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EXPLANATORY NOTES

BLUE MUD BAY/PORT
LANGDON, N.T.

Sheet SD/53—7/8
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Compiled by K. A. Plumb and H. G. Roberts

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Explanatory Notes on the Blue Mud Bay/Port Langdon Geological Sheet

Compiled by K. A. Plumb and H. G. Roberts

The Blue Mud Bay/Port Langdon 1:250,000 Geological Sheet area lies wholly within the Arnhem Land Aboriginal Reserve, in the north-eastern part of the Northern Territory; it contains the Blue Mud Bay and the western third of the Port Langdon 1:250,000 Sheet areas. It lies between latitudes 13° 00' S. and 14° 00' S. and longitudes 135° 00' E. and 137° 00' E.

The only permanently inhabited settlements in the Sheet area are the Groote Eylandt and Umbakumba Mission Stations, both on Groote Eylandt.

Access to the Sheet area is poor. Groote Eylandt Mission is accessible by sea and air, and a vehicle track links it to Umbakumba Mission. The mainland can be reached by sea although no landing facilities exist, and 4-wheel-drive vehicles can travel overland from Mainoru Station to the south-west, or Rose River Mission to the south, during the dry season only; no vehicle tracks exist on the mainland within the Sheet area. A small landing field, suitable only for light aircraft in dry weather, and lacking any facilities, is situated on the Koolatong River flats. A weekly air service connects Groote Eylandt Mission with Darwin.

The average annual rainfall for the Sheet area is between 45 and 50 inches. Most of the rain falls during the summer months, from December to May, under the influence of the north-west monsoon. Maximum daily temperatures range from about 90° F. to 95° F. in December to about 80° F. in June; minimum temperatures range between about 80° F. and 60° F. for the same months.

Maps and air-photographs of the Sheet area available during 1962 were: air-photographs at a scale of 1:50,000 flown by the Royal Australian Air Force in 1950; uncontrolled photomosaics of Blue Mud Bay—Western Extension and Blue Mud Bay—Eastern Extension at a scale of approximately 4 miles to 1 inch;
and planimetric maps of Blue Mud Bay and Port Langdon Sheet areas at a scale of 1:250,000 prepared by the Royal Australian Survey Corps from a controlled photo-scale slotted-template assembly. The geological map was compiled on a photo-scale trace of this assembly and reduced to 1:250,000 scale.

Previous Investigations

In 1803 Matthew Flinders (1814) noted the general geological and physiographic features of the islands and coast of Blue Mud Bay whilst charting the coast-line of Australia. In 1818 King (1826) made similar observations along the coast of Arnhem Land. W. H. Fitton (1825), in an account of the geology of parts of the Australian coast, included detailed descriptions of rocks from Arnhem Land, based on specimens and information supplied to him by Flinders and by King.

Lindsay passed through the Sheet area in 1883 during his survey of Arnhem Land and made numerous observations of the rocks in the Walker River/Parsons Range area (Lindsay, 1884, 1887); he mentioned that a prospecting party led by Walker had been in the area during 1875. Brown (1908) and Jensen (1914) visited Blue Mud Bay and Groote Eylandt by sea and made geological notes. Love (1911) and Murphy (1912) led prospecting parties on the mainland of Arnhem Land and gave sketchy accounts of the geology.

In 1954 the Broken Hill Proprietary Co. Ltd made a reconnaissance survey of the eastern part of Arnhem Land and determined the basic structure and stratigraphy of the area (Crohn, 1956); this work provided a basis for a photogeological map of the Blue Mud Bay/Port Langdon Sheet area produced by Ruker (1962). In 1955 Dixon, of Frome–Broken Hill Co. Pty Ltd, made a reconnaissance survey of the Gulf of Carpentaria; he visited Groote Eylandt and noted the unconformity at the base of the Groote Eylandt Beds (Dixon, 1956).

During 1958 the Bureau of Mineral Resources conducted an underwater gravity survey along part of the Northern Coast of Australia; several measurements were made in the Blue Mud Bay/Port Langdon Sheet area (Williams and Waterlander, 1958). A reconnaissance airborne magnetometer survey of the Gulf of Carpentaria (including part of the Sheet area) was completed for Delhi Australian Petroleum Ltd in 1962 (Hartman, 1962).

These notes and the accompanying geological map are based on a regional survey of Arnhem Land by geologists of the Bureau of Mineral Resources during 1962.
PHYSIOGRAPHY

The Sheet area contains parts of the three major physiographic divisions of Arnhem Land—the Arafura Fall, the Gulf Fall, and the Coastal Plain (Roberts, Dunn, & Plumb, in prep.). Their distribution is shown in Figure 1.

Gulf Fall: The Gulf Fall is defined as the dissected hilly country with moderate to strong relief drained by streams flowing into the Gulf of Carpentaria; a watershed in the north-western part of the Sheet area divides it from the Arafura Fall. Elevations within the Gulf Fall range from 1100 feet in the Parsons Range to sea-level along the coast. The present topography is controlled mainly by the differential erosion of the bedrock. Three physiographic units—the Main Ranges, the Walker Plateau and the Groote Eylandt Plateau—have been differentiated on Figure 1.

