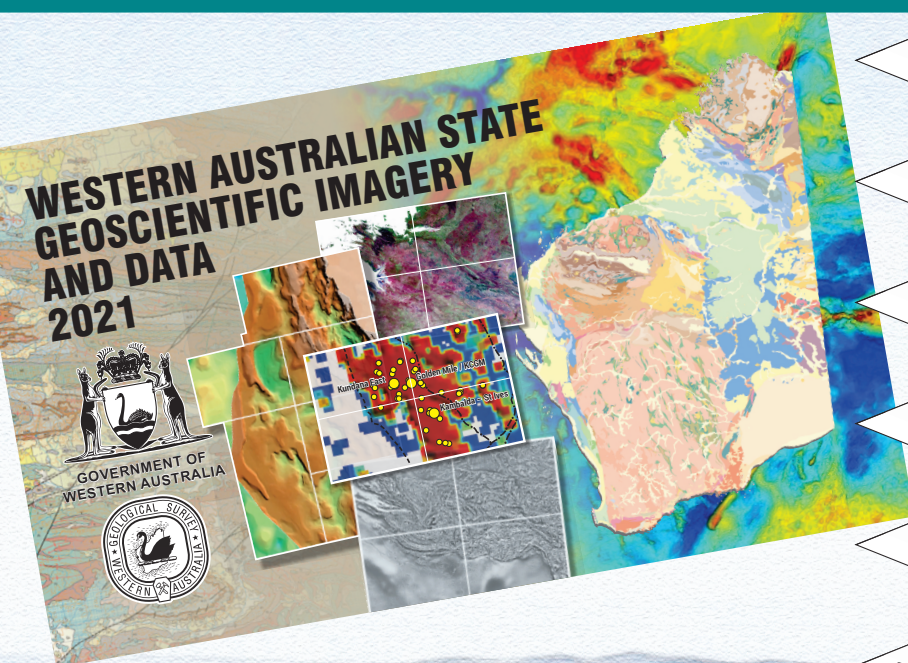


Fieldnotes



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

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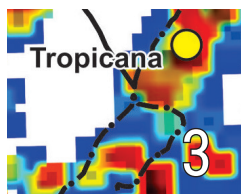


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Disclaimer

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Access publications

All publications

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Maps, USB data packages and various premium publications are available to purchase as hard copies from the eBookshop or the First Floor counter at Mineral House, 100 Plain Street, East Perth WA 6004. An online cart and payment system is in place. Records, Reports, Bulletins and other non-series books cannot be purchased in hard copy but are all available as PDFs to view and download free of charge.

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:

- subscribing to the **GSWA eNewsletter** – there will be a Fieldnotes page with a link to the latest issue
- browsing previous issues from the **eBookshop**.

GSWA eNewsletter

The GSWA eNewsletter is an online newsletter delivered roughly once a month that contains information on workshops, field trips, training, events and the latest releases of maps, books and digital data packages. If you would like to stay informed about new products, services and other news, please [subscribe](#).

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: The Western Australian State geoscientific imagery and data, 2021 USB contains a selection key statewide images and datasets, as well as Accelerated Geoscience Program products that were not included in previous USB releases



Statewide imagery and data in significant new release

The Geological Survey of Western Australia (GSWA) has just released its largest ever data package comprising statewide imagery and data. **Western Australian geoscientific imagery, 2021** provides an update on the 2019 product, and includes additional information, similar to a Geological Exploration Package.

The package includes statewide datasets and associated documentation that were produced under the Accelerated Geoscience Program (AGP), but were not included in their entirety in the three previously published AGP digital datasets. The new AGP datasets provide key information to investigate the relationship between crustal architecture; regolith geology; and geochemical, geophysical and isotopic signatures with known mineralization which can provide insights into the potential for new discoveries at the statewide, regional and district scale.

Datasets include isotope and geochronology images and data, new geophysical images, new regolith regimes and major crustal boundaries maps. The major crustal boundaries and associated 3D geomodel integrates the most recent geophysical data with current understanding of the geological evolution of the State at a significantly improved level of detail compared to similar existing national datasets.

Mineralization-related information has been filtered to show only mineralization-related sites derived from the Mines and Mineral Deposits database (MINEDEX), and bedrock and alluvial gold workings from the Inventory of abandoned mines features.

'Harmonized' geochemical datasets from the Western Australian Mineral Exploration (WAMEX) industry geochemistry database are included for the most commonly analysed elements (As, Au, Cu, Pb, Zn, Ni and Co) for maximum grade in-hole and for soil geochemistry. These were created from the many disparate submission names and units in the WAMEX database.

The abandoned gold workings and 'harmonized' WAMEX data can be visualized in point form and as pseudocolour drape images, facilitating a spatial overview of mineralization trends and patterns at different scales. Much of this information can be viewed in tailored GeoMap.WA projects requiring no specialized GIS software. For the more advanced user, the package includes all previously unpublished raster datasets in Albers projection that could further assist in prospectivity studies that require metric units.

The State imagery component of the package contains a selection of useful statewide datasets, including updates to geophysical imagery and the 1:500 000 geology layers,

as well as new geophysical datasets such as isostatic residual gravity and 10 km upward-continued aeromagnetics. Many of these layers were key data inputs into the compilation of the major crustal boundaries map and 3D model.

How to access

Western Australian geoscientific imagery, 2021 is available as a USB to order from the Department of Mines, Industry Regulation and Safety (DMIRS) eBookshop. The cost is \$55.

For more information, contact **Warren Ormsby** or **David Martin**.

