Pressure dependence of elastic wave velocity in mafic rock cores collected from Oman Drilling Project Phase I

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Structure of oceanic crust is proposed based on ophiolite stratigraphy and seismic wave velocity structure (e.g., Christensen and Smewing, 1981: White et al., 1992). While rocks of deep oceanic crust have never been directly sampled by drilling in intact modern ocean crust, deep crust has recently been drilled in the Oman ophiolite interpreted as ancient oceanic crust (Oman Drilling Project). During Phase I, core samples were collected from lower crust section of the ophiolite (GT1: layered gabbro and GT2: foliated gabbro) and across the boundary between the sheeted dikes and gabbro (GT3). These core samples provide important information to understand oceanic crust structure. In this study, we measured elastic wave velocity of core samples under pressure conditions consistent with the thickness of oceanic crust, which we can use to infer seismic wave velocity structure of oceanic crust.
Based on physical property data measured on D/V Chikyu, we selected three or four experimental samples from each drilling hole, representative of the average P-wave velocity, density and porosity in each hole. Experimental samples from Hole GT1 and GT2 are mainly olivine gabbro with density and porosity of 2.9 to 3.0 g/cm^3, and approximately 0.5 %, respectively. Samples from Hole GT3 are mainly diabase and gabbro with density and porosity of 2.8 to 3.0 g/cm^3 and approximately 0.7 %, respectively. P-wave velocity anisotropy of each sample is lower than 3.5 %. Intra-vessel deformation and fluid flow apparatus at Hiroshima University are used to measure the elastic wave velocity under confining pressure. Elastic wave velocity was measured from the pulse transmission method, with the amplitude and the frequency of a trigger wave of 5 V and 2 MHz, respectively. 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 that approximately corresponds to a 6 km deep of oceanic crust.
Experimental results show that the elastic wave velocity (*Vp, Vs*) of olivine gabbro collected from Hole GT1 increases with increasing confining pressure from 5 to 200 MPa. *Vp* increases from 6.95 to 7.21 km/s and *Vs* increases from 3.86 to 3.92 km/s. Velocity under wet conditions is similar to that obtained under the dry conditions, suggesting that the influence of pore fluid for elastic wave velocity is very low due to low porosity. Our experimental results are consistent with the velocity of olivine gabbro collected from outcrops in the Oman ophiolite (Christensen and Smewing, 1981). We compare velocity structure inferred from our experimental results with that based on geological survey and discuss whether core samples from Oman are good analogue for modern oceanic crust.

Keywords: Oman Drilling Project, Seismic wave velocity structure, Oceanic crust, Elastic wave velocity, Pressure dependence, Mafic rocks

