# One Decade of Strain in the Southern Cascadia Margin: Collaborative Research Between Humboldt State University and University of Alaska, Fairbanks

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**Investigations Undertaken**

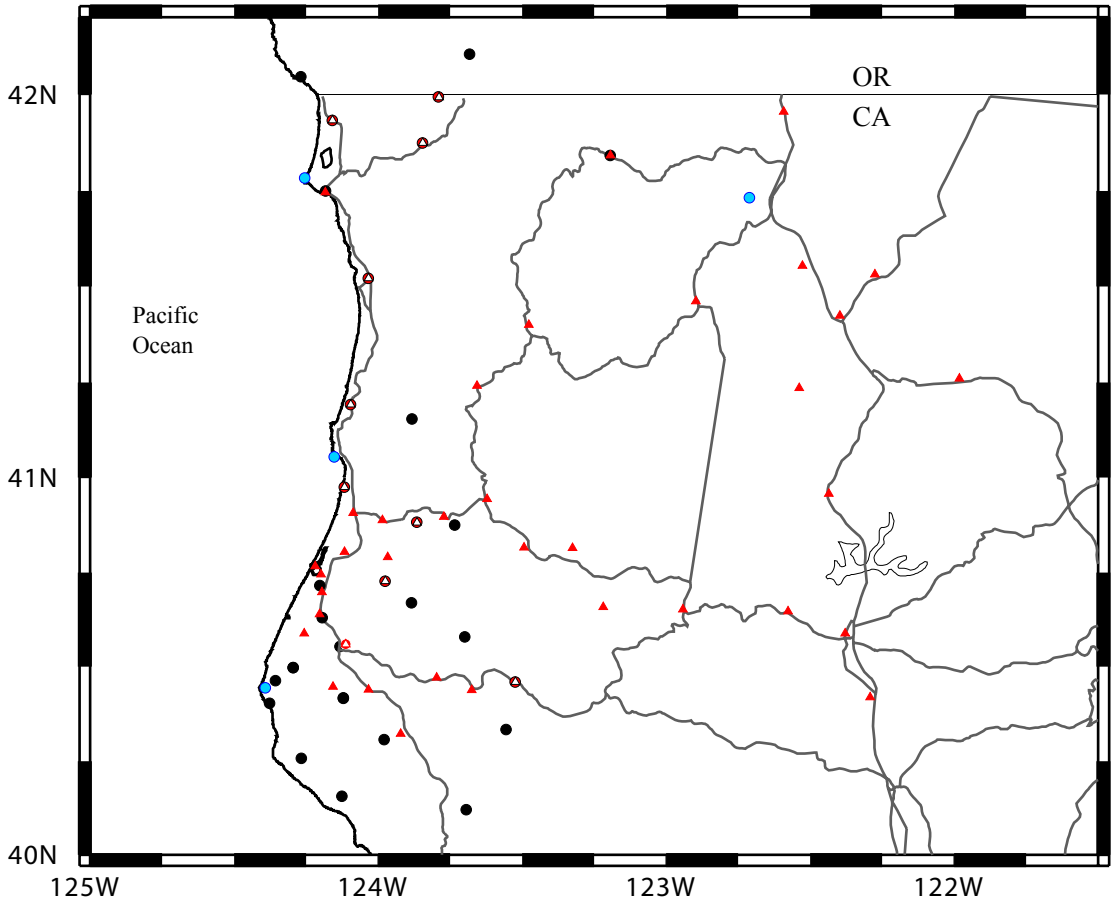
In May of 2001, Humboldt State University (HSU) and University of Alaska-Fairbanks (Jeff Freymuelller, UAF) completed a 2 week campaign-mode GPS survey to investigate the kinematics of elastic strain accumulation within northwestern California (Figure 1). The campaign encompassed the region approximately N 40.5$^o$ – N 42$^o$ to W 122$^o$ – W 124$^o$ (Figure 1). This region includes the transition zone between the northwestward propagating Pacific-North American plate boundary that is the San Andreas fault system, and the northeast converging Juan de Fuca/Gorda-North American plate boundary (Atwater, 1970; Silver, 1969). Many workers have documented the potential for and the occurrence of great earthquakes (M ~8) along the Cascadia subduction margin within the Holocene (Atwater et. al, 1995). Associated with the southern end of the subduction zone is the onland subaerial portion of the deformation front within the upper crust of North America (Clarke and Carver, 1992). In addition, there are translational structures inboard of the subduction zone related to the northward migrating San Andreas transform system (Kelsey and Carver, 1988). Furthermore, GPS site velocity estimates of strain accumulation immediately south of this region related to the faults of San Andreas system suggest a substantial amount (~ 2 cm/yr total on 2 fault zones) of translational strain is entering this region (Freymueller et. al., 1999).