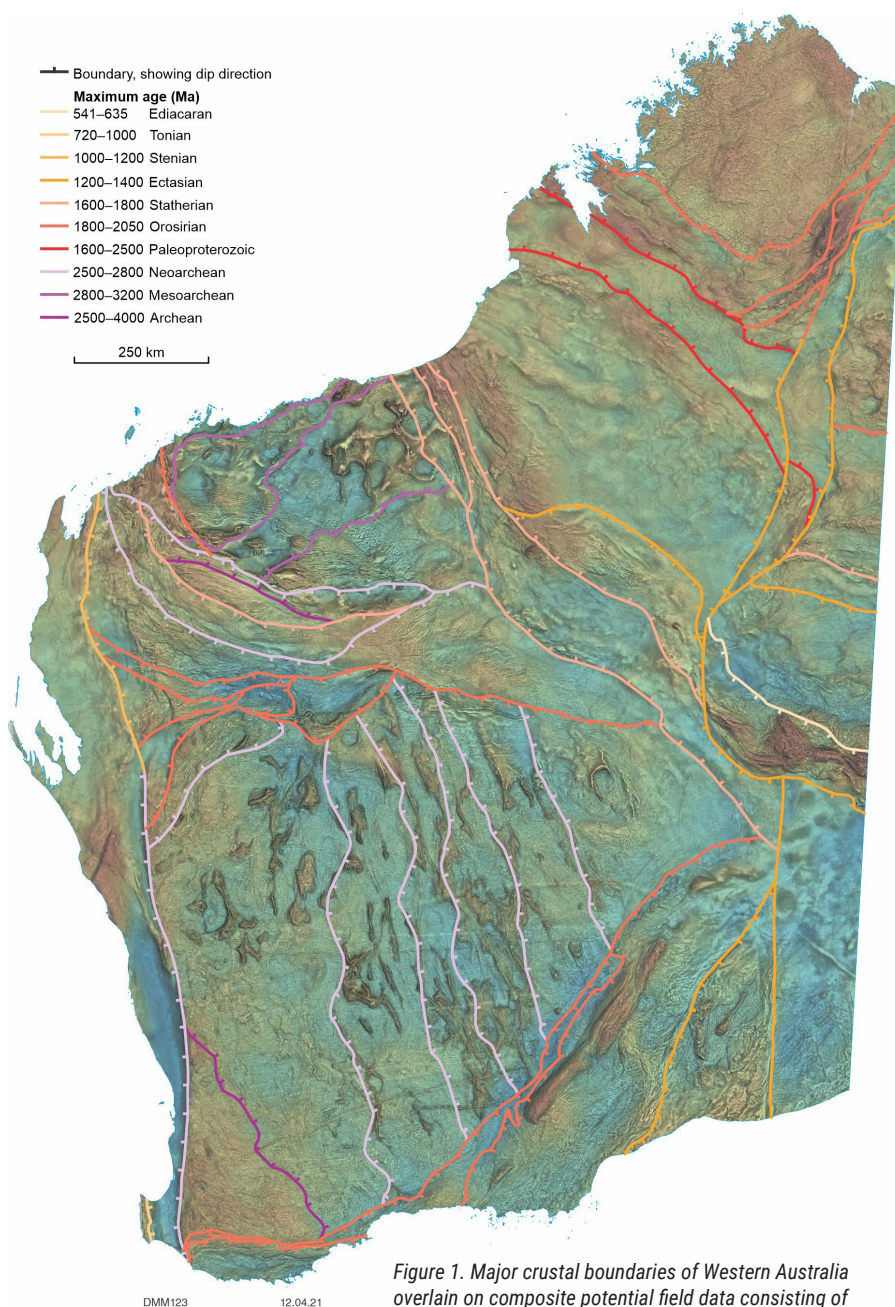


Figure 1. Major crustal boundaries of Western Australia overlain on composite potential field data consisting of isostatic residual gravity (colour) and first vertical derivative, reduced to pole aeromagnetics (texture). Boundaries are symbolized and coloured according to dip direction and maximum age, respectively

State geoscientific imagery and data, 2021

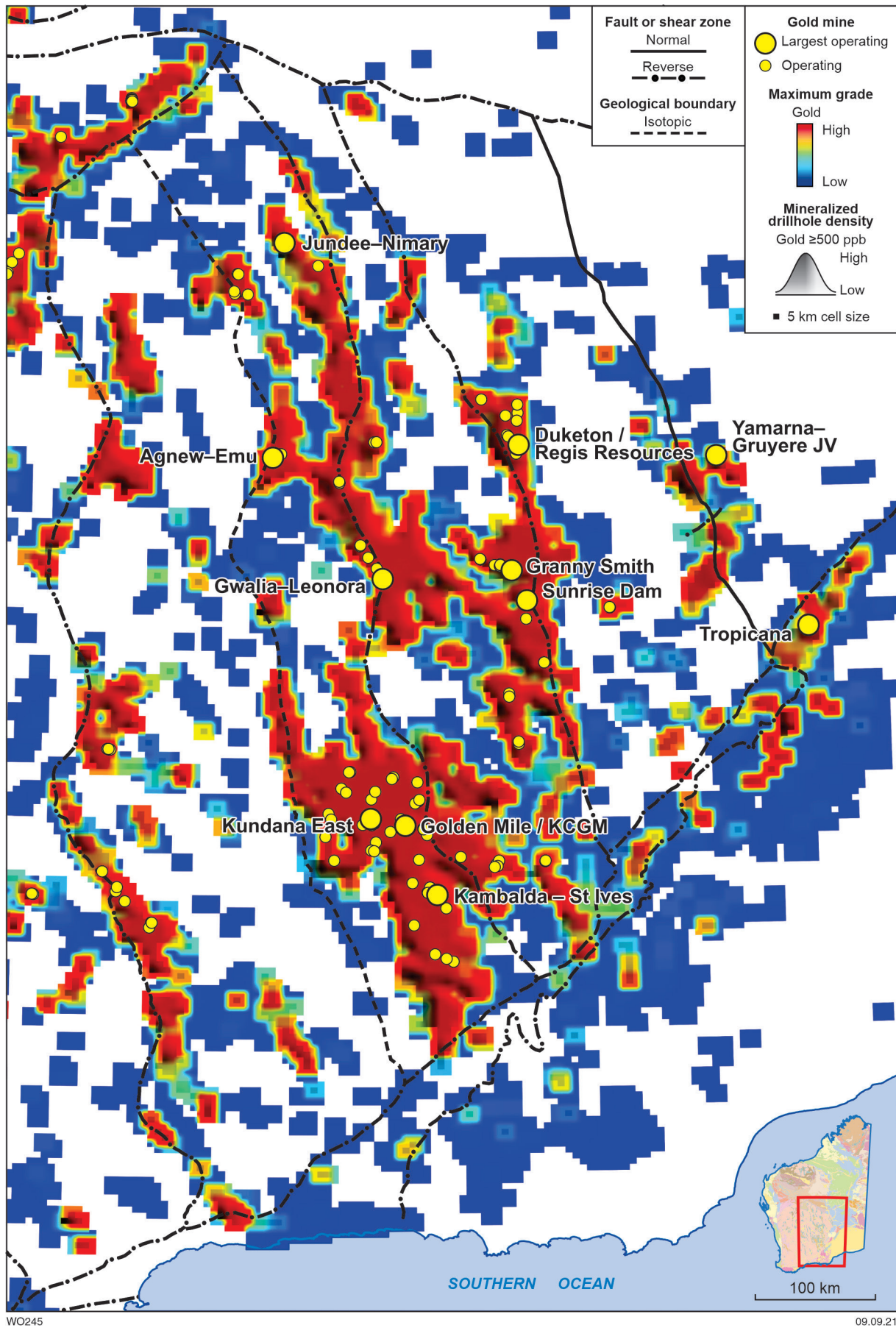


Figure 2. Maximum grade (colour stretched and smoothed) for gold for drillholes collared within the search area (one cell to either side, i.e. over nine cells in total) for a cell size of 5 km, draped over a grey-scale hill-shaded layer depicting the number of drillholes with maximum grade ≥ 500 ppb gold. Red represents the highest grade and blue, the lowest grade. Higher elevation represents a larger number of drillholes

Round 24 of Co-funded Exploration Drilling Program

On 20 October 2021, the Minister for Mines and Petroleum, Bill Johnston, announced the list of 51 successful applicants for Round 24 of the Exploration Incentive Scheme's (EIS) Co-funded Exploration Drilling Program. There were 84 applications submitted. More than 35% of successful applicants are searching for battery minerals with 73% of those looking for nickel.

