LEEUWIN

WESTERN AUSTRALIA 1 : 50 000 REGOLITH–LANDFORM RESOURCES SERIES

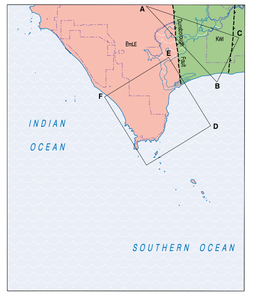
GEOLOGICAL SURVEY OF WESTERN AUSTRALIA

SHEET 1929 - III **FIRST EDITION 2002**

LANDSAT TM IMAGE WITH FIELD SITE LOCATIONS

Date of imagery: 13 March 1996

INTERPRETED ONSHORE BEDROCK GEOLOGY



SIMPLIFIED LAND SYSTEMS, SHADED RELIEF, INFRASTRUCTURE, AND DRAINAGE

The Leeuwin Regolith–Landform Resources map provides information on the regolith (soils) and underlying rocks, on the landforms (landscape), topography, infrastructure, and on the mineral and construction material resources of Leeuwin. This map will be of value in landuse planning, the sustainable development of resources, and in identifying natural hazards, both onshore and in shallow nearshore zones.

The map also delineates land systems, which are areas of discrete recurring patterns of landform, regolith, materials, and vegetation. These patterns are related to geological and hydrogeological units, and form the basis of identifying landuse, including mineral resource potential.

M_1	M_2	M_3	M_5

M_1 Marine shoreface
M_2 Marine nearshore
M_3 Marine offshore
M_5 Marine reef

- Qe — Quindalup System — beach and dunefields
- Bw — Blackwood System — estuary and river system
- Sp — Spearwood System — deflated dunes
- Sc — Scott System — mixed deflated dunes and river system
- Co — Cowaramup System — low hills underlain by Proterozoic rocks

SCALE 1:250 000

0 5 10 Kilometres

LEGEND

1, 2, M — MARINE — 48 094 ha 82%

Extensive offshore sandplain. Level to gently inclined nearshore, and level to very gently inclined shoreface, formed dominantly of submerged rocky platforms and reefs (1), small emergent rocky reefs, stacks, and islands in the nearshore environment (2), minor patches of nearshore and shoreface sand.

Sand deposits are composed mostly of shell fragments and quartz grains. Rock reefs and platforms are formed from Leeuwin Complex (1) or calcarenite of eolian and beach origin (2).

Possible source of limesand for agricultural applications, and sand and limestone for construction.

Active processes include erosion and deposition by tides, currents, and wave action. The rocky coastline and shallow reefs are a hazard to boats. Rapid deposition and erosion of coastal deposits can occur during storms.

Primarily used for fishing and recreation.

Sand of Holocene age mostly undersain by Leeuwin Complex rocks.

3, 4, Qe — QUINDALUP SYSTEM — 4 857 ha 6%

Mostly parabolic dunes, swales, and blowouts; sandy beaches and foredunes common along the coast (3). Gently to steeply inclined slopes, occasionally very steep to precipitous. Older deflated dunes form cliffs and rocky headlands. Multiple overlapping dune formations with intervening paleosols.

Dominantly calcareous eolian sand composed of shell fragments, quartz, and minor garnet and other heavy minerals (4), overlying a core of weakly lithified calcarenite. Organic sandy soils occur in swales.

Source of limesand, sand, and limestone. Some potential for heavy mineral sands within the beach and dune sands.

Eolian processes active in the dunes, and coastal processes on the beaches. Major hazards are collapse or subsidence of calcarenite, particularly overhanging cliffs. Migrating sand from blowouts and steeper dune faces is a minor hazard.

Landuses include conservation, recreation and tourism, and minor urban development and grazing.

Overlies older dunes of the Spearwood System, and the Proterozoic rocks of the Leeuwin Complex (4).

5, 6, Bw — BLACKWOOD SYSTEM — 4 271 ha 5%

Blackwood River, with associated adjacent terrace of level to very gently inclined plain dotted with swampy hollows, and estuary including some islands, and intertidal and supratidal flats. The river has cut down through the Leederville Formation in places (5).

Sand and gravel common on the alluvial terraces. Ferruginous gravel on hillcrests. Low-lying swampy areas are filled with organic sandy soils.

Source of yellow sand (6) and ferruginous gravel. Some potential for heavy minerals sands.

