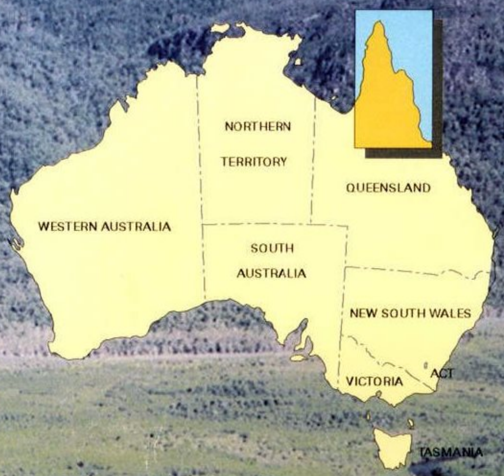
ATLAS OF NORTH QUEENSLAND GEOLOGY

1:3 Million Scale



Relief and Bathymetry

Satellite Imagery

Regolith

Surficial Geochemistry

Groundwater

Geology

Geophysics

Mineral Deposits

Land Categories

AGSO
AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION

Compiled by
JHC Bain and JJ Draper

DEPARTMENT OF MINES AND ENERGY

Atlas of North Queensland Geology
1:3 Million Scale

Compiled by JHC Bain[1] and JJ Draper[2]

1997

[1]Australian Geological Survey Organisation, Commonwealth Department of Primary Industries and Energy, Canberra, ACT.

[2]Geological Survey of Queensland, Queensland Department of Mines and Energy, Brisbane, Qld.

DEPARTMENT OF PRIMARY INDUSTRIES AND ENERGY

Minister for Resources: Senator the Hon Warwick Parer
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AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION

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Director: Gerhard Hofmann

ISBN: 0 642 25007 3

Co-published by: Australian Geological Survey Organisation, Department of Primary Industries and Energy, Canberra and the Geological Survey of Queensland, Department of Mines and Energy, Brisbane.

Colour Separation by: Tennyson Graphics, Melbourne, Australia

Printed by: Mercury-Walch Pty Ltd, Hobart, Australia

Cover picture: Hinchinbrook Island (Ian Oswald-Jacobs)

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Introduction

This atlas has been designed as a companion volume to ***"North Queensland Geology"*** by JHC Bain & JJ Draper (eds), AGSO Bulletin 240, Canberra, and Queensland Geology 9, Brisbane, 1997. The following 1:3 million scale maps provide a sample of the type of maps that can be generated from the range of geoscience information held by AGSO and GSQ. ***"North Queensland Geology"*** - book, atlas and 1:1 million scale map - is a product of the National Geoscience Mapping Accord (NGMA), and an outcome of more than 25 years of collaborative work in North Queensland by GSQ and AGSO/BMR. It summarises the geoscience knowledge of North Queensland acquired by government, universities and industry, that provides the basis for modern and effective resource exploraration and land management. For information about the availability of relevant associated reports, maps and datasets refer to Sales Centres at AGSO, Canberra and DME, Brisbane.

Acknowledgements

We obtained data, information, inspiration, advice, editorial and technical assistance, and a lot of help from a great many sources in AGSO, GSQ and beyond. In particular we wish to thank the following for their contributions to this atlas: *Heike Apps, Vera Ashby, Richard Blewett, Cameron Buchanan, Dmitar Butrovski, Paul Brugman, Bob Bultitude, Bruce Cruikshank, Peter Goldsworthy, John East, Greg Ewers, Paul Garrad, Trevor Graham, Rien Habermehl, Danny Haipola, Laurie Hutton, Bruce Kilgour, Jan Knutson, Doug Mackenzie, Leanne McMahon, Colin Pain, Matti Peljo, Tim Ransley, Mitch Ratajkoski, Peter Wellman, John Wilford, Warwick Willmott, Ian Withnall; the many other AGSO, BMR and DME field and office staff, past and present, who helped acquire and assemble the building blocks; AGSO Geophysical Mapping Group; Australian National University Centre for Resource and Environment Studies; AUSLIG; Cape York Peninsula Land Use Strategy; Environmental Systems Research Institute Inc (ESRI) Digital Chart of the World; Earth Resource Mapping (ER Mapper); Geoimage Pty Ltd; Great Barrier Reef Marine Park Authority.*

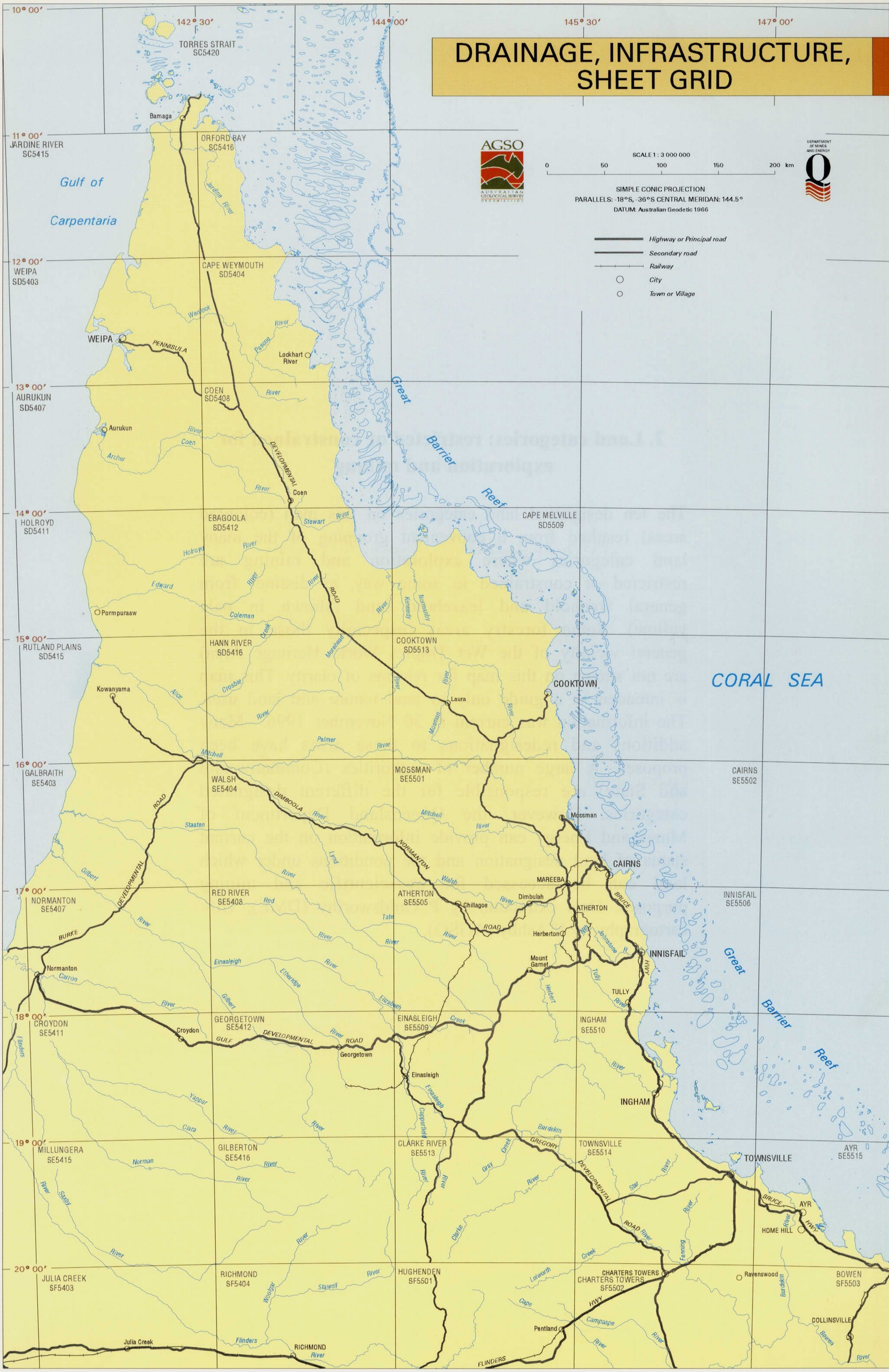
JHCB & JJD

1. Drainage, infrastructure, sheet grid

The streams, roads, railways, settlements and place names shown on this map are derived mostly from ESRI's Digital Chart of the World. Most of the Great Barrier Reef information was supplied in digital form by the Great Barrier Reef Marine Park Authority; additional reef outlines outside the Park were interpreted from satellite imagery. The 1:250,000 sheet areas defined by the one by one and a half degree grid are named and numbered according to the National Grid. Cartography by V Ashby (AGSO).

DRAINAGE, INFRASTRUCTURE, SHEET GRID

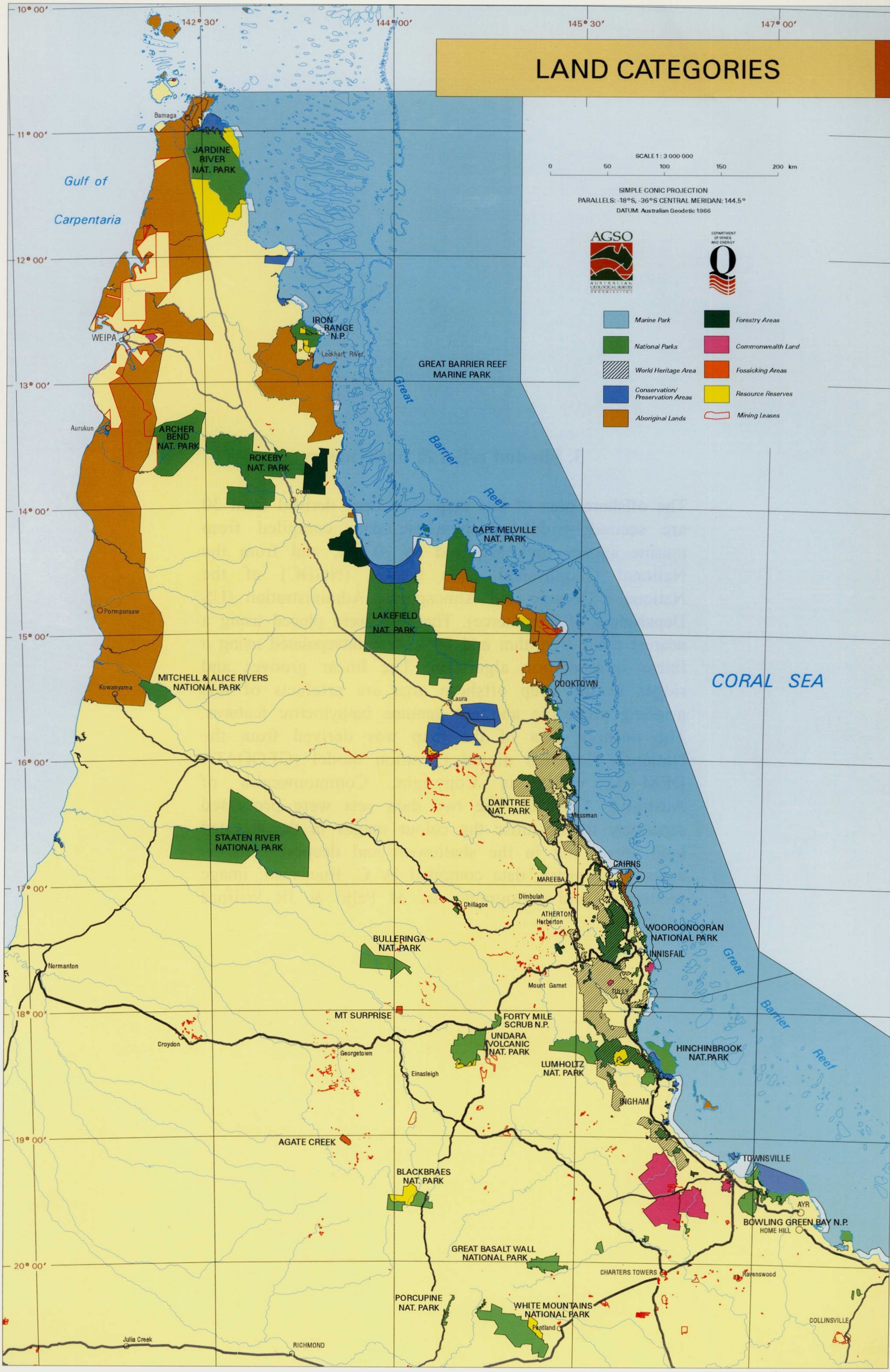
1



2. Land categories: restricted or constrained for exploration and mining

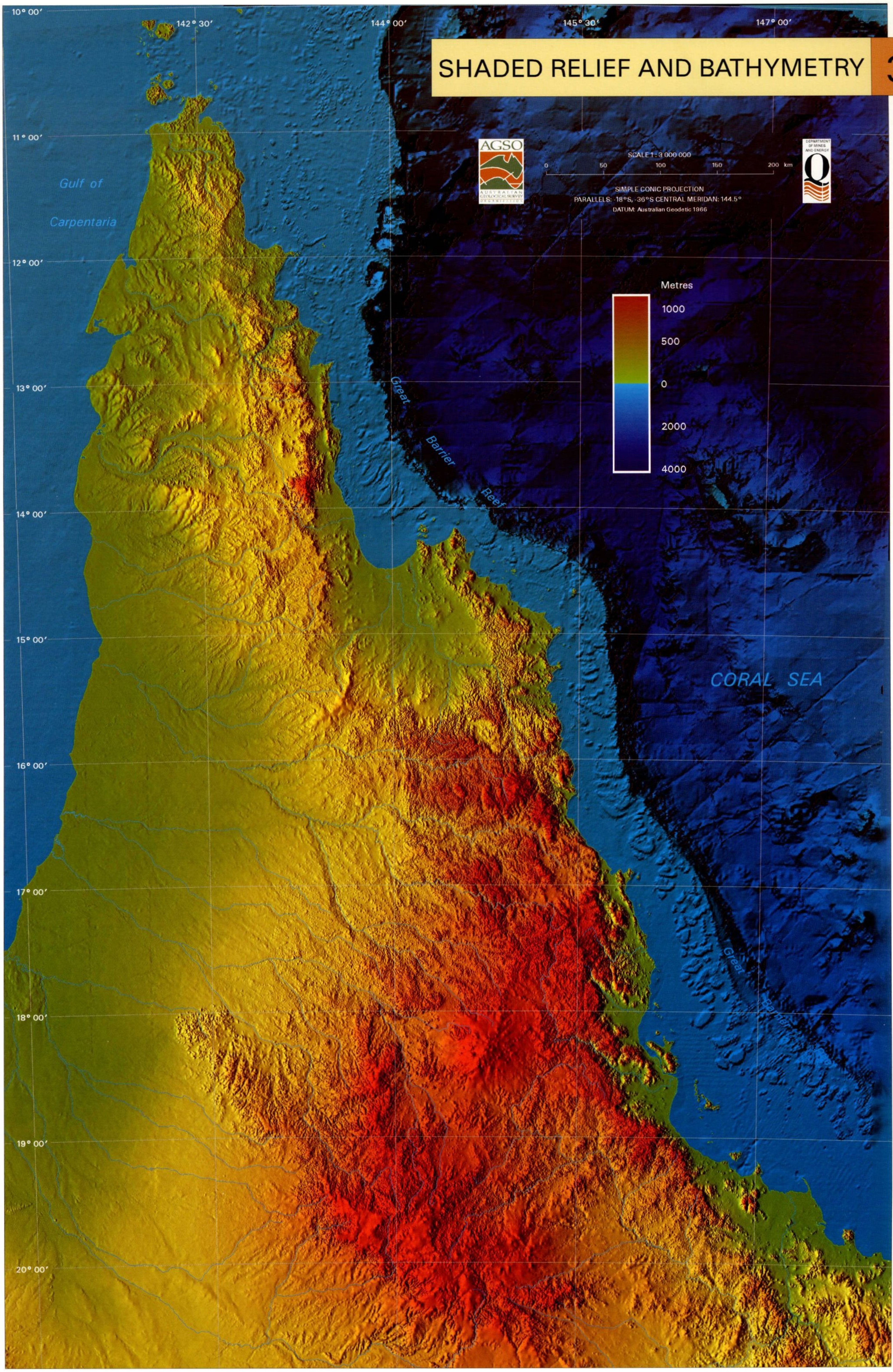
The ten designated land categories on this map (coloured areas) resulted from a convenient grouping of the many land categories where exploration and mining are restricted or constrained in some way, as distinct from general freehold and leasehold land (shown in pale yellow). Some forestry areas (especially those in the general vicinity of the Wet Tropics World Heritage Area) are not shown on this map for reasons of clarity. This map is intended as a guide only to land tenure and land uses. The information was current at 30 November 1996. Many additions and redesignations to these areas have been proposed. A large number of authorities (Commonwealth and State) are responsible for the different designated categories. However, the Queensland Department of Mines and Energy can provide information on the current status of land designation and the conditions under which land can be accessed for geoscientific and mining purposes. Data extraction by P Goldsworthy (DME); GIS/ cartography by V Ashby (AGSO).

LAND CATEGORIES 2



3. Shaded relief & bathymetry

The offshore area of this map has been derived from 30 arc second gridded bathymetric data compiled from marine survey data acquired by AGSO, and from the National Geophysical Data Centre (NGDC) of the National Oceanic and Atmospheric Administration (US Department of Commerce). The data were placed using a nearest point algorithm and 80% were interpolated using a linear interpolation algorithm. The linear grooves and ridges in the deep offshore area are artefacts of this gridding procedure and not genuine bathymetric features. The onshore area of the map was derived from the National 9 second digital elevation model (GEODATA DEM-95) which is Copyright, Commonwealth of Australia, AUSLIG. The two data sets were processed separately to maximise the colour ranges in the elevated land areas, and in the shallowest and deepest marine areas. Bathymetric data compiled by C. Buchanan; image processing and cartography by M Peljo & JR Wilford (AGSO).

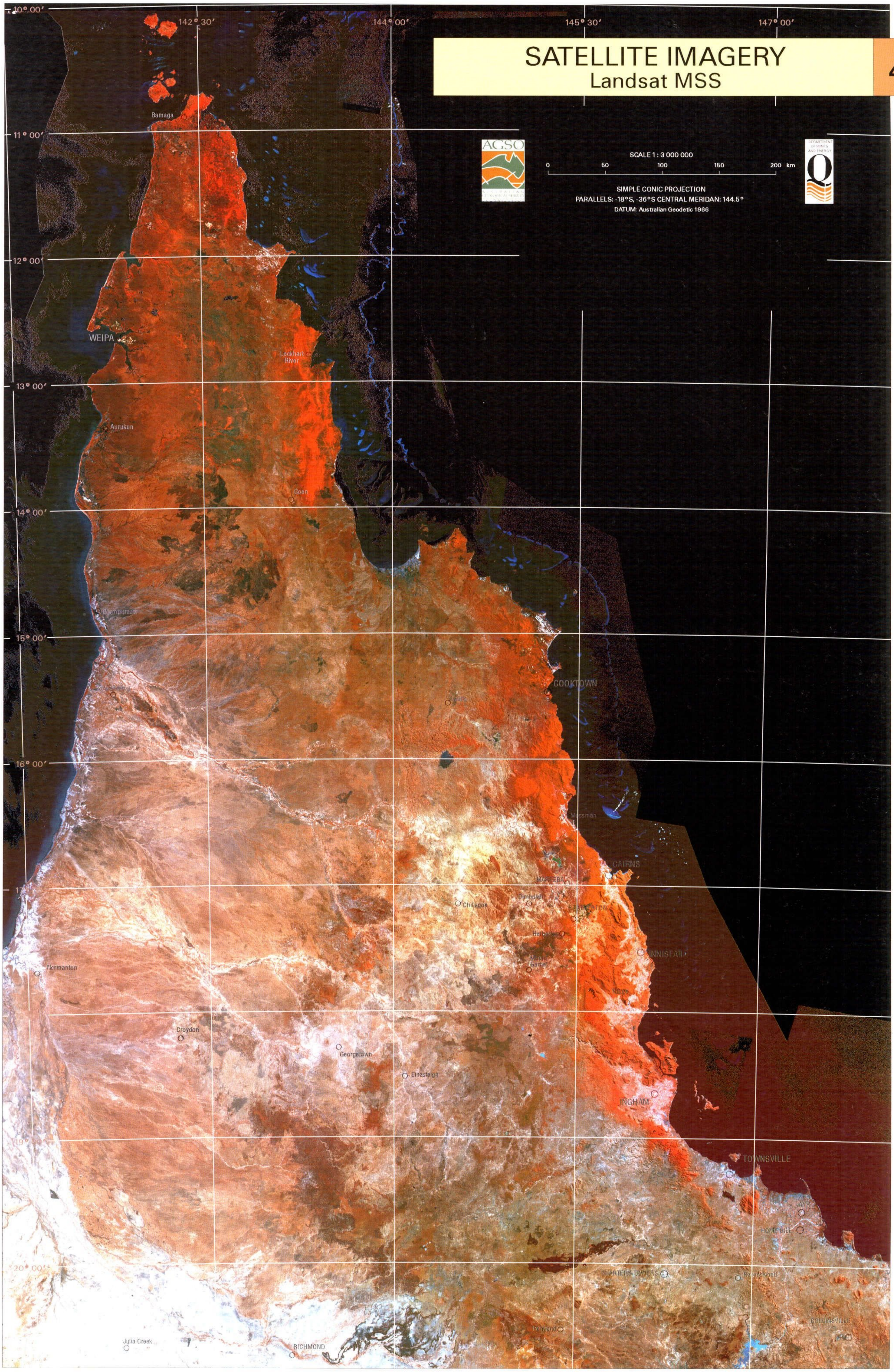

SHADED RELIEF AND BATHYMETRY
3
10° 00′
11° 00′
12° 00′
13° 00′
14° 00′
15° 00′
16° 00′
17° 00′
18° 00′
19° 00′
20° 00′
142° 30′
144° 00′
145° 30′
147° 00′
AGSO
AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION
SCALE 1 : 3 000 000
0
50
100
150
200 km
SIMPLE CONIC PROJECTION
PARALLELS: -18°S, -36°S CENTRAL MERIDAN: 144.5°
DATUM: Australian Geodetic 1966
DEPARTMENT OF MINES AND ENERGY
Gulf of
Carpentaria
Metres
1000
500
0
2000
4000
Great
Barrier
Reef
CORAL SEA
Great

4. Satellite imagery: Landsat MSS

The mosaic image of LANDSAT MSS (Multi Spectral Scanner) satellite views was provided by Geoimage Pty Ltd. The image was enhanced using ERmapper® and displayed as bands 4, 2, 1 in red, green and blue. The imagery has a pixel resolution of 80 metres. Areas of lush green vegetation (much of it rainforest) are shown red on this image. In the south several young basalt flows are clearly visible as a result of distinctive vegetation that shows dark on this image. The relationship between geology, relief, temperature, rainfall, and vegetation is quickly apparent when plates 3,4,5,6 & 8 are compared. Imagery processed by JR Wilford & M Peljo (AGSO).

SATELLITE IMAGERY
Landsat MSS

4

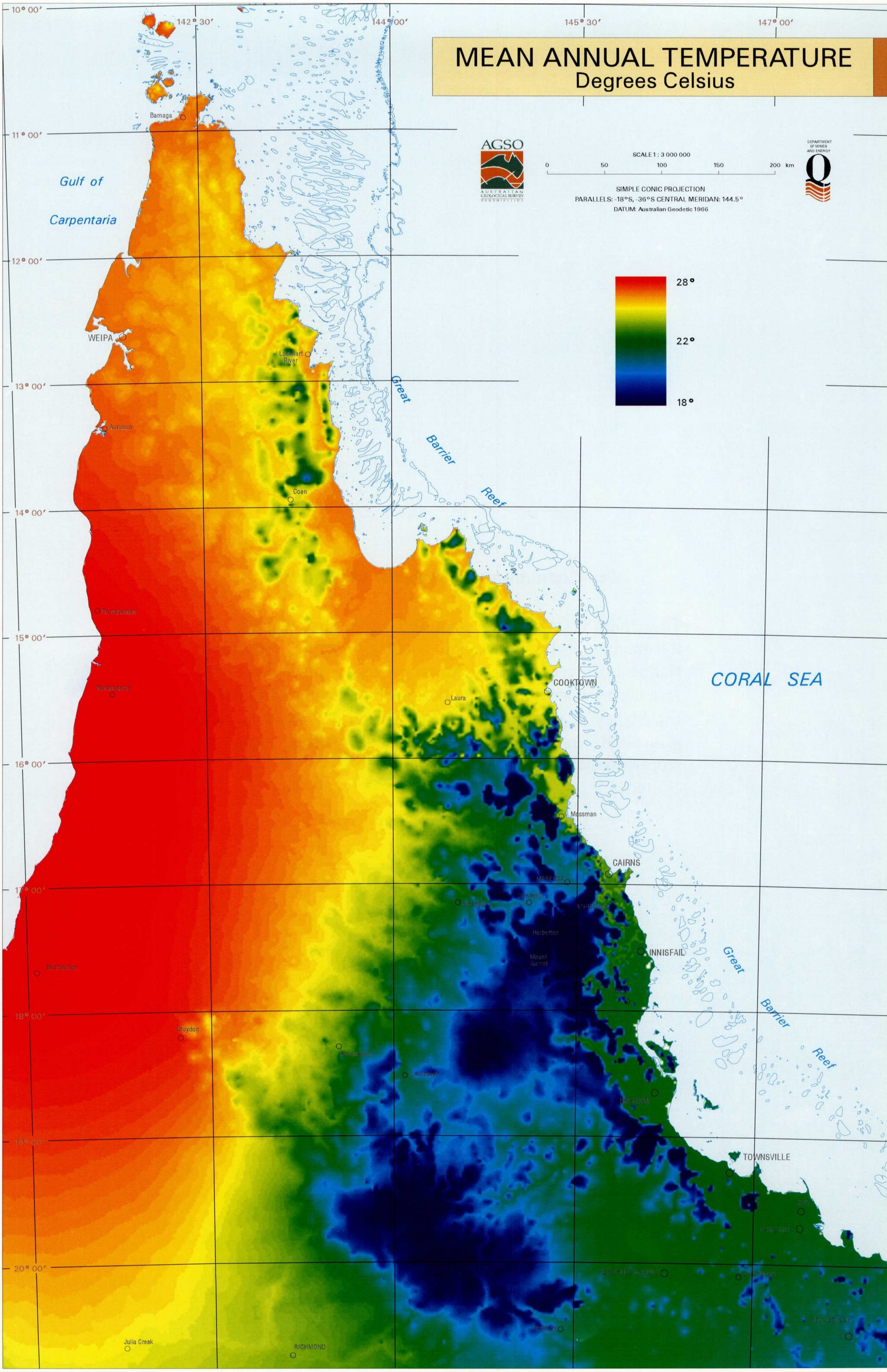


5. Mean Annual Temperature: degrees Celsius

The temperature grid was acquired from the Centre for Resource and Environmental Studies (CRES), Australian National University. A software package called BIOCLIM was used to generate the grid from bioclimatic parameters. ER Mapper® was used to colour the grid. Values in each grid cell measure temperature in degrees Celsius. Copyright CRES. Imagery processed by M Peljo & JR Wilford (AGSO).

MEAN ANNUAL TEMPERATURE
Degrees Celsius

5

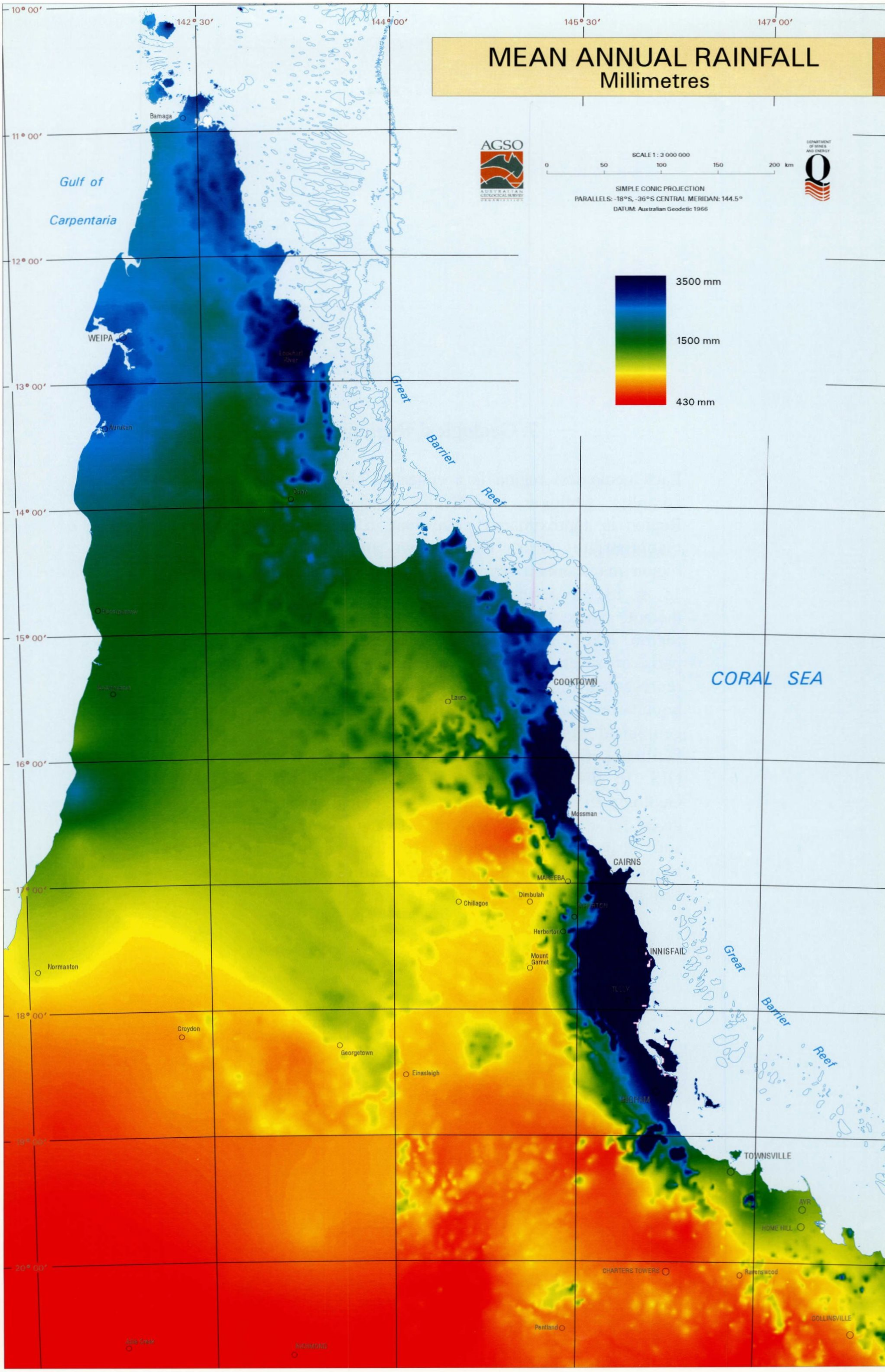


6. Mean Annual Rainfall: millimetres

The rainfall grid was acquired from the Centre for Resource and Environmental Studies (CRES), Australian National University. A software package called BIOCLIM was used to generate the grid from bioclimatic parameters. ER Mapper® was used to colour the grid. Values in each grid cell measure rainfall in millimetres. Imagery processed by M Peljo & JR Wilford (AGSO).

