Department of Mines, Industry Regulation and Safety
GOVERNMENT OF WESTERN AUSTRALIA

2022 GEOSCIENCE HIGHLIGHTS

Geological Survey of Western Australia

ARCHEAN GEODYNAMICS

West Yilgarn GIS 2022 — USB package

Amalgamates the South West and Narryer Terranes into the existing Youanmi Terrane project.
This product includes:

- An integration of recent mapping of the South West Terrane with existing mapping of the Narryer and Youanmi Terranes
- New Explanatory Notes for lithostratigraphic units
- New geochemical and geochronological data
- Update of available GSWA publications

Mapping the Darling Range

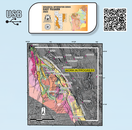
The Darling Scarp area records a multistage geological history spanning the Archean to the Mesozoic, representing an ideal target for improving our understanding of the evolution of craton margins through time.

Detailed meso- and microstructural investigations are being combined with geochronological and metamorphic data, with the aim of unravelling the sequence of superposed deformation events, their geometry, kinematics and tectonic significance. This will further our understanding of the evolving tectonic environments into which a vast array of mafic magmas were emplaced during Proterozoic times, and of the the potentially seismic nature of the low-temperature shear zones associated with the development of the Darling Fault.

East Yilgarn GIS 2022 — USB package

Includes an update of the interpreted bedrock geological map of the region southwest of the Zuleika Shear Zone, incorporating:

- Results from the Eastern Goldfields Greenstone Geochemical Barcoding Project
- New available information and interpretations from exploration activity



REPORT 232 — The Yilgarn Protocraton

New geochronology from across the western Yilgarn Craton identifies an early 100 Ma period of extensive but sporadic magmatism from 3010–2920 Ma.

We describe the stratigraphic–magmatic framework of these magmas, which form several volcano-sedimentary greenstone belts and granitic suites in the Youanmi Terrane and define the Southern Cross Supergroup and Thunderbird Supersuite.

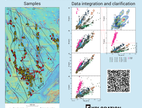
Fortescue–Hamersley GIS 2022 — USB package

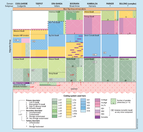
This product and accompanying GSWA Record 2022/4 includes;

- Mafic sills associated with the Pyradie, Boongal and Jeerinah Formations of the Fortescue Group, interpreted from new geochemistry and geochronology
- New Mapping on WYLOO 1:100 000 and YARRALOOLA 1:250 000 map sheets shows more detailed subdivisions of the Fortescue Group, Hamersley Group and Ashburton Formation

Eastern Goldfields Greenstone Geochemical Barcoding Project

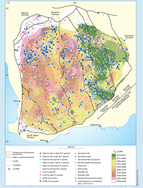
We are establishing a detailed chemostratigraphic 'barcode' of the igneous sequences within greenstone belts throughout the Eastern Goldfields. These barcodes can be applied in a predictive sense to help resolve specific stratigraphic and structural problems at various scales.





Yilgarn Granite Project

We are applying a uniform geochemical classification scheme to the expanding dataset of felsic geochemical data from the Yilgarn Craton. We aim to investigate temporal and spatial geochemical trends in terms of potential geodynamic influences and in terms of rare- and critical-metal fertility



All the AGP State GIS datasets and associated documentation are now available on the Western Australian State Imagery and Data Catalogue. Documentation for the Yilgarn Craton and selected images is also available for free download from the Data and Software Center and selected data and images can be found on GeoVIEW.WA.

