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DEPARTMENT OF MINES
SOUTH AUSTRALIA

PROGRESS OF MAPPING ON THE MARREE FOUR-MILE SHEET

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Plan No. 63-437: Geological sketch maps, locality plan and diagram. Scale 8 miles to 1 inch.

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REPORT ON

PROGRESS OF MAPPING ON THE MARREE FOUR-MILE SHEET

1. ABSTRACT

A geological reconnaissance has almost completed the mapping of the remainder of the Marree four-mile area, which straddles the edge of the Great Artesian Basin. Earlier mapping, under B.P. Webb, finished three one-mile sheets.

Precambrian basement rocks include part of the Mt. Painter granitic complex and the Adelaide System from Willouran to Marinoan Series. Within the basin are exposed sandstones equivalent to the Blythesdale Group and a predominantly shaley Aptian to Cenomanian succession. The base of the Cenomanian has not been recognized but Albian limestones should provide a useful marker. A post-Winton succession has been noted. Tertiary sandstones and duricrust are extensive, and reach a thickness of about 200 feet near Blanchewater.

A possible dolomitic equivalent of the Etadunna Formation occurs near the Clayton Embankment. Quaternary deposits include clays, ancient outwash gravels and more recent gypsum-covered pediments and sand ridges.

Folding within the basin has been mostly very gentle and has produced such broad structures as the Coorymanna dome. This appears explicable by gentle basement folding. Localized, more intense folding, such as that which produced near-vertical dips at Blanchewater, has possibly been caused by minor gravitational gliding.

2. INTRODUCTION

The Marree four-mile sheet is of interest because of its location at the edge of the Great Artesian Basin, a possible source area of petroleum. It comprises twelve one-mile sheets, two of which, Marree and Wilpoorinna, were mapped in 1961 by Webb, Horwitz, Coats and myself. The Murnpeowie sheet was partially mapped by Coats in 1961 also. The Gardiner one-mile, forming the south-east corner of the sheet, was compiled by Coats and published in 1961.

Accompanied by a driver, I made a geological reconnaissance of the remainder of the area in 1962, spending about 76 days in actual mapping between May and November. This report is not a final appraisal of the area, since palaeontological reports are not yet available and it is anticipated that

further mapping will be required.

The Commonwealth Railways line to Alice Springs crosses the south-western corner of the sheet, where also is the only township, Marree, just over 400 road miles north of Adelaide. From Marree, the Birdsville track runs NNE, through the western part of the area. The eastern side is serviced by the Strzelecki track which passes through Hurnpeowie H.S., the largest settlement outside Marree. The other occupied homesteads on the sheet are Mundowdna, Mulkaninna, Clayton and Wilpoorinna.

Away from the Willouran and Northern Flinders Ranges, which occupy respectively the south-west and south-east corners of the sheet, the topography is rather subdued and composed of flat-topped hills or plateaus of duricrust or ancient pediment gravels, outwash gravels and tracts of sand ridges. Rainfall is irregular and the annual average less than six inches. Vegetation is thus rather sparse and creek and lake-beds normally dry. There are two main directions of drainage, to the north-west toward Lake Eyre (e.g. The Frome and the River Clayton) and to the north-east into Lakes Gregory and Blanche (e.g. Cooryanna and Tooncatchyin Creeks).

I am grateful for the companionship and assistance of Departmental drivers, in particular Mr. N.J. Lines, and also for the hospitality and co-operation of Mr. and Mrs. L. Litchfield of Mundowdna, who kindly made regular radio contact during the field work. B.P. Thomson, Senior Geologist, and Drs. M.H. Ludbrook and H. Wopfner kindly read the manuscript and made useful suggestions.

3. PREVIOUS WORK

The most useful previous work has been that done in the last few years by Survey geologists, who have established the main mapping units by one-mile mapping and through the palaeontological work of Dr. M.H. Ludbrook. Reports by earlier

geologists such as Brown, who noted Tertiary leaf impressions near the present Clayton M.S., are nevertheless well worth referring to. Some of the reports listed below do not deal directly with the Marree four-mile area but are necessary references (e.g. Stirton, Woodard and Johns)

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Johns, R.K., 1956 - Geological Atlas of South Australia, sheets Farina, Lyndhurst. 1 inch/1 mile.

