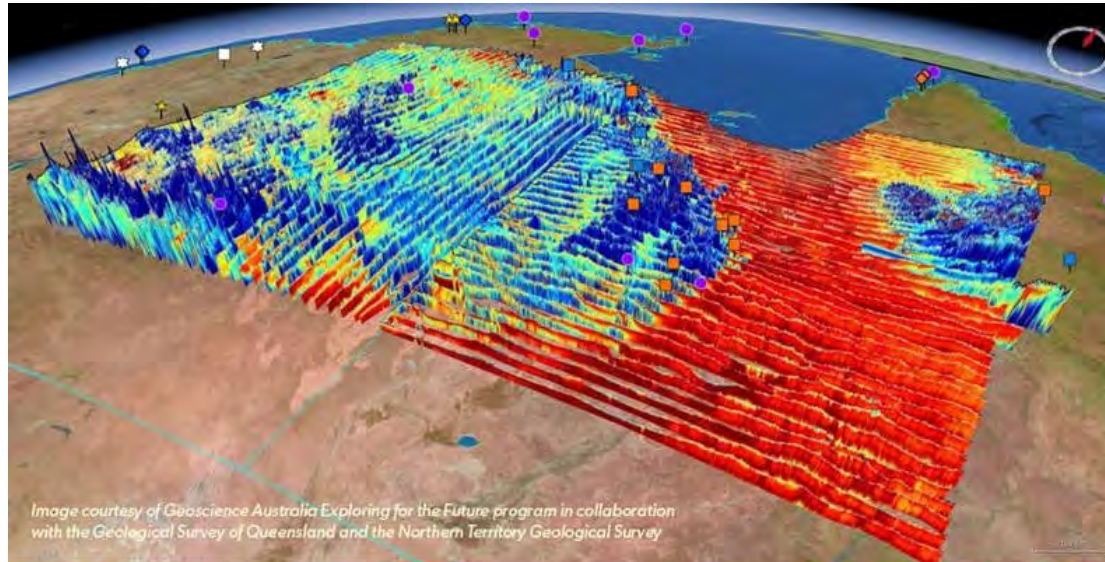


Science in the Surveys 2019

Tuesday 26 March 2019



Session Three

Chair: **John Greenfield**

- 1:40** Outcomes and learnings from the DET CRC
***David Giles**, University of South Australia*
- 2:05** Mining the core library: integrating legacy data with new geoscience to support discovery in South Australia
***Anthony Reid**, Geological Survey of South Australia*
- 2:30** New insights into the setting and styles of Palaeoproterozoic base metal mineralisation in the NT
***Ian Scrimgeour**, Northern Territory Geological Survey*
- 3:30** Afternoon Tea

Deep Exploration Technologies CRC

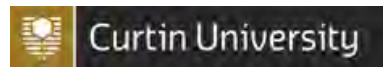
Outcomes and lessons learned



David Giles

Program 3 Leader, DET CRC
Chief Scientific Officer, MinEx CRC
UniSA, Future Industries Institute

Science in the Surveys, Maitland, 26th March 2019



Business
Cooperative Research
Centres Programme





Signature #1 INDUSTRY LED and ENGAGED

- 63 Participants and Affiliates
- Industry led agenda through Science Steering Committee and Project Review Panels
- Head office embedded in industry
- ~30% of research funding going to industry
- 110 industry-based researchers (27 cash funded industry FTE years, 78 in-kind FTE years)
- ~ half annual conference delegates from industry



Signature #2 OUTCOME FOCUSSED

- 96 of 96 (100%) of Commonwealth Milestones met
- 1607 of 1721 (93.3%) Project Milestones met
- 12 technologies licensed including...
 - RoXplorer® CT drilling rig
 - Multisensor AutoSonde
 - Lab-at-Rig®
- 9 patents, 4 registered designs, 6 trademarks



Signature #3 PRACTISED and PRACTICAL



Mineral Systems Drilling Program in the southern Gawler Ranges, South Australia

AJ Fabris, L Tylkowski, J Brennan, RB Flint, A Ogilvie, S McAvaney, M Werner, M Pawley, C Krapf, AC Burtt, R Rowe, C Henschke, NC Chalmers, S Rechner, I Hardwick and J Keeling



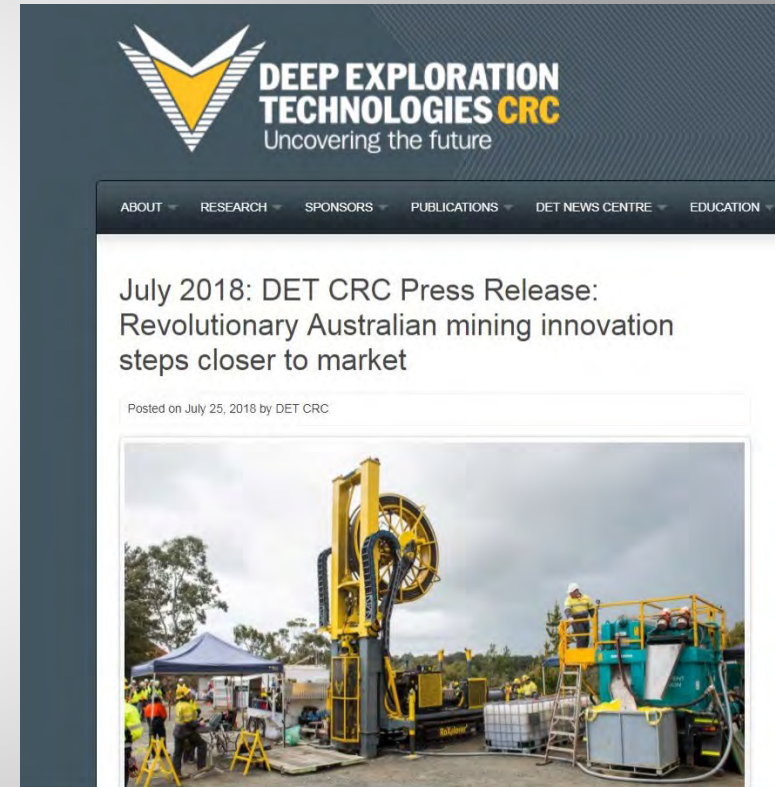
Report Book 2016/00030

PACE
Copper



Signature #4 COMMUNICATIVE

- Hundreds of internal technical reports
- Quarterly project reporting
- Quarterly eNewsletter
- Technology summaries
- DET CRC TV – animations, researcher interviews
- Press releases
- ½ year SSC meetings
- Annual report and AGM video
- Annual conference and demonstrations



Signature #5 VIBRANT EDUCATION PROGRAM

- Reached target of 40 HDR completions (last count 43)
- 407 Driller trainees



NOT JUST SURVIVE but PROSPER

End-user cash support increased from,

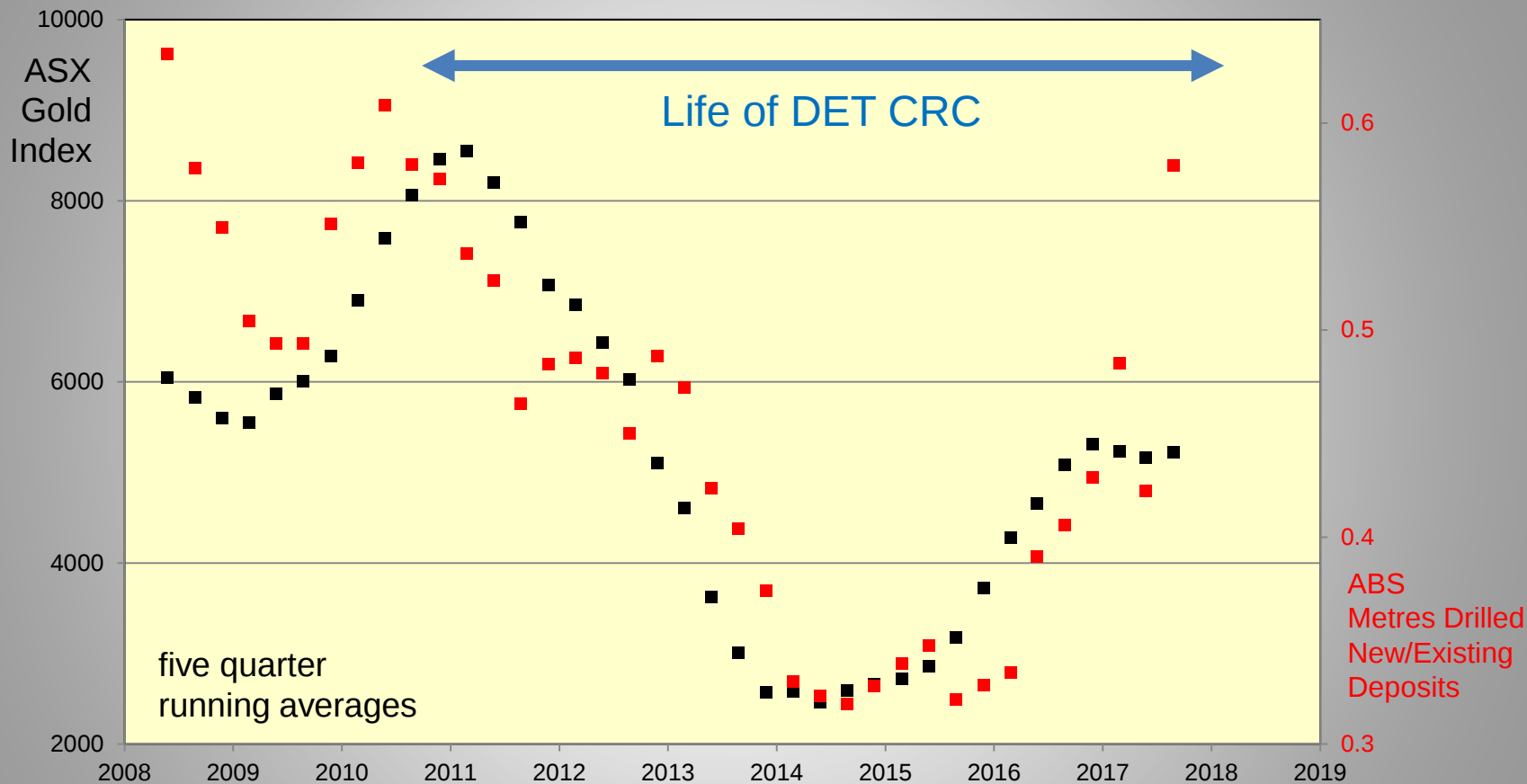
\$20.6 M  \$33.7 M,

And in-kind support increased from,

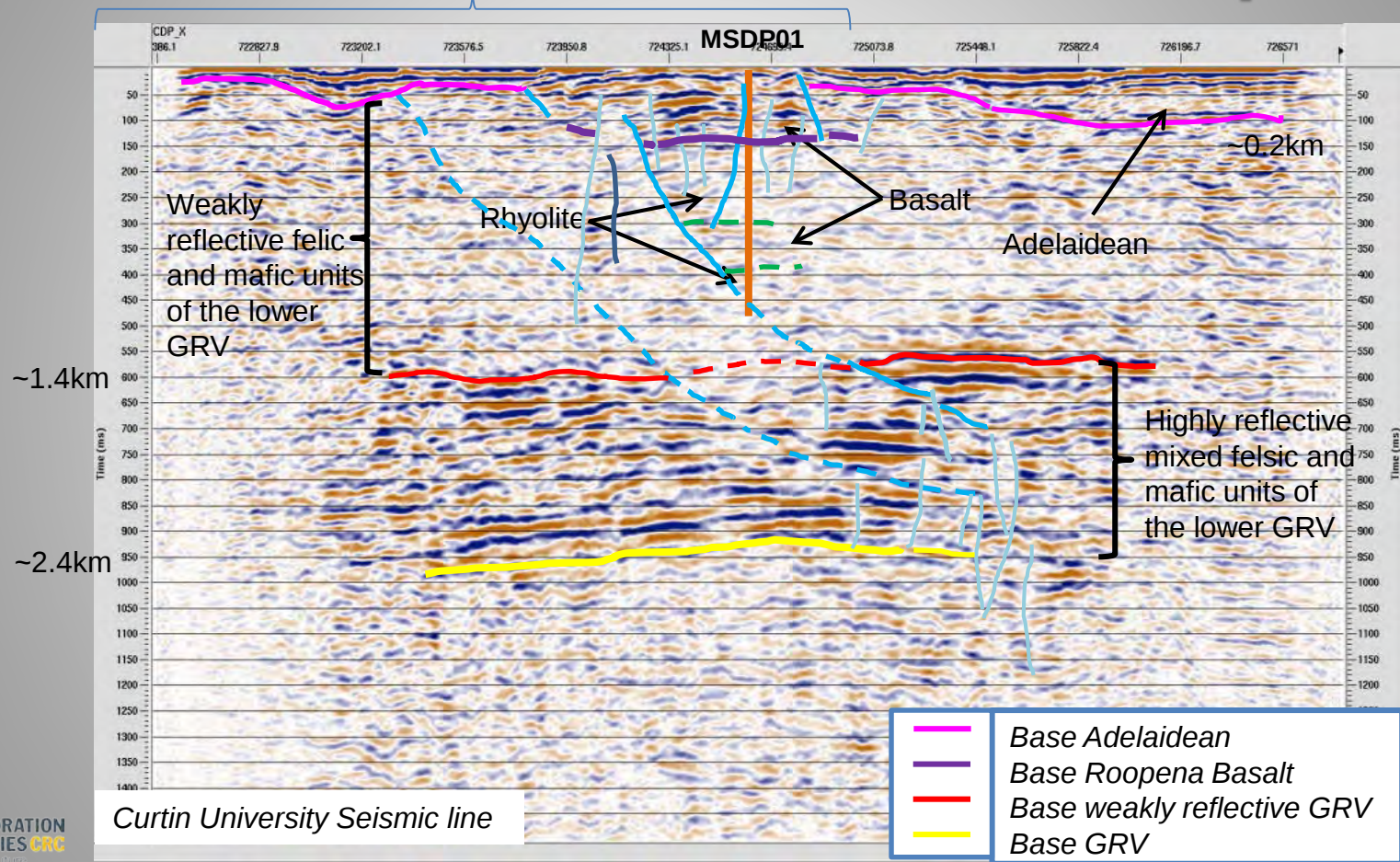
\$61.5 M  \$93.1 M,

Over the life of DET CRC

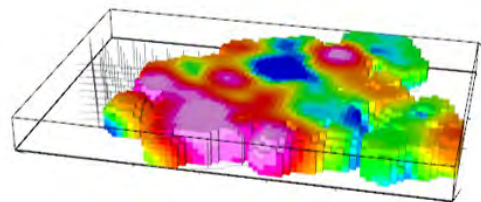
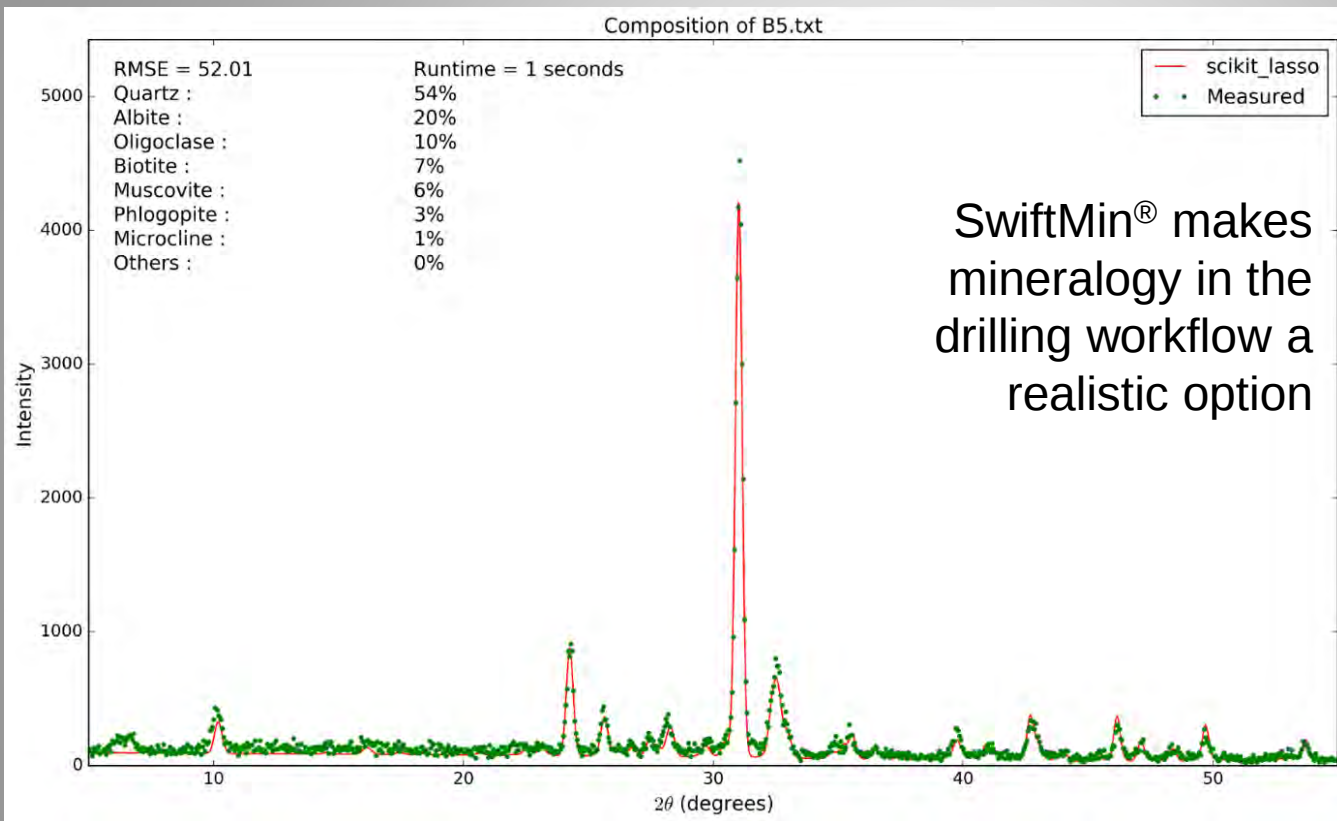




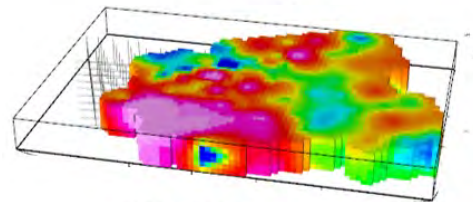
Outcome #1 Seismic and EM techniques



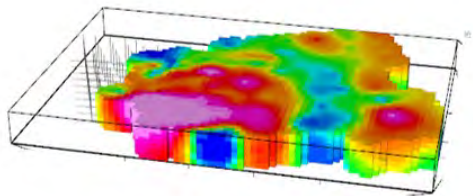
Outcome #2 Software for Geochemistry and Mineralogy



pXRD chalcopyrite



pXRF S ppm

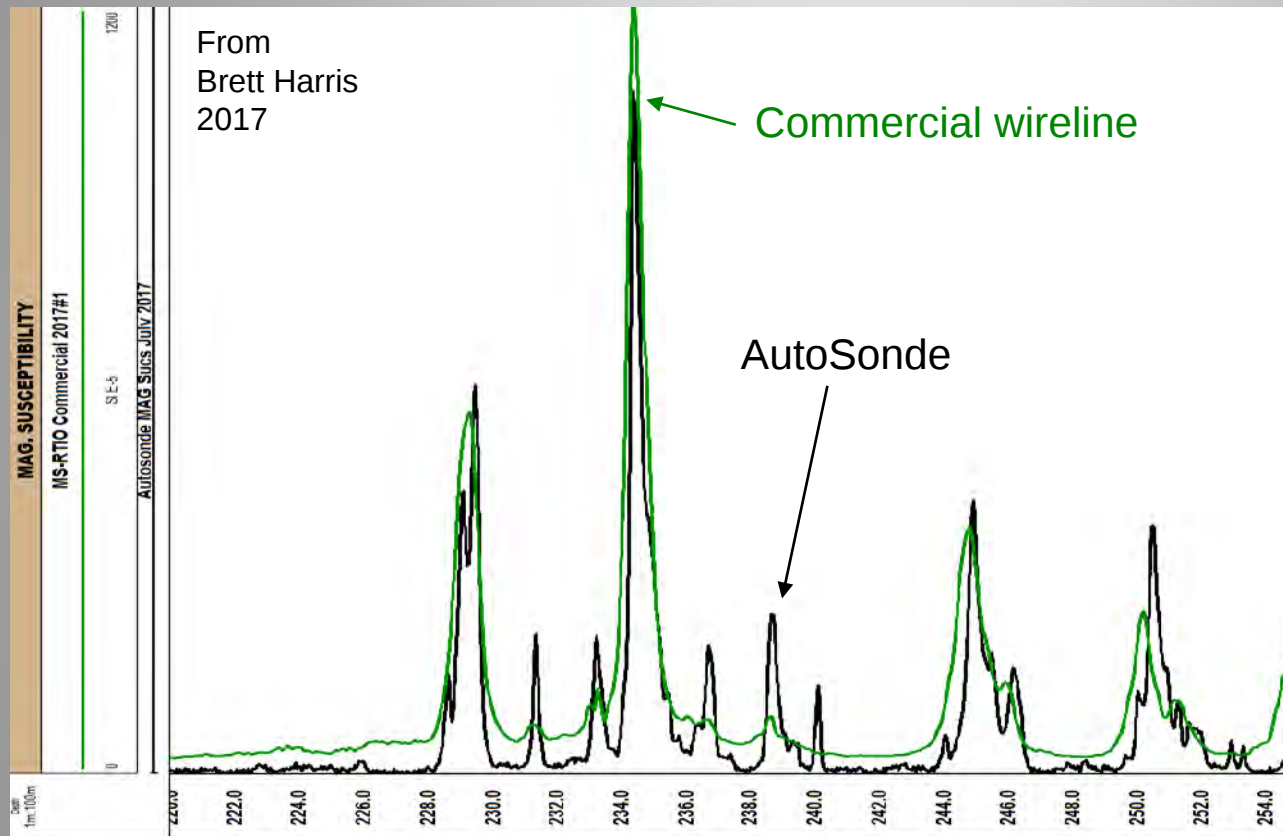


pXRF Cu ppm

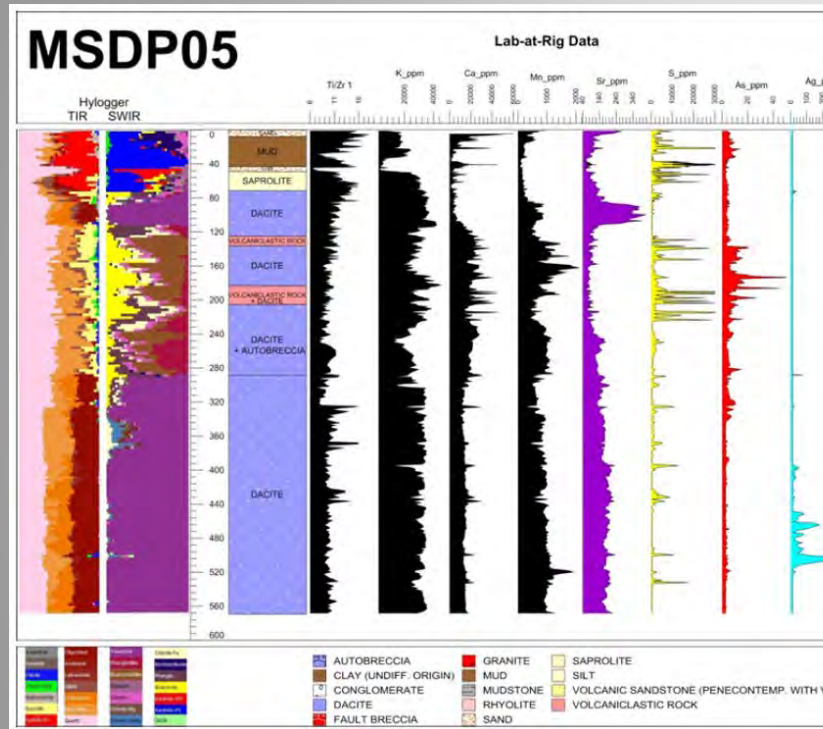
Outcome #3 Wireless Sub



Outcome #4 Downhole Tools



Outcome #5 Lab-at-Rig[®]



Outcome #6 RoXplorer®



Key challenges for CT drilling in mineral exploration:

- Coil durability
 - Ground up rig design
 - ROP with low weight-on-bit drilling
 - Hole integrity / fluid loss
 - Sample representivity
-
- DET CRC's target:
 - greenfields rig to 500m, weight less than 10 tonnes and \$50/m

Port Augusta Field Trial Feb-March 2017

Twinned drill holes
MSDP02 Diamond
MSDP15 Coiled Tubing



400m of flat lying, consolidated, Proterozoic
sedimentary cover, overlying basalt

Stavely Field Trial May-June 2017

Twinned drill holes
Stavely12 Sonic
Stavely21 Coiled Tubing



136m of flat lying, unconsolidated (running sands, swelling clays)
Cainozoic sedimentary cover, overlying mafic and intermediate volcanics

https://www.youtube.com/watch?v=ZRdT6PI5m_I&t=78s

Tregolana Shale

Nuccaleena Dolomite

Yerelina Subgroup (sandstone and shale)

Tapley Hill Formation (dolomitic shale)

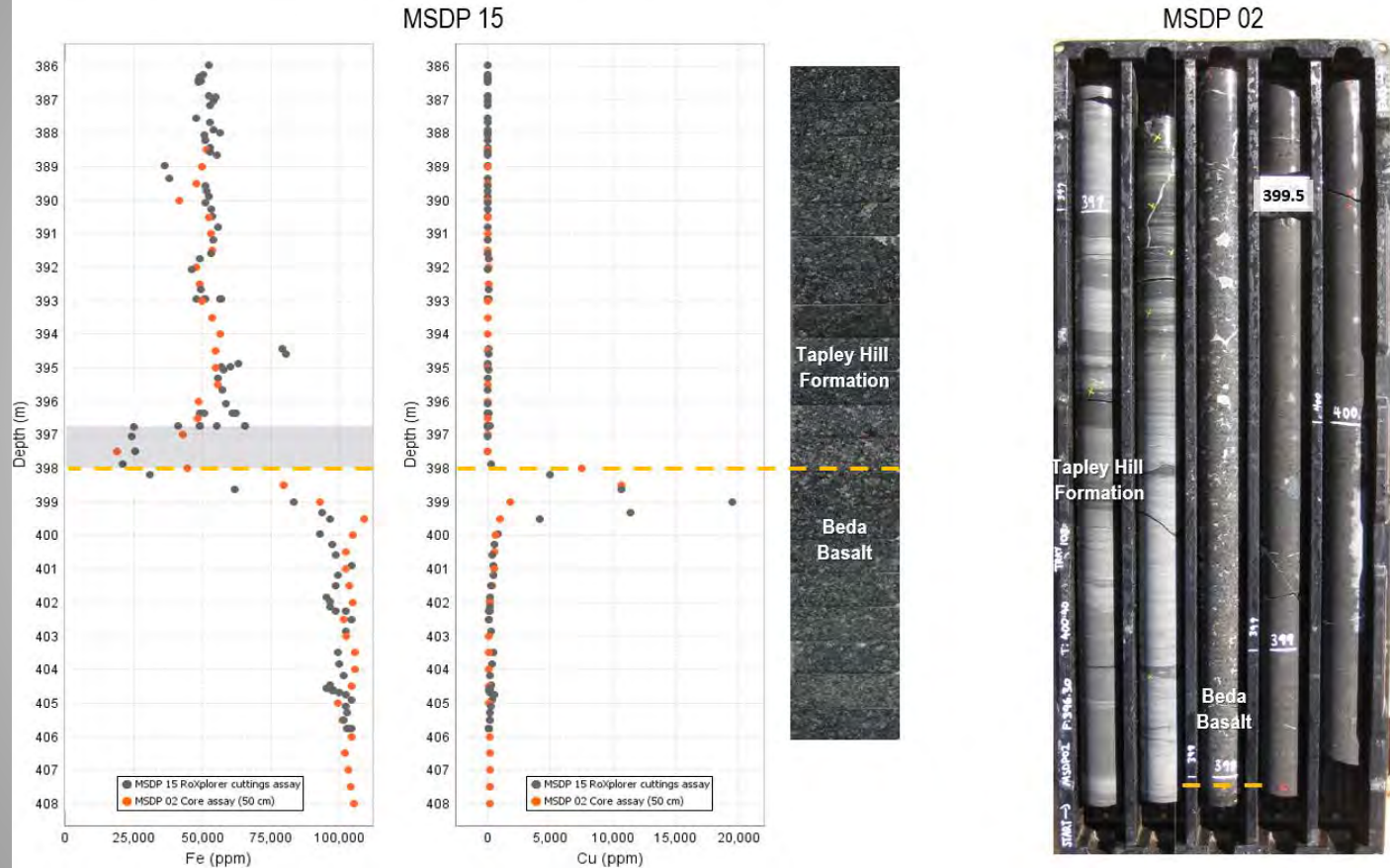
Beda Basalt

0-6.25 Pooraka Fm
6.25-136.58 Tregolana Shale
136.58-146.89 Nuccaleena Dolomite
146.89-224.5 Yerelina Subgroup
224.5-397.95 Tapley Hill Fm
397.95-564.5 Beda Basalt



Lab-at-Rig[®] for CT Drilling “Bucket” trial @ MSDP15

398 m



Richard's Top 10 Reflections for CRCs

- 1) Industry Leadership
- 2) Collaboration: “Publish or Perish” versus “Partner and Prosper”
- 3) Clarity, Focus and Consistency (longevity of CRCs is important)
- 4) Detail and Accountability (e.g. Project Agreements, SMART PPTs, milestones, KDPs, Quarterly Reports/traffic lights and annual conference)
- 5) Agreeing What Constitutes Success (incl. clear project scopes and TRLs)
- 6) Right People: goals of sponsors and research leaders aligned
- 7) Good Communications (Internal and External)
- 8) Budgets: not just for staff (also building and testing prototypes) and not just to research organisations (also to industry)
- 9) Independent Board and CEO
- 10) Strong E&T Program

To which I will add...

