1 : 250,000 GEOLOGICAL SERIES—EXPLANATORY NOTES

HERMANNSBURG

NORTHERN TERRITORY

SHEET SF/53—13 INTERNATIONAL INDEX

COMMONWEALTH OF AUSTRALIA

1 : 250,000 GEOLOGICAL SERIES—EXPLANATORY NOTES

HERMANNSBURG

NORTHERN TERRITORY

SHEET SF/53—13 INTERNATIONAL INDEX

Compiled by T. Quinlan and D. J. Forman

Issued under the authority of the Hon. David Fairbairn, Minister for National Development

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS
CANBERRA 1968

COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT
MINISTER: THE HON. DAVID FAIRBAIRN, D.F.C., M.P.
SECRETARY: R. W. BOSWELL, O.B.E.

BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS
DIRECTOR: J. M. RAYNER, O.B.E.

THESE NOTES WERE PREPARED IN THE GEOLOGICAL BRANCH
ASSISTANT DIRECTOR: N. H. FISHER

Printed in Australia by the Commonwealth Government Printer, Canberra

Compiled by T. Quinlan and D. J. Forman

Explanatory Notes on the Hermannsburg Geological Sheet

The area of the Hermannsburg Sheet lies between 23° and 24°S, and 132°00′ and 133°30′E. The town of Alice Springs is 27 miles to the east of the Jay Creek Aboriginal Settlement, which is on the eastern margin of the area.

A network of gravel and station tracks provides ready access to most parts of the area. The Commonwealth Department of Works maintains two systems of formed earth roads which cross the area. One is south of the MacDonnell Ranges, and links Alice Springs with the Jay Creek Aboriginal Settlement, Hermannsburg Mission, and the Areyonga, Haasts Bluff, and Papunya Aboriginal Settlements to the west. The other is to the north of the MacDonnell Ranges, and consists of the road to Yuendumu and a branch road connecting it with Haasts Bluff Aboriginal Settlement.

A tourist company has graded an earth road, suitable only for four-wheel-drive vehicles, through the MacDonnell Ranges from Jay Creek Aboriginal Settlement to Glen Helen tourist camp. Most homesteads and aboriginal settlements have landing grounds which are suitable for light aircraft and planes of the Royal Flying Doctor Service. A local airline provides a passenger and mail service to some homesteads and native settlements.

About a quarter of the Sheet area is reserved for the use of aborigines. Seven lease-holders use the remainder for raising beef cattle. No minerals have been produced, but two authorities to prospect have been taken out to cover the southern portion; one is for petroleum exploration and the other for non-metallic minerals.

The average annual rainfall is 10 inches; more rain falls in the summer than in the winter months. The daily range in temperatures is similar to that for Alice Springs, which is described by Slatyer (1962). The mean summer maximum and minimum temperatures at Alice Springs are 95° and 70°F and the mean winter maximum and minimum are 67° and 40°F.

Much of the area is covered by spinifex. Short grass and forbs pastures are restricted to undulating country or areas of alluvium (Perry & Lazarides, 1962), and are generally associated with woodlands of low trees and scrub (mulga, witchetty bush, ironwood, beefwood, and corkwood). Stands of river red gum occur on river flats and along watercourses.

Topographic maps and air-photographs covering the Hermannsburg Sheet area are: a photomosaic, at a scale of 4 miles to 1 inch; a planimetric map, at a scale of 1:250,000; dye-line maps, at air-photograph scale, controlled by slotted templet assembly, and showing principal points, wing points, and topographic detail; air-photographs, at a scale of 1:46,000 approximately.

The maps have been prepared by and are available from the Division of National Mapping, Department of National Development. The air-photographs were taken by the Royal Australian Air Force.

Geological Investigations

The earliest knowledge of the geology of central Australia was acquired during lengthy exploring trips. The difficulties of travel were such that observations were necessarily scattered and incomplete. H. Y. L. Brown was one of the first geologists to visit and write about the area. In reports published between 1889 and 1902 (Brown, 1889, 1890, 1897, and 1902) he distinguished between the sedimentary rocks, which he regarded as Cambrian, and the metamorphic basement.

Chewings' first paper on the geology of central Australia was published in 1891, and he published further work at intervals up to 1935 (Chewings, 1891, 1894, 1914, 1928, 1931, 1935). He postulated the fault-bound Amadeus Hinterland to explain the preservation of the sediments and to account for the other features he had noted.

The 1894 Horn Expedition to central Australia travelled over much of the western MacDonnell Ranges. Tate & Watt (1896) collected Ordovician fossils from the 'Horn Valley' and regarded all the sediments as Ordovician; their report is the earliest record of geological mapping, rather than traversing, of the western MacDonnell Ranges.

Mawson & Madigan (1930) divided the sediments into 'series' of Ordovician, Cambrian, and Proterozoic age. Madigan (1932a, b) revisited the area and mapped it in more detail. He confirmed the stratigraphic succession established in the joint paper with Mawson, and measured over 24,000 feet of Proterozoic, Cambrian, Ordovician, and post-Ordovician beds. His geological map of the western MacDonnell Ranges was a major advance on previous publications. In 1952 Mawson recognized glacio-fluvial conglomerates in the Proterozoic sediments at Ellery Creek (Mawson, 1957), and correlated them with the Sturtian Tillite in the Flinders Ranges.

The sediments of the MacDonnell Ranges and the Amadeus Geosyncline were discussed by Hossfeld (1954) in his paper on the stratigraphy and structure of the Northern Territory. He disagreed with Madigan's sequence and thicknesses.

In 1956 Prichard & Quinlan (1962) mapped the southern portion of the Hermannsburg Sheet area, and Forman & Milligan (Forman et al., 1967) mapped part of the northern portion in 1964. A number of reports (Joklik, 1955; Noakes, 1956; Öpik, 1956; Quinlan, 1962; Wells et al., 1965, 1967; and Ranford et al., 1966) describe the geology of the surrounding area and contain information which is relevant.

A number of oil exploration companies have undertaken field work in the Amadeus Basin. Thomas (1956) reviewed the literature for Frome-Broken Hill Pty Ltd. Field parties from this company measured sections in the Amadeus Basin in 1958 and 1959 (for those within the Hermannsburg Sheet area see McLeod, 1959); isopach and lithofacies maps were constructed from these sections (Leslie, 1960). Taylor (1959) examined the fossils collected and discussed the stratigraphy. Jaccard (1961) made a geological reconnaissance of the Amadeus Basin for Conorada Petroleum Corporation.

McNaughton (1962) assessed the petroleum prospects of oil permits 43 and 46 in the Amadeus Basin for Magellan Petroleum, and Stelck & Hopkins (1962) measured sections and discussed the stratigraphy of the northern portion of the Amadeus Basin. Additional sections of the Larapinta Group were measured by Haites (1963) for this company. He used these to construct isopach maps of the four formations of this Group. Banks (1964) reported an investigation of the occurrence of non-metallic minerals, including salt, in sediments of the Amadeus Basin.

In 1953, the Titanium Alloy Manufacturing Company undertook an extensive programme of geochemical sampling and drilling for copper in the Goyder Formation of the Pertaoorrta Group in the Waterhouse Range. The results were not encouraging and the investigation was abandoned in 1955. Horvath (1956) describes the geophysical surveys which were undertaken in connexion with this project.

Geophysical Investigations

An aeromagnetic traverse by the Bureau of Mineral Resources in 1960 indicated that there is a substantial thickness of sediment in the Missionary Plain Syncline. It gave no information on the nature of the contact of the sediments with the basement, on the northern margin of the Amadeus Basin. The results of the 1965 aeromagnetic and radiometric survey are discussed by Young & Shelley (1966).

The existence of a steep gravity gradient along the northern margin of the Amadeus Basin was demonstrated by Marshall & Narain (1954). This can be traced to the west, across the Hermannsburg Sheet area, as a narrow zone. Langron (1962) suggested that the marked gravity relief is 'probably due to a combination of the density contrast between basement and sediments, the very great thickness of sediments, overthrusting, and crustal warping'. Marshall & Narain (1954) and Forman et al. (1967) have presented evidence to suggest that crustal warping is the main cause of the gradient.