The Undifferentiated Gulf Fall is an area of undulating and hilly country bordering the Main Ranges and Walker Plateau and with relief ranging between about 50 and 150 feet. Most of this area is underlain by rocks of the McArthur Group, although exposures of Roper Group occur in the south-west and scattered mesas of Cretaceous rocks are present throughout. The topography ranges from long parallel strike ridges in folded areas to low rounded hills in areas of flat-lying rocks. The elevation reaches a maximum of 550 feet in the south-west and gradually decreases eastwards to where the outcrops disappear beneath the Coastal Plain.

The Main Ranges are the Bath Range, in the central part of the Sheet area, and the Parsons Range, which forms the watershed between the Gulf Fall and the Arafura Fall, in the north-west. The Bath Range is an elongate, north-trending dissected plateau of flat-lying rocks at the axis of a broad syncline; elevations range up to 500 feet and the relief above the surrounding country is up to 350 feet. The Parsons Range consists of a series of prominent north-easterly strike ridges of resistant sandstones of the Parsons Range Group; in the north these ridges trend into a small plateau of shallower dipping sandstone. Elevations range from 800 feet in the south to 1100 feet in the north; relief varies from about 400 feet near the Walker Plateau to 900 feet around the upper Koolatong River.

The Walker Plateau, a dissected, depressed plateau surrounding the headwaters of the Walker River, has a bedrock of horizontal Lower Cretaceous rocks with inliers of Proterozoic rocks in the valleys; much of the area is now covered by sand. The elevation of the Plateau, which is partly surrounded by the higher Main Ranges, varies from about 350 to 500 feet; the elevation of the river bed ranges down to about 170 feet.

The Groote Eylandt Plateau is a rugged dissected plateau with elevations ranging up to 400 feet; it is composed of horizontal rocks of the Groote Eylandt Beds. Cliffs up to 150 feet high are common along its margins.
Arafura Fall: The Arafura Fall is confined to the north-west of the Sheet area and contains the western part of the Parsons Range. The bedrock of the area, outside the Parsons Range, is folded Roper Group rocks and dolerite sills, with scattered thin outcrops of Cretaceous rocks. Relief is low; scarps, when present, are usually only about 50 feet high; elevations range from about 250 to 1100 feet. Scarps and mesas occur where resistant sandstone crops out, and low rounded hills are formed where soft units, such as the Mainoru Formation, crop out. Much of the area is now covered by soil.

Coastal Plain: The Coastal Plain is an area of low relief which borders the coast and extends up to 60 miles inland. The surface slopes gently seawards and elevations range from sea-level to about 300 feet around the headwaters of the Rose River. The bedrock is mostly laterite, which has formed on a variety of rocks, but mainly on Cretaceous siltstone. Most of the Plain is now covered by sand, and the laterite is exposed in small scarps, up to 30 feet high, along the coastline. Maximum relief is developed to the east of the Baiguridji River where the general level of the laterite surface rises towards the north. Erosion has, in places, produced relief of up to 100 feet.

The Tidal Flats occur within the Coastal Plain: they are low-lying areas near the coast subject to seasonal and tidal flooding. The flats represent emerged lagoons in which deposits of silt, fine sand, and evaporites have accumulated; small, meandering tidal creeks cross them.

Extensive Coastal Sand Dunes occur along the northern part of the mainland coast and along the east coast of Groote Eylandt. The dunes, which are up to 250 feet high, have been built up by wind action from beach-sand deposits stranded by marine regression.

Drainage: The Arafura Fall is drained by the Goyder River and its tributaries, a north-flowing system which enters the Arafura Sea on the northern coast of Arnhem Land. The Gulf Fall and Coastal Plain are drained by the Koolatong, Walker, and Rose River systems, and by numerous minor streams flowing into the Gulf of Carpentaria.

Within the Coastal Plain a simple pattern of consequent streams has developed sub-perpendicular to the coastline. In the Arafura Fall the major streams are superimposed consequent streams; the minor consequent streams form a dendritic pattern. The major streams in the Gulf Fall are also superimposed, but the subsequent streams are controlled by the structure of the Proterozoic rocks.
STRATIGRAPHY

The stratigraphy of the Sheet area is summarized in Table 1. It will be fully described and defined in Roberts et al. (in prep.).

Precambrian

Within the Sheet area extensive exposures of Precambrian rocks occur. Recent radiometric age determinations made at the Australian National University (Webb, McDougall, & Cooper, 1963) indicate that the Tawallah Group (Dunn, Smith, & Roberts, in prep.), a lateral equivalent of the Parsons Range Group, contains rocks ranging in age from a minimum of 1480 m.y. to more than 1600 m.y. For the present these dates are taken to indicate a Lower Proterozoic age for the Parsons Range Group. Recent determinations made on rocks from the Roper Group (McDougall, pers. comm.) are considered by the present authors to indicate an Upper Proterozoic age for the Group.

The ages assigned to the older rock units are based entirely on their structural and stratigraphic relationships.

Archaean

The Myaoola Granite, which is exposed on a peninsula between Trial and Myaoola Bays in the north-eastern part of the Sheet area, is characterized by a foliation, garnet (or biotite after garnet), and two feldspars, one of which is porphyritic. It is probably related to the Bradshaw Granite, exposed to the north in the Arnhem Bay/Gove Sheet area (Dunnet, 1965).

