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1961/54

GEOLOGY OF THE BEDOURIE, MACHATTIE, BIRDSVILLE, BETOOTA 4-MILE SHEET AREAS IN WESTERN QUEENSLAND.

by

M.A. Reynolds, F. Olgers and W. Jauncey.

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TABLES

PLATES.

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Figure 1.

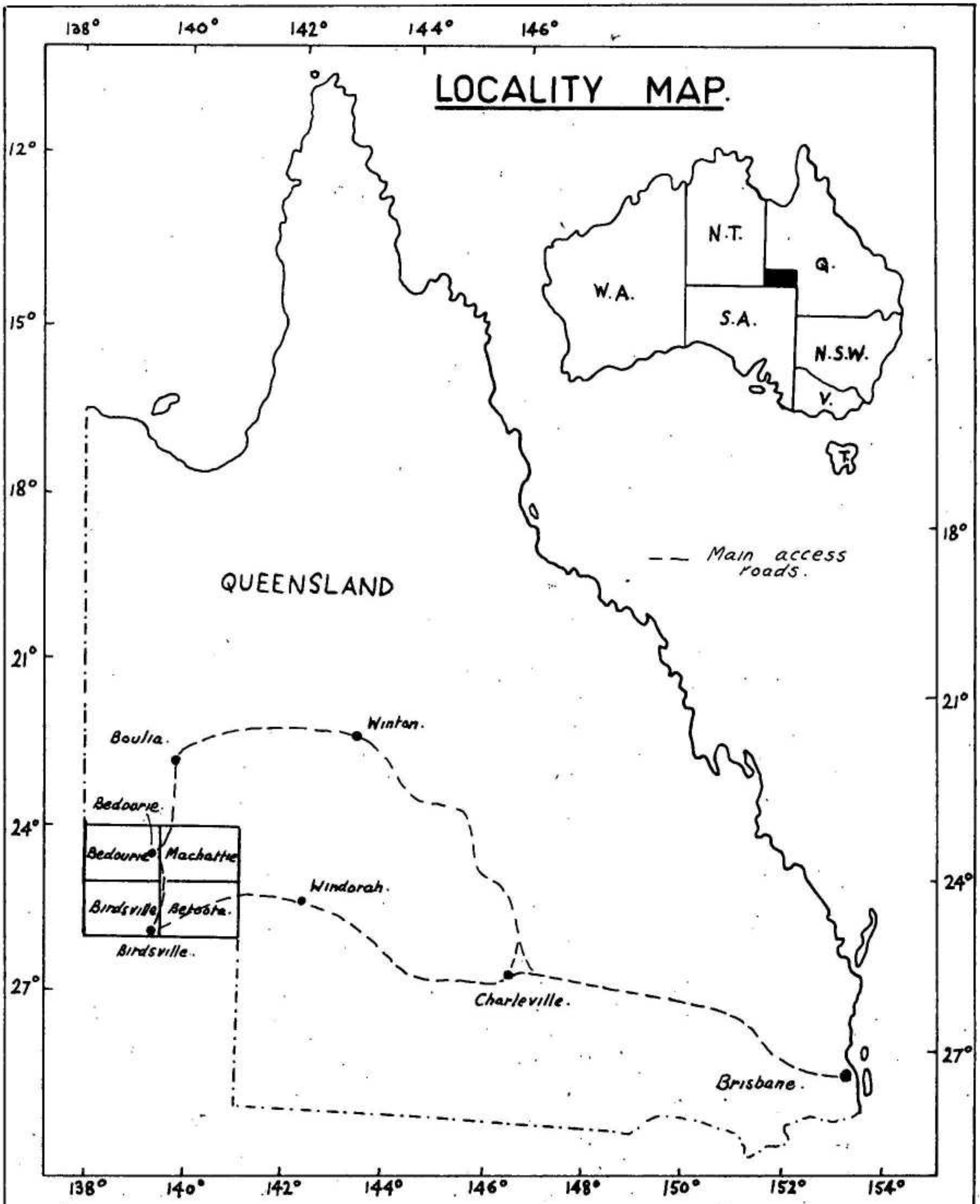
LOCALITY MAP.
138°
140°
142°
144°
146°
148°
150°
152°
154°
12°
15°
18°
21°
24°
27°
W.A.
N.T.
Q.
S.A.
N.S.W.
V.
T.
QUEENSLAND
Main access roads.
Boulia.
Winton.
Bedourie.
Bedourie
Machattie
Birdsville
Betoota.
Windorah.
Birdsville.
Charleville.
Brisbane.

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PLATE I

Fig.1
Bedourie from north
Eyre Creek in back-
ground.

Fig.2
Birdsville from north.
Diamantina River in
background

Fig.3
Betoota from east.

PLATE II

Aboriginal initiation ground,
Glengyle Station

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SUMMARY

Surface exposures are of Cretaceous and Tertiary rocks; bore logs for the area reveal a thickness of nearly 6,000 feet of Mesozoic sediments in the region of Betoota, thinning to the north and north-west. Limestone of probable Lower Palaeozoic age is recorded in the logs for some bores in the Machattie and Bedourie 4-mile Sheet areas, and one bore in the Bedourie 4-mile Sheet area bottomed in granite (age determination 833 million years). The Toolebuc Member of the Wilgunya Formation (Lower Cretaceous) extends from the Mt. Whelan 4-mile Sheet area into the north of the Bedourie 4-mile Sheet area.

Several structural features are present in the area. In the south-east of the Betoota area a broad dome is elongated in a north-easterly direction, and some minor trends occur to the west of it. A north-easterly trending structural line is apparent in the Machattie 4-mile Sheet area. Consideration of sub-surface geology has led to the postulation of a large fault in the north of the Bedourie 4-mile Sheet area.

INTRODUCTION

GENERAL.

The Bedourie, Machattie, Birdsville, Betoota 4-mile Sheet areas form a rectangular block of about 30,000 square miles in the west of Queensland. The western margin is the Northern Territory border, the southern margin the South Australian border. Townships in the region are Bedourie, Birdsville and Betoota (see plate I); the nearest towns are Boulia (75 miles from the north edge) and Windorah (105 miles from the east edge).

The programme of mapping laid down for the Great Artesian Basin Geological Party in 1960 included the region which forms the subject of this report and part of the Mt. Whelan 4-mile Sheet area; the area immediately north of the Bedourie area. The party comprised M.A. Reynolds, who has worked in western Queensland since 1957, and F. Olgers and W. Jauncey who were working in their first field season with the Bureau of Mineral Resources. The party was in the field from June until October, 1960. Rock types of the Great Artesian Basin formations were examined on the trip from Brisbane to Boulia, with particular attention paid to those near Roma and Tambo (type areas of the Roma and Tambo Formations), and those east of the Hamilton River (typical outcrop of the Cretaceous Toolebuc Member). In the early part of the field season, two long traverses were made through various areas in western Queensland to examine the complete range of outcrops of formations to be mapped. S. Skwarko of the Palaeontological Section joined the party for the second traverse at the end of June and worked in the region until early August. Although each member of the party worked in various parts of the region, Olgers and Jauncey concentrated on the mapping of the Machattie, Birdsville and Betoota areas while Reynolds did most work in the Mt. Whelan and Bedourie areas. Aerial photographs at scale about 1:50,000 were used for plotting of topographic and geological information. The photographs were taken by Adastra in 1957 and 1958. Areas not visited were mapped by aerial photograph interpretation. The party broke camp in mid-October and all except Reynolds returned to Canberra. Reynolds made helicopter traverses into the north-eastern and central parts of the Simpson Desert in early November and visited the southern part of the Toomba Range (west side of Toko Range) to measure three sections there.

Geological maps at 4 miles to one inch scale of the Bedourie, Machattie, Birdsville, Betoota areas have since been prepared on uncontrolled bases using reductions from 1 mile mosaics. The geology in the Bedourie, Machattie, Birdsville and Betoota areas is similar and most of the units mapped in the region as a whole are common to all of the 4-mile Sheet areas; this report is a summary of the geology together with some sections which deal with general problems of the region and considerations of its economic geology. The report is accompanied by maps of generalised geological and topographical detail at scale 10 miles to one inch. Sand dunes have not been shown on the topographical map because they will be mapped accurately by the Department of National Mapping on controlled maps later.

The Diamantina Shire embraces nearly all of the Bedourie-Machattie-Birdsville-Betoota 4-mile Sheet areas. The topographical map shows the shire boundary and station boundaries; 13 stations and parts of stations occur in the region. The population of the shire is about 260, which includes about 50 half-caste and aboriginal people who are employed on the stations. Nomadic aboriginals do not live in the region but there is ample evidence that large numbers once inhabited parts of the country: stone artefacts are fairly common, initiation (Plate II) and play-grounds are outlined in large gibbers, birth places and burial places were seen. Birth places are marked by small mounds of rocks and from a distance resemble weathering nodules; they are most common in clay-pan and sandy country. The dead were buried in sand dunes, or in gibber country, under large mounds of rocks; skeletons are found in some places.

Cattle raising and fattening is the main industry of the region. Large numbers of cattle have run wild along the unfenced Mulligan River country and in the eastern edge of the Simpson Desert; large packs of wild horses ("brumbies") were also seen in the desert. The only other large wild animals in the region are dingoes and a few kangaroos (kangaroos are only seen in numbers north of the vermin-proof fence near Boulia). Small wild life, marsupial mice, hopping mice, etc., are abundant in sandy country. Because of permanent water holes and flowing bores, bird life is varied and abundant. Snakes and lizards are not often seen although death adders are reported to be fairly common in the channel country.

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Although the type of country varies, there is little relief and it is generally arid. Trees are only common along creeks and rivers and vegetation elsewhere is scarce. Mitchell grass grows in the north-east corner of the region on dark soil plains (over marine Cretaceous shales and calcareous sandstones); elsewhere stock feed mainly on the thick herbage which grows after rain. Parachelia ("parakeelya" - Calandrinia balonnensis - Madigan, 1938, p.520), a particularly good herb for feed, is common in some parts of sand dune country.

The winter climate is generally the more pleasant - warm to hot days (temperatures average 60°F) and cool nights - but cold winds from the south are fairly common. The dominant wind, however, is the gentle south-east trade wind. Conditions are driest in winter and towards the end of the season (September) dust and sand storms blow across the region. These are sometimes formed by strong winds from the west. Some of the station tracks formed over sand dunes become blocked by drift sand during dust storms. The annual average rainfall is 6 to 8 inches; most of this falls in the summer months when the weather is very hot, (temperatures average 110°F) and more humid than usual. Vehicle travel is sometimes impossible in summer because of rain affecting the tracks. In addition the main rivers, whose heads are in areas of monsoonal influence, are most likely to flow, inundating large tracts of the country.

Access by road vehicle into the region during dry periods is good on the low plateau country. Travelling is slow and rough in Mitchell grass downs and in the channel country, and mostly impossible in the Simpson Desert west of the Mulligan River. Sand dune country east of the river can be penetrated by travelling between and around dunes or crossing them at some places; sand dunes in the region are more easily crossed travelling from west to east. The clayey nature of the soil in many parts of the region and flooding of road crossings generally prevents travel after rains.

Names of topographic features in the Bedourie-Machattie-Birdsville-Betoota region shown on Queensland Department of Public Lands Maps vary in many cases from names used locally. Where the local names are widely used, they are shown on maps with the alternative name given in parentheses.

The whole of the region lies within the Queensland Authorities to Prospect for oil Nos. 66P and 67P held by Delhi Australian Petroleum Ltd., and Santos Limited.

PREVIOUS INVESTIGATION

The region has not attracted much attention in the past, probably due to paucity of outcrops, limited range of geological units, difficulty of access to mineral deposits if present and the cost of their cartage out of the area. Some interest has been shown in the region for water as it is part of the Great Artesian Basin, and also in the search for oil, particularly in the last four years. Early geological maps of Queensland showed the region as Cretaceous covered in the south-west part by "Desert Sandstone" (Daintree, 1872), or as Lower Cretaceous "Rolling Downs Formation" (Jack and Etheridge, 1892). Dunstan (1920) published a geological map which shows the northern part of the region as Cretaceous.

In his accompanying report, Dunstan says that Lake Kalidawarry, at the junction of the Mulligan River and Eyre Creek, is reported to contain many thousands of tons of salt, and that several thick seams of gypsum occur at Pulchera Waterhole on the Mulligan River.

Whitehouse (1930) divided the Cretaceous beds of the Great Artesian Basin into the "Roma, Tambo and Winton Series" (from the base up). He stated that the "Roma Series" was not known along the western and north-western margins of the Basin and the "Tambo Series" completely overlapped the lower beds. It was also pointed out that the "Winton Series" was probably restricted to the centre of the Basin, east of the region under consideration. Whitehouse correlated the uppermost (Tertiary) sandstones and shales in the Basin with the "Eyrian Series" (Woolnough and David, 1926) of South Australia. The western part of the Great Artesian Basin in Queensland is included in Whitehouse's (1940) account of the late geological history of Queensland. He stated that the mesas and buttes of western Queensland are mostly made up of rocks of the mottled zone of lateritisation, and postulated two periods of lateritisation which were placed provisionally in the early and late Pliocene. The existence of Tertiary highly silicified limestones in several areas of Queensland, including those at Roseberth and Cacoory, north of Birdsville, was also recorded. Whitehouse (1941) discussed the main physiographical units of western Queensland in great detail. The geological map that accompanies his report shows that the western half of the area is covered by sandhills of the Simpson Desert, whereas the eastern portion consists of Mesozoic and Cainozoic sediments. Further detailed descriptions of the Queensland part of the Great Artesian Basin were given by Whitehouse (1945, 1948, 1954). He shows that most of the Bedourie-Machattie-Birdsville-Betoota area is covered by Cainozoic deposits; a large inlier of Winton Formation (Upper Cretaceous) occurs 40 miles east of Bedourie and the Tambo Formation (Lower Cretaceous) crops out to the north of the area, overlapping older Mesozoic beds including the Artesian Basin aquifers.

Accounts of the Simpson Desert and its borders, including the barren sandridge and gibber plain country to the west and north-west of Birdsville, were given by Madigan (1936, 1938, 1945). He regards the Mulligan River, (Eyre Creek on the accompanying maps) which runs 30 miles west of Birdsville, as the eastern boundary of the Simpson Desert.

The most recent work done in the Bedourie-Machattie-Birdsville-Betoota area has been by Santos geologists (Sprigg, 1958, and Wopfner, 1960). Sprigg showed the base of the marine Cretaceous beds dipping in a south-easterly direction from approximately 1,000 feet below sea level in the north-west to about 4,000 feet below sea level in the south-east. He stressed the importance of north-east, south-west trending folds, first noted by Lockhart Jack (1925, 1930) and re-examined by Wopfner in 1957, which occur in the central part of the Great Artesian Basin in north-eastern South Australia and south-west Queensland. Wopfner (1960) discussed the structures in more detail. One of the structures, the Betoota dome, was drilled to 9,824 feet by the Delhi-Frome-Santos group in 1960; a subsidy report on this well is in preparation.

Most of the stratigraphic names used in this report are taken from those proposed by Casey (1959). Reports by Bureau geologists which consider parts of the Bedourie-Machattie-Birdsville-Betoota area are by Casey, Reynolds, Dow, Pritchard, Vine and Paten (1960), Dickins (1960) and Reynolds (1960 c, d). Paten (1960, 1961) of the Queensland Geological Survey who worked with the Bureau geological parties has described Tertiary deposits and the lateritisation and silicification of rocks in western Queensland. The area is included in a map showing the distribution of laterite and associated materials in Queensland, (Connah and Hubble, 1960).

PHYSIOGRAPHY

The most important descriptions of the physiographic features of western Queensland are given by Whitehouse (1941, 1948) and by Wopfner (1960); Madigan (1938) gives a valuable account of the history of exploration in the Simpson Desert, and (1945), details of his crossing of the centre of the desert in 1939.

The Bedourie-Machattie-Birdsville-Betoota 4-mile Sheet areas can be divided into 4 main physiographic units which occupy various parts of the region:

1. undulating plateau country;
2. rolling downs;
3. alluvial flats and channel country;
4. Simpson Desert and sand dune belts.

Cretaceous and Tertiary sediments in western Queensland have commonly either been lateritised or deeply weathered to give the appearance of lateritised sediments. True laterites, however, do not exist because they have been eroded away or the composition of the beds has been altered considerably by two apparent periods of silicification. These sediments are referred to as "laterised sediments" because of their appearance.

1. UNDULATING PLATEAU.

Although the most widespread of the units in the region, undulating plateau country forms little more than a third of the area. The plateau effect is developed as a result of

(i) the very low southerly dip of sediments,

(ii) subsequent planing of the surface during lateritisation, and

(iii) "case-hardening" by silicification to form a duricrust.

The plateau is formed on Cretaceous sediments covered in part by Tertiary sandstones. The sandstones were deposited in a north-south belt up to 35 miles wide which runs west of Bedourie and Birdsville, and across the southern part of the Betoota 4-mile Sheet area. Distribution of Tertiary sandstone gibbers suggests that the sandstone deposits were once linked along the southern edge of the region.