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1961b - Mesozoic non-marine molluscs (pelecypoda: Unionidae) from the north of South Australia. Trans. Roy. Soc. S.Aust. 84, 139-143.

1962a - Exploratory drilling, Lake Eyre. Sub-surface stratigraphy. S.A. Mines Dept. Rept. Bk. 54/104 (unpublished).

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Mawson, D., 1927 - Geological notes on an area along the north-eastern margin of the north-eastern portion of the Willouran Range. Trans. Roy. Soc. S.Aust. 51, 386-390.

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Sprigg, R.C., 1949 - Thrust structures of the Witchelina area, South Australia. Trans. Roy. Soc. S.Aust. 73, 40-47.

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4. PRECAMBRIAN

Most of the outcropping Precambrian occurs on the Wilpoorinna and Gardiner one-mile sheets, with small extensions onto the Marree and Apollinaris sheets. In the Willouran Ranges south of Marree, rocks of the Adelaide System dip to the north-east and include a diapirically intruded segment of the Willouran Series, the Sturtian Series with basal unconformity and part

of the Marinoan sequence. The top of the Sturtian as recognized in the Marree-Gardiner region is marked in many places by a lenticular boulder deposit which is often overlain by a prominent yellow-brown dolomite.

At the southern margin of the Apollinaris sheet is a north-trending anticlinal ridge of upper Sturtian siltstones and dolomites. Near the northern extremity of the Flinders Ranges, the Precambrian mapped by Coats, Horwitz and Thatcher includes the Sturtian, which lies unconformably on ancient metamorphic and granitic rocks. The Sturtian contains the Mt. Fitton talc deposits and is overlain conformably by Marinoan slates, quartzites, siltstones and dolomites. Fold axes trend approximately east-west.

5. CRETACEOUS

Rocks of Neocomian age, Blythesdale Group sandstones and conglomerate, have been recognized only on the Gardiner sheet. They are overlain by concretionary ironstone, shales and calcareous sandstone of Aptian age. At depth within the Basin the Blythesdale equivalent may be partly Jurassic in age.

Through the mapping of Webb, Horwitz and Coats, and palaeontological work by N.H. Ludbrook, it has been possible on the Marree one-mile sheet to indicate the junction between Aptian and Albian sediments. The boundary marker, a thin coarse sandstone, has unfortunately not been recognized on other one-mile sheets of the Marree four-mile. Marginal Aptian sediments south of Marree include ferruginous slate breccias and sandstones and lie unconformably on steeply-dipping Precambrian rocks which are ferruginized at the junction. Within a general succession of grey shales, the Aptian includes concretionary ironstone beds and fossiliferous grey argillaceous limestones, and nearer Precambrian contacts, scattered boulders of chiefly quartzite and red porphyry.

The Albian lithology is similar to the Aptian and comprises dark grey shale, mudstone, siltstone and interbedded ironstone. In the central or younger parts of the outcropping Albian are lenticular concretionary impure limestones, fossils from which have been examined by N.H. Ludbrook (locality at extreme north-west corner of the Marree one-mile). Similar fossiliferous limestones occur over a wide area in the Cooryanna region. (These may possibly be partly upper Albian in age - personal communication, N.H. Ludbrook).

The base of the Cenomanian (Winton Formation equivalent) has not been identified. The nearest convenient, but not very precise, boundary is the top of the Albian limestones. Above these limestones in the Cooryanna - Toopawarinna region are shales, sandy shales, siltstones and ironstone which could at least in part be Cenomanian. The base of the Cenomanian in the Blanchewater region is even more obscure. Ludbrook has identified Cenomanian at Reedy Springs, north-west of Blanchewater ruins. The rocks are carbonaceous sands, shales and ironstones. South-west of View Hill the lithology is still suggestive of the Cenomanian. In view of the proximity of the Aptian on the Gardiner sheet the Cenomanian may thus completely cover the Albian here.

Unconformably above what is presumed to be Cenomanian in the Clayton area is a sequence of shales and arkosic sandstones which underlies the basal Tertiary pebble bed. These relationships can be seen just north-east of Hayes Hill Proper, where cross-bedded kaolinitic sandstone and siltstone and banded sandstone lie on an irregular erosional contact with underlying banded shales showing slumping. Near Lake Harry and Marion bores, white and pale mauve-coloured banded kaolinitic sandstones, siltstone and shale with claystone conglomerates may also be of equivalent age. Comparable, but not necessarily equivalent, post-Winton beds have been described by Wopfner (1963) north of

Cordillo Downs. Certain kaolinitic sandstones with anomalous (possibly depositional) dips in the Hungerannie area (Forbes, 1960a) are similar to the Cordillo and Clayton occurrences.

