AUSTRALIA MINERALS

REALISE THE OPPORTUNITY

Critical mineral opportunities in Australian Mining waste: Ms Allison Britt, Geoscience Australia

Mineral potential of New South Wales: stepping out under cover: Mr Paul Dale, Geological Survey of NSW

New geoscience expanding the search space for gold and copper-gold in the Northern Territory: Dr Ian Scrimgeour, Northern Territory Geological Survey

Gold in Northeast Tasmania: an under-explored high-grade gold province: Dr Andrew McNeill, Mineral Resources Tasmania

South Australia's world class IOCGs: established and emerging prospectivity: Mr Tom Wise, Geological Survey of South Australia

Victoria – it's not just Fosterville: emerging world-class gold and copper opportunities: Mr Cameron Cairns, Geological Survey of Victoria

Environmental management in Tasmania: research and regulation: Mr Clint Siggins, Mineral Resources Tasmania

The West Australian Perspective: Dr Gaomai Trench, Geological Survey of Western Australia

Australian Government
Geoscience Australia

Critical mineral opportunities in Australian mining waste

Allison Britt

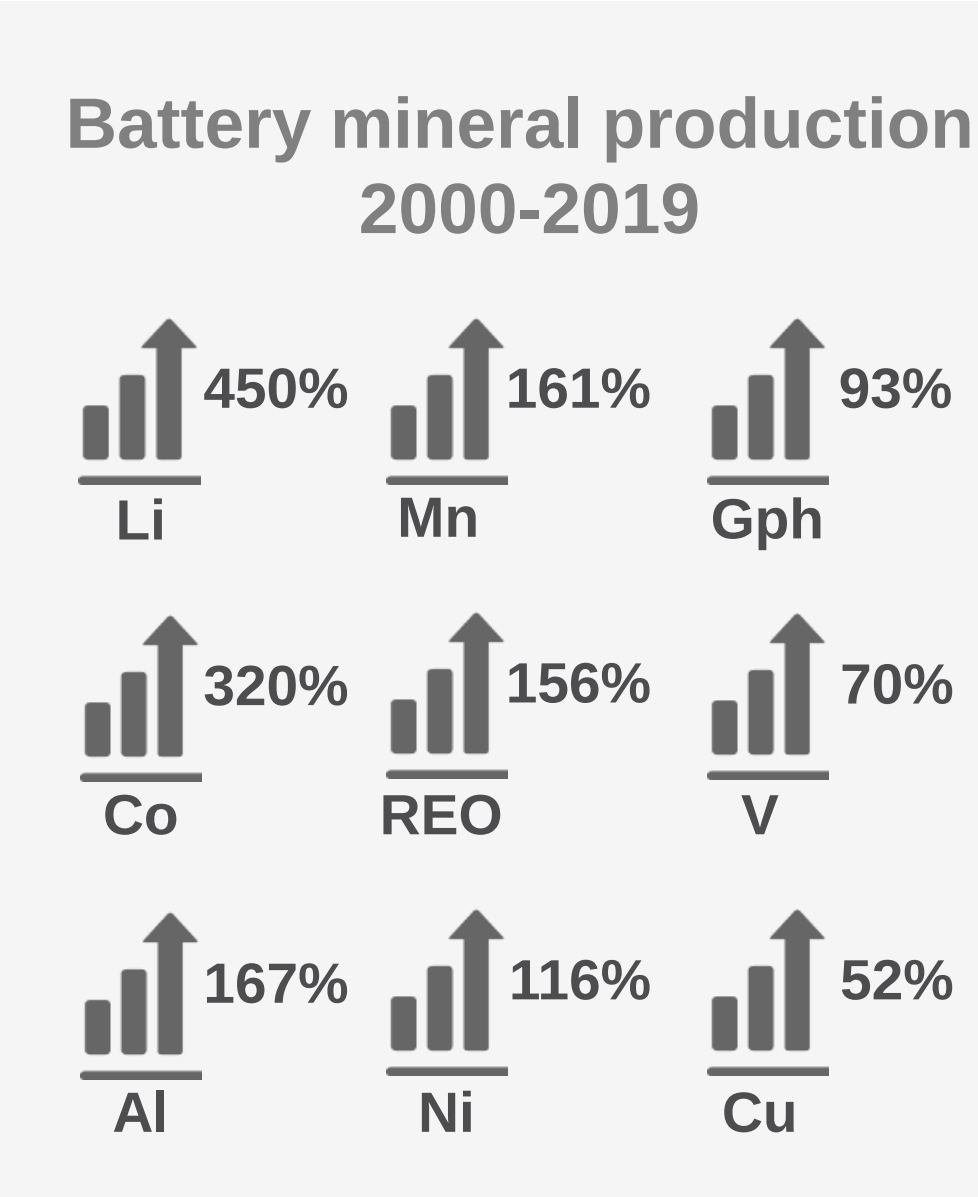
Director Critical Minerals, AAA Branch, Geoscience Australia






The opportunity in tailings dams

- Critical minerals markets predicted to grow.
- Processing does not recover all of the target elements let alone associated minor elements.
- Some legacy sites offer grades similar to modern low-grade deposits.
- Tailings already pre-processed.
- Opportunity to create cleaner tailings stored in modernised, safer storage facilities.



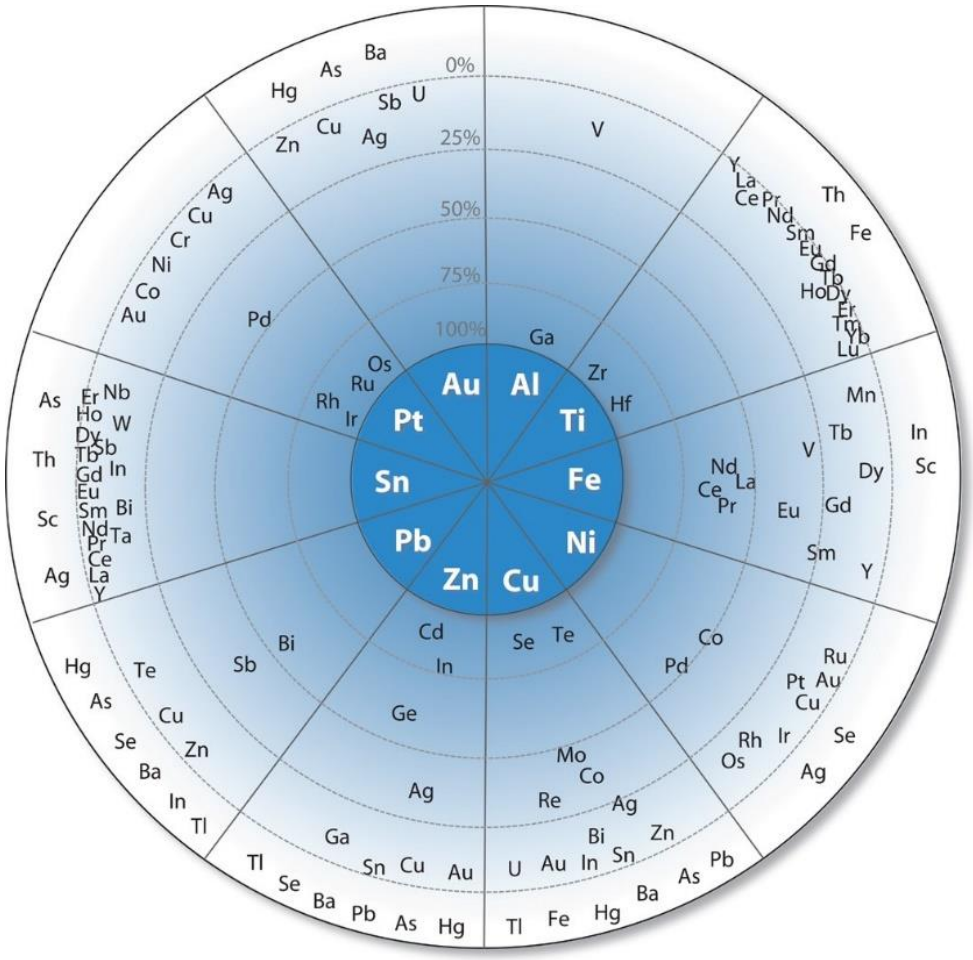
Early investigations

Lack of robust data, so two assumptions:

1. For most commodities, mines have a co-located tailings dam or waste rock dump.
2. Reasonable to use known major and minor element associations to predict critical mineral potential in mining waste.

Also considered:

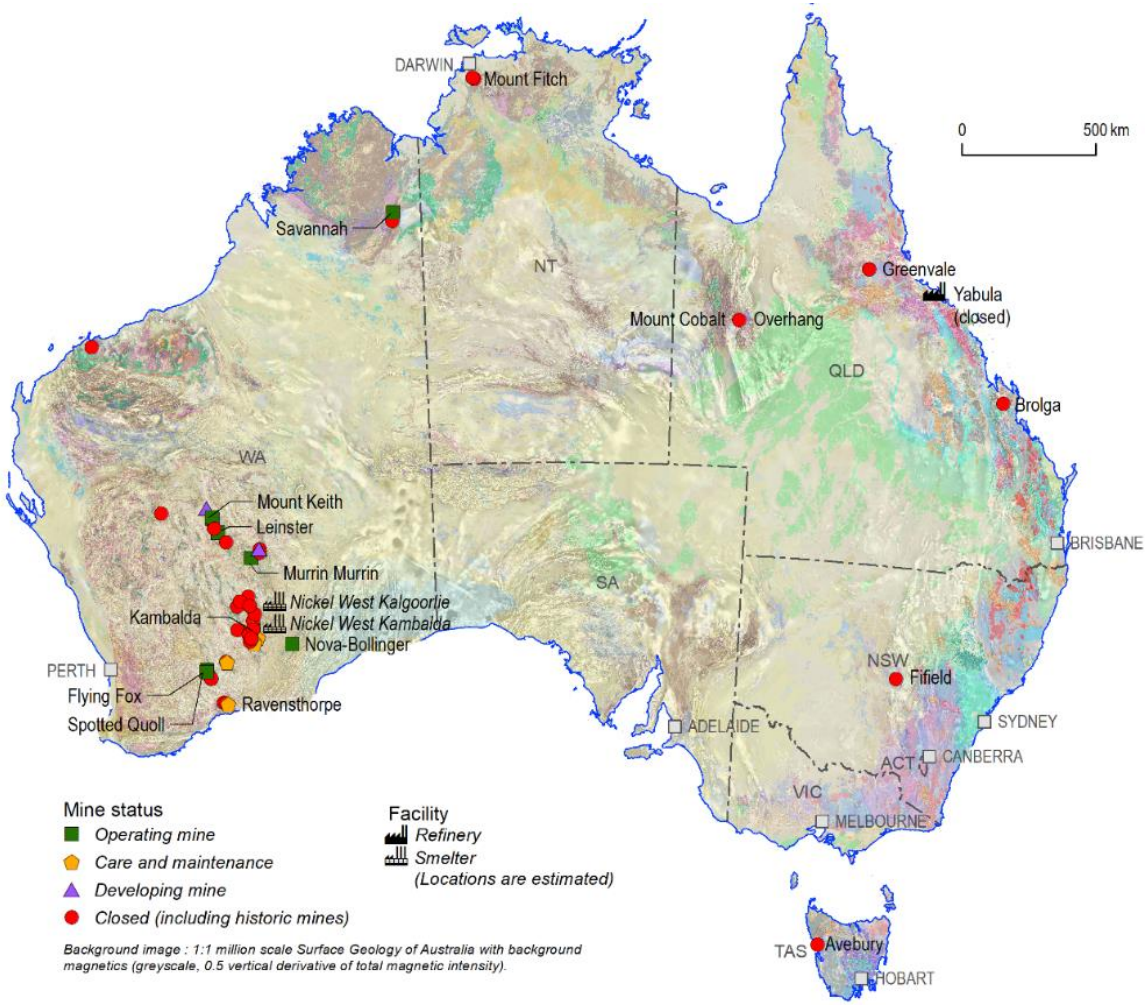
- Refineries and smelters.
- Mines under development - chance to add recovery circuits before operations begin.



From Nasar et al, 2015 and Mudd et al, 2019

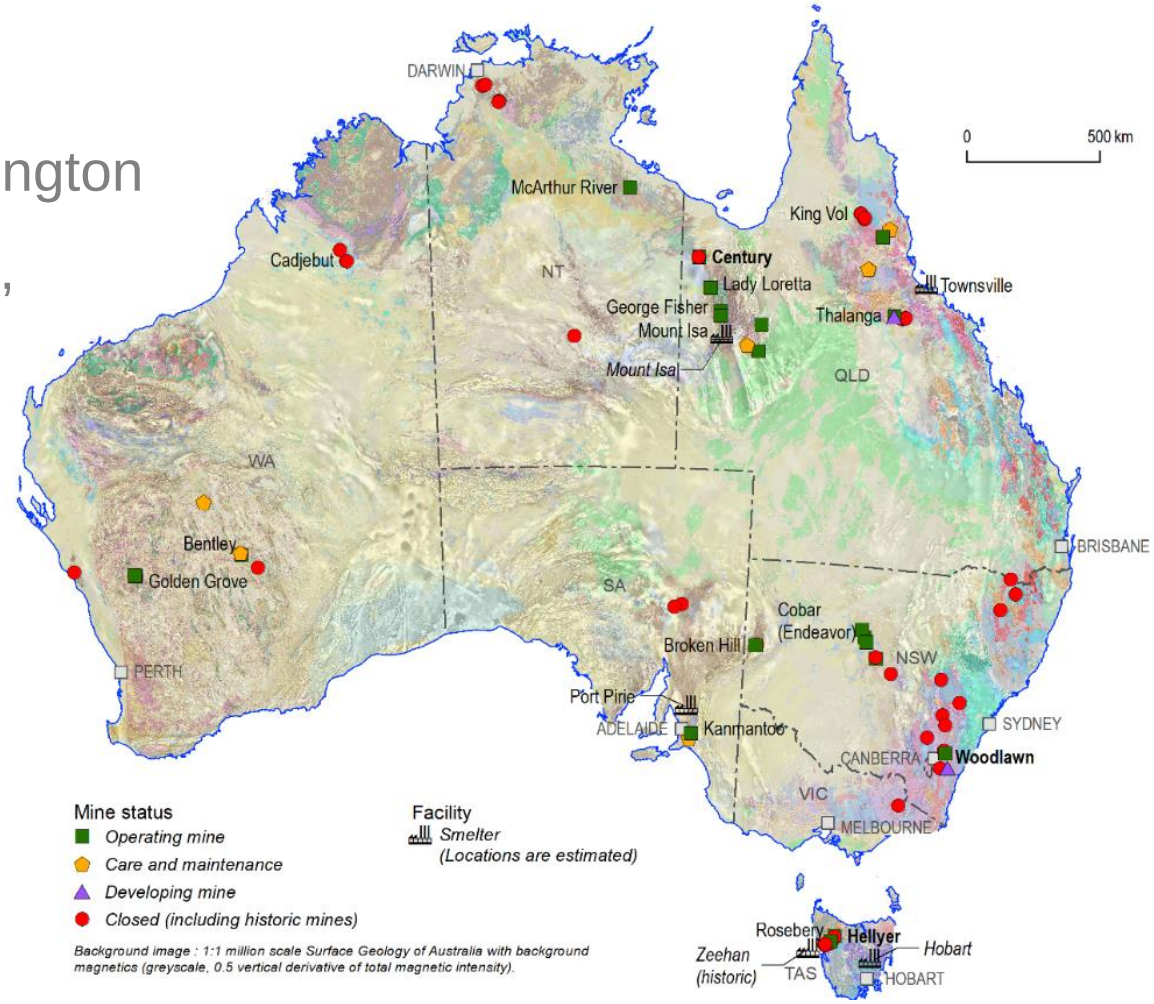
Nickel - *Co, Sc, PGE, Se, Te, Mo*

- Intrusion-hosted
  e.g. Radio Hill, West Musgrave, Fifield, Greenvale
- Komatiite-associated
  e.g. Otter-Juan, Blair, Cliffs
- Nickel Laterite (on ultramafics)
- Some already producing Co, PGE
  e.g. Nova-Bollinger, Murrin Murrin
- 64 potential sites, 43 legacy



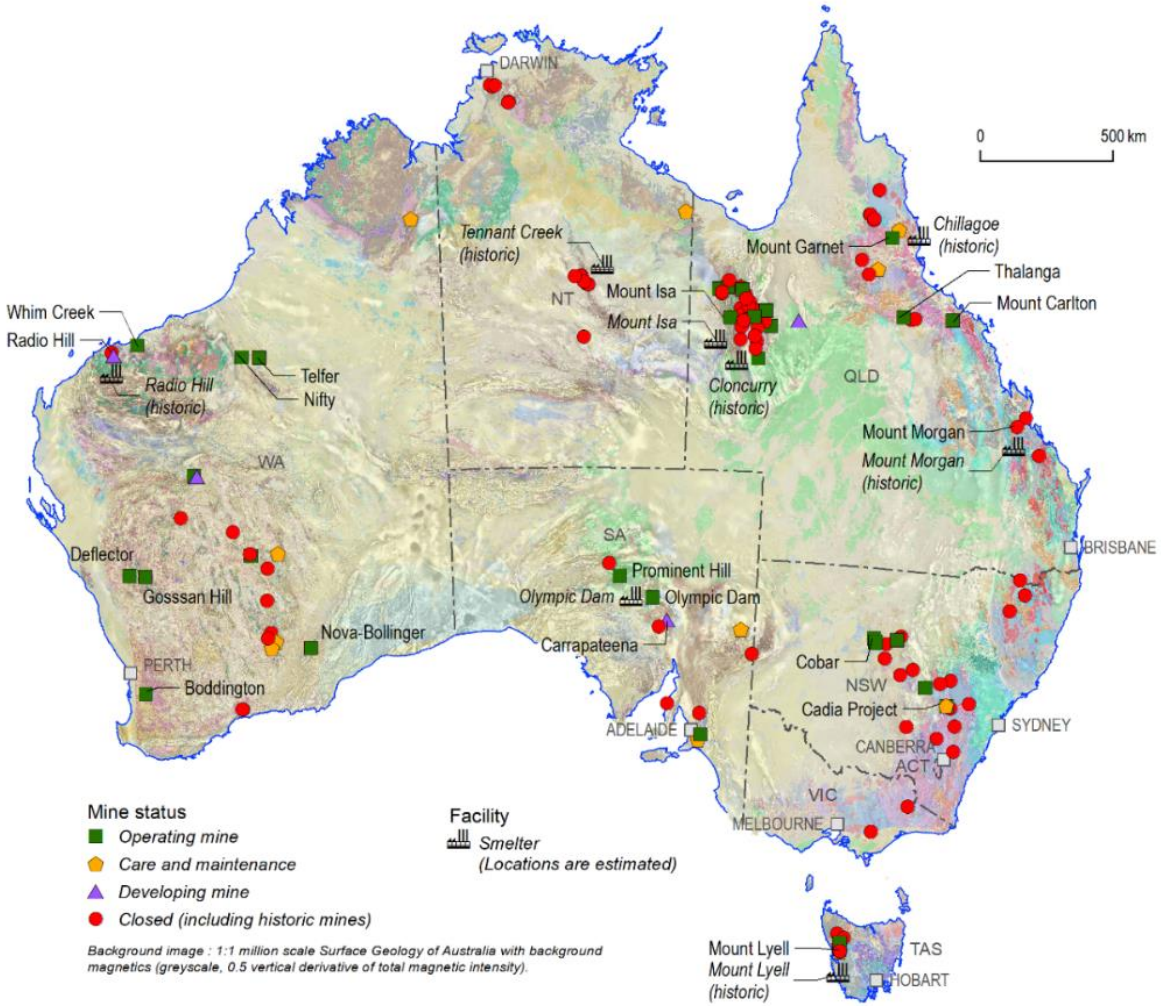
Zinc-Lead-Silver - *Sb, Cd, Ge, Ga, In, Sn, Te, Se, Bi, Mn, Co*

- Sediment-hosted
  - Broken Hill type, e.g. Broken Hill, Cannington
  - Mount Isa type, e.g. Mount Isa, Century, McArthur River, Teena, George Fisher
- Volcanic-hosted massive sulphide
  e.g. Hellyer, Rosebery, Woodlawn
- Mississippi Valley type
  e.g. Cadjebut, Magellan
- Historic production of Cd, Se
  e.g. Risdon, Broken Hill
- 66 potential sites, 44 legacy



Copper

- Iron ore-copper-gold - *REE, Co, In, Nb, Sb, Te, V, W*
  e.g. Olympic Dam, Carrapateena
- Porphyry-epithermal - *Mo, Re, Sb, Ga, In, Ge, Mn, Se, Te, PGE*
  e.g. Cadia, Copper Hill
- Sediment-hosted - *Co, Se(?)*
  e.g. Mount Isa, Gunpowder, Walford Creek, Mount Gunson
- Historic production of Co
  e.g., Mount Isa, Mount Gunson
- 146 potential sites, 91 legacy



Quantifying the opportunity

Not yet possible. We do know:

- Huge potential: >1000 sites
- Zinc-lead-silver, copper, tin, tungsten and nickel tailings good leads.
- Excellent prospects at other sites too, e.g. rare earths at historic Mary Kathleen uranium mine, gallium at Pinjarra alumina refinery.

Critical minerals in tailings is just *one aspect* of a much broader national strategy.

Australian Government critical minerals publications

Available online and on the Australia Minerals USB

AUSTRALIA MINERALS

REALISE THE OPPORTUNITY

Mineral Potential of NSW
Stepping out under cover

Paul Dale - NSW Division of Resources & Geoscience

PDAC – March 2020

NSW GOVERNMENT | Planning, Industry & Environment

Acknowledgement

On behalf of the Division of Resources & Geoscience,

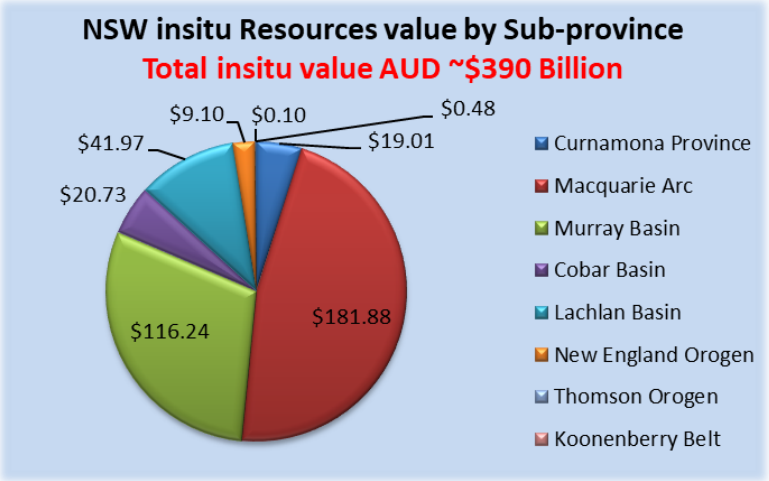
I acknowledge that we meet today on land that is the traditional territory of many nations including the Chippewa, the Haudenosaunee and the Wendat peoples, and is now home to many diverse First Nations, Inuit and Métis peoples.

I also acknowledge the many Aboriginal First Nations people in NSW on whose lands we live and work, and of whose lands I will be speaking today.

AUSTRALIA MINERALS

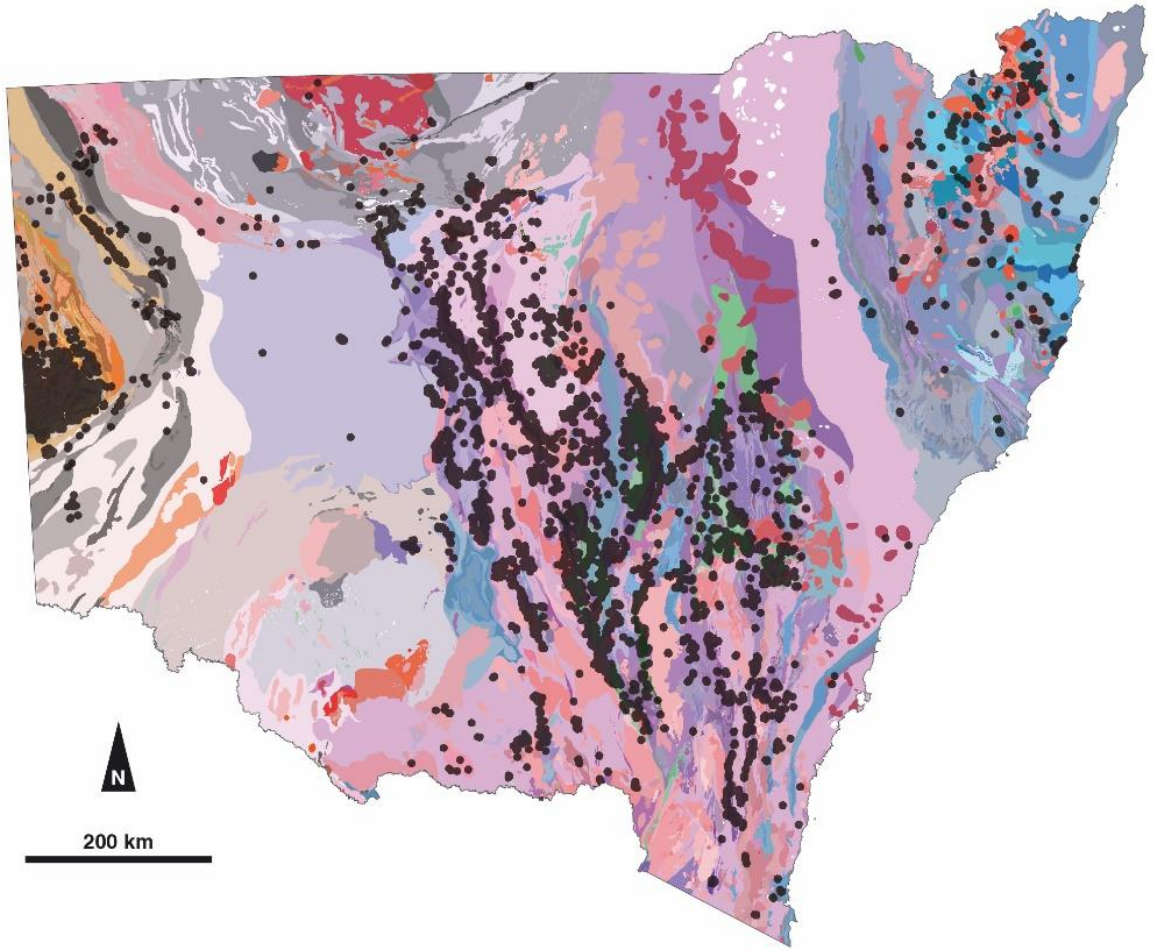
Metallic deposit types mined in NSW

- **Broken Hill Type Deposit (BHT) e.g. Rasp, Pinnacles & Broken Hill Operations**
- **Volcanic hosted massive sulfide (VHMS) e.g. Tritton, Woodlawn**
- **Cobar-type deposit e.g. CSA, the Peak & Endeavor**
- **Orogenic gold e.g. Tomingley**
- **Epithermal e.g. Cowal**
- **Porphyry Au-Cu e.g. Cadia & Northparkes**
- **Heavy Mineral Sands (HMS) e.g. Ginkgo & Snapper**



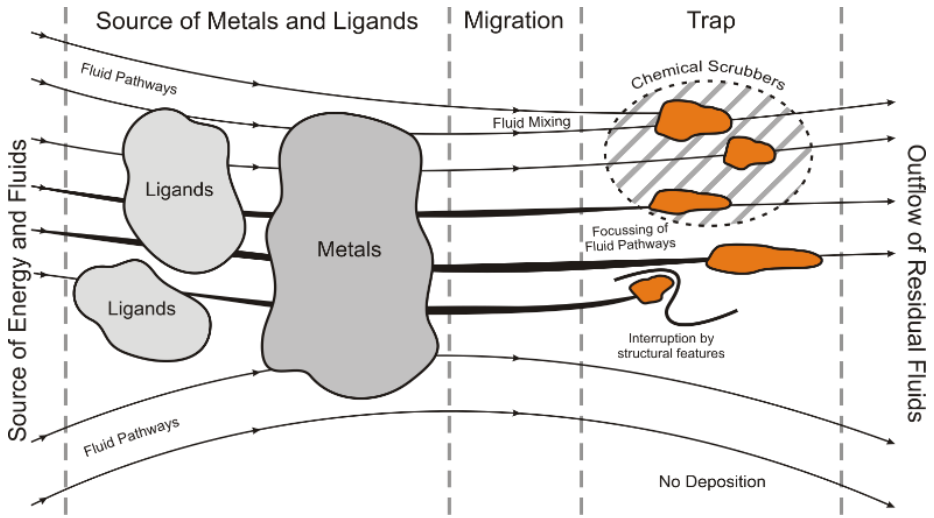
The NSW mineral discovery challenge

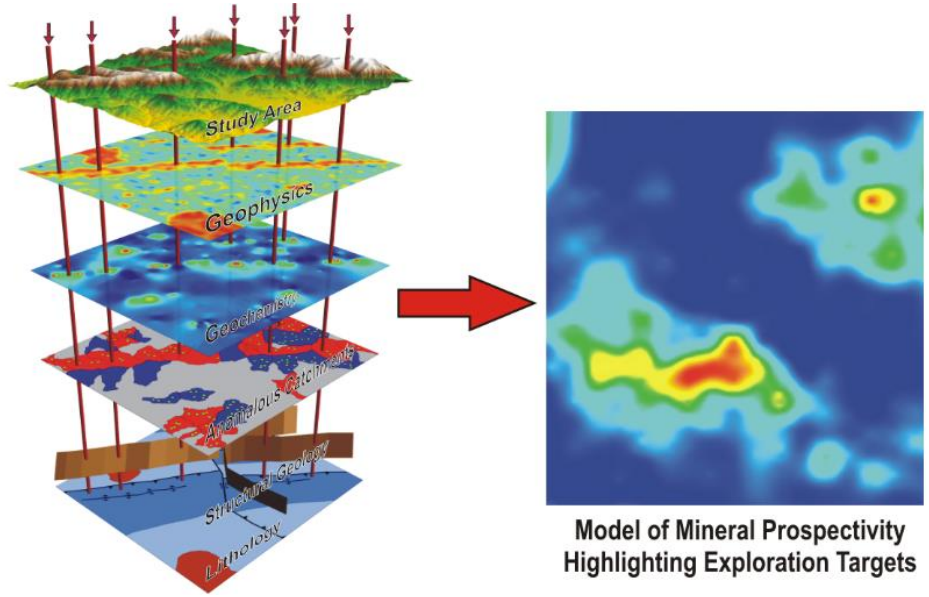
- NSW's known metal occurrences and deposits occur almost exclusively in areas where prospective basement is at or near-surface.
- Mineral exploration has also focussed almost exclusively on these areas.
- Explorers need new tools and new data to give them the confidence to explore in covered terranes.



Mineral Potential Mapping

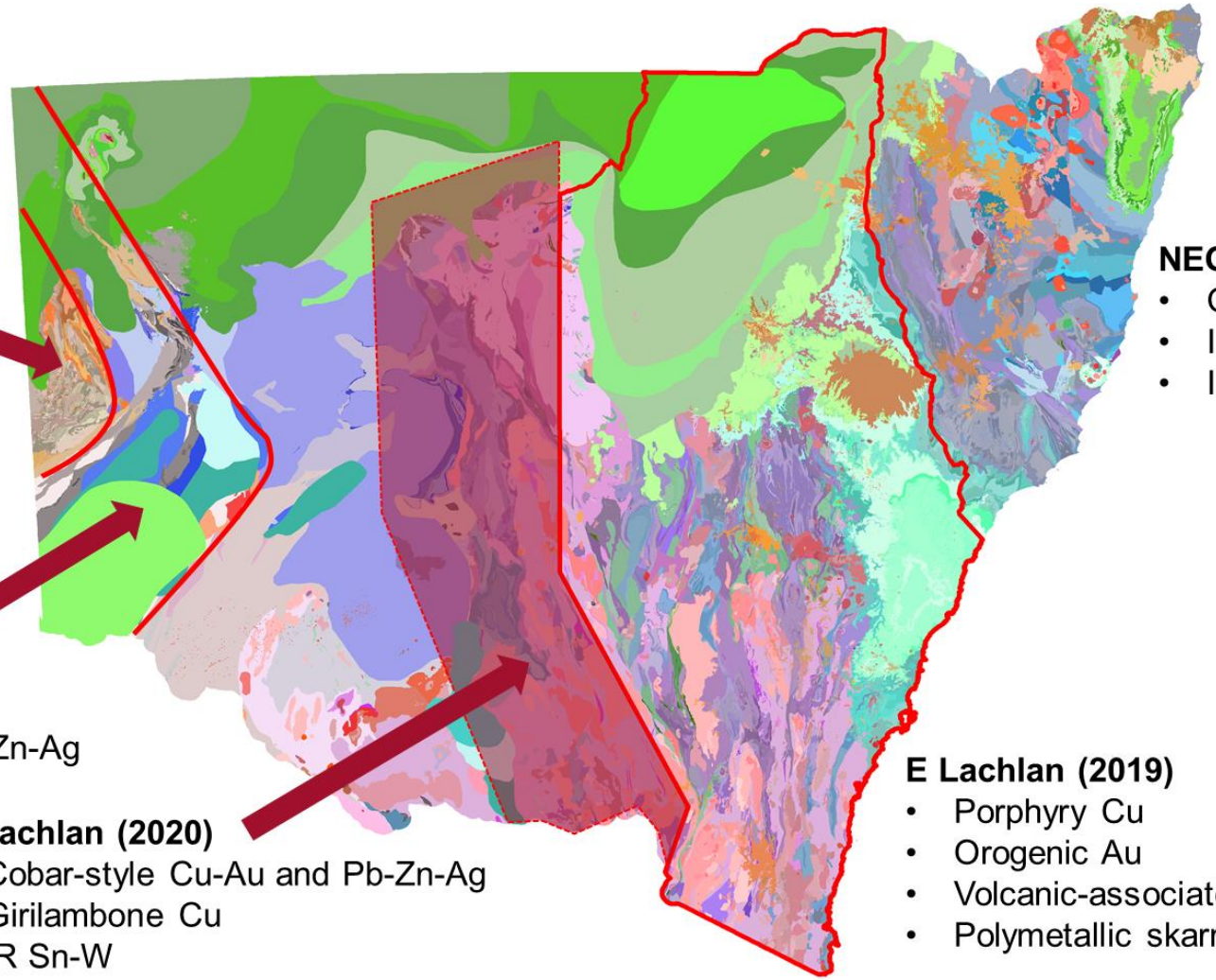
- Develop mineral system models and identify economic potential for key mineral systems
- Separate analyses for different:
  - geographic regions,
  - mineral system models,
  - orogenic terranes and time periods
- Developed in association with Kenex mostly using a weights of evidence approach





Model of Mineral Prospectivity Highlighting Exploration Targets

Mineral Potential Mapping



Curnamona (2018)
- Broken Hill type Pb-Zn-Ag
- Iron oxide Cu-Au

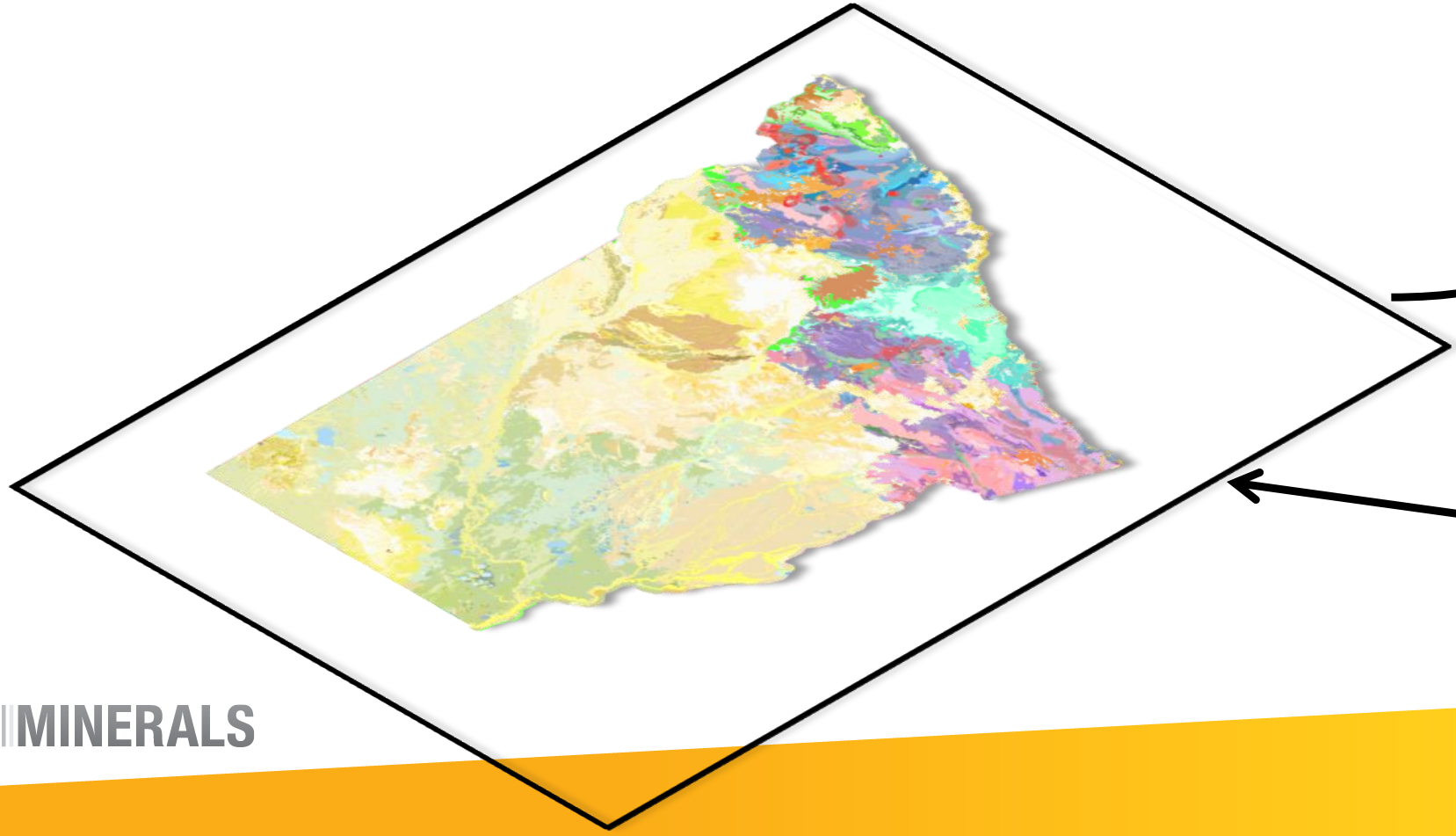
Delamerian (2018)
- Orogenic Au
- Volcanic-associated Cu-Pb-Zn-Ag

W Lachlan (2020)
- Cobar-style Cu-Au and Pb-Zn-Ag
- Girilambone Cu
- IR Sn-W

NEO (2017)
- Orogenic Au-Sb
- IR Sn-W
- IR Au

E Lachlan (2019)
- Porphyry Cu
- Orogenic Au
- Volcanic-associated Cu-Pb-Zn-Ag
- Polymetallic skarns

NSW Seamless Geology

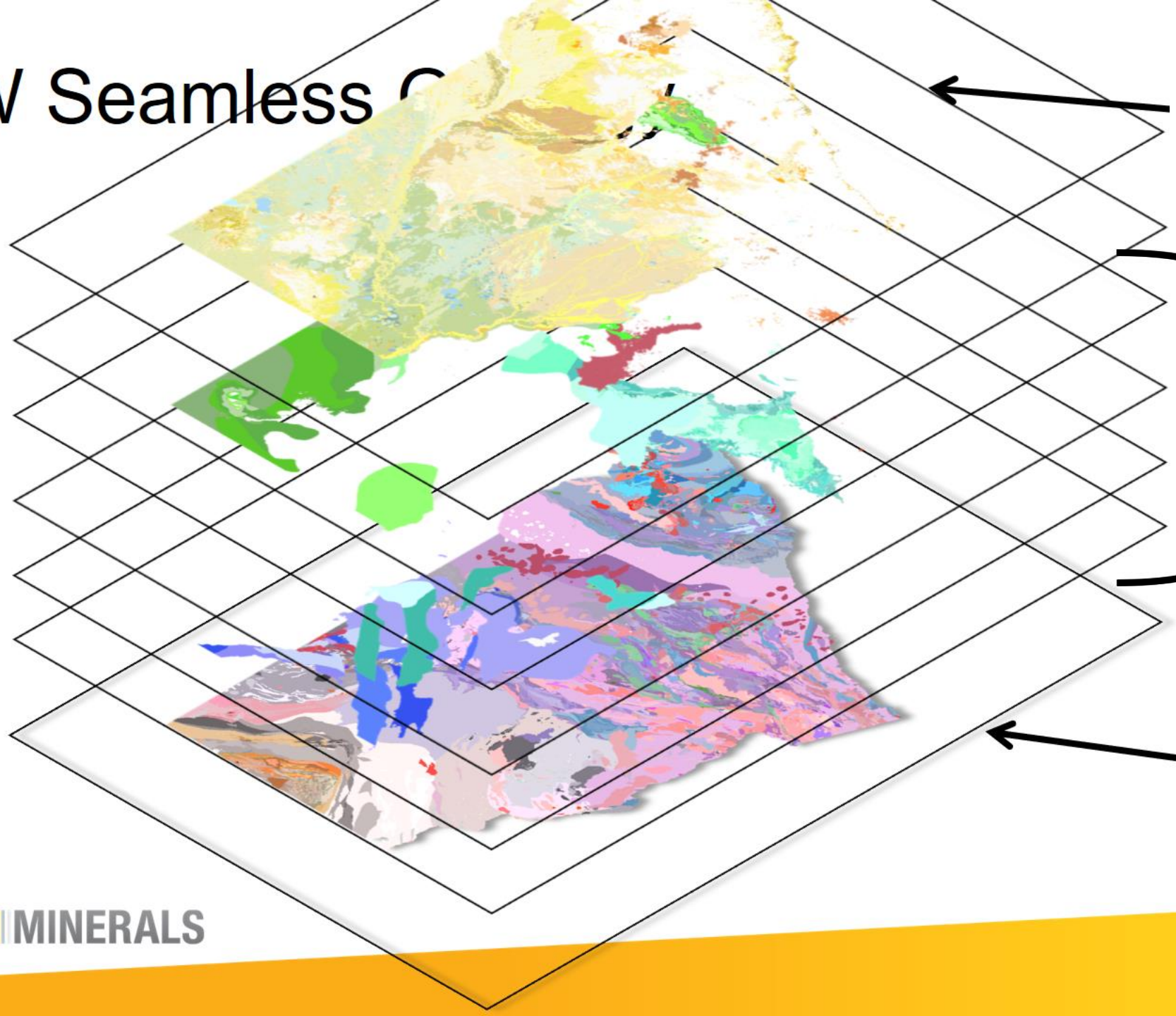


Unconsolidated cover (e.g. Cenozoic)

Consolidated cover (e.g. P-T, J-C basins)

Solid basement

NSW Seamless G



Unconsolidated cover (e.g. Cenozoic)

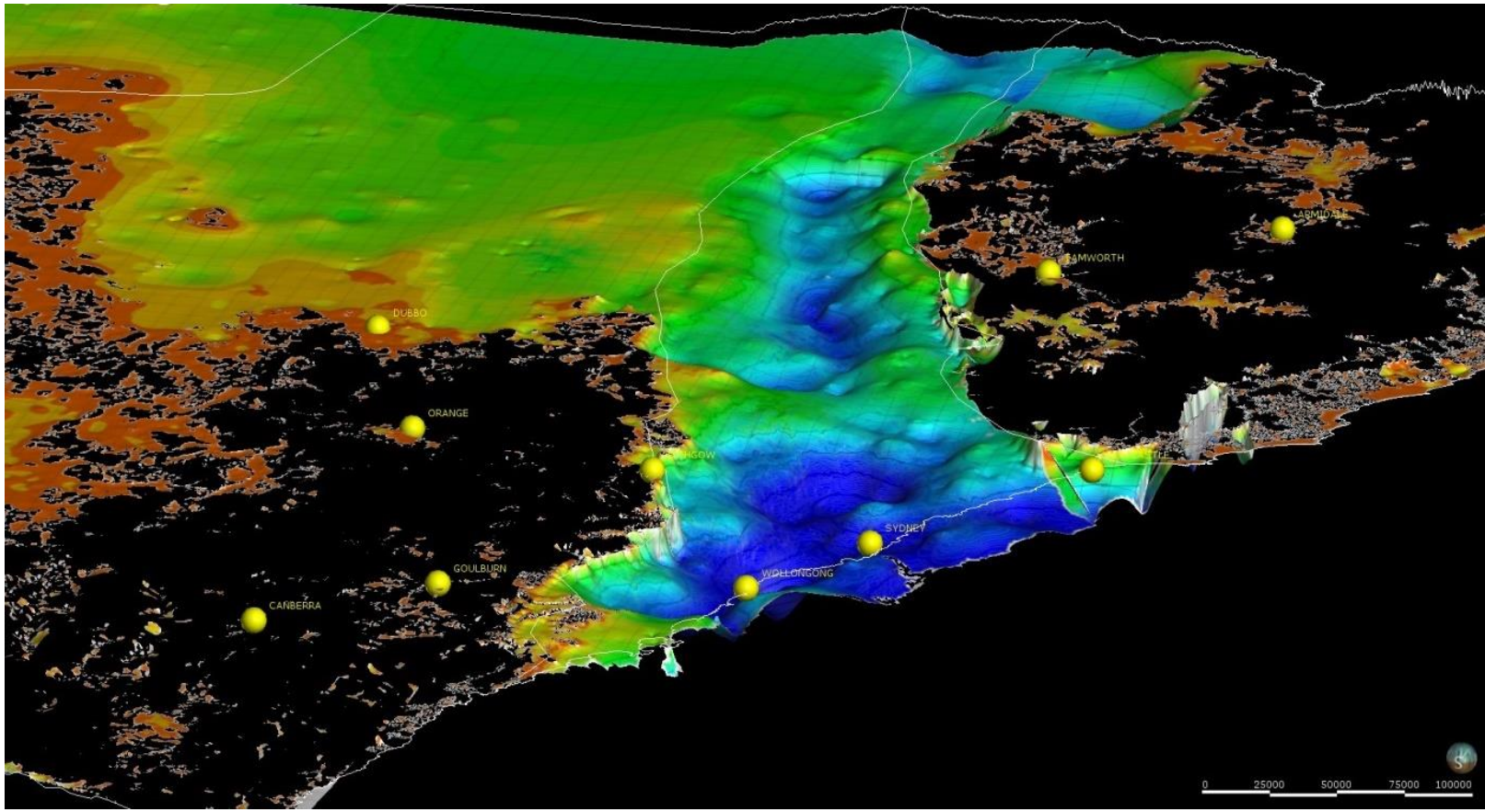
Consolidated cover (e.g. P-T, J-C basins)

Solid basement

Constraints to exploration - Cover

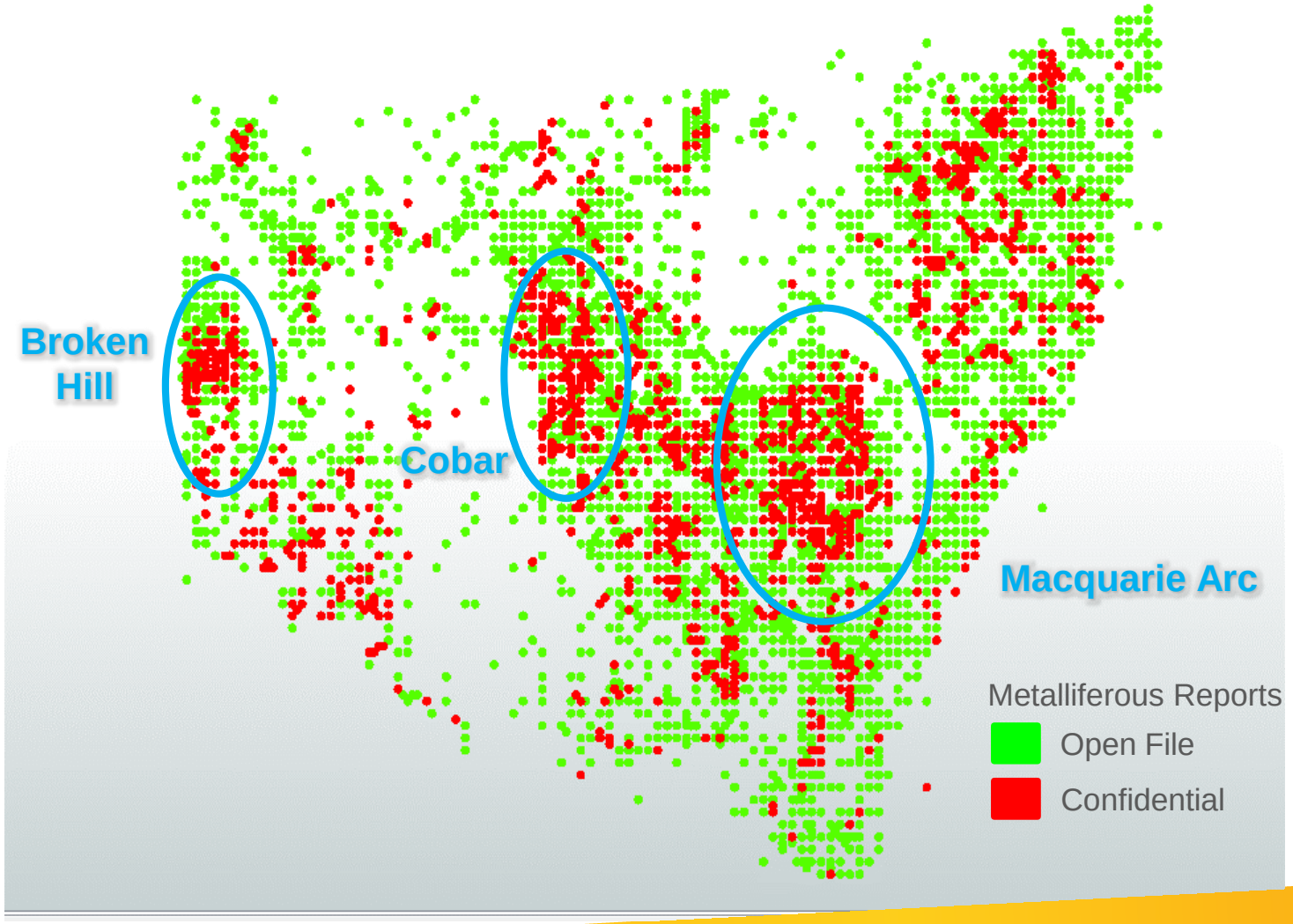
A depth to basement model has been created to:

- Constrain thickness of post-Carboniferous cover on crystalline basement.
- Define geometry of overlying basins.
- Integrate 3-D basinal architecture with seamless geology.



