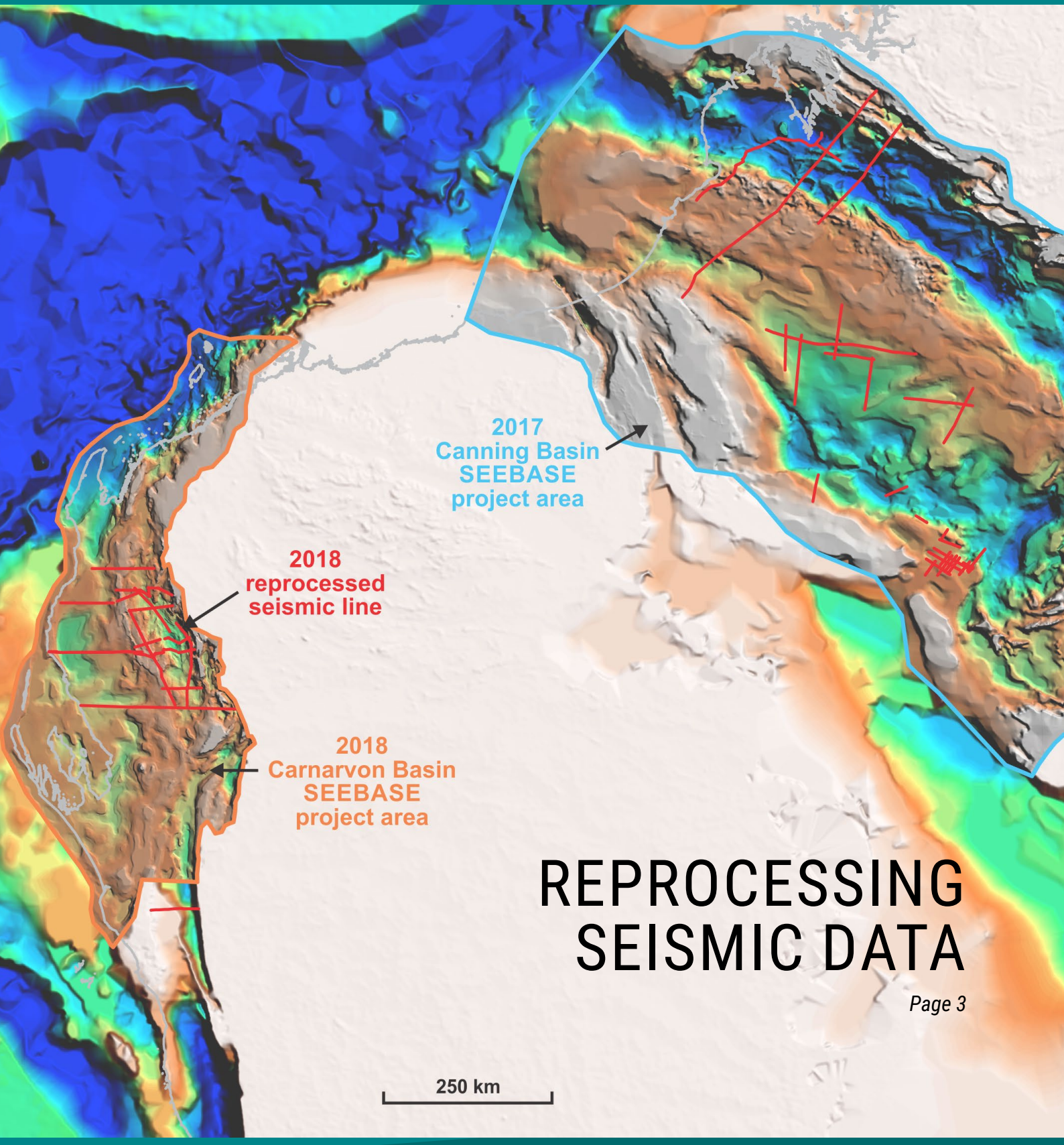
A Geological Survey of Western Australia Newsletter

APRIL 2019 NUMBER 90

Fieldnotes

Government of Western Australia
Department of Mines, Industry Regulation and Safety

www.dmp.wa.gov.au/GSWA



REPROCESSING SEISMIC DATA

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Geological Survey of Western Australia

What's inside

FEATURES

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Fieldnotes

Fieldnotes is a free digital-only quarterly newsletter published by the Geological Survey of Western Australia (GSWA). The newsletter provides regular updates to the State's exploration industry and other geoscientists about GSWA's latest work, programs, products and services.

Access Fieldnotes by:

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- accessing all previous issues from the **eBookshop**.

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GSWA publishes a vast amount of pre-competitive geoscience information on the State, contributing to billions of dollars' worth of resources for exploration and development. To find more information about publications and maps we publish, go to our **website**.

Cover image: Newly reprocessed seismic lines (red) have helped clarify some structures over the Canning and Carnarvon Basins. Seismic reprocessing along with the recent SEEBASE projects for both basins (pictured) were funded by the EIS to aid exploration in the area (see article on page 3)

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Maximizing the potential from reprocessing seismic data

EXPLORATION INCENTIVE SCHEME

A large volume of 2D seismic data in the Canning, Carnarvon and Perth Basins was reprocessed in 2018 and officially released at the GSWA 2019 Open Day on 22 February 2019. The reprocessing projects were funded by the State Government's Exploration Incentive Scheme (EIS).

The Geological Survey of Western Australia (GSWA) is currently reassessing and interpreting the structure and stratigraphy of the onshore Canning, Carnarvon and Perth Basins. However, due to a lack of exploration activities in recent years, these areas are mainly covered by vintage seismic data originally acquired by petroleum exploration companies between the 1960s and 1990s. Most of this data has never been reprocessed and had only been scanned into digital SEG-Y format for interpretation. Their poor-quality data and uncertain seismic datum have resulted in difficulties in interpreting the stratigraphy, basin structures and defining the tectonic boundaries.

Seismic reprocessing of the legacy data is cost effective compared with acquiring new seismic data to fill large data gaps, and has a quick turnaround to provide good-quality data coverage. Therefore, GSWA selected a regional grid of seismic lines to be included in two reprocessing projects to better image the subsurface geology, interpret the structure and stratigraphy, and enhance the understanding of the onshore Western Australian basins. The data selection was based on several criteria, such as availability of raw field data and observational logs, proximity to well constraints, and geological significance.

The seismic lines were selected with a focus on areas where the geology is poorly understood and exploration remains stagnant:

- the Kidson Sub-basin and Munro Arch of the Canning Basin
- the Merlinleigh and Coolcalalaya Sub-basins, and Gascoyne Platform of the onshore southern Carnarvon and far northern Perth Basins.

This reprocessing project comprises 66 individual seismic lines from 11 seismic surveys with a total length of 2852 km in the above basins.

In addition to the legacy petroleum exploration company data, some of the deep crustal seismic profiles acquired by governments in the Canning Basin were also chosen for reprocessing to improve understanding about the basin architecture. This is due to the fact that the original processing was optimized to better image the deeper part of the crust beneath the basin. The lines in this reprocessing project include the Bureau of Mineral Resources (BMR; now Geoscience Australia) Canning Basin 1988, a portion of Canning Coastal 2014 and the northernmost part of the YOM 2011 seismic surveys. The basin-oriented reprocessing project includes five lines totalling 935 km of seismic data from three deep crustal surveys.

