

# Über-Weak Asthenosphere from Post-Seismic Deformation After Mega Quakes and Global Seismic Anisotropy

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## Abstract:

Plate tectonics can be understood from the dynamics of the cold, top thermal boundary layer of Earth's mantle which is convecting over timescales of millions of years. However, how forces are transmitted depends on the flow strength of rocks (viscosity). For example, the low viscosity of the region underneath the plates, the asthenosphere, matters greatly for plate dynamics, and might indeed be required for a planet to express plate tectonics, rather than other styles of heat loss. Here, I discuss two different scale efforts to better understand the nature and degree of the weakness in the mantle. Huge earthquakes such as the 2011 Tohoku-oki event deform the Earth transiently and we can use the geodetically measured surface deformation to sample upper mantle scales of response. The data can be used to invert for the viscosity of the mantle wedge and subducting plate. We show that laboratory derived rheologies including a plastically weakened plate control subduction behavior. On global, and longer time-scales, observations of seismic wave propagation anisotropy can provide further constraints on the global extent of a weakened asthenosphere, and I show that the asthenosphere has to be weak, but can not be too weak. Crossing spatio-temporal scales in upper mantle dynamics modeling from seismic cycle to millions of years is a challenge and an opportunity for our understanding of plate tectonics and seismic hazard due to megathrust fault systems such as in Cascadia or Japan.