Pressure dependent elastic properties of basalt by GHz frequency ultrasonic interferometry

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We are utilizing gigahertz (GHz) frequency ultrasonic interferometry to investigate the physical properties of silicate liquids and glasses at pressures relevant to planetary interiors. The micron wavelength of GHz frequency measurements eliminates unwanted diffraction making it well suited to the study of amorphous materials. Here we report initial results on the elastic properties of basaltic glass (BCR-2) compressed in the diamond anvil cell from 0 to 5.5 GPa at ~0.1 GPa pressure intervals. At one-atmosphere, the P- and S- wave velocities are 6025 ± 5.8 and 3493 ± 2.2 m/s, respectively. On compression up to 4.5 GPa, P- and S-wave velocities decrease – behaviour atypical of solids but well established in fully polymerized (network) glasses (e.g. silica). P- and S-wave velocities decrease by 1% and 6%, respectively, over this pressure range. Above 4.5 GPa velocities increase with pressure. Measurements at frequencies between 1 and 2 GHz show no frequency dependence, and compression - decompression cycles demonstrate that these elastic properties are fully reversible up to at least 5.5 GPa. This study is the first to locate a velocity minimum for basaltic composition, which is ~2 GPa higher than the minimum for silica. The magnitude of the velocity decrease is also more modest than the decrease displayed by more polymerized glasses (13% for both P- and S- waves in silica). The velocity reduction with pressure is consistent with mode softening of the aluminosilicate network - as proposed for fully polymerized glasses, while the shift in the minimum to higher pressure and overall more subtle response to compression likely reflects the more compact and depolymerize structure of basaltic glass. Experiments are underway to investigate how these properties change on heating into the liquid state.