Velocity gradient in the oceanic crust layer 3 based on seismic velocity of cores drilled from the Oman ophiolite

*Kohei Hatakeyama[1], Ikuo Katayama[1], Natsue Abe[2], Keishi Okazaki[3], Katsuyoshi Michibayashi[4], The Oman Drilling Project Science Party

1. Department of earth and planetary systems science, Hiroshima University , 2. Japan Agency for Marine-Earth Science and Technology, 3. Kochi Institute for Core Sample Research, Japan Agency for Marine-Earth Science and Technology, 4. Nagoya University

Seismic velocity of lower oceanic crust gently increases with the depth (seismic layer 3). Elastic wave velocity measurements of gabbro collected from ophiolite and ocean drilling suggest that velocity gradient of layer 3 is due to crack closure caused by increasing lithostatic pressure (Saito et al., 2015, Carlson and Miller, 2004). However, in the ophiolite stratigraphy, mineral assemblage of oceanic crust is heterogeneous, as the contents of olivine and pyroxene increase in the lower oceanic crust (Salisbury and Christensen, 1978; Christensen and Smewing, 1981). Therefore, it is necessary to consider the effect of crack closure and mineral assemblage with the depth of oceanic crust to understand velocity gradient of layer 3. In this study, the effects of pressure and mineral assemblage on elastic wave velocity of mafic rocks forming middle to lower oceanic crust drilled from the Oman ophiolite (Oman Drilling Project) were examined. Experimental samples were diabase and gabbro drilled from sheeted dyke-gabbro transition (Hole GT3A), foliated gabbro (Hole GT2A), layered gabbro (Hole GT1A) and crust-mantle transition (Hole CM1A). Modal analysis was performed on thin section. Intra-vessel deformation and fluid flow apparatus at Hiroshima University were used to measure elastic wave velocity under confining pressure. Elastic wave velocities (V_P and V_S) were measured from the pulse transmission method. After measurements under dry condition, measurements under wet conditions injecting pore water were performed. Pore pressure was set at 10 MPa using a syringe pump. In both experiments, confining pressure was up to 200 MPa. Experimental results showed increasing velocity with confining pressure, suggesting closing cracks. Under wet conditions, V_P of diabase increased relative to those determined under dry condition, indicating the effect of pore fluid. In contrast, the effect of pressure and pore fluid on velocity was weak in gabbro samples. We assumed that the pressure dependence of velocity is caused by closing cracks, and theoretical model of O’ Connell and Budiansky (1974) was applied to estimate crack density. Although crack density decreased with pressure, the pressure dependence of crack density was small under high pressure condition. The experimental results under high pressure were almost consistent with velocity calculated from modal composition, and samples of lower oceanic crust showed relatively high velocity. These results may reflect that the effect of mineral assemblage is predominant in the factor of velocity gradient of layer 3.

Keywords: Oman Drilling Project, Oceanic crust layer 3, Elastic wave velocity, Crack, Mineral assemblage

