PORT HEDLAND

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

WESTERN AUSTRALIA 1 : 50 000 URBAN GEOLOGY SERIES

SHEET 2657 III

URBAN GEOLOGY OF THE PORT HEDLAND 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.

Within the sheet area are the towns of Port Hedland and South Hedland, the light industrial area of Wedgefield, and the settlement of Finucane Island. There are major iron-ore processing and loading facilities at Finucane Island (Goldsworthy Mining Limited) and Port Hedland (Mount Newman Mining Company Proprietary Limited). South Hedland has been developed as a major regional administrative centre as well as a residential area. The new North West Coastal Highway crosses the sheet from west to east, and the Mount Goldsworthy to Port Hedland and Mount Newman to Port Hedland railways cross the area from east to west and south to north respectively. The Leslie Salt Company has constructed a series of evaporating ponds to the east of Port Hedland to produce salt using solar energy. Elsewhere the major industry is stock grazing, the sheet area including parts of Boodarrie and Pippingarra Stations. The land area is 544 km^2 which includes 9 km^2 of islands.

The geology of the Port Hedland 1 : 250 000 sheet, which includes this Port Hedland 1 : 50 000 sheet, was mapped by Low and Noldart of the Geological Survey of Western Australia in 1960-1 (published in 1965) and remapped by Hickman (GSWA) and Gibson (BMR) in 1975-7 (published in 1982). The Port Hedland 1 : 50 000 sheet was remapped by Archer of the Survey in 1977. For the mainland section of the sheet and Finucane Island, extensive field traverses were carried out on a base-map scale of 1 : 50 000, using 1971 air photographs for minor extrapolation. Other 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 Port Hedland 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 24 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 generally flat-lying or of low relief. However, in the western and southern parts of the area, some north-trending ridges of sand, reaching a maximum elevation of 30 m, stand proud of the flood plain but are too limited in extent to be shown as a separate physiographic unit.

STRATIGRAPHY

PRECAMBRIAN

The only pre-Cainozoic rock cropping out in the sheet area is the (assumed) Precambrian **quartz vein** that crops out sporadically around White Hill and Bubbacurrie Well. The vein trends north-south and is composed of milky white to pale-grey, massive quartz with patchy red and yellow-brown iron-oxide staining. The vein, which ranges up to a width of 30 m, is extensively shattered.

In the southern part of the sheet, granitic basement is exposed in the bottom of sand pits, drains and other excavations at depths of as little as 0.5 m, but it does not crop out within the sheet. The granite is coarse-grained, even-grained and leucocratic, with minor quartz and pegmatite veins.

CAINOZOIC

Two low mounds of massive and pisolitic laterite occur near Higgins Well. This is assumed to be part of the Tertiary **Poondano Formation** which crops out extensively outside the sheet area. The laterite is structureless giving no indication of the original lithology. The **high-level sand** forms the north-trending ridges, previously referred to in the physiographic section. 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 remainder of the flood plain is underlain by a variety of sediment types. The most common 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 sands to sandy clays. Colour ranges 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 minor crab-hole development in areas between claypans in many places. These areas are also distinguished by the common development of wild grasses as opposed to the 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.

At a number of locations where sections through the silty sand have been cut by creeks or by human activity, a thin layer of greyish, nodular and earthy calcrete is exposed. Although it does not crop out within the sheet, it is assumed to occur extensively a few metres below surface.

Colluvium occurs on the slopes of outcrops of the quartz vein in the White Hill area. It is formed almost entirely of quartz scree but includes small quantities of red-brown sand and silt.

Alluvium occurs in all watercourses, which range in width from less than a metre to 300 m. The sediments range from silt and silty sand, particularly in the smaller watercourses and near present-day sea level, through silt-free sands, to coarse sands and gravels with pebbles of Precambrian rocks. The coarse sands and gravels occur mainly in the larger watercourses and increase in abundance towards the southern boundary of the sheet. The major watercourse is Beebingarra Creek, the bed of which is composed of pinkish-grey coarse sand and gravel with numerous, occasionally large, subangular to subrounded pebbles of Precambrian rock, and large, slightly eroded feldspar crystals.

