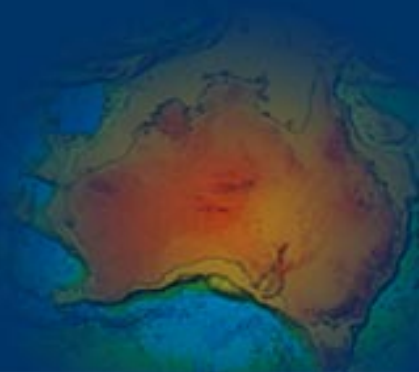
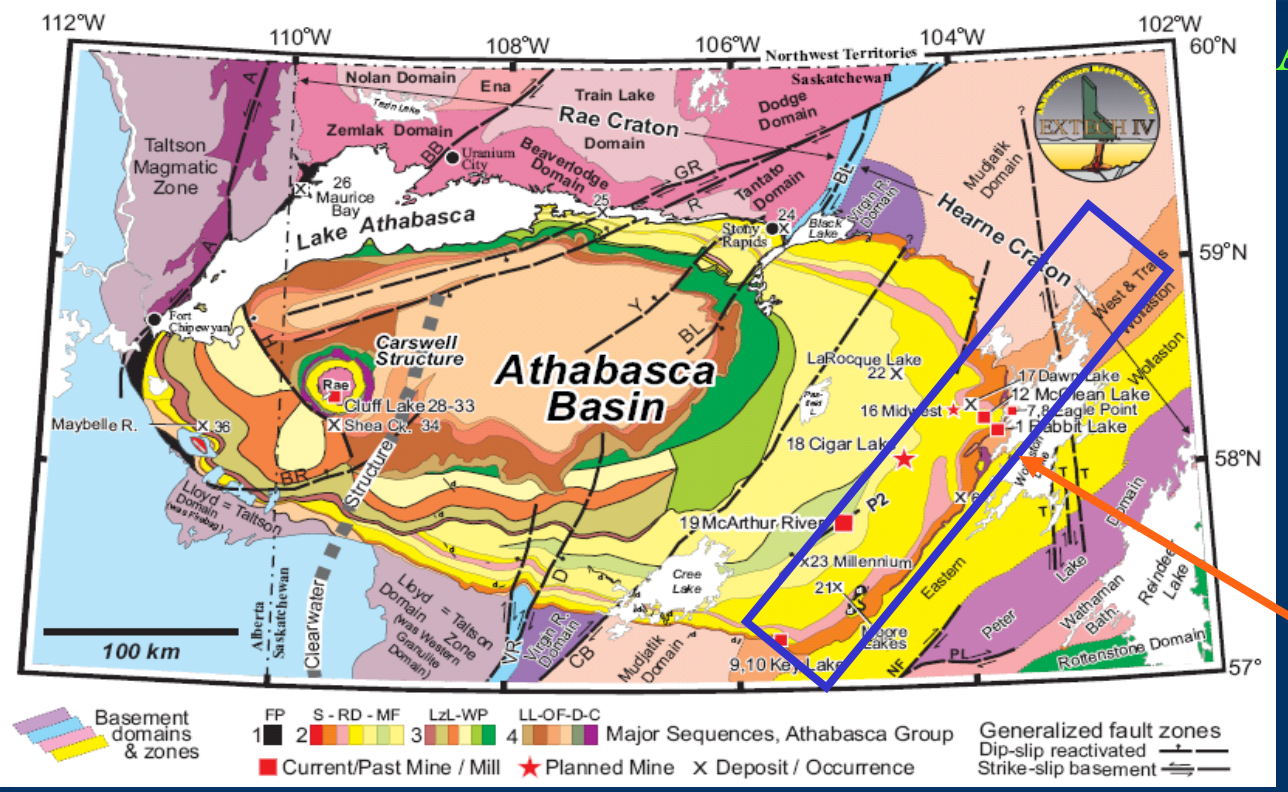
Australian Government

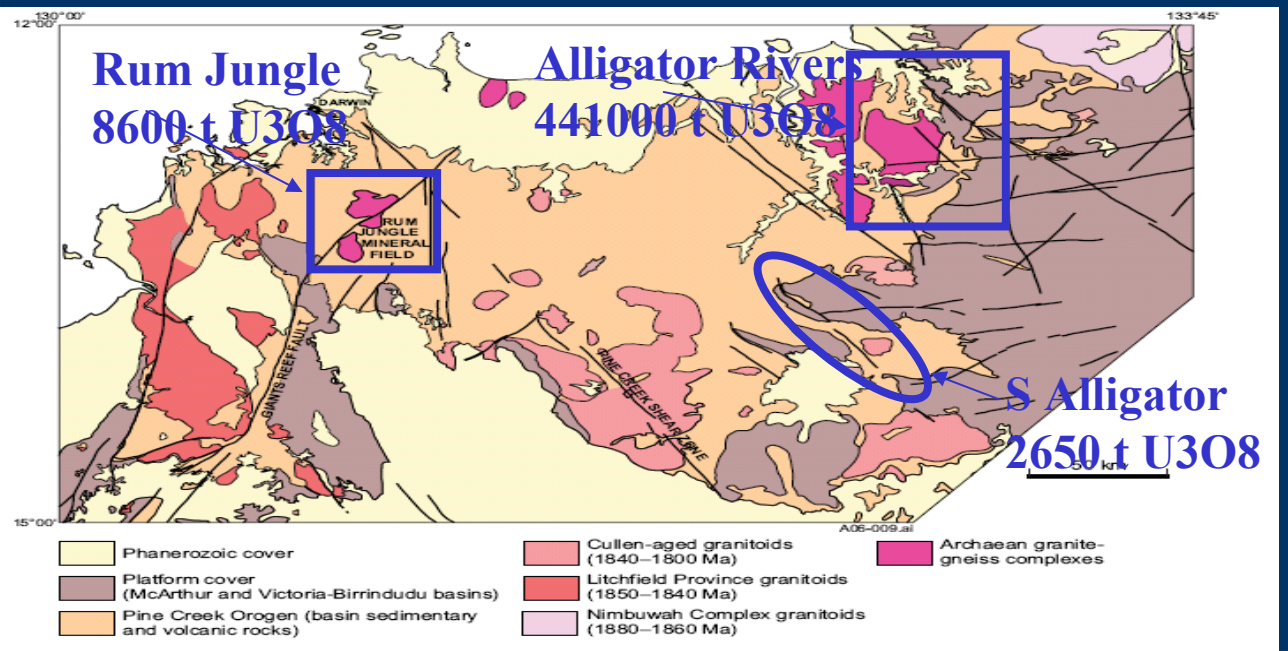
Geoscience Australia

Unconformity-Related Uranium Systems: Regional Scale Constraints

Subhash Jaireth, Tony Meixner, Peter Milligan, Ian Lambert and Yanis Miezitis







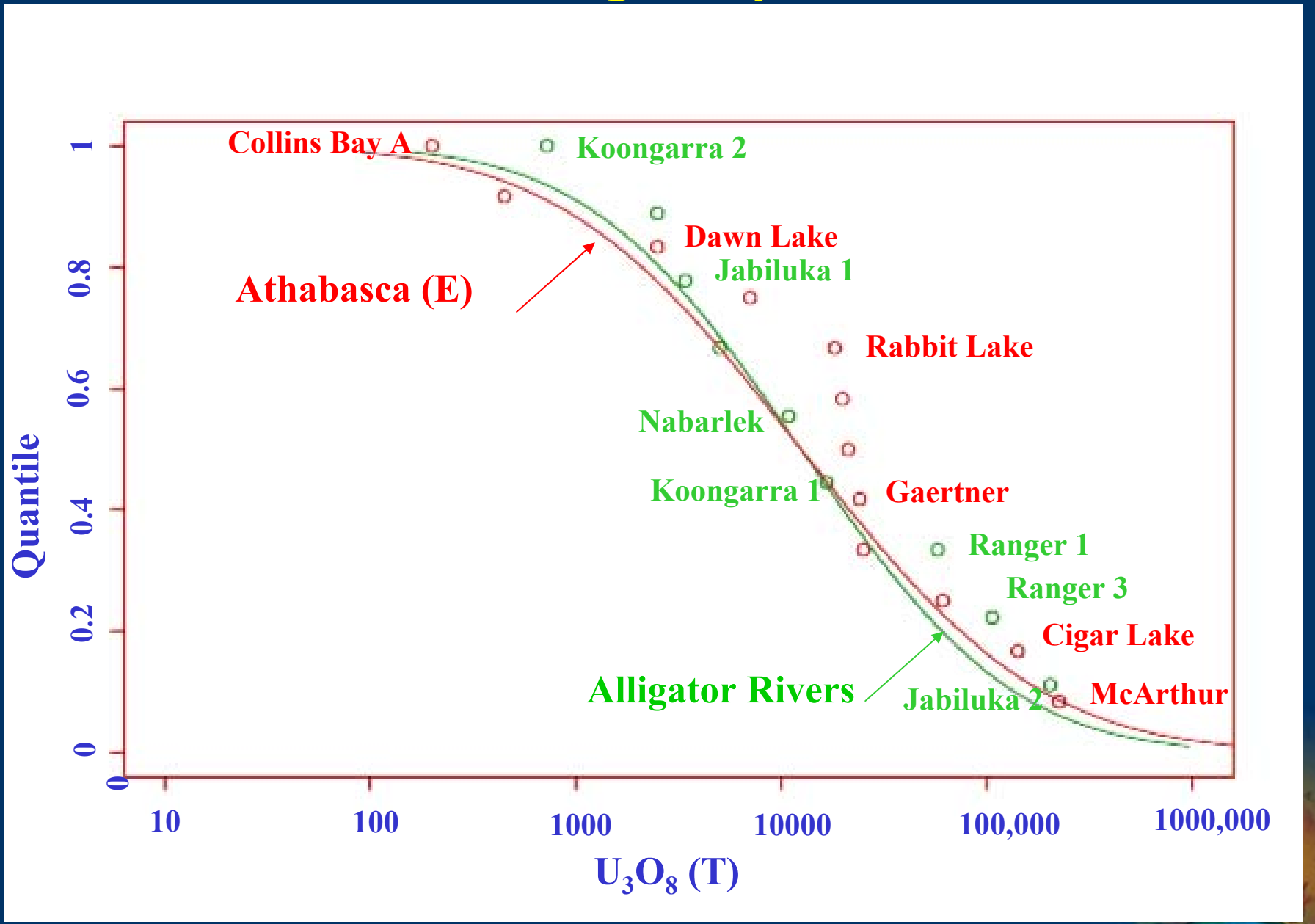
Athabasca:

- 653000 T U3O8
- Most of the basin preserved
- Significant mineralisation in the cover rock above the unconformity
- A NE trending structure coincident with a gravity-high edge

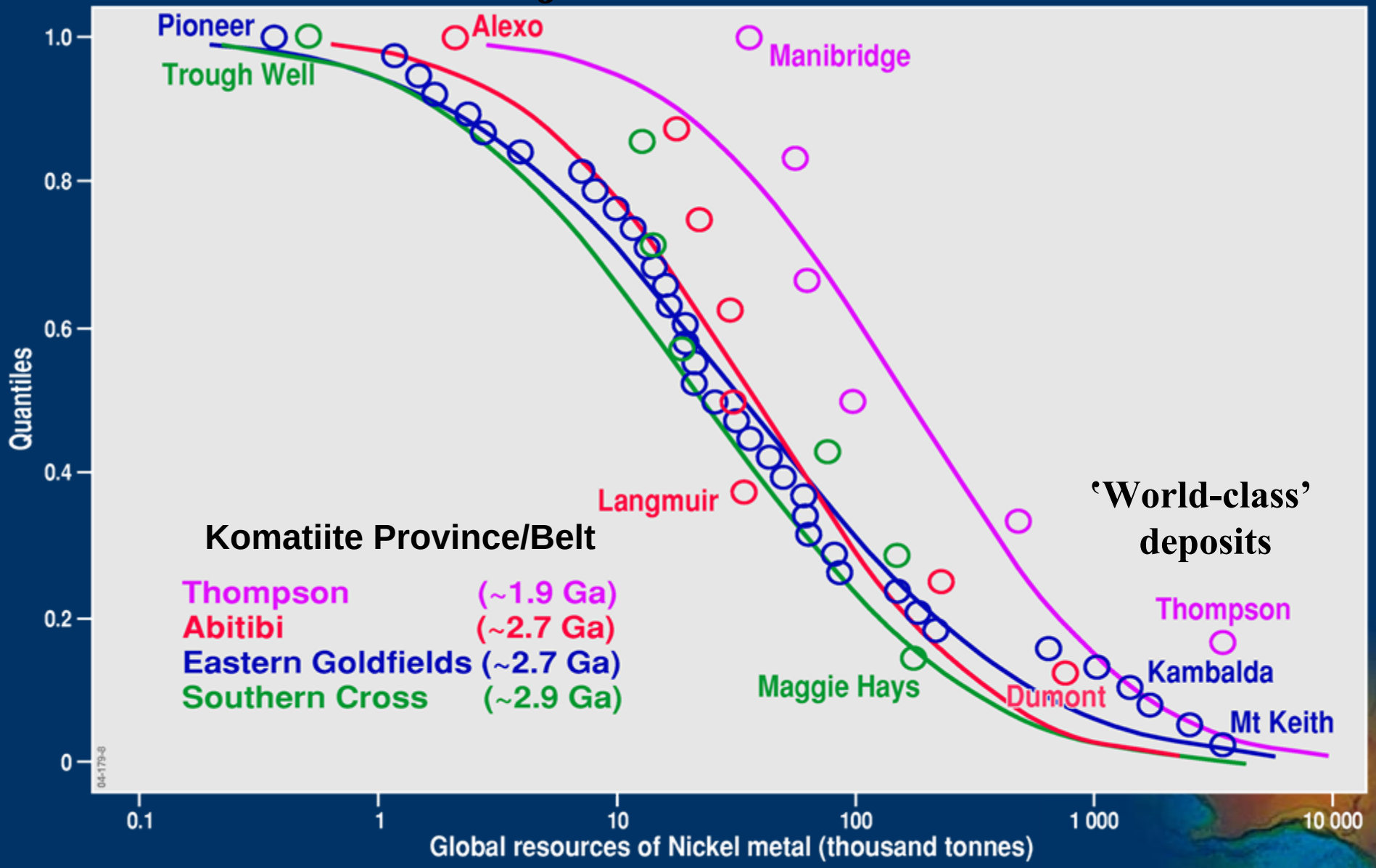
Pine Creek Orogen (Kombolgie):

- 453000 T U3O8
- ~ 50% of the basin eroded
- No significant mineralisation in the cover rock above the unconformity (as yet)

Cumulative Frequency Distribution



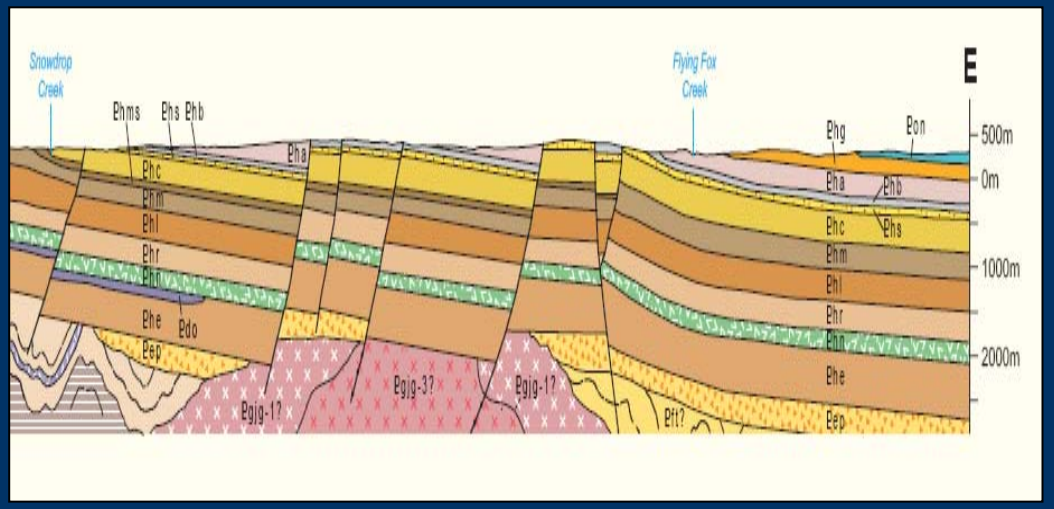
Cumulative Frequency Distribution of Major Nickel Provinces

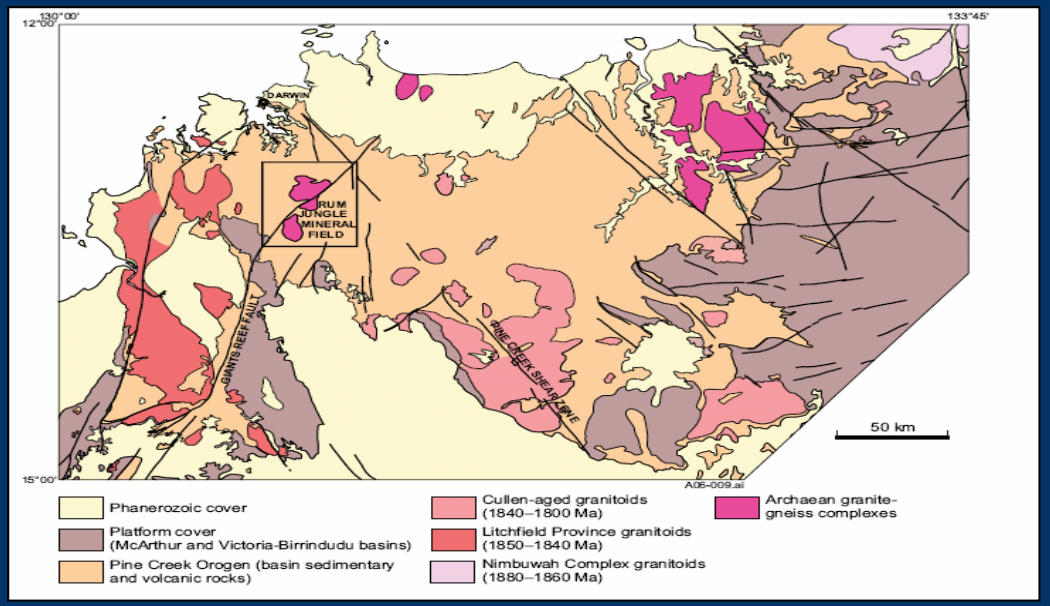


Outline

- Uranium occurrences widely distributed but Major Deposits are localized in specific zones/fields
- > 90% of U resources confined to one field,
- Therefore need to go beyond the components (source, pathway, trap) of mineral system to explain the distribution of U endowment; hence the presentation will
  - focus on the Architecture of the system
  - to delineate important regional constraints