Maximising available data

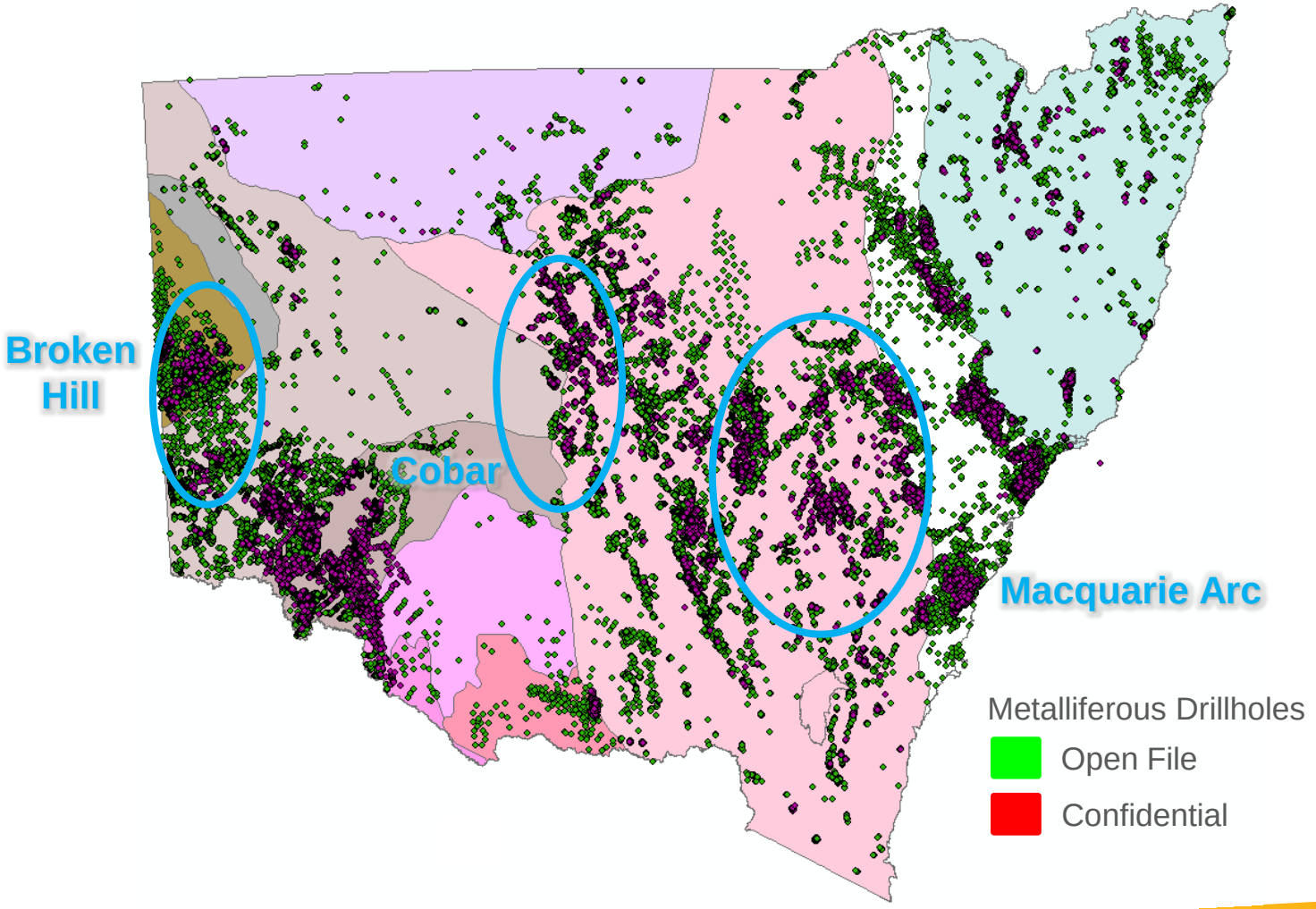
- GSNSW stores a vast collection of drillhole logs, geochemistry, and geophysical data extracted from reports
- In June 2021 confidential company reports and data that were submitted before 1st June 2016 will be released



Maximising available data

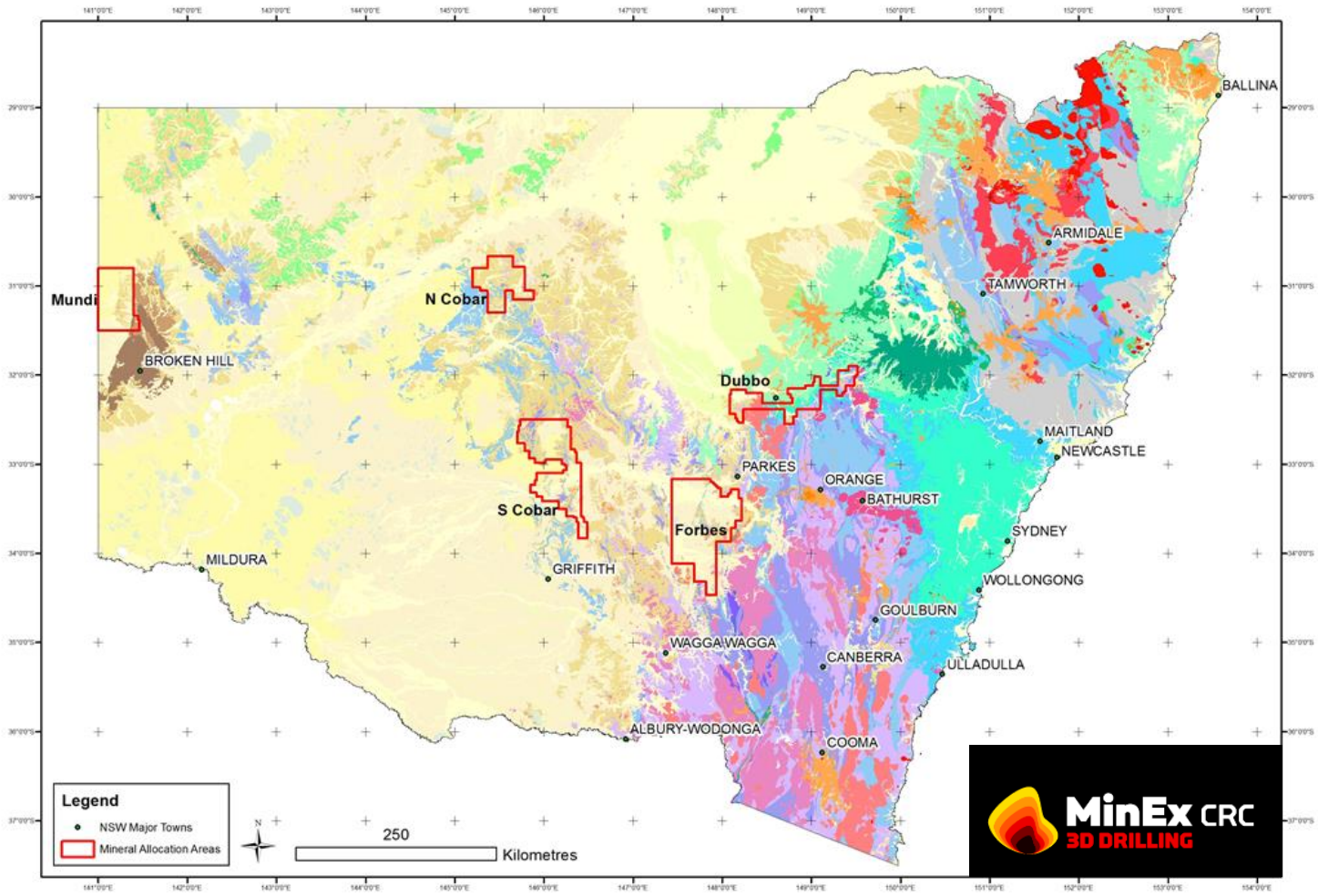
- GSNSW stores a vast collection of drillhole logs, geochemistry, and geophysical data extracted from reports
- In June 2021 confidential company reports and data that were submitted before 1st June 2016 will be released
- Digital confidential data* to be released includes:
  - 43% of all exploration reports
  - 49% of all drill collar records
  - 82% of all drillhole samples
  - 48% of all surface samples

** Digital capture of data commenced in Yr 2000.*



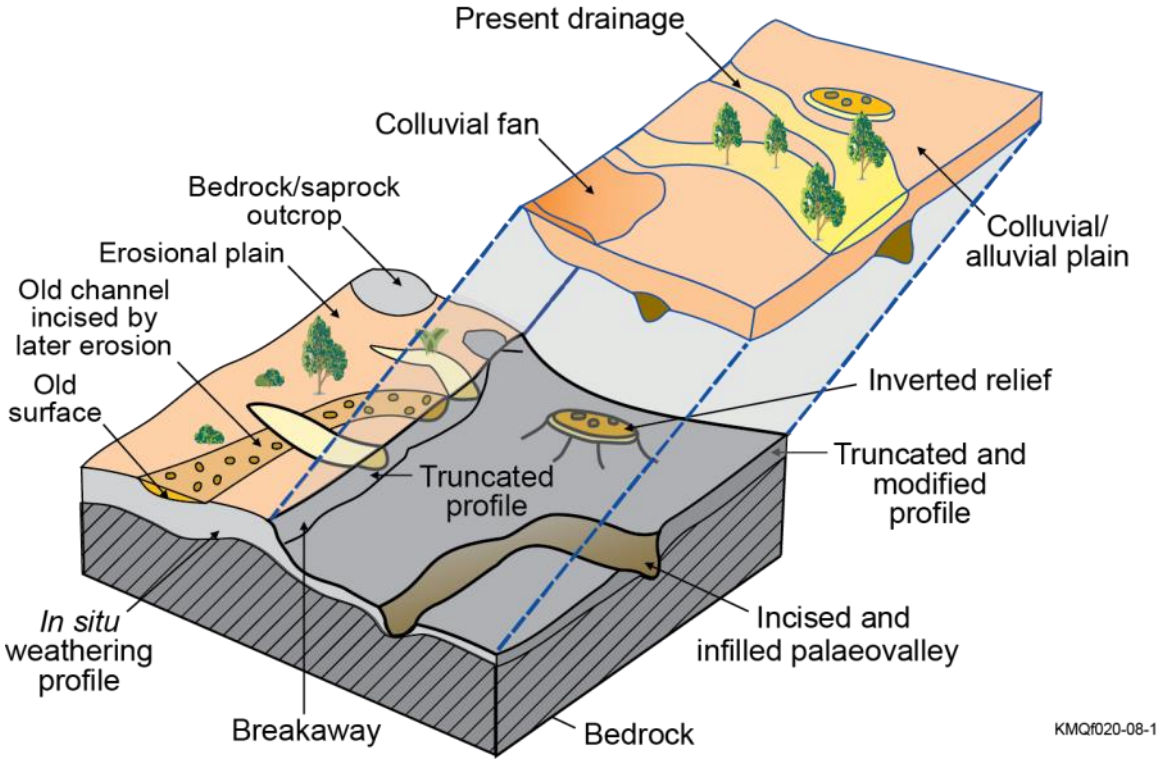
NSW approach to National Drilling Initiative

- Area Selection Criteria:
  - extensions of important mineralised terranes under cover
  - excluding environmentally sensitive areas and hard-rock aquifers.
- Five areas were identified:
  - North Cobar, South Cobar, Mundi, Forbes & Dubbo.
- Intended program of work:
  - Compile and assess legacy data
  - Conduct targeted geochemical and geophysical surveys.
  - Bio-geochemistry and hydro-geochemistry
  - Palaeo-surface regolith studies
  - Complete drilling on 5km grid



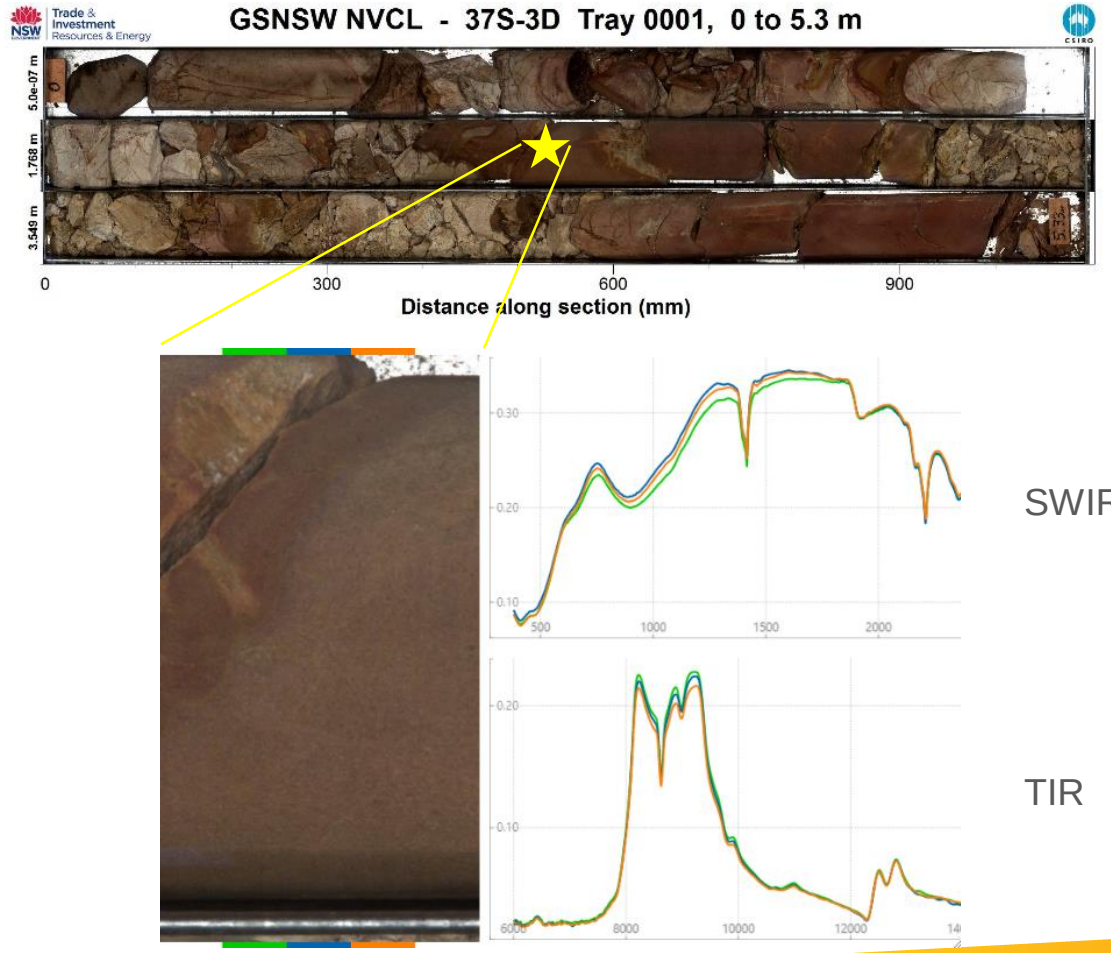
Interpreting cover at the surface and depth

Example - Cobar Regolith



Cobar Mineral Exploration Guide, McQueen (2013)

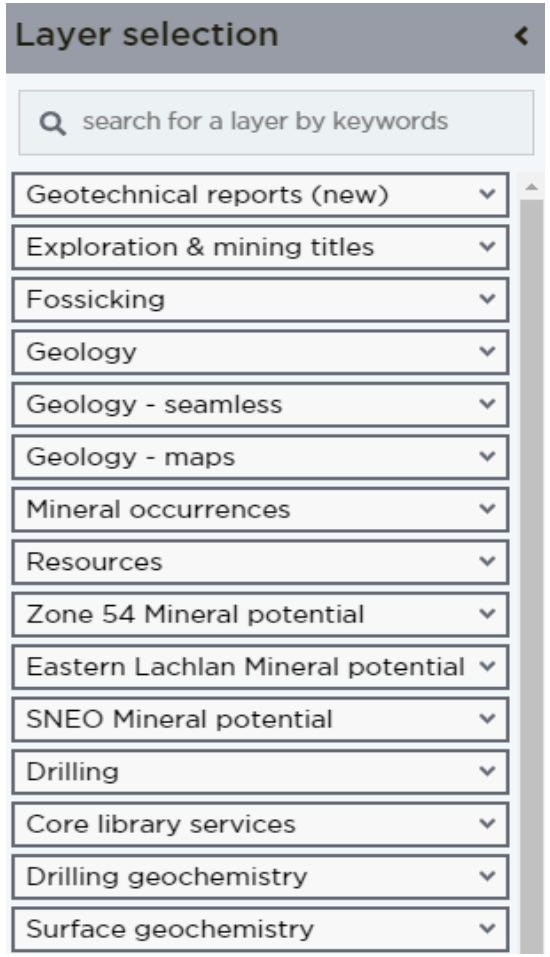
National Virtual Core Library



NSW data delivery platforms

Visualise, Interrogate & deliver data with MinView

- 400+ layers
- Daily updates
- Contains:
  - Geoscientific data
  - Reference data
  - Base maps
  - Links to reports, core library samples, hyperspectral data, geophysical surveys & more …



Supported on Windows, iOS and Linux operating systems

Further information

Visit the NSW stand for live demonstrations.

search.geoscience.nsw.gov.au

dwh.minerals.nsw.gov.au

Minview.geoscience.nsw.gov.au

NSW Geology Maps
Apple: download NSW Geology Maps from the App Store
Android: Browse to tinyurl.com/gsnsw123

Please visit

Michael Wright – Deputy Secretary

Paul Dale, or

Alvin D'Almaida

at the NSW stand

www.resourcesandgeoscience.nsw.gov.au

AUSTRALIA MINERALS

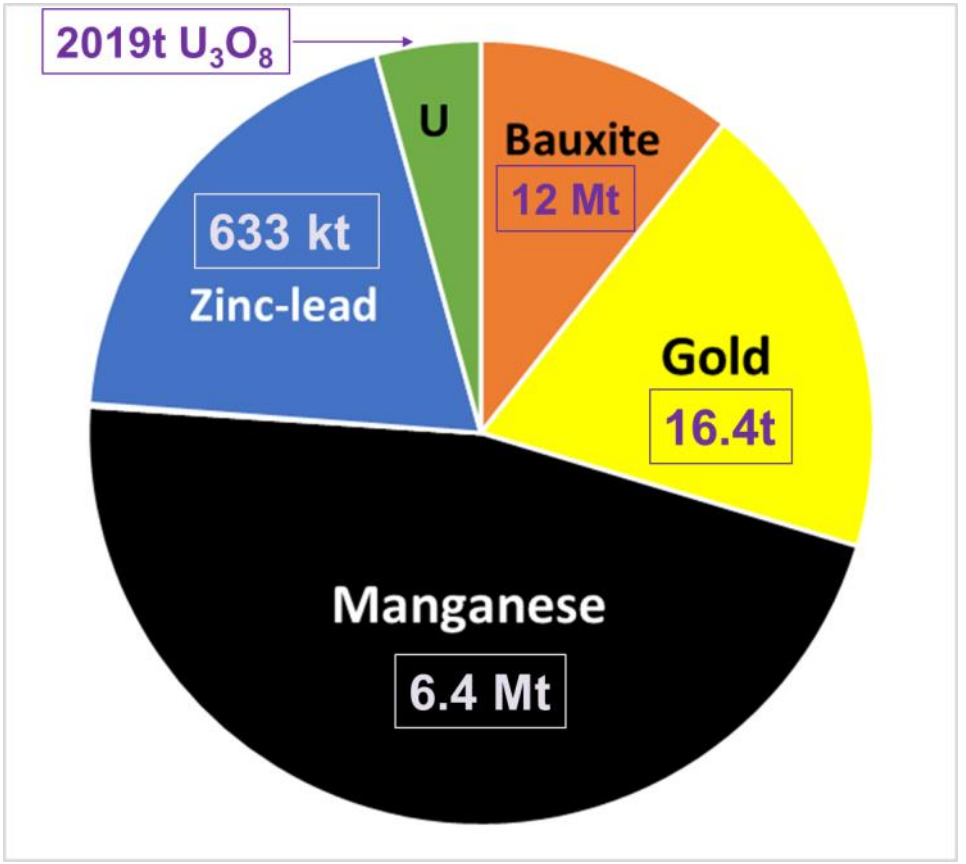
REALISE THE OPPORTUNITY

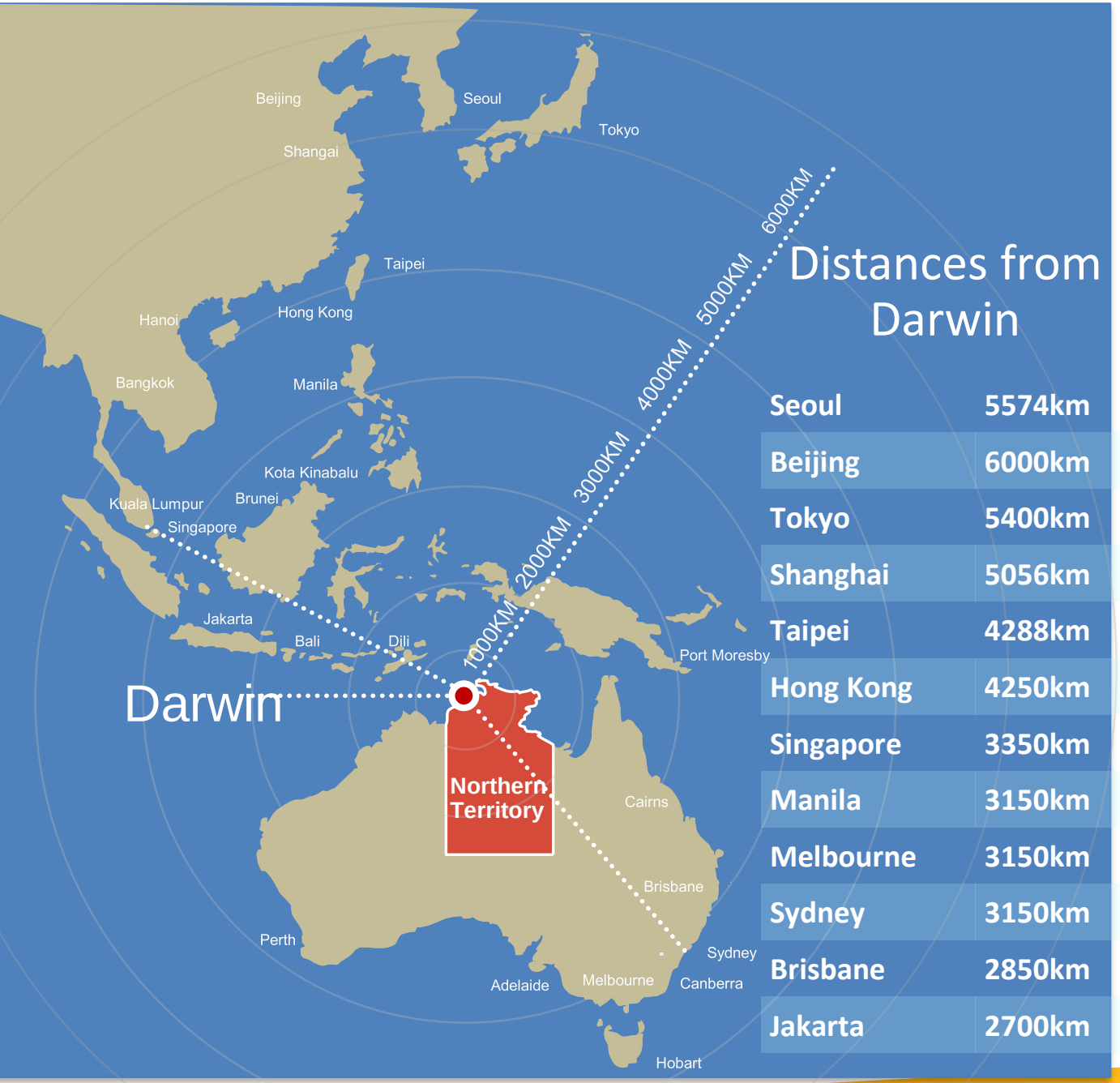
New geoscience expanding the search space for gold and copper-gold in the NT

Ian Scrimgeour
Executive Director
Northern Territory Geological Survey

Australia's Northern Territory

Mineral production 2018/19





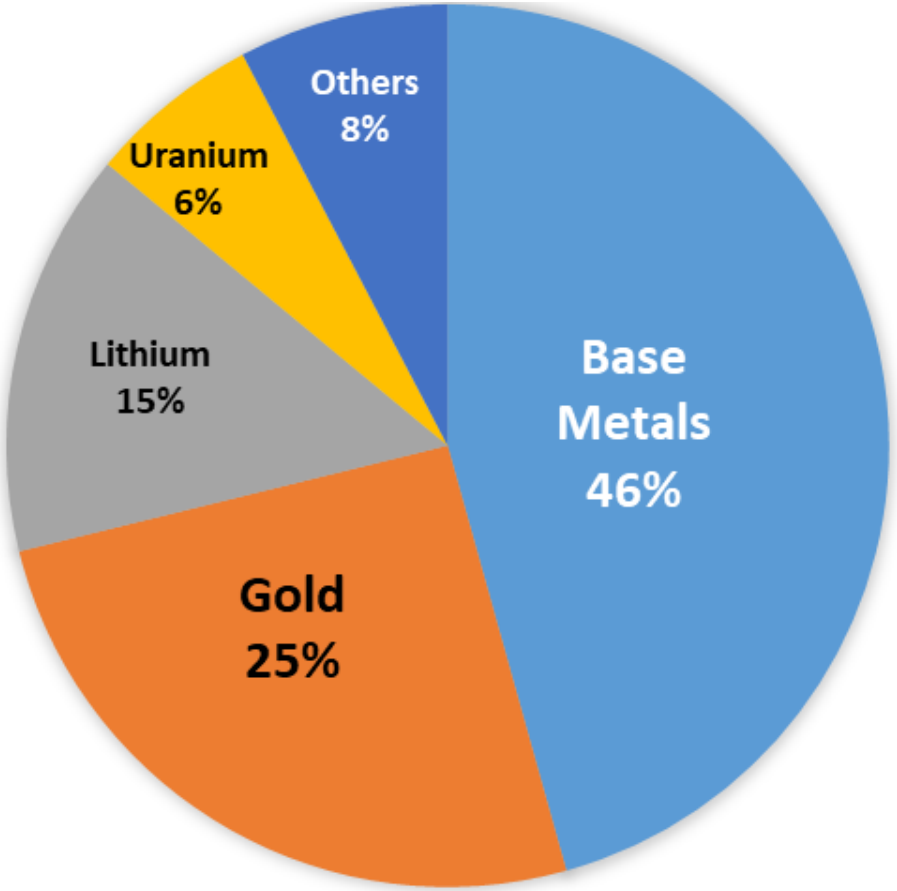
Distances from Darwin

Seoul	5574km
Beijing	6000km
Tokyo	5400km
Shanghai	5056km
Taipei	4288km
Hong Kong	4250km
Singapore	3350km
Manila	3150km
Melbourne	3150km
Sydney	3150km
Brisbane	2850km
Jakarta	2700km

Exploration in the Northern Territory

- Key commodities are **copper, zinc, gold, lithium and uranium**
- Large areas underexplored
- Other main commodities for exploration and developing projects:
  - **cobalt, potash, phosphate, vanadium, rare earths, tungsten**
  - Major emerging **shale gas** sector
- Many projects seeking partners for joint ventures, equity investment, project finance, construction and/or offtake
- Exploration expenditure up 78% in two years, to $132M (2018/19)

On-ground exploration expenditure by commodity: 2018-19



Resourcing the Territory **initiative**

RESOURCING THE TERRITORY

NORTHERN TERRITORY GOVERNMENT

4 year (2018-2022), $26 million NT Government initiative to grow the exploration sector

Tanami airborne survey: *Photo courtesy of Prodigy Gold*

Supporting industry innovation through grants for greenfields exploration

Upgrading the Territory's coverage of geophysical data

Unlocking the resource potential of the Barkly and Gulf regions

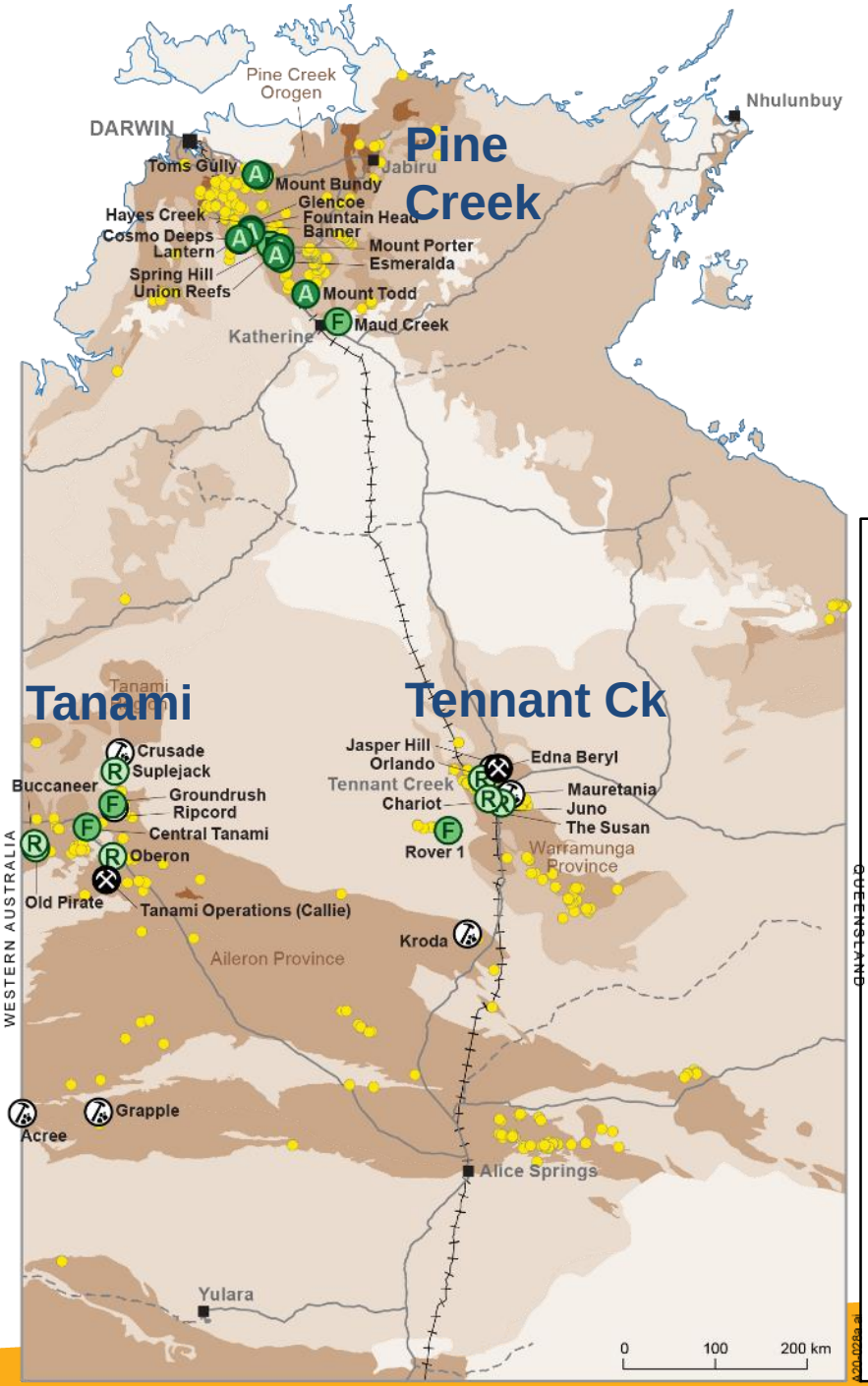
Stimulating greenfields exploration in central Australia

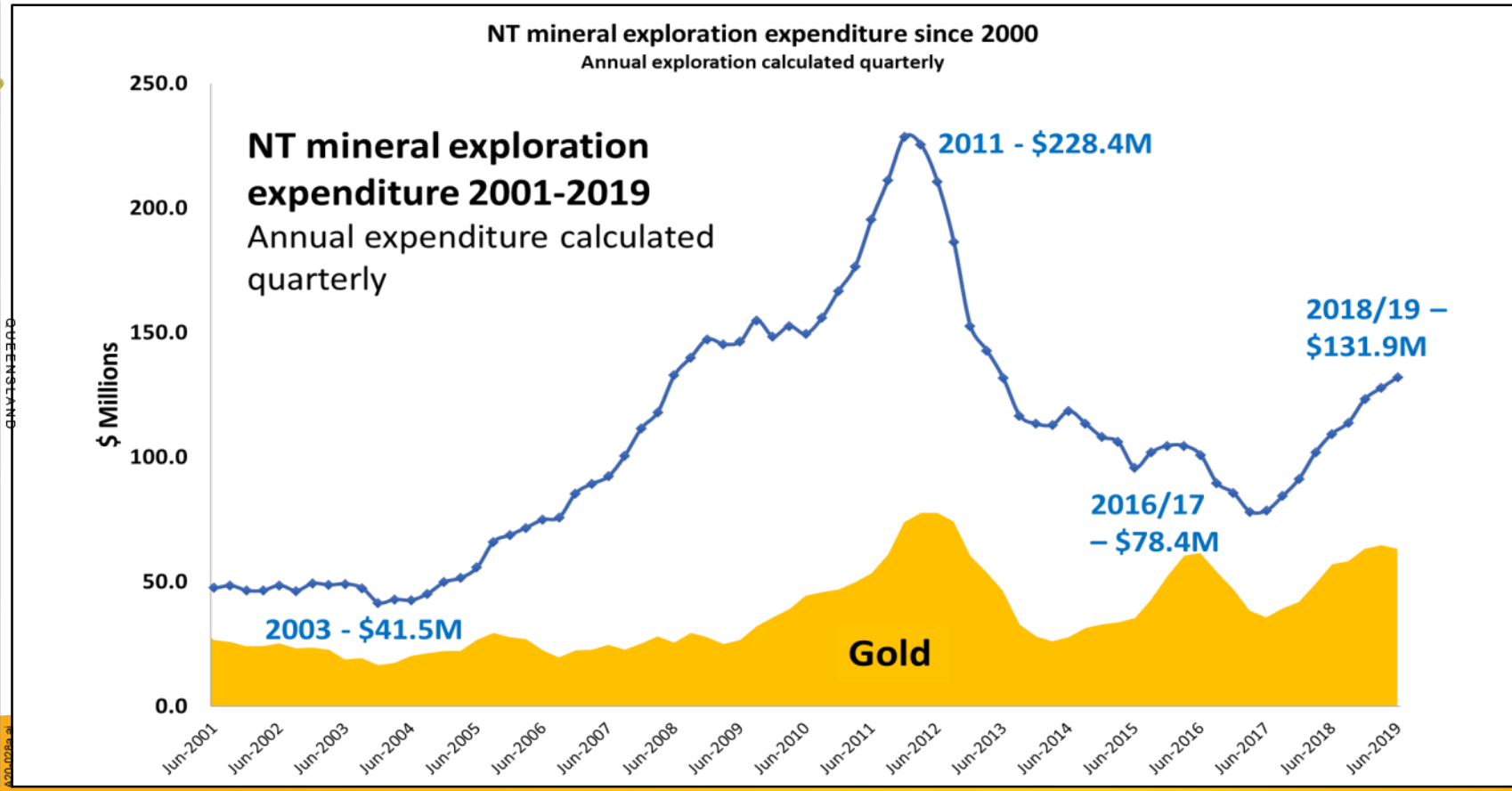
Promoting the Territory's resource potential and investment opportunities; and

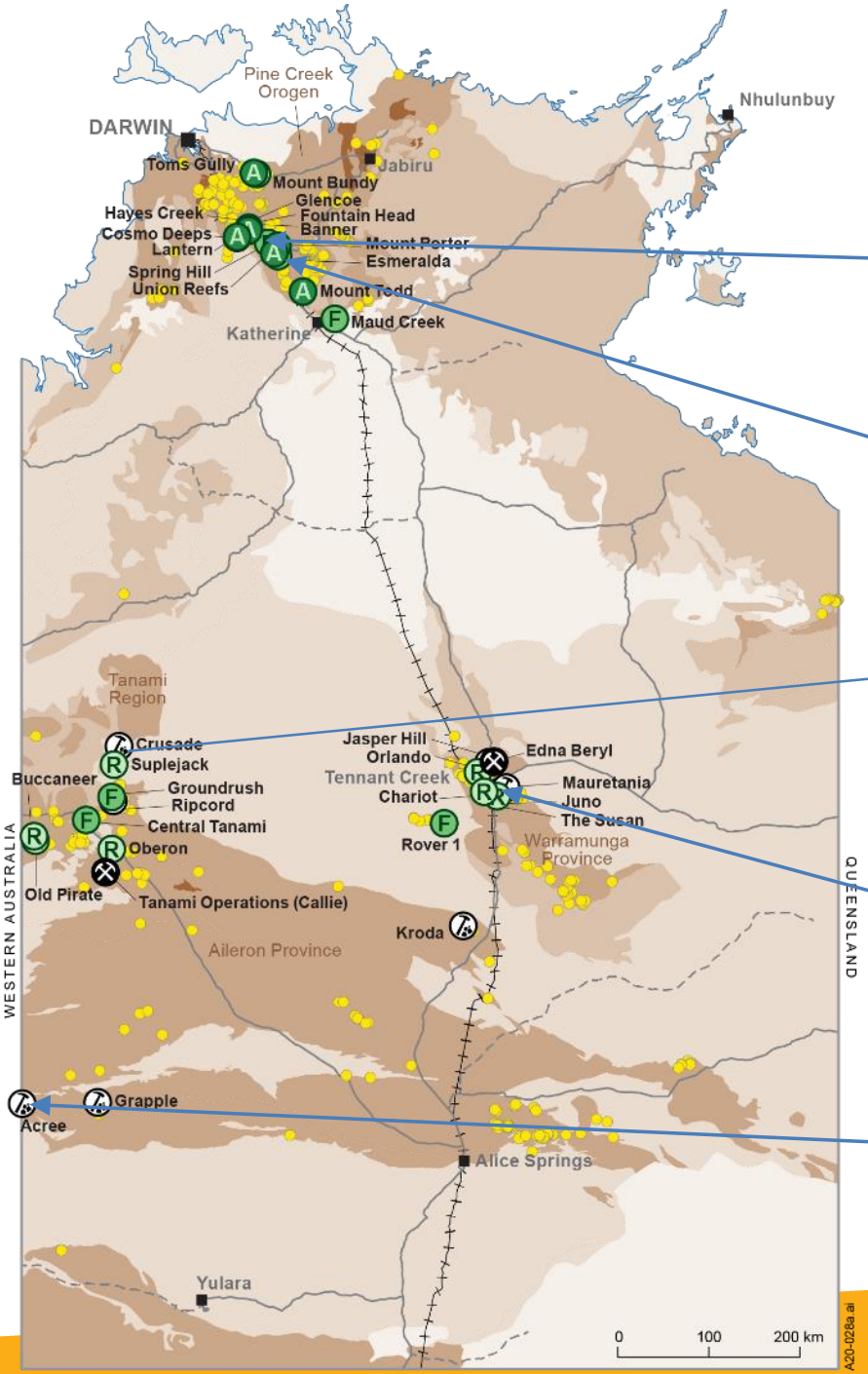
Making exploration and geoscience data more accessible

Gold in the Northern Territory

Three major goldfields
Orogenic gold in Pine Creek and Tanami goldfields
Ironstone-hosted copper-gold in Tennant Creek field







Recent gold exploration highlights:

Kirkland Lake Gold – Lantern
18.7m @ 40.8 g/t Au

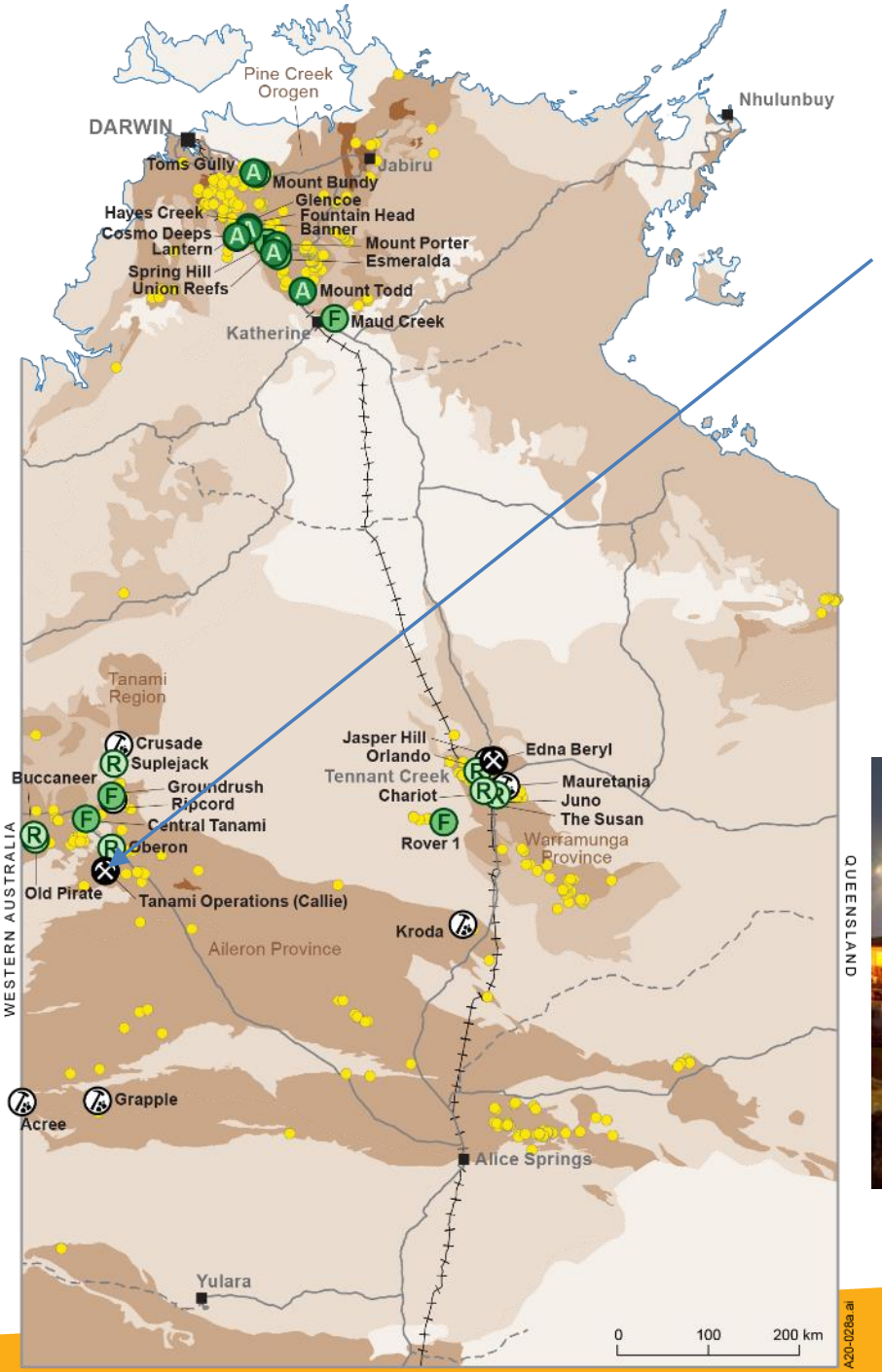
PNX Metals – Banner
5m @ 60.9 g/t Au

Northern Star Resources – Crusade
47m @ 3.66 g/t Au

Emmerson Resources – Mauretania
11m @ 54 g/t Au

IGO Ltd – Arcee (greenfields discovery)
12m @ 3.5 g/t Au

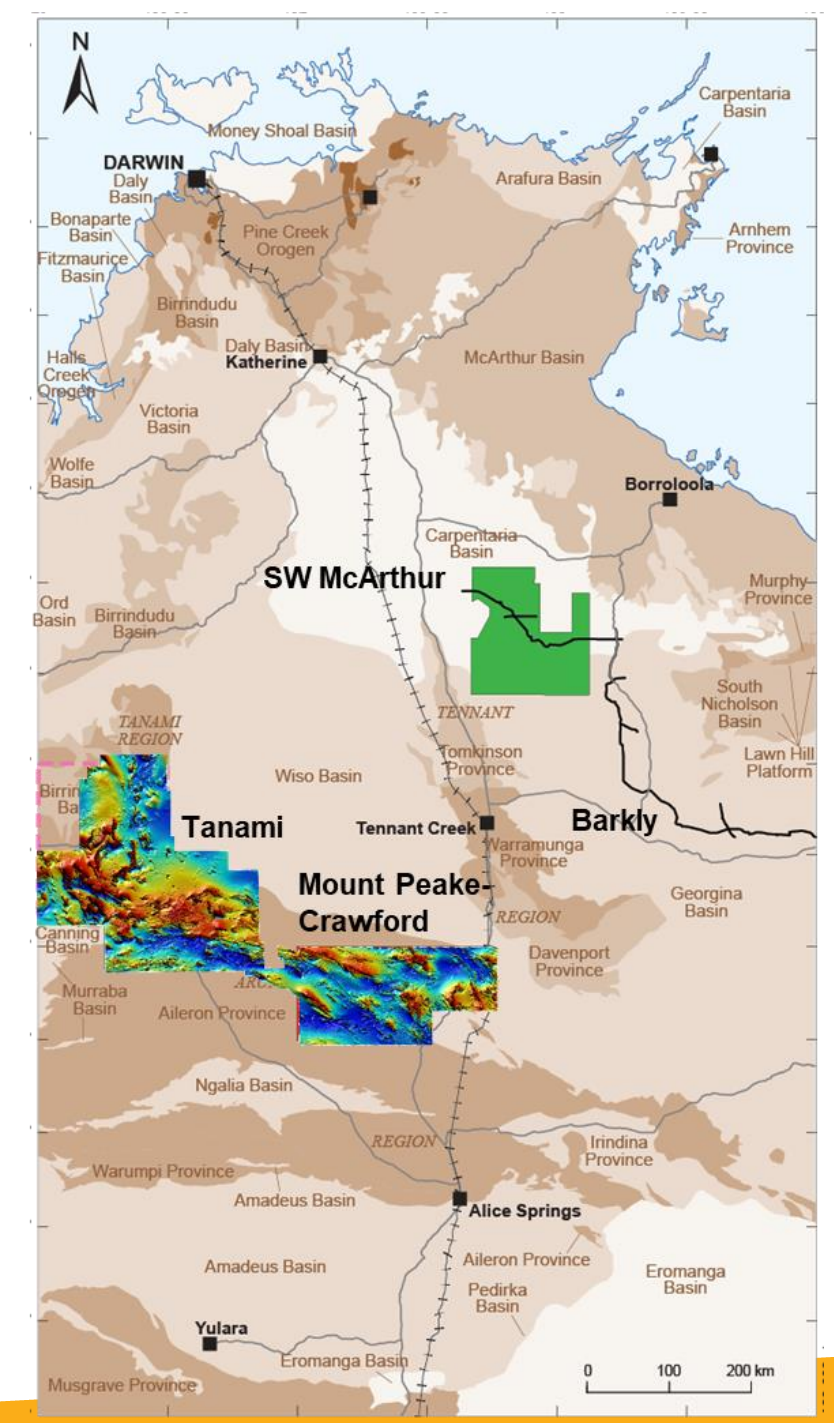
Tanami gold province



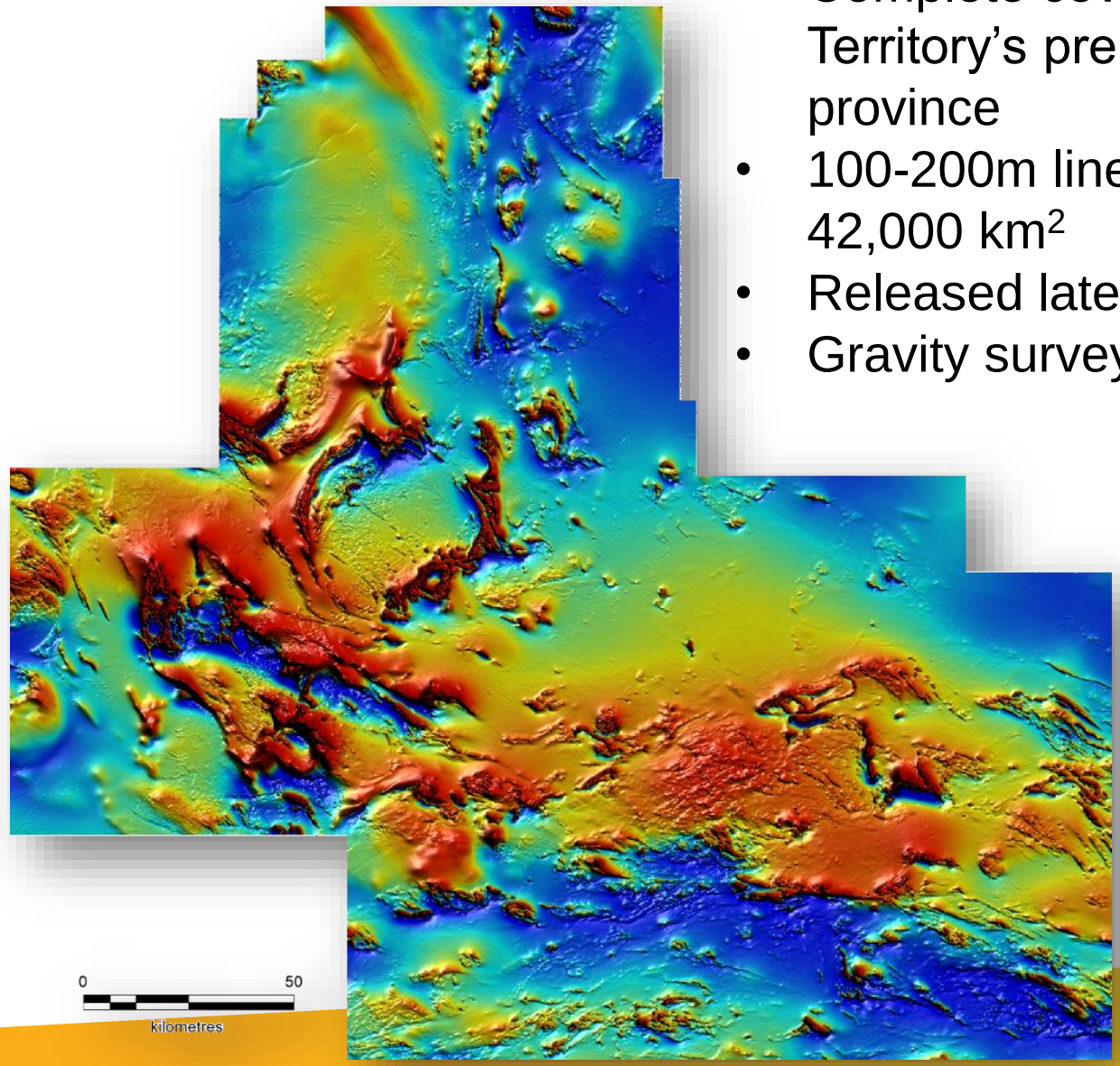
Newmont's Tanami operations

- 10 Moz production, over 5 Moz resources; 0.5 Moz/year production
- Current Ore Reserves: **26.6 Mt @ 5.5 g/t Au**
- 450 km gas pipeline and power station completed in 2019
- 1400m shaft to be developed, commencing 2020

Tanami gold province

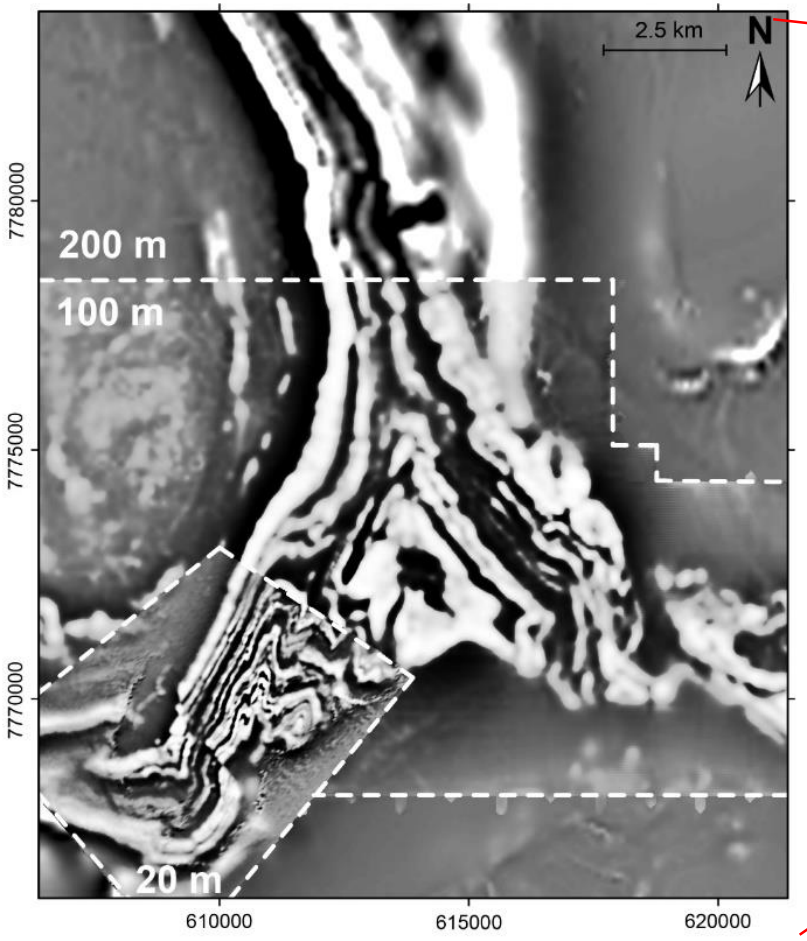


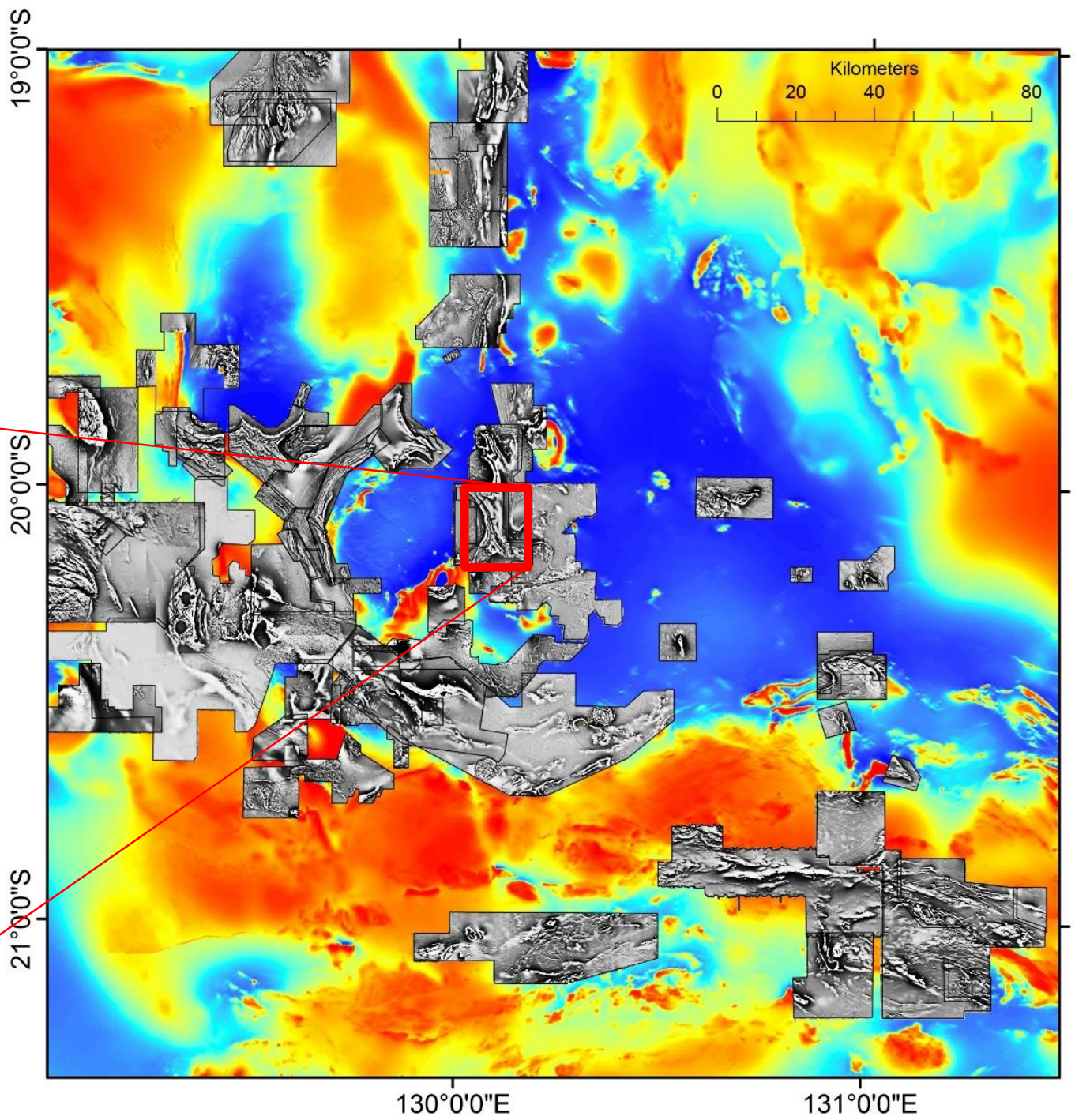
- Complete coverage of the Territory's premier gold province
- 100-200m line spacing; 42,000 km^2
- Released late 2019
- Gravity survey in 2020



Maximising the value of industry data

CSIRO-NTGS collaboration in the Tanami gold province

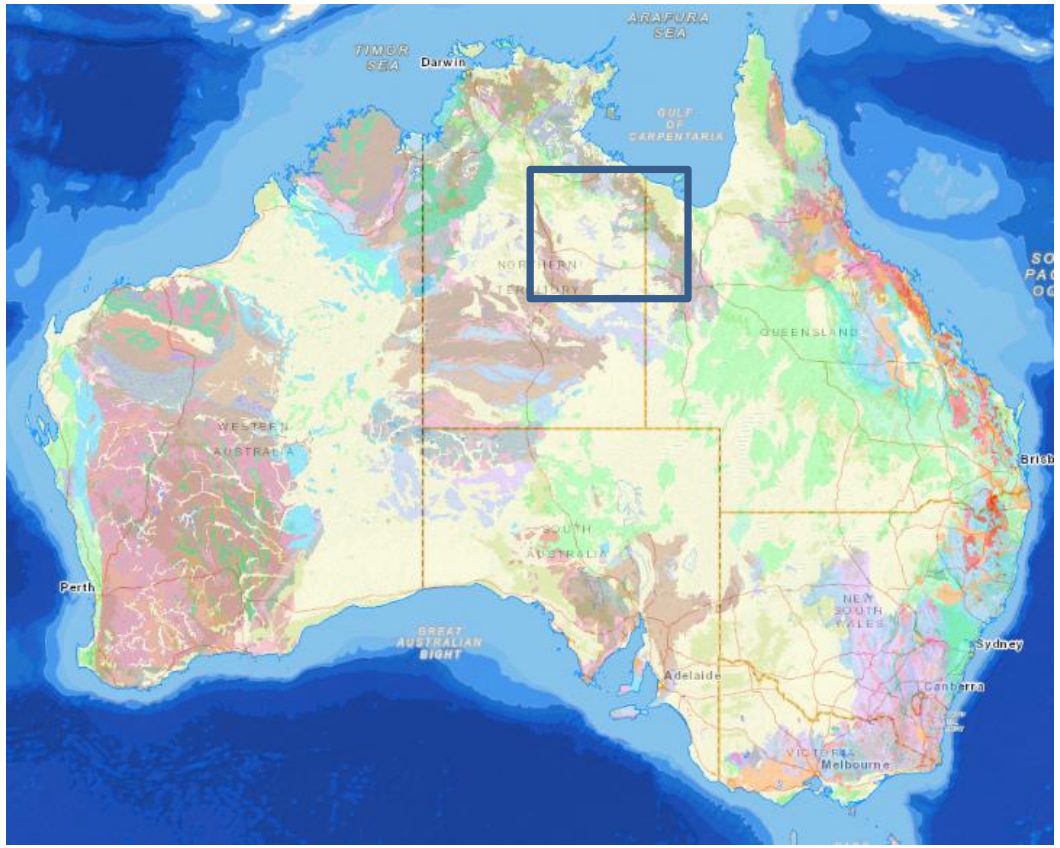




Australian Government
Geoscience Australia

Exploring for the Future
minerals | energy | groundwater

T-ISA (Tennant Creek-Mt Isa) Project



Why? Covered frontier between two known endowed mineral provinces

GA acquired new data to map geology and mineral systems from lithospheric roots to the near surface

- Surface geochemistry (soil, hydro)
- Cover thickness models
- Airborne electromagnetic data (AusAEM)
- Solid geology maps
- U-Pb geochronology
- Isotopic mapping
- Reflection seismic
- Long-period magnetotellurics (AusLAMP)
- Seismic velocity (AusARRAY)

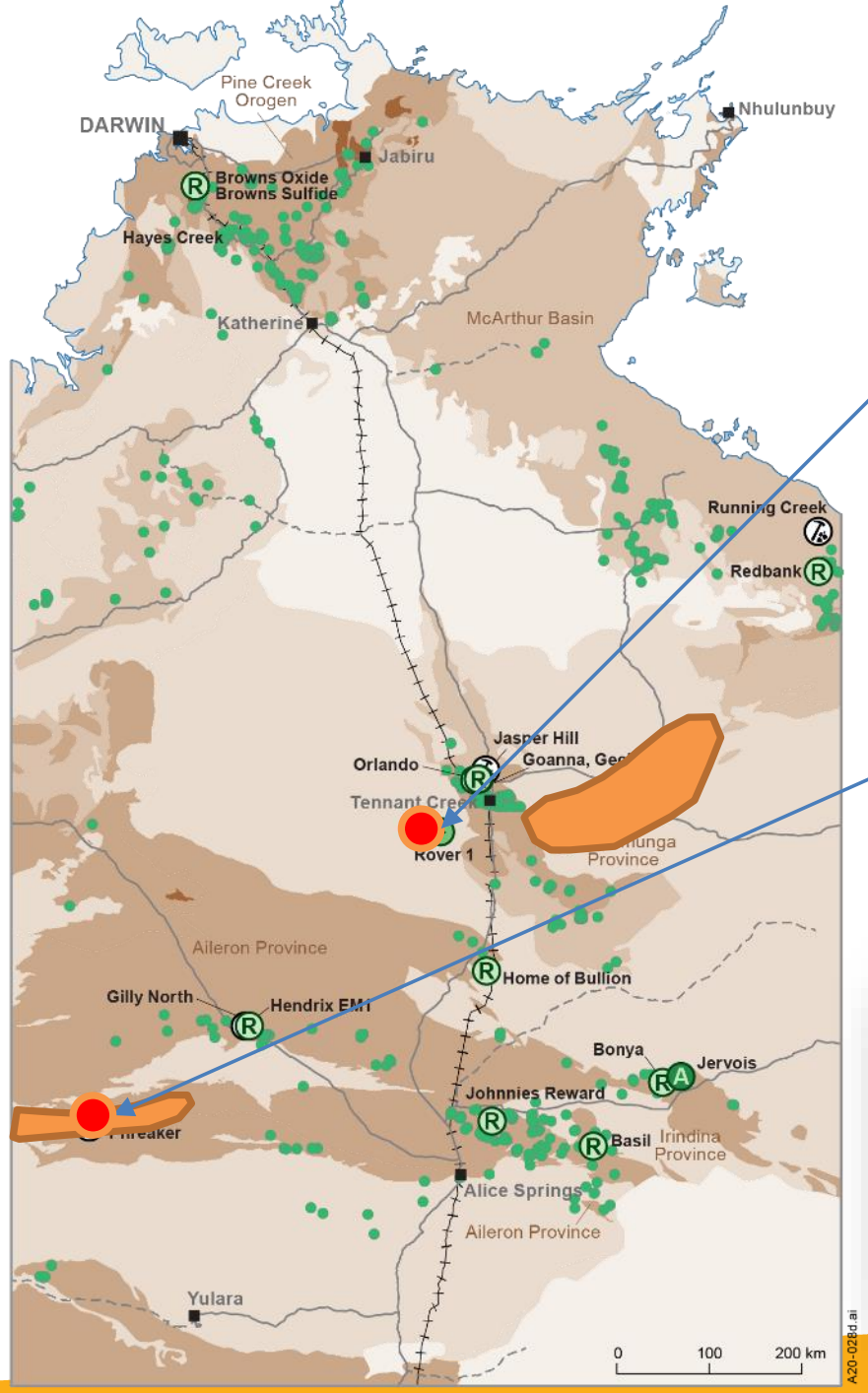
NTGS co-invested, acquired gravity, managed land access, undertook field mapping, supplied data and expertise

NORTHERN TERRITORY GOVERNMENT

RESOURCING THE TERRITORY

AUSTRALIA MINERALS

Copper-gold in the Northern Territory

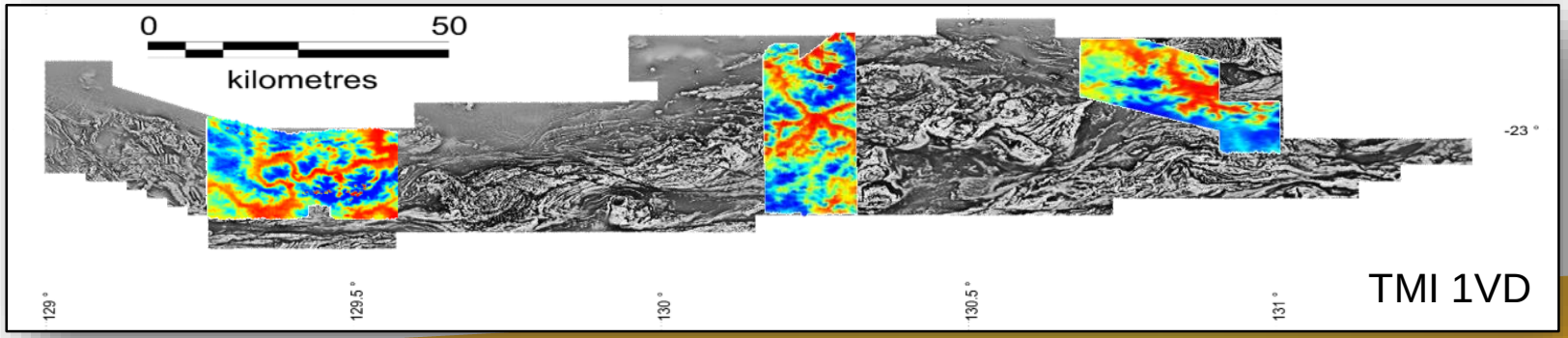


Castile Resources Ltd– Rover 1

- New well-funded company focussed on undercover Rover copper-gold field (6.8 Mt @ 1.21% Cu, 1.7g/t Au)
- New pre-competitive geoscience to further expand field

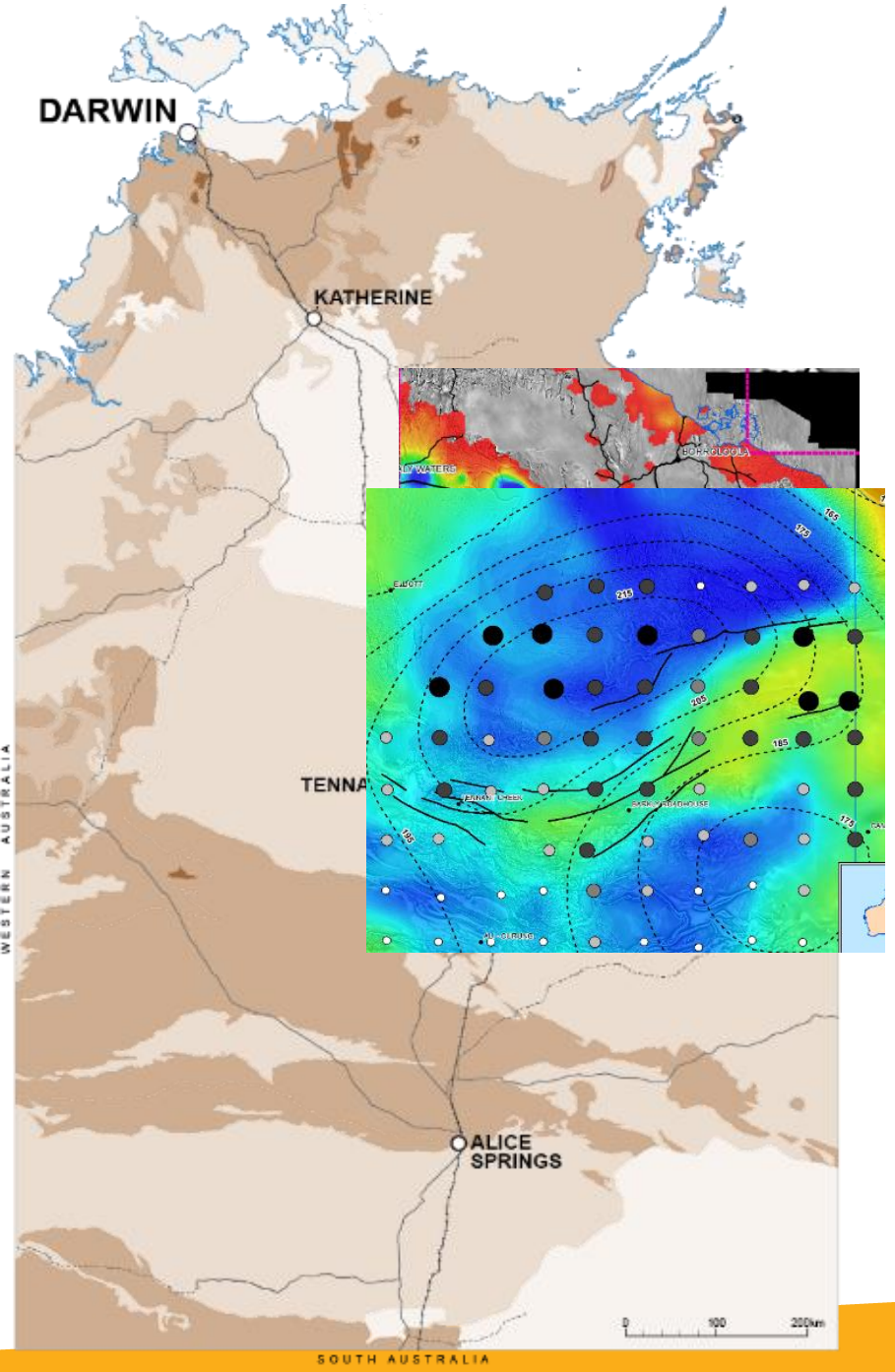
IGO Ltd – Prodigy Gold – Lake Mackay project

- Numerous greenfields intersections in previously undrilled region
- **Grapple:** 9 m @ 3.26% Cu, 1.8 g/t Au, 49.1g/t Ag, 3.63% Zn, 1.09% Pb and 0.26% Co
- **Arcee:** 12m @ 3.5 g/t Au

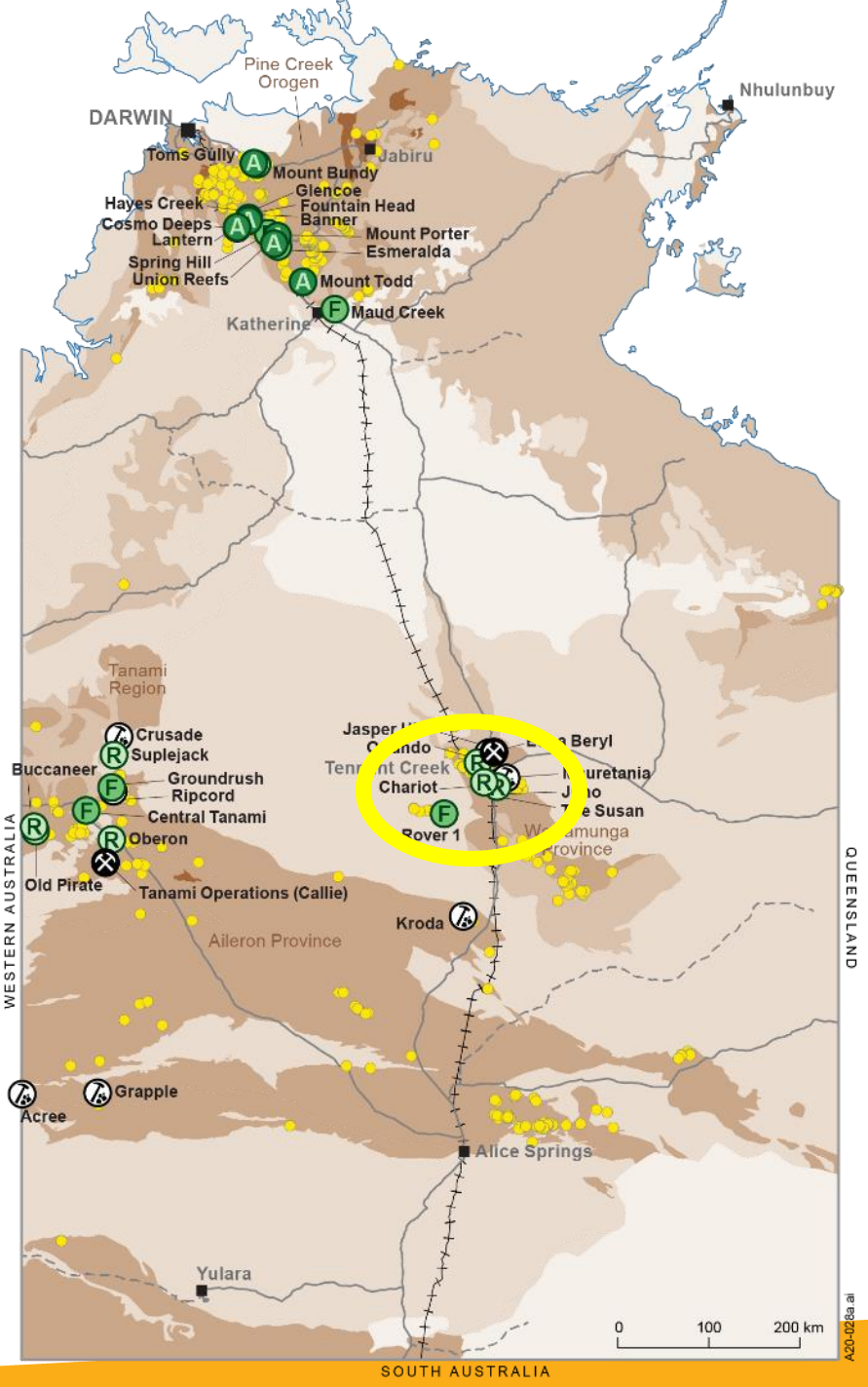


‘East Tennant’ region – emerging greenfields copper-gold province

Australian Government
Geoscience Australia



- Focus of activity under Geoscience Australia’s *Exploring for the Future* program
- Basement at exploreable depths (100-300m) along strike from Tennant Creek Cu-Au field
- Evidence for offsets in lithospheric and Moho depth, associated with gravity ridge and high conductivity zone in MT
- Very limited drilling in region shows evidence for hematite alteration
- Further seismic and drilling data to come

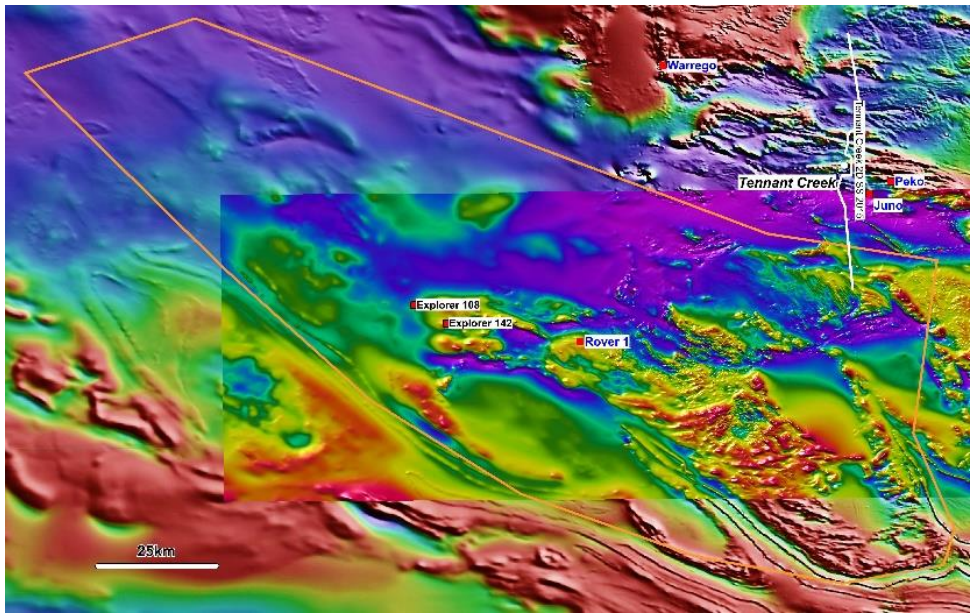


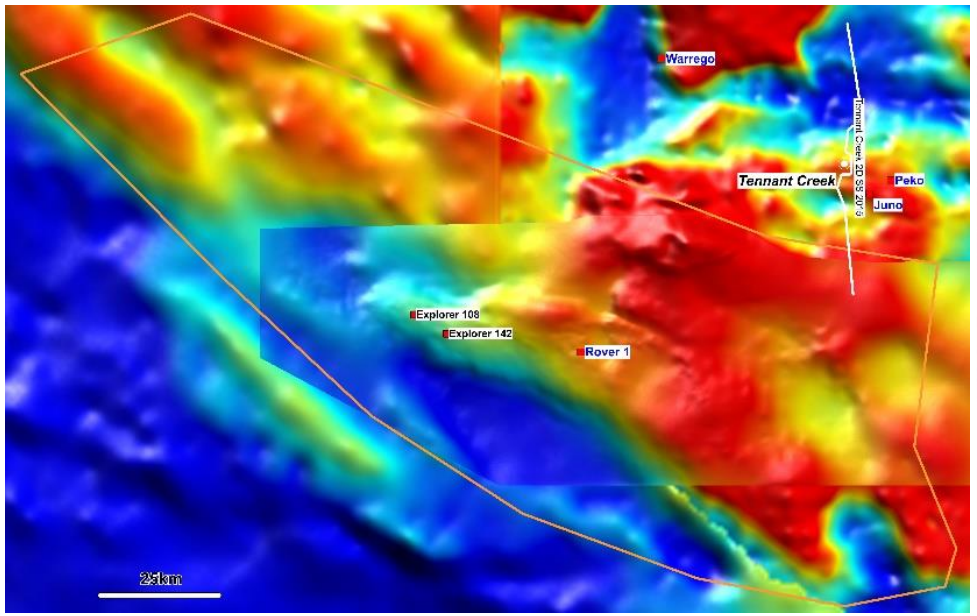
Tennant Creek – large amount of historical data, but not easily accessible

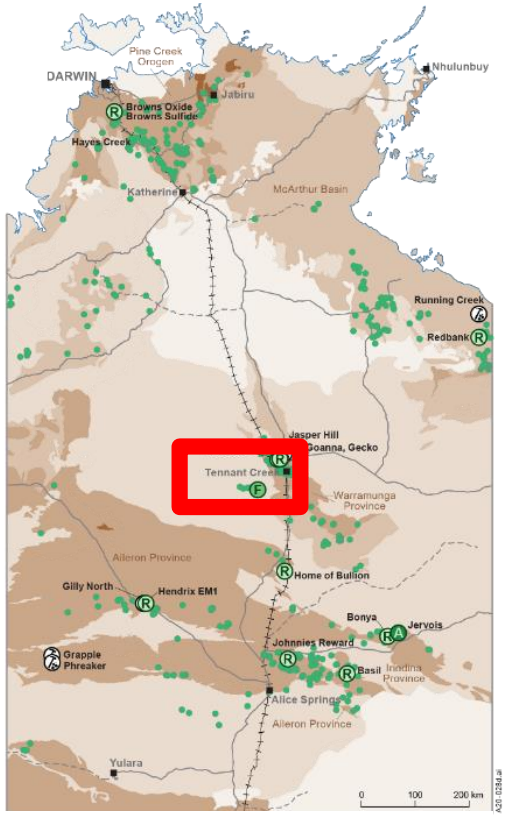
Numerous NTGS projects underway to improve accessibility and utility of data

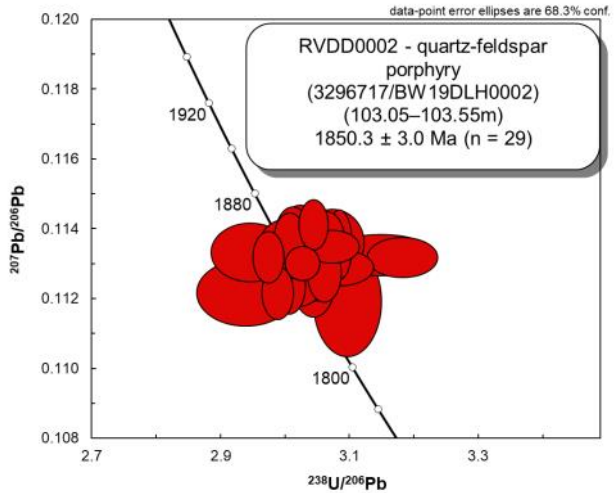
- Capture of all drilling and geochemistry data underway
- Compilation of all industry and Govt geophysics
  - High resolution grids of merged magnetic and gravity datasets
  - Enhancement filters of merged grids
  - Combined database of all gravity station data
- 3D mineral deposit atlases of Tennant Creek and Rover fields

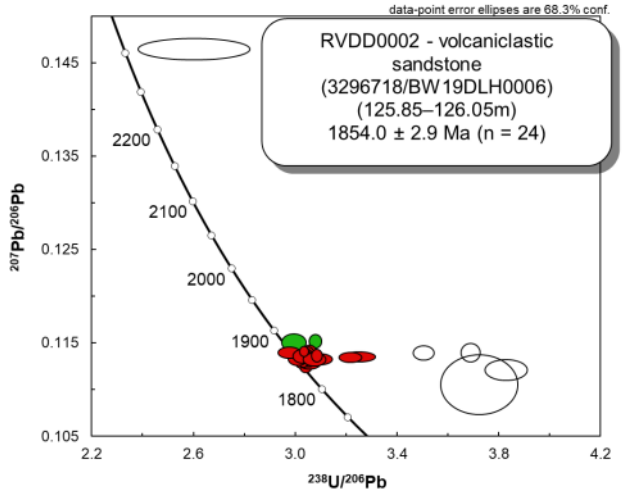
Rover field – studies underway to unravel framework (NTGS and GA)







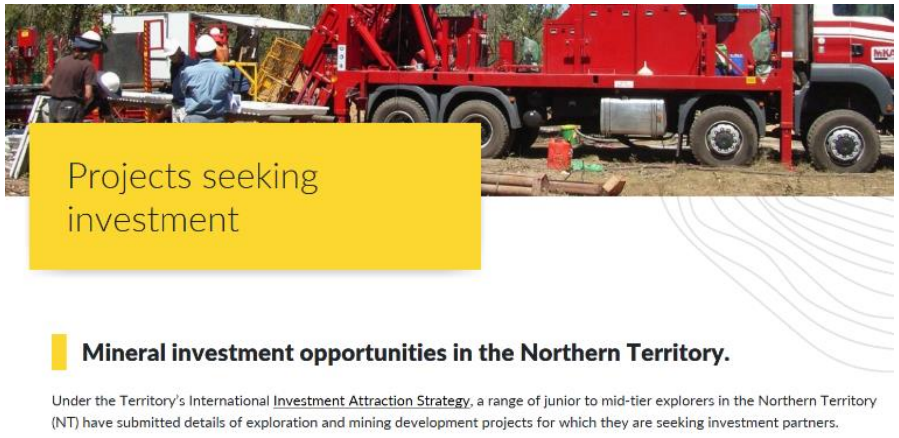


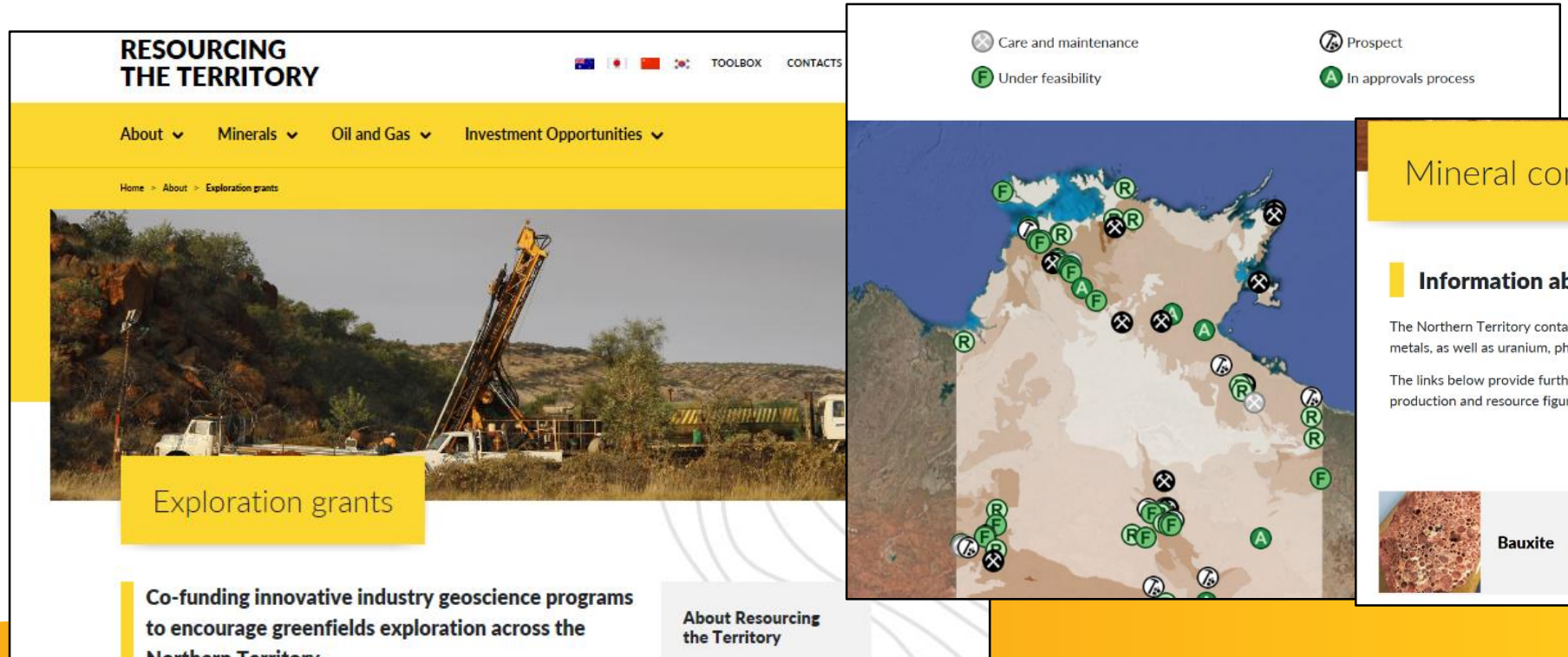


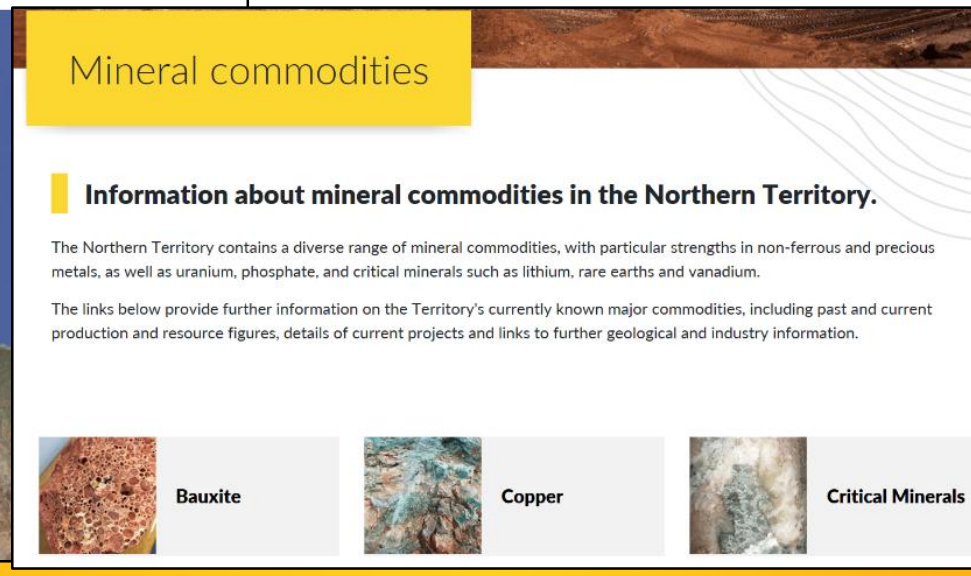
AUSTRALIA MINERALS

Resourcing the Territory website

- Information on commodities, status of projects, investment opportunities, geoscience programs and grants for explorers
- Launched late 2019
- resourcingtheterritory.nt.gov.au





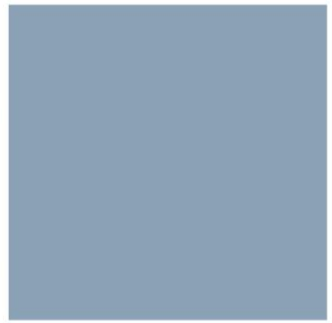


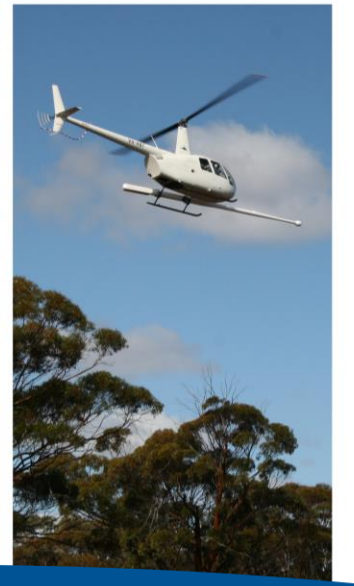
Gold in North Eastern Tasmania: an underexplored province

