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

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Transport of ocean floor sediments by plate motions might play an important role in the circulation of materials within the Earth. Imaging subducted sediments through seismological observations requires a thorough understanding of elastic properties of sediment origin hydrous minerals. Topaz is a hydrous mineral, which can be formed from subducted sediment at high pressures. We have studied elastic constants of single-crystal topaz and their temperature dependence by the sphere-resonance method.
A sphere sample (D=6.483(1) mm) was made from a topaz single-crystal ($Al_{1.97}SiO_4(F_{1.56},OH_{0.42})$) collected from Nakatsugawa, Gifu Pref. by the two-pipe method. The uniformity of crystallographic orientation was confirmed with SEM-EBSD (Shizuoka Univ.) measurement. Resonant frequencies were measured at frequencies from 600 kHz to 1.5 MHz with different specimen-holding forces. Extrapolating to the specimen-holding force of zero, we obtained frequencies of "free" oscillation. 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. At room temperature (18.7ºC), C11=281.3, C22=346.3, C33=294.8, C44=108.5, C55=132.5, C66=130.3, C12=121.5, C13=80.90, C23=81.73 (GPa). Using determined elastic constants, compressional- and shear-wave velocities were estimated for an isotropic polycrystalline aggregate of topaz at high temperature. Compresional- and shear-wave velocities at 800ºC are 9.32 km/s and 5.57 km/s, respectively. These values are significantly higher than those in minerals like olivine or garnet.

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