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The influence of OH content on elastic constants of topaz [$Al_2SiO_4(F,OH)_2$]

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Abstract

Topaz, $Al_2SiO_4(OH)_xF_{(2-x)}$, may play a significant role in transporting water and fluorine into the Earth's interior at subduction zones. Seismological detection of topaz gives us insights into the transport mechanisms of water and fluorine but requires a thorough understanding of its elastic properties. The influence of OH content on elastic constants of topaz has not been fully understood, though experimental and theoretical studies have been done on topaz with various OH contents. We thus determined elastic constants of topaz for five natural single-crystal specimens with different OH contents (x = 0.28~0.72) via the sphere resonance method at an ambient condition. Our determined C_{11}, C_{22}, C_{44}, C_{66}, C_{12}, C_{23}, and C_{31} increase with OH content while C_{33} and C_{55} decrease. For the change in OH molar content from 0.0 to 1.0, relatively large changes (>3.0%) are seen in C_{33} [8.0(6)%], C_{55} [4.9(6)%], and C_{22} [3.1(7)%]. The OH content dependence of elastic constants is qualitatively similar to that of theoretically determined values except for C_{11}. The theoretical value of C_{11} decreases as the OH molar content increases from 0.0 to 1.0, whereas the experimental value of C_{11} slightly increases. Our elastic constants are significantly higher (>3%) than theoretically determined values, especially in diagonal components (C_{ii}). The theoretical lower values must be related to the used lattice parameters, which are systematically larger than the measured lattice parameters. The theoretical approach should be modified to reproduce measured lattice parameters and lead to the agreement of theoretical and experimental elastic constants. Our results provide a clue to a better understanding of the elasticity of topaz and a basis for the seismological detection of subducted oceanic sediments.

Keywords: Topaz, elastic constants, sphere resonance method, OH content dependence