Mini Proposal to PBO: Western Mojave Desert Densification

Zheng-Kang Shen and David Jackson, UCLA

The San Andreas fault contributes most to the Pacific-North America relative plate motion. The rest of the motion is partitioned into many subsidiary faults. While the subsidiary faults can produce very damaging earthquakes, we still cannot pin down their deformation rates precisely if they are located in the "strain shadow" of the San Andreas, i.e. their deformation field overlaps that of the San Andreas. This happens for the faults in and around the Los Angeles basin, such as the San Gabriel Mtn southern frontal fault system and the Whittier, New Port-Inglewood, and Palos Verdes faults.

Data analysis results of the EDM and GPS measured in and around the Los Angeles basin show a deformation pattern subject to multiple interpretations (Eberhart-Phillips et al., 1990; Lisowski et al., 1991; Feigl et al., 1993; Donnellan et al., 1993; Shen et al., 1996; Wells et al., 1998; Argus et al., 1999). Figure 1 shows the velocity field in the region from the 2.0 release of the SCEC velocity map. Its velocity profile across the Mojave section of the San Andreas is shown in Figure 2. Assuming a thick skinned crustal deformation, the deformation could be due to a right slip along the San Andreas of (a) 30 mm/yr slip and 30 km locking, (b) 25 mm/yr slip and 20 km locking, or (c) 20 mm/yr slip and 15 km locking. Assuming a thin skinned deformation, it could also be due to (d) 30 mm/yr right slip and 20 km locking at the San Andreas, or (e) a broad shear zone in the lower crust/upper mantle whose concentration and motion orientation do not necessarily coincide with the surface trace of the San Andreas (Hadley and Kanamori, 1977; Gilbert et al., 1994; Snay et al., 1996; Shen et al., 1996). One could argue one model over another based on different physical constraints, but the model uncertainties associated with the data are always there. Part of the uncertainties comes from high correlations of model parameters such as the San Andreas locking depth, its slip rate, and the slip rates along the local faults in and around the Los Angeles basin.

How shall we solve the problem? One way of course, is to density observations in the Los Angeles Basin area and make as accurate measurements as possible. It can improve the model constraints, but will not solve the problem completely. Here we suggest another way to assess the problem, taking advantage of symmetric pattern of crustal deformation caused by a vertical strike slip fault such as the San Andreas.

We propose to densify the GPS observation in the western Mojave Deseart, delineated by the Mojave section of the San Andreas, the White Wolf, and the Mojave Desert Shear Zone. Deformation in the region is mainly contributed from fault slips along the San Andreas, the White Wolf, and the Garlock faults, plus the faults in the Mojave Shear Zone. There will also be contributions from the postseismic deformation from the Landers and Hector Mine earthquakes. Data from the proposed network, combined with the data from other existing continuous and survey mode GPS networks in and around the region, will help differentiate the deformation sources, and particularly solve for the locking depth and slip rate along the San Andreas. Assuming a symmetric deformation pattern across the San Andreas, we can successfully isolate the deformation caused by the subsidiary faults south of the San Andreas from that caused by the San Andreas. Even if the deformation from the San Andreas isn't symmetric, data from this proposed network will help understand the interactions between faults and the dynamics of the lower crust in the region.

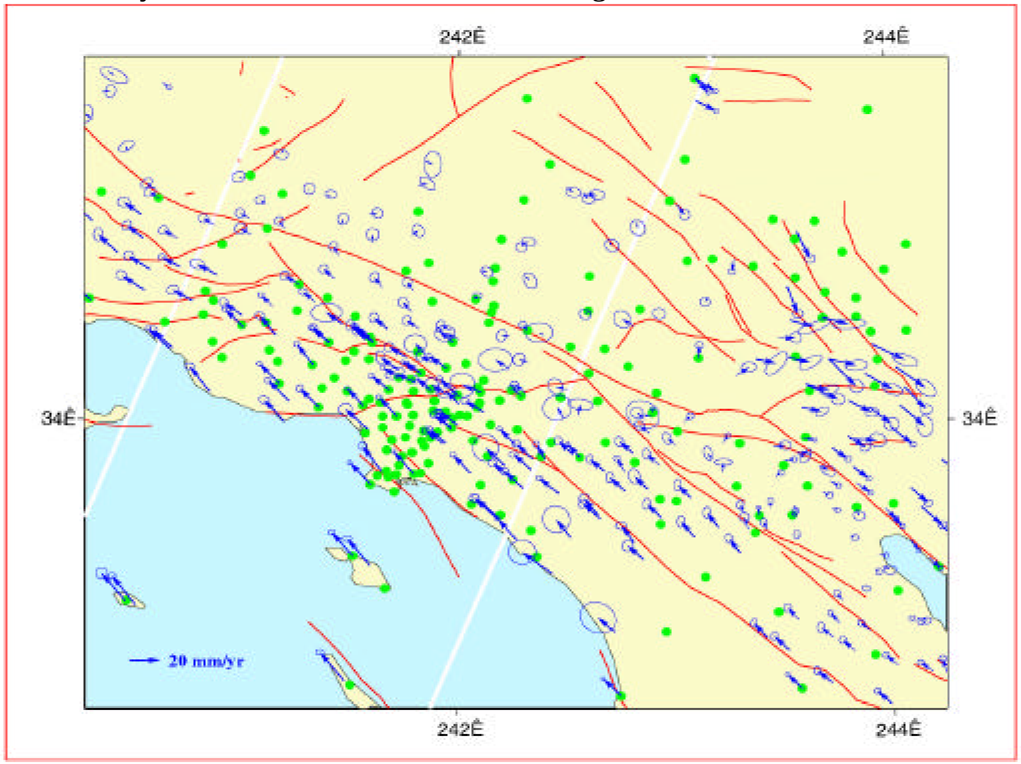

Fig. 1. Proposed area of study. Blue arrows are the horizontal velocities from the SCEC velocity map v2.0. Error ellipses are 95% confidence. White brackets delineate the sites whose velocities are shown in a profile across the San Andreas in Figure 2. The SCIGN stations are shown as green dots.