A total of \$6.35 million in grants has been offered to companies. In addition to the battery commodities, other projects are targeting traditional metals such as gold, copper, silver and base metals, rare earth and platinum group elements. The project locations match the diversity of commodities, ranging from the South West to the Pilbara and Kimberley, Goldfields and remote regions of Western Australia's eastern border (Fig. 1).

In the 2021 budget, the State Government announced a \$2.5 million increase to the EIS, raising the annual allocation from \$10 million to \$12.5 million. In line with the increase to the EIS budget and increasing costs in drilling, there are new changes to the application capped values (50% of direct drilling costs) for Round 25 and beyond as follows:

- \$220 000 for one or two deep hole(s) application (was \$200 000 for one deep hole)

- \$180 000 for a multihole application (was \$150 000)
- \$40 000 for a prospector application (was \$30 000)

Since it commenced in 2009, the EIS Co-funded Exploration Drilling Program has offered funding to more than 1100 projects, resulting in more than 968 000 m of drilling across the State. The proportion of percussion drilling to diamond drilling is approximately 2:1, which has resulted in significant amounts of diamond core being submitted to one of two State core libraries.

The Joe Lord Core Library in Kalgoorlie, which was reaching near capacity for holding drillcore, has recently undergone a three-fold expansion to accommodate new core from EIS-co-funded drilling. See the story in this issue for more details.

The next round of EIS co-funded drilling (Round 25) will open for applications on 7 February 2022, and will be open for four weeks. Round 25 will be for drilling from 1 June 2022 to 31 May 2023. **Find** all information, including advice, guidelines and a copy of the co-funding agreement.

For more information, contact **Charlotte Hall**.

GENERAL

- 1 AIC Mines Ltd
- 2 AIC Mines Ltd
- 3 Alchemy Resources Ltd
- 4 Altura Mining Ltd
- 5 Antipa Minerals Ltd
- 6 Antipa Minerals Ltd
- 7 Ardea Resources Ltd
- 8 Ausgold Exploration Pty Ltd
- 9 AusQuest Limited
- 10 Avenira Limited
- 11 Bangemall Metals Pty Ltd
- 12 Black Cat Syndicate Limited
- 13 Black Raven Mining
- 14 Breaker Resources NL
- 15 Bryah Resources
- 16 Coronet Resources Ltd
- 17 De Grey Mining Ltd
- 18 Desert Metals Limited
- 19 DevEx Resources
- 20 First Development Resources Pty Ltd
- 21 Great Western Exploration Ltd
- 22 Hexagon Energy Material Ltd
- 23 Hexagon Energy Materials Ltd
- 24 Kalgoorlie Nickel Pty Ltd
- 25 Karora Resources
- 26 Lamboo Operations Pty Ltd
- 27 Lefroy Exploration Limited
- 28 Matlock Geological Services Pty Ltd
- 29 Maximus Resources Ltd
- 30 MCA Nominees Pty Ltd
- 31 Midas Minerals Ltd
- 32 Moho Resources Ltd
- 33 Musgrave Minerals Ltd
- 34 Opis Resources Pty Ltd
- 35 Pilbara Manganese Pty Ltd
- 36 Pilbara Minerals Ltd
- 37 Red 5 Limited
- 38 Regis Resources Ltd
- 40 Rincon Resources Ltd
- 39 Rincon Resources Ltd
- 41 S2 Resources
- 42 Sipa Exploration NL
- 43 Southern Star Exploration Pty Ltd
- 44 Tali Resources Pty Ltd
- 45 TechGen Metals Ltd
- 46 Tempest Minerals Ltd
- 47 Todd River Resources
- 48 WA1 Resources Ltd
- 49 Warriedar Mining Pty Ltd
- 50 Western Gold Resources

PROSPECTOR

- 51 Sandgroper Minerals Pty Ltd

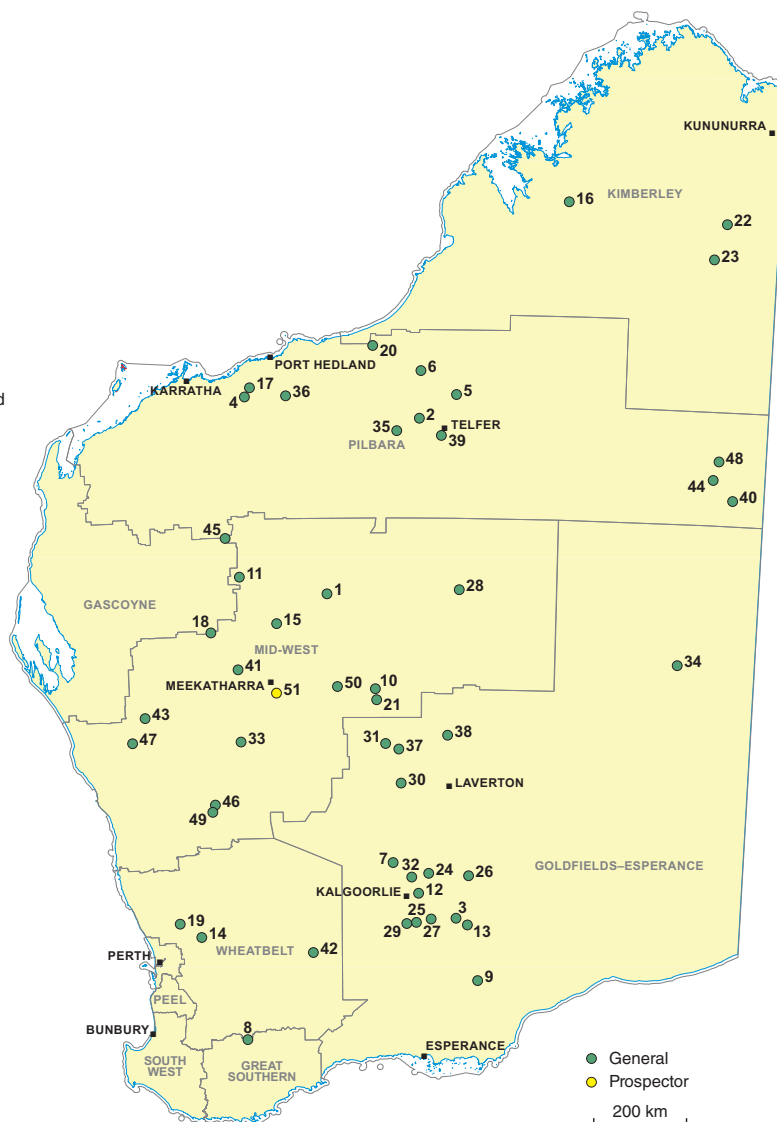


Figure 1. Locations and names of successful applicants, Round 24

Velocity anomalies and out-of-plane reflections

Barnicarndy 1 is the first well drilled in the frontier eponymous graben of the Canning Basin (Fig. 1). The well is near the south-southeast end of the graben. The well penetrated 2585 m of clastic sedimentary rocks overlying an angular unconformity formed at the top of steeply dipping Proterozoic dolomite basement.

