CONTENTS ENVELOPE 59

REPORT NO. 2

JULY 13, 1959 TO OCTOBER 13, 1959

During the period covered by this Report, Exoil Pty. Ltd. conducted a geological reconnaissance of the Woomera-Maralinga Area. This survey was under the direction of the Company's field geologist Mr. K.G. McKenzie who prepared a Report - "A Geological Reconnaissance of the Woomera-Maralinga Area" dated November 18, 1959.

A copy of the abovementioned Report is attached and we request that it be read as forming the geological content of this Report No. 2.

EXOIL PTY. LTD.

December 14, 1959.

SOUTH AUSTRALIAN OIL EXPLORATION LICENSE NO.19.

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A GEOLOGICAL RECONNAISSANCE OF THE WOOMERA - MARALINGA AREA.

by

K.G. McKenzie

Geologist

EXOIL PTY. LTD.

dated 18th November, 1959.

INTRODUCTION

The Company concession in South Australia covers 85,776 sq. miles and is contained by the W.A./S.A. border from 27°S Lat., south to the coast, by 27°S Lat. to the north, and by 134°E Long. to the east as far south as 30°S Lat., where the concession boundary veers south-west to the coast avoiding basement rocks which outcrop from north of Wynbring Rocks to Fowler's Bay.

The area is divided into two sedimentary basins:- the Eucla Basin and the Officer Basin.

Of these the Eucla Basin has been described and its stratigraphy (in the western portion) published. The Company's Eyre No.1 well, 15 miles south of Madura, W.A., will test the most prospective thickness known from this basin and a full report will follow the completion of this well. There is little further reference to the Eucla Basin in this report, except by way of comment on its northern margins.

The presence of the Officer Basin to the north of Emu Field was suggested by regional gravity and aerial magnetometer surveys carried out by the Bureau of Mineral Resources, Geology and Geophysics, in 1956 and 1958 respectively. The sedimentary thickness in this Basin was estimated as being greater than 2000', possibly as much as 10,000'. Some confirmation of this thickness has been reported by R.C. Sprigg who measured 5000' in an Ordovician (?) sandstone formation exposed along the northern margin of the Basin.

A preliminary reconnaissance of the Officer Basin was planned, and an exploration party comprising the author as geologist-party chief, a driver mechanic and cook, duly set out. The party was equipped with an International ASW 120 4 wheel drive vehicle and trailer and was in contact with Woomera Radio via an M51A model Traeger transceiver.

The area of interest lies within the Woomera and Maralinga prohibited areas, and also within the Aboriginal Reserve. To the north access is by road through another prohibited area, the Ernabella Mission.

Permission to enter the Woomera and Maralinga areas was applied for, and obtained at the commencement of the recce. Permission to enter Ernabella Mission was contingent upon permission to enter the Aboriginal Reserve which was forthcoming only after a delay of several weeks.

Accordingly the Woomera and Maralinga areas were first investigated, and finally, permission having been obtained from the S.A. Aborigines Department, a rapid traverse was made through the Aboriginal Reserve.

Over a twenty-seven day period the party covered 4000 miles, mostly over gravelled roads and sandy tracks.

Fuel dumps were established at Watson and Kingoonya, and the fuel then ferried, where needed, into the Maralinga and Woomera areas respectively.

The vehicle had a twenty four gallon water tank and also carried a 44 gallon water drum, so that fresh water was never a problem.

The reconnaissance ended at Woomera on October 21st, 1959, and the party emplaned for Adelaide.

RECOMMENDATIONS

The rapid reconnaissance emphasised the need for further exploration in the area before a qualitative evaluation of the concession's possibilities could be made.

At this stage, therefore, it is recommended that a further, more detailed, surface geological survey be made of the area, if possible in conjunction with gravity traverses on a sub-regional scale. The gravity work will provide valuable surface survey data in addition to information on the nature of the basin profile sub-surface.

The primary objective of further geological work would be to carefully map the prospective reservoir formation. A secondary objective would be to develop the surface geology in the rest of the area by traverses along the gravity lines.

These projected surveys will need to be carefully planned with especial emphasis on the supply of fuel, food and water.

The terrain is very difficult and cannot be traversed in standard vehicles. It is recommended, therefore, that Landrovers are used throughout the operation.

The cost of maintaining such a combined operation in the field, under the difficult conditions obtaining, will be considerable, and it may be economically more attractive to investigate the area by drilling a stratigraphic test. Once again the major problems will be those of supply.

ACKNOWLEDGEMENTS.

The author wishes to express his indebtedness to Cols. Durance and Trainor, Range Commanders at Woomera and Maralinga respectively, for the full co-operation of their administrations throughout the recce. In particular, Messrs. Penifold, Halden and Jamieson of Woomera Security, and Messrs. Cullinan, McCachy, Murray and McQuade of Maralinga Security, were most helpful in providing relevant maps and escort to known outcrops.

When in Watson accommodation was provided by Phil Osborne; at Mt. Eba the party was indebted to Ken Hartington, the Camp Manager, for accommodation and board.

Woomera Radio proved an excellent means of communication in emergency.

Dr. N.H. Ludbrook, of the S.A. Mines Department, examined the palaeontological material collected, and her findings form Appendix B to this report.

Mr. Brian Forbes, of the S.A. Mines Department, supplied borelogs and localities, where known, of bores on the eastern margins of the concession. These data are incorporated in Appendix A.

Mr. L. Nossiter, Dept. of Supply, Salisbury, S.A., provided valuable spot height data.

Mr. Kunoth of Mt. Clarence, Mr. Rankin of Mabel Creek, and Mr. Matthews of Commonwealth Hill, provided valuable information on localities within their properties.

PHYSIOGRAPHY.

The area of primary interest lies immediately south of where the Officer River peters out into sandhills and mulga scrub.

Between Mabel Creek and Welbourn Hill on the main Adelaide-Darwin road a laterite-capped tableland dissected by major creeks draining to the east forms its eastern boundary.

Northward the granitic batholith of the Everard and Birksgate Ranges, backed by the Archaean charnockites of the Musgrave, Mann and Tomkinson Ranges, separates the Officer Basin from the Amadeus Sinkland.

To the south the natural boundary of the Basin is the series of linear, broadly ESE-WNW trending, sand ridges which culminate in Mt. Beadell some miles south of Maralinga. Bore No.7, near Maralinga, reached diorite at a depth of 1724', which indicates a basement high in this area forming the divide between the Officer and Eucla Basins.

Westerly, the limits of the Officer Basin are poorly defined. At the W.A./S.A. border, a few hundred feet of tillitic sediments, thought to be Permian, overlies Proterozoic Nullagine rocks, so the basin floor evidently rises gradually westwards to the Border.

This vast area, of approximately 60,000 square miles, is dominated by sandhills and mulga scrub, with intervening flats surfaced by "kunkar" limestone and supporting a blue-bush, black oak flora. Numerous salt lakes, relics of a once vast inland drainage system, are also characteristic.

Outcrops of formations other than the "kunkar" are rare, and are often located on the western margins of these salt lakes, while the eastern, windward, margins are usually flanked by gypseous drifts, soft, hummocky, and supporting a flora of low, bright green bushes.

Near Mt. Beadell sandhill country supports the distinctive Ooldea "mallee", both yellow and red-flowering varieties being noted. This disappears north of Maralinga and does not reappear until the vicinity of Vokes Hill.

The only major creek known to drain into the Basin is the Officer River, the banks of which are lined with massive "ghost" gums. But these gradually disappear to the south as the creek becomes less distinct.

From south to north the topography falls away from Maralinga (968' a.s.l.) to about 600' a.s.l., then rising to 880' a.s.l. between Observatory Hill and Emu Field. After a slight initial fall, there follows a gradual rise northwards to the Everard Ranges.