Lower Proterozoic and Archaean

The Mirarrina Complex consists of igneous and metamorphic rocks exposed to the north of the Parsons Range. Although the contacts are obscured by faulting it is likely that most of the Complex is unconformably overlain by the Ritarango Beds. The oldest rocks of the Complex are foliated and folded garnetiferous gneiss and granite, porphyritic in potash feldspar; in the Arnhem Bay/Gove Sheet area (Dunnet, 1965) the rocks are associated with low-grade metasediments. They are probably Archaean.

The gneiss and granite have been intruded by stocks of massive gabbro and dolerite, and reaction between them has formed large amounts of diorite; intense hybridization is developed adjacent to the contacts, which are chilled. The basic rocks are massive to weakly foliated in outcrop, with a varying colour index and quartz content. Thin sections indicate a composition range from tonalite to meladiorite and gabbro. Mafic inclusions or segregations are common, as are pyrite and chalcopyrite. The gabbro may be Archaean in age, but is more probably Lower Proterozoic.
Large dykes trending north-north-east and small stocks of massive quartz-feldspar porphyry have intruded these older rocks. The porphyry is characterized by rounded, resorbed, and embayed quartz phenocrysts up to half an inch in diameter and large spherical feldspars up to one inch in diameter, set in a fine-grained siliceous groundmass. Hybrid rocks occur at the contact of the porphyry with the gabbro. The youngest rocks of the Complex consist of numerous north-north-easterly dykes of pyritic dolerite intruded along shear zones in the Complex; they appear to intrude the Ritarango Beds. The quartz-feldspar porphyry may be co-magmatic with the Fagan Volcanics, and the dolerite dykes with a laccolith intruding the Fagan Volcanics, and both are thus probably of Lower Proterozoic age.

**Lower Proterozoic**

The *Grindall Metamorphics* are undifferentiated geosynclinal sediments which have been highly folded and subjected to low-grade regional metamorphism. They are exposed on islands in Blue Mud Bay and on the mainland near Grindall Point. Their grade of metamorphism (greenschist facies) is considered evidence of a distinct structural break between them and the older Myaoola Granite. The Metamorphics are intruded by the Caledon Granite.

The *Caledon Granite*, which is exposed around the coast of Blue Mud Bay, is a massive granite with low biotite content and no foliation. It shows many features of a high-level granite and intrudes the Grindall Metamorphics and the Myaoola Granite. One thin section contains fayalite and serpentine with minor amounts of augite and orthopyroxene; potash feldspar is more abundant than plagioclase. The Granite is probably co-magmatic with the Bickerton Volcanics.

The *Ritarango Beds* are exposed only in the north-western part of the Sheet area and no relationships with the Grindall Metamorphics or the Caledon Granite are known. Although intensely faulted, the Beds and the overlying Fagan Volcanics are not strongly folded, and are therefore probably younger than the Grindall Metamorphics. The base of the unit is not exposed; the exposed section consists dominantly of arenites and is about 10,000 feet thick. Local shearing and quartz veining are common.

The *Fagan Volcanics* unconformably overlie the Ritarango Beds. The unit contains three main volcanic flows interbedded with sediments. The lower flow is over lain by massive purple ashstone, in places containing numerous interbeds of quartz sandstone; the middle flow is overlain by alternating beds of purple tuffaceous shale and feldspathic quartz sandstone, in which the third flow is interbedded near the top. The presence of compaction bands in outcrop and the thickness and extent of individual flows suggest that the volcanics may be welded ash-flows. Thin sections show them to have a rhyolitic or trachytic composition with phenocrysts of quartz and potash feldspar in a fine-grained felsic or feldspathic groundmass. No ignimbritic texture is present.
The Bickerton Volcanics are exposed only in the coastal parts of the Sheet area and consist of massive red porphyritic acid igneous rocks. From their similarity in appearance and stratigraphic position to the Fagan Volcanics they are considered to be of similar age. Thin sections show phenocrysts of quartz, sericite after plagioclase, and serpentine after (?) olivine; the groundmass is a micrographic intergrowth of quartz and alkali feldspar. The presence of olivine suggests that the Volcanics are co-magmatic with the Caledon Granite.

The Sheridan Formation is exposed in a few isolated localities around the headwaters of the Koolatong River; the sediments are small valley infillings derived from the erosion of the unconformably underlying Fagan Volcanics. The unit is unconformably overlain by the Mattamurta Sandstone.

McArthur Basin Succession

Unconformably over the older rocks of the Sheet area a thick succession of sediments was deposited in the McArthur Basin, which extends from the northern coast of Arnhem Land, southwards beyond the Queensland Border (Roberts et al., in prep.). In the Sheet area this succession has been divided into three Groups—the Parsons Range, McArthur, and Roper Groups; the Groote Eylandt Beds are considered a lateral equivalent of the rocks of the Parsons Range Group. In the Sheet area most of the McArthur Basin sediments were deposited in a central, more deeply subsiding, north-trending belt; to the west, in the Mount Marumba Sheet area (Roberts & Plumb, 1964), the total succession is thinner, and to the east, on the coast of Blue Mud Bay, the section is considerably thinner than in the central belt.

Lower Proterozoic

The Groote Eylandt Beds crop out on the islands and coast around Blue Mud Bay. In the north the exposed section is only about 300 feet thick; a thin basal conglomerate is overlain by 50 to 100 feet of flaggy reddish brown micaceous sandstone, succeeded by flaggy and blocky white cross-bedded quartz sandstone.