Significant recent alluvial reworking of Quaternary units has occurred in the area of Beebingarra Creek. 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 near Pippingarra are **levees** composed of medium- to coarse-grained, slighty silty sand, generally reddish-buff in colour. The levees rise to an elevation of up to 3 m above the surrounding flood plain.

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 commonly occurs close to the coast. The limestone is a pinkish-cream to buff-orange, fine- to medium-grained, lithified calcareous sand with minor oolitic limestone layers. 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 0.5 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 mollusc 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. In particular, near the mouth of Beebingarra Creek, there are extensive areas of pink to yellowish grey-brown sandy silt and very silty sand. 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. Mixing with buff-coloured, coastal sands, and minor dune development, 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 on Finucane Island and Downes Island, they have sharper relief and reach elevations of 24 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. In a sand pit near Pretty Pool, the base of the younger shelly sand unit is marked by a 3 m thick layer composed entirely of whole shells and coarse shell fragments.

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 that 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 margins.

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 alluvial sediments at Baynes Well. South of Widges Well, the alluvium of Beebingarra Creek is screened (and the oversize crushed and rescreened) to produce a range of sand and aggregate products for use in the manufacture of calcium silicate bricks. At White Hill, quartz scree is excavated as an aggregate, mainly for use as road base.

At numerous locations in the sheet area, the silty sand unit has been excavated to provide fill, mainly for local road construction and maintenance purposes. It has also been used in the construction of levee banks of the solar salt operation.

Pisolitic laterite of the Poondano Formation may also be suitable for use in road construction.

LIMESTONE AND LIMESAND

The dune limestone and older and younger shelly sands may have some potential as sources of lime although this has not been fully evaluated. The dune limstone has been quarried in the eastern parts of the sheet area for use in road and levee construction associated with the salt operation. Sand for fill and road construction is extracted from the shelly sand units near Pretty Pool.

SILICA

The White Hill quartz vein may have potential to provide high-quality silica for industrial purposes.

WATER

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

Groundwater is generally suitable only for stock watering and there are about 16 station wells within the sheet area. The Geological Survey has records of a further 24 bores drilled in the area, but not equipped.

The water table is within 4 m of the surface near the tidal flats, but is as deep as 15 m in the southern part of the sheet area.

The Cainozoic sediments in the south are very thin, only 2 – 5m thick, and water supplies are obtained from the weathered granite bedrock. Yields from the weathered granite are generally much less than 100 m^3/d, and a number of bores drilled into fresh granite or dolerite bedrock have been dry.

Groundwater salinity ranges from 1 000 – 2 000 mg/L TDS in the south, to 4 000 – 6 000 mg/L TDS towards the tidal flats, including the South Hedland area. Locally, however there may be thin layers of fresher water at the water table, or close to creeks.

At Port Hedland there is a thin layer of brackish or saline water at sea level in the coastal dunes, overlying sea water in the sand and limestone which extend down to the granite bedrock at 64 m.

ENGINEERING GEOLOGY

PRECAMBRIAN

Granite, gneiss and pegmatite do not crop out in the area, but where exposed beneath superficial deposits in the coastal plain they are extremely weathered, sometimes to clay. No engineering problems are foreseen with these rocks when fresh, but the normal precautions should be taken with the stability of foundations, natural slopes and excavations when the rocks are weathered. The fresh rock from south of the area has been used as railway ballast, but is generally too friable and mica-rich to produce a high class product for this or concrete aggregate.

Massive quartz veins, associated with the granitic rocks, crop out in the vicinity of White Hill and Bubbacurrie Well and have supplied armour blocks for bridge abutments and causeways.

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.

Laterite is a rock with varying engineering properties depending on its state of erosion; but it is of minor engineering significance in this area, except perhaps for use as a road construction material.