Post-drilling data show that the velocities start off at 3000 m/s at 210 m, 3500 m/s at 450 m and 4200 m/s at 855 m in shallow intervals (Fig. 2). The velocities are approximately 500–1000 m/s faster than the nearest wells in the Willara Sub-basin and the Kidson Sub-basin, at equivalent depths for the upper half of the well trajectory. The anomalies in the velocity profile indicate that the Barnicarndy Graben has had a complex history of tectonic movement, and thick sections have been eroded after the Permian deposition.

Quantitative analyses also suggest that the seismic profile from the Kidson survey does not reflect entirely from within the vertical plane of the well, although Barnicarndy 1 is sited on the seismic line at ground level (Fig. 1). The steeply dipping basement near the south-southeast end of the graben causes out-of-plane

reflections in the 2D seismic data, such that the survey images shallow basement reflected from farther south, rather than what is vertically below the survey route.

How to access

GSWA Record 2021/9 Geophysical analysis of Barnicarndy 1: data quality control, velocity anomalies, out-of-plane reflections, and correlation uncertainties is available as a free downloadable PDF from the Department of Mines, Industry Regulation and Safety (DMIRS) eBookshop.

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

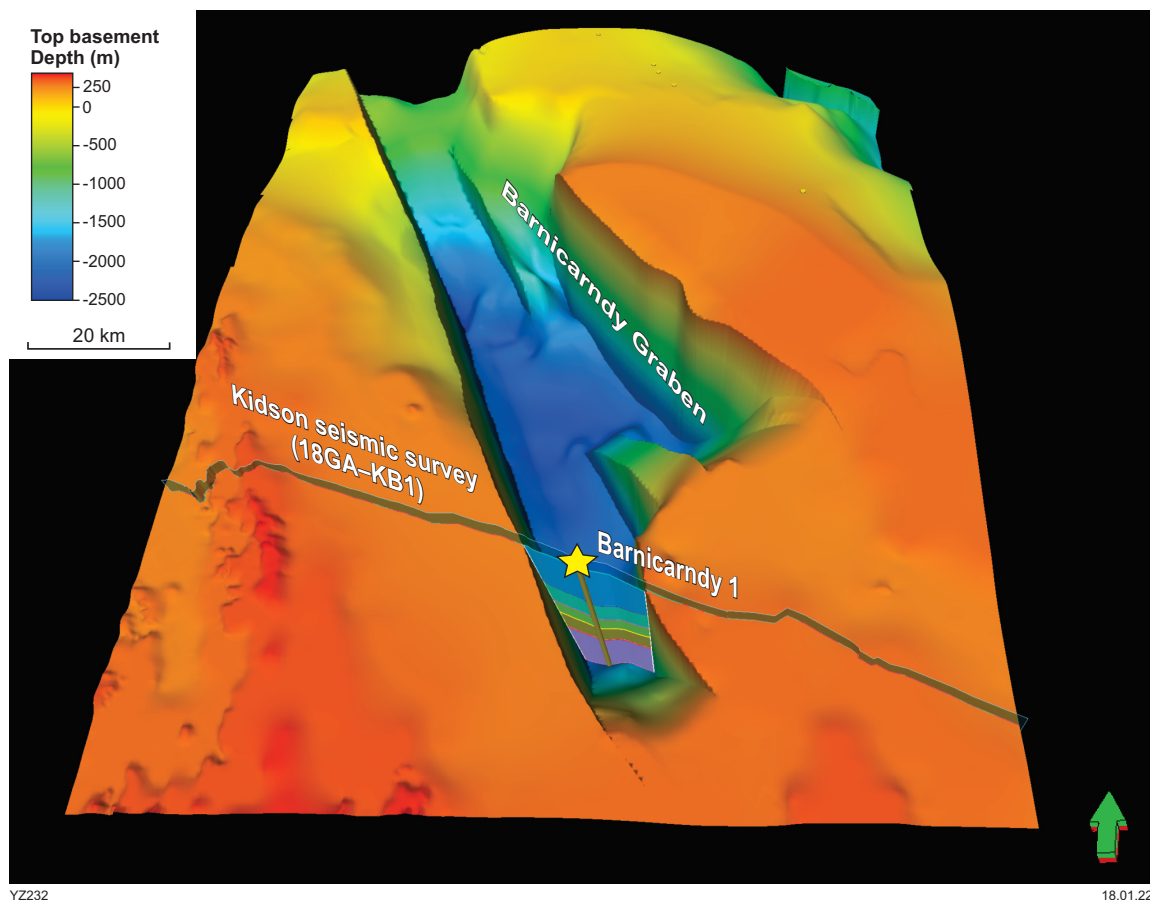


Figure 1. 3D model of the Barnicarndy Graben, showing the position of the Barnicarndy 1 well and the Kidson seismic survey

