RODINGA
NORTHERN TERRITORY
COMMONWEALTH OF AUSTRALIA

1 : 250,000 GEOLOGICAL SERIES—EXPLANATORY NOTES

RODINGA
NORTHERN TERRITORY

SHEET SG/53-2 INTERNATIONAL INDEX

Compiled by P. J. Cook

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Minister for National Development

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS
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COMMONWEALTH OF AUSTRALIA

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Explanatory Notes on the Rodinga Geological Sheet

The Rodinga Sheet area covers about 6500 square miles in the southern part of the Northern Territory. It is situated near the eastern boundary of the Amadeus Basin and the northwestern boundary of the Great Artesian Basin. The sediments in the area range from Proterozoic to Mesozoic, with a thin veneer of Tertiary and Quaternary deposits in many areas. The geological mapping was carried out in 1964 by L. C. Ranford and P. J. Cook of the Bureau of Mineral Resources.

Alice Springs, the nearest town, is situated about 45 miles north of Deep Well. Access to most of the area is fairly good. There are a number of graded roads and numerous station tracks to bores and boundary fences. The main road from Alice Springs to Port Augusta crosses the northwest corner of the Sheet area. The railway from Alice Springs to Port Augusta and the Overland Telegraph line pass through the middle of the area. The permanent settlements include the Santa Teresa Mission and Deep Well, Maryvale, and Allambi homesteads. Several of the stations on the railway are permanently inhabited (e.g. Bundooma and Deep Well Sidings). There are airstrips at Santa Teresa Mission and Maryvale homestead. With the exception of the southeast corner, the Sheet area is subdivided into several large pastoral leases.

The average annual rainfall is about 10 inches; it is unreliable, and most of it falls in sporadic summer storms. Temperatures are high in summer, frequently exceeding 100° F., but are moderate in winter, with a daily maximum of 70° to 80° F. and frequent frosts at night. Dust storms are common.

Maps and air-photographs covering the Rodinga Sheet area are available from the Division of National Mapping, Department of National Development, Canberra. They comprise: (i) a photomosaic at a scale of 4 miles to 1 inch; (ii) a planimetric map, at a scale of 1 : 250,000, 1966; (iii) dyeline maps at a scale of about 1 : 46,500 (air-photograph scale) controlled by a slotted templet assembly, with principal points, wing points, and topography and drainage; and (iv) air-photographs, flown at 25,000 feet by the Royal Australian Air Force, at a scale of about 1 : 46,500.

Previous investigations

On each of his three journeys through central Australia, from 1860 to 1862, J. M. Stuart travelled along the Finke River, which he named, together with Chambers Pillar, the James Ranges, and the Waterhouse Range.
Giles (1889) passed by Chambers Pillar on his way to the MacDonnell Ranges, soon after the start of his first expedition in 1872, and East (1889) made observations on the topography and geology along the Overland Telegraph Line. Chewings (1886, 1891, 1894, 1914, 1929, 1931, 1935) briefly mentions the area, as does Brown (1889, 1890, 1891, 1895). Tate & Watt (1896; Tate, 1896) carried out some geological work during the Horn Scientific Expedition. Day (1916) travelled extensively through the Rodinga Sheet area and made some geological observations, Ward (1925), Mawson & Madigan (1930), and Madigan (1930, 1932, 1935, and 1938) all mention the geology of the area briefly. Voisey (1939) published an article on aspects of the stratigraphy of the Amadeus Basin, including the Rodinga Sheet area. Jensen (1944) described the geology of the whole central Australian region. Quinlan (in Perry et al., 1962) carried out a reconnaissance geological survey of the Rodinga Sheet as part of a reconnaissance of the Amadeus Basin.

In 1956, the Bureau of Mineral Resources started systematic mapping of the Amadeus Basin in the Hermannsburg Sheet area (Prichard & Quinlan, 1962). Between 1960 and 1966, the whole Basin has been mapped as part of the Commonwealth Government's oil search programme (Forman, 1966; Forman et al., 1966; Forman 1968; Ranford et al., 1966; Wells et al., 1964 et seq.). The Institut Français du Pétrole prepared a photogeological map of the Sheet area, as part of a programme covering the whole basin (Scavinc, 1961, unpubl.), and later reviewed the petroleum prospects of the basin (Trumpy & Tissot, 1963, unpubl.). Morgan (1963, unpubl.) described a sample of spilitic from the Bitter Springs Formation in Ooraminna No. 1 well. Barrie (1964, unpubl.) discussed the results obtained from four diamond drillholes in the Stairway Sandstone as part of the search for phosphate, and Crook & Cook carried out sedimentological studies on the phosphorites (Crook, 1964, unpubl.; Cook, 1963, 1966a, unpubl.; Pritchard & Cook, 1965). The geology of the Tertiary rocks of the area has been outlined by Lloyd (1968).

The Bureau of Mineral Resources completed the first seismic work in 1961 (Moss, 1962). Subsequently Langron (1962a, b) and Lonsdale & Flavelle (1963) reported on gravity surveys, and Quilty & Milson (1964) on the aeromagnetic survey. Young & Shelley (1966) have reported on aeromagnetic and radiometric surveys of the northern half of the Sheet area.

