

Geoscience Strategy

Update 2026–31

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Background and retrospective

As a trusted, world-leading geological survey, the Geological Survey of Western Australia (GSWA) provides objective and authoritative geoscientific data, information, and knowledge to support the responsible use and development of the State's natural resources.

Western Australia (WA) preserves a globally unique, near-continuous rock record that spans 4.4 billion years of Earth history including the origin of the continents and of life on Earth. This information is globally important for advancing our understanding of Earth's evolution and planetary processes and provides valuable analogues for future exploration of the Moon, Mars and beyond. This record also underpins WA's extraordinary resource endowment, including globally significant mineral and energy resources.

To support the responsible use, development and stewardship of this geological endowment GSWA carries out three scientific activities:

- Acquisition of geoscientific data;
- Conversion of data into informed knowledge; and
- Delivery and provision of data and knowledge.

The application of rigorous, evidence-based scientific data collection is essential for generating knowledge from data and plays an important role in targeting new data acquisition.

These pre-competitive data, together with the knowledge derived from them, provide a shared foundation for responsible resource development. They enable the resources industry to design more effective exploration programs, improving the likelihood of discovery, while also supporting the government and the wider community in making informed, evidence-based decisions about mining, geohazards, land use issues and environmental stewardship. Through geoheritage and geotourism strategies, this knowledge helps connect people to the State's globally unique geological history, promoting a broader appreciation of the rocks, minerals, and landscapes that form part of our shared natural heritage.



GSWA's core principles

At the core of GSWA's mandate is the responsibility to build a comprehensive understanding of WA's geological history and whole-of-Earth-system framework. This encompasses the lithosphere, hydrosphere, atmosphere and biosphere, and the interactions between them through deep time. Geological surveys add the fourth dimension (time) to natural resource understanding by showing not only where rocks, structures and resources occur, but when they formed, interacted and were reworked. This temporal framework is essential for reconstructing geological evolution and improving exploration prediction. By charting the evolution of geological and biological processes through time, we aim to develop an integrated picture of how the State's geology, resources and natural hazards have formed, evolved and continue to change. This whole-of-Earth-system perspective underpins our ability to interpret the past, understand the present and anticipate future geological behaviour in a rapidly changing environment.

As the custodians of WA's geological record, we are responsible for maintaining the rigour, consistency and integrity of the State's stratigraphic nomenclature, geological frameworks and tectonic models. This custodial role ensures that the scientific foundations on which industry, government and research communities rely remain authoritative, coherent and up-to-date. Our stewardship provides the stable reference system needed for exploration, land use planning, environmental assessment and long-term resource management.

These enduring responsibilities form the foundation of the Survey's work, but their value lies not only in scientific stewardship alone. GSWA also has a critical role in driving discovery and innovation, creating new opportunities and championing the resources sector to the benefit of WA, while helping secure the State's position as a leading jurisdiction across the full lifecycle of resource development. This requires GSWA to translate deep scientific understanding into world-leading geoscience intelligence and decision-ready information that can guide exploration, investment, regulation, infrastructure planning and long-term strategic choices.

To do this effectively, GSWA must also embrace innovative practices and harness the full value of data and technology to support decision-making. By combining authoritative geoscience with modern analytical methods, digital delivery, machine-readable data and emerging capabilities such as machine learning and artificial intelligence, the Survey can strengthen both the reach and impact of its work. In this way, the focus of the Geoscience Strategy and the five-year geoscience plan is not only to maintain and advance WA's foundational geological knowledge, but to also ensure that knowledge is translated into products, datasets and insights that directly support industry growth, infrastructure development, environmental resilience and strategic decision-making. By aligning our core scientific strengths with emerging economic and societal needs, we ensure that GSWA's foundational knowledge continues to deliver tangible and lasting benefits for WA.

Value of pre-competitive geoscience data

Pre-competitive geoscience is one of the most powerful tools available to governments seeking to stimulate exploration and diversify their resource economies. It provides open, high-quality, baseline geological information that reduces uncertainty, lowers exploration costs and encourages private investment. Although the work of geological surveys is generally at a much larger scale than those of the resource sector, the data are critical for de-risking the subsurface and revealing previously unrecognised opportunities. Pre-competitive geoscience data also acts as a catalyst for emerging industries, from critical minerals and geothermal energy to hydrogen storage and carbon sequestration, and helping governments lay the groundwork for entirely new non-mining economic sectors, including groundwater management, environmental regulation, land use planning, and geohazard assessment.

The strategic value of pre-competitive geoscience is amplified by the long lead times required to bring new mineral discoveries into production. International studies indicate that the average global journey from discovery to mine commonly spans 15.7 years, with more recent projects taking even longer (S&P Global 2023). In Australia, commodity-specific benchmarking indicates similarly long development times, around

14.5 years (S&P Global 2023), with copper projects averaging around 20 years from discovery to first production (Schodde 2017). In this context, investment in pre-competitive geoscience data is not simply about improving today's exploration outcomes, it is about shaping the project pipeline, investment choices and future resource options that will determine the State's economic resilience and competitiveness over the next several decades. This dynamic is particularly important in Australia, where junior explorers have increasingly driven the discovery pipeline since the early 1980s, and in recent years, have accounted for over 80 per cent of all new discoveries (Schodde 2023). However, these companies often operate with limited cash reserves and depend on external capital to sustain fieldwork and drilling. For this part of the sector, government-funded pre-competitive geoscience is not simply a scientific public good, it is a critical enabling input that helps narrow the search space, reduce exploration risk and improve the efficiency with which scarce private capital is deployed.

Even before significant discoveries are made, independent economic analyses of government-funded pre-competitive geoscience data (Acil Allen, 2015; Economic Consulting Services, 2019; Acil Allen 2020; Fogarty, 2021) consistently show a significant return on investment. These datasets are shown to add value to the national economy through:

- Stimulating exploration activity;
- Creating jobs;
- Attracting international investment;
- Enabling earlier and more efficient discoveries;
- Increasing royalties and tax revenue; and
- Reducing financial risk for explorers.

The Exploration Incentive Scheme (EIS) has become one of the State's most important mechanisms for supporting early-stage exploration. Its value lies not only in co-funded drilling and geophysics, but also in generating pre-competitive geoscience data that helps define prospective regions, improves targeting and provides the geological context to test concepts that might otherwise remain untested, particularly in WA's greenfields regions. In doing so, the EIS not only stimulates exploration activity, but adds

to the body of new geological and geophysical information that grows over time as a public asset.

This value is increasingly evident in greenfields regions like the West Arunta region, where the emerging Aileron story shows how public and co-funded geoscience can accelerate discovery and de-risk a new mineral province. GSWA datasets including core geochemistry, HyLogger data, geochronology and isotope acquisition, and the Aileron magnetic and radiometric survey were complemented by Encounter's EIS co-funded airborne electromagnetic survey, sharpening targeting and helping define new priority areas. Together, these inputs show how pre-competitive geoscience data and targeted co-investment can move from regional understanding to exploration momentum and broader commercial opportunity.

In this context, EIS is not simply an exploration support program, it is a major strategic mechanism for building the pre-competitive geoscience foundations of WA's future resource pipeline, while also helping convert those foundations into discovery through targeted co-investment in drilling and geophysics.

A changing global landscape

In the early 2020s, GSWA produced several public-facing strategic documents that helped (re)define its business as usual (Geoscience Strategy, 2022), understand its role in society for the next decade (Unearthing Western Australia Strategy 2030) or transform parts of its business (Geoscience Data Transformation Strategy 2021–2025), all to ensure it remained a world-class geological survey organisation.

Since the publication of GSWA's strategic documents, environmental, societal, technological and governance shifts, including geopolitical developments, have significantly changed the global demand for energy and raw materials. The urgency to mitigate climate change continues to greatly influence the resources sectors focus on low-carbon commodities, while supply-chain security has emerged as a defining issue in an increasingly fragmented global economy. At the same time, many nations now view critical minerals as essential not only for energy security but also for defence capability, quantum technologies, advanced computing, space

systems and other high-tech applications. These developments are likely to influence the types of pre-competitive geoscience datasets required to support new mineral and energy discoveries, including the identification of geological carbon and hydrogen storage resources.

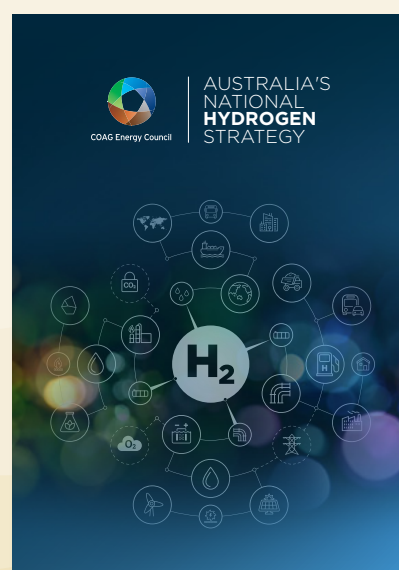
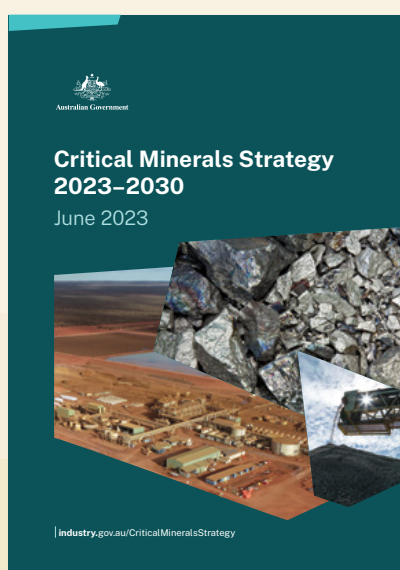
For a clean energy economy that meets the 2050 net-zero emission target, renewable energy sources such as solar and wind, alongside hydrogen for fuel, storage and processing, are pivotal. This has driven strong global demand for 'battery metals' and other critical or strategic minerals such as copper, lithium, nickel, cobalt and the rare earth elements. Over the next decade, demand for these materials is predicted to exceed supply. Although WA is well positioned to supply many of these strategic and other critical minerals, there is an urgent need to make new and significant discoveries in the State. The shift from traditional hydrocarbon fuels to manufactured or natural hydrogen, together with carbon capture and storage (CCS), will require new geoscience datasets that identify sources of natural hydrogen, and map geological reservoirs suitable for short- and long-term geological storage of hydrogen and CO₂, respectively.

In addition, changing climatic conditions and population growth are placing increasing pressure on the State's groundwater resources for public, agricultural and industrial use. While groundwater resource exploration remains

the remit of the Department of Water and Environmental Regulation (DWER) and the Department of Primary Industries and Regional Development (DPIRD), these agencies are increasingly relying on GSWA's pre-competitive geoscience datasets, such as airborne magnetic and electromagnetic surveys, to identify new potable groundwater sources. Although GSWA is currently collaborating with these agencies, future groundwater exploration may require new or higher-resolution geoscience datasets to support sustainable resource management.

