Slow Slip Events, Nonvolcanic Tremor and the Guerrero Seismic Gap, Mexico

Vladimir Kostoglodov
Instituto de Geofísica, UNAM
vladi@servidor.unam.mx

Research Group G-GAP
ISTerre,Grenoble; IPGP, Paris; GeoAzur, Nice, France; IGEF, UNAM

Last decade was remarkably fruitful in discovering new seismotectonic phenomena: Slow Slip Events (SSE) and Nonvolcanic Tremor (NVT) in different active plate boundaries. The Guerrero seismic gap located in the Central Mexico subduction zone is a hot area of intensive study as it possibly has accumulated, for the last 100 years, sufficient elastic strain to be released in Mw~7.8-8.0 earthquake. Since its installation, the permanent GPS network in Mexico detected four large Slow Slip Events (SSE) of the equivalent seismic magnitude Mw~7.5 with a periodicity of about 4 years. There are also some indications of smaller and more frequent SSEs. Comprehensive analysis and modeling of GPS data revealed a very important strain release by those SSE in the gap. It comes out that the interplate coupling and elastic strain accumulation in the seismogenic zone of the Guerrero gap is much lower than in the neighboring segments of the zone, which suffer large subduction thrust earthquakes more frequently. Since 2005, when continuous seismic data became available the NVT was discovered in Mexico, and systematic studies of this new phenomenon started in Guerrero. The MASE experiment and new seismic network in Guerrero recorded the NVT with different characteristics and locations. It occurred that an inherent relation exists between the tremor activity and the SSE. Detailed analysis of the NVT duration and epicenters distributions, a modeling of the 2006 SSE in Mexico show that the NVT bursts with duration of a few weeks occur periodically every 3-4 months without clear GPS indication of large concurrent slow events. Meanwhile large SSEs modulate notably the intensity and frequency of the NVT bursts. Low energy NVT is occurring persistently at a distance of ~215 km from the trench. During large SSEs, the duration and frequency of the NVT bursts increased and low energy bursts are also observed as close as ~150 km to the trench. Some NVT bursts may coincide with smaller SSEs, extending ~180 km to ~220 km

from the trench with durations of a few weeks. Our observations indicate that some parts of the NVT in Guerrero can be associated with the Low-Frequency Earthquakes (LFE). However, the amount of identifiable LFEs is very small. We also observed strong triggering of the NVT activity by teleseismic waves after Maule, Chile 2010 earthquake that overlapped with the 2009-2010 SSE in Guerrero. Conversely the Great Tohoku 2011 earthquake did not produce any noticeable tremor excitation in Guerrero. The origin of the nonvolcanic tremor as well as the SSE is not yet clear. Based on the available data and comparing NVT-SSE observations in other regions (Japan, Cascadia, Costa Rica, Alaska, New Zealand), it seems that the model of dislocations on micro-cracks filled with dehydrated fluids can explain the physics of deep (~30-40 km) NVT with a very low static stress drop of n·10kPa. There are some indications that the NVT is mostly related with the episodes of small SsEs occurring along the subduction interface downdip from the shallower zone of large SSE.