- Don't get comfortable
- Research is not linear
- The goal posts might move
- The landscape will certainly change – think about technology change in the last 10 years
- Flexibility of approach required
- True to the vision – agnostic to how we get there

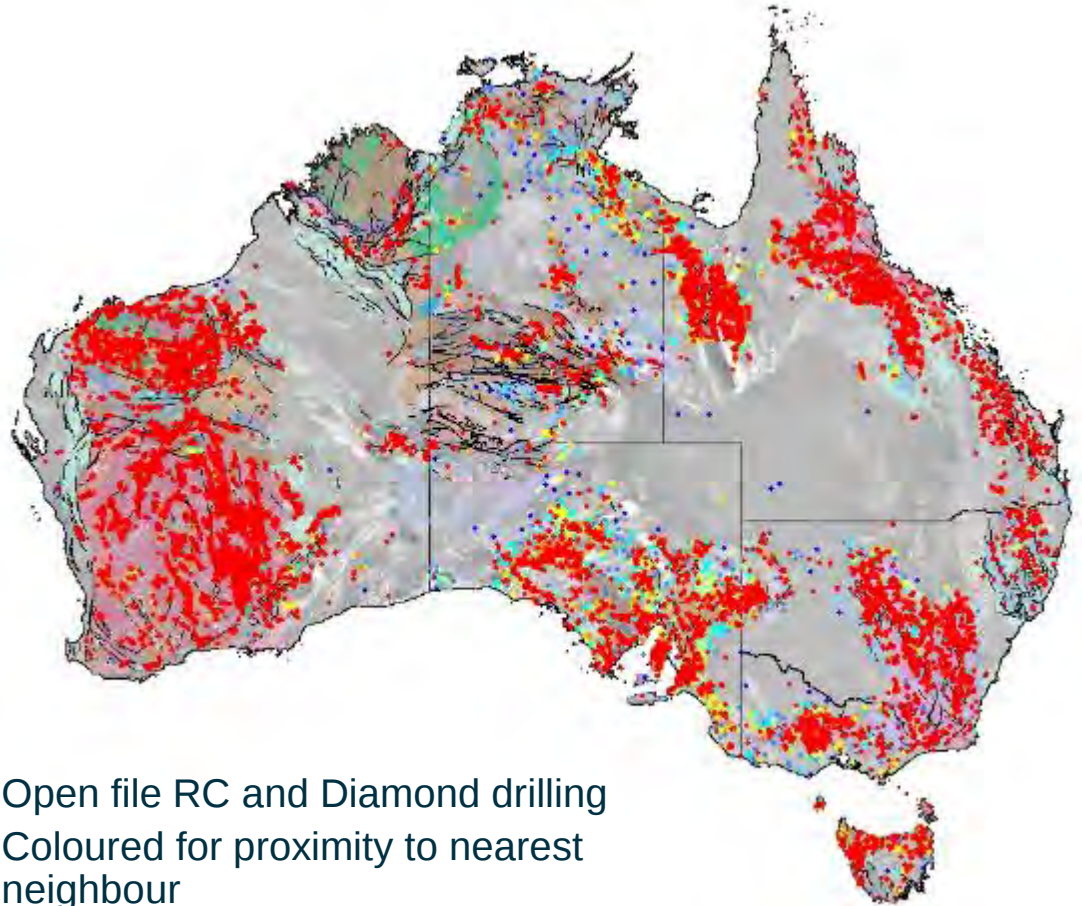


And...

It doesn't matter how smart we are (or how sophisticated is our AI)
it's still all about the data.

n= 714,876

n(WA) = 559,456



Open file RC and Diamond drilling
Coloured for proximity to nearest
neighbour

And... You can't do it alone



Mining the core library: integrating legacy data with new geoscience to support discovery in South Australia

Anthony Reid

Senior Principal Geoscientist

*...on behalf of the Geological Survey of South
Australia team*

Science in the Surveys, Maitland, NSW

26th March 2019



Government of South Australia
Department for Energy and Mining





**GEOLOGICAL
SURVEY OF**
South Australia



Australian Government

Geoscience Australia



**Planning &
Environment**



MinEx CRC



**Geological Survey of
Western Australia**



**THE UNIVERSITY
of ADELAIDE**

NCRIS

National Research
Infrastructure for Australia

An Australian Government Initiative

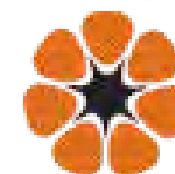


AuScope

AN ORGANISATION FOR A NATIONAL
EARTH SCIENCE INFRASTRUCTURE PROGRAM



NCI



**NORTHERN
TERRITORY
GOVERNMENT**



Government of South Australia

Department for Environment
and Water



**Flinders
UNIVERSITY**
ADELAIDE • AUSTRALIA



**MONASH
University**



**UNIVERSITY of
TASMANIA**

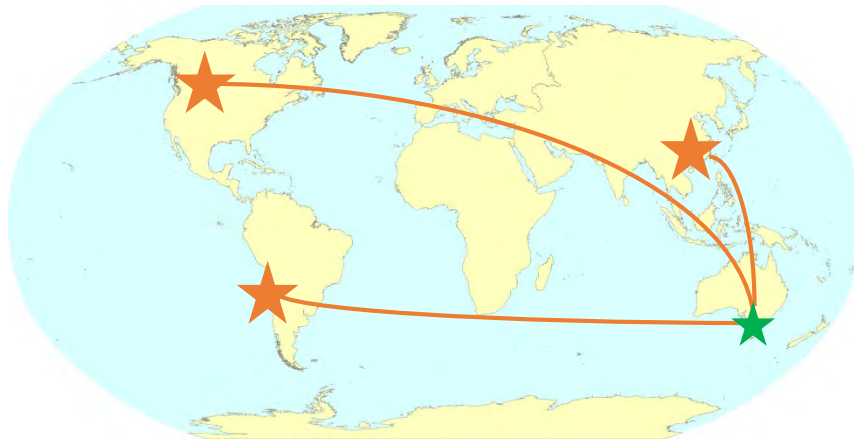
Working together

Department for Energy and Mining

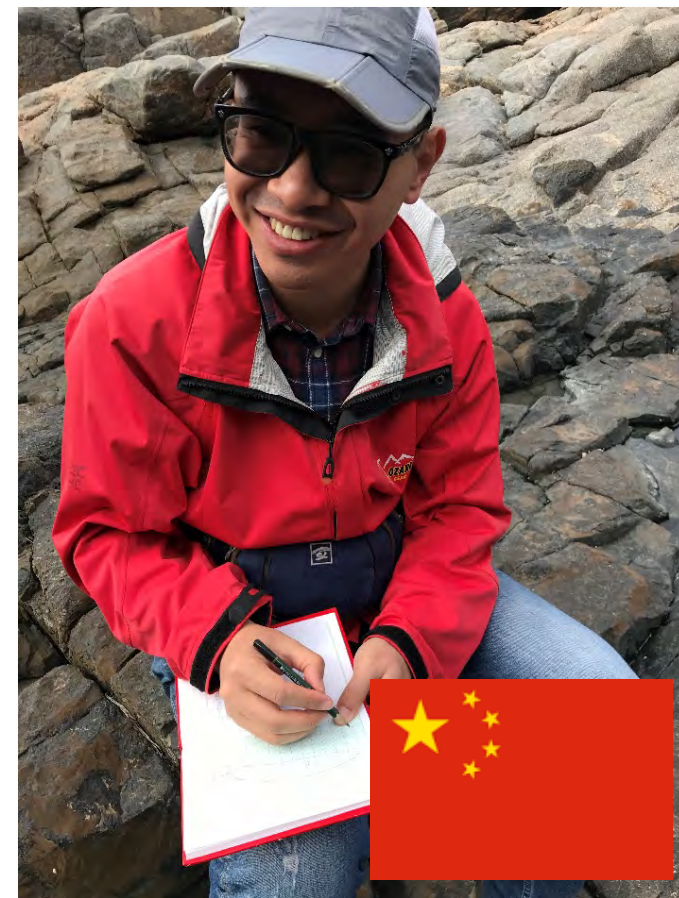


MOU: Geological Survey of Chile

GGSA's strategic international partnerships



MOU: Geological Survey of Saskatchewan



MOUs:

- China Geological Survey, Nanjing;
- China National Nuclear Corporation

**Mineral & energy
resources in SA:
Employs 12,000 people
\$5.6b production
\$4b exports
\$237m royalties**



STRONGER PARTNERS STRONGER FUTURES

- Building relationships
- between Aboriginal
- communities, explorers
- and Government

http://www.energymining.sa.gov.au/minerals/land_access/stronger_partners_stronger_futures

Stronger Partners Stronger Futures

Co-designing the Future Working Paper



MOVING AHEAD

Building stronger
relationships between
Aboriginal communities,
explorers and government

