Government of **Western Australia**
Department of **Mines and Petroleum**

RECORD 2015/14

GEOLOGICAL MAP OF WESTERN AUSTRALIA, 14TH EDITION — EXPLANATORY NOTES

by
DMcB Martin, RM Hocking, A Riganti, and IM Tyler




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Geological Survey of Western Australia

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Contents

Figure

Tables

Geological map of Western Australia, 14th edition — Explanatory Notes

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Abstract

The Western Australian State geological map is a flagship product of the Geological Survey of Western Australia. On average it is produced about once per decade. The 2015 edition is the 14th in the series, and the first to be compiled entirely digitally and released simultaneously as a printed map and complementary digital data layers. These explanatory notes provide details on the compilation and style of presentation of both the printed map and digital data, and a high-level summary of the geology of the State as depicted on the map.

KEYWORDS: Explanatory Notes System, State map

Introduction

The Geological Map of Western Australia 2015 is the 14th edition of a map series that began with the publication of the first Geological Sketch Map of Western Australia in 1894, soon after the establishment of the Geological Survey of Western Australia (GSWA) in 1888. This current edition marks a significant departure in methods of compilation and presentation compared to previous editions, and reflects the data-driven approach of modern map making. The data behind this map are primarily held at larger scales in GSWA's GIS databases, and in the textual Explanatory Notes System (ENS). Consequently, these notes do not attempt to provide a comprehensive account of the geology, but rather provide a brief explanation of the geological units used on the printed map in the context of the current understanding of the geological evolution of the State. The notes also provide a translation from the simplified unit codes used on the printed map to the corresponding meaningful geological names recorded in ENS. They are an overview, so a Further Reading section is provided instead of full in-text referencing.

Map compilation

The 2015 State map differs from previous editions in that it is the first statewide map at this scale to be compiled entirely by simplification of larger-scale digital data. Previous editions were compiled and drafted by hand, in part at final scale for the 1988 map, with the exception of the 1998 map, which was compiled at 1:1 000 000 and then digitized. This generally resulted in oversimplified maps with compromised spatial accuracy arising both from the compilation method and the inaccuracies in the source materials, which only in the second half of the 20th century incorporated information from 1:250 000 series maps, aerial photography, and aeromagnetic data.

The primary data sources for the current 1:2 500 000 map are the State 1:500 000-scale interpreted bedrock geology and linear structural features datasets (themselves simplified from either 1:100 000 or 1:250 000-scale datasets), and a wide variety of geophysical and remotely sensed data. The approach has been to first simplify polygons by 'rolling up' this more detailed data according to parent unit definitions in ENS. Strict rules for polygon area and width, and line length were then applied in order to optimize the size of map elements for readability at the nominal map scale. The digital 1:2 500 000 layer that accompanies the printed map is the product of this first round of simplification. Some additional simplification has been required in areas of particularly detailed geology to further improve the readability of the printed map. Nevertheless, wherever possible the aim has been to preserve as much detail as possible at the nominal scale. This second process resulted in the merging of smaller polygons with larger or more geologically significant adjacent polygons and further reduction in structural line density and node density on some polygon boundaries.

Dolerite sills in the Bangemall Supergroup, a small outcrop of the Cambrian Mu Formation in the Amadeus Basin, and the Warlawurru Supersuite granite in the Musgrave Province are the only units that have been enlarged at the nominal scale for the sake of readability.

Another departure from the approach used in the making of the 1998 map is that formal lithostratigraphic units are not further subdivided based on lithology in the current version. This approach resulted in a loss of map detail in some units (e.g. the Kimberley and Fortescue Groups), but is consistently applied across the map, resulting in a more uniform style of presentation. Additional details such as offshore faults and contours of Phanerozoic and Neoproterozoic sediment thicknesses have also been omitted for clarity. In the case of offshore data this is now largely the jurisdiction of Geoscience Australia.

Main tectonic units

The main tectonic units of Western Australia, which are the building blocks of the State, are shown in the 1:10 000 000 inset map above the legend (Fig. 1). Three categories of tectonic units are recognized:

1. Cratons — regions of crust that have been stable since c. 3200 Ma or have been assembled by plate tectonic processes and stabilized since that time. Exposed Archean cratons are outlined in red
2. Basins — deposits of sedimentary and volcanic rocks, generally younger than c. 2800 Ma and largely unmetamorphosed. These units are individually labelled and coloured according to their age
3. Orogens — sedimentary basins and craton margins that have been tectonically reworked and metamorphosed during the assembly of high-level cratons, which are depicted with overprints and are individually labelled. Orogens may be the product of multiple orogenic or tectonic events.

Definition and age of rock units

All map units and their ages are defined according to data held in ENS. The current map uses a revised numerical timescale compared to the 1998 edition with the aim of better discriminating the temporal distribution of lithotectonic units. To this end, the timescale starts at 3800 Ma so as to include the oldest exposed rock units. Thereafter the Precambrian is divided into eight major time divisions between c. 3800 and 541 Ma (Table 1) that reflect distinct tectonostratigraphic episodes in the evolution of the State. These numbered divisions are bound by significant breaks in magmatism or orogenesis, with the exception of the two internationally recognized 'golden spikes' at 2500 Ma and 541 Ma that mark the Archean–Proterozoic and Proterozoic–Phanerozoic boundaries, respectively. Each major division is further subdivided into 100 Ma intervals (labelled alphabetically from oldest to youngest) into which each lithostratigraphic unit has been placed, based on current geological and geochronological constraints. As the Phanerozoic timescale follows the current standard subdivisions of the International Commission on Stratigraphy, the last chronological interval of the Precambrian is only 59 Ma long. Overall, the timescale is linear, but divided into differently scaled sections with changes at 600, 100, and 10 Ma in order to allow more detailed representation of Phanerozoic units.

Table 1. Precambrian chronological subdivisions

Major interval	*Age range (Ma)*	*Minor intervals*
1	3800–3400	a, b, c, d
2	3400–3100	a, b, c
3	3100–2800	a, b, c
4	2800–2500	a, b, c
5	2500–2100	a, b, c, d
6	2100–1600	a, b, c, d, e
7	1600–900	a, b, c, d, e, f, g
8	900–541	a, b, c, d

Precambrian lithological units are mainly shown at the Group/Suite level or higher, unless lower level units have a rank of 'top of the list' (TOL) in ENS (i.e. are not subdivisions of stratigraphically higher-ranked units). Phanerozoic units mainly reflect broad groupings by lithology and age, with no reference to formal lithostratigraphic units. Since the coding system in ENS is too complex to depict at the nominal map scale, each unit has been assigned a new code, based on either the names of the constituent formal units or a combination of dominant lithology and age interval (as detailed in Table 1). Unit boxes are a fixed size and arranged according to their interpreted relative temporal position. They are based on either the arithmetic mean of the maximum and minimum ages in ENS or else as interpreted mean ages based on mapped relationships to units of known age. The vertical blue lines indicate a combination of links to related units, the known age range of a unit, or uncertainties in the absolute temporal constraints. Since they are generalized to the age of the corresponding interval, the unit age ranges presented on the right hand side of the legend may not represent the full age range of a specific unit. Detailed age data, formal GSWA lithostratigraphic codes, and other attributes for individual units are available in the significantly more detailed digital 1:2 500 000 layer, which is not intended for optimal viewing at the nominal scale.