A facies change occurs at the northern end of Bickerton Island and the section thickens markedly to the south-east to about 2000 feet on Groote Eylandt. The lower part consists of massive grey to purple-brown pebbly sandstone. Feldspar, clay after feldspar, and white clay matrix are abundant and quartz pebbles up to one inch in diameter occur throughout; very large-scale cross-bedding is characteristic. Massive boulder conglomerate occurs in places; rounded boulders of Bickerton Volcanics and sandstone similar to the Groote Eylandt Beds, up to five feet in diameter, are present. These impure basal rocks grade upwards into blocky cross-bedded white and pink quartz sandstone, which are the youngest beds exposed on Groote Eylandt.
Parsons Range Group: Exposures of the Parsons Range Group in the Sheet area are confined to the Parsons Range. The Group contains mainly quartz arenites, although lutites and carbonate-lutites occur in the upper half.

The Katherine River Group to the west (Walpole, Malone, Dunn, Randal, & Yates, in prep., and Roberts et al., in prep.), the Tawallah Group to the south (Dunn et al., in prep.), and the Groote Eylandt Beds to the east, are regarded as stratigraphic equivalents of the Parsons Range Group. In the central subsiding belt of the McArthur Basin the Group is about 20,000 feet thick. The Groote Eylandt Beds in the east are only 300 feet thick; and to the west in the Mount Marumba Sheet area (Roberts & Plumb, 1965) the Katherine River Group is about 9000 feet thick.

The Mattamuria Sandstone is the basal unit of the Group and consists dominantly of quartz sandstone and feldspathic quartz sandstone with a maximum thickness of about 10,000 feet. It is overlain by the Badalingarmirri Formation, consisting of quartz sandstone beds up to several hundred feet thick alternating with beds of less resistant siltstone and fine-grained sandstone from 200 to 300 feet thick. The overlying Marura Siltstone consists mainly of fine-grained sediments containing varying proportions of dolomite. It is usually poorly exposed. The more resistant Fleming Sandstone, at the top of the Group, is a jointed medium to coarse-grained quartz sandstone. The lower part of the unit is characteristically flaggy and thin-bedded.

Lower (?) Proterozoic

McArthur Group: The McArthur Group is exposed mainly to the south and east of the Parsons Range. These rocks, together with a small northerly extension into the Arnhem Bay/Gove Sheet area, represent the northernmost exposure of rocks of the McArthur Group, although possible stratigraphic equivalents (upper part of the Habgood Group) occur farther to the north (Dunnet, 1965). The Group is very extensive in the southern part of the Carpentaria Province (Dunn et al., in prep.).

In the Blue Mud Bay/Port Langdon Sheet area a maximum thickness of about 12,000 feet was deposited in a north-south belt between the Parsons Range Fault Zone and the Koolatong Fault Zone; to the east of the latter the only units present, the Bath Range Formation, Baiguridji Formation, Yarrawirrie Formation, and Blue Mud Bay Beds, thin to only about 1500 feet total thickness. West of the Parsons Range Fault Zone, in the Mount Marumba Sheet area (Roberts & Plumb, 1964), the Dook Creek Formation, a probable stratigraphic equivalent of the McArthur Group, is only about 1000 feet thick.

By analogy with rocks deposited elsewhere in the McArthur Basin most of the McArthur Group rocks in the Blue Mud Bay/Port Langdon Sheet area are thought to have been deposited in a fore-reef environment.
In the eastern part of the Sheet area the Blue Mud Bay Beds overlie the Groote Eylandt Beds with apparent conformity and appear to be overlain conformably by the Baiguridji Formation. Although the section is thinner, the succession in the Blue Mud Bay Beds resembles the Zamia Creek Siltstone and Yarrarwirrie Formation. It is not known whether the beds are a stratigraphic equivalent of part, or all, of the McArthur Group below the Baiguridji Formation; lithology suggests that they may simply be the result of an overlap of the Zamia Creek Siltstone and Yarrarwirrie Formation on to a stable shelf.

The basal unit of the McArthur Group in this Sheet area is the Kookatong Siltstone. Siltstone and dolomitic siltstone dominate the lithology of the unit, particularly in the lower half, while higher in the sequence flaggy to massive dolomite, chert breccia, and algal dolomite become locally prominent, particularly in the Strawbridge Creek area. Thin interbeds of fine-grained sandstone occur throughout.

The Strawbridge Breccia is composed entirely of massive chert breccia containing angular fragments of banded chert in a chaledony matrix. It is resistant and well exposed. Overlying the Strawbridge Breccia is the Vaughton Siltstone, which consists almost entirely of fine-grained fissile and flaggy thin-bedded rocks. The lower parts of the unit contains dolomitic siltstone, with minor interbeds of dolomitic fine-grained sandstone, chert and dolomite; the upper part consists of distinctive black shale. The overlying Conway Formation contains persistent beds of algal chert. The algae form colonies which occur in single beds over wide areas. Associated with the beds of algal chert are laminated cherty siltstone and dolomitic siltstone.

