Time-resolved biogeochemical insights to fungal redox transformations of selenium, the essential toxin

MARY SABUDA[1]*, CARLA ROSENFELD[1,2], JOSHUA TORGESON[1], CARA SANTELLI[1,2]

[1] Department of Earth Sciences, University of Minnesota, Minneapolis, MN 55455 (*correspondence: sabudama@gmail.com, torge158@umn.edu)

[2] BioTechnology Institute, University of Minnesota, Minneapolis, MN 55455 (carlar@umn.edu, santelli@umn.edu)

Selenium (Se) is both a micronutrient required for most life and an element of environmental concern due to its toxicity at high concentrations. Mining of shale beds for phosphate ores can release Se into the environment, where it can exist as Se(-II), elemental Se(0), or aqueous Se(IV or VI). While most knowledge of biotic Se transformations is related to anaerobic bacterial processes (i.e. [1]), recently, some environmentally-cosmopolitan fungi have been shown to perform aerobic Se(IV/VI) reduction [2] forming both solid nanoparticulate Se(0) and volatile Se(-II) phases, which is ideal for engineering an efficient, cost-effective bioremediation strategy. However, little is understood about the chemical or genetic mechanisms of this transformation over time. To this end, culture experiments of *Alternaria alternata* were grown with 0.1 mM and 0.5 mM concentrations of selenite (Se(IV)) to constrain the aqueous geochemistry, quantify biomass-associated Se, and discern the location and speciation of Se with respect to the fungal cells over 32 days.

The aqueous geochemical results from this novel work reveal that 0.1 mM Se(IV) is fully removed from solution after only 14 days, and 40% of the 0.5 mM Se(IV) is removed from solution after 32 days of fungal growth. While biomass-associated Se analyses are in-progress, Transmission Electron Microscopy (TEM) images of the fungi reveal complex and intriguing patterns of both intracellular and extracellular Se. After only 5 days, amorphous nanoparticulate Se is gathered along the periphery of the cell in a polymeric-type substance, and intracellular Se consists of ~75 nm amorphous particles scattered throughout. Strikingly, Se nanoparticles are also aligned along the cell membrane. Combined, this time-series experiment provides insight for discerning the mechanism(s) behind these essential Se transformations, and ultimately helps to engineer an effective Se bioremediation strategy.

[1] Debieux et al., (2011) *Proc Natl Acad Sci* **108**, 13480 - 13485. [2] Rosenfeld et al., (2017) *Geobiology*, **15**, 441-452.