The new reprocessing adopted modern techniques and advanced algorithms using a consistent workflow and good quality control. Refraction statics correction and datum correction were applied to the seismic data to compensate for the effects of variations in elevation, weathering thickness and weathering velocity, and to establish reliable ties at line intersections both within and across surveys. With other optimal processing steps such as coherent noise attenuation, reiterative velocity analysis and deconvolution, and various types of migrations, a large portion of the seismic data have shown significant enhancement of quality (Fig. 1) with only a few seismic lines gaining subtle or no improvement. This type of data rejuvenation has a direct impact on the interpretability of the seismic data. For example, faults are now better imaged and the trap configuration (or lack thereof) of key petroleum wells in the southern Carnarvon Basin can now be better assessed; the Munro Arch of the Canning Basin, instead of being an anticlinal 'arch', appears on the new dataset to be an area of transition between the Willara and Kidson Sub-basins.

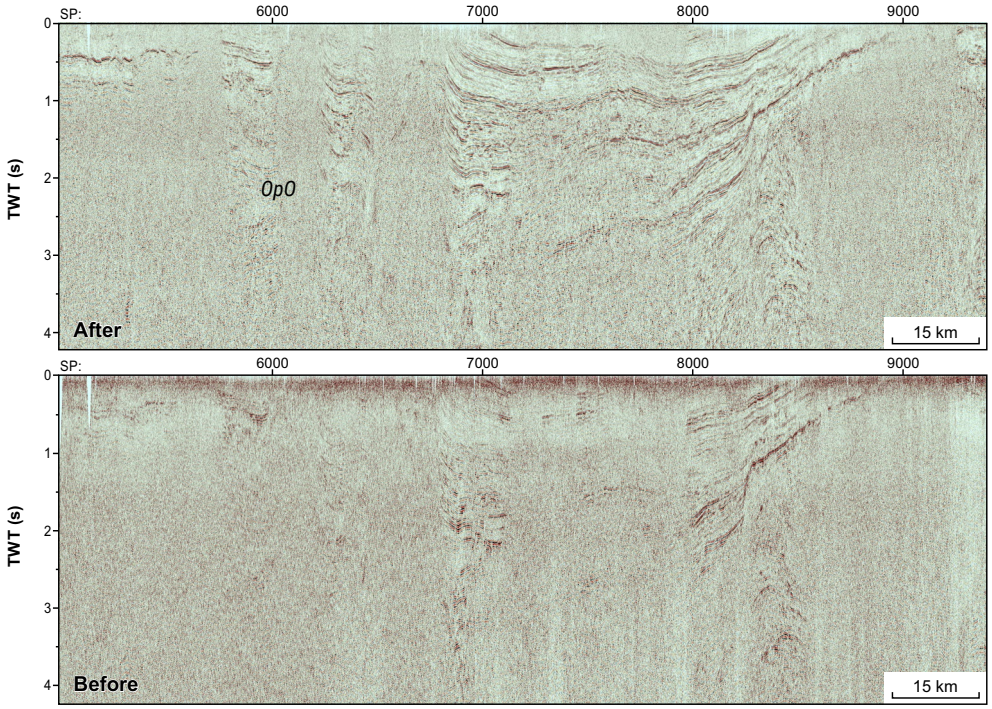


Figure 1. Comparison between original and reprocessed profile of seismic line BMR88-001

The two reprocessing projects for the legacy and deep crustal data were contracted to ION Geophysical Corporation (Cairo) and Velseis Integrated Seismic Technologies (Brisbane), respectively, and managed by Geoscience Australia. External consultants were also employed for the purpose of quality control. The final data are available through GSWA's petroleum database, WAPIMS (https://wapims.dmp.wa.gov.au/wapims), including SEG-Y in time and depth domains, velocity profiles and reprocessing reports.

For more information, contact **Alex Zhan** or **Charmaine Thomas**.

1:500 000 State regolith geology of northern Western Australia

Regolith is the mostly unconsolidated mantle of weathered rock that covers large parts of Western Australia. 'Typically, regolith has been viewed as an impediment to discovering bedrock mineralization but, as it is derived from the physical and chemical weathering of bedrock, the distribution and composition of various types of regolith can be used as pathfinders to bedrock-hosted mineralization. Furthermore, regolith can host mineralization in its own right, including gold, nickel and bauxite' (Marnham and Morris, 2003 *in* A seamless digital regolith map of Western Australia: a potential resource for mineral exploration and environmental management: GSWA, Annual Review).

At GSWA 2019 Open Day, the Geological Survey of Western Australia (GSWA) released a seamless 1:500 000-scale regolith geology of northern Western Australia (Fig. 1). This project is funded by the Western Australian State Government-funded Exploration Incentive Scheme (EIS). The digital layer is a compilation of existing GSWA regolith and surface geology maps. The layer covers the area of Western Australia north of the 25°S parallel, corresponding to about half of the State with the full coverage expected by late 2019. This product supersedes the northern part of the 1:500 000 State regolith map 2003. Whereas the 2003 regolith map was largely a synthesis from 1:250 000 map sources, was partly generated by manual drawing and only used generic regolith codes, this new product incorporates all regolith coverage available at 1:100 000 scale, a revised regolith classification scheme, and was compiled using an automated algorithm for polygon generalization.

The layer is intended to assist government, industry and community in future exploration under cover for mineral, agricultural and groundwater needs as well as understanding the landscape evolution and geomorphology of Western Australia.

Regolith geology from 1:100 000- and 1:250 000-scale maps has been compiled to produce a seamless digital regolith coverage. To produce a compilation readable at 1:500 000 scale, polygon line work had to be modified. The modification included aggregation of clusters of small polygons with the same code into larger shapes, elimination of microfeatures, and simplification of polygon contours using the cellular automata (CA) model of the GeoScaler software plug-in for ArcGIS, developed by the Geological Survey of Canada. Following this step, manual editing was required during edge fitting and topology cleaning to improve the polygon line work to comply with GSWA's cartographic scale standards. Aggregation has been performed on residual/relict and outcrop units only to avoid losing the information on a small cluster or area of those units during the GeoScaler Generalisation. All alluvium units have been preserved during the aggregation process so that no impact is made on the landscape interpretation.

The coding of regolith units in the layer follows GSWA's regolith classification scheme (GSWA, Record 2013/7) with the addition of a suffix representing major physiographic subdivisions across the State (Fig. 3). Earlier maps that did not conform to the current scheme have been recoded accordingly.