Architecture of the Unconformity U System

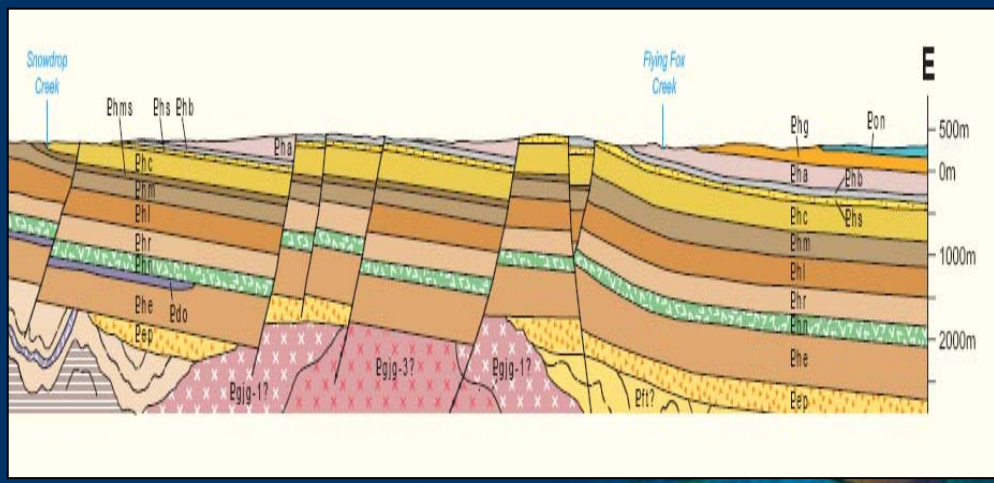




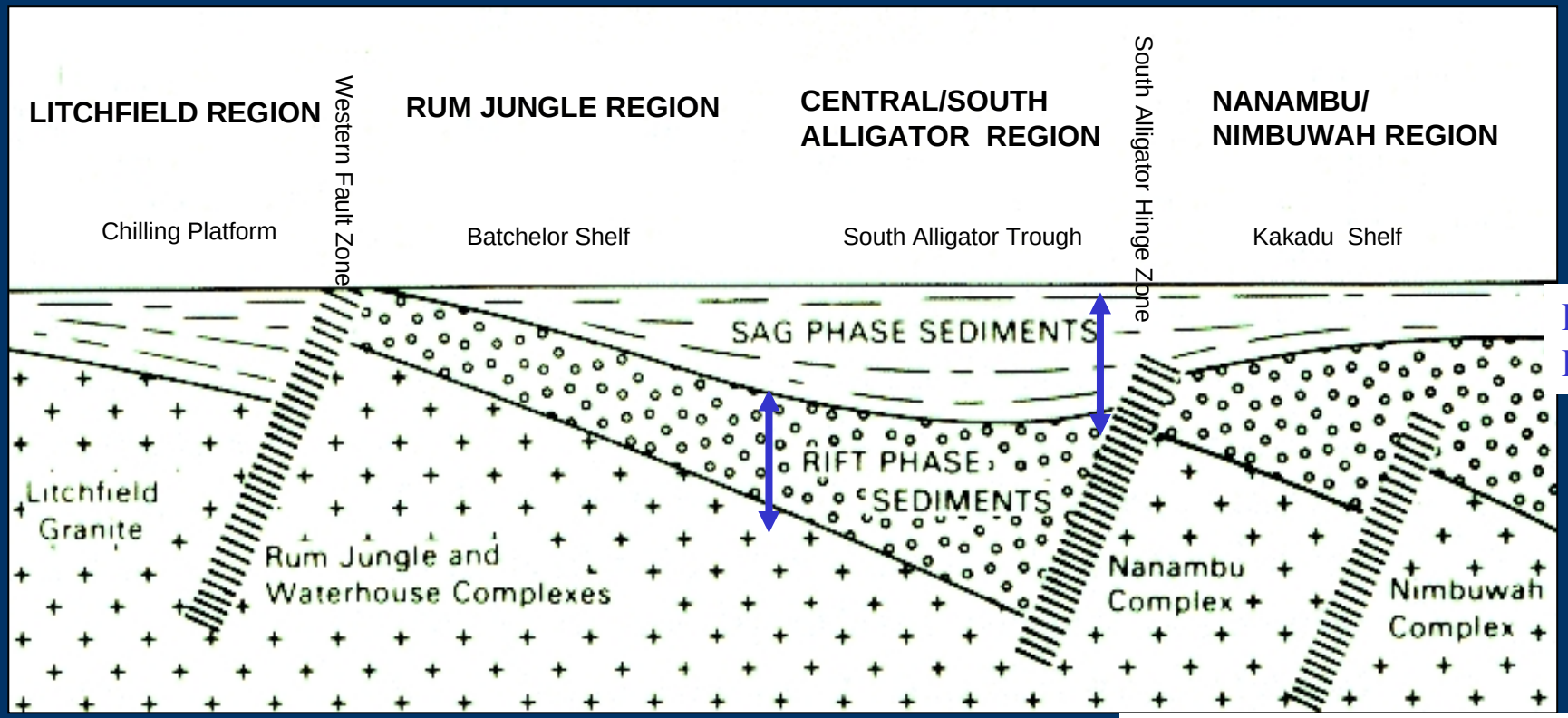
- Unconformity
- Overlying flat platform cover: Fluvial siliciclastic, Red-bed sandstone
- Underlying metamorphosed package
- Inliers/domes of Archaean complexes
- Palaeo-regolith below the Cover (few cms to tens of meters thick)
- Basement faults

Architecture of the Unconformity U System: Unconformity

- Contact between the Oxidised Aquifer and the Reduced Trap



Pine Creek Orogen: Intracratonic Basin



Intracratonic Basin

Adapted from Needham et al., 1988

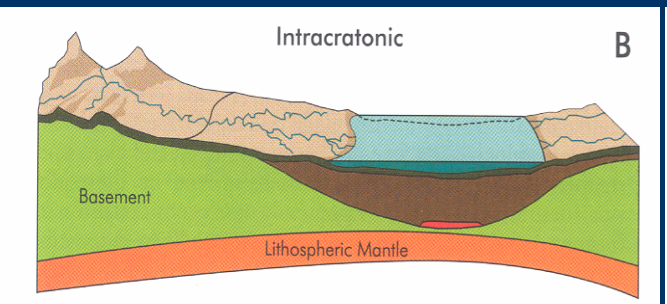
Orogenesis:
Edith River Group
El Sherana Group

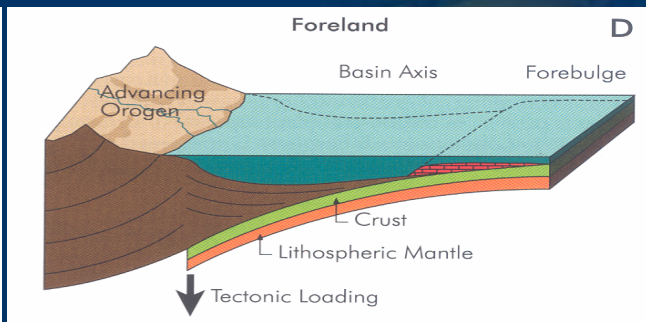
~ 1870 to 1800 Ma

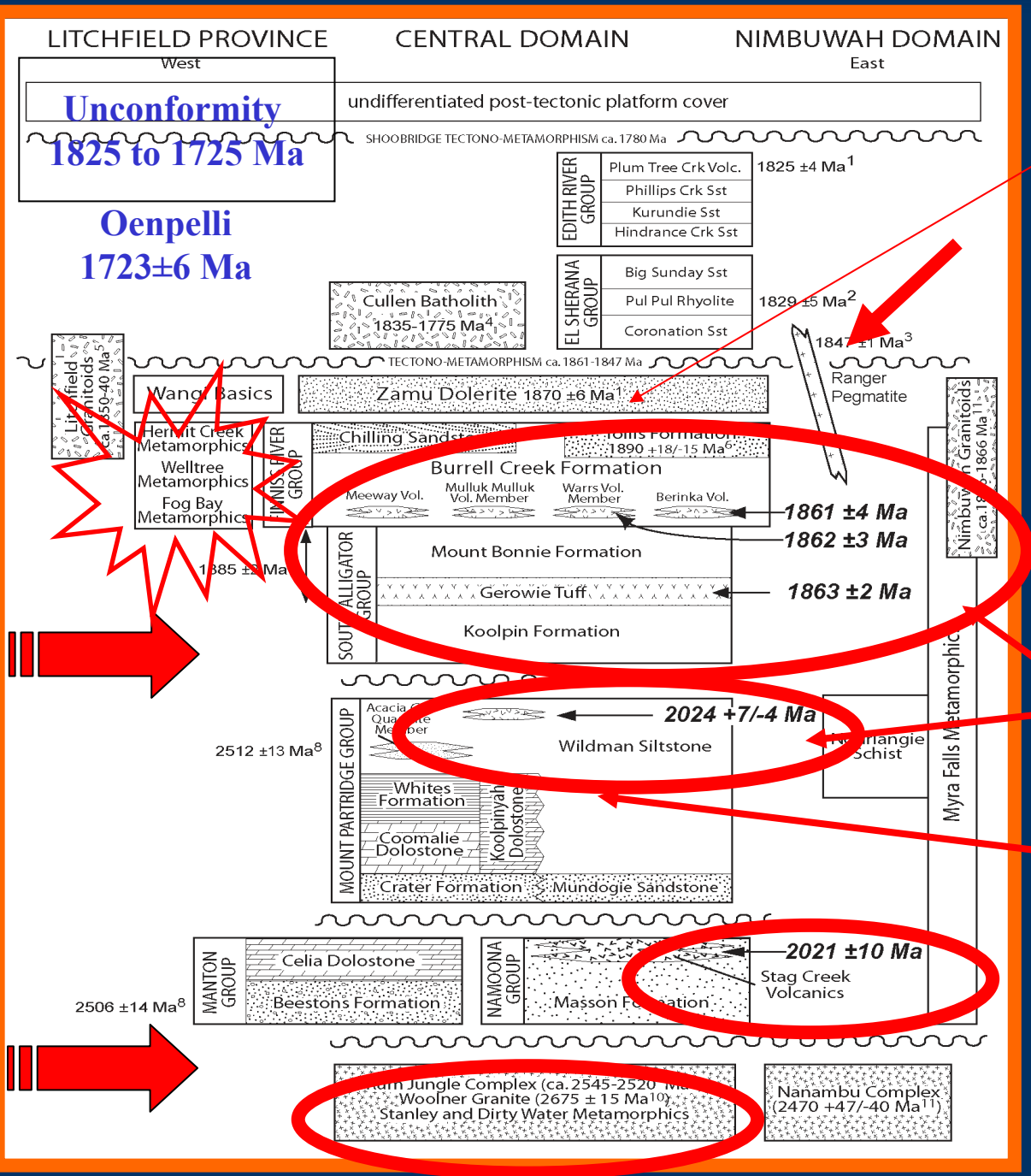
Sag Phase:
Finnis River Group
South Alligator Group