MEAN ANNUAL RAINFALL
Millimetres

6



7. Geological Regions

Each geological region is a cohesive, albeit in some cases complex geologic assemblage: e.g., the Georgetown Region is approximately equivalent to the established, but inappropriate term, Georgetown Inlier. A geological region may contain several geological provinces (eg Plates 11 & 13) or sedimentary basins (eg Plate 10), or parts thereof, where the province or basin extends beyond the region. The Georgetown Region for example, contains parts of seven Provinces and three Basins. Regions are represented on the map by single polygons, and their boundaries, although roughly coincident with major geological boundaries, are generalised (smoothed). This facilitates data management in relational databases and GIS. In the associated book (AGSO Bulletin 240/Qld Geology 9) basic descriptive geological information is given for each region and the various inter-regional rock and structural associations are defined in terms of provinces. Compiled by JHC Bain & JJ Draper; cartography by HE Apps (AGSO).

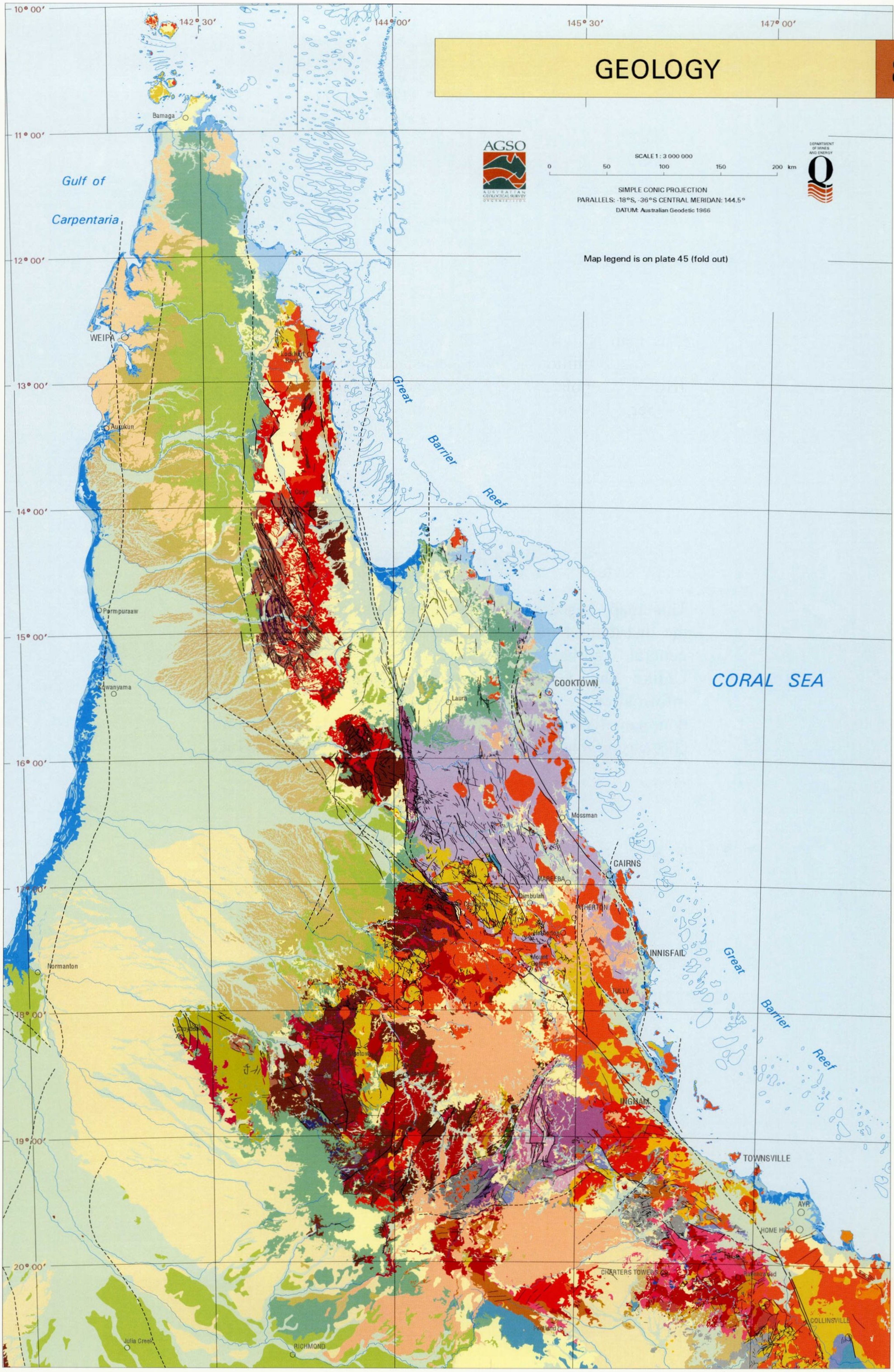

REGIONS
7
TORRES STRAIT REGION
GULF OF CARPENTARIA REGION
COEN REGION
QUINKAN REGION
CORAL SEA REGION
CARPENTARIA LOWLANDS REGION
CAIRNS REGION
GEORGETOWN REGION
CLARKE RIVER REGION
CHARTERS TOWERS REGION
PROSPERPINE REGION
BELYANDO REGION
AGSO
SCALE 1 : 3 000 000
SIMPLE CONIC PROJECTION
PARALLELS: -18°S, -36°S CENTRAL MERIDAN: 144.5°
DATUM: Australian Geodetic 1966
Bamaga
WEIPA
Lockhart River
Aurukun
Coen
Pormpuraaw
Kowanyama
COOKTOWN
Laura
Mossman
CAIRNS
MAREEBA
Chillagoe
Dimbulah
ATHERTON
Herberton
INNISFAIL
Mount Garnet
TULLY
Normanton
Croydon
Georgetown
Einasleigh
INGHAM
TOWNSVILLE
AYR
HOME HILL
CHARTERS TOWERS
Ravenswood
COLLINSVILLE
Pentland
Julia Creek
RICHMOND

8. Geology

This map is at 1:3 million scale, but is otherwise identical to the 1:1 million North Queensland Geology map (Bain, JHC & Haipola, D, 1997) that accompanies Bain, JHC & Draper, JJ (eds), 1997, "North Queensland Geology", AGSO Bulletin 240/Queensland Geology 9, Canberra & Brisbane. Map polygon boundaries have been omitted for clarity because of the scale and complexity of the dataset. Polygons smaller than the resolution of the printer are "absorbed" by adjacent polygons. The map was compiled from all AGSO/BMR and DME vector digital geological map datasets available in September 1996, using Arc/Info® software. Individual datasets were formed into 1:250,000 sheet areas, rasterised, and smoothed to reduce the number and complexity of polygons. The raster data were re-vectorised and merged into a single seamless dataset. Most of the map is derived from post-1970 mapping (much of it at 1:100,000 scale, especially in the geologically complex eastern part of the map) published as second edition 1:250,000 scale geological series, and special regolith-landform and coastal zone maps. First edition (mostly pre-1970) 1:250,000 geological series maps were used for the Torres Strait Islands, parts of Cape York Peninsula north of 14^0 S, the Cape Melville area, the Carpentaria and Eromanga Basins in the southwestern part of the map, and much of the Ingham-Innisfail and Ayr-Bowen areas. Some boundaries were derived from a digital version of the 1975 1:2,500,000 scale Queensland Geology map. Cainozoic map unit boundaries in Cape York Peninsula north of 16^0 S are derived from AGSO/CYPLUS regolith landform and coastal zone maps. Compiled by JHC Bain and D Haipola; GIS/cartography by D Haipola, V Ashby & HE Apps (AGSO).

GEOLOGY

8

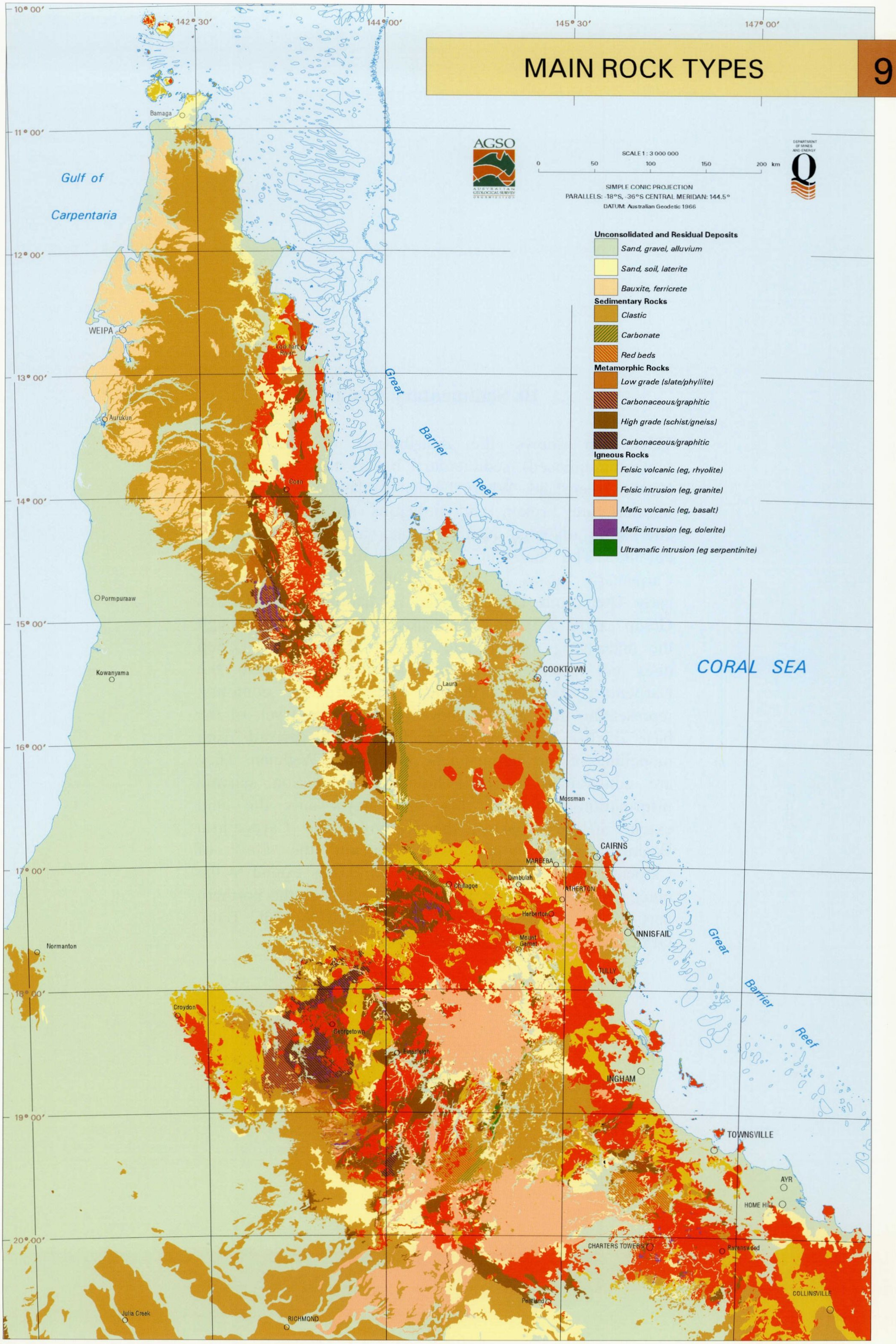

10° 00′
11° 00′
12° 00′
13° 00′
14° 00′
15° 00′
16° 00′
17° 00′
18° 00′
19° 00′
20° 00′
142° 30′
144° 00′
145° 30′
147° 00′
AGSO
AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION
SCALE 1 : 3 000 000
0 50 100 150 200 km
SIMPLE CONIC PROJECTION
PARALLELS: -18°S, -36°S CENTRAL MERIDAN: 144.5°
DATUM: Australian Geodetic 1966
DEPARTMENT OF MINES AND ENERGY
Map legend is on plate 45 (fold out)
Bamaga
Gulf of Carpentaria
WEIPA
Aurukun
Pormpuraaw
Kowanyama
Normanton
Great Barrier Reef
CORAL SEA
COOKTOWN
Laura
Mossman
CAIRNS
MAREEBA
Dimbulah
ATHERTON
INNISFAIL
TULLY
INGHAM
TOWNSVILLE
AYR
HOME HILL
CHARTERS TOWERS
COLLINSVILLE
RICHMOND
Julia Creek

9. Main Rock Types

This map, based on the geological map (Plate 8), shows the distribution of the dominant rock types in each of the general age-based categories of the geological map. Unlike the Geology map, this map gives no age information - polygons enclose rocks of a particular dominant type irrespective of age. Compiled by JHC Bain; GIS/cartography by M Ratajkoski & HE Apps (AGSO).

MAIN ROCK TYPES

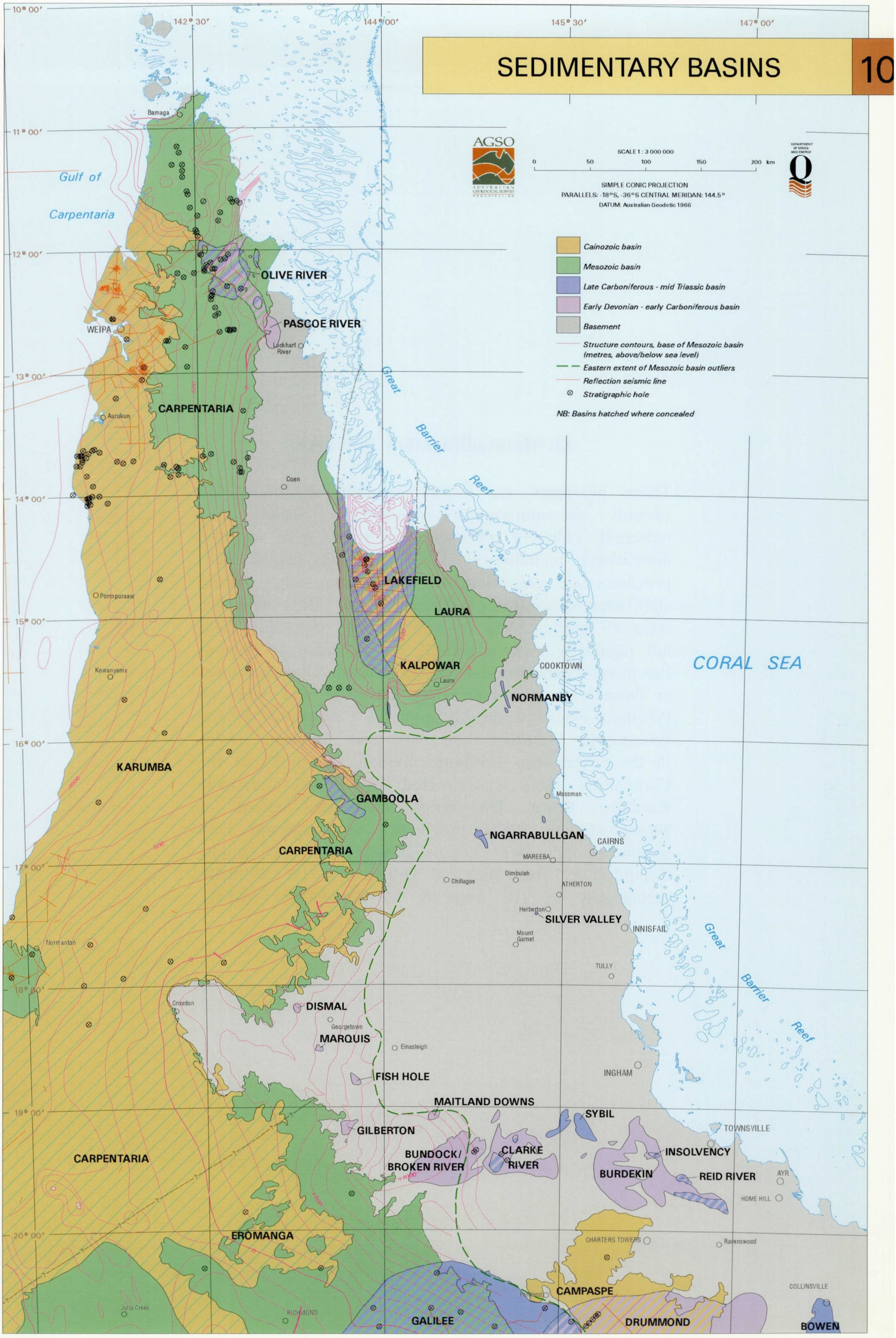
9



10. Sedimentary Basins

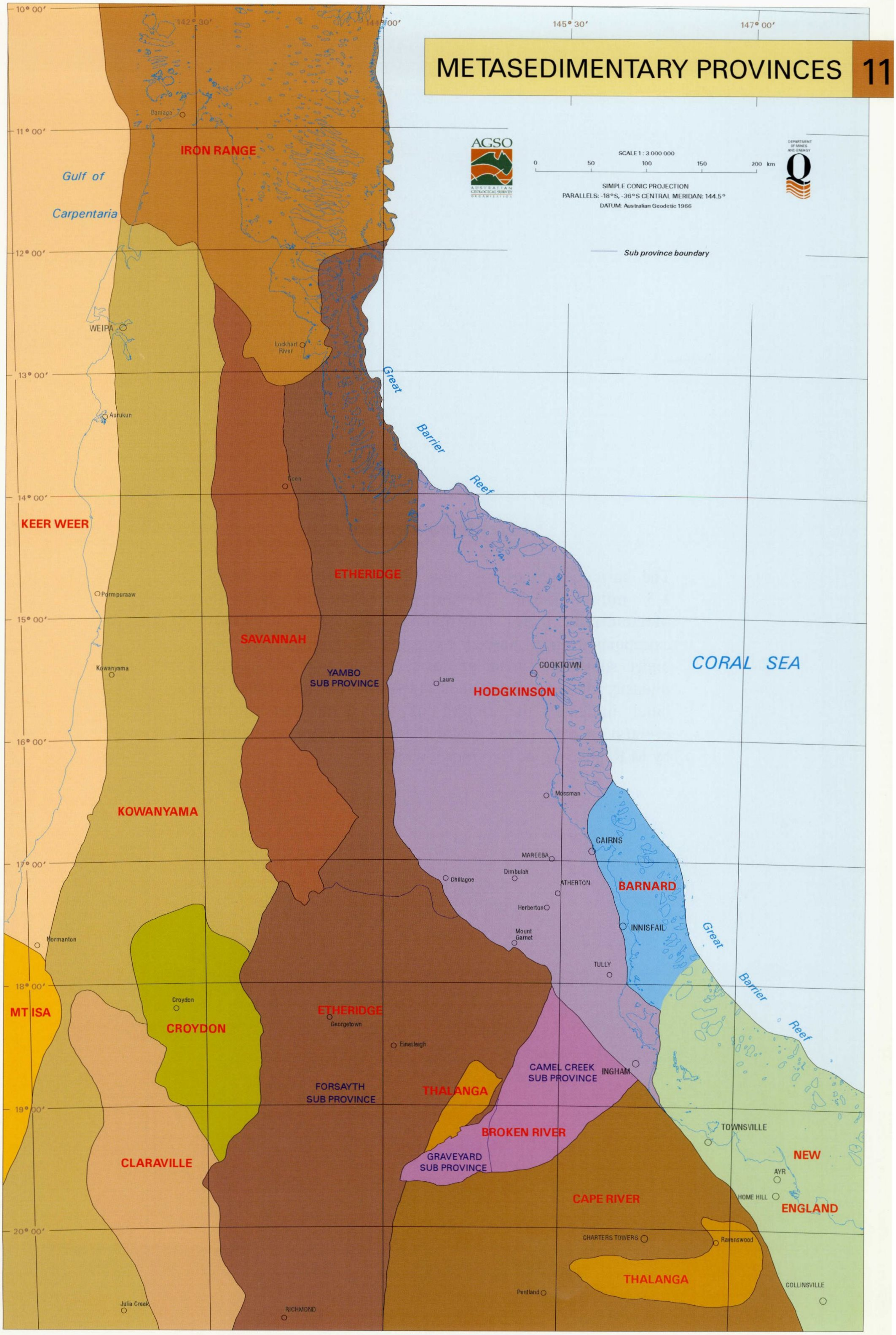
This map shows the distribution of the various (unmetamophosed) sedimentary basins that crop out in North Queensland. Where basins overlap, concealed basin outlines are broken and polygons are coloured with alternating diagonal bands of the various representative colours. The boundary between the Eromanga and Carpentaria Basins is purely arbitary - the late Jurassic-early Cretaceous Gilbert River Formation/Rolling Downs Group extend without break across this boundary although the underlying mid to late Jurassic Eulo Queen Group does not extend more than about 50 km into the Carpentaria Basin as defined. The structure contours, representing the distance above or below sea level, of the base of the Mesozoic basin, have been derived from modelling of the aeromagnetic data by P. Wellman. They are constrained by drill hole and reflection seismic information. Although this map shows only the land extent of these basins, the Karumba and Carpentaria Basins clearly extend west beneath the Gulf of Carpentaria. The Laura and Lakefield Basins extend to the outer edge of the Great Barrier Reef, as does the northern part of the Carpentaria Basin. Compiled by JHC Bain; GIS/cartography by H Apps (AGSO.

SEDIMENTARY BASINS



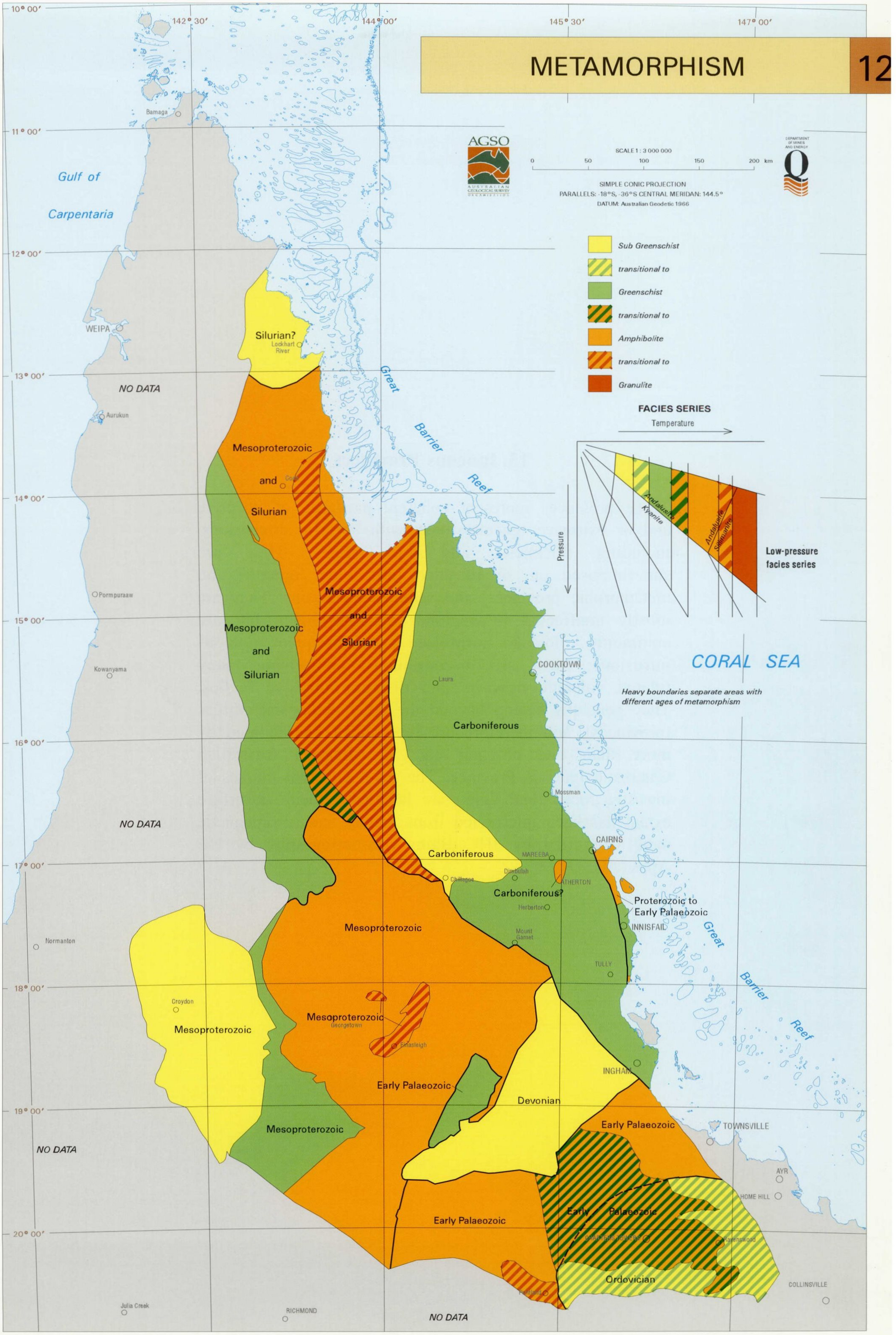
11. Metasedimentary Provinces

These provinces are mostly strongly deformed and variably metamorphosed sedimentary basins: they represent coherent packages of rock with specific dimensions, including thickness, and age ranges. Sub-provinces are equivalent to sub-basins; some contain significant quantities of igneous rocks. Most extensive areas of igneous rocks of common age, especially those not regionally metamorphosed, are allocated to Igneous Provinces. Provinces may extend beneath other provinces or basins, e.g., the Proterozoic Etheridge and Savannah Provinces extend westwards from the Georgetown Region beneath the Mesozoic Carpentaria and Eromanga Basins in the Carpentaria Lowlands Region and much of the Carpentaria Basin is concealed beneath the Cainozoic Karumba Basin. Boundaries may be faulted or superpositional. Some provinces are composite with basement and cover components, others are simple. Compiled by JHC Bain, JJ Draper and IW Withnall; cartography by HE Apps & M Ratajkoski (AGSO).


METASEDIMENTARY PROVINCES
11
AGSO
SCALE 1 : 3 000 000
0 50 100 150 200 km
SIMPLE CONIC PROJECTION
PARALLELS: -18°S, -36°S CENTRAL MERIDAN: 144.5°
DATUM: Australian Geodetic 1966
Sub province boundary
10° 00'
11° 00'
12° 00'
13° 00'
14° 00'
15° 00'
16° 00'
17° 00'
18° 00'
19° 00'
20° 00'
142° 30'
144° 00'
145° 30'
147° 00'
Gulf of
Carpentaria
CORAL SEA
Great
Barrier
Reef
IRON RANGE
KEER WEER
ETHERIDGE
SAVANNAH
YAMBO
SUB PROVINCE
HODGKINSON
KOWANYAMA
BARNARD
MT ISA
CROYDON
ETHERIDGE
FORSAYTH
SUB PROVINCE
THALANGA
CAMEL CREEK
SUB PROVINCE
BROKEN RIVER
GRAVEYARD
SUB PROVINCE
CLARAVILLE
CAPE RIVER
NEW
ENGLAND
THALANGA
Bamaga
WEIPA
Lockhart River
Aurukun
Coen
Pormpuraaw
Kowanyama
Laura
COOKTOWN
Mossman
CAIRNS
MAREEBA
Dimbulah
Chillagoe
ATHERTON
Herberton
INNISFAIL
Mount Garnet
TULLY
Normanton
Croydon
Georgetown
Einasleigh
INGHAM
TOWNSVILLE
AYR
HOME HILL
CHARTERS TOWERS
Ravenswood
Pentland
COLLINSVILLE
Julia Creek
RICHMOND

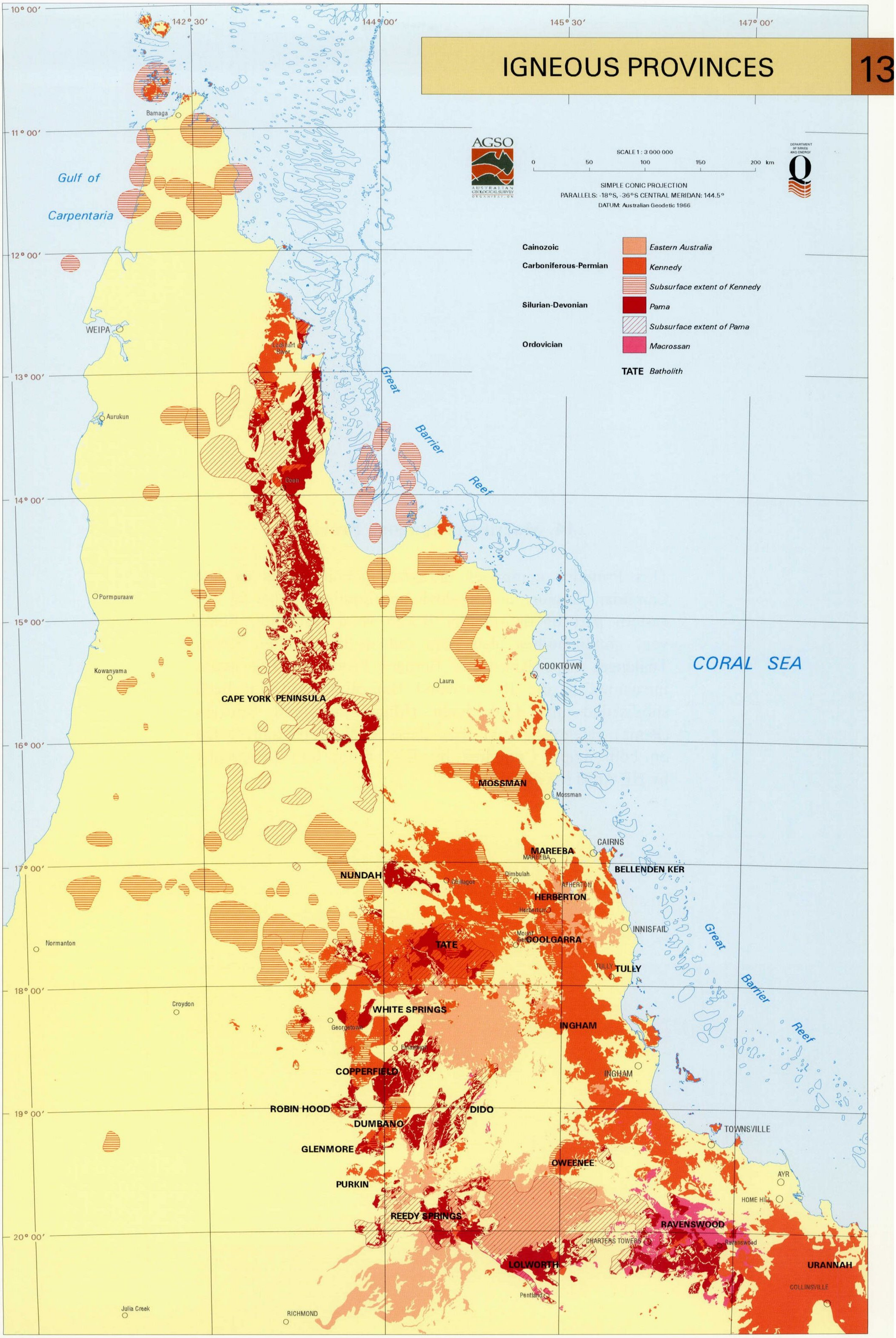
12. Metamorphism

The basic design of this map follows that of the AGSO 1:5 million scale Metamorphic Map of Australia. Metamorphic facies information has been substantially extrapolated from limited control sites, and by inference, under substantial areas of cover. Colour indicates relative intensity of metamorphism (facies) and the geological age label indicates the timing of the main metamorphic event(s) in that area. Compiled by JHC Bain; cartography by M Ratajkoski & HE Apps (AGSO).


