SIMPSON DESERT NORTH
NORTHERN TERRITORY

SHEET SG/53-4 INTERNATIONAL INDEX
DEPARTMENT OF MINERALS AND ENERGY
BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

1:250 000 GEOLOGICAL SERIES—EXPLANATORY NOTES

SIMPSON DESERT NORTH
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Compiled by A. Mond

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Explanatory Notes on the Simpson Desert North Geological Sheet

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The Simpson Desert North 1:250 000 Sheet area was mapped in 1971 as part of a regional reconnaissance survey of the northwestern Eromanga Basin. It is situated in the centre of the Simpson Desert, in the southeast corner of the Northern Territory.

The area is unpopulated, undeveloped, and, with the exception of a few rocky outcrops around dry lakes, entirely covered by sand. The dominant southeast trade wind has formed longitudinal sand dunes, which are the characteristic feature of the whole Simpson Desert and make travelling difficult. The only access routes, which were made during seismic surveys, are bulldozed tracks parallel and at right angles to the sand dunes. These tracks are likely to last for years; tracks even ten years old can be easily identified. While travelling parallel to dunes in a light four-wheel-drive vehicle, slow but steady progress can be maintained at rates up to 10 km/hour (consumption about 2.5 km/litre). Travelling at right angles to sand dunes is much more difficult, even when following a bulldozed track. The most difficult part is the crossing of the active dune crests, which are undulating areas of unconsolidated sand 15-30 m wide. It is much easier to travel east because of the asymmetrical shape of the dunes.

The Sheet area is located in one of the driest parts of the continent. Few climatic details are available as this and the surrounding areas are uninhabited. Some meteorological observations were carried out by Madigan (1945) while crossing the desert, but his observations were made during an exceptionally wet season and over a limited time. The climate of this region has more recently been discussed by Slatyer (1962). Most of the area is enclosed by the 150-mm isohyet. Although the annual distribution of rainfall is fairly even on a long-term average (but with slightly more in summer than in winter), actual rainfall is very erratic, both seasonally and annually. At Charlotte Waters, 200 km southwest of the Sheet area, the average annual rainfall over 44 years was 130 mm, with monthly means ranging from 4.57 mm (September) to 19.05 mm (January). The mean annual temperature at Charlotte Waters over a 30-year period was 21.9°C with a mean maximum of 29°C and mean minimum of 14.5°C. Monthly mean temperatures ranged from 22.5°C (January) to 12.3°C (July). The maximum recorded temperature is 48.5°C and the minimum 5.3°C. Sturt (1849) mentioned shade temperatures of 42-54°C.

There is no permanent surface water in the area, although rainwater will stand for a limited period in the claypans, interdune hollows, and river floodplain areas.

Two sets of aerial photographs provide complete coverage of the area; a 1:50 000-scale set was taken in 1957, and a 1:85 000-scale set (RC9) was taken in 1971. Both sets, together with a 1:250 000 planimetric map, are available from the Division of National Mapping, Canberra.
Previous investigations

The Simpson Desert was first seen and entered by the exploring expedition of Captain Charles Sturt in 1845. In his attempt to reach the centre of the continent from the east he was finally forced to turn back at the Queensland/Northern Territory border at about latitude 24°40'S 'by the dreadful waterless sea of sand dunes and Spinifex' (Sturt, 1849). In an attempt to cross the continent from east to west in 1848, the Leichhardt expedition vanished probably in the Simpson Desert, for it seems unlikely that a party of such a size would disappear anywhere else (Madigan, 1936). Thirty-five years later, during his 1883 expedition, Charles Winnecke followed the Hay River, which he discovered and named, southwards to about latitude 24°33'S. Here he found six flooded areas separated by high sand dunes, which he explored on both sides of the river (Winnecke, 1884; Madigan, 1938). Also in 1883, a survey was started of the state boundary from Poeppels Corner, north along the 138th meridian, to the sea. Completed in 1886, it shows every dune on the eastern side of the desert (Madigan, 1938).

In 1929, C. T. Madigan set out on an aerial reconnaissance of the dry lakes of South Australia and the southeastern part of central Australia. On Flight 4, he covered the northwestern part of the Sheet area and pointed out that '... about midway between the Hale and Hay Rivers there was an area of claypans, with some low mound-like hills, to the north of our track' (Madigan, 1930). As a result of this trip, Madigan recognized and described the Simpson Desert as a distinct physiographic unit (Madigan, 1930, 1936), and, in 1929, he gave the area its name in honour of A. A. Simpson, then president of the Royal Geographical Society of Australasia.

