Hot-pressing and characterization of polycrystalline topaz for sound velocity measurement

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In subduction zones, a large amount of water is stored as hydrous minerals, such as brucite, talc, serpentine, chlorite, topaz, phengite and amphibole. Laboratory measurements of sound velocity on these hydrous minerals can help interpret seismic data and allow for a better understanding of water distribution and storage in the mantle. To ensure reliable sound velocity measurement of simultaneous P and S waves, well-sintered high quality polycrystalline samples are required.

Topaz [$Al_2SiO_4(OH, F)_2$, space group: Pbnm], usually found as accessory mineral in F-rich granitic rocks or in ultra-high-pressure metamorphism rocks, contains up to 20% fluorine or water. Phase equilibrium experiments suggest that topaz is stable up to 12 GPa and 1100 °C. Thus, topaz can potentially transport water and/or fluorine to depths up to ~360 km. Previous studies on topaz have reported data on its equation of state and crystal structure up to 14 GPa, single-crystal elasticity at ambient pressure from resonant ultrasound spectroscopy, as well as elasticity under pressure from first principles simulations. However, direct measurement of sound velocity of topaz under high pressure has never been reported. In this study, we report our progress in hot-pressing and characterization of polycrystal topaz for direct sound velocity measurements using ultrasonic interferometric measurement at high pressure. We used natural topaz (from Thomas Rg, Millard Co., Utah, USA) as starting material. Single-crystal topaz was carefully selected and ground to fine powder. The X-ray diffraction spectrum of the starting material powder is indexed as pure topaz with lattice parameters of a = 4.669 Å, b = 8.812 Å, and c = 8.415 Å, unit cell volume of 346.234 $Å^3$, yielding a theoretical density of 3.517 g/cm3. The powder was kept at 150 °C for more than 48 hours before loading into a gold capsule for hot-pressing experiment. The hot-pressing experiments were conducted at 1000 °C and 10 GPa for 3 hours using the USCA-2000 multi-anvil apparatus with 14/8 COMPRES cell assemblage. No phase transition was detected within the resolution of powder X-ray diffraction. The recovered sample has been characterized for its quality for acoustic measurements under high pressure, more details about its microstructure and grain size from SEM, X-ray diffraction and density measurements will be presented.