



CELEBRATING 40 YEARS

PROSPECT

WESTERN AUSTRALIA'S INTERNATIONAL RESOURCES DEVELOPMENT MAGAZINE March - May 2018

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This year marks forty years of *Prospect* magazine.

The magazine has charted the rise of Western Australia as a globally recognised player in numerous industries, particularly the resources sector.

Prospect articles have promoted the innovation, strength and resilience of Western Australian industries.

The publication milestone coincides with a return of confidence in the Western Australian economy – the domestic economy is back in growth and our export economy is powering ahead.

The Western Australian Government is committed to growing our State's economy.

Recent overseas visits – with our traditional trading partners China, Japan (story page 2) and Korea (page 6), and to Africa (page 4) and Kazakhstan (page 7) – have strengthened existing relationships while opening the door to further collaboration and new possibilities.

At home, we are focused on growing our State's economy through jobs for Western Australians.

The \$16.7 million New Industries Fund (story page 19) will work to support and accelerate new and emerging businesses to create Western Australian jobs.

In the oil and gas sector, an LNG Jobs Taskforce (story page 10) will see government and industry work together to establish Western Australia as an LNG hub, helping to create new long-term job opportunities.

In the Pilbara region, a new collaboration agreement between the Western Australian Government and industry, with a strong emphasis on jobs (story page 11), will build on the existing social and economic contributions of Western Australia's resources industry.

The growth of Western Australia over the past forty years to become a leading resources and export economy is testament to the ability of Western Australians to work to their strengths, as well as our ability to innovate and prosper.

This Government is working to strengthen Western Australia's prospects for the next forty years and beyond.

Mark McGowan

PREMIER; MINISTER FOR STATE DEVELOPMENT, JOBS AND TRADE

Bill Johnston

MINISTER FOR MINES AND PETROLEUM

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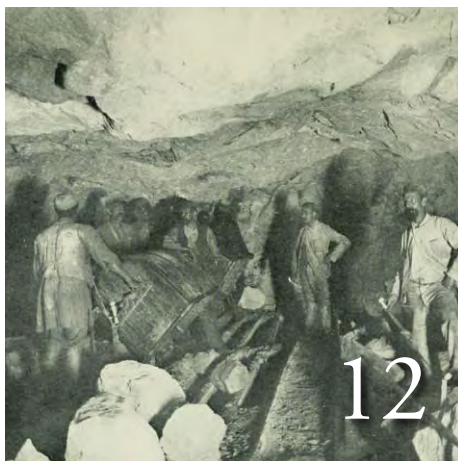
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Western Australia's government and business leaders travelled from Perth to China and Japan in November, meeting with the State's biggest trading partners.

GROWING WA GLOBALLY: CHINA AND JAPAN TRADE MISSIONS

Western Australian Premier and Minister for State Development, Jobs and Trade, Mark McGowan, led a high profile team of Western Australian business leaders and representatives on trade missions to China and Japan in November.

The delegation focussed on engaging with Western Australia's major trading partners to expand on existing relationships into growth areas for the State's economy, particularly in the tourism and education sectors.

"China and Japan are Western Australia's two biggest trading partners, together making up nearly 65 per cent of our exports, so it made sense that my first overseas visit as Premier included time in each country," Mr McGowan said.

"Both countries have played a role in the growth of major export sectors like iron ore and natural gas, gold and agriculture, and also present real opportunities for growth in other industries. We respect these important trade and investment partnerships.

"The Chinese portion of the trip had a particular focus on international education and tourism, both crucial sectors if we are to grow and diversify the State's economy to create more local jobs."

The Premier said there was enormous scope in the tourism and higher education sectors in Western Australia.

"Currently, the number of Chinese students coming to Western Australia, as a proportion of the national figure, is 3.7 per cent of the international enrolments of students from China," Mr McGowan said.

"Obviously, with 11 per cent of the population of Australia, that is significantly below what our State should be attracting.

"We are very keen to expand the number of Chinese students. I will continue to promote Western Australia as an ideal study destination for Chinese students."

The mission to China included the launch of the first phase of a digital strategy aimed at promoting Perth as a study destination to help boost the number of Chinese enrolments.

The digital strategy included initial establishment of a website, which will support social media campaigns and relationship marketing, with the aim to increase the profile of Perth as a study and lifestyle destination to both students and parents.

While in China, the delegation travelled to Hangzhou, the capital of Zhejiang Province to celebrate the 30th Anniversary of the Sister State Relationship Western Australia shares with the province.

The Memorandum of Understanding between Western Australia and Zhejiang sees both parties strive to cooperate in trade, education, tourism, e-commerce, health care, and research and development.

The delegation also visited Shanghai, and Ms Ellery and several university delegates visited Guangzhou, in Guangdong Province.

Mr McGowan and Mr Papalia travelled to Japan to meet the leadership of major Japanese companies, along with senior government figures.

The Japan visit included time in Tokyo and in Kobe, capital of Sister State Hyogo Prefecture, and focussed on reaffirming the relationship and exploring opportunities for greater collaboration in tourism to help boost Western Australia's economy.

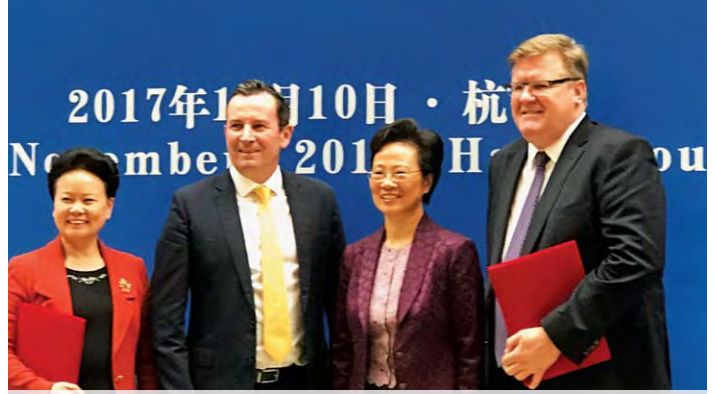
The Premier and Minister met with Japanese companies that have significant investments in Western Australia and have been major contributors to the State's economy for decades, including Mitsubishi, Mitsui, Japanese Steel Mills, JERA, Tokyo Gas, and Tokyu Corporation.

The delegation also met with key members of the Japanese National Diet (Japan's Parliament), including the Minister for Agriculture, Forestry and Fisheries; as well as representatives from Japan Oil; Gas and Metals National Corporation; Itochu; Marubeni; Nisshin Flour Milling; and Japan Bank for International Cooperation.

Site tours included Kawasaki Heavy Industry's shipyard, and the Kobe Children's Hospital.

While in Japan, Mr McGowan was bestowed with an Honorary Doctorate from Tokyo City University. The university conducts a very successful cross-cultural program with Western Australia, which has so far grown to include more than 300 students who study in Western Australia each year. ■

Minister for Asian Engagement, Bill Johnston, followed his visit to China with a visit to Korea (story page 6).



The Premier witnessed a Memorandum of Understanding signing in Zhejiang Province with Vice Governor Liang Liming.

Joining Western Australian Premier and Minister for State Development, Jobs and Trade, Mark McGowan on the overseas visits, which marked the Premier's first international trip as leader of Western Australia, were Education and Training Minister Sue Ellery, Asian Engagement Minister Bill Johnston and Tourism Minister Paul Papalia, along with invited representatives from the tourism and education sectors.

The Premier was also accompanied by Vice-Chancellors from Western Australia's major universities, The University of Western Australia, Murdoch University, Edith Cowan University, and Curtin University, along with representatives from the University of Notre Dame.

Directors and chief executives of a range of businesses in Western Australia that rely on tourism also accompanied the Premier, including Perth Airport CEO, Kevin Brown; Optus Stadium CEO, Mike McKenna; the Perth Arena general manager; and the deputy director of the Perth Convention Bureau.

Nobel Prize winner, Professor Barry Marshall, Chief Scientist Professor Peter Klippen and Professor Lyn Beazley, the chair of StudyPerth were also part of the delegation. ■

While Western Australia is the main minerals and petroleum exporting region of Australia and produces a significant proportion of the world's minerals and petroleum commodities, the State is also fully focussed on expanding its economy.

- Western Australia's largest export market in 2016–17 was China (\$60.2b or 50%), followed by Japan (\$15.7b or 13%) and Hong Kong (\$9.6b or 8%).
- In 2016–17, Western Australia had majority shares of Australia's exports to Hong Kong (75%), United Kingdom (64%) and China (63%).
- Minerals and petroleum accounted for 90% (\$108.2b) of merchandise exports in 2016–17.
- Agriculture, food, fibre, fisheries and forestry exports accounted for 7% (\$8.5b) of merchandise exports in 2016–17.
- Western Australia accounted for 19% of Australia's business investment in 2016–17.
- In 2016, international student enrolments in Western Australia totalled 55,274.

Source: www.jtsi.wa.gov.au

– WA Economic Profile – January 2018



In Hangzhou, China, the Premier attended key business engagements including meeting with executives at Chinese multinational company Alibaba.



Signing the MoU: (from left), COMESA Legal Counsel Brian Chigawa, COMESA Secretary General Sindiso Ngwenya, Mines and Petroleum Minister Bill Johnston, DMIRS Deputy Director General Dr Phil Gorey.

WESTERN AUSTRALIA CEMENTS TIES WITH AFRICA

The signing of a new six-year Memorandum of Understanding (MoU) with the Common Market for Eastern and Southern Africa was the defining moment of Western Australia's presence at the Africa Mining Indaba 2018 in February.

Mines and Petroleum Minister Bill Johnston, Department of Mines, Industry Regulation and Safety (DMIRS) Deputy Director General Dr Phil Gorey and Department of Jobs, Tourism, Science and Innovation (JTSI) Commercial Manager Africa Mr Filippo Raggi represented Western Australia at Africa's largest mining conference.

The high-level visit encouraged increased representation by Western Australian mining and service companies, and was augmented by the attendance of Chamber of Minerals and Energy Deputy Chief Executive Nicole Roocke and William Witham, CEO of the Australia-Africa Minerals and Energy Group based in the State's capital city of Perth.

Minister Johnston signed the MoU with COMESA Secretary General Sindiso Ngwenya, marking a renewed commitment to strengthening the partnership's inter-governmental collaboration.

The MoU aids the sharing of knowledge and expertise in mining and petroleum law and regulations in tenement management systems, State agreements, ownership of minerals royalty regimes, geological survey practices and data, and safety and environmental regulation.

"As part of our continuing relationship with COMESA, DMIRS presented a business case that highlights the need for more intensive, in-country, regulatory capacity-building programs tailored to mineral and petroleum resource development," Dr Gorey said.

"It is a template COMESA members can use to seek funding from multilateral organisations for longer-term training and capacity building that could create an opportunity for Western Australia's tertiary and vocational education and training institutions."

DMIRS also presented a document to COMESA on the Principles for a Sustainable Resources Sector, covering both the minerals and petroleum sectors.

"This document presents the key principles on which the regulatory framework for Western Australia's resources sector was developed," Dr Gorey said.

"They encourage investment, ensure the rights of explorers to the resources they find, and answer an obvious need for transparent, well-administered policy and regulatory frameworks.

"The principles will facilitate the sustainable development of Africa's resources and the flow-on of benefits that will improve lives in African communities."

Dr Gorey said that Western Australia and COMESA have been working on longer-term training to ensure sustainable regulatory training and support is provided to regulators in member countries.

"This training will complement the two-day in-country policy and capacity building workshops that have been successfully delivered by DMIRS officers under the MoU," he said.

DMIRS teams have so far held workshops in Ethiopia, Kenya, Nigeria, Uganda, Zambia, Zanzibar and Zimbabwe.

Dr Gorey said that he regarded the visit to Indaba 2018 as a great success, not only in terms of achieving objectives such as the MoU signing, but also in the amount of networking through attending meetings and official functions.

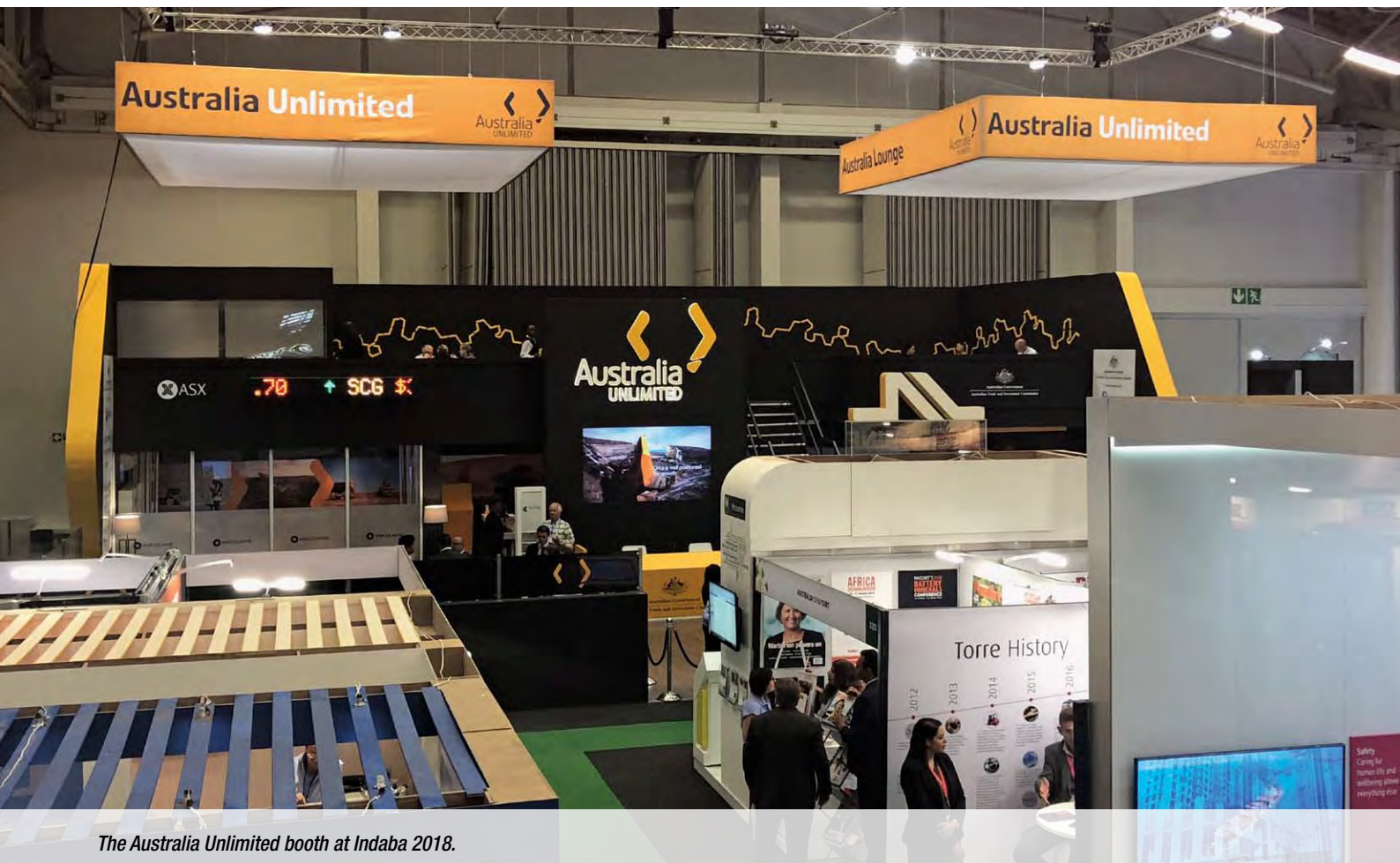
"It was a very busy schedule and the first time that a Western Australian Minister for Mines has attended an Indaba," he said.

The next major event involving Africa on Western Australia's calendar is Australia Africa Week in August.