GSWA's strategic opportunity

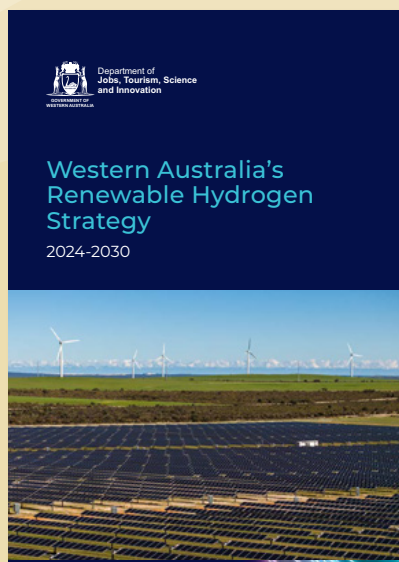
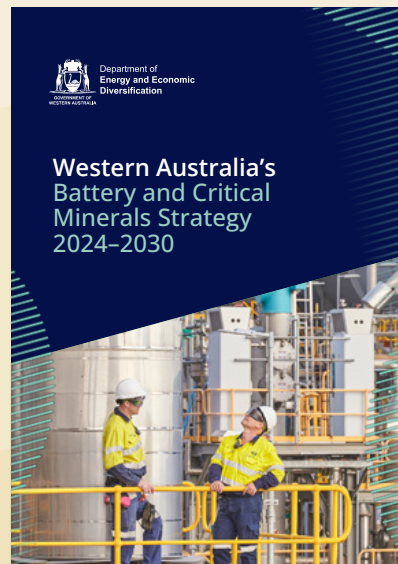
National strategies around the evolving energy transition are underpinned by numerous strategic documents and policies including the International Energy Australia's Roadmap for the Global Energy Sector (2021), Australia's 2023–2030 Critical Minerals Strategy (2023), Australia's National Hydrogen Strategy (2024), and the Australian Academy of Science's decadal plan for Australian Geoscience (National Committee for Earth Science, 2018). Most recently, the Federal Government has provided \$3.4 billion over 35 years (with an initial \$556.1 million over 10 years) to Geoscience Australia under the Resourcing Australia's Prosperity (RAP) initiative. This funding is designed to help map the continent's mineral, energy, and groundwater resources.



On a State level, the WA Government has focused on developing several long-term strategies to help diversify its economy by reducing reliance on the iron ore sector, and to become a world leader in mitigating carbon emissions by transforming its energy sector (Diversify WA: 2024 update; Western Australia's State Battery and Critical Minerals Strategy 2024–2030; Western Australia's Renewable Hydrogen Strategy 2024–2030; Western Australia's carbon capture and storage action plan and, the 10-year Science and Technology Plan 2025–2035). Although these strategic visions encompass a wide range of sectors, many contain geoscience at their core.

Over the next decade, the State Government's geoscience focus will increasingly centre on the opportunities needed to support critical and strategic mineral supply and downstream value-adding, clean energy, energy security and

decarbonisation. Realising this vision will require industry, government and academia to work far more closely toward shared goals, demanding a step-change in coordination, alignment and sustained commitment across all parties. GSWA will underpin this effort through the collection, delivery and interpretation of high-quality pre-competitive geoscience data, providing integrated datasets that are immediately usable by expert practitioners, while also being machine-readable and amenable to machine learning and artificial intelligence-based applications. In doing so, GSWA will help ensure that public geoscience is not only a scientific asset, but also an enabling platform for economic activation, supply chain resilience and energy security while strengthening the long-term exploration ecosystem by supporting infrastructure, expertise and the services required to deliver high-quality pre-competitive geoscience.



A new beginning – long-term geoscience planning and coordination

In 2025, GSWA's Geoscience Directorate was restructured so that its staff and resources could be better aligned and be more agile, and with the introduction of new communication tools to help facilitate efficient cooperation and collaboration across projects.

The Survey also introduced three, informal, long-term 'themes' aimed to deliver on the State's main focus areas:

Critical materials for renewable and strategic technologies

Natural energy systems and carbon mitigation

Hydrogen as a future energy source

An additional two themes that summarise the organisation's forward-looking scientific foundation and essential stewardship role, will also be introduced:

Future resource knowledge and system foresight

Geoscience for society, safety and stewardship

The first of these new themes centres on building future resource knowledge and system foresight, work that scans emerging mineral and energy opportunities, tracks global trends in critical minerals and energy systems, and provides long-range geological intelligence to guide geoscience activities, investment, land use planning, and policy. The second of the new themes focuses on 'Geoscience for society, safety and stewardship', encompassing the monitoring and understanding

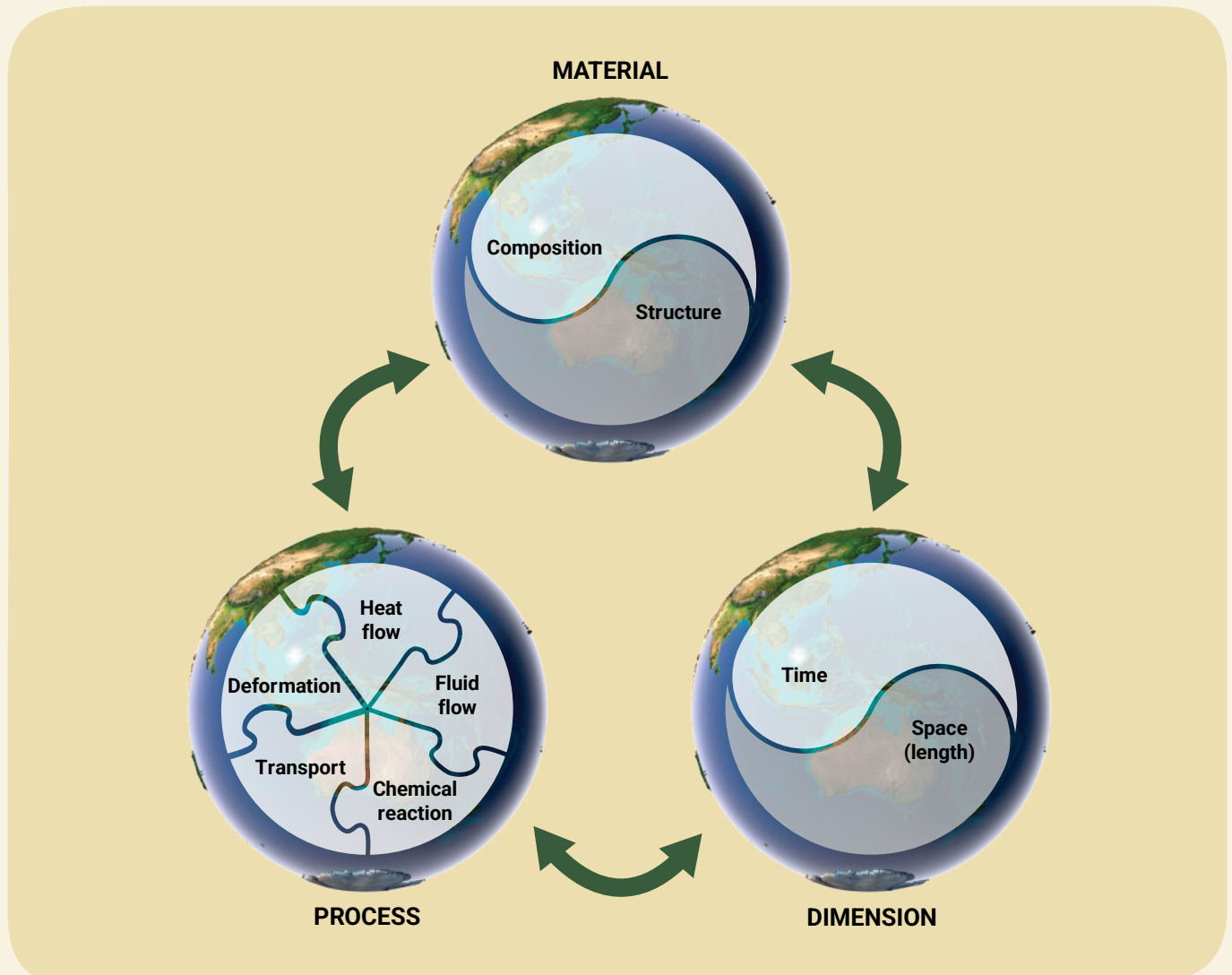
of seismic hazards, groundwater, communication of WA's geology to the public, and the protection, curation and promotion of WA's geological heritage. Together, they ensure the organisation's work is scientifically robust, socially relevant and aligned with both community expectations and future economic opportunities, while equipping government, industry and the public with the evidence needed for informed decisions.

This update and revision to the Geoscience Strategy is intended to formalise those five themes, to precisely define the work programs that will support them and outline the high-level deliverables. Additionally, this strategy will:

- Be a living, public-facing document that will be updated regularly.
- Define the fundamental geoscientific questions that will drive the individual work programs.
- Inform what GSWA will do in-house and where GSWA will collaborate externally.
- Allow GSWA staff to understand how their business as usual maps into the individual work programs and the long-term, higher-level activity themes and to promote staff interaction and multidisciplinary collaboration.
- Inform industry, academia, government and the public what data GSWA intend to acquire and what type of information and knowledge products are planned for delivery.

Enabling steps: applying an integrated geoscience framework

The need for prediction in geological engineering and in mineral and energy exploration has led to the development of system-based approaches. Petroleum Systems and Mineral Systems approaches are unifying cross-discipline concepts that encompass the disparate processes and elements relating to the formation of economically viable resources. The success of these unifying concepts highlights the limitations of thinking and acting within relatively narrow geoscience disciplines such as geology, geophysics and geochemistry, and have demonstrated the potential of an integrated geoscience approach. Ore deposits and energy resources, however rare and hard to find, have formed as part of a dynamic Earth system. It is therefore essential to understand the geology of WA and its resources from an integrated whole-of-Earth-systems approach.



A simplified approach that illustrates the complexity of the unique, complex nature of the Earth system is the interaction between Earth **materials**, spatial and temporal **dimensions** and physical **processes**. An integrated systems approach can also be used to identify gaps in the characterisation of a geoscience problem, because analysing material, dimension or process components in isolation will leave significant gaps in understanding. GSWA's activities and capabilities can be mapped against this Earth system perspective.

There is a growing recognition that Earth processes, including how, when and where mineral and energy resources have formed, cannot be understood by a focus on exposed rocks alone, but require mapping of the entire lithosphere through integration of geophysical and geochemical techniques. The 2012–2021 Australian Research Council Centre of Excellence for Core to Crust Fluid systems (CCFS), of which GSWA has been a participant, has demonstrated how innovative collaborative research in an integrated

geoscience environment can build capacity and capability on a level of national and international significance. While GSWA needs to continue to generate knowledge of WA's basin and bedrock geology, it is essential to better characterise and image the Earth's composition and structure from the surface regolith down to the deep lithosphere–asthenosphere boundary and to integrate this 'mapping' with our knowledge and understanding of lithospheric processes. Over the next decade the results from the WA Array and WAMT programs will be integral for integrating data and information across the scale of the entire lithosphere and to build a holistic understanding of the Earth processes that have shaped and formed WA's geology and mineral and energy deposits.