Precambrian rocks

The Precambrian legend is divided into three columns that contain information regarding lithological coding and tectonics, as follows (from left to right):

Column 1 — sedimentary and volcanic rocks within major named lithostratigraphic units, generally at Group level or higher and mainly of low metamorphic grade

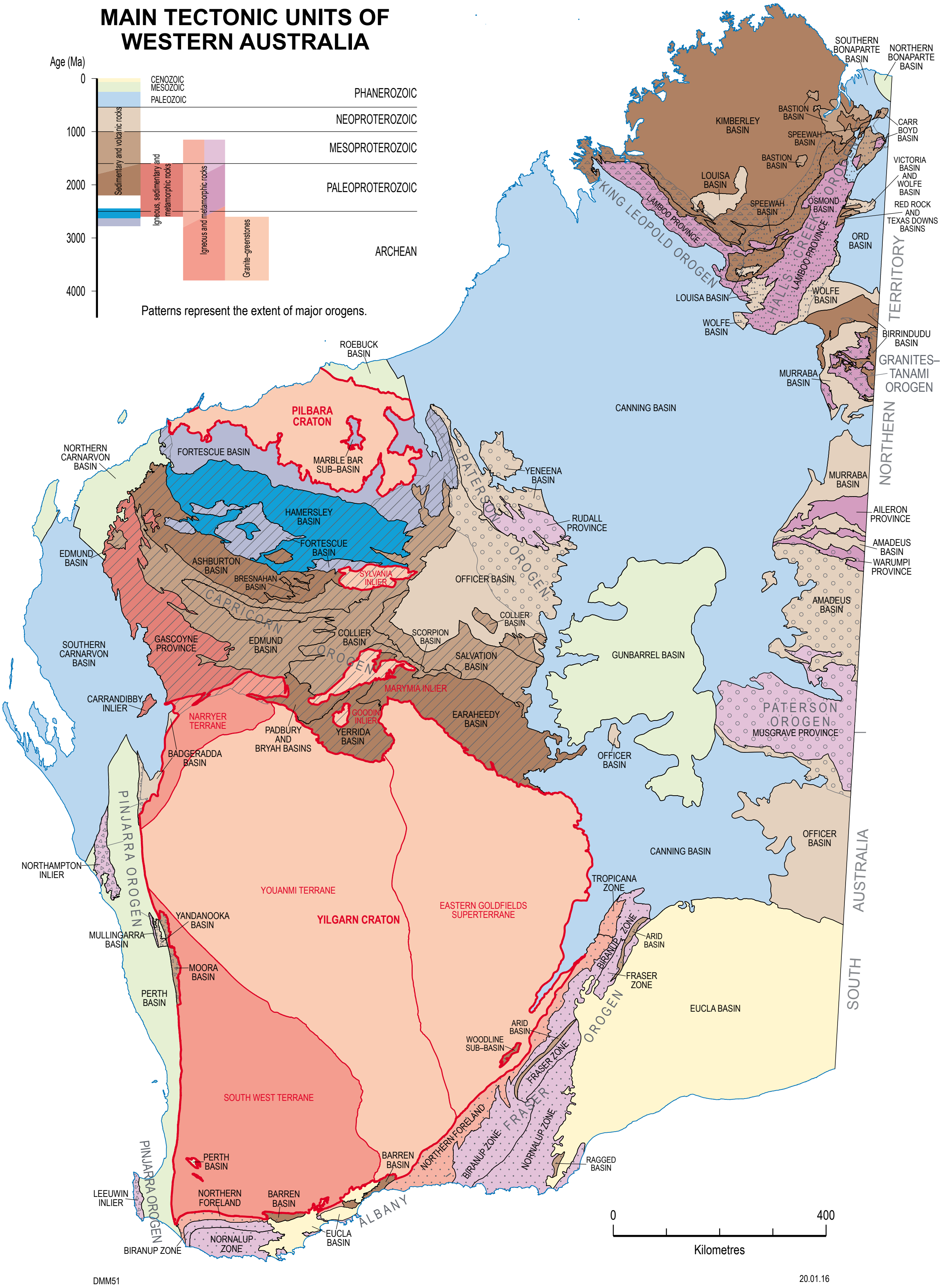

Figure 1. Main tectonic units of Western Australia

Column 2 — other sedimentary, volcanic and intrusive igneous rocks of low to high metamorphic grade. No lithostratigraphic information is provided for these units

Column 3 — timing and relative spatial distribution of orogenies and selected tectonic events.

The rocks in Column 1 are indicated by a single capital letter (e.g. P), or a capital letter followed by either a lower case letter or numeral (e.g. Mu or F1). The letters have been chosen to reflect the formal name of the lithostratigraphic unit. The numerals represent stratigraphic sequences or subdivisions within recognized units and are shown by an upward-younging numerical sequence attached to a capital or capital and lower case letter combination, representing either the lithostratigraphic unit or basin. Thus, the Bryah Group (Br) contains a sequence designated Br1 and Br2. The correlation between these subdivisions and the detailed lithostratigraphy is shown in Table 2. Wherever possible, units forming a geological succession in the same area are arranged together in a single column. Nevertheless, no relative spatial distribution is implied by the lateral arrangement of legend boxes or columns.

Formally undivided and higher metamorphic grade rocks in Column 2 of the legend are represented by single lower case letters that refer to the following rock types:

s — sedimentary rocks

f — felsic volcanic rocks

b — mafic and ultramafic volcanic rocks

d — dolerite, gabbro, and ultramafic intrusions

g — granite intrusions (syenite — gy)

n — gneiss (primarily orthogneiss)

Each of these letters is followed by a number and lower case letter that signifies the approximate age of the unit, according to Table 1. Units that are known to be the product of two distinct events (usually involving gneissic overprints or granite intrusion) are represented by two unit codes, with the younger in parentheses (e.g. g4b(n7c)). Uncertainties in the age of map units are shown with vertical blue range bars for units in both Columns 1 and 2. Similarly the height of the bars in Column 3 reflects known age ranges according to data held in ENS.

Phanerozoic rocks

The Phanerozoic legend differs in concept from the Precambrian legend because there are few igneous rocks of Phanerozoic age in Western Australia. Of those only Cambrian flood basalts, Lower Cretaceous basalt in southwestern Western Australia, and scattered diatremes are exposed. Additionally, there has been minimal metamorphism of the Phanerozoic succession by comparison with older rocks.

The Phanerozoic legend is also divided into three columns:

Column 1 — coding and relative lateral correlations

Column 2 — detailed legend narrative

Column 3 — the timing and relative spatial distribution of orogenies and selected tectonic events.

The legend format has been modified from that of the previous edition in order to show the lateral variation of Phanerozoic rocks across the state (Column 1). It uses a broadly west-to-east, marine-to-continental grouping of map units placed within a vertical arrangement highlighting the major depositional packages, rather than being set out strictly by formal age divisions. The paleoenvironmental implications of these groupings do not extend into the Precambrian. This approach also conveys the age uncertainties of some units and illustrates proposed correlations between various units. Owing to the space available, unit narratives (Column 2) are more detailed than for Precambrian units. The code system is based on age (leading capitalized code, in places with secondary modifier) and lithology (trailing lower case letter, see Tables 3 and 4).

The correlation between the map units and the formal lithostratigraphy is shown in Tables 3 (Paleozoic) and 4 (Mesozoic and Cenozoic).

Orogenies and tectonic events

The temporal distribution of orogenies and tectonic events is depicted for the first time on a State map, as a column on the far right hand side of the legend. The true spatial distribution of these events is not depicted on this map, but is available for most major events via the 1:500 000 Orogenic events of Western Australia digital layer. Boxes are arranged in the legend to reflect the rough east–west spatial distribution of events according to their generalized central meridian value. All known orogenies in the State are shown, but some tectonic events have been omitted owing to a lack of space.

Explanation of mapped geological units

Eoarchean (4000–3600 Ma)

The oldest mapped rock units in Western Australia are in the Narryer Terrane, on the northwestern margin of the Yilgarn Craton, one of the oldest known crustal fragments, which also contains the oldest detrital zircons on Earth. The bulk of the terrane consists of granite and granitic gneiss, the oldest components of which (n1a) are tonalite–trondhjemite–granodiorite (TTG) gneiss of the Meeberrie Gneiss, which includes dismembered anorthosite–gabbro–ultramafic igneous rocks of the Manfred Complex, dated at c. 3730 Ma. Similar aged rocks (3800–3550 Ma) on the Pilbara Craton are restricted to enclaves or xenoliths within younger units in the East Pilbara Terrane.