Ludbrook (1962a, p. 6) describes upper Cretaceous arkosic mudstones from Lake Eyre borings. These may be equivalent to the outcropping Post-Winton beds and appear to lie conformably on the Winton below Lake Eyre.

By reference to the Koppermamma bore (Ludbrook, 1962b) estimated maximum thicknesses of the Aptian, Albian and Cenomanian are respectively 700, 900 and 900 feet. At the Yarra Hill bore the thickness of the Mesozoic from basement up to the Albian limestones is about 1000 feet.

6. TERTIARY

East of the Birdsville track, the Tertiary is a predominantly sandy sequence usually capped by siliceous duricrust. Duricrust containing leaf impressions was collected near Smart Bluff. Early Tertiary plant fossils from similar beds on the Callamma one-mile (west of Murree) have been described by E.K. Harris (1962). Commonly the base of these beds is marked by a thin band of polished pebbles of various forms of quartz and is overlain by pale red-brown, yellowish or grey sands of varying grainsize and state of lithification. The basal gravel is similar to that observed at the base of the Tertiary in the Cordillo region (Wopfner, 1960, 1963). Near Kinnacudinna Hill and elsewhere these beds include coarse, dark ferruginous cross-bedded sandstone. North of Koorae Hill, the duricrust overlies a calcareous sandstone which weathers into curious botryoidal shapes and overlies shaley sandstone and sand. The calcareous member seems to be fairly widespread.

The thickness of the sandy beds varies between about 12 feet, as at Lake Harry, and approximately 150 feet, as near Blanchewater. At Blanchewater, the duricrust is about 80 feet thick, but elsewhere is usually 10-25 feet thick. Direct

silicification has usually affected only the sandy beds, but sometimes involves the Cretaceous and, in some marginal areas, Precambrian rocks.

Near the western end of the River Clayton there are exposures of a flaggy, white, fine-grained dolomite or limestone which is tentatively correlated with Stirton's (1961) Etadunna Formation of Tertiary age. The maximum observed thickness of this limestone is 15 feet (overlying green clay).

Ten feet of sandstone, siltstone, green clay and minor limestone at the Clayton embankment may also be of the same age. On the Murnpeowie one-mile sheet are limited outcrops of cream pisolitic limestone or dolomite which may overlie the duricrust and are possibly equivalent to the Etadunna Formation.

Some features associated with Precambrian inliers south-east of Lake Pinnaroo may date back into the Tertiary or earlier times. Two rounded hills of folded siltstones are bordered in places by a narrow raised platform on which is a thin deposit of yellowish limestone or dolomite. This limestone also occurs sporadically up the slopes of the hills, and may be an ancient spring deposit. On the western side of the larger hill are wedges of breccia, suggestive of talus associated with a coastal cliff.

7. QUATERNARY

The earliest Quaternary deposits are grey, purplish or reddish gypseous clays which have been observed overlying the duricrust in the eastern part of the Wilpoorinna one-mile sheet and in a zone extending from the Apollinaris and Gardiner Sheets to the Waraminna one-mile sheet. North-east of Wilpoorinna H.S. the clays contain a narrow, winding outcrop of reddish sandstone, possibly representing an old stream channel.

Overlying the above clays and extending beyond their limits into the ranges are cross-bedded gravels and coarse conglomerates forming a prominent upper-level boulder deposit.

These appear to be old outwash gravels and are composed principally of quartzite and quartz derived from the Precambrian. On the Apollinaris sheet the boulders are up to 2 feet in length. Basinward, the deposit is finer and partly composed of duricrust pebbles. South-west and south of the Clayton Embankment, Quaternary gravels and accumulations of duricrust boulders are arranged in northerly- or north-easterly-trending strips, which may be shoreline features of an ancient Lake Eyre.

Impure, fine-grained gypsum deposits are common throughout the Marree region and are considered to post-date the older Quaternary gravels and to have formed at least in part through near-surface alteration of older gypseous rocks. Surface gypsum forms a thick crust on Quaternary clays from which the overlying gravels have been eroded. Thin near-surface gypsum beds develop beneath duricrust, Quaternary conglomerates and Recent gravels and on Precambrian and Cretaceous shales. Gypseous pediments south of Marree gently truncate the Quaternary conglomerate surface. Within the basin, gypsum often occurs on what seem to be eroded remnants of gently sloping pediments.