"What started as Africa Down Under and several related events involving DMIRS and JTSI has coalesced into what we are now calling Australia Africa Week, a showcase for Western Australia as a world leader in mining, mining-related educational services, and the mining, equipment, technology and services sector," Dr Gorey said. ■

Western Australia's trade and investment relationship with Africa

- Western Australia was responsible for 27 per cent, or \$1.6 billion, of Australia's trade with Africa.
- Latest figures have shown that of the 134 ASX-listed companies operating in Africa, 92 were based in Western Australia and developing a total of 231 mining projects in 29 African countries.
- In Namibia alone, there are 12 Western Australian companies operating 23 mining projects.
- Hundreds of Western Australian mining, equipment, technology and services sector companies are known to be operating in Africa.
- The most significant Western Australian mining companies operating in Africa, by market capitalisation, include:
 - AVZ Minerals – Democratic Republic of Congo (lithium) and Namibia (vanadium, tin, lanthanides, copper, iron ore, and gold)
 - Base Resources – Kenya (mineral sands)
 - Cardinal Resources – Ghana (gold)
 - Iluka Resources – Sierra Leone (mineral sands)
 - Perseus Mining – Burkina Faso, Cote d'Ivoire, Ghana, and Sierra Leone (gold)
 - Rand Mining – Liberia (iron ore)
 - Resolute Mining – Cote d'Ivoire, Ghana, and Mali (gold)
 - South32 – South Africa (manganese and coal)
 - Tawana Resources – Liberia (iron ore) and South Africa (diamonds)
 - Tribune Resources – Ghana (gold)
 - West African Resources – Burkina Faso (gold).



The Australia Unlimited booth at Indaba 2018.



(L-R) Namhoon Kim, Vice Chairman of Korea Tennis Association (KTA); Penny Bond, Senior Policy Advisor; Sangmin Park, KTA Vice Chairman; Minister Bill Johnston; Yonghoon Kwak, KTA Chairman; and Jean Ough, Government of Western Australia Korea office Commissioner.

WESTERN AUSTRALIA FORGES LINKS WITH KOREA

In his capacity as Minister for Asian Engagement, Bill Johnston travelled to China and Korea last November, meeting with key business executives and government representatives.

Mr Johnston accompanied Western Australian Premier and Minister for State Development, Jobs and Trade, Mark McGowan; and Ministers Sue Ellery and Paul Papalia on their inaugural official delegation to China, along with 37 senior education and tourism representatives (see story page 2).

Following the China trip, Mr Johnston travelled to Seoul, South Korea, where he met with senior business executives and the Korean Deputy Minister for Trade, Industry and Energy, to highlight the importance of Western Australia's relationship with South Korea.

"My initial meeting was with the chargé d'affaires of Australia to the Republic of Korea to hear the embassy's views on the current state of the South Korean economy and North Korea's effect on economic issues," Mr Johnston said.

"I met with the Pohang Iron and Steel Company to seek an update on POSCO's overseas resource development strategy and its current iron ore investments in Western Australia, including Roy Hill.

"I met with the Deputy Minister for Trade, Industry and Energy to seek his advice on the Korean government's strategy to secure mineral resources, particularly the five core minerals – lithium, cobalt, nickel, manganese and tungsten – required for developing new industries for South Korea's fourth industrial revolution."

The minister also met with Hyundai Steel, the Energy and Mineral Resources Development Association of Korea, and the South Korean representative of Meat and Livestock Australia, and toured KT Olleh Square to see new concepts in telecommunications technology.

Mr Johnston also held meetings with key figures regarding cultural and people-to-people exchange between South Korea and Western Australia.

Minister Johnston concluded his visit by meeting with key Western Australian personnel on ways to further the State's relationship with Korea.

"I concluded with a roundtable discussion with representatives from Woodside, Tourism WA and the Government of Western Australia Korea Office regarding further development of the cooperative relationship with South Korea in relation to resources, liquefied natural gas, tourism and education," he said.

In 2017, Korea passed the United Kingdom to become Western Australia's fourth largest export market (\$7.1 billion), behind China (\$60.1b), Japan (\$16.5b) and Hong Kong (\$8.6b).

The Western Australian Government's South Korea Office is based in Seoul. For more information on trade and investment opportunities in Western Australia, visit www.jtsi.wa.gov.au ■

WA ROYALTIES SYSTEM SHOWCASED IN KAZAKHSTAN



DMIRS' Systems and Analysis Manager, Vince D'Angelo with a welcoming committee representative.

A senior official from the Department of Mines, Industry Regulation and Safety (DMIRS) recently showcased Western Australia's (WA) world-class resources sector and regulatory leadership at a workshop in Astana, Kazakhstan.

DMIRS' Systems and Analysis Manager, Vince D'Angelo said he was invited to present at the workshop by the Organisation for Economic Cooperation and Development (OECD) as part of its involvement in the Kazakhstan Mining Competitiveness Project.

"The project supports the Kazakhstan Government's efforts to increase investment in its mining industry, and helps to align the nation's

mining policy framework with international best practices," Mr D'Angelo said.

"As part of their mining taxation reform, the Kazakhstan Government has expressed an interest in using WA's mining legislation as its template.

"They are keen to understand WA's taxation mechanisms for the mineral sector, in particular our royalty system."

Kazakhstan's mineral taxation policies are covered separately under general tax code legislation instead of mining-specific legislation. This means its mineral revenue payments are embedded in the tax code, whereas WA's are set in mining legislation.



- **Kazakhstan has the largest and strongest performing economy in central Asia and was the first member of the former Soviet Republic to repay all of its debt to the International Monetary Fund, seven years ahead of schedule.**
- **Kazakhstan has an abundant supply of accessible mineral and fossil fuel resources.**
- **Development of petroleum, natural gas, and mineral extractions has attracted most of its \$40 billion in foreign investment since 1993, and accounts for 57 per cent of the nation's industrial output.**

By modernising its tax system, Kazakhstan hopes to become more transparent and attract additional investment, so investors can understand exactly what their financial obligations will be before they invest.

During the presentation, Mr D'Angelo provided an overview of how the Australian tax system works and detailed how DMIRS administers the State's royalties system.

"I was able to share how WA uses technology to lodge forms and returns online and its audit process," Mr D'Angelo said.

"I also provided an outline of some of the challenges relative to mining taxation in WA that Kazakhstan may face as they go through the reform project."

Kazakhstan's Government is eager to learn from WA experiences in resource exploration and development regulation. Delivery of these in-country workshops is part of DMIRS' ongoing program to showcase the State's stewardship of its resource sector. ■

GOVERNMENT OF WESTERN AUSTRALIA

INTERNATIONAL TRADE AND INVESTMENT UPDATE



Western Australian Government International Offices

The Western Australian Government operates a network of trade and investment offices in key global markets, managed by the Department of Jobs, Tourism, Science and Innovation. The Government of Western Australia Offices are the first in-market point of contact for international trade and investment opportunities and for creating links with Western Australian businesses. Here, *Prospect* shares some recent highlights from each of our international teams based in London, Dubai, Mumbai, Singapore, Jakarta, Shanghai, Tokyo and Seoul. We encourage businesses to make direct contact with our in-market teams to discuss identification and development of highly prospective trade and investment opportunities.

China

Western Australia's China focus was boosted by the November 2017 visit of the Premier and the Ministers for Tourism, Asian Engagement and Education accompanied by a 40 member delegation from the tourism and education sectors. While in China the Premier reaffirmed the Western Australian commitment to the Sister State agreement with Zhejiang Province, and launched a digital media platform to assist Western Australia's international education sector. Recently appointed Commissioner Stuart Crockett is leading a renewed focus on assisting SME's to enter and sustain a presence in this large, complex market, including companies from sectors such as construction, robotics, aged care, tourism, food and beverage, agriculture, mining, architecture and life sciences.

India

Western Australia's Sister State relationship with the Indian State of Andhra Pradesh continues to provide an important gateway for Western Australian businesses wishing to access key in-market decision makers. Commissioner Peter Baldwin's team is particularly focused in Andhra Pradesh on supporting business development in the mining and energy sectors and related services, including education. Recent examples have included: support for Village Energy entry to India market, including signing of an MOU to establish a

micro-grid trial in Andhra Pradesh; commitments for trials of road safety devices with KSI Global; and Curtin University getting support to establish a mining partnership in Andhra Pradesh. Nationally, recent strong interest from major Indian businesses during the Geological Survey of Western Australia's recent roadshow suggest there will soon be strategic investments from India, and examination of a potential direct air service from a major Indian city to Perth.

Indonesia

The Western Australia – East Java Sister State agreement was reaffirmed in October 2017, when Minister for Asian Engagement Bill Johnston visited Surabaya. Development of strengthened partnerships in education and training with East Java is a priority focus for Commissioner Jennifer Mathews and team, working with the Western Australia – East Java Universities Consortium of 5 and 10 universities respectively. Supporting Indonesia to achieve its energy availability and distribution objectives has been priority area of work. In December 2017, the Western Australian Government hosted a visit by a high-level mining and energy delegation from East Java. A Letter of Intent was signed between PT Petrogas and Horizon Power regarding the use of distributed energy resources to support East Java's future energy needs. Minister Bill Johnston visited

Indonesia in March 2018 to address a renewable energy seminar in Makassar, arranged by the Australian Consulate-General. The Minister was able to promote Western Australia's capabilities in the renewable energy sector as Indonesia seeks to meet its renewable energy target of 23 per cent by 2025 – twice current levels.

Japan

Our State's Tokyo and Kobe based team, led by Commissioner Craig Peacock, has a strong current focus on improved Japan market access for fresh agrifood products and the establishment of direct flights between Tokyo and Perth. Following the November 2017 visit to Japan by Premier Mark McGowan and Tourism Minister Paul Papalia, the Japan team is working with airlines that have shown interest in direct flights between Tokyo and Perth, which would provide for increased tourism and education, and allow high value products such as live rock lobster to re-establish in the Japanese market. The Japan team has been assisting a range of Japanese universities and schools to expand and strengthen their links with Perth schools and universities, and to facilitate familiarisation and exchange visits for students.

London

The London-based, Europe-focused team led by Agent General John Atkins has had a strong recent focus on investment attraction to Western

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Australia, including business facilitation at the Asia-Pacific Regional Conference held in Perth in November 2017. The Europe team has had a wide range of interest from European companies interested in Western Australia's global strength as a supplier of lithium and other battery materials.

In March 2018, Premier, Mark McGowan and Minister for Tourism, Paul Papalia were on the first direct Perth-London flight on the Qantas "Quokka" Dreamliner. This milestone non-stop flight to London also enabled high-level meetings with tourism and defence industry leaders and investors in the UK and Germany.

In another milestone, Stuart Russell retired from our London office after 40 years of service; Jeet Jandu has joined us as Senior Trade and Investment Manager.

Middle East and Africa

With ongoing assistance from the Dubai team led by Commissioner Pankaj Savara, Curtin University officially opened its newest campus in Dubai, United Arab Emirates in September 2017. The Dubai Office also provided support to FST Iran group, the first Iranian mining investment into Australia after the end of business sanctions with Iran.

The Dubai Office team also covers Western Australia's interests in Africa, and facilitated

Western Australia's Mines and Petroleum Minister Bill Johnston's role as a keynote speaker at the 2018 Mining Indaba in Cape Town, including engagement with the Common Market for Eastern and Southern Africa (COMESA) representatives for the mining sector.

The Dubai-based team supported Premier Mark McGowan when he held a range of valuable meetings with UAE government and company representatives, when he visited Dubai and Abu Dhabi in February 2018. These meetings, and our support for the 16 companies attending the major Gulfood trade show in February (in partnership with Department of Primary Industries and Regional Development), are a small sample of the diverse range of support provided to Western Australian companies in the Middle East markets.

Singapore

Building on the official visit of Chief Scientist, Professor Peter Klinken to Singapore in February 2016, the Singapore team led by John Catlin has organised several visits and high-level exchanges involving prominent scientists and innovators from Perth. This work builds on earlier assistance to Edith Cowan University in establishing linkages into Singapore, which resulted in commercial partnerships with government-linked healthcare group SingHealth and the International Sports Academy of Singapore.

The Singapore and Perth based teams continue to work closely with international business associations, based both in-market and in Perth, to assist business and trade development in ASEAN nations. A particular focus during the past year has been on facilitating new business linkages for Western Australia's defence-related technologies and maritime services sectors.

The relationship building and trade development visit to Singapore in October 2017 by Minister for Mines and Petroleum and Asian Engagement Bill Johnston included a meeting with the Minister for Trade of Singapore.

South Korea

The Government of Western Australia Office in Seoul, led by Jean Ough, coordinated a successful market visit by Minister Bill Johnston in November 2017. The Minister met key stakeholders in the resources, culture and sports sectors and it was clear that the Korean parties are keen to develop a closer relationship with Western Australia. As a result of the visit, the Korean Office also arranged a visit by Dr Phil Gorey, from the Department of Mines, Industry Regulation and Safety, where he spoke at a symposium on lithium opportunities and met with companies regarding potential investment in the mining sector. ■



An LNG Jobs Taskforce will build on Western Australia's existing LNG industry to create long-term jobs. Photo: JTSI

GAS JOBS TASKFORCE TO TRANSFORM WA INTO A GLOBAL LNG HUB

Western Australia is set to transform into a global liquefied natural gas (LNG) hub with a spotlight on gas jobs thanks to a recently announced industry and government collaboration.

At the 2018 Australasian Oil and Gas Exhibition and Conference held in Perth in mid-March, Premier and Minister for State Development, Jobs and Trade, Mark McGowan, announced plans to establish an LNG Jobs Taskforce.

The taskforce will consist of both industry and government representatives with members working collaboratively to maximise the benefits that flow from the local LNG industry.

The taskforce will aim to establish Western Australia as a LNG hub, helping to create new

long-term job opportunities focused on servicing, maintaining and improving existing operations.

Liquefied natural gas is Western Australia's second most valuable commodity with sales of \$12.7 billion in 2016-17.

Western Australia's share of the nation's LNG export capacity by late 2018 will be about 57 per cent, or close to 50 million tonnes, with LNG volumes having increased by 84 per cent in the past five years.

The taskforce will focus on harnessing the job opportunities the LNG industry can be providing the Western Australian community, including new technology, education and maintenance services.

"WA jobs are my number one priority, and the creation of this jobs taskforce will make sure we build on our existing LNG industry to create more long-term local jobs," Mr McGowan said.

"Australia is set to have the world's largest LNG export capacity by mid-2018, surpassing Qatar, so now is the time for our State to act and become a global hub.

"As we build on our existing LNG operations, courses could be provided by education and training providers that align with the needs of industry, ensuring young Western Australians get the skills required for future job opportunities.

"Oil and gas projects help drive our economy, generating jobs in the industry and revenue with flow-on effects to the rest of the economy." ■



Acting Director General of JTSI, Richard Sellers.

FAREWELL TO STEVE WOOD

Staff from the Department of Jobs, Tourism, Science and Innovation (JTSI) and Tourism Western Australia (TWA) farewelled Steve Wood on 13 April. Mr Wood was appointed CEO of TWA and Director General of the newly amalgamated department at the formation of JTSI last year. He was previously the Director General of the Department of State Development from May 2011.

The Public Sector Commission has directed the Director General of Transport, Richard Sellers, to act as Director General of JTSI and CEO of TWA from 16 April 2018. ■

PILBARA COLLABORATION CHARTER



A new agreement between the Western Australian Government and industry will see greater collaboration to deliver benefits to the Pilbara. Photo: Rio Tinto Western Australia iron ore operations. Copyright 2017 Rio Tinto

A significant collaboration agreement between the Western Australian Government, the Chamber of Minerals and Energy of Western Australia and the State's largest resources companies has ushered in a new way of working together in the Pilbara.

The Pilbara Collaboration Charter has a strong focus on jobs, as well as economic and social benefits, and builds on the existing social and economic contributions of Western Australia's resources industry.

Premier Mark McGowan, CMEWA chief executive Reg Howard-Smith, and leaders from eight major resource companies signed the charter in late November.

