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COMMONWEALTH OF AUSTRALIA

DEPARTMENT OF NATIONAL DEVELOPMENT

BUREAU OF MINERAL RESOURCES
GEOLOGY AND GEOPHYSICS

RECORDS:

1966/27

EXPLANATORY NOTES

HERMANNSBURG GEOLOGICAL SHEET, N.T.

Compiled by T. Quinlan and D.J. Forman

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ADDENDUM

Since the compilation of these notes two changes have been made to the stratigraphic nomenclature.

(a) The upper part of the Stokes Formation (page 11) has been named the Carmichael Sandstone, and the name Stokes Siltstone has been applied to the lower part.

(b) The Pertnjarka Formation (page 12) has been re-defined as the Pertnjarka Group, and the three members have been defined as formations as follows:

	These Notes			Revised Nomenclature
Pertnjarka Formation	Conglomerate Member	Pzp(c)	Pertnjarka Group	Brewer Conglomerate
	Sandstone Member	Pzp(s)		Hermannsburg Sandstone
	Siltstone Member	Pzp(a)		Parke Siltstone

These changes have the approval of the stratigraphic nomenclature committee and will be formally published by A.T.Wells and others in the Bulletin on the Amadeus Basin which is currently in preparation, on the First Edition of the Hermannsburg 1:250,000 Geological Sheet, and the published Explanatory Notes.

EXPLANATORY NOTES ON THE HERMANNSBURG GEOLOGICAL SHEET

Compiled by

T. Quinlan and D.J. Forman

INTRODUCTION

The area of the Hermannsburg Sheet lies between the 23rd and 24th parallels of south latitude and between the meridians of 132° 00' and 133° 30' of east longitude. The town of Alice Springs is 27 miles to the east of the Jay Creek Native Settlement, which is on the eastern margin of the area.

A network of gravel and station tracks provide 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 Native Settlement, Hermannsburg Mission, and the Areyonga, Haasts Bluff and Papunya Native Settlements to the west. The other is to the north of the MacDonnell Ranges, and consist of the Yuendumu beef road and a branch road connecting it with Papunya Native Settlement.

A tourist company has graded an earth road through the MacDonnell Ranges from Jay Creek Native Settlement to Glen Helen tourist camp. This road is suitable (1964) only for four wheel drive vehicles. Most homesteads and native 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.

Approximately 1600 square miles, or 25% of the Sheet area, have been reserved for the use of the aborigines. Seven lease holders use the remainder for raising beef cattle. There has not been any mineral production from within the area, 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, with more rain falling 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. (Fig. 1).

Much of the area is covered by spinifex. Short grass and forbs pastures are restricted to undulating country or areas of alluvium (Perry and 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 water courses.

Topographic maps and air photographs covering the Hermannsburg Sheet area are:

(i) a photo mosaic, at a scale of 4 miles to 1 inch;

(ii) a planimetric map, at a scale of 1:250,000.

(iii) dye-line maps, at air photograph scale, controlled by slotted template assembly, and showing principal points, wing points, and topographic detail.

(iv) 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.

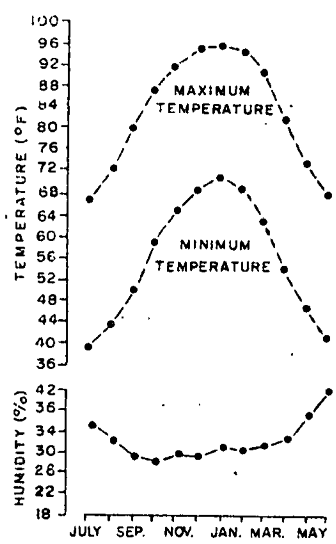
Chewings first paper on the geology of central Australia was published in 1891, and he published further work at intervals up to 1935 (Chewings, 1891, 1894, 1914, 1928, 1931, 1935). He postulated the fault-bound Amadeus Hinterland to explain the preservation of the sediments and to account for the other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

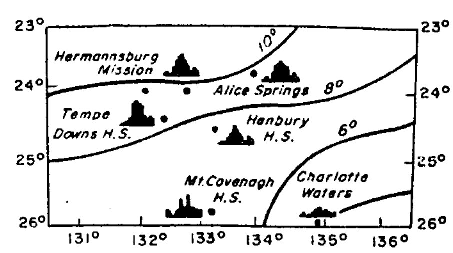
Mawson and Madigan (1930) divided the sediments into 'series' of Ordovician, Cambrian, and Proterozoic age. Madigan (1932 a and b) revisited the area and mapped it in more detail. He confirmed the stratigraphic succession established in the joint paper with Mawson, and measured over 24,000 feet of Proterozoic,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

FIG 1



Mean monthly maximum and minimum temperatures and 3 p.m. relative humidity for Alice Springs



Isohyets and histograms of annual rainfall distribution (July to June) at recording stations

To accompany record 1966/27 NT/A/91

As part of the policy of the Commonwealth Government to assist in the exploration and development of mineral resources, officers of the Bureau of Mineral Resources started a program of geological mapping of central Australia in 1949.

In 1956 Prichard and Quinlan (1962) mapped the southern portion of the Hermannsburg Sheet area and Forman and Milligan (Forman et.al. 1965) mapped part of the northern portion in 1964. A number of reports (Joklik 1955, Noakes 1956, Opik 1956, Quinlan 1962, Wells et.al. 1965 (a and b), and Ranford et.al. 1965) 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) made an assessment of the petroleum prospects of oil permits 43 and 46 in the Amadeus Basin, for Magellan Petroleum Corporation and Stelck and 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 on 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. Horvatch (1956) describes the geophysical surveys which were undertaken in connection with this project.

GEOPHYSICAL INVESTIGATION

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 survey are discussed by Young and Shelly (1966).

The existence of a steep gravity gradient along the northern margin of the Amadeus Basin was demonstrated by Marshall and Narian (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 and Narain (1954) and Forman et.al. (1965) 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 2,500 and 4,000 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.

A short seismic traverse south of Hermannsburg Mission in 1961 (Turpie and 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. The traverse commenced in the Gardner Range, passed through Gosses Bluff, thence northwards to a point which is underlain by metamorphic rocks of Precambrian age. Moss (1964) states that the maximum thickness of sedimentary rocks in the Gardner Range is 26,000 feet.