From east to west the country possibly falls slightly from Mabel

Creek to Tallaringa Well, then rises to Emu Field and presumably continues to rise westwards to the interstate border.

Finally, a word of warning. Although the map accompanying this report shows several rock-holes, those are all in the nature of soaks that have formed in the capping "kunkar" formation, and are usually dry. The exploror, Ernest Giles, travelling north and west from Ooldea (Youlden) in 1874, was fortunate enough to strike water at two places during his traverse across this region. The present-day regional geologist can scarcely hope to duplicate his good fortune. Drinking water must be carried.

BASEMENT

Outcrops of basement rocks flank the Basin to the north, south-east and south. To the west Proterozoic Nullagine equivalents have been mapped (Utting, '55) from the W.A./S.A. border westwards, overlain in part by sediments occasionally tillitic.

In the north the basement complex may be subdivided into the batholithic "red" granite of the Everard and Birksgate Ranges, and the Archaean granitic gneisses, quartzites, charnockites and mica schists of the Musgrave, Mann and Tomkinson Ranges, and the Deering Hills, and their associated acid to basic intrusives.

To the south-east and south, basement first outcrops south of Lake Phillipson where a feldspathic gneiss was sampled trending N30E with a vertical dip. Massive granite was sampled 7 miles north-west of Commonwealth Hill Homestead. Gneisses and meta-granites were sampled along the Mulgathing Rocks boundary fence SW of this, also at Wynbring Rocks (trending N70E) and east of Tarcoola. Basement was also mapped south of Ooldea near Pidinga Lakes where dark-colored gneisses trend S17E and dip 37°SW.

Westwards, Utting has correlated a series of conglomerates, brown quartzites, sandstones, shales and quartz-feldspar porphyries with rocks of the Proterozoic Nullagine System. These are probably equivalent to the Marinoan Series in South Australia with which Dr. Ludbrook has tentatively correlated a series of brown sandstones, and green and chocolate shales that are encountered subsurface by bores in the Maralinga area.

SEDIMENTS.

Sandhills and mulga scrub and kunkar surfaced intervening flats blanket the older sediments almost throughout this vast area.

Outcrops of these older sediments, when encountered, are usually located on the western margins or in the floors of the numerous salt lakes. They are few and far between, and dips are invariably gentle so that without sufficient height data it is difficult to construct a satisfactory stratigraphic section.

Although astro-fixes have been made every twenty or so miles along the principal roads and tracks, heights above sea level for these localities are sadly lacking. Altimeters were carried by the party but it was found that the closing discrepancy was too great at the end of a long closed traverse to enable altimeter readings to be used for any purpose other than to measure thickness of sediments exposed at the outcrop localities encountered during each traverse.

The following stratigraphy therefore is highly tentative. Although formation names have been given they are used here purely for convenience and are not formally defined.

RECENT-PLEISTOCENE.

The "kunkar" flats, "kopae" (gypsum) drifts, and red sandhills are all comparatively young deposits.

Kunkar is a creamy-coloured, concretionary, non-marine limestone ? developed over calcium-rich rocks. It may be defined, somewhat loosely, as a carbonate laterite. A typical kunkar profile consists of concretionary, fairly compacted limestone extending from the surface to depths of up to 20' although a few feet are more usual. Individual concretions are occasionally developed about a sub-angular core of black or reddish chert. This overlies a lime-enriched porous red earth, over fe-rich yellow-brown-purple heavy, clayey, earth, over red and white sandy earth. This profile suggests considerable leaching during a cycle of alternating wet and dry seasons. The formation is characterised by a bluebush, samphire black oak and mulga flora. Age is probably Pleistocene.

Kopae is a white, to dirty-coloured gypsum dust that has been piled up on the easterly leeward windward shore of the many salt lakes. It forms low, hummocky, soft drifts that occasionally rise 40' above lake level. They support a flora of low bright green bushes. Age is probably Pleistocene.

The sandhills are long, linear, and usually support a mulga scrub. When over basement low wattle bushes dominate. The Ooldea "mallee" is prominent in certain areas and other "mallee" eucalypts are occasionally encountered. There is little apparent movement of free sand except at the crests of the major drifts.

The component sands are fairly sorted, usually coarse-grained, highly quartzose, fe-enriched to give the red colour.

Their age is probably Pleistocene-Recent. Some authorities have felt that these sands may have developed gradually from Lower Palaeozoic times in nearby areas (Carroll - Simpson Desert Sands Trans. Roy. Soc. S.A. Vol.68 1944 pp.49-59), but in the Officer Basin, with a sedimentational history extending to the Tertiary, it seems more likely that their development has been comparatively recent and a product of the present arid climatic cycle.

MIO-PLIOCENE.

Observatory Hill Sandstone. A siliceous laterite or "billy". Usually an angular, poorly-sorted, vitreous, grey quartz sandstone, coarse-grained to pebbly to conglomeratic with a creamy-coloured siliceous cement. The formation is very hard, and impermeable. It is thought to be continental in origin. On Commonwealth Hill H.S. near Thunderbolt Tank, the formation is about 100' thick and outcrops in low flat-topped breakaway type hills. At Observatory Hill the formation contains well-rounded pebbles to cobbles of the Lake Maurice cherts. South-west of Welbourn Hill H.S. the matrix is prominent to dominant, and angularity of the quartz grains is pronounced. The formation typically forms a thin rubbly capping to Lower Cretaceous, Aptian, marine siltstones, between Cooberpedy and Welbourn Hill.

MIOCENE (?)

Lake Maurice Cherts. Definitely younger than the Emu Field siltstones and definitely older than the Observatory Hill sandstone, these beds are exposed at Lake Maurice, although a low hill of bedded black cherts, reportedly outcrops about 30 miles ENE of the Lake. The cherts are dark-coloured, nodular, sometimes banded and exposed in a low breakaway formed on an island in the middle of the Lake, and also along its western margin. The total exposure is about 20', of which the cherts occupy about 3' - 4', being overlain by a lime-cemented, grey-white, clay, fe-stained in part and underlain by a red loamy sand associated with a grey-green clay, both of which appear to be fossil soils. There is thus a disconformitybetween the cherts and the Observatory Hill sandstone, and another disconformity between the cherts and the Emu Field siltstones. The formation is flat-bedded.

The section in the cherts follows:-

6" - 2'	fe-enriched, banded, nodular chert.
3'	banded cherts with a calcereous pellet cement.
3"	laminated, yellowish siltstone.
2"	haematitic chert.

The depositional environment of the formation was probably lagoonal.

EOCENE

The only known Eocene formations from the Officer Basin have been encountered in bores to the north of Maralinga. Dr. N.H. Ludbrook ('58) refers to paralic dark-grey to brown carbonaceous silty sands and a bryozoal calcarenite and calcereous sands which either overlie or are partially equivalent to them.

Further north a questionably Eocene formation outcrops at Emu Field.

Emu Field Siltstones. At Observatory Hill the siltstones directly underlie the sandstone formation, but about one mile north of the junction of 25th Avenue and West Street, they underlie a gravel carrying pebbles and cobbles of the Lake Maurice cherts. Here the siltstones are exposed for 20' and range in colour from red-white to green to yellow-brown, some of the lower beds being richer in fe, at least one exhibiting a well-defined mud-crack pattern. The siltstones are thin-bedded, well-bedded, laminated, highly micaceous, slightly kaolinitic, but in the main quartzose. Compaction is fair, porosity good, and they have a rather rough feel.

In the Emu Field area the formation is represented by well-bedded, thin-medium bedded, laminated, in part vaguely cross-bedded, pinkish-white to purple to yellow, highly micaceous, very fine-grained quartz sandstones and siltstones. Individual grains are sub-angular to sub-rounded. The formation is porous, non-fossiliferous and possibly lacustrine in origin. Dips are gentle.

