

Fieldnotes



Government of Western Australia
Department of Mines and Petroleum

Geological Survey of
Western Australia



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Successful applicants for Round 11 Co-funded Drilling

The government is continuing to support the quest for new resource discoveries across Western Australia through the latest round of the Exploration Incentive Scheme (EIS) Co-funded Exploration Drilling Program.



GENERAL

- | | |
|--|-------------------------------------|
| 1 Altia Resources Pty Ltd | 20 Impact Minerals Ltd |
| 2 Apollo Minerals Ltd | 21 Independence Group |
| 3 Aruma Resources | 22 John Williams |
| 4 Black Raven Mining Pty Ltd | 23 Marindi Metals Pty Ltd |
| 5 Boadicea Resources Ltd | 24 Matsa Resources Ltd |
| 6 Buxton Resources Ltd | 25 MDR Thomson Pty Ltd |
| 7 Cassini Resources Ltd | 26 Ming Gold Ltd |
| 8 Cauldron Energy Pty Ltd | 27 Minotaur Gold Solutions |
| 9 Cazaly Resources Ltd | 28 Northern Minerals Ltd |
| 10 Cullen Resources Ltd | 29 Northern Star Resources |
| 11 Douglas Kennedy and Leonard Haworth | 30 Octagonal Resources (WA) Pty Ltd |
| 12 Echo Resources Ltd | 31 Pioneer Resources Ltd |
| 13 Encounter Resources | 32 Poseidon Nickel Ltd |
| 14 Encounter Resources | 33 Quadrio Resources |
| 15 Fortescue Metals Group Ltd | 34 Salt Lake Mining Pty Ltd |
| 16 FQM Exploration (Australia) Pty Ltd | 35 Sol Jar Property Pty Ltd |
| 17 Geocrystal Ltd | 36 White Cliff Minerals Ltd |
| 18 Golden Eagle Mining Ltd | 37 Windward Resources |
| 19 Hastings Rare Metals | |

PROSPECTORS

- 38 David Woodiwiss
39 Derwyn Isobel Parker
40 John Brady
41 Michael Morawa
42 Peter Kerley
43 Roxbury Trading Pty Ltd
44 Steve Argus

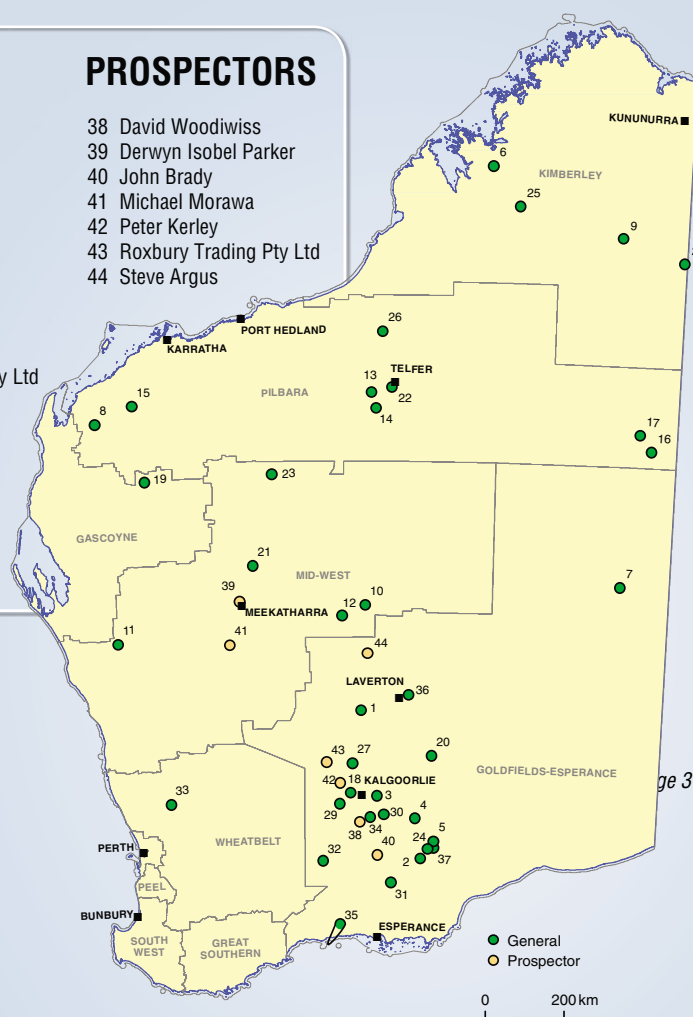


Figure 1. Locations of successful projects for Round 11

The Minister for Mines and Petroleum, Bill Marmion, announced the 44 successful Round 11 projects to be drilled in 2015–16 at the opening of the 2015 Association of Mining & Exploration Companies (AMEC) Conference, saying the Scheme was helping to underwrite Western Australia's continued prosperity.

The EIS is an important investment in the State's future, particularly in the challenging financial environment faced by exploration companies.

Now in its seventh year, this highly competitive drilling program has resulted in major discoveries, with more being made every year.

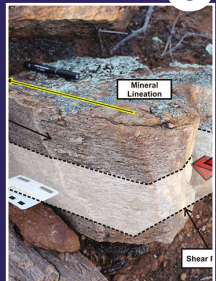
The successful projects are chosen via a transparent process which is subject to ongoing probity audits and ratified by a

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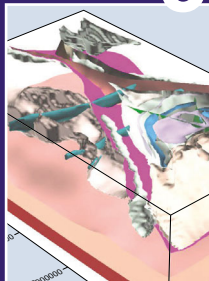
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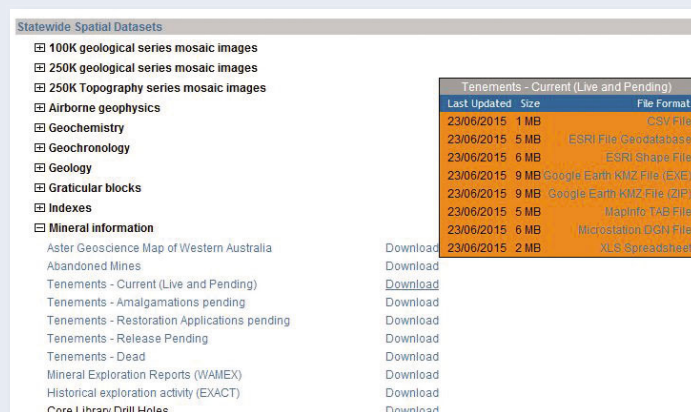


Download free datasets

The Data and Software Centre provides **free** download of a large number of statewide geology and resource datasets in various formats for use in geographic information system (GIS) applications. Data types include both vector and imagery data.

Key datasets include:

- 1:250 000 and 1:100 000 Geological Series mosaic images
- 1:250 000 topography series mosaic images
- Geochemistry
- 1:100 000 and 1:250 000 Geological Series maps in vector format
- Airborne geophysics images
- Mineral information including tenements and MINEDEX



The screenshot shows the 'Statewide Spatial Datasets' page. On the left is a tree view of dataset categories. On the right is a table titled 'Tenements - Current (Live and Pending)'.

Statewide Spatial Datasets			
100K geological series mosaic images			
250K geological series mosaic images			
250K Topography series mosaic images			
Airborne geophysics			
Geochemistry			
Geochronology			
Geology			
Graticular blocks			
Indexes			
Mineral information			
<hr/>			
Aster Geoscience Map of Western Australia	Download		
Abandoned Mines	Download		
Tenements - Current (Live and Pending)	Download		
Tenements - Amalgamations pending	Download		
Tenements - Restoration Applications pending	Download		
Tenements - Release Pending	Download		
Tenements - Dead	Download		
Mineral Exploration Reports (WAMEX)	Download		
Historical exploration activity (EXACT)	Download		
Core Library Drill Holes	Download		


Tenements - Current (Live and Pending)			
Last Updated	Size		File Format
23/06/2015	1 MB		CSV File
23/06/2015	5 MB		ESRI File Geodatabase
23/06/2015	6 MB		ESRI Shape File
23/06/2015	9 MB		Google Earth KMZ File (EXE)
23/06/2015	9 MB		Google Earth KMZ File (ZIP)
23/06/2015	5 MB		MapInfo TAB File
23/06/2015	6 MB		Microstation DGN File
23/06/2015	2 MB		XLS Spreadsheet

Figure 1. Statewide spatial datasets from the Data and Software Centre

- Petroleum information including wells
- Special category lands including file notation areas.

