments are fine to coarse, angular to subangular, off-white sandstones which are frequently crossbedded, poorly consolidated and may have good porosity. Pyrite was reported in the two Northern Territory wells (Amerada, 1965 & 1966).

The Cretaceous strata are, in all wells, separated from the underlying sandstones by the ?Upper Jurassic - Lower Cretaceous Cadna-owie Formation (Freytag *et al.*, 1967; Wopfner *et al.*, 1970) which is a shale formation with occasional fine sand and silt interbeds.

The overlying Cretaceous strata - Bulldog Shale (Freytag, 1966) and Oodnadatta Formation (Freytag, 1966) (Fig. 26) - are a series of dark grey, fissile shales containing marine fossils and occasional mudstone and siltstone layers. Most of the upper shale layers contain thin bands of hard limestone (cf. Wooldridge Limestone; Fig. 26). In Purni 1 and Mokari 1 the Cretaceous shales are overlain by the Winton Formation - a series of grey soft, silty shales interbedded with fairly well-sorted sandstones.

These two southeastern wells also contained thin Tertiary deposits (Eyre Formation; Wopfner *et al.*, in prep.) of sands and hard silicified layers (Fig. 13). All wells penetrated Quaternary aeolian sands at the top of the section.

The Mesozoic and younger strata described above are present throughout the Pedirka Basin and show a gradual increase in section eastwards, towards the central parts of the Great Artesian Basin (Figs. 11 & 12). There is little facies variation within these strata and increased thicknesses occur in all formations.

The Jurassic sediments unconformably overlie the Permian throughout the basin and the Mesozoic formations are conformable throughout the section.

The early Jurassic sediments are interpreted as having been deposited on a floodplain. The Algebuckina Sandstone was deposited at first onto a stable surface and indicates low energy, fluviatile conditions followed by a more vigorous environment during the late Jurassic. The Cretaceous strata record a gradual marine transgression, a period of marine deposition and a final retreat of the sea.

The Cainozoic sediments represent the results of a terrestrial deposition and weathering regime which is continuing today. The mesas in the western parts of the basin are generally covered with a silcrete capping - the result of deep weathering of the old land surface during the Tertiary. Post-silcrete sediments include river sands, gravels and clays and large areas of Quaternary aeolian sands forming the long, parallel dunes of the Simpson Desert.

BASIN HISTORY AND PALAEOGEOGRAPHY

The formation of the Archaean Arunta and Musgrave Blocks took place long before any sedimentation occurred in the area.

To the southeast of the future Pedirka Basin, the peri-cratonic Adelaide Geosyncline was receiving large thicknesses of sediments during the late Proterozoic (Wopfner, 1972). The Amadeus Basin, to the north of the Musgrave Block (Fig. 5), was also developing and the two areas may have been interconnected periodically as part of a single depositional entity, an extension of the Adelaide Geosyncline (Wopfner, 1972). Upper Proterozoic sediments probably underlie much of the Pedirka Basin, particularly in the south, and may be represented by shallow marine clastics and limestones.

The Petermann Ranges Orogeny at the end of the Proterozoic had its greatest effect within the Amadeus Basin but it also caused a northeast-trending ridge of Proterozoic rocks (now known as the Black Hill Range) to be uplifted along the northwestern limit of the future Pedirka Basin. Further movement of these rocks occurred throughout the Phanerozoic and they played an important part in the development of the sedimentary depositional areas within that part of Australia.

Further subsidence of the Amadeus Basin and Adelaide Geosyncline (Warburton Basin; see Wopfner, 1972) in the early Cambrian initiated the development of shallow seas which deposited the Lower Cambrian dolomites at McDills 1. These seas probably covered much of the future Pedirka Basin's area at that time and similar sediments may underlie much of the region, particularly in the central, southern and western parts. Renewed subsidence in the Amadeus Basin during the middle and late Cambrian spread southeastwards and caused the thick accumulation of sands and partly dolomitic silts found in Mt. Crispe 1. Davy (1973) suggests a shallow, possibly restricted marine environment for the deposition of the Cambrian sediments in Mt. Crispe 1.

A period of erosion existed during the early Ordovician and many of the Cambrian strata, if deposited, may have been removed. The early to middle Ordovician marine transgression probably occurred from the southeast, i.e. from the Warburton Basin (Wopfner, 1969). The Warburton was joined to the Amadeus Basin and also possibly to the Officer Basin (Wopfner, 1972). The Stairway Sandstone was deposited in the Amadeus Basin and it probably extends to the area under the Pedirka Basin. The present extent of these Ordovician sands and silts is considerable and was possibly even greater during the late Ordovician. The shales in Mokari 1 and Purni 1 are envisaged as fine-grained equivalents of the quartzites and sands in Mt. Crispe 1, Witcherrie 1 and McDills 1 - the shoreline therefore transgressed from the southeast.

The gentle epeirogenic Rodingan Movement (Wells *et al.*, 1970) during the late Ordovician and Silurian caused the seas to retreat and for the youngest Ordovician formations to be removed by erosion. Maximum folding occurred within the north-eastern Amadeus Basin where a ridge dividing it from the Georgina Basin was formed and the movement produced only gentle north-easterly folds in the Pedirka and Officer Basins (Wopfner, 1972).

Shallow seas transgressed from the Amadeus Basin during the late Silurian and early Devonian. The Mereenie Sandstone was laid down in the shallow seas and their contiguous terrestrial environment. As the seas transgressed eastwards they finally penetrated into the southwestern Georgina and western Pedirka Basins by the middle to late Devonian.

The Mereenie Sandstone depositional era was halted by the Pertnjara Movement (Wells *et al.*, 1970) whose main effect was to uplift the Proterozoic ridge, now known as the Black Hill Range, which was to act as a sediment source for the succeeding Finke Group.

The initial deposition of the Finke Group occurred during the late Devonian and on the southeastern side of the ridge. The Polly Conglomerate represents rapid erosion and terrestrial deposition close to the Proterozoic ridge with finer sediments being deposited in the central and southwestern parts of the Pedirka Basin. The overlying formations reflect the gradual reduction in energy levels and sedimentary sources for the Finke Group and their aerial extent suggests that the depositional area was possibly decreasing. Interfingering with the chronologically equivalent Pertnjara Group occurred during the deposition of the Langra and younger formations and the Black Hill Range was completely covered by the end of the Devonian (Jones, 1972).

The late Devonian to early Carboniferous era was one of renewed orogeny and erosion in the Amadeus Basin. The Alice Springs Orogeny initiated the development of the Permian Pedirka Basin and brought to an end the thick Proterozoic to Lower Palaeozoic deposition which had occurred in the Warburton Basin.

A roughly northeast-southwest line along the McDills Trend represents the eastern limit in the Northern Territory of the deep Lower Palaeozoic Basin (McDills Gravity Platform) and the western edge of the area that was to receive the thickest Upper Palaeozoic and Mesozoic sediments. The Permian sediments west of this line are thinner. The Pedirka Basin was only slightly affected by the movements of the Alice Springs and the synchronous Kanimblan Orogenies which resulted in gentle doming and faulting along northeast trends. The Black Hill Range received renewed uplift and more substantial mountain ranges were formed mainly to the northwest and southeast of the basin.

The late Carboniferous was a time of cold to glacial conditions throughout Australia and ice sheets rapidly spread from southern Victoria towards the Pedirka Basin at the start of the Permian. The sea also invaded from the west and may have spread through the Pedirka Basin to the Tasman Geosyncline (Crowell & Frakes, 1971). The Crown Point Formation was therefore deposited mainly under periglacial conditions in a series of alternately high and low velocity regimes (Crowell & Frakes, 1971).

No evidence exists for a marine origin for any Permian sediments deposited in the Pedirka Basin. It is therefore suggested that the late Sakmarian shore line lay to the south and that a period of non-deposition and erosion existed before the deposition of the Purni Formation. The Artinskian (Stage 3) strata of both the Arckaringa (Townsend, 1973) and Pedirka Basins were both deposited under similar terrestrial conditions which were accompanied by syndepositional growth of structures. Throughout the late Carboniferous and early Permian the eastern Pedirka Basin underwent gentle subsidence and maximum sedimentary thicknesses accumulated in the eastern parts of the basin. The youngest Permian sediments so far intersected are Artinskian in age but it is likely that younger strata may have been deposited and could be preserved towards the eastern limits of the basin (Fig. 23).

The late Permian, Triassic and early Jurassic were times of erosion in the Pedirka Basin. Remnants of Triassic deposition may be preserved in the east (Williams, 1973). The Great Artesian Basin started forming as the terrestrial Algebuckina Sandstone was deposited across the area from the east. This was followed by the Lower Cretaceous marine transgression which also came from the east and deposited the diachronous Cadna-owie Formation and the overlying Bulldog Shale and Oodnadatta Formation. The sea retreated northeastwards during the middle Cretaceous and the final Great Artesian Basin deposits were the freshwater sands of the Winton Formation.

The Tertiary period commenced with the deposition of limestones, sands and silts etc. in freshwater lakes, rivers and floodplains. A prolonged period of deep weathering followed during which silcrete was formed on all the exposed formations.

The area was tilted slightly to the east after the silcrete formation. Since then the drier climate has encouraged the formation of aeolian dunes and prolonged erosion has left a generally flat landscape with isolated silcrete mesas between the alluvial sands and gravels in the creek areas.

The region is still active tectonically and earthquakes, which are amongst some of the strongest recorded in Australia, have been traced to epicentres within the Simpson Desert (Youngs & Wopfner, 1972).

PETROLEUM POTENTIAL

Results of drilling in the Pedirka Basin so far have given it an ambiguous hydrocarbon potential. Only six petroleum exploration wells have been drilled to date. No hydrocarbon indications, other than fluorescence, were encountered but extremely valuable information on the stratigraphy of the basin was obtained. Large unexplored areas of the basin can be regarded as having considerable potential and therefore are worthy of further investigation.

Fig. 27 shows the porosities, determined from logs and cores, in various wells drilled in the Pedirka Basin. It is clear that good porosities and permeabilities exist throughout the sedimentary section and that it only requires suitable trapping conditions for hydrocarbons to have accumulated not only in the Permian but also older and younger rocks.

Cambrian

The Cambrian strata so far penetrated in the Pedirka Basin show potential mainly as source beds. No suitable reservoirs have been identified but further work may identify reef facies and other suitable carbonate beds - sands are the predominant Cambrian facies farther west in the Amadeus Basin (Wells *et al.*, 1970).

Ordovician

The Ordovician has been proved as a good hydrocarbon producer in the Amadeus Basin (Wells *et al.*, 1970). The Pacoota

Sandstone is the main reservoir, the Stairway Sandstone has also produced smaller quantities. The upper sandstone unit of the Stairway Sandstone is likely to be present under much of the western Pedirka Basin where it could also be overlain by the Stokes Siltstone which would act as a cap rock. Wells *et al.* (1970) suggest that the Carmichael Sandstone may extend at least into the northwestern Pedirka Basin and this is another potential Ordovician reservoir.

Petroleum exploration drilling in the Amadeus Basin has revealed that porosity and permeability in the Pacoota and Stairway Sandstones are far patchier than the outcrops had indicated. The development of lateral changes in the reservoir properties is due to burial processes acting on the original grainsize variations. Predictions for positions of possible reservoirs should concentrate on reconstructing the palaeoenvironments and hence locating areas where coarser sized sand grains may have been deposited (Williams *et al.*, 1965).

Small epeirogenic movements leading up to the Alice Springs Orogeny will have folded the Ordovician strata into structures suited to trapping hydrocarbons. Structural traps, like those of the Mereenie and Palm Valley Gas Fields are envisaged in the western parts of the basin.

Stratigraphic traps are also a possibility. The two sandstone formations will have been unconformably overlain by the Devonian and younger formations following the Rodingan and Pertnjara Movements. The Carmichael Sandstone contains silty layers within its predominantly arenaceous facies and possibly small amounts of hydrocarbons could be trapped stratigraphically under suitable conditions.

The massive sands and shales of the Ordovician formations are high in organic content and could also be the source beds for Ordovician and younger reservoirs.

Devonian

The Devonian rocks offer little or no potential as source beds. They are nearly entirely terrestrial with no coal and were not deposited under conditions suitable for the generation of hydrocarbons.

The Mereenie Sandstone, Polly Conglomerate and Langra Formation all contain possible reservoir beds. The middle unit of the Langra Formation and the Horseshoe Bend Shale could act as cap rocks in structural traps. The interfingering of the Finke with the Pertnjara Group in the northwest of the Pedirka Basin could provide stratigraphic traps in the area of the Black Hill Range.

Permian

The coals of the Gidgealpa Group in the Cooper Basin (Gatehouse, 1972) are believed to be the source of the substantial quantities of hydrocarbons encountered in the Permian and there is every possibility that similar accumulations could have been formed in the Pedirka Basin.

The sands of the Purni Formation have potential as reservoir beds, especially in the eastern Pedirka Basin where younger and thicker Permian coal-bearing strata appear to exist. An artesian flow of water from a sand within the Upper Member was reported in McDills 1 (Amerada, 1965) and confirms the good reservoir qualities of the Permian sands. Wells *et al.* (1970)

also report that the Permian sands are good aquifers throughout the Northern Territory.

Figure 28 shows Stiff patterns (Youngs, 1971) drawn from the results of analyses of waters from some of the wells. The patterns clearly demonstrate the similarity between the water from the Permian in McDills 1 and that from the Mesozoic and Finke Group aquifers in Witcherrie 1. This suggests that the Permian and Devonian sediments in these two wells have been flushed by Artesian waters and therefore may not have much hydrocarbon potential in their immediate surroundings. The waters from Mokari 1 have salinities higher than those in Witcherrie 1 and suggest that hydrocarbon accumulations could exist in these strata as flushing appears to have been considerably less or even absent (Youngs, 1971). If younger Permian sediments are preserved in the east there is a possibility that Lower Triassic (cf. Nappamerri Formation in the Cooper Basin) could also be present and in this case it would provide the Permian reservoirs with an excellent cap rock (Fig. 23) (Williams, 1973). Coal-bearing Permian sediments have been identified in the Eringa Trough west of Mt. Crispe 1 (FPC(A), 1966a; Vamgas, 1970). In this area, although the Triassic caprock is absent, the varied and terrestrial nature of the strata could have enabled hydrocarbons to become trapped. The Upper Purni Formation is similar, both in age and lithology, to the Patchawarra Formation in the Cooper Basin where the interfingering sands and shales provide reservoirs and caprocks for the gas produced from the adjacent coals (Kapel, 1972; Townsend & Youngs, 1972). In the deeper parts of the basin the

Purni Formation is likely to have been buried deeply enough for hydrocarbons to have been generated from the coals. Shibaoka *et al.* (1973) suggest that depths need only to be less than 1 000 m.

Accumulations may be found in both structural and stratigraphic traps. The former will have been formed partly by syndepositional movement during the Permian and also by the later movements associated with the Great Artesian Basin (see Figs.10, 11, 17 & 18). The thinning of the sediments over the "highs", their rapid lateral facies changes due to terrestrial deposition and the large post-Permian unconformity all offer possibilities of stratigraphic traps throughout the basin and at its margins where Permian strata wedge out against older rocks.

Apart from McDills 1 and Mokari 1, the wells drilled so far have not explored any reasonable Permian structures. Fig. 11 shows a number of gentle structures which warrant further investigation and much more seismic work still needs to be done, particularly in the northern areas, to reveal other suitable targets.

Mesozoic

The Algebuckina Sandstone and its equivalents have excellent porosities and permeabilities throughout the Great Artesian Basin and they are the main aquifers in South Australia. They have not produced any hydrocarbons to date but there is every possibility that they could, provided the hydrocarbons have not been lost by flushing of artesian waters (Youngs, 1971). The Precipice Sandstone, which is the main hydrocarbon-producing unit in the Surat Basin, is in a similar stratigraphic position unconformably overlying Permian and Triassic rocks (Power & Devine, 1970). The overlying Cretaceous formations could provide suitable cap rocks for the Jurassic and also possibly reservoir beds in sandy facies of the Cadna-owie and Oodnadatta Formations.

CONCLUSIONS AND RECOMMENDATIONS

Exploration in the Pedirka Basin is still at an early stage. Valuable stratigraphic information has been obtained but logistical problems are likely to make intensive exploration in the Simpson Desert difficult at the present.