Richards (1958) and Brunnschweiler et al. (1959) describe magnetic and gravity surveys of Gosses Bluff made on behalf of Frome-Broken Hill Co. Pty Ltd. The Bouguer anomaly map constructed by Richards (1958) shows a circular gravity 'low' in the centre of the structure, a feature which is typical of salt domes. He estimated the depth to the salt to be between 2500 and 4000 feet. A further semi-detailed gravity survey was made along seismic traverses, and also on a grid inside Gosses Bluff, by the Bureau of Mineral Resources in 1962.

10283/68—2

A short seismic traverse south of Hermannsburg Mission in 1961 (Turpie & Moss, 1963) showed that the thickness of the sedimentary rocks was greater than 20,000 feet. A seismic party from the Bureau of Mineral Resources shot a seismic reflection traverse across the Missionary Plain Syncline in 1962, from the Gardiner Range through Gosses Bluff to a point which is underlain by metamorphic rocks of Precambrian age. Moss (1964) states that the maximum thickness of sedimentary rocks in the Gardiner Range is 26,000 feet.

PHYSIOGRAPHY

The Hermannsburg Sheet area has been divided into four physiographic regions (see also Mabbutt, 1962; and Forman & Milligan, 1967), which are illustrated in Figure 1. They are:

High ranges and hills: Crystalline igneous and metamorphic rocks and quartzite crop out in ranges and hills within the central portion of the area. These rocks are resistant to weathering, and local relief can be 2000 feet or more. The valley floors are narrow and have thin veneers of alluvium. The highest points are Mount Zeil (4955 feet) and Mount Sonder (4417 feet).

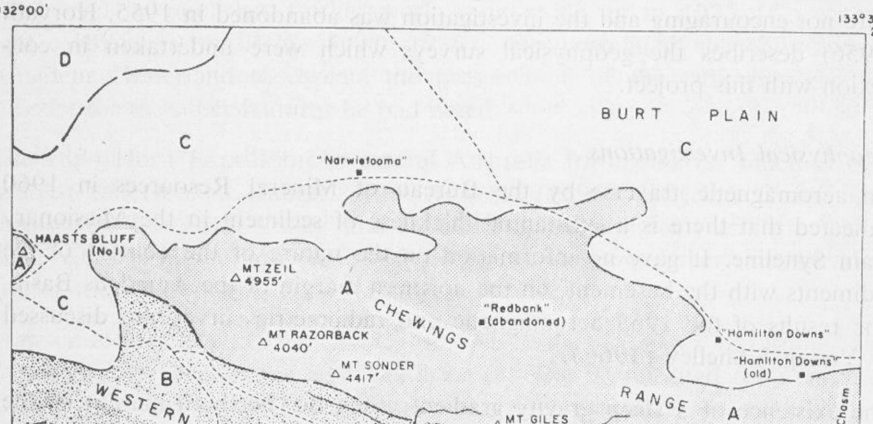

Fig. 1. Physiographic divisions

Strike ridges and valleys: The very steeply dipping sedimentary rocks of the MacDonnell, Gardiner, and Waterhouse Ranges have been eroded to produce a landform of parallel strike ridges and valleys, cut by transverse drainage channels. The valley floors are underlain by varying thicknesses of alluvium and unconsolidated sediment. The relief is commonly greater than 500 feet.

Plains with some dunes and low outcrops: The Burt Plain and the Missionary Plain together cover half of the area. They are areas of low relief, with some areas of outcrop and sand dunes covered with spinifex and aeolian sand. There are alluvial sediments on the perimeters of the plains, and small alluvial flood plains are associated with the major watercourses.

Sand plain with longitudinal dunes: A small area in the north-west is covered by parallel sand dunes. They have a westerly trend and are fixed by spinifex and low scrub.

STRATIGRAPHY

The stratigraphy is summarized in Tables 1 and 2. The type sections for most of the sedimentary rock units are at Ellery Creek.

The stratigraphic nomenclature which has been used for the Hermannsburg Sheet area has been revised on five occasions. Table 3 relates the nomenclature of previous workers to that used here.

Miss Joyce Gilbert-Tomlinson has examined the Lower Palaeozoic faunal succession (pers. comm.). The palaeontological identifications and the ages of the Lower Palaeozoic units (Table 2) are the results of her work.

Subsurface data are sketchy. Two exploratory wells have been drilled by petroleum exploration companies, Gosses Bluff No. 1 by Exoil (N.T). Pty Ltd (Planalp & Pemberton, 1963), and Palm Valley No. 1 by Magellan Petroleum (1965). The stratigraphic succession in these holes is:

Rock Unit	*Gosses Bluff No. 1 Lat 23°49′15″S Long 132°18′00″E*	*Palm Valley No. 1 Lat 24°00′00″S Long 132°46′20″E*
Pertnjara Group	—	0–1010′
Mereenie Sandstone		1010′–3050′
Stokes Siltstone	0–1040′	3050′–4298′
Stairway Sandstone	1040′–4535′ (TD)	4298′–5330′
Horn Valley Siltstone	—	5330′–5636′
Pacoota Sandstone		5636′–6658′ (TD)

The Resident Geologist's Office at Alice Springs has information on 134 water bores and wells. Few detailed logs of these bores are available and all are less than 500 feet deep.

PRECAMBRIAN

The *Arunta Complex* crops out as a belt of hilly country between the Heavitree Quartzite and the Burt Plain and as outcrops within the Burt Plain. The complex comprises gneiss, schistose gneiss, schist, amphibolite, metaquartzite, and granite, and is intruded by dykes of pegmatite and dolerite. The Heavitree Quartzite unconformably overlies the Arunta Complex and the pegmatite and dolerite dykes.

The structure of the moderate-grade metamorphics of the Arunta Complex is described by Forman et al. (1967). They also describe low-grade schists within the Arunta Complex which were produced during a later period of folding and retrograde metamorphism (the Alice Springs Orogeny).

The *Heavitree Quartzite* overlies the Arunta Complex unconformably and forms the base of the Amadeus Basin succession. It is overlain conformably by the Bitter Springs Formation. The Quartzite is about 1400 feet thick at Ellery Creek Big Hole.

Prichard & Quinlan (1962) recognize three members. The basal member is about 700 feet thick and consists of medium to coarse quartz sandstone, commonly cemented to quartzite. The middle member, about 200 feet thick, consists of coarse-grained siltstone containing about 40 percent of medium to coarse quartz grains. The top member is medium-grained quartz sandstone generally silicified to quartzite, and includes pale yellow-brown argillaceous quartz siltstone up to 100 feet thick below the uppermost quartzite bed.

Forman et al. (1967) show that the Heavitree Quartzite is metamorphosed to metaquartzite, sericite-quartz schist, and schistose quartzite within the Ormiston Nappe Complex in the Ormiston Gorge/Mount Razorback area.

The Bitter Springs Formation (Joklik, 1955; Ranford et al., 1965) is 2500 feet thick at Ellery Creek and rests conformably on the Heavitree Quartzite. It is unconformably overlain by the Areyonga Formation (Prichard & Quinlan, 1962).

Within the Hermannsburg Sheet area it crops out in the MacDonnell Ranges, and parts or all of the formation are intricately folded and deformed. The style of deformation, its mobility in the core of the Goyder Pass diapir, and the occurrence of saline groundwater in particular portions of the formation, were taken as evidence for the presence of evaporites (McNaughton et al., 1965). Salt was found in June 1963, when Ooraminna No. 1 Well (Lat. 24°00′06″ S, Long. 134°09′50″ E) was abandoned in salt of the Bitter Springs Formation at a total depth of 6105 feet (Planalp & Pemberton, 1963).

The *Areyonga Formation* consists essentially of two members, a siltstone (750 feet thick) and a calcareous quartz sandstone (550 feet thick). The formation disconformably overlies the Bitter Springs Formation and is conformably overlain by the Pertatataka Formation.

Both members are exposed in Ellery Creek, but the lower member is not present at all localities. The rock weathers to a buff or white kaolinitic quartz sandstone with some surface silicification. An Upper Proterozoic age has been assigned to the formation.