Table 2. Translation of formal unit map codes to Precambrian lithostratigraphic units, arranged in approximate age order

Code	*Lithostratigraphic Unit*	*Parent Unit*	*Tectonic Unit*
Cn4	Maurice Formation Sir Frederick Conglomerate Ellis Sandstone Clutterbuck Formation Angas Hill Beds Carnegie Formation Disappointment Group	Supersequence 4	Centralian Superbasin
Cn34	Louisa Downs Group Albert Edward Group	Supersequence 3 and 4	
Cn3	Boondawarri Formation Wahlgu Formation Turkey Hill Formation western Amadeus Basin Kuniandi Group Duerdin Group Mount House Group	Supersequence 3	
Cn2	Lupton Formation	Supersequence 2	
Cn1	Sunbeam Group Buldya Group Bitter Springs Formation Heavitree Quartzite Kulail Sandstone Dean Quartzite Vaughan Springs Quartzite	Supersequence 1	
Cn	Redcliff Pound Group Badgeradda Group		
Tj	Tjauwata Group	Bentley Supergroup	Bentley Basin
Mi	Mission Group		
Py	Pussy Cat Group Cassidy Group		
Km	Karnka Group Mount Palgrave Group		
Tu	Tollu Group		
Kn	Kunmarnara Group		
Sv	Salvation Group		Salvation Basin
B2	Manganese Group Collier Group	Bangemall Supergroup	Collier Basin
Cg	Carr Boyd Group Glidden Group		Carr Boyd Basin Glidden Basin
Wc	Wade Creek Formation Bungle Bungle Formation Mount Parker Formation		Osmond Basin
Y	Yandanooka Group		Yandanooka Basin
Mc	Moora Group		Moora Basin
B1	Uaroo Group Edmund Group	Bangemall Supergroup	Edmund Basin
Sc	Scorpion Group		Scorpion Basin
Bh	Bresnahan Group		Bresnahan Basin
Mm	Mount Minnie Group		Mount Minnie Basin
Mb	Mount Barren Group		Mount Barren Basin
Cb	Crowhurst Group Bastion Group Birrindudu Group		Crowhurst Basin Bastion Basin Birrindudu Basin
K2	upper Kimberley Group	Kimberley Group	Kimberley Basin
K1	lower Kimberley Group		
Sp	Speewah Group		Speewah Basin
Hc	Halls Creek Group		Halls Creek Basin

Table 2. continued

Code	*Lithostratigraphic Unit*	*Parent Unit*	*Tectonic Unit*
C	Capricorn Group		Blair Basin
Wy	Wyloo Group		Ashburton Basin
Ta	Tanami Group		Tanami Basin
Mn	Miningarra Group		Earaheedy Basin
To	Tooloo Group		
Mo	Mooloogool Group		Yerrida Basin
Wi	Windplain Group		
Pa	Padbury Group		Padbury Basin
Br2	upper Bryah Group	Bryah Group	Bryah Basin
Br1	lower Bryah Group		
T2	Shingle Creek Group		Turee Creek Basin
T1	Turee Creek Group	Mount Bruce Supergroup	
H2	upper Hamersley Group		Hamersley Basin
H1	lower Hamersley Group		
F5	Fortescue Group sequence 5		Fortescue Basin
F4	Fortescue Group sequence 4		
F3	Fortescue Group sequence 3		
F2	Fortescue Group sequence 2		
F1	Fortescue Group sequence 1		
G	Glen Group	Murchison Supergroup	Youanmi Terrane
Po	Polelle Group		
N	Norie Group		
Mu	Murchison Supergroup (undivided)		
D	De Grey Supergroup		De Grey Superbasin
Nu	Nullagine Group		Mosquito Creek Basin
Wh	Whundo Group		Whundo Basin
S	Soanesville Group		Soanesville Basin
R	Roebourne Group		Karratha Terrane
P	Pilbara Supergroup		Pilbara Craton

Table 3. Translation of map unit codes to lithostratigraphic units

Code	*Age*	*Stratigraphic unit*	*Tectonic unit*
Pz	Permian	Liveringa Group Kennedy Group Wagina Sandstone	Canning Basin Southern Carnarvon Basin Perth Basin
Pl		Noonkanbah Formation Byro Group Carynginia Formation	Canning Basin Southern Carnarvon Basin Perth Basin
Ps		Poole Sandstone Wooramel Group High Cliff Sandstone, Irwin River Coal Measures	Canning Basin Southern Carnarvon Basin Perth Basin
CPe	Late Carboniferous – Early Permian	Kulshill Group Grant Group Paterson Formation Lyons Group Nangetty Formation	Southern Bonaparte Basin northern Canning Basin southern Canning Basin Southern Carnarvon Basin Perth Basin
Pc		Collie Group	Collie, Wilga and Boyup Sub-basins (Perth Basin)
PZs	Paleozoic	Lucas Formation	eastern Canning Basin
Cz	Carboniferous	Langfield and Weaber Groups Yindagindy and Williambury Formations, Moogooree Limestone	Southern Bonaparte Basin Southern Carnarvon Basin
DCl	Late Devonian – Early Carboniferous	Fairfield Group	Canning Basin

Table 3. continued

Code	*Age*	*Stratigraphic unit*	*Tectonic unit*
Ds	Devonian	Cockatoo Group Mahony Group Conglomerates associated with reef complexes, Lillybooroora Conglomerate	Southern Bonaparte Basin Ord Basin Canning Basin
		Nannyarra Sandstone, Gneudna Formation, Munabia Sandstone, Willaraddie Formation	Southern Carnarvon Basin
Dk		Ningbing Group Reef complexes — platform, marginal slope and basin facies	Southern Bonaparte Basin Canning Basin
SDs	Silurian–Devonian	Mereenie Sandstone	Amadeus Basin
OSs	Ordovician–Silurian	Prices Creek Group, Carranya Sandstone Tumblagooda Sandstone Bindoo Sandstone Wanna Formation Stokes Siltstone	Canning Basin Southern Carnarvon Basin Perth Basin Officer Basin Amadeus Basin
ЄOs	Cambrian–Ordovician	Carlton Group Windoo Sandstone Lennis Sandstone	Southern Bonaparte Basin Ord Basin Officer Basin
Єz	Cambrian	Goose Hole Group	Ord Basin
Єb		Antrim Plateau Volcanics, Lally Conglomerate Table Hill Volcanics	Southern Bonaparte and Ord Basins Officer Basin
Єd		Davis Dolerite	Large Igneous Provinces
Єs		Mu Formation Wirrildar beds	Amadeus Basin Officer Basin

Table 4. Translation of map unit codes to Mesozoic and Cenozoic lithostratigraphic units

Code	*Age*	*Stratigraphic unit*	*Tectonic unit*
Qk	Quaternary	Exmouth Sandstone, Bundera Calcarenite Kwinana Group, miscellaneous units Miscellaneous coastal deposits	Northern Carnarvon Basin Perth Basin Western Australian coastal zone
CZs	Quaternary–Neogene	Interior eolian and alluvial deposits	statewide
CZv	Cenozoic	Interior valley-fill deposits	statewide
CZi	Miocene & Eocene	Robe Pisolite, Poondano Formation	Pilbara region
Nmk	Miocene, minor Oligocene	Cape Range Group Eucla Group	Northern Carnarvon Basin Eucla Basin
Ges	Eocene	Merlinleigh Sandstone	Northern Carnarvon Basin
Gek		Giralia Calcarenite Plantagenet Group, Eundynie Group	Northern Carnarvon Basin Eucla Basin
Gk	Paleocene–Eocene	Cardabia Calcarenite	Northern Carnarvon Basin
IPz	Cenozoic or Mesozoic	Cenozoic or possibly Mesozoic sedimentary rocks	Northern Canning Basin
MZz	Mesozoic inferred	Larranganni Formation, Hazlett beds	Eastern Canning Basin
Kk	Cretaceous	Korojon Calcarenite, Toolonga Calciltutite Upper Coolyena Group	Northern and Southern Carnarvon Basins Perth Basin
Kl		Anketell Sandstone Winning Group Lower Coolyena Group Samuel Formation, Bejah Claystone	Canning Basin Northern and Southern Carnarvon Basins Perth Basin Gunbarrel Basin
Ks		Various sandstone-dominated units Nanutarra Formation, Yarraloola Conglomerate Warnbro Group	Canning Basin Northern Carnarvon Basin Perth Basin
Kb		Bunbury Basalt	Perth Basin
Js	Jurassic and earliest Cretaceous in Perth Basin	Wallal and Barbwire Sandstones, Alexander and Meda Formations, Jarlemai Siltstone	Canning Basin
		Cadda Formation, Parmelia Group, Otorowiri and Yarragadee Formations	Perth Basin
Jz	Jurassic	Eneabba Formation, Cattamarra Coal Measures	Perth Basin
Trs	Triassic	Erskine Sandstone Woodada Formation, Lesueur Sandstone	Canning Basin Perth Basin
Trl		Blina Shale, Milyit Sandstone Kockatea Shale	Canning Basin Perth Basin

No mapped rock units of this age are identified in the Pilbara region, but geochemical and geochronological data point to the existence of >3550 Ma basement to Paleoarchean greenstone successions in the East Pilbara Terrane.

