



DELIVERING
RESULTS

Department for Manufacturing,
Innovation, Trade, Resources and Energy

WHAT ROLE FOR GOVERNMENT IN PRE-COMPETITIVE R&D

Ted Tyne

Executive Director, Mineral Resources

Workshop on Exploration Undercover
ASEG-PESA 2013 Melbourne



**Government
of South Australia**

Department for Manufacturing,
Innovation, Trade,
Resources and Energy



www.dmitre.sa.gov.au

What role for government in pre-competitive R&D



- **Adding value to our wealth of pre-competitive datasets through targeted R&D and research partnerships that will attract explorers to invest in exploration**
- **Targeted pre-competitive R&D and research partnerships on exploration undercover, deep exploration and copper and uranium mineral systems that will highlight discovery opportunities**



Geological Surveys and Pre-Competitive Data

Australia's Geological Surveys have an enviable record of outstanding science delivery and pro-active geological programs covering almost 150 years of Australia's history

*In the past two decades there has been a significant re-focussing of Geological Survey programs from regional mapping coverages and collection of mineral deposit information towards programs that will support exploration success – **High Fraser Institute rankings for “Geological Databases” for Australia***

The term “pre-competitive data” highlights the importance of the public good value of this information – referred to as non-exclusive, non-rival public good data by government funding authorities

Dan Wood – Keynote Address ASEG-PESA 2013

Discovering deeper porphyry ore bodies – is there a role for geophysics?

on discovery ...

the Cadia Orebody was discovered through analysis of the comprehensive Mineral Deposits information sheets published by the Geological Survey of NSW

on deep exploration technologies ...

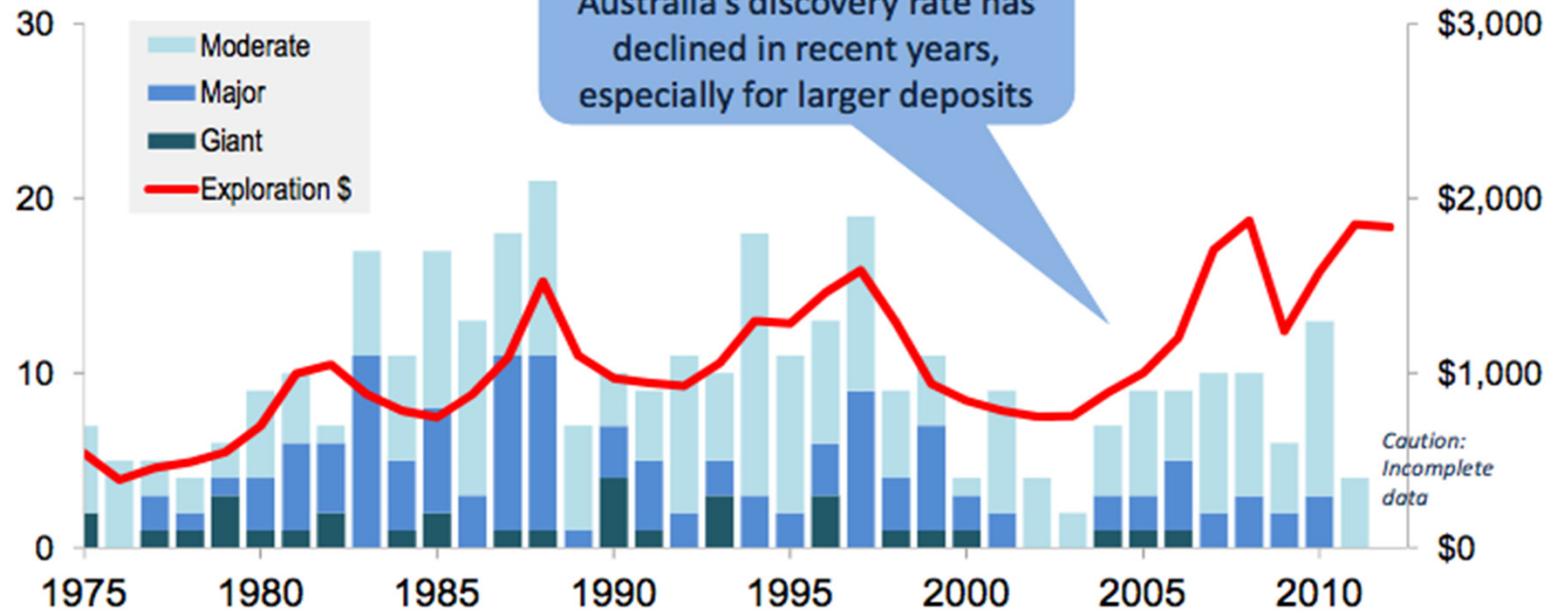
Greater effort is required in integrating geology-geochemistry-geophysics and geophysics is best used as an ore-system vectoring tool



Discoveries & Expenditures : Australia

Number of Discoveries

Exploration Expenditures (June 2012 A\$m)



Discoveries and expenditures exclude Bulk Minerals (such as coal, iron ore and bauxite)

"Moderate" >100Koz Au, >10Kt Ni, >100Kt Cu equiv, >5 kt U₃O₈
 "Major" >1moz Au, >100Kt Ni, >1mt Cu equiv, >25 kt U₃O₈
 "Giant" >6moz Au, >1 mt Ni, >5mt Cu equiv, >125 kt U₃O₈

Sources: ABS and MinEx Consulting © August 2012

MinEx Consulting

Strategic advice on mineral economics & exploration

17

after Richard Schodde, MinEx Consulting 2012



Government Geoscience – the public policy debate ...

In the last 10+ years Australian, Canadian and other western governments have continued to question the value of Geological Surveys to the resources sector and the community

AND ...

governments have continued to question who should pay for this information ... or rather ...

why shouldn't industry pay for all of this free data ???



March 2010

Government geoscience to support mineral exploration: *public policy rationale and impact*

PREPARED FOR

**Prospectors and Developers
Association of Canada**

BY

J.M. Duke, PH.D

PDAC



The geoscience knowledge provided by federal, provincial and territorial governments as a public good is widely acknowledged to be one of Canada's competitive advantages in attracting mineral exploration and to have contributed to this country's standing as a leading mineral producer.

As governments move into deficit in the wake of the recent recession, survey budgets will likely come under renewed pressure.

This paper reviews the public policy rationale for government geoscience and its impact on mineral exploration, and concludes that **a more robust public effort will be needed as part of a strategy to deal with decreasing rates and increasing costs of mineral discovery.**

Geoscience Australia and the State/NT Geological Surveys contend that ...



Greenfields exploration is a high cost, high risk activity with a low probability of a commercial discovery.

The provision of pre-competitive geoscience assists companies make informed decisions on selecting licences in greenfield areas and reducing the cost and risk of exploration.

However, Australia's Geological Surveys need to do more than deliver a stream of world class pre-competitive data ... focus on underwriting exploration success and that means discovery under cover ...



GOVERNMENT

PRIVATE SECTOR

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Land Access

Availability of Finance

Human & Intellectual Capital
Education and training
R&D – new exploration & processing technologies

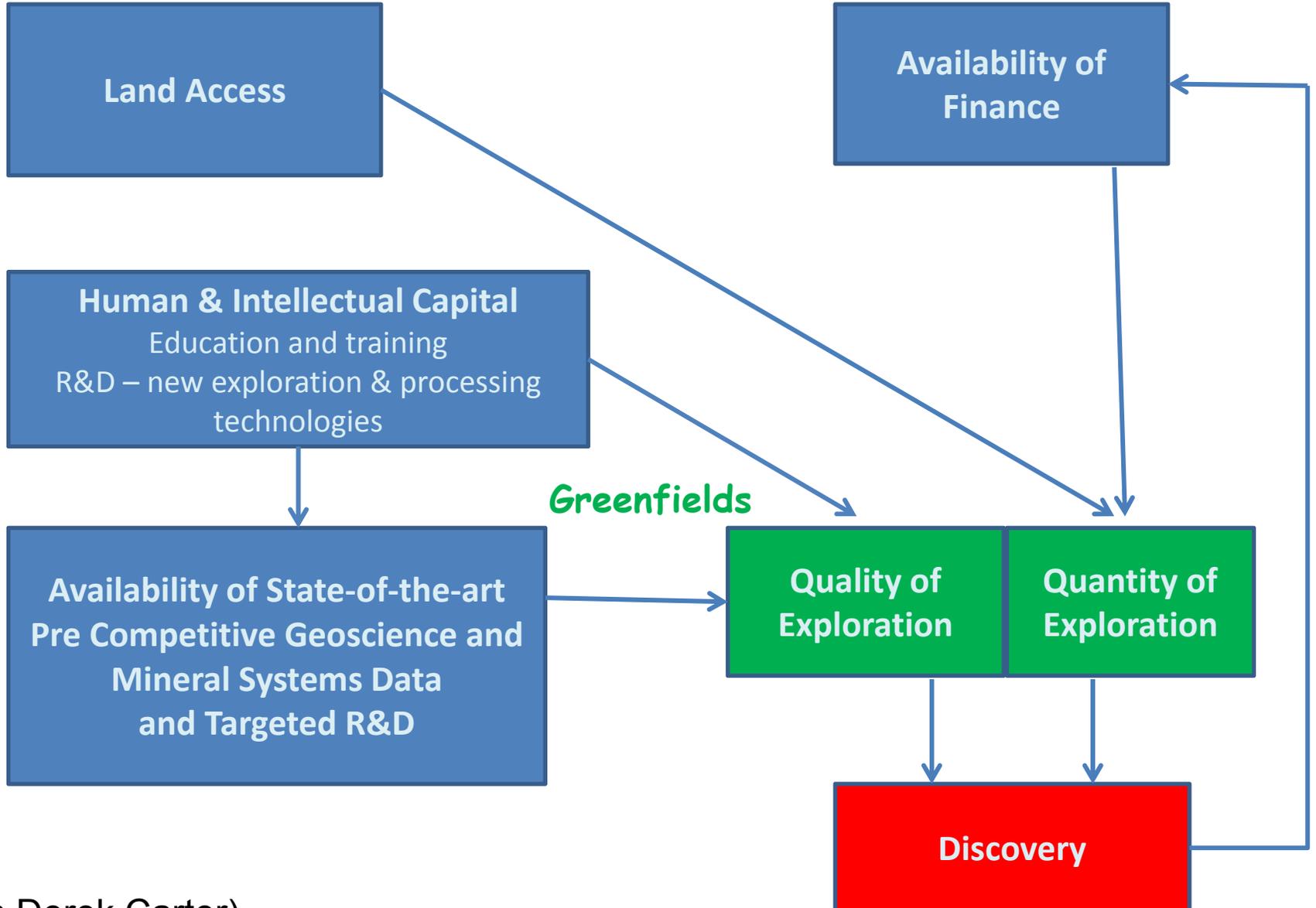
Availability of State-of-the-art
Pre Competitive Geoscience and
Mineral Systems Data
and Targeted R&D

Greenfields

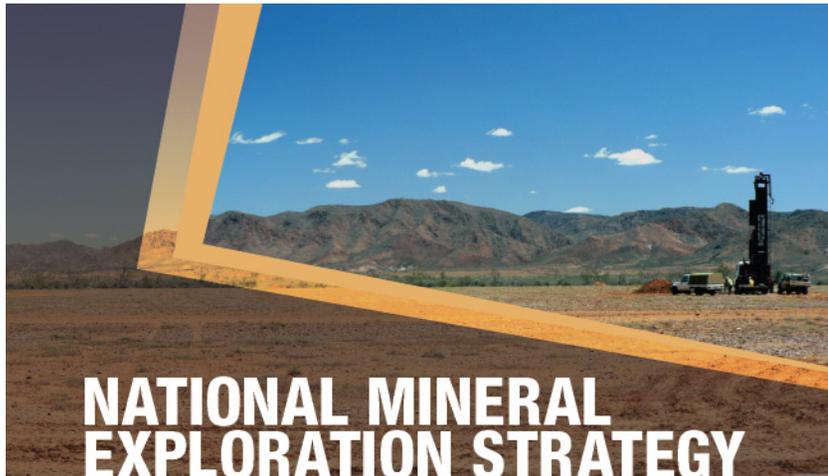
Quality of Exploration Quantity of Exploration

Discovery

(From Derek Carter)



Geoscience Australia and the state/NT Geological Surveys strategy focused on greenfields discovery



VISION:

Unlocking Australia's hidden resource potential.

MISSION:

To address greenfield exploration challenges, stimulate new discoveries, ensure continuity of the pipeline of mineral resource investments, and the longevity of Australia's mineral resources industry.

SCOPE OF THE STRATEGY

This National Mineral Exploration Strategy focuses on the acquisition and delivery of pre-competitive geoscience, applied geoscience research initiatives to assist exploring undercover and a mineral exploration investment attraction plan. Supporting activities associated with the strategy aimed at cross-jurisdictional collaboration on regulatory reform are also underway. The strategy will not address the financial challenges facing the minerals sector.

THE THREE ELEMENTS OF THE NATIONAL MINERAL EXPLORATION STRATEGY ARE:



Delivery of State-of-the-art Pre Competitive Geoscience and Mineral Systems Data and Targeted R&D

focus on underexplored and undercover regions

** Please see National Mineral Exploration Strategy, produced by Exploration Investment and Geoscience Working Group (EIGWG) of the Standing Council on Energy and Resources (SCER) as well as Australian Academy of Science UNCOVER documents for further context*



What role for government in Pre-Competitive R&D



South Australia's perspective ...



