

RECORD
2022/12

GSWA 2022 EXTENDED ABSTRACTS

ADVANCING THE PROSPECTIVITY OF
WESTERN AUSTRALIA



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

Geological Survey of
Western Australia





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Advancing the prospectivity of
Western Australia

November 2022

Perth 2022



**Geological Survey of
Western Australia**

MINISTER FOR MINES AND PETROLEUM
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Based on consultation with the Western Desert Lands Aboriginal Corporation (WDLAC) on the cultural significance of the name, Waukarlycarly, it has been agreed to change the name of the well to Barnicarndy 1 and the tectonic subdivision to Barnicarndy Graben. This and all future publications will now refer to the Barnicarndy 1 stratigraphic drillhole (previously Waukarlycarly 1) and the Barnicarndy Graben (previously Waukarlycarly Embayment).



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<i>R Wade, Chamber of Minerals and Energy; C Wilkinson, Australian Petroleum Production and Exploration Association</i>	

Introducing GSWA Open Day 2022



I am very happy to welcome you to the Geological Survey of Western Australia (GSWA) Open Day 2022, our annual showcase of products and geological work for 2022.

We made innovative improvements to last year's Open Day, which had a record number of delegates who enjoyed the new format, with tickets sold out earlier than anticipated. For the second time, we are hosting this event in November, instead of February. Also for the second time, we are at the Hyatt Regency Hotel in East Perth, rather than in Fremantle.

We are hosting a broader range of presentations, a panel discussion that tackles a pertinent issue for the resources sector and the State, and more opportunities to get hands-on with the technology that will shape the future of geoscience. We are also more focused on the experience of our delegates who have responded with overwhelming positivity and enthusiasm to the 2021 Open Day.

In addition to our business as usual, this year GSWA has been working on several key priorities as part of the GSWA strategy 2030:

- **Garnering Geoscience Knowledge** – we released our Geoscience Strategy (www.dmirs.wa.gov.au/gswastrategicpriorities) this year, aimed at building our geological understanding of the State by acquiring and synthesizing pre-competitive data utilizing collaborative research and strategic partnerships
- **Transforming our Data** – we commenced the Geoscience Data Transformation Program, a five-year program that will enable the delivery of the Geoscience Data Transformation Strategy. This program will modify the way we store, analyse and deliver our data to ensure its fluidity with emerging technology and innovation.

I am confident that this year will surpass what we achieved last year and will augment industry knowledge in the resources sector.

Michele Spencer
Executive Director, Geological Survey



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



EXPLORATION
INCENTIVE
Scheme

GSWA OPEN DAY Program

Friday 25 November 2022, Hyatt Regency Hotel Perth

08:15 Doors Open

SESSION 1, Chair: Charlotte Hall

09:00 Welcome to Country

09:15 Opening Address

09:25 First Keynote

09:45 Second Keynote

Prof. Simon Forrest

The Hon. Bill Johnston MLA

Minister for Mines and Petroleum

Michele Spencer

Nicole Roocke

Minerals Research Institute of Western Australia

MORNING TEA 10:00 – 10:45

SESSION 2, Chair: Simon Johnson

10:45 WaterSmart Farms: prospecting for fractured rock aquifers in the Wheatbelt

11:00 Is mineral carbonation an option for CO₂ mitigation in Western Australia?

11:10 Exploration Incentive Scheme

11:20 Sedimentary-hosted Cu systems in the Paterson Orogen

11:30 Changing perspective: a whole-of-lithosphere approach to mineral discovery

11:45 WA-Array – the next statewide dataset

Richard Chopping

Trevor Beardsmore

Louisa Dent

Fawna Korhonen

Graham Begg

Minerals Targeting International

Ruth Murdie

LUNCH 12:00 – 13:15

SESSION 3, Chair: Klaus Gessner

13:15 Geoscience Data Transformation Program

13:30 CO₂ sequestration in Western Australia

13:45 Natural hydrogen: indications from onshore Western Australia sedimentary basins

14:00 Mineral Systems Atlas

14:10 Land access and Aboriginal engagement

14:20 Tenure for emerging industries

Tony Perry

Deidre Brooks

Peter Haines

Matt Clarke

Michael McMahon

Samantha Carter

AFTERNOON TEA 14:30 – 15:15

SESSION 4, Chair: Richard Chopping

15:15 Panel Discussion:

Competing or cooperating? Optimizing
land use for net zero

Samantha Carter

Geological Survey of Western Australia

Jaco Hugo

Rio Tinto, Copper

Matt Darcey

Department of Planning, Lands and Heritage

Roannah Wade

Chamber of Minerals and Energy

Claire Wilkinson

Australian Petroleum Production and Exploration Association

SUNDOWNER ON THE MEZZANINE 16:30 – 18:00

WaterSmart Farms: prospecting for fractured rock aquifers in the Wheatbelt

R Chopping, R George¹ and B Harris²

WaterSmart Farms is a project led by the Department of Primary Industry and Regional Development (DPIRD) that aims to provide water security for the Wheatbelt in the face of a drying climate. The project focuses on three core areas: WaterSmart dams, desalination technologies and groundwater studies. To assist with the groundwater studies, the Geological Survey of Western Australia and Curtin University have been collaborating on the method development and conceptual understanding of the bedrock fractured-rock aquifer system beneath the Wheatbelt.

In response to a drying climate, anecdotally there has been an increase in deeper drilling for aquifers in the Wheatbelt. This drilling has penetrated the zone 100–150 m below the surface, beneath traditional aquifers in paleochannels and the saprolitic regolith, and into the bedrock of the Yilgarn Craton. Some of these water bores have seen good yields at relatively low salinity, with the water derived from fractured zones within the Yilgarn.

The pre-Mesozoic geology of the Wheatbelt and surrounds was compiled and published as the South West Terrane interpreted bedrock geology (IBG) as a digital layer for the Accelerated Geoscience Program.

This geological mapping provides the backbone for successfully prospecting for fractured-rock aquifers in the region. Two main ingredients are examined: geological units likely to produce a competency contrast, and also brittle structures. This allows for focusing on the areas likely to have more open fractures to host groundwater.

In addition to this mapping, which assists in narrowing the search space for these aquifers, ground geophysics are used to assist in the targeting (acquisition at a typical site depicted in Fig. 1). Many structures are apparent in magnetic data, and ground magnetic data can provide insights into a more local-scale view compared to the aeromagnetics used in the production of the IBG. Acoustic resonance studies are also to be conducted at drilling sites. Drilling of the first round of targets is anticipated in late November 2022, pending contractor availability. These drilling results will help refine the conceptual model of how fracture systems have developed within the Yilgarn, increasing the chance of success for future water bore programs in the region. Finally, these drillholes will be augmented with optic fibres placed in the holes, allowing for future monitoring of not just water parameters but also seismic and other properties.



Figure 1. Acquisition of ground magnetic data by Dominic Howman (Senior Technical Officer, Curtin University) at a site near Williams. The magnetometer is carried in a backpack with the antenna receiving GPS signals for positioning and timing for diurnal magnetic corrections

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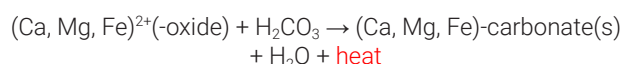
² Curtin University – WA School of Mines, 26 Dick Perry Ave, Kensington WA 6151

Is mineral carbonation an option for CO₂ mitigation in Western Australia?

TJ Beardsmore

Humankind's current annual greenhouse gas (GHG) emissions of about 50 billion tonnes CO₂e¹ must be halved by 2030, to be on track to limit global warming to 1.5 °C above pre-industrial levels by 2100. However, existing international GHG emission reduction measures achieve only a fraction of the amount required, and the deficit must necessarily be chemically, biologically or physically sequestered (IPCC, 2022).

Mineral carbonation is a process long recognized for its potential to sequester significant CO₂ (Lackner et al., 1995). The fundamental principle is that CO₂ reacts with Ca²⁺, Mg²⁺ or Fe²⁺ in silicate rocks or industrial wastes, to produce inert carbonate minerals that can be 'permanently' stored, or used in new products. Carbonation reactions are more efficient if CO₂ is dissolved in water to create a mildly acidic solution that accelerates breakdown of metal-bearing compounds. The generic, exothermic reaction is:



Common silicate minerals like olivine, serpentine, amphibole (including asbestiform varieties), talc and pyroxene are amenable to carbonation, and are abundant in mafic and ultramafic rocks. Some industrial wastes may also be compositionally favourable, such as certain mine tailings, combustion ashes from coal-fired power stations and waste incinerators, blast furnace slags and cement calcination residues.

Mineral carbonation occurs naturally, but slowly. Rapid sequestration of substantial CO₂ requires an accelerated, industrial-scale approach, using in situ or ex situ processing techniques. In situ carbonation injects CO₂ as a near-pure (slightly damp), supercritical phase or dissolved in water, into favourable rock formations at elevated temperatures and pressures (Fig. 1a, b). Ex situ carbonation combines CO₂ and solid feedstocks in artificial reactors (Fig. 1c), which might be conventional processing plants, industrial waste piles, or deep boreholes into the Earth's upper crust (Oelkers et al., 2008; Santos et al., 2013). Western Australia has abundant materials favourable for mineral carbonation – its mafic and ultramafic rocks alone might theoretically capture up to 144 trillion tonnes of CO₂ in their upper 1000 m. There are also hundreds of tailings facilities associated with Ni, V, Cr, Fe, Au, diamond, and bauxite mines, that may contain reactive minerals (Fig. 2).

The technical feasibility of mineral carbonation has been amply demonstrated (e.g. see reviews by Olajire, 2013; Power et al., 2013; McGrail et al., 2017; Gislason et al., 2018; Veetil and Hitch, 2020). Despite this, the process remains little used, because CO₂ and carbonation products have low values, and the availability of suitable feedstocks is poorly defined (including in Western Australia). Mineral carbonation economics will improve as research increases processing efficiencies and better characterizes feedstocks. However, appropriate government policy support is also needed to motivate its use.

To help establish mineral carbonation in Western Australia's GHG emission abatement strategy, CSIRO and Edith Cowan University are testing whether local mafic and ultramafic rocks are favourable for in situ processing, and Curtin University is developing a roadmap to define what research, policy settings and stakeholder engagement are required to promote ex situ processing. The Geological Survey of Western Australia is contributing geological data and advice to both these projects.

