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Micro-CT investigation of the pore network of hydrothermal vent chimneys

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Summary

Hydrothermal vents occur where hot hydrothermal vent fluid (>350°C) mixes with cold seawater (~2°C) at seafloor spreading centers, where minerals precipitate at the hydrothermal fluid-seawater interface. Hydrothermal vents provide a habitable environment for many chemosynthetic microorganisms and macrofauna by providing a substrate for colonization that is protected from the uninhabitable temperatures of the plume. As dissolved gases such as H_2S, H_2, and CH_4 are transported across a hydrothermal chimney wall, they form a chemical gradient from the relatively high concentrations within the vent fluids to the exceptionally low concentrations in the nearby seawater. To investigate this process, chimney samples were acquired from the Bio9, Tica and P vents from the East Pacific Rise at 9°50'N during a sequence of dives with DSV Alvin. Chimneys were subsampled to provide a representative distribution of vent type, and high-resolution synchrotron x-ray computed tomography imagery of these samples was acquired. The porosity and pore connectivity of chimney walls was investigated by processing and analyzing micro-CT data using the PerGeos software package, and subsequently correlated to complementary mineralogical and geochemical data.

Porosity was found to range from 22% to 49% in the Bio9 vent samples, 41 to 53% in the Tica vent samples and 7% to 13% in the P-vent samples. Pore connectivity in samples analyzed from each vent displayed no disconnected pore space, whereas one P-vent sample displayed anisotropic connectivity. These data suggest that diffuse flow would occur at all investigated vents, and advective transport would occur across the Bio9 and Tica vent chimneys due to high pore connectivity and high porosity. Advective transport is likely to be limited across the P-vent chimney due to disconnected pore space and low porosity. Together, these results provide vital constraints on ongoing attempts to model the transport of chemical compounds across vent chimney walls.