COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS

RECORDS:

1965/13

THE GEOLOGY AND OCCURRENCE OF GROUNDWATER, FINKE 1:250,000 SHEET AREA (SG53/6), NORTHERN TERRITORY.

by

K. Rochow

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SUMMARY

Reconnaissance mapping during the period 1960-62, carried out in conjunction with groundwater investigations in the Finke 1:250,000 Sheet area (SG53/6), has established the following stratigraphic sequence on the margin of the Great Artesian Basin within the Northern Territory:-

Age	Unit	
Cretaceous	- Rumbalara Shale	
	——Unconformity——	
Triassic? to Lower Cretaceous	- De Souza Sandstone	Finke "series" (of Chewings 1914, and Quinlan, 1962)
	——Regional Unconformity——	
Lower Permian	- Crown Point "series"	
	——Unconformity——	
Carboniferous?	- Unit 4 - thin bedded sandstone	
	——Local disconformities——	
	- Unit 3 - Red and green micaceous shale and mudstone	
? ? ?	Unconformity?	
	Unit 2 - Cross-bedded sandstone	
	Unit 1 - Granite pebble conglomerate	
	——Angular Unconformity——	
Ordovician?	- Stairway Sandstone	
	——Unconformity——	
Upper Proterozoic	- Pertatataka Formation	
	——Angular Unconformity——	
Precambrian	- Igneous and metamorphic rocks.	

The deltaic-type conglomerate and current-bedded conglomeratic sandstone at the base of the Finke "series" (see footnote,p. 2) fan out over the northern part of the Kulgera-Umboara granite block and spread beyond it onto the Upper Proterozoic and Lower Palaeozoic sediments of the Amadeus Basin; the latter are folded and faulted against the older Precambrian rocks along the southern flank of the Mount Kingston Range. Shales and thin-bedded sandstones of Units 3 and 4 overlap the lower portion of the Finke "series" onto Cambro-Ordovician and younger Palaeozoic sediments to the north. Small crustal movements along preexisting fault planes in the bedrock resulted in the

tilting of the four lower units to the south and east, before deposition of the Lower Permian glacials and the De Souza Sandstone. The Rumbalara Shale was deposited (during a Lower Cretaceous marine transgression) after further tilting to the south-east.

Groundwater is obtained from the three major sandstones (Unit 2, Unit 4 and the De Souza Sandstone). Where it is below the piezometric surface, Unit 2 generally provides large supplies of salt water; the water from Unit 4 varies considerably in quantity and quality from place to place. The De Souza Sandstone invariably provides good supplies of good quality water. Small supplies of fresh water are available in the Quaternary alluvium along the major water courses and in localised aquifers in the igneous and metamorphic rocks.

GENERAL GEOLOGY

Within the Finke 1:250,000 Sheet area there are four main lithological types:-

1. Igneous and metamorphic rocks of Precambrian age.
2. Shale, siltstone and sandstone of Upper Proterozoic age.
3. Sandstone of Middle Ordovician age.
4. Flat-lying and poorly-consolidated sandstones of Carboniferous?, Permian and Mesozoic age.

The latter have been subdivided into the Rumbalara Shale (Sullivan and Opik, 1951), of Cretaceous age, and the Finke River "series" (Chewings, 1914), which is here called the Finke "series" (after Quinlan, 1962). A subdivision of the Finke "series" is here proposed as the result of a reconnaissance survey conducted during 1960-62*.

PRECAMBRIAN IGNEOUS AND METAMORPHIC ROCKS

These rocks form part of a belt of older Precambrian rocks which extends along the South Australian border to the Musgrave Ranges, where they have been described (Glaessner and Parkin, 1958, and Wilson, 1947), as consisting of strongly metamorphosed sedimentary rocks intruded by granite, adamellite, charnockite, pegmatites, dolerite, and basic and ultrabasic rocks. In the Umbeara area the complex consists mainly of granite, granodiorite, quartz-feldspar pegmatites, and metamorphic rocks with several groups of olivine dolerite dykes (Quinlan, 1962). Mica, possibly of economic quality, is present within some of the pegmatites, but no production has been recorded.

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* This report by Rochow was written in 1963. The area has now been systematically mapped in greater detail than previously and formal stratigraphic nomenclature has been established - see Wells, A.T., Stewart, A., and Skwarko, S.K. - "The geology of the south-eastern part of the Amadeus Basin."Bur.Min.Resour.Aust.Rec. 1964/35.
This report is now issued as written, without the revision of stratigraphy and stratigraphic names which was made by Wells et al. Wells et al.'s stratigraphy and names, which followed Rochow as closely as possible, supersedes those appearing in this report.

UPPER PROTEROZOIC SHALE, SILTSTONE AND SANDSTONE.

Outcrops are confined to the Mount Kingston Range, where the rocks are strongly folded and faulted against the older Precambrian. In the absence of fossils the sequence has been correlated on lithological grounds with the Pertatataka Formation (Prichard and Quinlan, 1962). The sequence, as exposed, consists of 1,500 feet of green shale which weathers to a rich red-brown in outcrop, with thin interbeds of siltstone and silty sandstone. Ripple marks and flow casts are locally abundant.

SANDSTONE OF MIDDLE ORDOVICIAN AGE.

At Mount Watt the Pertatataka Formation is unconformably overlain by a white friable quartz sandstone containing fossils of Middle Ordovician age (J. Gilbert-Tomlinson, personal communication). This formation is probably equivalent to the Stairway Sandstone.

SANDSTONES AND SHALES OF CARBONIFEROUS?, PERMIAN AND MESOZOIC AGE.

These sediments crop out over the greater part of the Finke Sheet area. They rest unconformably on the Precambrian granite and on Upper Proterozoic and Palaeozoic sediments of the Amadeus Basin, and they have a maximum thickness of 2,500 feet. A generalized section in descending order is:-

AGE	UNIT	THICKNESS	LITHOLOGY
Cretaceous	Rumbalara Shale	0-900'	Shale
Unconformity			
?Triassic to Lower Cretaceous	De Souza Sandstone	50-300'	Sandstone
Regional Unconformity			
Lower Permian	Crown Point "series"	50-100'	Silty sand boulder beds
Unconformity			
?Carboniferous	Unit 4	100-500'	Sandstone, silty sandstone and silt
Local Disconformities			
	Unit 3	200-300'	Red and green Micaceous shale and mudstone
?Unconformity			
	Unit 2	400-500'	Sandstone
	Unit 1	0-200'	Conglomerate
Angular Unconformity			

The Finke River "series" of Chewings (1914) consists of Units 1 to 4, the Crown Point "series" of Ward (1925) and the De Souza Sandstone. The Crown Point "series" in the Phillipson Bore, in South Australia, is correlated with the Lower Permian glacials (Ludbrook, 1961).

