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Significance of temporal and spatial variations of geological fault slip rates for models of lithospheric deformation

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The advent of space-geodetic techniques (GPS; InSAR, etc.) over the last ten years has revolutionized our ability to measure active surface deformation in the continental lithosphere. One of the most important questions regarding the significance of these measurements for models of lithospheric deformation is the relationship between strain accumulation and strain release. On short time scales (years), both strain accumulation and release are monitored using high-precision space-geodetic techniques. On longer time scales (e.g., thousands of years, duration of interseismic intervals), however, strain accumulation measurements are derived from geologic strain release data as proxies. What is the significance of these geological proxies and how can such data be incorporated into modeling studies?

Synthesized fault slip data and recently monitored (GPS) surface strain from the Wasatch fault region, Basin and Range Province, western USA, show that strain rates vary on time scales significantly shorter than those scales over which tectonic strain accumulates. The longer-term geomorphic and geologic slip-rate proxy data indicate that non-uniform strain release on scales from meters to kilometers appears to be the norm rather than the exception. In comparison with geodetic data for the same fault zone, these data imply either significant variations in strain accumulation over short time scales or non-uniform release mechanisms at constant strain accumulation (see Friedrich et al., JGR, 2003). At present it is not possible to rule out either possibility due to the lack of reliable information about the fault geometry, and the distribution

of strain and fault-slip at depth.

Synthesis of geological fault slip data over time-scales ranging from years to millions of years along strike of the San Jacinto dextral fault zone, southern California, also indicate order of magnitude variations in fault slip proxies (e.g., Bennett et. al., Geology, 2004); it is noteworthy that the most significant variations occur along strike of the fault zone (Gans et al., in prep, Gans et al. EGU 2004). In contrast to geodetic surface strain data, the geological data may be used as a direct measure of temporal and spatial variations of fault slip. Such data imply that models relying on fault-slip data averaged over long temporal or spatial scales may not properly reflect the actual fault motion.

We postulate that the temporal and spatial scales over which geological fault slip data vary may be useful parameters in models of lithospheric deformation.