The *Pertatataka Formation* crops out poorly, and is considered to overlie the Areyonga Formation conformably and to be conformably overlain by the Arumbera Sandstone. No fossils have been found in the Pertatataka Formation, and an Upper Proterozoic age has been assigned to it.

Lower Palaeozoic

Cambrian

The sedimentary rocks known to be of Cambrian age are, in descending order, the Pacoota Sandstone (in part), the Goyder Formation, and the Jay Creek

TABLE 1: PRECAMBRIAN AND CAMBRIAN STRATIGRAPHY

Age	*Rock Unit*	*Lithology*	*Thickness (feet)*	*Stratigraphic relationship*	*Economic geology*
CAMBRIAN — PERTAOORRTA GROUP (Cp)	Undifferentiated (Cp)	Sandstone, siltstone, shale, limestone.			
	Goyder Formation (Cg)	Pale brown fine to medium kaolinitic quartz sandstone commonly micaceous; limestone; siltstone; minor limestones.	1600		Minor occurrences of secondary copper minerals. Usable supplies of good to moderate quality groundwater.
	Jay Creek Limestone (Cj)	Blue-grey, yellow-brown dolomitic limestone and limestone; minor interbeds of shale.	175–1000		Minor occurrences of galena.
	Hugh River Shale (Cl)	Grey or black shale; thin interbeds of limestone, silty sandstone, siltstone.	1600		
				DISCONFORMITY	
	Arumbera Sandstone (Ca)	Red-brown medium very silty sandstone; purple-red micaceous siltstone	800–2800		Building stone. Minor occurrences of secondary copper minerals.
	Petermann Sandstone (Ce)	Red-brown sandstone.	About 640		
	Deception Formation (Cd)	Red-brown siltstone; with minor fine silty sandstone.	About 600	A conformable sequence in the Gardiner Range, laterally equivalent to Pertayoorrta units at Ellery Creek.	
	Illara Sandstone (Ci)	Red-brown sandstone with minor siltstone.	250–650		
	Tempe Formation (Ct)	Siltstone, fossiliferous limestone and sandstone; glauconitic.	About 760		
	Eninta Sandstone (Cn)	Red-brown sandstone and siltstone. Some conglomerate beds.	300–1200	Unconformably overlies Pertatataka Formation in Gardiner Range.	Some secondary copper mineralization near faults.
PROTEROZOIC	Pertatataka Formation (Pup)	Red, green siltstone; shale; thin limestone and sandstone beds.	2200–4000		
	Areyonga Formation (Pua)	Pale brown, white, medium calcareous quartz sandstone; green tillitic siltstone; conglomerate.	0–1300	Disconformably overlies Bitter Springs Formation. Tillitic siltstone and conglomerate may or may not be present.	Small to moderate supplies of stock quality water from sandstones.
				DISCONFORMITY	
	Bitter Springs Formation (Pub)	Dark grey dolomitic and cherty limestone; siltstone; evaporites.	2500	Conformably overlies the Heavitree Quartzite.	Aggregate. Large quantities of poor groundwater from black pyrite shales.
	Heavitree Quartzite (Puh)	White, pale brown, purple, medium and coarse quartzite and silicified silty quartz sandstone; silicified sandstone; siltstone.	500		Aggregate and building stone. Small quantities of moderate quality groundwater.
				UNCONFORMITY	
PRECAMBRIAN	Arunta Complex (pCa)	Gneiss, schist, amphibolite, quartzite, granite, dolerite, pegmatite.			
	(pCg)	Granite			
	(pCq)	Metaquartzite, quartz sericite schist.			

TABLE 2: CAMBRIAN TO QUATERNARY STRATIGRAPHY

Age	*Group*	*Rock Unit*	*Lithology*	*Thickness (feet)*	*Stratigraphic relationship*	*Economic geology*
QUATERNARY		(Qa)	Alluvium.	1–250		Good to moderate quality groundwater below piezometric surface.
QUATERNARY		(Qs)	Aeolian sand.	1–50		
QUATERNARY		(Qt)	Travertine, kunkar.	1–100		
					UNCONFORMITY	
TERTIARY		(Tc)	Conglomerate.			
					UNCONFORMITY	
TERTIARY		(Tl)	Chalcedonic limestone.	1–20		
					UNCONFORMITY	
TERTIARY		(Ta)	Laterite.	50–200		Suitable as gravel for road construction. Yields small to moderate quantities of variable quality groundwater below piezometric surface.
TERTIARY		(Ts)	Sandstone, sandy siltstone, lignite.	1–200		Small to moderate supplies of moderate quality groundwater.
					UNCONFORMITY	
UPPER PERMIAN		(P)	Brown and grey sandy clay.	100		
					UNCONFORMITY	
DEVONIAN TO CARBONIFEROUS	PERTNJARA GROUP	Brewer Conglomerate (Pzb)	Grey calcareous conglomerate and sandstone.	10,000 vertical thickness. 21,500 foreset thickness.		
DEVONIAN TO CARBONIFEROUS	PERTNJARA GROUP	Hermannsburg Sandstone (Pzr)	Red-brown fine to medium silty sandstone, with scattered limestone and dolomite pebbles, current-bedded.	0–2000	? Conformable on Mereenie Sandstone in west. Unconformable on Larapinta and Pertaoorrta Groups in east.	Moderate supplies of good quality groundwater from aquifers near top of formation.
DEVONIAN TO CARBONIFEROUS	PERTNJARA GROUP	Parke Siltstone (Pzk)	Red-brown siltstone, some calcareous lenses.	0–800		
					UNCONFORMITY	
ORDOVICIAN TO DEVONIAN		Mereenie Sandstone (Pzm)	Brown fine quartz sandstone, very thickly current-bedded.	0–2000		Large supplies of good to moderate quality groundwater.
					UNCONFORMITY	
CAMBRIAN TO ORDOVICIAN	LARAPINTA GROUP (C-Ol)	Undifferentiated (C-Ol)	Fossiliferous sandstone, siltstone, shale, dolomite, limestone.			
CAMBRIAN TO ORDOVICIAN	LARAPINTA GROUP (C-Ol)	Carmichael Sandstone (Oc)	Red-brown sandstone, silty sandstone, siltstone.	0–200		
CAMBRIAN TO ORDOVICIAN	LARAPINTA GROUP (C-Ol)	Stokes Siltstone (Ot)	Dark red and purple siltstone, shale with thin limestone beds.	0–2000		
CAMBRIAN TO ORDOVICIAN	LARAPINTA GROUP (C-Ol)	Stairway Sandstone (Os)	Pale brown fine and medium silty quartz sandstone; quartz sandstone.	0–1500		Moderate supplies of good to moderate quality groundwater.
CAMBRIAN TO ORDOVICIAN	LARAPINTA GROUP (C-Ol)	Horn Valley Siltstone (Oh)	Siltstone with thin fossiliferous limestone beds, and some thin sandstone beds.	0–1400		
CAMBRIAN TO ORDOVICIAN	LARAPINTA GROUP (C-Ol)	Pacoota Sandstone (C-Op)	Pale brown fine and medium quartz sandstone; kaolinitic and silty quartz sandstone; micaceous siltstone.	0–2700		Moderate supplies of good to moderate quality groundwater.

Limestone. A Cambrian age has been assigned to the Hugh River Shale and to the Arumbera Sandstone (Wells et al. 1965).

The Pertaoorrta Group was defined by Prichard & Quinlan (1962) to include the Goyder Formation, the Jay Creek Limestone, and the Hugh River Shale. Wells et al. (1965b) and Ranford et al. (1965) altered the status of the units and recognized five new formations in the Gardiner Range, the Eninta Sandstone, the Tempe Formation, Illara Sandstone, the Deception Formation, and the Petermann Sandstone. These changes together with the present usage are shown in Table 3. The Arumbera Sandstone was included in the Pertaoorrta Group by Wells et al. (1965) because 'it is considered to be lithologically related' to the units which overlie it. All fossils collected from the Pertaoorrta Group date it as Cambrian.

