A Geological Survey of Western Australia Newsletter

JANUARY 2020 NUMBER 93

Fieldnotes

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

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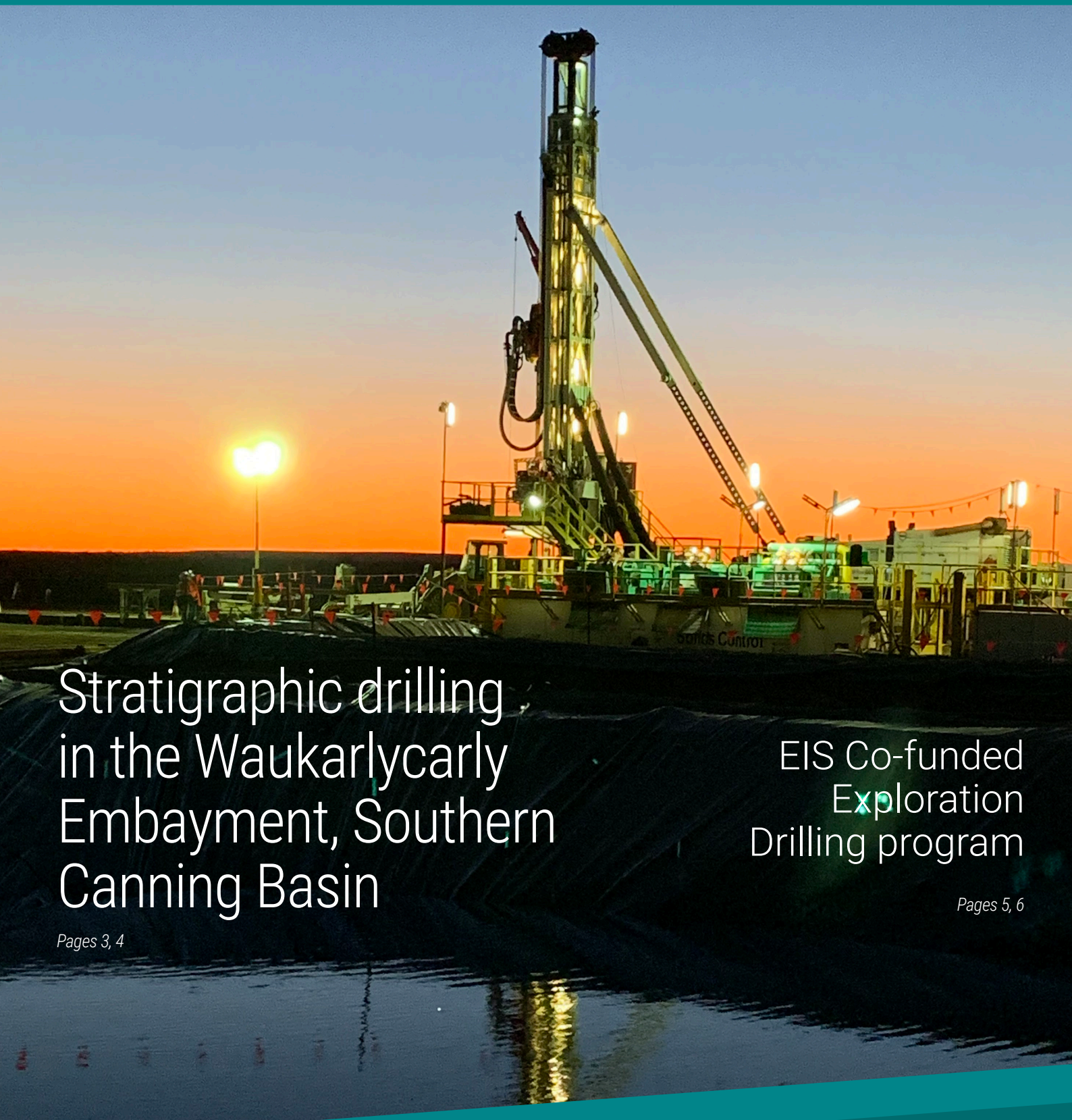

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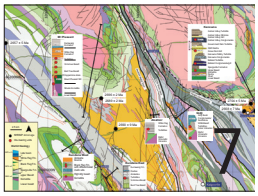

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Fieldnotes

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Cover image: Sunrise over GSWA Waukarlycarly 1 stratigraphic drillhole with a reflection of DDH1's ER01 drill rig on the turkey's nest (see article on pages 3 and 4)

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Stratigraphic drilling in the Waukarlycarly Embayment, Southern Canning Basin

Drilling of the Geological Survey of Western Australia (GSWA) Waukarlycarly 1 stratigraphic drillhole began on 1 September 2019 in the Waukarlycarly Embayment on the southwestern margin of the Canning Basin. The drillhole reached a total depth (TD) of 2680.53 m on 30 November 2019. This stratigraphic drilling project was funded by Geoscience Australia's (GA) Exploring for the Future Initiative with the Geological Survey and Resource Strategy Division (GSRSD) of the Department of Mines, Industry Regulation and Safety (DMIRS) participating as project operator.

This drilling project was Stage 2 of a larger Southern Canning Basin project which included the acquisition of the 872 km-long Kidson seismic line in June–August 2018. The seismic line extended from the Arunta Orogen and overlying Amadeus Basin near the Western Australia – Northern Territory border, through the Kidson Sub-basin, ending on the Pilbara Craton. Drilling along the seismic line was designed to correlate seismic reflectors with basin and basement stratigraphy in a poorly understood part of the Canning Basin.

The Waukarlycarly 1 location was picked in an interdune area on the edge of the Great Sandy Desert, based in part on budgetary constraints limiting the depth at which basement could be reached, but also due to the complete lack of subsurface geological knowledge in the Waukarlycarly Embayment. A number of other logistical benefits such as available water bores, ongoing stakeholder engagement in the area, existing lay down area, and access through the Nifty airstrip also assisted in the final site selection.

Objectives

All the primary objectives of the Waukarlycarly 1 stratigraphic drilling project were successfully achieved. A continuous core through the Canning Basin sedimentary strata was crucial and while budgetary constraints resulted in a well design that included a rotary top-hole section, continuous coring was completed from 580 to 2680.53 m, totalling 2095.09 m of cumulative core, with 99.7% recovery. There were three stages of continuous coring to TD; SQ core from 580 to 727.10 m (147.10 m), PQ core from 727.10 to 1602.00 m (874.90 m) and HQ core 1602.00 to 2680.53 m measured depth (1078.53 m).

Another key objective was the intersection of about 100 m of pre-Canning Basin basement strata. A major angular unconformity was encountered at the base of the Canning Basin sedimentary succession with nearly 95 m of basement sedimentary rocks successfully cored.

A final but critical objective, essential for correlation of the Waukarlycarly 1 stratigraphic drillhole to the Kidson seismic line, was the acquisition of downhole geophysical surveys. Several surveys were completed in Waukarlycarly 1 including a standard suite of wireline logs and a Vertical Seismic Profile (VSP). The wireline logs were run in three stages; 727 m to surface, 1602 to 727 m and 2679 to 1602 m. The VSP was obtained from 2620 to 650 m with casing intervals hindering a clear signal through the uppermost section of the drillhole.

Natural core break at well site reveals fragmentary trilobite fossils

Preliminary results

Waukarlycarly 1 intersected 60 m of Cenozoic clays before penetrating a thick Permian sequence of mudstone, sandstone and diamictite down to 855 m. This glacial interval, tentatively assigned to the Paterson Formation outcropping over basement nearby, and the equivalent Grant Group of Canning Basin nomenclature, unconformably overlies over 500 m of oxidized sandstone of uncertain age range. This sandstone interval conformably overlies a fossiliferous mudstone interval nearly 900 m thick which in turn overlies an interbedded sandstone and siltstone succession. The mudstone unit and the underlying sandstone and siltstone package are tentatively correlated to Ordovician formations of the Southern Canning Basin. A final red sandstone and conglomerate unit was intersected at the base of the Canning Basin strata, overlying a major unconformity at 2585.7 m. Steeply dipping beds, tentatively assigned to the Neoproterozoic Yeneena Basin were cored from 2585.7 to 2680.53 m beneath the unconformity. This succession consisted of an upper weathered/oxidized red dolomite from 2585.7 to 2635 m followed by fresh grey dolomite to TD.

