Australian Government
Geoscience Australia

Frome uranium province, South Australia:

Systems analysis and potential for major basin-hosted uranium deposits

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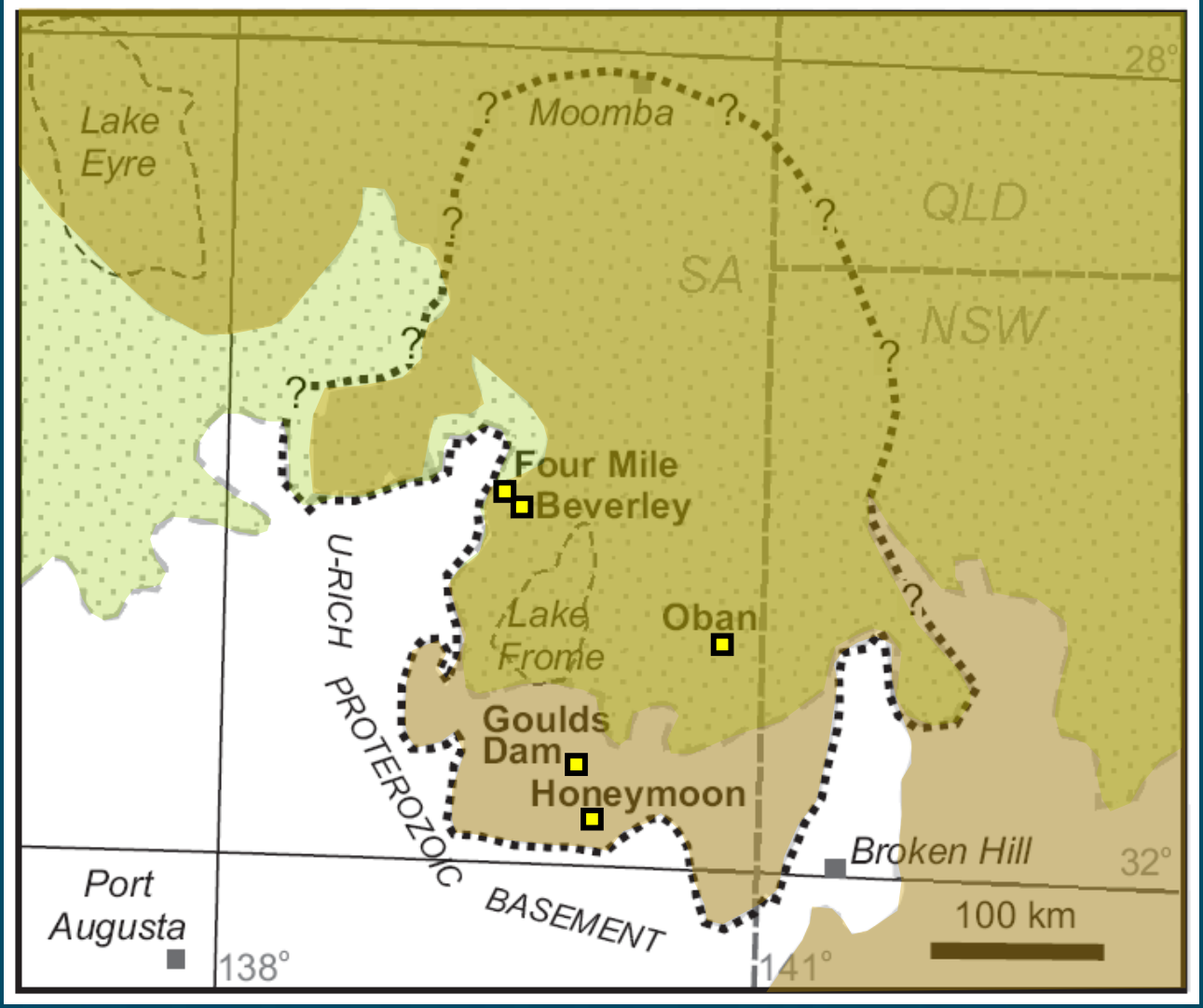
Frome uranium province –
southern Lake Eyre Basin and Eromanga Basin(?)

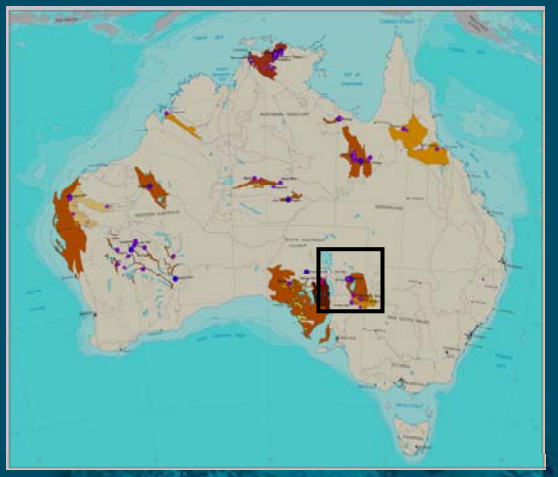


FROME URANIUM PROVINCE

LAKE EYRE BASIN (CENOZOIC)

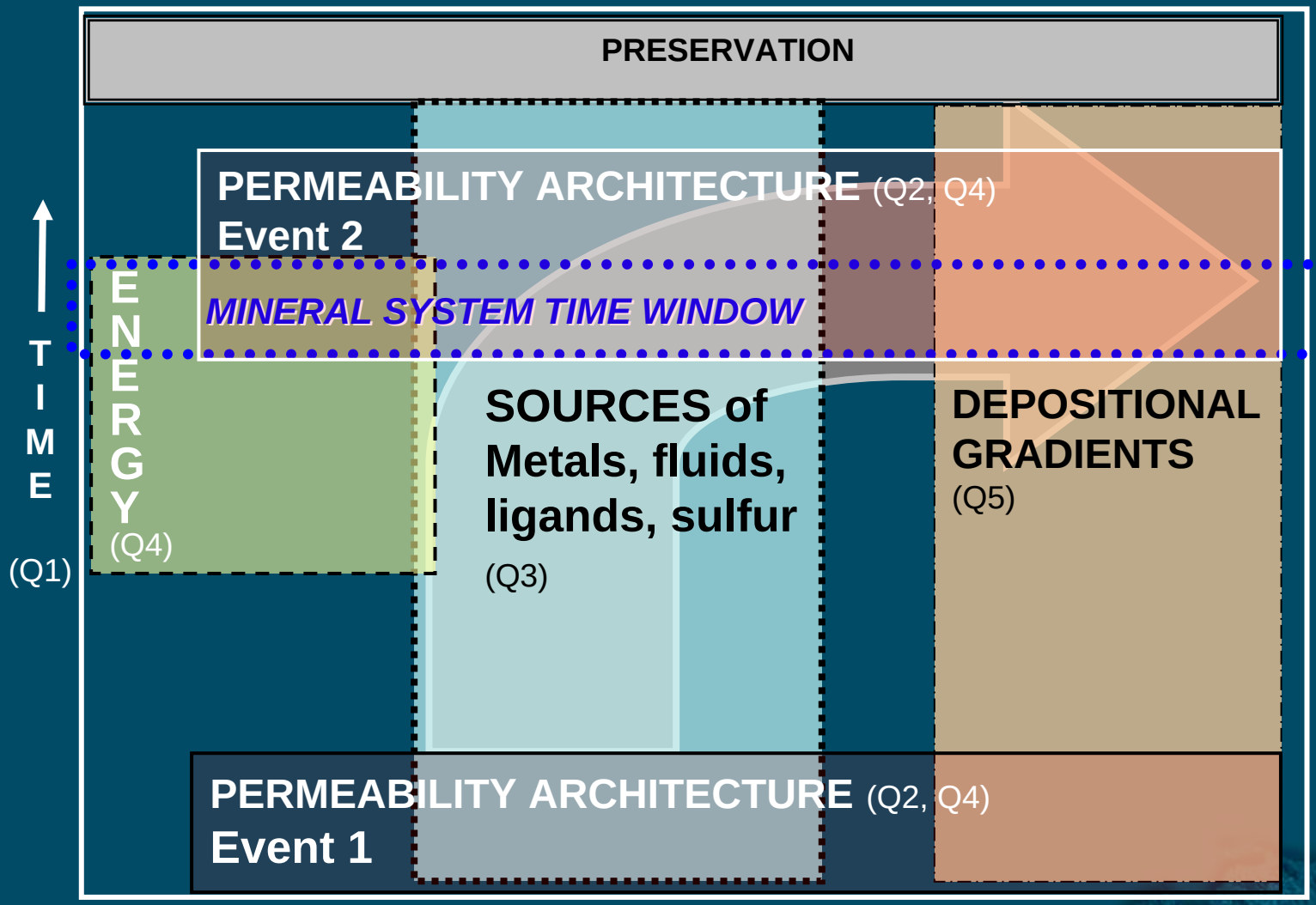
EROMANGA BASIN (MESOZOIC)

SEDIMENT-HOSTED URANIUM DEPOSIT



MINERAL SYSTEM – geological components

(all components are a product of geodynamic and tectonic evolution, 'Q1')