EXPLORATION OPPORTUNITIES AND GEOLOGY OF SA



Pathways to Discovery

- New statewide and regional datasets
- New geophysics and spectral data
- Multi-element reanalysis of historic calcrite samples

Pathways to Prospectivity

- Multidisciplinary mineral systems analysis
- Multidisciplinary approach with mineral systems focus

Discovery to Development

- Six-month target approvals for mining lease assessment
- Online tenement applications, tracking, management and reporting

Next Generation Policy

- World's best practice in resources industry regulation and management
- Next generation suite of industry policies and guidelines

Innovation through Integration

- Unique and innovative products and data delivered through SARIG 2020
- 3D modelling of mineral systems and prospective terranes

PACE exploration

PACE mining

Water for Mining

- Partnerships with key agencies and industry to address water issues
- Mapping the state's groundwater systems

PACE Partnerships

- PACE Targeting – geophysical surveying
- PACE Discovery Drilling – exploration drilling
- PACE Geochronology – mineral systems dating

**PACE
2020**

Communities

- Community engagement strategy and toolkits for industry
- Continuing support for regional and remote communities

SA Geothermal

- Partnership with South Australian Centre for Geothermal Energy Research
- Precompetitive data, state prospectivity model and reservoir modelling
- Research into enhanced (engineered) geothermal systems (EGS) and hot sedimentary aquifer (HSA) systems

PACE energy

PACE global

Data Pathways

- Launch and expansion of SARIG 2020
- National Virtual Core Library online
- Digitising of historic company reporting

Unconventional Gas Resources

- Investigation of South Australia's unconventional gas potential
- Research into factors affecting productivity in unconventional reservoirs

CO2CRC

- Support for the Cooperative Research Centre for Greenhouse Gas Technologies (CO2CRC), Australian School of Petroleum, University of Adelaide
- Research into carbon capture and storage methods and technologies

South Australian Resources Analysis

- Triple bottom line Minerals ScoreCard
- South Australian minerals industry annual review

Building Awareness

- Linking investors with explorers
- Fostering greater awareness of the resources sector
- South Australian Minerals and Petroleum Expert Group (SAMPEG) ambassadors



Example 1 – What role for SA in Pre-Competitive R&D

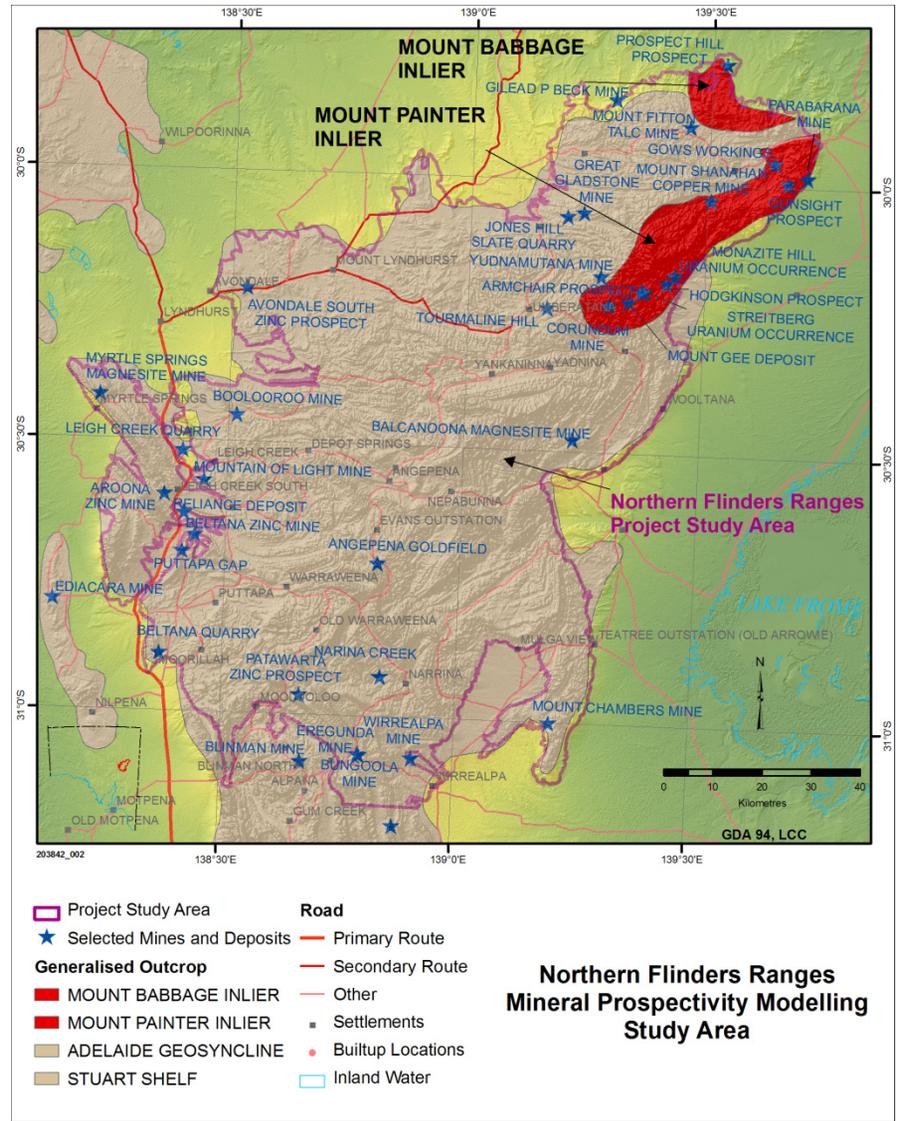
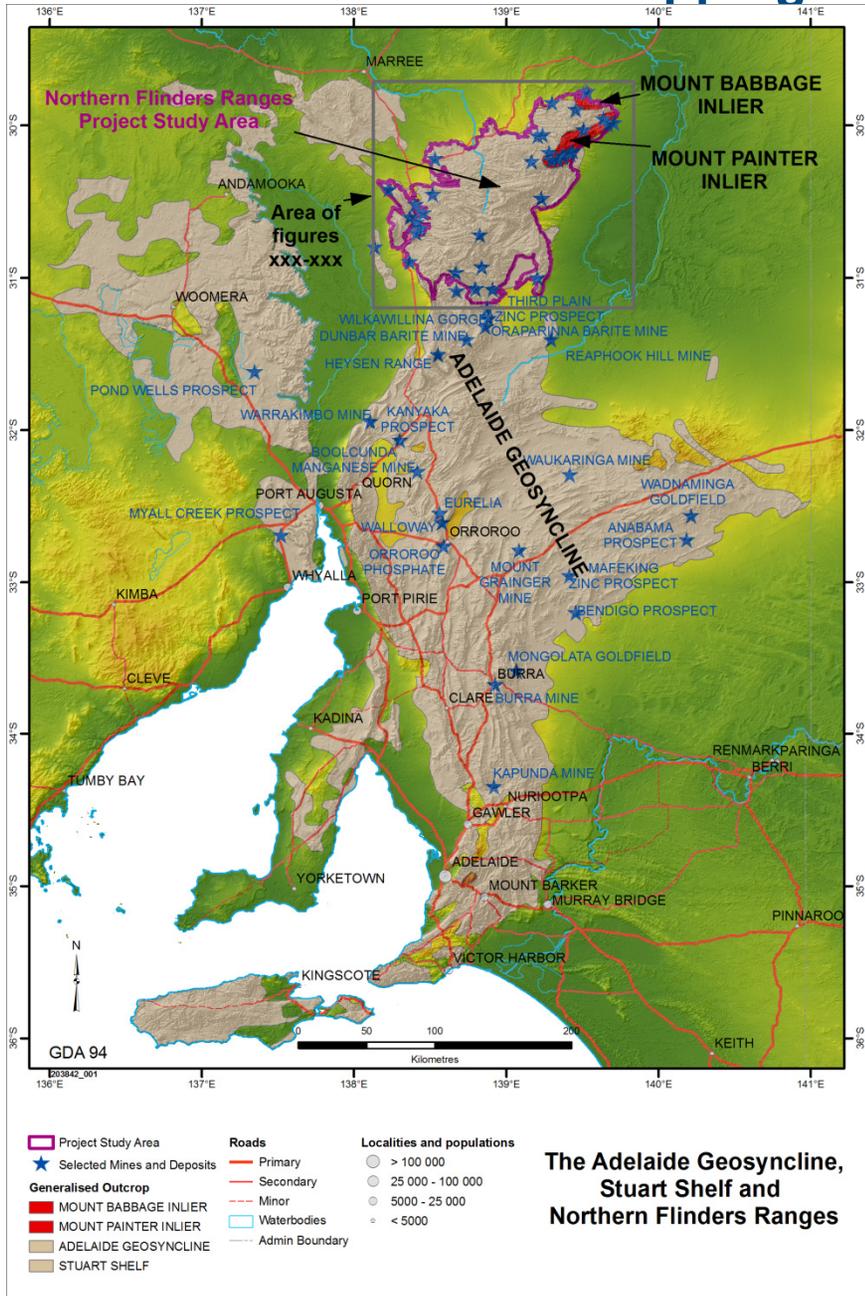
Land Access + Exploration Targeting Challenges

Assessment of Mineral Prospectivity of the Northern Flinders Ranges Using GIS Analysis

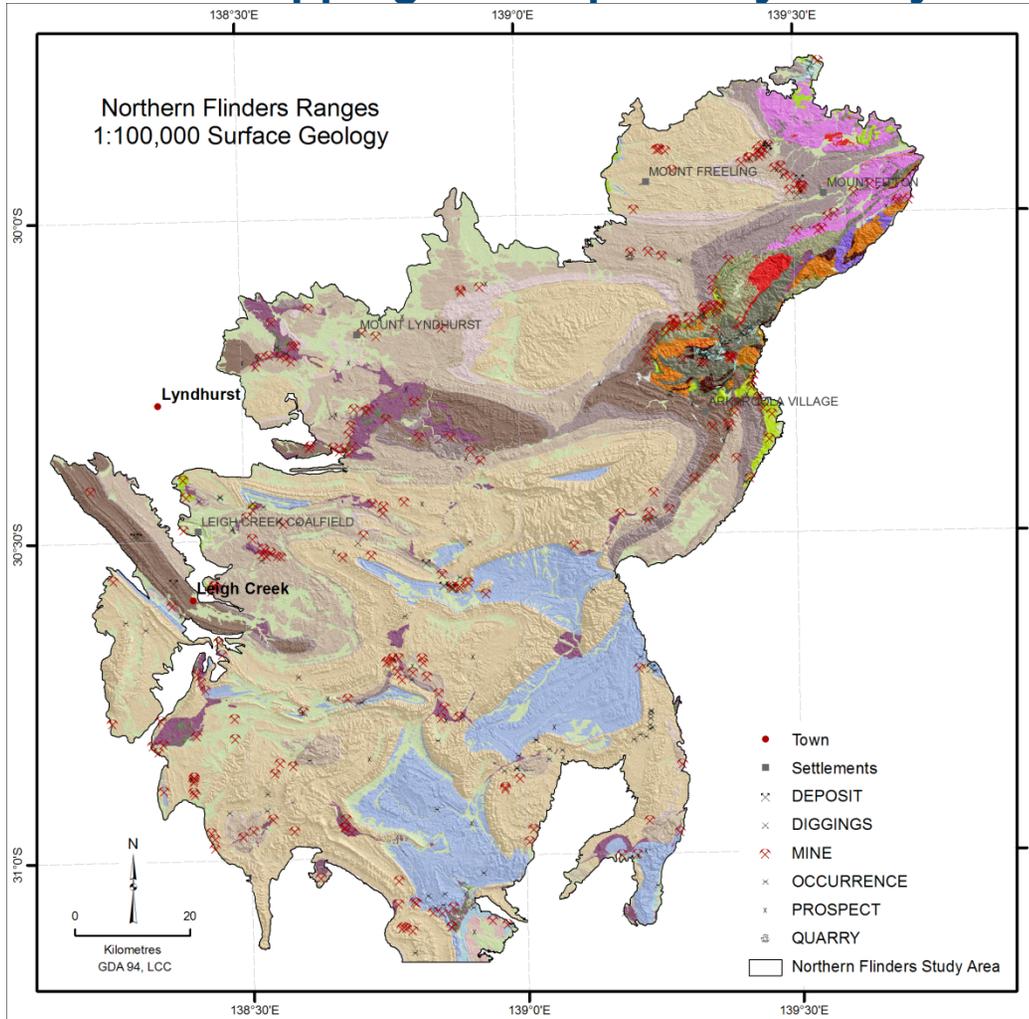
**W.M. Cowley, L.F. Katona and G. Gouthas
Geological Survey Branch, Mineral Resources Group
Report Book number 2009/19**