Frome-Broken Hill Company Pty Ltd was the first company to become interested in the petroleum possibilities of the Amadeus Basin. Thomas (1956, unpubl.) reviewed the geology of the basin, MacLeod (1959) and Wulff (1960) worked in the eastern part of the basin, and Taylor (1959a, b) identified the fossils collected by the parties. Brunnschweiler (1961) discussed the geology of the Mount Burrell Anticlinorium. The leases were subsequently relinquished by the company and Magellan Petroleum (N.T.) Pty Ltd were granted a lease covering most of the northern half of the Sheet area, and Exoil (N.T.) Pty Ltd the southern half. Both the companies have carried out geological and geophysical surveys in the Sheet area (McNaughton, 1964; Stelek & Hopkins, 1962; Grasso, 1963; Ranneff, 1963; Hopkins, 1964; Banks, 1964; Michoud, Eyssautier, & Gates, 1964; and
Williams et al., 1965). Seismic surveys have been carried out for Exoil (Campbell, 1964), and aeromagnetic surveys for the same company by Aeroservices Pty Ltd (Harman, 1963, 1964; Isaacs & Hartman, 1963).

Four exploratory wells have been drilled in the Sheet area: Ooraminna No. 1 (Planalp & Pemberton, 1963); Mount Charlotte No. 1 (McTaggart, Pemberton, & Planalp, 1965); Waterhouse Ranges No. 1 (Williams, 1965); and Orange No. 1.

PHYSIOGRAPHY

The topographic expression of the rock units is given in Tables 1-3, and the relationship of the geology to topography is shown in Figure 1. As in most parts of the Amadeus Basin, the areas of greatest relief are commonly areas of gently dipping strata. There are six main physiographic units.

Mountain ranges and hills. The hills and ranges rise from 200 to 1000 feet above the general level of the plain. All the main ranges—the James Ranges, Charlotte Range, Waterhouse Range, Rodinga Ranges, Pillar Range, and the ranges around Phillipson Pound—occur within this physiographic division. The mountain ranges and hills are generally composed of gently dipping Palaeozoic sediments, ranging from the Arumbera Sandstone to the Pertnjara Group. In a few localities the drainage is dendritic, but the streams generally follow strike valleys underlain by the recessively weathering rock units.

![Map of physiographic divisions](image)

Fig. 1. Physiographic divisions.
Sand plain with many sand dunes and some low outcrop. This division only occurs in the northwest corner; it is underlain by the very gently dipping Pertjara Group or by flat-lying Tertiary sediments. The outcrops have a relief of 50 feet. The drainage pattern is poorly defined.

Sand plain with dunes. Much of the south and southeast is included in this division on the northwestern margin of the Simpson Desert. The dunes are up to 50 feet high, and are of the longitudinal type, with a northwesterly trend. Most of the plain is underlain by flat-lying or very gently dipping Upper Palaeozoic and Mesozoic sediments. Vegetation is generally sparse, and the drainage pattern is poorly defined.

Gibber or alluvial plains with mesas or low hills. Much of the central part of the area is assigned to this division; most of the Mount Burrell Anticlinorium is covered by gibber plain. Discontinuous strike ridges rise 50 to 100 feet above the surrounding plain; there are also some low mesas. The underlying sediments are faulted and tightly folded and predominantly Proterozoic and Cambrian in age. The numerous creeks are generally dry and the drainage pattern is irregular.

Alluvial floodplain with some claypans. An alluvial floodplain flanks the Finke River in the southwest. Relief is low and the only outcrops are those along the river bank. The area is underlain by flat-lying Upper Palaeozoic, Mesozoic, and possibly Tertiary sediments.

Mesas and buttes with intervening sand and alluvium. The mesas rise to 200 feet above the general level of the plain. In some areas the tops of the mesas may be remnants of an old penepalned surface. The creeks on the sides of the mesas are soon dissipated in the surrounding plain and the drainage pattern is poorly defined.

STRATIGRAPHY

The stratigraphy and palaeontology are summarized in Tables 1 to 3. One formation, the Santo Sandstone, is defined on the Rodinga Sheet area by Wells et al. (1968). All others were originally defined outside the area. Joyce Gilbert-Tomlinson has supplied the following note on the palaeontology and stratigraphy of the Pertaoortta Group:

'Arambera Sandstone: I consider that the trace fossils found in the middle and upper parts of the sequence in the Alice Springs Sheet area mark the local base of the Cambrian System. The formation may straddle the Proterozoic-Phanerozoic boundary.

Todd River Dolomite. Brachiopods date the formation as Lower Cambrian.

Jay Creek Limestone of the Western MacDonnell Ranges is apparently the equivalent of the Giles Creek Dolomite and Shannon Formation. It contains two assemblages: the older is Ordian (lowest Middle Cambrian) and occurs also in the lower Giles Creek; the younger is Mindyallan (lower Upper Cambrian) and occurs also in the lower Goyder Formation or upper Shannon. The section between the two is either barren (Shannon) or contains stromatolitic algae (Giles Creek). It would be unwise to assume continuous deposition during this interval. The faunas mentioned have been found on the Hermannsburg and Alice Springs Sheets, not Rodinga.

