

## Unconformity-Related Uranium Systems—Regional-Scale Constraints

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The Pine Creek Orogen (PCO) contains a global resource (production plus remaining resources) of around 453 000 tonnes of  $U_3O_8$ . Although Athabasca Basin in Canada contains more uranium (approximately 200 000 t of  $U_3O_8$  more), the cumulative frequency curves of the resources in the two regions reveal a similar endowment. Within the PCO, the Alligator Rivers Uranium Field contains the largest resources (150 times more than the South Alligator Valley Field and 50 times more than the Rum Jungle Field).

We explain the distribution of U endowment in the PCO by discussing the role of six important elements of the architecture of the unconformity-related uranium system:

- unconformity surface;
- reduced basement of graphitic rocks below the unconformity;
- flat-lying platform cover of fluvial sediments containing red-bed sandstone;
- inliers/domes of Archaean granite-gneiss;
- palaeo-regolith at the unconformity surface; and
- first-order basement faults and their periodic reactivation resulting from far-field tectonic processes.

The Rum Jungle and Alligator Rivers Uranium Fields are confined to the palaeo-island highs on the Batchelor and Nanambu shelves at the margin of troughs. The island highs also contain the remnants of Archaean complexes in the Rum Jungle Field and the Nanambu Complex in the Alligator Rivers Field. The granites and gneisses in the Archaean complexes were the primary/first-order source of uranium in the Palaeoproterozoic psammitic and pelitic rocks of the reduced basement and the sandstones of the Kombolgie Subgroup. The Archaean granites and gneisses have not been mapped in the vicinity of relatively U-poor South Alligator Valley field.

Uranium deposits in the Rum Jungle and Alligator Rivers Fields lie on the fringes of regional gravity high zones. A preliminary analysis of the gravity data using multiscale edge analysis ('worming') shows a spatial correlation between uranium deposits and gravity gradients.

In the Athabasca Basin a palaeo-regolith (up to 70 m thick) is present immediately below the Athabasca Group. A similar palaeo-regolith was mapped at Granite Hill, 4 km south of Jabiluka. The chloritised and haematized regolith shows phosphate enrichment and uranium depletion (~ 5 ppm U) relative to the protolith, indicating that such a protolith could have supplied uranium to the ore-forming fluids.

Periodic reactivation of basement faults in the Athabasca Basin is thought to be responsible for creating a system of palaeo-ridges and valleys for the deposition of the Athabasca Basin sediments. This reactivation also affected the unconformity surface and the palaeo-regolith. A similar process possibly occurred in the PCO, resulting in the close association between the ridges of gravity high, major basement fault zones (e.g. Jim Jim, Bullman, South Alligator-Palette) and uranium deposits.