Rift Phase:
Mount Partridge Group
Namoona Group

~ 2000 to 1870 Ma





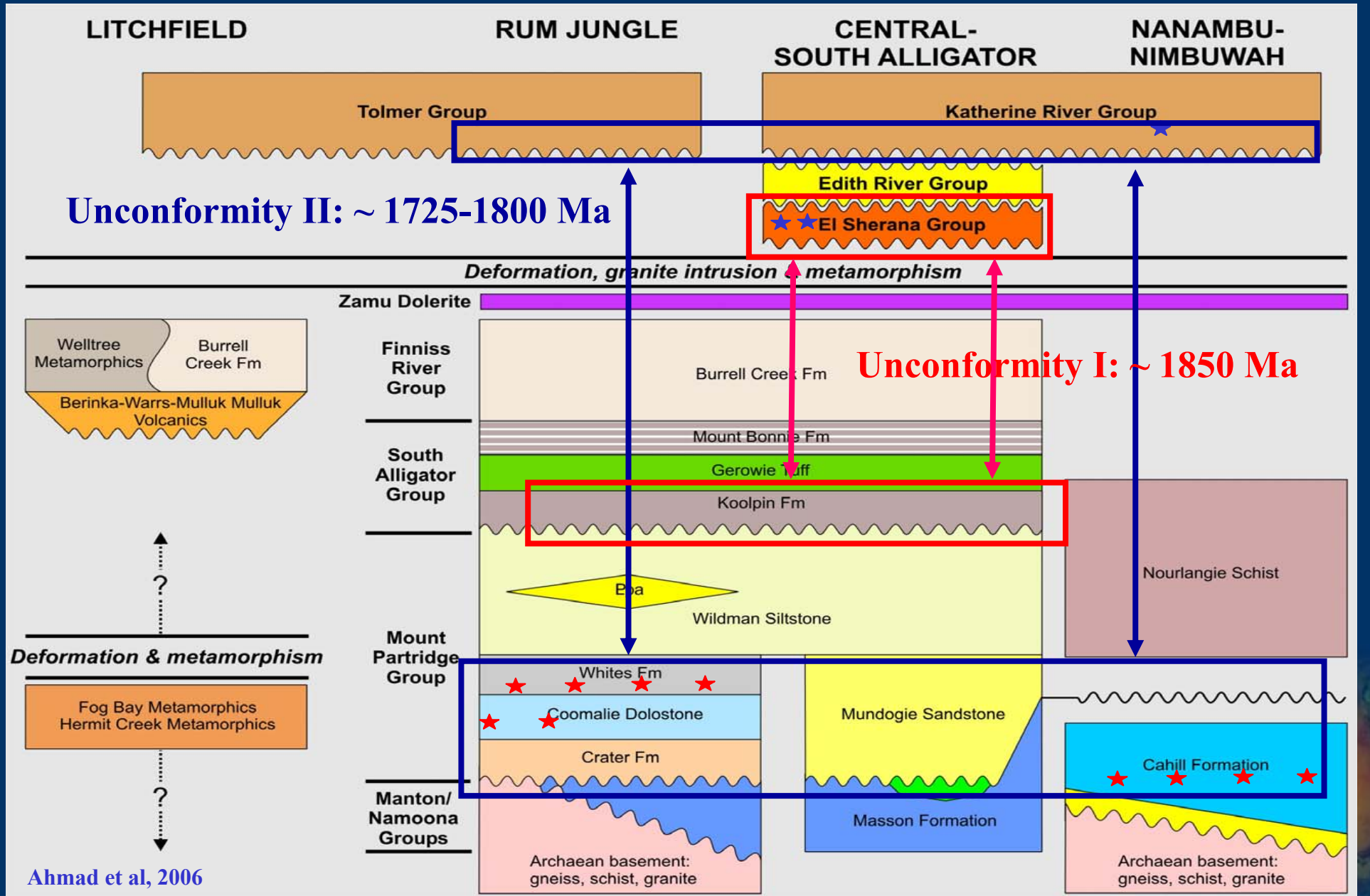


Zamu Dolerite ~ 1870 Ma

- Deformation over by ca. 1847 Ma
- Peak metamorphism ca. 1855 Ma
- Rapid deposition and felsic volcanism at ca. 1863 Ma
- Significant time/stratigraphic break - up to 150 Ma
- Mount Partridge Group is constrained at ca. 2024 Ma
- Initial rifting occurred prior to ca. 2050-2020 Ma
- Neoarchaean basement ca. 2545 - 2520 Ma

Worden, 2005

Two Unconformity Systems



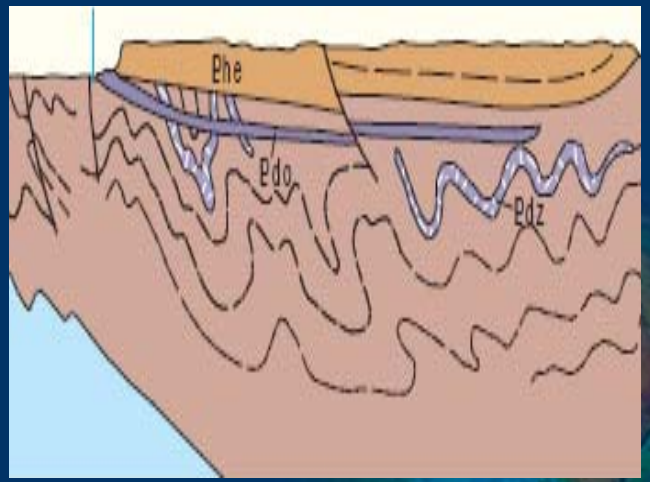
Ahmad et al, 2006

S Alligator Valley Field

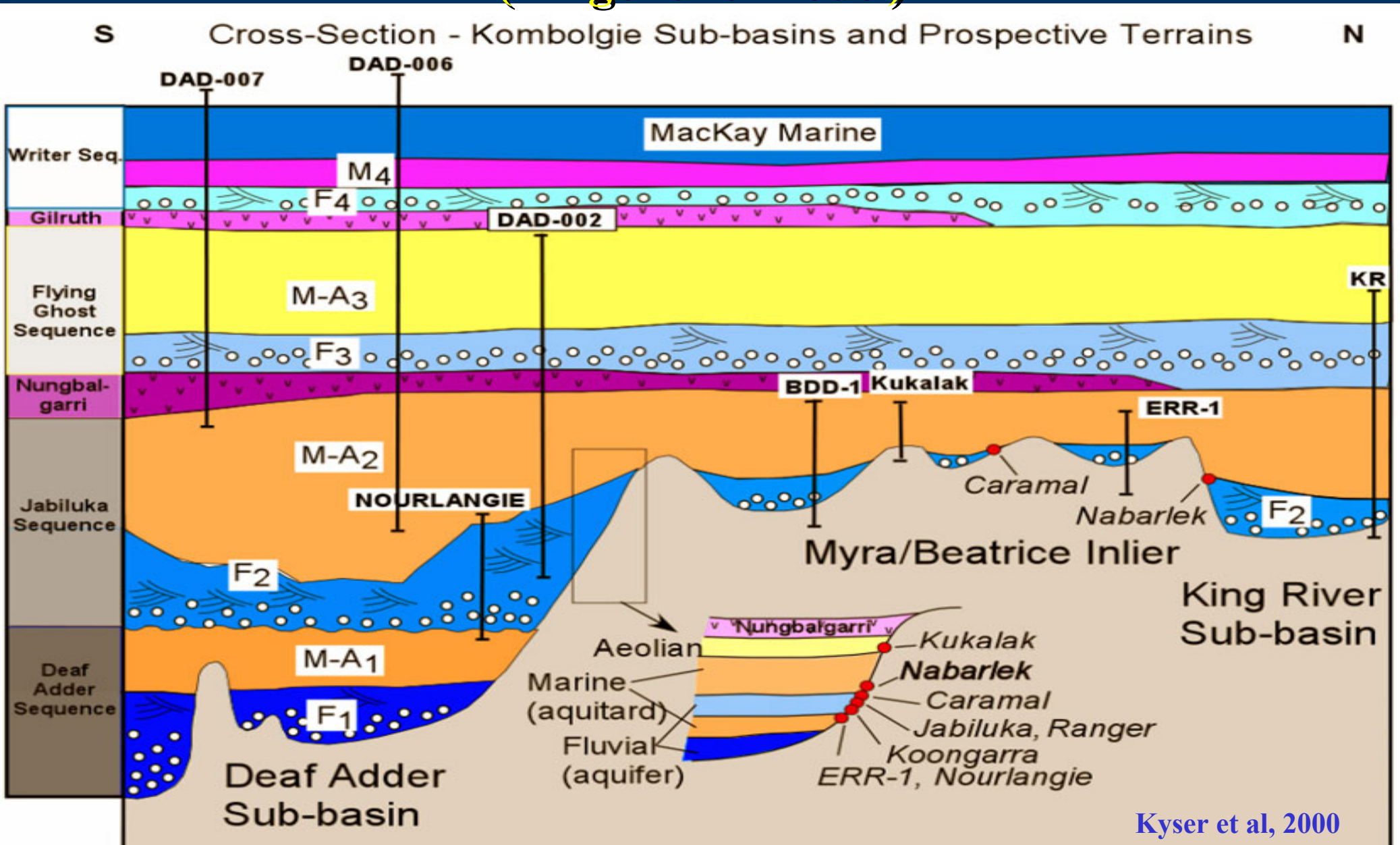
- Two(?) Mineralised Unconformity Systems:
  - II (Younger): Between South Alligator Group (containing host Koolpin Formation) and the Katherine River Group (Mamadawerre Sandstone): Active elsewhere in the Pine Creek
  - I (Older): Between South Alligator Group (containing host Koolpin Formation) and El Sherana Group (Coronation Sandstone): Possible?
- Coronation Sandstone:
  - Conglomerate, sandstone, volcaniclastic siltstone and shale, and minor mafic and felsic rocks
  - Valley-fill succession formed in a braided river system
  - Potential problems (small thickness; deformed and metamorphosed)