Gas and oil have been recovered from Permian formations in the Cooper Basin to the southeast of the Pedirka Basin and from the Ordovician strata in the Amadeus Basin to the northwest. Sediments of identical age and similar lithology are present in and beneath the Pedirka Basin. A natural gas pipeline connecting the gas fields at Mereenie and Palm Valley with those in the Cooper Basin, and hence into a possible national grid, would run through the Pedirka Basin. A future development of this nature would greatly enhance the feasibility of producing gas from the Pedirka Basin.

Exploration is at an early stage and there are many recommendations for future work:-

1. Reconnaissance seismic work needs to be carried out around the margins of the entire basin and in the area west of McDills 1.

2. More detailed seismic work is required to define previously discovered structures which could then be drilled for anticlinal traps at all levels of the Palaeozoic section.

To the west of the McDills Trend, exploration should be focussed both on the Lower to Middle Palaeozoic sediments which may reach considerable thicknesses beneath the Pedirka Basin and also on the Permian where the coal-bearing Upper Member of the Purni Formation is known to be present. To the east of the McDills Trend, the Permian strata have more potential than to the west and the thick Upper Member of the Purni Formation should be fully investigated, particularly in the east where Triassic shales could possibly overlie it. The Ordovician strata in the eastern area of the basin require investigations into facies and cementation variations to highlight possible reservoir beds in the region.

3. The seismic work around the basin margins would help to place the limits of the Palaeozoic formations and thereby help in the future appraisal of pinch-out traps.

4. A series of stratigraphic wells around the basin margins is required to answer problems concerning both facies changes and the presence of the Palaeozoic strata.

(a) In the north the possible presence of thin Permian sediments overlying the Arunta Block needs confirmation. This would enhance this area's potential, mainly for stratigraphic traps.

(b) A number of wells are required around the southern edges of the basin. South and east of the four FPC(A) wells, beyond the limit of the good coal seismic reflections, there is a need to confirm the postulated thin Permian sediments and to identify their age, extent, lithology and relationship to older and younger rocks.

(c) Similar wells are needed in the southwest of the basinal area to investigate whether the Permian strata are continuous from the Pedirka into the Arckaringa Basin.

This dividing area is informally named the Bitchera Ridge (Devine & Youngs, 1973) and the information concerning the continuity of Permian sediments over it is vitally important for increasing our knowledge of Permian palaeogeography and hence the ability to locate hydrocarbon traps within this marginal region.

There is clearly a need for much exploration to be carried out throughout the Pedirka Basin, particularly in the eastern area, and it is hoped that the problems of access within the Simpson Desert will not deter future explorationists from seeking the possible hydrocarbon reserves in the basin.

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Plate 1: climbing-ripple laminae in sands of the Purni Formation at One Tree Point, N.T.
Photo: Dr. H. Wopfner

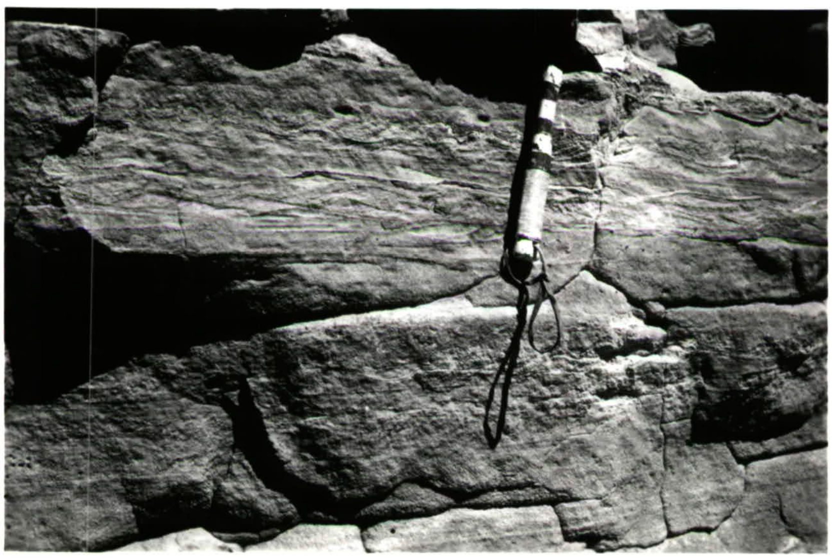

Plate 2: cross stratification in sands of the Purni Formation at One Tree Point, N.T.
Photo: Dr. H. Wopfner

Plate 3: contorted beds in the Purni Formation at Cunningham's Gap, N.T.

Photo: Dr. H. Wopfner

A P P E N D I X I

PERMIAN PALYNOLOGY

by

WAYNE K. HARRIS

DEPARTMENT OF MINES
SOUTH AUSTRALIA

F.P.C.(A.) PURNI, WITCHERRIE AND MOKARI NO.I WELLS, PEDIRKA BASIN: PALYNOLOGICAL EXAMINATION OF CORES

by

Wayne K. Harris
Palaeontology Section

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Rept.Bk.No.~~847~~ 72/71
G.S. No.4840
D.M. No.847/71
Pal. No.17/71

27th April, 1972

DEPARTMENT OF MINES
SOUTH AUSTRALIA

Rept.Bk.No.72/71
G.S. No.4840
D.M. No.847/71
Pal. No.17/71

F.P.C. (A.) PURNI, WITCHERRIE AND MOKARI NO.I WELLS, PEDIRKA BASIN: PALYNOLOGICAL EXAMINATION OF CORES

ABSTRACT

Palynological examination of cores and cuttings from F.P.C.(A.) Witcherrie, Purni and Mokari No.1 Wells in the Pedirka Basin suggests the following:

1. The Crown Point Formation is lowest Permian Stage 2.

2. The Purni Formation may be as old as Stage 2 but is, on the available evidence, no younger than Stage 3.

3. There is no palynological evidence of any marine incursion in the Permian in this area.

4. Core 1 in Mokari No.1 is of Lower Jurassic J2 age, not Permian as formerly believed.

INTRODUCTION

Palynological examination of cores from the three F.P.C.(A.) Wells, Witcherrie, Purni and Mokari, in the Pedirka Basin was requested by Miss B. Youngs of the Petroleum Exploration Division. Hitherto, there were no palynological reports on cores from Witcherrie, and only a brief analysis of cuttings at about 141.5m in Purni and a more detailed report on Mokari No.1 was made by P.R. Evans (B.M.R.). With two exceptions this present report deals with the Permian palynology and where evidence of age existed (e.g. Mokari) this has been updated to conform with Evan's (1969) sequence of Permian stages. Thus correlations between neighbouring basins, Cooper and Arckaringa, can be made more meaningful. The rock nomenclature is that used in the Mokari No.1 Well completion report.

Without exception the quality of preservation of the microfossils was poor and this necessarily constrains the reliability of the data. Additional caution must be used when assessing the age of the lithostratigraphic units. For instance there are no cores available of the Lower Member of the Purni Formation, and there are only three samples from the Crown Point Formation.

RESULTS AND DISCUSSION

Table I lists the relevant sample data and the Palynological Stage assignment.

Crown Point Formation - Cores 5 and 7 Purni No.1, Core 2, Witcherrie No.1.

Assemblages from this unit are characteristically Stage 2 with low species diversity (especially with respect to striate bisaccate grains). *Parasaccites* spp. and *Protohaploxypinus* spp. dominate the microfloras. Elements such as *Verrucosisporites pseudoreticulatus* and *Vittatina* spp. that characterise Stage 3, are absent. The microflora described by Evans (1964) from the Crown Point Formation in the area is comparable. Thus this formation is correlated with the Merrimelia Formation in the Cooper Basin (Paten 1969) and Unit 2 in the Arckaringa Basin. There is no evidence of marine influence in the unit.

"Purni Formation"

At this stage it is not possible to subdivide the formation on palynological evidence partly because of poor preservation and low sample frequency. All microfloras appear to be of Stage 3 aspect but no samples from the "lower member" are available, the unit could extend down into Stage 2. Evans in Jacque (1966) suggests that cores 3, 4 and 5 are spore unit Plb and Pla/b (i.e. Stage 2) but this may have been influenced by poor preservation.

Stage 3 assemblages are marked by more diverse microfloras, an increase in striate bisaccate grains, of Vittatina sp. and the first appearance of V. psudoreticulatus. There is no evidence to suggest that stages younger than 3 are present.

The Purni Formation thus correlates with the lower member of the Gidgealpa Formation (Paten 1969), the Mt. Toondina Beds and possible part of Unit 1 in the Arckaringa Basin. There is no evidence of marine influence in the unit.

Jurassic

Core 1 in Witcherrie No.1 Well was logged as Permian in the well completion report (Magnier 1964). It yielded an assemblage tentatively referred to Jurassic J2 of Evans (1966). The presence of abundant Tsugaepollenites spp. (al. Applanopsis) indicates that the assemblage is no older than J2 (Evans 1966). Evans states that the characteristics of units J3-4 are "still vaguely determined" and the assemblage from this core could be within these units.

SAMPLE DATA

Well Name	Location	Depth in feet (metres in parenthesis)	Rock Unit	Palynological Zone	Sample No.
Purni No.1	S26°17'10" E136°5'35"	Cuttings 4640 (1414.2)	Purni Fm. (U.Member)	Stage 3	S2297
		Core 2 @ 4741 (1435.1)	"	Stage 3	S2274
		Core 3 @ 5091 (1551.7)	Purni Fm. (M.Member)	Stage 3	S2275
		Core 4 @ 5256 (1602)	"	?Stage 3	S2276
		Core 5 @ 5641 (1719.4)	Crown Point Formation	Stage 2	S2277
		Core 7 @ 5810 (1770.9)	"	Stage 2	S2278
itcherrie No.1	S26°22'20" E135°39'16"	Core 1 @ 1826 (556.6)	?	? J2	S2279
		Core 2 @ 1891 (576.4)	Crown Point Formation	Stage 2	S2298
Mokari No.1	S26°19'06" E136°26'22"	Core 1 @ 5790 (1764.8)	?Evergreen Fm.	J1	S2296
		Core 2 @ 6075 (1851.7)	Purni Fm. (U.Member)	?Stage 3	S2280
		Core 3 @ 6555 (1998)	"	Stage 3	S2281
		Core 4 @ 6618.3 (2017.2)	Purni Fm. (M.Member)	Stage 3	S2282
		Core 5 @ 6651.5 (2027.3)	"	Stage 3	S2283

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APPENDIX II

PERMIAN CLAY PETROLOGY

by

Dr. W.G. SPENCER

INVESTIGATION OF THREE CLAYS FROM WITCHERRIE AND PUMI

1. INTRODUCTION

Three samples of well core were received from the SA Department of Mines, Petroleum Section, with a request for the determination of the proportion of clay-size particles, the composition of the clay fractions and any interesting features. The samples were labelled as follows:

Mark	Sample No.	Locality	
HW 277/1	P 374/71	Witcherrie #1, core #1, 1834'.	559 m Pumi
HW 277/2	P 375/71	Witcherrie #1, core #4, 2572'.	784 m
HW 278/1	P 376/71	Pumi #1, core #7, 5810'.	1771 m

2. PROCEDURE

Portions of each sample were dispersed in water using a mechanical blender and deflocculant. The suspensions were allowed to sediment for separation of the 'clay' size fraction (0-2 microns e.s.d.). Examination of the resultant suspensions by plummet balance gave an estimate for each sample of the proportion of material below two microns in size.

The lessthan two microns material was used to produce oriented samples on ceramic plates. These were saturated with glycerol and examined by X-ray diffractometer using cobalt radiation.

3. RESULTS

3.1 Clay Mineralogy of Sample P 374/71

The proportion of material below two microns in size is 36%. The clay fraction is composed principally of mica and kaolin, the ratio of mica to kaolin being about 1.5:1, with quartz and chlorite as accessory components.

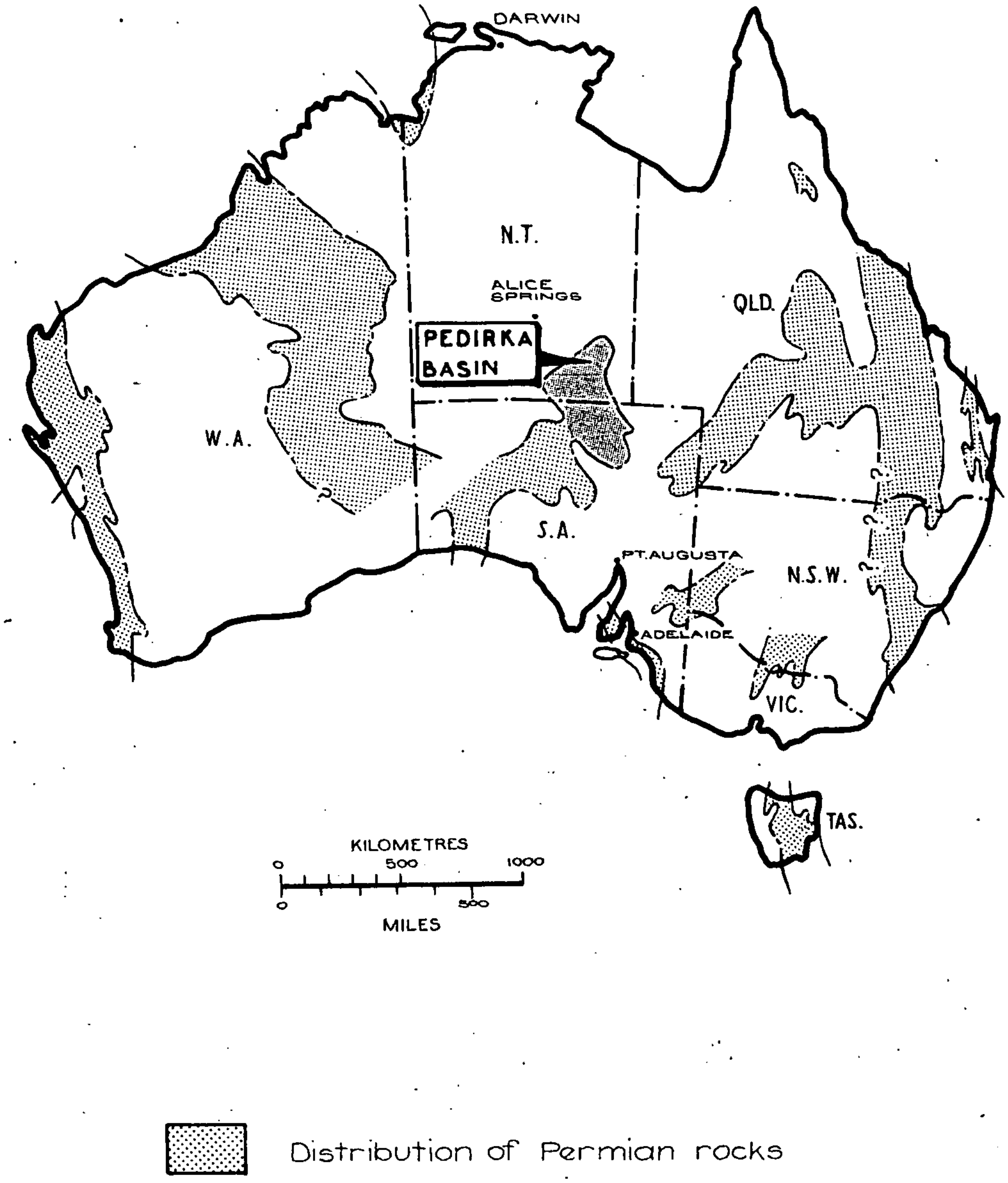
3.2 Clay Mineralogy of Sample P 375/71

The proportion of material below two microns in size is 4%. The clay fraction is composed principally of kaolin, montmorillonite and mica in approximately equal amounts with quartz and chlorite as accessory components.

3.3 Clay Mineralogy of Sample P 376/71

The proportion of material below 2 microns in size is 12%. The clay fraction is composed principally of mica and kaolin, the ratio of mica to kaolin being about 5:1 with quartz and chlorite as accessory components.

JC:2



TAKEN FROM H.WOPFNER-1972, IN A PAPER PRESENTED TO ANZAAS.