Goyder Formation. There is a marked faunal break as well as a lithological break between the lower fauna (sometimes referred—as above—to the Jay Creek or Shannon) of Mindyallan age and the upper fauna of rare trilobites of Franconian age. Both faunas are found on the Alice Springs Sheet.'
<table>
<thead>
<tr>
<th>Formation</th>
<th>Maximum thickness (feet)</th>
<th>Lithology</th>
<th>Topographic expression</th>
<th>Relationships</th>
<th>Fossils</th>
<th>Water supply prospects</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pertataaka Formation (Pup)</td>
<td>6040</td>
<td>Silty shale, minor dolomite, limestone, sandstone, conglomerate.</td>
<td>Strike ridges and valleys.</td>
<td>Unconformable or discontinuous on Bitter Springs and Areynonga Formation.</td>
<td>Stromatolites common.</td>
<td>Good in places.</td>
<td></td>
</tr>
<tr>
<td>(Pup c)</td>
<td>200</td>
<td>Conglomeratic sandstone.</td>
<td>Prominent strike ridge north west of Maryvale.</td>
<td></td>
<td>Poor stromatolites.</td>
<td>Poor.</td>
<td>?illitic.</td>
</tr>
<tr>
<td>Julie Member (Pui)</td>
<td>1770</td>
<td>Dolomite, limestone, calcareous sandstone; minor siltstone.</td>
<td>Strike ridges.</td>
<td></td>
<td></td>
<td>Poor.</td>
<td>Sandstone lenticular in places.</td>
</tr>
<tr>
<td>Waldo-Peddle Member (Pul)</td>
<td>c.200</td>
<td>Interbedded sandstone, siltstone, shale.</td>
<td>Low strike ridges.</td>
<td></td>
<td></td>
<td>Moderate</td>
<td>Incompetent folding.</td>
</tr>
<tr>
<td>Olympic Member (Puf)</td>
<td>c.600</td>
<td>Dolomite, siltstone, conglomerate, sandstone.</td>
<td>Strike valley.</td>
<td></td>
<td></td>
<td>Poor.</td>
<td>?illitic.</td>
</tr>
<tr>
<td>Limbna Member (Pum)</td>
<td>c.400</td>
<td>Cross-laminated sandstone, calcarenite, siltstone.</td>
<td>Low strike ridges.</td>
<td></td>
<td></td>
<td>Poor.</td>
<td></td>
</tr>
<tr>
<td>Ringwood Member (Pur)</td>
<td>c.500</td>
<td>Calcareous, dolomite, siltstone.</td>
<td>Low strike ridges.</td>
<td></td>
<td></td>
<td>Poor.</td>
<td></td>
</tr>
<tr>
<td>Areynonga Formation (Pua)</td>
<td>600 (Mount Charlotte No. 1)</td>
<td>Silty sandstone, conglomerate; minor dolomite with red chert.</td>
<td>Prominent ridges.</td>
<td>Disconformable or unconformable on Bitter Springs Formation.</td>
<td></td>
<td>Moderate.</td>
<td>Fluvialglacial in part. Presence in Mount Charlotte No. 1 questionable.</td>
</tr>
<tr>
<td>Bitter Springs Formation (Pub)</td>
<td>c.1000</td>
<td>Algal dolomite, limestone, siltstone, sandstone, shale, spilitic basic lava.</td>
<td>Low hills.</td>
<td>Base not exposed.</td>
<td></td>
<td>Good in places; salty.</td>
<td>Incompetent in places.</td>
</tr>
<tr>
<td>Age</td>
<td>Formation (map symbol)</td>
<td>Thickness (feet)</td>
<td>Lithology</td>
<td>Topographic expression</td>
<td>Relationships</td>
<td>Fossils</td>
<td>Water supply prospects</td>
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<td></td>
<td>Santo Sandstone (Pzt)</td>
<td>200</td>
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<td></td>
<td>Shale (Pzh)</td>
<td>500</td>
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<tr>
<td></td>
<td>Langra Formation</td>
<td></td>
<td>Conglomeratic sandstone, white sandstone, conglomerate, micaceous siltstone</td>
<td>Subsurface only.</td>
<td>?Unconformable on Stokes Siltstone.</td>
<td>—</td>
<td>Large quantities but very saline.</td>
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<tr>
<td></td>
<td>(Pzn)</td>
<td>c.500</td>
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<td></td>
<td>Pertjara Group</td>
<td></td>
<td>Sandstone, pebbly sandstone, conglomerate siltstone.</td>
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<td></td>
<td>(Pzp)</td>
<td></td>
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<tr>
<td></td>
<td>Brewer Conglomerate</td>
<td></td>
<td>Coarse conglomerate, very thick-bedded.</td>
<td>Rounded hills.</td>
<td>?Disconformable on Hermannsburg Sandstone.</td>
<td>—</td>
<td>Poor.</td>
</tr>
<tr>
<td></td>
<td>(Pzb)</td>
<td>c.500</td>
<td></td>
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<tr>
<td></td>
<td>Hermannsburg Sandstone</td>
<td></td>
<td>Red-brown silty sandstone with pebbles; minor siltstone.</td>
<td>Prominent ridges and ranges.</td>
<td>Relationship with Parke Siltstone uncertain; unconformable on older rocks.</td>
<td>—</td>
<td>Aquifer near base: large supply moderate quantity.</td>
</tr>
<tr>
<td></td>
<td>(Pzt)</td>
<td>1500</td>
<td></td>
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<td></td>
<td>(Pzk)</td>
<td>150 est.</td>
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<td>to</td>
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<td>Carboniferous</td>
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<tr>
<td>to</td>
<td>(Pzzr)</td>
<td>1700 est.</td>
<td></td>
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</tr>
<tr>
<td>Devonian</td>
<td>Larapinta Group</td>
<td></td>
<td>Fossiferous sandstone, siltstone, shale, limestone.</td>
<td>—</td>
<td>—</td>
<td>—</td>
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<tr>
<td></td>
<td>(C-OL)</td>
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</tr>
<tr>
<td>Formation</td>
<td>Thickness</td>
<td>Description</td>
<td>Structure</td>
<td>Quality</td>
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<tr>
<td><strong>Larapinta Group (C-OL)</strong></td>
<td></td>
<td>Fossiliferous sandstone, siltstone, shale, limestone.</td>
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<tr>
<td><strong>Stokes Silstone (O1)</strong></td>
<td>500</td>
<td>Green siltstone and shale; limestone.</td>
<td>Strike valleys.</td>
<td>Poor.</td>
<td></td>
<td></td>
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<tr>
<td><strong>Stairway Sandstone (O2s)</strong></td>
<td>600</td>
<td>Sandstone, siltstone, sandstone units; some red-beds.</td>
<td>Strike ridges.</td>
