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Geology of the Murray-Darling Basin — Simplified Lithostratigraphic Groupings

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Abstract

A digital database for the geology of the Murray-Darling Basin was compiled from existing 1:250 000 scale and 1:100 000 scale geological and metallogenic mapping. Simplified lithostratigraphic groupings were applied to provide fundamental surficial geology data for the Murray-Darling Basin Soil Information Strategy project. These groupings recognise that within major tectonic units, specific lithologies can be characteristic of particular stratigraphic periods. The integrated geology provides a relatively seamless dataset that gives an overview of the geology of the Murray-Darling Basin for basin-wide studies.

The datasets produced by the Murray-Darling Basin Soil Information Strategy project are available via the World Wide Web. As part of this web package, the derived dataset of the 'Geology of the Murray-Darling Basin – Simplified Lithostratigraphic Groupings' is able to be viewed and queried. Information is presented at a basin-wide scale, sub-catchment or 1:250 000 scale mapsheet level.

Results for all datasets produced by the Murray-Darling Basin Soil Information Strategy project may be viewed by visiting the Murray-Darling Basin Soil Information Strategy webpage at the following address;

http://www.agso.gov.au/land_water/mdbsis/

Contents

Figures

Tables

Appendices

Geology of the Murray-Darling Basin

Simplified Lithostratigraphic Groupings

1. Introduction

The Murray-Darling Basin Commission has funded a three year project to develop a soil information strategy to provide a spatial overview of the Basin's soil resources. The project not only collated all existing State and Commonwealth information on soils, but also developed strategies to enhance future land resource data collection and mapping programs (Bui, 1997).

As part of the collaborative Murray-Darling Basin Soil Information Strategy (MDBSIS) project, the Australian Geological Survey Organisation (AGSO) has integrated the geology of the Murray-Darling Basin (MDB) at 1:250 000 scale. Since the data was compiled in the first instance as an input to identifying soils, a strategy was required to ensure that the database was able to reflect the influence of parent material as one of the dominant soil forming factors. Given this scenario, lithology was considered to be more important in determining soil characteristics and ultimately soil type rather than the stratigraphy. Thus the task of integrating the basin-wide geology into broad lithology groupings was undertaken to improve the usefulness of the dataset, in the context of the MDBSIS project.

The mapsheets have been compiled into a seamless dataset using the Arc/Info GIS. The database incorporates 92 1:250 000 scale mapsheets and combines existing 1:250 000 scale geological, metallogenic and surficial geology mapping from the New South Wales Department of Mineral Resources, the Victorian Department of Natural Resources and Environment, the Queensland Geological Survey and AGSO, with more recent 1:100 000 scale mapping where available.

2. Objectives

The objectives of the project are:

- to compile all existing 1:250 000 scale and 1:100 000 scale geological mapping for the MDB
- to create (as much as possible) a seamless geology coverage for the entire MDB
- to provide an overview of the geology of the MDB
- to group the geology into the most useful and meaningful dataset for basin-wide studies.

The project aims to provide a baseline surface geology dataset for input into basin-wide studies. The initial priority is to provide fundamental geological mapping for input into the MDBSIS project, which has a soil resource focus.

3. Spatial Coverage

The dataset covers the extent of the Murray-Darling drainage basin. This represents an area of over one million square kilometres spanning the states of Queensland, New South Wales, Victoria and South Australia.

The datasets were compiled at 1:250 000 scale (and 1:100 000 scale where available), which encompassed wholly or parts of ninety-two 1:250 000 scale mapsheets (Figure 1).

Surface geology can be queried on a basin-wide scale as a single dataset, by sub-catchment or by individual 1:250 000 scale mapsheets within the MDB.

4. Geological Overview

Methodology

The vast area of the Murray-Darling Basin, coupled with the varying geological history of the tectonic units located within the basin, meant that the basin could not be considered as a whole when determining any lithology groupings. Rather than attempt standardisation over the whole of the MDB, the basin was sub-divided into major tectonic units using the framework devised by Palfreyman (1984). Within these tectonic units, rock types were grouped according to dominant lithology in broad time periods (recognising that specific lithologies can be characteristic of particular stratigraphic periods). This provided a simple classification on a lithostratigraphic basis.

The lithology groupings (Appendix 1) were determined by considering the method of formation or subsequent deposition, the broad age of the geological units and the influence of the mineralogy as a determinant of soil characteristics. Weighting was also given to the spatial extent of particular lithologies when determining the lithology groupings. Expert advice was sought to confirm the most suitable approaches, particularly in the complex Lachlan Fold Belt. The broad geology groupings from the Geology of Australia map (AGSO, 1976) were also taken into consideration when deriving the lithology classes.

A brief geological overview of the major tectonic units within the MDB is presented below, using the tectonic framework (Figure 2) devised by Palfreyman (1984).

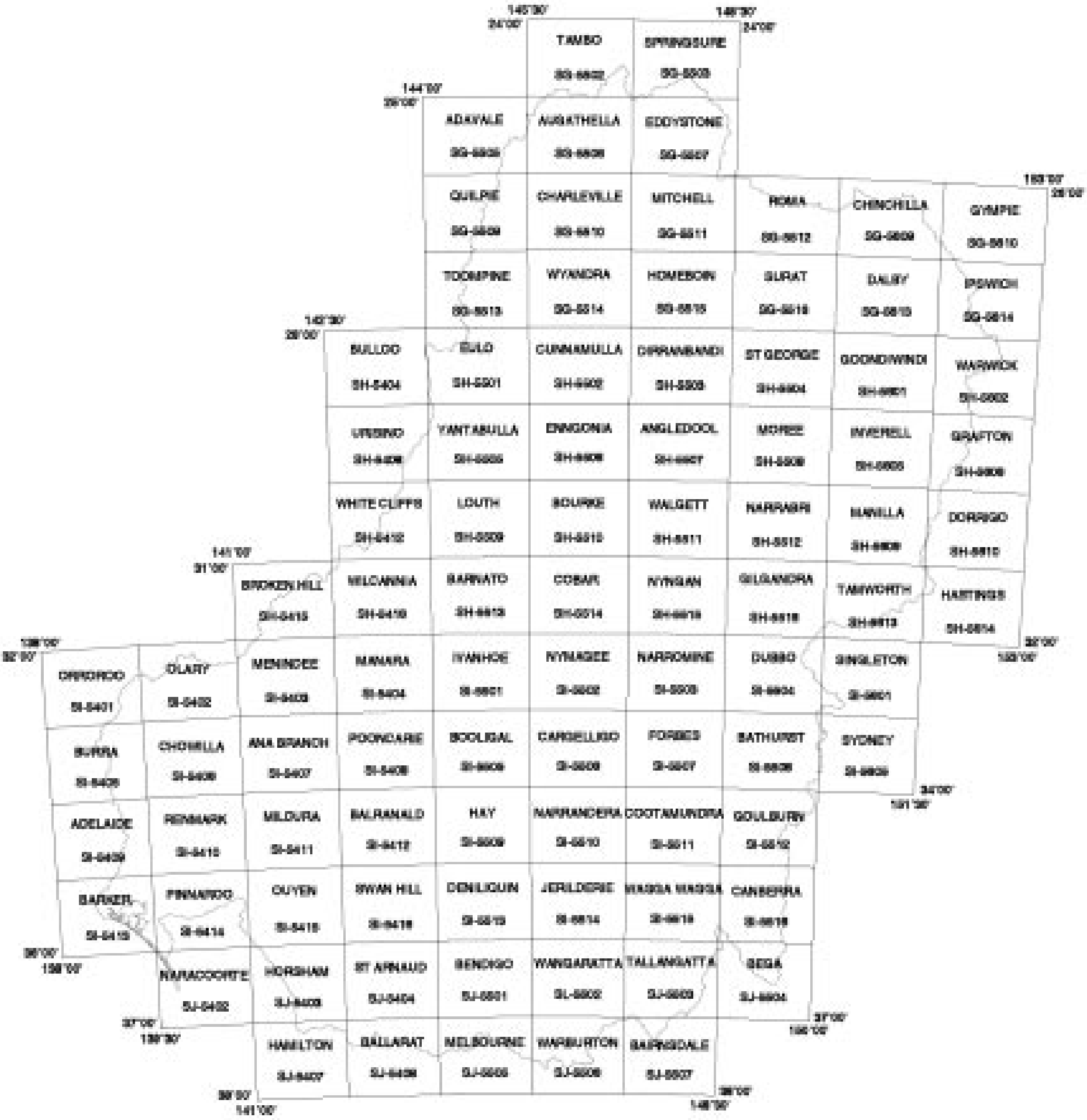


Figure 1. 1:250 000 scale mapsheet index

4.1. Lachlan Fold Belt

The Lachlan Fold Belt (LFB) forms a major part of the south-eastern MDB, extending within the MDB from central and south-eastern NSW to central and eastern Victoria. Scheibner & Basden (1996) describe the LFB as a 'composite orogenic belt composed of Early Cambrian to Early Devonian pre-cratonic complexes developed over mixed ensialic (microcontinents) and ensiamatic (oceanic or ophiolitic) basement'.

