DAMPIER - EAGLEHAWK ISLAND - ROSEMARY

GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

WESTERN AUSTRALIA 1:50 000 URBAN GEOLOGY SERIES

SHEET 2256 IV AND PART OF SHEETS 2156 I & 2257 III

URBAN GEOLOGY OF THE DAMPIER, EAGLEHAWK ISLAND AND ROSEMARY SHEET

The aim of this Urban Geology series 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 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.

Land-use in the Dampier sheet area is three-fold : an industrial, port, and related residential complex, processing and exporting iron ore from an inland mine site; a series of evaporation ponds and allied facilities using solar energy to produce salt for export; and several uninhabited islands used sporadically for recreation. A railway from Tom Price carries iron ore to the stockpiles and processing plant from which conveyor belts feed ship-loaders; salt is trucked to the ship-loader in bottom-dump road trains. The total land surface is 121 km² of mainland, including the salt pans, and 110 km² of islands.

The geology of the Dampier 1:250 000 sheet was mapped previously by Kriewaldt, Horwitz, Ryan and Bock of the Geological Survey of Western Australia and the results published in 1964. The Dampier 1:50 000 sheet was remapped in 1976, using a 1:50 000 topographic base map and 1971 and 1972 air photographs. The work of the earlier mappers was utilized, with modifications to the Quaternary units to conform with adjacent urban geology map subdivisions.

PHYSIOGRAPHY

Physiographically, the Dampier area is dominated by landform of the Dampier Archipelago, which consist of rugged, often precipitous terrain and extensive sea cliffs interspersed with sweeping sandy bays and mangrove fringes. Sand deposition is currently joining islets in the Malus Islands and is assumed to have had a similar effect recently on Enderby Island. In the south and southeast, tidal muds of coastal flats represent the latest phase of land building in the area, now somewhat modified by the lewes of the salt evaporators. Two small segments of coastal plain occur within the sheet area as low, undulating sandy plains.

STRATIGRAPHY

Within the mapped area, Proterozoic volcanic rocks unconformably overlie Archaean granite. Later in the Proterozoic, a differentiated granophyre, carrying large rafts of granite from the basement, intruded this unconformity. Quaternary sediments conceal much of the granite but only thinly mantle parts of the Proterozoic sequence.

ARCHAEAN

Granite and gneissic granite probably underlie much of Roo Cove but are susceptible to erosion and therefore only crop out in a few small areas. Where protected by overlying gabbro or enclosing granophyre, the granitoids give rise to positive boulder and rock landforms covered with thin soils. The granite is coarse grained and leucocratic, usually pink-grey. It is even grained to porphyritic and pink feldspar phenocrysts are set in equal amounts of grey quartz and pink and white feldspar with subordinate ferromagnesians, usually dark brown biotite. The gneissic granite is sheared, presumably by local faulting, and is widely penetrated by quartz stringers.

PROTEROZOIC

The **Mount Roe Basalt** comprises some 1 300 metres of basaltic lavas with some agglomerates. Arkose is locally present at the basal unconformity and as lenses in the lavas. On Goodwin and Malus islands, there are acidic igneous rocks having the microscopic characteristics of lava. At the top of the succession on Rosemary Island, there are bedded and cross-bedded, pale green, fine-grained, tuffaceous rocks, white quartz sandstone, and purple and green shales. In general, the rock units, being on the northern limb of a large anticline, dip from 10° to 30° in a northerly direction.

Intruded at the unconformity beneath the Mount Roe Basalt is the **Gidley Granophyre**, a massive and layered, differentiated and hybridized suite of rocks. The lower unit, a basic differentiate, is a coarse-grained gabbro consisting of plagioclase and mafic minerals which surround hornblende phenocrysts up to 100 mm long, often in radiating groups. Gradations to feldspathic diorite and quartz diorite (tonalite) are common, and the assimilation of granite basement has caused some hybridization. The gabbro is resistant to weathering and forms rugged hills with boulderscore slopes.