Many of these data are updated overnight. Use the 'last updated' date (see Fig. 1) to determine the currency of the dataset. To view a dataset's metadata, click on the dataset name.

How to download

1. To open a category, click on the plus sign 
2. To download a dataset, click on the 'Download' link and select a data format (see Fig. 1)
3. Accept the licence agreement then 'save as' to a folder on your computer. The dataset is downloaded as a compressed file for transfer. It must be uncompressed before using in your GIS application.

Software

The Data and Software Centre also provides **free** download of GeoMap.WA (GIS) and Mineral Exploration Reporting template (MRT) software plus a number of user manuals and training videos. Go to <www.dmp.wa.gov.au/datacentre>.

For more information, contact
Neville D'Antoine (neville.d'antoine@dmp.wa.gov.au).

An easy tour of the Pilbara — from your armchair

In August 2009 the Geological Survey of Western Australia (GSWA) published a popular geology guidebook **Discovery trails to early Earth — a traveller's guide to the east Pilbara of Western Australia**. The book was launched in Marble Bar.

This is a lavishly illustrated roadside guidebook brimming with colour photos of landscapes and rocks, and tantalizing tidbits of information for the inquisitive traveller. Six discovery trails centred on Marble Bar in the Pilbara cross a land more than 3500 million years old. These trails take you on journeys to view ancient volcanoes, the famed 'Marble Bar', see traces of early life on Earth, and find reminders of glaciation gouged into the rocks.

A spin-off from the guidebook is a virtual tour using Google Earth. GSWA prepared the KMZ files for each of the trails that are now live on the Department of Mines and Petroleum website.

What can you do?

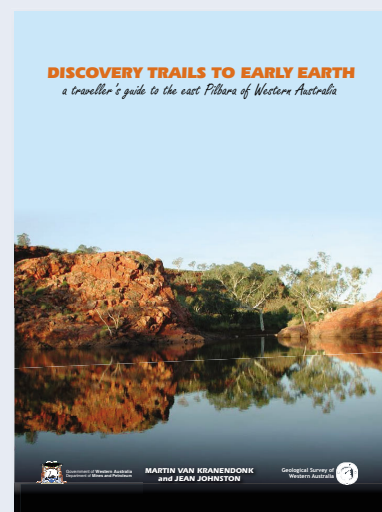
- Go to the GeoTourism section of the DMP website at <www.dmp.wa.gov.au/geotourism>.
- Go to 'Download a virtual tour' link and save the KMZ file to your computer.
- Double click the KMZ file to load it into Google Earth (which must be installed on your computer) and the GSWA Pilbara-Trails.kmz appears in ▼Places.
- Activate the trail by ✓GSWA PilbaraTrails.kmz or Play tour.

You can now take a virtual tour or look at individual stops along the six drive trails.

Relax at home and let Google Earth transport you to the Pilbara to view each stop along the six numbered trails across this ancient land; for instance, Stop 6.13 Granite tors, is stop 13 along trail 6, which runs along the Hillside Track for 140 km and has 13 stopping points.

Purchase **Discovery trails to early Earth — a traveller's guide to the east Pilbara of Western Australia** from GSWA's online bookshop or send an email to bookshop@dmp.wa.gov.au to order a hardcopy for \$25 (plus postage). Order 10 or more copies to receive a special discount price of \$14.85 each.

For more information, contact
Jean Johnston (jean.johnston@dmp.wa.gov.au).



continued from page 1

	Applicant Name	Drilling Project Title	Target Commodities
1	Altia Resources Pty Ltd	Valdez prospect	Ni, Cu, PGE
2	Apollo Minerals Ltd	Oceanus Drilling Project	Ni, Cu, PGE
3	Aruma Resources	Glandore Deep Hole	Au
4	Black Raven Mining Pty Ltd	Erayinia King North VTEM	Zn, Cu, Au
5	Boadicea Resources Ltd	Symons Hill Nickel EM Target	Ni, Cu, Co
6	Buxton Resources Ltd	Double Magic	Ni, Cu
7	Cassini Resources Ltd	Succoth Prospect – West Musgrave	Ni, Cu, PGE
8	Cauldron Energy Pty Ltd	Yanrey Regional Uranium Project	U
9	Cazaly Resources Ltd	Mt Angelo North Conductor 1	Cu, Zn, Pb, Ag, Au
10	Cullen Resources Ltd	Mt Eureka – Southern Gold Prospect	Au
11	Douglas Kennedy & Leonard Haworth	Yallalong Antimony	Sb
12	Echo Resources Ltd	Gladius Targets	Au
13	Encounter Resources	Throssell	Au, Ag, Cu, Co, Pb, Zn
14	Encounter Resources	Yeneena Geochemical Vectors	Au, Ag, Cu, Co, Pb, Zn
15	Fortescue Metals Group Ltd	Trifecta Base Metals Project	Pb, Zn, Cu, Ag, Au
16	FQM Exploration (Australia) Pty Ltd	Kiwi Copper Project	Cu
17	Geocrystal Ltd	Webb Diamonds	Diamonds
18	Golden Eagle Mining Ltd	Bullabulling Shear	Au, Ni
19	Hastings Rare Metals	Yangibana Carbonatite Exploration	Rare Earths
20	Impact Minerals Ltd	Mulga Tank	Ni, Cu, Au, PGE
21	Independence Group	Bryah Basin	Cu, Au Pb, Zn, Ag
22	John Williams	Hasties East Prospect	Au, Cu
23	Marindi Metals Pty Ltd	Anomaly B	Cu, Pb, Zn, Ag, Au
24	Matsa Resources Ltd	Fraser Range Deep Diamond Drilling	Ni, Cu
25	MDR Thomson Pty Ltd	Ellendale Southeast	Diamonds
26	Ming Gold Ltd	Great Sandy	Cu, Au, Ni, W, Bi, Ag
27	Minotaur Gold Solutions	The Saints Stratigraphic Hole	Ni
28	Northern Minerals Ltd	Browns Range Project – Dazzler and Iceman Prospects	Heavy Rare Earth Elements (HREE)
29	Northern Star Resources – Kalgoorlie Operations	West Kundana EM Anomaly Drilling	Au
30	Octagonal Resources (WA) Pty Ltd	Burns Prospect	Au, Cu
31	Pioneer Resources Ltd	Fairwater Nickel Project	Ni
32	Poseidon Nickel Ltd	Emily Ann – Lake Johnson	Ni
33	Quadrio Resources	Calingiri Copper Project	Cu, Mo, Ag, Au
34	Salt Lake Mining Pty Ltd	Fletcher Trend Project	Ni, Au
35	Sol Jar Property Pty Ltd	Munglinup Nickel/Graphite Project	Ni, Graphite
36	White Cliff Minerals Ltd	McKenna Magmatic Nickel Sulphide Project	Ni, Cu
37	Windward Resources	Fraser Range Ni-Cu EM Conductor Targets	Ni, Cu
38	David Woodiwiss	Logan's Find	Au
39	Derwyn Isobel Parker	Jasper Star	Au, Ag
40	John Brady	Princess Royal East	Au
41	Michael Morawa	Tuckabianna East	Au, Cu, Pb, Zn, Ag
42	Peter Kerley	Never Can Tell	Au
43	Roxbury Trading Pty Ltd	Oakley gold prospect	Au, Cu, Pb, Zn, Ag
44	Steve Argus	Cattleman Au-Mo Project	Au, Mo

Figure 2. List of successful applicants for Round 11

committee representing all the peak resource industry bodies in Western Australia.

Significant success stories have included the Nova and Camelwood nickel deposits, the Yeneena copper deposits, Millenium zinc and the Dusk til Dawn gold discovery. The Sirius Nova discovery, which was supported by co-funding in 2011–12, is currently in mine development stage with production due to commence in 2016.

The recently released Economic Impact Study shows that the EIS generates \$10.3 million of exploration activity for every \$1 million spent by the EIS with the long run expected benefit to the State, in terms of higher GSP, being \$23.7 million.

The Co-funded Drilling Program refunds up to 50% of direct drilling costs with caps of \$150 000 for a multi-hole project, \$200 000 for a single deep hole, and \$30 000 for a prospector's project. Payments are made to successful

applicants after completion of drilling and submission of reports which are released publically via the Department of Mines and Petroleum's (DMP) WAMEX database after a six-month confidentiality period.

Round 11 of the EIS attracted 79 applications requesting \$8.86 million in co-funding.

