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ウルトラカタクラスティック脈に記録された地震すべり: 有馬ー高槻構造線六甲活断層を例に
Repeated seismic slips recorded in ultracataclastic veins along active faults of the Arima-Takatsuki Tectonic Line

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It is well known that direct evidence of earthquakes within fault zones is limited to the presence of pseudotachylyte (e.g., Lin, 2008). In addition to pseudotachylyte, previous studies have shown that the meso- and microstructural features of cataclastic veins that lack the primary cohesion of the host rocks, including crush-origin pseudotachylyte, fault gouge, fault breccia and some calcite veins, may represent primary evidence of brittle deformation caused by recurrent seismic slip within seismogenic fault zones (e.g., Lin et al., 2012, 2013a,b). It has also been reported that during the 2008 Mw 7.8 Wenchuan earthquake, ultracataclastic veins were produced along the seismic slip plane and injected into fractures within the seismogenic fault zone (Lin, 2011). Therefore, studies on cataclastic veins would provide new insights into the deformation process of seismic slip recorded in seismogenic fault zones.

In this study, we report on the structural mode of typical ultracataclastic veins including crush-origin pseudotachylyte and fault gouge veins that formed repeatedly as simple veins and complex networks within a fault zone along active faults of the Arima-Takatsuki Tectonic Line (ATTL), southwest Japan. We also discuss the formation mechanisms of such veins and their tectonic significance in terms of seismic faulting events.

Field investigations, combined with meso- and microstructural analyses, reveal that numerous ultracataclastic veins are widely developed within a fault zone (<150 m wide) as simple veins, complex lenses, and networks, along active faults of the ATTL, southwest Japan. These veins comprise mainly crush-origin pseudotachylyte vein and weakly consolidated to unconsolidated fault gouge that is black, dark-brown, brown, gray, and brownish-red in color. Meso- and microstructural features show that these pseudotachylyte and fault gouge veins and networks formed during multiple stages, as earlier veins are generally cut and overprinted by younger veins, indicating that the vein-forming events occurred repeatedly and that ultracataclastic material was injected into networks of faults and fractures in the fault zone. The pseudotachylyte and fault gouge veins are characterized by an ultrafine- to fine-grained matrix and angular to subangular fragments of host granitic rocks of various sizes, ranging from submicron to millimeters. SEM-EDS and powder X-ray diffraction analyses show that all the ultracataclastic veins are characterized by crystalline materials composed mainly of quartz and feldspar, similar to the host granitic rocks.

The present results support the existing hypothesis that ultrafine- to fine-grained materials formed by comminution can be fluidized and injected rapidly into fracture networks located far from the source fault plane in a solid-fluid-gas system during seismic slip; therefore, such materials provide a record of paleoseismic faulting events that occurred repeatedly within the seismogenic fault zone.

References:

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