DEPARTMENT OF MINES
SOUTH AUSTRALIA

GEOLOGICAL SURVEY
REGIONAL SURVEYS DIVISION

1:250 000 Geological Series - Explanatory Notes

NOOLYEANA

SOUTH AUSTRALIA

Sheet SG/53-16 International Index

Compiled by

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Rept.Bk.No.73/161
G.S. No. 5166
DM. No.1289/71

3rd July, 1973

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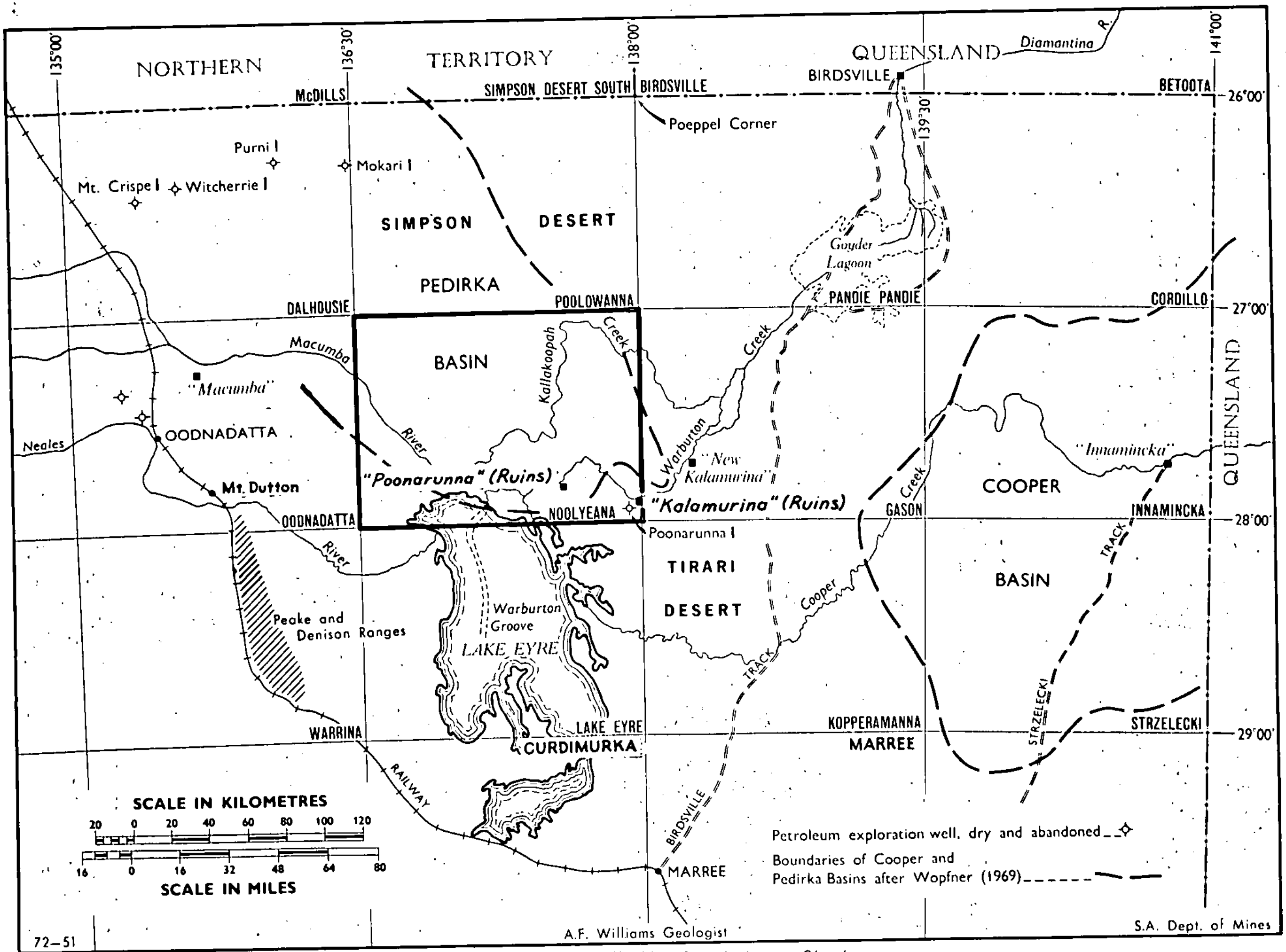

Fig. 1. Regional locality Map for Noolyeana Sheet

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EXPLANATORY NOTES FOR THE NOOLYEANA 1:250 000 SHEET

ABSTRACT

The NOOLYEANA 1:250 000 sheet area lies in the northern portion of the Great Artesian Basin in South Australia. The area mapped includes the southern part of the Simpson Desert and northern Lake Eyre. The oldest outcrops in the area are the Cretaceous (Albian to Cenomanian) claystones and sandstones of the Winton Formation which are exposed in the southwest corner of the area. Ordovician (70 m), Jurassic (149 m) and Cretaceous (1 116 m) rocks were intersected in the subsurface in French Petroleum Company (Australia) Poonarunna No. 1 which was drilled in the south east corner of the sheet area in 1964.

Cainozoic rocks deposited include Lower Tertiary fluviatile sandstones which have generally been silicified (together with part of the Winton Formation), ?Upper Tertiary limestones and marls equivalent to the Etadunna Formation, a sequence of Pleistocene channel sands and clays, aeolian sand of the Simpson Desert and more recently the alluvium of the gibber plains, lakes and rivers.

Structural trends on the map area vary from northeast to northwest.

INTRODUCTION

The NOOLYEANA 1:250 000 sheet area (hereafter referred to as NOOLYEANA) lies about 850 km north of Adelaide between latitudes 27° and 28° south and longitudes 136°30' and 138° east. The sheets adjoining it are GASON to the east, LAKE EYRE to the south, OODNADATTA to the west and POOLOWANNA to the north (see Fig. 1). The area is uninhabited. The southwestern and southeastern portions of the area form a part of Macumba and Kalamurina cattle stations. The nearest station homestead is New Kalamurina which is about 25 km northeast of Poonarunna Bore (formerly French Petroleum Company (Australia) Poonarunna 1 - now a flowing artesian bore). Two abandoned stations, Old Kalamurina and Poonarunna are situated along the Warburton Creek on NOOLYEANA. The nearest town is Oodnadatta, about 105 km west of NOOLYEANA. The sand hills of the Simpson and Tirari Deserts and the salt channels of the Warburton and Kallakoopah Creeks and Macumba River make vehicle travel through the area difficult. There are only a few tracks on the gibber country in the southwest and one graded track from New Kalamurina to Poonarunna 1 and about 25 km down river from there. In good seasons, drovers were known to take cattle from Oodnadatta across the north end of Lake Eyre to the Birdsville Track cattle stations (Farwell, 1960).