www.energymining.sa.gov.au

August 2018

400 km

Google Earth

© 2018 Google
Image Landsat / Copernicus
Data SIO, NOAA, U.S. Navy, NGA, GEBCO

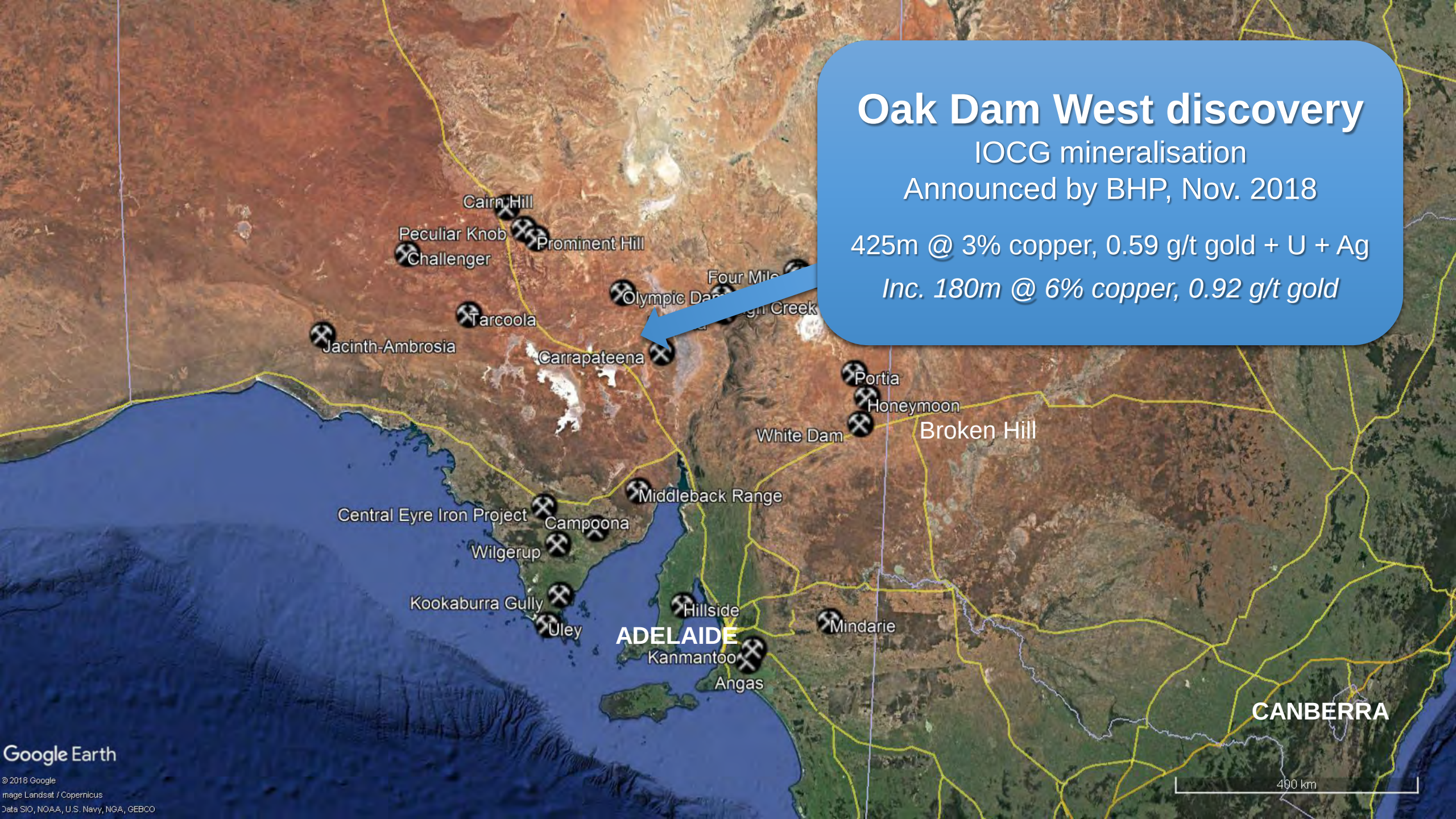
Oak Dam West discovery

IOCG mineralisation

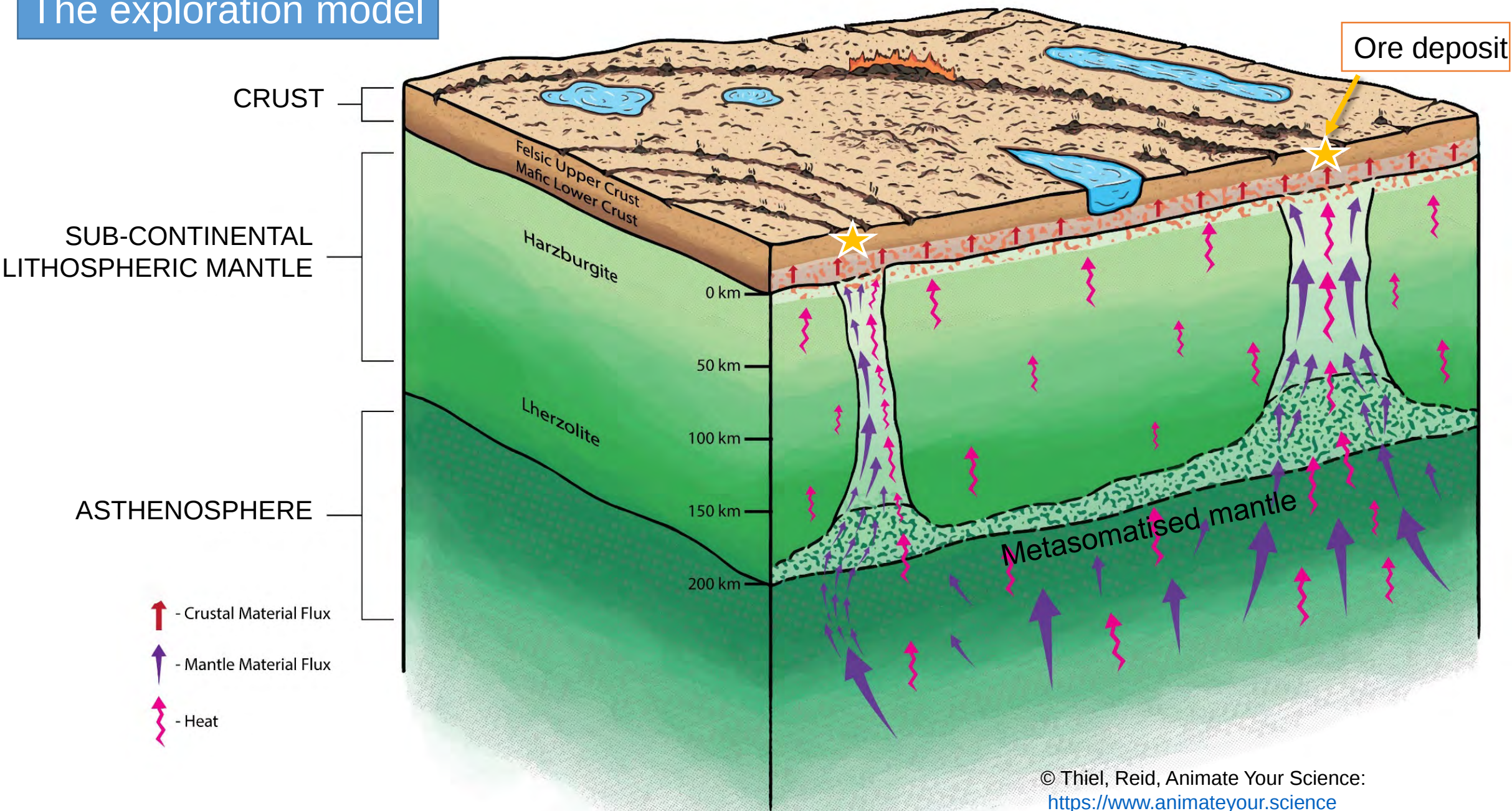
Announced by BHP, Nov. 2018

425m @ 3% copper, 0.59 g/t gold + U + Ag

Inc. 180m @ 6% copper, 0.92 g/t gold



The exploration model

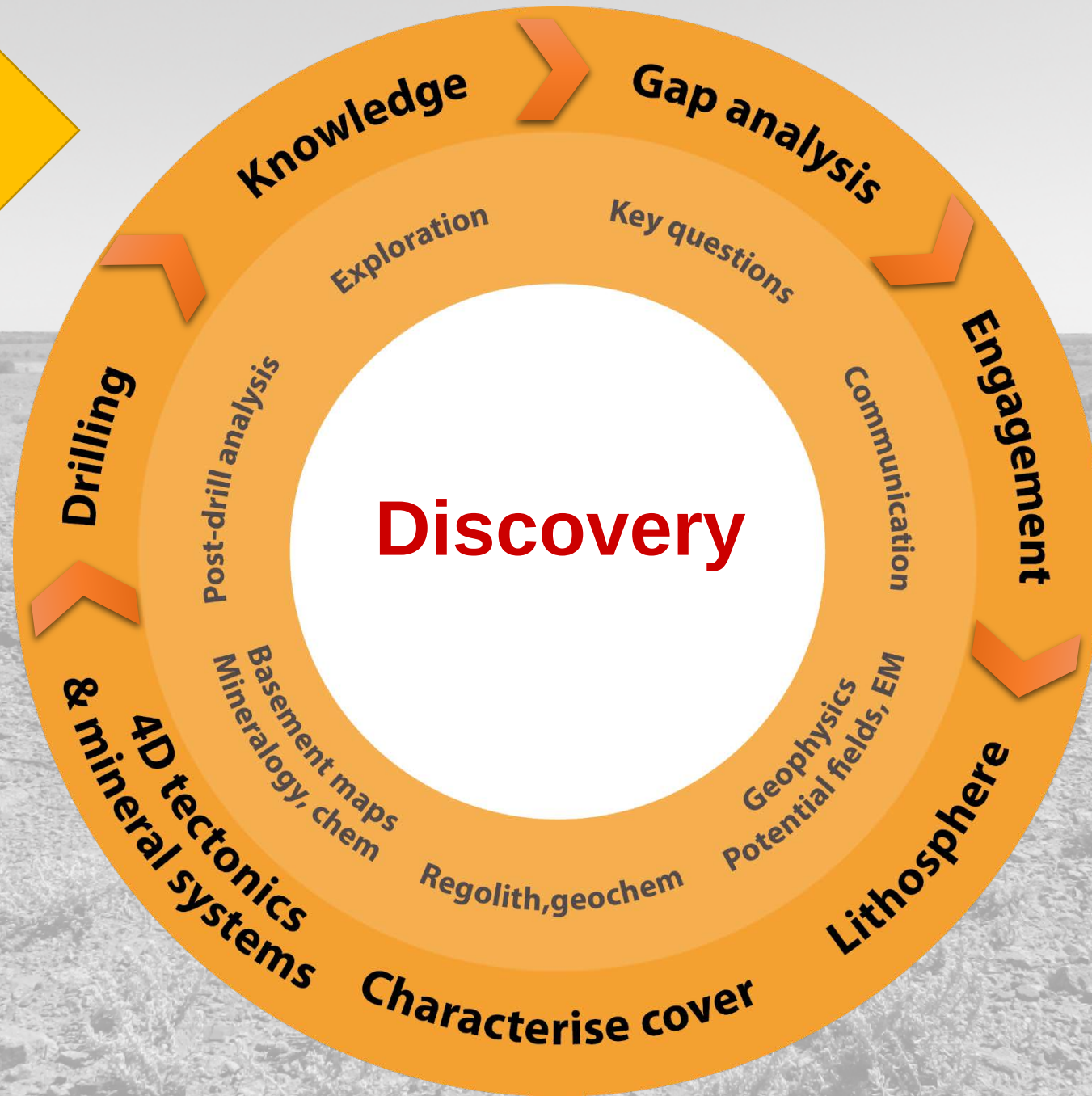


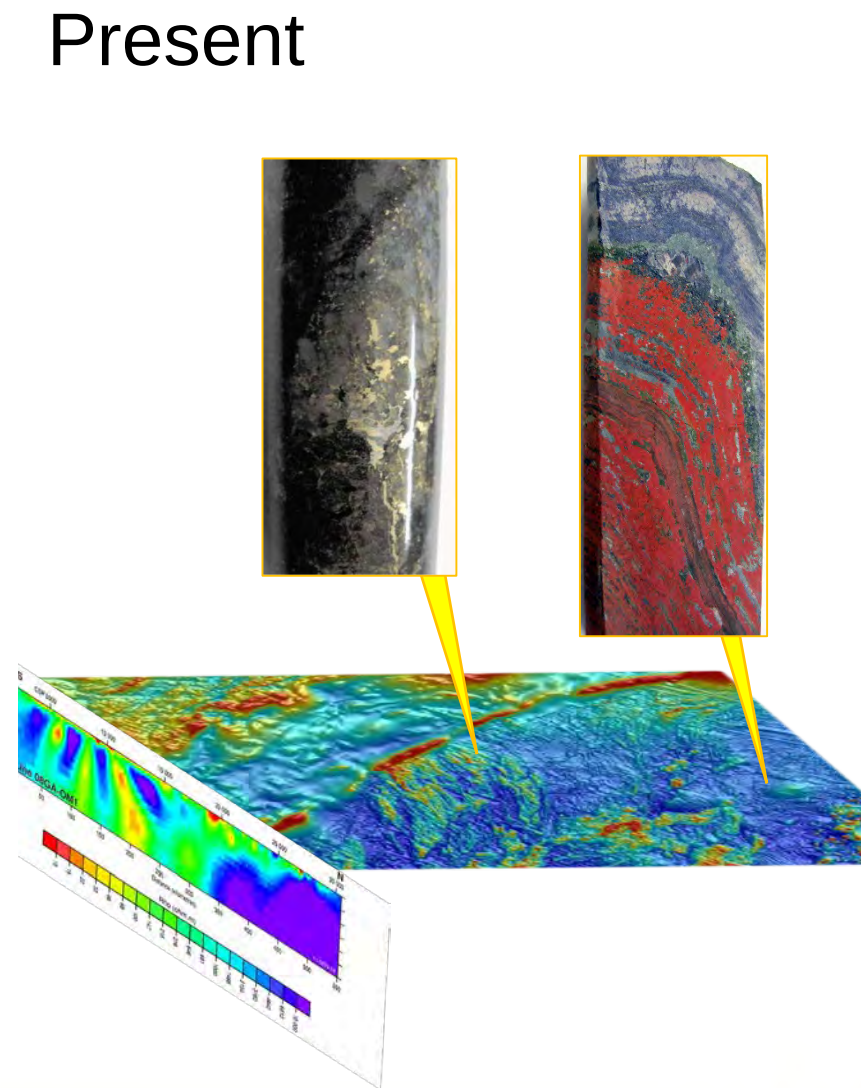
The reality





An UNCOVER
workflow





Geological Survey of South Australia

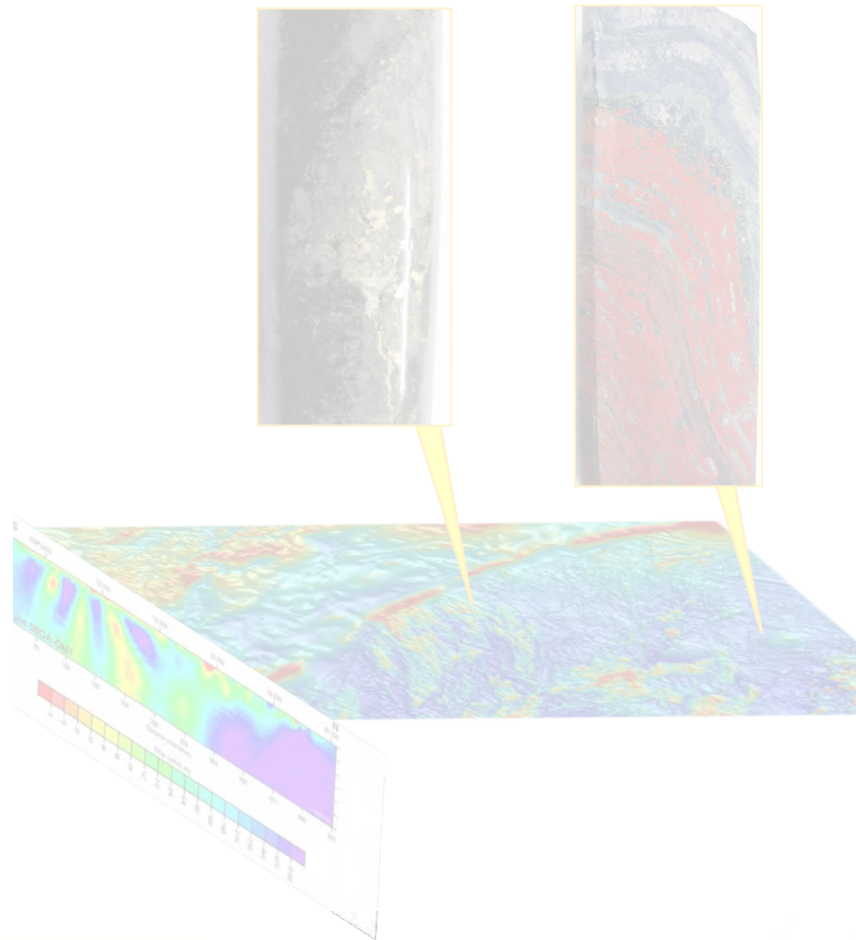


Government of South Australia
Department for Energy and Mining

Past



Present



Future

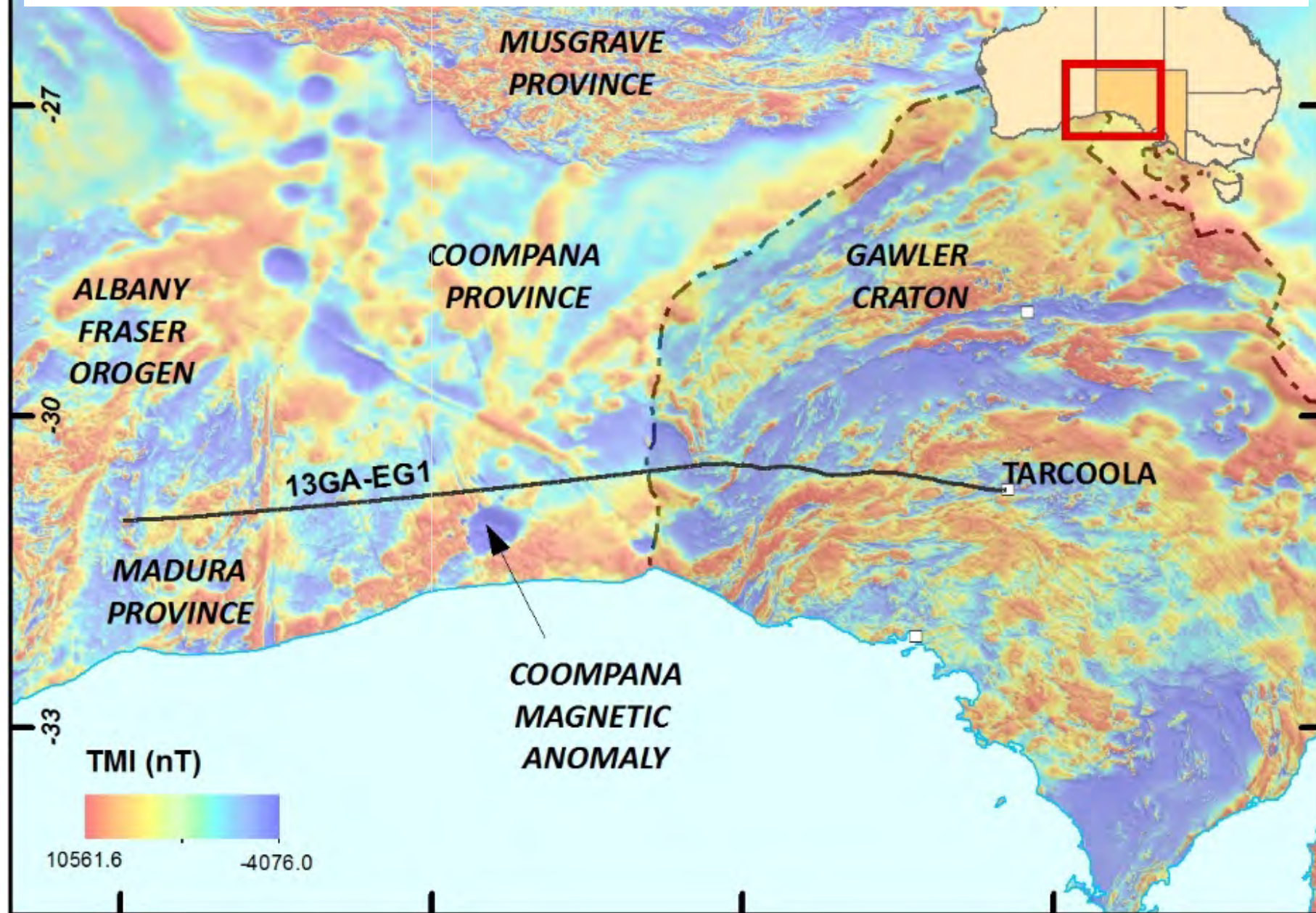


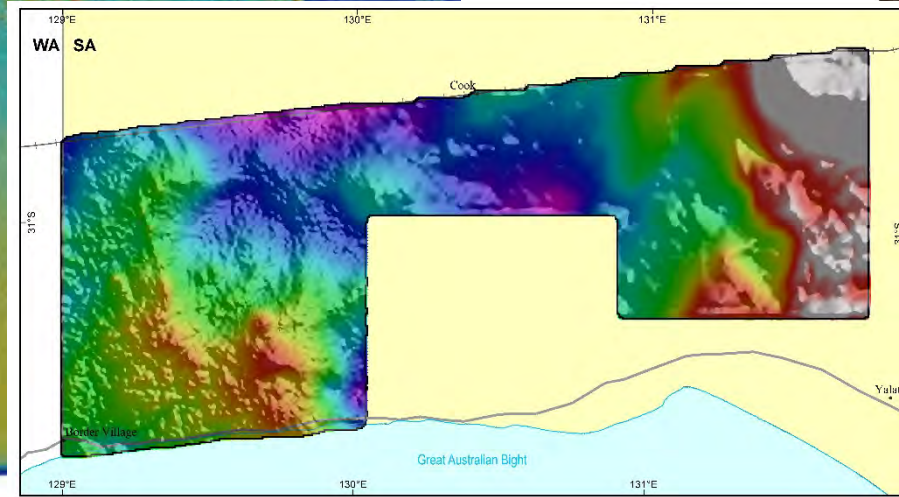
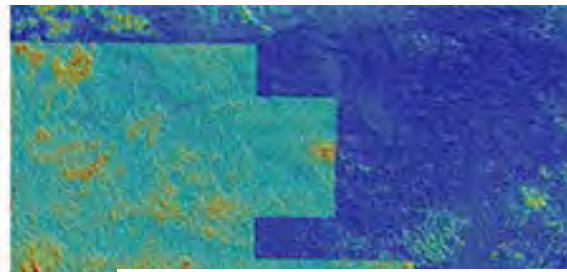
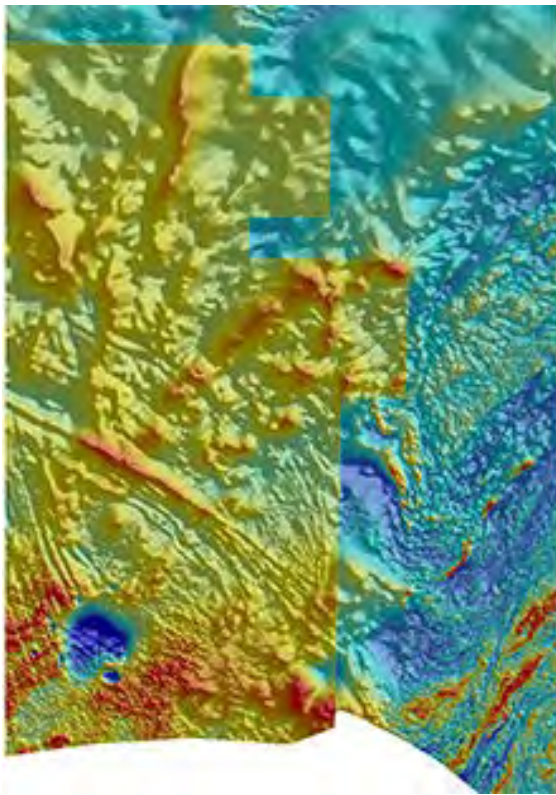
Geological Survey of South Australia



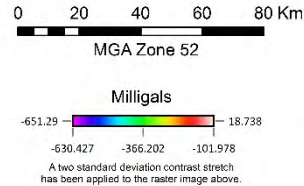
Government of South Australia
Department for Energy and Mining

Frontier region geoscience: Coompana program

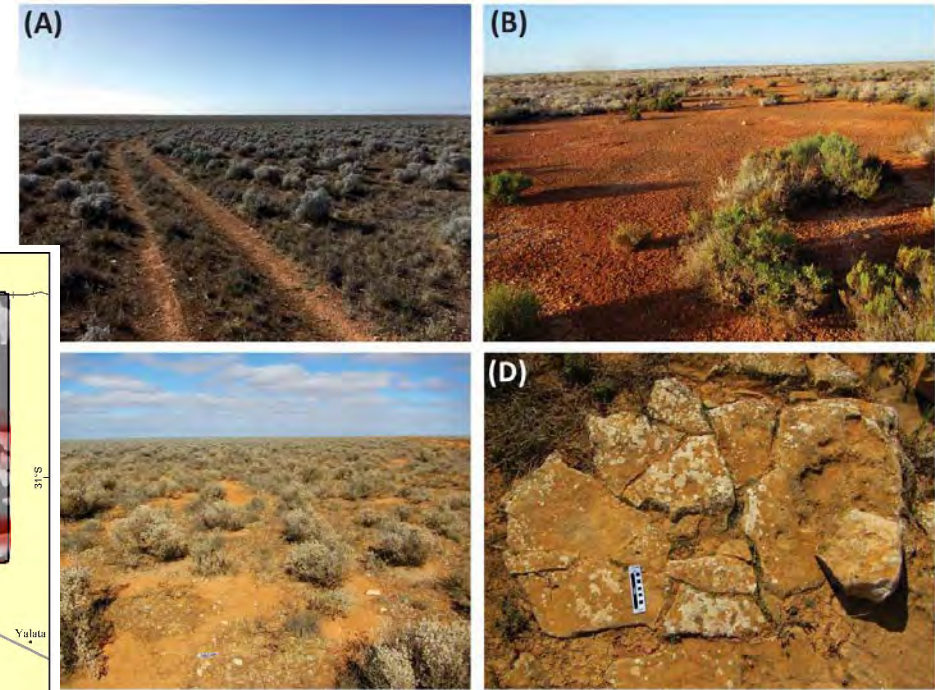




After



New ground gravity survey 2016

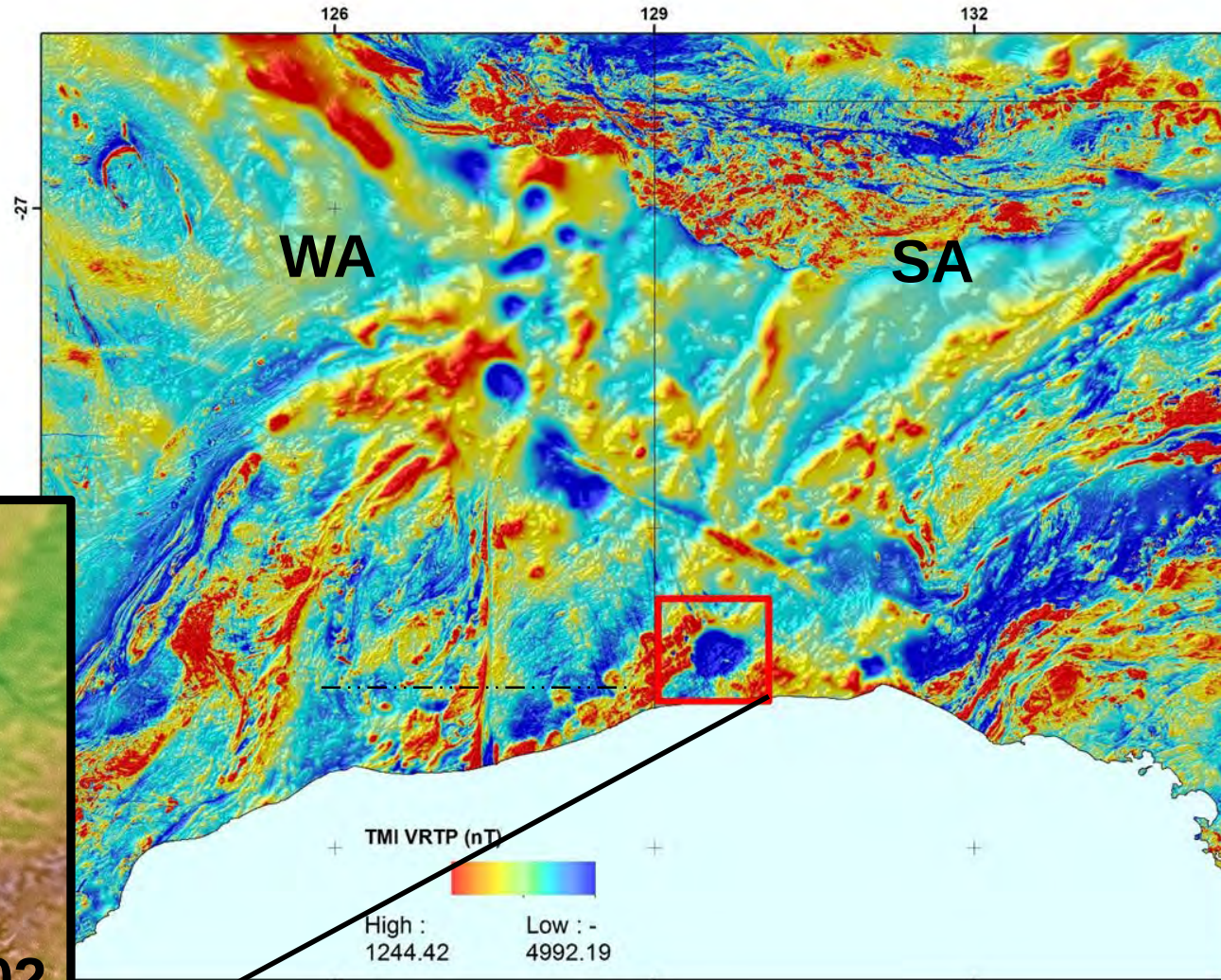
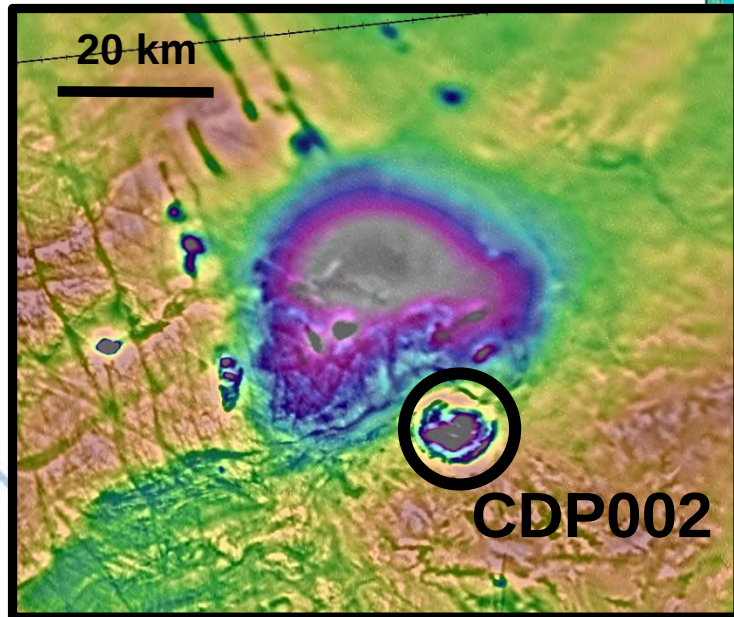


Surface mapping: regolith landforms
Surface geochemical survey: CSIRO
See *MESA Journal* v98, 2019

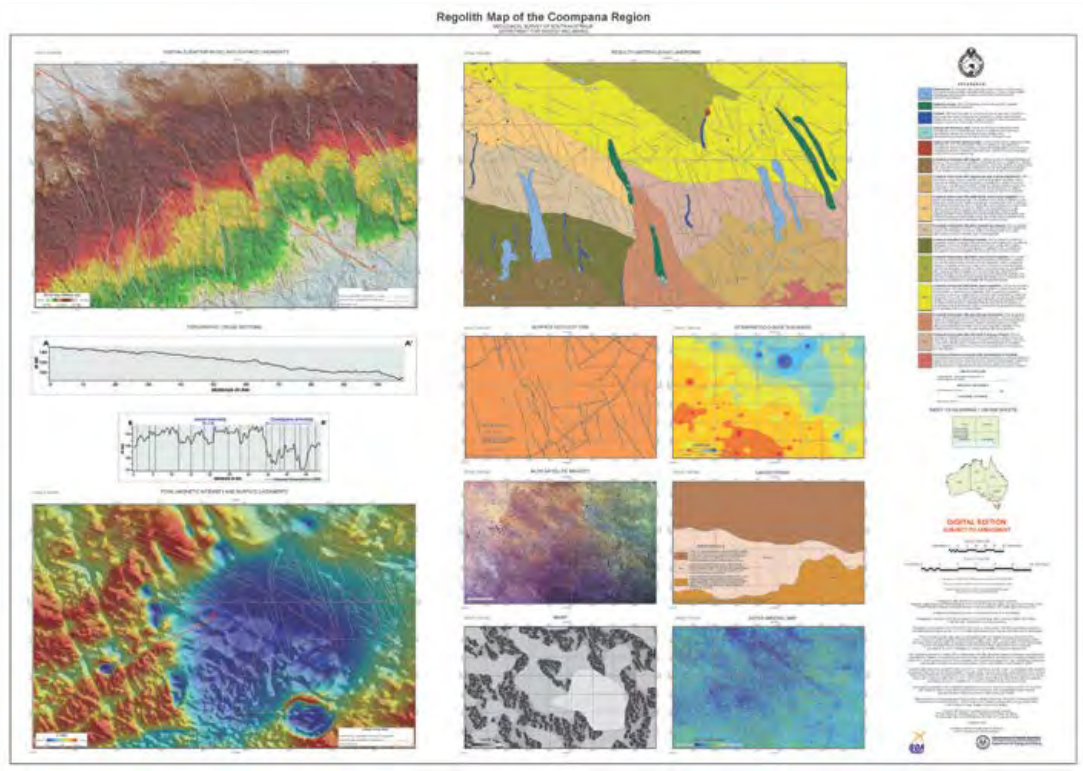
Coompana: Pre-drilling and related work

Key result: mafic magmatism at 1074 Ma

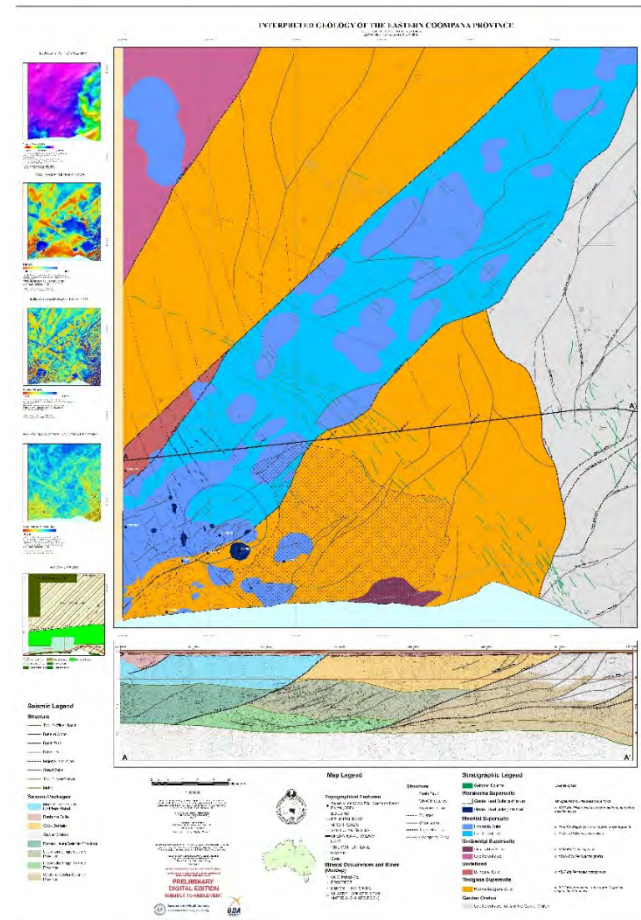
- Drillhole **CDP002**: olivine dolerite with granophyric zones
- Remanently magnetized
- U-Pb zircon 1074 ± 6 Ma
- Part of Warakurna LIP



Coompana: data and knowledge outputs



Surface geology map, including regolith landforms plus neotectonic features

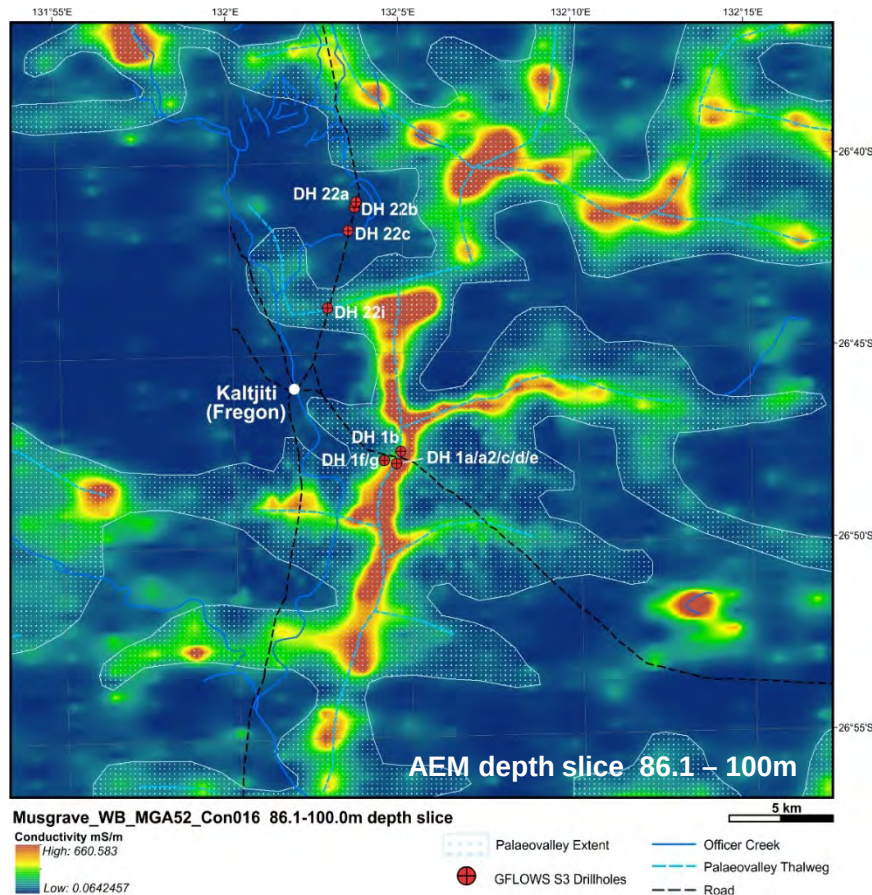


Interpreted basement geology map



Geoscience for community: regional water collaboration

GFLAWS: Finding Long-term Outback Water Solutions



Government of South Australia
Department for Environment
and Water



Flinders
UNIVERSITY
ADELAIDE • AUSTRALIA

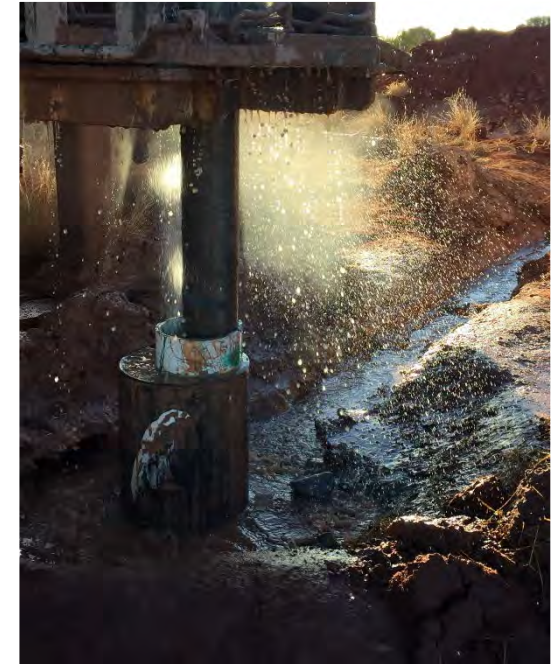
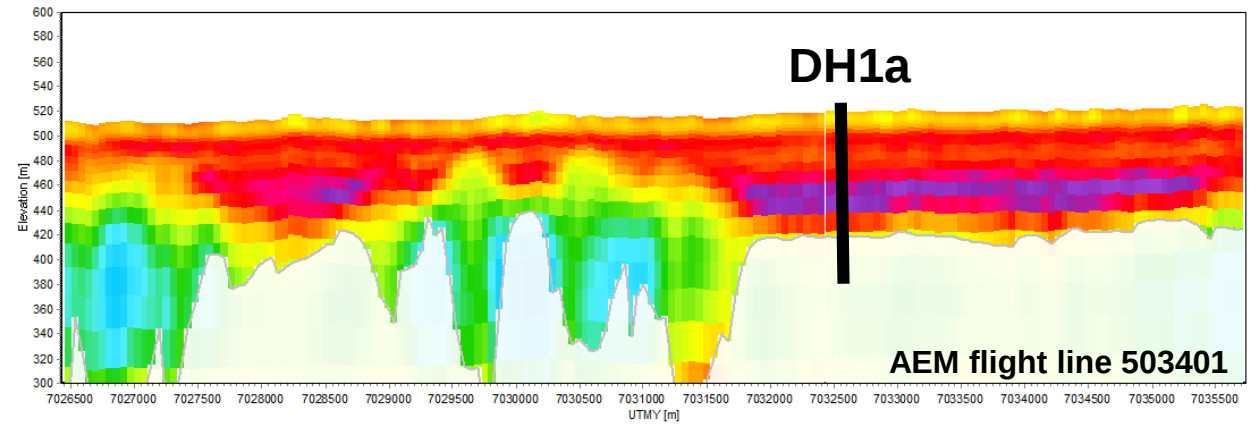


The Goyder Institute for Water Research is a partnership between the South Australian Government through the Department for Environment and Water, CSIRO, Flinders University, the University of Adelaide, the University of South Australia and The International Centre of Excellence in Water Resources Management. The Institute enhances the South Australian Government's capacity to develop and deliver science-based policy solutions in water management. It brings together the best scientists and researchers across Australia to provide expert and independent scientific advice to inform good government water policy and identify future threats and opportunities to water security.