The Zamia Creek Siltstone consists of regular interlaminated chert, cherty siltstone, and dolomitic siltstone. Graded bedding is a common feature of the unit. The overlying Yarrawirrie Formation is distinguished from the Zamia Creek Siltstone by a flaggy quartz sandstone and a 'chert fragment sandstone', a rock containing abundant angular chert fragments and quartz grains set in a silty matrix. Mushroom-shaped growths of botryoidal quartz and lenses of algal chert occur within the unit.

The Baiguridji Formation crops out very poorly in a valley between the Yarrawirrie Formation and Bath Range Formation. Dolomitic siltstone occurs at the base, overlain by flaggy purple to pink micaceous fine-grained sandstone and siltstone. The top has flaggy grey-green fine cherty sandstone and siltstone which commonly crop out in a cliff or scarp beneath the resistant Bath Range Formation.

The Bath Range Formation contains a diversity of rock types. The base is marked by two or three bands of massive white to pale grey feldspathic siltstone. Higher up in the unit pelletal dolomite and pelletal chert (silicified pelletal dolomite?) are characteristic. Interbedded with these are laminated dolomitic siltstone, flaggy fine-grained feldspathic sandstone, chert sandstone, chert breccia, and interlaminated siltstone and chert.
The few small outcrops of the *Kookaburra Creek Formation* which underlie the Roper Group in the south-western corner of the Sheet area are characterized by the abundance of oolitic chert. No definite relationship is visible between the Kookaburra Creek Formation and the Bath Range Formation, which is inferred to underlie it. The Kookaburra Creek Formation is the only unit of the McArthur Group which can be traced in outcrop beyond the southern border of the Sheet area; it provides a link with the McArthur Group succession to the south.

**Upper(?) Proterozoic**

*Roper Group*: The Roper Group, which is composed of alternating sandstone and siltstone, is about 2000 feet thick in the Blue Mud Bay/Port Langdon Sheet area, compared with 6000 feet farther south on the Urapunga Sheet area (Dunn, 1963). Associated with this northward thinning there is a general increase in the proportion of silty rocks within the Group.

The *Limmen Sandstone* is the lowest unit of the Group and unconformably overlies the McArthur Group. A basal conglomerate, containing pebbles of chert from the McArthur Group, is present.

The characteristic feature of the generally poorly outcropping *Mainoru Formation* is the abundance of flaggy purple micaceous shale and fine-grained glauconitic sandstone. The lower half of the unit consists largely of flaggy cherty siltstone and dolomitic siltstone which crop out as prominent ridges in places. The contact between the Mainoru Formation and the overlying *Crawford Formation* is gradational; in the Sheet area the Crawford Formation contains much more silt-sized material than farther to the south. It generally crops out as a small scarp, controlled by beds of massive pink micaceous quartz greywacke; glauconite is characteristic of the unit.

The *Abner Sandstone* is divided into four members, but the two sandstone members, the *Arnold Sandstone Member* and the *Hodgson Sandstone Member*, are not very prominent in the Sheet area; the Arnold Sandstone Member thins out completely in the north. The main component of the formation in the Sheet area is the *Jalboi Member*, which consists chiefly of micaceous siltstone and glauconitic micaceous sandstone; only a few thin quartz sandstone beds occur. The ferruginous sandstone of the *Munyi Member* is not as prominent as in the Urapunga Sheet area; to the north quartz sandstone and micaceous shale are present in its place.

The *Corcoran Formation* only crops out occasionally in creeks and low rises. It is overlain by the *Bessie Creek Sandstone*, which is a useful marker bed and is the youngest unit of the Roper Group unit in the Sheet area.

**Dolerite Intrusives**: Extensive sills of dolerite, up to 300 feet thick, and following single beds for large distances, are common within the Roper Group. The sills exhibit the same structural deformation as the enclosing sedimentary rocks.
On the east coast of Bickerton Island a small sill of fine-grained dolerite intrudes the Groote Eylandt Beds; it shows no apparent similarity to those intruding the Roper Group.

Near the headwaters of the Koolatong River a laccolith of dolerite and diorite intrudes the Fagan Volcanics. This has been subjected to the same deformation as the enclosing volcanics and is therefore considered to be of similar age to the volcanics and to be unconformably overlain by the Parsons Range Group.

**MESOZOIC**

**Lower Cretaceous**

Thin outliers of horizontal Mullaman Beds unconformably overlie the Precambrian rocks throughout the Sheet area. The top of the unit has been eroded off, leaving a maximum section only about 50 feet thick. Marine and freshwater sediments are present. Massive quartz sandstone and ferruginous sandstone, of freshwater origin, generally occur locally in valleys. The overlying marine claystone and clayey sandstone are more widespread. Exposures around the headwaters of the Walker River contain an abundant shelly fauna of Neocomian age (Skwarko, 1964).

**CENOZOIC**

**Laterite**: A laterite profile is present beneath the sand cover of the Coastal Plain and is exposed in small scarps bordering the coast. It has generally developed on Lower Cretaceous rocks, but is found also on Precambrian rocks, such as granite. The profile is generally about 20 to 30 feet thick, with a maximum of about 50 feet. A ferruginous zone consisting of ferruginous loam, a mottled zone, and a paludal zone consisting of white clay, can be recognized. The original texture of the rock is destroyed in the ferruginous zone and the profile is truncated by erosion in places. It is probably of Tertiary age.

Large areas, principally the Yarrawirrie Plains in the south, and the north-western corner of the Sheet area, are covered by a younger ferruginous cemented detritus (‘ferricrete’). This is included with laterite on the map.

