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南海トラフに沈み込む海洋地殻最上部の岩相と水理特性
Lithology and fluid transport property of the topmost part of the oceanic crust subducting into the Nankai Trough

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Fluids in subduction plate boundaries play important roles for both mechanical and chemical aspects. Recently, oceanic crust has been recognized as a source of water along seismogenic subduction plate boundary (Kameda et al., 2011). For documenting hydration state of topmost part of subducting oceanic crust, we performed visual, optical and Electron Probe Micro Analyzer (EPMA) observations and powder X-ray Diffraction (XRD) analyses of basaltic rocks retrieved from the Site C0012 of Integrated Ocean Drilling Program (IODP) Expedition 333. We also measured porosity and permeability of samples selected from each lithology. We further interpreted Logging-while-drilling (LWD) data of Hole C0012H obtained during the IODP Expedition 338 to estimate the thickness of seafloor alteration.

The IODP Site C0012 is located at the top of Kashinozaki Knoll, tectonically uplifted topographic high on the Philippine Sea Plate coming into the Nankai Trough. Basaltic rocks in Holes C0012A, E, F, G occuring below 520 mbsf, are mainly composed of upper pillow basalts and lower massive basalts. The pattern of alteration is lithology-dependent: in pillow basalts, volcanic glasses and vesicles were replaced by clay minerals; while alteration of massive basalt showing doleritic texture is characterized by red-colored Fe-oxyhydroxide veins with alteration halos. Potassium-bearing alteration minerals (K-feldspar and celadonite) occur in places.

Permeability measurement of representative samples of each lithology was performed at JAMSTEC-Kochi, under the room temperature conditions with effective pressures of 5 to 120 MPa. Permeability was measured by using N2 gas as a pore fluid, and calculated by steady-state gas flow method. Gas permeability decreases with increasing effective pressures and pore pressures, following the Klinkenberg equation. Klinkenberg-corrected permeability of pillow basalt ranges 10-19 to 10-20 m2 at effective pressure of 5 MPa, while that of massive basalt ranges 10-17 to 10-19 m2. Permeability contrast between the two lithologies would reflect microtextural difference between two lithologies, because of the absence of significant difference in porosity.

LWD data of basaltic rocks were obtained from Hole C0012H of the IODP Expedition 338. Low resistivity and velocity intervals are corresponding to pillow basalts, whereas high resistivity and velocity intervals are corresponding to massive basalts. Contrastingly, gamma ray trend is independent from resistivity and velocity trends: positive at around lithological boundaries. Positive peaks of gamma ray would reflect potassium-bearing alteration caused by permeability contrast between each lithology. Below 680 mbsf, all logging data become constant and non-fluctuated, suggesting that lithology become homogeneous below this depth without strong alteration. Therefore the thickness of hydrated part of oceanic crust at Site C0012 is roughly estimated to be ~100 m.