Physical property measurements at high pressure and temperature using a large-volume cylinder

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We have newly developed a large-volume piston-cylinder type apparatus of 60 mm inner diameter, 500 mm outer diameter and 200 mm height. We are able to produce a sample volume as large as 20 mm diameter and 20 mm height. Such a large volume allows us to determine accurate velocity and attenuation in mineral and rock samples at high pressure and temperature.

For high temperature acoustic measurements using ultrasonic transducers, a buffer rod must be used in between the sample and the transducer. Because a large temperature gradient in a buffer rod, an accurate velocity in the sample can not be determined by simply observing the first transmitted waves, e.g., in a pulse transmission technique. However, if one could observe both the direct (first) and reflected (second) echoes, the travel time only within the sample can be determined accurately from the difference of the two arrivals. High acoustic impedance of platinum is suited as a buffer rod for observing both the direct and reflected waves in ceramics, minerals, rocks and glasses. By using platinum rods, Aizawa and Ito reported compressional-wave velocities in a fused silica to 1185C, and in an amphibolite to 800C at 1 GPa. Here we have determined anelasticity in both materials as a function of temperature at 1 GPa. A quality factor, Q, rapidly decreases with increasing temperature. Both velocity and Q are low in amphibolite at the solidus temperature, and Q is extremely low at hypersolidus temperature. Low velocity and low Q values in this study are consistent with those observed in the lower crust right beneath the volcanoes in the Japan arc. Partial melting is expected in the lower crustal low-velocity low-Q zone.

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