

沖縄トラフ海底熱水鉱床試料の岩石磁気測定

Rock-magnetic studies on seafloor hydrothermal deposits in the Okinawa Trough

*加藤 千恵¹、大野 正夫¹、畠山 唯達²、石橋 純一郎³、戸塚 修平⁴、島田 和彦³

*Chie Kato¹, Masao Ohno¹, Tadahiro Hatakeyama², Jun-ichiro Ishibashi³, Shuhei Totsuka⁴, Kazuhiko Shimada³

1. 九州大学大学院比較社会文化研究院環境変動部門、2. 岡山理科大学情報処理センター、3. 九州大学大学院理学研究院地球惑星科学部門、4. 九州大学大学院理学府地球惑星科学専攻

1. Department of Environmental Changes, Faculty of Social and Cultural Studies, Kyushu University, 2. Information Processing Center, Okayama University of Science, 3. Department of Earth and Planetary Sciences, Faculty of Science, Kyushu University, 4. Department of Earth and Planetary Sciences, Graduate School of Sciences, Kyushu University

Investigation of the mineral assemblage of seafloor hydrothermal deposits are crucial for understanding its formation environment and process. Rock-magnetic measurements of the deposits are quick and effective to detect magnetic metal sulfides which are sensitive to the environment. We report our results of rock-magnetic measurements conducted on sulfide ores from seafloor hydrothermal deposits in the Okinawa Trough. One sample is a sulfide ore of chimney structure collected from hydrothermal mound in the Noho Site and others are sediment core samples drilled at the Izena Hole.

X-ray diffraction (XRD) measurements and chemical analyses indicate that the chimney structured ore mainly consist of pyrrhotite and a Cu-Fe-S sulfide. Crystal structure of the Cu-Fe-S sulfide is similar to that of sphalerite and its chemical composition is close to CuFe_2S_3 . From these characters, CuFe_2S_3 isocubanite is the candidate for the Cu-Fe-S sulfide.

Since the magnetic properties of CuFe_2S_3 isocubanite were rarely found in the literature, we first conducted low-temperature magnetometry measurements and magnetic hysteresis measurements of isocubanite. Isocubanite was synthesized by heating a cubanite sample (from Henderson No.2 mine, Chibougaman, Qubec, Canada) at 300 °C in vacuum (e.g. Sawada et al., 1962; Nenasheva and Kravchenko, 2015). Results of the magnetic measurements showed that isocubanite is weakly ferromagnetic at room temperature, and undergo a magnetic transition to relatively strong ferromagnetic at ~100 K. Saturation magnetization was 0.09 Am^2/kg at room temperature and 0.4 Am^2/kg at 50 K. Similar magnetic measurements were performed on the Cu-Fe-S sulfide in the chimney ore which was magnetically separated from pyrrhotite. The Cu-Fe-S sulfide was paramagnetic at room temperature and became ferromagnetic at below ~100 K. Saturation magnetization at 50 K was ~20 Am^2/kg . Such strong magnetization and sharp magnetic transition at low temperature is inconsistent with the behavior of isocubanite, but rather comparable to that of $\text{Cu}_{1-\epsilon}\text{Fe}_{3+\epsilon}\text{S}_4$ 'new phase' reported by Wintenberger et al. (1994) as an ageing product of isocubanite. Results of our magnetic measurements indicate that 'new phase' is a solid solution which includes CuFe_2S_3 composition.

Some of the sediment core samples contain a Cu-Fe-S sulfide with similar XRD pattern and chemical composition to that found in the chimney ore. Those sediment core samples also show a magnetic transition at ~100 K. Intensity of the magnetization at low temperature could be explained by assuming that the Cu-Fe-S sulfide in the sediment core samples is isocubanite, based on rough estimate of mineral proportion from XRD.

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