Australian Government

Geoscience Australia

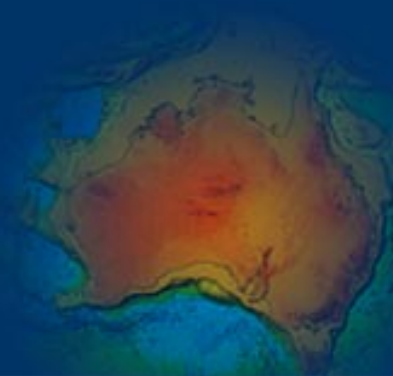
Onshore Energy Security Program:

Uranium Project and regional projects

Andy Barnicoat and Roger Skirrow

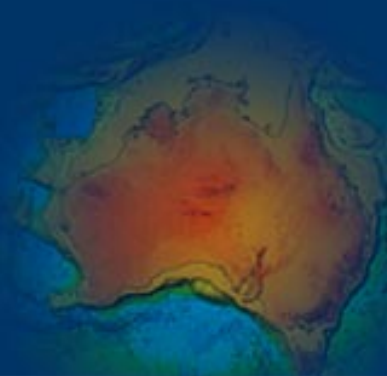
Geoscience Australia

Presented at Cameco-GA Workshop following
AusIMM *Australia's Uranium Conference*,
Darwin, 17th May 2007



Outline

- Brief review of GA's Onshore Energy Security Program (Andy)
- U systems and National Projects (Andy)
- Regional Projects and geophysical acquisition program (Roger)
- Seek input into GA's plans for precompetitive data acquisition

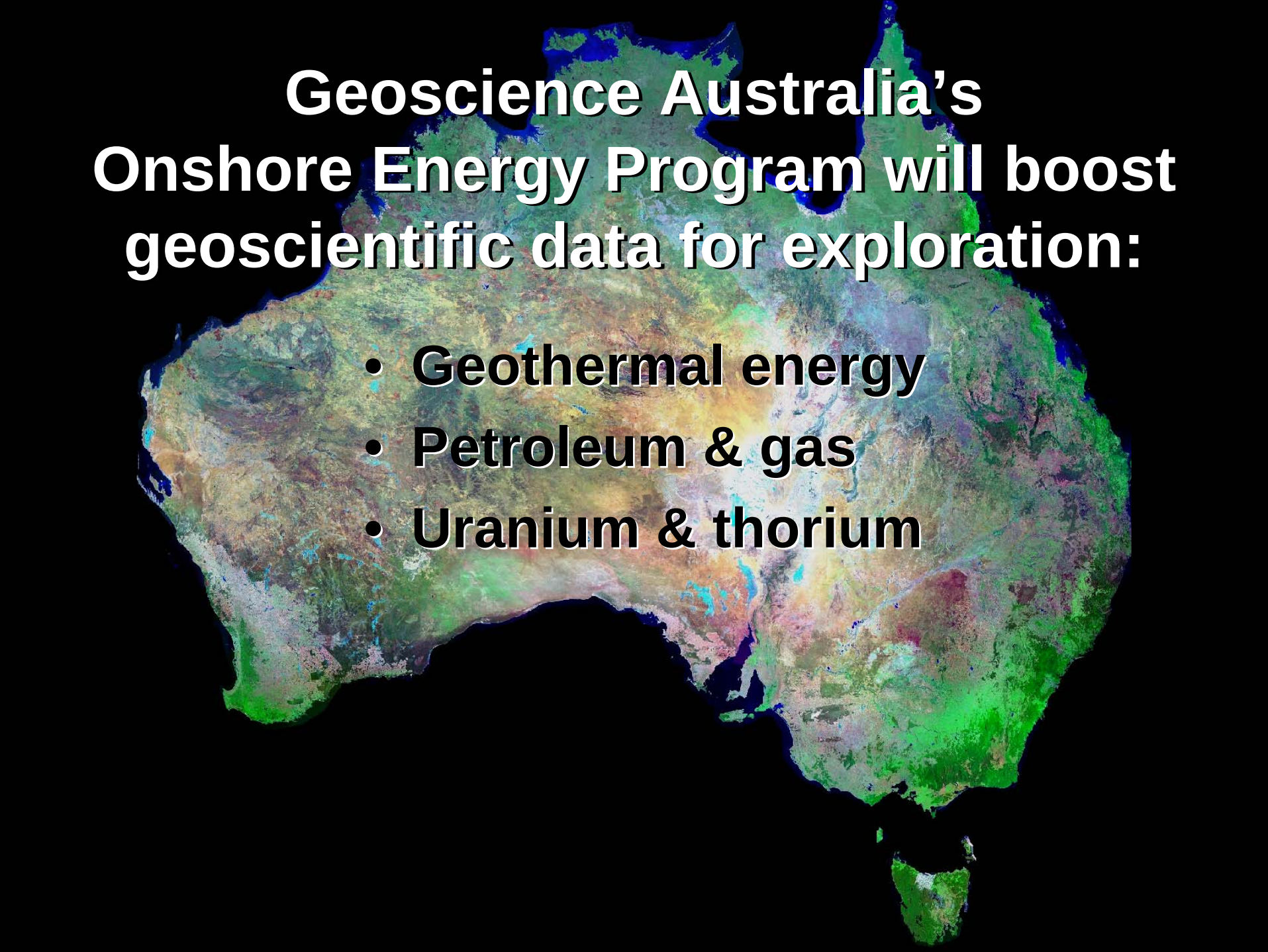


Ministerial Statement to Parliament on Energy Initiatives 14 August, 2006

“ The Government will also commit an additional $58.9 million over five years to identify onshore energy sources such as petroleum and geothermal energy.”

The Hon John Howard MP

Geoscience Australia's Onshore Energy Program will boost geoscientific data for exploration:



- Geothermal energy
- Petroleum & gas
- Uranium & thorium

Plan for the Energy Program

Aug 2006 now

June 2011

TOOLS:
Seismic
AEM
MT
Radiometrics
Mags
Gravity
Geological synthesis
Geochemistry
Geochronology
Drilling
IM

Geothermal Project

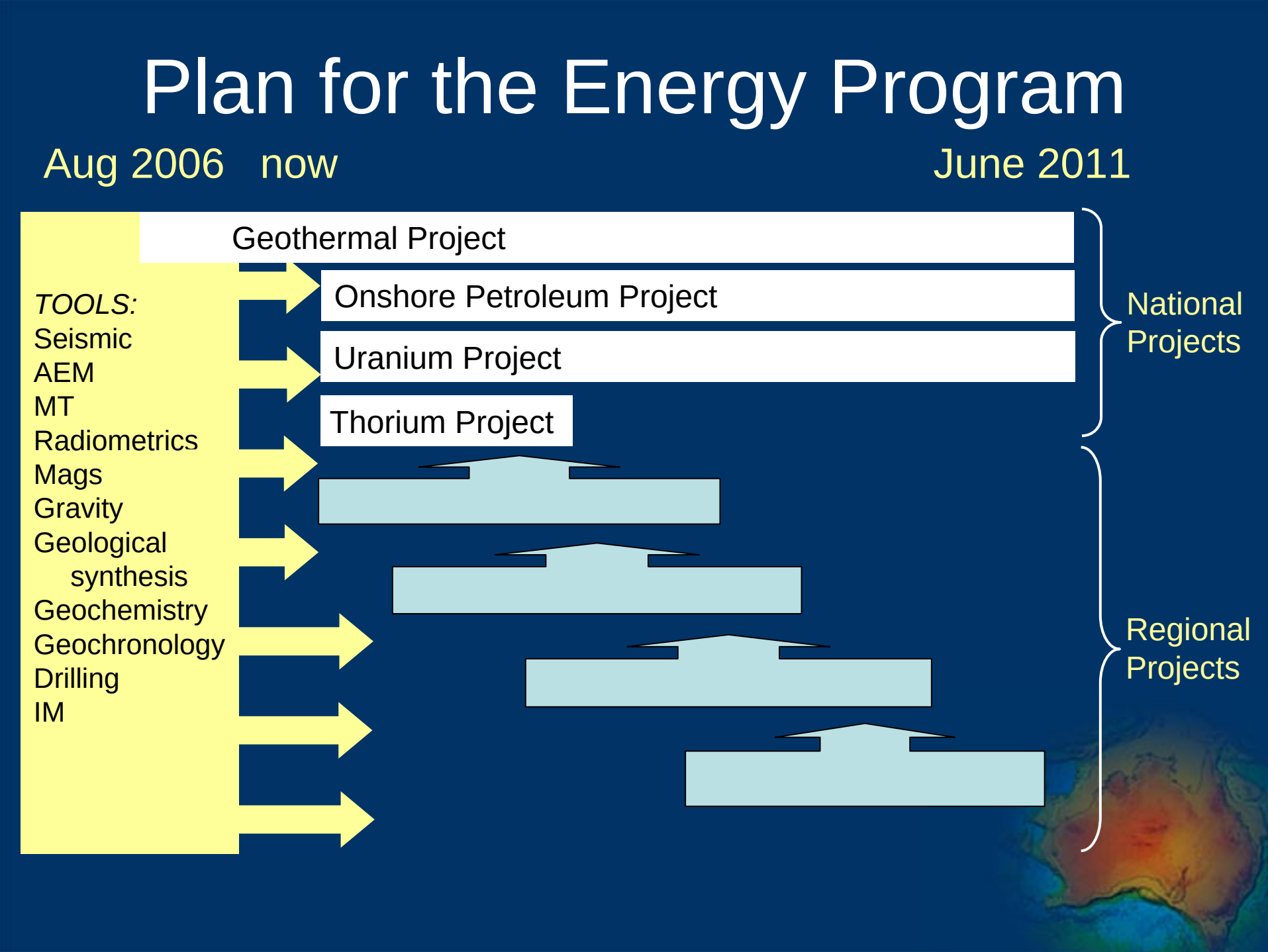
Onshore Petroleum Project

Uranium Project

Thorium Project

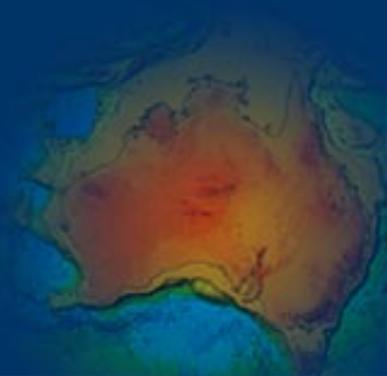
National Projects

Regional Projects



Key principles for OESP projects

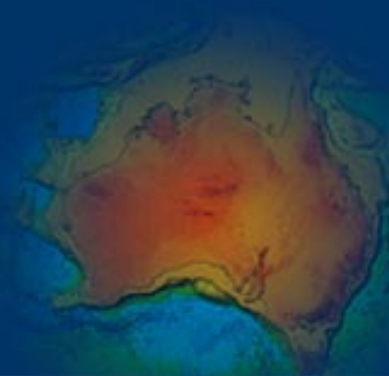
- Should have ‘material’ impact on exploration for energy-related resources
- Focus on greenfields regions
- Gaps in science knowledge to determine what & where new data are acquired
- Collaborative with State and NT geological surveys under NGA agreements



Uranium Systems Project

Three strands:

1. **Processes in U mineralising systems**
2. **National scale U distribution and potential**
3. **Regional scale U potential**



Mineral Systems: ‘5 Questions’

Q1. What is the geodynamic and P-T history of the system?

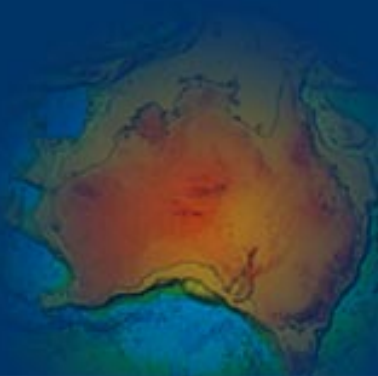
Q2. What is the architecture of the system?

Q3. What are the fluids, their sources and/or reservoirs?

Q4. What are the fluid flow drivers and pathways?

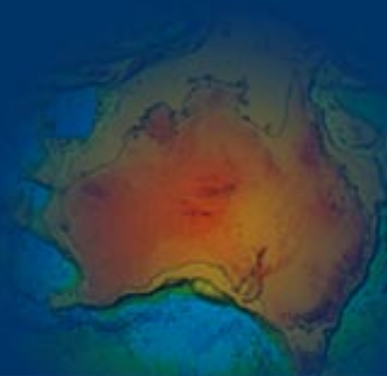
Q5. What are the metal (and sulphur) transport and depositional processes?

