



Australian Government

Department of Industry, Innovation and Science

Australian Trade and Investment Commission

# AUSTRALIA'S CRITICAL MINERALS STRATEGY

2019



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# Joint-Ministerial Foreword

Australia's traditional resources industries have long been a vital part of the Australian economy, perhaps never more so than in the past two decades. In 2018-19 resource and energy commodity exports are expected to earn more than \$264 billion, representing more than two thirds of our goods exports.<sup>1</sup> These export earnings contribute to the royalties and the corporate and income taxes that help to pay for essential services including hospitals, schools, infrastructure, defence and border security.

Global demand for our resources has broadened in recent years to include minerals used in a range of emerging high-tech applications across a variety of sectors such as renewable energy, aerospace, defence, automotive (particularly electric vehicles), telecommunications and agri-tech. Known as critical minerals, this group of minerals is considered essential for the economic and industrial development of major and emerging economies.

This presents an opportunity for Australia to develop its commercially viable and world leading reserves of many of these critical minerals, attract investment from new markets, diversify our resources industry and capitalise on the strengths of our world leading resources sector.

However, the scarcity of critical minerals leaves them potentially vulnerable to supply constraints and shortages. Many countries with specific economic and industrial development requirements are starting to take a more strategic approach to ensure security of supply of these minerals. These approaches include efforts to diversify supply and to source from countries with the geological capability to satisfy critical minerals demand.

*Australia's Critical Minerals Strategy 2019* outlines the Liberal-National Government's policy framework for our critical minerals market. Our goal is to create the conditions needed to grow this emerging sector by supporting innovation, attracting new investment and promoting marketing opportunities, while delivering the infrastructure needed to bring new critical minerals projects into production.



**Senator the Hon  
Matthew Canavan**

Minister for Resources  
and Northern Australia



**Senator the Hon  
Simon Birmingham**

Minister for Trade,  
Tourism and Investment

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<sup>1</sup> Office of the Chief Economist (2018) *Resources and Energy Quarterly - December 2018*. Australian Government, Canberra, p.iv and p.7.

## Vision

Australia is a world leader in the exploration, extraction, production and processing of critical minerals

## Goals

To enable the development of Australia's critical minerals sector, including downstream processing and manufacturing opportunities, by attracting investment, supporting innovation and connecting opportunities with infrastructure

## Actions

Investment	
Australian Critical Minerals Prospectus	Austrade, with support from Geoscience Australia, has developed a report of Australia's potential for critical minerals mining projects and investment.
Investment roadshows	Austrade delivers international roadshows promoting investment in critical minerals and the potential for more lithium-ion battery manufacturing in Australia.
Export Credit Agency (Efic)	Efic helps finance the expansion by Australian businesses into international markets.
Exploring for the Future	The \$100.5 million <i>Exploring for the Future</i> initiative (2016-2020) helps explorers target new mineralisation by imaging the deepest roots of mineral systems all the way through to the surface, and is employing many world-first techniques.
MinEx Cooperative Research Centre	The \$218 million MinEx Cooperative Research Centre is the world's largest mineral exploration collaboration bringing together industry, government and research organisations. Its 10-year research program will develop and deploy the next generation of drilling technology.
Australia Minerals	<i>Australia Minerals</i> is increasing investment in exploration, especially in greenfield areas. This group is unique world-wide, as it brings together all of the country's Chief Geologists. This group regularly visits major investors.
Major Projects Facilitation Agency	The Major Projects Facilitation Agency provides a single entry point for major project proponents seeking tailored information and facilitation of their regulatory approval requirements.
Innovation	
Cooperative Research Centre Projects	The Government has prioritised \$20 million of funding in Round 7 of the Cooperative Research Centre Projects program for projects with a specific focus on critical minerals.
Cooperative Research Centre for Optimising Resource Extraction	The CRC for Optimising Resource Extraction will receive \$34.45 million from 2016-2021 to develop energy-saving and resource-expanding technology that will allow lower-grade ores to be economically and eco-efficiently mined.
Infrastructure	
Northern Australia Infrastructure Facility	The \$5 billion Northern Australia Infrastructure Facility provides concessional loans to eligible infrastructure projects in Northern Australia.
Other Commonwealth infrastructure investment	Investment in transport infrastructure through the Infrastructure Investment Program, including the \$3.5 billion Roads of Strategic Importance initiative.

# The opportunity

Technological change has been driving global demand for a new group of metals, non-metals and mineral elements considered necessary for the economic wellbeing of the world's major and emerging economies. The importance of rare earth elements and other critical minerals stems from their unique catalytic, metallurgical, nuclear, electrical, magnetic, and luminescent properties. The growing significance of these minerals is demonstrated through their use in the manufacture of mobile phones and computers, flat-screen monitors, wind turbines, electric cars, solar panels, rechargeable batteries, defence industry technology and products, and many other high-tech applications.

As demand for critical minerals grows, there are significant economic opportunities for Australia. We have existing projects and significant geological reserves of minerals deemed critical by other nations (see Figure 1) and we are well placed to capitalise on rising global demand for secure supplies of critical minerals. For example, Australia:

- has the world's third largest reserves of lithium and is the largest producer<sup>2</sup> of lithium in the world
- is ranked sixth in the world for rare earth elements and second for production<sup>3</sup>, yet many of these deposits remain untapped
- has large resources of cobalt, manganese, tantalum, tungsten, and zirconium.

Australia also has world-leading expertise in resource extraction and processing, high-tech engineering and renewables research. Australia is a highly attractive destination for investment, with competitive advantages across the full spectrum of technical, capital allocation, and risk considerations, including political and economic stability, technology, training, research and development, environmental and labour standards, and legal and regulatory certainty.

While the market for some critical minerals is relatively mature, other minerals markets remain largely underdeveloped. Australia is moving up the lithium value chain as lithium producers invest in lithium processing. By comparison, investment in other minerals with high geological potential, such as cobalt and rare earth elements, has been slower. With the right supporting framework, the Government expects cobalt and other critical mineral markets could develop in response to increasing global demand.