Andrew McNeill

1 March 2020

Gold in North Eastern Tasmania



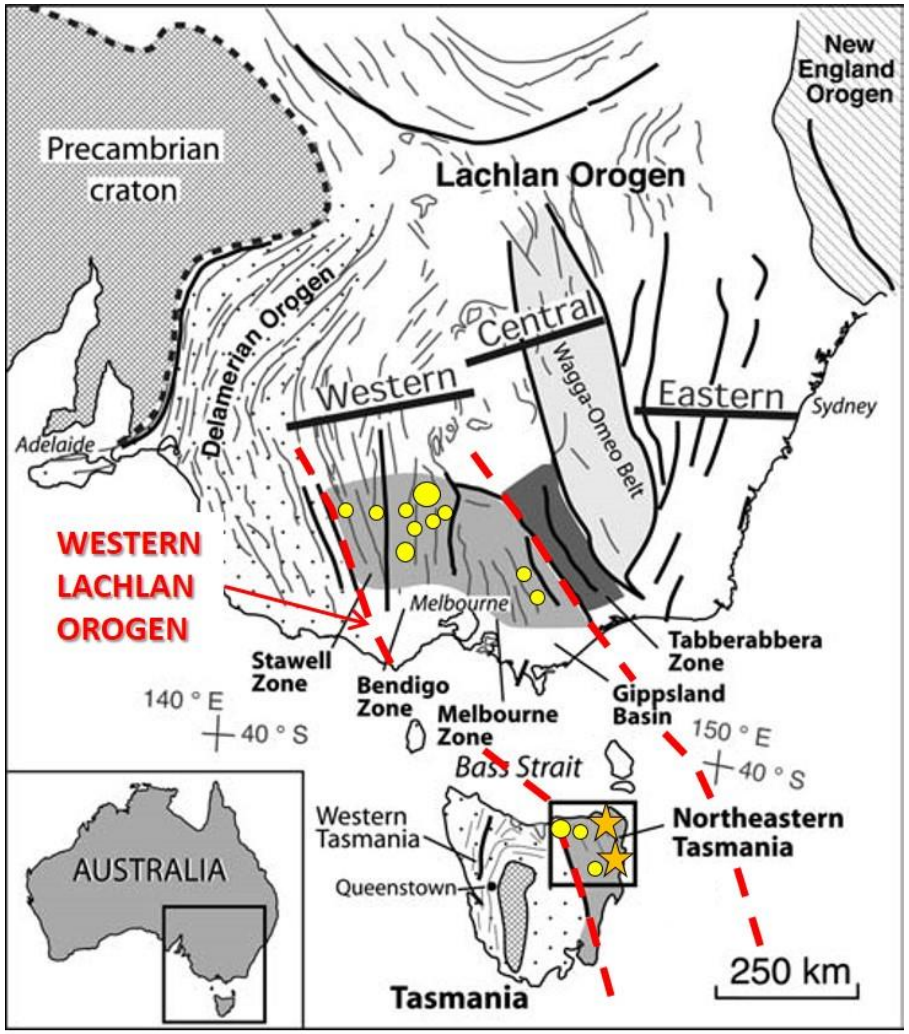


Department of State Growth

Tasmanian Government

TOP

Geological Setting



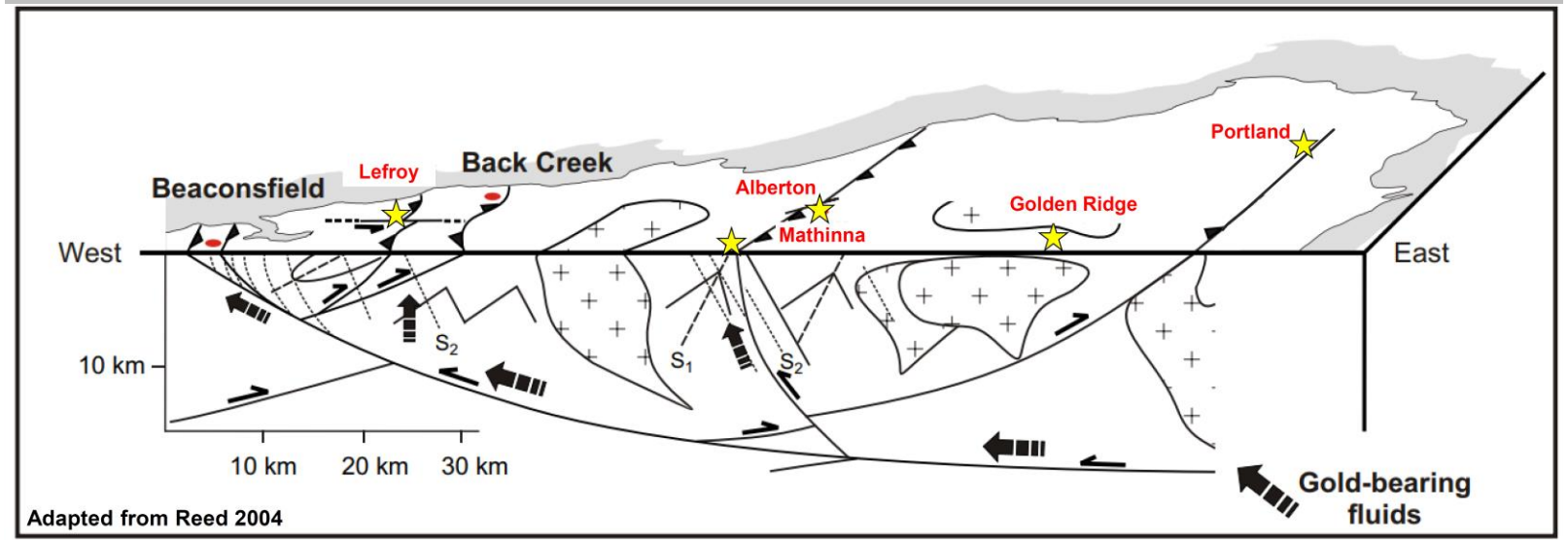
Major Goldfield

Ordovician to Lower Devonian succession of turbiditic sandstone and mudstone (Mathinna Group)

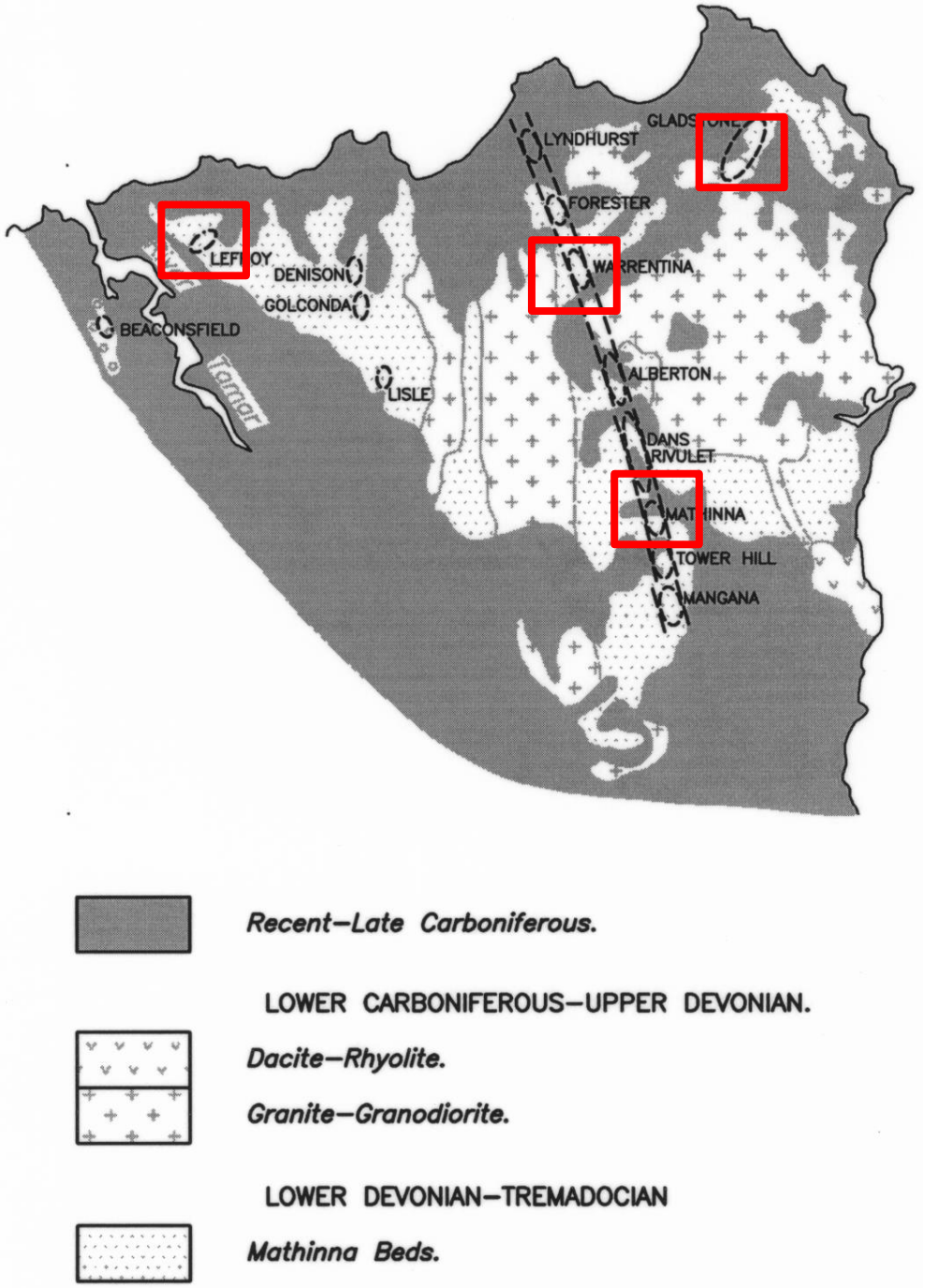
Tabberabberan Orogeny:

Two phases of deformation, with peak metamorphism at ca 390 Ma and Intruded at 400- 376 Ma by multiple granitic plutons

Similar Geological setting to Victorian goldfields which have yielded > 50 Moz Au



Past mining and exploration



Goldfields discovered by prospectors between 1858 (Mangana) and 1883 (Warrentinna)

Most mining from 1850s to late 1930s

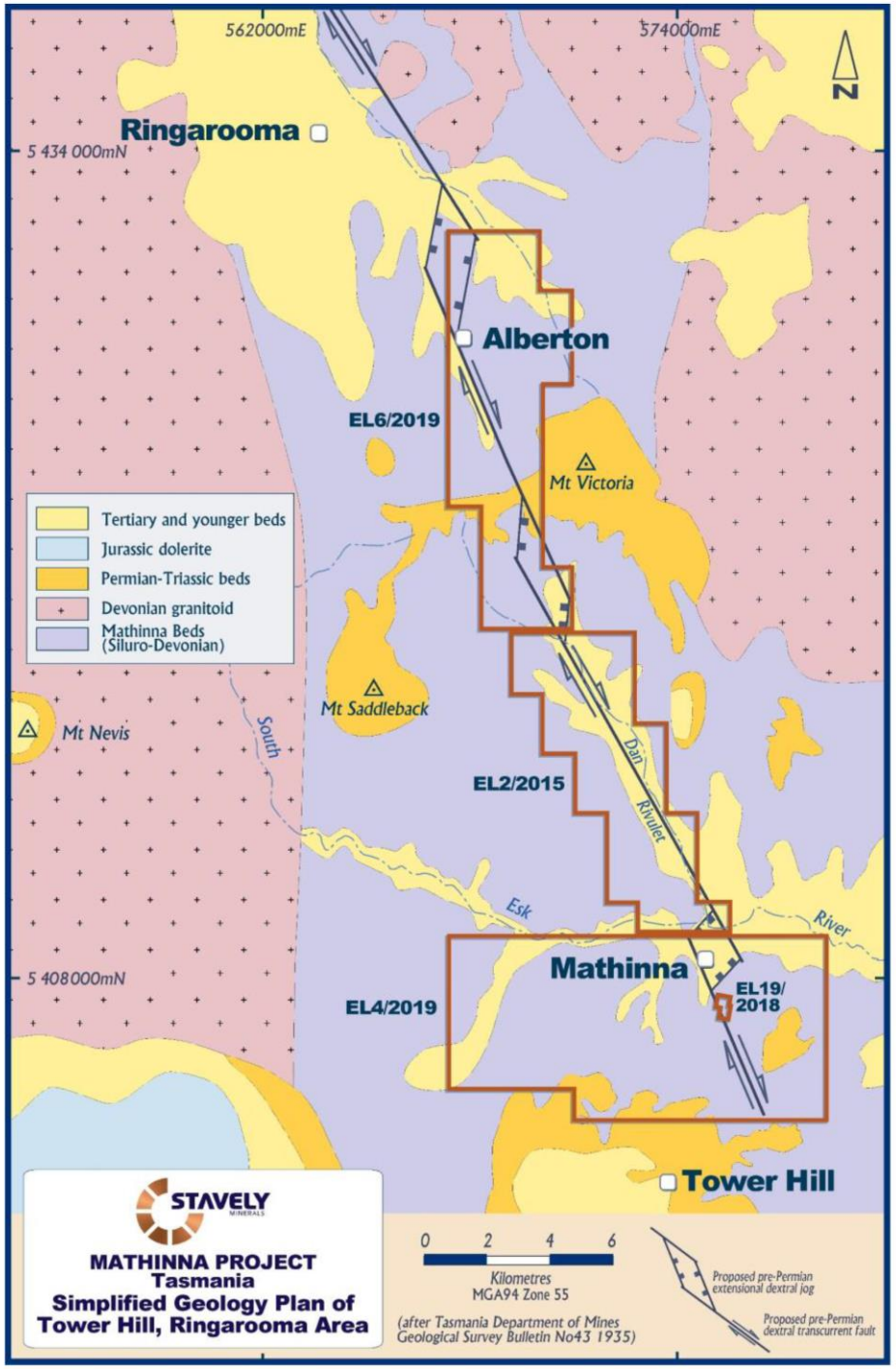
Total production approximately 2.8 Moz gold from alluvial and hard rock sources (underestimate)

65% of production from the Tasmania Mine at Beaconsfield (1.8 Moz @ 15.9 g/t Au)

Apart from Beaconsfield and Mathinna (mined to >500m depth) most mines are <150m depth

Limited modern exploration – in period 2013-2019 total recorded gold-focussed exploration expenditure was only A$4.2 million

Mathinna



Stavely Tasmania now hold tenements over the "Main Slide" from Mathinna to Alberton

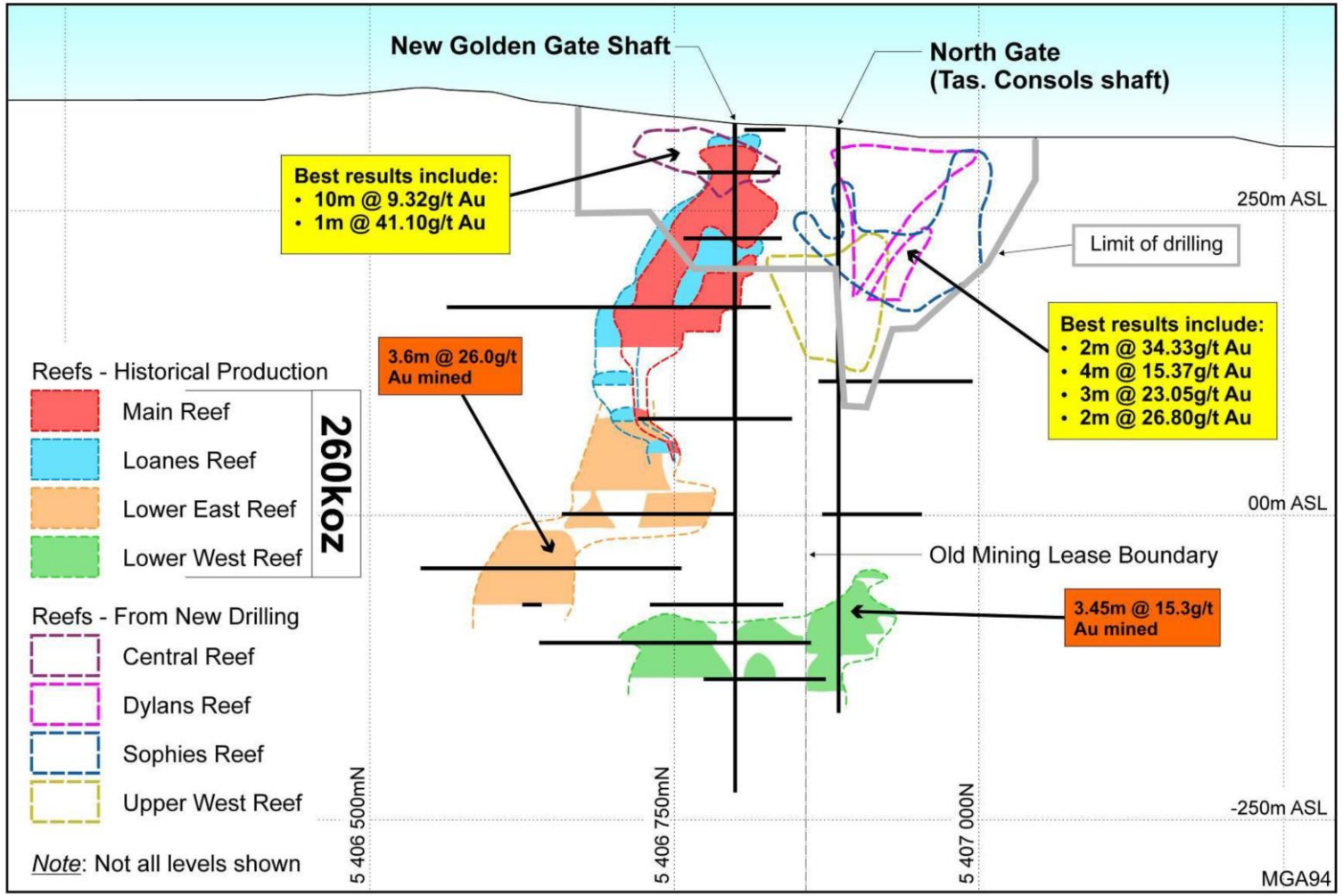
The main slide hosts more than half the known gold occurrences in North East Tasmania

The only modern exploration drilling has been around Golden Gate (Mathinna) Mine and smaller deposits to the north (Una, Hinemoa)

Drilling at Mathinna has targeted both tailings from previous mining and potential extensions immediately north of the known mineralisation

STAVELY MINERALS

Mathinna



Stavely's focus is the Golden Gate Mine:

Production (to 1934) of 260,000 oz Au at average grade of 28 g/t

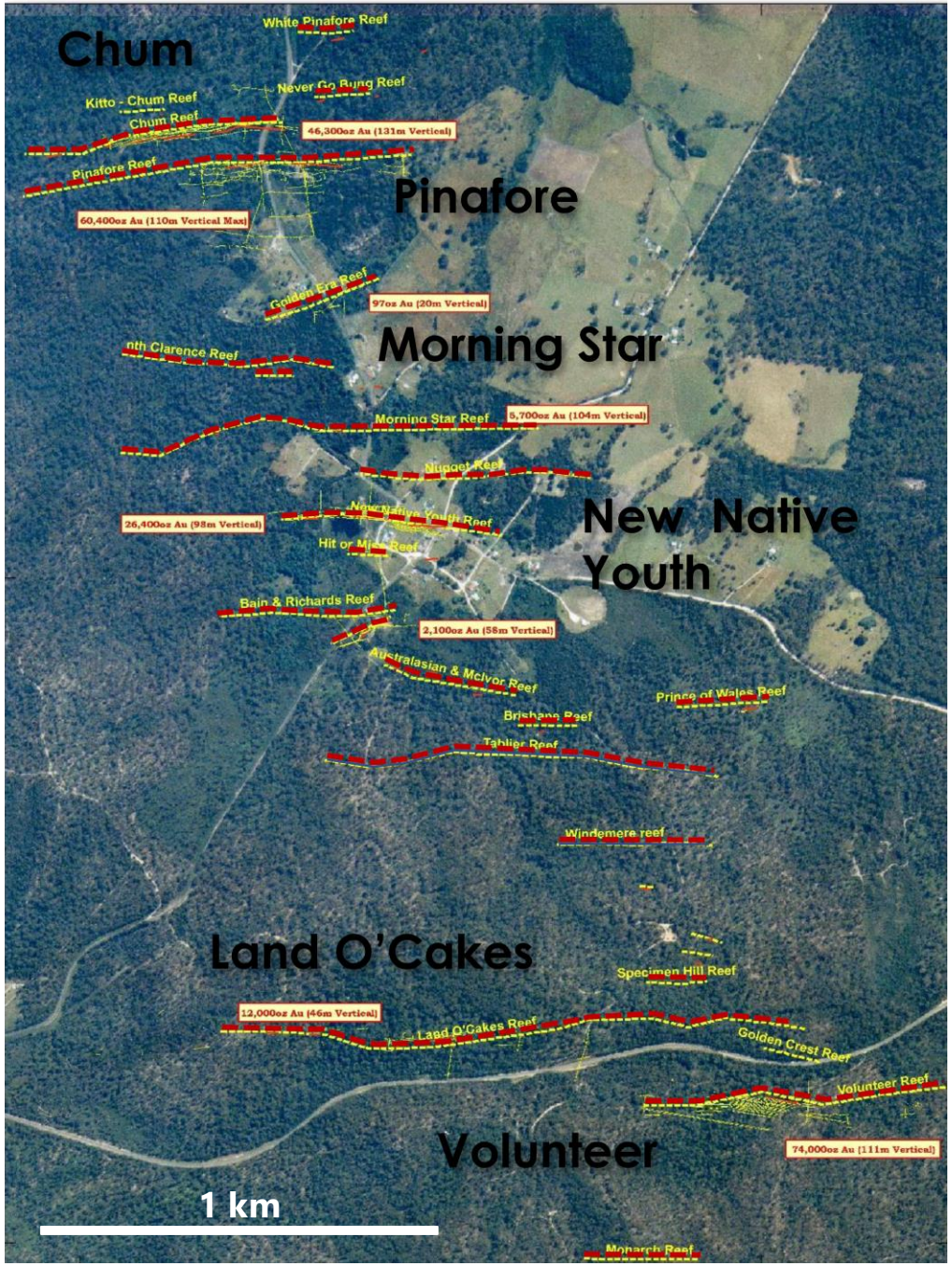
Exploration in 1990s located 4 new reefs and defined resources of 40,000 oz Au @ 7 g/t

Drilling was <200m depth, and reefs not closed off

System remains open at depth and along strike

Stavely have completed an initial drilling program (in part co-funded), but results have not been received/reported

Lefroy



Typically west-plunging high-grade shoots on more than 20 east-west reefs

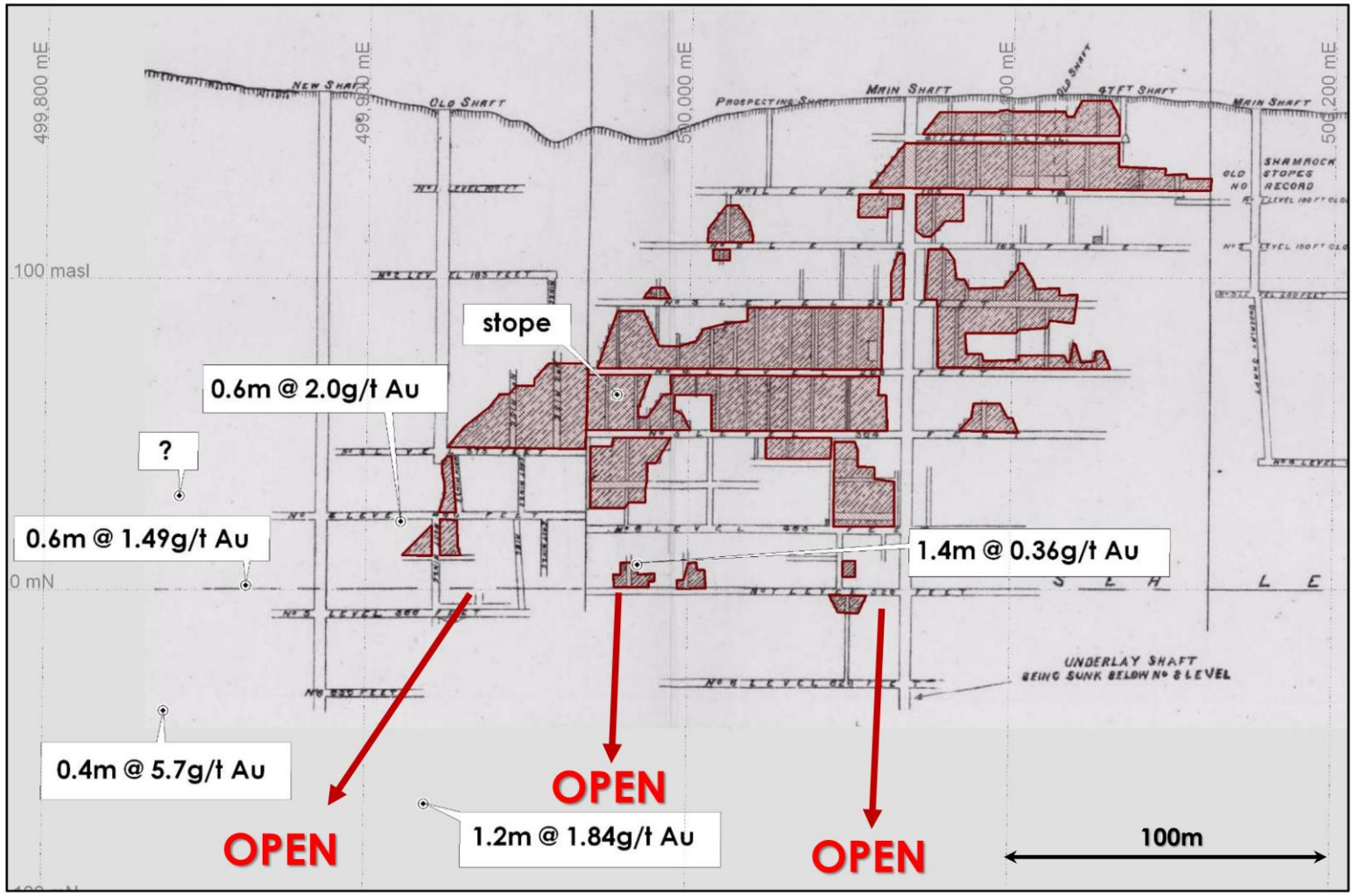
Total production of 174,000 oz (at 28 g/t Au)

Most mining to <120m depth

An increasing proportion of refractory gold contributed to closure of all mines by 1904

Regional soils (2009-2010) define coincident As and Au-anomalism along strike from known mines and potentially define new reefs – not followed up in detail

Past mining and exploration



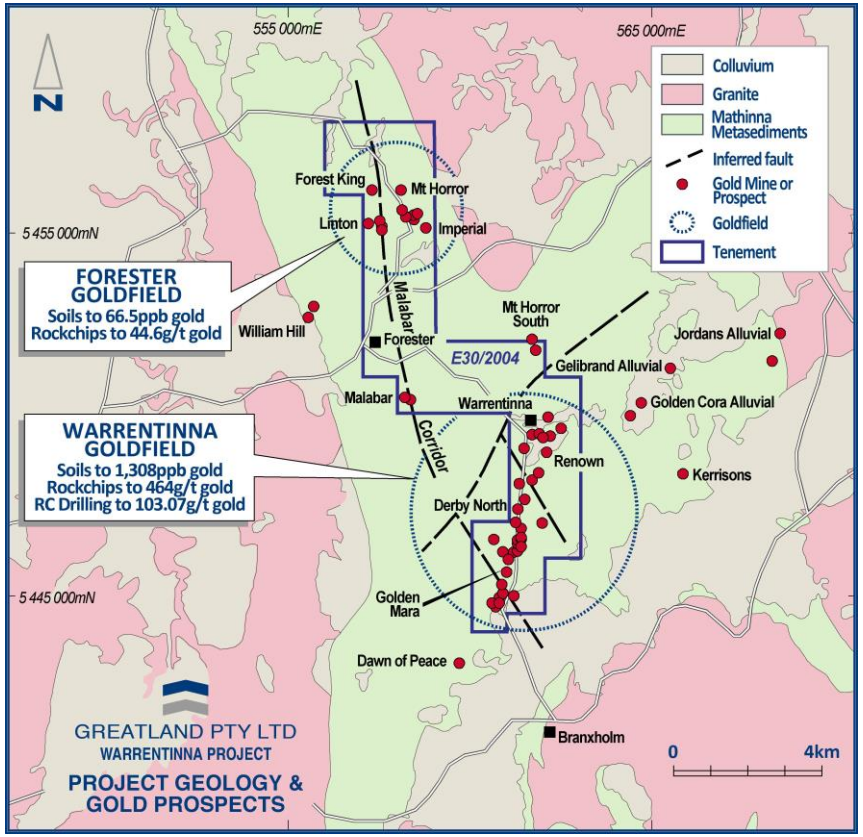
Volunteer Mine (Lefroy field)

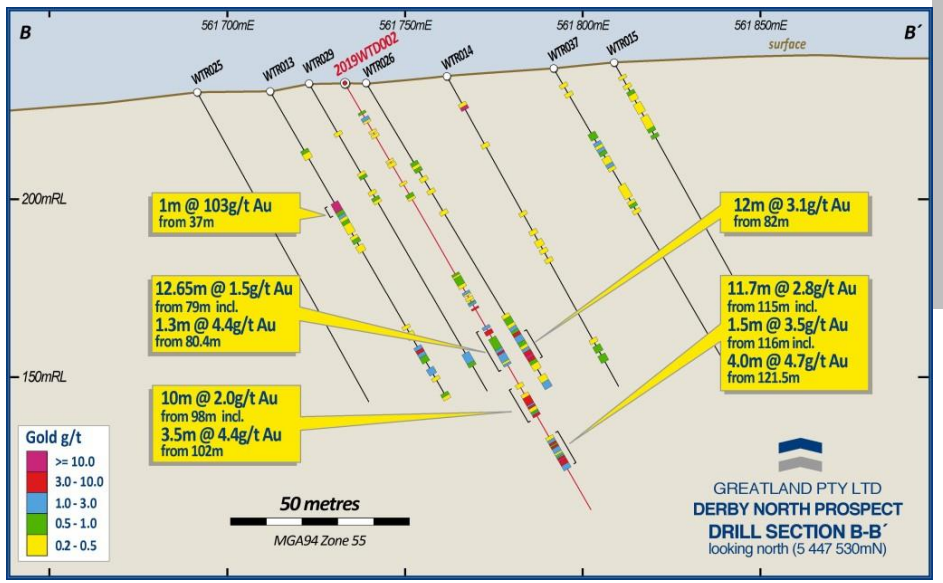
Production of 72,000 oz @ 85 g/t Au

Mining to 130 m depth

Extent of modern drill intersections shown

Warrentinna





Warrentinna goldfield being explored by Greatland Gold Pty Ltd (EL30/2004)

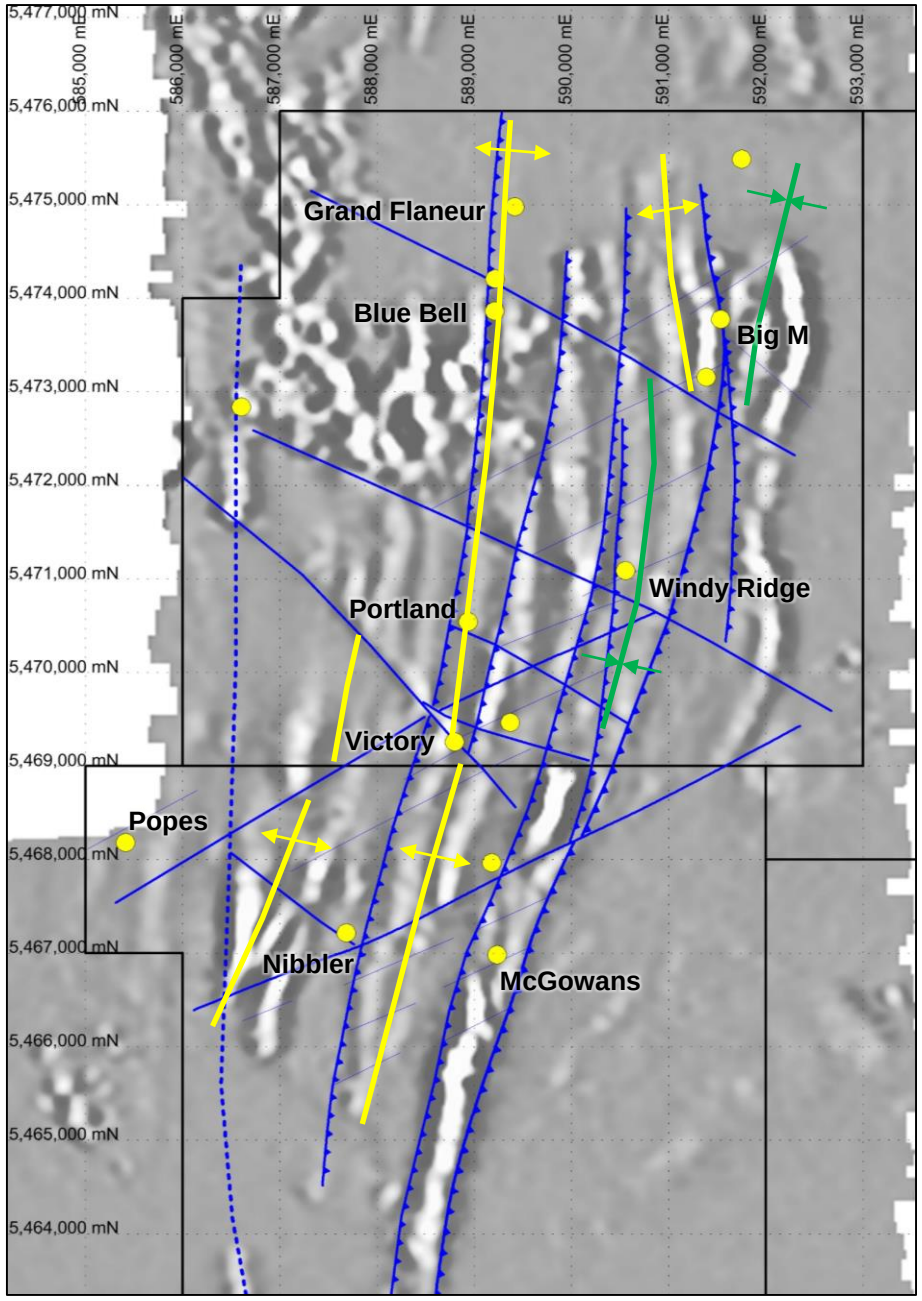
Have focussed on Derby North Prospect

Soil sampling and RC drilling to 100m depth defined a new zone of gold mineralisation (100 x 150m; open at depth and to North and east)

Recent diamond drilling (to 125m depth) has confirmed RC results and intersected (11.7m @ 2.8 g/t Au) what Greatland believes may be a new zone of mineralisation.

GREATLAND GOLD

Portland Goldfield



Sporadic mining form 1870-1917 yielded only 5,200 oz of Au, more than 65% of which was alluvial, with hard rock grades of 15-45 g/t Au

Field abandoned due to reduced recovery of gold from sulphide ores at depth

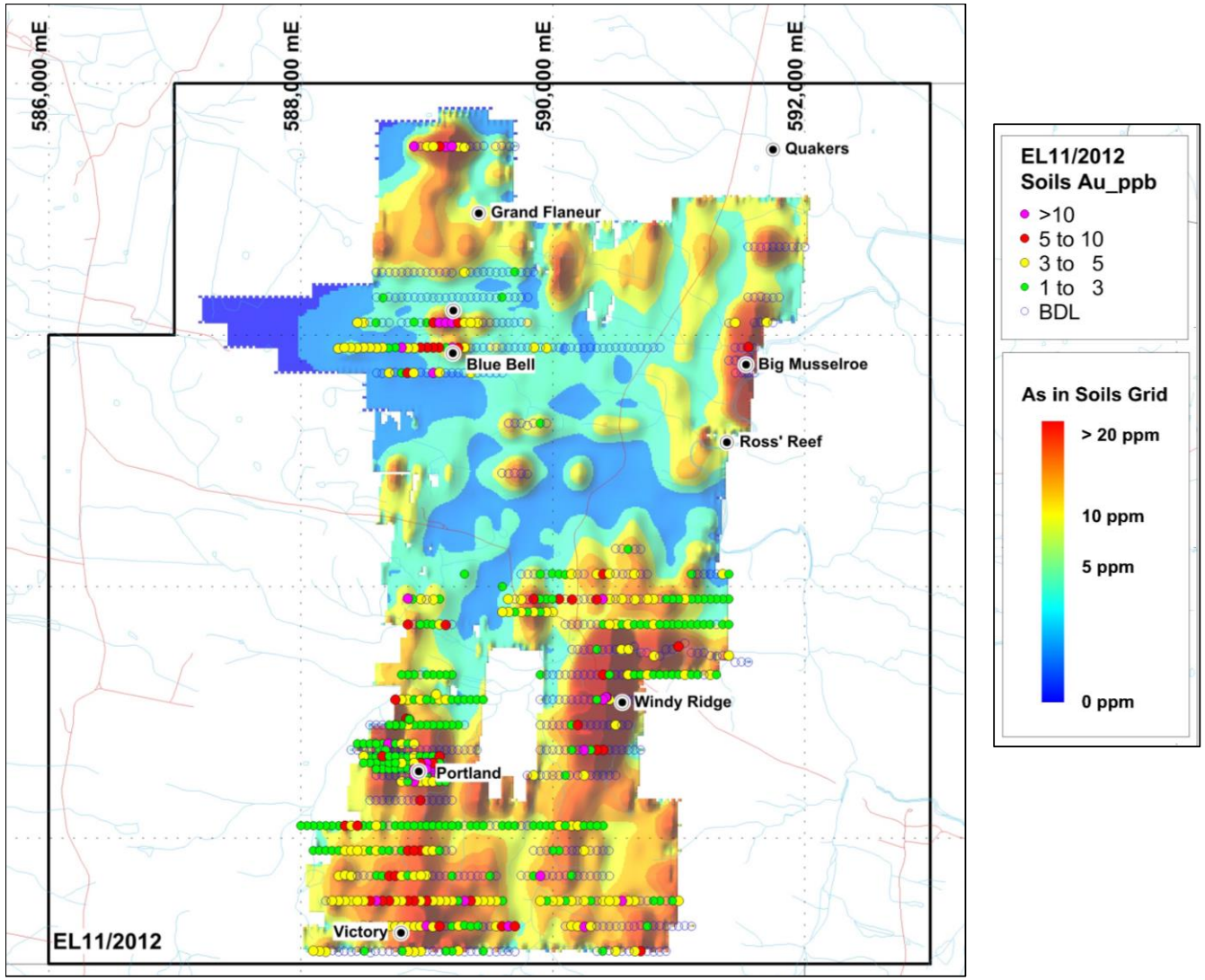
Small amount of prospecting and some surface exploration, including shallow (<50m) RC drilling between historical workings prior to 2010

Tasmetals JV have concentrated on district scale exploration since 2012, have developed a stratigraphic and structural framework and have located several new prospects

TASMETALS JOINT VENTURE

Pacific Trends RESOURCES

Portland Goldfield



Regional soil sampling completed with strong Au-As-Sb-Bi association at known mineralisation

2 km long As soil anomaly at **Windy Ridge**

Mapping located extensive silicified thick channel sandstones with sulphide mineralisation

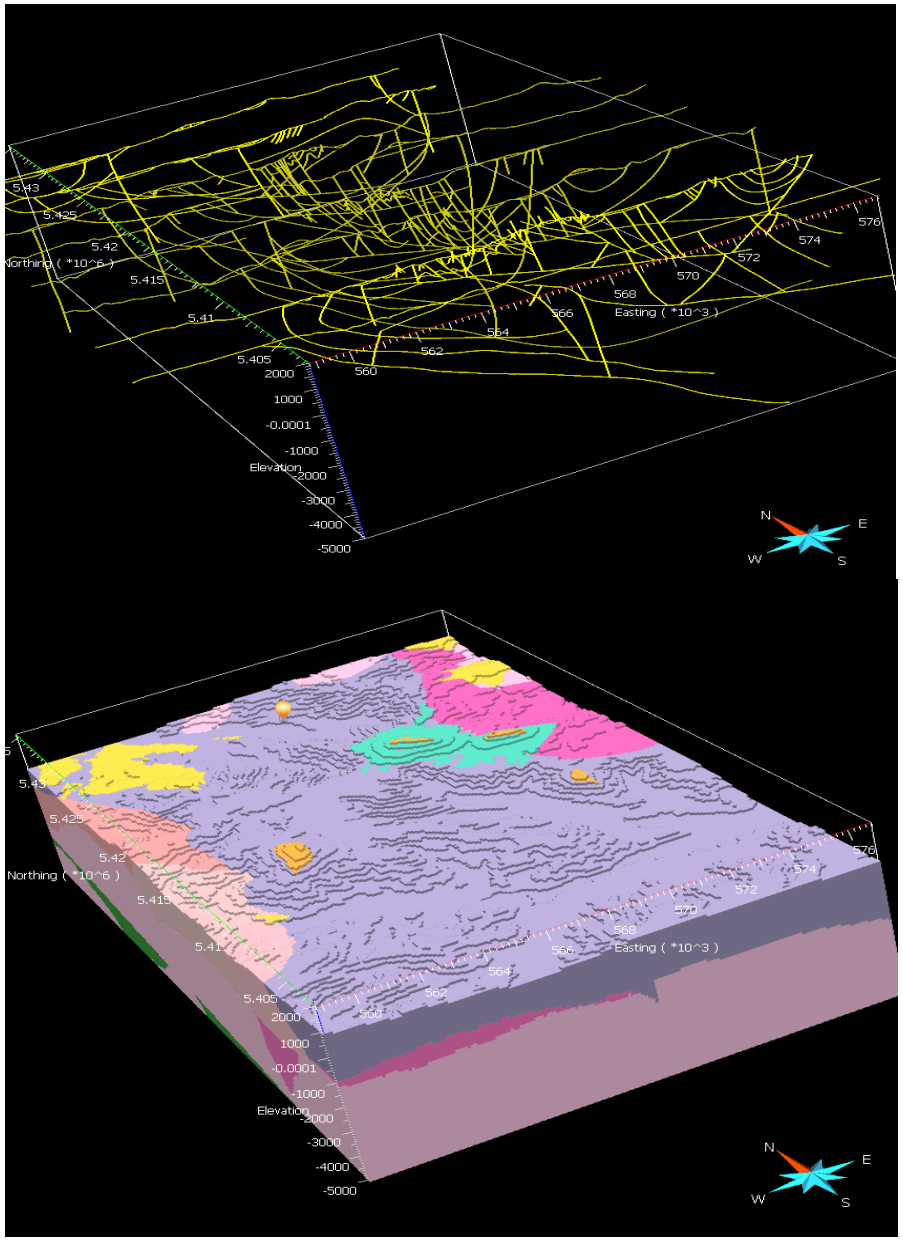
Rock chip grab sampling (to 19.7 g/t Au)

Follow-up trenching (over 1 km strike) all with anomalous Au

Best result from trenching of 15m @ 4.7 g/t Au

Drilling planned in 2020

Summary



North East Tasmania has a similar geological setting high but is relatively under-explored when compared to the Victorian goldfields

Many of the historical high-grade gold mines (eg, Golden Gate, 260,000 oz Au at average grade of 28 g/t) are not fully explored

MRT completed pre-competitive geoscience project in North East Tasmania in the 1990s (NETGOLD) and the area is covered by 1:25,000 geological mapping, gravity airborne magnetics and radiometrics

More recently LiDAR data has become freely available and MRT are working on semi-regional 3D modelling of prospective areas (Alberton – Mathinna completed)

Contact details

Tasmanian Government

Andrew McNeill

Chief Government Geologist

Andrew.mcneill@stategrowth.tas.gov.au

Ph: 03 61654732

www.mrt.tas.gov.au

Core to Cosmos

AESC
australian earth sciences convention

Call for Abstracts

The Geological Society of Australia invites you to participate in the Australian Earth Sciences Convention in 2021 in Hobart. Submit an Abstract to the following Themes.

THEMES:

Energy and Resources
A systems approach to hydrocarbon and mineral resources; from exploration to remediation.
Jonathon Cloutier – *University of Tasmania*
Caroline Tiddy – *University of South Australia*

Earth Structure
Plate tectonics, regional geology, structure, metamorphism, tectonic architecture and geophysics of the deep earth.
Jo Whittaker – *University of Tasmania*
Jack Mulder – *Monash University*

Core to Crust
General and specific contributions concerning the geochemistry, mineralogy, petrology and geophysics of the crust, mantle and core.
Stephen Foley – *Macquarie University*

Crust, Surface and Cosmos
Geological and geochemical controls on earth system processes including origin and evolution of life on Earth and elsewhere.
Indrani Mukherjee – *University of Tasmania*
Ashleigh Hood – *University of Melbourne*

Geoscience in Society, Education and Environment
Exploring the role of geoscience in daily life, tourism, hazards, heritage, water and the environment.
Claire Kain – *Mineral Resources Tasmania*

Earth Observations and Models
Understanding the dynamic surface of Earth with observations and computational inferences, analysis and modelling.
Matt King – *University of Tasmania*

Symposia

AESC 2021
Hobart, Tasmania
HOTEL GRAND CHANCELLOR

9–12 Feb 2021
www.aesconvention.com.au

QUERIES TO CONFERENCE DESIGN:
mail@conferencedesign.com.au
PHONE: (03) 6231 2999

REGISTRATION:
Mid-June

EXHIBITION:
The convention will host an exhibition. We welcome companies and businesses to participate so they can promote the emerging opportunities in their organisation, state or territory.