"The Pilbara Collaboration Charter provides a framework through which government and industry can work together to deliver further social and

economic benefits to communities in the Pilbara," Mr McGowan said.

"With a particular focus on jobs, and bridging the gap between training and employment, this charter ensures that those in the Pilbara have access to economic opportunity."

The first priority for the charter is employment, education and training, particularly the development of pathways to job creation.

Other areas included in the charter are community development and health, procurement and supply chain and joint project initiatives.

The cross-collaborative approach outlined in the charter emphasises high-level communication between government and industry, and engagement with Federal Government and relevant local governments.

This approach is aimed at ensuring efforts deliver sustainable improved social and economic impact to Pilbara communities over a longer-term horizon.

The charter was developed by the CMEWA in collaboration with BHP, Chevron Australia, CITIC Pacific Mining, Fortescue Metals Group, Rio Tinto Iron Ore, Roy Hill, Woodside, and Yara Pilbara.

"This Government has worked closely with the Chamber of Minerals and Energy and industry to ensure a productive relationship with the resources industry, and this charter is a new way for us to continue to work together," Mr McGowan said.

For more information or to view a copy of the charter, visit the Department of Jobs, Tourism, Science and Innovation website at www.jtsi.wa.gov.au/pilbara-collaboration-charter. ■



Better known for its massive iron ore deposits, the Pilbara has become the focus for a new gold rush.

THE NEW PILBARA GOLD RUSH

In mining terms, the Pilbara is synonymous with iron ore. It is one of the world's biggest suppliers of seaborne ore and has played a large part in establishing the fortunes of the big miners BHP and Rio Tinto and in more recent times FMG.

On the other hand, gold is synonymous with Western Australia's goldfields region where years of gold mining activity has spurred townships and successful mining companies.

However, gold is not unknown in the Pilbara. The region already hosts the Telfer, Nullagine and Paulsen's mines. All of which begs the question, what has caused the current gold rush in the Pilbara?

In July of 2017, the Canadian company Novo Resources announced the discovery of small, conglomerate (i.e. lumps of rock) hosted gold nuggets in the Pilbara. This announcement kicked off a mini gold rush; share prices spiked on news from nearby companies as other similar finds were announced, and new ground was rapidly pegged.

It was not so much the gold that was discovered that has driven this interest; in fact, gold volumes recovered from conglomerates in the region remain relatively modest. Conglomerate gold deposits are rare in WA, with existing mineralisation found as alluvial gold at the surface or quartz vein-hosted gold in so-called Archean greenstone belts.

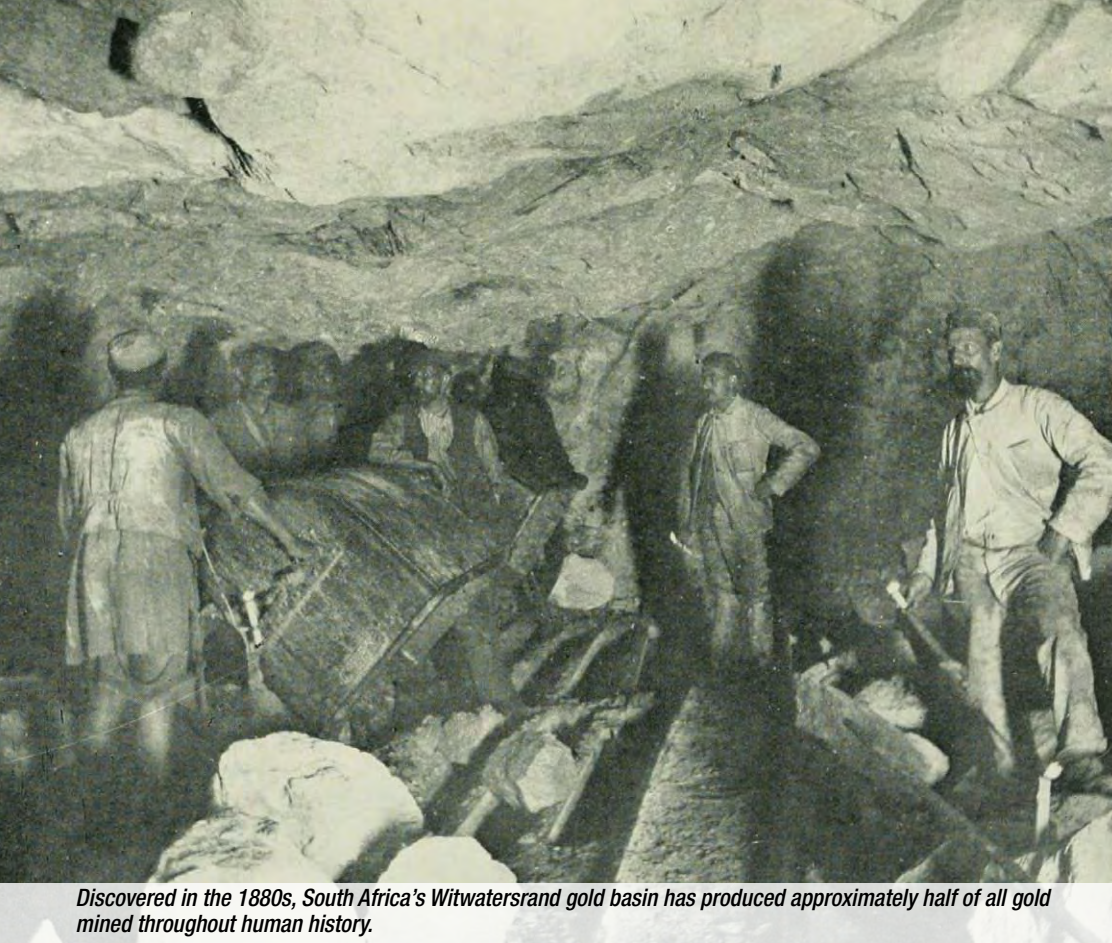
Rather, excitement is driven by the possibility that these discoveries might represent a repeat of the famous Witwatersrand gold basin in South Africa which hosts a wealth of gold-rich deposits and was home to the world's largest gold rush in the 1800s. Although only discovered in 1886, approximately half of all gold mined throughout human history has come from the Witwatersrand gold basin.

Even today, after more than a century's worth of production, "The Rand" retains some of the largest reserves in the world. South Africa currently holds reserves and resources of approximately 617 million ounces of gold in reserves and resources, the majority of which is concentrated in the

Witwatersrand basin. This is more than three times Western Australia's known reserves and resources which currently stands at around 197 million ounces. A gold endowment at only a fraction of the South African scale could support a mining industry in the Pilbara for decades into the future.

There is some evidence for the theory. The deposits are superficially similar: conglomerate hosted, nuggetty gold associated with pyrite. Second, there is some evidence, which is not conclusive, for the so called "Vaalbara" hypothesis – the idea that the Pilbara craton in Western Australia and the Transvaal craton in South Africa (which hosts the Witwatersrand basin) were connected approximately 2.8 billion years ago, when the host rocks were deposited. This idea has encouraged speculation on apparent similarities in stratigraphy (see Figure 1), palaeomagnetic signatures, geochronology and geodynamic history between the two cratons.

Of course, mere correlations do not necessarily mean a repeat of the Witwatersrand gold deposits.



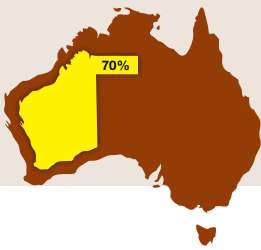
Discovered in the 1880s, South Africa's Witwatersrand gold basin has produced approximately half of all gold mined throughout human history.

Even if true, exploration odds remain long, and there are considerable hurdles between today's explorers and a profitable mine, or even the confirmation of economic gold deposits. The nature of the exploration needed for deposits of this type is such that solid data on grade and continuity is not expected until mid-2018 at the earliest.

Believers of the conglomerate gold story say it has the potential to transform the Pilbara and write a new chapter in its mining history, while naysayers claim the theory lacks credibility and predict the rush will be over soon. However, given the potential payoff, this is a story worth keeping an eye on in the near future.

More information about the Pilbara Craton can be found on the department's website – www.dmirs.wa.gov.au ■

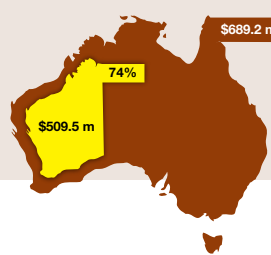
WA accounts for 70 per cent of Australia's total gold production



10 Gold projects account for 59 per cent of WA's total gold production



WA accounts for 74 percent of Australia's total gold exploration spend



Value of gold sales in 2016-17 was a record \$11 billion



RAPID RISE IN EXPLORATION APPLICATIONS

Last year the Department of Mines, Industry Regulation and Safety received the highest number of Programme of Work (PoW) applications since 2011.

In 2017, the department received 2575 PoW applications. This was the second highest number since the department started producing approval performance reports in 2009 – see Figure 1.



Strategic Projects Senior Advisor Graham Cobby said it was the largest annual increase in more than five years.

"The number of PoW applications received in 2017 increased by 43 per cent, compared to 2016," Mr Cobby said.

"This was an indication of more favourable economic conditions for investment in exploration.

"It was also accompanied by an increased interest in gold and lithium – which is likely to continue into 2018."

Despite the increase in PoW applications, the department's approvals performance continued to meet timeline targets.

"The department finalised 99 per cent of PoW applications within the target timeline of 30 business days," Mr Cobby said.

"We also saw a reduction in the number of PoW applications carried over for the quarter from 252 in the first quarter 2017, to 191 in the fourth quarter 2017."

The department publishes quarterly approval performance reports on its website. ■



DOWNSTREAM PROCESSING ADDS SPARKLE TO WA'S LITHIUM BOOM

Pilbara Minerals' Pilgangoora project. Photo Pilbara Minerals

Western Australia's lithium boom is shifting into a higher gear as miners move towards downstream processing of the metal powering the world's battery power revolution.

Mining and exploration for lithium has been going on in Western Australia for more than 25 years, but the recent rapid advances in electric vehicle and battery storage technology have created a wave of exploration and investment that is turning Australia's biggest State into a global hub for lithium.

Western Australia ranks fourth globally in lithium resources with world-class deposits in the South West at Greenbushes, the Goldfields–Esperance region near Ravensthorpe, Southern Cross about 370km east of Perth, Kalgoorlie in the State's goldfields, and in the Pilbara south of Port Hedland.

WA has a major strategic advantage over other lithium producers because it is close to big manufacturers of lithium products in Asia, such as China, Japan and South Korea, according to Dr Phil Gorey, Deputy Director General of the State's Department of Mines, Industry Regulation and Safety (DMIRS).

"WA also has the advantage of shorter construction and ramp-up times and lower capital costs compared with other major producers such as Chile and Argentina," Dr Gorey said.

"Western Australia's lithium concentrate sales have more than doubled over the past 10 years, reaching 866,000 tonnes worth more than \$604 million in 2017, but DMIRS and the State Government are particularly heartened by the swing towards downstream processing," he said.

"Secondary processing of lithium concentrate from spodumene ore into lithium carbonate and/or lithium hydroxide dramatically increases export value."

At the moment, all battery metals exported from Western Australia are in raw mineral concentrates that will undergo secondary processing and value-adding in overseas plants.

However, many current and potential battery metal miners are working towards developing in-house or co-invested processing of their product to maximise returns to shareholders.

"The secondary processing of lithium concentrate into lithium carbonate or lithium hydroxide, and nickel concentrate into nickel sulphide suitable for battery use, has tremendous economic potential for Western Australia," Dr Gorey said.

"Downstream processing of lithium also has the potential to deliver \$2.2 billion in investment to WA and create many hundreds of jobs."

Tianqi Lithium Australia is constructing a \$400-million lithium hydroxide processing plant with an annual capacity of 24,000 tonnes a year at Kwinana, just south of Perth, to process its share of spodumene concentrate from the Greenbushes mine.

Tianqi has already approved a feasibility study into a \$317-million doubling of the plant capacity to 48,000 tonnes per year that is targeted for completion by late 2019.

The plant is claimed to be the largest of its kind in the world and will be capable of producing the world's highest quality lithium hydroxide.

The Kwinana project is expected to create up to 500 local jobs during construction and 115 local jobs once operational.

In November 2017, Tianqi's Greenbushes partner Albemarle revealed that it will build its own lithium hydroxide plant at Kemerton, near Bunbury in Western Australia's South West region.

The plant will be capable of producing 20,000 tonnes per annum and Albemarle is already flagging a staged expansion of the facility to 100,000 tonnes per annum by 2025.

The total development will have capital expenditure of more than \$1 billion, involve 750 to 1000 construction jobs and employ a peak operational workforce of 270 people.

Lithium-focused companies such as Lepidico, Lithium Australia and NeoMetals are developing new proprietary hydrometallurgical processes to produce lithium carbonate, lithium hydroxide and lithium titanate from a wider variety of hard-rock lithium-bearing silicate minerals.

Neometals and Mineral Resources are assessing the development of a downstream lithium processing facility at their Mt Marion project near Kalgoorlie.

The plant is planned to be commissioned by 2020 and would have a capacity of 20,000 to 25,000 tonnes per year of lithium carbonate.

Kidman Resources and Chilean lithium giant SQM are examining the design and feasibility of a refinery to produce lithium carbonate or lithium hydroxide as part of their Mt Holland project near Norseman.

The refinery is estimated to cost \$400 million and produce either 37,000 tonnes per year of lithium carbonate or 44,000 tonnes per year of lithium hydroxide.

It is expected to create up to 200 jobs during construction and an operational workforce of 180.

Historically, WA's lithium sales have been dominated by production from Greenbushes.

The operation which began producing in 1985 is now owned and operated by Talison Lithium, a subsidiary of two global lithium giants, Tianqi Lithium Corporation, which owns 51 per cent, and Albemarle Corporation, which owns 49 per cent.

There have been a number of recent significant milestones in Western Australia's continuing growth as a lithium producer, including:

- The restart of the Mt Cattlin lithium concentrate project near Esperance by Galaxy Resources in November 2016.