The *Arumbera Sandstone* consists of lenses of sandstone and siltstone ranging in thickness from 50 to 500 feet. 'Clay pellets', current bedding, and slump-roll structures are common in the sandstone. The formation is 800 feet thick at Ellery Creek, and increases to 2700 feet at Stokes Pass. It overlies the Pertatataka Formation with apparent conformity and is disconformably overlain by the Hugh River Shale. No fossils have been found in the formation, and a Cambrian age has been assigned to the upper portion.

The *Hugh River Shale* disconformably overlies the Arumbera Sandstone and is conformably succeeded by the Jay Creek Limestone. It is 1600 feet thick at Ellery Creek, where a thin bed of limestone containing brecciated fragments of chert and limestone marks the base of the formation. The lithology changes to the west. Near Stokes Pass the dominant rocks are very fine-grained micaceous silty sandstone (commonly calcareous), siltstone, and shale.

Algal colonies are common in the thin limestone beds at Ellery Creek, but they cannot be used to date the formation. The relation with the overlying Jay Creek Limestone indicates that the Hugh River Shale is of Cambrian age.

The *Jay Creek Limestone* conformably overlies the Hugh River Shale. The boundary with the overlying Goyder Formation is gradational, both vertically and laterally. Many of the limestone beds are algal biostromes; clastic limestone with current-bedding structures, oolitic limestone, and mottled limestone are common.

From Jay Creek to Ellery Creek the formation is continuous, but west of Ellery Creek it occurs sporadically, not as erosional remnants of a once continuous body, but as discrete lenses or tongues extending from the main body.

At Ellery Creek the formation is 175 feet thick, and it contains numerous algal fossils. *Girvanella* and trilobites of late Middle Cambrian age have been collected from near the base.

The *Eninta Sandstone* is a fine and medium-grained ferruginous, feldspathic, micaceous sandstone, with interbeds of micaceous siltstone and some conglomeratic sandstone. The sandstone is laminated and thinly bedded, and current-bedding is common. It is about 1200 feet thick at the type locality in the Gardiner Range, and is tentatively regarded as being laterally equivalent to part of the Arumbera Sandstone.

TABLE 3: STRATIGRAPHIC NOMENCLATURE FOR THE HERMANNSBURG 1:250,000 SHEET AREA

Pre 1932	*Madigan, 1932*	*Chewings, 1935*	*Prichard & Quinlan, 1962*	*Wells, Forman, & Ranford, 1965*	*Ranford, Cook & Wells, 1965 Wells, Ranford, Stewart, Cook & Shaw, 1967*	*These notes; Wells et al., 1967 in press*
Walker Creek Series [1]; Pertnjara Series [3]	Pertnjara Series	Pertnjara Series	Pertnjara Formation	Pertnjara Formation	Pertnjara Formation	Pertnjara Group: Brewer Conglomerate, Hermannsburg Sandstone, Parke Siltstone
Walker Creek Series [1]; Pertnjara Series [3]	Larapintine Series: Mereenie Sandstone	Larapinta Series: Marena Red Sandstone	Mereenie Sandstone	Mereenie Sandstone	Mereenie Sandstone	Mereenie Sandstone
Mareeno Bluff Series [1]	Larapintine Series: (not seen)	Larapinta Series: Mareena Valley Shales and Mudstone	Larapinta Group: Stokes Formation	Larapinta Group: Stokes Formation	Larapinta Group: Stokes Formation	Larapinta Group: Carmichael Sandstone; Stokes Siltstone
Mareeno Bluff Series [1]	Larapintine Series: Horn Valley Beds	Larapinta Series: Stairway Quartzite	Larapinta Group: Stairway Greywacke	Larapinta Group: Stairway Sandstone	Larapinta Group: Stairway Sandstone	Larapinta Group: Stairway Sandstone
Mareeno Bluff Series [1]	Larapintine Series: Horn Valley Beds	Larapinta Series: Stairway Valley Beds	Larapinta Group: Horn Valley Formation	Larapinta Group: Horn Valley Siltstone	Larapinta Group: Horn Valley Siltstone	Larapinta Group: Horn Valley Siltstone
Pacoota Quartzite [2]	Larapintine Series: 'No. 4 quartzite'	Larapinta Series: 'No. 4 quartzite'	Larapinta Group: Pacoota Sandstone	Larapinta Group: Pacoota Sandstone	Larapinta Group: Pacoota Sandstone	Larapinta Group: Pacoota Sandstone
Pataoorrta Series [2]; Pertaoorrta Series [3]	Pertaoorrta Series	Pertaoorrta Series	Pertaoorrta Group: Goyder Formation	Pertaoorrta Formation: [MacDonnell Ranges] / [Gardiner Range]	Pertaoorrta Group: [MacDonnell Ranges] / [Gardiner Range]	Pertaoorrta Group: [MacDonnell Ranges] / [Gardiner Range]
Pataoorrta Series [2]; Pertaoorrta Series [3]	Pertaoorrta Series	Pertaoorrta Series	Pertaoorrta Group: Goyder Formation	Goyder Member	Goyder Formation	Goyder Formation
Pataoorrta Series [2]; Pertaoorrta Series [3]	Pertaoorrta Series	Pertaoorrta Series	Pertaoorrta Group: Jay Creek Limestone	Jay Creek Limestone Member / Petermann Sandstone Member	Jay Creek Limestone / Petermann Sandstone	Jay Creek Limestone / Petermann Sandstone
Pataoorrta Series [2]; Pertaoorrta Series [3]	Pertaoorrta Series	Pertaoorrta Series	Pertaoorrta Group: Jay Creek Limestone	Jay Creek Limestone Member / Deception Member	Jay Creek Limestone / Deception Formation	Jay Creek Limestone / Deception Formation
Pataoorrta Series [2]; Pertaoorrta Series [3]	Pertaoorrta Series	Pertaoorrta Series	Pertaoorrta Group: Jay Creek Limestone	Jay Creek Limestone Member / Illara Sandstone Member	Jay Creek Limestone / Illara Sandstone	Jay Creek Limestone / Illara Sandstone
Pataoorrta Series [2]; Pertaoorrta Series [3]	Pertaoorrta Series	Pertaoorrta Series	Pertaoorrta Group: Hugh River Shale	Hugh River Shale Member / Tempe Member	Hugh River Shale / Tempe Formation	Hugh River Shale / Tempe Formation
Pataoorrta Series [2]; Pertaoorrta Series [3]	Pertaoorrta Series: 'No. 3 quartzite'	Pertaoorrta Series: 'No. 3 quartzite'	Arumbera Greywacke	Arumbera Greywacke Member / Eninta Sandstone Member	Arumbera Sandstone / Eninta Sandstone	Arumbera Sandstone / Eninta Sandstone
Glen Helen Series [1]; Pataknurra Series [2]; Pertaknurra Series [3]	Pertatataka Series	Pertatataka Series	Pertatataka Formation	Pertatataka Formation	Pertatataka Formation	Pertatataka Formation
Glen Helen Series [1]; Pataknurra Series [2]; Pertaknurra Series [3]	Pertatataka Series: 'No. 2 quartzite'	Pertatataka Series: 'No. 2 quartzite'	Areyonga Formation	Areyonga Formation	Areyonga Formation	Areyonga Formation
Glen Helen Series [1]; Pataknurra Series [2]; Pertaknurra Series [3]	Pertaknurra Series	Pertaknurra Series	Bitter Springs Limestone	Bitter Springs Limestone	Bitter Springs Formation	Bitter Springs Formation
Glen Helen Series [1]; Pataknurra Series [2]; Pertaknurra Series [3]	Pertaknurra Series: Heavitree quartzite	Pertaknurra Series: 'No. 1 quartzite'	Heavitree Quartzite	Heavitree Quartzite	Heavitree Quartzite	Heavitree Quartzite
Arunta Complex	Arunta Complex	Arunta Complex	Arunta Complex	Arunta Complex	Arunta Complex	Arunta Complex

[1] Chewings (1894) [2] Mawson & Madigan (1930) [3] Chewings (1931)

10283/68

The *Tempe Formation* conformably overlies the Eninta Sandstone and is overlain by the Illara Sandstone. It is a recessive unit about 600 feet thick and is considered to be laterally equivalent to the Hugh River Shale. J. Gilbert-Tomlinson (pers.comm.) has tentatively dated the fossils collected from the cherty dolomite as late Lower Cambrian or early Middle Cambrian.