CRETACEOUS

Cretaceous beds of Aptian age underlie the tableland between Cooberpedy and Welbourn Hill H.S. At places richly fossiliferous the beds carry a fauna of molluscs, belemnites and fossil wood. They are at least 200' thick. The fossiliferous horizons consist of dark greenish-grey calcareous mudstones, impermeable, fairly well-compacted but crumbling rapdily when exposed to weathering. Bands of gypsum are common in the formation and there are also occasional fe-rich horizons. Grey, organic shales encountered in bores at Mt. Clarence Homestead at depths up to 190' contain a rich Aptian flora (personal communication Mr. Balme).

At Lake Phillipson Bore the thickness of cretaceous sedimentation is 166'10" of which the first 100' are Aptian.

The lower 66'10" in Lake Phillipson Bore can probably be correlated with the Neocomian Blythesdale Sandstone. A similar sandstone outcrops in the bed of Lake Phillipson. Here about 6' of siliceous, indurated, x-bedded, quartz sandstone, pebbly to coarse-grained, poorly sorted, with individual grains generally sub-angular, are found in outcrop. Elsewhere the formation is represented by ferruginous grits, and is observed in low breakaways near Lake Phillipson. It may also outcrop in the bed of Lake Maurice.

4.7 miles west of Observatory Hill 70' of gently dipping questionably Cretaceous beds outcrop on the western margin of a large salt lake. These are the Stonehenge Beds. Strongly-jointed carbonaceous siltstones and mudstones, occasionally silicified with one thin (about 4" thick) bed of grey dolomitic limestone flecked with orange-pink calcite forming a good marker. Associated are chocolate-brown micaceous siltstones. The section is as below:-

Surface - 14'	"kunkar" limestone with rounded banded chert pebbles.
14' - 22'	Chocolate-purplish, thin-bedded, laminated, porous, micaceous siltstones disconformable below the kunkar.
22' - 24'	Greenish siltstones, rubbly due to weathering.
24' - 29'	Blue-grey, probably carbonaceous siltstones, fairly hard.
29' - 41'	Chocolate-brown siltstones.
41' - 41'4"	Grey dolomitic limestone flecked with orange-pink calcite.
41'4" - 43'4"	Blue-grey, thin-bedded, carbonaceous shales and siltstones somewhat micaceous.
43'4" - 43'6"	Blue-grey, silicified, shale.
43'6" - 48'6"	Grey, carbonaceous shales.
48'6" - 53'6"	Chocolate-dark brown micaceous siltstones.
53'6" - 54'	Silicified, grey shale.
54' - 62'	Thin-med bedded, blue-grey carbonaceous siltstones, fairly hard.
62' - 63'3"	Lighter-grey, hard, thick-bedded mudstone, possibly calcareous.
63'3" - 68'3"	Softer, thin-bedded, grey to purple shales, containing a bed 1' thick of silicified mudstone.
68'3" - 78'3"+	Softer, purplish, micaceous siltstones, possibly underlain by thin, mud-cracked, grey-green, non-fossiliferous limestone.

The Stonehenge Beds may be equivalent to the paralic carbonaceous Eocene siltstones encountered at depth by bores near Maralinga (Ludbrook'58), but the dolomitic marker is not mentioned from the latter, and no lignitic horizons were recognised in the former. Stratigraphically they appear to underlie the Emu Field Siltstones and are here tentatively placed in the Cretaceous.

PERMIAN (??) Orolov.

Mt. Johns Sandstone. The formation with the most continuous outcrop occurs along the northern basement margin as far south as 70 miles NW of Emu Field. Trend of the outcrop is about N60E. The formation is well-bedded, strongly x-bedded, thin-bedded to thick-bedded, in part laminated, of good porosity, usually clean, but occasionally arkosic. It would form an excellent reservoir. It is quartzose, grain-size varying from fine to coarse, sorting from good-fair-poor, grains are sub-rounded to sub-angular and their surfaces are often frosted. Compaction is fair to good. The formation is non-fossiliferous except for rare animal trails and burrows. It is ripple-marked and rain-spattered. Thin horizons of fine gypsum dust were noted at Mindabi. At Mindabi too, the formation has been opalised -

a"boxwerk" mineralisation in three planes, along, across and at right angles to the bedding.

The author measured over 300' of these sediments near Mindabi, but Sprigg records 5000' of thickness in this formation at Chamber's Bluff.

As to its position in the stratigraphy there is no evidence. The Emu Field siltstones may be a facies of this formation, but it is never micaceous elsewhere. Its position with respect to basement suggests a Permian age.

Sprigg however, postulates an Ordovician age for these sandstones correlating them with the Ordovician sandstones in the Northern Territory. The author however, has never seen gypseous bands in the Territory Ordovician sandstones. Also, the limestone beds at the base of the formation, which are mentioned by Sprigg, when seen by the author north of Mt. Johns, bore no resemblance to either the Horn Valley or the Walker Creek beds from the type Ordovician exposures at Ellerys Creek and elsewhere in the Territory, nor did these resemble the Territory Cambrian limestones.

On the other hand, Dr. Ludbrook, S.A. Mines Department, purely on lithology, thinks these sandstones are ~~very~~ younger possibly Eyrian in age.

Tillites are mentioned by Sprigg as outcropping near these sandstones, but were not seen by the author in his rapid reconnaissance. These could be Permian in age, although Sprigg correlates them with the Proterozoic Sturtian Tillites.

Again, sediments correlated by Sprigg with Cretaceous shales lap these sandstones at several localities. The author feels, therefore, that the formation is Lower Mesozoic to Permian in age (perhaps older, in deference to Sprigg).

The Mt. Johns Sandstone is a good reservoir and the considerable measured thickness (over 5000' according to Sprigg) indicates that the reservoir characteristics are likely to persist southwards into the Basin. It is of prime importance, therefore, that the formation be accurately mapped and its position in the stratigraphy established.

No sediments older than the Mt. Johns Formation were encountered during the reconnaissance.

STRUCTURE

A regional reconnaissance of this nature does not permit of any structural comments other than the broadest of generalisations.

Sprigg ('58) feels that "certain thick, gently north-dipping dyke swarms in the Ernabella area suggest the sole of an overriding nappe directed to the south".

Structure south-east of Ernabella, in the Mt. Johns range, suggests thrust faulting with the sediments thrust over basement (north down, south up). Structure in the same sandstone formation south of the Birksgate Ranges appears to confirm this direction of movement.

From the few strikes and dips available the Basin sediments are seen to be gently-dipping so that broad basinal structures are likely.

Maralinga Village is located on an ESE-trending regional high. North of the village is an apparent regional low extending from Serpentine Lakes through Lake Wyola, Lake Maurice and the Maralinga Test Area (contained by West Street, 25th Avenue and Emu Road) eastwards to Wilkinson Lakes. This is followed by a regional high through Vokes Hill, Observatory Hill-Emu Field, and this in turn by another low where it is felt the greatest thickness of sediments was deposited in the Officer Basin.

Gravity and magnetometer work have suggested a thickness of sediments up to 10,000' in this area, and it seems possible that structure has played an important part in deepening the trough.

North of this low is the regional high extending from Coffin Hill eastwards to Mindabi and Mt. Johns which abuts the basement complex.

Basement trends from observed outcrops suggest a passage to the east connecting the Officer and Artesian Basins.

In this regard it it noted that the Lake Phillipson Bore reaches a depth of 3140' in sediments before entering basement granite, and it is suggested that Permian glaciation gouged this channel through the basement complex to connect with the Artesian Basin.

SEDIMENTATIONAL HISTORY.