Furthermore, progressing the understanding of WA's geological complexity requires a substantial advance in imaging and computing capabilities and in our knowledge of whole-of-Earth-system processes, including the ability to become more predictive in mineral and energy exploration. The recent creation of GSWA's geoscience data science team and access to the Pawsey Centre's high-performance computing facility, as well as the continued transformation of GSWA's geoscience data into machine readable AI- and ML-ready datasets, are essential for integrating information at the lithosphere scale and to produce predictive models of Earth evolution and the formation of mineral and energy deposits.



Activity themes



Critical materials for renewable and strategic technologies

Since the end of the Second World War, the discovery rate of Tier 1 and Tier 2 mineral deposits, including gold, base metals, precious metals and uranium, has declined sharply across most mature exploration jurisdictions (Schodde 2025). At the same time, the average depth of discovery has increased across all commodities, reflecting a simple reality: the majority of deposits exposed at or near the surface have already been found. Future discoveries will increasingly be made in deeper, more complex search spaces, often buried beneath significant regolith or sedimentary cover.

This shift fundamentally changes the exploration challenge. It means that we must understand not only the geology of the basement rocks that host the minerals, but also the nature, architecture, and evolution of the entire lithosphere, and in particular the regolith that conceals them.

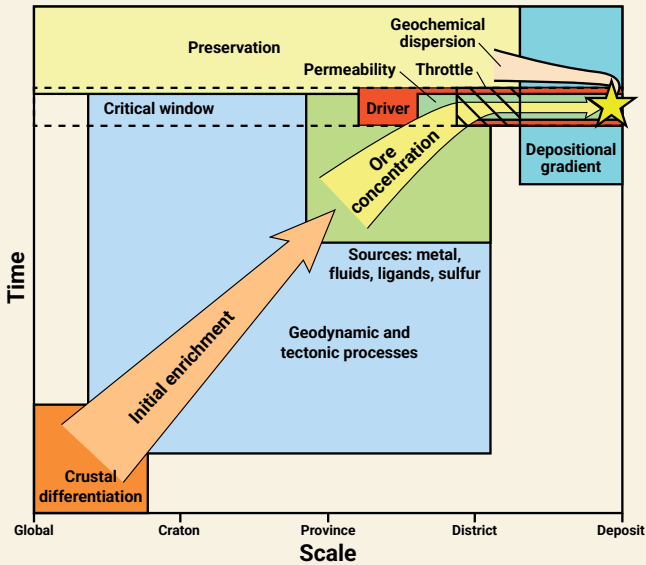
The national UNCOVER Initiative, led by the Australian Academy of Science, was established to address this national challenge: how to discover the next generation of major mineral deposits hidden beneath Australia's extensive cover. It provides a strategic framework built around four key research themes, each grounded in the 'Mineral Systems' approach of Wyborne et al. (1984):

- Characterising Australia's cover;
- Understanding lithospheric architecture;

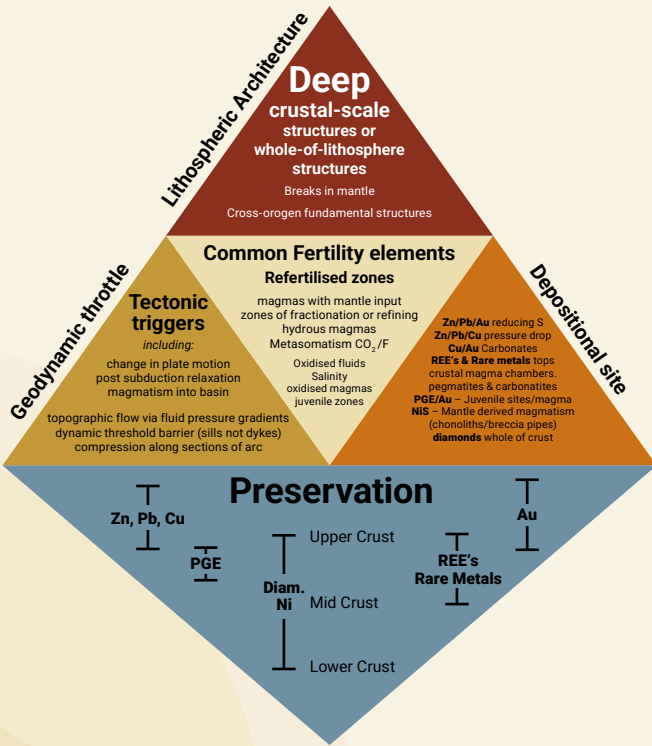
- Resolving the distal footprints of ore systems; and
- Developing exploration tools for covered terranes.

An integrated Mineral Systems/UNCOVER approach reduces exploration risk by identifying regions where the geological conditions are most favourable for forming economic mineral deposits. It recognises that ore formation reflects the interaction of numerous fundamental geological processes operating across multiple spatial and temporal scales, commonly grouped into key components including **common fertility elements, lithospheric architecture, geodynamic throttle, depositional site, preservation** (Occhipinti et al. 2020). Each component is defined by diagnostic, mappable geological criteria that guide effective exploration targeting. In applying this framework, GSWA adopts an **investigative lens** that focuses on these underlying processes themselves: the fertility of the crust and mantle, the architecture that governs fluid and magma pathways, the geodynamic conditions that modulate energy and flux, the depositional environments that localise mineralisation, and the preservation potential that determines what remains detectable today.

Huston et al. (2016)



Occhipinti et al. (2020)



Because Mineral Systems models are often developed for particular commodities or deposit types (such as magmatic Ni–V–PGE systems, magmatic REE systems or sedimentary-hosted base metal systems) GSWA’s emphasis on the investigative lens ensures that data acquisition remains commodity-agnostic and centred on the geological processes that control mineralisation across multiple system types. To translate this process-based understanding into practical workflows, the geoscience program is structured around a complementary **predictive lens**: a set of geoscientific questions and testable hypotheses (Appendix) that define the data required, guide integration across disciplines, and ultimately enable the Mineral Systems concept to be applied consistently across covered and underexplored terrains.

These predictive questions form the basis of focused work activities that synthesise geological, geophysical, geochemical and geochronological datasets within a whole-of-Earth-system framework. Through this approach, each activity contributes new data, interpretations and knowledge products that collectively strengthen the State’s capacity to evaluate mineral potential using a modern, process-driven Mineral Systems methodology.

Prioritisation of the work activities across the next five years will be required as the volume of work is extensive and the generation of some datasets will require data generated from other programs, including those progressively released from the WA Array and WAMT programs. Each work program will require interaction and collaboration between GSWA staff with different skill sets and disciplines, and where those skills sets are missing, this will inform on the areas that GSWA will be required to engage in external collaborative projects. Ultimately, GSWA may digitally integrate these new commodity agnostic datasets into new, State- or province-scale predictive mineral or commodity group maps that would act as first-pass filters for explorers and investors and would also be useful in triaging parcels of land for rapid land use assessments.



Natural energy systems and carbon mitigation

The WA Government is positioning the state as a major global hub for long-term CO₂ storage (Carbon Capture and Storage, CCS). Proposed storage pathways include injection into depleted oil and gas reservoirs, newly identified geological storage plays and surface-level mineralisation using highly reactive mine-waste residues. Current assessments suggest that WA possesses far more geological storage capacity than required for its own domestic emissions, creating the potential to store CO₂ from international emitters, particularly energy-intensive economies across Asia.

This emerging CCS industry sits alongside two other major policy drivers shaping WA's subsurface-energy landscape: the State's Domestic Gas Policy, which ensures long-term security of gas supply for local industry and households, and the growing interest in geothermal energy as a stable, low-emissions heat source. Both policy areas rely heavily on high-quality geoscientific data and a detailed understanding of the State's sedimentary basins, reservoirs, seals, fault systems and fluid behaviour. As CCS, natural gas and geothermal development increasingly overlap in terms of data needs, regulatory frameworks and subsurface access, GSWA's role in providing integrated, basin-scale geological knowledge becomes even more critical.

To support the CCS component of this broader energy strategy, WA has developed its own legislative framework for greenhouse gas transport and storage, reflecting the fact that subsurface regulation is divided between State and Commonwealth jurisdictions. While offshore greenhouse gas storage beyond the three-nautical-mile boundary is governed under the *Commonwealth Offshore Petroleum and Greenhouse Gas Storage Act 2006*, the *Petroleum Legislation Amendment Act 2024 (WA)*, supported by associated regulations and guidelines, establishes the legal basis for greenhouse gas transport and permanent storage within the State's onshore areas and State waters, with scope to accommodate other gases such as hydrogen.

This gives WA a more complete and coordinated framework for enabling CCS as part of its wider subsurface energy and decarbonisation agenda.

To address the State's focus on clean energy and decarbonisation, GSWA will update and expand the current 2013 edition of the WA CO₂ Storage Atlas, extending coverage to all WA's onshore basins and helping identify the most prospective underground reservoirs for long-term carbon sequestration, whether they are economically or strategically important today or whether they might become significant in the future. The Atlas will serve as a scientifically rigorous reference, providing government and industry with the technical foundation needed to assess, approve, and invest in future CCS projects. The work will initially focus on harmonising and cleaning existing data across all of WA's onshore basins, rather than collecting new data. The harmonised data and spatial datasets will be released digitally alongside detailed written reports (the 'Atlas') identifying the key storage plays in each of the onshore basins. The Atlas will include detailed information on reservoir quality, pressure and seal integrity, formation depths, structural complexity, thermal history and depositional settings. The Atlas will also identify significant gaps in the existing datasets and will lay the foundation for future data collection from diamond drill core stored in the Perth Core Library for inclusion in subsequent iterations.

Many of the datasets required for CCS assessment, such as basin architecture, reservoir and seal properties, pressure and temperature regimes, and structural and stratigraphic frameworks, are also fundamental inputs for broader subsurface studies. The harmonised datasets produced for the Atlas will therefore support a wide range of basin-related applications, including petroleum and natural gas exploration, geothermal resource evaluation, natural hydrogen and helium exploration, and the assessment of sedimentary-hosted critical mineral and base-metal systems. By standardising and

modernising these datasets, the GSWA will generate a high-quality, basin-scale geoscience foundation that enhances CCS readiness while simultaneously improving the State's overall subsurface knowledge base. Importantly, CCS depends not only on technical suitability and investment readiness, but also on public confidence in containment, induced seismicity risk management, groundwater protection, monitoring, verification, closure and long-term stewardship. In this context, the Atlas and associated studies will not just support project development and investment, but also enable transparent regulation, informed decision-making and broader community confidence in the safe and responsible deployment of carbon storage.