Paleoarchean (3600–3200 Ma)

The Paleoarchean is characterized by the development of the first volcano-sedimentary successions on protocontinental basement in the East Pilbara Terrane of the Pilbara Craton, represented by the Warrawoona, Kelly, and Sulphur Springs Groups and associated lower order units of the Pilbara Supergroup (P). Deposition of the Warrawoona Group was accompanied by intrusion of granites (g1d) belonging to the Callina and Tambina Suites. The Kelly Group unconformably overlies the Warrawoona Group and is interpreted to be temporally equivalent to greenstone units in the Rocklea, Milli Milli, and Sylvania Inliers (s2a, f2a, b2a). Basement to these successions has not been recognized. Deposition of the Kelly Group was accompanied by intrusion of the Emu Pool Suite (g2a). A second angular unconformity marks the base of the Sulphur Springs Group, which is a temporal correlative of the Roebourne Group (R) in the Karratha Terrane and of sedimentary rocks (s2b) in the Rooney, Springo, and Rat Hill Inliers in the southeast Pilbara Craton. Both of these groups are intruded by the Cleland Supersuite (g2b). Similar aged granites are also present in the Rocklea, Milli Milli, and Sylvania Inliers of the Pilbara Craton, and the Narryer Terrane of the Yilgarn Craton. In the Karratha Terrane, the Nickol River Formation (s2b) unconformably overlies the Roebourne Group and Cleland Supersuite. Sedimentary rocks in the Rat Hill Inlier were intruded by metagabbro (d2b).

On the Yilgarn Craton, older Narryer Terrane gneisses (n1a) were deformed and metamorphosed at amphibolite and granulite facies (n1a(n2a)) during development of granitic gneisses (n2a), which partly coincided with granitic intrusions. Narryer Terrane rocks were reworked during the development of the Yarlarweelor Gneiss Complex (n2a(n6c)).

Mesoarchean (3200–2800 Ma)

Mesoarchean granites and greenstones form a substantial part of both the Pilbara and Yilgarn Cratons. On the Pilbara Craton, the Soanesville Group (S) was deposited in the East Pilbara Terrane and the Regal Formation (b2c) and Whundoo Group (Wh) in the West Pilbara Superterrane. Granites (g2c) of the Mount Billroth Supersuite intrude the Soanesville Group in the East Pilbara Terrane. Granites of this age are also found in the Kurrana Terrane, whereas the slightly younger Railway Supersuite intrudes the Whundoo Group in the Karratha Terrane. Mafic and ultramafic intrusive rocks of the Dalton Suite (d2c) were intruded in the East Pilbara Terrane.

Collision between the West Pilbara Superterrane and the East Pilbara Terrane during the 3068–3066 Ma Prinsep Orogeny coincided with intrusion of the Elizabeth Hill Supersuite (g3a). This was followed by deposition of the Nullagine Group (Nu) and De Grey Supergroup (D) on a regional unconformity and intrusion of the Orpheus Supersuite (g3a) and Maitland River and Sisters Supersuites (g3b) in the East Pilbara and Karratha Terranes. Intrusion of the Sisters Supersuite was coeval with the c. 2930 Ma North Pilbara Orogeny. Basalt (b3a) exposed in the Wyloo Dome is interpreted to be an approximate temporal equivalent of the De Grey Supergroup. The latest Mesoarchean was characterized by collision of the Kurrana Terrane with the East Pilbara Terrane during the 2905–2890 Ma Mosquito Creek Orogeny. This was followed by the intrusion of extensive post-orogenic granites (g3c), including the Split Rock and Cutinduna Supersuites, primarily in a belt trending northwest across the Pilbara from the Billinooka Inlier in the southeast. Similar aged granites are also present in the Wyloo Dome.

Widespread deposition of greenstones across the Yilgarn Craton in the Narryer Terrane (s3b, f3b, b3b), the Youanmi Terrane (s3b, f3b, f3c, b3b, b3c), including commencement of deposition of older components of the Murchison Supergroup (Mu), the Southwest Terrane (s3b, f3b, b3b), and the Burtville Terrane (b3b, b3c) was followed by intrusion of granite. The granite was deformed by later events to form granitic gneisses (n3c) in the South West Terrane and the granite (g3b) in the Ravensthorpe greenstone belt of the Youanmi Terrane. Deposition of the Norie Group (N) within the Murchison Supergroup coincided with intrusion of mafic rocks (d3c) in layered igneous complexes of the Meeline and Boodanoo Suites. These events were broadly coeval with the De Grey Supergroup and Sisters Supersuite on the Pilbara Craton.

Neoarchean (2800–2500 Ma)

On the Pilbara Craton, the Neoarchean is characterized by deposition of extensive successions of the Fortescue Group (F1–5) and the lower Hamersley Group (H1). Granites (g4a) belonging to the Gregory Range Suite intruded around the eastern craton margin and the Gidley Granophyre of the Flying Foam Suite intruded in the west. Geochronological data suggest that the Archean–Proterozoic boundary lies within the upper part of the Mount McRae Shale at the top of the lower Hamersley Group. The Pinjian Chert Breccia, which primarily developed over the Carawine and Wittenoom Dolomites, is included in the lower Hamersley Group, although its age is uncertain.

Deposition of the Fortescue Group on the Pilbara Craton was broadly coeval with the deposition of greenstones in the Eastern Goldfields Superterrane and Marymia Inlier (s4a, f4a, f4b, b4a), the Polelle (Po) and Glen (G) Groups of the Murchison Supergroup, and other volcano-sedimentary successions (s4a, f4a, b4a), such as the Marda Complex in the Youanmi Terrane of the Yilgarn Craton. Neoarchean mafic intrusive rocks (d4a, d4b) include the Gnanagooragoo Igneous Complex in the western Yilgarn Craton, the Ora Banda and Mapa Igneous Complexes in the eastern Yilgarn Craton, and the Flying Foam Suite and dolerite sills in the Fortescue Group in the Pilbara Craton.

The upper Fortescue Group (F5) is roughly coeval with late stage greenstones of the Yilgarn Craton that include felsic volcanic rocks (f4b) of the Black Flag Group in the Kalgoorlie Terrane, the Toppin Hill Formation in the Yamarna Terrane, and late orogenic-sedimentary rocks (s4b), such as the Kurrawang Formation and the Jones Creek Conglomerate.

The abundant, widespread Neoarchean granites of the Yilgarn Craton are largely undivided (g4), but show a broad geochemical evolution that reflects a changing tectonic setting. This is represented in the western Youanmi Terrane by the early granites (g4a), such as the Cullculli and Rothsay Suites, followed by the later (g4b), more evolved granites such as those of the Tuckanarra, Jungar, and Walganna Suites. Gneisses (n4a) in the Narryer, Youanmi and Southwest Terranes, and the Munglinup Gneiss (n4a) and granitic gneisses (n4b) in the Tropicana Zone of the Albany–Fraser Orogen were formed as result of deformation during late- or post-Archean tectonism. Neoarchean granitic rocks are present in the northern foreland of the Albany–Fraser Orogen and are represented by the Rocky Bore and Despair Granites (g4b) and the Warrigal Gneiss (n4b) in the Narryer Terrane. A 200 km-wide belt of small quartz syenite intrusions was intruded into the Yilgarn Craton between 121° and 123° west, and is further subdivided into four distinct belts that correspond closely to major north-northwest trending crustal-scale faults. Most of these intrusions are too small to be shown at the nominal scale and are instead indicated with plus symbols on the map face. Larger intrusions in the southeast Yilgarn, such as the Fitzgerald Peaks Syenite, are shown as polygons (gy4b) on the map.

