SOUTH LAKE WOODS
NORTHERN TERRITORY

COMPILED BY P. J. KENNEWELL
Explanatory Notes on the South Lake Woods Geological Sheet

Compiled by P. J. Kennewell

The South Lake Woods Sheet area is in the Tanami Desert, Northern Territory. It includes parts of the Wiso Basin and the Tennant Creek Block and lies between latitudes 18° and 19°S and longitudes 132° and 133°30'E.

There are no permanent settlements in the Sheet area, and access is poor. A station track extends across the southern part of Lake Woods, providing access to the northeast corner of the Sheet area in dry weather. Cross-country travel with a four-wheel-drive vehicle is possible, but is difficult owing to sand dunes, scrub, spinifex, and a lack of landmarks for navigation.

The climate is arid, with an annual rainfall of 350 mm and annual evaporation of 2700 mm. Most rain falls between November and March. Mean temperatures range from a maximum of 37°C in January and from a maximum of 26°C to a minimum of 11°C in July (Australia, Bureau of Census & Statistics, 1970).

Vegetation is typically xerophytic, with spinifex dominant on sand plains, light eucalypt and mulga scrub on gentle rises, and saltbush common on claypans. There is no permanent water, although Lake Woods and many small claypans commonly retain water after heavy rain. The area supports no industries.

Aerial photographs at a nominal scale of 1:80,000 flown in 1967, and a 1:250,000 scale topographic map are available from the Division of National Mapping, Canberra.

Previous investigations

Chewings (1931), after visiting the Winnecke Creek area to the west, and the area along the Overland Telegraph line to the east, concluded that the 'Winnecke Creek Tableland formation' (Wiso Basin sediments) formerly covered the area between those districts.

In 1940, Whitlock, a surveyor with the Northern Territory Administration, prepared a now-obiterated track across the Sheet area, and O'Brien, also from NTA, traversed the Sheet area in 1961 in search of grazing country. Aerial photographs at 1:50,000 scale were taken in 1950 by the RAAF.

In 1964, Aero Service Limited flew an aeromagnetic survey which extended onto the extreme western edge of the Sheet area, showing 'magnetic basement' at less than 100 m in the southwest and more than 1700 m in the northwest of the Sheet area (Zarzavatjian & Hartman, 1964).

Interest in the area increased in 1965. Wongela Geophysical Pty Ltd, under contract to the Bureau of Mineral Resources (BMR), carried out a helicopter gravity survey of the Sheet area, providing a map showing the northwest-trending Oorapitpa Gravity High separating two areas of lower gravity values, the Lander Regional Gravity Low and the Buchanan Regional Gravity Platform (Flavelle,
1965; Fraser et al., in press). Photo-interpretation of the Sheet area was carried out by BMR (Riveneau & Perry, 1965) before a reconnaissance geological survey by BMR using a helicopter (Milligan et al., 1966). This survey showed flat-lying Palaeozoic sediments extending over most of the Sheet area and folded Proterozoic rocks in the southeast.

Present investigation

The South Lake Woods Sheet area was mapped in 1975 by BMR using a helicopter, as part of a reconnaissance geological survey of the southern Wiso Basin (Kennevel & Huleatt, in prep.). Although 1:80 000 scale aerial photographs were used for navigation, the geological sheet was prepared by amending the 1:250 000 photo-interpretation map, prepared from 1:50 000 scale photographs.

Physiography

Many landforms developed are typical of an arid environment, although some are relicts of an earlier, wetter, period. The Sheet area is a plain with drainage from very gentle rises generally below 275 m altitude into broad, ill-defined valleys above 200 m altitude; traced southward, these valleys are continuous with those in which the Lander River dissipates. Valley floors are virtually flat, and it is uncertain whether they drain to the west and eventually into the Camfield River in the neighbouring Wave Hill Sheet area, or to the northeast into Lake Woods. The formlines shown on the map are compiled by the author from spot elevations obtained at 7-km spacings during the 1965 gravity survey, and give only a broad indication of relief. Five physiographic units are recognised (Fig. 1). The area forms part of the Tennant Creek Surface of Hays (1967).

