Abstract

Results from field mapping and analyses of structural and petrochemical data from the southern Sierra Nevada batholith are presented to offer insight into the development of a major intra-arc fault system. The Kern Canyon fault system comprises an early ductile shear zone overprinted in its northern and central segments by a younger, recently active brittle fault. The divergence of these two faults at their middle latitudes poses a complex puzzle with regard to the physical and temporal evolution of deformation in the southern Sierra. Faulting began with ductile thrusting (the Proto-Kern Canyon fault zone) during emplacement of granitic plutons in the central to eastern part of the batholith at ca. 95 Ma. Early thrusting resulted in mismatched levels of pluton emplacement depths across the fault, truncation of significant regional geochemical markers in the batholith, and exhumation of the deepest level of the batholith in its southernmost region. Early ductile thrusting gave way to dextral strike-slip shearing by ca. 90 Ma. The youngest plutons in the batholith, emplaced along the fault between 90 and 80 Ma, are north-south elongate and reflect the dextral transpressional setting into which they were emplaced and deformed. Metamorphic country rocks were also highly sheared along the fault, and paleostress estimates from these deformed rocks suggest stresses along the middle segment of the Proto-Kern Canyon fault were 20–40 MPa, while strain rates were as high as 10^{-12} s^{-1} (comparable with other ductile faults). Strain studies and aspect ratios of igneous and metamorphic rocks strung out along the shear zone suggest ductile dextral displacement was 5–15 km. While ductile shearing ceased in the southern part of the batholith by ca. 85 Ma, it continued along the middle and northern segments of the Proto-Kern Canyon fault until ca. 80 Ma, when brittle

deformation took over. This chronology suggests that the modern Kern Canyon fault, which shows ample evidence of activity into at least Quaternary time, initiated as a brittle structure in the southwestern part of the batholith, perhaps as early as 85 Ma, and shunted into the ductile shear zone at its middle latitudes ca. 5 Myrs later.