The predicted and actual formations and boundary depths contrasted markedly. While a number of predicted Devonian to Ordovician units were not encountered, an expanded Lower Ordovician interval will provide insight into the early deposition of the Canning Basin as well as an understanding of the regional basin and tectonics.

GSWA Waukarlycarly 1 stratigraphic drillhole with DDH1 Rig ER01 at dusk and 178 mm casing in the foreground

Each core tray was photographed dry, wet and under ultraviolet light as soon as possible after core reached the surface, and the full core and cuttings are currently being analysed by the HyLogger at the Perth Core Library (Table 1). A number of post-well analyses have been planned, including organic and inorganic geochemistry, geochronology, routine core analysis and various paleontological studies prior to the release of the Interpretative Well Completion Report and a Digital Core Atlas in June 2020.

For more information, contact **Leon Normore**.

Table 1. Cuttings and core recovery

Drill type	*Sample*	*Hole diameter*	*Depth from (m)*	*Depth to (m)*	*Recovery (m)*
Rotary	Cuttings	311 mm (12¼")	0	23.63	21.00
Rotary	Cuttings	216 mm (8½")	23.63	218.00	194.37
Rotary	Cuttings	156 mm (6⅛")	218.00	580.00	362.00
Core	SQ Core (102 mm)	146 mm (5¾")	580.00	727.10	147.10
Core	PQ Core (85 mm)	114 mm (4½")	727.10	1602.00	874.90
Core	HQ Core (63.5 mm)	89 mm (3½")	1602.00	2680.53	1078.53

Round 20 dominated by gold and nickel exploration

EXPLORATION INCENTIVE SCHEME

In mid-November 2019, Minister for Mines and Petroleum Bill Johnston announced that 41 successful projects will benefit from the State Government's highly competitive Exploration Incentive Scheme (EIS) Co-funded Exploration Drilling program (Table 1). Up to $4.93 million was offered and will apply to projects drilled between January and December 2020. Project locations were spread across the State, but nearly half were located in the Eastern Goldfields (Fig. 1). The eastern Pilbara and Paterson Orogen also continue to show a strong presence of successful applicants with the primary focus on copper–gold targets.

Table 1. List of successful applicants Round 20

Map ID	Application type	Applicant name	Drilling project	Target commodities
1	General	ACH Nickel Pty Ltd	Foster Deeps	Ni, Au
2	General	Agnew Gold Mining Company	Agnew Stratigraphic Drilling Project	Au
3	General	AIC Mines Limited	Lamil Exploration Project	Au, Cu
4	General	Antipa Minerals Ltd	Protos AEM Target	Au, Cu, Ag
5	General	Ausgold Limited	Red Hill Vanadium Project	V, Ti, Fe
6	General	Chalice Gold Mines Ltd	Auralia	Ni, Cu, Co, Au, PGE
7	General	Cullen Exploration P/L	Wongan Hills	Au, Cu, Zn
8	General	Darlot Mining Company	Dingo Ridge	Au
9	General	David Reed	Kalgoorlie Project	Au
10	General	Dreadnought Resources Ltd	Illaara Intrusions	Au
11	General	First Au Limited	Gimlet Gold Project	Au
12	General	Focus Minerals Limited	Lake Carey Regional Diamond Drilling	Au
13	General	Great Boulder Resources	Winchester	Au
14	General	Great Southern Mining Limited	Cox's Find Gold Project	Au
15	General	Hamelin Resources Pty Ltd	Lamil	Cu, Au
16	General	Independence Group NL	Wineye Prospect	Ni, Cu, Co
17	General	Independence Newsearch Pty Ltd	Merlin Deeps	Ni, Cu, Cu, PGEs
18	General	Kairos Minerals Ltd	Roe Hills Nickel	Ni, Cu
19	General	Kesli Chemicals Pty Ltd	Midway Well	Potash
20	General	Kidman Resources	Texas Rare-Element Pegmatite Project	Li, Ta, Nb, Cs, Sn
21	General	Kin Mining NL	Cardinia VMS	Au, Ag, Cu
22	General	Maria Resources Pty Ltd	Leviathan Project	Ni, Cu, Pb, Au, Zn, PGE, Co, Zr, Nb, REE
23	General	Newcrest Mining Limited	Aileron	Cu, Au
24	General	Peako Limited	Landrigan	Cu, Pb, Zn, Ag, Au +/-Mo
25	General	Redstone Resources Ltd	Tollu	Cu, Ni, Co
26	General	Rox Resources Ltd	Musket Deeps 2019	Ni
27	General	Rumble Resources Ltd	Braeside polymetallic target	Au, Ag, Cu, Pb, Zn
28	General	Salt Lake Potash	Lake Way Paleochannel Project	Sulphate of Potash (K2SO4)
29	General	Serena Minerals Limited	Lyons River	Pb, Zn Ag, Cu
30	General	Southern Star Exploration Pty Ltd	Gwardar Nickel Prospect	Ni-Cu-PGE
31	General	Sunrise Dam Gold Mine, Anglogold Ashanti Australia Ltd	Western Ramps	Au
32	General	Todd River Metals Pty Ltd	Nanutarra Ni-Cu-PGE	Ni, Cu, PGE
33	General	Vango Mining Ltd	Marymia (Plutonic Dome) Gold Project	Au
34	General	Venturex Sulphur Springs Pty Ltd	Breakers VMS	Zn, Cu, Pb, Ag, Au
35	General	Venus Metals Corporation Ltd	DeGrussa North Cu-Au Project	Cu, Au
36	General	Woomera Mining Ltd	Mt Venn Gold Project	Au
37	Prospector	Andrew Pumphrey	Patricia Gold Project	Au
38	Prospector	BMGS Menzies Pty Ltd	Black Jack Gold Project	Au
39	Prospector	David Ross	Wardiacca Carbonatite Prospect	REE, Nb, phosphate
40	Prospector	Lysander Resources Pty Ltd	Bisector Propsect	Au
41	Prospector	Zebina Minerals Pty Ltd	Kurramia Project	Au

EIS Co-funded Exploration Drilling program

GENERAL

1 ACH Nickel Pty Ltd
2 Agnew Gold Mining Company
3 AIC Mines Limited
4 Antipa Minerals Ltd
5 Ausgold Limited
6 Chalice Gold Mines Ltd
7 Cullen Exploration P/L
8 Darlot Mining Company
9 David Reed
10 Dreadnought Resources Ltd
11 First Au Limited
12 Focus Minerals Limited
13 Great Boulder Resources
14 Great Southern Mining Limited
15 Hamelin Resources Pty Ltd
16 Independence Group NL
17 Independence Newsearch Pty Ltd
18 Kairos Minerals Ltd
19 Kesli Chemicals Pty Ltd
20 Kidman Resources
21 Kin Mining NL
22 Maria Resources Pty Ltd
23 Newcrest Mining Limited
24 Peako Limited
25 Redstone Resources Ltd
26 Rox Resources Ltd
27 Rumble Resources Ltd
28 Salt Lake Potash
29 Serena Minerals Limited
30 Southern Star Exploration Pty Ltd
31 Sunrise Dam Gold Mine, Anglogold Ashanti Australia Ltd
32 Todd River Metals Pty Ltd
33 Vango Mining Ltd
34 Venturex Sulphur Springs Pty Ltd
35 Venus Metals Corporation Ltd
36 Woomera Mining Ltd