Geophysical analysis of Barnicarndy 1

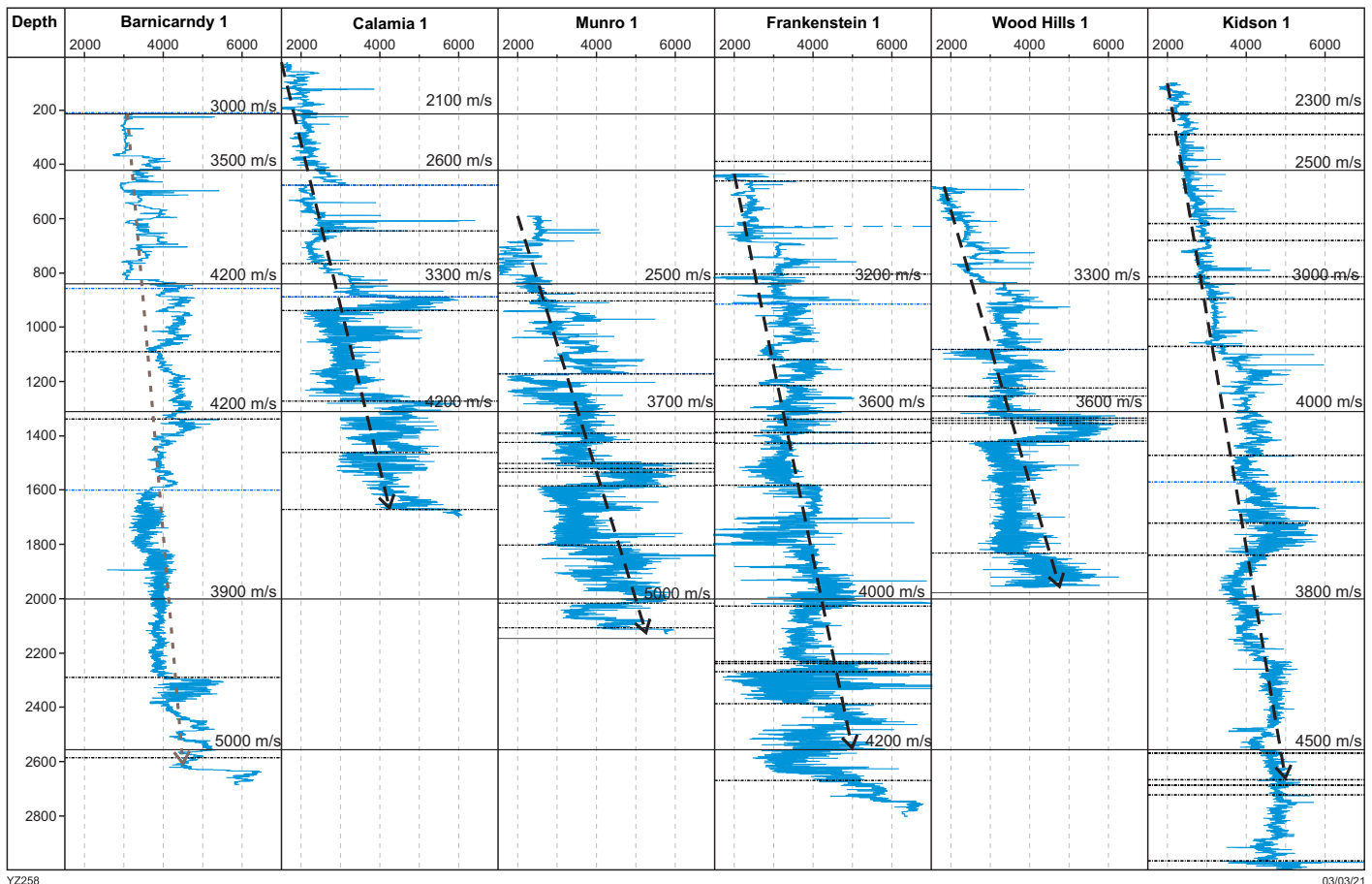


Figure 2. Velocity comparison between Barnicarndy 1 and offset wells

Renewable hydrogen strategy

Publication facilitates renewable hydrogen strategy

The Government of Western Australia has developed a renewable hydrogen strategy with the vision that Western Australia will become a significant producer, exporter and user of renewable hydrogen. Western Australia has outstanding potential for renewable energy, with an abundance of sun, wind and space. The Western Australian Renewable Hydrogen Roadmap (November 2020) includes the evaluation of using depleted oil and gas fields for hydrogen storage. A key aspect is the ability to store the hydrogen on a transitory basis and to be able to recover the hydrogen in high concentrations.

The Department of Mines, Industry Regulation and Safety (DMIRS) commissioned RISC to conduct a literature review of hydrogen storage and scoping study of storage potential of depleted oil and gas fields in Western Australia, along with a high-level literature review of other examples of underground hydrogen storage such as aquifers, salt caverns, underground mine sites and tunnels. RISC notes that there are alternative options for storing hydrogen on a transitory basis, such as surface and chemical methods, which are not included in the scope of this review.

The official [government media release](#) is now available.

Hydrogen Storage Potential of Depleted Oil and Gas Fields in Western Australia – Literature Review and Scoping Study by RISC is available as a free downloadable PDF from the DMIRS eBookshop.

For more information, contact [Deidre Brooks](#).



Joe Lord Core Library expansion



Expanded core library ready for core

The \$7 million expansion to one of Australia's largest drillcore libraries will enhance support to explorers looking for the next big resource discovery in Western Australia.

The Joe Lord Core Library in Kalgoorlie completed its expansion project in November 2021 after continued interest in the exploration of Western Australia's resource-rich regions resulted in the facility being filled to capacity.

The core library stores drillcore samples that contain valuable geoscientific information for exploration companies and others seeking new resource discoveries. Researchers and explorers can inspect the core samples and review results to reduce the technical and financial risk of exploration activities.

The extension will provide better access, more space and improved amenities to view and analyse the drillcores.

Mines and Petroleum Minister Bill Johnston said the wealth of information available at the Joe Lord Core Library can potentially save mining companies millions of dollars. 'The core library expansion highlights the State Government's ongoing support of the exploration industry in Western Australia,' Mr Johnston said. 'Measures to reduce exploration risk and attract investment will ensure the resources sector continues to be the bedrock of WA's economy.'

Mineral exploration hit \$2.1 billion in the 2020–21 financial year, an increase of 21% from \$1.7 billion in 2019–20. This increased Western Australia's share of national mineral exploration expenditure to 65%.

Much of the drillcore stored at the core library comes from the State Government's Exploration Incentive Scheme (EIS), a \$12.5 million per year program that aims to stimulate private sector resource exploration in Western Australia.

