9 Testing the Temporal Persistence of Slip Rate Along the Little Lake Fault, Eastern California Shear Zone

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9.1 Introduction

In the eastern California shear zone (ECSZ), short-term interseismic strain rates measured from geodesy outpace longer-term geologic measurements of fault slip-rate by a factor of about two. This discrepancy characterizes slip rates both summed across the zone as a whole (Oskin et al., 2008) and along individual structures. An early InSAR study in the northern Mojave Desert (Peltzer et al., 2001) exemplifies the latter through demonstration of rapid interseismic deformation focused on the Little Lake and Blackwater faults (Figure 2.18). The magnitude of this strain suggests up to 7 mm/yr of dextral strike slip, despite modest Quaternary slip-rates of 0.5 mm/yr for the Blackwater fault (Oskin and Iriondo, 2004). Conversely, the sinistral Garlock fault, a cross-cutting conjugate to the Little Lake-Blackwater faults displays the opposite sense of rate discrepancy. There, geodetic data indicates that interseismic strain accumulates at a slower average rate than suggested by older, offset geologic markers (Figure 2.19). A potential explanation for this mismatch is that the Garlock and Little Lake-Blackwater faults undergo alternating periods of relatively slow and fast fault slip, corresponding with earthquake clusters along each zone (Dolan et al., 2007). As such, understanding the nature of short and long-term variations in fault slip-rate in the ECSZ has clear implications for seismic hazards in southern California, as well as for interactions and interconnectivity among fault networks within zones of distributed shear.

9.2 Methods

Here, we test the persistence of rapid, decadal strain accumulation along the Little Lake fault (Figure 2.18) through combination of new geologic fault slip-rates and InSAR measurements. Geologic constraints exploit a series of fluvial landforms spanning the Little Lake fault, emplaced during intermittent outflows of the Pleistocene Owens River. New geologic mapping and ground-based lidar surveying of these features provide fault-slip measurements for landforms of varying age. Geochronologic control on these features relies on new $^{40}$Ar/$^{39}$Ar dating of Quaternary basalts and $^{10}$Be exposure dating of outwash boulders on Late-Pleistocene terrace surfaces. New measurements of interseismic strain spanning the Little Lake - Blackwater and Garlock faults utilize an updated catalog of ERS and Envisat data spanning the last decade and a half.

Figure 2.18: Overview of active faults and regional topography of the eastern California shear zone (ECSZ) and southern Walker Lane belt (WLB). Labeled faults are abbreviated as follows: ALF-Airport Lake fault, BF-Blackwater fault, GF-Garlock fault, KCF-Kern Canyon fault, LLF-Little Lake fault, OVF-Owens Valley fault, SNFF-Sierra Nevada frontal fault. Major historical earthquake surface ruptures in the ECSZ and WLB are outlined in white, with stars denoting epicentral locations. Radar scene T442/F2889 is outlined by the dashed white box.

9.3 Findings

Geologic slip rates measured from displaced landforms along the Little Lake fault suggest modest, sustained dextral slip averaging ca. 0.7 mm/yr over the past ca. 65 to 200 ky (Figure 2.19). This rate agrees well with Qu-
Figure 2.19: Compiled dextral displacements (A) and corresponding fault slip rates (B) as a function of age for the Little Lake, Blackwater, and Garlock faults. Linear regressions in (A) indicate constant slip rates through time. Geodetic measurements represent interseismic deformation measured from InSAR and GPS. See Ganev et al. (2012) for a summary of Garlock fault measurements. References in legend: OI04 - Oskin and Iriondo (2004); P01 - Peltzer et al. (2001); R80 - Roquemore (1980).

ternary averaged slip rates along the Blackwater fault, and is substantially slower than geologic slip rates for the Garlock structure. As such, our data suggests that temporal variations in slip, if they occur, happen at shorter time scales than $10^4$-$10^5$ years. Although feasible at the time scale of individual earthquakes or earthquake clusters ($10^3$ yr), our preliminary InSAR results demonstrate similar, modest rates of interseismic strain accumulation along the Little Lake fault. Taken together, our work suggests that relatively rapid strain measured in earlier InSAR studies is transient over decadal periods and does not reflect long-term oscillations between the Little Lake-Blackwater and Garlock faults. Future work will better constrain recent rates of interseismic strain accumulation in this area using InSAR and will investigate the possibility that short-term interseismic strain transients reflect fault interaction and acceleration following nearby earthquakes in the ECSZ (Figure 2.18).

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9.5 References