Unit 1

Unit 1 is a conglomerate composed of well-rounded pebbles and cobbles, and some boulders, of granite and metamorphic rocks. It crops out on both flanks of the Black Hill Range (which is the eastern end of the Kingston Range) at Horseshoe Bend. The conglomerate is probably equivalent to the granite-pebble conglomerate north of Unbeara (shown as Pzf in Plate 1). Imbrication of the pebbles, and north-sloping foresets, in the cross-bedded sandstone lenses indicate that material has been transported from the south. Occasional angular fragments of shale of the Pertatataka Formation within Unit 1 prove that at least part of the Mount Kingston Range was undergoing erosion while the remainder was being buried.

The stratigraphic thickness of Unit 1 as measured on the north flank of the Black Hill Range, is about 200 feet. At this locality the conglomerate rests unconformably on shale of the Pertatataka Formation. On the south flank of the range Unit 1 is faulted against the Pertatataka Formation.

Unit 2.

Unit 2 consists of coarsely cross-bedded fine to medium grained sandstone, with some conglomerate lenses and isolated pebbles of granitic and metamorphic rocks. The sandstone is distinguished in outcrop from the De Souza Sandstone by the absence of pebbles of sedimentary rocks. Outcrops are restricted to the flanks of the Black Hill Range, near Horseshoe Bend, and to a small area north of Lilla Creek. Subsurface data from bores indicate a much wider distribution (Plates 1 and 4) with the sandstone ultimately lensing out on to sedimentary rocks of Cambrian and Ordovician age south of Maryvale. The eastward subsurface extension of Unit 2 is unknown. It extends westward to the salt lakes on the Kulgera 1:250,000 Sheet area, where water of high salinity enters the formation. The upper and lower boundaries of the unit are well defined: they are placed at the base of the shale of Unit 3 and at the top of the conglomerate of Unit 1. Encroaching sand dunes cover part of the rock mass at Horseshoe Bend, but where it is exposed, the unit is lithologically uniform except near the base, where there are zones, several feet thick, of a coarse silty sandstone and thin-bedded siltstone with ripple marks. Because of the lack of outcrop the thickness of the unit was not measured, but it is estimated to be between 400 and 500 feet. The contact with the underlying conglomerate is conformable, but some of the cobbles and pebbles from the conglomerate may have been locally reworked and deposited at the base of Unit 2. At the top Unit 2 there is a very thin bed of ferruginised sandstone containing quartz and quartzite pebbles, to the exclusion of the granitic and metamorphic pebbles which are common in the underlying beds. This indicates a marked change in the source of the sediment. Moreover the overlying shales represent an abrupt change in lithology. Consequently it is expected that more detailed mapping will demonstrate the presence of a disconformity between Units 3 and 2. Some slump structures were found within Unit 2 in the area south of Horseshoe Bend Homestead; the direction of slumping is to the south.

Unit 3

This unit consists of distinctive red and green micaceous shale, mudstone and siltstone, with very thin interbeds of fine-grained sandstone, The unit crops out along the Finke River from Idracowra Homestead to Crown Point, and westwards along Lilla Creek where the unit overlies a granite-pebble conglomerate, which probably belongs to Unit 1. Subsurface information is insufficient to determine the eastward extent of Unit 3. To the north and west the shale overlaps Unit 2 and lies directly on sediments of Cambrian and Ordovician age. The base of Unit 3 is placed at the distinct change in lithology from sandstone to shale.

The upper boundary is commonly ill-defined because of interfingering of the shale with sandstone of Unit 4. This boundary is considered to be disconformable, and is defined as the base of the lower-most cross-bedded sandstone which contains angular fragments of leached shale derived from Unit 3. The following section, measured at a point half a mile north of Engoordina Homestead, illustrates the transition from Unit 3 to Unit 4:

Unit 4	4-500 feet	Thin bedded silty sandstone
	2 "	Red and green micaceous shale
	10 "	Cross-bedded fine to medium sandstone
	10 "	Red and green micaceous shale
	6 "	Coarse grained, cross-bedded silty micaceous sandstone with fragments of leached shale ranging from 1 inch to 1 foot in length.
Disconformity		
Unit 3	2-300 feet	Red and green micaceous shale, mudstone and siltstone.

Ripple marks, mud cracks, halite casts, pyrite and gypsum are common throughout the unit and indicate sedimentation in shallow, saline water. Shale samples from bores, are predominantly blue-green (some are grey) indicating that the distinctive red of the outcrops is a result of oxidation during the present weathering cycle. The high salinity and reducing conditions of the depositional environment may explain the paucity of fossils in the unit.

At Horseshoe Bend the shale is silty and sandy from about 30 feet above the base, and grades upward into a thin-bedded fine-grained clayey sandstone which contains small lenses of rounded and polished pebbles of quartz and quartzite. The sandstone is about 50 feet thick and grades upward, and probably laterally, into shale. Discrete isolated lenses of fine-grained white sandstone of unknown lateral extent are common within Unit 3; a lens 80 feet thick was intersected 140 feet above the base of the unit in Bore G53/6-2, on Lilla Creek Station.

The stratigraphical thickness of the unit is 300 feet at Horseshoe Bend Homestead and at Bore G53/6-68 (20 miles west of Horseshoe Bend Homestead). To the south-west of Bore G53/6-2 the unit is thinner and it probably wedges out against the granite at Umbeara.

Unit 4

Unit 4 consists typically of white, thin-bedded siltstone and fine to medium grained silty sandstone, with some beds and lenses of coarse-grained cross-bedded sandstone and conglomerate near the base. It crops out discontinuously from Idracowra to the Rumbalara Ochre Mines, where it dips to the south-east beneath the Crown Point "series" and the De Souza Sandstone.

The full thickness of Unit 4 cannot be measured from outcrops, Bore G53/6-87 intersected 500 feet of sandstone assigned to the unit, but probably did not reach the bottom of the succession. The exposed thickness is generally less, e.g. approximately 100 feet at Crown Point, because of erosion which occurred before the deposition of the overlying Crown Point "series".

The unit rests disconformably on Unit 3. The upper boundary is well defined in the Rumbalara area, where it is placed at the change from thin-bedded clayey sandstone and siltstone to a boulder bed or conglomeratic, coarsely cross-bedded, medium-grained sandstone. The boulder bed is assigned to the Crown Point "series" and the cross-bedded sandstone is part of the De Souza Sandstone.

