# Faulting in deforming dunite under wet conditions: role of aqueous fluid in semi-brittle behavior of dunite

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The subduction zone produces a major fraction of the Earth's seismic activity. The mechanisms of intermediate-depth (> 40 km depth) and deep-focus (> 300 km) earthquakes are fundamentally different from those of shallow (< 40 km) earthquakes. This is because the frictional strength of silicate rocks exceeds the upper limit of the stress level in the upper mantle (< 300 MPa: Obata and Karato, 1995) at pressures higher than 1 GPa (~30 km depth). Therefore, the cause of intraslab seismicity at intermediate depths has been attributed to dehydration of serpentinite (e.g., Peakock, 2001) because the water released during dehydration reaction of serpentinite reduces the effective confining pressure. The dehydration embrittlement model is now widely accepted, because the location of the double seismic zone in the subducting Pacific slab corresponds to the main dehydration field in the pressure-temperature diagram of the hydrous peridotite (Omori et al., 2002).

To revisit the origin of intraslab earthquakes in wet slabs, we conducted uniaxial deformation experiments on as-is dunite and water-saturated dunite at pressures 1-2 GPa and temperatures 670-1250 K with a constant displacement rate using a deformation-DIA apparatus. Pressure, stress, and strain were measured in situ by using x-ray diffraction patterns and radiographies. Acoustic emissions (AEs) were also recorded continuously on six sensors, and three-dimensional AE source location were determined. Formation of throughgoing faults was observed when differential stress exceeds the confining pressure (i.e., Goetze's criterion) in as-is and water-saturated dunites. Creep strength required for the initiation of a faulting in as-is dunite was quite similar to that in dry dunite (Ohuchi et al., 2017) at each temperature, suggesting that the fracture strength of dunite is not a function of dissolved water content in olivine. Creep strength of water-saturated dunite was systematically lower than that of as-is dunite (~0.5 GPa at each temperature), resulting in decrease in the threshold temperature for a faulting (as-is dunite: 1150 K: water-saturated dunite: ~900 K). Even though the critical strain rate for initiation of a faulting was > 1E-4 /s in as-is dunite, faulting was observed in water-saturated dunite which was deforming at a lower strain rate (between 1E-5 and 1E-4 /s). Increase in AE rate and strong AEs were recorded around the timing of a faulting in both as-is and water-saturated dunites. Increase in strain rate just before a faulting was observed in as-is dunite, not in water-saturated dunite. Strain localization (and thus adiabatic instability) would not be required for the initiation of a faulting in water-saturated dunite.

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