A Densified Geodetic Velocity Solution for the North San Francisco Bay Region

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Introduction

We present an expanded and updated velocity solution of 64 sites (excluding existing Plate Boundary Observatory sites and excluding sites currently with velocity uncertainties > 1 cm/yr for the southern end of the North San Francisco Bay area). These velocities are now reaching a level of maturity and precision that they may be used for meaningful analysis and incorporation into regional velocity solutions. We are concerned with the interaction of fault systems in the North Bay area, specifically the Rodgers Creek and southern Maacama Faults, which we thought to pose a significant potential hazard to the area. All data from the rapidly deforming area in The Geysers (see Figure 1) are excluded for the purpose of this presentation.

We acquired publicly available and restricted data sets from a number of sources to augment our own data collection, listed in Table 1, below.

Dislocation modeling and comparison to UCERF2 model

We use a simple elastic model where the dislocation is free to slip but locked above a given depth. The locking depth is found on the fault-normal plane in the UCERF2 model for the fault sites used for the solution. An extended model allows each finite fault segment except the fissured fault which is covered by data, to have a top and bottom locking depth. A locking depth of 0 m gives a surface creep model, at any significant level and the required fault slip rates are changed very little.

Both models are weighted according to the data because the velocity uncertainties, as well as the velocity solutions, are not rigorously described. We use a 3.5 m/yr for the 64 sites used north of San-Paulis Bay.

Proximity to other geodetic networks

The University of California, Berkeley, oversees the BAVU network around the San Francisco Bay area and the USGS’s Petabyte exists north of Clear Lake. Our network bridges this poorly sampled gap and provides a means by which to begin working towards a rigorously combined geodetic solution for the whole of the Bay Area and northern California coast.

Additionally, we are occupying alignment array sites to support the work of Jim Lienkaemper (USGS).

Conclusions

As of the time of this presentation, the velocity solution is only a few weeks old. More time and better analysis will reveal characteristics and intricacies of the fault slip rates in the North Bay area.

Our simple model of slip on a deep dislocation yields estimates of slip rate that prefer a higher slip rate on the Maacama-Rodgers Creek-Hayward Fault system and less on the San Andreas Fault compared to the current UCERF2 model and petrophysical modeling solutions. Shallow creep is still to be more rigorously and realistically modeled.

Future work will include better analysis of noise characteristics of more realistic velocity uncertainties, incorporation of available PBO GPS solutions and other continuous GPS solutions, and combination with AUSOS and/or persistent scatterer (PS) SAR.

References


Figure 1: Velocity solution relative to Pacific plate (ITRF2005, Altamimi et al., 2007). Only sites with 1σ uncertainties are shown (10 sites are shown here). More sites have been included, especially near Santa Rosa (intersection of Rodgers Creek Fault and profile B-B), but currently suffer from a lack of observation period (2 years).

Figure 2: Zoomed view of current GPS velocities at alignment array REGS (Rodgers Creek, Francis Crook Flaherty), relative to site AREG. Though these velocity are based on just one year of data, further measurements may support the existence of surface creep.

Figure 3: Profiles through data and models as shown in Figure 1.

Figure 4: Comparison of data and model velocities, relative to the Pacific (ITRF2005), for sites used for the solution.

Table 2: Results from UCERF2 and our elastic dislocation modeling.