These opportunities are additional to those where Australia is already a leading producer. For example, nickel and aluminium are not on many critical mineral lists; however, they are a major part of lithium-ion batteries and of lightweight metals, respectively. The opportunities for Australian resource producers to supply these expanding markets are likely to also be significant.

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2 Geoscience Australia (2019) *Australia's Identified Mineral Resources 2018*. Australian Government, Canberra.

3 Geoscience Australia (2019) *Australia's Identified Mineral Resources 2018*. Australian Government, Canberra.

# Matching resource potential to international demand

Figure 1 shows Australia's deposits, operating mines and current and pipeline projects for critical minerals.

The Australian Government has examined the lists of critical minerals published in several markets and matched those against Australia's known geological endowment. Table 1 sets out the results of that analysis. It shows that Australia has moderate to high geological potential in 24 minerals that are deemed critical by many countries.

This is a dynamic list that may change as the understanding of Australia's resource potential develops, and as demand for critical minerals changes in response to technological and market developments.

The Government is using its international network to stay informed of market developments as countries seek increased supplies of critical minerals. For example, the Government has been strengthening links with the United States (U.S.) since President Trump released an Executive Order in December 2017 directing the development of a *United States Critical Minerals Strategy*. In February 2018 then Prime Minister Turnbull and President Trump agreed to work together on exploration, extraction, processing, research and development. And in December 2018, Minister Canavan and then Secretary Zinke, the U.S. Secretary of the Interior, signed a letter of intent committing Geoscience Australia and the U.S. Geological Survey to work together on critical minerals issues.

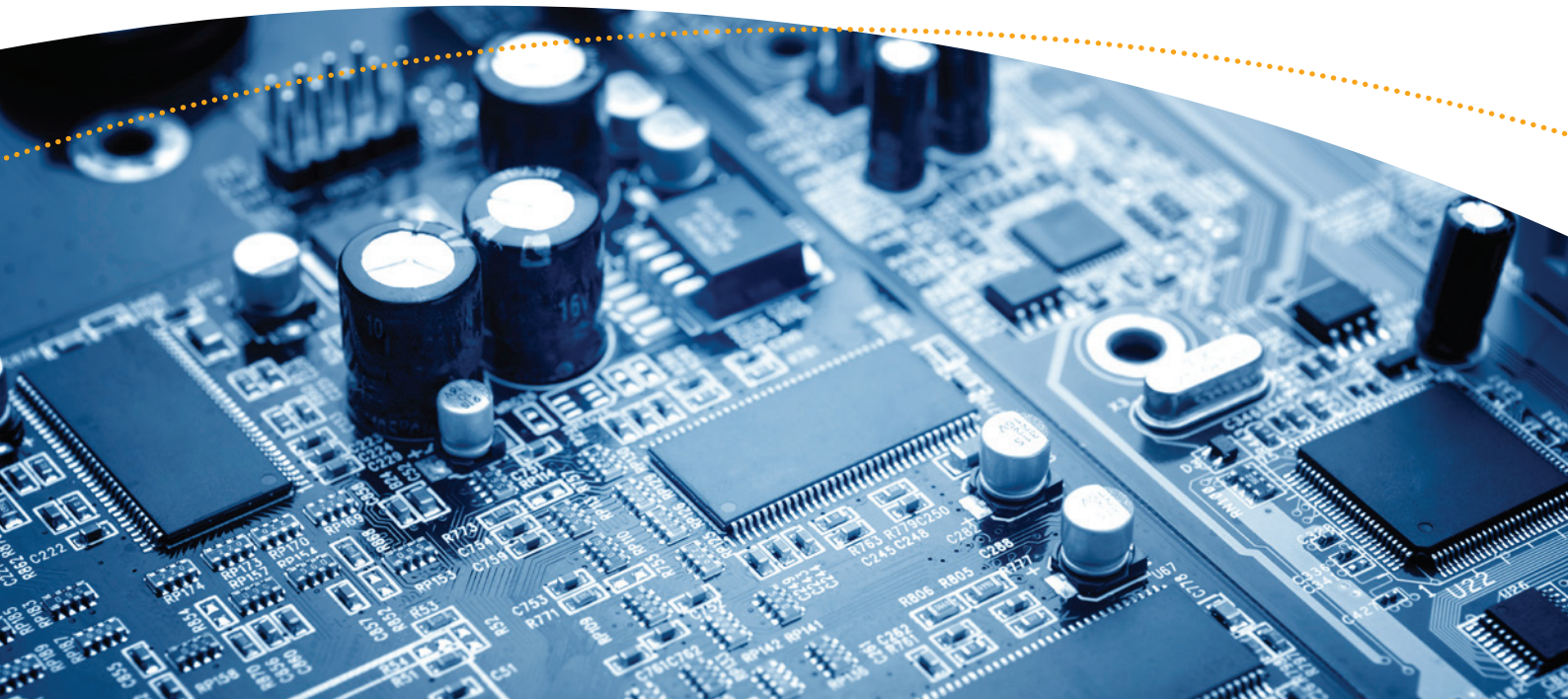
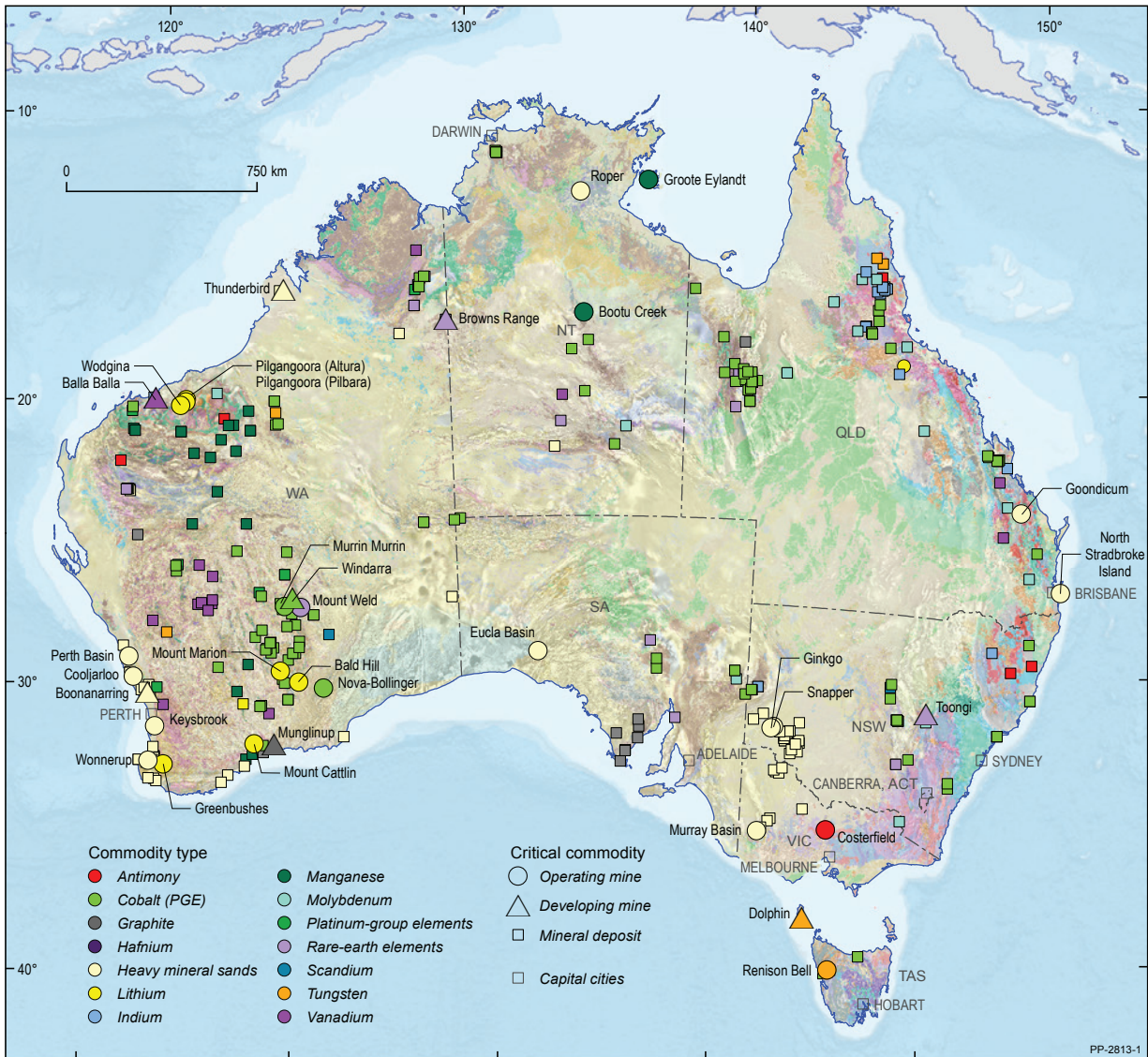