PROSPECTOR

37 Andrew Pumphrey
38 BMGS Menzies Pty Ltd
39 David Ross
40 Lysander Resources Pty Ltd
41 Zebina Minerals Pty Ltd

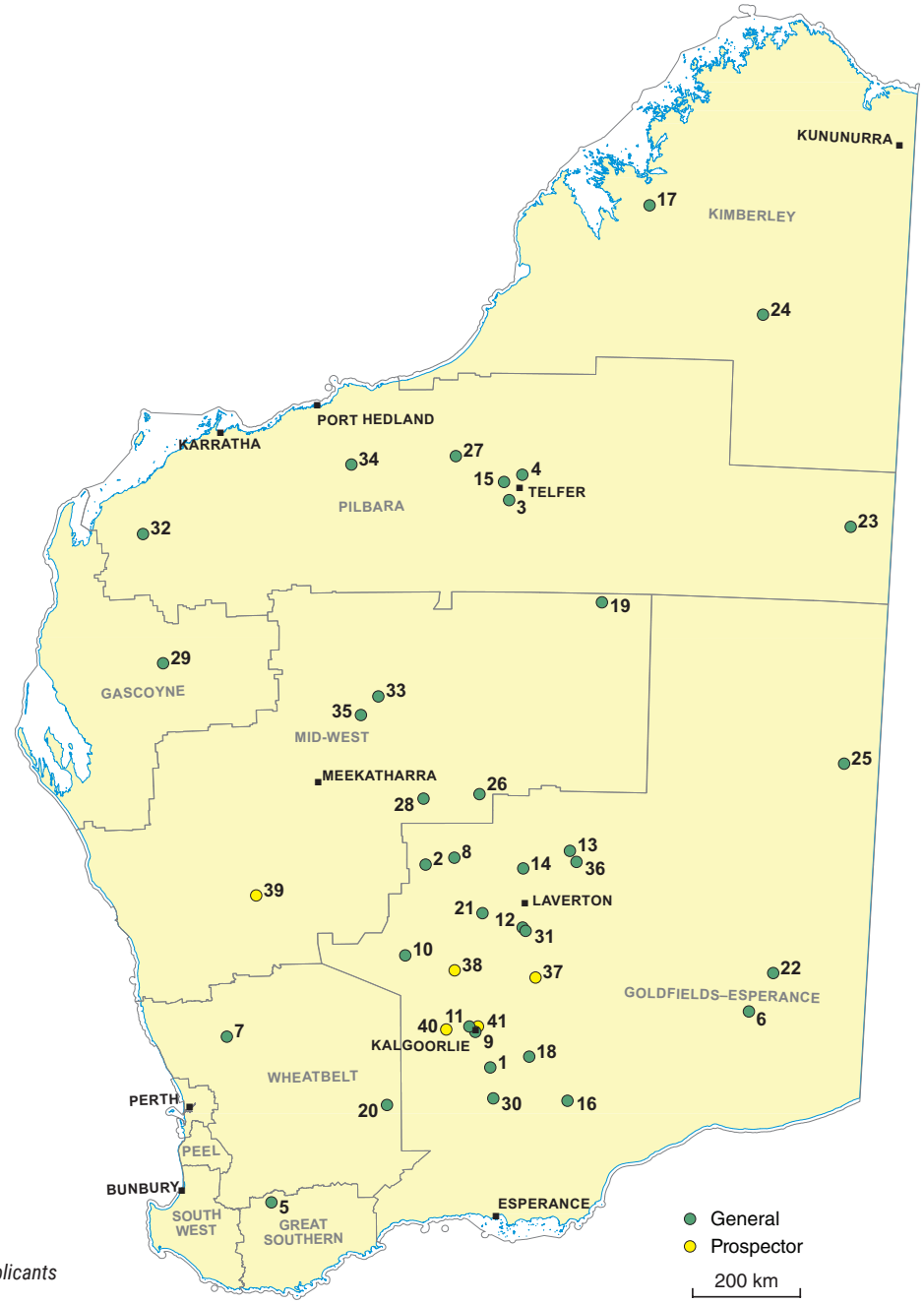


Figure 1. Map showing location of successful applicants

The number of applicants searching for gold was slightly higher than previous years, possibly aligning to the strong market values recorded in the past financial year. Applications listing potash as the exploration target are now a regular occurrence for co-funding. The applications reflect an emerging industry sector, which is being supported by the McGowan Government with the introduction of new lower tenure rental rates for mining leases.

At least one-third of successful applicants are searching for battery commodities and this is dominated by nickel and nickel–cobalt exploration. Exploration in battery and critical minerals supported by the EIS, in both co-funded drilling and pre-competitive data acquisition, is aiding the State Government's Future Battery Industry strategy[1]. A focus for the Strategy is for Western Australia to become globally recognized as a leading producer of battery minerals, technologies and expertise.

This focus necessitates improving the competitiveness of Western Australia's battery minerals and materials industry, and expanding the range of battery minerals extracted and processed in Western Australia.

EIS success stories from recent rounds of co-funded drilling include significant copper (with silver and gold) intersections at Peako Limited's East Kimberley Landrigan prospect, and in the West Kimberley, Dreadnought Resources intersected multiple mineralized zones at the Grants copper–gold target. These results, combined with the past success by Buxton Resources (Double Magic prospect) and Panoramic Resources (Savannah Prospect) signify the Lamboo Province of the Kimberley region as a nickel–copper endowed region.

The next round of co-funded drilling (Round 21) will open for applications on Friday 21 February 2020, at the Geological Survey Open Day. Round 21 will be for drilling between 1 July 2020 and 30 June 2021.

For more information, contact **Charlotte Hall**.

1 www.jtsi.wa.gov.au/economic-development/economy/future-battery-industry-strategy/future-battery-industry-strategy

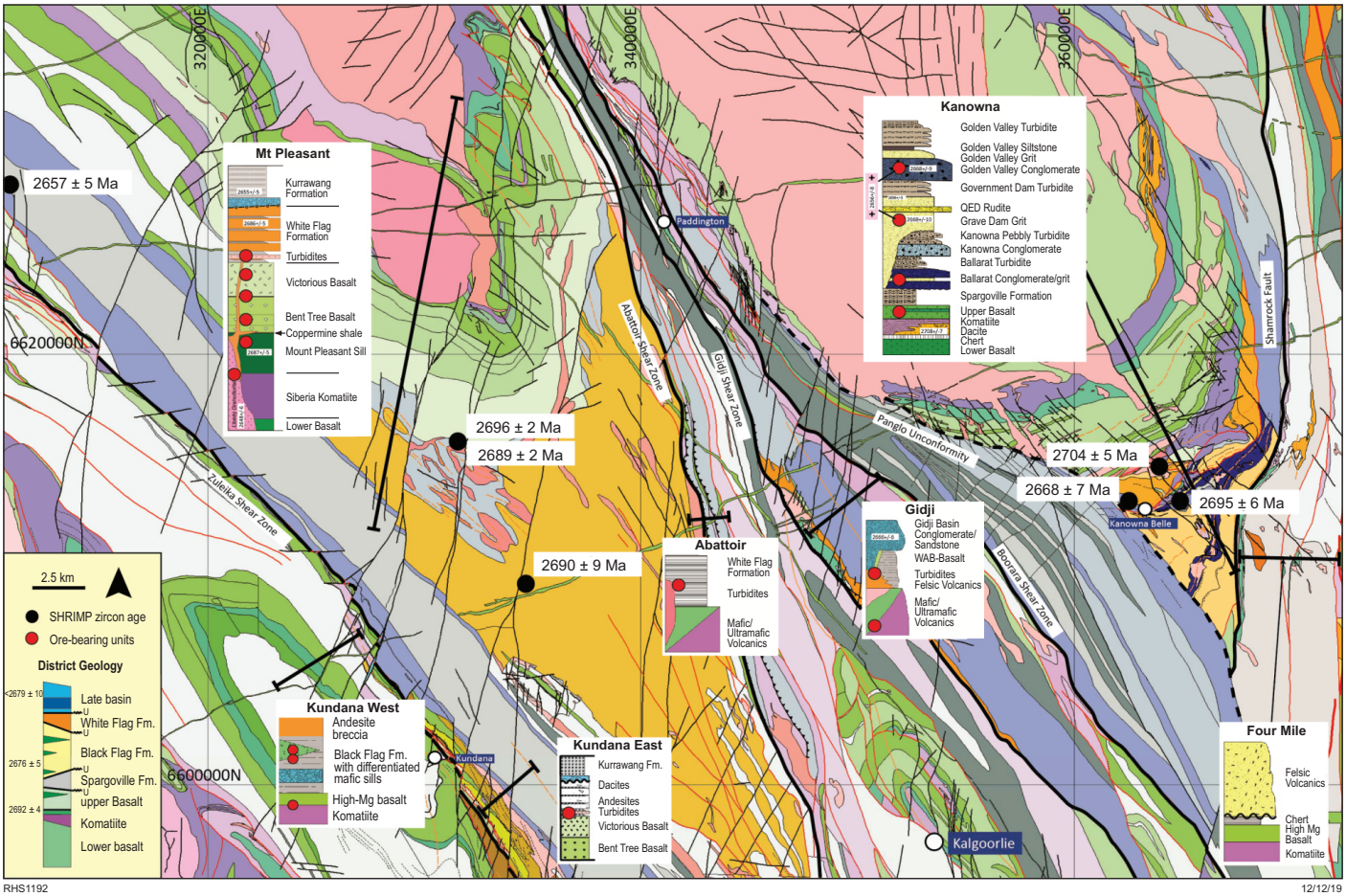
Stratigraphy and structure in the Neoarchaean of the Kalgoorlie district

The remarkably prodigious gold endowment of the Neoarchaean was controlled by specific characters of the stratigraphy, structural geology, and geochemistry of greenstone belts. This Report is an unmodified reproduction of Dr Gerard Tripp's PhD thesis which synthesizes stratigraphic, structural and geochronological data to understand the geology of the Kalgoorlie greenstones, and to assess the controls on major gold deposits. Voluminous, previously unavailable regional-scale datasets from exploration and mining provide new insights into the controls on gold deposits in the north Kalgoorlie district of the Eastern Goldfields Province (EGP) in Western Australia.

