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Heavy Metals and Microbiology in Serpentinizing Ecosystems: A Blessing or a Curse?

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Serpentinization reactions associated with the aqueous alteration of ultramafic rocks are a prolific source of carbon and energy for microbial communities in subterranean ecosystems. These reactions were likely widespread on the early Earth and may sustain other habitable environments in the solar system. This presentation explores the role of heavy metals in serpentinites to both challenge and shape their resident microbial communities.

Ultramafic rocks, by definition, contain a high heavy metal content. Consequently, serpentinized peridotites are currently mined as major sources of chromium and nickel. Microbial communities in serpentine soils have been shown to aid in the metal resistance of serpentine endemic plants through both active and passive processes. Microscopic observations of microbial cells and metal distributions *in situ*, as well as co-registered measurements of microbial community composition and trace metal geochemistry are helping to illuminate the mechanisms of resistance to metal stress. In this context, hot spots of energy and nutrients afforded in near surface soils may enable metal resistance in ways that are unsustainable in deep subsurface environments.

Conversely, the high pH (9-12) fluids generated as a product of serpentinization are exceptionally metal poor. As these fluids seep onto the seafloor or from ophiolites on continental margins they rapidly sequester atmospheric carbon dioxide, creating hydrothermal chimneys and extensive travertine terraces. Microorganisms within these carbonate structures possess mechanisms for efficient metal accumulation, though microbial activities may be limited by trace metal availability. A combination of microscopic and spectrometric approaches, coupled with metagenomic analysis of carbonate-hosted biofilms has provided insight into metal preferences of key enzymes, accumulation processes, and co-associations to *in situ* metal availability.

Taken together, this work provides a blueprint for approaches that can be used to investigate metal-microbe interactions in serpentine systems. It also shows ways in which metals may challenge microbial communities in terms of toxicity, as well as limit their growth in terms of availability. A mechanistic understanding of these processes allows for a more holistic understanding of habitability in extreme environments on Earth, and to consider the role that metal availability in serpentinite systems played in the origins and early evolution of life.