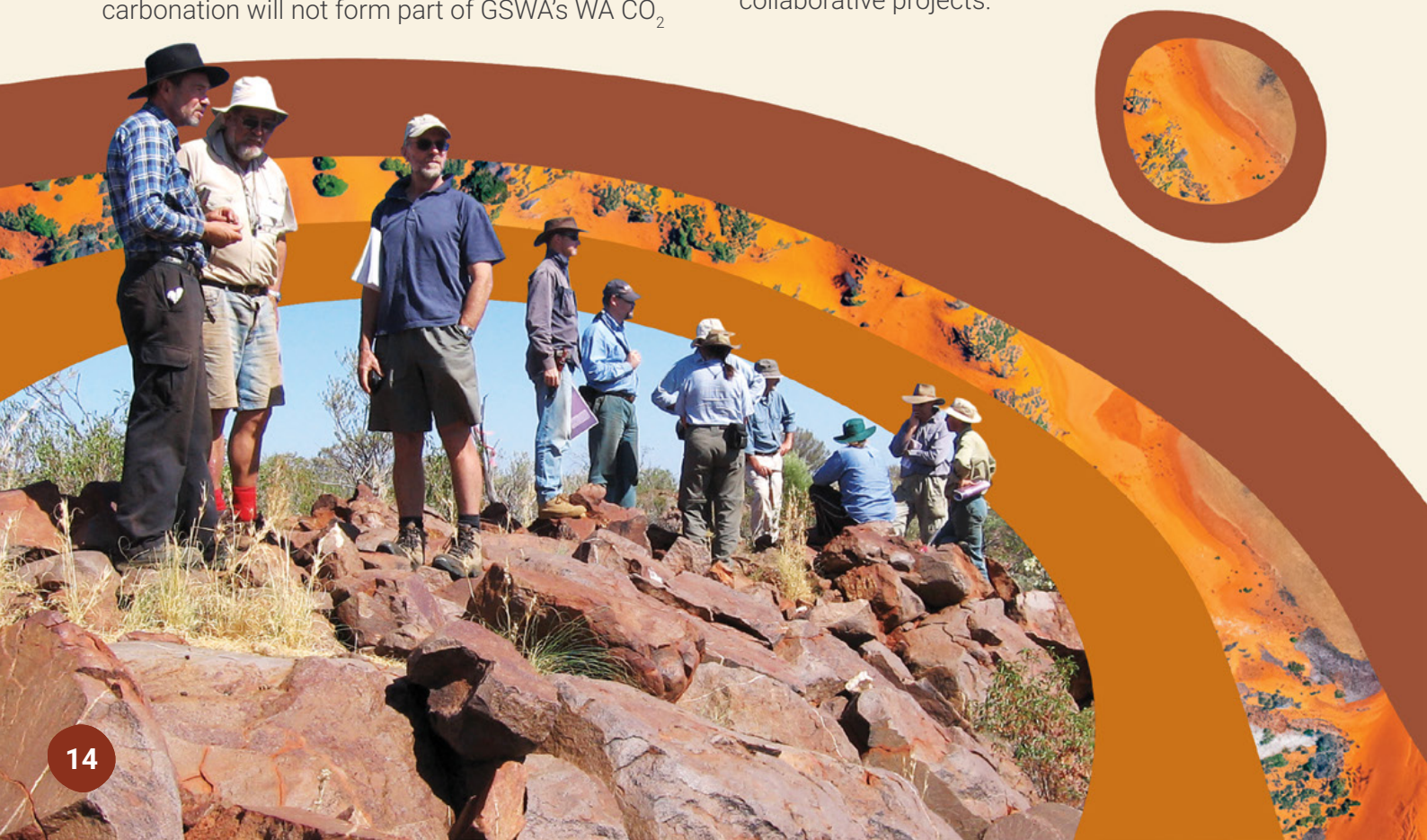
Parallel to the subsurface storage pathways, the Minerals Research Institute of WA (MRIWA) is advancing the Mineral Carbonation Roadmap, which positions WA to leverage its enormous volumes of reactive mining residues for long-term carbon storage. Although mineral carbonation may not match the gigatonne-scale potential of geological CCS, it will form a critical and necessary component for the State's broader decarbonisation ambitions. Its strategic value may be greatest where large residue inventories, major emissions sources and enabling infrastructure corridors coincide, allowing hub-scale development models that integrate carbon management with industrial activity and regional growth. While mineral carbonation will not form part of GSWA's WA CO₂

Storage Atlas, GSWA will contribute by identifying key mining residues, their volumes, compositions and carbon storage potential, with results released digitally through secondary resource assessments.

All geoscientific work conducted in this theme will also use the integrated Earth System approach – **material, process** and **dimension** – and will be structured around a series of major geoscientific questions (Appendix). These questions define the core work programs that will underpin WA's multi-component subsurface energy strategy. The key activities will include:

- Basin Architecture and tectonic framework;
- Depositional systems and reservoir development;
- Source systems and fluid generation;
- Geological storage systems; and
- Geothermal systems.

For each of the major work programs, GSWA will generate targeted data, information and knowledge products. Prioritisation across the next five years will be essential, as the volume of work is extensive and some datasets depend on outputs from other programs. Each work program will require collaboration between GSWA staff with diverse skill sets, and where capability gaps exist, these will guide GSWA's engagement in external collaborative projects.



 Theme

3

Hydrogen as a new energy source

Alongside the rapid development of CCS, the WA Government is also positioning the State as a major powerhouse in low-emissions hydrogen. The strategy aims to leverage the State's vast solar and wind resources to become a global leader in the production, use and exporting of manufactured hydrogen and hydrogen-based products such as ammonia and 'green' steel. Recent studies by the CSIRO and GSWA have also highlighted the State's significant potential for natural geological or 'white' hydrogen. WA's extensive cratons and sedimentary basins form complex geological systems capable of generating, migrating and trapping naturally occurring hydrogen underground.

These same geological systems also have the potential to host naturally occurring helium, a critical and increasingly scarce industrial gas that is used to cool superconducting magnets in MRI machines and quantum computers, enable semiconductor manufacturing, support aerospace pressurisation systems, and provide ultra-sensitive leak detection for high-tech industries. Helium is commonly generated through the radiogenic decay of uranium and thorium in ancient crustal rocks, of which WA has some of the oldest and most uranium-rich on Earth. Under the right structural and stratigraphic conditions, helium can accumulate in the same types of traps that host natural hydrogen and conventional hydrocarbons. As global helium shortages intensify, the possibility that WA's cratons and basins may contain economically significant accumulations adds another dimension to the State's emerging subsurface-energy opportunity.

Together, hydrogen (manufactured and geological), helium, CCS, natural gas and geothermal resources form a converging set of industries that rely on the same foundational geoscience: **basin architecture, reservoir quality, fluid pathways, thermal regimes, structural controls** and **seal integrity**. They also share overlapping regulatory

and data requirements. With the passing of the *Petroleum Legislation Amendment Act 2024* (WA), which establishes the legal basis for the exploration, transport, and storage of hydrogen and other gases, industry interest in natural hydrogen and helium exploration across WA is expected to accelerate. At the same time, the State's Domestic Gas Policy continues to ensure long-term security of supply for local industry, while growing interest in geothermal energy is driving demand for high-resolution thermal and structural data. Collectively, these developments reinforce the need for integrated, basin-scale geoscience capable of supporting multiple subsurface-energy pathways simultaneously.

To deliver on the State's clean energy objectives, GSWA will prioritise mapping and characterising the geological factors that influence the generation, migration, and trapping of natural hydrogen and helium. All the geoscientific work conducted in this activity theme will also use the integrated Earth System approach—**material, process** and **dimension**—and will be organised around a series of geoscientific questions that define individual work programs. For each major question, GSWA will generate targeted data, information and knowledge products. Prioritisation across the next five years is essential as the volume of work is extensive and some datasets depend on outputs from other programs (Appendix). Each work program will require collaboration between GSWA staff with diverse skill sets, and where capability gaps exist, these will guide GSWA's engagement in external collaborative projects.



Theme

4

Future resource knowledge and system foresight

This theme brings together the activities that help us understand what comes next for WA, so GSWA's geoscience can be converted into maximum economic advantage for WA (and Australia), reduce sovereign supply-chain risk and be used to sharpen engagement and prioritisation for resource strategy. It ensures our programs evolve in step with emerging industries and long-term resource needs, and that our evidence base is organised in a way that supports clearer strategic choices by government and industry. It includes work aimed at:

- **Characterising future mineral and energy potential**, by identifying new commodities, geological domains, and opportunities across critical minerals, hydrogen, geothermal systems, and other low-carbon energy resources.
- **Assessing secondary prospectivity and resource recovery potential**, by identifying opportunities in mine waste residues for the recovery of critical and strategic minerals, and the long-term supply of basic raw materials including construction materials and industrial minerals that could support regional infrastructure, manufacturing and future supply chain resilience.

- **Tracking global and national trends**, by monitoring shifts in technology, supply chains and energy systems to anticipate how WA's geology can support future industries, and where the State can build competitive advantage.
- **Providing evidence for long-term planning**, by ensuring government and industry have reliable, forward-looking geological intelligence to guide investment, land use decisions and policy development.

Acting as a strategic radar, this theme helps keep all three major themes aligned with future demand, not just present needs, while also providing a practical basis for stronger engagement, clearer prioritisation, and better-directed resource strategy effort. In doing so, it positions WA to lead in the next generation of resource and energy opportunities and to capture greater value from GSWA's overall geoscience investment.

Theme
5**Geoscience for society, safety and stewardship**

This theme covers the essential public good and stewardship functions that underpin safe communities, responsible resource development, and the preservation of WA's geological heritage. It also reflects GSWA's role in safeguarding and interpreting one of the world's most significant geological archives. WA preserves a globally unique, near-continuous rock record spanning around 4.4 billion years of Earth history, including evidence for the origin of continents and the emergence of life on Earth. This information is globally important for advancing understanding of Earth's evolution and planetary processes and provides valuable analogues for future exploration of the Moon, Mars and beyond. It includes:

- **Understanding and managing natural seismic hazards**, by monitoring WA's natural seismicity, understanding the engineering properties of the Earth's surface and their relation to other Earth processes that affect public safety and infrastructure.
- **Regulatory and monitoring responsibilities**, by providing the scientific basis (such as long-term background seismic monitoring) for oversight of the resources sector and ensuring activities like CCS or hydraulic fracturing are safe, compliant, and environmentally responsible.
- **Maintaining geological databases and improving data access**, by ensuring the State's geoscience information is curated, preserved, interoperable and accessible, so that government, industry, researchers and the community can reliably find, use and benefit from authoritative geological data over the long term.
- **Studying WA's globally significant rock record** and promoting it as a natural laboratory to investigate the origin of continents, the emergence of life, and other fundamental stages in Earth history.
- **Public education and stakeholder engagement**, by equipping the community, industry, and government with accessible, evidence-based, trusted geological knowledge to support informed opinions and decisions.
- **Geoheritage and Geotourism**, by protecting significant geological sites, promoting their value, and helping people understand the deep history and unique character of WA's geology and landscapes.

This theme ensures that geoscience remains connected to people, places, and societal expectations. It reinforces the organisation's role as a trusted public institution, not just a technical agency.



Data products, data integration and data delivery

Through these themes, GSWA will place greater emphasis on ensuring its outputs are not only scientifically rigorous, but also decision-ready, capable of informing investment choices, regulatory frameworks, strategic planning and long-term resource development pathways.

To better support exploration and investment, GSWA will prioritise the rapid release of relevant, industry-ready datasets and products as soon as they reach a usable level of completeness, enabling industry and government to make decisions in near-real-time. This will be reinforced through more targeted products that connect geological insight with practical decision-making needs and help users understand the significance, application, and strategic implications of the underlying geoscience.

