Analysis of Crustal Deformation Along the Southernmost Segment of the San Andreas Fault System, Imperial Valley, California: Implications for Earthquake Prediction

14-08-0001-G1679

R.E. Reilinger
Earth Resources Laboratory
Dept. of Earth, Atmospheric, and Planetary Sciences
Massachusetts Institute of Technology
Cambridge, Massachusetts 02142
(617) 253-7860

INVESTIGATIONS

This project involves using geodetic observations in conjunction with other geophysical and geological information to investigate contemporary tectonic processes along the southernmost segment of the San Andreas fault system. Our primary efforts during the present contract period include:

1. Completing a multi-institutional GPS campaign along an approximately 500 km section of the Pacific-North America plate boundary from northeast of Los Angeles, California to the Gulf of California, northern Mexico.

2. Continuing analysis and interpretation of 1986 to 1990 GPS measurements in the Imperial Valley-Salton Trough with emphasis on temporal and spatial patterns of regional strain accumulation, and strain release associated with the 1987 Superstition Hills earthquakes.

RESULTS

1. From 7 March through 3 April 1991, a consortium of universities, and state and federal agencies, undertook an extensive Global Positioning System measurement campaign along a 475 km section of the Pacific-N. American plate boundary from the Gulf of California, Baja, California, Mexico to the Big Bend segment of the San Andreas fault northeast of Los Angeles, California (Figure 1). Participating institutions included Caltech, CICESE, L-DGO, M.I.T., NGS, Riverside County Flood Control, San Bernardino County Survey, UNAVCO, University of Mexico, University of Texas at Dallas, and USGS. A total of 23 Trimble 4000 SST and 4 Ashtec receivers were used to observe 108 stations. In addition, simultaneous observations were made by the Orange County Survey using 8 dual frequency Ashtec receivers (sites not shown in Figure 1).

   The primary objective of the 1991 STRC GPS campaign was to continue monitoring the spatial and temporal distribution of crustal strain along this seismically active segment of the plate boundary. Towards this end, most sites observed in the Coachella Valley-Riverside County portion of the network have a history of GPS observations dating to 1988, and all sites

in the Imperial Valley date to 1986. Through cooperation of the San Bernardino County Survey, the network was extended north along the San Andreas fault in western San Bernardino County (site selection and coordination directed by Ken Hudnut). In addition, observations were made at 4 sites in San Diego County to facilitate ties to GPS observations planned by the San Diego County Survey (site information provided by Duncan Agnew, UCSD).

Complete copies of the original field data for the U.S. portion of the 1991 STRC experiment (excluding NGS and Orange County) are on file at M.I.T. and the Riverside County Flood Control. M.I.T. is converting the data to RINEX format for distribution to all participants in the experiment and for archiving at UNAVCO, SCEC, NGS, and NASA CDDIS.

2. We continue to concentrate on reduction, analysis, and interpretation of the 1986-1991 GPS observations in collaboration with Caltech, L-DGO, NGS, and U.T. Dallas. Initial results from the 1986-1989 observations are reported in 2 papers submitted for publication to JGR. Preliminary processing of the 1990 observations by Shawn Larsen at Caltech (Bernese) and Richard Bennett at M.I.T. (GAMIT), using broadcast orbits, indicate average day-to-day repeatability of less than 4 mm in baseline length. Some improvement is expected with inclusion of regional and global fiducial stations and improved satellite orbits.

   Figure 2 shows horizontal displacements from 1988 to 1990 based on our preliminary and partial 1990 reduction. These measurements give a preliminary deformation rate across the Imperial Valley of 4.5 $\pm$ 0.4 cm/yr. This rate is less than our previous GPS estimates (1986-1988: 5.9 $\pm$ 1.0 cm/yr; 1988-1989: 5.2 $\pm$ 0.9 cm/yr), and, while higher, is in better agreement with conventional geodetic estimates obtained from 15 years of USGS EDM observations of the Salton Network (3.4 $\pm$ 0.1 cm/yr; Prescott et al., EOS, 68, 1506, 1987).

PUBLICATIONS

Larsen, S. C., R. E. Reilinger, H. Neugebauer, and W. Strange, GPS Measurements of Deformation Associated with the 1987 Superstition Hills Earthquake, Imperial Valley, California: Evidence for Conjugate Faulting, *Seismological Research Letters, 62,* 34, 1991 (abstract).

Larsen, S., and R. Reilinger, Age constraints for the Present Fault Configuration in the Imperial Valley, California: Evidence for Northwestward Propagation of the Gulf of California Rift System, *J. Geophys. Res.,* in press, 1991.

