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Measurements and numerical modeling of strain partitioning and interplate coupling in NW Oregon in cooperation with PANGA

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Investigations: During the first year we were able to re-occupy the existing GPS network in NW Oregon, to install and occupy 16 new GPS sites in the Portland region (**Figure 1**), to process the data, and to compare to earlier GPS measurements of the USGS and Cascades Volcano Observatory. Results (**Figure 2**) were presented at a poster at the Plate Boundary Observatory meeting in October 1999 and will be presented at the PANGA Investigators meeting in November, and at Fall 1999 AGU meeting. In addition, we are developing finite-element models to help in understanding the observed GPS results. In particular, we are seeking physically robust alternatives to dislocation models that can be used to assess seismic hazards more realistically. We ran into no unanticipated problems.

Results: The expanded network allows us to start to separate the strains from rigid body rotations. This is an important distinction because the rotational velocities, if mistaken for strain, could lead to higher estimates of plate coupling and seismic hazards. At this point it appears that a rigid rotation of the Oregon forearc about a pole in Eastern Oregon accounts for the largest part of the velocities of the Oregon coastal sites in the North America reference frame. In the central Oregon forearc, plate coupling appears to be very small and located offshore. The GPS results are in agreement with uplift data. In northern Oregon, west of Portland, essentially all of the forearc motion can be explained by rigid rotation and very little, if any, plate coupling is required (**Figure 3**).

Future work: In the next year, we will re-occupy the central Oregon network and expand it to the south to overlap the USGS Cape Blanco network. With these measurements we can determine a pole of rotation for the entire Oregon forearc and isolate the plate locking strain signal. We will model the plate boundary strain with finite elements to place bounds on the possible locked portion of the thrust fault.

Non-technical summary: Our measurements with the Global Positioning System are showing the motions and deformation of Oregon that are caused by tectonic forces acting on it. We are finding that the motion is largely a rigid-body rotation possibly caused by a push from California to the south or from drag of the subducted seafloor beneath. At this point we would conclude that the greater seismic hazard is from the upper plate faults

that accommodate motion relative to North America than from the subduction fault offshore to the west.

Presentations:

McCaffrey, R., C. Goldfinger, M. Murray, P. Zwick, J. Nabelek, C. Smith, and C. Johnson, GPS constraints on forearc sliver motion, plate coupling, and strain partitioning in northwestern Oregon, *EOS* **79**, p. F874, 1998.

Dragert, H., A. Qamar, R. McCaffrey, C. Goldfinger, M. Miller, Measurement and interpretation of contemporary crustal strain along the Cascadia margin, *Seismol. Soc. Amer*, 1999.

Goldfinger, C., R. McCaffrey, M. Murray, P. Zwick, J. Nabelek, C. L. Smith, C. Johnson, GPS Constraints on plate coupling in central-western Oregon, *Seismol. Soc. Amer*, 1999.

Johnson, C., M. Long, R. McCaffrey, C. Goldfinger, P. Zwick, J. Nabelek, GPS determination of deformation and inferred plate coupling in Oregon, Pacific Northwest, *EOS* **80**, p. S315, 1999.

McCaffrey, R., C. Goldfinger, C. W. Stevens, C. K. Johnson, P. Zwick, M. Long, C. Williams, J. Johnson, Y. Zhou, J. Nabelek, M. H. Murray, and C. L. Smith, GPS measurements of plate coupling and strain partitioning in northwestern Oregon, *AGU Fall* 1999.

McCaffrey, R., C. Johnson, and M. Long, PANGA velocity field computed with GAMIT/GLOBK, *PANGA Investigators Meeting*, Vancouver B.C., 1999.

McCaffrey, R., C. Johnson, M. Long, C. Stevens, C. Williams, P. Zwick, C. Goldfinger, J. Johnson, J. Nabelek, Y. Zhou, M. Murray, C. Smith, GPS Measurements of Plate Coupling and Forearc Motion in Western Oregon, *PANGA Investigators Meeting*, Vancouver B.C., 1999.

