BOODARRIE

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

URBAN GEOLOGY OF THE BOODARRIE SHEET

The aim of this Urban Geology survey is to provide information for those concerned with aspects of raw material and water supply, rural, urban, industrial or transport development. The intention is to point out geological factors which may affect planning on a broad, rather than a specific, basis. Detailed site investigations will still be required, but it is hoped that this information will provide a useful framework for such further work.

The sheet area is covered by parts of Boodarrie and Mundabullangana Stations, and stock grazing is the only land use. The only significant road is the old North West Coastal Highway which is unsealed. The land area is 440 km², which includes 1 km² of islands.

The geology of the Roebourne 1 : 250 000 sheet, which includes Boodarrie, was mapped previously by Ryan, Kriewaldt, Bock and Horwitz of the Geological Survey of Western Australia in 1962-3 (published in 1966). The Boodarrie sheet was remapped in 1977 by Archer of the Survey. For the mainland section of the sheet, extensive field traverses were carried out on a base-map scale of 1 : 50 000 using 1971 air-photographs for minor extrapolation. The offshore islands were mapped entirely by air-photograph interpretation. Additional text data were provided by relevant sections of the Geological Survey.

PHYSIOGRAPHY

The physiography of the Boodarrie sheet is broadly divided into the units shown on the inset map. The coastal dunes include sharp, angular, sparsely vegetated or mobile dunes rising to a maximum elevation of 15 m, low, rounded and well-vegetated dunes, and lithified dunes. The coastal flats include tidal mangrove swamps and samphire flats, as well as extensive flats of mud and silt which are submerged by exceptionally high tides. The flood plains are flat-lying or of low relief. The sand ridges in the southeast corner of the sheet reach elevations of 30 m and stand out clearly from the surrounding flood plain which is up to 12 m lower.

STRATIGRAPHY

The whole of the sheet is underlain by sediments of Cainozoic age. From borehole information, granite is known to occur at depth but is not exposed within the Boodarrie sheet.

CAINOZOIC

The oldest unit cropping out on the sheet is assumed to be the **high-level sand** which forms north-trending ridges in the southeast corner, immediately east of the Turner River. It is assumed to represent the remnants of an earlier (?pre-Pleistocene) coastal plain and is distinguished from the sediments of the present Coastal Plain more by topography than by lithology. The ridges form the highest ground on the sheet (up to 30 m elevation) and generally are 5-10 m higher than the surrounding plain. The sand is red-brown or orange-brown, fine- to coarse-grained and poorly sorted but with a low silt content. Grains are predominantly subangular.

The flood plain is underlain by a variety of sediment types, the most common of which is a red-brown to yellowish-brown **silty sand** which is assumed to have been formed by reworking of the earlier (high-level) sand by flooding rivers. The silty sand is composed of unsorted to poorly sorted, fine to coarse, frosted, subangular to subrounded quartz grains (many of them iron stained), with minor amounts of feldspar and limonite, and Precambrian rock fragments. Silt content varies considerably, and minor amounts of clay are commonly present. In the south of the sheet, a few pebbles of Precambrian rocks occur on the surface of the silty sand. Although dated as Pleistocene, some Holocene reworking of surface material may have occurred locally. In many parts of the Coastal Plain, this reworking has led to the formation of claypans underlain by **clayey sand** which is distinguished from the silty sand by its much higher clay and silt content. Lithologies range from very silty, fine- to medium-grained sand to sandy clay. Colours range from pale red-brown to yellow-brown. Claypans are typically ringed by low (up to 1 m) ridges of fine- to medium-grained, slightly silty eolian sand, generally pale reddish-brown in colour. The presence of expanding-lattice clay minerals has caused the development of minor crab holes in areas between claypans in many places. These areas are also distinguished by the common development of wild grasses as opposed to predominant patchy spinifex cover on the silty sand.

The clayey sand sub-unit has been mapped only where it is sufficiently extensive to be shown at this scale; however, minor claypan development and eolian reworking are common on the Coastal Plain. Close to the coast, mixing with coastal sands is also common.