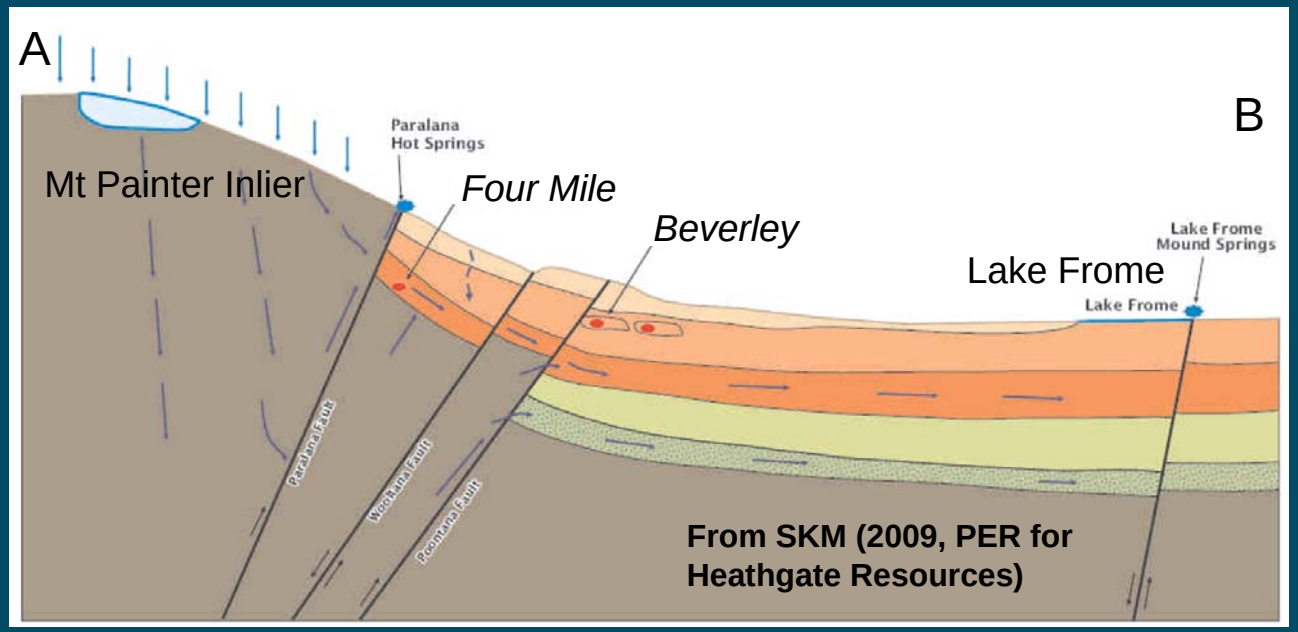
*[Q1-Q5 are the Five Questions of the pmd*CRC]*

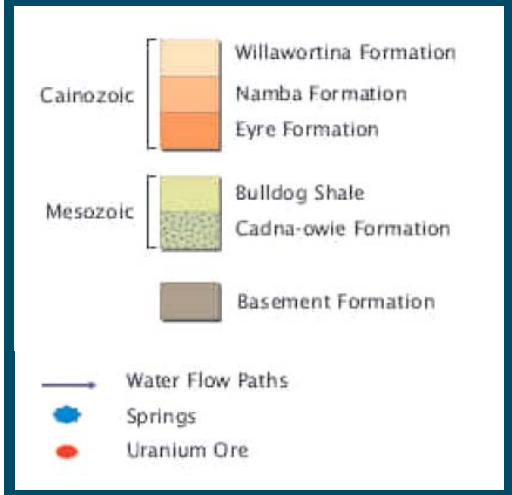
(From Skirrow, 2009)

