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地球化学的手法による熱水活動変遷の解析

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Geochemical and Geochronological Studies on the Evolution of Submarine Hydrothermal Systems

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Abstract

As our understanding of seafloor hydrothermal systems grows, we recognize they are not always stable and sometimes show dramatic changes. In this review, the authors present a compilation of geochemical and geochronological studies that are helpful when investigating the evolving processes of submarine hydrothermal systems.

Chapter II describes the systematics and methodology of three dating techniques with discussions on their application to minerals formed by seafloor hydrothermal activities. The K-Ar (Ar-Ar) technique is popular for dating igneous rocks, but it is not appropriate for dating hydrothermal minerals because potassium is a trace component of sulfide/sulfate minerals. Following recent progress, micro-analytical techniques applying laser fusion are applicable for dating fluid inclusions and/or hydrothermal alteration minerals, which could provide important geochronological information. Uranium and thorium series disequilibrium dating have been employed for previous geochronological studies of hydrothermal minerals obtained from submarine ore deposits. To cover a wide time range, it is necessary to use various combinations of parent and daughter nuclides. Applying ESR dating to hydrothermal minerals is a rather new challenge. Although it needs several investigations to establish the methodology, it could be a useful rapid dating technique for a time range of less than one thousand years.

Chapter III introduces studies focusing on the evolution of seafloor hydrothermal activities over a short time scale (one week to a few years). Detection of event plumes associated with seafloor lava eruption brought an awareness of episodic hydrothermal activity triggered by magmatic perturbation. Subsequent dive studies revealed evolving geochemical processes, such as major changes of volatiles and elemental species concentrations of venting fluid. With remote real-time monitoring of acoustic T-waves generated by seafloor seismic activities, event detection

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and response cruises have been conducted successfully to investigate various evolving processes in more detail.

Chapter IV introduces studies focusing on the evolution of seafloor hydrothermal activities over a long time scale (tens of thousands of years). Radiometric dating studies of hydrothermal minerals such as sulfide and manganese oxide collected from the TAG mound, which is one of the largest hydrothermal mound structures, reveal an age distribution over at least 15000 years separated by quiescent intervals lasting up to 2000 years. On slow spreading ridges such as the Mid-Atlantic ridge, major fracture systems focus the hydrothermal discharge at one place for more than one thousand years with repeated reactivation.

In Chapter V, the authors discuss the direction of future studies. Although hydrothermal systems on mid-oceanic ridges have been well studied, those related to arc-backarc magmatic activities could provide more appropriate fields for studying the evolutionary process of submarine hydrothermal systems. Combining geochronological studies with geochemical and mineralogical studies would be important for reconstructing the evolution process in more detail.

Key words：age dating techniques, magmatic perturbation, event plume, hydrothermal mound, submarine ore deposits
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