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

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Annual Project Summary

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Investigations Undertaken

This project is a continuation of our study of the structure and petrology of the Kern Canyon fault at Engineer Point, Lake Isabella, CA (Figure 1; Chester, 2001). The Kern Canyon fault is a deeply exhumed, large displacement, strike-slip fault in batholithic, metasedimentary and metavolcanic rocks of the southern Sierra Nevada (Moore and du Bray, 1978). At Engineer Point, the fault consists of a broad fractured and mineralogically altered damage zone several hundred meters thick (Ross, 1986). The fault is located along and strikes approximately parallel to the eastern shoreline of the peninsula. Correlation of offset plutonic and metamorphic rocks across the Kern Canyon fault in the vicinity of this peninsula suggests dextral separation of approximately 15 km (Ross, 1986; Moore & du Bray, 1978). Previous reports also suggest that there may have been a significant component of dip-slip in this region (Treasher, 1948; Engel, 1963; Saleeby, 1992). Rock exposures are present over the peninsula and along the wave cut beaches. We have visited the fault during mid-summer months when water levels in the reservoir are moderate to high (~2595'), and also during low-water (~2572') common during the fall and spring when a greater portion of the fault zone is exposed and most of the peninsula is dry and accessible.

The initial portion of this study, carried out with contributions from L.Neal (TAMU), R Wintsch (Indiana University), and Fred Chester (TAMU), focused on documenting the overall petrology and structure of the fault zone at Engineer Point (Chester, 2001). Fault rock structures, relative intensity of hydrothermal alteration, and protolith rock types were mapped at a scale of 1:6000. Mesoscopic scale fracture density traverses and fault and fracture orientations have been measured at the regional and fault zone scales. Approximately 30 oriented samples representative of the various protoliths and fault-rocks were collected for optical microscopy and quantitative microprobe analyses.

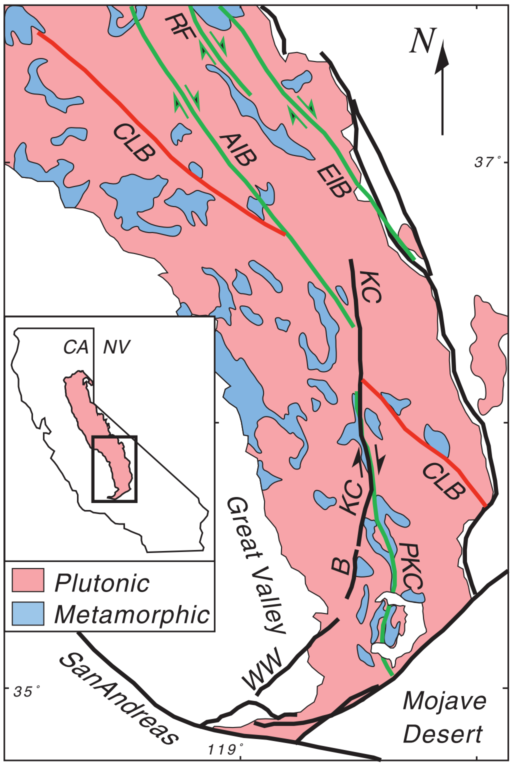

Figure 1. Map of the southern Sierra Nevada batholith showing the location of the Kern Canyon fault zone (KC) relative to other tectonic features, including the axial intrabatholithic break (ABI), cryptic lithospheric boundary (CLB), eastern intrabatholithic break (EBI), proto-Kern Canyon fault (PKC), Rosy Finch shear zone (RF), Breckenridge fault (B), and White Wolf fault (WW) (modified from Saleeby and Busby, 1993, and Kistler, 1993).

Results to Date

Work during FY2001 (contract # 01HQGR0056) has focused on (1) characterizing the mesoscopic structure of the fault core through trenching, (2) producing detailed maps of the fault core, (3) characterizing the microscopic damage and host rock alteration as a function of distance from the cataclastic zone, and 4) detailed mapping of small faults, joints and distribution of alteration in the damage zone of the fault. Trenching has been performed in collaboration with D. Kirschner (Saint Louis University).

Trenching has successfully exposed the eastern portion of the main cataclastic zone at Engineer Point. Exposures illustrate that distribution of deformation is highly asymmetric with most of the damage concentrated on the western side of the fault. Overall the density of microfractures increases towards the cataclastic zone. The relative occurrence of healed, sealed and open microfractures varies across the zone and appears to reflect damage associated with several distinct phases of faulting (Chester, 2001).

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Non-Technical Summary

In order to reduce the loss of life and property as a result of the occurrence of large-magnitude earthquakes, we must increase our understanding of the physical and chemical processes that govern repeated earthquake generation along large-displacement continental fault zones. Geologic field investigations of large-displacement faults that are exposed at the Earth's surface offers a cost-effective way to investigate the internal structure, mineralogy, and chemistry of fault zones in detail, and is complementary to other approaches such as deep drilling and geophysical (indirect) imaging. We will use a variety of techniques in the laboratory to analyze rocks collected in the field. These data will be used to help constrain and test existing hypotheses for fault weakening and earthquake generation. In addition, data gathered from this study will help guide future field, experimental, and theoretical investigations of the earthquake process.