



## **Metallogenic and geobiologic outputs thorough seafloor hydrothermal systems related with Izu-Bonin Mariana arc-backarc magmatism**

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### *1. Hydrothermal activities related with arc-backarc magmatism*

Several present and past seafloor hydrothermal activities have been located along Izu-Bonin Mariana region. It is quite reasonable to expect hydrothermal activity at the magmatic centers in arc-backarc systems. Rifting of an island-arc or continental crust is likely to provide a favorable setting for circulation of sea water. An arc submarine volcano often has a shallow magma chamber which act as a heat source. This combination would provide an ideal structure for hydrothermal system to focus fluid venting at the summit.

Seafloor hydrothermal system plays an important role in geochemical cycling of the elements through the seafloor. During circulation through the crust by thermally driven convection, seawater reacts with the crust weathering and metamorphosing it, and eventually evolves as hydrothermal fluid. The ascending fluid transports chemical species to the seafloor, which are leached from surrounding rocks or supplied from the magma. On the seafloor, the fluid precipitates hydrothermal deposits including abundant metal-rich sulfide minerals as a result of drastic change of temperature and chemical condition due to mixing with cold seawater. The hot-spring water gives rise to buoyant plumes that rise hundreds of meters into the water column and spread laterally transporting dissolved and particulate chemical species into the ocean.

Another important function of seafloor hydrothermal system is to provide reduced chemical species which is utilized as metabolic energy source for microbial chemosynthesis. The chemosynthetic organisms are basis of food webs of macrofaunal communities that populates the fluid ventings. Along hydrothermal fluid circulation, heat energy is transformed into chemical energy, which supports the biosphere on and beneath the seafloor. Metallogenic and geobiologic outputs thorough hydrothermal systems are sparkling residue stuck to a cooking pot in the subduction factory.

### *2. Wide variations in hydrothermal deposits along IBM*

The hydrothermal systems along IBM arc-backarc system appears to have wide variations in mode of occurrence, reflecting diversity in magma composition (acidic to basic) and in tectonic setting (backarc spreading, backarc rifting, volcanic front). Vigorous venting of high temperature fluid around 300 C was observed at two arc volcanoes in Izu-Bonin arc, Suiyo Seamount and Myojin Knoll. Both hydrothermal activities accompany abundant sulfide-sulfate deposits, which are modern analogue of Kuroko mineralization. Active high temperature systems on the spreading center of Mariana Trough show rather similarities to those in mid-oceanic ridge. In some seafloor calderas on Izu-Bonin arc front, records of past high-temperature activity was located. Low temperature emanation of acidic fluid

was found at the central cone of Kaikata caldera on Izu-Bonin arc front, which would be considered as low sulfidation system. In backarc rift setting, fossil barite-silica chimneys with thin manganese - oxyhydroxide coating was discovered in Sumisu rift. Widespread distribution of hydrothermal manganese is notable, not only among the recent arc front, but also in some past submarine volcanoes. A porphyry copper-type hydrothermal activity was recently reported as associated with back-arc volcanism in Izu-Bonin arc system.

Although these wide variety, a common key factor distinguish IBM hydrothermal systems from those in mid-oceanic ridge. Magmatic contribution strongly affects mode of occurrence of the hydrothermal systems in arc-backarc setting. Shallow magma chamber beneath the seafloor limits size of fluid circulation cell. Involvement of magmatic volatiles into the fluid controls fluid chemistry more acidic and oxic, and might promote chemosynthesis based on reducing species supply. Moreover, sporadic magma generation causes efficient concentration of metallogenic and geobiologic outputs on a small area within the volcanic edifice.

### *3. Present and future studies on IBM hydrothermal activities*

Investigation of seafloor hydrothermal systems has been led by energetic efforts of submersible dive programs in the past decades. Although the submersible investigation is essential to access hydrothermal field distributed within a narrow area, it has limitation that can survey only on the seafloor. In order to reveal the relationship between hydrothermal outputs and IBM magmatic activity, we need to access the region beneath the seafloor by drilling. Since hydrothermal interaction occur between the seafloor and the top of magma, only short intrusion of drilling would be useful for our purpose.

Archaean Project since 2000 is the interdisciplinary project among geophysics, geochemistry, microbiology, and geology. The project conducted drilling programs and submersible surveys including direct sampling, monitoring, and in-situ incubation, within Suiyo Seamount hydrothermal system. This is the first attempt to study the insight of hydrothermal activities by combination of these different devices. Results from the project are expected to provide new information about linkage between various processes in the subduction factory and the biosphere.