The LFB comprises three major lithotectonic assemblages (Coney, 1992). These are greenstone belts of Early - Middle Cambrian age, Ordovician - Silurian turbidite fan deposits and finally the complex sedimentary, volcanic and plutonic associations of early - mid Silurian to Late Devonian - early Carboniferous age.

Ordovician - Silurian turbidite fan deposits dominate much of the LFB. These quartz-rich sands and muds extend across the entire LFB and appear to be sourced from Gondwanaland (Coney, 1992).

The LFB has undergone several stages of deformation. Most of the LFB was affected by the late Ordovician - early Silurian Benambran orogeny which caused the inversion of a back arc basin resulting in a collision thrust belt called the Wagga-Omeo Zone (Scheibner & Basden, 1996). Extension in the early - mid Silurian eastern LFB was followed by the localised Bowning-Bindi deformation in the late Silurian - Early Devonian.

Emplacement of extensive orogenic granites occurred in the Silurian and Devonian periods (Chappell *et al*, 1988). This represented a major transition in the LFB towards a mature continental margin orogen and is linked with complex sedimentary associations and explosive volcanism that occurred on an extraordinary scale (Coney, 1992). Post-orogenic Carboniferous granites completed the development of the LFB.

The mid-Devonian Tabberabberan orogeny terminated pre-cratonic development and was followed by a diachronous onset of transitional tectonic volcanism and sedimentation. The Kanimblan orogeny converted the LFB into a neocraton, and subsequent late Carboniferous - Holocene sedimentation has provided platformal character (Scheibner & Basden, 1996).

4.2. Darling Basin

The Darling Basin is located in the Cobar and Nymagee regions of western New South Wales. The area is one of significant mineralisation with important copper and gold deposits formed in the rocks of the Cobar Supergroup (Gilligan *et al*., 1994).

Major crustal extension through reactivation of faults in the earliest Devonian led to the formation of the Darling Basin. A number of troughs and basins formed where extension was greatest (Cobar Basin, Mount Hope, Rast and Melrose Troughs), with areas of lesser extension forming shelves (Kopyje, Mouramba, Winduck and Walters Range Shelves). Sedimentary and volcanic fill of these shelf and trough features comprise the Cobar Supergroup (Suppel & Gilligan, 1993).

Deep-water turbiditic sedimentation took place in the basins and troughs, while to the south in the Mount Hope and Rast Troughs, turbiditic sedimentation was accompanied by deep-water felsic volcanism. Thick accumulations of felsic volcanics also occur on the eastern part of the Kopyje Shelf associated with the Florida, Babinda, Majuba and Mineral Hill Volcanics. In contrast, the remaining shelf and trough features of the Cobar Supergroup contain very few volcanic intercalations and are characterised by quartz-rich clastics. Each of the Darling Basin depocentres show two-phase evolution, with a period of synrift sedimentation followed by a period of sag phase sedimentation (Gilligan *et al*., 1994).

Deformation of the Cobar Supergroup occurred in the late Early Devonian resulting in different structural zones. This was followed by basin inversion and deposition of the fluvial Mulga Downs Group of the Barka Basin.

4.3. Barka Basin

The Barka Basin is a molassic transitional tectonic sequence of late Early Devonian to early Carboniferous age. The Barka Basin onlaps the neighbouring Kanmantoo Fold Belt and comprises the Mulga Downs Group. These fluviatile sediments are dominantly medium to coarse-grained quartz sandstones with minor siltstone (Glen *et al.*, 1985).

4.4. New England Fold Belt

The New England Fold Belt forms the eastern part of the Tasman orogenic system and extends from north of Sydney to the central Queensland coast. The orogen developed late in the Palaeozoic era close to the Gondwana continental margin (Coney, 1988).

The New England Fold Belt is divided into two parts for the pre-Permian rocks within the MDB. The Tamworth Belt lies west of the Peel River fault system. On the eastern side of the Peel River fault system lies the Tablelands Complex (Korsch & Harrington, 1981) of which there are several structural subdivisions.

The Tamworth Belt contains sedimentary rocks of Cambrian to Early Permian age that were deposited in a fore-arc basin. By comparison, the rocks of the Tablelands Complex have been subjected to low to medium grade regional metamorphism during at least four regional deformations that took place during the late Palaeozoic. These sedimentary rocks of similar age are considered to be an accretionary subduction complex (Leitch *et al*., 1988).

Depositional environments in the Early Permian commonly transgressed the boundaries of the above sub-divisions. The Tablelands Complex was intruded by granite plutons during the Permian and Triassic and is partly covered by the extensive late Permian Emmaville Volcanics and less extensive Tertiary volcanics (Gilligan & Brownlow, 1987).

Korsch & Harrington (1981) divide the Tablelands Complex into four main sedimentary associations. These are the ?Devonian Woolomin association, the Late Devonian - Carboniferous Sandon and Beenleigh associations, the late Carboniferous - Early Permian Nambucca, Silverwood and Coffs Harbour associations, and the Late Permian Dummy Creek association.

The major geological units outcropping in the Tamworth Belt include the Devonian Tamworth Group and Baldwin Formation, the early Carboniferous Keepit Conglomerate, Mandowa Mudstone, Tangaratta Formation, Tulcumba Sandstone, Namoi Mudstone and Merlewood Formation, the late Carboniferous Currabubula Formation and the Permian Temi Formation and Werrie Basalt.

4.5. Gunnedah Basin

The Gunnedah Basin is located in north-eastern NSW, situated between the Bowen Basin to the north and the Sydney Basin in the south. It contains a sequence of marine and non-marine Permian and Triassic sediments and is an important Permian coal bearing basin (Tadros, 1993).

Basin extension and subsequent subsidence initiated deposition in the Gunnedah Basin during the early Permian, commencing with the fluvial Maules Creek Formation containing numerous coal seams. This formation is conformably overlain by the Late Permian marine shelf sediments of the Porcupine Formation and the regressive marine Watermark Formation. A second coal sequence, the Black Jack Formation, was deposited in a deltaic and fluvial environment in the Late Permian (Tadros, 1993).

Triassic sediments unconformably overlie the Permian sequences. Two depositional sequences have been identified in the Digby Formation. The lower stage consists of a conglomerate unit deposited by braided stream systems after uplift of the adjacent New England Fold Belt. The later stage deposited sandy sediments as the elevation of the New England source area declined, and the system changed from braided to meander streams. A basin-wide palaeosol horizon caps the Digby Formation. The Napperby depositional sequence represents the upper limit of the Gunnedah Basin sequence, with a regional unconformity existing between the Triassic and overlying Jurassic sediments of the Surat Basin north of the Liverpool Ranges (Tadros, 1993).

The Gunnedah Basin sequence includes a number of basic intrusions of Mesozoic and Tertiary rocks. These are associated with massive extrusions of the Garrawilla Volcanic complex and the Liverpool, Warrumbungle and Nandewar Ranges (Tadros, 1993).

The physiography of the Gunnedah Basin within the MDB consists of mountain ranges along the margins of the MDB in the south, with extensive areas of Quaternary alluvium occupying the low lying areas of the Liverpool Plains. Resistant sandstone outcrop forms isolated hills and ridges, with extrusive domes of the Jurassic Garrawilla Volcanics scattered throughout the central and western parts of the basin (Tadros, 1993).

4.6. Clarence-Moreton Basin

The Clarence-Moreton Basin is considered to be an off-shoot from the south-east margin of the Great Artesian Basin, linked by a narrow strait throughout the Mesozoic (McElroy, 1962). Although the basin extends from north-eastern NSW into south-eastern Queensland, only the Queensland portion of the basin resides within the MDB.

Sedimentation commenced in the Middle Triassic in a slowly subsiding basin and continued until the Cretaceous period. A sequence of coal measures, mature quartzose sandstone and less mature sandstone was repeated during this cycle of deposition (McElroy, 1962).

In the Queensland portion of the basin, the Triassic - Jurassic depositional cycle consists of the Ipswich Coal Measures, the Bundamba Group and the Marburg Subgroup, with the Jurassic - Cretaceous cycle containing the Walloon Coal Measures.

Coal measures were deposited in shallow floodbasins and peat-forming wetlands. Basin subsidence and margin uplift resulted in the deposition of the fluvial Bundamba Group and Marburg Subgroup conglomerate and sandstone units. Major extrusions of intermediate and basic lavas and pyroclastics occurred during the Tertiary (McElroy, 1962).