METAMORPHISM
12
10° 00′
11° 00′
12° 00′
13° 00′
14° 00′
15° 00′
16° 00′
17° 00′
18° 00′
19° 00′
20° 00′
142° 30′
144° 00′
145° 30′
147° 00′
AGSO
SCALE 1 : 3 000 000
0
50
100
150
200 km
SIMPLE CONIC PROJECTION
PARALLELS: -18°S, -36°S CENTRAL MERIDIAN: 144.5°
DATUM: Australian Geodetic 1966
Sub Greenschist
transitional to
Greenschist
transitional to
Amphibolite
transitional to
Granulite
FACIES SERIES
Temperature
Pressure
Andalusite
Kyanite
Andalusite
Sillimanite
Low-pressure facies series
Heavy boundaries separate areas with different ages of metamorphism
Gulf of Carpentaria
CORAL SEA
Great Barrier Reef
NO DATA
Bamaga
WEIPA
Lockhart River
Aurukun
Pormpuraaw
Kowanyama
Normanton
Croydon
Julia Creek
RICHMOND
COOKTOWN
Laura
Mossman
CAIRNS
MAREEBA
Dimbulah
Chillagoe
ATHERTON
Herberton
Mount Garnet
INNISFAIL
TULLY
Georgetown
Einasleigh
INGHAM
TOWNSVILLE
AYR
HOME HILL
COLLINSVILLE
Ravenswood
Pentland
Silurian?
Mesoproterozoic and Silurian
Mesoproterozoic and Silurian
Mesoproterozoic and Silurian
Carboniferous
Carboniferous
Carboniferous?
Proterozoic to Early Palaeozoic
Mesoproterozoic
Mesoproterozoic
Mesoproterozoic
Mesoproterozoic
Early Palaeozoic
Devonian
Early Palaeozoic
Early Palaeozoic
Early Palaeozoic
Ordovician

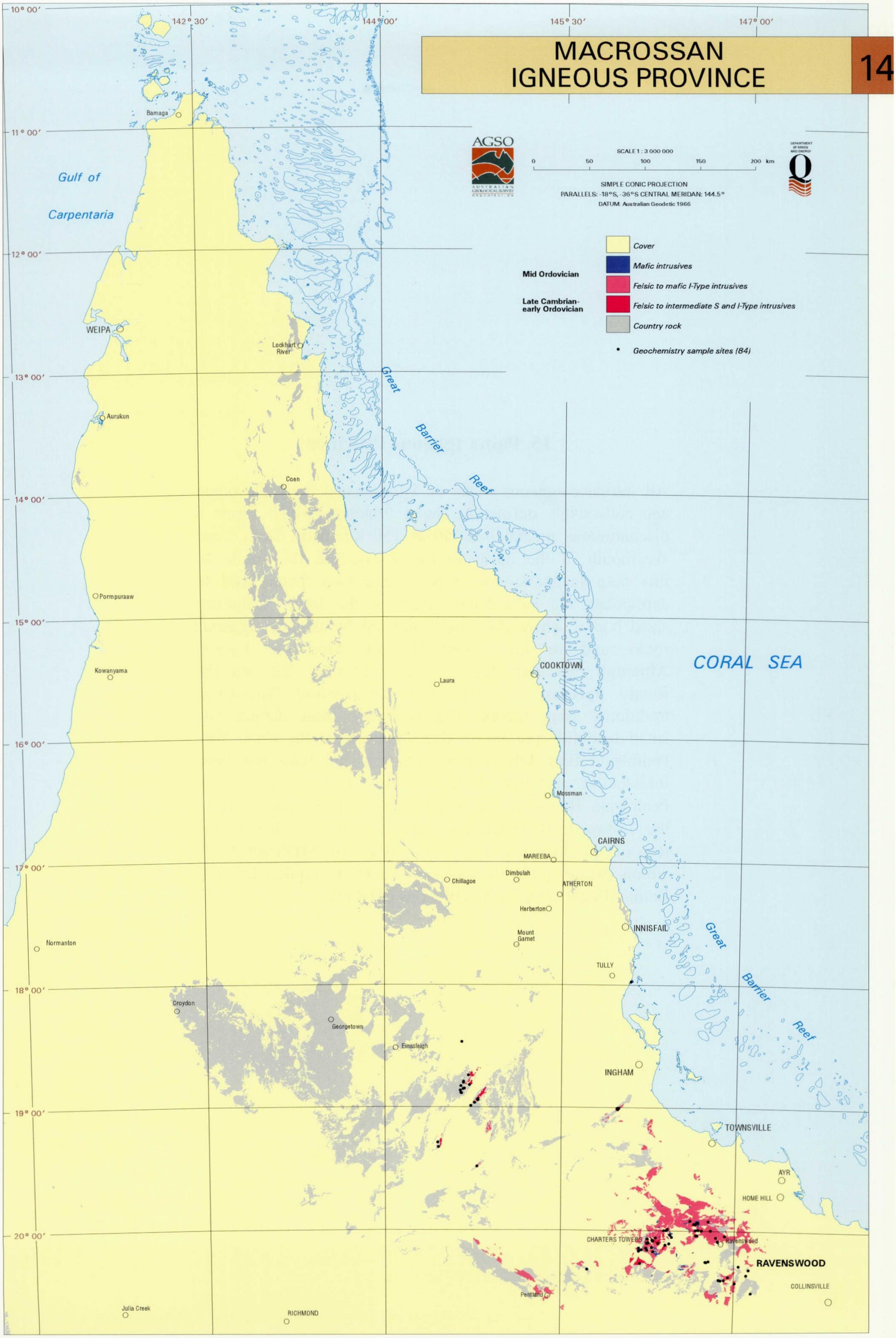
13. Igneous Provinces

These provinces represent coherent packages of intrusive and or extrusive igneous rocks with specific dimensions, including thickness, and age ranges. They are superimposed on, or intruded into, older igneous and metamorphic provinces, and sedimentary basins. They are mostly unaffected by regional metamorphism, but are commonly locally hornfelsed by subsequent igneous intrusions. Most are discontinuous, comprising many related volcanic deposits and discrete intrusive bodies. They generally extend beyond the other geological entities (provinces), and therefore are represented on the map by more than one polygon e.g., the Eastern Australian Cainozoic Igneous Province. The main coherent masses of intrusive rocks (batholiths) are labelled - their subsurface extent has been interpreted from gravity and aeromagnetic data. Compiled by JHC Bain; GIS/cartography by HE Apps (AGSO).


IGNEOUS PROVINCES
13
AGSO
AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION
SCALE 1 : 3 000 000
0 50 100 150 200 km
SIMPLE CONIC PROJECTION
PARALLELS: -18°S, -36°S CENTRAL MERIDAN: 144.5°
DATUM: Australian Geodetic 1966
Cainozoic
Eastern Australia
Carboniferous-Permian
Kennedy
Subsurface extent of Kennedy
Silurian-Devonian
Pama
Subsurface extent of Pama
Ordovician
Macrossan
TATE Batholith
10° 00′
11° 00′
12° 00′
13° 00′
14° 00′
15° 00′
16° 00′
17° 00′
18° 00′
19° 00′
20° 00′
142° 30′
144° 00′
145° 30′
147° 00′
Gulf of
Carpentaria
Bamaga
WEIPA
Aurukun
Pormpuraaw
Kowanyama
Normanton
Croydon
Julia Creek
RICHMOND
Lockhart River
Coen
Laura
COOKTOWN
Great
Barrier
Reef
CORAL SEA
CAPE YORK PENINSULA
MOSSMAN
Mossman
CAIRNS
MAREEBA
MAREEBA
BELLENDEN KER
NUNDAH
Chillagoe
Dimbulah
ATHERTON
HERBERTON
Herberton
INNISFAIL
Mount Garnet
COOLGARRA
TATE
TULLY
TULLY
WHITE SPRINGS
Georgetown
Einasleigh
INGHAM
INGHAM
COPPERFIELD
ROBIN HOOD
DIDO
DUMBANO
GLENMORE
TOWNSVILLE
OWEENEE
AYR
HOME HILL
PURKIN
REEDY SPRINGS
RAVENSWOOD
CHARTERS TOWERS
Ravenswood
LOLWORTH
URANNAH
COLLINSVILLE
Pentland

14. Macrossan Igneous Province

This Province comprises intrusive igneous rocks of late Cambrian (minor) and Ordovician (dominant) age in the eastern part of the greater Ravenswood Batholith. Some very small bodies also crop out in the Broken River, Thalanga, Cape River and Barnard Provinces. The mafic intrusions in the Ravenswood Batholith have not been subdivided into Ordovician (Macrossan) and Silurian (Pama) categories, and thus these bodies are represented on both maps. Compiled by JHC Bain; GIS/cartography by HE Apps (AGSO).

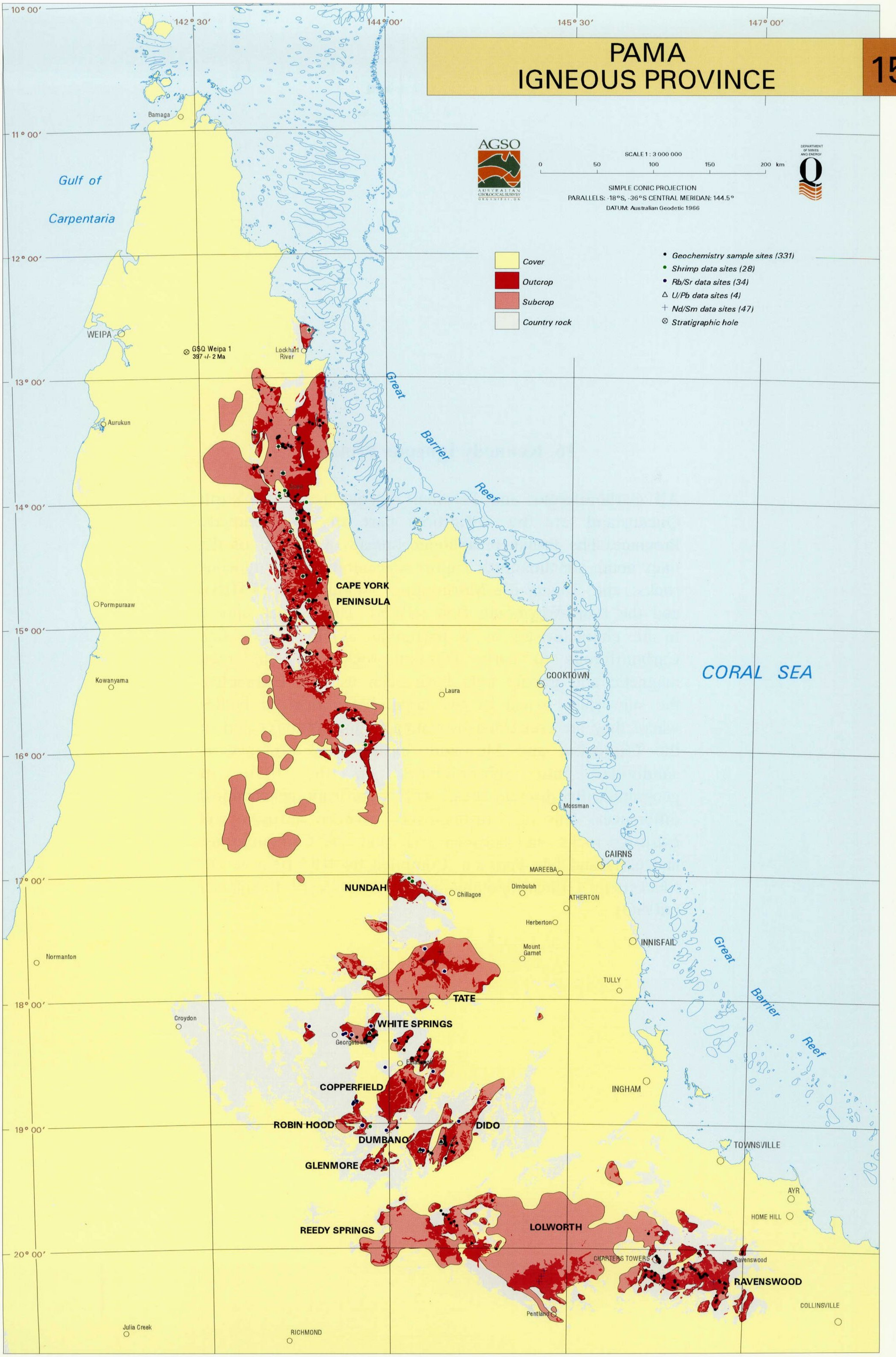

MACROSSAN
IGNEOUS PROVINCE
14
AGSO
AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION
SCALE 1 : 3 000 000
0 50 100 150 200 km
SIMPLE CONIC PROJECTION
PARALLELS: -18°S, -36°S CENTRAL MERIDAN: 144.5°
DATUM: Australian Geodetic 1966
DEPARTMENT OF MINES AND ENERGY
Cover
Mid Ordovician
Mafic intrusives
Felsic to mafic I-Type intrusives
Late Cambrian-early Ordovician
Felsic to intermediate S and I-Type intrusives
Country rock
Geochemistry sample sites (84)
10° 00′
11° 00′
12° 00′
13° 00′
14° 00′
15° 00′
16° 00′
17° 00′
18° 00′
19° 00′
20° 00′
142° 30′
144° 00′
145° 30′
147° 00′
Gulf of
Carpentaria
CORAL SEA
Great Barrier Reef
Great Barrier Reef
Bamaga
WEIPA
Lockhart River
Aurukun
Coen
Pormpuraaw
Kowanyama
Laura
COOKTOWN
Mossman
CAIRNS
MAREEBA
Dimbulah
Chillagoe
ATHERTON
Herberton
INNISFAIL
Mount Garnet
TULLY
Normanton
Croydon
Georgetown
Einasleigh
INGHAM
TOWNSVILLE
AYR
HOME HILL
CHARTERS TOWERS
Ravenswood
RAVENSWOOD
COLLINSVILLE
Pentland
Julia Creek
RICHMOND

15. Pama Igneous Province

All intrusive igneous rocks of Silurian and early Devonian age collectively define the Pama Province, which forms a discontinuous medial belt, 50 to 150 km wide, from Cape Weymouth in the north to Ravenswood in the south. In this map magnetic and gravity data have been used to extrapolate the subsurface extent of the large, batholith-sized bodies where they are concealed by younger igneous rocks and or the Cainozoic and Mesozoic basins. Although this map demonstrates continuity between the Reedy Springs, Lolworth and Ravenswood Batholiths, traditional usage dictates that we retain these names. The small batholiths/plutons to the southwest of the Cape York Peninisula Batholith have no outcrop and have not been intersected in drill holes. Most of the Cape York Peninisula Batholith and much of the outcropping part of the Lolworth Batholith are early Devonian, whereas the rest of the Province is, on the basis of SHRIMP U-Pb zircon dating, probably mostly Silurian. Compiled by JHC Bain; GIS/cartography by HE Apps (AGSO).

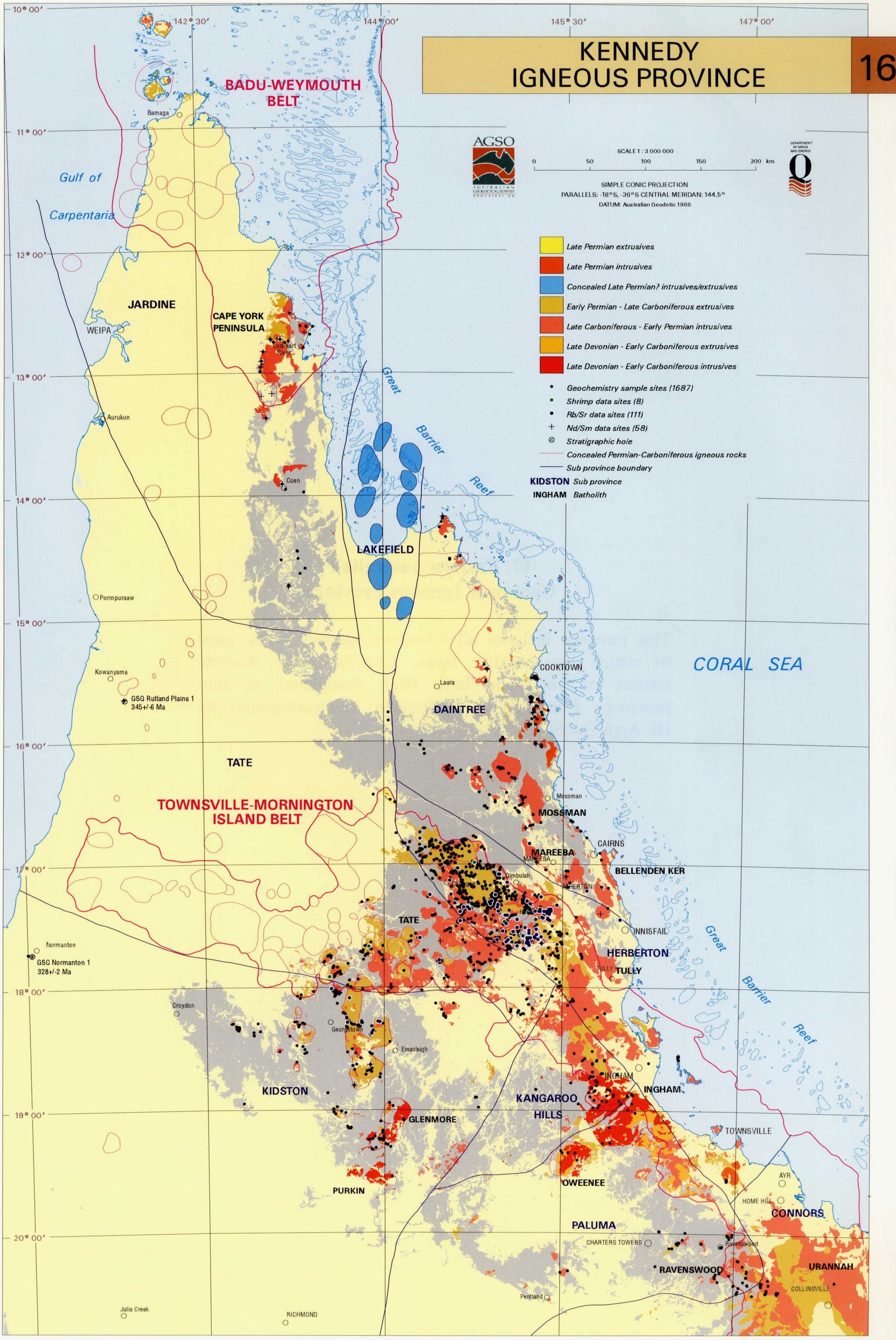
15

PAMA IGNEOUS PROVINCE



16. Kennedy Igneous Province

All Carboniferous and Permian igneous rocks in North Queensland are by definition part of the Kennedy Province. The Province, although spread over most of the map area, contains two major concentrations of igneous rocks: the Townsville-Mornington Island Belt (TMIB), and the Badu-Weymouth Belt (BWB). These areas appear to be characterised by a particular abundance of late Carboniferous to early Permian rocks. In this map magnetic and gravity data have been used to extrapolate the subsurface extent of the large, batholith-sized bodies where they are concealed by younger igneous rocks and or the Cainozoic and Mesozoic basins. The province is subdivided into sub-provinces on the basis of geographically discrete areas with significant geochemical differences. This map distinguishes between intrusive and extrusive rocks, and between early and late Carboniferous, and early and late Permian. Compiled by JHC Bain & DE Mackenzie; GIS/cartography by HE Apps & M Ratajkoski (AGSO).

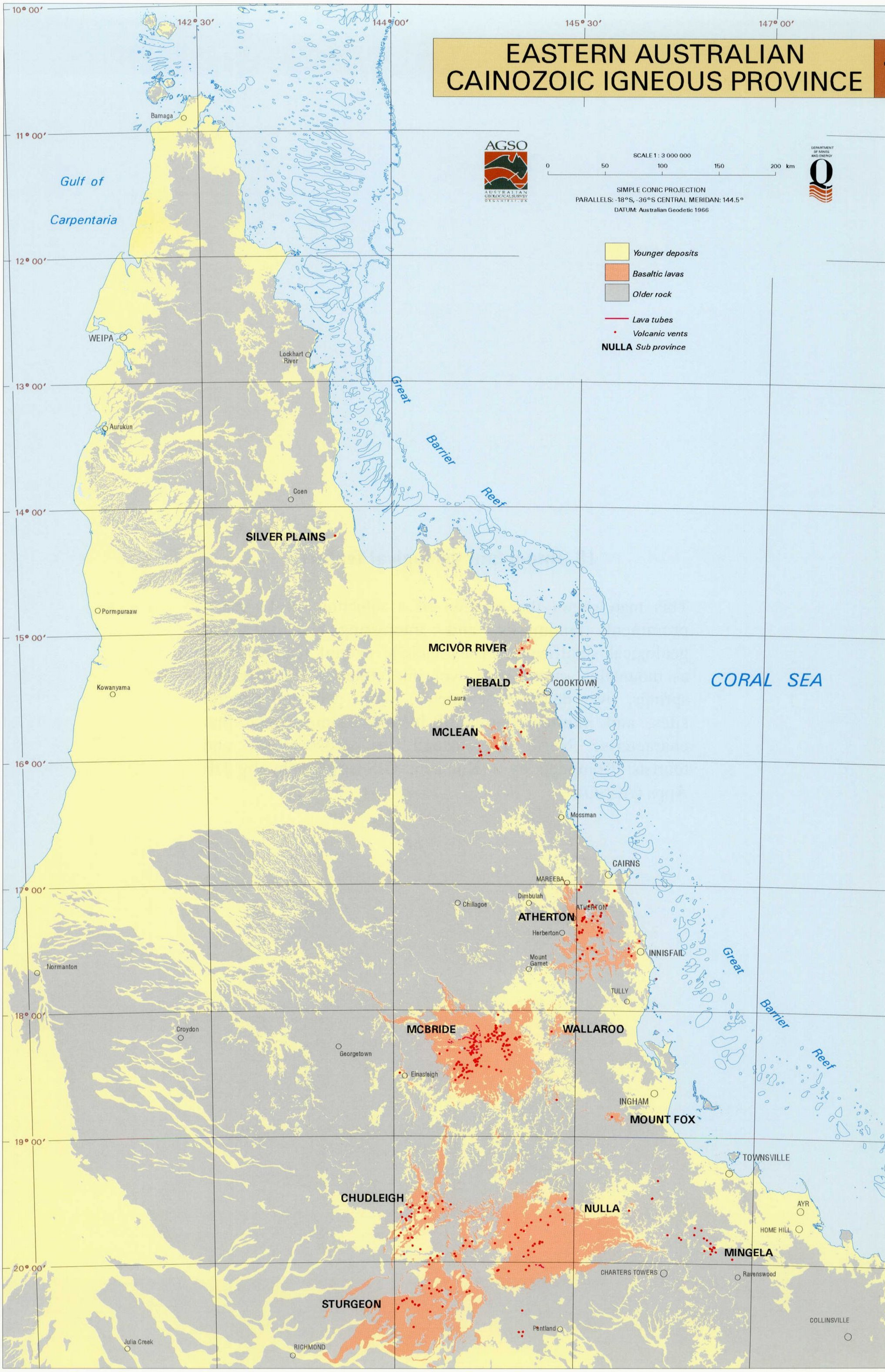

KENNEDY IGNEOUS PROVINCE
16
AGSO
AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION
SCALE 1 : 3 000 000
0 50 100 150 200 km
SIMPLE CONIC PROJECTION
PARALLELS: -18°S, -36°S CENTRAL MERIDAN: 144.5°
DATUM: Australian Geodetic 1966
DEPARTMENT OF MINES AND ENERGY
Late Permian extrusives
Late Permian intrusives
Concealed Late Permian? intrusives/extrusives
Early Permian - Late Carboniferous extrusives
Late Carboniferous - Early Permian intrusives
Late Devonian - Early Carboniferous extrusives
Late Devonian - Early Carboniferous intrusives
Geochemistry sample sites (1687)
Shrimp data sites (8)
Rb/Sr data sites (111)
Nd/Sm data sites (58)
Stratigraphic hole
Concealed Permian-Carboniferous igneous rocks
Sub province boundary
KIDSTON Sub province
INGHAM Batholith
10° 00′
11° 00′
12° 00′
13° 00′
14° 00′
15° 00′
16° 00′
17° 00′
18° 00′
19° 00′
20° 00′
142° 30′
144° 00′
145° 30′
147° 00′
BADU-WEYMOUTH BELT
Bamaga
Gulf of Carpentaria
JARDINE
WEIPA
CAPE YORK PENINSULA
Lockhart River
Aurukun
Great Barrier Reef
Coen
LAKEFIELD
Pormpuraaw
Kowanyama
GSQ Rutland Plains 1
345+/-6 Ma
Laura
COOKTOWN
CORAL SEA
DAINTREE
TATE
TOWNSVILLE-MORNINGTON ISLAND BELT
Mossman
MOSSMAN
MAREEBA
CAIRNS
Dimbulah
BELLENDEN KER
TATE
INNISFAIL
HERBERTON
TULLY
Normanton
GSQ Normanton 1
328+/-2 Ma
Croydon
Georgetown
Einasleigh
KIDSTON
INGHAM
KANGAROO HILLS
GLENMORE
TOWNSVILLE
OWEENEE
PURKIN
AYR
HOME HILL
CONNORS
PALUMA
CHARTERS TOWERS
Ravenswood
RAVENSWOOD
URANNAH
COLLINSVILLE
Pentland
Julia Creek
RICHMOND

17. Eastern Australian Cainozoic Igneous Province

This province includes all Cainozoic igneous rocks, most of which are basaltic lavas. Geographically discrete centres of volcanism have been designated as sub-provinces. Compiled by J Knutson; GIS/cartography by HE Apps (AGSO).

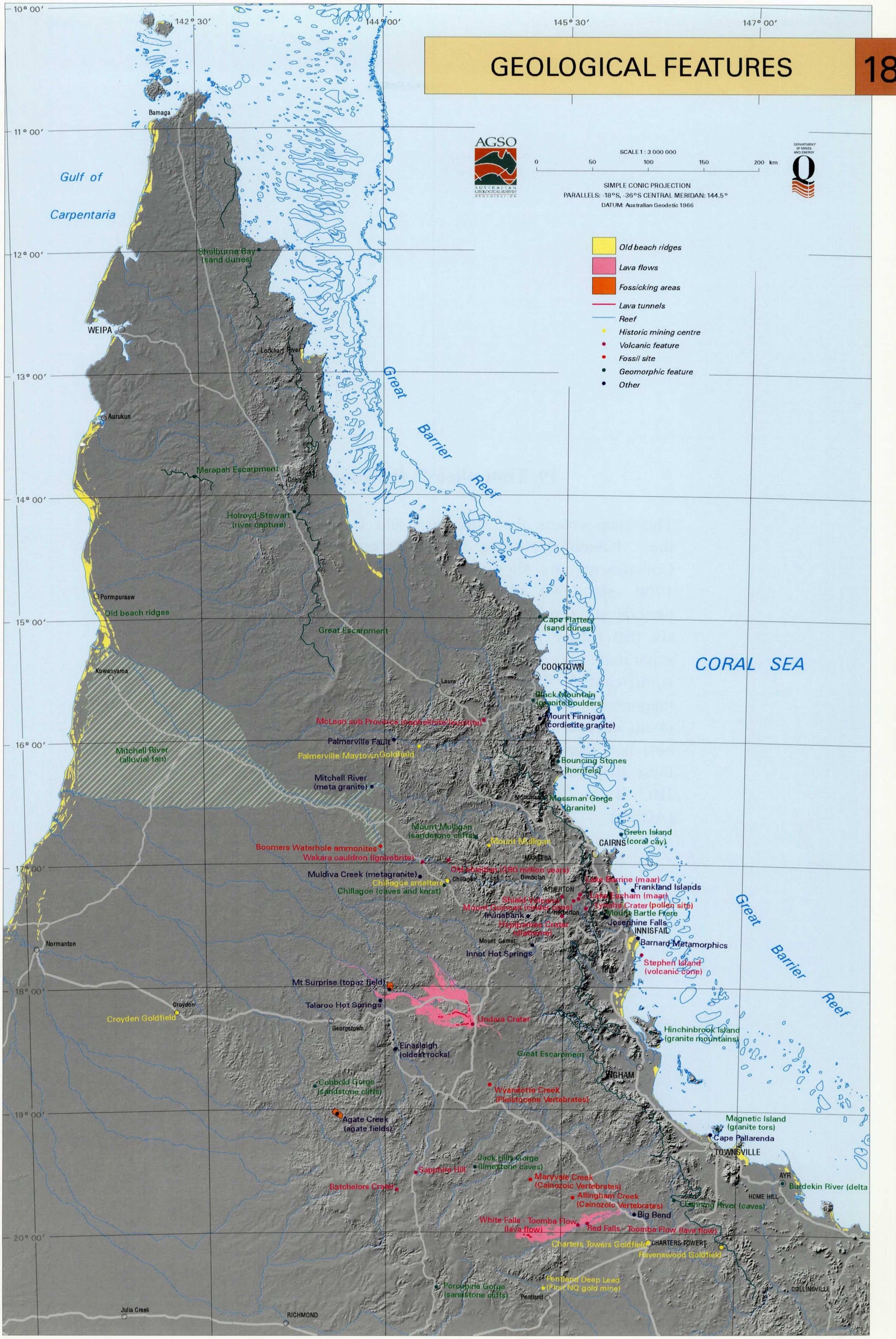
EASTERN AUSTRALIAN CAINOZOIC IGNEOUS PROVINCE

17



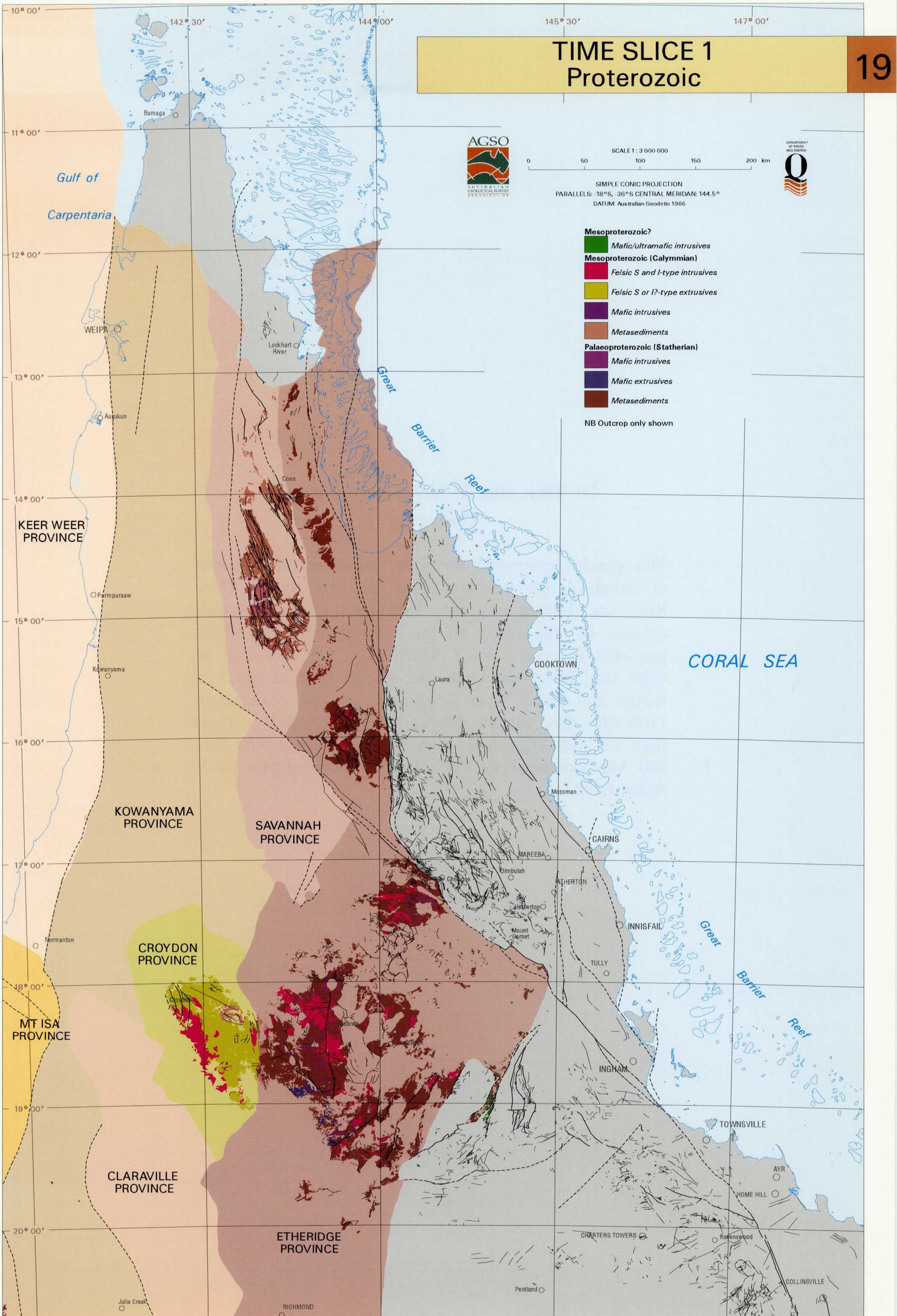
18. Important geological features

This map shows the location of a selection of the many prominent landmarks and interesting localities of geological significance. They include natural features such as mountains, caves, reefs, volcanic craters, tunnels & hot springs, river deltas, escarpments, fossil, gem and mineral sites, and mining centres of historical importance that characterise North Queensland for geoscientists and tourists. Compiled by J Knutson; GIS/cartography by HE Apps (AGSO).


