

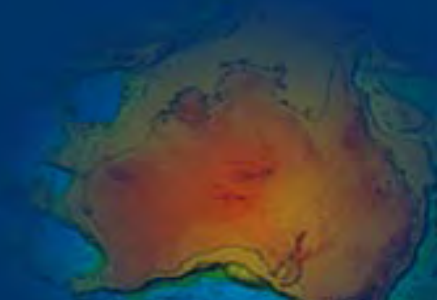


Australian Government

Geoscience Australia

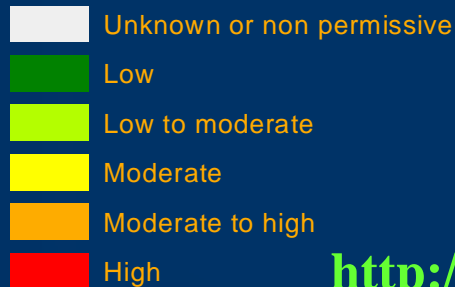
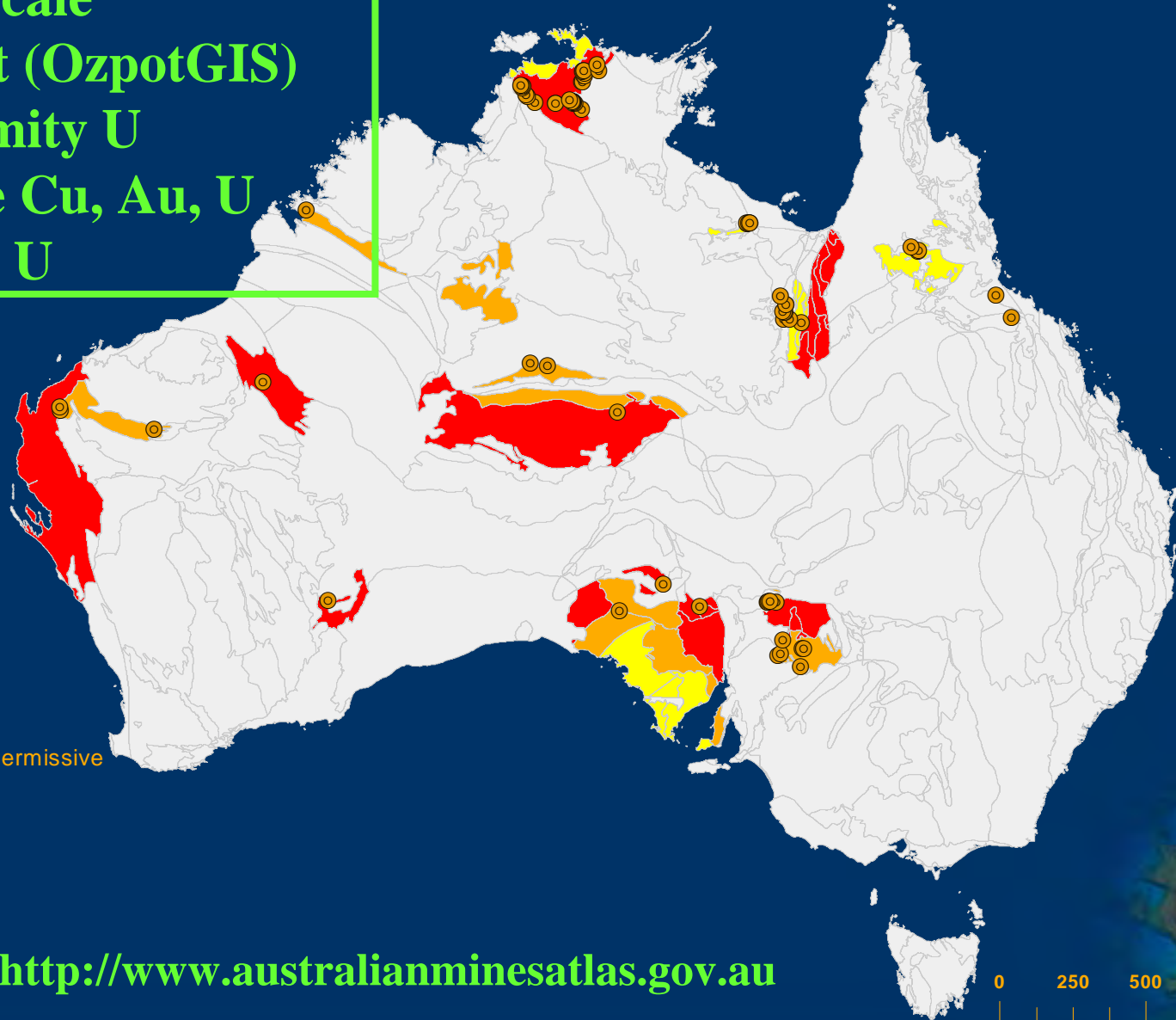
Uranium in North Australian Craton: Resources, Metallogeny and Potential

**Subhash Jaireth, Ian Lambert, Aden McKay, Yanis
Miezitis**



Mineral Potential of Uranium Deposits

- Regional scale assessment (OzpotGIS)
- Unconformity U
- Iron-oxide Cu, Au, U
- Sandstone U



<http://www.australianminesatlas.gov.au>

0 250 500 1,000 Kilometers

Geoscience Australia

Outline

- **Summary of Uranium resources in NAC**
- **Uranium metallogeny in NAC**
- **Potential of Unconformity U, Iron-oxide Cu-Au-U and Sandstone U deposits**
- **Uranium associated with Alkaline Complexes and carbonatites**

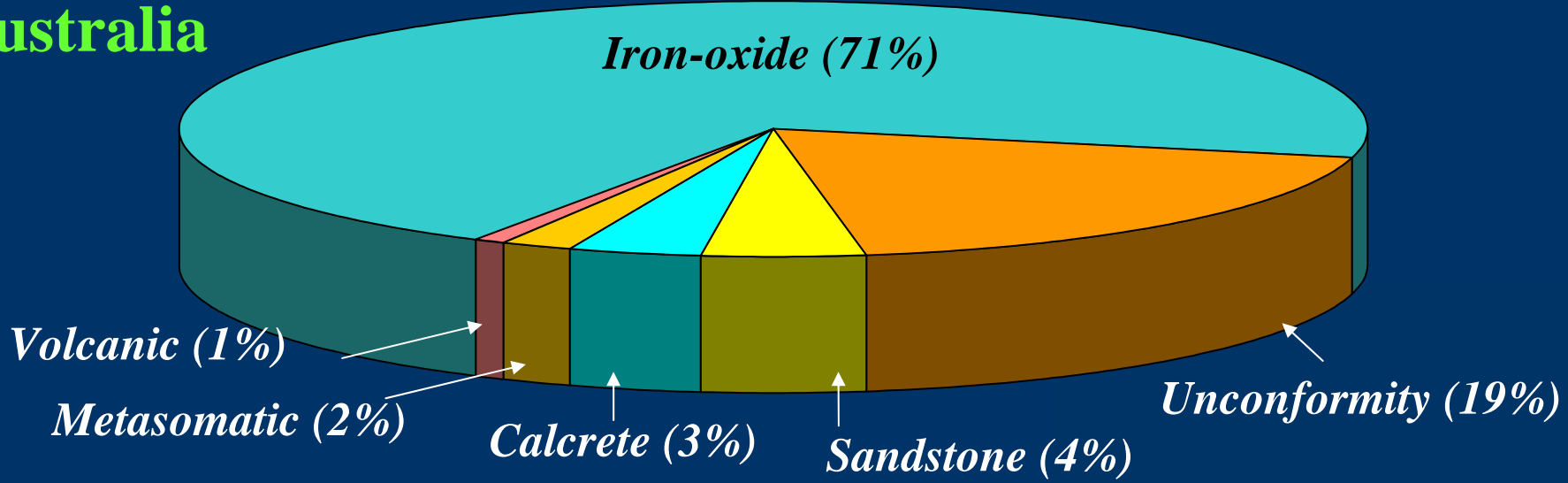


Uranium Mines and Deposits

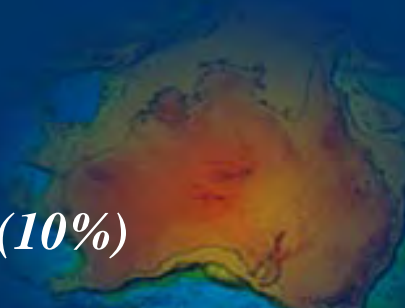
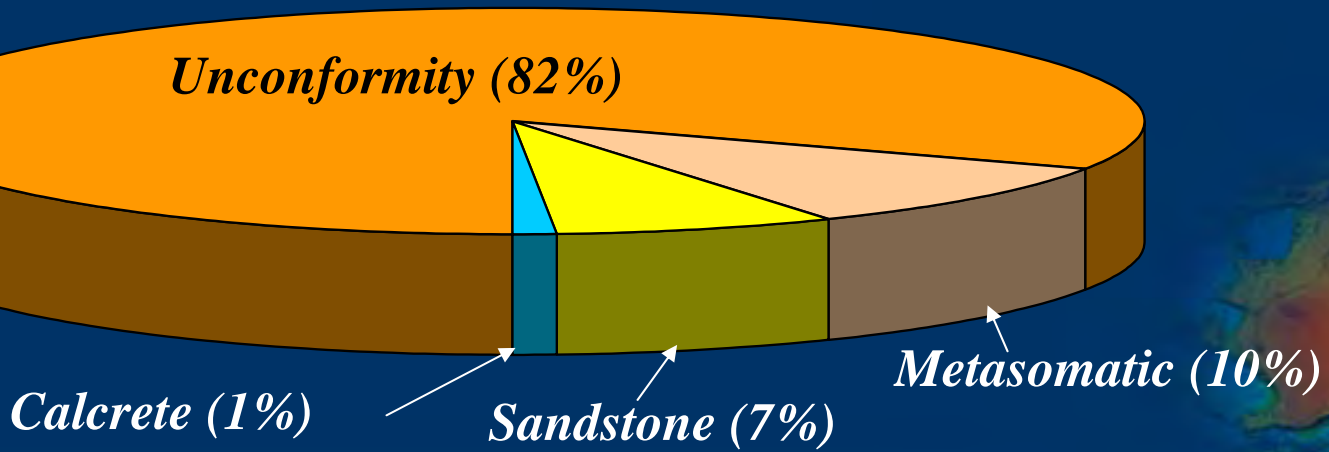