Alluvium occurs in all watercourses, which range in width from less than a metre to over 500 m. The sediments range from silt and silty sand, particularly in the shallow watercourses and near present-day sea level, through silt-free sand, to coarse sands, and gravel with pebbles of Precambrian rock. Coarse sands and gravels occur mainly in the larger watercourses and increase in abundance towards the southern boundary of the sheet. The major river is the Turner River, which is at its widest at the southern edge of the sheet, before it divides into two major, and a number of minor, branches as it nears the coast. The main lithologies of the Turner River alluvium are pinkish-buff to pinkish-grey, medium- to coarse-grained sand and gravel with minor to moderate amounts of rounded Precambrian rock fragments.

Significant recent alluvial reworking of Pleistocene units has occurred in the area between and around the two branches of the Turner River. These **flood-plain sediments** are distinguished from the Pleistocene silty sand by their lower sand (and higher silt) content. The sediments are marked by the presence of numerous, and generally very minor, drainage channels. The typical lithology is red-brown or yellow-brown, fine-grained, very silty sand, but sandy silt also occurs widely and the development of claypans and crab holes is common. Within the flood-plain sediments are **levees** composed of medium- to coarse-grained, slightly silty sand, generally reddish-buff in colour. The levees are extensive in the area around Sandy Hill where they reach a maximum elevation of 31 m, up to 13 m above the level of the surrounding floodplains.

At and near present-day high-tide levels, a **lime-cemented beach conglomerate** occurs at a number of places along the coast. It consists of angular to subrounded shells and corals, sponges, rounded quartz grains, and pebbles of Precambrian rocks, all set in a hard, orange-buff calcareous matrix which tends to deep orange below high-water mark. Low-angle cross-bedding is evident at some locations.

Dune limestone occurs at the coast near Oyster Inlet. The limestone is a pinkish-cream to buff-orange, fine- to medium-grained, lithified calcareous sand with minor oolitic limestone horizons. Cross-bedding is common. Over much of the outcrop, upward leaching and reprecipitation of calcium carbonate has led to the formation of a hard cap rock up to 50 cm thick in which root casts are common. As further evidence of the dunal origin, the limestone occurs as rounded ridges elongated parallel to the present coastline. The ridges are up to 10 m, but generally 3-5 m, above the surrounding coastal sediments. The dune limestone has been correlated with the Tamala Limestone which occurs extensively along the west and south coasts of Western Australia, and is assumed, therefore to be predominantly Pleistocene, although lithification is probably continuing.

Overlying and flanking the dune limestone are deposits of **residual sand**, formed by weathering (decalcification) of the limestone. The sand is pale creamish-buff to red-brown, fine- to medium-grained, slightly to moderately silty and non-calcareous. Although the formation of the sand is assumed to have commenced in the Pleistocene, the presence of shell fragments in many locations, including the Holocene bivalve *Anadara granosa*, suggests that the process is continuing.

The Holocene **silty sand** is distinguished from its Pleistocene counterpart by the presence of *Anadara granosa*, often in profusion as fragmented or whole shells (see sketch). Other molluscan shells and fragments occur in lesser numbers. The sand is red-brown to buff and consists of fine to coarse, subangular to subrounded quartz grains, with minor limonite and Precambrian rock fragments in places. The shell content, either as whole shells or large fragments, ranges up to 10 per cent but is commonly much lower. Silt content varies considerably, and in some areas sandy silt predominates. Small claypans also occur in some places. As it occurs on the lower side of a break in slope ranging up to 3 m high, this unit is probably derived from the Pleistocene silty sand by marine reworking during Holocene times. The observed mixing of the Holocene silty sands with buff coloured coastal sands, and the minor dune development in the area south of Oyster Inlet, are evidence of recent eolian reworking.