The plateau is represented by flat-topped hills and mesas in the northern, higher part of the region where erosion has been most active. It is more continuous to the south and slopes with a low gradient towards the Birdsville area; in the south-west corner, the plateau disappears below the sand dunes of the Simpson Desert. The Diamantina River and Eyre Creek have breached the plateau. Tertiary sandstone areas show more relief than lateritised and silicified Cretaceous sediments which have an inherent conchoidal fracture and disintegrate more readily. Greatest relief occurs in the south-east corner where the sediments are folded and subsequently eroded along the axes of folds. East of Betoota the limbs of the Betoota dome form north-north-east to south-south-west trending cuestas with scarps up to 150 feet higher than the intervening plain. The more resistant Tertiary sandstone duricrust breaks down into gibbers which cover large areas of plateau to produce a rough undulating surface. Duricrust has been mostly eroded from plateau areas where the Tertiary sandstone was not deposited. Such areas are now mainly fairly flat with small convexly rounded white hills developed around the edges; the plateau surface and alluvial flats around the edges are covered in most parts by dark brown ironstone gravel.

Younger Tertiary lacustrine limestone deposits have formed in small shallow basins on the plateau; they have been partly to wholly silicified and in many places remain only as chalcedony rubble.

2. ROLLING DOWNS

This type of country is common in the Great Artesian Basin. It forms almost half of the Machattie 4-mile Sheet area; similar country occurs in the northern part of the Bedourie 4-mile Sheet area.

The rolling downs are low undulating country formed in areas where calcareous concretions and lenses crop out or weather out at the surface. The soil is generally dark grey and formed over little-altered Cretaceous shales and siltstones. Mitchell grass grows well on the downs and is the most reliable stock feed in western Queensland. Owing to the low rainfall, the grass has a strongly developed root system which forms clumps; erosion then produces low mounds which, interspersed with deeply cracked soil and calcareous rock outcrops, form a very rough surface. Trees are uncommon except near creeks.

The downs appear to be the base level of the present period of erosion.

3. ALLUVIAL FLATS AND CHANNEL COUNTRY

Alluvial deposits are widespread in the region and cover almost a quarter of the area; bore records show thicknesses of up to 103 feet (Bedourie Bore near Eyre Creek). The deposits occur mainly in the flood plains and along the

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PLATE III

Fig. 1 Eyre Creek, looking north from above the Queensland-South Australia border.

Fig. 2 "Gilgai" country north of Eyre Creek on Glengyle Station.

courses of the Diamantine River, Eyre Creek* and the Mulligan River (and their tributaries). These streams contribute to the Lake Eyre system of internal drainage.

The rivers are intermittent streams and, except for an occasional winter flow, are only active in the summer after heavy monsoonal rains at their heads to the north. The streams have very low gradients and the large volumes of water overflow the river banks and spread laterally in the Bedourie-Machattie-Birdsville-Betoota region for distances of 30 miles and more; Whitehouse (1948) points out that a similar river, the Cooper which flows east and south of the region, may be 90 miles wide in full flood. Because of their spasmodic activity, their low gradients and flooding habit, the streams have braided courses.

Both the Diamantina River and Eyre Creek have multiple channels; the channels are more or less parallel and divide and connect at many places. Waterholes occur in the main and minor channels; some contain permanent water. The waterholes in the main streams are generally fairly straight and long whereas those in the channels of tributaries are mainly short and curved, particularly around the heads of dunes. The Mulligan River and subsequent Eyre Creek, which run in a south-south-easterly direction along the eastern boundary of the Simpson Desert have, for most of ~~their~~ their course, a single channel. This is due to the sandy nature of the country; the soil is too porous to allow the formation of extensive tributaries.

Two large lakes, Machattie and Wickamunna (or Philippi), and the Bilpamorea Claypan occur in the area. Lake Machattie is the lateral flood lake of Eyre Creek. Lake Wickamunna had a similar relation to the Mulligan River until a sandhill developed across the connecting channel; it is now a saltpan. The great Bilpamorea Claypan is a lateral lake of the Diamantina River but its connecting channels have been largely blocked by sand. Similar smaller lakes are fairly common along the margins of the main stream courses. Swampy areas with thick lignum cover are fairly common along stream courses or near the edges; they show unusual aerial photograph patterns; some suggestive of rock outcrops with structure.

The alluvial soils in the banks of the main streams are in many parts more deeply fissured than the downs soils (locally, this type of country is called "gilgai" - see Plate III, Fig.2).; travel is therefore difficult and parts of the channel country are impassable because of deep cracks and steep-sided channels. Alluvia in or below plateau country are generally formed by lateritised rock debris; they form flat country and afford an excellent travelling surface.

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* The name "Eyre Creek" is retained for the creek and system of channels which runs south and west from the junction of Eyre and King Creeks and south-south-east from the junction with the Mulligan River. "Eyre Creek" has priority according to Madigan (1938, p.508) but he uses "Mulligan River" for the part below the junction of Eyre Creek and the Mulligan River after Hodgkinson (1877). Our usage of "Eyre Creek" is the same as the Queensland Lands Department.

PLATE IV

Fig. 1
Lake Peoppel
near Poeppel's
Corner

Fig. 2
Closely spaced
dunes with
spinifex, north
part of desert.

Fig. 3
Dunes between
Eyre Creek and
Poeppel's
Corner

PLATE V
SAND DUNES

Fig. 1.
Crest of dune,
Cluny Station

Fig. 2
North end of
dune, south of
Lake Machattie

Fig. 3
South end of
dune, partly
consolidated
sand.

The largest trees in the region, mainly coolibah, occur along the main stream channels (see Plate III, fig.1); lignum is thick in parts of the channel country. Samphire and other salt bush growth is very common in salt pan and salty soil alluvial country.

4. SIMPSON DESERT AND SANDY COUNTRY.

The western part of the region is covered by sand dunes of the Simpson Desert (see Plate IV, figs. 2 and 3). Madigan (1945) regards the Mulligan River as the eastern boundary of the Simpson Desert. Scattered dunes and small sand dune groups occur over most of the rest of the region.

The dunes of the Simpson Desert trend in a north-north-west to south-south-east direction, reach an average height of 50 feet and attain great lengths (Madigan, 1938, p.513 quotes "at least 100 miles in places"). Most ridges, in the desert and elsewhere, are steepest on the eastern side. The longitudinal direction of the dunes is a consequence of the prevailing wind from the south-south-east; the steep east sides result from the infrequent strong west winds. The distance between adjacent dunes is ¼ mile, and the areas between them are occupied by sand drifts and claypans. In the main part of the desert the dunes are parallel for long distances but braiding at the northern ends occurs. The sand is fixed in most parts by spinifex cover, (Plate IV, fig.2). The dunes are lower, more wavy and further apart in the south-west corner of the region between Eyre Creek and Poeppels Corner (Plate IV, fig.3); claypan lakes, such as Lake Poeppel (Plate IV, fig.1) are very common between dunes and gidgea trees seem to survive in this area.

East of the Simpson Desert and towards Birdsville, dunes are more widely spaced but retain the north-north-west trend; gibber plains occur in some places between dunes. Here, and elsewhere in the eastern part ofthe region where scattered long dunes occur, evidence of recent sand movement is common: loose sand along crests (Plate V, fig.1), sand covering vegetation at the northern ends of dunes (Plate V, fig.2), semi-consolidated cores of dunes exposed at southern (windward) ends (Plate V, fig.3).

Other main areas of sand accumulation are the hollows in the plateau country formed by the main streams and lakes. The dunes are more irregular here and the areas between them are occupied by claypans. The irregular arrangement of dunes and the looseness of the sand east of the Simpson Desert are the effect of the west winds.

The sands of the region are generally various shades of red in colour. They are presumably derived mainly from the Tertiary sandstones, and the colour is due to the iron oxide coatings of the grains, probably produced by lateritization.

DESCRIPTION OF ROCK UNITS

The following are prepared from field notes, previous descriptions of rock units and logs of bores obtained from the Irrigation and Water Supply Commission, Brisbane, station people and drillers. The main details are summarised in the chart, Table I.

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TABLE I: STRATIGRAPHY AND TECTONIC HISTORY

ERA	PERIOD		STRATIGRAPHICAL UNIT	DERMI-FROME-SANTOS SUB-DIVISION	SYMBOL	LITHOLOGY	THICKNESS feet	OCCURRENCE	TECTONIC HISTORY	CORRELATION
CAINOZOIC	Quaternary				Czs	Aeolian sand (associated with claypan limestone)	50 (Av.)	sand dunes and drift		
					Czg	Gibbers		gibber gravel		
					Cza	Alluvium - gypsiferous clay, silt, sand, gravel	103 (Maxm)	streams, lakes swamps		
										unconformity
	Tertiary		Austral Downs Limestone		Ta	White to brown dense limestone and chalcedony; fossils; uranium mineral	10 (outcrop) 70 (bore)	Scattered small basins	result from late Pliocene Orogeny (?)	Noranside Limestone; Horse Creek Formation
										unconformity
			Marion Formation		Tm	Sandstone, grit and siltstone; torrential; freshwater	55 (Maxm)	west and south parts of region	Silicification Lateritisation Peneplanation	"Syrian Series" (South Australia) Springvale Formation
									Minor folding (Maryborough Orogeny)	unconformity
MESOZOIC	Cretaceous	? UPPER	Winton Formation	Winton Formation	Ku?w	Siltstone, arkosic sandstone, shale, with calcareous beds and lignite bands; outcrops light coloured, kaolinised with ironstone bands; brackish to freshwater	1350 (DFS No.1 Well)	low plateau over most of southern half of region	filling Great Artesian Basin	
		LOWER	upper Wilgunya Formation	Tambo Formation	Klw_2	Mainly dark shales and siltstone with calcareous and fossil beds, more sandy near top where calcareous arkosic sandstone lenses; lateritised in parts; marine environment	2000 (bore)	in plateau under duricrust and rolling downs where calcareous sandstone	regression of shore-line towards centre of Basin	Tambo Formation
			Toolebuc Member	——?—— *	Klwt	Limestone to calcareous siltstone, fossiliferous; some altered to ironstone	30 (bore)	rolling hills near Sandringham	renewed sagging in centre of Basin	Tambo Formation
			lower Wilgunya Formation	Roma Formation	Klw_1	Dark shales, siltstone with sandy and calcareous bands outcrops gypsiferous; marine	400 to 500 (Av.)	small outcrop in north part of Bellourie area.	slow settling in Basin	Roma Formation
			Lower Mesozoic freshwater to transition beds	BYTHESDALE GROUP: Transition Beds		Sandstone, sandy siltstone, and claystone; freshwater to marine	200 (bore)	bores only	filling Basin	Longsight Sandstone
	Jurassic	MIDDLE - UPPER		Mooga Sandstone	Kll	Fine to medium-grained, clean, quartz sandstone; tight to medium porosity; dark grey micaceous shale	Ca.800	D.F.S. Betoota No. 1 Bore		
				Fossil Wood Beds		V. fine to fine-grained quartz sandstone with dark brown to grey very lignitic, silty shale. Some coal seams.	250	D.F.S. Betoota No. 1 Bore.		
				Gubberamunda		Very coarse grained quartz [illegible]stone, good	500	D.F.S. Betoota No. 1 Bore.		

	LOWER		Walloon Coal Measures		Coarse-grained to conglomeratic sandstone with very lignitic shale. Trace coalified wood.	750	D.P.S. Betoota No. 1 Bore	Unconformable on Pre-Jurassic
								unconformity
PALAEOZOIC			Pre-Jurassic		Red/green coarse to conglomeratic sandstone steep dips, sheared	1500 (bottom not reached)	D.P.S. Betoota No. 1 Bore.	Much titled/folded; 70°-80° dips. Eroded before deposition of Mesozoic	?Devonian or older
		Lower Palaeozoic?		$P_{2}1$	"blue rock"	62+ (bottom not reached)	Kidman bore, Sandringham	overlain by Longsight sandstone equivalent	Cambrian-Ordovician beds of Georgina Basin
PRECAMBRIAN				P	Granite (833 million years)		Kamaran Downs No. 3 bore	Occurs on west side of north-west trending fault.	Boulia Shelf basement rocks.

* position of boundary with respect to Wilgunya Formation subdivision unknown.

1. PRECAMBRIAN AND PALAEOZOIC ROCKS.

The only definite Precambrian rock known from the area is the granite from the base of Kamaran Downs water bore No. 3 (Bedourie 4-mile Sheet). The nearest outcrop of comparable rock is the small granite, pegmatite, schist inlier in the Simpson Desert 73 miles north-west of Kamaran Downs bore No. 3. The sample examined from the bore was composed of chips of quartz, orthoclase feldspar, biotite; the age was determined as 833 million years by the potassium-argon method at the Australian National University by Professor Everton in 1961, (pers. comm.). The granite was overlain by 12 feet of "quartz bedrock" (part of the Precambrian bedrock) and Mesozoic beds. It may be possible to correlate the granite with Proterozoic granite around the north-west margin of the Simpson Desert.

Three bores in the northern half of the region reached bedrock which may be part of the southern, buried edge of the Georgina Basin. These are as follows:

Kidman bore, Sandringham Station (north-east corner of Bedourie 4-mile Sheet area) - "blue rock" from 858 to 920 feet; occurs below artesian aquifers;

Coorabulka No.10 bore (centre of Machattie area) - "hard rock" from 1715 to 1737 feet; occurs below artesian aquifers;

Cluny No.1 bore (Machattie area, 30 miles E.S.E. of homestead) - "limestone" from 2221 to 2225 feet; occurs below artesian aquifers. This may be a limestone or hard lens in the aquifer beds, but is more likely basement. Although the driller of this hole is not known, G.R. Beauchamp or D. McInnes were operating in the region at that time (1917) and such experienced drillers would not have drilled further in a rock which they thought was basement.

These rocks are correlated with the Lower Palaeozoic carbonate rocks which crop out further north in the Mt. Whelan and Boulia 4-mileSheet areas. Crownwheel (Ludlow No.2) Stock route bore penetrated "limestone" from 1022 to 1025 feet which may also have been Lower Palaeozoic basement, but the occurrence of the main artesian aquifer at 1025 feet suggests that the "limestone" is part of the aquifer beds.

Milton and Seedsman (1961) state that a 17,900 ft./sec. refractor at Breadalbane is probably the Lower Palaeozoic sequence. Between this horizon and the base of the Mesozoic is a 15,400 ft./sec. refractor, thought to be the "red marl/limestone" beds known from the base of Breadalbane No. 7 (homestead) bore from 668 to 731 feet. 'Reflections at CB29 (2 miles north of Bedourie) indicate a thickness greater than 5,000 feet for this sequence' (Lower Palaeozoic to "red marl" sequence). The 15,400 ft./sec. refractor ("red marl/limestone") unit thins to the south, and is not known at CB19 (Cluny homestead) or south of there. According to Milton and Seedsman, the absence of reliable reflections from below the Mesozoic south of CB8 (northern edge of Lake Machattie) suggests that the Lower Palaeozoic ends here. Bore evidence confirms the suggested distribution of the Lower Palaeozoic rocks but the "red marl/limestone" beds occur only as far south as Breadalbane No. 9 bore (Springvale 4-mile Sheet area), 8 miles south of Breadalbane homestead. Samples of red 19 marly sediments collected from Montara bore (south edge of Mt. Whelan 4-mile Sheet) on Sandringham and thought to be equivalent to the marls met in Breadalbane bores, have yielded Lower Cretaceous microfossils (P. R. Evans, B.M.R., pers. comm.); the casing history of the hole probably precludes the possibility of contamination of samples. Therefore the 15,400 ft./sec. refractor may be in the Lower Cretaceous marine shales or underlying aquifer beds in which hard bands such as "limestone" are recorded.

Milton and Seedsman record refractors of 19,400 ft./sec. at Cluny No. 4 bore and old Roseberth (19 miles north of Birdsville), and 18,100 ft./sec. at new Roseberth; they coincide with a reflection "Z" believed to be at the base of the Mesozoic. These refractors may represent Proterozoic rocks such as found at Well Creek near Marree in South Australia - slate at 944 feet depth with velocity 19,300 ft./sec.

At Betoota (and Innamincka, South Australia) the beds encountered in the bores below the Mesozoic have refraction velocities of 16,400 ft./sec.; they are thought to be Palaeozoic (?Devonian) in age. A stratigraphic thickness of 1500 feet of sheared, steeply dipping red and green conglomeratic sandstones of this age were penetrated before the subsidised DFS (Delhi-Frome-Santos) Betoota No. 1 Bore was abandoned. The sandstones are unconformably overlain by sandstones with lignite whose age is given as Lower Jurassic in the DFS completion report (1961). Milton and Seedsman were not able to trace these Palaeozoic rocks beyond 20 miles west of Betoota on the road to Birdsville.