<td>Stock quality. Thin phosphorite bands.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Horn Valley Silstone (O1h)</strong></td>
<td>150</td>
<td>Siltstone, shale, limestone.</td>
<td>Valleys.</td>
<td>Poor.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Pacoota Sandstone (C-Op)</strong></td>
<td>1500</td>
<td>Sandstone, silty sandstone; cross-bedded in places; some pebble bands; rare phosphorite, glauconite.</td>
<td>Prominent ridges.</td>
<td>Poorly exposed.</td>
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</tr>
<tr>
<td><strong>Pertaoorrrta Group (Cp)</strong></td>
<td></td>
<td>Sandstone, siltstone, shale, dolomite; limestone.</td>
<td></td>
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<tr>
<td><strong>Goyder Formation (Cg)</strong></td>
<td>1200</td>
<td>Silty sandstone, siltstone, limestone.</td>
<td>Strike valleys and scarp.</td>
<td>Small supply in upper part. Poorly exposed.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Jay Creek Limestone (Cj)</strong></td>
<td>1400</td>
<td>Interbedded brown and green shale and yellow or grey limestone, dolomite.</td>
<td>Strike valleys, low limestone ridges.</td>
<td>Poor. Fauna on Rodinga is Ordian.</td>
<td></td>
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<tr>
<td><strong>Shannon Formation (Cs)</strong></td>
<td>1800</td>
<td>Interbedded grey and pink limestone, grey and brown shale, siltstone; some dolomite.</td>
<td>Strike valleys, limestone ridges, low hills.</td>
<td>Poor. Fauna is Mindyallan.</td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Giles Creek Dolomite (Ck)</strong></td>
<td>1100</td>
<td>Thick-bedded dolomite, limestone, shale, siltstone.</td>
<td>Strike ridges.</td>
<td>Poor. Fauna in lower part of formation is Ordian.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Chandler Limestone (Cl)</strong></td>
<td>600</td>
<td>Limestone and dolomite, with chlorite laminae and evaporites.</td>
<td>Low ridges and mounds.</td>
<td>Water very saline. Highly contorted and incompetently folded. Evaporites not seen in outcrop.</td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Todd River Dolomite (Cr)</strong></td>
<td>150 est.</td>
<td>Dolomite, sandstone, siltstone; glauconitic in places.</td>
<td>Strike ridges.</td>
<td>Poor. Fauna is Lower Cambrian.</td>
<td></td>
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<tr>
<td><strong>Arumbera Sandstone (Cs)</strong></td>
<td>2500 est.</td>
<td>Sandstone, conglomeratic sandstone, siltstone; glauconitic in places.</td>
<td>Very prominent strike ridges.</td>
<td>Moderate quantities of stock water in places. Rapidly thins to south. Lower part may be uppermost Proterozoic.</td>
<td></td>
<td></td>
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<tr>
<td>Age</td>
<td>Formation (map symbol)</td>
<td>Maximum thickness (feet)</td>
<td>Lithology</td>
<td>Topographic expression</td>
<td>Stratigraphic relationships</td>
<td>Fossils</td>
<td>Water supply prospects</td>
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</tr>
<tr>
<td>Quaternary</td>
<td>(Q)</td>
<td>—</td>
<td>Alluvium, sand, travertine, gypsum, conglomerate.</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>(Section only).</td>
</tr>
<tr>
<td></td>
<td>(Qa)</td>
<td>100</td>
<td>Alluvial gravel, sand, silt.</td>
<td>Streams, alluvial flats, scree slopes.</td>
<td>Veneer on older sediments.</td>
<td>Good.</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>(Qs)</td>
<td>50</td>
<td>Aeolian sand.</td>
<td>Dunes, sand plains.</td>
<td>—</td>
<td>Poor.</td>
<td>Gypsum Bore area only.</td>
</tr>
<tr>
<td></td>
<td>(QI)</td>
<td>5</td>
<td>Travertine.</td>
<td>Flats.</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>(Qg)</td>
<td>5</td>
<td>Gypsum</td>
<td>Mounds in depression.</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>(Qc)</td>
<td>10</td>
<td>Conglomerate, scree.</td>
<td>Gibber plains, scree slopes.</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Tertiary</td>
<td>(T)</td>
<td>—</td>
<td>Sandstone, calcareous silty sandstone, limestone, travertine, conglomerate.</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Tl)</td>
<td>50</td>
<td>Chalcedonic limestone, silstone, calcareous sandstone.</td>
<td>Mesa cappings and low ridges.</td>
<td>Unconformable on older sediments.</td>
<td>Gastropods, ostracods, vertebrates (Miocene or Younger).</td>
<td>Above water-table.</td>
</tr>
<tr>
<td></td>
<td>(Te)</td>
<td>50</td>
<td>Coarse conglomerate.</td>
<td>Low rubbly outcrops.</td>
<td>—</td>
<td>Good if below water-table.</td>
<td>Clasts of siltite.</td>
</tr>
<tr>
<td></td>
<td>(Tb)</td>
<td>10</td>
<td>Siltite.</td>
<td>Mesa cappings.</td>
<td>—</td>
<td>Above water-table.</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>(Ta)</td>
<td>5</td>
<td>Laterite, ferricrete.</td>
<td>Mesa cappings.</td>
<td>—</td>
<td>Above water-table.</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>(Ts)</td>
<td>c.200</td>
<td>Siltstone, sandstone, conglomerate, clay, lignite.</td>
<td>Mesa cappings and low outcrops.</td>
<td>—</td>
<td>Spores.</td>
<td>Moderate amounts of stock water.</td>
</tr>
<tr>
<td></td>
<td>(Md)</td>
<td>c.300</td>
<td>Sandstone, conglomeratic sandstone, conglomerate, siltstone. Cross bedding, ripple marks.</td>
<td>Mesas.</td>
<td>Unconformable on Horseshoe Bend Shale and older formations.</td>
<td>Indeterminate plants and problematica.</td>
<td>Some moderate-quality water.</td>
</tr>
</tbody>
</table>
Samples of shale from the Ooraminna No. 1 and Mount Charlotte No. 1 wells have been dated by the rubidium/strontium method. The samples from Ooraminna No. 1 indicate an age of 760 m.y. ± 33 m.y. for the Pertatataka Formation (Harding, 1966, unpubl.). Samples from Mount Charlotte No. 1 well indicate an age of 822 m.y. ± 8 m.y. for the Pertatataka Formation (?) and 1168(?) m.y. for the Bitter Springs Formation (V.M. Bofinger, pers. comm.).

