Borehole strain observations of very low frequency earthquakes in Cascadia

*Jessica C Hawthorne[1], Abhijit Ghosh[2], Alexandra A Hutchison[2]

1. University of Leeds, 2. University of California Riverside

We identify and examine strain signals associated with very low frequency earthquakes (VLFEs) in central Cascadia. The several hundred M 3.3 - 4.7 VLFEs considered were identified by cross-correlation with the templates of Ghosh et al. (2015) and are located beneath southern Vancouver Island and the Olympic Pensinsula. In the seismic records, the events appear to have most of their energy at periods of 20 to 50 seconds. Here we use nearby PBO borehole strainmeters to examine how deformation accumulates on timescales of 2 minutes to 2 hours. The strain signals produced by VLFEs are small, so we focus on the closest stations: B005, B007, B003, and B004, and we isolate components of strain that have small atmospheric and hydrologic noise. Then we compute moment rates averaged over the 600 VLFE times. First, we estimate the average moment rate within 1 minute of the VLFEs. We estimate that the strain rate in the 2 minutes centered on the VLFEs is about 1.5 times the average strain rate in the surrounding 12 hours. We interpret this increased strain rate as a factor of 1.5 increase in moment rate, which implies an average moment per VLFE equivalent to that of a M 3.4 earthquake, within the range of seismic moment estimates for the VLFEs. Next, we examine the strain rate in the time intervals around the VLFEs. The estimated strain rates decrease only gradually before and after the VLFEs, suggesting that, on average, the slow slip moment rate is higher closer in time to the events. For instance, the strain rate---and by inference the moment rate---in the 2 hours centered on the VLFE times is about 1.2 times larger than the average rate in the 12 hours centered on the VLFEs. Similar strain rates are estimated before and after the VLFEs. The high moment rates in the surrounding intervals may help constrain how VLFEs interact with the larger slow slip event. VLFEs may be more likely to occur when the slip rate in the surrounding slow slip event is higher.

Keywords: slow slip, very low frequency earthquakes, borehole strain