**Soils**: Large areas of the Sheet area are covered by alluvium, residual soils, and sand; they are described in Table 1 and on P.O.

**STRUCTURE**

The structure of the Sheet area is dominated by a faulted and folded horst structure bounded by the Parsons Range and Bath Range Fault zones, with comparatively stable blocks to the east and west. A marked difference in structural style is present between the Archaean and Lower Proterozoic basement rocks and the overlying Proterozoic sedimentary rocks. The Lower Cretaceous rocks are undeformed.

The structure of the Sheet area is illustrated in Figure 2.
**Fig. 2**

**STRUCTURAL SKETCH MAP—BLUE MUD BAY, PORT LANGDON SHEETS**

**REFERENCE**

- **Canozoic and Mesozoic Cover**
- **Roper Group**
- **McArthur Group**
- **Parsons Range Group, Groote Eylandt Beds**
- **Ritutango Beds, Fagan and Ridderton Volcanics, Sheridan Form.**
- **Archean/Lower Proterozoic, Granite and Metamorphics**

*Note—Description refers to tectonic environment during deposition of McArthur Basin Succession.*

- **Geological Boundary**
- **Trend line with dip of bedding**
- **Horizontal strata**
- **Fault with direction of down throw, dip unknown**
- **Thrust fault, with direction and angle of dip**
- **Minor fault**
<table>
<thead>
<tr>
<th>Taxonomic Group</th>
<th>Common Name</th>
<th>Habitat</th>
<th>Physical Properties</th>
<th>Distribution</th>
<th>Remarks</th>
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<td>Grasses (Poaceae)</td>
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<tr>
<td>Cynodon dactylon</td>
<td>Bermuda Grass</td>
<td>Cereals, lawn, and meadow pastures</td>
<td>Thin, soft</td>
<td>North and South America, Europe, Africa</td>
<td>Naturally invasive; some naturalized in warmer parts of the world.</td>
</tr>
<tr>
<td>Cenchrus ciliaris</td>
<td>Needlegrass</td>
<td>Cereals, grasslands, and meadows</td>
<td>Tall, coarse</td>
<td>North and South America, Europe, Africa</td>
<td>Naturally invasive; some naturalized in warmer parts of the world.</td>
</tr>
<tr>
<td>Setaria viridis</td>
<td>Green foxtail</td>
<td>Field crops, lawns, and gardens</td>
<td>Tall, coarse</td>
<td>North and South America, Europe, Africa</td>
<td>Naturally invasive; some naturalized in warmer parts of the world.</td>
</tr>
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<td>Malvernianae</td>
<td>Lowland Grasses</td>
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<td>Holcus lanatus</td>
<td>Timothy</td>
<td>Cereals, grasslands, and meadows</td>
<td>Tall, coarse</td>
<td>Europe, North Africa, North America</td>
<td>Naturally invasive; some naturalized in warmer parts of the world.</td>
</tr>
<tr>
<td>Dactylis glomerata</td>
<td>Orchard grass</td>
<td>Cereals, grasslands, and meadows</td>
<td>Tall, coarse</td>
<td>Europe, North Africa, North America</td>
<td>Naturally invasive; some naturalized in warmer parts of the world.</td>
</tr>
<tr>
<td>Poa annua</td>
<td>Annual meadow grass</td>
<td>Cereals, grasslands, and meadows</td>
<td>Thin, soft</td>
<td>Europe, North Africa, North America</td>
<td>Naturally invasive; some naturalized in warmer parts of the world.</td>
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<tr>
<td>Poa pratensis</td>
<td>Kentucky bluegrass</td>
<td>Cereals, grasslands, and meadows</td>
<td>Tall, coarse</td>
<td>Europe, North Africa, North America</td>
<td>Naturally invasive; some naturalized in warmer parts of the world.</td>
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<tr>
<td>Poa pratensis</td>
<td>Bromegrass</td>
<td>Cereals, grasslands, and meadows</td>
<td>Tall, coarse</td>
<td>Europe, North Africa, North America</td>
<td>Naturally invasive; some naturalized in warmer parts of the world.</td>
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<td>Bromus inermis</td>
<td>Cheatgrass</td>
<td>Cereals, grasslands, and meadows</td>
<td>Tall, coarse</td>
<td>Europe, North Africa, North America</td>
<td>Naturally invasive; some naturalized in warmer parts of the world.</td>
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<td>Bromus erectus</td>
<td>Sporobolus</td>
<td>Cereals, grasslands, and meadows</td>
<td>Tall, coarse</td>
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<td>Naturally invasive; some naturalized in warmer parts of the world.</td>
</tr>
<tr>
<td>Hordeum vulgare</td>
<td>Barley</td>
<td>Cereals, grasslands, and meadows</td>
<td>Tall, coarse</td>
<td>Europe, North Africa, North America</td>
<td>Naturally invasive; some naturalized in warmer parts of the world.</td>
</tr>
<tr>
<td>Hordeum vulgare</td>
<td>Oat</td>
<td>Cereals, grasslands, and meadows</td>
<td>Tall, coarse</td>
<td>Europe, North Africa, North America</td>
<td>Naturally invasive; some naturalized in warmer parts of the world.</td>
</tr>
<tr>
<td>Triticum aestivum</td>
<td>Wheat</td>
<td>Cereals, grasslands, and meadows</td>
<td>Tall, coarse</td>
<td>Europe, North Africa, North America</td>
<td>Naturally invasive; some naturalized in warmer parts of the world.</td>
</tr>
<tr>
<td>Triticum aestivum</td>
<td>Winter wheat</td>
<td>Cereals, grasslands, and meadows</td>
<td>Tall, coarse</td>
<td>Europe, North Africa, North America</td>
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</tr>
<tr>
<td>Triticum aestivum</td>
<td>Spring wheat</td>
<td>Cereals, grasslands, and meadows</td>
<td>Tall, coarse</td>
<td>Europe, North Africa, North America</td>
<td>Naturally invasive; some naturalized in warmer parts of the world.</td>
</tr>
</tbody>
</table>

