THE UNIVERSITY OF ADELAIDE

THE EFFECTS OF WEATHERING AND DIAGENETIC PROCESSES ON THE GEOCHEMICAL STABILITY OF URANIUM MILL TAILINGS

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Abstract

Uranium mill tailings from the Ranger mine, located in the Alligator Rivers Region of the Northern Territory, Australia, were examined to assess the effects of weathering and diagenesis on their long-term geochemical stability. Run of mill uranium tailings are a complex heterogeneous mixture of lithogenic (primary gangue minerals and weathering products) and secondary (components that form during milling) minerals, residual process chemicals and biogenic (products of biological activity) phases. Following transfer to the tailings storage facility, post depositional reactions alter the mineralogical and hydrochemical characteristics of the tailings solids and pore waters in accordance with weathering and diagenetic processes.

In this thesis, a detailed examination of tailings cores and pore waters, kinetic column test work and geochemical modelling was combined with results from earlier studies to examine the key processes governing the geochemical stability of the Ranger tailings. Conclusions drawn from the work clearly demonstrates that the solid state speciation and mobility of metals and radionuclides in the tailings pile are governed by the processes of oxidative dissolution of sulfide minerals, weathering of phyllosilicates and organic matter diagenesis. The processes are spatially dependent, evolve over time and are influenced by the following key factors:

- Tailings water content or degree of saturation;
- The nature and content of organic matter in the tailings;
- Redox potential of the tailings solid-pore water interface; and
- The specific reactivity of precursor minerals (primary/secondary) from the milling process and pore water solutes.

Combined, these processes lead to the formation of authigenic minerals, which control the solubility of pore water constituents. These mechanisms will also have a profound impact on the long-term geochemical stability of the tailings pile and, as such, will need to be taken into account in the design, management and closure of the final tailings repositories at the Ranger site.

Declaration

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text.

I give consent to this copy of my thesis, when deposited in the University Library, being available for loan and photocopying.

Greg Sinclair

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