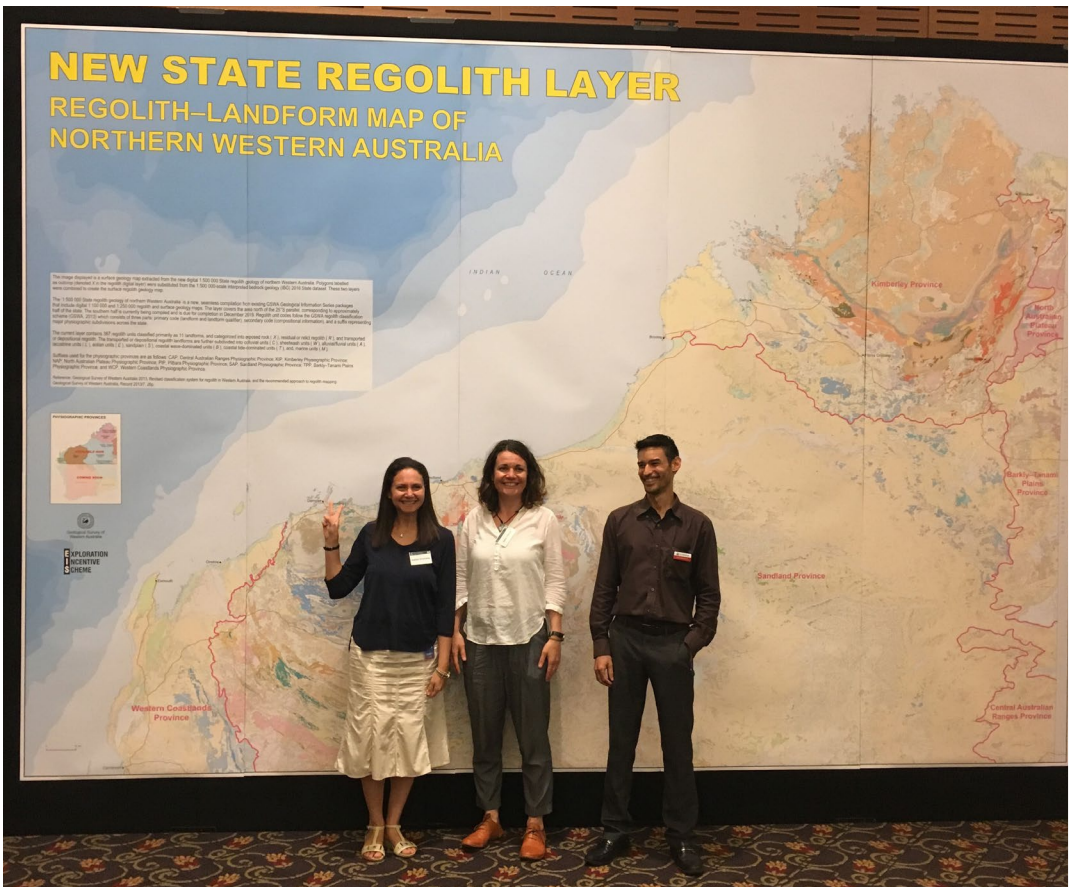


Figure 1. 1:500 000 State regolith geology of northern Western Australia displayed at GSWA 2019 Open Day. From left to right: Isabel Granado, Sara Jakica and Joe Hogen-Esch (team member, Nadir De Souza Kovacs, not present)

In the new 1:500 000 State regolith layer, regolith codes consist of three parts: primary code (landform and landform qualifier), secondary code (compositional information), and physiographic province (major physiographic subdivisions across the State based on Pain et al., 2011 The physiographic regions of Australia — Explanatory notes; Fig. 3). For the scale of this product, tertiary codes (parent rock or cement) were deemed to be too detailed and were therefore rolled up into higher level codes.

State regolith geology

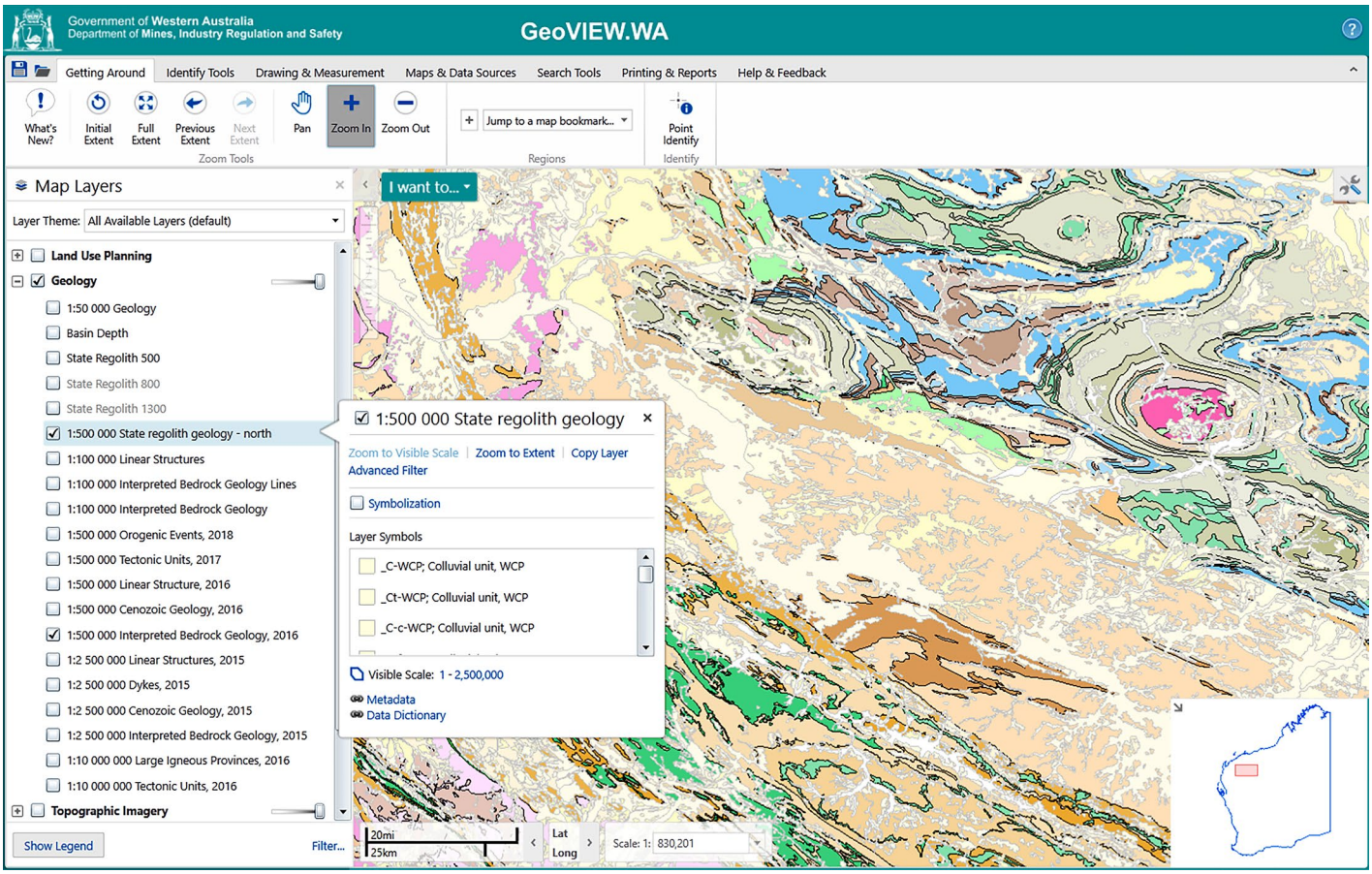


Figure 2. 1:500 000 State regolith layer overlying the 1:500 000 Interpreted Bedrock Geology layer over the central Pilbara as viewed in GeoVIEW.WA

