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The bioremediation of thiocyanate from gold mine tailings.

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The effective removal of thiocyanate (SCN^-) from gold mine tailings is a desirable outcome to limit the environmental impact of both legacy and operational mining facilities. A gold mine tailings storage facility (TSF) at a gold mine in Victoria, Australia, holds large quantities of SCN^- contaminated mine waste. The TSF receives waste from the gold extraction process in the form of a mineral solid phase and associated waters, containing concentrations of >800 mg L^{-1} SCN^- in a slightly alkaline solution, which after settling of the solid phase forms a reservoir of surface water for re-use in the gold extraction process. In the search for the effective removal of SCN^-, a by-product of the use of cyanide as a lixivant for gold, the ability for bacteria to degrade SCN^- to less toxic products offers the potential to harness this metabolic process in a biotechnological remediation strategy. This study aimed at assessing the ability to promote SCN^- biodegradation in the TSF and also at culturing a SCN^- degrading microbial community from the TSF for testing in a SCN^- degrading bioreactor.

In order to establish an SCN^- degrading microbial community, surface samples were obtained from the TSF at the Victorian gold mine and used to inoculate a moderately saline and alkaline media, reflective of the surface water of the TSF. Cultures were capable of SCN^- degradation in the absence of organic carbon and requiring the minimal nutrient amendments of phosphate and trace metal addition. After initial testing in batch experiments one culture was chosen for use in a lab-scale bioreactor, initially in a batch set-up but followed by an extended period of continuous flow, with the addition of SCN^- containing media. Using 16S rRNA sequencing, the cultures were found to be dominated by bacteria of the *Pseudomonas* and *Agrobacterium* genera, with a significant abundance of *Thiobacilli*, the former and latter known to contain strains capable of SCN^- degradation.

In addition to establishment and testing of this bioreactor microbial community, surface water from the TSF was used to test the ability to promote *in situ* SCN^- degradation. Through batch tests the promotion of SCN^- biodegradation was found to be initiated by nutrient addition. Again using 16S rRNA sequencing we found that degradation of SCN^- coincided with the proliferation of bacteria of the *Thiobacillus* genus.

These experiments will help to inform the implementation of effective bioremediation strategies of SCN^- contaminated mining facilities. The bioreactor community is capable of rapid SCN^- degradation, requiring the addition of minimal nutrient inputs, offering a route to the removal of SCN^- from waste-streams or legacy mining impacted waters. While the current findings also suggest that it may be possible to stimulate the SCN^- degrading members of the microbial community *in situ* in the surface waters of the TSF.