Geoscience Mapping & Prospectivity Analysis



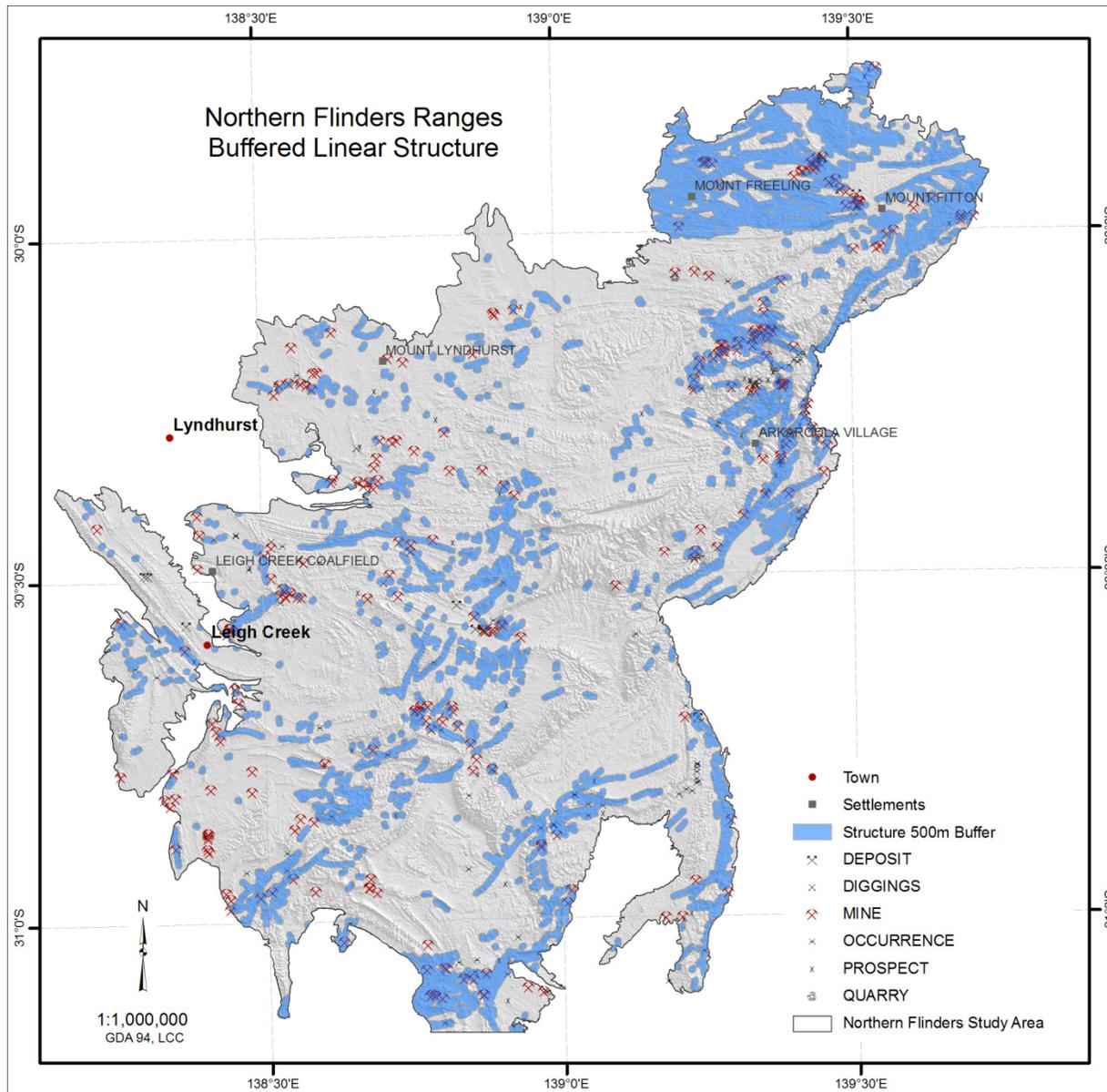
Geoscience Mapping & Prospectivity Analysis



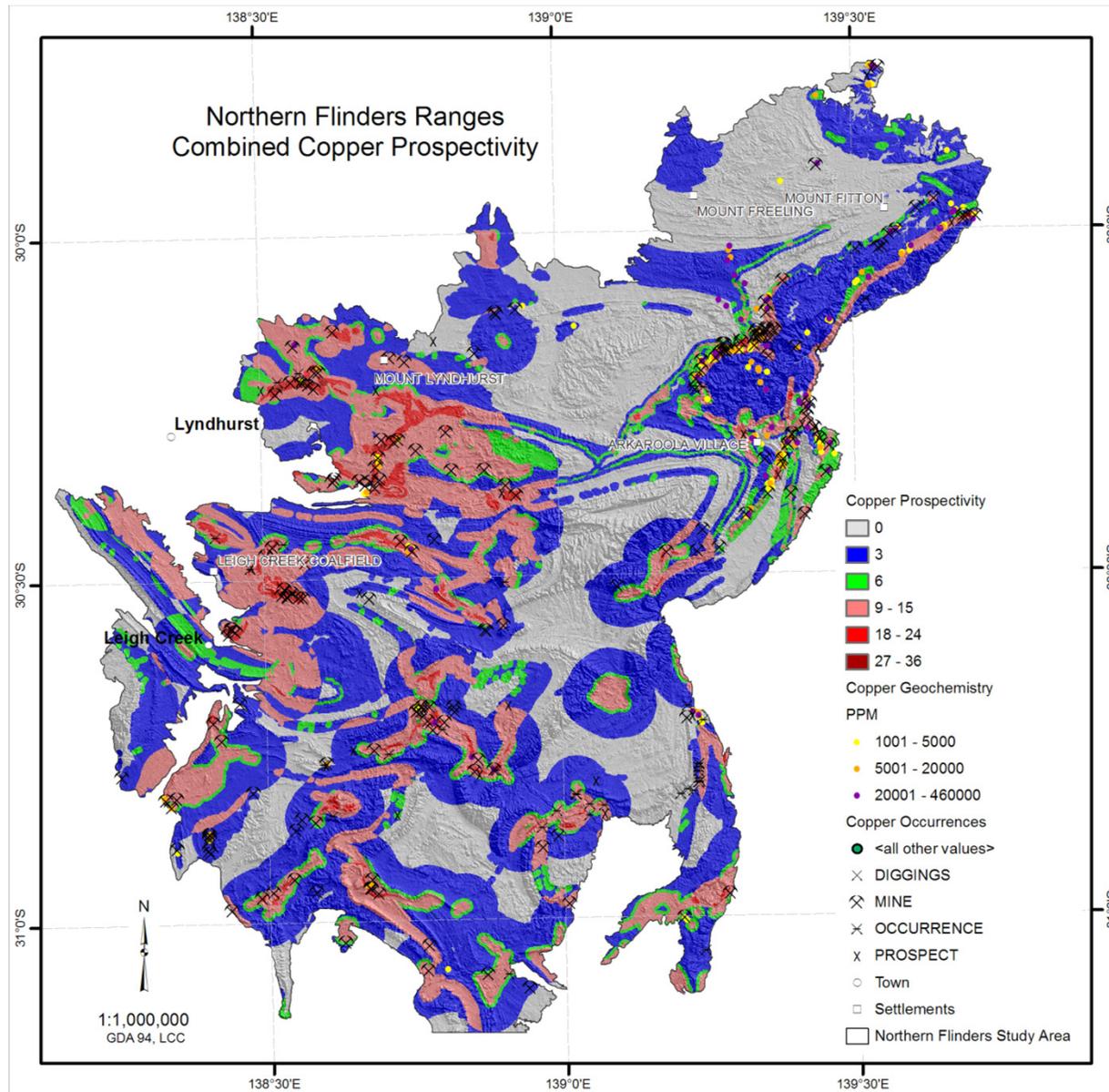
Surface Geology 1:100 000 scale

- | | | |
|--|--|---|
| <ul style="list-style-type: none"> ■ Cainozoic ■ Mesozoic ■ Palaeozoic breccias ■ Palaeozoic granitoids ■ Delamerian and post-Delamerian granitoids ■ Lake Frome Group ■ Aroona Creek, Wirrealpa Limestones; ■ Billy Creek Formation ■ Hawker Group, Uratanna Formation | <ul style="list-style-type: none"> ■ Wilpena Group ■ Yerelina Subgroup ■ Umberatana Group (interglacial) ■ Yudnamutana Subgroup ■ Burra Group ■ diapirs ■ Callanna Group ■ Wooltana Volcanics ■ Meso-Neoproterozoic mafic intrusives ■ Moolawatana Suite | <ul style="list-style-type: none"> ■ Petermorra Volcanics ■ Mount Neill Granite ■ Pepegoona Porphyry ■ Palaeo-Mesoproterozoic granitoids ■ Palaeo-Mesoproterozoic felsic volcanics ■ Palaeo-Mesoproterozoic metasediments ■ Radium Creek Metamorphics ■ quartz ■ undifferentiated breccia ■ fault and shear zones |
|--|--|---|

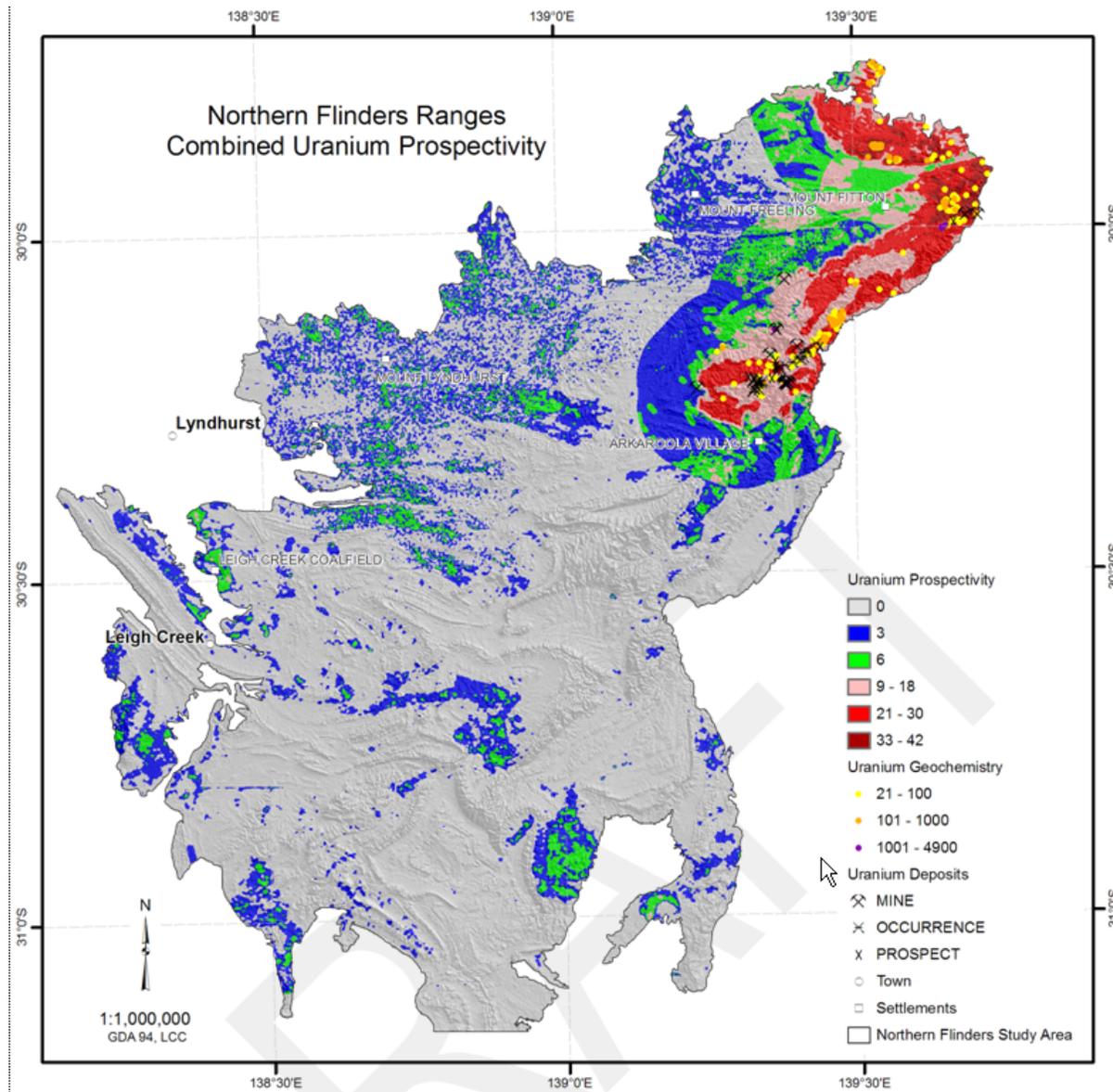
Geoscience Mapping & Prospectivity Analysis



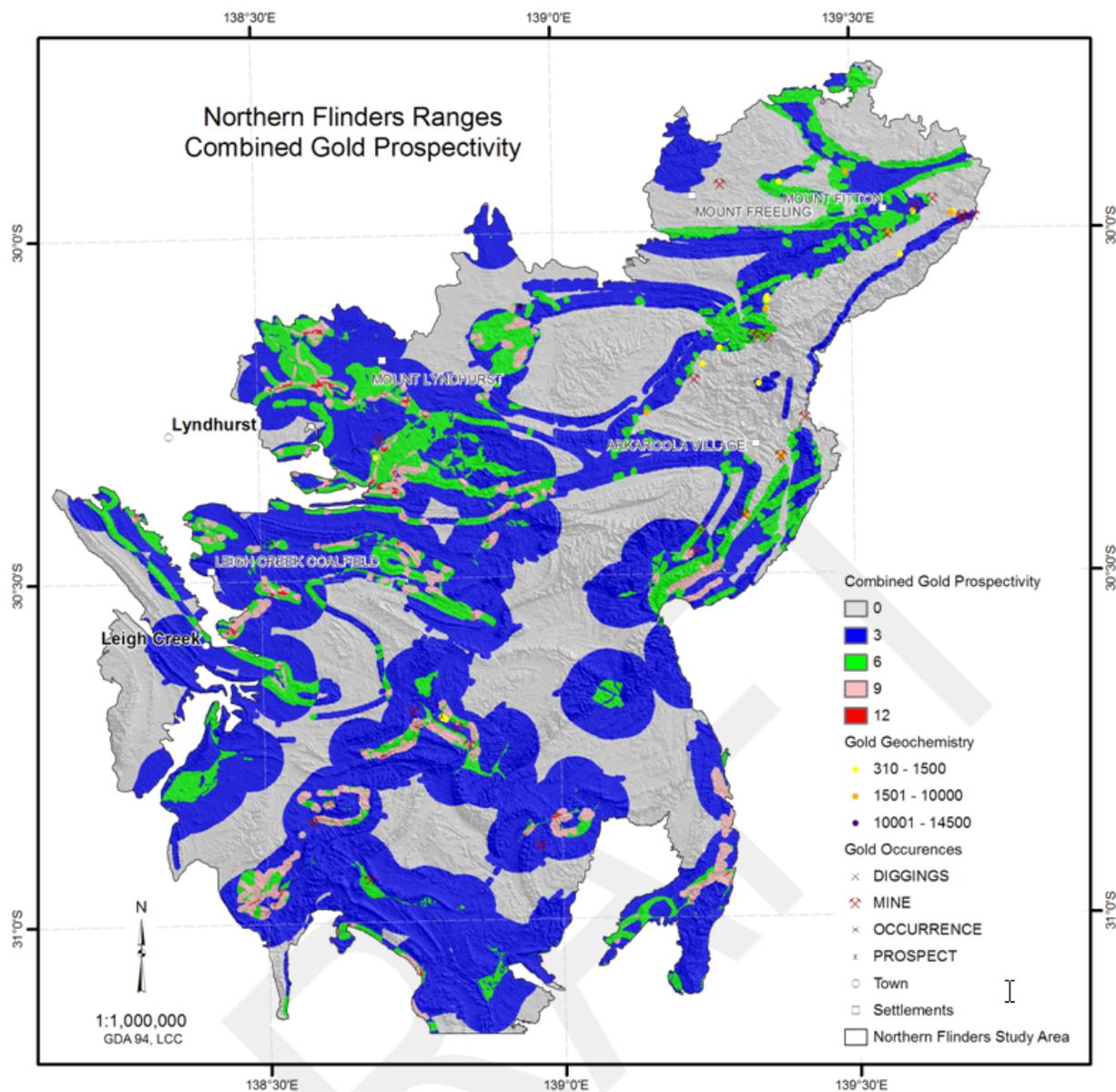
Geoscience Mapping & Prospectivity Analysis



