Relationship between electrical resistivity and seismic velocity of crustal rocks from the Oman Drilling Project Hole GT3A: Implications for in situ geophysical properties of oceanic crust

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Geophysical properties of oceanic crust are strongly influenced by the presence of fluid-filled cracks. In order to quantitatively interpret the geophysical data and understand fluid behavior in the oceanic crust, laboratory measurements on rock's physical properties are essential. In this study, we measured the electrical resistivity and elastic wave velocity of oceanic crustal rocks collected from drillcores of the Oman ophiolite, in which tectonic fragments of ancient oceanic plate are preserved on land. The measurements were performed under dry and brine-water-saturated conditions using discrete cubic samples that were taken from the drilled cores. The experimental results reveal that the gabbro sequence shows relatively higher electrical resistivity and elastic wave velocity compared with the sheeted dike complex. Application of effective medium theory to the measured velocities suggests that the aspect ratio of cracks decreases across the dike–gabbro transition, whereas the crack density is less sensitive to variations in lithologic sequence. Electrical resistivity changes markedly at low crack densities, possibly reflecting percolation of fluids through the crack network. Applying a crack fluid flow model based on percolation theory, variation in the measured conductivity is related to crack density and aspect ratio inferred from the measured velocities. To attempt to interpret in situ geophysical data in oceanic crust, we applied the cross-property relationship establiedh by our laboratory measurements to geophysical properties obtained by logging measurements at IODP Hole 1256D. Results show that electrical resistivity can be successfully modeled by crack density and aspect ratio inferred from seismic velocity. Our experimental data and analysis suggest that the physical properties of oceanic crust can be interpreted using the same model at both laboratory and in situ scales.

Keywords: Electrical resistivity, Seismic velocity, Oceanic crust, Crack, The Oman Drilling Project, Hole 1256D

