Multiple Deformation Mechanisms Operating at Seismogenic Depths: Tectonic Pseudotachylyte and Associated Deformation From the Central Sierra Nevada, California

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Multiple deformation mechanisms operating at seismogenic depths: Tectonic pseudotachylyte and associated deformation from the central Sierra Nevada, California

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Background and Structure

The East-West-Southwest trending, left-lateral, strike-slip Granite Pass Fault (GPF) is cross-cut by the North-East-South-West striking, steeply-dipping, left-lateral strike-slip Great Valley Fault (GVF). The GPF is active at depths between 2.4-6.0 km with ambient temperatures between 110-160°C (Kirkpatrick et al., 2012). The GVF is an East-West to North-East-South-West striking, steeply-dipping, left-lateral strike-slip fault that is active at depths between 2.4-6.0 km with ambient temperatures between 110-160°C (Kirkpatrick et al., 2012).

Pseudotachylyte

Flow streaks, thin, alternating layers of very fine-grained, contrasting colored bands or streaks, which tend toward anastomosing forms. This feature is typically associated with cataclasite and pseudotachylyte.

Cataclasite

Rounded/Embayed morphology of quartz and feldspar clasts in cataclasite (25.0% clast), used to measure clast area, position, and shape data, multiple generations of pseudotachylyte in a single sample suggest multiple earthquakes along the same section of the fault. The size and orientation of the faults, 2 dimensional clast size as a function of position, 2 dimensional clast circularity as a function of position, note that both the cataclasite and pseudotachylyte contain a wide range in circularity and clast class is determined. 3-D clast aspect ratio (aspect ratio) in a function of position, the majority of the cataclasite and pseudotachylyte. Histograms of clast aspect ratio (aspect ratio) in a function of position, note that both the cataclasite and pseudotachylyte contain a wide range in circularity and clast class is determined. 3-D clast aspect ratio (aspect ratio) in a function of position, note that both the cataclasite and pseudotachylyte contain a wide range in circularity and clast class is determined.

Evidence for plastic deformation associated with the GVP and GVF zones includes cataclasite formation, grain boundary sliding (GBS), deformation banding, subgrain formation, and rotation (SR). A) Quartz, and kinking and folding in plastic deformation temperatures between 300-500 °C (Passchier and Trouw, 2005). B) Neocrystallized quartz with "owychite" banding, showing the zone of plastic deformation, with corresponding marked increase in the density of grain boundaries (GBS), which is consistent with dislocation glide and temperatures between 300-500 °C (Passchier and Trouw, 2005). C) Neocrystallized quartz with subgrain formation and rotation (SR). A) Quartz, and kinking and folding in plastic deformation temperatures between 300-500 °C (Passchier and Trouw, 2005). B) Neocrystallized quartz with "dehydration" banding, showing the zone of plastic deformation, with corresponding marked increase in the density of grain boundaries (GBS), which is consistent with dislocation glide and temperatures between 300-500 °C (Passchier and Trouw, 2005). C) Neocrystallized quartz with subgrain formation and rotation (SR).

Conclusions

1) Well-preserved tectonic pseudotachylyte from the GVP and GVF provide convincing evidence for ancient seismogenic faulting (Kirkpatrick et al., 2008, 2012), and multiple generations of pseudotachylyte in a single sample suggest multiple earthquakes along the same section of the fault. 2) Clasts in cataclasite and pseudotachylyte have similar ranges in size and shape characteristics. 3) Pseudotachylyte tends to have a lower clast to matrix ratio than cataclasite from the fault zones. 4) Alteration and precipitation of hydrothermal minerals is consistent with temperature conditions between 170-320 °C. 5) Cross-cutting relationships suggest that some pseudotachylyte formation occurred post-hydrothermal alteration, suggesting the possibility that some H₂O was present during pseudotachylyte formation. 6) Crystal-plastic deformation suggests deformation temperatures between 300-550 °C; however, it is not clear if plastic deformation occurred pre-, post-, or post pseudotachylyte formation.