Scientific activities in the Simpson Desert started in the winter of 1939 with an expedition of 9 men and 19 camels led by Madigan (Madigan, 1946a), who traversed the southern part of the Simpson Desert North Sheet area. During the journey across the desert and around the southeastern margins, the expedition collected representatives of 50 families of plants, totalling 350 species, of which 75 were collected from the desert proper. A popular account of the journey was published by Madigan (1946b) and the scientific results were published as a series of reports in the Transactions of the Royal Society of South Australia (Carroll, 1944; Hickman, 1944; Kinghorn, 1945; Madigan, 1945, 1946a; Musgrave, 1945; Whitley, 1945; Crocker, 1946; and Eardley, 1946, 1948).

In dry lakes, at about 137°E, 24°45'S, the expedition discovered Aboriginal chipped-flint artifacts and broken grinding stones, including schist which may have come from the MacDonnell Ranges (Madigan, 1945). As the natives from the south and the Diamantina area have always denied any knowledge of the desert, it would seem likely that tribes from the north penetrated a long way south by following the streams from the MacDonnell Ranges after a wet season.


Geophysical studies of the Simpson Desert, including part or the whole of the Simpson Desert North Sheet area, were made by a number of organizations in subsequent years. In 1960, the Bureau of Mineral Resources (BMR) carried out a
reconnaissance gravity survey using helicopters (Barlow, 1966). During this survey, Department of the Interior surveyors determined levels down the Hay River, and established an astrofix at the southernmost station, NT 32 (also a regional magnetic station), about 92 km down the river. An aeromagnetic survey in the Simpson Desert was flown by Aero Service Ltd for BMR in 1962 (Quilty & Millsom, 1964), using a line-spacing of eight kilometres. From April to June 1964, Compagnie Générale de Géophysique (1964) carried out a reconnaissance seismic survey for Mercure International Petroleum Pty Ltd. Two perpendicular traverses were covered by continuous reflection profiling. Between May and December 1966, a reconnaissance seismic survey using continuous-cover reflection methods was conducted in the western Sheet area by Austral Geo Prospectors Pty Ltd (Schisler, 1967) for Amerada Petroleum and Exxon. In May 1967, Adastral Hunting Geophysics (1967) flew an airborne magnetometer survey of the northern half of the Sheet area for Exxon Pty Ltd. Lines were spaced 2.5 km each side of every second line of the 1962 BMR survey.

Dry lakes in the northwest Sheet area were visited in the mid-sixties by Mr F. Bird from Indiana Station. While looking for stray cattle, he discovered a lung-fish tooth. This motivated Prof. J. W. Warren from Monash University to organise a small expedition, which briefly visited most of these lakes in July 1971 and recovered a small but important collection of fossils including 5 shark teeth (J. W. Warren, pers. comm.). Such fossils are likely to help determine the extent of the Tertiary marine transgression in central Australia.

PHYSIOGRAPHY

The surface elevation of the Simpson Desert North Sheet area drops from 182 m in the northwest, to 110 m in the northeast, and to 65 m in the southeast. Sand dunes, alluvial plains along rivers, and low hills adjacent to dry lakes are the main landforms in the Sheet area. The Simpson Desert is the classic area for parallel dunes, which were first described in 1849 a little to the east of the Sheet area by Captain Charles Sturt, who believed they originated by 'the rush of a mighty current of water'.

The sand dunes are between 10 and 30 m high, and many run continuously with a mean trend of 334° for 160 km, although individual dunes may be up to 300 km long. They are straight and evenly spaced, mostly about 400 m apart. Characteristic are tuning-fork juncurnces opening to the south-southeast, which is caused by the helicoidal flow (Langmuir circulation) of air cells moving with the prevailing south-southwesterly winds and confirms the one-wind theory for the origin of the longitudinal dunes in this desert (Folk, 1971). They have serrated tops with active crests, and are asymmetrical in cross-section, the western slope averaging 15°, the eastern 25°. This asymmetry was produced by occasional strong side-winds that came mostly from the west. Apart from the crests, which are 15-30 m wide and support only rare spinifex clumps or small bushes, the dunes are colonized by plants and considered to be stable.

