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Ultra-low friction during dynamic rupture in serpentinite

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The high-velocity frictional properties of serpentinites, which are key to understand the dynamics of earthquake ruptures in subduction zones, are commonly expected to be governed by the dehydration reaction of serpentine minerals which occurs upon heating. Here, we performed stick-slip experiments which show that serpentinite dramatically weakens during fast slip due to amorphisation and potentially melting of serpentine minerals at microscale asperity contacts, in addition to water devolatilisation off the slip plane. The devolatilisation is very localised near the slip plane, and likely provides an efficient thermal buffer which limits the extension of the slip zone. The devolatilisation and amorphisation mechanisms are very efficient dynamic weakening mechanisms, as demonstrated by the occurrence of total stress drops (up to 180 megapascals (MPa)) over very short timescales (less than 20 microseconds) and large amplitude elastic wave radiation during the dynamic slip events. Such a rapid weakening of serpentinites at high-velocity could be a key process facilitating the propagation of intermediate-depth subduction earthquakes.