The country is of little value for pastoral use during the dry seasons which are usual in this area. For instance, average rainfall according to the station owner at New Kalamurina is less than 130 mm per annum and extremely irregular. Two years or more may pass without appreciable rainfall. Average day temperatures range from 20°C maximum in winter to 35°C in summer (station records, New Kalamurina).

Mapping was carried out by G.W. Krieg and the author as part of a helicopter mapping programme covering the Simpson Desert, Lake Eyre and surrounding areas (Krieg, 1971). Some ground work was done by the author along Warburton Creek in 1970. RC9 photography (1:82 000 scale) from the South Australian Lands Department was used for field mapping and air photograph interpretation.

The author wishes to acknowledge Dr. H. Wopfner and members of the Petroleum Exploration and Regional Surveys Divisions of the South Australian Department of Mines and Dr. C.R. Twidale, University of Adelaide for their help and criticism during the preparation of these explanatory notes.

PREVIOUS WORK

(a) Historical

One of the first explorers to enter the area was Warburton (1866) who travelled along the northern edge of Lake Eyre on to the GASON area. Later, Lewis (1875) traversed the whole of the shores of Lake Eyre except the southwest portion and made a detailed examination of the flood plains to the east and northeast. A generalised account of early exploration in this area is given by Threadgill (1922).

(b) Geological

Early geological observations include those of Debney (1881 a and b) and Brown (1892). Gregory (1906) passed through the southern part of NOOLYEANA collecting samples of fossil bones. His book, "The Dead Heart of Australia" deals with the geology, history, physiography, water resources and plight of the aborigines of this area and contains an excellent bibliography.

Madigan (1930 to 1946) described various aspects of the geology of Lake Eyre and its surrounding areas. He crossed the Simpson Desert in 1939 (well to the north of the S.A.-N.T. border) from Andado Bore in the Northern Territory to Queensland and thence down to Goyder Lagoon, along Warburton Creek to Lake Eyre and down its eastern shore to Marree.

Since 1953, Stirton (now deceased) and colleagues (among them Dr. R.H. Tedford, Curator of Vertebrate Palaeontology at the American Museum of Natural History) have carried out stratigraphic and vertebrate palaeontological studies (Stirton et al., 1961, 1967) in the Tirari Desert, part of which extends on to NOOLYEANA (the Tirari Desert is the area between Cooper Creek, Warburton Creek and the east of Lake Eyre - see Fig. 1). Other literature relevant to NOOLYEANA includes that by King (1956, 1960), Sprigg (1958a, 1958b, 1961, 1963), Johns and Ludbrook (1963), Ludbrook (1966), Wopfner (1960-1973) and Jessup and Norris (1971)(see selected bibliography).

The subsurface geology of the Great Artesian Basin in this area has been described by Sprigg (1958a), Wopfner (1960, 1964, 1969), Canaple and Smith (1966), Tanner (1966), Nugent (1969) and Demaison et. al., (1970).

Mapping on aread adjacent to NOOLYEANA at the time of writing of these notes was almost complete. OODNADATTA to the west has already been published (Freytag et al., 1967) and GASON (Williams, 1973b), POOLOWANNA (Williams and Youngs, 1972) and LAKE EYRE (Williams, in prep.) are being compiled. Photogeological maps of NOOLYEANA have been prepared by French Petroleum Company Australia (hereafter FPC(A)) in 1963 and by Gregory in 1970. The area was covered by a regional helicopter survey in 1971 (Krieg, 1971) when virtually all Pleistocene exposures in the Simpson and Tirari Deserts were visited. A few exposures of pre-Quaternary rocks were examined on the southwest corner of NOOLYEANA. As mentioned earlier limited ground work was done in the southeast corner by the author in 1970. Stratigraphy and nomenclature for the published map was based on that used on OODNADATTA (Freytag, et al., 1967).

(c) Geophysical and petroleum exploration

In the late fifties, petroleum exploration was initiated in areas surrounding NOOLYEANA (Sprigg, 1958a). Initially, surface mapping was carried out on OODNADATTA by Santos geologists (see Wopfner, 1956). An aeromagnetic survey which included NOOLYEANA was flown in 1961 by Aeroservice Corporation of the U.S. (Delhi-Santos, 1961). In the early sixties, the seismic section of the South Australian Department of Mines carried out reconnaissance refraction and reflection work on parts of NOOLYEANA. This comprised seismic lines between Mount Dutton on OODNADATTA and New Kalamurina on GASON in 1961 and 1963 and down the Macumba River in 1963 and 1964. This data was incorporated with that obtained by FPC(A) in 1963-64, from the southern half of NOOLYEANA (see tectonic sketch on map for shot point locations). A helicopter gravity survey in 1963 (Wongela Geophysical P.L., 1964) included all of NOOLYEANA.

This exploration culminated in late 1964 when Poonarunna 1 was drilled in the southeastern corner of the map sheet. Here, it was hoped that the bore would intersect hydrocarbons in Permian sediments on the edge of an older Palaeozoic structure (see later). No significant hydrocarbon shows were encountered (Magnier and Cooper, 1964).

PHYSIOGRAPHY

NOOLYEANA may be broadly divided into four physiographic zones; the gibber plains and mesas in the southwestern corner, the NNW-SSE dune system of the Simpson and Tirari Deserts, the channels and flood plains of the Warburton Creek, Kallakoopah Creek and Macumba River and Lake Eyre and associated playas.

(i) The gibber plains and mesas

These occur in the southwest of the map area. The gibber plains are generally flat or gently undulating - never more than 20-40 m above sea level or 30-50 m above regional base level in Lake Eyre. Remnant mesas, capped by silcrete which represents the level of a former higher land surface and bounded by steep slopes, are scattered throughout this area. The tops of these mesas can be up to 40 m above the general plain level. Drainage from this area flows into the Macumba River and then into Lake Eyre although some creeks drain into swamps on the stony flats. The plains support saltbush (*Atriplex* sp.) and sandhill canegrass (*Zygochloa paradoxa*) and the creeks are usually lined with gidgee (*Acacia cambagei*) and some eucalypts. A variety of grasses and bushes may be found in the creeks and swamps after a good rain. These include Mitchell grass (*Astrebla pectinata*), buck bush (*Salsola kali*) and burrs and bindyis (*Bassia* sp.).

(ii) The sand dunes of the Simpson and Tirari Deserts

These trend north-northwesterly. They are subparallel and generally steeper on the eastern side. Their height rarely exceeds 30 m. They are fixed except for a few metres of loose sand at the top of the dune (see later under Stratigraphy). Vegetation in the desert includes saltbush (*Atriplex* sp.), sandhill canegrass (*Zygochloa paradoxa*), gidgee (*Acacia cambagei*), mulga (*Acacia aneura*) and needlebush (*Hakea leucoptera*) (see Crocker 1946a, for vegetation in the Simpson Desert).