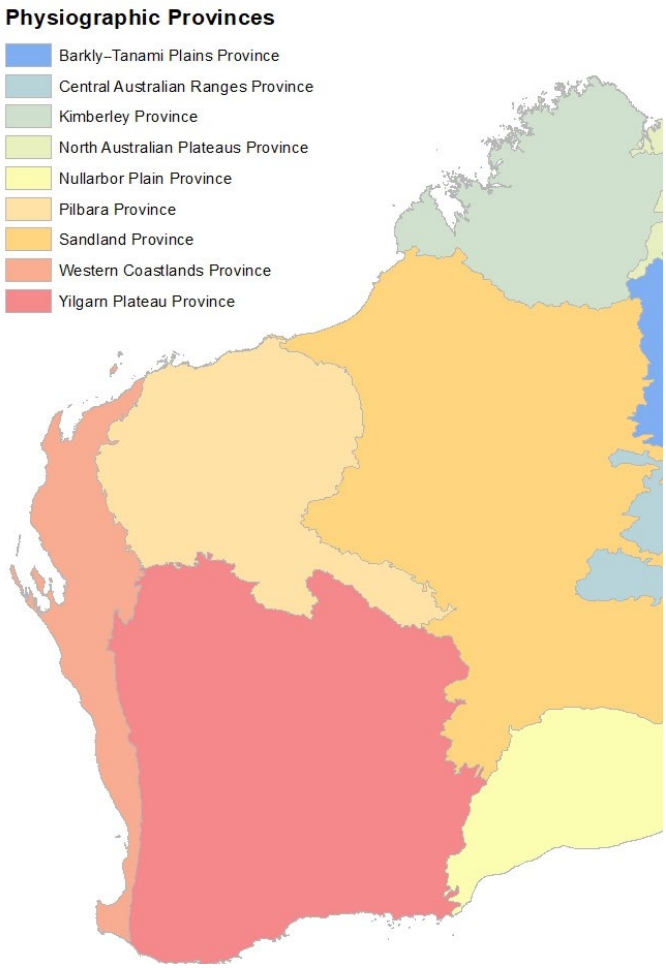


Figure 3. Geomorphological Physiographic Provinces of Western Australia

Regolith units are assigned to eleven landforms. They comprise areas of outcrop (_X, including bedrock and weathered rock), residual or relict material (_R, representing in situ regolith or remnant deposits from an earlier landscape), and nine transported units: _C, colluvium; _W, sheetwash; _A, alluvial/fluvial; _L, lacustrine; _E, eolian; _S, sandplain; _B, coastal (wave-dominated); _T, coastal (tide-dominated); and _M, marine. Suffixes used for the physiographic provinces are as follows: CAP, Central Australian Ranges Physiographic Province; KIP, Kimberley Physiographic Province; NAP, North Australian Plateaus Physiographic Province; PIP, Pilbara Physiographic Province; SAP, Sandland Physiographic Province; TPP, Barkly–Tanami Plains Physiographic Province; and WCP, Western Coastlands Physiographic Province.

Data are held in GDA decimal degrees.

The **1:500 000 State regolith geology of northern Western Australia** layer is available to view and download using GeoVIEW.WA and at the **Data and Software Centre** (Fig. 2). The formats available for downloading are QGIS, MapInfo and ESRI files. This is a dynamic layer and will be updated regularly as we map through the State.

For more information, contact **Sara Jakica**.

How deep does the basin go?

EXPLORATION INCENTIVE SCHEME

Despite the many exploration successes in the offshore Carnarvon Basin, exploration in the onshore portion of the basin is hampered by sparse and generally poor-quality seismic data. Therefore the depth to basement and the structural configuration of the basin are inadequately defined. To help address this, the Geological Survey of Western Australia (GSWA) commissioned Frogtech Geoscience to update its SEEBASE (**S**tructurally **E**nhanced view of **E**conomic **BASE**ment) grid over the Carnarvon Basin within Western Australian State jurisdiction (includes onshore Carnarvon Basin and offshore between the coast and Barrow Island), and to provide an interpretation of underlying basement composition. The resulting Exploration Incentive Scheme (EIS)-funded 2018 Carnarvon Basin SEEBASE provides significant improvement in resolution compared to the previous 2005 OZ SEEBASE version.

The 2018 Carnarvon Basin SEEBASE study was produced using Frogtech Geoscience's unique methodology combining interpretation and modelling of potential field data along with calibration data such as 2D seismic, geological maps and wells. This multidisciplinary approach results in a better understanding of the underlying basement terranes, depth to basement, regional structural geology and basement composition of the Carnarvon Basin within the study's area of interest (Fig. 1).

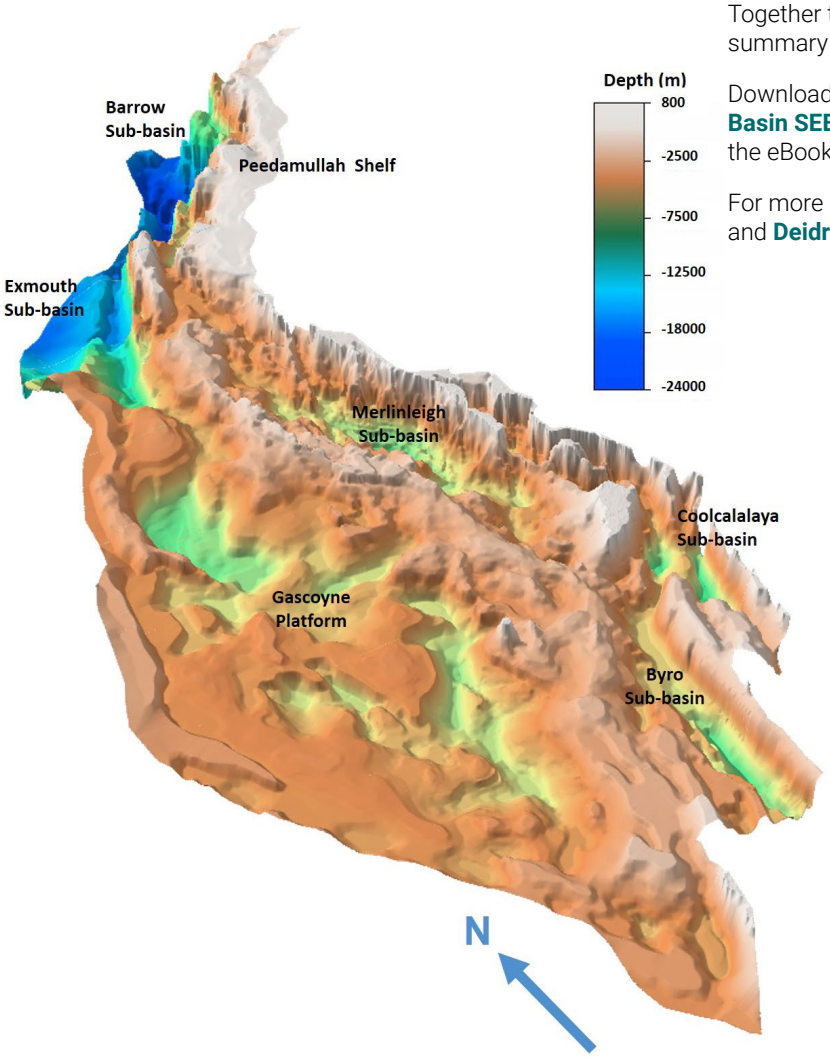


Figure 1. View looking northeast over 3D surface of depth to basement beneath the Carnarvon Basin

This integration has proven powerful and has illustrated the strong basement control on the distribution and location of basin elements. For example, Permo-Carboniferous rift development of the basin was controlled by the reactivation of terrane boundaries, major basement fabric and/or rheologically weaker terranes. Basement structures of the Capricorn Orogen reactivated during the Kuunga Orogeny strongly influenced the localization of the Merlinleigh Sub-basin as well as the Byro and Coolcalalaya Sub-basins. Compartmentalization within the sub-basins and development of en echelon depocentres is also strongly controlled by north–south basement structures of the Capricorn Orogen and the Pilbara Craton. A deep, narrow and localized trough strongly reflects the rheologically weak basement of the underlying North West Shelf accretion complex which formed during collision between the Pilbara Craton and an unknown terrane during the Paleoproterozoic.

All the data and structural interpretations have been compiled into an integrated ArcGIS project containing: SEEBASE grid, sediment thickness grid, processed and filtered gravity and aeromagnetic grids, crustal thickness grid, depth to Moho grid, stretching factor map, basement thickness grid, interpreted basement terrane and basement composition maps. The processing workflow and enhancements of datasets are documented in the Report and accompanying appendices. Together the Report and ArcGIS project provide an excellent summary of the key features within the Carnarvon Basin.

Download a free PDF of **GSWA Report 191 2018 Carnarvon Basin SEEBASE Study and GIS** by Frogtech Geoscience from the eBookshop.

For more information, contact **Charmaine Thomas** and **Deidre Brooks**.

