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Two Types of Sandstone Uranium Systems in the Frome Embayment?

Preliminary Results of Fluid Flow and Chemical Modelling

The Beverley and Four Mile sandstone uranium deposits contain more than 75% of known uranium resources in the Frome Embayment **(Fig. 1).** The principal aim of fluid-flow and chemical modelling is to understand the hydro-geological architecture that favoured removal of uranium from the source rocks and its transport into reduced sandstones.

The modelling explores fluid-flow and chemical models associated with two possible basin architectures: post-Paralana Fault and pre-Paralana Fault. Modelling is based on a simplified cross-section interpreted from seismic survey data close to the mineralised area **(Fig. 2).**

The post-Paralana Fault model **(Fig. 3)** shows that oxygen-saturated waters leaching uranium from the Proterozoic rocks in the Mount Painter Inlier do not reach the Tertiary aquifers (Eyre and Namba Formations), but are channelled along the Paralana Fault and related structures simulating the active Paralana Hot Springs. The pre-Paralana Fault model **(Fig. 4)** allows the uranium-rich waters to flow in the Tertiary aquifers where they are reduced and can form sandstone-hosted mineralisation.

Chemical modelling of uranium transport and deposition associated with the post-Paralana Fault architecture was undertaken to simulate the chemistry of the Paralana Hot Spring system. Oxygen-saturated fluids moving through permeable structures in the uranium-enriched granites initially dissolve uranium **(Fig. 5).**

However Fe^{+2}-bearing silicates in the granite control the oxidation state of the fluid at depth, and uranium concentration in the reduced fluid drops to less than parts per trillion. The model thus explains the very low values of uranium in the Paralana Hot Spring (cf Brugger et al, 2005).

Conclusions

- A post-Paralana Fault basin architecture severely limits flow of uranium-bearing oxidised fluids from uplift basement into the Tertiary aquifers such as Eyre and Namba Formations.
- A basin architecture without the Paralana Fault or similar structure could be important on allowing uranium-rich oxidised waters into reduced aquifers such as Eyre and Namba Formations. Hence, deposits such as Beverley may have formed prior to uplift along the Paralana Fault.
- A post-Paralana fault basin architecture produces relatively reduced fluids low in uranium similar to those observed at the Paralana Hot Spring. Their mixing with uranium-rich groundwaters in aquifers such as the Eyre and/or Namba Formations may form mineralisation (such as Four Mile).
- Numerical modelling highlights the possibility of two differing processes and ages of uranium deposition in the Frome region, requiring further testing.

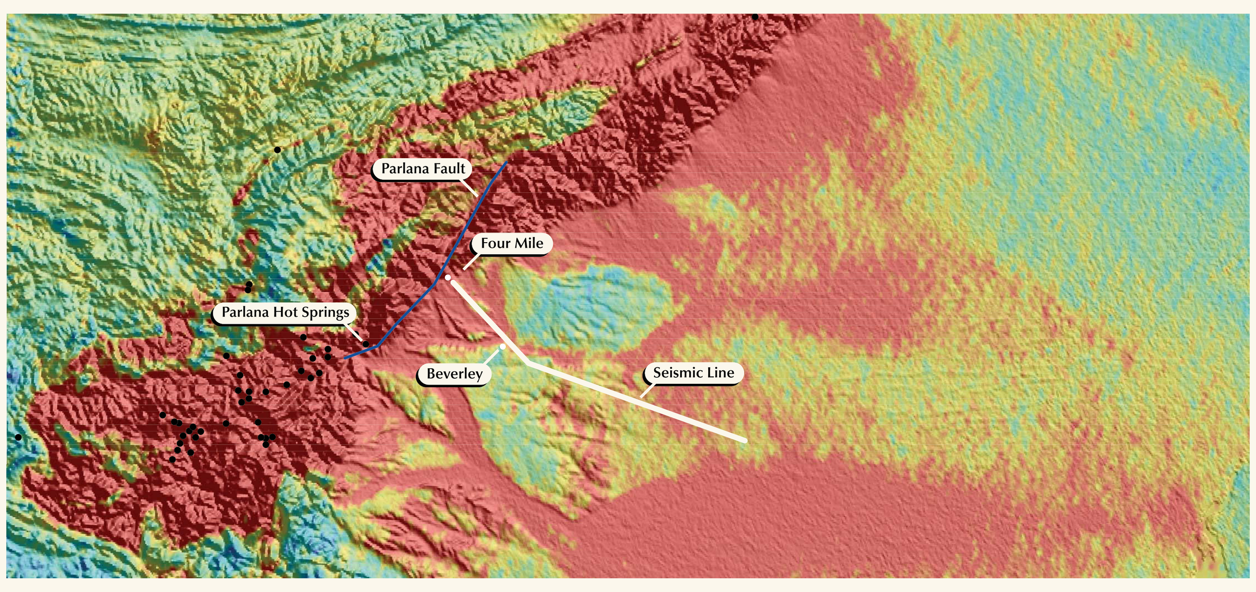


Figure 1. Digital elevation model of the Lake Frome area with the drape of radiometrics (uranium). Black and white dots denote the location of the mineral occurrences and uranium deposits, respectively. Vertical scale exaggeration 10 times.