The Officer Basin is known to have a sedimentational history extending into the Tertiary. Its origin in time, however, is obscure.

The oldest sediments known were encountered on the eastern margin of the basin immediately above basement, at Lake Phillipson Bore, and consist of a series of grey sandy shales of Lower Permian age (Balme pers. comm.), associated with possible boulder and pebble tillites. This evidence of Permian glaciation east of the Basin is matched by the presence of tillite beds, correlated with Permian glaciation, west of the W.A./S.A. border (Wilkinson Range Series, Utting'55). No tillites were encountered during traverses through the Basin proper, but at several outcrop localities well-rounded boulders and cobbles of a dark-grey quartzite were noted. No outcrops of this quartzite were seen on the reconnaissance either in or on the margins of the basin, therefore, these boulders and cobbles may be reworked glacial erratics, although no striations or facetting were observed on those examined. The lack of these markings, however, is not considered conclusive evidence against glaciation. Reworking of the erratics may have destroyed these surface features, but in any case only a small percentage of boulders in a tillite are so marked. The only other evidence for glaciation is exposed 3 miles west of Wintinna Homestead. Here about 60' of a leached pink calcareous clay, may be a loess deposit that has subsequently been calcified.

The possibility of Permian glaciation in the Officer Basin, therefore, cannot be ignored.

At Lake Phillipson these Lower Permian beds are overlain by organic shales often micaceous and brown coals, also Permian in age. Marginal swamps were the probable environment of deposition. At about this time the basal limestone beds of the Mt. Johns Sandstone formation were being deposited. These are khaki-coloured, possibly freshwater limestones, the dark colour indicating mildly anaerobic conditions. They may have been developed in coastal lagoons.

Sedimentation continued in the Basin during Permian to Lower Mesozoic time with the deposition along the northern margin of a vast thickness of cross-bedded, quartzose sandstones. Apart from the characteristic cross-bedding these sandstones are ripple-marked, rain-spattered, usually well-sorted and non-fossiliferous with the exception of rare worm burrows. All these features indicate a transitional environment of deposition. The gypsum beds at Mindabi indicate that here lacustrine conditions obtained. Elsewhere the formation resembles a beach deposit. The considerable thickness exposed indicates that the facies persists basinwards grain size diminishing and the sediments becoming darker-coloured with increasing distance from their source.

The deposition of a clean, quartz sandstone, equivalent to the Blythesdale sandstone, then followed. Indications are that by this time the

Officer Basin was becoming shallower. Greenish, Aptian siltstones and mudstones, similare to those exposed at Mt. Clarence H.S. were laid down in the centre of the Basin and red and white siliceous shales on the northern margins. The Stonehenge Beds are a paralic facies possibly deposited during this period. The Beds are also important in that they provide evidence for movement during Cretaceous (?) time. They are strongly jointed, the major joint trending S75°E, and the minor S07°W. S75°E is approximately the trend of the regional highs and lows mentioned earlier (see Structure), therefore may be reasonably considered to be the trend of the axes of folding.

(It is thus of prime importance to establish the position of the Stonehenge Beds in the stratigraphy. Mr. Balme has examined samples, but through lack of palynological material was unable to furnish an age.)

Eocene sedimentation probably commenced with the deposition of the multi-coloured, micaceous Emu Field siltstones in warm shallow waters. Near Maralinga paralic carbonaceous silts and lignites gave way northwards to bryozoal calcarenites. The latter probably developed near-shore at depths of 20-200 metres.

A period of uplift leading to the development of the lower fossil soil horizon at Lake Maurice was followed by the deposition of the lagoonal Lake Maurice cherts in the southern part of the Basin, while the northern half probably remained exposed. No great thickness of the cherts was deposited. Erosion processes then removed all but a few feet of these beds.

During Mio-Pliocene time a siliceous laterite developed over the eastern half of the Basin extending as far west as Emu Road. Meanwhile, in the Eucla Basin, the richly fossiliferous Nullarbor Limestone had deposited as far north as Lake Yarle and barrier dunes developed over the basement high forming a natural boundary to further ingression by Miocene seas.

By late Pliocene time a vast shallow inland lake drained the ranges to the north and north-west and the tableland to the east. A regional uplift saw the gradual disintegration of this lake and the erosion of the laterite-capped tableland.

During Pleistocene and Recent times the area has developed to its present physiographic aspect.

OIL POTENTIAL.

The Officer Basin has never been tested by the drill and is a rank wildcat.

No oil or gas seeps, or outcrops of oil bearing strata are known from the area.

Geophysical work, however, has suggested a sedimentary thickness of 10,000' south of the Officer River. Of this postulated 10,000' over 5,500' have been measured on the margins of the basin proper.

The measured thickness includes one good reservoir formation, in this report, for convenience, called the Mt. Johns formation. This formation, at least in part, is a fine to coarse-grained, generally well-sorted, fairly compacted, clean, porous, quartz sandstone, characteristically cross-bedded, indicating shore-line deposition.

The age of the Mt. Johns Formation has not been established with certainty (see Sediments). The primary task of any future geological work in this area, therefore, must be to determine the age of this formation and its position in the stratigraphy.

Source beds are known to exist in several localities on the margins of the Basin.

The Stonehenge Beds, characteristically dark-stained siltstones and shales also, at present undated, are one possible source of commercial hydrocarbons.

Greenish, Lower Aptian, marine siltstones and shales, badly weathered in outcrop, are highly organic in bores and therefore good source beds. They are known from Mt. Eba north to Welbourn Hill.

Finally, Lake Phillipson Bore penetrated favourable source rocks in the form of organic, dark-coloured Permian siltstones and shales.

The indurated, often ferruginous equivalents of the Blythesdale sandstone (Neocomian) which outcrop near Lake Phillipson are a possible cap rock.

The accumulation of commercial oil depends on the presence of favourable lithologies laid down in a favourable environment, favourably located in structural or stratigraphic traps.

Therefore, before a final assessment of the oil potential of the Officer Basin can be made, the structure will have to be more clearly defined and the presence of traps demonstrated.

CONCLUSIONS

The reconnaissance has pointed the need for further exploration in the area, both geological and geophysical, before test drilling is commenced.

The main barriers to the successful completion of this further exploration will be physical; the problems of terrain, water, supply.

Together, these problems may make further exploration prior to test drilling, uneconomic, even impractical, and it may best serve the Company's interest to drill a stratigraphic test where the Basin is deepest. The area can then be evaluated on the results of such a test.

Prior to any further operations in the area, a full liaison must be established with Woomera and Maralinga Security, and with the Native Patrol Officers of the Aboriginal Reserve.

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C O P Y

APPENDIX A.

Engineer-in-Chief's Dept.
Conservator of Water's Branch.

Eng.-in-Chief's Dept. S GO 108/01

LAKE PHILLIPSON BORE
Diamond Drill Hole
Pastureal Sheet 14

Grid F 4
P. Leahy
J. Jolley

9/11/1901

From		To	Printed log as in P.P. No. 29. 1902	Amendments in ink to printed log
0	-	4' 0"	Surface soil.	Surface soil red.
4'	-	15' 9"	Gypsum & soil.	Gypsum and soil red.
15' 9"	-	45' 0"	Clay with water-worn pebbles.	Clay with waterworn pebbles. yellow with quartzite pebbles and limonite stained quartzite layers.
45' 0"	-	60' 3"	Pipe clay.	Cream clay.
60' 3"	-	73'10"	Light blue clay.	Light grey clay.
73'10"	-	100' 0"	Clay with sand & water-worn pebbles.	Clay with yellow sand and water-worn pebbles.
100' 0"	-	166'10"	Indurated siliceous sand.	Indurated siliceous sand medium grained.
166'10"	-	174' 5"	Brown coal.	Brown coal.
174' 5"	-	180' 2"	Blue shale.	Grey shale.
180' 2"	-	198'10"	Blue shale with iron pyrites.	Grey shale with iron pyrites.
198'10"	-	227' 9"	Carbonaceous shale.	Carbonaceous shale.
227' 9"	-	256' 3"	Brown coal.	Brown coal.
256' 3"	-	276' 8"	Light blue shale with iron pyrites.	Light grey shale with iron pyrites balls.
276' 8"	-	280' 5"	Brown coal.	Brown coal.
280' 5"	-	297' 1"	Light blue shale.	Light grey shale.
297' 1"	-	303'10"	Brown coal.	Brown coal.
303'10"	-	310'11"	Light blue shale.	Light grey shale.
310'11"	-	312'10"	Brown coal.	Brown coal.
312'10"	-	322'	Light blue shale with iron pyrites.	Light grey shale with iron pyrites.
322' 0"	-	366' 0"	Micaceous and siliceous sand.	Micaceous and siliceous sand, grey very fine.