Architecture of the Unconformity U System: Overlying Flat Platform Cover

- Source of U
- Source of Fluids
- Diagenetic history



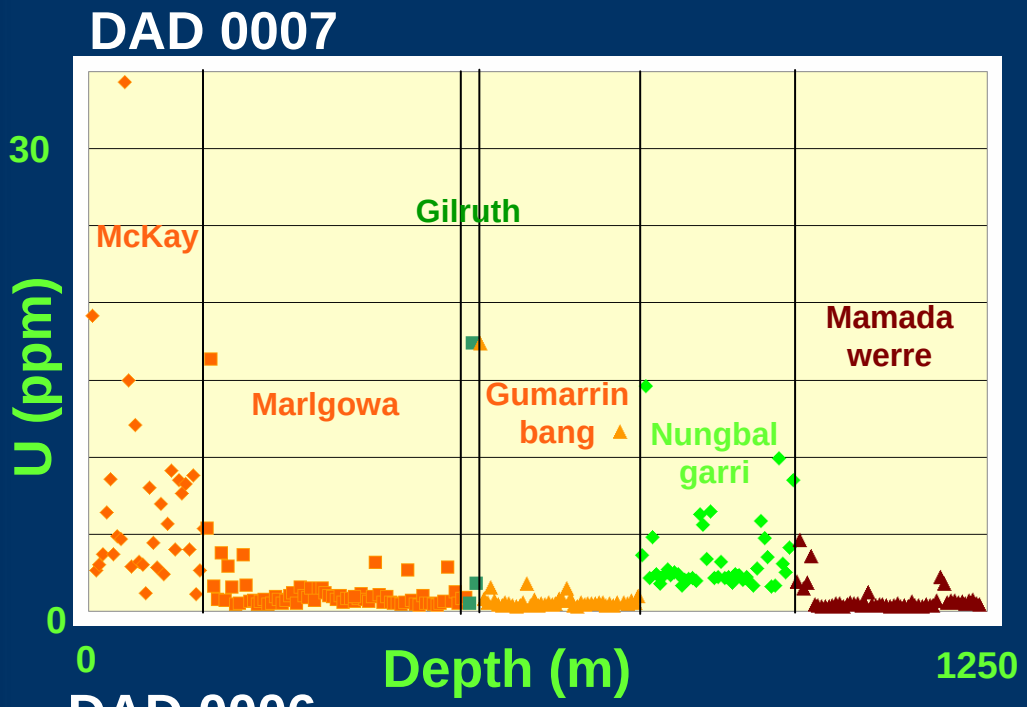
Favourable Source of U and Fluids: Overlying Sandstone (Diagenetic Model)