References

- Gislason, SR, Sigurdardottir, H, Aradottir, ES and Oelkers, EH 2018, A brief history of CarbFix: Challenges and victories of the project's pilot phase: *Energy Procedia*, v.146, p.103–114, doi:10.1016/j.egypro.2018.07.014.
- IPCC 2005, Carbon Dioxide Capture and Storage - IPCC Special Report Prepared by Working Group III of the Intergovernmental Panel on Climate Change: Metz, B, Davidson, O, de Coninck, HC, Loos, M and Meyer, LA (editors): Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 442p., <www.ipcc.ch/site/assets/uploads/2018/03/srccs_wholereport-1.pdf>.
- IPCC 2022, Climate Change 2022 – Mitigation of Climate Change: Working Group III contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, <www.ipcc.ch/report/ar6/wg3/>.
- Lackner, KS, Wendt, CH, Butt, DP, Joyce Jr, EL and Sharp, DH 1995, Carbon dioxide disposal in carbonate minerals: *Energy*, v.11, p.1153–1170, doi:10.1016/0360-5442(95)00071-N.
- McGrail, BP, Schaefer, HT, Spane, FA, Horner, JA, Owen, AT, Cliff, JB, Qafoku, O, Thompson, CR and Sullivan, EC 2017, Wallula Basalt Pilot Demonstration Project: Post-injection results and conclusions: *Energy Procedia*, v. 114, p. 5783–5790, doi:10.1016/j.egypro.2017.03.1716.
- Oelkers, EH, Gislason, SR and Matter, J 2008, Mineral carbonation of CO₂: *Elements*, v. 4, p.333–337, doi:10.2113/gselements.4.5.333.
- Olajire, AA 2013, A review of mineral carbonation technology in sequestration of CO₂: *Journal of Petroleum Science and Engineering*, v.109, p.364–382, doi:10.1016/j.petrol.2013.03.013.
- Power, IM, Harrison, AL, Dipple, GM, Wilson, SA, Kelemen, PB, Hitch, M and Southam, G 2013, Carbon Mineralization: From Natural Analogues to Engineered Systems: *Reviews in Mineralogy & Geochemistry*, v.77, p. 305–360, doi:10.2138/rmg.2013.77.9.
- Santos, RM, Verbeeck, W, Knops, P, Rijnsburger, K, Pontikes, Y and Van Gerven, T 2013, Integrated mineral carbonation reactor technology for sustainable carbon dioxide sequestration: 'CO₂ Energy Reactor': *Energy Procedia*, v.37, p.5884–5891, doi:10.1016/j.egypro.2013.06.513.

¹ CO₂e – Equivalent carbon dioxide, the amount of CO₂ emission that would cause the same amount of global warming as another greenhouse gas, over a given time period. CO₂e is obtained by multiplying the emission of each greenhouse gas by its Global Warming Potential (GWP) and summing the equivalent CO₂ emissions. For instance, 1 t of methane and nitrous oxide have GWPs equivalent to (at least) 25 t and 298 t of CO₂, respectively, over 100 years

Snæbjörnsdóttir, SO, Sigfússon, B, Marieni, C, Goldberg, D, Gíslason, SR and Oelkers, EH 2020, Mineral Storage of CO₂: Nature Review: Earth and Environment, v. 1(2), p. 90–102, doi:10.1038/s43017-019-0011-8.

Veetil, SP and Hitch, M 2020, Recent developments and challenges of aqueous mineral carbonation - a review: International Journal of Environmental Science and Technology, v.17, p.4359–4380, <www.researchgate.net/publication/341631430>.

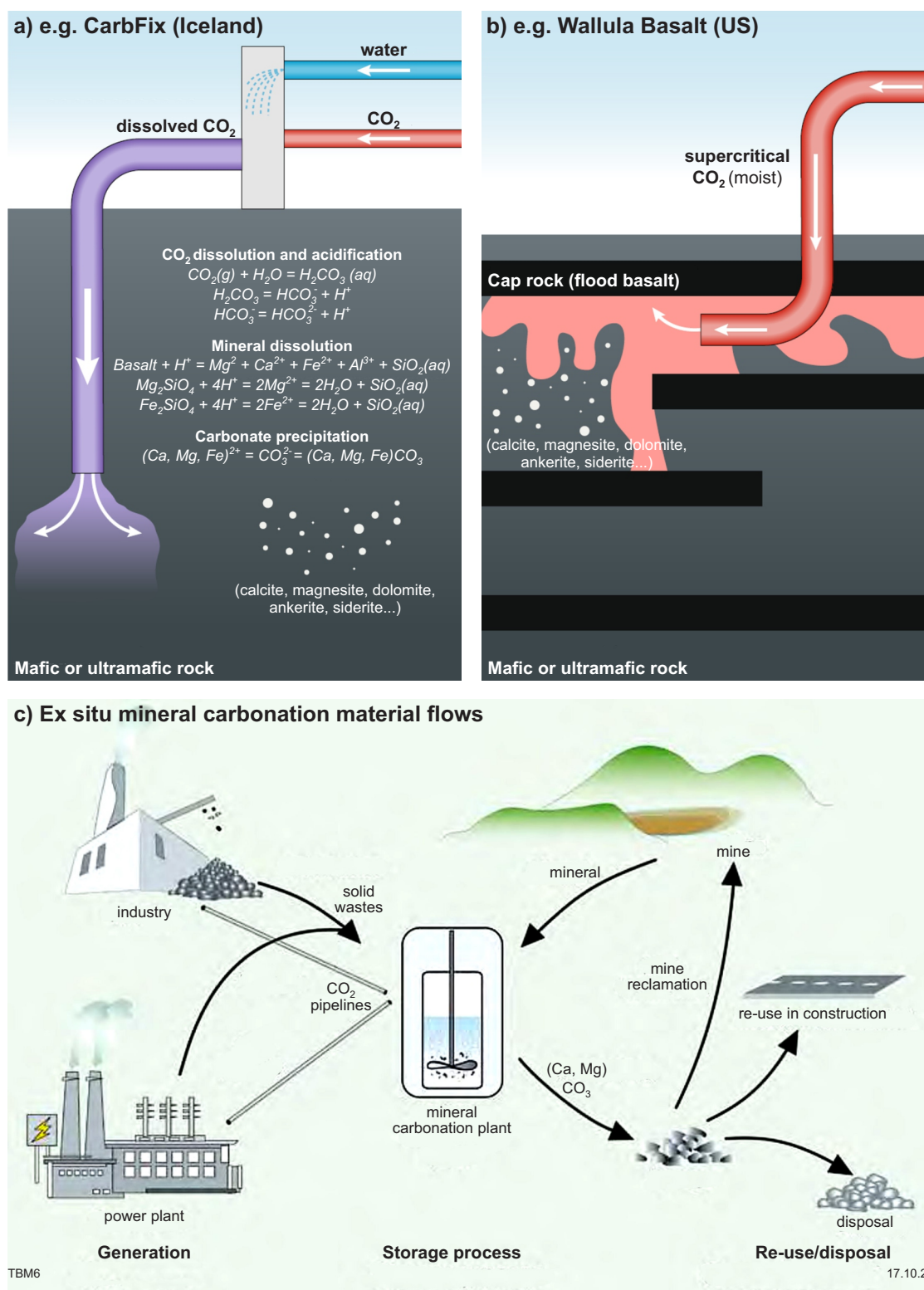


Figure 1. Conceptual illustrations of mineral carbonation: a,b) in situ processing, where CO₂ is injected into suitable rock formations in solution (a) or as a moist supercritical phase (b), to create a mildly acid solution that dissolves silicate minerals, releasing metals that can combine with CO₂ to form new carbonate minerals (modified from figure 4 in Snæbjörnsdóttir et al., 2020); c) ex situ processing, showing generalized material fluxes and process steps associated with use of silicate rock waste or industrial residues (after figure 7.2 in IPCC, 2005)

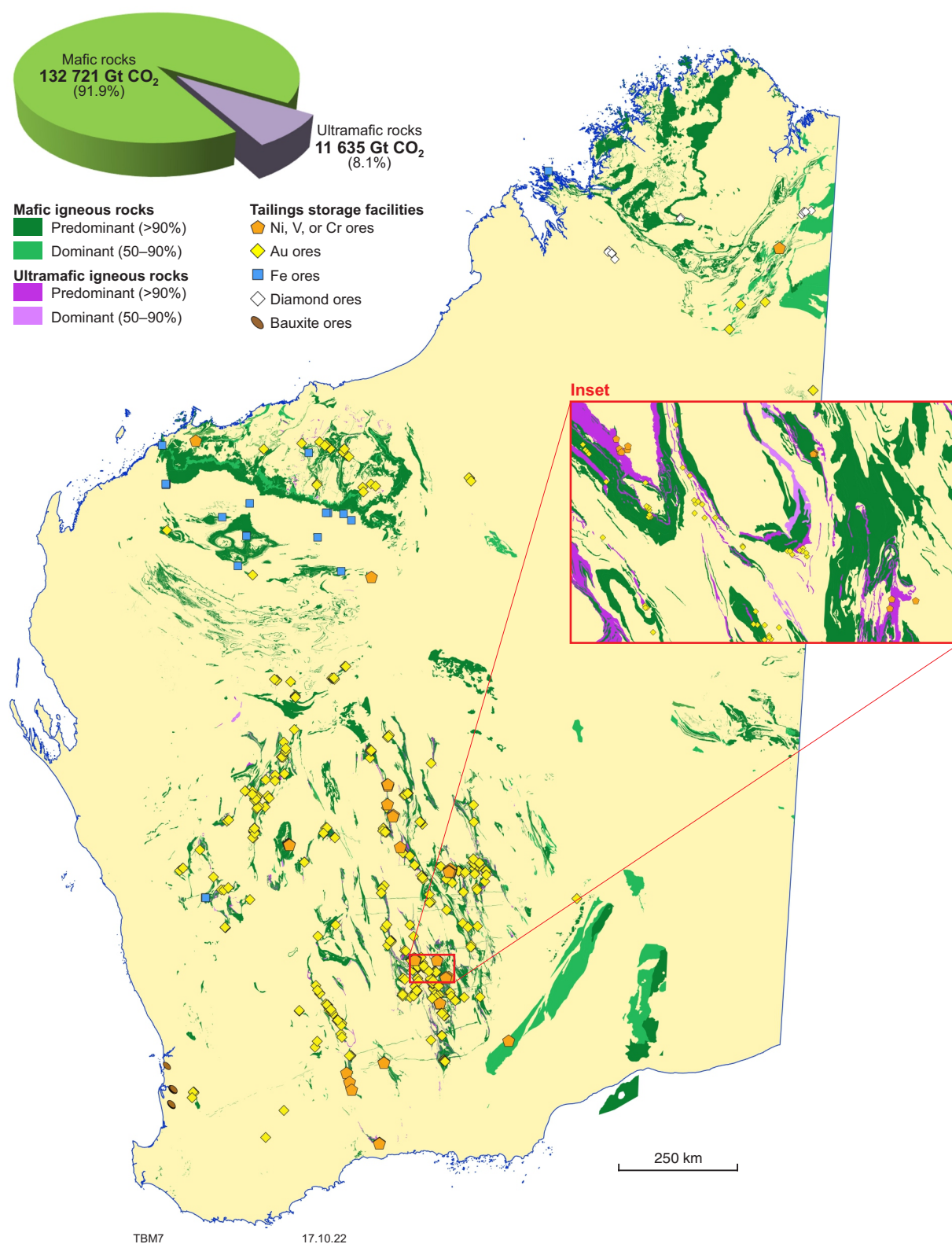


Figure 2. Map showing the distribution of outcropping or near-surface mafic and ultramafic rock units prospective for mineral carbonation, and tailings storage facilities associated with selected commodities, where wastes from ore processing will likely contain favourable minerals. Inset A shows estimated theoretical maximum masses of CO₂ that bedrock units could sequester, assuming average basaltic and peridotitic (including serpentinized) compositions and densities, average respective carbon capture factors of 0.15 and 0.38 (tonnes CO₂ captured per tonne of rock), and 100% carbonation of MgO and CaO as pure magnesite (MgCO₃) or calcite (CaCO₃). Inset B illustrates the level of detail in the GIS map layer used for these calculations

Exploration Incentive Scheme

L Dent and C Hall

The Exploration Incentive Scheme (EIS) is a State Government initiative that encourages exploration in Western Australia for long-term sustainability of the State's resources sector.

