# Steady State Deformation and Ultrasonics: A Study on the Elasticity of Polycrystalline Olivine

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It is well known that elasticity is a key physical property in the determination of the structure and composition of the Earth and provides critical information for the interpretation of seismic data. This study investigates the stress-induced variation in elastic wave velocities, known as the acoustoelastic effect, in San Carlos olivine, which has not been previously investigated. The newly developed experimental ultrasonic acoustic system, the DIASCoPE, is incorporated into the D-DIA multi-anvil apparatus at the COMPRES supported 6BMB beamline to obtain in-situ compressional and shear elastic wave velocities. To facilitate the use of the DIASCoPE, a hybrid sample assembly is required that includes aspects of an ultrasonics experiment and a deformation experiment. Using this cell, two suites of low strain experiments were conducted on polycrystalline San Carlos olivine. Each sample was isostatically hot-pressed at 1150°C and 295.5 MPa for 8 hours, cored to produce a right cylinder and polished to ¼ µm to produce parallel ends. Each sample is in series with a fully dense sintered alumina piston in the center of the assembly with gold foils on the interfaces, and an alumina buffer rod is placed below the sample. We measured diffraction of the sample and alumina buffer rod at 12 minute intervals, and collected compressional and shear wave scans and radiographic images at 6 minute intervals.

In our first experiment San_381, the sample was uniaxially deformed at 3.2-4.4 GPa at a nominal strain rate of ~$3.8 \times 10^{-6}$ $sec^{-1}$ at 450-800°C in three deformation steps. Preliminary analysis of the data indicates that compressional and shear wave velocities change in response to loading in different ways: compressional wave velocities change proportionally to compressive stress in the elastic regime and shear wave velocities show less linear dependence with the stress state. In addition, once the sample reaches its yield point, the linearity between the relative wave velocity variation and the macroscopic stress changes. In our second experiment San_416, the sample was uniaxially deformed at 7.8-10.5 GPa and 450-900°C in three deformation steps. Each deformation step included compression at a nominal strain rate of ~$3.3 \times 10^{-6}$ $sec^{-1}$ to approximately 2.8-4% strain, and decompression at a nominal strain rate of ~$9.6 \times 10^{-7}$ $sec^{-1}$ back to "hydrostatic" condition. Preliminary analysis for San_416 will be presented below.

With pressure conditions ranging from 3.2-10.5 GPa, the results of this study will be the first to evaluate the acoustoelastic effect for olivine at upper mantle pressure and temperature conditions.