These rapid release outputs, referred to here as Level 1 products, will be designed around the specific geoscience activities they support and released early and transparently. Each Level 1 product will be accompanied by a concise abstract outlining:

- the purpose and rationale for the product;
- the data acquisition, processing, and integration methods used; and
- any limitations, uncertainties, or caveats relevant to interpretation or application.

This approach ensures transparency, scientific rigour, and immediate utility, while enabling industry to access new knowledge as soon as it becomes available. Broader, more comprehensive geological syntheses will continue to play a central role in the knowledge needed to address the State's major geological questions. These higher-level interpretations will draw on multiple Level 1 products and datasets, integrating them into cohesive models and frameworks. By decoupling data release from synthesis development, the Survey can maintain its commitment to deep scientific understanding while also delivering value at a pace aligned with industry needs.

Together, these Level 1 releases and higher-order syntheses create a clear product pathway, from timely, usable data through to integrated interpretation, that can then be packaged and communicated in formats tailored to different decision-makers. Depending on the audience and opportunity, these products may include investor-facing opportunity packages, prospectivity storylines, regional opportunity profiles, policy briefs, regulator-ready datasets, and industry-



facing roadmaps for emerging commodities and subsurface industries. This translation function will be especially important in areas where geoscience is shaping new or rapidly evolving sectors including critical minerals, hydrogen, carbon storage, geothermal systems, mine waste reprocessing and other future resource opportunities, where users often need more than data alone. They need clear interpretation of what the geology means, where the strongest opportunities may lie, what uncertainties remain, and how geoscientific knowledge can support better sequencing of policy, investment and delivery.

By strengthening this interface between science and decision-making, GSWA will help ensure its work is more effectively used to guide exploration, support regulatory maturity, attract investment and unlock greater economic and public value for WA. Potential deliverables include:

- **Targeted Opportunity Packages** — decision-ready packages for priority sectors such as critical minerals, hydrogen/helium, carbon storage, geothermal systems and mine waste repurposing, designed to support investment, exploration and strategic planning.
- **Regional Opportunity Profiles** — regional-based prospectivity and opportunity narratives that integrate geological insight with practical context for government, industry and regional stakeholders, including local delivery infrastructure and ‘common processing’ potential.
- **Decision-Ready Briefs and Datasets** — accessible guidance on how to find, access and use GSWA information, how it expands prospectivity potential/analysis, and examples of implementation into workflows, supported by richer policy briefs, technical notes and regulator-ready geoscience products that support emerging policy, regulatory and investment decisions.

Data integration, processing and modelling

GSWA's ability to deliver high-value geoscience in the digital era depends on resolving a longstanding strategic challenge: the need for IT service-delivery risk minimisation versus the organisation's requirement for scientific and technological enablement. To meet industry expectations and support modern geoscience workflows, GSWA must evolve from a consumer of centrally controlled services into an empowered technological incubator capable of rapid development, integration and experimentation.

A critical barrier to innovation has been the lack of flexibility in data governance and computational infrastructure to support GSWA's ability to prototype, iterate and deploy modern scientific tools. GSWA has demonstrated its ability to manage and execute technology-focused programs such as the Geoscience Data Transformation Program (GDTP) and the Geodata science team, both of which have natively integrated with existent systems to deliver value. Expanding this capability is critical for accelerating the pace of delivery required in this plan and would enable the delivery of statewide digital products through Application Programming Interfaces (APIs), modernised web interfaces, and AI-ready data services. This requires a step change in computational infrastructure and governance to enable technical decisions to be made at pace by the delegated authority.

Existing programs such as the GDTP have significantly improved data Findability and Accessibility, but achieving the full FAIR principles now depends on advancing our capabilities in Interoperability and Reusability. Strengthening data integration, processing, and modelling will allow GSWA to move beyond siloed domain knowledge and toward a unified, statewide geoscience understanding.

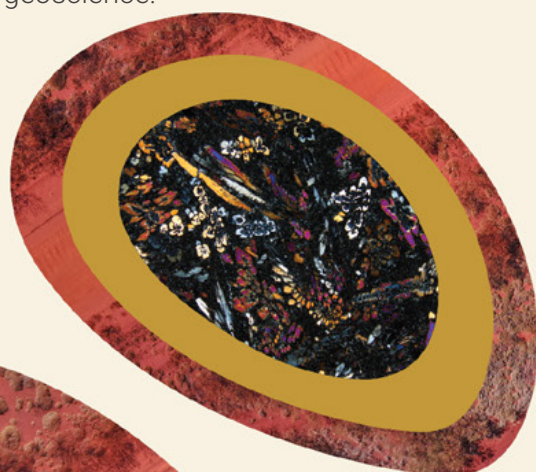


Key enablers include:

- **Internal capability uplift in data engineering, modelling, infrastructure management, and platform development** – GSWA staff are equipped with the skills and tools to build, maintain and evolve digital systems in-house, reducing reliance on external vendors for core scientific infrastructure and enabling faster, more responsive capability development that is directly aligned to geoscience priorities.
- **Authority to design and operate scientific-grade digital systems** – GSWA operates as a sovereign digital entity within the WA government ecosystem, with the technical authority and governance frameworks to design, apply and deploy systems that meet scientific-grade standards ensuring data integrity, reproducibility and fitness-for-purpose across the full geoscience workflow.
- **Expansion of interoperable, reusable data services and APIs** – GSWA's data holdings are accessible through well-documented, standards-compliant APIs that enable seamless integration with industry, research and government systems, reducing duplication, lowering barriers to data use and positioning GSWA as a central node in the broader geoscience data landscape.

- **Leveraging GDTP foundations to deliver next-generation geoscience endpoints and services** – The geoscience data and technology platform serves as a stable, scalable foundation from which the Geodata Science team can seek to continuously release new data services, analytical endpoints, and discovery tools, translating platform investment into tangible, high-value outputs for explorers, researchers, and policy makers.

Other WA agencies have already demonstrated that innovation and compliance can coexist. Projects like Landgate's Digital Twin and WA Health's Enterprise Medical Imaging Platform show that large-scale technology projects can be executed in a compliant fashion and leverage digital practise to deliver real benefits to the public. GSWA must follow this trajectory, modernising its digital foundations to support the next generation of integrated geoscience.



Prioritised work program and activities

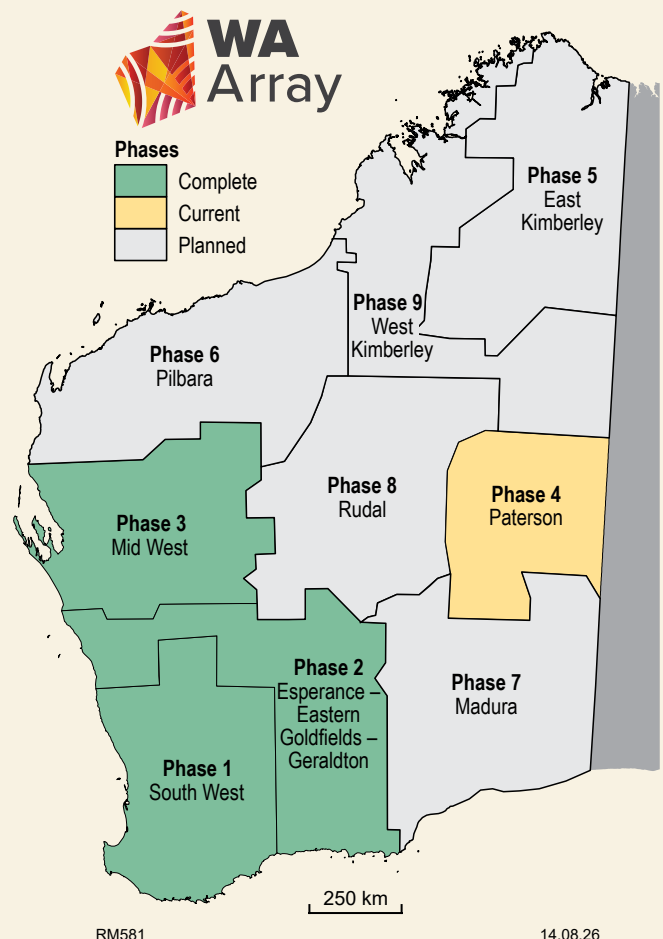
Although this update of the Geoscience Strategy is framed through the five-year geoscience plan, the intention is for it to roll forward beyond that timeframe, with work activities reassessed and updated each year.

The first three years will carry the most detailed and operationally focused plans, as they will drive the program's direction, compilation efforts, and product delivery. Because shifting geopolitics and societal needs may influence our longer-term outlook, years Four and Five are best treated as a forward strategic view rather than a commitment to specific activities. At the end of each year, the program will be reviewed, the third-year activities will be refined, and the outlook for years Four and Five will be updated. It is important, however, that geopolitical or societal pressures do not reshape the program so dramatically that projects remain unfinished or data are not released. For this reason, years One and Two need to be relatively firm, with some flexibility in year Three, while years Four and Five remain more strategic in nature.

The plan is aspirational, and it is unlikely that all proposed work activities could be completed within a five-year period, so prioritisation will be essential. Many activities will run concurrently and continue throughout the life of the plan, progressing into new geological areas, provinces, or terranes over time. Achieving an integrated understanding of Earth processes across the entire lithosphere depends on the availability of deep-Earth geophysical data. The WA Array and WAMT programs are central to generating this information. As these programs require a further six years to complete, the five-year Geoscience Plan is dependent on the delivery of their data and can only operate effectively in areas where those datasets exist.

WA Array and WAMT Phases 1–3 have focused on the Yilgarn Craton, including the Eastern Goldfields Superterrane, and its western, southern, and northern margins. Phase 4 will extend coverage

into the far eastern part of the State. As a result, the first two to three years of the program will naturally concentrate on work activities in areas where deep-Earth geophysical data already exist, primarily the Yilgarn Craton and its margins, while beginning to establish work in the eastern regions of WA in anticipation of the forthcoming datasets. It should be noted that the order of deployment is strongly influenced by land-access, and to some degree geopolitical constraints, and therefore any planning beyond Phase 4 should be regarded as indicative rather than definitive.



In the Natural Energy Systems and Carbon Mitigation space, work will be driven principally by the compilation and delivery of the WA CO₂ Storage Atlas. The Atlas and associated digital data and reports will be released for individual basins and staged across the first two years of the plan. Many of the compiled datasets for the Atlas will also act as valuable ‘inputs’ for many of the other defined work activities and so it is anticipated that some higher-level syntheses outside of the WA CO₂ Storage Atlas will also be released in the first couple of years. Gaps identified in the primary datasets will drive data collection activities in the mid to latter years of the plan. Work associated with the mineral carbonation activities will be conducted alongside the secondary prospectivity work in the ‘Future resource knowledge and systems framework’ theme. This will concentrate on compiling and delivering a number of secondary resources assessments that will continually be updated with new information as and when it becomes available.

Much of the work in the ‘Hydrogen as a future energy source’ space is in a preliminary phase as little is known about the geological generation of hydrogen (and helium). The work will initially focus on the development and delivery of a digital Statewide Hydrogen Prospectivity Map. This map will help drive subsequent work which will focus on the collection of new field data, particularly in areas identified with a high potential for geological generation, as well as the field verification of legacy data wherever possible. Significant effort will also be focused on understanding the distribution, structural and stratigraphic integrity and quality of salt layers and diapirs across the State and the stratigraphic framework of the basin in which they occur.