The upper acidic unit is a fine- to medium-grained, porphyritic, blue-grey granophyre containing equal amounts of grey quartz, pink feldspar and dark ferromagnesian laths, and subordinate white feldspar. The phenocrysts are quartz, feldspar and, less commonly epidote. Granite xenoliths up to 30 m long are locally common and assimilation of granite, arkose and basic rocks has produced several local hybrid granophyres. Arkoses, basal to the overlying lavas, have been metasomatized by the granophyre. Small dykes, apparently offshoots of the Gidley Granophyre, intrude the basalt on Enderby Island.

Apparently the youngest igneous rocks of the area, are the long narrow **dolerite** dykes which cut all other Precambrian rocks. A number of dykes trend northeasterly, but the majority do not follow any particular trend. The dolerite is dense, blue grey, fine- to medium-grained, and generally melanocratic. Accessory pyrite is disseminated or aggregated, and rare to common in different dykes. Weathering to a dusky brown, the dolerite dykes generally form negative, trench-like features in the country rock.

CAINOZOIC

The red-brown, **silty sand** which forms broad coastal plains inland occurs in a small area on Enderby Island and in the southeast of the mapped area. It is a poorly sorted quartz sand, fine to coarse grained, and includes small but significant proportions of limonite grains. Individual quartz grains are frosted and subangular to subrounded. Pebbles of bedrock are common, and small surface concentrations of chalcedonic quartz occur. Calcrete nodules (kankar) have formed in patches and lenses a metre or two below the surface, and small platey gypsum crystals are seen close to sea level.

Dune limestone is recorded on islands in the northwest of the sheet area. Correlated with Tamala Limestone further southwest, it is a pink, lime-cemented dune sand commonly forming low cliffs two to three metres high.

A veneer of **outwash gravel** has been mapped in one small area in the extreme southwest. The veneer consists of generally flattish pebb les aligned parallel with the land surface and interlocked to form a continuous, vegetation-free, stone pavement. The sub-unit is thought to derive from the silty sand unit by gentle water erosion (sheet flooding), wind deflation, or both. Only a few centimetres thick, the veneer grades laterally into its parent unit.

Alluvium is seen in all present-day watercourses, which are often too small to be shown at this scale. The character of the sediments changes from coarse gravel and boulders near hill slopes through fine sands in river headwaters to very fine silt in lower reaches.

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 at far right). Other mollusc shells and fragments may occur in smaller numbers. Red-brown to fawn, the quartz sand is very fine to coarse grained, subangular to subrounded, and contains up to ten per cent shell fragments and whole shells. This unit is almost certainly derived from the Pleistocene silty sand with some material added during Holocene times.

The two **shelly sand** units comprise fine to coarse sand and between 30 and 70 per cent shell fragments. Rounded pebbles and boulders frequently occur and the silt content increases near mangrove fringes. Fossil molluscs, especially *Anadara*, and massive corals are abundant on some storm-built beaches to the virtual or total exclusion of quartz. The units represent beach and foredune deposits, the older unit is distinguished by the partial development of soil, marked weathering of fossils, fewer corals, and a base level some two to three metres higher than the younger, stillforming unit. The younger beach sand also occurs widely as a thin veneer, 0.2 to 0.3 m thick, in hollows of coastal rocks.

Mud and silt is being deposited within the inter-tidal zone, especially between mangrove trees, and on Spring-tide flats where samphire and other halophytes are colonizing the landward margin. Little or no sedimentation is occurring on the mud flats in 'Pond Zero', the westernmost salt evaporation pond. The sediments of the unit range from brown gelatinous muds through grey-brown silts to brown silty sands, all heavily salt-impregnated. Some shells are seen, particularly in the sandier lenses.

STRUCTURE

The Archaean granite is part of a major domal structure in the Dampier area, of which a northern segment is seen within this sheet area. Proterozoic volcanic rocks dip north from this dome, forming the northern limb of a major anticline which closes to the west. A large right-hand drag structure in this limb passes through Enderby Island. As mentioned above, a thick differentiated gabbro/granophyre sequence which was intruded at the unconformity between granite and basalts caused minor and localised shearing.

ECONOMIC GEOLOGY

CONSTRUCTION MATERIALS

Granite and granophyre have been quarried at several points on the northern shore of Roo Cove. The rock was used (generally after crushing) for the construction or protection of causeways, railways, roads, and the levees containing the evaporation ponds. Further supplies of such material are virtually unlimited. Levee cores have been filled by clayey silt obtained from pits at White Peak and the southeastern corner of the mapped area. Pebbly sand and gravel quarried northeast of White Peak and near Dampier townsite was used as foundation material for houses and roads.

