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Removal of Selenium and Nitrate in Groundwater Using Organic Carbon-Based Reactive Mixtures

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Treatment of selenium and nitrate in groundwater was evaluated through column experiments. Four columns consisting of reactive mixtures, either organic carbon-limestone (OC-LS) or organic carbon-zero valent iron (OC-ZVI), were used to determine the removal efficiency of selenium with different concentrations of nitrate. The source waters were collected from a mine site in Korea or were prepared artificially based on the mine drainage water or deionized water, followed by spiking of elevated concentrations of Se (40 mg/L) and nitrate (100 or 10 mg/L as NO_3-N).

The results for the aqueous chemistry showed that selenium and nitrate were effectively removed both in the mine drainage water and deionized water-based artificial input solution. However, the removal of selenium was delayed when selenium and nitrate coexisted in the OC-LS columns. The removal of selenium was not significant when the influent nitrate concentration was 100 mg/L as NO_3-N, while most of nitrate was gradually removed within the columns. In contrast, 94% of selenium was removed when the influent nitrate concentration was reduced to 10 mg/L as NO_3-N. In the OC-ZVI column, selenium and nitrate was removed almost simultaneously and completely even with the high nitrate concentration; however, a high concentration of ammonia was produced as a by-product of abiotic reaction between ZVI and nitrate. The elemental analysis for the solid samples after the termination of the experiments showed that selenium was accumulated in the reactive materials where removal of aqueous-phase selenium mostly occurred. The X-ray absorption near-edge structure (XANES) study indicated that selenium existed in the forms of SeS_2 and Se(0) in the OC-LS column, while selenium was present in the forms of FeSe, SeS_2 and absorbed Se(IV) in the OC-ZVI column.

This study shows that OC-based reactive mixtures have an ability to remove selenium and nitrate in groundwater. However, the removal of selenium was influenced by the high concentration of nitrate. Thus, it suggests that the presence of nitrate should be considered for the treatment of selenium in groundwater.