The end of mafic volcanism is constrained by U–Pb SHRIMP age determination for the Golden Mile Dolerite at 2685 ± 4 Ma (host to the largest Archean greenstone gold deposit). This age determination indicates a possible 3-million-year time gap between the intrusion of the Golden Mile Dolerite (>2681 Ma) and overlying Lakewood dacite volcanics (<2678 Ma), allowing for the possibility that the Golden Mile dolerite was a high-level intrusion at the Upper Basalt / Black Flag Group interface.

The stratigraphy of post Upper Basalt rocks, including three newly defined formations, is separated on the basis of this work into four units from oldest to youngest: 'Talbot formation'; White Flag Formation; 'Gibson–Honman formation' (~2675 Ma); and 'Gidji Lake formation' (~2660 Ma). Gibson–Honman formation includes felsic volcanic rocks at Gibson–Honman Rock, Lakewood dacitic volcanics, and Perkolilli rhyolitic volcanics. Gidji Lake formation includes felsic volcaniclastic rocks at Gidji, Binduli Porphyry Conglomerate and Grave Dam Grit at Kanowna. The stratigraphy includes unconformities between White Flag Formation and Talbot formation (locally), and between Gibson–Honman and Gidji Lake formations. The Panglo member in the Kanowna district is interpreted as a correlative of the Kurrawang Formation, and represents a major change to the district stratigraphy that identifies late, unconformable clastic sequences in the vicinity of the Kanowna Belle gold deposit.

Five major deformation events are separated into pre-Kurrawang and post-Kurrawang deformation episodes, which record a change from early extension to bulk contraction, with the latter including synorogenic clastic sedimentation. Major map scale F1 folds are located at Kanowna and the Golden Mile in a restricted distribution that may reflect typically poor preservation of D1 fabrics. Localized synorogenic extension resulted in the deposition of linear fault-controlled, late clastic sedimentary sequences at <2650 Ma (Kurrawang, Panglo), unconformably



Basement interpretation lithological map of the north Kalgoorlie district, generalized legend and with local selected lithostratigraphic columns for the section lines marked in black

overlying F2 folded rocks. The deposition of those sequences marks the onset of penetrative deformation over a relatively short time interval (~2650–2639 Ma). A regionally pervasive S3 foliation transects F1 and F2 fold axial planes. The S3 foliation trends uniformly over the district, and is axially planar to F3 folds with inclined axial planes in the late clastic sequences. The maximum age of the regional S3 foliation is constrained by the <2650 Ma rocks that are folded and foliated by it, and a minimum age at 2639 ± 3 Ma from Lode–Au veins that were synchronous with, and overprinting, the regional foliation.

The Zuleika Shear Zone marks a domain boundary that juxtaposes crustal blocks with minor stratigraphic differences and thickness of sequences, yet the blocks do not have significantly different deformation intensity or metamorphic grade. Fault-bounded domains in the Kalgoorlie Terrane were therefore not diverse crustal blocks amalgamated by strike slip or accretion, but were more likely subjacent depocentres, possibly half-grabens, bounded by early extensional faults such as the Zuleika Shear Zone and Bardoc Tectonic Zone.

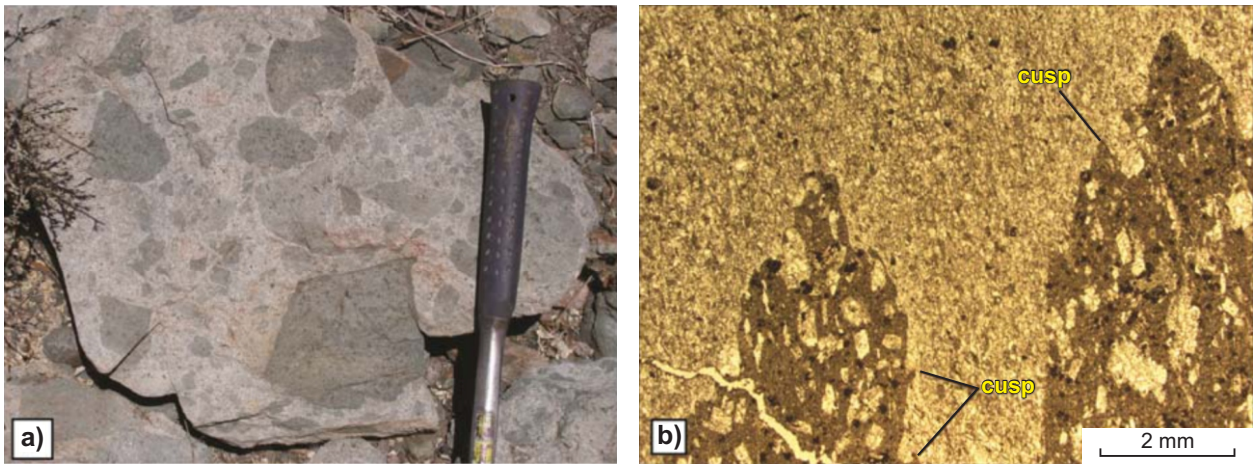
Geological sequences of the Yindarlgooda Dome show no major differences in lithotectonic assemblages, stratigraphic sequence, or age, from sequences in the adjacent Boorara Domain. On this basis, the allocation of 'terrane boundary' status to the Mount Monger Fault as separating a western back-arc (Kalgoorlie Terrane) from an eastern accreted volcanic arc (Gindalbie Terrane) is suspect, and casts doubt on the application of subduction/arc-accretion models to greenstones of the southern EGP. Models that propose rifting of a pre-~2700 Ma greenstone basement may be better analogues for the tectonic setting of the Kalgoorlie greenstones.

At a regional scale, major gold districts in the EGP have spatial and temporal relationships with unconformable, late clastic sedimentary sequences that mark areas of thick greenstone preservation. There is diversity of mineralization styles and settings in the largest gold deposits, including early synvolcanic hydrothermal alteration and mineralization systems, and late-tectonic, vein-hosted lode–Au deposits. High-level mineralization styles were developed early in the formation of the greenstone belts with spatially coincident, late-tectonic mineralization, indicating persistent mineral systems at fixed locations throughout several uplift and deformation cycles. That persistence suggests fundamental structural controls.

Structural controls on the different mineralization styles include early formed disseminated sulfide replacement mineralization (e.g. Binduli) deformed and cut by late, syntectonic lode–Au vein-style mineralization (e.g. Binduli, Kundana). The Binduli district is spatially associated with the ~2664 Ma Binduli Porphyry Conglomerate unconformity that is interpreted to separate the Gibson–Honman and Gidji Lake formations. Kanowna Belle gold deposit is hosted in hypabyssal porphyritic rocks that have a spatial association with a ~2660 Ma unconformity at the base of the Grave Dam sequence (Gidji Lake formation). Unconformable sedimentary and volcaniclastic rocks of the Gidji Lake formation (~2660 Ma) are present in the vicinity of the eastern margin of the world-class Mount Charlotte / Fimiston gold camp. This spatial association of major gold deposits with rocks located above an unconformity internal to the Black Flag Formation is a new understanding of the critical controls on Neoarchaean gold deposits and is a key criterion for area selection in exploration.

GSWA Report 199 Stratigraphy and structure in the Neoarchaean of the Kalgoorlie district, Australia: Critical controls on greenstone-hosted gold deposits by GI Tripp is available as a free download from the DMIRS eBookshop.

For more information, contact **Hugh Smithies**.