In the Mount Musgrave-Crown Point area, the unit has been reduced by erosion to 50-100 feet thick; it is overlain by cross-bedded sandstone with conglomerate lenses. Some of the conglomerate lenses occupy large cut and fill structures in the cross-bedded sandstone; the remainder are roughly conformable with the Unit 4 sediments. Discordances occur where the Unit 4 sandstone is slump-contorted, giving an angular unconformity between it and the overlying conglomerate beds, which are assigned to the Crown Point "series".

These observations indicate an erosional unconformity between Unit 4 and the Crown Point "series"; the erosion was most intense in the Crown Point area where the formation of the Crown Point Monocline (Plate 3) produced a structural high. Slumping of the Unit 4 sandstone in the vicinity of the monocline suggests that at least some of the reduced thickness of sediment may be tectonic rather than erosional.

There is no direct evidence to suggest thickening of Unit 4 to the south of Crown Point Ridge, but possibly the sandstone intersected between 1233 and 1474 feet in Charlotte Waters No.1 Bore belongs to Unit 4.

No diagnostic fossils were found but, between Idracowra and Horseshoe Bend Homestead, Scolithus-like vertical pipes and bedding-plane worm tracks are abundant in the lower 100 feet of the unit. The Scolithus-like vertical pipes reported by Sullivan and Opik (1951) in the De Souza Sandstone were most likely derived from this part of the section.

Crown Point "series"

Ward (1925) referred to the sediments which crop out on the Finke River at Crown Point and at Yellow Cliffs as the Crown Point "series" and he considered them to be of glacial origin. The lithology of the sediments which crop out at Crown Point has been discussed by David and Howchin (1924). Sediments which are assigned to this unit crop out in a large area to the north-east of Rumbalara siding.

Lithologically, the Crown Point "series" consists of boulder beds, from 10 to 50 feet thick, interbedded with mudstones, thin to medium bedded, poorly-sorted sandstone, and some cross-bedded sandstone. The boulder beds are unstratified and consist of poorly sorted and unstratified clayey and silty sandstone with isolated angular and rounded fragments of quartzite, siltstone, quartz and igneous and metamorphic rocks.

At Crown Point the "series" rests unconformably on slumped and contorted thin-bedded silty sandstones which are assigned to Unit 4. North-west of Rumbalara the "series" consists of several boulder beds, up to 10 feet thick, which display no internal bedding. The pebbles and boulders range from less than 1 inch to about 2½ feet in maximum diameter, and are of quartzite and quartz with some igneous and metamorphic rocks. They are mostly rounded; some are faceted and a few are striated. Mudstone, thin to medium bedded, poorly sorted, sandstone and some cross-bedded sandstone are interbedded with the boulder beds.

A glacial or periglacial origin for the boulder beds is proposed because of the lack of internal bedding and because some of the boulders are faceted and striated. However, the possibility that the sediments are merely reworked material of glacial origin cannot be discounted. In the field it is difficult to follow any particular bed as a marker because of changes in lithology and thickness. These changes may be due to irregularities in the surface of deposition and the abrupt changes in environment which would be expected with deposition from a glacier or from the outwash of a glacier.

Malcolm's Bore on Andado Station (No. G53/3-3), approximately 40 miles east of the Rumbalara Ochre Mine, intersected a thicker section than is usually seen in outcrop. The log of the bore is -

Comments	Drillers Log	
Rumbalara Shale	0-57'	Yellow clay
	57-284'	Shale
	284-327'	Sandy shale
(Unconformity (?Top of the De Souza Sandstone)		
	327-387'	White sand
	387-603'	White clay
	603-620'	Sand
	620-646'	White clay
	646-1270'	Grey shale
	1270-1458'	Sandy grey shale
	1458-1552'	Grey clay
	1552-1571'	Sandy grey clay, quartz boulder at 1569'
?Sakmarian		
	1571-1704'	Loose waterworn stones with clay
	1704-1801'	Pure sand
	1801-1844'	Grey clay

Microfossils of Lower Cretaceous age (Aptian-Neocomian) have been identified by Ludbrook from a sample at 600 feet (in Sprigg, <u>et al</u>. 1960). Artinskian spores have been identified by Balme from a sample at 1350 feet (in Sprigg, <u>op.cit</u>.).

The interval 327 to 620 feet is probably in the De Souza Sandstone, but the upper and lower limits of the formation in the bore are unknown. The Artinskian beds are assigned to the Permian Crown Point "series"; they have no equivalent in outcrop. The boulder bed intersected between 1571 and 1704 feet is probably equivalent to the periglacials at Crown Point, and to the boulder bed of the Lake Phillipson Bore which is of lowermost Sakmarian age (Ludbrook, 1961). Consequently there may be up to 1200 feet of Permian sediments in Malcolm's Bore compared with less than 100 feet at Crown Point. This variation in thickness, in conjunction withthe reworking of the periglacial rudites into the overlying De Souza Sandstone at Rumbalara, indicates an erosional unconformity between the Crown Point "series"and the De Souza Sandstone.

Slump-contorted, thinly-laminated siltstone and fine sandstone in the Cunninghams Gap area are included in the glacial sequence by David and Howchin (1924). Similar slump-contorted beds were observed beneath glacio-fluvial sediments east of Rumbalara siding. At Crown Point they are directly overlain by tillite. David and Howchin (1924) reported slump-contorted sediments immediately above tillite at Yellow Cliffs. About 1 mile south of the junction of Lilla Creek and the Finke River the slump-contorted beds are sandwiched between Unit 3 shale and typical cross-bedded De Souza Sandstone. This outcrop illustrates the unconformity below the glacials (angular discordance and absence of Unit 4) and the unconformity above the glacials (angular discordance and absence of tillite or fluvioglacial sediments).

Angular fragments of thinly laminated siltstone, possibly derived from the underlying slump-contorted beds, are found in fluvio-glacial conglomerate in the Cunningham's Gap area, indicating local erosional unconformities between the slumped beds and younger sediments of the glacial sequence.

De Souza Sandstone

The name De Souza Sandstone was given by Sullivan and Öpik (1951) to a coarsely cross-bedded conglomeratic sandstone that disconformably underlies the Rumbalara Shale at the Rumbalara Ochre Mines. The sandstone crops out in an area between the Ochre mines and Rumbalara siding and in an area adjacent to the Finke River, south of Yellow Cliffs.

The sandstone is commonly reddish-brown and silicified in outcrop, but is typically quite soft, and even unconsolidated, in bores. In the Rumbalara area the sandstone is composed of medium to coarse grains of quartz with little matrix. The formation contains lenses of conglomerate consisting of quartz and quartzite pebbles, with some pebbles of igneous and metamorphic origin, set in a matrix of medium to coarse grained sandstone. To the south and west, between Finke and Umbeara, the sandstone is feldspathic and a higher proportion of the pebbles are of igneous origin.