Figure 1: Major Critical Mineral Operating and Developing Mines in Australia



Source: Geoscience Australia, 2019.



**Table 1: Table of critical minerals in Australia<sup>4</sup>**

	Critical Mineral	U.S. list <sup>5</sup>	E.U. list <sup>6</sup>	Japan list <sup>7</sup>	Australia's Geological Potential <sup>8</sup>	Australia's Economic Demonstrated Resource <sup>9</sup>	Australia's Production	Global Production	Market Value (Global) (US\$m) <sup>10</sup>
1	Antimony	✓	✓	✓	Moderate	138 kt	5.5 kt	150 kt	\$185.2
2	Beryllium	✓	✓		Moderate	-	-	230 t	\$918.6 <sup>11</sup>
3	Bismuth	✓	✓		Moderate	-	-	14 kt	\$69.2
4	Chromium	✓		✓	High	-	-	31 000 kt	\$4,705.3
5	Cobalt	✓	✓	✓	High	1221 kt	5 kt	110 kt	\$541.8
6	Gallium	✓	✓	✓	High	-	-	495 t	\$918.6 <sup>11</sup>
7	Germanium	✓	✓	✓	High	-	-	134 t	\$918.6 <sup>11</sup>
8	Graphite	✓	✓	✓	Moderate	7140 kt	0	1200 kt	\$1,076.1
9	Hafnium	✓	✓		High	756 kt	-	-	\$918.6 <sup>11</sup>
10	Helium	✓	✓		Moderate	-	4 hm <sup>3</sup>	160 hm <sup>3</sup>	\$591.0
11	Indium	✓	✓	✓	High	-	-	0.72 kt	\$918.6 <sup>11</sup>
12	Lithium	✓		✓	High	2803 kt	14.4 kt	43 kt	\$1,430.6
13	Magnesium	✓	✓	✓	Moderate	-	0	1100 kt	\$716.4
14	Manganese	✓		✓	High	231 000 kt	3200 kt	16 000 kt	\$5,443.7
15	Niobium	✓		✓	High	216 kt	-	64 kt	\$1,709.5 <sup>12</sup>
16	Platinum-group elements	✓	✓	✓	High	24.9 t	2.6 t	200 kt	\$19,316.6
17	Rare-earth elements	✓	✓	✓	High	3270 kt	14 kt	130 kt	\$415.4 <sup>13</sup>
18	Rhenium	✓		✓	Moderate	-	-	52 kt	\$918.6 <sup>11</sup>
19	Scandium	✓	✓		High	-	-	-	- <sup>13</sup>
20	Tantalum	✓	✓	✓	High	55.4 kt	-	1.3 kt	\$1,552.9
21	Titanium	✓		✓	High	Ilmenite: 276 500 kt Rutile: 32 900 kt	Ilmenite: 1400 kt Rutile: 300 kt	Ilmenite: 6700 kt Rutile: 750 kt	\$1,609.9
22	Tungsten	✓	✓	✓	Moderate	386 kt	0.11 kt	95 kt	\$164.0
23	Vanadium	✓	✓	✓	Moderate	3965 kt	0	80 kt	\$1,709.5 <sup>12</sup>
24	Zirconium	✓		✓	High	52 662 kt	600 kt	1600 kt	\$1,003.4

4 Source: Austrade (2019) Australian Critical Minerals Prospectus. Note: t = tonne; kt = kilotonnes; and hm<sup>3</sup> = million cubic metres.