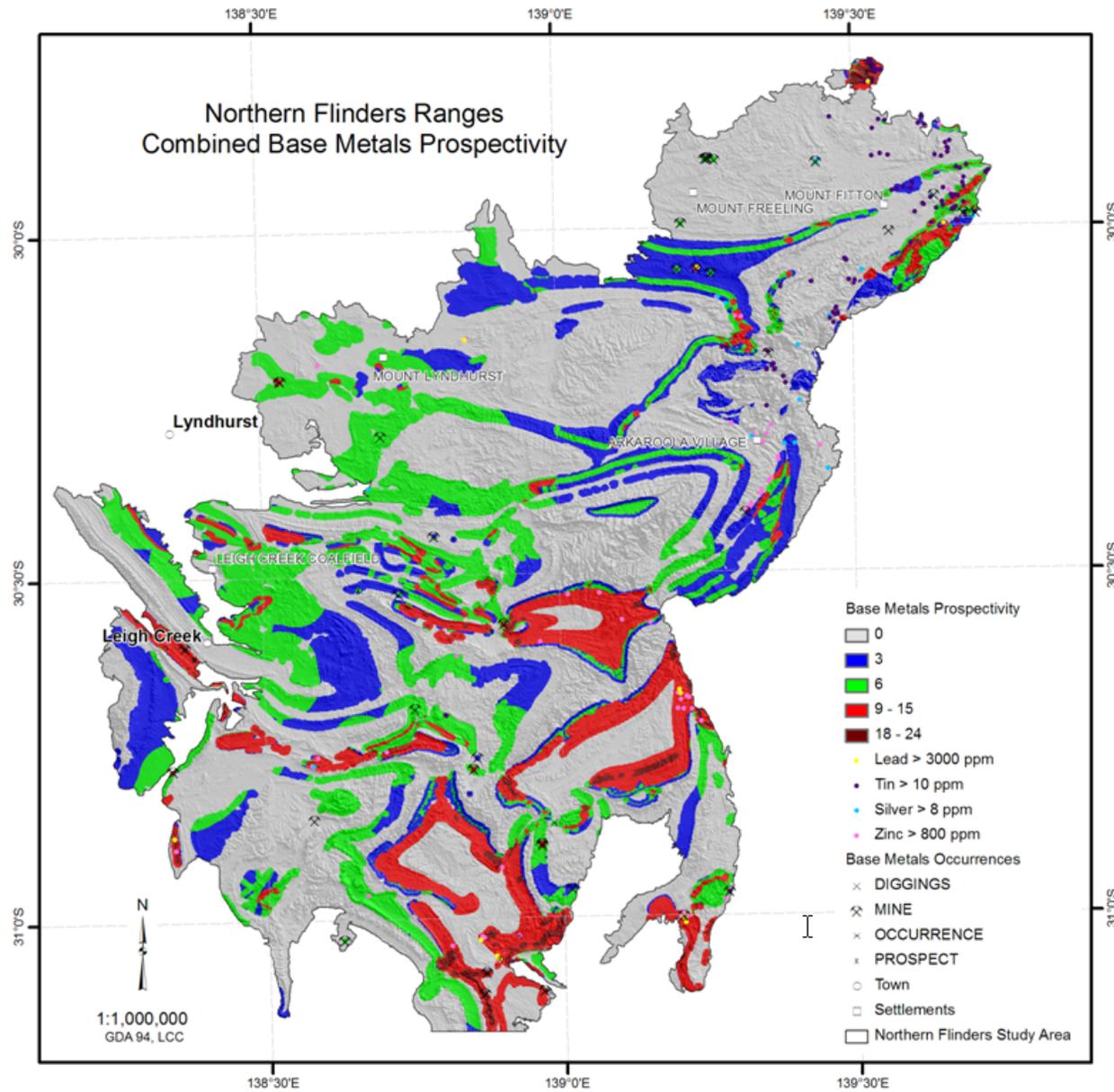
Geoscience Mapping & Prospectivity Analysis



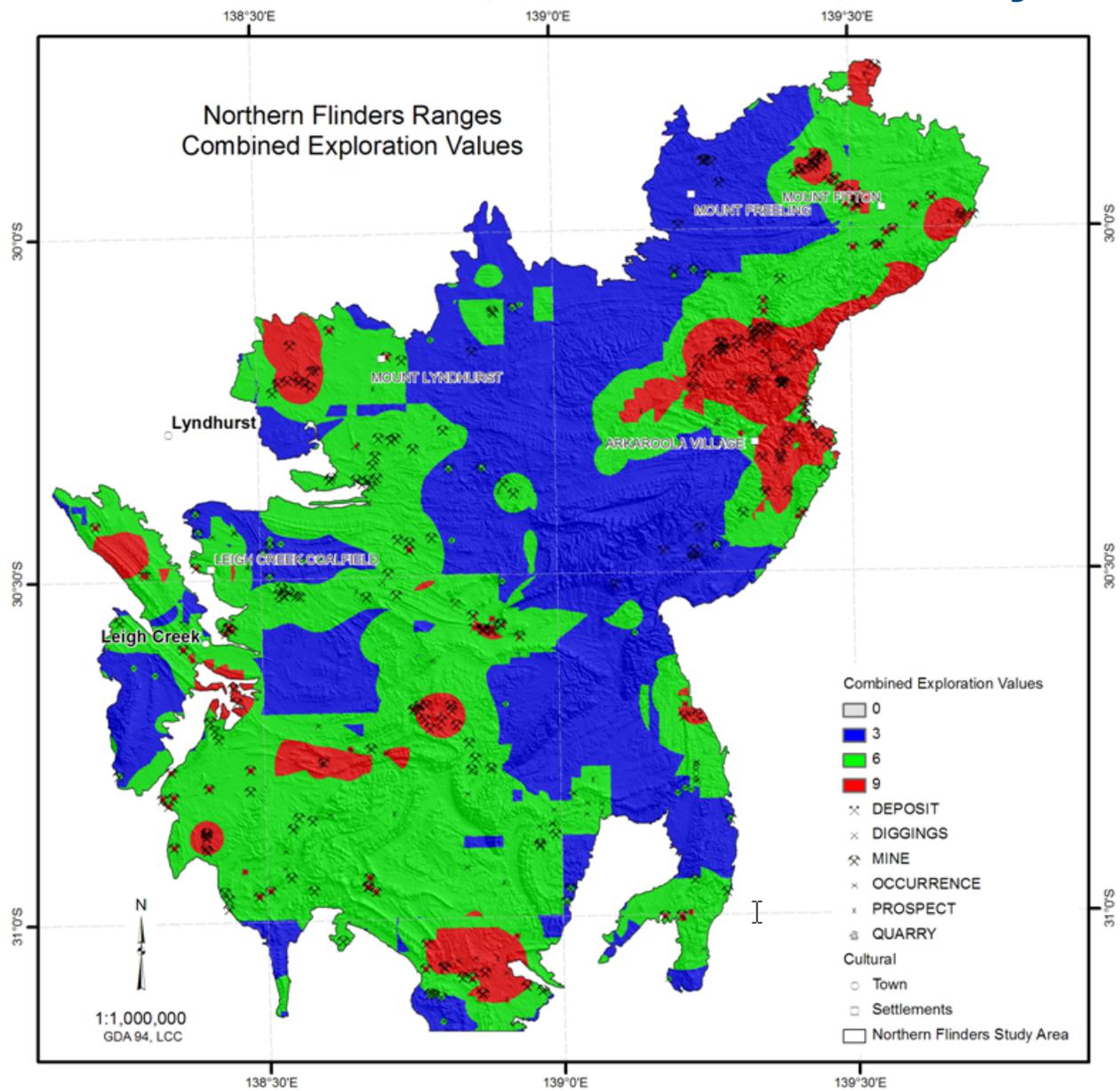
Geoscience Mapping & Prospectivity Analysis



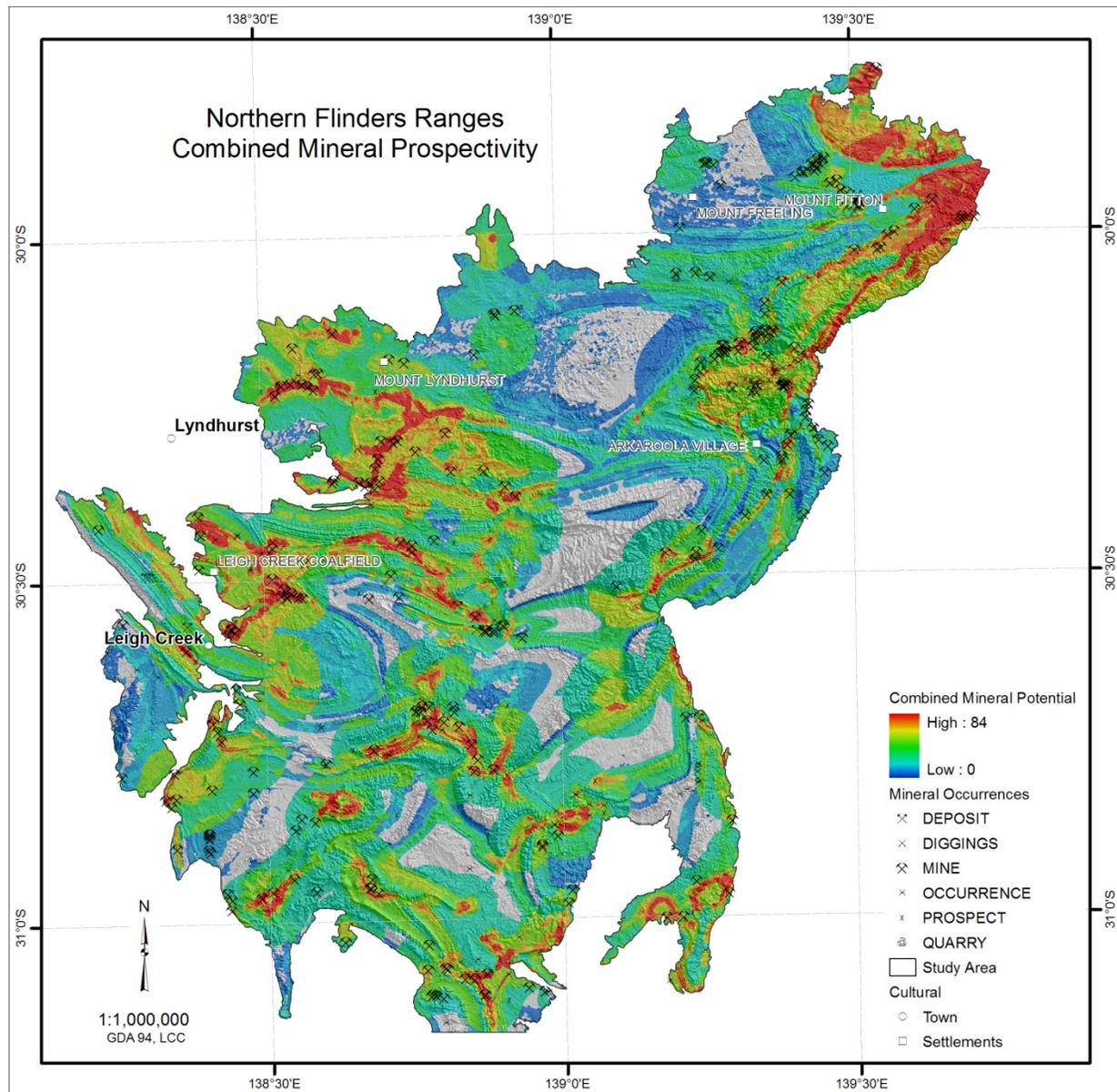
Geoscience Mapping & Prospectivity Analysis



Geoscience Mapping & Prospectivity Analysis



Geoscience Mapping & Prospectivity Analysis



Example 2 – What role for SA in Pre-Competitive R&D

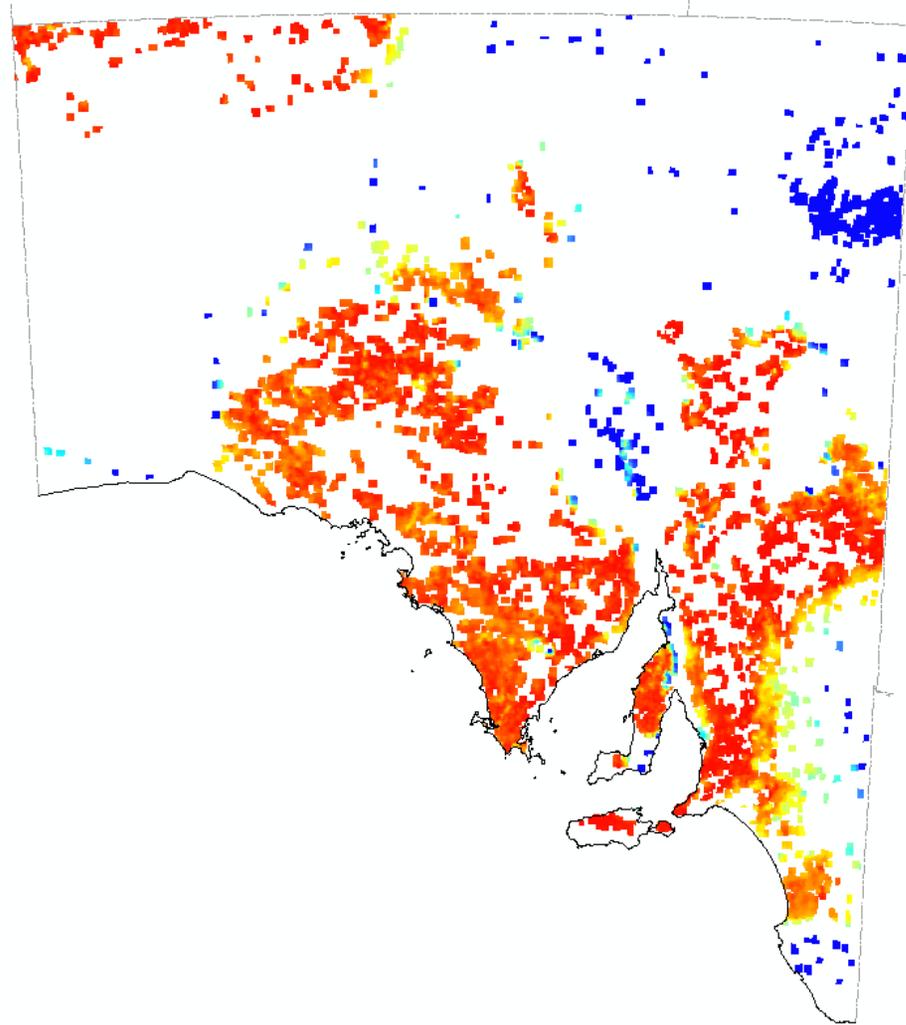
SA Data Integration ...