The *Illara Sandstone* is cross-bedded, with many slumped sets, and convolute bedding is common. Fossils have not been found. The unit is about 650 feet thick in the Gardiner Range.

The *Deception Formation* is approximately 600 feet thick in the Gardiner Range, where it lies conformably between the Petermann and Illara Sandstones. The unit is not known to be fossiliferous.

Both the upper and lower boundaries of the *Petermann Sandstone* are transitional, and the unit is 800 feet thick in the Gardiner Range. The sandstones may be thinly-bedded, current-bedded, slump-folded, or ripple-marked. No fossils have been found.

The *Goyder Formation* is the uppermost formation of the Pertaoorrta Group; the interbeds of limestone and siltstone occur in the lower half and interbeds of quartz sandstone in the upper half. Iron and manganese staining of outcrops is common.

The formation is 1600 feet thick at Ellery Creek. Fossils have been found in two localities. In the Lawrence Gorge, through the northern flank of the Waterhouse Range, two genera of Upper Cambrian trilobites were collected near the top of the formation. Poorly preserved fossil fragments were collected from 900 feet above the base at Ellery Creek.

Cambrian to Ordovician

Five formations of Upper Cambrian to probable Upper Ordovician age are included in the *Larapinta Group*.

The *Pacoota Sandstone* is conformable on the Goyder Formation of the Pertaoorrta Group, and is succeeded conformably by the Horn Valley Siltstone. Much of it is current-bedded, and ripple marks and sun cracks are also preserved.

It is 2700 feet thick in the type section. The top 200 feet consists of green and black fine to medium-grained very silty glauconitic sandstone, thinly interbedded with green micaceous siltstone and current-bedded quartz sandstone; this bed can be traced westwards to Stokes Pass.

Upper Cambrian and Lower Ordovician trilobites were collected from the Pacoota Sandstone at Ellery Creek. About 400 feet above the base there are two beds of 'pipe rock', closely spaced worm tubes perpendicular to the bedding planes (*Scolithus,* A.A. Öpik, pers.comm.). Associated with the 'pipe rock' are bedding-plane markings attributed to trilobites (*Cruziana*). Worm markings and burrows are abundant on bedding planes in the uppermost member of the formation.

The age of the Pacoota Sandstone extends from late in the Cambrian to early in the Ordovician.

The *Horn Valley Siltstone* at Ellery Creek lies above a resistant bed of quartzite (Pacoota Sandstone), and is 440 feet thick. It thickens to the west—at Stokes Pass it is 1400 feet thick—and becomes thinner to the south (Ranford et al., 1965). It conformably overlies the Pacoota Sandstone, and is conformably overlain by the Stairway Sandstone.

The Horn Valley Siltstone is richly fossiliferous, containing gastropods, brachiopods, trilobites, nautiloids, and pelecypods. Graptolites were found near Stokes Pass. The fauna indicates a late Lower or early Middle Ordovician age.

The *Stairway Sandstone* lies conformably on the Horn Valley Siltstone. Beds of phosphorite, 1 to 4 inches thick, occur in the formation; they are composed almost entirely of phosphatic pellets in a sandy matrix. Some sandstone or limestone beds also have pellets or nodules sparsely scattered throughout them (Cook, 1963, 1966). At Ellery Creek the formation is 1075 feet thick and is overlain unconformably by the Mereenie Sandstone.

Trilobite fragments and gastropod and pelecypod moulds have been collected. Bedding plane tracks and trails are common (including *Cruziana*), and widely spaced worm tubes perpendicular to the bedding (*Diplocraterion,* A. A. Öpik, pers. comm.) are present at many localities. The age of the Sandstone is Middle Ordovician.

The *Stokes Siltstone* conformably overlies the Stairway Sandstone and is overlain conformably by the Carmichael Sandstone. The section near Stokes Pass is about 2000 feet thick, and consists of siltstone with thin fossiliferous limestone beds overlain by dark red and purple shale. Bryozoa, crinoid (or cystoid) stems, probably three brachiopods, gastropods, trilobite fragments, at least one nautiloid, and pelecypod casts were collected near Stokes Pass. The fauna indicates that the formation was deposited in the early Upper Ordovician or late Middle Ordovician.

The *Carmichael Sandstone* conformably overlies the Stokes Formation and is unconformably overlain by the Mereenie Sandstone. The formation is approximately 200 feet thick at Stokes Pass, and represents the upper unit of the Stokes Formation as defined by Prichard & Quinlan (1962). It is poorly exposed in most places, and is commonly covered by scree of Mereenie Sandstone. Fossils are rare; trace fossils and *Cruziana* suggest that the formation is of Ordovician age.

Upper Palaeozoic

Within the Hermannsburg Sheet area the Mereenie Sandstone and the Pertnjara Group are considered to be of Upper Palaeozoic age. Upper Permian sediments have been intersected in a waterbore.

The *Mereenie Sandstone* consists of two members. The basal 260 feet is hard to medium-hard red-brown fine-grained quartz sandstone. It is succeeded by 640 feet of friable to medium-hard light red-brown medium-grained sandstone. The higher member is cross-bedded on a major scale with sets up to 50 feet thick and half a mile long; the lower member is not cross-bedded. The Mereenie Sandstone is 900 feet thick at Ellery Creek, and 2000 feet thick at Stokes Pass. It unconformably overlies the Stokes Siltstone at Ellery Creek and at Goyder Pass, and the Pacoota Sandstone on the north flank of the Waterhouse Range. It is overlain unconformably by the Pertnjara Group, though at all localities it is apparently conformable between the overlying and underlying formations.

No fossils have been found in the Mereenie Sandstone within the area of this Sheet, and an Upper Palaeozoic age has been assigned to it.

The *Pertnjara Group* overlies the Mereenie Sandstone with a regional unconformity.

The basal formation, the *Parke Siltstone,* does not occur east of the Finke River. It is overlain by 1000 to 2000 feet of *Hermannsburg Sandstone*. Fine pebbles, mainly of dolomite and limestone, are scattered through the sandstone and in the vicinity of Ellery Creek the rock is a conglomerate. The uppermost formation, the *Brewer Conglomerate,* consists of very thick lenses and wedges of blue-grey boulder conglomerate, with a matrix of calcareous sandstone. The conglomerate changes southward to a grey medium-grained calcareous sandstone.

The thickness of the Pertnjara Group, measured from where the formation overlies the Mereenie Sandstone at Ellery Creek to the highest beds exposed in the trough of the Missionary Plain Syncline, is about 21,500 feet. The section was measured northwards from the axis of the syncline, and along the axis to the east; it includes the thickest part of the wedge-shaped conglomerate. The vertical thickness of the formation probably does not exceed 10,000 feet in the syncline.

The age of the Pertnjara Group is regarded as Devonian, or Devonian to Carboniferous (Wells et al., 1965), on the evidence of Middle or Upper Devonian spores (Hodgson, 1967) and the Devonian placoderm fish *Bothriolepis* (Gilbert-Tomlinson, 1967), both collected from the Mount Liebig Sheet area.

Cuttings taken from a waterbore (long. 132°03′E, lat. 23°20′S) contained spores of Upper Permian age (P. R. Evans, unpublished data), in a sandy clay. The unit is less than 100 feet thick, and rests unconformably on rocks of the Arunta Complex. It is not known in outcrop.

Tertiary

Flat-lying *Tertiary sediments* crop out in the Waterhouse Range and in the strike valleys of the MacDonnell Ranges. They have also been intersected in waterbores drilled on the Burt Plain. These sediments have been referred to the Cretaceous (Crespin, 1950; Hossfeld, 1954; Prichard & Quinlan, 1962; Quinlan, 1962; Perry et al., 1963). They are now correlated on lithological grounds with those which have been found in the Alice Springs Farm Area, which contain Tertiary spores (P. R. Evans, pers. comm.).