*Based on AGCRC and pmd*CRC work*

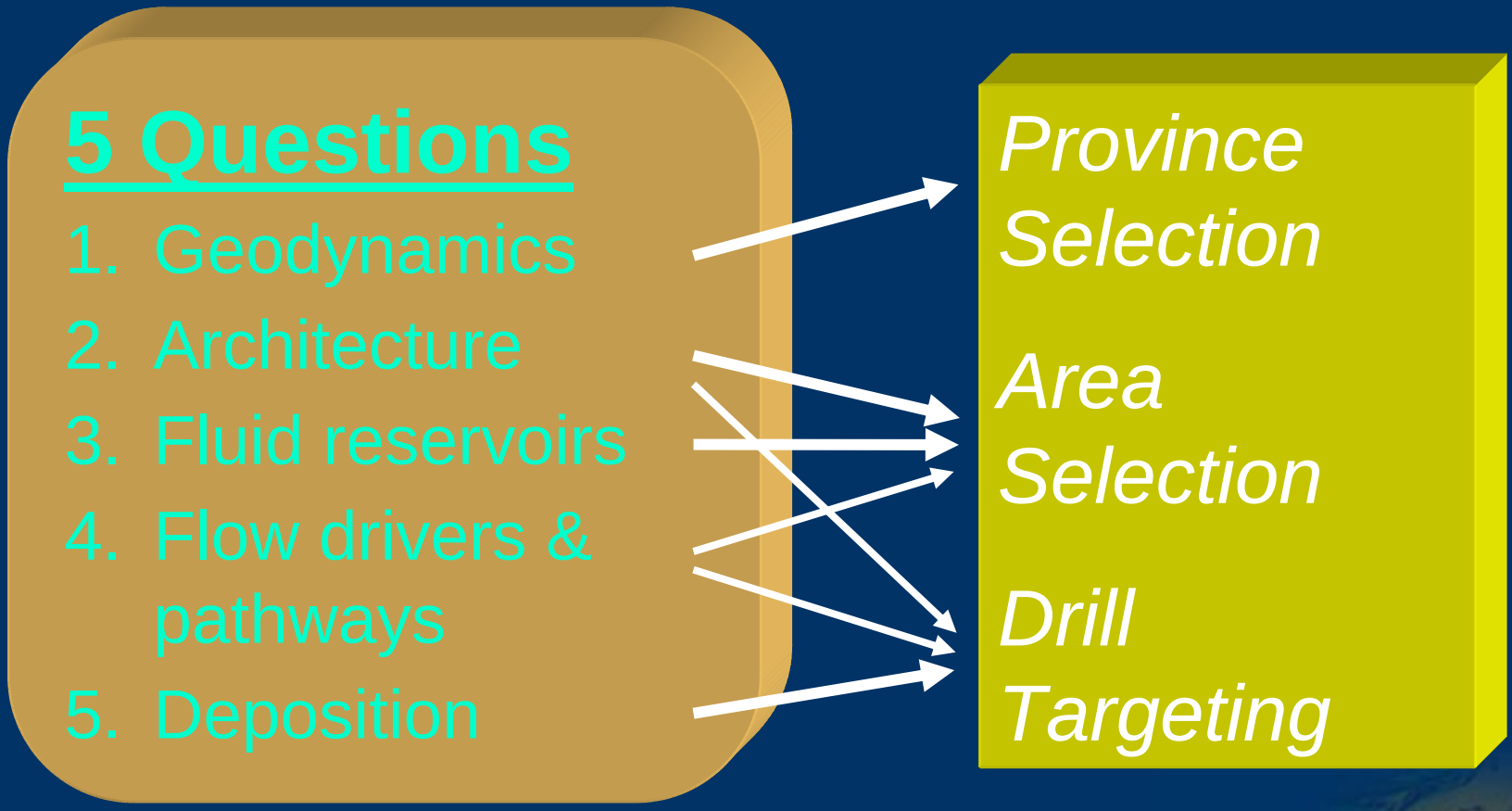


How do the 5 Questions help?

- Mineral System focus: provide an integrated framework for understanding ore deposits
- Concentrate on processes (not deposits)
- Provide the basis for a systematic (qualitative) approach to evaluating prospectivity



5 Questions and Exploration



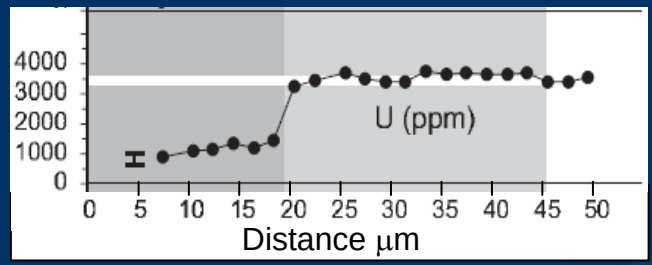
'What?'

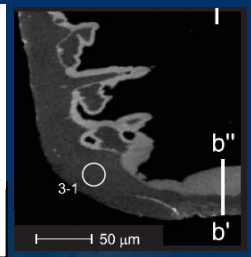
'Where?'

U systems: Processes

- Are HHP granites and/or derived U-rich sediments a pre-requisite for U mineralisation?
  - minimum grades of metal sources
- What form does the metal source need to be for sediment-hosted U systems?
  - mineralogical source of U and its distribution
- Processes of U deposition
  - beyond redox
- What is Australia's potential for as yet unrecognised U deposit styles?


Olympic Dam – BHP Billiton Ltd

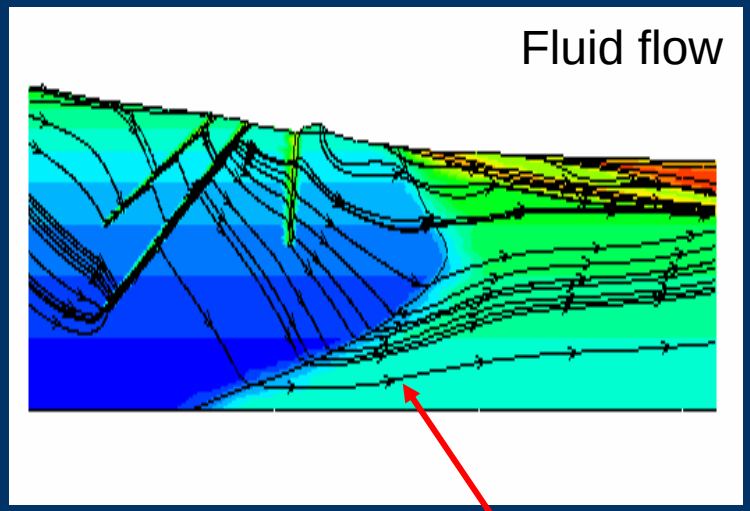


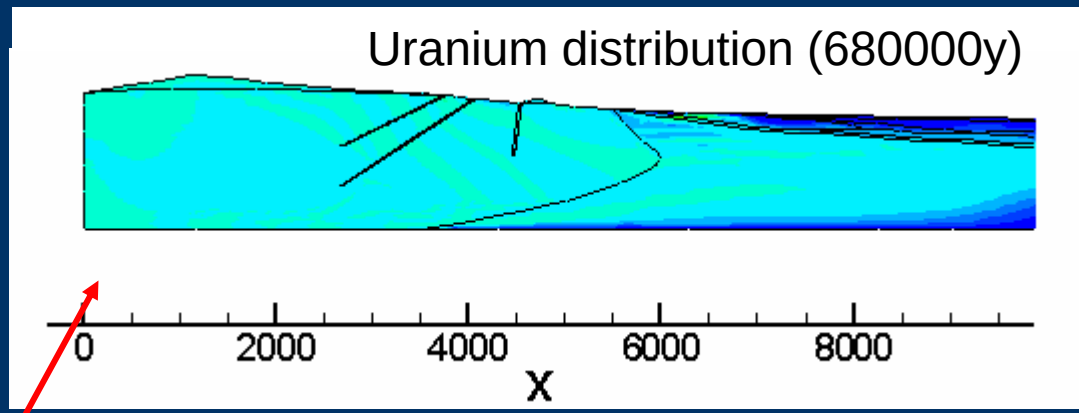


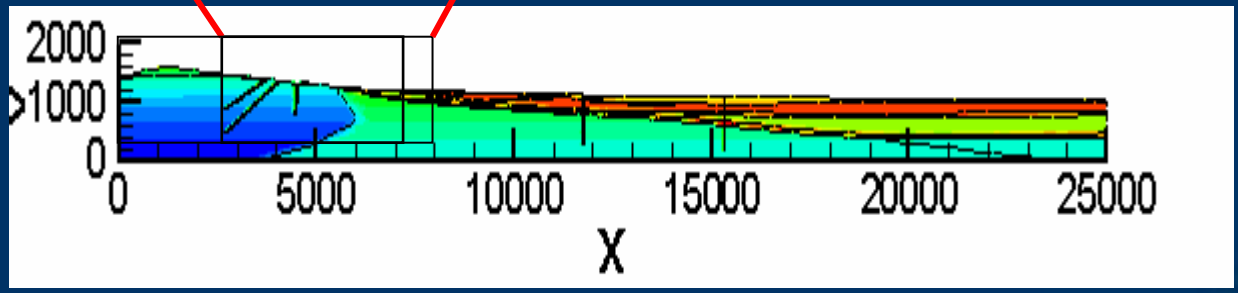
Experimental leaching of U from zircon

Geisler et al. 2003 American Mineralogist

Numerical Simulation as a Tool







Courtesy of Fiona Elmer , CSIRO

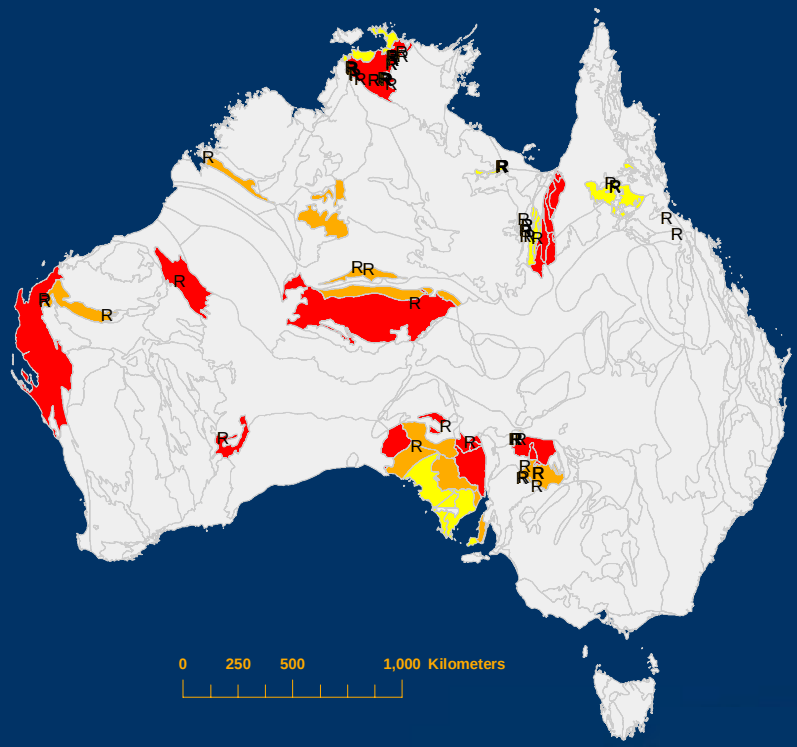
CSIRO

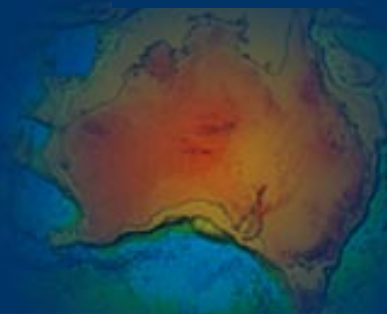
Government of South Australia
Primary Industries and Resources SA

pmd*CRC

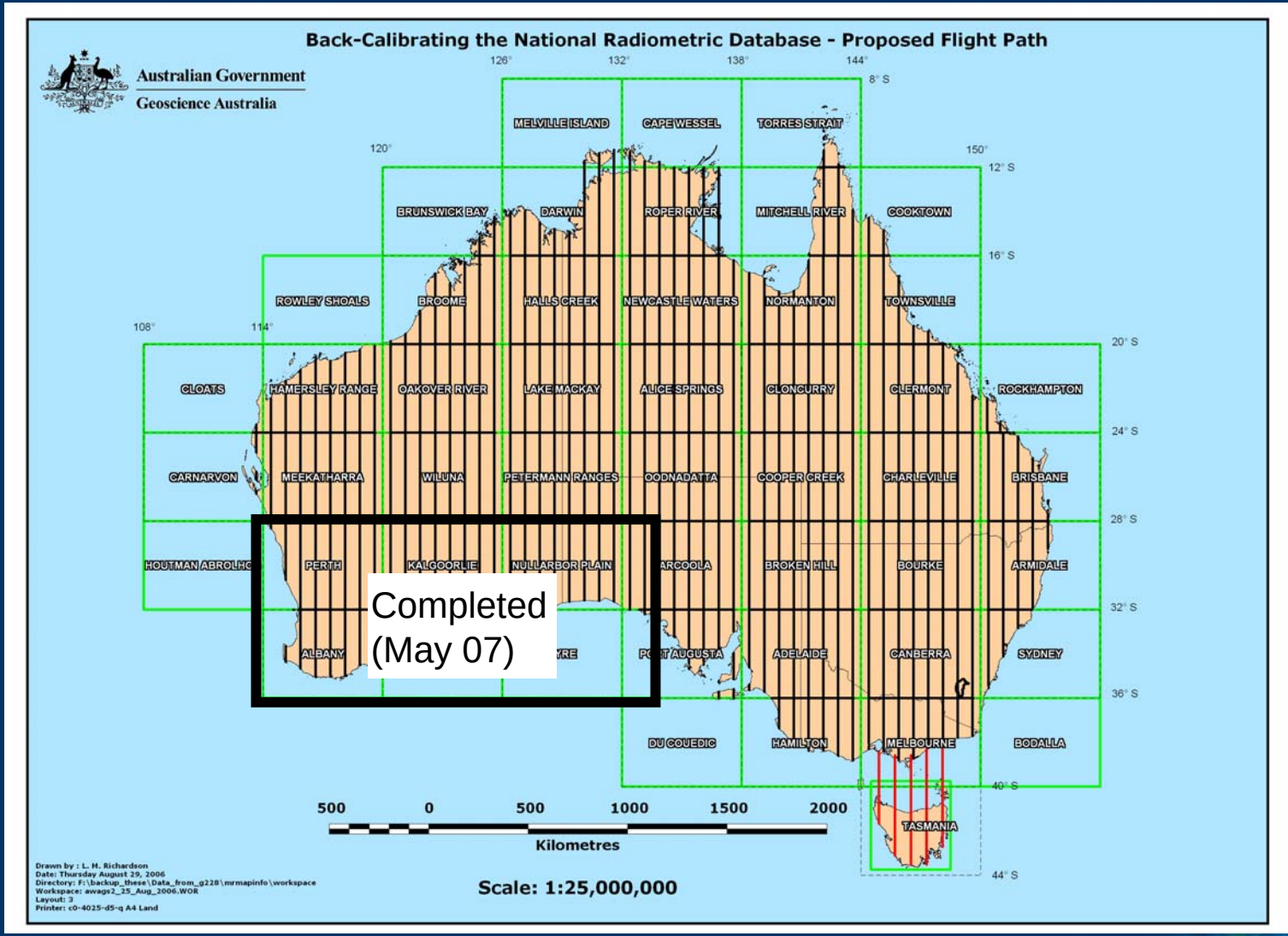
National-scale products

- Update of U occurrences database
- Distribution of U at surface:
  - Airborne radiometric survey
- Distribution of U in analysed samples:
  - National Geochemical Survey of Australia
- Distribution of U-rich igneous rocks; selected regions then continent
- Distribution of U-rich sedimentary rocks; selected regions then continent