To the low interdune areas, which constitute up to four-fifths of the desert surface, Folk (1971) applied the term 'reg'—a deflationary flat in the Sahara (Gautier, 1935). In some places, such areas are occupied by dry lakes and, more rarely, the terminal portion of ephemeral streams.
The Plenty and Hay Rivers, both intermittent streams, disperse their waters into the Simpson Desert. Narrow alluvial plains are limited to areas close to the river channels and form only a minor part of the Sheet area. They consist mostly of fine to coarse sand, with some gravel in places.

Low hills in the northwest and near the central Sheet area are formed by weathered and partly silicified Cretaceous (Winton Formation) and Tertiary rocks. The hills are drained by streams which flow to the northwest and terminate in ephemeral lakes. The lakes are shallow (seldom more than 2 m deep) and vary in length from a few metres up to 9 km. In some places, lake margins are poorly defined: the surrounding area merges almost imperceptibly into the lake, and the only indication of a margin is the ring marking the edge of the deposit of fine silt, which covers the bottom and sides of the lake. In other places, sand dunes border the lake edges.

The vegetation of the Simpson Desert area has been discussed by Crocker (1946), Eardley (1946, 1948), Perry & Lazarides (1962), and Wiedemann (1971). Crocker (loc. cit.) classified the vegetation of the Simpson Desert into three groups (edaphic complexes). Only two of these occur in the Sheet area: (1) the *Triodia basedowii* (‘porcupine grass’ or ‘spinifex’)-*Zygophylopa paradoxa* (‘cane grass’) complex of the sand on crests, slopes, and interdune corridors; and (2) *Eucalyptus coolabah* (‘desert box’)-*Atriplex nummularium* (‘giant saltbush’) complex of the river channels and floodplains.

**STRATIGRAPHY** (Table 1)

The succession consists of a Precambrian basement overlain by Permian rocks of the Pedirka Basin, which are overlain by rocks of the Mesozoic Eromanga Basin and Cenozoic Lake Eyre Basin. Interpretation of the subsurface stratigraphy is based on petroleum exploration wells—the Amerada Hale River 1 (Simpson Desert South Sheet area) and the FPC The Brothers 1 (Bedoukie Sheet area)—geophysical data, and the geology of adjacent Sheet areas.

**BASEMENT ROCKS**

Interpretation of the aeromagnetic data (Quilty & Milsom, 1964) shows that the basement rocks in the Simpson Desert North Sheet area are characterized by intense magnetic anomalies, elongated in a predominantly north-northwest direction. As basement rocks of the Arunta Complex crop out along the northern edge of the Eromanga Basin, and have been intercepted in the shallow stratigraphic holes, BMR Hay River 2, 3, and 4 on the Hay River Sheet area (Yeates, 1971), it thus seems likely that they continue into this area.

In Amerada Hale River 1, 29 km south of the Sheet area, basement volcanic rocks were intersected between 1434 and 1732 m. The sequence consists of volcanic-pebble conglomerate, tuffaceous agglomerate, interbedded basalt with intrusive feldspathic dykes, and possible andesite sills (Amerada Petroleum Company, 1966). The extent of this sequence, which was encountered only in Amerada Hale River 1, is unknown. However, the proximity of this well to the Simpson Desert North Sheet area suggests that the sequence could be present here too.
<table>
<thead>
<tr>
<th>Age</th>
<th>Rock Unit</th>
<th>Lithology</th>
<th>Thickness (m)</th>
<th>Depositional Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td>CENOZOIC</td>
<td>Qa</td>
<td>Alluvial sand, lacustrine silt and clay; some salt, dust</td>
<td>0-5</td>
<td>Fluvial, lacustrine, aeolian</td>
</tr>
<tr>
<td>Qs</td>
<td>Aeolian sand, minor alluvial sand and gravel along rivers</td>
<td>2-35</td>
<td>Aeolian, fluvial</td>
<td></td>
</tr>
<tr>
<td>T</td>
<td>Fine sandstone, green and yellow mudstone and siltstone, gypsum, silcrete, ironstone</td>
<td>10</td>
<td>Fluvial, marine, lacustrine, aeolian</td>
<td></td>
</tr>
<tr>
<td>Ts</td>
<td>Coarse sandstone, commonly silicified</td>
<td>1-5</td>
<td>Fluvial</td>
<td></td>
</tr>
<tr>
<td>LATE TERTIARY</td>
<td>Winton Formation Kw</td>
<td>Labile sandstone, siltstone, mudstone, calcareous in part; some coal, weathered limestone</td>
<td>0-650</td>
<td>Fluvial and paludal</td>
</tr>
<tr>
<td>LOWER CRETACEOUS</td>
<td>Allaru Mudstone Kla</td>
<td>Dark grey mudstone</td>
<td>200-250</td>
<td>Marine</td>
</tr>
<tr>
<td>ROLLING DOWNS GROUP</td>
<td>Toolebuc Limestone Kio</td>
<td>Grey calcareous siltstone, greyish brown limestone</td>
<td>30-45</td>
<td>Shallow marine</td>
</tr>
<tr>
<td></td>
<td>Wallumbilla Formation Klu</td>
<td>Dark grey mudstone, glauconitic labile sandstone and siltstone, calcareous in part; minor pyrite</td>
<td>150-200</td>
<td>Marine</td>
</tr>
<tr>
<td>JURASSIC</td>
<td>JK</td>
<td>Sandstone, pebbly sandstone, some carbonaceous siltstone, coal, dreikanter</td>
<td>200-500</td>
<td>Jurassic fluvial; Cretaceous, at least in top part, marine</td>
</tr>
<tr>
<td>PALAEOZOIC</td>
<td>P</td>
<td>Sandstone, siltstone, conglomerate, coal</td>
<td>0-200</td>
<td>Terrestrial</td>
</tr>
<tr>
<td>PERMIAN</td>
<td>UNCONFORMITY</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PROTEROZOIC</td>
<td>E</td>
<td>Gneiss, schist, quartzite, volcanics (probably basalt and pyroclastics)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
PERMIAN