The oldest unit of the Amadeus Basin sequence, the Heavitree Quartzite, is not exposed in the Rodinga Sheet area, but is probably present at depth; and there are no exposures of the crystalline basement.

**GEOPHYSICAL DATA**

**Gravity**

Parts of several gravity features occur in the Sheet area; these have been named by Lonsdale & Flavelle (1963, unpubl.) and Cook (1966b, unpubl.). The Bouger values range from -110 milligals in the Amadeus Gravity Depression to -30 milligals on the McDills Gravity Platform.

![Gravity map](image)

**Fig. 2. Gravity map.**

The Amadeus Gravity Depression is best developed in the northeast corner; it corresponds to a considerable thickening of the Palaeozoic sequence towards the northern margin of the basin. Similarly, the East Rodinga Gravity Low corresponds to a thick sequence of Palaeozoic sediments preserved in the Camel Flat Syncline. The Rodinga Gravity High follows closely the limits of a complicated structural zone with mainly Proterozoic sediments exposed in the Mount Burrell Anticlinorium of Brunnschweiler (1961).
A notable feature of the Ooraminna Anticline is that it is a gravity 'low', which suggests that basement is not involved in the folding and that there is probably a major décollement between basement and the sediments, most probably in the Bitter Springs Formation. The same décollement is probably present throughout the Sheet area, with a less important one in the Chandler Limestone. It was first postulated by Wells et al. (1965) in the northwestern part of the Basin, on geological grounds, and has proved to be a major factor in the complex tectonics of the northern part of the Amadeus Basin (Forman et al., 1967; Forman, 1968; Wells et al., 1968).

**Aeromagnetic**

The greatest depth to magnetic basement is about 20,000 feet in the northwest; the minimum depth of about 2000 feet is in the northeastern margin. The magnetic basement contours change from a predominantly east-west trend in the northwest to a north-south trend on the eastern margin.

There is no clear relationship between the depth to magnetic basement and the structural relief of surface structures. This is probably because the décollement in the Bitter Springs Formation isolates the basement from the folding.

**Radiometric**

Only the northern half of the area has been covered by radiometric survey. Radiometric values range from 25 to 62.5 counts per second. There is no obvious correlation between the surface geology and the radiometric contours. Other parts of the Amadeus Basin show a clear correlation between radiometric 'lows' and areas of aeolian sand cover, Mereenie Sandstone, or Pertnjara Group.

**Seismic**

Seismic work has been undertaken by companies and by the Bureau of Mineral Resources in several parts of the Sheet area.

Moss (1962, unpubl.) carried out several refraction and reflection seismic traverses parallel to the railway from Bundooma Siding to Polhill Siding. The results indicate a considerable thickness of sediments in the Orange Creek Syncline and south of Mount Charlotte. An anticlinal structure with about 200 feet of closure was also found in the Bundooma Siding traverse.

Seismic work by Geoseismic (1962) in the Camel Flat Syncline also established the existence of a considerable thickness of sedimentary rocks, but failed to show any reversals. Work by Namco International Inc. (1965) south of Mount Charlotte revealed the presence of two anticlinal structures, one of which was subsequently drilled (Mount Charlotte No. 1 well).

Geophysical Associates have more recently carried out an extensive seismic survey in the Orange Creek Syncline for Magellan Petroleum.

**Folding**

There was possibly some epeirogenic movement after the Areyonga Formation was laid down, but the first major folding episode in the Amadeus Basin was the Petermann Ranges Orogeny, in late Upper Proterozoic or Lower Cambrian time (Forman, 1966, 1968). The orogeny produced uplift
and some folding in the Rodinga Sheet area. Major uplift occurred during the Rodingan (Silurian?) Movement and there may also have been some minor folding, but almost all the structures were formed during the Alice Springs Orogeny in Devonian/Carboniferous time.

![Diagram with geological elements and labels]

Fig. 3. Structural sketch-map.

The Alice Springs Orogeny (Forman, 1968) produced major folding along predominantly easterly or northeasterly axes, with broad gently dipping synclines, such as the Camel Flat or Orange Creek Synclines, and steep anticlines such as the Waterhouse Range Anticline. Many of the anticlines are extremely complex folds, with evidence of folded thrust slices (e.g. the Mount Burrell Anticline) and imbricate structures (e.g. the Allambi Imbricate Structure) in their core. These structures are described in detail by Wells et al. (1968). In places (e.g. Phillipson Pound) there are folds with north-trending axes which possibly formed at a late stage in the Alice Springs Orogeny.