Low rises and pediments occur throughout the Sheet area, rising almost imperceptibly from the surrounding sandplain. Most rises are covered by lateritic gravel, although low rocky outcrops and small scarp occur in places. Vegetation is commonly sparse, and some short creeks incise gently sloping surfaces. Pediments surround many rises, and consist of clayey sand with a few pebbles of the bedrock exposed on the adjoining rise. They are commonly covered by scrub.

Sand plains extend over most of the Sheet area, and are characteristically flat and featureless, with a monotonous cover of spinifex and sparse small shrubs. Low sand ridges, possibly relict shorelines of Lake Woods, occur in the northeast part of the Sheet area. Gypsum is common in small dunes developed around salt lakes.

Dunefields have developed in many parts of the Sheet area and grade laterally into the sand plains. Wind has formed the sand into dunes up to about 5 m high, extending for up to 15 km. Their orientation is west-northwest, parallel to the prevailing winds. Spinifex growth has stabilised the dunes to a large extent.

Floodouts occur on the eastern edge of the Sheet area, where streams from the Ashburton Range flow westward, dissipating in the sand plains, and depositing their load of silt, sand, and gravel on large flat scub-covered areas.

Salt lakes and claypans occur throughout the Sheet area in the poorly-draining depressions. These rounded flat areas contain water after heavy rain, but are commonly dry with sun-cracked surfaces. Gypsum forms a thin surface crust on salt lakes, but is absent on claypans.
Fig. 1. Physiographic units of the South Lake Woods area.
<table>
<thead>
<tr>
<th>Period</th>
<th>Rock unit and symbol</th>
<th>Lithology</th>
<th>Est. max. thickness (m)</th>
<th>Distribution in Sheet area</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>QUATERNARY</td>
<td>Qa</td>
<td>Sand, gravel, silt, clay</td>
<td>30</td>
<td>Extreme E edge</td>
<td>Unconsolidated alluvial deposits formed in floodouts</td>
</tr>
<tr>
<td></td>
<td>Ql</td>
<td>Sand, silt, clay, evaporites</td>
<td>30</td>
<td>Throughout</td>
<td>Unconsolidated lacustrine deposits formed in gentle depressions</td>
</tr>
<tr>
<td></td>
<td>Qs</td>
<td>Red, fine-grained, silty and clayey quartz sand</td>
<td>8</td>
<td>Throughout</td>
<td>Unconsolidated aeolian sand, in sand plains and dunefields</td>
</tr>
<tr>
<td></td>
<td>Qg</td>
<td>Fragments of lateritized bedrock, sand, silt</td>
<td>3</td>
<td>Throughout</td>
<td>Unconsolidated gravel derived from underlying lateritized bedrock</td>
</tr>
<tr>
<td></td>
<td>Qc</td>
<td>Sand, silt, rock fragments</td>
<td>10</td>
<td>Throughout</td>
<td>Unconsolidated colluvial deposits surrounding gentle rises</td>
</tr>
<tr>
<td>CRETACEOUS OR TERTIARY</td>
<td>Buchanan Hills Beds KTb</td>
<td>Coarse to fine-grained, silty, poorly sorted, angular quartz sandstone; sandy siltstone; conglomerate</td>
<td>4</td>
<td>Throughout</td>
<td>Caps some outcrops, underlies some gravel rises; fluvial</td>
</tr>
<tr>
<td>EARLY CRETACEOUS</td>
<td>Mullaman Beds Klm</td>
<td>Very fine to medium-grained, subrounded to rounded, clayey quartz sandstone</td>
<td>52</td>
<td>Extreme NE; concealed by thin cover of aeolian sand</td>
<td>Unconformably overlies older rocks; marine or non-marine</td>
</tr>
<tr>
<td>MIDDLE CAMBRIAN (TEMPLETONIAN)</td>
<td>Point Wakefield Beds Gmp</td>
<td>Red-brown siltstone, claystone; fine-grained angular, well-sorted sandstone, minor conglomerate</td>
<td>30</td>
<td>Throughout</td>
<td>Unconformably overlies older rocks; shallow marine</td>
</tr>
<tr>
<td>Period</td>
<td>Rock unit and symbol</td>
<td>Lithology</td>
<td>Est. max. thickness (m)</td>
<td>Distribution in Sheet area</td>
<td>Remarks</td>
</tr>
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<tr>
<td>MIDDLE CAMBRIAN (ORDIAN)</td>
<td>Lothari Hill Sandstone Gml</td>
<td>Fine to medium-grained, soft, red quartz sandstone</td>
<td>90</td>
<td>SW; concealed by thin cover of aeolian sand</td>
<td></td>
</tr>
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<td></td>
<td>Hooker Creek Formation Gmh</td>
<td>Red-brown, very fine-grained sandstone, siltstone</td>
<td>170</td>
<td>Central W; probably concealed by aeolian sand in SW</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Montejinni Limestone Gnm</td>
<td>Light brown, hard, medium crystalline dolomite</td>
<td>160</td>
<td>Basal formation of Wiso Basin; unconformably overlies older rocks; shallow marine</td>
<td></td>
</tr>
<tr>
<td>EARLY CAMBRIAN</td>
<td>Helen Springs Volcanics Gh</td>
<td>Tholeitic basalt</td>
<td>20</td>
<td>May be present on E edge; concealed by aeolian sand</td>
<td></td>
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<tr>
<td>LATE EARLY PROTOTEROZOIC OR EARLY CARPENTARIAN</td>
<td>Hayward Creek Formation E lg</td>
<td>Medium-grained, well-rounded, silicified quartz sandstone</td>
<td>5000</td>
<td>Extreme SE</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tomkinson Creek Beds E t</td>
<td>Medium-grained, well-sorted, well-rounded silicified quartz sandstone</td>
<td>15000</td>
<td>N, central, SE and possibly NE; probably concealed by thin Phanerozoic sediments under much of Sheet area</td>
<td></td>
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</tbody>
</table>