5 The United States lists 35 minerals and commodities as critical to their economic and national security. The full list may be accessed at <https://www.usgs.gov/news/interior-releases-2018-s-final-list-35-minerals-deemed-critical-us-national-security-and>.

6 The European Union lists 27 raw materials as critical due to risks of supply shortage and their impacts on the economy being higher than those of most of the other raw materials. The full list may be accessed at <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52017DC0490>.

7 In March 2018, the Japanese Ministry of Economy, Trade and Industry released a report that identified the following 31 minerals as key: Li, Co, Ni, Cu, REE, PGM, W, Mg, Be, Re, Ti, Cr, Mo, Mn, Nb, P, Zn, Sn, Pb, Sb, Ta, In, Ga, C, Ge, Zr, Sr, V, F, Au and Ag.

8 Source: Geoscience Australia.

9 Geoscience Australia (2019) *Australia's Identified Mineral Resources 2018*; U.S. Geological Survey *Mineral Commodity Summaries 2018*.

10 United Nations CommTrade database. Note: Highest-importing countries only are summed, as shown in mineral summaries following. They are not market totals, and aggregations across various mineral groups (see next footnote) will not sum.

11 Data are aggregated for Be, Cr, Ge, V, Ga, Hf, In, Nb, Re and Ti articles of metals including scrap, waste and powder.

12 Data are aggregated for Nb, Ta, V and Zr ore and concentrates.

13 Scandium has been included with rare earth elements by the UN Commtrade database.

# National actions

*Australia's Critical Minerals Strategy 2019* (the Strategy) aims to refine Australia's policy settings to enable the resources sector to supply the growing markets for raw and refined critical minerals. It is a key part of the Australian Government's broader plan for Australia's resources sector, set out in the *National Resources Statement*. The Strategy sets out actions to refine the settings in Australia's critical minerals market in three key areas. In particular, we will:

- promote **investment** into Australia's critical minerals sector and downstream processing activities
- provide incentives for **innovation** to lower costs and increase competitiveness
- connect current and pipeline critical minerals projects with **infrastructure** development.

These steps will help to ensure Australia's critical minerals sector will be ready with a reliable and cost-competitive supply of critical minerals to meet growing global demand.

The Strategy will coordinate efforts at the national level and builds on the policies, incentives, programs and strategies of state and territory governments.

For example:

- In January 2019, Western Australia released its *Future Battery Industry Strategy* to capitalise on the state's battery minerals and potential to develop a local value-adding lithium-ion battery industry.
  - In February 2019, New South Wales released its *Minerals Strategy* focused on growing investment in metals and rare earth elements, particularly at greenfield sites.
- In December 2018, the Australian Government and state and territory governments committed, through the Coalition of Australian Governments (COAG) Energy Council, to develop a joint work program to harness the emerging opportunities of the critical minerals sector, including for downstream industries.

## 1. Attracting investment into Australia's critical minerals sector

### Goal:

Increase investment into the critical minerals sector (including downstream processing capabilities) and secure markets for Australian critical minerals products.

Australia has an attractive investment environment and operates a liberal investment regime that is open and transparent. The Australian Government's approach, set out in Australia's Foreign Investment Policy and 2017 *Foreign Policy White Paper*, has been, and will continue to be, consistently in favour of foreign investment where proposals are not contrary to the national interest.

Attracting new sources of capital is crucial to the development of Australia's critical minerals sector. The Australian Government is promoting investment and markets for Australian minerals by:

- improving the data and knowledge base of Australia's resource potential
- identifying potential investors and off-take opportunities for Australian projects.

### *Actions to attract investment*

Austrade is the Government's lead agency on international investment promotion. An offshore network covers 83 offices and includes staff working directly on resources and energy investment attraction and trade services. Austrade uses a key account model (the process of building long-term relationships with most valuable clients) enabling dedicated client service across the full range of investment opportunities and potential challenges. This service was utilised by lithium giant Albemarle in developing and implementing their project plans for a lithium hydroxide processing facility in Kemerton, Western Australia. Austrade facilitates foreign investment in critical minerals and related industries by:

- connecting potential greenfield investors with opportunities through liaison with Austrade's offshore network, Geoscience Australia, and the Australian states and territories
- identifying investment opportunities (debt/equity) and offtake agreements for projects (current and pipeline)
- identifying investors for gaps in potential value chains
- facilitating investment in downstream processing and value-chain creation, including mineral processing and battery and/or battery component manufacturing.

Austrade initiatives to promote investment into the critical minerals sector include:

- *The Lithium-Ion Battery Value Chain: New Economy Opportunities for Australia* report outlines the potential for Australia to develop a lithium-based supply chain feeding into a potential lithium-ion battery production capability. The report demonstrates that the downstream critical components in advanced battery production can be manufactured in Australia, and that battery manufacturing technology is a critical gap in the supply chain. Minister Birmingham launched this report in December 2018.
- Developing the *Australian Critical Minerals Prospectus* with support from Geoscience Australia, Australian resources companies and states and territories. The prospectus supports knowledge projects and greenfield investment opportunities as well as technical, commercial and geological data for potential investors.
- Developing a list of potential investors and off-takers for Australian critical minerals to help clients better target diverse financing opportunities for Australian critical minerals projects.
- An investor roadshow of Australian companies to North America in the first quarter of 2019, which included representation at the leading mining conference – the Prospectors and Developers Association of Canada in Toronto from 3 to 6 March 2019. The roadshow helped Australian companies to connect to U.S. investors.
- Promoting Australian critical minerals through targeted investor identification and engagement with potential lithium-ion battery investors.

## MARKET OPPORTUNITY

# LITHIUM

Many countries consider lithium to be a critical mineral. It is used in rechargeable batteries (making up 46% of global use for this mineral), ceramics, glass, lubricating greases, and polymer production.

In 2017, the lithium market value was around US\$1.4 billion. Australia captured approximately US\$550 million of this as export revenue, with a 33% share of global production.