McCaffrey, R., C. Stevens, C. Johnson, P. Zwick, M. Long, C. Williams, C. Goldfinger, J. Johnson, Y. Zhou, J. Nabelek, M. Murray, and C. Smith, GPS measurements of plate coupling and strain partitioning in northwestern Oregon, *Plate Boundary Observatory Workshop*, Snowbird, Utah, 1999.

Williams, C.A., and R. McCaffrey, Modeling of surface deformation at subduction zones: Alternatives to dislocation models, *AGU Fall* 1999.

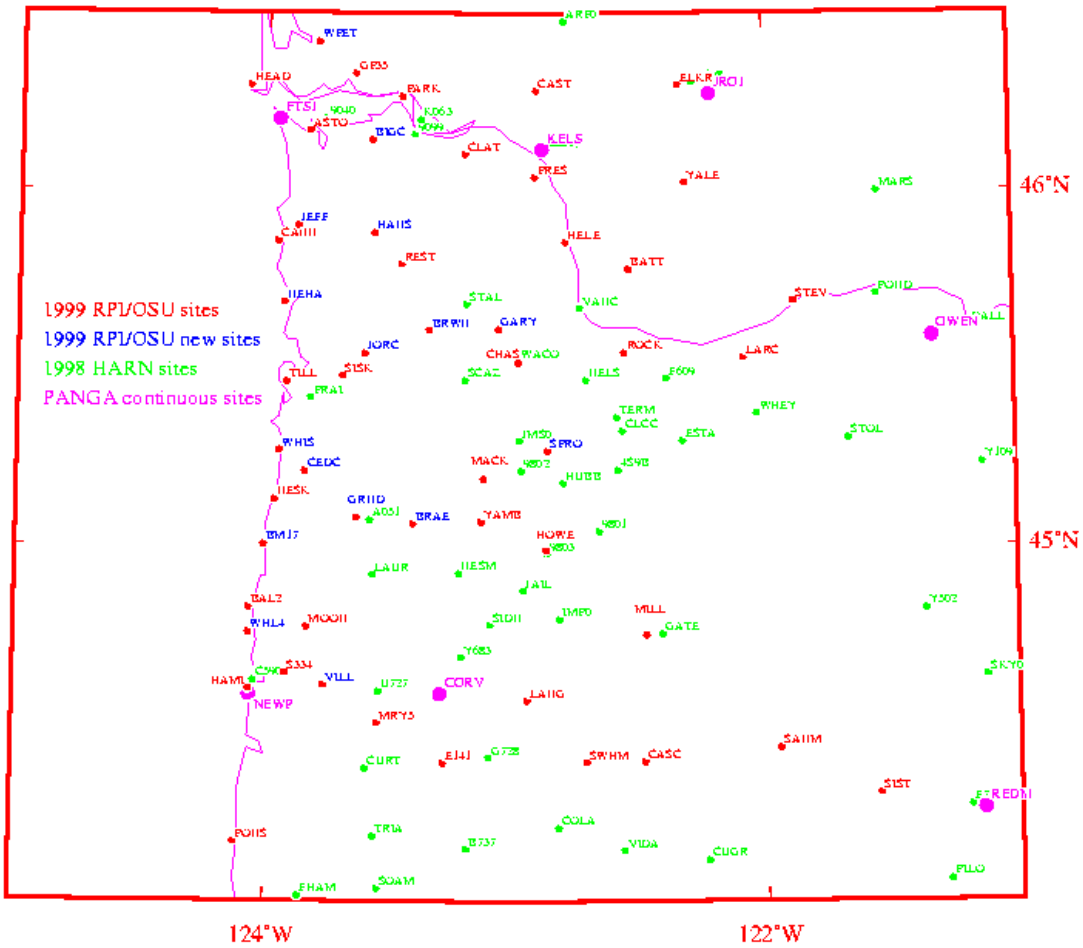

Figure 1. Map of NW Oregon showing the GPS network. Red labels show existing sites occupied in 1999, blue labels are sites occupied for the first time in 1999, and green are sites occupied during the 1998 HARN survey. Large purple dots show the PANGA permanent stations.