ENERGY GEOSCIENCE HIGHLIGHTS

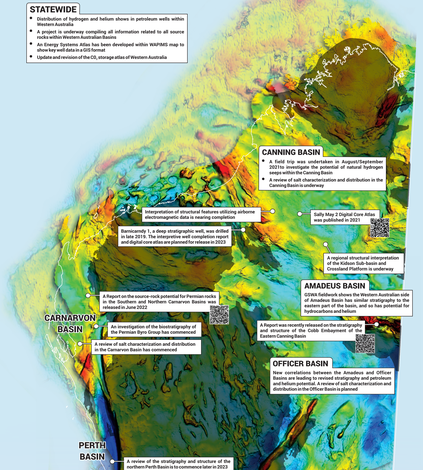
General information about the work of the Energy Geoscience and Carbon Strategy branch of the Geological Survey of Western Australia (GSWA) is available on the Department of Mines, Industry Regulation and Safety (DMIRS) website, at <www.dmirs.wa.gov.au/oilgasgeothermal>.

The department's eBookshop contains geological products including publications, maps and data packages. Most of these are available in PDF format free of charge from <www.dmirs.wa.gov.au/ebookshop>.

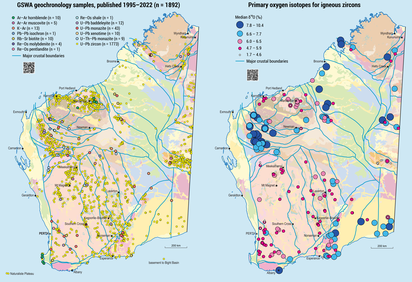
EXPLORATION INCENTIVE SCHEME

STATEWIDE

- Distribution of hydrogen and helium shows in petroleum wells within Western Australia
- A project is underway compiling all information related to all source rocks within Western Australian Basins
- An Energy Systems Atlas has been developed within WAPIMS map to show key well data in a GIS format
- Update and revision of the CO$_2$ storage atlas of Western Australia



GEOCHRONOLOGY GEOCHEMISTRY

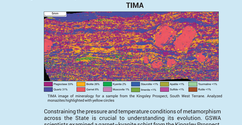


EXPLORATION INCENTIVE SCHEME

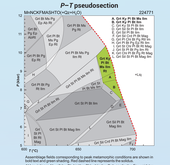
John de Laeter Centre

THE UNIVERSITY OF WESTERN AUSTRALIA

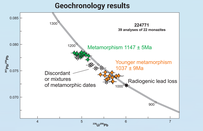
Expanding our knowledge of the timing of metamorphism in Western Australia



P–T pseudosection



Geochronology results



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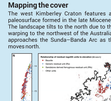
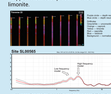
GEOSCIENCE MAPPING THROUGH COVER

Mapping the cover

The west Kimberley Craton features an extensive paleosurface formed in the late Miocene to Pliocene. The landscape tilts to the north due to the downward warping to the northwest of the Australian plate as it approaches the Sunda–Banda Arc as the continent moves north.



Characterizing the properties of the regolith is crucial to imaging through it, especially imaging the thickness to bedrock. Seismic studies using horizontal-to-vertical spectral ratios (HVSR) in the Ord River Valley paleosurface environment indicate that gradational velocity changes between cover and bedrock can obscure the likely depth to bedrock. Even so, the cover was still better mapped than sharp contact between saprolite and limonite.

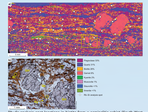


Proterozoic margins

Highlights from new work on the Lamboo Province and Kimberley Basin include:

- Lu–Hf isotope data from the Lamboo Province indicates a common source with c. 2500 Ma and 1885–1860 Ma age components
- Deposition occurred prior to the Halls Creek Orogeny, and assembly of the Eastern, Central and Western zones of the Lamboo Province occurred prior to 1885 Ma
- Previously separate sub-basins have been grouped into the Kimberley Basin, with deposition in a sag basin following the 1837–1808 Ma Halls Creek Orogeny
- Craton-wide sedimentation at c. 1800 Ma across the North Australian Craton was fluvial to shallow marine over relatively flat-lying metamorphosed basement

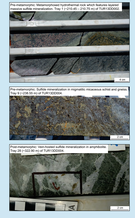
Rb–Sr on biotite and muscovite, in collaboration with Curtin University, has identified low-temperature geologic events that may not be captured by other commonly used decay systems, such as U–Pb. Samples were analysed across the State, and application of other novel isotopic systems, such as Lu–Hf garnet geochronology, is currently underway.