Figure 2. Tectonic units within the Murray-Darling Basin

4.7. Surat Basin

The Surat Basin contains 2500 metres of mainly Jurassic clastic continental sedimentary rocks and lower Cretaceous marine beds largely obscured by Cainozoic alluvium (Exon, 1976).

During the Jurassic period there were 5 cycles of terrestrial deposition. These cycles are characterised by coarse-sand braided stream deposits grading up into finer sand and silt deposits of meandering streams. Labile sand, silt, mud and coal were laid down in swamps, lakes, deltas and shallow seas to complete the cycle of deposition. During the mid-late Jurassic, much of the sediment was supplied by andesitic volcanic activity (Exon, 1976).

Deposition changed from terrestrial to shallow marine during the Early Cretaceous. A series of marine transgressions and regressions deposited the Rolling Downs Group with deposition ceasing in the late Albian (Exon, 1976).

A deep weathering profile developed during the Late Cretaceous and early Tertiary. Basic volcanic activity occurred during the Oligocene-Miocene and since this time the Surat Basin has remained relatively stable, with extensive erosion occurring around the margin of the MDB (Exon, 1976).

The physiography of the Surat Basin within the MDB consists of extensive alluvial systems, with large areas of undulating residual sands formed on the Hutton Sandstone with undulating clayey downs country developed on the easily weathered Rolling Downs Group. Remnants of formerly widespread flows in the mid-Tertiary form basalt capped mesas in the north. Dissected sandstone country with cuestas and mesas have formed where resistant sandstone and less resistant interbeds occur. In lower areas within the basin, dissected tablelands occur where ferruginised and silcified surfaces have resisted weathering (Exon, 1976).

The geology of the Surat Basin is characterised by the terrestrial fluvial cycles that took place in the Jurassic and the shallow marine environment that existed during the Early Cretaceous, as evident in the Eromanga Basin. Outcropping units laid down during the Jurassic period include the Precipice Sandstone and Evergreen Formation, the Hutton Sandstone and Walloon Coal Measures, the Springbok Sandstone and Westbourne Formation, the Gubberamunda Sandstone and Orallo Formation, with the final terrestrial cycle depositing the Mooga Sandstone and Bungil Formation.

The Early Cretaceous marine transgression ended the fluvial cycles and initiated deposition of the Rolling Downs Group. This group includes the Doncaster and Coreena members of the Wallumbilla Formation, the Surat Siltstone and the Griman Creek Formation.

4.8. Eromanga Basin

The Eromanga Basin is a Jurassic to Cretaceous sedimentary basin that forms part of the Great Artesian Basin. The basin is characterised by terrestrial sequences in the Jurassic period, followed by shallow marine in the early Cretaceous and ranging from paralic to fluvial and lacustrine in the late Cretaceous. During the Late Cretaceous, much of the Rolling Downs Group was subjected to chemical weathering, with a second phase of weathering taking place during the early Tertiary (Senior *et al*., 1978).

The physiography of the Eromanga Basin within the MDB is characterised by large areas of low relief and extensive alluvial systems formed by the Paroo and Warrego Rivers. The alluvial systems are separated by dissected plateaux with strongly dissected Jurassic sediments occurring along the margin of the MDB (Senior *et al*., 1978).

The major geological units outcropping in the Eromanga Basin include the Jurassic Hutton Sandstone and Injune Creek Group, the Jurassic - Cretaceous Hooray Sandstone, the Cretaceous Rolling Downs Group and the Tertiary Glendower Formation, interspersed by large areas of Cainozoic alluvium and fluvial sandy sediments.

4.9. Murray Basin

The Murray Basin developed in the Cainozoic era, following the break up between Antarctica and the southern margin of Australia. The Cainozoic history indicates slow rates of subsidence coupled with low rates of sediment supply (Brown & Stephenson, 1989).

There were three major depositional sequences in the Tertiary correlating with periods of sea level rise and fall. Deposition of the earliest Tertiary sequence commenced in the Paleocene and continued throughout the Eocene to the Lower Oligocene. During the Paleocene to Eocene, the Warina Sand of the Renmark Group was deposited in the central western depocentre. Later in the Eocene, carbonaceous silt, sand and clay were deposited in fluvio-lacustrine environments forming the Olney Formation of the Renmark Group (Brown & Stephenson, 1989).

The second sequence of Tertiary deposition ranged from the Oligocene to mid-Miocene. This resulted from a major marine transgression which partly flooded the western area of the Murray Basin. An epicontinental sea deposited marl and limestone of the Murray Group, with clay being deposited in the shallow-marginal marine environments. The sea level fell during the mid-Miocene, causing the Olney Formation, Geera Clay and Winnambool Formation to locally prograde back over the limestones of the Murray Group. This sea level decline was followed by a short period of erosion, and most authors suggest that the sea entirely retreated from the Murray Basin (Brown & Stephenson, 1989).

The third depositional sequence took place in the Upper Miocene to Pliocene and involved a series of marine transgressions and regressions. The initial transgression deposited clay and marl in a shallow marine environment, while at the same time the coarse-grained sandy Calivil Formation was deposited in fluvial and fluvio-lacustrine environments in the eastern half of the Murray Basin. A marine regression during the Early Pliocene led to the deposition of the fluvial and strand plain Loxton-Parilla Sands (Brown & Stephenson, 1989).

Uplift along the western margin of the Murray Basin during the early Pleistocene lead to the tectonic damming of the Murray River which formed Lake Bungunnia, resulting in the deposition of the Blanchetown Clay. Along the northwest margin, uplift also increased the rates of erosion, depositing the colluvial Pooraka Formation. To the east and north, fluvial sedimentation continued resulting in the deposition of the Shepparton Formation and the formation of the Riverine Plain (Brown & Stephenson, 1989).

Paleoclimates during the late Cainozoic indicate increasing seasonal aridity. Development of landforms within the Murray Basin can be strongly related to climatic variation and interactions between fluctuating saline groundwaters and surface geomorphic processes. Glacial aridity activated processes of aeolian dunefields, groundwater discharge lakes, gypsum and clay lunettes and bed-load channel sands. Sand availability has been the dominant controlling factor in the distribution of dunefields, with climatic conditions initiating and re-activating the dunefields. Wetter inter-glacial periods provided vegetation stabilised landforms, suspended load channel sediments and sand dominated lunettes (Brown & Stephenson, 1989).

5. Lithology Groupings

The lithology classes and corresponding broad time periods are listed in Appendix 1 with the major tectonic units highlighted. The dominant geological units that occur within each group have been included. Although this list is not comprehensive, it is designed to give a clearer indication for the basis of the lithology groupings.

The classes were created to reflect characteristic lithologies that occurred throughout periods of geological history. The classes also take into account spatial extent of the various geological units, given the large area of the MDB.

The Cainozoic era was divided into eight classes to reflect the varying depositional environments that existed throughout much of this time and the vast extent of the sedimentary basins that these units occupy. The lithology classes include lacustrine sediments, estuarine sediments, alluvium, beach sands, residual and aeolian sands, colluvial surfaces, duricrusts and volcanics. This breakdown largely reflects the relatively detailed surficial geology of the Murray Basin (Brown & Stephenson, 1989), but has also been applied to the other sedimentary basins throughout the MDB and depositional areas within the Lachlan and New England Fold Belts.

Sedimentary rocks of Palaeozoic and Mesozoic age were grouped on the basis of age, grain size, method of deposition and the degree of metamorphism. Metamorphic events that occurred in the Proterozoic era during the Delamerian orogeny, the Cambrian and Ordovician periods in the Lachlan Fold Belt and during the Carboniferous period in the New England Fold Belt form the basis of these metasedimentary groupings. Groupings of coarse and fine grained sediments were created for the Siluro-Devonian, Permian, Triassic, Jurassic and Cretaceous periods. A further division occurs in the mid Devonian arising from the Tabberabberan orogeny.

Volcanic classes were established for the Proterozoic era and for each period during the Palaeozoic and Mesozoic eras. The exception to this is the Siluro-Devonian period in the Lachlan Fold Belt, for which explosive volcanic tuff and ignimbrite rocks (dominantly Silurian) were grouped as ‘Silurian volcanics’, while rhyolites and lava flows (dominantly Devonian) form the basis of the ‘Devonian volcanics’ group. Basic rocks including basalts and gabbros of Siluro-Devonian age were grouped together.

Granite emplacement occurred extensively in the Lachlan and New England Fold Belts throughout the Siluro-Devonian and Permo-Triassic periods respectively. Lithology classes for granites were established for the Proterozoic era and the Siluro-Devonian, Carboniferous, Permian and Triassic periods. A further division was created to distinguish granodiorites of the Lachlan Fold Belt emplaced during the Siluro-Devonian as being either I-type or S-type in origin.

Ultramafic rocks of Cambrian and Permian ages occur in the MDB and form a single grouping. These rocks are associated with the Wagga-Omeo Metamorphic Zone in the Lachlan Fold Belt and the Great Serpentinite Belt of the New England Fold Belt.