TABLE 1. STRATIGRAPHY OF THE SOUTH LAKE WOODS SHEET AREA—(cont.)
STRATIGRAPHY

Palaeozoic rocks of the Wiso Basin extend into the Sheet area over Proterozoic basement rocks of the Tennant Creek Block. A thin veneer of Cainozoic sediments obscures all but small low areas of commonly weathered bedrock. The stratigraphy is summarised in Table 1.

Proterozoic

The Tomkinson Creek Beds (Pt) (Randall et al., 1966) crop out as long, gentle strike ridges in the southeast, and as low, rounded boulders in the central and northern part of the Sheet area. Silicified quartz sandstone is typical; mostly it is medium-grained, well rounded and well sorted, but fine or coarse-grained, silty, angular or poorly sorted sandstone also crops out. Ripple marks, both symmetrical and asymmetrical, and medium-scale low-angle cross-bedding are present, and a shallow marine depositional environment is inferred. Siltstone, limestone, chert, and dolerite form part of this group in the neighbouring Helen Springs Sheet area, but have not been identified in the South Lake Woods Sheet area; they may be present, but weather more readily than the resistant silicified quartz sandstones, and do not crop out. The thickness of the Group in the Sheet area is uncertain, but it is estimated at about 15,000 m in the adjoining Helen Springs Sheet area (Randall & Brown, 1969).

Medium-grained well-rounded silicified quartz sandstone in the extreme southeast of the Sheet area has been mapped as Hayward Creek Formation, (Pt1g), a formation within the Tomkinson Creek Beds. It is continuous with mapped outcrops of that unit in the neighbouring Tennant Creek Sheet area (Mendum & Tonkin, in prep.) and is at least 5,000 m thick.

The age of the Tomkinson Creek Beds is late Early Proterozoic to Early Carpentarian (Dr L. P. Black, BMR, pers. comm., 1977).

Palaeozoic

The Helen Springs Volcanics (6lh) do not crop out in the Sheet area, but are exposed 5 km to the east in the adjoining Helen Springs Sheet area and were intersected at a depth of 71 m in Burge Bore, 2 km north of the Sheet area, in the adjoining Newcastle Waters Sheet area. They may be present in the extreme east of the Sheet area either beneath thin Cainozoic sediments, or beneath the younger Palaeozoic rocks, and probably extend under the northeast part of the Sheet area. The tholeiitic basalts are probably coeval with and may be continuous with the Antrim Plateau Volcanics and are assigned an Early Cambrian age (Randall & Brown, 1969).