Printed log asin PP. No.29 1902		Amendments in ink to printed log
366' 0" - 377'10"	Sandstone with iron pyrites.	Ironstone with iron pryites.
377'10" - 393' 2"	Brown coal.	Brown coal.
393' 2" - 427' 1"	Soft micaceous shale, with iron pyrites.	Soft micaceous shale with iron pyrites, very fine sandy shale.
427' 1" - 466' 1"	Grey shale with iron pyrites.	Grey shale with iron pyrites.
466' 1" - 472' 3"	Coal.	Coal and pyrites.
472' 3" - 510' 3"	Shale.	Grey sandy shale.
510' 3" - 511'3"	Coal.	Coal.
511' 3" - 527' 5"	Grey shale with thin bands of coal.	Grey shale with thin bands of coal.
527' 5" - 542' 4"	Grey shale with iron pyrites.	Grey shade with iron pyrites.
542' 4" - 551' 3"	Micaceous shale with thin bands of coal.	Micaceous shale with thin bands of coal. Bottom of lignite series.
551' 3" - 744' 6"	Grey shale with iron pyrites.	Grey shale with iron pyrites.
744' 6" - 863' 0"	Blue shale.	744' - 826' Dark grey shale. 826' - 863' Grey shale.
863' 0" - 870' 0"	Micaceous sandstone.	Micaceous sandstone.
870' 0" - 881' 0"	Calcareous shale.	Shale and trace of lignite.
881' 0" - 1007' 6"	Micaceous shale.	Hard grey shale, flat bedded.
1007' 6" - 1009' 0"	Quartzite.	Grey hard quartzite.
1009' 0" - 2032' 0"	Micaceous shale.	1009'0" - 1469'0" Hard grey flat bedded shale. 1469'0" - 1687'0" Dark grey somewhat gramular fine grained rock, with little scattered mica and small black spottings and roughenings on surface due to soluble salts. (probably pyrite.)

Printed log as in PP. No.29 1903, 1904		Amendments in ink to printed log
2032' 0" - 2301' 0"	Micaceous shale with bands of greyish calcareous rock.	1687'0" - 2263'0" as above. Flat bedded. There are bedding plane films of pyrite weathered to sulphate. 2263'0" - 2283'0" Dark grey conchoidal shale.
2301' 0" - 2312' 0"	Micaceous shale.	2301'0" - 2312'0" Shale 2310' Light grey calc shale.
2312' 0" - 2340' 0"	Blue shale with pyrites and quartzite.	At 2339' sandy shale with quartzite pebbles.
2340' 0" - 2357' 0"	Quartz streaks.	2339'0" - 2355'0" Grey conchoidal shale with carbonate of lime veinlets.
2357' 0" - 2382' 0"	Blue shale.	2355'0" - 2559'0" Light grey fine grained shale with conchoidal fracture.
2382' 0" - 2950' 0"	Micaceous shale.	2600'0" - 2751'0" As above - grey. 2782'0" - 2836'0" Grey conchoidal shale with very light grey sub-crystalline limestone at 2818 ft.
2950' 0" - 2960' 0"	Blue shale with bands of calcareous back.	2836'0" - 3140'0" No amendments to log.

Printed log as in PP. No.29 1903, 1904		Amendments in ink to printed log
2960' 0" - 3097' 0"	Sandy shale.	
3097' 0" - 3102' 0"	Sandy shale with bands of calcareous rock.	
3102' 0" - 313' 0"	Blue shale and granite.	
313' 0" - 3134' 6"	Granite gravel.	
3134' 6" - 3140' 0"	Blue sandy shale.	
3140' 0" - 3161' 0"	Granite.	3140'0" - 3161'0" Gneissic red hornblendic granite.

Supplementary log notes from the volume "Records of Bores".

"Discoveries of Minerals, Fossils, etc."

377' - 393'	Analysis of coal seam; ash 6.38% to, coke 33.12% volatile hydrocarbons 39.48%, water 21.02%.
2000' and 2075'	Shale containing 10% bituminous matter, may contain trace of oil.
2260'	Shale core slightly inflammable - burns white.
2400'	Grey shale with conchoidal fracture - no fossils.
2818'	Calcareous quartzose sandstone.
2836'	Argillaceous shale.
2896' -	2905' Blue argillaceous shale.
2948'	Dense blue clay shale.
2958'	" " " "
2980'	" " " "
3015'	" " " "
3034'	" " " " plus feldspar pieces.
3047'	Blue sandy shale plus red feldspar pieces.
3100'	Fragment of red granite in blue argillaceous shale.
3117'	Blue sandy argillaceous shale with feldspar pieces.

3161 ft. 675 ft. of 6½ in. left in bore.

80 small Too saline for men or camels.

(?)
reported when
bore at 743 ft. 85 4 oz./gall.

0 - 166'10"	Cretaceous.
166'10" - 3000' +	Permian.

COPY

DEPARTMENT OF MINES, ADELAIDE.

NAME MUDDAUGANA SERIAL NO. 3

ADDRESS GRID. B. 6

LOG

post Eocene

0 - 190	Surface to bottom of shaft.	
190 - 235	Soft white limestone with hard white china boulders every few feet. Last 3 feet slightly yellowish.	
198 feet	Struck water. Did not rise.	
220 feet	Gas bubbles in water.	
225	Whiting at 225 ft.	
235 - 241	Hard white limestone polyzoal.	
241 - 244	Soft white limestone.	
244 - 244½	Very hard grey chert and limestone rock. Turns brown on exposure to air.	
244½ - 248	Polyzoal creamy limestone.	
248 - 270	White limestone, fairly hard.	
270 - 280	White limestone, polyzoal. Struck water. Rose to 190 ft.	
280 - 463	Polyzoal at 330, whiting 400, White limestone, alternating hard and soft.	Wilsons Bluff Lst
463 - 464	Yellowish limestone.	
464 - 467	Pea green clay. Turns brown on drying. Highly calcareous. Glauconite?	
467 - 473	Sandy carbonaceous. Dark brown clay.	Cretaceous
473 - 484	Clay. greenish.	
484 - 627	Lignitic clay, stated to burn after drying. Black shale with trace of oil.	
627 - 784	Blue shale. Very sticky.	
784 - 787	Blue clay with coarse gravel. Struck water rose to 190 ft.	
787 - 790	Coarse limestone silica sand. fine gravel.	
790 - 794	Very coarse gravel.	
794 -	Quartz coarse sand. Bottom of bore.	Permian

WATER ROSE TO 139 FEET, AND ON PUMPING WITH SAND PUMP TO 131 FEET FROM SURFACE.