The geophysical survey (Compagnie Générale de Géophysique, 1964) did not provide any evidence for the existence of a pre-Mesozoic basin in the Simpson Desert North Sheet area. The presence of Permian rocks (as shown in a cross-section) is inferred from the geology of the adjacent areas which suggest that, towards the eastern and northern margins of the Sheet areas, the Permian succession thins by onlap against the rising basement.

In Amerada Hale River 1, 116 m of Permian was intersected: white fine to coarse sandstone (in places kaolinitic, carbonaceous, and pyritic) is interbedded with coal, siltstone, and conglomerate. Seismic data indicate that the Permian section is relatively thin in this area, but that it thickens to the southeast.

In most parts of the Pedirka Basin the Permian section comprises, in ascending order, glacial, marine, and freshwater deposits (Wopfner, 1964). Palynological examination of samples from water-bores (Balme, 1959; Evans, 1964) and petroleum exploration wells (Magnier, 1964a, b) south and southwest of the Sheet area indicates a lower Permian (Săkmarian-Artinskian) age.

JURASSIC TO LOWER CRETACEOUS

Apart from the seismic horizon that represents the top of the Jurassic to Lower Cretaceous sequence, there is no other information about the Jurassic to Lower Cretaceous in the Sheet area.

To the south, in Amerada Hale River 1, the Jurassic to Lower Cretaceous sequence can be subdivided into a lower unit, consisting almost entirely of sandstone, and an upper unit of calcareous sandstone interbedded with shale. These two subdivisions correspond to the Algebuckina Sandstone and Cadna-owie Formation of northwestern South Australia (Wopfner, Freytag, & Heath, 1970) and to the lower and upper Hooray Sandstone of southwestern Queensland (Galloway & Senior, 1971).

Towards the northern margin of the Eromanga Basin no comparable subdivision is apparent, and the Jurassic to Lower Cretaceous sequence was named the Longsight Sandstone (Casey, 1959). In BMR Hay River 4, about 15 km north of the Sheet area, the section from 235 to 85 m, which Burger & Mond (1973) regard as the Longsight Sandstone, consists of pyritic clayey sandstone, siltstone, and calcareous sandstone. The presence of spores of palynological units K1b-c to K2a (Aptian-Lower Albian) indicates that sand deposition took place there later than in the deeper parts of the basin.

Rolling Downs Group

The precise nature of the Wallumbilla Formation in the Sheet area is unknown. The sequence termed 'Roma Formation' in Amerada Hale River 1 (Amerada, 1966) and FPC The Brothers 1 (Magnier & Swenev, 1965) is lithologically similar to, and occupies the same stratigraphic position as, the Wallumbilla Formation elsewhere in the Eromanga Basin. In Amerada Hale River 1 it consists of glauconitic and calcareous mudstone, siltstone, and fine sandstone with rare pyrite, Inoceramus fragments, and argillaceous limestone.
The Wallumbilla Formation thins towards the northern margin of the Eromanga Basin and pinches out north of the Sheet area. In the central Eromanga Basin, it can be divided into the Doncaster and Coreena Members. Because of insufficient information no attempt was made to subdivide the unit in this area.