The Minister said the Liberal National Government had committed a further \$10 million a year to the EIS until the end of June 2017.

Applications for the next round of Co-funded Exploration Drilling, for projects to be drilled in 2016, will be open between 4 September and 16 October 2015.

For more information, contact Margaret Ellis (margaret.ellis@dmp.wa.gov.au) or go to www.dmp.wa.gov.au/eisdrilling.

The Mutherbukin Tectonic Event



The Mutherbukin Tectonic Event represents a protracted period of Mesoproterozoic reworking of the Capricorn Orogen and offers significant insight into the tectonic drivers and heat sources during the evolution of long-lived intraplate orogens and their relationships with mineral systems.

Report 146 Pressure–temperature–time evolution of the Mutherbukin Tectonic Event: a model for Mesoproterozoic intraplate reworking of the Capricorn Orogen outlines the metamorphic, structural and temporal evolution of the Capricorn Orogen during this protracted period of intraplate reworking. Mineral assemblages and tectonic fabrics occur predominantly within a 50 km-wide fault-bound corridor, the Mutherbukin Zone, in the central part of the Gascoyne Province. This zone preserves a crustal profile, with greenschist facies rocks in the north grading to upper amphibolite facies rocks in the south. Upper crustal rocks across the region also record evidence for faulting and hydrothermal fluid flow at this time, including zones of mineralization.

Sensitive high-resolution ion microprobe (SHRIMP) U–Pb dating of accessory phosphate phases, integrated with phase equilibria *P–T* modelling and garnet chemistry, reveals a dominant history of

prolonged transpression and crustal thickening between c. 1320 and 1270 Ma (thin-skinned upper crustal thickening), followed by transtension and crustal thinning from c. 1210 to 1170 Ma. Thermal modelling of this event confirms that thin-skinned, upper crustal thickening of radiogenic crust typical of the Gascoyne Province forms a ‘thermal lid’, which can reproduce the metamorphic conditions over the appropriate time scales.

Fluid flow and hydrothermal alteration in the upper crust was synchronous with these deformation and metamorphic events, indicating a strong, dynamic link between events in the middle and upper crust. These relationships are critical for understanding mineral systems in the province and for constraining where and when mineral deposits might form.

Download Report 146 free of charge from <www.dmp.wa.gov.au/ebookshop>.

For more information, contact Simon Johnson (simonpaul.johnson@dmp.wa.gov.au).

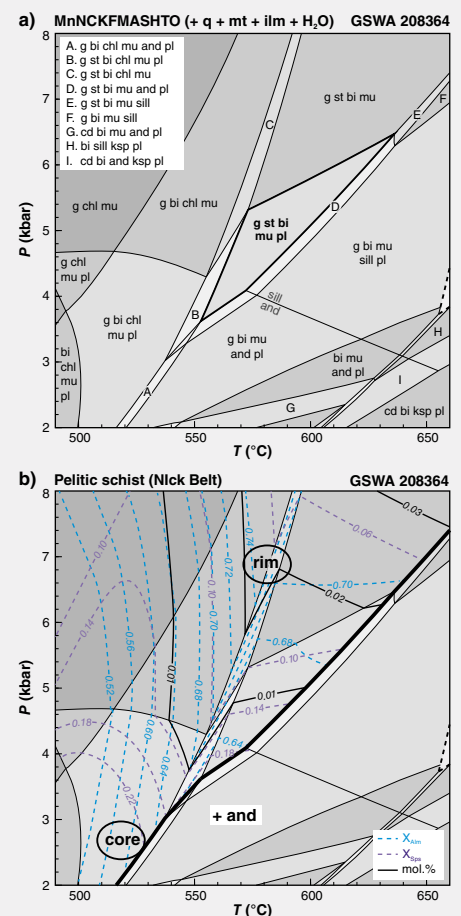
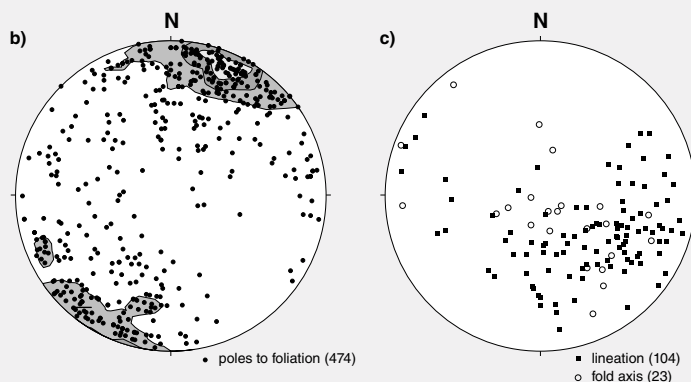
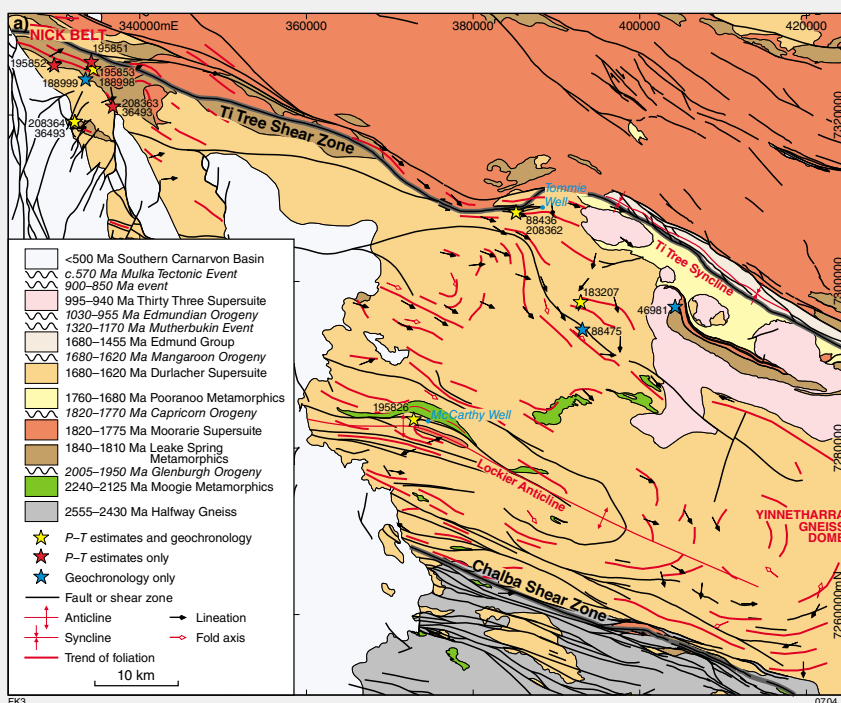


Figure 2. *P–T* pseudosection for garnet-bearing pelitic schist from the Nick Belt (GSWA 208364), also showing compositional isopleths and proportion (in mol.%) of garnet. Black ellipses denote approximate *P–T* conditions for garnet cores and rims; sizes are schematic and do not correspond to uncertainties. Garnet data are not shown for andalusite-bearing assemblages to the right of the thick solid line (labelled ‘+ and’)

Figure 1. Simplified geological map of the Mutherbukin Zone in the Gascoyne Province. Stars show sample locations and types of analyses.

Structural evolution of the Pleiades Lakes region: northeastern Albany–Fraser Orogen



The Pleiades Lakes region is located in the remote northeastern Biranup Zone of the Albany–Fraser Orogen in southeastern Western Australia, approximately 30 km east of the Tropicana gold mine. With the recent interest in gold exploration, emphasis has been placed upon understanding the development of this poorly exposed portion of the orogen. Detailed field mapping, structural measurements, geothermometry, microtectonic and metamorphic petrography were used to determine the tectono-thermal evolution of the Pleiades Lakes region. Structural data indicate at least three separate tectonothermal events, consistent with activity during the Paleoproterozoic Biranup Orogeny, in addition to Stage II of the Mesoproterozoic Albany–Fraser Orogeny. High-temperature metamorphism and deformation associated with the Zanthus Event (c. 1680 Ma) resulted in the development of localized gneissic fabrics (D_1). In the Northern Domain of the Pleiades Lakes region, D_2 is defined by north-trending shear foliations with sinistral reverse kinematics (top-up to northwest). Progressive fabric perturbation, resulting from interactions with competent amphibolite, has produced a broad spread in fold axis and lineation orientations during D_2 (northeast–southeast plunges). In the Southern Domain, D_2 is marked by east-trending shear foliations, with dextral reverse kinematics (top-up to northwest). Progressive deformation has resulted in asymmetric Z-folds and lineations that plunge to the southeast. D_2 reflects a north to northwest-directed fold vergence and transport direction, which is consistent with northwest-directed convergence during Stage II of the Albany–Fraser Orogeny. D_3 reflects east–west directed shortening, which has resulted in the development of interference folds.