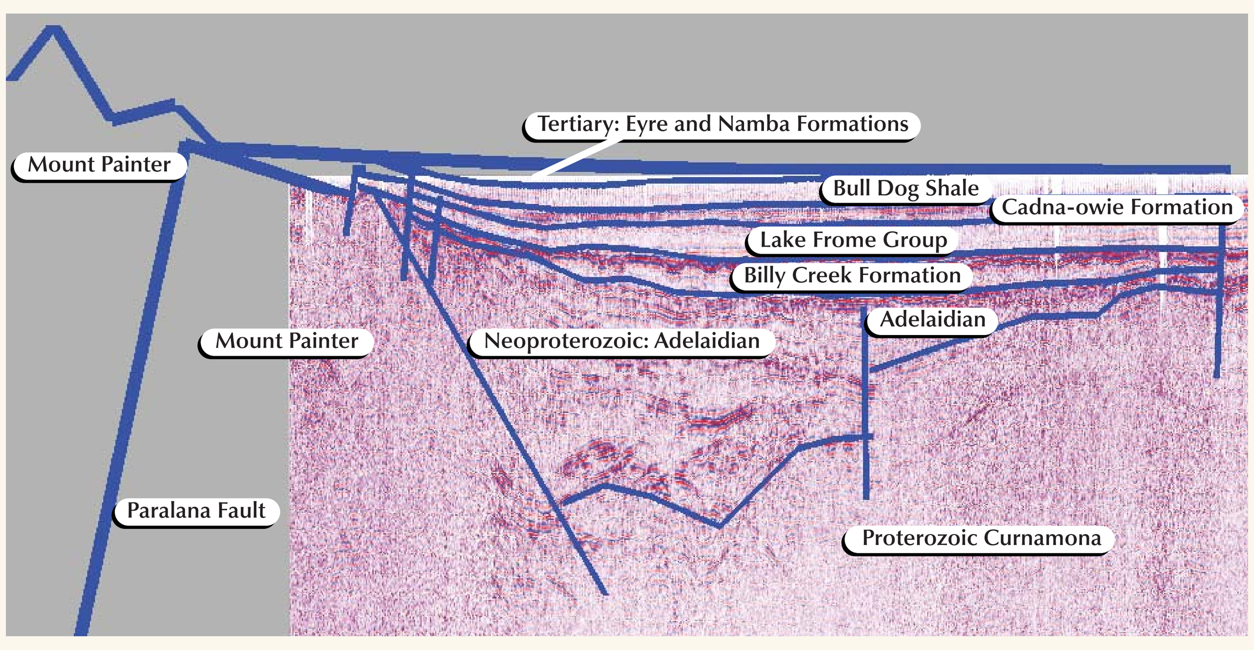
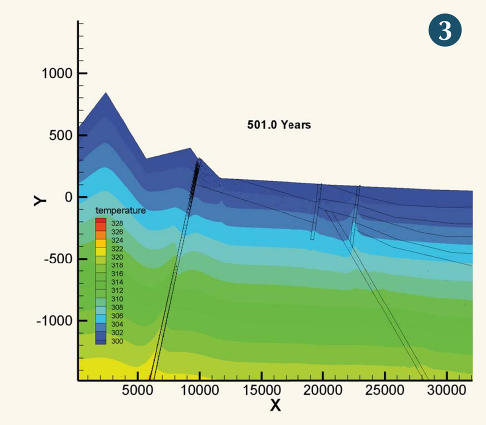


Figure 2. Preliminary geological interpretation of the seismic line across the Lake Frome area. Vertical scale exaggeration 10 times.



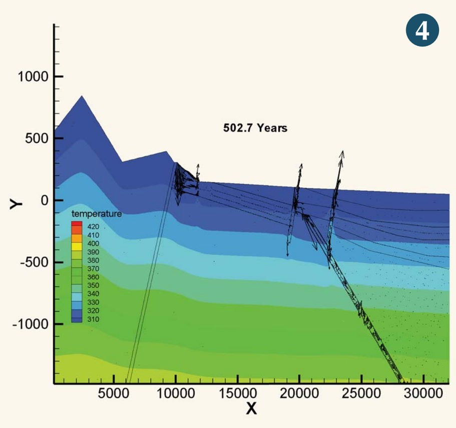


Figure 3. Fluid flow vectors for the Post-Paralana Fault basin architecture. Vertical scale exaggeration 10 times.
Figure 4. Fluid flow vectors for the Pre-Paralana Fault basin architecture (note that the position of the Paralana fault is still shown in the figure, but the physical properties of the fault are "disabled"). Vertical scale exaggeration 10 times.