The major deposits of the Recent are sand ridges, talus and outwash derived from duricrust or Quaternary conglomerate, and lake and flood-plain alluvium.

8. STRUCTURAL GEOLOGY IN THE BASIN

From a comparison of bore logs, the Blythesdale Group equivalent appears to have a regional slope of between about 20 and 60 feet per mile, assuming that all bores are at the same elevation. The slope of 60 feet per mile between Marree and Lake Harry is thus probably exaggerated a little through difference in surface elevation. Over wide areas the duricrust appears to be nearly horizontal or rarely exceeds a dip of 3 degrees. Steeper folding near Marree and near Woolawatana has already been demonstrated by Coats et al.

One of the most prominent structures in the sense of area covered is a broad, uplifted tract which may conveniently be termed the Cooryanna dome. Evidence for the dome is the attitude of the limbs and the widespread occurrence of Albian limestones near its core, which is drained by Cooryanna Creek. A comparison of bore depths near the centre of the dome (Yarra Hill, Cooryannina) with depths on the west limb (Bullamanna, Clayton) is also confirmatory. A minor synclinal axis is superimposed on the western limb.

South of the north-trending Cooryanna dome are successively the approximately easterly-aligned Lake Arthur trough, Nookwarinna dome and Apollinaris trough. The latter trough is partially filled with Quaternary clays and gravel and appears to extend north-east via Perseverance Dam toward the southern part of Lake Gregory. East of this depression is the Kooroo Hill dome, succeeded to the east by Quaternary deposits.

The Kooroo Hill dome is terminated to the south-east by a winding ridge of steeply easterly-dipping duricrust which is monoclinal in character for at least part of its length. This feature was first recognised by Coats (personal communication). Blanchewater Hill forms part of the ridge, which extends in a north-easterly direction. A similar ridge, continuous with the above, runs south-east from Blanchewater, curving across the Peterborra one-mile sheet (east of the Barree four-mile) toward the duricrust ridge mapped by Coats in the Woolawatana area. Near Blanchewater the duricrust and underlying Tertiary and Cenomanian are vertical, or very nearly so, in places. South of the eastern ridge there is folding with axes trending approximately northerly.

A possible cause of the above local steepening of dip is minor gravitational gliding of the sediments away from the north-east Flinders Ranges. The structure seems to be too irregular in plan for it to be ascribed to basement faulting. Apart from the Blanchewater phenomenon, folding in the basin

sediments appears to be explicable by broad, gentle basement folding. The parallelism of basement and basin structure is particularly evident south-west of Smart Bluff.

Near Blanchewater L.W. Parkin (personal communication) has pointed out the easterly dip of superficial deposits and postulated recent movement of the Blanchewater structure. This suggestion is also supported by the incision of the creek south of Blanchewater ruins.

