Suiyo hydrothermal system: implications from numerical simulations including precipitation of anhydrite

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The hydrothermal system at Suiyo seamount is different from those at mid-ocean ridges. For example, most fluids at the Suiyo hydrothermal system mainly comes from only a high temperature source. Moreover, the precipitation of anhydrite was found extensively from drilled cores at the active hydrothermal area. In addition, it is supposed that the shallow crust of Suiyo seamount has layerd structure.

We will show that the layerd crustal structure is important for the formation of anhydrite precipitation and the chemistry of the hydrothermal fluids.

We suppose that the crust is layerd, in which the permeability is large at the upper part and small at the lower part. We also suppose that lower heat source is localized. With these assumptions, the hydrothermal circulation has two scales: of volcano and of layerd structure. The former is heated from below, and it produces high-temperature Ca-rich fluid. The latter is affected by the layerd crustal structure, and it mainly consists of SO4-rich seawater. In this situation, the two fluids can mix and the precpiptation occurs. We focus on this mixing area.

We managed numerical simulations of fluid flow in the mixing area as a two-dimensional permeable flow, including the precipitation and dissolution of anhydrite. We also include the permeability change with the precipitation. High-temperature Ca-rich fluid comes from the bottom of the circulation, and low-temperature SO4-rich fluid flows from the seafloor. The precpiptation may occur when the two fluids mix. The fluids flow out from the seafloor.

We found that anhydrite precipitates near the boundary of the layerd structure, where low-temperature circulation forms in the upper layer and high temperature circulation occurs around it. The high temperature fluids are focused at the seafloor, vent without mixing with seawater because of the precipitation. These features are similar to the observed evidences of the Suiyo hydrothermal system.

This circulation structure is unstable when the precipitation is small or absent, but it tend to become stable as the mineral precipitates. The stable structure forms within about 20 years, when the permeability of the upper layer is of 4x10^12 m^2.