Termitaria sampling in uranium exploration: refining an old technique

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Cameco Australia Pty Ltd (Cameco) and its various joint venture partners currently explore for uranium across approximately 2300 km^2 of greenfields tenure in Arnhem Land, Northern Territory. These very extensive project areas comprise 10 to 50 m high, dissected, fault-bounded, sandstone plateaus, flanked by areas of topographically subdued, weathered and eroded terrain.

In 2012 and 2013, conventional soil, vegetation and termitaria orientation studies were trialled over areas of known mineralisation within the project areas in order to determine whether these lower cost, low impact techniques could be effectively applied to first pass exploration in this terrain. While both the vegetation and termitaria orientation studies returned encouraging results, the tenor and coherency of the uranium anomalies observed in the termitaria data suggested that this technique was, at least in the areas trialled, more effective at providing a vector to sub-surface uranium mineralisation.

In 2014, Cameco engaged CSIRO to assist in a field-based collaborative research study to explore the mechanism/s by which uranium and other pathfinder elements were introduced into and fixed within termite mounds (**Figure 1**). This information would assist in assessing the potential effectiveness of termitaria sampling in different regolith terrains, guide optimisation of the geochemical sampling technique and determine the most appropriate protocol for sample analysis.

The 2014 termitaria study areas were located in northwestern Arnhem Land, approximately 40 km northeast of Gunbalanya. There are three distinct landforms noted in the study areas, each with a different vegetation assemblage: open eucalypt forest, grasslands with sparse timber and seasonally flooded grasslands. Each of these vegetation assemblages is inhabited by a distinct community of termite species adapted to live in that particular environment. The study examined the impact these different termite species may have on the sampling methodology and results.

Although the processes by which gold and base metals are transported to and concentrated within the mound structures have seen some dedicated research (Petts 2009, Stewart *et al* 2012, Stewart and Anand 2014), the pathways of uranium sequestration are poorly understood. Aspandiar *et al* (2008) and Stewart and Anand (2014) have hypothesised that metals can be introduced into termite mounds through the following processes:

- vertical physical transport of metal-enriched particles from the water table by burrowing termites
- vertical physical transport of metal-enriched particles from regolith horizons (ie laterite) above the water table by burrowing termites
- concentration of metals in the mound from termite food sources (ie living vegetation, dead wood, leaf litter) that are enriched in metals sourced from the water table.

To investigate which of these mechanisms plays a role in uranium concentration in the termite mounds, three anomalous nests identified from the orientation study were dissected and sampled in detail. A selection of the samples were submitted for PIXE (particle-induced X-ray emission) and XRF (X-ray diffraction) mapping to examine the deportment of uranium and selected trace and major elements (including As, Al, Ca, Cu, Fe, Ga, Pb, Ti, Sr, Zn) within the mound matrix. This knowledge was used to guide the preparation of the sample material for geochemical analysis. The samples were sieved into four different size fractions, and then subjected to various leaching digests.

The outcomes of this study indicate that termite speciation is less likely to impact on the effectiveness of the sampling technique than the oxidation state of the soil used by the termites to build the mound. In the areas where the mounds and surrounding soils were sampled, the cemented mound material contained more uranium than the surrounding soil. The highest uranium results were contained in the fine clay fraction (<52 µm) of the mound with the majority of the uranium occurring in the organic material that coats/binds the clay. There was no evidence to suggest that the

Figure 1. Internal structure of a *Coptotermes acinaciformis* nest within the study area. The outer clay carapace envelopes an inner organic-rich carton which doubles as the termites living quarters and food source.

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processes of physical biogenic transport of uranium-enriched particles from either regolith horizons or the water table played a significant role in uranium remobilisation into the nests. These findings indicate that the most likely process responsible for the increased concentration of uranium in the termite mounds in the study area is via the consumption of vegetation that has drawn soluble uranium, produced during the weathering of a source, up from the water table. The uranium-enriched vegetation is ingested by the termites and is excreted out in the organic material used by the termites to bind clay and sand fragments during nest building.

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