2. LOWER MESOZOIC FRESHWATER TO TRANSITION BEDS.

They consist of 2,500 feet of freshwater to transition beds ranging in age from Lower Jurassic to Lower Cretaceous (Neocomian) in DFS Betoota No. 1 bore. The beds have been named Walloon Coal Measures and Blythesdale Group (Gubberamunda Sandstone, Fossil Woods beds, Mooga Sandstone, Transition Beds) after Whitehouse (1954); their lithologies and thicknesses are shown in Table I. The upper part at least, of the Blythesdale Group is equivalent to the Longsight Sandstone (Casey, 1959) known from bores and outcrops north of the region and these units form the main aquifers in the Artesian Basin; the relation is shown in Table I.

The Longsight Sandstone was named by Casey after Longsight Peak (22°30'S., 139°31'E.) in the Boulia 4-mile Sheet area to the north. A full description of the unit has been given by Casey, Reynolds, Dow, Pritchard, Vine and Paten (1960). The formation crops out in the Boulia and Mt. Whelan 4-mile Sheet areas on the edge of the Great Artesian Basin and forms the main aquifer in western Queensland. It is conformably overlain by the Wilgunya Formation (aquiclude) and overlies Proterozoic to Lower Palaeozoic rocks with unconformity. The age is Lower Cretaceous.

No outcrops of Longsight Sandstone occur in the Bedourie, Machattie, Birdsville, Betoota areas. Apart from the section shown in the DFS Betoota No. 1 bore, the greatest thicknesses shown by water bores are Coorabulka No. 10 (369 feet), Cluny No.3 (more than 558 feet), Gemerchie - Monkira No.1 (more than 330 feet), Bindiacca - Glengyle (more than 549 feet). The lithologies are mainly sand and sandstone with bands of shale and pipe clay;

gravel bands are also recorded. Some bores contain brown to black shale and clay with "lignite" beds and some have thin "limestone" bands. These beds are correlated with similar, but generally thinner beds to the north of the region which are equivalent to the Longsight Sandstone.

3. WILGUNYA FORMATION

The formation was named by Casey (1959) after Wilgunya Creek, a tributary of the Hamilton River in the Boulia 4-mile Sheet area. The type area is 8 miles north-east of Dover homestead at 22°32'S., 140°50'E. The formation has been fully described by Casey et al. (1960) and Reynolds (1960 a,c,d.). The macrofauna has been listed by Dickins (1960), and Crespin (1960, 1961) has identified the microfossils. The Longsight Sandstone is conformably below the Wilgunya Formation, and the Winton Formation is conformable above. The age is Lower Cretaceous.

Reynolds (1960 c) divided the Wilgunya Formation into 3 parts: upper part of Wilgunya Formation (Klw_2), Toolebuc Member (Klwt) and lower part of Wilgunya Formation (Klw_1). On fossil evidence the Toolebuc Member and upper part of Wilgunya Formation are equivalent to the Tambo Formation of Whitehouse (1954), the lower part is equivalent to Whitehouse's Roma Formation. Insufficient lateral control was available to allow the Wilgunya Formation to be discarded in favour of Whitehouse's names. This may soon be possible as a result of further drilling in the Great Artesian Basin and detailed microfossil studies now in progress. Because fossils are the best means of correlation, the division should be Roma and Tambo Stages, not formations.

(a) Lower part of Wilgunya Formation (Klw_1). Unfossiliferous shaly beds which are thought to be lower Wilgunya Formation crop out in the north part of the Bedourie 4-mile Sheet area between the Mulligan River and Sandringham homestead. The position of their contact with the overlying Toolebuc Member is uncertain because the beds are overlain by sand and alluvium around the edges of the outcrops. Lithology in outcrop is predominantly highly gypsiferous shaly siltstone with calcareous siltstone nodules. In bores, the Wilgunya Formation consists of dark-coloured shales, claystones and siltstones with minor sandy and calcareous beds. The lower part is generally more sandy than most of the upper part. Thickness is uncertain; Sandringham homestead bore started in the Toolebuc Member, probably near the base, and penetrated 563 feet of sediment before reaching the Longsight Sandstone aquifer. However, the beds have an unknown southerly dip and true thickness cannot be determined. Where beds have very low dips in the Springvale, Boulia 4-mile Sheet areas, bores beginning in or near the base of the Toolebuc Member penetrated 400 to 500 feet of lower Wilgunya Formation. The Toolebuc Member possibly occurs in some bore logs in the Bedourie-Machattie-Birdsville-Betoota areas; thicknesses of lower Wilgunya Formation in these bores vary from 400 to 500 feet. The bores are Adria Downs, Cluny Nos. 2 and 4, Coorabulka No.7, Kamaran Downs No. 4 and Kidman on Sandringham Station and the divisions are shown graphically in Appendix II. Shallow water conditions generally persisted during the deposition of the lower part of the Wilgunya Formation; the marginal beds are sandy, foraminifera are mainly arenaceous with abundant and well-formed tests, and the beds increase in thickness towards the centre of the Great Artesian Basin but the increase is small and fairly gradual (Reynolds, 1960 c, p.6). The lower part of the Wilgunya Formation is conformable over the Longsight Sandstone and unconformable on older rocks to the north of the region in the Mt. Whelan 4-mile Sheet area. Reynolds (1960c, p.6) states that the overlying Toolebuc Member appears to be conformable on the lower Wilgunya Formation. Outcrops of the Toolebuc Member seen in the Bedourie 4-mile Sheet area in 1960 suggest that a minor hiatus occurred before the Toolebuc Member formed.

In Delhi-Frome-Santos No. 1 Bore, Betoota, beds correlated with the Roma Formation are 755 feet thick; their upper limit is determined by foraminifera. This is thicker than usual for the Roma Formation equivalent (lower Wilgunya Formation) further north.

(b) Toolebuc Member (Klwt). The Toolebuc Member named by Casey (1959) and described by Casey et al. (1960) was discussed as an important stratigraphic unit by Reynolds (1960 a-d). The type area is in the Boulia 4-mile Sheet area, along the eastern side of the Hamilton River where the member forms a belt 1 to 4 miles wide. The lithology in the type area is irregularly thin-bedded, pink to grey, sandy calcarenite, calcareous siltstone with nodular concretions and some coquinite. Fossils include large *Aucellina hughendenensis* and *Inoceramus* (mainly fragments) which are common in the thin-bedded limestone, together with fish bones and scales; nodular concretions have yielded many species of ammonites, and the belemnite Dimitobelus is common. One of the most distinctive properties of the Member is the microfossil assemblage - it contains abundant *Globigerina planispira*, one or two other species of *Globigerina* and rare radiolaria.

In 1959, the Toolebuc Member was traced from the Boulia area 75 miles south-west to Hilary Tank (Springvale 4-mile Sheet area, on stock-route from Boulia to Bedourie); and 70 miles north and east to McKinlay and Bunda Bunda. It was correlated with the Kamileroi Limestone of Laing and Power (1959), and traced further to the south-west in 1960, through the Mt. Whelan 4-mile Sheet area to the north-east part of the Bedourie area. The member appears to end against a fault immediately east of the Mulligan River. The Toolebuc Member is not as apparent in the Mt. Whelan area as it is in the Boulia area; outcrops occur in lateritised Wilgunya Formation and their upper parts have been ferruginised. Also, the concretionary beds seem to be missing: a small section measured in a new earth tank (Twelve Mile Tank on Marion Downs) showed -

	Top 12 feet	alluvial gravel and sand
Toolebuc Member	3 "	green clay
	2 "	richly fossiliferous (A. hughendenensis mainly) limestone in thin irregular interbeds with green grey shale
	3 "	green clay chale with sandy interbeds
lower Wilgunya Formation	4 "	grey to dark grey shale

Unaltered thin-bedded limestone and concretionary calcareous siltstone reappear at the south end of the Mt. Whelan area and a belt up to 10 miles wide extends south and south-west through Sandringham station in the Bedourie area to the fault-line.

The lithology in the Bedourie area is generally similar to above. The thin-bedded limestone in the lower part is not as common. A different lithology was seen at some localities: at GAB 31, 2 miles east of 8-mile Waterhole, a small erosional unconformity was shown between grey calcareous siltstone and coarse sandy calcarenite (with weathered belemnites, white-coated bone fragments, round clay pebbles, fossil wood fragments and coarse grains of quartz) in a large loose block on the surface. Lithology similar to the sandy calcarenite was seen elsewhere in the area; it is not as common north-east of the region. It suggests that lower Wilgunya beds were exposed to erosion and supplied material for the Toolebuc Member.

The possible Toolebuc Member in bores in the region has been recognised not so much on lithology but on its position from 400' to 500' above the base of the lower Wilgunya Formation. This applies particularly to beds such as the 1 foot band of "hard rock" 401 feet above the base of the Wilgunya Formation in Coorabulka No. 7 bore, the "sandy shale" 442 feet above the base in Cluny No. 4, and "honeycomb sandstone" 435 feet above the base in Kidman (Sandringham) bore. Other descriptions - "grey and brown shale with hard band" over "grey sandy shale" (Adria Downs bore) 480 feet above the base ofthe Wilgunya Formation, and "limestone and grey shale" 496 feet above the basein Kamaran Downs No. 4 bore - are more suggestive of the Toolebuc Member.

Casey et al. (1960) recorded that the Toolebuc Member has a 3-4 times normal background count, and suggested that gamma-ray logging of bores in the western part of the Great Artesian Basin would be useful in the determination of its extent.

Since then, radioactive horizons have been recorded from Delhi Frome Santos Betoota No.1 well (Betoota 4-mile Sheet) and Conorada No.1 well(Brighton Downs 4-mile Sheet) by this method. These horizons are probably equivalent to the Toolebuc Member.

The thickness of the Toolebuc Member in the Bedourie 4-mile Sheet area was not determinable in outcrops; the most probable Toolebuc Member beds in bores had a maximum thickness of 30 feet (Adria Downs bore).

Large fossil collections were made by S. Skwarko, and a report will be prepared later. Some genera new to the Toolebuc Member were found. Crespin (1961, p.13), on the evidence of microfossil assemblages places samples GAB 31, 85 304 in the Toolebuc Member and GAB 35, 37 and 38 tentatively in the Member. Field determinations of macrofossils other than the normal assemblage of Aucellina, Inoceramus, ammonites, belemnites and fish remains were ?Oxytoma (GAB 35), a pelecypod like Solen and a small gastropod (GAB 38). Crespin records Globigerina, radiolaria, glauconite infillings of ostracods, cidaroid spines, Inoceramus prisms, and fish remains in the microfossil assemblages. The change from Toolebuc Member to upper Wilgunya Formation may occur within the boundaries of the Toolebuc Member as shown in the Bedourie 4-mile Sheet area; the study of fossils and associated micro- 23 fossils will help to determine the boundary.

An erosional break is suggested at the base of the Toolebuc Member in the Bedourie 4-mile Sheet area. The upper boundary is conformable and hard to determine.

(c) Upper Wilgunya Formation The upper part of the Wilgunya Formation is mainly dark-coloured shales and siltstones with thin calcareous and some fossiliferous bands; it becomes more sandy towards the top. This unit is also discussed in detail by Reynolds (1960c). In most outcrop areas, it has been altered by lateritisation as in the north-east corner of the Bedourie 4-mile Sheet area. Fossils may be preserved as internal or external moulds in the lateritised sediments and are most commonly found in ironstone (replaced limestone) concretions and bands. Fragments similar to the barytes and barium, strontium, alumina, phosphate nodules found elsewhere in upper Wilgunya Formation, were found in the form of crystalline cœlestite? plates 1 to 2 inches thick weathered out on the surface south of Lake Wickamunna (Bedourie area).

The thickness of the upper Wilgunya Formation varies in the Bedourie-Machattie-Birdsville-Betoota region from about 900 feet in the north, (estimated from Coorabulka No. 10 bore which started at or near the top of the formation) to 2,000 feet in the south-west (Adria Downs bore). Delhi-Frome-Santos (1961) suggest a thickness of 1140 feet for the Tambo Formation equivalent based on foraminiferal evidence; but this is less than the upper Wilgunya Formation (including the Toolebuc Member) thickness which is suggested by the lithology - the base is regarded as at the bottom of the glauconitic sandstone" (shown by Delhi-Frome-Santos in the "Roma Formation equivalent") and the thickness of the unit would be 1350 feet.

Fossil and associated microfossil assemblages will be studied later to determine the boundary between the Toolebuc Member and upper Wilgunya Formation. The upper Wilgunya Formation is generally poor in both macrofossils fossils and microfossils. Inoceramus, mainly fragmentary, is fairly common and some ammonites have been found in the region. Preservation of macrofossils is mainly as moulds in ironstone. Dentalium-like impressions were noted in ironstone outcrop west of the Mulligan River about 3 miles north of Browns Camp Waterhole. Dunstan (1920, p.19) records fossils found near latitude 24°S., longitude 138°30'E., west of the Mulligan River; they were determined as 'Aucella (Aucellina) hughendenensis, Nautilus hendersoni'. Foraminifera in outcrop samples are generally poorly-developed arenaceous types; these, and other micro-fossils are not common.

The lower boundary of the upper Wilgunya Formation is uncertain; in the upper part the formation grades conformably into the Winton Formation. The upper boundary in outcrop is the top of a calcareous arkosic sandstone unit described by Reynolds (1960 c, p.10). It extends into the northern and eastern parts of the Machattie 4-mile Sheet area. Samples from here, and other parts of the Great Artesian Basin, were sent to the Australian Mineral Development Laboratories, South Australia, for petrographic analyses. They consist essentially of equal amounts of fresh angular quartz and feldspar (mainly plagioclase) in recrystallised calcite cement. Minor constituents are

PLATE VI

WINTON FORMATION

Fig. 1. Winton Formation under duricrust of Tertiary sandstone; Curalle dome; 12 miles south of Planet (Barrolka 4-mile).

Fig. 2. Typical Winton Formation outcrop, road cutting - about 22 miles west of Middleton on Boulia road.

chert, igneous rock, mica, schist fragments and rare to common glauconite. The cement is clayey and limonitic in parts. Heavy mineral analyses of samples yielded little useful data for correlation. Specific gravities varied from 2.14 (sandy calcareous claystone) to 2.56 (calcareous arkosic sandstone). The sediments are poorly sorted and some show faint, small-scale current bedding; ripple marks were seen in outcrop. Fossils include rare Inoceramus fragments and pieces of wood; Crespin (1961) found glauconitic replacement of radiolaria. The beds form rolling downs in which no outcrops apart from calcareous sandstone concretions and lenses occur; thickness in outcrop is therefore unknown. The unit is not conspicuous in bores - it may be the sandy unit, often referred to the base of the Winton Formation, which yields brackish to salt water. Where these calcareous sandstone lenses occur in lateritised profiles they have probably been ferruginised and give rise to the ironstone gravels so common in association with outcrops of the lowest Winton beds. The "red brick" bed from 67 to 91 feet in Cluny No. 4 bore may be the altered equivalent of the calcareous sandstone unit. When more is known of the thickness of the bed or beds, it may be possible to name it as a member of the Wilgunya Formation.

4. WINTON FORMATION.

The Winton Formation is formed of blue shales and sandstones with intercalated coal seams and fossils, (Unio), as found in wells and bores near Winton (Whitehouse, 1954). The lowest beds occur in the northern part ofthe Machattie 4-mile Sheet area and the formation thickens to the south and south-west; it has been extensively lateritised and forms the low plateau country which exists over most of the Birdsville and Betoota 4-mile Sheet areas. In outcrops the formation is composed of white to light brown and red fine to coarse-grained kaolinised clayey arkosic sandy beds with thin interbeds of siltstone. Close interbedding and small scale lensing occurs in some sections (compare Plate VI, fig. 2). Beds of intraformational conglomerate have also been seen. Outcrops generally have blocky cleavage and conchoidal fracture. Calcareous beds, such as the "Betoota limestone" (Wopfner, 1960), occur in the Winton Formation but have been mostly ferruginised in outcrops. Some calcareous beds show ripples and ?shrinkage cracks. Calcareous concretions have likewise been ferruginised and show slickensiding (Reynolds, 1960c, p.12). Thin coal seams which are found in water bores are missing in outcrops but some silicified fossil wood and replaced small woody fragments are found. Fossil plant remains found near Birdsville were probably in beds of the Winton Formation; the reference to them is given by Dunstan (1920, p.21); 'Zamites ensiformis' was determined by Etheridge (1898). Opaline rocks such as are found with lateritised Winton beds on Springvale and Coorabulka Stations was also found on Glengyle Station. There are unconfirmed reports of precious opal having been found. The upper parts of lateritised Winton Formation have been silicified in many parts to form a "duricrust"; gibbers derived from those caps are very similar to gibbers formed from Tertiary Marion Formation, but the Marion gibbers may be distinguished easily where they contain coarse angular chert grains.

