Geomicrobiological control of selenium solubility in subsurface phosphate overburden deposits

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Microbial reduction of Se(VI) is controlled by oxygen and lithology within mixed deposits of shale, chert, and mudstone mined from the Meade Peak member of the Phosphoria Formation in southeast Idaho. Waste rock and groundwater from backfilled mine pits, which have been studied using geochemical, microbial cultivation and cultivation-independent molecular methods, host indigenous populations of *Dechloromonas*-like bacteria that can rapidly and near-quantitatively reduce soluble Se(VI) concentrations within a consortium of hydrocarbon-degrading organisms. Most-probable number estimates of Se(VI)-reducers are highest in well sediments and in shale, and very low in chert and mudstone. Reduction rates vary between lithologies, but all experiments show reduction in saturated, anaerobic microcosms with isotopic fractionation of 2.4 per mil (82/76; product enriched in 76) for Se(VI). Operational waste management strategies that promote Se(VI)-reduction by indigenous organisms using native carbon offer a sustainable, design-based approach to natural attenuation of selenium in mined rock.

Effect of natural gas production on geochemistry and microbiology in a fractured organic-rich shale

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Unconventional natural gas reservoirs are becoming increasingly important energy sources. Gas is stored in unconventional reservoirs by adsorption to the solid matrix and also within groundwater found in fractures and pores. Gas production is enhanced by groundwater pumping, which lowers pressure in the matrix and liberates adsorbed gas. We consider the effect that gas production has had on the composition of groundwater and gas and the function of the microbial community in the Antrim Shale, an unconventional resource in the Michigan Basin, U.S.A. We analyzed gas, water, and microbial biomass samples collected from eight wells in January 2009 and compared our findings to analyses performed as early as 1991 on the same wells. We also examined production records from field stations associated with seven wells. Water production has decreased sharply over time and is currently at 0.2 to 14.6% of peak levels. Compositionally, the proportion of CO_2 in produced gas has increased by as much as 15 mole% while CH_4 content has correspondingly decreased. Isotopically, the δ13C and δD of CH_4 decreased slightly. The δ13C of CO_2 is more variable but increased slightly for most wells. The alkalinity of groundwater decreased in all of the wells by 20 to 50%. SO_4^{2-} content increased in each well with initial values from below 50 µM to over 200 µM on average. Functional gene analysis of biomass shows that SO_4^{2-}-reducing microorganisms were present in all of the samples we collected. Our results suggests that SO_4^{2-}-bearing groundwater is seeping into the Antrim, possibly from the underlying gypsum-bearing karst aquifer, as the formation is dewatered to produce gas and that this has created conditions favorable for microbial SO_4^{2-} reduction. These findings imply that gas production may ultimately cause the rate of biogenic CH_4 production to decrease as SO_4^{2-}-reducing microorganisms begin to compete with methanogens for electron donors.