Origin and significance of Neogene Mn ores in the Hokuroku district, Japan

YUYA TSUKAMOTO[1*], TAKESHI KAKEGAWA[1]

[1]Department of Earth Science, Tohoku University, Sendai, Japan
(*correspondance:yuya.tsukamoto.q5@dc.tohoku.ac.jp)

Mn ores are present in ca. 12 Ma volcanic and sedimentary rocks in the Hokuroku district of Akita, Japan. It is important to constrain their origin to understand long-trem submarine hydrothermal history at the bottom of Neogene Japan sea. Therefore, in the present study, geological, mineralogical, geochemical studies are performed on Mn ores and associated rocks in the Hokuroku district.

X-ray diffraction and Raman spectroscopic analyses identified MnOOH as a major mineral in examined ore samples. Besides todorokite, hausmannite and more than 10 kinds of Mn minerals are present. These ores are not coexisted with Fe minerals.

Detailed geological survey revealed that host and foot wall rocks of Mn ores were intensively altered. These alteration profiles represent pathways of submarine hydrothermal circulation beneath the contemporary ocean floor. Multiple hydrothermal circulation initially leached and enriched Mn locally in sub-seafloor tuff. Those Mn were further remobilized by later hydrothermal circulation initiated by dolerite intrusion. During later hydrothermal circulation, Fe in hydrothermal fluids were precipitated as hematite at depth, yielding relative enrichment of Mn in fluids. Such Fe segrigation represents evolution of redox conditions while submarine hydrothermal fluids were migrating in sub-seafloor rocks. Most Mn ores were formed in sub-seafoor porous tuff as disseminated ores by interacting oxic seawater. Discahrged fluids on seafloor also precipitated Mn ores. Such Mn ores often show banded and colloform textures associated with reduced carbon. This implies that a part of Mn oxides were formed by microbial processes.

Chlorite geothermometer and general mineral assembladges suggest that temperature of the Mn-rich hydrothemrmal fluids were not high enough to generate sulfidic “black smoker.” Such hydrothermal process is different from deep hydrotehrmal circulation model for 15 Ma Kuroko genesis. Bimodal volcanic activities, which succeeded from Kuroko age, are important to form Mn ores in the Hokuroku district, although formation model of Mn ores have many differences with those of Kuroko ores.