GEOLOGICAL FEATURES
18
AGSO
AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION
SCALE 1 : 3 000 000
0 50 100 150 200 km
SIMPLE CONIC PROJECTION
PARALLELS: -18°S, -36°S CENTRAL MERIDAN: 144.5°
DATUM: Australian Geodetic 1966
DEPARTMENT OF MINES AND ENERGY
Old beach ridges
Lava flows
Fossicking areas
Lava tunnels
Reef
Historic mining centre
Volcanic feature
Fossil site
Geomorphic feature
Other
10° 00′
11° 00′
12° 00′
13° 00′
14° 00′
15° 00′
16° 00′
17° 00′
18° 00′
19° 00′
20° 00′
142° 30′
144° 00′
145° 30′
147° 00′
Gulf of Carpentaria
Great Barrier Reef
CORAL SEA
Bamaga
Shelburne Bay (sand dunes)
WEIPA
Lockhart River
Aurukun
Merapah Escarpment
Holroyd-Stewart (river capture)
Pormpuraaw
Old beach ridges
Great Escarpment
Cape Flattery (sand dunes)
COOKTOWN
Kowanyama
Laura
Black Mountain (granite boulders)
Mount Finnigan (cordierite granite)
Palmerville Fault
Palmerville/Maytown Goldfield
Mitchell River (alluvial fan)
Mitchell River (meta granite)
Bouncing Stones (hornfels)
Mossman Gorge (granite)
Mount Mulligan (sandstone cliffs)
Mount Mulligan
Green Island (coral cay)
CAIRNS
Boomers Waterhole ammonites
Wakara cauldron (ignimbrite)
MAREEBA
Muldiva Creek (metagranite)
Chillagoe smelters
Chillagoe (caves and karst)
Chillagoe
Dimbulah
Lake Barrine (maar)
Frankland Islands
ATHERTON
Lake Eacham (maar)
Synods Crater (pollen site)
Mount Bartle Frere
Irvinebank
Josephine Falls
INNISFAIL
Barnard Metamorphics
Normanton
Mount Garnet
Innot Hot Springs
Stephen Island (volcanic cone)
Mt Surprise (topaz field)
Talaroo Hot Springs
Croydon
Croyden Goldfield
Georgetown
Undara Crater
Einasleigh (oldest rocks)
Hinchinbrook Island (granite mountains)
Great Escarpment
INGHAM
Cobbold Gorge (sandstone cliffs)
Wyandotte Creek (Pleistocene Vertebrates)
Agate Creek (agate fields)
Magnetic Island (granite tors)
Cape Pallarenda
TOWNSVILLE
Jack Hills Gorge (limestone caves)
Sapphire Hill
Maryvale Creek (Cainozoic Vertebrates)
Batchelors Crater
Allingham Creek (Cainozoic Vertebrates)
AYR
Burdekin River (delta
HOME HILL
Big Bend
White Falls - Toomba Flow (lava flow)
Red Falls - Toomba Flow (lava flow)
Charters Towers Goldfield
CHARTERS TOWERS
Ravenswood Goldfield
Pentland Deep Lead (First NQ gold mine)
Porcupine Gorge (sandstone cliffs)
Pentland
COLLINSVILLE
Julia Creek
RICHMOND

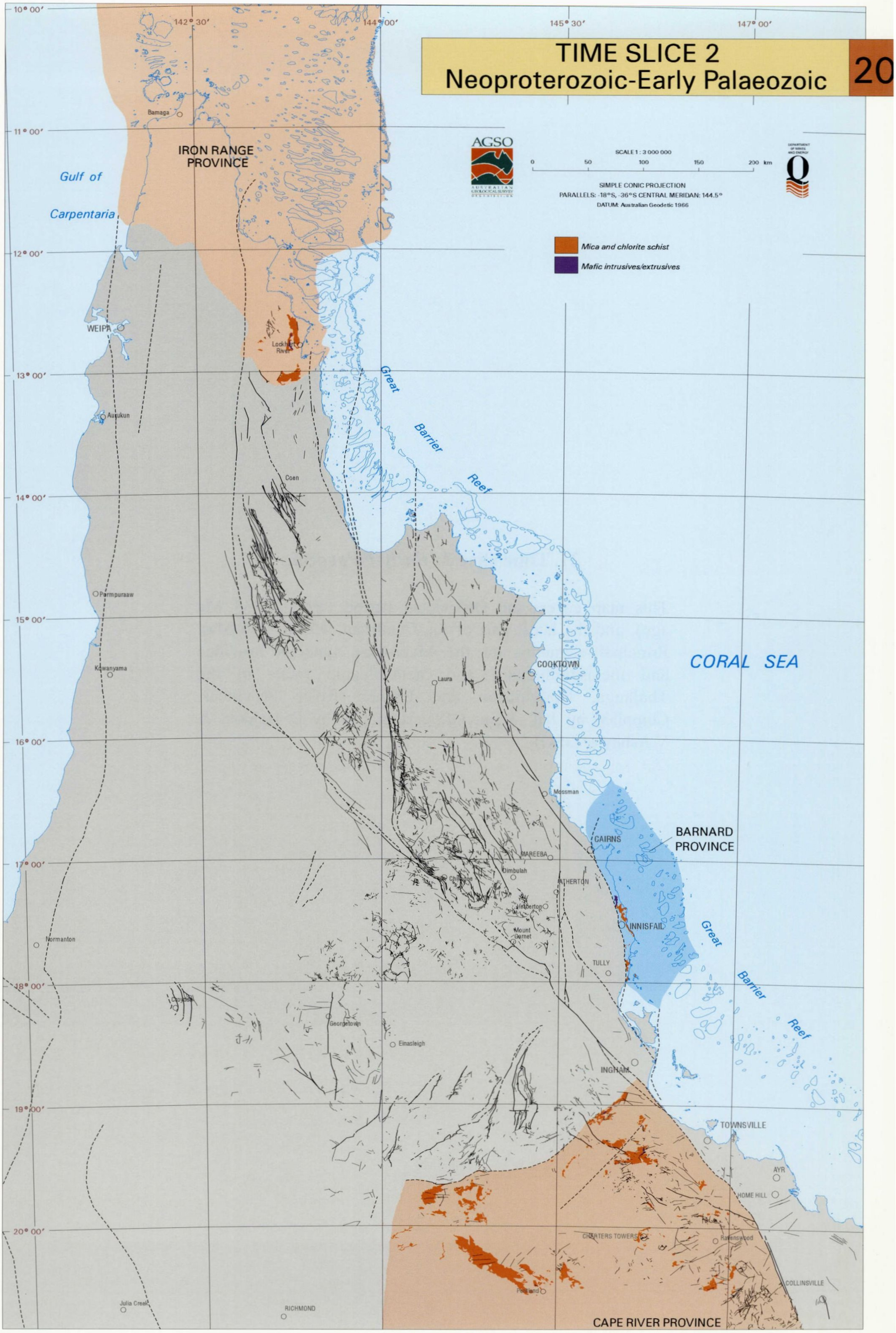
19. Time slice 1: *Proterozoic*

This map covers the Statherian and Calymian periods of the Palaeoproterozoic and Mesoproterozoic eras. Constituents are thought to have been formed between 1700 and 1500 Ma ago. Subcropping rocks of these periods are shown in the paler colours. This map and the six that follow it display elements of the geological map separated into seven periods (or time slices) marking significantly different styles of sedimentation and magmatism, or separated by substantial periods of erosion, or an absence of any geological record. Plate 26 (a fold out) is a geological timescale that provides a link between these maps, and the Geology map (Plate 8). Compiled by JHC Bain; GIS/cartography by D Haipola & V Ashby (AGSO).


TIME SLICE 1
Proterozoic
19
AGSO
SCALE 1 : 3 000 000
0 50 100 150 200 km
SIMPLE CONIC PROJECTION
PARALLELS: -18°S, -36°S CENTRAL MERIDAN: 144.5°
DATUM: Australian Geodetic 1966
Mesoproterozoic?
Mafic/ultramafic intrusives
Mesoproterozoic (Calymmian)
Felsic S and I-type intrusives
Felsic S or I?-type extrusives
Mafic intrusives
Metasediments
Palaeoproterozoic (Statherian)
Mafic intrusives
Mafic extrusives
Metasediments
NB Outcrop only shown
10° 00′
11° 00′
12° 00′
13° 00′
14° 00′
15° 00′
16° 00′
17° 00′
18° 00′
19° 00′
20° 00′
142° 30′
144° 00′
145° 30′
147° 00′
Gulf of
Carpentaria
Great Barrier Reef
CORAL SEA
KEER WEER
PROVINCE
KOWANYAMA
PROVINCE
SAVANNAH
PROVINCE
CROYDON
PROVINCE
MT ISA
PROVINCE
CLARAVILLE
PROVINCE
ETHERIDGE
PROVINCE
Bamaga
WEIPA
Lockhart River
Aurukun
Coen
Pormpuraaw
Kowanyama
Laura
COOKTOWN
Mossman
CAIRNS
MAREEBA
Dimbulah
Chillagoe
ATHERTON
Herberton
INNISFAIL
Mount Garnet
TULLY
Normanton
INGHAM
TOWNSVILLE
AYR
HOME HILL
CHARTERS TOWERS
Ravenswood
COLLINSVILLE
Pentland
Julia Creek
RICHMOND

20. Time slice 2: *Neoproterozoic-Early Palaeozoic*

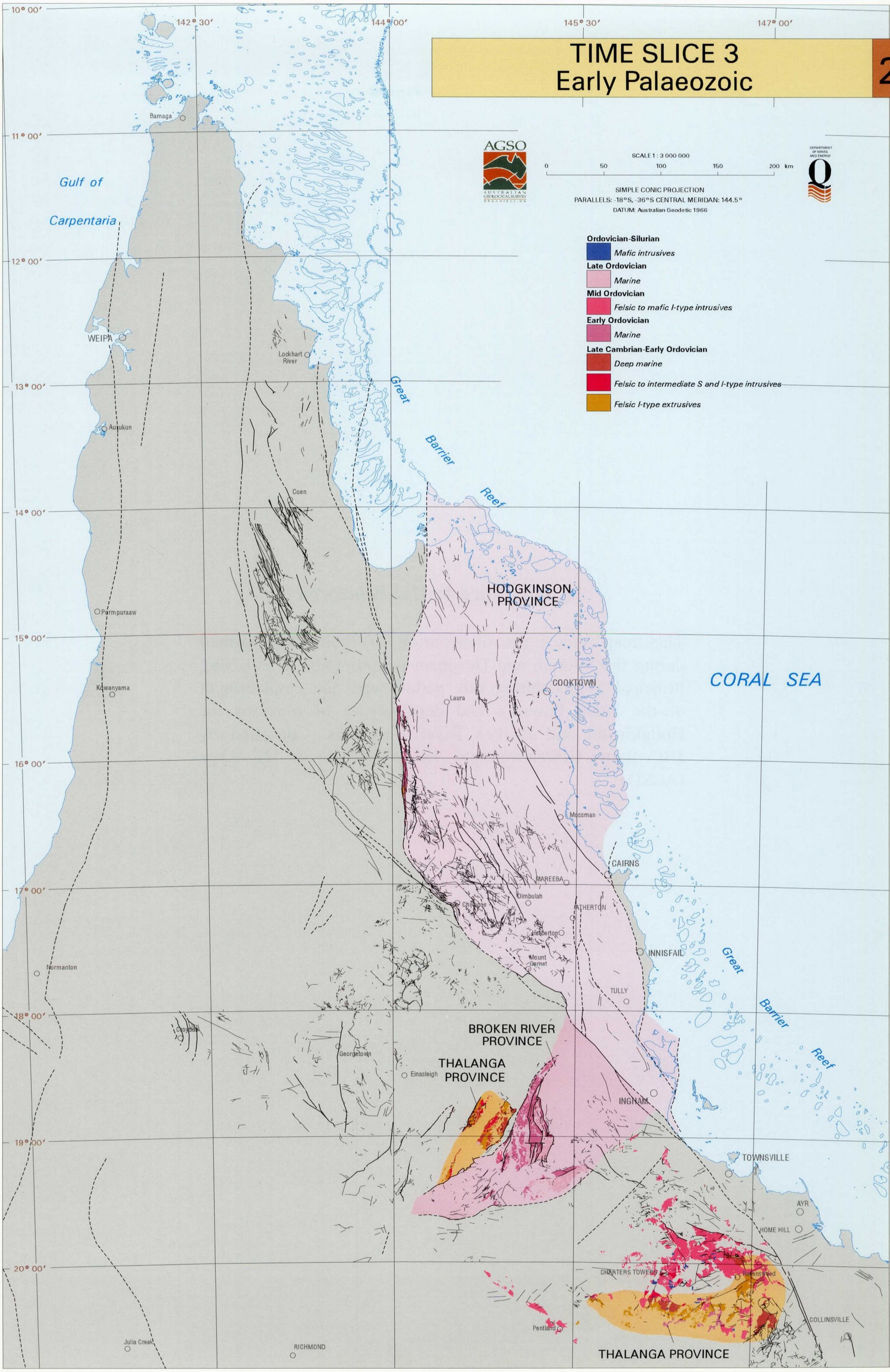
This poorly constrained timeslice is represented by rocks of unknown age that constitute the Iron Range, Cape River and Barnard Provinces. Outcrops are shown in dark colours, the full extent of the subcropping parts of the provinces in paler colours. These rocks are known to be older than latest Cambrian and, in the case of the Iron Range and Cape River Provinces, younger than about 1100 Ma: they contain detrital zircons that were derived from an 1100 Ma source. They may well be younger than 600 Ma. Compiled by JHC Bain; GIS/cartography by V Ashby (AGSO).



TIME SLICE 2
Neoproterozoic-Early Palaeozoic
20
AGSO
SCALE 1 : 3 000 000
SIMPLE CONIC PROJECTION
PARALLELS: -18°S, -36°S CENTRAL MERIDIAN: 144.5°
DATUM: Australian Geodetic 1966
Mica and chlorite schist
Mafic intrusives/extrusives
IRON RANGE PROVINCE
Gulf of Carpentaria
Great Barrier Reef
CORAL SEA
BARNARD PROVINCE
CAPE RIVER PROVINCE
Bamaga
WEIPA
Lockhart River
Aurukun
Coen
Pormpuraaw
Kowanyama
COOKTOWN
Laura
Mossman
CAIRNS
MAREEBA
ATHERTON
Dimbulah
Chillagoe
Herberton
INNISFAIL
Mount Garnet
TULLY
Normanton
Croydon
Georgetown
Einasleigh
INGHAM
TOWNSVILLE
AYR
HOME HILL
CHARTERS TOWERS
Ravenswood
COLLINSVILLE
Pentland
Julia Creek
RICHMOND

21. Time slice 3: *Early Palaeozoic*

This map covers the Ordovician period (490 to 434 Ma ago), and the latest part of the Cambrian (495 to 490 Ma). Principal elements are the Macrossan Igneous Province and metasedimentary and metavolcanic rocks in the Thalanga, Hodgkinson and Broken River Provinces. Compiled by JHC Bain; GIS/cartography by D Haipola & V Ashby (AGSO).

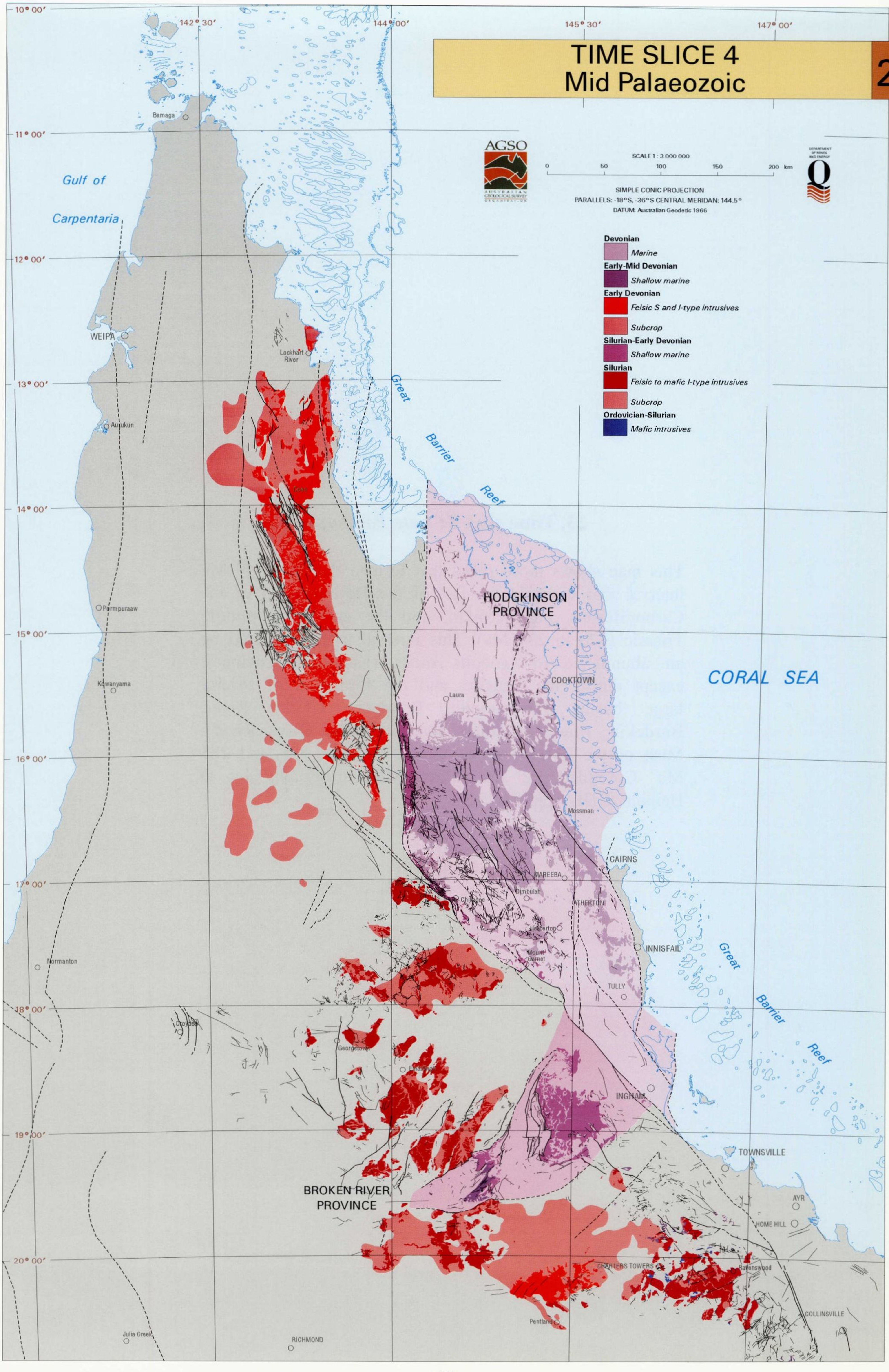

TIME SLICE 3
Early Palaeozoic
21
AGSO
AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION
SCALE 1 : 3 000 000
0 50 100 150 200 km
SIMPLE CONIC PROJECTION
PARALLELS: -18°S, -36°S CENTRAL MERIDAN: 144.5°
DATUM: Australian Geodetic 1966
DEPARTMENT OF MINES AND ENERGY
Ordovician-Silurian
Mafic intrusives
Late Ordovician
Marine
Mid Ordovician
Felsic to mafic I-type intrusives
Early Ordovician
Marine
Late Cambrian-Early Ordovician
Deep marine
Felsic to intermediate S and I-type intrusives
Felsic I-type extrusives
10° 00′
11° 00′
12° 00′
13° 00′
14° 00′
15° 00′
16° 00′
17° 00′
18° 00′
19° 00′
20° 00′
142° 30′
144° 00′
145° 30′
147° 00′
Gulf of
Carpentaria
Great Barrier Reef
CORAL SEA
HODGKINSON PROVINCE
BROKEN RIVER PROVINCE
THALANGA PROVINCE
THALANGA PROVINCE
Bamaga
WEIPA
Lockhart River
Aurukun
Coen
Pormpuraaw
Kowanyama
Laura
COOKTOWN
Mossman
CAIRNS
MAREEBA
Dimbulah
Chillagoe
ATHERTON
Herberton
INNISFAIL
Mount Garnet
TULLY
Normanton
Croydon
Georgetown
Einasleigh
INGHAM
TOWNSVILLE
AYR
HOME HILL
CHARTERS TOWERS
Ravenswood
Pentland
COLLINSVILLE
Julia Creek
RICHMOND

22. Time slice 4: *Mid Palaeozoic*

This map shows the distribution of rocks that formed during the Silurian and Devonian periods (434 to 354 Ma). Principal events during this period were the emplacement of the Pama Province and development of most of the Hodgkinson and Broken River Provinces. Compiled by JHC Bain; GIS/cartography by D Haipola & HE Apps (AGSO).

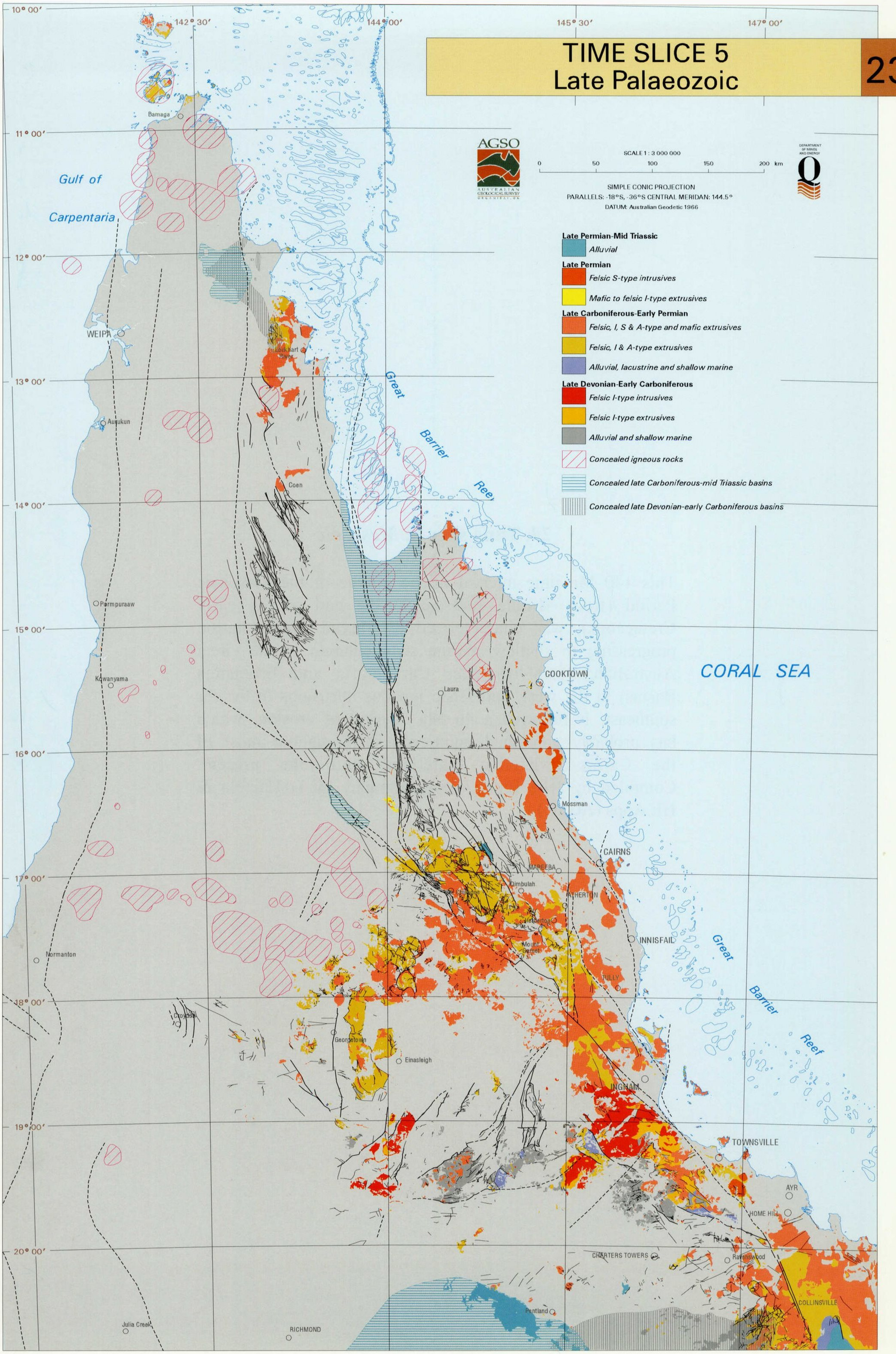
TIME SLICE 4
Mid Palaeozoic

22



23. Time slice 5: *Late Palaeozoic*

This map shows those rocks that formed during a 140 Ma interval that included the last of the Devonian, all of the Carboniferous and Permian, and the early and middle Triassic (370 to 230 Ma). This interval is characterised by an abundance of igneous rocks (Kennedy Province), except during the Triassic, and the formation of several large basins (Drummond, Bundock, Clarke River, Burdekin, Bowen, Galilee, Lakefield and Olive River). Most of the igneous rocks formed between 325 and 285 Ma. Compiled by JHC Bain; GIS/cartography by D Haipola & HE Apps (AGSO).

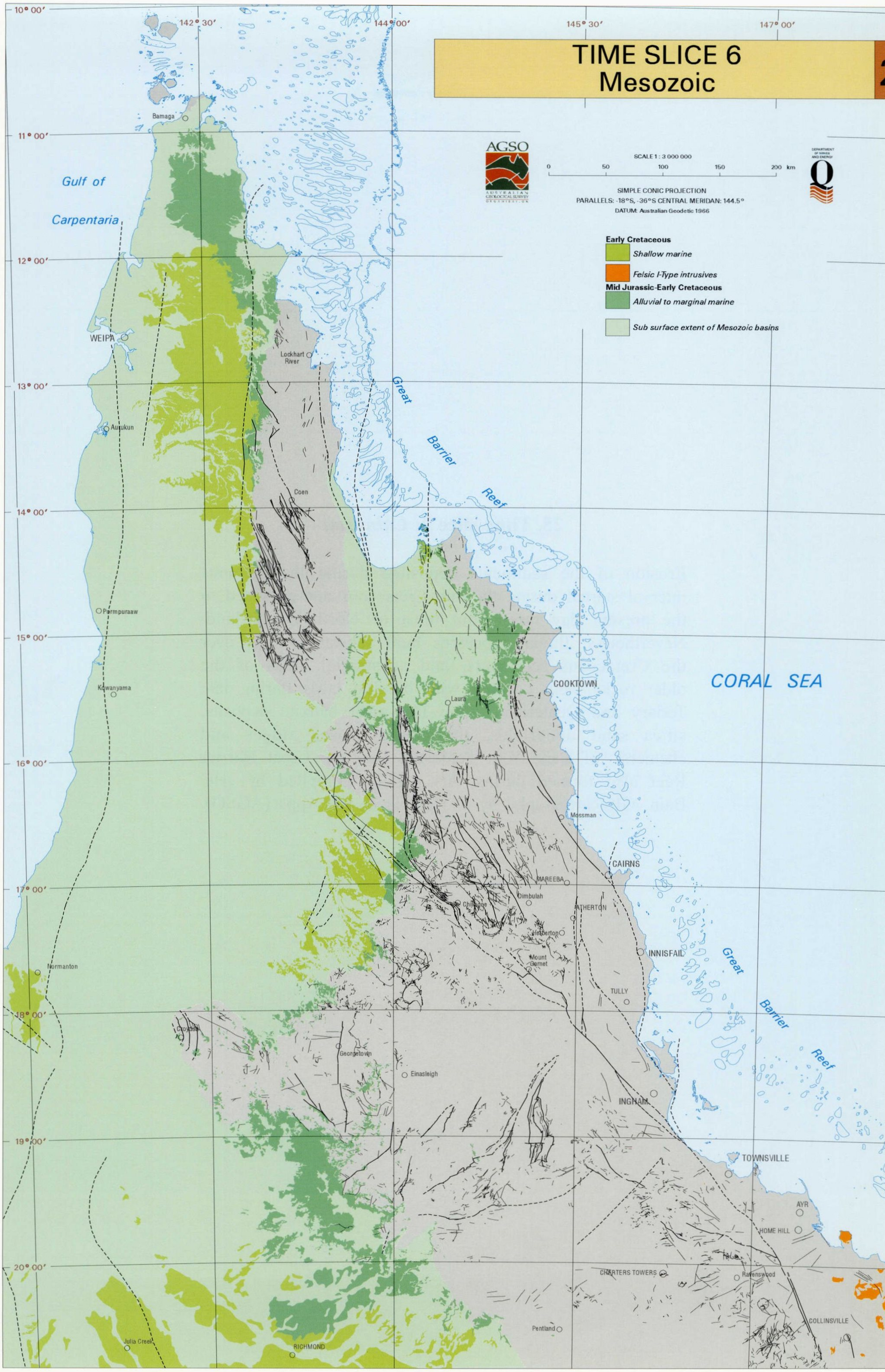

TIME SLICE 5
Late Palaeozoic
23
AGSO
SCALE 1 : 3 000 000
0 50 100 150 200 km
SIMPLE CONIC PROJECTION
PARALLELS: -18°S, -36°S CENTRAL MERIDAN: 144.5°
DATUM: Australian Geodetic 1966
Late Permian-Mid Triassic
Alluvial
Late Permian
Felsic S-type intrusives
Mafic to felsic I-type extrusives
Late Carboniferous-Early Permian
Felsic, I, S & A-type and mafic extrusives
Felsic, I & A-type extrusives
Alluvial, lacustrine and shallow marine
Late Devonian-Early Carboniferous
Felsic I-type intrusives
Felsic I-type extrusives
Alluvial and shallow marine
Concealed igneous rocks
Concealed late Carboniferous-mid Triassic basins
Concealed late Devonian-early Carboniferous basins
10° 00′
11° 00′
12° 00′
13° 00′
14° 00′
15° 00′
16° 00′
17° 00′
18° 00′
19° 00′
20° 00′
142° 30′
144° 00′
145° 30′
147° 00′
Gulf of
Carpentaria
CORAL SEA
Great Barrier Reef
Great Barrier Reef
Bamaga
WEIPA
Lockhart River
Aurukun
Coen
Pormpuraaw
Kowanyama
Laura
COOKTOWN
Mossman
CAIRNS
MAREEBA
Chillagoe
Dimbulah
ATHERTON
Herberton
Mount Garnet
INNISFAIL
TULLY
Normanton
Croydon
Georgetown
Einasleigh
INGHAM
TOWNSVILLE
AYR
HOME HILL
CHARTERS TOWERS
Ravenswood
COLLINSVILLE
Pentland
Julia Creek
RICHMOND

24. Time slice 6: *Mesozoic*

This 140 Ma time interval in the middle of the Mesozoic Period (from Middle Jurassic to the end of the early Cretaceous), was characterised by fluvial sedimentation progressing to shallow marine sedimentation in the Great Australian Basin (includes Carpentaria and Eromanga Basins) in the west, and felsic igneous intrusions in the far southeast. It followed a 46 Ma period of erosion, which has probably continued uninterrupted throughout most of the Cairns-Townsville hinterland until the present. Compiled by JHC Bain; GIS/cartography by D Haipola & HE Apps (AGSO).