FIG. 1

	DEPARTMENT OF MINES — SOUTH AUSTRALIA	Scale: 1:32 x 10^{-6}
Compiled: B.Youngs	PEDIRKA BASIN — S.A. & N.T.	Date: 11TH. APRIL 1973
Drn. A.G.R. / Ckd. A.F.	LOCATION OF THE BASIN WITHIN AUST.	Drg. No. S 10259 994·2/3 +81

300-6.72 C5552

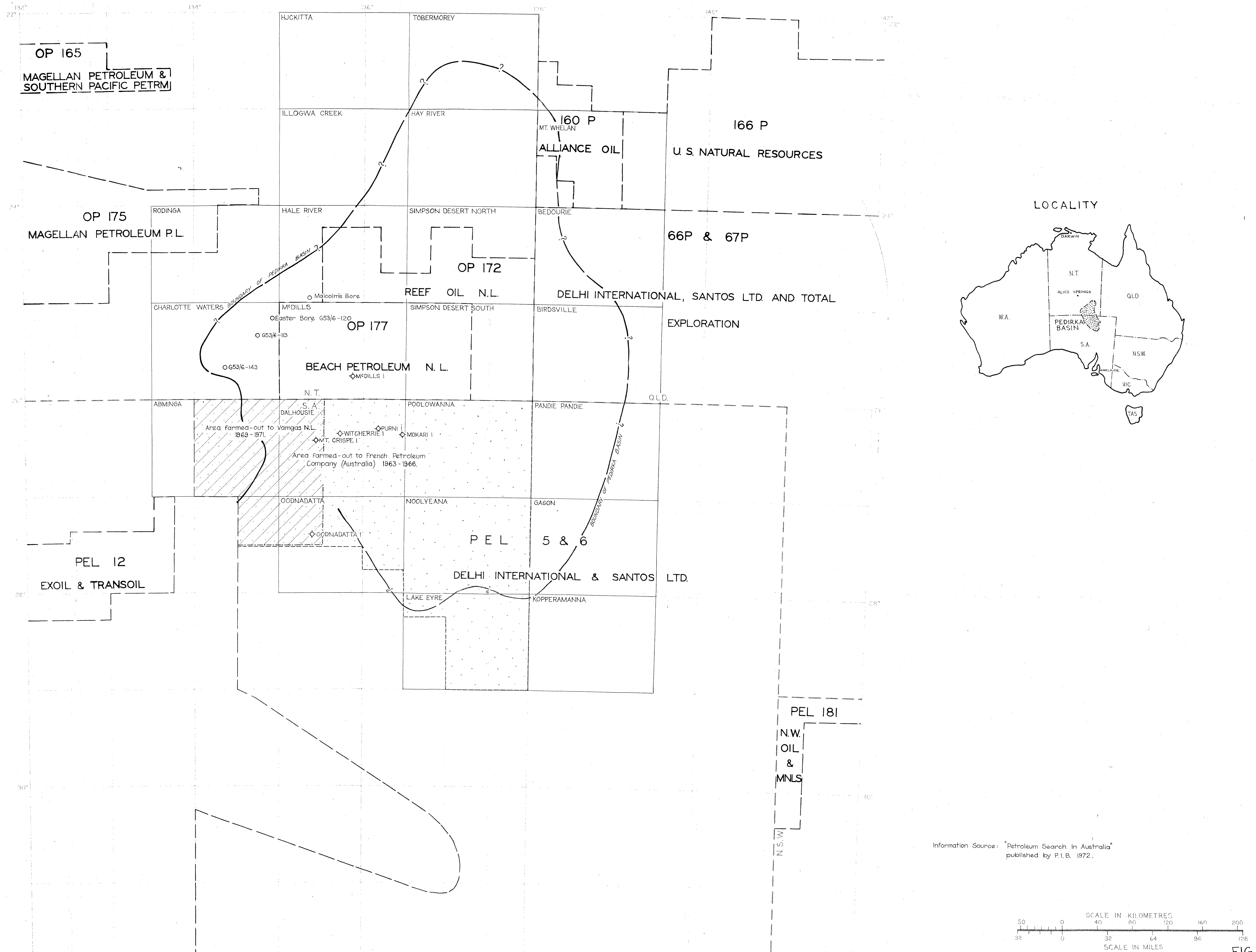


FIG. 2

DEPARTMENT OF MINES — SOUTH AUSTRALIA			
PEDIRKA BASIN - SA NT & QLD PETROLEUM EXPLORATION TITLES CURRENT AT 1.10.72 MAP SHEET AREAS			
PETROLEUM GEOLOGY SECTION	B.C. Youngs GEOLOGIST	Drn. B.Y.	SCALE 1:2 000 000
		Trd. S.J.C.	73-252
		Ckd.	594-2/3-81
Director of Mines		Exd.	DATE 11 APRIL 1973

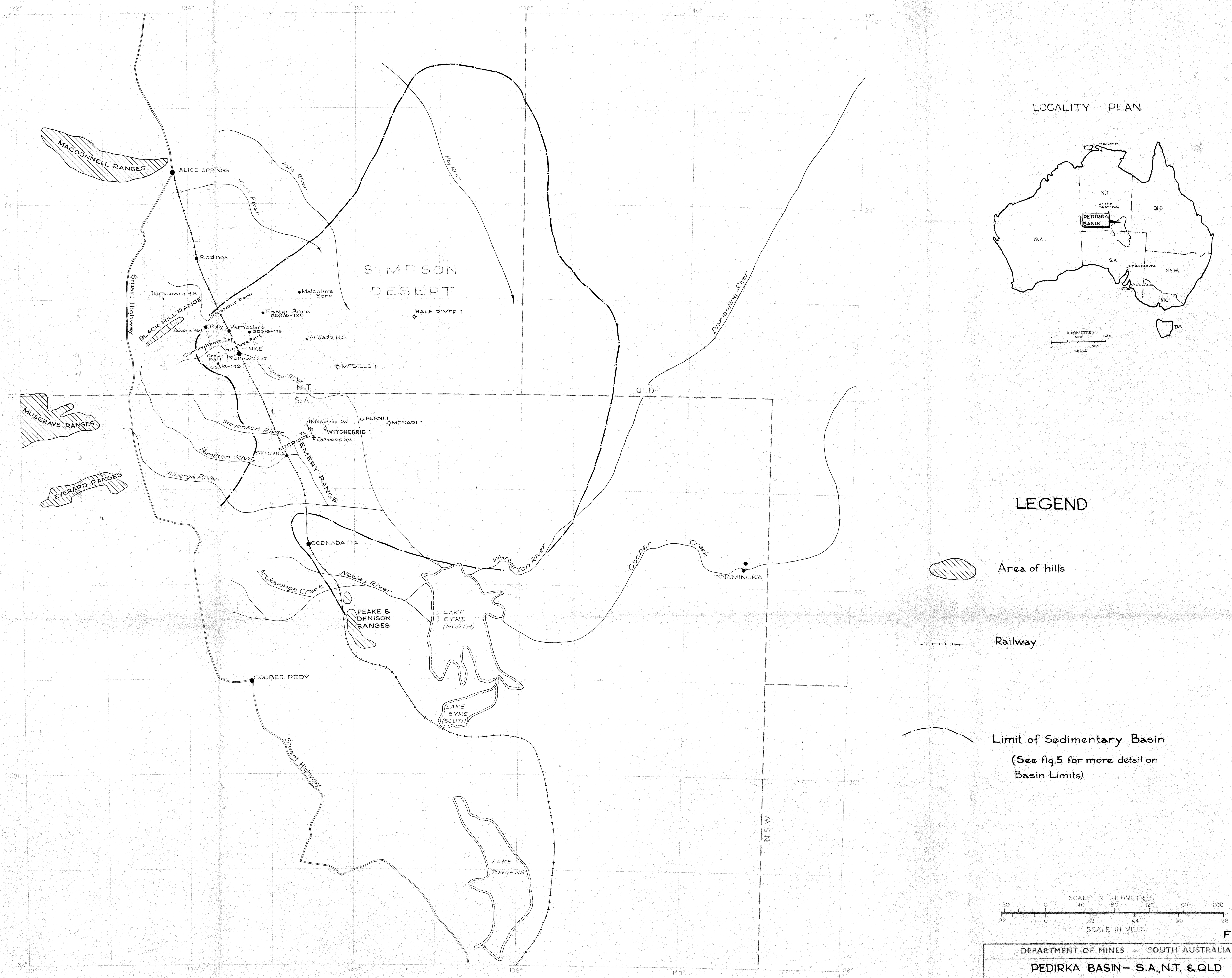
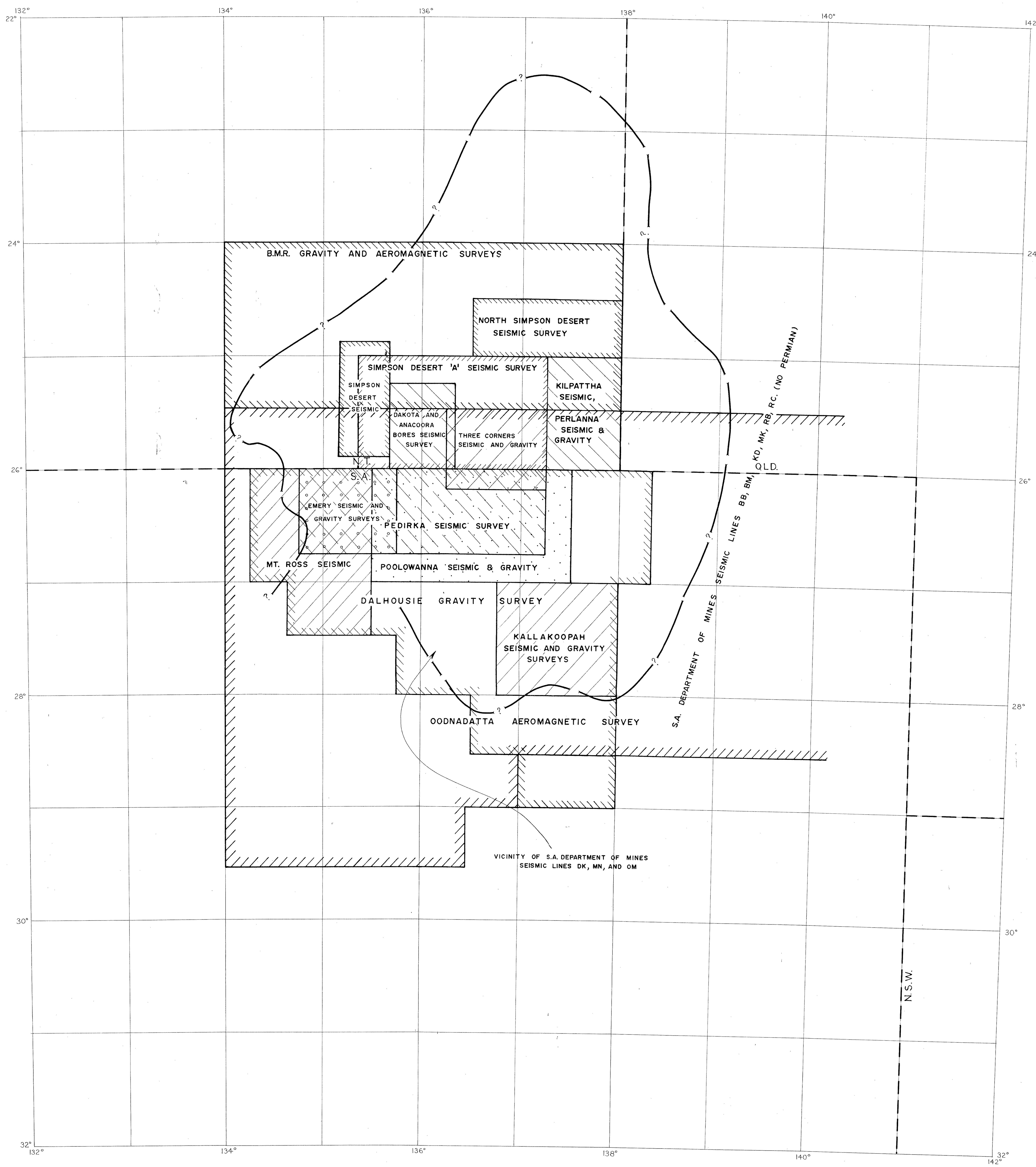


FIG. 3

DEPARTMENT OF MINES — SOUTH AUSTRALIA			
PEDIRKA BASIN – S.A., N.T. & QLD PHYSIOGRAPHY & BASIN LIMITS			
PETROLEUM GEOLOGY SECTION	GEOLOGIST	Drn. B.C.Y.	SCALE 1:2 000 000
		Tcd. G.M.	73-253
		Ckd.	994-2/3+81
Director of Mines		Exd.	DATE: 8th May 1973



NORTHERN TERRITORY

Simpson Desert 'A' Seismic Survey	Amerada Petroleum	Austral	1966
Simpson Desert Seismic Survey	Beach Petroleum	Geoseismic	1962
Dakota and Anacoora Bores Seismic Survey	" "	"	1964
Perlanna Seismic and Gravity Survey	Aust. Aquitaine Petroleum	C.G.G.	1966
North Simpson Desert Seismic Survey	" " "	"	1964
Kilpattha Survey	" " "	"	1964
Three Corners Seismic and Gravity Survey	Beach Petroleum	Geosurveys	1971

Results of B.M.R. Work are given in Langron, 1962; Moss, 1962; Quilty and Milsom, 1964.

SOUTH AUSTRALIA

Emery Seismic and Gravity Survey	F.P.C.(A)	C.G.G.	1966 a *
Pedirka Seismic Survey	"	"	1963
Poolowanna Seismic and Gravity Survey	"	"	1966 b *
Kallakoopah Seismic and Gravity Survey	"	United	1964
Mt. Ross Seismic Survey	Vamgas	"	1970
Dalhousie Gravity Survey	F.P.C.(A)	Wongela	1964
Oodnadatta Aeromagnetic Survey	Delhi	Aeroservice	1961 a&b, 1962

QUEENSLAND

Details of Work in the Georgina Basin are given in Smith, 1967

*See also Drayton, 1967

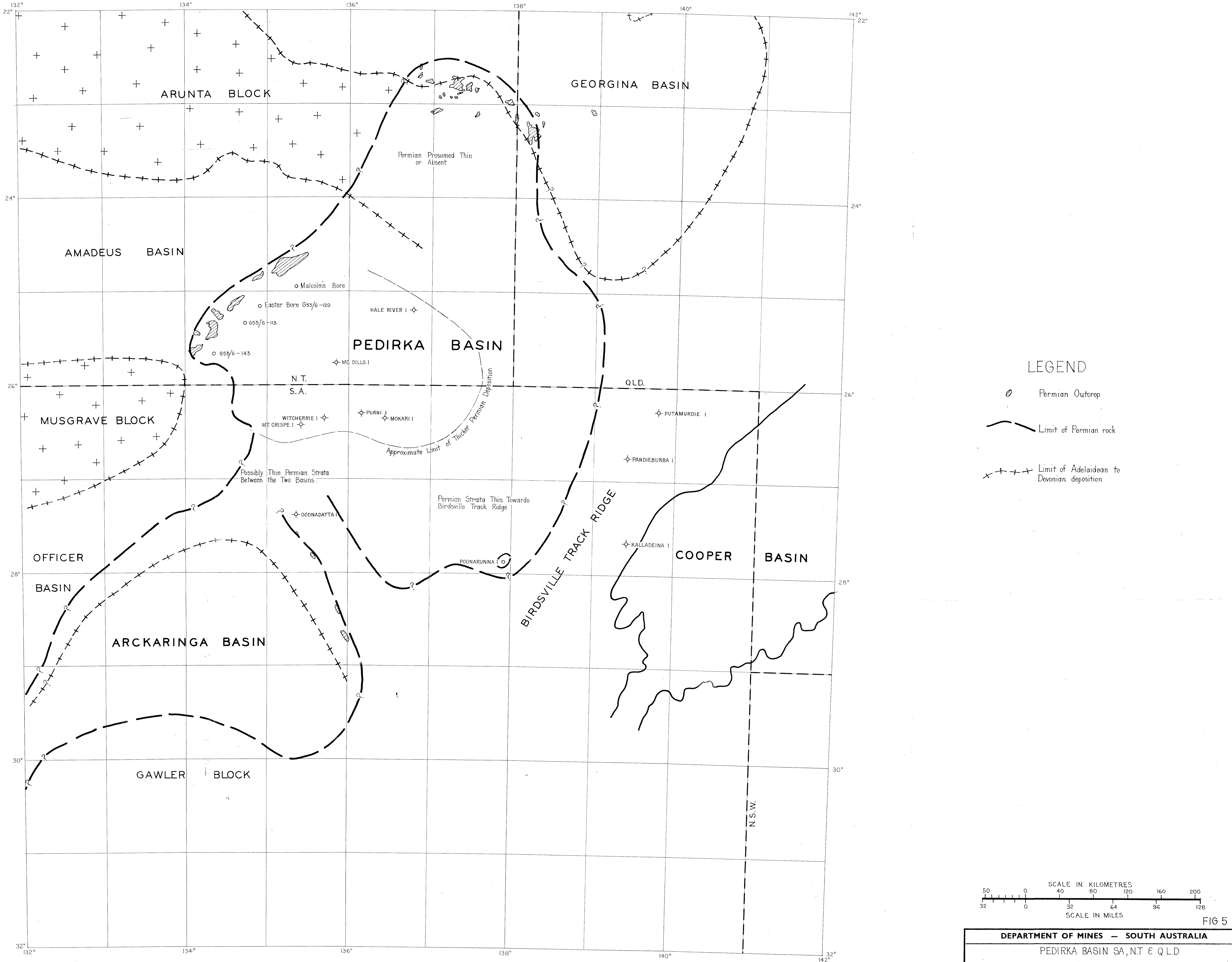
SCALE IN KILOMETRES
50 0 40 80 120 160 200
32 0 32 64 96 128
SCALE IN MILES

FIG. 4

DEPARTMENT OF MINES — SOUTH AUSTRALIA

PEDIRKA BASIN — S.A., N.T., & QLD.
AREAS COVERED BY GEOPHYSICAL SURVEYS

PETROLEUM GEOLOGY SECTION	GEOLOGIST	Drn. B.C.Y.	SCALE: 1:2 000 000
		Tcd. D.J.M.	73-254
		Ckd.	944.2/3+81
Director of Mines		Exd.	DATE: 17 MAY 1972