Two phases of accumulation of shelly sand along the coast have been identified. The **younger shelly sand** forms the present beaches and the coastal dune system. It is medium- to coarse-grained on the beaches, becoming fine- to medium-grained and subangular to subrounded in the dunes. The colour ranges from pale buff to pale pinkish brown. The sand is composed of shell fragments (up to 70%) and quartz. Whole *Anadara* and other molluscs are common, and massive corals occur on the beaches. The dunes are generally low and rounded, but, in places, notably in parts of the northwest corner of the sheet, they have sharper relief and reach elevations of 15 m above sea level. Soil development is generally poor and the vegetation sparse to patchy. In many areas, the seaward side of the coastal dune is unvegetated. These **mobile dunes** have been mapped as a sub-unit.

The **older shelly sand** is lithologically similar to the younger sand, but is distinguished by the partial development of soil, giving rise to an almost complete cover of grasses and shrubs. The dunes are rounded and low-lying, or almost flat-lying. The sand is pale or pinkish buff to buff-brown, fine- or fine- to medium-grained and subangular to subrounded. Shell content is generally less than in the younger sand; whole shells are scarce and shell fragments are generally smaller and pitted.

The **mud and silt** unit is currently being deposited within the intertidal zone, and recently in the supratidal zone. Lithologies range from brown, black and grey muds through silts to grey, brown and red mottled clayey and silty sands, all heavily salt-impregnated. In the supratidal zone, colonization by samphire and other halophytes is common, as is a patchy, thin cover of buff-coloured, wind-blown coastal sand. Mangrove thickets are colonizing the ocean margin.

ECONOMIC GEOLOGY

CLAY

No good-quality clay is known in the area. Parts of the clayey sand and flood-plain sediment units may have some application as brick-making materials.

CONSTRUCTION MATERIALS

Sand is extracted from the residual sand unit at Boodarrie Landing, and from levees at Sandy Hill and near Moorambine Well. Fill for local road-making and maintenance purposes is extracted from the silty sand unit at sites beside the old North West Coastal Highway.

LIMESTONE AND LIMESAND

The dune limestone and the older and younger shelly sands may have some potential as sources of lime although this has not been evaluated. The dune limestone may also have some application as a road stone or fill material.

WATER

Average annual rainfall in the area is about 300 mm, mainly falling as cyclonic rain between December and April. Rivers and creeks flow only briefly, after heavy rain.

The Turner River bore field, which supplies water to Port Hedland, is within the sheet, and there are in addition about 15 wells supplying water for pastoral purposes.

The water table throughout the area south of the tidal flats is within the Cainozoic sediments, and ranges from 6 — 9 m below the surface.

The alluvium along the Turner River is the best aquifer. It is 10 — 40 m thick and is composed of sand and gravel layers in silt and clay, with minor calcrete development below the water table. The sands and gravels close to the present river course are about 6 m thick, and borehole yields are as much as 300 m³/d. The salinity is 200 — 300 mg/L TDS close to the river, but rises to over 1 000 mg/L TDS at a distance of 3 km. The aquifer is recharged by periodic river flows when the water table can be raised by as much as 3 m.

Elsewhere, groundwater is suitable only for stock watering, as the salinity ranges from 2 000 — 3 000 mg/L TDS and yields from the fine-grained Cainozoic sediments are low.

The granitic rocks below the Cainozoic sediments are weathered to depths of 20 m, but water yields are low, except close to the Turner River where one bore yielded 600 m³/d from weathered granite and calcrete. Groundwater is generally not present in the unweathered granite bedrock, although rare fracture zones sometimes provide useful supplies.

ENGINEERING GEOLOGY

CAINOZOIC

This group includes a variety of superficial units with differing engineering properties. Much of this material occurs in the flatter parts of the area, where future development is expected, and consequently its varying properties are significant. It is stressed that detailed investigation at the actual site of any proposed development is necessary, and the information given here can only serve as a guide.

The most widespread unit is silty sand. This consists of a non-plastic sandy soil down to 0.5 m depth, followed by sandy clay in which the clay content increases downwards to about 2 m at which depth there is usually a clayey layer. The material between 0.5 m and 2.0 m depth generally has a plasticity index of less than 16, whereas the material from the sand-plain country in the Karratha — Wickham area, 150 — 200 km to the west, often has a plasticity index up to 30.