The Montejinni Limestone (6mm) is the basal formation of the Wiso Basin, and crops out as a pavement of finely crystalline mottled dolomite dipping gently northeast at locality 63, in the centre of the Sheet area. It consists of 20 m of grey-brown carbonate rock in Burge Bore. It probably extends under the southwest part of the Sheet area, concealed by younger rocks. In the adjoining Winnie Creek Sheet area an early Middle Cambrian age was inferred for the formation from a fauna including Biconulites, Acrotheca and other phosphatic brachiopods, and echinoderm fragments, and the alga Girvanella (Milligan et al., 1966). The fauna, and subsurface data from stratigraphic and water-bore data to the north suggest a correlation with the Tindall Limestone of the Daly River
Basin (Randal, 1973), and the Gum Ridge Formation of the Georgina Basin (Opik, 1957). BMR Green Swamp Well No. 6 stratigraphic hole, 38 km to the south in the adjoining Green Swamp Well Sheet area, penetrated an incomplete section 152 m thick.

The Hooker Creek Formation (6mh) (Kennewell & Huleatt, in prep.) crops out only in the central western part of the Sheet area, although it probably extends under the southwestern part, concealed by thin sand. The very fine-grained micaceous sandstone and siltstone are characteristically red-brown, laminated, and bioturbated in parts. The formation conformably overlies the Montejinni Limestone, and is best exposed at locality 2 in the walls of a sinkhole. In BMR Green Swamp Well No. 6 hole, 38 km south of the Sheet area, it is dolomitic in parts. 162 m thick, and contains several beds of dolomite up to 10 m thick. In the adjoining Winnecree Creek Sheet area (Huleatt, in press a), it contains a fauna including *Biconulites* and hyolithids; *Acrotreta*, *Acrothela*, and linguloid brachiopods, echinoderm ossicles, and *Redlichia* and ptychopariid trilobites. Small oncoids are numerous. The fauna indicates an early Middle Cambrian (Ordian) age and, together with the lithological characteristics of the sediments, suggests a shallow marine depositional environment for the Hooker Creek Formation.

Light brown, hard, medium crystalline dolomite containing indistinct algal structures has been mapped as Undivided Hooker Creek Formation or Montejinni Limestone in the extreme southwest part of the Sheet area. It is uncertain whether this unit is continuous with the Montejinni Limestone cropping out in the north of the adjoining Winnecree Creek Sheet area, or whether it is a thick dolomite bed within the Hooker Creek Formation.

The Lothari Hill Sandstone (6ml) (Kennewell & Huleatt, in prep.) does not crop out in the Sheet area, but may extend into the southeastern part, concealed by a thin cover of aeolian sand. In BMR Green Swamp Well No. 5 hole, 13 km south of the Sheet area, it is 87 m thick and composed almost entirely of soft, red, white-weathering, fine to medium-grained quartz sandstone. In the adjoining Green Swarm Well Sheet area (Kennewell, in press) it is shown by drill-holes to underlie some areas of no outcrop; this is probably due to its softness. The similar area of no outcrop in the southwest of the South Lake Woods Sheet area may be underlain by similar rocks. The Lothari Hill Sandstone is inferred to have a Middle Cambrian (Ordian) age and, in the neighbouring Tanami East Sheet area, was deposited in a shallow marine or supratidal environment (Huleatt, in press b).