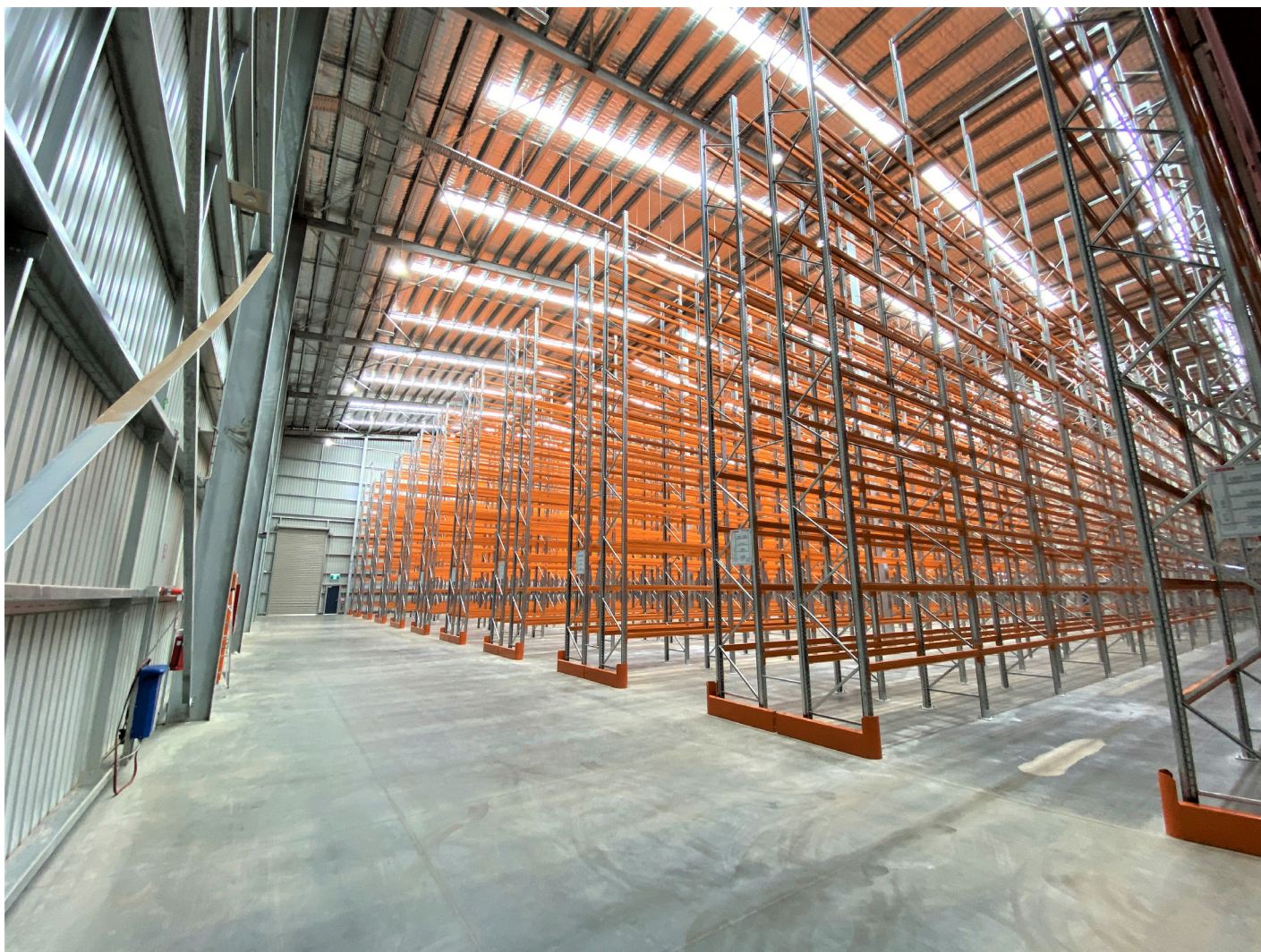
The EIS supports a Co-funded Exploration Drilling Program that encourages innovative exploration in greenfields and underexplored areas of the State.

The scheme also funds the Energy Analysis Program which promotes the re-analysis of existing data including core, sidewall core and cuttings, to better understand petroleum and geothermal systems.

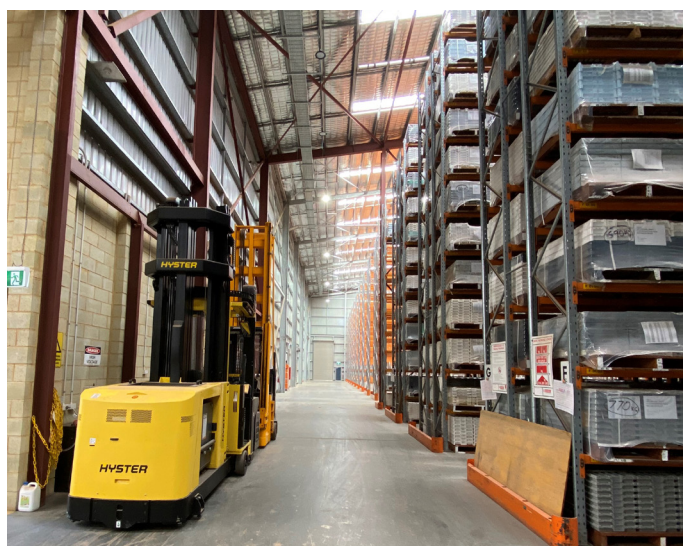
Find more information on Western Australia's [core libraries](#) and the [EIS](#).



Joe Lord Core Library expansion



- ◇ The Joe Lord Core Library covers 2100 square metres, has 9520 storage bays, and can display 3 km of drillcore.
- ◇ Western Australia has two purpose-built drillcore libraries: Joe Lord Core Library in Kalgoorlie and the Perth Core Library in Carlisle.
- ◇ Drillcores help build a geological map of Western Australia from the surface to more than 5 km underground.
- ◇ EIS success stories include the discovery of the Nova nickel mine, Bellevue Gold project, Tropicana gold mine and the Yeneena copper-cobalt project.



Left: (L-R) Dr Phil Gorey (Deputy Director General, DMIRS); Hon Bill Johnston (Minister for Mines and Petroleum); Hon Ali Kent MLA (Member for Kalgoorlie); Mr Jeff Haworth (Executive Director, Geological Survey and Resource Strategy, DMIRS); Hon Kyle McGinn MLC (Mining and Pastoral Region)

Declared the best on record!

The Geological Survey of Western Australia (GSWA) held its annual Open Day on Friday 12 November 2021 at the Hyatt Regency Hotel in Perth, Western Australia. With over 200 delegates across the minerals and energy resources sector, geoscientific research and related industries, this year's Open Day has been declared the best on record.

Our core themes – forging a pathway for geoscience, inspiring young professionals, and engaging successfully with industry – inspired us to modernize the way that we display our information, showcase our research, and stimulate our network. Relevance and accessibility were also key concepts, as well as having a bit of fun!

The demand for ticketing was overwhelming (we sold out!) and a testament to the power of consistent digital marketing. Attendees represented over 50 different organizations across geoscience research, mining and metals, oil and gas, universities, emerging energy, and data/information services. It was encouraging to see many fresh, young faces of the next generation of geoscientists. Hopefully in 2022, we will once again be able to welcome guests from interstate.

We kicked off the day with welcoming addresses from Executive Director, Jeffrey Haworth, and Hon Bill Johnston MLA, Minister for Mines and Petroleum. Michele Spencer, Director of Mineral and Energy Resources, introduced a film screening of 'This is GSWA', marking the short film's first broadcast to a live audience. Session 1 focused on the strategic outlook for GSWA – who we are, what we do, and where we are going – featuring presentations by Director of Regional Geoscience Simon Johnson and MinEx CRC Chief Executive Officer Andrew Bailey.

Session 2 provided the latest research outputs from the Accelerated Geoscience Program (AGP) from each theme leader – State GIS, Critical Minerals, South West Yilgarn, Far East Yilgarn, and New Energy Systems. Session 3 consisted of a series of shorter talks that concentrated on significant ongoing research projects. Before and after each presentation, our staff had the invaluable opportunity to network with attendees and make important connections. These sessions captured the collaborative and pertinent nature of our research, ranging from projects that are finalized to those that are just getting off the ground.