The Winton beds vary from a few feet thick in the north of the region to 500 feet in Adria Downs bore in the Birdsville area and to 1350 feet in DFS No.1 Bore, Betoota. Outcrops are

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not more than 150 feet thick (scarps of the limbs of the Betoota dome in the south-east corner of the region and on the limbs of the Curalle dome further south(see Plate VI, fig. 1).

The Wilgunya-Winton Formation contact is transitional. Unconformity occurs between the Winton Formation and overlying Tertiary formations. The age of the Winton is given as ?Upper Cretaceous in Reynolds (1960c).

5. TERTIARY ROCKS

The Tertiary formations in the Bedourie-Machattie-Birdsville-Betoota region are similar in most respects to the Tertiary rocks fully described from the Boulia, Glenormiston, Mt. Whelan, Springvale 4-mile Sheet areas by Casey (1959), Casey et al (1960), Reynolds (1960), Paten (1960, 1961). Only brief notes therefore are made in this report.

(a) Marion Formation. Casey (1959) proposed the name "Marion Formation" for the silicified sandstone and siltstone unit which caps hills west of Marion Downs homestead (Springvale 4-mile Sheet area). The formation forms a belt which continues south from the Mt. Whelan 4-mile Sheet area through the eastern halves of the Bedourie, Birdsville areas. The torrential sandstone deposits overlying the Winton Formation in the south-east corner of the Betoota 4-mile Sheet area are tentatively correlated with the Marion Formation. The gibber distribution across the hilly country in the southern part of the Betoota area suggests that the sandstone outcrops may have been once continuous.

The sandstones in the western belt are fine to medium-grained and composed mainly of angular quartz. Coarse grit lenses are common and in many places contain chert in addition to quartz. Silty interbeds also occur. Beds seen in the south-east corner of the region are unsorted conglomeratic sandstone up to 50 feet thick. The only fossils known in these areas are silicified fossil wood (Casey et al, 1960; Wopfner, 1960).

The beds have been ferruginised in some places and are leached white in others (i.e. probably lateritised). As a result of silicification, the Marion Formation in most places forms part of the widespread "duricrust" of western Queensland. Paten (1961) refers to "billy" and "billy crust" developed by silicification of the Marion Formation and similar sediments. However silicification has affected most of the lateritised sediments in western Queensland including the altered siltstones and shales of Cretaceous formations and the term "duricrust" (first used by Woolnough, 1927) is preferred as a more general term. Duricrust caps the flat-topped hills of the plateau country and possibly passes beneath younger sediments in structural depressions as shown elsewhere by Wopfner (1960); bore records suggest that it may extend at depth under the Simpson Desert. Breakdown by erosion of the duricrust on the Marion Formation has formed the shiny brown-coated gibbers which cover wide areas in central Australia.

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Wopfner (1960, p.182) records 'red nodular laterite and lateritised sands', up to 120 feet thick in the "Haddon syncline", overlying the duricrust in structural depressions. The red pisolitic sandstone beds from below the Tertiary limestone at Samphire Tank (Adria Downs) and along the east side of Eyre Creek in the Birdsville area are very similar to red sandy beds seen in south-west Queensland and are thought to be equivalent. However Wopfner states that at several localities a thin conglomeratic bed of well-rounded pebbles of duricrust is present between the duricrust and the laterite. This means:

(i) the duricrust was eroded after folding and alluvial deposits of duricrust pebbles and sand formed; then followed deep ferruginisation and deposition of Tertiary limestones in small basins; or,

(ii) the duricrust developed at depth in lateritised Tertiary sandy beds (equivalent to Marion Formation) as well as in other lateritised older beds and round duricrust pisolites formed in the zone above; folding followed and limestone was deposited later in some of the hollows.

The latter argument is preferred. Round duricrust pisolites have been seen in the ferruginous zone of laterite where they have obviously formed at several localities; this is generally at the base of the duricrust profile. However, at GAB 102 locality (Betoota 4-mile Sheet) duricrust pisolitic nodules occur as shown in Figure 1.

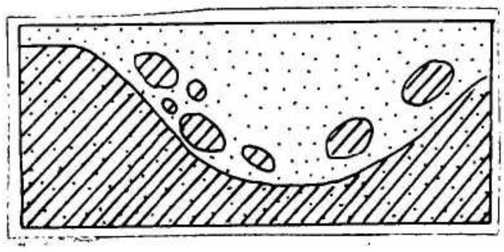

Fig. 1. Part of duricrust profile at GAB 102 locality.

This appeared to be a normal erosional unconformity with eroded surface covered by a boulder to pebble conglomerate. However, the "boulders and pebbles" follow the surface of the duricrust and are not in close contact. The sandy part above the duricrust is ferruginous. Hence the "boulders and pebbles" are thought to be duricrust pisolitic nodules developed above the duricrust in the laterite profile before folding. The red laterite sandy beds referred to above are therefore tentatively correlated with the Marion Formation.

The formation is up to 20 feet thick in the type area but thickens to the south. At GAB 76 locality,

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1 mile south of Humpamurra Tank on Glengyle Station (Bedourie 4-mile Sheet), 15 feet of thick-bedded grit overlies 40 feet of thin-bedded fine-grained sandstone to siltstone above the Winton Formation in a folded section.

Both the Wilgunya and Winton Formations are unconformably overlain by the Marion Formation; in most places the unconformity is erosional but angular unconformity has been recorded along the south-east limb of the Morney anticline (east of the Betoota area) by Wopfner (1960, p.182 and 185). The erosional unconformity is not obvious in some places where silty beds of underlying formations have been reworked at the beginning of deposition of the Tertiary sandstones (particularly where the beds have since been lateritized. The only indication of change in formations is the appearance in the silty bed of scattered sand grains and lenses of coarse grit. The Tertiary limestone deposits are rarely found above the Marion Formation but where found they are unconformable.

The Marion Formation is probably equivalent to the "Eyrian Series" of South Australia and possibly to the Springvale Formation (Casey, 1959 redefined by Paten, 1960).

(b) Tertiary limestone deposits. Scattered outcrops of Tertiary limestone and chalcedony occur throughout the Bedourie, Machattie, Birdsville, Betoota 4-mile Sheet areas. Tertiary limestone basins are fairly common in western Queensland and each contains beds thought to be nearly equivalent in age. Three of these formations have been named: Austral Downs Limestone (Noakes and Traves, 1954), Noranside Limestone (Casey, 1959) and Horse Creek Formation (Paten, 1960). The Austral Downs Limestone is the most widespread and extends along the Georgina River into the Mt. Whelan 4-mile Sheet area. Because of this, the priority of its name, and the scattered nature of Tertiary limestone equivalents in the Bedourie-Machattie-Birdsville-Betoota region, the deposits in the region are mapped as Austral Downs Limestone.

The lithology in outcrops is similar: white to brownish-white dense limestone altered in part or entirely to white, blue and brown chalcedony. Red sandy pisolites occur in the base of the formation in some places such as Samphire Tank on Adria Downs. A red to brown sandy calcareous to dolomitic? breccia with brown medium-grained sandstone fragments which is found near Dickerrie Waterhole on Eyre Creek (Birdsville 4-mile) is thought to be basal Tertiary limestone. Samples from GAB 72 locality, north of Katonkra Waterhole on Eyre Creek, Glengyle Station, contained a yellow mineral which has been identified by W.M.B. Roberts as similar to the uranium mineral carnotite but containing arsenic (See Appendix I). This is the only locality in the region in which fossils were found. They consisted of low-spiral gastropods, smaller high-spired gastropods and ?ostracods; they are similar to fossils from the Horse Creek Formation in the Springvale 4-mile Sheet area.

Thickness in outcrop is not more than 10 feet but bore logs suggest greater thickness:

PLATE VII

Gidyea Hill, Simpson Desert, 28 miles
west-south-west of Poeppel's Corner,
(Poolowanna 4-mile Sheet)

Old Cacoory - 70 feet of "surface rock" (probably Tertiary limestone as found in outcrop south of the bore);

Old Cacoory dud - started in Tertiary limestone and penetrated 57 feet of "clay, conglomerate, white and brown rock"; the 16 feet of "white clay" below may also be part of the formation;

Gulgong No. 2 bore (dud) - 33 feet of limestone with salty water at the base;

Gemerchie (Monkira) - "conglomerate, hard white quartz" to 21 feet, over gravel and sand, and ?duricrust.

The position appears to be confined to small shallow basins on the plateau top, larger basins along the courses of the main streams and some of the basins appear to be structurally controlled.

6. YOUNGER SEDIMENTS.

More than half the region is covered by gibbers, ironstone gravel, sand and alluvium and they have been discussed in some detail under Physiography. They are younger than the Tertiary limestone deposits but the ages of the sediments with respect to each other is hard to determine.

The main alluvial deposits are aligned along stream courses which appear to date from Tertiary limestone times judging by the distribution of the limestones. They are formed of grey to blue-grey gypsiferous clays, silts, white sands and gravels up to 103 feet thick as in the Bedourie town bore near Eyre Creek. Lime accumulates in bands in the sands and "stalactites", irregularly bent and up to 1 foot long, occur.

Some old lake deposits (?spring deposits) occur in the south-west corner of the region near Poeppel's Corner (junction of South Australia, Queensland, Northern Territory). Small hills occur between the sand dunes of the Simpson Desert and are formed of soft limey, gypsiferous material capped by travertine up to 4 feet thick. They are about 50 feet higher than the present interdune lake level, (see Plate VII). (Samples of the material have been submitted for chemical analysis). The deposits may have been formed by springs which have ceased flowing; they have been well-eroded and dunes now cross the old lake areas. Madigan (1938, p.511) records that Lindsay noted springs in this area during his crossing of the Simpson Desert. Reynolds came to the conclusion that springs possibly occurred near there because of the presence of dingoes, rabbits and birds.

Sand dunes and recent movement of sand have been discussed (p. 13 and see Plate V). The predominant trend of dunes is north-north-west to south-south-east and the eastern side is generally steeper. The main control of sand movement is exercised by winds from the south-south-east but westerlies cause the steepening of the east side. Distribution of aboriginal artefacts suggests that the most favoured meeting places were on the west side of dunes; this suggests that if these places were chosen for shelter from winds, the westerlies were not as active then as they are now. The source and colour (predominantly reddish) of the sands is attributed to the lateritised sands of the Marion Formation. The dunes are 50 feet high on the average.

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White sandy limestone occurs at the base of sand dunes in some places. Similar white limestone has been found in small mounds in small round claypans among sand deposits near Kookabingicka Waterhole on Glengyle; this material looked like algal limestone in part.

Gibbers (Plate VIII) are formed by erosion of the more sandy beds in the duricrust. They are generally light brown to red-brown, sub-rounded to rounded polished pebbles but some areas are covered by cobbles and even boulders of the silicified rock. Where they accumulate in shallow depressions of the plateau surface they have been stained dark brown by stagnant water which has remained after rains; such beds give unusual air-photo patterns and may be mistaken for ironstone outcrops. The process of erosion which controls gibber distribution is due to the arid climate. The gibbers are not moved significantly by water action, but they do move downwards as the underlying soil is eroded away. This results in accumulations of gibbers in bands - a type of soil-creep effect. The resultant air-photo pattern particularly over low rounded hills is suggestive of beds which have been domed, (Plate VIII, fig. 2).

Beds of ironstone are eroded in the same way as the duricrust and the gravel formed gives similar but blacker air-photo patterns.

7. SPECIAL PROBLEMS

The formation of calcareous concretions and their ferruginisation, and processes of lateritisation and silicification are problems which have important consequences when the geological history of western Queensland is considered. Calcareous concretions in surface outcrops may indicate an important limestone horizon in the predominantly shaly and silty beds of the Cretaceous formations which rarely crop out; or they may be due to a purely local secondary accumulation of calcite and of no importance in widespread correlation. Ferruginisation of calcareous beds is a very important weathering process and has occurred widely in western Queensland - the Toolebuc Member, an important marker bed in the Wilgunya Formation, has been traced in the Mt. Whelan 4-mile Sheet area only by following small ironstone patterns on air-photos. Tracing of marker beds is very important in elucidating the structural history of the region, particularly in beds of Cretaceous age. Later history of the region can only be studied when processes of lateritisation and silicification have been considered.

(a) Calcareous concretions and lenses in the Wilgunya Formation

Definitions: The term "concretion" has been used rather than "nodule", to describe the spherical bodies which are present in the Wilgunya Formation. Pettijohn (1956) described concretions as normally spherical, spheroidal, or disc-shaped structures which are the product of accumulation of mineral matter in the pores of the sediment about a nucleus or centre. The term "concretionary structure" has been avoided, because it seems to imply that it is characteristic of concretions; it has been replaced by the term "concentric structure". Concretions may or may not have concentric structures.

Classifications of concretions were given by Tarr (1921), Richardson (1921), and Pautin (1958). Pautin's classification has been used here. He divided concretions into three classes:

(i) Syngenetic, or those which were deposited or formed at the time of deposition of the enclosing sediment.

(ii) Diagenetic, or those which formed in the enclosing sediment while it was still soft and unconsolidated.

(iii) Epigenetic, or those which formed after the consolidation of the enclosing sediment.

Occurrence: Calcareous concretions have been found in the lower and upper parts of the Wilgunya Formation. They seem to be most abundant in the Toolebuc Member at the base of the upper Wilgunya Formation. The concretions are more compact than the enclosing sediments and weather out to form characteristic boundery outcrops in the Boulia area (Casey et al., 1960) and elsewhere in the western part of the Great Artesian Basin area. At Hilary Tank, 65 miles north of Bedourie on the Boulia-Bedourie road, several large concretions with diameters of up to 3 feet occur. These concretions contain a Roma-type fauna and were found just below the platy limestones of the Toolebuc Member in the lower part of the Wilgunya Formation. At Breadalbane No.2 bore and south-west of the bore on Sandringham Station, concretions containing numerous ammonites were found. The concretions weathered out of Toolebuc Member sediments and lie stratigraphically above the platy limestone at the base of the member.

Numerous calcareous sandy lenses are present in the shales of the upper Wilgunya Formation which crop out over a large area in the north-eastern portion of the Machattie 4-mile Sheet area. They form scattered bouldery outcrops on the black soil plains which developed over the shales. Wood fragments are abundant in some ofthe lenses. The shales and interbedded calcareous sandstone lenses give a characteristic pattern on aerial photographs. Some spherical calcareous sandy concretions were also found on the soil plains in the north-east of the Machattie area.

Characteristics and mode of origin of the concretions: The main characteristics of the concretions (not including the lenses) will be discussed separately in the following paragraphs.

Composition: Most concretions derived from the Wilgunya Formation consist of argillaceous material cemented by carbonate; their composition seems to differ from the parent rocks only in the carbonate content.

Shape and Size: The concretions have a roughly spherical shape and their diameters range from a few inches to several feet. The predominantly spherical shape indicates that the rate of growth and thus the supply of carbonate was equal in all directions around the centre of the concretion. Hence they were formed before an appreciable amount of compaction took place, as this would have led to an unequal reduction in permeability of the host rock in directions parallel and at right angles to the bedding of the sediment, and concretions with angles to the bedding of the sediment, and concretions with ovoid shapes would have resulted. The predominantly spherical shape of the concretions therefore seems to indicate that they have a diagenetic origin.

Structure: The most important feature, shown by the majority of boulders, is the presence of bedding planes. Pettijohn (1956, p.203) stated that this is the case with most concretionary structures, and it indicates that these bodies were formed after deposition of the enclosing sediment (diagenetic or epigenetic). Radial or concentric structures have not been noted in any of the concretions. Slickensides are present on the surface of some concretions; these structures were probably formed by slipping of the enclosing sediments over the concretion during compaction.

Fossils: The large concretions found at Hilary Tank contained a poor fauna of Roma type fossils. The concretions at Breadalbane No.2 and the locality 6 miles south-west of it were richly fossiliferous containing many well-preserved ammonites. Most fossils collected at these localities were obtained from concretions, not from the siltstones and shales that make up the host rock for the concretions. This is probably because the enclosing rocks are soft and friable and fossils were destroyed by weathering, whereas the concretions are hard and resisted weathering, and formed boulder outcrops.

In many examples in the literature, it has been shown that concretions formed around decaying animal or vegetable matter (Weeks, 1953); an environment is created locally which facilitates the precipitation of lime from circulating waters. It is not known whether this process has played an important role in the formation of the concretions in the Wilgunya Formation, for single fossils are rarely found at their core; nor has it been shown that the concretions are more fossiliferous than the host rock or contain different types of fossils.

Septaria: Several septaria, containing numerous ammonoids have been found in the Mt. Whelan area near Breadalbane No.2 bore. Weathering has removed the outer shells of the septaria, and the interior vein system was exposed. All veins were filled with crystalline gypsum.

The origin of septarian structure has to date not been conclusively determined. Davies (1913) considered that precipitation of carbonate between the grains of the original matrix caused expansion, which resulted in the cracking of the nodule. Todd (1913) supported this expansion theory. Crook (19?3) stated that septarian structure is due to shrinkage, and Richardson (1918) considered that the cracking of the concretion is due to desiccation of a colloidal centre by chemical means. The septaria in the Wilgunya Formation do not throw any light on the problem of the formation of concretions in the Wilgunya Formation.