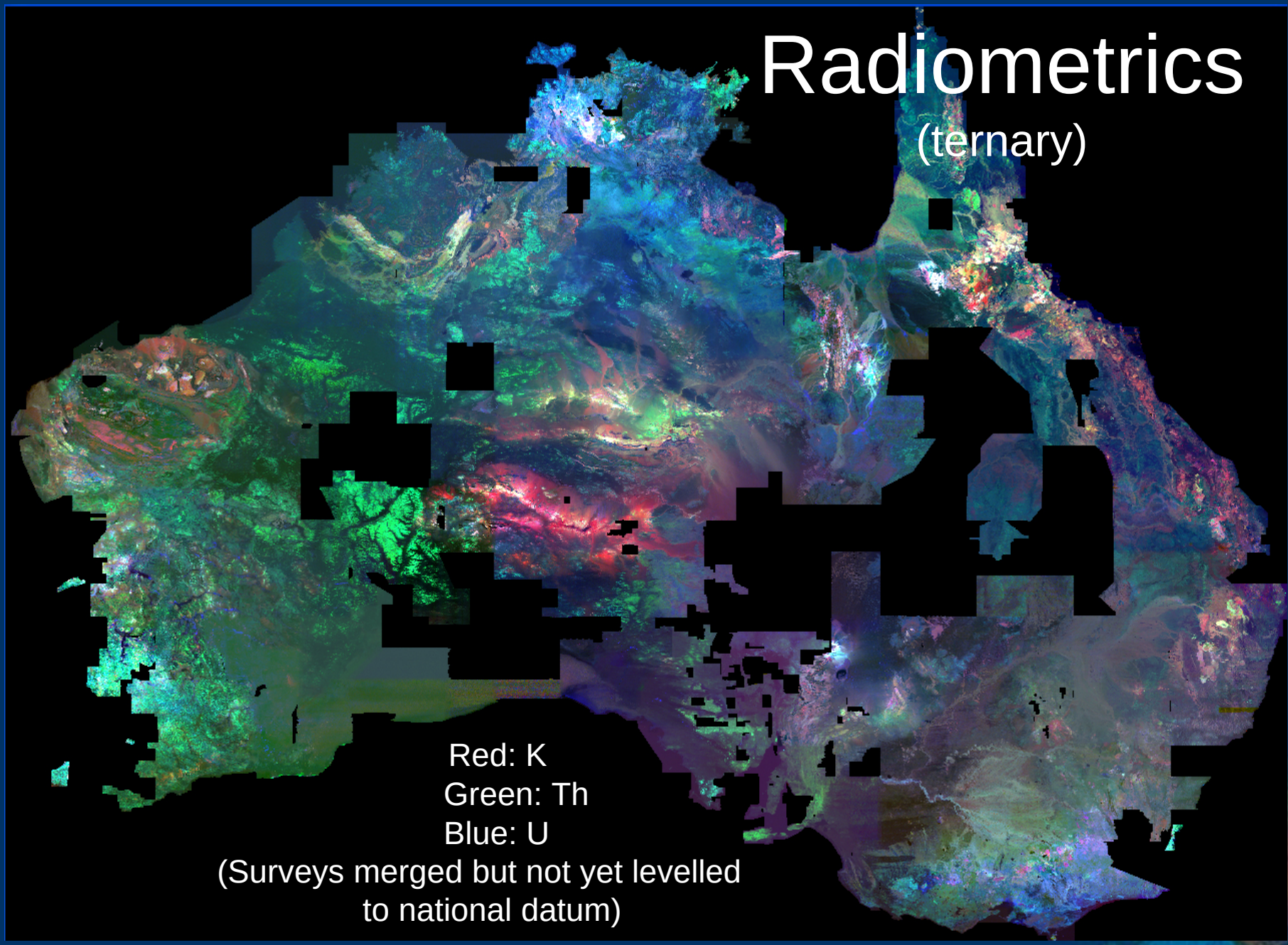


Australia Wide Airborne Geophysical Survey - AWAGS



Radiometrics

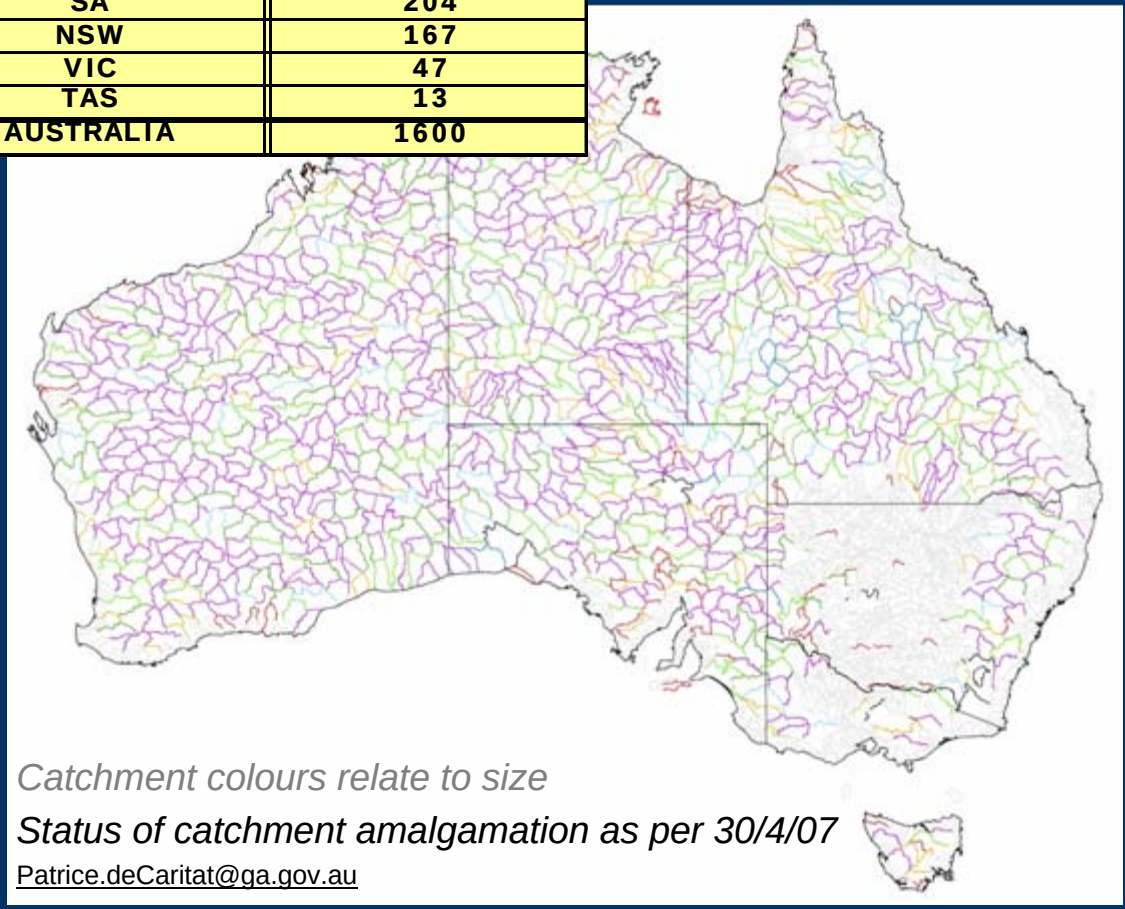
(ternary)



Red: K
Green: Th
Blue: U
(Surveys merged but not yet levelled to national datum)

National Geochemical Survey of Australia (NGSA)

S/NT	# Samples
WA	529
Qld	361
NT	279
SA	204
NSW	167
VIC	47
TAS	13
AUSTRALIA	1600



Catchment colours relate to size

Status of catchment amalgamation as per 30/4/07

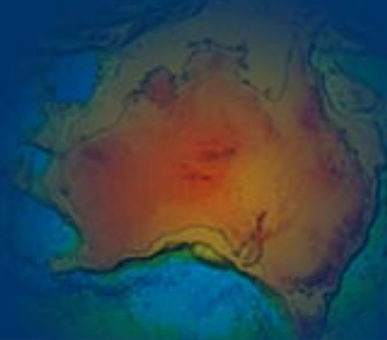
Patrice.deCaritat@ga.gov.au

- Sample transported regolith at outlets of ~1600 catchments over mainland Australia
- Average density ~1 site/5000 km^2 Sample at 2 depths (surface and ~80 cm depth)
- Total analyses for 60+ elements on 2 size fractions

Pilot Project Methodology

- Pilot studies show the methodology works in Australian landscapes & climatic conditions
  1. Divide landscape into large catchments
  2. Identify lowest point on catchment boundary
  3. Locate floodplain or equivalent depositional landscape setting
  4. Sample catchment outlet sediment at surface and at depth of ~75cm

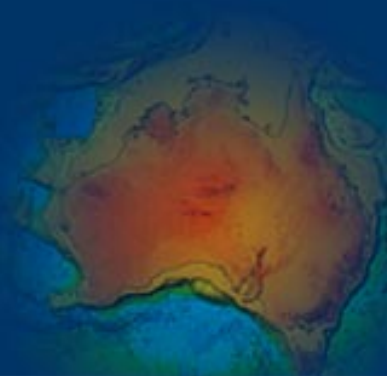
- U and Th distribution largely corroborate radiometrics patterns, but details are not straightforward (disequilibrium in the radioactive decay chain ?)



National Geochemical Survey of Australia (NGSA)

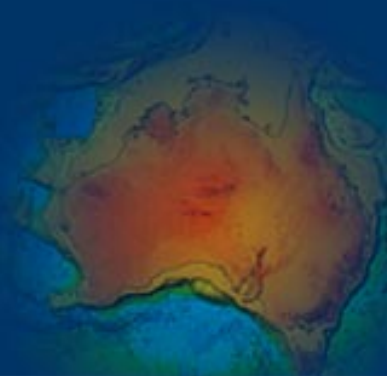
NGSA will deliver:

- Real U and Th concentration measurements that can be compared to airborne radiometric estimates
    - helps get a handle on radioactive decay chain disequilibrium processes
- U and Th concentrations where airborne radiometric data are absent
- Concentration measurements for other elements useful in assessing U mineralisation styles