LIME SAND

Shelly sand forms extensive deposits on Enderby and Goodwyn Islands, and also occurs on Malus Island and the Intercourse group. The deposits are similar to, but larger than, those currently being quarried at Heanor Cove for use in the iron ore pelletizing plant at Dampier. Calcium carbonate content ranges up to about 90 per cent because of the abundance of shell fragments in the unit. Silica, dolomite and small amounts of clay occur in the sand, but large tonnages are available in which these impurities are negligible.

LIMESTONE

Relatively small deposits of dune limestone occur on islands in the northern part of the area but lime sand is potentially a more important source of calcium carbonate.

METALS

No metal ore production has been recorded from the area and no significant occurrences are known. Coarse, aeneaceous sediments at the base of the Mount Roe Basalt probably merit investigation because similiar Proterozoic deposits elsewhere in the Pilbara are locally auriferous or contain anomalous uranium concentrations.

SALT

Dampier Salt Limited commenced construction of solar evaporation ponds 7 km south of Dampier in 1969. By March 1970 seawater had been allowed to flood approximately 4 050 ha, an area theoretically capable of producing about 800 000 tonnes of salt per annum. In 1972, its first year of production, Dampier Salt exported 348 625 tonnes and in the following year exports had risen to 993 658 tonnes. In 1974 production exceeded 1 300 000 tonnes and operations have continued to expand steadily.

WATER

The average annual rainfall is 300 mm, most of which falls during the December to April period. The rainfall is mainly cyclonic, so that monthly and annual totals vary widely. Evaporation is high, the annual average is 2 400 mm. Watercourses are small and flow only briefly after heavy rain.

No boreholes or wells are recorded in the sheet area but fresh to brackish groundwater may be obtainable in places from fractured igneous Archaean and Proterozoic rocks, or from the larger deposits of dune sands on Malus and Enderby Islands. Colluvial and alluvial deposits are either too small or too low-lying to be prospective.

Any supplies are likely to be small (no more than 50 m^3/day) and unreliable. Water levels are expected to be generally 5-15 m below ground level, depending on surface elevation.

Groundwater prospects are generally poor and no large supplies of fresh or brackish water are available, either for domestic or industrial use. Water is supplied to Dampier by pipeline from a borefield at Millstream, about 100 km to the south.

ENGINEERING GEOLOGY

The engineering properties of rocks, including strength, suitability for foundations, stability on slopes and in excavations, and suitability as construction materials, depend on geological features such as mode of origin, composition, susceptibility to processes of change such as metamorphism, weathering and erosion, and their present mode of occurrence. The generalized properties are described with this in mind. It is stressed that individual site investigation will still be required for any engineering project within the area.

ARCHAEAN

Granite and gneissic granite are strong and stable when fresh, and no engineering problems are foreseen unless weathering has occurred in the rock substance or along structures such as foliation, joints and shears. Such weathering could lead to poor foundation characteristics in the former case and instability in cuttings in the latter.

PROTEROZOIC

The igneous rocks of Proterozoic age are generally competent and, unless extensively jointed or weathered, are expected to have satisfactory engineering properties. In places, they are more closely jointed than the Archaean rocks, and this feature, in conjunction with resistance to weathering, leads to the development of scree.

Quarries for concrete aggregate and railway ballast have been opened in granophyre east of White Peak, and in basalt adjacent to this area. The extensive scree deposits which form from these rocks could be a source of fill material for major construction.

The Proterozoic sedimentary rocks are generally weaker than the igneous rocks. However, they are of minor extent and have little engineering significance in this area.

CAINOZOIC

The Cainozoic includes a wide variety of superficial units which have complex field relationships and differing engineering properties. For example, the behaviour of a unit is modified by such factors as the properties of an underlying unit, the level and salinity of groundwater, and the pH of the unit.