Department for Energy and Mining

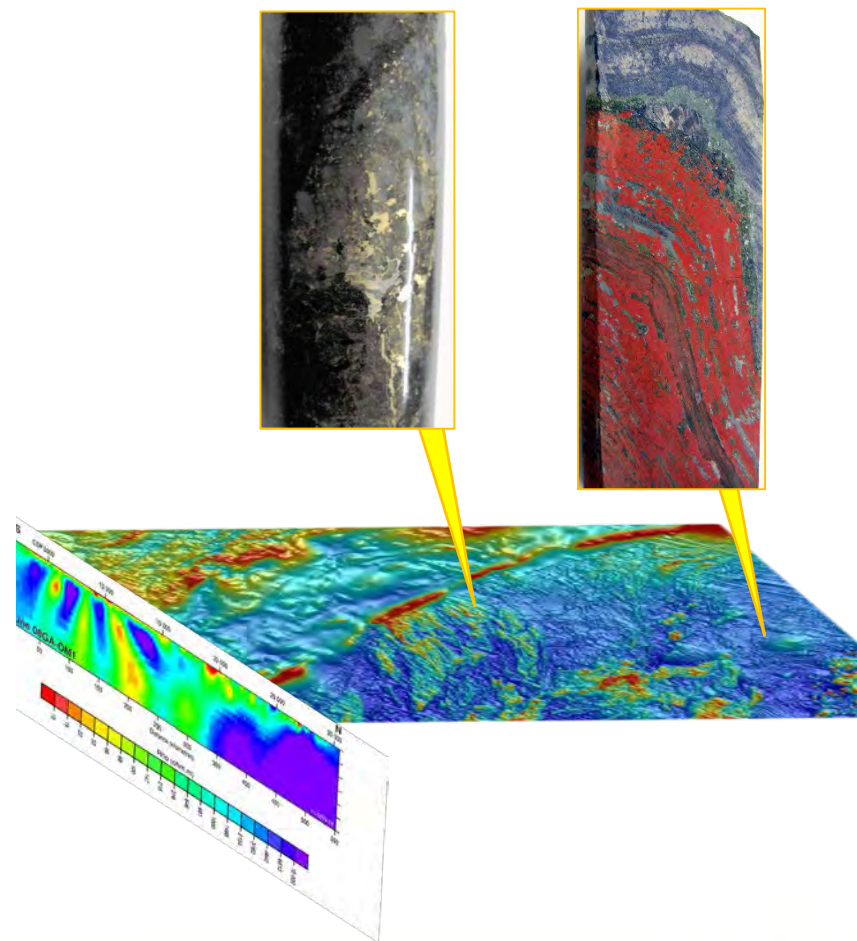
GFLOWS outcomes:

- AEM identified paleovalleys & potential water resources
- Drilling proved saprolithic fractured rock aquifer underlying paleovalley sediment
- New water source for community





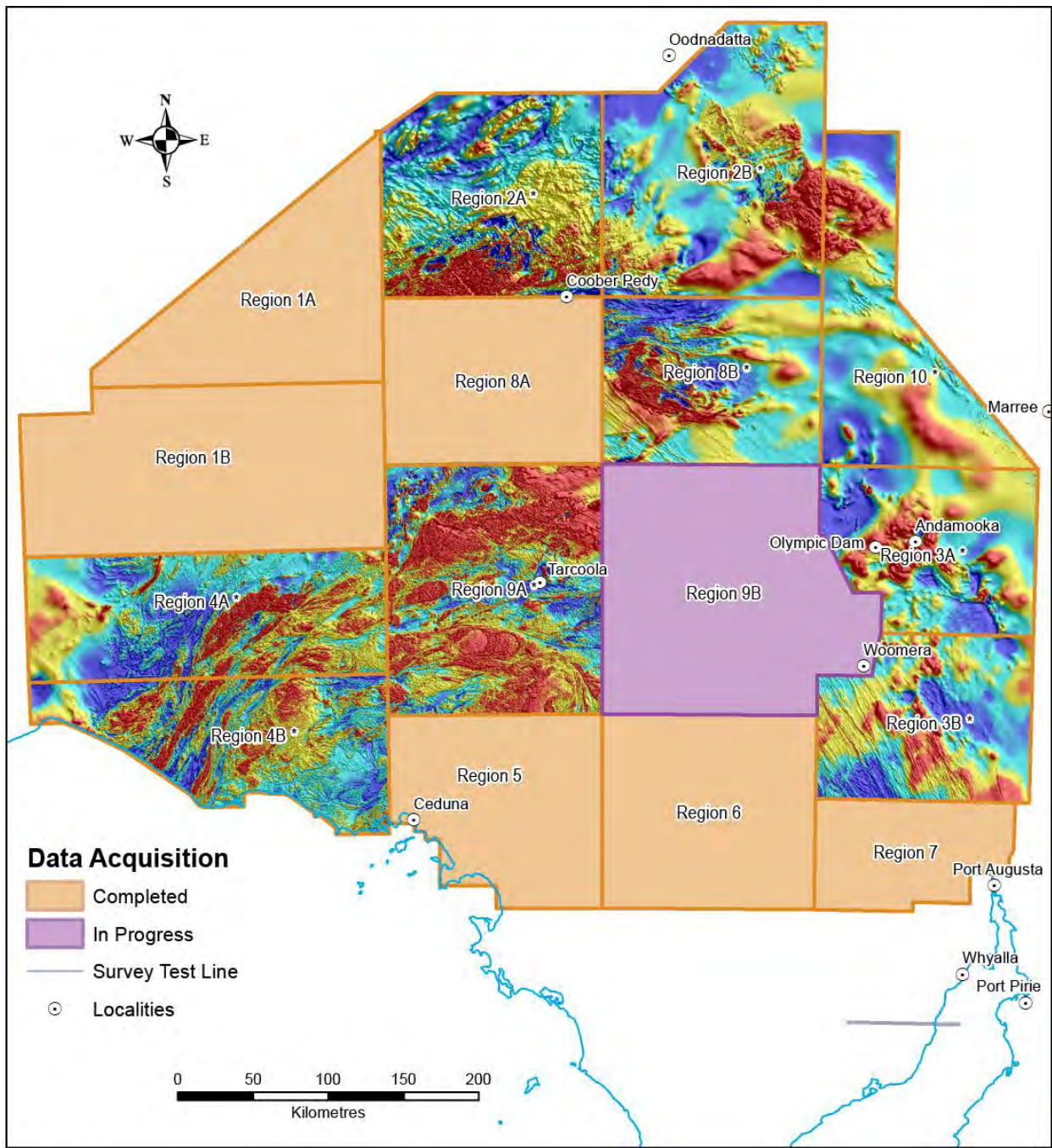
Present



Geological Survey of South Australia

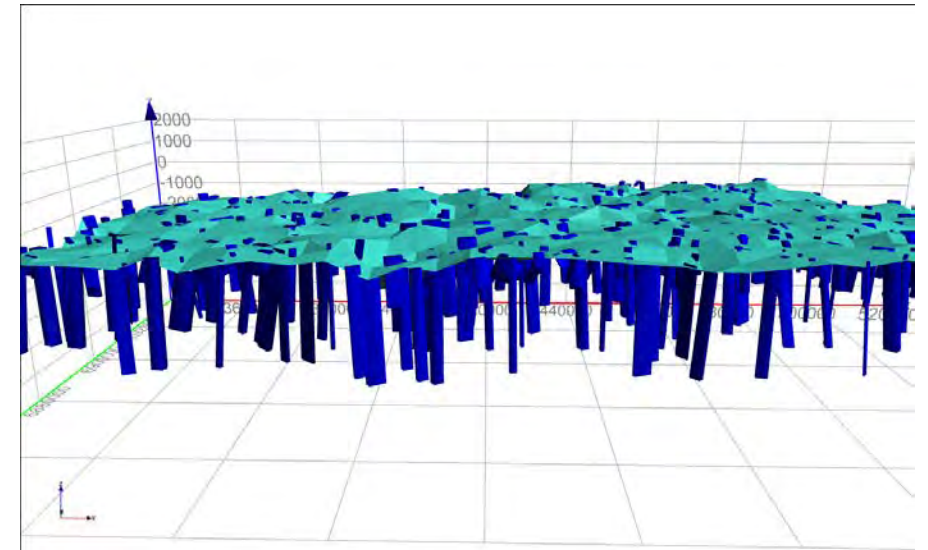


Government of South Australia
Department for Energy and Mining



Gawler Craton Airborne Survey Progress March 2019

- Next generation airborne magnetic and radiometric coverage for South Australia
- World's single largest contiguous airborne TMI survey; 200m line spacing
- Value add products & collaboration with GA and CSIRO

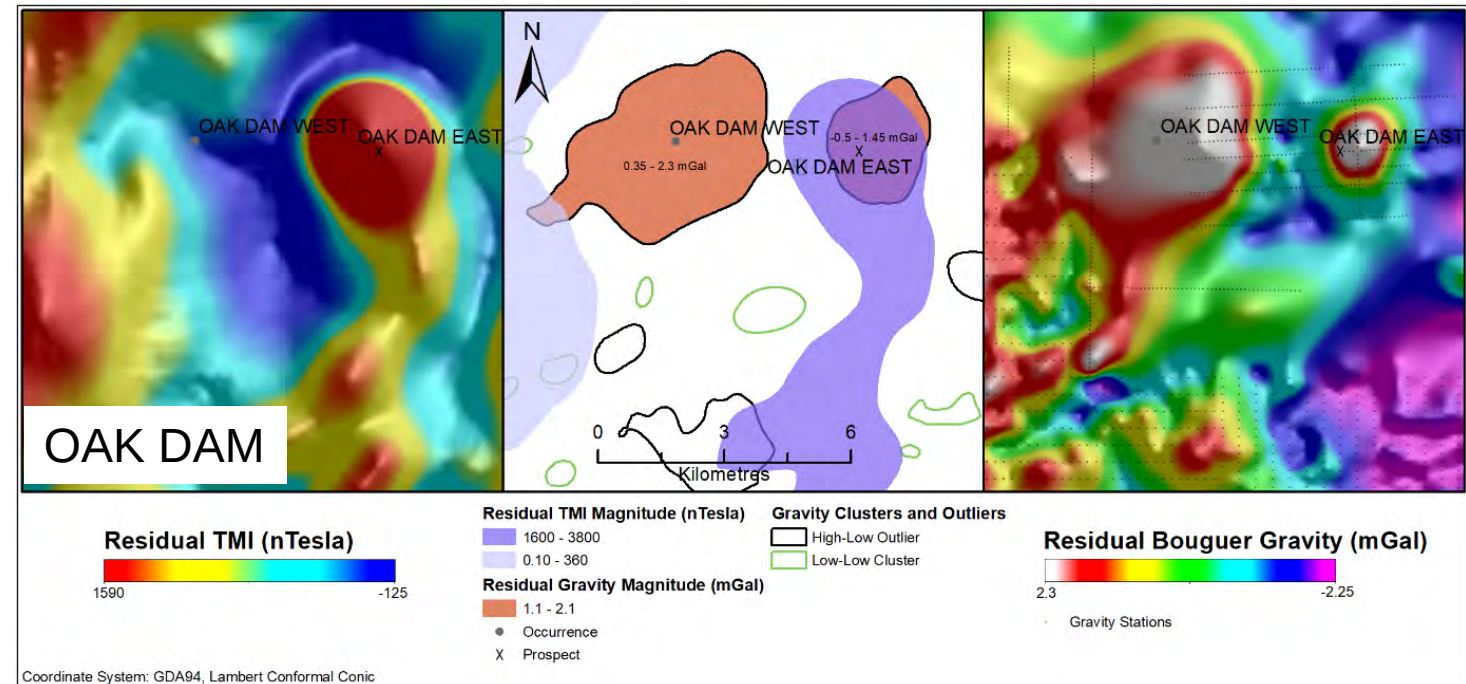
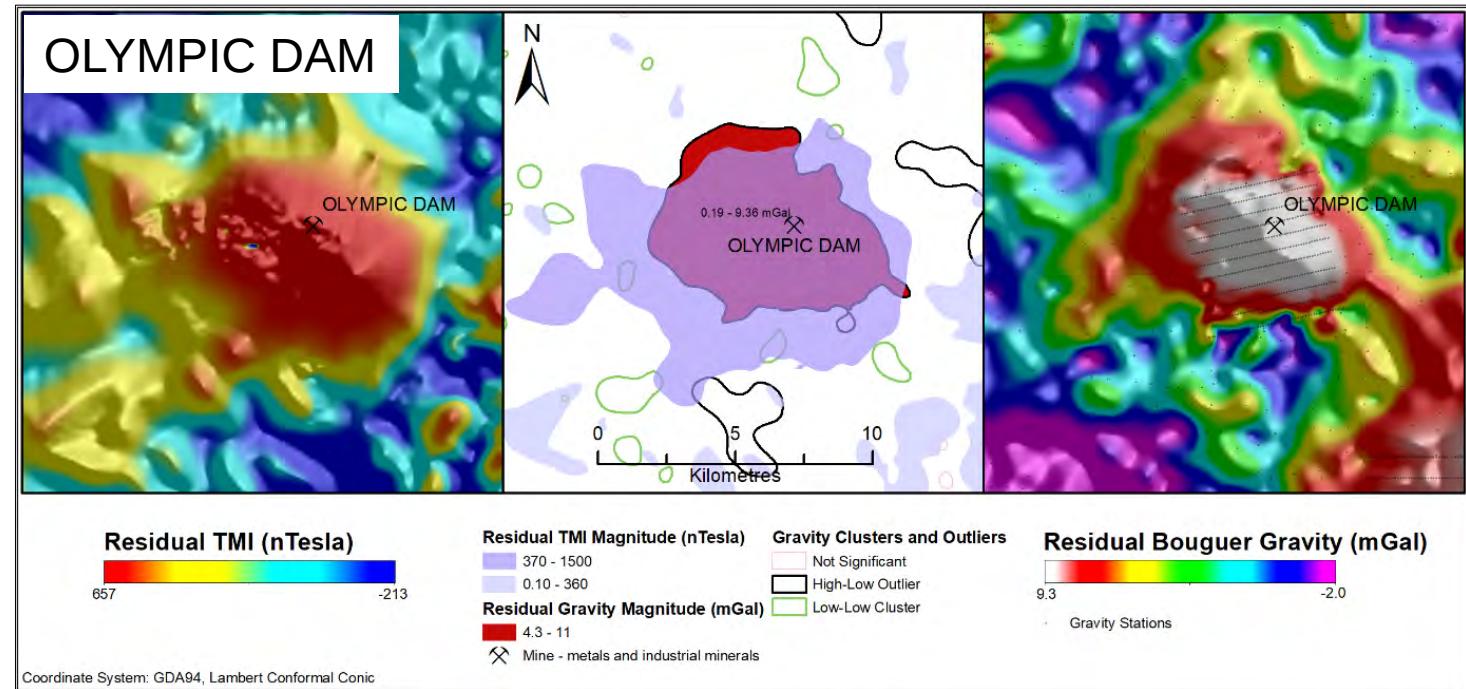


Optimum magnetic source solutions for
depth to crystalline basement

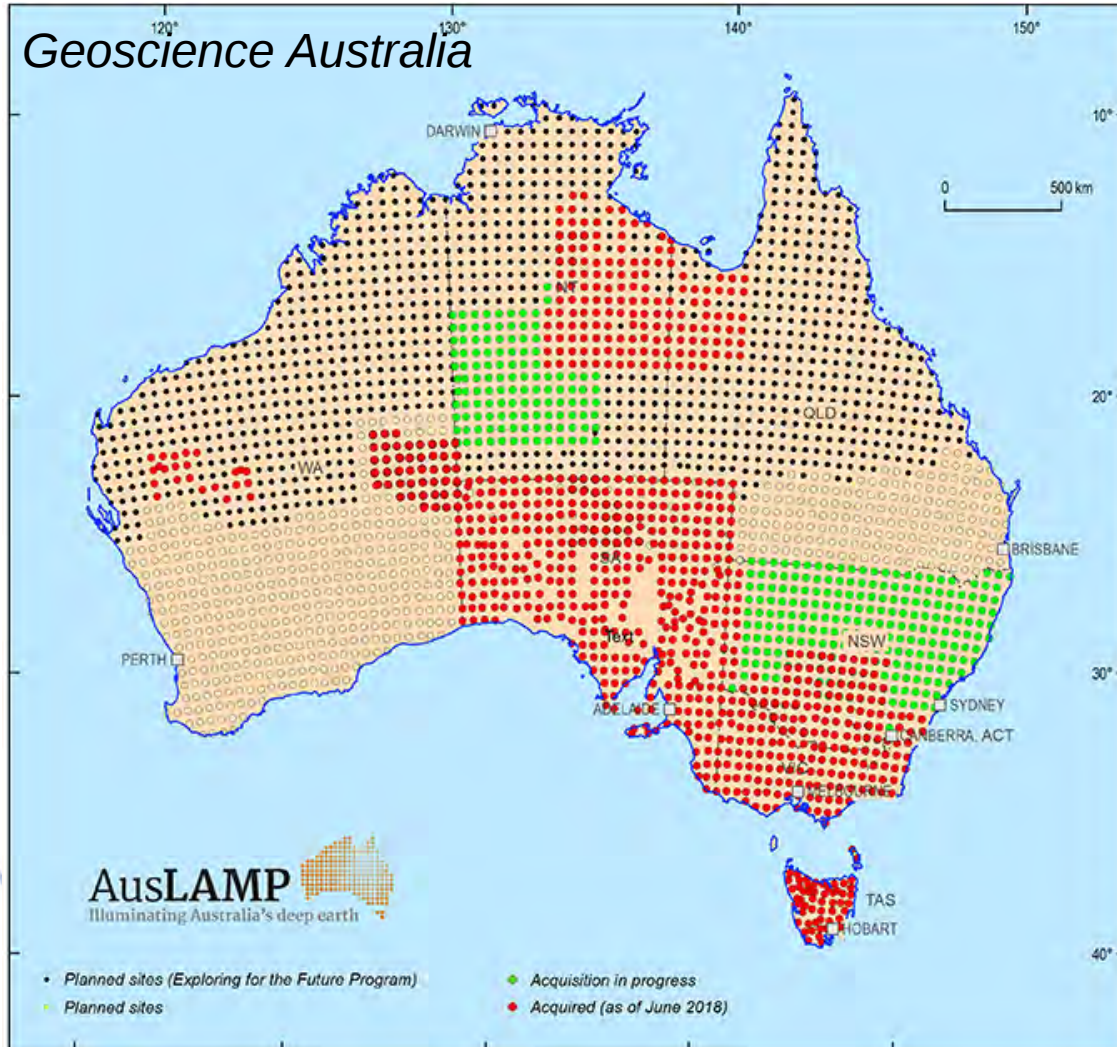
Geophysical targeting methodologies

- Spatial statistics to quantify correlations between magnetic and gravity responses
- Gravity and magnetic polygons over selected IOCG deposits/prospects
- Oak Dam West gravity high

See Katona and Fabris, in press. GAC-MAC 2019, Quebec, SC Volume
“Exploring for IOCG Deposits”



AusLAMP South Australia: complete

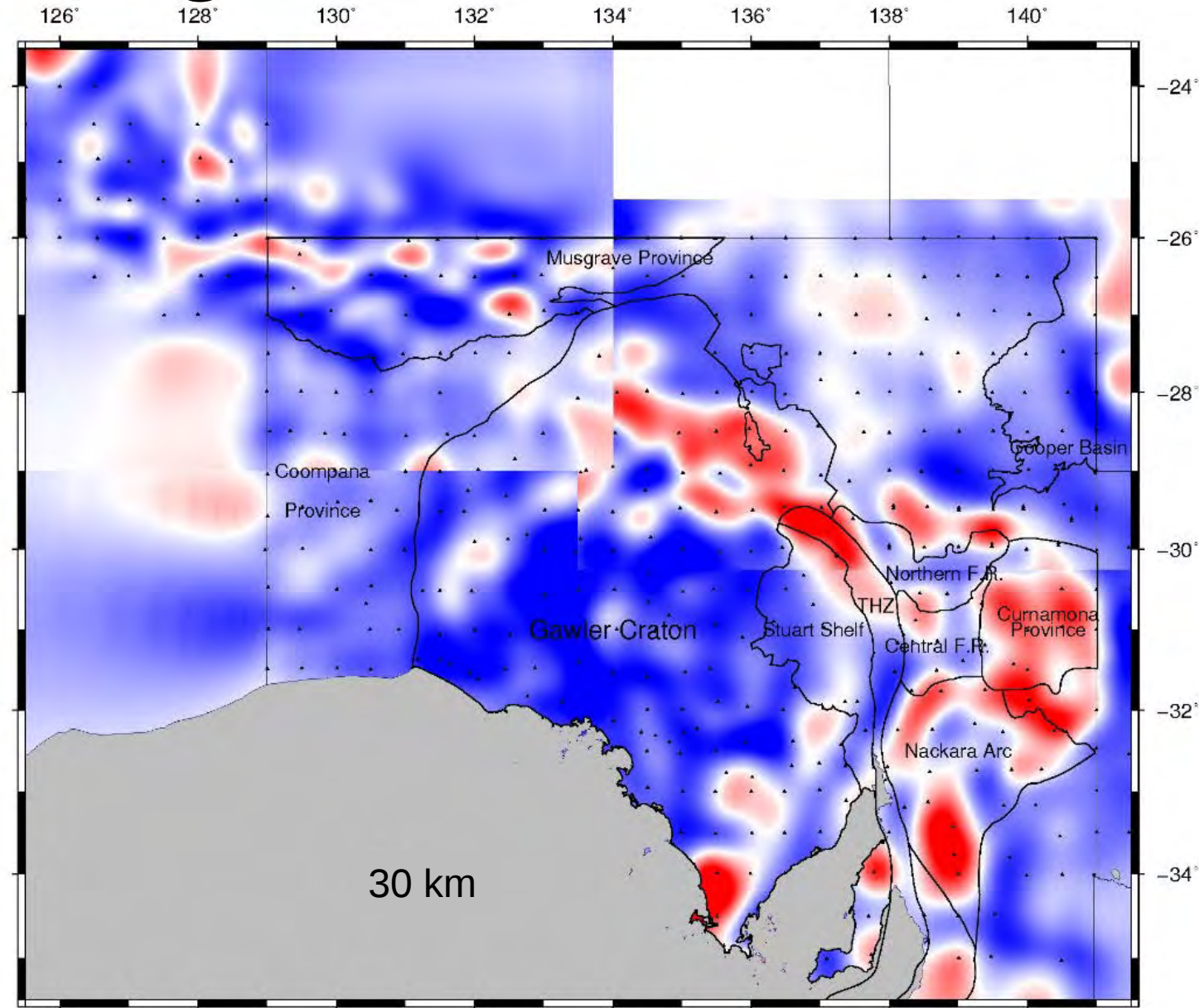


- 906 new MT sites uploaded
 - 406 AusLAMP MT sites
 - 167 Eucla-Gawler MT sites
 - 329 Olympic Domain MT sites