DEPARTMENT OF MINES — SOUTH AUSTRALIA

PEDIRKA BASIN SA, N.T & Q L D

LIMITS OF PERMIAN AND LOWER PALAEOZOIC BASINS

PETROLEUM GEOLOGY SECTION	B. G. YOUNGS GEOLOGIST	Drn. B.G.Y	SCALE: 1:2 000 000
		Tcd. B.D.W	73-255
		Ckd. A.F.	334 2/3 + 81
Director of Mines		Exd.	DATE: 11 April 1973

LEGEND

Contour (Value in metres below sea level)

Fault

PEDIRKA SUB BASIN Disused name

(From Laherrere and Drayton 1965)

SCALE IN KILOMETRES 50 0 40 80 120 160 200

32 0 32 64 96 128 SCALE IN MILES

FIG 6

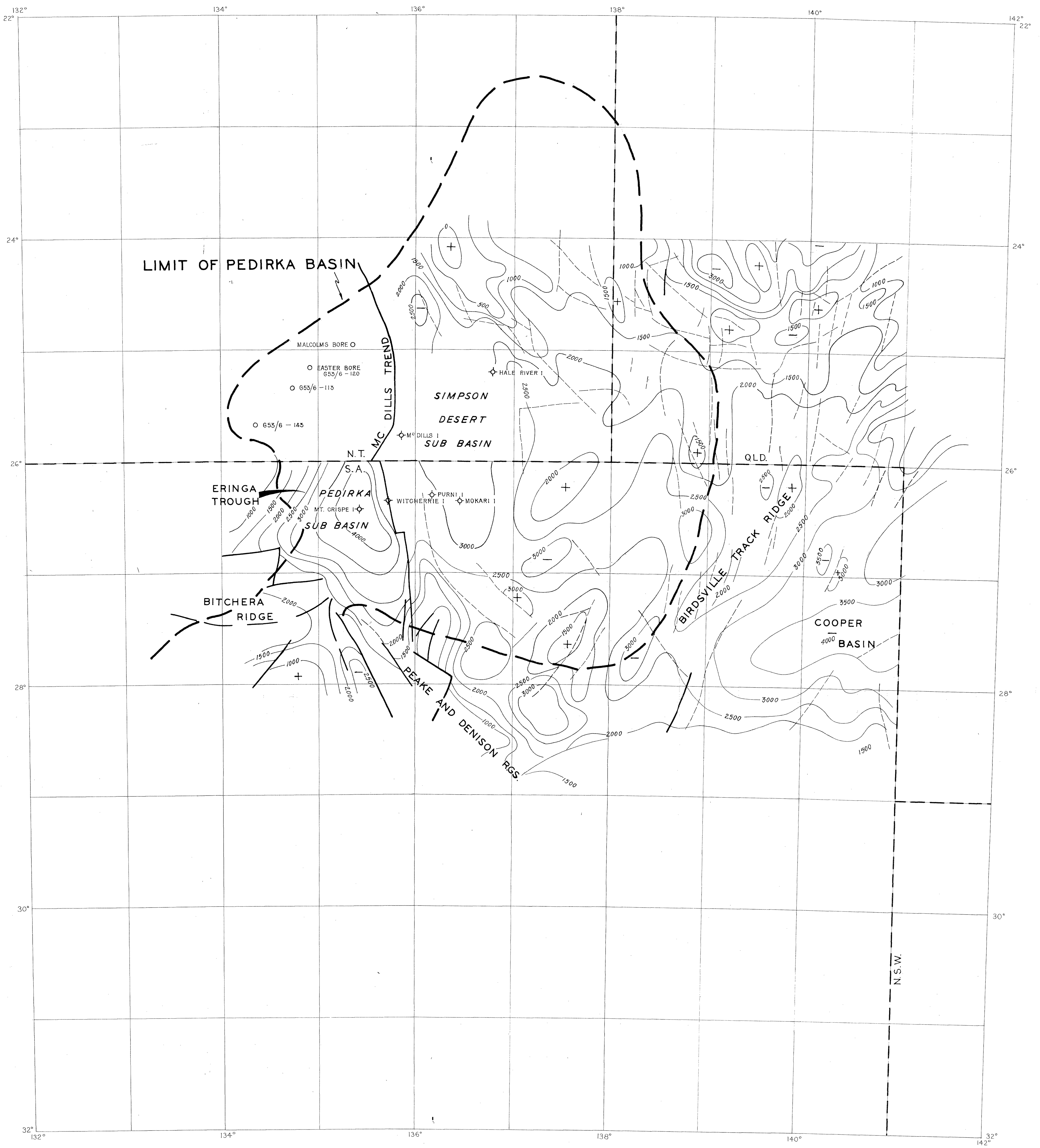
DEPARTMENT OF MINES — SOUTH AUSTRALIA

THE PEDIRKA BASIN N.T. SA. AND QLD.

DEPTH TO MAGNETIC BASEMENT

(INTERPRETATION BY AEROSERVICE)

PETROLEUM GEOLOGY SECTION	B.C. YOUNGS GEOLOGIST	Drn. B.C.Y.	SCALE: 1:2 000 000
		Tcd. B.D.W.	73-256
		Ckd.	S54 2/3+81
Director of Mines		Exd.	DATE: 11 APRIL 1973



LEGEND

/ Trend line

PEDIRKA SUB-BASIN Disused name

— — Lineament

4000 Contour (Value in metres below sea level)

(From Laherrere and Drayton, 1965)

SCALE IN KILOMETRES

50 0 40 80 120 160 200

32 0 32 64 96 128

SCALE IN MILES

FIG.7

DEPARTMENT OF MINES — SOUTH AUSTRALIA

PEDIRKA BASIN S.A., N.T. AND QLD.

DEPTHS TO MAGNETIC BASEMENT (METES B.S.L.)

(INTERPRETATION BY C.G.G.)

PETROLEUM GEOLOGY SECTION	B. C. Youngs GEOLOGIST	Drn. B.C.Y.	SCALE: 1:2 000 000
		Tcd. B.D.W.	73-257
		Ckd. A.F.	994-3/3+81
Director of Mines		Exd.	DATE: 11 April 1973

LEGEND

Gravity Contour (Interval 20 milligals)

Gravity High

Gravity Low

SCALE IN KILOMETRES

50 0 40 80 120 160 200

32 0 32 64 96 128

SCALE IN MILES

FIG. 8

DEPARTMENT OF MINES — SOUTH AUSTRALIA			
PEDIRKA BASIN S.A. N.T. AND QLD. GRAVITY CONTOURS			
PETROLEUM GEOLOGY SECTION	B. C. YOUNGS.	**Drn.** B.C.Y.	**SCALE:** 1:2 000 000
	GEOLOGIST	**Tcd.** R.B.	**73–258**
		Ckd.	994·2/3 + 81
Director of Mines		**Exd.**	**DATE:** 25 May 1973

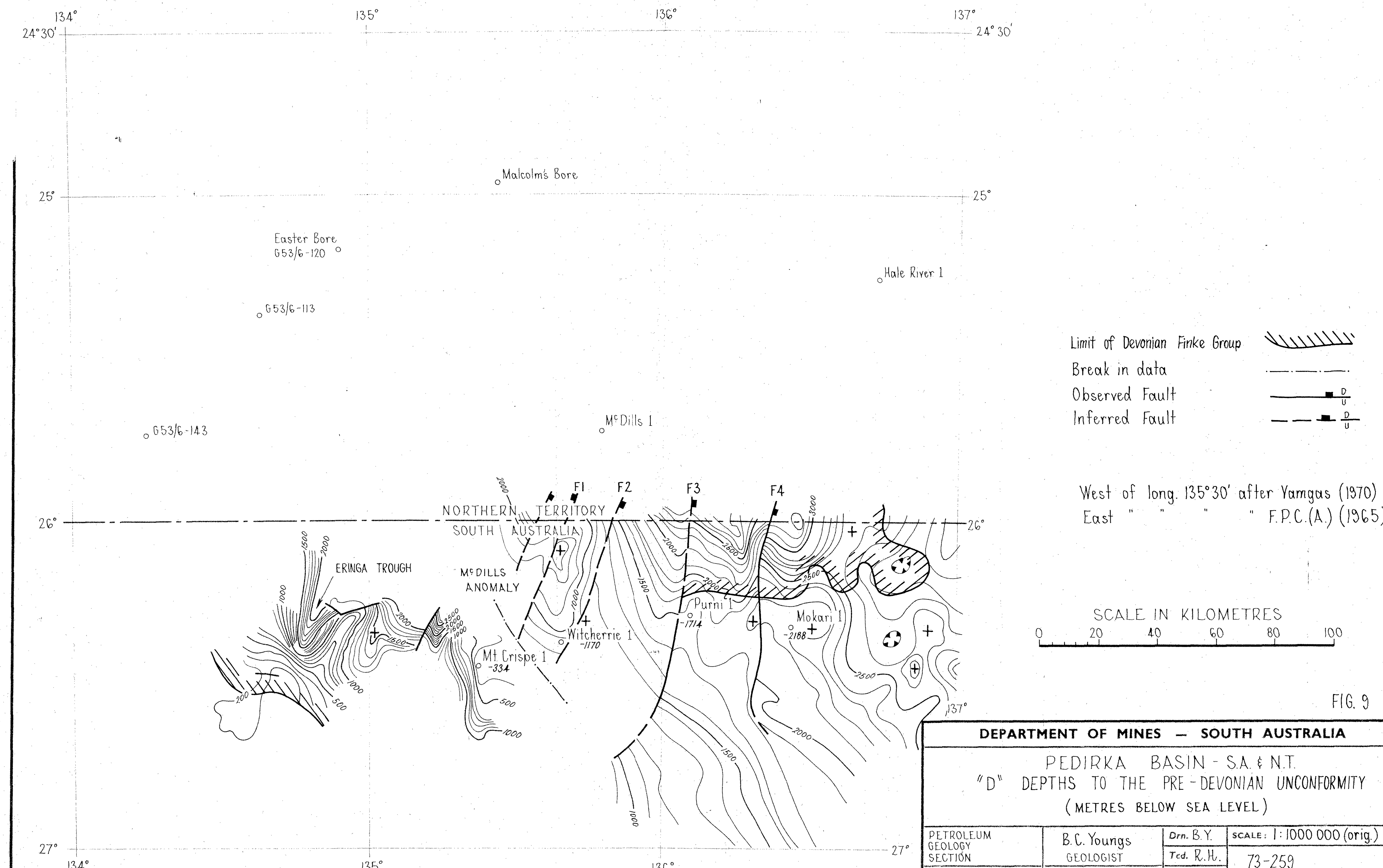


FIG. 9

DEPARTMENT OF MINES — SOUTH AUSTRALIA

PEDIRKA BASIN - S.A. & N.T.
"D" DEPTHS TO THE PRE-DEVONIAN UNCONFORMITY
(METRES BELOW SEA LEVEL)

PETROLEUM GEOLOGY SECTION	B.C. Youngs GEOLOGIST	Drn. B.Y.	SCALE: 1:1000 000 (orig.)
		Tcd. R.H.	73-259
		Ckd.	994·2+81
Director of Mines	SUP. GEOLOGIST	Exd.	DATE: 7-5-73

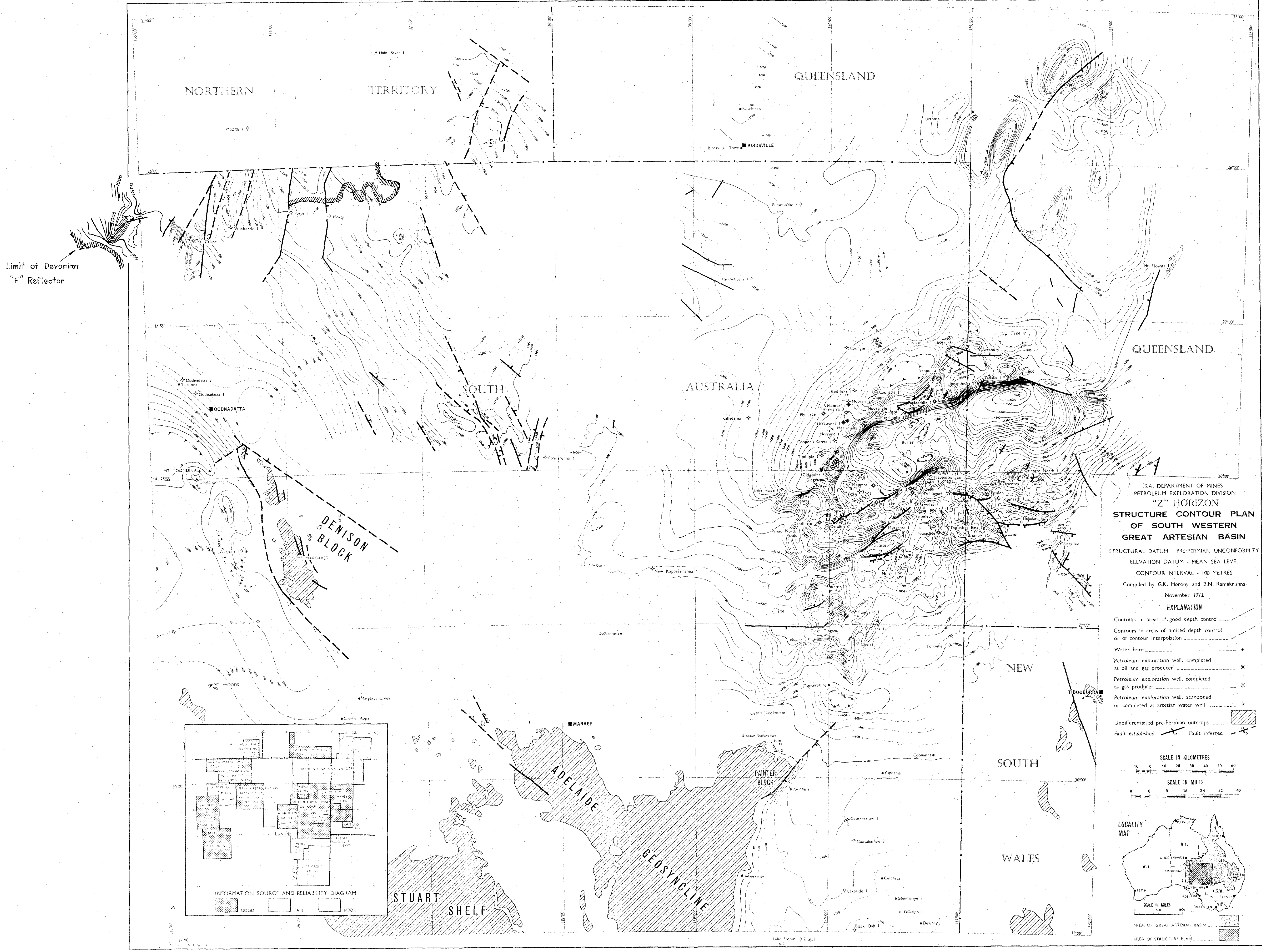


FIG. 10

PETROLEUM EXPLORATION DIVISION	DEPARTMENT OF MINES – SOUTH AUSTRALIA	Scale: 1:2,000,000
Compiled: G.K.M. & B.N.R.	PEDIRKA BASIN – S.A. & N.T.	Date: 11-5-73
Drn. W.J.E. / Ckd.	"Z" – DEPTHS TO BASE OF PERMIAN (METRES BELOW SEA LEVEL)	Drg. No. 73-260 994-2/3

