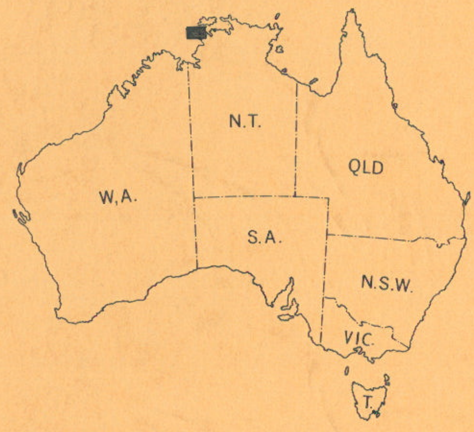
1:250 000 GEOLOGICAL SERIES — EXPLANATORY NOTES

FOG BAY
NORTHERN TERRITORY



SHEET SD/52-3 INTERNATIONAL INDEX

DEPARTMENT OF MINERALS AND ENERGY
BUREAU OF MINERAL RESOURCES, GEOLOGY AND GEOPHYSICS

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Explanatory Notes on the Fog Bay 1:250 000 Sheet Area

Compiled by Daniele Senior and R. J. Hughes

The Fog Bay 1:250 000 Sheet area is bounded by latitudes 12° and 13° South and longitudes 129° and 136°30′ East; most of the Sheet area is sea.

The land part of the Fog Bay Sheet area was mapped in 1972 by the Bureau of Mineral Resources (BMR) using a helicopter; ground access is limited to a single vehicle track from Finniss River station, on the adjoining Darwin Sheet area, to the coast.

The area is uninhabited apart from a few nomadic aborigines and a transiently-occupied weather station at Dum-In-Mirrie Island, where there is an airstrip.

Vertical aerial photographs taken at a nominal scale of 1:85 000 cover the area. A planimetric map at 1:250 000 scale, available from the Division of National Mapping, Canberra, was used as a base for the geological map. Admiralty charts at various scales are available for the offshore area.

Previous investigations

Ward (1957) collected heavy mineral samples from Fog Bay.

An unsubsidized petroleum exploration well, Flat Top 1, was drilled in 1970 by Australian Aquitaine in the central west part of the Sheet area. Flat Top 1 was drilled to obtain data on the depth and regional slope of basement, and to evaluate the possibility of hydrocarbon entrapment resulting from the regional thinning of the sedimentary rocks over the Van Diemen Rise.

Geophysical surveys are listed in Table 1.

TABLE 1. GEOPHYSICAL SURVEYS IN FOG BAY SHEET AREA

Year	*Abbreviated title*	*Reference*
Seismic		
1964	Marine Seismic survey, Flat Top Bank area	Walton, 1964
1967	Hyland seismic survey	Amberg, 1967
1967	Marine seismograph survey, Timor Sea	Namco, 1967
1969	Timor Sea gravity, magnetic, and seismic survey, 1967	Jones, 1969
Gravity		
1969	Timor Sea gravity, magnetic, and seismic survey, 1967	Jones, 1969
Aeromagnetic		
1963	Anson Bay aeromagnetic survey	Adastra, 1965
1969	Timor Bay aeromagnetic and seismic survey, 1967	Jones, 1969

PHYSIOGRAPHY

The land area can be divided into six main physiographic units:

1. Strike ridges and hills rising from swamps.

2. Gently rolling country underlain by a thin mantle of sand resting on laterite. Most of the northern half of the mainland consists of this unit.