Consequently, the engineering problems experienced with foundations and borrow materials further west are greatly reduced here in the Port Hedland area. The greater depth to the water table in this area, compared with the Karratha — Wickham area, aids the situation.

It should be noted however that investigations for one structure, in an area to the east on silty sand, recorded the presence of collapsing soil; that is, soil that changes in structure when it becomes wet, and collapses due to a reduction in volume.

In addition to the silty sand, scattered areas of claypan exist which could introduce the problems usually associated with clayey soils.

Alluvium occurs in the beds of the rivers and creeks, and varies from fine sand to coarse gravel. Extensive sand and gravel deposits in the Turner River, south of the area, provide aggregate and base course material for road construction when washed and crushed.

The various beach and dune deposits are generally friable, and, when loose, may be unstable in excavations and on slopes. They are liable to soil erosion if cleared of vegetation. The younger beach and dune deposits near the coast are of limited use in construction because of their salt content. However, some of the older deposits, for example north of Boodarrie, have provided brick sand.

The lime-cemented beach conglomerate and dune limestone, where seen in outcrops, are usually well-cemented, hard rocks, often resistant to erosion. However, because they are rich in carbonate, they can contain solution cavities which could pose problems for foundations. They have a use for armour blocks on earth embankments and as base course for roads when quarried and crushed.

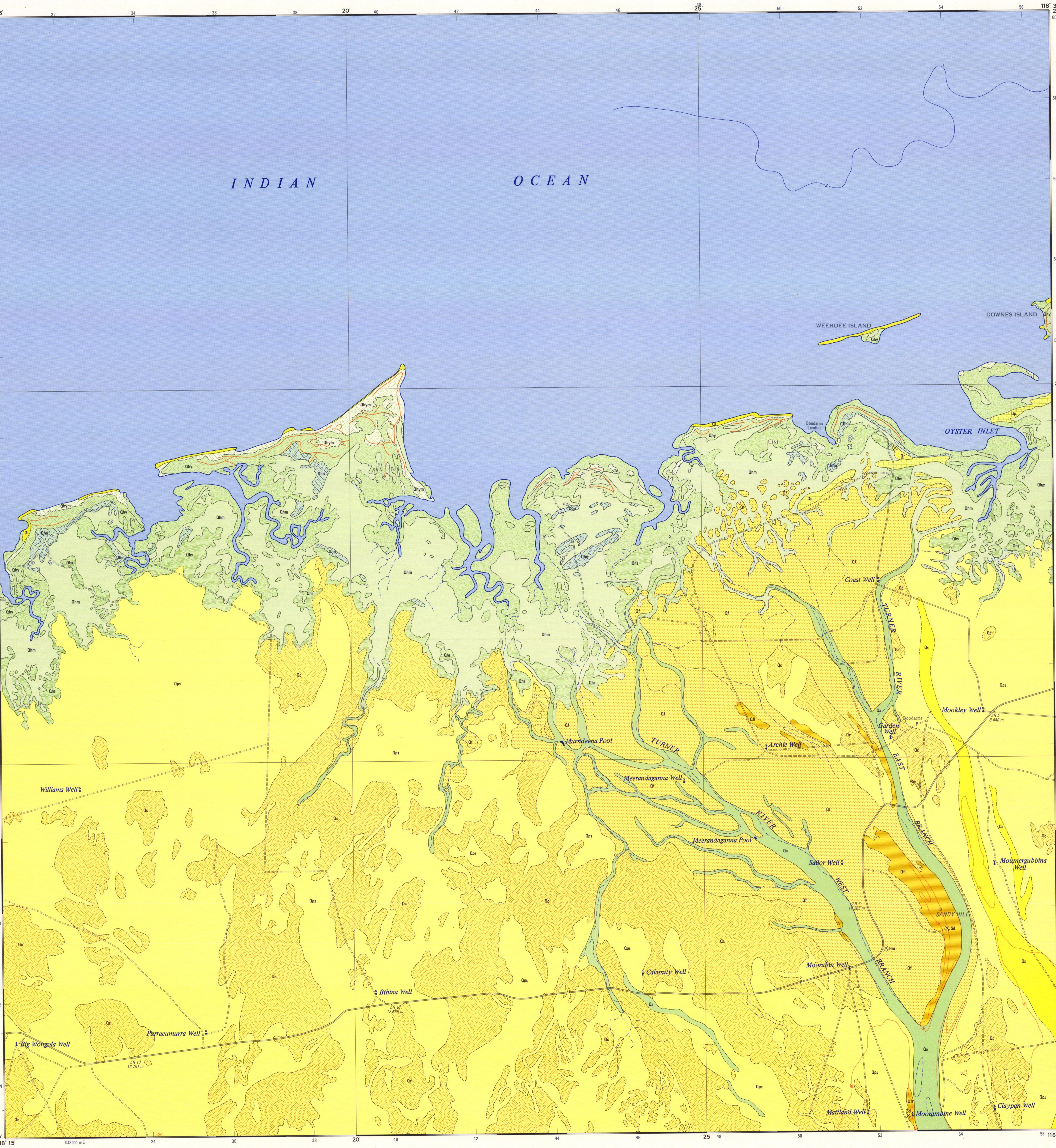
Sand from either dune or river deposits is added to laterite gravel, obtained from pits to the east of the area, to control the clay content and render the final product suitable for use as a road construction material.