Each year, \$12.5 million in funding is provided to assist the resource sector by co-funding exploration drilling and energy analysis programs, and contributing to the generation of pre-competitive, regional, geoscience datasets.

Recently, the EIS has contributed to the collection of statewide Airborne Electromagnetic (AEM) data (Fig. 1a), large-scale geochemical barcoding and granite geochemistry projects, regional petrophysical sampling of drillcore, and acquisition of passive and active seismic.

In the past five years, the EIS Co-funded Drilling Program has recorded an increase in the amount of diamond drilling conducted for exploration (Fig. 1b). HyLogger analysis is

routinely run on these cores, and to further maximize their benefit, new petrophysical sampling is being undertaken on a number of these diamond cores. Together, these analyses are continuously generating a multicomponent dataset for exploration under cover in Western Australia. The petrophysical sampling program is currently targeting drillcores that will provide complementary data to help interpret new and existing geophysical data.

Planned future EIS programs will contribute to 2D active reflective and passive seismic projects across the State, and coil tube drilling (MinEx CRC collaboration) initiatives (Fig. 1c).

Together, these core-scale to State-scale programs will complement one another, providing new insight into Western Australia's crustal architecture, structure of the continental mantle, and develop an understanding of the State's undiscovered resource potential.

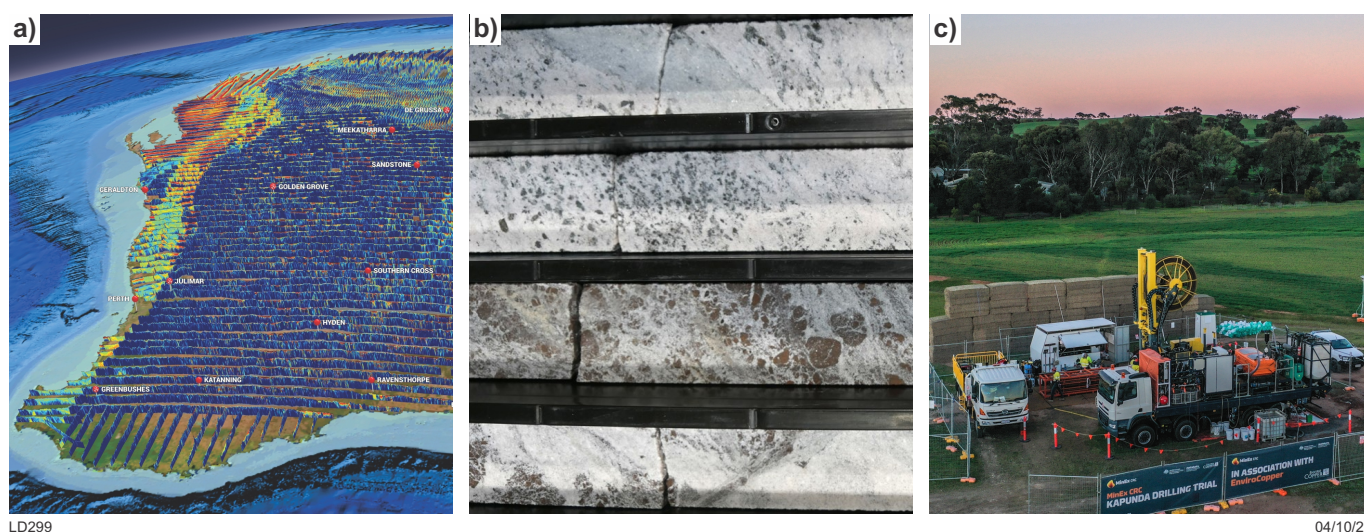


Figure 1. a) Coil tube drill rig (Minex CRC), which will be used for the National Drilling Initiative (NDI) across Australia including in Western Australia; b) Lynas Corporation Mount Weld carbonatite core; c) AEM data collected across Western Australia (data available through the Geological Survey of Western Australia's MAGIX system, GeoVIEW.WA and the Geoscience Australia data catalogue

Sedimentary-hosted Cu systems in the Paterson Orogen

FJ Korhonen, DE Kelsey, Y Lu, Gessner, K, SP Johnson, P Duuring and PW Haines

As Australia phases into the New Energy Transition, the Geological Survey of Western Australia (GSWA) has prioritized the need to promote the discovery of battery and critical minerals through pre-competitive geoscientific datasets and knowledge, particularly in greenfields regions. It is also recognized that future discoveries will need to be made in areas obscured by extensive cover. A key area for greenfields exploration in Western Australia is the northwestern Paterson Orogen on the northeastern margin of the Pilbara Craton; a region highly prospective for gold–copper and base metal mineral systems. This area is located within ‘The Gap’, where thick Phanerozoic basins and cover extend over Proterozoic basins and orogens, as well as craton margins. There is growing consensus that craton margins are favourable settings for the critical features and processes that generate Cu mineral systems, but that improved integrated mapping and interpretation techniques are required to map and characterize these potentially prospective regions under cover.

At least two sediment-hosted mineral systems have so far been identified in the Paterson Orogen, including a low-temperature Cu system related to initial inversion of the Yeneena Basin between about 840 and 790 Ma, and a

later higher temperature Cu–Au–W–Pb–Zn mineralization event associated with regional granitic magmatism at c. 650 Ma. Our understanding of the geology of the western Paterson Orogen is improving dramatically through new datasets and new uses of old data. Large-scale geophysics and 3D modelling, isotopic mapping and geochronology from surface and drillhole samples are being used to better define the crustal architecture, characterize the nature of the basement, and delineate major crustal boundaries. These models are being further integrated with hyperspectral and geochemical characterization, petrographic studies, metamorphic and structural analysis, and petrophysics. Although these techniques have been in the GSWA toolkit for some time, we are continuously refining and expanding our datasets, as exemplified by WA-Array and the use of novel isotopic and geochronologic techniques in our work program.

Into the future, new drilling technologies will be tested in the Paterson Orogen through the MinEx CRC’s Coiled Tubing drilling platform, which will allow us to characterize a range of mineralogical and chemical proxies to delineate the distal footprint of a major Cu deposit in the Paterson Orogen. This work will provide a foundation for understanding mineral systems in the northern basins of Western Australia.

Changing perspective: a whole-of-lithosphere approach to mineral discovery

GC Begg^{1,2}

A top-down, crustal-centric perspective has dominated the study of Earth Science for more than 200 years, driven by the direct accessibility of the top few kilometres of the crust. Similarly, the study of ore deposits has mostly been guided by observations from the immediate deposit environment, and this has strongly influenced exploration tactics. This approach served explorers well while deposits had a direct surface expression. Global discovery statistics indicate that this search space has inexorably become depleted, particularly in so-called Tier 1 jurisdictions such as Australia. New search spaces are required, and many (most?) of these will involve the search for blind or covered deposits. This calls for a breakthrough in predictive capability.

Advances in geoscience over the last 25 years have given us the opportunity to revolutionize our understanding of the continental lithosphere. These advances have happened in disciplines such as geochronology, seismology, mantle petrology, electrical geophysics (e.g. magnetotellurics), and geochemistry (e.g. isotopic and trace element analysis), coupled with continental- and global-scale datasets (e.g. geology, topography, gravity, magnetics, passive seismic, remote sensing) and powerful visualization and interrogation platforms (e.g. GIS). This revolution, now at an advanced stage, has been accompanied by an emerging understanding that ore deposits are an outcome of mineral systems that are also linked in space and time to the 4D evolution of the whole lithosphere and the interaction with global geodynamic processes (e.g. Griffin et al., 2013;

Begg et al., 2018). Therefore, mapping both crustal, and subcontinental lithospheric mantle (SCLM) architecture, history and geodynamic evolution to a resolution in space and time that is relevant to understanding metallogeny and the generation of mineral systems is required. This will be key to future successful targeting of ore deposits.

Pre-competitive data now needs to address this scale. To date, our data has been very crustal centric, largely ignoring the volumetrically dominant SCLM, which frequently comprises at least 75% of the lithosphere. A comprehensive passive seismic (WA-Array) and magnetotelluric survey, integrated with our existing extensive multidisciplinary data on the crust, will create the world's most sophisticated 3D understanding of the full continental lithosphere. The outcomes will push our understanding of continents and mineral systems to the next level, presenting new research challenges, and new exploration opportunities that can pave the way for the next generation of greenfields discovery.

References

- Begg, GC, Hronsky, JM, Griffin, WL and O'Reilly, SY 2018, Global-to deposit-scale controls on orthomagmatic Ni-Cu (-PGE) and PGE reef ore formation, *in* Processes and Ore Deposits of Ultramafic-Mafic Magmas through Space and Time: Elsevier, p. 1–46.
- Griffin, WL, Begg, GC, and O'Reilly, SY 2013, Continental-root control on the genesis of magmatic ore deposits: *Nature Geoscience*, v. 6, p. 905–910.

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WA-Array – the next statewide dataset

RE Murdie, H Yuan and JP O'Donnell

The WA-Array passive seismic array will generate the next statewide dataset for the Geological Survey of Western Australia (GSWA). The seismic data will be used to assist in evaluating future competing land uses and will incentivize exploration and investment in Western Australia's resources sector.

WA-Array represents the extension of AusArray into Western Australia, and will be one of the largest passive seismic programs undertaken anywhere in the world. Funded by the Government of Western Australia and run by GSWA, WA-Array is designed to investigate Western Australia's crustal and lithospheric mantle structure with the aim of identifying prospective regions for mineral exploration. This is especially pertinent for the large tracts of the State where the basement geology is shrouded beneath a veneer of cover.

