Structure and Petrology of the Kern Canyon Fault, California: A Deeply Exhumed Strike-slip Fault

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Abstract

The mesoscopic structure and petrology of the Kern Canyon fault at Engineer Point, Isabella Lake, is characterized to better understand the physical and chemical processes that control earthquake nucleation and rupture propagation along mature faults in the middle to lower seismogenic zone of the continental crust. The 140 km long Kern Canyon fault is an exhumed, large displacement fault that cuts batholithic and metamorphic rocks in the southern Sierra Nevada Mountains, California. At Engineer Point, the Kern Canyon fault displays approximately 15 km of right lateral separation, and consists of a fractured, sheared and mineralogically altered zone several hundred meters thick. At least three distinct phases of deformation are recorded in the zone: an early phase of ductile shear within an S-C phyllonite, a subsequent, dominant phase of brittle faulting characterized by a throughgoing zone of cataclastic rocks, and a late stage of minor faulting along thin, hematitic gouge zones. The phyllonite zone trends N20-40E and displays extensive retrograde alteration primarily involving transformation of feldspar to mica, calcite and quartz. The cataclastic zone cuts the phyllonite, trends N20E, and consists of a relatively narrow core of foliated cataclasites cut by mesoscopic slip surfaces. Mesoscale fracture intensity decreases linearly with log distance from the cataclastic core and approaches background levels at approximately 50 m. S-C fabrics and subsidiary fault slip data indicate that both the phyllonitic and cataclastic shear zones were dominantly strike-slip. Slip lineations on the hematitic gouge zones suggest normal oblique-slip. The damage zone of the fault contains many quartz- and calcite-filled veins and the cataclastic rocks often are calcite-cemented. Some quartz veins are greater than 1 m thick. Fault-parallel and pinnate veins exist along the foliated cataclasites and localized slip surfaces. Cross cutting relations indicate quart-filled veins began forming during the phyllonite phase, and calcite-filled veins formed largely during the cataclastic-faulting phase. The structures and synfaulting mineral reactions record faulting under evolving fluid chemistry and metamorphic conditions possibly associated with progressive unroofing during faulting. Future work will involve additional structural analysis of the cataclastic zone as well as additional petrologic and geochemical analyses of the fault rocks to determine the distribution of slip, mechanisms of deformation, and chemical reactions during faulting.