Engineering problems can occur with the superficial materials if they contain expansive clays. This applies particularly to the silty sand unit which has limited extent in this area and is therefore of little engineering significance. Outwash gravel falls in the same category, although in adjacent areas it is suitable for foundations and provides a useful fill material.

The gravel and sand elements of alluvium, although of limited extent in the Dampier sheet area, could be useful as aggregate or fill.

The various beach and dune deposits are generally friable, and when loose may be unstable in excavations and on slopes. They are liable to erosion if cleared of vegetation. Except for older, leached deposits, they are of limited use in construction because of their salt content.

Dune limestone is cemented in part and may be suitable as a fill material. Because of its variable nature and the presence of solution cavities, it could cause problems beneath foundations.

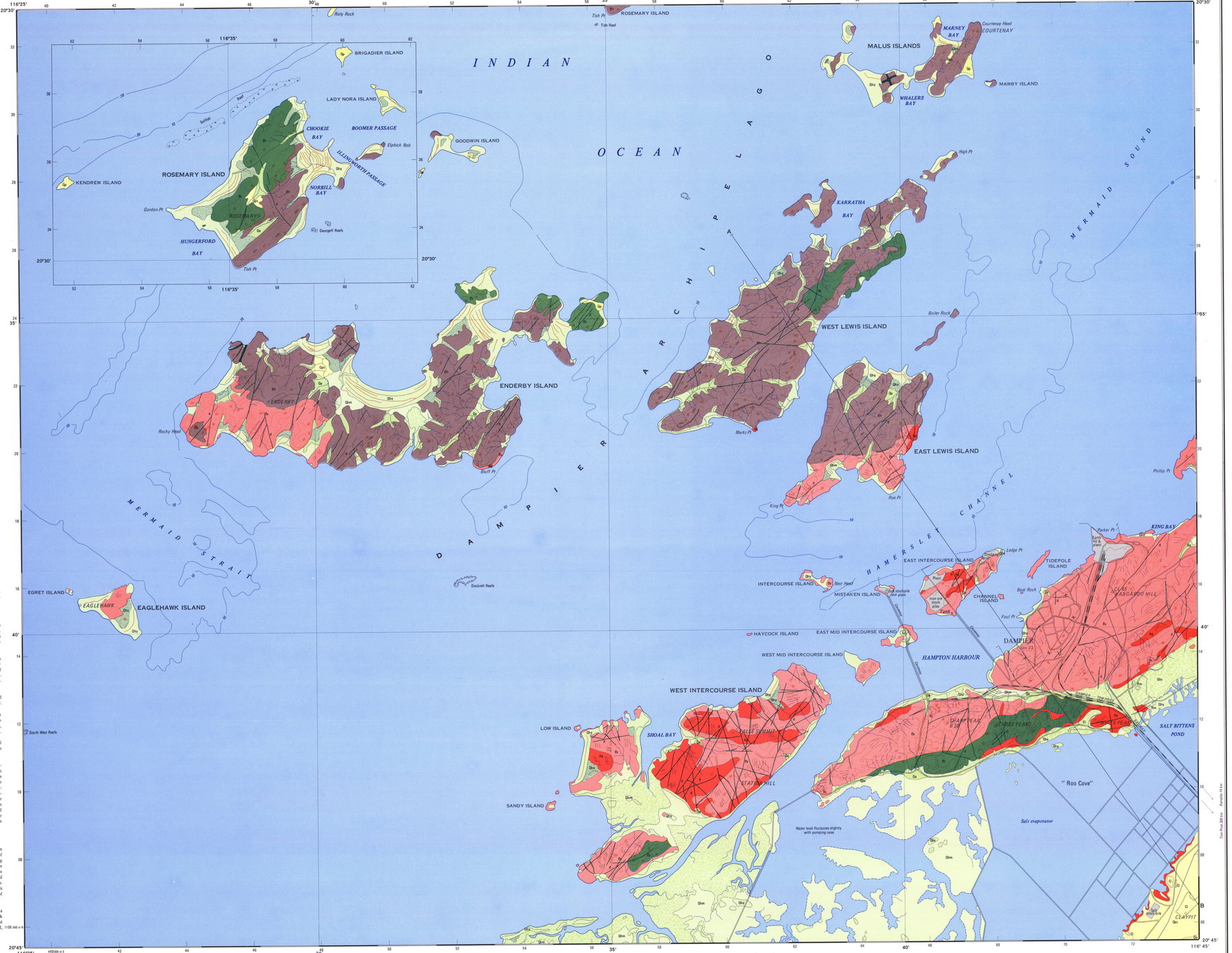
The mud and silt of tidal areas is a weak material and poses foundation problems for roads, railways and levees. The problem has been solved by the provision of properly compacted, stable embankments of suitable material. The possibility of using lime stabilisation for road embankments is being studied. Suitable materials for embankments include the less clayey parts of the Cainozoic deposits in conjunction with rock fill obtained from the stronger parts of the older rock units. For levee construction, silty sand containing clay has been used, but it requires thorough compaction. Weak, unconsolidated mud and silt is displaced from beneath the fill during construction. For bridges on this material elsewhere, piles up to 18 m have been driven without reaching basement rocks.