Thin interbeds of white shale are common, especially in the upper part of the section near the contact with the Rumbalara Shale. The conglomerate lenses and the presence of erosional features at the base of the formation in the Lilla Creek area, indicate transgressive overlap of the De Souza Sandstone onto the warped and eroded Lower Permian and earlier sediments. The base if the De Souza Sandstone between Lilla Creek and the Ochre Mines rests in turn on Unit 3, Unit 4, and the Crown Point "series".

The top of the De Souza Sandstone is quite distinct in the Rumbalara area, where the cross-bedded conglomeratic sandstones are separated from the Rumbalara Shale by a 2 foot bed of horizontally-bedded ferruginised sandstone and grit. Cut and fill structures indicate a disconformity between the formations. South of Goyder Creek the boundary is obscure because of thin beds of white shale at the top of the De Souza Sandstone. In this area the boundary is placed at the top of a thin bed of ferruginised sandstone.

In the Charlotte Waters Bore the De Souza Sandstone is at least 300 feet thick and possibly more than 850 feet thick (depending on interpretation of the bore log), but it is less than 50 feet thick near Rumbalara Siding. This is probably due to variations in thickness of the formation as it was deposited, combined with subsequent erosion before the deposition of the Rumbalara Shale.

The De Souza Sandstone is correlated with the main aquifer in the Great Artesian Basin in South Australia. This aquifer is considered to be of Upper Triassic to Upper Cretaceous age (Glaessner and Parkin, 1958). Conglomeratic sandstone to the south of Tarlton Downs Homestead (which is about 200 miles east-north-east of Alice Springs) contain a probable Triassic to Lower Jurassic flora (Smith et al., 1961). This sandstone probably dips below the Cretaceous shale to the south and would therefore occupy a stratigraphic position equivalent to the De Souza Sandstone. Therefore the De Souza Sandstone and its lateral equivalents may range in age from Upper Triassic to Lower Cretaceous.

Rumbalara Shale.

The Rumbalara Shale of Lower Cretaceous age (Sullivan and Öpik, 1951) consists predominantly of shale and siltstone, but sandstone lenses (mostly glauconitic) are present near the base, especially in the Goyder Creek Area. The basal bed of the formation is ochreous at Rumbalara and has been exploited in the ochre mines (Sullivan and Öpik, op.cit.).

The maximum exposed thickness of the formation is 900 feet in the area south of Charlotte Waters Bore.

GEOLOGICAL STRUCTURE

The sediments of the Finke "series" were deposited in a downwarped area along the south-eastern margin of the Amadeus Basin and overlap the Precambrian rocks which crop out at Umbeara. They are flat-lying or have a very low dip to the south-east and east; the dips are very nearly constant within the area bounded by two faults in the Precambrian and Older Palaeozoic rocks, i.e. the Crown Point and Mount Kingston structures.

The faults are reflected in areas of outcrop of the Finke "series" as monoclinal axes. Movement along the faults is thought to have occurred both during and after the deposition of the Finke "series".

Crown Point Monocline.

North of a line running approximately through Crown Point and Lilla Creek (Plate 3) the Finke "series" dips due east at about 20 feet per mile. South of this line the Finke "series" dips at about 33 feet per mile, with a strike of 208 degrees.

Poor outcrop has prevented accurate location of the axis of this structure, but it is considered to be monoclinal, dipping to the south-east, and is here termed the Crown Point Monocline.

East of Crown Point there is no outcrop in the critical area on which to determine the extension of the Crown Point Monocline. However, in the area south and east of Finke, contours on the base of the Rumbalara Shale have been constructed, using bore logs (Plate 4). The contours indicate that in this area there has been no significant folding or faulting since Lower Cretaceous time. The base of Rumbalara Shale dipa uniformly at 40 feet per mile in a direction of 125 degrees.

If the base of the Rumbalara Shale is projected up-dip from Finke to Rumbalara, using the dip of 40 feet per mile, it is found that the base of the formation is approximately 350 feet below its predicted position. Therefore,somewhere between Finke and Rumbalara there must exist a fold axis or fault. This structure is probably an eastward extension of the Crown Point Monocline.

Movement along this structural line is probably responsible for the thinning or erosion of Unit 4 prior to deposition of the Crown Point "series". The structure may also represent the north-western limit of deposition of the Crown Point "series" and the De Souza Sandstone.

Mount Kingston Axis.

The Mount Kingston axis trends in an east-north-easterly direction and is the result of the upward movement of a wedge of Upper Proterozoic sediments which domed and faulted the overlying Finke "series". In the core of the structure, rocks of the Finke "series" have been steeply tilted; dips of up to 40 degrees fall off to less than 0.1 of a degree (9 feet per mile) within several miles. Faulting occurs on both flanks of the Mount Kingston Range but is best exposed along the southern flank of the ridge where Unit 1 is partially or wholly faulted out. At either end the structure reduces to a gentle fold; the south-western fold is monoclinal. Dips are to the north in the western part of the monocline and limited outcrop and subsurface control indicate reversal to a southerly dip in the east.

Examination of outcrops of the base of the Finke "series" showed that Unit 1 was deposited on an undulating surface of sedimentary rocks of Upper Proterozoic age and probably abuts the higher sections of the Mount Kingston Range. The range was therefore a feature of the Pre-Permian unconformity surface. Post-Permian uplift and erosion have exhumed this fossil land surface. Unit 4 is the youngest formation of the Finke "series" known to be affected by this vertical movement of older rocks. Generally the structural history of the Finke Sheet area may be summarised as follows:-

1. Faulting and folding of the Amadeus Basin sediments against the Umbeara Block, at the close of sedimentation in the Amadeus Basin, caused a basinal downwarp in the Finke area.

2. Minor adjustment, to relieve stresses built up in the previous cycle, produced gentle folding in the Finke River sediments and local disconformities above them.

3. Further vertical movements in the bedrock, probably during the Jurassic period, initiated the deposition of the deltaic De Souza Sandstone and prepared the way for the marine invasion of the area in Lower Cretaceous time.

4. General uplift with some relative movements between crustal blocks took place between the Lower Cretaceous and Middle Tertiary.

5. No relative vertical movement or thrusting has occurred in the Finke area since the Middle Tertiary but regional uplift may have initiated the present deep erosion into the sediments below the lateritic surface.

GEOLOGICAL HISTORY

The Lower Permian Crown Point "series" is the only unit for which a definite age is available. Units 1, 2, 3, and 4 of the Finke "series" are pre-Lower Permian and a Carboniferous age is herein tentatively assigned to them.

