Selenium in the environment: Abiotic and biotic controls on Se redox

CARLA E. ROSENFELD[1], BRUCE R. JAMES[2] AND CARA SANTELLI[1]

[1]Smithsonian Institution, National Museum of Natural History, Washington, DC USA; rosenfeldc@si.edu, santellic@si.edu

[2]University of Maryland, Department of Environmental Science and Technology, College Park, MD USA; brjames@umd.edu

Worldwide, selenium (Se) is proving to be a significant environmental concern, with many anthropogenic activities (e.g., coal mining and combustion, phosphate mining and agricultural irrigation) releasing potentially hazardous concentrations into soil and natural water ecosystems. Various abiotic and biological processes coupled to Mn(III,IV)(hydr)oxides and microorganisms mediate Se oxidation/reduction (redox) transformations in soils, thus influencing its solubility and bioavailability. Several common soil fungi aerobically reduce soluble Se(IV,VI) anions to Se(0). In this research, we assess the relative contribution of biotic and abiotic pathways for these aerobic Se transformations.

To study biotic and abiotic contributions to Se transformations, soluble Se(IV) was combined with Mn(III,IV)(hydr)oxides, a Se-transforming fungus (*Alternaria alternata*), and/or oxalic acid to mimic Se biogeochemistry at plant-soil-water interfaces. Despite slightly increasing the redox potential of the solution, the presence of Mn oxides did not inhibit aerobic fungal-mediated Se(IV,VI) reduction to red precipitates of biogenic Se(0). Without the addition of fungi, reduction of Se(IV) to Se(0) did not occur, although there was an initial rapid decrease in Se(IV) concentration (50-75% loss within 1 day) in the presence of Mn oxides. This decrease was likely due to surface adsorption or precipitation of Se(IV) anions. In the absence of Mn oxides, the magnitude of Se(IV) loss from solution was nearly three times higher with fungi than in abiotic controls (41% loss of Se(IV) after 10 days in the presence of *A. alternata* as compared to 15% without fungi). Bioreduction of Se(IV) to Se(0) did occur in all *A. alternata* treatments, though it is unknown whether alternative processes such as volatilization or incorporation into fungal biomass also play a role in removing Se(IV) from solution.

Results from this study are key for understanding Se-transforming reactions in soils, and the role that both abiotic and biotic processes play in influencing Se bioavailability and mobility within and out of contaminated ecosystems.