Limestones remain undifferentiated in this classification. They are predominantly associated with the Ordovician and Siluro-Devonian periods in the Lachlan Fold Belt, the Devonian and Carboniferous periods in the New England Fold Belt and the Tertiary period in the Murray Basin.

6. Digital Data Compilation

Digital data was compiled from existing geology mapping by the relevant state geological surveys and AGSO. The most recent 1:250 000 scale mapping was incorporated, including more detailed 1:100 000 scale geology data where available.

6.1. Data source/lineage

The Great Artesian Basin (GAB) project within AGSO supplied digital geology information for much of the overlap between the GAB and the MDB in Queensland. The geology data was originally traced from hardcopy maps at 1:250 000 scale (broad Mesozoic and Quaternary groupings). Additional geology linework was digitised from hardcopy 1:250 000 scale maps. Digital data was sourced using this procedure for the following 1:250 000 scale mapsheets:

- TAMBO, SPRINGSURE, ADAVALE, AUGATHELLA, EDDYSTONE, QUILPIE, CHARLEVILLE, MITCHELL, ROMA, GYMPIE, TOOMPINE, WYANDRA, HOMEBOIN, SURAT, BULLOO, EULO, CUNNAMULLA, DIRRANBANDI and ST GEORGE.

The AGSO Spatial Information and Mapping Service scanned data from 1:100 000 scale and 1:250 000 scale plate film positives in Intergraph format. A graticule was generated and the data was warped using an affine transformation. The data was vectorised in a PC environment, manually cleaned and then converted to ArcInfo. Information was sourced using this method for the following mapsheets:

- CHINCHILLA, DALBY, IPSWICH, GOONDIWINDI and WARWICK (@ 1:250 000 scale)
- TANTANGARA, BRINDABELLA and ARALUEN (@ 1:100 000 scale).

The Victorian Department of Natural Resources and Environment supplied geology data in Intergraph format. Files were converted to Arc/Info and transformed to give real world coordinates. Information was sourced using this method for the following 1:250 000 scale mapsheets:

- BALLARAT, MELBOURNE, WARBURTON, BAIRNSDALE and TALLANGATTA.

The NSW Department of Mineral Resources supplied geology data in ArcInfo export format as either unedited linework or with polygon topology. Information was sourced using this method for the following 1:250 000 scale mapsheets:

- URISINO, YANTABULLA, ENNGONIA, ANGLEDOOL, MOREE, INVERELL, GRAFTON, WHITE CLIFFS, LOUTH, BOURKE, WALGETT, NARRABRI, MANILLA, DORRIGO, BROKEN HILL, WILCANNIA, BARNATO, COBAR, NYNGAN, GILGANDRA, TAMWORTH, HASTINGS, NARROMINE, DUBBO, SINGLETON, FORBES, SYDNEY, COOTAMUNDRA, GOULBURN, WAGGA WAGGA, CANBERRA and BEGA-MALLACOOTA.

The Minerals Division of AGSO supplied 1:250 000 scale and 1:100 000 scale geology data in ArcInfo export format. Information was sourced using this method for the following mapsheets:

- BATHURST (@ 1:250 000 scale)

- WAGGA WAGGA and PARKES (@ 1:100 000 scale).

6.2. Database Construction

The primary digital data was received in either Arc/Info export format (.e00) or as Intergraph design files (.dgn).

Files in Intergraph format were converted into raw ArcInfo coverages using the *igdsarc* command with level information retrieved using an Arc/Info AML (*igds2arc.aml*). The files were then transformed to provide real world coordinates.

Many of the Arc/Info datasets were received as unedited line coverages with varying amounts of polygon topology. ArcEdit was used to remove or fix offshoots and dangling or duplicate arcs.

Polygon topology was constructed using the Arc/Info *build* command. Polygon and Arc attributes were added consistent with the AGSO digital data standards (AGSO, 1998).

Arc/Info coverages (typically 1:250 000 scale mapsheets) were appended using the *mapjoin* command. Tolerances were set such that no coordinate drift occurred.

6.3. Projection Details

The digital datasets for whole basin and sub-catchment geology are stored in a Lambert Conformal Conic projection that was defined to suit the spatial representation of the MDB (Table 1). Individual mapsheets are stored in the relevant Universe Transverse Mercator projection.

6.4. Documentation

Documentation was created to comply with ANZLIC standards using the NRIC developed Arc/Info AML *doco.aml* (NRIC, 1997). Metadata is attached to the digital data as the following infofiles;
- <*filename.md1*> - base metadata for the dataset
- <*filename.md2*> - descriptions about feature attribute data
- <*filename.md3*> - dataset lineage
- <*filename.md4*> - dataset abstract.

An ASCII readme file <*filename.rme*> was also created during the metadata process. This provides a summary of all the information contained in the INFO files (NRIC, 1997). Another ASCII file <*filename.txt*> has been added to highlight filenames of the digital data and the purpose for the data creation.

Table 1. Projection details for whole-basin and sub-catchment geology data

Projection:	Lambert Conformal Conic
Datum:	Australian Geodetic Datum (1966)
Spheroid:	Australian National Spheroid
Parameters	
Major axis:	6378160
Minor axis:	6356775
Central Meridian:	146° 00’ 00” E
1st Standard Parallel:	28° 30’ 00” S
2nd Standard Parallel:	34° 30’ 00” S
Latitude of Projection’s Origin:	31° 30’ 00” S
False Easting:	00° 00’ 00”
False Northing:	00° 00’ 00”

6.5. Naming Conventions

Datasets are available at three levels of spatial extent. These are as a basin-wide dataset, as sub-catchments within the MDB, or as individual 1:250 000 scale mapsheets. The naming of these datasets has been designed to allow users to easily understand that area covered by the dataset.

1. Basin-wide geology;
- geol_mdb.

2. Sub-catchments - there are 26 surface drainage sub-catchments within the MDB (Figure 3). The naming convention for these datasets uses the prefix (*geol_*) followed by an abbreviation (usually the first five letters) of the sub-catchment name;

- *geol_avoca* (Avoca)
- *geol_benan* (Benanee)
- *geol_borde* (Border)
- *geol_broke* (Broken)
- *geol_campa* (Campaspe)
- *geol_castl* (Castlereagh)
- *geol_conda* (Condamine-Culgoa)
- *geol_darli* (Darling)
- *geol_goulb* (Goulburn)
- *geol_gwydi* (Gwydir)
- *geol_kiewa* (Kiewa)
- *geol_lachl* (Lachlan)
- *geol_lgeor* (Lake George)
- *geol_loddo* (Loddon)
- *geol_lomur* (Lower Murray)
- *geol_macqu* (Macquarie-Bogan)
- *geol_malle* (Mallee)
- *geol_mooni* (Moonie)
- *geol_murra* (Murray Riverina)
- *geol_mbidg* (Murrumbidgee)
- *geol_namoi* (Namoi)
- *geol_ovens* (Ovens)
- *geol_paroo* (Paroo)
- *geol_upmur* (Upper Murray)
- *geol_warre* (Warrego)
- *geol_wimer* (Wimera-Avon)

3. The filenames for the individual 1:250 000 scale mapsheet areas are named geol_<*mapsheet number*>. Some examples are provided below;

- CHARLEVILLE 1:250 000 mapsheet - *geol_g5510*
- GOONDIWINDI 1:250 000 mapsheet - *geol_h5601*
- NARROMINE 1:250 000 mapsheet - *geol_i5503*
- RENMARK 1:250 000 mapsheet - *geol_i5410*
- TALLANGATTA 1:250 000 mapsheet - *geol_j5503*
- WARBURTON 1:250 000 mapsheet - *geol_j5506*.

6.6. Geology Data Attributes

The Arc/Info coverage feature attributes for arcs (Table 2) and polygons (Table 3) are described below. These attributes are consistent with the AGSO Geoscience Data Dictionary - Version 98.04 (AGSO, 1998).

Due to copyright constraints, a restricted set of polygon attributes is available with the datasets. This reduced set contains only the derived information for the lithology groups (*lith_grp*, *lith_code*). Complete polygon information (Table 3) is available only after receiving permission from the relevant agency responsible for compiling the original geology mapping.

7. Data Limitations

7.1. Quality Assurance

Visual comparison of digital data with original maps was undertaken in ArcView. This is a valuable checking tool as the functionality of ArcView allows the user to zoom and pan relatively easily. A series of commands were followed in Arc/Info to check for inconsistencies in the digital data. The <*dissolve lines # all*> command was used to remove any pseudo nodes. The <*dissolve poly # all*> was used to ensure that the arc attributes UNITBDY and POLYBDY were correct. An Arc/Info AML *unitbdy.aml* was used to check for polygon and arc labelling inconsistencies. This AML identifies adjacent polygons with the same map symbol that are joined by a geological boundary. However, this method cannot determine incorrectly labelled polygons that do not occur adjacently.

