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## Direct observations of a dynamic earthquake rupture in the lower crust

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A significant number of studies in recent years have demonstrated that earthquakes in the lower crust are more abundant than previously thought. Specifically in continental collision zones, earthquakes are suggested to play a crucial role in permitting fluid infiltration and driving metamorphic transformation processes in crustal portions that are typically considered dry and metastable. However, the mechanisms that trigger brittle failure in the lower crust remain debated and the sequence of events that ultimately lead to seismic slip is unclear. To further understand this process we performed field and microstructural observations on an amphibolite facies fault (0.9-1 GPa) in granulite facies anorthosite from the Bergen Arcs, Western Norway. The fault preserves an exceptional record of brittle deformation and frictional melting that allows us to constrain the temporal sequence of deformation events. Most notably, the fault is flanked on one side by a damage zone where wall rock minerals are fragmented with little to no shear strain (pulverization). The fault core consists of a zoned pseudotachylyte bound on both sides by fine-grained cataclasites. Spatial relationships between these structures reveal that asymmetric pulverization of the wall rock and comminution preceded the seismic slip required to produce melting. These observations are consistent with the propagation of a dynamic shear rupture. Our study implies that high differential stress levels may exist within the dry lower crust of orogens, causing brittle faulting and earthquakes in a portion of the crust that has long been assumed to be characterized by ductile deformation.