(iii) The channels and flood plains of the main creeks and rivers

The flatness of the country is emphasised by the drainage pattern of the Warburton Creek which divides into several distributaries before it reaches NOOLYEANA. One of these, the Kallakoopah Creek winds its way out into the desert eventually joining the Macumba River and flowing into Lake Eyre. There are many lakes and interdunal areas connected to both the Warburton and Kallakoopah Creek which become inundated in times of flood (e.g. March-July, 1971). Most of the creek channels of the main rivers are below sea level (the Kallakoopah and Warburton Creek floodwaters flow back up the Macumba River and vice versa). Main vegetation along these creeks is saltbush (Atriplex sp.), lignum (Meuhlenbeckia cunninghamii) and eucalypts (Eucalyptus microtheca).

(iv) Playas - Lake Eyre

Lake Eyre is normally a dry saltpan which slopes gently to the south and at its lowest elevation is about 10-15 metres below sea level. The southern most portion of the lake on NOOLYEANA is about 10 metres below sea level. At the time of the survey (June, 1971) however, most of the lake was covered with water, due to exceptionally heavy rains in March of the same year in central and western Queensland, the main catchment area for the Diamantina River or Warburton Creek, (the Diamantina River becomes the Warburton Creek after flowing through Goyder Lagoon). The average depth at the northern end of the lake was probably less than 30-40 cm. The surface of the lake is marked by a narrow channel about 40 km long and ½-1 km wide which starts at the mouth of the Warburton Creek. This channel, named the Warburton Groove, is remarkably straight, and runs in a north-south direction. It is thought to be a result of Recent tectonism (Wopfner and Twidale, 1967). Smaller playas are common north of Lake Eyre in the interdunal corridors. Most are elongate in a north-northwesterly direction.

The whole system of lakes and buried channels (as evidenced by meander traces in the interdunal corridors) north of Lake Eyre are undoubtedly remnants of a much larger ancestral drainage system. Encroaching sand dune sand fluviatile deposition filled many of these channels, gradually limiting drainage to the Warburton Creek and Macumba River systems as seen today.

STRATIGRAPHY

The oldest outcropping rocks on NOOLYEANA are the claystones and sandstones of the Middle Cretaceous Winton Formation. Older Cretaceous, Jurassic and (?) Ordovician rocks were intersected in Poonarunna 1 in the southeast corner of NOOLYEANA. Younger rock units exposed on the map area include the Winton Formation, the Lower Tertiary Eyre Formation which has been partially or completely silicified, Pleistocene fluviatile sediments and a number of Recent units such as the sand of the Simpson Desert, slope deposits and creek and lake alluvium.

A summary of the subsurface and surface stratigraphy on NOOLYEANA appears on Tables I and II.

TABLE I

Surface Stratigraphy

AGE	MAP UNIT	MAP SYMBOL	LITHOLOGY	THICKNESS (METRES)	NOTES
CAINOZOIC QUATERNARY Recent	lake alluvium	Qrl	Fine, orange to brown, clayey sands and grey silty clays containing halite and gypsum.	0.3-0.6+	In salinas and claypans.
	creek alluvium	Qra	Grey sandy clays and clayey sands of main rivers (Warburton, Kallakoopah, Macumba); gravels, sands and clays of the lesser creeks, brown sandy silts and clays of the flood plains. Thin veneers of aeolian sand.	10+	Probably includes Tingana Clay of Firman (1970).
Recent —	aeolian sand	Qrs	Orange brown, fine to medium grained quartz sand of desert dunes. Sand clayey at base and in inter-dunal flats. Plant remains and carbonate infilled root cavities near dune base.	2-20	Dunes are subparallel and steeper on eastern side. Dominant NNW trend. Basal portion of dune may be part of an older dune system (Wopfner and Twidale, 1967).
Pleistocene	low angle slope deposits and gibber plain	Qrt	Pale brown to red brown sandy clays containing gypsum (reworked from older deposits) and mantled by a layer of silcrete gibbers; includes low angle slope and lag deposits.	1+	Equivalent in part to Callabonna Clay (Firman, 1970).
	gypsum crust	Qpr	Weathering profile with gypsum crust, intermediate mottled zone with layers of crystalline gypsum and occasional basal ferruginous zone. Some thin bands of celestite.	1-3	Soil stratigraphic unit developed in older rocks and associated with a Pleistocene land surface.

TABLE I continued

CAINOZOIC TERTIARY	Pliocene to Pleistocene	unnamed fluviatile deposits	Qps	Multicoloured, cross-bedded channel sands and clays with occasional vertebrate remains. Heavily gypsified in part.	2-20	May include equivalents of Wipajiri Formation, Mampuwordu Sands, Tirari Formation and Katipiri Sand (Stirton et al., 1961). Traces of old meanders visible in interdunal flats. Exposed along edges of playas and main creeks.
	?Miocene	Etadunna Formation	Qmd	White dolomitic limestone with interbedded grey, marly, sandy clays - suspended outcrop south of Muntee-Kallana bore.	5+	Weathered equivalents of this formation described in Poonarunna 1 may outcrop in cliffs along the Warburton Creek downstream from the bore.
	?Oligocene	Silcrete	Tsi	Grey, massive, columnar and pisolitic, silicified sandstone and claystone.	1-6	Very resistant soil stratigraphic unit developed in older sediments and associated with a mid-Tertiary land surface. Helps delineate structure.
	Palaeocene -Eocene	Eyre Formation	Tee	Light, coloured, fine to coarse quartz sandstones and siltstones. Some ferruginous beds. Silcreted at top.	1-15	Equivalent to Macumba Sandstone on OODNADATTA (Freytag et al.,1967) and Murnpeowie Formation on MARREE (Forbes, 1966). Both these formations are now included in the Eyre Formation (Wopfner et al.,1973).
MESOZOIC CRETACEOUS	Albian-Cenomanian	Winton Formation	Kw	White, pale grey and yellow claystones, siltstones and kaolinitic sandstones. Some ferruginous beds and occasional plant remains.	10+	Surface and near surface exposures chemically altered. Some Oodnadatta Formation may be exposed in lowermost section of some mesas or intersected in seismic shot holes.

TABLE II

Subsurface Stratigraphy
(mostly from Poonarunna 1)

AGE		MAP UNIT	MAP SYMBOL	LITHOLOGY	THICKNESS (METRES)	NOTES
CAINOZOIC TERTIARY	?Miocene	Etadunna Formation	Tmd	White dolomitic limestone and grey, marly sandy clays.	53	Probably fairly widespread in subsurface on NOOLYEANA.
	Paleocene -Eocene	Eyre Formation	Tee	Fine grained quartz sandstones and siltstones.	36	
MESOZOIC CRETACEOUS	Cenomanian	Winton Formation	Kw	Interbedded soft, grey, clayey siltstone, with some lignitic fragments, soft, grey, fissile shale and green-grey, feldspathic sandstone with traces of pyrite.	573	Lignite bed in one seismic shot hole. Paludal and lacustrine deposit (Harris, 1971).
		Oodnadatta Formation	Klo	Alternating grey, clayey to silty shale and siltstone with traces if pyrite. Some feldspathic sandstone near top.	295	Breaks on geophysical logs at 885 and 890 m correspond to Wooldridge Limestone and the underlying basal Coorikiana Sandstone members of this formation - see Townsend, 1971a. Blue sandstones in seismic shot holes may be equivalent to the Mt. Alexander Sandstone Member (Freytag, 1966).
	Aptian	Bulldog Shale	Klb	Alternating grey to dark grey shales and siltstones with traces of pyrite.	202	Marine deposit.

