Subject offered for a contract starting in September 2011

SUBJECT TITTLE: Studying Non-Volcanic Tremors in the Mexican subduction zone.

Advisor: **SHAPIRO, Nikolai, DR CNRS, nshapiro@ipgp.fr**
Second Advisor/ Supervisor:

Host lab/ Team: *please fill in and leave out meaningless information*
IPGP- Team Seismology – UMR7154

Financing: Doctoral contract with or without assignment

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Presentation of the subject: (1 or 2 pages)

Recent observations demonstrate existence of a new type of deformation that episodically occurs on faults during their interseismic period. It involves repeated episodes of slow sliding of a few centimetres over a period of several weeks or months and seismic emission called nonvlcanic tremor (NVT) that is distinctly different from the seismic signals generated by earthquakes. The occurrence of slow slip in combination with seismic tremors was first discovered in Cascadia and Japan and, then, in many other subduction zones and within large strike-slip faults (e.g., San Andreas fault in California).

The existence of the slow earthquakes and non-volcanic tremors highlights a behavior of the faults and of the surrounding medium that we were ignoring. This makes clear that we need to deeply revise our vision of the seismic cycle and of the fault mechanics. Also, because these transient deformation phenomena intervene in the loading/unloading process of the faults, they likely are one major factor that governs the date and size of the next major 'regular' earthquake on a fault. Their understanding is therefore needed, not only to further constrain the mechanical behavior of the faults, but also to become capable of providing realistic earthquake scenarios and trustful hazard estimates.

While slow earthquakes and NVT were first discovered in Japan and Cascadia, there are other regions providing very favorable geological conditions for studying these phenomena. Among important factors to consider are: the subduction convergence rate and coupling that determine the intensity of seismic cycle, the subduction geometry that affects the size of the area where the ETS occur and the accessibility of land-based observations, and existence of good instrumental and historical records of past earthquakes and transient events. Combination of these factors makes the Pacific coast of central Mexico an almost ideal natural laboratory where we can advance our understanding of slow earthquakes and non-volcanic tremors and their relation to seismic cycle. A fast subduction (~6cm/year) of a young Cocos plate gives rise to very active thrust

fault seismicity with several M≥8 earthquakes per century. Another particular feature of this subduction zone is its flat geometry that results in a very favorable observational setting with a ~200 km long portion of the subduction interface lying at depths ≤40 km and is well exposed to land based geodetic and seismic stations. Recent observations revealed that slow earthquakes and non-volcanic tremors occur on the more than 100 km wide flat segment of the subduction interface (e.g., Kostpglodov et al., 2010). The size (equivalent to magnitudes between 7 and 7.5) and the duration (several months) combined with a very favorable observational setting makes them particularly attractive object to study. Another important aspect is that these slow slip events are located in the Guerrero seismic gap where no large subduction earthquake occurred since 19th century making it prone to occurrence of a catastrophic event in a near future. Therefore Central Mexico is a very suitable location to study the relationship between the slow transient events and the evolution of seismic gap.

Therefore, in this PhD project we propose to carry out a detailed study of nonvolcanic tremors in the Mexican sudduction zone. This analysis will be done with using records from two seismological temporary networks: (1) Middle America Subduction Experiment (MASE) and (2) G-GAP – joint French-Mexican experiment funded by the French Agence National de Recherche. The available data sets cover several years of observations that include occurrence of two strong slow-slip events in 2006 and 2010-2011. The goals of the analysis are to refine the location of NVT events in space and time and to understand better mechanics of their generation. In particular, two important questions are: (1) if the NVT are located on the subduction interface or are broadly distributed within the continental crust? (2) if the NVT and the slow earthquakes are manifestation of the same deformation process or if their origins are different? Answering these questions will help to better constrain the nature of deformation mechanisms underlying these transient phenomena and in particular the role of the anelastic rheology of the medium surrounding the fault.

The candidate will work within the seismology team at IPGP and is expected to develop strong collaborations with the partners of the G-GAP project in ISTerre, Grenoble and UNAM, Mexico.