Distribution of Uranium Resources + Production by Deposit Types

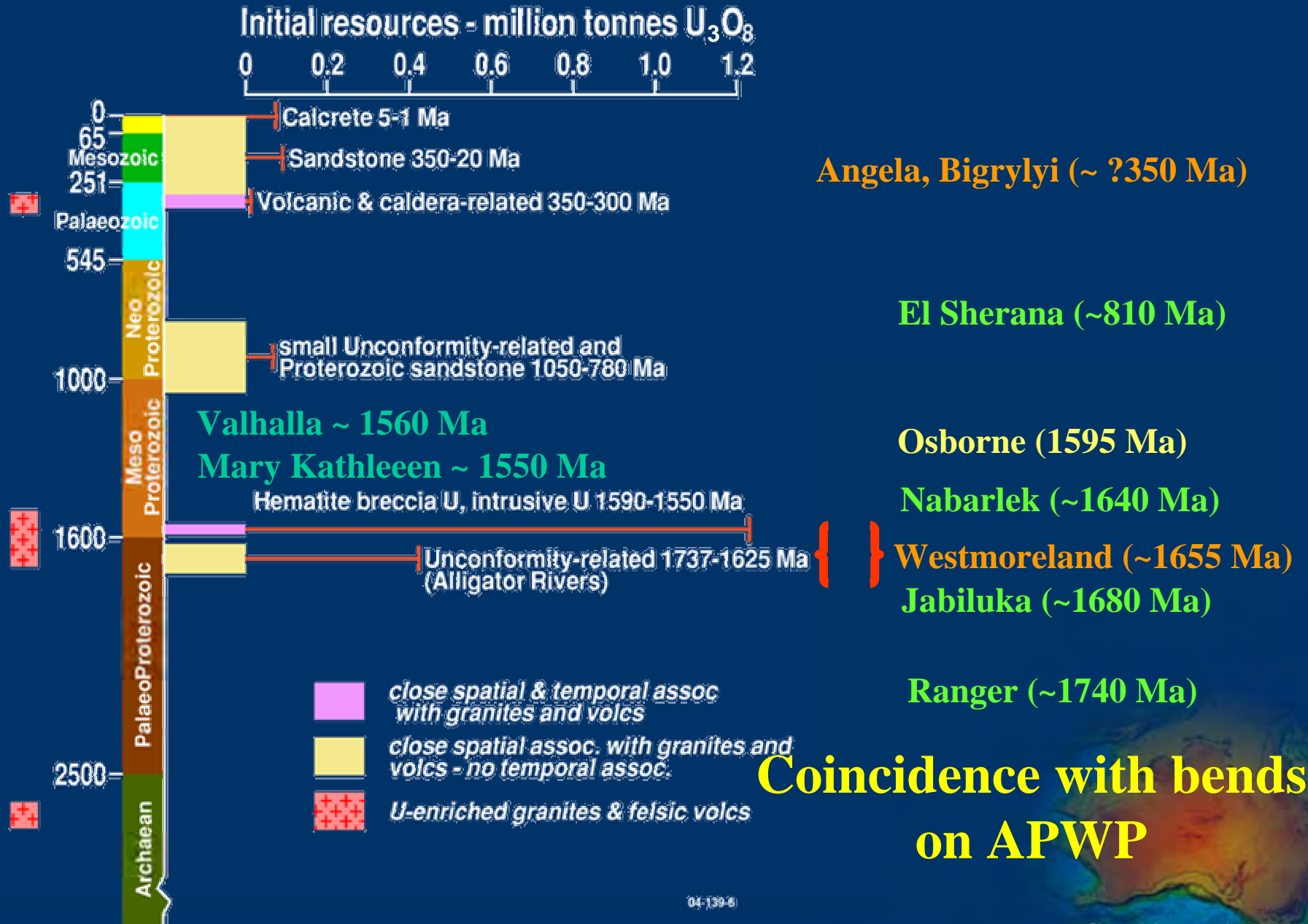
Australia

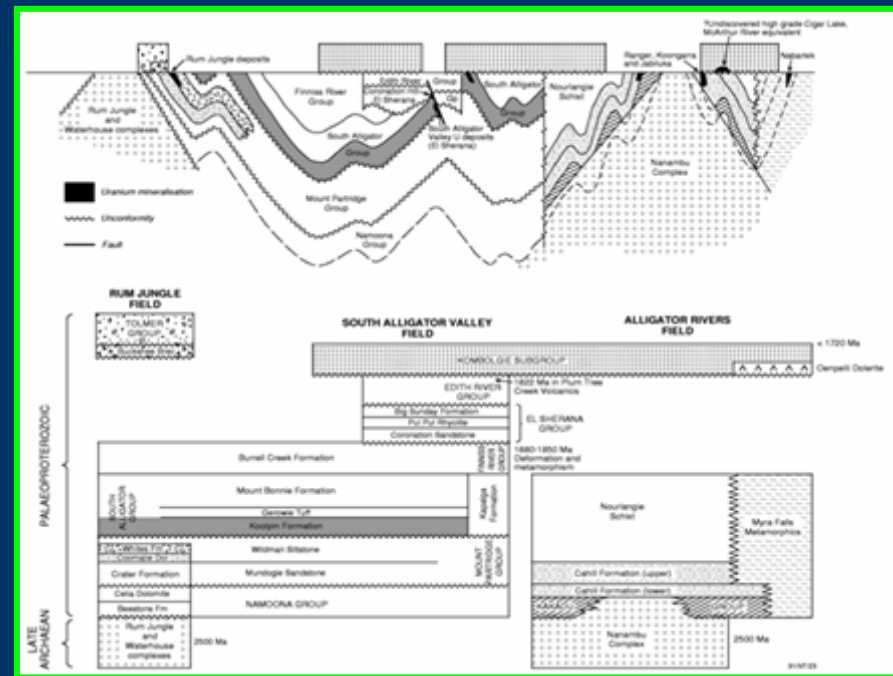


NAC



Periods of U Mineralisation in Australia

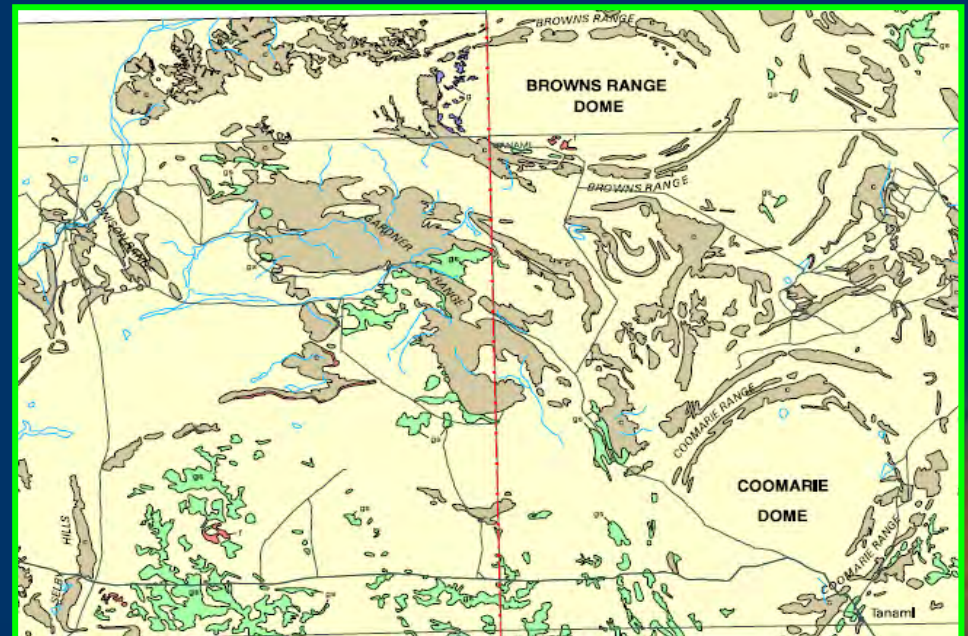




Unconformity Uranium in Tanami

Pine Creek

Tanami



Tanami

**Birrindudu: Coomarie,
Talbot Well, Gardiner**

*Aquifer
& trap*

D_{6+} ?Chewings ~ 1590-1570 Ma;
Liebig (~ 1640 Ma)

Trigger

?1735-1640 Ma

Strangways? ~ 1730-1710 Ma

Pargee

D_5 Faulting

Mount Charles

Trap/host

D_{3-4} Stafford Event ~ 1810-1800 Ma

Frederick Suite 1825-1790 Ma

Birthday Suite 1825-1810 Ma

**Ware Group: Wilson,
Century, Nanny Goat,
Mt Winnecke**

1825-1815 Ma

D_1 Tanami Event ~ 1830 Ma

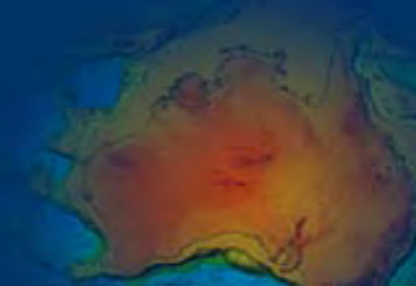
**Tanami Group: Killi Killi
Callie, Ferdies**

