

Elucidation of the growth history of Fe-Mn nodules in the western North Pacific Ocean using X-ray CT and elemental mapping

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In recent years, densely distributed Fe-Mn nodules were discovered in the Japanese Exclusive Economic Zone (EEZ) around Minamitorishima Island in the western North Pacific Ocean [1]. Previous study revealed that the nodules contain Co and Ni up to 0.65% and 0.8%, respectively, and their geochemical features indicate that they are mainly of hydrogenous origin [1]. In this study, to elucidate their genesis and growth history, we focus on the internal structures of the oxide layers and nuclei of the Fe-Mn nodules using X-ray CT.

On the basis of the X-ray absorption coefficients, we found out that the nodules have up to five different oxide layers. The X-ray absorption coefficients corresponds to both the growth textures and chemical compositions of the oxide layers. Moreover, several peaks appeared in the histograms of the total oxide thickness, which clearly corresponds to the numbers of the oxide layers. This suggests that formations of the Fe-Mn nodules in the Minamitorishima EEZ occurred intensively during certain periods.

We also characterized the nuclei of the nodules. Due to the difference in the shape and the X-ray absorption coefficients, we classified the nuclei of the nodules into four types. Comparison with XRF mapping analysis and ICP-MS measurement of the nuclei revealed that consolidated pelagic clay is the majority of the nuclei of the nodules in the Minamitorishima EEZ.

Consequently, our results imply that a large quantity of lumps of pelagic clay occurred on the seafloor at the timing of change of the oxide layers. It is conceivable that an intensification of deep-sea current eroded the surface sediment and exposed lumps of pelagic clay onto the seafloor, which triggered the formation of the Fe-Mn nodules in the Minamitorishima EEZ.

[1] Machida et al. (2016) *Geochemical Journal*, 50, 539–555.