White Flag Formation photographs: a) matrix-supported andesite breccia from the upper parts of the sequence at White Flag Lake (GDA: 31706E, 6608679N). Fragments are angular, ranging from pebble to boulder size composed chiefly of coherent hornblende andesite and set in a fine-grained sandstone matrix of feldspar–hornblende crystal and lithic debris; b) PPL photomicrograph of andesite volcanic breccia/peperite; White Flag Lake island (GDA: 31822E, 6608069N). Fragments of hornblende andesite lava are distributed in volcaniclastic sandstone matrix, but locally have wispy cuspate re-entrants at the margins of the lobes

Geodynamic evolution of the North Australian Craton

The Granites–Tanami Orogen in Western Australia and the Northern Territory preserves a complex record of Paleoproterozoic basin development, deformation and magmatism in the west–central North Australian Craton. The orogen provides an important source of information about the assembly and development of the North Australian Craton, and hosts numerous orogenic gold deposits, including the world-class Callie deposit in the Dead Bullock Soak goldfield.

Geological study of the Granites–Tanami Orogen is hampered by extensive Mesoproterozoic to Cenozoic sedimentary cover (Fig. 1), with most information derived from widely spaced areas of low, weathered outcrop, and from drillcore. Geological event frameworks have been constructed, although significant differences exist between aspects of the models, including the timing and correlation of sedimentary packages and the number, timing and character of tectonic events. Most published geochronological data have been obtained from the Northern Territory, with fewer data obtained for rocks in Western Australia.

This Report provides a compilation of SHRIMP U–Pb zircon geochronology of metasedimentary and granitic rocks in the Granites–Tanami Orogen (Fig. 2), carried out as part of collaborative research between the Geological Survey of Western Australia (GSWA), Geoscience Australia (GA) and the Northern Territory Geological Survey (NTGS) in the middle to late 2000s. Samples were collected to provide constraints on the timing and provenance of sedimentation, stratigraphic correlations and the ages of magmatic suites. This Report assesses the geochronological framework for the orogen within the broader context of the North Australian Craton to evaluate potential geodynamic settings of basin formation, magmatism and deformation.

GSWA Report 196 Geochronology of metasedimentary and granitic rocks in the Granites–Tanami Orogen: 1885–1790 Ma geodynamic evolution by DW Maidment, MTD Wingate, JC Claoué-Long, S Bodorkos, D Huston, JA Whelan, L Bagas, A Lambeck and Y Lu is now available as a free download from the DMIRS eBookshop.

For more information, contact **Michael Wingate**.

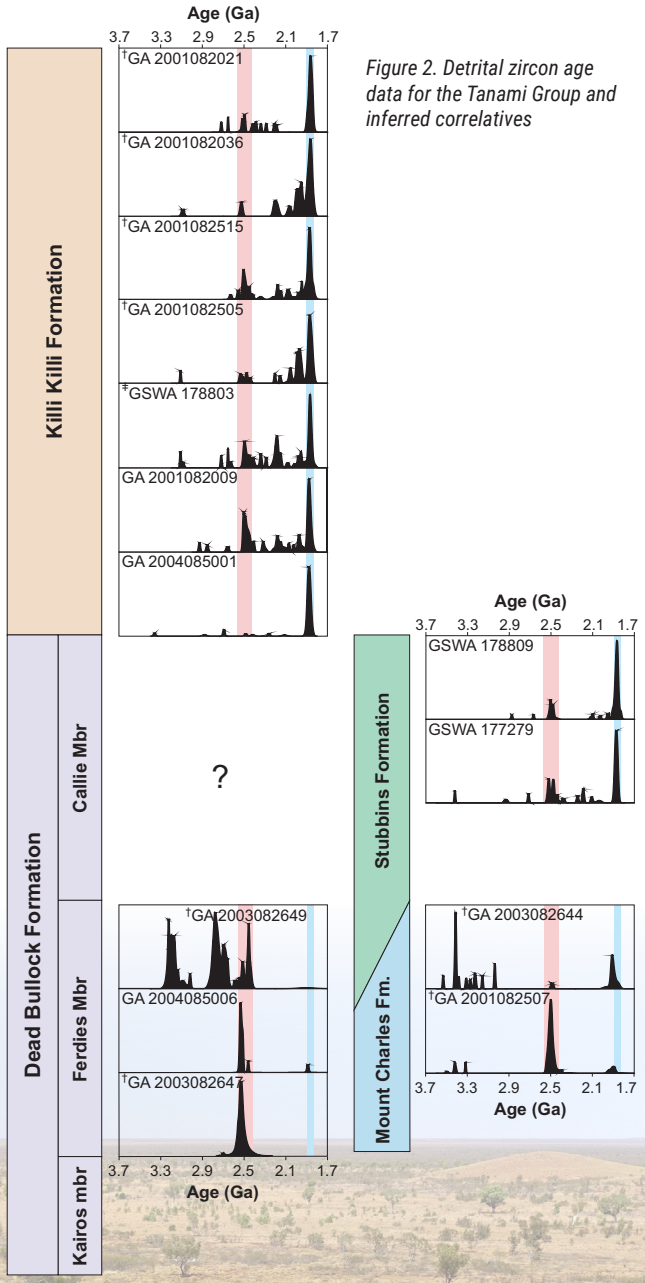


Figure 2. Detrital zircon age data for the Tanami Group and inferred correlatives

Figure 1. View across covered Paleoproterozoic rocks of the Granites–Tanami Orogen from laterite developed on basalt of the Cambrian Antrim Plateau Volcanics, about 7 km southwest of Rabbit Flat

Archean domes and gravitational instabilities

EXPLORATION INCENTIVE SCHEME

The Geological Survey of Western Australia (GSWA) recently published the theses of Frediano Clos (Monash University) and Adam Beall (University of Melbourne), two PhD students whose research projects received support from the Exploration Incentive Scheme (EIS). Although the approaches taken were very different – Dr Beall used computer simulations to explore geodynamic processes and Dr Clos carried out a field-based structural analysis – both projects made significant contributions to understanding gravity-driven processes in Archean tectonics.

Figure 1. Outcrop-scale view (horizontal exposure) of the c. 2960 Ma Kynea Migmatite, in the core of the Yalgoo Dome, showing small-scale sheath folds with subvertical axis, highlighted by leucosome layers

Frediano Clos shows in his thesis (GSWA Report 201) that the Meso- to Neoarchean Yalgoo Dome in the northwest Yilgarn Craton offers a unique view on the fundamental processes necessary to generate an Archean felsic continental crust. Frediano combined field work, geochemistry and phase equilibrium modelling to investigate the tectonomagmatic evolution of the Yalgoo Dome. In his work, Frediano was able to unravel how three phases of mantle-derived magmatism and crustal reworking from c. 2970 to 2600 Ma interacted with deformation processes to form the present-day architecture of the Yalgoo Dome – an elliptical granitic structure wrapped by a composite greenstone belt. Frediano demonstrated that vertical sheath folds in the Yalgoo Dome's migmatitic core developed in a single, synanatectic deformation event that was locally refolded during the last phase of diapirism (Fig. 1).

The key finding of Adam Beall's thesis (GSWA Report 202) is that intraplate instability dynamics in Earth's continental crust may vary significantly and can be an important influence on crustal evolution in the absence of tectonic forces. Adam analysed the removal of dense lower crust or lithosphere into the mantle by delamination and Rayleigh-Taylor instabilities (Fig. 2) using numerical and analytical models. From his models, Adam found that delamination occurs significantly faster than Rayleigh-Taylor instabilities and requires the existence of a weak lower crustal channel. In further investigations, Adam explored possible relationships between granitoid doming in Archean dome-and-keel structures and the removal of their restites, and proposed that continental shortening provides a mechanism for generating thick cratonic keels.

GSWA Report 201 Structural and geochemical evolution of the Yalgoo Dome, Yilgarn Craton (Western Australia) by F Clos and **GSWA Report 202 Gravitational instabilities beneath the continents** by APJ Beall are both now available as free downloads from the DMIRS eBookshop.

For more information, contact **Klaus Gessner**.