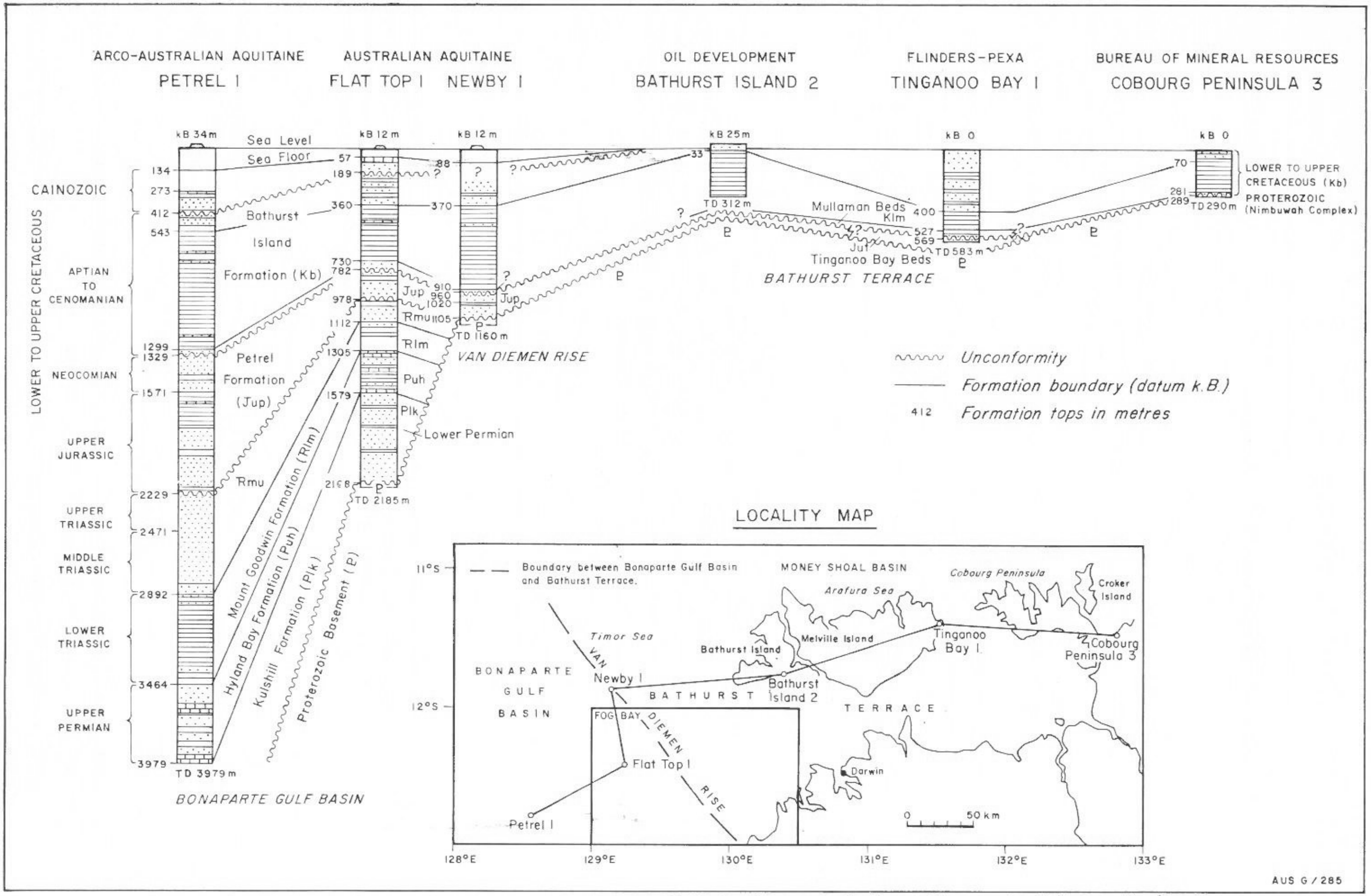

Fig. 1. Stratigraphic Correlation from the Bonaparte Gulf Basin across Bathurst Terrace to Cobourg Peninsula.