**latest work in progress –
refining depth to crystalline basement**



Old – no attributes, only depth. Coarse grid (2km x 2km)

New – accurately located point data attributed with depth of horizon, elevation of horizon, geology.

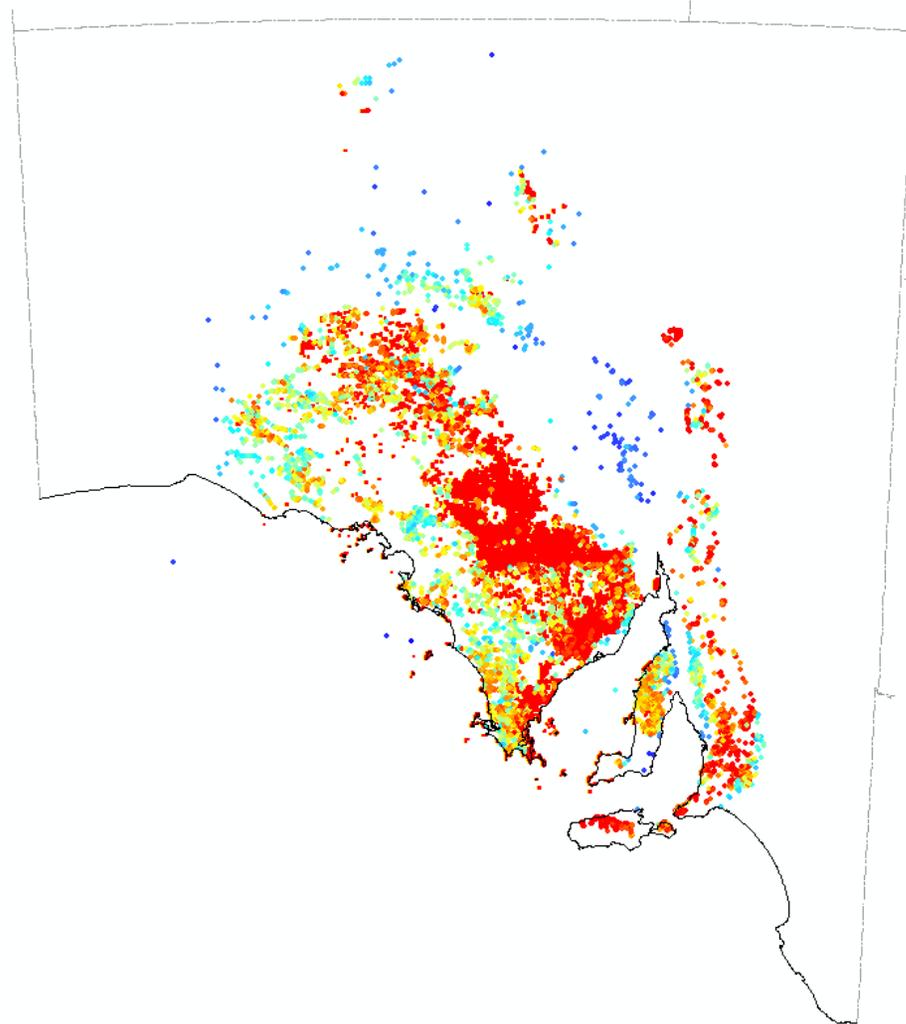


Depth to Crystalline Basement Project Objectives



Old – no attributes, only depth. Coarse grid (2km x 2km)

New – accurately located point data attributed with depth of horizon, elevation of horizon, geology.

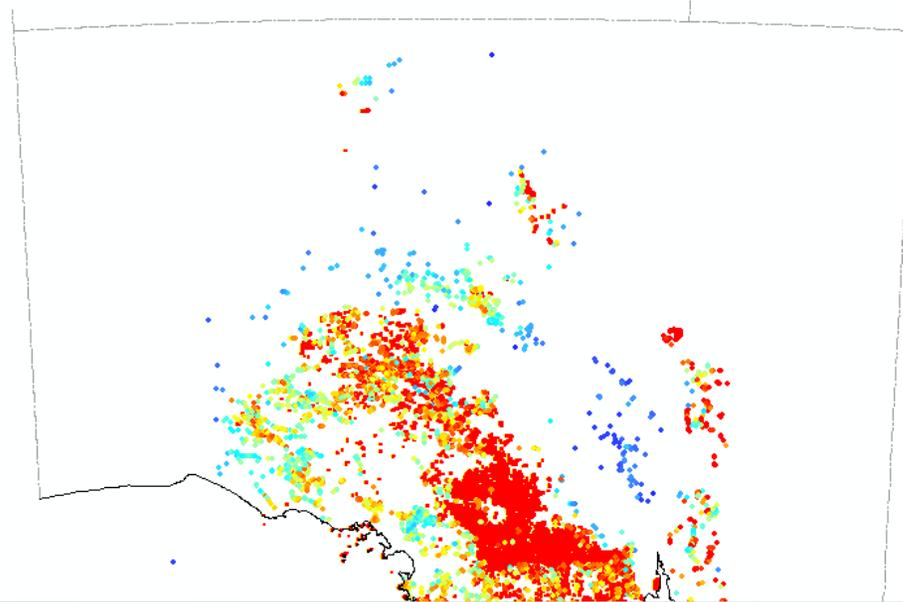


Depth to Crystalline Basement Project Objectives



Old – no attributes, only depth. Coarse grid (2km x 2km)

New – accurately located point data attributed with depth of horizon, elevation of horizon, geology.



DHNUMBER	DEPFROM	GISCODE	LON	LAT	GLCODE	MAPUNIT	MAINUNIT	AGE	STRATNO	STRATNAME	
20964	89	E-ok	137.884722	-35.748554	13178	Ek	Ek	15200 Cambrian	4627	Kanmantoo Group	Sandstone; siltstone, occasionally sulphidic; metamorphosed
25930	1.32	E-ok	138.002389	-35.718363	13178	Ek	Ek	15200 Cambrian	4627	Kanmantoo Group	Sandstone; siltstone, occasionally sulphidic; metamorphosed
349	858	A-	130.85502	-32.536389	19200	A	A	27840 Archaean	2960	Unnamed GIS Unit - see description	Undifferentiated Archaean rocks
2943	1701	M--c-b	133.885977	-33.492724	17016	Mcb	Mcb	20040 Mesoproterozoic	3330	Blue Range beds	Sandstone, minor grit and pebble beds, white, massive to cr
2971	5.79	L--p	133.641909	-32.148786	18082	Lp	Lp	24240 Palaeoproterozoic	4522	St Peter Suite	Granite, adamellite; granodiorite; diorite; pegmatite; amphi
2974	1.07	L--p	133.641909	-32.148786	18082	Lp	Lp	24240 Palaeoproterozoic	4522	St Peter Suite	Granite, adamellite; granodiorite; diorite; pegmatite; amphi
3774	3100	M--c-b	134.23861	-33.561712	17016	Mcb	Mcb	20040 Mesoproterozoic	3330	Blue Range beds	Sandstone, minor grit and pebble beds, white, massive to cr
10314	2.43	L-l	135.921432	-34.660936	18044	Ll	Ll	24240 Palaeoproterozoic	3748	Lincoln Complex	Gneissic granite; granodiorite; adamellite. Veins of pegmatite
10315	1.98	L-l	135.921432	-34.660936	18044	Ll	Ll	24240 Palaeoproterozoic	3748	Lincoln Complex	Gneissic granite; granodiorite; adamellite. Veins of pegmatite
10533	20.42	L-	135.869099	-34.71813	17900	L	L	24240 Palaeoproterozoic	4724	Unnamed GIS Unit - see description	Undifferentiated Palaeoproterozoic rocks.
10537	19.2	L-	135.869099	-34.71813	17900	L	L	24240 Palaeoproterozoic	4724	Unnamed GIS Unit - see description	Undifferentiated Palaeoproterozoic rocks.
10539	12.8	L-	135.869099	-34.71813	17900	L	L	24240 Palaeoproterozoic	4724	Unnamed GIS Unit - see description	Undifferentiated Palaeoproterozoic rocks.
10540	11.27	L-	135.869099	-34.71813	17900	L	L	24240 Palaeoproterozoic	4724	Unnamed GIS Unit - see description	Undifferentiated Palaeoproterozoic rocks.
10541	12.65	L-	135.88057	-34.718498	17900	L	L	24240 Palaeoproterozoic	4724	Unnamed GIS Unit - see description	Undifferentiated Palaeoproterozoic rocks.
10542	7.92	L-	135.88057	-34.718498	17900	L	L	24240 Palaeoproterozoic	4724	Unnamed GIS Unit - see description	Undifferentiated Palaeoproterozoic rocks.
10543	3.35	L-	135.88057	-34.718498	17900	L	L	24240 Palaeoproterozoic	4724	Unnamed GIS Unit - see description	Undifferentiated Palaeoproterozoic rocks.
10544	3.35	L-	135.88057	-34.718498	17900	L	L	24240 Palaeoproterozoic	4724	Unnamed GIS Unit - see description	Undifferentiated Palaeoproterozoic rocks.
10545	3.35	L-	135.88057	-34.718498	17900	L	L	24240 Palaeoproterozoic	4724	Unnamed GIS Unit - see description	Undifferentiated Palaeoproterozoic rocks.
10546	1.97	L-	135.88057	-34.718498	17900	L	L	24240 Palaeoproterozoic	4724	Unnamed GIS Unit - see description	Undifferentiated Palaeoproterozoic rocks.
14343	0	M--s	136.346745	-34.681495	17116	Ms	Ms	20040 Mesoproterozoic	4155	Spilsby Suite	Granite, grey, coarse-grained porphyritic (Adamellite to gran
14346	0	M--s	136.346767	-34.681503	17116	Ms	Ms	20040 Mesoproterozoic	4155	Spilsby Suite	Granite, grey, coarse-grained porphyritic (Adamellite to gran
14352	0	M--s	136.347178	-34.681364	17116	Ms	Ms	20040 Mesoproterozoic	4155	Spilsby Suite	Granite, grey, coarse-grained porphyritic (Adamellite to gran
17214	148	L-	136.788913	-34.64245	17900	L	L	24240 Palaeoproterozoic	4724	Unnamed GIS Unit - see description	Undifferentiated Palaeoproterozoic rocks.



Depth to Crystalline Basement Project



The screenshot shows the SA Government website page for the 'Depth to Crystalline Basement Project'. The page is titled 'DMITRE Minerals' and is part of the 'Geological Survey of SA' website. The main content area is titled 'Depth to crystalline basement datasets' and provides information about the project's goals and data sources. A search bar is located in the top right corner, and a navigation menu is visible below the header. The page also includes a sidebar with a tree view of the website's structure.

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Department for Manufacturing,
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Site Map | What's New | Printer Friendly Page

DMITRE Minerals

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Industry overview | PACE 2020 | Geological Survey of SA | Publications & Information | Access to Land | Licensing & Regulation | Mines & Developing Projects | Opal Mining | Earthquakes

Education

You are here: Minerals / Geological Survey of SA / Geoscientific Data / Depth to crystalline basement datasets

Depth to crystalline basement datasets

The depth to crystalline basement project will assemble GIS datasets that portray or infer depth to crystalline basement in South Australia, on a province-by-province basis.

These datasets will be made available for public download.

A depth to basement surface will simultaneously be produced and updated as the project progressively models each province. A reliability map will also be produced and made available. The project's focus for 2011–2012 is the Gawler Province.

Defining depth to crystalline basement

Crystalline basement for the purposes of this dataset is generally taken to be the shallowest rocks affected by a pervasive orogenic event in any given area.

For the Gawler Province, this includes Mesoproterozoic and older rocks affected by the Mesoproterozoic Kararan Orogeny and older events. On current interpretations this definition includes the Itilee Basin (Blue Range Beds) but excludes the Cariewerloo Basin (Pandurra Formation). The eastern and southeastern margins of the area are placed along the eastern edges of the Torrens Hinge Zone and Stuart and Spencer Shelves and along the Kangaroo Island Shear Zone. These included areas are essentially unaffected by the Delamerian Orogeny.

