Microbiological Treatment of Nitrate and Selenate from Coal Mine-Affected Water in a Subsurface,Semi-Passive, and *in situ* Water Treatment Facility

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Abstract

Metallurgical coal mining generates significant amounts of waste rock, which can release nitrate and selenate upon atmospheric exposure, with resulting changes in surface water and ground water quality. Microorganisms residing on waste rock in the local subsurface have the metabolic potential to denitrifyand reduce selenium to treat mine-affected waters and stabilize waste rock. To support these processes, waste rock facilities have been designed to inject nutrients (e.g., methanol and phosphoric acid) in semi-passive water treatment of mine-impacted waters. Microbial community data regularly collected fromsubsurface semi-passive reactors throughout the startup and operations phases showed that native heterotrophic denitrifying bacteria and selenium reducing bacteria were enriched as a result of nutrient amendment. The microbial community was stable while the source water and geochemical parameters remained unchanged; however, a significant shift in the microbial community coincided with changes in the source of water treated. Metagenomic sequencing of microbial communities within the active treatment zone revealed multiple biochemical pathways of nitrate reduction. Geochemical and water quality data indicate near complete selenate reduction, yet a low abundance of in known selenate reduction genes were recovered. This may suggest that biologically mediated selenium reduction may be more widespread, both functionally and taxonomically. Further research into these pathways and mechanisms for nitrate and selenium reduction will help to strengthen our understanding of selenium reduction mechanisms and their application in mine water waste management.

Keywords

Selenium, metagenomic, suboxic

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Conflicts of interest

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