Regional seismic interpretation and structure of the southern Perth Basin

The southern Perth Basin represents the southernmost extent of the Gondwanan interior rift in Western Australia, and now forms part of the passive margin of Australia. It contains proven petroleum systems that have yet to be developed. Although exploration began in the 1960s, patchy seismic survey coverage and poor seismic data quality have obscured stratal geometries and many aspects of the major structures. Prior to this project, the most recent subsurface maps based on original interpretation of both onshore and offshore seismic data were produced more than 25 years ago; newly acquired and reprocessed seismic data and new well and drillhole data warranted a fresh interpretation of this part of the basin. The southern Perth Basin is an informal name taken here to be that part of the Perth Basin south of metropolitan Perth including the southern part of the offshore Vlaming Sub-basin.

Geological Survey of Western Australia (GSWA) **Report 184** presents a new seismic interpretation of the basin that is tied to revised well formation tops constrained by palynology. Newly reprocessed legacy seismic data and recent seismic data acquisition have helped image the deepest depocentres of the basin, and have resulted in identification and confirmation of the tectonic events that shaped the basin.

The southern Perth Basin saw almost uninterrupted sedimentation from at least the early Permian (or possibly earlier) until Early Cretaceous breakup. Three sedimentary intervals, in particular, show growth and thickening into the major faults, suggesting at least three phases of extension: pre-Permian or earliest Permian extension, Late Triassic to Early Jurassic extension, and Late Jurassic to Early Cretaceous rifting. The Darling, Busselton, Dunsborough and Badaminna Faults all played significant roles during basin tectonism. Late Jurassic to Early Cretaceous oblique rifting saw intense basinwide normal faulting, rapid subsidence and localized contractional structures along major faults. This led to extrusion of the Bunbury Basalt and continental breakup between the Australia–Antarctic continent and Greater India.

The subsurface depth maps (Fig. 1) created from this project will provide a starting point for future exploration activity for hydrocarbons and/or groundwater. They will also inform the location of any future geoscientific studies including seismic surveys or stratigraphic drilling.

Download a free PDF of **GSWA Report 184 Regional seismic interpretation and structure of the southern Perth Basin** by CM Thomas from the eBookshop.

For more information, contact **Charmaine Thomas**.

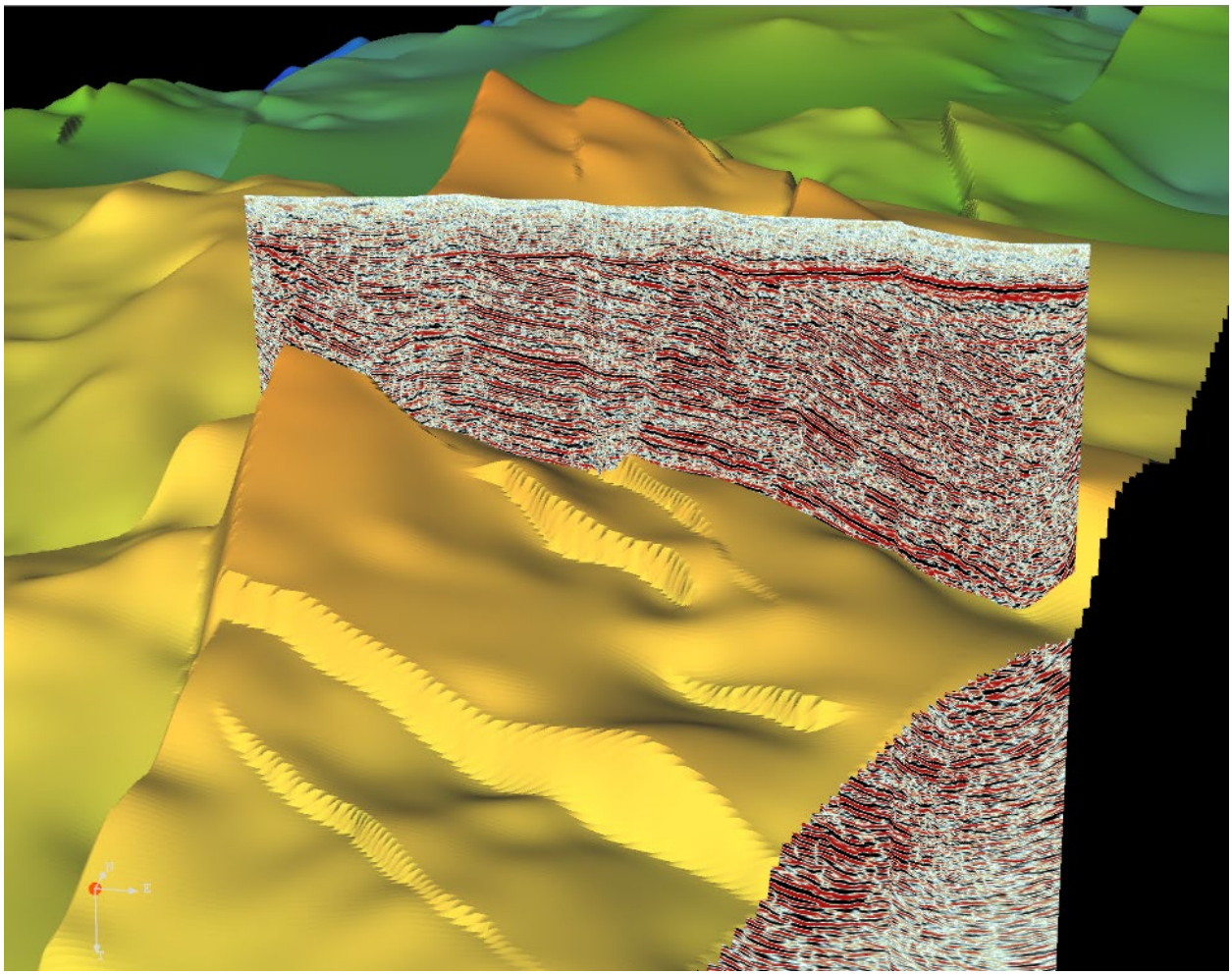


Figure 1. 3D surface of Top Wonnerup Member looking northwest over the crest of the Harvey Ridge

Petroleum geochemistry of the Perth Basin

Recent discoveries in the northern Perth Basin have revived interest in petroleum exploration and supplied the impetus to reassess the hydrocarbon source rocks within the basin. The discoveries include a new Permian gas–condensate play at Waitsia and a new Triassic shale-play in Arrowsmith 2. Volumetric assessments by the US Energy Information Administration have estimated that up to 25 trillion cubic feet (Tcf) of gas and up to 8 Tcf of gas with 500 million barrels of oil/condensate could be present within the Permian and the Triassic sedimentary successions, respectively.

GSWA Report 188 released in December 2018 contains interpretation and modelling of the petroleum geochemistry, organic petrology, apatite fission track analysis, heat flow, subsurface temperature, and other exploration data from the onshore Perth Basin. Previous geochemical studies indicate that the condensate from Whicher Range 1 has a Permian source; oil and gas–condensate from the Cliff Head, Dongara, Eremia, Hovea, Jingemia, Mondarra, Mount Horner, North Erregulla, Woodada and Yardarino fields are derived from Triassic source rocks; oil and gas–condensate from Gingin 1 and Walyering 1 and 2 are from a Jurassic source; and the oil from Gage Roads 1 is sourced from a Jurassic–Cretaceous source (Fig. 1). Thermal and burial history modelling of the 60 wells that contain Total Organic Carbon and Rock-Eval data shows variations in the timing of petroleum generation and accumulation across the basin from the different hydrocarbon source rocks.

