

Elastic velocity measurements of a pore-space-bearing gabbro up to 1.0 GPa: Roles of dry pore-spaces on V_p/V_s of rocks

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In order to determine the role of dry pore-spaces on the elastic properties of crustal rocks, we performed simultaneous measurement of compressional-wave (V_p) and shear-wave (V_s) velocities of an pore-space-bearing olivine gabbro sample up to 1.0 GPa at the room temperature with a piston-cylinder high pressure apparatus. Based on the V_p and V_s data, we evaluated the changes in V_p , V_s , V_p/V_s , Poisson's ratio, bulk density, compressibility, volume, and total porosity of the rock as a function of pressure.

The rock sample studied is an olivine gabbro collected from the Oman ophiolite, the Wadi Bani Umar area, Sultanate of Oman. The sample is a fine-grained (< 1 mm) homogeneous and isotropic rock without recognizable foliation and lineation. We prepared two cylindrical rock samples (14 mm in diameter and 12 mm in length) from the olivine gabbro for high pressure experiment. One is an 'uncracked sample' with few visible cracks. The other is a 'cracked sample' which was pre-heated to 500 degree celsius at 0.5 GPa and pre-pressurized up to 1.0 GPa before the velocity measurement. Petrographic observation suggests that the sample developed cracks after the pre-heating and the pre-pressurization. Both samples were dried in a vacuum-oven at 120 degree celsius for 24 hours before experiments.

For both of the samples, the measured V_p and V_s markedly increase at lower pressures, and gradually increase at higher pressures. The results are attributed to the decrease of pore-space abundances during pressurization. The measured V_p , V_s , V_p/V_s and Poisson's ratio of the 'cracked sample' is systematically lower than those of the 'uncracked sample' in lower pressures (up to 0.6 GPa) and comparable in higher pressures (0.6-1.0 GPa). Based on the compressibility changes of the studied samples as a function of pressure, we evaluated the total porosity of the sample. The total porosity decrease with increasing pressures suggesting that the pore-space abundances decreases with increasing pressure. To define the influences of the pore-spaces on the elastic properties of the rocks, we determined the 'pore-space-free' intrinsic elastic values of the sample by a liner regression of the high pressure data of the 'uncracked sample', and evaluated the deviations in the elastic values of the 'pore-space-bearing' rocks. The deviations exhibit a negative correlation with the total porosity. The present results illustrate that the development of dry pore-spaces in crustal rocks significantly lower not only their V_p and V_s but also V_p/V_s and Poisson's ratio.

Keywords: Elastic wave velocity, Piston-cylinder high-pressure apparatus, gabbro, pore-space, V_p/V_s ratio, Poisson's ratio