The Toolubuc Limestone is presumed to be present in the subsurface because it has been recognized in wells south and east of the Sheet area. In Amerada Hale River 1, it consists of 38 m of grey shale and greyish brown limestone with fossil fragments (Inoceramus prisms). Elsewhere in the Eromanga Basin, it generally consists of thinly interbedded limestone and calcareous siltstone, with layers of Inoceramus fragments, and forms a useful widespread marker separating the Wallumbilla Formation from the Allaru Mudstone. In the subsurface it can be recognized in most places on gamma-ray logs by anomalously high radioactivity.

The Allaru Mudstone was intersected to the north in the BMR Hay River 2 and 4 wells. It consists of dark grey mudstone, which contains spores of palynological unit K2b (middle Albanian) (Burger & Mond, 1973). The nearest outcrops to the Sheet area are around Lake Caroline, about 15 km to the north in the Hay River Sheet area.

The Winton Formation is a widespread continental deposit and one of the few stratigraphic units to crop out in the Sheet area. Most outcrops are around dry lakes near the centre and in the northwest, and consist of highly weathered lithic sandstone, silicified siltstone and mudstone, and weathered limestone.

The sandstone is very fine to fine and is commonly cross-stratified. It consists of about 70 percent lithic fragments, 25 percent quartz, and minor clay matrix and accessory minerals; extensive replacement by iron oxide is common. The rock fragments have been replaced by kaolin (AMDEL, 1972).

The limestone is composed almost entirely of very fine-grained calcite with traces of clay and few detrital quartz grains. It is pale pinkish orange, and has an irregular, somewhat nodular surface.

The lack of marine fossils and the presence of abundant fragmentary plant material suggest that the Winton Formation is a freshwater sequence. Spores and pollen of early Upper Cretaceous (Cenomanian) age were recovered from drill holes in South Australia and Queensland (Dettmann, 1963; Dettmann & Playford, 1969; Harris, 1968, 1971). The spore assemblage from the BMR Gascoyne 2 well in South Australia (Harris, 1971) is dominated by laevigate monolete and trilete spores, and probably represents a restricted environment, such as swamp where there is minimal water transport. Swampy land with forests is also indicated by the presence of coal and silicified wood.

**Tertiary**

Coarse-grained fluvial sandstone rests disconformably on the weathered and uneven surface of the Winton Formation. The sandstone is commonly silicified and its top part has, in most places, been converted to silcrete. It can be correlated with the Eingambran Formation (Wells, Ranford, Stewart, Cook, & Shaw, 1967). In South Australia, lithologically similar units in the same stratigraphic position (the Eyre Formation and Mackunda Sandstone) contain Lower Tertiary plant fossils. The original thickness of the unit in this area is unknown.
Along the western and southern margins of the dry lakes there are good exposures of green fine-grained sandstone, green and yellow mudstone and siltstone, and layers of gypsum; in places there are silcrete and ironstone. Although the relation of this sequence to the Tertiary sandstone is obscured by sand, it is believed to be younger. Fossils found in the sequence (Prof. J. W. Warren, pers. comm., 1972) do not establish the precise age or the environment of deposition; they include silicified wood, a pectenoid shell, two fragments of silicified bone, one coprolite, five shark teeth, and one fragment of a lungfish toothplate. The bone fragments are believed to be parts of a large animal such as a turtle or perhaps a mosasaur. The lungfish is probably of freshwater origin, but the shark teeth suggest marine conditions; both may be Tertiary or Upper Cretaceous. In general, the lithology and fossils suggest correlation with the Eudunda Formation in South Australia (Stirton, Tedford, & Miller, 1961), for which an Oligocene age was suggested. However, Ludbrook (1963) recorded Foraminifera from the basal part of the Eudunda Formation in a borehole drilled in the southeast part of Lake Eyre North, and, on the palynological evidence of Balme (in Ludbrook, 1963), the formation is thought to be no older than Miocene.