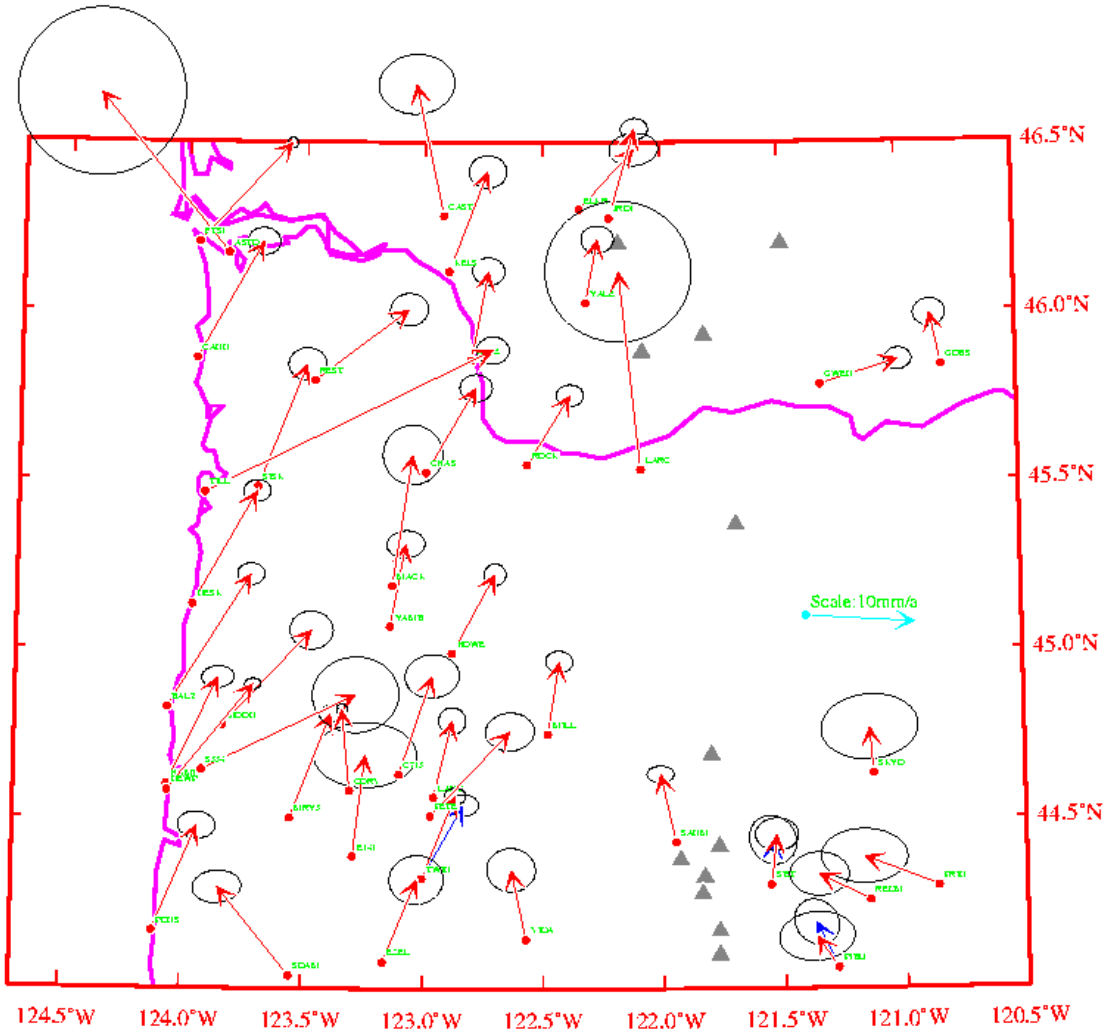

Figure 2: GPS Velocities of campaign sites in NW Oregon estimated from linear fits to time series of site positions. These are in a North America reference frame determined by finding a NA rotation pole in the ITRF96 frame and removing this rotation from the Oregon sites. Blue vectors are the USGS velocities for TWIN, SIST, and PIBU that show agreement with our estimates. Ellipses are at 95% confidence level.