A microtectonic analysis of recrystallization textures in mylonites (D_2) defined temperature conditions between 450–700°C. Peak metamorphic conditions determined from co-existing minerals in pelitic schist reflect

upper-amphibolite facies, which likely coincides with peak metamorphism during Stage II of the Albany–Fraser Orogeny (possibly around 1180 Ma). Closing temperatures of Fe²⁺ and Mg cation exchange, between biotite and garnet, established

temperatures of 584°C and 594°C for 4 and 8 kbar, respectively. This was followed by further retrogression into greenschist facies metamorphic conditions, most likely as a consequence of tectonic exhumation and fluid flow during D_2 resulting from northwest-directed convergence during Stage II of the Albany–Fraser Orogeny. Both the Pleiades Lakes region and the Tropicana gold mine area have structural similarities, specifically pertaining to deformation during Stage II. Both D_2 (Pleiades) and D_5 (Tropicana) contain south-dipping high-strain zones, formed during northwest-directed convergence. D_5 (Tropicana) reflects a lower metamorphic condition than D_2 (Pleiades). Although it is uncertain if gold remobilization and/or mineralization is associated with D_5 at Tropicana, D_2 at Pleiades does not exhibit any observable gold mineralization.

Record 2014/15 Structural evolution of the Pleiades Lakes region, northeastern Albany–Fraser Orogen, Western Australia by MA Stokes has recently been released and is an Honours thesis researched, written and compiled through a collaborative project between the Geological Survey of Western Australia (GSWA) and James Cook University. The work was supervised by Dr Jan-Marten Huizenga (James Cook University) and overseen by Prof. Tom Blenkinsop (Cardiff University) and Catherine Spaggiari (GSWA). The Record includes three detailed maps as separate plates.

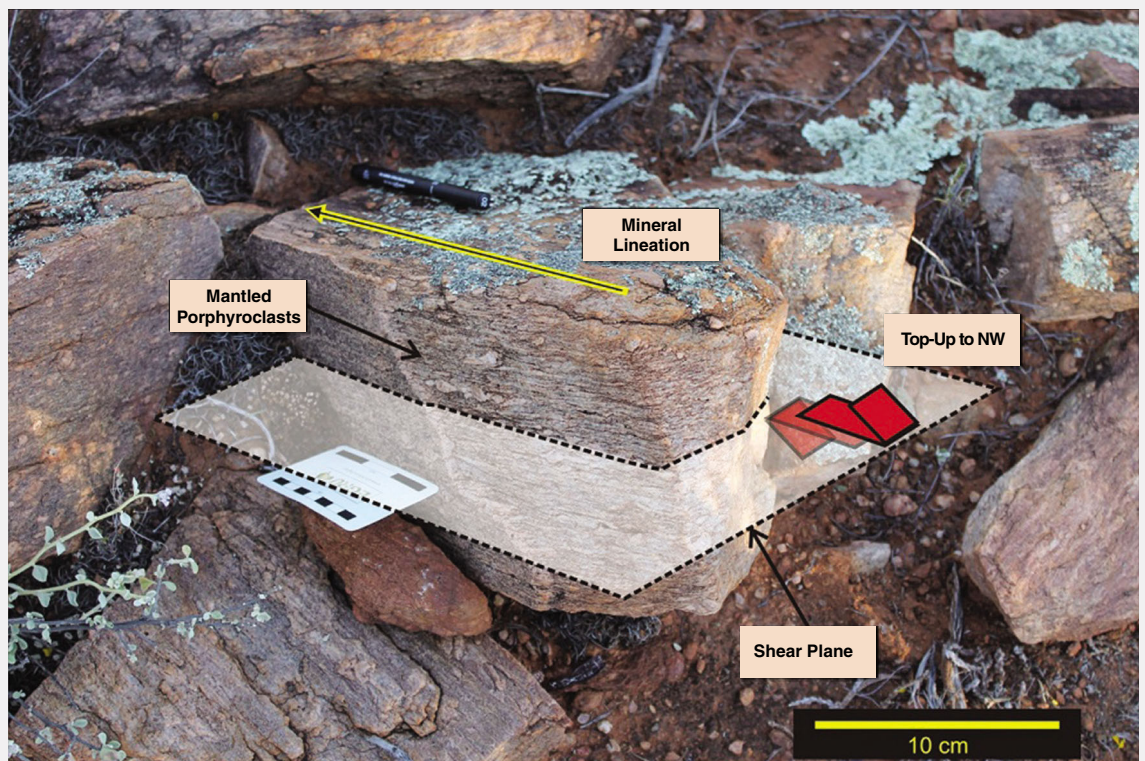


Figure 1. Mylonitized, interlayered metasyenogranite and K-feldspar megacrystic granite dominated by quartz ribbons less than 1 cm wide. Mantled K-feldspar porphyroclasts (<1 cm) display a strong top-up towards the northwest shear sense. Superimposed upon this photograph is the shear plane of the mylonite, the shear sense, as well as the mineral lineation.

For more information, contact
Catherine Spaggiari (catherine.spaggiari@dmp.wa.gov.au).

Yilgarn Gold Exploration Targeting Atlas Part 2



The second part of the three-part Yilgarn Gold Exploration Targeting Atlas (YETA) was released in January 2015, as GSWA Report 132. Now the digital data behind Part 2 is available. The Report investigates 22 targeting criteria for gold exploration, applicable at the district scale. The results are presented as quantitative spatial analyses and as qualitative interpretations, depending on the nature of the data.

As with Part 1 of the Atlas (regional scale), robust spatial statistics provide strong support for many conventional structural targeting criteria (e.g. proximity to faults, fault jogs and fault bends, fault density and fault intersection density) at the district scale. Quantitative analyses also strongly support the association of gold with the Mafic Group intrusions at the district scale.

Drillhole databases provided by Barrick Ltd and Norton Goldfields Ltd (Laverton and Kalgoorlie – Ora Banda districts) and St Barbara (Southern Cross district) have been used to demonstrate qualitative associations of felsic to intermediate (including Mafic Group) intrusions with long wavelength (phengitic) white mica and elevated Mo+Bi+W. A similar relationship exists between high-strain (fault, shear) zones and short wavelength white mica and elevated As+Sb. These contrasting spectral and trace-element signatures are commonly interpreted as indicating oxidized (alkaline) and reduced (acid) signatures, respectively. Some major gold deposits occur on the boundaries between these oxidized

and reduced hydrothermal cells, an observation that has been interpreted by some as indicating a fluid mixing origin for the gold. However, the YETA study shows that other deposits lie within oxidized or reduced hydrothermal domains. Those that are on redox boundaries can alternatively be interpreted to reflect strain partitioning around intrusions.

Other useful gold targeting criteria to emerge from these district-scale analyses are spectrally determined white mica abundance and the presence of Fe-rich chlorite, summing the oxidized and reduced pathfinder elements (Mo+Bi+W+As+Sb), and the rare-alkali index ($[(Rb+Cs)/Th]N$).

The results published in Part 2 of the YETA will be of interest to the many geologists engaged in district (project) scale exploration for orogenic and intrusion-related gold.

Report 132 District-scale targeting for gold in the Yilgarn Craton: part 2 of the Yilgarn Gold Exploration Targeting Atlas is available as a free download from <www.dmp.wa.gov.au/ebookshop>.

The USB contains

- Report 132 as a PDF document (also available as a free PDF from eBookshop)
- A digital appendix to Report 132, consisting of a complete set of tabulated results and charts of spatial analyses, supplied as MS Excel spreadsheets, and ESRI ArcGIS shapefiles consisting of:
 - targeting criteria features
 - buffers created for containment and proximity analyses
 - gold deposits intersected by buffers.

For more information, contact Wally Witt (wally.witt@dmp.wa.gov.au).