QUaternARY

Although a number of authors have discussed the morphology and origin of the Simpson Desert dunes (Sturt, 1849; Madigan, 1936, 1938, 1946a; King, 1960; Wells et al., 1967; Wopfner & Twidale, 1967; Mabbutt, 1968; Mabbutt & Sullivan, 1968; and others), little attention has been paid to their composition, structure, and colour. Carroll (1944) described the grainsize, sorting, and mineralogy of samples collected by Madigan’s expedition. She was the first to report that the sand on the crests was coarser than that on the interdune deflationary flats. Crocker (1946), who was a member of Madigan’s expedition, studied the grain size distribution of the sand and made an excellent analysis of the bimodality of the sand of the deflationary flats. In July and December of 1965, R. L. Folk, while visiting professor at the Australian National University, examined an area on the western margin of the Simpson Desert and described the bimodality of desert reg deposits (Folk, 1966, 1968). He defined the interrelation of the grain size properties of a suite of desert sand samples and related it to dune micro-geomorphology (Folk, 1971), and discussed the red colour, silica diagenesis, and shape of the grains (Folk, 1969).

The grain size distribution of sand in the dunes is positively skewed, resembling that of beach dunes, but the sorting is not as good. Dune subenvironments show much overlap in grain size properties, but small consistent distinctions can be observed: crests are coarsest, best sorted; lee flanks are finest, most poorly sorted; and windward flanks are intermediate in these aspects.

Sediment of the deflationary flats tends to be more poorly sorted than dune sand, and is composed of both finer and coarser material.

Simpson Desert sand is intense dark reddish orange (2.5 YR 4/7 on Munsell colour chart). Microprobe analysis reveals small pits on quartz grains filled with hematitic clay, which gives the reddish colour. The red clay partly represents reworked lateritic coating developed under a former, more humid climate. The colour is more intense in dunes than in regs because wind-blown lateritic dust accumulates
on dune faces, and is washed into them by rain or the action of desert dew. Intense heat and oxidation serve to bake the dust and form clay-iron cutans.

Most of the grains of the Simpson Desert sand are angular; any ‘roundness’ is inherited, and grains in dunes are just as angular as grains in intervening fluvial deflation flats.

Sediments of the ephemeral lakes (Qa) appear to have been derived from the Cretaceous and Tertiary rocks which crop out along their margins. The character and thickness of these sediments are unknown and can be revealed only by drilling.

STRUCTURE

With the exception of the Cretaceous and Tertiary rocks cropping out in the western Sheet area, there is little surface expression of subsurface structure. However, as a result of geophysical surveys, petroleum exploration wells, and strati-
graphic drilling in this and adjacent Sheet areas, the broad structure of the Simpson Desert North Sheet area is fairly well known.

The dominant structure of the Precambrian basement is a gentle slope to the southwest. Imposed on this is a broad depression delineated by the contours of depth to magnetic basement (Fig. 1). There is evidence of faulting in the basement on either side of the depression.

The Permian rocks forming a northern extension of the Pedirka Basin wedge out against the Precambrian basement. The maximum thickness is within the depression in the Precambrian basement and there is marked thinning over Precambrian highs.

The Mesozoic Eromanga Basin sediments form a very broad syncline plunging less than 1° towards the southeast. Its axis roughly coincides with the axis of the Precambrian depression.

Cainozoic sediments in this area form the northern part of the Lake Eyre Basin which was initiated in the early Tertiary or possibly late Cretaceous, when the Sheet area was tilted towards the southwest. Tilting, which accompanied the Mount Lofty/Flinders Ranges System block-faulting, was renewed again during the late Tertiary, and continued during the Pleistocene. Lake Eyre, which has been an intermittent lake since the early Cenomanian (Ludbrook, 1963), is now below sea level and is still tilting to the south, where flood waters accumulate (Sprigg, 1961, 1963).

GEOLOGICAL HISTORY

Proterozoic rocks were deformed and metamorphosed by Precambrian earth movements before the eruption of volcanic rocks in the late Precambrian. During the late Precambrian and early Palaeozoic, the Sheet area was a relatively stable platform. There is no record of sedimentation in the area until the early Permian, when there appears to have been a shallow basin in central Australia; the extent of the basin can be revealed only by deep drilling. By the end of the Sakmarian, the connexion with the open sea was disrupted. Sedimentation continued in intracratonic freshwater basins which filled with sediments and became shallow and swampy. In this environment the Lower Artinskian sequence was deposited (Wopfner, 1964). The interval between the Artinskian and the Upper Jurassic was essentially a period of erosion, denudation, and peneplanation. There is no record of Triassic sedimentation in the Sheet area; if Triassic sediments were deposited they have been subsequently eroded.

