Simultaneous measurements of resistivity, seismic velocity and porosity of mafic samples collected from the Oman ophiolite during hydrostatic compressional experiments

*tanimoto kazumasa[1], Yuya Akamatsu[1], Ikuo Katayama[1]

1. Hiroshima University

Geophysical observations indicates that the oceanic crust is divided into layer2 and 3, in which layer2 is characterized by remarkable increase of seismic velocity and resistivity in contrast to a nearly constant at layer 3 (e.g., Detrick et al 1994). This transition is located at around ~1.2 km, which is likely caused by the change of crack density, geometry and connectivity. In this study, we performed simultaneous measurements of seismic velocity, resistivity and porosity during high pressure experiments using crustal samples collected from the Oman ophiolite. We apply the effective medium theory and percolation model to the experimental results and discuss how these physical properties are influenced by crack networks to understand the origin of layer 2/3 transition.

The samples used in this study were basalt (1 samples) and diabase (3 samples) collected from the Oman ophiolite. We developed simultaneous measurement system of seismic velocity, resistivity and porosity under hydrostatic pressure in our laboratory. Seismic velocity, resistivity and porosity were measured under confining pressure up to 200 MPa and pore pressure fixed at 1 MPa using NaCl solution. Electrical resistivity was calculated from the impedance and phase difference between current and voltage that were obtained by two terminal method, and seismic velocities (Vp, Vs) were measured by a pulse transmission method using piezoelectric transducers with a resonant frequency of 2 MHz. Porosity was calculated by initial porosity measured by pycnometer before compaction, and volume change of pore fluid after compaction using a syringe pump.

Experimental results show that seismic velocity and resistivity increase systematically with confining pressure in all samples. The change of seismic velocity and resistivity are both sensitive to the presence of thin crack with a small aspect ratio. The systematic increases of velocity and resistivity is likely related to closure of the thin crack. In contrast, porosity was remained even at 200 MPa in basaltic sample, which is likely due to the presence of equant pore with a large aspect ratio. By applying the effective medium theory and percolation model to these experimental results, the relationship between seismic velocity and resistivity is explained by carack density, geometry and connectivity. We applied these models to the geophysical data obtained at the DSDP 504B site in the East Pacific Ocean, and found that (1) layer 2/3 transition caused by decreasing crack density, (2) a constant resistivity at the shallow part of layer 2 is due to high crack connectivity, although resistivity increases below the certain threshold.

Keywords: Oceanic crust, Layer 2/3, Electrical resistivity, Seismic structure, Crack properties