Global lithium production rose from 14,000 tonnes in 2000 to 43,000 tonnes in 2017 and Australia has kept pace to become the world's largest producer of lithium. By 2019–20, Australia could account for around 80% of global lithium supply from hard rock deposits.

A number of lithium companies operating in Australia are taking up downstream processing to produce the more lucrative lithium hydroxide. Lithium hydroxide is worth almost 20 times more than unprocessed concentrate. This is a sign that our economy is moving to capture more of the full value chain of lithium, which is worth around AU\$213 billion annually (including processing, battery cell production and product assembly).

*Sources: Office of the Chief Economist (2018) Resources and Energy Quarterly - December 2018; Austrade (2019) Australian Critical Minerals Prospectus; GM Mudd et al. (2019) Critical Minerals in Australia: A Review of Opportunities and Research Needs. GEOSCIENCE AUSTRALIA RECORD 2018/51; Austrade (2018) The Lithium-ion Battery Value Chain: New Economy Opportunities for Australia.*

### *Developing geoscience information on critical minerals*

The Government is producing information on where new deposits may be found, as well as where critical minerals may exist in ores already being mined. Geoscience Australia implements a number of programs to identify areas of resource potential, to reduce investment risks of exploration, and to improve the effectiveness of exploration programs.

The Australian Government is investing in two major initiatives central to de-risking exploration and attracting more investment:

- The \$100.5 million *Exploring for the Future* (2016–2020) initiative, being led by Geoscience Australia in collaboration with state and Northern Territory geological surveys, gathers new innovative high-resolution geoscience data and information about the potential mineral, energy and groundwater resources concealed beneath the surface in large areas of northern Australia. This program helps explorers target new mineralisation by imaging the deepest roots of mineral systems all the way through to the surface, and is employing many world-first techniques.
- The \$218 million MinEx Cooperative Research Centre (MinEx CRC) is the world's largest mineral exploration collaboration bringing together industry, government and research organisations. Its 10-year research program will develop and deploy the next generation of drilling technology. Geoscience Australia and geological surveys in the states and Northern Territory are leading the National Drilling Initiative of the MinEx CRC. This program is the world's first to systematically map regional geology and architecture and to define the potential for mineral systems undercover.

Geoscience Australia is a leading participant, alongside industry, academia and the Australia Academy of Science, in the UNCOVER initiative. UNCOVER focuses Australia's geoscience effort on providing the knowledge base and technology that

will substantially increase the success rate of mineral exploration beneath post-mineralisation cover in Australia. Both *Exploring for the Future* and the MinEx CRC are aligned with the overall strategy of UNCOVER.

As highlighted in the *National Resources Statement*, the Government will investigate the feasibility of expanding current efforts by Geoscience Australia to continually improve the information on Australia's critical minerals, as well as making resources data more accessible to the market. This will include examining improvements in both precompetitive (collected by government) and exploration (collected by companies) data collections to better understand greenfield exploration trends.

Through the COAG Energy Council, Resources Ministers from state and territory governments noted the importance of an integrated, precompetitive approach to improving geoscience information. Accordingly, governments are committed to developing a data strategy to improve the discoverability and utilisation of key geological, environment and heritage data sets. This is likely to include an online portal for decision support, with full data and decision process transparency. The Australian Government also coordinates trade and investment with states and territories through the biannual Trade and Investment Ministers' Meeting.

### *Other actions*

- The *Australia Minerals* group is increasing investment in exploration, especially in greenfields areas. This group is unique world-wide, as it brings together all of the country's Chief Geologists who have custodianship of the understanding of their jurisdictions' mineral prospectivity, as well as being representatives of their jurisdictions' regulators. This group regularly visits major investors.

- The Major Projects Facilitation Agency (MPFA) encourages investment by providing a single entry point for regulatory project-approvals advice for both domestic and international project proponents. For example, the Nolans Rare Earths Project, granted Major Project status by the Australian Government in September 2016, has benefited from the MPFA's facilitation services, including for the completion of its environmental approvals. Critical minerals projects over \$20 million can access MPFA's facilitation services, and projects over \$50 million are eligible to apply to the Government for Major Project Status.
- The Australian Government's Export Credit Agency (Efic) provides specialist finance solutions to Australian businesses seeking to expand into international markets. Efic works with banks and other financial institutions to help business access working capital when sufficient funds cannot be accessed from private capital markets.

Together, these initiatives will help to reduce risk for investment decisions and better prioritise data acquisition for exploration, environmental and other purposes.

## 2. Spurring innovation in the critical minerals sector

### Goal:

An innovative critical minerals sector that is globally competitive across a broader range of minerals.

The development of new technologies and the improvement of extraction processes by Australian operators will help to reduce the cost of critical mineral extraction and improve the environmental impact of the separation of critical minerals. Addressing these two key challenges will improve Australia's competitiveness in global critical minerals markets, particularly while the market price of some critical minerals is still low or volatile, and position us as a world leader and supplier of choice to the global market.

New technologies and processes for isolating critical minerals generated as by-products could also help to generate further value from our existing smelting and refining capacity. For example, during Australia's production of 462,000 tonnes of refined zinc in 2017, there was the potential to also generate about 1,000 tonnes of cadmium, 271 tonnes of antimony and smaller quantities of indium, gallium and germanium<sup>14</sup>. This opportunity was recently taken up by the Risdon zinc refinery in Tasmania, which has now added germanium and indium capability.

Currently, processes such as the separation of critical minerals from ore are energy-intensive. For example, the separation of rare earth elements (REE) from iron-oxide copper-gold deposits would involve additional finer grinding of the ore. The added energy intensity of the process would make it costly, and while the price for some REE is low, extraction is not economically viable using current technology. Further, separation of individual REE from other REE is difficult, as they have such similar chemical properties and this process is itself energy intensive.

14 GM. Mudd, et al. (2019) *Critical Minerals in Australia: A Review of Opportunities and Research Needs*. GEOSCIENCE AUSTRALIA RECORD 2018/51.