Conclusion: The concretions in the Wilgunya Formation were probably formed by the localized precipitation of carbonate material in the interstices between the grains. Precipitation took place from circulating solutions containing lime. The formation of the concretions must have taken place in the sediment close to the interface between water and sediment, when circulation of fluids had not yet been stopped by compaction ..

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Origin of the calcareous sandy lenses in the upper part of the Wilgunya Formation: The calcareous sandy lenses in the upper Wilgunya Formation appear at the surface as small isolated bouldery outcrops. In no case has it been possible to study the relationship between the lenses and the enclosing sandy shales. However, it is thought that the composition of the lenses and the enclosing sediments only differs in the carbonate content.

The microfossil fauna was studied by Crespin (1961); wood fragments were abundant in some places. The fragments were well preserved and never flattened.

Examination of thin sections showed graded bedding in many samples. The presence of graded bedding means that the rocks are more permeable in a direction parallel rather than at right angles to the bedding, which may account for the lenticular shape of the enclosed bodies. The lenses in the upper Wilgunya Formation were probably formed in very much the same way as the spherical concretions; that is by localized precipitation of carbonate material between the grains from circulating fluids before compaction made the sediment impermeable.

(b) Alteration to ironstone

In many places calcareous beds and concretions have been altered entirely or in part to ironstone. Some, at least, of the ironstone bands and concretions in the laterite profile are replaced limestone: fossil moulds and sedimentary structures are commonly preserved. It is perhaps significant that outcrops of limestone and calcareous sandstone form the base of the laterite profile in many places; the top layers of the calcareous beds may be ferruginised but underlying shales and siltstone are very little weathered.

The formation of the ironstone is by direct replacement of calcium carbonate or in some cases by precipitation. The ironstone varies from dark brown hematite (as kidney ore in some places) to brown limonite. Erosion of these beds has formed the ironstone gravels which are so widespread in the region, particularly over the Winton Formation in the central and southern part of the Machattie 4-mile Sheet area.

(c) Lateritisation

Studies of the laterite profile in western Queensland were started by the Georgina Basin Geological Party in 1957 and have been continued by the Great Artesian Basin Party. As more evidence is gathered, it seems more certain that the deeply weathered beds in western Queensland were once part of a laterite profile. Subsequent silicification has almost completely changed the composition of the various zones.

It is now thought that the Marion Formation was probably lateritised. The presence of white lateritised Wilgunya Formation breccia in the basal parts of silicified Marion Formation was earlier thought to preclude this possibility. However, white breccia fragments which are sandy are probably part of the Marion Formation and these as well as Cretaceous fragments which occur elsewhere at the base of the Marion Formation have "floated" up into the soil zone of the profile (i.e. they form the sub-soil breccia). Leaching of the beds which form the Breccia and their partial induration is thought to have occurred concurrently with the lateritisation process.

The evidence given in the discussion on ferruginisation of limestone beds and concretions shows that limestone beds, which may be partly altered to ironstone on top, form the base of the laterite profile in many places. This suggests that the movement of solutions during lateritisation is downward, with the downward movement halted by limestone bands until such time as those bands have been altered to ironstone. The dissolved lime is probably precipitated with oxidised sulphide from the shales as calcium sulphate (gypsum) in the underlying beds. This fact may be important in the study of processes of lateritisation but is not discussed further in this report.

(d) Silicification

This process has had a profound influence in shaping the topography of the area. It has affected the Austral Downs Limestone and the Marion Formation, both of Tertiary age, and the Winton Formation of Upper? Cretaceous age.

The Austral Downs Limestone has been silicified to varying degrees, and in places has been completely replaced by chalcedony. The chalcedony is found either in solid outcrop as at Carcoory Ruins (north-west corner Betoota 4-mile Sheet); as large boulders at Tomytonkna W.H. (Bedourie 4-mile Sheet), or as gibbers such as those to be found in the southern part of the Betoota 4-mile Sheet area.

The Marion Formation is highly silicified, particularly where it consists of very coarse-grained, chert-bearing sandstone. The gibbers which cover large areas of the region are derived from this sandstone. Although, as indicated by the comparative ubiquity of the gibbers, the Marion Formation must once have been widely distributed, its appearance in solid outcrop is now limited.

The Winton Formation has been less silicified, and to a limited depth below its present surface level. In the east limb of the Betoota Dome, where the Winton Formation is overlain by Tertiary sediments, the zone of silicification in the Cretaceous rocks is only 30 feet thick. Over most of the area, the silicified Winton rocks form a duricrust. In the large area of the Machattie 4-mile Sheet area covered by the Wilgunya Formation there is no evidence at all of silicification.

As stated by Fisher, (1957), in a hot climate with alternating wet and dry seasons silica is readily taken into solution. Deep chemical weathering has been noted in many bores in the area, and surface indications of lateritisation have been frequently noted, although no true laterites are present. It is reasonable to assume that the Marion Formation was once of greater thickness than is the case today, and has since been eroded. Water percolating from the surface would, in suitable climatic conditions, dissolve silica from the upper beds of the Marion sandstones and carry it downwards. At the base of the Tertiary sediments the change in lithology to less permeable siltstones and sandy siltstones of the Cretaceous would halt the progress of these solutions, which would then impregnate the basal beds of the Marion Formation and, to a lesser degree, the top beds of the Winton Formation with silica. Lateral movement of these siliceous solutions would also bring silica to Cretaceous sediments not overlain by Marion sandstones.

The reasons for the silicification of the Austral Downs Limestone are not clear. Evidence from other areas (Casey et.al. 1960) suggests that it is younger than the Marion Formation, and so would not be affected by the processes outlined above.

STRUCTURE

Structures are difficult to define in the Bedourie, Machattie, Birdsville, Betoota 4-mile Sheet areas. It is a region of low relief and mostly covered by sand, gravel and alluvium. Lateritisation and silicification have obscured the bedding of most outcrops. Fresh shaly beds occur below calcareous concretions and lenses in some areas but do not crop out. It is rare to be able to measure dips.

The syncline, 20 miles south-west of Glengyle was mapped from actual bedding in Tertiary sandstone. Steeply dipping beds occur in the Winton Formation east of Cluny but reliable measurements were obtained only in two small hills; the structure is interpreted as a small monoclinal flexure. A similar structure shown in the section A-B south of Pippagitta bore is doubtful and it is based on subsurface basement contours as shown in the Springvale 4-mile Sheet report (Reynolds, 1960c); data from Pippagitta bore were not used to prepare the Springvale contour map, so this data would alter the contours to produce a small flexure, as shown in the section.

The main fold in the region is the "Betoota dome" (Wopfner, 1960) who records dips of 3 to 5 degrees on the flanks. As both Winton Formation and Tertiary sandstone are weathered, their dips are generally difficult to measure and the unconformity between them, as reported elsewhere by Wopfner, was not obvious in the Betoota dome. The folding, however, is clear on air-photos and the anticlinal axis of the dome has been eroded to four steep east and west-facing scarps, with low dip slopes preserved by the duricrust.

The duricrust has obviously been folded and buckled during tectonic activity in the region but is a very hard marker to use, for elucidating structure either by air-photo interpretation or by ground surveys. Duricrust may show dips due to -

(i) deposition of silica near or at the water table so will form at an angle to the dip of the beds;

(ii) irregular deposition which would produce an uneven surface;

(iii) surface slope produced by erosion;

(iv) tectonic folding.

However, some obvious structures shown by duricrust dips and trends in air-photos shown by scarps, strong to faint lines (?joints, faults, etc.) and lines of possible small structures in the duricrust have been included on the map.

Some possible bedding and structural trend lines shown on air-photos but not obvious in the area occur where the calcareous sandstones of the upper Wilgunya Formation crop out. These may be due to minor buckling of beds near the shelf margin during regional tectonic activity.

The inferred fault in the Bedourie 4-mile Sheet area is a continuation of the fault shown by ironstone west of Pulchera Waterhole in the Mt. Whelan 4-mile Sheet area to the north. It explains the anomalous position of the granite ridge below Kamaran Downs bore No. 3. The thickness of the Longsight Sandstone as interpreted from bore logs increases considerably to the east of Kamaran Downs No. 3; bore logs also show that the top of the unit is much higher east of the ridge than over it. These facts suggest that the Longsight Sandstone was laid down in a basin whose west side was formed by the granite ridge, and that the basin sediments were subsequently uplifted along the old fault line. Because ironstone beds have been affected by the movement, the age of the last movement is thought to be post-lateritisation.

GEOLOGICAL HISTORY

The history of tectonic events which have affected the Great Artesian Basin in western Queensland will be discussed in detail in a later report, but the state of knowledge in this region and some conclusions reached to date are outlined below:

(1) The history of events in the Precambrian is not known; in the Lower Palaeozoic a basin (Georgina Basin) which was filled by marine sediments extended into the region. Its western limit is the north-west trending fault near Kamaran Downs No. 3 bore and the southern and eastern limits are apparently almost the same as the Boulia Shelf edge. According to geophysical evidence (Milton and Seedsman, 1961) the south edge of the Georgina Basin is near the north edge of Lake Machattie; bore logs show possible Lower Palaeozoic "limestone" as far south as Cluny No. 1 bore. There is no evidence that Lower Palaeozoic sedimentation (at least with a lithology similar to the outcropping sediments) extended beyond the above south-east limit of the Georgina Basin.

(2) ?Devonian sedimentation may have been widespread in the southern and south-eastern parts of the region, because the Betoota bore penetrated a large thickness of doubtful Devonian aged sediments; 2,000 feet of continental Devonian sediments crop out in the Dulcie Range to the north-west. The Georgina Basin and areas of granite to the north-west were apparently land at the time, or a shallow shelf (Boulia Shelf) area on which there was little or no deposition.

(3) Between the ?Devonian and Jurassic, major folding and some faulting occurred, but the extent to which they affected the Bedourie-Machattie-Birdsville-Betoota region is not known. No sedimentation is known in the area from the ?Devonian to the Jurassic.

(4) During the Jurassic, down-warping in the central part of the Great Artesian Basin began and over 2,000 feet of fresh-water sediments were deposited in the south-east part of the region (DFS No.1 bore, Betoota). However, no deposition apparently occurred on the Boulia Shelf area until fairly late in the Jurassic or early Cretaceous time.

(5) By early Lower Cretaceous the whole of the region formed part of a vast freshwater lake. Deposition of the Longsight Sandstone occurred filling the low areas in the shelf area and continuing to fill the Great Artesian Basin in its central part.

(6) The influx of the sea over the region occurred gradually during Lower Cretaceous (Aptian) time. The Longsight Sandstone became marine and the lower Wilgunya Formation formed in a fairly uniform marine environment. The thickness of

deposits appears to be fairly constant in this region and other areas in western Queensland; this fact suggests that the Basin was fairly shallow and sinking at a slow steady rate.

(7) Sagging in the central part of the Great Artesian Basin began again in Lower Cretaceous (Albian) time. The margin of the upper Wilgunya Formation, well-marked by the Toolebuc Member around but inside the margin of the Great Artesian Basin, suggests withdrawal of the sea towards the area of sag. Conditions in the basin changed gradually from marine to brackish and freshwater in Winton Formation (Upper? Cretaceous) time. As this change occurred the margin of the lake also gradually regressed.

(8) Minor regional folding occurred in western Queensland at the end of the Cretaceous (? at the time of the "Maryborough orogeny" of David, 1950). The buckling seems to have been along north-north-east to south-south-west axes; the result of its imposition on the main structural trends of the region (north-north-west to south-south-east) was -

(i) formation of low areas in which Tertiary sandstone beds and equivalent formations were deposited;

(ii) development of the present drainage system.

These results are also partly due to a regional downwarping from north to south which occurred shortly after this post Cretaceous movement.

(9) At this stage the surface was planed and widespread lateritisation commenced. Because of the great depth of weathering shown by some bores logs, it is thought that lateritisation took a long time. Silicification followed and formed an uneven siliceous layer (the duricrust) through the lateritised beds.

(10) Further folding followed later in the Tertiary, probably at the time of the "Kosciuko uplift" near the end of the Pliocene. As a result of the folding:

(i) beds were folded upwards against the granite ridge below Kamaran Downs No.3 bore and some bucking of beds appears to have occurred against the shelf margin further east;

(ii) springs became active and Tertiary limestone deposits were formed; some of these may not be due to springs but most seem to be fairly closely associated with known or suspected structural features where springs could be expected; subsequently silicified in parts;

(iii) large amounts of lateritised sands were freed and formed the basic material for development of the Simpson Desert dunes and other aeolian sand deposits;

(iv) the old stream systems were reactivated and although modified by the more recent structures and sand dune development, they formed a similar drainage pattern;

(v) duricrust and lateritised beds were exposed to erosion and widespread gibber and ironstone gravels occur in the region, not far removed from the place of their breakdown.

ECONOMIC GEOLOGY

1. HYDROLOGY

Artesian water: The north-west corner of the Bedourie 4-mile Sheet area lies roughly 40 miles south of the edge of the Great Artesian Basin, while the Betoota 4-mile Sheet area extends to the south-east over the deeper central regions. Nearly all bores in the area lie within the "Georgina Group", as defined by Ogilvie (1954).

Of 27 artesian bores in the area, only one has proved unsuccessful; two others have since become sub-artesian. In the remaining bores, the main artesian flow has been obtained from the Longsight Sandstone horizon, except in Delhi-Frome-Santos Betoota No. 1 well, water-supply bore, where the aquifer is the Mooga Sandstone (Blythesdale Group). However it is not improbable that in this area the Longsight Sandstone and the Blythesdale Group are in part equivalent.

In the course of preparing the drill site of the Delhi-Frome-Santos Betoota No. 1 bore, it was decided to sink a bore to obtain artesian water. This was sited 400 yards from the deep oil bore, and a comparatively small artesian flow was obtained at 3616 feet from beds of the upper Blythesdale Group, mainly splintery shales and fine-grained sandstone which were considered to constitute the Mooga Sandstone. The flow was 28,800 gallons per day; chemical analysis revealed the presence of 265.2 grains per gallon of dissolved solids, which included 125.6 of sodium chloride and 114.1 of sodium carbonate. This is the only bore in the area which draws water from a pre-Cretaceous aquifer.

The Longsight Sandstone, the main aquifer in this part of the basin, has given a consistent supply of good water. In the parts of the region nearest to the edge of the basin, the aquifer is found at depths varying between 700 feet and 1,000 feet; in bores to the south-east such as Bedourie or Bedkira, the depth increases to 1,500 feet, whereas the deeper bores farther south and south-east obtain water from over 2,000 feet, (Adria Downs - 3,090 feet, Cacoory - 2,673 feet).

Daily rate of flow figures are not available for all bores, and even those that are do not reflect accurately present-day conditions, because they were in many cases calculated ten or more years ago, and the rate of flow has almost certainly declined in recent years. For instance, the daily rate of flow at Cluny No. 1 Bore decreased by 30% between 1952 and 1956.

In about one third of the bores, artesian water has been recorded from the Wilgunya Formation. There is no apparent connection between the aquifers, which range in depth from

290 to 2167 feet. Wilgunya aquifers have been noted in the Boulia area to the north (Casey et. al., 1960), in places where the lithology becomes siltstone rather than claystone. In the south the water-bearing beds are mainly sandy. It has not been possible, however, to find any lateral correlation for any aquifer. The only figures available regarding amount of flow from Wilgunya aquifers are from two aquifers in Ludlow No. 2 bore. From a depth of 720 feet, 50,000 gallons per day were obtained, and from 905 feet 70,000 gallons per day. Since no information to the contrary is furnished, it may be assumed that the water was fresh or slightly brackish. Water supplies from the Wilgunya Formation, however, are generally small and of poor quality.

The one artesian bore which proved unsuccessful is Kamaran No. 3 bore in the Bedourie 4-mile Sheet area. After passing through 1500 feet of Cretaceous sediments, the drill entered granite. Only 25 feet of sandstone were encountered at the base of the Cretaceous succession, and no water was obtained. However, an artesian flow of salt water rose from a sandstone band in the Wilgunya Formation, some 200 feet above the granite.

The two bores which were once artesian and are now sub-artesian are Coorabulka No. 10 bore and Ingledoon No. 1 bore, both situated in the northern half of the Machattie 4-mile Sheet area. The Coorabulka bore was drilled in 1909, when a flow of 1,062,400 gallons per day was recorded. By 1943 the flow had decreased by over 75%; subsequently it was found necessary to use a wind-pump to obtain water. As Coorabulka No. 11 bore, about 5 miles to the north-west and at the same elevation, was drilled in 1956 and gave a flow of 958,000 gallons per day the gradual failure of Coorabulka No. 10 as an artesian bore was not due to reduction in local potential, but, more likely to silting of the hole or corrosion of the casing or both. The same explanation holds for Ingledoon No. 1 bore, 35 miles to the north-east.