The forward-looking ‘Future resource knowledge and systems framework’ theme is designed to operate steadily in the background, generating strategic insights that will inform other components of the geoscience program. In the near term, however, the highest priority for primary data collection will be assessing the secondary resource potential of mine waste residues across the State. Although much of this work will be undertaken through desktop studies and collaborative efforts, physical sampling and geochemical and mineralogical characterisation of mine wastes will occur across the life of the program. All resulting data and information will be progressively published through a digital WA Mine Waste Residue Atlas, which will expand over time as new information becomes available.

The ‘Seismic hazards and geophysical applications’ component of the Geoscience for society, safety and stewardship theme will be the primary source of new data collection and delivery. Most seismic data acquisition activities will align with the long-term WA Array program, although background, baseline seismic monitoring for CCS will continue as a separate but equally important priority. Custodianship of WA’s geology will remain core business for GSWA; however, building on the momentum of the Geoscience Data Transformation Program, future work will place greater emphasis on enhancing data interoperability and reusability in line with the FAIR data principles.



Collaboration and capability needs

GSWA recognises that successful delivery of this plan depends on strong, purposeful collaboration across government, industry and, most importantly, academia.

Many of the scientific, technical and economic opportunities outlined in this strategy sit at the intersection of public policy, resource development, research capability and enabling technology. Delivering at the scale and pace required will therefore depend on partnerships that combine GSWA's core role as the State's authoritative geoscience custodian with complementary expertise, specialist infrastructure and coordinated investment.

Collaboration will enable GSWA to access cutting-edge research, leverage specialist facilities and draw on a broader pool of scientific talent, ensuring our work remains innovative, relevant and aligned with national and global geoscience developments. To maximise public value and avoid duplication, GSWA will adopt a more deliberate partnership model, selecting collaboration mechanisms that are fit for purpose and designed to accelerate impact. Depending on the opportunity, this may include co-funded programs focused on priority scientific challenges; challenge-led consortia that bring multiple organisations together around emerging State needs; or data partnerships to improve integration, interoperability and reuse of geoscientific information.

Effective collaborative partnerships should be structured around clear problem statements, defined deliverables, data sharing arrangements, intellectual property expectations, publication pathways and confidentiality where required. They should also include clear adoption pathways, so that outputs are not left as stand-alone research products but are translated into usable datasets, methods, interpretations or tools, with mechanisms to bring successful outcomes back into GSWA workflows, systems

and decision-making. In this way, collaboration becomes not just a means of extending capability, but a disciplined way of accelerating impact, strengthening organisational learning and ensuring that external partnerships deliver lasting value for WA.

To maximise impact, GSWA will prioritise external engagement that:

- **Enhances GSWA's ability to deliver integrated, high-quality geoscience**, particularly where partners bring unique knowledge, datasets, facilities, methods or regional insight that materially strengthens interpretation and outcomes.
- **Accelerates or expands delivery** through partnerships that provide additional capacity, specialist skills, or aligned research programs.
- **Avoids duplication and maximises public value** by coordinating effort across organisations, enabling data sharing and interoperability, and aligning research agendas with State and national priorities.
- **Provides access to specialist instrumentation**, analytical facilities, or advanced modelling techniques that are not available inhouse, including cutting-edge or pre-commercial research capabilities that can be translated into operational workflows.
- **Connects GSWA with a broader pool of researchers**, enabling knowledge transfer, capability uplift, workforce development and exposure to emerging scientific methods and digital approaches.

- **Supports externally led projects that rely on GSWA data, products, or services**, ensuring they are used effectively and that insights flow back into GSWA and to stakeholders where appropriate.
- **Establishes challenge-led, time-bound collaborative programs** focused on high-value geoscience challenges relevant to WA's future industries, with clear problem statements, shared datasets, defined deliverables and pathways to adoption.
- **Leverages public and private research investment** to attract national and international expertise, advancing knowledge that contributes directly to the State's strategic geoscience goals.

Purpose-built infrastructure and collaboration environments will be an important part of this delivery model. In particular, the Perth and Kalgoorlie Core Libraries, and associated geoscience facilities present a significant opportunity to deepen engagement between government, industry and research partners by enabling shared access to physical samples, digital datasets and applied analytical capability. Used strategically, these platforms can support accelerated discovery, more integrated interpretation, innovation in exploration and subsurface assessment, and stronger alignment between public geoscience and the State's broader economic and research priorities.

- **Core library centres of excellence** — GSWA will develop and establish the Perth and Kalgoorlie Core Libraries as a collaborative, applied geoscience platform. This will integrate physical assets including core, cuttings, samples, with digital data and partner capability to enable shared workflows, improved sample-to-data traceability, consistent analytical standards, and faster translation of GSWA and partner science into industry- and regulator-ready outcomes.

- **Perth Core Library Innovation Hub** — GSWA will effect a targeted capacity and capability uplift, aligned with the Centre of Excellence, to establish a dedicated, applied collaboration environment that elevates GSWA's technology, data and Perth Core Library infrastructure into a practical 'test-and-learn' platform. The Hub will support cross-sector collaboration (minerals, energy, storage, hydrogen/CCS), applied analytics and modelling pilots, and challenge-led programs that accelerate discovery and strengthen decision-ready delivery. A core component of the Hub will be a geoscience learning and outreach space, museum-style interpretive displays and teaching facilities linked to real samples and active projects that are designed to support STEM engagement, school and university partnerships, workforce awareness, and broader community interest in Earth science and WA's future resource opportunities.

To ensure external stakeholders clearly understand where GSWA seeks collaboration, we will publish our forward work program for Years 1 and 2 and update it regularly as the plan progresses. Alongside this, GSWA will maintain a public-facing, collaboration-specific list identifying the areas where partnership is essential – either because work is underway and would benefit from external expertise, or because it is strategically important but cannot be delivered with current internal resources. This approach improves transparency, invites targeted collaboration, and supports alignment of effort where it will deliver the greatest value for WA.



What does success look like?

Success will be demonstrated through the value we create for the State, the strength of our scientific contribution, and the trust we maintain with our stakeholders. Over the life of this strategy, GSWA will measure our impact and success through the following outcomes:

- **We attract and retain a thriving workforce**, with staff who are engaged, supported and able to work in a safe, inclusive and productive environment.
- **We maintain enduring social licence**, demonstrated through community, government, and industry confidence in our transparency, integrity and responsible scientific practice.
- **Our products and services enable exploration success**, improving geological understanding, reducing uncertainty and supporting informed investment decisions across the resources sector.
- **Our scientific excellence is widely recognised**, with GSWA research being published, cited, presented and actively used by the geoscience community in WA, nationally and internationally.
- **Industry continues to place strong confidence in WA**, reflected in sustained or improving rankings, stable investment levels and ongoing demand for GSWA's data, expertise and collaborative engagement, noting that this may be affected by long-term commodity cycles and global markets.

Together, these outcomes reflect an organisation that is scientifically credible, operationally strong, and delivering meaningful public value for WA.



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Appendix – Geoscience questions and activities

Critical materials for renewable and strategic technologies

Lithospheric Architecture and Fertility

Questions

What are the key structural and compositional differences within and between Archean and Proterozoic lithosphere?

How has the mantle composition changed through time?

How do magmatic and geodynamic cycles drive or spatially relate to metallogenic cycles?

Activities

Define the location, geometry, character and movement history of the major crustal and trans-lithospheric structures.

Define the compositional domains and lithospheric blocks for the Archean and Proterozoic and how they were assembled.

Delineate and characterise fluid and magmatic pathways.

Delineate zones of refertilised lithospheric mantle.

Understand lithospheric mantle evolution through time and space.

Constrain and map fertile magmatic additions to the crust.

Define the characteristic lithology, mineral assemblages, structures, age and tectonic setting of metallogenic belts.

Products

Statewide and regional geological, isotopic and geochemical maps.

Statewide and regional lithospheric architecture and compositional maps.

Mineralisation age maps.

Enablers

Joint geophysical inversion models.

Higher level syntheses and Reports.

Whole of lithosphere thermal models.

4D geochemical evolution models of the lithosphere.

Geochemical barcoding.

Compilation of Explanatory Notes.

Value

Improves targeting of major mineral systems by identifying the deep structures, lithospheric domains and magmatic pathways most likely to control mineralisation.

Reduces exploration risk and search space by providing a stronger predictive framework for where fertile crust and mantle domains occur, particularly beneath cover and in underexplored regions.

Supports more effective exploration models through integrated understanding of how lithospheric architecture, mantle evolution, magmatism and metallogenic cycles relate across time and space.

Strengthens prospectivity analysis at regional to State scale by delivering consistent geological, isotopic, geochemical and lithospheric architecture datasets that can be incorporated into targeting workflows.

Improves confidence in undercover exploration by providing whole-of-lithosphere models that help interpret concealed terranes, major structures and fertile corridors not evident from surface geology alone.

Supports commodity-specific exploration strategies by defining the age, setting and characteristic features of metallogenic belts, allowing industry to better match deposit models to geological context.

Geodynamic throttle and tectonic triggers		
Questions	Products	Value
How has the style and character of WA's geodynamic events through time? What is the response of craton margins through time? Activities Refine time–space evolution of key Archean, Proterozoic and Phanerozoic domains with a focus on key metallogenic periods. Map, locate and characterise arcs, oceans, rifts and LIPs. Refine timing and style of orogenesis. Assess whether tectonic events triggered melting or fluid flow. Characterise the formation, evolution and inversion of key (meta)sedimentary basins. Identify zones of reactivation vs refertilisation. Assess whether lithosphere response is a first-order driver for basin formation.	Statewide and regional 4D geodynamic maps and time slices. Statewide and regional metamorphic and thermal evolution maps. Statewide and regional geological, isotopic and geochemical maps. Statewide and regional mineralogical and alterations maps. Enablers 3D and 4D basin evolution, inversion and fluid flow models. Regional stratigraphic and biostratigraphic correlations. Compilation of Explanatory Notes.	Improves understanding of fertile geodynamic settings by identifying how arcs, rifts, large igneous provinces, basin systems and craton margins evolved through time, and how these relate to mineral system development. Reduces exploration uncertainty by clarifying the timing, style and consequences of major tectonic events, including whether deformation, melting and fluid flow were linked to mineralisation. Improves targeting along craton margins and reactivated terranes by distinguishing zones of reactivation, inversion and refertilisation that may localise mineral systems. Provides stronger predictive frameworks for undercover exploration by integrating time-space geological evolution with basin architecture, fluid pathways and tectonic inheritance. Improves the interpretation of company-acquired datasets by providing regional 4D geodynamic maps, thermal evolution models, stratigraphic correlations and explanatory frameworks that put local results into a broader geological context. Supports more effective basin and frontier exploration by improving understanding of basin formation, inversion, fluid flow and lithospheric controls on sedimentary and basement-hosted mineral systems.