TABLE II continued

MESOZOIC CRETACEOUS	Neocomian to Aptian	Cadna-owie Formation	K1c	Interbedded carbonaceous, cemented sandstone and grey compact fissile shale.	46	Aquifer in this portion of the Great Artesian Basin. "C horizon" reflection arises from within this bed.
JURASSIC	Upper	Algebuckina Sandstone	Jua	Poorly consolidated, medium to coarse grained quartz sandstone with interbeds of grey fissile shales and occasional bituminous matter.	365	Main aquifer in this part of the Great Artesian Basin. Correlation of this formation with areas to the east is discussed by Wopfner (in Parkin, 1969 - pp.142-147).
	Middle to Upper	Birkhead Formation equivalent	Jmb	Grey siltstones, sandstones and black pyritic shales with plant and mollusc remains.	54	
	Lower to Middle	Hutton Sandstone	J1h	Conglomeratic sandstone with heterogeneous pebbles.	?	May be present in Poonarunna 1 - at base above steeply dipping siltstones - Wopfner, pers. comm., 1971.
?PALAEOZOIC ?ORDOVICIAN		Unnamed	?Ord	Argillaceous, quartzitic siltstones with traces of pyrite.	69	Weathered at top. Steeply dipping (80°). Age Ordovician?

TABLE III

Formation tops and thicknesses in Poonarunna 1

FORMATION	TOP (METRES)		THICKNESS (METRES)	
Quaternary Sand	0		6	
Etadunna Formation	6		53	
Eyre Formation	59		36	
Winton Formation	95		573	
Oodnadatta Formation	668		295	
(a) Wooldridge Limestone Member		884		9
(b) Coorikiana Sandstone Member		948		15
Bulldog Shale	963		202	
Cadna-owie Formation	1 165		46	
Algebuckina Sandstone	1 211		365	
Birkhead Formation	1 576		54	
Ordovician (?)	1 630		69	
TOTAL DEPTH			1 699	

NOTE: Stratigraphy is based on that on OODNADATTA except for bottom two units.

Pre-Mesozoic (subsurface only)

Poonarunna 1 was drilled on the margin of the Pedirka Basin - a Palaeozoic Basin underlying the Mesozoic rocks of the Great Artesian Basin (Youngs, 1973). The well was intended to intersect Permian sediments but it passed from Mesozoic sandstones directly into steeply dipping siltstones, thought to be Ordovician in age. Permian sediments in this basin have been intersected in French Petroleum Company (Australia) Witcherrie 1 (1964a), Purni 1 (1964), Mt. Crispe 1 (1966a) and Mokari 1 (1966b) - all drilled on DALHOUSIE to the northwest of NOOLYEANA. Lower Permian (?) glacial sediments (Crown Point Formation) were found in all four wells and younger freshwater sediments (Purni Formation) were found only in Purni 1 and Mokari 1. The Permian in the southeast Pedirka Basin (see Fig. 1 for basin boundary after Wopfner, 1972) has not been intersected. Here it may be thin or absent. The geology and hydrocarbon potential of the Pedirka Basin has been discussed by Youngs (1973).

Mesozoic

Poonarunna 1 penetrated 1 535 m of Mesozoic sediments, 419 m of which were Jurassic rocks and 1 116 m were Lower to early Upper Cretaceous sediments. For a detailed discussion of the subdivision and correlation of the Mesozoic in the western Great Artesian Basin including that on NOOLYEANA, the reader is referred to Wopfner (in Parkin, 1969 - Fig. 65 and pp. 140-147). Williams and Youngs (1972) and Williams (1973a) also indicate correlation with surrounding areas in Queensland and the Northern Territory. The nomenclature for NOOLYEANA where possible has followed that used on OODNADATTA (Freytag, et al., 1967).

Jurassic (subsurface only)

The oldest Jurassic encountered in Poonarunna 1 is about 55 m of grey siltstone, sandstone and black pyritic shale equivalent to Birkhead Formation (Wopfner, in Parkin, 1969 - p. 142). There are some conglomeratic sandstones near the base which may be equivalent to the Hutton Sandstone (Wopfner, pers. comm., 1971).

Conformably overlying the Birkhead Formation is the Upper Jurassic Algebuckina Sandstone, a poorly consolidated, medium to coarse grained quartz sandstone with interbeds of grey shale and occasional bituminous matter. There is a marked thinning to the west as surface outcrops of Algebuckina Sandstone around the Peake and Denison Ranges are only about 20 metres thick (Wopfner, et. al., 1970) although portion has probably been eroded.

The Algebuckina Sandstone is the main aquifer in this part of the Great Artesian Basin.

Cretaceous (subsurface and surface)

The oldest Cretaceous rocks intersected in Poonarunna 1 are equivalents of the Cadna-owie Formation (Wopfner et al., 1970) and consist of carbonaceous sandstone and grey shales. The sandstones serve as an artesian aquifer but with poorer quality water and a lower supply than the Algebuckina Sandstone.

The next youngest formations, the Bulldog Shale and Oodnadatta Formation, are fairly similar according to lithological logs although the Oodnadatta Formation is siltier and more calcareous. Radioactive and sonic logs however show two distinct breaks in the Bulldog - Oodnadatta sequence at about 885 and 950 m. These intervals have been correlated by Townsend (1971a) with the Wooldridge Limestone and Coorikiana Sandstone Members of the Oodnadatta Formation (Freytag, 1966). The Coorikiana Sandstone marks the lower boundary of the Oodnadatta Formation (Townsend, 1971a, 1971b and Krieg, 1971). These two members are mappable units on adjacent OODNADATTA (Freytag et al., 1967).

On OODNADATTA, a fine grained glauconitic sandstone, the Mount Alexander Sandstone (Freytag, 1966) has been included as part of the upper Oodnadatta Formation. "Blue sandstones" recorded on drillers logs of seismic shot holes on NOOLYEANA (records in Petroleum Exploration Division, South Australian Department of Mines) may be equivalent to this member (this is interpretive as these logs are often very vague).

The next youngest and the oldest outcropping formation on NOOLYEANA is the Winton Formation. Where exposed, this is chemically altered and consists of white, pale grey and yellow claystones, siltstones and kaolinitic sandstones. Some ironstone nodules are present (gypsite ferruginization - see later) and plant remains may be distinguished in less weathered sediments (too oxidised however for identification - pers. comm., W.K. Harris, S.A.D.M., 1971). A lignite bed was penetrated in one seismic shothole. In Poonarunna 1 the Winton Formation is composed of 573 m of interbedded siltstones and shales with traces of lignite and pyrite.

