

The structure of iron- and silica-rich mounds at hydrothermal environment in shallow marine, Satsuma Iwo-Jima

KURATOMI, Takashi^{1*}; KIYOKAWA, Shoichi¹; IKEHARA, Minoru²; GOTO, Shusaku³; HOSHINO, Tatsuhiko⁴; IKEGAMI, Fumihiko¹; MINOWA, Yuto¹

¹Kyushu University, ²Center for Advanced Marine Core Research, Kochi University, ³Geological Survey of Japan, AIST, ⁴Japan Agency for Marine-Earth Science and Technology

Satsuma Iwo-Jima Island, located 38km south of Kyusyu, Japan, is a volcanic island in the northwestern rim of Kikai caldera. Iron- and silica-rich mounds develop with hydrothermal activity (pH=5.5, 50-60 degree Celsius) in Nagahama bay located south-western part of the island. The brownish seawater at the bay is due to mixing of the hot spring water with seawater (Shikaura and Tazaki, 2001). Very high deposition rate (33 cm per year) of iron-rich sediments was observed in the bay (Kiyokawa et al., 2012). In this study, we analyzed samples (20-30 cm long) recovered from mounds at the seafloor of Nagahama bay by the observation with X-ray CT scan, FE-SEM, and the thin-sectioned sample, and the chemical analysis with EDS, XRF, XRD and DNA, and found that the structure of mounds has unique information.

Visual observation indicated that the samples were made from two layer: black high-density hard layer and brownish low-density soft layer. X-ray CT scan observation shows that the inside of samples is constructed from the aggregation of convex structure (3-4 cm). Soft layer is covered by a hard layer as a rim. The soft layer has many pipe-like structures (typical radius: 1 mm). Petrographic observations indicate that soft and hard layers have filament-like forms, and the form in soft layer is perpendicular to that in the hard layer. The number of small particles (about 20 μm) observed on filament-like forms in soft layer increases toward hard layer. FE-SEM observation shows that filament-like form in hard layer consists of aggregation of bacillus-like form as the chain of particle (about 2 μm). At soft layer, on the other hand, bacteria-like form with smaller particles (<0.5 μm) is observed. Bacteria-like form could be classified into 3 types (helix, ribbon-like, twisted). Furthermore, the result of XRD and XRF show that hard layer consists of ferrihydrite and opal-A (Si: 26.8%, Fe: 56.0%) and soft one is composed by ferrihydrite, opal-A, quartz, cristobalite and tridimite (Si: 36.5%, Fe: 43.5%). DNA analysis indicated predominance of *Mariiprofundus ferrooxydans* that is known as iron-oxidizing bacteria belonging to Zeta-proteobacteria.

The forming process of the mounds at Nagahama bay is that firstly chemical and biological reaction made soft layer. During occurrence of the reaction, volcanic ash originating from Iwo-dake was contained as silica in the soft layer. Bacteria-like form in soft layer is considered to be the stalk made by iron-oxidizing bacteria according to the result of DNA analysis. Such neutrophilic iron-oxidizing bacteria prefers an environment of redox interface between hydrothermal water and seawater (Chan et al., 2011), and their activity made hard rim at outer soft layer. Inside of hard rim, the keeping of both reaction resulted in relative iron-rich layer and layering at hard rim. Because such process occurred repeatedly, the mounds at Nagahama bay had the aggregation of convex structure with many pipes as the hydrothermal vent. The high depositional rate of iron hydroxides is likely to be influenced by the activity of bacteria.

Keywords: hydrothermal activity, iron-hydroxide, iron-oxidizing bacteria, shallow marine