The style of folding in the Rodinga Sheet area (broad synclines and sharp anticlines) is due to the presence of two planes of décollement in the section. Some minor folding of the Great Artesian Basin sediments (De Souza Sandstone, etc.) occurred after the deposition of the Lower Cretaceous.

**Faulting**

There are two main sets of faults, a west to northwesterly set parallel to the main folding, and another set at right angles to it.
The west or northwesterly faults are particularly well developed in the Mount Burrell Anticline; they are low-angle thrusts, many of which have been folded. The early part of the compression movement from the north was probably first absorbed by thrusting. A good example of a folded thrust, affecting mainly rocks of the Pertatataka Formation, occurs in the Mount Burrell Anticline; the folded thrust can be shown to have originally dipped gently to the north. The thrusts in the Allambi Imbricate Structure also dip to the north; here large slices of sediments appear to have broken off as they were pushed over the plane of décollement in response to overthrusting from the north.

The north-south normal faults are generally short, and have vertical displacements of up to 2000 feet. In places they appear to postdate the west-trending faults, but elsewhere they apparently branch off them. In the Phillipson Pound area, block faulting is particularly well developed; the fault blocks generally displace the Pertnjara Group or Mereenie Sandstone against the Pertaoorrra Group.

In the southeast, a large arcuate fault, with a displacement of about 2000 feet, has been delineated by the aeromagnetic survey of Hartman (1963); there is no surface expression.

GEOLOGICAL HISTORY

There is no record of the geological history of the Rodinga Sheet area before the Bitter Springs Formation was laid down, at first probably in a restricted shallow basin. The upper part of the formation was deposited in more open sea, in which extensive algal colonies grew in the intertidal zone. Volcanic activity during the later phase resulted in lava flows (possibly submarine) in the north and east.

Temperature dropped considerably during Areyonga Formation time and marine glaciogenic deposits were laid down in places. The area was then uplifted and subsequently eroded, particularly in the south and west.

This was followed by a major transgression at the beginning of Pertatataka Formation time, when the sea spread over the entire area. The sediments were probably mainly derived from a source a considerable distance to the southwest, but there was also a minor source to the northeast. Sandy sediments were deposited in the north, and calcareous (and lutaceous) sediments in the south. During a second glacial period thin tillites were again deposited over most of the area. In the latter half of Pertatataka Formation time temperatures rose again and algal limestone and dolomite were deposited in many areas.

The Petermann Ranges Orogeny in the late Proterozoic or early Lower Cambrian probably terminated Pertatataka sedimentation and had a profound effect on the shape of the Amadeus Basin. Much of the Rodinga Sheet area was probably lifted above sea level.

At the opening of Pertaoorrra Group sedimentation, the southern half of the area was probably land. To the north, the Arumbera Sandstone was deposited, possibly in a shallow sea, although it may have been partly continental. The coarseness of the sediments may be due to the effects of the
Petermann Ranges Orogeny, and the conglomerates are possibly partly synorogenic. Terrigenous sedimentation decreased considerably and largely calcareous sediments of the Todd River Dolomite were deposited in a restricted marine basin. The restriction continued through Chandler Limestone time and evaporites were deposited over the entire Sheet area. The carbonate rocks associated with the salt may also be evaporitic; the sequence is barren of fossils.

The sea became less saline during the lower Middle Cambrian. In the east, there was little or no terrigenous sedimentation and the predominantly carbonate sequence of the Giles Creek Dolomite was deposited. This was followed by the Shannon Formation, laid down in a very shallow sea; this is indicated by the presence of algal colonies, cross-laminae, intraformational breccias, and the oolitic nature of many of the carbonate rocks.

To the west, the Jay Creek Limestone and the Goyder Formation were deposited, also in a shallow sea. There was however a greater inflow of terrigenous sediments; the Jay Creek Limestone is sandy and in many places the Goyder Formation is very sandy. This increase in terrigenous sediments suggests that the source area lay to the west, and the open sea to the east, throughout much of Pertacoorta Group time.

Similar palaeogeographic conditions persisted into the Larapinta Group, and most of the palaeocurrent directions in the Pacoota Sandstone indicate a westerly source area. At this time there was probably an increase in the inflow of sandy material into the basin, and the depositional environment was considerably more vigorous, though still predominantly shallow-water marine. As a result a thick body of fine to coarse sand was deposited over the northern half of the area. The sea deepened when the Horn Valley Siltstone was laid down. There was a prolific pelagic fauna due to congenial conditions in the upper waters. In the bottom waters, lack of circulation and the accumulation of a considerable amount of organic material derived from the pelagic fauna produced strongly reducing conditions which resulted in the deposition of black pyritic fine-grained lutites. Later, a body of sand (possibly built up by the coalescing of offshore bars) formed the lower Stairway Sandstone. The source area for the terrigenous sediments now lay to the southeast and the open sea to the west. At the same time, a small embayment developed in the Mount Charlotte area, with a local transgression. During middle Stairway Sandstone time conditions became more variable; black phosphatic shale was deposited in the north and red-beds in the south. Later in Stairway Sandstone time, a shallow sea spread over the entire area. The currents still flowed mainly from the southeast, but connexions to the open sea now lay to both the east and west. Fine to coarse sands were deposited. The broad epeiric sea so established persisted into Stokes Siltstone time, and the entire area was covered by a highly saline shallow sea. Salt crystals, now represented by pseudomorphs, were common in the lutites. Larapinta Group sedimentation probably closed with the deposition of the marine deltaic Carmichael Sandstone over most of the area, although none of it has been preserved.