TIME SLICE 6
Mesozoic

24

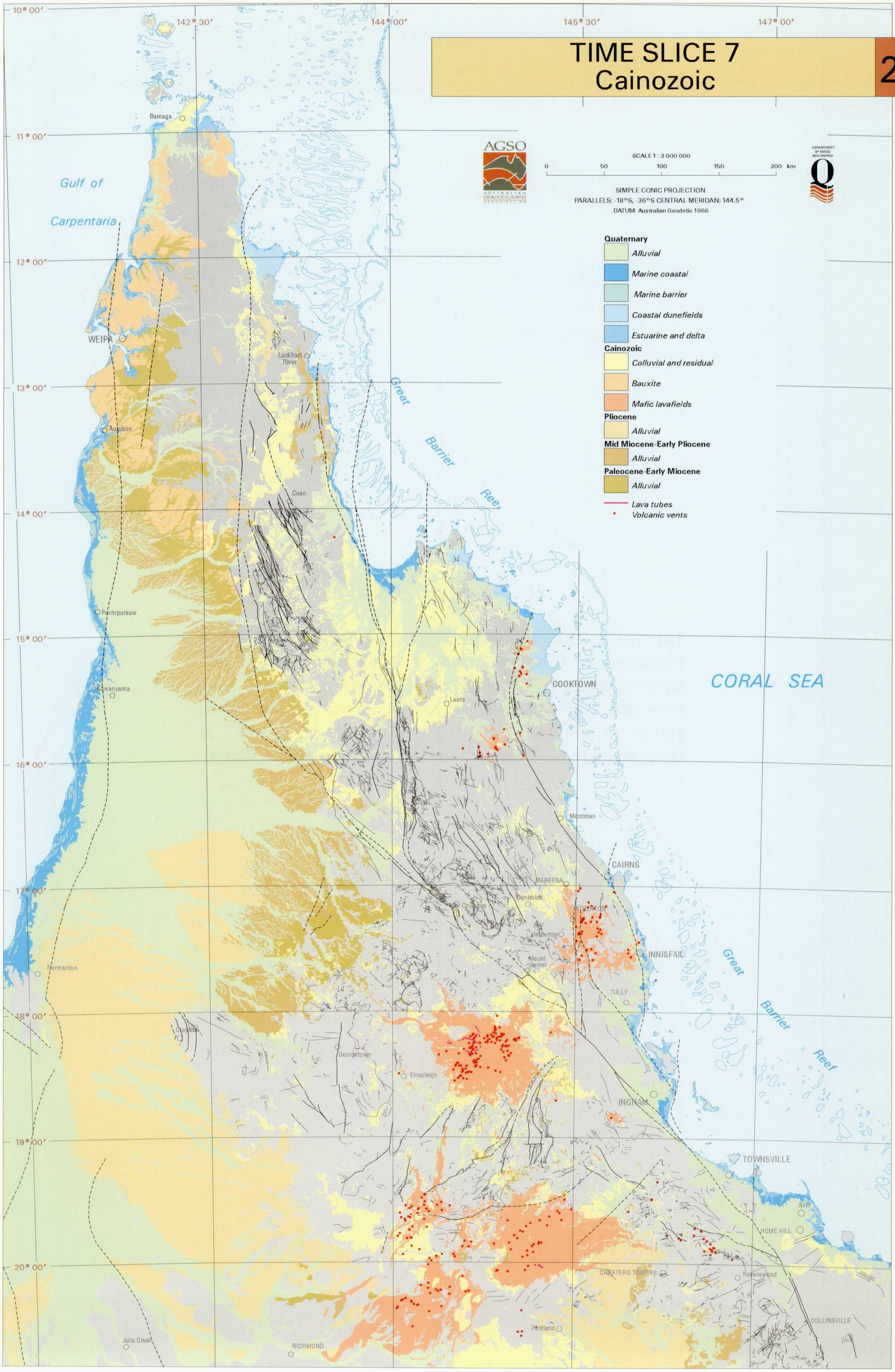


25. Time slice 7: *Cainozoic*

Erosion of the sediments deposited during the previous interval started during the late Cretaceous and persisted to the present day throughout most of North Queensland. Nevertheless, fluvial processes built substantial fans over the Cretaceous sediments, and substantial areas of the older rocks were covered with basaltic lavas during late Teriary and Quaternary time. The great bauxite deposits, silica sand dunefields, the coastal beach ridges and cheniers of Cape York Peninsula, and the Great Barrier Reef also formed during this period. Compiled by JHC Bain; GIS/cartography by D Haipola & HE Apps (AGSO).

TIME SLICE 7
Cainozoic

25

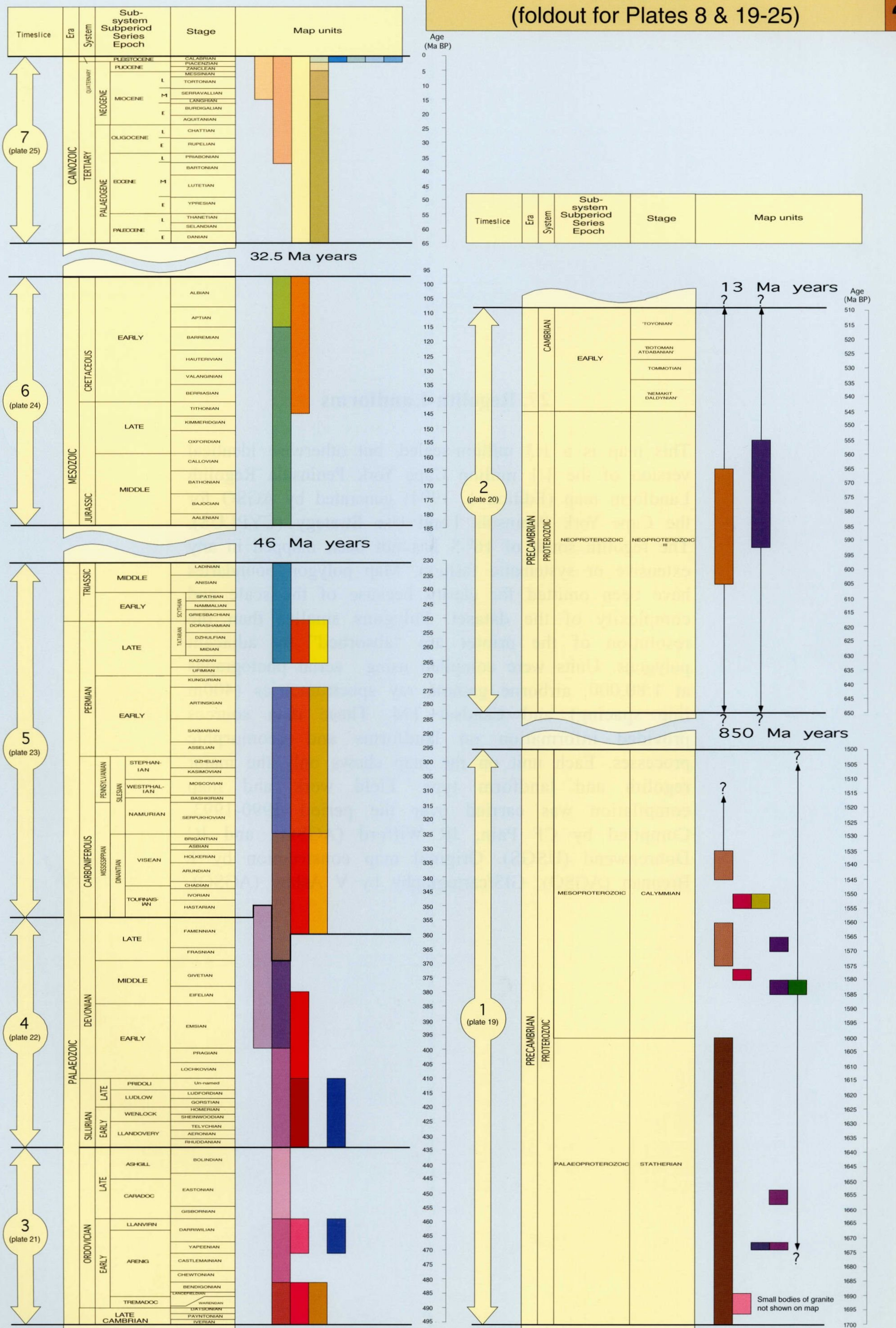


26. **Timescale** (fold out)

This plate, based on version 97-1 of the Australian Phanerozoic Timescale and Biozonation Chart, 1997, shows the temporal distribution of the geological map units and of the timeslices depicted in the previous seven plates. Compiled by JHC Bain (AGSO) & JJ Draper(GSQ); Graphics by P Brugman (AGSO).

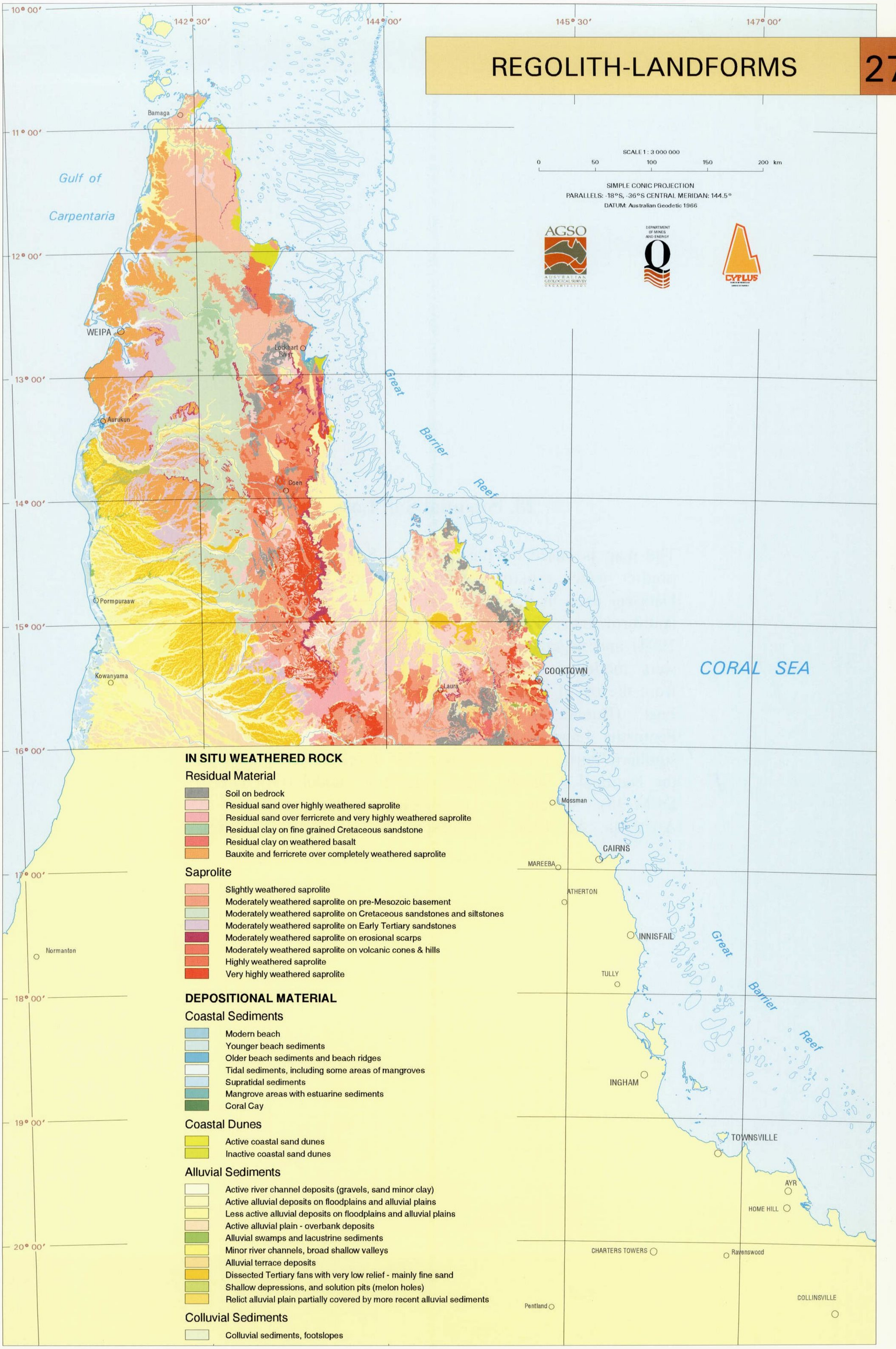
TIMESCALE
(foldout for Plates 8 & 19-25)

26



27. Regolith-Landforms

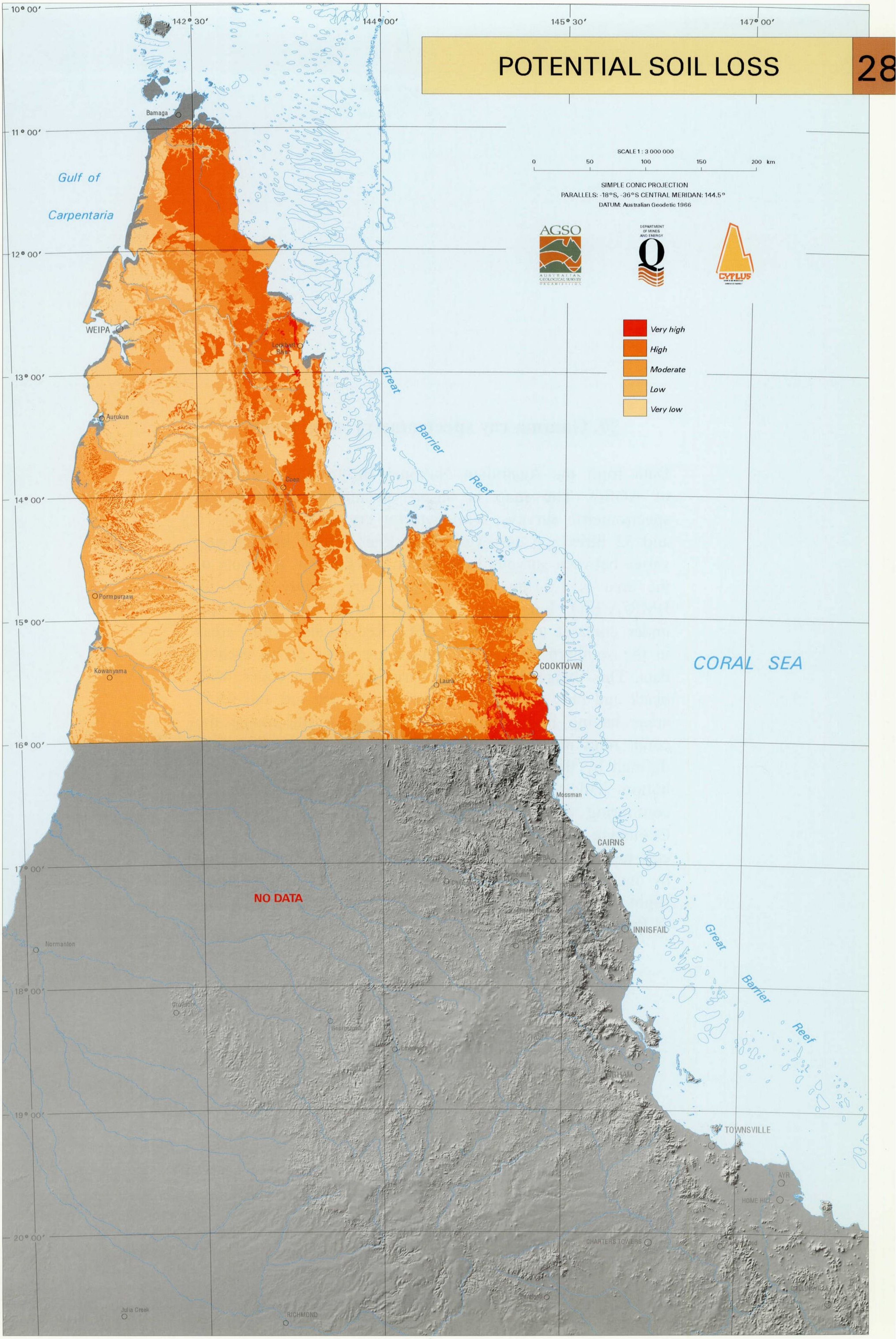
This map is a 1:3 million-scaled, but otherwise identical version of the 1:1 million Cape York Peninsula Regolith Landform map (Edition 1, 1994) generated by AGSO for the Cape York Peninsula Land Use Strategy (CYPLUS). The regolith south of 16^0 S has not been mapped in any extensive or systematic fashion. Map polygon boundaries have been omitted for clarity because of the scale and complexity of the dataset. Polygons smaller than the resolution of the printer are "absorbed" by adjacent polygons. Units were compiled using aerial photographs at 1:80,000, airborne gamma ray spectrometrics (400m line spacing) and Landsat TM. These data sources provided information on landforms and geomorphic processes. Each unit on the map shows only the major regolith and landform type. Field work and map compilation was carried over the period 1990-1993. Compiled by CF Pain, JR Wilford (AGSO), and JC Dohrenwend (USGS). Original map construction by T Brennan (AGSO). GIS/cartography by V Ashby (AGSO).


REGOLITH-LANDFORMS
27
SCALE 1 : 3 000 000
0 50 100 150 200 km
SIMPLE CONIC PROJECTION
PARALLELS: -18°S, -36°S CENTRAL MERIDIAN: 144.5°
DATUM: Australian Geodetic 1966
AGSO
CYPLUS
10° 00′
11° 00′
12° 00′
13° 00′
14° 00′
15° 00′
16° 00′
17° 00′
18° 00′
19° 00′
20° 00′
142° 30′
144° 00′
145° 30′
147° 00′
Gulf of
Carpentaria
Great Barrier Reef
CORAL SEA
Bamaga
WEIPA
Lockhart River
Aurukun
Coen
Pormpuraaw
Kowanyama
Laura
COOKTOWN
Mossman
CAIRNS
MAREEBA
ATHERTON
INNISFAIL
TULLY
INGHAM
TOWNSVILLE
AYR
HOME HILL
CHARTERS TOWERS
Ravenswood
Pentland
COLLINSVILLE
Normanton
IN SITU WEATHERED ROCK
Residual Material
Soil on bedrock
Residual sand over highly weathered saprolite
Residual sand over ferricrete and very highly weathered saprolite
Residual clay on fine grained Cretaceous sandstone
Residual clay on weathered basalt
Bauxite and ferricrete over completely weathered saprolite
Saprolite
Slightly weathered saprolite
Moderately weathered saprolite on pre-Mesozoic basement
Moderately weathered saprolite on Cretaceous sandstones and siltstones
Moderately weathered saprolite on Early Tertiary sandstones
Moderately weathered saprolite on erosional scarps
Moderately weathered saprolite on volcanic cones & hills
Highly weathered saprolite
Very highly weathered saprolite
DEPOSITIONAL MATERIAL
Coastal Sediments
Modern beach
Younger beach sediments
Older beach sediments and beach ridges
Tidal sediments, including some areas of mangroves
Supratidal sediments
Mangrove areas with estuarine sediments
Coral Cay
Coastal Dunes
Active coastal sand dunes
Inactive coastal sand dunes
Alluvial Sediments
Active river channel deposits (gravels, sand minor clay)
Active alluvial deposits on floodplains and alluvial plains
Less active alluvial deposits on floodplains and alluvial plains
Active alluvial plain - overbank deposits
Alluvial swamps and lacustrine sediments
Minor river channels, broad shallow valleys
Alluvial terrace deposits
Dissected Tertiary fans with very low relief - mainly fine sand
Shallow depressions, and solution pits (melon holes)
Relict alluvial plain partially covered by more recent alluvial sediments
Colluvial Sediments
Colluvial sediments, footslopes

28. Potential Soil Loss

The map is based on the Universal Soil Loss Equation to predict water erosion hazard on Cape York Peninsula. Datasets used in the Soil Loss Equation include: regolith-landform maps (Pain et al 1994), soil maps (Biggs et al. 1994) and vegetation maps (Carnahan, 1989). The datasets were modelled using ArcInfo GRID®. The map extends from the tip of Cape York to latitude 16^0 S. Generated by J East (Bureau of Resource Sciences) for the Cape York Peninsula Land Use Strategy (CYPLUS). The unmapped southern portion is represented by a greyscale version of the National 9 second digital elevation model (GEODATA DEM-95) which is copyright, Commonwealth of Australia, AUSLIG. Cartography by HE Apps (AGSO).

POTENTIAL SOIL LOSS

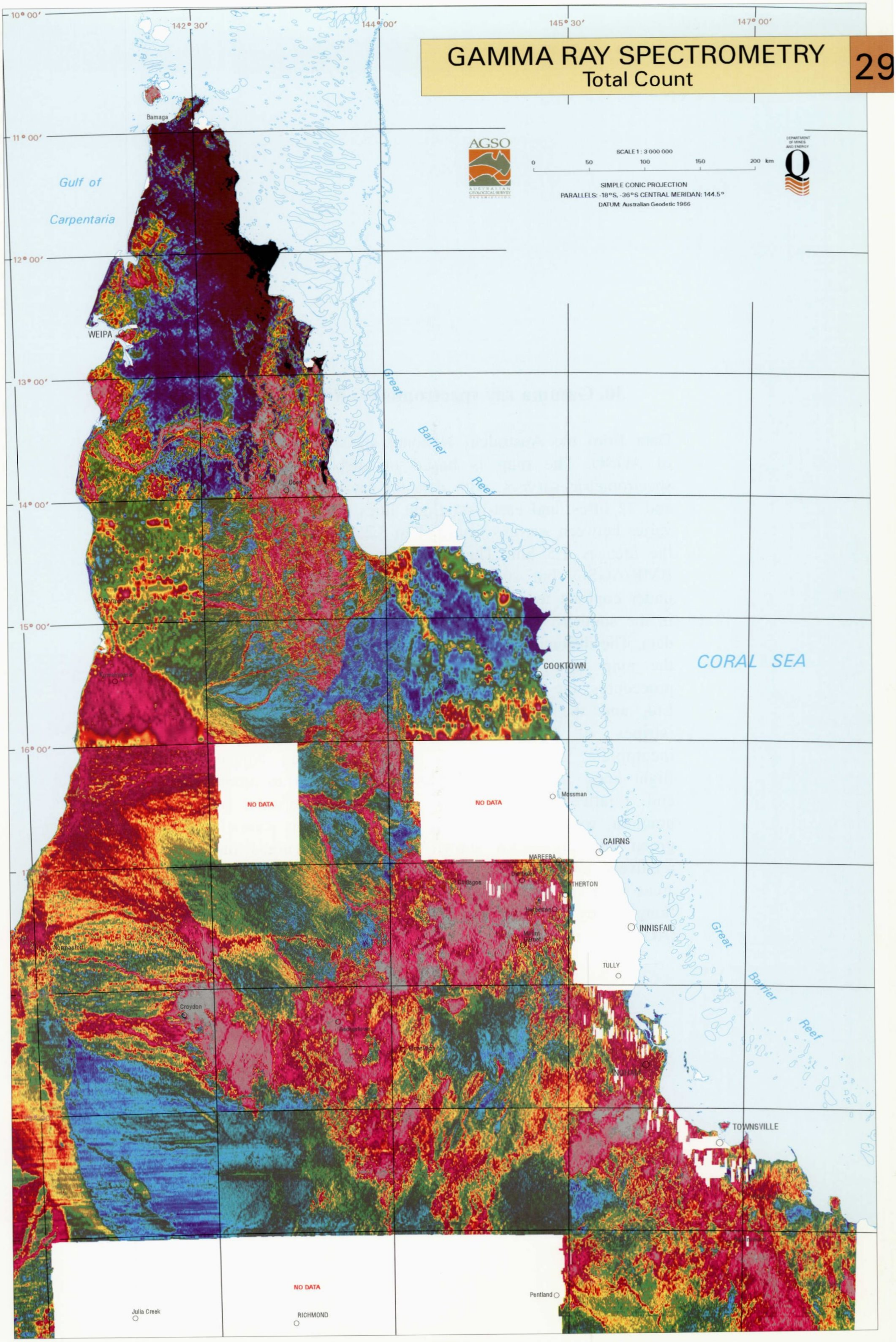


29. Gamma ray spectrometry: *total count*

Data from the Australian National spectrometric database of AGSO. The map is based on airborne gamma-ray spectrometric surveys, with detector crystal volumes of 16 and 32 litres and east-west flight lines. Flight line spacing varies between surveys from 0.4 to 3.2 km, but for most of the area is 1.5 km. The surveys were mainly flown by BMR/AGSO, but small areas are by private companies under contract to AGSO or GSQ. Rectangular white areas in the southern half of the image are areas of no useable data. This image displays the variation in total count, with black and blue areas having low counts, and red and white areas having high counts. Over much of the image the count rates are sufficiently high that the features are well defined by the data. The different textures of the top and bottom halves of the map result from the use of different contouring procedures; the bottom half was gridded by Geoimage Pty Ltd, and the top half by AGSO. Residual east-west `stripes' of various widths are artefacts caused by incomplete `micro-levelling' of data between adjacent flight lines. Imaging by P Wellman, GIS/cartography by M Peljo (AGSO).

GAMMA RAY SPECTROMETRY
Total Count

29

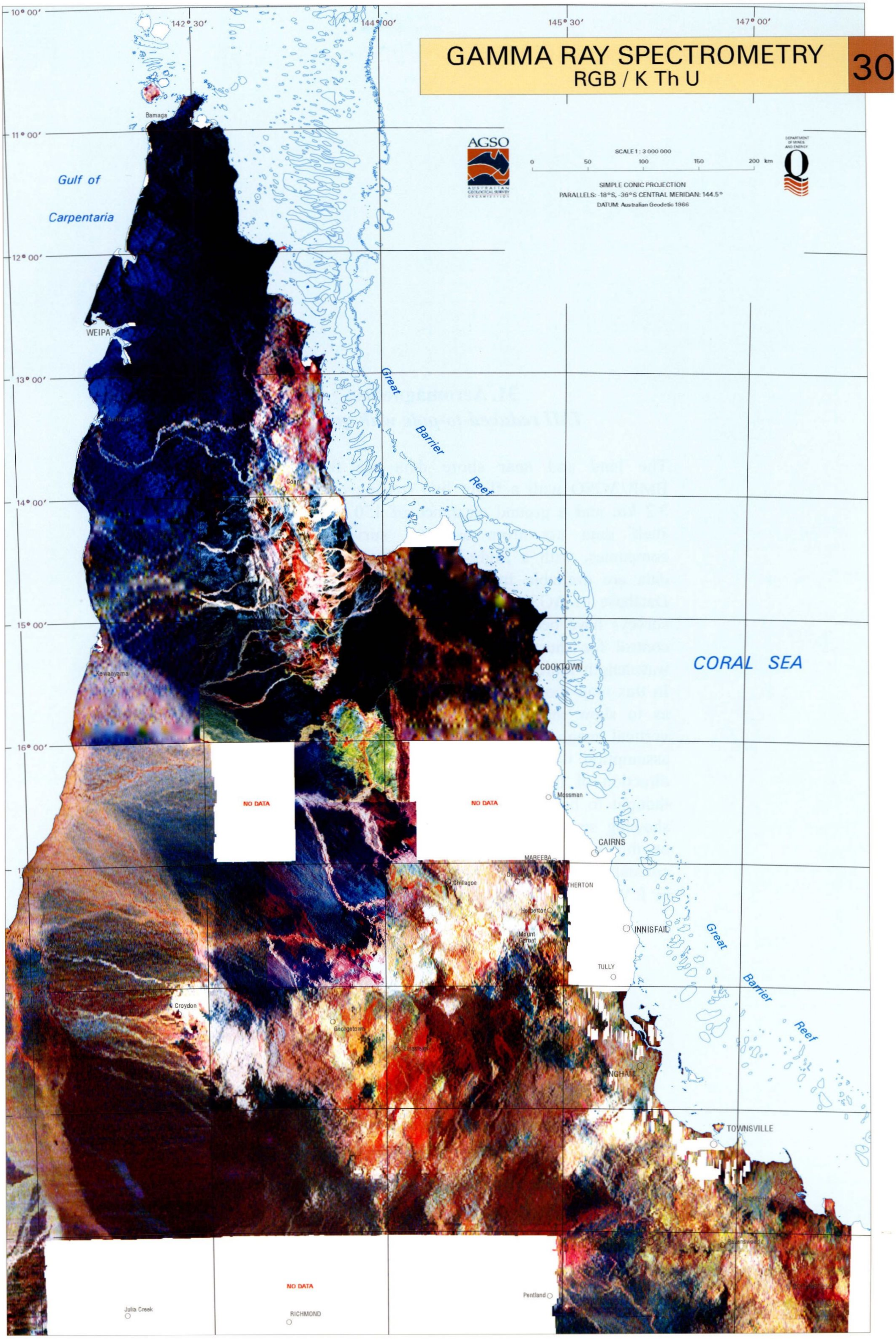


30. Gamma ray spectrometry: *RGB/KThU*

Data from the Australian National spectrometric database of AGSO. The map is based on airborne gamma-ray spectrometric surveys, with detector crystal volumes of 16 and 32 litres, and east-west flight lines. Flight line spacing varies between surveys from 0.4 to 3.2 km, but for most of the area is 1.5 km. The surveys were mainly flown by BMR/AGSO, but small areas are by private companies under contract to AGSO or GSQ. Rectangular white areas in the southern half of the image are areas of no useable data. The different textures of the top and bottom halves of the map result from the use of different contouring procedures; the bottom half was gridded by Geoimage Pty Ltd, and the top half by AGSO. Residual east-west `stripes' of various widths are artefacts caused by incomplete `micro-levelling' of data between adjacent flight lines.. This image displays the variation in amount and relative abundance of potassium, thorium, and uranium, with uranium shown as blue, thorium shown as green and potassium shown as red. Dark areas have relatively low amounts of the three elements, and light areas have relatively high amounts of the three elements. Imaging by P Wellman, GIS/cartography by M Peljo (AGSO).