- The start-up of Reed Industrial Minerals' Mt Marion project near Kalgoorlie in the December quarter of 2016.
 - The establishment of a lithium direct-shipping ore operation at Wodgina near Port Hedland by Mineral Resources, which achieved its first shipment in April 2017.
- Several new lithium projects and an expansion of an existing mine are currently under way in WA:
- In March 2017, Altura Mining started on-site earthworks and early construction at its Pilgangoora project in the Pilbara, which is expected to begin producing in 2018.
 - Also in March last year, Talison Lithium committed to doubling the lithium concentrate production capacity of its Greenbushes project.
 - Joint venture partners Tawana Resources and Alliance Mineral Assets Limited have started constructing the \$42-million Bald Hill lithium and tantalum mine in the Eastern Goldfields, with first lithium concentrate production in mid-March 2018.
 - In July last year, Kidman Resources and SQM announced a 50-50 joint venture to develop the Mt Holland lithium project near Southern Cross, marking the first time a Chilean company has invested in a Western Australian mining project. However, Antofagasta PLC of Chile did invest in the Yeneena exploration project (50–70 km southwest of Telfer) in 2013–16.
 - In September last year, Pilbara Minerals began construction of its Pilgangoora project.
- Western Australia's lithium boom has been underscored by record sales, which have more than doubled during the past 10 years.
- In 2016–17, sales of spodumene concentrate and direct-shipping ore reached more than 866,000 tonnes worth more than \$604 million.
- "Together, these projects have the potential to boost the State's annual lithium concentrate production to almost three million tonnes by 2020 – nearly four times what it was in 2016," Dr Gorey said.
- "And if all the projects now under development in WA reach full capacity, the industry could generate more than \$100 million per year in royalties for Western Australia." ■

Lithium production and downstream processing



Project	Company	Production rate	Product and downstream processing
Greenbushes	Tianqi/Albemarle	By 2019, production capacity will rise to 1.34 million tonnes (Mt) per year of 6 per cent Li concentrate	Tianqi constructing 48,000 tonnes per year lithium hydroxide plant at Kwinana Albemarle proposes to build a lithium carbonate plant in Kemerton
Wodgina	Mineral Resources	Planning 6 per cent Li concentrate production of 0.5 Mt per year by 2020	Direct shipping ore Spodumene concentrator plant being built, and option of 100,000 tonnes per year lithium carbonate production from plant at Wodgina being investigated
Pilgangoora	Pilbara Minerals	Initial 0.5 Mt per year of Li concentrate building to 2 Mt Feasibility into 5 Mt per year planned	Spodumene concentrate and direct shipping ore (via Atlas Iron) Option of downstream processing including Korea lithium JV
Mt Holland/Earl Grey	Kidman Resources/SQM	Planning 300,000 tonnes per year of 6 per cent Li concentrate	30,000–40,000 tonnes per year lithium hydroxide or lithium carbonate Feasibility into WA refinery being examined
Mt Marion	Neometals/Mineral Resources/ Jiangxi Ganfeng Lithium	Planning production increase to 450,000 tonnes per year of 6 per cent and 4 per cent Li concentrate	Spodumene concentrate Lithium hydroxide plant proposed
Pilgangoora	Altura Mining	220,000 tonnes per year of 6 per cent Li concentrate initially Planning 440,000 tonnes per year	Spodumene concentrate
Mt Cattlin	Galaxy Resources	160,000 tonnes per year of 6 per cent Li concentrate production in 2017	Spodumene concentrate
Bald Hill	Tawana Resources/ Alliance Mineral Assets Limited	155,000 tonnes per year of 6 per cent Li concentrate	Spodumene concentrate

LEGEND

CURRENTLY MINING

IN CONSTRUCTION

EXPLORATION

COMMITTED OR PLANNED DOWNSTREAM PROCESSING IN WA

WA is poised to become a battery metals powerhouse

Western Australia is now famous for its lithium, but the State is also well placed to supply five other prominent battery materials.

Nickel

Western Australia's lithium boom has stirred activity in nickel – a crucial component in battery production.

BHP Nickel West announced in August 2017 that it will spend \$55 million to build the world's largest nickel sulphate plant at Kwinana, about 40 km

south of State capital Perth, to produce 100,000 tonnes of electrolytic nickel per year.

Western Australia is well stocked with nickel, with globally significant resources of about 35 million tonnes of contained metal in 87 deposits.

WA is Australia's only nickel producer, and although only eight mines are operating at the moment, 25 other mines are under care and maintenance.

Many of these could reopen if demand from the battery and other industries raises nickel prices to an economic tipping point.

The Savannah nickel–copper–cobalt project, in particular, is currently under consideration by Panoramic Resources Ltd for a restart.

In 2016–17, WA sold 157,490 tonnes of nickel worth more than \$2 billion.

Australian Bureau of Statistics figures show that Western Australia's nickel explorers are spending three times more than 18 months ago.

About \$28.7 million was spent exploring for nickel–cobalt deposits in the December quarter of 2017.

Continued Page 16

That was up from \$22.4 million in the June quarter and \$25.7 million in the September quarter, marking the sixth straight quarterly rise in exploration spending.

Cobalt

Cobalt, which in WA is a by-product of nickel mining, is a critical component in many battery designs, and supply concerns have driven prices upwards – 47 per cent in 2016, and around 57 per cent last year.

On 26 January this year, trade in cobalt closed at just under US\$80,000 per tonne, the highest end-of-day price since trading began on the London Metal Exchange.

In 2016–17, 4732 tonnes of WA cobalt valued at \$237 million were sold, generating more than \$5 million in royalties.

Known cobalt resources in WA total about 1.32 million tonnes and in 2015 the State boasted the world's second largest reserves of cobalt reserves after the Democratic Republic of the Congo.

The DRC hosts around half of the world's cobalt, but the African nation has been in the spotlight for some time over ethical issues, such as the use of child labour in mines.

Concern over stable supply, the increase in price, and potential for increased demand from battery applications has sparked considerable exploration interest in cobalt in Western Australia.

Graphite

WA has about two million tonnes of defined graphite resources in four of WA's 13 active graphite projects, but WA is not yet a current producer of graphite though historic production is recorded.

The two most advanced projects are Hexagon Resources' McIntosh project in the East Kimberley region and Buxton Resources Ltd and Montezuma Mining's Yalbra project in the Gascoyne region.

The State's graphite resources are small on a global scale, but could yield high-purity graphite and graphene, the wonder material that is so thin it's classed as two-dimensional.

Manganese

Western Australia has been producing manganese for more than 50 years, but the only active mine is at Woodie Woodie in the Pilbara, recently reopened by Consolidated Minerals.

Global demand for manganese has doubled over the past decade, driven in part by increasing demand for high-purity manganese dioxide for use in lithium-ion batteries used in grid storage and electric vehicles.

Now some WA-based companies such as Montezuma Mining are evaluating their projects specifically as sources of battery-grade manganese dioxide.

Vanadium

WA has significant vanadium resources that include King River Copper's large Speewah deposit in the East Kimberley. ■

Department of Mines, Industry Regulation and Safety RESOURCES SECTOR AWARDS FOR EXCELLENCE

Golden Gecko • Community Partnership • Safety & Health



SPOTLIGHT ON EXCELLENCE IN WESTERN AUSTRALIA'S RESOURCES SECTOR

As one of the world's top destinations for mining investment, Western Australia is continually demonstrating excellence and innovation to improve processes, safety and outcomes.

The Department of Mines, Industry Regulation and Safety's (DMIRS) Resources Sector Awards for Excellence aims to highlight projects and partnerships that are at the forefront of community partnerships, safety and health, and environmental innovations and excellence.

Incorporating three different areas recognising excellence in the resources industry, the Resources Sector Awards for Excellence acknowledge innovation, outstanding performance and leadership to ensure that the State's resources are developed in a responsible manner for the benefit of all Western Australians.

The prestigious Golden Gecko Award for Environmental Excellence, Safety and Health and Community Partnership Resources Sector Awards not only recognise leaders in the sector, but also help to share the advances and meaningful community engagement that is being done across the State.

The department's Director General David Smith said the awards provided the perfect platform to showcase and celebrate industry advances and innovation.

"Striving for excellence in health, safety, social and environmental responsibility is something the department strongly encourages, and helps to raise standards that benefit both the community and industry," Mr Smith said.

"The calibre of past entries has demonstrated a determination to promote a safe work environment, environmental excellence, and the importance of community partnerships in the resources sector, and I am sure 2018 will be no different."

The Golden Gecko Awards, Safety and Health and the Community Partnership Resources Sector Awards will be held on 25 October. More information is available at www.dmirs.wa.gov.au/excellenceawards ■



NEW DEPARTMENT SUPPORTING A SAFE AND FAIR WESTERN AUSTRALIA

As one of the Machinery of Government reforms announced by the State Government in 2017, the bulk of the Department of Commerce has merged with the Department of Mines and Petroleum to create the Department of Mines, Industry Regulation and Safety (DMIRS).

The new department's mission is to support a safe, fair and responsible future for the Western Australian community, industry and resources sector.

The organisational structure of the new department brings together like services under five groups to ensure the community and industry receive the best service possible.

Resource and Environmental Regulation Group

Responsible for the regulation of one of Western Australia's largest industry sectors, the Resource and Environmental Regulation Group plays a critical role in building WA's economy and ensuring the State's resources are developed in a sustainable and responsible manner.

The group provides regulatory and policy oversight of the resources sector, in all areas apart from worker safety. The group also delivers the department's geoscience functions, reducing risk for explorers and increasing the attractiveness of Western Australia as a destination of choice for resource companies.

The group consists of:

- Resource Tenure
- Resource and Environmental Compliance
- Geoscience and Resource Strategy (including the Geological Survey of Western Australia).

Industry Regulation and Consumer Protection Group

The Industry Regulation and Consumer Protection Group will contribute to safer, more responsible actions by traders and industries, the early identification of emerging trends and issues and importantly, a better informed, risk aware community.

The group will look after the interests of industry and the community in Western Australia through the significant legislation program it administers and through compliance, conciliation, dispute resolution and enforcement. Additionally, it will maintain and monitor industry specific technical standards, and use sophisticated analysis and surveillance to monitor industries.

The group consists of:

- Building and Energy (formerly Building Commission and EnergySafety)
- Consumer Protection.

Safety Regulation Group

The Safety Regulation Group will play a significant part in building and strengthening Western Australia's economy by ensuring one of its most significant assets, its workforce, operates in a healthy and safe environment where their rights as workers are protected.

The group provides regulatory and policy oversight of workers' health and safety in the resources and general industries sectors and the licensing regime, and safety legislation for dangerous goods, including regulation of the State's major hazard facilities and petroleum operations.

The group is also responsible for the coordination, governance, and consistent management of public sector labour relations and parts of the State's private sector workforce.

The group consists of:

- WorkSafe
- Mines Safety
- Dangerous Goods and Petroleum Safety
- Labour Relations
- Regulatory Support.

Service Delivery Group

The Service Delivery Group will design and deliver services that will meet the needs and expectations of our community, customers and industry.

The group will ensure the department is client focused and alert to opportunities to improve and evolve service delivery methods that are efficient and effective, and keep pace with the advancement of technology.

Where possible, the group will collaborate with other agencies to make services easier for customers to access and use.

The group consists of:

- Licensing Services
- Customer Information
- Investigations for dangerous goods, mines and petroleum safety and WorkSafe.

Strategic Business Innovation Group

The Strategic Business Innovation Group will focus on a whole-of-department strategic capability, fostering innovative thinking across the department in support of building a high performance organisation.

The group consists of the following:

- Business Innovation
- Strategic Policy
- Internal Audit and Risk.

Corporate Services Group

The Corporate Services Group supports the department to achieve its strategic and operational objectives.

The group brings together a range of corporate functions, which work collectively to help the organisation plan and operate, by offering specialist advice, effective business systems and internal controls.

The group consists of:

- Facilities Services
- Executive and Information Management Services
- Human Resources
- Finance and Financial Planning. ■

GSWA OPEN DAY 2018 PROMOTES WORLD CLASS GEOSCIENCE

The cutting edge of geoscience was on display at the Department of Mines, Industry Regulation and Safety's (DMIRS) Geological Survey of Western Australia (GSWA) Open Day 2018 held on 23 February.

Promoted as the premier geological event in WA, the popular annual event lived up to its reputation by showcasing the latest geological information through a range of presentations, demonstrations and poster displays.



Mines and Petroleum Minister Bill Johnston opening the event.

Mines and Petroleum Minister Bill Johnston, who launched the open day, said he was impressed by GSWA's continuing commitment to providing world-class products.

"Perth's geologists and geoscience community clearly hold the open day in high regard, so GSWA will continue to do what it does best – providing the maps, geoscience publications and invaluable data that have earned great respect nationally and internationally," he said.

Mr Johnston also opened Round 17 of the Co-funded Drilling Program, which is one of the most visible programs within the Exploration Incentive Scheme (EIS).

"The Co-funded Drilling Program focuses on innovative exploration in underexplored greenfield regions, and greatly assists resource exploration in Western Australia," he said.

"The program is successful, competitive and provides a number of benefits, as it adds to our geological knowledge of the State, helps diminish risks for future explorers, improves exploration efficiency and supports a range of employment opportunities."

DMIRS Geoscience and Resource Strategy Executive Director, Jeffrey Haworth said EIS funding allowed GSWA to make significant advances in geoscience and mapping.

"EIS funding has supported many of GSWA's achievements across mapping, business systems and geoscience, and today is about underlining these efforts and opening them up for discussion," he said.

A presentation on Frogtech's new SEEBASE model of the Canning Basin was visually stunning and drew an enthusiastic crowd. This update of a 2005 study increases the resolution of the Canning Basin depth-to-basement model and incorporates newly acquired geophysical data, surface geology, and information on petroleum wells and mineral boreholes.

Another well-attended open day presentation featured information on GSWA's major review of diamond prospectivity in Western Australia. The review compiled and assessed about 88,000 exploration diamond samples, and the presentation outlined the project's methodology and results of the indicator minerals, mineral chemistry and spatial prospectivity analyses. Despite prolific diamond exploration, the study identified regions that are still highly prospective and underexplored. The study provides a sound springboard for renewed diamond exploration in Western Australia.

Preliminary data for the NE Canning airborne gravity survey, also funded by the EIS, was another major new product released on the day.

The annual extensive poster display highlighted the results of ongoing collaborative research programs funded by EIS, and by the Mineral Research Institute of WA, including mineral exploration targeting with the CSIRO, the Centre for Exploration Targeting and Curtin University as part of the Capricorn Distal Footprints project.

Staff also demonstrated a range of business systems including the latest updates for GeoVIEW. WA, GSWA's award-winning, state-of-the-art geoscientific web application that is continuously updated with the latest geoscience and resource information.

Along with the displays and demonstrations of online systems, other presentation highlights included:

- The latest results from ongoing mapping, geochronology and geochemistry programs in the Yilgarn Craton
- An appraisal of the geological setting of the current Pilbara conglomerate-hosted gold nugget 'gold rush', and the reality of comparisons to South Africa's highly endowed Witwatersrand Basin
- A study on the fingerprinting of gold nuggets in the Kurnalpi Goldfield
- New work in the Fortescue and Hamersley basins in the Pilbara
- The innovative use of the composition of zircons from granites as a guide to the prospectivity of in the Pilbara and the Yilgarn
- Battery metals in Western Australia.

The pre-competitive geoscience information GSWA publishes is critical in reducing the technical and financial risks involved in exploration, attracts new investors to WA and reinforces the State's reputation as a global centre for mining and energy excellence. ■



GSWA's Don Flint (left) and Ian Tyler (right) with Minister Johnston.

INNOVATION FUND TO DRIVE REGIONAL JOBS



Innovation across Western Australia's regions has received a supercharge boost thanks to the early March launch of the \$4.5 million regional component of the State Government's New Industries Fund.

The New Industries Fund is a \$16.7 million initiative by the Western Australian Government to support and accelerate new and emerging businesses to create Western Australian jobs.

The regional funding will see up to \$300,000 allocated to each of Western Australia's nine regions for initiatives to drive innovation, diversification and job creation at a local level.

Innovation and ICT Minister Dave Kelly described regional Western Australian communities as having 'some of the most innovative people in the world'.

"As the world economy is disrupted by new technologies, it is important that regional Western Australia remains at the cutting edge," Mr Kelly said.

"The New Industries Fund will support businesses and communities in regional Western Australia to diversify the economy and create WA jobs."

The funding will target small-medium enterprises (SMEs), start-ups, organisations providing innovation support in the regions, and transform existing businesses to seize new industry opportunities.

A further \$1.4 million will be invested in inter-regional projects that drive collaboration between innovators across the State to promote economic diversification and job growth.

Projects that could be considered under the inter-regional stream include technology development initiatives to support regional growth and development programs, and commercialisation support for regional start-ups and SMEs.

Each region will establish a Regional Innovation Partnership to identify collaboratively strategic projects that have the greatest potential to grow regional communities.

An independent assessment panel will consider submissions and make recommendations to the State Government on the allocation of funding.

Regional Development Minister Alannah MacTiernan said innovation was critical to building the capability and economic sustainability of the State's regional communities.

"This funding will support our regions to develop their unique competitive advantages, focusing on developing new businesses and industries as well as helping existing businesses transform to meet the challenges of the 21st century," she said. ■

Organisations and businesses can register to join a Regional Innovation Partnership at www.newindustries.wa.gov.au.

The Department of Jobs, Tourism, Science and Innovation manages the New Industries Fund: www.jtsi.wa.gov.au

MINISTER LAUNCHES ROUND 17 OF CO-FUNDED DRILLING PROGRAM



Mines and Petroleum Minister Bill Johnston

Mines and Petroleum Minister Bill Johnston officially opened Round 17 of the Co-funded Drilling Program at the Geological Survey of Western Australia (GSWA) Open Day 2018.

