Study of Non-Volcanic Tremors in the Cascadia Subduction Zone

Amir Farahbod

The Cascadia subduction zone extends 1,100 km from northern California to southwestern British Columbia. The region is characterized by complicated tectonics due to the interactions of three main lithospheric plates: the large Pacific and North American plates and the intervening Juan de Fuca plate system, which includes the Explorer, Juan de Fuca and Gorda plates. The Cascadia subduction zone is thought to be capable of generating megathrust earthquakes at an interval of 500-600 years. The seismogenic portion of the plate interface is mostly offshore and is currently locked, as inferred from geodetic data. However, episodic surface displacements in the direction opposite to the long-term deformation trend, which is caused by relative plate convergence across a locked interface, are observed about every 10 to 19 months, and are accompanied by non-volcanic tremors.

During this study, I located several episodic and minor tremor sequences along the Cascadia subduction zone from Vancouver Island to northern California between February 2003 and December 2005. My results suggest that Cascadia tremors occur within a distributed deformation zone surrounding the plate interface. I observe spatial and temporal correlations between the greatest magnitude of slow slip and the location of the first day of tremor activity for some episodic sequences in northern Cascadia. In addition to ETS events, minor tremors also occurred in the region of slow slip, but during different time intervals. In northern California and Oregon, tremors are mainly located where the interplate thermal structure is 550°C–600°C, while the distribution of northern Cascadia tremor epicentres borders the downdip extension of the thermal transition zone in northern Puget Sound, and places the majority of tremors where the interplate thermal structure is 500°C–550°C. A close correlation between tremors and microearthquakes, and anti-correlation with big earthquakes is apparent in the Cascadia subduction zone. Tremors mainly occur when b-value is close to an extremum. The only clearly identified gap in tremor activity in northern Cascadia correlates with the lowest measured coda Q in the region.