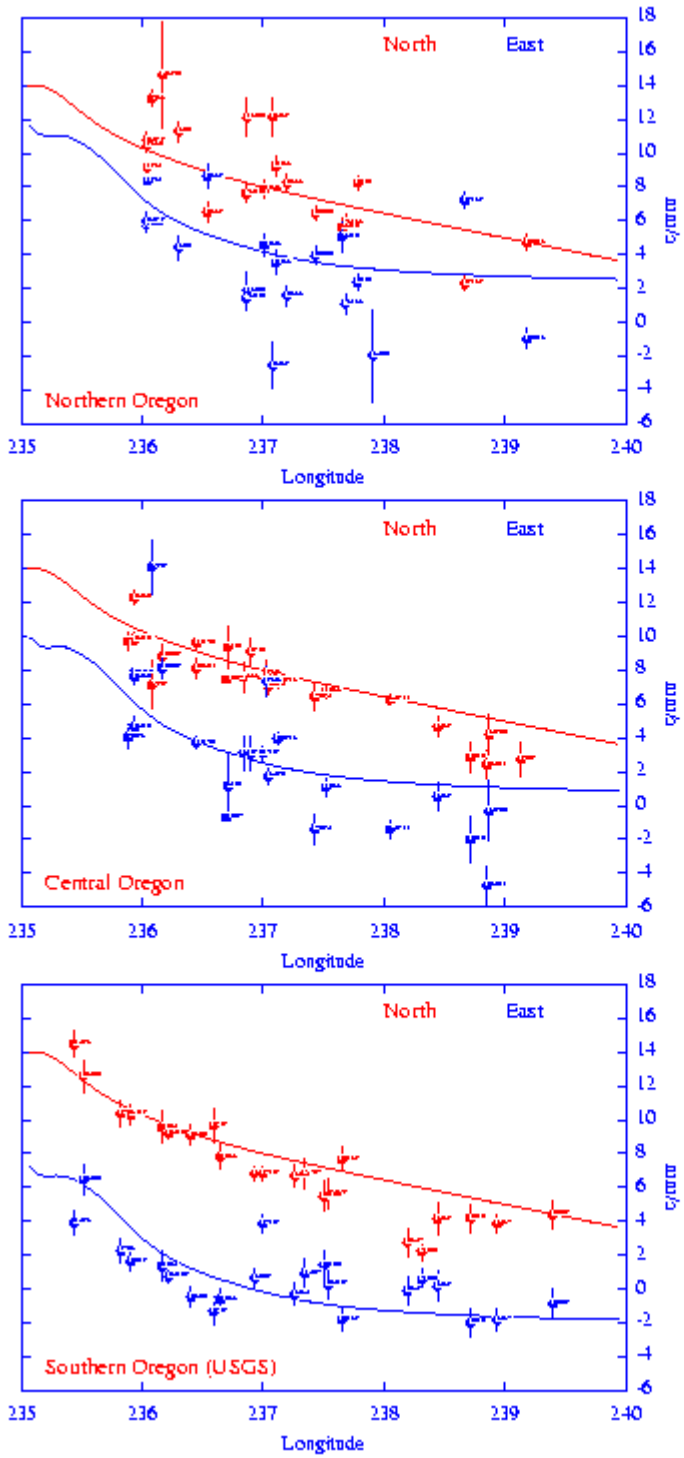

Figure 3. Fits of models of forearc rotation and plate coupling to observed GPS results from Oregon. The three panels show e-w profiles of the north and east components of the GPS velocities along with model predictions (smooth lines). The model comprises a rotation of the Oregon forearc about a point in eastern Oregon and about 20% plate coupling offshore.