TABLE 2. STRATIGRAPHY OF THE FOG BAY SHEET AREA

		Formation and map symbol	*Lithology*	*Estimated thickness (m)*	*Environment*
CAINOZOIC	Quaternary	Qa	Alluvium; silt, fine sand gravel	Up to 25	Fluvial, floodplain deposits of Finniss River
	Quaternary	Qs	Quartzose sandstone, poorly consolidated sand and silt	Up to 4	Colluvial and eluvial
	Quaternary	Qm	Saliferous organic mud and silt	Up to 20	Intertidal, paralic, deltaic and lagoonal
		Czm	Coquina, calcarenite, conglomerate	Up to 5	Littoral shallow marine
		Czr	Coralline limestone (section only)	Unknown	
		Czl	Chemically altered rocks of a trizonal lateritic profile	20	Tropical humid-terrestrial
			UNCONFORMITY		
MESOZOIC	Lower to Upper Cretaceous	Bathurst Island Formation (Kb)	Sublabile sandstone, siltstone and mudstone; calcareous in part (section only)	Up to 800	Shallow marine and deltaic
	Lower Cretaceous	Mullaman Beds (Klm)	Fine sandstone, siltstone and mudstone	Up to 100	Shallow marine
			UNCONFORMITY		
	Upper Jurassic	Petrel Formation (Jup)	Friable, fine to very fine sandstone, coarser in lower part with minor interbeds of micaceous and lignitic shale (section only)	Up to 200	Paralic to shallow marine
			REGIONAL UNCONFORMITY		
	Middle to Upper Triassic	Rmu	Fine to coarse quartzose sandstone and red brown micaceous shale and sandstone (section only)	Up to 50	Fluvial-paralic
	Lower Triassic	Mount Goodwin Formation (Rlm)	Ferruginous micaceous shale and fine micaceous sandstone (section only)	Up to 250	Marine

TABLE 2. STRATIGRAPHY OF THE FOG BAY SHEET AREA.—*(cont.)*

PALAEOZOIC	Upper Permian	Hyland Bay Formation (Puh)	Grey to black, fissile, pyritic and lignitic shale interbedded with fine to coarse sandstone and biomicrite (section only)	Up to 300	Shallow marine
	Lower Permian	Kulshill Formation (Plk)	Fine to coarse, friable sandstone and diamictites, interbedded with very fine micaceous sandstone, grey shale and siltstone	Up to 800	Fluvio-deltaic
PRECAMBRIAN			REGIONAL UNCONFORMITY		
	Adelaidean	Fitzmaurice Group Moyle River Formation (Ꝑfm)	Orthoquartzite, sheared quartzite, schist, minor conglomerate; abundant quartz veins in places	Unknown	Marine
			REGIONAL UNCONFORMITY		
	Proterozoic	Ꝑ	Quartzite, metamorphics and igneous intrusives (section only)	Unknown	
	Archaean to Lower Proterozoic	Ꝑg Litchfield Complex	Biotite granite	Unknown	Igneous, plutonic

3. Swampland which occupies the southern half of the mainland and is mostly covered with tall swamp grass.

4. Saliferous coastal plains with tidal inlets and strandlines. This unit occurs around the coastal part of the Sheet area and is featured by tidal swamp mangroves interspersed with a few sand ridges.

5. Cliffs marking a former coastline are present up to 5 km inland. Regression of the sea has left a parallel series of beach strandlines in front of these cliffs in the northern part of Fog Bay. Most of the strandlines have been modified by aeolian activity.

6. Coral islands. A line of coral islands occurs west of Port Patterson. Former coral banks are shown on the bathymetry maps in the northwest part of the Sheet area.

STRATIGRAPHY

The stratigraphy of the Fog Bay Sheet area is summarized in Table 2. Apart from geophysical data the only subsurface information in the Sheet area is provided by Flat Top 1. A stratigraphic correlation of this well with the other drill-holes in the region is given in Figure 1.

Information from Newby 1 (north of the Sheet area) and Flat Top 1 is included in these Notes by courtesy of Australian Aquitaine Petroleum Pty Ltd. The nomenclature shown in Table 2 for the Permian to Jurassic units follows that of Laws & Brown (in press).