PHYSIOGRAPHY

The Hermannsburg Sheet area has been divided into four physiographic regions (see also Mabbutt, 1962; and Forman and Milligan, 1965), which are illustrated in Fig. 2. They are:

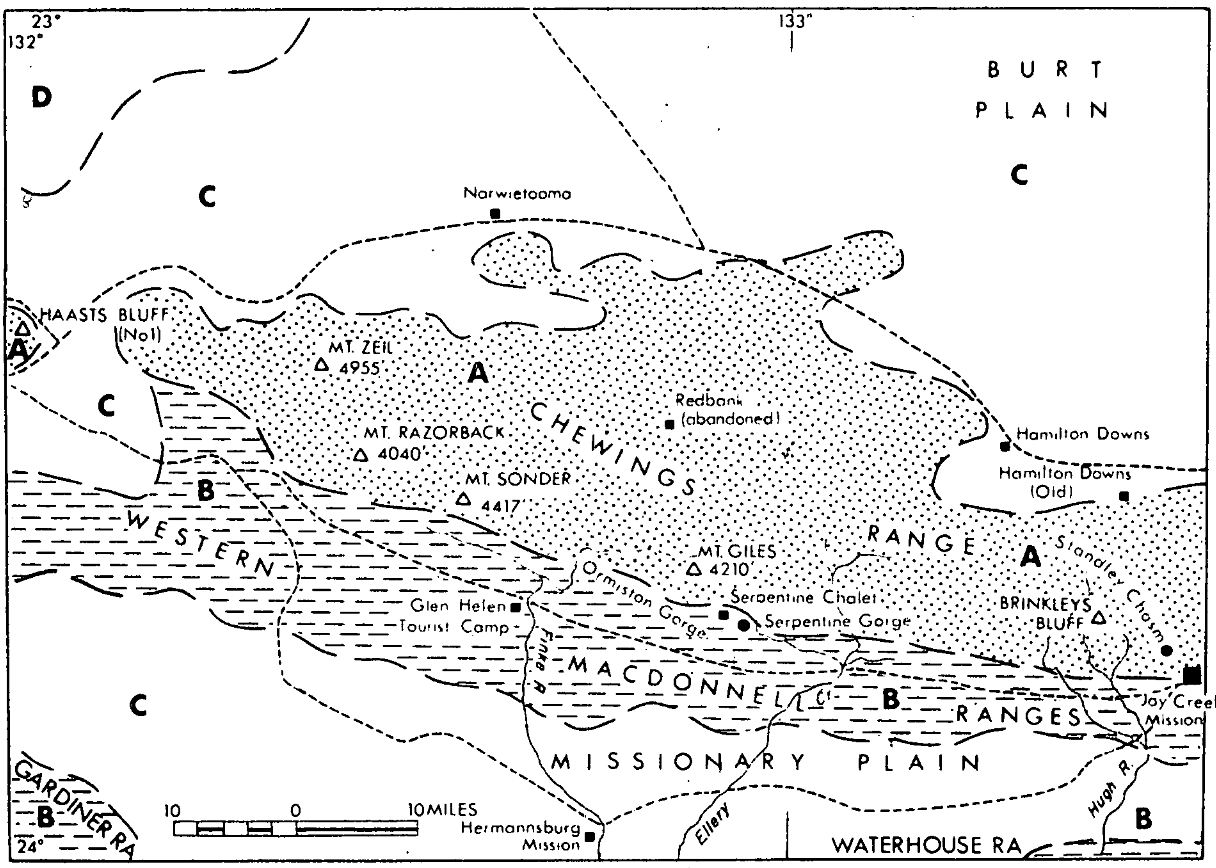
High ranges and hills - Crystalline igneous and metamorphic rocks and quartzite crop out in ranges and hill within the central portion of the area. These rocks are resistant to weathering, and local relief can be 2,000 feet or more. The valley floors are narrow and have thin veneers of alluvium. The highest points are Mt. Zeil (4,955 feet) and Mt. Sonder (4,417 feet).

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, which are covered with spinifex and aeolian

FIG 2

PHYSIOGRAPHIC DIVISIONS



A High ranges and hills

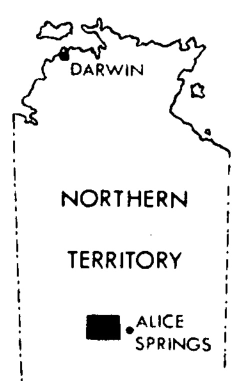
B Strike ridges and valleys

C Plains with some dunes and low outcrop

D Sand plains with longitudinal dunes

Hamilton downs ■ Homestead

------------ Road



LOCALITY MAP

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To accompany record 1966/27

sand. There are alluvial sediments on the perimeters of the plains and small alluvial flood plains are associated with the major water courses.

Sand plain with longitudinal dunes - A small area in the north-western corner of the area 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 Table 1 and conforms with the Australian code of stratigraphic nomenclature. (Raggatt, 1950 and 1953). 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 2 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 1) 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 and Pemberton, 1963), and Palm Valley No. 1 by Magellan Petroleum Corporation (Magellan Petroleum, 1965). The stratigraphic succession in these holes is summarized in Table 3.

Table 3

Stratigraphic units intersected in bores drilled by Petroleum exploration companies on the Hermannsburg 1:250,000 Sheet area.

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 Formation	-	0-1010'
Mereenie Sandstone	-	1010'-3050'
Stokes Formation	0-1040'	3050'-4298'
Stairway Sandstone	1040'-4535' (TD)	4298'-5330'
Horn Valley Formation	-	5330'-5636'
Pacoota Sandstone	-	5636'-6658' (TD)

The Resident Geologist's Office at Alice Springs have 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, quartzite 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 are described in Forman et.al. (1966). 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).

HEAVITREE QUARTZITE

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) recognise 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% of medium to coarse quartz grains. The top member is medium-grained quartz sandstone generally sillicified to quartzite and includes pale yellow-brown argillaceous quartz siltstone up to 100 feet thick below the uppermost quartzite bed.

Forman et.al. (1966) 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 the sequence of hard, dark-grey, well bedded, often laminated, dolomitic and cherty limestone; which is interbedded with dark grey or black shale and siltstone and dull red argillaceous limestone.

Intraformational breccias, algal biostromes and Collenia biotherms are common. The formation is 2500 feet thick at Ellery Creek and rests conformably on the Heavitree Quartzite. It is unconformably overlain by the Areyonga Formation. (Prichard and Quinlan. 1962).

The name Bitter Springs Limestone was applied by Joklik (1955) to rocks of this unit at Bitter Springs Gorge, 40 miles east-north-east of Alice Springs. He gave no section or thickness for the unit.

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 in the formation (McNaughton et.al., 1965). Subsequently salt was found in June 1963 when

Ooraminna No. 1 Well was abandoned in salt of the Bitter Springs Formation at a total depth of 6,105 feet, (Planalp and Pemberton 1963).

The Areyonga Formation (Prichard and Quinlan 1962) 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.

At Ellery Creek the lower member consists of tillitic siltstone with lenticular interbeds of pebble conglomerate and thin yellow limestones. This lower member is not present at all localities. In the bed of Ellery Creek and other major water courses, the higher member consists of a brown soft, friable, current bedded, medium-grained, feldspathic quartz sandstone with a calcareous cement. This rock weathers to a buff or white coloured kaolinitic quartz sandstone with some surface silicification.