The digital datasets have also been checked by the AGSO Data Manager. This process involves a series of quality control checking routines against AGSO digital data standards.

Table 2. Attributes of arcs within the MDB geology coverages

Feature attribute	Field Type	Definition
feature	12,12,C	Feature type
ufi	6,6,I	Unique feature identifier
agso_code	8,8,I	An identification code assigned to the feature as specified in the book 'Symbols Used on Geological Maps' (1989)
class	2,2,I	A measure of the status of a feature, ie. whether it has accurate, approximate or inferred status
type	64,64,C	A fill of any fault eg. QUARTZ, a type of dyke or vein eg DOLERITE or a rock type of marker bed eg. SANDSTONE
desc	100,100,C	A description of the feature
name	64,64,C	The name of the feature, eg. Kelly Hills Fault
flt_system	64,64,C	A group of faults that are parallel or nearly so, and that are related to a particular deformation episode eg. MOUNT ISA FAULT SYSTEM
azimuth	3,3,I	Azimuth of the feature
defn	64,64,C	Geological ages(s) eg. ORDOVICIAN, SILURIAN, DEVONIAN or the number of deformations to which the structure is related eg. 2
polybdy	1,1,C	A field used to discriminate polygon boundaries from non polygon boundaries
unitbdy	1,1,C	A field used to discriminate solid geology boundaries from non solid geology boundaries
width	4,5,B	The width of a fault, dyke, vein or marker bed in metres
plotrank	2,5,B	A field used to discriminate plotting from non plotting and artificial features

Table 3. Attributes of polygons within the MBD geology coverages

Feature attribute	Field Type	Definition
feature	12,12,C	Feature type
ufi	6,6,I	Unique feature identifier
map_symb	20,20,C	Map text identifying the lithology of the solid geology unit as originally mapped
plot_symb	4,4,C	Abbreviated form of map_symb
stratno	7,7,I	Stratigraphic index number
unitname	64,64,C	The name of the stratigraphic unit including rank terms that are part of the name
supergroup	64,64,C	An assemblage of related groups, or of formations and groups, having significant lithological features in common
group	64,64,C	The formal lithostratigraphic unit which includes two or more contiguous or associated formations with significant lithological features in common
subgroup	64,64,C	A formally differentiated assemblage of formations within a group
formation	64,64,C	A body of rock strata which is unified with respect to adjacent strata by consisting dominantly of a certain lithological type or combination of types or by possessing other unifying lithological features
member	64,64,C	A lithostratigraphic unit of subordinate rank
era	100,100,C	A prime division of geological time, eg. Palaeozoic
period	100,100,C	A geological time unit during which the rocks of the corresponding system were formed
rocktype	24,24,C	Dominant lithological grouping
lith_desc	254,254,C	A description of the lithology of the solid geology unit
plotrank	1,1,I	A field used to discriminate plotting from non-plotting and artificial features
mapno	10,10,C	1:250 000 or 1:100 000 scale mapsheet number
lith_grp	100,100,C	Simplified lithostratigraphic grouping. Used to group geology across the MDB
lith_code	4,4,C	Abbreviated form of lith_grp

7.2. *Edge matching*

The data has been edgematched where possible to produce a seamless geology dataset for the entire Murray-Darling Basin. While not a trivial task, it was made somewhat easier by generating broad lithology classes.

In some areas, particularly north-western NSW, remotely sensed imagery (Landsat TM and MSS) were used to improve edge differences in the geology mapping across mapsheet and state boundaries.

Radiometric data interpretation was also used to improve mapsheet edge inconsistencies, particularly those sheets surrounding the FORBES 1:250 000 scale mapsheet.

The ‘Granites and Related Rocks of the Lachlan Fold Belt’ map (Chappell *et al*., 1991) was used as a regional dataset to resolve many of the edgematching differences throughout the Lachlan Fold Belt. This dataset was particularly useful in the GOULBURN and WAGGA WAGGA 1:250 000 scale map areas, and also those parts of the CANBERRA 1:250 000 mapsheet for which 1:100 000 scale data does not exist.

7.3. *Positional Accuracy*

Positional accuracy for some of the older geological maps was also an issue. This arose due to inaccurate topographic bases that were the best available at the time for the geological mapping conducted in the mid to late 1960’s.

Projection details of the data also posed accuracy problems. As the data was collected from a number of sources, complete projection information was often hard to obtain. Many of the datasets lacked datum information, and where absent, the data was checked and in some cases transformed to AGD66. Landsat data was useful in determining the veracity of any transformations.

8. Reliability

Reliability has been divided into four categories (Figure 4). The broad groupings largely reflect the age of mapping and the way in which the data was compiled.

The Murray Basin surficial geology dataset has been placed into a single reliability category (Category C). The twenty-six 1:250 000 scale mapsheets that form this dataset were compiled as a single dataset at 1:250 000 scale and further generalised to 1:1 000 000 scale.

The reliability for the 1:250 000 scale data has been determined according to when the mapping was undertaken. There was a distinct time gap in the age of mapping obtained for 1:250 000 scale geology in the MDB, between the mid-late 1970’s and the late 1980’s. A major geological mapping effort took place in south-western Queensland and north-western New South Wales during the mid-late 1960’s and early 1970’s. This reliability grouping also includes some other mapsheets in NSW mapped later in the 1970’s and forms a reliability category of 1:250 000 scale data pre-1977 (Category D). A more recent geology mapping effort has taken place in the late 1980’s and 1990’s, and this data has been placed in a category of 1:250 000 scale data post-1987 (Category B). A final reliability category exists for the 1:100 000 scale geology data (Category A).

9. Availability of Datasets

The datasets produced by the MDBSIS project are being made available via the World Wide Web. As part of this web package, the derived dataset of the ‘Geology of the Murray-Darling Basin - Simplified Lithostratigraphic Groupings’ is able to be viewed and queried.

The data is presented after previewing the dataset documentation. Clients are able to view information at a basin-wide scale or select areas to see data at a sub-catchment or 1:250 000 scale mapsheet level. A further selection enables clients to view and query polygonal data, with feature attributes presented in a tabular form.

The Murray-Darling Basin Soil Information Strategy project information is located at the following address;

http://www.agso.gov.au/land_water/mdbsis/

The underlying original geological maps (and complete sets of polygon attributes - see Section 6.6) are available from the relevant agency responsible for their compilation.

Hardcopy maps have also been produced for the basin-wide lithology data (Kingham, 1998) at 1:1 500 000 plotscale in AO format. These are available through the AGSO Sales Centre (ph: 02 6249 9519, fax: 02 6249 9982) as print on demand plots.

Clients requiring further information or those who would like to purchase digital datasets can supply their details and data requirements to the email address provided as part of the website, or telephone the MDBSIS data manager on (02) 6249 9505.