The oldest rocks in the Gascoyne Province are represented by the Halfway Gneiss (n4c) in the Glenburgh Terrane. The Peak Hill Schist (s4) has been assigned a Neoarchean median age based on the large uncertainty in its age constraints and possible correlation with greenstones in the Marymia Inlier, although it may equally belong to a younger sedimentary succession that overlies the inlier. In either case, it has been strongly affected by deformation within the Capricorn Orogen.

Paleoproterozoic (2500–1600 Ma)

There is an extensive Paleoproterozoic rock record in Western Australia which documents the assembly of the West Australian Craton (WAC) in the Capricorn Orogen, and the North Australian Craton (NAC) throughout the King Leopold, Halls Creek and Granites–Tanami Orogens, plus the collision of both cratons in the Paterson Orogen during the poorly constrained Yapungku Orogeny (1760–1300 Ma). The earliest Paleoproterozoic rocks are represented by the upper Hamersley Group (H2) on the Pilbara Craton. The Hamersley Group is conformably overlain by the Turee Creek Group (T1), which in turn is unconformably overlain by the Shingle Creek Group (T2), formerly known as the lower Wyloo Group. The new formal name replaces the informal term in recognition of its affinity with the Turee Creek Basin. The Shingle Creek Group is probably a temporal equivalent to the Moogie Metamorphics (s5c) in the Glenburgh Terrane of the Gascoyne Province. The Turee Creek Basin has also been referred to as the McGrath Trough, which formed as a foreland basin in response to the collision of the Glenburgh Terrane and the Pilbara Craton during the 2215–2145 Ma Ophthalmian Orogeny.

Paleoproterozoic successions on the Yilgarn Craton are slightly younger than those on the Pilbara Craton and began with deposition of the Windplain Group (Wi) in the Yerrida Basin at c. 2170 Ma. This was followed by intrusion of the Mount Weld Carbonatite (d6a) at c. 2020 Ma. On the northern margin of the Yilgarn Craton, the Windplain Group is overlain by the Mooloogool Group (Mo), which in turn is overlain by the Bryah (Br1, Br2) and Padbury (Pa) Groups. These successions were deposited in pre-, syn- and post-tectonic basins, developed in response to collision of the Yilgarn Craton with the combined Pilbara Craton and Glenburgh Terrane to form the WAC during the 2002–1947 Ma Glenburgh Orogeny.

Deposition of the Tooloo Group (To) marks the initiation of the Earaheedy Basin, which overlies localized felsic volcanic rocks (f6b) in the Imbin Inlier. The Tooloo Group is temporally equivalent to the Camel Hills Metamorphics (s6b) that are intruded by the Dalgaringa and Bertibubba Supersuites (g6b) in the southern Gascoyne Province and may be a correlative of the Padbury Group. The Tooloo Group is overlain by the Miningarra Group (Mn), which may be temporally equivalent to the Wyloo Group (Wy) and Leake Spring Metamorphics (s6c) in the central Capricorn Orogen. The Yarlarweelor Gneiss Complex (n2a(n6c)) constitutes the Narryer Terrane basement that was intruded by early granitic gneisses (n6c) of the Moorarie Supersuite during the Capricorn Orogeny (1817–1772 Ma), but some components may also be partly a product of the earlier Glenburgh Orogeny.

The oldest component of the NAC is the Sophie Downs Suite (g6b), followed by deposition of the Halls Creek (Hc) and Speewah (Sp) Groups, Marboo and Moola Bulla Formations (s6c), Koongie Park Formation (f6c), and Tickalara Metamorphics (b6c) and intrusion of the Panton Suite, Ruins Dolerite, and associated mafic rocks (d6c) in the Kimberley region. Similar aged rocks in the Granites–Tanami Orogen include the Tanami Group (Ta) and Browns Range Metamorphics (s6c) and the Lander Rock Formation (s6c) in the Aileron Province. Assembly of the NAC was accompanied by extensive granite intrusion (g6c), including the Paperbark and Sally Downs Supersuites in the Kimberley and unnamed granites in the Granites–Tanami region. The Bridget Suite in the Pilbara Craton is of a similar age (g6c).

The interpreted collision of the WAC and NAC during the poorly constrained Yapungku Orogeny (1760–1300 Ma) resulted in the formation of Paleoproterozoic Western Australia, which was subject to episodic reworking events. In the northwest this reworking resulted in deposition of sedimentary (s6d) and mafic volcanic (b6d) rocks, including the Yandagooge Formation in the Talbot and Connaughton Terranes of the Rudall Province, the lower and upper Kimberley Group (K1, K2), and the Crowhurst, Bastion and Birrindudu Groups (Cb) in the Kimberley region. Intrusion of the Hart Dolerite (d6d) into the Speewah and Kimberley Groups also took place at this time. The age of the Hidden Basin beds (s6) on the northwest margin of the Aileron Province is poorly constrained but they may be a correlative of the Birrindudu Group (P Haines, 2015, written comm.). Punctuated intracratonic reactivation in the Capricorn Orogen resulted in deposition of the Capricorn (C) and Mount Minnie (Mm) Groups and Pooranoo Metamorphics (s6d). Deposition of the Stirling Range Formation (s6d), Mount Barren Group (Mb), and Woodline Formation (s6d) on the southeastern margin of the Yilgarn Craton also took place at this time. Orogenesis was accompanied by extensive granite intrusion (g6d, n6d) in the Aileron (Rapide Granite), Granites–Tanami (Balwina Granite), Kimberley (Wotjulum Porphyry and San Sou Monzogranite) and Gascoyne (Moorarie Supersuite) Provinces. Coeval granite intrusion (g6d, n6d) also happened in the Biranup and Nornalup Zones of the Albany–Fraser Orogen, including the Bobbie Point Metasyenogranite.

Latest Paleoproterozoic reworking resulted in deposition of the Bresnahan Group (Bh) and Mount Augustus Sandstone (s6e) and the intrusion of the Durlacher Supersuite (g6e) in the Capricorn Orogen during the 1682–1619 Ma Mangaroon Orogeny. Intrusion of granites (g6e, n6e) in the Biranup Zone of the Albany–Fraser Orogen took place during the broadly coeval Biranup Orogeny (1710–1650 Ma). Similarly aged units in the Arunta region include the Lake Mackay Quartzite (s6e) and Pollock Hills Formation (f6e) and the intrusion of the Mount Webb Granite, Waluwiya Suite (g6e), and Ininti Granite (n6e) in the Warumpi Province.

Mesoproterozoic (1600–1000 Ma)

Mesoproterozoic rocks are widespread in Western Australia and record the intracratonic effects of orogenic events along the margins of Paleoproterozoic Western Australia. Most notably the accretion of the South Australian Craton (SAC) along the Albany–Fraser Orogen and in the Musgrave Province and later events along the western margin in the Pinjarra Orogen. The Edmund (B1) and Scorpion (Sc) Groups of the Bangemall Supergroup are the earliest Mesoproterozoic rocks in the State. These were deposited in the Capricorn Orogen, prior to the intrusion of the Waldburg (d7a) and Narimbunna (d7b) Dolerite Suites into the Edmund Group. These mafic rocks are broadly coeval with granites (g7a) in the Tabletop Zone of the Rudall Province and the Warlawurru Supersuite in the Musgrave Province. This was followed by the deposition of the Quadrio Formation and Cornelia Sandstone (s7c) in the eastern Capricorn Orogen and possibly the poorly constrained Moora and Cardup Groups (Mc) and the Yandanooka Group (Y) in the Pinjarra Orogen. These events were broadly coeval with the deposition of the Malcolm Metamorphics and the protoliths to the Gwynn Creek Gneiss (s7c) in the Albany–Fraser Orogen. The orogen also records the intrusion of the Recherche Supersuite granitic rocks (n7c) and the reworking of Yilgarn Craton granites (g4) in the Northern Foreland during stage one of the Albany–Fraser Orogeny (1330–1260 Ma). Coeval events in the Musgrave Province consisted of deposition of the protoliths to the Wirku Metamorphics (s7c) and the intrusion of the Papulankutja and Wankanki Supersuites (g7c) during the 1345–1293 Ma Mount West Orogeny.