Depositional and common fertility elements		
Questions	Products	Value
What are the key characteristics of magmatic-hosted mineral systems? What are the key characteristics of sedimentary-hosted mineral systems? What are the key sources of crustal fluids and how have they changed over time? Activities Assess and characterise mafic and ultramafic magmatic systems and their associated plumbing systems (Ni–V–PGE, Au, Cu and Ti). Assess and characterise felsic and alkaline magmatic systems and their associated plumbing systems (Li, Au, REE, Sn). Identify major depositional growth fault structures and identify associated fluid/magmatic pathways. Characterise the reactivation/inversion history of all major fault and shear zone structures, including the deposition growth faults. Constrain fluid compositions. Identify redox/oxidation traps.	Statewide and regional, geological, geochemical, alteration and crustal structure maps. Basin-scale structural and thermal maps and models. Sediment dispersion pathway maps. Enablers Statewide and regional geochemical barcodes of mafic and felsic rocks. Geophysical and petrophysical models of altered, mineralised and barren rocks. 3D and 4D basin evolution, inversion and fluid flow models. Regional stratigraphic and biostratigraphic correlations. Basin provenance models.	Improves targeting of magmatic-hosted mineral systems by distinguishing the key characteristics, plumbing architectures and fertility indicators. Strengthens exploration for sedimentary-hosted mineral systems by identifying the major structures, depositional controls, fluid pathways and trap sites that localise mineralisation within basin settings. Improves vectoring toward mineralisation through better recognition of fluid compositions, oxidation or redox traps, alteration patterns and structural reactivation histories associated with ore-forming processes. Increases exploration efficiency and investment confidence by linking magmatic and sedimentary mineral systems to their broader crustal structure, magmatic centres, basin evolution, sediment pathways, depositional settings. Enhances targeting in covered and basin-hosted settings by integrating basin-scale structural and thermal models with sediment pathways, provenance studies and fluid-flow interpretations.

Preservation		
Questions	Products	Value
How has the breakup of Gondwana defined the landscape evolution of WA?	Statewide and regional regolith regimes, thickness and geochemical maps.	Improves exploration in weathered and covered terrains by clarifying how landscape evolution, regolith development and weathering processes influence the preservation, expression and detectability of mineral systems.
What is the effect of weathering on the bedrock and mineral dispersion?	4D geodynamic, landscape and geomorphological maps.	
How does the chemical and mineralogical expression of a mineral deposit become dispersed through surface and weathering processes?	Regional and Statewide Heavy mineral maps. Sediment dispersion pathway maps.	Reduces uncertainty in geochemical targeting by distinguishing bedrock signatures from transported or weathering-related signals, and by improving understanding of chemical dispersion pathways.
Activities	Enablers	
Constrain denudation and weathering history for key areas of the State.	Geophysical and petrophysical models of regolith.	Strengthens targeting through regolith and paleodrainage understanding by identifying paleochannels, sediment pathways and distal footprints that may vector toward concealed mineralisation.
Constrain the morphology and evolution of paleochannels.	Geochronological evolution of regolith.	
Define chemical and physical processes on bedrock material.	Geochemical dispersion models.	Improves efficiency of sampling programs by providing regional frameworks for where transported cover, residual regolith and sediment pathways are likely to preserve, dilute or displace mineral signatures.
Constrain the distal footprints and chemical dispersion pathways for key mineral deposits.	Compilation of Explanatory Notes.	Strengthens regional prospectivity analysis through Statewide and regional regolith, geomorphological, heavy mineral and sediment dispersion maps that can be incorporated directly into exploration workflows.
Constrain geochemical conditions for ionic clay-hosted REE deposits.		Enhances exploration for commodity-specific weathering-related systems by constraining the geochemical conditions associated with ionic clay-hosted REE deposits and other regolith-hosted resources.

Natural energy systems and carbon mitigation

Basin architecture and tectonic framework

Questions

Where are the key structural and tectonic controls on WA basin formation and evolution?

Activities

Define major crustal structures, tectonic domains and lithospheric blocks controlling basin development.

Characterise basin formation, evolution and inversion history across WA sedimentary basins.

Delineate and characterise fault architecture, reactivation history and fluid pathways.

Assess the role of lithospheric structure as a first-order control on basin subsidence and inversion.

Products

2D and 3D fault and structural domain maps and models.

Regional age, isotopic and geochemical maps.

Stratigraphic thickness maps.

Bedrock and basin thermal structure maps.

Enablers

3D and 4D basin evolution and inversion models.

Regional stratigraphic and biostratigraphic correlations.

Burial and exhumation history models.

Fault seal and juxtaposition analysis.

Compilation of Explanatory Notes.

Value

Improves understanding of the structural and lithospheric controls on basin prospectivity for natural gas, petroleum and carbon storage systems.

Reduces subsurface uncertainty and enhances targeting of energy systems and CCS opportunities by clarifying the geometry, history and reactivation of major faults, tectonic domains and basin blocks that influence reservoir development, seal integrity, charge, migration and storage containment.

Improves prediction of fluid migration, leakage risk and storage security by characterising fault architecture, juxtaposition, reactivation history and seal behaviour.

Strengthens basin-scale screening and investment confidence by identifying the settings most likely to support commercially viable hydrocarbon systems and long-term secure carbon storage.

Depositional systems and reservoir development		
Questions	Products	Value
How have depositional systems controlled reservoir distribution and quality? Activities Characterise basin-scale depositional systems. Define reservoir and seal presence, quality, geometry and heterogeneity. Assess reservoir quality evolution. Assess seal quality evolution. Assess reservoir and seal porosity and permeability.	Regional facies, sediment depositional and dispersion pathway maps. Play-based exploration fairway maps and petroleum systems maps. Net reservoir distribution, permeability and porosity maps. Enablers Biostratigraphic, chemostratigraphic and sequence stratigraphic frameworks. Burial diagenesis and compaction models. Fracture and secondary porosity mapping. 3D stratigraphic correlation frameworks. Compilation of Explanatory Notes.	Improves prediction of reservoir and seal distribution by defining how depositional systems control the presence, geometry, continuity and heterogeneity of key subsurface intervals. Reduces exploration uncertainty by clarifying where high-quality reservoirs and competent seals are most likely to occur, and how their properties vary across basin settings. Enhances targeting of natural gas and petroleum systems through better understanding of facies architecture, depositional pathways, net reservoir development and play fairways. Supports more effective CCS assessment by identifying the reservoir and seal combinations most likely to provide adequate injectivity, containment and long-term storage security. Provides stronger regional context for company datasets through facies maps, petroleum systems maps, stratigraphic frameworks and 3D correlation models that improve subsurface interpretation. Builds a shared subsurface framework that supports petroleum and gas exploration, while also enabling future CCS and broader subsurface energy system development.

Source systems and fluid generation		
Questions	Products	Value
What are the origins, timing and distribution of hydrocarbons, hydrogen and basin fluids? Activities Constrain petroleum source rock distribution and maturity. Assess the petroleum systems integrity and charge history for key basin plays. Identify frontier basin opportunities and data gaps requiring new acquisition. New data acquisition in gap areas.	Statewide digital energy systems atlas. Source rock richness and quality, and thermal maturity maps. Hydrocarbon migration pathway and petroleum system maps. Play fairway analysis maps. Enablers Basin modelling and petroleum systems models. Regional stratigraphic and biostratigraphic correlations. Geochemical fingerprinting of hydrocarbons. Burial and thermal modelling history. Hydrocarbon generation and expulsion timing modelling.	Improves understanding of basin charge systems by defining where hydrocarbons, hydrogen and associated basin fluids were generated, migrated and accumulated through time. Enhances targeting of natural gas and petroleum systems through better prediction of migration pathways, charge timing, trap fill history and petroleum systems integrity. Supports assessment of natural hydrogen prospectivity by improving understanding of fluid origins, migration pathways, trapping conditions and basin-scale controls on hydrogen occurrence and preservation. Improves identification of frontier opportunities by highlighting underexplored basin sectors, unresolved charge risks and key data gaps that require new acquisition. Supports more efficient exploration investment by helping industry focus on basin plays with the most favourable combinations of source, maturity, migration and trap timing.

Geological storage systems		
Questions	Products	Value
What are the key geological controls for long-term CO₂ and intermediate-term gas underground storage? What are the seismic hazards associated with CO₂ injection and underground storage? What is the opportunity for in-situ and ex-situ mineral carbonation across the State?	WA CO₂ Storage Atlas. Supercritical CO₂ depth maps. CO₂ storage fairway maps. Seal lithofacies maps. Present-day pressure and temperature maps. Basin-wide reservoir quality maps. Baseline background seismicity catalogue. Secondary prospectivity and mineral carbonation assessments. CO₂ emissions map.	Reduces storage and investment uncertainty by defining storage fairways, reservoir quality, injectivity potential and containment risks at regional scale. Supports more effective site selection and screening through basin-wide maps of storage formations, seal lithofacies, reservoir quality, pressure, temperature and supercritical CO₂ depth. Improves confidence in operational performance by constraining hydraulic capacity, injectivity behaviour and the geomechanical conditions that influence storage efficiency and pressure management. Supports long-term stewardship and compliance by defining monitoring, reporting and post-injection seismicity requirements that strengthen oversight and community confidence. Provides stronger regional context for government and industry decisions through products such as the WA CO₂ Storage Atlas, storage fairway maps, seismicity catalogues, digital mine waste residue atlas and emissions mapping. Builds a shared technical and regulatory framework that supports CCS deployment, underground gas storage and the emergence of a mineral carbonation industry in WA.
Activities	Enablers	
Identify and characterise regional and intraformational seals. Define reservoir and seal quality and trends. Define injectivity/hydraulic capacity potential. Identify and characterise geological storage fairways. Identify prospective storage formations/sites. Identify and evaluate containment risks. Design and implement fit-for-purpose seismic monitoring networks and operational requirements for prospective CO₂ storage sites, including station siting, instrumentation selection, and telemetry infrastructure to establish pre-injection baseline seismicity. Develop real-time telemetry, automated event detection and quality-control platform and workflow for operational monitoring.	Basin temperature and pressure modelling. Cross-basin stratigraphic correlations. Compilation of Explanatory Notes. Fault leakage and risk assessment. Geomechanical properties database. Petrophysical interpretations and well log correlations. Standardised stratigraphic frameworks. Dynamic injectivity modelling. Operational real-time seismic monitoring platform.	

Geological storage systems

Assess how existing seismic infrastructure (WA Array and permanent stations) can contribute to baseline monitoring at prospective storage locations.

Define long-term monitoring and reporting requirements for post-injection seismicity.

Identify and prioritise bedrock and mine waste residue sites that are amenable for mineral carbonation.

Precisely constrain the geochemistry and mineralogy of priority in-situ and ex-situ mineral carbonation sites.

Regulatory roadmap and changes to support the development of a mineral carbonation industry in WA.

Post-injection monitoring strategies.

New legislation that supports the development of a mineral carbonation industry.

Geothermal systems		
Questions What are the geological factors that make up a geothermal system? Activities Define geothermal fairways in the State.	Products Statewide digital energy systems atlas. Surface heat flow maps. Enablers Basin temperature and pressure modelling. Assessment of conductive vs advective heat transport domains in basins.	Value Reduces exploration uncertainty by defining geothermal fairways and distinguishing areas where favourable heat, fluid flow and reservoir conditions are most likely to coincide. Improves assessment of geothermal resource style and quality by distinguishing conductive and advective heat transport domains and their implications for system performance. Provides a stronger regional framework for project targeting by linking local geothermal potential to broader basin architecture, thermal structure and subsurface fluid systems. Builds a shared knowledge base for emerging geothermal industries that can support direct heat use, industrial decarbonisation and future low-emissions energy opportunities in WA.