*Note: All information is based on visual estimates for the index to be revised from maps. Noissor measurements available.*
<table>
<thead>
<tr>
<th>Era</th>
<th>Age</th>
<th>Event</th>
<th>Remarks</th>
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</thead>
<tbody>
<tr>
<td>Cenozoic</td>
<td>Tertiary to Recent</td>
<td>Slight epigenetic movements with alternate transgression and regression of sea on Coastal Plain—alternating sedimentation and erosion</td>
<td>Topographically high areas eroded continuously. Deposition of sand, ferricrete, alluvium, and coastal deposits alternates with erosion of earlier lateralite plain</td>
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<tr>
<td>Tertiary (?)</td>
<td></td>
<td>Epigenetic uplift and erosion of earlier surface. Laterite profile developed on new erosion surface</td>
<td>Topographic highs remain within Gulf Fall due to resistance to erosion</td>
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<tr>
<td>Mesozoic</td>
<td>Lower Cretaceous to Tertiary</td>
<td>Epigenetic uplift and regression of sea. Slight erosion</td>
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<td></td>
<td>Lower Cretaceous</td>
<td>Marine transgression. Deposition of fresh-water and marine sediments on stable shelf—Mullumun Beds</td>
<td>Fresh water deposits older than marine</td>
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<tr>
<td>Palaeozoic</td>
<td>Upper Proterozoic to Lower Cretaceous</td>
<td>Erosion of Precambrian terrain to form low plain areas with topographic highs of resistant rocks</td>
<td>Regios very stable. Base of Lower Cretaceous sediments correspond to old erosional plain. Main ranges, such as Paruns Range, formed at this stage</td>
</tr>
<tr>
<td>Precambrian</td>
<td>Upper Proterozoic</td>
<td>Faulting and folding of Upper Proterozoic rocks</td>
<td>Belt of maximum subsidence uplifted to form horst. Vertical movements occur on earlier wrench faults</td>
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<tr>
<td></td>
<td></td>
<td>Dolerite intrusion</td>
<td>Extensive sills within Roper Group</td>
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<tr>
<td></td>
<td>Lower (?) Proterozoic</td>
<td>Faulting and folding. Uplift of area east of Paruns Range Fault Zone</td>
<td>Area east of Paruns Range Fault Zone becomes stable block</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Deposition of Roper Group to west of Paruns Range Fault Zone</td>
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<td>Lower Proterozoic</td>
<td>Depression of Paruns Range Group (up to 12,000 feet of carbonates and silt) within subsiding trough; deposition of Groote Eylandt Beds on semi-stable shelf to east</td>
<td>Maximum subsidence between Paruns Range and Koelalang Fault Zones</td>
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<tr>
<td></td>
<td></td>
<td>Faulting and folding of Lower Proterozoic rocks. Erosion and deposition of Sheridian Formation in valleys</td>
<td></td>
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<td>Intrusion of dolerite and diorite</td>
<td>Lava with within Roper Volcanics; dyke-rocks in Mirrannina Complex</td>
</tr>
<tr>
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<td></td>
<td>Acid volcanism, intrusion of acid igneous rocks, deposition of silt and sands</td>
<td>Pagup Volcanics; quartz-feldspar-phryjic within Mirrannina Complex in central belt; Rickarton Volcanics on eastern stable shelf; Caledwe Granite within basement rocks to east</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Intrusion of dolerite and diorite</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Faulting and folding of Rirango Beds</td>
<td>Faults can be traced into Mirrannina Complex</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Development of central subsiding trough. Deposition of Rirango Beds</td>
<td>No indication of equivalent sedimentation in east. Trough probably bounded by Paruns Range and Koelalang Fault Zones</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Orogeny. Intense folding of Grindall Metamorphics and crystalline 'basement'</td>
<td>Eastern part of Sheet area becomes a stable block</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Deposition of geosynclinal sediments—Grindall Metamorphics</td>
<td></td>
</tr>
<tr>
<td>Archaean</td>
<td></td>
<td>Intense folding, metamorphism, and granulatization of sediments</td>
<td>Msapola Granite; gneisses of Mirrannina Complex. Oldest rocks exposed in the Sheet area.</td>
</tr>
</tbody>
</table>
Basement Rocks

Both the Myaoola Granite and the gneissic granite of the Mirarrmina Complex are foliated; their structural history is complex. Outcrops of the Myaoola Granite are insufficient to determine a structural pattern. The Mirarrmina Complex gneisses show no regular fold pattern, but schists, farther north in the Arnhem Bay/Gove Sheet area (Dunnet, 1965), have a steep dipping foliation striking about 190°. Later faulting, related to that in the Ritarango Beds and Fagan Volcanics, can be recognized.