The Point Wakefield Beds (6mp) (Kennewell & Huleatt, in prep.) crop out as low rubbly rises of red-brown siltstone and claystone, typically laminated, micaceous, and strongly bioturbated, interbedded with fine-grained, angular well-sorted sandstone. Two metres of conglomerate, possibly representing the base of the Beds, crops out at locality 41, in the centre of the Sheet area. The Beds form a thin veneer over older rocks in places, and are probably not thicker than 30 m, the thickness recorded in BMR Green Swamp Well No. 3 hole, 37 km south of the Sheet area. In this drill-hole they overlie Ordian (earliest Middle Cambrian) sediments with a very slight unconformity. A Templetonian (early Middle Cambrian) or slightly younger age (Dr. P. A. Jell, pers. comm.) has been provisionally determined for ptychopariid trilobites form these beds in the neighbouring Tennant Creek Sheet area. The lithologies, depositional features, and faunas suggest a shallow marine origin.
Cretaceous

The Mullaman Beds (Klm) extend into the northeast part of the Sheet area, but do not crop out as they are covered by a thin blanket of aeolian sand. Burge Bore, 2 km to the north of the Sheet area, penetrated 52 m of Mullaman Beds, consisting of very fine to medium-grained, sub-rounded to rounded quartz sandstone with a clayey matrix. Skwarko (1973) describes marine sediments overlying a basal non-marine unit in the Mullaman Beds in the northern Wiso Basin, and dates them as Early Cretaceous.

Cretaceous or Tertiary

The Buchanan Hills Beds (KTb) form cappings on some outcrops of older rocks, underlie many gentle rises, and commonly occur as fragments in the overlying gravels. Quartz sandstone predominates, and is coarse to fine-grained, silty, poorly sorted, and angular, grading to sandy siltstone in places. At locality 54, in the east, a basal conglomerate is composed of pebbles and cobbles of the underlying Tomkinson Creek Group. The Buchanan Hills Beds are only thin, with a maximum recorded thickness of 4 m at locality 54.

A laterite soil profile is developed on the unit, indicating deposition earlier than Miocene, the epoch in which the unlateritized Camfield Beds, in the neighbouring Wave Hill Sheet area, were deposited (Bultitude, 1973). The poor sorting of the beds suggests terrestrial deposition.

Quaternary

Colluvium (Qc) occurs throughout the Sheet area, underlying pediments extending from the many low rises. Sand is the main constituent, but it is mixed with silt and rock fragments from nearby rises. The colluvium is transported by soil creep and a few small streams to form deposits probably no more than 10 m thick. Arculate rows of mulga scrub typify the colluvium.

Gravel (Qg) caps many low rises throughout the Sheet area, overlying areas in which bedrock is near the surface. It probably originates by decomposition and subsequent winnowing of the underlying lateritized rocks, resulting in pebbles and cobbles of bedrock enclosed in a matrix of sand and silt. The deposits are no more than several metres thick, and in some places the underlying formation can be identified by the lithology of the enclosed fragments.

A thin blanket of sand (Qs) covers almost all the Sheet area, surrounding the smaller areas of gravel and colluvium. It is quartzose, red owing to staining by iron oxides, silty and clayey, and typically fine-grained. Gypsum may be present around salt lakes. Wind action has produced longitudinal dunes which trend east-southeast, are up to 15 km long, and reach a height of about 5 m. Drilling in adjoining Sheet areas has not penetrated more than 3 m of sand. Several low rises in the sand plain in the northeast of the Sheet area probably represent shorelines of Lake Woods during an earlier, wetter period.

Lake deposits (Ql) floor claypans and salt lakes in almost imperceptible channels and depressions throughout the Sheet area. They consist of poorly sorted sand, silt, and clay, often sun-cracked after dry periods. A crust of gypsum with traces of halite forms after evaporation of water from salt lakes. Most lake deposits are probably thinner than 10 m, although those of Lake Woods may be much thicker.
Alluvium (Oa) is restricted to the extreme eastern edge of the Sheet area, where streams flow off the Ashburton Range in the adjoining Helen Springs Sheet area, depositing sand, gravel, silt, and clay in floodouts.

STRUCTURE

Folded Proterozoic rocks underlie the southeast, central, and possibly northwest parts of the Sheet area, and are overlain elsewhere by flat-lying Phanerozoic sediments of the Wiso Basin.

Proterozoic quartzites of the Tomkinson Creek Beds in the east and southeast of the Sheet area are folded with northwest-trending axes, and dip at up to 90°. Two faults have been mapped in this area, and many lineaments are present. Strong folding, with overturning of strata, and a north-trending fault are prominent at locality 1, in the central part of the Sheet area.

