Preservation and Oxidation Rates of Extinct Hydrothermal Chimneys from the Endeavour Segment, Juan de Fuca Ridge

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Seafloor massive sulfide (SMS) deposits that are exposed on the seafloor are subject to two major weathering processes, dissolution and oxidation, due to the combined presence of Fe^{2+} ions and dissolved O_2. Oxidation of sulfide minerals remobilizes and potentially releases significant amounts of metals into solution. Provided with sufficient time and appropriate environmental conditions, oxidative processes impact the preservation potential of SMS deposits. This may have a significant impact on the economic potential of SMS deposits, including diminishing deposit grades and tonnages over time and how far an economic SMS deposit may be found away from an active spreading ridge axis. Here, we present mineralogical and geochemical data from a suite of 15 sulfide-rich rock samples collected from inactive/extinct chimneys sites along the hydrothermally-active Endeavour Segment of the Juan de Fuca Ridge. Samples were collected using the remotely operated vehicle ROPOS from a series of progressively older inactive vents situated on faulted blocks along an approximately 600 m transect perpendicular to the active rift zone. Unlike previous investigations into SMS oxidation that relied upon experimental methods, this approach is observation-based, and focuses on chimney- to microscopic-scale observations of sulfide degradation over time. Detailed petrographic work from samples collected at these inactive vents indicate that polymineralic massive sulphides create galvanic cells due to differences in resting potential of individual minerals. These electrochemical cells result in preferential oxidation of the anodic minerals (e.g., chalcopyrite, sphalerite) and protection of the cathodic minerals (e.g., pyrite), resulting in near euhedral pyrite in contact with anhedral chalcopyrite. Consistent preferential oxidation of sulphide mineralogy provides clarity into features of the seafloor such as the overwhelming abundance of pyrite in older seafloor talus fields.