Seismic slip propagation from brittle to ductile regimes inferred from the pseudotachylytes, Woodroffe shear zone, Australia

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The process of earthquake generation and rupture propagation within a seismogenic zone is inherently complex at all scales, but a lack of adequate geological data inhibits any detailed investigations into the actual process of rupture and slip within a seismic fault zone. It is well known that large earthquakes occur repeatedly in the mature active faults and nucleate near the base of seismogenic zone which is generally less than 10-15 km in depth in continental crust. Fault-related pseudotachylyte is the only material that recorded the seismic nature of ancient seismic fault zones from brittle to ductile regimes, which provide insight into the earthquake generation process within the seismogenic fault zone.

Large volumes of pseudotachylyte veins are documented from the Woodroffe shear zone, central Australia. There are three types of pseudotachylytes: cataclasite-related pseudotachylyte (C-Pt) mylonite-related pseudotachylyte (m-pt), and ultramylonite-related pseudotachylyte (Um-Pt). M-Pt and Um-Pt are associated with mylonite-ultramynolite development and are overprinted by C-Pt. The foliations of M-Pt and Um-Ptare generally parallel to that of the country mylonite-ultramylonite zone. The C-Pt veins cross-cut the foliations of mylonite, M-Pt and Um-Pt. The field occurrences and meso-microstructures show that the M-Pt and Um-Pt formed cyclically in the semi-brittle to ductile regimes, which were overprinted by cataclasis and C-Pt formation in the brittle-dominated regime during uplift of the shear zone.

Recent seismic studies show that large earthquakes can rupture the entire seismogenic zone and co-seismic slip not only propagate upward to the Earth's surface where displacement can be observed but also down to deep fault zone where is a ductile-dominated regime. The coexistence of large volumes of C-Pt, M-Pt, and Um-Pt veins in the Woodroffe shear zone suggests that these pseudotachylytes formed by seismic faulting occurred repeatedly in the brittle-dominated seismogenic zone in the upper crust and propagated down to the ductile portions of the lower crust.