Tectonic movements associated with the close of sedimentation in the Amadeus Basin created a basinal downwarp in the Finke 1:250,000 Sheet area during the Carboniferous Period. A large positive area of granite and metamorphic rocks along the South Australia - Northern Territory border contributed the major part of the sediment in the early stages of the basin (Unit 1 and 2).

During deposition of Unit 3, significant amounts of sedimentary material (mostly quartzite) were contributed from the Amadeus Basin to the north-west. Downwarping in this period was at a minimum and shallow, stagnant, saline water conditions existed.

Renewed downwarping preceded deposition of the Unit 4 sandstone, resulting in local disconformities between Units 3 and 4. Toward the close of Unit 4 sedimentation local upwarping reduced deposition and initiated a period of erosion which lasted until glacio-fluvial material spread out over the basin during the Lower Permian.

After the Lower Permian a long period of erosion preceded the deposition of the De Souza Sandstone. The De Souza Sandstone was laid down during a renewed period of downwarping which culminated in a marine invasion in the Lower Cretaceous.

Uplift of the area after the Lower Cretaceous initiated a period of erosion that, except for peneplanation and deep weathering (with the formation of billy) during the Middle Tertiary, has continued to the present.

OCCURRENCE OF GROUNDWATER

At least 90 bores of various depths have been drilled within the area of the Finke 1:250,000 Sheet (see appendix). Correlation of the bore logs and surface mapping has enabled the main aquifers and their distribution to be recognised. (Plates 1 and 2). The main aquifers, in descending stratigraphic order, are:-

1. De Souza Sandstone
2. Unit 4
3. Unit 2

The area has been divided into 5 zones based on the conditions of occurrence of groundwater (Plate 2).

ZONE 1

Within the limits of this zone the groundwater is confined. The piezometric surface within Zone 1 (Plate 4) is essentially flat, resting at 470 feet above sea level. Therefore a bore will flow wherever the reduced level of the natural surface is below 470 feet.

The aquifer in this zone is the De Souza Sandstone. It is not known if the lower sand in the Charlotte Waters Bore forms part of the De Souza Sandstone; as the two sands are similar and although the lower aquifer contains water of high salinity (see Appendix), both waters rise to the same level.

The De Souza Sandstone contains many impervious beds of clayey sandstone, but groundwater is always struck not more than a few feet below the base of the Rumbalara Shale, which acts as a regional aquiclude. The approximate depth at which the water will be struck can be computed from structure contours drawn on the base of the Rumbalara Shale (Plate 2).

Supplies of water may also be obtained from local aquifers in the Rumbalara Shale, but these are invariably of high salinity and of no economic importance.

ZONE II

In Zone II, as in Zone I, the main aquifer is the De Souza Sandstone, but it is difficult to differentiate between the De Souza Sandstone and the underlying sandstone in bore logs. Hence the northern boundary of Zone II is drawn to include all bores in which water is of good quality and the piezometric surface is 470 to 500 feet above sea level. This boundary passes 4 miles north-west of the calculated position of the 500-foot structure contour line on the base of the De Souza Sandstone. The 200 feet of clay recorded in the lower section of Bloodwood Bore may belong to Unit 3, so it is likely that bores near the north-western boundary of Zone II obtain supplies of water from sandstone in the upper part of Unit 3 in areas of efficient recharge; but here the base of the Rumbalara Shale is above the piezometric surface. Groundwater occurs under water table conditions, except where there are local aquicludes. The total depth of any bore in this zone could be expected to be 525 feet ± 25 feet.

Recharge to the De Souza Sandstone aquifer is mainly from flood waters in Goyder Creek and the Finke River: each flows for more than 20 miles through outcrops of the sandstone. The large quantity of recharge water available is reflected in the low salinity of the groundwater, which rarely exceeds 1000 parts per million (ppm, see Appendix). The relatively high sulphate content is typical of groundwater derived from arid areas (Ward, 1946) and suggests that no recharge is received from the Queensland part of the Great Artesian Basin. Ward (op.cit.) suggests that groundwater in the Artesian Basin aquifer in the Finke area (the De Souza Sandstone and its lateral equivalents) flows to the south-east towards a neutral line where it is balanced by an opposite flow from the east. The nearly horizontal piezometric surface in the Finke area indicates that the rate of ground-water movement to this neutral line must be very small, and that most of the recharge water from the Finke River is held in storage in the vicinity of the intake area.

Accurate information on maximum supplies from individual bores is not available as pastoralists often do not test bores at the maximum rate. However, supplies of less than 1000 gallons per hour (gph) are uncommon and one bore (Anacoora, 50 miles east of Charlotte Waters) delivered 29,000 gallons per hour in 1900.

ZONE III

There are only four bores in this zone on which to base an appreciation of the availability of groundwater (see Appendix). Field mapping indicates that apart from Unit 2, only the sandstones of Unit 4 are below the piezometric surface in this zone (Plates 3 and 4). The sandstones of Unit 2 generally contain saline water in Zone III, so Unit 4 is the only significant aquifer.

Generally the sandstones of Unit 4 are fine-grained and clayey, with low permeability. Within the lowermost 50 feet of the unit there are several beds of cross-bedded, medium to coarse grained sandstone up to 10 feet thick which are good potential aquifers. The two bores in this zone (G53/6-55 and G53/6-87) which yielded a good supply of water were drilled to the base of this unit.

On the basis of outcrop distribution and the bore logs it is estimated that Unit 4 dips to the east at about 25 feet per mile. The approximate western limit of the zone is therefore placed along the intersection of the base of Unit 4 and the piezometric surface, which is between 700 and 800 feet above sea level.

Near Crown Point, Unit 4 wedges out beneath an unconformity (Plate 3); this line marks the south-eastern limit of Zone III. Information is not available on the subsurface distribution of Unit 4 to the east, but the possibility that it wedges out beneath an unconformity, at least locally, in this direction cannot be overlooked.

The salinity of the groundwater in Bore G53/6-55 at Rumbalara (see Appendix) is near the upper limit for cattle, but bores G53/6-70 and G53/6-87 obtained fairly fresh water. These three bores do not give complete information on the distribution of saline water, but it seems likely that groundwater in the main aquifer in Unit 4 generally has a high salinity except in, or adjacent to, areas of high relief where there is effective local recharge.

ZONE IV

Apart from perched water in alluvium along the major water courses, groundwater in Zone IV is saline, ranging from 10,000 ppm to 100,000 ppm total dissolved solids (see Appendix). Therefore it is of no economic importance to the cattle industry except in topographically high areas where local recharge lowers the salinity. The main aquifer is sandstone of Unit 2 which either crops out or is present at shallow depths (0-400 feet) over the whole of the area, (Plates 1 and 2). It is fairly porous, and moderate yields from bores (1000 gph.) are common. The high salinity of the groundwater in Unit 2 is probably caused by recharge of salt water into outcrops of Unit 2 sandstone in the salt lake area along Kurinjga Creek in the Kulgera Sheet area. Probably, also, evaporite minerals are present within sediments of the Finke "series", especially Unit 3 which is gypsiferous in outcrop. In bore G53/6-79 crystals of sodium chloride were found in a sample of the aquifer, which is sandstone with thin interbeds of shale in the upper part of Unit 2.