< 1840 Ma

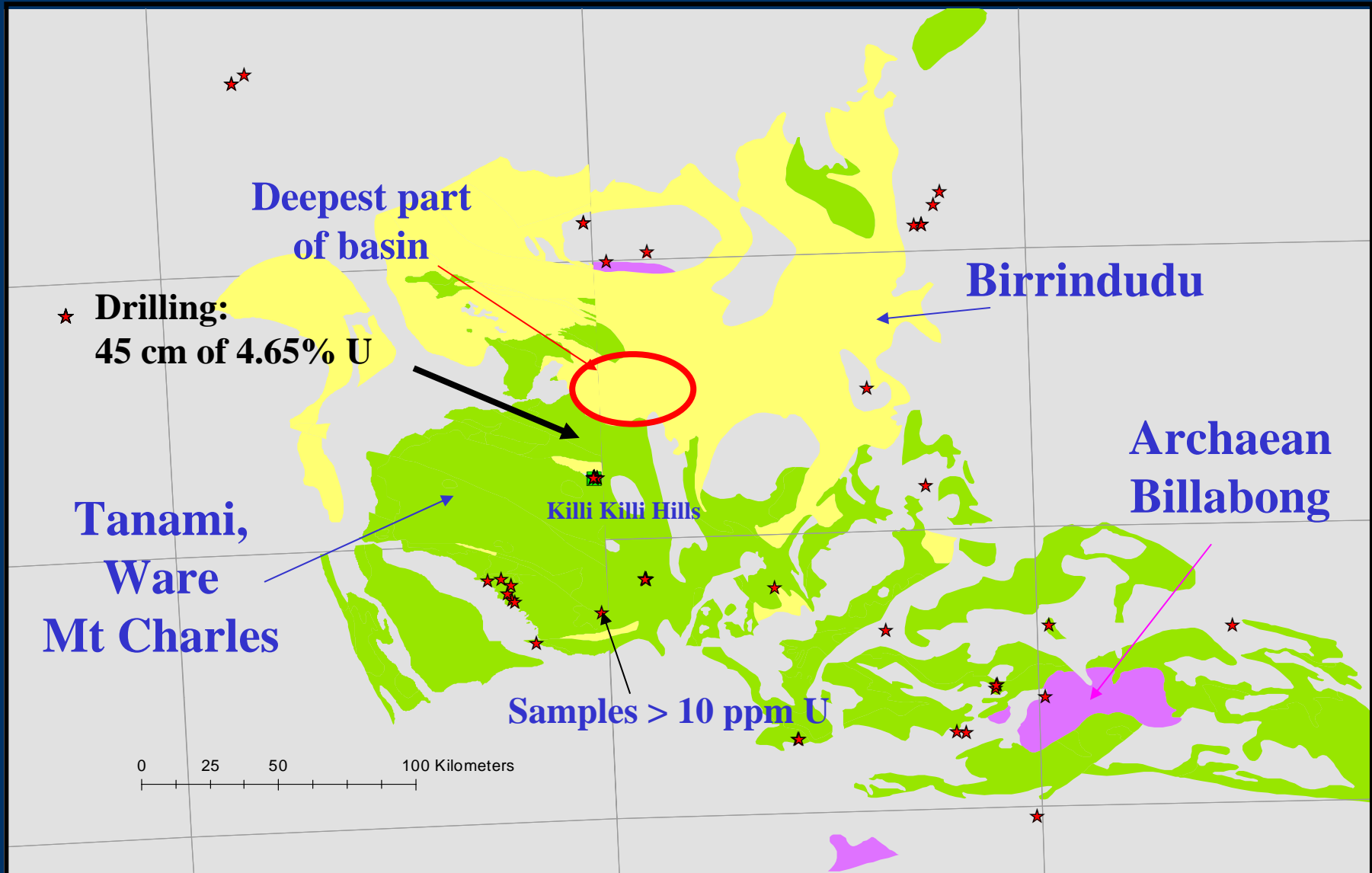
Billabong Complex

Source

~ 2510 Ma



Unconformity Uranium in Tanami

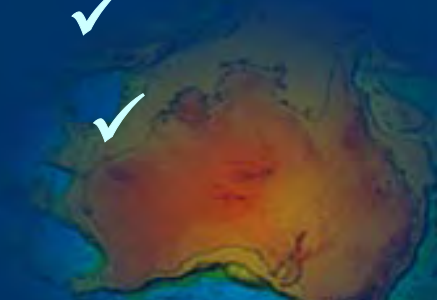


Critical Elements: Unconformity Uranium

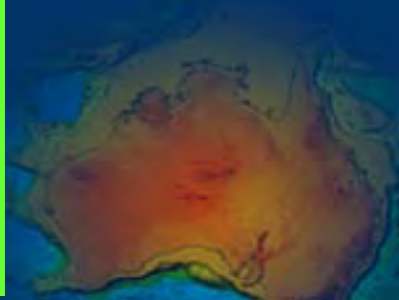
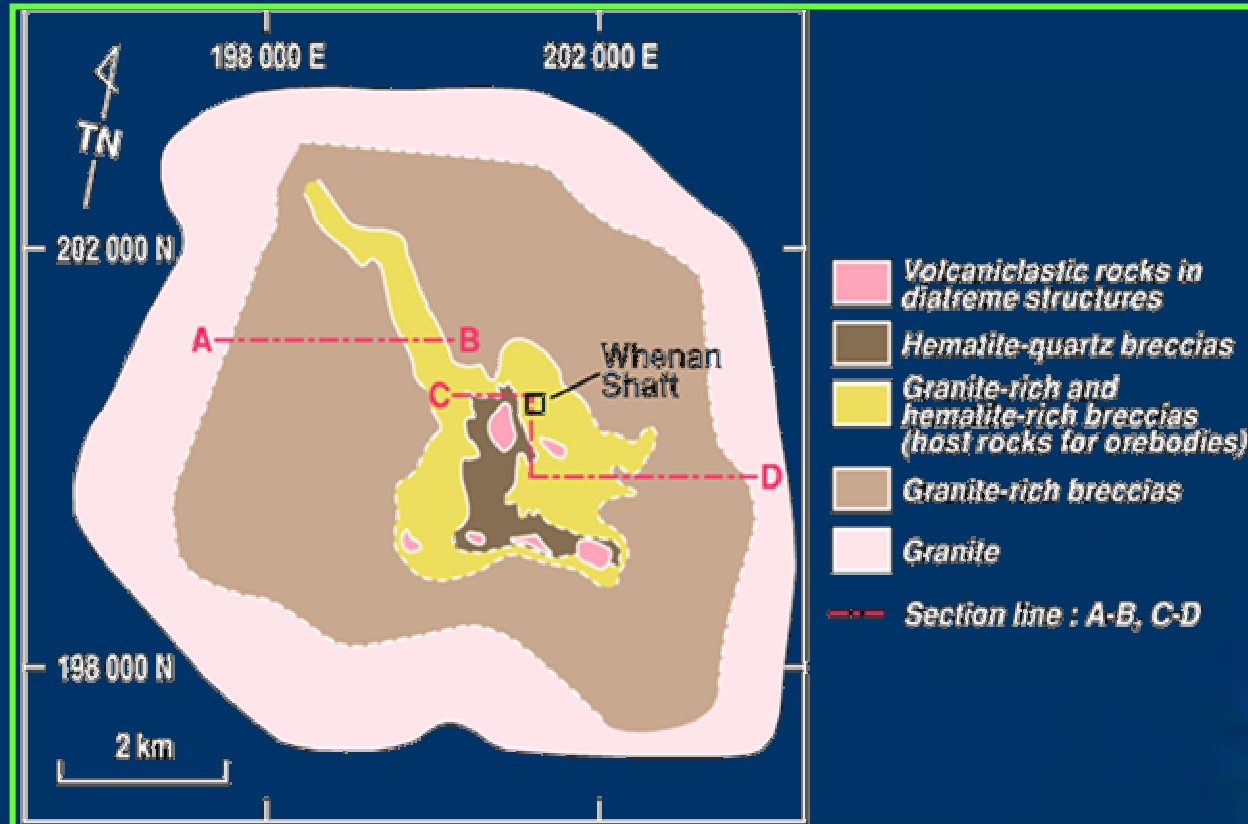
- Proximity to Archaean complexes/
domes
- Cover of oxidised rocks above the
unconformity (> 2-4 kms thick)
- Reduced rocks below the unconformity
- Faults and breccia zones
- Deformation event as trigger of fluid
flow