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 sandplain country in the Karratha – Wickham area, 150 – 200 km to the west, often has a plasticity index of up to 30.

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

It should be noted however that investigations for one structure in the area, 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.

The sandy clay dug from drains and other excavations in the South Hedland area is used for foundation pads for houses and the sub-base for roads.

In addition to the silty sand, scattered areas of claypan exist and this 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.

Investigations for the foundations of the bridges where the new highway crosses South Creek and South West Creek showed depths of superficial material of 8–10 m and 9–12 m respectively. The material overlying the bedrock was described as sandy clay, clayey sand, sand, and shingle. This material is partly alluvium and partly the sandy clay of the coastal plain.

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 have provided brick sand.

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 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.

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 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 friction piles for bridges in the salt pond area have been driven to 5 m without reaching the older basement rocks. There is a thickness of at least 24 m of superficial material at the railway overpass, west of the salt ponds.

Some of the area adjacent to the wharf at Port Hedland has been reclaimed by filling a tidal estuary with dredge tailings consisting of a mixture of limestone blocks and sand, silt and clay. In some areas beneath buildings where the infilling soft mud is thin (up to 5 m), the mud was removed before placing the fill. In others where it is thicker (up to 10 m), piles were driven through it to limestone; at one point in the middle of the tidal estuary, superficial material is 24 m thick.

Piles, particularly in the harbour area, broke through a 3 m layer of limestone into underlying sand but were bedded satisfactorily.

Silting up of the harbour by tidal erosion is a problem but possible solutions are being studied locally.

