Accelerated field-scale (bio)remediation of alkaline tailings by coupling microbial and abiotic strategies

T.C. SANTINI[1], G.D. SCULLETT-DEAN[1], A. CHIU[1], G.W. TYSON[2], L.A. WARREN[3]

[1]The University of Western Australia, Perth, WA, Australia (*correspondence: talitha.santini@uwa.edu.au)
[2]Queensland University of Technology, Brisbane, QLD, Australia
[3]University of Toronto, Toronto, ON, Canada

Nearly 2 billion tonnes of alkaline tailings are produced worldwide each year. Remediation and closure of tailings storage facilities is an urgent challenge for the global mining industry. Remediation works to date have typically focussed solely on abiotic strategies to neutralise pH, remove salts, improve structural properties, and increase plant nutrient concentrations and microbial community biomass and diversity; all of which are key remediation targets to transform tailings into a productive soil-like material. Microbial communities have been viewed as passive responders to, rather than active agents of, remediation. Our research has pioneered a microbially-driven strategy for fast and complete pH neutralisation in alkaline tailings, using bauxite residue (alumina refining tailings) as a case study. This has now been successfully scaled up from laboratory to field.

Here, we will discuss development and present results from a successful year-long field trial of our microbially-driven bioneutralisation technique coupled with a variety of abiotic remediation strategies at an alumina refinery in Western Australia. We demonstrate enhanced and accelerated *in situ* remediation of bauxite residue by combining microbial bioneutralisation (by fermentation of added glucose) with regular tillage (physical disaggregation), compost addition, and irrigation. This is reflected in greater extent and depth of pH neutralisation (pH decreased from 13 to ≤9.5 to a depth of 20 cm in nine months), greater salt export (EC decreased from 11 mS cm^{-1} to ≤5 mS cm^{-1} to a depth of 20 cm in nine months), greater alkaline mineral weathering and dissolution, higher organic C and N retention, and higher microbial diversity and activity in coupled microbial and abiotic treatments than in treatments receiving either microbial or abiotic treatments. Ongoing work focussed on trace element geochemistry and microbial community succession will also be discussed, as well as application to other alkaline tailings.