Pine Creek

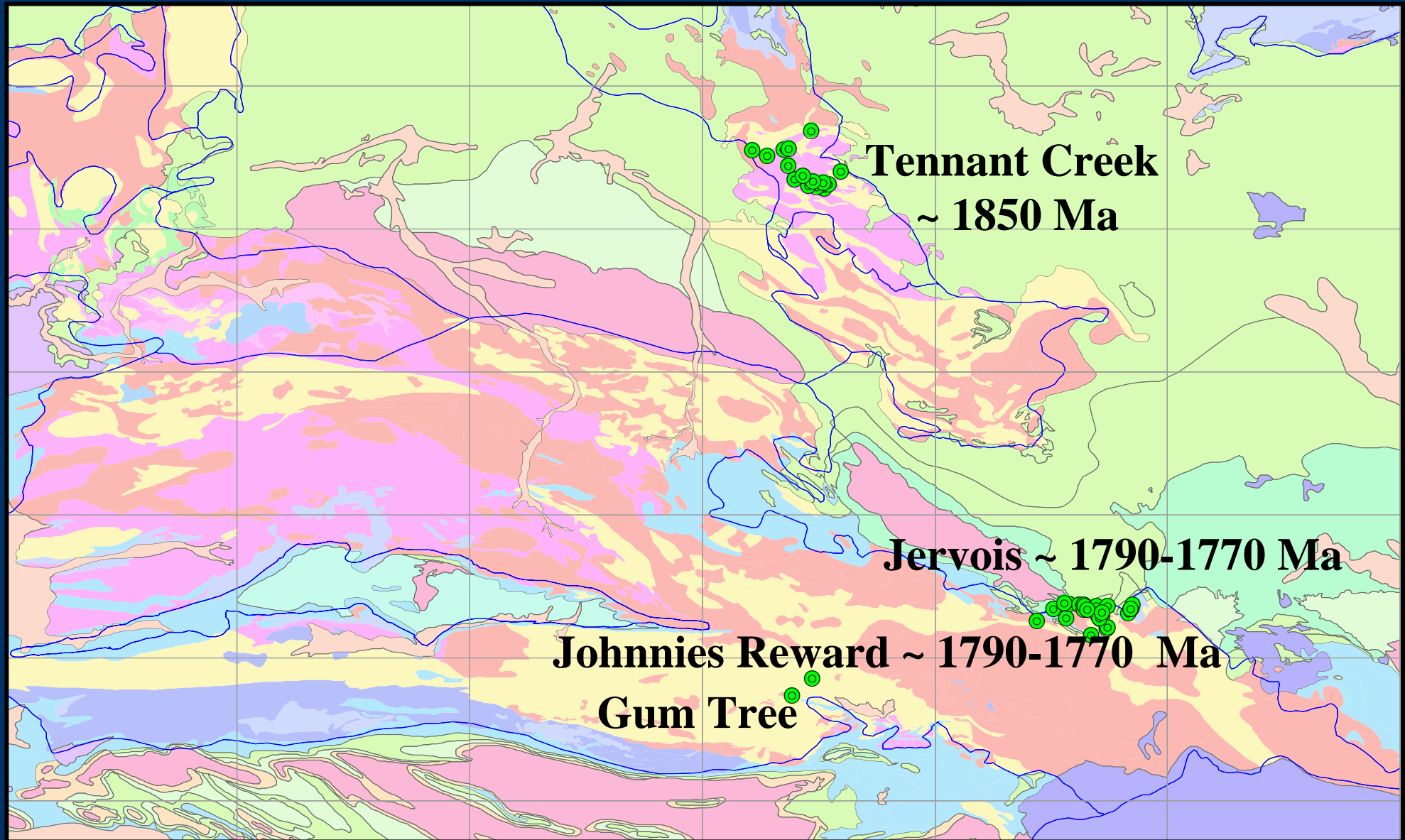
Tanami



Iron-oxide Copper Gold with Uranium

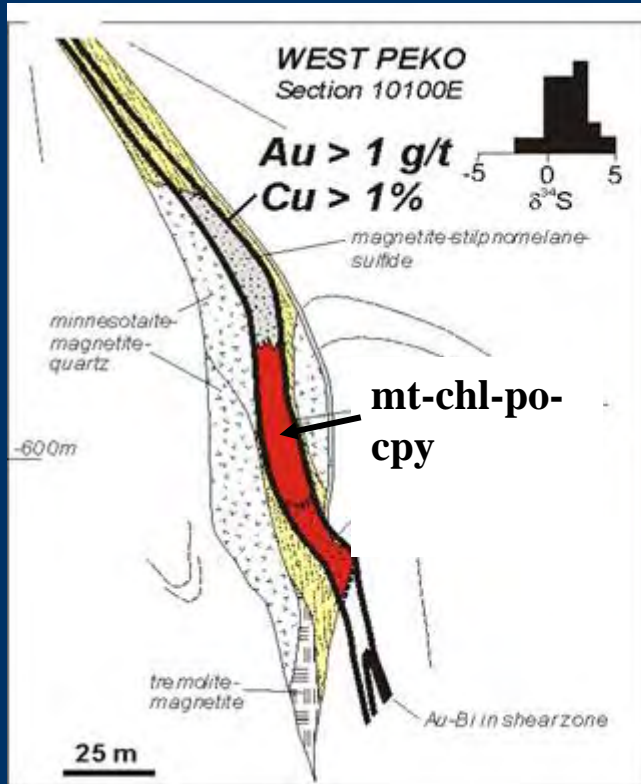


Iron-oxide Cu-Au deposits

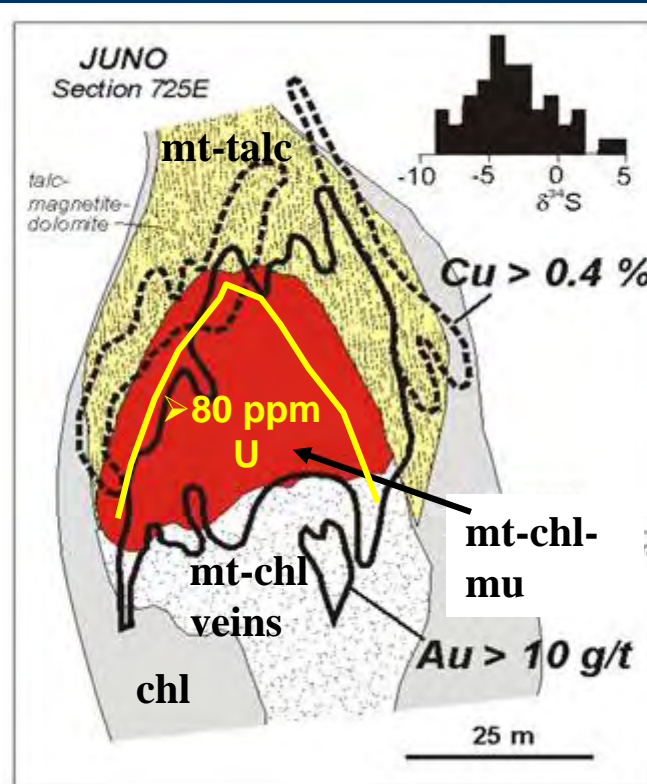


Uranium in Iron-oxide Cu-Au-Bi deposits

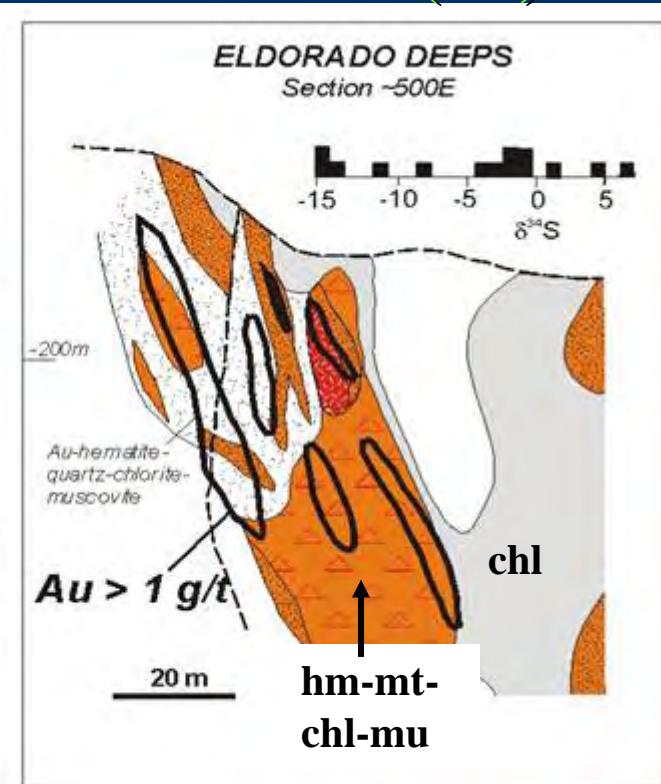
Reduced Cu-Au-Bi



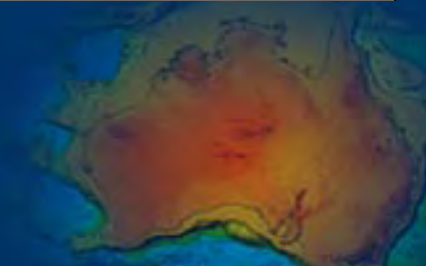
Intermediate Au-Bi



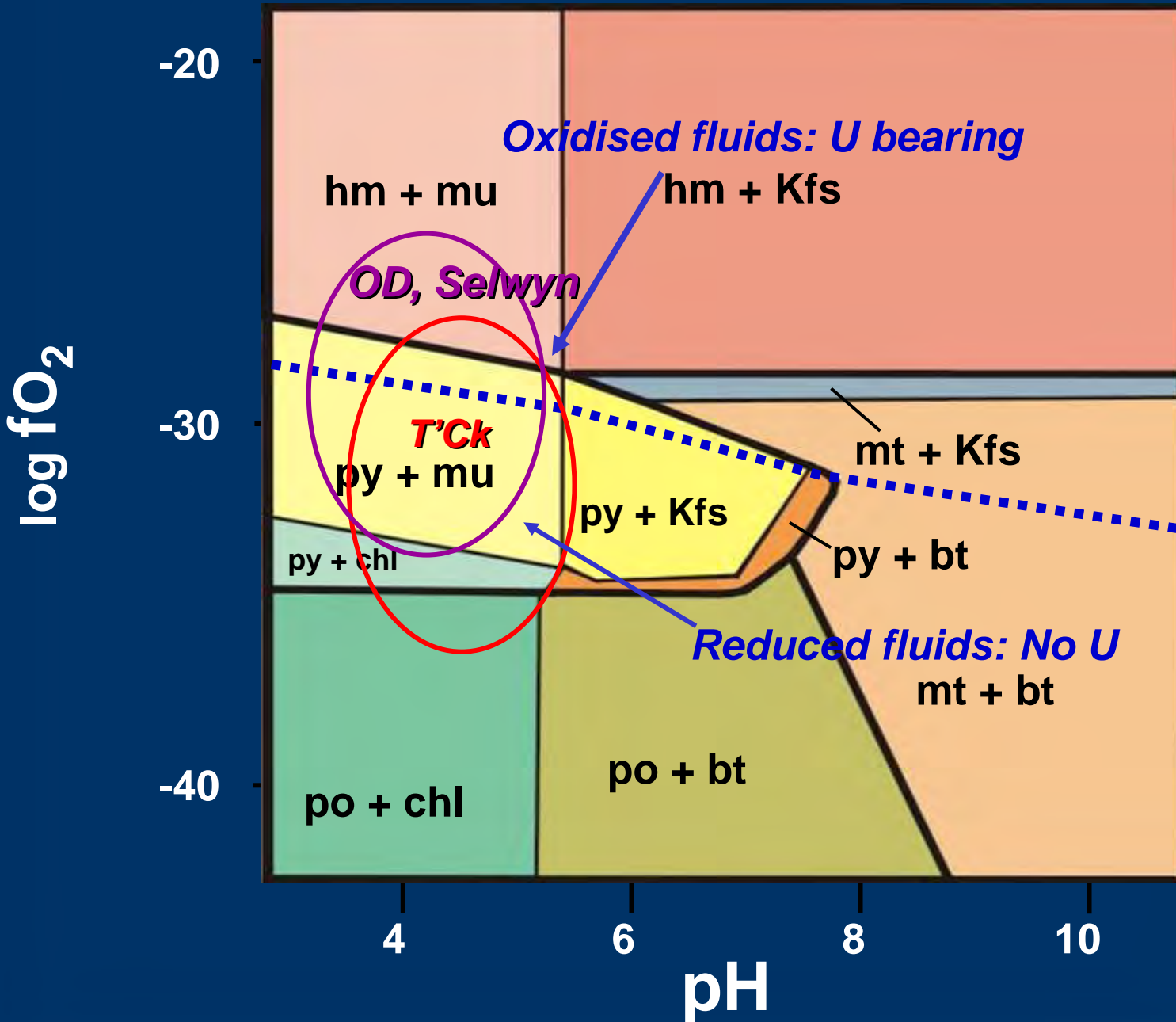
Oxidised Au(-Bi)



(Large, 1975; Skirrow, 1993, 2000)

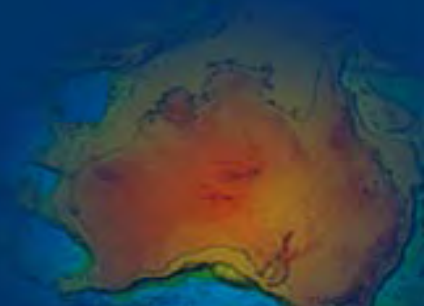


Uranium rich Iron-oxide Cu-Au-Bi deposits

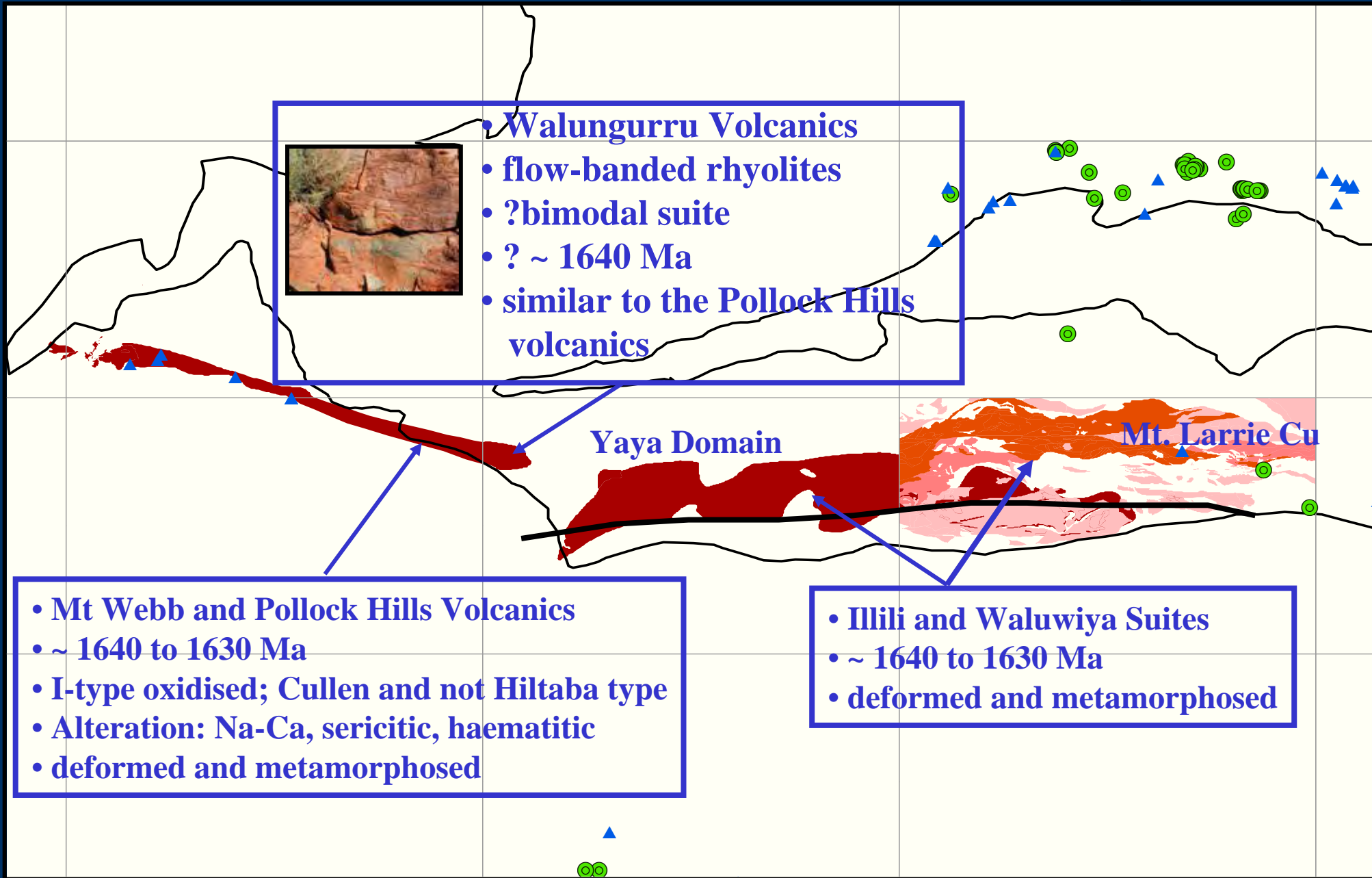


**Oxidised Fluids
Mixing/Reacting
with Reduced
fluids/Ironstones**

300°C, 1.5 kb
 $m_{\text{total sulfur}} = 0.003$
 $a_{K^+} = 0.1$



Ironoxide Cu-Au-U in Warumpi?