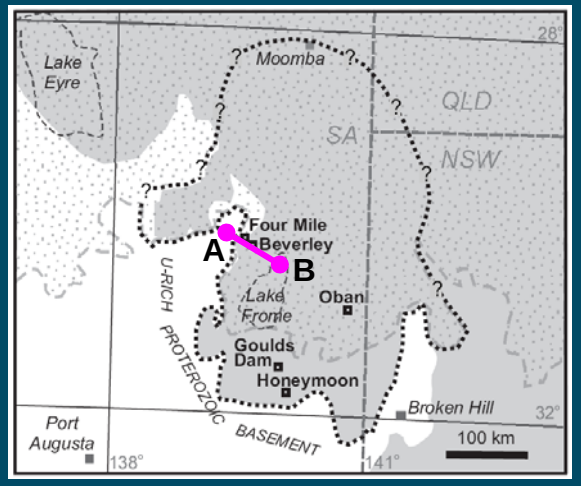
Part A

Sources of energy, uranium and fluids

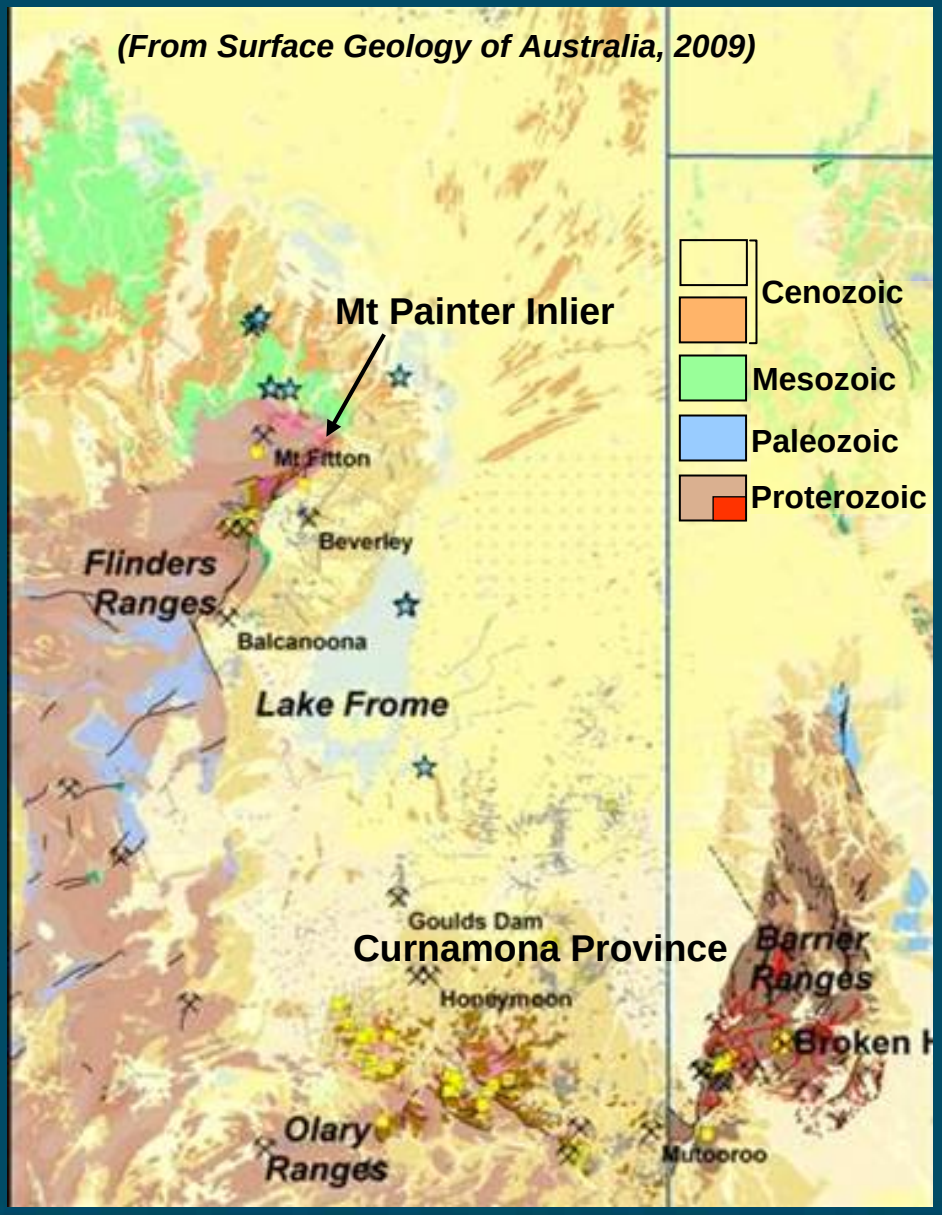
SCHEMATIC SECTION: PREVIOUS MODELS



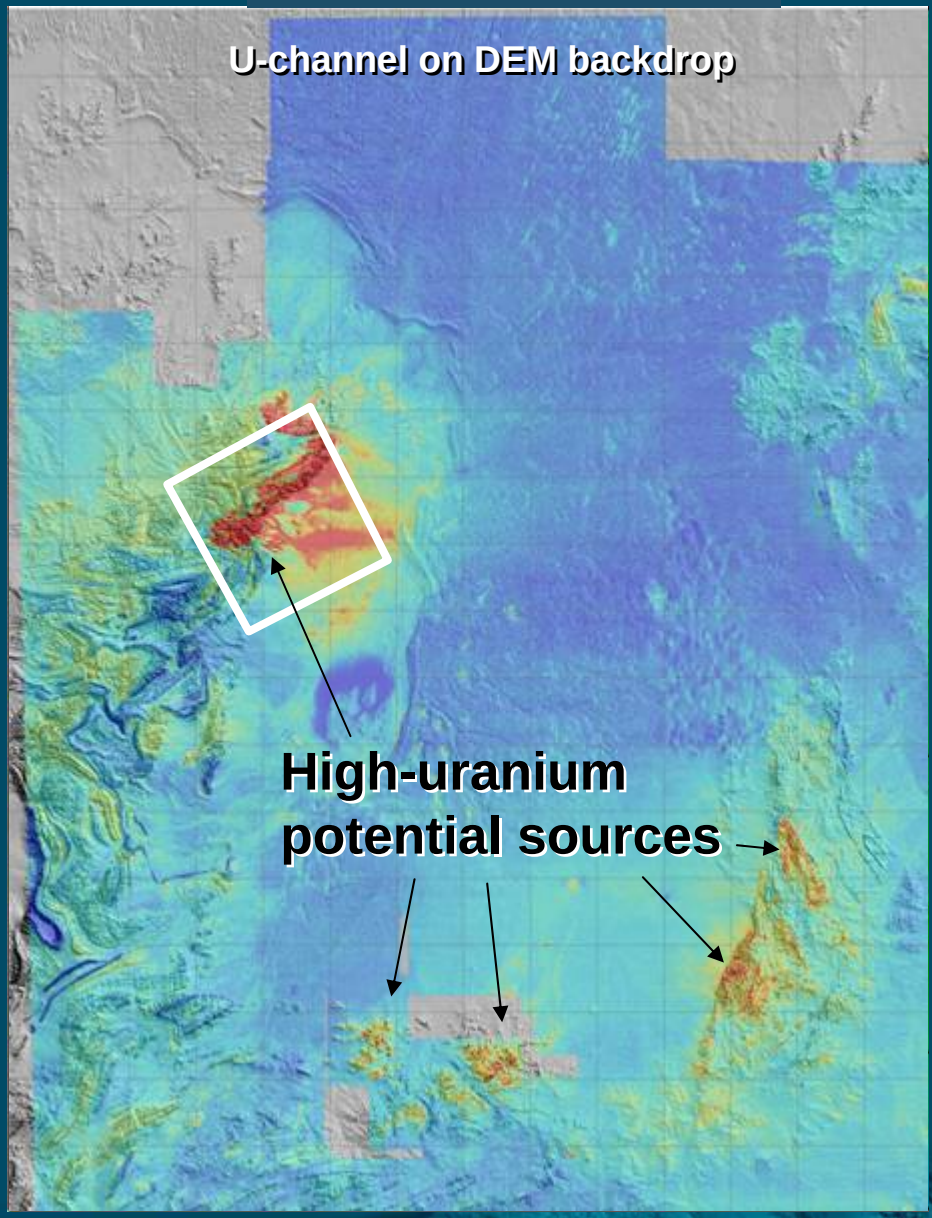




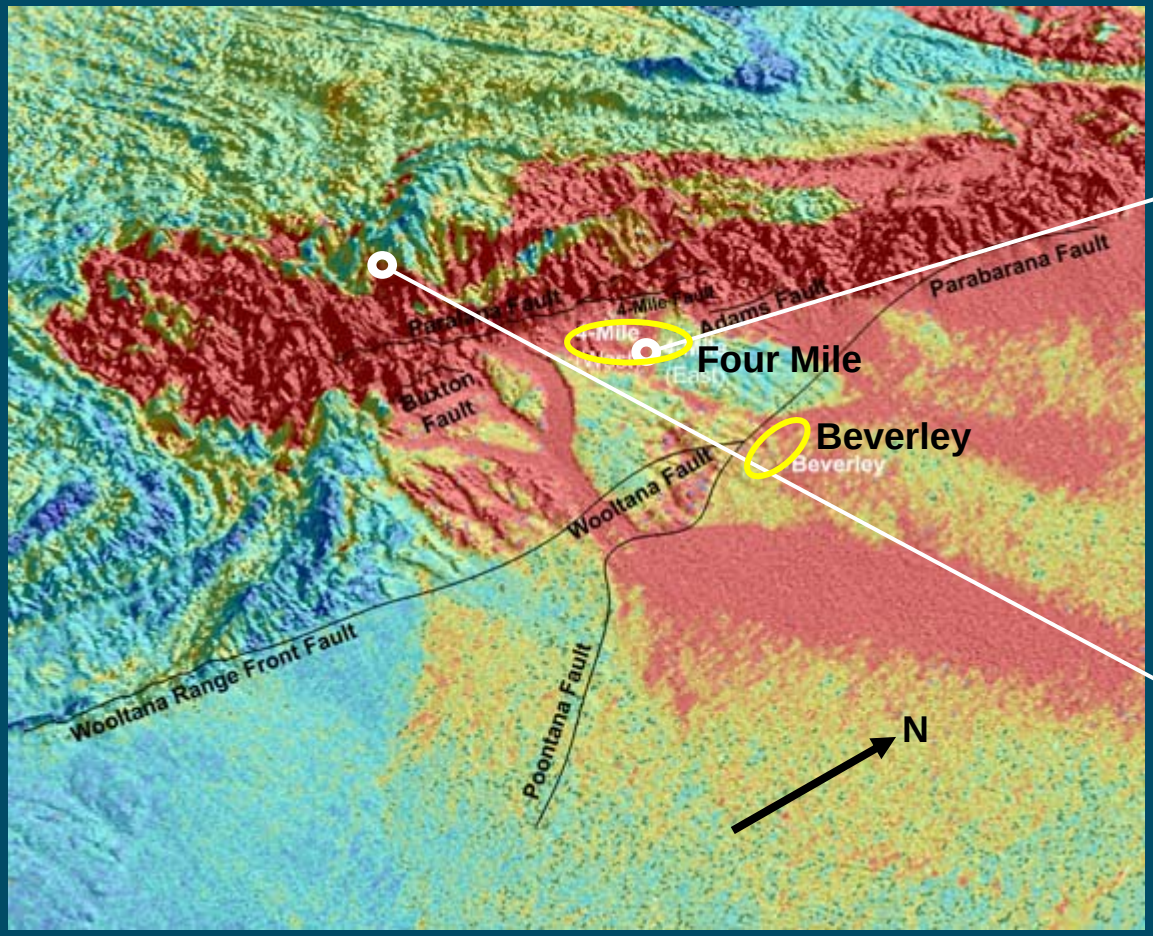
GEOLOGY



RADIOMETRICS



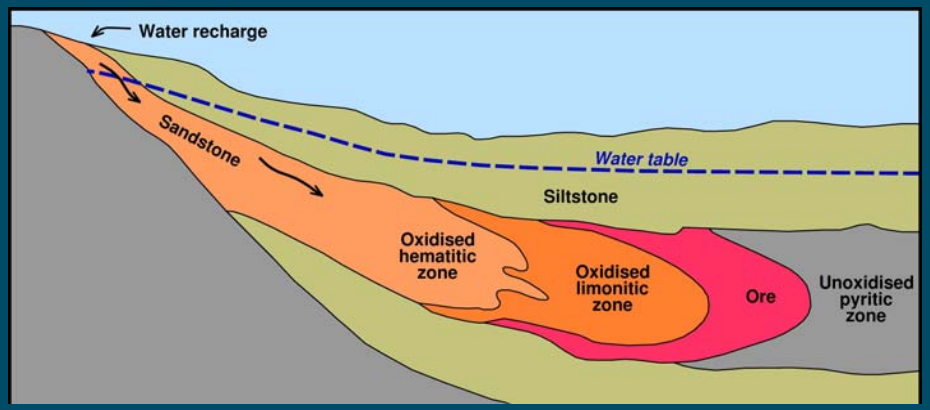
Mt Painter Inlier – U source?



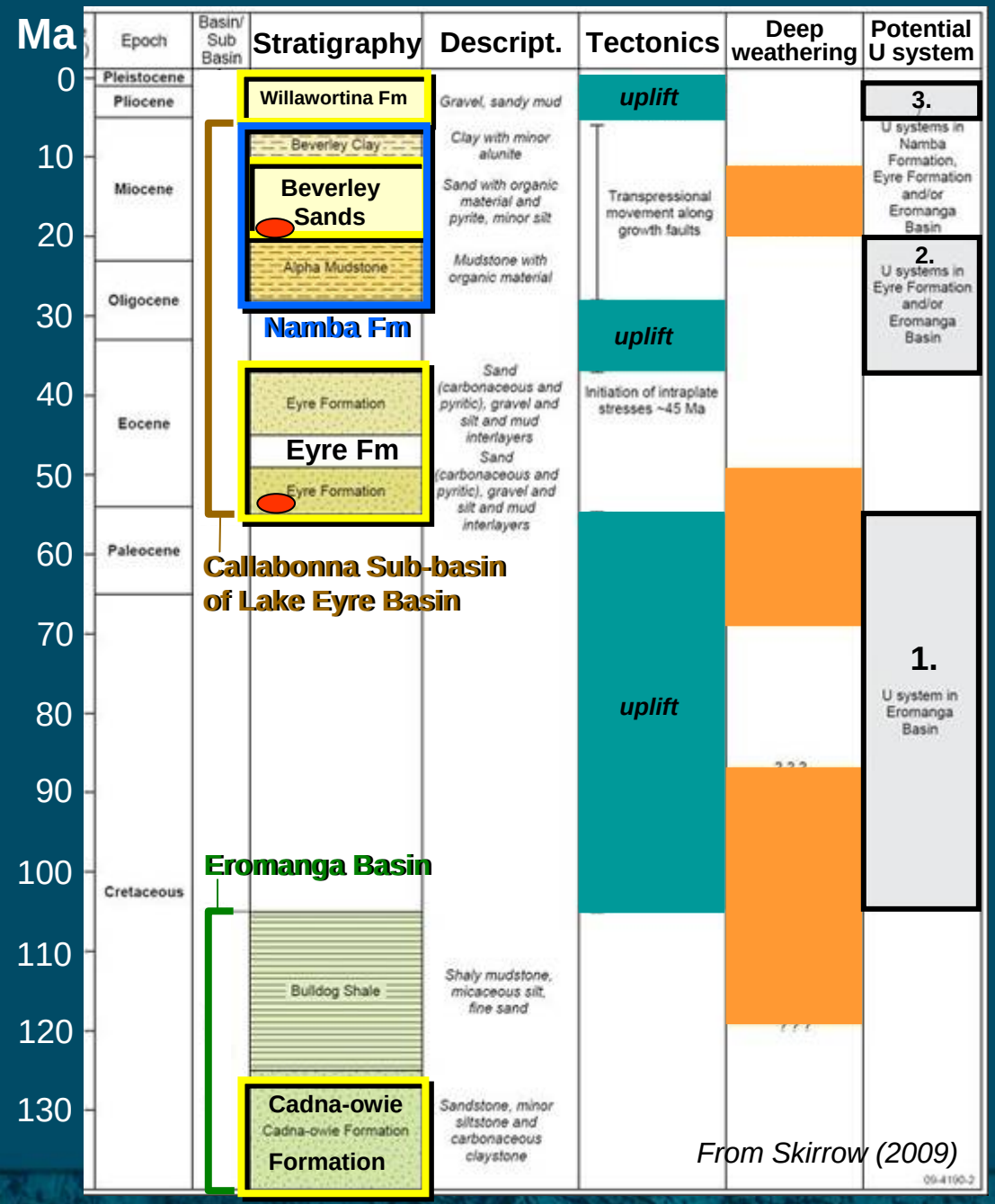
(oblique view looking northwest; U-channel radiometrics over DTM)

Previous models and shortcomings

- Widely held views –
  - Uranium source for both Beverley and Four Mile was Mt Painter Inlier
  - Beverley and Four Mile formed recently within the modern fluid flow regime (i.e., from MPI towards Lake Frome)
- However, Four Mile 'too close' to basin margin for a 'conventional' sandstone-uranium model of formation (supported by numerical modelling), and deposit ages not known.