Cainozoic

Tertiary

Sediments of probable Tertiary age which are exposed on NOOLYEANA include fine to coarse grained, grey quartz sandstone and occasional siltstone. They are assumed to be equivalent to the Eyre Formation (Wopfner et al., 1973) which has been defined to include the Macumba Sandstone on OODNADATTA. The sandstones on NOOLYEANA are generally finer grained than those on OODNADATTA and some layers are heavily ferruginized. About 37 m of fine quartz sandstone were intersected in Poonarunna 1.

As with other portions of the Great Artesian Basin, many of the exposed Tertiary and Cretaceous rocks in this area have undergone silicification (silcrete). Most mesas on NOOLYEANA are capped by silcrete exhibiting massive, nodular or pisolitic structures. The age of the silification is thought to range from Oligocene to Miocene (Wopfner and Twidale, 1967). Younger silicification has been observed by the author near Lake Eyre and is also mentioned by Wopfner and Twidale (1967) and Jessup and Norris (1971).

The only other (?)Tertiary on NOOLYEANA is about 53 m of white dolomitic limestones and grey marls above the Winton Formation in Poonarunna 1. These have been correlated with the Etadunna Formation (Wopfner and Twidale, 1967). Weathered clays and sands outcropping downstream from the bore may be equivalent to these sediments (Tedford, pers. comm., 1971). Wopfner (in Wopfner and Twidale, 1967) equates the Etadunna Formation with the similar limestones on CORDILLO.

White patches on the aerial photographs of NOOLYEANA on the north side of Koorakarina Creek have been photointerpreted as Etadunna Formation since similar looking outcrops to the south on LAKE EYRE are known to be Etadunna Formation from field work by the author.

Quaternary

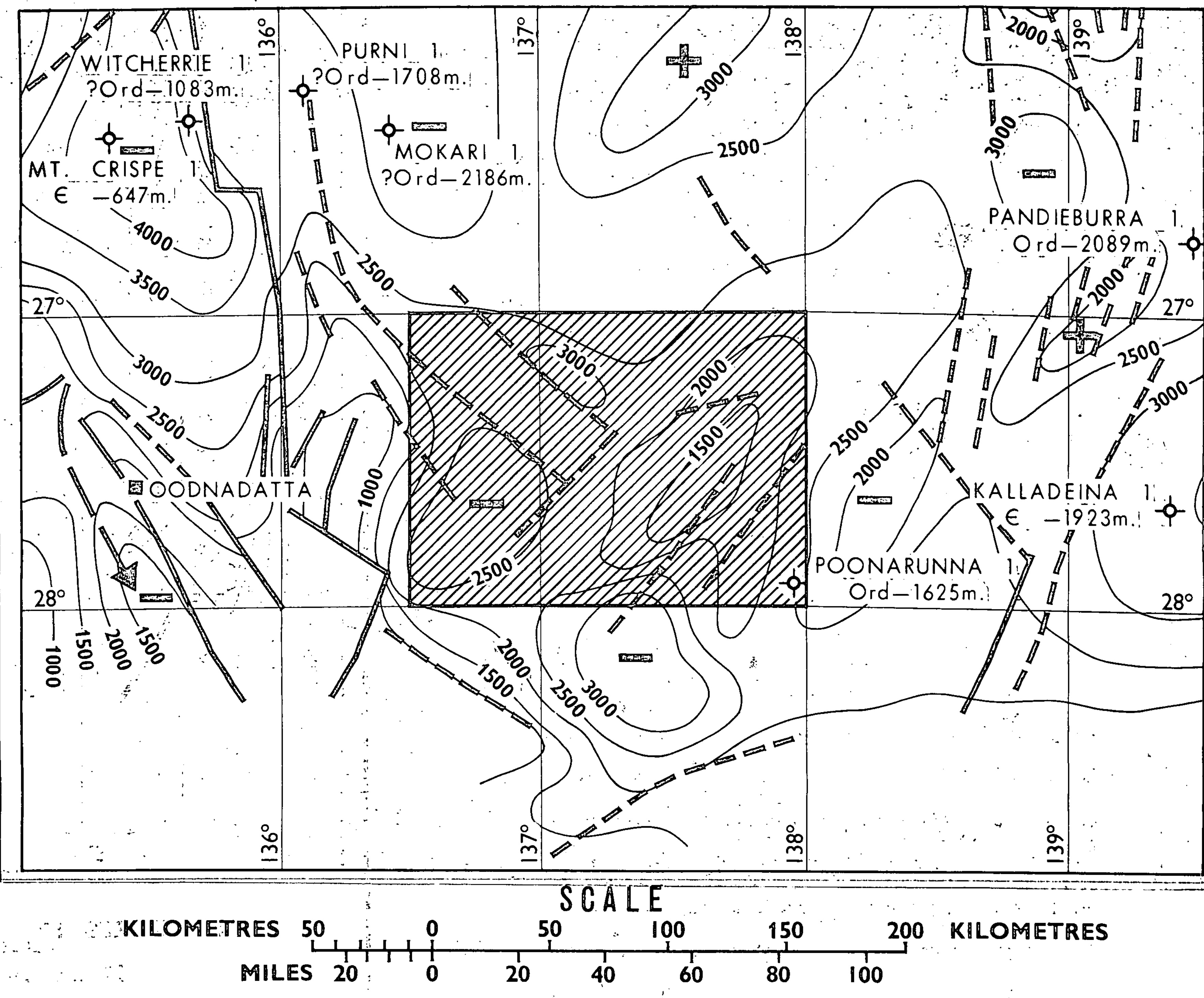
Most of the area covered with dunes on NOOLYEANA is underlain by a sequence of channel sands and clays. Nearly all exposures of these deposits were visited (by helicopter), most occurring along the Kallakoopah Creek, Warburton

Creek and the edges of some playas. Drillers logs from seismic shot holes down the Macumba River and Manarrinna Creek indicate a sequence of brown and grey sandy clays and sandstones with gypsiferous beds near the top. No attempt was made to subdivide these deposits because of a diverse range of lithologies and lack of continuity of outcrop. In one exposure, four such channel deposits were seen disconformably overlying each other. Sedimentary structures such as the cut and fill type, cross bedding and ripple laminations are present, indicating environments of several different energy levels. Vertebrate remains are common (Stirton et al., 1961). These sediments are coarser grained on the western edge of the map area. Their age is uncertain. The older subsurface sediment may be as old as Late Tertiary, whereas exposed sediments are probably late Pleistocene.

On NOOLYEANA, as with the majority of the Great Artesian Basin in this part of Australia, gypsum is prevalent as massive crusts and thinner crystalline layers exposed in cliff sections of Cretaceous and younger rocks. It is a product of a weathering profile (the gypsite profile of Wopfner and Twidale, 1967) which developed in Late Pleistocene times after the commencement of a period of aridity. Ferruginization is common at the base of this profile and is most commonly developed in Cretaceous sediments. Celestite sometimes occurs as nodules on the present day land surface (Williams, 1972).