Three successful bores (see Appendix) which obtain water from Unit 2 are situated in or adjacent to topographically high areas where local recharge of fresh water has diluted the saline groundwater.

Aquifers are present within the steeply dipping Upper Proterozoic sediments of the Mount Kingston Range but the water is too saline for cattle.

The shape and altitude of the piezometric surface in this zone is apparently related to a combination of the structure of the Finke "series" and the altitude of the surface of the ground. North of the Crown Point Monocline the piezometric surface slopes to the east at a lower gradient than the dip of the Unit 2 sediments (Plate 4). Near Lilla Creek, the slope of the piezometric surface steepens and swings to the south-east, roughly parallel to the dip of the Unit 2 sandstone.

At Pollys Corner, four miles west of Horseshoe Bend, the piezometric surface is above the bed of the Finke River and a permanent salt water hole is formed by outflow from the adjacent outcrops of Unit 2 sandstones. At bore G53/6-79 also, the land surface is below the piezometric surface, and a flowing bore resulted.

It is suspected that at least some of the salt water in the alluvium and water holes along the Finke River in the Finke 1:250,000 Sheet area is derived from outflow of groundwater from Unit 2. Salt water is known to flow down the Finke River from sources beyond the area of outcrop of Unit 2, so that both recharge into and outflow from outcrops of Unit 2 may occur, depending on the altitude of the piezometric surface at the time.

ZONE V

There is no aquifer of regional areal extent in this zone and consequently few generalisations can be made on the occurrence of groundwater. Within this zone, granite either crops out or occurs at shallow depths below the sediments, and aquifers of the Finke "series" always lie above the piezometric surface. Groundwater is obtained from local aquifers in the granite and in alluvium along the larger water-courses. The aquifers within the granite are of various types and include shear and fracture zones, quartz veins and some pegmatites, strongly jointed granite, and zones of weathered granite.

There is probably little or no interconnection between the various aquifers and the piezometric surface is related to the surface contours, ranging from 10 to 80 feet below the natural surface. The salinity and supply of water from bores in the granite is largely unpredictable. Groundwater which is perched in alluvium along the creeks is usually of good quality, but supplies are variable.

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APPENDIX

BORE DATA.

ZONE I

Bore Name	File No. G53/6-	Reg.No. W.R.B.	T.D.S.	ppm Cl	ppm SO_4	$\frac{SO_4}{Cl}$	Standing Water Level in feet from surface.	Water Struck - Depth in feet from surface.	Supply g.p.h.	Strata	
Coglin	27	2014					230?	305	1440	0-305 305-371	Clay and shale Drift sand
Charlotte Waters No.1	44	931	31250				140	614	1950	0-614 614-925 925-1116 1116-1233 1233-1445 1445-1472 1472-1474	Clay and shale Siliceous sand Clayey sand Soft grey micaceous rock White siliceous sand Very soft siliceous and micaceous sandstone White siliceous sand.
Charlotte Waters No.2	45	3510	1250	555	164	0.295	141	615	1000	0-615 615-645	Blue shale Fine quartz sand
Marianne	51	2015					195	332	1400	0-332 332-481	Clay and shale Pure sand
Centenary	83	4012	1461	558	299	0.536	180	231	1100	0-224 224-231	Blue shale Soft sandstone
Minga	84	4013	3492	1195	773	0.647	49	49		0-75	Sandstone
Nine Mile	89	2188					154	381	650	0-370 370-412 412-423	Clay and shale White sand Light sandy clay

ZONE II

Bore Name	File No. G53/6-	Reg.No. W.R.B.	T.D.S.	ppm Cl	ppm SO_4	$\frac{SO_4}{Cl}$	Standing Water Level in feet from surface.	Water Struck - Depth in feet from surface.	Supply g.p.h.	Strata	
Nine Mile	24	561	1096	495	57	0.115	365	450	600	0-85 85-400 400-450 450-455	Sandstone Drift sand Black, grey and chocolate clay with bars of sandstone Drift sand
Claude	28	2013					280?	280	1440	0-308 308-327	White sandstone, clayey sandstone, and thin beds of white clay Brown and dark grey shale
Bloodwood No.2	33	2021	529	129	58	0.483	466?	462	960	0-40 40-260 260-458 458-520 520-570	Red soil Sandstone Clay Sand Clay
Finke Railway	39	1794 2016 1793	725	225	86	0.338	265	320	6500	0-434 420 434	Sand Boulders Gravel

ZONE II

Bore Name	File No. G53/6-	Reg.No. W.R.B.	T.D.S.	ppm Cl	ppm SO_4	SO_4/Cl	Standing Water Level in feet from surface.	Water Struck - Depth in feet from surface.	Supply g.p.h.	Strata	
Finke Colsons	40	3990								0-468	White sand with thin beds of white clay.
New Crown Homestead	47	3230	2392	735	436	0.593	180				
Sandy	52	3992	417	85	46	0.541	260			0-100 100-300	Sandstone and conglomerate Sand
	80	4009					212	214	700	0-60 60-250	Sandstone with pebbles Sand
	81	4010					240	244		0-250	Sand
Camel Float	82	4011	619	160	121	0.756	186	207	1100	0-198 198-230 230	Shale Soft sandstone White clay
Siberia	85	4014	413	158	79	0.500	248			0-290	Sandstone
Cindy No.1	86	4015					260	266	1200	0-49 49-304	Sandstone Sand
Willoughby	90	2189						190	1000	0-278 278-280	White clayey sand Coarse siliceous sand

ZONE III

Bore Name	File No. G53/6-	Reg.No. W.R.B.	T.D.S.	ppm Cl	ppm SO_4	SO_4/Cl	Standing Water Level in feet from surface.	Water Struck - Depth in feet from surface.	Supply g.p.h.	Strata	
Mines Branch Rumbalara	55	3993	?7-8000				390	412	600-1000	0-101 101-432	Clay and sandstone Sandstone
Rumbalara Railway	56	3994	Stock water				350			0-474	Sandstone
-	59	1857	9274	3960	1764	0.445	130	160		0-220 220-415 415-455 455-500	Clayey and silty fine sand Brown micaceous clay, mudstone. Grey slightly clayey very fine sandstone Fine white sandstone
	70	2773	2945	1090	369	0.338	300	300	Very small	0-580	Siltstone and fine silty sandstone
Good Friday	88	4016	good				430	435		0-500	Fine to medium white clayey sandstone
Cimbore	87	3542	3854	1680	568	0.295	444	449	600	0-361 361-449 449-500	silty fine to medium grained sandstone Fine sandy clay Fine grained sand with some clay