Biotite granites of the *Litchfield Complex* crop out in a small area near the eastern margin of the Sheet area. These are the oldest rocks exposed in the Sheet area and have been dated by the Rb-Sr whole rock isochron method at 1760 m.y. (Leggo *in* Walpole et al., 1968). Compston & Arriens (1968) reassessed the age as a little over 1800 m.y. However, Sweet et al. (1974) imply that part of the Litchfield Complex is Archaean and that it was only remobilized during the early Carpentarian. Offshore, the nature of the basement is only poorly known. Flat Top 1 was completed in hard grey to pink quartzite similar to the Moyle River Formation.

The *Moyle River Formation* unconformably overlies the Litchfield Complex. It crops out in a tightly folded syncline extending from latitude 12°44′S southwards to Peaked Hill. There is also a small outcrop at Hatter Hill. The thickness of the Moyle River Formation is not known in the Fog Bay Sheet area but is estimated to be 11 000 m in the Port Keats Sheet area to the south (Morgan, 1972).

Permian and Triassic sediments intersected in Flat Top 1 thin rapidly eastwards and pinch out against the eastern flank of the Bonaparte Gulf Basin (see Section A-B). In Flat Top 1 the Permo-Triassic is separated from the Upper Jurassic by a major unconformity. A seismic reflector, which correlates with the uppermost sandstones of the Triassic, allows the unconformity to be traced to the eastern edge of the Bonaparte Gulf Basin, where it disappears against the Van Diemen Rise (Section A-B). However, thin Upper Jurassic rocks probably extend eastwards across part of the Bathurst Terrace as they do to the north in the Bathurst Island area (Hughes, in press).

Another hiatus separates the Upper Jurassic from the overlying *Bathurst Island Formation.* On the basis of lithological descriptions and electric logs of the Bathurst Island Formation in Flat Top 1 the Moonkinu and Wangarlu Mudstone Members of the Bathurst Island Formation, as defined by Hughes & Senior

(1974) on the Bathurst Island and Cobourg Peninsula Sheet areas, can be recognized. However, their distribution across the Fog Bay Sheet area is not known. Although the Bathurst Island Formation extends across the Bathurst Terrace it does not crop out in the Fog Bay Sheet area and so, with the exception of the diamictites of probable Permian age south of Fog Bay, the interval between the Permian and the Cretaceous is not represented onshore.

A major unconformity separates the Bathurst Island Formation from the overlying Quaternary sediments in Flat Top 1 and no rocks of Tertiary age were encountered.

Onshore, a laterite profile is exposed in cliffs to the north of Fog Bay and to the south of Turtle Island. Inland, the laterite is covered with sandy soil and the only evidence for its presence are scattered ferruginous and pisolitic boulders. Quaternary sediments are widespread but thin and generally modified by soil formation.

STRUCTURE

The Precambrian basement surface has a slight westward slope to approximately 129°30′ (Bathurst Terrace), then slopes more steeply westwards (Van Diemen Rise) towards the centre of the Bonaparte Gulf Basin (Section A-B).

A pronounced gravity gradient (Wangites Gravity High) extends northwards from the Moyle River Fault (Cape Scott Sheet Area), across Fog Bay Sheet area, to a point offshore, west of Bathurst Island. As seismic surveys in the Fog Bay and Bathurst Island Sheet areas have shown no corresponding structural feature, the gravity gradient is thought to correspond to a major change in basement density.

The Adelaidean orthoquartzite, schist and conglomerate of the Moyle River Formation are tightly folded in a north-trending syncline. The sediments are strongly sheared and an axial plane cleavage oriented at 80°-90°/330° is present.

No major linear structures have been detected in the cover sediments. Seismic surveys over the Fog Bay Sheet area indicate that the sedimentary section thickens gradually westwards to the Van Diemen Rise, where an appreciable increase in thickness occurs into the Bonaparte Gulf Basin.