## MARKET OPPORTUNITY

# COBALT

Many countries include cobalt on their list of critical minerals. Its unique combination of properties make it ideally suited to high temperature, high-wear applications including superalloys for jet engines; magnets; carbides; and diamond tools. Cobalt is also used in batteries, catalysts and pigments. While substitutions for cobalt exist, these result in increased cost or decreased performance of the final product. A more comprehensive substitution is unlikely to emerge over the medium term.

In 2017, global cobalt production had a market value of almost US\$542 million; with a 68% increase in world cobalt consumption forecast between 2015 and 2025. The Democratic Republic of the Congo (DRC) currently produces 58.2% of the world's 110,000 tonne annual production. In 2017, Australia only produced 4,971 tonnes, despite holding the world's second largest economic demonstrated resource of cobalt (behind the DRC).

Cobalt is primarily produced as a by-product of copper and nickel ore processing and production. As a result, cobalt supply is closely tied to the copper and nickel markets.

*Sources: Austrade (2019) Australian Critical Minerals Prospectus; KB Shedd et al. (2017) Global Trends Affecting the Supply Security of Cobalt. Mining Engineering; GM Mudd et al. (2019) Critical Minerals in Australia: A Review of Opportunities and Research Needs. GEOSCIENCE AUSTRALIA RECORD 2018/51.*

Innovation could also reduce waste and create downstream recycling opportunities, including in the battery recycling sector. Australia's capacity to develop new recycling technologies could deliver greater environmental and economic returns in the medium term.

Australian resources operators are well equipped to develop less energy- and chemical-intensive processing methods for REE and other critical minerals to improve the environmental impact of separation of critical minerals. Achieving this goal will reinforce Australia's environmental credentials and differentiate Australian operations from less environmentally conscious operations.

The Australian Government is providing incentives for industry to collaborate in the critical minerals sector.

Australia's Cooperative Research Centre (CRC) program provides grant funding to support industry-led collaborative research partnerships solving industry-identified problems:

- The Government has prioritised \$20 million of funding in Round 7 of the Cooperative Research Centre Projects (CRC-P) program for projects with a specific focus on critical minerals. The funding will provide opportunities to improve the critical minerals extraction and production capabilities of Australia's resources sector, and to increase the value added to the economy.
- The CRC for Optimising Resource Extraction (CRC ORE) will receive \$34.45 million from 2016–2021 to develop energy-saving and resource-expanding technology that will allow lower-grade ores to be economically and eco-efficiently mined. CRC ORE is focused on extracting more value through finding, developing and linking technology step-change operational

innovations across the whole-of-mine chain. CRC ORE undertakes research, as well as implementation at live mine sites, seeking opportunities to optimise ore body characterisation, geometallurgy, blasting, comminution, mine planning and economic evaluation.

Companies that are developing new processes to mine critical minerals are well supported by Australian metallurgical testing service companies, local engineering firms, and by the R&D capability of organisations such as Australia's Nuclear Science and Technology Organisation (ANSTO) and the Commonwealth Scientific and Industrial Research Organisation (CSIRO) to prove process steps, provide innovative solutions to bespoke orebody-related R&D issues, and to construct viable flowsheets. ANSTO and CSIRO have strong capability, experience, and pilot testing facilities for the existing Australian industry and CSIRO also has the capability for metal production, the next step in the value chain.

These research organisations are complemented by Australia's world leading Mining Engineering and Technical Services (METS) companies. The METS sector delivers technological advancements and helps improve productivity, safety and environmental standards. This contribution helps to make Australia one of the safest, cleanest and most productive mining countries.

Additionally, through the COAG Energy Council, the Australian, state and territory governments will examine and help to prioritise the resource sector's long term R&D efforts including in environmental management, geoscience, exploration, innovation, technology and critical minerals.



### 3. Infrastructure investment

#### Goal:

Connecting critical minerals opportunities with infrastructure developments.

The Australian Government plays an important role in the development of infrastructure to support globally competitive industries and provide access to growing international markets. The Government's support for infrastructure development has the capacity to stimulate and enhance economic productivity, reduce capital costs for businesses, build our competitive advantages, and deliver a multiplier effect throughout the economy, generating lasting economic and social benefits.

Australia has an abundance of critical minerals resources across the country. As the mineral systems and deposit types that critical minerals are typically found in are, in many cases, already extensively mined for their major metals, critical mineral mines are often supported by existing infrastructure, as shown in Figure 2. The widespread distribution of critical minerals also suggests possible flexibility in the development of future infrastructure and supply chains for a number of them.

The Australian and state and territory governments continue to invest in upgrades to existing infrastructure. Road upgrades can reduce commercial costs for operators in Australia's critical minerals sector by improving roads' flood immunity to reduce road closures during wet seasons, supporting more productive heavy vehicle access and usage, and improving access to key infrastructure, such as ports, and electricity generation for resources developments.

Lithium mines and production around Port Hedland in the northwest of Western Australia will benefit from upgrades to the Marble Bar Road – Coongan Gorge, for which the Australian Government is providing up to \$43.58 million through the Northern Australia Roads Program (NARP). By widening and reconstructing a narrow section of the Marble Bar Road that passes through Coongan Gorge, the project will improve road safety and accessibility for freight vehicles, with the Marble Bar Road providing an important link between mining and other resource operations in the East Pilbara and Port Hedland. The upgrade is an important response to the continuing need of the resources industry in the area for a reliable and fit-for-purpose road network.

Australian Government commitments to upgrade sections of the Great Northern Highway will improve access for freight vehicles to and from Wyndham Port. These projects could benefit developments such as the Browns Range dysprosium project southeast of Halls Creek:

- \$44.91 million (through the NARP) to upgrade the Great Northern Highway between Maggie Creek and Wyndham will improve road safety and freight efficiency. This section of the Great Northern Highway is a key inter-town link between Wyndham (including the Port of Wyndham), Kununurra and Halls Creek. For example, the upgrade is expected to improve access for freight vehicles to and from Wyndham Port, enable higher freight capacity and reduce the impact of flooding on road users by improving accessibility.

Figure 2: Road Infrastructure and Critical Minerals Mines and Deposits



Source: Geoscience Australia, 2019.