Regional Projects and status of OESP data acquisition

Roger Skirrow



Uranium Systems Project

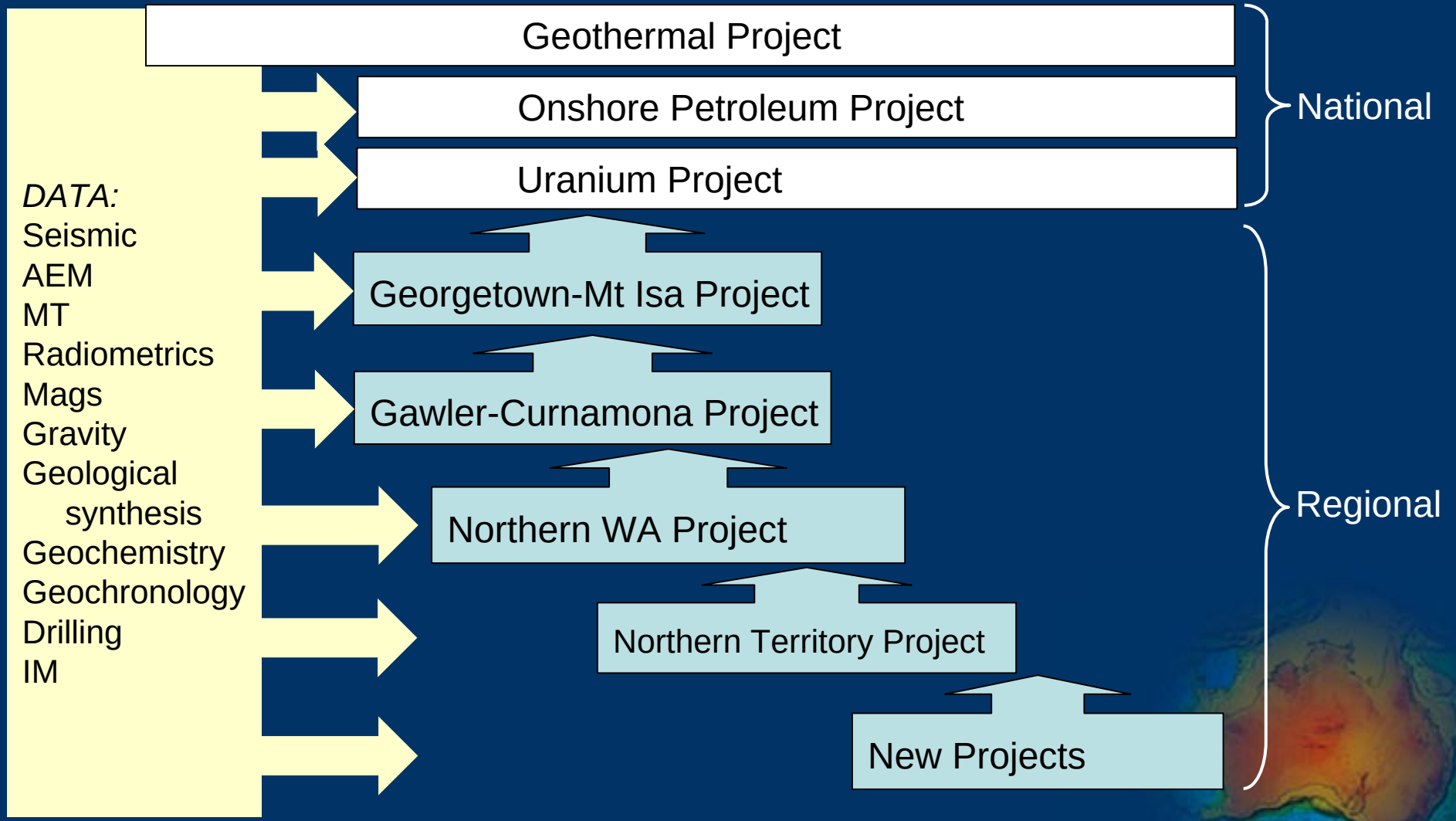
(led by Roger Skirrow)

Three modules:

1. **Processes in U mineralising systems**
   - U sources, transport, deposition
2. **National scale U distribution**
   - Radiometrics
   - Maps of U-rich igneous & sed (source) rocks
   - National Geochemical Survey of Australia
3. **Regional assessments of U potential**

Plan for the Energy Program

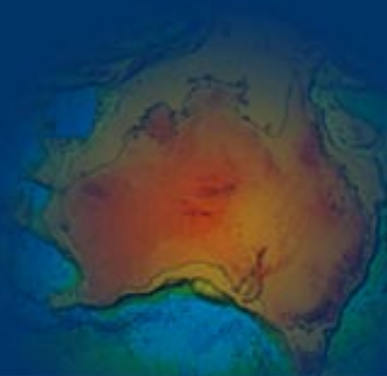
Aug 2006 now — June 2011



Regional Projects:

‘Umbrellas’ for data acquisition & assessment of energy potential (including U)

Science questions & appropriate data acquisition currently being scoped

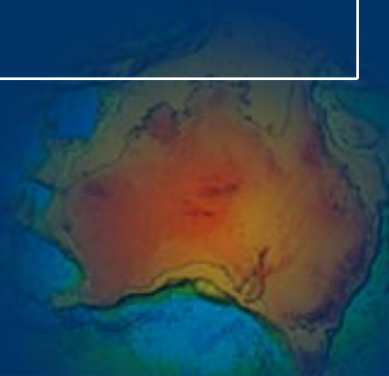


Regional work on U systems

Knowledge gaps	Data/methods	Products
Basin / basement architecture & stratig of unconformity-related & sandstone-U systems	AEM, shallow seismic, geochronology, sequence stratigraphy, drilling?	3D solid geology; AEM datasets; Seismic interps; Geochron data

Regional projects

Uranium Project



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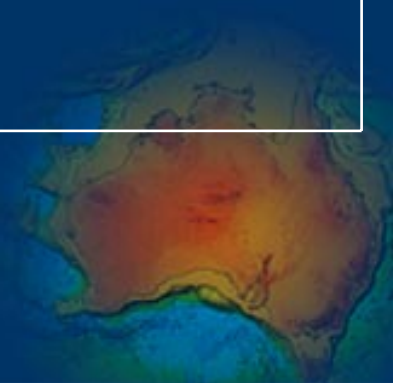
Crustal architecture & tectonics of U-rich vs U-poor IOCG systems	Seismic interp, MT, geochron, drilling?	3D solid geology; Seismic interps; Geochron data

Regional projects

Uranium Project



Regional work on U systems

Regional projects

Uranium Project

Knowledge gaps	Data/methods	Products
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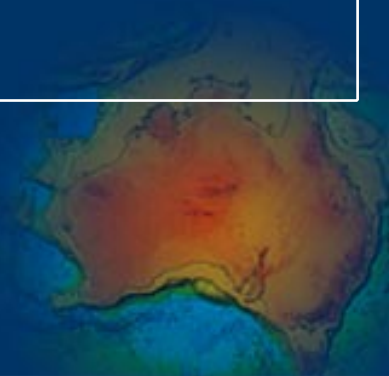
Crustal architecture & tectonics of U-rich vs U-poor IOCG systems	Seismic interp, MT, geochron, drilling?	3D solid geology; Seismic interps; Geochron data
Timing of U processes	Dating of alteration & U mineralisation	Geochron data; Regional time-slice maps of U events



Regional work on U systems

Uranium Project Regional projects

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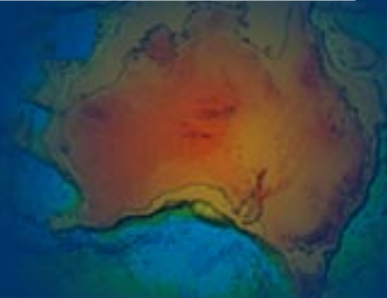
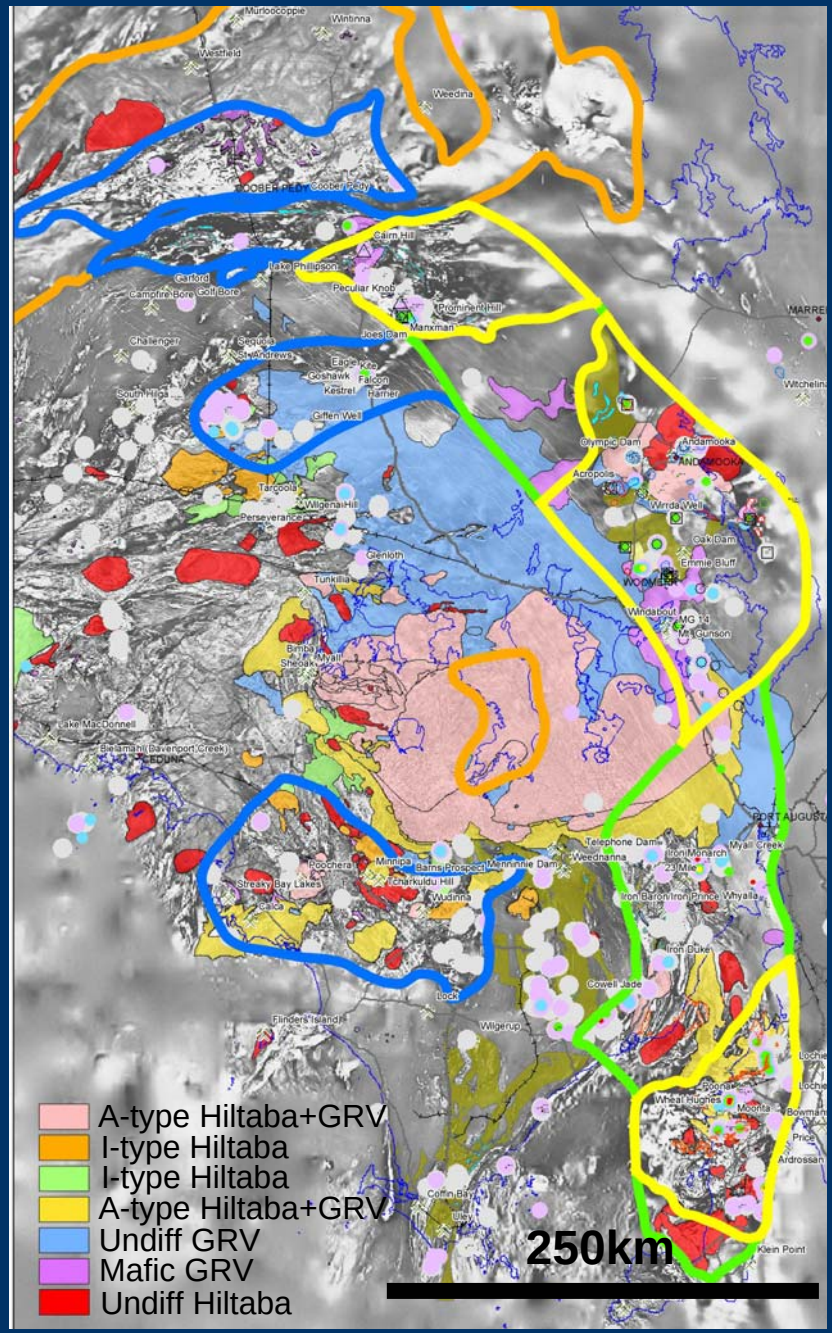
Crustal architecture & tectonics of U-rich vs U-poor IOCG systems	Seismic interp, MT, geochron, drilling?	3D solid geology; Seismic interps; Geochron data
Timing of U processes	Dating of alteration & U mineralisation	Geochron data; Regional time-slice maps of U events
Regional U prospectivity	Synthesis of new & existing data with U systems learnings	Maps of ranked potential for U (-Cu-Au) mineralisation



IOCG-U Potential Map, Gawler Craton

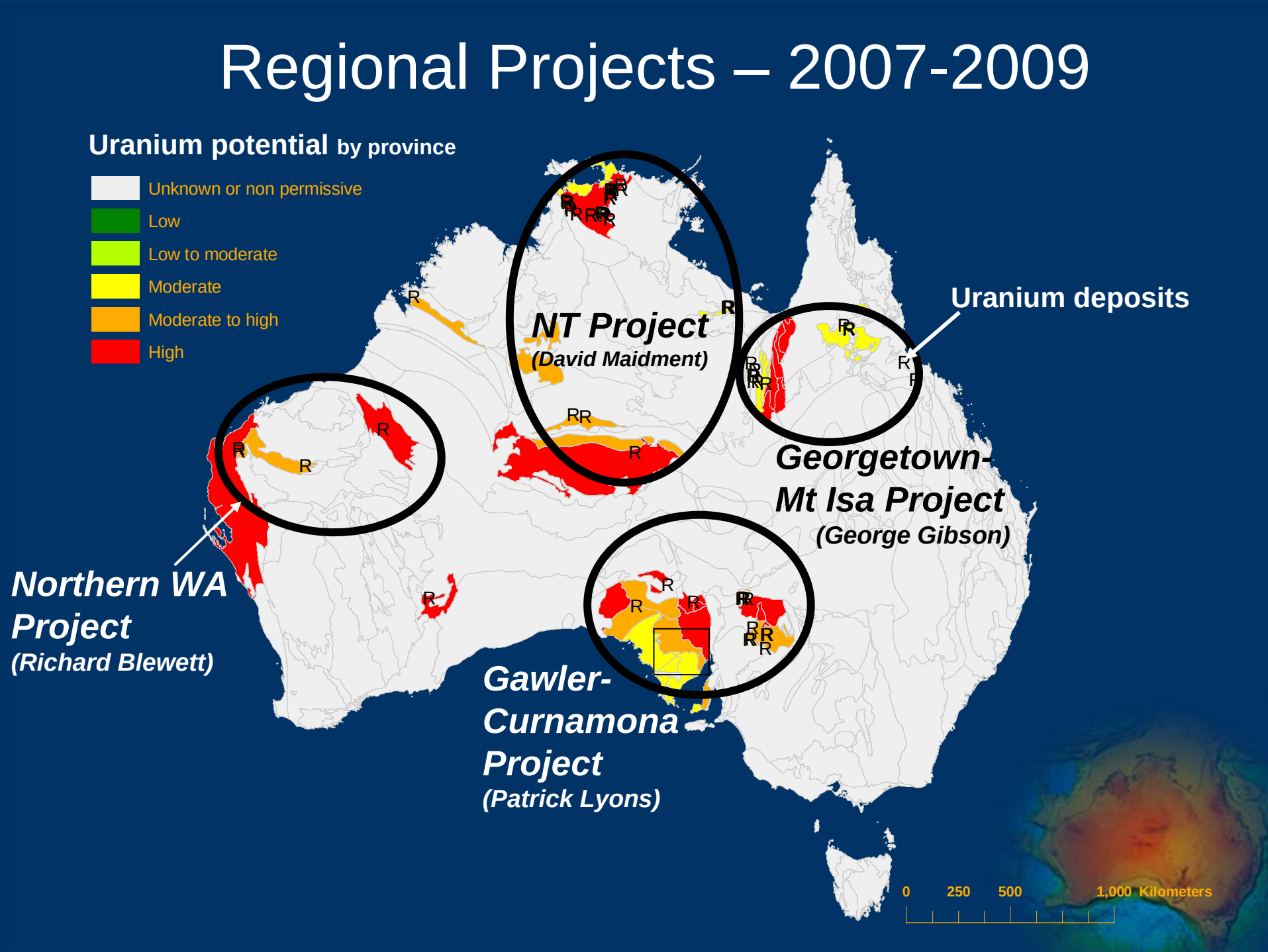
- **Areas ranked by potential, based on presence of 'essential ingredients' of IOCG mineral system**