During the 2 week campaign-mode GPS survey, 31 existing benchmarks with historical GPS measurements were observed for 8 hours each in two separate daily sessions. The sites surveyed included those of the High Precision Geodetic Network (HPGN; ~ 40 km spacing; 1991; initiated by the California Department of Transportation

and the National Geodetic Survey), the HPGN-Densification network (HPGN-D; ~ 10 km spacing; 1993), the Cascade Volcano Observatory (CVO; 1996), and Humboldt State University (2000) (Figure 1). In the time immediately following the campaign, until October of 2001, Todd Williams surveyed an additional 10 sites to bring the total sites surveyed in 2001 to 41. These 41 sites will comprise the sites for which velocities will be estimated for this experiment. During each survey, a secure campaign site was used as a continuously (~ 18-24 hours/day) operating station in addition to the other sites determined during any given field observation period. This method was used in addition to utilizing the existing regional Continuously Operating Reference Stations (CORS) network to estimate the local tropospheric conditions to aid in more accurately determining each stations' position for the given time epoch.

In addition to this latest HSU/UAF survey, the United States Geological Survey (USGS) completed a campaign-mode GPS survey within the same region in July of 2001. The USGS survey observed 11 coincident sites to the HSU/UAF 2001 survey (Figure 1). These data have been retrieved from the University of California - Berkeley archive (ftp://quake.geo.berkeley.edu/pub/gps/survey/usgs/), have been processed, and will be utilized in the 2001 GPS site coordinate determinations. Two of the 11 coincident sites that have been permanently integrated into the USGS Mendocino GPS network were installed as part of the HSU/UAF experiment (sites CW-07 and CW-08; http://quake.wr.usgs.gov/research/deformation/gps/auto/Mendocino/).

Figure 1. Location map of GPS sites in Northwestern California.




Continuously Operating (GPS) Reference Station (CORS)

HPGN and HPGN-D; NGS; CVO: HSU Benchmarks Reobserved 2001 HSU/UAF

USGS Mendocino Network Campaign GPS site

Coincident GPS Site Between USGS and HSU/UAF 2001 Surveys

Major Roads

The regional CORS sites will be included in the velocity estimates for the same days campaign sites were observed in the last 10 years. Sites surveyed in 2000 by HSU not surveyed in 2001, but, surveyed by the USGS in 2001, brings the total number of sites to 48.

All of these GPS station sites will be used to estimate potential locked patches of the coupled zone between the offshore Gorda plate and the adjacent North American plate. Also, we hope to utilize these data in modeling the broader plate boundary transition zone that is the Mendocino Triple Junction.

**Results**

The site velocity estimates have not been completed as of yet, however, 95% of the post processing of the data necessary to estimate velocities for the last decade in this region is completed.

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**Acknowledgements**

Figure 1 was created with Generic Mapping Tools (GMT) software version 3.3.6.
More information on the HPGN: http://csrc.ucsd.edu/projects/hpgn.html

**Non-technical Summary**

In this research we use satellite based surveying (global positioning system (GPS) geodesy) to determine how the ground surface in northern California is deforming in response to stresses induced by plate tectonics. The field work involved conducting an intensive two week survey in which 6 persons occupied, for 8 hour sessions, existing benchmarked sites that had been surveyed previously. The difference in site position between previous surveys and those of this past summer, as determined from GPS geodesy, will give a picture of how various locations in northern California are moving relative to each other and to more stable regions further east. This type of information can be used, through the implementation of models, to develop

hypotheses about how the region will deform during earthquakes and what the possible spatial pattern of future earthquakes will be.

**Reports Published**
None.

**Availability of seismic, geodetic, or processed data.**
Rinex survey data will be submitted to the UNAVCO project archive.