The mud and silt of tidal areas is a weak material and poses foundation problems for roads, railways and levees. The problem can be solved by the provision of stable embankments made by the proper compaction of suitable material. Weak, unconsolidated mud and silt are displaced from beneath the fill when it is placed. The levees for salt ponds to the east of the area were constructed from the local sandy clay with limestone blocks as armour.

The depth of the superficial material in areas covered by tidal mud is not known, but work in an area to the east suggests that it is at least 5 m.

ENVIRONMENTAL GEOLOGY

Man has had limited impact on the area covered by the Boodarrie sheet. The only potentially significant environmental feature is soil erosion. On the flood-plain areas this is likely, at worst, to be a minor problem, local remedial action being sufficient to repair gullying. However, there are large areas of mobile, or sparsely vegetated, dunes along the coast which have, as yet, suffered little damage from human activities but which could be rendered unstable by increased activity, causing some risk of blow-outs.



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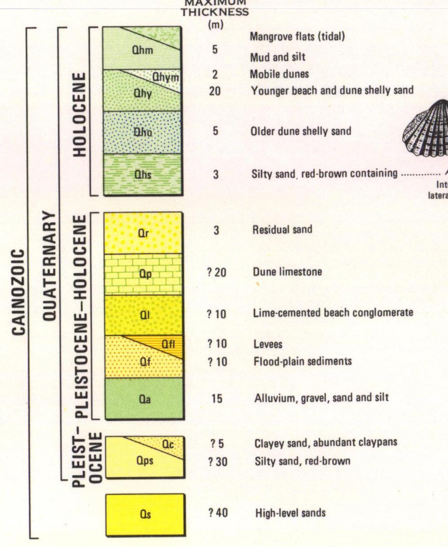
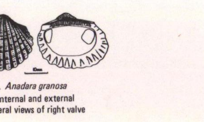


MAXIMUM THICKNESS (m)	
5	Mangrove flats (tidal); Mud and silt
2	Mobile dunes
20	Younger beach and dune shelly sand
5	Older dune shelly sand
3	Silty sand, red-brown containing .... *Anadara granosa*
3	Residual sand
? 20	Dune limestone
? 10	Lime-cemented beach conglomerate
? 10	Levees
? 10	Flood-plain sediments
15	Alluvium, gravel, sand and silt
? 5	Clayey sand, abundant claypans
? 30	Silty sand, red-brown
? 40	High-level sands