ZONE IV

Bore Name	File No. G53/6-	Reg.No. W.R.B.	T.D.S.	ppm Cl	ppm SO_4	$\frac{SO_4}{Cl}$	Standing Water Level in feet from surface.	Water Struck - Depth in feet from surface.	Supply g.p.h.		Strata
Idracowra Drought Relief	1	1725	8000	2930	1747	0.600	70	175	Large	0-10 10-90 90-185	Limestone Clay Sandstone
	2	1766 and 3335	5836	2440	1120	0.459	340	510	150	0-135 135-150 150-180 180-260 260-400 400-558 558-562	Brown silty clay Fine medium grained sand Silty clay Fine grained sand, white Silty clay White sand Granite
Angatheta	7	3332 and 1834	404	20	6	0.300	26	30	550	0-30	Alluvium
	8	3333								0-100	Alluvium and sandstone
Old Crown Well	20	2012, 912, 507, 963.	2553	910	345	0.379	42		1000	0-48	Alluvium
New Mallee	21	563	836	305	67	0.219	460	470	960	0-7 7-215 215-225 225-470 470-496 496-600	Alluvium Clay Sandy clay Sandstone Coarse gravel Sandstone
Lilla Creek Homestead Well	25	3334	1886	628	274	0.436	48		100	0-50	Creek alluvium Green shale below 50'
Indianna Well	26	1838	5961	2409	1040	0.431	30		600	0-35	Alluvium - probably clayey bottom
Old Mallee	31	3989							Dry		Granite at 410'
	42	1837					330 ?	335-345 516-525	200	0-330 330-525 525-540	Red sandy clay White sandy clay Granite
Poona Well	50	1339	4727	1025	1964	1.92	35	35	700	0-40	Red and green micaceous shales with fine white sandstone at bottom.
John's Well	53	1840								0-40	Green micaceous shale and fine white sand
Langra Well	63	1275	8659	3874	1560	0.403	about 25'			0-30	Green micaceous shale with fine white sandstone at bottom
	66	3998	19000					140 183	Very small	0-45 45-185	Sandstone and clay Sandstone
	67	3999							Dry	0-92	Sandstone