Explanation requires system perspective



From Skirrow (2009)

Mineral system evolution and alternative model

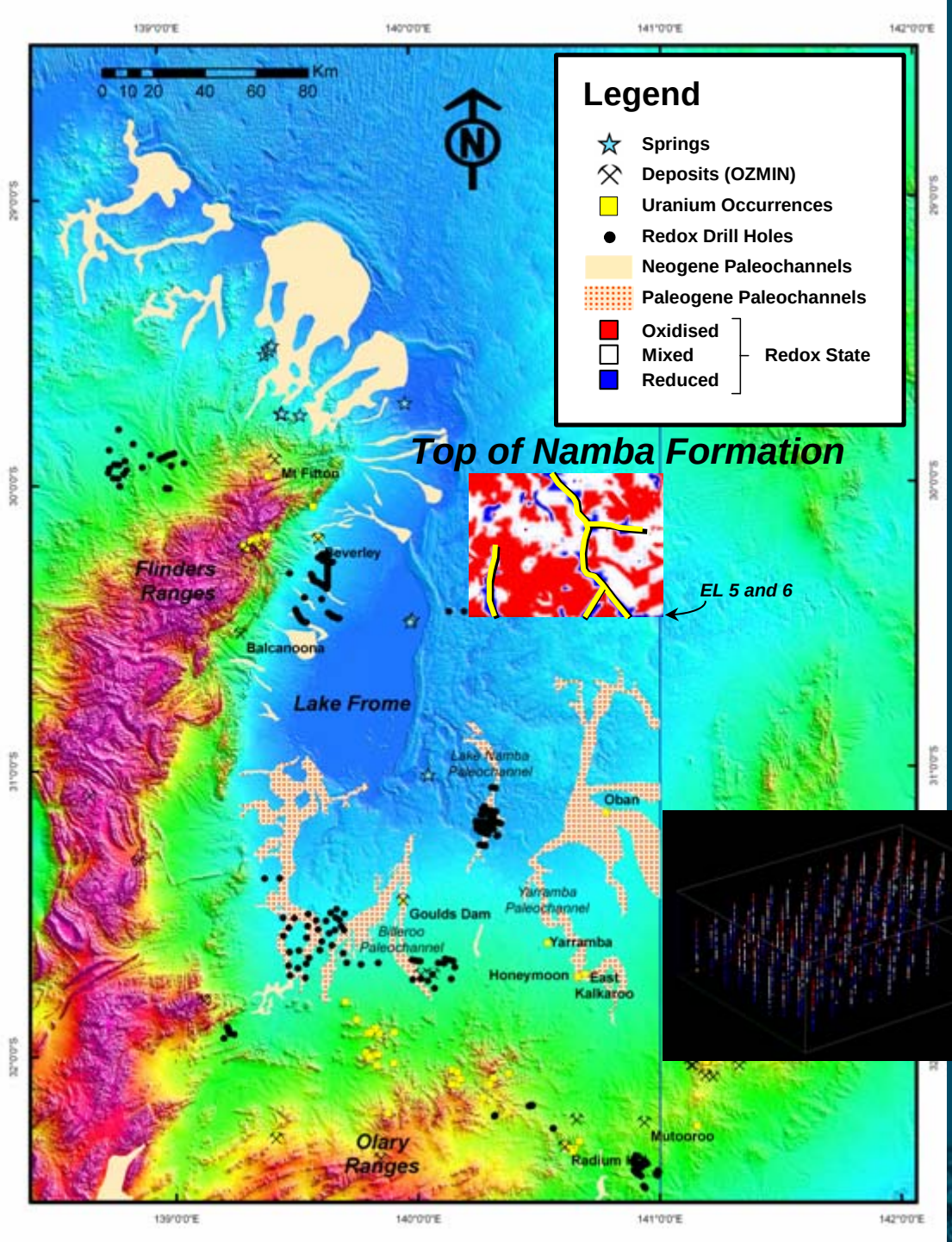
- 3 periods of regional uplift.
- At least 2 deep weathering events with potential to release & store uranium from Prot basement.
- Permeable seds at 4+ strat levels, ± reductants.
- Potentially 3 episodes of uranium mineralisation since late Mesozoic.

Constraints on uplift from: Foster et al. (1994), Mitchell et al. (2002), Célérier et al. (2005), Quigley et al. (2006).
Constraints on weathering from: Pillans (2006), Smith et al. (2009).

Part B

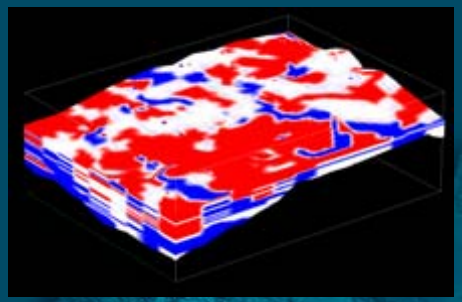
Permeability architecture

- Sandy units in Mesozoic (e.g., Cadna-owie Fm) and Cenozoic formations (e.g., Eyre Fm, Beverley Sands)
- Paleovalleys and paleochannels
- Fault geometry



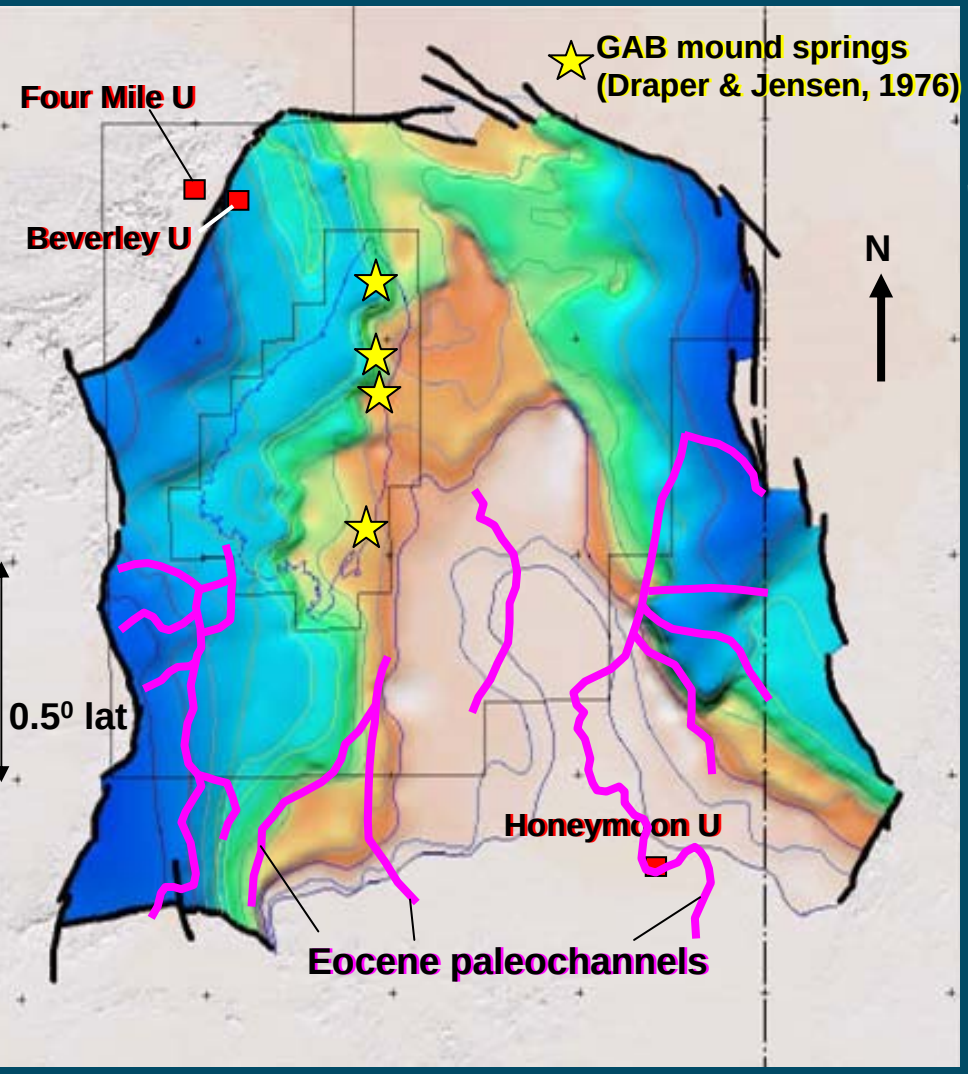
Paleovalleys/channels marked by reductants?

- Drill logs searched
- Reduced zones = Fe^{2+} minerals, reduced-C, reduced-S, "black", etc
- Oxidised zones = Fe^{3+} minerals, "red", etc
- Gridded in 3D
- North-south paleovalleys in Namba Fm as well as Eyre?

