(A) Review of Microbial Induced Carbonate Precipitation Treatment in the Remediation of Diverse Mine Tailings

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Mine tailings are the waste materials produced during mineral or natural resource extraction. These tailings can contain hazardous substances like heavy metals, arsenic, cyanide, and toxic organic compounds. When not adequately managed, they pose a significant environmental and human health risk, often being stored in large ponds or dams.

Microbially induced calcite precipitation (MICP) presents a promising solution for addressing the various concerns related to mine tailings storage, remediation and reclamation. The microorganisms involved in MICP can effectively bind contaminants within tailings, acting as a source control treatment to prevent leaching into the environment. Additionally, the formation of calcium carbonate minerals contributes to tailings stability and strength, reducing the risk of landslides and erosion.

Research indicates that MICP is effective across diverse tailings sources and conditions, including not only metal resources and coal tailings but also oil sands tailings. In the case of oil sands mine tailings, MICP has demonstrated the ability to reduce permeability, improve dewatering, and enhance shear strength. Furthermore, the microorganisms in MICP can immobilize contaminants in contaminated groundwater, preventing their spread to other areas of the site. The formation of calcium carbonate minerals also helps neutralize acidic groundwater, a common issue in mine tailings locations.

MICP offers several advantages over traditional remediation methods. It is a natural process that avoids the need for harsh chemicals or heavy machinery. Moreover, MICP can be applied in situ, which is particularly advantageous for remote or inaccessible tailings sites. MICP tends to be cost-effective, as the required materials are readily available and relatively inexpensive.

However, challenges remain. Different microorganisms may have varying metabolic capabilities, making them better suited to specific tailings and soil types. Site conditions, such as temperature, pH, and the presence of other contaminants, can impact the effectiveness of MICP. While promising, large-scale application of MICP for mine tailings remediation requires further research and development to address these challenges and ensure its suitability across diverse conditions.

Sarah Miles

Sarah joined Geosyntec in 2021 after earning her Doctorate in Environmental Engineering from the University of Alberta and B.Sc. in Earth Science at Memorial University of Newfoundland. During her PhD, she completed extensive work on oil sands tailings remediation projects, specifically on treatment of the naphthenic acid fractions within oil sands tailings water. With a focus on potential bioremediation strategies, her projects used microbial isolates, the native microbial community and chemical oxidation multistep treatments to degrade this target organic fraction. At Geosyntec, Sarah now focuses on diverse remediation projects at complex sites containing petroleum/chlorinated hydrocarbon contamination.