Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.12202

Fluid mixing and spatial mineralogical and geochemical variability in the LCHF chimneys

KARMINA A. AQUINO[1], GRETCHEN L. FRÜH-GREEN[1], JÖRG RICKLI[1], ANNELEEN FOUBERT[2], STEFANO M. BERNASCONI[1] AND SUSAN LANG[3]

[1]ETH Zürich
[2]University of Fribourg
[3]University of South Carolina

Presenting Author: karmina.aquino@erdw.ethz.ch

Carbonate-brucite chimneys are characteristic of low- to moderate temperature, ultramafic-hosted alkaline hydrothermal systems, such as at the Lost City Hydrothermal Field (LCHF) located on the Atlantis Massif at 30°N near the Mid-Atlantic Ridge. These chimneys form as a result of mixing between warm, high pH, serpentinization-derived vent fluids and cold seawater. The temporal variability in mineralogy and geochemistry associated with the aging of the LCHF chimneys as hydrothermal activity wanes has been previously documented [1]. However, little is known about spatial heterogeneities within and among actively venting chimneys, and the role of microorganisms in mediating their formation.

The mineralogy and geochemistry of active hydrothermal chimneys is largely controlled by the mixing proportions of hydrothermal fluid and seawater. Our new textural (SEM, micro-CT) and geochemical ($^{87}Sr/^{86}Sr$ and stable C, O, and clumped isotope) studies indicate that in vent fluid-dominated zones, chimneys are predominantly composed of brucite and calcite precipitated at relatively high temperatures. Zones dominated by seawater are brucite-poor and aragonite is the dominant carbonate mineral. Carbonates precipitate mostly out of oxygen isotope equilibrium due to rapid precipitation. Yet, these carbonates precipitate closer to carbon isotope equilibrium and record $\delta^{13}C$ within the range of marine carbonates. Contrary to previous study [1] we show that calcite is a primary mineral in these active hydrothermal chimneys and does not exclusively form as an alteration product of aragonite. Elevated formation temperatures and lower $^{87}Sr/^{86}Sr$ relative to aragonite in the same sample suggest that calcite is the first carbonate mineral to precipitate.

Brucite is a significant component of the chimneys and is intimately associated with microbial biofilms. The close association with organic matter is not observed with calcite or aragonite, suggesting an important connection between microbial activity and brucite mineralization. We use the new observations discussed above to modify an earlier model of formation and evolution of the Lost City hydrothermal chimneys [1].

[1] Ludwig, K. A., Kelley, D. S., Butterfield, D. A., Nelson, B. K., Früh-Green, G., (2006), *Geochimica et Cosmochimica Acta*, 70(14), 3625–3645.