Larsen, S., R. Reilinger, H. Neugebauer, and W. Strange, GPS Measurements of Deformation Associated with the 1987 Superstition Hills Earthquakes, Imperial Valley, California, *J. Geophys. Res.,* submitted, 1991.

Larsen, S., and R. Reilinger, GPS Measurements of Strain Accumulation Across the Imperial Valley, California: 1986-1989, *J. Geophys. Res.,* submitted, 1991.

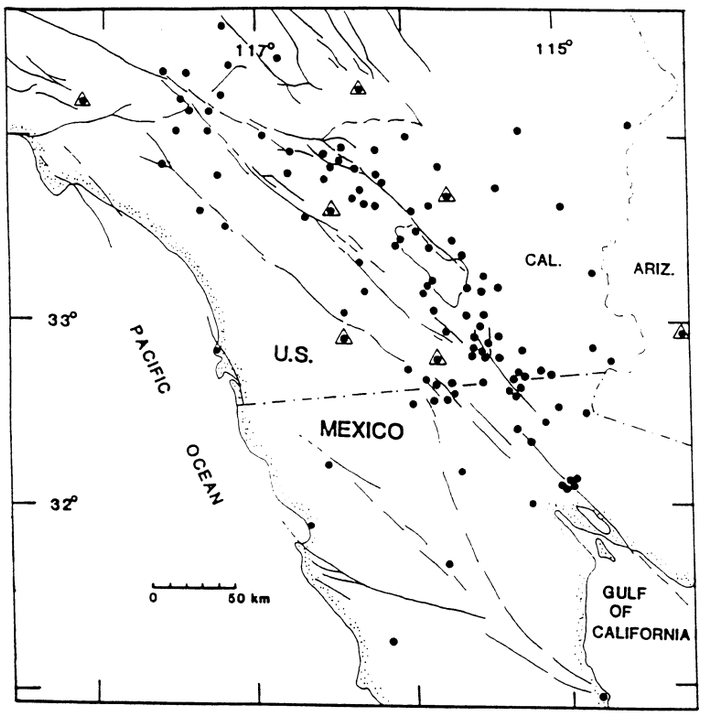

Figure 1. GPS sites observed during the 1991 Salton Trough-Riverside County (STRC) campaign (●). Triangles show mobile VLBI stations.

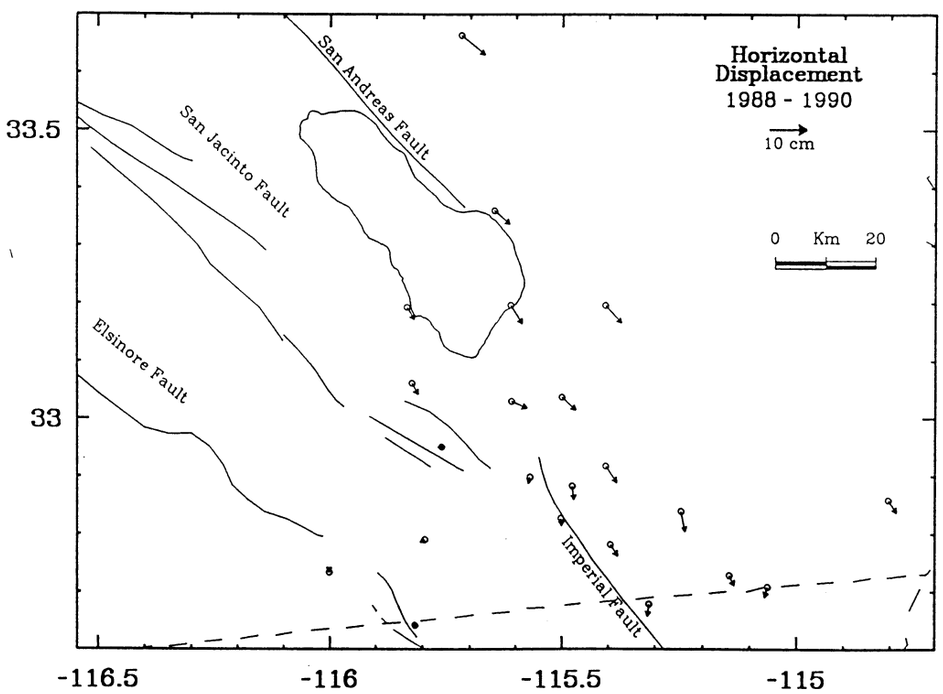

Figure 2. Preliminary GPS horizontal station displacements from 1988-1990. Only part of the 1990 data have been included (provided by Shawn Larsen).