Deposition of the Oldham Sandstone (s7d) in the Ward and Oldham Inliers of the Capricorn Orogen may be related to the 1321–1171 Ma Mutherbukin Tectonic Event. Broadly equivalent units in the Albany–Fraser Orogen include mafic intrusions of the Fraser Range Metamorphics (d7d) in the Fraser Zone and the deposition of the Mount Ragged Formation (s7d) prior to stage two of the Albany–Fraser Orogeny (1225–1140 Ma). Stage two of the Albany–Fraser Orogeny was coeval with the Musgrave Orogeny (1225–1150 Ma) and is associated with the intrusion of granites (g7e) of the Esperance Supersuite in the Albany–Fraser Orogen and the Pitjantjatjara Supersuite in the Musgrave Province. Broadly coeval events related to the 1205–1150 Ma Darling Orogeny resulted in the deposition of metasedimentary rocks (s7e) and quartzofeldspathic gneisses (n7e) in the Northampton Inlier of the Pinjarra Orogen. Deposition of the Carr Boyd and Glidden Groups and Bungle Bungle and Mount Parker Formations (Cg) in the Kimberley region is of a similar age.

The latest Mesoproterozoic is characterized by the deposition of the Collier and Manganese Groups (B2) and Salvation Group (Sv) in the Capricorn Orogen and the protoliths to the Mullingarra Gneiss (s7f) in the Pinjarra Orogen. The age of the Eel Creek Formation (s7) on the northeastern margin of the Pilbara Craton is very poorly constrained but it may be late Mesoproterozoic. The 1090–1040 Ma Giles Event in the Musgrave Province records a major period of sedimentation, volcanism, and intrusion of voluminous mafic and felsic igneous rocks. The sedimentary and volcanic rocks constitute the Bentley Supergroup, which comprises the Kunmarnara (Kn), Tollu (Tu), Mount Palgrave and Kaarnka (Km), Pussycat and Cassidy (Py), and Mission (Mi) and Tjauwata (Tj) Groups. The mafic (d7f) and locally felsic (g7f) igneous rocks constitute the Warakurna Supersuite, which includes the Giles Suite and Alcurra Dolerite in the Musgrave Province and the Kulkatharra and Prenti Dolerites in the Capricorn Orogen.

Deposition of the Wade Creek Formation (Wc) in the Kimberley region is also interpreted to have taken place in the latest Mesoproterozoic. Granite intrusion (g7f) in the Northampton Inlier was related to the 1095–990 Ma Pinjarra Orogeny, which may have overlapped with initiation of the 1026–954 Ma Edmundian Orogeny in the Capricorn Orogen.

Neoproterozoic (1000–542 Ma)

The Neoproterozoic records the final amalgamation of Rodinia at c. 950 Ma, its breakup at about 750 Ma, and dispersal prior to Gondwana assembly by c. 570 Ma. The Neoproterozoic rock record of Western Australia is dominated by the development of the Centralian Superbasin, with minor granite intrusions represented by the Thirty Three Supersuite (g7g) in the Capricorn Orogen, granitic rocks (n8c) and metamorphosed anorthosites (d8c) in the Leeuwin Inlier, and the Mount Crofton Granite (g8c) in the Rudall Province. The accepted subdivision of the Centralian Superbasin succession into four supersequences (Cn1 to Cn4) has been applied where possible, but where this level of refinement is below map resolution or there is insufficient knowledge, the succession is undivided (Cn). The supersequences comprise Tonian mixed carbonates, evaporites, siltstone and sandstone (Cn1), Cryogenian glacial rocks of the Sturtian (Cn2) and Elatina (Cn3) glaciations, and synorogenic Ediacaran–Cambrian sandstone (Cn4). The basal sandstones in Cn1 are poorly constrained in age, with a commonly accepted older limit of c. 850 Ma, although they could be up to 1000 Ma old. In the east Kimberley, a single succession may span Supersequences 3 and 4 (Cn34). Work since 1998 suggests that the Throssel and Lamil Groups in the Rudall Province and the Badgeradda Group (for which detrital zircon populations closely resemble those from known Centralian units) are the same age as the Centralian Superbasin.

Deformation during the 670–510 Ma King Leopold, 635–540 Ma Paterson, and 580–520 Ma Petermann Orogenies across Western Australia in the latest Neoproterozoic and early Cambrian terminated the series of linked basins that constituted the Centralian Superbasin and succession. These were the only deformational events associated with the prolonged global assembly of Gondwana from multiple continental fragments and may record the final docking of Australia with Antarctica and greater India. The earlier Miles Orogeny between about 650 and 600 Ma coincides with arc assembly and accretion in East Africa, but Proterozoic Australia was probably not connected to Africa at this time.

Paleozoic (542–251 Ma)

After the Petermann and Paterson Orogenies there was Early and Middle Cambrian deposition (Ꞓs) in the Amadeus and southern Officer Basins, followed by mild deformation attributed to the 520–505 Ma Delamarian Orogeny south of the Musgrave Province. Widespread extrusion of continental flood basalts (Ꞓb), dolerite emplacement (Ꞓd) into the Manganese Group, and associated dykes (all of which form the Kalkarindji Large Igneous Province) took place at c. 510 Ma. New depocentres east of the Kimberley block, marking the first stages of the Southern Bonaparte and Ord Basins, were infilled by a mixed carbonate and clastic, shallow-marine to fluvial succession (Ꞓz), while the Canning Basin region appears to have been a topographic high shedding sediment towards the east (P Haines, 2015, written comm.). Deposition continued into the Ordovician (ꞒOs) in the Southern Bonaparte Basin and possibly the Ord Basin and may have begun in the southern Officer Basin at this time. Thermal sagging and extension formed the Canning Basin in the Early Ordovician, presumably related to Phase One of the Alice Springs Orogeny (the Rodingan Movement). Although shallow marine to coastal mixed deposition (ꞒOs) ensued in both the Canning and Amadeus Basins, the two depocentres may have been separate, rather than connected by the previously postulated Larapintine Seaway. Ordovician to Silurian sand-dominated deposition (OSs) may have continued in the southern Officer Basin and commenced in the Southern Carnarvon Basin, but the age of these units is poorly constrained. Small areas shown as SDs in the Amadeus Basin could be either Silurian or Early Devonian.

Minor deformation of Ordovician rocks in the northern Canning Basin tilted them by up to 20° prior to the formation of reef complexes (Dk) in the late Middle Devonian. Reef growth continued into the Late Devonian in a long-term transgressive–regressive couplet that lasted almost to the end of the Devonian. In central Australia there was significant crustal shortening and reworking in the compressional Alice Springs Orogeny in the Late Devonian, but in Western Australia all movement west of the Halls Creek Orogen was extensional, with dextral movement along the eastern margin of the Kimberley block. The product of this was early Late Devonian (Frasnian) sandstone and conglomerate deposition (Ds) in the Ord and Southern Bonaparte Basins, respectively, and tectonically driven conglomerate outpourings along the margin of the northern Canning Basin (Ds) contemporaneous with reef development. In the Southern Bonaparte Basin, reef development only took place in the Famennian, and reefs did not extend south to the Ord Basin. Mixed carbonate and sandstone deposition took place in the Southern Carnarvon Basin (Ds), with alluvial fan development in the latest Devonian. The global extinction event across the Frasnian–Famennian boundary is marked by faunal extinctions and by changes in depositional style, which vary across the State (clastic to carbonate in the Southern Bonaparte Basin, carbonate to clastic in the Southern Carnarvon Basin). These differences are taken to reflect regional variations in tectonic activity and climate over Late Devonian Western Australia.