One of several schemes within the Exploration Incentive Scheme (EIS), the program offers co-funding for innovative exploration in underexplored greenfield regions.

Mr Johnston applauded the flagship drilling program's many successes and economic benefits.

"The program greatly assists resource exploration in Western Australia, as it adds to our geological knowledge of the State, helps diminish risks for future explorers and supports a range of employment opportunities," he said.

"The application process is keenly contested, which reflects the quality of the program and our reputation as a global centre for mining and energy excellence."

Recent success stories from previous rounds include important finds in the eastern Pilbara, including Antipa Minerals Minyari copper-nickel-cobalt discovery, Sipa Resources' Paterson North copper-gold project and Encounter Resources' copper and zinc prospects.

In the Eastern Goldfields, Great Boulder Resources discovered significant copper-nickel-cobalt at Mount Venn, east of Laverton.

Funding single deep holes has encouraged companies to drill for mineralisation well below shallow surface anomalies. MacPhersons Resources recently intersected visible gold in the Boorara dolerite zone 310 metres below previous known gold mineralisation.

Round 17 applications will be reviewed by an external expert team, along with senior staff from GSWA.

Successful applicants will be announced in May-June 2018, and they will have 12 months to carry out drill programs from July 2018 to the end of June 2019.

The annual Open Day showcases the latest geoscience information and GSWA's recent activities. ■



Lindsay Collin's work included research on Shark Bay's stromatolites.

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COLLINS COLLECTION INCLUDES GEOLOGICAL ICONS

.....

Western Australia has a long history of some of the most notable geological icons in Australia and the world.

Some of these icons include the Earth's oldest mineral grains at Jack Hills in the State's Mid West, the earliest evidence of life on Earth with 3.5 billion year old rocks in the Pilbara, 2.5 billion year banded iron formations, the Devonian barrier reef in the Kimberley and the modern stromatolites at Shark Bay.

These geological icons and more can be found in the catalogue of the Perth Core Library. In 2016 the Perth Core Library took receipt of the Lindsay Collins collection of sedimentary and paleontological specimens and samples from Curtin University. This collection is the largest academic collection ever donated to the core library.

A large part of the collection is comprised of stromatolites from the Shark Bay area and sedimentary samples from the Abrolhos Islands and North West Shelf.

The living stromatolites at Shark Bay are world famous. These modern-day analogues of Archean stromatolites are little altered from their ancestors that were first found 3400 million years ago, and flourished about 2800 million years ago. The stromatolites flourish in a placid super-saline environment.

Stromatolites are renowned as the most extensive and diverse organisms of their kind found

anywhere on Earth. They were first discovered by former Executive Director of the Geological Survey of Western Australia (GSWA), the late Dr Phil Playford, in 1954 and were largely responsible for Shark Bay being listed as a World Heritage Area.

Lindsay Collins was a respected geologist from Western Australia. His research interests at Curtin University encompassed continental shelf sedimentology and substrate mapping, the coral reefs of the Western Australian continental margin, petroleum reservoirs, coastal mapping using Geographic Information Systems (GIS), tertiary limestone deposition and evolution, stromatolites, and warm and cool water carbonates. His most recent research was focused on Shark Bay, with which he had a long association, and the little known coral reefs of the Kimberley.

Professor Collins also worked in petroleum exploration as a specialist sedimentologist, and as a researcher in continental shelf, coral reef and coastal geology, specialising in carbonate sedimentation.

He investigated coastal vulnerability at Geraldton Port and in the Mid West region, the evolution of stromatolites in coastal embayments and lakes, the growth history of coral reef systems of Australia's western margin, and slope and coastal processes and sediments.

He has been Chief Scientist aboard RV Franklin, a national research vessel, on several instances. Prof Collins was the Head of Applied Geology at Curtin for six years. Up until his death he was a member

of the Australia-New Zealand Science Council for the Integrated Ocean Drilling Program (IODP) and a Project Leader for the WA Marine Science Institution (WAMSI) Kimberley Research Program. A long association with Shark Bay led to the Curtin Shark Bay Project and the Caring for Our Country Shark Bay Project.

Sadly he passed away on 2 September 2015, but his legacy lives on in his personal extensive collection now housed in the Perth Core Library. ■



Lindsay Collins. Photo: Curtin University

FORTY YEARS OF PROSPECT MAGAZINE



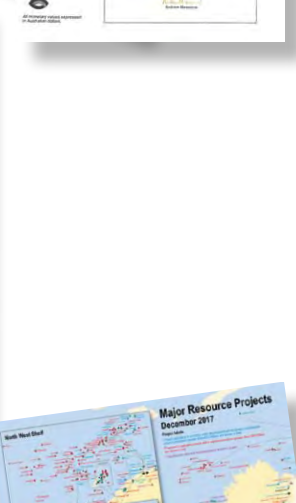
A



B



C



D

- A) The front cover from a 1979 edition of *Prospect*. The basic template was used for the next nine years.
- B) The first cover to feature a colour photo was in October 1987.
- C) Development of the Ord has featured in *Prospect* on a number of occasions – the above article appeared in the March–May 2007 edition.
- D) The very first major projects map (left) and how it looks today (right).

This edition of *Prospect* marks forty years for “Western Australia’s international resources development magazine”.

It didn’t start out that way. Beginning in 1978, *Prospect* was created as a “quarterly bulletin for senior management issued by the Government of Western Australia”.

The first edition included a policy review, commodity review, regional overview, statistical analysis, economic indicators, newspaper clippings and a major projects map. There were no glossy covers featuring photos of some of the massive resource projects starting to take shape throughout Western Australia. A simple headshot of the then Minister and a signed introductory letter he had penned was the template enshrined for the first nine-and-a-half years of *Prospect* covers.

The first break from tradition came in October 1987, when a North West Shelf rig graced the magazine’s first full-colour cover. After a relatively

stable design template for the first decade of its existence, between 1987 and 1993 the magazine underwent seven redesigns – ranging from relatively minor adjustments to complete design overhauls.

While covers, ministers and even department names may have changed, one thing that has stayed the same is the important information *Prospect* provides in showcasing Western Australia’s resources development – including the resource projects map which has been a feature since the first edition.

Developments such as the North West Shelf, Gorgon, Kalgoorlie-Boulder’s Super Pit, the Ord River Irrigation Scheme, Pilbara Cities and the Dampier-Bunbury Natural Gas Pipeline are just a small selection of the projects that have helped shape Western Australia and have been featured in *Prospect*. The magazine has also highlighted the relationships Western Australia has fostered with our international trading partners from around the world.

Prospect charted the introduction of important legislation and associated amendments, including the *Mining Act 1978*, the *Mines Safety and Inspection Act 1994* and numerous State Agreement Acts.

For forty years *Prospect* has promoted the innovation, strength and resilience of Western Australian industries and the legislation that underpins them. The magazine has charted Western Australia’s rise to a globally recognised player in a number of industries, particularly the resources sector.

To commemorate forty years of *Prospect*, a selection of articles from the magazine’s archives have been reproduced and provide markers for some notable events in the history of Western Australia’s development. ■



Iron ore is the powerhouse of Western Australia's resources economy. Worth more than \$60 billion last year, more than 780 million tonnes of Western Australian iron ore was shipped to international customers. In 2008 the sector was worth \$30 billion and shipped 303 million tonnes. That same year, *Prospect* marked the arrival of the State's newest iron ore producer – Fortescue Metals Group.

This article originally appeared in the March – May 2008 edition of *Prospect*.

Continuous miner breaks new ground for WA's iron ore industry

Jean Stewart, Department of Industry and Resources



With May this year firmly fixed in its sights for the historic first shipment of iron ore, the Fortescue Metals Group (FMG) is forging ahead on the final stages of development of its Cloudbreak operations in the Pilbara region of Western Australia.

With a project team of 3000 on the task, FMG is confident it will make its May 15 deadline for the first shipment to China.

The Cloudbreak development will represent one of the largest 'single iron ore' mines in the world. FMG's project is among the largest mineral projects to be developed in Australia for some time and will also represent significant earnings potential for the State and Australia as a whole.

That reputation is now riding on the success of innovative mining techniques.

Unlike conventional iron ore mining, the FMG operations will not drill and blast to extract the ore. Instead, continuous mining techniques will carve the ore from the earth with massive tungsten-tipped rollers.

Ore will then be transported to purpose-built shipping facilities at Port Hedland along a specially engineered, highly efficient open-access rail system that will carry up to 135 tonnes of ore per car.

FMG Executive Director of Operations Graeme Rowley said reaching that point in the three-and-a-half year timeframe had been an enormous challenge, with the company taking some knocks along the way.

"Some people have been very dubious of FMG's ability to succeed because we brought about broader views and supported different concepts," he said.

"We have had to think outside the box from the beginning because if you are confined in your own paradigm you won't shape the future. It's been great to be a part of it.

"We have also been amazed at the challenges that confront entrepreneurs. Financing AUD\$2.4 billion for infrastructure requires significant borrowings against the ore reserves, so we had to be confident of the potential.

"It took a great part of the imagination and initiative to then go and seek those borrowings."

FMG's initiative to replace the traditional blasting, excavating and trucking involved with extracting iron ore, took them on an extensive search for the right continuous miner machine. While surface miners are not a new concept and have traditionally been used in coal mining and road binding, they are new to Western Australia's iron ore industry.

Mr Rowley said FMG travelled the world to see continuous miners in action, breaking through ores that were harder than Western Australia's iron ore.

Back in Australia the team worked with metallurgists to design better rollers with tungsten picks. Tungsten metal extended the life of the picks by three or four times, which will reduce shut-down time for repairs and maintenance.

The company purchased 14 machines with plans for each to extract 750 tonnes of ore an hour. However, exciting test results indicate each machine will be churning out about 1000 tonnes per hour, or more.



Mr Rowley said the continuous miners were more efficient and resulted in less down time than was experienced with traditional blasting, excavating and trucking operations.

"This technique will enable us to extract the ore in layers and minimise the amount of unwanted materials, such as clay which contains alumina. This, in turn, improves the quality of ore extracted," he said.

FMG's reputation is riding on the success of innovative mining techniques.

"Blasting mixes the ore with those impurities and complicates the extraction process."

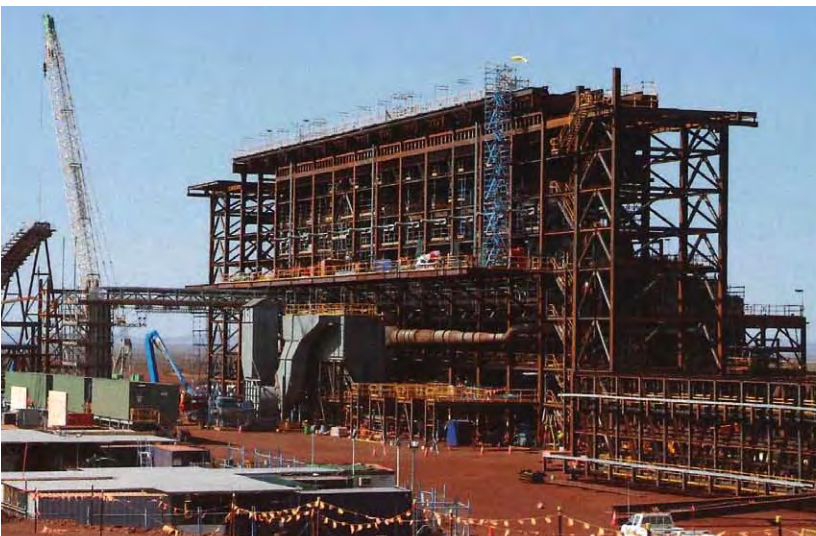
Mr Rowley confirmed that drill and blast techniques would still be used to break through the overburden to expose the ore to the continuous mining machines.

Rehabilitation of the large open-cut mines will be undertaken continuously as mining progresses across the ore body.

Once the top soil is removed and set aside, the overburden that is removed with the mining of the ore, is transported along massive mobile conveyors and dumped behind the extractors into the previously mined pit.

The company believes the aerated overburden will have a similar volume so the soil level will not be lowered significantly. The previously mined area can then be top-dressed to the original level and replanted as the operations move along.

Mr Rowley is quick to point out that, despite earlier criticisms FMG faced for daring to think outside the square, other iron ore giants, BHP Billiton and Rio Tinto Iron Ore, are now trialling the same continuous mining techniques.





The rise of China has been one of the most significant shifts in the world economy since the post-World War Two economic boom. China's \$11.9 trillion economy is now ranked second only to the United States. Back in 2004 China's economic rise was taking shape and Prospect featured a special report on China's industrial expansion and its impact on Western Australia's resources industry. At the time, State exports to China totalled \$4.2 billion and represented WA's second-largest export partner, behind South Korea. Last year WA's exports to China reached \$60.2 billion and represented our largest export partner, worth more than our exports to the next four largest export countries combined (exports to Japan, Hong Kong, South Korea and United Kingdom were worth \$36.4 billion).

This article originally appeared in the March–May 2004 edition of *Prospect* and provides a fascinating snapshot in time and is also a reminder of the importance of China to Western Australia's economy today.



China ▶▶

China's industrial expansion: what it means for Western Australia

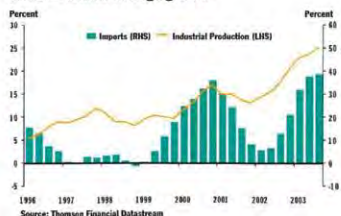
BY KURT SIBMA
DEPARTMENT OF TREASURY AND FINANCE

The emergence of China as a major industrialised economy and important source of world economic growth has become increasingly apparent in recent times. China's rapidly expanding economy and growing influence on global commodity markets is having a very large impact on economic activity in Western Australia and creating a wealth of mutual opportunities for producers and exporters.

China has had one of the fastest growing economies in the world over the past decade, with official data indicating that gross domestic product (GDP) has increased at an average annual rate of 9.3% over this time. This exceeds the OECD average of 2.6% growth per annum and reflects the range of economic and institutional reforms undertaken by Chinese authorities since 1978 to transform China into a modern, market-based economy. Given that GDP per capita is still quite low in comparison with more developed economies, it is likely that China will continue to experience high rates of economic growth in the years to come.

Economic reforms in China have occasioned a significant change in the structure of the Chinese economy, with the manufacturing and service industries expanding relative to traditional sectors such as agriculture. The manufacturing sector has been the standout performer in recent times, with industrial production up 24.7% in the year to September 2003, taking annual average growth over the past five years to 15.4%.¹

Industrial production and imports China — annual average growth



This has transformed China into a major global consumer, producer and trader of many mineral commodities. In 2002, China accounted for 17% of world aluminium consumption, 20% of world alumina

consumption, 21% of crude steel consumption, 28% of iron ore consumption and 8% of nickel consumption.²

Reflecting the strength of demand for industrial raw materials and its own relatively limited natural supply, import growth in China has surged in recent years. In the year to September 2003, total imports were valued at US\$381.2 billion — an increase of 38.8% from a year earlier.³

China's industrial expansion has not only been important for local producers in terms of creating strong demand for export volumes, but it has also played a large part in driving the recent upswing in many commodity prices. In the December quarter 2003, the Western Australian commodity price index expanded by a robust 28% in US\$ terms — the largest increase in more than three years. This has provided a very timely cushioning effect for many of the State's exporters in circumstances where the A\$ appreciated by more than 30% in 2003 against the US\$.

Commodity price index Western Australia



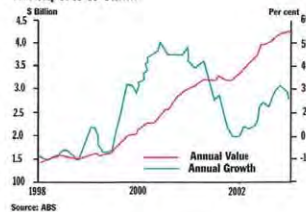
In 2003, China surpassed Korea to become Western Australia's second largest merchandise export market (after Japan). China now accounts for 13.1% of the State's exports (valued at A\$4.2 billion), up from a 6.1% share a decade ago. Over the past five years, China has accounted for more than a third of the State's total merchandise export growth, with annual growth averaging 24.8%.

