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The Frictional Properties of Phyllosilicates at Earthquake Slip Speeds

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Most mature natural faults contain a significant component of sheet silicate minerals within their core. In order to elucidate the ease which earthquake ruptures may propagate along such faults, we conducted a series of high velocity (1.3 m/s) laboratory friction experiments on synthetic fault zones containing pure kaolinite, sericite, illite, talc and montmorillonite under dry and wet conditions. The normal stress in the experiments was varied between 0.8 to 2.45 MPa. Under dry conditions, peak friction was reached during acceleration of the fault zones to the steady-state velocity. At the highest normal stress it varied between 0.7 and 0.4. The peak friction for each of the sheet silicates correlates well with the corresponding mineral electrostatic separation energy. The peak friction rapidly decreases to steady state values, typically $\sim$0.2 for all the minerals tested, over slip weakening distances of between 1 to 3 m. Under wet conditions the peak friction reduces considerably or disappears. Thus steady-state friction is established almost immediately and has values corresponding to those under dry conditions. Correspondingly, the slip weakening distances in these wet experiments are very small. The results suggest that it will be energetically very easy for earthquake ruptures to propagate through wet, sheet silicate-rich fault zones.