Sub-Artesian Water: Attempts to obtain economic supplies of sub-artesian water have met with varying success, and have been made almost entirely in the southern part of the area. In the Birdsville area six bores were sunk on Adria Downs property, only two of which were successful; water rose under pressure from sediments best interpreted as Recent alluvial deposits. In Adria Downs No. 1 and No. 2 salt water was found in yellow, sandy clay of Winton age; fresh water rose under slight pressure from Tertiary to Recent sediments, but insufficient quantity to be of any use. In the rest, only salt or "bitter" water was encountered. Two other shallow bores in this area, Dickerrie No. 1 and No. 2 on Glengyle property, were drilled side by side and between them produce some 45,000 gallons of good water per day from a sequence of sand and sandy gravel of Recent age.

The Betoota area contains only three producing sub-artesian bores. Two of these are on Mt. Leonard property in the south-east. They are the Wyerie twin bores, which are 50 yards apart on either side of the road which leads from Mt. Leonard to Planet. The main water supply comes from the base of the Tertiary rocks which cap the east limb of the Betoota Dome. Other aquifers were met with in the underlying Winton Formation at depths of 220 and 335 feet, but the supply was very small, and nothing is known of the quality. One other bore, 4 miles south of Mooraberrie Homestead, produces good water, but no record is available of strata or aquifers. Several attempts were made at the beginning of the century to find suitable sub-artesian aquifers in the area around Mooraberrie; there are no records of these bores and in some cases their location has become obscure. However, it is certain that in every instance only salt water was found.

Delhi Petroleum Company, in 1959, drilled three bores to a depth of about 500 feet in the area around Betoota. Delhi Well No. 1 and Delhi Well No. 2 penetrated alluvium and Winton sediments, finding only a moderate supply of poor quality or salt sub-artesian water. Delhi Well No. 3 disclosed a predominantly shale succession and no water.

Two sub-artesian bores in the Machattie 4-mile sheet area, Coorabulka No. 10 and Ingledoon No. 1, have already been described in the section on artesian water. In the Bedourie area there were previously no sub-artesian water bores. During the 1960 seismic survey carried out by the South Australian Mines Department, a shot-hole (No.100), drilled to 75 feet, gave a sub-artesian supply of 24,000 gallons per day of brackish, slightly bitter water. The owner of Kamaran Downs, on whose property the shot-hole is situated, proposes to instal a wind pump and use the water for stock. Judging from the log of the nearby Kamaran No. 3 bore (2 miles to the north), the aquifer in this case seems to be of Tertiary age.

Aquifers: The only reliable aquifer in this area is the basal Cretaceous Longsight Sandstone. It provides a considerable annual output, and even considering the increasing demand placed on it in terms of new bores, there would seem to be still a good potential, for bores drilled within the last six years have yielded flows of between 500,000 and 1,000,000 gallons per day. The water is usually hot, particularly in bores drilled to 2,000 feet or more. Drillers' logs and locally gathered information seems to indicate consistently good quality.

Water obtained from the Wilgunya Formation is moderately good, but salt flows have been recorded. Lateral correlation of the aquifers has not been possible, and on this basis it would be very difficult to predict a position or depth at which a water supply might be found. In every instance where artesian or sub-artesian water has flowed from the Wilgunya Formation, it has been found by chance in drilling to greater depths to obtain artesian water from the Longsight Sandstone. Water is more likely to be found where the lithology is more sandy or silty than where it is shaly.

The Winton Formation seems very unreliable; in many places it has yielded only salt or brackish water. Nor do the Winton aquifers have a very high potential, and quantities measured are usually small. In fact, none of the sub-artesian bores in this area draw their supplies from the Winton horizons.

The Marion Formation, on the other hand, produces useful quantities of brackish to good water, and at sufficient pressure for it to be called sub-artesian. Wyerie bores and the bore at Mooraberrie in the Betoota area, and the shot-hole bore on Kamaran Downs in the Bedourie area draw their supplies from sediments of probable Tertiary age. Even in some unsuccessful bores small but uneconomical amounts of fresh water have issued from the sandstones of the Marion Formation. Thus while the Tertiary aquifer is not entirely reliable, it has produced more favourable results than the Winton Formation.

Four bores (Adria Downs Nos. 1 and 2, Dickerrie Nos. 1 and 2) in the Birdsville area derive their supplies from the sands and gravels in the alluvium. This water is under slight pressure. Water from recent formations has also been recorded in other, deeper bores in the region.

Springs: The only springs known in the region occur in the extreme north-western margin (Alnagatta, Bookerra and Beppery Springs) and in the south-west corner near Poeppel's Corner. Little is known of these springs. Beppery Springs yield a good supply of water suitable for stock and attempts have been made by Mr. Clanchy of Kamaran Downs to keep them open as a permanent supply. It is thought that the springs in the south-west corner also yield fairly good water as noted in the earlier discussion on spring deposits.

Ground Water: Wells sunk to reach ground water are mainly in the west of the area, and have met with varying success. With two exceptions, wells have been sunk to depths of the order of 20-30 feet; these exceptions are both on the Betoota 4-mile Sheet area and are:- Glenny Well, four miles north of the South Australian/Queensland border fence and 24 miles south-east of Roseberth, holds good water at a depth of 35 feet; it is brought to the surface by wind-pump and stored in a tank. Eight miles to the east of here, Ringamurra Well, 80 feet deep, contains useless, salty water. No lithological record is available for either of these wells.

On Glengyle property in the west there are several wells, but the general record of water obtained is poor. A well was sunk at Muncoonie in 1960 to a depth of 24 feet where it produced salt water; a small supply of fresh water issued from a calcareous sandstone band at 20 feet. This is the only case in which a record of lithology is available. Aborigines who formerly roamed the area are reputed to have dug shallow wells for water, but their positions are not known and none have been seen by the authors.

Numerous soaks occur in the region; they are mainly below the beds of dry large waterholes in the main stream channels. Tim's Soak on Eyre Creek, 5½ miles north-north-east of Bedourie, is about 10 feet deep and yields a good supply of potable water: fresh water is obtained in soaks down to 10 feet in Dickerrie, Titchery, Kalidawarry, Kuddaree waterholes along Eyre Creek on Glengyle Station; others have been reported elsewhere in the region.

Surface water: During the summer season three rivers bring water from the monsoonal rains in the north into the region. They are the Mulligan River which flows to the south-south-east along the border of the Simpson Desert, Eyre Creek (and its tributary King Creek), which is joined by the Mulligan River at the south edge of the Bedourie 4-mile Sheet area, and the Diamantina River which flows from north-east to south-west across the Machattie and Betoota areas. Both Eyre Creek and the Diamantina have broad flood-plains dissected by many channels of generally shallow depth; the present course of the Mulligan River is limited to a large extent by sand dunes but flood-outs occur between dunes just north of where the Mulligan joins Eyre Creek.

In many places along the courses of all these rivers, deeper channels have formed which retain a more-or-less permanent supply of water. This may, however, be almost completely dissipated in times of drought, for when local rain fails (annual average only 8 inches), evaporation greatly depletes the supply. The following waterholes were reported in 1960 to be permanent: Tomydonka and Glengyle holes on Eyre Creek, the Birdsville hole in the Diamantina (town supply) and Paracoola Waterhole on Mt. Leonard Station. However, even these may some day go dry - Madigan (1945) reported that Dickerrie Waterhole in Eyre Creek (Birdsville area) was permanent but all waterholes along Eyre Creek in the Birdsville area were dry when visited in August, 1960.

Generally speaking, the larger waterholes carry water if not at the surface, in shallow soaks below the surface, most of the time.

The quality of the water depends on how long it has been stored in most cases; water filling Kalidawarry Waterhole on Eyre Creek in the west part of Glengyle remains fresh for 2 years and then, if not supplemented during that time, turns salty. This part of the course of Eyre Creek contains salt waterholes and Dunstan (1920) has reported salt deposits at Lake Kalidawarry up to four feet thick.

2. <u>OIL</u>

In 1959, Delhi-Frome-Santos sank an exploratory oil well in the centre of the Betoota Dome. A gas show was encountered in sandstone of the Blythesdale Group and oil stains were recorded from the Walloon Coal Measures. Drill stem tests proved negative in both cases.

Mott (1952) includes the Bedourie bore as one with 'reported showings of oil or gas not confirmed by analysis, but considered important and authentic'; the nature of the showing and the source of information is not given.

The only beds that are considered as good source beds for oil are the Lower Palaeozoic marine beds of the Georgina Basin whose south-east margin is thought to occur through the region. Their thickness is not known but Milton and Seedsman (1961) postulate greater than 5,000 feet of Palaeozoic to the "red marl" beds near Bedourie. The "red marls" may be Permian or Lower Cretaceous. Probable Lower Palaeozoic beds occur in the region at depth east of the fault near Kamaran Downs No. 3 bore but do not occur above the granite in the bore. They are <u>possibly</u> folded against the fault as shown in section A-B of the map and may yield oil if reservoir conditions occur within them. The dark marine shales of the Cretaceous are also possible source beds, but there is no record of oil or gas having been found in the Wilgunya Formation in any of the bores in the area.

3. <u>OTHER FUELS AND MINERALS.</u>

(a) Coal and lignite have been reported in the logs of some of the water bores (see graphic logs of bores of the various 4-mile Sheet areas). Dunstan (1920, p.29) states: 'Mr. McIntyre, an experienced well-borer, states that in several of the artesian bores sunk about Sandringham to the west of the Georgina River (Eyre Creek) he has met with 6 feet of brown coal much impregnated with iron pyrites and that it is closely associated with the water-bearing beds'. These occurrences do not appear to be of economic importance.

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PLATE VIII

GIBBER PLAINS AND HILLS

Fig. 1.
Peg 50/44 (extreme left) and gibber plains
2½ miles north of old Cacoory.

Fig. 2
Low gibber hills with claypans on top
near Bedourie-Birdsville road.
(gibbers = dark grey, claypans = light grey)

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PLATE IX

Gypsum scarp (6-8' high) along north-west side of Pulchera Waterhole, Mulligan River, (Mt. Whelan 4-mile) taken in 1958.

(b) Small traces of uranium minerals are known from the Toolebuc Member (Casey et al, 1960, p.65) and from fossiliferous Tertiary limestone (Appendix I of this report).

(c) ?Celestite was found as crystalline fragments on the surface south of Lake Wickamunna in the Bedourie 4-mile Sheet area; they are from the upper Wilgunya Formation and in about the same stratigraphic position as the alumina, barium, strontium, phosphate mineral found in the Springvale 4-mile Sheet area (Reynolds, 1960c, p.21).

(d) Gypsum deposits which occur in the northern part of the Bedourie area (and south edge of the Mt. Whelan area, see Plate IX) are also described by Reynolds (1960c). They are quite thick but not of economic importance because they are so isolated.

(e) Lake Kalidawarry on Eyre Creek in the west part of Glengyle Station and other small lakes nearby contain large quantities of salt. Dunstan (1920) reports 'many thousands of tons of the mineral are supposed to be buried below deposits of recent alluvium.'

(f) As in the Springvale area, unconfirmed reports of precious opal were received for the Bedourie area. The deposits were supposed to occur one mile north of Humpamurra Tank on Glengyle Station, and at another locality 14 miles to the east. Potch opal veining in ironstone was noted at the first locality and precious opal could be present. The veining appears to be associated with small structures.

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As a final note, we wish to record our gratitude to Mr. A.B. White, mechanic; Mr. P. Rothlisberger, cook, and the late Mr. A. Stenstad, field assistant, whose death in April, 1961, is noted with regret.

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APPENDIX I

EXAMINATION OF A MINERAL IN A SHELLY LIMESTONE FROM THE BOULIA AREA S.W. QUEENSLAND.

The specimen, labelled GAB 72*, was submitted in December, 1960 by M.A. Reynolds for identification of a bright yellow mineral. This mineral forms rare coatings on coarsely crystalline calcite lining small cavities in the rock.

A scraping of the mineral gave an X-Ray powder diagram of calcite, principally, with a group of low angle lines from the unknown, superimposed. An X-Ray spectrographic analysis showed the metallic elements in the powder scrapings to be uranium, arsenic, and vanadium in that order of abundance.

Because of the extremely minute quantity of mineral present the spectrogram was fairly weak so it was considered necessary to verify the presence of uranium by the fluoride bead test; this gave a strong positive result.

The group of low angle lines conforms to the pattern of carnotite, a potassium uranium vanadate. The presence of arsenic cannot be explained; it is not part of the carnotite structure, therefore its presence may be explained either as an impurity in the limestone or as part of some other unidentified mineral.

W.M.B. ROBERTS
Bureau of Mineral Resources,
Canberra.

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* GAB 72 locality is in Tertiary limestone beds north of Eyre Creek on Glengyle station.

Casey et al. 1960 noted that fish scales and teeth coated with a pale yellow-green mineral are present in the Toolebuc Member of the Wilgunya Formation in the Boulia area, ~~giving it a radiometric count of 3 to 4 times background~~.

An X-ray diffraction determination was carried out by W.M.B. Roberts, which showed the presence of novacekite (hydrated magnesium uranium arsenate) and carnotite.

APPENDIX II

Hydrology Tables and Correlation Charts

Introduction.

In this appendix all available details concerning artesian and sub-artesian bores have been tabulated. In some instances this information is incomplete due to inadequate records.

The bores have been listed in tables in alphabetical order of 4-mile Sheet areas; each table is accompanied by a graphic representation of the bore-logs for that area. In the graphic diagrams details have been included of strata, aquifer horizons and elevations of the bores; the positions of the bores are taken from geological sketch maps of the 4-mile Sheet areas. In addition, tentative correlations have been made for some of the units described in this report.

BEDOURIE 4-MILE SHEET AREA

Name of Bore (Station)	Registered Number	Position	Artesian (A) or Sub-artesian (S.A.)	Depth (Ft.) Water Struck	Depth (Ft.) Water rose to	Supply (Gallons per day)	Quality	Driller and Year Drilled
Bedourie (Government)	316	Bedourie Town	A	25 41 255 355 1162,1190-) 1314)	? Surface 40 Surface Surface	? ? ? ? 1905-2,649,401	Brackish) Brackish) Salt) Salt) Good)	1905
Bindiacca (Glengyle)	2419	40 miles S.W. of Bedourie	A	20 1891,1966,) 2062,2161.)	? Surface	? 1926- 500,000) 1948- 244,000)	Salt) Good)	1926
Eight Mile Creek (Sandringham)	4322	9 miles E. of Sandringham H.S.	A	710) 741) 760)	Surface	1916- 716,000	Good	1916
Gulgong No.2 (Glengyle)	2417	7 miles S.S.W. of Bindiacca	S.A.	33	33	?	Salty	1925
Kamaran Downs Homestead or Philippi No.1 (Kamaran Downs)	12914	Kamaran Downs Homestead	A	1015 1090	Surface Surface	Small flow 600,000	Good Good	Station Plant 1955
Kamaran No.2 or Philippi No.2 (Kamaran Downs)	13149	6 miles S.S.W. of Kamaran H.S.	A	1045,1060,) 1080,1140,) 1218.)	Surface	534,000	Good("Sweet")	F.A. Peterson 1956
Kamaran Downs No.3 or Philippi No.3. (Kamaran Downs)	13283	16 miles S.W. of Kamaran Homestead.	A	1295	Surface	960	Salt	F.A. Peterson 1958
Kamaran Downs No.4 or Philippi No.4 (Kamaran Downs)	13649	6 miles N.N.E. of Kamaran Downs H.S.	A	758 915) 947) 961)	525 Surface	? 80,000) 150,000) 344,000)	Good Good	R. Ruwaldt 1958
Kidman's, or, Duck Creek Bore (Sandringham)	12625	19 miles E.S.E. of Sandringham H.S.	A	290 740,780,) 875.)	Surface Surface)	? 165,000	Good Good	Godfrey Brothers 1954
Ludlow No.2 or Crown Wheel Bore (Government Bore on Sandringham property)	12040	13 miles N. of Bedourie, ¼ mile W. of Bedourie-Boulia Road	A	176 720) 905) 950) 1025)	Soak Surface	? 50,000) 70,000) 460,000) 793,000)	Salt Good	Godfrey Brothers 1952
Pippigitta (Glengyle)	2806 2807	9 miles S.W. of Bedourie	A			1948-1,238,000	Good	2806-McInnes 2807-V.Beauchamp, 1924
Sandringham Homestead or Sandringham No.1 (Sandringham)	4319	Sandringham Homestead	A	35 568 609,702,) 721.)	19 Surface Surface)	?) ?) 147,000))	Good	1915
Shot-hole No.100, S.Australian Mines Dept. (Kamaran Downs)	None	2 miles S. of Kamaran Downs No.3	S.A.	75	40	24,000	Brackish slightly bitter	S.Australian Mines Dept.
Wickamunna or Sandringham No.5 (Sandringham)	4323	15 miles S.W. of Sandringham Homestead	A	745 829	Surface Surface	1917-1,000,000)1955-) 1917-3,000,000)1,355,000)	Good	D. McInnes 1917
Wilcaneer or Kalidawarry No.1	**3113**	**13 miles W.S.W. of Bindiacca**	**A**	**2167 2336**	**Surface Surface**	**1929 - 750,000) 1948 - 380,000)**	**Good**	**1929**