Hydrogen as a future energy source

Natural hydrogen generation		
Questions	Products	Value
What are the key geological factors that control natural hydrogen and helium generation, migration and accumulation? Activities Identify and characterise geological environments favourable for natural hydrogen/helium generation. Identify potential hydrogen/helium source environments. Identify potential hydrogen/helium migration zones from deep sources into basins and the near surface. Identify structural and stratigraphic traps suitable for natural hydrogen accumulation and containment. Characterise basin fluid systems controlling the migration and preservation of hydrogen. Characterise subsurface microbial communities and their role in hydrogen consumption and preservation.	Statewide digital hydrogen/helium prospectivity map. Statewide maps of recorded natural hydrogen and helium occurrences. Statewide geological, isotopic and geochemical maps. Basinal pressure and formation waters salinity maps and datasets. Enablers Basin evolution and inversion history. Basin-scale fluid flow modelling. Soil gas monitoring. Fluid inclusion studies.	Reduces exploration risk by improving the understanding of natural hydrogen and helium prospectivity by identifying the geological factors that control generation, migration, trapping and preservation. Supports more effective screening of hydrogen and helium opportunities through statewide prospectivity mapping, occurrence datasets, and integrated geological, isotopic and geochemical frameworks. Enhances targeting of new exploration plays and strengthens regional basinal frameworks for project targeting by linking deep hydrogen and helium source environments to basin architecture, migration corridors and near-surface expressions. Helps guide investment and data acquisition by identifying the areas where further sampling, monitoring or drilling is most likely to improve confidence in natural hydrogen and helium potential.

Future resource knowledge and system foresight

Characterising Earth resources

Questions

What is the State's prospectivity for mineral and energy systems and potential for geological carbon storage?

Is there significant secondary prospectivity in WA mine waste?

Activities

Estimate the potential of bedrock-hosted critical, strategic and precious mineral resources.

Determine the identity, department and potential resources of selected by-product/co-product critical and strategic minerals.

Compile water chemistry data for formation waters analysed during petroleum exploration.

Systematic mapping, sampling and analysis of WA quartz veins.

Investigate data recovery of mineral ore/mine waste data embedded in DMPE regulatory and environmental databases.

Continue to monitor and record CO₂ emission points and identify hard-to-abate industries

Identify and define the potential of crystalline bedrock resources and mine residues for CO₂ sequestration.

Define a spatial catalogue of all mine waste residues.

Identify and prioritise the potential secondary prospectivity for critical and strategic minerals across all WA mine residue sites.

Products

Statewide CO₂ emissions map.

Secondary prospectivity resource assessments.

Geochemical and mineralogical datasets derived from physical sampling activities.

Enablers

Geochemical barcoding of altered rocks.

Regolith geochemistry around mineralised sites.

Predictive modelling of secondary prospectivity.

Automated workflows for assessing temporal area and volume change in mining landscapes.

New legislation and policy on the management and reporting of mine waste information.

Value

Reduces uncertainty in critical and strategic mineral supply by identifying bedrock-hosted resource potential and the occurrence of by-product and co-product minerals that may improve project value and supply chain resilience.

Strengthens secondary resource opportunity assessment, including carbon mitigation opportunities by identifying and prioritising mine waste, residues and legacy materials that may host recoverable critical, strategic and precious minerals.

Improves understanding of resource circularity and material efficiency and enhances targeting and reprocessing decisions helping to stimulate the circular economy.

Strengthens circular resource opportunities in basic raw materials by identifying where mine waste and recycled materials can supplement supply of construction and industrial inputs, reducing pressure on new extraction while creating additional value from legacy mining landscapes.

Improves confidence in future-facing resource strategies by linking emissions sources, hard-to-abate industries and subsurface or mineral-based carbon mitigation options into a more complete Earth-resource framework.

Characterising Earth resources

Identify and prioritise the potential secondary prospectivity for basic raw materials and industrial minerals across all WA mine residue sites.

Digital deep-dive review of priority mine residue sites.

Precisely constrain the geochemistry and mineralogy of priority mine residue sites and the deportment of critical, strategic and precious elements.

Document material flows from mine-to-waste facilities.

Regulatory roadmap and changes to statutory reporting for mine waste residues.

Regulatory roadmap and usage guidelines for utilisation of Delithiated Beta Spodumene (DBS).

Provides a stronger basis for investment and policy decisions through secondary prospectivity assessments, CO₂ emissions mapping, and predictive models that identify where new value may be unlocked from both primary and secondary resources.

New energy potential and resource disruptors		
Questions What are the future disruptors in the energy and resources sectors? Activities Monitor future energy generation and storage trends, new technologies and market disruptors. Evaluate the prospectivity of open pits as energy storage sites for ‘pumped hydro’ power generation.	Products Statewide New Energy Opportunity Map. Open Pit Pumped Hydro Screening assessments. Enablers Pit topographic, hydrological and grid connectivity modelling. Integrated mine infrastructure and pit geometry dataset.	Value Supports earlier identification of new energy opportunities by translating global technology and market trends into place-based opportunity screening relevant to WA. Creates new value pathways for mining assets by assessing whether open pits and associated infrastructure could be repurposed for pumped hydro energy storage and other future energy applications. Supports mine closure and asset transition planning by identifying opportunities to extend the value of legacy or operating mine sites beyond extraction.

Geoscience for society, safety and stewardship

Seismic hazards and geophysical applications

Questions

What is the seismic hazard across WA, and how can improved continuous monitoring and site characterisation inform community safety, building design and land use planning?

What are some of the geological controls on groundwater?

Activities

Characterise seismic site conditions for all WA Array and permanent stations.

Develop 1D shear-wave velocity (VS) models from surface to seismic bedrock across key domains at all seismic stations.

Provide site-characterisation data as open-access inputs to National Seismic Hazard Assessment (NSHA) updates.

Develop and maintain a Statewide broadband seismic monitoring network capable of detecting and locating earthquakes across populated regions.

Monitor induced and triggered seismicity associated with resource extraction, CCS injection, and geothermal operations using dense passive seismic sub-arrays where required.

Develop automated workflows for earthquake source analysis, including focal mechanism solutions where data quality permits.

Investigate groundwater level variations using ambient seismic noise recorded by the WA Array passive seismic stations.

Map the distribution of fractures and faults for groundwater mapping in high-use areas.

Provide datasets for other agencies to inform on groundwater potential.

Products

Statewide and regional maps of site condition.

Automated focal mechanism catalogue for WA earthquakes.

Statewide and regional Palaeovalley distribution and architecture maps.

Statewide and regional 2D and 3D depth-to-basement and regolith interface maps.

Enablers

Continuously update earthquake catalogue with update precision for WA.

Baseline and operational seismicity monitoring.

AEM interpretations.

Regional indicators of groundwater fluctuation from seismic observation.

Increased interagency collaborations with DWER and DPIRD.

Value

Reduces uncertainty in seismic risk and improves infrastructure and investment planning by helping industry and government better understand where ground conditions, seismic response and subsurface structure may influence design, location and resilience.

Enhances groundwater exploration and management and provides stronger regional context for other agencies and industry users through open-access datasets that support groundwater assessments, hazard planning and broader geoscientific interpretation.

Supports safer and more efficient resource and subsurface CCS operations and strengthens regulatory confidence and operational oversight by providing baseline and operational seismicity data, focal mechanism analysis and fit-for-purpose monitoring networks in areas of subsurface activity.

Builds a long-term public geoscience capability that strengthens community safety, supports responsible development and improves confidence in the State's subsurface management.

Custodianship of WA's geology		
Questions	Products	Value
How can GSWA continue to provide trusted advice? Activities Compile and maintain Statewide geology layers and databases to ensure rigour, consistency, and integrity of the State's stratigraphic nomenclature (Explanatory Notes System), geological frameworks, and tectonic models. Manage GSWA Collections. Manage statutory reporting requirements through the WAMEX and WAPIMS databases. Provide specialist advice to the Department, and external stakeholder groups and organisations.	Continually maintained and improved online digital databases connected through the Discovery Portal. Digital thin section catalogue. Digital mineral composition (TIMA) maps and catalogue. Major, minor and accessory phase mineral compositional data. Digital 3D type-fossil scans and catalogue. Enablers Improved data governance. Population of high-quality data into and maintenance of all geoscience databases. Continued update and delivery of Statewide geology, isotopic and geochemical maps. Continued update and delivery of Statewide geophysical grids and maps. Continued improvement to data delivery, interoperability and reusability. Continued management and update of GSWA vocabularies and ontologies. Continued maintenance and improvement of data lodgement portals and quality of data submitted. High-resolution thin section and mineral imaging and automated mineralogy (TIMA). Machine-assisted mineral and texture recognition. 3D scanning instruments and software.	Provides a trusted and authoritative geological framework that reduces uncertainty and inefficiency supporting exploration, development and investment decisions across WA. Provides a permanent, accessible digital record of valuable and irreplaceable physical collections and assets, supporting comparison of globally significant stratigraphic successions, representative rock, alteration and mineralisation types, and provides training resources for students, industry and early-career geoscientists. Supports more efficient exploration and project assessment, strengthens compliance, transparency and future data reuse through effective statutory reporting and data lodgement systems. Supports better cross-sector decision-making by providing specialist geological advice and authoritative data to government, industry and other stakeholders involved in land use, resource development, environmental management and strategic planning.

Community engagement		
Questions	Products	Value
How can GSWA help to protect and promote WA's geology?	GSWA-generated field guides.	Preserves long-term public geoscience value by managing and promoting WA's globally unique rock record as enduring assets that support future exploration, research, policy, education and planetary science.
How can GSWA improve our engagement with the public and help inspire the next generation of geoscientists?	GSWA-generated digital story maps.	
Can the Industry Ready Graduate program and GSWA-hosted internships help the next generation of geoscientists?	Input into geological signage at key geotourism sites.	Strengthens the long-term capability of the geoscience sector and directly supports workforce development by increasing awareness of geoscience careers, improving student engagement, and creating clearer pathways from education into employment through internships and industry-informed graduate programs.
Activities	Enablers	
Improve documentation and management of Geoheritage sites.	Inventory of Geoheritage sites and Reserves.	Builds a stronger foundation for long-term sector resilience by improving public geoscience awareness, supporting tertiary participation, and helping sustain the people, skills and public trust needed for future exploration, stewardship and resource development.
Support and promote Geotourism.	Continued improvement in the Geoheritage nomination process.	
Increase geoscience awareness and teaching in schools by providing resources for teachers.	Design and implementation of more informative GSWA web pages.	
Promote geoscience and the GSWA to the public.		
Revise and improve GSWA webpages.		
Revise and improve social media strategy and products.		
Help to increase the number of tertiary students enrolled and employed in geoscience.		
Increase IRGP cohort size and capture industry input into the program.		
Provide other opportunities for students within GSWA.		

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