WA-Array will build on the data being collected by permanent telemetered seismic stations and from data gathered in previous seismic campaigns in Western Australia. The program will see the deployment of a series of temporary arrays, each comprising 165 seismic stations in a grid pattern at 40-km intervals (Fig. 1). Each temporary array will record for a duration of one year before migrating to the next of nine regional areas. It will take 10 years and 1600 individual seismic stations to cover the whole of Western Australia. GSWA is working with Aboriginal land councils and traditional owners, individual land owners, national park authorities, shire councils, mining, energy and pastoral tenement holders, and community groups in order to secure access. Much of Western Australia is inaccessible by vehicle, so the majority of sites will be accessed by helicopter.

Current research indicates that the locations of many giant mineral deposits correlate spatially with large gradients in the thickness of the underlying lithosphere, i.e. with large changes in the lithosphere–asthenosphere

boundary (LAB) depth. This observation suggests that translithospheric faults and shear zones at the juxtaposition of lithospheric blocks provide conduits for the upward transfer of metalliferous melts and fluids from the mantle to the shallow crust. As enduring loci of tectonic activity, craton margins are primed for both the generation and preservation of giant mineral systems. It thus behoves us to map Western Australia's lithospheric architecture in as much detail as possible – especially where the basement geology is concealed beneath sedimentary cover, precluding traditional geological mapping. Seismic imaging, using earthquake and ambient noise sources, is one of the few geophysical methods capable of probing the entire lithosphere, from the shallow crust to the LAB.

The results of this program will create a step change in our understanding of Western Australia's lithosphere by imaging its architecture in hitherto unprecedented detail. Data products will include high-resolution 3D seismic velocity models of the crust and lithospheric mantle showcasing heterogeneities, terrane boundaries, translithospheric faults and shear zones; a seamless Moho map; a map of the LAB; and local seismicity maps to inform seismic hazard analyses. Regarding the latter, strong ground motion recordings from local earthquakes will contribute to the National Seismic Hazard Assessment (NSHA) of risk to industrial infrastructure (e.g. pipelines, hydrogen generation and storage facilities) as well as informing appropriate building codes for residential and commercial buildings.

The knowledge gleaned from WA-Array will not only provide a sound scientific basis for mineral and energy exploration, but also for evaluating crucial land use decisions over the coming decades, at a time when large areas of the State are expected to accommodate renewable energy projects, including those required to support a future hydrogen energy industry.

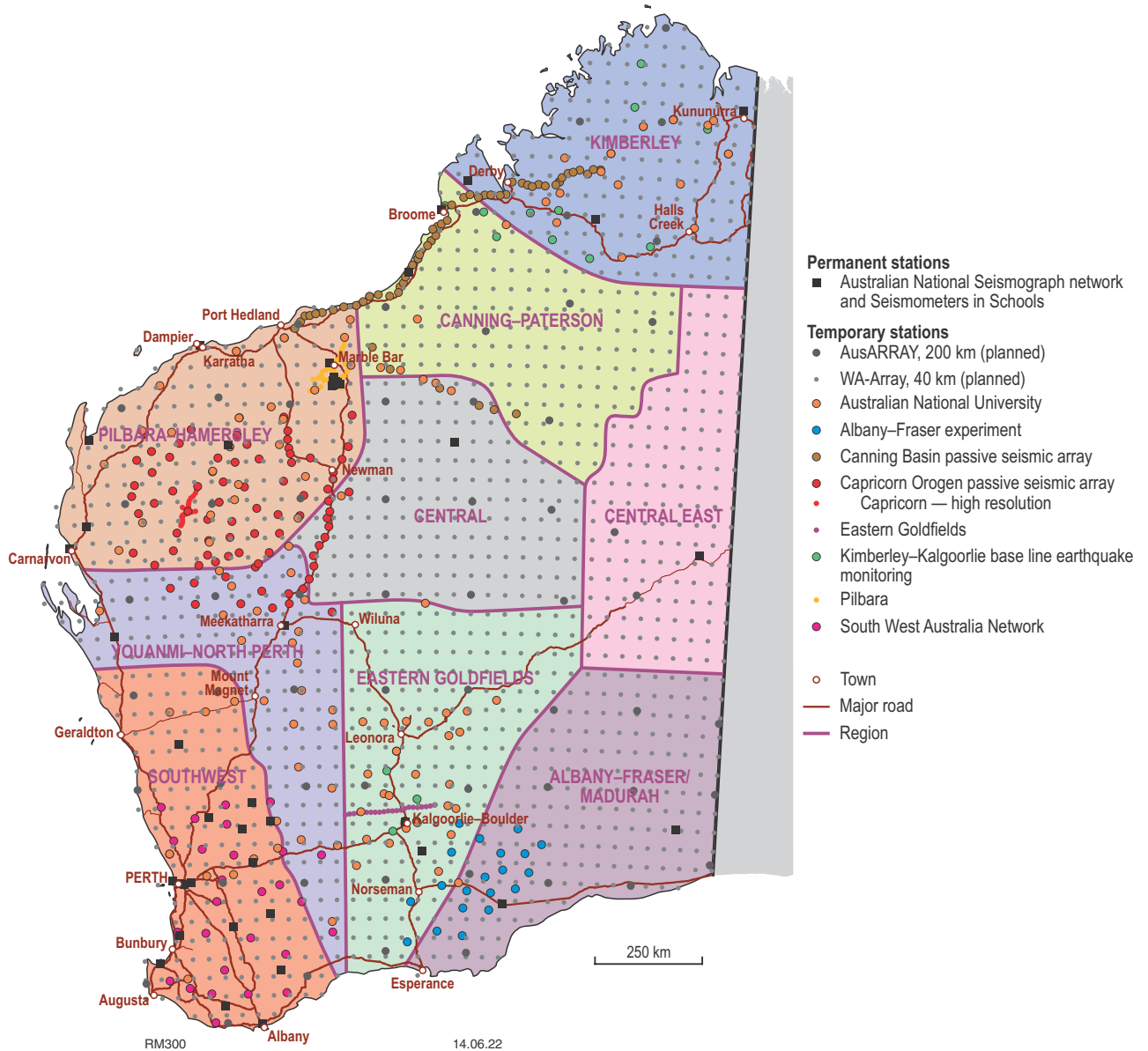


Figure 1. Map of preceding, existing and planned seismic station locations in Western Australia. WA-Array will see the deployment of a migrating array of 165 broadband passive seismic stations. Each deployment will be for a duration of one year before migration to the next of nine designated regions

Geoscience Data Transformation Program

T Perry and D Purnomo

The Geological Survey of Western Australia (GSWA) manages an extensive, comprehensive, multibillion-dollar collection of geoscientific data, of around four petabytes of data.

The collection is highly regarded and valued by many people from the resources industry, academia, other government agencies, and the general public. GSWA's ability to meet the increasing demand for easier access to our data has been restricted by the limited connectivity between different datasets, and the lack of a fully standardized and digitized data collection.

In January 2021, the Geoscience Data Transformation Strategy was published, setting out the intention to transform, rationalize and modernize the geoscience data collection.

The Geoscience Data Transformation Program (GDTP) has been established to manage the development and implementation of a new data management framework that will *digitally transform the wealth of Western Australia's world-class geoscience data to unlock its hidden mineral and energy resources potential, through the introduction of sophisticated data storage, access, management and interrogation systems and technology.*

The Program commenced in late 2021. As a multiphased program of work, it is expected that enhancements will be released progressively, with final implementation ready by the 2025–26 financial year.

The Program

The GDTP will deliver a range of technical, operational and strategic improvements to create the most advanced geoscience 'intelligent dataset' in Australia. The Program aims to increase accessibility and usability of all data for all users, and in particular, assist industry to maximize the untapped potential of Western Australia's yet-to-be discovered natural resources.

This will be achieved by:

- Creating a **unified, simplified, standardized** framework that accommodates and manages all geoscience data requirements
- Ensuring data is **FAIR** (Findable, Accessible, Interoperable and Reusable)
- Increasing **connectivity** between different datasets to improve data interrogation and sharing
- Utilizing modern data structure and storage management arrangements that allow **flexible, adaptive** responses to changing technology, future demands and new opportunities
- Improving user **self-service** capabilities by introducing easy-to-use data lodgement and retrieval using online platforms
- **Aligning** the data framework with the Western Australian Whole-of-Government Cloud Policy, increasing geoscience data usage for and between all users
- Enhancing the translation of data into **valuable** information, knowledge discovery, and business development and innovation opportunities.

Data framework

The four foundational elements to the data framework are shown in Figure 1.

These four elements will be brought together to create an operating framework that will increase accessibility to all GSWA data (see Fig. 2).

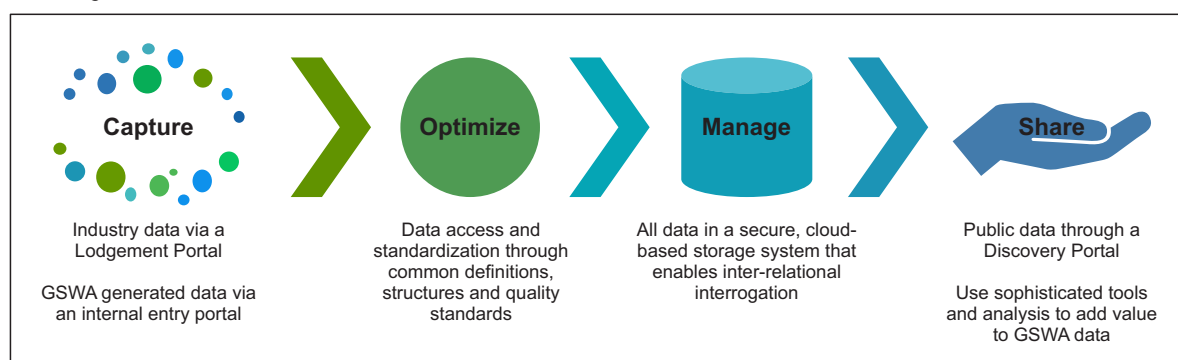


Figure 1. GDTP key elements

Approach

The Program consists of seven core working streams, each responsible for investigating and identifying the specific requirements for that element, which will inform the design of the final data management framework and operational arrangements (see Fig. 3).

More information

Geoscience Data Transformation Strategy Geoscience Data Transformation Program

For Program queries, contact GDTP@dmirs.wa.gov.au.