Datasets that provide depth to crystalline basement information or estimates

- Drillhole Stratigraphy (high confidence)**
The primary and most accurate data source for depth to crystalline basement is drillhole stratigraphy. Drillholes whose stratigraphy matches the crystalline basement criteria were extracted from SA Geodata as a point dataset and stratigraphic attributes (sourced from SA Geology) were appended to each data point.
Rule: Depth to crystalline basement surfaces interpolated from combinations of input datasets should honour the drillhole basement intercepts.
- Outcropping basement surface geology (high confidence)**
Surface geology extracted from the South Australian 100k geology GIS layer represents crystalline basement at surface.
Rule: Depth to crystalline basement surfaces should honour the perimeter of outcropping basement units and honour the topographic surface within outcropping basement units.
- Drillholes that stop short of crystalline basement but intersect a surface interpolated from crystalline basement intercepts (medium confidence)**
These end of hole depths are used to force an interpolated crystalline basement surface downward, where the pilot interpolated surface intersected non basement intersecting drillholes.
Rule: Depth to crystalline basement surfaces should always be deeper than non-basement intersecting end-of-hole measurements.
- Seismic interpretation (medium confidence)**
Crystalline basement picks along seismic lines are depth-converted and used to delineate crystalline basement in areas where drillhole information is sparse or non-existent.
- Geophysical depth estimates (variable confidence)**
Geophysical modelling of crystalline basement depth in areas where the geophysical source is believed to originate in the basement is used where drillhole information is sparse. Known depths (drillholes) will be used to validate the geophysical estimates to increase confidence in the results.

[Download the Depth to Crystalline Basement 2012 data package \(.zip\)](#)

sa.gov.au
Find what you're looking for

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Example 3 – What role for SA in Pre-Competitive R&D

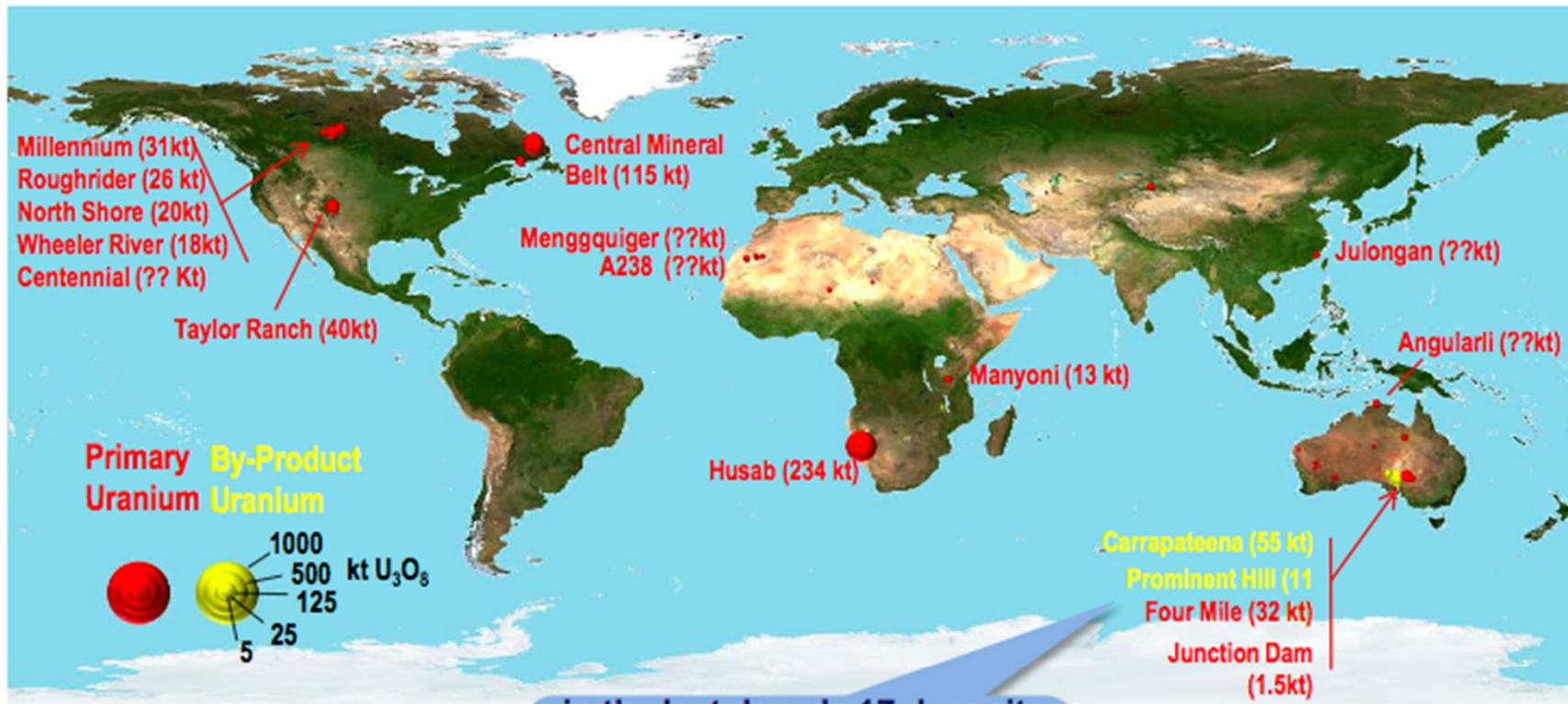
Uranium Geoscience - International Partnering

South Australia is building strategic partnerships and targeted R&D to grow capacity and deliver new uranium mineral systems insights which will lead to new discoveries

...



Global Context - Uranium discoveries: Since 2000



in the last decade 17 deposits
 >10 kt U_3O_8 have been found in
 the world
 3 of those were in South
 Australia

Source: MinEx Consulting ©
 July 2012





THE INDEPENDENT AUTHORITY
MINING | METALS | FERTILIZERS

Uranium

*“Uranium is the next great China story.
What China did for iron ore in the last decade,
it will do for uranium in the coming decades”.*

*A Trench & D Packey 2012
Australia’s Next Top Mining Shares – Major Street Press*



China – South Australia – Saskatchewan Uranium Geoscience Partnership established October 2012



3D Data Compilation & Modelling – Athabasca Basin

Saskatchewan Ministry of Energy and Resources

Early March 2009 Memorandum of Understanding signed between DMITRE (PIRSA) and the Saskatchewan Ministry of Energy and Resources, CANADA

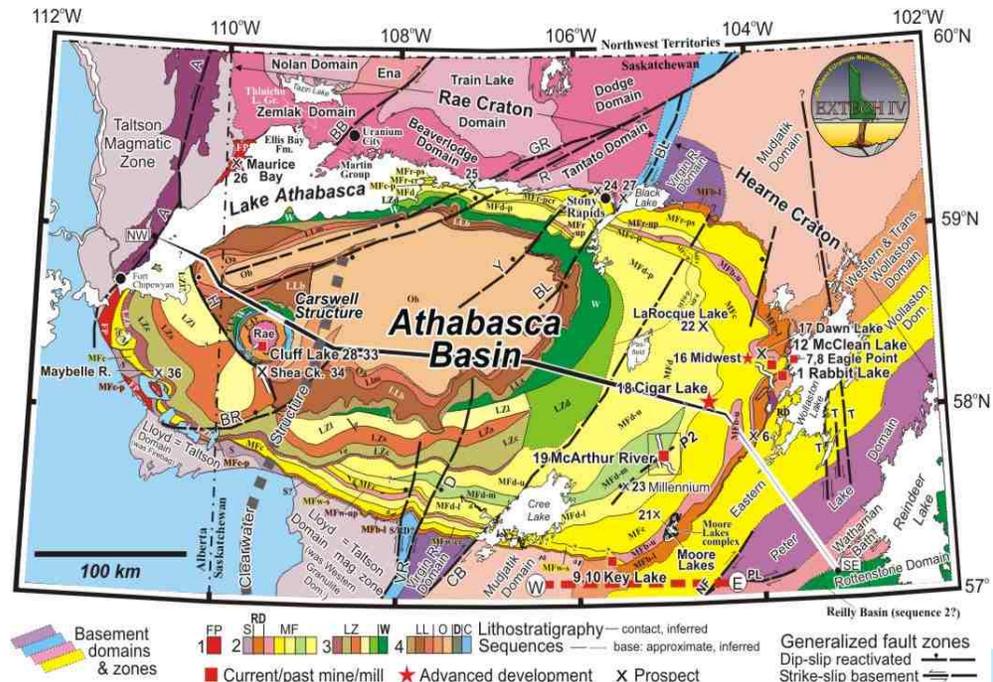
Saskatchewan is the leading jurisdiction in North America for uranium exploration and mining production.

Athabasca Basin

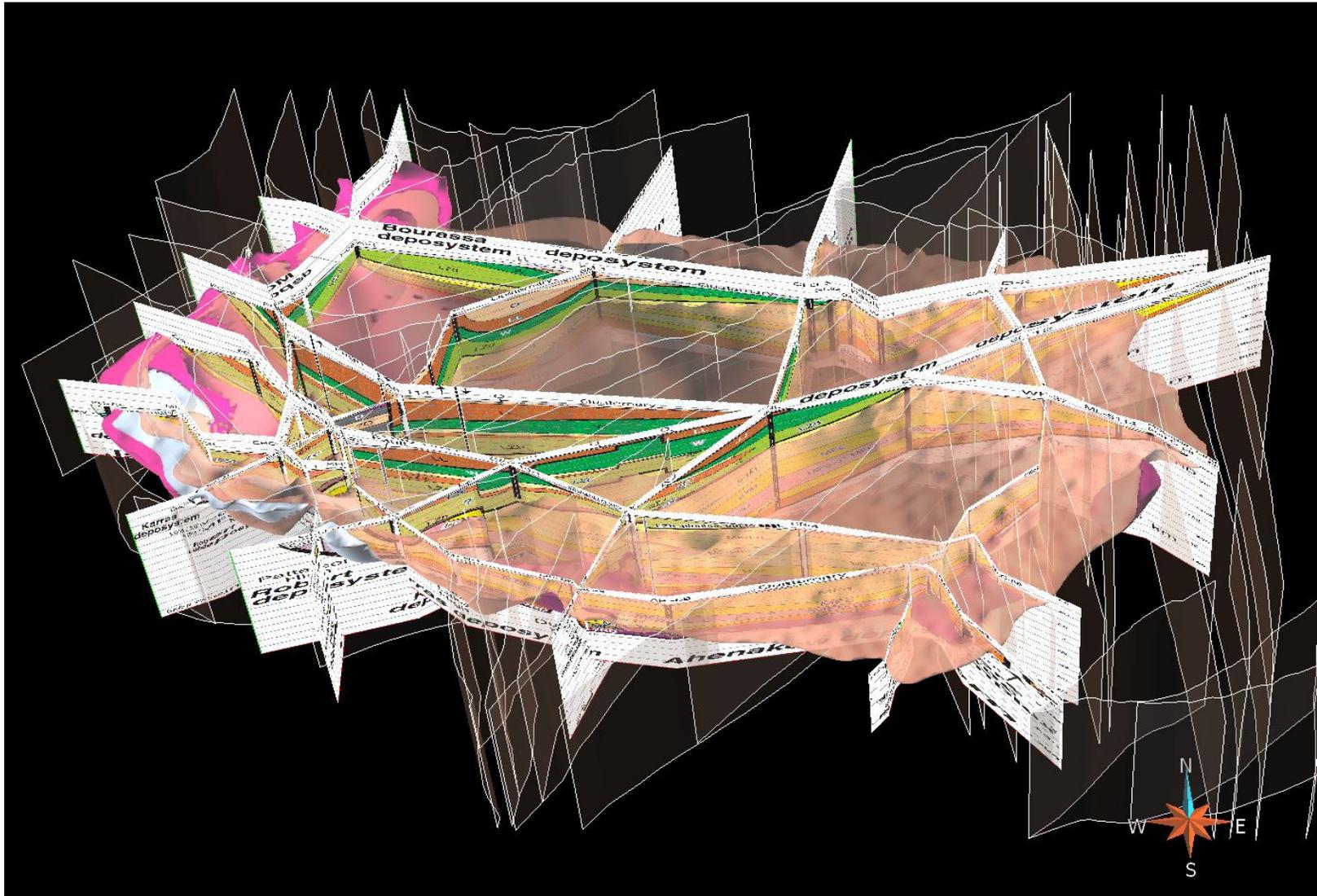
World's largest high grade U mines
 Produces ~23% world U

MoU aims to:

- Promote geoscientific exchange
- Facilitate geoscience knowledge sharing
- Generate new U models for SA
- Develop regulation and best practice policy



Athabasca Basin – 3D modelling work



CARIEWERLOO BASIN UNCONFORMITY-RELATED URANIUM PROJECT

Wilson T., Fairclough, M., Gouthas G., van der Wielen S., Mauger A. and Gordon G.

A Memorandum of Understanding between the Geological Survey of South Australia and the Saskatchewan Ministry of Resources and Energy, Canada was signed in 2009.

Analogies between the Athabasca Basin, Canada and the Cariewerloo Basin, South Australia.



