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Depositional process of Fe-Mn oxide minerals at an active submarine volcano, in the Izu-Bonin Arc

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Ferromangaese crusts (hereafter called Fe-Mn crusts) consist mainly of Fe and Mn oxides and often cover the hard-rock substrates on the flank and summit of seamounts. Because of a very slow rate of growth (<1-15mm/m.y.), Fe-Mn crusts are considered as condensed stratigraphic record of oceanographic and geologic conditions of the surrounding environment during accretion of the successive laminae at the seafloor (Hein et al., 1992). Even though Fe-Mn crusts form basically by hydrogenetic precipitation, the exact mechanisms of growth and metal enrichments are poorly understood.

We carried out an experimental approach to investigate on-site metal-oxide precipitation on artificial substrates. Mn-free (plastic, glass, ceramic) substrates were deployed for 12 years on the Bayonaise Knoll of a possible hydrothermal area in the Izu-Bonin arc, at depths of 918-920 m. The mineralogical and chemical characrerization to the experimental surfaces were documented by field emission scanning electron microscopy (FE-SEM) and energy dispersive X-ray spectroscopy (EDS).

FE-SEM observations of the surfaces revealed the presence of ball-, doughnut- and rod- shaped structure contain substantial amount of Fe-Mn oxides. These size and shape of the precipitates looks like microorganisms or bacterial mats. The average growth rate of the objects is calculated ave. 0.05-2.79 mm/m.y. The X-ray element mapping of the precipitate showed Mn-Fe enrichment with Si and Ca (without sediments or calcareous planktons) and may be associated with coprecipitation.

This finding was the first evidence of modern active precipitation of initial Fe-Mn oxides from hydrothermal/ normal sea waters in the ocean floors. The Fe-Mn oxides are probably hydrogenetic precipitate of ferruginous vernadite, a major constituent of Fe-Mn crusts. Ferruginous vernadite is the only one major iron-hosting marine authigenic manganese mineral (Usui & Terashima, 1997) and is characterized by low crystallinity caused by randomly-stacked sheets of manganese and iron hydroxides (Ostwarld, 1984). Thus, our data suggests that the precipitation initiates from the formation of Fe-Mn oxide even in hydrothermal areas.

Keywords: ferromanganese crust, low-temperature hydrothermal activity, bayonaise knoll, manganese mineral, vernadite, biomineralization