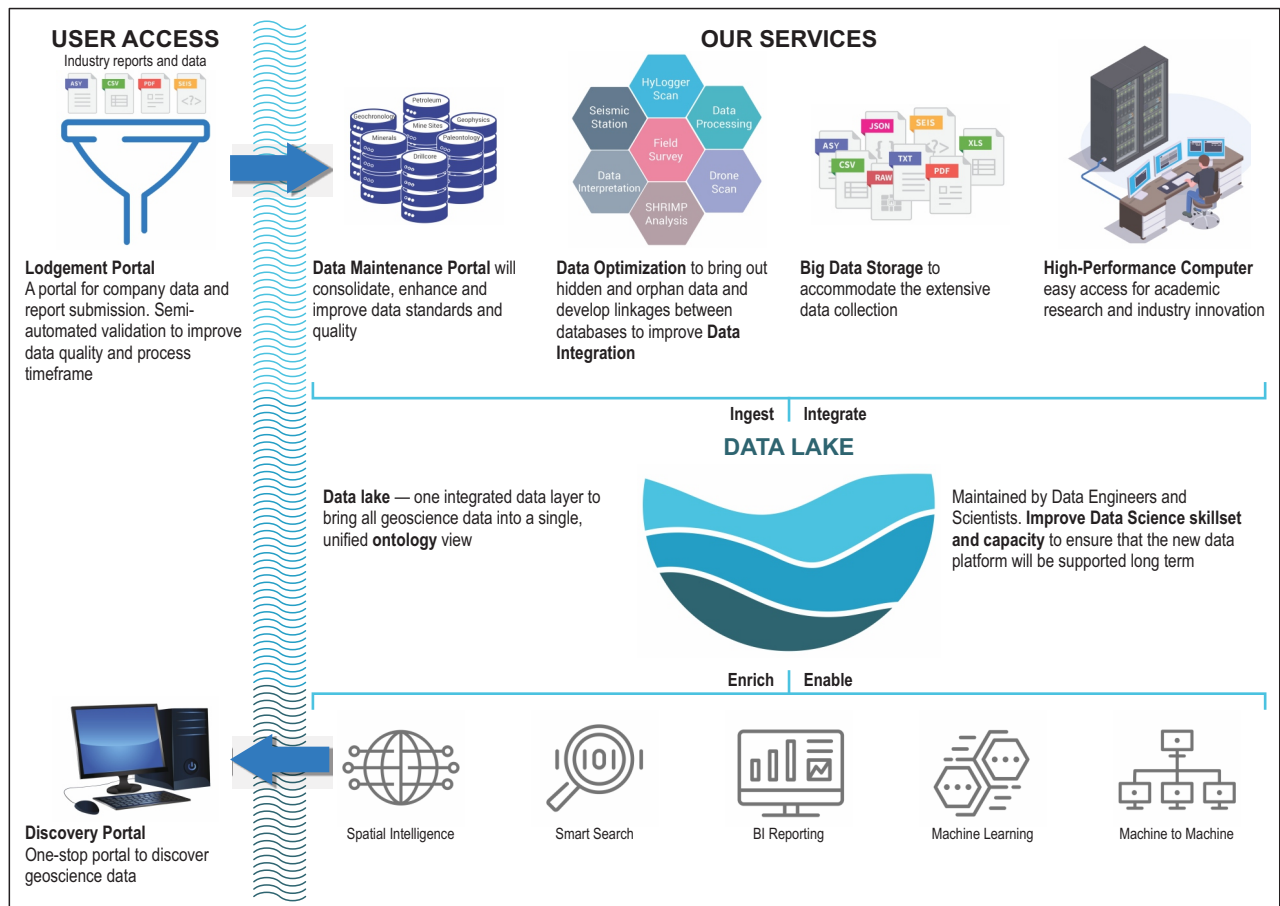


Figure 2. GDTP data management framework

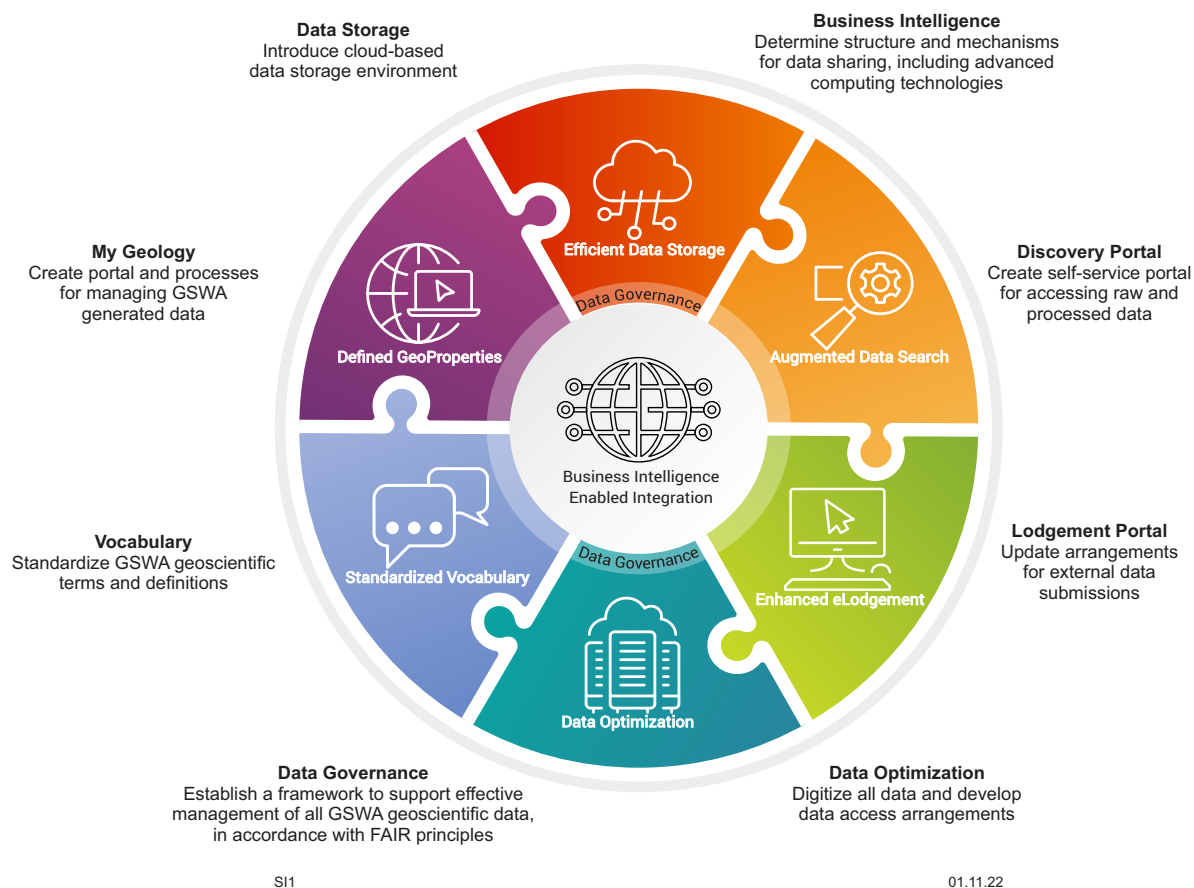


Figure 3. GDTP work streams

CO₂ sequestration in Western Australia

D Brooks

Geological storage of CO₂ (geosequestration), also referred to as Carbon Capture and Storage (CCS), is the permanent storage of captured CO₂ emissions via injection into porous and permeable sedimentary rocks (Fig. 1). Geosequestration of CO₂ is an attractive option to store large volumes of CO₂ that would otherwise have been vented to the atmosphere. The storage capacity of geological reservoirs is huge and the potential reservoirs in Western Australia are in some cases close to the high CO₂ emitting industries (Dentith et al., 2015).

The Gorgon CO₂ injection project in the Northern Carnarvon Basin is the only active CCS operation within Western Australia. The injection project was approved by then Premier Colin Barnett on 14 September 2009. The *Barrow Island Act* was the first legislation regulating CO₂ storage in the world. With an expected lifespan of more than 40 years, the injection project is described as the largest CO₂ storage project in the world. The Gorgon Joint Venture started injecting CO₂ in early August 2019. By July 2022, **more than 6 million tonnes of CO₂** had been injected.

The South West Hub CCS research project is located 13 km northwest of Harvey in southwestern Western Australia (Fig. 2). The objective of the project is to obtain pre-competitive geological and geophysical data to enable industry to make commercial decisions on CCS technology for future projects (van Gent et al., 2017). As operator of the project, the Department of Mines, Industry Regulation and Safety (DMIRS), undertook research to reduce the uncertainty around the suitability of the site for future CO₂ sequestration. DMIRS managed the drilling of four wells and seismic acquisition between 2010 and 2018.