Following a short-lived regression in the latest Famennian, deposition resumed in a shelf setting in the west Kimberley (DCl); sandier later Carboniferous deposits in that area are not exposed. Elsewhere, Carboniferous deposition (Cz) was initially in carbonate-dominated shelfal conditions, with later mixed siliciclastic and carbonate marine to continental deposition.

Mild folding of older rocks took place along the western margin of the State in the Late Carboniferous, but had minimal effect in the north. This folding event was followed by continental-scale Gondwana glaciation (CPe). Post-glacial outwash, but with scattered persistent alpine glacial influence, was in sand-rich deltaic to shallow shelfal settings (Ps). Lower energy deposition in shallow shelfal settings followed (Pl), which, in turn, was followed by sandier, locally deltaic deposition (Ps). In the southern part of the State, downfaulting in the Yilgarn Craton created the Collie Sub-basin of the Perth Basin. The entire succession in this sub-basin, which correlates with equivalent units in the Perth Basin proper and may have at its base Carboniferous-age glacigene rocks, is included in the Collie Group (Pc). Sedimentary rocks in the eastern Canning Basin of unknown, but presumed Paleozoic age, including the Lucas Formation, are shown as Pzs.

Mesozoic (251 – 65.5 Ma)

Deposition in onshore Western Australia throughout the Mesozoic largely reflects offshore events and processes, initiating first along the North West Shelf, but moving increasingly down the western margin throughout the Cretaceous, reaching the southern margin in the latest Cretaceous. The effects of these processes reached onshore in some marginal basins, but for most of the interior of the State, deposition was entirely continental and often superficial, apart from two major transgressions.

A widespread transgression took place in the latest Permian to earliest Triassic that is recorded onshore in the Perth and Canning Basins, but only offshore in the Northern Carnarvon Basin. The transgression saw a shift to shaly marine deposition (ŦRl) from the sandier, less marine facies of the Late Permian. These facies are preserved in the northeastern Canning Basin, but not the south, which appears to have been a bypass zone throughout the Triassic and Jurassic. In the Perth Basin marine facies are restricted to the northern part of the basin, grading into deltaic and fluvial rocks farther to the south. Subsequently, gradual progradation led to mixed siliciclastic, marginal marine to continental deposition (ŦRs) in the northern Canning Basin (only short lived), offshore North West Shelf (forming the main reservoirs for the giant oil and gas fields of the shelf), and Perth Basin. Subsidence was rapid along the North West Shelf and in the Perth Basin, owing to impending breakup along the central and southern North West Shelf, and rifting farther north on the northern margin of Gondwana. This tectonic activity is reflected onshore as the Fitzroy Movement.

Fluvial progradation waned slightly over the Triassic–Jurassic boundary along the offshore North West Shelf and in the Perth Basin, with a return to mixed nearshore marine and deltaic deposition in the Early to mid-Jurassic (Jz) on the southern North West Shelf. The onshore Canning Basin remained inactive at this time, as it had been since the early Middle Triassic following the Fitzroy Movement. In the Late Jurassic and Early Cretaceous a series of narrow rift valleys developed along the North West Shelf. As rifting proceeded, subsidence and sandy deposition in mixed fluvial and nearshore marine settings (Js) accelerated in the Perth Basin due to active faulting and deposition resumed in the northern Canning Basin. Narrow rifts, probably transtensional, also developed along the offshore southern margin in the Callovian, forming the Bremer and Eyre Sub-basins of the Bight Basin.

In the earliest Cretaceous, the active spreading ridge along Australia's margin shifted southwards, initiating rifting and breakup between Greater India and Australia along the western margin. Rifting was accompanied by the extrusion of extensive basalt flows (Kb) in the central and southern Perth Basin. Sandy and conglomeratic deposits (Ks) formed locally near the basin hinterland in the Northern Carnarvon Basin, possibly coevally with major deltaic progradation in the southern North West Shelf and as a veneer across much of the onshore Canning Basin. Extensive mixed siliciclastic material (Ks) also accumulated within the Perth Basin, although the main depocentre of this sediment is found in the offshore Vlaming Sub-basin where it is several kilometres thick. Sag after breakup along the southern, western, and northwestern margins led to the second major transgression of the Mesozoic, following which there was finer grained siliciclastic deposition (Kl), including a widespread radiolarian siltstone in the mid-Cretaceous that appears to have resulted from deep tropical weathering rather than deep pelagic conditions. In the Bight Basin, this unit is interpreted as the product of transgression from the south, as Australia separated from Antarctica, rather than transgression via the Canning Basin. In the Late Cretaceous, global oceanic circulation patterns changed as Gondwana fragmented further, causing a shift around Western Australia's margins from siliceous pelagic (Kl) to calcareous pelagic (Kk) deposition, including the deposition of chalk in the Perth Basin.

Scattered outcrops of non-fossiliferous sandstone and siltstone in the eastern Canning Basin are inferred to be Mesozoic (MZz), but could be Paleozoic or early Cenozoic.

Cenozoic (65.5 – 0 Ma)

The Cenozoic in Western Australia is characterized by four phases or cycles of carbonate-dominated deposition around the State's margins (Paleocene – Early Eocene, Middle – Late Eocene, Late Oligocene – Middle Miocene, and Late Miocene onwards), each associated with a marine transgression. In the terrestrial realm a progressive increase in aridity recorded in the State's interior is likely to be a reflection of the major changes in oceanic current regime (such as the establishment of the Leeuwin and Antarctic Circumpolar currents) and the rapid northward migration of the continent over this time period. Paleocene to Early Eocene chalky limestones (Gk) are exposed onshore only in the Northern Carnarvon Basin, although in the Middle and Late Eocene, limestones (Gek) also extend discontinuously down the coast to Shark Bay and near Kalbarri. Although classified as part of the Southern Carnarvon Basin, these landward-thinning units essentially belong to the Northern Carnarvon Basin and overlie the Southern Carnarvon Basin succession. Quartz sandstone with some marine indicators (Ges) is present in the northwestern Merlinleigh Sub-basin of the Southern Carnarvon Basin, including on top of Kennedy Range. On the southern margin and within some larger paleovalleys over the Eucla, mixed marine and coastal siliciclastic and calcareous deposits (Gek) are preserved, with coastal barrier deposits from two high sea-level stands extending around the northern margin of the Eucla Basin. Late Oligocene and Miocene limestones (Nmk) accumulated during the last major transgression of the Cenozoic, mantling the Eucla Basin and onlapping much of the Northern Carnarvon Basin. The Middle Miocene transgression coincided with a global peak in temperatures, such that coral reefs formed along the southern coast at that time. Channel iron deposits (Czi) accumulated mainly in the Pilbara region during the Miocene and Eocene, derived from deep weathering of abundant iron-rich units.

During the Miocene, the Australian plate entered a compressional phase as it moved north towards Asia, resulting in reverse movement of many pre-existing normal faults along the western and northwestern margins, the formation of coastal anticlines, and progressive regional uplift of southern Australia. Because of this and repeated exposure of the continental shelf during Pleistocene glaciation periods, thick eolian and coastal deposits (Qk) accumulated along the west coast, in part anchored by the rising anticlines. Coastal marshes and dunes are also shown elsewhere where significant and are similarly coded.

Much of the State's interior was sculpted in the Cenozoic by an extensive paleodrainage network. Inset valleys and overlying broader valleys were variably infilled as the network dried out and stagnated, first in the Eocene and then the Miocene (Czv). The climate continued to oscillate between humid and arid through the Neogene, with increasing long-term aridity, leading to dune fields in areas with sandstone-rich source terranes, interspersed with alluvial and colluvial deposits, including groundwater calcretes (Czs). Display of these pervasive deposits has generally been minimized in favour of bedrock on the map, except where significant areas are present. The last major active phase of these paleodrainage channels was probably c. 25 to 16 Ka.