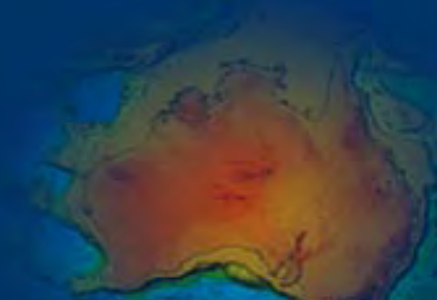
Potential for IOCG, Mt Webb Suite

Positive:

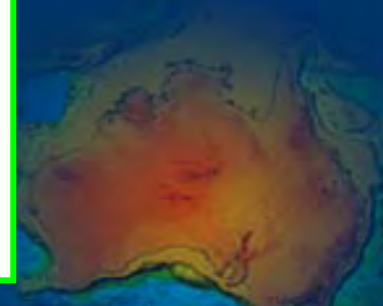
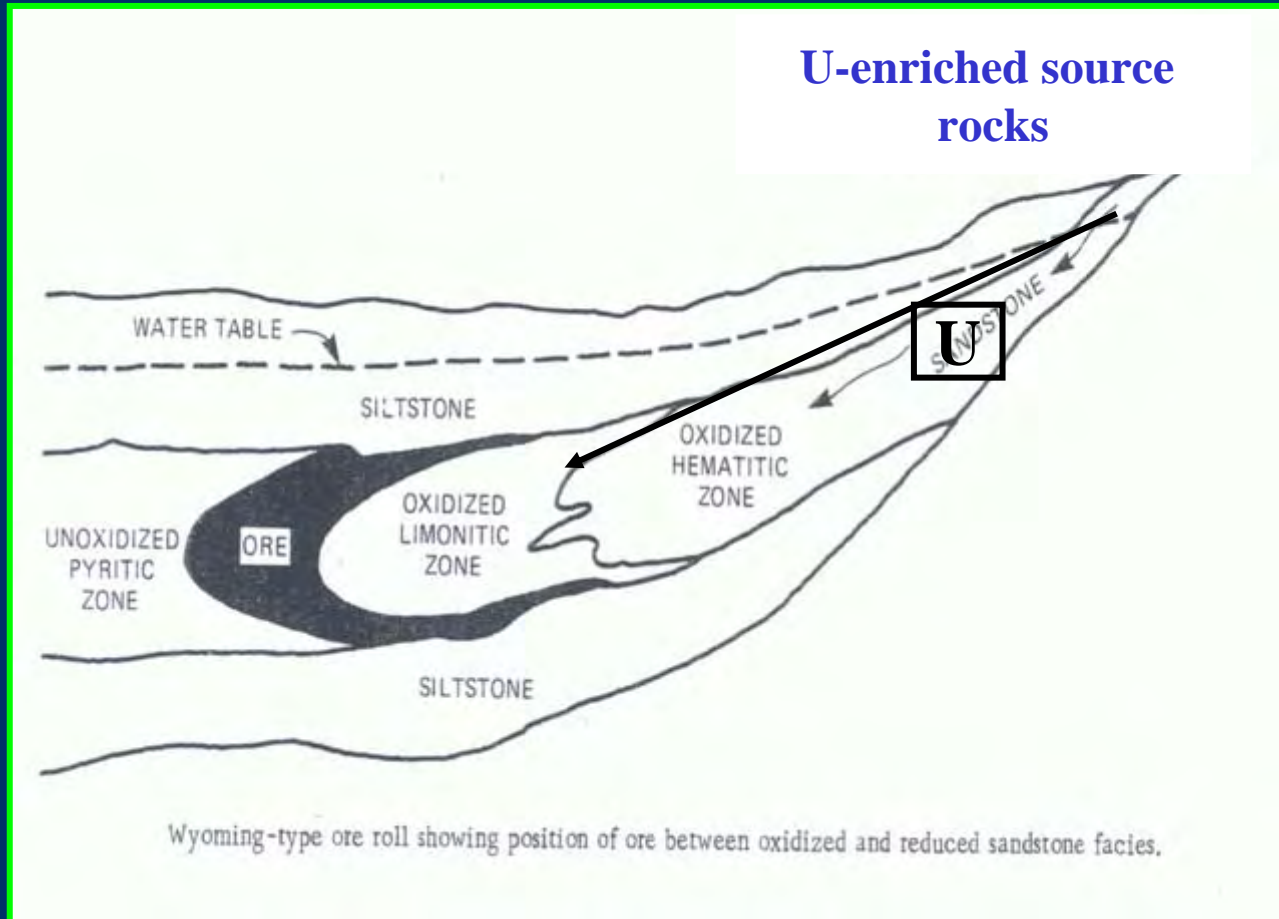
- **Rifted backarc setting (similar to IOCG in the Andes)**
- **Coexisting bimodal volcanics and intrusive**
- **I-type fractionated and oxidised granitoids**
- **Enriched in U**
- **Na-Calcic, sericitic and local haematitic alteration**

Negative:

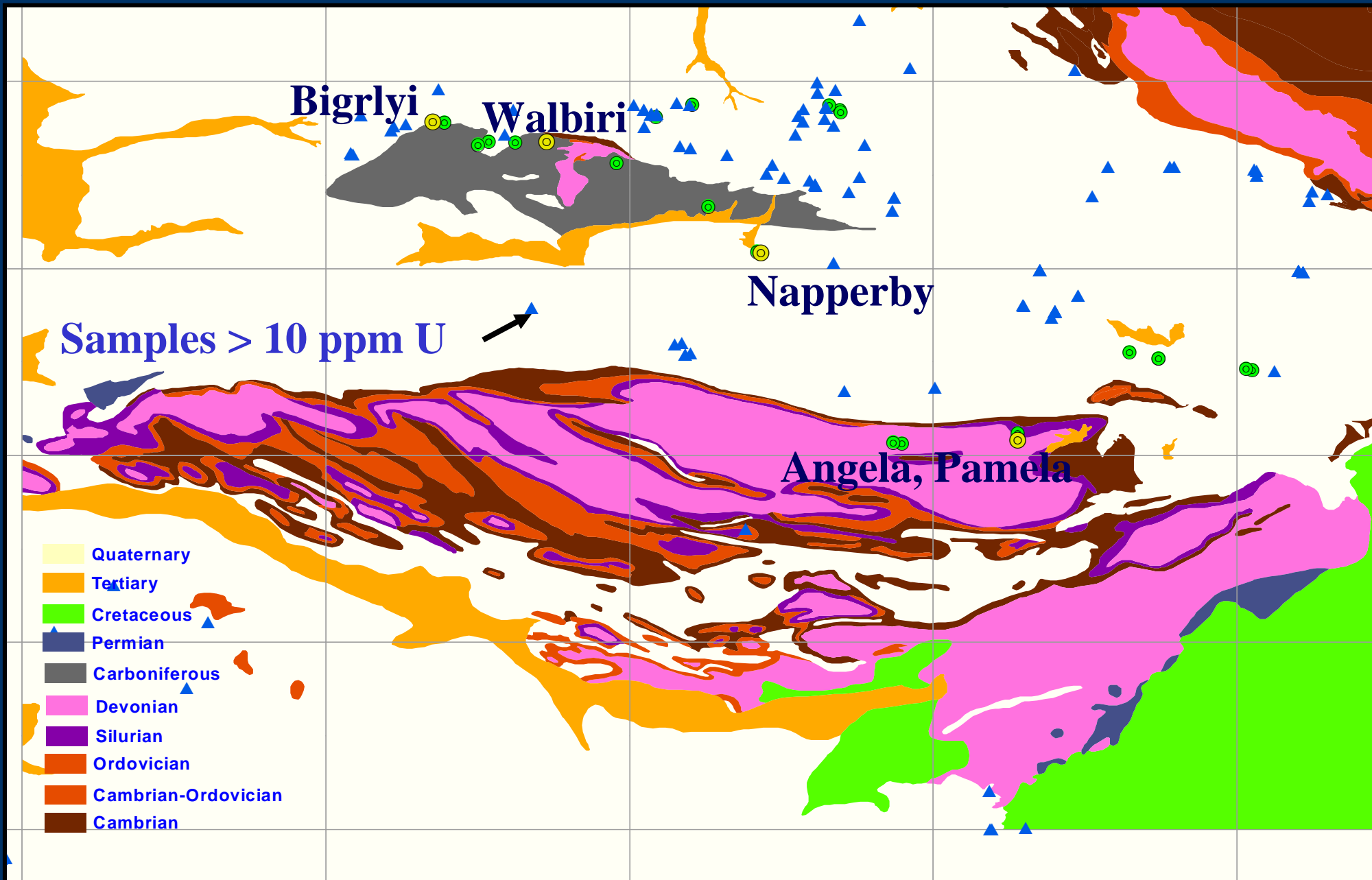
- **I-type and not A-type**
- **Cullen-type and not Hiltaba-type (Budd et al, 2001)**
- **Extent of alteration local**
- **No diatreme or maar vents**