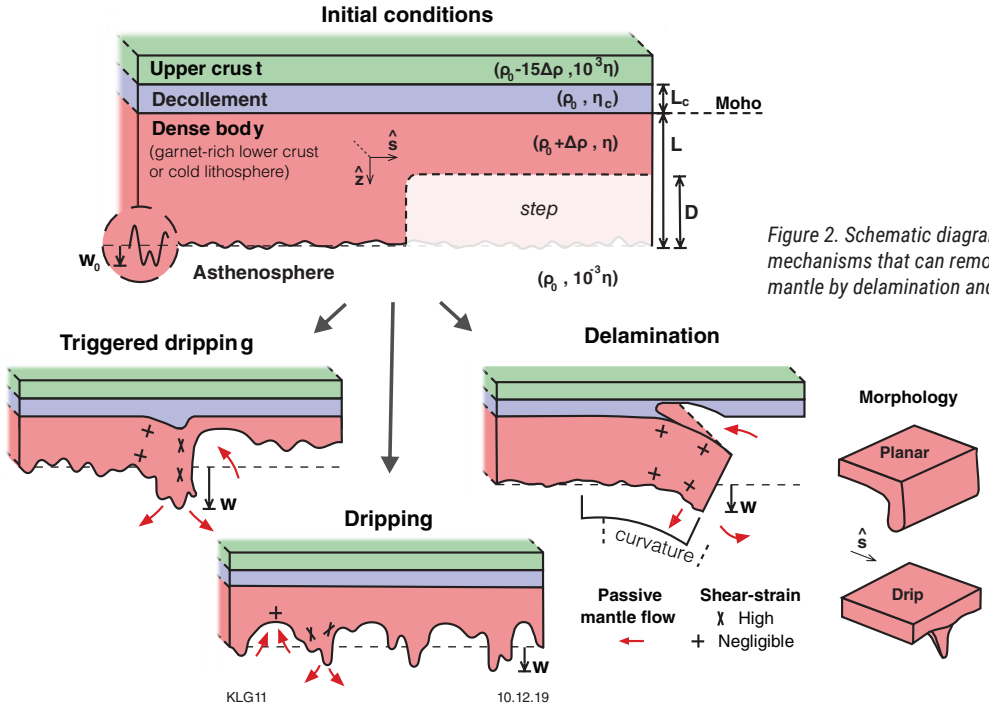


Figure 2. Schematic diagram of the initial conditions and the three mechanisms that can remove dense lower crust or lithosphere into the mantle by delamination and Rayleigh-Taylor instabilities

GEOLOGICAL SURVEY

OPEN DAY 2020

Friday 21 February 2020

8.30 am – 4.30 pm

Followed by a Sundowner

Esplanade Hotel, Fremantle

Cnr Marine Terrace and Essex Street

This is a great opportunity to hear presentations on the latest results from GSWA's geoscience programs, including collaborative work with CSIRO, Geoscience Australia, Curtin University, and the Centre for Exploration Targeting (CET).

Activities and results of the Exploration Incentive Scheme will be outlined including the launch of Round 21 of the Government Co-funded Exploration Drilling program.

Throughout the day there will be geological presentations, an extensive poster display, and demonstrations of online systems and technology innovations.

Register online at

www.dmp.wa.gov.au/GSWAOpenDay

For further information, call **(08) 9222 3646**

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

Current resource projects Goldfields region

In 2012, the series mapping section was tasked with producing a map showing the road network in the Goldfields region to assist with the delivery of mining infrastructure components. The request had come via a Kalgoorlie councillor from a relative who worked in a prominent haulage company, also situated in Kalgoorlie. It was conveyed that there had been many instances where drivers were getting lost when delivering their loads to remote mines resulting in them turning their trucks around, often on narrow loose surfaced roads, as a result of vague or oversimplified directions. In September 2012, the first edition of what was thought to be a one-off map was created and released as **Current resource projects Goldfields region**.

The criteria for the map was to show all current roads and tracks as well as major projects and mines with their classifications. The roads were downloaded from Landgate where use was made of the existing classifications within the dataset with the final map showing the road type and surface. As the request was made relating to the delivery of mining infrastructure components, it was thought that the **Major resource projects** and the **Mines — operating and under development** data, sourced from MINEDEX, would be the two most suitable features to use on the map.

Symbolizing of the mines was done in a way to emphasize the major projects, with mines and construction material quarries being less prominent. Labelling of all major projects as well as mines and processing plants enabled easy identification of prospective destinations.

Since the initial edition in 2012 there have been three updates, with the last edition being released in November 2019 (Fig. 1) . The map's title was changed in 2013 to **Resource projects Goldfields region — 2013** and included full reference to the map. Feedback has been positive which possibly provides for future editions.

Resource projects Goldfields region – 2013 and **Resource projects Goldfields region – 2019** are available as free downloads from the DMIRS eBookshop.

For more information, contact **Shaun Coldicutt**.

Transport logistics have changed since the early days of gold and resource mining

Example of the loads being transported through the Goldfields terrain

Goldfields resources map

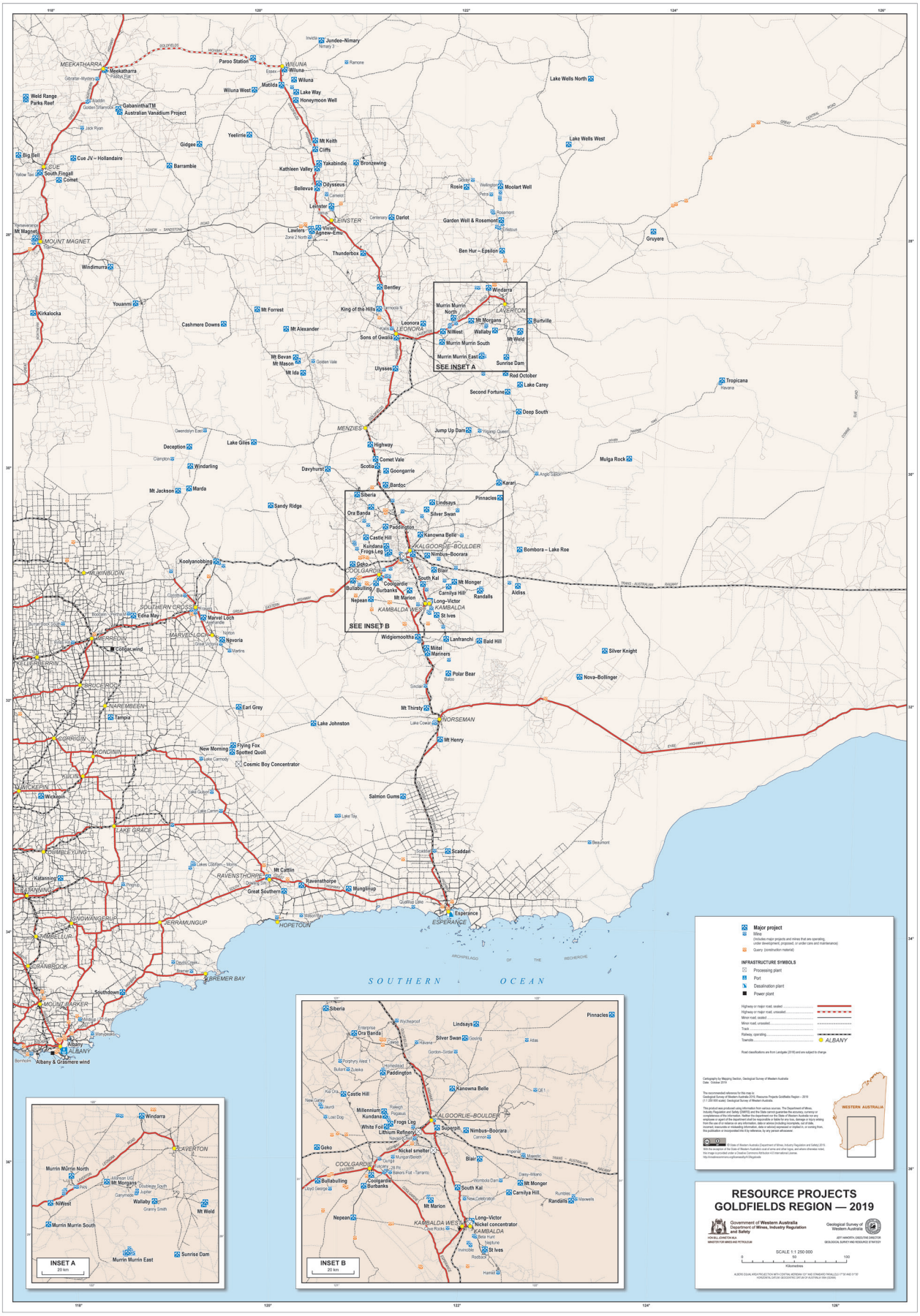


Figure 1. The 2019 edition of the Goldfields resources map

One year in

EXPLORATION INCENTIVE SCHEME

The MinEx Cooperative Research Centre (MinEx CRC) is a 10-year, $218 million research centre based at the Australian Resources Research Centre (ARRC) in Kensington, Western Australia and brings together drilling technologies, sensing specialists and geologists in a unique world-leading and world-largest geoscience collaboration tackling discovery under cover. Launched in 2018, the CRC is now a year old and progressing towards its first phase milestones.