An Upper Proterozoic age has been assigned to the formation. The Pertatataka Formation (Prichard and Quinlan 1962) consists of dark grey or black siltstone, which weathers to a red or green, with interbeds of limestone, feldspathic sandstone, and calcareous siltstone. Outcrop is mostly poor, and the formation is considered to conformably overlie the Areyonga Formation 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 Limestone. A Cambrian age has been assigned to the Hugh River Shale and to the Arumbera Sandstone (Wells et.al. 1965a).

The Pertaoorrta Group was defined by Prichard and Quinlan (1962), to include the Goyder Formation, the Jay Creek Limestone and the Hugh River Shale. Two subsequent changes in the nomenclature, which are relevant to the Hermannsburg Sheet area, were made by Wells et.al. (1965 a) and Ranford et.al. (1965). These changes together with the present useage are shown in Table 2. The Arumbera Sandstone was included in the Pertaoorrta Group by Wells et.al. (1965 a) because 'it is considered to be lithologically related' to the units which overly it.

The Arumbera Sandstone (Prichard and Quinlan 1962; Wells et.al. 1965 b) consists of a sequence of red-brown, fine to medium grained, very silty sandstone and purple-red micaceous siltstone. The sandstone and the siltstone are in very large lenses, which vary 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 2,700 feet at Stokes Pass. It overlies the Pertatataka Formation with apparent conformity and it 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 (Prichard and Quinlan, 1962) disconformably overlies the Arumbera Sandstone and is conformably succeeded by the Jay Creek Limestone. It is 1,600 feet thick at Ellery Creek, where it consists of dark-grey or black shale with thin interbeds of hard, dark grey limestone. A thin bed of limestone containing brecciated fragments of chert and limestone marks the base of the formation.

The lithology of the formation changes to the west. Near Stokes Pass the formation is 1,700 feet thick and the dominant lithologies 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 which exists between the formation and the overlying Jay Creek Formation indicates that the Hugh River Shale is of Cambrian age.

The Jay Creek Limestone was defined by Prichard and Quinlan (1962) as the rock unit of well-bedded blue-grey or yellow-brown, dolomitic limestone, with minor thin interbeds of shale, which 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. They are not erosional remnants of a once continuous body, but it is not known if they are discrete lenses or if they are 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.

Five formations within the Pertaoorrta Group were recognised (Wells et.al., 1965 (a); Ranford et.al., 1965), in the Gardiner Range, in the south western corner of the area. Their relation with the formations recognised by Prichard and Quinlan (1962) is illustrated in Table 2. The units are, in descending order, the Petermann Sandstone, the Deception Formation, the Illara Sandstone, the Tempe Formation, and the Eninta Sandstone.

The Eninta Sandstone (Wells et.al. 1965 b; Ranford et.al. 1965) is the name which was given to the sequence of 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. The unit is about 1,200 feet thick at the type locality in the Gardiner Range, and is tentatively regarded as being of lower Cambrian age and to be laterally equivalent to part of the Arumbera Sandstone based on its stratigraphic relations with the Tempe Formation. The latter conformably overlies the Eninta Sandstone, which in turn unconformably overlies the Pertatataka Formation.

The Tempe Formation (Wells et.al. 1965 b; Ranford et.al. 1965) consists of a sequence of red and green siltstone, green-brown and grey brown, fossiliferous, glauconitic, sandy dolomite, and yellow-brown glauconitic feldspathic sandstone. Beds of dark grey and black, fetid, cherty dolomite occur near the base. It 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 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 (Wells et.al. 1965 b; Ranford et.al. 1965) lies conformably between the Tempe Member below and the Deception Member above. It consists of red-brown fine and medium-grained, ferruginous, micaceous, sandstone with minor siltstone interbeds. The Sandstone is cross-bedded, many of the sets have slumped, and convolute bedding is common. Fossils have not been found, but it is regarded as Cambrian in age because of its stratigraphic position. The unit is about 650 feet thick in the Gardiner Range.

The Deception Formation was named by Wells et.al. (1965 b), and its stratigraphic status was revised by Ranford et.al. (1965). It is a sequence of red-brown, micaceous siltstone with minor interbeds of red-brown, fine-grained sandstone and some thin calcareous beds. It 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, but it is regarded as Cambrian in age because of its stratigraphic position.

The Petermann Sandstone (Wells et.al., 1965 b; Ranford et.al. 1965) is the name which was given to the sequence of red-brown, and white fine and medium-grained micaceous sandstone, which is conformable with the underlying Deception Formation and the overlying Goyder Formation. Both boundaries are transitional in character, and the unit is 800 feet thick in the Gardiner Range. The sandstones may be thinly-bedded, current-bedded, slump folded of ripple marked. No fossils have been found in the formation and a Cambrian age has been assigned to it.

The Goyder Formation (Prichard and Quinlan, 1962) is the uppermost formation of the Pertaoorrta Group. It is predominantly a white, buff or pale yellow-brown fine to medium-grained kaolinitic quartz sandstone. 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 1,600 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. The age of the Goyder Sandstone is Upper Cambrian.

Cambrian to Ordovician

Four formations of Upper Cambrian to probable Upper Ordovician age are included in the Larapinta Group (Madigan, 1932; Chewings, 1935; Prichard and Quinlan, 1962; Wells et.al. 1965a). They are, in ascending order, Pacoota Sandstone, Horn Valley Siltstone, Stairway Sandstone, and Stokes Formation.

The Pacoota Sandstone (Mawson and Madigan, 1930; Prichard and Quinlan 1962) is a series of silicified, quartz sandstone and siltstone conformable on the Goyder Formation of the Pertaoorrta Group, and succeeded conformably by the Horn Valley Siltstone. The formation consists of thinly bedded, buff, fine-grained and medium-grained, kaolinitic quartz sandstone and quartz sandstone, mostly cemented by silica. Much of it is current-bedded, and ripple marks and sun cracks are also preserved.

It is 2,700 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 member 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. Opik, 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 base of the Horn Valley Siltstone (Madigan 1932,a; Prichard and Quinlan 1962, Wells et.al. 1965a), at Ellery Creek is at the top of a resistant bed of quartzite (Pacoota Sandstone), which is succeeded by 180 feet dominantly of siltstone, but containing thin beds and lenses of quartz sandstone and silty quartz sandstone, some of which are glauconitic. Above this are 240 feet of siltstone interbedded with thin, sparsely fossiliferous, green limestone beds. The top 20 feet of the formation are soft siltstone and fine-grained silty quartz sandstone. The total thickness is 440 feet.

