Geochemical Characterisation of Waste at the Former Rum Jungle Mine Site

Acid and metalliferous drainage (AMD) from mining wastes produced at the Rum Jungle mine (in the 1950s and 1960s) has had a severe environmental impact on the immediate mine area and Finniss River. Whilst the site was rehabilitated in the 1980s, the Northern Territory and the Australian Commonwealth Governments recognised the need to develop an improved rehabilitation strategy for the site, and in response initiated a set of comprehensive technical studies. One of those studies involved the geochemical characterisation of the material contained in waste and tailings storage structures at the mine.

The geochemical characterisation was conducted at four locations; Main, Intermediate, Dyson's Overburden Heaps and Dyson's Pit (which was backfilled with tailings, contaminated soils and spent copper extraction residues). The objectives were to:

- Determine the potential for acid generation and/or dissolution of contained metals; and
- Identify potential implications for the Rum Jungle Remediation Plan with regard to materials handling and specific residue management requirements.

Excavated pit and excavating equipment in operation

Samples were collected using excavators and a coring drill rig. Field and laboratory tests were carried out, including paste pH and paste electroconductivity (EC), acid base accounting, elemental and mineralogical composition and metal leachability. Instrumentation was installed in the wastes contained in Dyson's Pit to measure oxygen concentration, temperature and the depth to the groundwater table.

Current material characteristics

Materials in the overburden heaps had considerable heterogeneity, in terms of colour, texture and grain-sizes. Field observations indicated heterogeneity on a range of spatial scales (from centimetres to many metres), both vertically and laterally. Although it was possible to infer the lithological unit of discrete waste fragments based on visual observations, it was found that geochemical characteristics (e.g. acid potential, leachable metal content) did not correlate with these observations.

Material in Dyson's Pit (tailings, copper extraction residues and contaminated soils) showed a lesser degree of heterogeneity within each material category, likely due to blending resulting from comminution and mineral processing to recover metals.

The paste pH results indicated that the majority of materials are acidic. The often recorded high paste EC values are consistent with the presence of abundant stored oxidation products. The acid neutralising potential of the materials was typically low indicating that reactive neutralising minerals (if ever present) had already been depleted or were not available for neutralising acidity.

Water soluble solutes that most often exceeded ANZECC Stockwater Quality Guidelines in the leach extraction tests were copper and sulfate. Other solutes that were released at significant concentrations varied from facility to facility (reflecting differences in the composition and state of acidification of the materials deposited) and included aluminium, arsenic, cadmium, cobalt, nickel, selenium, uranium and zinc.

Potential for long-term acid and metalliferous drainage

All the waste facilities contain residual sulfides and therefore have potential to continue to generate acidic conditions over the long-term.

The rate of generation of acid and metalliferous drainage from the residual sulfide minerals will be controlled by the rate of oxidation and weathering of the sulphides. The rate of release and concentrations in percolate will be determined by the rate of infiltration. Contaminants of concern that might be released in the long-term include iron, and a range of metals and metalloids present in or as sulfide minerals, e.g. arsenic, cadmium, cobalt, copper, nickel, selenium and zinc. Dissolution of mineral phases in response to acidic conditions could result in release of other elements such as aluminium and silicon (from aluminosilicates), and chromium and manganese (from oxides).

The geochemical characteristics and physical conditions of each waste facility will in part determine the priority to be given to remediation of the facility, and influence the choice of remediation action for the facility. A scheme for ranking the parameters considered significant in relation to the management of AMD was devised and used to rank each storage facility. The ranking indicated that Main Heap should be given the highest priority when considering future rehabilitation activities. The lowest priority was assigned to Dyson's Heap according to the ranking scheme.

The ranking scheme was comparative and based on the geochemical characteristics investigated. Other factors may need to be considered before deciding on future management strategies. These factors might include the:

- Inferred future quality of seepage from the base of the facilities;
- Current and future rates of contaminant production in each of the facilities; and
- Fate and impacts of contaminants.