Ultrasonic P and S wave velocity measurements on polycrystalline olivine during deformation using the DIASCoPE and D-DIA apparatus at APS 6BMB

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The development of the DIASCoPE which can collect ultrasonic spectra in under a second allows ultrasonic measurements to be incorporated into a standard in-situ deformation experiment in the D-DIA apparatus. This instrumentation is installed at the COMPRES supported 6BMB beamline at the Advanced Photon Source. To facilitate such experiments we developed a hybrid D-DIA sample assembly with characteristics of both an ultrasonic assembly and a deformation assembly. Using this cell we conducted a suite of low strain experiments on polycrystalline San Carlos olivine. The olivine was pre-sintered at 1150 C at 300 MPa, cored to produce a right cylinder and then polished so as to produce perfectly parallel ends. The olivine was assembled in series with an alumina buffer rod and another fully dense alumina polycrystal (‘the piston’) with gold foils on the interfaces. The sample was deformed at 3 GPa a strain rate of ~5 x 10-6/sec at 450, 650 and 850 C. We measured diffraction from the sample at 12 minute intervals, measured diffraction from the alumina piston at 12 minute intervals, and collected P- and S- wave scans and radiographic images every 6 minutes. For each deformation sequence we fit the diffraction data using EPSC models to obtain the load supported by the sample. Sample lengths were determined from the radiographs and fit with a polynomial as a function of time within each sequence to produce a smooth sample length vs time curve. Travel times were determined using a fitting routine in Plot85 and velocities were calculated using the smoothed sample length curves. Preliminary analysis of the data indicate that P and S wave velocities change in response to loading in different ways with P wave velocities changing proportional to compressive stress but the S-wave velocities being more strongly influenced by the onset of ductile deformation.