Active processes include channel erosion, and flooding and waterlogging along the river.

Used for grazing and conservation, with urban development around Augusta. Natural vegetation remains along much of the Blackwood River and in a few nature reserves.

The materials of the Blackwood System overlie Cretaceous and Proterozoic rocks.

7, 8, Sp — SPEARWOOD SYSTEM — 1 548 ha 2%

Ridge composed of a series of deflated parabolic dunes (7) and swales. Gently to moderately inclined slopes, with rare steep to precipitous rocky slopes or cliffs (foot overhang in places. Hosts karstic features (8) such as caves, dolines, and subsurface drainage systems formed during an earlier, wetter period.

Red to brown, residual quartz sand over cuirasse-surfaced calcarenite. Organic sandy soils occur in swales.

Source of limestone and building sand.

Steep rocky slopes and karstic features may be prone to subsidence or collapse, and are a hazard to people, stock, and machinery. Cleared westerly slopes are prone to erosion by prevailing southwesterly winds.

Uses include conservation, tourism, and recreation. Small areas have been cleared for grazing and urban development.

Overlain by the dunes of the Quindalup System, and overlies Leeuwin Complex rocks. Formed by eolian processes during the Pleistocene, and modified by surface water and groundwater leaching and precipitation.

9, 10, Sc — SCOTT SYSTEM — 640 ha <1%

Flat to gently inclined, undulating terraces with closed and open drainage depressions, and low rises; surrounded by low-lying poorly drained swampy areas.

Leached quartz sand occurs on dry sandy rises (9; from Tille and Lantzke, 1990). Some areas of yellow sand. Mixture of fluvial and eolian deposits; waterlogged soils commonly have organic accumulations (10).

Alluvial terraces are a possible source of sand and gravel. Sandy rises are a potential source of white sand. Some potential for heavy mineral sands.

Waterlogging and flooding occur during winter.

Landuses include grazing, conservation, and some cropping. Vegetation has been cleared in places for grazing, and other areas have been set aside for nature reserves. Some drainage channels have been dug.

Fluvial to coastal zone between the Blackwood and Quindalup Systems. Overlies Cretaceous and Proterozoic rocks.

11, 12, Co — COWARAMUP SYSTEM — 4 541 ha 5%

Low hills to rises with gently to moderately inclined slopes and swampy drainage depressions. Level to gently undulating areas north of Cowes Road.

Residual materials (11) and colluvial deposits overlying weathered rocks of the Leeuwin Complex. Hillcrests are commonly capped by ferruginous gravel or duricrust, and leached quartz sand. Exposures of granulite common.

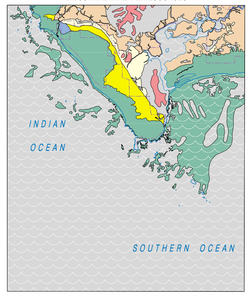
Source of gravel (12) and quartz sand. Potential source of rammed-earth building materials, hard rock aggregate, and dimension stone.

Waterlogging occurs during the winter in areas of low slope, and erosion can occur in cleared areas during heavy rain.

Landuses include viticulture, grazing, urban development, recreation, and tourism.

Overlain by the materials of the Quindalup and Spearwood Systems. Underlain by Leeuwin Complex rocks. To the east, the Leeuwin Complex is entrapped in places by the Leederville Formation.

POTENTIAL CONSTRUCTION AND INDUSTRIAL MINERAL RESOURCES



- Ferruginous gravel — *Cubf*

  Cemented, ferruginous nodular duricrust forming coppings on hillcrests, locally concealed by residual quartz sand. Potential source of aggregate for road construction.

- Red and yellow sand — *SpEa, SpEe*

  Loose, red or yellow, quartz-rich eolian sand, formed as a weathered residuum over limestone. Potential source of sand for building pads; other construction purposes, and landfill.

- Limestone — *QaEd, SpEd*

  Colonite and calcarenite formed by weathering of carbonate-rich sand dunes. Rock varies in strength from moderately weak to very strong, and may be excavated as aggregate or boulders. Overlain by variable thickness of red and yellow sand. Low-grade limestone may be used for road base, landfill, and for construction purposes.

- Limesand — *M1, M2, M3, QmEa, QmEe, QmEd, QmEc, QmEs, QmEe, QmEw*

  Loose, shell-rich sand of eolian or marine origin, with calcium carbonate contents up to 90%. May be suitable for agricultural applications and construction purposes.