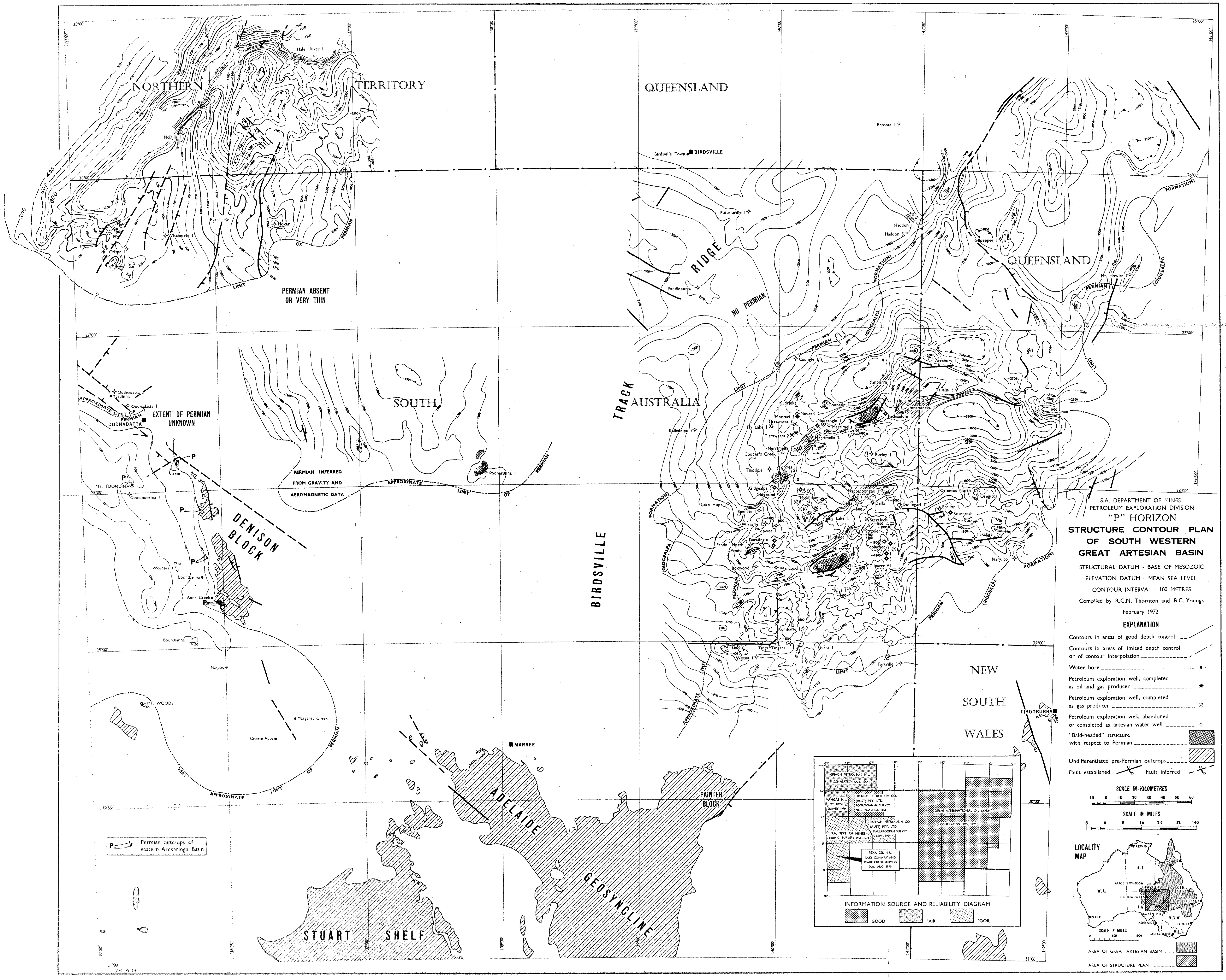


FIG. 11

PETROLEUM EXPLORATION DIVISION	**DEPARTMENT OF MINES – SOUTH AUSTRALIA**	Scale: 1:2,000,000
Compiled: R.C.N.T. & B.C.Y.	PEDIRKA BASIN – S.A. & N.T.	Date: 7-5-73
Drn. W.J.E. Ckd.	"P" – DEPTHS TO TOP OF PERMIAN (METRES BELOW SEA LEVEL)	Drg. No. 73-261 994-2/3

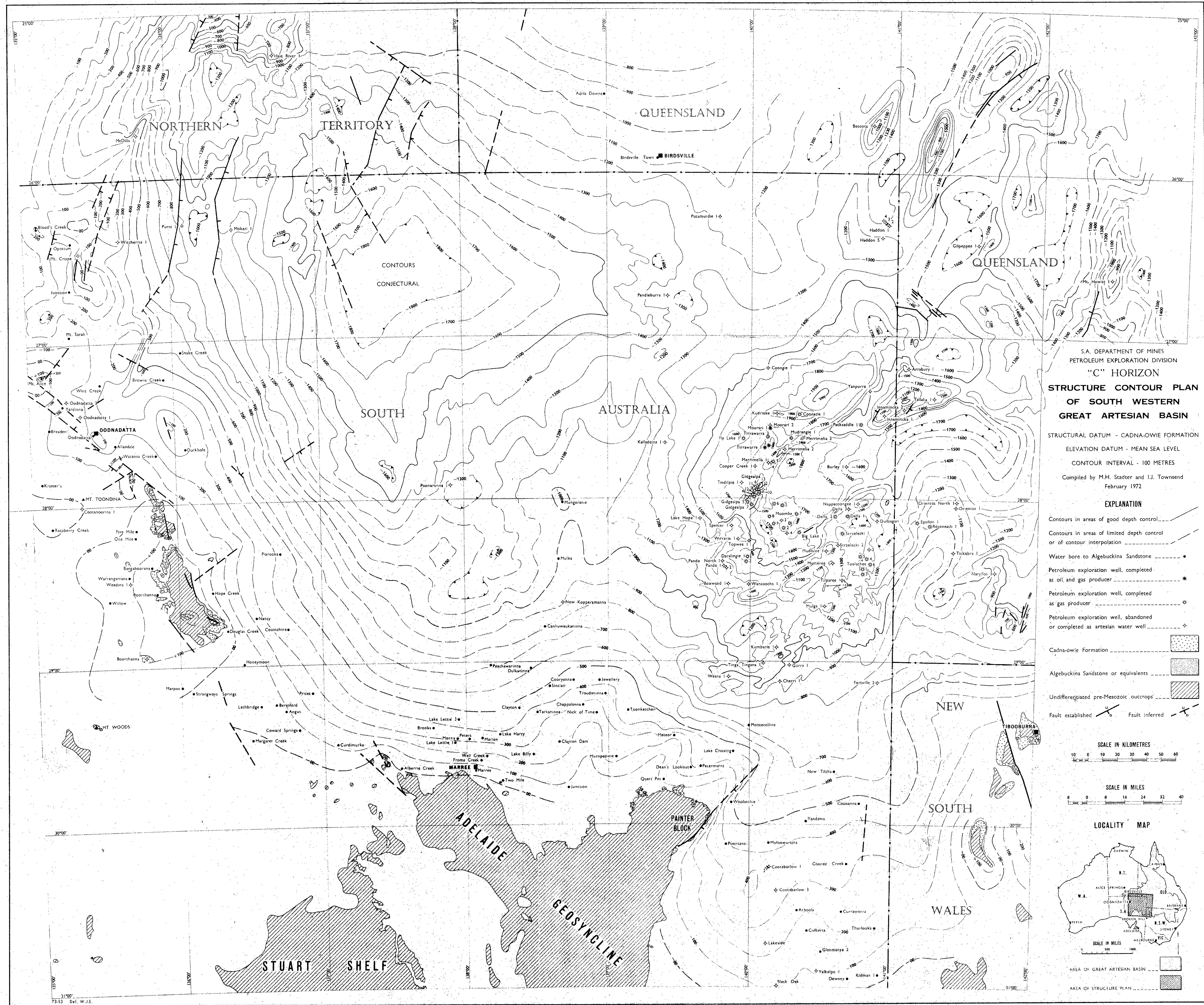
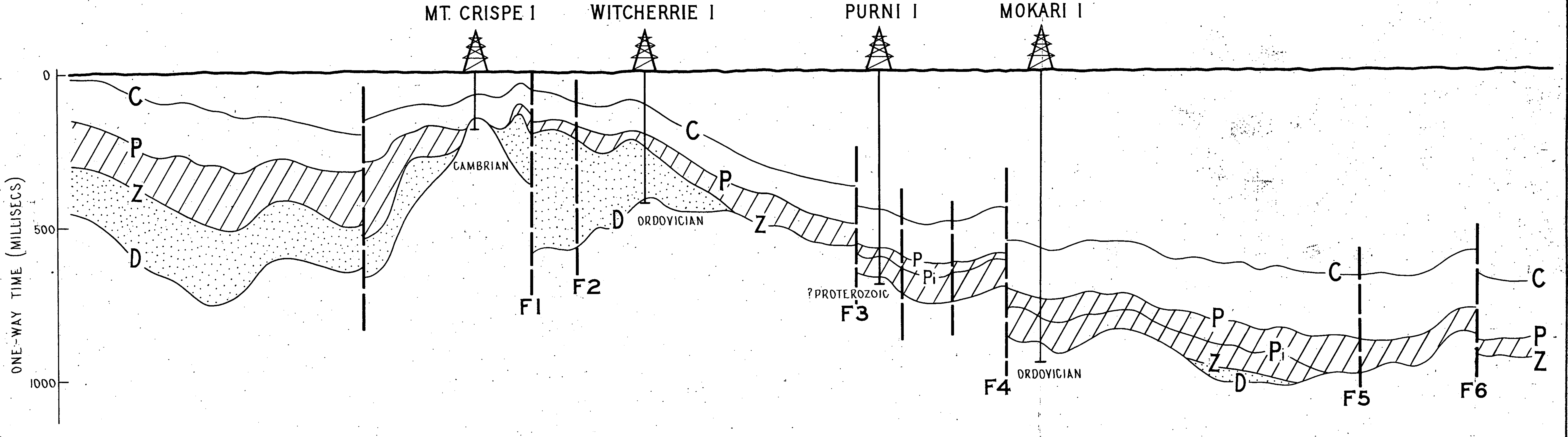


FIG. 12

PETROLEUM EXPLORATION DIVISION	DEPARTMENT OF MINES – SOUTH AUSTRALIA	Scale: 1:2,000,000
Compiled: M.H.S. & I.J.T.	PEDIRKA BASIN – S.A. & N.T.	Date: 7-5-73
Drn. W.J.E. Ckd.	"C"–DEPTHS TO CADNA-OWIE FORMATION (L. CRETACEOUS) (METRES BELOW SEA LEVEL)	Drg. No. 73-262 394-2/3



Adapted from Drayton, 1967

L E G E N D

C = Top of Cadna-owie Formation

P = Top of Permian

Pi = Base of coal-bearing, Upper Purni Formation

Z = Base of Permian or Mesozoic (if Permian is absent)

D = Base of Devonian, when present

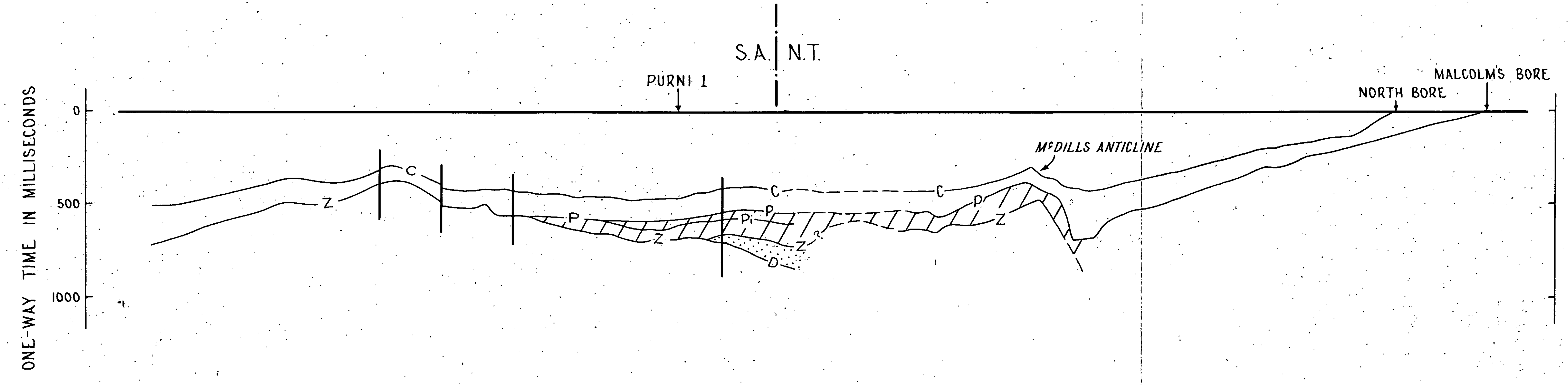
Permian

Devonian

FIG. 13

PETROLEUM GEOLOGY SECTION		DEPARTMENT OF MINES – SOUTH AUSTRALIA	Scale: 1:600,000
Compiled: B. Youngs		PEDIRKA BASIN - S.A. & QLD.	Date: 14 April 1972
Drn. R. H.	Ckd. A. F.	SEISMIC CROSS-SECTION THROUGH F.P.C. (A.) WELLS	Drg. No. 73-263 994-2/3 + 61

1M-2.70 A1811



APPROXIMATE SCALE IN KILOMETRES

0 15 30 45 60 75

N.T. Adapted from Yakunin, 1965

S.A. After Drayton, 1967

LEGEND

C = Top of Cadna-owie Formation

P = Top of Permian

Pi = Base of coal-bearing, Upper Purni Formation

Z = Base of Permian or Mesozoic (if Pemian is absent)

D = Base of Devonian when present

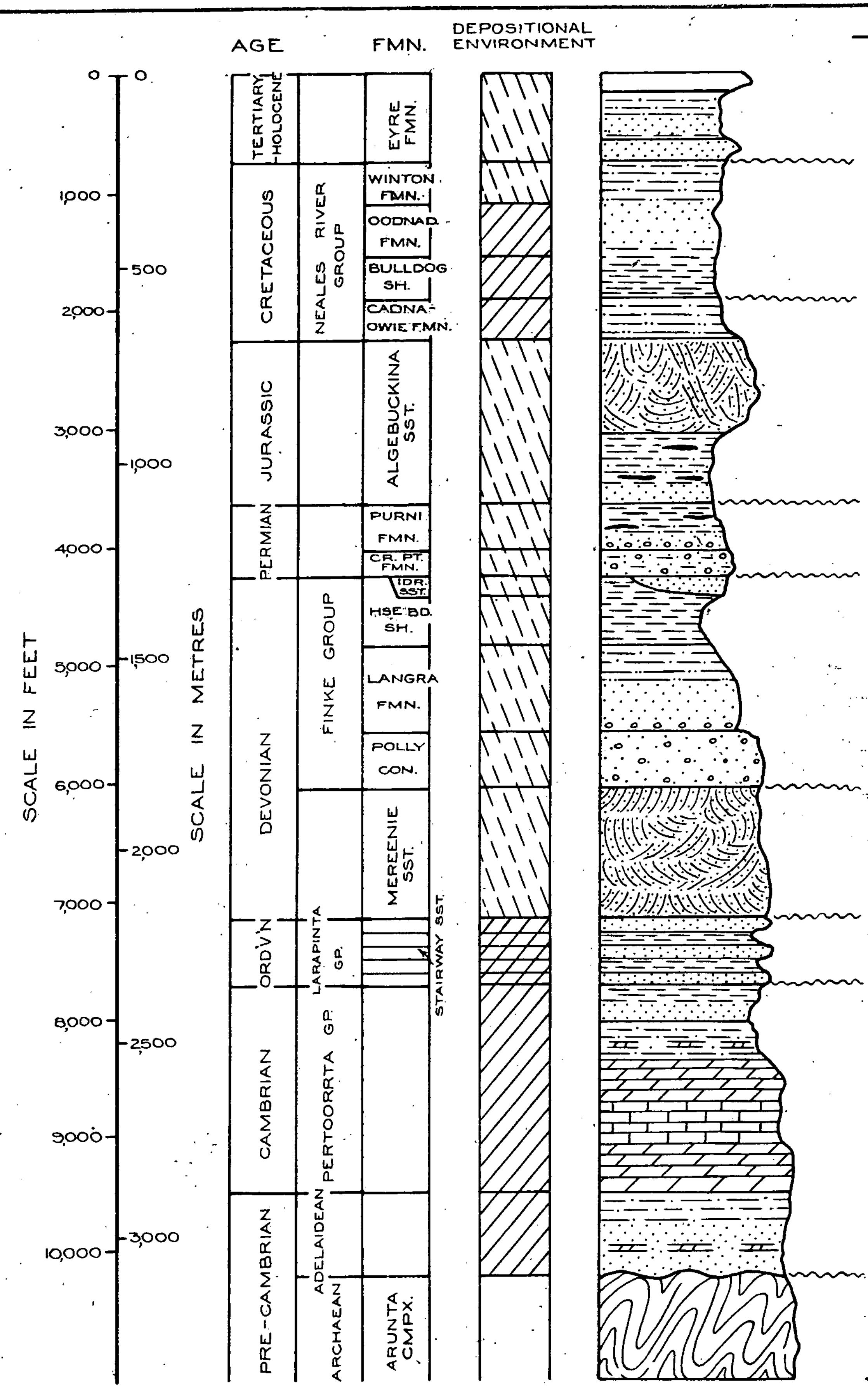
Permian

Devonian

FIG. 14

PETROLEUM GEOLOGY SECTION	DEPARTMENT OF MINES – SOUTH AUSTRALIA	Scale: 1:750 000 (app.)
Compiled: B. Youngs	PEDIRKA BASIN - S.A. & N.T.	Date: 19 April 1972
Drn. R.H. Ckd. A.F.	GENERALISED SEISMIC SECTION PURNI 1 TO MALCOLM'S BORE	Drg. No. 73-264 994-2/3+81

1M-2.70 A1811



EYRE FORMATION: Sands and gravels, usually capped by a silcrete layer.