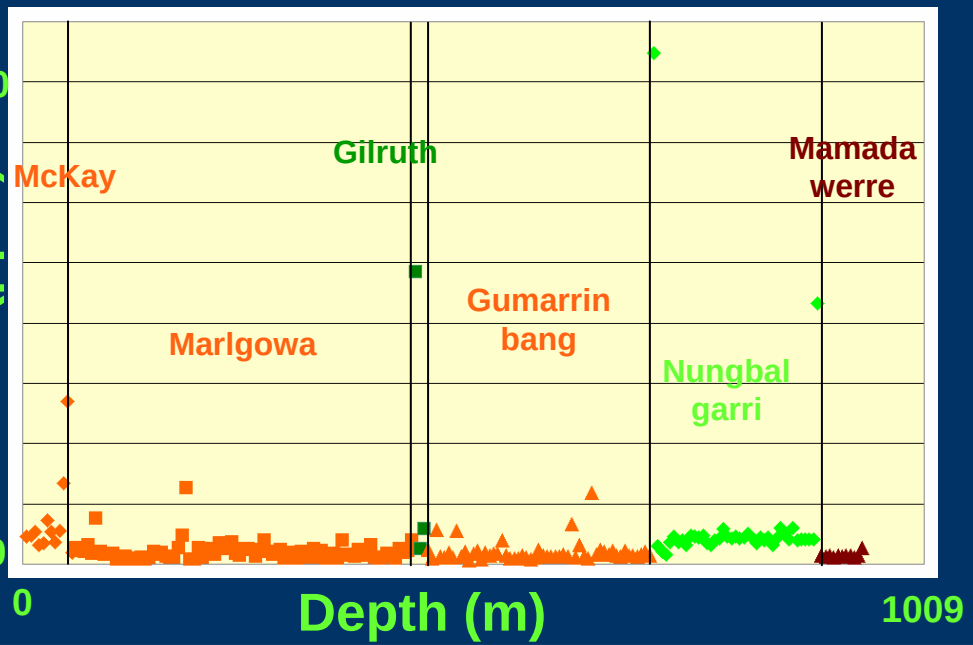


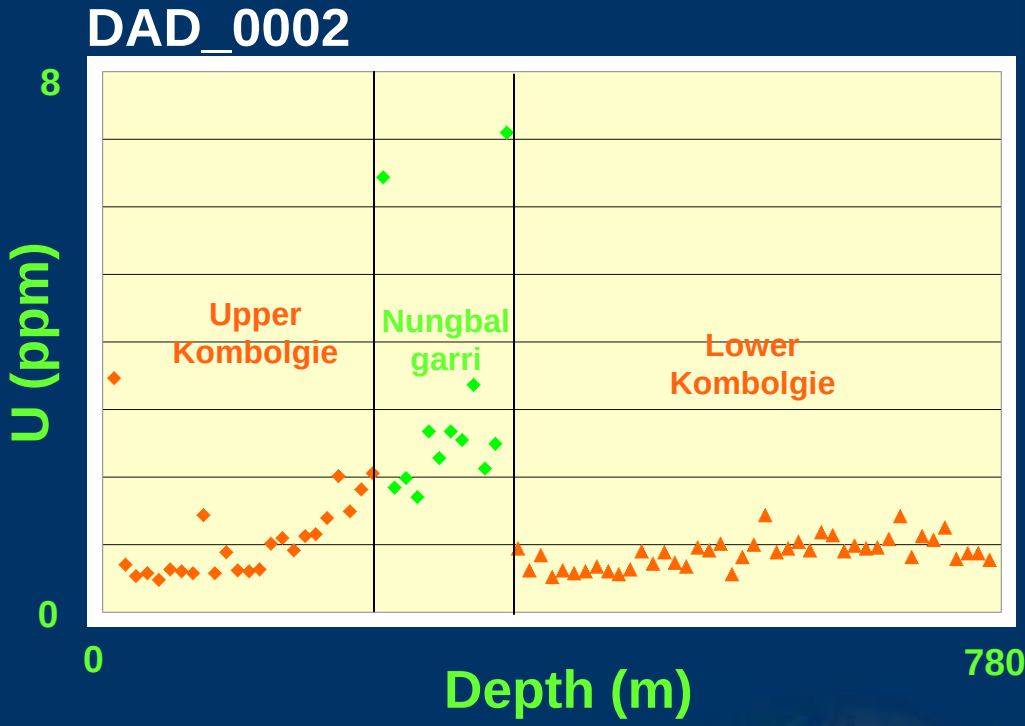
Kyser et al, 2000

Uranium in the Kombolgie Rocks

Doubtful that U was sourced from Kombolgie Sandstones



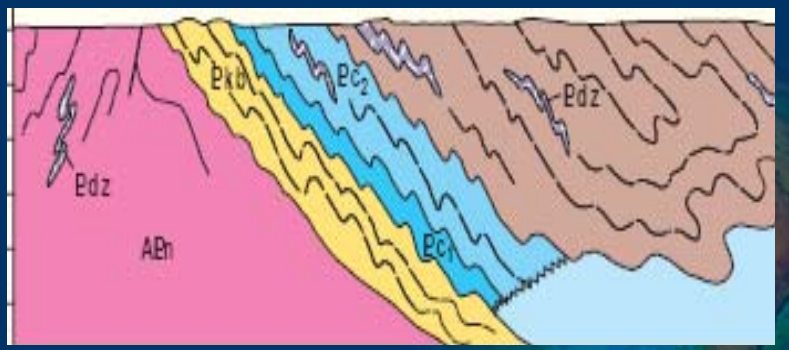


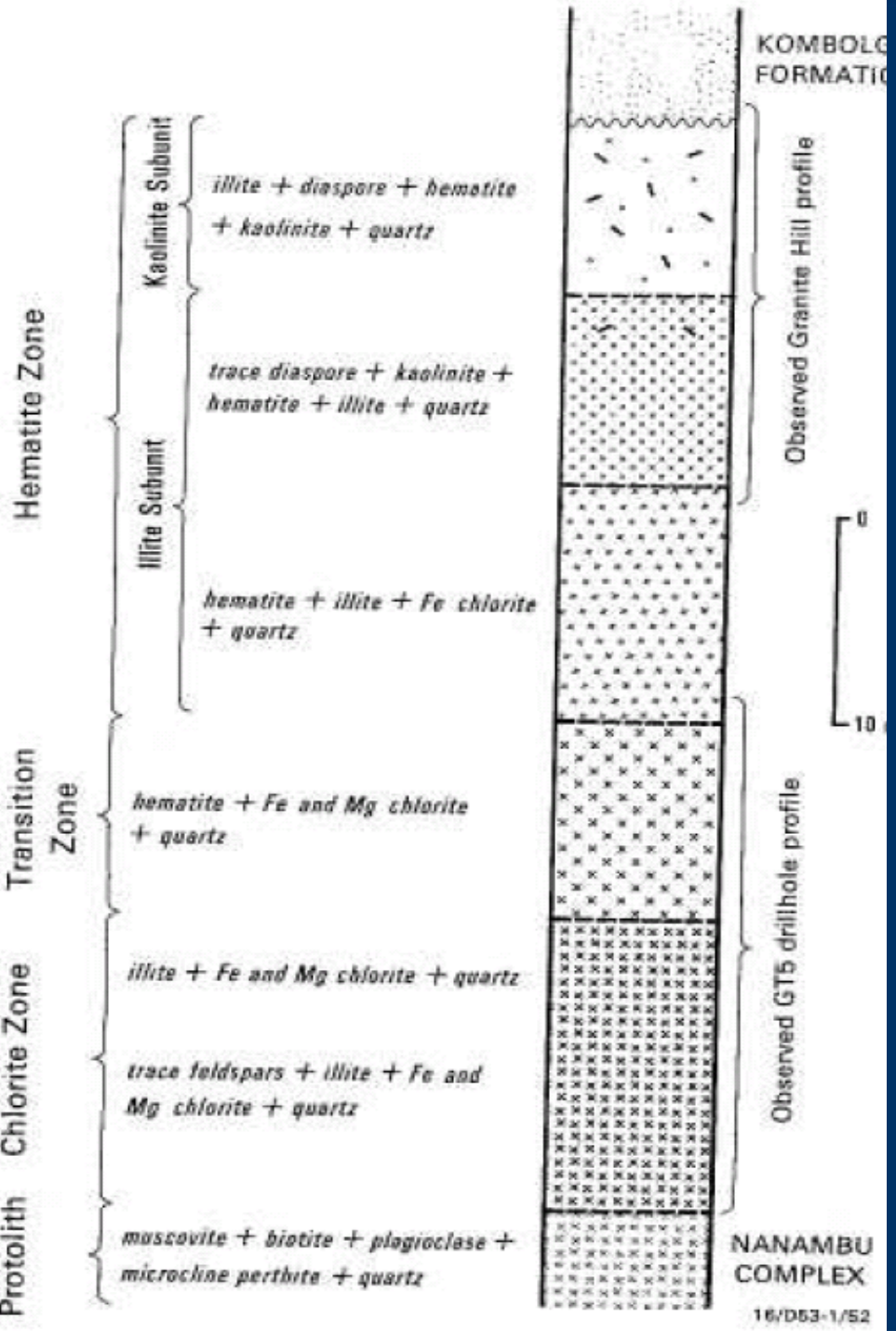


- Uranium ~ 1-2 ppm
- local scale redistribution during diagenesis
- concentration at the contact with mafic volcanics

Architecture of the Unconformity U System: Underlying Metasediments and Felsic rocks

- Source of U: commonly contain between 10 to 20 ppm U
- Alteration: dissolution of monazite and uraninite
- Trap





Palaeo-regolith: How important?

Saprolitic palaeo-weathered profile over Nanambu Complex (Granite Hill)

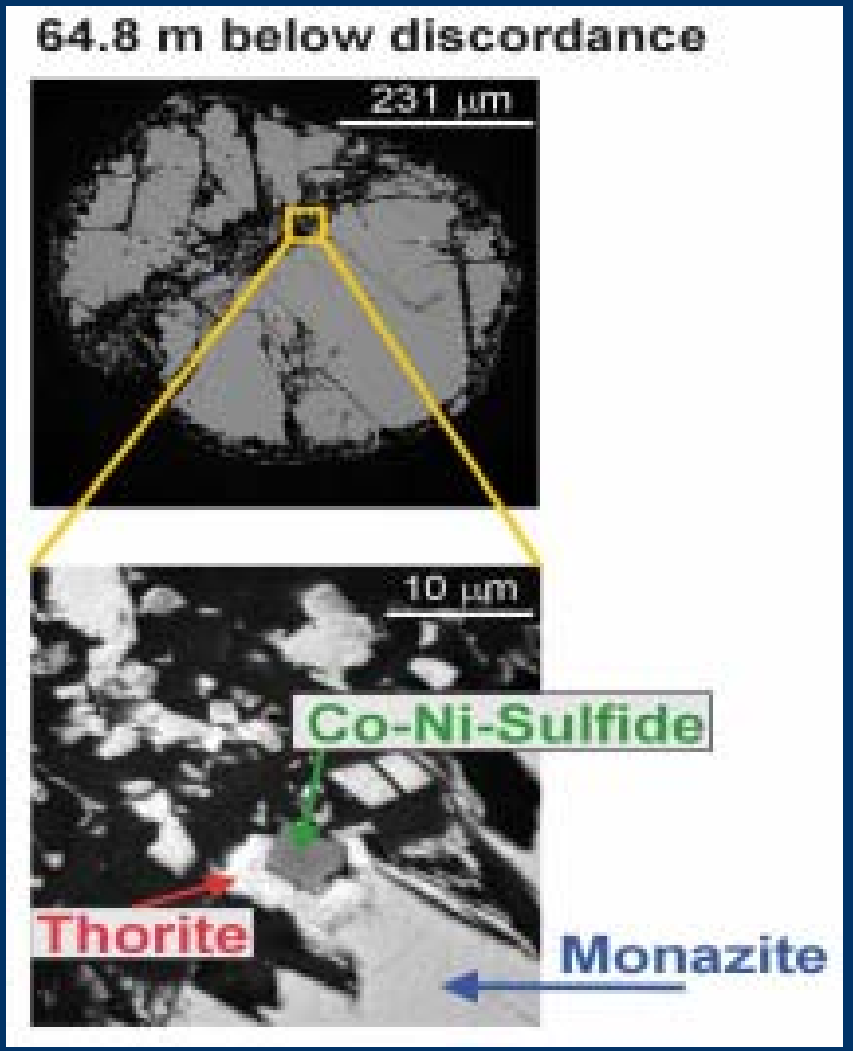
- **commonly 50 m thick**
- **alteration following burial beneath the Kombolgie (illite and haematite, phosphate)**
- **depleted in U (about 5 ppm) compared to the protolith**

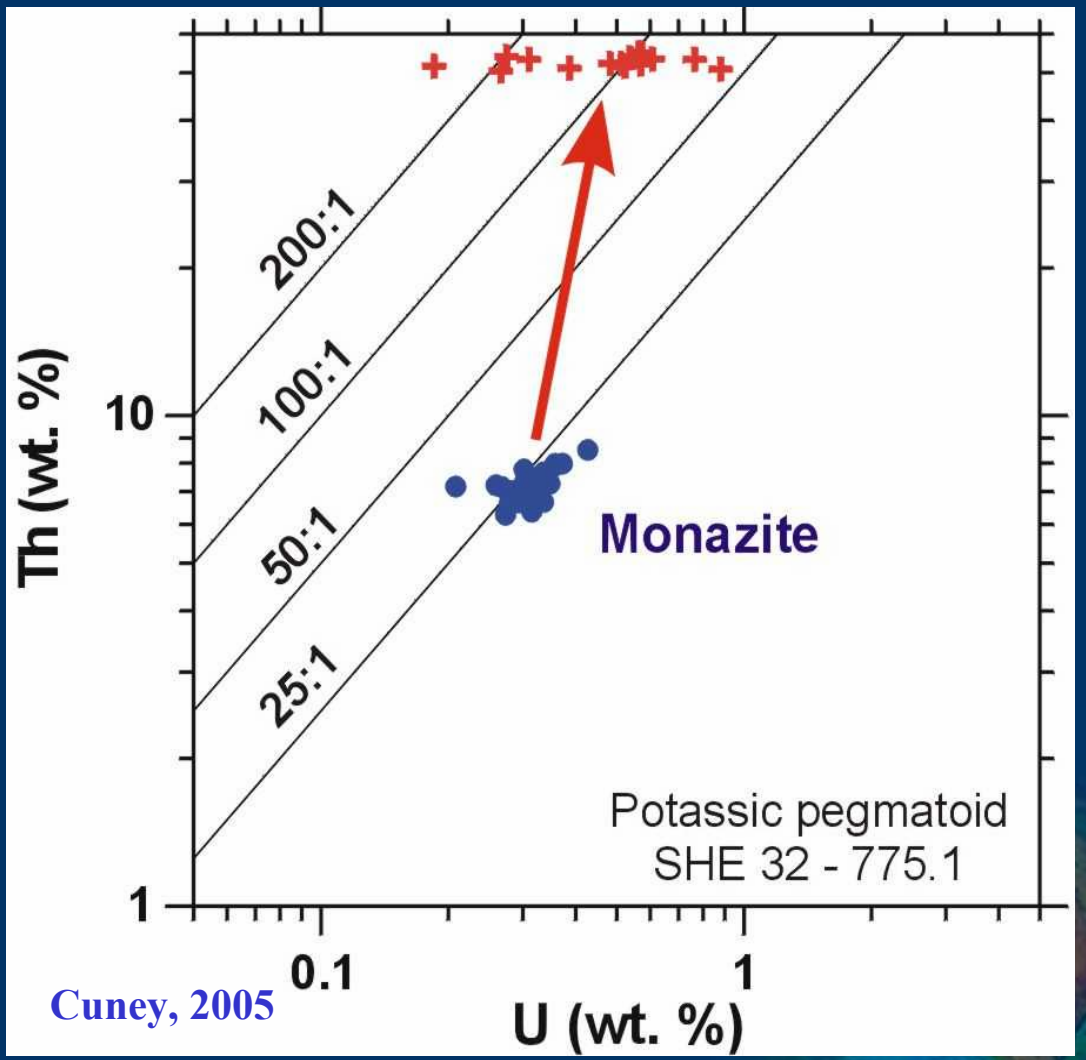
?Presence of U depleted regolith: An important indicator