GAMMA RAY SPECTROMETRY
RGB / K Th U

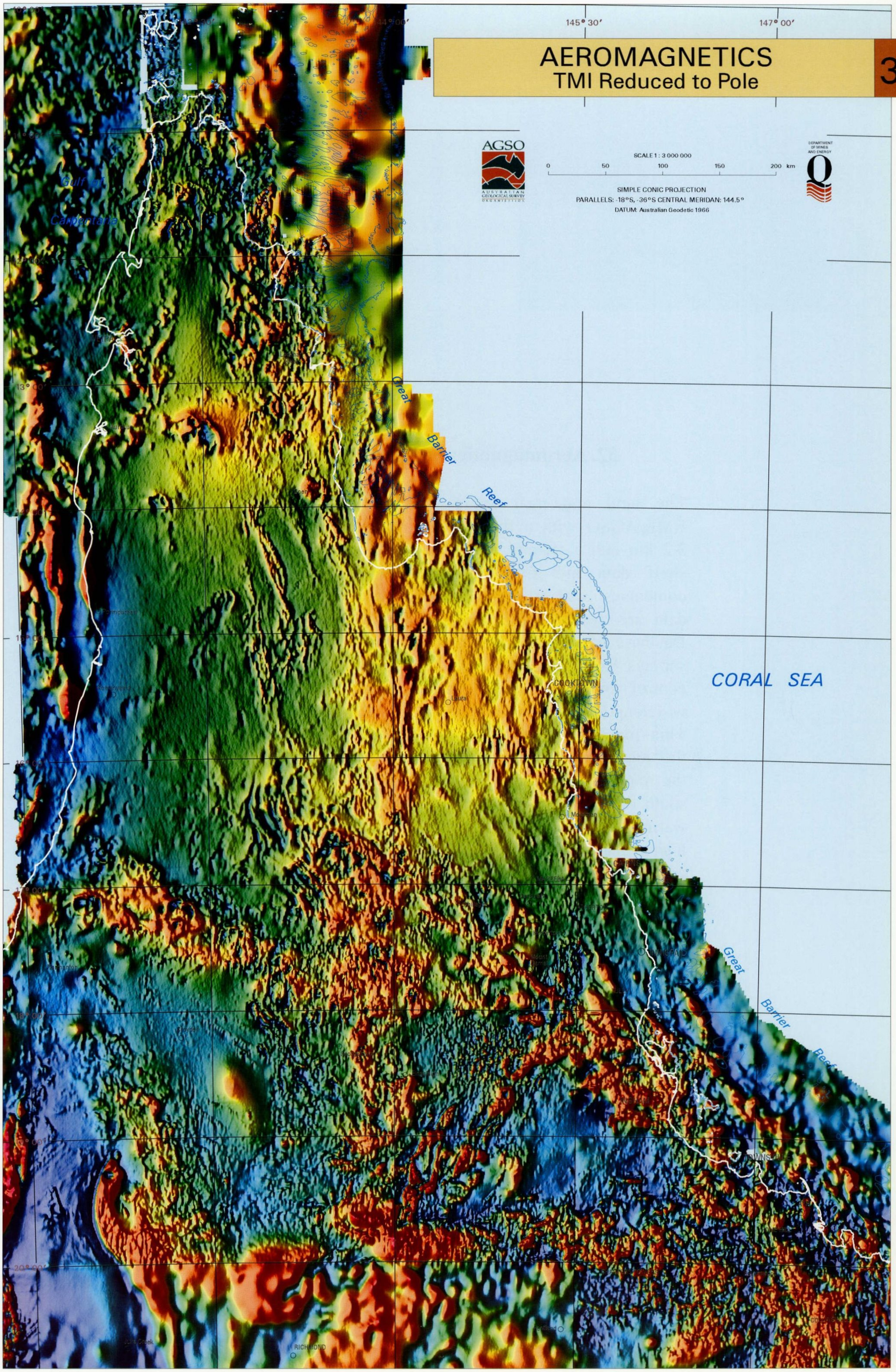
30



31. Aeromagnetics:
TMI reduced-to-pole with gradient

The land and near shore data are from surveys by BMR/AGSO with a flight line spacing of generally 1.5 to 3.2 km and a ground clearance of 150 m. The continental shelf data are from airborne surveys by petroleum companies, with a flight-line spacing of 2 to 50 km. All data are available from the Australian National Magnetic Database of AGSO. The grids derived from the individual surveys have been joined at their margins; this gives good control for short wavelength anomalies, but anomalies of wavelength more than about 600 km are poorly controlled. In this map the observed anomalies have been modified so as to show the anomalies that would be observed for a vertical magnetic field: the calculation is based on the assumption that rocks in the area are magnetised in the direction of the present Earth's field. This assumption is thought to be true for most rocks, but is untrue for areas showing small intense low anomalies. The warmer colours on this map represent crustal rocks with higher magnetite contents than those in areas with cooler colours. Imaging by P Wellman, GIS/cartography by M Peljo (AGSO).

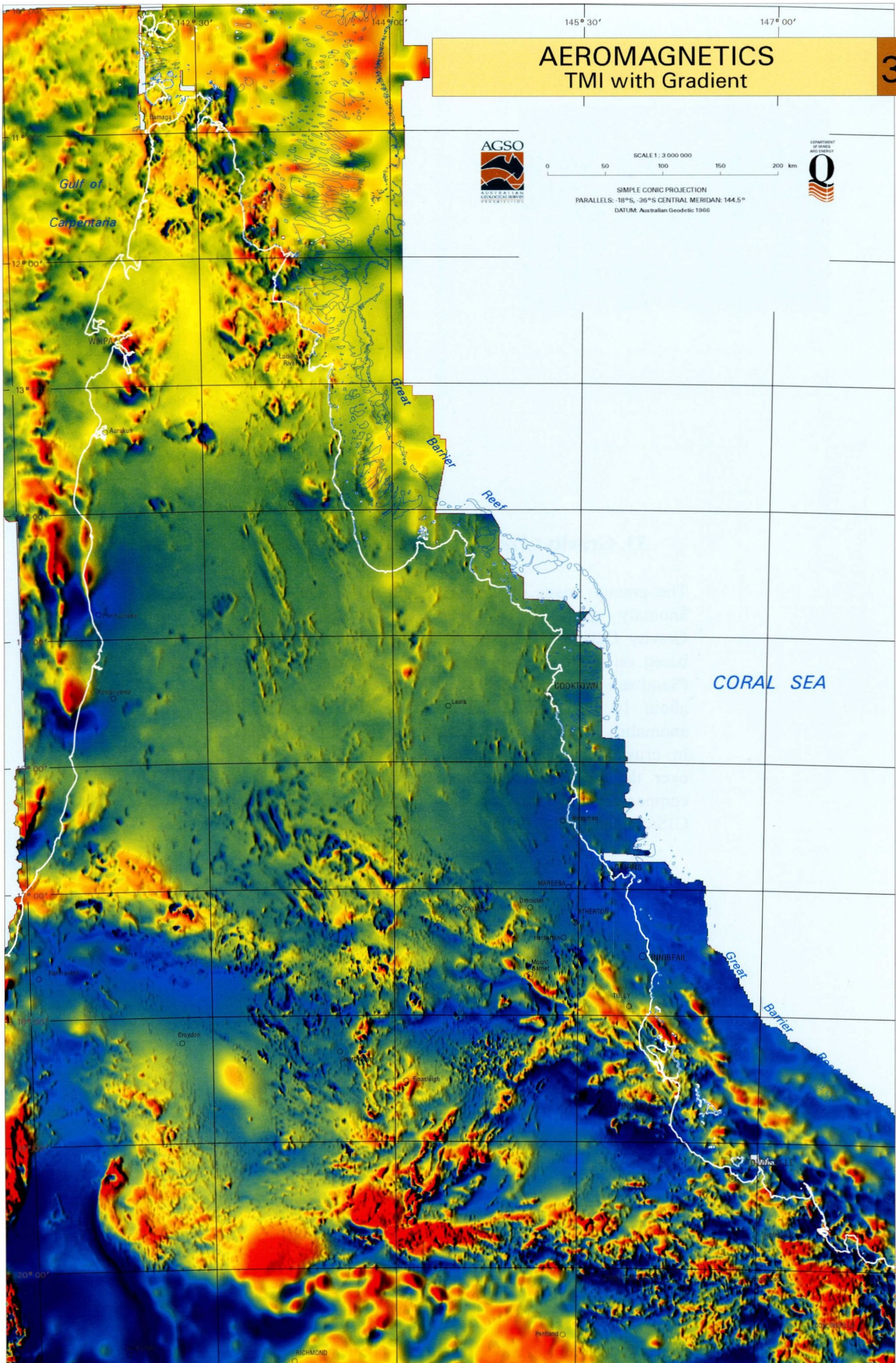
AEROMAGNETICS
TMI Reduced to Pole



32. Aeromagnetics: *TMI with gradient*

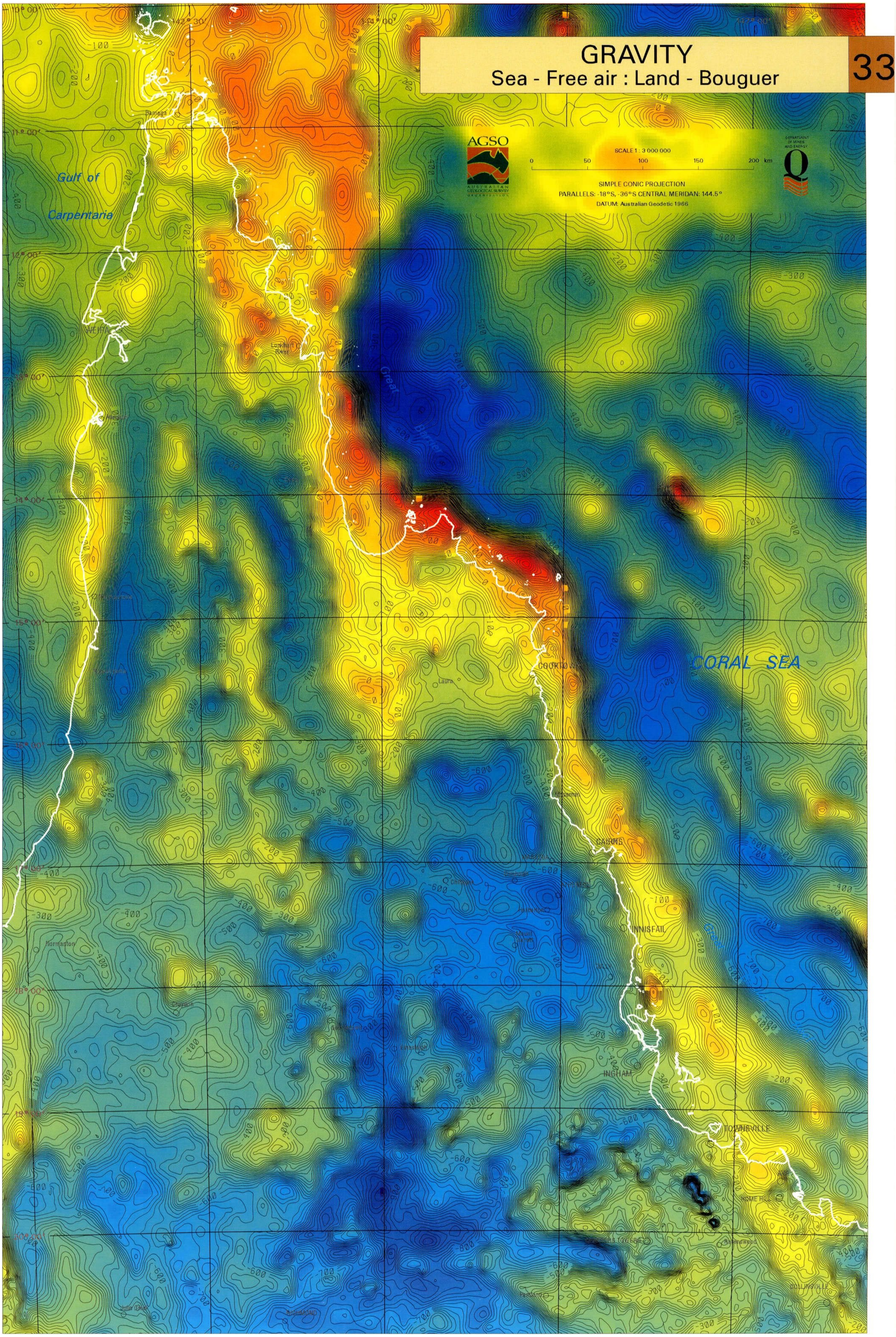
The land and near shore data are from surveys by BMR/AGSO with a flight line spacing of generally 1.5 to 3.2 km and a terrane clearance of 150 m. The continental shelf data are from airborne surveys by petroleum companies, with a flight-line spacing of 2 to 50 km. All data are available from the Australian National Magnetic Database of AGSO. The grids derived from the individual surveys have been joined at their margins; this gives good control for short wavelength anomalies, but anomalies of wavelength more than about 600 km are poorly controlled. This map shows observed total magnetic intensity, with the intensity due to the Earth's core removed. Note that the major high anomalies are associated with a low to the south due to the 54^0 dip of the earth's magnetic field. The warmer colours on this map represent crustal rocks with higher magnetite contents than those in areas with cooler colours. Imaging by P Wellman, GIS/cartography by M Peljo (AGSO).

AEROMAGNETICS
TMI with Gradient



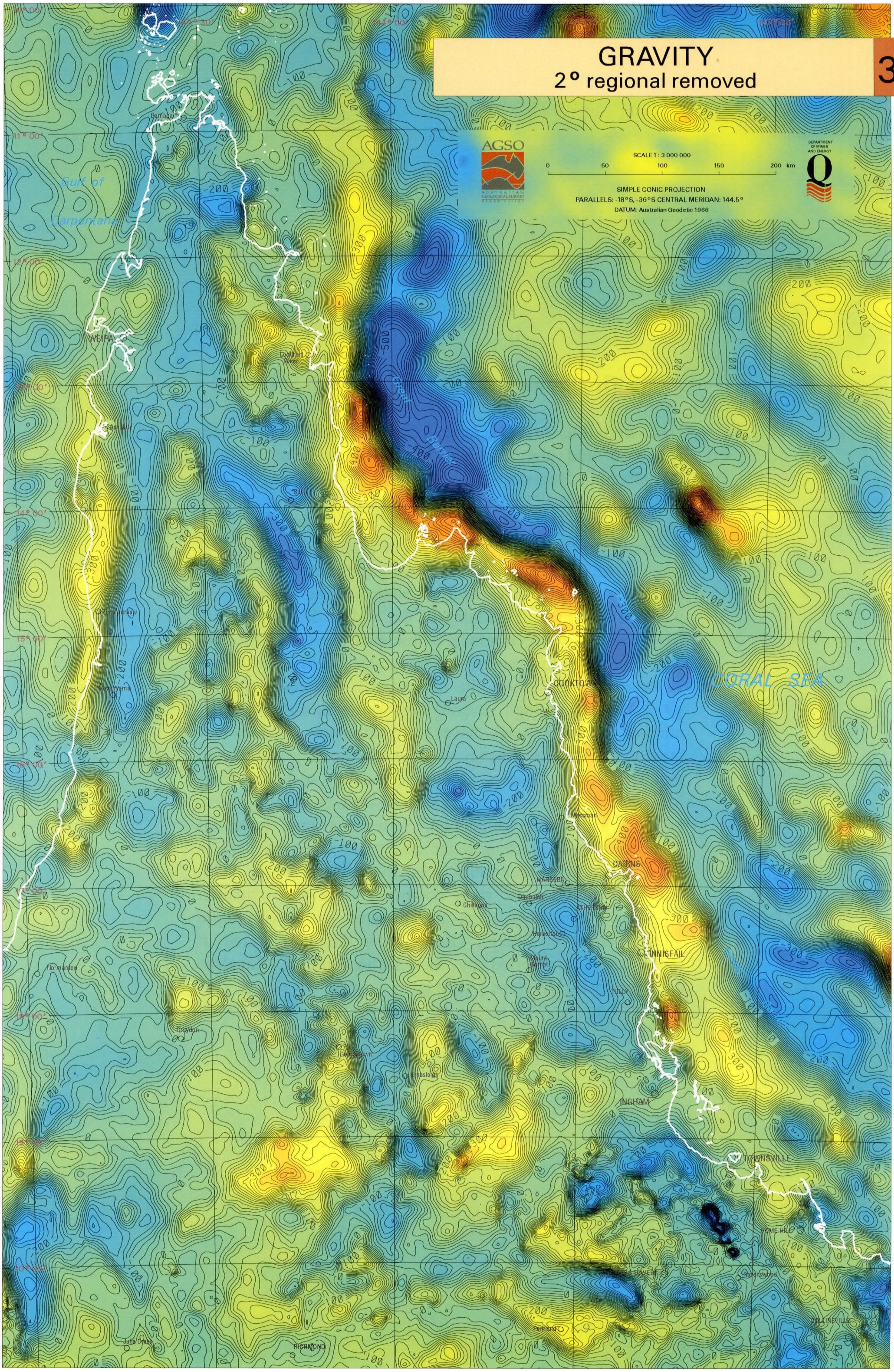
33. Gravity: *Free air (sea) & Bouguer (land)*

The gravity image on land is based on a Bouguer gravity anomaly grid derived from the Australian National Gravity Database held by AGSO and the image at sea is based on geoid altitude measured by satellite observations (Sandwell & Smith 1995). The grids have been joined about 10 km outside the coastline. The map has large anomalies along the continental margin due to the change in crustal thickness, and a prominent negative anomaly over the higher altitude land areas due to the isostatic compensation of this topography. Imaging by P Wellman, GIS/cartography by M Peljo (AGSO).


GRAVITY
Sea - Free air : Land - Bouguer
33
AGSO
SCALE 1: 3 000 000
0 50 100 150 200 km
SIMPLE CONIC PROJECTION
PARALLELS: -18°S, -36°S CENTRAL MERIDIAN: 144.5°
DATUM: Australian Geodetic 1966
Gulf of Carpentaria
CORAL SEA
COOKTOWN
CAIRNS
INNISFAIL
INGHAM
TOWNSVILLE

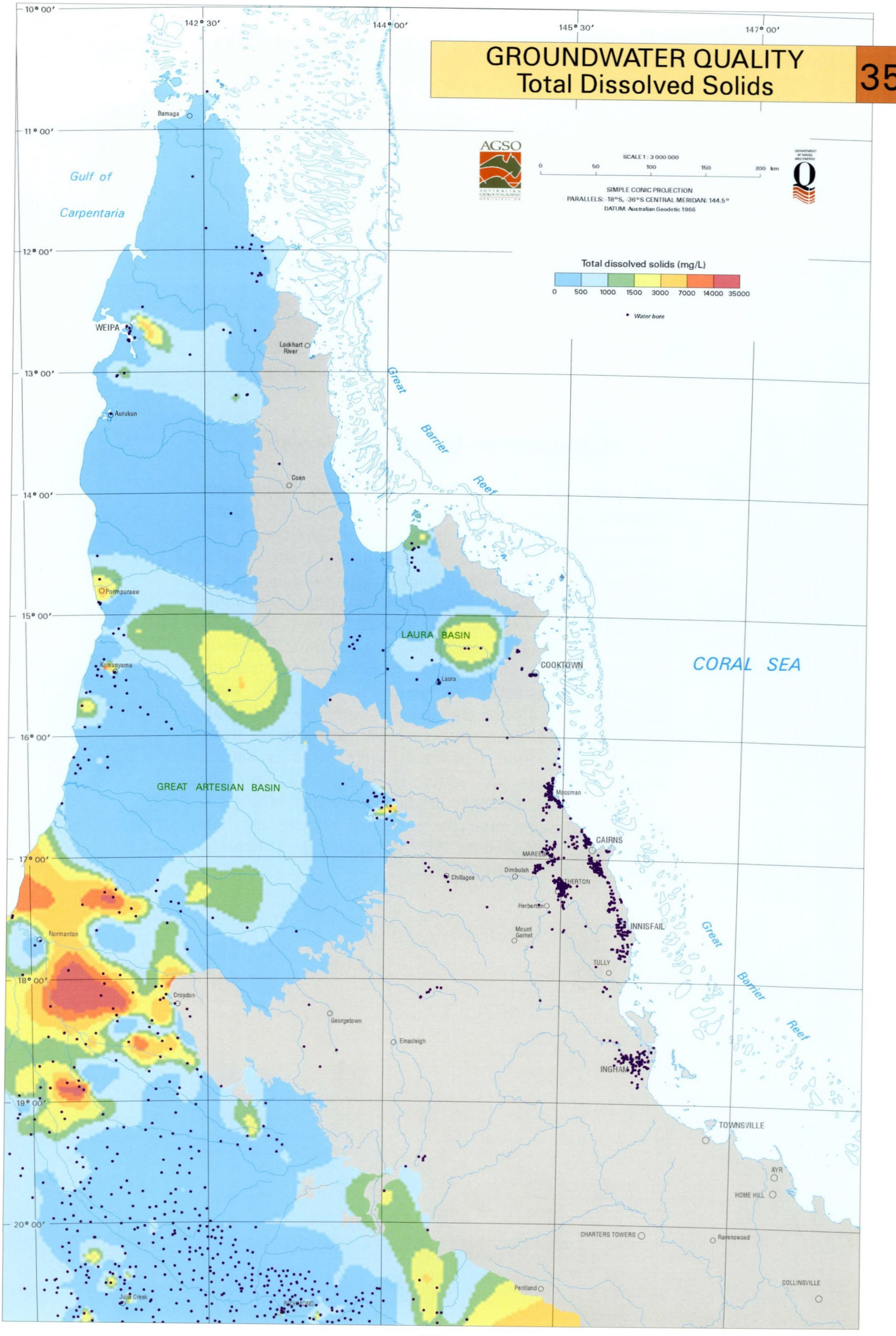
34. Gravity: *(2^{o} regional removed)*

The gravity image on land is based on a Bouguer gravity anomaly grid derived from the Australian National Gravity Database held by AGSO and the image at sea is based on geoid altitude measured by satellite observations (Sandwell & Smith 1995). The grids have been joined about 10 km outside the coastline. In this map a two degree average has been removed from the grid, in order to isolate the anomalies due to the upper crust. Imaging by P Wellman, GIS/cartography by M Peljo (AGSO).


GRAVITY
2° regional removed
34
AGSO
SCALE 1 : 3 000 000
SIMPLE CONIC PROJECTION
PARALLELS: -18°S, -36°S CENTRAL MERIDIAN: 144.5°
DATUM: Australian Geodetic 1966
CORAL SEA
CAIRNS
INNISFAIL
INGHAM
COOKTOWN
RICHMOND

35. Groundwater quality: *total dissolved solids*

Data from the AGSO Great Artesian Basin Groundwater Database and the Queensland Department of Natural Resources. Registered water bores are shown. Total dissolved solids (TDS) values (in mg/L) give an indication of groundwater quality and have been obtained from chemical analyses of water samples taken from individual water bores. TDS values have been gridded with a cell size of 2.5 km. Groundwater data are scarce in many areas, and the interpolation and gridding of the widely distributed data have created some artefacts - mapped patterns are only approximate. Most areas, in particular within the Great Artesian Basin, show the occurrence of good quality groundwater, although several large anomalies show that a number of water bores have high salinities. Groundwater quality in the Laura basin is generally good. The large number of water bores along the eastern seaboard from Mossman to Ingham are associated with shallow aquifers in unconsolidated Quaternary sediments and fractured Cainozoic basalt. Groundwater quality in these aquifers is very good, with generally less than 1000 mg/L TDS, making it suitable for rural domestic, stock and irrigation purposes. Most other areas are fractured rocks with some alluvial cover in valleys. Groundwater data are scarce in these areas. Compiled by MA Habermehl, T Ransley; cartography by HE Apps (AGSO).



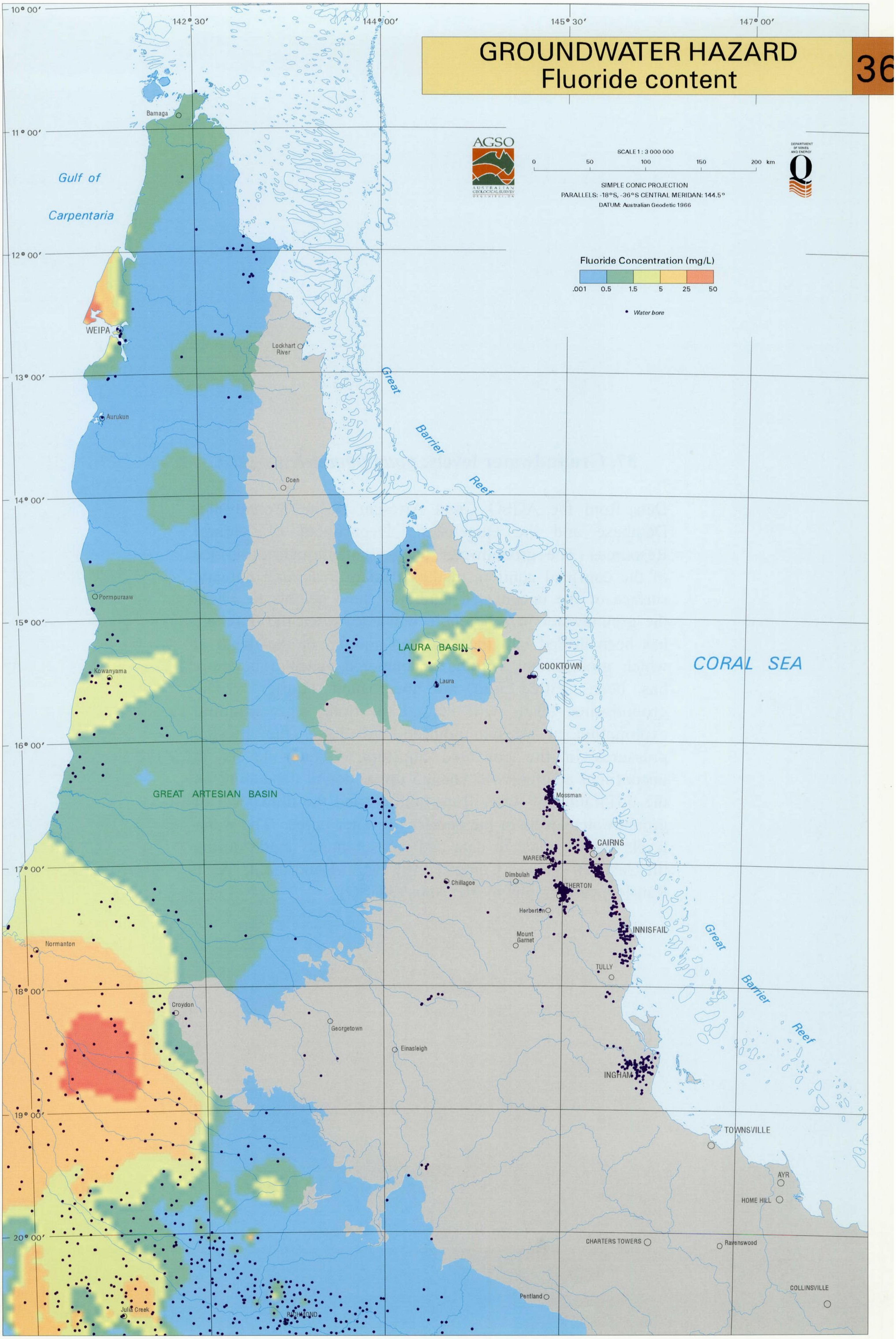
GROUNDWATER QUALITY
Total Dissolved Solids
35
AGSO
SCALE 1 : 3 000 000
0 50 100 150 200 km
SIMPLE CONIC PROJECTION
PARALLELS: -18°S, -36°S CENTRAL MERIDAN: 144.5°
DATUM: Australian Geodetic 1966
Total dissolved solids (mg/L)
0 500 1000 1500 3000 7000 14000 35000
Water bore
10° 00′
11° 00′
12° 00′
13° 00′
14° 00′
15° 00′
16° 00′
17° 00′
18° 00′
19° 00′
20° 00′
142° 30′
144° 00′
145° 30′
147° 00′
Gulf of
Carpentaria
Bamaga
WEIPA
Aurukun
Lockhart River
Coen
Pormpuraaw
Kowanyama
LAURA BASIN
Laura
COOKTOWN
CORAL SEA
Great
Barrier
Reef
GREAT ARTESIAN BASIN
Mossman
CAIRNS
MAREEBA
Dimbulah
Chillagoe
ATHERTON
Herberton
Mount Garnet
INNISFAIL
TULLY
Normanton
Croydon
Georgetown
Einasleigh
INGHAM
TOWNSVILLE
AYR
HOME HILL
CHARTERS TOWERS
Ravenswood
Pentland
COLLINSVILLE
Julia Creek
RICHMOND

36. Groundwater hazard: *fluoride content*

Data from the AGSO Great Artesian Basin Groundwater Database and the Queensland Department of Natural Resources. Fluoride values have been gridded with a cell size of 5 km. The fluoride values (in mg/L) are a useful indicator of mineralisation in some rock types. Fluoride is a health hazard if the concentration in drinking water is too high for humans (>1.5 mg/L). Higher values (>2.0 mg/L) are also a problem for stock use. High fluoride content in otherwise potable, good-quality groundwater can make the groundwater unsuitable for domestic and stock water supplies. The distribution and concentration of fluoride content derived from the chemical analyses of water samples taken from individual water bores is shown. Groundwater data are scarce in many areas, and the interpolation and gridding of the widely distributed data have created some artefacts - mapped patterns are only approximate. Compiled by MA Habermehl & T Ransley; cartography by V Ashby (AGSO).