The formation thickens to the west, at Stokes Pass it is 1,400 feet thick, and it 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, at least two brachiopods, c.f. Ampyx gastropods, brachiopods, trilobites, nautiloids, and pelecypods. Graptolites were found near Stokes Pass. The fauna indicates a late Ordovician or an early middle Ordovician age.

The Stairway Sandstone (Chewings, 1935, Prichard and Quinlan, 1962; Wells et.al., 1965a) is the rock unit of white to pale brown, thinly bedded, fine-grained silty, quartz sandstone and quartz sandstone, commonly cemented by silica. Thin beds, one to four inches thick, of phosphorite 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). It conformably overlies the Horn Valley Siltstone and is overlain conformably by the Stokes Formation. At Ellery Creek it is 1075 feet thick and is overlain unconformably by the Mereenie Sandstone.

Trilobite fragments, gastropod and pelecypod moulds have been collected from the formation. Bedding plane tracks and trails are common (including Cruziana) and widely spaced worm tubes perpendicular to the bedding (Diplocraterion, A.A. Opik, pers. comm.) are present at many localities.

The age of the Sandstone is Middle Ordovician.

The Stokes Formation (Prichard and Quinlan 1962) is the poorly outcropping sequence of siltstone, shale, sandstone, and thin limestone which conformably overlies the Stairway Sandstone and is overlain unconformably by the Mereenie Sandstone.

The section near Stokes Pass is about 2,000 feet thick. It can be divided into two parts. The upper part consists chiefly of fine-grained very silty sandstone and the lower part consists of siltstone with thin fossiliferous limestone beds overlain by dark red and purple shale.

Fossils have been found in the lower half of the formation. 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.

UPPER PALAEOZOIC

Within the Hermannsburg Sheet area the Mereenie Sandstone and the Pertnjarra Formation are considered to be of Upper Palaeozoic age. Upper Permian sediments have been intersected in a water bore.

The Mereenie Sandstone (Madigan 1932a) 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.

It is 900 feet thick at Ellery Creek, and 2,000 feet thick at Stokes Pass. The Mereenie Sandstone unconformably overlies the Stokes Formation 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 Formation. At all localities there is apparent conformity between its attitude and that of the overlying or 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.

Devonian to Carboniferous

The Pertnjara Formation (Chewings 1931; Prichard and Quinlan 1962) is the sequence of siltstone sandstone and conglomerate that overlies the Mereenie Sandstone with a regional unconformity.

Three members of the formation have been mapped. The basal member of red-brown micacious siltstone with thin calcareous and limestone beds does not occur east of the Finke River.

This is overlain by 1,000 to 2,000 feet of red-brown, fine-grained to medium-grained, silty and felspathic sandstone. Fine pebbles, mainly of dolomite and limestone, are scattered through the sandstone and in the vicinity of Ellery Creek the sandstone is replaced by a conglomerate. The uppermost member consists of very thick lenses and wedges of blue-grey boulder conglomerate, with a matrix of calcareous sandstone. The conglomerate changes to a grey medium grained calcareous sandstone in a southerly direction.

The thickness of the Pertnjara Formation 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 Pertnjara Formation is regarded as Devonian or Devonian to Carboniferous (Wells et.al. 1965a). This opinion is based on the occurrence of two fossil forms, a Devonian placoderm and Middle or Upper Devonian spores. The former was collected by R.M. Hopkins of Magellan Petroleum Corporation (Tomlinson, pers. comm.), from near the base of the formation, on the north flank of the Mereenie Anticline (on the Mt. Leibig 1:250,000 Sheet area). The latter were identified in cuttings from a water bore drilled near Mereenie No. 1 Well, in the same locality (Hodgson, 1964).

UPPER PERMIAN

Cuttings taken from a water bore, which was drilled at a point 11 miles to the west of Mt. Henghlin (longitude 132° 3' east, and latitude 23° 20' south) contained spores of Upper Permian age (Evans, unpublished data).

Lithlogically the unit consists of unconsolidated brown and grey fine to medium grained sandy clay. Its thickness in the bore is less than 100 feet, and it rests unconformably on rocks of the Arunta Complex. The unit 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 water bores drilled on the Burt Plain. These sediments have been referred to the Cretaceous (Crespin, 1950; Hossfeld, 1954; Prichard and 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. The latter contain Tertiary spores (Evans, pers. comm.).

Lithologically the sediments consist of variegated (white, grey, orange and brown) weathering to white, fine-grained sandy clay; grey laminated siltstone; white, weathering to pale brown, 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 1,000 feet within the area of the Burt Plain.

Rocks of the Arunta Complex on the eastern margin of the area have been deeply weathered, and the weathering products have been referred to as laterite. In outcrop they are 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. In any one hole there are textural differences in the cuttings which have been taken from different depths. On this basis zones of weathering, similar to those of a laterite profile (ferruginous, mottled, pallid), can be recognized.

Thin sequences of chalcedonic limestone (and calcareous siltstone) overlie weathered Precambrian rocks in the vicinity of Hamilton Downs Homestead. Lithologically they are similar to rock near Alcoota Homestead (80 miles to the north-east) which contain vertebrate fossils of late Tertiary age (Newscome and Rochow, 1964; Woodburne, 1966).

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 with a matrix of soil. The source for the cobbles and boulders was the conglomerate of the Pertnjara Formation, and the Heavitree Quartzite. 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 to the north of the Hermannsburg Sheet area. They occur where the piezometric surface is, or has been, at a shallow depth. The travertine and kunkar, like the evaporites in the salt lakes, is believed to be essentially a groundwater deposit.

Aeolian Sand Much of the Burt and Missionary Plains are areas of sand accumulation. This sand is thought to be aeolian in origin and to have been redistributed from ancient, longitudinal sand dunes. The latter have been preserved in the north-western corner of the Sheet area.