SIX INCH CASING, SURROUNDED WITH 2 INCHES OF CEMENT, CEMENTED ONTO GREY ROCK AT 244 FEET FROM SURFACE, CUTTING OFF 1st AND 2nd WATERS.
FIVE INCH CASING FROM BOTTOM OF BORE TO PUMP.

DEPARTMENT OF MINES, ADELAIDE

NAME	COMMONWEALTH RAILWAYS	SERIAL NO. 15
ADDRESS	FISHER	GRID. B. 5
BORE		

LOG

0 - 190	Hard limestone.
190 -220	Red sand.
220 - 295	Water struck.
295 - 340	Coarse sand.
340 - 391	Water struck.
391 - 429	Blue shale.
429 - 475	" "
475 - 600	Blue sandy shale.
600 - 793	Red shale.
793 - 883	Hard red rock.
883 - 912	Soft rock.

Tertiary
↑
↓
Cretaceous

END OF BORE AT 912'

Supply 10000 gallons per 24 hours.

2.848 ozs. 5" casing.

DEPARTMENT OF MINES, ADELAIDE

NAME COOK BORE COMMONWEALTH RAILWAYS.

SERIAL NO. 14 LOGGED BY R.C. SPRIGG.

GRID. B. 5

LOG.

0 -	10	Hard limestone.	Nullarbor Lst.
10 -	28	Soft white limestone.	
28 -	115	Limestone yellow, pink and white.	
115 -	170	Clay and limestone.	Wilson's Bluff Lst.
170 -	237	White limestone to 225 then yellow rock and sand.	
237 -	287	Through sand at 274' and then onto 287'.	
287 -	300	Mixture brown clay and sand.	Hampton Congl.
300 -	336	Grey clay.	
336 -	384	Blue shale.	
384 -	424	Grey clays.	
424 -	541	Pipe clay sand and gravel.	Cretaceous
541 -	606	Light blue clay.	
606 -	638	Blue clay.	
638 -	710	Rock and clay.	
710 -	731	Red sandstone struck at 719' still in water 2 oz/gll. fair supply.	
731 -	734	More water over 3 oz. 960 gr/gall.	
734 -	742	1440 " "	Permian
742 -	762	Shale and granite boulders.	
762 -	793	White and red shale.	
793 -	800	Grey shale.	
800 -	805	Light coloured shale.	
805 -	830	Ferruginous shale.	
830 -	843	Shale.	
843 -	862	Ferruginous shale.	
862 -	898	Shale.	
898 -	900	Shale and mudstone.	
900 -	918	Grey shale.	
918 -	977	Ferruginous fine grits and sand.	
977 -	993	Ferruginous fine grits and sand plus pale green salt mudstone.	

NAME COOK BORE COMMONWEALTH RAILWAYS

SERIAL NO. 14 LOGGED BY R.C. SPRIGG

GRID B. 5

LOG (CONTD)

993	- 1021	Series of sands or fine grits ? nature.
1021	- 1044	Shales.
1044	- 1056	Shales.
1056	- 1076	Ferruginous shales and sands.
1076	- 1080	Black shales.
1080	- 1081	Grey shales.
1081	- 1144	Pale green shale.
1144	- 1162	Shale and fine grit.
1162	- 1167	Dark fine grit.
1167	- 1180	Shale.
1180	- 1184	Ferruginous shale.
1184	- 1202	" " and mudstone.
1202	- 1208	Shale and sandstone.

END OF BORE AT 1208'

(1920 gr/gall.) Sample of water appears worse.

It was proposed to use first water for washing out, etc. in Boiler use, so 372' 8" casing 739' 6" casing were placed in Bore 6" casing plugged at 580 ft. and slotted 430 ft. 454 ft.

Static water level was 315'

Depth at which water struck.

424', 731', 742'.

DEPARTMENT OF MINES, ADELAIDE

NAME DEAKIN BORE SERIAL NO. 10

ADDRESS NULLARBOR PLAINS

LOG.

0 - 40	Capstone and boulders.	Nullarbor Lst
40 - $80\frac{1}{2}$	Limestone with hard bands of red clay.	
$80\frac{1}{2}$ - 260	White limestone - Water struck.	Wilson's Bluff Lst
260 - 362	White porous limestone finished on white clay just entered the shale.	Cretaceous

Estimated 15000 gals. per day - stock water

6" casing ,697 ozs.

MABEL CREEK (N.H. Ludbrook, D.M. 1496/56)

	Bore No. 2	14-119'	Tertiary to Recent clay
		119'-203'	L. Cretaceous grey shale
		203'-323'	Blythesdale Ss.
Localities unknown	(Bore No. 8	101-119'	L. Cretaceous shale, ss.
	(	119-183'	Blythesdale ss.
	(Bore No.10	100-220'	Blythesdale ss.
	(Bore No.11	100-241'	Blythesdale ss. (? some Permian also?)
	"Tub Hole"	40m. NE of Mable Creek HS : surface fossils L. Cretaceous.	

(Drillers Log)

Bore No. 1	0- 34'	Clay and limestone
	34- 80'	Limestone
3	0- 70'	Clay, ironstone
	70- 90'	s.s.
	90-166'	shale, clay
	166-319'	sandstone
4	0- 95	clay, ls.
	95-126	purple shale, clay
5	0- 25'	Loam, clay, lime
	25-106'	purple shale, clay
	106-245'	sandy clay, ss.
6	(Beside Bedourie Bore)	
	0-102'	loam, ironstone, clay
	102-118'	shale
	118-350'	ss.
	350-703'	shale
7	0-120'	loam, ironstone, clay
	120-148'	ss.

S. & E. of Musgraves: Bull. 5, S.A. Geol. Survey (R.L. Jack)

D.M. Bore Folder (drillers logs only)

E2	Sailor's Well	8- 19'	argillaceous ss.
	Marla Bore	0- 94'	loam, clay
		94-339'	choc. slate
	Wintinna Bore	0-113'	clay
		113-170'	p. grey sh.
		170-224'	yellow sh., black clay (?L. Cret.)
		224-583	ss., sand.
	Welbourne Hill No. 7	18-123'	yellow and grey sh.
		123-568'	ss., sand (some sh.)
	Welbourne Hill 1 (121/57) at Reids Ck.?	23-317'	grey clay, shale
		317-447'	" mudstone, ss.
		447-532'	sand.

E4 Commonwealth Hill bores usually granite near surface or about 80-100', overlain by clay, ss.

Some Exceptions	Bore 49 (3m. W of Comm.Hill)	16-100'	white sandy pipe clay
		100-165'	blue clay
	Bore 42	5-111'	mostly conglomerate (?)*
	Bore 6 S.P.	0- 80'	clay, grit
		80-130	ss., clay
		130-136	clay, "rock".
		136-138'	ss.
	Bore 6 C	12- 43'	ss.
		43-126	clay, sand
		126-132	ss., gravel
		132-143	clay, blue shale
	Bore 9 S.P.	0- 15'	clay, granite) all granite?
		15- 80'	clay, ss.)
		80-174'	decomp. granite)

* Bore 200 yds. W. 0- 45' ss.
45-116' granite.

DM 1346/52

E 4

Tallaringa Area. (N.H. Ludbrook 1954)

Bore No. 1	3- 27'	limestone	Recent -
	27-160'	sandy clays	? Tertiary terrestrial
	160-173'	coarse sand	(early Tert./Late Cret.

E.P.D. O'Driscoll 1952 — The Hydrology and Geology of the Mt. Eba District D.M. 1346/52 Plans L52-41, 52-323 (sec.)

E 5

Mulgathing

Bore 65		granite at 51'	
62	2- 95'	clay	
	95-110'	"hard blue rock"	
	110-136'	" " quartz rock"	
63	0- 35'	clay	(v. near 65)
	35- 80'	ss.	
	80-162	sand	
Bore 2 McC	3- 10'	ss.	(NE cnr. P.L. 1829)
	10- 48'	clay	
	48-100'	ss.	