Not surprisingly, trade in resource commodities forms the mainstay of this relationship, reflecting Western Australia's enormous natural resource wealth and its position as an efficient, low-cost and relatively close-by producer.

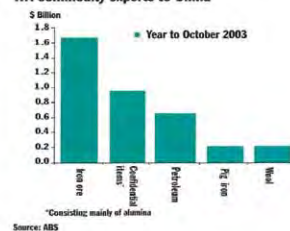


Busy marketplace: Shoppers crowd a shopping centre in Guangzhou, capital of China's southern Guangdong province, where much of Western Australia's LNG exports to China will be consumed.

WA exports to China



WA commodity exports to China



1. Source: Thomson Financial Datastream.
2. Source: Deutsche Bank.
3. Source: Thomson Financial Datastream.



The Golden Gecko Awards for Environmental Excellence started in 1992. Yet to adopt the 'Golden Gecko' moniker, the event was called the Department of Minerals and Energy's Awards for Environmental Excellence in the Mining and Petroleum Industries. In 1992 and 1993, a total of nine companies were recognised and presented with the top award. The following year only two top awards were handed out. This also marked the first time in the award's short history that an individual was honoured with the top prize. The following is the story of that individual.

This article originally appeared in the September–November 1994 edition of *Prospect*.

FOR THE first time, an individual has been honoured in the Department of Minerals and Energy's 1994 Awards for Environmental Excellence in the Mining and Petroleum Industries. Ray Gerrard, of Rally Revegetation Services, received the Minerals Operations sector award for innovative technology.

His entry was an innovative seeder which he developed for efficient and highly-effective minesite revegetation.

Mr Gerrard, who has an agricultural background, started his small family business in the Chittering Valley in 1989. In 1991, he moved family and business to Kalgoorlie where he joined the Goldfields Land Rehabilitation Group.

Acting on advice from the group, he approached Nufab Industries with his seeder design and two years later, the first Nurally Seeder was rolled out of its shed.

The machine immediately revolutionised minesite revegetation by providing one-stop seeding and fertilising processes which were both quick and effective. It can be attached to a variety of earthmoving equipment normally used in mine revegetation, including bulldozers, tractors and graders.

The citation stated that the machine was able to "rip the ground, accurately broadcast a mix of variable-sized seed and fertilise in a single pass while working on slopes of up to 30 degrees".

Another first at the presentations was an award to CSR Readymix, which won in the Mineral Operations sector to become the first sand mining company to be so honoured.

The company's Jandakot sand quarry at Banjup, in Perth's southern suburbs, represented a major environmental challenge due in part to being located in highly-porous silica sands, low in nutrients with low water-holding capacity and the possibility of year-round wind erosion.

The company undertook extensive research to determine the most efficient rehabilitation techniques and has now developed a blueprint for rehabilitation of sandpits under control of CSR Radomes. The excavated surface of the Jandakot site is contoured to match the surrounding area and a layer of topsoil and vegetation fragments spread from an area being cleared. About 50,000 plants were grown, along with others raised from seeds present in topsoil or from seeding programs.

Ray Gerrard's Nurally Seeder, which won him a DOME award for innovative technology.



Awards honour environmental excellence

Today, the quarry features minimal open space because all excavated areas are revegetated during winter.

A Certificate of Merit in the Petroleum Operations sector was awarded to West Australian Petroleum Limited. The

honour was given for the company's careful planning and execution of a transition zone seismic survey at Barrow and Thevenard islands in the north of Western Australia.

More than 375km of high-quality seismic line was recorded in waters which contain significantly coral reefs, shallows rich in marine life and land areas which include some of the State's most important nature reserves. The work was done with minimum environmental impact.

Speaking at the awards, Mines Minister George Cash said that by the end of 1894, 13,841 acres (about 5,500ha) were under mining lease, mainly in the goldfields. No one in those heady days thought to question the then-relatively low impact of this activity on the landscape or to consider rehabilitating mined areas.

But by the early 1970s, most major mining companies had either environmental staff or commissioned consultants. Today, the administrative system ensures the submission and approval of a Notice of Intent. This contains specific undertakings by the developer and includes establishing a bond commensurate with the cost of environmentally acceptable site rehabilitation. And as of July 1 this year, environmental inspectors had been appointed.

Mr Cash said, "This does not mark a change in the government's attitude towards encouraging industry self-regulation, but rather recognises the benefits that may be gained by having a small group of specialist environmental officers to inform, advise and assist in the achievement of the Government's environmental goals.

"We can be proud of the record of so many companies and individuals in this State who have not only pioneered innovative rehabilitation techniques, but have also been instrumental in changing community attitudes."

He said one legacy of mining's early days was abandoned mine sites and that he would seek federal government funding to compile them in a register. "We need to know what is there and what the relative public safety risks and environmental aspects of each of these old sites is.

"The assessment and selective rehabilitation of these abandoned mine sites is an important element in our strategy to improve the public perception of the impact of mining."

Mr Cash said of 25 companies selected by the United Nations from around the world to illustrate good environmental management techniques, eight were from Australia and five of those from Western Australia. ■



In 1989, Japan became Western Australia's first Liquefied Natural Gas (LNG) customer. Almost three decades later, the nation remains Western Australia's biggest LNG export market. Back in 1989, Australia did not appear in the list of the top five LNG exporters in the world. Today Australia is second behind Qatar, and is scheduled to surpass the Arabian Gulf country within the next year or so. The article presciently points to the growing importance of LNG exports for WA and its use as a cleaner fuel for global energy supply. Today LNG is Western Australia's second-most valuable resource commodity, behind only iron ore.

The following article originally appeared in the Spring 1989 edition of *Prospect*.

OPPORTUNITIES

Markets thirsty for gas

World trend is to LNG as an economical source of power

OVER the last year, the LNG market has strengthened and the opportunities for additional sales in the 1990s, and significant market growth post 2000, have received a boost with Japan, Republic of Korea and Taiwan forecasting increased demand.

One of the reasons for the increased demand is that LNG is seen as a clean form of energy, and, as concerns over the Greenhouse Effect and nuclear power generation grow, LNG is being increasingly seen as an economic and desirable alternative.

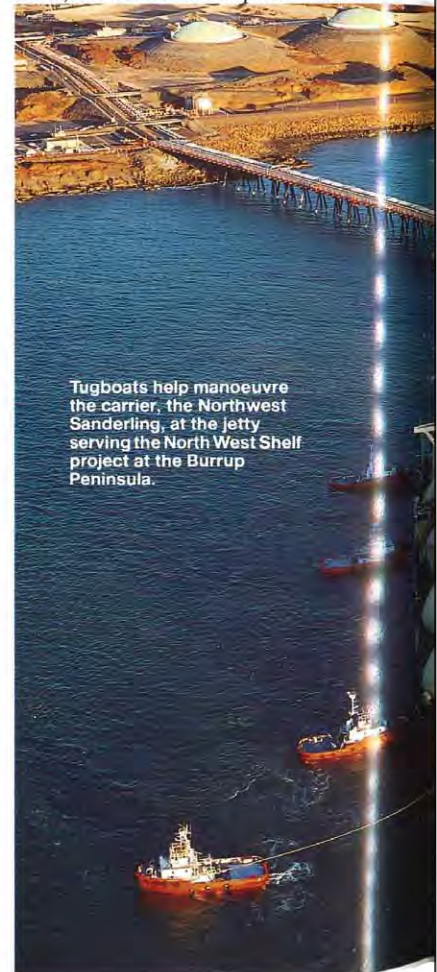
In addition, the growth of energy

consumption in these countries is spurred on by the continuing expansion of their industrial development.

Around the world gas is being seen as the fuel for power generation. Cedigaz has estimated that the world gas market grew by 3.8% in 1988 to 1,970 billion cubic metres (BCM) and international trade in gas rose by 5.6% to 267 BCM, of which the LNG trade accounted for 60.5 BCM, an increase of 8%. The leading LNG export-

ter, Indonesia increased sales by 11.2% to 24.6 BCM, while Algeria increased its sales by 6% to 14.9 BCM. Table 1 summarises the LNG trade in the years 1985 to 1987.

In Japan, the increased demand for LNG has been reflected in the negotiation of five shipments of LNG from Algeria, a further 25 shipments from Indonesia to Osaka Gas over a 5½ year period and the extension of the Alaskan LNG contract to 2004 with an increased volume option of up to 10%. In June 1989, it was reported that Japanese buyers and Indonesia had agreed amendments to existing LNG contracts, which included a price reduction



Tugboats help manoeuvre the carrier, the Northwest Sanderling, at the jetty serving the North West Shelf project at the Burrup Peninsula.

TABLE 1: LNG TRADE 1985 TO 1987

(Billion cubic metres)

	Share		Share		Share	
	1985	%	1986	%	1987	%
Exporters						
Indonesia	19.94	39.1	20.28	39.6	22.21	39.5
Algeria	12.64	24.8	12.00	23.4	14.02	25.0
Malaysia	5.92	11.6	6.86	13.4	7.93	14.2
Brunei	6.86	13.5	6.98	13.6	7.01	12.5
Abu Dhabi	3.11	6.1	2.93	5.7	2.87	5.1
USA	1.37	2.7	1.30	2.5	1.26	2.2
Libya	1.04	2.0	0.86	1.7	0.80	1.4
WORLD	50.88	99.9	45.21	100.0	56.01	100.0
Importers						
Japan	37.20	73.1	38.14	74.5	39.23	70.0
France	7.86	15.4	7.67	15.0	9.36	16.7
Belgium	2.40	4.7	2.59	5.1	2.85	5.1
Spain	2.43	4.8	2.48	4.8	2.49	4.4
South Korea	—	—	0.15	0.3	1.96	3.5
West Germany	—	—	0.12	0.2	0.12	0.2
WORLD	49.89	100.0	51.15	100.0	56.01	100.0

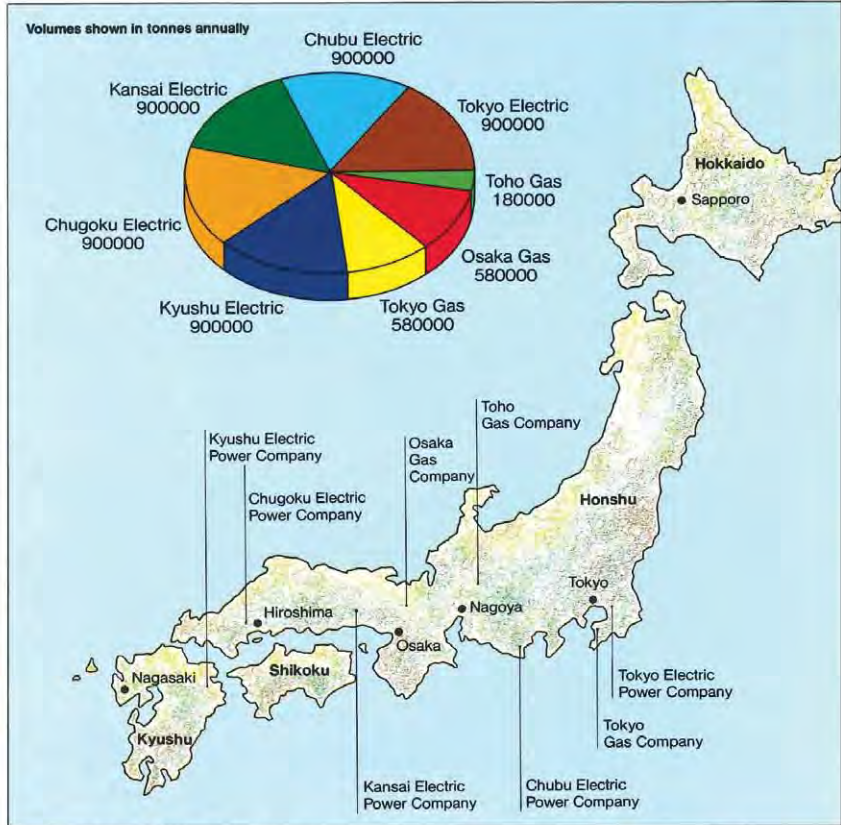
Source: Cedigaz (Petroleum Economist, December 1988)

and an additional 240 cargoes, each of 56,000 tonnes, scheduled for delivery from 1990 to 2003.

In 1988, 31.4 million tonnes of LNG was imported into Japan at an average price of US\$3.10/million BTU, compared to 29.7 million tonnes imported in 1987 at an average price of US\$3.45/million BTU. LNG supply contracts to Japan for the year 1989 and 1994 are shown in Table 2.

South Korea's first LNG initiative was the construction of the Pyongtaek terminal, located 100 km south west of Seoul, and connected by a gas pipeline to the Incheon power plant. The first commercial cargo of natural gas was received at the terminal in late 1986 when Indonesia delivered a shipment of LNG from its Arun plant.

At present, South Korea is undergoing a major LNG import expansion programme as part of an environmentally inspired effort to increase gas utilisation throughout the country. South Korea's expansion initiative is dependent upon a competitive LNG import deal being



The location of WA's eight Japanese LNG customers who will buy a total of nearly 6 million tonnes of North West Shelf gas a year.

negotiated. Currently in the third year of its twenty year contract to import two million tonnes annually of Indonesian LNG, South Korea's future major LNG import expansion programme is centered upon two new initiatives. The first plan involves the Asan ocean terminal taking an additional 1 million tonnes/annum of LNG for utility gas markets in Seoul and Kwanju. The second plan calls for 2 million tonnes/annum of LNG imports to meet demand in Pusan. The imported LNG will be used in city gas distribution and as an energy source in electricity generation. Both Indonesia and Malaysia are actively seeking to obtain the contract for this 3 million tonnes which will be required by the mid 1990s. A doubling of LNG use in South Korea can be anticipated to 10 million tonnes/annum by the year 2010.

Currently, Taiwan has a small, established natural gas market based on local reserves. To supplement these limited remaining gas reserves of 11 BCM, the Taiwanese Government decided in 1984 to import an initial 1.5 million tonnes per year of LNG from Badak, East Kalimantan, for twenty years commencing in 1990. To cater for this importation of natural gas, an LNG receiving terminal is being

constructed at Yung-an, near Kaoshiung. The terminal will be owned and operated by the Chinese Petroleum Corporation, and will be used initially for power generation, the manufacture of fertilizers and for residential and industrial applications.

The increased demand for gas in Taiwan may require the importation of a further 2 million tonnes of LNG by 1994, and perhaps a further 2 to 3 millions of LNG will be required by 2000.

Potential demand forecasts for LNG requirement in Japan, South Korea, and Taiwan are summarised in Table 3 for the years 1995, 2000, 2005 and 2010.

Forecasts contained in this Table should be treated with some caution and must be considered on the high side. However they do indicate a substantial potential for new LNG contracts amounting to about 7.8 million tonnes by the year 1995, 21.8 million tonnes by the year 2000, 26.8 million tonnes by the year 2005 and 36.8 million tonnes by the year 2010. For the forecast Japanese demand of 48 million tonnes in 2000 to be met, substantial new LNG contracts will have to be signed in the next five years to enable new LNG plants to be built in time. More conservative forecasts of LNG demand in Japan indicate levels of 44, 47, and 50 million tonnes for the years 2000, 2005, and 2010 respectively.



Western Australia's prosperity has been built on the back of its mineral resources – particularly gold. While other resources may be more valuable to the State's economy, gold started Western Australia on its path to prosperity. This year Kalgoorlie-Boulder celebrates 125 years since gold was first discovered. Back in 1993, *Prospect* magazine marked the 100th anniversary with a special feature on the city. The piece included a story on the development of the Super Pit. In 1993, the Super Pit was only 110 metres deep. Today, it plunges more than 600 metres downwards, stretches 3.5 kilometres long and is 1.5 kilometres wide.