Lithologically the sediments consist of variegated fine-grained sandy clay, weathering white; grey laminated siltstone; white fine to medium-grained quartz sandstone; and thin beds of lignite. The maximum thickness of the sediments is not known, but is probably at least 1000 feet within the area of the Burt Plain.

Rocks of the Arunta Complex on the eastern margin of the area have been deeply weathered to *laterite:* in outcrop a ferruginous rock with a nodular texture. No trace of the original structure or texture of the parent rock remains. Cuttings taken from bores drilled in the Tertiary sediments are of weathered rock for depths as much as 200 feet below the eroded top of the sediments. Textural differences in the cuttings give evidence of the development of a laterite profile (ferruginous, mottled, pallid zones).

Thin sequences of *chalcedonic limestone* and calcareous siltstone overlie weathered Precambrian rocks near Hamilton Downs homestead. Lithologocally they are similar to the Waite Formation near Alcoota homestead (80 miles to the north-east), which contains vertebrate fossils of late Tertiary age (Woodburne, 1967).

Thin beds of *conglomerate* of probable Tertiary age occur on bevelled surfaces within the MacDonnell Ranges and on the northern margin of the Missionary Plain. They are an unconsolidated aggregation of well rounded pebbles, cobbles, and boulders weathered out from the Brewer Conglomerate and Heavitree Quartzite with a matrix of soil. Scarps bound the outcrops of the gravels, and they are now being dissected.

Quaternary

A zone of *travertine* and *kunkar* fringes the salt lakes immediately north of the Hermannsburg Sheet area where the piezometric surface is, or has been, shallow. Like the evaporites in the salt lakes, they are believed to be essentially a groundwater deposit.

Aeolian Sand. Much of the Burt and Missionary Plains is covered with aeolian sand redistributed from longitudinal sand dunes (which have been preserved in the north-western corner).

Alluvium. Thin deposits of brown and red-brown silty sand and gravel occur in narrow corridors associated with elements of the drainage system. North of the MacDonnell Ranges a wedge-shaped body, at least 250 feet thick, of alluvium unconformably overlies the Tertiary sediments. It is thought to be a piedmont deposit formed by the coalescing of individual alluvial fans.

STRUCTURE AND GEOLOGICAL HISTORY

The moderate-grade metamorphic rocks of the Arunta Complex developed during the Proterozoic Arunta Orogeny (Forman et al., 1967). During this orogeny the foliation within the gneisses and quartzite was isoclinally folded about north-south axes, and the long axes of the metamorphic minerals grew parallel to the b-axes of the folds; then the folds were refolded about tight to isoclinal east-west axes (chevron folds) with steeply dipping axial planes. A weak mineral lineation was developed parallel to the axes. This structural pattern is preserved in the quartzite of the Chewings Range east of Mount Giles and in the gneisses with which this quartzite has both a gradational and a faulted contact.

After the intrusion of pegmatite and dolerite dykes and a long period of erosion the Heavitree Quartzite was deposited unconformably over the gneissic and granitic basement rocks.

The Heavitree Quartzite and the Bitter Springs Formation were deposited in the sea during a period of tectonic stability. The Areyonga Formation was deposited with at least local disconformity over the Bitter Springs Formation. Prichard & Quinlan (1962) believe that the Areyonga Formation was deposited during a period of glaciation which followed uplift of areas to the north of the present basin margin. The Pertatataka Formation succeeds the Areyonga Formation conformably or the Bitter Springs Formation disconformably. Forman (Forman et al., 1967) believes that the Pertatataka Formation was deposited during a period of mild tectonic activity along the southern margin of the Amadeus Basin and that the tectonic activity culminated later in the Petermann Ranges Orogeny. The Petermann Ranges Orogeny caused folding of the sediments over a décollement (Wells et al., 1965) in the Bitter Springs Formation; the Arumbera Sandstone of probable Lower Cambrian age and the equivalent Eninta Sandstone represent the first influx of sediment from the uplifted area to the south. The Eninta Sandstone is unconformable on the Pertatataka Formation in the Gardiner Range, but the Arumbera Sandstone is conformable with it in the MacDonnell Ranges farther removed from the Petermann Ranges Orogeny. The Hugh River Shale, Jay Creek Limestone, and Goyder Formation in the MacDonnell Ranges and Waterhouse Range are believed to be equivalent to the Tempe Formation, Illara Sandstone, Deception Formation, Petermann Sandstone, and Goyder Formation of the Gardiner Range area (Wells et al., 1965; Ranford et al., 1965), which is closer to the orogenic source area and consequently contains less limestone and more clastic material.

The Larapinta Group succeeds the Pertaoorrta Group conformably and represents stable marine sedimentation from Upper Cambrian to Upper Ordovician. Land lay to the south and sedimentation was accompanied by a southerly marine transgression, at least during the later part.

A large part of the area was unwarped above sea level during the late Ordovician Rodingan Movement (Wells et al., 1967) and part of the Larapinta Group eroded. The Mereenie Sandstone was then deposited during a period of broad vertical movement from Silurian to ?Middle Devonian. It is largely continental in origin but some of it may have been laid down in a shallow sea. The northern part of the area was again uplifted and eroded during the Middle to Upper Devonian Pertnjara Movement (Forman, 1968). The Pertnjara Group was then deposited in a continental environment during the Upper Devonian and Lower Carboniferous. Angular unconformities within the Group (Wells et al., 1967) are evidence of at least two more movements, but these are unnamed. During the Alice Springs Orogeny (Forman et al., 1967; Forman, 1968) nappes developed in the rocks below the Bitter Springs Formation in the Ormiston Gorge/Mount Razorback area. The rocks above the Bitter Springs Formation, including the Pertnjara Group, were detached from the nappes and slid southwards and folded over the décollement surface within the Bitter Springs Formation.

Two nappes are preserved in the Ormiston Gorge/Mount Razorback area. One (the Razorback Nappe) lies above the other (the Ormiston Nappe) and the resultant complex has been called the Ormiston Nappe Complex (Forman et al., 1967). The Arunta Complex has undergone retrograde metamorphism to the greenschist facies adjacent to the Heavitree Quartzite on the limb of each nappe (McCarthy, in Forman et al., 1967), and the Heavitree Quartzite and Bitter Springs Formation have been progressively metamorphosed within them.

The MacDonnell Ranges Homocline lies to the south of a major crustal upwarp (Forman, 1968), and the Waterhouse Range Anticline and the Gardiner Range Anticline are disharmonic folds over the incompetent Bitter Springs Formation. The Waterhouse Range Anticline is separated from the MacDonnell Ranges Homocline by the Missionary Plains Syncline.

The salt horizon in the Bitter Springs Formation and a possible upper salt horizon in the base of the Tempe Formation of the Gardiner Range and the Hugh River Shale to the north-east are believed to have greatly influenced the structure of the sediments. Prichard & Quinlan (1962) and McNaughton et al. (1965) consider Gosses Bluff to be a diapiric structure caused by salt intruded from the Bitter Springs Formation. It is also possible that salt could be intruded from the upper salt horizon. However, Crook & Cook (1967) present evidence to show that Gosses Bluff may be an astrobleme. The structure near Goyder Pass was interpreted as a diapir by Prichard & Quinlan (1962), and this interpretation has been further discussed by McNaughton et al. (1966). However, the presence of thrusting in the Alice Springs Sheet area (Wells et al., 1967) between the lower décollement in the Bitter Springs Formation and an upper décollement in the upper salt horizon, and the presence of the Ormiston Nappe Complex to the south, have suggested to one of the authors (D.J.F.) that the structure may have been caused by thrusting upwards from the Bitter Springs Formation into the possible salt horizon within the Pertaoorrta Group.

Thin veneers of Tertiary and Quaternary continental sediments have been deposited in parts of the area.

ECONOMIC GEOLOGY

Water

Water is the only mineral currently being exploited. Surface water is conserved in a number of small dams on the Missionary Plain and in three dams within the MacDonnell Ranges. They are all in areas where supplies of groundwater cannot be found. No attempt has been made to conserve flood waters in the major watercourses.