Research is conducted in three themes: drilling technologies, data from drilling, and the National Drilling Initiative (NDI). The Geological Survey of Western Australia (GSWA) is participating in both the NDI and also a project, headed by The University of Western Australia's (UWA) Centre for Exploration Targeting (CET), on building faster and more automatic 3D geological maps that incorporate better measures of uncertainty.

The first of the annual public conferences by the CRC was held in late November 2019 in Perth (Fig. 1) discussing the first outputs of research. Highlights of this conference included fast-paced research projects and outputs from the CRC PhD cohort, and discussions from a wide range of industry and researcher participants.

A key element of the first stage of research is to understand how to better integrate data to make exploration decisions. An element of this is to better utilize structural information that is semi-automatically recoverable from core and downhole images. To assist with defining the algorithms for this, a diverse range of data scientists and geologists met at the Perth Core Library in early December 2019 (Fig. 2) using the Exploration Incentive Scheme (EIS) co-funded drillcores to illustrate examples of features to be extracted from imagery to assist both logging and better constraining 3D geological maps.

For more information, contact **Ian Tyler** or **Richard Chopping**.

Figure 1. Delegates enjoying the first annual MinEx CRC conference, held in Perth, November 2019

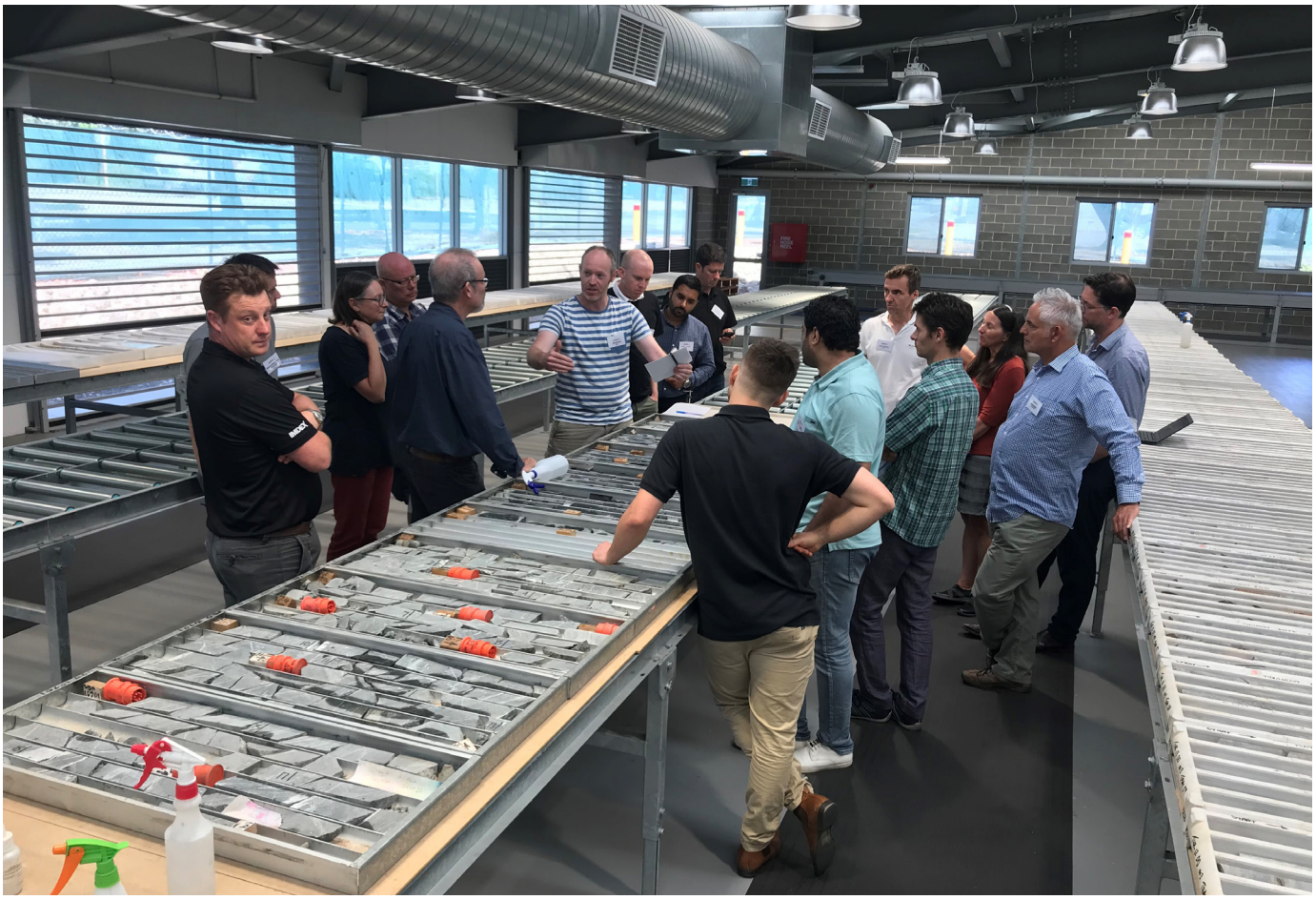


Figure 2. Participants in the MinEx CRC workshop examining EIS co-funded drillcore to understand what key structural features could be recovered automatically by image recognition systems and fed directly into 3D maps and drilling program design software

AusAEM20–WA Project

EXPLORATION INCENTIVE SCHEME

The Department of Mines, Industry Regulation and Safety's (DMIRS) Geological Survey division and Geoscience Australia (GA) have recently entered into a new National Collaboration Framework Agreement for the Western Australian component of the Australian 20 km Airborne Electromagnetic Survey Objective (AusAEM20).

AusAEM20 is a collaborative, national goal of the Commonwealth, State and Territory geological survey agencies to acquire airborne electromagnetic (AEM) data at 20 km or closer line spacing across the Australian continent. It is a successor to the 2017–20 Geoscience Australia Exploring for the Future (EFTF) AusAEM Project, which, on completion, will have covered a substantial part of northern Australia. The AusAEM20–WA Project, as the Western Australian agreement is referred to, will complete the 20 km AEM coverage of those parts of Western Australia that have not been surveyed as part of Year 2 of EFTF AusAEM (Fig. 1).

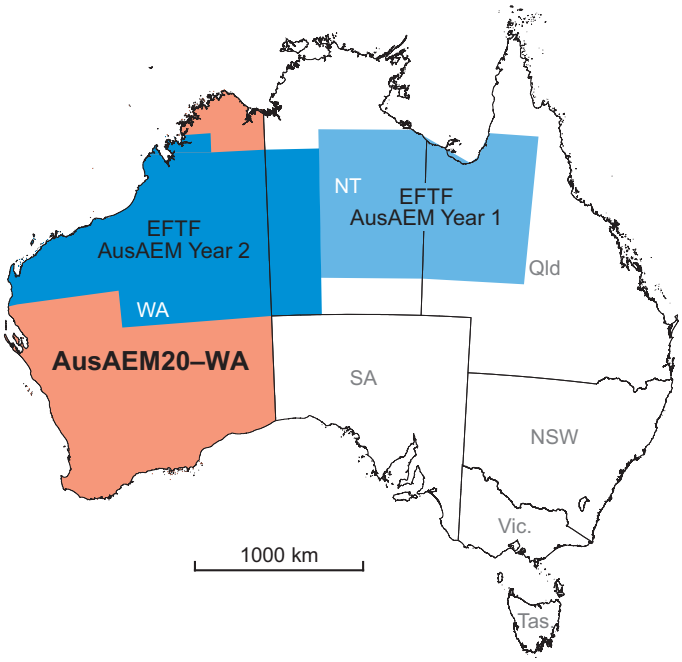


Figure 1. Location of AusAEM20–WA survey areas

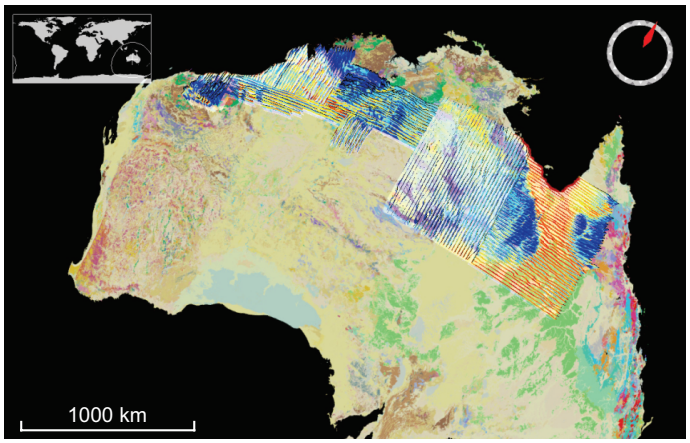


Figure 2. AusAEM profiles from 2018 and 2019 surveys (image courtesy of Geoscience Australia)

We anticipate that acquisition of the 65 000 km of data that will be needed for this coverage will take place over the next two to three years.