GROUNDWATER HAZARD
Fluoride content

36

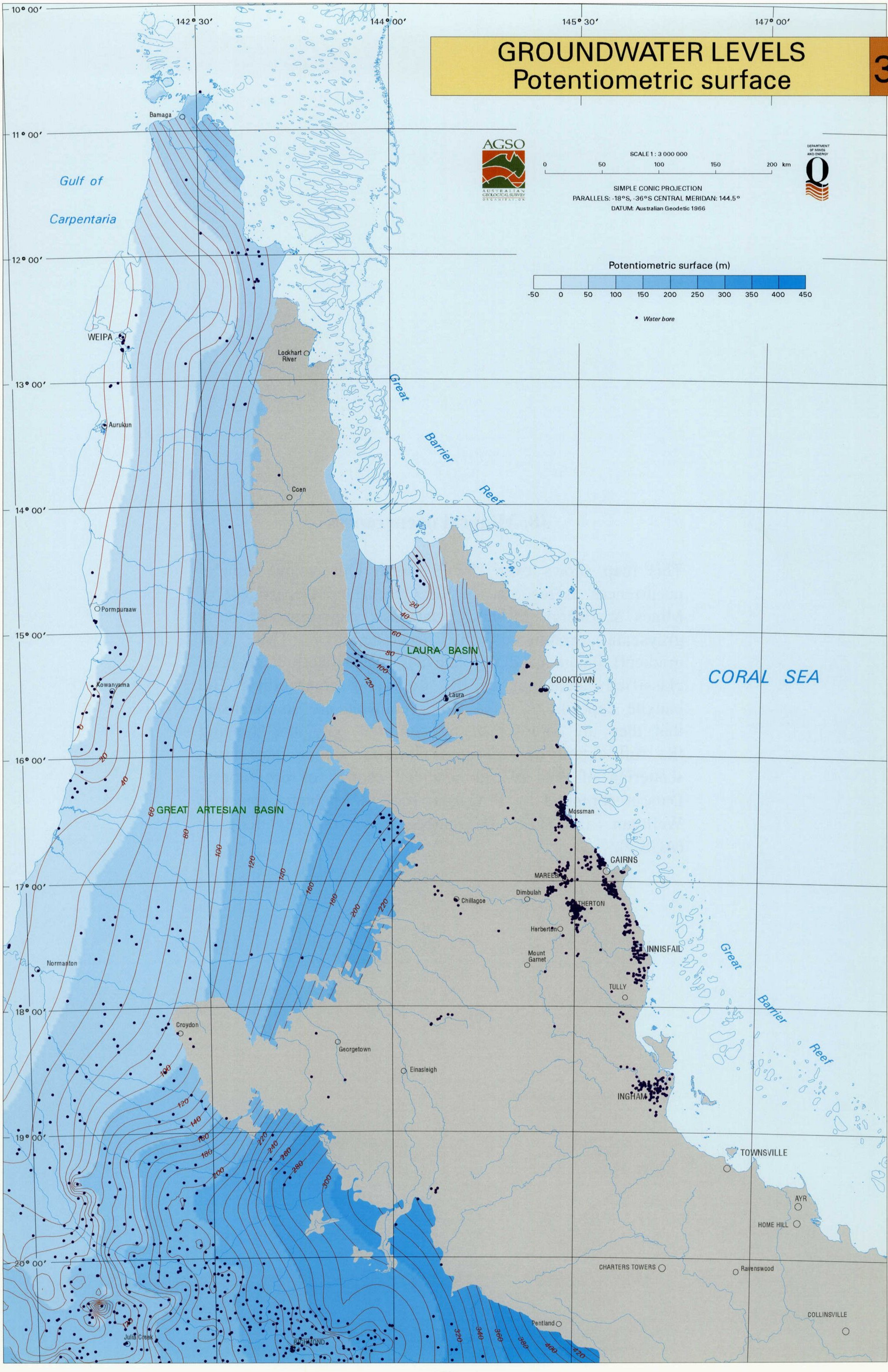


37. Groundwater levels: *potentiometric surface*

Data from the AGSO Great Artesian Basin Groundwater Database and the Queensland Department of Natural Resources. The groundwater levels (potentiometric surface of the confined aquifers in the artesian areas, and phreatic surface of the unconfined aquifers) show heights to which the groundwater in a borehole will rise, when the borehole has been drilled into the confined aquifer, or the depth at which groundwater will be encountered, when a borehole has been drilled into an unconfined aquifer. The groundwater levels will change in time, as continuing exploitation of artesian aquifers will lower the artesian pressures in the confined aquifers. Water levels in unconfined aquifers will change up or down, depending on the infiltration of water from rainfall, and the drawdown of groundwater levels in the aquifer by water bores. The water levels shown relate to data and measurements made during the last 20 years. Compiled by MA Habermehl, & T Ransley; cartography by HE Apps (AGSO).

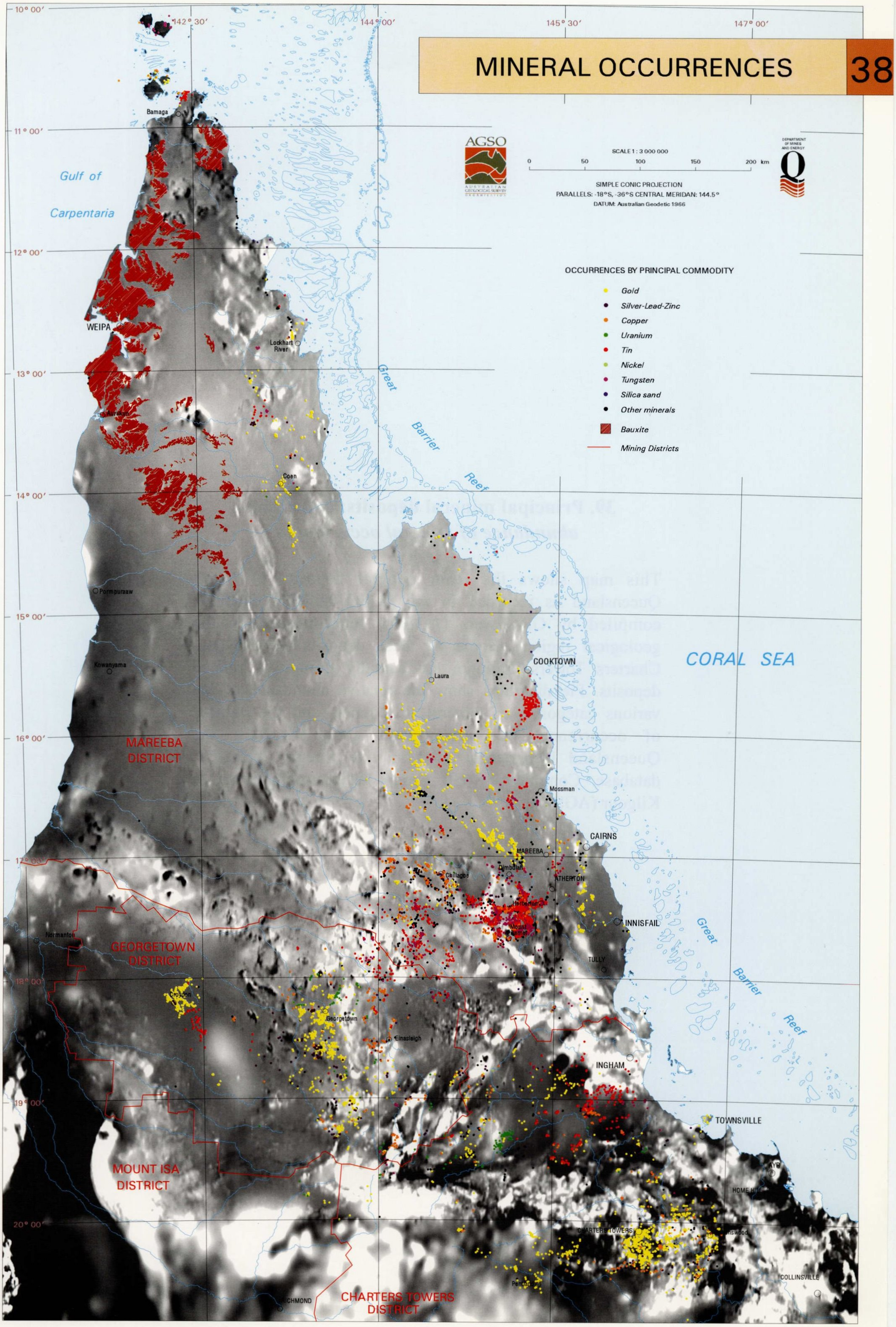
GROUNDWATER LEVELS
Potentiometric surface

37



38. Mineral occurrences

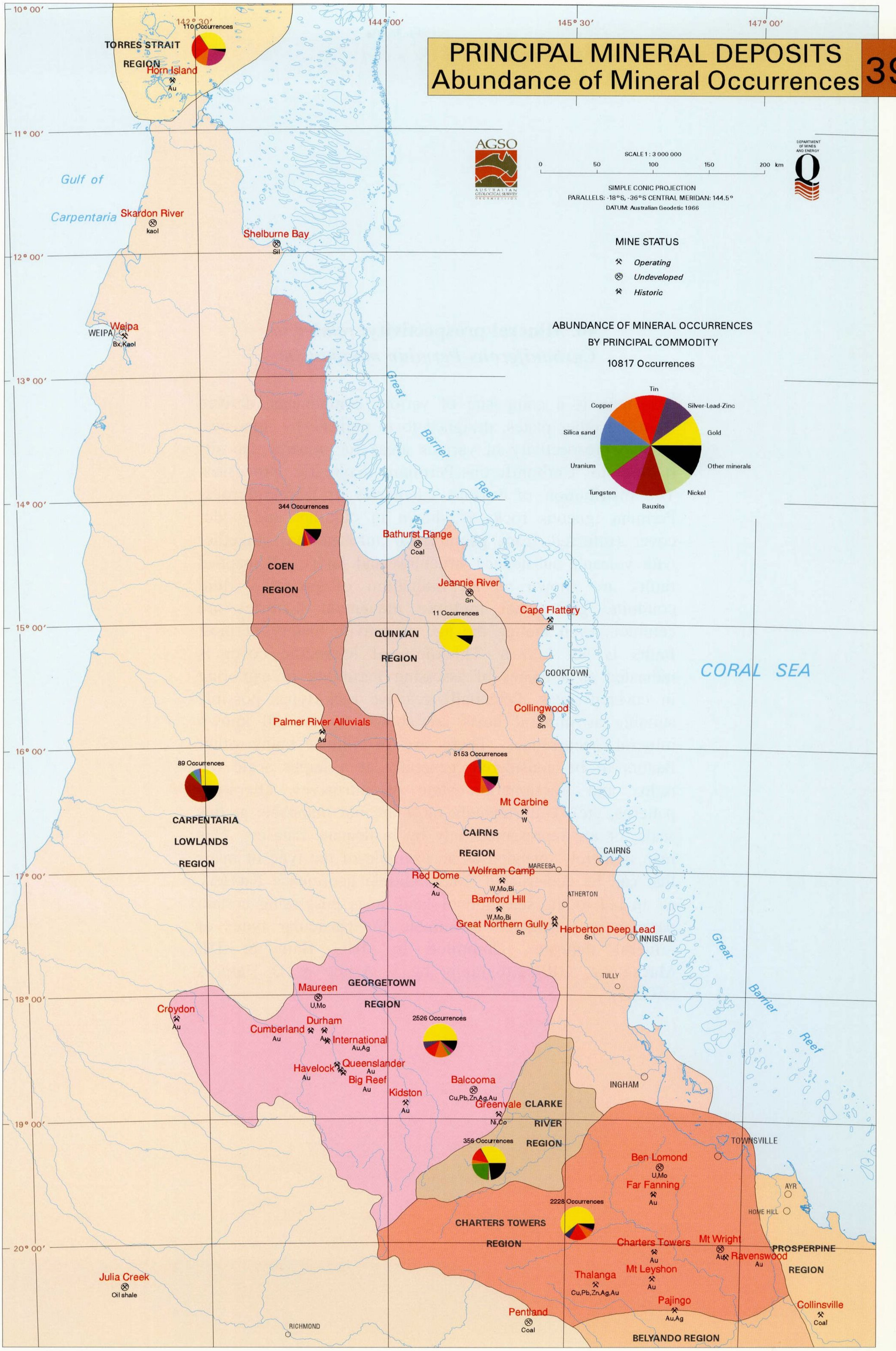
This map shows over 10,700 North Queensland mineral occurrences as recorded in the Queensland Department of Mines & Energy MINOCC database, superimposed on a greyscale version of the aeromagnetics (TMI with gradient) image used in plate 31. Occurrences have been classified according to the dominant commodity. The bauxite deposits of Cape York Peninsula are so extensive that they are represented by coloured polygons showing the full extent of aluminous laterite, rather than by a scattering of dots placed near the centres of ore blocks. Dataset compiled by P. Garrad (GSQ); Magnetic image P Wellman (AGSO); GIS/cartography by B Kilgour (AGSO).



MINERAL OCCURRENCES
38
AGSO
AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION
DEPARTMENT OF MINES AND ENERGY
SCALE 1 : 3 000 000
0 50 100 150 200 km
SIMPLE CONIC PROJECTION
PARALLELS: -18°S, -36°S CENTRAL MERIDAN: 144.5°
DATUM: Australian Geodetic 1966
OCCURRENCES BY PRINCIPAL COMMODITY
Gold
Silver-Lead-Zinc
Copper
Uranium
Tin
Nickel
Tungsten
Silica sand
Other minerals
Bauxite
Mining Districts
10° 00′
11° 00′
12° 00′
13° 00′
14° 00′
15° 00′
16° 00′
20° 00′
142° 30′
144° 00′
145° 30′
147° 00′
Gulf of Carpentaria
CORAL SEA
Great Barrier Reef
Bamaga
WEIPA
Lockhart River
Aurukun
Coen
Pormpuraaw
Kowanyama
Laura
COOKTOWN
Mossman
CAIRNS
MAREEBA
Dimbulah
ATHERTON
Chillagoe
Herberton
Mount Garnet
INNISFAIL
TULLY
Normanton
Croydon
Georgetown
Einasleigh
INGHAM
TOWNSVILLE
CHARTERS TOWERS
COLLINSVILLE
RICHMOND
MAREEBA DISTRICT
GEORGETOWN DISTRICT
MOUNT ISA DISTRICT
CHARTERS TOWERS DISTRICT

39. Principal mineral deposits: *and relative abundance of mineral occurrences*

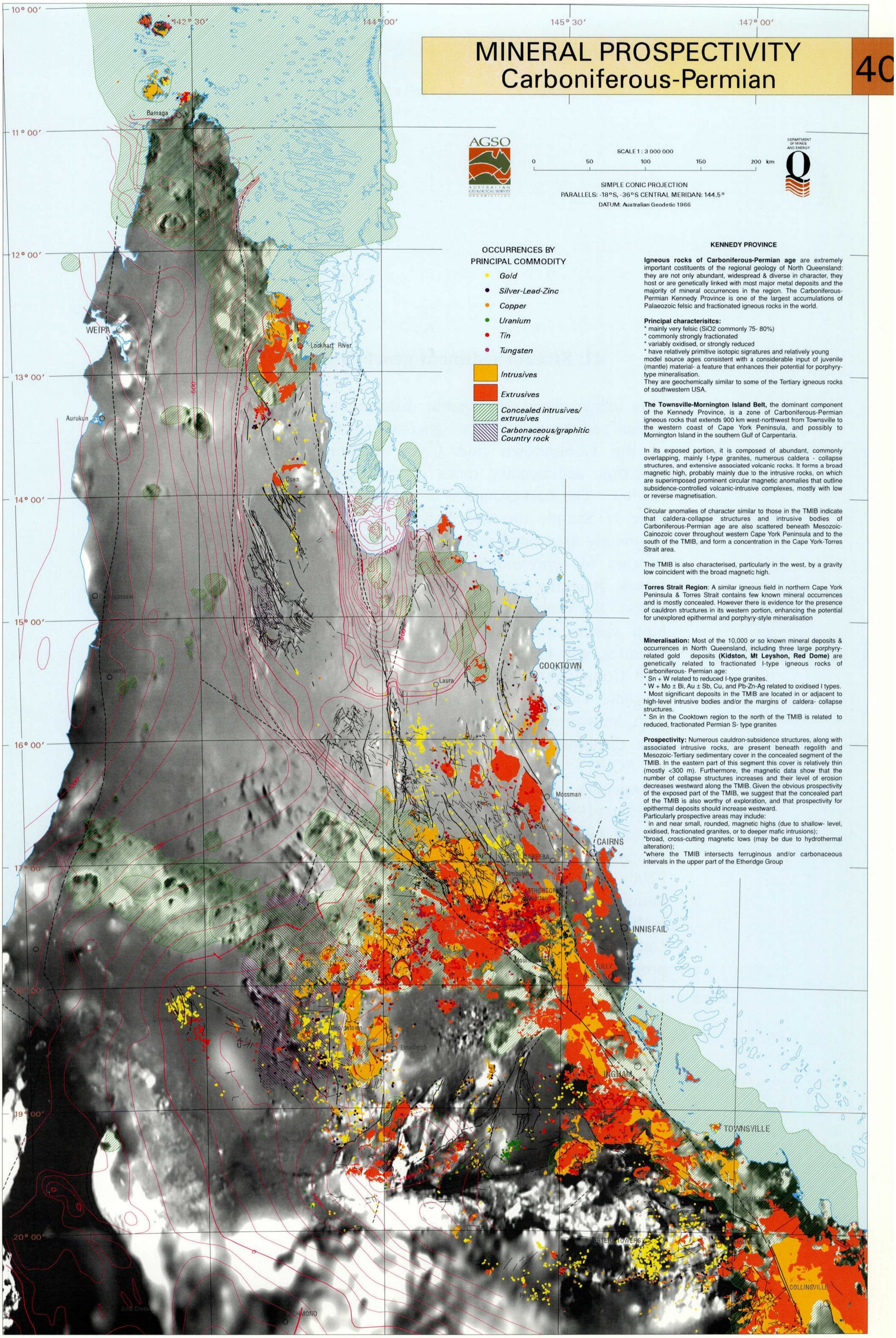
This map shows the main mineral deposits of North Queensland as recorded in the AGSO OZMIN database, compiled by GR Ewers (AGSO), superimposed on the geological regions. Some of these deposits eg Croydon, Charters Towers, Pajingo, are actually groups of related deposits. Pie diagrams show the relative abundance of the various categories of mineral occurrence, and the number of occurrences in each region compiled from the Queensland Department of Mines & Energy MINOCC database. Compiled by GR Ewers; GIS/cartography by B Kilgour (AGSO).


PRINCIPAL MINERAL DEPOSITS
Abundance of Mineral Occurrences
39
AGSO
AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION
SCALE 1 : 3 000 000
0 50 100 150 200 km
SIMPLE CONIC PROJECTION
PARALLELS: -18°S, -36°S CENTRAL MERIDAN: 144.5°
DATUM: Australian Geodetic 1966
DEPARTMENT OF MINES AND ENERGY
MINE STATUS
Operating
Undeveloped
Historic
ABUNDANCE OF MINERAL OCCURRENCES
BY PRINCIPAL COMMODITY
10817 Occurrences
Tin
Silver-Lead-Zinc
Gold
Other minerals
Nickel
Bauxite
Tungsten
Uranium
Silica sand
Copper
10° 00′
11° 00′
12° 00′
13° 00′
14° 00′
15° 00′
16° 00′
17° 00′
18° 00′
19° 00′
20° 00′
142° 30′
144° 00′
145° 30′
147° 00′
110 Occurrences
TORRES STRAIT
REGION
Horn Island
Au
Gulf of
Carpentaria
Skardon River
kaol
Shelburne Bay
Sil
WEIPA
Weipa
Bx,Kaol
Great
Barrier
Reef
344 Occurrences
COEN
REGION
Bathurst Range
Coal
Jeannie River
Sn
11 Occurrences
QUINKAN
REGION
Cape Flattery
Sil
COOKTOWN
CORAL SEA
Collingwood
Sn
Palmer River Alluvials
Au
89 Occurrences
CARPENTARIA
LOWLANDS
REGION
5153 Occurrences
Mt Carbine
W
CAIRNS
REGION
CAIRNS
MAREEBA
Red Dome
Au
Wolfram Camp
W,Mo,Bi
ATHERTON
Bamford Hill
W,Mo,Bi
Great Northern Gully
Sn
Herberton Deep Lead
Sn
INNISFAIL
TULLY
Great
Barrier
Reef
Maureen
U,Mo
GEORGETOWN
REGION
Croydon
Au
Durham
Au
Cumberland
Au
International
Au,Ag
2526 Occurrences
Queenslander
Au
Havelock
Au
Big Reef
Au
Kidston
Au
Balcooma
Cu,Pb,Zn,Ag,Au
Greenvale
Ni,Co
CLARKE
RIVER
REGION
INGHAM
TOWNSVILLE
356 Occurrences
Ben Lomond
U,Mo
Far Fanning
Au
AYR
HOME HILL
2228 Occurrences
CHARTERS TOWERS
REGION
Charters Towers
Au
Mt Wright
Au
Ravenswood
Au
PROSPERPINE
REGION
Thalanga
Cu,Pb,Zn,Ag,Au
Mt Leyshon
Au
Julia Creek
Oil shale
Pajingo
Au,Ag
Collinsville
Coal
Pentland
Coal
RICHMOND
BELYANDO REGION

40. Mineral prospectivity: *related to Carboniferous-Permian magmatism*

This map is a composite of various components, derived from the other plates, designed to to indicate by inference, relative prospectivity of various areas for mineral deposits related to Carboniferous-Permian magmatic processes. The distribution of various categories of Carboniferous-Permian igneous rocks is shown in outcrop, and under cover (inferred from geophysical information), together with volcanic subsidence structures and faults. All mapped faults are shown as an indication of potential fluid conduits, given that multiple movement histories are common, even though the age or activity history of most faults is not known. Thickness of Mesozoic cover is indicated as a means of assessing feasibility of exploring in covered areas. Potentially reactive rock types possibly suitable as mineral hosts are shown, as are all known mineral occurrences. There are of course many other factors to be considered, generally at a larger scale (eg redox and fractionation state of intrusives, alteration patterns, etc). Unfortunately most are not mappable at this scale, or are represented only by inadequate datasets. This map is merely intended as an example of the type of maps that can be constructed from multiple geoscience datasets, as an aid to the selection of land areas possessing certain parameters considered favourable for particular types of mineral deposits. Compiled by JHC Bain & DE Mackenzie; GIS/cartography by V Ashby & D Haipola (AGSO).

MINERAL PROSPECTIVITY
Carboniferous-Permian



KENNEDY PROVINCE

Igneous rocks of Carboniferous-Permian age are extremely important costituents of the regional geology of North Queensland: they are not only abundant, widespread & diverse in character, they host or are genetically linked with most major metal deposits and the majority of mineral occurrences in the region. The Carboniferous-Permian Kennedy Province is one of the largest accumulations of Palaeozoic felsic and fractionated igneous rocks in the world.

Principal characterisitcs:
* mainly very felsic (SiO_2 commonly 75- 80%)
* commonly strongly fractionated
* variably oxidised, or strongly reduced
* have relatively primitive isotopic signatures and relatively young model source ages consistent with a considerable input of juvenile (mantle) material- a feature that enhances their potential for porphyry-type mineralisation.

They are geochemically similar to some of the Tertiary igneous rocks of southwestern USA.

The Townsville-Mornington Island Belt, the dominant component of the Kennedy Province, is a zone of Carboniferous-Permian igneous rocks that extends 900 km west-northwest from Townsville to the western coast of Cape York Peninsula, and possibly to Mornington Island in the southern Gulf of Carpentaria.

In its exposed portion, it is composed of abundant, commonly overlapping, mainly I-type granites, numerous caldera - collapse structures, and extensive associated volcanic rocks. It forms a broad magnetic high, probably mainly due to the intrusive rocks, on which are superimposed prominent circular magnetic anomalies that outline subsidence-controlled volcanic-intrusive complexes, mostly with low or reverse magnetisation.

Circular anomalies of character similar to those in the TMIB indicate that caldera-collapse structures and intrusive bodies of Carboniferous-Permian age are also scattered beneath Mesozoic-Cainozoic cover throughout western Cape York Peninsula and to the south of the TMIB, and form a concentration in the Cape York-Torres Strait area.

The TMIB is also characterised, particularly in the west, by a gravity low coincident with the broad magnetic high.

Torres Strait Region: A similar igneous field in northern Cape York Peninsula & Torres Strait contains few known mineral occurrences and is mostly concealed. However there is evidence for the presence of cauldron structures in its western portion, enhancing the potential for unexplored epithermal and porphyry-style mineralisation

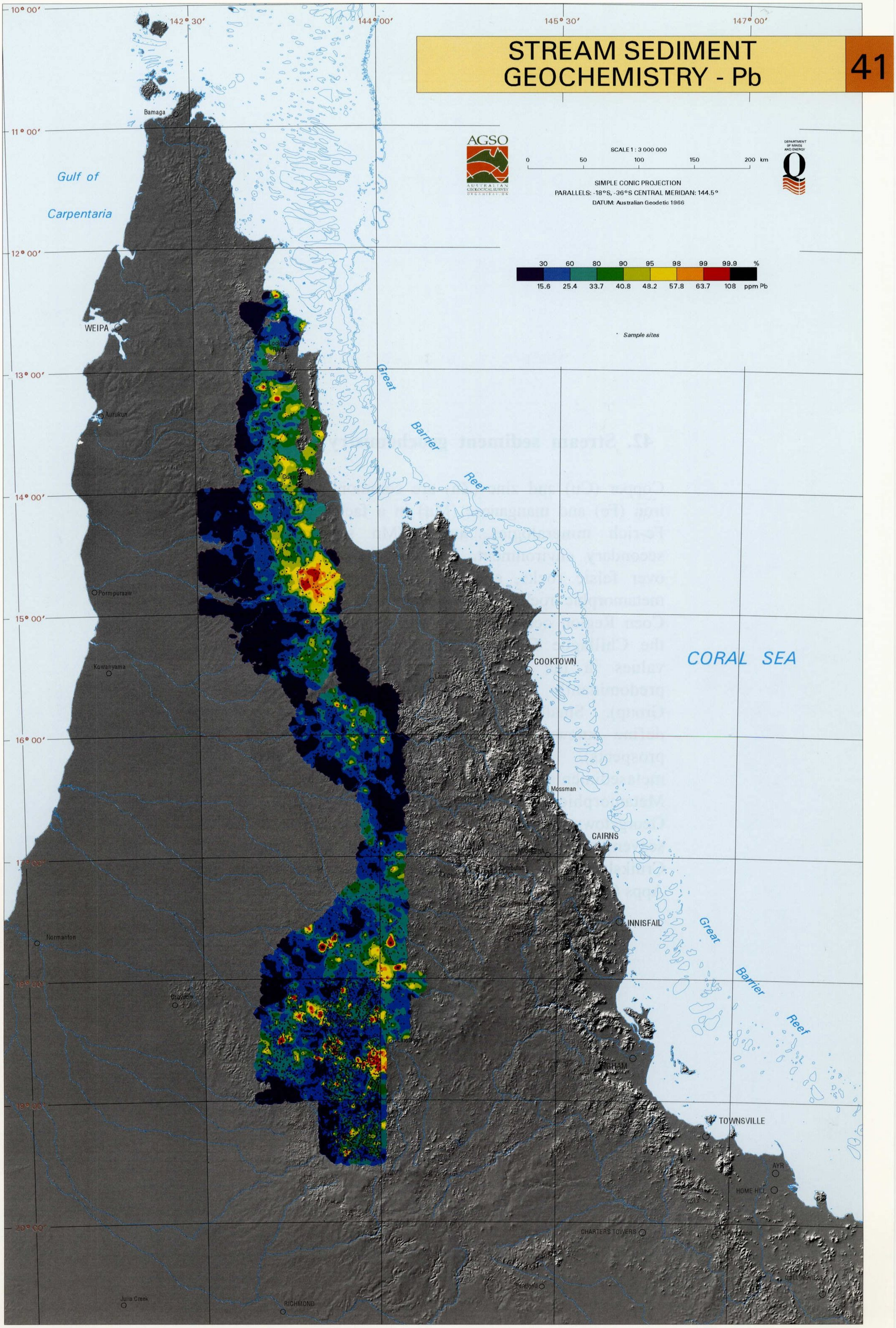
Mineralisation: Most of the 10,000 or so known mineral deposits & occurrences in North Queensland, including three large porphyry-related gold deposits **(Kidston, Mt Leyshon, Red Dome)** are genetically related to fractionated I-type igneous rocks of Carboniferous- Permian age:
* Sn + W related to reduced I-type granites.
* W + Mo ± Bi, Au ± Sb, Cu, and Pb-Zn-Ag related to oxidised I types.
* Most significant deposits in the TMIB are located in or adjacent to high-level intrusive bodies and/or the margins of caldera- collapse structures.
* Sn in the Cooktown region to the north of the TMIB is related to reduced, fractionated Permian S- type granites

Prospectivity: Numerous cauldron-subsidence structures, along with associated intrusive rocks, are present beneath regolith and Mesozoic-Tertiary sedimentary cover in the concealed segment of the TMIB. In the eastern part of this segment this cover is relatively thin (mostly <300 m). Furthermore, the magnetic data show that the number of collapse structures increases and their level of erosion decreases westward along the TMIB. Given the obvious prospectivity of the exposed part of the TMIB, we suggest that the concealed part of the TMIB is also worthy of exploration, and that prospectivity for epithermal deposits should increase westward.