This article originally appeared in the June–August 1993 edition of *Prospect*.

KALGOORLIE

100 YEARS ON

A spirit of prosperity takes hold in the Goldfields during this centenary year

Stories by Steve Keogh



AS THE City of Kalgoorlie-Boulder celebrates its first centenary and begins its second, there's an air throughout the Goldfields of confidence in the future, probably unmatched since the early goldstrikes and certainly since a goldrush flourish in the 1930s.

Mindful of past hopes dashed, locals are quick to correct themselves when they use the word "boom". They say current growth is steadier than earlier speculative frenzies.

But there's no mistaking that the sort of optimism and imagination which 100 years ago led diggers to push their wheelbarrows through

hundreds of kilometres of trackless scrub — or which built a 650km pipeline to bring water from the west coast to the isolated gold town — still thrives.

Local people are determined to take advantage of the current prosperity to build a diverse regional economy able to withstand future shocks.

"There's a changed mental approach," says Ian Burston, chief executive of the Kalgoorlie Consolidated Gold Mines (KCGM). "People are increasingly asking: 'What do we have to do for long-term development?'"

City mayor Ron Yuryevich, who has lived in the Goldfields all his life, says, "We've

never had the sort of security we have today.

"I remember 1974-75 when Mt Charlotte was the only mine operating. Confidence was rock-bottom; you couldn't get any lower. Then there was the nickel boom when the economy shot up overnight but disappeared as quickly."

How can community growth and confidence be measured? For starters, Mr Yuryevich says one only has to

look at the sustained strength of the housing market.

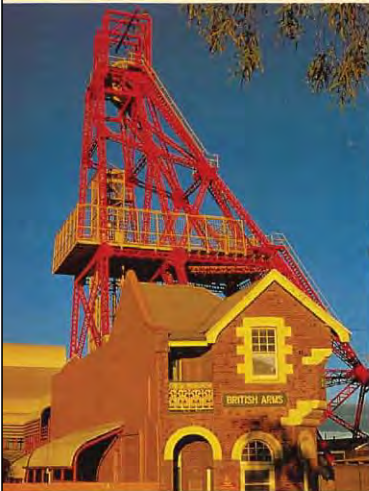
"The Australian Census recorded a 14 per cent growth in housing units between 1986-1991. In the 12 months to February this year, council approvals for residential construction were up \$4.5 million over the previous 12 months," he says.

But there are many other signs of civic confidence and growing sophistication in the community.

IN 1893, the arid bushland of the Eastern Goldfields was scattered with prospectors seeking a find to rival the riches discovered at Coolgardie, 550km east of Perth, the year before. On June 10, held up by a horse that had lost a shoe, Paddy Hannan, Tom Flanagan and Dan Shea made camp and began prospecting. Hannan found the first nuggets and seven days later rode 40km west to Coolgardie and registered a claim. This started a rush which led soon after to the discoveries, a few kilometres east of the original claim, of the fabulous lodes of the Golden Mile and the birth of rival twin-communities Kalgoorlie and Boulder. A hundred years later, the City of Kalgoorlie-Boulder (population 26,000) is the busy centre of the Goldfields-Esperance Region (population of more than 50,000) which produces mineral products worth almost \$2 billion a year. From Esperance, on the spectacular coastline 400km south of the city, to Laverton about the same distance to its north, and east to the South Australian border, the region covers 560,000 square km.



A prospecting party pauses for a break and a photo during the Goldfields rush. Note the sidearms strapped to the waists. Camels were often used in the early days for long journeys across arid country.



Many of the city's fine historic buildings have been restored and newer commercial buildings are being well-maintained.

An increasingly diverse range of dining, drinking and shopping outlets compete for the leisure dollars of visitors and the city's youthful population. Traditional, lively, almost frontier-like front bars are still well-patronised.

A new \$14 million airport and terminal built by the city council to attract interstate flights opened earlier this year.

Nearing completion, an \$11 million arts centre attached to the Kalgoorlie College will accommodate qual-

ity performances in a 630-seat auditorium.

It includes an A-Class art gallery, only the second in WA, and function areas, as well as lecture rooms and studios to meet the needs of the college's music, dance and drama students.

KCGM has spent \$3 million developing the Hannan's North Tourist Mine. This spectacular park traces 100 years of mining history and technology, from the canvas and brush prospectors' camps of a century ago to modern operations.

Last year, more than 30,000 visitors walked through carefully restored buildings, rode a narrow-gauge train, descended into an underground mine and watched a gold-pour.



The tourist mine joins the impressive Museum of the Goldfields and numerous other high-standard historical displays throughout the region.

For the first time in its 91-year history, the Chamber of Commerce and Industry has elected a woman president, accountant Pat Leighton.

Regional communities have also benefited from the sustained prosperity of the 1980s. New and re-opened gold and nickel mines and exploration activity have boosted the populations of smaller regional communities such as Leonora and Laverton. The new wealth is reflected in improved community facilities and revitalised townscapes.

Coolgardie, 40km west of Kalgoorlie-Boulder, similarly has developed considerable tourism infrastructure and is an impressive gateway to the region.

As well as its nickel mines, Kambalda is the base for Western Mining Corp's St Ives gold mine, the State's fourth-largest producer.

While falling agricultural prices have impacted on communities in the south of the region, Esperance continues

to grow as a tourist centre and as a regional port at rates that rival Kalgoorlie-Boulder.

A new bulk loader has been built to service six-weekly shipments of nickel concentrate to Finland from Forrestania.

Nickel worth almost \$500 million left the Goldfields region in 1991-92.

Westrail is upgrading the rail line between Leonora and Esperance to handle nickel exports from Mt Keith and possibly iron ore from a re-opened Koolyanobbing mine.

The upgraded line will also make possible sea-rail deliveries of fuel to the Goldfields, adding to activity in an increasingly busy port.

In addition to gold and nickel, other identified resources in the region include, base metals, rare earths, a major phosphate deposit and high-quality granite. Vast areas remain unexplored. Other opportunities being actively pursued are:

Industrial development:

Planning has begun for a heavy industrial site at Mungari, between Kalgoorlie-Boulder and Coolgardie and close to the major east-west rail line, a 220kv power line, the Great Eastern Highway and the water supply pipeline.

Mungari could accommodate plants manufacturing chemicals for the mining industries and others processing minerals from the region. **Natural Gas:** The Western Australian Government has called for expressions of interest in a private sector-built, owned and operated gas supply line from the North-West Shelf to the Goldfields.

The Super Pit

THE LOW range of hills that became the legendary Golden Mile is no longer. The forest of headframes has been felled, or along with some surface buildings, removed to feature as attractions in a tourist park.

Disappearing, too, are 2000km of shafts, drives, stopes and cross cuts from which thousands of miners won 60 million ounces of gold in almost 100 years of mining.

In their place, open-pit mines are gradually spreading until they join into a huge Super Pit which will eventually be 5km long, 2km wide and 450 metres deep. Pit depth now is 110 metres.

The ascendancy of open-pit mining came as falling grades and rising production costs threatened underground mining. The Super Pit is operated by Kalgoorlie Consolidated Gold Mines, a joint venture between Homestake Australia and Normandy Poseidon Ltd, to complete the vision.

According to KCGM chief executive Ian Burston, pit operations will produce about 550,000 ounces of gold from 50 million tonnes of ore and waste for each of the next 17 years, giving

Kalgoorlie-Boulder a stability it has rarely experienced.

And what will be left when the Super Pit is finished? "There'll be a huge hole in the ground and there's every chance we'll start mining again. Frankly, we don't know what's down there because we haven't looked yet," Mr Burston said. Overburden is being converted into a low range of tree and scrub covered hills, east of the city not unlike the original Golden Mile.

Also disappearing are a hundred years' worth of mine tailings — 53 million tonnes (Mt). They have long been Kalgoorlie-Boulder's outstanding topographic feature and a source of dust that has plagued the city.

Kaltails, a joint venture between Poseidon Gold Ltd and Gold Corporation, is reprocessing them in a 24 hour-a-day hydraulic mining operation.

Each year about 67,000 ounces of gold and twice that amount of silver are recovered from 6Mt of tailings. The total resource of about 60Mt dates back to the early 1900s.

After retreatment the whole area will be rehabilitated and revegetated.

Photos this page: Special exhibits are teaching visitors to the Goldfields more about the region's colourful history: Kalgoorlie's Museum of the Goldfields (top) and a gold-pour at Coolgardie's Gold Battery.

Facing page, top left: A no-frills lifestyle at this prospectors' camp during the goldrush days.

Bottom right: There's still gold in the underground mine at Hannan's North Tourist Mine complex.

IRON ORE PROCESSING**Pilbara – Cape Preston – Sino Iron
CITIC PACIFIC**

The Sino Iron project is located at Cape Preston, 100km southwest of Karratha. The project is the largest magnetite mining and processing development in Australia, with a mine life of more than 25 years. Six processing lines are now operational. The first shipment of magnetite concentrate to China occurred in late 2013. The project comprises in-pit crushers, a 29km slurry pipeline, with an annual capacity to produce up to 24Mt of magnetite concentrate. The downstream processing facility has required significant investment in dedicated supporting infrastructure including a new port facility, a 51GL desalination plant and a 450MW combined cycle gas fired power station.

Expenditure: \$16b.

Employment: Construction: 4000
Operation: 1000

OIL & GAS DEVELOPMENTS**Pilbara – Wheatstone LNG Development
CHEVRON AUSTRALIA PTY LTD**

Chevron Australia Pty Ltd as Operator of the Wheatstone Project is completing construction of two LNG trains and a domestic gas plant at the Ashburton North Strategic Industrial Area near Onslow. The Project, which includes a deepwater port, will initially produce 8.9Mtpa of LNG and have a 200TJ per day domestic gas plant connected to the Dampier-to-Bunbury Natural Gas Pipeline. First LNG production commenced on 9 October 2017, and the first export shipment left on 31 October 2017.

Expenditure: \$40b.

Employment: Construction: 7200
Operation: 400

LITHIUM**Kwinana – Tianqi Lithium Processing Project
TIANQI LITHIUM AUSTRALIA PTY LTD**

Tianqi Lithium Australia Pty Ltd holds a 51% interest in Talison Lithium, the operator of the Greenbushes mine in the South West of WA. The company has committed to a major expansion of the mine and the construction of a lithium hydroxide processing plant at the Kwinana Strategic Industrial Area, south of Perth. The processing plant will be constructed in two stages. The first stage will accommodate the production of 23,900tpa of lithium hydroxide and will occur between 2016–2018. The second stage will expand the plant to produce up to 47,800tpa of lithium hydroxide and will occur between 2018–2020. The final product will be shipped to customers in China. Lithium hydroxide is a highly-valued resource for industries involved in energy storage, hybrid vehicles, aviation and other technological industries.

Expenditure: \$608m.

Employment: Construction: 500
Operation: 115

OIL & GAS DEVELOPMENTS**Carnarvon Basin – Greater Western Flank
Phase 2****WOODSIDE ENERGY**

The Greater Western Flank 2 Project was approved in December 2015 and will develop gas and condensate from the Keast, Dockrell, Sculptor, Rankin, Lady Nora and Pemberton fields via a subsea tieback to the existing Goodwyn platform. The project has awarded most major contracts and commenced manufacturing and fabricating key project infrastructure. The project is expecting start-up from the initial tranche of five wells in 1H 2019, with the remaining three wells expected in 1H 2020.

Expenditure: \$2.8b.

**Carnarvon Basin – Persephone Project
WOODSIDE ENERGY**

The Persephone project achieved start-up in July 2017, six months ahead of schedule. The Persephone field produces using subsea tieback to the existing North Rankin Complex.

Expenditure: \$1.2b.

**Carnarvon Offshore Basin – Barrow Island
– Gorgon Project****GORGON JOINT VENTURE**

The Gorgon Foundation Project on Barrow Island, is a three train LNG development with a nameplate capacity of 15.6Mtpa and includes a domestic gas plant capable of delivering at least 300TJ/d of gas to the mainland. Cost estimates for the project construction are expected to total more than A\$55b. The project involves the processing of gas from both the Gorgon and Jansz/lo gas fields and includes potentially the largest commercial CO₂ geosequestration project in the world. Train one start up and first shipment of LNG commenced in March 2016. Train 2 produced first LNG in October 2016 and train three was commissioned in March 2017. Commissioning of the CO₂ injection project is expected in Q4 2018.

Expenditure: \$55b.

Employment: Construction: 8000
Operation: 300

AGRICULTURE**East Kimberley – Project Sea Dragon
SEAFARMS GROUP LIMITED**

Seafarms Group is a Queensland based producer of farmed prawns. Seafarms proposes to invest up to US\$1.45b over the next eight years in Project Sea Dragon, a large scale, integrated, land based aquaculture project to produce black tiger prawns for export markets in Asia. The aquaculture component of the project will be located in the Northern Territory and is planned as a staged development commencing with Stage 1, 1000ha of ponds and supporting infrastructure. In Western Australia a founder stock and quarantine centre is operational in Exmouth, a processing plant is proposed for Kununurra, and subject to competitive tender Wyndham port will be utilised for export and import. The project will create approximately 300 jobs in the Kimberley during construction, 150 direct jobs in the region at Stage 1 building to 700 direct jobs when fully operational. Seafarms Group expect to commence development during 2018.

HEAVY MINERAL SANDS**Shark Bay – Coburn Mineral Sands Project
STRANDLINE RESOURCES LIMITED**

The Coburn mineral sands project, located south of Shark Bay and approximately 250km north of Geraldton, contains total ore reserves of 308Mt at an average grade of 1.2% heavy minerals, all of which lie within the portion of the project area that has received government environmental approvals for mining. At a mining rate of 23.4Mtpa, the project is expected to produce 49,500tpa of zircon, 109,000tpa of chloride ilmenite and 23,500tpa of a mixed rutile-leucocoxene over its 19 year mine life. In November 2017, Strandline announced that it had initiated a funding and development strategy aimed at bringing the Coburn project into production.

Expenditure: \$173m.

Employment: Construction: 170
Operation: 110

INFRASTRUCTURE**West Kimberley – Browse LNG Precinct
WA STATE GOVERNMENT**

The State Government is developing the Browse Liquefied Natural Gas (LNG) Precinct approximately 60km north of Broome. By focussing development at a suitable location, the Precinct will minimise the environmental footprint of gas processing and any social impacts in the region while maximising opportunities for the local community to benefit from development of the Browse Basin gas fields. The Precinct will have the capacity to accommodate at least two LNG processing operations, with a combined capacity of up to 50Mtpa. The State Government has acquired the land for the Precinct and will secure all relevant approvals to ensure the Precinct is 'project ready'.

IRON ORE

Pilbara – Balla Balla Infrastructure Project BALLA BALLA JOINT VENTURE

BBI Group (BBIG) is proposing the Balla Balla Infrastructure project (BBIP), a rail and port development, which when constructed will comprise an integrated port and rail infrastructure system that will provide a new gateway to the iron ore rich Pilbara region in Western Australia. Initial planned annual capacity of the rail and port is 50Mtpa. The Balla Balla port is located halfway between Dampier and Port Hedland. The proposed infrastructure for the BBIP includes a train loading facility at the central Pilbara iron ore source, a 165km single-track standard gauge railway and a multi-user port facility. The Railway (BBI Rail Aus Pty Ltd) Agreement 2017 was executed between the State, the Company and the Guarantors in January 2017 with the Railway (BBI Rail Aus Pty Ltd) Agreement 2017 being ratified in December 2017.

Expenditure: \$5.6b.