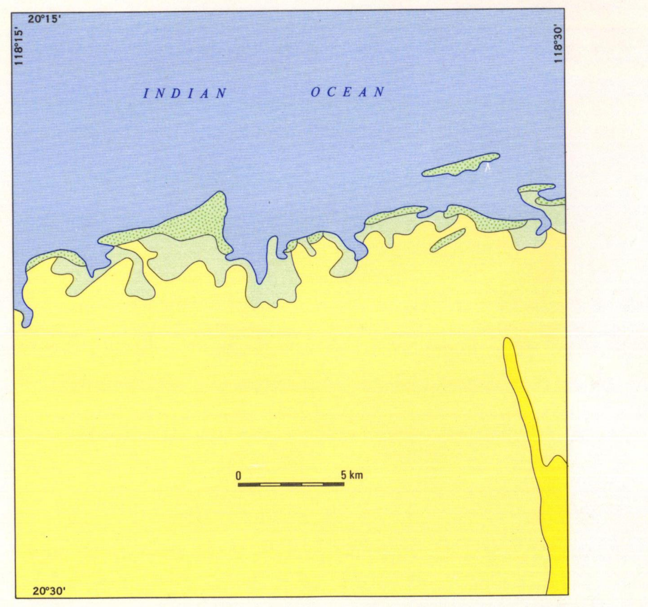


Anadara granosa
Internal and external lateral views of right valve

SYMBOLS

- Geological boundary
  - Accurate
  - Approximate or transitional
- Shallow excavation
- Mineral occurrence
  - Road material — Rm
  - Sand — Sd
- Major road
- Minor road
- Track
- Homestead — Boodarrie
- Horizontal control; minor
- Benchmark, height accurate — ZR 5 8.440 m
- Contour in metres — 20
- Dune crest (September 1971)
- Watercourse
- Windpump or bore
- Bathymetric contour in metres — 5

The representation on this map of a track does not necessarily imply right of way



PHYSIOGRAPHIC DIAGRAM

- Coastal dunes
- Coastal flats
- Sand ridges
- Floodplains

Compiled and published by the Geological Survey of Western Australia. Cartography by the Geological Mapping Section, Department of Mines. Topographic base from compilations by the Department of Lands and Surveys.

Copies of this map may be obtained from the Geological Survey of Western Australia, 66 Adelaide Tce., Perth.

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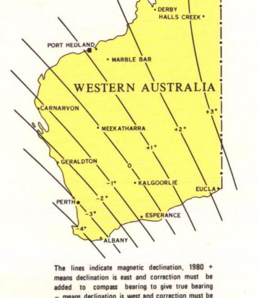
DECLINATION DIAGRAM



INDEX TO ADJOINING SHEETS

		MINILYA SANDBANK 2657 IV
CAPE THOUIN 2557 III	BOODARRIE 2557 II	PORT HEDLAND 2657 III
PEAWAH 2556 IV	MOORAMBINE 2556 I	COOLIARIN 2656 IV

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SCALE 1 : 50 000

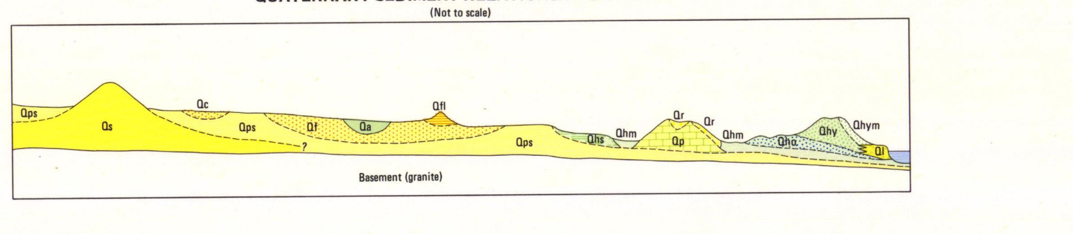
KILOMETRES

CONTOUR INTERVAL 20 M

Ticks inside the sheet edge represent 2000 metre intervals of the superimposed Australian Map Grid, Zone 50, AUSTRALIAN NATIONAL SPHEROID.

QUATERNARY SEDIMENT RELATIONSHIP DIAGRAM

(Not to scale)



BOODARRIE
URBAN GEOLOGY
2557 II

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