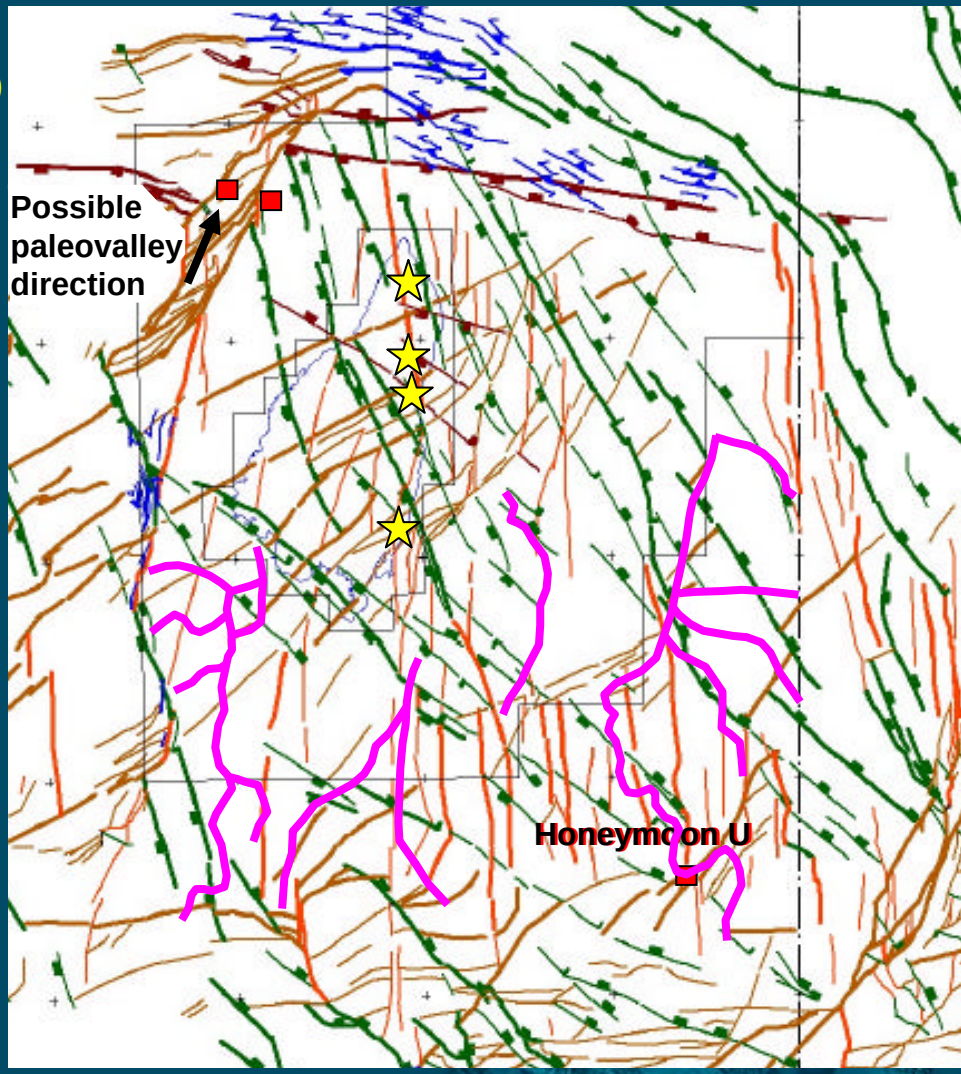


FAULT ARCHITECTURE

Depth to pre-Paleozoic basement



Basement-involved faults

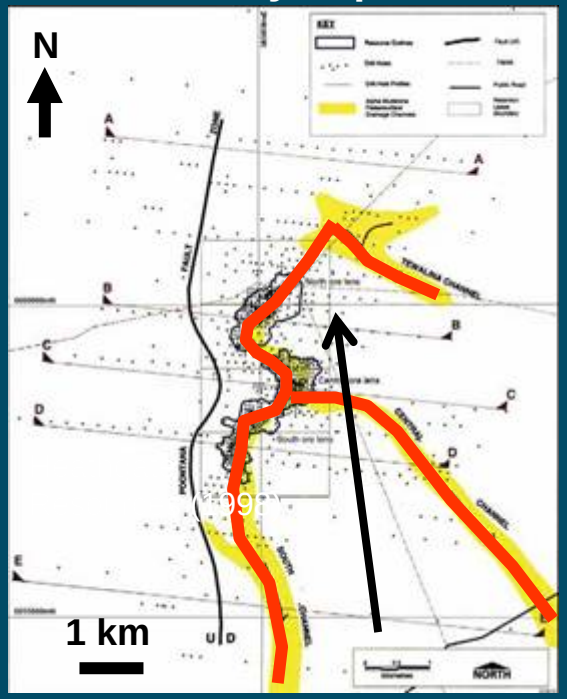


From Teasdale et al. (2001 – Arrowie SEEBASE)

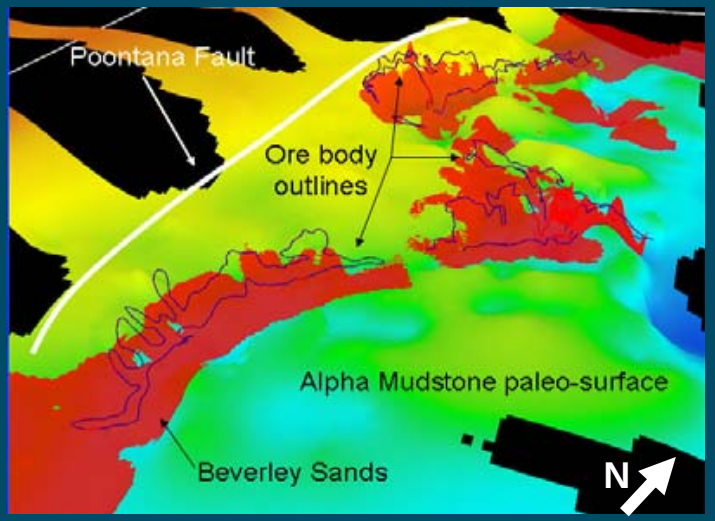
PERMEABILITY ARCHITECTURE OF URANIUM SYSTEMS

- **Paleovalleys / channels in both Eyre Fm and Namba Fm trend broadly south to north in the region, controlled by reactivated faults.**
- **Four Mile and Beverley paleovalleys may have trended N or NNE, not E or SE.**

Beverley deposit



From Heathgate (1998)

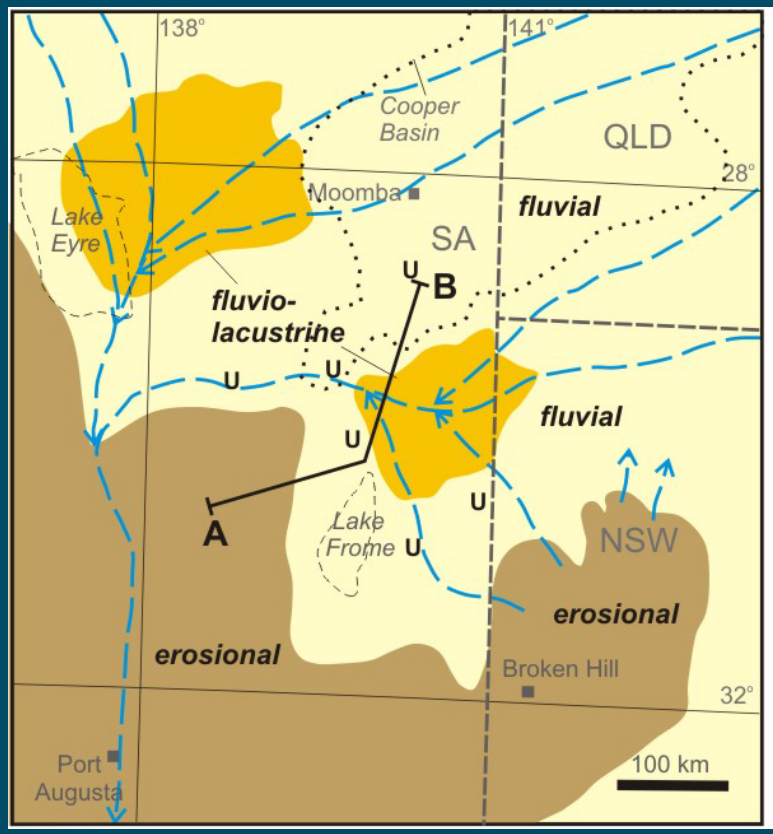


From McConachy et al. (2006)

Part C

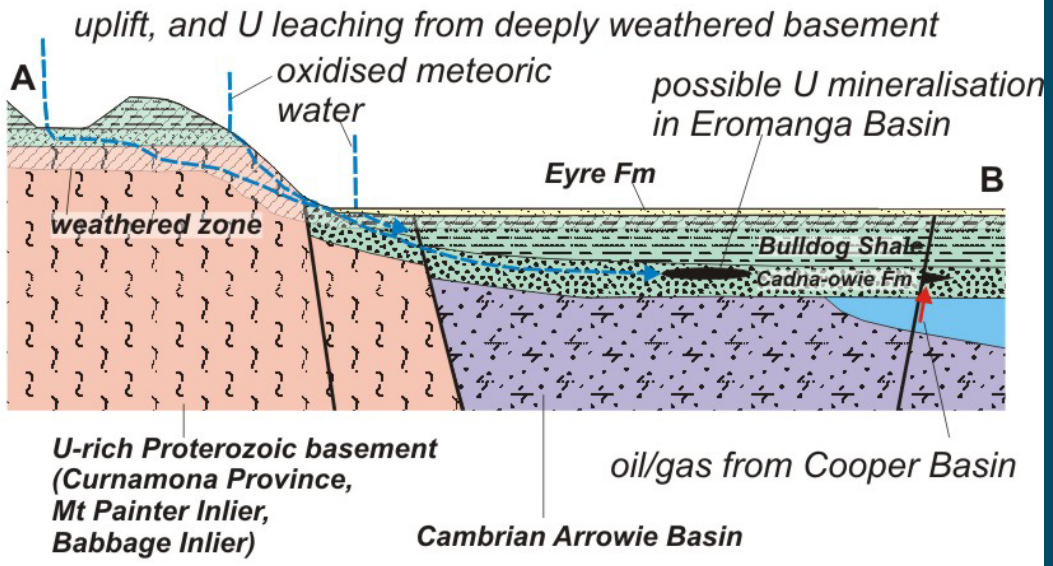
Model of 3 uranium episodes, and potential for major deposits