Sandstone Uranium

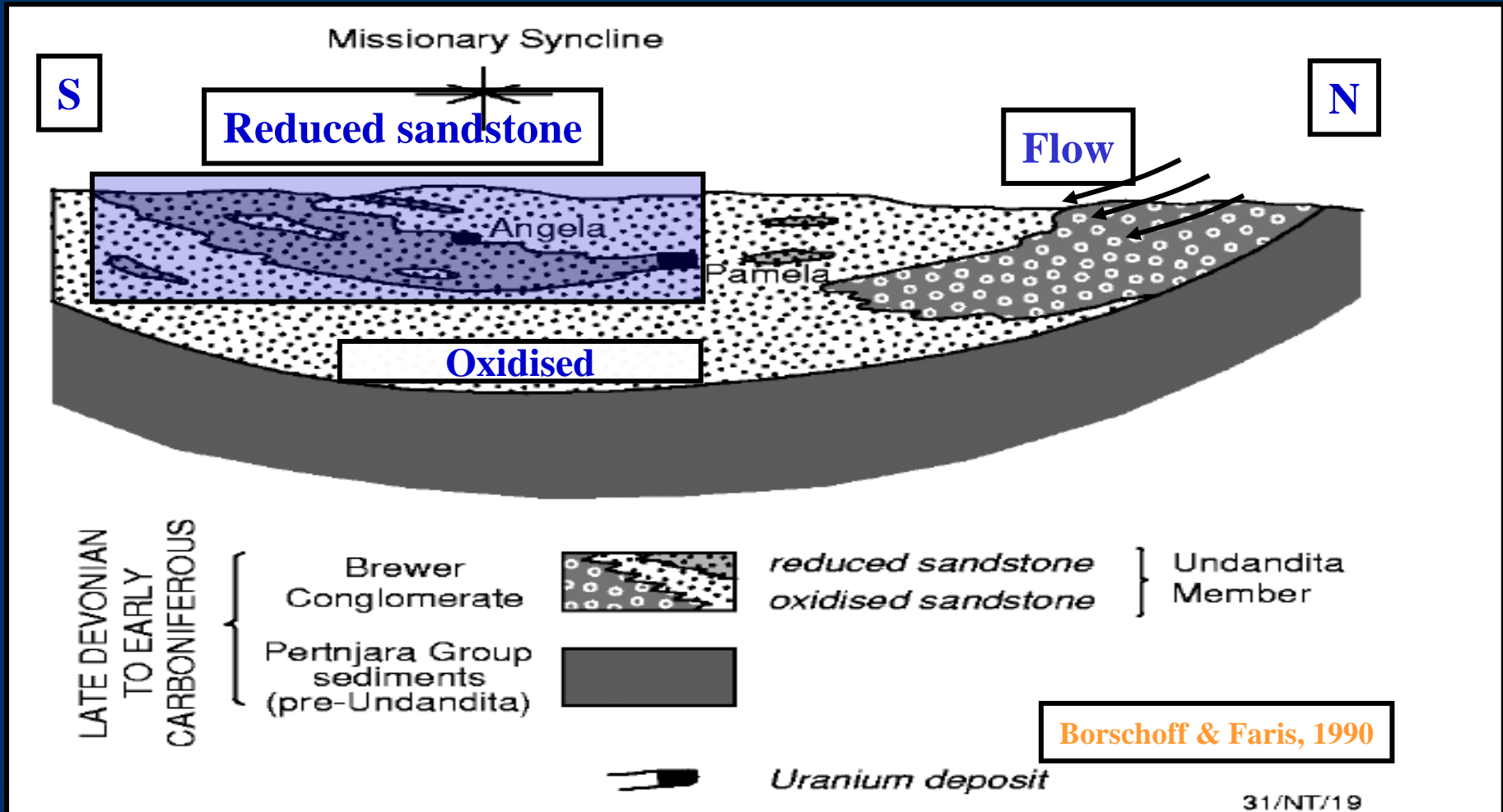


Sandstone U in Ngalia and Amadeus Basins

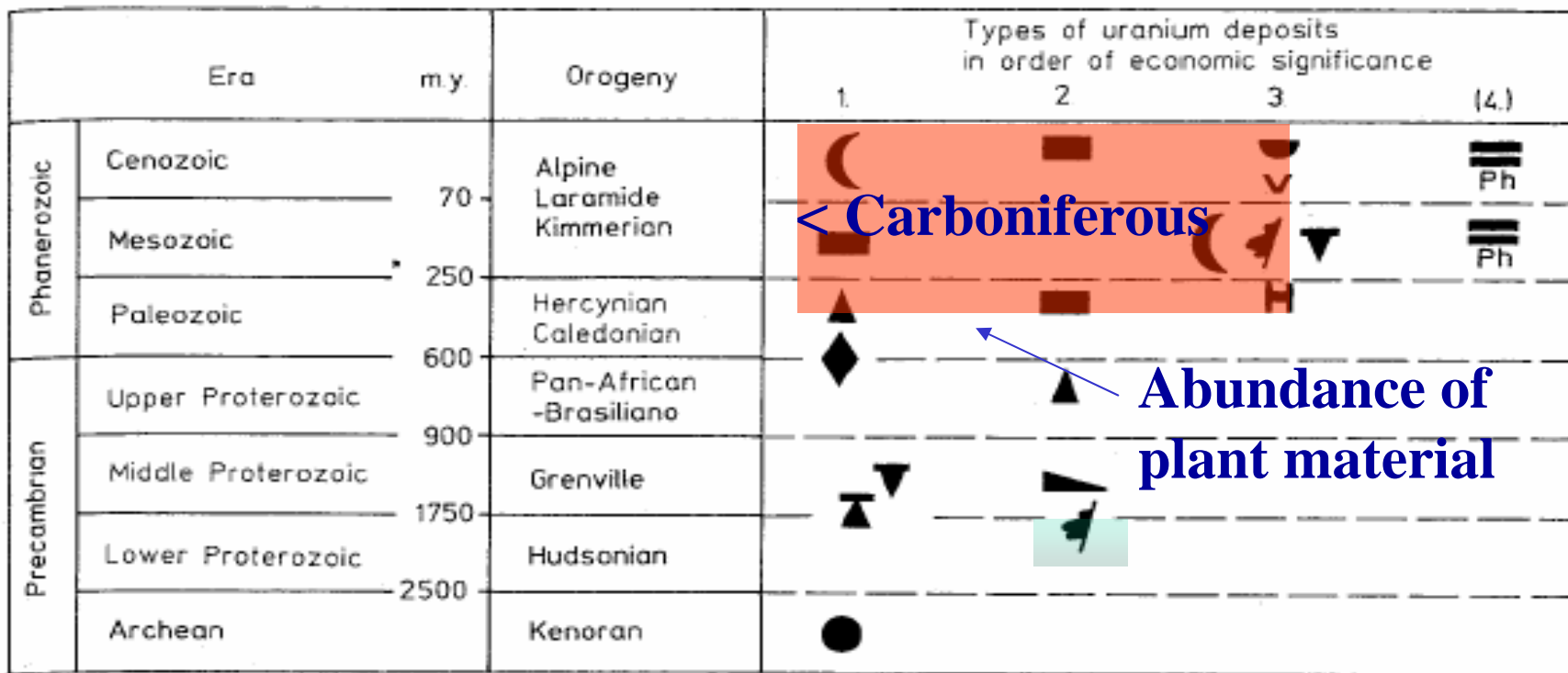


Sandstone Uranium

- L. Devonian to Carboniferous sandstones
- Red & grey sandstones; red sandstone with shales (reductants)
- Mineralisation age: unknown















Distribution of U Deposit-Types with Time



< Carboniferous

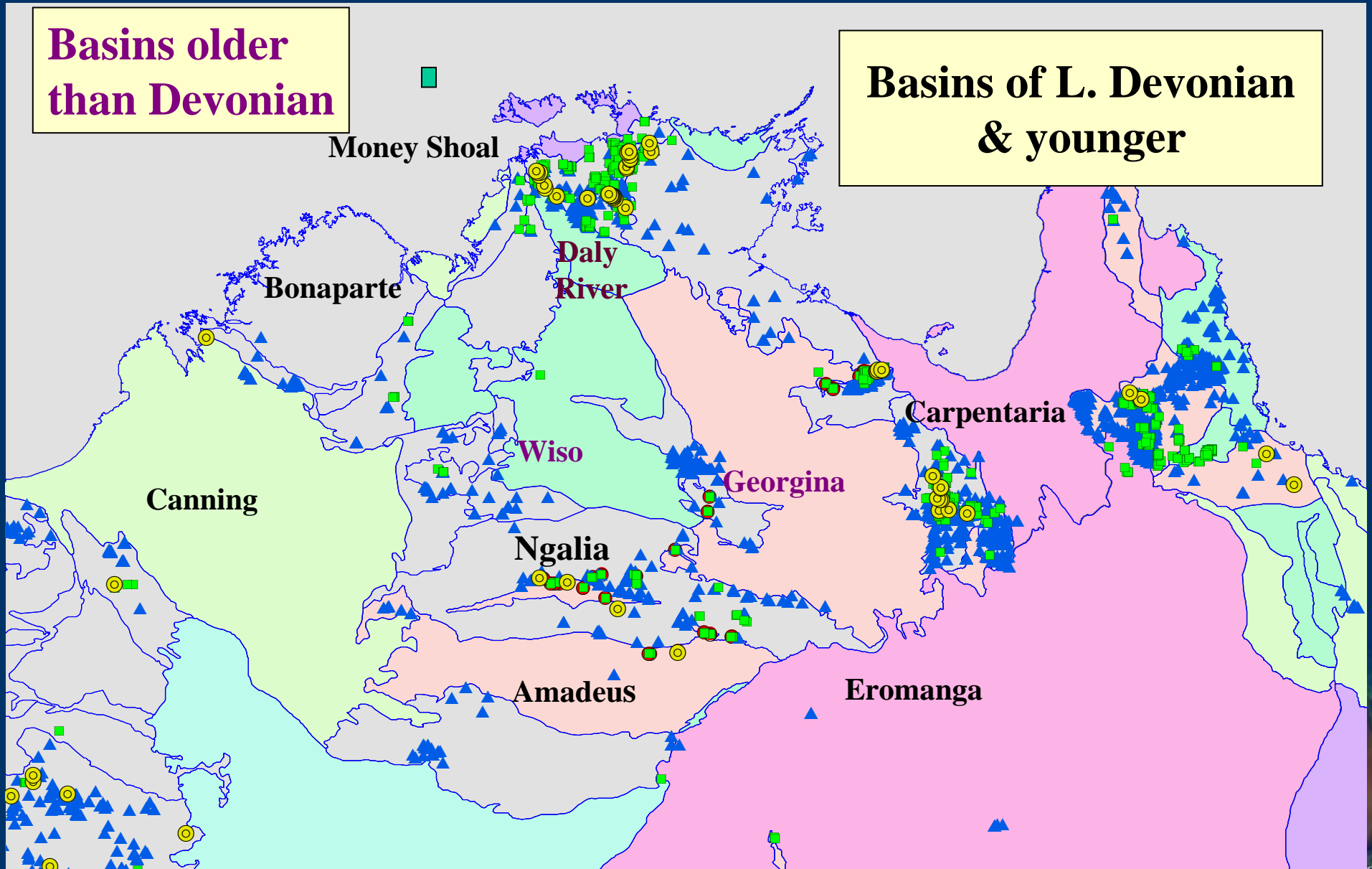
Abundance of plant material

-  Unconformity-contact deposit (type 1)
-  Subunconformity-epimetam. (2)
-  Vein (3)
-  Sandstone (4), tabular (4.1)
-  Sandstone, rollfront (4.2)
-  Sandstone, tectonic-lithologic (4.3)

-  Collapse breccia pipe (5)
-  Surficial (6)
-  Quartz-pebble conglomerate (7)
-  Breccia complex (8)
-  Intrusive (9)
-  Phosphorite (10)

F Dahlkamp (1993)

Basins with Potential for Sandstone Uranium



Sandstone Uranium Deposits

(Alternative style with potential in Australian Proterozoic Basins)

3. Reductants

Reduced rocks

Oxidised sandstone

U-rich fluids

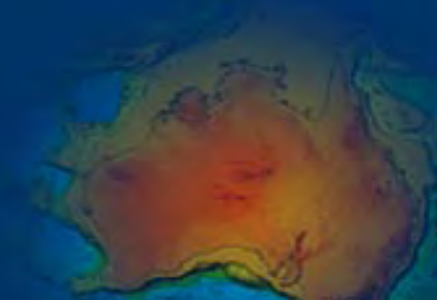
2. Tectonic trigger for fluid flow

1. Diagenetic

Oxidised above Mgt/Hmt buffer

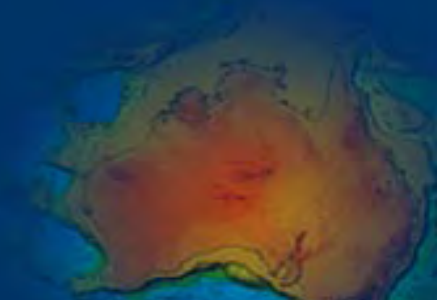
T > 150 deg C

Salinity moderate to high

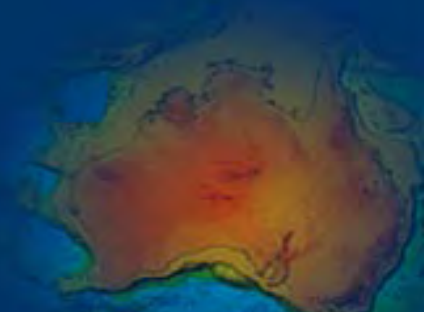


Critical Elements

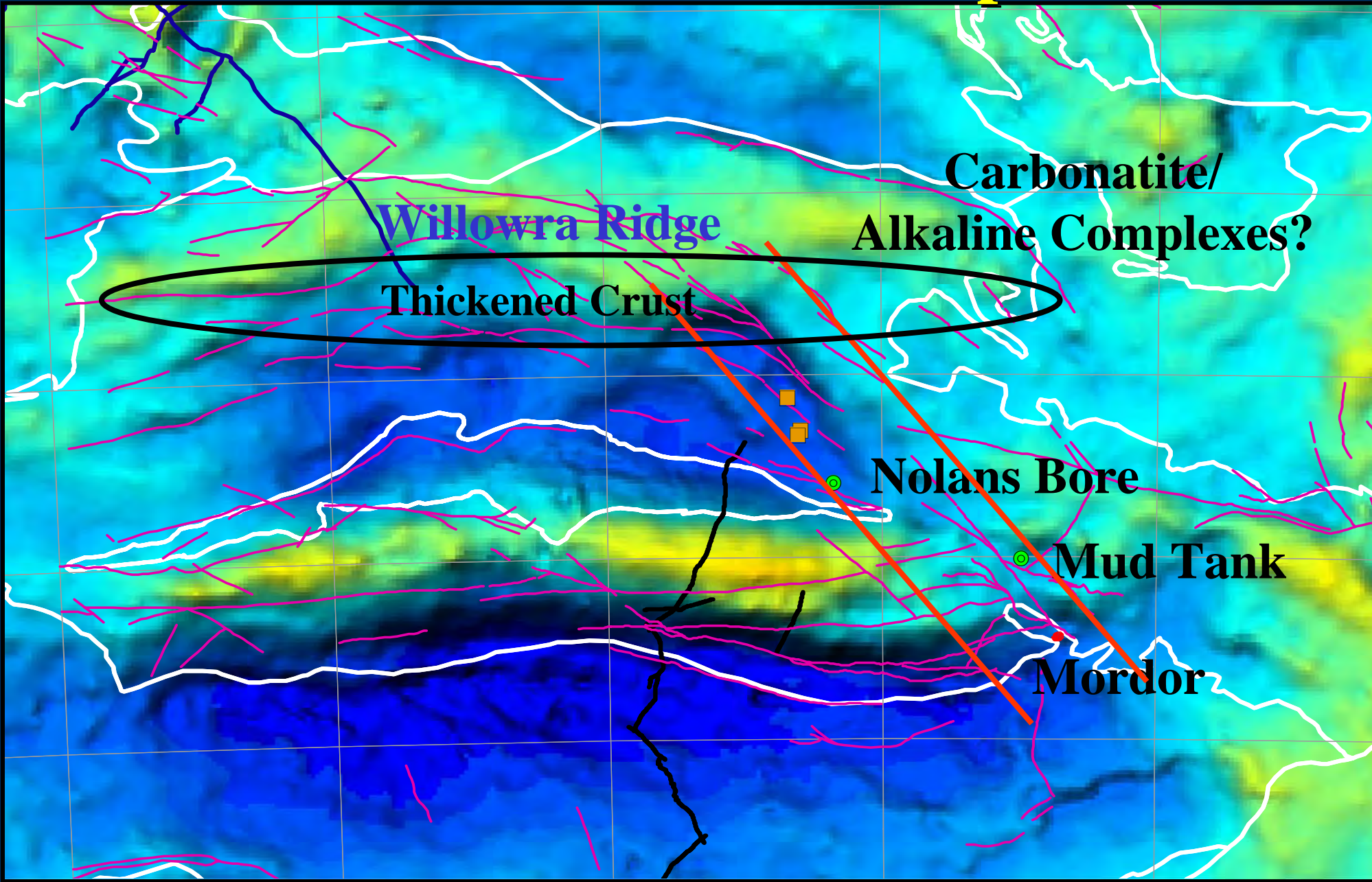
- **Proximity to Uranium-rich protolith**
- **Basins with red sandstones (thickness > 4 to 6kms): to generate hot and moderately saline and oxidised fluids**
- **Deformation event to trigger fluid flow**
- **Reductants (any rock would do)**