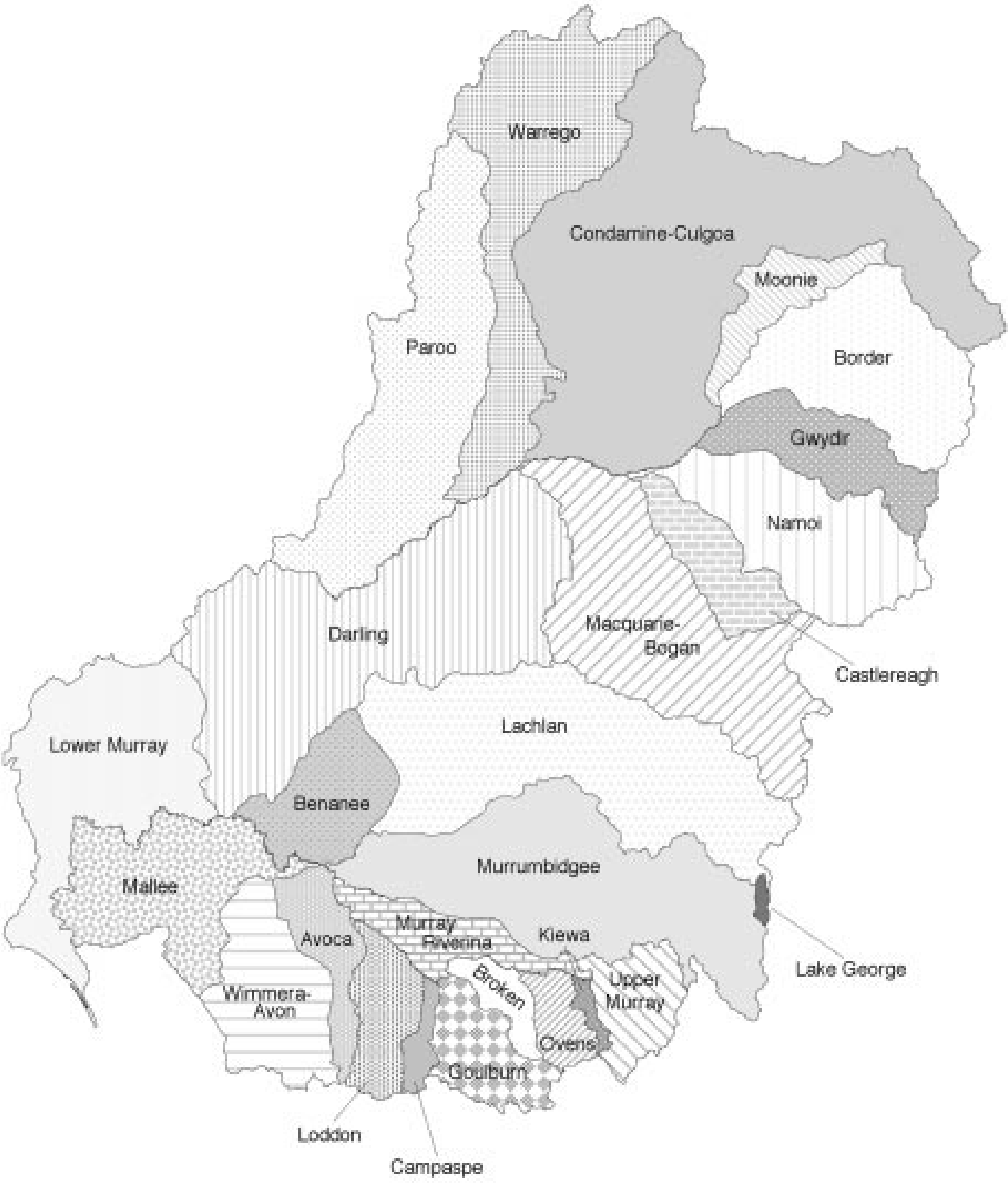
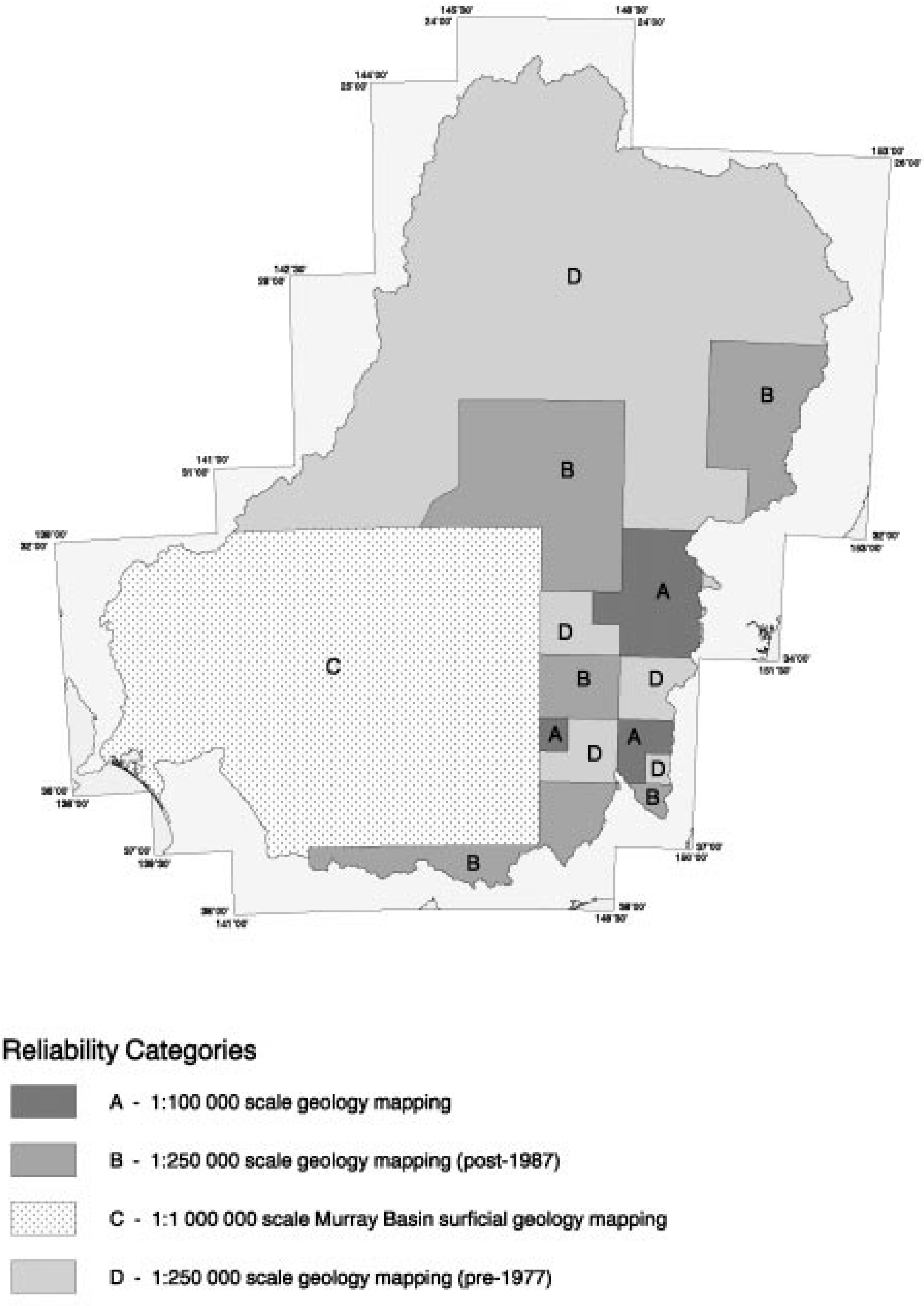


Figure 3. Surface drainage sub-catchments within the Murray-Darling Basin

Data source: Australian River Basins (AUSLIG, 1998).

Figure 4. Reliability diagram



10. Acknowledgments

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A multitude of tasks in Arc/Info were undertaken to produce the final digital datasets. I would like to acknowledge the assistance and many long hours of work by Ingo Hartig and Evert Bleys.

The experience and advice of senior geologists was also invaluable in determining appropriate lithology groupings. I would like to thank Doone Wyborn (ANU) and Robyn Johnston, Ray Evans, Jim Kellett and Ross Brodie (AGSO) for their valued input.

The basin-wide 1: 1 500 000 scale map (Kingham, 1998) is an important product for this project as it provides a basin-wide overview for the geology of the Murray-Darling Basin. I would like to thank Ingo Hartig for his cartographic work in the map production.

Appendix 1. Lithology groupings

Age	Lithology Group	Tectonic Unit	Geological Units
Cainozoic	Lacustrine sediments	Murray Basin Surat Basin	
	Estuarine sediments	Murray Basin	St Kilda Formation, Padthaway Formation
	Alluvium	Extensive throughout the sedimentary basins, some widespread areas in the Lachlan Fold Belt	
	Beach sands	Murray Basin	Loxton-Parilla Sands
	Residual and aeolian sands	Murray Basin Eromanga Basin Surat Basin	
	Colluvial surfaces	Murray Basin Eromanga Basin Lachlan Fold Belt	Pooraka Formation
	Duricrusts	Murray Basin Eromanga Basin minor Lachlan Fold Belt and Surat Basin	Glendower Formation, Ripon Calcrete, Bakara Calcrete
	Volcanics	Lachlan Fold Belt Gunnedah Basin New England Fold Belt Clarence-Moreton Basin Surat Basin	Liverpool Range beds, Comboyne Basalt, Main Range Volcanics, Turtle Rock Volcanics, Morass Creek, Older Volcanics
Cretaceous	Fine-grained sediments	Surat Basin Eromanga Basin	Wallumbilla Formation, Allaru Mudstone, Roma Formation, Surat Siltstone
	Coarse-grained sediments	Surat Basin Eromanga Basin Barka Basin	Mackunda Formation, Winton Formation, Bungil Formation, Griman Creek Formation, Drildool Beds, Keelindi Beds
Jurassic	Volcanics	Surat Basin	Garrawilla Volcanics
	Fine-grained sediments	Surat Basin Eromanga Basin Clarence-Moreton Basin	Moolayember Formation, Birkhead Formation, Westbourne Formation, Evergreen Formation, Southlands Formation, Orallo Formation, Kumbarilla Beds, Walloon Coal, Purlawaugh Beds
	Coarse-grained sediments	Eromanga Basin Surat Basin Clarence-Moreton Basin Gunnedah Basin	Precipice Sandstone, Hutton Sandstone, Adori Sandstone, Hooray Sandstone, Springbok Sandstone, Gubberamunda Sandstone, Mooga Sandstone, Marburg Sandstone, Pilliga Sandstone
Triassic	Fine-grained sediments	New England Fold Belt	Gunnee Formation, Ballimore Beds
	Coarse-grained sediments	Gunnedah Basin	Grogin Conglomerate, Napperby Formation, Digby Formation, Boulderwood Formation
	Volcanics	Lachlan Fold Belt	Mount Leinster igneous complex
	Granites	New England Fold Belt	Ruby Creek Granite, Herries Adamellite, Stanthorpe Adamellite, Gilgai Granite, Bolivia Range Leucogranite
Permian	Fine-grained sediments	Gunnedah Basin New England Fold Belt Sydney Basin	Maules Creek Formation, Black Jack Formation, Watermark Formation, Gladstone Formation, Condadilly Formation, Willow Tree Formation Borambil Creek Formation, Condamine

