

MIS022-P06

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## Distribution of hydrothermal clay minerals in cores obtained by IODP Exp.311 from the Iheya North Knoll, Okinawa Trough

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An active hydrothermal field at the Iheya North Knoll, Okinawa Trough, was the subject of detailed investigations during the Integrated Ocean Drilling Program (IODP) Expedition 311, conducted in September, 2010. Five sites were drilled during the expedition: the active hydrothermal mound (Site C0016), 600 m northwest of the mound (Site C0015), 100 m east of the mound (Site C0013), 450 m east of the mound (Site C0014) and 1550 m east of the mound (Site C0017). Mineralogy and geochemistry of hydrothermal clay minerals of the core samples were studied in order to reveal physical and chemical condition below the seafloor based on their vertical and lateral distribution.

Grain size separation in silt (2-63 micrometer) and clay (<2 micrometer) fractions according to Stokes' law was performed by setting powdered core sediment in a standing cylinder. Mineralogy of the bulk sediment and of the clay fraction was determined by X-ray diffractometry (XRD). For the clay fraction, measurements were carried out on air-dried, ethylene glycol-saturated, HCl-treated and heated (200 - 300 degC) condition, in order to identify clay minerals. Morphology of the clay minerals was observed using transmission electron microscopy (TEM), at 200kV accelerating voltage in the Research Laboratory for High Voltage Electron Microscopy, Kyushu University. Chemical composition of the clay minerals was obtained in TEM observation using energy dispersive spectrometry (EDS).

Vertical distribution of clay minerals from site C0013 (100 m east of hydrothermal mound) was summarized followings, where dominant clay minerals were listed up.

UnitI (0 - 4.5~6.8 mbsf) : kaolinite, illite, pyrite and quartz from 1 mbsf; smectite, barite and sphalerite from 4.7 mbsf

UnitII (4.5~6.8 - 12 mbsf) : chlorite, chlorite-smectite mixed layer mineral, smectite, anhydrite, gypsum and pyrite

UnitIII (12 - 23 mbsf) : chlorite, anhydrite and pyrite

UnitIV (23 - 55 mbsf) : chlorite and quartz

Vertical distribution of clay minerals from site C0014 (450 m east of hydrothermal mound) was summarized as follows.

UnitI (0 - 12~16 mbsf) : quartz, muscovite and calcite dominantly; opaline silica, cristobalite, feldspar and chlorite (probably detrital) according to the onboard study

UnitII (12~16 - 29 mbsf) : kaolinite and smectite from 13 mbsf; smectite and cristobalite from 17-20 mbsf; illite-smectite mixed layer mineral and illite from 21-23 mbsf; chlorite and chlorite-smectite mixed layer mineral from 26-28 mbsf; quartz and pyrite

UnitIII (29 - 128 mbsf) : chlorite and illite; chlorite dominantly above 40 mbsf and illite dominantly below 40 mbsf; quartz and pyrite; anhydrite and gypsum from 65 mbsf

Diverse occurrence of clay minerals was notable in both Sites C0013 and C0014. The occurrence of clay minerals at the Iheya Knoll hydrothermal field is characterized by a systematic change with depths, from smectite near the seafloor, then mixed layer minerals, to chlorite and/or illite in the deeper portion. This change is likely to reflect an increase in temperature with depth. With analogical inference based on geothermal field studies, the temperature profile at Site C0014 is considered as 100 to 200 degC at 17 to 29 mbsf and > 200 degC below 29 mbsf. According to the onboard study report, measured temperatures at Site C0014 were 55 degC at 16 mbsf, 135~145 degC at 47 mbsf and > 210 degC at 50 mbsf. At Site C0013, the clay mineral change was observed at shallower depth (0 - 12 mbsf) than in Site C0014 and the dominant occurrence of chlorite below 12 mbsf indicates that temperature was > 200 degC. This vertical distribution is in accordance with larger temperature gradient in the vicinity of the center of the hydrothermal field.

Keywords: Iheya North Knoll Okinawa Trough, IODP Expedition 311, hydrothermal clay minerals, hydrothermal alteration, X-ray diffractometry (XRD), transmission electron microscopy (TEM)