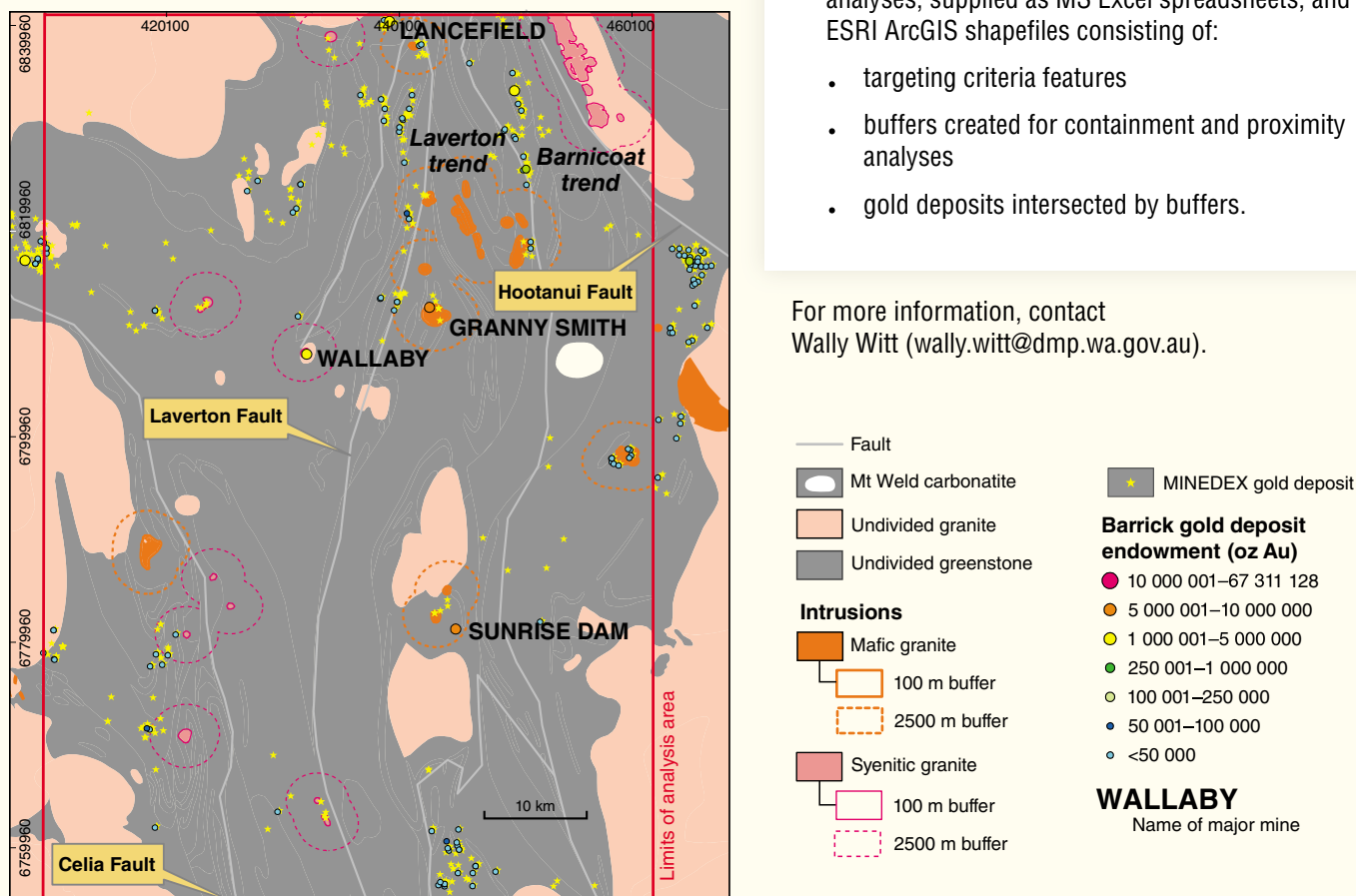


Figure 1. Laverton district, Eastern Goldfields Superterrane; mafic granite and syenitic granite intrusions

New publication focuses on graphite

Mineral Resources Bulletin 26 Graphite in Western Australia illustrates the numerous graphite prospects and occurrences present in Western Australia. Almost all are found in graphitic schists or gneisses derived from the metamorphism of sedimentary rocks ranging from Archean to Mesoproterozoic age. Of these, only a few deposits have previously been mined with a total recorded production of 222 t, mostly coming from the Munglinup deposit in the far south of the state, with smaller amounts from the Donnelly River deposit in the southwest.

Currently, two companies are well advanced in the exploration of two new high-grade, flake graphite deposits. In the Halls Creek area of the east Kimberley region, Lamboo Resources has identified five high-grade graphite targets at its McIntosh deposit. Open-ended Target 1 has a resource of 7.135 Mt over a 580 m strike length grading 4.73% total graphitic carbon (%TGC) for 337 700 t of contained graphite at a 2% TGC cutoff grade. The company recently announced that it plans to supply 50 000 t per annum flake graphite concentrate to a Chinese client up to the end of 2018. The four remaining high-grade prospects are currently being intensively explored, and beneficiation trials are underway.

At Yalbra, in the Gascoyne region in the central west of the State, Buxton Resources Ltd is exploring six, closely spaced, graphite-rich targets. Buxton Resources recently announced that the Yalbra 1 prospect has a very high-grade resource over a 600 m strike length of 4.022 Mt grading 16.17% TGC using a 4% cutoff grade. The mineralization remains open both along strike and at depth. Detailed exploration is continuing.

The Munglinup deposit, between Ravensthorpe and Esperance, has an estimated resource of 1.47 Mt at 18.2% total (fixed) carbon (%TC) over a strike length of 555 m.

In recent years, higher prices on world graphite markets have resulted from increased demand for high-grade, large-flake graphite, especially for the refractories industry, the world's largest graphite consumer. There is also new-found demand for high-tech graphite applications such as the lithium-ion battery industry supplying batteries in increasing numbers for electric cars. Accordingly, many countries including Australia have recommenced exploration to prove up new and existing deposits of high-grade flake graphite. Should this increased demand persist, Western Australia's potential graphite operations could establish the State as a producer and exporter of both high-grade flake graphite and finer grade graphite concentrates into world markets.

How to purchase

To purchase a hard copy of the publication, please email bookshop@dmp.wa.gov.au. It is available for \$25 (including GST) as a hardcopy book. You can also download a free PDF from www.dmp.wa.gov.au/ebookshop.

For more information, contact
Mike Fetherston (mike.fetherston@dmp.wa.gov.au).

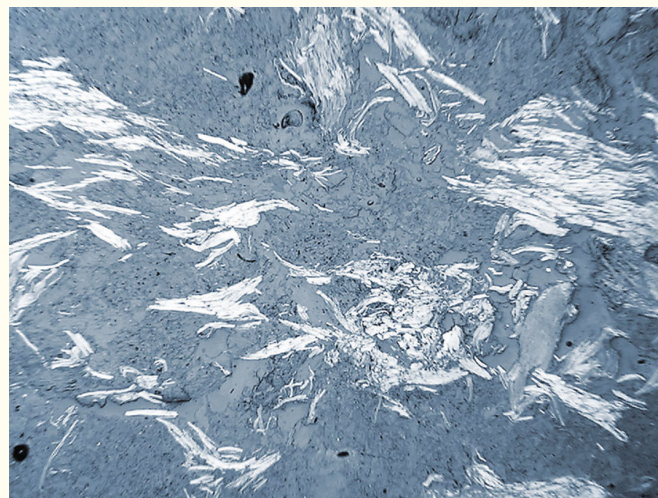


Figure 1. Flake graphite in a weathered quartz-feldspar matrix



Figure 2. Sampling graphite powder at the McIntosh deposit

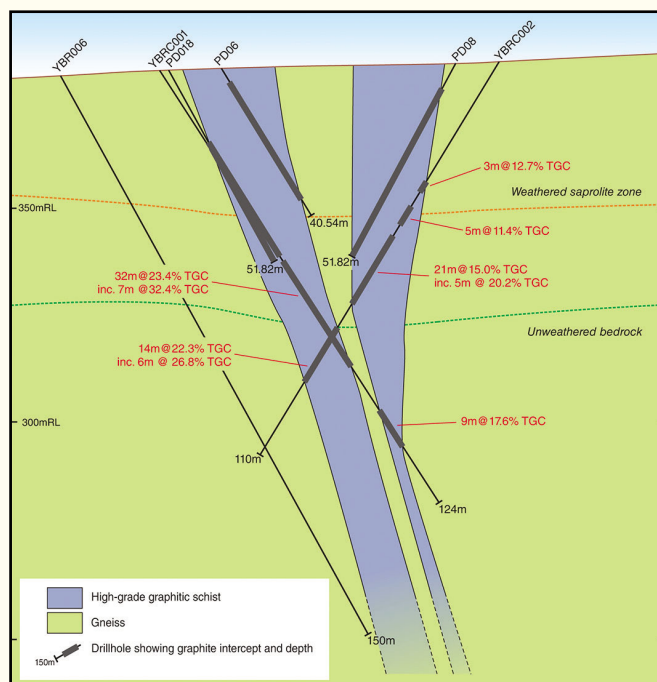


Figure 3. Cross-section through Yalbra 1 prospect showing graphite drillhole intercepts

Tectonic units and orogenic events data release

The **1: 500 000 tectonic units of Western Australia, 2015** is the first update to this dataset since the release of the preliminary version in 2007. The new dataset depicts both the onshore and offshore distribution of the constituent elements of cratons, orogens, basins, and igneous supersuites. The onshore units seamlessly match the interpreted bedrock geology, as well as the offshore units derived from the Geoscience Australia Australian Geological Provinces GIS dataset.

