Modeling the chemical evolution of an ultramafic oceanic hydrothermal system: Insights from reactive transport simulations

P. ALT-EPPING AND L.W. DIAMOND

Institute of Geological Sciences, RWI-Group, University of Bern, Baltzerstrasse 3, CH-3012, Bern, Switzerland, (alt-epping@geo.unibe.ch)

We use a loosely coupled reactive transport approach to simulate the chemical evolution of an ultramafic oceanic hydrothermal system. Changes in mineral alteration patterns and in the composition of the circulating hydrothermal fluid are investigated as spatially and temporally continuous profiles along the fluid's pathway. Our model represents a 1D trajectory of seawater infiltrating and reacting with peridotitic oceanic crust. The fluid travels at a fixed flow rate, it is heated to 400 ºC on its descent into the reaction zone and is cooled on its ascent back to the seafloor.

Fluid–rock interaction progressively modifies the primary mineralogy of the peridotite. The alteration of pyroxenes drives two changes that become increasingly prominent over time: 1) Silica is depleted from the rock. This is first apparent in the high-temperature reaction zone and then it gradually affects regions of lower temperature. It is manifested by the appearance of silica-depleted alteration phases such as brucite or (secondary) forsterite; (2) The redox buffering capacity of the rock is decreased. Owing to the continuous inflow of oxidized seawater and the concomitant mineral alteration reactions, sulfur as SO_4^{-2} and carbon as CO_2,aq can penetrate deeper into the oceanic crust. This causes previously formed magnetite to be replaced by hematite and pyrite along a redox front that migrates progres-sively deeper into the system over time. However, if sufficient Ca^{+2} is released from the rock during alteration, anhydrite may become saturated, such that anhydrite then controls the rate at which this redox front migrates into the crust.

These coupled, transient processes occurring deep within the hydrothermal system impart chemical fingerprints on the composition of the vent fluid and on the composition of chimney deposits at the seafloor. For instance, a lower redox buffering capacity of the rock at depth entails the partial redissolution of brucite and its subsequent replacement by calcite and aragonite in the chimney deposit. Examples of this type demonstrate that reactive transport simulations are useful in correlating observable changes in chemical parameters (i.e. the composition of the vent fluid or chimney deposit) with processes that occur in regions of the system that are not easily accessible by direct seafloor exploration.

Tracing migratory behavior of Ayu (*Plecoglossus altivelis*) using Sr isotopic composition of otolith

H. AMAKAWA[1]*, T. SUZUKI[1], T, TAKAHASHI[2], Y. TATSUMI[2] AND T. OTAKE[1]

[1]Ocean Research Institute, University of Tokyo, Japan (*correpondence: amakawah@ori.u-toyko.ac.jp)

[2]Institute for Research on Earth Evolution (IFREE), JAMSTEC

To reveal migratory behavior of diadromous fish is essential for both fish ecology and fisheries management. Ayu, which is endemic in Japan and East Asia, hatches in river and then migrate to coastal and estuary areas and finally migrate back to river. Although natal homing of Ayu has been a matter of debate, conventional methods have not been successful in verifying the natal homing. Recently, Sr isotopic composition of otolith, which is believed to reflect Sr isotopic composition of ambient water, has emerged as a novel and effective natural marker for studying migratory behavior of fish. Here, we apply Sr isotopic composition of otolith for revealing migratory behavior of Ayu.

We used Ayu samples collected from Nagara, Kushida, Miya and Unosumai rivers in Japan. The inner (marine living period) and outer (river living period) parts of otolith were sampled by either rustrum (a part of otolith formed during river living period) cut method or microdrilling method. The Sr isotopic compositions of otolith samples together with that of riverwaters samples were determined by TIMS.

The ranges of Sr isotopic composition of otolith and riverwater are 0.70631 ~ 0.71242 and 0.70609 ~ 0.71247, respectively. The correlation between the isotopic composition of otolith and that of riverwater are fairly well (r^2 = 0.966). Additionally, the inner parts formed during marine living period range 0.70918 ~ 0.70926, which are indistinguishable with the Sr isotopic composition of seawater (~ 0.71092). These facts imply that the otolith of Ayu faithfully records the Sr isotopic signal of ambient water and indicate the great potentiality for revealing natal homing of Ayu.