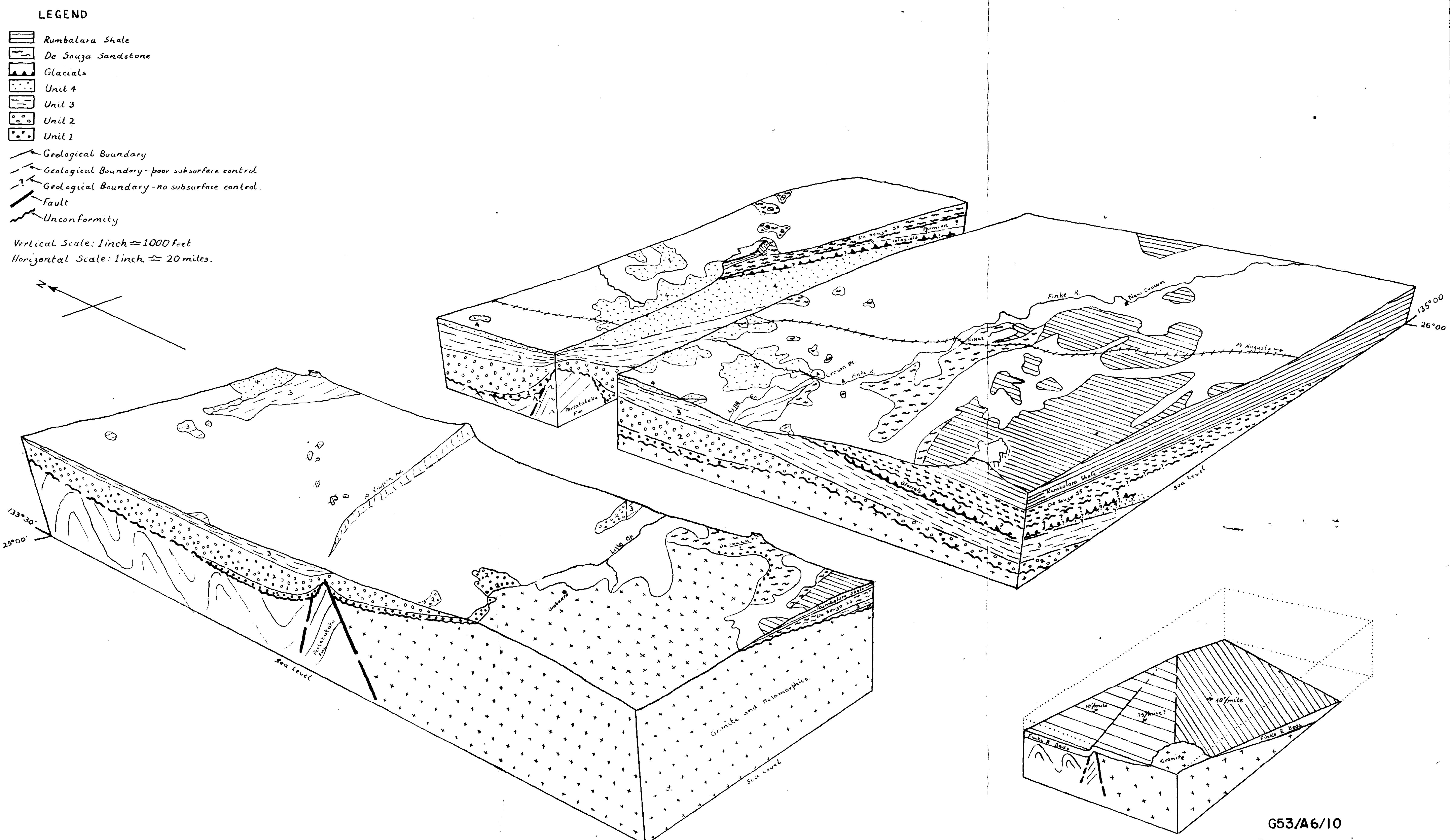
ZONE V

Bore Name	File No. G/53/6-	Reg. No. W.R.B.	T.D.S.	ppm Cl	ppm SO_4	$\frac{SO_4}{Cl}$	Standing Water Level in feet from surface.	Water Struck - Depth in feet from surface.	Supply g.p.h.	Strata	
	17	1770	4276	1620	835	0.515	57	70 90-95	Small 950	0-15 15-90 95-116 116-121	Sand Green silty fine to very coarse sand. Green silty fine to very coarse sand Granite.
Taylors	18	3231	Poor quality				20		Limited	Total Depth - 60'	
Etenia	34	2020							300	100' in metamorphics	
	36	1848							Dry	0-6 6-270 270-304 304-320	Red top soil White sandstone with thin layers of white clay Fine white sand Drift sand
	35	2019					40		400	80' in metamorphics	
	37	1849							Dry	0-7 7-24 24-207 207-374 374-385	Hard sandstone Clay Sandstone Sand Granite
	38	1850							Dry	0-33 33-350 350-368	Mixed clay and sand Sand Weathered granite
	48	1851	1842	710	323	0.455	334	340-343	20	0-154 154-340 340-535 535-542	White fine to medium sand White and green sandy silt and clay Fine to coarse silty sand Weathered granite
	62	3996	5101	1885	1133	0.602	25				Grey and brown fine to medium grained sand.
	93	4019	high							0-180	White fine to medium sand

PLATE 1
FINKE Geological Map
SG 53/6
133°30'
135°00'
25°00'
26°00'
REFERENCE
QUATERNARY RECENT
Qca Alluvium
Qcw Piedmont deposits, wash
Qcm Red earth soil
PLEISTOCENE RECENT
Qpx Evaporite deposits & salt lakes
Qpt Kunkar, calcrete, alluvium
Qps Aeolian sand
MESOZOIC
Lat Laterite
K Rumbalara Shale
PALAEOZOIC
Pzs De Souza Sandstone
Crown Point "series"
Pzd Unit 4 (Silty Sandstone)
Pzc Unit 3 (Shale)
Pzb Unit 2 (Sandstone)
Pza Unit 1 (Conglomerate)
PzF Undifferentiated
Oms Stairway Sandstone
Finke "Series"
PROTEROZOIC
Pup Pertatataka Formation
OLDER PRECAMBRIAN
gr Granite
Unconformity (section only)
Established geological boundary, position accurate
Established geological boundary, position approximate
Probable geological boundary
Strike and dip of inclined strata
Strike and dip of vertical strata
Established fault, position accurate
Established fault, position approximate
Probable fault
Synclinal axis
Anticlinal axis
Road
W.H. Waterhole
Watercourse
Mine
Homestead
Dam
Water Bores:-
Sufficient Supply
Insufficient Supply
Windmill
Dry
Salt
Insufficient
Salt
BORE LOG
Shale
Vertical section of bore log
Sandstone 1" : 400 ft
Crest of sand dune
Boundary of land holdings
B.M.R. Seismic traverse with shot point numbers
INDEX TO ADJOINING SHEETS
NEWBURY
RODINGA
HALE RIVER
KULGERA
FINKE
MCDILLS
ALBERGA
ABMINGA
DALHOUSIE
GEOLOGICAL RELIABILITY DIAGRAM
A. Reconnaissance - Scattered traverses and air-photo interpretation.
B. Air-photo interpretation.
FINKE
ENGOORDINA
KINGSTON RANGE
FINKE RIVER
GOYDER CREEK
LILLA CREEK
MT. SQUIRE
MT. MUSGRAVE
RUMBALARA
POINT EREMOPHILA
MT. McGOWAN
MT. DANIEL
MT. GRUNDY
MT. CECIL
DUFFIELD
UMBEARA
CHARLOTTE WATERS
NEW CROWN
WALL CREEK
G.L. 1880
SCALE 4 MILES TO 1 INCH
MILES 0 5 10 15 20 MILES
Schematic Cross-Section through Crown Point, looking North-east.
Rumbalara Shale
De Souza Sandstone
Granite
Sea Level
1000'
NT
G53/A6/8
G53/6-1A To accompany B.M.R. Record No 1965/13
Resident Geologists Office Alice Springs Jan 1963.


GROUNDWATER ZONES
FINKE
1:250,000
SHEET AREA
SG53/6
133°30'
135°00'
25°00'
26°00'
ZONE IV
ZONE III
ZONE II
ZONE I
ZONE V
FINKE RIVER
GOYDER CREEK
Lilla Creek
Spring Creek
Goyder Creek
RUMBALARA
Finke
New Crown
Charlotte Waters
Wall Creek
Engoordina
Black Hill Well
Lilla Creek
Umbeara
Bloodwood Bore
Willoughby Bore
REFERENCE
Form Lines on Natural Surface
Contours on Piezometric Surface
Groundwater Zone Boundary
Equipped Bore with File No of bore (see appendix)
Dud Bore (Salt)
Dud Bore (Insufficient supply)
Homestead
Road or Track
Ochre Mine
Railway
ZONE I
Piezometric Surface = 470 feet above sea-level.
Depth below surface at which water is struck marked thus 300'
Aquifer :- De Souza Sandstone
ZONE II
Piezometric Surface = 470 feet above sea-level
Depth below surface at which water is struck ≏ Surface level – 500 feet.
Aquifer :- De Souza Sandstone
ZONE III
Piezometric Surface = 700 to 800 feet above sea-level
Depth below surface at which water is struck is variable
Aquifer :- Unit 4.
ZONE IV
Piezometric Surface contours are approximate, because of the small number of measuring points. The depth at which the water is struck is variable.
Aquifer :- Unit 2 and Pertatataka sediments.
ZONE V
Groundwater is present in small isolated aquifers in granite and shallow alluvium and Pzf. The piezometric surface is usually shallow (about 50 feet ± 30 feet) and is related to the surface contours.
Scale: 1 inch ; 4 miles
4 2 0 4 8M
INDEX TO ADJOINING SHEETS
HENBURY
RODINGA
HALE RIVER
KULGERA
FINKE
McDILLS
ALBERGA
ABMINGA
DALHOUSIE
G53/A6/9
G53/6-2A To accompany B.M.R. Record 1965/13
Resident Geologists Office Alice Springs Jan 1963

BLOCK DIAGRAM OF FINKE 1:250,000 SHEET AREA (SG53/6) SHOWING GEOLOGY & STRUCTURE.



G53/A6/10

Diagrammatic Representation of Structural Features

G 53/6 - 3A To accompany B.M.R. Record No. 1965/13

Resident Geologists Office
Alice Springs Jan 1963

COLUMNAR SECTIONS FROM BORES IN FINKE AND McDILLS 1:250,000 SHEET AREAS (SG53/6 & 7)

The bores are projected onto a line passing through Andado No2 bore and Horseshoe Bend, bearing 120°

G53/6-4A To accompany BMR Record 1965/13

G53A/4

Resident Geologist's Office
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