GEOLOGICAL SOCIETY OF AUSTRALIA Incorporated

AUSTRALIA MINERALS

REALISE THE OPPORTUNITY

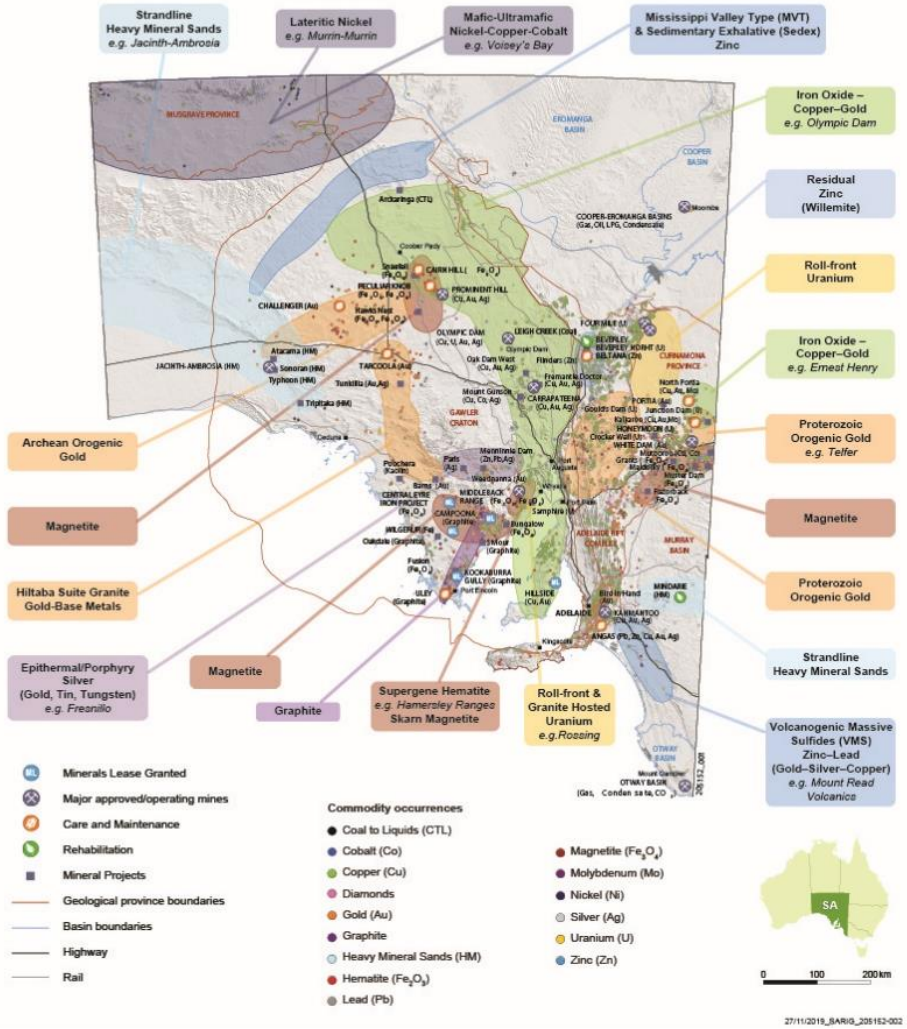
South Australia's world-class Iron Oxide–Copper–Gold Mineral Systems: established and emerging prospectivity

Tom Wise

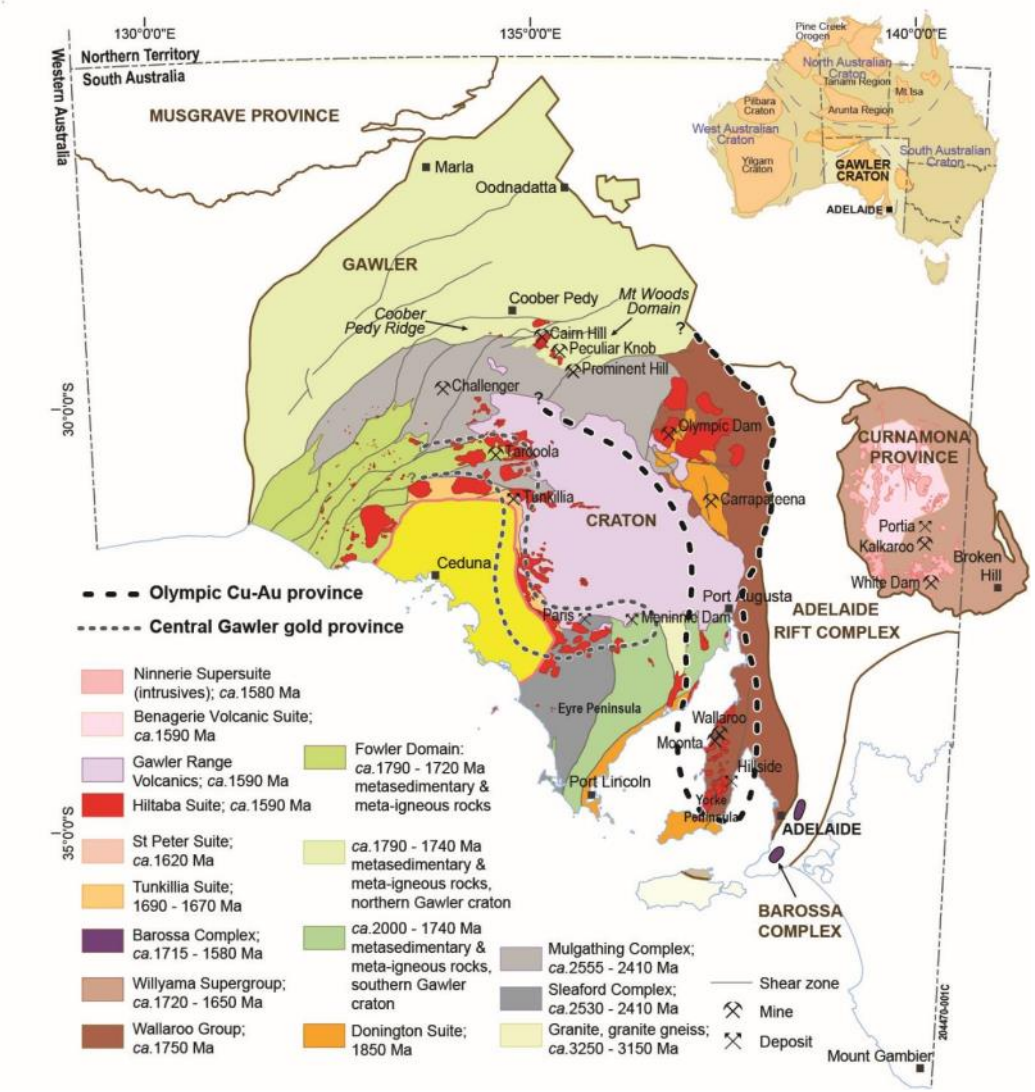
The South Australian Opportunity

South Australia has exploration opportunities across a broad range of commodities and mineralisation styles

- Strategies in key commodities:
  - Copper to the World
  - Discover Gold
  - Critical Minerals



AUSTRALIA MINERALS



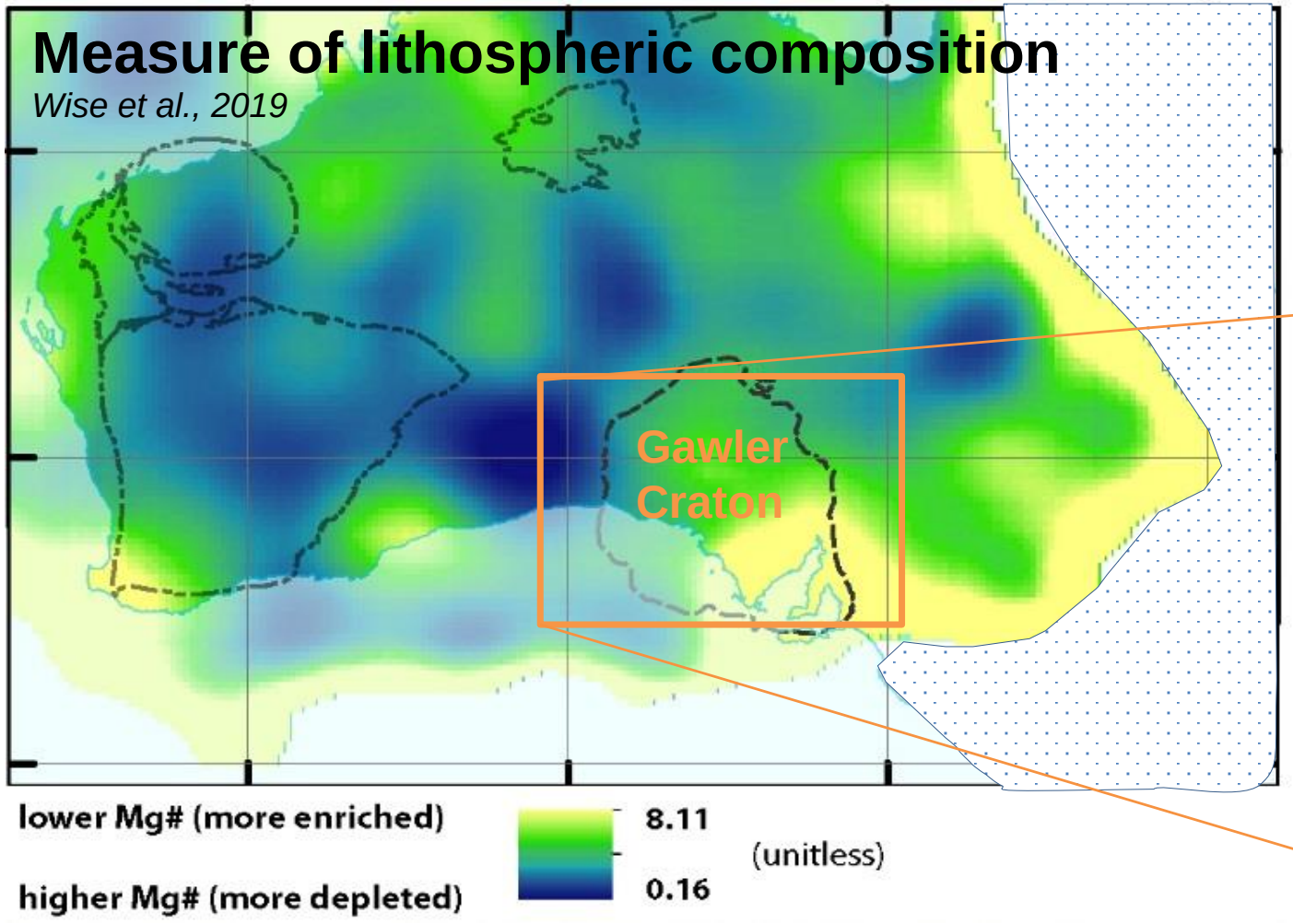
Gawler Craton: Established Prospectivity

- Great place to find world-class mineral deposits, but why?
- Recent research supporting the Gawler as the premier Iron Oxide–Copper–Gold destination

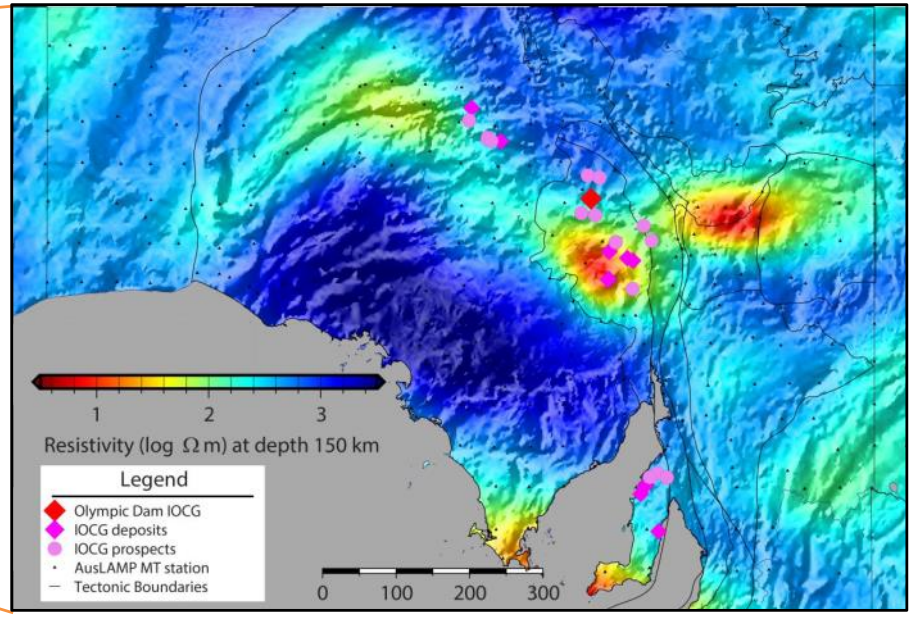
Gawler Craton: Established Prospectivity

Iron Oxide–Copper–Gold Mineral Systems Workshop

Gawler Craton: Established Prospectivity

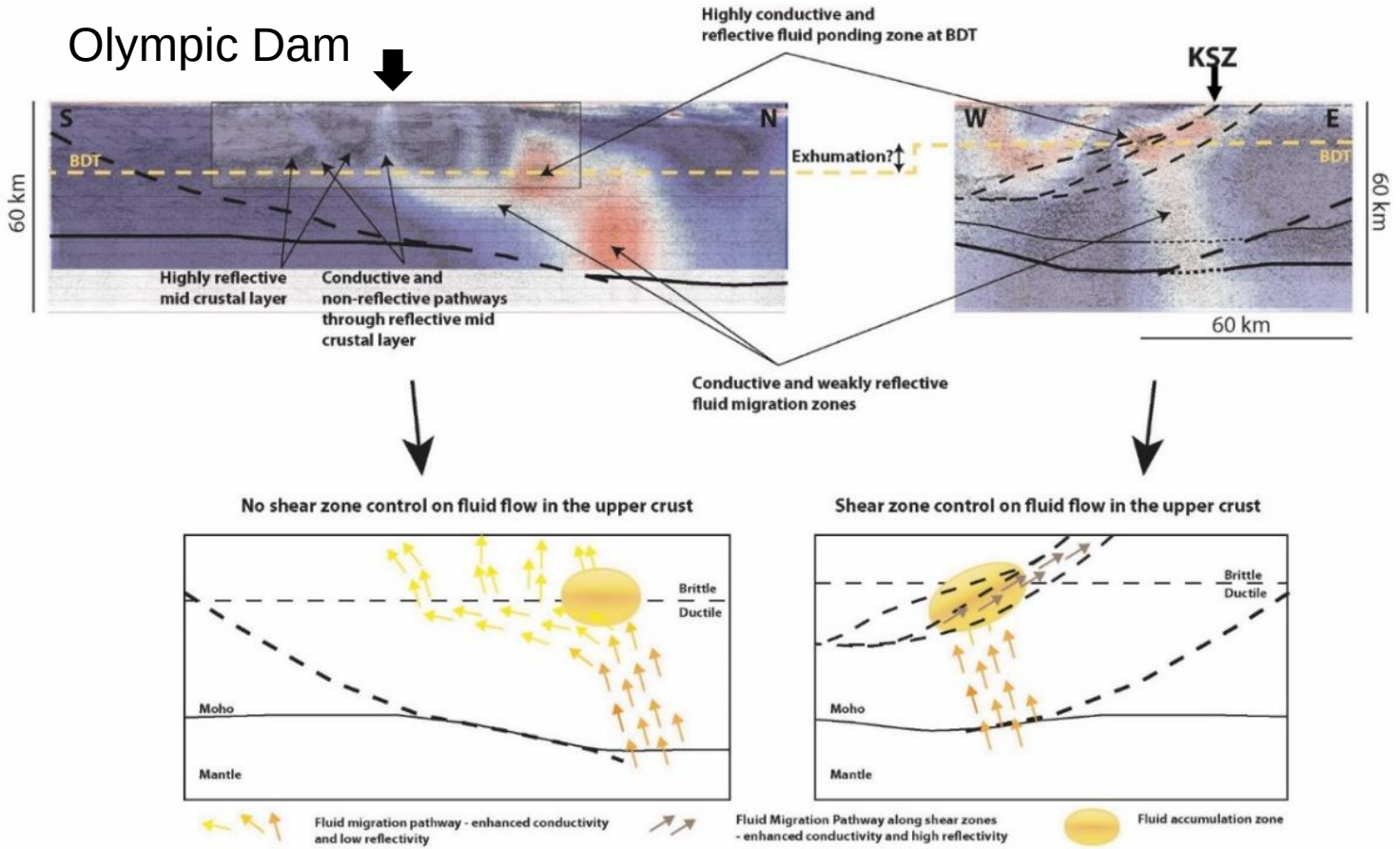


One of the most metasomatised pieces of ancient cratonic lithosphere.



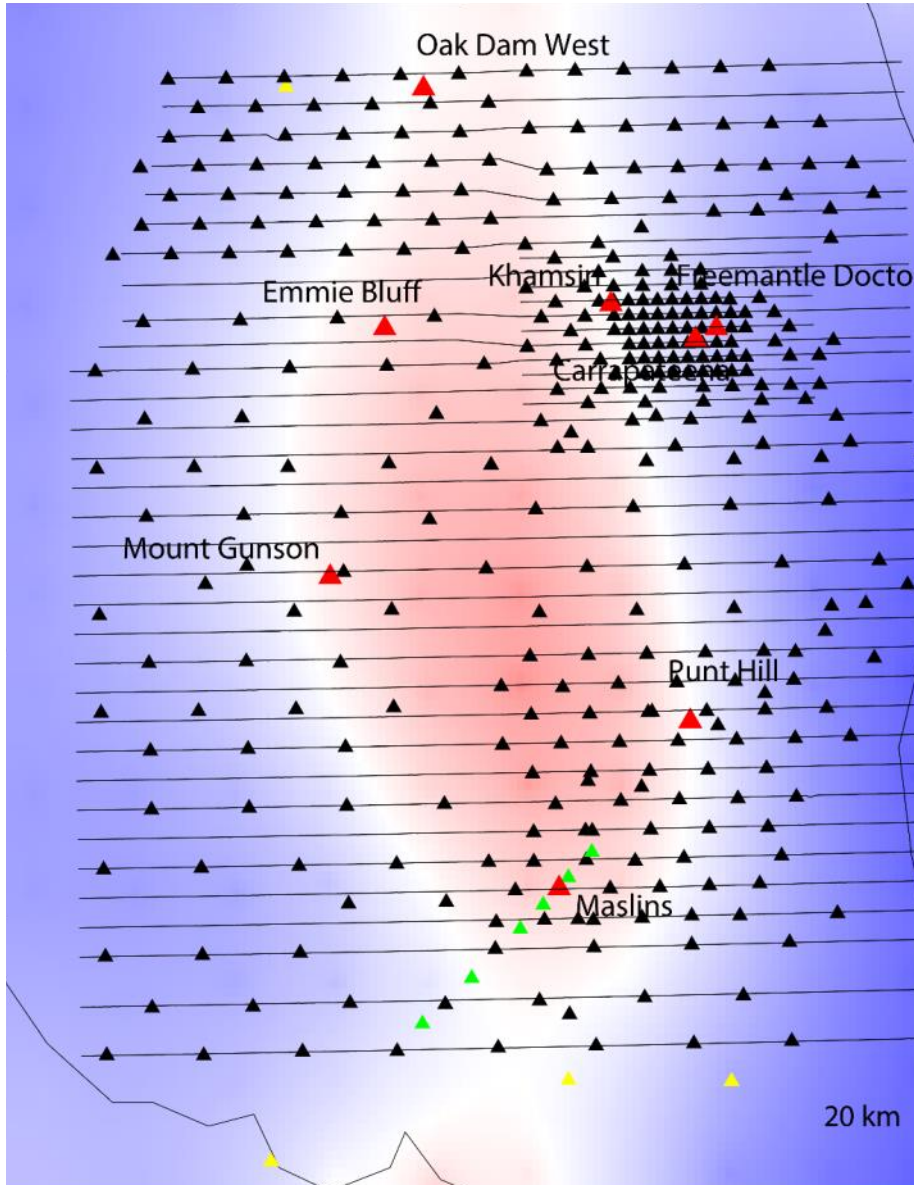
Thiel et al., in prep

Gawler Craton: Established Prospectivity



Wise and Thiel, 2020

Magnetotellurics and seismic mapping the roots of IOCG mineralising systems



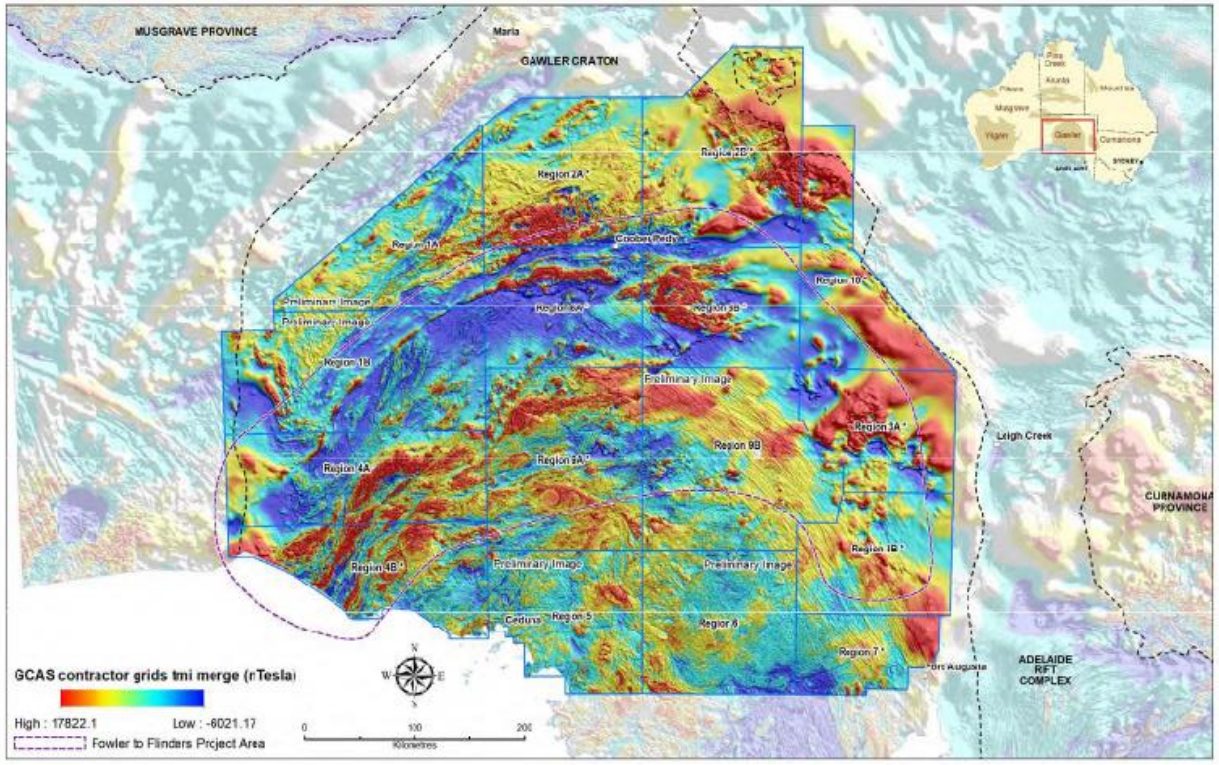
Gawler Craton: Established Prospectivity

Olympic Domain infill survey – modelling in progress 3D geometries at Domain-camp scale

The Gawler Craton: Established Prospectivity

Airborne Survey

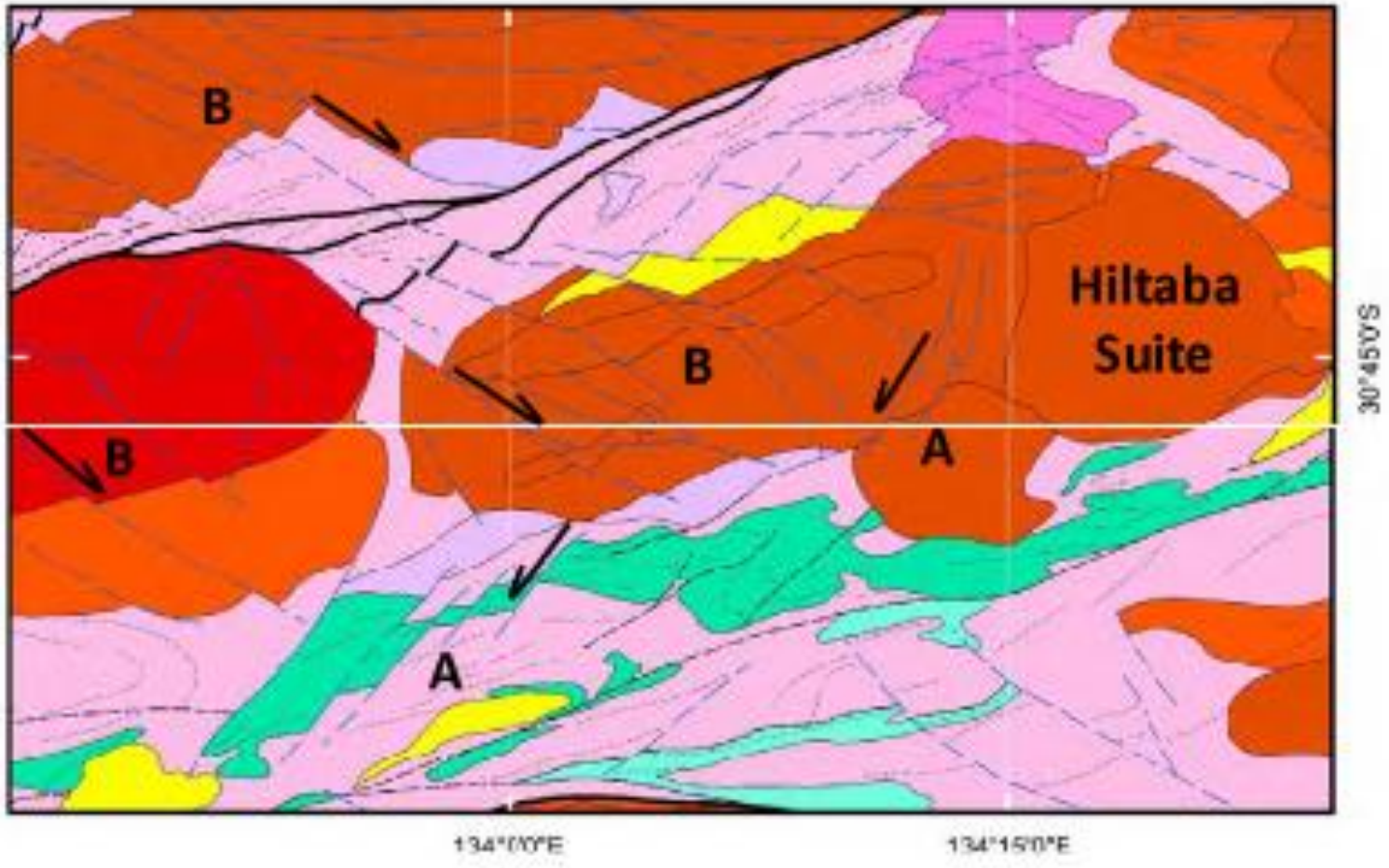
Airborne aeromagnetics, radiometrics, Digital Elavation Model



Summary metrics:

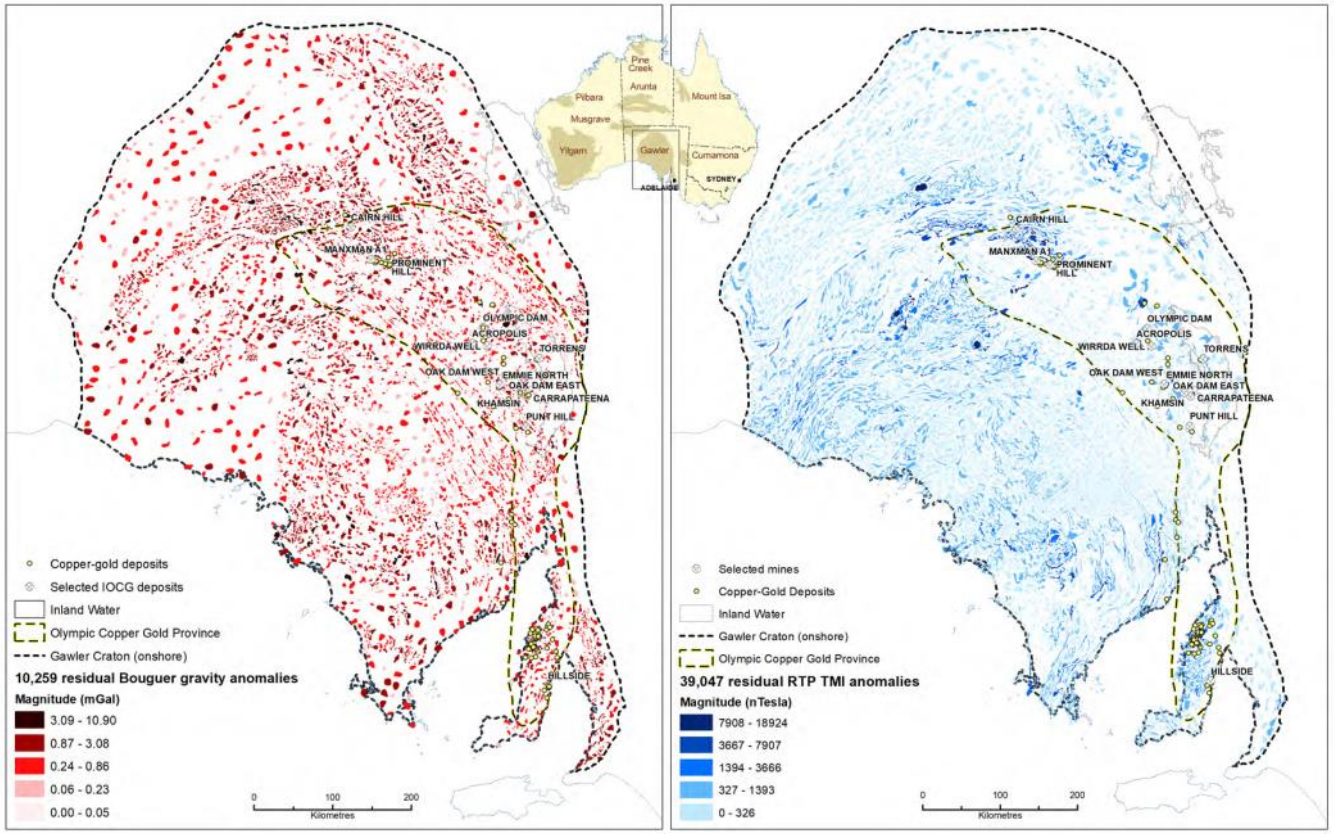
- 200metre line spacing
- 60m ground clearance
- 1.67M line kilometres
- 294,000 sq. km
  - Acquisition complete
  - Contractor reports released
  - Value-add in progress

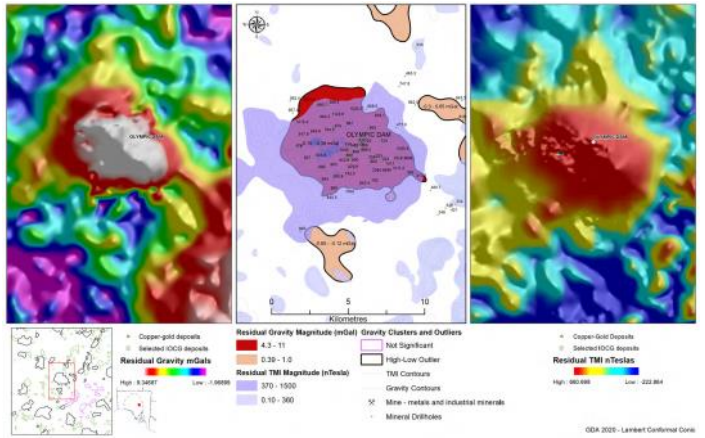
Gawler Craton: Established Prospectivity



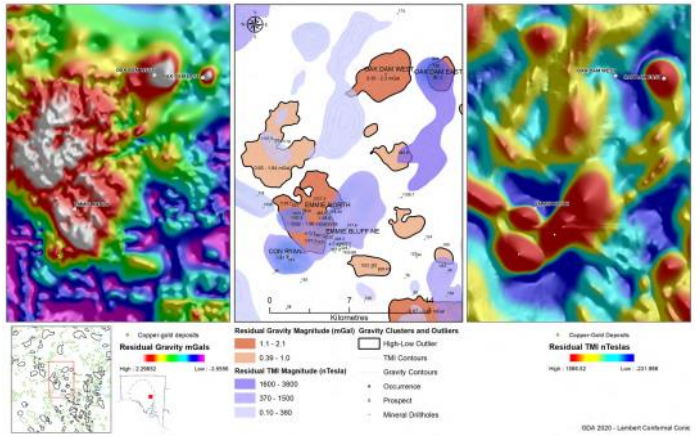
Gawler Craton Airborne survey forms the basis for structural interpretation and classification of IOCG signatures

Gawler Craton: Established Prospectivity





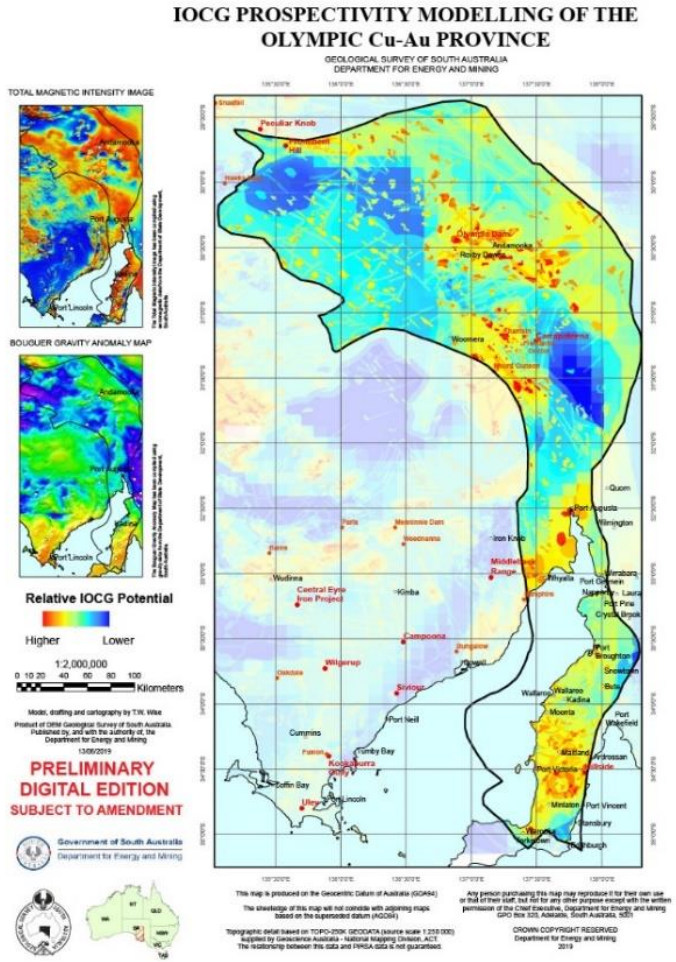
Olympic Dam

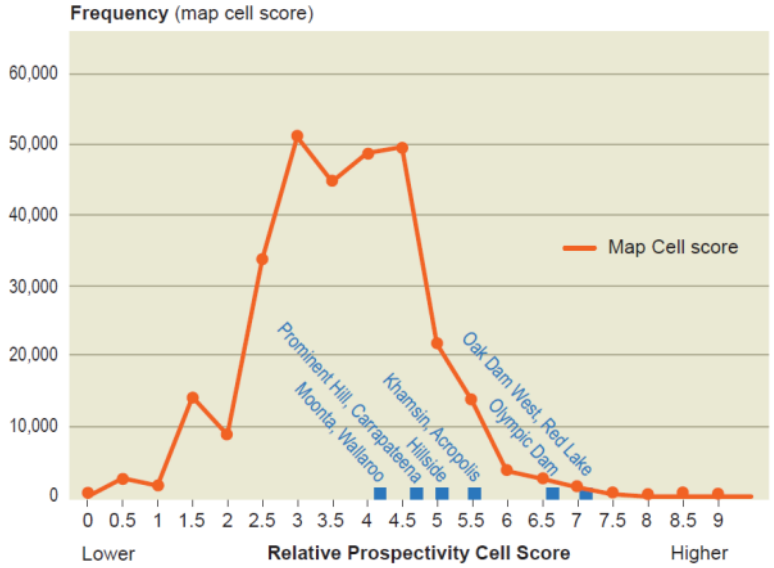


Oak Dam West

Gawler Craton: Established Prospectivity

- IOCG prospectivity model
- Integration of multiple data types
- Proxies for parts of the mineralising system
- Validated by highlighting existing deposits, and areas of untested potential

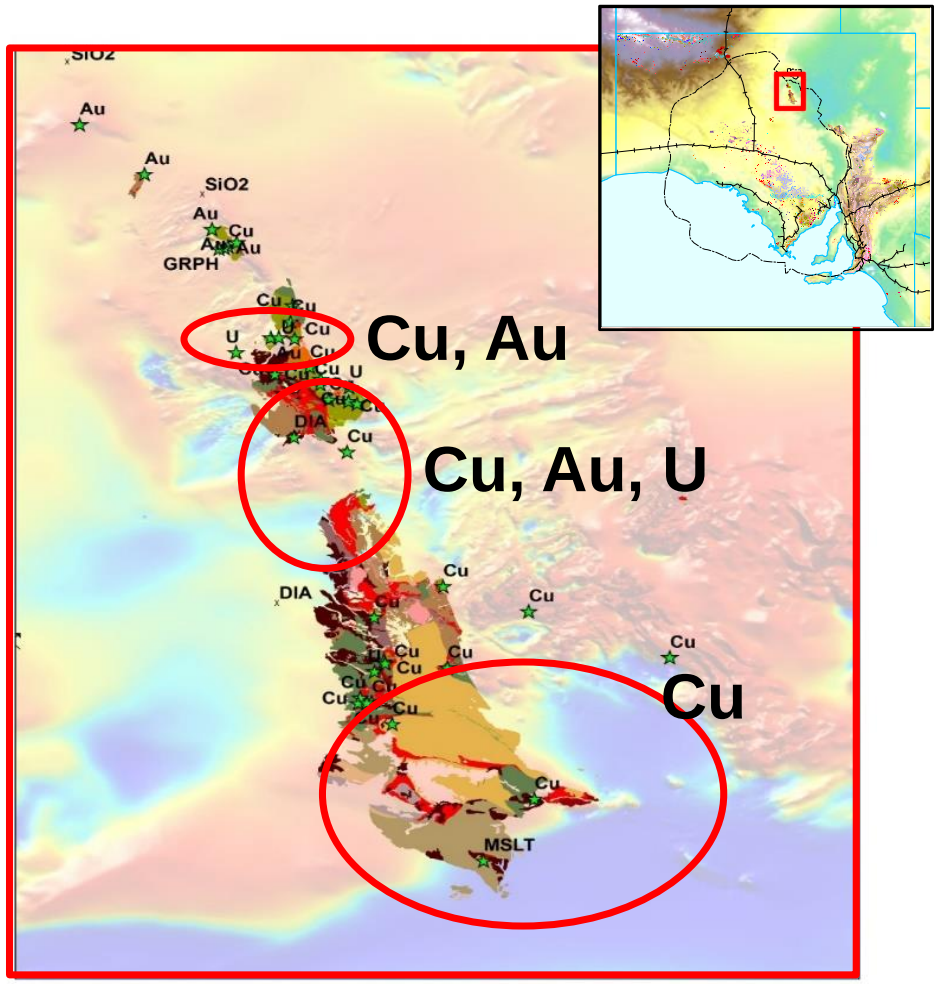




AUSTRALIA MINERALS

Gawler Craton: Established Prospectivity

Gawler Craton: Emerging Prospectivity



Peake and Denison Ranges

Under explored region in northern South Australia

Mineral Occurrences:

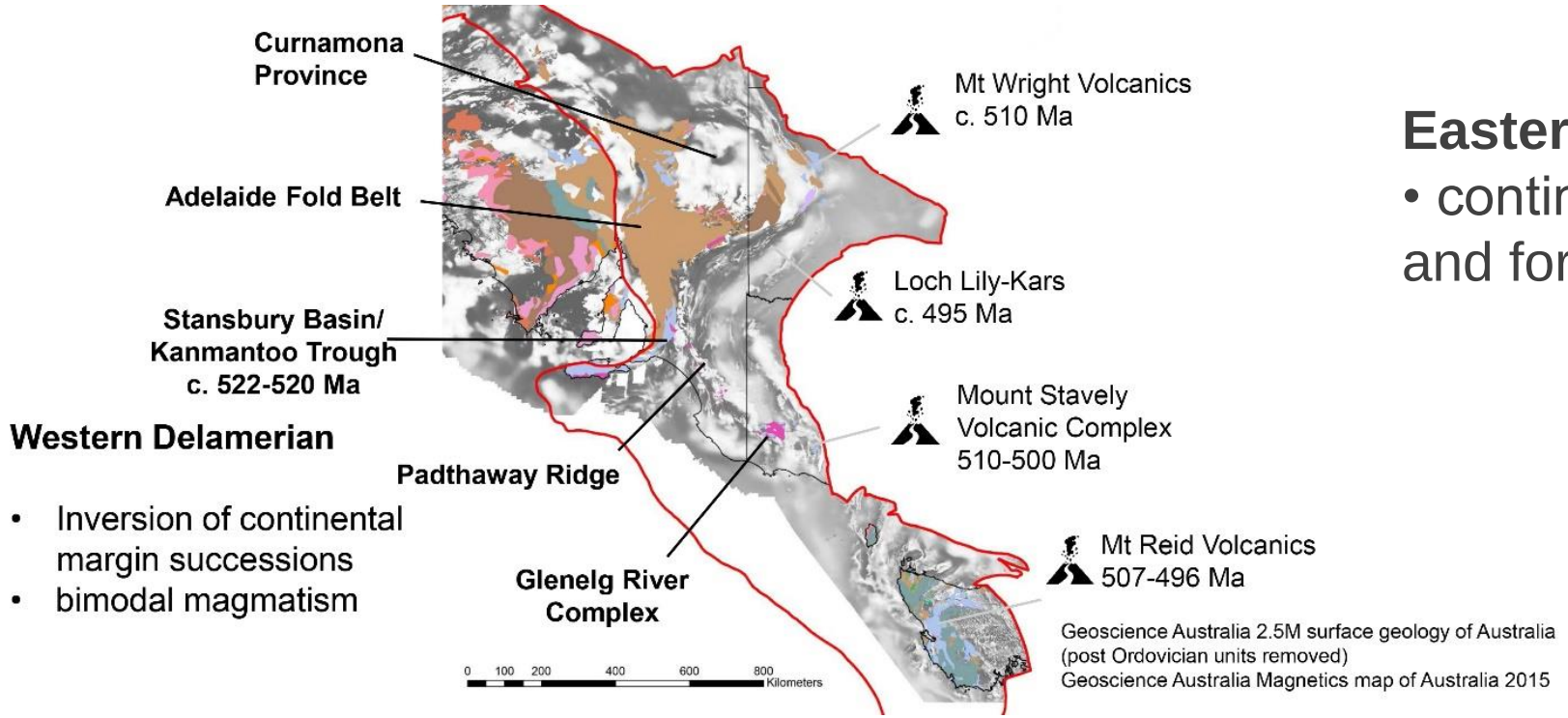
- Cu in Palaeoproterozoic basement
- Cu in Neoproterozoic sediments
- Au at basal Neoproterozoic unconformity
- Hydrothermal Cu assoc. with Cambrian granites
- Unconformity U

Mineralisation models currently/recently being tested:

- IOCG
- Cloncurry-style
- Broken Hill Type

Delamerian Orogen: Emerging Prospectivity

Frontier region in eastern South Australia with Cu-(Mo-Au) Porphyry potential associated with Cambrian arc systems



Eastern Delamerian

• continental volcanic arc and forearc successions

Delamerian Orogen: Emerging Prospectivity

Four year work program as part of the MinEx CRC National Drilling Initiative:

- Field Mapping
- Drilling Program – utilising latest Coil-Tubing technology
- Legacy Data Capture
- Geological Synthesis

Stay tuned for exploration area releases in the coming years

MinEx CRC

Contact

Tom Wise, Senior Geologist

E: tom.wise@sa.gov.au

Department for Energy and Mining

11 Waymouth Street
Adelaide, South Australia 5000

E: demreception@sa.gov.au

SOUTH AUSTRALIA

Government of South Australia

Department for Energy and Mining

GEOLOGICAL SURVEY OF South Australia

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AUSTRALIA MINERALS

REALISE THE OPPORTUNITY

VICTORIA

It’s not just Fosterville: emerging world-class gold and copper opportunities

Cameron.Cairns@ecodev.vic.gov.au
Manager Minerals Geoscience
Geological Survey of Victoria

earthresources.vic.gov.au

VICTORIA Australia

VICTORIA

Capital: Melbourne (World's second most liveable city)

Area (land): 227,436km^2 (6th)

Population: 6.59 million (2nd)
>75% in Melbourne, 4 in top 20 city/urban centres

Best performing Australian economy
First in 4 of 8 indicators, including construction

Highly skilled: One third of Australian graduates

Melbourne Airport: Busiest passenger and container airport, 33 direct international destinations

Port of Melbourne: Largest container and automotive port in Australia

AUSTRALIA MINERALS

STATE OF DISCOVERY

1. Confident communities and responsible explorers
2. Advancing geoscience and encouraging mineral exploration and development
3. Victoria as a global mining hub
4. Improve regulation practice and industry compliance
5. Deliver modern, fit-for-purpose laws

North Central Victoria Goldfields Ground Release

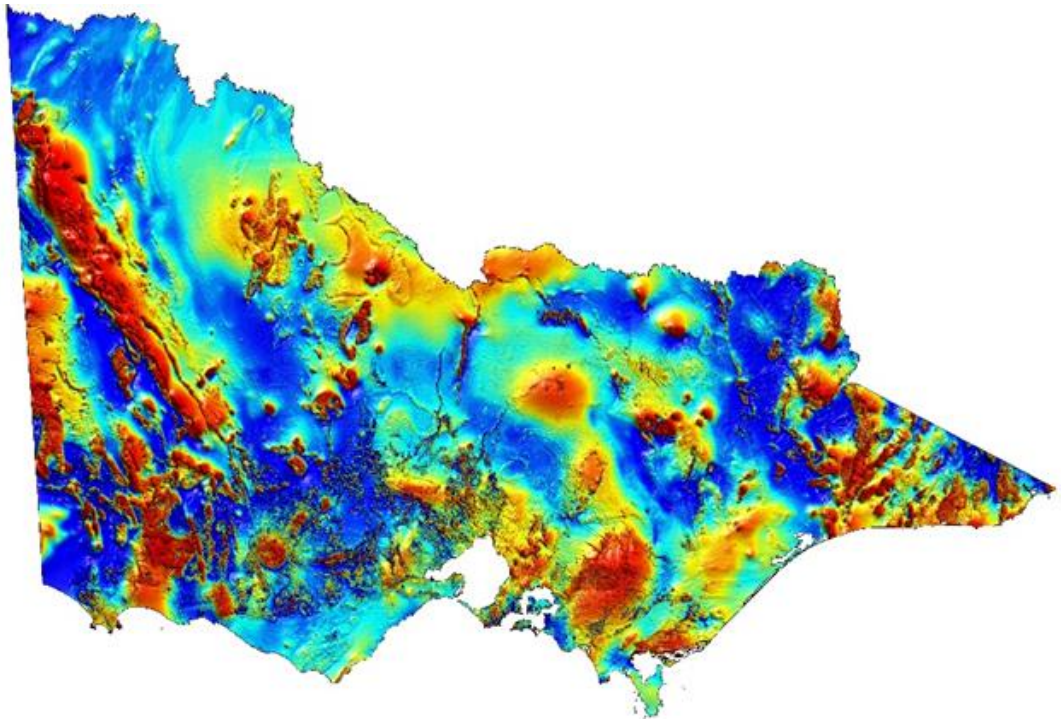
TARGET Minerals Exploration Grants

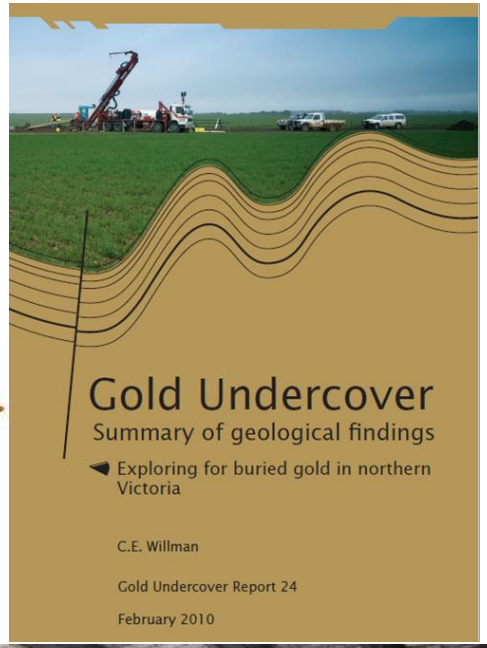
Mining, Engineering, Technology Services accelerator