Soft white to grey claystones and siltstones with sandstone interbeds glauconitic in parts. Yellow ochre at the base.

Medium to coarse, white, friable, steeply cross-bedded, micaceous sandstones.

Sands, silts, shale and coals in generally thin interbeds. Conglomeratic at the base; sandy in the middle and coals at the top only. Pyrtic and micaceous in parts Diamictites with interbedded conglomerates, sands and shales. Glacial deposits.

IDRACOWRA SANDSTONE: White fine grained calcareous sandstone.

HORSESHOE BEND SHALE: Red and green shales and silts with biotite gypsum, ripple marks and mud cracks.

LANGRA FORMATION: White fine to coarse grained sandstone. Conglomeratic at base grading to silty at top.

POLLY CONGLOMERATE: hard, light, sandy matrix with pebbles of various sizes and origins.

THESE FORMATIONS HAVE BEEN IDENTIFIED IN AND AROUND THE PEDIRKA BASIN. FULLER DESCRIPTIONS APPEAR IN THE TEXT.

White-pale brown thinly to thickly bedded sandstone. Generally fine grained. It is frequently cross-bedded and often contains mud cracks. It weathers to a red-brown colour. Reaches upto 600m. in southeastern Amadeus Basin. Deposited in a desert with a shallow sea gradually encroaching from the west.

Five alternating sandstone and siltstone formations. Mid. sandstone (Stairway Sst.) is the most widespread of the formations-white-grey, fine to coarse sandstone with ripple marks, mud cracks ect. Two lowermost formations are absent from the southeastern Amadeus Basin.

Siltstones and shales predominate in this Group in the southeastern Amadeous Basin Carbonates are also present in the sequence and are limestones, dolomites and interlaminated cherts. Evaporites may also be present in the Group. Few pebbly sandstones and red silts and shales.
These clastics were deposited in a shallow east-west trough (Amadeus Basin) and were derived mainly from the south and west.

A varied sequence of formations composed of siltstones, sandstones, conglomerates, limestones, dolomites and quartzite. The sands and conglomerates near to the top were deposited in a glacial and periglacial environment; the remaining strata were laid down mainly in shallow seas and lagoons.

A very varied sequences of metamorphosed sediments and volcanics which has been intruded by a fine, even-grained granite. The complex is overlain everywhere with much unconformity.

THESE FORMATIONS HAVE BEEN IDENTIFIED AND NAMED IN THE AMADEUS BASIN (WELLS ET AL, 1970). IT IS POSSIBLE THAT LATERAL EQUIVALENTS EXIST BENEATH THE PEDIRKA BASIN BUT THEY HAVE NOT BEEN PROVEN.

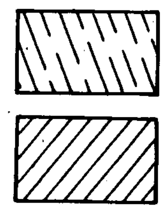


FIG. 15

(Information was derived from exploration wells within the basin and from Wells et al., 1970. Thicknesses were taken as an average from all wells in which a unit was intersected.)

Compiled: B.C.Y.	**DEPARTMENT OF MINES – SOUTH AUSTRALIA**	Scale:
Drn. A.G.R. Ckd. A.F.	PEDIRKA BASIN S.A. & N.T. IDEALISED COMPOSITE SECTION	Date: 11th April 1973
		Drg. No. 73–265 994·2/3+81

1M–7.70 A1811

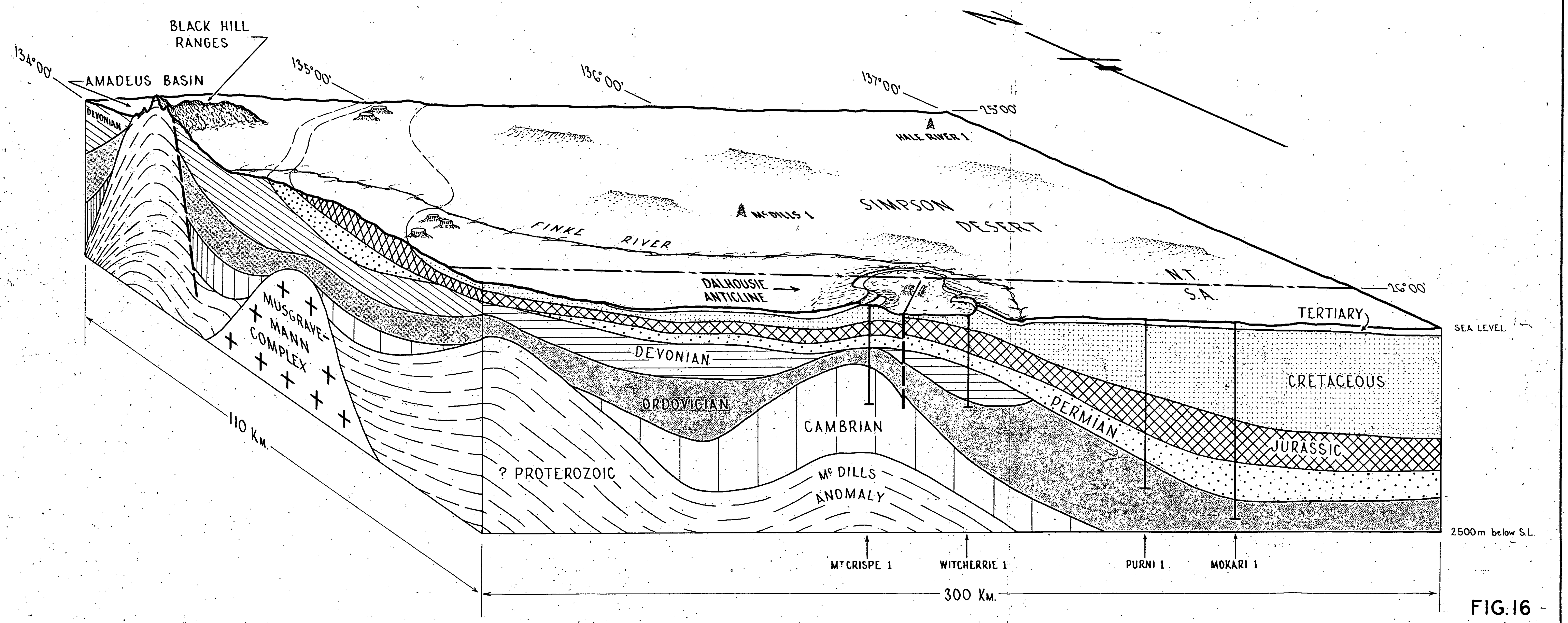
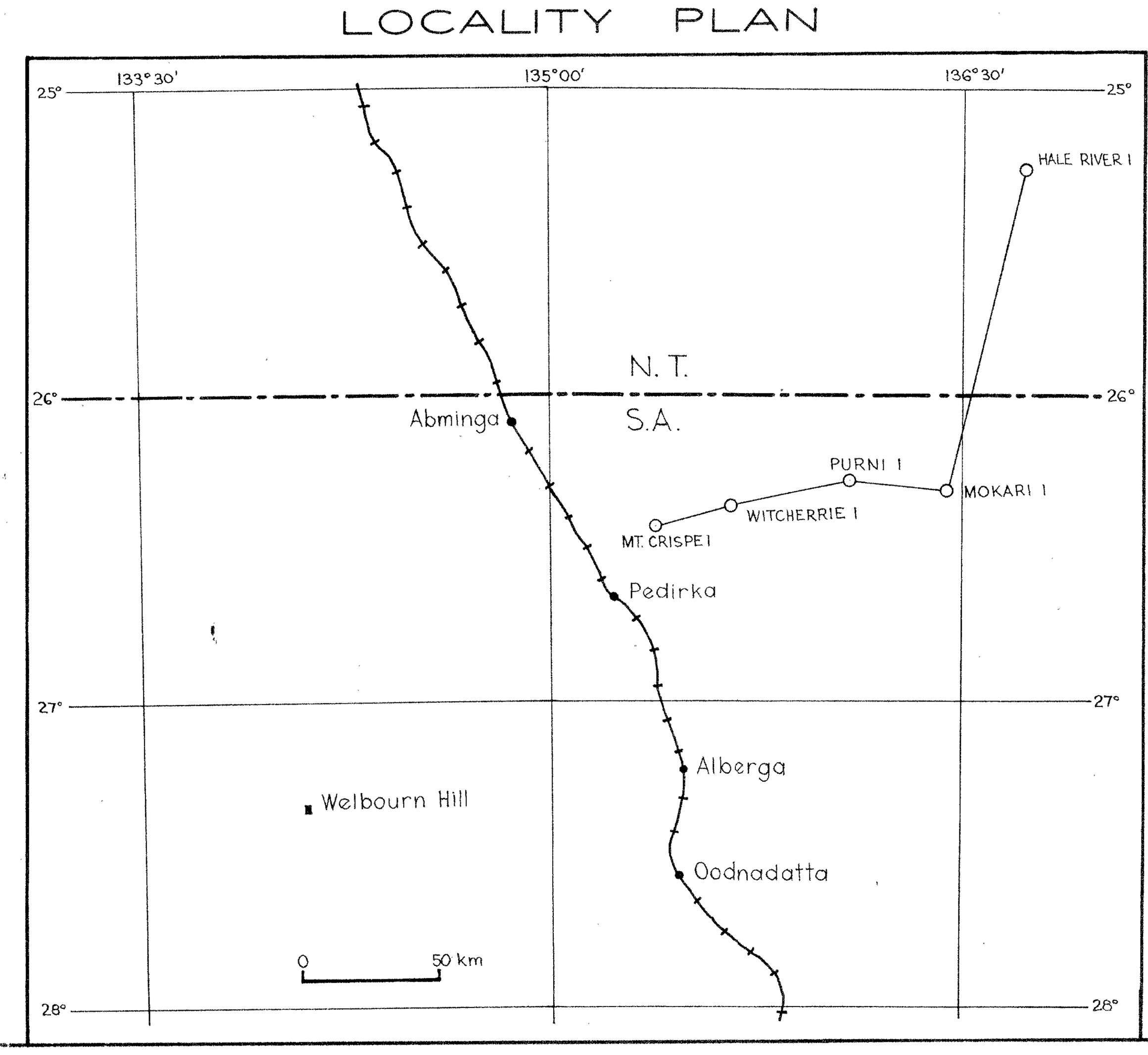


FIG.16

PETROLEUM GEOLOGY SECTION	DEPARTMENT OF MINES – SOUTH AUSTRALIA	Scale: Diagrammatic
Compiled: B. Youngs	PEDIRKA BASIN - S.A. & N.T.	Date: 24 April 1972
Drn. R. H. / Ckd. A.F.	SCHEMATIC BLOCK DIAGRAM	Drg. No. 73 - 266
		994-2/3 +81

1M–2.70 A1811

LOCALITY PLAN



⊗ Palynology sample reported in Appendix I

✱ Sample reported in Appendix II

FIG 17

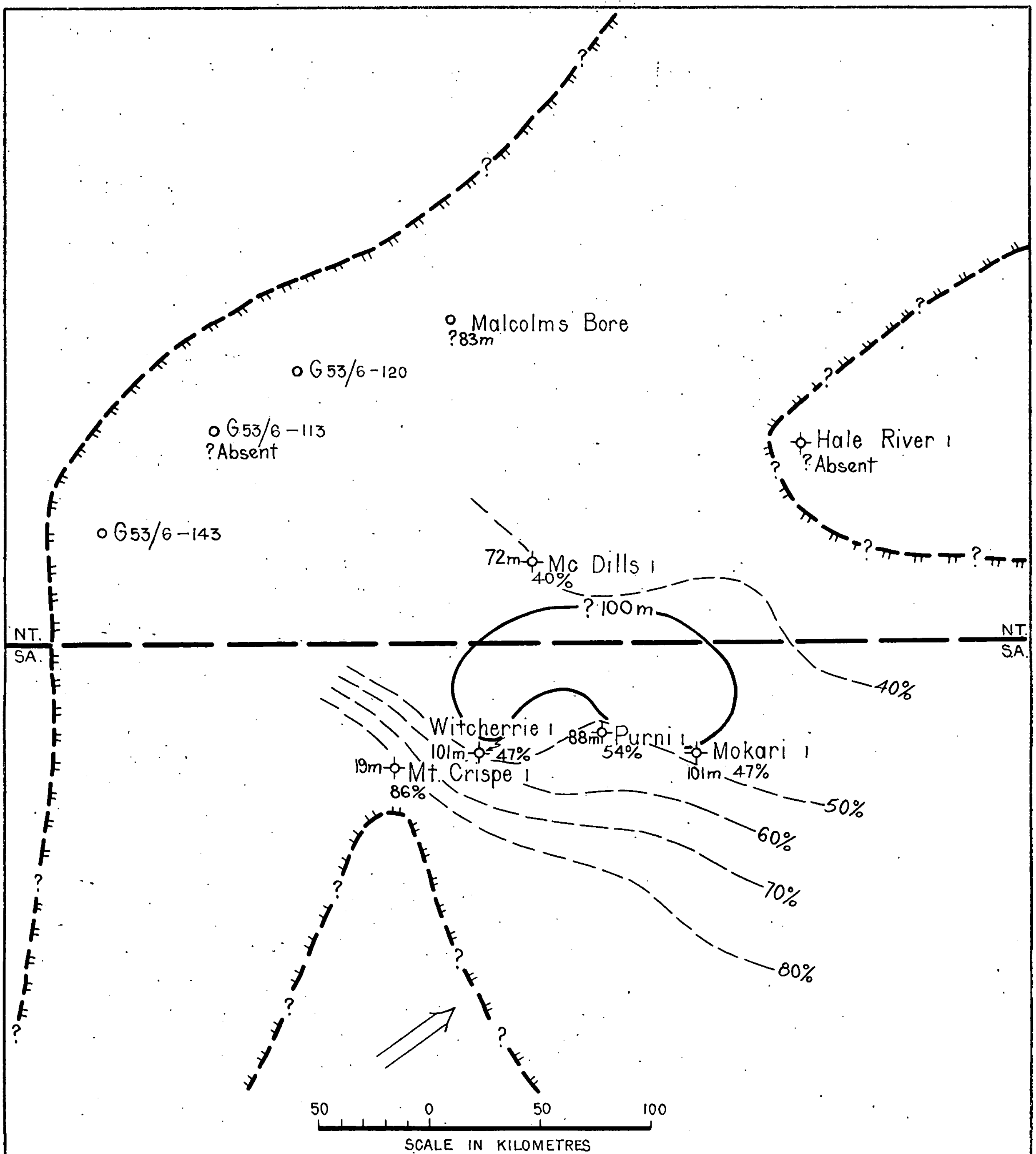
DEPARTMENT OF MINES — SOUTH AUSTRALIA			
PEDIRKA BASIN S.A. AND NT. LOG CORRELATIONS OF PRE-CRETACEOUS FORMATIONS			
PETROLEUM GEOLOGY SECTION	B.C. Youngs GEOLOGIST	Drn. B.C.Y.	SCALE: 1:2400
		Tcd. A.F.	73-267
		Ckd.	994-2/3-81
Director of Mines		Exd.	DATE: 11 April 1973

