

Non-traditional Stable Isotope Systematics of Seafloor Hydrothermal Systems

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Seafloor hydrothermal activity at mid-ocean ridges is one of the fundamental processes controlling the chemistry of the oceans and the altered oceanic crust. Past studies have demonstrated the complexity and diversity of seafloor hydrothermal systems and have highlighted the importance of water-rock reactions and subsurface environments in controlling the composition of hydrothermal fluids and mineralization types. In addition, the far-field consequences of hydrothermal venting on deep oceanic metal reservoirs, in comparison to other marine sources, is just starting to be recognized.

Isotope ratios of various metals and metalloids, such as Fe, Cu, Zn, Ge, Se, Cd and Sb have recently provided new approaches for the study of seafloor hydrothermal systems. Here, I will present new results of non-traditional isotope systematics of seafloor hydrothermal systems, in particular:

(1) the mechanisms of metal isotope fractionation in hydrothermal chimney environments through paired isotopic analysis of mono-mineralic sulfides in contact with hydrothermal fluid;

(2) the controlling parameters of metal isotope signatures of hydrothermal vent fluids through the study of mid-oceanic and back-arc hydrothermal vent fields, spanning wide ranges of pH, temperature, metal concentrations and contributions of magmatic fluids enriched in SO₂.

(3) the potential role of high-temperature seafloor venting in affecting deep sea metal isotope composition through the investigation of metal isotope systematics in hydrothermal plume.

Ultimately, the use of complementary stable isotope systems should help identify the complex interactions between fluids, minerals, and potentially organisms in seafloor hydrothermal systems and constrain metal sources in marine environments.

Mineral and Melt Inclusion Geochemistry of the Nea Kameni Dacites, Santorini, Greece

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Since the voluminous 3.6 ka Minoan eruption, the Santorini volcano has been periodically erupting small volumes of dacitic magma forming the Kameni islands. This study focuses on variations in mineral geochemistry of lavas spanning from 46-47AD to 1950 to better understand the temporal evolution of silicic magmatism at the Santorini volcano. In addition to feldspar geochemistry, this study utilizes silicate melt inclusion analyses to document melt compositions associated with different feldspar populations. On a bulk level, the dacites of Nea Kameni have remained compositionally homogeneous while containing a mixture of mafic grains and crystal clots. The Kameni dacites contain two populations of feldspar, one An₃₈₋₆₅ interpreted as crystallising from the dacitic liquid and a second An₈₆₋₉₄ derived from a mafic magma. The two feldspar populations are distinct in terms of ⁸⁷Sr/⁸⁶Sr as determined via LA-ICPMS with the higher anorthite plagioclase having higher ⁸⁷Sr/⁸⁶Sr. The same two isotopic populations appear to be contributing to the Kameni magmatic system for the past 1900 years.

Analysis of glassy melt inclusions from the 1940 eruption preserve a similar bimodal distribution of glass compositions consistent with host compositions. Interestingly, despite their assumed cumulate nature, high-An feldspar retain euhedral, undegassed glassy melt inclusions. High-An plagioclase contain mafic melt inclusions whereas the lower An plagioclase contains melt inclusions more similar to the groundmass glass. Pre-eruptive volatiles (S, Cl, H₂O) are maintained in both populations of melt inclusions.

The ⁸⁷Sr/⁸⁶Sr data indicate that the dacitic magmas cannot represent fractionated equivalents of the mafic input to the Kameni system (similar to the Minoan eruption). The presence of abundant glassy clasts of dacite as lithics within the Minoan deposits suggests that prior to the last catastrophic eruption a similar period of relative quiescence may have occurred. Kameni-style volcanism may be a common occurrence at Santorini, just with low preservation potential.