Alkaline Complexes and/or Carbonatites

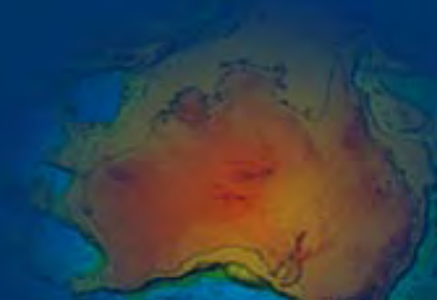


Alkaline/Carbonatite Complexes?



Conclusions

- **No known major U deposits in southern part of NAC**
- **High potential for several U-mineral systems:**
 - **Unconformity U (Tanami)**
 - **Iron-oxide Cu, Au, U (Tennant Creek, Warumpi)**
 - **Sandstone U (Ngalia, Amadeus and other basins)**
 - **Westmoreland-style sandstone U**
 - **Calcrete U**
 - **U-bearing alkaline complexes, carbonatites, pegmatites, skarns and veins/breccia zones**



Future Work

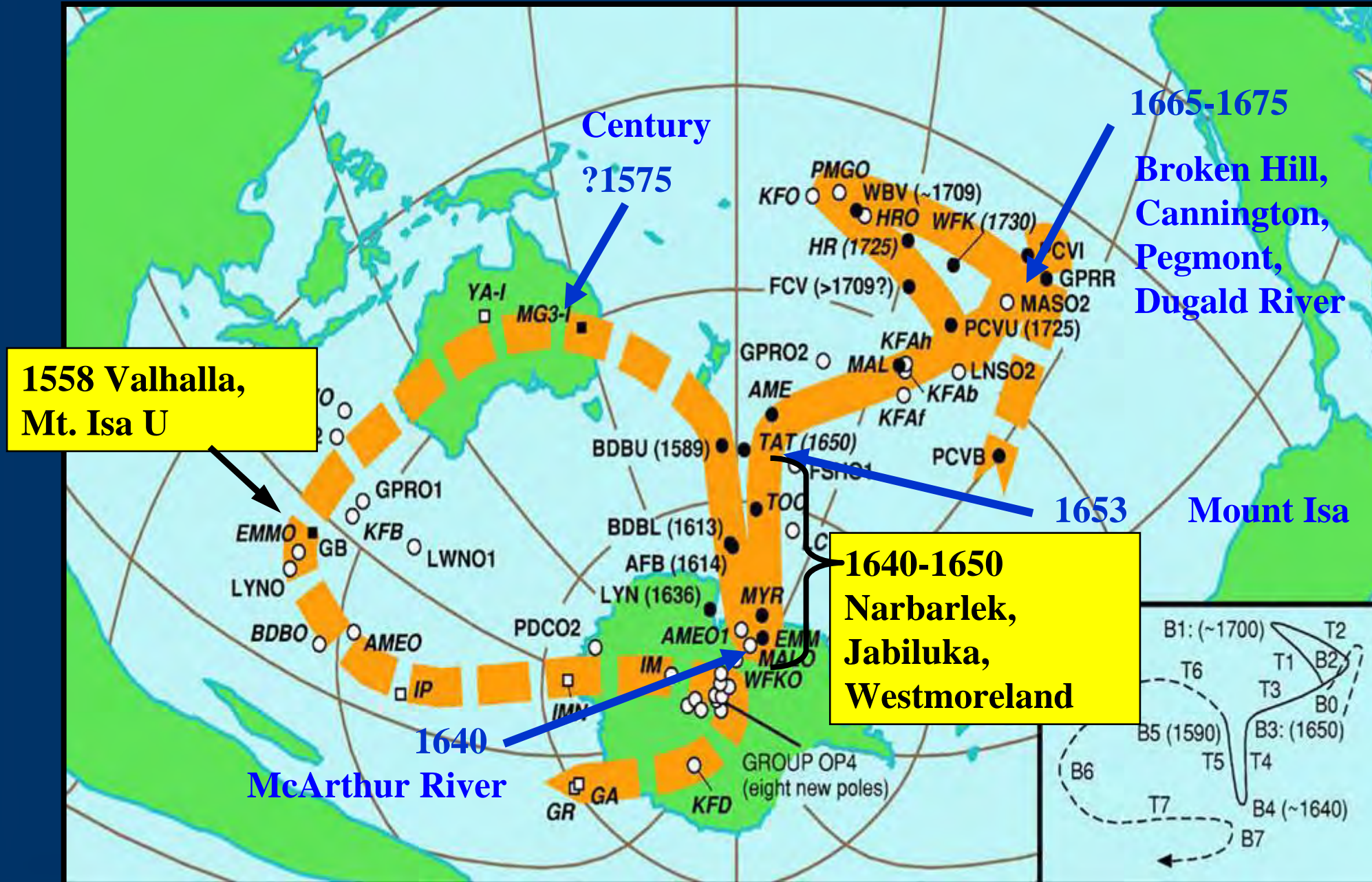
- Detailed work in Tanami (diagenetic history, timing of deposition of Birrindudu Group)
- U-assays in known Ironoxide Cu-Au deposits
- Detailed studies of the Mt. Webb Suite and equivalent intrusive and volcanic rocks
- Dating of U and REE bearing occurrences in Arunta



END

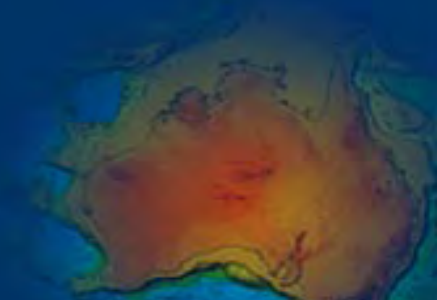


Apparent Polar Wander Path-Paleomagnetism

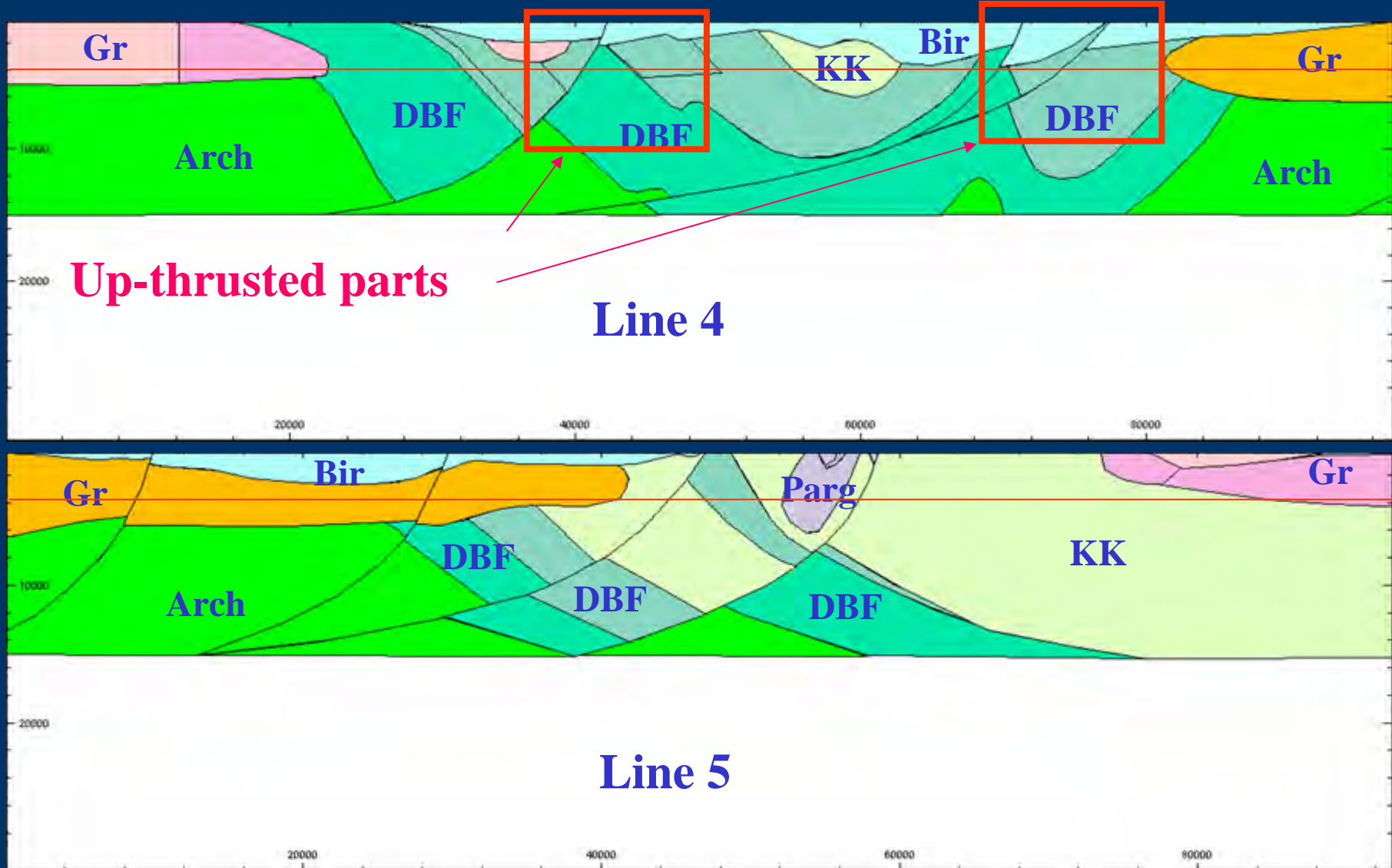


Critical Elements: Sandstone Uranium

- Proximity to Uranium-rich protolith
- Red and grey sandstones; red sandstone with shales (reductants)
- Age: preferably younger than L. Devonian-Carboniferous
- Dips < ~ 30 deg
- Deformation event as trigger of fluid flow?