FIG 18

DEPARTMENT OF MINES — SOUTH AUSTRALIA

PEDIRKA BASIN S.A. AND N.T.
LOG CORRELATIONS OF PRE-CRETACEOUS FORMATIONS

PETROLEUM GEOLOGY SECTION	B. C. Youngs GEOLOGIST	Drn. B.C.Y.	SCALE: 1:2400
		Tcd. A.F.	73-266
		Ckd.	994 2/3 +81
Director of Mines		Exd.	DATE: 11th April 1973



Approx. limit of subcrop

100m Approx. isopach in metres

10% Sand percentage

Possible direction of origin of sediments

FIG. 19

Petroleum Geology Section	**DEPARTMENT OF MINES — SOUTH AUSTRALIA**	Scale: 1:2500000
Compiled: B. Youngs	PEDIRKA BASIN S.A. & N.T.	Date: 11 April 1973
Drn. B.D.W. Ckd. D.J.M.	TENTATIVE ISOPACHS AND SANDSTONE PERCENTAGES CROWN POINT FORMATION	Drg. No. S10260 994-2

300-6.72 C5552

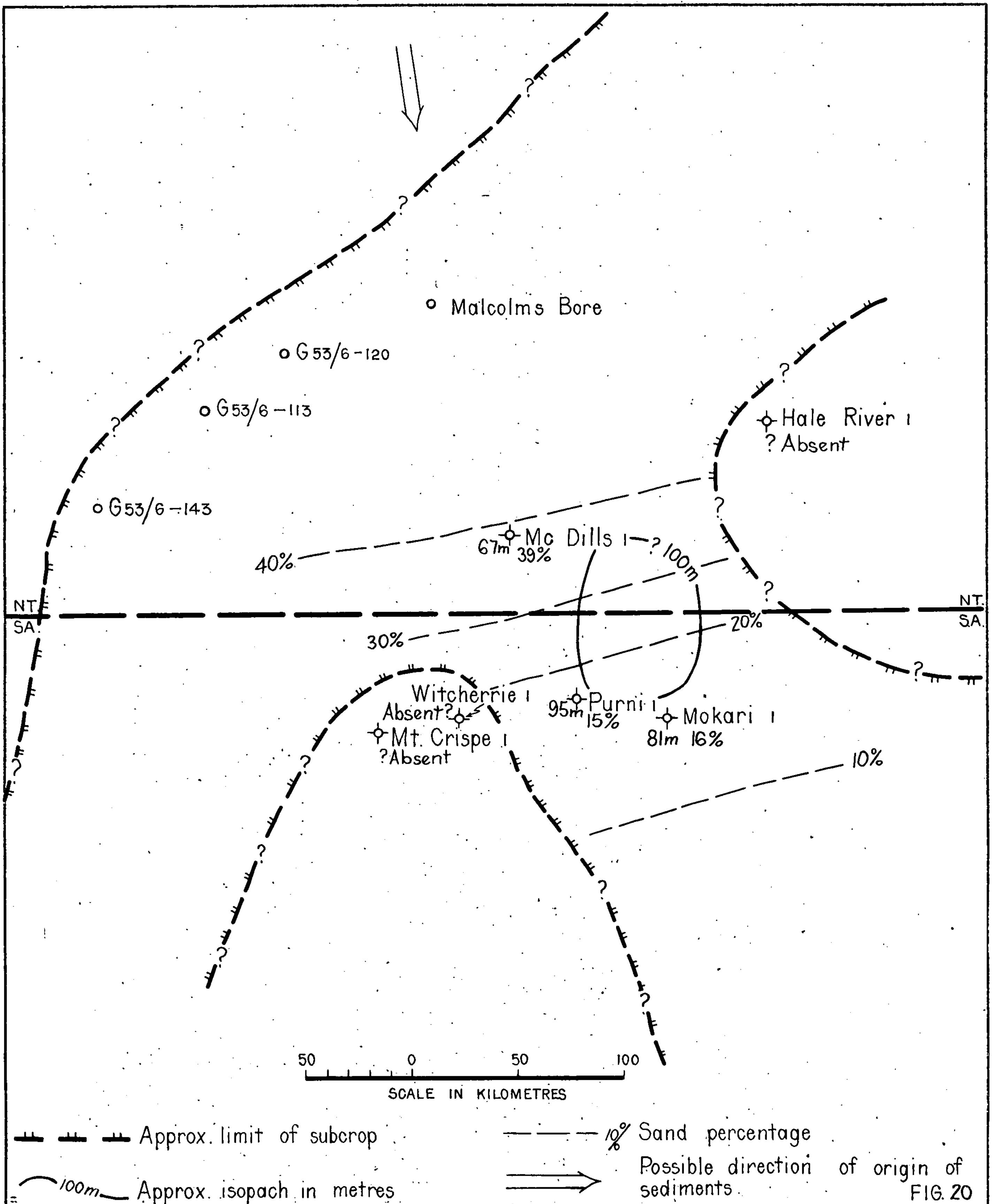
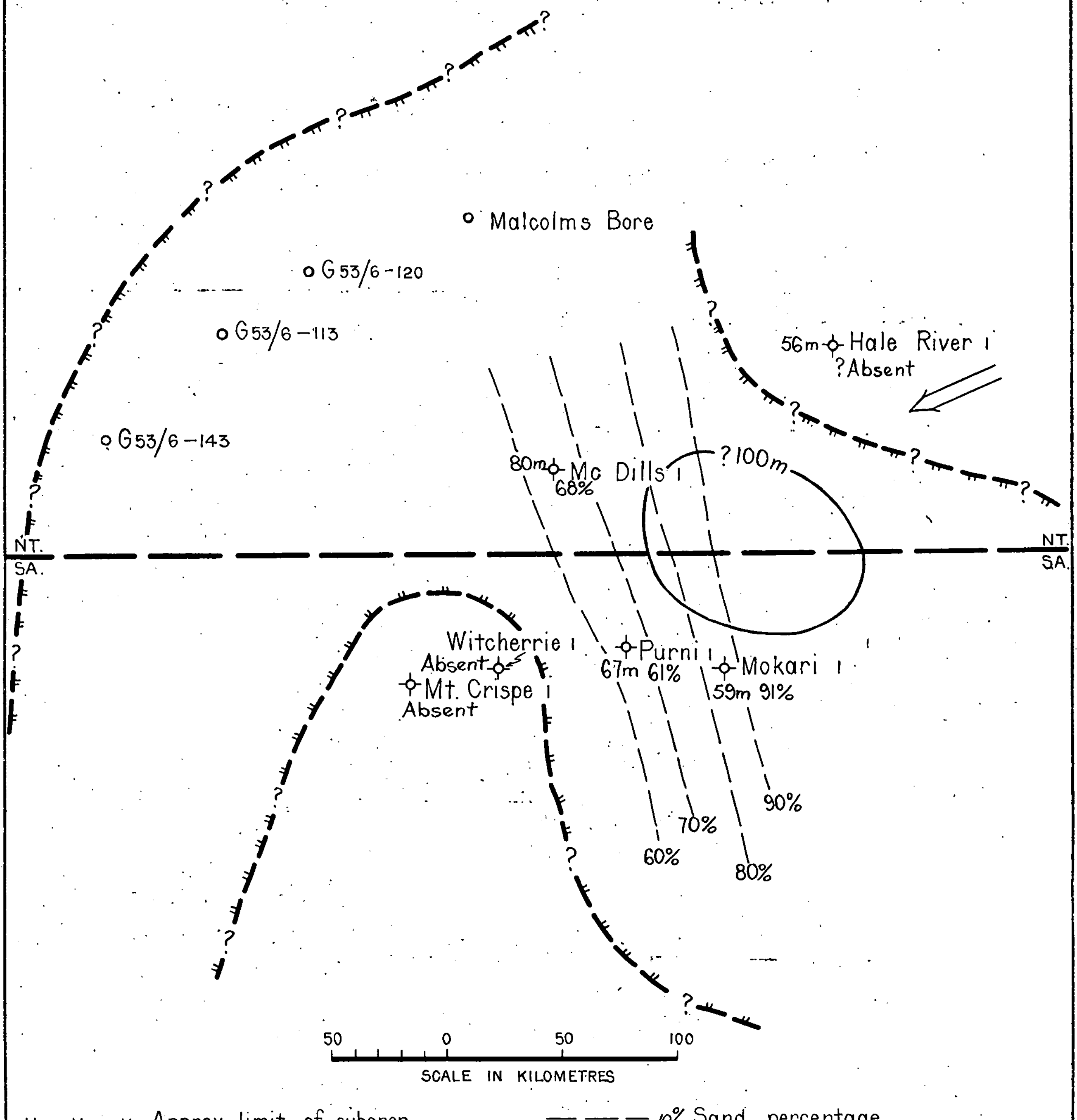


FIG. 20

Petroleum Geology Section.	DEPARTMENT OF MINES – SOUTH AUSTRALIA	Scale: 1:2500000
Compiled: B. Youngs	PEDIRKA BASIN S.A. & N.T.	Date: 11 April 1973
Drn. B.D.W. Ckd. D.J.M.	TENTATIVE ISOPACHS AND SANDSTONE PERCENTAGES LOWER PURNI FORMATION	Drg. No. S10261 994·2

300-6.72 C5552



Approx. limit of subcrop

Approx. isopach in metres

10% Sand percentage

Possible direction of origin of sediments.

FIG. 21

Petroleum Geology Section.	DEPARTMENT OF MINES — SOUTH AUSTRALIA	Scale: 1:2500000
Compiled: B. Youngs	PEDIRKA BASIN S.A. & N.T.	Date: 11 April 1973
Drn. B.D.W. Ckd. D.J.M.	TENTATIVE ISOPACHS AND SANDSTONE PERCENTAGES MIDDLE PURNI FORMATION	Drg. No. S10262 994·2

300-6,72 C5552

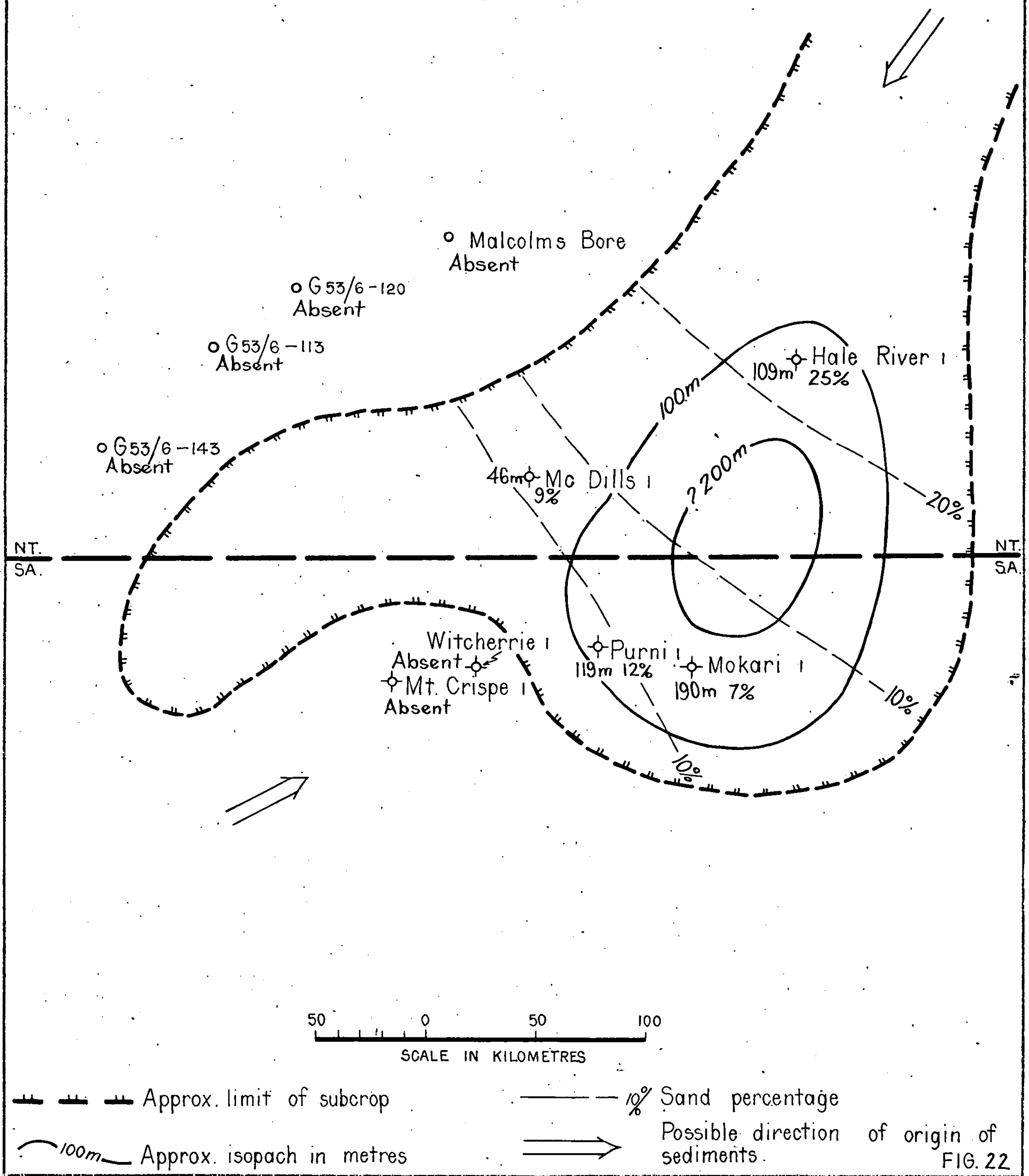


FIG. 22

Petroleum Geology Section.	DEPARTMENT OF MINES — SOUTH AUSTRALIA	Scale: 1:2500000
Compiled: B. Youngs	PEDIRKA BASIN S.A. & N.T.	Date: 11 April 1973
Drn. B.D.W. Ckd. D.J.M.	TENTATIVE ISOPACHS AND SANDSTONE PERCENTAGES UPPER PURNI FORMATION	Drg. No. S10263 994-2