MACHATTIE 4-MILE SHEET AREA

Name of Bore (Station)	Registered Number	Position	Artesian (A) or Sub-Artesian (S.A.)	Depth (Ft.) Water Struck	Depth (Ft.) Water Rose to.	Supply (Gallons per day)	Quality	Driller and Year Drilled
Bedkira. (Government bore on Cluny property).	12165	15 miles S.S.E. of Cluny No. 3 bore; 16 miles S.E. of Cluny Homestead.	A	91 1715-1735 1789-1813	42 Surface Surface	? 146,000 698,000	Salt Fresh Fresh	Godfrey Brothers 1953.
Cluny No.1 (Cluny).	2060	1 mile S of Cluny-Monkira Road; 32 miles from Cluny.	A	5 56 2103 2149 2168 2190 2215	Soak ? ½" over casing) ¾" " ") 1½" " ") 15" " ") 42" " ")	? Large 1921- 875,000) 1948- 825,000) 1951- 825,000) 1952- 838,000)	Fresh Brackish Good	1917
Cluny No.2 (Cluny)	2061	28 miles S.E. of Cluny Homestead.	A	290 2173 2238 2432 2471	? Surface) ½" over casing) 20" over casing) 56" " ")	Good supply ? 1920-1,205,000 1922-1,334,000 1948-1,260,000 1952-1,278,000	Good ? Good	1919
Cluny No.3 (Cluny)	2062	13 miles E. of Cluny Homestead	A	1651 1700 1746 1832 1909	Surface) 11" over casing) 18" " ") 36" " ") 39" " ")	1922-1,178,000 1947-8-1,111,000 1951 -1,113,000 1952 - 943,000 1956 - 661,000	Good	1922
Cluny No.4 (Cluny)	12607	30 miles S.S.E. of Cluny Homestead.	A	2314) 2326)	Surface)	1956 -1,115,000	Good	Godfrey Brothers 1955
Coorabulka No.5 (Coorabulka)	2129	On Duck Creek, 26 miles S. of Coorabulka Homestead	A	198 650 1200 1331 1336 1548	Soak Soak 50 ¾" over casing) ?) 50" over casing)	Small ? ? 1903-1,930,000) 1943- 365,440)	? Salt Good Good	1903
Coorabulka No.7 or Pallico (Coorabulka)	2131	On King Creek, 36 miles S.W. of Coorabulka Homestead	A	61 930 935 1080 1092	Soak 1" over casing) 3" " ") 63" " ") ? " ")	Small 1905-1,250,000) 1943- 721,530)	? Good	1905
Coorabulka No.10 (Coorabulka)	2134	42 miles S. of Coorabulka Homestead	SA	350 1469 1483 1574 1596 1607 1684	141 Casing top) 3" over casing) 9" " ") 29" " ") 40" " ") 56" " ")	? 1909-1,062,400) 1943- 251,290) Originally art-) esian; has) probably become) S.A. due silt-) ing and/or corr-) osion of casing)	Salt Good	1909
Coorabulka No.11 (Coorabulka)	13130	5½ miles N.W. of No.10	A	280 1405 1430 1460 1475 1495 1508	Surface Surface ¼" over casing) 1½" " ") 7" " ") 20" " ") 43" " ")	Small flow Small flow 1956- 958,000) (60lb/sq.in.)) Now controlled) at 100,000)	Good Good Good	1956

Gemerchie *or* Peppin (Monkira)	3822	20 miles S.E. of Coorabulka No.10	A	2105,2126,) 2145,2184,) 2212)	Surface	?	Good	
				2281		?	Good	
Georgtina (Government bore on Monkira property	12312	25 miles W. of Monkira on Monkira-Cluny road	A	215	108	?	Good	
				2575,2615) 2640,2675) 2720,2756)	Surface)	1,107,000	Good	
Ingledoon No.1 (Davenport Downs)	2391	Border of Machattie and Springvale 4-mile Sheets, 17 miles E.N.E. of Coorabulka No.5	SA	?	?	Was originally artesian bore; is now sub-artesian, probably due to silting and/or corrosion. No data of flow available.	Good	1903
Ingledoon No.2 (Davenport Downs)	2392	8 miles of Ingledoon No.1	A	?	?	?	Good	1909

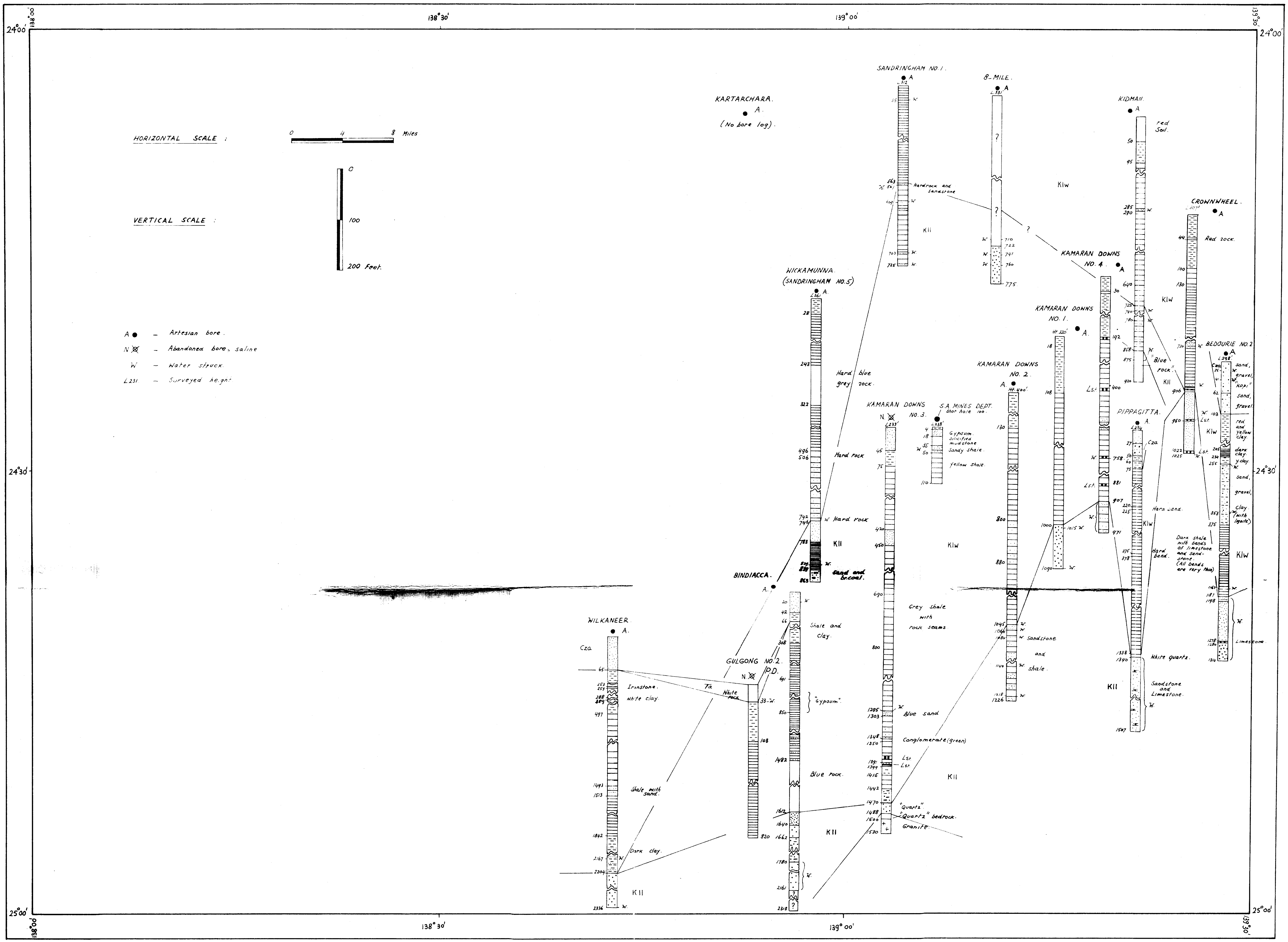
BIRDSVILLE 4-MILE SHEET AREA

Name of Bore (Station)	Registered Number	Position	Artesian (A) or Sub-Artesian (S.A.)	Depth (Ft.) Water Struck	Depth (Ft.) Water Rose to.	Supply (Gallons per day)	Quality	Driller and Year Drilled
Adria Downs Bore (Adria Downs)	13088	34 miles N.W. of Birdsville (Track from Birdsville to bore).	A	60 150 540 3080	40 30 ? Surface	? ? ? 321,820	Good Good Salty Good	Godfrey Brothers 1957
Adria Downs No.1 (Adria Downs)		17½ miles N.W. of Birdsville	S.A.	42 55-60 190	-- 42	Seep Small supply Small supply	Fresh Fresh Salt	R.Ruwaldt. 1958
Adria Downs No.2 (Adria Downs)		200 yards W. of No.1	S.A.		Similar to No.1			R. Ruwaldt. 1958
Adria Downs No.3 (Adria Downs)		26 miles W.N.W. of Birdsville	S.A.	66 68-200	40	Small supply) 2400 Small supply)	Fresh Salt	R.Ruwaldt. 1958
Adria Downs No.4 (Adria Downs)		40 miles N.W. of Birdsville	S.A.	29-34	25	15,640	Very good	R. Ruwaldt. 1959
Adria Downs No.5 (Adria Downs)		7½ miles N.N.W. of No. 4.	S.A.	45-47	29	19,920	Very good	R. Ruwaldt. 1959
Adria Downs No.6 (Adria Downs)		6 miles W.S.W. of No.3	S.A.	34	33	48	Salt	R. Ruwaldt. 1959.
Dickerrie No.1 (Glengyle)		8 miles N.N.W of Adria Downs No.5	S.A.	22-25	20	24,000	Good	R. Ruwaldt. 1959.
Dickerrie No.2 (Glengyle)		20 feet W of No.1	S.A.	22	20	20,400	Good	R. Ruwaldt. 1959.
Moochala (Glengyle)		8 miles N.N.W. of Annandale	S.A.	31-35	30	16,800	Salty	R. Ruwaldt. 1959.
Muncoonie No.1 (Glengyle)		At Muncoonie Out-station.	S.A.	18-26 26-29 29-34	? ? ?	5,760	? Bitter Salt	R. Ruwaldt. 1959.
Muncoonie No.2 (Glengyle)		100 yards up-river from No.1	S.A.	24 25½ 32½	20	5,760	Fresh Salt	R. Ruwaldt. 1959.
Old Annandale (Glengyle)	1106	100 yards S.E. of Old Annandale ruins.	S.A.	45	?	No supply. Failed.	Good	L.J.Shepley 1924.

BETOOTA 4-MILE SHEET AREA

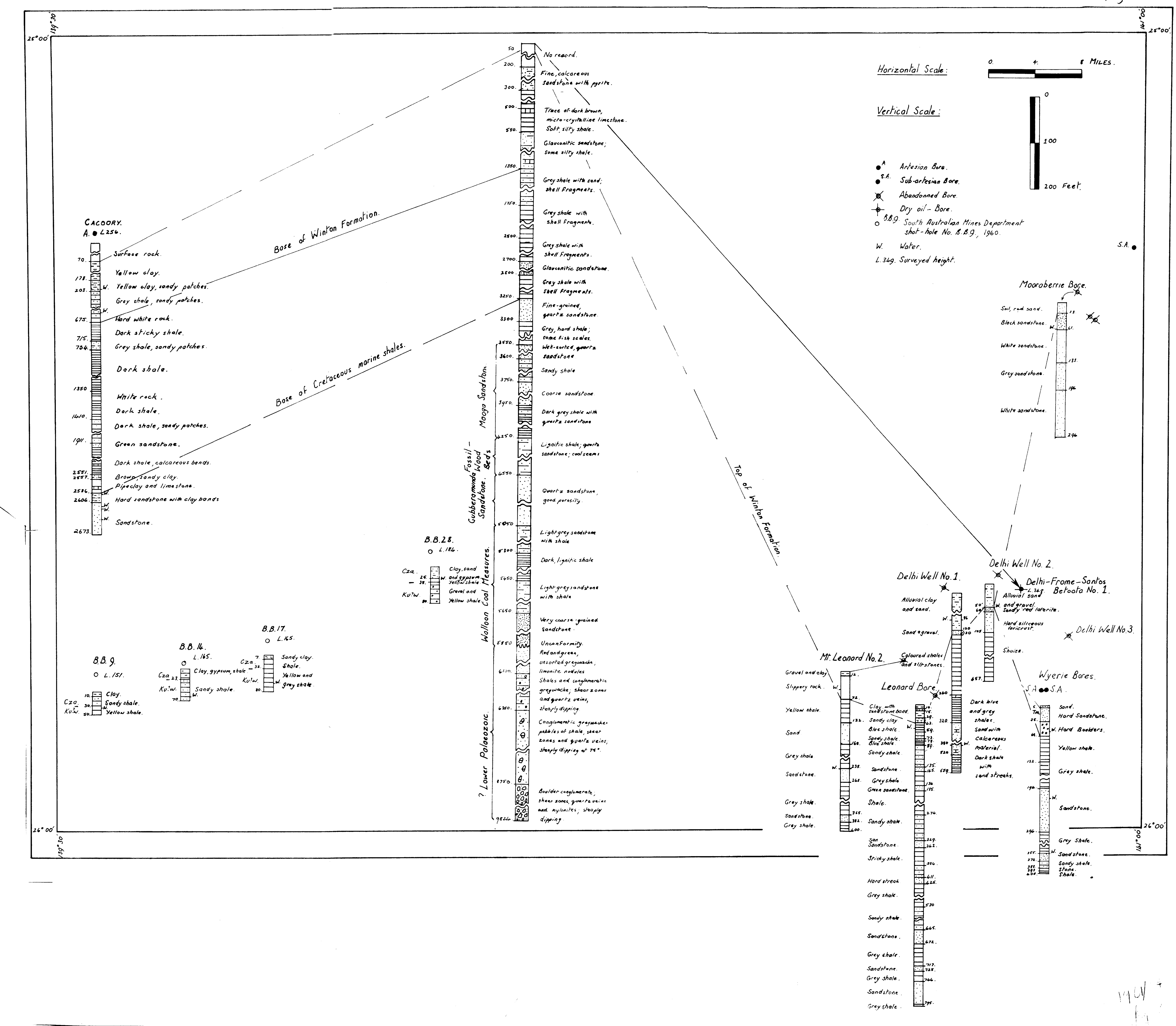
Name of Bore (Station)	Registered Number	Position	Artesian (A) or Sub-artesian (S.A.)	Depth (Ft.) Water Struck	Depth (Ft.) Water Rose to	Supply (Gallons per day)	Quality	Driller and Year Drilled
Cacoory Bore (Roseberth)	12177	½ mile N. of ruins of Cacoory Homestead; 70 miles S. of Bedourie on Bedourie-Birdsville road.	A.	195 560 2590, 2615,) 2620, 2640,)	30 60 Surface	? ? 504,000	Salty Salty Good	Richardson Godfrey Brothers 1954.
Cacoory Dud Bore (Roseberth)	6858	1½ miles E.S.E. of Cacoory Bore	S.A.	45 180, 378	? ?	? ?	Fresh Salty	J. Shepley 1938
Delhi Well No.1 (Mt. Leonard)	14000	1 mile W.S.W. of Betoota	S.A.	86 380	23 80	ca. 8400 2400	Bad Bad	Delhi Australian Petroleum Co.Ltd. 1959
Delhi Well No.2	14001	4 miles E.N.E. of Betoota	S.A.	50	?	?	Salt	Delhi Australian Petroleum Co.Ltd. 1959
Delhi-Frome-Santos Betoota No.1 Water-supply Bore (Mt. Leonard)	?	400 yards S. of D.F.S. Betoota No.1 Bore	A.	3616, 3630	Surface	35,000	265.2 grains per gallon. 12[illegible].6gr. NaCl 114.1gr. Na_2CO_3 20.0 gr. organic matter.	Mines Administration Pty. Ltd. 1959.
Leonard Bore (Mt. Leonard)	12694	10 miles S. of Betoota	S.A.	52	32	300	Bad	
Mt. Leonard 1 or Wyerie No.1 (Mt. Leonard)	13142	12 miles S.E. of Betoota	S.A.	55 218 355	? ? ?	9600) 7200) 1200)	Good	Cole
Mt. Leonard 2 (Mt. Leonard)	13143	9 miles S.W. of Betoota	S.A.	60 238	? ?	1440) 7200)	Bad	Cole
Mt. Leonard No.3 or Wyerie Bore No.2 (Mt. Leonard)	14082	50 yards from Wyerie No.1, on the other side of the road. (Twin bores).	S.A.	As in Wyerie 1.	?	As in Wyerie 1	As in Wyerie 1	J. Titchbourne
Roseberth (Roseberth)	7192	Roseberth ("The Bluff") Homestead.	S.A.	47	?	?	Salty	D.J. Shepley 193[illegible]

DIAGRAMMATIC CORRELATION OF BORE LOGS IN THE BEDOURIE 4-MILE AREA.



