Fungi-mediated redox transformations of selenium

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Although microfungi are prevalent and active in soil and water ecosystems, little is understood about their role in metal and metalloid redox transformations and ultimate impact on environmental health. Microbiologically mediated redox transformations of selenium (Se), a metalloid of increasingly significant environmental concern, greatly influence its solubility, bioavailability, and toxicity. Ongoing research has established that even in aerobic environments, several common soil fungi can remove dissolved Se(IV,VI) anions from solution through volatilization and reduction to insoluble Se(0) nanoparticles [1]. In this research, we experimentally assess the contribution of different fungal pathways for aerobic selenite and selenate transformations and characterize the resulting Se-containing products and biominerals using a combination of solution chemistry, transmission electron microscopy (TEM), and X-ray absorption near edge structure spectroscopy (XANES).

Batch growth experiments of six Ascomycete isolates were performed in varying concentrations of Se(IV or VI)-containing media, and the concentrations and forms of Se were tracked with time. Solution chemistry showed a decrease of dissolved Se(IV or VI) concentrations when grown aerobically with fungi, but the rate of loss and resulting Se-containing products depended on the fungal species as well as the initial Se specie and concentration. With all fungal species, greater Se(IV) was removed from solution and a red, nanoparticulate Se(0) mineral was observed in many of the cultures (including in several Se(VI)-grown cultures), indicating partial or complete reduction of the metalloid. TEM and Se K-edge XANES confirmed the presence of intracellular and extracellular amorphous Se(0) nanoparticles. XANES analyses further revealed the presence of a Se(-II)-containing organic compound, particularly in Se(VI)-grown fungal isolates. Results from this study are key for understanding Se-transforming reactions and the role that fungi play in influencing Se bioavailability and mobility within and out of contaminated ecosystems.

[1] Rosenfeld, C.E., *et al.* (2017) *Geobiology. Jan 2. doi: 10.1111/gbi.12224.*