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The structure of iron oxidized mounds at shallow marine hydrothermal environment in Satsuma Iwo-jima Island, Kagoshima

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Satsuma Iwo-Jima, located 38km south of Kyusyu Island, Japan, is a volcanic island in the northwestern rim of Kikai caldera. Here is preserved and identified on occurring iron precipitation at shallow ocean where can be recorded modern analogy of iron precipitation and sedimentation. Iron oxidized mounds are developing at seafloor with hydrothermal activity (pH=5.5, 50-60 degree Celsius), and there is high deposition rate of iron-oxides (33 cm/year: Kiyokawa et al., 2012).

Result of sea sonar scan seismic images shows that the iron oxidized mounds in Nagahama bay are estimated about 7.8 m^3 in volume, which formed 2-3 thick mound at 32.68 m^2 area for 20 years. Each mound is formed two layers: blackish hard layer and brownish soft layer. The inside of samples is constructed from the aggregation of convex structure (3-4 cm) covered by hard layers as a rim. Petrographic observations indicate that both layers have filament-like forms, and the form in soft layer is perpendicular to that in the hard layer. The number of iron oxides particles observed on filament-like forms in soft layer increases toward hard layer. Hard layer consists of aggregation of bacillus-like form as the chain of particle (about 2 um). At soft layer, on the other hand, bacteria-like form with smaller particles ($<$0.5 um) is observed. Bacteria-like form could be classified into 3 types (helix, ribbon-like, twisted). Furthermore, hard layers consist of ferrihydrite and opal-A (Si: 26.8%, Fe: 56.0%) and soft one is composed by ferrihydrite, opal-A and silica mineral (Si: 36.5%, Fe: 43.5%). *Mariprofundus ferrooxydans* known as iron-oxidizing bacteria belonging to Zeta-proteobacteria identified in this matter, but they are nothing at floating iron oxide samples.

The process of forming iron oxidized mounds: 1. Soft layers were made by chemical and biological activity. The filament-like forms at soft layer is the stalks of iron oxidizing bacteria. 2. The hard layers were made by adsorption of iron oxyhydroxide around stalks. Iron oxidizing bacteria is prefer to the redox interface (Chan et al., 2011) such as the mixing zone located in hard layer between hydrothermal fluid and seawater. 3. Hydrothermal activity form the liner structure at hard layer. Iron oxidized mounds were formed by repeating of those process over ten times.

Based on the seismic data, the forming rate of iron oxidized mounds is about over 1.2 cm/yr. Formation of hard layers in these mound is the result of adsorption of iron oxyhydroxide around stalks made by the activity of iron oxidizing bacteria. The iron providing rate ($2.474*10^6$ kg(Fe)/m.y./m^2) from the Nagahama bay iron mounds is as about ten times as that of the Hamasley Group sediment ($2.51*10^5$ kg(Fe)/m.y./m^2). Furthermore, if there is the Nagahama bay iron oxidized mounds at Archean, $6.0*10^8$ times of these mounds need to form the Joffre Member volume (360 m/2m.y.). In this study, we strongly suggest that the combination of chemical and biological reaction is important system to form large amount of iron oxide deposit.

Keywords: iron oxidizing bacteria, hydrothermal fluid, iron oxide, satsuma iwo jima, biomineralization