The carbon capture and storage process

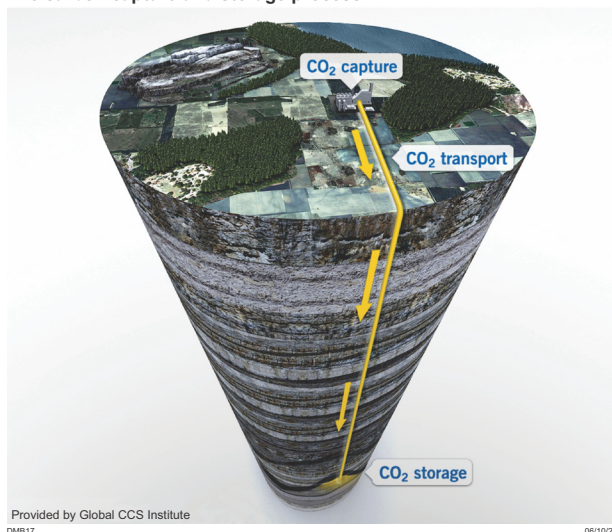


Figure 1. The basic principles of Carbon Capture and Storage

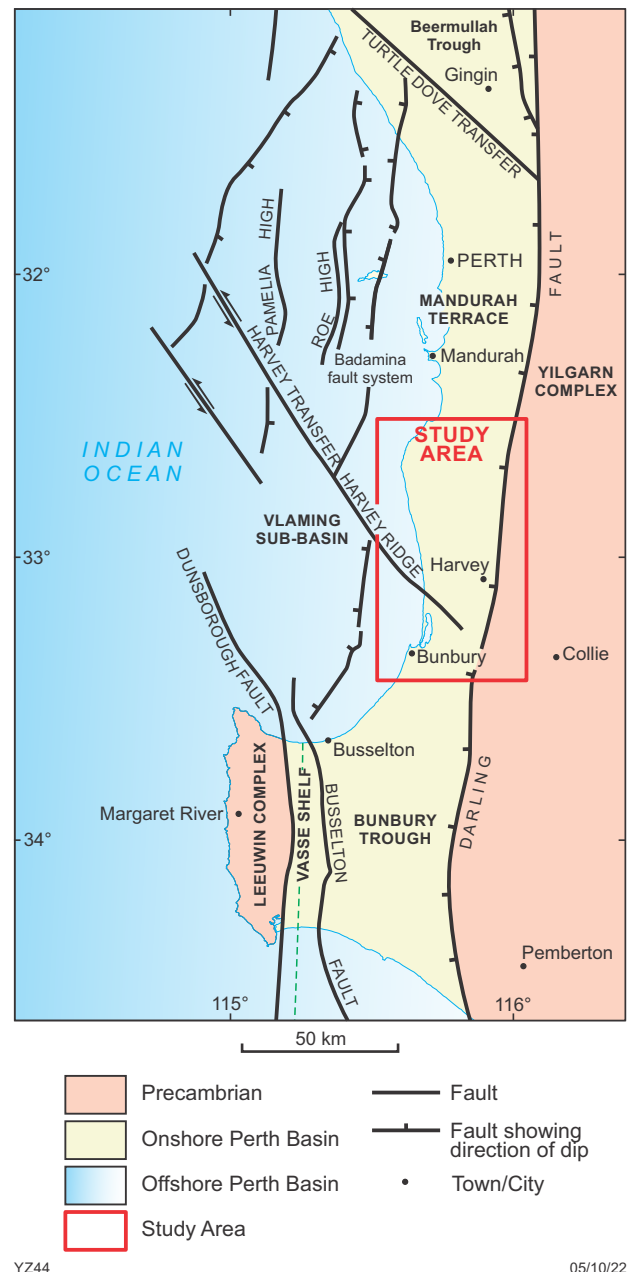


Figure 2. Location of the South West Hub CCS research project

With successive large volumes of new data, 3D static and dynamic models were updated several times (Sharma and van Gent, 2018) with the final version completed in 2018, the year the Federal Government funding finished. To date, no deep CO₂ injection has been attempted at the site. CSIRO is continuing its field research in the area via its in situ laboratory near the Harvey 2 wellsite.

The Ministerial Taskforce on Climate Action, established in May 2021, has identified the enhancement of CO₂ sequestration as a key government priority. The Geological Survey of Western Australia (GSWA) received Western Australian State Government funding through this taskforce to create a new CO₂ storage Atlas of Western Australia. The project commenced on 1 July 2022 and will finish on 30 June 2024. The new Western Australia Carbon Dioxide Geological Storage Atlas will provide government and industry with a clearer understanding of the potential for permanent sequestration of CO₂ by identifying new carbon dioxide geological storage sites and the further analysis of known storage sites.

DMIRS is working on the new proposed Greenhouse Gas (GHG) legislation. Cabinet approved drafting of the new bill following increased interest from the resources and industrial sectors. The 2022 Greenhouse Gas Storage and Transport Bill will re-introduce the lapsed 2013 bill and include additional provisions including the allowance for mineral carbonation projects. It is likely this bill will be passed in 2023.

References

- Dentith, MC, Dent, LM, George, AD, Langhi, L, Sanchez, G, Seyedmehdi, Z, Strand, J, Vaslin, A and Zaheer, R 2015, Geosequestration potential of the Carboniferous–Permian Grant Group and Permian Poole Sandstone, northwest Canning Basin, Western Australia: Geological Survey of Western Australia, Report 139, 101p.
- Sharma, S and van Gent, D 2018, The Australian South West Hub Project: Developing Confidence in Migration Assisted Trapping in a Saline Aquifer – Understanding Uncertainty Boundaries Through Scenarios that Stress the Models; 14th Greenhouse Gas Control Technologies Conference: Melbourne, 21–26 October 2018, doi:10.2139/ssrn.3366170.
- van Gent, D, Burke, M and Sharma, S 2017, South West Hub Project, Western Australia: appraising 'migration-assisted' containment for carbon storage in sandstone strata: The APPEA Journal, v. 57, no. 2, p. 669–675, doi:10.1071/AJ16024.

Natural hydrogen: indications from onshore Western Australian sedimentary basins

PW Haines, LS Normore, SN Alavi and CM Thomas

There is little doubt that hydrogen will play a significant role as we progress towards net zero carbon emissions. While most discussion is centred on various types of manufactured hydrogen, the Geological Survey of Western Australia (GSWA) is evaluating the potential for naturally occurring hydrogen within Western Australia. Once considered a rare curiosity, the study of naturally occurring hydrogen and its economic potential is a rapidly growing field of research worldwide (Zgonnik, 2020; Stalker et al., 2022). The 'natural hydrogen system', nevertheless, remains poorly understood.

Sources of natural hydrogen

Numerous mechanisms for the generation of natural hydrogen have been proposed (Zgonnik, 2020; Boreham et al., 2021a,b), but not all are likely to be of economic significance. Most significant include the reaction of water with reduced iron in minerals and the radiolysis of water by natural radiation in the crust. Hydrogen may be generated in the basement beneath, and within sedimentary basins, but conditions for the economic accumulation of natural hydrogen will be more prevalent in basins.

Indications of hydrogen in Western Australian basins

Boreham et al. (2021a) reported that hydrogen can be detected, occasionally in significant concentrations, in archived gas samples from numerous wells and fields throughout Australia and its offshore basins. In onshore Western Australia, such detections of hydrogen were observed in the northern Perth Basin, northwest Canning Basin and Bonaparte Basin.

To investigate further the occurrence of hydrogen in Western Australian basins, we undertook a search of onshore and State Waters (excluding Barrow Island) legacy well data, mostly well completion reports, for any reports of hydrogen during drilling, or from subsequent laboratory analysis of gas samples. This resulted in the discovery of 17 wells in the Canning Basin, 16 wells and fields in the Perth Basin, and one well in the Southern Carnarvon Basin (Fig. 1). Such reports are likely to significantly underrepresent the presence of hydrogen in Western Australian wells because hydrogen is not routinely analysed for, and when detected, was often assumed to be an artefact of drilling, and may not have been reported on that assumption. While hydrogen may be generated as an artefact during drilling and testing operations, observations in most reports are more consistent with natural hydrogen, but this requires further work.

While the concentrations of hydrogen were often small, some reports are significant; e.g. Meda 1, drilled in the northwest Canning Basin in 1958, yielded concentrations from 0.9% to 95.3% hydrogen in laboratory analysis of gas from six drill stem tests. Some, but not all, tests of Meda 1 followed acidization, so a contribution of hydrogen from acid-metal reaction is possible. Studies of the Meda area, including the search for surface hydrogen seepage and a fluid inclusion stratigraphy study of Meda 1 core and cuttings is in progress.

Apart from petroleum well data, hydrogen has also been reported in mineral exploration drillholes (Boreham et al., 2021b), shallow drilling for gas seeps in the Perth Basin (Gole and Butt, 1985), and in Perth Basin water bores. Surface hydrogen seeps, often referred to as 'fairy circles', have been reported in the Perth Basin and Yilgarn Craton (Frery et al., 2021, 2022). GSWA has investigated similar evidence of seepage in the southern Perth Basin by extended autonomous monitoring which detected a weak diurnally varying hydrogen flux.

References

- Boreham, CJ, Edwards, DS, Czado, K, Rollet, N, Wang, L, van der Wielen, S, Champion, D, Blewett, R, Feitz, A and Henson, PA 2021a, Hydrogen in Australian natural gas: occurrences, sources and resources: The APPEA Journal, v. 61, no. 1, p. 163–191, doi:10.1071/AJ20044.
- Boreham, CJ, Hope, JM and Edwards, DS 2000, Characterisation of natural gases from west Australian basins: Geoscience Australia, Canberra, viewed 2 May 2022, <<http://pid.geoscience.gov.au/dataset/ga/33569>>.
- Boreham, CJ, Sohn, JH, Cox, N, Williams, J, Hong, Z and Kendrick, MA 2021b, Hydrogen and hydrocarbons associated with the Neoproterozoic Frery's Leg Gold Camp, Yilgarn Craton, Western Australia: Chemical Geology, v. 575, article no. 120098, 23p., doi:10.1016/j.chemgeo.2021.120098.
- Frery, E, Langhi, L, Maison, M and Moretti, I 2021, Natural hydrogen seeps identified in the North Perth Basin, Western Australia: International Journal of Hydrogen Energy, v. 46, no. 61, p. 31158–31173, doi:10.1016/j.ijhydene.2021.07.023.
- Frery, E, Langhi, L and Markov, J 2022, Natural hydrogen exploration in Australia - state of knowledge and presentation of a case study: The APPEA Journal, v. 62, no. 1, p. 223–234, doi:10.1071/AJ21171.
- Gole, MJ and Butt, CRM 1985, Biogenic-thermogenic near-surface gas anomaly over Gingin and Bootline gas fields, Western Australia: The American Association of Petroleum Geologists Bulletin, v. 69, no. 12, p. 2110–2119, doi:10.1306/948855F7-1704-11D7-8645000102C1865D.
- Grosjean, E, Edwards, DS, Hong, Z, Jinadasa, N, Sohn, J and Buckler, T 2022, Geochemical Compositions of Natural Gases from the offshore well Dorado 1, Roebuck Basin, Australia: Geoscience Australia: Data release, 7p., <<http://pid.geoscience.gov.au/dataset/ga/146412>>.
- Stalker, L, Talukder, A, Strand, J, Josh, M and Faiz, M 2022, Gold (hydrogen) rush: risks and uncertainties in exploring for naturally occurring hydrogen: The APPEA Journal, v. 62, no. 1, p. 361–380, doi:10.1071/AJ21130.
- Zgonnik, V 2020, The occurrence and geoscience of natural hydrogen: A comprehensive review: Earth-Science Reviews, v. 203, article no. 103140, 51p., doi:10.1016/j.earscirev.2020.103140.