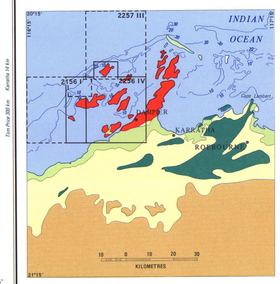
ENVIRONMENTAL GEOLOGY

Suitable sites for disposal of urban and light-industrial waste can probably be found in many small valleys near Dampier. Diversion of drainage may be necessary in some cases to prevent leachate flowing into the ocean, because over most of the area there is an inadequate depth of soil to act as a natural filter. Disposal of toxic waste may be possible in the mainland hard-rock areas subject to data from detailed site investigation to locate sites free from open jointing or other features which allow escape of any spillage. Sites on the outer islands may prove difficult to locate in view of the open characteristics of the Mount Roe Basalt.

As soils are generally thin over stable bedrock, soil erotion is a very minor problem in the area. Houses in Dampier are built on thick silty sand pads, and minor gullerying has occurred on some unprotected pad slopes. With the increasing vegetation cover becoming established, the incidence of such gullerying will decrease.

Further information may be obtained from the Geological Survey of Western Australia in Perth.





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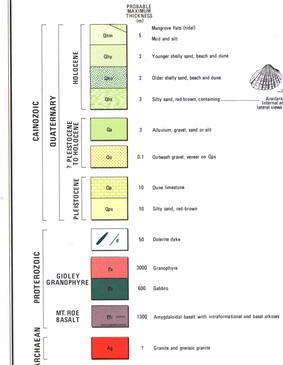
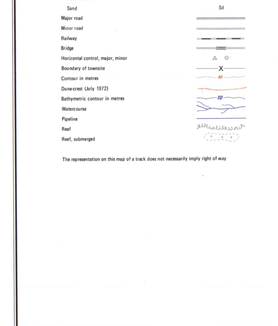
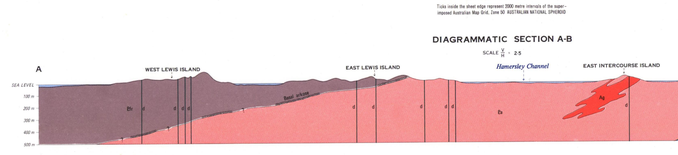


SYMBOLS

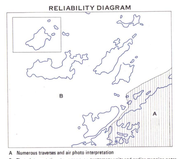


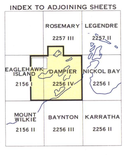


Geology : E. R. Biggs, 1976

Compiled and published by Geological Survey of Western Australia. Cartography by Geological Mapping Section, Department of Mines. Topographic base from compilations by Department of Lands and Surveys. Printed by Government Printing Office, Perth.

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





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SCALE 1:50 000

KILOMETRES

CONTOUR INTERVAL 20 m

Ticks inside the sheet edge represent 5000 metre intervals of the superimposed Australian Map Grid, Zone 50 AUSTRALIAN NATIONAL SPHEROID

DIAGRAMMATIC SECTION A-B

SCALE $\frac{1}{10}$: 2·5

DAMPIER EAGLEHAWK ISLAND ROSEMARY URBAN GEOLOGY

2256 IV, 2156 I, 2257 III

FIRST EDITION 1980