Particularly prospective areas may include:
* in and near small, rounded, magnetic highs (due to shallow- level, oxidised, fractionated granites, or to deeper mafic intrusions);
* broad, cross-cutting magnetic lows (may be due to hydrothermal alteration);
* where the TMIB intersects ferruginous and/or carbonaceous intervals in the upper part of the Etheridge Group

41. Stream sediment geochemistry - *Pb*

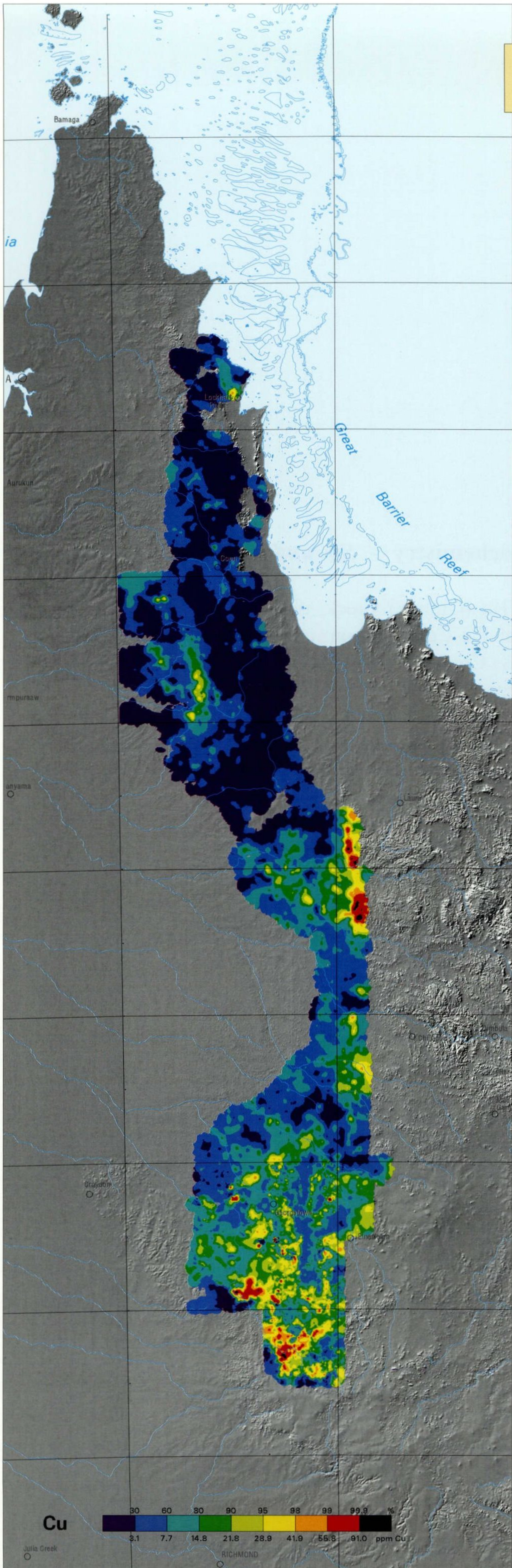
This image shows the spatial distribution of lead (Pb) in stream sediments over the igneous and metamorphic rocks of the Georgetown and Coen Regions, and adjacent Mesozoic sedimentary rocks of the Carpentaria Lowlands Region. The background is a hill-shaded relief image (see plate 3). Sample sites are shown as small black dots. Pb is commonly associated with Ba, Rb and Sr in a factor which appears to represent K-rich mineralogy. Extensive high values generally correspond to areas underlain by felsic rocks. For example in the central part of the Coen Region high values correspond with the Ebagoola and Kintore Granites, and in the Georgetown Region with the Forsayth and Copperfield Batholiths, and the Newcastle Range Volcanic Group. Many smaller anomalies are associated with known or potential mineralisation. The geochemical data displayed in this and following plates were obtained by AGSO's stream sediment geochemical surveys of the Georgetown Region (1974-80), and northward to the Coen Region (1990-93). 4570 samples were collected over the central part of the Georgetown Region during the early surveys and data for 17 to 24 elements are available. The 3200 samples in the later program were collected at a more regional scale and analysed for 39 elements, including Au by Bulk Cyanide Leach. Geochemical compilation and imaging BI Cruikshank; image processing M Peljo; cartography HE Apps (AGSO).

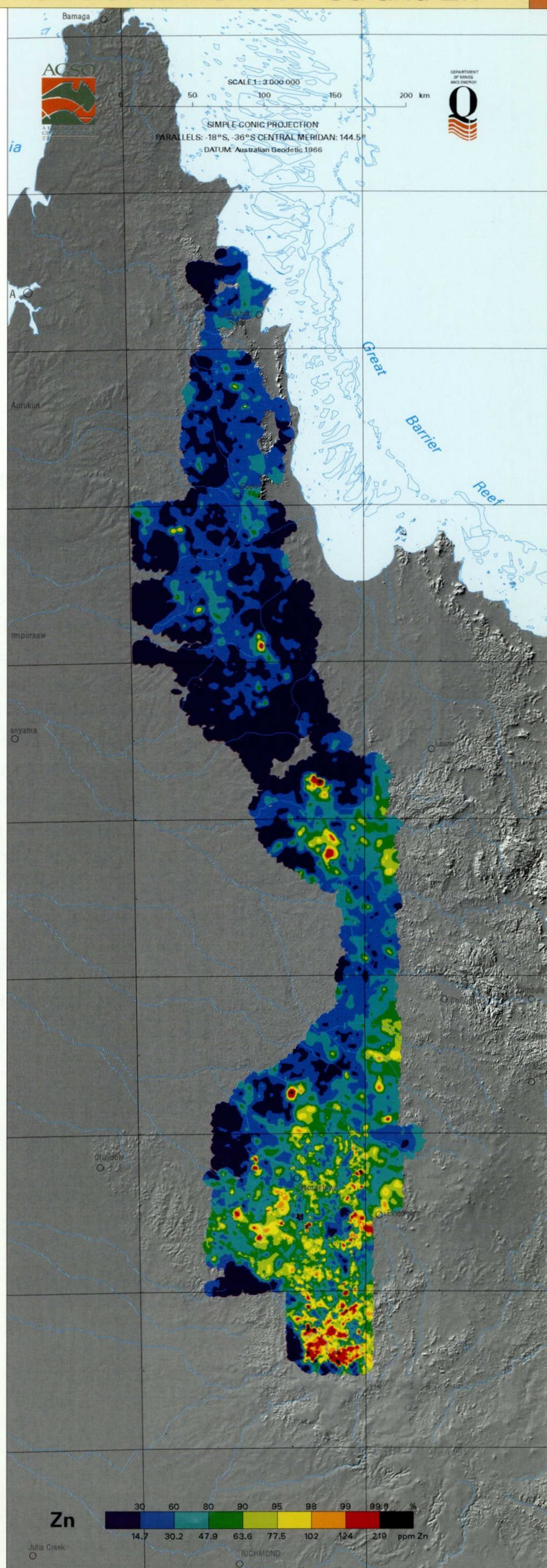

STREAM SEDIMENT GEOCHEMISTRY - Pb
41
AGSO
AUSTRALIAN GEOLOGICAL SURVEY ORGANISATION
SCALE 1 : 3 000 000
0 50 100 150 200 km
SIMPLE CONIC PROJECTION
PARALLELS: -18°S, -36°S CENTRAL MERIDAN: 144.5°
DATUM: Australian Geodetic 1966
DEPARTMENT OF MINES AND ENERGY
30 60 80 90 95 98 99 99.9 %
15.6 25.4 33.7 40.8 48.2 57.8 63.7 108 ppm Pb
Sample sites
10° 00′
11° 00′
12° 00′
13° 00′
14° 00′
15° 00′
16° 00′
142° 30′
144° 00′
145° 30′
147° 00′
Gulf of
Carpentaria
CORAL SEA
Great
Barrier
Reef
Bamaga
WEIPA
Aurukun
Pormpuraaw
Kowanyama
Normanton
Croydon
Julia Creek
RICHMOND
COOKTOWN
Laura
Mossman
CAIRNS
INNISFAIL
TOWNSVILLE
AYR
HOME HILL
CHARTERS TOWERS

42. Stream sediment geochemistry - *Cu and Zn*

Copper (Cu) and zinc (Zn) are commonly associated with iron (Fe) and manganese (Mn) in a factor which indicates Fe-rich mineralogies, and Fe/Mn scavenging in the secondary environment. Regionally Cu tends to be low over felsic rocks, and high over metasedimentary and metamorphic rocks. The high values to the south of the Coen Region occur over the sediments and metabasalts of the Chillagoe Formation, and the more extensive high values in the south of the Georgetown Region are predominantly over Deadhorse Metabasalt (Etheridge Group). Smaller, and mostly less conspicuous anomalies define known mineralisation (Cardross, Phyllis May prospects). Most Zn highs are associated with metasedimentary rocks, such as the Einasleigh Metamorphics in the south and southeast of the Georgetown Region. Zn is particularly prone to Fe/Mn scavenging. Geochemical compilation and imaging BI Cruikshank; image processing M Peljo; cartography HE Apps (AGSO).

STREAM SEDIMENT GEOCHEMISTRY - Cu and Zn

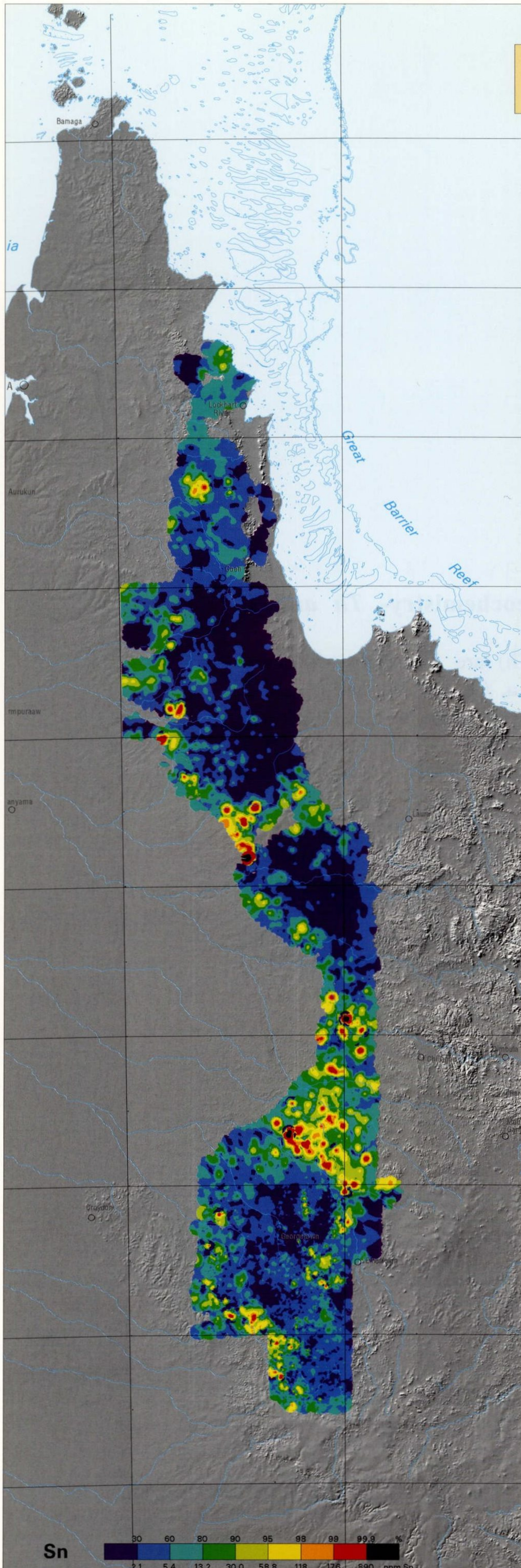


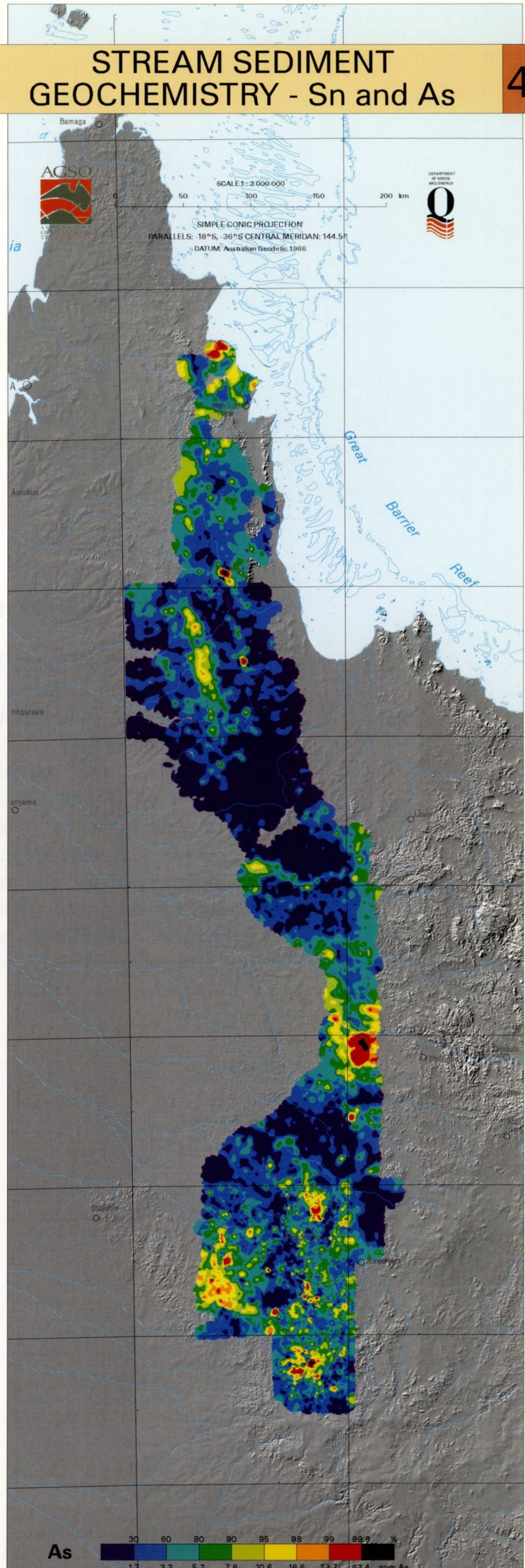


43. Stream sediment geochemistry - *Sn and As*

High tin (Sn) values occur at Tin (Granite) Creek, draining Permian granite, in the north of the Coen Region, and over Sn-bearing granites (O'Briens Creek Supersuite) in the north of the Georgetown Region. However, Sn values over granites in the rest of the Georgetown and Coen Regions are particularly low, with most high Sn values over Mesozoic sediments adjacent to the granitic and metamorphic rocks in both regions. High arsenic (As) values in the south and southwest of the Georgetown Region are associated with several units, including Proterozoic carbonaceous pyritic metasediments. The large As feature in the north of the Georgetown Region corresponds with a former Cu, Ag and Au mining field (Cardross) which also shows regional Bi and Sb highs. A feature of interest is the linear, low-level anomaly over the Lindalong and Lukin River Shear Zones near the centre of the Coen Region. Geochemical compilation and imaging BI Cruikshank; image processing M Peljo; cartography HE Apps (AGSO).

STREAM SEDIMENT GEOCHEMISTRY - Sn and As



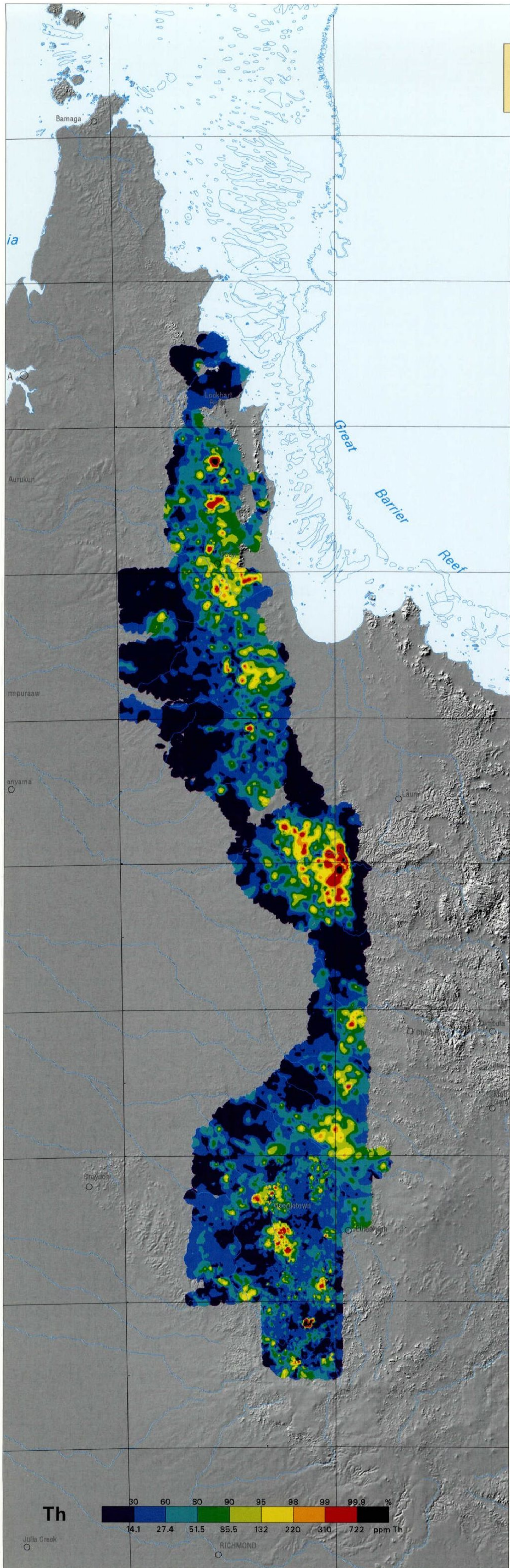


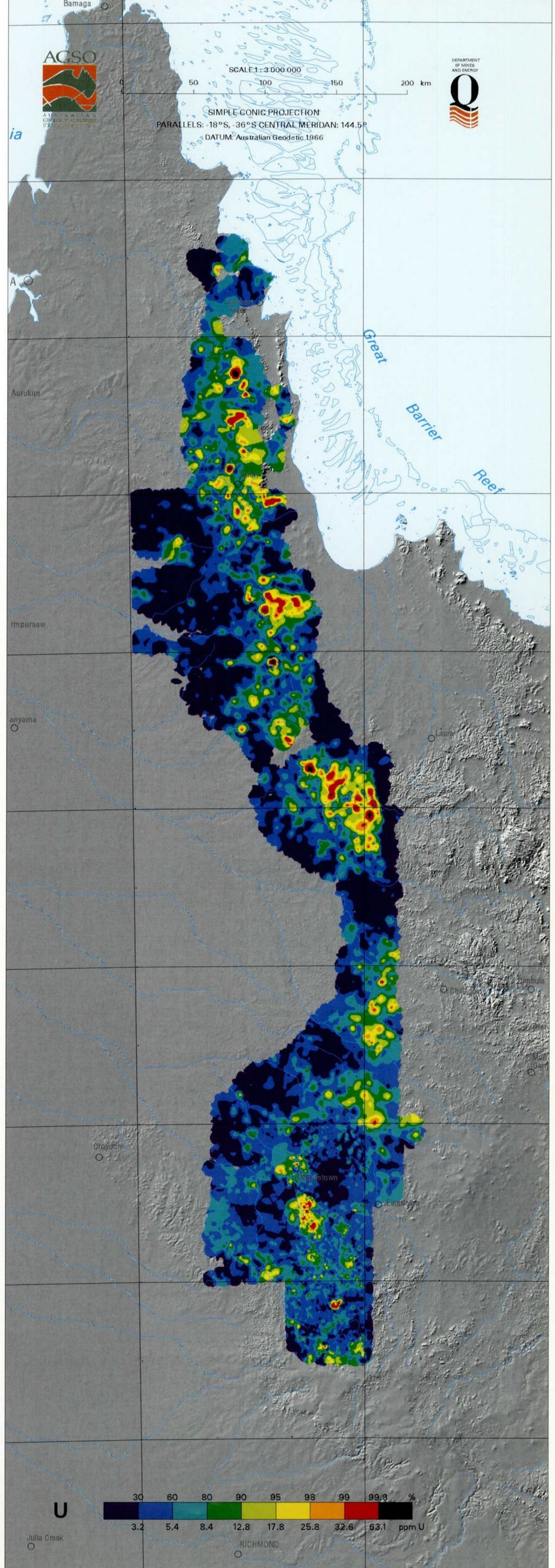
44. Stream sediment geochemistry- *Th and U*

Uranium (U) and thorium (Th) are invariably associated with the rare earth elements La, Ce and Nd, and Y and P in a factor which indicates the presence of the U-bearing, resistant phosphate minerals monazite ([La, Ce,Nd,Th]PO_4) and xenotime (YPO_4). The spatial distribution of U and Th in the survey area is almost identical with highs for both U and Th concentrated over the granitic and metamorphic rocks of the two regions. Most differences are due to a variations of the relative amounts of monazite (REE, Th) and xenotime (Y). Geochemical compilation and imaging BI Cruikshank; image processing M Peljo; cartography HE Apps (AGSO)

STREAM SEDIMENT GEOCHEMISTRY - Th and U

44





North Queensland Geology

Compiled by John H.C. Bain & Dan Haipola

About this map

Geology (mostly post-1970) by: JHC Bain, LP Black, RS Blewett, RV Burne, DC Champion, TL Graham, GAM Henderson, J Knutson, DE Mackenzie, J McPhie, BS Oversby, C F Pain, DS Trail, JR Wilford, D Wyborn (BMR/AGSO); EM Baker, RJ Bultitude, W Cooper, LC Cranfield, SB Crouch, J Domagala, PJT Donchak, JJ Draper, BG Fordham, PD Garrad, FE von Gnielinski, KG Grimes, LM Gunther, MC Gunther, RW Halfpenny, RA Hegarty, G Hofmann, KH Holmes, LJ Hutton, MR Jones, SC Lang, SR Law, JD Macansh, TPT McLennan, RA Mcleod, ML O'Flynn, ID Rees, IP Rienks, ADC Robertson, K Tenison Woods, DL Trezise, M Scott, DE Searle, AW Stephens, JV Warnick, WF Willmott, IW Withnall. (GSQ); JC Dohrenwend (USGS)), with contributions from: G. Murtha (CSIRO); TH Bell, AC Duncan, JD Fitzgerald, D Hopley, CJ Johnston, PW Llewellyn, JP Patrick, PJ Pollard, SO Peters, TH Reddicliffe, MJ Rubenach, PJ Stephenson, WK Witt (James Cook University of North Queensland); Aye Ko Aung, JS Jell, DA Lockhart, NJ McNaughton, NJ Rich (University of Queensland); DC Champion, M Hayne, R D Holmes, AD Lawrence, DN Richards (Australian National University); R Mawson, JA Talent (Macquarie University); JS Hartley (consultant); SD Beams (Terra Search); AGIP Nucléare Australia Pty Ltd, BHP Minerals Pty Ltd, Central Pacific Minerals NL, Comalco Ltd, CRA Exploration Pty Ltd, Esso Exploration & Production Australia Ltd, Getty Oil, Hunter Resources Ltd, Kidston Mines Ltd, Minatome Australia Pty Ltd, Normandy Exploration Ltd, Pancontinental Mining Ltd, Placer Pacific Pty Ltd, PNC Exploration Ltd, Queensland Metals Corp, Shell Minerals, Urangesellschaft Australia Pty Ltd.

Geology (mostly pre- 1970) by: BJ Amos, MB Bayley, JG Best, JG Binnekamp, DH Blake, CD Branch, WE Bush, HF Doutch, RHS Fardon, RZ de Ferranti, JB Firman, DH Green, CM Gregory, RR Harding, KK Hughes, J Ingram, FE de Keyser, KG Lucas, R Morgan, RS Needham, U Kyaw Nyein, F Olgers, AGL Pain, DA Palfreyman, IR Pontifex, MA Reynolds, J Smart, JR Stewart, DS Trail, RR Vine, DA White, WF Willmott (BMR); DJ Casey, DE Clarke, LG Cuttler, RW Day, DW Dearne, VR Forbes, KG Grimes, RJ Paten, RM Tucker, WG Whitaker, KW Wolff, JT Woods, DH Wyatt, , (GSQ).

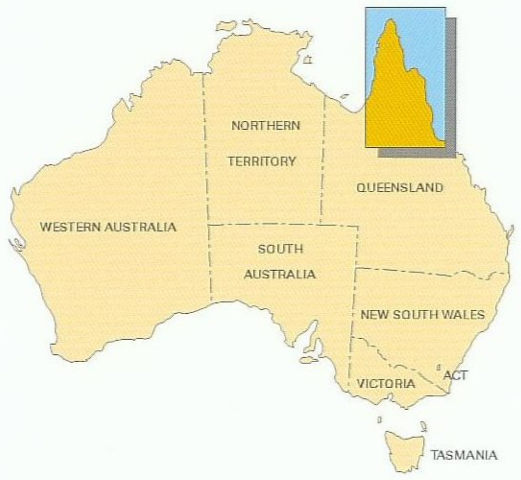
Other data sources: Drainage, coastline, place names (modified from the Digital Chart of the World); reefs & reef names (derived from information provided by the Great Barrier Reef Marine Park Authority); mine & mineral deposit names & locations (AGSO OZMIN database)

Geological compilation & map design 1996 by: JHC Bain (AGSO). Substantial editorial advice was provided by JJ Draper, IW Withnall, RJ Bultitude, LJ Hutton (GSQ) and RS Blewett, DE Mackenzie, P Wellman (AGSO). Assistance with colour design and production was provided by R Swoboda & JN Mason.

Digital map construction 1996 by: D Haipola (AGSO) with assistance from V Ashby, P Brugman, D Butrovski, & A. Hoggett (AGSO)

Bibliographic reference: Bain, J.H.C. & Haipola, D., 1997- North Queensland Geology (1:3,000,000 scale map), in Bain JHC and Draper JJ 1997 Atlas of North Queensland Geology, Australian Geological Survey Organisation, Canberra and Queensland Department of Mines and Energy, Brisbane.

Geological boundary
Fault, major
Fault, minor
Fault, concealed
Undeveloped mineral deposit
Operating mine
Historic mine
Highway or Principal road
Secondary road
Vehicle Track
Railway
City
Town or Village
Homestead or Outstation



GEOLOGY LEGEND (foldout for Plate 8)

45

Quaternary
- *Sand, gravel, silt, clay, soil; siliceous hardpan:* ***alluvial***
- *Mud, silt, sand:* ***marine coastal***
- *Quartzose, feldspathic & shelly sand & gravel; beachrock:* ***marine barrier***
- *Quartz sand:* ***coastal dunefields***
- *Sand, silt, mud:* ***estuarine & delta***

Cainozoic
- *Quartzose sand, silt, clay; soil; talus; ferricrete, silcrete:* ***colluvial & residual***
- *Bauxite, ferricrete:* ***residual***
- *Alkali basalt, basanite, hawaiite, tholeiitic basalt, nephelinite, & leucitite lava, breccia & scoria:* ***mafic lavafields***

Pliocene
- *Silt, clay, clayey quartzose sand & gravel:* ***alluvial***

Mid Miocene-Early Pliocene
- *Clayey quartose sand & gravel, clay:* ***alluvial***

Paleocene-Early Miocene
- *Poorly consolidated clayey quartzose sandstone & pebble conglomerate:* ***alluvial***

Early Cretaceous
- *Calcareous claystone, siltstone, glauconitic sandstone; carbonaceous limestone; calcareous concretions:* ***shallow marine***
- *Biotite granite, hornblende-biotite granodiorite:* ***felsic I-type intrusives***

Mid Jurassic-Early Cretaceous
- *Quartzose sandstone, conglomerate, siltstone, claystone; carbonaceous shale, coal; glauconitic sandstone:* ***alluvial to marginal marine:***

Late Permian-Mid Triassic
- *Sandstone, siltstone, carbonaceous mudstone, coal; conglomerate, "red beds", rare tuffs:* ***alluvial***

Late Permian
- *Muscovite-biotite granite: felsic S-type intrusives*
- *Andesite to rhyolite lava, rhyolitic ignimbrite & tuff; volcaniclastic sediments:* ***mafic to felsic I-type extrusives***

Late Carboniferous-Early Permian
- *Sandstone, siltstone, carbonaceous mudstone; tuff; conglomerate; coal:* ***alluvial, lacustrine & shallow marine***
- *Granite, granodiorite, & tonalite; microgranite, microgranodiorite; rhyolite; dolerite, granophyre, diorite, gabbro:* ***felsic I, S, & A-type & mafic intrusives***
- *Rhyolitic to andesitic ignimbrite, lava, tuff & breccia; basalt lava; volcaniclastic sediments; limestone :* ***felsic I & A-type extrusives***

Late Devonian-Early Carboniferous
- *Sandstone, siltstone, conglomerate, mudstone; "red beds"; limestone, carbonaceous mudstone; rhyolite lava, rhyolitic ignimbrite & tuff; coal:* ***alluvial & shallow marine***
- *Biotite granite, microgranite; hornblende-biotite granodiorite, microgranodiorite; diorite; rhyolite:* ***felsic I-type intrusives***
- *Rhyolitic to dacitic ignimbrite; andesite to basalt lava & breccia; rhyolitic lava, tuff & breccia:* ***felsic I-type extrusives***

Devonian
- *Sandstone, mudstone; minor conglomerate, chert, basalt; rare limestone:* ***marine***

Early-Mid Devonian
- *Limestone, sandstone (calcareous in places), mudstone, conglomerate:* ***shallow marine***

Early Devonian
- *Porphyritic muscovite-biotite granite, leucogranite, aplite, & pegmatite; biotite & hornblende-biotite granodiorite, monzogranite & tonalite:* ***felsic S & I-type intrusives***

Silurian-Early Devonian
- *Sandstone, mudstone, limestone, chert, siltstone; basalt; conglomerate; tholeiitic basalt lava:* ***shallow marine***

Silurian
- *Porphyritic biotite-hornblende granodiorite & tonalite; quartz diorite, gabbro, troctolite; biotite granite, garnet-muscovite leucogranite:* ***felsic to mafic I-type intrusives***

Ordovician-Silurian
- *Pyroxene-hornblende-quartz gabbro to diorite; minor olivine-pyroxene gabbro:* ***mafic intrusives***

Late Ordovician
- *Sandstone, mudstone, conglomerate, limestone, siltstone; basalt; chert, jasper:* ***marine***

Mid Ordovician
- *Hornblende-biotite & biotite granodiorite & granite:* ***felsic to mafic I-type intrusives***

Early Ordovician
- *Mudstone, siltstone, sandstone; basalt; chert, jasper:* ***marine***

Late Cambrian-Early Ordovician
- *Sandstone, siltstone; felsic & intermediate volcanics:* ***deep marine***
- *Biotite & hornblende-biotite granite & granodiorite; hornblende-pyroxene metadiorite:* ***felsic to intermediate S & I-type intrusives***
- *Rhyolite to dacite lava & breccia; rhyolitic to dacitic breccia; andesite, andesitic breccia, basalt; minor sandstone & siltstone:* ***felsic I-type extrusives***

Late Neoproterozoic-Mid Cambrian
- *Mica & chlorite schist, biotite gneiss, amphibolite, quartzite, meta-arenite, calc-silicate granofels, migmatite; minor metachert, ironstone, serpentinite, phyllite*
- *Greenstone, metadolerite, metabasalt?,amphibolite:* ***mafic intrusives/extrusives***

Neo-Mesoproterozoic
- *Serpentinite, clinopyroxenite, amphibolite: mafic/ultramafic intrusives*

Mesoproterozoic (Calymmian)
- *Mudstone, siltstone (partly carbonaceous); metasandstone, slate, phyllite, quartzite, mica schist (locally graphitic), gneiss; migmatite*
- *Porphyritic biotite-muscovite granite; garnet-muscovite leucogranite, pegmatite; granodiorite, tonalite; trondjhemite; microdiorite:* ***felsic S & I-type intrusives***
- *Rhyolitic ignimbrite; rhyolite, dacite & andesite lavas; dacitic ignimbrite; volcanic-derived sandstone; siltstone:* ***felsic S or I?-type extrusives***
- *Metadolerite, grading into foliated amphibolite:* ***mafic intrusives***

Palaeoproterozoic (Statherian)
- *Mica schist, quartzite, gneiss, calc-silicate, slate, phyllite, mudstone, siltstone, meta-arenite (mainly carbonaceous, some calcareous); amphibolite; migmatite*
- *Metadolerite & metagabbro, grading into foliated amphibolite & granulite:* ***mafic intrusives***
- *Metabasalt with local pillows, hyaloclastite breccia, grading into foliated amphibolite & granulite:* ***mafic extrusives***

Note: Only the dominant rock types are listed, generally in order of abundance
Main depositional environments & main igneous classes are in **bold type**