Needham, 1988

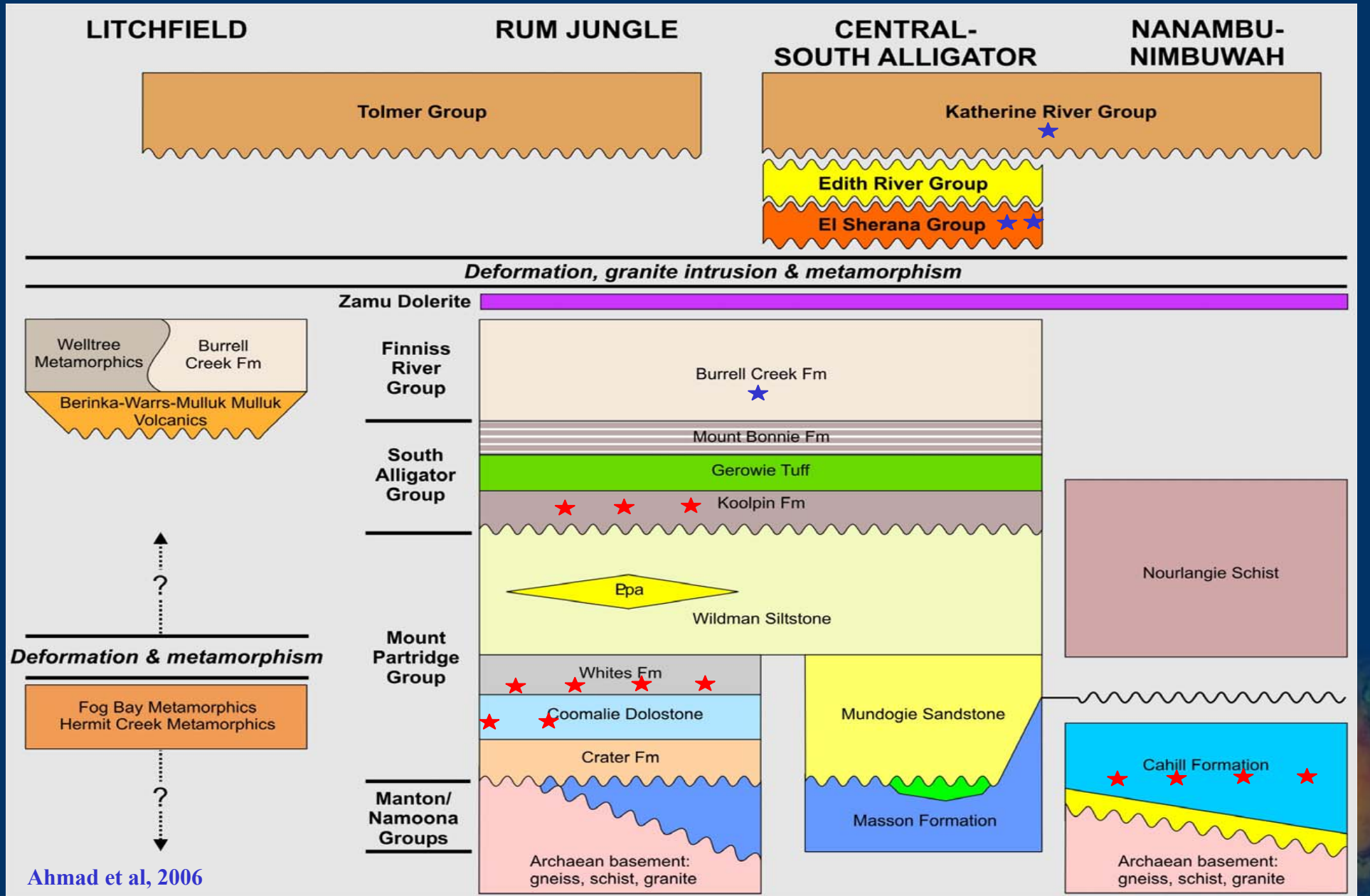
Basement as a major U-source ?

U - MOBILISATION MECHANISM: monazite alteration





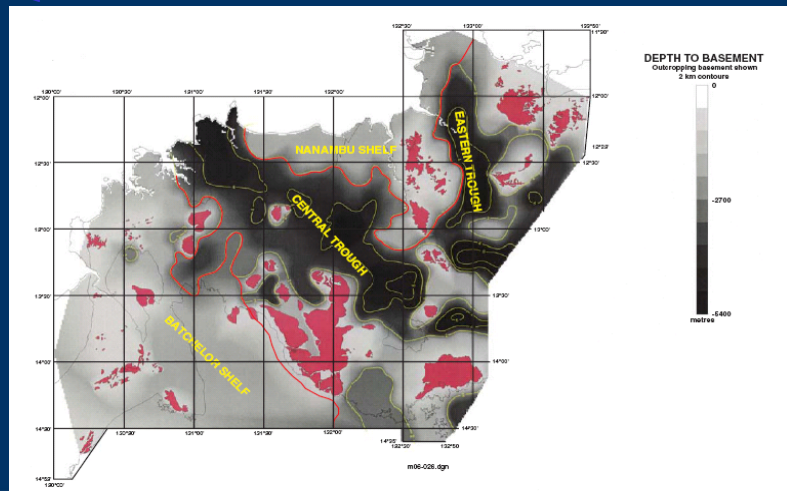
Stratigraphical/Lithological Control



Ahmad et al, 2006

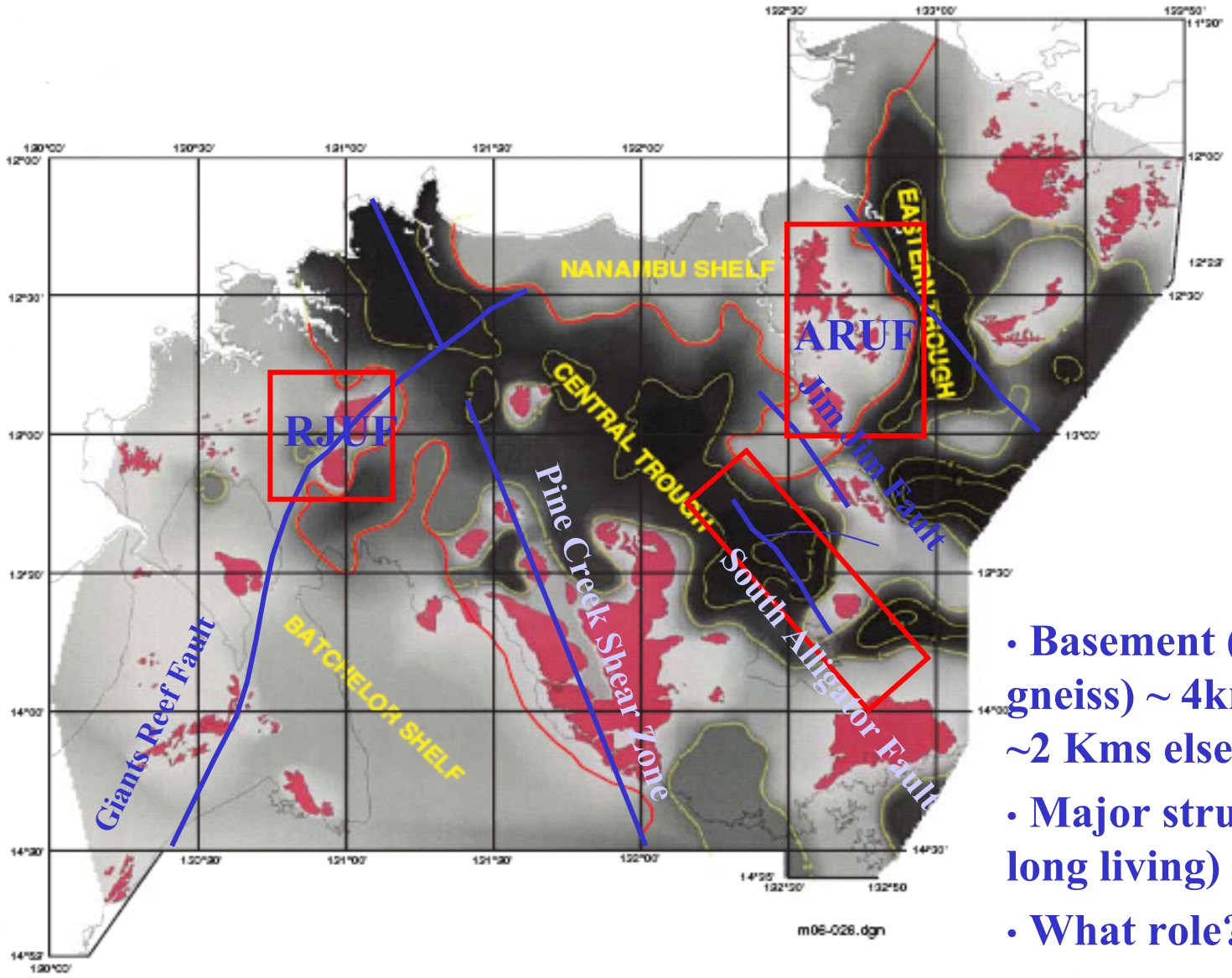
Architecture of the Unconformity U System: Basement Faults

