Heterogeneity of crack distribution in the oceanic crust inferred from downhole variations in P-wave velocity of the Oman Drilling Project Hole GT3A

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Accurate determination of heterogeneity of crack distribution is essential to estimate the effect of water-saturated cracks on seismic velocity. The heterogeneity of pore structure can be quantified as a Representative Elementary Volume (REV) concept. The REV is defined as a minimum volume at which the physical properties become uniform for any larger scale. In this study, to investigate the effect of water-saturated cracks on the seismic velocity of the oceanic crust, we evaluated the scale of REV for microcracks in the crustal section of the Oman ophiolite.
Downhole variations in P-wave velocity measured for the drilled cores from the Oman Drilling Project Hole GT3A were used to infer the spatial distribution of microcracks in the oceanic crust. The P-wave velocity with a frequency of 500 kHz was measured on ˜400 m continuous core sections at every 4 cm interval with the whole-round Multi-Scanner Core Logger (MSCL-W) system onboard D/V Chikyu. To quantify the abundance of cracks, the crack density parameter was computed from the velocity based on the effective medium model. The average values of the crack density within one-dimensional windows were calculated as the length of the window increased to determine the characteristic length of REV.
Results show that the average crack densities are highly variable at small window lengths, converging to constant as the window length increases to several meters. This suggests that the REV of crack distribution can be on the order of several meters so that the effect of microcracks on seismic velocity can be represented by the average crack density over several meters scale. Given these results, the conventional interpretations of seismic velocity based on the submicron-scale REV should be reconsidered, in the context of pore pressure equilibration within the REV due to wave-induced fluid flow

Keywords: Seismic velocity, Crack, Oceanic crust, Heterogeneity, Oman Drilling Project