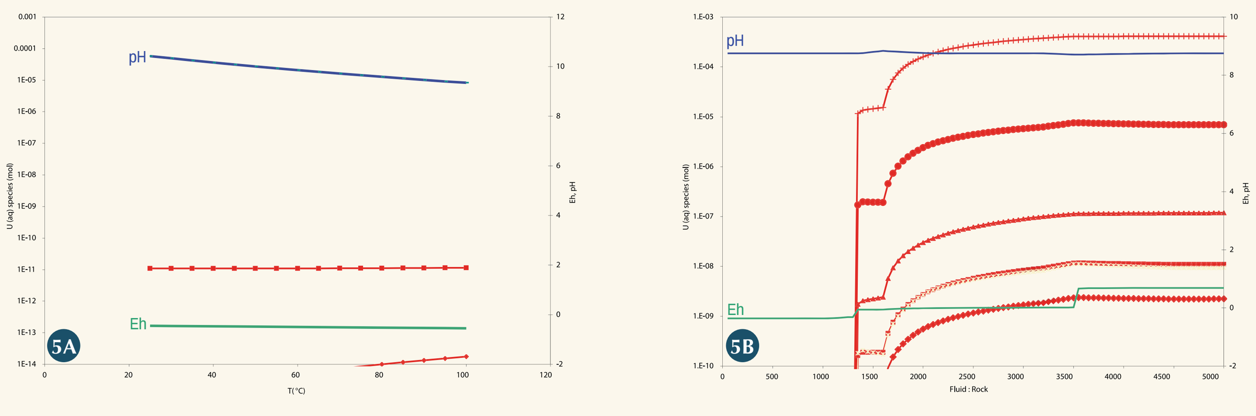


Figure 5. Concentrations of major uranium species, pH and Eh for models of (A) Cooling of the fluids producing the Paralana Hot Springs; (B) Water-rock interaction for the roll-front uranium mineralisation. U (aq) species shown in red.

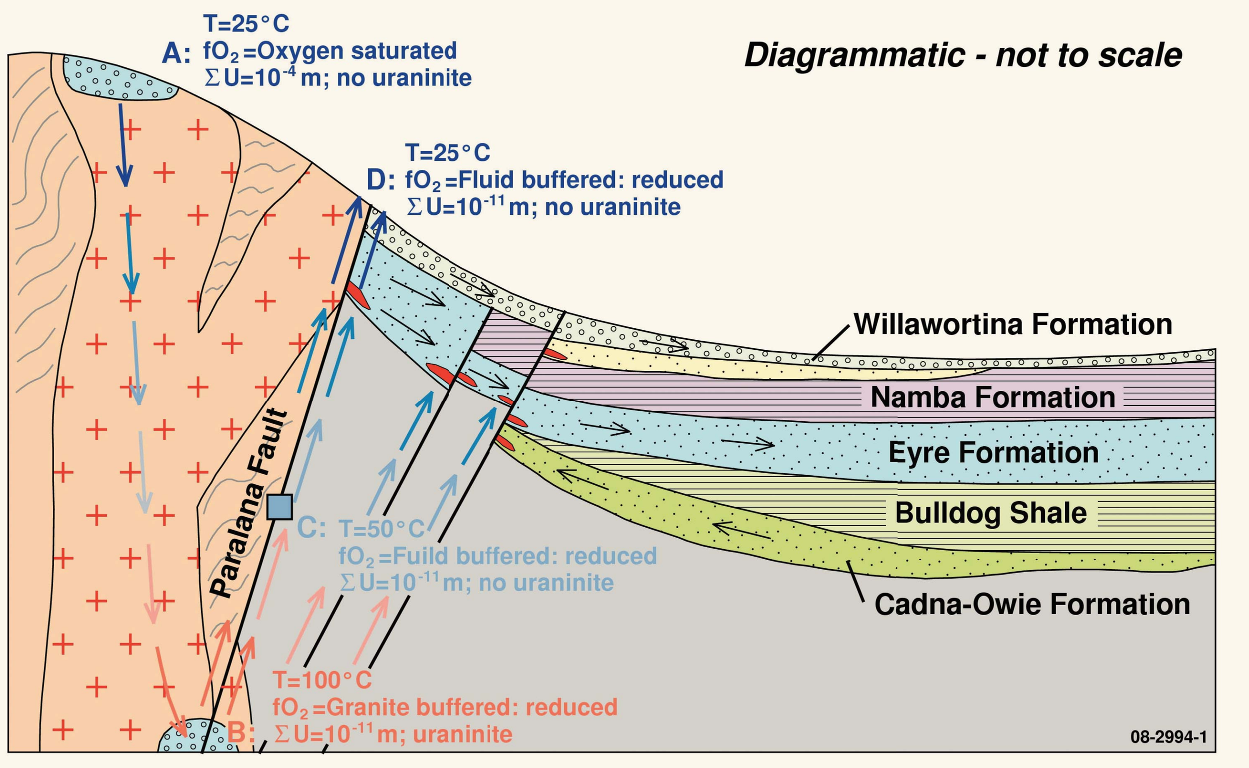


Figure 6. Schematic diagram of the conceptual geologic model used for geochemical modelling of the Paralana Hot Springs and sandstone-hosted uranium mineralisation. The blue to red arrows show the heating and cooling cycle of fluid related to the Paralana Hot Springs; the black arrows show the fluid flow in the present-day aquifers; the red zones show hypothetical zones of uranium mineralisation.

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