GEOSCIENCE MAPPING THROUGH COVER

Topping up knowledge beneath the Canning Basin

New results at Top Up Rise



EXPLORATION INCENTIVE SCHEME

MinEx CRC

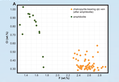
With five EIS cores intersecting crystalline basement beneath the eastern Canning Basin, we have learnt:

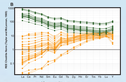
- The detrital zircons in peraluminous metagarnitic and metasedimentary rocks has a North Australian Craton signature of 1880–1870 Ma. Metamorphism and magmatism occurred 1624–1604 Ma
- Two generations of sulfide mineralization: one prior to, and one subsequent to metamorphism
- An olivine gabbro intruded at 968 Ma, with the youngest history shown in a late Neoproterozoic mylonite

Fluid fingerprinting using apatite

Studies of apatite to help chemically fingerprint the hydrothermal fluids producing mineralization shows that unaltered apatite are:

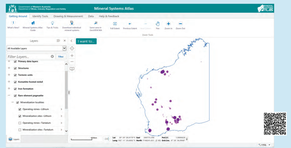
- Poorer in F, severely depleted in LREE and depleted overall in total REE
- Enriched in Cl





MINERAL SYSTEMS ATLAS

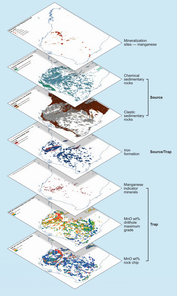
The Mineral Systems Atlas provides exploration-relevant spatial data via an online browser-based viewer. Critical processes for mineralization and their mappable proxies are identified using the mineral systems approach, which examines source, active pathways, traps (physical and chemical) and modification/preservation. Selected practical mappable proxies are included in the Atlas itself.



New systems just released

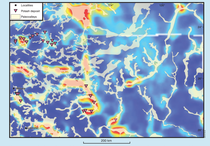
Manganese

- An important raw ingredient for batteries, wind turbines, and aluminium/steel alloys
- Stratiform, supergene, hypogene, and iron-formation deposit classes have been grouped into a manganese mineral systems model



Evaporite brine-related potash

- A critical nutrient for plant growth that is vital to world agriculture. Potash-rich brines can provide a cost-efficient method of producing the premium fertilizer sulfate of potash
- These brines occur in semi-arid and arid zones in Western Australia, where they are closely associated with inland saline lakes, playas and paleovalleys



Other systems covered to date

- Komatiite-hosted nickel
- Iron formations
- Rare-element pegmatites
- Layered intrusion-hosted vanadium
- Future work will target mafic-hosted nickel–cobalt–copper–platinum group elements

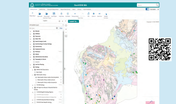
The Atlas is under continuous development. Additional layers will be added to existing mineral systems and prospectivity 'heat' mapping is planned for selected systems.
Mineral systems are described through an online Guide and standalone GSWA Record. These resources provide a useful synopsis of current knowledge for explorers, students and researchers alike.

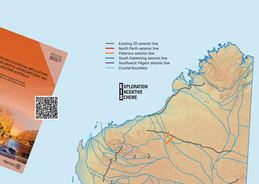
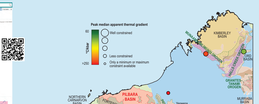
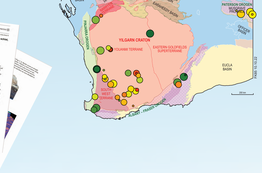
For more information, contact:
Warren Ormsby (warren.ormsby@dmirs.wa.gov.au)

Download these recently published systems

- Evaporite brine-related potash
- Komatiite-hosted Ni–Cu–PGE deposits
- Manganese

STATE GEOSCIENCE





Proposed seismic reflection lines to test key major crustal boundaries have been scouted and tenders prepared, with final line selection in early 2023 and anticipated aquisition in 2024