FROME URANIUM PROVINCE EVOLUTION

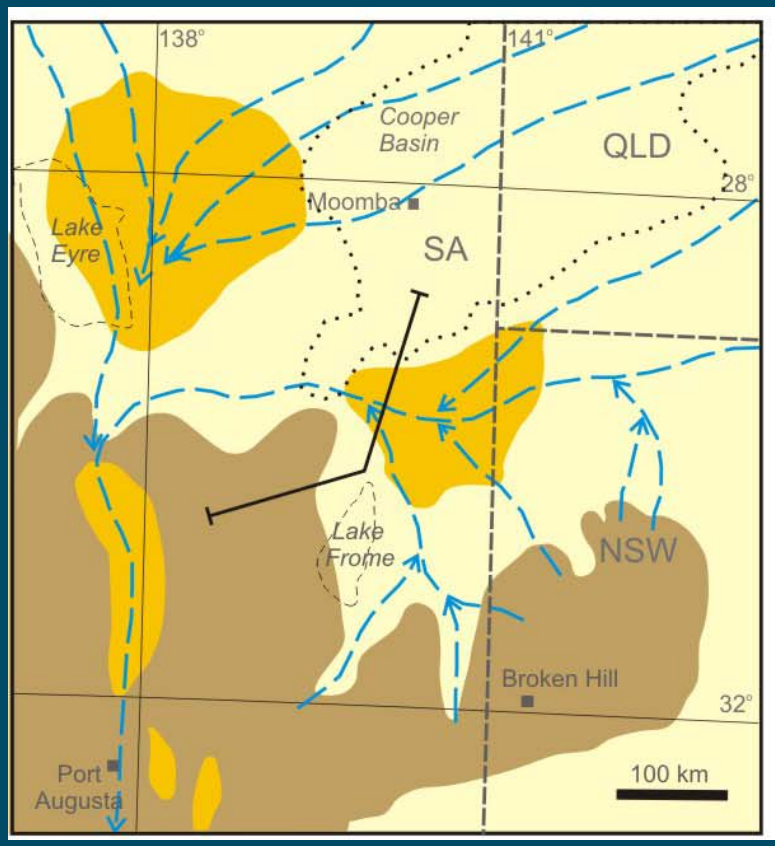


Paleogeographic reconstruction
from Langford et al. (1995)

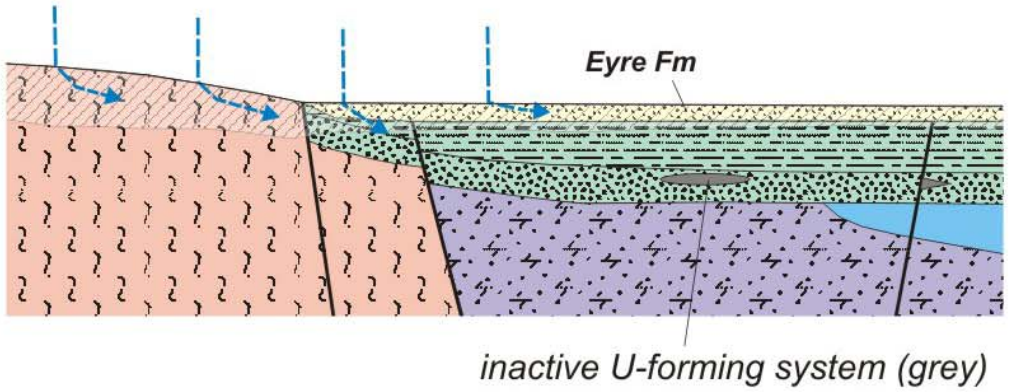
Late Cretaceous, Paleocene
and early Eocene
(~100 to ~52 Ma; episode 1 U system)



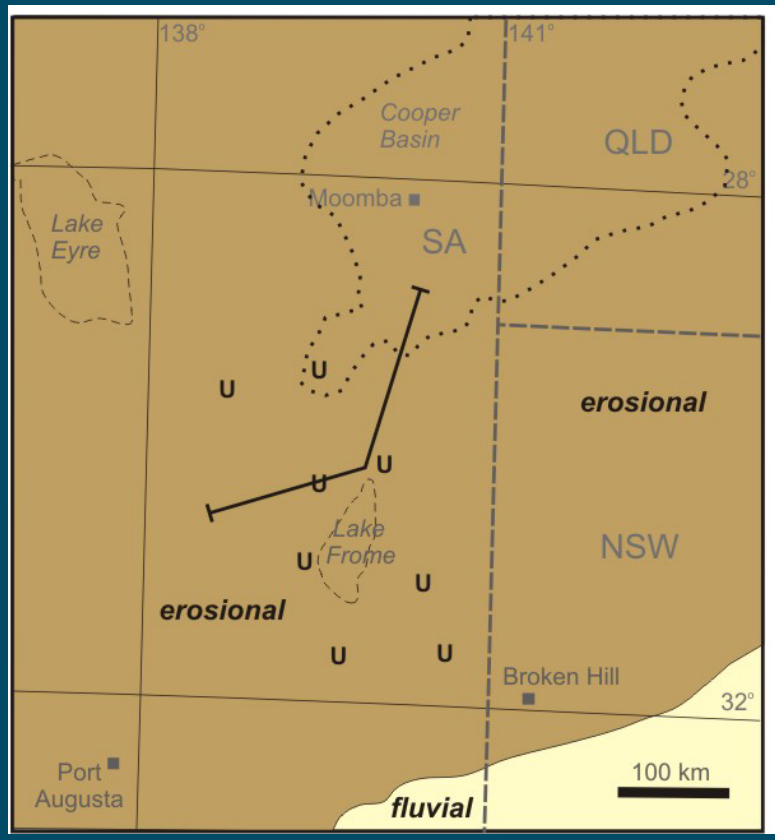
FROME URANIUM PROVINCE EVOLUTION



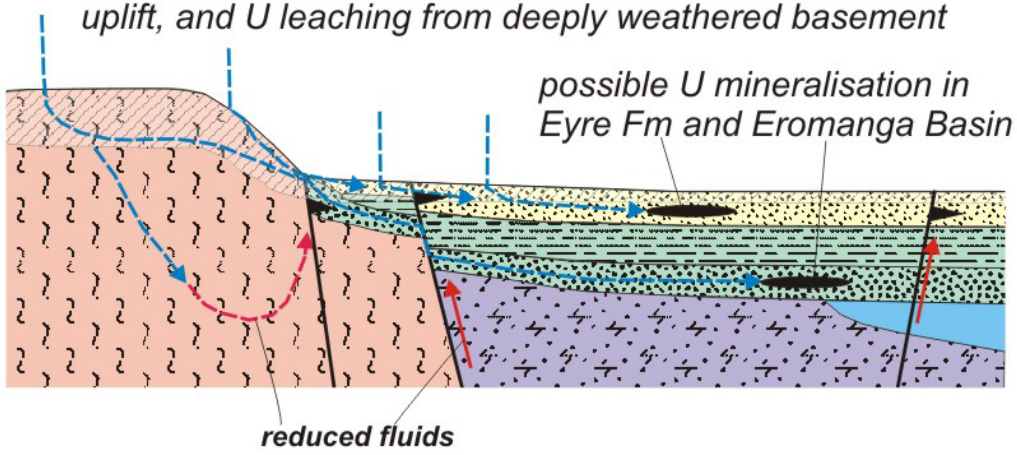
Middle and Late Eocene
(~52 to ~37 Ma)



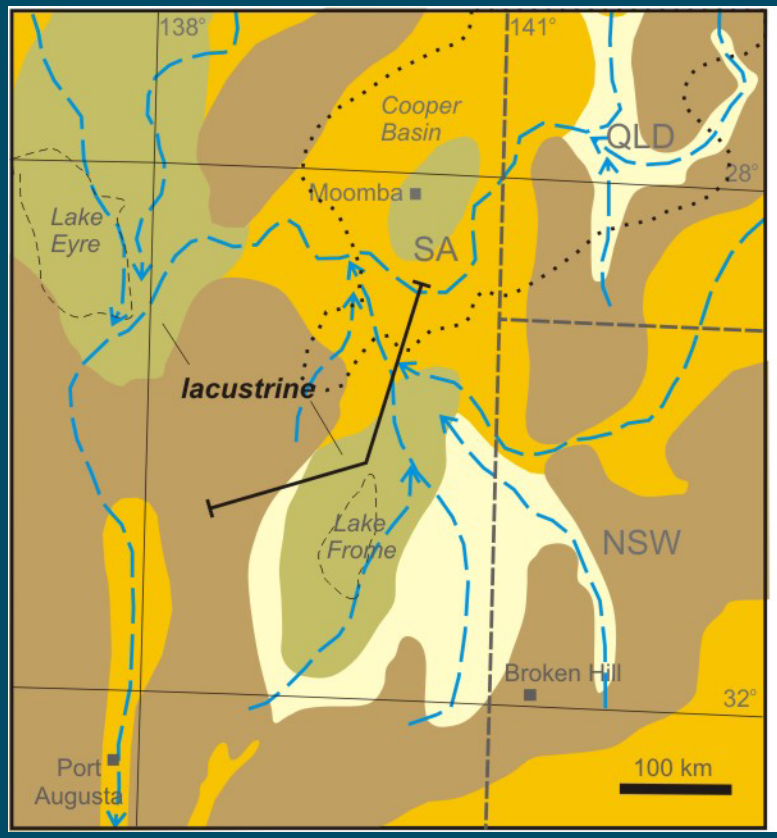
FROME URANIUM PROVINCE EVOLUTION



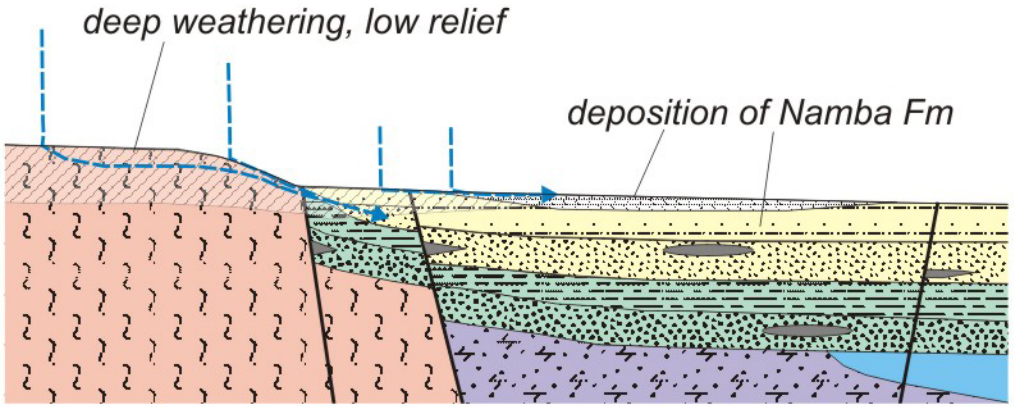
Late Eocene to Early Oligocene
(~37 to ~28 Ma; episode 2 U system)



