Acoustic properties from discrete measurements and downhole logging of Eastern Flank of the Juan de Fuca Ridge (IODP Exp. 301)

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IODP Expedition 301 drilled on the eastern flank of the Juan de Fuca Ridge for the purpose of establishing a multidisciplinary research program to evaluate the formation-scale hydrogeologic properties within the oceanic crust, determine the distribution of fluid pathways within an active ridge flank hydrothermal system, resolve linkages between geomicrobial, alteration, and fluid flow processes, and establish relationships between seismic and hydrologic anisotropy. These goals were accomplished by a series of coring and downhole logging operations as well as by installing and replacing several subseafloor long-term observatories. Here we show the results obtained from physical properties and downhole logging measurements. The primary focus is placed on the acoustic properties (P-wave velocity, S-wave velocity, and P-wave quality factor) of 10 basaltic samples obtained under high confining pressures (up to 40 MPa) and their internal structures interpreted from computed tomography (CT) images. The basaltic samples were selected from pillow-lava and massive-flow intervals. The porosities of our samples range from 1.48 to 4.84 % and they are low comparing with shipboard measurement samples. Both P-wave velocity and S-wave velocity curves show the typical exponential relationship with pressure, which is due to the closure of microcracks. This observed microcrack closure dependence of velocity is important, because the properties measured at atmospheric pressure are not in situ properties. P-wave velocities obtained from saturated samples at 5.5MPa (in situ effective pressure) range from 5178 m/s to 6185 m/s with an average value of 5676 m/s. This average value is higher than the average velocity that was obtained from shipboard analyses (5340 m/s), whereas S-wave velocities under the same conditions range from 2936 m/s to 3549 m/s with an average value of 3269 m/s. The velocity pressure dependence and theoretical equations were used to estimate the microcrack aspect ratios. Furthermore, P-wave quality factors were calculated using the spectrum division technique and show a clear relationship with pressure.