The Rodingan Movement resulted in uplift or tilting, probably during the Silurian. It was followed by a considerable period of erosion, when up to
5000 feet of sediments were removed in some areas (e.g. the northeast corner). The Merenie Sandstone was deposited unconformably on the Larapinta and Pertnjaara Groups. The depositional environment is uncertain: it may have been partly aeolian and possibly lacustrine, and partly shallow-water marine. The Merenie Sandstone appears to have onlapped from west to east across the area, which suggests that if it is partly of marine origin, the connexion with the open sea probably lay to the west.

The Merenie Sandstone is overlain apparently conformably by the Pertnjaara Group. In the southwest, where the Merenie Sandstone was probably not deposited, the Pertnjaara Group lies disconformably on the Larapinta Group. Here, the Parke Siltstone is present, but elsewhere the Hermannsburg Sandstone directly overlies the Merenie Sandstone. This relationship suggests the presence of an unconformity between the Parke Siltstone and Hermannsburg Sandstone, but it may be due to the leasing out of the siltstone.

The Pertnjaara Group was probably laid down entirely on land. The Parke Siltstone is a lacustrine deposit, and the presence of halite pseudomorphs indicates that conditions were highly saline at times. The fish fragments found in the western part of the basin support a lacustrine origin. The pebbly, poorly sorted, and kaolinitic nature of the Hermannsburg Sandstone suggests a predominantly fluvialite environment. The Brewer Conglomerate was also laid down under continental conditions, but the lithology is largely a function of its synorogenic nature. It is uncertain when the Alice Springs Orogeny began*: the first movements may have occurred during the deposition of the Hermannsburg Sandstone. The major movement undoubtedly occurred in Brewer Conglomerate time, and produced a massive conglomerate near Larrier Bore in the north. The same orogeny produced folding and faulting throughout the area and brought the Amadeus Basin sedimentation to a close.

The relationship of the Finke Group to the Pertnjaara Group is uncertain, and both groups may have been deposited simultaneously. The Langra Formation is a coarse conglomerate; it may be partly or wholly continental, and is possibly also synorogenic. The Horseshoe Bend Shale was deposited under quieter conditions in a shallow subaqueous, probably lacustrine, environment. The presence of pseudomorphs after halite indicates that conditions were saline. The pebbly, kaolinitic, cross-bedded nature of the overlying Santo Sandstone suggests that continental sedimentation continued, in a fluvialite environment.

During the Permian, the climate of the region became colder, and tillites in the Crown Point Formation are preserved a few miles south of the Rodinga Sheet area; they may be partly fluvial-glacial and partly marine glacial.

The post-Permian (Jurassic?) De Souza Sandstone was deposited in the south. Cross-bedded sand, containing plant remains in places, was laid down; it may be partly fluvialite. During the Lower Cretaceous, a major marine transgression occurred and the Rumbalara Shale was laid down in a shallow sea in the south. Later in the Cretaceous, the land rose a little and the sea regressed a considerable distance to the south and east; the continental

*Forman (1968) redefined the Alice Springs Orogeny as the event during which the Pertnjaara Group was folded either late in the Devonian or in the Carboniferous.
environment established has continued up to the present time. During the Tertiary, the climate was very much wetter and the relief greater than at present. Rivers flowed south through many parts of the area, depositing fluviatile sands and gravels along their courses. In the north, there were large lakes in which lacustrine deposits, including freshwater limestones, were laid down. While this wetter, tropical climate lasted, weathering was severe and considerable lateritization took place.

At the close of the Tertiary the climate gradually became more arid; the lakes and rivers dried up and sand dunes developed over much of the area. The aridity has slightly lessened recently, and some vegetation has grown on the sand dunes.

**Economic Geology**

*Surface Water*

There are several permanent waterholes along the Finke River. The waterholes on the southern bends of the river are generally fresh, but those on the northern bends, where the river runs across the area of near-surface Langra Formation, are saline (T. Quinlan, pers. comm.). Semipermanent waterholes and rockholes occur in the ranges in the north. In places, watercourses have been dammed, and the dams generally retain water throughout the year. All potable and accessible surface water in the area is used for the watering of stock.

*Groundwater*

The 160 wells which have been drilled in the Rodinga Sheet area range from less than 100 feet to over 400 feet in depth. The water potential of the main rock units is listed in Tables 1 to 3. The Quaternary alluvium and Mereenie Sandstone generally produce good-quality water; the Tertiary rocks, Hermannsburg Sandstone, Larapinta Group, Pertaoorrt Group, and Pertatataka Formation commonly produce water suitable for stock, with about 7000 parts per million of total dissolved solids; the Langra Formation, Chandler Limestone, and Bitter Springs Formation invariably produce highly saline water.

The depth of the water-table ranges from about 250 feet in the Orange Creek and Camel Flat Synclines (and in other synclinal areas where the aquifer is the Mereenie Sandstone) to less than 100 feet in the southwest. Little is known about the southeastern corner, but the water-table is probably fairly deep. In the Mount Burrell Anticlinorium, the water-table is 150 to 200 feet deep.

