Laboratory Measurements of Seismic Wave Attenuation in Natural Dunite

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In order to examine the processes responsible for the attenuation of seismic shear waves in the Earth's upper mantle, torsional forced-oscillation and microcreep experiements have been conducted on a natural dunite specimen at high temperatures to 1300C and seismic frequencies from 0.001 to 1Hz. The dunite specimen (from Anita Bay, NZ) consists mainly of olivine (90%) of about 100 micron average grain size, but some olivine crystals of size up to several millimeters occur randomly. It also contains trace amounts of hydrous phases (loss on ignition is 0.2 wt.%). We measured both untreated and prefired (1200C, 20hrs) specimens to assess the possible role of water on viscoelasticity. Water weakening of olivine aggregates in creep is currently interpreted in terms of increased concentrations of point defects, resulting in enhanced rates of ionic diffusion and dislocation climb. By analogy, it has been speculated that water significantly affects low-strain viscoelastic behavior as well. Our measurements demonstrate that dissipation (1/Q) of the prefired specimen is similar to that of untreated one, due to the loss of water from the system. Results of an alternative approach where the specimen was sealed in a Pt capsule would be reported.