Alluvium Thin deposits of brown and red-brown silty sand and gravel occur in narrow corridors associated with elements of the drainage system. To the north of the MacDonnell Ranges there is a wedge shaped body, at least 250 feet thick, of alluvium unconformably overlying the Tertiary sediments. This body 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 Arunta Orogeny of Upper Palaeozoic time (Forman et.al. 1966). During this orogeny the foliation within the gneisses and quartzite were isoclinally folded about north-south axes and the long axes of the metamorphic minerals grew parallel to the b-axes of these folds. These folds were refolded about tight to isoclinal east-west trending folds (chevron folds) with steeply dipping axes. A weak mineral lineation was developed parallel to the axes of these folds. 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 Upper Proterozoic 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 and Quinlan (1962) believe the Areyonga Formation was deposited during a period of glaciation which followed uplift of areas to the north of the present basin margin. The Upper

Proterozoic Pertatataka Formation conformably succeeds the Areyonga Formation or, where it was not deposited, it overlies the Bitter Springs Formation disconformably. Forman (Forman et.al., 1965) believes 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 climaxed in the Petermann Ranges Orogeny after deposition of the Pertatataka Formation. The Petermann Ranges Orogeny caused folding of the sediments over a decollement (Wells et.al., 1965a) in the Bitter Springs Formation and 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 overlies the Pertatataka Formation unconformably in the Gardiner Range but, in the MacDonnell Ranges farther removed from the Petermann Ranges Orogeny, the Arumbera Sandstone overlies the Pertatataka Formation conformably. The remainder of the Pertaoorrta Group is equivalent to the molasse-type deposits of the Petermann Ranges Orogeny. The Hugh River Shale, the Jay Creek Limestone, and the Goyder Formation in the MacDonnell Ranges and Waterhouse Range are believed to be equivalent to the Tempe Formation, the Illara Sandstone, Deception Formation, Petermann Sandstone and the Goyder Formation of the Gardiner Range area (Wells et.al., 1965a; Ranford et.al, 1965) which is closer to the orogenic source area and consequently contains less limestone and more elastic 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 southwards marine transgression at least during the later part.

The Alice Springs Orogeny (Forman et.al., 1966) commenced after deposition of the Larapinta Group. The first effect of the orogeny was gentle uplift and gradual recession of the sea. The Mereenie Sandstone deposited during this period from late Ordovician to ? Middle Devonian is partly marine and partly continental. The orogeny reached a climax in the Middle or Upper Devonian and probably carried on into the Carboniferous. The Pertnjara Formation was deposited during this period and was itself folded by the Orogeny. The Alice Springs Orogeny caused nappe formation in the rocks below the Bitter Springs Formation in the Ormiston Gorge - Mount Razorback area and thrusting, sliding and folding of the sediments over the decollement surface within the Bitter Springs Formation.

Two nappes are preserved in the Ormiston Gorge - Mount Razorback area. One nappe (the Razorback Nappe) lies above the other (the Ormiston Nappe) and the resultant complex has been called the Ormiston Nappe Complex (Forman et.al., 1966). The Arunta Complex has undergone retrograde metamorphism to the greenschist facies adjacent to the

Heavitree Quartzite on the overturned middle limb of each nappe (McCarthy, 1966) 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 et.al., 1966) 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 and Cook (1966) present evidence to show Gosses Bluff may be in "Astrobleme". The structure near Goyder Pass was interpreted as a diapiric structure by Prichard & Quinlan (1962) and this interpretation has been further discussed by McNaughton et.al. (1966). However, the presence of thrusting on the Alice Springs Sheet area (Wells et.al., 1965b) between the lower decollement in the Bitter Springs Formation and an upper decollement in the upper salt horizon and the presence of the Ormiston Nappe Complex to the south has suggested another interpretation for the Goyder Pass structure to one of the authors (D.J.F.). This interpretation suggests that the structure has 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 which have been constructed 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 water courses or rivers.

Groundwater is available from aquifers of Precambrian to Quaternary age (Table 1). 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 quantitatively assessed using the concept of groundwater provinces.

Jones and Quinlan (1959 and 1962) recognised three provinces within the area, Burt, MacDonnell, and Hermannsburg, their boundaries correspond to those of the physiographic units (Fig. 1).

Aquifers in the Burt Groundwater Province (Jones and 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 at shallow depths 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 aquifers which are of limited areal extent. They occur 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 interconnection 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 drilling 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 dependant 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 of 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.

The Arumbera Sandstone

Sandstones of the Arumbera Sandstone, the Larapinta Group, and the Mereenie Sandstone are suitable for dressing or for use as freestone in buildings. Limited use has been made of these 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 (Upper Proterozoic), Jay Creek Limestone (Middle Cambrian), Horn Valley Formation (Lower or Middle Ordovician), and the 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 Upper Proterozoic and Cambrian sequence, and the Horn Valley Siltstone and the 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 3,092 feet in the Stairway Sandstone (Planalp and Pemberton, 1963). Drill stem testing in Palm Valley No. 1 Well by Magellan Petroleum Corporation of four intervals within the Stairway Sandstone, Horn Valley Siltstone and the Pacoota Sandstone yielded a total of 14 million cubic feet of natural gas (Magellan Petroleum, 1965).

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TABLE 1

SUMMARY OF THE STRATIGRAPHY OF THE HERMANNSBERG 1:250,000 SHEET

Age	Rock Unit	Map Symbol	Lithology	Thickness (feet)	Stratigraphic Relationship	Fossils	Economic Geology
Quaternary	Undifferentiated	Qa	Alluvium	1-250		-	Supplies of good to moderate quality groundwater are available where the alluvium is below the piezometric surface
		Qs	Aeolian sand	1-50		-	-
		Qt	Travertine, kunkar	1-100	UNCONFORMITY	-	The formation will produce large supplies of groundwater suitable for stock.
Tertiary	Undifferentiated	Tc	Conglomerate		UNCONFORMITY	-	Small to moderate supplies of moderate quality groundwater.
		Tl	Chalcedonic limestone	1-20	UNCONFORMITY	-	-
		Ta	Laterite; ferricrete	50-200		-	Suitable as gravel for road construction. Small to moderate quantities of variable quality groundwater are available, where the weathering extends below the piezometric surface.
		Ts	Sandstone; conglomerate sandstone; sandy siltstone, lignite	1-200	UNCONFORMITY		Small to moderate supplies of moderate quality groundwater.
Upper Permian	Undifferentiated	-	Brown and grey sandy clay	100	UNCONFORMITY	microspores pollens	
Devonian to Carboniferous	Pertnjara Formation	Pzp(c)	Grey calcareous conglomerate and sandstore	10,000 - vertical thickness 21,500 foreset thickness	In the west it overlies the Mereenie sandstone, apparently conformably. In the east it unconformably overlies the Larapinta and Pertaoorrta Group.		
		Pzp(s)	Red-brown, fine to medium grained silty calcareous sandstone, with scattered pebbles, current bedded	0-2000		-	Moderate supplies of good quality groundwater from aquifers near the top of the formation
		Pzp(a)	Red-brown siltstone, some calcareous lenses	0-800	UNCONFORMITY		
	Mereenie Sandstone	Pzm	Brown fine grained quartz sandstone, thickly to very thickly current bedded		In the west, it overlies the Stokes Formation, apparently conformably. In the east it unconformably overlies the Larapinta Group. UNCONFORMITY	-	The formation is capable of yielding moderate supplies of good to moderate quality groundwater.
Ordovician to Cambrian	Larapinta Group: Stokes Formation	Ot	Fine grained silty sandstone, dark red and purple shale; siltstone with thin limestone beds	0-200		bryozoa brachiopods gastropods trilobites nantiloids pelecypods	-
	Larapinta Group: Stairway Sandstone	Os	Pale brown, fine and medium-grained silty quartz sandstone; quartz sandstone	0-1500		trilobite fragments gastropods pelecypods worm tubes	The formation is capable of yielding moderate supplies of good to moderate quality groundwater
	Larapinta Group: Horn Valley Siltstone	Oh	Siltstone with thin limestone beds	0-1400		gastropods pelecypods graptolites trilobites brachiopods nautiloids	-

