

## 粘土鉱物の酸素同位体比温度計：沖縄トラフ伊平屋北海丘熱水域の海底下の熱水変質帯への応用

## Application of oxygen isotope geothermometry to hydrothermal alteration in the Iheya North field, Okinawa Trough

三好 陽子<sup>1\*</sup>, 石橋 純一郎<sup>1</sup>, ケビン・フォーレ<sup>2</sup>  
Youko Miyoshi<sup>1\*</sup>, Jun-ichiro Ishibashi<sup>1</sup>, Kevin Faure<sup>2</sup>

<sup>1</sup>九州大学大学院理学府地球惑星科学専攻, <sup>2</sup>GNSサイエンス, ニュージーランド

<sup>1</sup>Department of Earth and Planetary Sciences, Graduate School of Sciences, Kyushu University, <sup>2</sup>Division of Geological Resources, GNS Science, Lower Hutt, New Zealand

Oxygen isotope values of clay minerals enable estimation of their formation temperature, based on the temperature dependence of oxygen isotope equilibrium between clay minerals and water. We measured oxygen isotope values of hydrothermal clay minerals in sediment from the Iheya North Knoll hydrothermal field in the Okinawa Trough. The sediment was obtained by seafloor drilling during the Integrated Ocean Drilling Program (IODP) Expedition 311. Five sites were drilled during the expedition: on a hydrothermal mound at the center of the activity (Site C0016); at 600 m northwest of the mound (Site C0015); at 100 m east of the mound (Site C0013); at 450 m east of the mound (Site C0014) and; at 1550 m east of the mound (Site C0017). We investigated temperature conditions of hydrothermal alteration below the seafloor of the Iheya North field by applying oxygen isotope geothermometry.

Silt (2-63 micrometer) and clay (<2 micrometer) fractions were separated according to Stokes' law by settling powdered core sediment in a standing cylinder. Mineralogy of the bulk sediment and of the clay fraction was determined by X-ray diffraction. Chemical composition of some clay minerals in the clay fraction was determined by transmission electron microscopy (TEM-EDS). Oxygen isotope values of representative clay fraction samples were determined at GNS Science in New Zealand. For measurement of oxygen isotope values, oxygen was extracted from the clay fraction samples using a CO<sub>2</sub>-laser and BrF<sub>5</sub> following the method of Sharp (1990). Prior to isotope measurement, free Fe-oxides were removed following Mehra and Jackson (1960). Where two dominant clay minerals were identified in a clay fraction sample, their abundance ratio was estimated on the chemical composition of the clay fraction determined by EPMA analysis.

Occurrence of hydrothermal clay minerals at the Iheya North field was classified into three hydrothermal alteration zones with increasing depth, based on the clay mineral assemblages; kaolinite and montmorillonite alteration zone (Zone 1); Mg-rich chlorite and Mg-rich chlorite-smectite mixed layer mineral alteration zone (Zone 2); and sericite and Mg-rich chlorite alteration zone (Zone 3) at Site C0013. Hydrothermal clay mineral assemblages at Sites C0014 and C0016 are similar to those at Site C0013.

The oxygen isotope value of smectite in Zone 1 at Site C0013 had a value of +11.4 per mil (VSMOW). Its formation temperature was estimated to range between 130 - 160 °C, assuming a value from 0 to +1.5 per mil for the oxygen isotope value of water in equilibrium with the mineral. The oxygen isotope values of the Mg-rich chlorite in Zone 2 and the sericite in Zone 3 at Site C0013 range from +1.6 to +3.3 per mil and their formation temperatures were estimated to be > 220 °C. Formation temperatures of the clay minerals at Sites C0014 and C0016 were comparable to those found in the same alteration zones at Site C0013.

This study revealed a layered structure of the hydrothermal alteration zones below the seafloor at a distance of up to 450 m from the hydrothermal mound at the Iheya North field. In addition to different clay mineral assemblage found in each hydrothermal alteration zone, the estimated formation temperatures showed a large gap between Zone 1 and Zones 2 and 3.

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