In order to achieve the goal, we need a network spanning the western Mojave Desert and its surrounding faults. Assuming that occupations of the Mojave Shear Zone and the San Gabriel Mtns are taken care of in other proposals, we address the importance of network densification within the desert and across the White Wolf and Garlock faults. We could do the experiment in two ways: (a) a survey mode network of ~70 stations, or (b) a continuous network of ~30 stations in the region. Some of the sites should be along profiles across the faults. One of the profiles should be built upon the existing SCIGN profile extended from the Los Angeles basin into the high desert (Figure 1). At least one other profile should go across the White Wolf and Garlock faults. Other stations should be about evenly distributed in the region. It is important to have a 2-D coverage of the region, since the deformation in the region is clearly 2-D and cannot be precisely described by 1-D profiles only. For the profile sites, we should aim at about 5-10 km spacing if survey mode sites are deployed, and 10-20 km spacing if continuous sites are deployed, respectively. For the 2-D coverage of the region the average spacing can be ~30 km and ~40 km for the survey mode and continuous sites respectively.

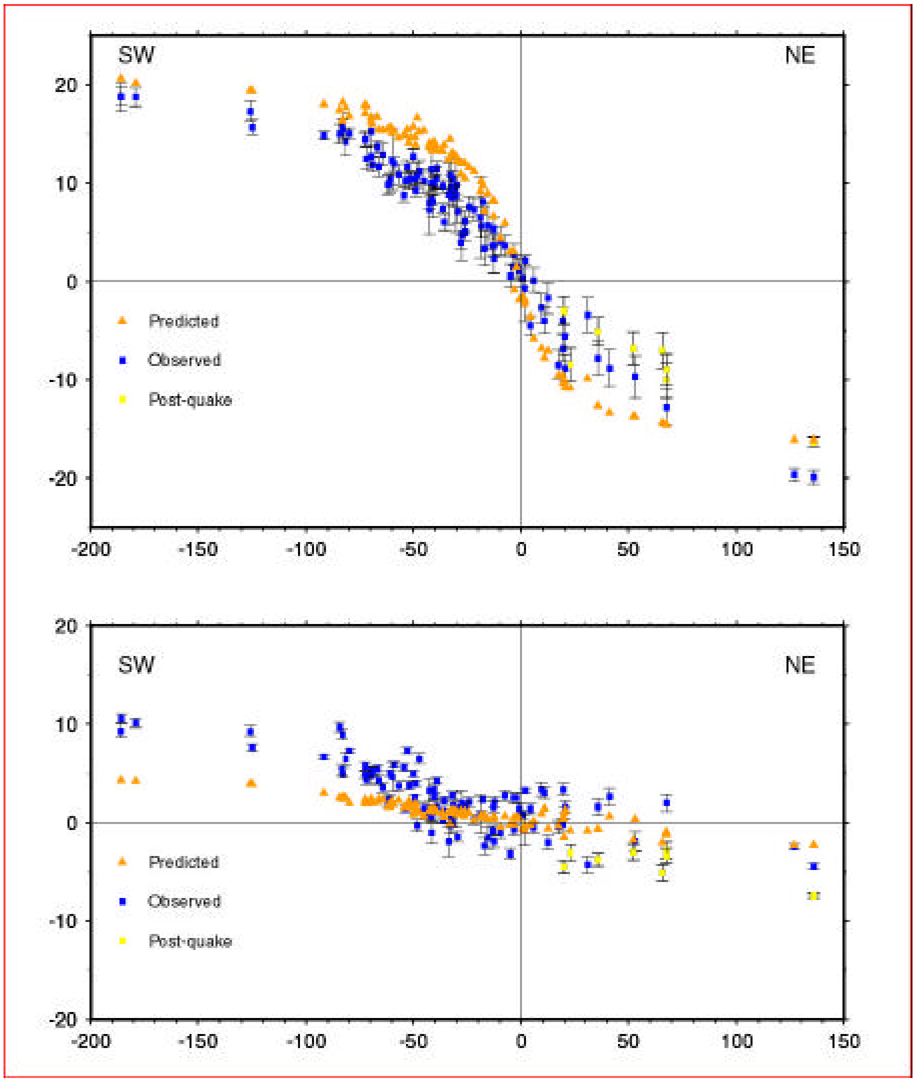

Fig. 2. Velocity profile across the Mojave section of the San Andreas. Data are from the SCEC velocity map v2.0, stations located in the white brackets in Figure 1. Orange triangles are predictions from a block-fault model with 30 mm/yr slip beneath 20 km locking depth at the Mojave section of the San Andreas (Shen and Jackson, 1999).

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