GEOLOGICAL HISTORY

Archaean, Lower Proterozoic and Carpentarian rocks were deeply eroded before thick sequences of sand, minor conglomerate, and silt were deposited in a marine trough to form the Moyle River Formation in the early or middle Adelaidean. Uplift accompanied by folding and faulting followed, and there is no record of any further deposition in the Fog Bay Sheet area until early Permian time.

Throughout the early Permian, sands and unsorted clasts were laid down in a fluvio-deltaic environment to the west of the Van Diemen Rise. The same area was covered by a marine transgression from late Permian to early Triassic time. The marine shales of the Mount Goodwin Formation grade upwards into thick coarse fluvial sands and redbeds of Middle to Upper Triassic age. The Sheet area remained dry land until late Jurassic time, when the sea lapped onto the Van Diemen Rise and paralic conditions developed over much of the Bathurst Terrace. The transgression continued throughout the late Jurassic with fine to coarse sand and silt being deposited on the bevelled basement surface of the Bathurst Terrace.

The absence of Neocomian sediments in Flat Top 1 suggests that by the beginning of the Cretaceous the sea had retreated from the Fog Bay Sheet area.

By Aptian times marine conditions again prevailed near Flat Top 1, and during the Cenomanian the sea encroached onto the Bathurst Terrace. At this time pyritic mud and silt (Wangarlu Mudstone Member, Bathurst Island Formation) accumulated in an open sea environment, but before the end of the Cenomanian the sea had begun to withdraw and sublabile sand, silt, and mud (Moonkinu Member, Bathurst Island Formation) were deposited in deltaic and littoral environments.

Most of the Sheet area remained dry land in the Tertiary, and chemical weathering in a humid tropical climate produced a cover of laterite (Czl). Submergence and changes of sea level during the late Tertiary to Quaternary resulted in the formation of coral reefs (Czr) and raised beach deposits peripheral to the present-day coastline (Czm). Quaternary weathering and erosion has produced a widespread cover of sandy soil and alluvium.

ECONOMIC GEOLOGY

Hydrocarbons

Petroleum could be present in the western part of the Fog Bay Sheet area. It may have migrated from source beds in the deeper part of the Bonaparte Gulf Basin and been trapped in stratigraphic pinch-outs on the Van Diemen Rise. Only two exploration wells, Australian Aquitaine Flat Top 1 in this Sheet area and Australian Aquitaine Newby 1 in the Bathurst Sheet area, have been drilled to test this possibility.

The main objectives of the drilling were to determine the nature and thickness of the Permo-Triassic sequence, test the continuity of the Upper Jurassic sandstone, and reach Proterozoic basement within reasonable depth limits.

Good reservoirs were encountered in the Jurassic, Triassic, and Permian sequences. They consist of fine to coarse sand and poorly consolidated sandstone. The porosities range from 15 to 30 percent and permeability is fair to good. However, sealing is inefficient in the upper part where salinities suggest invasion of salt water. No significant hydrocarbons were encountered, but abundant carbonaceous matter was observed in the Lower Permian.

Limestone

Cliffs of calcareous sandstone and coquina limestone up to 5 m high are present near Point Blaze and to the north of Fog Bay. They were formerly shell and coral beach sediments subsequently stranded owing to eustatic changes in sea level.

Heavy mineral sands

At Point Blaze, Ward (1957) examined a small, heavy mineral sand deposit which was a surface concentration of magnetite, hematite, zircon, and rutile. The highest values occurred at the top of the present-day beach near the base of a linear foredune. During the 1972 survey (Hughes & Senior, 1973) six auger holes were drilled at widely spaced localities along the coastline. Analyses showed a very low concentration of heavy minerals (0.27 to 2.26%). Opaque iron oxides form the dominant constituent of the heavy fraction, with minor amounts of zircon and rutile (Appendix 3 *in* Hughes & Senior, 1973).

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