Figure 1. Our panellists (L-R) Katy Evans, Klaus Gessner, David Giles, Cam McCuaig, Simon Johnson, Jayne Baird, Sandra Occhipinti, Steffan Hagemann, and Geoffrey Batt

GSWA Open Day 2021

The panel discussion which followed tackled the complexities facing geoscience in an ever-changing world and controversial future. This incredible group of geoscience experts and industry representatives brought a wealth of professional and personal perspectives that combined into a truly rare experience.

During the day, we hosted an online event space on the Slido application. All questions were submitted through the app, and we also hosted some engaging live polls. Attendees had opportunities to liaise with online systems professionals and managers of our renowned WAMEX, WAPIMS and MINEDEX databases. There was also a stunning display of our breakthroughs in photogrammetry, 3D geology, and drone technology. Our more creative staff hosted a puzzle competition that was hotly contested!

The GSWA Open Day 2021 was an open day like no other! Progressive, relevant, expertly organized, and exclusive. Like any live event, some things worked very well and some things will be finetuned for the future. We can't wait to do it all again on Friday 18 November 2022 and bring you along for the ride.

How to access

Access the GSWA Open Day 2021 program, extended abstracts and view posters and presentations.

For more information, contact **Sabrina Bednarski**.

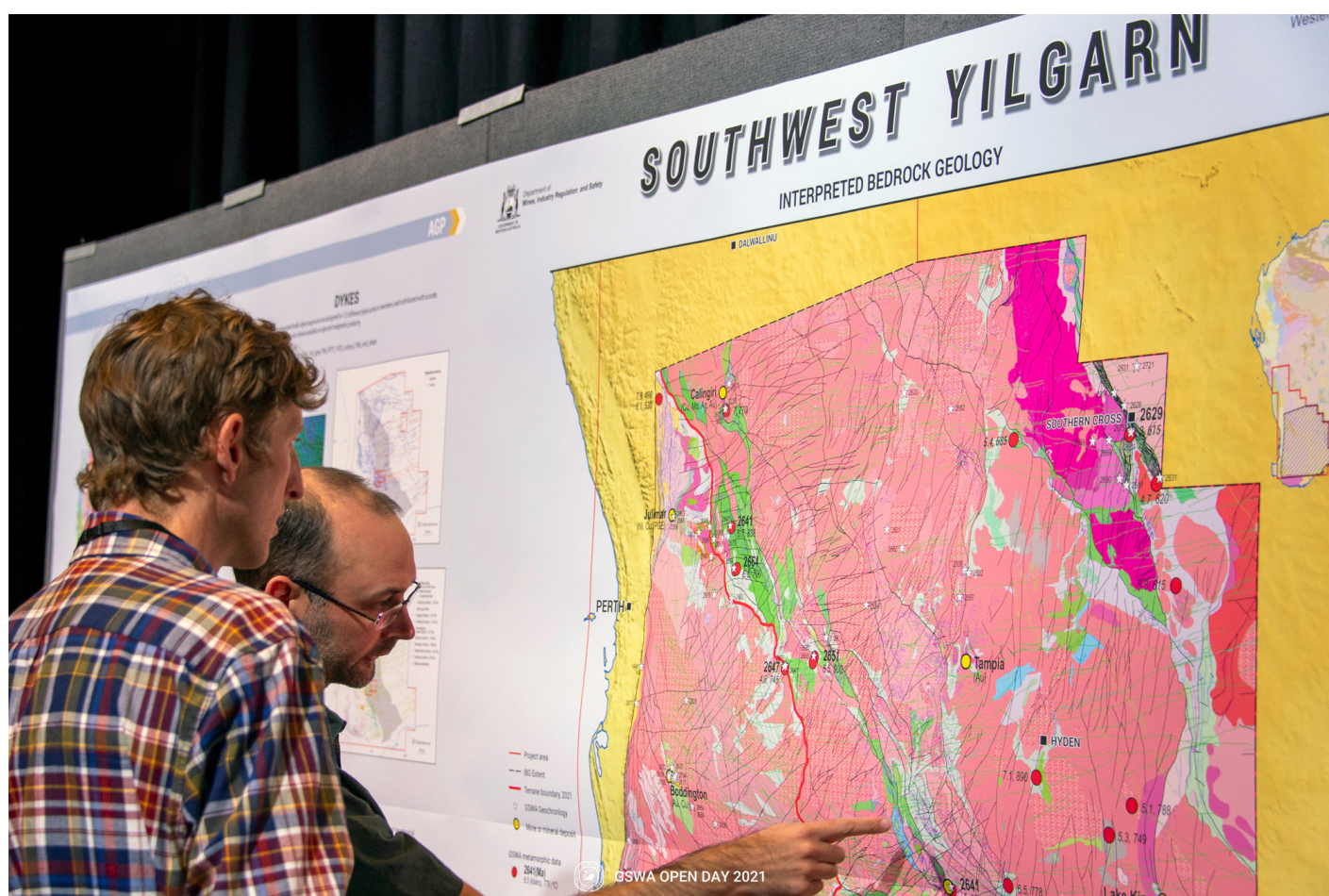


Figure 2. GSWA Senior Geoscientist, Tim Ivanic, taking an Open Day attendee through research on the Southwest Yilgarn's interpreted bedrock geology

Where we are working

Statewide

- New spatial geoscience layers in the Mineral Systems Atlas for manganese and potash
- New layers in WAPIMs-hosted Energy Systems Atlas
- Update on geothermal prospectivity

Pilbara

- Integrated geochemical, isotopic and geochronological study of igneous and sedimentary rocks of the Fortescue and Hamersley Basins
- Compilation of 1:100 000-scale interpreted geology maps and Explanatory Notes for the North Pilbara

Carnarvon Basin

- Triassic and Permian hydrocarbon source rocks
- Characterization and distribution of salt
- Biostratigraphy of the Byro Group

Canning Basin

- Barnicandy 1 post-well analysis
- AEM interpretation
- Characterization and distribution of salt
- Petrophysical and petrographic reservoir analysis for Olympic 1, Theia 1 and Senagi 1

Canning Basin

- Seismic monitoring 2021–31 mapping lithospheric architecture and current stress regimes

Paterson

- Geochronological and mineralization studies

East Pilbara

- Passive seismic 2020–22 mapping structure of Archean crust using teleseismic earthquakes

West Tanami

- REE mineralization studies

Murraba Basin

- Lucas Outlier geochronology
- Update to stratigraphy incorporating new geochronology

Amadeus Basin

- Regional review of stratigraphy and structure

The Gap

- Uncovering the remote heart of the State through integrated studies within MinEx CRC

Officer Basin

- Officer Basin SEEBASE
- Revision of formation tops
- Characterization and distribution of salt

Southwest

- SWAN passive seismic 2020–22 monitoring seismic hazard and imaging crustal architecture

Perth Basin

- Sedimentology of Harvey Wells core
- Southwest Hub project

Eastern Goldfields

- Seismic monitoring 2021–31 monitoring seismic hazard and imaging crustal architecture