- Sand and gravel — *BwEa, CoEa, ScEa*

  Fluvial sediments ranging from silty clay to sandy gravel. Potential source of sand and gravel for building and fill.

- White sand — *BwEg, CoEg, ScEg*

  Predominantly, subrounded to rounded, medium to coarse quartz sand. Potential source of sand for concrete and landfill.

- *BwEa, BwEg, BwEk, BwEw, BwTc, BwTf, BwTs, CoEa, CoEe, CoEf, M1, M2, M3, QmEa, ScEa, ScEg*

  Colluvial sand and gravel, alluvium and associated hardpans, weathered bedrock, and nearshore rocky seabed; limited potential.

SCALE 1: 250 000

0 5 10 Kilometres

REFERENCE

Age / Land System	Phanerozoic / Cainozoic / Holocene	Phanerozoic / Cainozoic / Pleistocene	Phanerozoic / Cainozoic / undivided	Proterozoic	Description
	M_1 M_2 M_3		M_5	EmLE	M_1 Marine. Shoreface; shell and quartz sand; minor rock platform
					M_2 Marine. Nearshore sandplain and sandy hollows; shell and quartz sand; minor rock ridges and flats
					M_3 Marine. Offshore sandplain; shell and quartz sand
	M_5				M_5 Marine. Reef or rock flat; undivided eolian calcarenite and **Leeuwin Complex**
				EmLE	**Leeuwin Complex**; undivided felsic granulite and granite; minor mafic granulite and anorthosite; fresh to weathered
Quindalup (*Qe*)	QmEa	QmEe		P	QmEa Alluvial. Drainage depression; includes seasonally active channels; silty sand; formed in eolian deposits and weathered bedrock
	QmEb	QmEc			QmEb Coastal. Beach; includes foredune; marine shell and quartz sand; modified by wave action
	QmEb	QmEc			QmEc Coastal. Foredune; eolian shell and quartz sand
	QmEb	QmEd			QmEd Eolian. Parabolic dunes; eolian shell and quartz sand; built up by waves, modified by wind
	QmEb	QmEd		EmLE +	QmEe Eolian. Swampy swale; waterlogged organic soil over shell and quartz sand
	QmEb	QmEd			QmEd Eolian. Parabolic dunefield; shell and quartz sand
	QmEb	QmEd			QmEe Eolian. Blowout; actively eroding shell and quartz sand
	QmEb	QmEd			QmEw Eolian. Undivided dunefield; shell and quartz sand
	QmEb	QmEd			QmEs Eolian. Limited dunefield; colcarenite eolianite; weakly lithified shell and quartz sand; includes coastal rock platform
	QmEb	QmEd		P	**Leeuwin Complex**; pegmatite vein
	QmEe			EmLE	**Leeuwin Complex**; undivided felsic granulite and granite; minor mafic granulite and anorthosite; fresh to weathered
Blackwood (*Bw*)	BwEa	BwEc	BwEa		BwEa Alluvial. Stream channel; includes stream beds and banks; tidal in part
	BwEa	BwEc			BwEa Alluvial. Swamp; waterlogged organic sand and silt
	BwEa	BwEc	BwEa		BwEa Alluvial. Drainage depression; includes seasonally active channels; formed in slope and terrace deposits, and weathered bedrock; silty sand
	BwEa	BwEc			BwEc Tidal. Estuary; silty sand
					BwEt Tidal. Intertidal flat; silty sand
	BwEa		BwEg		BwEs Tidal. Supratidal flat; silty sand
	BwEa				BwEa Alluvial. Channel bench adjacent to channel; subject to occasional flooding, affected by tides
	BwEa		BwEk		BwEk Alluvial. Terrace; silt, sand and gravel overlying **LEEDERVILLE FORMATION**
	BwEg				BwEg Residual. Rises; leached quartz sand over undivided fluvial and coastal sediments
Spearwood (*Sp*)	SpEa		SpEd		SpEa Eolian. Swampy swale; waterlogged organic soil over brown residual quartz sand
	SpEa		SpEd		SpEb Alluvial. Drainage depression; includes seasonally active channels; formed in eolian deposits and weathered bedrock; colcareous silty sand
	SpEa		SpEd		SpEd Eolian. Deflated undivided dunefield; brown residual quartz sand over colcarenite
	SpEa		SpEd		SpEe Eolian. Colcareous eolianite; colcrete dove well-indurated shell and quartz sand
Scott (*Sc*)	ScEa			ScEa	ScEa Alluvial. Swamp; waterlogged organic sand
					ScEa Alluvial. Terrace; silty and gravelly sand
				ScEg	ScEg Eolian. Low rises and deflated dunes; leached quartz sand over undivided fluvial and coastal sediments
Cowaramup (*Co*)	CoEa		CoEa	EmLE +	CoEa Alluvial. Swamp; waterlogged organic silty sand
	CoEa		CoEc		CoEa Alluvial. Drainage depression; includes seasonally active channels; formed in weathered bedrock and slope deposits; silty clayey sand
	CoEa		CoEc		CoEc Alluvial. Terrace; silty sands and gravels over **Leeuwin Complex**
					CoEe Residual. Undivided slopes; silty gravelly sand over mantled sandy clay
			CoEg		CoEg Residual. Low hills and rises; leached quartz sand
			CoEf		CoEf Residual. Low hills and rises; ferruginous duricrust overlying mottled soil (weathered **Leeuwin Complex**); includes small areas of leached quartz sand
				EmLE	**Leeuwin Complex**; undivided felsic granulite and granite; minor mafic granulite and anorthosite; fresh to weathered