Groundwater is available from aquifers of Precambrian to Quaternary age. The total groundwater resources are more than adequate for likely pastoral development, although locally it may not be possible to obtain a suitable or a sufficient supply. The basic data are not available to make a quantitative assessment of the groundwater resources, but they have been qualitatively assessed using the concept of groundwater provinces. Jones and Quinlan (1959, 1962) recognized three provinces within the area—Burt, MacDonnell, and Hermannsburg; their boundaries correspond to those of the psysiographic units.

Aquifers in the *Burt Groundwater Province* (Jones & Quinlan, 1959) are unconsolidated sands of Tertiary and Quaternary age, Quaternary travertine and kunkar, and weathered zones in the Precambrian metamorphic rocks. The piezometric surface is less than 50 feet from the surface in outcrop areas of travertine; it may also be shallow along the major streams, but it becomes deeper towards the ranges. The depth at which water will be struck shows a similar relationship. Generally the water contains less than 1500 parts per million total dissolved salts and is suitable for all purposes, except in some areas near the outcrops of travertine and in poor recharge areas with metamorphic aquifers, where the water is saline, containing more than 3000 parts per million total dissolved salts. The resources are probably large, and water is readily available, except in areas of shallow basement and near the margins of the province.

Groundwater in the *MacDonnell Province* is stored in local aquifers in fractured and weathered zones in metamorphic rocks and unconsolidated sands in small areas of alluvium. The piezometric surface and the depth at which water is struck in the alluvium are less than 100 feet below the surface. The quality of the water is variable, depending on local recharge. A large quantity of recharge water is available, but low permeability and poor inter-connection of the aquifers limits intake. Resources are small, except in small alluvial basins near the margins of the province. Groundwater is not always readily available from the metamorphic rocks because of difficult conditions.

The *Hermannsburg Province* is an area of consolidated and folded sandstones and limestones of Upper Proterozoic and Palaeozoic age, and of Tertiary and Quaternary sediments. Not all the sediments are aquifers, and the depth at which water is struck is dependent on the geological structure. The piezometric surface is generally less than 250 feet from the surface and is largely controlled by the local topography. The salinity is variable, depending on the extent of recharge and the presence of saline rocks. In some areas almost all the aquifers contain saline water (e.g. the Bitter Springs Formation in the Gardiner Range). Large reserves are available in the sandstone aquifers but they occur in areas of poor pastoral potential (e.g. within the MacDonnell Ranges).

Building Stone and Aggregate

Ample supplies of building stone and rock suitable for crushing as aggregate are available. The carbonate rocks of the Bitter Springs Formation and the Jay Creek Limestone and some parts of the Heavitree Quartzite make suitable aggregate.

Sandstones of the Arumbera Sandstone, the Larapinta Group, and the Mereenie Sandstone are suitable for dressing or for use as freestone in buildings. They have been used in building homesteads.

Petroleum

A sedimentary sequence over 30,000 feet thick is exposed in the MacDonnell Ranges. This sequence includes possible source beds, reservoir beds, and cap rock for oil and natural gas.

Possible source beds include the Bitter Springs Formation (Proterozoic), Jay Creek Limestone (Middle Cambrian), Horn Valley Formation (Lower or Middle Ordovician), and Stokes Formation (Middle or Upper Ordovician). Possible reservoir beds include most of the Larapinta Group, the Mereenie Sandstone, and part of the Goyder Formation. The Bitter Springs Formation and Jay Creek Limestone could contain hydrocarbons in joint or solution openings.

Beds capable of acting as cap rock are plentiful in the Proterozoic and Cambrian sequences, and the Horn Valley Siltstone and Stokes Formation in the Ordovician.

The dips on the northern flank of the Missionary Plain Syncline exceed 60° and accumulations of oil and gas could be difficult to find. Stratigraphic and structural traps could exist on the southern flank, where the dips are less than 12°, and in small anticlinal closures in the Larapinta Group along the axis of the Missionary Syncline.

Natural gas was found in sediments of the Larapinta Group in the two holes drilled by petroleum exploration companies. Exoil (N.T.) Pty Ltd reported 'trip gas' in Gosses Bluff No. 1, at 3092 feet in the Stairway Sandstone (Planalp & Pemberton, 1963). Drill stem testing in Palm Valley No. 1 Well of four intervals within the Stairway Sandstone, Horn Valley Siltstone, and Pacoota Sandstone yielded a total of 14 million cubic feet per day of natural gas (Magellan Petroleum, 1965).

REFERENCES

BANKS, J. E., 1964—Mineral reconnaissance in the Amadeus Basin, Northern Territory, Australia. Report to *Magellan Petroleum* (unpubl.).

BROWN, H. Y. L., 1889—Government Geologist's report on a journey from Adelaide to the Hale River. *S. Aust. parl. Pap.* 24.

BROWN, H. Y. L., 1890—Report of geological examination of country in the neighbourhood of Alice Springs. *S. Aust. parl. Pap.* 189.

BROWN, H. Y. L., 1897—Reports on Arltunga Goldfield, etc. *S. Aust. parl. Pap.* 127.

BROWN, H. Y. L., 1902—Report on the White Range gold mines, Arltunga goldfield. *S. Aust. parl. Pap.* 76.

BRUNNSCHWEILER, R. O., LESLIE, R. B., and RICHARDS, K. A., 1959—Review of geological and geophysical information, Gosses Bluff, N.T. *Frome-Broken Hill Co. Pty Ltd Rep.* 4300-G-30 (unpubl.).

CHEWINGS, C., 1891—Geological notes on the upper Finke Basin. *Trans. Roy. Soc. S. Aust.*, 14, 247-255.

CHEWINGS, C., 1894—Notes on the sedimentary rocks in the MacDonnell and James Ranges. *Trans. Roy. Soc. S. Aust.*, 18, 197-198.

CHEWINGS, C., 1914 Notes on the stratigraphy of central Australia. *Trans. Roy. Soc. S. Aust.*, 38, 41-52.

CHEWINGS, C., 1928—Further notes on the stratigraphy of central Australia. *Trans. Roy. Soc. S. Aust.*, 52, 62-81.

CHEWINGS, C., 1931—A delineation of the Precambrian plateau in central and north Australia with notes on the impingent formations. *Trans. Roy. Soc. S. Aust.*, 55, 1-11.

CHEWINGS, C., 1935—The Pertatataka Series in Central Australia, with notes on the Amadeus Sunkland. *Trans. Roy. Soc. S. Aust.*, 59, 141-163.

COOK, P. J., 1963—Phosphorites in the Amadeus Basin of Central Australia. *Aust. J. Sci.*, 26, 55-56.

COOK, P. J., 1966—The Stairway Sandstone—a sedimentological study. *Bur. Miner. Resour. Aust. Rec.* 1966/1 (unpubl.).

CROOK, K. A. W., and COOK, P. J., 1967—Gosses Bluff—diapir, crypto-volcanic structure or astrobleme? *J. geol. Soc. Aust.*, 13 (2), 495-516.

CRESPIN, I., 1950—Report of micropalaeontological examination of samples from the 16 mile Government Bore, west of Alice Springs, Northern Territory. *Bur. Miner. Resour. Aust. Rec.* 1950/48 (unpubl.).

FORMAN, D. J., 1968—Palaeotectonics of Precambrian and Palaeozoic rocks of central Australia. *Ph.D. Thesis, Harvard Univ.*

FORMAN, D. J., MILLIGAN, E. N., and MCCARTHY, W. R., 1967—Regional geology and structure of the north-east margin, Amadeus Basin, Northern Territory. *Bur. Miner. Resour. Aust. Rep.* 103.

GILBERT-TOMLINSON, Joyce, 1967—A new record of *Bothriolepis* in the Northern Territory of Australia. *Bur. Miner. Resour. Aust. Bull.* 80.

HAITES, B., 1963—Stratigraphy of the Ordovician Larapinta Group in the western Amadeus Basin, N.T. Report to *United Canso Oil & Gas Co.* (unpubl.).