The Jurassic to Lower Cretaceous rocks record the change from a continental regime in late Jurassic to an epicontinental marine environment in the early Cretaceous (Wopfner et al., 1970). The lower part of this sequence was deposited from rivers with low gradients on a stable senele land surface. A seasonally arid climate suggested by the presence of dreikaners was followed by a moist subtropical climate indicated by the fossil flora. In the Lower Cretaceous, a shallow sea covered the Eromanga Basin, and in it were deposited the Wallumbilla Formation, Toolabuc Limestone, and Allaru Mudstone. In the late Albian, marine sedimentation gradually gave way to continental sedimentation, and the Winton Formation was the last Cretaceous unit to be deposited throughout the Eromanga Basin. By the end
of the Cenomanian, sedimentation had almost ceased, and during the late Cretaceous and early Tertiary the Winton Formation was eroded and deeply weathered. In the early Tertiary, a veneer of fluvial sands and channel deposits was deposited on the weathered and uneven surface of the Winton Formation. Subsequent tectonic movements resulted in uplift, erosion, and deep weathering and silicification of Tertiary and Cretaceous sediments.

In Australia the lower Miocene and Pliocene seas were generally transgressive, but during the upper Miocene there was a general regression of the sea (Fairbridge, 1953). On the evidence of foraminifers, Lloyd (1968) suggested that a brief marine incursion in central and northern Australia could have occurred in the lower Miocene. He believed that in the late Tertiary and Pleistocene there had been considerable movement of the land in central and northern Australia, and that uplift had been sufficient to lead to a final retreat of the sea and account for the present elevations.

The sand that forms the dunes of the Simpson Desert was brought in by the rivers draining the ranges to the east and north, and has been accumulating in topographically low areas since the early Pleistocene. Vegetation was plentiful and there was a giant-marshupial fauna living on the fringes of extensive freshwater lakes. Subsequently, the climate became drier and sand dunes formed, as aridity increased toward the end of the Pleistocene.

In conflict with most authors, who consider that glacial periods coincide with wetter climates and that the dunes must have formed in a drier, warmer interglacial period, Galloway (1965a, b) believes that Australia’s longitudinal dunes were formed in a cold, dry, windy, glacial period when there was reduced precipitation; later, an increase in rainfall enabled the growth of vegetation, which stabilized the dunes in their present position.

The problem of the long-term tendency towards a drier climate since the dunes formed has been fully discussed by Whitehouse (1940a, b; 1963), Madigan (1946a), Crocker & Wood (1947), Gill (1955, 1961), Galloway (1965a, b), Mabbitt (1965, 1967), and Folk (1971). It seems that over the last one-hundred years increasing aridity has resulted in the death of vegetation, and has caused a reactivation of the dune crests.

MINERAL RESOURCES

The Simpson Desert North Sheet area is remote, inaccessible, and almost entirely covered by sand, and the only records of economic geology are from petroleum exploration.

Petroleum

The Permian section of the Pedirka Basin is identical with that of the Cooper Basin, in which coal measures are believed to be both source and reservoir rocks for petroleum. If the favourable structures known to exist in the Permian section of the Simpson Desert South Sheet area are found to contain petroleum, exploration in the Simpson Desert North Sheet area might follow. At the present time, however, seismic exploration has not indicated the presence of any suitable structures in the Sheet area, in either the Permian or the Mesozoic sequence.
Water

The only surface water in the Sheet area lies in ephemeral lakes after rain and remains there no longer than a few weeks before it evaporates. Similarly, water-holes along the Plenty and Hay Rivers may hold water following the wet season, but these are not common.

The area is unsuitable for pastoral use because of lack of food, and thus no water-bores have been drilled. However, drilling for water and oil in surrounding areas indicates that groundwater is available in the subsurface of the whole Sheet area. The clean porous Jurassic sandstones are the main aquifers in the Great Artesian Basin, and good supplies of artesian and subartesian water have been obtained from the De Souza and Longsight Sandstones throughout the northwestern part of the Eromanga Basin.

In the Simpson Desert South, McDills, and Hay River Sheet areas some shallow bores and wells have been sunk in Quaternary units, and these also produce good supplies of water.
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