SYMBOLS

Geological boundary — exposed
Fault — normal, concealed, tick on downthrow side
Palaeocurrent direction, showing trend — from eolian cross-bedding, direction known
Gneissic banding, showing strike and dip — inclined
Fracture or joint, showing strike and dip — inclined
Airphoto lineament — unspecified; jointing
Highway; bridge
Formed road
Track

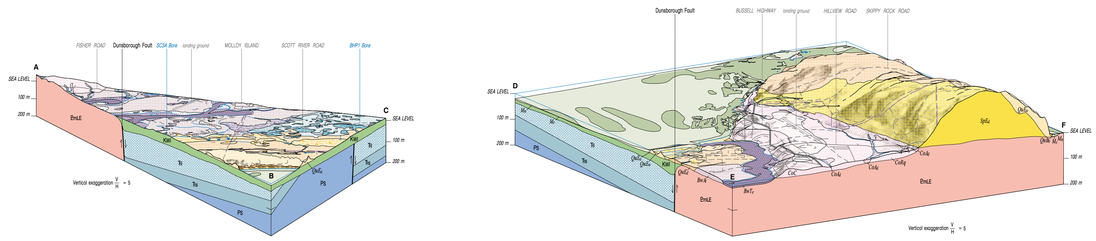
Powerline
Townsite — population between 1 000–10 000
Locality
Building
National Park boundary
Reserve boundary
Horizontal control; major, minor
Cliff or scarp
Sand dune
Contour, height in metres (AHD)
Watercourse
Coastline (LAT)
Bathymetric contour, depth in metres (LAT)
Lake, swamp
Drain

AUGUSTA Borup

Bore
Government water exploratory bore — BC94
Dam; tank
Lighthouse
Rock, exposed
Jetty
Wave pattern denotes permanent water

Quarry
Mineral and rock commodities — Heavy mineral sands (HM); Ilmenite (Ilm); Gravel (Gvl); Limesand (Lsd); Limestone (Lst); Sand (Sn)

BLOCK DIAGRAMS



BEDROCK GEOLOGY

CRETACEOUS	Kld	LEEDERVILLE FORMATION (Wonnerup Group)
TRIASSIC	Ts	LESUEUR SANDSTONE
	Ta	SABINA SANDSTONE
PERMIAN	Ps	Sue Group
PROTEROZOIC	EmLE	Leeuwin Complex