The younger geological units on NOOLYEANA include the gibber covered red brown clays and lag and low angle slope deposits (which mantle the Cretaceous and Tertiary rocks on the south-west edge of NOOLYEANA), the orange brown sand of the Simpson and Tirari Deserts and the gravels, sands and clays of the creeks, rivers and playas.

The sand of the desert is a white to orange brown, fine to medium grained quartz sand which forms longitudinal dunes (Madigan, 1936; Bagnold,1941) trending north-northwesterly. The dunes vary in height from about 2 to 30 m and may be up to 30 or more km in length. Dune spacing varies from about 3 to 6 per km. The lower parts of the dune are fixed by vegetation, the upper portions being mobile. Dunes are asymmetric with steeper sides generally to the east,



DEPTH TO MAGNETIC BASEMENT (CONTOUR INTERVAL 500m)

— INTERPRETATION NO. 2 — LAHERRERE AND DRAYTON, 1965.

Fault — Inferred fault — — — — Datum M.S.L.

59783

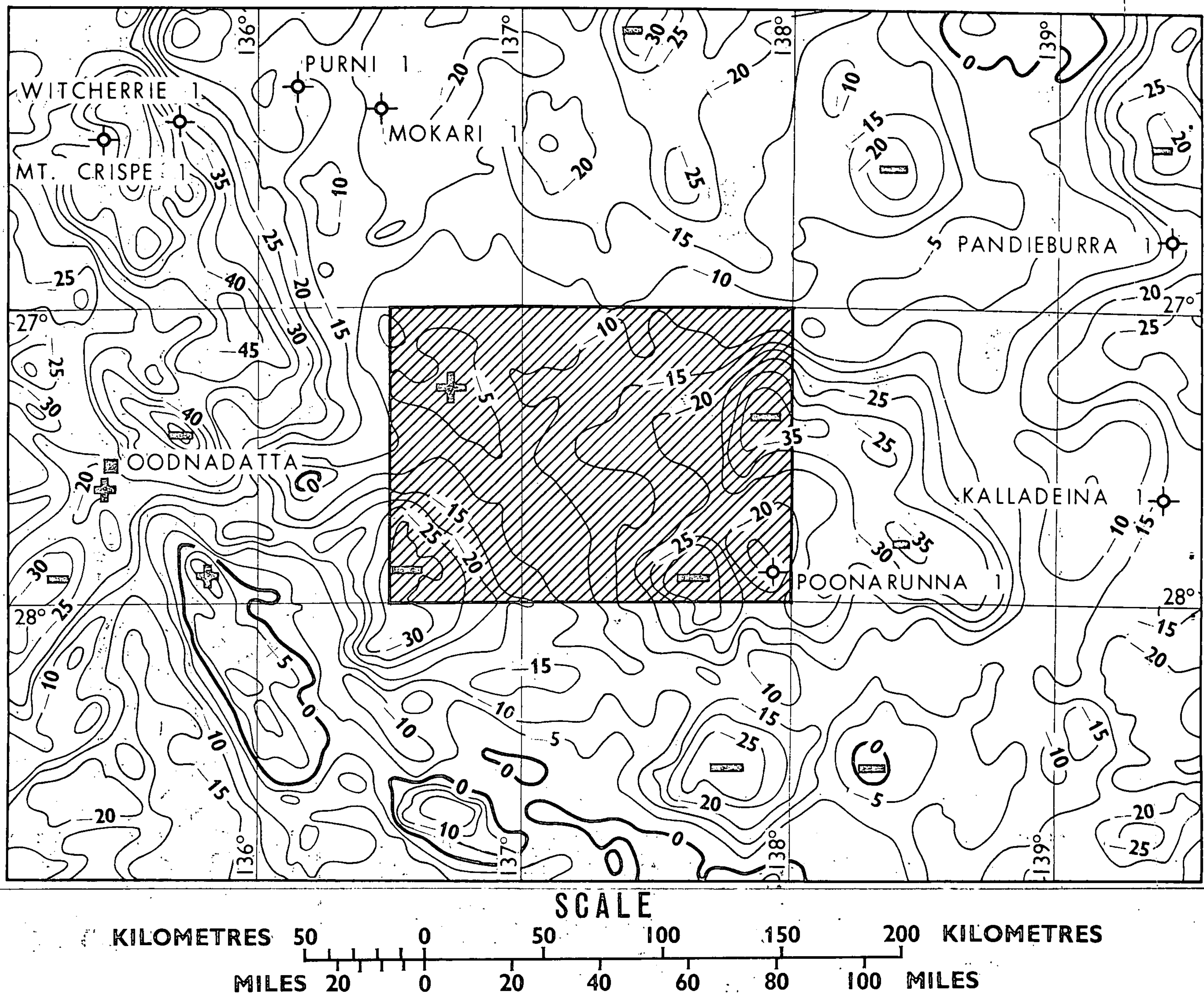
MAP OF NOOLYEANA AND SURROUNDING AREAS SHOWING DEPTH TO MAGNETIC BASEMENT FIG. 2 but this depends on the present day causal wind. Ages ascribed to the dunes range from late Pleistocene to middle Recent (Crocker, 1946a; Heath and Wopfner, 1963; Wopfner and Twidale, 1967; Folk, 1971a, 1971b; Twidale, 1972). Firman (1970) assigned the name Simpson Sand to the dunes and underlying sand. Wopfner and Twidale (1967) consider this underlying portion to be part of an older dune system. The dune sand is considered derived from northward aeolian transportation of sediments deposited in the vicinity of Lake Eyre by the large river systems draining the basin area (see Wopfner and Twidale, op. cit., p. 136).

STRUCTURE

Briefly, the subsurface structure on NOOLYEANA consists of broadly folded Mesozoic and Cainozoic sediments underlain by possible thin Permian sediments of the Pedirka Basin which in turn overlie folded Lower Palaeozoic and older rocks. Structural trends vary from northeast to northwest.

Subsurface geological information on NOOLYEANA is restricted to that known from Poonarunna 1. However, during the course of petroleum exploration in the Great Artesian Basin, much geophysical information in the form of contour maps of depth to magnetic basement, Bouguer gravity anomaly and depth to "Z", "P" and "C" seismic reflectors, has been compiled by both private companies and the Petroleum Exploration Division of the South Australian Department of Mines (see earlier under geophysical exploration).