AusLAMP SA learnings

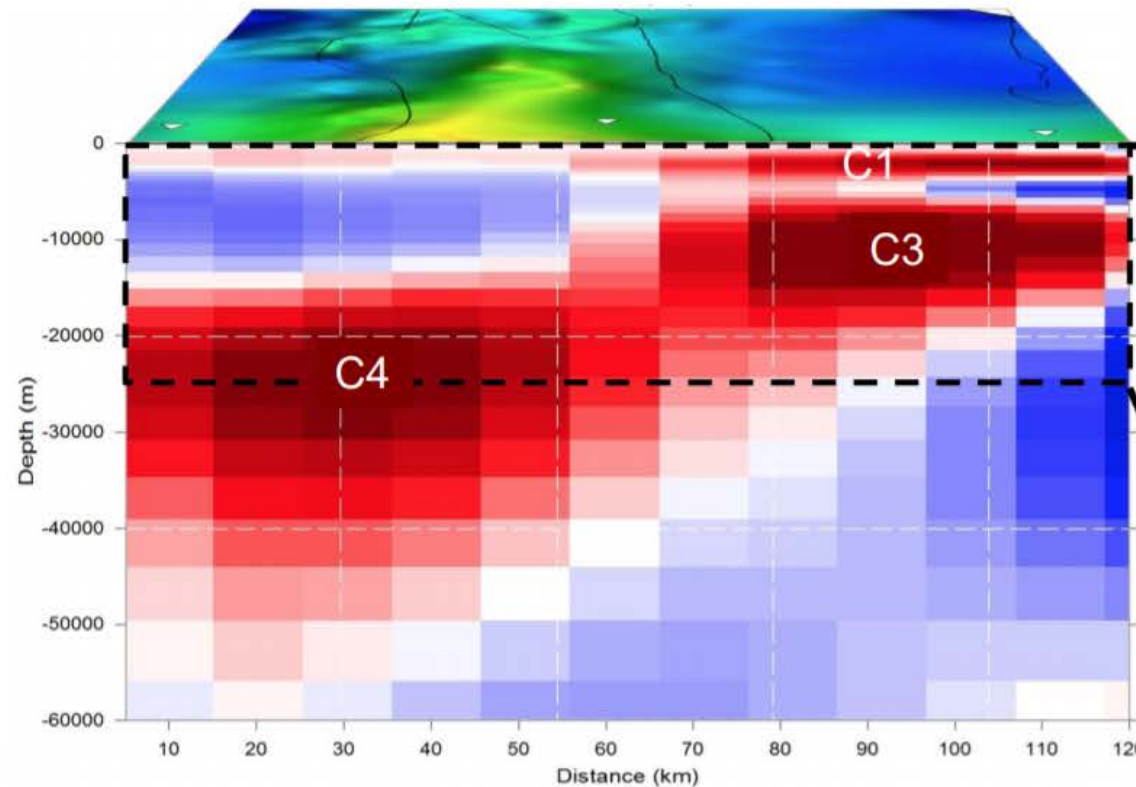
- Correlation of Cu – Au mineralisation with crustal conductors on cratonic margins
- Images of Gawler metasomatised mantle
- metasomatised mantle Gawler – Curnamona lithospheric connection



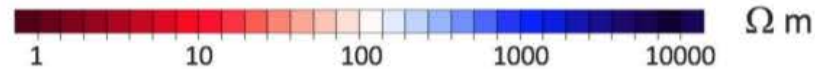
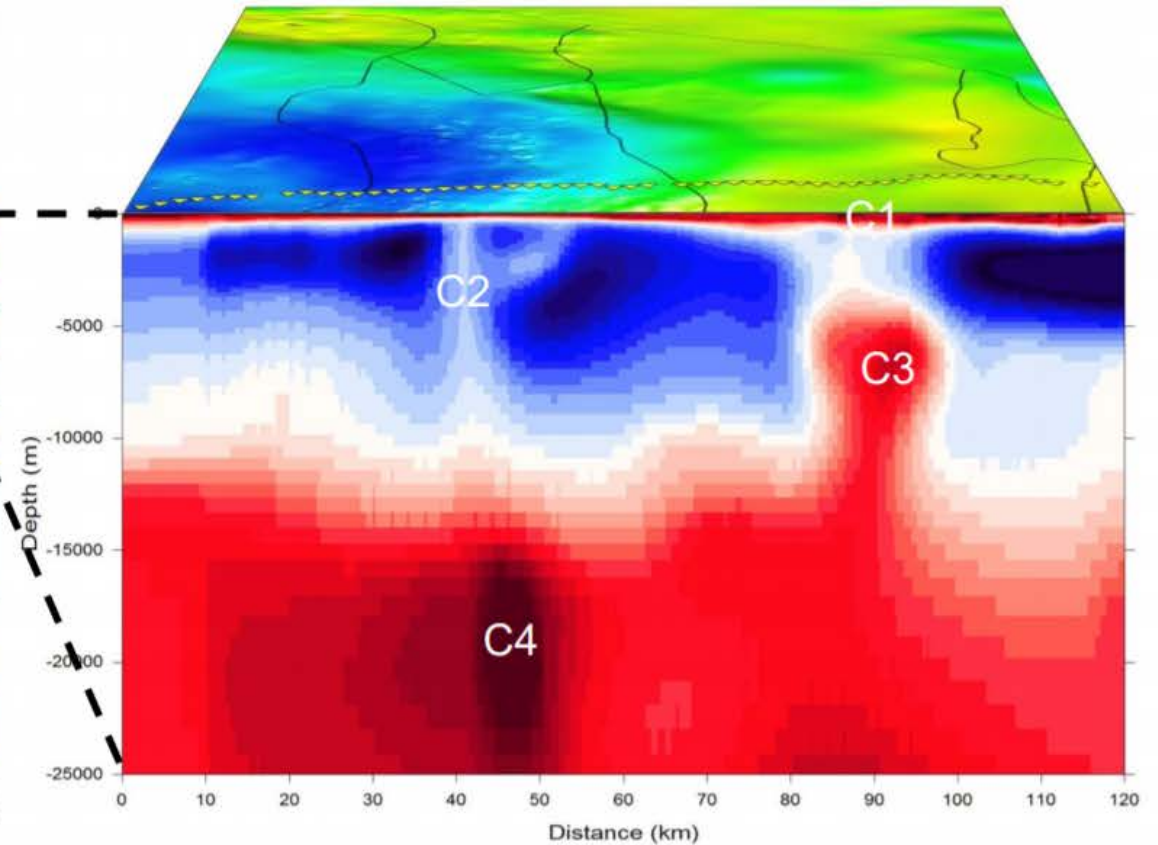
Next steps: Scale reduction

1. Curnamona Province

AusLAMP Section



BBMT Section



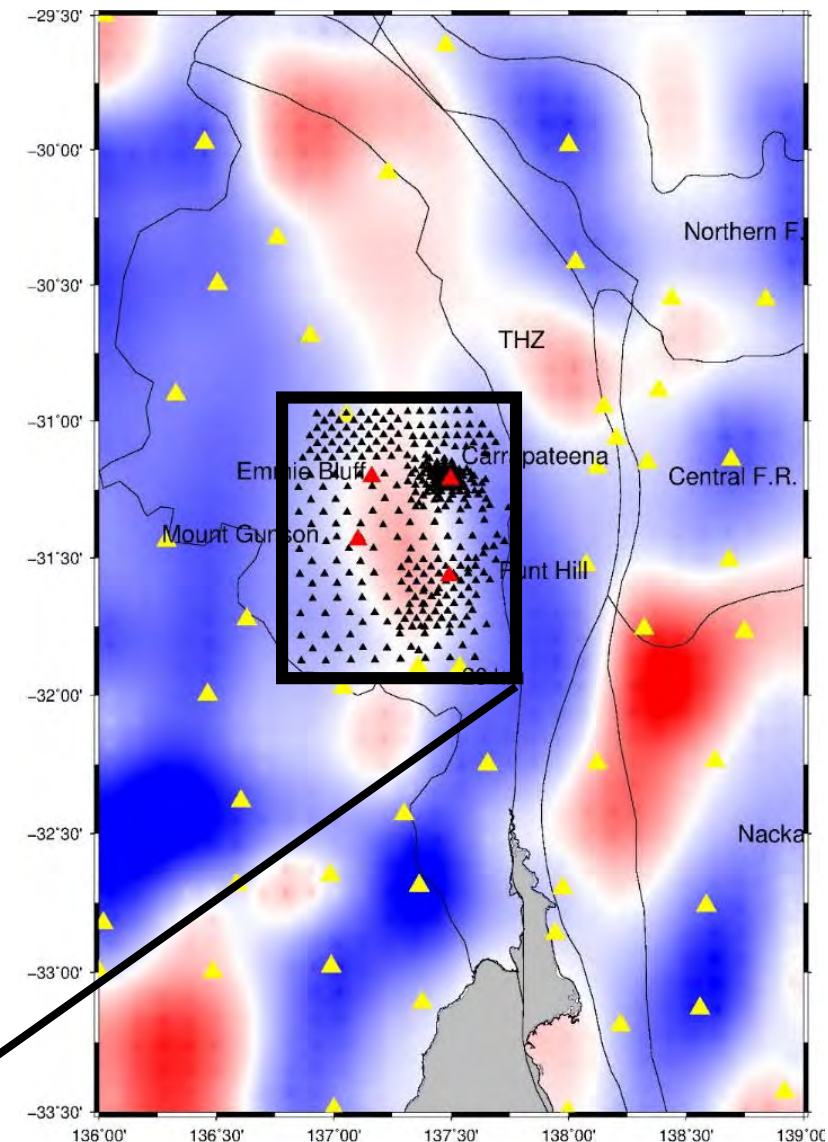
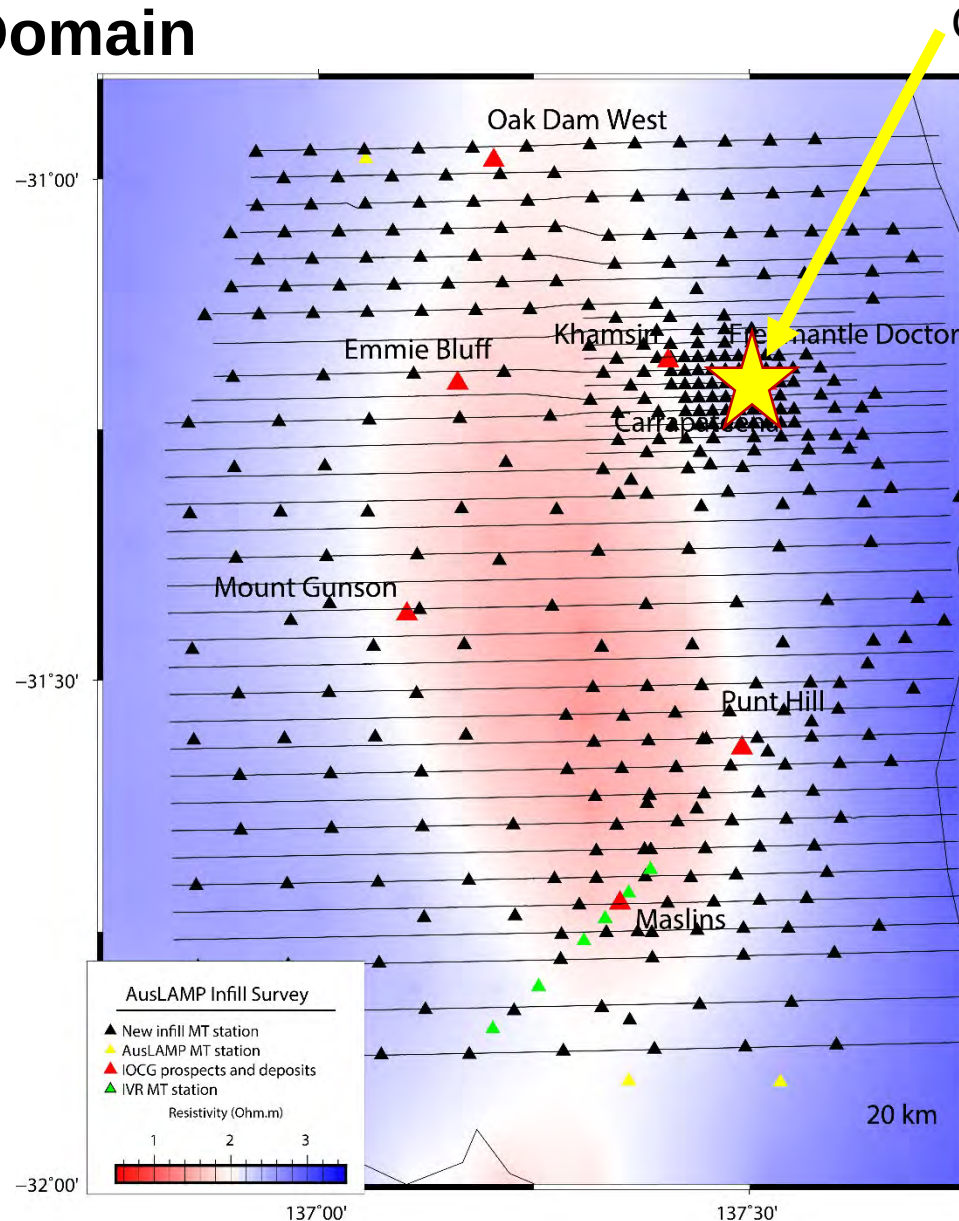
Flinders Ranges Curnamona AusLAMP model,
Robertson et al 2016, EPSL

Curnamona Broadband Model,
collected by Ben Kay, UoA, 2017

Next steps: Scale reduction

2. Olympic Domain

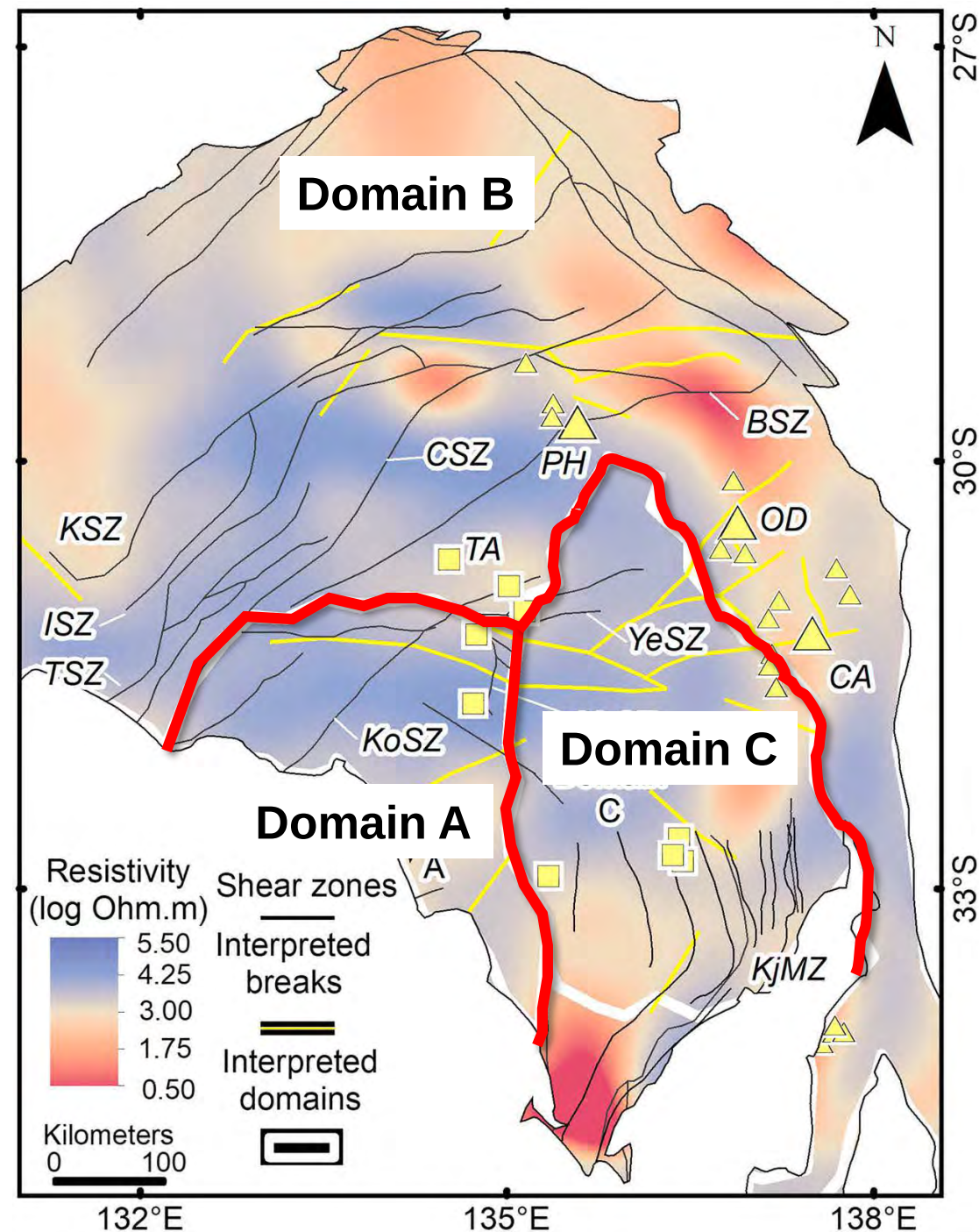
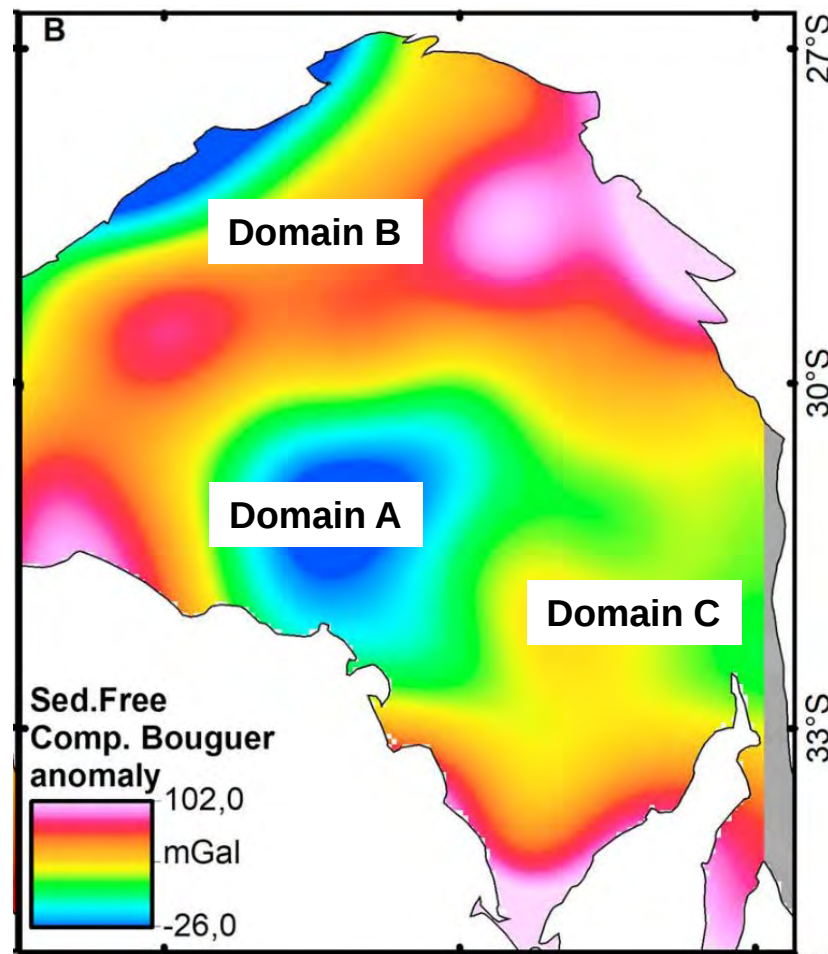
- 329 Broadband and audiomagnetotellurics sites
- Site spacing between 1.5 km to 5 km across 100 km x 100 km
- AEM 1.5 km - 3 km line spacing
- 6 added stations by Investigator Resources (green colour)



Lithospheric architecture: integration of satellite gravity and AusLAMP resistivity models

- Upper crustal structures connect to deep crustal domains
- Interpreted to reflect craton amalgamation
- Mesoproterozoic deposits near boundaries

Motta, et al. 2019.
Proxies for basement
structure...
*Journal of Geophysical
Research: Solid Earth*,
124.
<https://doi.org/10.1029/2018JB016829>

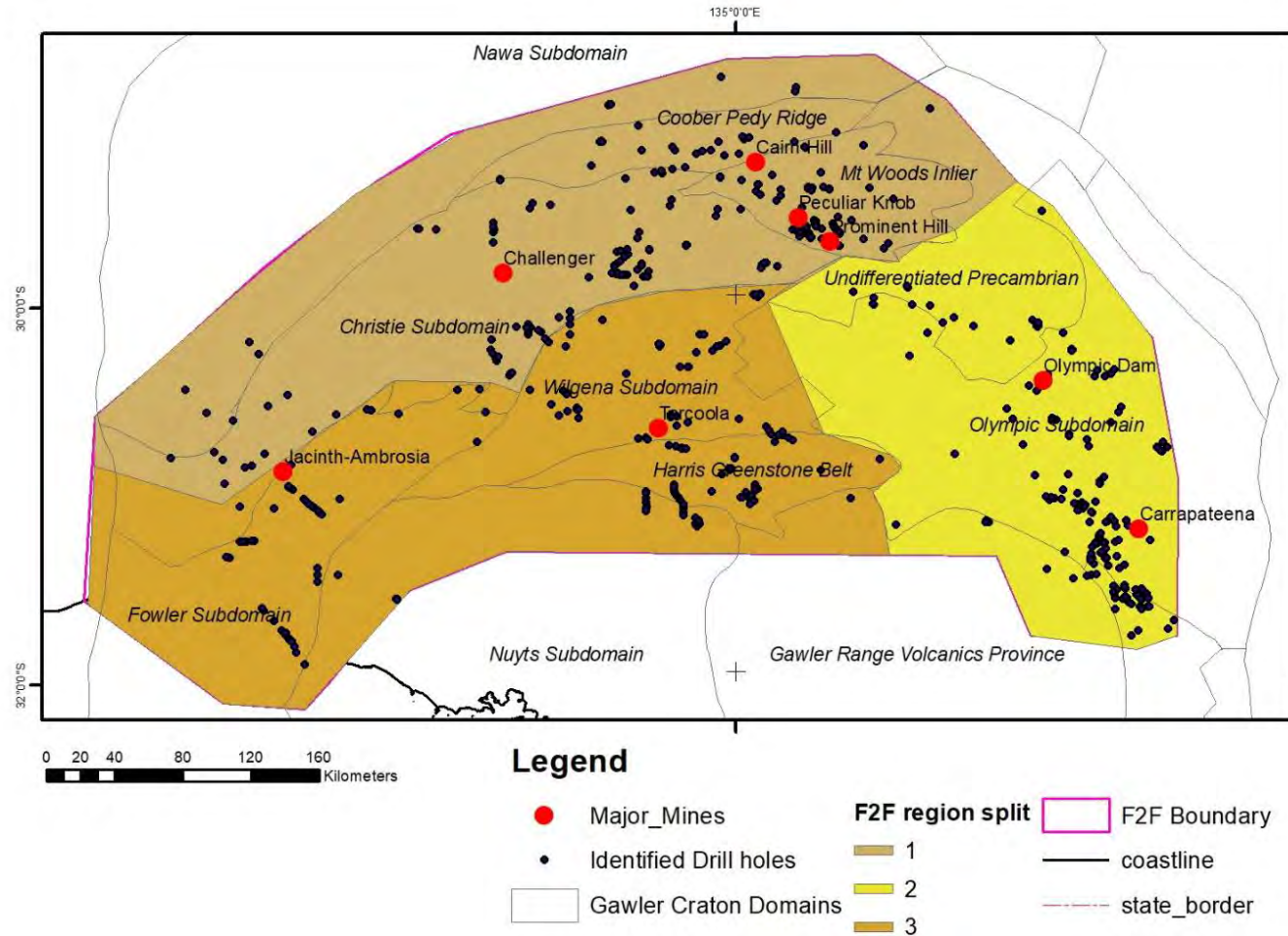


South Australian Drill Core Reference Library

~7.5 million metres of core



Drill hole data review project



796 diamond drill holes

Central Gawler Craton focus

Sparsely populated database

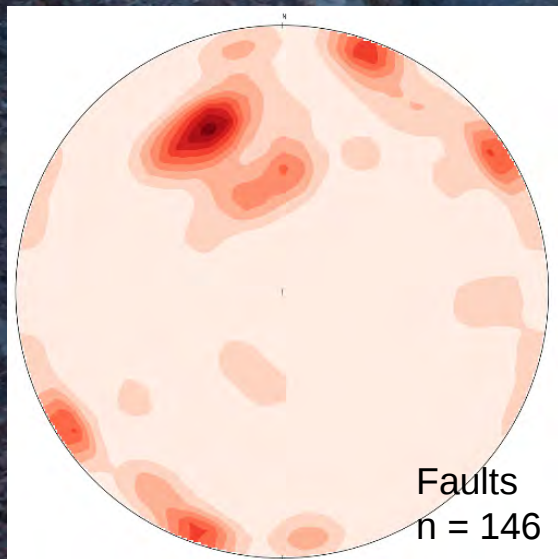
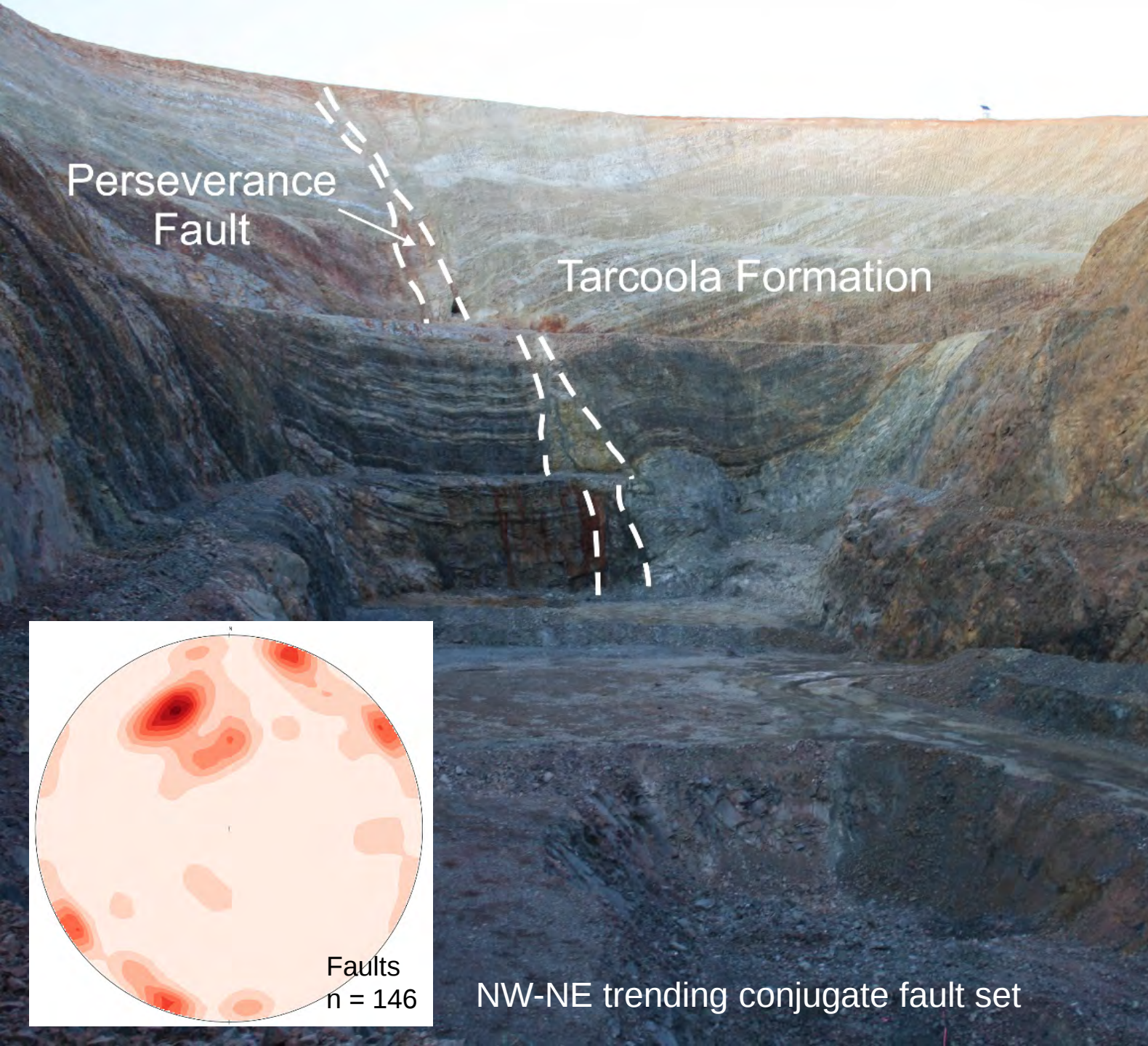
<30% stratigraphic logs
<10% have petrology
<10% specify depth to
basement