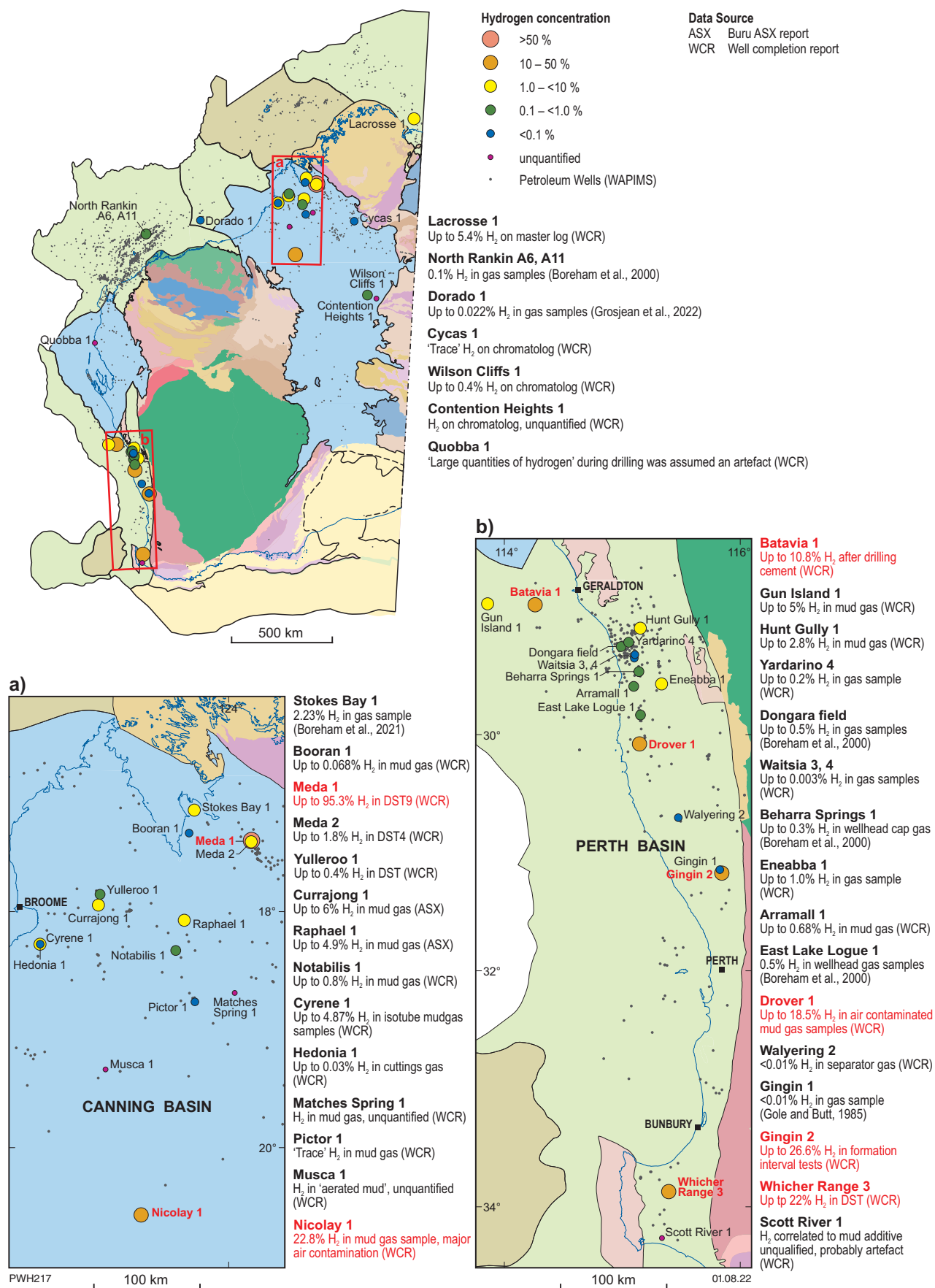


Figure 1. Hydrogen occurrences in Western Australian petroleum wells and fields located during a search of open-file data, mostly well completion reports (and appendices), with other data sources indicated: a) detail of northwest Canning Basin; b) detail of Perth Basin. Concentrations >10% H₂ are highlighted in red. While wells in Commonwealth Waters were not systematically searched, several known reports are also indicated

Mineral Systems Atlas

M Clarke

The Mineral Systems Atlas (MSA) provides exploration-relevant spatial data regarding prospectivity via an online browser-based interface. Mineral systems within the Atlas are described through an online MSA Guide (Fig. 1) and standalone GSWA Record. The Atlas emphasizes critical processes and their mappable proxies related to mineralization. All data are curated and symbolized to focus on the related mineral system. These layers are available for free download from the Data and Software Centre for use outside of the online interface. The MSA continuously evolves through provision of new information. The most recently published systems add raster images in a consistent format suitable for prospectivity analysis outside of the MSA (Fig. 2).

Previously published systems include: komatiite-hosted nickel, iron formations, rare-element pegmatites, and layered intrusion-hosted vanadium. Newly published in 2022 are the manganese and evaporite brine-related potash mineral systems, adding 54 new layers to the MSA.

Potassium is a critical nutrient for plant growth and is vital to world agriculture. Potassium enriched brines contain the most widely defined and in-development potash resources in Western Australia; and can provide a more 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.

HOME

WHAT ARE MINERAL SYSTEMS?

Primary data layers

Structures

Tectonic units

Komatiite-hosted nickel

Iron formation

Rare-element pegmatite

Mineralization localities

Geochemistry--pegmatite

Be ppm pegmatite TRAP

Cs ppm pegmatite TRAP

F ppm pegmatite TRAP

Li ppm pegmatite TRAP

Ta ppm pegmatite TRAP

U ppm pegmatite TRAP

Geochemistry--Pegmatite

Geochemistry--granitic rocks

Lithology

Layered intrusion-hosted vanadium

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Geochemistry--Pegmatite

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What is this layer?

Sample locations for pegmatite analysed for their whole-rock and trace-element compositions. Geochemical data are stored in the GSWA geochemistry database (WACHEN).

Legend

Legend	Description
Geochemistry--Pegmatite	Sample locations for pegmatite featured in the GSWA geochemistry database (WACHEN)

Derived from

Geochemistry RECALC

RECORD 2020/7

RARE-ELEMENT PEGMATITES:
A MINERAL SYSTEMS ANALYSIS

by P. Dunning

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

Geological Survey of Western Australia

MINERAL SYSTEMS ATLAS

Figure 1. The online MSA Guide complements the GIS platform by describing the derived data layers, explaining the reasoning behind their inclusion in the specific mineral systems, and documenting their creation via an SQL query of source data. A Record (inset) provides further information

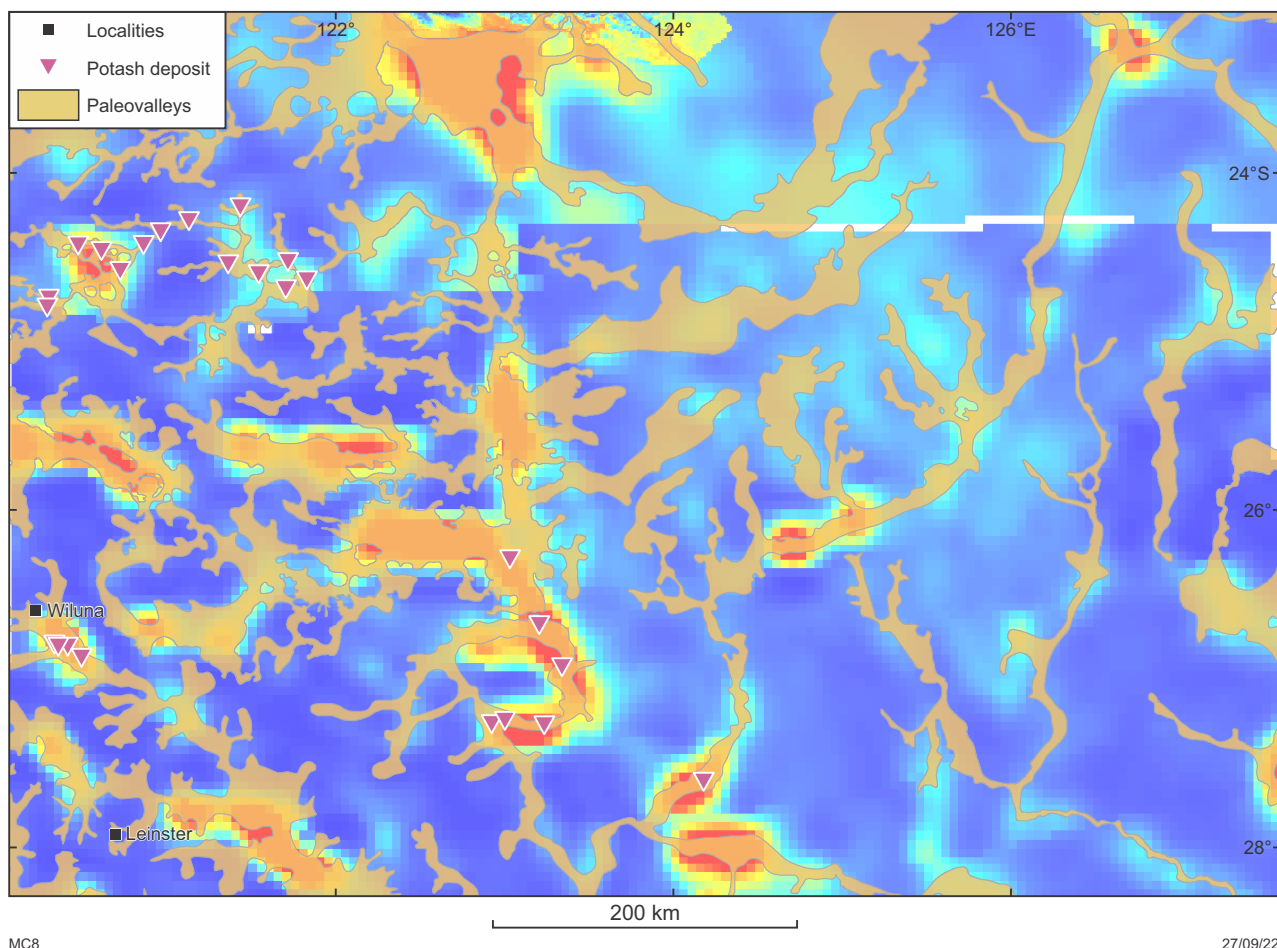


Figure 2. An example from the MSA's evaporite brine-related potash system. Known potash deposits and interpreted paleovalleys are superimposed over an airborne electromagnetic compilation image (blue to red = lower to higher conductivity)

Manganese is 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.

Future work on the MSA will target mafic-hosted nickel–cobalt–copper–platinum group elements. Developments to the MSA include: layers relevant to crustal architecture; additional data layers for the existing mineral systems, particularly for the lithium rare-element pegmatite system; and, prospectivity 'heat' maps for selected systems.

Land access and Aboriginal engagement

M McMahon

The Department of Mines, Industry Regulation and Safety (DMIRS) and the Geological Survey of Western Australia (GSWA) are committed to delivering better outcomes for Aboriginal people in Western Australia.

DMIRS is attempting to achieve this by implementing the following:

- Aboriginal Engagement Strategy
- Aboriginal Employment Program
- Aboriginal Empowerment Initiative.

The Aboriginal Engagement Strategy is based on the principle of Free, Informed and Prior consent.

Article 32 United Nations Declaration on the Rights of Indigenous Peoples states the following:

1. Indigenous peoples have the right to determine and develop priorities and strategies for the development or use of their lands or territories and other resources.
2. States shall consult and cooperate in good faith with the Indigenous peoples concerned through their own representative institutions in order to obtain their free and informed consent prior to the approval of any project affecting their lands or territories and other resources, particularly in connection with the development, utilization or exploitation of mineral, water or other resources.
3. States shall provide effective mechanisms for just and fair redress for any such activities, and appropriate measures shall be taken to mitigate adverse environmental, economic, social, cultural or spiritual impact.