Depth to magnetic basement contours (Aeroservice, 1961 and Laherrere and Drayton, 1965 - see Fig. 2) show several lows on NOOLYEANA with shallowing to the west on OODNADATTA and to the southwest on LAKE EYRE. Superimposed over this magnetic low on central and northern NOOLYEANA is a gravity feature (see Fig. 3) named the Noolyeana Gravity Swell by Wongela (1964 - see also Milton, 1971). This feature is thought to be a result of density contrasts between the basement and high density intrusive rocks (Wongela, 1964). To the east and south of this feature is a low, (part of Wongela's Cowarie Gravity Depression) which is considered due to density contrasts between Lower or Middle Palaeozoic and



BOUGUER GRAVITY (CONTOUR INTERVAL 5 MILLIGALLS)

AFTER DEPT. OF MINES PLAN NO. 71-684A. (B.E. MILTON)

59788

MAP OF NOOLYEANA AND SURROUNDING AREAS SHOWING PRELIMINARY BOUGUER ANOMALY CONTOURS

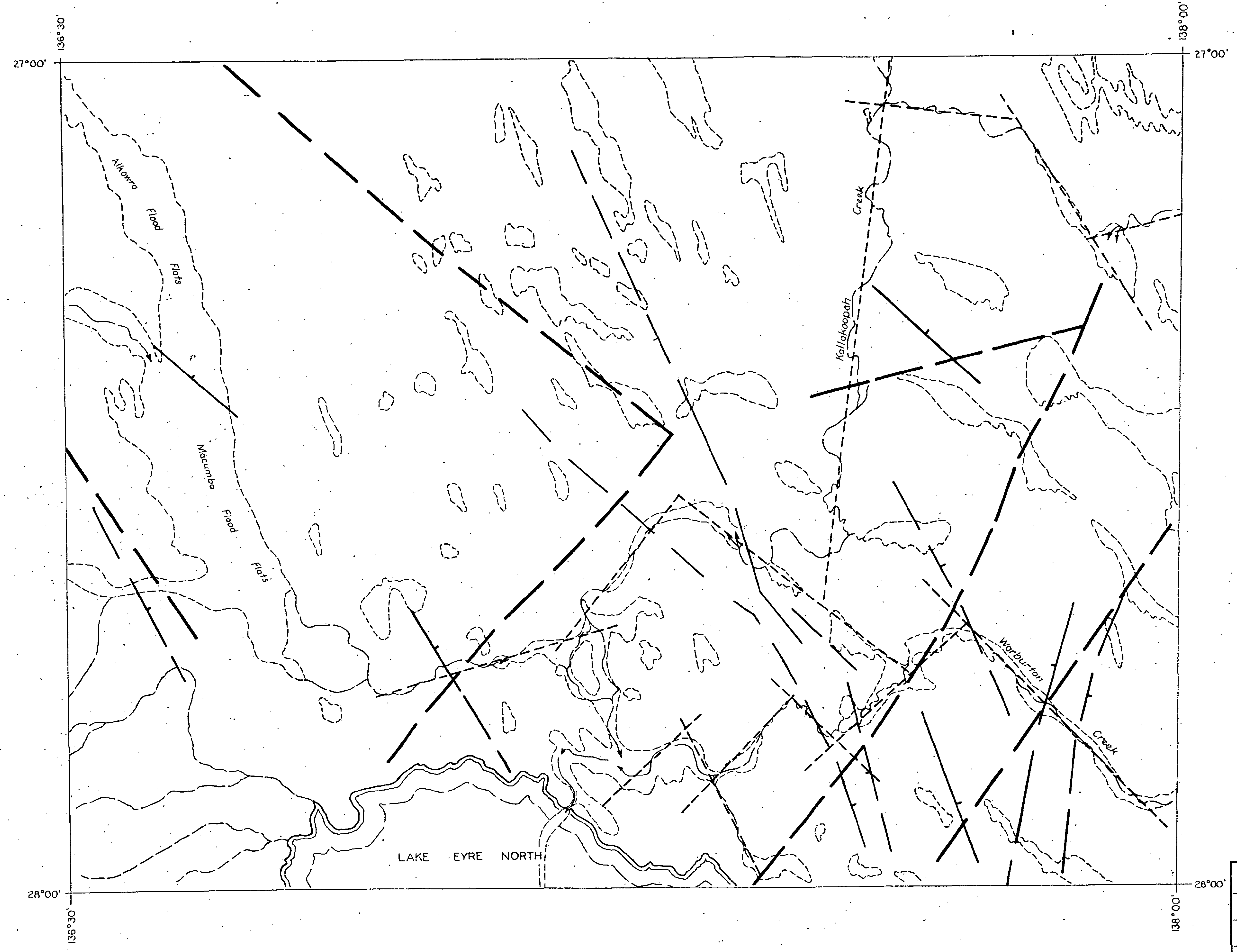
FIG. 3

younger rocks.

The "Z" horizon (Hall, 1968; with revision by Ramakrishna in 1972 - pers. comm., Ramakrishna, S.A.D.M., 1972) which is the deepest seismic reflector recognised over wide areas of the Great Artesian Basin, usually defines the pre-Permian unconformity. On southern NOOLYEANA, this horizon is at depths around 2 000 m whereas magnetic basement is of the order of 3 000 m. Demaison (1971) infers a Lower Palaeozoic syncline in this vicinity (e.g. folded Ordovician in Poonarunna 1). The "Z" horizon contours show the unconformity to have gentle relief, shallowing to the west, south and east and deepening to the north. Faults located by the seismic trend northeasterly (see tectonic sketch).

The next reflector, the "P" horizon (Krieg, 1967; with revision by Thornton, 1972, pers. comm., Thornton, S.A.D.M., 1972), arises from the first coal bed within the Permian and approximates the base of the Mesozoic. No Permian has yet been intersected on NOOLYEANA although it is considered present in the subsurface on the basis of seismic evidence (pers. comm., Morony, S.A.D.M. 1973). Poonarunna 1 was intended to intersect Permian but passed from Jurassic directly into folded Ordovician rocks. It may have been drilled on a Lower Palaeozoic high (Morony, op. cit.). To the east of the map area, on a ridge of older rocks (referred loosely as the Birdsville Track Ridge) which separates the Pedirka and Cooper Basins, Permian is absent and here Mesozoic sediments directly overlie flat lying and folded Lower Palaeozoic rocks (e.g. Cambrian in Delhi Santos Kalladeina 1 and Ordovician in Poonarunna 1). Here the "P" horizon coincides with the "Z" horizon.

Above the "P" horizon is the "C" horizon, a reflection arising from within the Cretaceous Cadna-owie Formation (see tectonic sketch - contours after Stadter, 1972). These contours show the similar configuration to the "Z" and "P" horizons. The Mesozoic is folded into a large synclinal structure which plunges gently northward shallowing to the east upon the "Birdsville Track Ridge" and southwest towards the Peake and Denison Ranges. Minor folding occurs in the vicinity of Poonarunna 1.



LEGEND.

