Hydrothermal alteration of serpentinized peridotite associated with volcanogenic massive sulfide deposits on the seafloor (as preserved in the Ligurian Ophiolites, Italy)

DJ Levine[1], JC Alt[1]
[1]Department of Earth and Environmental Sciences, University of Michigan, Ann Arbor, MI

Hydrothermal fluids are transported through the ocean subsurface where they are able to scavenge metals and then form massive sulfide deposits where they exit on the seafloor. Mantle material is exposed at the seafloor along detachment faults on slow-spreading mid-ocean ridges, and ultramafic-hosted hydrothermal systems occur in these rocks driven by gabbroic intrusions. It has been hypothesized that normal faults that cut the detachment surface act as upflow zones for hydrothermal fluids forming metal sulfide deposits in these settings, but such faults have not yet been directly sampled on the seafloor. Exposed ultramafic rocks in the Ligurian Ophiolites of Italy provide an opportunity to directly sample the subsurface of an ancient detachment fault that will allow for better understanding of the formation of massive sulfide deposits that form in ultramafic-hosted hydrothermal systems on the seafloor. A seafloor fault juxtaposed pillow basalts against serpentinite and serpentinite breccia on the seafloor, and both rock types are overlain by pillow basalts, a massive sulfide deposit, and pelagic sediment. The ~5 meter wide fault acted as a hydrothermal upflow zone, with rocks exhibiting increasing alteration approaching the fault. Background rocks 50 meters from the fault are completely serpentinized peridotite, and range from serpentinite veined and slightly replaced by carbonate, a mineralized talc shear zone with talc replacing serpentinite, and a serpentinite breccia with serpentinite clasts highly replaced by talc and carbonate and cemented by carbonate. The fault upflow zone rock consists mainly of carbonate minerals with traces of quartz, sulfides, serpentinite, and chrome spinel. The massive sulfide deposit requires high fluid temperatures (~350˚C) to transport metals, and alteration of serpentinite to talc is consistent with silica-rich hydrothermal fluids. This differs from carbonate precipitation and replacement which occur later and at lower temperatures (~100 ˚C), as indicated by oxygen isotope analyses. Petrological observations will be paired with geochemical analysis to better evaluate processes and degrees of alteration of the serpentinite at different distances away from the upflow zone, and help with determining the role that downwelling seawater plays on the hydrothermal discharge zone. Bulk rock major and trace element chemistry will enable a better understanding of fluid compositions and the relative roles of the carbonate space-filling versus replacement. Study of these rocks will provide a better understanding of hydrothermal processes in the subsurface of a seafloor ultramafic-hosted VMS system.