GSWA engagement and consultation

GSWA conducts various activities throughout Western Australia, such as field mapping, sampling, airborne and ground-based geophysical surveys.

When engaging with the Native Title groups or Prescribed Body Corporations (PBC), GSWA has enhanced its notification practices to create a more informative and less technical approach.

This has been achieved by providing:

- more appropriate, clear maps and data
- more information about how the fieldwork will be conducted.

Native Title claim process

The Native Title claim group (for an unclaimed area of land) lodges the Native Title claimant application with the Federal Court after extensive research is conducted by the Native Title representative body on behalf of the claimant group.

When and if the claim is registered, the group has certain procedural rights including the right to negotiate, once registered.

Following extensive consultation between the claimant group, the Native Title representative body and the Federal Court, a determination of claimed lands and waters can then either be litigated or a consent determination may be reached.

Once determined, a PBC would then be formed by the group which holds the Native Title. The *Native Title Act* (NTA) and PBC Regulations require that Native Title holders establish a PBC to hold and manage (as a trustee), or manage (as an agent) their Native Title interests, and register the PBC under the *CATSI Act* (s. 56(2)(a)(i), NTA).

Aboriginal engagement

In consulting with the Native Title groups (representative bodies) and PBC, GSWA seeks to achieve a long lead time with survey notifications so the groups have ample time to access the proposed activity.

Our engagement process is designed to achieve the following outcomes:

- Build strong relationships with our Indigenous partners
- Create an environment for open and honest communication
- Identify possible employment/business opportunities that may arise from GSWA activities
- Provide feedback about the survey results
- Listen to any feedback about how the survey was conducted and to improve future activities.

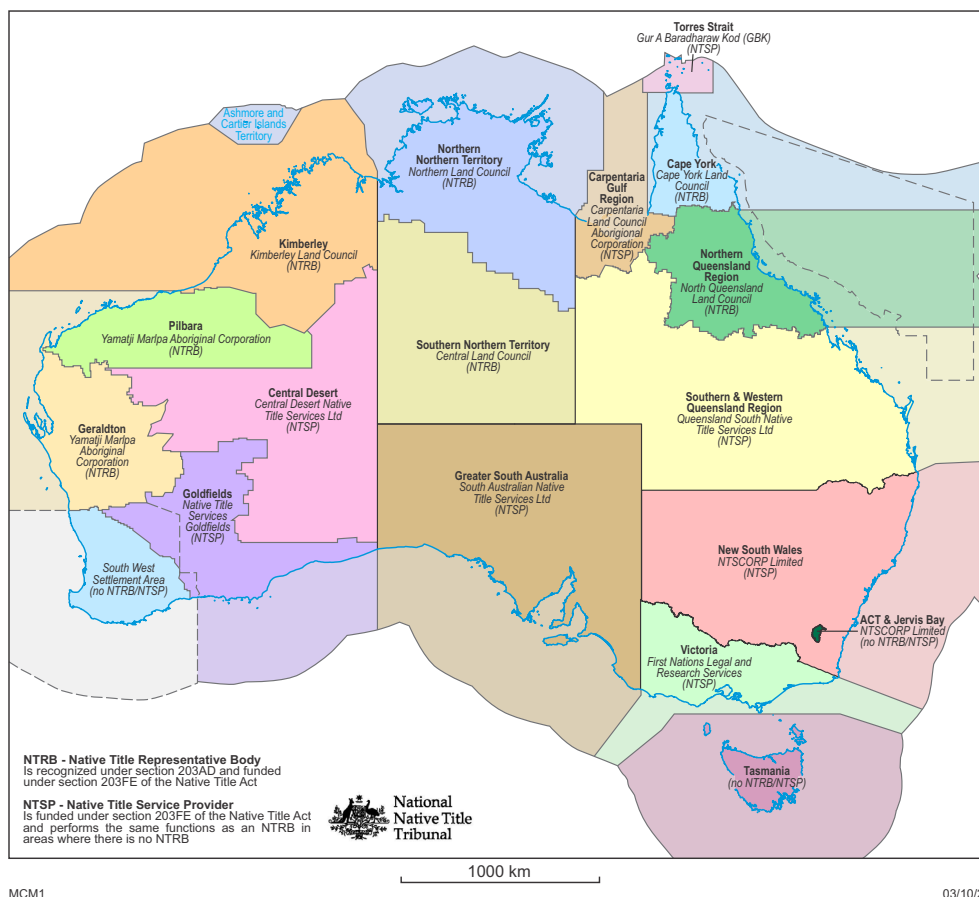


Figure 1. Initial engagement process

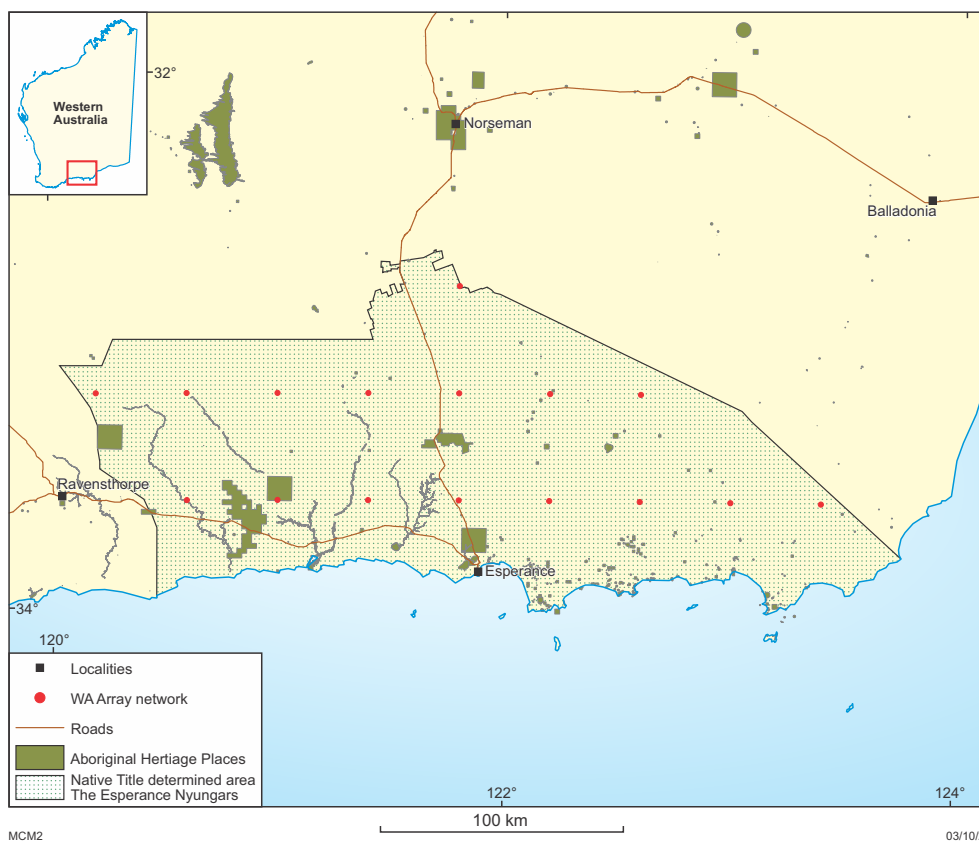


Figure 2. Extended engagement process

Tenure for emerging industries

S Carter

The ability to diversify and broaden the Western Australian economy requires the introduction of a new form of land tenure into the *Land Administration Act 1997* (LAA). It is proposed that this new tenure will be non-exclusive leasehold tenure that can be applied over large areas of Crown land. It provides lessees with the right to undertake activities on the land without creating 'private land' that excludes access by other parties such as resource companies and native title holders.

A diversification lease will be designed for broadscale, non-exclusive land use, similar to a pastoral lease, but will not restrict land use to a particular activity in the way that a pastoral lease does. These changes will mean Western Australia is better placed to leverage opportunities in the rapidly growing renewable energy sector which requires large areas of land for operations like carbon farming, wind farms, solar energy and hydrogen production.

A diversification lease will coexist with mining rights in a similar way as pastoral leases, so that mining tenement holders will have a right of access to the land. Some of the more significant provisions that will apply under the proposed amendments to the *Mining Act 1978* include:

- a diversification lease will be included in the definition of 'Crown land' and other provisions, in the same way as a pastoral lease is currently referred to

- the Minister for Mines will have to agree to any change, or variation, to the permitted use(s) under a diversification lease or any changes to the location of substantial structures or infrastructure on the lease area
- the access provisions in section 20 will generally apply to a diversification lease in the same way as they do to a pastoral lease, except that the restriction for mining and access to within 100 m of the improvements listed in section 20(5) will also include to within 100 m of a 'substantial structure' to take account of possible uses under a diversification lease.

The Land Use Planning branch helps shape and inform land use planning policy and outcomes by providing advice based on geoscience, resource mapping and prospectivity assessments. The branch aims to maintain access for exploration and development of the State's mineral, basic raw material, petroleum and geothermal energy resources while assisting with the delivery of State land use objectives to ensure the most appropriate use of land.

GSA Open Day 2022 panel discussion

Competing or cooperating? Optimizing land use for net zero

Panel chair: R Chopping

As the world transitions to a net zero carbon emissions future, there will be an increasing pressure on land use supporting this transition. Land is required for the surface and subsurface sequestering of carbon dioxide, storage of other greenhouse gases or hydrogen generated from renewable or natural sources. Balancing this, the transition will also require the extraction of resources such as critical or battery minerals, or lower carbon emitting energy sources. This resource extraction is likely to occur in similar locations to areas of focus for other land uses. An example might be the search for copper and other base metals in sedimentary basins in the heart of the State. These basins also present attractive places for storage of gases based on their geology; at the surface, they are also sparsely populated and therefore also suited to the development of renewable energy infrastructure.

This panel discussion will consist of an introduction by the panel chair, Richard Chopping, A/Director Mineral and Energy Resources, Geological Survey of Western Australia (GSA). This will be followed by a series of audience-sourced questions to experts from a diverse range of backgrounds and sectors including:

- Samantha Carter, General Manager Land Use Planning, GSA
- Matt Darcey, Assistant Director General, Land Use Management Department of Planning, Lands and Heritage
- Jaco Hugo, Program Director, Winu, Rio Tinto, Copper
- Roannah Wade, Manager, Resource Development & Sustainability, Chamber of Minerals and Energy
- Claire Wilkinson, Director Western Australia and South Australia, Australian Petroleum Production and Exploration Association.

The discussion will focus on finding common ground for us to cooperate on land use issues, rather than compete, as we undertake the journey towards net zero.

RECORD 2022/12

GSWA 2022 EXTENDED ABSTRACTS

Advancing the prospectivity of Western Australia

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Fieldnotes

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