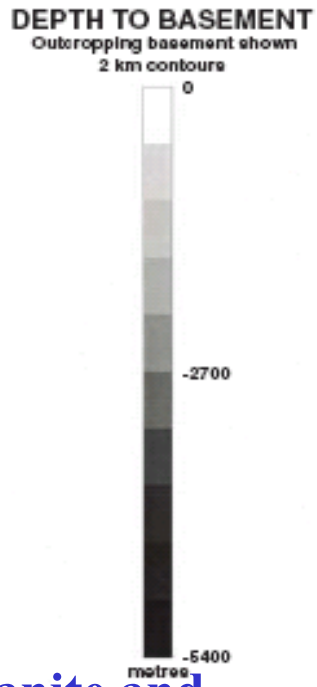
Determine the Architecture of the basin favourable for fluid flow from the deeper central parts to the shallower peripheral parts



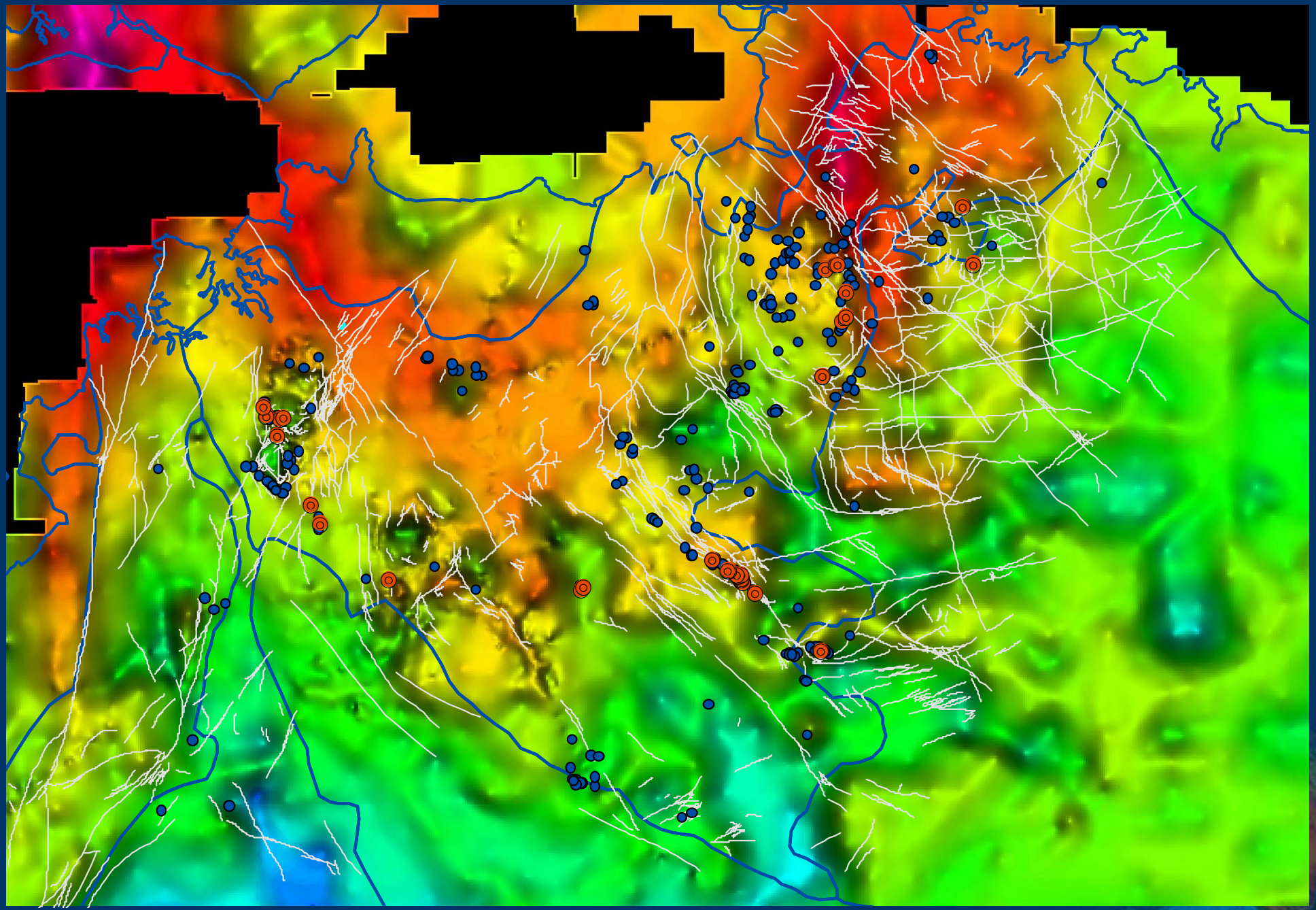
Depth to Basement from Regional Gravity Data

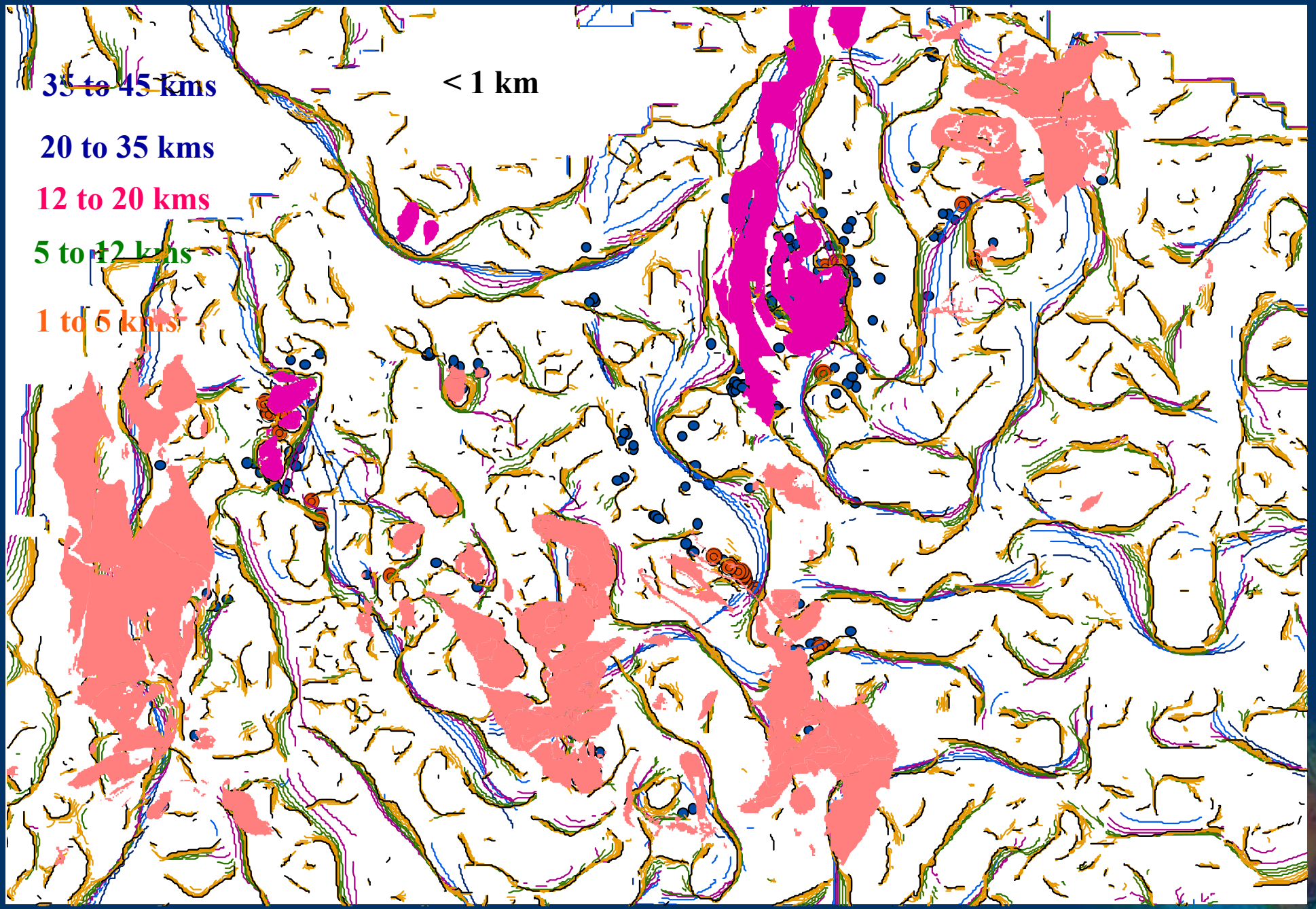
Lewis et al, 1995; Ahmad and McCready, 2001





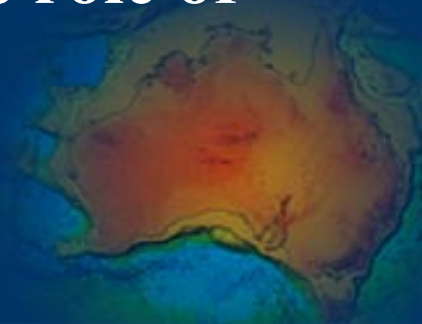
- Basement (granite and gneiss) ~ 4kms in the troughs; ~2 Kms elsewhere
- Major structures (deep and long living)
- What role?




35 to 45 kms
20 to 35 kms
12 to 20 kms
5 to 12 kms
1 to 5 kms
< 1 km

Conclusions: Some Important Regional Constraints

- Younger Unconformity (between South Alligator Group (containing host Koolpin Formation) and the Katherine River Group (Mamadawerre Sandstone) System more fertile
- The presence of U-rich basement rocks (with alteration of monazite)
- The presence of U-depleted palaeo-regolith
- Sandstone cover showing diagenetic alterations (indicative of significant quantities of fluids)
- Graphite-bearing metasediments (although the role of graphite is uncertain)



Conclusions: Some Important Regional Constraints

- Proximity to the edges of gravity highs: richest deposits associated with the 'worms' (UCH of 12 to 20 Kms) which may represent positions of maximum gradients of deeper crustal features.

- In the Athabasca Basin, the gravity-high ridge is associated with a regional structure. In the PCO more work is required to understand the 'worm' (the position of the gravity gradient).