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Shear deformation of lawsonite blueschist at high pressures and implications for earthquakes in the subduction zones

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Recent seismological observations indicate that many earthquakes occur at the top of subducting slabs where oceanic crust is transformed to blueschist facies rocks under high pressure and temperature conditions. Episodic slip and tremor (ETS) events and low frequency earthquakes (LFEs) and intermediate-depth earthquakes in cold subduction zones often occur where lawsonite blueschist is stable at the top of the subducting slab, but the mechanism of these earthquakes is still poorly constrained because of a lack of laboratory measurements of rock properties (i.e. lawsonite blueschist) in shear experiments at various conditions reflecting the source region of these earthquakes. Here we report the results of experimental deformation of lawsonite blueschist under high pressure and temperature conditions consistent with the stability field of lawsonite blueschist. Our data show that lawsonite blueschist deforms cataclastically at high pressures (1–2 GPa), producing faults and slip weakening through the formation of nanoparticles and amorphous phases along highly localized faults. Our results have important implications for the understanding of seismogenesis and the mechanism behind ETS/LFEs and intermediate-depth earthquakes in cold subduction zones.