GEOCHEMICAL PROCESSES AND THE ROLE OF NATURAL ORGANIC SOLUTES ON THE SOLUBILITY OF SELENIUM IN COAL MINE BACKFILL AQUIFERS, POWDER RIVER BASIN, WYOMING[1]

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Abstract: Concentrations of dissolved selenium (Se) as large as 165 micrograms per liter have been detected in groundwater samples from backfill aquifers at two coal mines in the southern Powder River Basin of northeastern Wyoming. During surface coal mining, the overburden is redistributed in relation to its original stratigraphic position. Exposure of previously buried material to surface oxidizing conditions decreases the stability of sulfides and organic matter containing Se and might result in increased Se concentrations in associated groundwater. Groundwater and backfill core samples were collected at three sites at two active coal mines. Characterization of the samples, sorption/desorption experiments, precipitation/dissolution experiments, and controlled oxidation/reduction experiments were completed to investigate geochemical processes affecting the solubility of selenium in coal mine backfill aquifers. Results of sorption/desorption experiments indicated that backfill-core samples have a large sorption capacity for Se and can sorb as much as 98 percent of Se added as selenite. Substantial differences in Se sorption rates occurred in the presence of individual organic solute fractions. The presence of hydrophilic acids caused the largest reduction in Se sorption by the backfill-core samples. Results from precipitation/dissolution experiments, and subsequent geochemical modeling using GEOCHEM, indicated that natural organic solutes had little effect on the calculated concentrations of Se species. Geochemical model results indicated the presence of $MgSeO_3^\circ$ and $CaSeO_3^\circ$ ion pairs. The presence of these ion pairs might represent a potential for uninhibited Se mobility, because neutral ion pairs might not be sorbed onto oxides and clays as compared to charged species. An experimental chamber was constructed to control oxidation/reduction conditions in groundwater and backfill core samples. The chamber was successful in controlling the redox status of samples at given measured Eh values. The results indicated that selenate can remain stable and soluble under reduced conditions, when equilibrium modeling would predict otherwise.

Additional Key Words: Selenium, sorption, precipitation/dissolution, dissolved organic carbon

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