HODGSON, E. A., 1967—Devonian spores from the Pertnjara Formation, Amadeus Basin, Northern Territory. *Bur. Miner. Resour. Aust. Bull.* 80.

HORVATH, J., 1956—Geophysical test survey of copper deposits, Waterhouse Range, Northern Territory. *Bur. Miner. Resour. Aust. Rec.* 1956/41 (unpubl.).

HOSSFELD, P. S., 1954—Stratigraphy and structure of the Northern Territory of Australia. *Trans. Roy. Soc. S. Aust.*, 77, 103-61.

JACCARD, J. P., 1961—Geological reconnaissance in the Amadeus Basin. *Conorada Petroleum Corporation Rep.* (unpubl.).

JOKLIK, G. F., 1955—The geology and mica fields of the Harts Range, Central Australia. *Bur. Miner. Resour. Aust. Bull.* 26.

JONES, N. O., and QUINLAN, T., 1962—An outline of the water resources of the central Australia. *Bur. Miner. Resour. Aust. Rec.* 1959/77 (unpubl.).

JONES, N. O., and QUINLAN, T., 1962—An outline of the water resources of the Alice Springs area. *Sci. ind. Res. Org. Melb., Land Res. Ser.* 6, 150-162.

LANGRON, W. J., 1962—Amadeus Basin reconnaissance gravity survey using helicopters, Northern Territory, 1961. *Bur. Miner. Resour. Aust. Rec.* 1962/24 (unpubl.).

LESLIE, R. B., 1960—Geology of the southern part of the Amadeus Basin, Northern Territory. *Frome-Broken Hill Pty Ltd Rep.* 4300-G-28 (unpubl.).

MABBUTT, J. A., 1962—Geomorphology of the Alice Springs area. *Sci. ind. Res. Org. Melb., Land Res. Ser.* 6, 163-184.

MACLEOD, J. H., 1959—The geology of the north-eastern part of the Amadeus Basin. *Frome-Broken Hill Pty Ltd Rep.* 4300-G-24 (unpubl.).

MCNAUGHTON, D. A., 1962—Petroleum prospects, Oil Permits 43 and 46, Northern Territory, Australia. *Report for Magellan Petroleum* (unpubl.).

MCNAUGHTON, D. A., QUINLAN, T., HOPKINS, R. M., and WELLS, A. T., 1967—The evolution of salt anticlines and salt domes in the Amadeus Basin, Central Australia. *Geol. Soc. Amer.* (in press).

MADIGAN, C. T., 1932a—The geology of the western MacDonnell Ranges, Central Australia. *Quart. J. geol. Soc. Lond.*, 88 (4), 672-711.

MADIGAN, C. T., 1932b—The geology of the eastern MacDonnell Ranges, Central Australia. *Trans. Roy. Soc. S. Aust.*, 56, 71-117.

MAGELLAN PETROLEUM, 1965—Palm Valley No. 1 Well, Northern Territory. *Report to Magellan Petroleum* (unpubl.).

MARSHALL, C. E., and NARAIN, H., 1954—Regional gravity investigations in the eastern and central Commonwealth. *Dep. Geol. Geophys. Univ. Sydney, Mem.* 1954/2.

MAWSON, D., 1957—The Sturtian glacial horizon in the MacDonnell Ranges. *Aust. J. Sci.*, 19 (4), 162.

MAWSON, D., and MADIGAN, C. T., 1930—Pre-Ordovician rocks of the MacDonnell Ranges (Central Australia). *Quart. J. geol. Soc. Lond.*, 86, 415-429.

MOSS, F. J., 1964—Gosses Bluff seismic survey, Amadeus Basin, Northern Territory, 1962. *Bur. Miner. Resour. Aust. Rec.* 1964/66 (unpubl.).

NEWCOME, A. E., and ROCHOW, K. A., 1964—Vertebrate fossils from Tertiary sediments in Central Australia. *Aust. J. Sci.*, 26, 352.

NOAKES, L. C. 1956—Upper Proterozoic and Sub-Cambrian rocks in Australia, *in* EL SISTEMA CAMBRICO, SU PALEOGEOGRAFIA Y EL PROBLEMA DE SU BASE, 2, 213-238. *20th int. geol. Cong., Mexico.*

ÖPIK, A. A., 1956—Cambrian geology of the Northern Territory, *in* EL SISTEMA CAMBRICO, SU PALEOGEOGRAFIA Y EL PROBLEMA DE SU BASE, 2, 25-54. *20th int. geol. Cong., Mexico.*

PERRY, R. A., and LAZARIDES, M., 1962—Vegetation of the Alice Springs area. *Sci. ind. Res. Org. Melb., Land Res. Ser.* 6, 208-236.

PERRY, R. A., QUINLAN, T., JONES, N. O., and BASINSKI, J. J., 1963—Preliminary assessment of groundwater suitable for irrigation in the Alice Springs Area, and its agricultural significance. *Sci. ind. Res. Org. Melb., Land Res. tech. Pap.* 21.

PLANALP, R. N., and PEMBERTON, R. L., 1963—Well completion report Exoil Ooraminna No. 1. *Report to Exoil (N.T.) Pty Ltd* (unpubl.).

PRICHARD, C. E., and QUINLAN, T., 1962—The geology of the southern half of the Hermannsburg 1 : 250,000 Sheet. *Bur. Miner. Resour. Aust. Rep.* 61.

QUINLAN, T., 1962—An outline of the geology of the Alice Springs area. *Sci. ind. Res. Org. Melb., Land Res. Ser.* 6, 129-145.

RANFORD, L. C., COOK, P. J., and WELLS, A. T., 1965—The geology of the central part of the Amadeus Basin, N.T. *Bur. Miner. Resour. Aust. Rep.* 86.

RICHARDS, K. A., 1958—Gravity and magnetic survey of Gosses Bluff, MacDonnell Ranges, N.T., 1958. *Frome-Broken Hill Co. Pty Ltd Rep.* 4300-P-2 (unpubl.).

STELCK, C. R., and HOPKINS, R. M., 1962—Early sequence of interesting shelf deposits, Central Australia. *J. Alberta Soc. Petrol. Geol.*, 10 (1), 1-12.

SLATYER, R. O., 1962—Climate of the Alice Springs area. *Sci. ind. Res. Org. Melb., Land Res. Ser.* 6, 109-128.

TATE, R., and WATT, J. A., 1896—General geology; in *Report of the work of the Horn Scientific Expedition to Central Australia,* Part III.

TAYLOR, D. J., 1959—Palaeontological report on the Southern Amadeus region, N.T. *Frome-Broken Hill Pty Ltd Rep.* 4300-G-27 (unpubl.).

THOMAS, Nancy M., 1956—Review of the geology of the Amadeus Basin. *Frome-Broken Hill Pty Ltd Rep.* 4300-G-11 (unpubl.).

TURPIE, A., and MOSS, F. J., 1963—Palm Valley Seismic Survey, Northern Territory, 1961. *Bur. Miner. Resour. Aust. Rec.* 1963/5 (unpubl.).

WELLS, A. T., FORMAN, D. J., and RANFORD, L. C., 1965—Geological reconnaissance of the north-west Amadeus Basin, N.T. *Bur. Miner. Resour. Aust. Rep.* 85.

WELLS, A. T., RANFORD, L. C., STEWART, A. J., COOK, P. J., and SHAW, R. D., 1967—The geology of the north-eastern part of the Amadeus Basin, N.T.—*Ibid., Rep.* 113.

WELLS, A. T., RANFORD, L. C., COOK, P. J., and FORMAN, D. J., 1967, in press—The geology of the Amadeus Basin. *Bur. Miner. Resour. Aust. Bull.* 100.

WOODBURNE, M. O., 1967—The Alcoota Fauna. *Bur. Miner. Resour. Aust. Bull.* 87.

YOUNG, G. A., and SHELLEY, E. P., 1966—Amadeus Basin airborne magnetic and radiometric survey, N.T. *Bur. Miner. Resour. Aust. Rec.* 1966/64 (unpubl.).

10283/68. By Authority: A. J. ARTHUR, Commonwealth Government Printer, Canberra