- Priority data collation and compilation
- Key drill holes flagged for follow up logging and analysis

Central Gawler Craton: New mapping and structural interpretation of Perseverance Gold Deposit

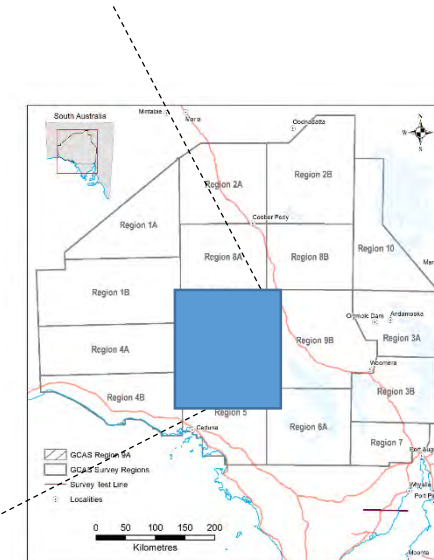


WPG Resources



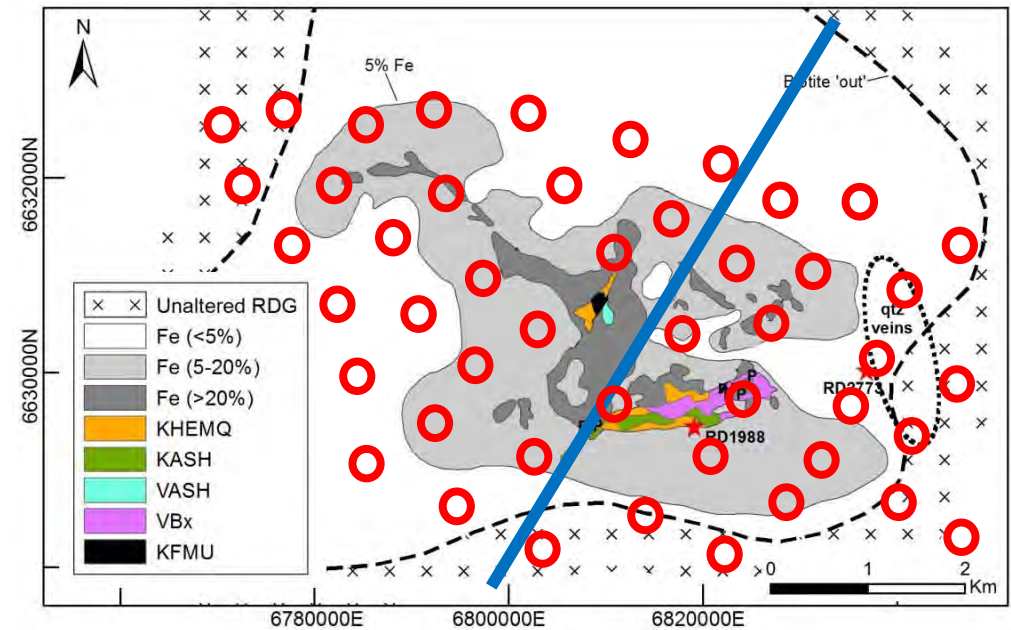
Key findings:

- Rheological control on Au deposition
 - esp. faults, mafic dyke margins, granite-sediment contact
- Progressive deformation; σ_1 N-S
- Upright Perseverance fault
- NNE-trending structures evident in new regional aeromagnetics

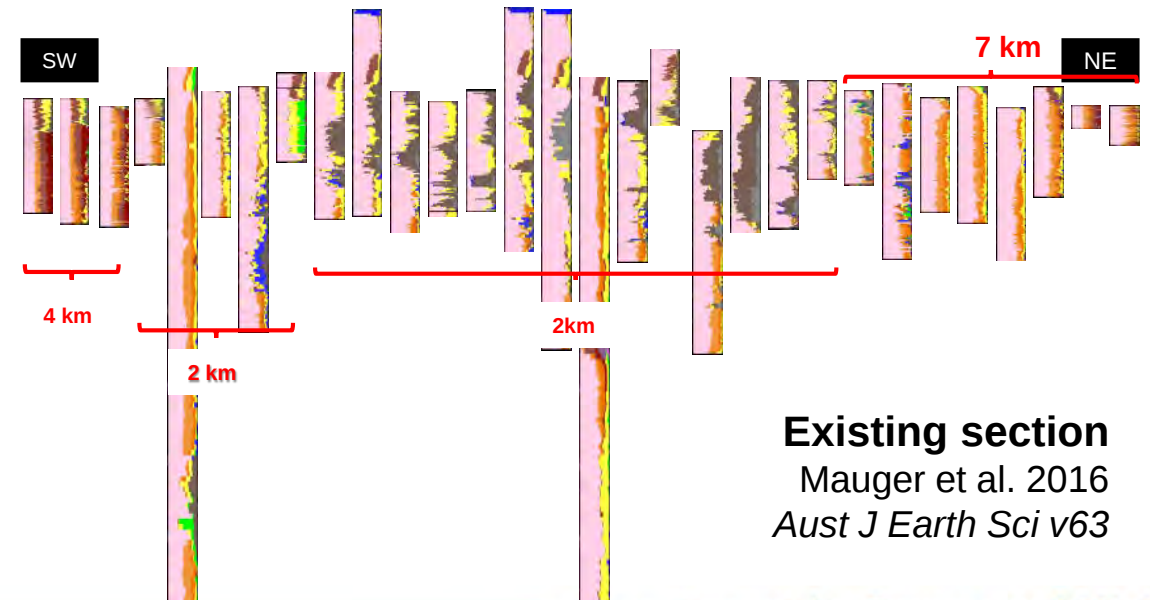


Distal mineral footprints: Olympic Dam spectral mineralogy project

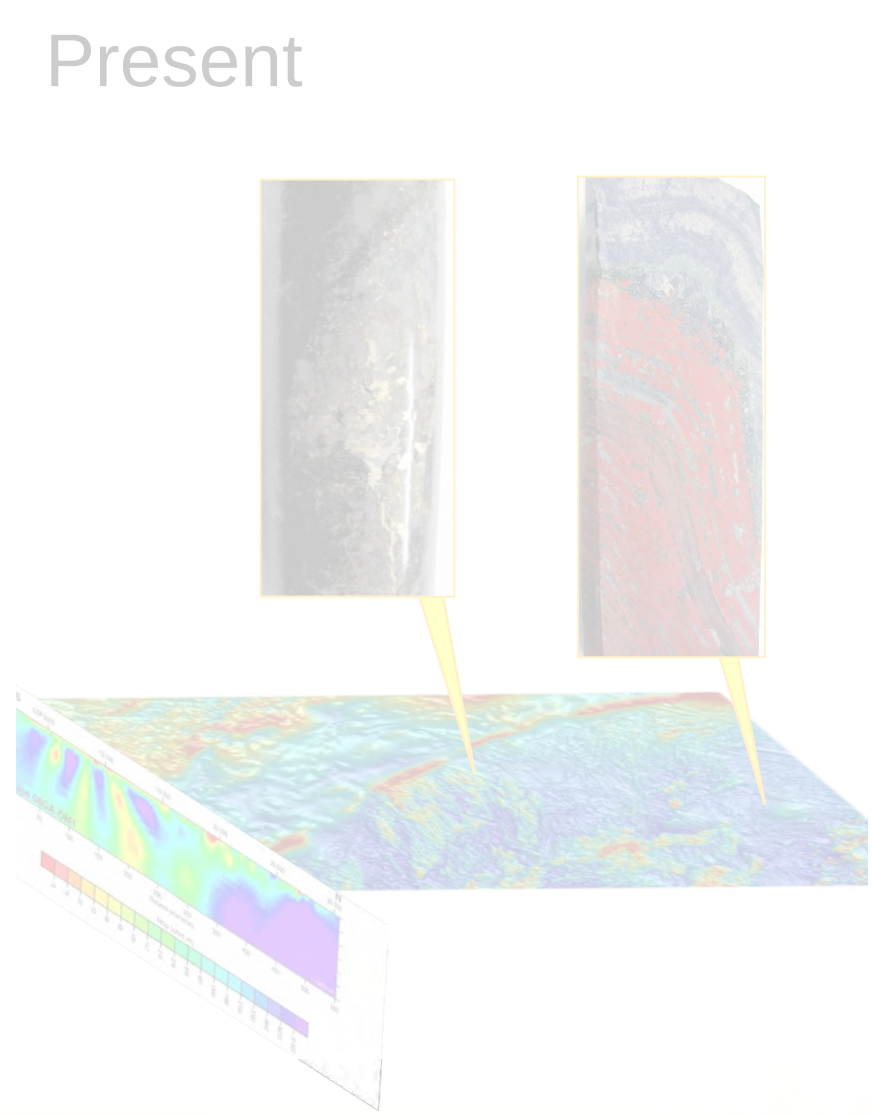
- BHP Olympic Dam team
- 2 yr program to scan 60 dh's (~40km)
- Add to previous 14 km section of 30 drill holes (20,000 m) completed in 2014
- Opportunity to build 3D model
- All data is open file and will be loaded on NVCL/SARIG
- Progress – 12,251m scanned (since 14/09/2018)



Olympic Dam orebody after Ehrig et al. 2012



Existing section
Mauger et al. 2016
Aust J Earth Sci v63

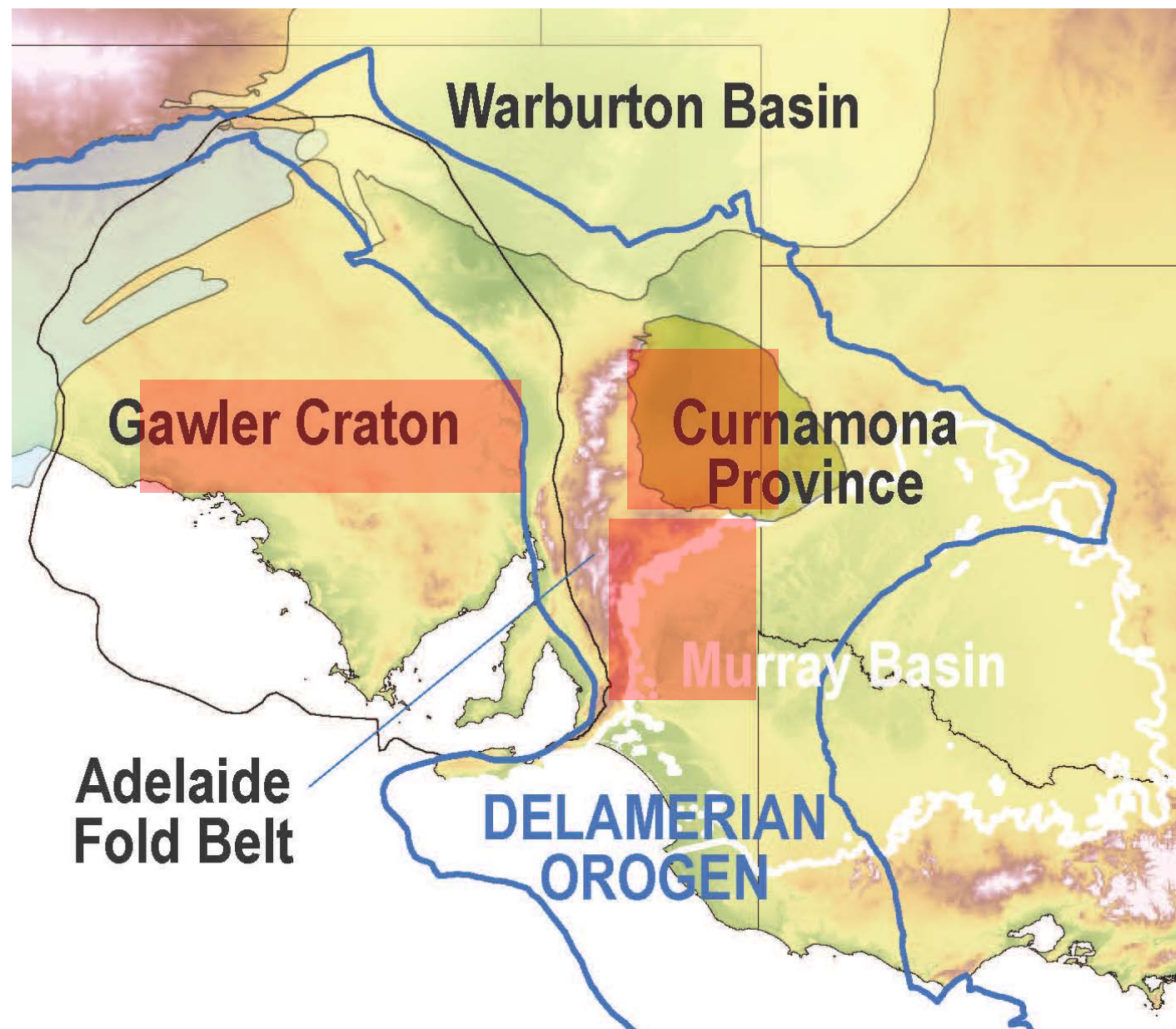




National Drilling Initiative

Focus areas:

1. Fowler to Flinders – Gawler Craton
2. Curnamona Province
3. Delamerian Orogen



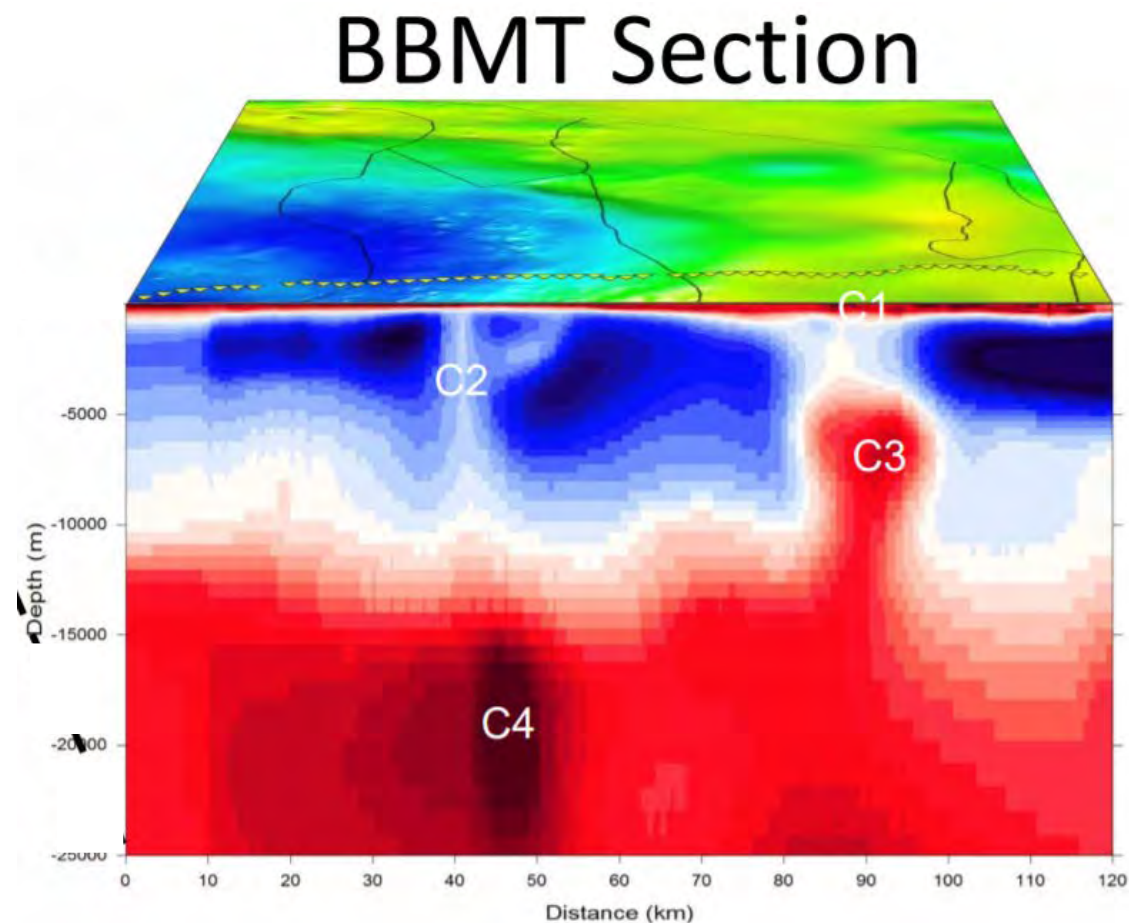


National Drilling Initiative

Mineral potential, infrastructure corridors, geoscientific gaps

Curnamona Province

- Gold, copper-gold
- Expression of MT conductivity zones?



Curnamona Broadband Model, collected by Ben Kay, UoA, 2017



National Drilling Initiative

Delamerian Orogen

- Copper, copper-gold, lead-zinc, mineral sands prospectivity
- Stratigraphic drilling – tectonic architecture, structural geology, mineral potential



Py-cpy in gt-and schist,
Kanmantoo mine



Future geoscience leaders



NEXUS
National Exploration
Undercover School



THE UNIVERSITY
of ADELAIDE



Minerals
Council of
Australia



Government of South Australia
Department for Energy and Mining



Future geoscience technologies



Contact

Anthony Reid

Senior Principal Geoscientist

Geological Survey of South Australia

Department for Energy and Mining

11 Waymouth Street
Adelaide, South Australia 5000

GPO Box 320
Adelaide, South Australia 5001

T: +61 8 8463 3000

E: demreception@sa.gov.au



@ajr_geo



Selected references

<http://www.energymining.sa.gov.au/>

<https://map.sarig.sa.gov.au/>

http://www.energymining.sa.gov.au/minerals/geoscience/geological_survey

Coompana Project:

Surface geochemistry: http://www.energymining.sa.gov.au/petroleum/data_and_publications/mesa_journal/feature_articles/featured_articles2/coompana_geochemistry

Regional drilling results; extended abstracts: <https://sarigbasis.pir.sa.gov.au/WebtopEw/ws/samref/sarig1/image/DDD/RB201800019.pdf>

Gawler Craton Airborne Survey: http://www.energymining.sa.gov.au/minerals/geoscience/pace_copper/gawler_craton_airborne_survey

AusLAMP: http://www.energymining.sa.gov.au/minerals/geoscience/geological_survey/gssa_projects/auslamp

Selected recent geoscience papers (external publications):

Heinson, G., Didana, Y., Soeffky, P., Thiel, S., Wise, T., 2018. The crustal geophysical signature of a world-class magmatic mineral system. *Scientific Reports* 8, 10608.

Mauger, A.J., Ehrig, K., Kontonikas-Charos, A., Ciobanu, C.L., Cook, N.J., Kamenetsky, V.S., 2016. Alteration at the Olympic Dam IOCG–U deposit: insights into distal to proximal feldspar and phyllosilicate chemistry from infrared reflectance spectroscopy. *Australian Journal of Earth Sciences* 63, 959-972.

Motta, J.G., Betts, P.G., de Souza Filho, C.R., Thiel, S., Curtis, S., Armit, R.J., 2019. Proxies for Basement Structure and Its Implications for Mesoproterozoic Metallogenic Provinces in the Gawler Craton. *Journal of Geophysical Research: Solid Earth* 124.

Pollett, A., Thiel, S., Bendall, B., Raimondo, T., Hand, M., 2019. Mapping the Gawler Craton–Musgrave Province interface using integrated heat flow and magnetotellurics. *Tectonophysics* 756, 43-56.

Skirrow, R.G., Wielen, S.E., Champion, D.C., Czarnota, K., Thiel, S., 2018. Lithospheric Architecture and Mantle Metasomatism Linked to Iron Oxide Cu-Au Ore Formation: Multidisciplinary Evidence from the Olympic Dam Region, South Australia. *Geochemistry, Geophysics, Geosystems* DOI: 10.1029/2018GC007561.

Curtis, S., Thiel, S., 2019. Identifying lithospheric boundaries using magnetotellurics and Nd isotope geochemistry: An example from the Gawler Craton, Australia. *Precambrian Research* 320, 403-423.

Curtis, S., Wade, C., Reid, A., 2018. Sedimentary basin formation associated with a silicic large igneous province: stratigraphy and provenance of the Mesoproterozoic Roopena Basin, Gawler Range Volcanics. *Australian Journal of Earth Sciences* 65, 447-463.

Reid, A.J., Jagodzinski, E.A., Wade, C.E., Payne, J.L., Jourdan, F., 2017a. Recognition of c. 1780 Ma magmatism and metamorphism in the buried northeastern Gawler Craton: correlations with events of the Aileron Province. *Precambrian Research* 320, 198-220.

Reid, A.J., Jourdan, F., Jagodzinski, E.A., 2017b. Mesoproterozoic fluid events affecting Archean crust in the northern Olympic Cu–Au Province, Gawler Craton: insights from $^{40}\text{Ar}/^{39}\text{Ar}$ thermochronology. *Australian Journal of Earth Sciences* 64, 103-119.

Reid, A.J., Payne, J.L., 2017. Magmatic zircon Lu–Hf isotopic record of juvenile addition and crustal reworking in the Gawler Craton, Australia. *Lithos* 292-293, 294-306.