F 2

Welbourne Hill Bore No. 6		(near homestead?)	
	0- 37'	gravel, clay	
	37- 67'	hard and decomposed "rock".	
	67-322	shale, clay	
	322-330	sand.	
Warranarrea Bore	0-100'	clay	
	100-424'	blue shale	
	424-466'	sand	
Welbourne Hill No. 4			D.M. 886/56
	2-140'	Silt, clay, marl	
	140-147'	sandy shale.	

F 3	No 1 Stuarts Ra.	0- 82'	clay
		82-199'	shale 6" boulder at 132'
		199-241'	" and ls.
		241-458'	sand.
F 4	Mt. Clarence No.1	10-105'	shale
		105-168'	clay, sand
		168-179'	sand, gravel.
	Woorong No. 3 Bore	2 - 37'	ls. and rubble
		37 -114'	sand, ss.
F 5	Bore No. 26 Mulgathing Rock hole		
		2 - 84'	clay, limestone
		84 -105'	broken granite
	Bore S 30 (Mulgathing)		
		5 - 15'	ls. rubble
		15 - 63'	ss., sand
		63 -120'	brown coal
		120- 128'	clay
		128 -130'	ss.

APPENDIX B.

PALAEONTOLOGICAL EXAMINATION OF MATERIAL FROM ~~AND~~ NORTH OF THE EUCLA BASIN.

by

N.H. Ludbrook

Pal Rept 9/59

ABSTRACT

Thirty four samples collected during a reconnaissance survey in the Eucla Basin and the area to the north cover a fairly wide stratigraphical range. An important collection of Aptian mollusca from near Mt. Clarence is included. Fourteen samples from the Israelite Bay area are also included.

EXAMINATION OF SAMPLES

F 106/59 — M36-F. Surface outcrop near Cocklebiddy W.A. Pink-cream dense, partially recrystallized Nullarbor Limestone (Lower Miocene) crowded with *Austrotrillina howchini*.

F 107/59 — M37-F. Surface grab sample from bore rubble, Fisher's Bore 19 miles north of Nullarbor H.S. Almost completely recrystallized and ferruginized calcareous clay. Oolitic structures are common. No fossils are present to establish the age of the material.

F 108/59 — M38-F. Surface outcrop, 5 miles north of Fisher's Bore. Pink-cream dense almost wholly recrystallized Nullarbor Limestone (Lower Miocene) with *Marginopora vertebralis* and abundant *Miliolidae*. Surface duricrusted, oolitic structures present.

F 109/59 — M39-F. Surface outcrop, Fisher, Transcontinental Railway. Duricrusted surface of the Nullarbor Limestone, which remains as pebbles or patches in the duricrust. Unreplaced Nullarbor Limestone contains abundant *Marginopora vertebralis* and *Miliolidae*.

F 110/59 — M40-F. Surface outcrop 14 miles west of Watson Nullarbor Limestone with *Marginopora vertebralis*, *Planorbulina*, *Miliolidae*, corals, and molluscan casts.

F 111/59 — M41-F. Surface - 20 feet Lake Yarle. Nullarbor Limestone with *Vasticardium* sp., *Spondylus* sp., and other molluscan moulds and casts. The microfauna is the same as in F 110/59.

F 112/59 M44-F. Watson Quarry 0-2 feet.
Surface of Nullarbor Limestone partially duricrusted and coated with kunkar.
Microfauna as in previous samples, Marginopora vertebralis and Miliolidae predominating.

F 113/59 M45-F. Watson Quarry 2'-16'.
This is duricrust developed on Nullarbor Limestone with oolitic structures.
Nullarbor Limestone retained as brecciated fragments.

F 114/59 M46-F. Watson Quarry 16-36'+
Fossils from the Nullarbor Limestone:
Cucullaea sp.
Chlamys eyrei (Tate)
Miltha sp. cf. hora (Cotton)
Diastoma cf. provisi Tate
Thericium sp.
Cypraeid sp.
Microfauna dominated by Marginopora vertebralis and Miliolidae

The composition of this fauna requires detailed study. Several of the elements occur only in the late Miocene and Pliocene elsewhere in South Australia. The presence of Austrotrillina howchini and Flosculinella bontangensis at several localities dates the Limestone as Lower Miocene (Indo-Pacific f_1-f_2) and their absence at Watson is not taken as indicating a younger age for the limestone quarried there. The molluscan assemblage needed warm shallow waters for its development.

F 115/59 M57-F. Old claypan, near Malbooma, 30 miles east of Wynbring Rocks.
This is a silicified limestone with remains of a freshwater gastropod, possibly Gabbia sp.
Similar freshwater limestones are apparently widespread in the vicinity of Lake Torrens. They occur at Ediacara and on the Witchelina Military sheet.

F 116/59 M61-F. Outcrop, flat-topped ridge 16.2 miles north north west from Ingomar H.S.
Duricrust. Silicified sandstone conglomerate and limestone.
No indication of age can be given.

F 117/59 M63-F. Low breakaway, 15 miles north east of Mt. Clarence H.S.
Chocolate-red ferruginized gypseous shales with Maccoyella barklyi (Moore) and Mytilus inflatus Moore.
The shales are rich in selenite.
Age: Aptian - probably lower part.

F 125/59 M74. Observatory Hill.
Silicified sandstone and possibly silicified shale. Two of the specimens have unusual siliceous slivers of uncertain origin. Without fossil evidence it is impossible to determine the age of superficially silicified sediments of this kind.

F 126/59 M89. Near Mt. Lindsay.
Fine pinkish-red sandstone with subangular quartz grains and worm burrows.
Although there is no fossil evidence to confirm it, this may be one of the arenaceous terrestrial sediments of Tertiary age, referred to as "Eyrian". (N.B. Eyrian at its type locality is Lower Cretaceous - Neocomian).

F 127/59 M91. Near Coffin Hill.
Similar to M89.

F 118/59 M64-F. Outcrop in bank of creek, approximately 200 feet below Coober Pedy which is 600 feet ASL. 15 miles east south east of Mt. Clarence H.S.

<u>Nucula truncata</u> Moore
<u>Maccoyella barklyi</u> (Moore)
<u>Pseudovicula australis</u> (Moore)
<u>Mytilus inflatus</u> Moore
<u>Fissilunula clarkei</u> (Moore)
<u>Panopaea rugosa</u> Moore
<u>Tatella maranoana</u> (Etheridge)
<u>Natica</u> (<u>Lunatia</u>) <u>variabilis</u> Moore
Belemnite sp. cf. <u>Peratobelus oxys</u> (T. Woods)
Fossil wood.

Age - Lower Cretaceous (Aptian) - probably lower part of Aptian. Some of the specimens are very well preserved.

F 119/59 M65-F. Mt. Willoughby H.S. P.S. 18 Grid F 2. This is a hard chemically deposited limestone for which no precise age can be given; peculiar type of recementation appears to be a duricrust phenomenon.