The onshore northern Perth Basin is the prime petroleum province of the Perth Basin, which is rich in hydrocarbon resources. The current petroleum-producing reservoirs of the basin are depleting rapidly. The new petroleum plays have the potential to compensate but are presently only at the initial stages of exploration. The compilation of geochemical and temperature data presented in this Report provide a starting point for future exploration of new plays within the northern Perth Basin.

Download a free PDF of **GSWA Report 188 Petroleum geochemistry and petroleum systems modelling of the Perth Basin, Western Australia** by KAR Ghori from the **eBookshop**.

For more information, contact **Ameed Ghori**.

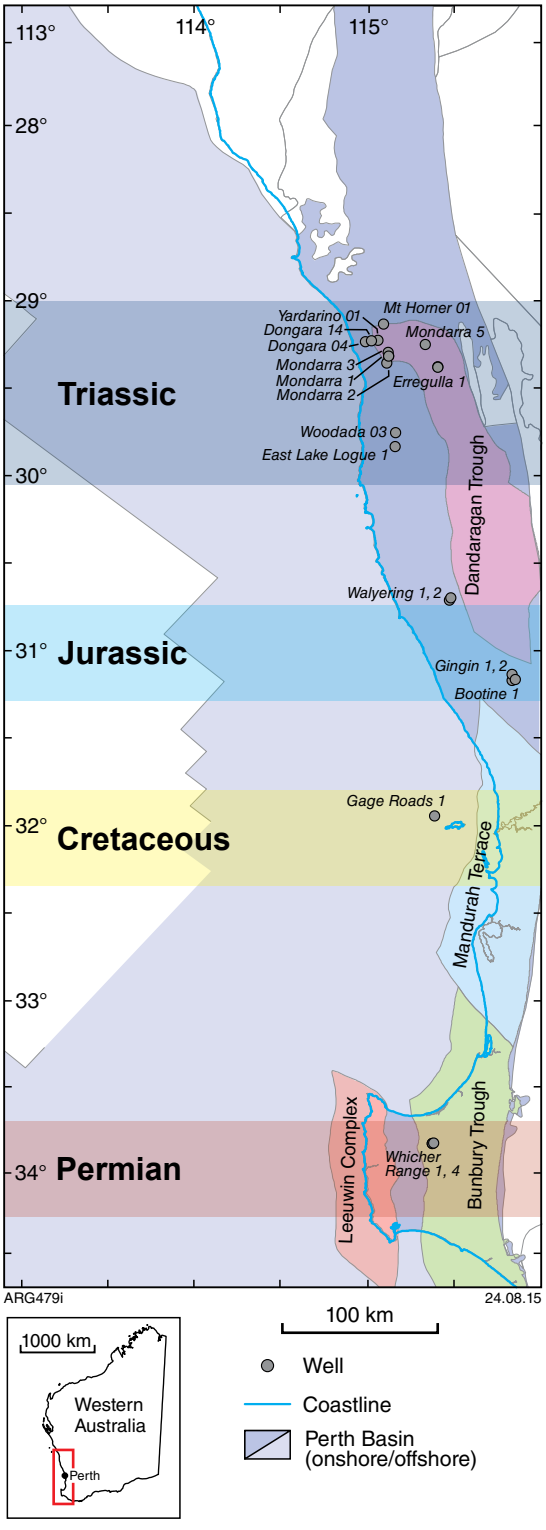
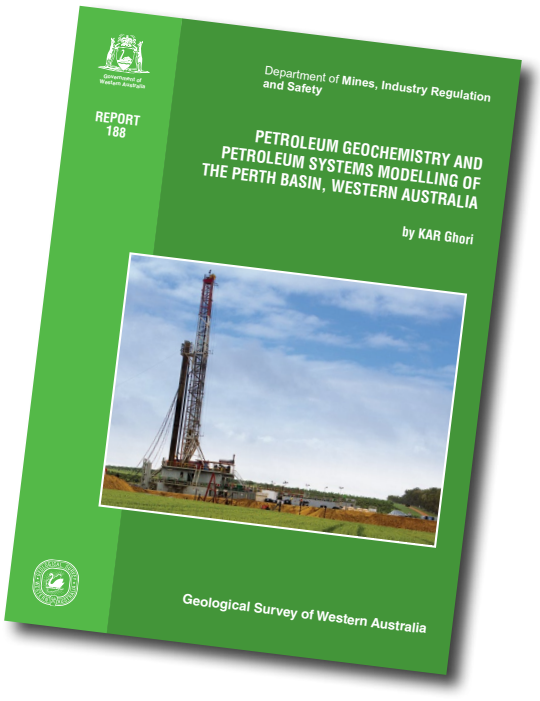


Figure 1. Perth Basin map showing selected discoveries and age of their source rocks



A dynamic approach to the delivery of mineral exploration data

EXPLORATION INCENTIVE SCHEME

The Mineral Systems Atlas is a new online, map-based product that delivers geoscience data tailored specifically for immediate use by mineral explorers in Western Australia for prospectivity or targeting studies (Fig. 1). A mineral systems approach has been used to identify the critical geological processes that form and preserve mineral deposits, and the potentially mappable geological features that indicate the occurrence of these processes. The Atlas is the collection of geological proxy maps for each featured mineral system. Map layers are created using queries that extract relevant data from primary Geological Survey of Western Australia (GSWA) geoscience databases, thereby ensuring that these layers can be automatically and seamlessly updated whenever new data are added to primary databases.

An important element of the Mineral Systems Atlas is the online Guide, which documents all aspects of the creation of the Atlas, including relationships between primary and derived data (Fig. 2). The Guide provides descriptions of current metallogenic models, of mappable geological proxies, and procedures used to generate these layers.

Development and implementation of the Mineral Systems Atlas was made possible with significant funding from the State Government's Exploration Incentive Scheme. The Atlas was officially released at the GSWA 2019 Open Day on 22 February, and presently contains map layers and supporting documentation for the komatiite-hosted Ni sulfide (Fig. 1) and enriched iron-formation mineral systems. The modular and hierarchical design of the online platform and user guide will permit the addition of new mineral systems and new geological proxy layers as they become available. Ongoing efforts will focus on expanding Atlas content to include all major mineral systems and commodity groups in Western Australia.

To access the Mineral Systems Atlas go to **www.dmp.wa.gov.au/MineralSystemsAtlas.**

For more information, contact the **Mineral Systems Atlas Team**.

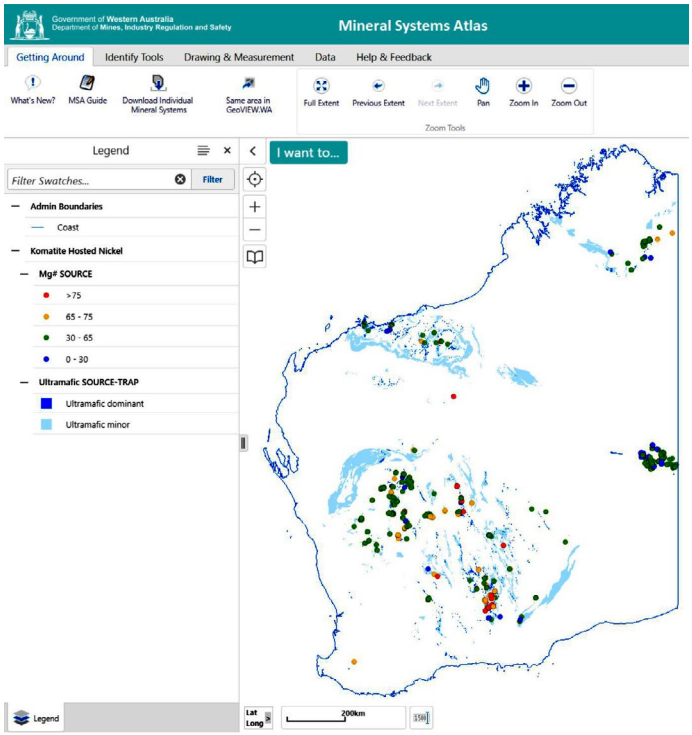


*Figure 1. Screenshot of the Mineral Systems Atlas portal, showing two 'geological proxy' layers for the komatiite-hosted nickel mineral system – ultramafic-bearing rock units (shown in shades of blue), and 'Mg number' calculated from whole-rock geochemistry of ultramafic rock samples (where Mg# = 100 * (MgO% / (MgO% + Fe_2O_3T%)). Both map layers indicate spatial favourability for appropriate magma and metal SOURCE)*