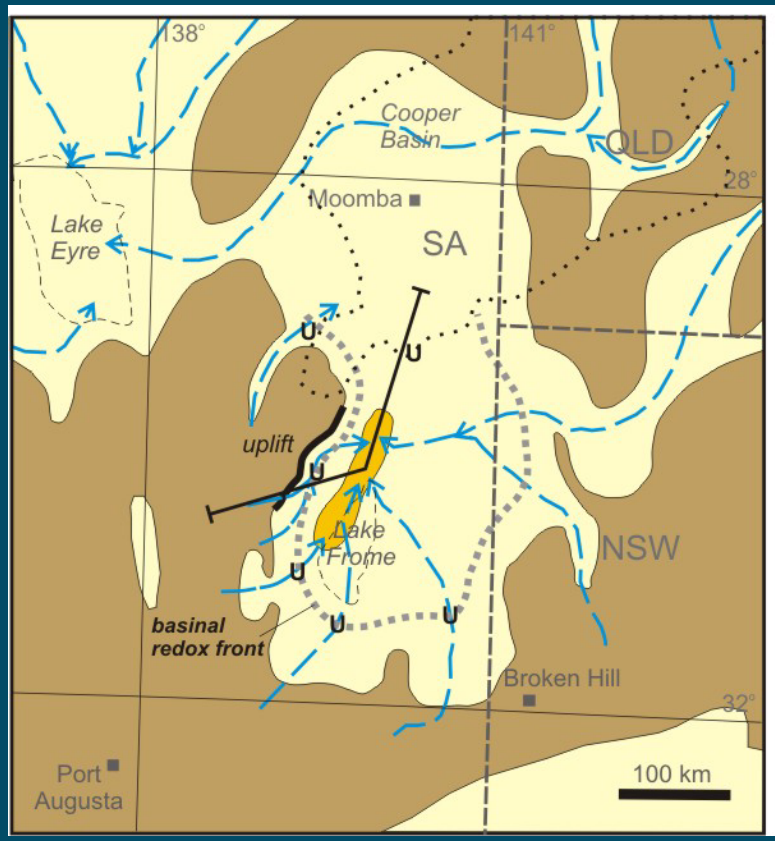
FROME URANIUM PROVINCE EVOLUTION



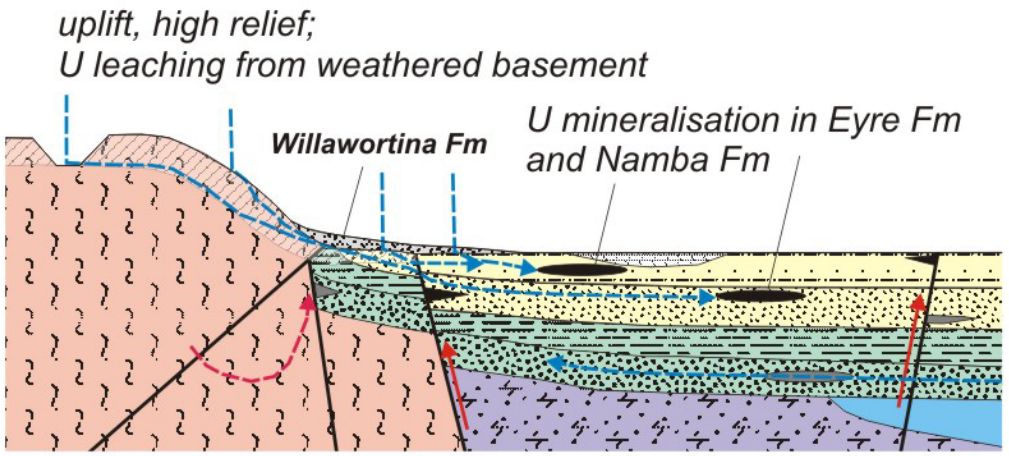
Late Oligocene to Middle Miocene
(~28 to ~10 Ma)



FROME URANIUM PROVINCE EVOLUTION



Pliocene and Pleistocene
(~5.3 to ~0.01 Ma; episode 3 U system)

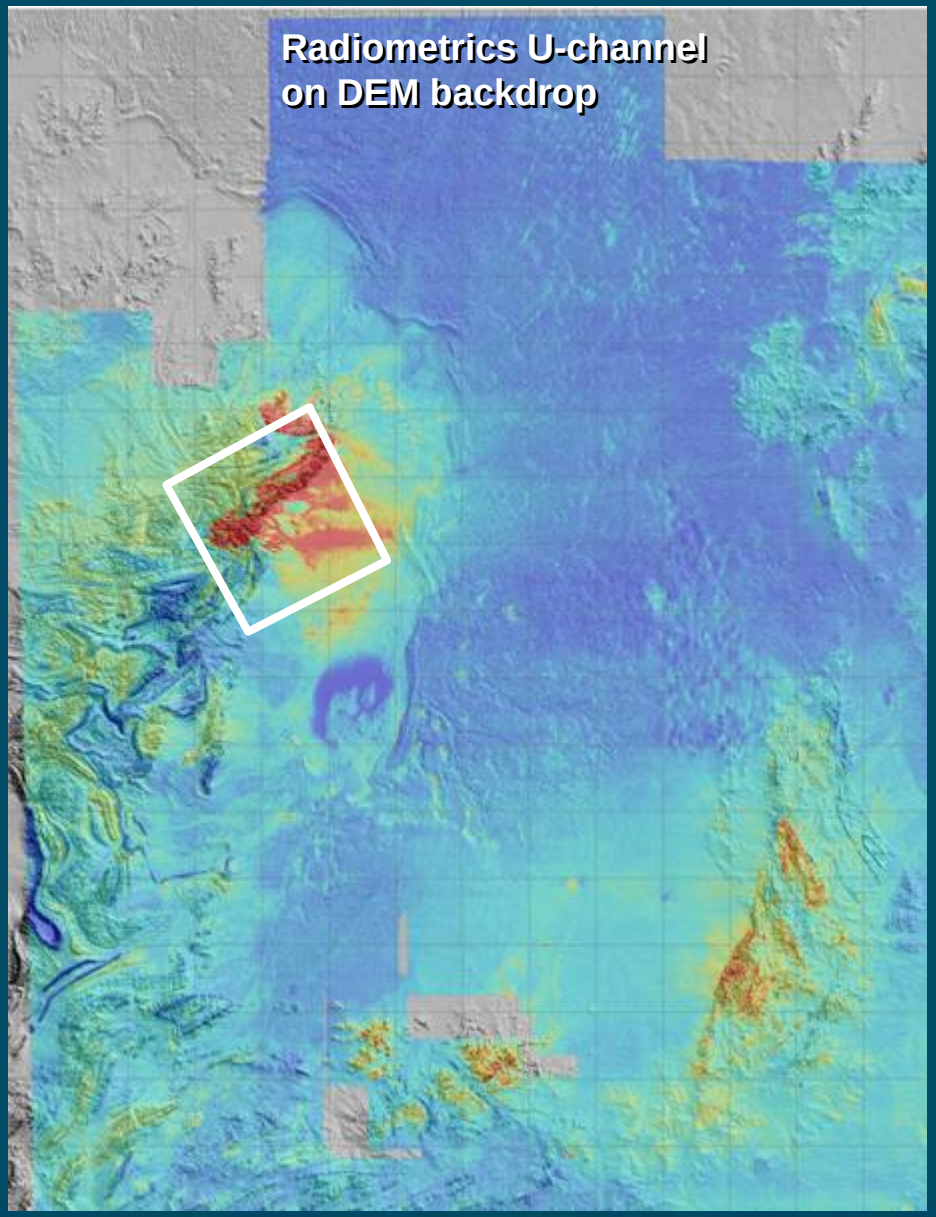


Conclusions

1) Frome uranium province: Cenozoic Lake Eyre Basin ± Mesozoic Eromanga Basin.
2) Three episodes of potential uranium mineralisation since late Mesozoic.
3) South-to-north paleovalley/channel systems, controlled by long-lived faults.
4) Potential for larger deposits in north of Frome uranium province within paleovalleys.