The Grindall Metamorphics are tightly folded, with dips generally greater than 60°, about an axis plunging about 60° to 060°. A slatey cleavage is subparallel to bedding. Prominent joints are perpendicular to, and parallel to, the axis of folding; faulting is common parallel to these joints. Only one main folding phase can be recognized.

Proterozoic Sedimentary Rocks

Central Horst Block: The structure of the area between the Parsons Range and Koolatong Fault Zones is dominated by north-trending faults and broad folding about north-trending axes. The intensity of faulting decreases with decreasing age of the rocks; this is considered to be the result of a long history of recurrent fault movements rather than a product of depth of burial.

The most intense faulting occurs within the Ritarango Beds where bedding and fold structures are obscured by numerous shear zones. Two sets of faults are present. The dominant set strikes between 190° and 200° and dips steeply. The minor faults in this group show right-lateral strike-slip displacement, but this is obscured on the larger faults, such as the Bath Range Fault, by apparent vertical displacements up to 25,000 feet; this movement probably occurred late in their development.

The second set of faults is a conjugate set of minor faults striking about 300° and 330° and intersecting along a line plunging steeply to the north. Strike-slip movements dominate the movement pattern, which shows orthorhombic symmetry, resulting from north-easterly compression. These faults are best developed in the cores of folds.

The structure of the Fagan Volcanics is similar, but less intense.

Within the rocks of the McArthur Basin intensity of faulting decreases markedly and only the major faults persist. These faults belong mainly to the set striking between 180° and 200° and dips are steep. Apparent displacements are usually vertical, but right-lateral strike-slip movements do occur. Within the Koolatong Fault Zone, near the Koolatong River, a small thrust fault, dipping about 50°W., has been observed. Elsewhere exposures are generally too poor to determine the attitude of faults accurately.
Development of the McArthur Basin has been controlled by major faults. The Parsons Range and Koolatong Fault Zones appear to have bounded the central belt of major subsidence, and other faults, such as the Bath Range Fault, may have been operative also. After sedimentation, the vertical movements on these ancient faults have been reversed.

Folding in the area is confined to the development of broad folds about axes striking between 180° and 210°; dips generally range between 5° and 20°, with steeper dips, up to vertical, in the vicinity of faults. The main structure is a large syncline outlined by the Parsons Range with the eastern limb faulted out. East of this the area shows numerous broad folds secondary to faulting. The relatively incompetent McArthur Group rocks are more folded than the Parsons Range Group.

**Western Stable Block**: Outcrops in the area west of the Parsons Range Fault Zone are almost exclusively Roper Group sediments. The structure consists simply of irregular warping, with dips in the order of 5° to 10°, and minor cross-faulting.

**Eastern Stable Block**: The area occupied by the basement ridge to the east of the Koolatong Fault Zone has been very stable since the folding of the Grindall Metamorphics. The sediments are subhorizontal, with minor faulting; the present structure probably reflects the attitude of the original sedimentary basin with little subsequent deformation.

**GEOLOGICAL HISTORY**

The geological history of the Sheet area is summarized in Table 2.

**ECONOMIC GEOLOGY**

**Manganese**

The occurrence of manganese on the shores of Blue Mud Bay was first recorded by Fitton (1825); Brown (1908) noted manganese on a beach at Groote Eylandt, overlying lateritic rocks.

In November, 1960, during a reconnaissance visit to Groote Eylandt, P. R. Dunn of the Bureau of Mineral Resources collected specimens of manganese ore from the vicinity of Groote Eylandt Mission; assays indicated grades of better than 50 percent Mn. Investigations by the Bureau during 1961 disclosed several major deposits in the vicinity of the Mission (Crohn, 1962).

At present (October, 1964) the Broken Hill Proprietary Co. Ltd is engaged in testing the area and extensive deposits of ore are indicated; plans for the construction of shipping facilities on Milner Bay capable of handling 70,000 tons of ore per annum have been announced by the company.
The deposits occur as flat-lying beds of pisolitic, nodular, and massive material, mainly beneath sand cover on the western side of the island. Similar deposits occur on the mainland, but only insignificant occurrences have been noted to date.

Water

Surface water is abundant in the Sheet area—many of the main streams are fed by springs and contain water throughout the year. Others retain long stretches of water behind rock bars and in scour pools. The Goyder, Koolatong, Walker, and Rose Rivers contain perhaps 90 percent of the surface storage. No bores have yet been sunk in search of water, but it is likely that plentiful supplies of underground water could be obtained in selected areas.

Future Prospects

Extensive deposits of bauxite occur on Gove Peninsula to the north of the Sheet area (Dunnet, 1965) associated with a laterite profile formed on Lower Cretaceous rocks. The extensive laterite deposits of the Coastal Plain in the Sheet area must therefore be considered as likely areas for exploration for bauxite. No bauxitic laterite has been noted to date and the extensive sand cover would hamper exploration.

Syngenetic lead, zinc, and copper mineralization occurs in rocks of the McArthur Group in the southern part of the Carpentaria Province and, although no sulphides have yet been found in the north, closer exploration is warranted, particularly in the black shales of the Vaughton Siltstone.
REFERENCES