GEOSCIENCE

Pre-competitive data and knowledge

- free maps, reports, data
- GeoVic: online GIS application





Geology

- Seamless: 1:250k and 1:50k
- 3D model full crust 1:250k

Geophysics

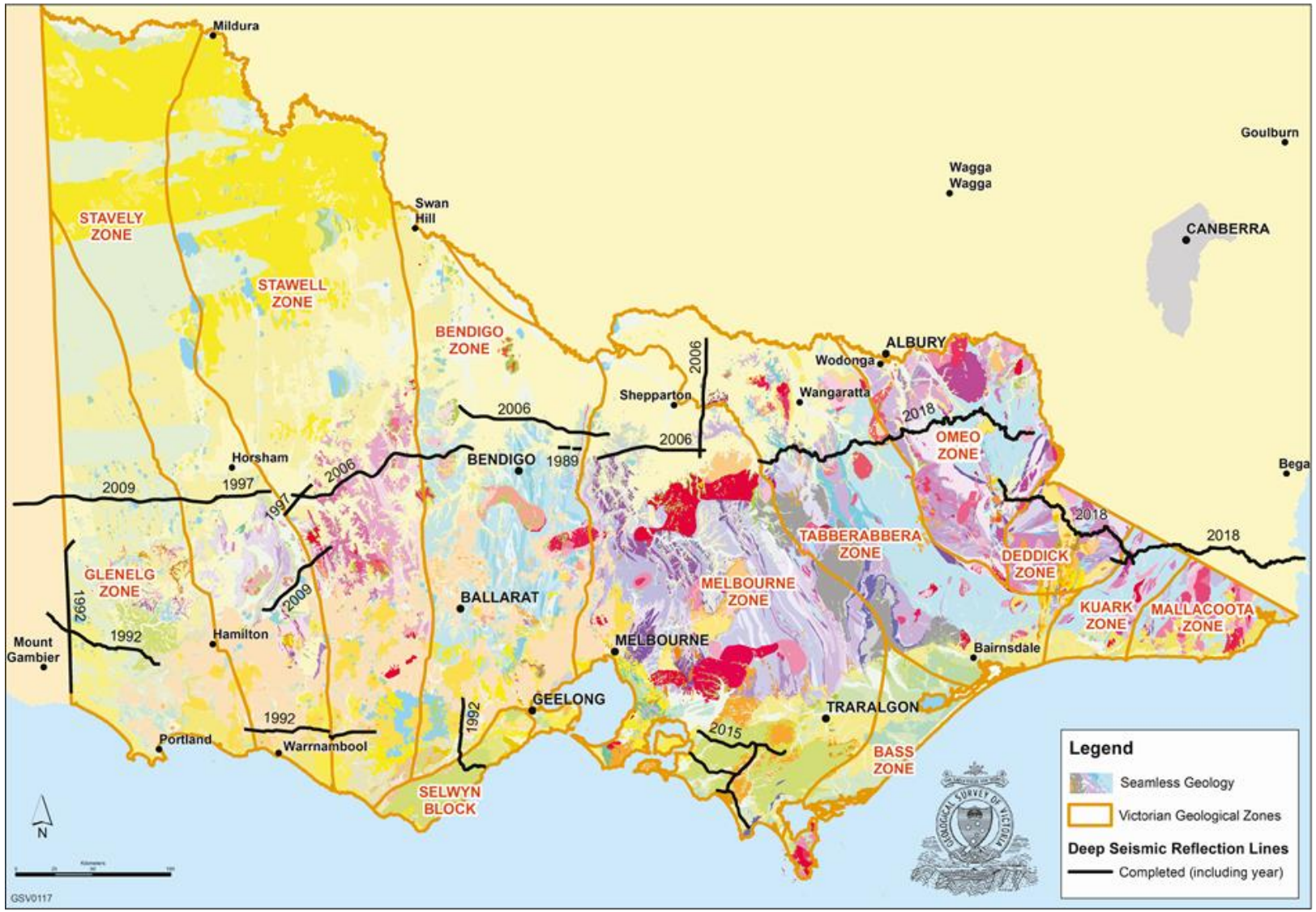
- Modern state-wide
- Magnetics: 200-400m line spacing
- Ground gravity: 1.5 km nominal spacing
- Deep 2D seismic reflection transects

Drill Core Library

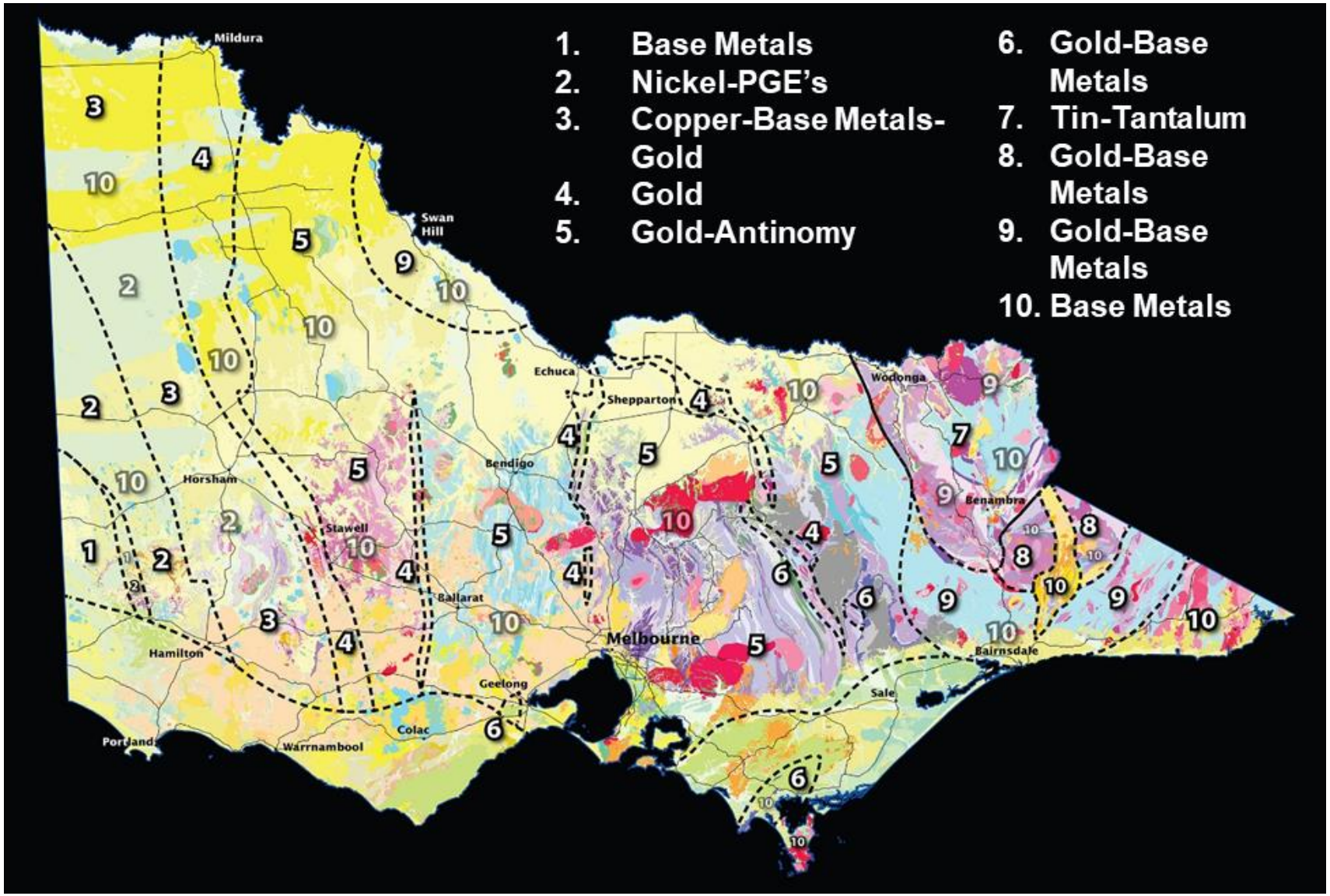
- 1.5 million metres drill core/cuttings
- >18,000 drill holes

AUSTRALIA MINERALS

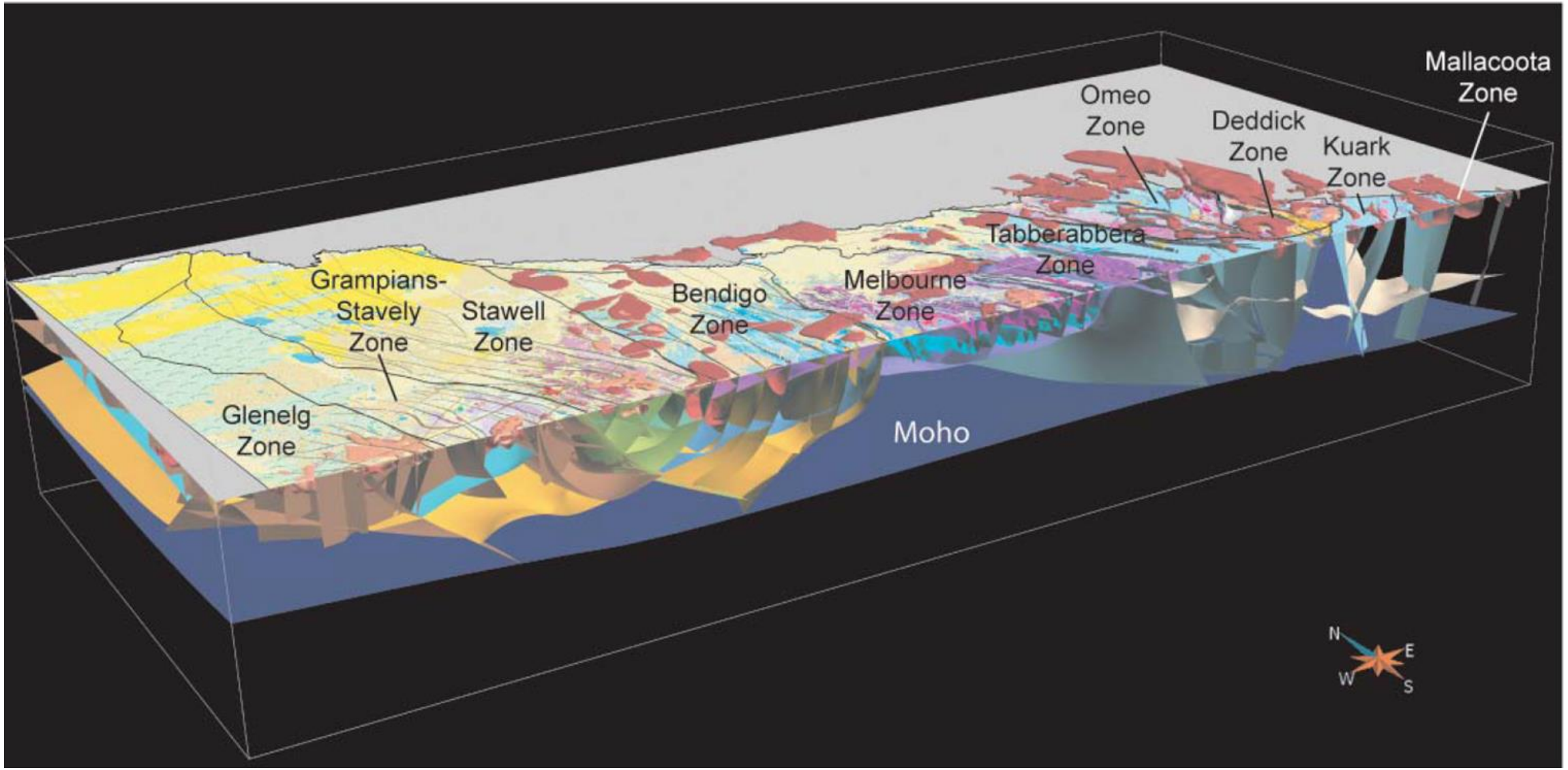
DEEP SEISMIC REFLECTION



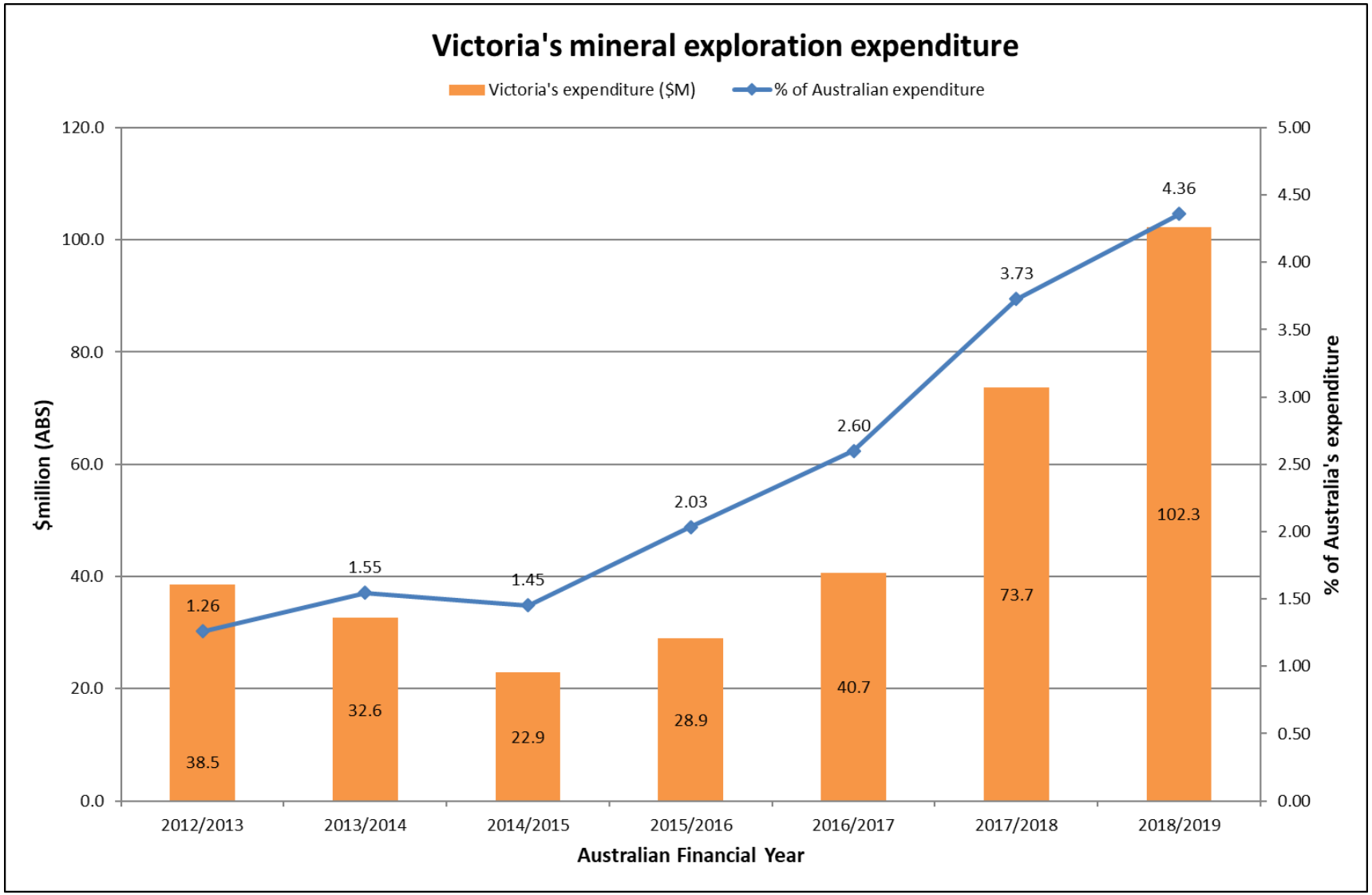
COMMODITIES – A SYSTEMS APPROACH



STATE WIDE INFORMED 3D MODEL



HEALTHY EXPLORATION ACTIVITY



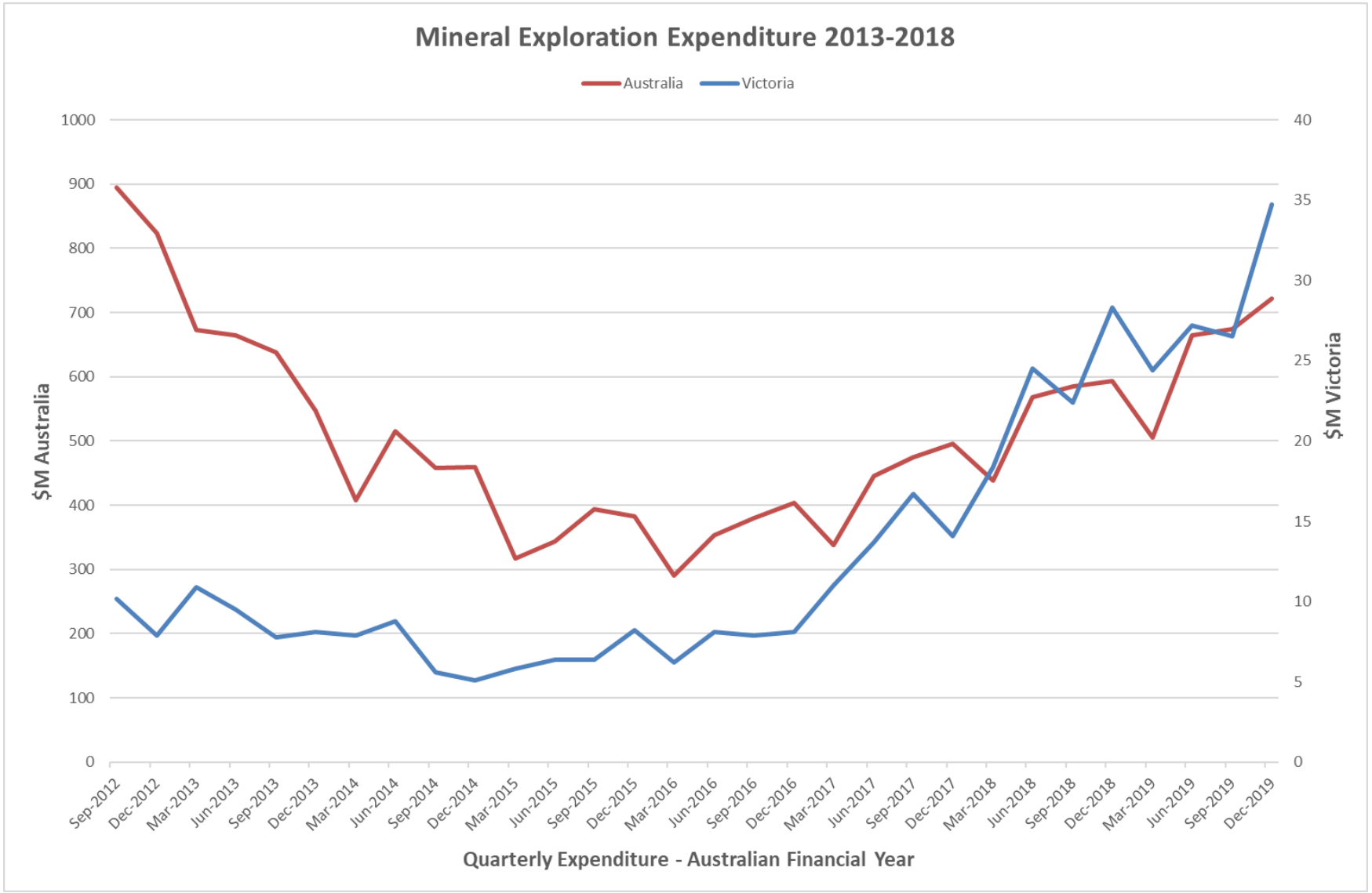
Source: ABS

Year	Drill metres
2012/2013	177,077
2013/2014	133,596
2014/2015	87,321
2015/2016	147,164
2016/2017	191,658
2017/2018	191,229
2018/2019	**348,192**

Source: GSV

INCREASING MINERAL EXPLORATION

#AustraliaMinerals



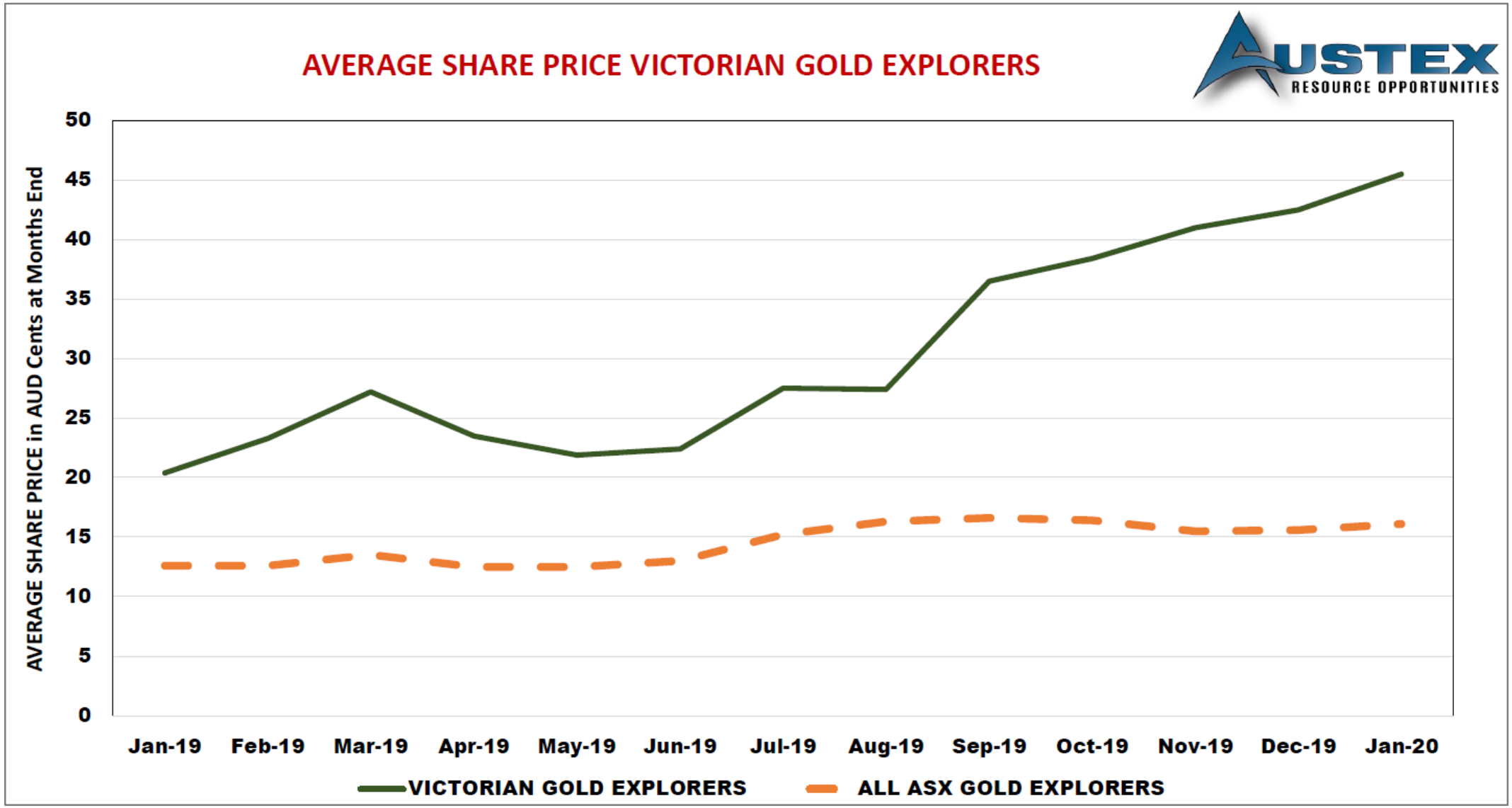
Year	Victoria $M	Australia $M
2012/2013	38.5	3,055.4
2013/2014	32.6	2,108.4
2014/2015	22.9	1,578.7
2015/2016	28.9	1,421.1
2016/2017	40.7	1,565.1
2017/2018	73.7	1,977.8
2018/2019	**102.3**	**2,347.6**

Source: ABS

Source: ABS

AUSTRALIA MINERALS

LISTED JUNIOR VALUE IN VICTORIA



FOSTERVILLE – Approaching ~10Moz

Production 2019

619,366oz @ 39.6g/t Au

Recovery: 98.8%

Operating Cash Cost/oz: $119/oz

AISC: TBA

Current reserves (February 2020)

2.1Moz @ 21.8g/t Au

Guidance

2020: 590,000-610,000k ($130-150/oz)

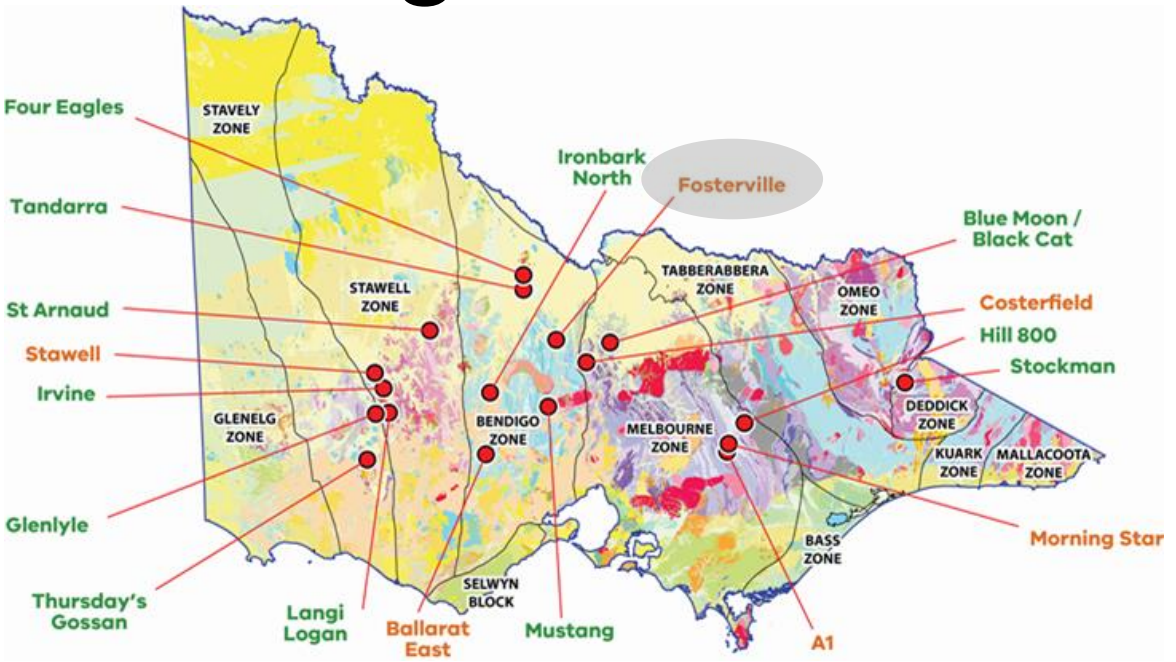
2021: 550,000-600,000k

2022: 500,000-600,000k

Exploration 2020

$70M

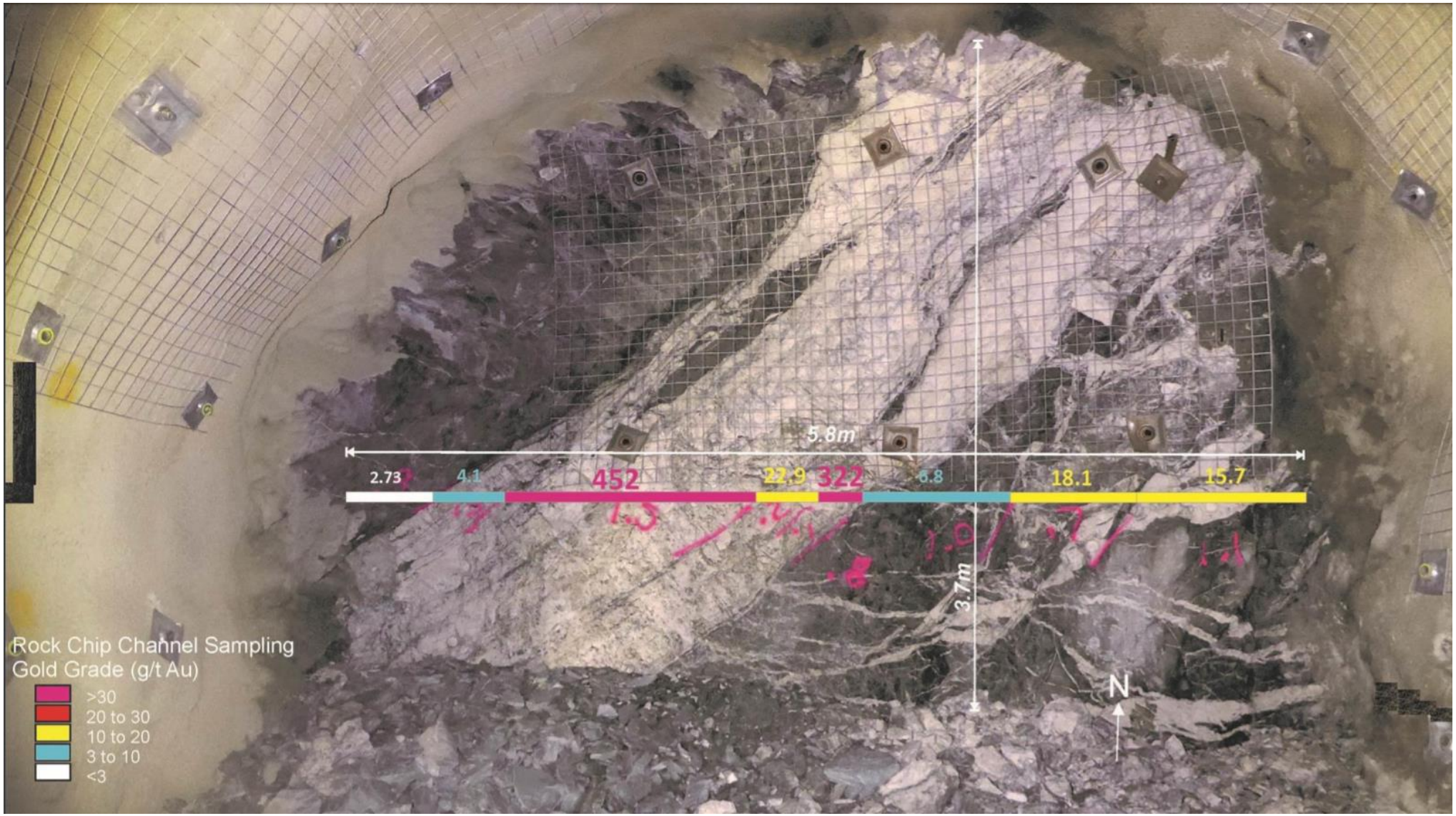
Robbins Hill



Source: KLG, Fosterville Gold Mine Update, AIG (Victoria) Minerals Roundup 2019

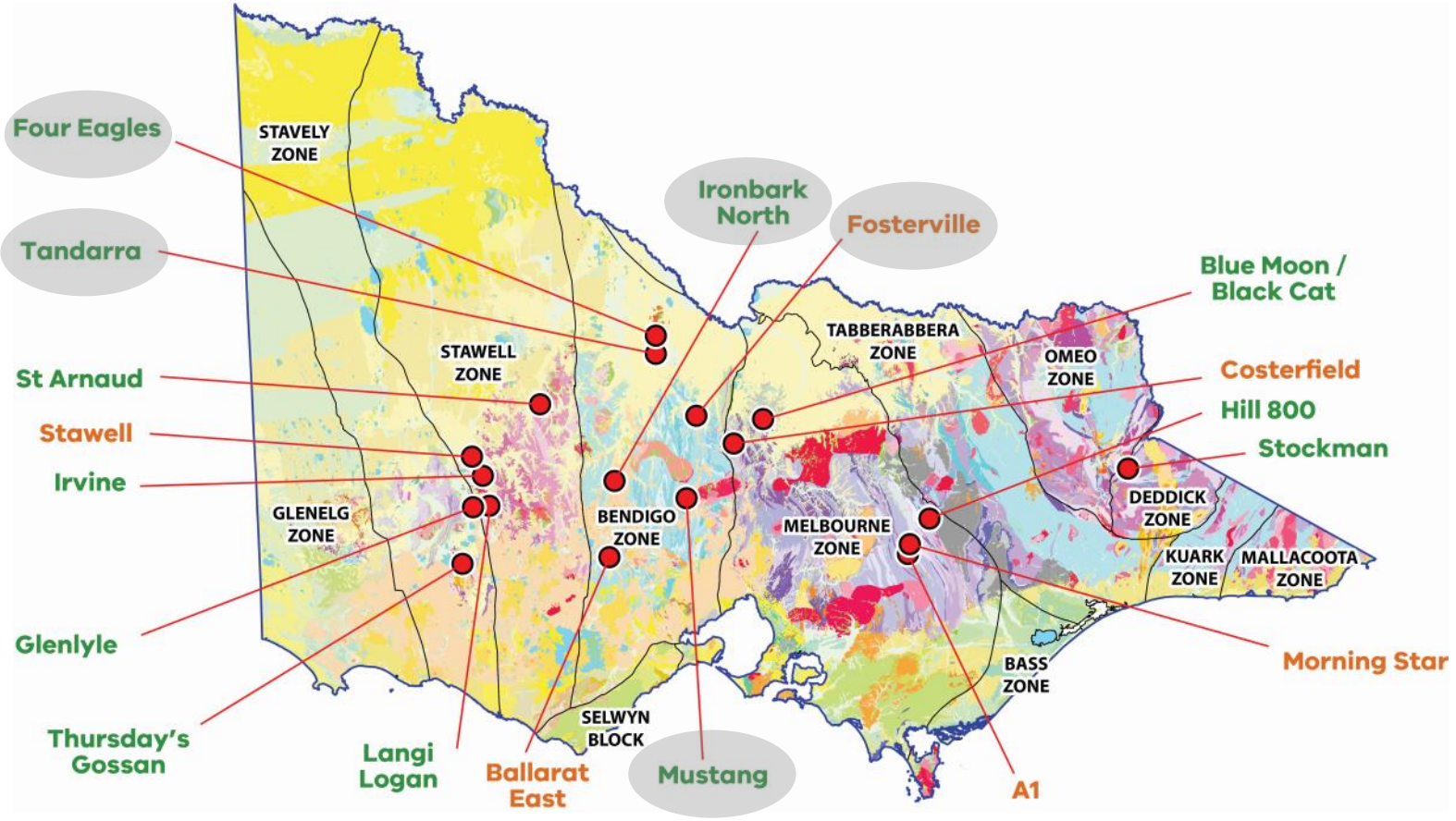
AUSTRALIA MINERALS

FOSTERVILLE – Swan Zone



Source: [KLG, Fosterville Gold Mine Update, AIG (Victoria) Minerals Roundup 2019]

WORLD CLASS GOLD

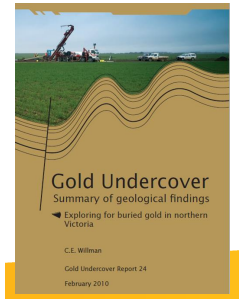


Gold Undercover

Multi-disciplinary modern applied geoscience

24 reports, new (free) data, two seminal papers

Potentially 32Moz yet to find in north Bendigo



Company	Intersection	Producing Mine / Prospect
BENDIGO ZONE		
Kirkland Lake Gold	3.6m @ 924 g/t Au (ETW 3.2m) *incl 0.5m @ 6,590 g/t Au (ETW 0.4m)* 7.0m @ 918 g/t Au (ETW 6.8m) *incl 3.7m @ 1,722 g/t Au (ETW 3.3m)* 7.6m @ 87.6 g/t Au (ETW 5.5m) 5.2m @ 45.0 g/t Au (ETW 4.7m) 5.0m @ 59.1 g/t Au (ETW 4.7m)	Fosterville (Swan)
	1.2m @ 239 g/t Au (ETW 0.9m) *incl 0.4m @ 701 g/t Au (ETW 0.3m)* 58.7m @ 4.8 g/t Au (ETW 20m)	Fosterville (Cygnet)
	2.8m @ 1,083 g/t Au (ETW 2.6m) *incl 0.4m @ 8,610 g/t Au (ETW 0.3m)* 4.8m @ 40.8 g/t Au (ETW 4.4m)	Fosterville (Swan Footwall Splay)
	3.7m @ 24.5 g/t Au (ETW 3.4m) *incl 1m @ 82.3 g/t Au (ETW 0.9m)* 8.8m @ 11.7 g/t Au (ETW 7.2m) *incl 0.5m @ 81.7 g/t Au (ETW 0.4m)*	Fosterville (Robbins Hill)
Catalyst Metals/ Gold Exploration Victoria	11m @ 37.2 g/t Au *incl 1m @ 247 g/t Au* *and 1m @ 150.5 g/t Au* 3.4m @ 7.5 g/t Au *incl 0.7m @ 34 g/t Au* *and 1m @ 24.3 g/t Au*	Four Eagles (Boyd's Dam)
	5.0m @ 13.1 g/t Au *incl 3m @ 21.4 g/t Au*	Four Eagles (Cunneens)
Catalyst Metals/ Navarre Minerals	3m @ 44.6 g/t Au *incl 1.0m @ 131 g/t Au* 24m @ 4.2 g/t Au *incl 6.0m @ 14.3 g/t Au* 14.6m @ 3.0g/t Au *incl 7m @ 5.4 g/t Au* 0.4m @ 243 g/t Au	Tandarra (Tomorrow)
Kalamazoo Resources	0.8m @ 19.4 g/t Au	Mustang
Chalice Gold	20m @ 0.85 g/t Au *incl 8m @ 2.0 g/t Au*	Ironbark North

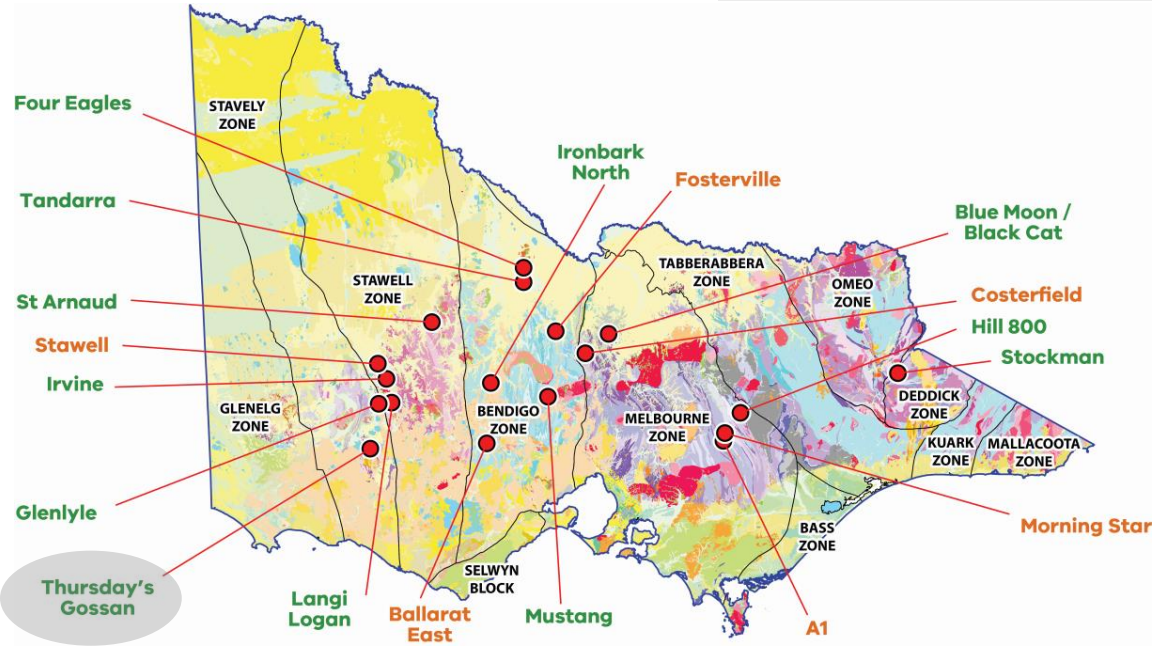
Selected publically reported mineralised intersections as of July 1, 2019.
All intersections are downhole, unless Estimated True Width (ETW) is stated.
(No available drilling results for Castlemaine Goldfields, Arete Capital Partners & Round Oak Minerals)

THE CAYLEY LODE

Cu-Au-Ag (chalcopyrite, bornite, chalcocite)
Cambrian (Arc) volcanics
Thursday's Gossan Prospect
Porphyry affinity - Magma/Butte analogy(?)