300-6.72 C5552

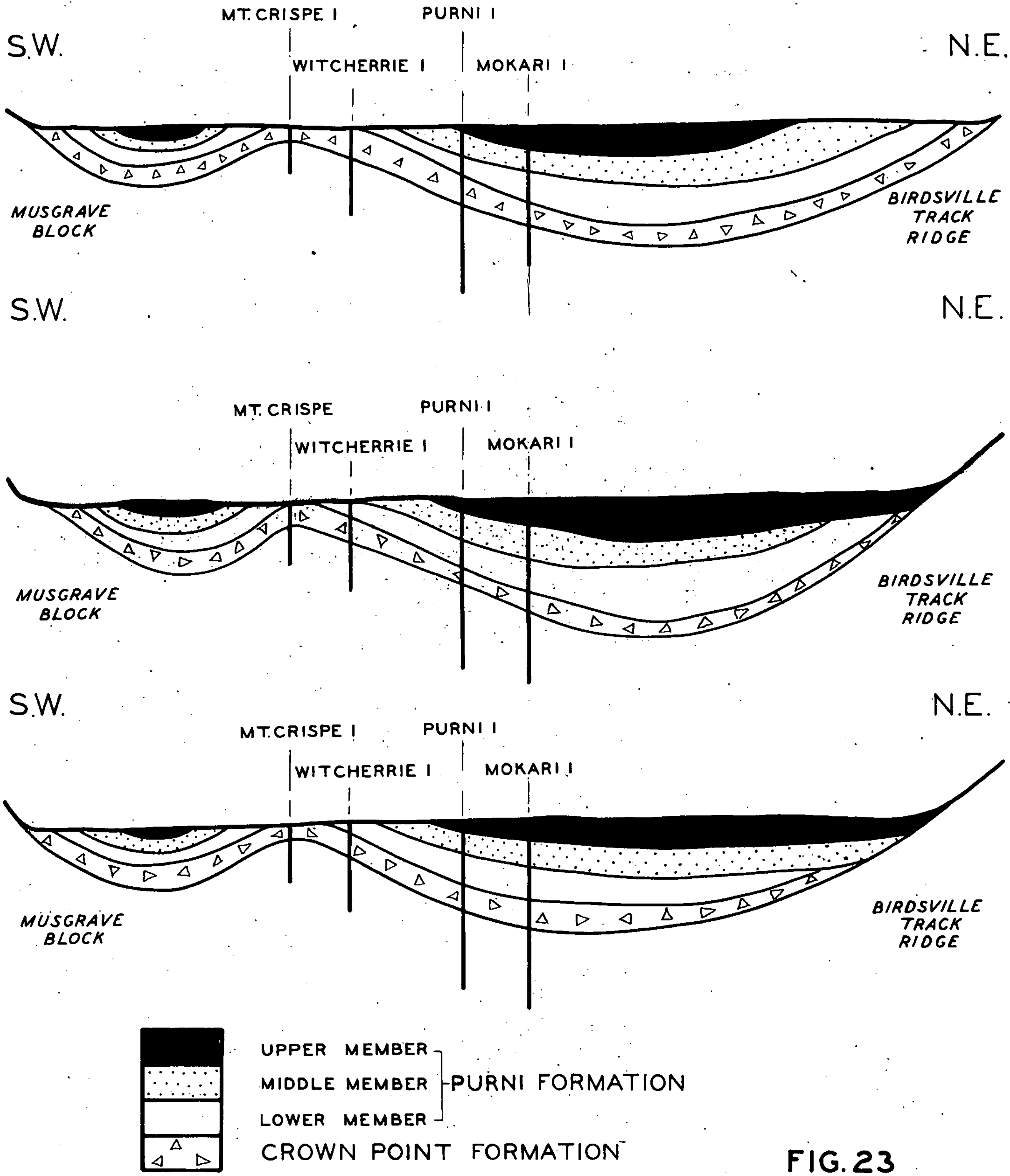


FIG. 23

	DEPARTMENT OF MINES — SOUTH AUSTRALIA	Scale: DIAGRAMMATIC
Compiled: B. YOUNGS	PEDIRKA BASIN — S.A. & N.T.	Date: 11TH APRIL
Drn. A.G.R. / Ckd. A.F.	POSSIBLE RELATIONSHIPS OF THE PERMIAN STRATA IN THE NORTHEASTERN PEDIRKA BASIN (SIMPSON DESERT SUB-BASIN)	Drg. No. S 10264 994·2/3+81

McDILLS 1				MOKARI 1				PURNI 1				WITCHERRIE 1				MALCOLM'S BORE
EVANS (B.M.R. UNIT)	No.	CORE DEPTH	HARRIS STAGES	EVANS (B.M.R. UNIT)	No.	CORE DEPTH	HARRIS STAGES	EVANS (B.M.R. UNIT)	No.	CORE DEPTH	HARRIS STAGES	EVANS (B.M.R. UNIT)	No.	CORE DEPTH	HARRIS STAGES	Balme (in Evans, 1964 & Rochow, 1965)
				P1c Cr Pt	2	1852m	Stage 3 (Up. mem)	P1c (Purni)	cutting	1417m	Stage 3 (Up. mem.)					92m - 479m Lower Artinskian = Stage 3
				P1b Cr Pt	3	1998m	Stage 3 (Up. mem.)		2	1435m	Stage 3 (Up. mem.)					
				P1b Cr Pt	4	2017m	Stage 3 (M. mem.)		3	1551m	Stage 3 (M. mem.)					
				P1b Cr Pt	5	2027m	Stage 3 (M. mem.)		4	1602m	Stage 3 (M. mem.)					
P1b Cr Pt	1	725m							5	1719m	Stage 2 Cr. Pt.		2	1891m	Stage 2 Cr. Pt.	479m. - 562m Crown Pt. Formation = Stage 2
P1a Cr Pt	4	904m							7	1771m	Stage 2 Cr. Pt.					
P1a Cr Pt	5	908m														
P1a Cr Pt	6	954m														

Abbreviations: Cr Pt = Crown Point Formation
Up. mem. = Upper Member } Purni Formation
M. mem. = Middle Member } Purni Formation

FIG. 24

PETROLEUM GEOLOGY SECTION
Compiled: B. Youngs
Drn. R.H.
Ckd. A.F.

DEPARTMENT OF MINES – SOUTH AUSTRALIA

PEDIRKA BASIN - S.A. & N.T.
RESULTS OF PALYNOLOGICAL STUDIES

Scale:
Date: 6 March 1972
Drg. No. S10265
994-2/3+81

1M-2.70 A1810

PETROLEUM GEOLOGY SECTION
Compiled: B. Youngs
Drn. R.H. | Ckd. A.F.

DEPARTMENT OF MINES — SOUTH AUSTRALIA

PEDIRKA BASIN - S.A. & N.T.
PERMIAN PALYNOLOGICAL TABLE

FIG 25

Date: 2 March 1972

Drg. No. S10266

984-2/3 +81

1M-2/70 A1810

		BALME'S ASSEMBLAGE	B.M.R. UNIT	EVANS' STAGES	PEDIRKA BASIN	COOPER BASIN ⊛	ARCKARINGA BASIN
U. PERMIAN		Dulhuntyspora	P4	5		Upper Gidgealpa Formation	
U. PERMIAN		Dulhuntyspora	P3d	5		Upper Gidgealpa Formation	
U. PERMIAN		Dulhuntyspora	P3c	5		Middle Gidgealpa Formation	↑ ?
LOWER PERMIAN	Artinskian	Dulhuntyspora	P3b	5		Middle Gidgealpa Formation	↑ ?
LOWER PERMIAN	Artinskian	Vittatina	P3a	4	↑ ?	Middle Gidgealpa Formation	↑ ?
LOWER PERMIAN	Artinskian	Vittatina	P2	4	↑ ?	Middle Gidgealpa Formation	↑ ?
LOWER PERMIAN	Artinskian-Sakmarian	Vittatina	P1c	3	Upper Purni Fm Middle Purni Fm Lower Purni Fm	Lower Gidgealpa Formation	Mt. Toondina Formation
LOWER PERMIAN	Artinskian-Sakmarian	Nuskoisporites	P1b	2		Merrimelia Formation	(Unit I) Stuart Range Formation
LOWER PERMIAN	Artinskian-Sakmarian	Nuskoisporites	P1a	2	Crown Point Formation	Merrimelia Formation	Boorthanna Formation (Unit II)
LOWER PERMIAN	Sakmarian	Nuskoisporites	C2	2	Crown Point Formation	Merrimelia Formation	
CARB.			C1	1			

⊛ This terminology has been superseded by Kapel (1972) and Gatehouse (1972).

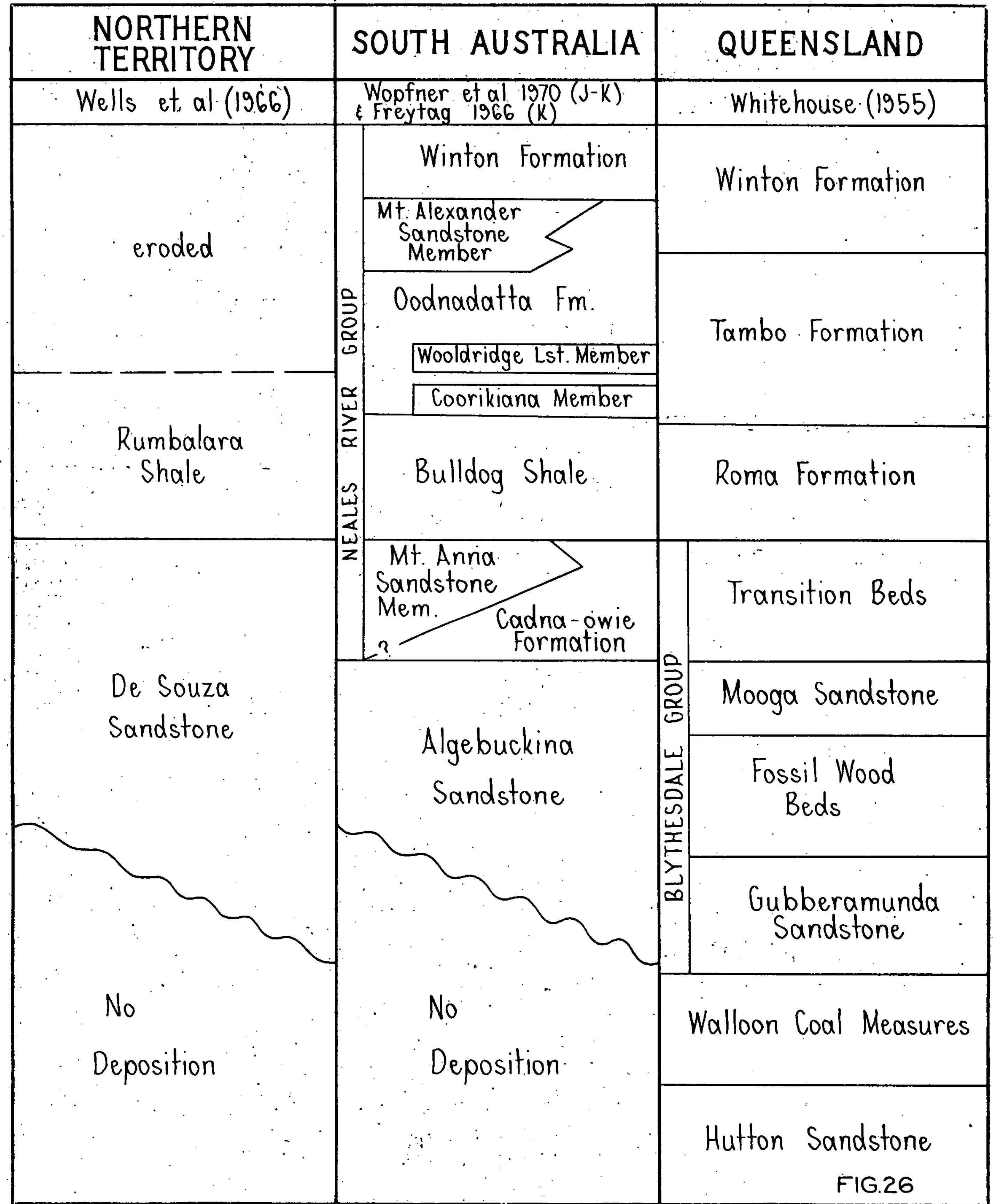


FIG.26

PETROLEUM GEOLOGY SECTION	DEPARTMENT OF MINES – SOUTH AUSTRALIA	Scale:
Compiled: B. Youngs	PEDIRKA BASIN - S.A. & N.T.	Date: 14 Feb 1972
Drn. R.H. | Ckd. A.F.	MESOZOIC NOMENCLATURE & CORRELATION	Drg. No. S10267 994-2/3+81

1M–2.70 A1810

DEPARTMENT OF MINES – SOUTH AUSTRALIA

PETROLEUM GEOLOGY SECTION

Compiled: B. Youngs

Drn. R.H. | Ckd. A.F.

PEDIRKA BASIN - S.A. & N.T.

POROSITIES FROM CORES AND LOGS

Scale:

Date: 3 March 1972

Drg. No. S10268

994·2/3+81

1M-270 A1810

FIG. 27

	MT CRISPE 1 (from logs)	PURNI 1 (from cores)	MOKARI 1 (from logs)	McDILLS 1 (from logs)	HALE RIVER 1
JURASSIC		20·5	⊛ 15·8 ⊛ 14·9	25-35	19 CORES 15-25 LOGS
PERMIAN		19·6, 22·0, 16·2 U. PURNI FM. 20·8, 20·7 CROWN PT. FM.	8·8, 3·7 U. PURNI FM. ⊛ 10·4 MID. & LWR. PURNI FM. 2·9 CROWN PT. FM.	15-25	⊛ 25 CORES 15-22 LOGS 11 CORES
DEVONIAN – FINKE GROUP				20-25	20-25
DEVONIAN – MEREENIE SST.				10-15	
ORDOVICIAN Stairway Sst.	14·4				
CAMBRIAN	5·4-11·4				

N.B. Good porosity was indicated in the Finke Group at Witcherrie 1

⊛ Good permeability also reported

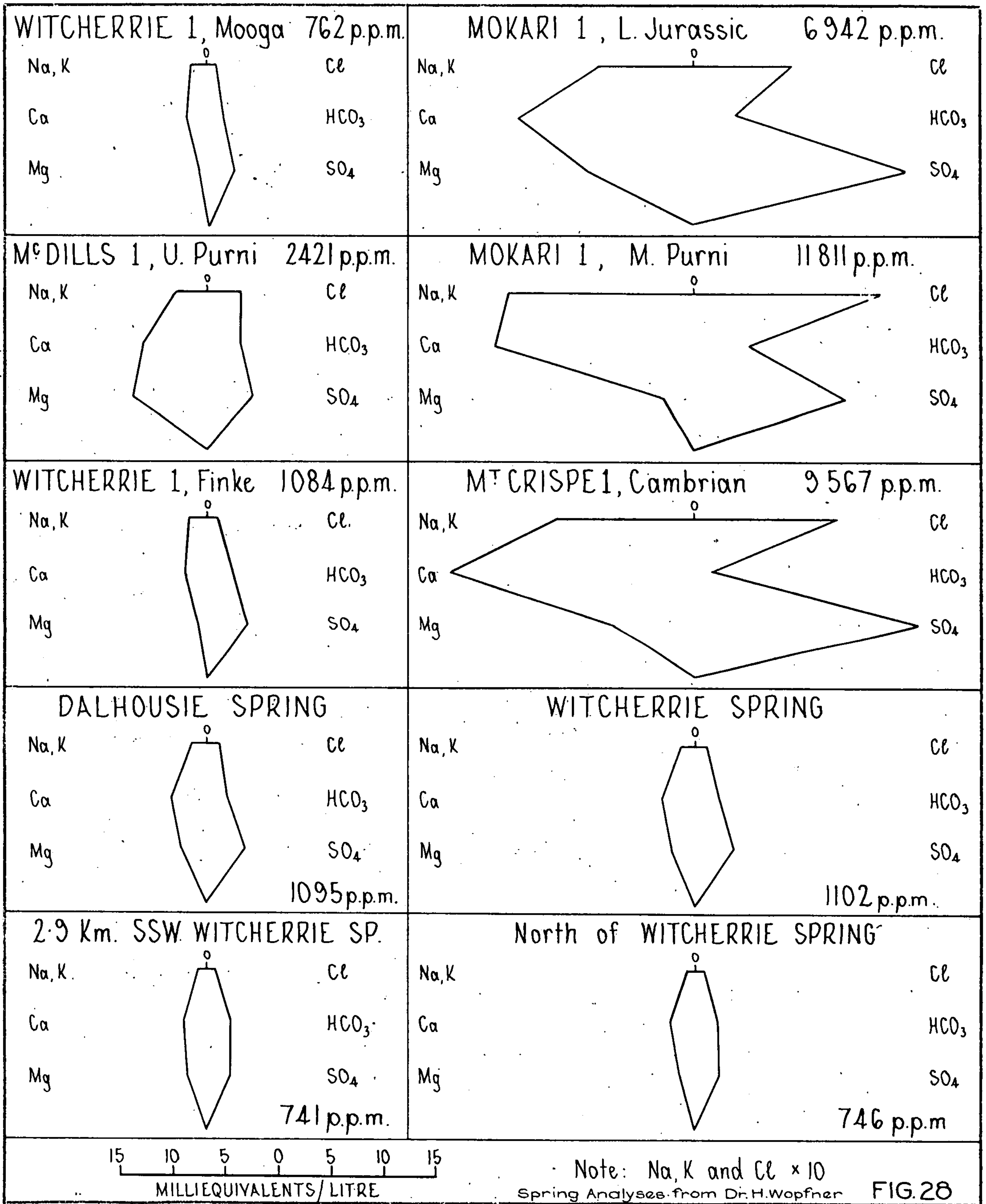


FIG. 28

PETROLEUM GEOLOGY SECTION	DEPARTMENT OF MINES – SOUTH AUSTRALIA	Scale: Graphical
Compiled: B. Youngs	PEDIRKA BASIN – S.A. & N.T.	Date: 18 April 1972
Drn. R.H. / Ckd. A.F.	WATER ANALYSES – STIFF PATTERNS	Drg. No. S10269 994-2/3+81

1M–2.70 A1810