Alkaline intrusions

Numerous alkaline intrusions consisting of leucite and olivine lamproite, lamprophyre, kimberlite, carbonatite, and syenite that are too small to be shown as polygons at 1:2 500 000, are shown as diamond symbols on the map face. The majority of the known diamondiferous intrusions are located within four igneous provinces, although recent work has identified numerous other occurrences outside of these well-known areas. In the West Kimberley Alkaline Igneous Province, olivine and leucite lamproites were emplaced extensively throughout the King Leopold Orogen and adjacent Phanerozoic cover of the Canning Basin during the Miocene. This province can be further divided into the large Ellendale and Noonkanbah fields and the smaller Eastern Lennard Shelf and Calwynyardah fields. Lamproites of the North Kimberley Alkaline Igneous Province intrude the northern Kimberley Basin and those of the East Kimberley Alkaline Igneous Province intrude the central part of the Halls Creek Orogen. Within the East Kimberley Alkaline Igneous Province the c. 1177 Ma Argyle Lamproite is economically the most important diatreme. In the North and East Kimberly Alkaline Igneous Provinces, most other intrusions are Neoproterozoic in age. Dykes belonging to the Bow Hill Lamprophyre Suite are shown separately as linear features in the accompanying dyke layer. The Mesozoic Carnarvon Basin Alkaline Igneous Province comprises small dykes and sills of alkali picrite that intrude close to the Wandagee Fault on the western margin of the Merlinleigh Sub-basin, some of which contain micro diamonds.

Two new alkali intrusive provinces, in the Aileron Province of the West Arunta Region (Webb Alkaline Igneous Province) and in the northern Eucla Basin (Shell Lakes Alkaline Igneous Province) have recently been identified from prominent regional aeromagnetic anomalies and have been confirmed by drilling. There are also a number of scattered kimberlite, lamproite, and lamprophyre intrusions, locally forming smaller less well-defined fields in the East Pilbara (Brockman Dyke), West Pilbara (Blacktop, Yanyare), Gascoyne Province (Barlee Range, Gifford Creek), Marymia Inlier (Nabberu), Earaheedy Basin (Mount Throssel, Jewill), and Eastern Goldfields Superterrane of the Yilgarn Craton.

Large carbonatite intrusions are mostly found in the Eastern Goldfields Superterrane of the Yilgarn Craton of which the economically important c. 2020 Ma Mount Weld Carbonatite is large enough to be shown as a polygon on the map (d6a). Other economically important carbonatites include the Ponton intrusion (Cundeelee) and the Cummins Range Carbonatite in the southern Halls Creek Orogen.

Diapirs

Eleven known and probable significant diapirs that pierce the land surface or have a notable surface expression are shown with bullseye symbols. With the exception of the Scorpion Diapir in the Paleoproterozoic eastern Scorpion Basin, the majority are related to halotectonics within strata of the Neoproterozoic Officer Basin. The most prominent of these are the Madley Diapirs and the Browne Diapir that are exposed in inliers within the Mesozoic–Cenozoic Gunbarrel Basin. Two new additions to the dataset are the Livesey and Ilma Diapirs in the southeastern Officer Basin. Both were recognized from their expression on Google Earth imagery. Disruption of the Throssell Paleovalley near the Clutterbuck Hills may also be due to diapiric uplift.

Impact structures

The record of terrestrial meteorite and cometary impacts in Western Australia is fairly extensive, consisting of a total of 14 confirmed impact structures that are either exposed or concealed. Many of these structures are clearly visible in the State aeromagnetic dataset. There have been two newly discovered and confirmed additions to this record since the publication of the 1998 State map, namely the Hickman Crater in the eastern Hamersley Province (identified from Google Earth imagery and confirmed by drilling) and the Yarrabubba Crater on the northern Yilgarn Craton. There are numerous other potential impact structures that have yet to be confirmed, which are not shown on the map. The Mundrabilla Meteorite is no longer shown since there is no known impact structure associated with the impactor.

Dykes

The improvement in quality and resolution of the statewide aeromagnetic dataset has enabled a significant improvement in the depiction of the distribution of dykes in the State. Dykes have been interpreted from aeromagnetic data, using 1:250 000 and 1:100 000-scale maps as a guide and assigned to known suites based on composition, age, orientation, and magnetization. However, for the printed map, the dykes have only been attributed as exposed or concealed. Detailed attributes are available via the accompanying 1:2 500 000 State interpreted dyke suites digital layer.

Most dykes are assigned to one of 28 formally named dyke suites or supersuites for the purposes of the digital layer (Table 5), with the exception of unassigned Archean dykes of the Pilbara Craton (A-od-P) and dykes of unknown affinity, which have been assigned as a generic Proterozoic dykes unit (P_-od).

Linear structures

Only major named structures or those that bound or offset units at 1:2 500 000 scale are shown on the State map, with some structures present in the digital data removed from the printed map to improve readability. The attribution of faults and shear zones differs from the 1998 map in that kinematics are shown only where known with a reasonable amount of confidence. Complex fault reactivations are generally not attributed on the printed map either, but more detail is available via the digital 1:2 500 000 State linear structures layer. Trend lines and lineaments are not shown and the extrapolation of structures based on geophysical interpretation has been kept to a minimum, except for major Precambrian structures beneath Phanerozoic cover. Structures are shown as concealed where covered by any strata that post-date the structure, rather than regolith alone. The names of individual structures have been omitted from the printed map for clarity, but are accessible via the 1:2 500 000 State linear structures digital layer.

Table 5. Dyke suites of Western Australia

Name	*Age (Ma)*	*Location*	*ENS code*
Proterozoic dykes	2500–541	State	P_-od
Kalkarindji Supersuite	510	NW Officer Basin	E-KJ-od
Milliwindi Dolerite	512	W Kimberley	E-KJM-od
Beenong Dyke Suite	1218–541	SE Yilgarn, Albany–Fraser Orogen	P_-BO-od
Nindibillup Dyke Suite	800–700	SE Yilgarn, Albany–Fraser Orogen	P_-NB-od
Northampton Dolerite Suite	748	Northampton Inlier	P_-NO-od
Mundine Well Dolerite Suite	755	Gascoyne Province, Pilbara Craton	P_-MW-od
Bow Hill Lamprophyre Suite	815	E Kimberley	P_-BH-y
Gairdner Dolerite	825	Musgrave and Rudall Province	P_-GD-od
Central Desert Dolerite Suite	975	W Arunta region	P_-CE-od
Lakewood Dolerite Suite	2500–541	Yilgarn Craton	P_-LW-od
Warakurna Supersuite	1084–1047	Capricorn Orogen, Musgrave Province, Yilgarn Craton	P_-WK-od
Alcurra Dolerite	1068–1067	Musgrave Province	P_-WKA-o
Gnowangerup–Fraser Dyke Suite	1218–1202	S Yilgarn Craton margin	P_-MMG-od
Boyagin Dolerite Suite	1218–1202	W Yilgarn Craton margin	P_-MMB-od
Muggamurra Dolerite Suite	1215–1205	N Yilgarn Craton margin	P_-MMU-od
Wheatbelt Dyke Suite	1215–1205	W Yilgarn Craton margin	P_-MMW-od
Preston Dolerite Suite	1816	W Pilbara Craton	P_-PR-od
Round Hummock Dolerite Suite	1000–541	Pilbara Craton	P_-RH-od
Panhandle Dyke Suite	2008	Hamersley region	P_-PH-od
Moodogara Dyke Suite	2208	Hamersley region	P_-MA-od
Widgiemooltha Supersuite	2420–2400	Yilgarn Craton	P_-WI-od, P_-WI-o
Bow River Dolerite Suite	2500–1600	E Kimberley	P_-BV-od
Leopold Downs Dyke Suite	2500–541	W Kimberley	P_-LO-od
Prince Regent Dyke Suite	2500–541	Kimberley	P_-PE-od
Kimberley Dyke Suite	2500–541	Kimberley	P_-KY-od
Cosmo Newbery Dyke Suite	2500-510	Yilgarn Craton	P_IP-NW-od
Prairie Downs Dyke Suite	2745	S Pilbara Craton	A-PD-od
Black Range Dolerite Suite	2772	E Pilbara Craton	A-BL-od
Pilbara Craton greenstones	4000–2500	Pilbara Craton	A-od-P

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