GA's AusAEM EFTF surveys have demonstrated that, even at this wide line spacing, AEM data are coherent at very broad reconnaissance scales (Fig. 2) and may be used to:

- determine trends in regolith thickness
- map regional variations in bedrock conductivity, within the depth of penetration of the system
- set context for and guide mineral exploration project generation by industry
- improve targeting for water resources definition
- provide input for other land-use applications in other industry sectors and land-use agencies.

However, if tendered prices are suitably attractive and if adequate funding is available, DMIRS is considering data acquisition at smaller line spacing in particular areas of interest.

For more information, contact **David Howard**.

Data downloads from **GeoVIEW.WA** – search by registration number in relevant airborne and ground surveys layers in 'Geophysical Surveys' collection.

Subscribe to the GSWA eNewsletter for data release alerts.

2019 Western Australian State Waters acreage release

Released: Tuesday 10 December 2019
Closes: Thursday 9 April 2020

Northern Carnarvon Basin

Combined Release Area L19-1/T19-1
Release Area L19-2

Perth Basin

Release Area T19-2

Applications are to be made in accordance with section 31 of the *Petroleum and Geothermal Energy Resources Act 1967* and section 21 of the *Petroleum (Submerged Lands) Act 1982* as appropriate.

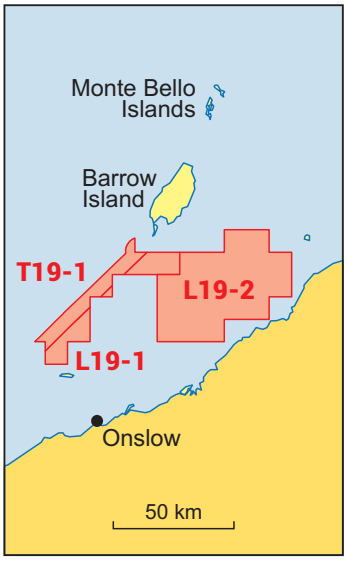
It is essential that the following guidelines be read in concert with this invitation:

- WA Petroleum Guideline - Criteria for Assessment; and,
- WA Petroleum and Geothermal Guideline for Exploration Permit Management,

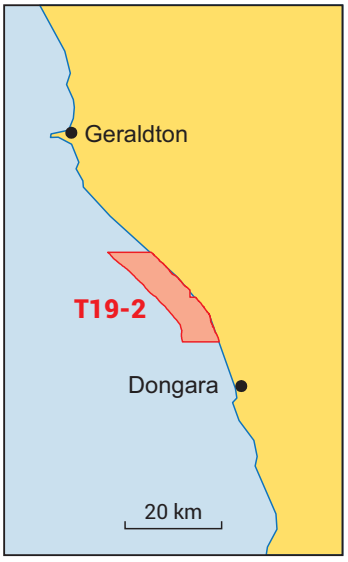
The criteria for the consideration of an application for the grant of a petroleum exploration permit will take into account work programs relative to the whole of the area applied for, the adequacy of the work program and the applicant's technical and financial ability to undertake the work.

For more information, see the **Department of Mines, Industry Regulation and Safety website**.

Northern Carnarvon Basin



Perth Basin



T19-1/L19-1..... 629 km^2
20 blocks

L19-2..... 1677 km^2
21 blocks

- Australia's premier hydrocarbon producing basin
- Many fields in vicinity, including the Barrow Island oilfield

T19-2..... 130 km^2
4 blocks

- Numerous fields in Dongara area
- Infrastructure onshore includes highways and gas pipelines

Petroleum data free to download at www.dmp.wa.gov.au/wapims

RB133 14.01.20

Product releases

• DIGITAL CORE ATLAS SERIES •

DMP Harvey 2, Perth Basin: Digital Core Atlas
by Gamarra, S and Symonds, A

DMP Harvey 4, Perth Basin: Digital Core Atlas
by Gamarra, S and Symonds, A

• REPORTS •

Report 198 Komatiite characteristics of the Fisher East nickel sulfide prospects: implications for nickel prospectivity in the northeastern Kurnalpi Terrane
by Burley, L and Barnes, SJ

Report 199 Stratigraphy and structure in the Neoarchaean of the Kalgoorlie district, Australia: Critical controls on greenstone-hosted gold deposits
by Tripp, GI

Report 201 Structural and geochemical evolution of the Yalgoo Dome, Yilgarn Craton (Western Australia)
by Clos, F

Report 202 Gravitational Instabilities Beneath the Continents
by Beall, APJ

• RECORDS •

Record 2019/10 Coal resources of the Canning Basin, Western Australia: exploration and evaluation history
by Simons, SL

Record 2020/3 The geodynamic context of Archean volcanism in the western Yilgarn Craton
by Koutsoumbis, I

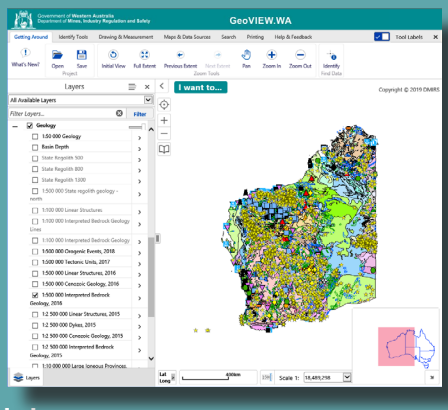
Record 2020/4 The Deflector Au–Cu Deposit: Defining an anomalous Yilgarn Craton mineralisation style using trace element geochemistry
by Egan, JFB

• DATA PACKAGES •

Drillholes related to coal exploration in the Canning, Eucla, northern Perth and Southern Carnarvon Basins

ONLINE SYSTEMS AND DATABASE INFORMATION SESSIONS — 2020

The Department of Mines, Industry Regulation and Safety (DMIRS) offers FREE introductory information sessions in the use of databases and online systems. The presentations allow hands-on interaction for most systems.



Topics include:

- navigating the department's website
- searching for geoscience publications using the **eBookshop**
- finding digital datasets using the **Data and Software Centre**
- searching for open-file mineral exploration reports using **WAMEX**
- searching the mineral drillholes and geochemistry databases
- using the interactive map viewers, **GeoVIEW.WA** and **TENGRAPH Web**
- navigating **GeoMap.WA**, a standalone GIS viewer for Windows
- searching on **MINEDEX**.

SCHEDULE 2020

There is an expectation that attendees have proficient computer skills and know how to do the following in GeoVIEW.WA and TENGRAPH Web:

Identify

- Zoom in/out
- Turn on layers
- Add drawings and measurements on the map
- Do a simple search
- Create a printout of the map
- Add coordinate readouts

PERTH, 1 Adelaide Terrace — 9.30 am – 12 noon

- **Monday 23 March, 6 July, 2 November *GeoMap.WA***
- **Tuesday 24 March, 7 July, 3 November *GeoVIEW.WA and TENGRAPH Web***
- **Thursday 26 March, 9 July, 5 November *WAMEX (includes drillholes and geochemistry) and MINEDEX***

KALGOORLIE, School of Mines — *for all online systems*

- **Thursday 16 April**
- **Tuesday 29 September**

Register

When you **register**, include your details (name, company name, telephone number), with the name, location and date of the training you wish to attend. See the **training page** on our website.