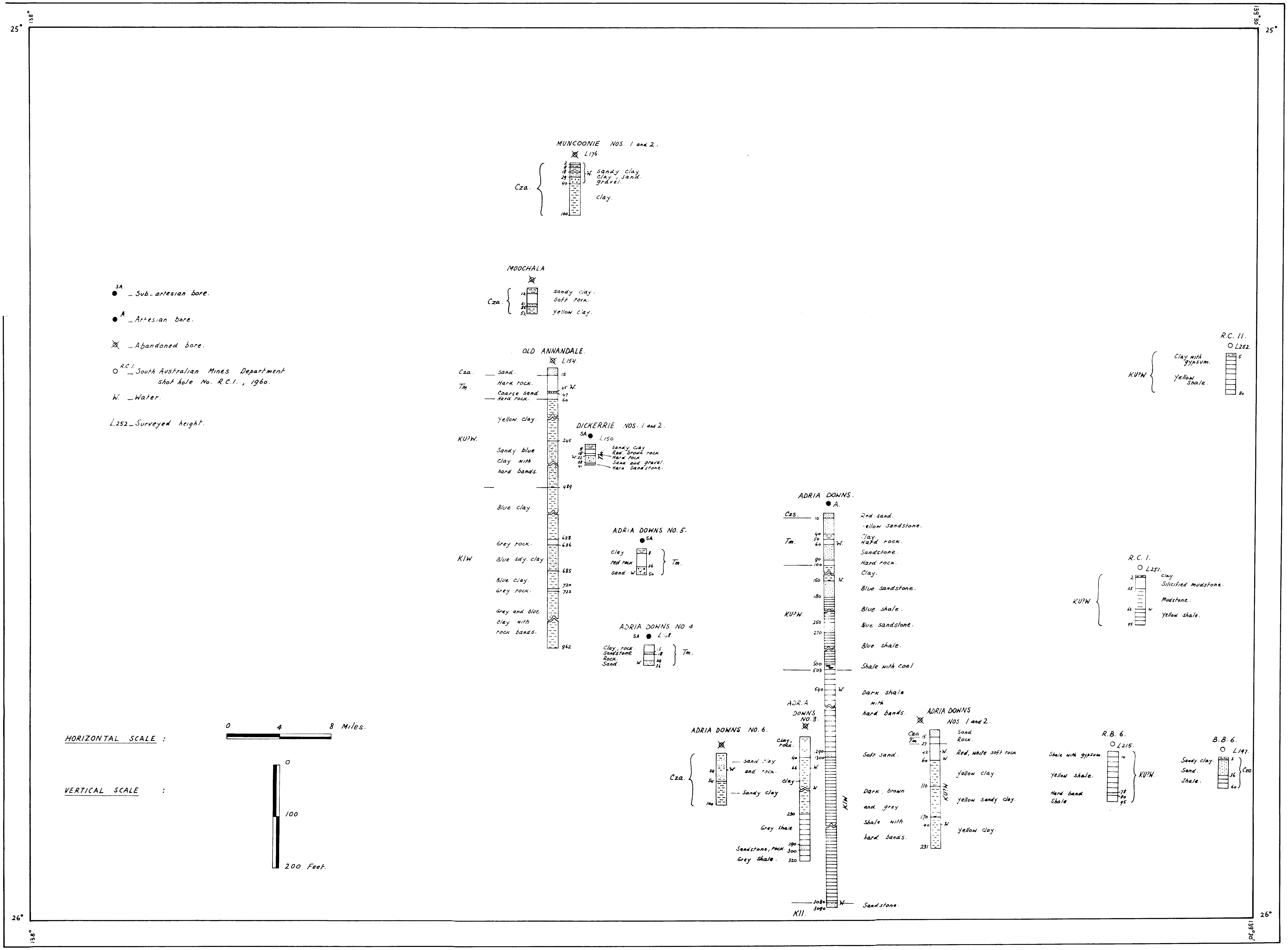
DIAGRAMMATIC CORRELATION OF BORE LOGS IN THE BETOOTA 4-MILE AREA.

Fig. 3



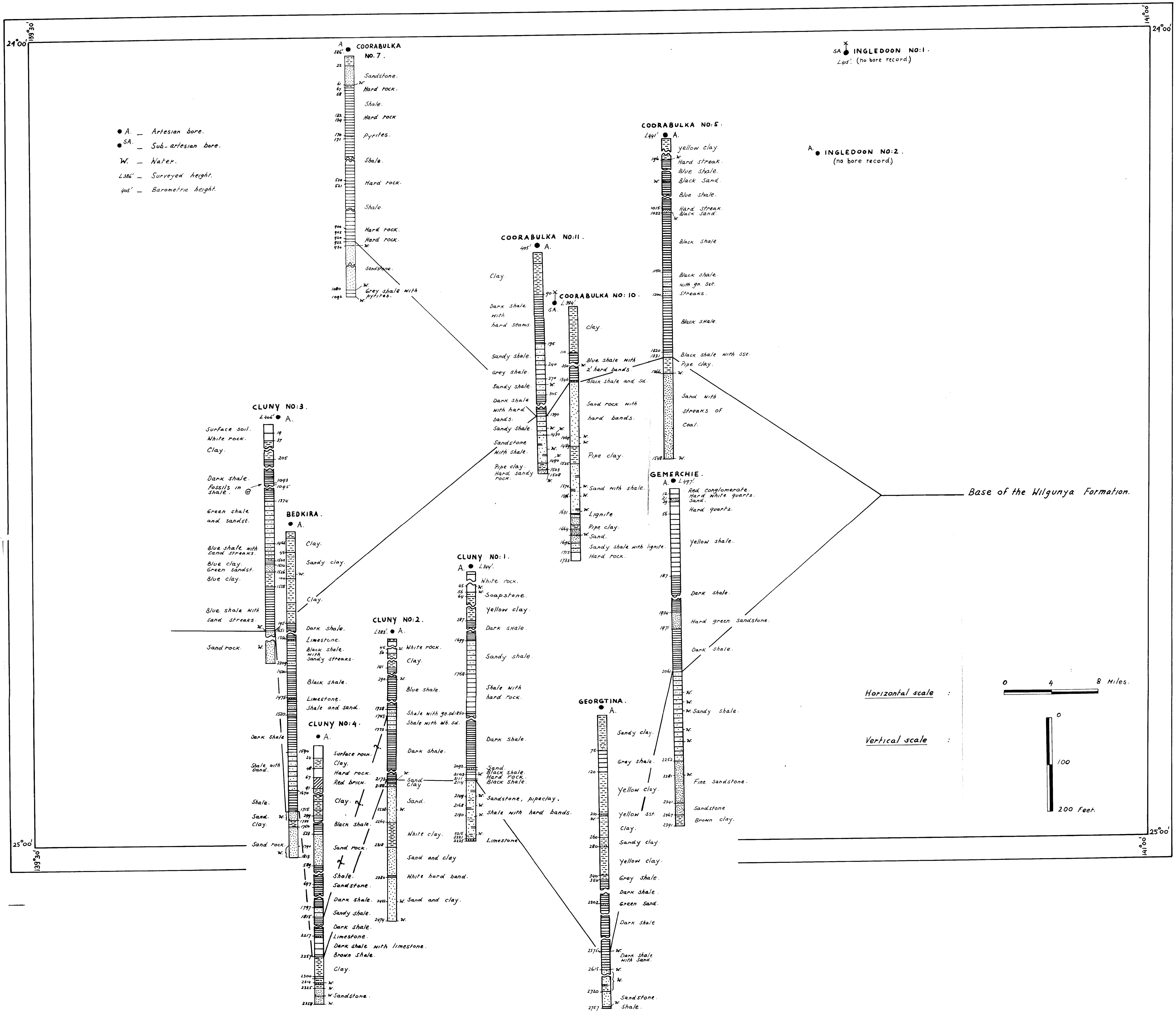
DIAGRAMMATIC CORRELATION OF BORE LOGS IN THE BIRDSVILLE 4-MILE AREA.

Fig 4



DIAGRAMMATIC CORRELATION OF BORE LOGS IN THE MACHATTIE 4-MILE AREA.

Fig 5

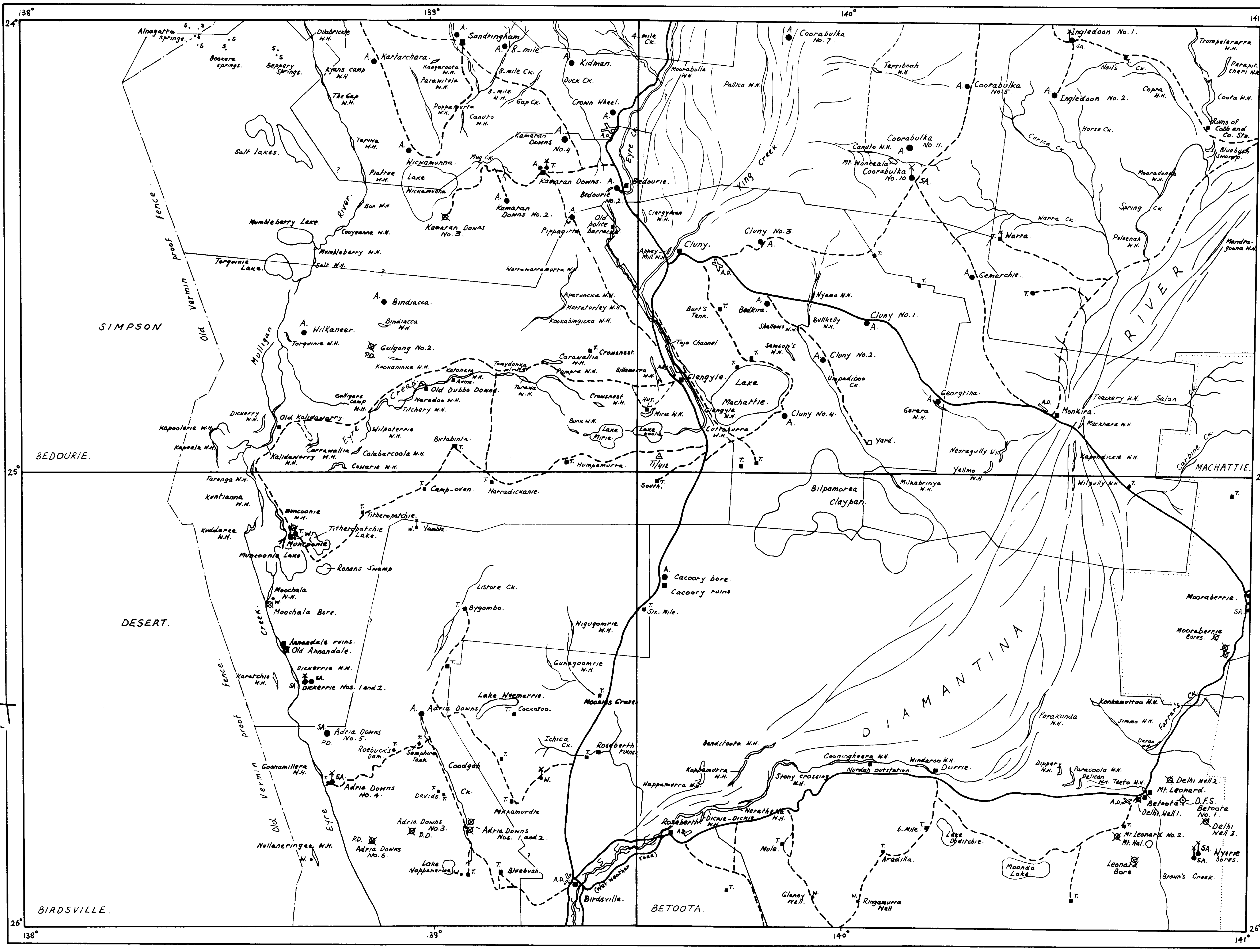


GEOLOGICAL SKETCH MAP OF THE BEDOURIE–MACHATTIE–BIRDSVILLE–BETOOTA AREA.

Figure 6.

TOPOGRAPHICAL SKETCH MAP OF THE BEDOURIE-MACHATTIE-BIRDSVILLE-BETOOTA AREA.

Figure 7.



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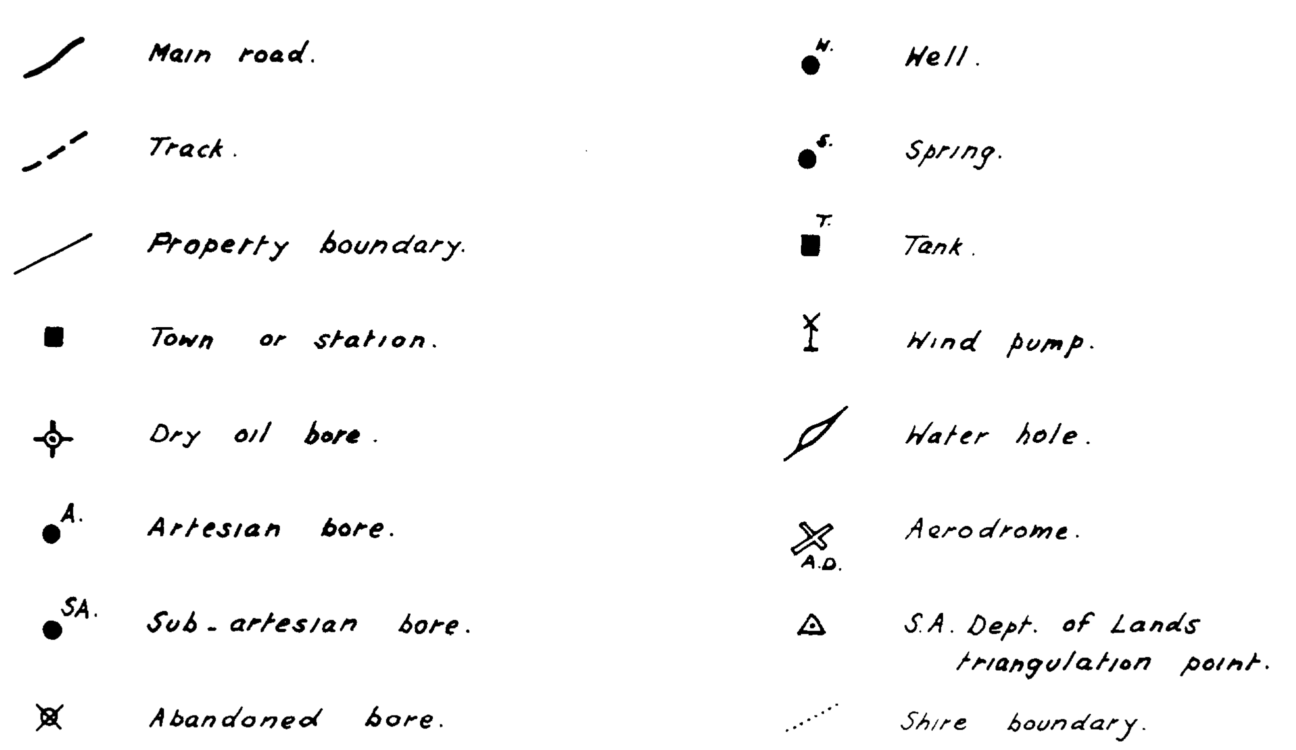
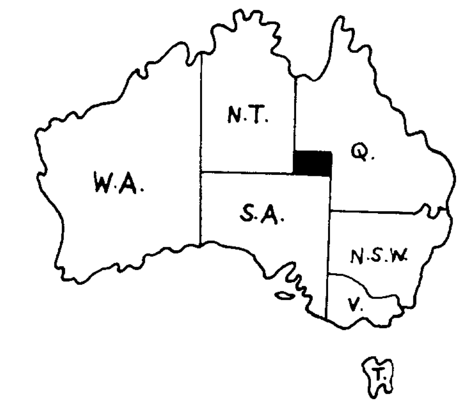
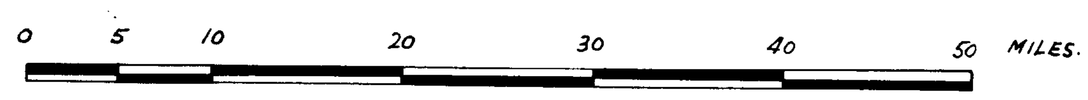


Compiled by the Geological Section from uncontrolled photo index sheets, prepared by the Division of National Mapping.



SCALE



1 inch = 10 miles.