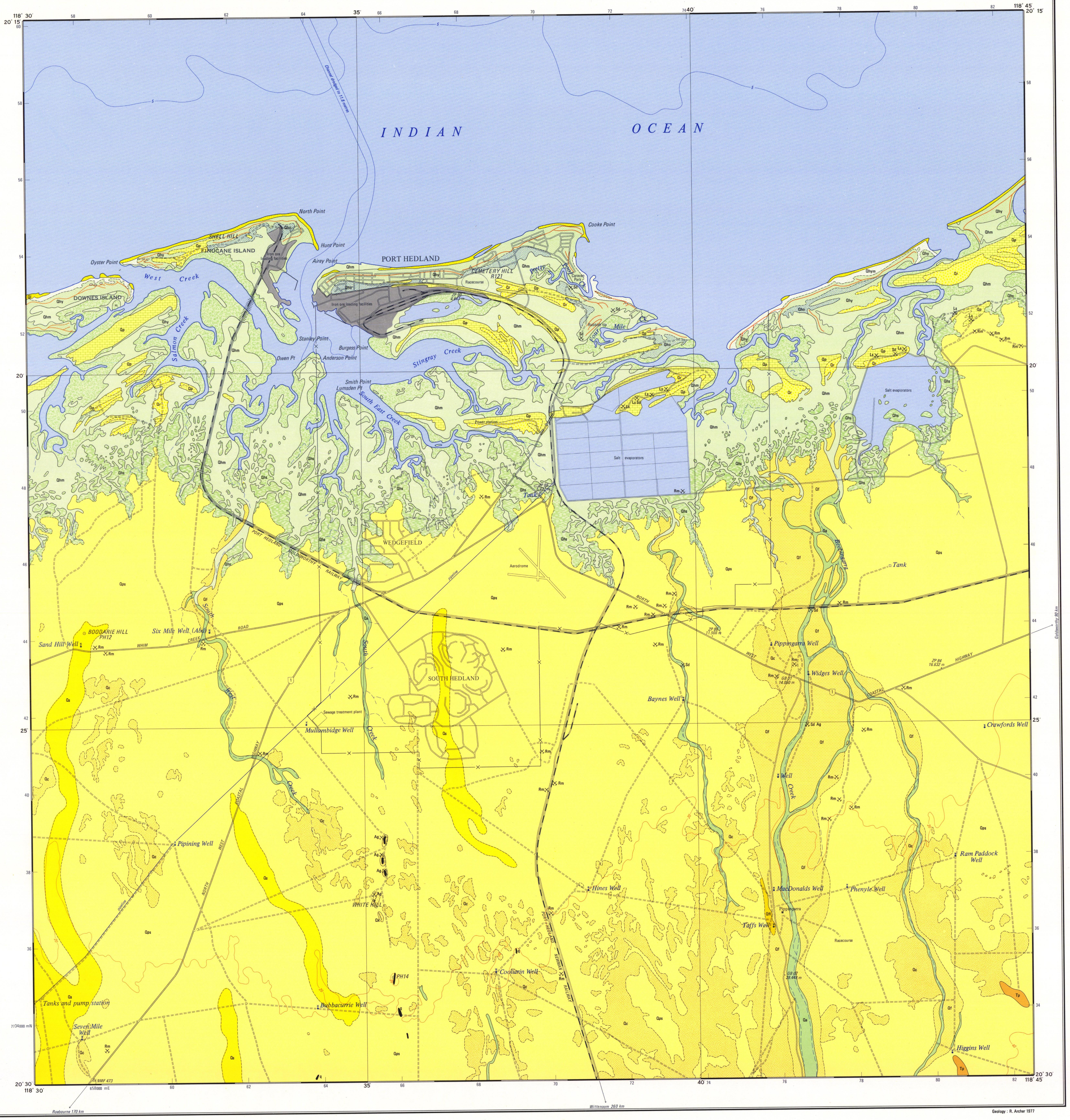
ENVIRONMENTAL GEOLOGY

The finer, silt and clay fractions of the Quaternary silty sands, silts and clayey sands inhibit free flushing of groundwater, and this may lead to retention of salts in the soil profile. Indiscriminate irrigation may remobilize these salts and cause salt scalding downslope from the irrigated area. This problem can be avoided by the use of a trickle irrigation system instead of sprinklers. Irrigation should be avoided on fine-grained soils unless adequate drainage has been provided.

Waste disposal may present problems in the future. Above-ground disposal of waste is often unacceptable, both aesthetically and because of the cost of preventing dispersal by wind. The most suitable sites would be deep disused sand, gravel, limestone, and "fill" pits. Waste disposal should not be considered on the flood-prone flats which fringe much of the coastal zone. No suitable sites exist for toxic waste disposal.

Soil erosion is a minor problem on the flood-plain areas, local remedial action usually being sufficient to repair gullying. However, there are large areas of mobile, or sparsely vegetated, dunes along the coast which have already suffered some damage from human activities. Further damage could render some areas unstable, leading to the risk of blow-outs developing.

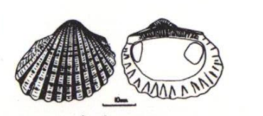
A number of sand, gravel and "fill" pits have been opened in the sheet area, many of them alongside roads and tracks. These cause visual pollution and lead to a waste of resources by piecemeal extraction. Future extraction should be from inconspicous sites, grouped for maximum resource utilization and for possible use as waste disposal areas when exhausted.



Geology : R. Archer 1977

REFERENCE

Era	Period	Epoch	Unit	MAXIMUM THICKNESS (m)	Description
CAINOZOIC	QUATERNARY	HOLOCENE	Qhm	5	Mangrove flats (tidal) Mud and silt
			Qhym	2	Mobile dunes
			Qhy	20	Younger beach and dune shelly sand
			Qho	5	Older dune shelly sand
			Qhs	3	Silty sand, red-brown, containing ....
		PLEISTOCENE–HOLOCENE	Qr	3	Residual sand
			Qp	? 20	Dune limestone
			Ql	? 10	Lime-cemented beach conglomerate
			Qfl	? 10	Levees
			Qf	? 15	Flood-plain sediments
			Qa	15	Alluvium, gravel, sand and silt
			Qk	10	Colluvium, quartz scree
		PLEISTOCENE	Qc	? 5	Clayey sand, abundant claypans
			Qps	? 30	Silty sand, red-brown
	TERTIARY ?		Qs	? 40	High-level sands
			Tp	20	**POONDANOO FORMATION** : laterite
PRECAMBRIAN			q	30	Quartz; milky-white to grey