Disclaimer

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New insights into the setting and style of base metal mineralisation in the Northern Territory

Ian Scrimgeour
Executive Director, NT Geological Survey

DEPARTMENT OF **PRIMARY INDUSTRY AND RESOURCES**

Resourcing the Territory initiative

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

Theme 1: Supporting industry innovation through grants for greenfields exploration

NT Government co-funding of greenfields exploration since 2008

48 Drilling projects completed

130 holes: >47,000 m drilled

37 Geophysics projects completed

~55,000 ground **gravity** stations

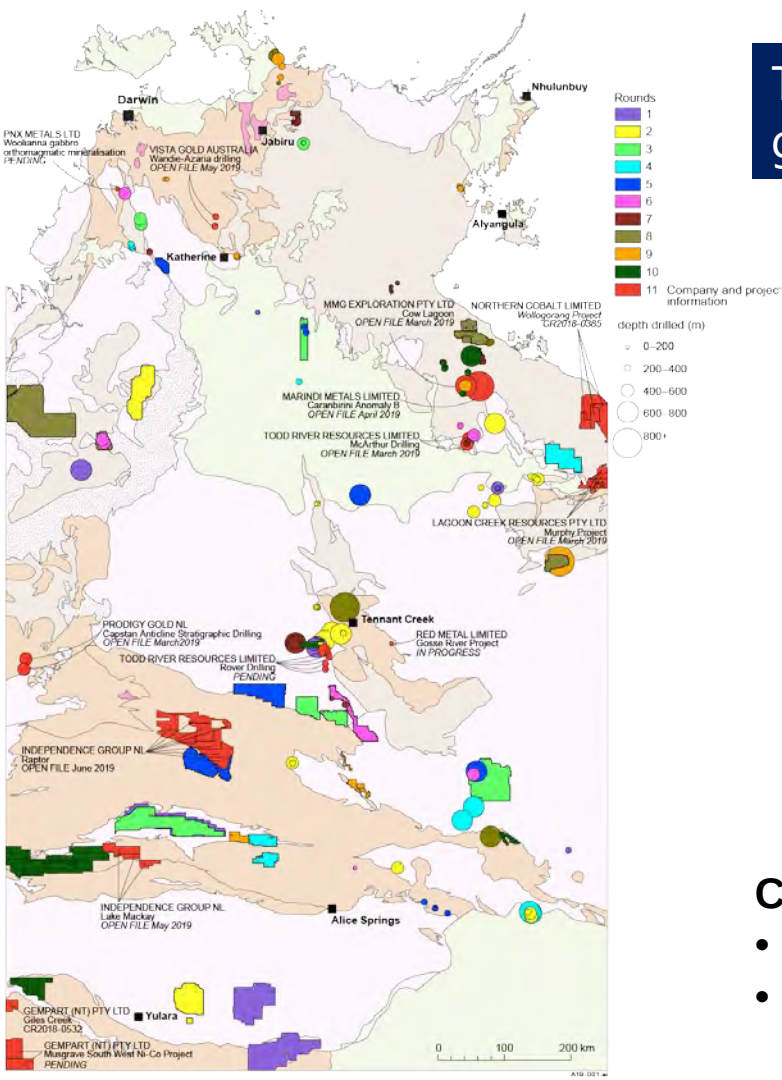
~122,000 line km of airborne **magnetic** and radiometric surveys

~30,000 line km of airborne **EM** surveys

plus **MT**, **seismic**, **SAM**, **3D IP** and **passive seismic** surveys

Changes to program under *Resourcing the Territory*

- More funding available, expanded eligibility
- Additional funding for utilising local service and supply



Theme 2: Upgrading the Territory's coverage of geophysical data

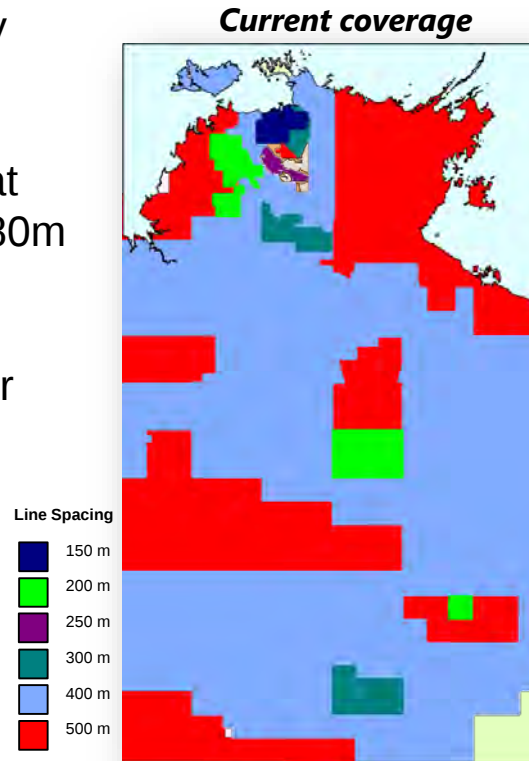
Upgrading areas of old and/or poor quality geophysical coverage

~36% of the NT not covered by mag-rad at minimum standard (400m line spacing & 80m flight height with differential GPS)

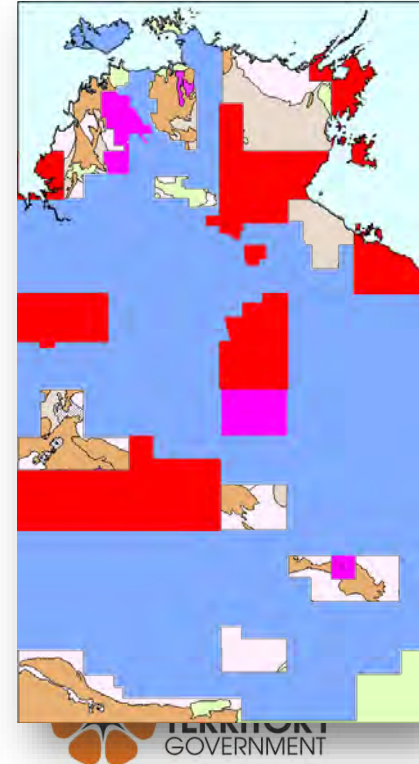
200m line-spaced magnetic coverage over basement provinces

2 km infill of gravity in key areas

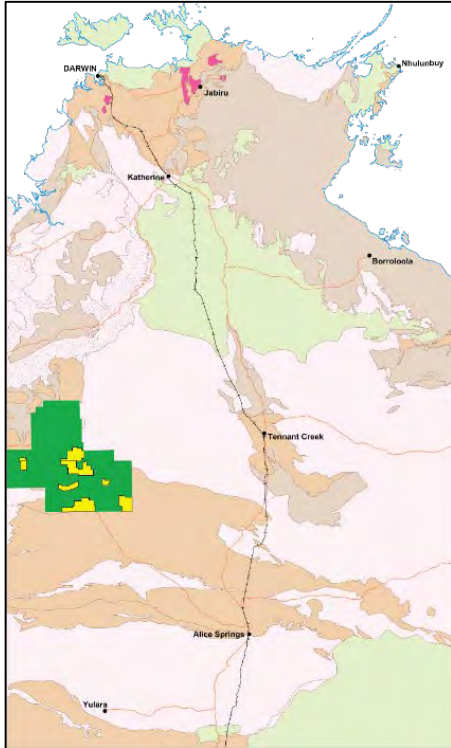
Industry infill encouraged



Acquired using GPS navigation



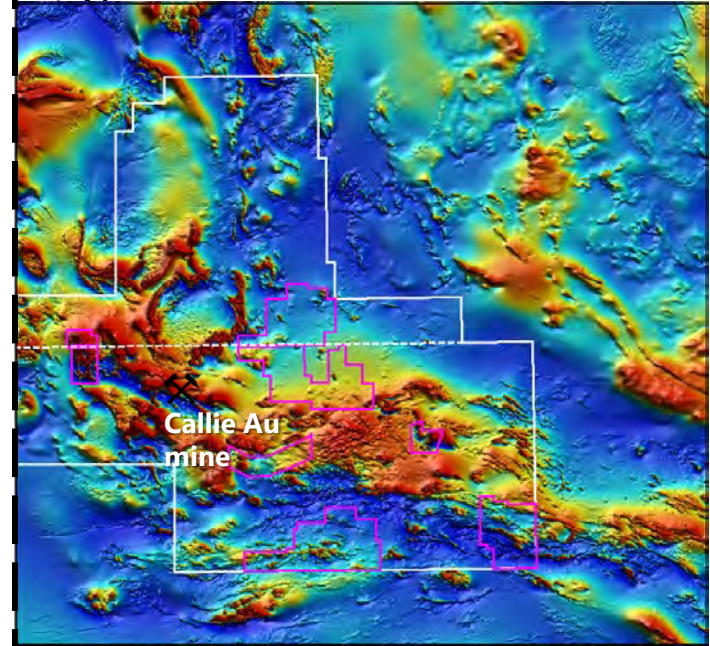
2018 Tanami Region Magnetic and Radiometric Survey



www.nt.gov.au

- Seamless coverage of highly prospective, non-outcropping gold province
- ~ 240,000 line km @ 200 m line spacing
- >30,000 line km of industry infill to 100 m line spacing
- Total area >42 000km²
- Funded by NTGS with infill funded by industry
- Release imminent

NTGS Tanami Survey (industry infill in

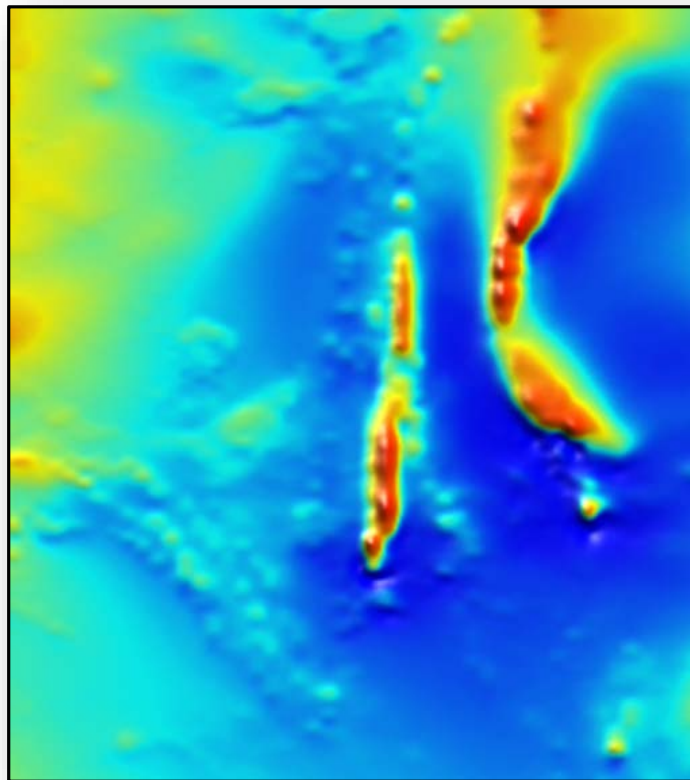


WA

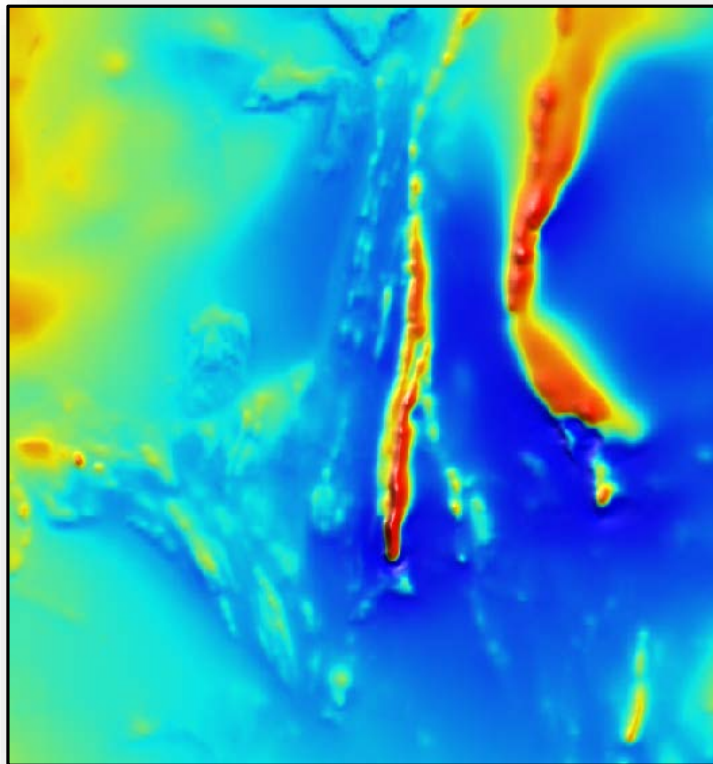
100 km



Existing coverage : 500m spacing

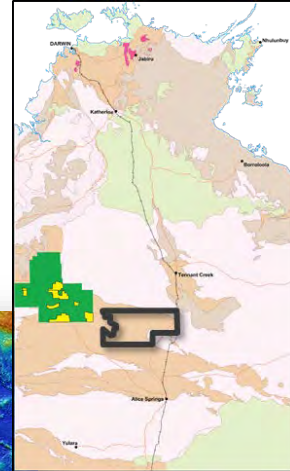
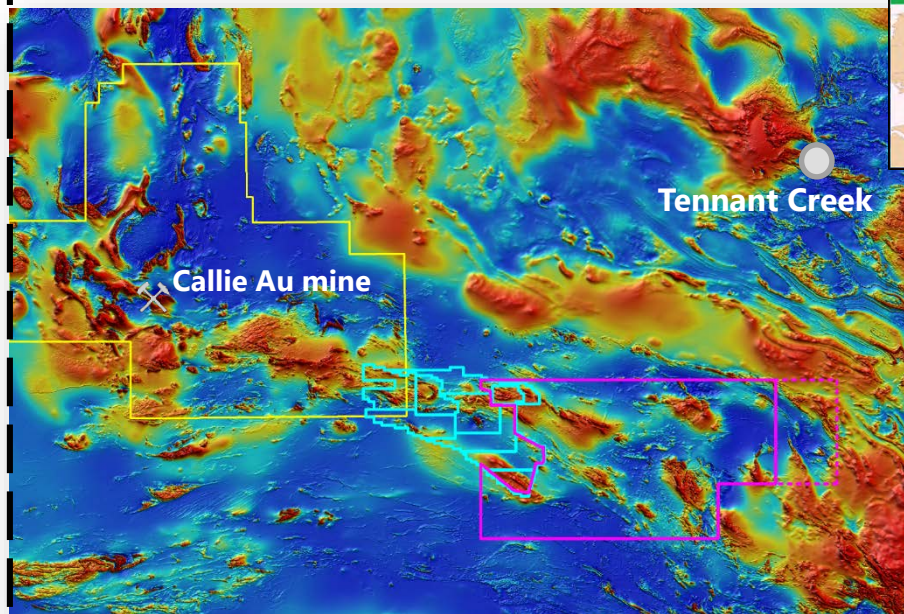


NTGS Tanami Region E-W Preliminary TMI – 200m spacing



2019 Mount Peake-Crawford Magnetic-Radiometric Survey

- Northern Aileron province (potential for Au, Cu, Ni, V, Li, Zn)
- 115,000 line km @ 200 m line spacing – industry infill sought to 100m
- Total area 18 000 km²
- Extending the Tanami Survey through linking 2019 IGO co-funded survey
- Expected commencement May/June 2019



*Tanami Survey
(yellow outline)*

*GDC Rnd 11
survey
(blue outline)*

*Mount Peake-
Crawford Survey
(pink outline)*

Theme 3: Unlocking the resource potential of the Barkly and Gulf regions.



*South Nicholson seismic survey
(courtesy of GA)*

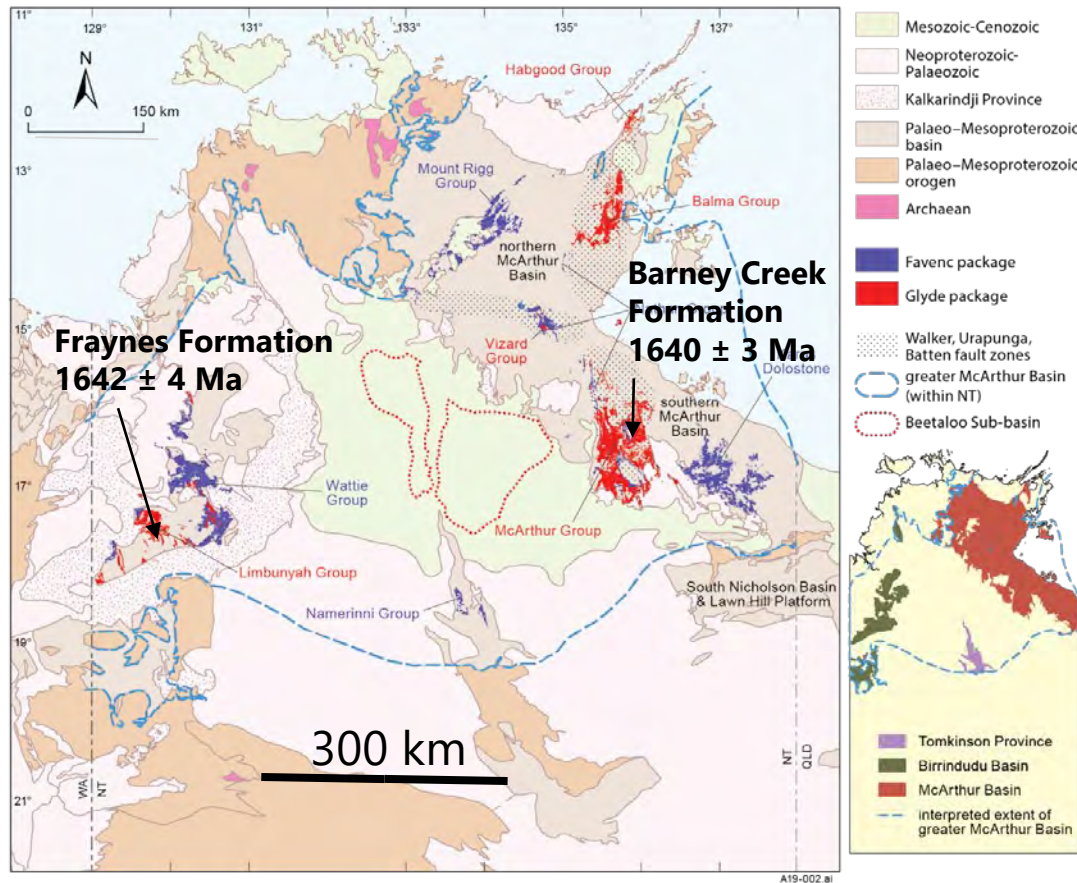
Building on work in greater McArthur Basin

New focus on South Nicholson Basin and
Lawn Hill Platform

Programs to highlight resource potential in
Tennant Creek area

Major collaborations:

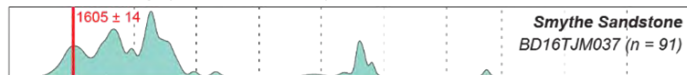
- Geoscience Australia/GSQ under *Exploring for the Future*
- CSIRO including embedded researchers
- ARC linkage with Adelaide Uni & industry



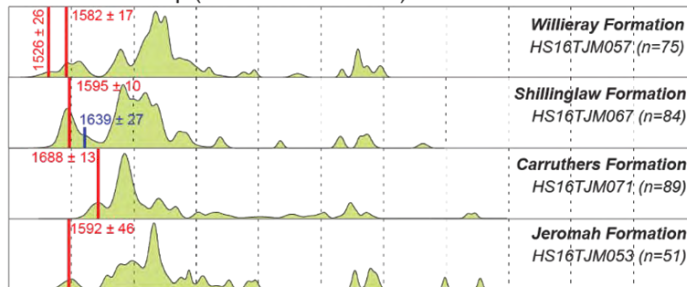
‘greater McArthur Basin’

Continuous distribution of prospective stratigraphy established over vast area of northern Australia

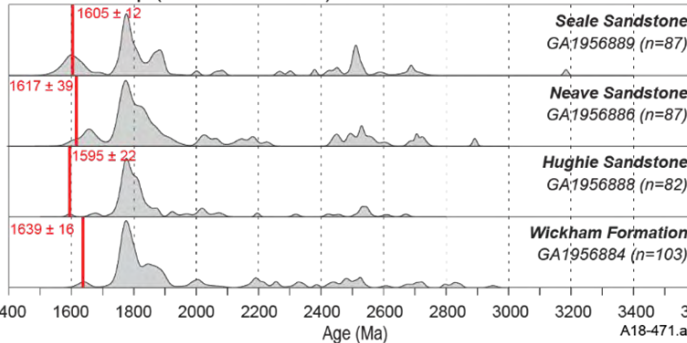
Nathan Group (McArthur Basin)



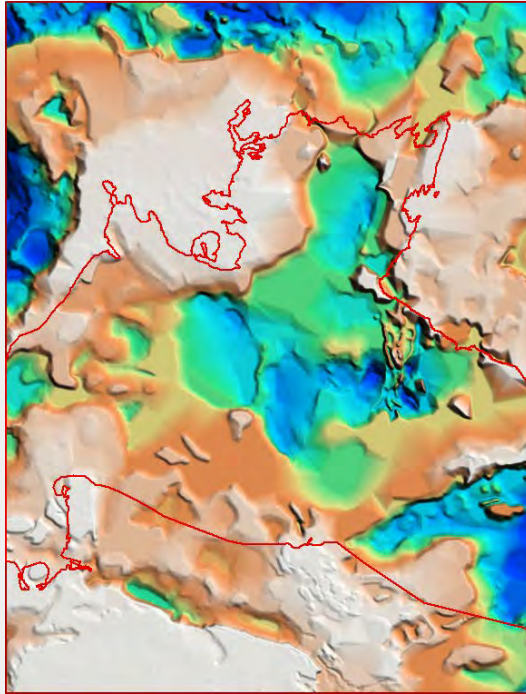
Namerinni Group (Tomkinson Province)



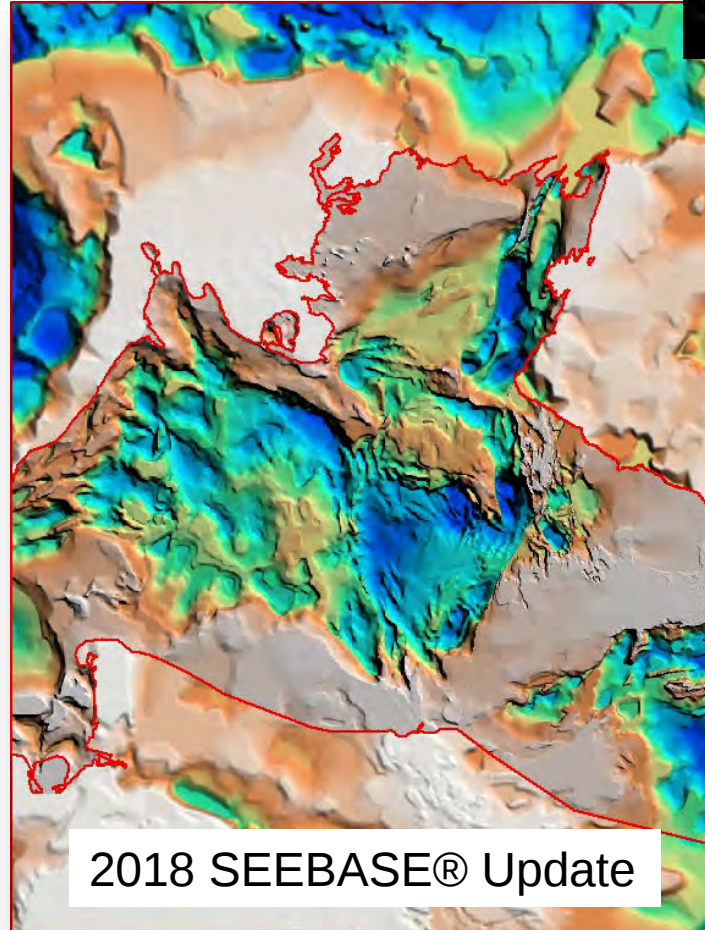
Wattie Group (Birrindudu Basin)



SEEBASE® Update: greater McArthur Basin



2006 OZ SEEBASE



2018 SEEBASE® Update

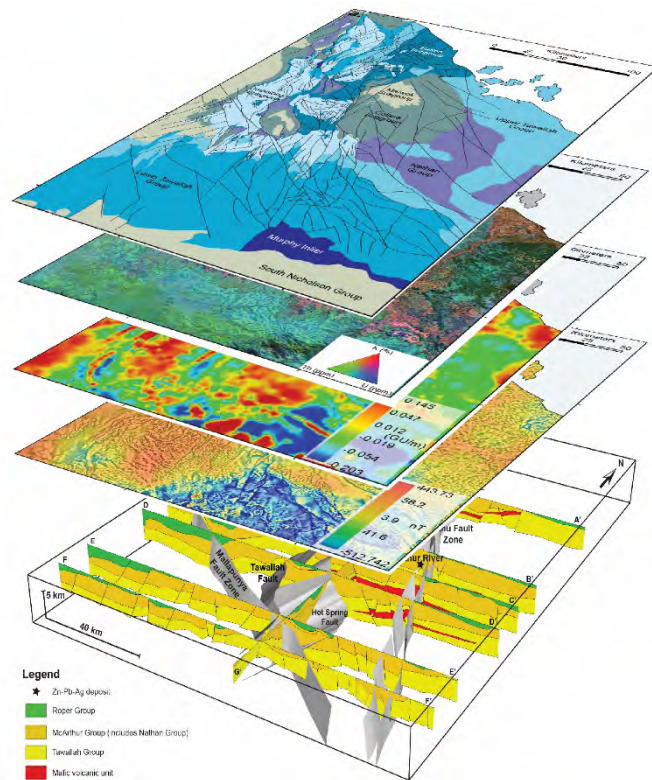
Depth to
basement

Frogtech
Geoscience
(2018)

Extending east
into
Queensland

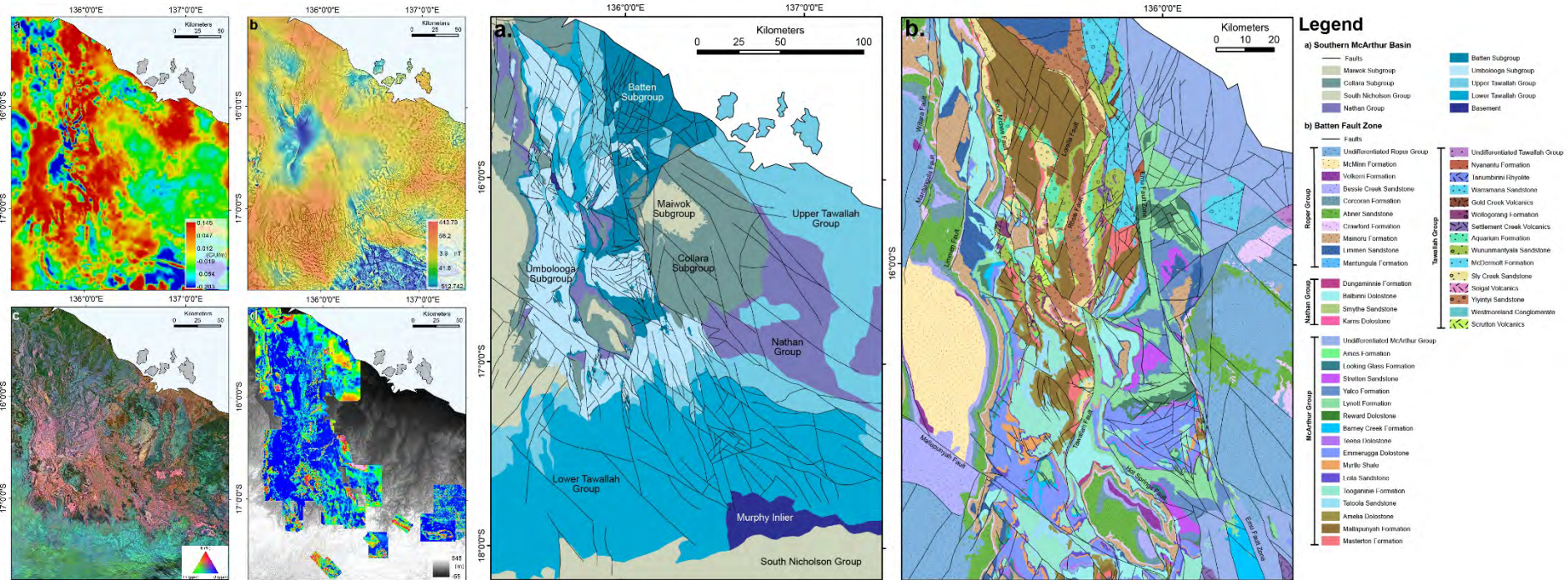
CSIRO-NTGS study on McArthur Basin

- Gravity acquisition by NTGS, reprocessing and stitching of multiple industry AEM surveys
- Solid geology and structural interpretation of geophysical data
- 2D forward modelling of high-resolution gravity profiles
- Carbon isotope and sequence stratigraphic assessment of McArthur Group
- Deformation-fluid-flow modelling
- Integration of results with geodynamic framework of northern Australian basin systems