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- Another \$30.79 million to upgrade the Great Northern Highway at the Bow River Bridge and its approaches. The upgrade, completed in November 2018, replaced the single lane, low-level Bow River Bridge with a new two lane, high-level bridge and also aligned and sealed the roads approaching the bridge. The project has increased road reliability and safety through improved flood immunity and enhanced network accessibility for local communities and business centres.
- An additional \$12.5 million to improve the Great Northern Highway between Ord and Turkey Creek. Funds for this project have been committed through the Northern Australia Beef Roads Program. Due to commence in 2019, this project will improve freight carrying capacity and connectivity by realigning the roads, installing passing lanes along high priority sections of the highway, and building a new two lane bridge over Frog Hollow which will increase flood immunity.

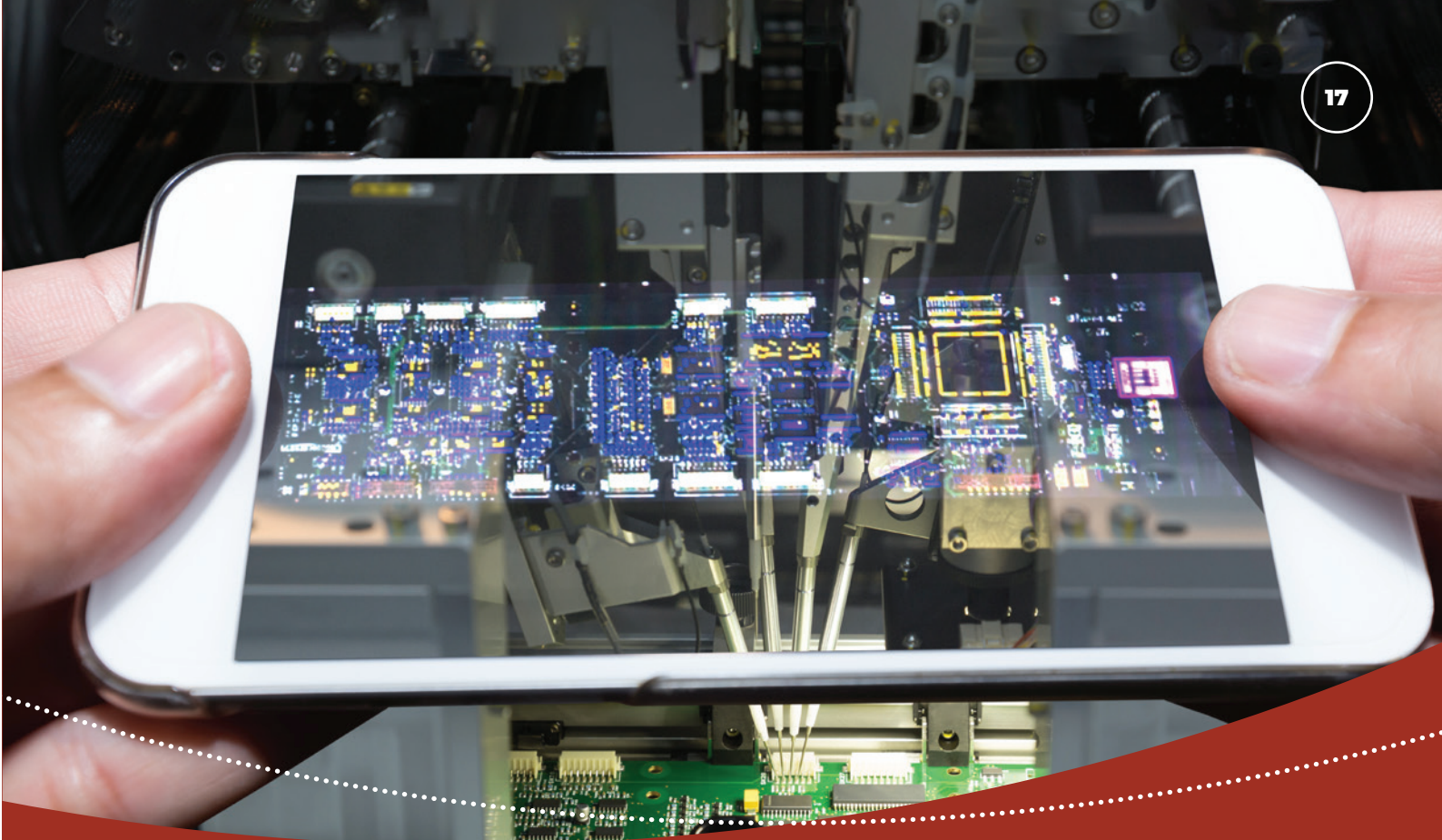
Other road infrastructure upgrades, such as the \$330 million in upgrades to the Outback Way, could improve access to undeveloped critical mineral resources in Western Australia, the Northern Territory and Queensland along its corridor, as well as enhancing road safety. The Mt Weld Central Lanthanide Deposit is one of the highest-grade REE deposits in the world. Mt Weld also hosts the undeveloped Duncan (REE), Crown (niobium, tantalum, titanium, REE, zirconium) and Swan (phosphate) deposits. Another deposit within reach of the Outback Way is the Nebo-Babel deposit which is currently stranded due to lack of infrastructure.

Building on these commitments, the \$3.5 billion *Roads of Strategic Importance* (ROSI) initiative will ensure that key freight routes efficiently connect agricultural and mining regions to ports, airports and other transport hubs. ROSI reserves \$1.5 billion for investment in freight corridors in northern Australia.

The \$5 billion Northern Australia Infrastructure Facility (NAIF) is another Government initiative that supports infrastructure development, including in the resources sector. The NAIF can provide financial assistance for infrastructure investments that facilitate the establishment or enhancement of business activity or increase economic activity in a region. As at 20 February 2019, of the projects in the due diligence phase of NAIF's assessment processes – 12 out of 24 are in the resources sector. One example of a project in the due diligence phase is the Sconi Cobalt-Nickel-Scandium project in north Queensland.