			Beds, Ashford Coal Measures, Illawarra Coal Measures, Berry Formation
	Coarse-grained sediments	Lachlan Fold Belt New England Fold Belt Gunnedah Basin	Eurydesma & Wallaby Beds, Bondonga Beds, Glenmore Formation, Kensington Formation, Long Swamp Formation, Megalong Conglomerate, Dunedoo Formation, Bacchus Marsh Formation
	Volcanics	New England Fold Belt Gunnedah Basin	Wallangarra Volcanics, Dundee Rhyodacite, Tent Hill Volcanics, Werrie Basalt, Boggabri Volcanics, Gunnedah Volcanics, Rylstone Volcanics
	Granites	New England Fold Belt	Greymare Granodiorite, Boxwell Granodiorite, Duval Adamellite, Cottesbrook Adamellite, Wards Mistake Adamellite, Wellingrove Granodiorite, The Basin Adamellite, Moonbi Adamellite
Carboniferous	Metasediments (includes late Devonian sediments)	New England Fold Belt	Texas Beds, Coffs Harbour association, Namoi Formation, Noumea Beds, Caroda Formation, Clifden Formation, Sandon Beds, Currabubla Formation, Lowana Formation, Merlewood Formation, Parry Group, Temi Formation
	Acid Volcanics	New England Fold Belt	Ermela Dacite Tuff
	Granites	Lachlan Fold Belt	Gulgong Granite, Leadville Monzonite, Ulan Granite, Havilah Granite, Botobolar Granite, Aarons Pass Granite, Bruinbun Granite, Lewis Ponds Granite, Icely Granite, Oberon Granite, Dunkeld Granite, Bathurst Granite, Rossdhu Granite, Tarana Granite, Turallo Quartz Diorite
Upper Devonian	Fine-grained sediments	Lachlan Fold Belt New England Fold Belt	Bolten Formation, Dinoga Formation, Edinboro Formation, Eungai Mudstone, Hervey Group, Hunter Formation, Kadina Formation, Koorawatha Formation, Kurrool Formation, Lawsons Creek Shale, Morgans Gully Siltstone, Merriganowry Shale Member, Mudgingar Creek Formation, Paling Yard Formation, Tarlo Formation
	Coarse-grained sediments	Lachlan Fold Belt Murray Basin Barka Basin Clarence-Moreton Basin	Beargamil Subgroup, Brymedura Sandstone, Buckaroo Formation, Bumberry Formation, Burrill Formation, Caloma Sandstone, Canangle Subgroup, Carlton Formation, Clagger Sandstone, Curra Curra Conglomerate, Cookbundoon Sandstone, Derale Formation, Devils Plain Formation, Gibbons Creek Sandstone, Hatchery Creek Conglomerate, Hervey Group, Macquarie Park Sandstone, Mandagery Formation, Meadows Tank Formation, Moroka Glen Formation, Mount Kent Conglomerate, Mulga Downs Group, Nangar Subgroup, Nundooka Sandstone, Strathaird Formation, Ravendale Formation, Rosenthal Creek Formation, Slowmans Creek Conglomerate, Snowy Plains Formation, Timbertop Conglomerate, Turon River Grits, Twofold Bay Formation, Worange Point Formation, Waree Creek Shale, Weddin Sandstone

Devonian	Volcanics	Lachlan Fold Belt	Byong Volcanics, Cowcumbala Rhyolite, Cumberland Rhyolite, Dulladerry Volcanics, Dungeree Volcanics , Fermoy Volcanics, Frampton Volcanics, Gatelee Ignimbrite, Illunie Rhyolite, Kadungle Volcanics, Kangaloolah Volcanics, Lake Mountain Rhyodacite, Meloola Volcanics, Milpose Volcanics, Minjary Volcanics, Mitta Mitta Rhyolite, Mountain Creek Volcanics, Mullions Range Volcanics, Rolling Grounds Latite, Rubicon Rhyolite, Ryans Creek Rhyolite, Snowy River Volcanics, Talbingo Basalt, Thorkidaan Volcanics, Wellington Rhyolite, Windamere Volcanics, Yeo Yeo Rhyodacite Member
Silurian-Middle Devonian	Fine-grained sediments	Lachlan Fold Belt New England Fold Belt Barka Basin Darling Depression	Anson Formation, Avoca Valley Shale, Baledmund Formation, Barnby Hills Shale, Belubula Shale, Biddabirra Formation, Blowering Formation, Blue Waterhole Formation, Bobs Creek Formation, Brookong Formation, Buckburraga Slate, Bullung Siltstone, Bumbolee Creek Formation, Burgoon Formation, Burraga beds, CSA Siltstone, Cadia Coach Formation, Campbells Formation, Canberra Formation, Cappanana Formation, Cary Formation, Combaning Formation, Connemarra Formation, Cookeys Plains Formation, Copper Creek Shale, Copperhannia Member, Covan Creek Formation, Cowombat Siltstone, Cunningham Formation, De Drack Formation, Deep Creek Siltstone, Donnellys Creek Siltstone, Euchabil Gap Formation, Gibsons Folly Formation, Glendalough Formation, Gospel Oak Shale, Great Cobar Slate, Greengrove Formation, Gungoandra Siltstone, Gwando Siltstone, Hanover Formation, Humevale Siltstone, Kilmore Siltstone, Kirawin Shale, Mackeys Creek Shale, Majurgong Formation, Maradana Shale, Millsville Formation, Mumbidgle Formation, Muttama Creek Siltstone, Rothlyn Formation, Round Top Formation, Saint Andrews Beds, Silver Gully Formation, Sourges Shale, State Circle Shale, Tanwarra Shale, Taylors Hill Formation, Tenandra Formation, Trigalong Formation, Tucklan Formation, Ulah Formation, Wallace Shale, Warratra Mudstone, Waterbeach Formation, Whychetella Formation, Whylandra Formation, Wilson Creek Shale, Wombiana Formation, Yarralumla Formation, Yarrimie Formation, Yass Formation, Yellowmans Creek Formation, Yiddah Formation, lower Amphitheatre Group, upper Amphitheatre Group

Silurian-Middle Devonian	Coarse-grained sediments	Lachlan Fold Belt New England Fold Belt Barka Basin Darling Depression	Adderley Formation, Alley Sandstone Member, Bagdad Formation, Bay Formation, Berkley Formation, Beugamel Sandstone, Biddabirra Formation, Biraganbil Formation, Black Mountain Sandstone, Bocobidgle Conglomerate, Boogledie Formation, Broadford Formation, Buckambool Sandstone, Burthong Formation, Calarie Sandstone, Carwell Creek Formation, Carwoola Formation, Chesleigh Formation, Chesney Formation, Cookeys Plains Formation, Cookman Formation, Coonardoo Sandstone, Daalboro Sandstone, Dargile Formation, Dunchurch Formation, Edols Conglomerate, Eildon Sandstone, Ewolong Formation, Fencers Creek Conglomerate, Glengeera Formation, Gleninga Formation, Gundaroo Sandstone, Guroba Formation, Inverleith Sandstone, Karawina Formation, Kingsford Formation, Kurrajong Park Formation, Majurgong Formation, McAdam Sandstone, McIvor Sandstone, Merrions Formation, Meryula Formation, Mirrabooka Formation, Montys Hut Formation, Moura Formation, Mullamuddy Formation, Myamley Sandstone, Norton Gully Sandstone, Nubingerie Formation, Nubrigyn Formation, Peppercorn Formation, Pocket Formation, Pullabooka Formation, Roxburgh Formation, Serpentine Creek Sandstone, Sinclair Valley Sandstone, Sugarloaf Creek Formation, Sutchers Creek Formation, Towanga Sandstone, Trealmont Formation, Wandeen Formation, Wapentake Sandstone, Warrah Conglomerate, Wilbertree Formation, Willow Glen Formation, Wiltagoona Sandstone, Winduck Group, Yarrabandai Formation
Silurian	Volcanics	Lachlan Fold belt	Box Ridge Volcanics, Bulls Camp Volcanics, Bushranger Volcanics, Clonolly Ignimbrite Member, Canowindra Volcanics, Colinton Volcanics, Coonambro Volcanics, Deakin Volcanics, Curumbenya Ignimbrite Member, Dulladerry Volcanics, Glenisla Volcanics, Goobarragandra Volcanics, Hawkins Volcanics, Ironbong Dacite Member, Kellys Plain Volcanics, Kohinoor Volcanics, Laidlaw Volcanics, Long Flat Volcanics, Mount Ainslie Volcanics, Mount Painter Volcanics, Paddys River Volcanics, Riversdale Volcanics, Sheevers Spur Rhyodacite, Uriarra Volcanics, Walleroobie Volcanics, Walker Volcanics, Woodlawn Volcanics, Willimigongong Ignimbrite
Silurian-Devonian	Basic rocks	Lachlan Fold Belt	Adelong Norite, Blacks Flat Diorite, Brangan Volcanics, Connolly Volcanics, Coolamine Igneous Complex, Currawang