West Yilgarn

- Field mapping
- Integrated structural, geophysical, geochemical, geochronological, and prospectivity studies
- Passive seismic survey

South West Yilgarn

- Gold mineralization studies

- 250 km
- Wagin Town
 - Road
 - Geoscience mapping and mineral systems studies
 - Seismic monitoring
 - Basins and Energy



Product releases

• BOOKS •

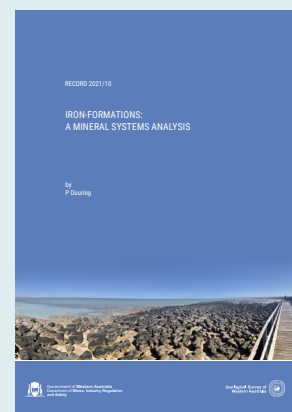
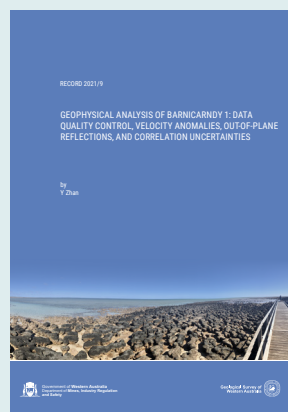
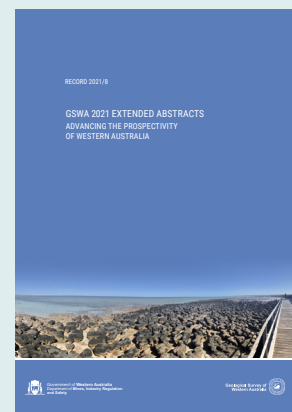
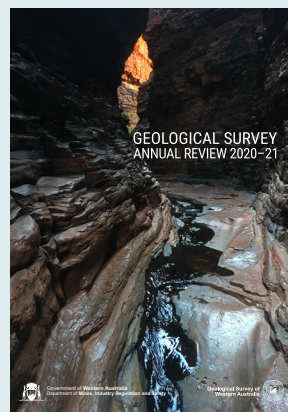
Geological Survey Annual Review 2020–21

Report 220 Depth to the basement estimate from seismic data – a comparative study
by Yang, A

Record 2021/8 GSWA 2021 extended abstracts: advancing the prospectivity of Western Australia

Record 2021/9 Geophysical analysis of Barnicarndy 1: data quality control, velocity anomalies, out-of-plane reflections, and correlation uncertainties
by Zhan, Y

Record 2021/10 Iron-formations: a mineral systems analysis
by Duuring, P



• DATA PRODUCTS •

1:10 000 000 tectonic units of Western Australia

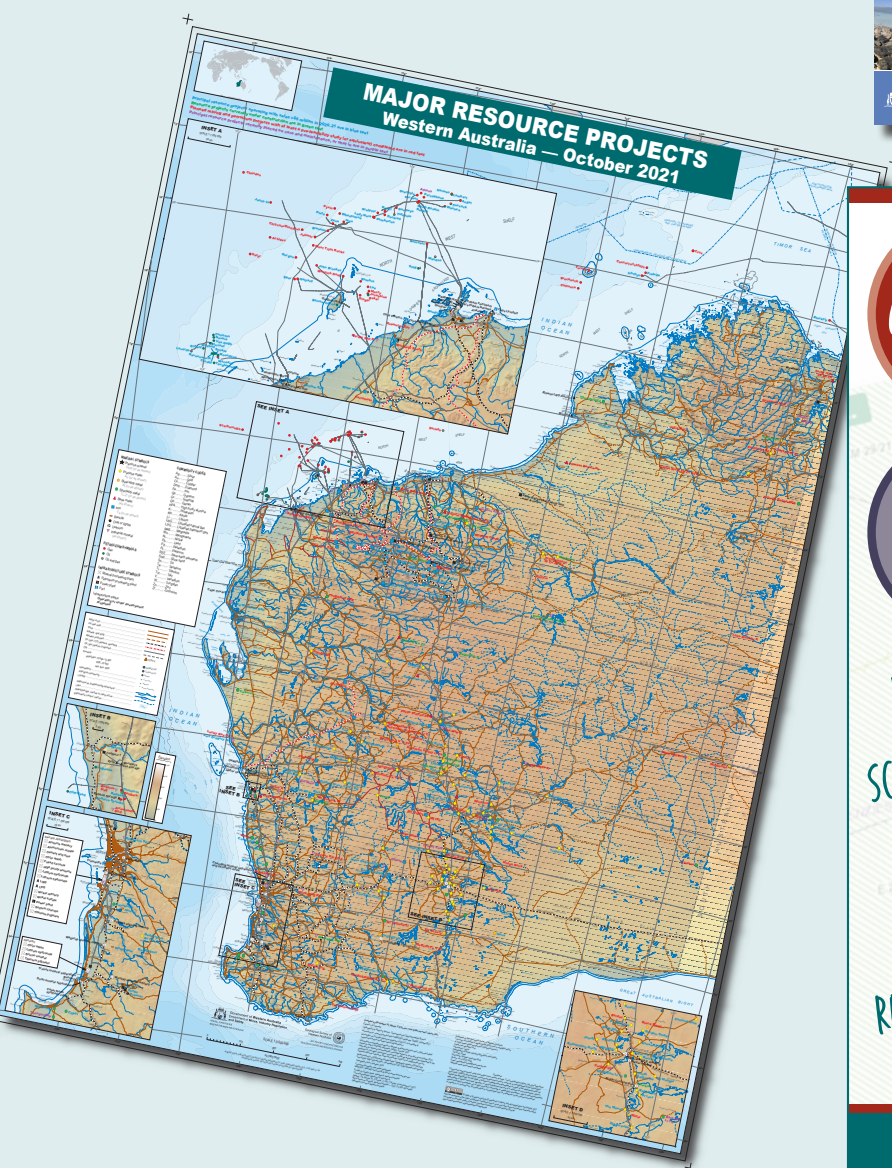
WAROX Text Extracts Online

Western Australian State geoscientific imagery and data, 2021

• MAPS •

Major resource projects, Western Australia — October 2021

by Sargent, SN, Wyche, NL, D'Ercole, C, Murray, SI and Irimies, F



GEOMAP.WA

GEOVIEW.WA

TENGRAPH WEB

MINEDEX

WAMEX

DRILLHOLES

DATE

Thursday 28 April 2022

SCHEDULE

09:00 – 10:00 **GeoMap.WA**
10:00 – 12:00 **GeoVIEW.WA** and **TENGRAPH Web**
12:00 – 13:00 **Lunch**
13:00 – 14:00 **Minerals and Mineral Deposits (MINEDEX)**
14:00 – 15:00 **Mineral exploration reports (WAMEX)** and **Exploration drilling and surface geochemistry database (Drillholes)**

REGISTER

www.dmirs.wa.gov.au/training

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

Geological Survey of Western Australia