The **1:500 000 orogenic events of onshore western Australia, 2015** is a new dataset that shows the present-day distribution of orogenic reworking of lithological and tectonic units. Recognized events include structural deformation, magmatism, metamorphism, and resetting of isotopic systems, although the events depicted in this dataset are primarily deformational. The orogenic events have been grouped into nine key time slices based on broad temporal divisions whose boundaries correspond, where practical, to recognized geological eras. However, some boundaries have been adjusted to accommodate correlation of broadly coeval events that span defined era boundaries. For convenience, the data are presented as a single layer in GeoVIEW.WA (www.dmp.wa.gov.au/geoview), but the individual time slices can be downloaded from the Data and Software Centre (www.dmp.wa.gov.au/datacentre).

For more information, contact
David Martin (david.martin@dmp.wa.gov.au).

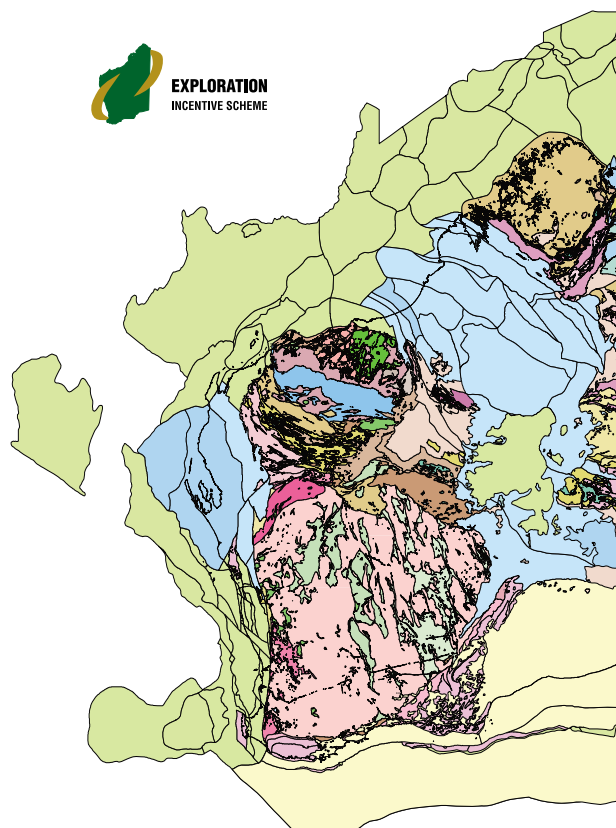


Figure 1. 1:500 000 tectonic units of Western Australia, 2015

New-look atlas released

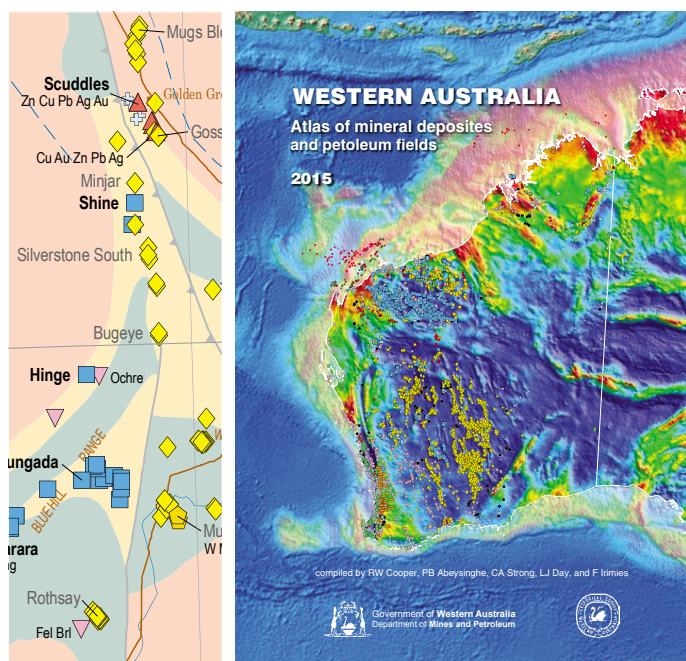
The 2015 edition of the **Atlas of mineral deposits and petroleum fields — Western Australia** was recently released. This is one of the most popular Geological Survey of Western Australia (GSWA) publications.

Enhancements that make this 2015 edition easier to view and use are:

- Clearer labelling of mines and deposits
- Larger scale maps (increasing from 17 to 28 pages)
- Improved layout of Indexes.

Information on minerals and construction materials comes from the Department of Mines and Petroleum (DMP) mines, mineral deposits, and prospects database (MINEDEX). Since its inception in 1984, MINEDEX has recorded the locations and other attributes of all mines and deposits with defined resources.

Information on petroleum fields in Western Australia (onshore and in state waters) and for adjacent offshore waters, controlled by the Commonwealth, is derived from a variety of DMP sources, including DMP's Western Australian petroleum and geothermal information management system database (WAPIMS). Only major fields are shown, and are identified by a representative well for that field.



This product is produced by GSWA every two years, but updated information can be found online in MINEDEX (www.dmp.wa.gov.au/minedex) and WAPIMS (www.dmp.wa.gov.au/wapims).

For more information, contact
Roger Cooper (roger.cooper@dmp.wa.gov.au).



Saying goodbye to a 2D Earth

The Geological Survey of Western Australia (GSWA) is sponsoring and co-organizing an international conference on 3D geological modelling that will take place from 2–7 August 2015 at the Quality Inn in Margaret River.

Integrating geophysical and geological datasets into testable, robust predictions of the 3D world beneath our feet still poses a major challenge. Although commercial systems provide adequate solutions for some specific scenarios, the ability to produce testable, reproducible models for which model uncertainties are well constrained by all the geological and geophysical observations remains a goal.

In this conference, a strong emphasis will be placed on discussing future methods for characterizing, visualizing and reducing model uncertainty, as this is a particular weakness of current methodologies, and a necessary step in providing predictions with error estimates, a fundamental requirement of all scientific endeavours. This conference will bring together geophysicists and geologists working at different scales, using

customized and commercial technologies and workflows, and working in different tectonic settings, to stimulate discussions between groups that do not often interact.

The conference will consist of invited and open presentations over four days with morning and evening sessions, including a full day of hands-on access to the latest commercial and academic 3D modelling and inversion software.

Internationally renowned keynote speakers will present different visions of how best to integrate geological and geophysical observations in 3D, so that the conference will be a real opportunity to bring together opposing views that will lead to new ideas. GSWA staff Klaus Gessner, Ruth Murdie, and Lucy Brisbout will present papers on technical and regional aspects of GSWA's 3D modelling approach. A number of academic partners from The University of Western Australia and Australian National University will present results from collaborative research funded through the Western Australian Government's Exploration Incentive Scheme.

Updated information for this event, including an up-to-date program and a list of keynote speakers can be found at www.cet.edu.au/news-and-media/events/event-details/2015/08/02/default-calendar/saying-goodbye-to-a-2d-earth.

For more information, contact Klaus Gessner (klaus.gessner@dmp.wa.gov.au).