			Basalt, Dungeree Volcanics, Honeysuckle Metabasic Igneous Complex, Jews Creek Volcanics, Lockhart Basic Intrusive Complex, Looney Intrusive Complex, Micalong Swamp Basic Igneous Complex, Mineral Hill Volcanics, Nargong Volcanics, Purnim Volcanic Member, The Pinnacle Dolerite, Warderie Volcanic Member, Wermatong Metabasalt, Windamere Volcanics, Yandilla Volcanics
Silurian-Devonian	Granites	Lachlan Fold Belt	Ararat Granite, Argalong Granite, Ballallaba Adamellite, Ballyhooley Granite, Barmedman Granite, Beanbah Granite, Beckworth Granite, Begonia Adamellite, Ben Nevis Granite, Bigga Granite, Binda Granite, Bogalong Granite, Bogong Granite, Bold Slate Granite, Bolton Granite, Broula Granite, Buddigower Granite, Bunroy Hut Granite, Burnt Hill Granite, Burrandana Granite, Burrinjuck Adamellite, Burrumbeet Adamellite, Cambrai Granite, Caragabal Granite, Carolees Granite, Clear Hills Granite, Collingullie Granite, Cow Flat Granite, Cucum Granite, Ellenden Granite, Epacris Hills Granite, Eugowra Granite, Eversley Granite, Ganantagi Granite, Ginini Leucoadamellite, Glendart Granite, Glenrowe Granite, Gobondery Granite, Gocup Granite, Googong Adamellite, Granya Granite, Grenfell Granite, Gundibindyal Granite, Happy Jacks Adamellite, Hume Park Granite, Hungerford Granite, Jackson Granite, Kyeamba Adamellite, Kyuna Granite, Langi Ghiran Granite, Little Forest Granite, Lobs Hole Adamellite, Lockhart Adamellite, Lords Granite, Lucas Creek Granite, Mannus Creek Granite, Marengo Granodiorite, McKeahnie Adamellite, Michelago Granite, Mt Foster Monzonite, Myocum Adamellite, Nariel Granite, Narraburra Granite, Nymagee Igneous Complex, Obley Granite, Pyalong Granite, Reids Flat Granite, Shannons Flat Adamellite, Strathbogie Granite, Throsby Granite, Thule Granite, Tinderra Granite, Urialla Granite, Wilmatha Granite, Wirrinya Granite, Wyangala Granite, Yarra Granite, Yennora Granite, Yerna Granite
Silurian-Devonian	I-type granodiorites	Lachlan Fold Belt	Anembo Granodiorite, Barry Granodiorite, Baynton Granodiorite, Bugtown Tonalite, Bemboka Granodiorite, Hangmans Creek Granite, Boebuck Adamellite, Boggy Plain Suite, Burnbank Granodiorite, Carcoar Granodiorite, Celeys Creek Granite, Crowther Monzodiorite, Coodravale Granodiorite, Ellerslie Granodiorite, Frogs Hollow Granite, Garland Granodiorite, Glenbog Granodiorite, Glenlogie

			Granodiorite, Gourock Granodiorite, Harcourt Granodiorite, Kempfield Granodiorite, Mount Youngal Tonalite, Mt Lonarch Granodiorite, Padua Granodiorite, Peakview Tonalite, Rocky Valley Granodiorite, Stawell Granodiorite, Sunset Hills Granite, Tara Granodiorite, Wild Wave Granodiorite
Silurian-Devonian	S-type granodiorites	Lachlan Fold Belt	Bolairo Granodiorite, Broken Cart Granodiorite, Callemondah Granodiorite, Clear Range Granodiorite, Cooma Granodiorite, Cootralantra Granodiorite, Couragago Granodiorite, Cowra Granodiorite, King Parrot Creek Granodiorite, McLaughlins Flat Granodiorite, Mowambah Granodiorite, Murrumbucka Tonalite, Rocky Bridge Granodiorite, Rough Creek Tonalite, Sutton Granodiorite, Taylors Crossing Tonalite, Tom Groggin Tonalite, Ungarie Granite, Wantabadgery Granite, Wheeo Granite, Wilgaroon Granite, Willoona Tonalite, Wyalong Granodiorite, Young Granodiorite
Ordovician	Metasediments (includes early Silurian quartzites)	Lachlan Fold Belt	Adaminaby beds, Alandoon Chert, Birkenburn beds, Blueys Creek Formation, Bogan Schist, Boltons beds, Bribbaree Formation, Bynguano Quartzite, Coombing Formation, Cotton Formation, Flint Hill Chert Member, Girilambone Group, Hoskins Formation, Illabo Formation, Kiandra Group, Kirribilli Formation, Mount Easton Shale, Mugincoble Chert, Mundoonen Sandstone, Numeralla Chert, Nungar beds, Nurri Group, Pinnak Sandstone, Pittman Formation, Rowena Formation, Ryrie Formation, Saint Arnaud Group, Tantangara Formation, Tidbinbilla Quartzite, Tucklan Formation, Warbisco Shale, Weemalla Formation, Whinfell Chert, Yarrimbah Chert Member
Ordovician	Volcanics	Lachlan Fold Belt	Blayney Volcanics, Bushmans Volcanics, Byng Volcanics, Fairbridge Volcanics, Forest Reefs Volcanics, Gooandra Volcanics, Goonumbla Volcanics, Kiandra Group, Marangulla Syenite, Mount Dijou Volcanics, Mount Pleasant Basalt Member, Murrumbogie Intrusive Complex, Nash Hill Volcanics, Nelungaloo Volcanics, Nine Mile Volcanics, Raggatt Volcanics, Rockley Volcanics, Sofala Volcanics, Stokefield Metagabbro, Tantitha Intrusive Complex, Walli Volcanics, Wombin Volcanics
Cambrian - Permian	Ultramafics	Lachlan Fold Belt New England Fold Belt	Coolac Serpentinite, Gundagai Serpentinite, Honeybugle Hornblendite, Honeysuckle Metabasic Igneous Complex, North Mooney Complex, Tumut Pond Serpentinite, Tyagong Serpentinite, Wambidgee Serpentinite, West Lynne Serpentinite,

			Yathella Serpentinite
Cambrian	Metasediments	Lachlan Fold Belt Kanmantoo Fold Belt	Cymbric Vale Formation, Garvey Gully Formation, Glenthompson Sandstone, Knowsley East Shale, Saint Arnaud Group
Cambrian	Volcanics	Lachlan Fold Belt	Jindalee Group, Mount William Volcanics
Proterozoic	Metasediments	Broken Hill Block Adelaide Fold Belt	Camels Hump Quartzite, Euriowie Subgroup, Far-Away-Hills Quartzite, Fowlers Gap Formation, Pintapah Quartzite, Ravendale Formation, Teamsters Creek Subgroup, Thorndale Composite Gneiss, Torrowangee Group, Willyama Supergroup, Wonominta beds, Yancowinna Subgroup
Proterozoic	Volcanics	Broken Hill Block	
Proterozoic	Granites	Adelaide Fold Belt	Mundi Mundi Granite
Undifferentiated	Limestone	Lachlan Fold Belt New England Fold Belt Murray Basin	Ashford Limestone, Borenore Limestone, Bowan Park Limestone Subgroup, Burrawong Limestone, Camelford Limestone, Canomodine Limestone, Cargo Creek Limestone, Cavan Bluff Limestone, Cavan Limestone, Cave Creek Limestone, Clandulla Limestone, Cliefden Caves Limestone Subgroup, Cobblers Creek Limestone, Cooleman Limestone, Cowriga Limestone Member, Glendale Limestone Member, Jerula Limestone Member, Jesse Limestone Member, Kildrummie Limestone Member, Liscombe Pools Limestone, Mount Frome Limestone, Murray Group Limestone, Nandillyan Limestone, Narragal Limestone, Reedy Creek Limestone, Regans Creek Limestone, Taemas Limestone, Wahringa Limestone Member, Wooloo Limestone Member, Yarrangobilly Limestone, Yuranigh Limestone Member

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