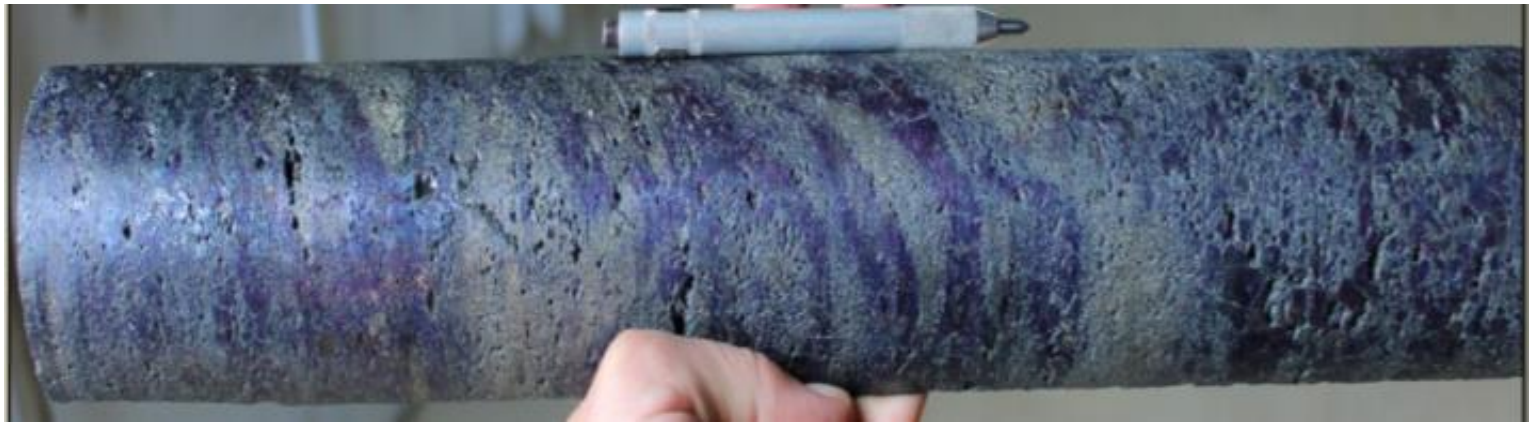
8m @ 9.69% Cu, 0.40g/t Au, 16.8g/t Ag from 177m
Incl 2m @17.3% Cu, 0.57g/t Au, 13.1g/t Ag

8m @ 5.12% Cu, 1.48g/t Au, 34.3g/t Ag from 121m
Incl 1m @ 26.8% Cu, 8.48g/t Au, 201g/t Ag*



GSV-GA Stavely Project

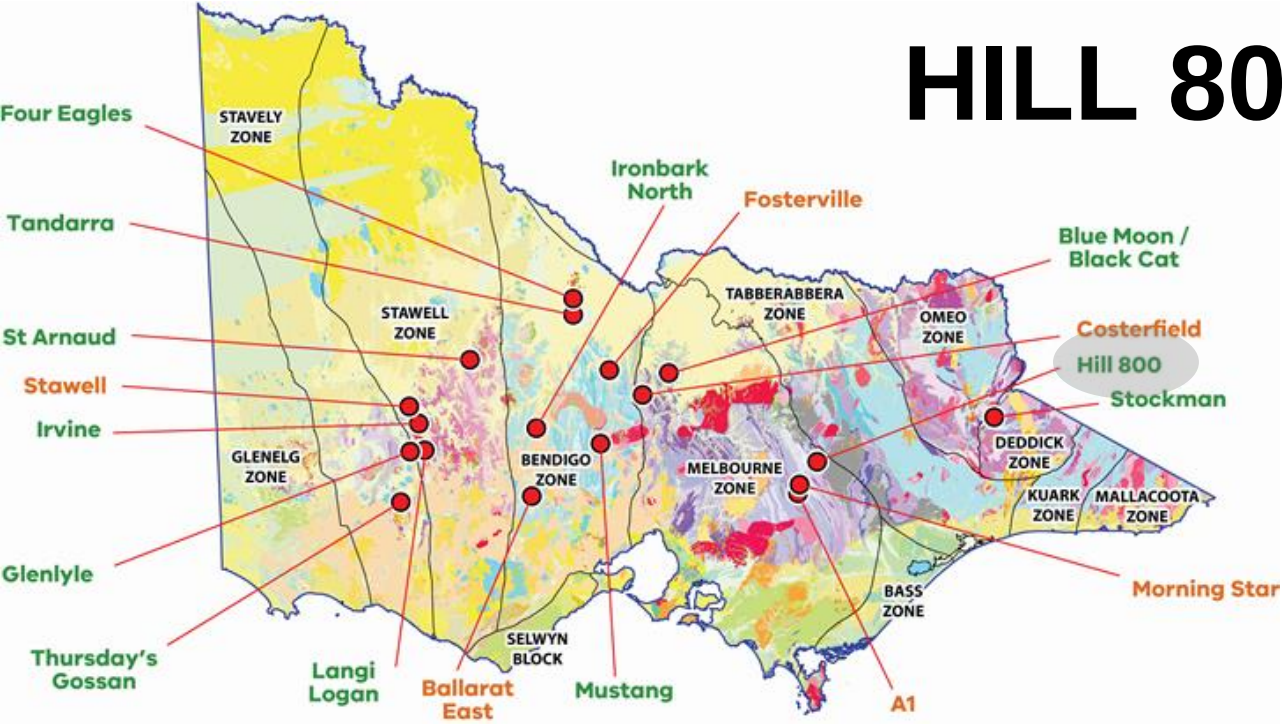
Pre-competitive data, 22 reports
3D geology (structural) model
Presentations
Short Film



32m @ 5.88% Cu, 1.0g/t Au, 58g/t Ag from 62m, Incl 12m @ 14.3% Cu, 2.26g/t Au, 145g/t Ag, *incl 2m @ 40% Cu, 3.0g/t Au, 517g/t Ag*

AUSTRALIA MINERALS

HILL 800



101m @ 1.44g/t Au from 21m
incl 12m @ 4.32g/t Au from 83m

17m @ 6.62g/t Au, 0.3% Cu from 157m
incl 2m @ 37.5g/t Au, 0.3% Cu from 172m
1m @ 20.2g/t Au, 0.2% Cu from 166m

11m @ 9.87g/t Au, 0.3% Cu and 14.6g/t Ag from 179m
incl 4m @ 26.7g/t Au, 0.7% Cu and 38.7g/t Ag

Copper – Gold ± Silver
Cambrian (Arc) volcanics
Gold at surface
Multiple porphyry targets
Western Tasmania affinity

H8DD002, 187m, 16.7g/t Au, 1.1% Cu

CRITICAL METALS

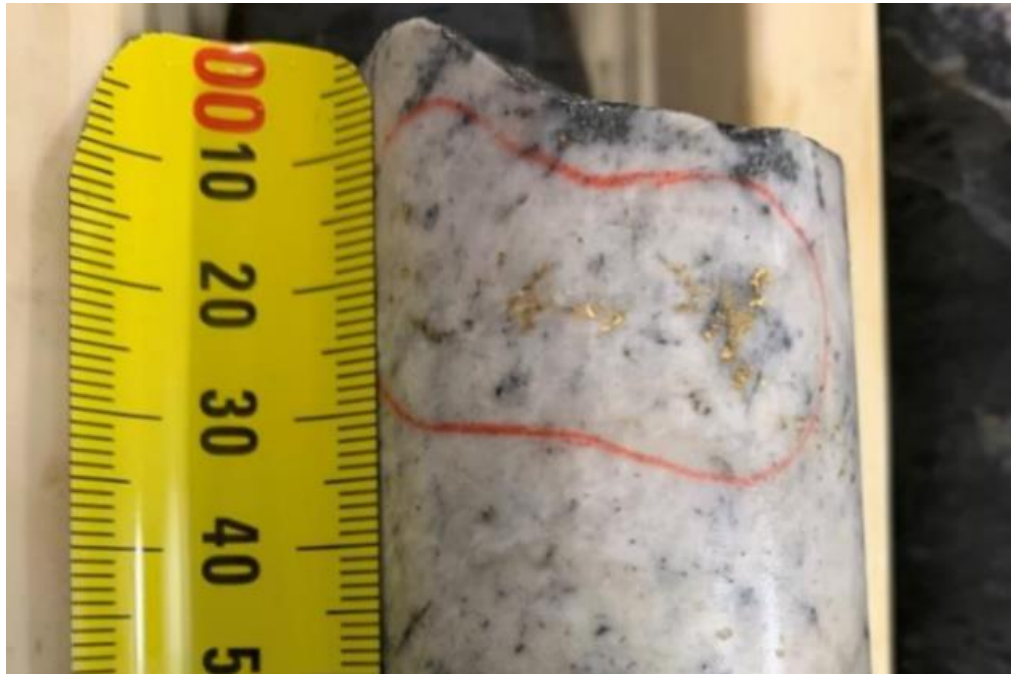
Antimony

Central Victoria

Costerfield – Australia's largest producer (World top 5)

1.18m @ 159.2g/t Au, 38.3% Sb

0.37m @ 303g/t Au, 52.1% Sb



Costerfield (Youle): 2.12m @ 85.3g/t Au, 6.5% Sb

Heavy Mineral Sands (Rare Earth Elements)

West/Northwest Victoria

World class province

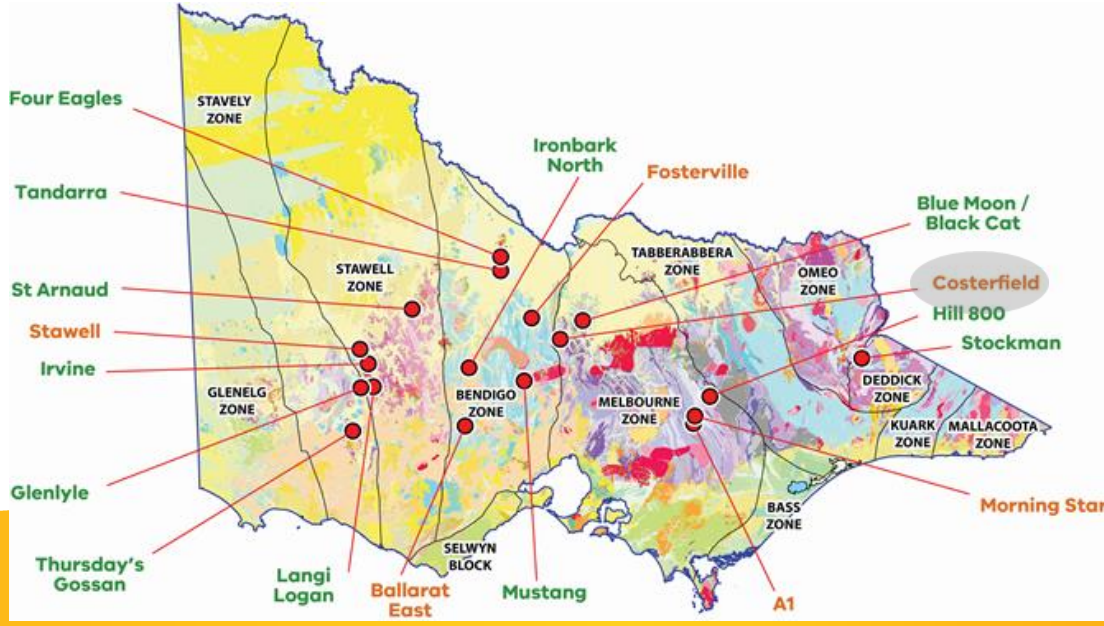
WIM (Wimmera) style

Lithium (Rare Earth Elements)

Northeast Victoria

Dorchap (pegmatite) Dyke Swarm

Early stage



AUSTRALIA MINERALS

#AustraliaMinerals

INTERNATIONAL MINING AND RESOURCES CONFERENCE + EXPO

27 - 29 OCTOBER 2020

imarcmelbourne.com

>7,000 delegates from >100 countries
>350 mining and resource experts
>35 international mining ministers
>100 hours networking opportunities

FREE Exhibition
>200 leading service companies

Exploration, Investment and Finance, Future Energy, International and Local opportunities, People, Projects and Infrastructure, Technology, Innovation and Operational Excellence, Country Focus sessions

AUSTRALIA MINERALS

THANK YOU

Cameron.Cairns@ecodev.vic.gov.au
Manager Minerals Geoscience
Geological Survey of Victoria
+61 3 9452 8972

earthresources.vic.gov.au

Environmental Management in Tasmania – Research & Regulation

Presented by Clint Siggins - Mineral Resources Tasmania

Environmental Management in Tasmania – Research & Regulation

Department of State Growth

Tasmanian Government

TOP

Environmental Management in Tasmania – Why is Research important?

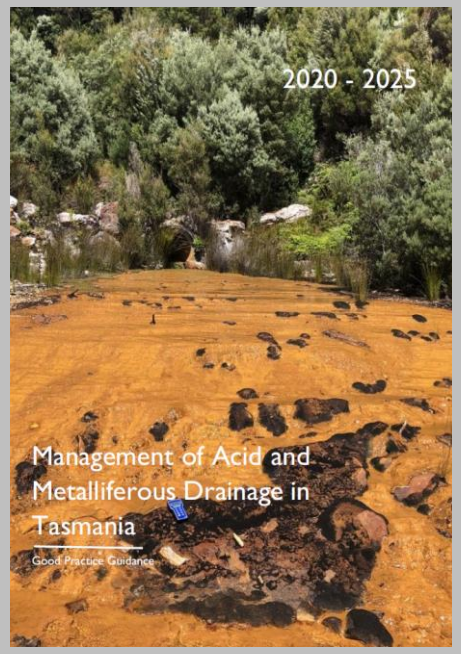
Environmental Management in Tasmania – Research

- Mining Sector Innovation Initiative Program - helping to keep the industry at the cutting edge of technology and best practice
- The initiative builds on Mineral Resources Tasmania's collaborative work with the University of Tasmania's Centre of Excellence in Ore Deposits (CODES) and with the Tasmanian Minerals, Manufacturing and Energy Council (TMEC)
- The program supports industry through:
    - Investigation of innovative solutions for mine rehabilitation and remediation;
    - Development of the Good Practice Guide – Management of Acid and Metalliferous Drainage in Tasmania;
    - Improving our understanding of landslip reactivation and implications for future planning and emergency response; and
    - Innovative uses for geoscientific data using new technologies.

Mining Sector Innovation Initiative Program

Completed projects

- Good Practice Guide – Management of Acid and Metalliferous Drainage in Tasmania
- Examining Pollutant Linkage Chains From Alluvial Tin Tailings



Mining Sector Innovation Initiative Program

Current projects

- PhD - Controlling Acid and Metalliferous Drainage at Legacy Mine Sites in Tasmania Using Industrial Wastes – shells, green liquor dregs
- Geochemical analysis of lake sediments from historical alluvial tin tailings site
- Hydrogeological studies of acid mine drainage from historical alluvial tin mining
- Geophysical investigation of historic tin tailings site
- PhD – Water Mining – Phytomining, Phytoremediation

Opportunities

- Use Hyperspectral data to monitor and assess success of rehabilitation programs
- Research into hyperspectral waste classification systems; i.e. scanners on haul roads to check classification

Innovative solutions for mine rehabilitation and remediation

Opportunities

- Kinetic testing on site v lab environment, is there any alternatives which produce similar outcomes
- Use Hyperspectral data for rehabilitation success monitoring to improve operational and environmental outcomes
- Research into hyperspectral waste classification systems; i.e. scanners on haul roads to check classification, can it be done on a commercial scale, can the sensors be trained to identify PAF waste on different sites
- Publicly available GIS layer for AMD prone geology
- Growth medium trials for use in Tasmania on different substrates

Good Practice Guide - Acid and Metalliferous Drainage (AMD)

- Good Practice Guide specific to Tasmania
- Developed to compliment existing references – Global Acid Rock Drainage (GARD) Guide
- Working Group of stakeholders including representatives from MRT, EPA & Industry
- Project Officer employed at Mineral Resources Tasmania
- Due for release in March 2020
- Umbrella document with supporting Fact Sheets

Good Practice Guide - Acid and Metalliferous Drainage (AMD)

- **Understanding AMD**
- **Acid Mine Drainage and the Mine Lifecycle**
- **Fact Sheets:**
  - **References and Glossary of Terms**
  - **Implications of not Managing AMD Correctly**
  - **Identification and Characterisation of Materials**
  - **AMD Prediction Methods**
  - **Monitoring Requirements**
  - **Prevention of AMD during Operations**
  - **Treatment of AMD**

Good Practice Guide

Environmental Management in Tasmania – Regulation - Mining

- Mining operations in Tasmania are regulated by two primary authorities:
  - Mineral Resources Tasmania (MRT)
    - Tenement and land management (including exploration)
  - Environment Protection Authority (EPA)
    - Environmental assessment, regulation and permit conditions for operation

Clint Siggins
Manager, Scientific Services

2 March 2020

Mineral Resources Tasmania

Thank You

Department of State Growth

Tasmanian Government

#AustraliaMinerals

GOVERNMENT OF WESTERN AUSTRALIA

AUSTRALIA MINERALS

REALISE THE OPPORTUNITY

The West Australian Perspective

- Critical and Dominant Minerals in Western Australia

Gaomai Trench

Manager – Resources Investment Information

Geological Survey and Resource Strategy Division

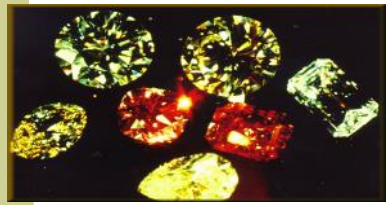
WA Department of Mines, Industry Regulation and Safety

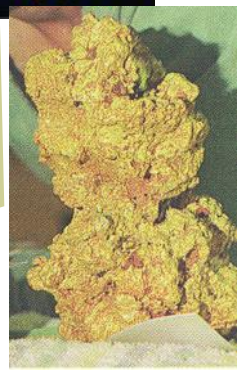
Greenbushes project

TOP

Dominant Minerals in Western Australia

World Leader in Mineral and Energy Production





Pb/Zn
Bauxite
Diamond
Iron Ore
Nickel

Kimberley

Oil & Gas
Salt

Nickel

Ta

Manganese

Pilbara

Gold

Iron Ore

Chromite

Nickel

Gold

Eastern
Goldfields

Yilgarn

Geraldton

Gold

Iron Ore
Cu/Zn

Kalgoorlie

Perth

Nickel

Bauxite
Ti Minerals

Coal

Li Ta

Esperance

AUSTRALIA MINERALS

WA's share of Global Production 2018

Lithium	60%
Iron ore	32.5%
Rare Earth Oxides	17.6%
LNG	13.9%
Diamond	10.7%
Alumina	10.3%
Ilmenite	10.2%
Nickel	6.5%
Gold	6.3%
Zircon	4.4%
Salt	4.3%
Cobalt	3.5%

Sources: DMIRS, USGS, Office of the Chief Economist, Energy Quest, International Aluminium Institute, GIIGNL Annual Report

Australia Tops global Lithium Production (2018)

	Country	Mine production
1	Australia	*57,000 MT*
2	Chile	*16,000 MT*
3	China	*8,000 MT*
4	Argentina	*6,200 MT*
5	Zimbabwe	*1,600 MT*
6	Portugal	*800 MT*
7	Brazil	*600 MT*
8	Namibia	*500 MT*
9	United States	unknown

- The latest data from the US Geological Survey shows that the world's top lithium producers are doing their best to meet rising demand from energy storage and electric vehicles
- Worldwide lithium supplies rose roughly 23 percent from 2017 to 2018
- Overview of the nine countries that produced the most lithium in 2018. Australia produced **more than 50%** of known world production
- If the electric vehicle market continues to grow, and if lithium-ion batteries continue their reign as the top batteries for electric vehicles, it's likely lithium demand will continue rising in years to come

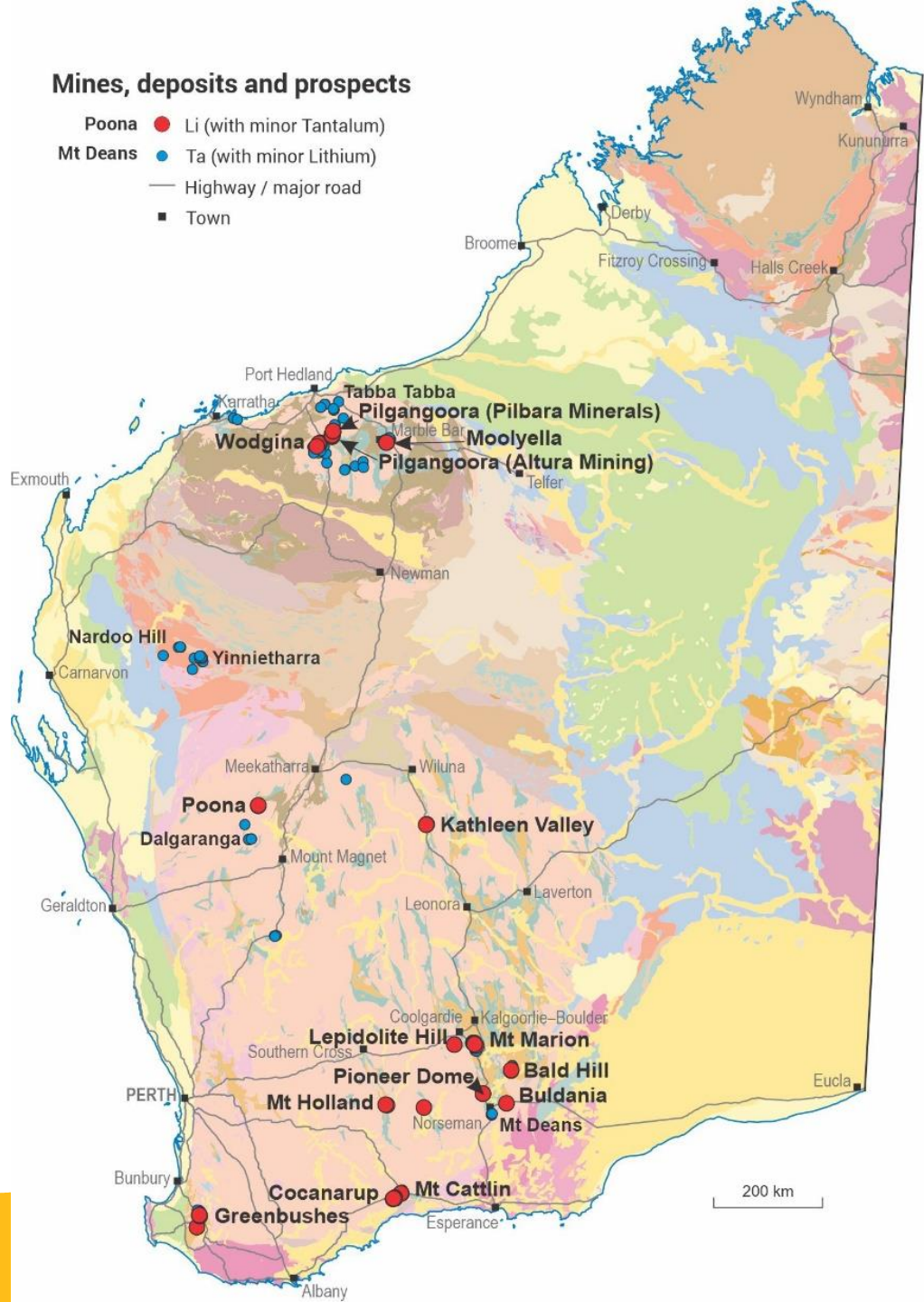
Lithium(-Cesium)

- World's largest Li supplier (51,000 tonnes, about 60% in 2018, USGS)
- 2nd largest reserves globally (USGS 2018):

  All deposits are 'hard rock' (pegmatite-hosted)
- World's largest single such deposit (Greenbushes)
- 7 operating mines:

  Greenbushes, Mt Marion, Mt Cattlin, Wodgina, Altura, Pilgangoora, Bald Hill
- Another advanced project at Earl Grey (Mount Holland)
- All Li currently exported as concentrate or DSO
- Downstream processing imminent in WA
- Also WA's first cesium (pollucite) mine at Sinclair (Pioneer Dome)

  7,000t @ 16.4% Cs (1,167t Cs)



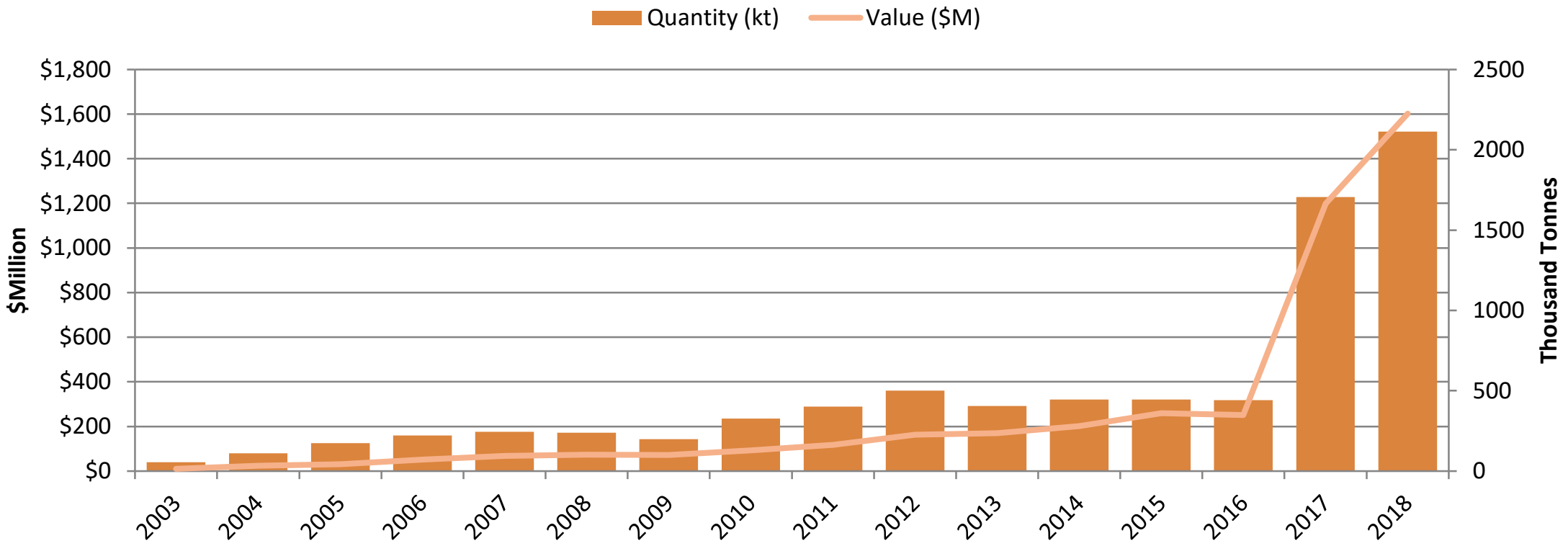
AUSTRALIA MINERALS

Greenbushes Lithium Mine

- Tianqi Lithium investing an extra A$516 million ($382 million) in 2019 to increase lithium production at its Greenbushes mine
- Project operator Talison Lithium, a joint venture between Tianqi and Albemarle Corp.
- China’s Tianqi, which holds a 51% stake in Talison, is constructing a 24 000 t/y lithium hydroxide plant in Kwinana, 40 km from Perth

Western Australia Lithium Production in last 15 Years

Spodumene Concentrate
Quantity and Value by Calendar Year



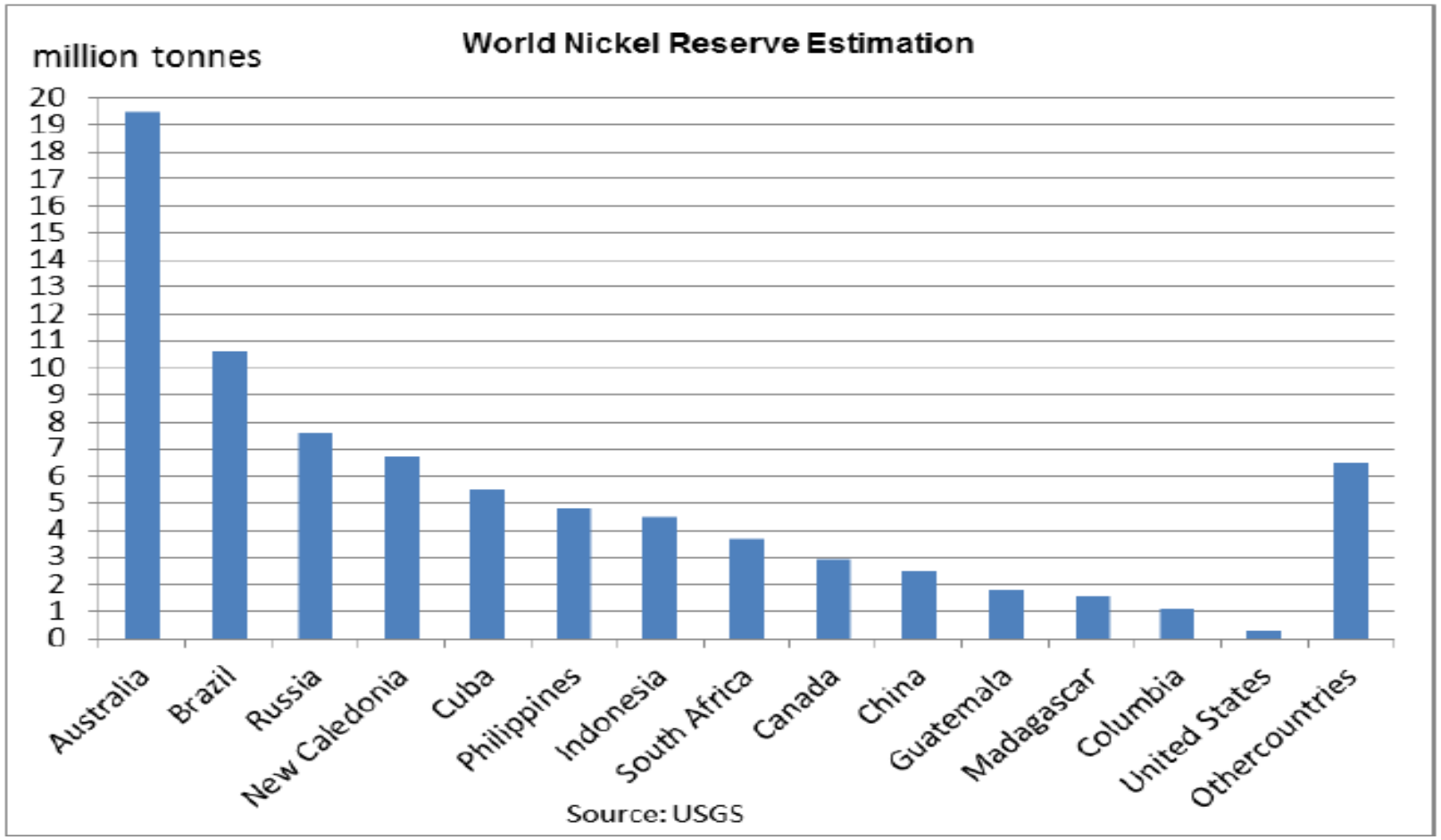
Source: DMIRS

AUSTRALIA MINERALS

Countries with the largest lithium reserves worldwide as of 2018 (in metric tons)

Country	Reserves in metric tons
Chile	8,000,000
Australia	2,700,000
Argentina	2,000,000
China	1,000,000
Zimbabwe	70,000
Portugal	60,000
Brazil	54,000
United States	35,000

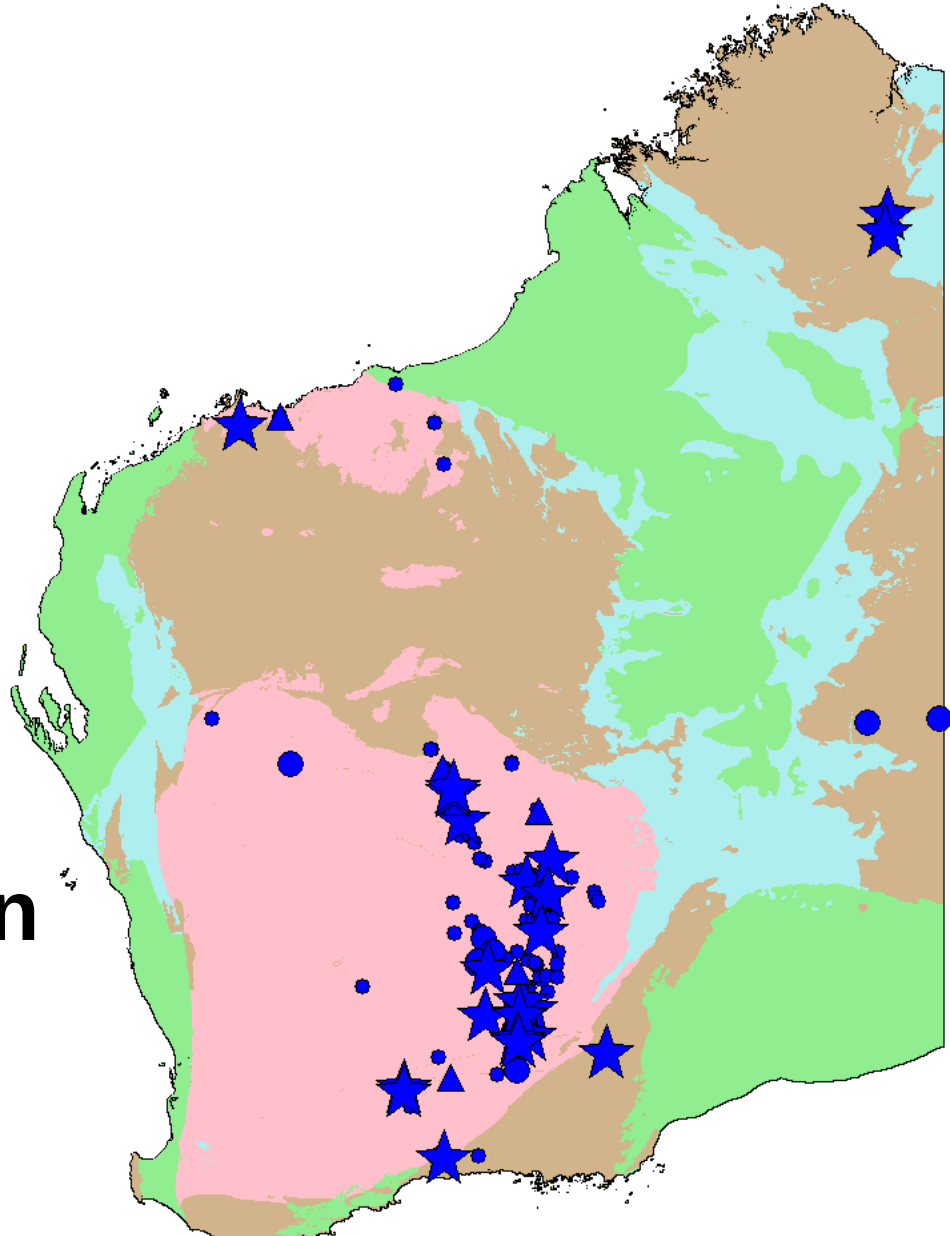
Australia holds the largest nickel reserves in the world (2017)



Western **Australia** has the largest **nickel** resources in Australia, with 96% of total **Australian** resources contained within **nickel** sulfide and lateritic **nickel** deposits

WA is Australia's only Nickel miner

- Current resources: 34.0 Mt contained Ni
- Production in 2018: 149,642 t
- New discoveries being made
- New mine opening: Nova–Bollinger
- Laterite & sulphide deposits
- Komatiitic and ultramafic intrusive style sulphide deposits as well as lateritic style



WA Ni exports 2018: $AUD 2.615 billion

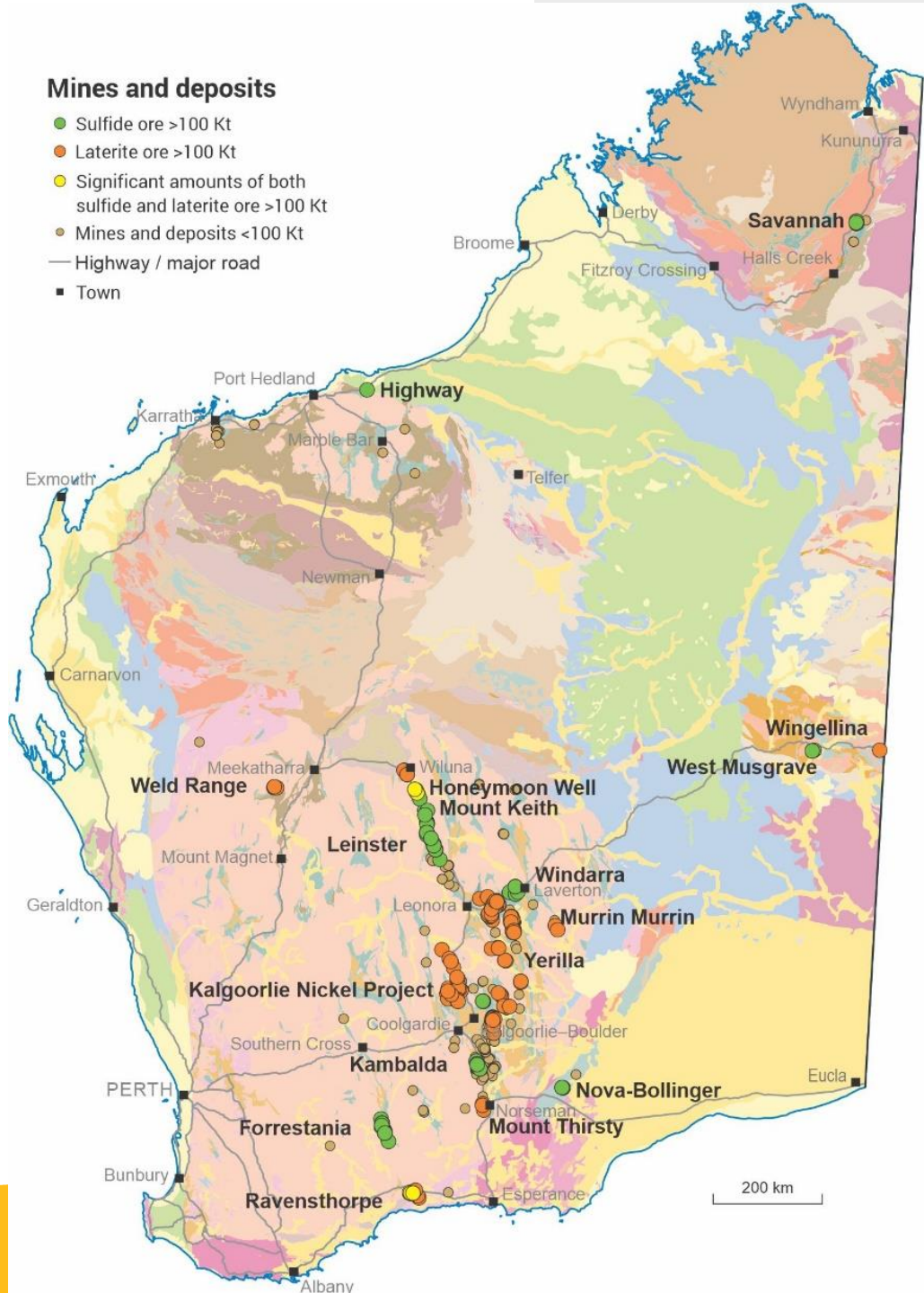
WA is 6th highest Nickel Producer (2018)

	Country	Mine production
1	**Indonesia**	*560,000 MT*
2	**Philippines**	*340,000 MT*
3	**New Caledonia**	*210,000 MT*
4	**Russia**	*210,000 MT*
5	**Canada**	*160,000 MT*
6	**Australia**	*148,000 MT*
7	**China**	*110,000 MT*
8	**Brazil**	*80,000 MT*
9	**Cuba**	*53,000 MT*

- Australia holds the highest nickel reserves in the world at 19 million MT, but in 2018 was only the fifth-largest nickel producer in the world
- After nickel's devastating price crash from 2014 to 2016, a number of mines closed.
- Following the commodity's recovery, companies including Mincor Resources have been actively working on a "nickel restart strategy" involving four deposits in Western Australia's Kambalda region.
- BHP is one of the top-producing companies in WA with its 100-percent-owned Nickel West division. The company recently announced its plans to continue growing and investing in the operation as demand for nickel rages on

Cobalt(-Scandium) +Nickel

- Known Co mostly in nickel deposits
- Resources: **2.84 Bt @ 0.05% Co** (46 deposits)
- World's 2nd largest Co reserves (after DRC)
- Produced approximately 3.59 Mmtpa of cobalt in 2018 (NS ENERGY)
- Production ranked 3rd globally in 2019
- Production entirely as by-product from nickel mines
- Now a focus on defining standalone cobalt resources
- Also potential in sediment-hosted Cu-Co deposits (several projects in WA)
- One known scandium resource (Kalgoorlie Nickel Project) – **23.9 million tonnes @ 40.3 gpt Sc**

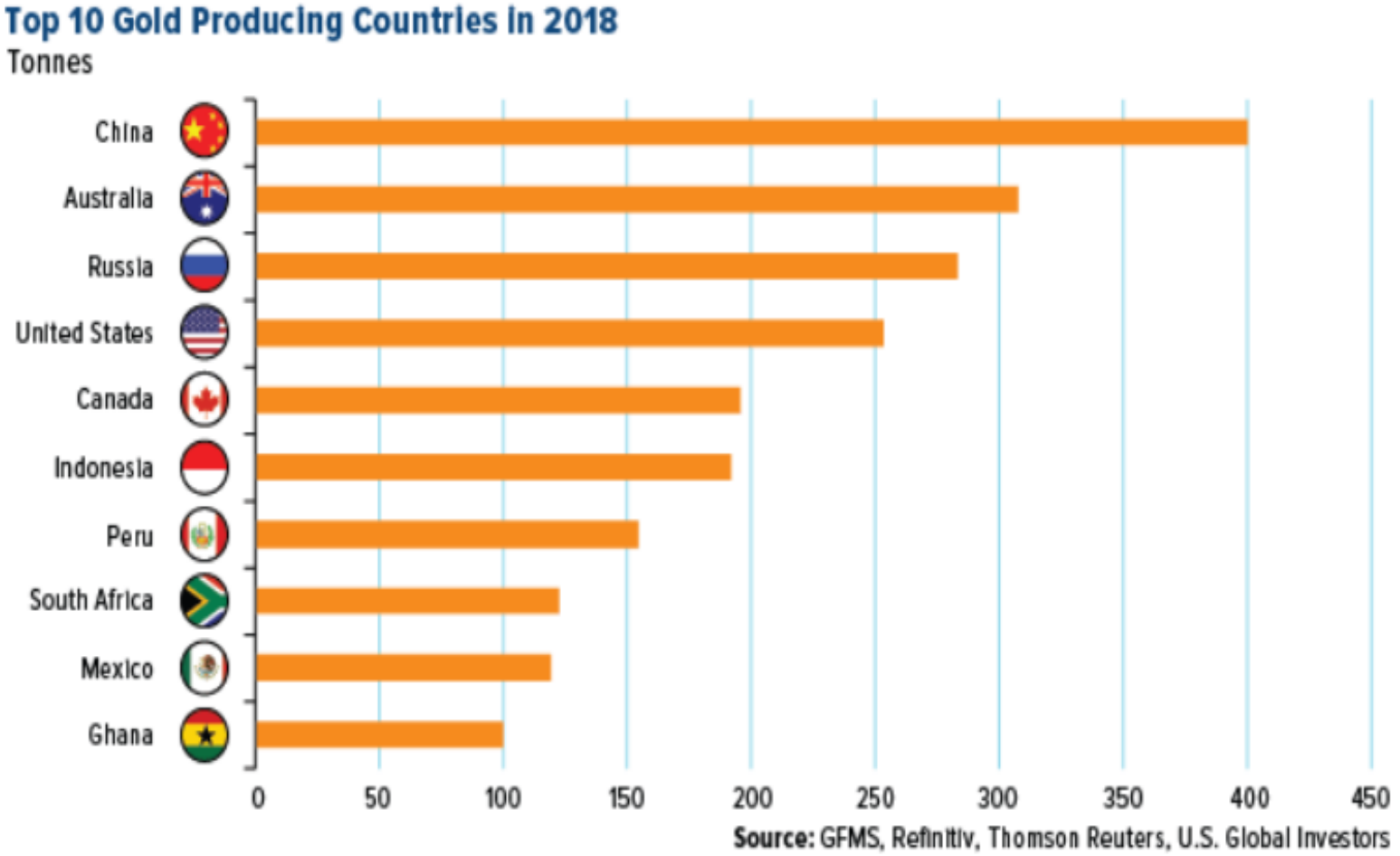


AUSTRALIA MINERALS

Cobalt reserves worldwide as of 2018, by country (in metric tons)

Country	Cobalt reserves in metric tons
DR Congo	3,400,000
Australia	1,200,000
Cuba	500,000
Philippines	280,000
Canada	250,000
Russia	250,000
Madagascar	140,000
China	80,000
Papua New Guinea	56,000
United States	38,000
South Africa	24,000
Other countries	640,000

Australia - Second Largest Gold Producer in the World



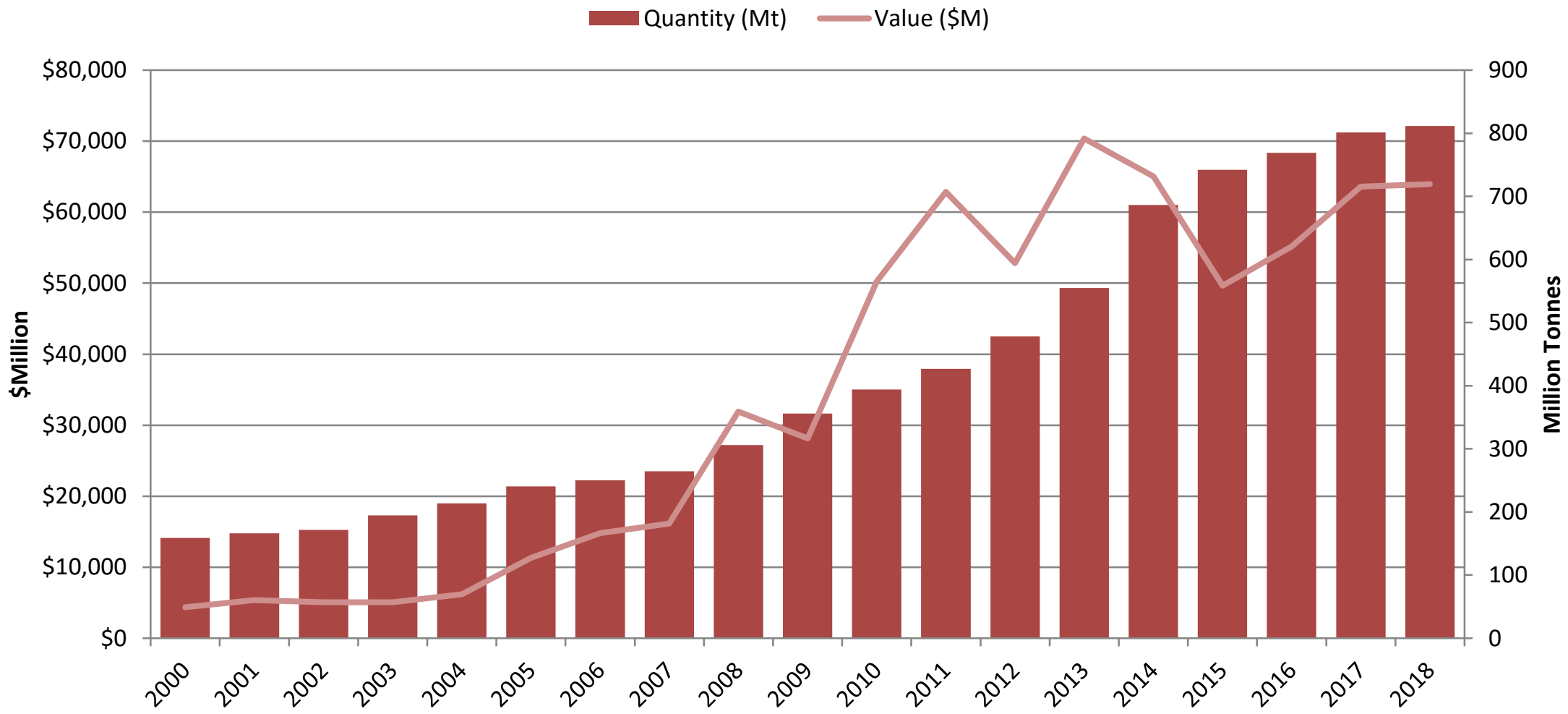
China – 399.7 tonnes
For many years China has been the top producing nation, accounting for 12 percent of global mine production.

Australia – 312.2 tonnes
Australia has posted six consecutive years of increases in production, up by 6 percent in 2018.

Western Australia – 211 tonnes

- Western Australia produced about 68% of Australia's total gold production.
- If considered a country, WA would be the world's 4th largest gold producer after US.

Iron ore production – Western Australia



Source: DMIRS

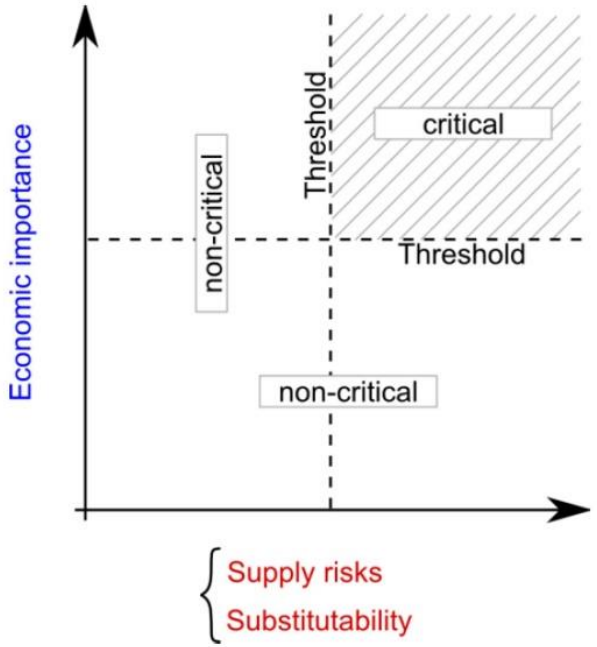
Critical Minerals in Western Australia

What are critical minerals?