1 – v. high potential
2 – high
3 – moderate-high
4 – moderate

Map available as pdf from:
www.ga.gov.au/minerals/research/regional/gawler/gaw_mapgis.jsp

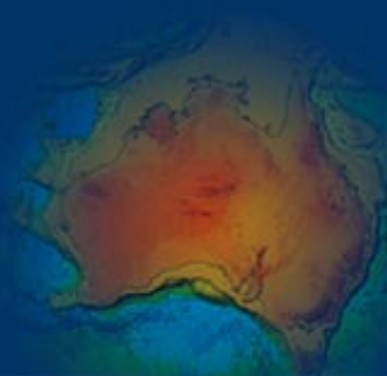
Regional Projects – 2007-2009



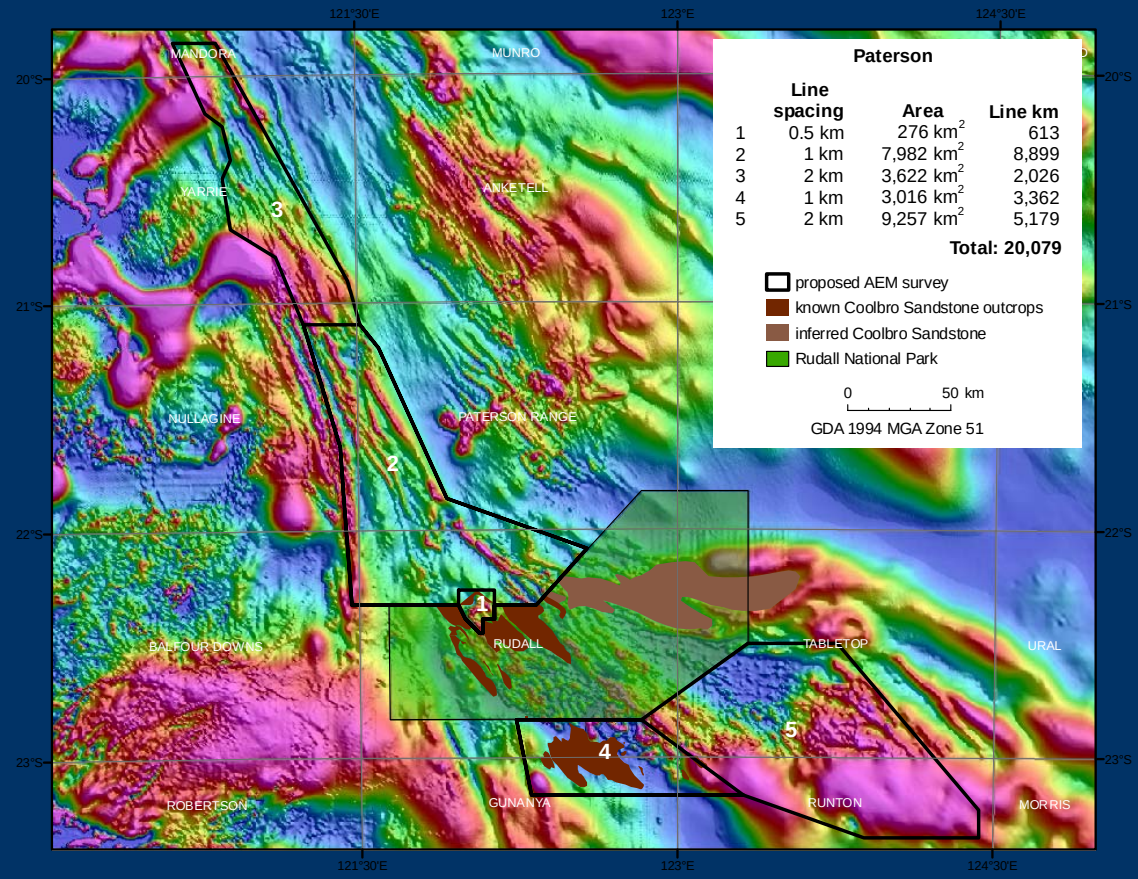
Northern WA Project – Outputs for 2007-2008

- Output 1 - Compilation and analysis of available geological and geophysical information (GIS, etc)
- Output 2 - Project Plan outlining the energy-related scientific questions to be addressed by the project and the tools to be employed.
- Output 3 - Processed and interpreted AEM data and progress report.

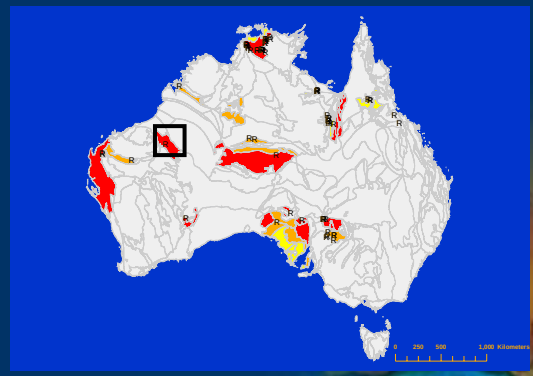
(similar for other regional projects)

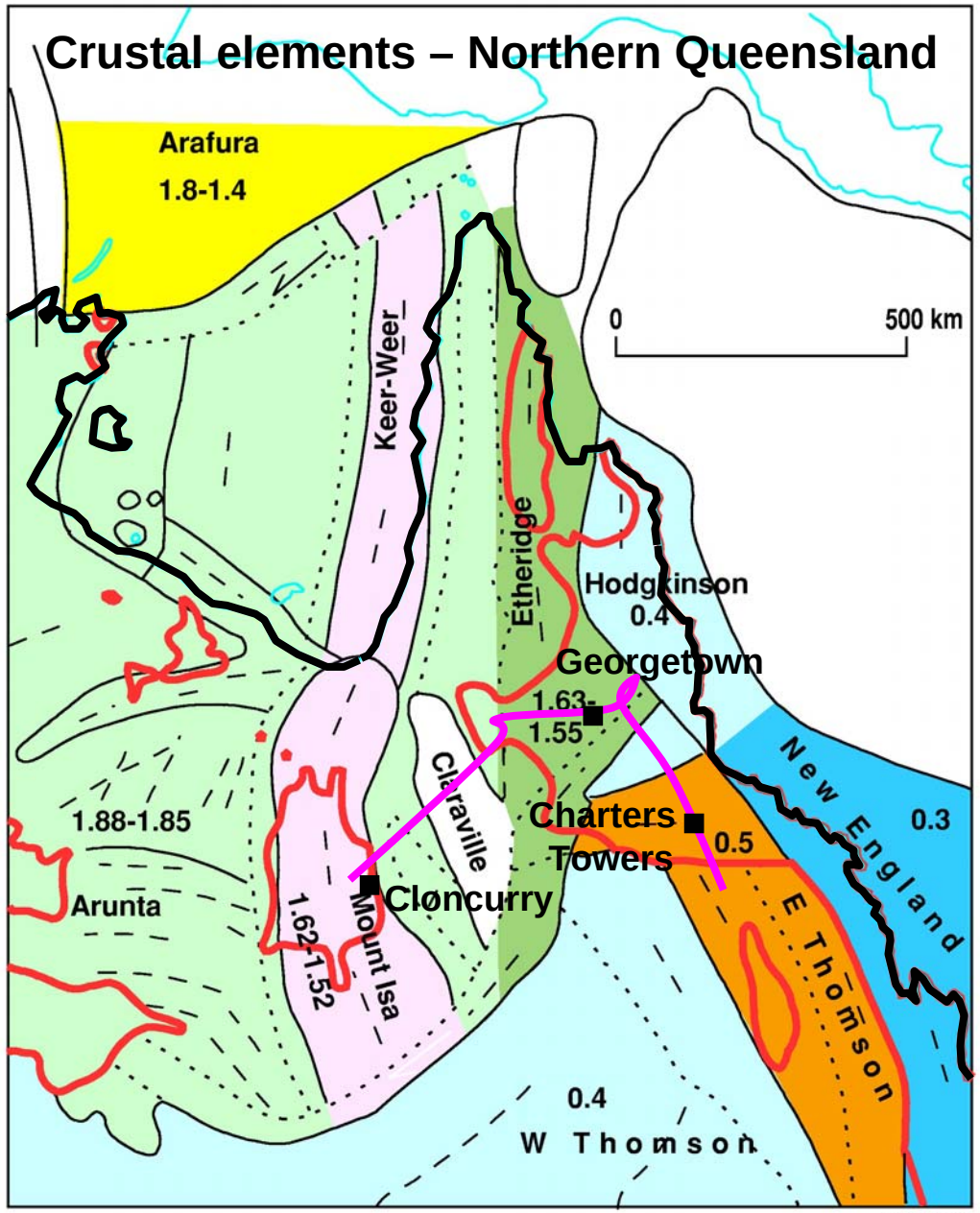


Paterson Airborne EM Survey



- Targeting unconformity-related & sandstone-hosted uranium systems
- Line spacing 0.5 to 2km
- Total 20,000 line km
- Expected to commence July 2007, 5-6 months to complete