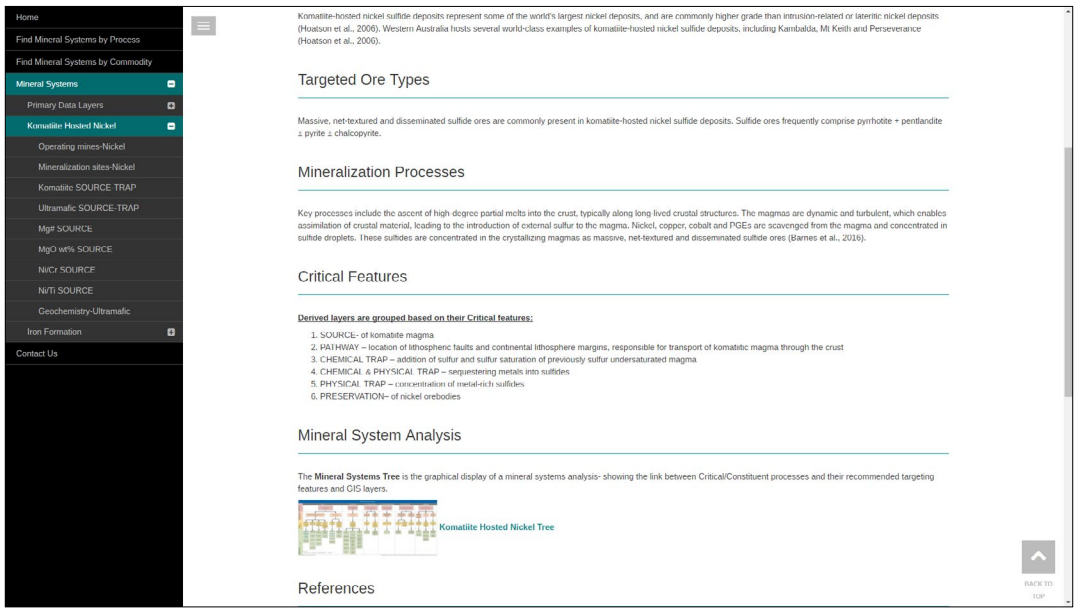


Figure 2. Screenshot of the Mineral Systems Atlas Guide showing the komatiite-hosted nickel system. The online guide complements the GIS platform by describing the derived data layers, explaining the reasoning behind their inclusion in the mineral system, and documenting their creation via an SQL query of GSWA primary databases

Eastern Goldfields high-resolution seismic traverses

EXPLORATION INCENTIVE SCHEME

The Geological Survey of Western Australia (GSWA) Exploration Incentive Scheme-funded Eastern Goldfields seismic survey is underway. Velseis Integrated Seismic Technologies, contracted after a public tender process, began recording data on 13 March 2019, with fieldwork scheduled for completion by the middle of April 2019.

Data are being acquired along an aggregate 300 km in seven traverses on established roads and tracks in the area between Ora Banda and Kambalda (Fig. 1). The acquisition program follows a comprehensive planning and stakeholder liaison phase undertaken between July and December 2018.

A single AHV-IV 380 Renegade 80 000 lb peak force Vibroseis unit (Fig. 2) provides the seismic source at 20 m-spaced vibration points, shooting into a ± 6000 m spread of 10 m-spaced receivers (Fig. 3) to provide nominal full-fold of 300. Table 1 is a list of the acquisition equipment and parameters. The target depth of interest is from 300–5000 m although the 5 second 'listen time' is likely to provide data to greater (nominal) depths.

GSWA will release final data products as soon as practicable after acquisition and processing is complete.

Figure 2. AHV-IV 380 Renegade Vibroseis truck on line during survey

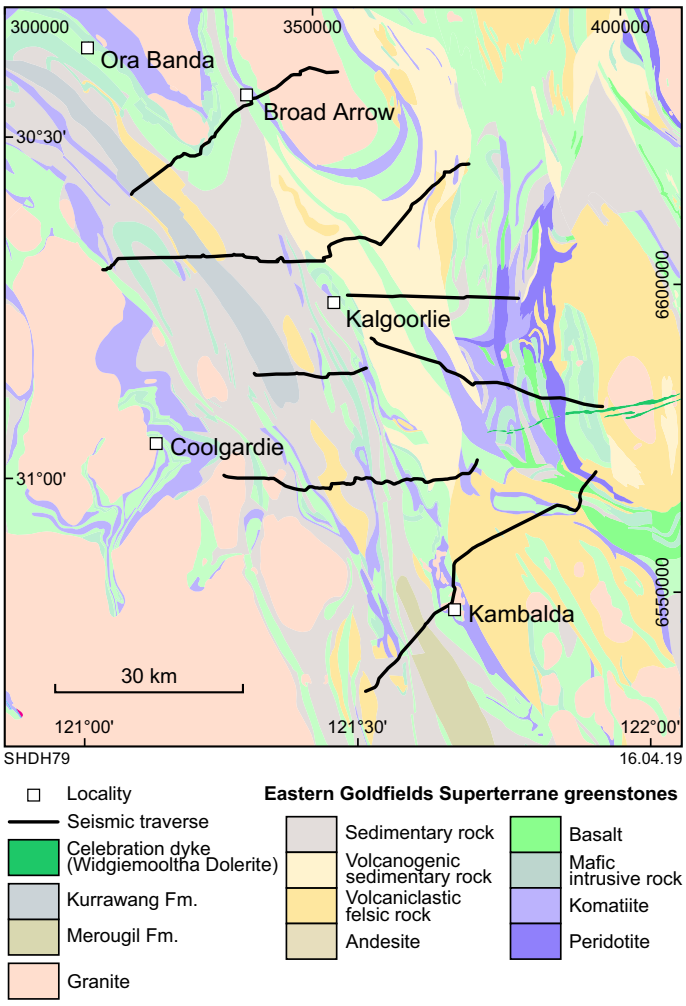


Figure 1. Location of seismic traverses on a 1:500 000 geological map

Figure 3. Geophone receiver group in spread along road verge

Table 1. Acquisition parameters

Instrumentation details	
Recording system	Sercel 428XL acquisition system
Number of channels	1200 live channels, 3000 working channels
Tape format	SEGD, 8058 IEEE demultiplexed, hard disk
Filters	Hi-cut 200Hz; Lo-cut N/A
Sample rate	2 ms
Correlated record length	5 s
Real-time correlation	Yes
Correlation type	Zero Phase, After sum
Source details – Vibroseis	
Vibrator type	2 x AHV-IV 380 Renegade 80 000 lb peak force (1 on line + 1 spare)
Electronics	Sercel 464 DSD, DPG in recorder
Sweep frequency	8–110 Hz
Sweep length	15 s + 5 s listen
Sweep function	Linear upsweep
Number of sweeps	1 standing
VP interval	20 m
Source array	1 in line
Phase locking type	Ground Force using M51 HP accelerometers
Amplitude control	Peak to peak
Sweep amplitude taper	300 ms
Drive level	70% subject to out of spec distortion
Receiver details	
Group interval	10 m
Geophones	Sensor RTC 10 Hz
Spread	5995 m — 5 m — 0–5 m — 5995 m
Phones per string	3 phones in line 2 m spacing, centred on station

These high-resolution 2D seismic data will complement GSWA's 100 m line spacing Eastern Goldfields aeromagnetic surveys, the regional 2.5 km-spaced gravity surveys, and the existing Geoscience Australia deep 2D seismic traverses. As well as delineating areas that might be suitable for more detailed 3D seismic exploration surveys, we expect that interpretation of the data integrated with GSWA's field mapping, and recent passive seismic and magnetotelluric survey projects, will provide a substantially improved understanding of the geological framework in this region.

