

海洋地殻内流体の熱水循環に伴う物質フラックス

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Geochemical Fluxes of Hydrothermal Fluid Circulation within Oceanic Crust

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Abstract

The recent Ocean Drilling Program (ODP) and submersible studies have verified the importance of fluid circulation below the seafloor and exchanges of water between the crust and the oceans. Heat flow data indicate the important contribution of low-temperature hydrothermal systems on ridge flanks, which transport more than 70% of global convection heat loss (= hydrothermal flux) from the seafloor. Global water mass flux of hydrothermal fluid on ridge flanks is estimated to be 4.8×10^{15} kg/year, which is much larger than the high-temperature hydrothermal fluid flux on the ridge axis.

Chemical exchanges between oceanic crust and oceans through low-temperature hydrothermal processes on ridge flanks are important in the context of global geochemical budgets. The first opportunity to collect samples of formation fluid circulating within the oceanic crust was provided by the discovery of low-temperature hydrothermal fluid emanating from an outcrop located at the 3.5 Ma ridge flank of the Juan de Fuca Ridge. Drilling into basement oceanic crust and deploying Circulation Obviation Retrofit Kit (CORK) facilities on the drilled holes provided another opportunity for directly sampling formation fluid. Based on the database of the chemical composition of these fluids, coupled with the estimated global water mass flux through the ridge flank region, global geochemical fluxes can be calculated. An alternative estimation can be obtained by a mass balance calculation between the chemical composition of altered and unaltered oceanic crust samples obtained by ODP drillings. Both estimations demonstrate that uptake of Mg, K, Li, Rb, and C from seawater and addition of Ca, Si, Mn, and other metals to seawater contribute to globally significant geochemical fluxes. Hydrothermal processes at the ridge flank region enhance axial fluxes of some elements, but offset and cancel the axial fluxes of others, which is comparable to riverine inputs into the oceans for some chemical species.

Hydrothermal fluid circulation at the ridge flank region represents a habitat that could potentially host a significant and unique subseafloor biosphere. Microbial activities in the deep sediment layer may be stimulated by the upward diffusion of formation fluid from the underlying basement. Several microbiological studies provide evidence for a unique microbial community within the subseafloor basement.

Key words : hydrothermal system on ridge flank region, geochemical balance of the ocean, global geochemical flux, hydrothermal alteration, subseafloor biosphere

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