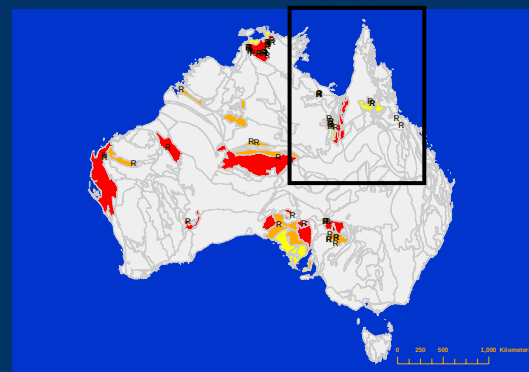


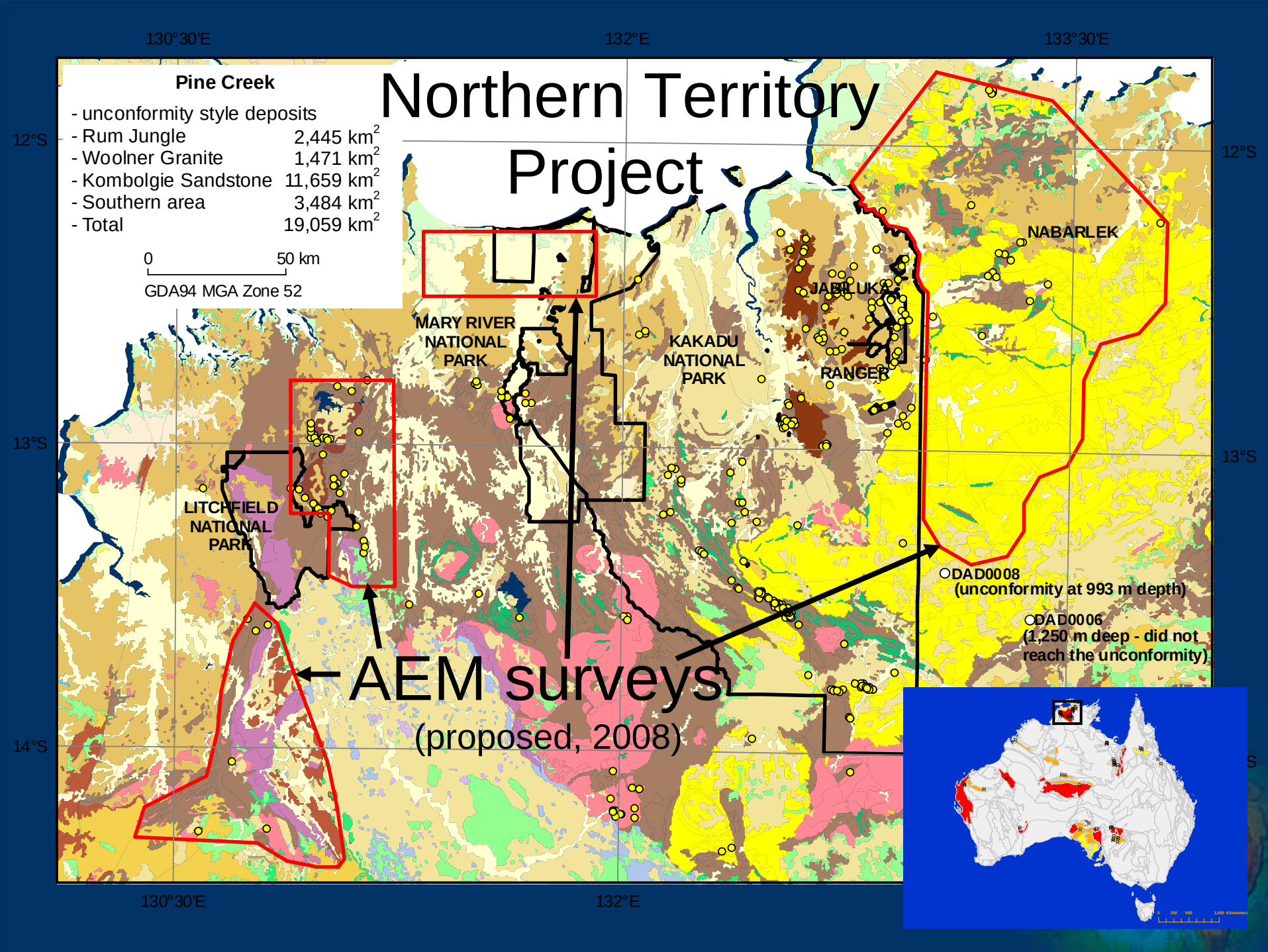
Georgetown-Mt Isa Project

Seismic lines

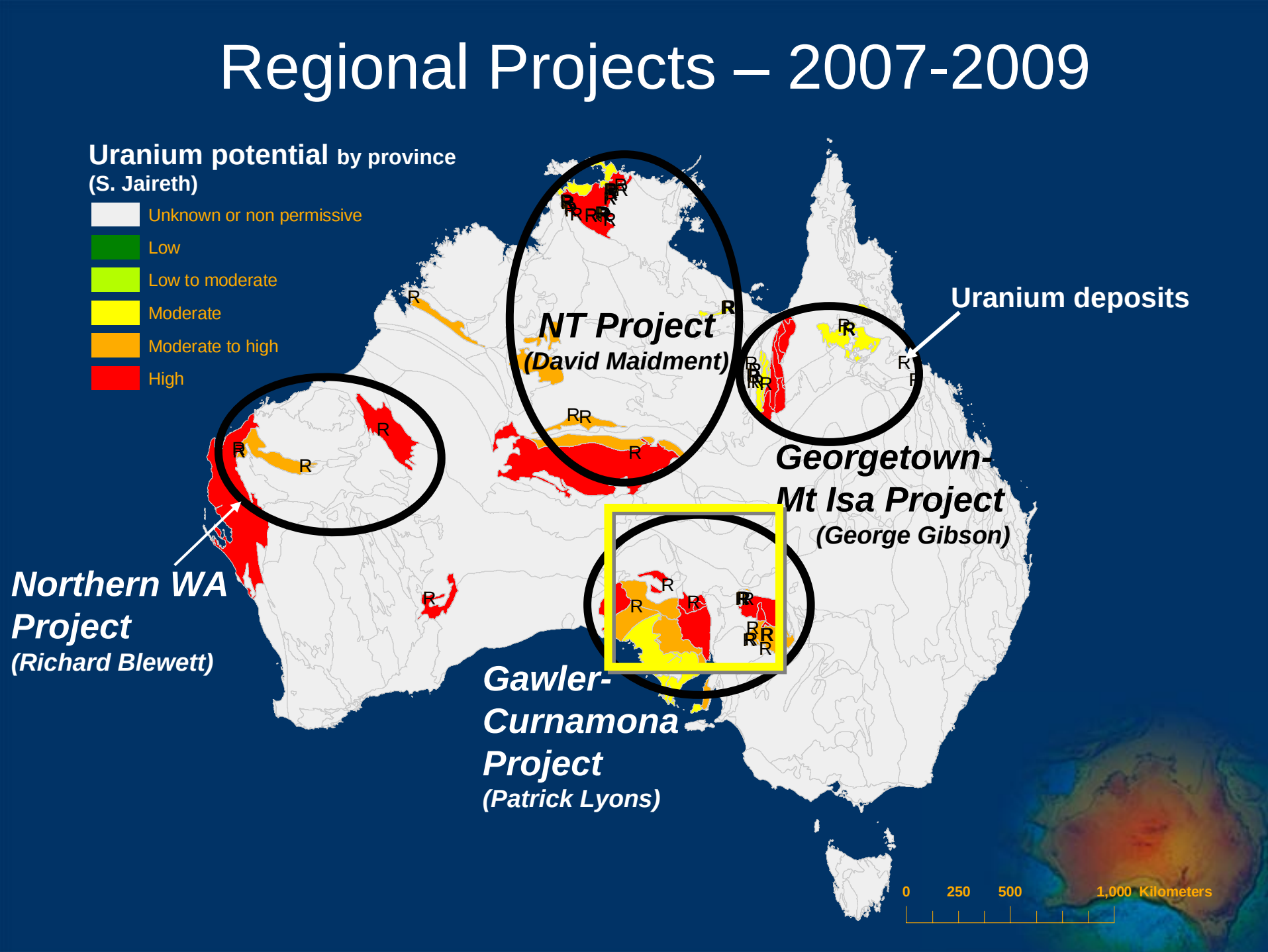
(Commenced May 2007, Energy Program + GSQ)

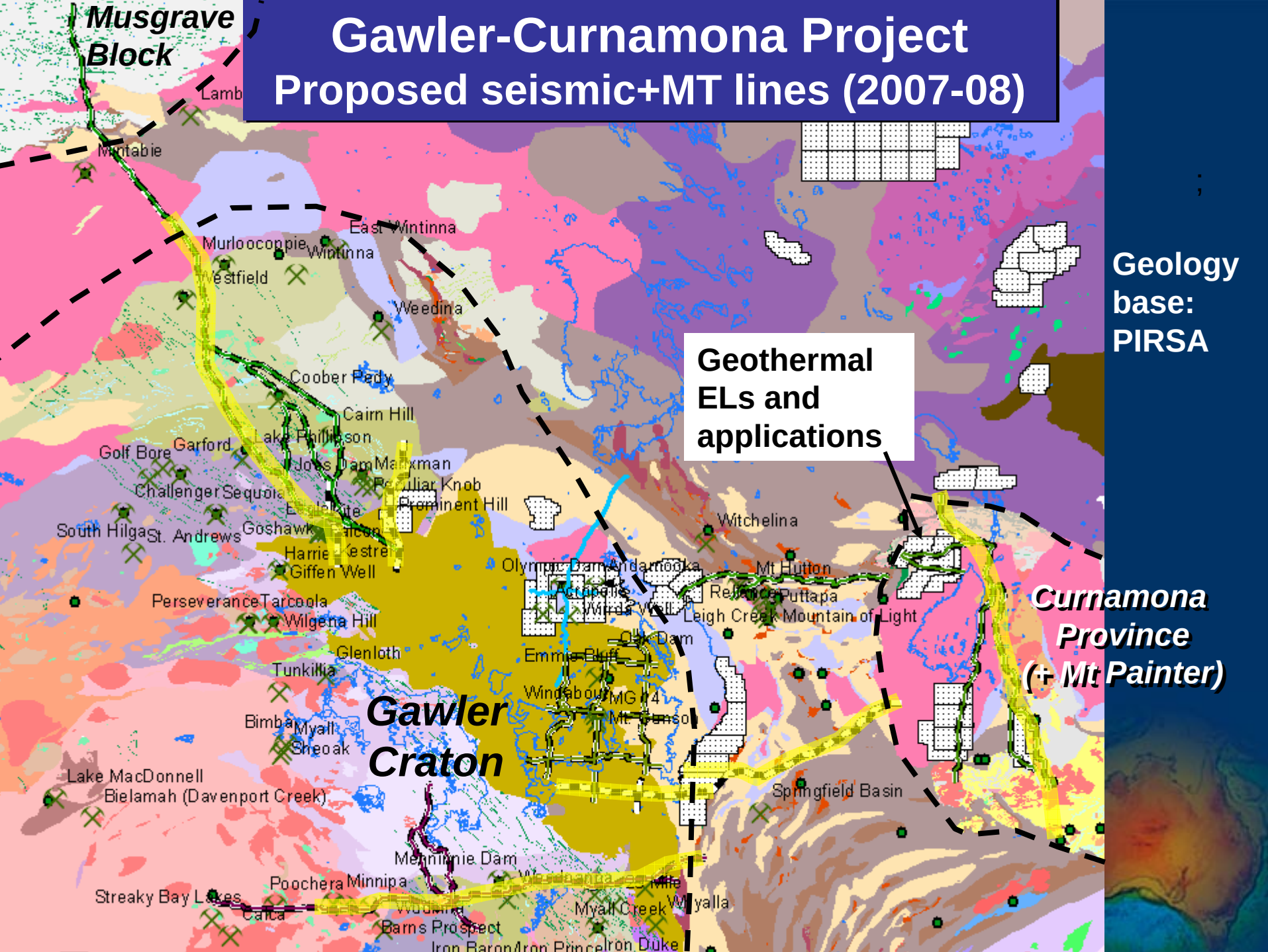
- Tectonic relationships between Mt Isa, Georgetown (Etheridge) & Palaeozoic provinces
- Geothermal potential in Georgetown (Etheridge) Prov
- Uranium potential:
  - Unconformity U
  - Sandstone U
  - IOCG-U



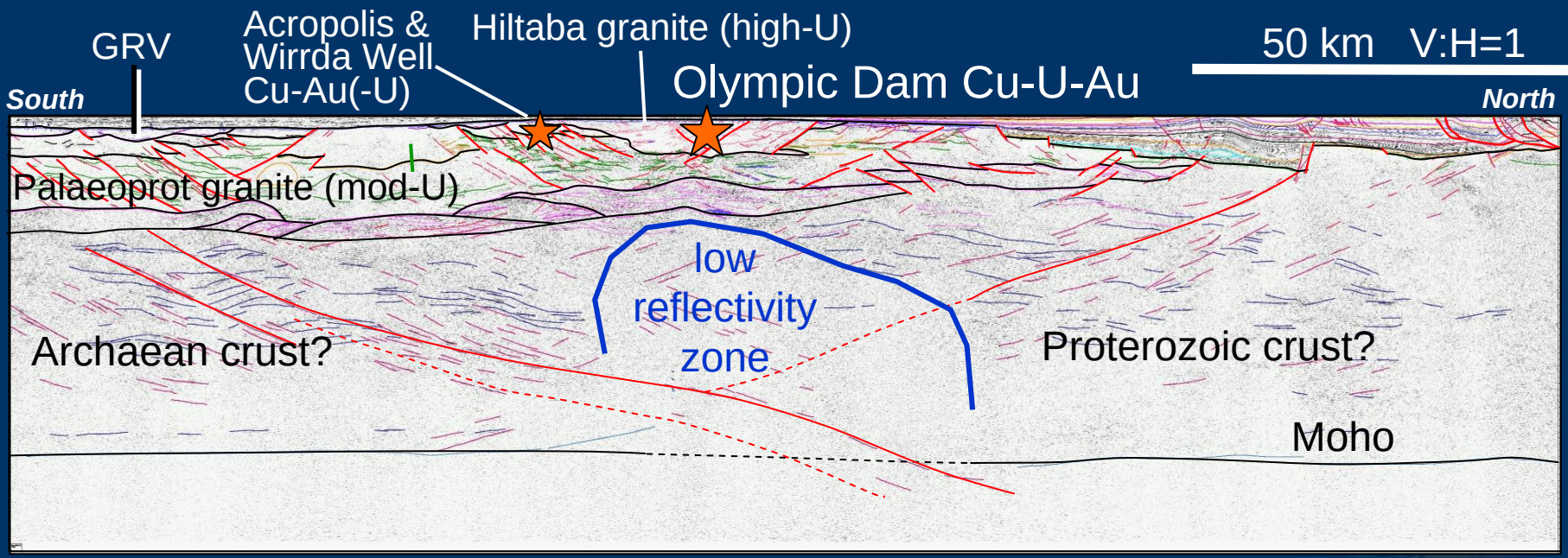

130°30'E
132°E
133°30'E
12°S
13°S
14°S
Pine Creek
- unconformity style deposits
- Rum Jungle 2,445 km2
- Woolner Granite 1,471 km2
- Kombolgie Sandstone 11,659 km2
- Southern area 3,484 km2
- Total 19,059 km2
0
50 km
GDA94 MGA Zone 52
Northern Territory Project
NABARLEK
JABILUKA
RANGER
MARY RIVER NATIONAL PARK
KAKADU NATIONAL PARK
LITCHFIELD NATIONAL PARK
DAD0008
(unconformity at 993 m depth)
DAD0006
(1,250 m deep - did not reach the unconformity)
AEM surveys
(proposed, 2008)

Regional Projects – 2007-2009




Musgrave Block
Gawler-Curnamona Project
Proposed seismic+MT lines (2007-08)
Geology base: PIRSA
Geothermal ELs and applications
Curnamona Province (+ Mt Painter)
Gawler Craton
Mintabie
East Wintinna
Murlooconpie
Wintinna
Westfield
Weedina
Coober Pedy
Cairn Hill
Garford
Golf Bore
Challenger
South Hilga
St. Andrews
Goshawk
Prominent Hill
Witchelina
Mt Hutton
Puttapa
Leigh Creek
Mountain of Light
Andamooka
Olympic Dam
Perseverance
Tarcoola
Wilgena Hill
Glenloth
Tunkillia
Emmie Bluff
Oak Dam
Bimba
Myall
Sheoak
Lake MacDonnell
Bielamah (Davenport Creek)
Springfield Basin
Menninnie Dam
Poochera
Minnipa
Streaky Bay Lakes
Myall Creek
Wyalla
Barns Prospect
Iron Baron/Iron Prince
Iron Duke

