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In Situ Bioremediation of Selenium and Nitrate for Full Scale Treatment of Mine Waste in the Elk Valley, British Columbia

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Active in-situ microbial reduction of nitrate and soluble selenate to selenite and elemental selenium (less mobile) was induced by subsurface methanol injections and can stabilize selenium (Se) in mined waste rock. Biogeochemical processes require careful balancing of oxidants (oxygen and nitrate) and reductants (methanol). Pulsed nutrient injection strategies were used in the field in attempts to minimize near-well biofouling. Molecular biology and biological engineering methods have been used to characterize the microbial ecology and metabolic capacity of waste rock to treat mine-affected water for mining operations in the Elk Valley, located in southern British Columbia, Canada.

Laboratory scale batch and column studies with native microbes demonstrated the capacity to reduce nitrate and Se in saturated waste rock and showed that oxygen and nitrate inhibition of Se reduction was overcome via carbon addition. Biofilm grown on waste rock in saturated aerobic column tests was capable of 50 to 99% nitrate reduction followed by 40 to 95% Se removal; Se was sequestered in the biofilm predominantly in the zero-valent state. Denitrification and Se reduction was most rapid and efficient under suboxic conditions, and as high as 99% removal.

These results were scaled up to a pilot test and ultimately to a full scale in-situ saturated rock fill bioremediation system treating over 20 million L/d. In-situ biofilm coupons were deployed to track the microbial community structure using 16S rRNA gene sequencing. Applying the tools of molecular biology, bioengineering, geochemistry, and principles of microbial ecology to the understanding of biomineralization/bioprecipitation has been effective for management of nitrate and Se in mining settings.

Participation

In-Person

References

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