Microbe-mineral Reactions Between Chemolithoautotrophic Bacteria and Asbestos Minerals: Exploring New Avenues for Reducing Exposure to Asbestos Fibers

Dr. Ileana Pérez-Rodríguez
Department of Earth and Environmental Science

Dr. Reto Gieré
Department Chair of Earth and Environmental Science

Large-scale movement of asbestos minerals, resulting from their mining and use in the built environment, illustrate the type of human-driven records defining the Anthropocene[1]. Due to the considerable health hazard of these minerals, asbestos-waste management and bioremediation represent important societal challenges at the international scale[2-4]. On one end, various treatment technologies for asbestos-containing waste have been explored with the goal of destroying the harmful fibers and enabling their reuse as secondary raw materials[2,5]. At the other end, bioremediation strategies relying on fungi, bacteria and plants have been investigated as a way to degrade fibers and reduce their dispersion in asbestos containing landfills and abandoned mines[3,6-8]. Here we propose to study the effect of chemolithoautotrophic microorganisms, our most distant known relatives in the tree of life[9], as potential resources for asbestos-waste treatment and bioremediation. As the primary producers of hydrothermal vent ecosystems along Mid-Ocean Ridges, chemolithoautotrophs are notorious for their close association with mineral surfaces while also exploiting inorganic energy sources under the broad range of physicochemical conditions generated by hydrothermal convection[10,11]. Given that asbestos minerals themselves are hydrothermal in origin, we seek to explore the extraction from asbestos fibers of *(i)* Si during biofilm-formation by anaerobic, chemolithoautotrophic and thermophilic *Aquificae* spp. from deep-sea vents[12], *(ii)* Fe^{2+} by neutrophilic, microaerobic Fe(II)-oxidizing *Zetaproteobacteria* from seafloor environments[13,14], and *(iii)* Fe^{3+} by chemolithoautotrophic Fe(III)-reducing *Deltaproteobacteria* from geothermal environments[15-17]. Studying these processes in chrysotile ($(Mg,Fe^{2+})_3Si_2O_5(OH)_4$), actinolite ($Ca_2(Fe^{2+},Mg)_5Si_8O_{22}(OH)_2$) and crocidolite ($Na_2(Fe^{2+},Mg)_3Fe^{3+}_2Si_8O_{22}(OH)_2$) will allow us to screen various microbe-mineral reactions for the generation of economically feasible asbestos-waste-treatment technology. If successful, these strategies could also be explored for use in field bioremediation through genetic engineering. Ultimately, the objective of our work is to develop tailored chemolithoautotrophy-based methodologies to alter and destroy asbestos in an effort to reduce exposure to, and the health hazards of, the fibers.