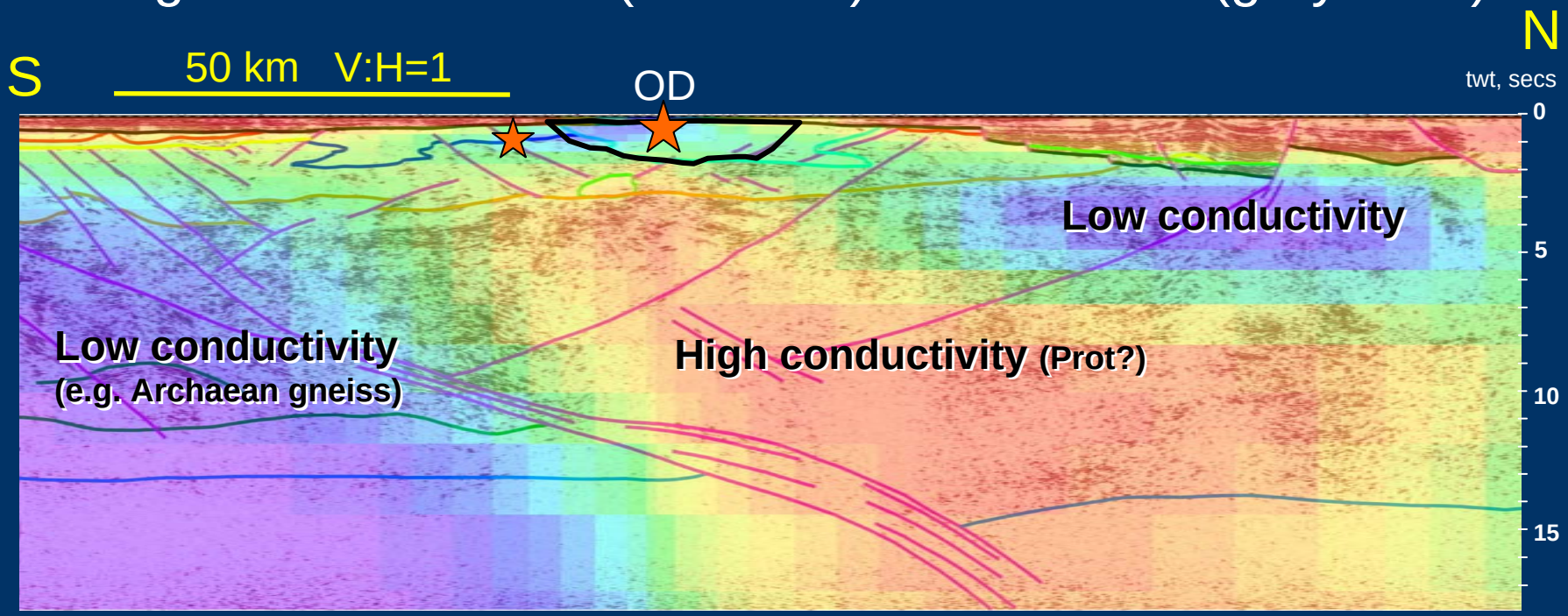
Olympic Dam region seismic section (2003)



- **IOCG-U above margin of Archaean cratonic core**
- **U-rich vs U-poor IOCGs: granites imaged**

Olympic Dam region:

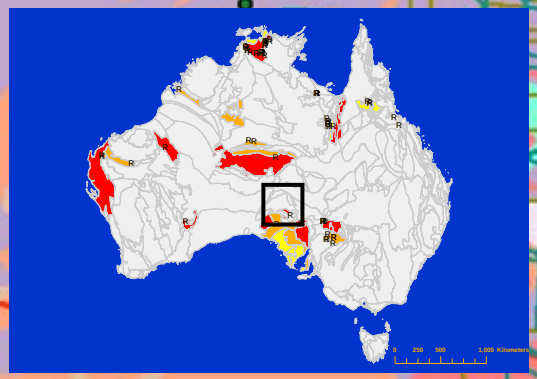
Magneto-telluric data (coloured) over seismic (greyscale)



- **Crustal-scale (electrically) conductive zone beneath U-rich Olympic Dam IOCG deposit**
- **Do U-poor IOCGs have similar crustal structure?**

Coloured MT image courtesy R. Gill, G. Heinson, N. Direen at The University of Adelaide, and published in Thiel et al. (2004).
MT image overlays GA-PIRSA seismic data with interpretive linework by GA-PIRSA-UofA (Lyons et al., 2005).

Northern Gawler Craton to Musgrave Block



1) Prominent Hill line (135km)

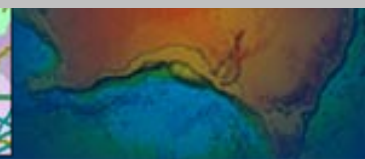
Energy-related aims:

- Compare structure with OD line (IOCGU)
- Pandurra Fm (u/c U)
- Geothermal

2) N-S line (~550km to NT; 330km to Officer Basin margin)

Energy-related aims:

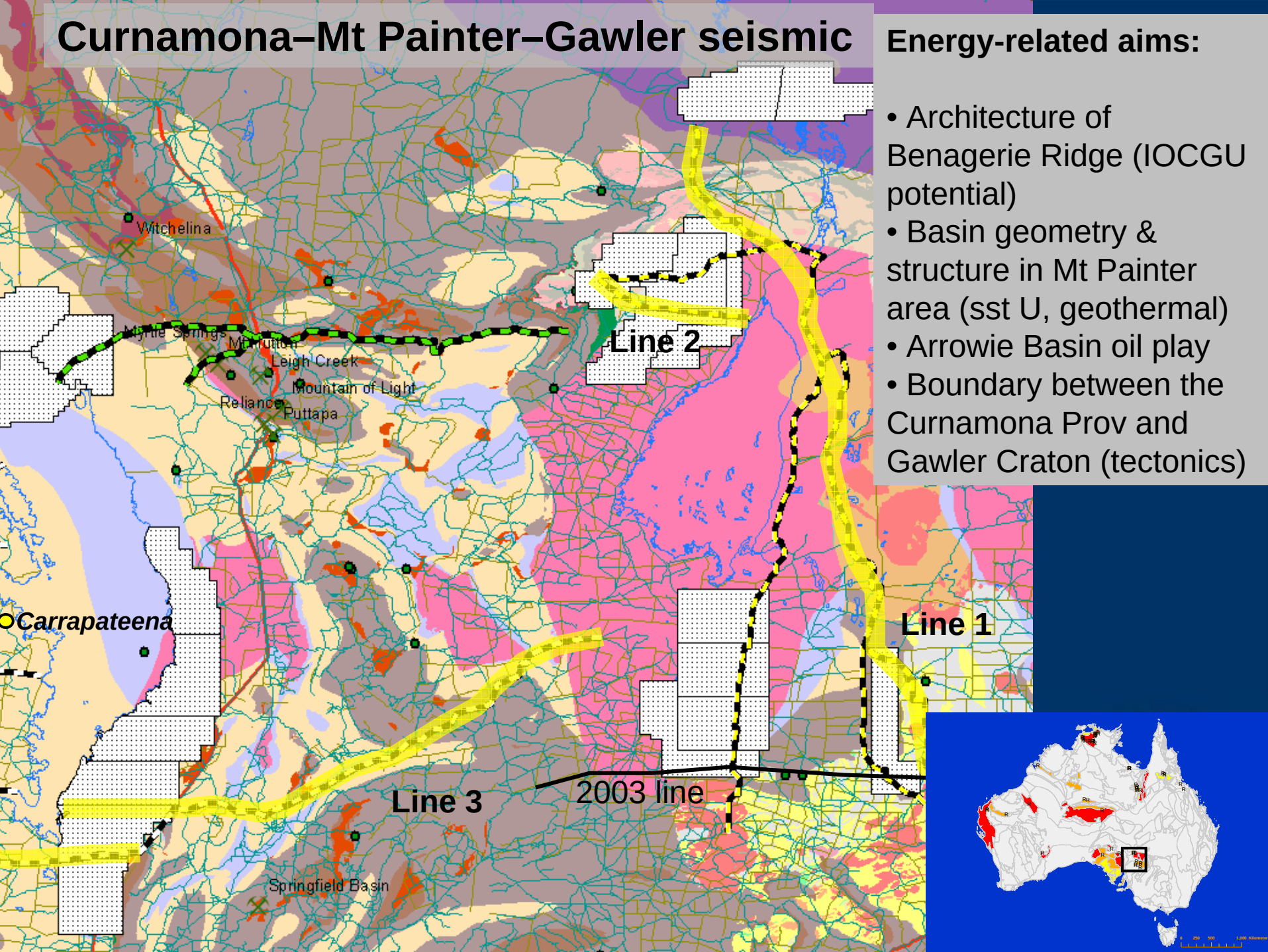
- Bulgunnia Fault (IOCGU)
- Pandurra Fm basal unconformity (U)
- northern Gawler structure (IOCGU, geothermal?)
- tectonics of Gawler wrt northern Australia



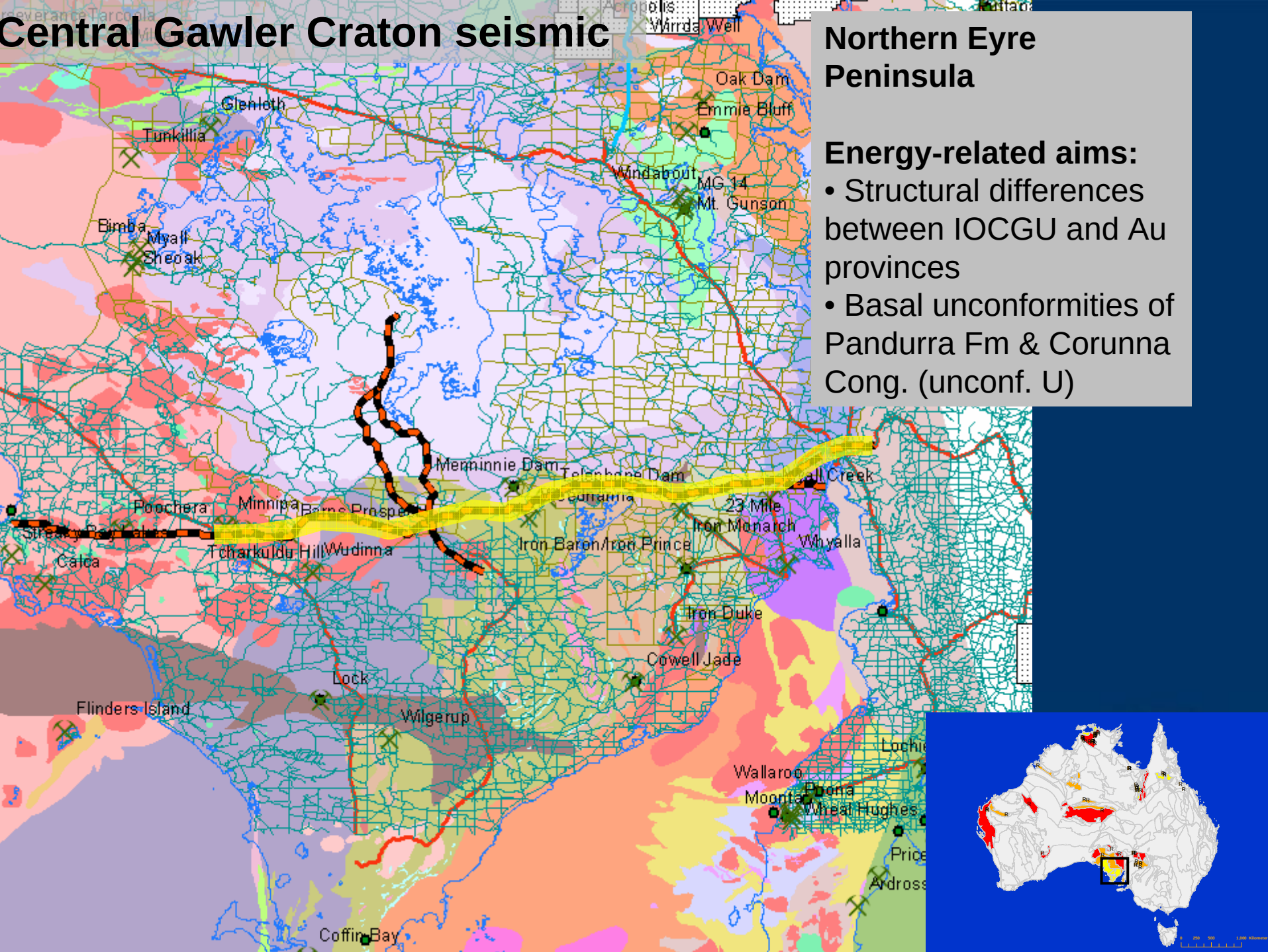
Curnamona–Mt Painter–Gawler seismic

Energy-related aims:

- Architecture of Benagerie Ridge (IOCGU potential)
- Basin geometry & structure in Mt Painter area (sst U, geothermal)
- Arrowie Basin oil play
- Boundary between the Curnamona Prov and Gawler Craton (tectonics)