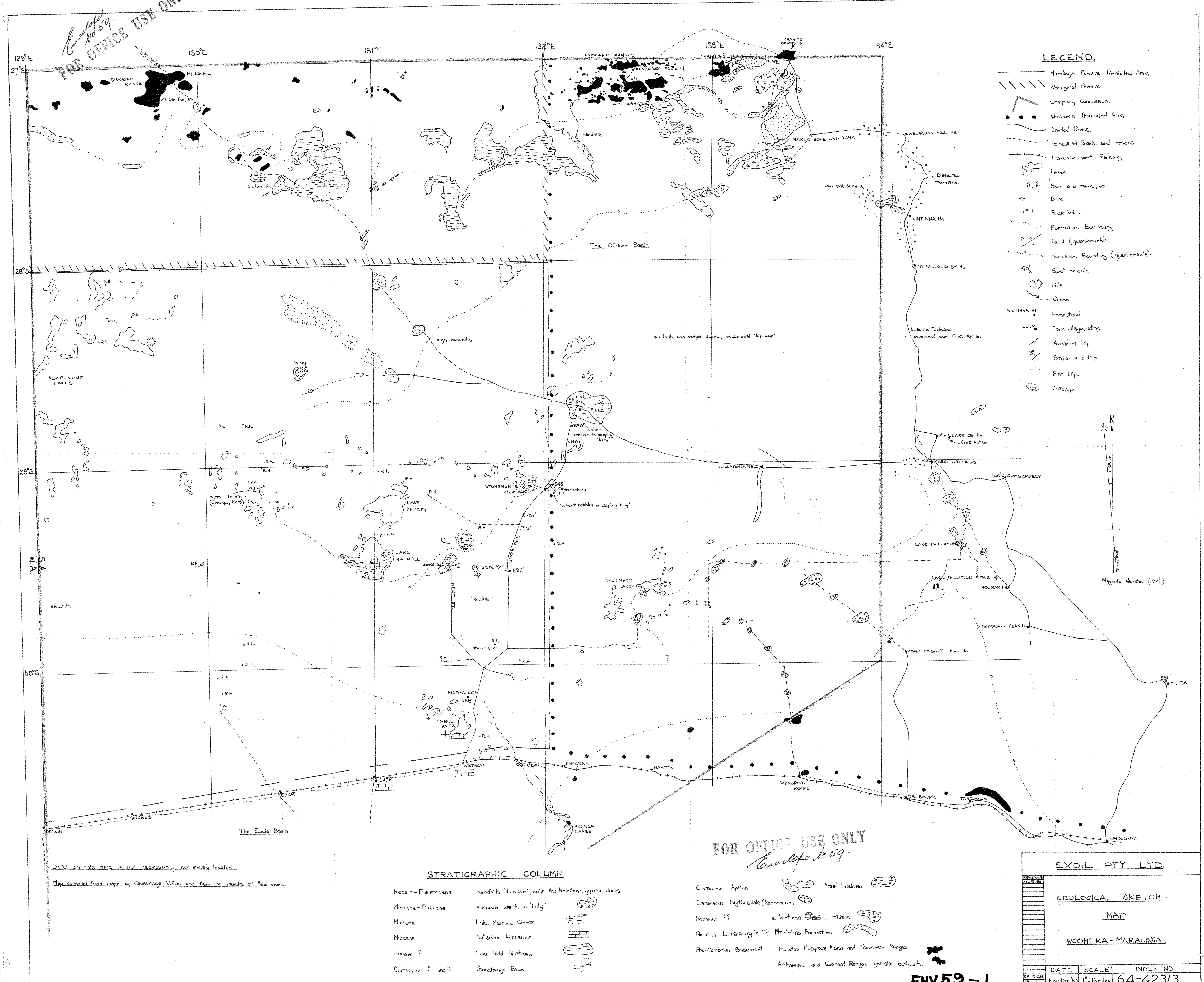
F 120/59 M66-F. 3 miles west of Wintinna H.S. 70 feet high breakaway.
2 specimens (1) 0 - 9' which is duricrust as F 119/59.
(2) 9 - 70' + a leached pink calcareous clay for which no age can be given.

F 121/59 M67-F. About 9 miles N 60° W from Wintinna H.S. Surface outcrop.
This is apparently the same as F 120/59 (1) and F 119/59.

F 122/59 M69-F. Mintabie Opal Field, about 25 miles south west of Marla Bore and Tank. P.S. 18S Grid E 2.
White agrillaceous sandstone with precious opal, siderite grains, gypsum.
No foraminifera were detected. Similar sandstone occurring in other opalfields overlies shales with a lower Aptian microfauna.

F 123/59 M85-F. Lake Maurice.
Dense buff quartzite, the age of which cannot be determined in the absence of fossils.
(see Geol. S. Aust. p. 77).

F 124/59 M86-F. 1 mile north of junction of West Street and 25th Avenue, Maralinga.
Mottled and banded pink and grey clayey sands, conglomerate and duricrust. The material is of non-marine origin. An exact age cannot be given, but it is thought to be post-Tertiary.



FOR OFFICE USE ONLY
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LEGEND
Maralinga Reserve - Prohibited Area.
Aboriginal Reserve.
Company Concession.
Woomera Prohibited Area.
Graded Roads.
Homestead Roads and tracks.
Trans-Continental Railway.
Lakes.
Bore and tank, well.
Bore.
Rock holes.
Formation Boundary.
Fault (questionable).
Formation Boundary (questionable).
Spot heights.
Hills.
Creek.
Homestead
Town, village, siding.
Apparent Dip.
Strike and Dip.
Flat Dip.
Outcrop
Magnetic Variation (1951).
129°E
130°E
131°E
132°E
133°E
134°E
27°S
28°S
29°S
30°S
BIRKSGATE RANGE
Mt. Lindsay
Mt. Sir Thomas
Coffin Hill
EVERARD RANGES
EVERARD PARK HS.
MT. CARMEENA
CHAMBERS BLUFF
GRANITE DOWNS HS.
MARLA BORE AND TANK
WELBOURN HILL HS.
WINTINNA BORE
WINTINNA HS.
Dissected tableland.
The Officer Basin
MT. WILLOUGHBY HS.
Laterite Tableland developed over Cret. Aptian
high sandhills
sandhills and mulga scrub, occasional 'kunkar'
SERPENTINE LAKES
Vokes Hill
EMU FIELD
chert pebbles in capping 'billy'
MT. CLARENCE HS.
Cret. Aptian
MABEL CREEK HS.
COOBERPEDY
TALLARINGA WELL
LAKE WYOLA
haematite etc. (George, 1905)
LAKE DEYDEY
STONEHENGE about 650'
Observatory Hill
LAKE MAURICE
25TH. AVE
EMU ROAD
WEST ST.
'kunkar'
WILKINSON LAKES
LAKE PHILLIPSON
LAKE PHILLIPSON BORE
INGOMAR HS.
MCDOUALL PEAK HS.
COMMONWEALTH HILL HS.
MT. EBA
S.A.
W.A.
sandhills
R.H.
about 600'
MARALINGA
YARLE LAKES
WATSON
OOLDEA
IMMARNA
BARTON
WYNBRING ROCKS
MALBOOMA
TARCOOLA
KINGOONYA
FISHER
COOK
HUGHES
DEAKIN
The Eucla Basin
PIDINGA LAKES
Detail on this map is not necessarily accurately located.
Map compiled from maps by Geosurveys, W.R.E. and from the results of field work.
STRATIGRAPHIC COLUMN
Recent - Pleistocene — sandhills, 'kunkar', soils, f/w limestone, gypsum dunes
Miocene - Pliocene — siliceous laterite or 'billy'
Miocene — Lake Maurice Cherts
Miocene — Nullarbor Limestone
Eocene ? — Emu Field Siltstones
Cretaceous ? undiff. — Stonehenge Beds
Cretaceous Aptian — , fossil localities
Cretaceous Blythesdale (Neocomian)
Permian ?? — at Wintinna , tillites
Permian - L. Palaeozoic ?? — Mt. Johns Formation
Pre-Cambrian Basement — includes Musgrave, Mann and Tomkinson Ranges Archaean and Everard Ranges granitic batholith.
EXOIL PTY LTD.
GEOLOGICAL SKETCH MAP
WOOMERA - MARALINGA.
DATE Nov. 11th. '59
SCALE 1" = 16 miles
INDEX NO. 64-423/3
AB
ENV 59 - 1