*Petroleum*

Three wells have been drilled for petroleum (Table 4); but only trace amounts of gas were encountered. Ooraminna No. 1 showed that hydrocarbons, and also salt, exist in the Bitter Springs Formation. The lower part of the Pertaoorrt Group was tested in Waterhouse No. 1, but results were disappointing. The Stairway Sandstone was tested in Mount Charlotte No. 1, but the formation is poorly developed in this area and the well did
not test it conclusively. A much thicker Ordovician section (including the Pacoota Sandstone) occurs to the north, in the vicinity of Orange Creek Syncline; the Ordovician and Cambrian sediments of this area have been tested in a fourth well (Orange No. 1).

The Great Artesian Basin sediments (i.e. Langra Formation to Rumbalara Shale) in the south are less than 2000 feet thick, and prospects are not encouraging.

**TABLE 4: OIL EXPLORATION WELLS**

<table>
<thead>
<tr>
<th>Well</th>
<th>Date drilled</th>
<th>Total depth (feet)</th>
<th>Bottomed in</th>
<th>Status</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Orange No. 1</td>
<td>1966</td>
<td>8886 +</td>
<td>Arumbera Sandstone</td>
<td>Dry and abandoned.</td>
<td>—</td>
</tr>
<tr>
<td>Waterhouse Anticline No. 1</td>
<td>1965</td>
<td>3081</td>
<td>Arumbera Sandstone</td>
<td>Dry and abandoned.</td>
<td>Slight petrolierous odour.</td>
</tr>
</tbody>
</table>

**Phosphate**

The Pacoota Sandstone and Stairway Sandstone contain pelletal phosphorites. Those in the Pacoota Sandstone occur in rare thin pelletal bands, unlikely to be of economic significance. The Stairway Sandstone phosphorites are also pelletal; pellets are up to 5 inches in diameter. They are brown, white, or rarely purple, thin-bedded, and may occur throughout the formation. In most parts of the Amadeus Basin, the phosphorites are commonest in the middle unit of the Stairway Sandstone, but in the Mount Charlotte area they may be most common in the upper unit. The maximum P\textsubscript{2}O\textsubscript{5} content recorded in a specimen from the Rodina Sheet area is 13.7 percent.

The phosphorites commonly contain up to 150 parts per million of copper, 100 parts per million of vanadium, and 70 parts per million of beryllium.

Cook (1966a, unpubl.) has shown that the Stairway Sandstone phosphorites have been concentrated by winnowing in situ. By this process, the fine sediments are removed, and leave a residual deposit of phosphatic pellets and nodules and some coarse quartz grains. The greatest phosphorite concentrations are likely to occur in the areas of maximum winnowing, particularly in the south. Concentrations might also occur in some of the Tertiary or Quaternary gravels adjacent to the Stairway Sandstone.

**Building Stone**

Sandstone of the Hermannsburg and Arumbera Sandstones and limestone of the Jay Creek Limestone have been used as building stone in Alice Springs and at the Santa Teresa Mission. The Mereenie Sandstone and the Larapinta Group also contain sandstone suitable for use as building stone.
Coal
Lignite occurs in the Tertiary sediments in the Yam Creek area. The beds are thin and of low grade. Other Tertiary deposits may also contain coal, but they are too small to be of commercial value.

Dolomite
Dolomite is common in the Giles Creek Dolomite, Chandler Limestone, Todd River Dolomite, Pertatataka Formation, and Bitter Springs Formation. In several areas the dolomite is adjacent to the railway. It is unlikely that it will be worked commercially in the foreseeable future because of the distance from potential markets.

Gypsum
A large area of superficial earthy gypsum occurs around Gypsum Bore to the north of the Rodinga Range. Gypsum is known to occur in the Bitter Springs Formation in other parts of the Amadeus Basin.

Limestone
Limestone is common in the Tertiary sediments, Horn Siltstone, Pertaoorrta Group, Pertatataka Formation, and Bitter Springs Formation. It would probably be suitable for the manufacture of lime.

Ochre
The Rumbalara ochre mines are situated a few miles south of the Rodinga Sheet area. Ochre from the base of the Rumbalara Shale was extracted commercially for a number of years, but production ceased in 1953. The Rumbalara Shale crops out over a wide area in the southeast and good ochre may be present in places.

Potash
Potash has not been found in the evaporites in the Chandler Limestone or Bitter Springs Formation. Glaucopite occurs in small quantities in the Stairway Sandstone, Todd River Dolomite, and Arumbera Sandstone, but the occurrences are of no commercial value.

Salt
Salt has been intersected in the Bitter Springs Formation in Ooraminna No. 1 and in the Bitter Springs Formation and Chandler Limestone in Mount Charlotte No. 1. It does not crop out. Water in the Langra Formation is always highly saline, and the formation may contain interbedded evaporites.

Iron
A lateritic cap was formed on various formations during the prolonged period of Tertiary weathering. Its thickness generally ranges from 1 to 5 feet, and it is probably of only moderate grade. Iron also occurs as a thin
encrustation on some of the carbonate rock in the Goyder Formation. Pyrite is present in several formations (e.g. the Horn Valley Siltstone), but is not of economic potential. Botryoidal limonite is associated with the Chandler Limestone near Mount Grevillea in the far west.

**Manganese**

Manganese is associated with iron in places, and commonly occurs in the upper part of the Goyder Formation. It generally occurs as an encrustation, up to 1 foot thick, on limestone or dolomite. Ranford et al. (1966) record 56 percent manganese in one sample from the Lake Amadeus Sheet area. Psilomelane is associated with the Chandler Limestone near the western margin of the Sheet area. It is thought to be of supergene origin (Pontifex, 1965).

**Copper**

A thin green coating of malachite occurs on some of the limestones and cherts in the Chandler Formation. Trace amounts of copper have also been detected in the psilomelane and limonite from the Chandler Limestone on the western margin of the Sheet area.

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