Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.10627

Global constraints on modern and ancient mid-ocean hydrothermal metal fluxes to seawater

PROF. DREW D SYVERSON, PHD[1], DAPO NOAH AWOLAYO[2] AND BEN TUTOLO[2]

[1]UNC-Charlotte
[2]University of Calgary
Presenting Author: dsyverso@uncc.edu

High-temperature fluids circulating within the subseafloor at Earth's mid-ocean ridges (MOR) are responsible for metal fluxes to the global oceans and the formation of economically and geologically important seafloor massive sulfide deposits. Yet, our understanding of how secular changes in seawater geochemistry may have affected the proportion of metals fluxed into the global oceans versus those that deposited in the subsurface remains limited. Here, we place initial constraints on this metal partitioning using a comprehensive analysis constrained by a global dataset of end-member hydrothermal fluids sampled from a variety of modern basalt hosted MOR hydrothermal systems (Diehl and Bach, 2020). In this analysis, we applied Si-Cl geothermobarometer calculations constrained by SiO2 and Cl concentration data measured in vapor-phase hydrothermal fluids venting at high-temperatures (>300 °C, n = 185) to produce a first order estimate of the global distribution of pressure and temperatures conditions at the deep seated root zone within the modern subseafloor. These, in turn, provide the requisite constraints on the conditions under which hydrothermal fluids equilibrate with the subsurface lithology, and hence the maximum endowment of dissolved metals achieved prior to upflow and cooling. Mass balance calculations that account for the difference between these maximum root zone metal concentrations and those measured in the sampled high temperature fluids indicate that a significant degree of sulfide deposition occurs during upflow towards the seafloor-seawater interface. Sulfide mineral deposition effectively limits the flux of metals, such as Fe and Cu, to seawater in modern high-temperature MOR environments. However, calculations assuming a much lower dissolved SO_4 concentration in Archean seawater suggest much lower degrees of subseafloor sulfide precipitation, and, ultimately, higher fluxes of metals from Archean hydrothermal vent systems. Although they conflict with the interpretation of invariant rock-buffered hydrothermal systems over Earth's history, these modeling results are consistent with Archean sedimentary archives that indicate a significant flux of metals to seawater and the unique geometry of preserved Archean hydrothermal systems.