

Tidal Calibration of PBO Strainmeters Located in the Pacific Northwest

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The Plate Boundary Observatory has installed a dozen Gladwin Tensor strainmeters in the coastal region between Vancouver Island and Oregon with the goal of measuring strain changes due to “episodic tremor and slip” (ETS) in the Cascadia subduction zone. I have used the theoretical Earth tides with Ocean load adjustments (Agnew, 1999) to calibrate five of those strainmeters. The primary goal is to detect significant strain changes that can be attributed to tectonic activity. Each instrument consists of four extensometers. For each extensometer, all of the expected tidal amplitudes are estimated along with the response to changes in atmospheric pressure. At two sites located adjacent to inlets, the sensitivity of each extensometer to changes in ocean height due to ocean tides are evaluated along with the standard tidal analysis. This evaluation becomes complicated because the local height change data needs to be filtered in two frequency bands—less than 18 hours and greater than 18 hours. Each of these bands affects the instrument differently. Finally, the amplitude and phase of the M2 and O1 tidal constituents are compared against the theoretical tides of the tensor strain. I use method suggested by Hart et al. (1996) (equation 13) where the theoretical tides are fit to the observed tides using standard least-squares regression. This method is simply a “black-box” approach where there are no assumptions made concerning isotropic borehole deformation and topographic affects. After removing the affects of the grout curing, the background noise level of each tensor component is evaluated in terms of a power-law spectral density such that rate changes can be estimated with realistic estimates of their significance using the methods of Langbein (2004).

References

- Hart et al., (1996), Tidal calibration of borehole strainmeters: Removing the effects of small-scale inhomogeneity, *JGR*, v101, p25,553—25,571.
- Agnew (1999), SPOTL: Some programs for Ocean-Tide loading, <http://igppweb.University Of California, San Diego.edu/~agnew/spotlmain.html>
- Langbein (2004) Noise in two-color EDM measurements revisited, *JGR* v102, doi:10.1029/2003JB002819.
- For more information see http://quake.wr.usgs.gov/research/deformation/twocolor/PBO_strain/

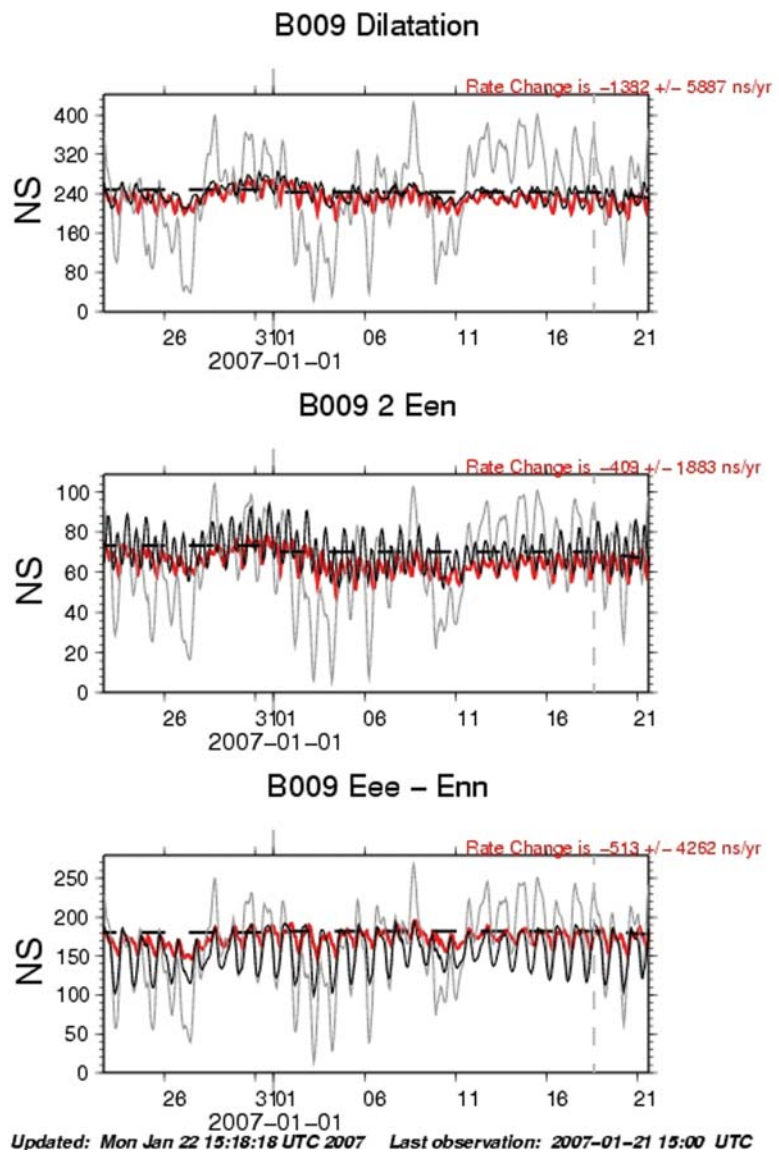


Figure 1. Example of reduction of borehole strainmeter data for site B009 located on Vancouver Island adjacent to Patricia Bay. The tidal range is 3.8 meters. Gray represents the raw data after the transforming the extensometer data into tensor quantities using tidal calibration. The black curve is the data after adjusting for changes in atmospheric pressure and the water level changes in Patricia Bay. Red represents the residual strain after removing the solid Earth tide and Ocean-load. The dashed line is a fit of linear trend over the 30-day interval and its rate change over the last 3 days; the rate change with its standard error is posted over each plot.