Saskatchewan
Ministry of
Energy and
Resources

CARIEWERLOO BASIN PROJECT DATA RELEASE 2012

HyLogger

95 drillholes

SWIR and TIR

PY-1 (DH 20712) SWIR

Vanguard-1 (DH 18092) TIR

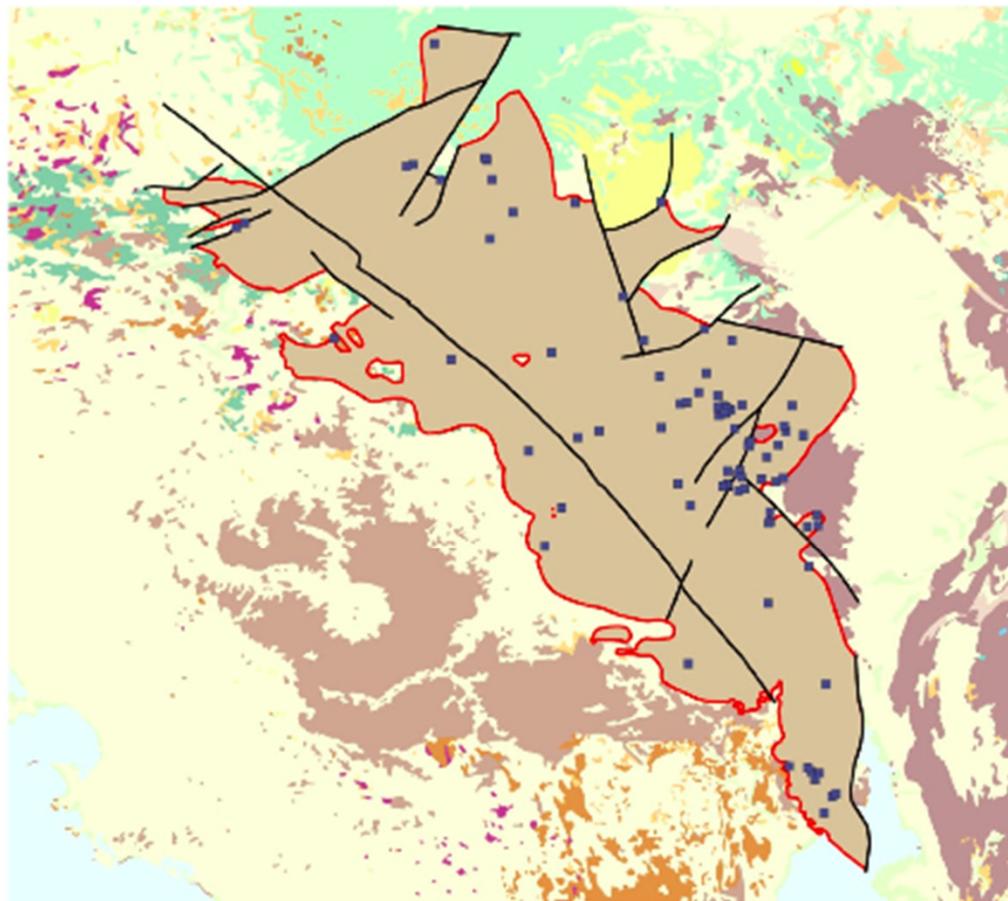
Stratigraphic Logging

HyLogger datasets

Geochemical Datasets

FPXRF

Assay



Example 4 – What role for SA in Pre-Competitive R&D

Land Access + Exploration Undercover Challenges

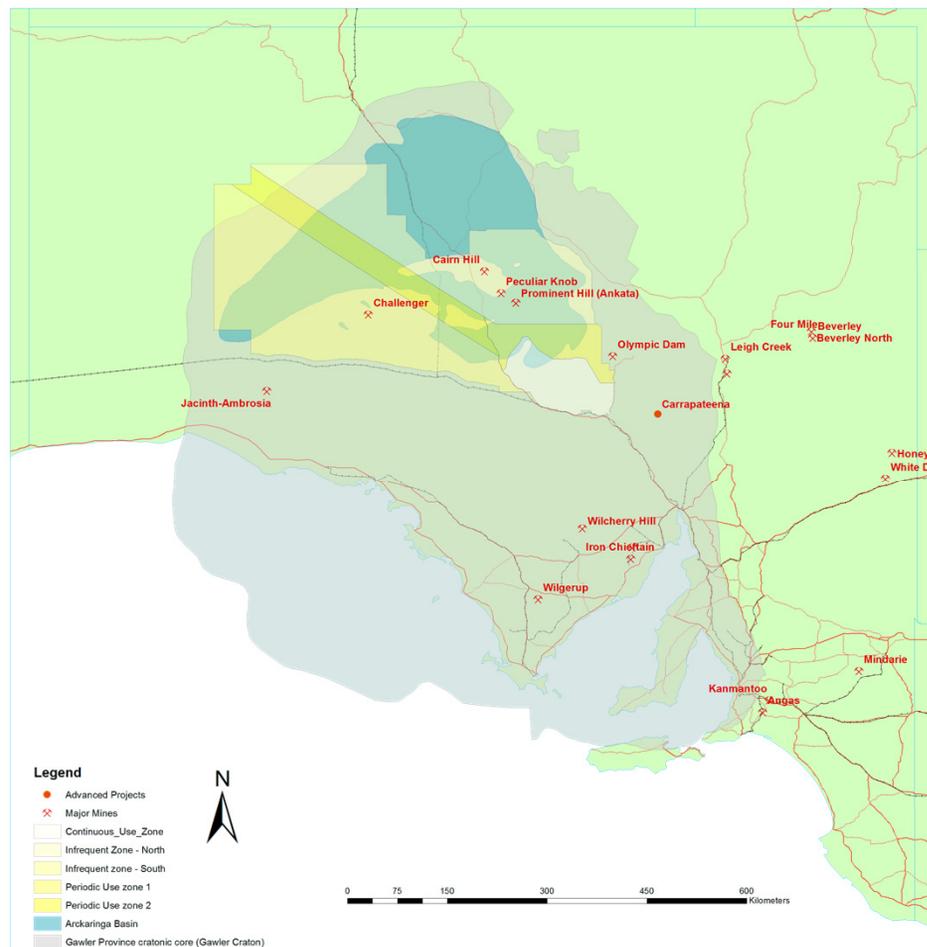
South Australia is building strategic partnerships and targeted research to open up the Woomera Prohibited Area to modern exploration and potential for new discoveries ...



PACE Program in WPA (2013-2015)



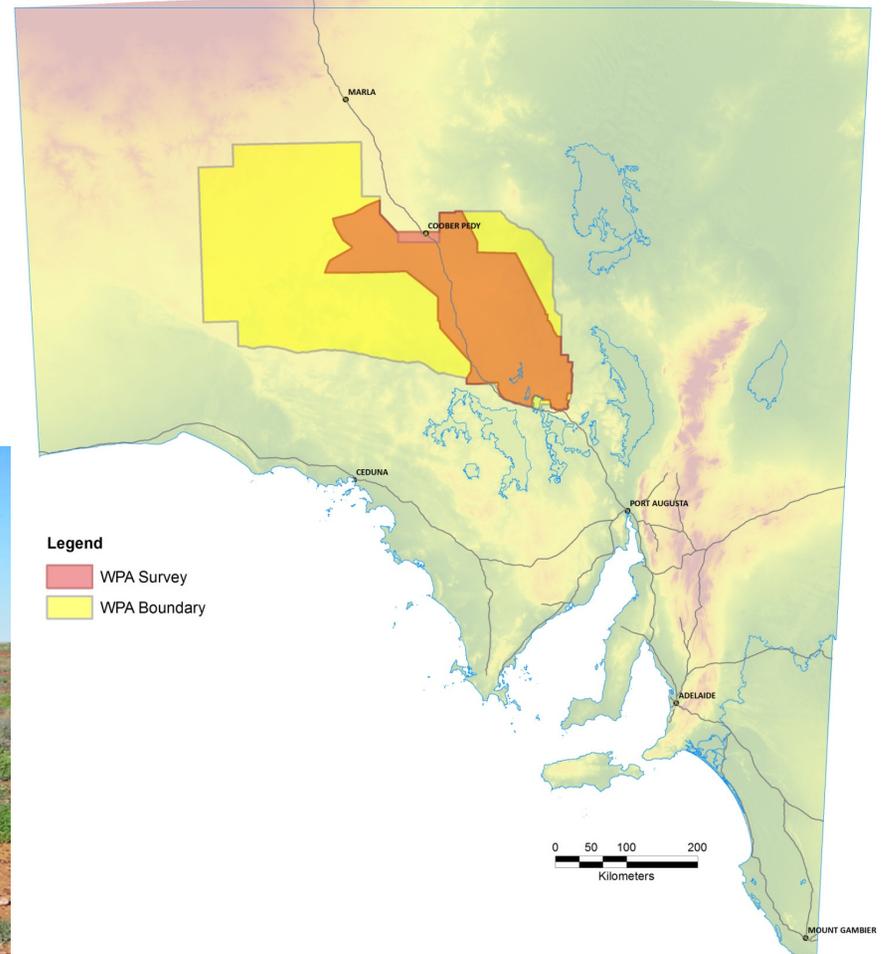
1. WPA Gravity survey (PACE 2020 extension)
2. WPA Alteration Footprints (PACE FRONTIERS)
3. WPA / eastern Gawler Craton regional drilling (PACE FRONTIERS)



PACE 2020 WPA Gravity Survey (2013 – 2014)



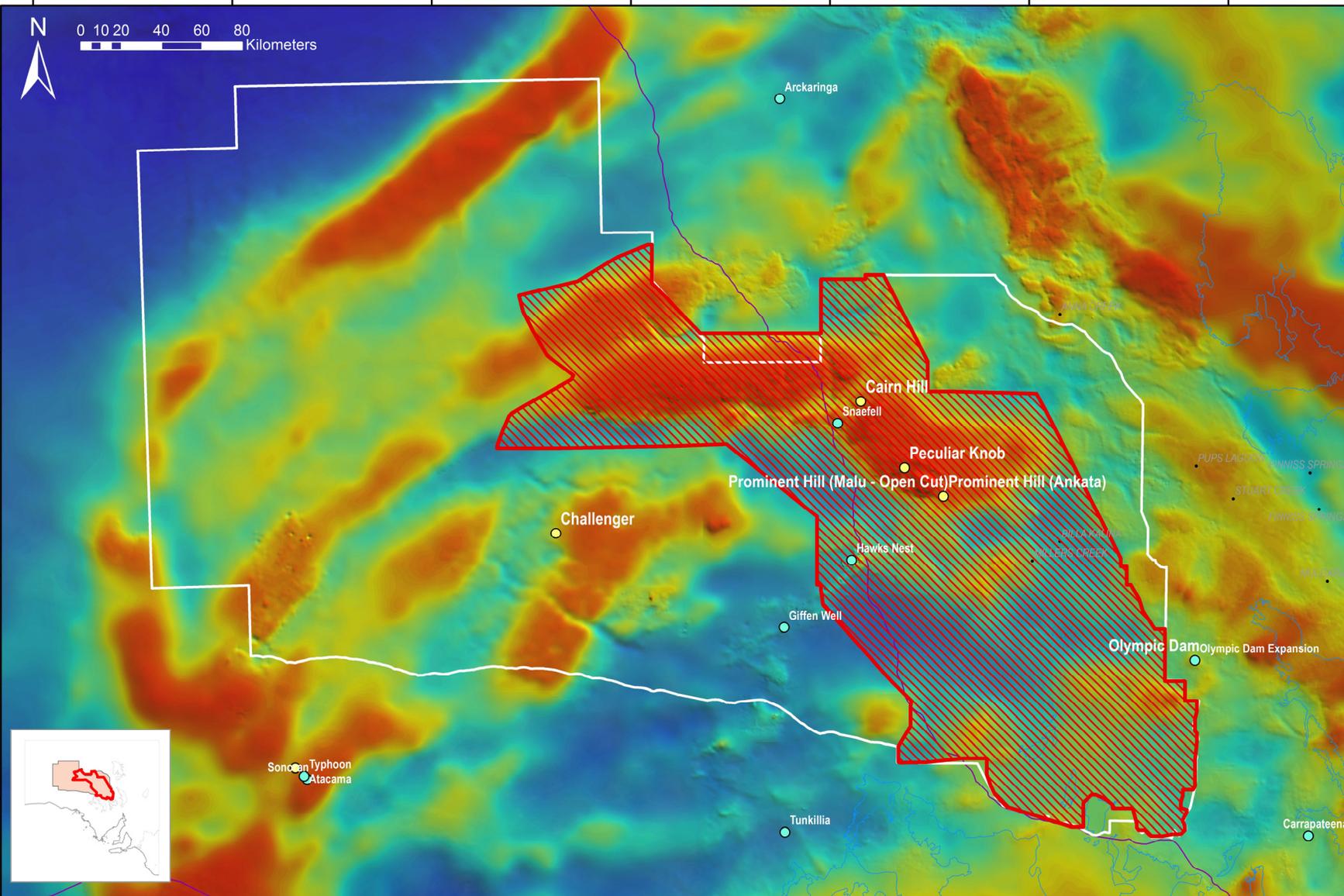
- Gravity survey designed by GSSA
- Approximately 34,000 gravity stations
- Majority of survey is a 1km x 1km grid (2km x 2km grid in Southern region of the Continual Use Zone)
- Partnership with GA in the tender process and managing the survey



131°0'0"E 132°0'0"E 133°0'0"E 134°0'0"E 135°0'0"E 136°0'0"E 137°0'0"E



0 10 20 40 60 80 Kilometers



28°0'0"S

29°0'0"S

30°0'0"S

31°0'0"S



Sonoran Typhoon
Atacama

Arckaringa

Cairn Hill

Snæfell

Peculiar Knob

Prominent Hill (Malu - Open Cut) Prominent Hill (Ankata)