TABLE I Continued

Age		Rock Unit	Map Symbol	Lithology	Thickness (feet)	Stratigraphic Relationship	Fossils	Economic Geology
Ordovician to Cambrian	Larapinta Group	Pacoota Sandstone	Є-Op	Pale brown, fine-grained and medium grained quartz sandstone; kaolinitic quartz sandstone; micaceous siltstone	0-2700	A Conformable sequence	worm tubes trilobites	The formation is capable of yielding moderate supplies of good to moderate quality groundwater
		Undiff.	Єp	Section only	1600		trilobites brachiopod fragments	Minor occurrences of secondary copper minerals. The formation is capable of yielding useable supplies of good to moderate quality groundwater.
		Goyder Formation	Єg	Pale brown, fine grained to medium grained, silty quartz sandstone commonly micaceous; calcaneous limestone; siltstone				
Cambrian		Jay Creek Limestone	Єj	Blue-grey, yellow-brown, dolomitic limestone; with minor interbeds of shale.	175-1000		Algae trilobites	Minor occurrences of galena.
	Pertaoorrta Group	Hugh River Shale	Єh	Blue-black shale; with minor intervals of shale.	1600	DISCONFORMITY	Algae	-
	Pertaoorrta Group	Arumbera Sandstone	Єa	Red-brown, medium grained, very silty sandstone; purple-red micaceous siltstone	800-2800		-	Flaggy beds suitable for building stone Minor occurrences of secondary copper minerals
	Pertaoorrta Group	Petermann Sandstone	Єe	Red-brown sandstone and silty sandstone with minor red siltstone	About 620	A conformable sequence in the Gardiner Range, laterally equivalent to Pertaoorta units at Ellery Creek	-	-
	Pertaoorrta Group	Deception Formation	Єd	Red-brown siltstone and shale with minor fine, silty sandstone	About 560		-	-
		Illara Sandstone	Єi	Red-brown sandstone and silty sandstone with minor siltstone	250-400		-	-
		Tempe Formation	Єt	Siltstone, shale, limestone and sandstone - very rich in glaueonite	About 760		Marine fossils	-
		Eninta Sandstone	Єn	Red-brown sandstone, silty sandstone and siltstone. Some conglomerate beds.	300-1200	Unconformably overlies the Pertatataka Formation in the Gardiner Range		Contains secondary copper mineralization near a fault zone in the Gardiner Range.
						UNCONFORMITY		
Upper Proterozoic		Pertatataka Formation	Bup	Red, green, siltstone; shale thin limestone beds	2200-4000		-	-
		Areyonga Formation	Bua	Pale brown, white, medium grained ? Kaolinite calcaieous quartz sandstone; green tillitic siltstone; conglomerate	0-1300	Unconformably overlies the Bitter Springs Formation. The tillitic siltstone and the conglomerate may or may not be present	-	Small to moderate supplies of stock quality water may be available from sandstone aquifers.
						UNCONFORMITY		
		Bitter Springs Formation	Bub	Dark grey, dolomitic and cherty limestone; siltstone; evaporites	2500	Conformably overlies the Heavitree Quartzite	Algal	A source of aggregate. Large quantitites of stock quality & saline groundwater available from black pyrite shales and siltstone
		Heavitree Quartzite	Buh	White, pale brown, purple, medium grained and coarse grained silicified silty quartz sandstone; silicified sandstone; siltstone	500		Worm trails	A source of aggregate and building stone. Small quantities of moderate quality, groundwater available. Exploited by the tourist industry.
						UNCONFORMITY		
Precambrian		Arunta Complex	pЄ	Gneiss, schist, amphibolite, quartzite, granite, dolerite and pegmatite			-	Exploited by the tourist industry.

TABLE 2

STRATIGRAPHICAL NOMENCLATURE FOR THE HERMANNSBURG 1:250,000 SHEET AREA

Pre 1932		Madigan, 1932		Chewings, 1935		Prichard and Quinlan, 1962		Wells, Forman & Ranford, 1965a			Wells, Ranford, Stewart Cook & Shaw, 1965; Ranford, Cook & Wells 1965. and these notes		
Walker Creek Series (1) Pertnjara Series (3)		Pertnjara Series		Pertnjara Series		Pertnjara Formation		Pertnjara Formation			Pertnjara Formation		
		Larapintine Series	Mareenie Sandstone	Larapinta Series	Marena Red Sandstone	Mereenie Sandstone		Mereenie Sandstone			Mereenie Sandstone		
			(not seen)		Mareena Valley Shales and mudstone	Larapinta Group	Stokes Formation	Larapinta Group	Stokes Formation		Larapinta Group	Stokes Formation	
					St irway Quartzite		Stairway Greywacke		Stairway Sandstone			Stairway Sandstone	
Mareeno Bluff Series (1)			Horn Valley Beds		Stairway Valley Beds		Horn Valley Formation		Horn Valley Siltstone			Horn Valley Siltstone	
	Pacoota Quartzite(2)		"No. 4 quartzite"		"No. 4 quartzite		Pacoota Sandstone		Pacoota Sandstone			Pacoota Sandstone	
Pataoorrta Series (2) Pertaoorrta Series (3)		Pertaoorrta Series		Pertaoorrta Series		Pertaoorrta Group		Pertaoorrta Formation	MacDonnell Ranges	Gardiner Range	Pertaoorrta Group	MacDonnell Ranges	Gardiner Range
							Goyder Formation		Goyder Member			Goyder Formation	
							Jay Creek Limestone		Jay Creek Limestone Member	Petermann Sandstone Member		Jay Creek Limestone	Petermann Sandstone
										Deception Member			Deception Formation
										Illara Sandstone Member			Illara Sandstone
							Hugh River Shale		Hugh River Shale Member	Tempe Member		Hugh River Shale	Tempe Formation
			"No. 3 Quartzite		"No. 3 Quartzite	Arumbera Greywacke			Arumbera Greywacke Member	Enita Sandstone Member		Arumbera Sandstone	Eninta Sandstone
Glen Helen Series (1) Pataknurra Series (2) Pertaknurra Series (3)		Pertatataka Series		Pertatataka Series		Pertatataka Formation		Pertatataka Formation			Pertatataka Formation		
			"No. 2 quartzite"		"No. 2 Quartzite	Areyonga Formation		Areyonga Formation			Areyonga Formation		
		Pertaknurra Series		Pertaknurra Series		Bitter Springs Limestone		Bitter Springs Limestone			Bitter Springs Formation		
			Heavitree quartzite		"No. 1 Quartzite	Heavitree Quartzite		Heavitree Quartzite			Heavitree Quartzite		
Arunta Complex		Arunta Complex		Arunta Complex		Arunta Complex		Arunta Complex			Arunta Complex		

