

Rock anelasticity due to grain boundary sliding: experimental data and seismological application

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Recent progress in seismology has revealed highly resolved, three-dimensional velocity and attenuation structures in the Earth's interiors. Although seismic properties of rock have long been measured at ultrasonic frequencies ($> \text{MHz}$), recent results of the low-frequency experiments performed at seismic frequencies (10^{-2} – 0.001 Hz) by using forced oscillation tests have revealed that, unlike ultrasonic waves, seismic waves can be affected by the anelastic relaxations caused by grain boundary sliding. Our experimental studies by using a binary eutectic organic polycrystalline system as a rock analogue showed that grain boundary sliding significantly affects seismic velocity and attenuation if, and only if, grain boundary is significantly disordered at near-solids temperatures or by certain impurities. Disordered grain boundary also enhanced steady-state diffusion creep. These results significantly change our insights into the origin of the seismic low-velocity regions and the asthenosphere seismologically and geodetically detected in the upper mantle.