Lithological boundaries

Dykes	Atley Igneous Complex
Bald Rock granite	Barrambie Igneous Complex
Early granite	Gum Creek greenstone
Sheared granite	North Cook Well greenstone
Metasediments	Base of Sandstone greenstone
Ultramafic	Southern Cross granites
Mafic with BIF	Murchison granites
BIF	Yarraquin Seismic Province
Massive mafic	Lower crust
Schist	

Faults

Youanmi Shear Zone
Edale Shear Zone
Fault in granites
Faults in Sandstone greenstone

RM55a

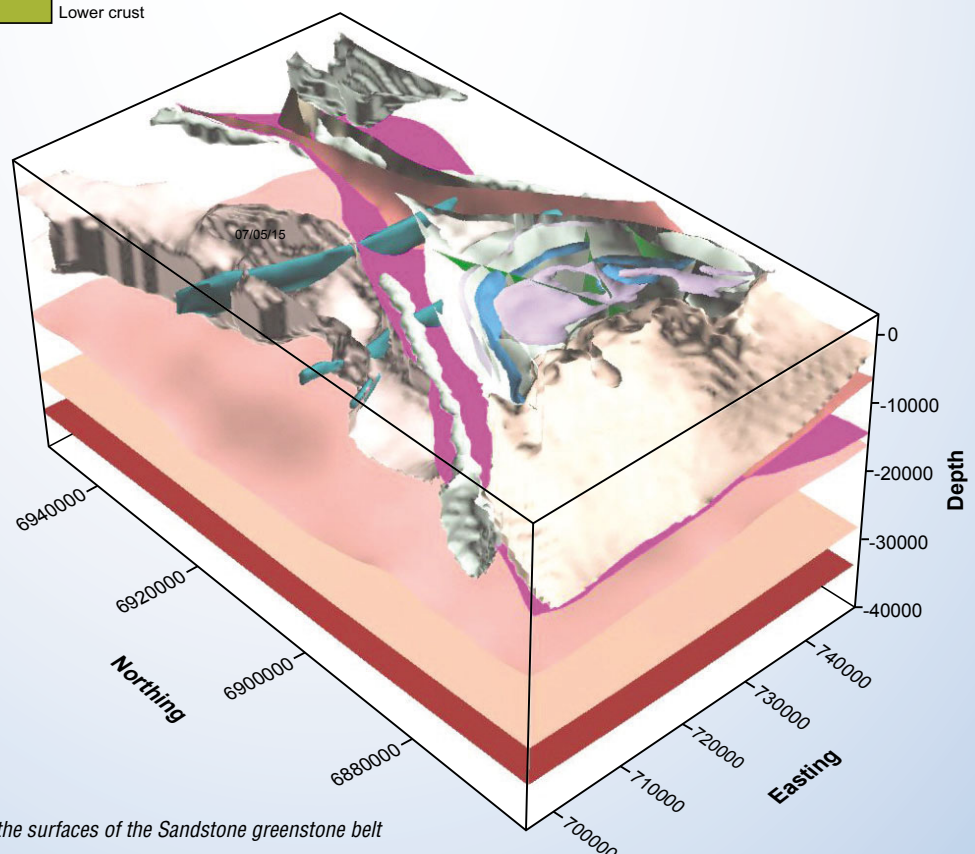


Figure 1. 3D model of the surfaces of the Sandstone greenstone belt

Eucla basement drilling program — results release

The Eucla basement stratigraphic drilling program, funded through the Exploration Incentive Scheme (EIS), was established to investigate the greenfields Madura and Coompana basement provinces that lie between the Albany–Fraser Orogen and Gawler Craton, beneath up to 500 m of cover rocks in the Bight and Eucla Basins, Western Australia.

The forthcoming workshop will include presentations from the Geological Survey of Western Australia, Curtin University and First Drilling.

Topics include:

- Drilling techniques and core acquisition
- Lithological and structural features
- Sulfides, veins and alteration
- Implications for geophysical data interpretations
- Geochronology
- Geochemistry, isotopes and crustal evolution
- Tectonic settings and implications for geodynamics and prospectivity
- Geology of the cover sequences

Date	Thursday 10 September 2015
Time	8.30 am – 5.00 pm
Venue	Hyatt Hotel
Location	East Perth
Cost	FREE but registration is essential.

To **register contact Deenikka Preedy** (deenikka.preedy@dmp.wa.gov.au) or 9222 3634. Please also indicate whether you wish to attend the public core viewing of representative sections on Monday 14 September 2015, at the Perth Core Library, Carlisle

The schedule of presentations is available on the DMP website at www.dmp.wa.gov.au/euclabasement. Short abstracts will be available on the day, and will be posted on the website afterwards.



Stratigraphic drilling program details

During 2013 and 2014, eight diamond holes were successfully drilled, providing 1560 m of high-quality, oriented HQ basement core, and PQ diamond and RC chips of cover rocks from selected holes. The site locations were chosen to investigate and map geophysical domains interpreted in magnetic and gravity data, rather than as specific targets, and to investigate potential host rocks to known mafic intrusions (i.e. Loongana, Haig and Serpent).

Given the large variation in lithologies and structures, both within individual cores and between cores, this drilling program is on track to greatly increase our knowledge of the basement provinces that are missing links in understanding Proterozoic Australian geology. Combined with work on existing EIS co-funded and donated company cores, the new drillcores also provide insight into the prospectivity of the vast region that lies beneath the Nullarbor Plain.

The stratigraphic drilling program has also provided valuable experience and knowledge of the challenging ground conditions associated with drilling in the Nullarbor region. Both RC and mud-rotary techniques have been trialled and assessed as alternative techniques for getting through the cover to basement.

For more information, contact Catherine Spaggiari (catherine.spaggiari@dmp.wa.gov.au).



Figure 1. Eucla drilling program



Figure 2. Drillcore gives valuable insight into prospectivity

GSWA regional geophysics surveys: 20 July 2015 update



The latest release of GSWA regional geophysical surveys is the Ngururrpa gravity survey.

Data downloads



Final data releases from the Geophysical Archive Data Delivery System are at www.ga.gov.au/gadds.

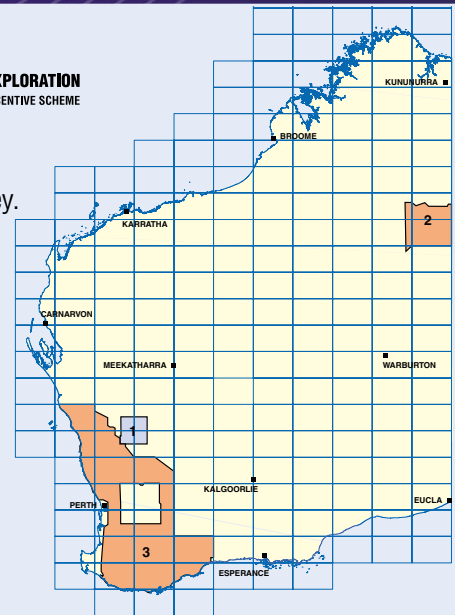
Grids and images from the GSWA website are available from www.dmp.wa.gov.au/geophysics.

Subscribe to the GSWA eNewsletter for alerts of preliminary and final data release dates.

Survey outline shapefiles are available online at www.dmp.wa.gov.au/geophysics.

For more information, contact David Howard (david.howard@dmp.wa.gov.au).

 Airborne mag-rad surveys
 Ground gravity surveys



ID	Area/Name	Method	Configuration	Units	Status	Start	End	Release
1	Yalgoo 2015	Mag-Rad	100 m; E/W	111 000 km	Survey 36%	31/05/15	Oct-15*	Dec-15*
2	Ngururrpa 2015	Gravity	Grid 2.5 km	4 964 stns	Pre-release	10/05/15	13/06/15	30/07/15*
3	SW Yilgarn 2015	Gravity	Roads 2 km	29 000 stns	Survey 10%	12/06/15	Oct-15*	Jan-16*

Mag-Rad = Magnetic/Radiometric

* Estimated date

Information current at: 19 July 2015

Seeing the sites on Rottnest

Did you know that as well as sun, sand and surf, the little rocky island of Rottnest has some geological features of international significance?