Essential for manufacturing

Supply chain vulnerable to disruption

No ready substitutes



The list varies between jurisdictions

https://www.isi.fraunhofer.de/content/dam/isi/dokumente/ccn/polinares/Polinares_WP_31_March_2012.pdf

Critical minerals in Western Australia

Consider exemplars illustrating prospectivity

Major ore component or by-product

Arbitrarily categorize as:

Energy metals - lithium(-cesium), cobalt(-scandium), **graphite, manganese, vanadium, (high purity) alumina, rare earth elements**

Industrial minerals – antimony, baryte, chromium, fluorite, **potash, phosphate,** tantalum(-tin), **titanium**, **tungsten,** niobium, **zirconium-hafnium**

Unknown prospectivity – beryllium, bismuth, gallium, germanium, helium, indium, rhenium

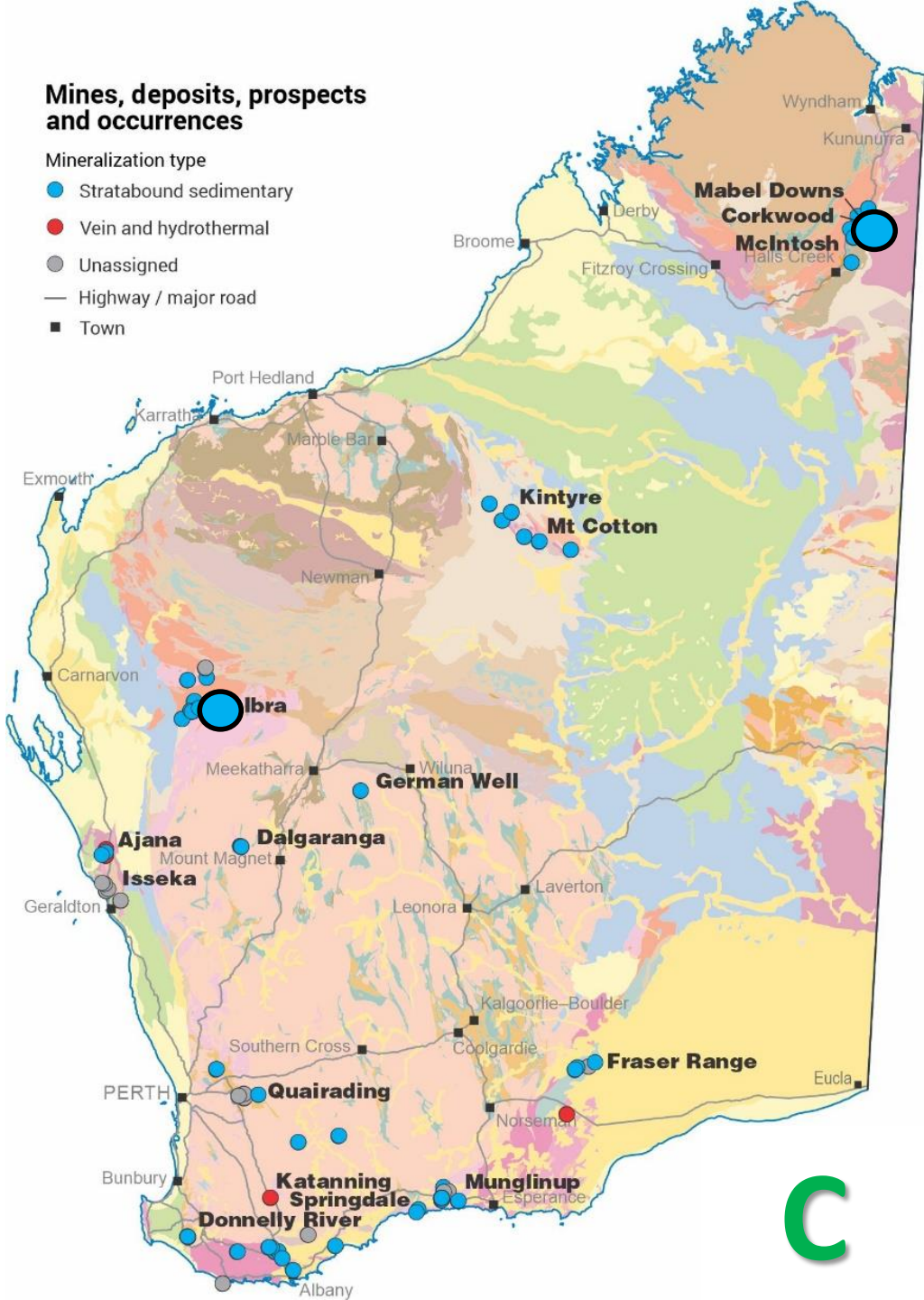
Details about any WA mineral project can be obtained from the WA Mines and Mineral Deposits database (www.dmp.wa.gov.au/MINEDEX)

Graphite

- Western Australia has resources over 1.6 Mt contained total graphitic carbon
- Majority are Archean to Mesoproterozoic graphitic schists or gneisses (metamorphosed carbonaceous sedimentary rocks)
- Defined resources at:

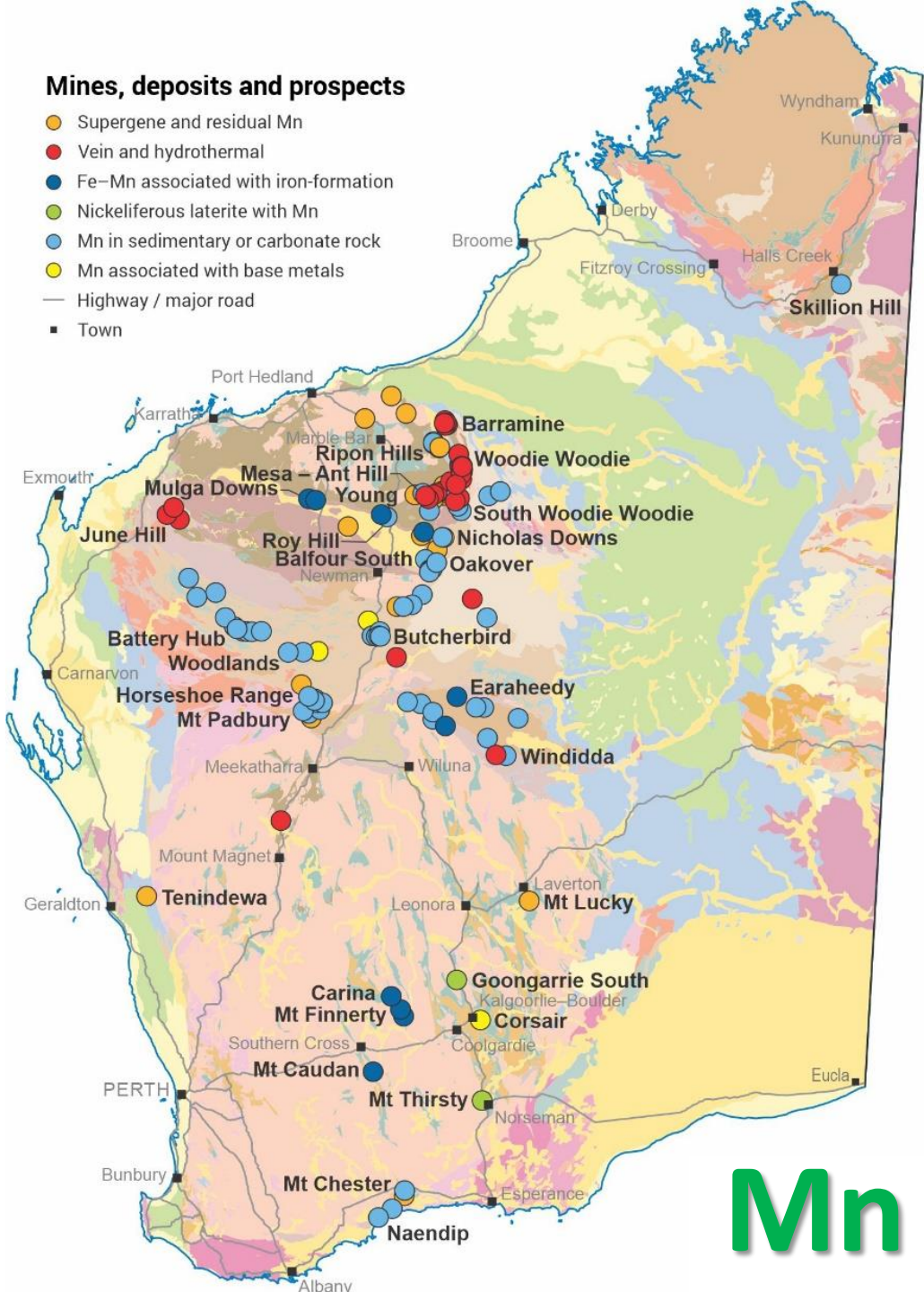
  Donnelly River
  McIntosh
  Munglinup River – Halberts
  Yalbra

- Munglinup Project's feasibility study indicate a 14 year mine life with 52ktpa production rate.
  - Reserves 4.24 million tones at 12.8% graphite content
  - Graphite concentrate is to be export from Perth Fremantle port



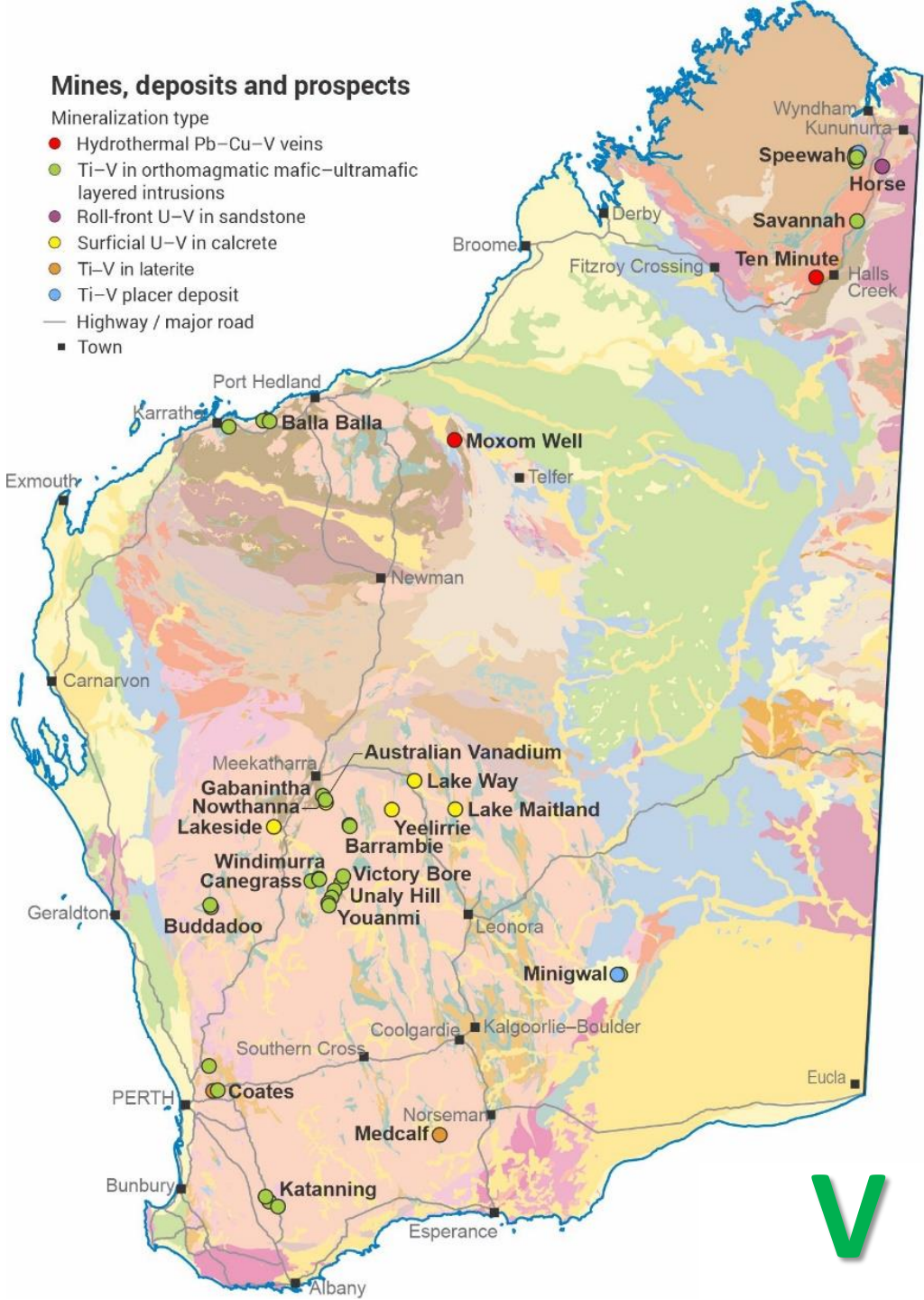
Manganese

- WA has a +50-year history of producing metallurgical-grade manganese ore, total 15.83Mt has been produced
- Current resources are 61.83 Mt (4th largest globally)
- Mostly ‘supergene’ or ‘residual’ on carbonates or iron formation
- One producing Mn project — Woodie Woodie (**Consolidated Minerals Ltd**)
  - Known with high manganese grades and low deleterious elements
  - Total resources 47.8Mt at 31.8% Mn and reserves 16.7Mt at 32.9% Mn
  - Produced 1.376Mt in 2019 and shipped 1.35Mt
- **Element 25** is developing the Butcherbird manganese deposit
  - Australia’s largest onshore manganese deposit
  - >260 Mt of manganese ore
  - Proposed downstream processing
  - Will produce high purity manganese include electrolytic manganese metal and battery-grade manganese sulphate



Vanadium

- Vanadium is becoming more widely used in green technology applications, especially in battery technology
- Western Australia is the 4th largest resources globally (24.09 Mt V2O5)
- Predominantly in magnetite in mafic intrusions (e.g. Windimurra, Speewah, Barrambie)
- Total production in WA since 2000 is 14,100 t V_2O_5
- No mines currently active, seven projects at Feasibility/pre-fesibility/scoping stage:
  - **Yilgarn Craton**: Windimurra/Australian Vanadium/Gabanintha/Barrambie/Medcalf
  - **Kimberley Craton**: Speewah
  - **Pilbara Craton:** Balla Balla
- **Speewah:** Australia's largest vanadiferous titanomagnetite deposit (Kimberley)
- **Barrambie and Medcalf:** Pre-feasibility studies supports production of V_2O_5 and TiO_2 for 12-20 years



Alumina

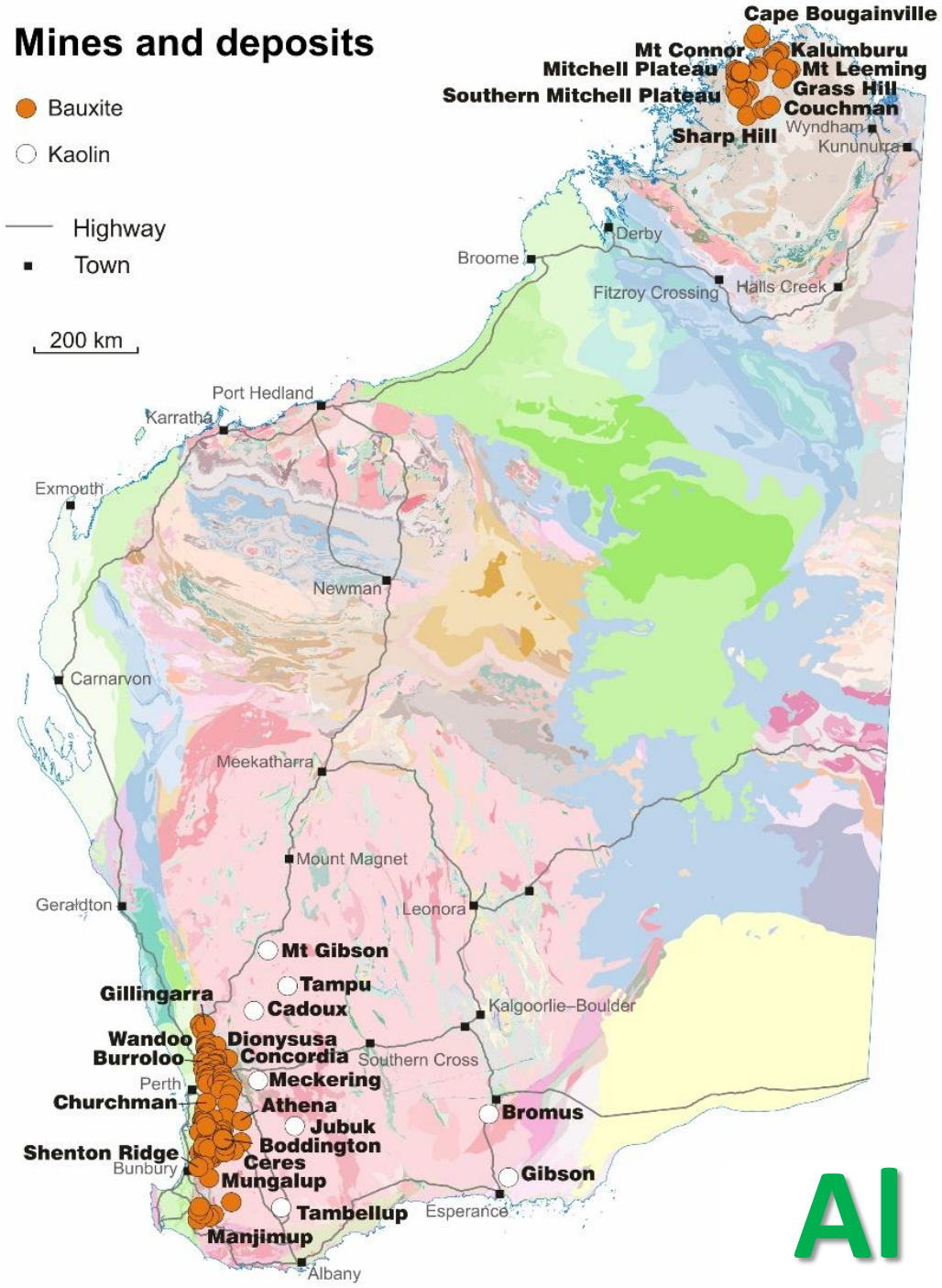
Significant bauxite resources:

3.34 billion tonnes @ 33.8% Al_2O_3

Accounts for all current production for industrial applications

Also 2.82 billion tonnes of **Al_2O_3** reported from:

- Iron and manganese ores (bulk, not shown)
- Kaolin deposits (e.g. **Cadoux**, **Meckering**)
  - 2020 DMIRS approved the **Cadoux** kaolin project
  - The approval covers planned mining, processing, site infrastructure, waste facilities and haul roads
  - FYI is developing a high purity alumina (HPA) processing operation at **Cadoux**
  - HPA project aim to be a significant producer of high purity alumina to supply LED, electric vehicle and smartphone markets
  - **Cadoux** kaolin deposit has enough ore to support an 8000 tonne per annum mine for at least 50 years with probable ore reserve estimation of 2.89 million tonnes grading at 24%.



Rare Earth Elements

Resources mostly carbonatite- or hydrothermal vein-hosted

Current production from:

Mt Weld (carbonatite-hosted)

- Significant high-grade **dysprosium** (Dy) resource at Duncan, reserves of 1.7 million tonnes TREO, including 6660 tonnes Dy_2O_3.
- Production for 2018-19 was 5898 t neodymium praseodymium (NdPr) from 19737 of total rare earth oxide.
- Lynas proposed processing facility to be build in Kalgoorlie and operational in 2023

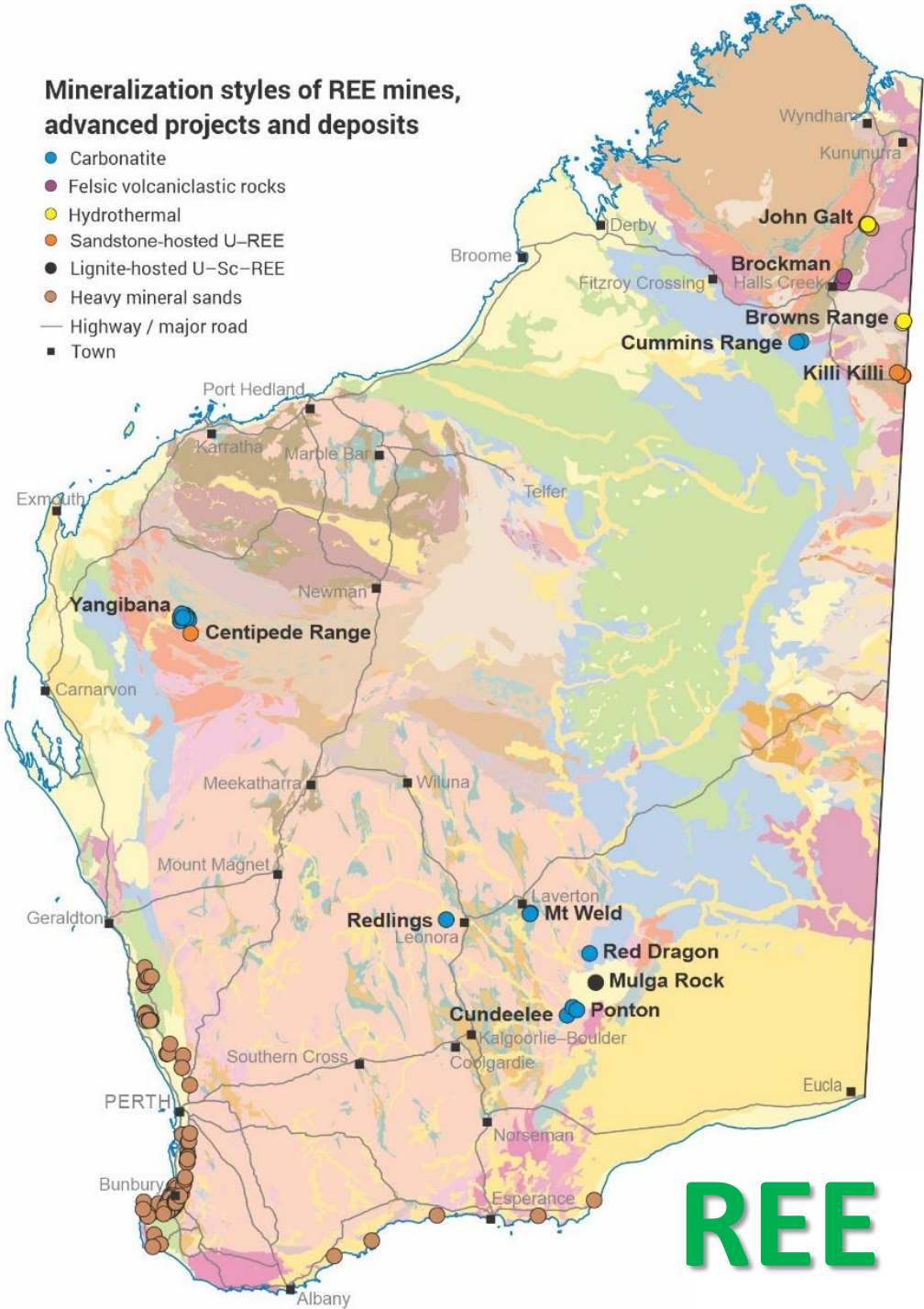
Browns Range (hydrothermal vein-hosted)

- The hydrometallurgical plant will produce 279kt of dysprosium contained with 3,127kt of TREO, in 6,000kt of mixed RE carbonate per annum
- Full-scale production is target for 2020

Yangibana rare earth deposits

- 21.3 million tonnes @ 1.12% TREO)
- predominately monazite, hosting high neodymium and praseodymium contents to product a mixed rare earths carbonate

Monazite in heavy mineral sand deposits (but problematic)

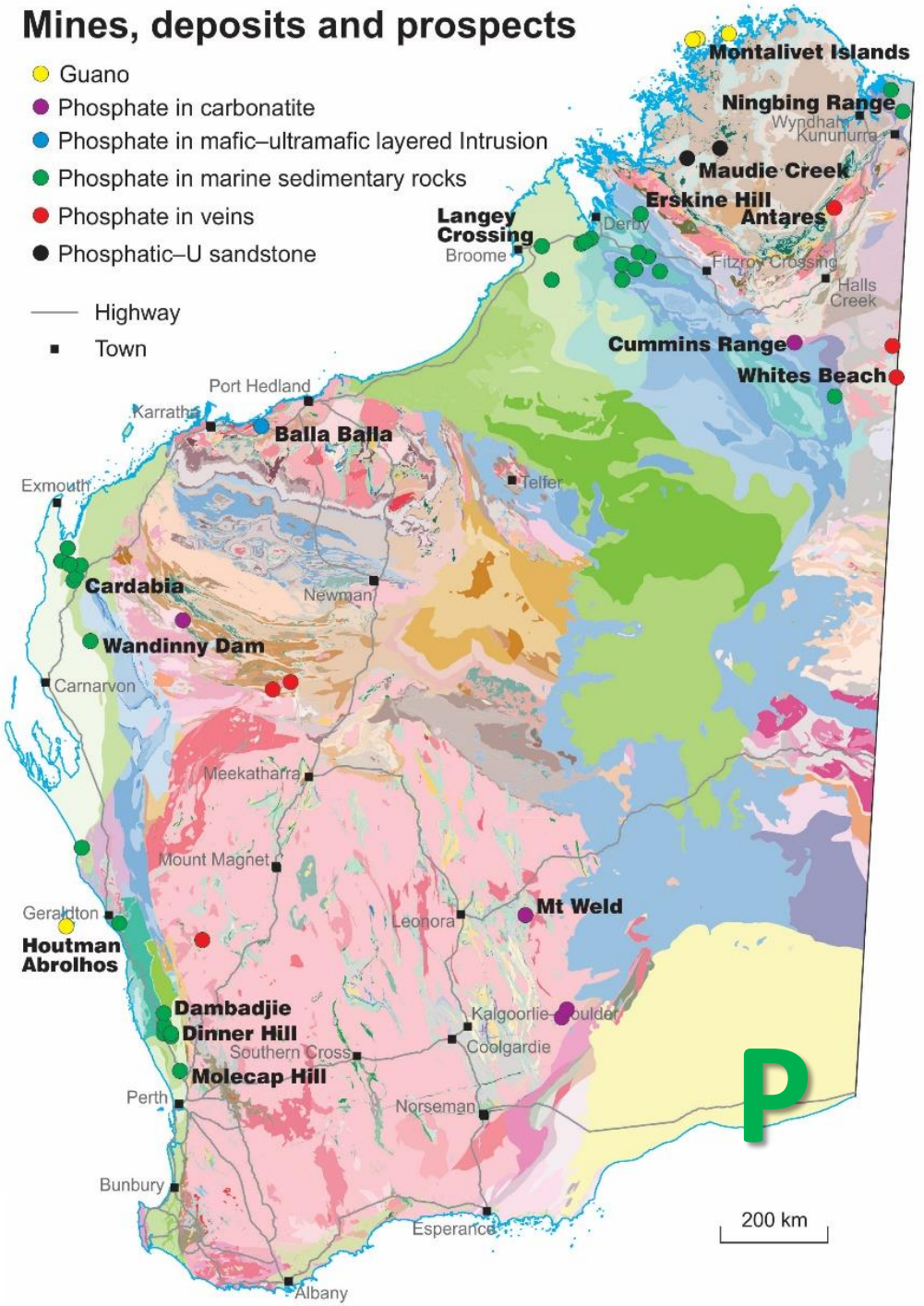


Phosphate

- Currently no phosphate production
- Minor (now depleted) phosphate production from islands
- Known phosphate resources (**46.5 million tonnes**) in:
  - Apatite and monazite over REE mineralization in carbonatites (e.g. Mt Weld, Cummins Range)
  - Phosphate nodule-rich horizons in sedimentary rocks:

    Glauconite-rich units in the Perth Basin (**Dinner Hill** and **Dambadjie**)

    Intersected in drillholes in the Southern Carnarvon Basin (**Cardabia**)
  - Apatite in layered mafic intrusions (e.g. **Balla Balla**)
- Also significant “deleterious” phosphorus in Fe and Mn deposits (**70.9 million tonnes P**)



Potash

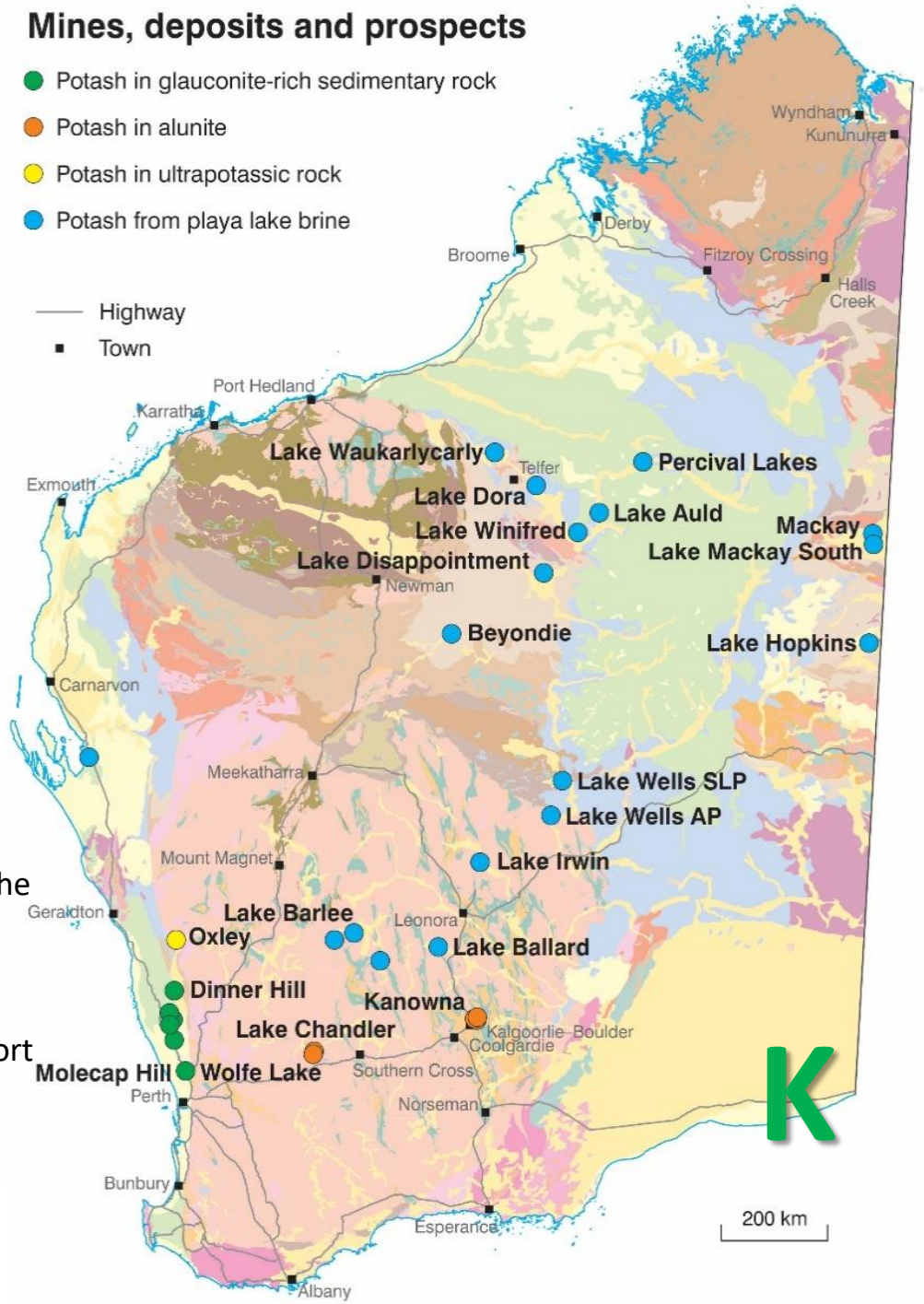
- About 90% of global potash (K_2O) use is in fertilizer products.
- Historical potash mining in WA (WWII) was from alunite-rich clay deposits (**Lake Chandler, Kanowna)**
- Currently several advanced projects:

  Sulfate of potash (SOP - K_2SO_4) brines from playa lakes (e.g. **Beyondie**, **Lake Disappointment**, **Lake Wells, Lake Mackay**); Total SOP resources: **901 million tonnes**

  Greensand glauconite in Perth and Carnarvon Basin sedimentary rocks (e.g. **Dinner Hill**)

  K-feldspar in Proterozoic ultrapotassic microsyenite (**Oxley**) and kaolinitic clays (**Cadoux**)

FYI Resources has received an approval from the Western Australian Department of Mines, Industry Regulation and Safety (DMIRS) for the Cadoux kaolin project in 2020.
The approval covers FYI's planned mining, processing, site infrastructure, waste facilities and haul roads.
This milestone paves the way for FYI to commence works on-site at Cadoux as FYI works on developing a high purity alumina (HPA) processing operation.
According to FYI, its aluminous kaolin deposit at Cadoux responds positively as a feedstock to the company's integrated processing flowsheet.
These factors support FYI's HPA project potential and aim to be a significant producer of high purity alumina in the rapidly developing LED, electric vehicle and smartphone markets.
FYI Resources' Cadoux kaolin deposit in WA's northeastern Wheatbelt has enough ore to support an 8000 tonne per annum mine for at least 50 years with probable ore reserve estimation of 2.89 million tonnes grading at 24%.

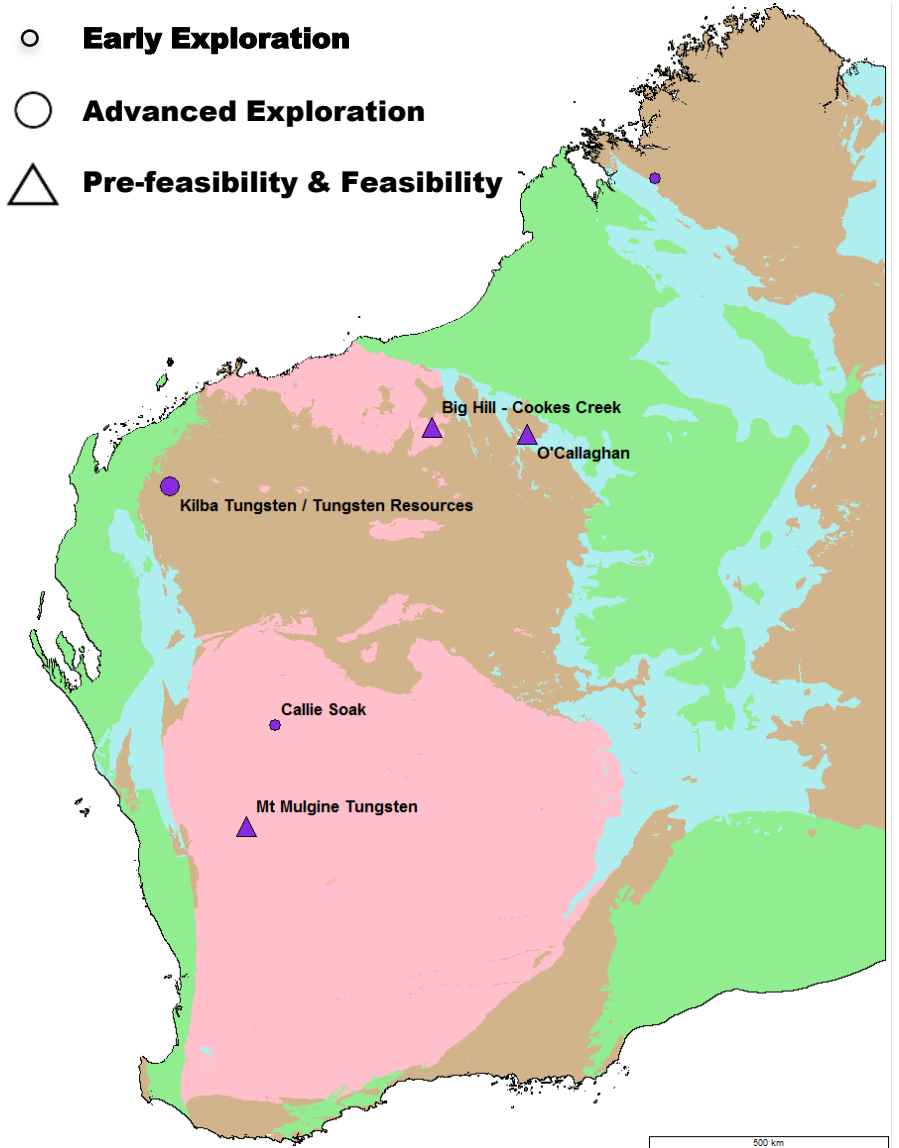


Number of advanced Tungsten projects

- WA has total WO3 resource of 411 thousand tonnes
- Newcrest's O'Callaghans deposit (part of Telfer mineral system) is one of the World's largest W deposits
- Mt Mulgine Project & Big Hill–Cookes Creek projects are both advanced projects (Tungsten Mining NL)
- Both mainly vein-type deposits, though Mt Mulgine has skarn component

Project	Owner	Tonnage (Mt)	Grade WO_3	Contained WO_3 (kt)
Kilba Tungsten	Tungsten Mining	4.98	0.244	12.14
Big Hill-Cookes Creek	Tungsten Mining	11.50	0.146	16.81
O'Callaghans	Newcrest	78.00	0.330	257.10
Mt Mulgine Tungsten	Tungsten Mining	70.90	0.175	124.29

Vein-type Skarn-type



Titanium-Zirconium (and Hafnium)

- All Ti and Zr production is from heavy mineral sands:

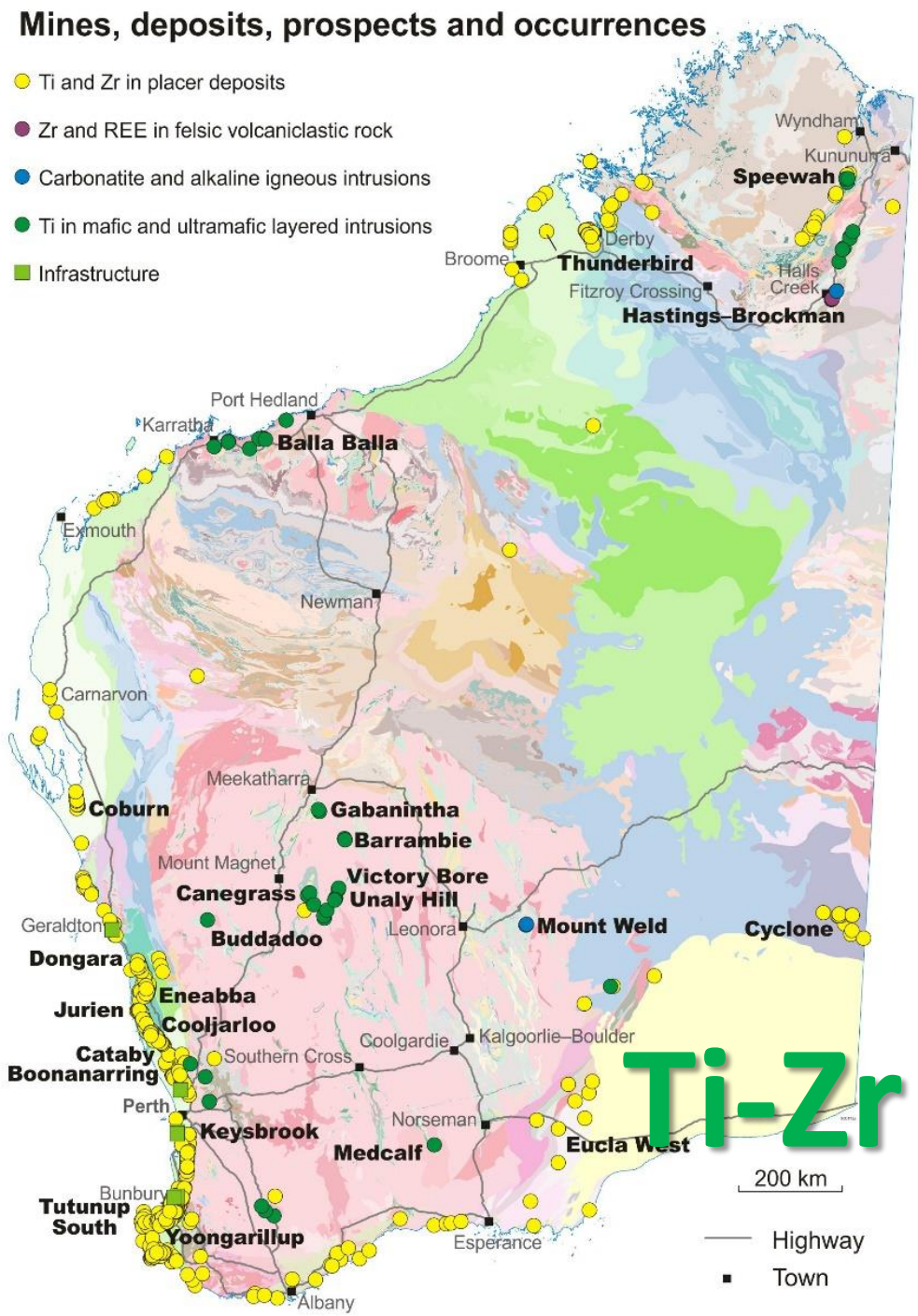
  Perth Basin (e.g. Boonanarring, Cataby, Keysbrook, Yoongarillup, Tutunup South, Cooljarloo)

  Eucla Basin (e.g. Cyclone)

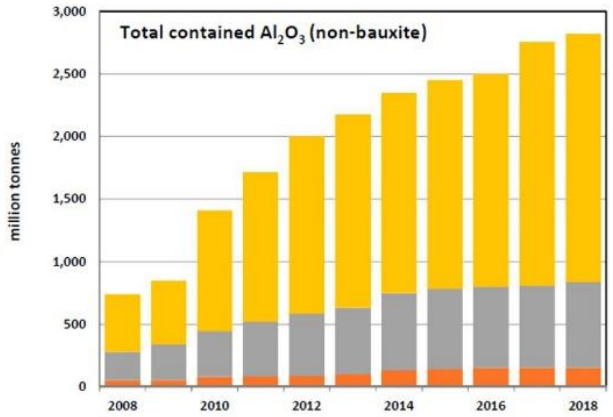
  Canning Basin (e.g. Thunderbird)

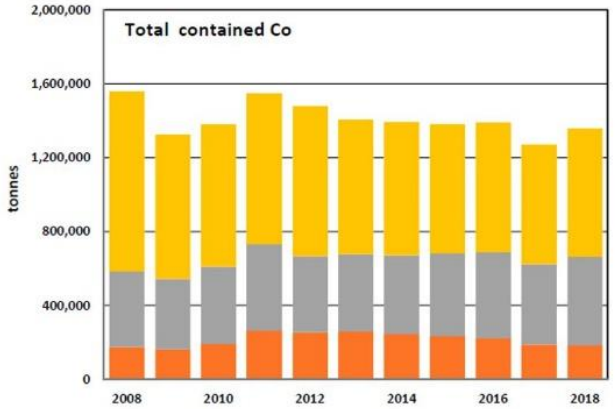
- Significant Ti resources in layered mafic igneous intrusions (e.g. Speewah, Gabanintha, Buddadoo)
- Zr resources also known at Mt Weld (carbonatite-hosted) and Hastings-Brockman (felsic volcanic-hosted) REE deposits.
- Hastings-Brockman also has a **hafnium** resource:

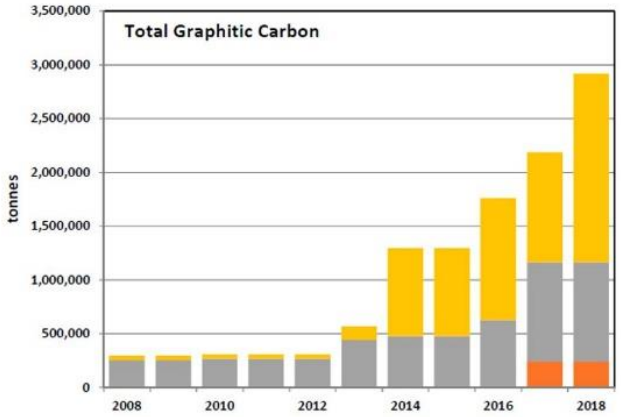
  36.2 Mt @ 0.032% HfO_2 for 11.6 kt HfO_2

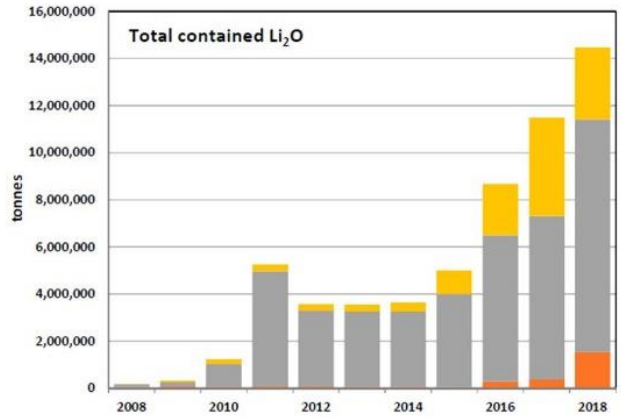


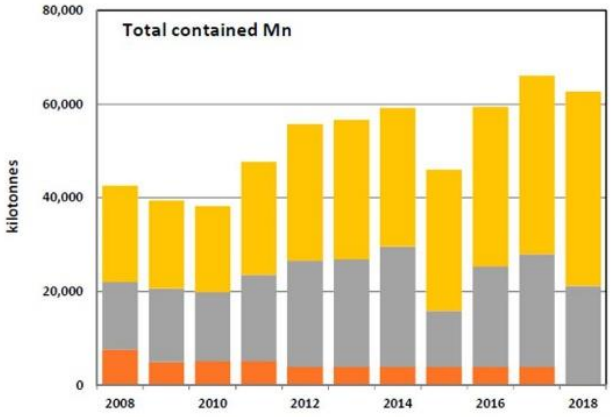
WA has abundant resources

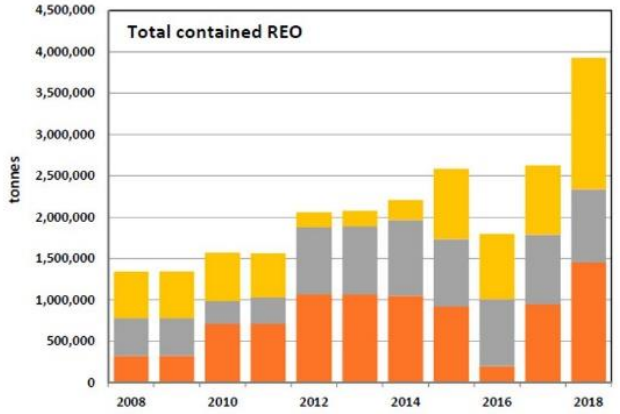


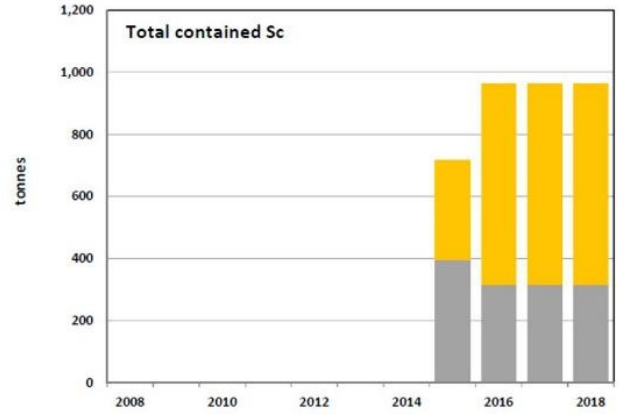


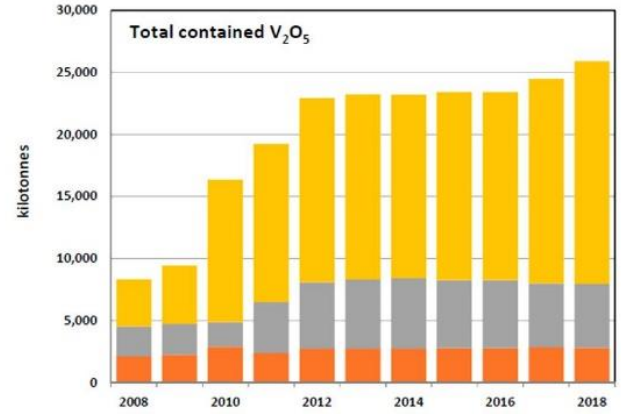












Measured resource Indicated resource Inferred resource

AUSTRALIA MINERALS

WA – commodity smorgasbord!

[modified from original obtained from https://sciencenotes.org/printable-periodic table/]

AUSTRA

WA Government Policy

- WA has substantial resources of all minerals used to manufacture rechargeable batteries (e.g. Li, Co, Ni, V)
- WA produces other minerals used in electric vehicles and energy storage systems, including rare earth elements
- The Future Battery Industry Strategy will:
  - capitalise on competitive advantages
  - build WA into a leading exporter of battery minerals, materials, technologies and expertise
  - expand WA's economic development, industry diversification, skills and employment

AUSTRALIA MINERALS