- Interpreted lineaments
- Faults from contour plan of "Z" horizon (after Hall, 1968)
- Faults from "Contours of magnetic intensity and interpreted depths to magnetic basement" plan, Great Artesian Basin (after Milton et al, 1972)

SCALE IN KILOMETRES

10 0 10 20 30

10 0 10 20

SCALE IN MILES

FIG. 4

REGIONAL SURVEY DIVISION	**DEPARTMENT OF MINES – SOUTH AUSTRALIA**	Scale: 1:500 000
Compiled: A.F.W.	NOOLYEANNA 1:250 000 SHEET	Date: 5th July 1973
Drn. TJE · Ckd. A.F.	RELATIONSHIP BETWEEN INTERPRETED LINEAMENTS AND FAULTS LOCATED FROM GEOPHYSICAL SURVEYS	Drg. No. BC 73-477

1M-2.70 A1811

Surface structure on NOOLYEANA is limited to the few outcropping Tertiary and Cretaceous rocks in the southwest corner. The silicified beds of the Eyre and Winton Formations reflect broad folds in the underlying sediments. Dips are of the order of only 1-3°. Here the Cretaceous and Tertiary rocks dip gently eastwards and disappear under the younger lacustrine and fluvial deposits in the Simpson Desert. There is little obvious faulting on the surface apart from a small structure just north of Koorakarina Creek. Some Recent gravity slumping was observed (see Heath, 1963).

Several lineaments are apparent on the east side of NOOLYEANA (see Fig. 4). Their association with the Warburton and Kallakoopah Creeks may indicate structural control of the courses of these creeks. No signs of faulting are observed in the vicinity of these lineaments. Figure 4 shows them to have minor coincidence with faults identified in the subsurface from aeromagnetic and seismic surveys (Milton, 1972 and Hall, 1968). It is suggested that certain of these lineaments are faults, possibly formed as a result of movement along older structures in Pleistocene to early Recent times. Evidence for such reactivation of older faults to the north of NOOLYEANA has been discussed by Youngs and Wopfner (1972).

GEOLOGICAL HISTORY

(Mainly after Wopfner, 1964b, 1969; Wopfner and Twidale, 1967; Wopfner et al., 1970).

The oldest rocks known from NOOLYEANA are the steeply dipping ?Ordovician siltstones in the bottom of Poonarunna 1. At the time of writing these notes there was no record of sedimentation in the interval between Ordovician and Permian on NOOLYEANA. During the Upper Palaeozoic, events leading to the development of the Pedirka Basin were initiated. These included syn-depositional epeirogenic uplifts and the formation of Permian grabens. ?Glacial sediments (Crown Point Formation) were deposited in Lower Permian times in the Pedirka Basin. Freshwater sedimentation followed later (Purni Formation). It should be noted that no Permian or Triassic has yet been encountered beneath

NOOLYEANA.

During the Jurassic, deposition took place under fluviatile and lacustrine conditions (Birkhead Formation, Algebuckina Sandstone). These conditions prevailed until the Lower Cretaceous when a marine transgression was initiated. Sedimentation continued under the influence of this marine environment (Cadna-owie Formation, Bulldog Shale, Oodnadatta Formation) till mid Cretaceous times (late Albian). This was followed by a marine regression and once more the area became restricted to an environment of non-marine deposition (Winton Formation) although sedimentation was continuous from the Oodnadatta Formation to the Winton Formation. The latter was the last sequence to have widespread deposition in the Great Artesian Basin (Wopfner, in Parkin, 1969).

Gentle faulting and folding was initiated during Upper Cretaceous - Lower Tertiary times resulting in uplift, weathering and erosion of the Cretaceous. Sedimentation was restricted to fluviatile environments (Eyre Formation). In the middle Tertiary (Oligocene-Miocene) the area was tectonically stable and underwent deep chemical weathering and leaching. This resulted in the widespread development of a hard siliceous soil horizon (silcrete) being formed near the surface of the weathered Cretaceous and early Tertiary sediments.

Tectonic movements resumed during the Upper Tertiary (Wopfner and Twidale, 1967) resulting in the uplift and warping of the silcrete layer. Sedimentation followed with the deposition of the Etadunna Formation equivalents under lacustrine conditions. Towards the end of the Tertiary and during the Pleistocene, fluviatile sediments were deposited in the structurally low area now covered by the sand dunes of the Simpson and Tirari Deserts. In late Pleistocene times the climate became more arid and a gypsiferous weathering profile developed (gypsite profile of Wopfner and Twidale, 1967). This was followed by further tectonic movements (Wopfner, 1968) erosion of the sediments, formation of the gibber plains, the sand ridge deserts and playa lakes and deposition of more recent creek and lake alluvium.

ECONOMIC GEOLOGY

Hydrogeology

The most valuable mineral on NOOLYEANA is artesian water which is essential for the pastoral industry. Good seasons are few and irregular, occurring about once every eight years (see Madigan, 1946 - Appendix B). Surface water becomes saline very quickly due to the high evaporation rate (2.54 m - Madigan, op. ci.) during the harsh summers.

The only flowing bore on NOOLYEANA is Poonarunna 1 in which a spot plug was placed at 1 280 m in Upper Jurassic sandstone aquifers. This bore flows at the enormous rate of nearly ten thousand cubic metres per day, at a temperature of 96°C. The salinity is unknown but probably of the order of 6-700 milligrams per litre. The aquifers are the Upper Jurassic Algebuckina Sandstone and Lower Cretaceous Cadna-owie Formation. These are overlain by over 1 000 m of impervious claystones and siltstones. The main intake to the artesian basin occurs in eastern Queensland and New South Wales, however some may occur to the southwest of the map area i.e. Peak and Denison Ranges. Water movement is to the southwest and overall, the waters are carbonate bearing (Ker, 1963).

The bore flows into the Warburton Creek along a narrow drain about $^3/_4$ km long. It should provide permanent water along the creek for about 20 km downstream during times of extreme drought.

A few earth tanks have been dug along the Warburton Creek and on the gibber plains in the southwest of the map area. They soon dry up in times of drought. Old wells along the Warburton Creek have been abandoned. Muntee Kallana bore was drilled east of Boy Creek in the early 1900's (no bore record) but was abandoned at about 365 m without intersecting any water (pers. comm., J. Kemp, 1971, former manager of Macumba Station). Johnson (1957a) carried out a groundwater inspection of New Kalamurina Station (on GASON) and reported unfavourable prospects.

Petroleum

Poonarunna 1 was drilled to intersect possible Permian sediments but failed to do this. The Jurassic section passed straight into ?Ordovician siltstones. No hydrocarbons were encountered.

Celestite

Celestite (strontium sulphate) was recorded at many exposures of the unnamed Tertiary fluviatile sediments. It usually occurs as nodules and fragments of a fine-grained rock composed of celestite and quartz. Three samples varies from 75 to 99% celestite (Spencer, 1971). These appeared on the surface above the massive gypsum crust of the gypsite profile. The celestite is assumed to have originated in a similar manner to the gypsum, i.e. from dissolution of salts in older rocks, transportation by groundwater and deposition in the upper levels of the gypsite profile (Williams, 1972).

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