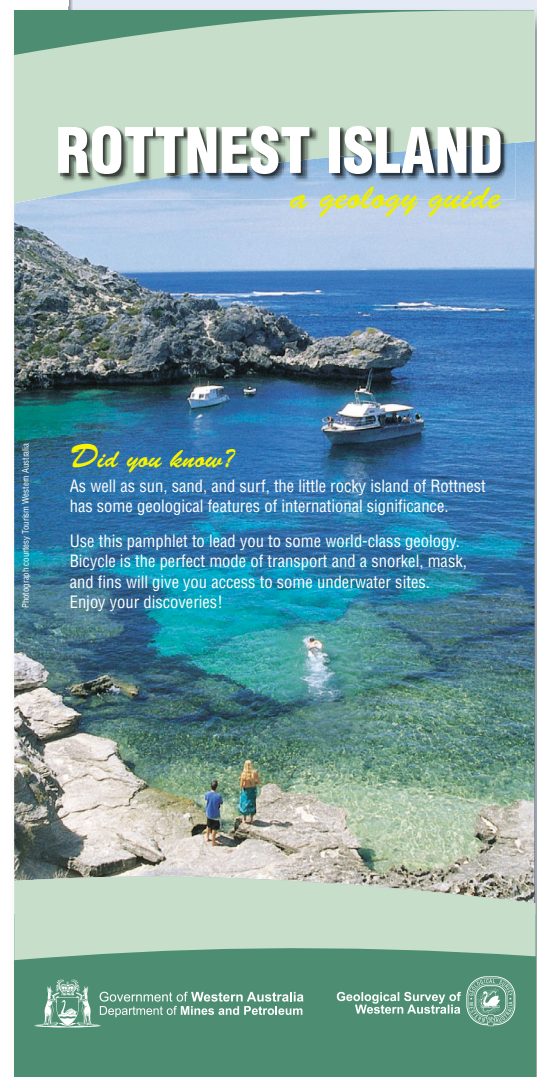
The Geological Survey of Western Australia recently published a pamphlet on some of the world-class geology found on Rottnest Island to coincide with a Forum Advocating Cultural & Eco-Tourism Inc (FACET) conference in Perth and on Rottnest on **Geotourism — Tourism Down Under**. Using the pamphlet, you can visit nine geological sites round the island from West End (in the far west) to The Basin (just round the corner from Thomson Bay).

Author Bob Gozzard draws attention to shoreline platforms and notches that are +2.4, +1.1, and +0.5 metres above present-day sea level.

At Fairbridge Bluff ancient corals grew about 125 000 years ago — and there is a similar modern coral reef growing today offshore from Parker Point. A snorkel, mask and fins will give you a great view underwater of about 25 species of coral.

'Paddy-field' terraces (so named as they look just like paddy fields!) and algal polygons are beautifully developed at Wilson Bay. The algal polygons are irregular hexagons and pentagons outlined by the growth of brown seaweed, probably due to the grazing habits of herbivorous reef fish, which seem to be responsible for the creation and maintenance of the polygon boundaries.

The free full-colour pamphlet is available from Mineral House, from the Rottnest Visitor Centre, and from other local Visitor Centres catering to the Rottnest visitor. It can also be downloaded free from the DMP website at www.dmp.wa.gov.au/ebookshop.



Product releases

Any prices include GST

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ISSN 1834-2272 ISBN (PDF) 978-1-74168-636-4

■ REPORTS

Report 139 Geosequestration potential of the Carboniferous–Permian Grant Group and Permian Poole Sandstone, northwest Canning Basin, Western Australia

by Dentith, MC, Dent, L, George, AD, Langhi, L, Sanchez, G, Seyedmehdi, Z, Strand, J, Vasilin, A, and Zaheer, R

Report 142 Mineral prospectivity of the King Leopold Orogen and Lennard Shelf: analysis of potential field data in the west Kimberley region

by Lindsay, MD, Aitken, AR, Ford, A, Dentith, MC, and Hollis, JA

This product consists of a PDF of the Report and appendices, including PDFs, tables in MS Excel (spreadsheet) format, and spatially located GIS data

Report 150 Building the crust of the Albany–Fraser Orogen; constraints from granite geochemistry

by Smithies, RH, Spaggiari, CV, and Kirkland, CL

Report 151 Early evolution of the Pilbara Craton from hafnium isotopes in detrital and inherited zircons

by Kemp, AIS, Hickman, AH, and Kirkland, CL

Appendices for this Report are provided as accompanying compressed files that can be downloaded free of charge from eBookshop

■ REPORT PLUS DATA PACKAGE

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by Witt, WK, Ford, A, and Hanrahan, B \$55

This product is a USB containing:

- Report 132 as a PDF document (also available as a free PDF from eBookshop)
- A digital appendix to Report 132, consisting of a complete set of tabulated results and charts of spatial analyses, supplied as MS Excel spreadsheets, and ESRI ArcGIS shapefiles consisting of:
 - targeting criteria features
 - buffers created for containment and proximity analyses
 - gold deposits intersected by buffers.

■ RECORDS

Record 2014/1 Geological Survey work program for 2014–15 and beyond

Record 2014/6 Albany–Fraser Orogen seismic and MT workshop 2014 (includes four plates)

by Spaggiari, CV and Tyler, IM

Record 2015/4 Tectonite type: their formation and significance, map production, field relationships and petrography

by Tomkins, AE

Record 2015/5 Temporal constraints on magmatism, granulite-facies metamorphism, and gold mineralization of the Hercules Gneiss, Tropicana Zone, Albany–Fraser Orogen

by Kirkland, CL, Spaggiari, CV, Smithies, RH, Wingate, MTD, Sweetapple, MT, Watkins, R, Tessalina, S, and Creaser, R

Record 2015/7 Limesand and limestone resources of southern WA

Record and data package \$55

■ NON-SERIES BOOKS

Rottneest Island — a geology guide (pamphlet)

by Gozzard, JR

■ 1:100 000 GEOLOGICAL SERIES MAPS

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by Quentin De Gromard, R, Howard, HM, and Smithies, RH

Kearney, WA Sheet, 4557

by Eacott, GR and de Souza Kovacs, N

Lake Percy, WA Sheet, 2934

by Romano, SS

Lewis, WA Sheet, 4657

by Eacott, GR and de Souza Kovacs, N

Richenda, WA Sheet 3963

by Phillips, C, de Souza Kovacs, N, and Hollis, JA

Towera, WA Sheet 1951

by Korhonen, FJ, Johnson, SP, Krapf, CAB, and Scheib, AJ

■ 1:250 000 GEOLOGICAL SERIES MAPS

Prince Regent — Camden Sound, WA Sheet SD 51-16 and part of Sheet SD 51-15

by Phillips, C and de Souza Kovacs, N

■ NON-SERIES BOOKS

Western Australia atlas of mineral deposits and petroleum fields 2015

by Cooper, RW, Abeyasinghe, PB, Strong, CA, Day, LJ, and Irimies, F

■ STATE MAPS

1:500 000 State interpreted bedrock geology of Western Australia, 2014

1:500 000 tectonic units of Western Australia, 2015

1:500 000 orogenic events of Western Australia, 2015

Free to download from Data Software Centre

■ RESOURCE POTENTIAL FOR LAND USE PLANNING

Regionally significant basic raw materials (eight maps):

Carnarvon, Dongara–Denison, Geraldton, Green Head – Jurien Bay, Leeman–Eneabba, Northampton, Wedge Island – Dandaragan, Exmouth

Basic raw materials (four maps):

Geraldton – Mullewa, Green Head – Three Springs, Morawa–Perenjori, Northampton–Kalbarri

■ NON-SERIES MAPS

Iron ore deposits of the Pilbara region 2015

Iron ore deposits of the Yilgarn Craton 2015

both by Cooper, RW

■ GEOLOGICAL INFORMATION PACKAGES

East Yilgarn, 2015: Geological Information Series

South Yilgarn, 2015: Geological Information Series

West Musgrave, 2015: Geological Information Series

Available to order from eBookshop for \$55

■ DATA PACKAGES

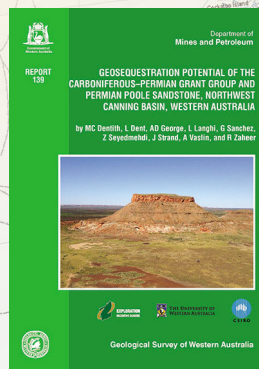
Compilation of geochronology, 2015

Iron ore deposits of the Pilbara region, 2015

Basic Raw Materials, Midwest and Gascoyne 2015

Available to order from eBookshop for \$55.

Unless otherwise stated, products are free to download from our eBookshop.



The Geological Survey of Western Australia (GSWA) has released almost 5000 geological products including books, maps and data packages. These can be found on our website at <www.dmp.wa.gov.au/GSWApublications>.

Maps, USB data packages, and selected premium publications are available to purchase as hard copies via the online cart on the eBookshop at <www.dmp.wa.gov.au/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.

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