For more information, contact **David Howard**.

Kidson Sub-basin seismic survey

EIS EXPLORATION INCENTIVE SCHEME

The acquisition of a deep crustal seismic reflection survey across the Kidson Sub-basin of the Canning Basin has been completed with a total length of 872 km in northern Western Australia (notably the longest single continuous onshore seismic line in Australia). The survey was conducted from June to August 2018 from about 30 km west of the Kiwirrkurra community to approximately 20 km east of Marble Bar. The collaborative project between GSWA and Geoscience Australia is co-funded by the WA State Government's Exploration Incentive Scheme (EIS) and the Commonwealth-funded Exploring for the Future (EFTF). The data processing is currently under way and the final seismic data will be formally released at the APPEA Conference in May 2019.

For more information, contact **Alex Zhan**.

Product releases

FREE DATABASE AND ONLNE SYSTEMS TRAINING — 2019

Learn how to access geoscience data online and understand the department's systems at these FREE training sessions.

Topics include:

- navigating the department's website
- searching for geoscience publications using the eBookshop
- finding digital datasets using the Data and Software Centre
- searching for open-file mineral exploration reports using WAMEX
- searching the mineral drillholes and geochemistry databases
- using the interactive map viewers, GeoVIEW.WA and TENGRAPH Web
- GeoMap.WA, a standalone GIS viewer for Windows

A desktop computer will be available for each participant.

PERTH

The Perth training has been divided into separate sessions: one for **advanced** (morning), and one for **beginners** (afternoon).

- **Wednesday 18 July**
- **Thursday 21 November**

KALGOORLIE

The Kalgoorlie training is open to **anyone** (full day).

- **Thursday 28 November (on the same day as GSWA Kalgoorlie Open Day)**

Register

When you **register** online, include your details (name, company name, telephone number), with the name, location and date of the training you wish to attend.

For the Perth sessions, please indicate whether you wish to attend the advanced (morning) or beginners (afternoon) training. See the training page on our website.

WA Petroleum Day

Friday 13 September

Hyatt Hotel, East Perth

As Western Australia's regulator for the resources sector, DMIRS holds the annual WA Petroleum Day to update industry on the latest news around policy, legislation and trends.

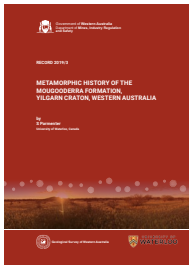
More information to follow.

• RECORDS •

Record 2018/12 Capricorn Orogen rutile study: a combined electron backscatter diffraction (EBSD) and laser ablation split stream (LASS) analytical approach
(with accompanying zip file containing appendix tables)
by Plavsa, D, Reddy, S, Clark, C and Agangi, A

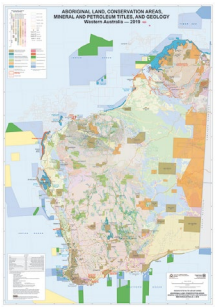
Record 2019/2 GSWA 2019 extended abstracts: advancing the prospectivity of Western Australia

Record 2019/3 Metamorphic history of the Mougooderra Formation, Yilgarn Craton, Western Australia
by Parmenter, S



• MAP •

Aboriginal land, conservation areas, mineral and petroleum titles and geology, Western Australia — 2019
by Ridge, KJ

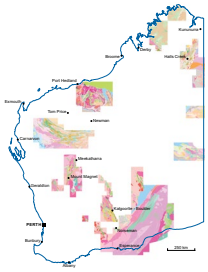


• DATA PACKAGE •

2018 Carnarvon Basin SEEBASE Study and GIS
by Frogtech Geoscience

1:100 000 intepreted bedrock geology of Western Australia
by Geological Survey of Western Australia

Meteorite impact structures of Western Australia 2018, Virtual Tour
by SC Goss



1:100 000 interpreted bedrock geology of Western Australia

Interpreted bedrock geology at 1:100 000 scale has been constructed as a digital map mosaic over Western Australia with partial to full coverage for the following regions:

- Pilbara
- Kimberley
- Tanami
- Western Capricorn
- West Arunta
- Murchison
- East Yilgarn
- West Musgrave
- East Albany–Fraser Orogen

The interpreted bedrock geology underpins, or is extracted from, published 1:100 000 Geological Series maps and Geological Information Series digital packages. This is a statewide compilation of all available 1:100 000-scale interpreted bedrock geology*. The coverage will be updated incrementally as new mapping and bedrock geology interpretation at 1:100 000 scale are completed.

The 1:100 000 interpreted bedrock geology is a set of intelligent spatial layers, rather than a single map, comprising:

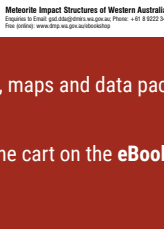
- interpreted bedrock geology (polygons)
- interpreted bedrock geology lines (e.g. BIF, quartz veins, dolerite dykes)
- interpreted linear structures (e.g. faults and folds)

The nomenclature and hierarchy for the lithostratigraphic units in the polygon and line layers are based on weekly updates from the Explanatory Notes System (ENS).

Note: *First release of the data in this format was June 2019. The spatial data are updated approximately every six months.

Download from: <www.dmp.wa.gov.au/infocentre>

1:100 000 interpreted bedrock geology of Western Australia
Enquiries to Email: gsd.dda@dmirs.wa.gov.au; Phone: +61 8 9222 3459; Fax: +61 8 9222 3444
Explore online at <www.dmp.wa.gov.au/geoview>.



Meteorite Impact Structures of Western Australia

A virtual tour of Western Australian meteorite impact structures

This product is a virtual tour and the placemarks at each Impact Structure have been positioned on-screen for viewing purposes only.

To make full use all of the features of the tour, this excursion should be run on Google Earth Pro.

Please note that removal of meteorite material from these sites is prohibited under Section 45 of the Museum Act (1969 as amended in 1973). All meteorite material found in Western Australia remains the property of the State.

REFERENCE

The recommended reference for this publication is:

Goss, SC, 2019, Meteorite Impact Structures of Western Australia: Geological Survey of Western Australia, digital data product.
Compiled by TR Farrell

Locations mentioned in the text refer to the Geocentric Datum of Australia 1994 (GDA94)

Disclaimer

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Meteorite Impact Structures of Western Australia – A virtual tour of Western Australian meteorite impact structures
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Free (online): www.dmp.wa.gov.au/ebookshop

The Geological Survey of Western Australia (GSWA) has released almost 6500 geological products including books, maps and data packages. These can be found on our **website**.

Maps, USB data packages, and selected premium publications are available to purchase as hard copies via the online cart on the **eBookshop**. Alternatively, these products can be purchased from the Information Centre, First Floor, Mineral House, 100 Plain Street, East Perth, WA 6004, Australia, Phone: +61 8 9222 3459; Fax: +61 8 9222 3444.

Records, Reports, Bulletins and non-series books cannot be purchased in hard copy but are all available as PDFs to view, and as a free download.