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

AUSTRALIA 1:250,000

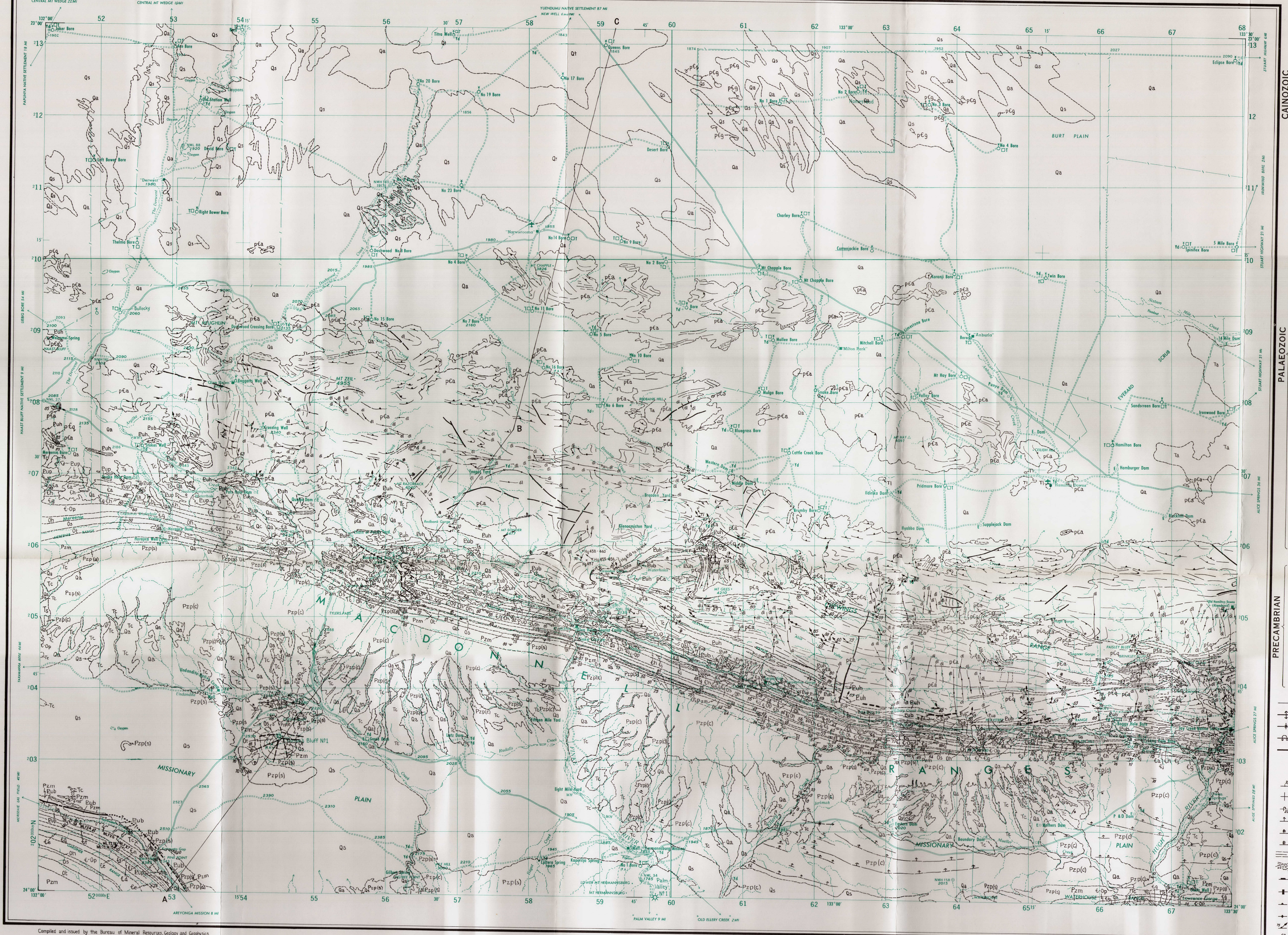
HERMANNSBURG

NORTHERN TERRITORY

1:250,000 GEOLOGICAL SERIES SHEET SF 53-13

PRELIMINARY EDITION, 1965

SUBJECT TO AMENDMENT



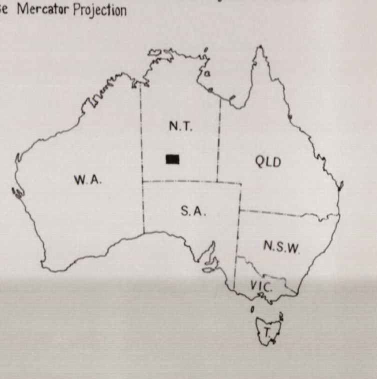
Reference

CAINOZOIC	QUATERNARY	Undifferentiated	Q	Alluvium, sand, travertine, conglomerate (section only)
			Qa	Alluvium
			Qs	Aeolian sand
			Qt	Travertine, kunkar
	TERTIARY		Tc	Conglomerate
			Tl	Chalcedonic limestone
			Ta	Laterite, ferricrete
			Ts	Sandstone, conglomeratic sandstone, sandy siltstone, lignite
PALAEOZOIC	DEVONIAN TO CARBONIFEROUS	Pertnjara Formation	Pzp(c)	Calcareous conglomerate
			Pzp(s)	Calcareous sandstone, pebbly sandstone
			Pzp(a)	Siltstone, shale
	ORDOVICIAN TO DEVONIAN	Mereenie Sandstone	Pzm	Sandstone
	CAMBRIAN TO ORDOVICIAN	Larapinta Group: Undifferentiated	€-Ol	Fossiliferous sandstone, siltstone, shale, limestone
		Stokes Formation	Ot	Siltstone, shale, fossiliferous limestone
		Stairway Sandstone	Os	Fossiliferous sandstone, silty sandstone
		Horn Valley Siltstone	Oh	Siltstone, fossiliferous limestone
		Pacoota Sandstone	€-Op	Fossiliferous sandstone, silty sandstone
	CAMBRIAN	Pertaoorrta Group: Undifferentiated	€p	Sandstone, siltstone, shale, dolomite, limestone
		Goyder Formation	€g	Sandstone, calcareous sandstone
		Jay Creek Limestone	€j	Limestone, shale, dolomite
		Hugh River Shale	€h	Shale, limestone, siltstone
		Arumbera Sandstone	€a	Silty sandstone, siltstone
		Petermann Sandstone	€e	Red-brown sandstone, silty sandstone
		Deception Formation	€d	Red-brown siltstone, shale
		Illara Sandstone	€i	Red-brown sandstone, silty sandstone
		Tempe Formation	€t	Siltstone, calcareous sandstone, fossiliferous glauconitic limestone
		Eninta Sandstone	€n	Red-brown sandstone, silty sandstone, siltstone
PRECAMBRIAN	UPPER PROTEROZOIC	Pertatataka Formation	Pup	Siltstone, sandstone, limestone
		Areyonga Formation	Pua	Calcareous sandstone, tillitic siltstone, conglomerate
		Bitter Springs Formation	Pub	Dolomitic limestone, shale, siltstone
		Heavitree Quartzite	Puh	Quartzite, sandstone
		Arunta Complex	p€a	Gneiss, schistose gneiss, granite, gneissic granite, schist, amphibolite, sericite-quartz schist, meta-quartzite, pegmatite
			p€g	Granite
			p€q	Meta-quartzite, quartz-sericite schist