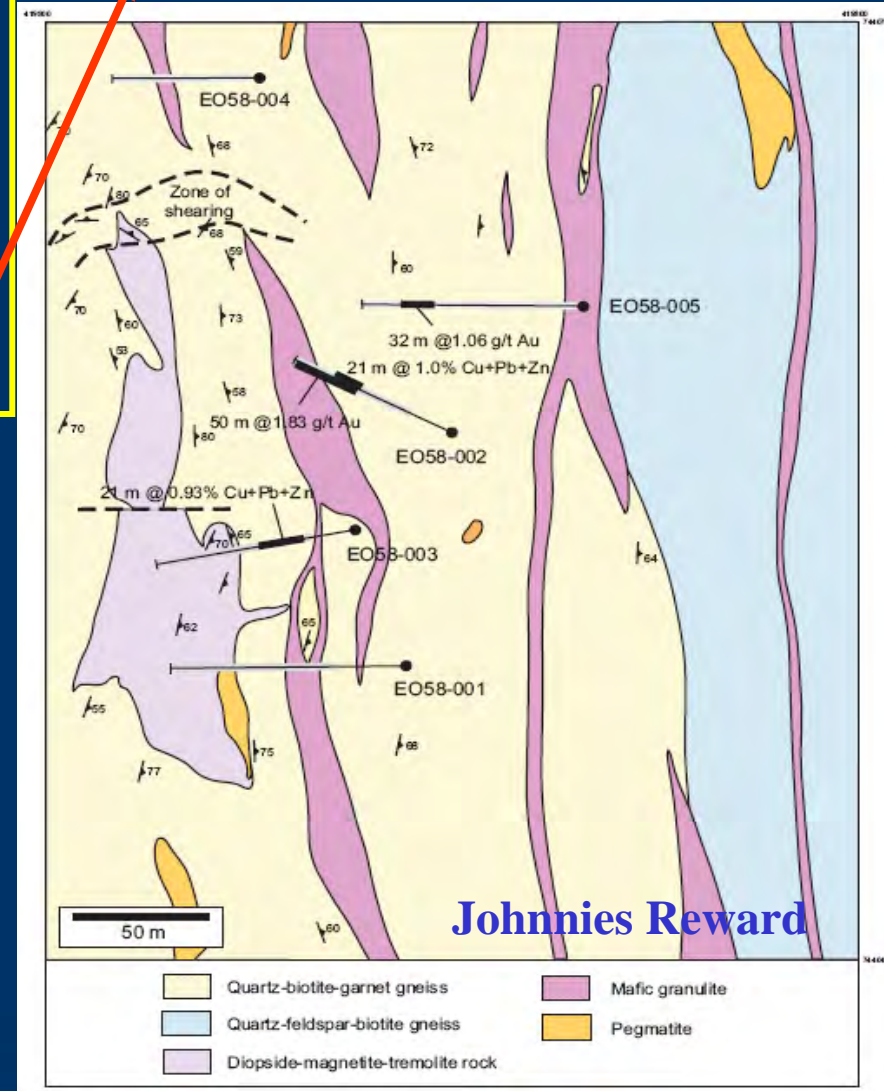
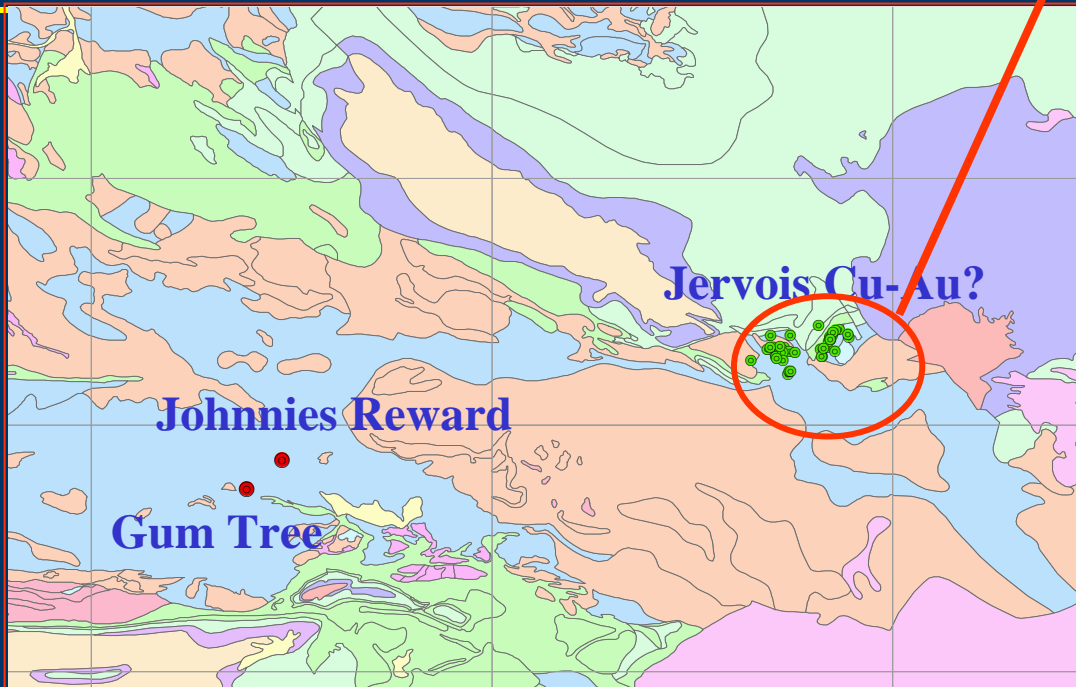
Unconformity Uranium in Tanami

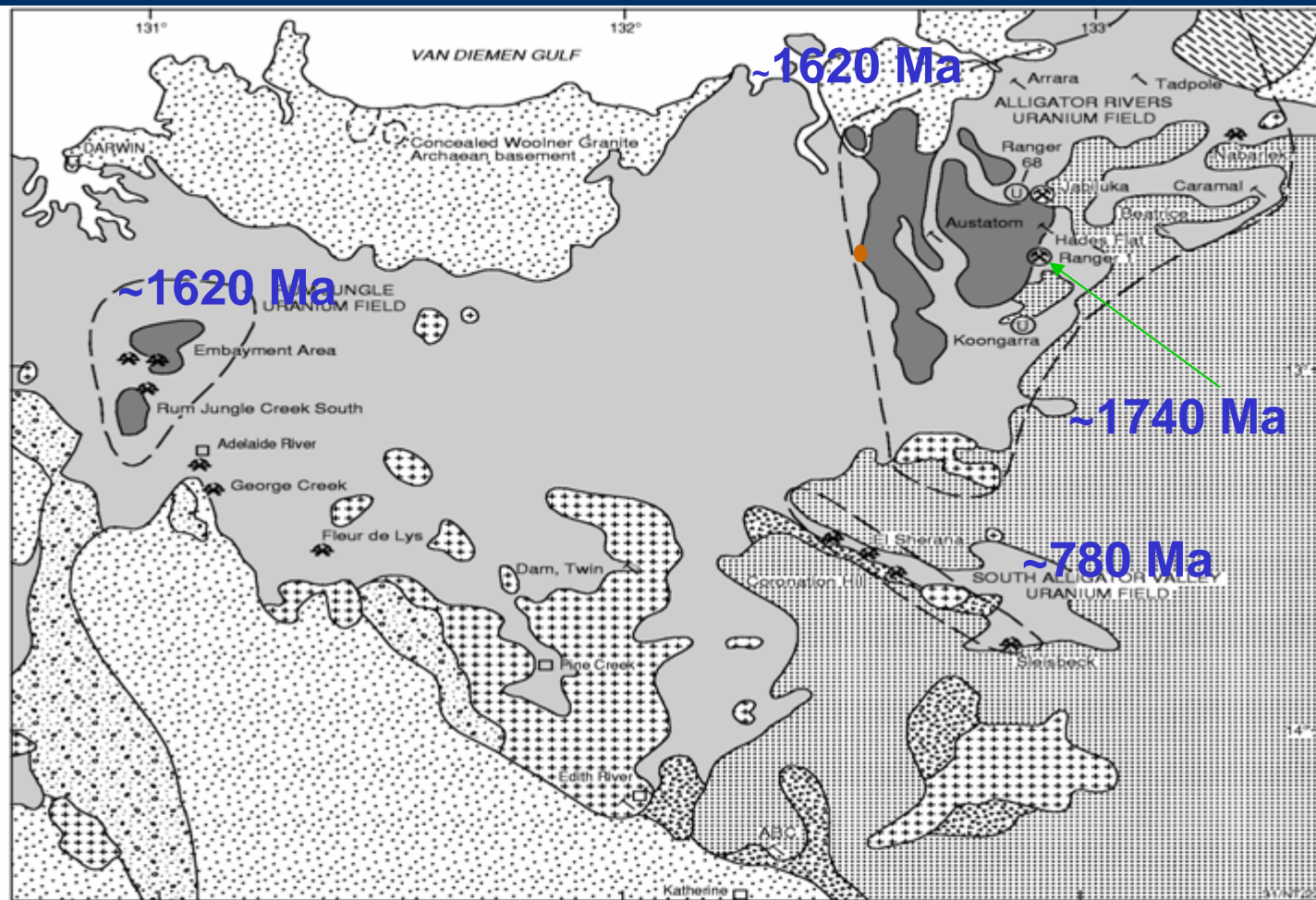


Ironoxide Cu-Au deposits? (Arunta)

- Granulite facies rocks of the Cadney Metamorphics (1730 Ma -1710 Ma event)
- Mineralisation (Cu, Pb, Zn, Au) with mgt bearing calcsilicates and gneisses
- Cu and Pb in the calcsilicate, Au in the quartz-biotite-garnet gneiss
- up to 300 ppm Th in some sections

- Jervois Cu-Au
- ironstones
- Bonya Schist (~ 1807 Ma)

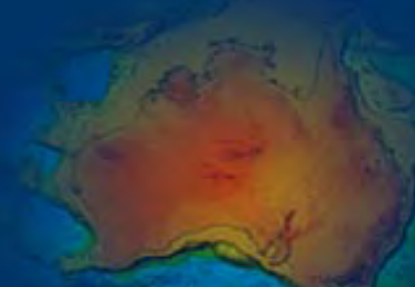




Pine Creek Inlier

- | | | |
|--------------------------------|--|---|
| PALAEOZOIC AND YOUNGER | | Sediments and volcanics |
| | | Sediments |
| | | Kombolgie Subgroup
Sediments and interbedded volcanics |
| | | Mostly felsic volcanics |
| PALAEOPROTEROZOIC | | Granite |
| | | Nimbuwah Complex
(Migmatite and anatectic granite) |
| | | Mostly geosynclinal metasediments |
| ARCHAEAN-
PALAEOPROTEROZOIC | | Rum Jungle, Waterhouse
and Nanambu complexes |

- Major unworked deposit
- Major mine
- Closed mine
- Prospect
- Town



Critical Elements of Ironstone Cu-Au Systems

(Based on Gawler)

- Orogenic belts at the craton margin;
subduction related margin
- I- and A-type fractionated, highly
oxidised granitoids
- Coeval bimodal volcanics
- High U/heat content of granitoids
- Regional Fe-, Na-, K-metasomatism
- Regional transtensional/extensional
faults, diatreme-maar vent zones

	<i>Gawler</i>	<i>Warumpi</i>
• Orogenic belts at the craton margin; subduction related margin	✓	✓ ?
• I- and A-type fractionated, highly oxidised granitoids	✓	✓ ?
• Coeval bimodal volcanics	✓	✓
• High U/heat content of granitoids	✓	✓ ?
• Regional Fe-, Na-, K-metasomatism	✓	✓ ?
• Regional transtensional/extensional faults, diatreme-maar vent zones	✓	✓ ?