Central Gawler Craton seismic

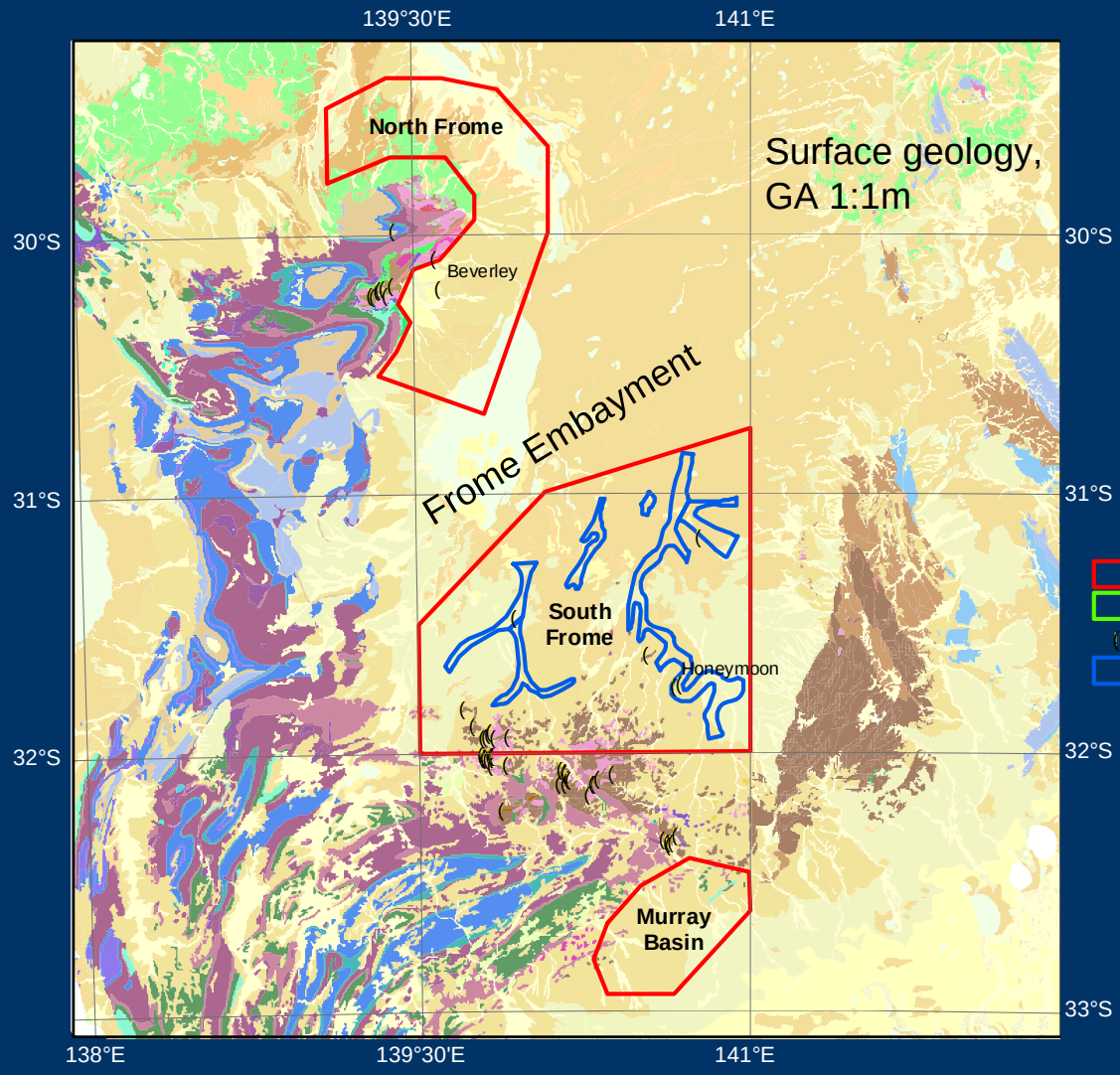


Northern Eyre Peninsula

Energy-related aims:

- Structural differences between IOCGU and Au provinces
- Basal unconformities of Pandurra Fm & Corunna Cong. (unconf. U)

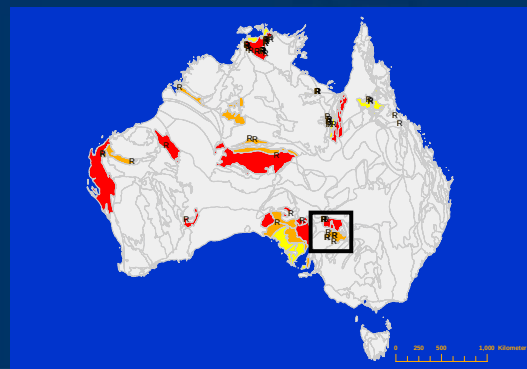
Frome Embayment, SA
AEM surveys (subject to change)



Frome

- palaeochannel deposits in Eyre Fm (eg. Honeymoon)
- palaeochannel deposits in Namba Fm (eg. Beverley)
- roll front / groundwater fracture controlled deposits (eg. Beverley 4 Mile)
- North Frome 7,231 km^2
- South Frome 17,789 km^2
- Murray Basin 2,582 km^2
- Total 27,602 km^2

Proposed AEM survey
Current Fugro surveys
Uranium occurrences
Palaeochannels (PIRSA)



Frome Embayment AEM
(part of Gawler-Curnamona Project)

Questions addressed by AEM

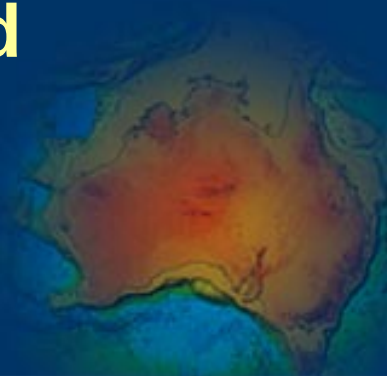
- Distribution of palaeochannels
- Thickness of cover over Alpha Mudstone
- Location of faults active in the Mesozoic/Cainozoic

Possible complementary studies

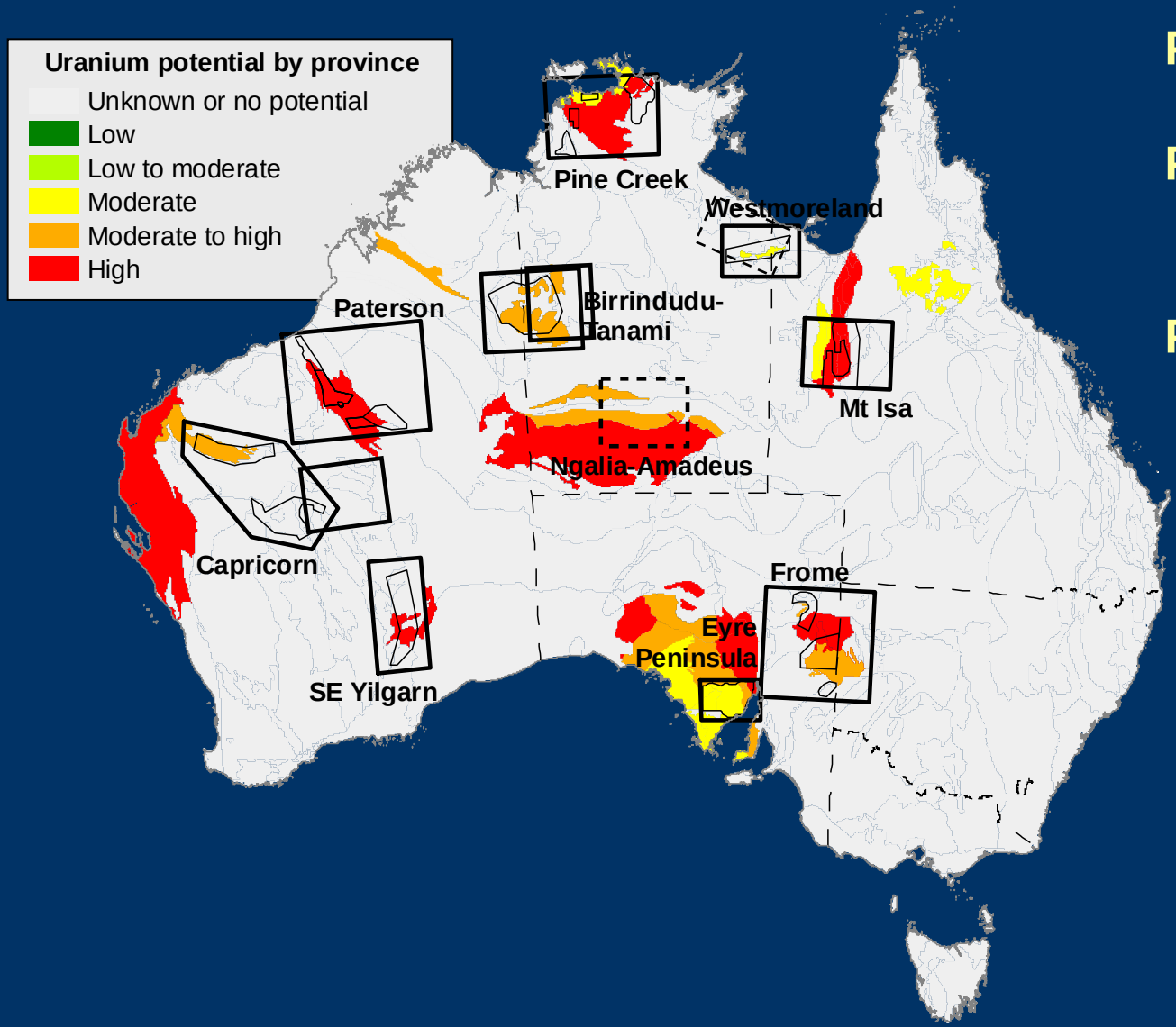
- Shallow seismic
- Detailed gravity

Industry funded infill may be considered

- Minimum 1:25,000 sheet area: ~700 line km
- All data must end up in the public domain



AEM acquisition across the continent – targeting uranium mineral systems



Planned AEM

Paterson

Proposed

Frome

Pine Creek

Possible

Birrindudu/Tanami

Eyre Peninsula

Mt Isa

Nth Yilgarn

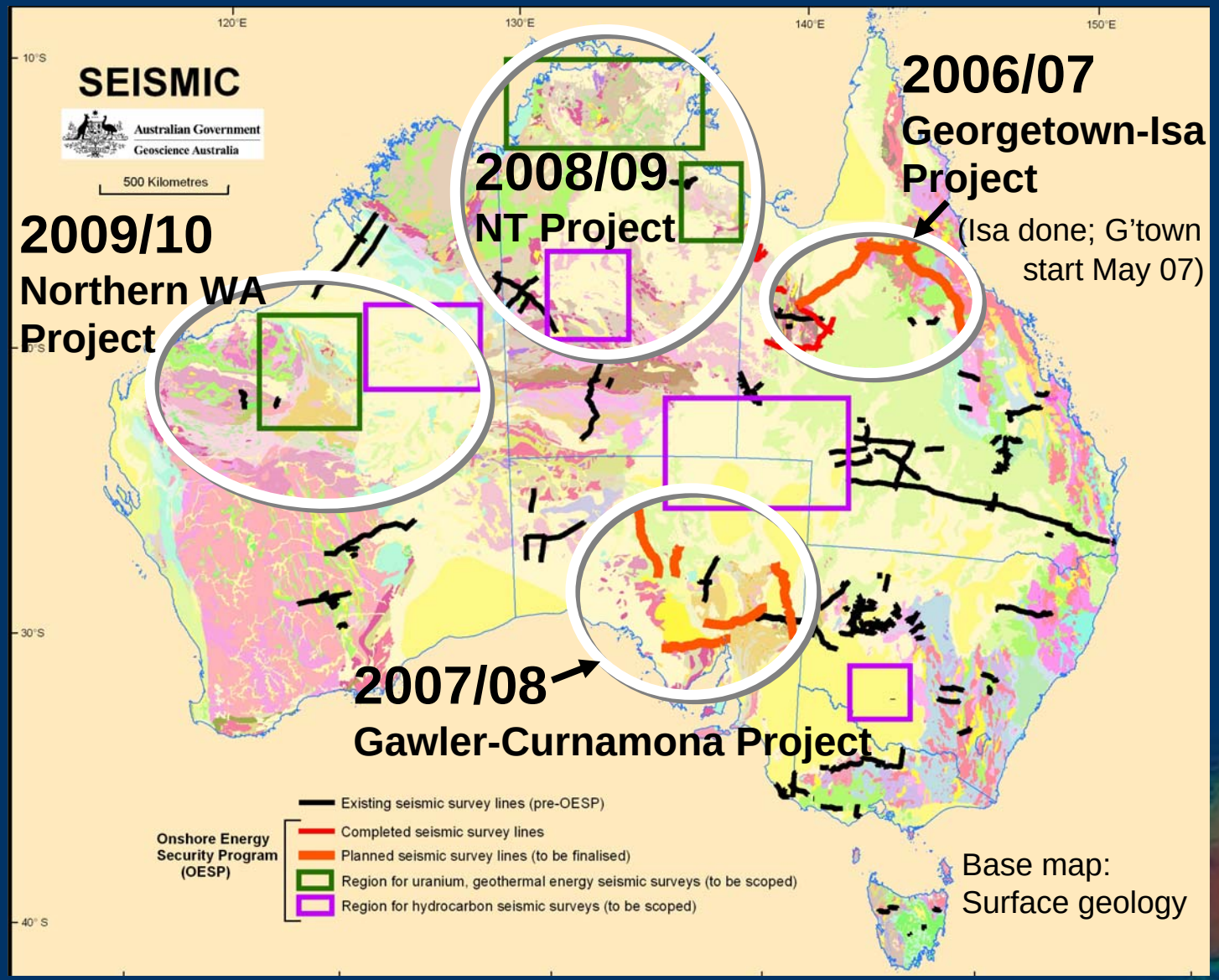
Gascoyne

Westmoreland

Amadeus-Ngalia

Sth Yilgarn

A national program of seismic acquisition targeting energy systems



Summary of uranium systems planned work in Energy Program

1. **Processes in U mineralising systems**
2. **National scale U distribution and potential**
   - **Includes national radiometric and geochemical surveys**
3. **Regional scale U potential**
   - **4 major areas identified for 2007-09**
   - **New data acquisition commenced**
   - **Data include seismic, MT, AEM, drilling**
   - **Geological synthesis**
   - **U potential evaluation**