Geological boundary
Anticline, showing plunge
Syncline, showing plunge
Overturned anticline
Fault
Where location of boundaries, folds and faults is approximate, line is broken; where inferred, queried; where concealed, boundaries and folds are dotted, faults are shown by short dashes
Strike and dip of strata
Vertical strata
Overturned strata
Dip < 15° (air-photo interpretation)
Dip 15°-45° (air-photo interpretation)
Dip > 45° (air-photo interpretation)
Trend lines (air-photo interpretation)
Joint pattern (air-photo interpretation)
Unmeasured joint
Vertical joint
Strike and dip of foliation
Vertical foliation
Foliation with trend of lineation
Trend of lineation

Macrofossil locality
× Hg 450 Specimen locality. Text reference prefixed by H
HLFX7 Measured section
Dyke; dl—dolerite, p—pegmatite
Bore
Windpump
Well
Tank
Earth tank
Dam on stream
WH Waterhole
Gas well
Abandoned well with show of gas
Road
Vehicle track
Fence
Anburla Homestead
Yd Yard
Landing ground
N.M.H157 Astronomical station
2045 Height in feet, barometric; datum: mean sea level

Compiled and issued by the Bureau of Mineral Resources, Geology and Geophysics, Department of National Development. Base map compiled by the Division of National Mapping, Department of National Development. Aerial photography by the Royal Australian Air Force; complete vertical coverage at 1:46,000 scale
Transverse Mercator Projection



INDEX TO ADJOINING SHEETS

Showing Magnetic Declination

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LAKE MACKAY SF 52-11	MOUNT DOREEN SF 52-12	NAPPERBY SF 53-9	ALCOOTA SF 53-10	HUCKITTA SF 53-11
MOUNT RENNIE SF 52-15	MOUNT LIEBIG SF 52-16	HERMANNSBURG SF 53-13	ALICE SPRINGS SF 53-14	ILLOGWA CREEK SF 53-15
BLOODS RANGE SG 52-3	LAKE AMADEUS SG 52-4	HENBURY SG 53-1	RODINGA SG 53-2	HALE RIVER SG 53-3
PETERMANN RANGES SG 52-7	AYERS ROCK SG 52-8	KULGERA SG 53-5	FINKE SG 53-6	McDILLS SG 53-7

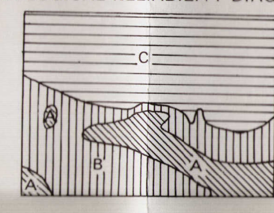
ANNUAL CHANGE 1'30"E

Scale 1:250,000

5 0 5 10 15 MILES

5 0 5 10 15 20 25 KILOMETRES

GEOLOGICAL RELIABILITY DIAGRAM

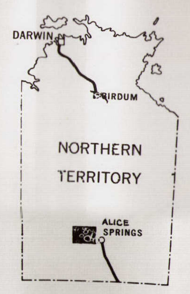


A Detailed Mapping

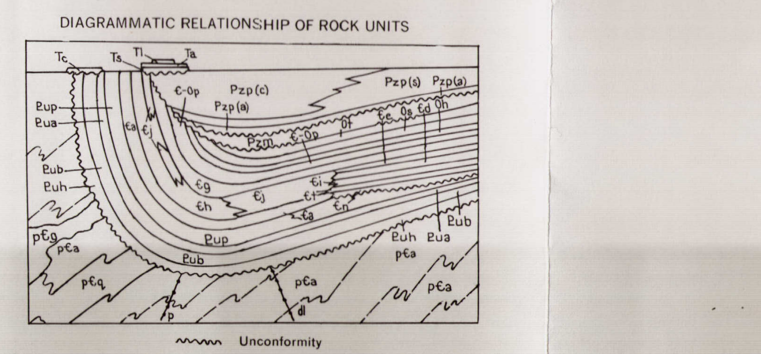
B Detailed reconnaissance, general reconnaissance, reconnaissance and air-photo interpretation.

C Air-photo interpretation

Geology, 1956, by : C.E. Pritchard, T. Quinlan, W.M. Burnett
1962, by : T. Quinlan, D. Woolley, L.C. Ranford.
1964, by : D.J. Forman, E.N. Milligan,
Compiled, 1964, by : D.J. Forman, E.N. Milligan, T. Quinlan, N.L. Kruger
Drawn by : N.L. Kruger.



DIAGRAMMATIC RELATIONSHIP OF ROCK UNITS



Section

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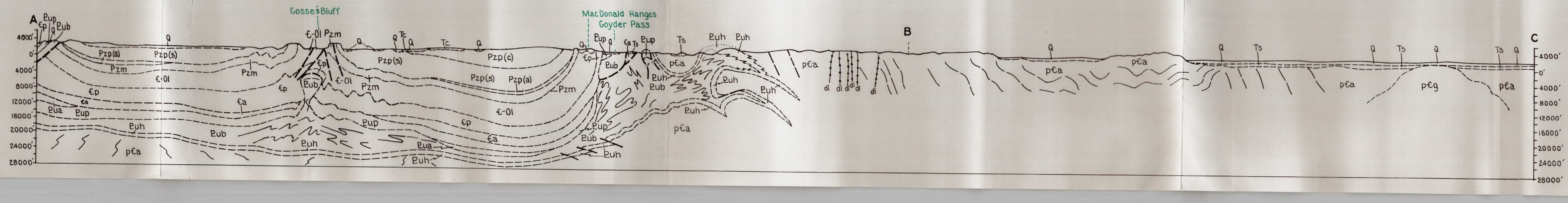

HERMANNSBURG

SHEET SF 53-13