Alternative model:

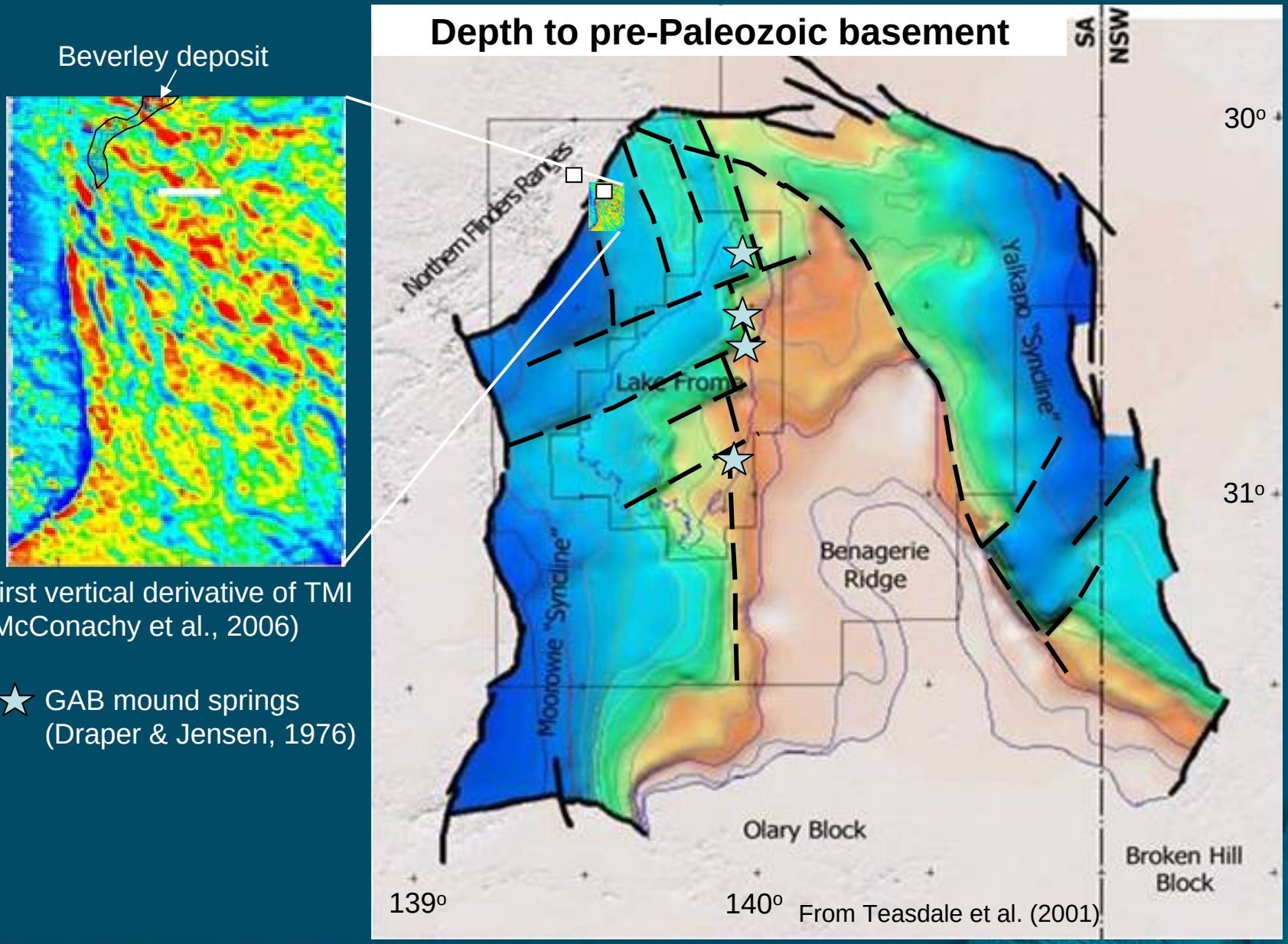
- At least three periods of uplift from late Mesozoic, recorded by geological observations (Celerier et al., 2005), apatite thermo-chronology (Foster et al., 1994; Mitchell et al., 2002), ^{10}Be studies of erosion rates (Quigley et al., 2006).
- Deep weathering in 3 episodes during/since late Mesozoic (Pillans, 2006; Smith et al., 2009).
- Potential for 3 episodes of uranium mobilisation, with groundwater flow driven by regional basement uplift.
- Uranium, sediment and water transport from south (or southwest) to north (or northeast), to satisfy mass-balance requirements of reductants.
- Or mobile reductant at Four Mile?



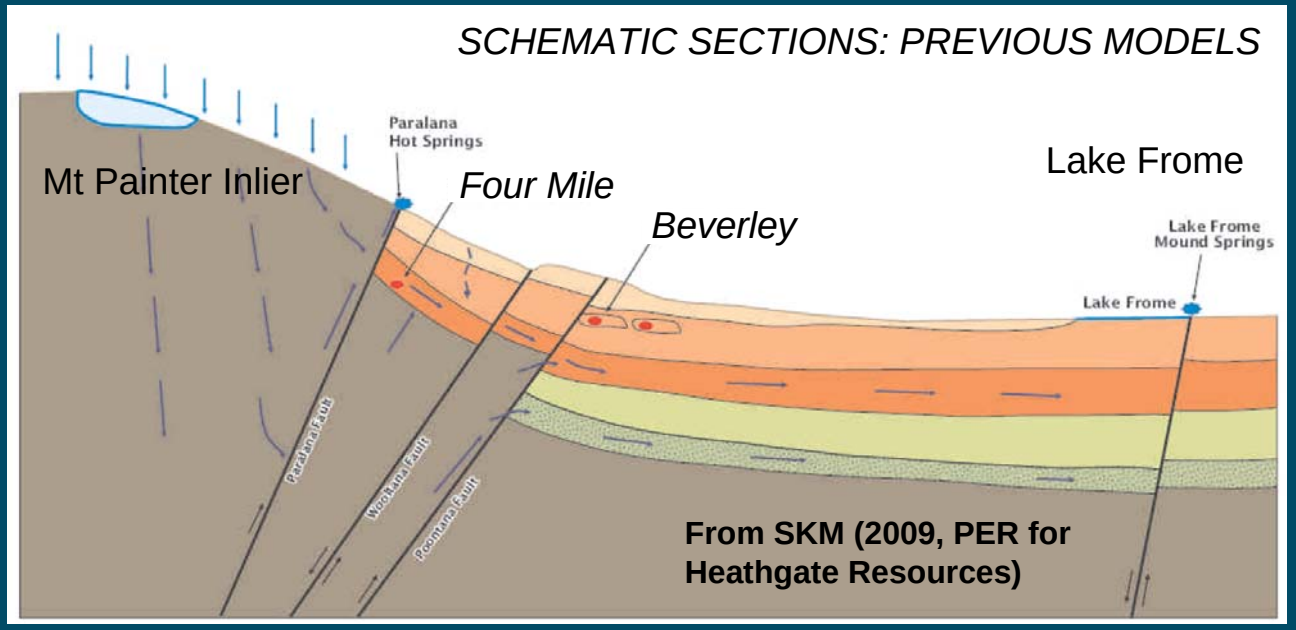
High-uranium potential sources

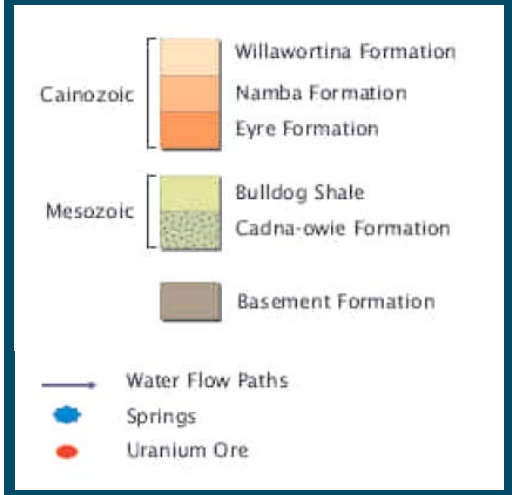
- Proterozoic Mount Painter Inlier and Curnamona Province
- Sediments derived from these sources

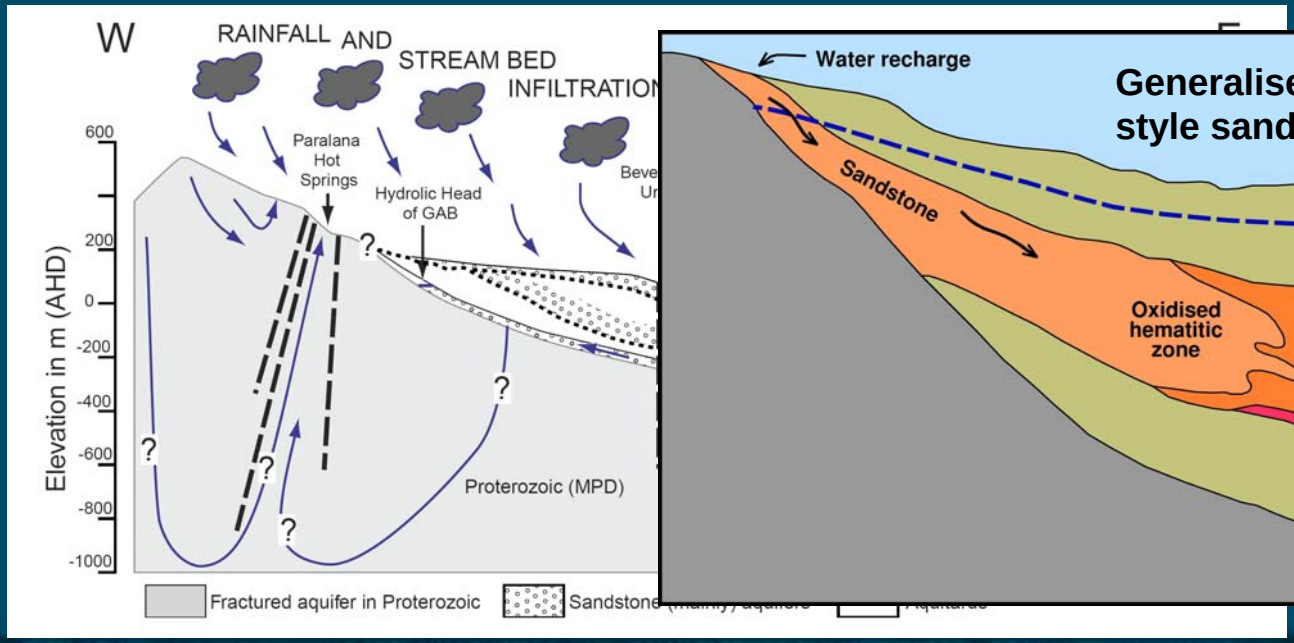
From Radiometrics Map of Australia (Geoscience Australia) over SRTM DEM data


Depth to pre-Paleozoic basement
Beverley deposit
First vertical derivative of TMI
(McConachy et al., 2006)
GAB mound springs
(Draper & Jensen, 1976)
SA
NSW
30°
31°
139°
140°
Northern Flinders Ranges
Lake Frome
Yalkapo "Syncline"
Moorowie "Syncline"
Benagerie Ridge
Olary Block
Broken Hill Block
From Teasdale et al. (2001)

SCHEMATIC SECTIONS: PREVIOUS MODELS







Uranium resources of Australia