Challenger

Hawks Nest

Giffen Well

Tunkillia

Olympic Dam Olympic Dam Expansion

Carrapateena

ANNA CREEK

PUPS LAGOON FINNISS SPRINGS

STUART CREEK

FINNISS SPRINGS

MULGARIA

BILAKAMIA

MULGERS CREEK

131°00'E 132°00'E 133°00'E 134°00'E 135°00'E 136°00'E 137°00'E



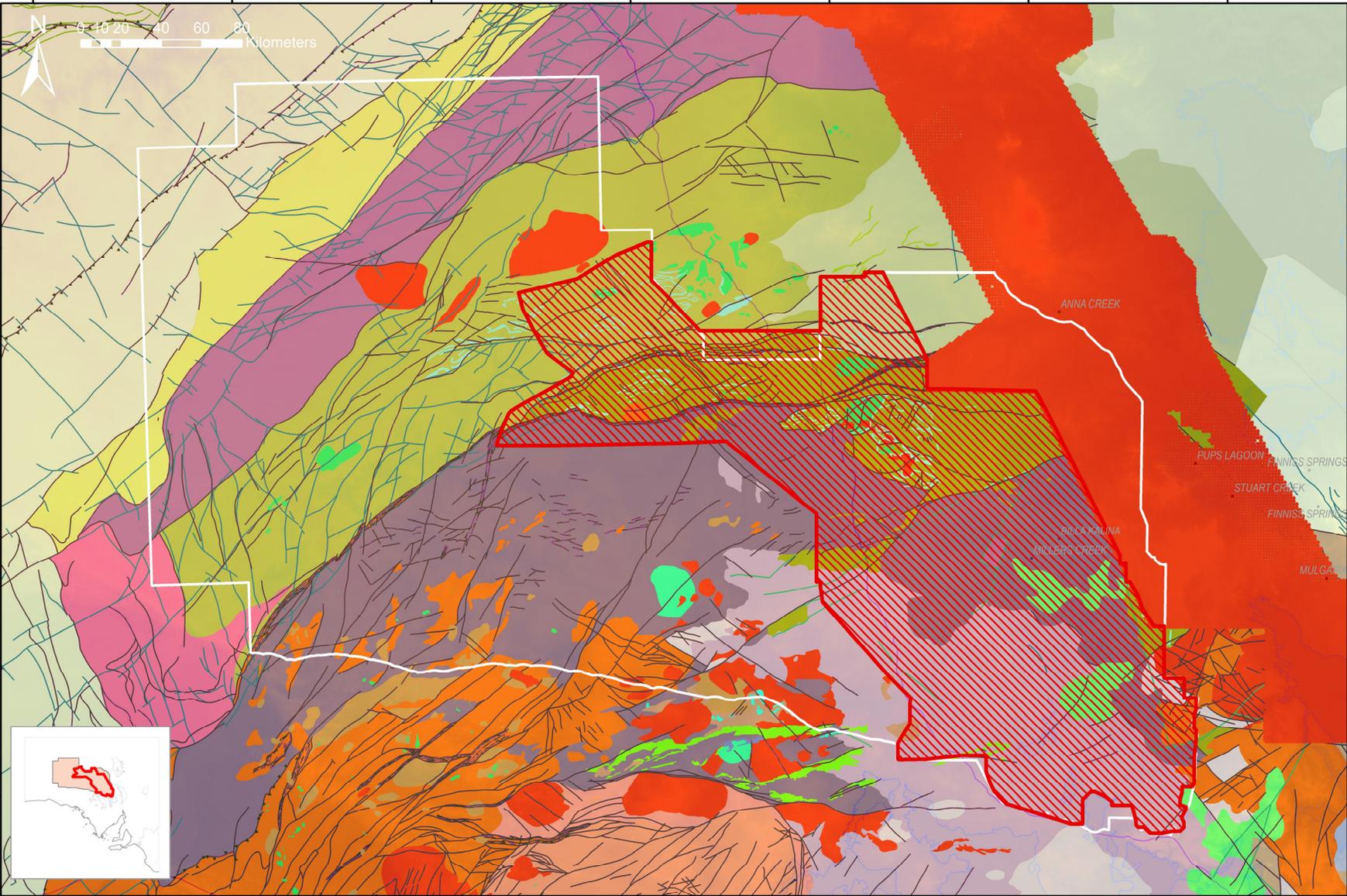
0 10 20 40 60 80 Kilometers

28°00'S

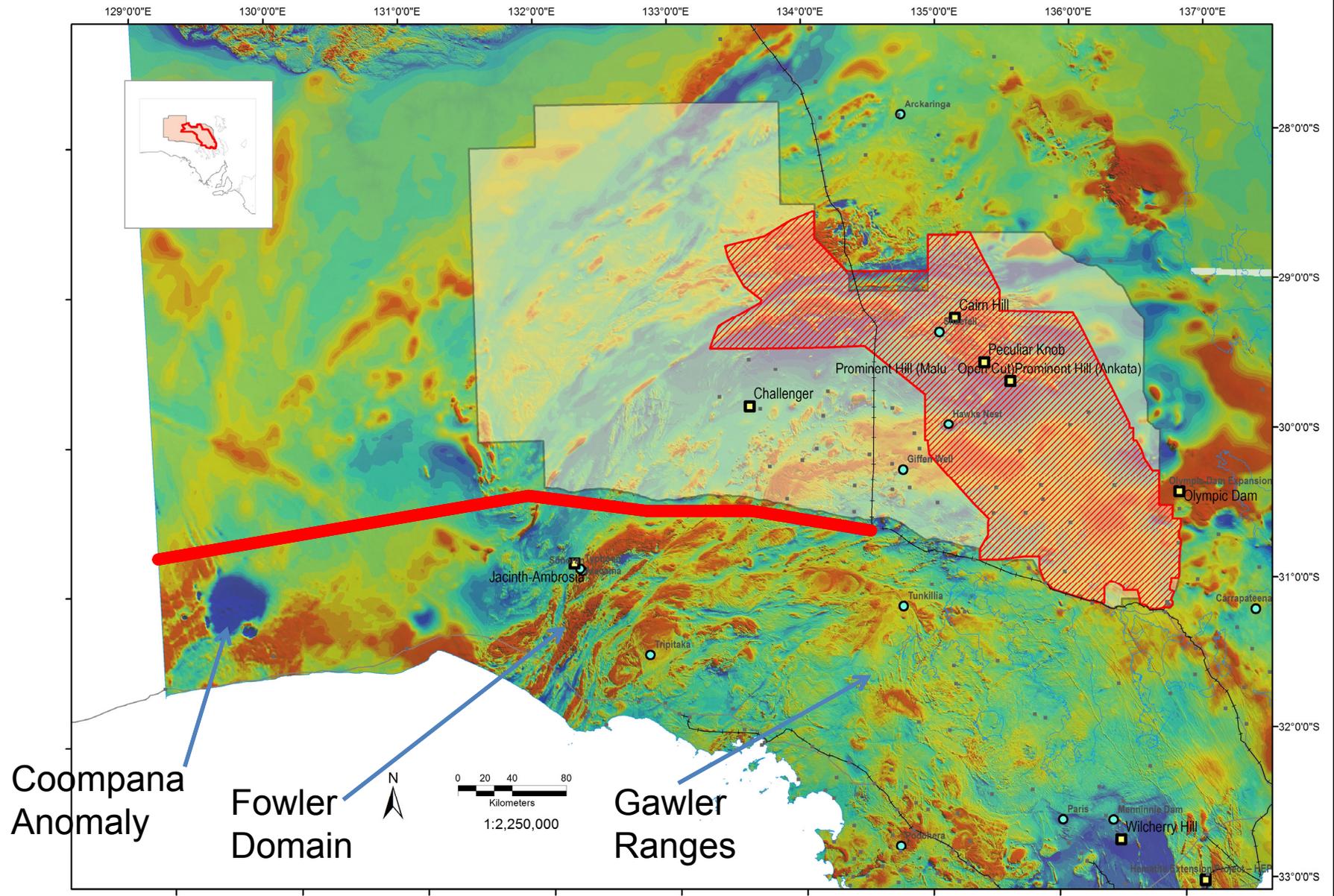
29°00'S

30°00'S

31°00'S



Western Gawler / Eucla Basin (TMI backdrop)



WPA Regional Mineral Systems Drilling (\$2 M 2014-15)

From DET CRC...

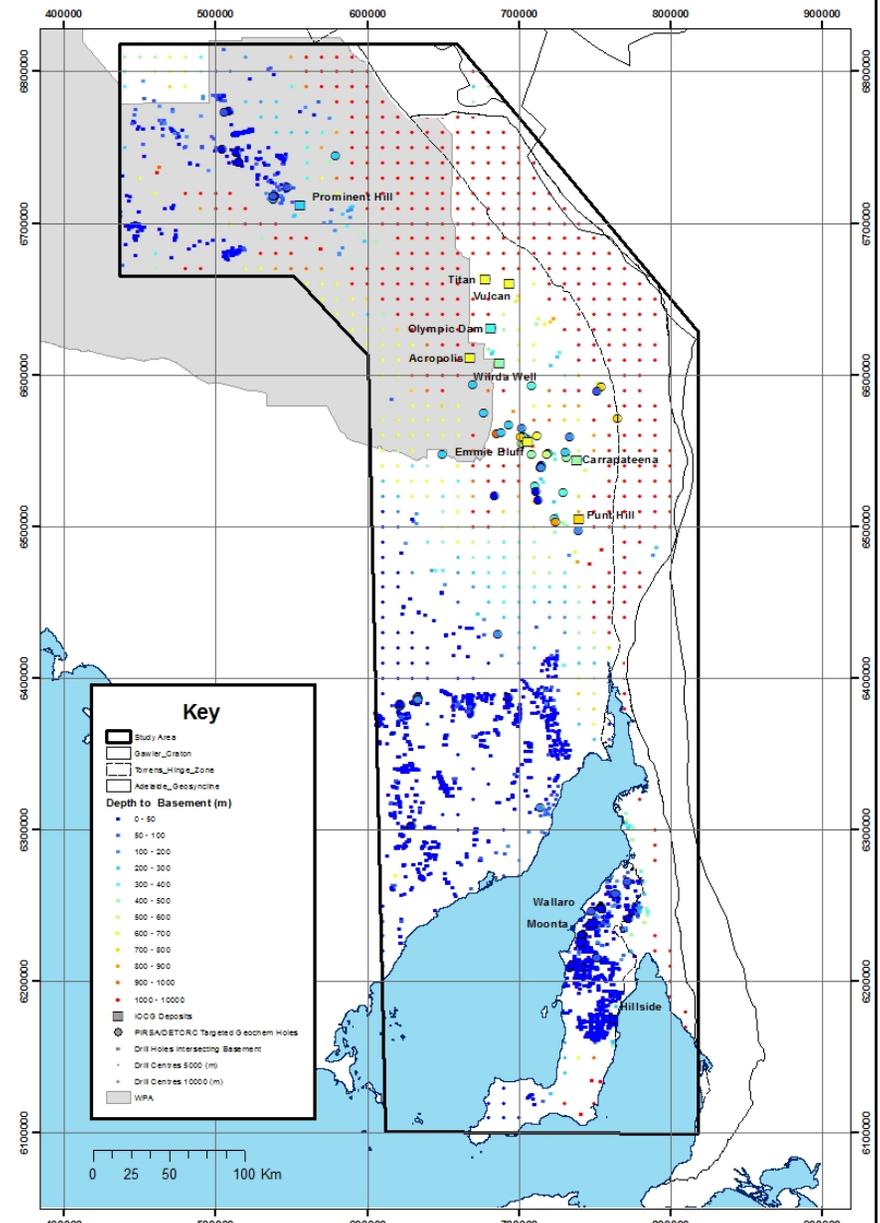
PACE Type Contract to drill 130,000m on 10km x 10km grid through cover for basement and/or unconformity sample at \$50/m: \$6.5M

(excluding where basement > 1km depth)

\$2 M invested @ \$200/m drilling =
10,000m drilling

If average hole ~ 500m then ~20
holes

(plus industry co-investment....)



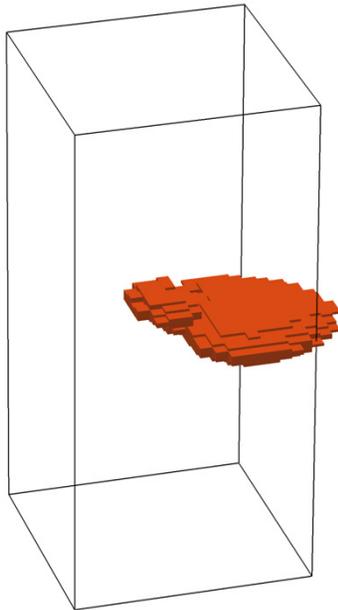
WPA Alteration Footprints (2013-2015)



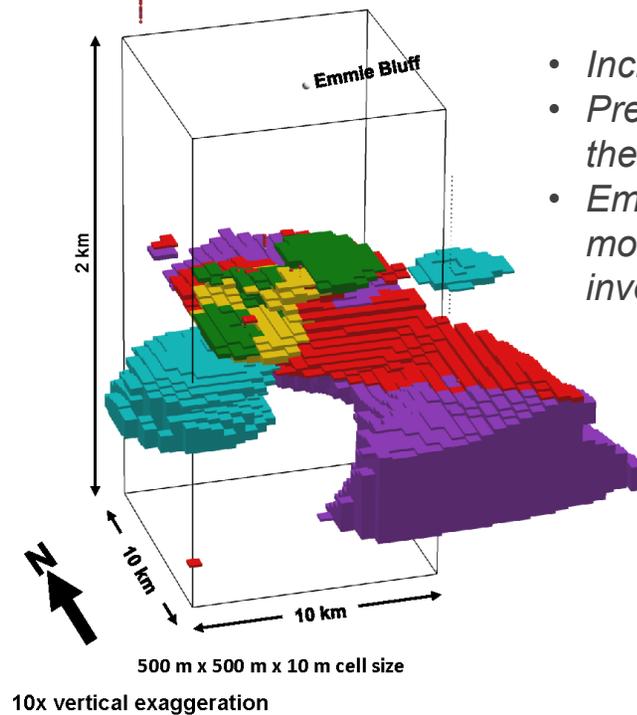
Mapping alteration in Eastern Gawler Craton (DET CRC P3.4)

- Characterisation of sunset clause release drilling samples and data in 2013-14 (e.g. Western Mining Stuart Shelf drilling from 1970s)
- Working with regional prospecting drilling in 2014-15

Emmie Bluff 3D Model Copper Shell (0.3%)



Emmie Bluff 3D Model Alteration Voxet



- Increase the size of the target
- Predict where you are within the mineral system
- Emmie Bluff case study – 3D model (geology, alteration, inversions, data)



What role for government in pre-competitive R&D?

A priority for Australia is to address the falling rate of discovery through innovative and integrated undercover exploration technologies that build on our wealth of existing pre-competitive data -

Australian Geological Surveys are working closely together to build value-adding on our pre-competitive databases as well as strategic R&D partnerships and targeted interdisciplinary research that will bring forward new discoveries under-cover.

A key driver for South Australia is to directly influence or support new discoveries through strategic international and R&D partnerships



Disclaimer



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