Normal fault, showing relative displacement

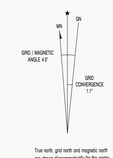
LEEUWIN MINERAL OCCURRENCES

NUMBER*	COMMODITY	EASTING	NORTHING
SPECIALITY METAL — HM, Ilm			
Regolith — diluvial to beach placers			
55	HM	326280	6199180
338	HM	326700	6202720
340	HM	334860	6207020
351	HM	330540	6201780
30642	HM	329900	6199580
30643	HM	328540	6200240
30644	HM 9m	332380	6202520
30645	HM 9m	331460	6201680
30646	HM 9m	332180	6203200
30647	HM 9m	332040	6201600
30648	HM 9m	332920	6202380
30649	HM 9m	332380	6201700
30650	HM 9m	332140	6201120
30651	HM 9m	330060	6203940
30652	HM 9m	334020	6202120
30653	HM 9m	330180	6202800
30654	HM 9m	330300	6202500
30655	HM	327300	6202280
CONSTRUCTION MATERIAL — Gvl, Lst, Lst, Sn			
Undivided			
8667	Gvl	327565	6203075
8668	Gvl	326770	6206070
8674	Sn	325840	6200890
8675	Lst	332890	6202240
8585	Gvl	330440	6199190
8586	Sn	330000	6198440
8641	Gvl	327875	6207160
8642	Gvl	329710	6206480
8644	Gvl	329485	6206715
8645	Gvl	327535	6202845
8649	Sn	330260	6198405
8653	Lst	331650	6201345
8655	Sn	334800	6207980
8657	Sn	334375	6206070
8687	Gvl	330365	6198820

*** KEY TO OPERATING STATUS**

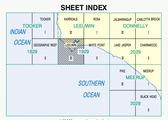
Bold numbers (e. 8667) — Operating quarry
Bold and Italic numbers (i.e. 8674) — Abandoned mine or quarry
Plain numbers (i.e. 111) — Mineral deposit
Italic numbers (i.e. 55) — Mineral occurrence or prospect

Numbers refer to GSWA MAWIN mineral occurrence database



True north, grid north and magnetic north are shown diagrammatically for the centre of the map. Magnetic north is correct for 2001 and moves easterly by about 0.1° in 1 year.

SHEET INDEX



1:50 000 maps shown in black
1:100 000 maps shown in green

Geology by J. Mamham and G. Hall, 1998–2000

Subsurface geology by:
BAXDOOR, L. J., 1984. Geology and hydrogeology of the Karridale Bore Line. Perth Basin: Western Australia Geological Survey Report 37, Professional Papers, p. 1–18.
BAXDOOR, L. J., 1985. Geology and hydrogeology of the Scott Coastal Plain. Perth Basin: Western Australia Geological Survey Record 1986/7, 58p.
BHP COMPANY LTD, 1974. Temporary Reserve 5892H Augusta area– Southern Perth Basin, WA. Annual Report for year ended 8th November 1974. Western Australia Geological Survey Statutory mineral exploration report, M1389 A35855, Item 11025 (unpublished).
ASDRY, R. P., 1969. A structural study of the Southern Perth Basin. Western Australia: Western Australia Geological Survey Report 31, 58p.

Edited by C. Strong and C. Brian

Cartography by J. Kirk and S. Caldicutt

Mineralization and rock commodity information from non-confidential data held in the MAWIN database, GSWA, at 31 July 2001.

Topography from the Department of Land Administration Sheet SI 50-9, 1929, with modifications from geological field survey

Limited imagery supplied by Remote Sensing Services, Department of Land Administration

Bathymetric data supplied by the Department of Transport. This map is not intended for marine navigation

Photograph 9 reproduced from Tille, P. J., and Lantzke, N. C., 1990. Busselton–Margaret River–Augusta Land Capability Study: Western Australia Department of Agriculture, Land Resource Series No. 5, 97p.

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Plotted by the Geological Survey of Western Australia

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Department of Mineral and Petroleum Resources
CLIVE BROWN, M.L.A. MINISTER FOR STATE DEVELOPMENT
JIM LIMERICK DIRECTOR GENERAL

Geological Survey of Western Australia
TIM GRIFFIN DIRECTOR

Grid lines indicate 1000 metre interval of the Map Grid Australia Zone 50

GDA
The Map Grid Australia (MGA) is based on the Geocentric Datum of Australia 1994 (GDA94)
GDA94 positions are compatible within one metre of the datum WGS84 positions

SCALE 1:50 000

1000 500 0 1 2 3 4 5
Metres Kilometres

UNIVERSAL TRANSVERSE MERCATOR PROJECTION
HORIZONTAL DATUM: GEOCENTRIC DATUM OF AUSTRALIA 1994
TOPOGRAPHIC DATUM: AUSTRALIAN HEIGHT DATUM (AHD)
HYDROGRAPHIC DATUM: LOWEST ASTRONOMICAL TIDE (LAT)

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