Subject offered for a contract starting October 2019

SUBJECT TITTLE:Observation and modelling of deformations during the seismic cycle associated with subduction megaearthquakes

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Financing: Doctoral contract with or without teaching assignment

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Over several thousand kilometres around the areas affected by subduction megaearthquakes, the plates stretch towards the trench for several decades after an earthquake (post-seismic phase) and are compressed at the end of the cycle (interseismic phase). This process, highlighted over the past two decades, is due to deformations generated at depth in a viscoelastic Earth by stresses induced by the megaearthquakes. It is observed in all areas with giant earthquakes (Chile, Southeast Asia, Japan, Alaska). These intraplate deformations reflect, among other things, events that may have occurred several decades ago and thus contain a kind of memory of the slip over the subduction interface. They can provide us with information on the mechanical properties of the mantle near the subduction zone but also far below the continents. They help to understand how stresses accumulate and then release during the seismic cycle and how these stresses are transmitted from one seismic zone to another.
The purpose of this thesis is to contribute to the collection, analysis and modelling of deformations during the seismic cycle, first in South America but also in other areas prone to megaearthquakes (Japan, Indonesia). Our team has been measuring by GPS deformations along the Chilean margin and in Southeast Asia (Indonesia, Thailand) for many years. We also have experience in 3D modelling of post-seismic deformations after the three recent megaearthquakes (Sumatra, Chile, Japan) (Klein et al. GJI 2016) and the numerical techniques used using the finite element method (http://www.zset-software.com) can easily be adapted to model the global seismic cycle, which

we have also modelled in a simplified 2-dimensional geometry (Trubienko et al. Tectonophysics, 2013). The recent occurrence of the 3 giant earthquakes makes it possible to study the mechanical and rheological properties of the Earth's mantle on time constants that are not those of geological times but those ranging from months to thousand years. We hope that this thesis will provide scientific results that are both fundamental and applied to a better understanding of seismic alea:

- How does the modelling of the intersismic phase with viscoelastic rheology affects the determination of the'coupling' which is an indication of stress accumulation and therefore seismic risk (Métois et al.JGR 2012, Pageoph 2016) but which is currently modelled assuming an elastic earth?
- How do seismic cycle deformations modify stresses and seismicity far away within the plates but also along the subduction interface?
- What is the relationship between stress variations during the seismic cycle and long-term "tectonic" deformations in the plates (viscoplastic rheology of the lithosphere rather than elastic)?

Experience or initial training in continuum mechanics and/or geodesy is not required but would be an advantage for the candidate. The subject can be modulated according to the candidate's profile and interests and may involve a more or less significant part of field data acquisition (GPS), particularly in Chile, data processing and/or modelling.
The thesis will take place at the ENS and will be supervised by C. Vigny, E. Klein and L. Fleitout.