Employment: Construction: 3300
Operation: 900

Pilbara – South Flank Project BHP BILLITON IRON ORE PTY LTD

BHP proposes to develop the South Flank sustaining mine project in the central Pilbara. Initial funding of A\$244 million has been approved for the project. The South Flank project will leverage and expand the existing Mining Area C hub and replace production from the 80Mtpa Yandi mine when it reaches the end of its economic life in the early-to-mid 2020s. The project is expected to be submitted for Board approval in the middle of 2018 calendar year, with the first ore targeted in the 2021 calendar year ramp up, timed to coincide with the closure of Yandi. Full development of South Flank would generate thousands of jobs during construction. South Flank is located approximately 130km by road north-west of the town of Newman, and adjacent to the Company's existing Mining Area C operation. The proposed project would establish mining operations at South Flank and transport ore to an expanded Mining Area C hub for processing and onward logistics. The proposed project is currently in study phase and is subject to a number of internal and external approvals.

Pilbara – West Pilbara Iron Ore Project – API Port/Rail

API MANAGEMENT PTY LTD

The Australian Premium Iron Joint Venture is proposing to develop the West Pilbara Iron Ore Project. Stage 1 of the project is based on the production of 40Mtpa of direct shipping iron ore from deposits, including Red Hill and Mt Stuart deposits, located 35-80km south west of Pannawonica. The ore is proposed to be transported by a 282km heavy haul railway for export via the proposed multi-user port at Anketell. State and Federal environmental approvals for the mine, rail and port elements of the project are in place. Subject to the successful completion of feasibility studies, and receipt of final regulatory approvals, the company anticipates construction to commence following a decision to proceed by the joint venturers and completion of funding arrangements.

Expenditure: \$6.8b.

Employment: Construction: 1500
Operational: 900

Shire of East Pilbara – Koodaideri Iron Ore Mine and Infrastructure Project

MOUNT BRUCE MINING PTY LTD

Rio Tinto is investigating the development of the Koodaideri iron ore deposit located about 110km north-west of Newman. The Koodaideri Project would have a capacity of about 40Mtpa of iron ore requiring the development of a new mining area at Koodaideri, crushing, screening, stockpiling and rail load out infrastructure plus a 170km railway. Rio Tinto is currently undertaking a project feasibility study that is focusing on obtaining consents and providing data to validate the project. Potential for first ore production in about 2021.

Expenditure: \$3b.

Employment: Construction: 1600
Operational: 600



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Significant resource projects in Western Australia

Western Australia continues to lead the way as Australia's premier resources investment destination. There are more than A\$126 billion worth of projects either committed or under consideration for the State during the next few years. These would create more than 25000 construction jobs and more than 4000 permanent jobs.

This section is intended as an overview and does not constitute an exhaustive list of projects within the Western Australia resources industry. Based on company announcements.

Significant Projects as at March 2018

	Project Value (estimated A\$m)		Employment	
	Construction	Permanent	Construction	Permanent
Iron and Steel				
API Management Pty Ltd – West Pilbara Iron Ore Project	6800	1500	900	
Balla Balla Joint Venture – Balla Balla Infrastructure Project	5600	3300	900	
BHP Billiton Iron Ore Pty Ltd – South Flank	n/a	n/a	n/a	
CITIC Pacific – Cape Preston Mine & Processing Projects	12000	4000	1000	
Mount Bruce Mining Pty Ltd – Koodaideri Iron Ore Mine and Infrastructure Project	3000	1600	600	
Sub Total	27400	10400	3400	
Oil, Gas and Condensate				
Browse LNG Precinct	n/a	n/a	n/a	
Chevron – Wheatstone LNG	40000	7200	400	
Gorgon Joint Venture Gas Processing Project	55000	8000	300	
Woodside Energy – Greater Western Flank Phase 2	2800	n/a	n/a	
Woodside Energy – Persephone	1200	n/a	n/a	
Sub Total	99000	15200	700	
TOTAL	126400	25600	4100	

All currency figures are in Australian dollars unless otherwise specified.

Abbreviations Key

b	billion	m	million
EPC	Engineering, Procurement and Construction	Mt	million tonnes
GL	gigalitres	Mtpa	million tonnes per annum
ha	hectares	MW	megawatts
JV	joint venture	t	tonnes
km	kilometres	THM	total heavy mineral
LNG	liquefied natural gas	TJ	terajoules
LOA	length overall	tpa	tonnes per annum

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For the past 12 months, *Prospect* has suspended hard copy subscription renewals.

Starting from the June 2018 edition, the Department will no longer provide hard copy editions directly to subscribers and is encouraging current subscribers to sign up for the free digital version of the magazine.

Hard copies of the magazine will still be available for collection from front reception areas at DMIRS' Mineral House building in East Perth and JTSI's office at 1 Adelaide Terrace in East Perth.

In order to download your digital version free of charge visit www.dmp.wa.gov.au/prospect and sign up to the Prospect magazine mailing list.

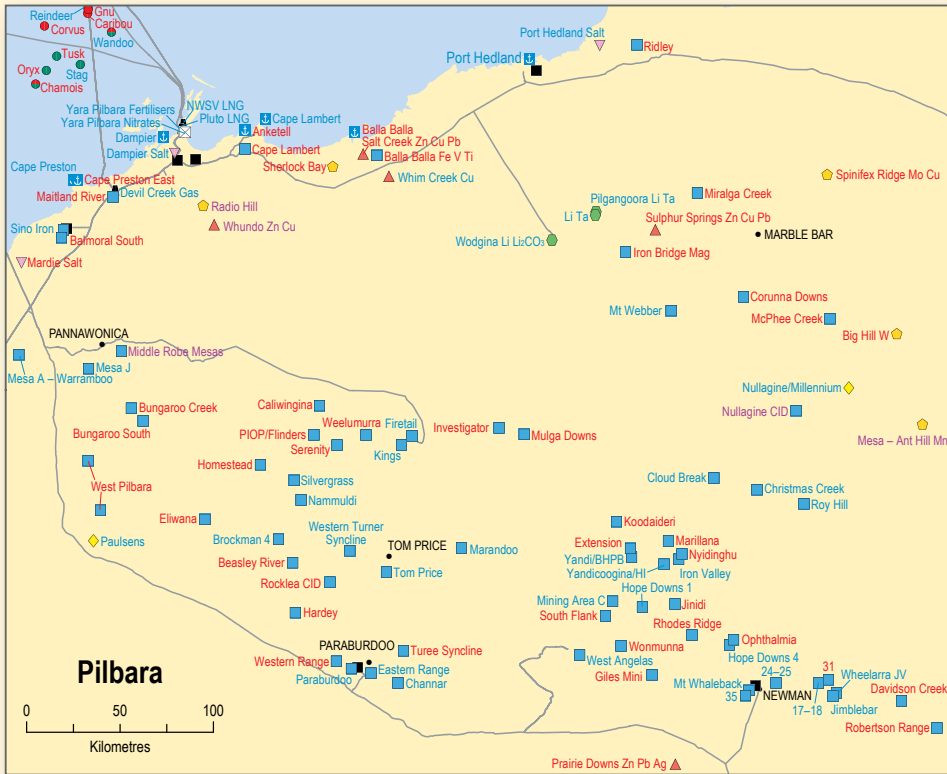
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Major Resource Projects

March 2018



Mineral symbols	Commodities
Precious metal Au (or as shown)	Ag..... Silver
Steel alloy metal Ni (or as shown)	Au..... Gold
Speciality metal Ti-Zr (or as shown)	Cu..... Copper
Base metal	Fe..... Iron
Iron	K..... Potassium
Alumina All sites are bauxite	KIn..... Kaolin
Coal and lignite	Li..... Lithium
Industrial mineral	Li ₂ CO ₃ Lithium carbonate
Processing plant	LNG..... Liquefied natural gas
	LPG..... Liquefied petroleum gas
	Mag..... Magnetite
	Mn..... Manganese
	Mo..... Molybdenum
	Ni..... Nickel
	Pb..... Lead
	Phos..... Phosphate
	REE..... Rare earth elements
	Sid..... Silica sand
	Ta..... Tantalum
	Ti..... Titanium
	Tic..... Talc
	V..... Vanadium
	W..... Tungsten
	Zn..... Zinc
	Zr..... Zirconium

Petroleum symbols
Gas field
Oil field
Oil and gas field
Significant oil discovery
Processing plant
Oil / gas pipeline, operating
Oil / gas pipeline, proposed

Infrastructure
Power plant
Irrigation / water / desalination
Port

Enquiries for latest information for Commonwealth controlled waters is available from the National Offshore Petroleum Titles Administrator (NOPATA) at <info@nopata.gov.au>



Project labels:

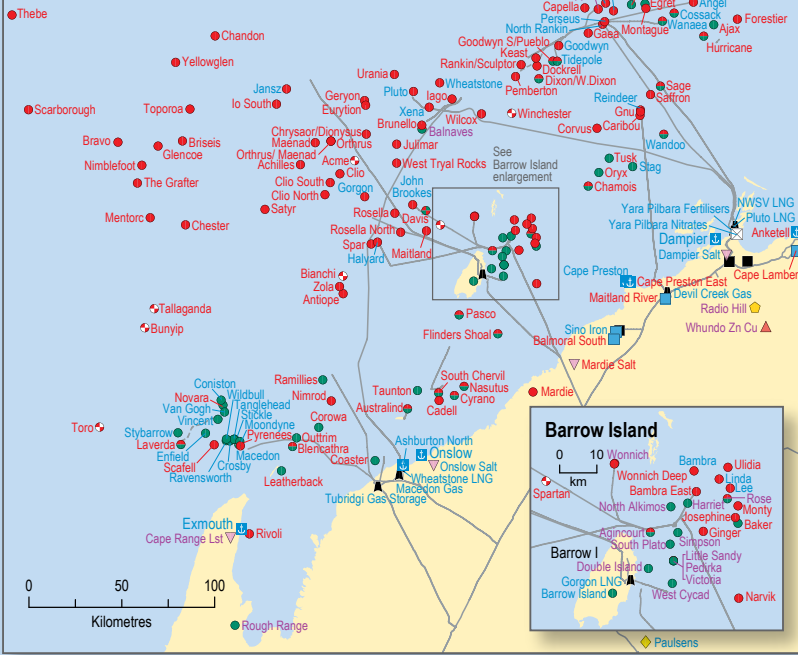
Projects operating or currently under development with an actual or anticipated value of production greater than A\$10 Million are shown in blue

Proposed or potential projects with a capital expenditure greater than A\$20 Million are shown in red

Projects under care and maintenance are shown in purple



North West Shelf



Major Resource Projects

March 2018

Project labels:

Projects operating or currently under development with an actual or anticipated value of production greater than A\$10 Million are shown in blue

Proposed or potential projects with a capital expenditure greater than A\$20 Million are shown in red

Projects under care and maintenance are shown in purple



Commodities

- Ag..... Silver
- Au..... Gold
- Co..... Cobalt
- Cu..... Copper
- Dmd..... Diamond
- Fe..... Iron
- Fl..... Fluorite
- Gp..... Gypsum
- Gr..... Graphite
- Grt..... Garnet
- K..... Potassium
- Kln..... Kaolin
- Li..... Lithium
- LNG..... Liquefied natural gas
- Lst..... Limestone
- Mag..... Magnetite
- Mn..... Manganese
- Nb..... Niobium
- Ni..... Nickel
- Pb..... Lead
- Pd..... Palladium
- PGE..... Platinum group elements
- Pt..... Platinum
- REE..... Rare earth elements
- Ta..... Tantalum
- Ti..... Titanium
- V..... Vanadium
- W..... Tungsten
- Zn..... Zinc
- Zr..... Zirconium

Mineral symbols

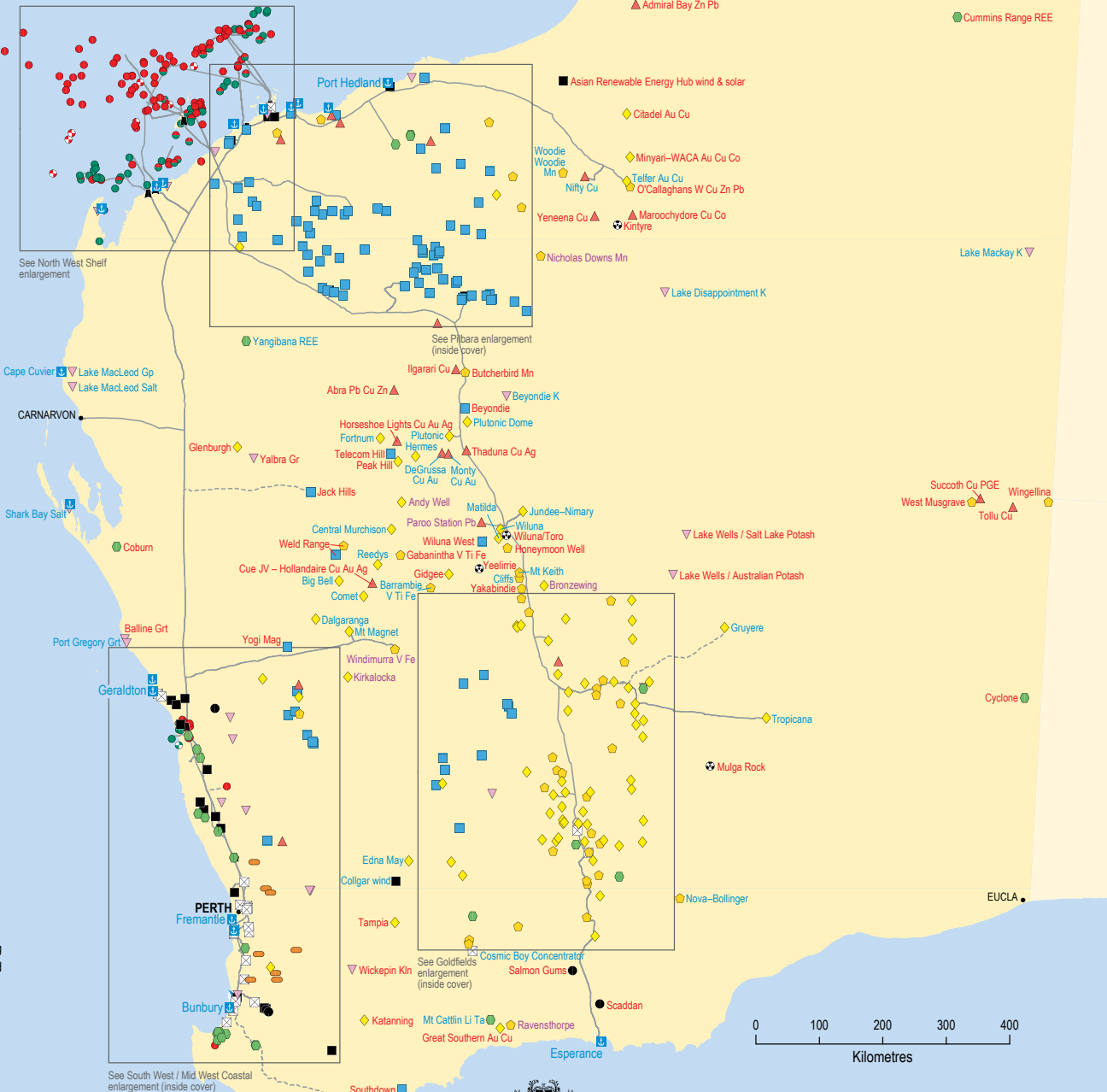
- ☆ Precious mineral
- Dmd
- ◆ Precious metal
- Au (or as shown)
- ◆ Steel alloy metal
- Ni (or as shown)
- Speciality metal
- Ti-Zr (or as shown)
- ▲ Base metal
- Iron
- Alumina
- All sites are bauxite
- Coal and lignite
- Uranium
- ▽ Industrial mineral
- ⊠ Processing plant

Petroleum symbols

- Gas field
- Oil field
- Oil and gas field
- Significant gas discovery
- Significant oil discovery
- Significant oil and gas discovery
- ▲ Processing plant
- Oil / gas pipeline, operating
- - - - Oil / gas pipeline, proposed

Infrastructure

- Power plant
- Irrigation / water / desalination
- Port



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