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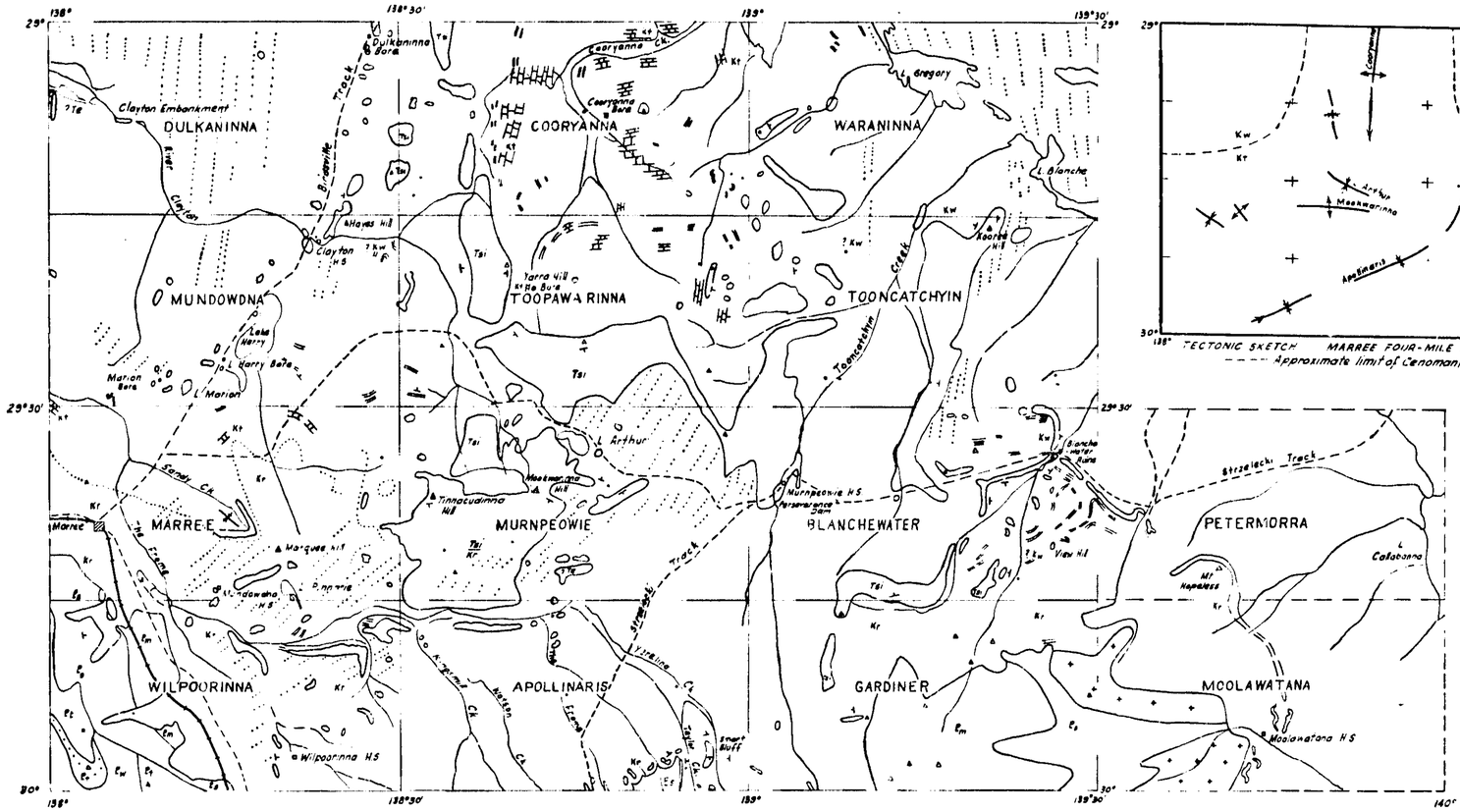
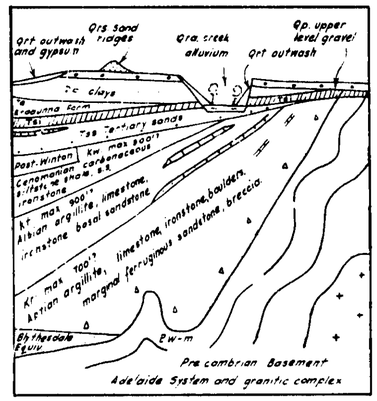
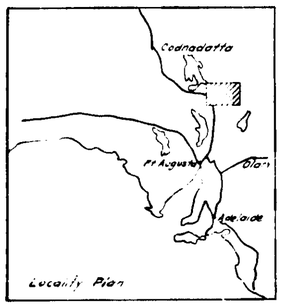




LEGEND

- Sand ridges
- ?Te — ? Etadunna Formation
- Tsi — Tertiary duricrust
- Kw — Cenomanian (Winton Equivalent)
- Cretaceous beds (often ironstone)
- Kt — Albian (Tambo equivalent)
- Albian limestone
- Kr — Aptian (Roma equivalent)
- Pm — Manitoan
- Ps — Sturtian
- Pt — Torrensian
- Pw — Willouran
- Granitic rocks



SCALE

MILES 0 4 8 16 24 32 40 MILES

To accompany report by B G Forbes

S.A. DEPT. OF MINES

GEOLOGICAL SKETCH MAP OF MARREE REGION

Associated Drawing	No.	No.	Amendment	Exd.	Date

Req. No.
D.M.
Compiled from

Approved	Passed
Director of Mines	

Drn. B G F
Tcd. A C W
Ckd.
Exd.

Scale : As Shown
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