SCEC 2000 Progress Report (Group E)
Title of Project: Coseismic static stress and fault interactions of the 1992 Landers and the 1999 Hector Mine earthquakes from InSAR, GPS, and elastic half-space modeling

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We performed a portion of the work necessary to study the interactions between and mechanical properties of the fault systems involved in the 1992 Landers and 1999 Hector Mine earthquakes and the surrounding crust by focusing on only the coseismic static displacements on the two earthquake ruptures and the stress changes they induced. We combined InSAR and GPS-measured displacements of the Earth's surface in elastic half-space model inversions and forward predicted the stress changes induced by the Landers earthquake on the Hector Mine rupture. Finally, we investigated the perturbation and evolution of loading on the Hector Mine rupture after the Landers earthquake by assuming that the frictional properties along the Hector Mine rupture depend on the rate of sliding and the state of the sliding surface (rate-and-state friction).

We used European Remote Sensing Satellite-1 and 2 (ERS-1 and ERS-2) SAR imagery archived at SCEC by the Western North America Interferometric Synthetic Aperture Radar Consortium (WinSAR) to form spatially dense, two-dimensional maps of the line-of-sight (LOS) component of the Hector Mine and Landers earthquake coseismic surface displacement fields. We combined these maps with point-wise GPS-measured displacements determined by other researchers in inversions for the distributions of slip on the two earthquake ruptures (GPS displacements for the Hector Mine earthquake were shared by Duncan Agnew). We used these slip distributions to predict perturbations of the stress fields in the Earth's crust to investigate the relationship between the two earthquakes.

While forward prediction of the stresses induced on an earthquake rupture does not require the boundary element method (BEM), we used existing boundary element codes to do this. We compared our models of the distribution of slip on the Hector Mine rupture with the stresses induced by the Landers earthquake and found that the concentrations of slip on the Hector Mine rupture near the hypocenter occurred where shear stress was reduced the least by the Landers earthquake. We further used the BEM to invert for shear stress drops on the ruptures and the background stress direction consistent with the slip distributions of the earthquakes.

We found that the shear stress changes induced on the Hector Mine rupture by the Landers earthquake appear to have influenced the Hector Mine slip distribution. Also, the Hector Mine earthquake cannot simply be explained in terms of static loading caused by the Landers earthquake plus the average background long-term loading but requires additional time-dependant loading such as that created by a rate-and-state frictional response. Our rate-and-state friction models are preliminary but indicate that it is possible that a Coulomb stress increase of 1 bar occurred at the Hector Mine hypocenter 7 years after the Landers earthquake. This stress change is not of sufficient magnitude to assert that the Landers earthquake triggered the Hector Mine earthquake but a combination of this 1 bar Coulomb stress change with the 1 bar change predicted by viscoelastic modeling strengthens the case.

Our results have been submitted to the Bulletin of the Seismological Society of America and will be listed as SCEC contribution number 571[*Price and Bürgmann,*

2001a]. They have also been presented at the Y2K SCEC annual meeting [*Price and Bürgmann,* 2000a] and the Fall 2000 AGU meeting [*Price and Bürgmann,* 2000b]. Future results will be presented in April, 2001 as an INVITED abstract at the annual meeting of the Seismological Society of America [*Price and Bürgmann,* 2001b].

Price, E.J., and R. Bürgmann, Interaction between the Landers and Hector Mine earthquakes from space geodetic techniques and boundary element modeling, *2000 SCEC Ann. Meet. Proc. Abs.*, 2000a.

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Price E.J., and R. Bürgmann, (INVITED) Interactions between the Landers and Hector Mine earthquakes from space geodesy, boundary element modeling, and time-dependent friction, *Ann. Meeting of the Seism. Soc. Am.,* 2001b.