Sediments of the Wiso Basin are almost flat-lying, and are probably thin throughout the Sheet area. The Montejimini Limestone, Hooker Creek Formation, and Lothari Hill Sandstone probably dip gently southwest. Unconformably overlying them are the Point Wakefield Beds, which are virtually flat-lying and extend over much of the Sheet area. Thin outliers rest on basement at localities 31 in the south, and 36 towards the east. A fault zone containing silicified breccia occurs in this unit at locality 35.

Numerous lineaments have been mapped, particularly in areas known to be underlain by basement rocks, but their nature is uncertain.

Five gravity provinces or units have been mapped in the Sheet area (Fraser et al., in press); they appear to be unrelated to the Palaeozoic rocks, and represent differences in the underlying Proterozoic rocks or features in the lower crust.

GEOLOGICAL HISTORY

During Proterozoic time, large thicknesses of sand were deposited, probably in a shallow sea and consolidated after burial on a subsiding sea floor (Tomkinson Creek Beds). Folding and faulting of these sands, with resultant overgrowth of the quartz grains, took place during the only known period of strong tectonism. Erosion reduced the uplifted terrain to a valleyed landscape before the extrusion of basalts (Helen Springs Volcanics). Shallow seas flooded the area again during early Middle Cambrian time (Ordian), depositing dolomite and limestone, dolomitic silt and fine sand (Montejimini Limestone, Hooker Creek Formation, and Lothari Hill Sandstone), before gentle tilting to the southwest occurred. A subsequent short period of erosion formed an almost flat surface on which only resistant quartzite protruded as small rises. The sea again covered the area, depositing silt and sand of the Point Wakefield Beds during early Middle Cambrian (Templetonian) time. Little is known of the subsequent geological history until the sea again flooded at least the northeastern part of the Sheet area during Early Cretaceous time, probably depositing marine sands over thin terrestrial deposits. The Buchanan Hills Beds were then deposited on a land surface, possibly by rivers, during Late Cretaceous or Early Tertiary time. A period of laterite development followed. The laterite crust was subsequently removed by erosion, leaving weathered rocks exposed, and a large shallow drainage system developed on the almost flat surface.
The surficial units were formed during Quaternary time: gravel forming on rises and being washed into valleys as colluvium; sand plains and lake deposits developing during an arid period; alluvium washing into the area from the Ashburton Range.

ECONOMIC GEOLOGY

Petroleum

Lack of thick Palaeozoic sediments makes the petroleum potential of the Sheet area negligible. Traces of bitumen were found in the Montejinni Limestone in BMR Green Swamp Well No. 1 hole, 46 km south of the Sheet area (Milligan et al., 1966), but the unit is tight, no reservoir rocks are present, and no structural or stratigraphic traps are known.

Construction Materials

Fair-quality road-surfacing material may be obtained by excavating rises of weathered rock or gravel. Quartzites of the Tomkinson Creek Beds may form better-quality aggregate if crushed.

Water

There is no permanent surface water in the Sheet area, but fresh water may remain in claypans for several months after rain.

No bores have been drilled, hence the groundwater potential is untested. Bores in the Tomkinson Creek Beds on Banka Banka station, 55 km east of the Sheet area, have been abandoned because of falling supply and poor-quality water, but bores at Newcastle Waters, 70 km north of the Sheet area, obtained small supplies (Randal, 1973); the prospects of obtaining water from these beds in the Sheet area are not good. The Helen Springs Volcanics have been successfully drilled on the flanks of the Ashburton Range, as they contain water in joints, faults, and porous zones in vesicular lavas (Randal, op. cit.): if penetrated at depth they may yield water. The Montejinni Limestone is the main producing aquifer in the northwest part of the Wiso Basin (Randal, op. cit.) and may contain water in the Sheet area. The Hooker Creek Formation was penetrated by bores BMR Winnecke Creek Nos. 1 to 4 in the adjoining Winnecke Creek Sheet area (Milligan et al., 1966), but produced no water. This formation is unlikely to be an aquifer in the Sheet area.

Supplies from the Point Wakefield Beds are untested, and although it is porous in outcrop, the thinness of this unit suggests it may be absent below the water-table in many places.
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