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PRESSURE DERIVATIVES OF THE ELASTIC PROPERTIES OF POLYCRYSTALLINE QUARTZ AND RUTILE

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Ultrasonic measurements at 298°K as a function of hydrostatic pressure to 7 kb for polycrystalline quartz and rutile yield the following values of pressure coefficients of the velocities of compressional (P) and shear (S) waves, the adiabatic bulk modulus (K_S), and its isothermal pressure derivative:

Property	Units	Quartz	Rutile
$(\partial \ln V_P/\partial P)_{T,P=0}$	mbar^{-1}	2.34 (±0.04)	0.83 (±0.05)
$(\partial \ln V_S/\partial P)_{T,P=0}$	mbar^{-1}	−0.80 (±0.03)	0.18 (±0.03)
K_S	mbar	0.378 (±0.010)	2.105 (± 0.043)
$(\partial K_S/\partial P)_{T,P=0}$		6.5 (±0.04)	6.4 (± 0.08)

These data are discussed in relation to the structure and the phase instability at high pressure. The relatively small values of $(\partial \ln V_S/\partial P)_T$ may indicate that neither high thermal gradient nor partial melting is required to account for the low velocity layer in the earth.

Transformation of the elasticity of the earth into parameters of composition, pressure, and temperature depends, in large part, on the use of equations of state. Parameters for the appropriate equations of state may be obtained for pressure above a few hundred kilobars from shock-wave experiments and for lower pressures from static or dynamic measurements in the laboratory. Because the chemical and mineralogical composition of the interior of the earth is still largely unknown, the parameters used in the equations of state may be based on those of model materials, or on some form of a universal equation of state (believed valid by some authors for suitably restricted materials). The universal equations of state were discussed recently by Simmons and England [1]. Better understanding of the equations of state is most likely to arise from careful measurements on specific materials. In this note, we report data on the elastic properties of hot-pressed polycrystalline quartz and rutile as a function of pressure.

Our measurements of the elastic properties were made on polycrystalline specimens produced by means of the resistance hot-pressing method described by Crandall et al. [2]. The shape of the specimens was a rectangular prism. The microstructural characteristics of the rutile specimen have been described earlier, and this specimen was cut from one of several specimens used in the earlier study of room-temperature elastic properties of this material [3]. Specific information about each specimen follows:

Quartz: density at 298°K, 2.645 g/cm^3 (0.2% porosity); size, 1.2338 × 1.2329 × 0.6122 cm; 99.9% SiO_2 with traces of Al, Mg, Ti, Fe, and Zr (each less than 0.01%).

Rutile (I): density at 298°K, 3.189 g/cm^3 (25% porosity); size, 1.0127 × 0.9943 × 0.4877 cm; 99.9% TiO_2 with 0.03% Pb, 0.02% Fe, and 0.01% Zn.