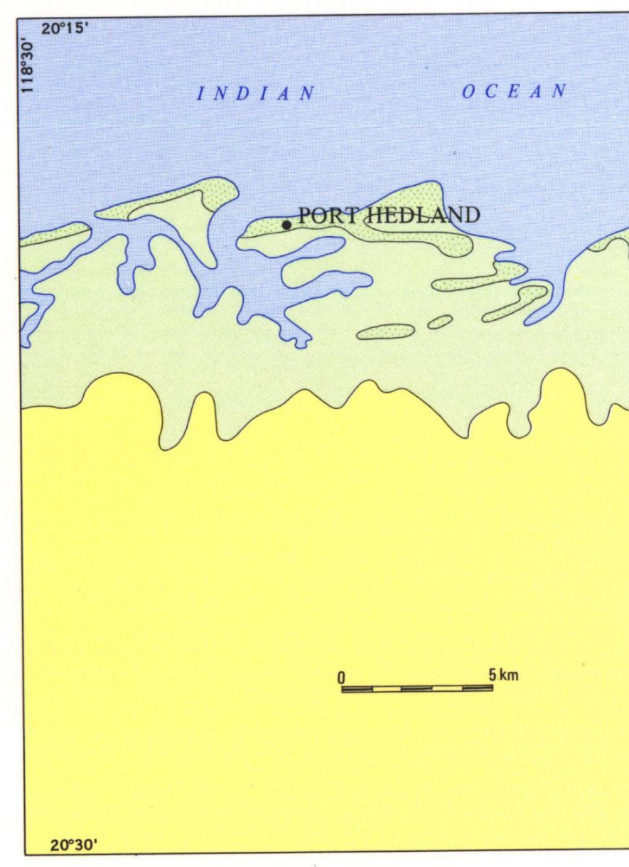


Anadara granosa
Internal and external lateral views of right valve

SYMBOLS

Geological boundary	
Accurate	——
Approximate or transitional	– – –
Shallow excavation	✕
Mineral occurrence	
Aggregate	Ag
Limestone	Ls
Road material	Rm
Sand	Sd
Highway	═1═
Major road	═
Minor road	═
Track	= = =
Railway	▬ ▬
Horizontal control; major, minor	△ ⊙
Benchmark, height accurate	ZP 86 11.566 m
Homestead	■ Pippingarra
Townsite boundary	—✕—
Contour in metres	— 20 —
Dune crest (September 1971)	——
Windpump or bore	●
Watercourse	– – –
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
- 🟨 Floodplain

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.

Printed by the Government Printing Office, Perth.

DECLINATION DIAGRAM

The lines indicate magnetic declination, 1980 + means declination is east and correction must be added to compass bearing to give true bearing – means declination is west and correction must be subtracted from compass bearing to give true bearing.

Annual change is −2' westerly

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HON. DAVID PARKER, M.L.A.
MINISTER FOR MINERALS AND ENERGY
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SCALE 1 : 50 000

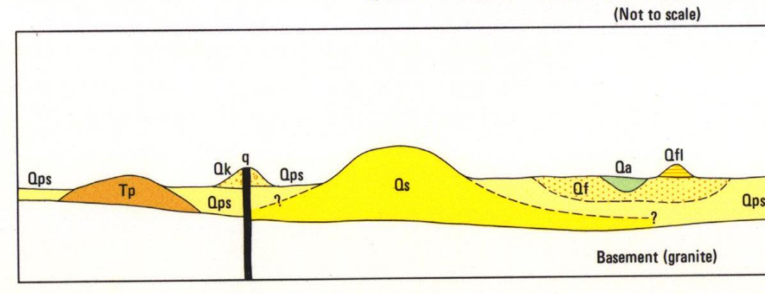
1 0 1 2 3 4 5 6
KILOMETRES

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)



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