GEODESY BY RADIO INTERFEROMETRY: DETERMINATION OF VECTOR MOTIONS FOR SITES IN THE WESTERN UNITED STATES

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Since the late 1970's, NASA's Crustal Dynamics Project has been using Mark III VLBI to study plate tectonic motion, plate boundary deformation and earth dynamics. One major thrust has been the study of crustal motions in the western continental United States. For this effort, several relatively large, fixed antennas (Mojave, Owens Valley, Hatcreek, Ft. Davis and Vandenberg) have been used along with two small, highly mobile VLBI systems which have periodically visited sites of tectonic interest.

For the work reported here, all dual frequency (S and X band) mobile VLBI experiments conducted between October, 1982 and February, 1987, and some fixed station only experiments dating back to 1979 were used. Each experiment was analyzed using weighted least squares. For each baseline, three orthogonal coordinates (length, transverse and vertical) were determined. The transverse component (in the horizontal direction at either site and perpendicular to the baseline vector), being very sensitive to earth orientation, was used only for data after January 1984, when the four station IRIS program (Carter et al., 1985) began making highly accurate measurements of the earth's orientation. The vertical component was not used because of its greater error due to uncertainties in the atmospheric delay. The length and transverse components for each baseline were solved via least squares for their rates-of-change. Though primarily a study of the western U.S., we have included several baselines to Westford and Fairbanks to provide some information on the rigidity of the North American plate. The length and transverse rates were used in a least-squares analysis of site motions. There were 83 length and 74 transverse determinations. Mojave was selected as the fixed reference point, and Westford was additionally held fixed to anchor the coordinate system. The results are shown in Figure 1, where velocity vectors and their one sigma error ellipses are plotted. For greater details of the experiments and analysis procedures, see Clark et al. (1987) and references therein.

Eastward motion is seen at Ft. Davis and Plattville, indicative of the expected spreading across the Basin and Range. Also as expected, the six sites west of the San Andreas show N.W. motions essentially parallel to the local trace of this fault. Pearblossom and Presidio,

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just east of the San Andreas, also show similar N.W. motions. None of the Pacific plate sites, however, shows the full predicted RM2 (Minster and Jordan, 1978) velocity of 56 mm/yr (now thought to be too high by about 20%). Interestingly, Fairbanks is required to move 14 mm/yr (1 sigma = 4 mm/yr) to the S.E in this solution. Thus, with respect to Fairbanks, Vandenberg and Ft. Ord do show the full RM2 motion and Mojave shows N.W. motion of about 14 mm/yr. Thus, inasmuch as Fairbanks can be considered representative of stable North America, there is evidence that significant N.W. motion is occurring well east of the San Andreas. This possibility is also supported by the southerly motion seen at Ft. Davis, Plattville, Ely, Flagstaff and Yuma.

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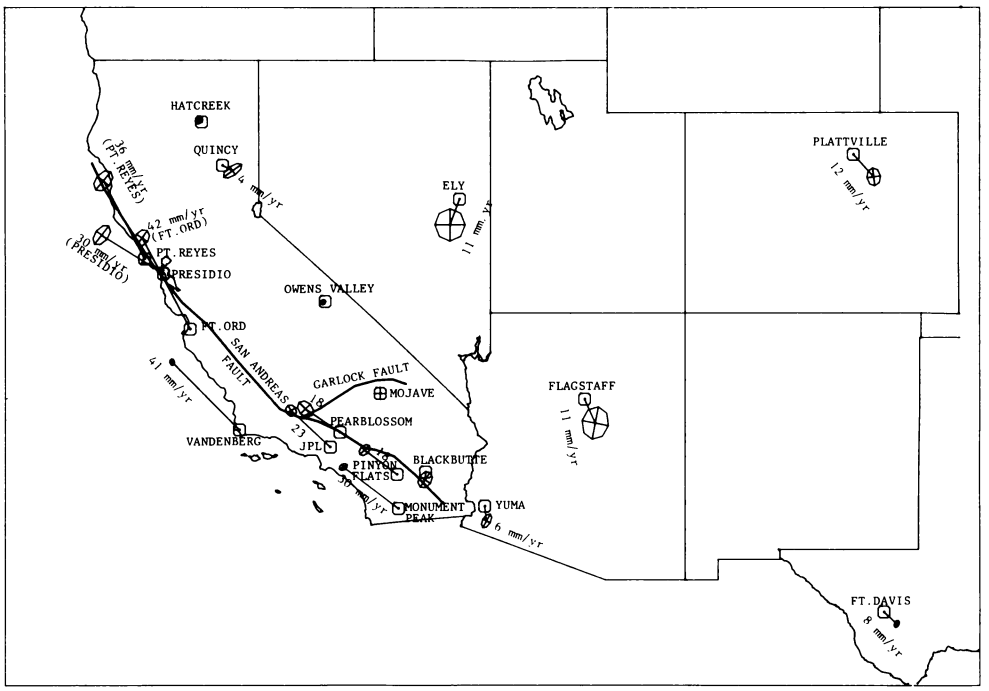

Figure 1: Western U.S. geodetic VLBI sites and their velocities in mm/yr with respect to a fixed Mojave. Also shown are the San Andreas and Garlock faults. The velocities of Owens Valley, Hatcreek and Blackbutte are essentially zero with respect to Mojave.

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