Embedded CSIRO researchers: Teagan Blaikie, Marcus Kunzmann

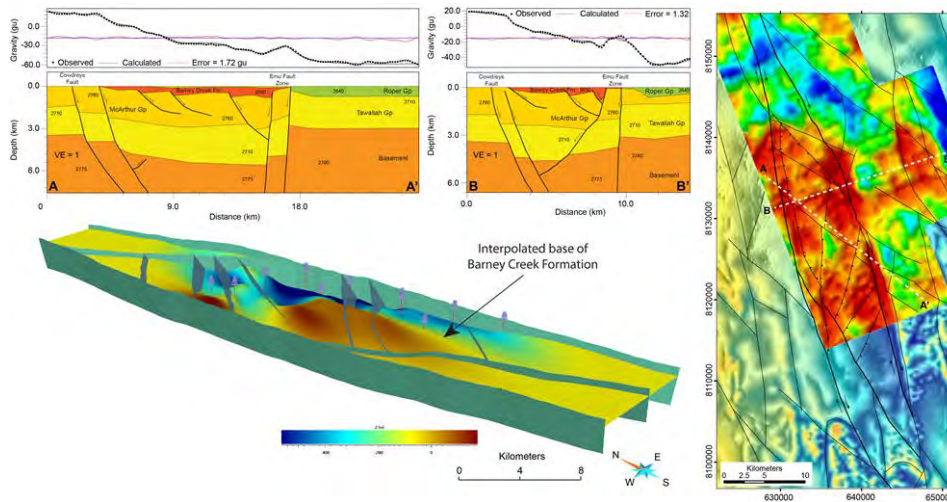
Solid geological interpretations



Two styles of sub-basin

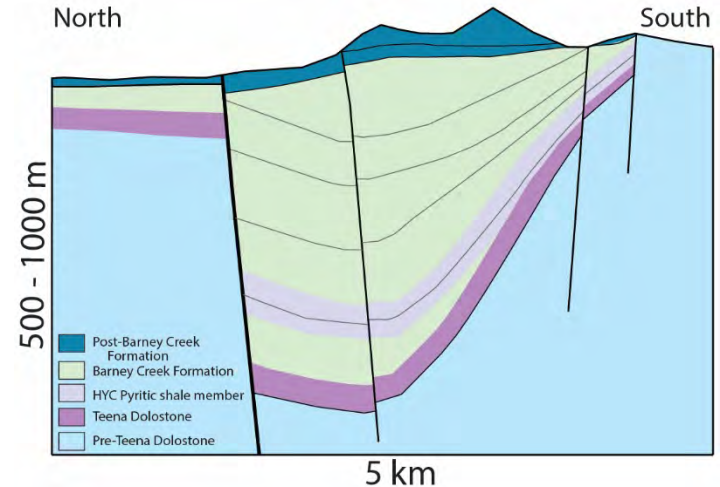
Type 1

Bound by NNW-trending faults along strike of the Emu Fault Zone , eg Glyde, Caranbirini



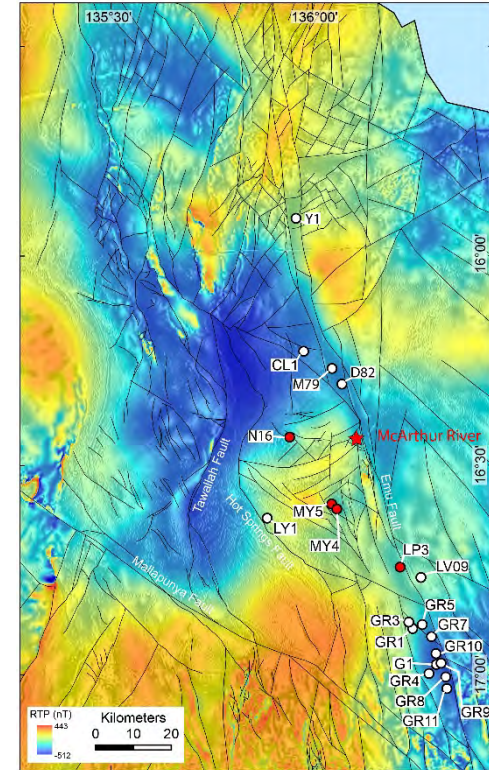
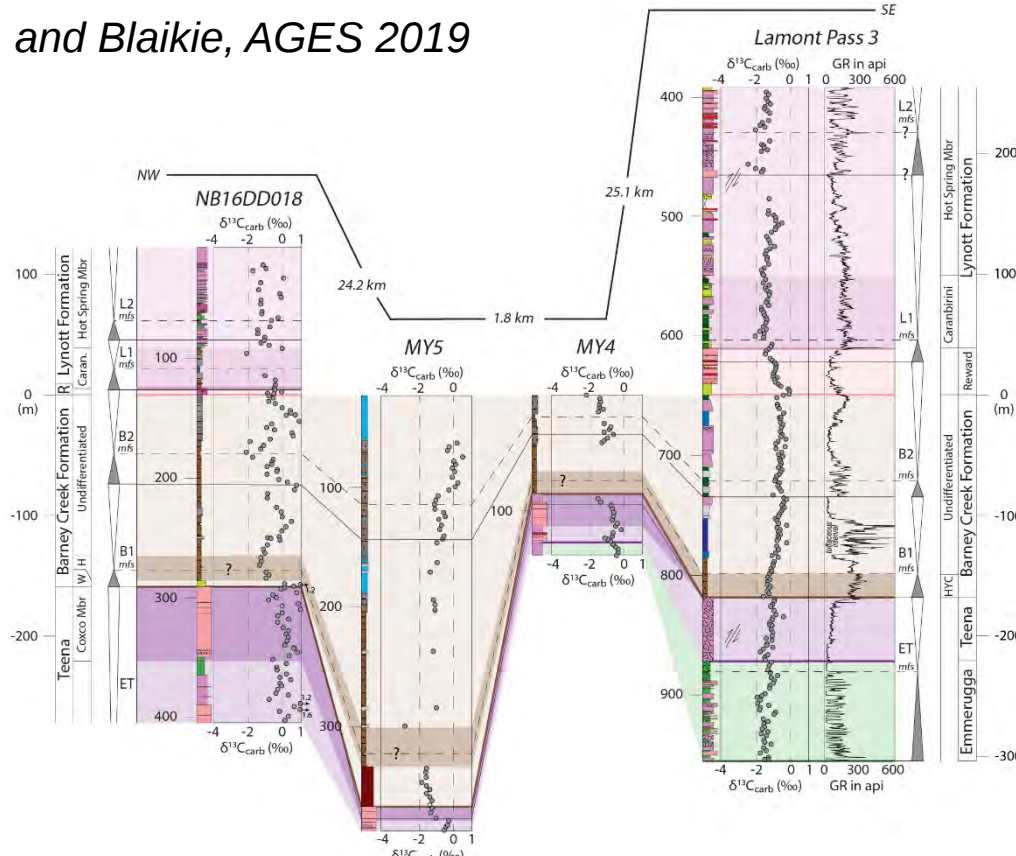
Type 2

Bound by EW-trending normal fault Eg Myrtle, Teena

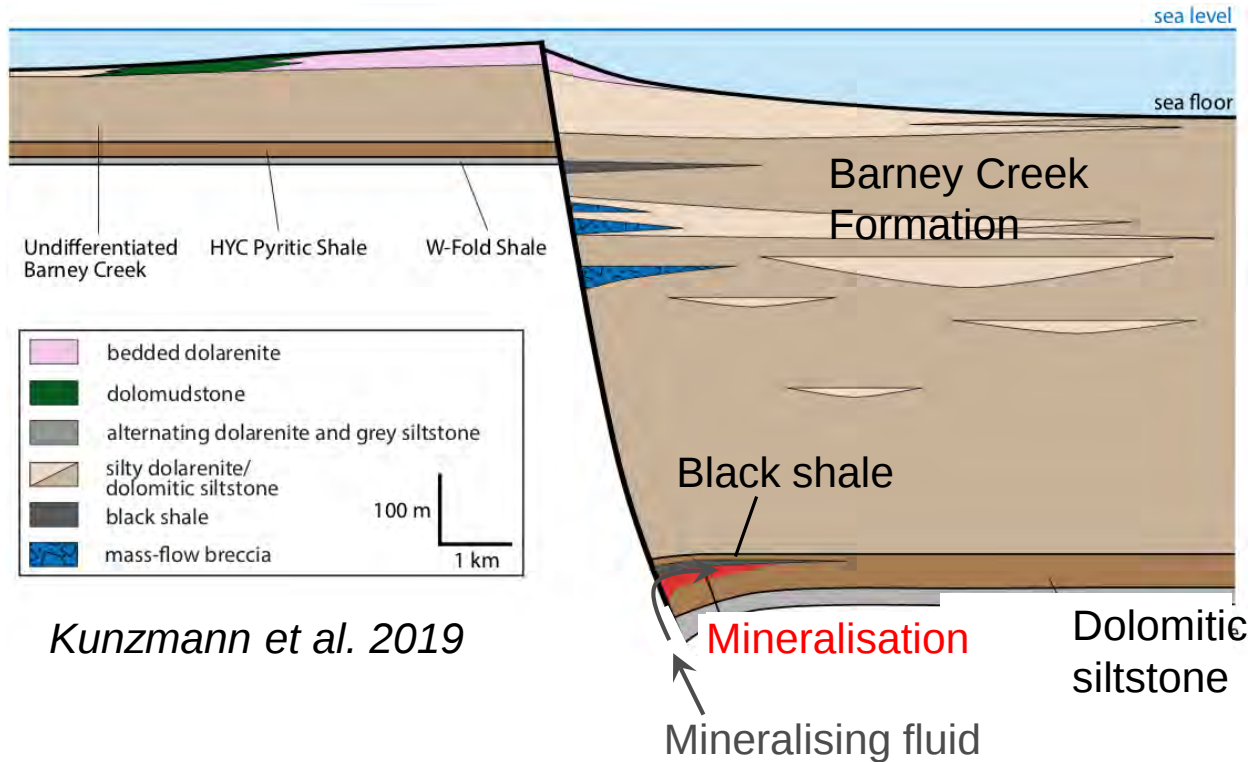


Consistent logging, sequence strat, facies analysis and carbon isotopes

Kunzmann and Blaikie, AGES 2019

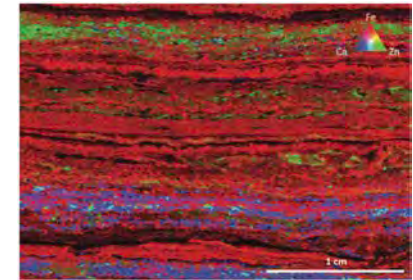


Diagenetic mineralisation model



Kunzmann et al. 2019

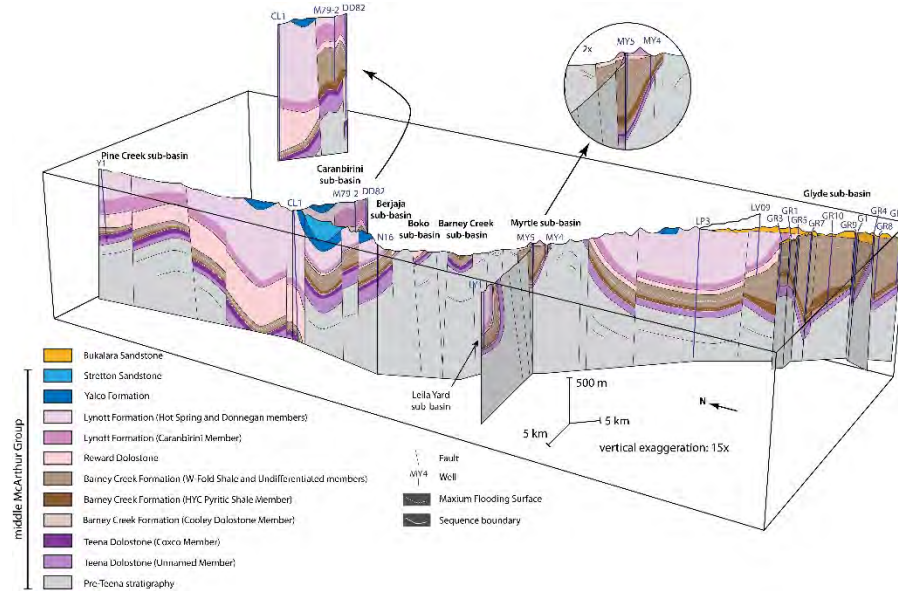
Diagenetic scenario:
black shale = seal,
diverting fluids into
BCF



Spinks et al. 2019

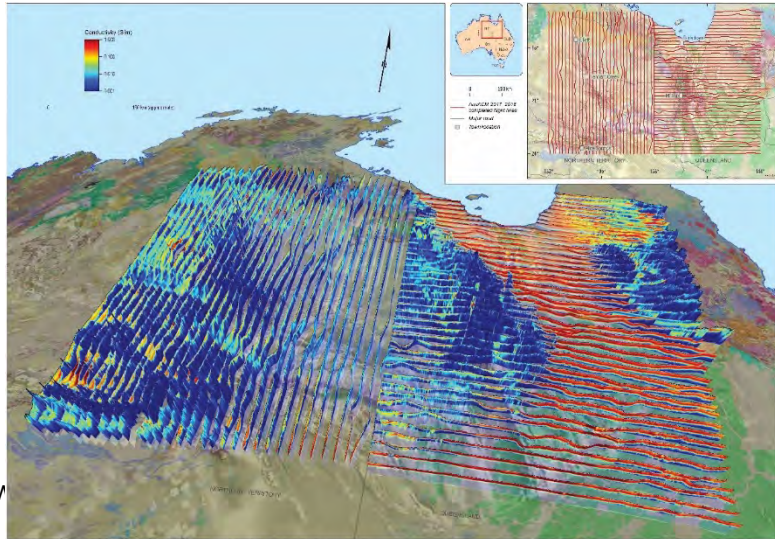
Selected findings from CSIRO-NTGS McArthur Basin study

- Key growth faults controlling mineralisation are often almost blind at surface
- Anomalously thick sequences of mafic volcanics in the Tawallah Group have spatial association to known mineralisation
- Short-lived compressional event at end of deposition of Barney Creek Formation may be tectonic driver for fluid flow and diagenetic mineralisation
- C isotope stratigraphy is a powerful tool for regional correlation, combined with sequence stratigraphy to recognise maximum flooding surfaces

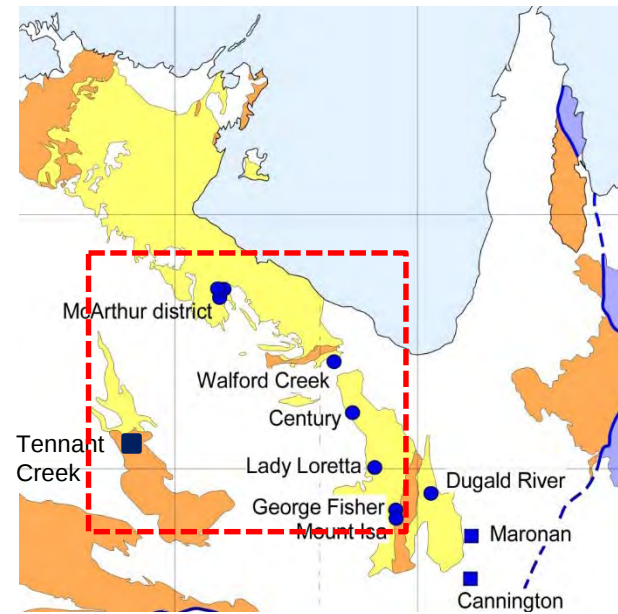


GA Exploring for the Future in TISA area (NTGS co-investing and collaborating)

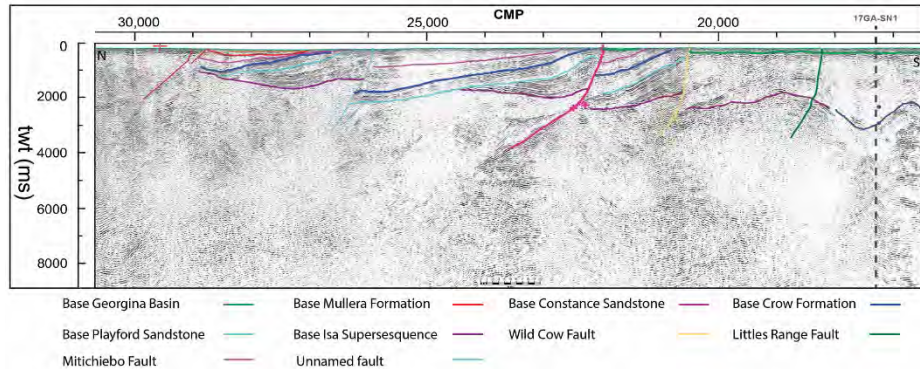
- Unprecedented level of new geoscience data at outcrop to lithospheric scale
- NTGS mapping South Nicholson and Lawn Hill in NT
- Potential for new undercover mineral province east of Tennant Creek



*Ley Cooper et al
AGES 2019*



South Nicholson seismic *Carr et al AGES 2019*



Theme 4: Stimulating greenfields exploration in central Australia

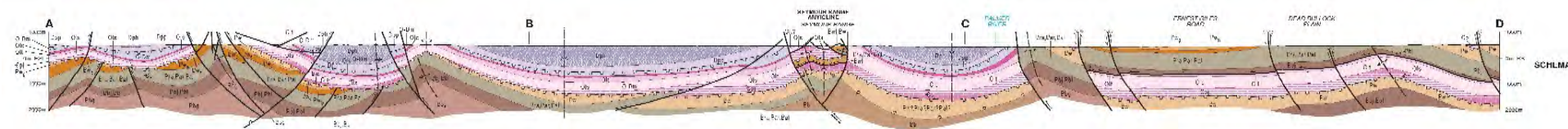
NTGS RECORD 2019-001

Using tourmaline to identify base metal and tungsten mineralising processes in the Jervois mineral field and Bonya Hills, Aileron Province



MV McGloin, A Weisheit, RB Trumbull and R Maas

- Focus on Amadeus Basin and Aileron Province (Arunta)
- Fundamental mapping, stratigraphic characterisation and geological framework
- Mineral systems of Aileron Province
- Neoproterozoic stratigraphy and 3D architecture of Amadeus Basin (*Edgoose et al, AGES 2019*)



NTGS studies of Aileron Province base metal deposits

- Emerging greenfields base metals province
- Syngenetic deposits (1825-1780 Ma) – typically associated with mafic/bimodal magmatism and exhalites in clastic sediments
- Recent discoveries (Grapple; EM1) are transgressive massive sulphide breccias that appear epigenetic (or remobilised syngenetic)
- Sulfur isotopes consistently show magmatic S source for both syngenetic and epigenetic deposits

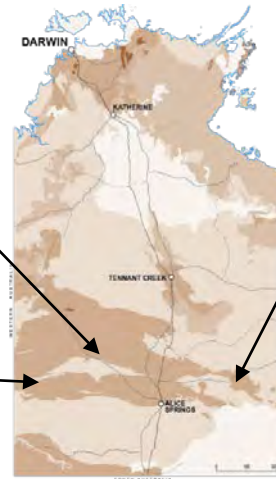
Todd River Resources - *EM1 (Mt Hardy)*

35.5m at 14.7% Zn, 2.92% Pb, 0.91% Cu and 59 g/t Ag,
incl. **11.3m at 22.9% Zn, 3.35% Pb, 1.0% Cu and 58g/t Ag**

Independence Group – *Grapple*

9 m @ 1.8 g/t Au, 3.26% Cu, 49.1g/t Ag, 3.63% Zn, 1.09%
Pb and 0.26% Co

www.nt.gov.au



KGL Resources – *Jervois*

25.8 Mt @ 1.49% Cu,
27.1 g/t Ag

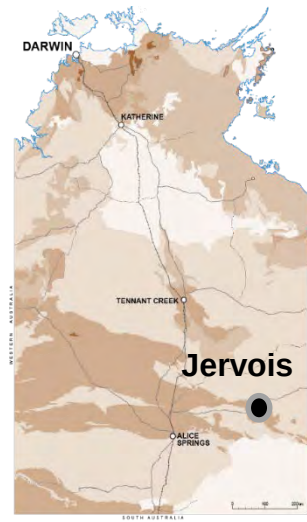


Jervois Cu-Ag-(Pb-Zn-Au) mineral system (KGL Resources)

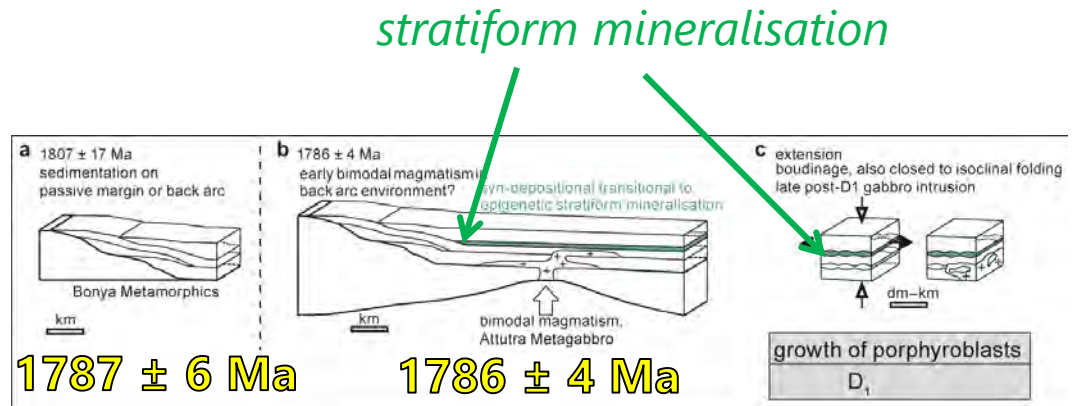
Regional 1:100k mapping and mineral system study

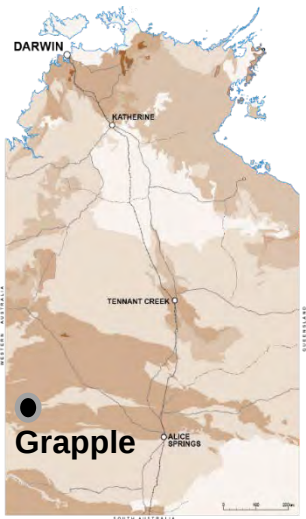
25.8 Mt @ 1.49% Cu, 27.1 g/t Ag (including Pb-Zn resource)

- Now interpreted to have strong affinities with Broken Hill-style deposits
- Associated with metaexhalites (eg garnetites, magnetite-rich layers, tourmalinites, apatite-rich layers) and bimodal magmatism
- Primary sediment-hosted mineralisation at **1.79 Ga**, overprinted by epigenetic magnetite hosted copper-silver at **1.76-1.75 Ga**



McGloin et al 2019, NTGS Record and in prep





Timing of sulfide mineralisation at Grapple

(Independence Group-Prodigy Gold)

- Host Lander Rock Formation was deposited after ca 1.84 but prior to ca 1.81 Ga.
- Sulfides in the breccia have Pb isotope model age of ca 1.84–1.83 Ga
- The mineralised breccia postdated regional deformation dated at ca 1.67 Ga
- Extensive magmatism and associated fluid influx at ca 1.64 Ga.

1.67-1.64 Ma mineralising event?

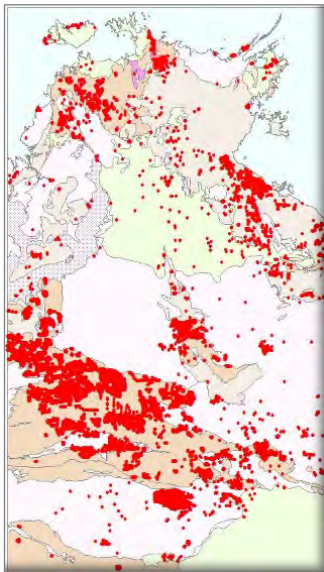
Reno et al, AGES 2019

Theme 6: Making exploration and geoscience data more accessible

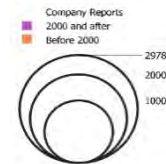
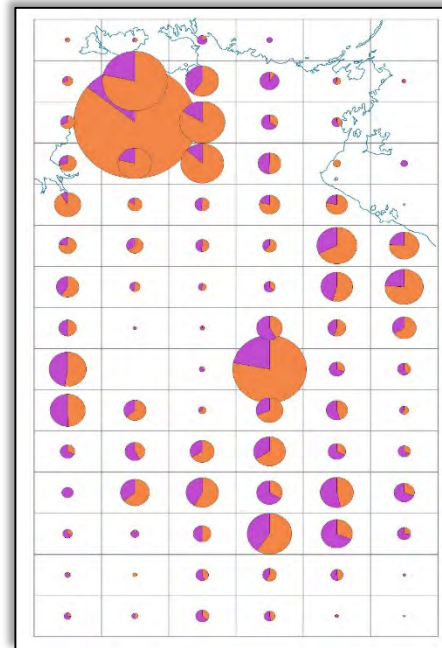
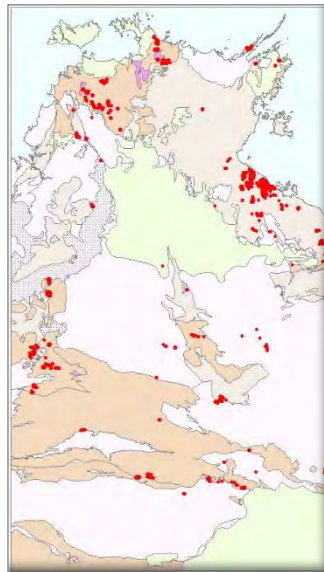
- Major campaign to upgrade NT-wide drilling and geochemistry datasets
- Ongoing input of incoming data, plus major legacy data capture
- Commenced in Batten Fault Zone, moving to Tennant Creek, then remainder of Barkly

DRILL HOLES

>152,000 total



>15,000 new



- NTGS has a diverse range of projects and collaborations in process
- Strong commitment to collaborating with industry
- Focus remains on ensuring industry has access to the best available datasets



Annual Geoscience Exploration Seminar (AGES)

AGES 2020
Alice Springs
March 24-25, 2020

www.ages.nt.gov.au

Thank you