In 2018, the NAIF made an investment decision to provide a loan of up to \$19.5 million to support emerging lithium and tantalum producer, Pilbara Minerals, in its upgrade of a public road, located south of Port Hedland. The project will enable larger freight movements and mitigate the risk of transport disruptions from extreme weather by providing an alternative route from the mine to Port Hedland. It will also increase safety for all road users in the region. The road will remain in public hands and be available to all users with total public benefit over the 17-year life of the mine assessed at nearly \$27 million.

Australia has a track record of building the infrastructure required to mine and transport its natural resources to global markets. This can be expected to continue in the case of critical minerals.



## MARKET OPPORTUNITY

# RARE EARTH ELEMENTS

Many countries include rare-earth elements (REE) on their critical minerals lists. REE are used in renewable energy production; electric vehicles; military technologies; high-end technological applications, such as mobile phones and other electronics; lasers; speciality alloys; and batteries.

In 2017, the REE market value was US\$415 million, with 130,000 tonnes of global production coming primarily from China (80.8% of production).

While REE are abundant in the earth's crust, their occurrence in economic concentrations is less common than for other exploited metals. To date, the demand for REE has been met by a relatively small number of producers and mines. In 2016, Australia had the second highest global production of REE (16%), producing lanthanum, cerium, neodymium, praseodymium and the rare and valuable dysprosium.

Mining of REE is challenging, as REE are sometimes by-products or co-products of other metals and their supply is influenced by these markets. Also, they may require bespoke waste-management solutions to deal with radioactive co-products or other chemicals.

*Sources: Austrade (2019) Australian Critical Minerals Prospectus; GM Mudd et al. (2019) Critical Minerals in Australia: A Review of Opportunities and Research Needs. GEOSCIENCE AUSTRALIA RECORD 2018/51.; USGS (2018) Mineral Commodity Summaries. Rare Earths.*

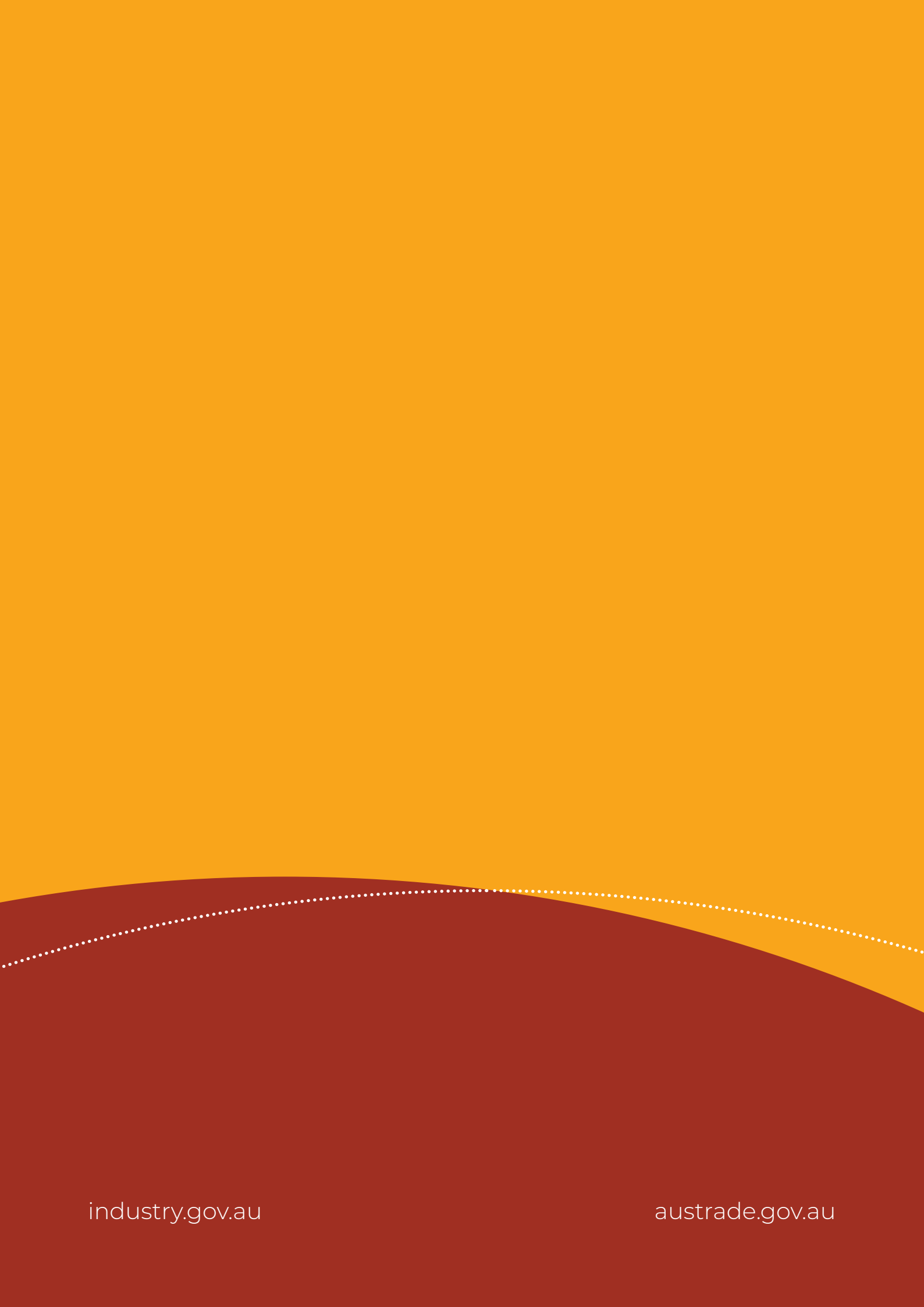
# Conclusion

The Australian Government is committed to working with the critical minerals sector to create the investment, innovation and infrastructure that is required for it to reach its potential.

The Government will also work with the states and territories to develop a joint work program that builds on existing exploration initiatives and identifies new supply chain opportunities.

These actions, combined with the world leading skills and knowledge of Australia's resource companies, will ensure that Australia can competitively supply many of the mineral resources that underpin the technologies of the modern age.





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