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Elastic constants of single-crystal quartz and their temperature dependence studied via sphere-resonance method

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Single-crystal elastic constants of rock-forming minerals and their temperature dependence are critical for interpreting observed seismic velocities. A good interpretation requires a thorough understanding of elastic properties of major constituent minerals. Compared with mantle minerals such as olivine, to which a lot of work have been done, elastic properties of crustal minerals have been poorly constrained. Quartz is one of the most abundant minerals in the crust. We have studied elastic constants of single-crystal quartz and their temperature dependence by the sphere-resonance method.

A sphere sample (D=5.826(1) mm) was made from a synthetic quartz single-crystal by the two-pipe method. Resonant frequencies were measured with ultrasonic transducers (Panametrics, V156RM), a lock-in-amplifier (SRS, SR844) and a function generator (Tektronix, AFG320). Measurements were made at frequencies from 400 kHz to 1.2 MHz with different specimen-holding forces. Extrapolating to the specimen-holding force of zero, we obtained frequencies of "free" oscillation. The sample and transducers were placed in a temperature-controlled container. The temperature was changed from 0 to 40oC. Elastic constants were determined by comparing measured and calculated resonant frequencies. The xyz algorithm (Visscher et al., 1991) was employed to calculate resonant frequencies of the sphere sample. Preliminary analysis has shown that C11, C33, C44, C12, C13 and C14 at room temperature (19.4oC) are 87.224, 105.47, 58.328. 6.885, 11.914, 18.116 (GPa), respectively. The temperature dependence of elastic constants will also be presented in this poster.

Keywords: elastic constants, resonance method, temperature dependence, quartz