Subject offered for a contract starting in September 2013

SUBJECT TITTLE: Impact of incoming oceanic plate on subduction zone interplate coupling

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Financing: Doctoral contract with or without assignment

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The largest and most destructive earthquakes occur in subduction zones. Water from the dehydrating subducting plates is presumed to have a critical effect on the mechanical behavior of the megathrusts and on the occurrence of intraslab earthquakes. Therefore, major effort and resources have been dedicated in the past few decades to understanding the dehydration processes in subduction zones. At the same time, relatively little effort has been directed toward quantifying the amount of water in oceanic plates entering the subduction systems. This is surprising considering that the likelihood of succeeding in constraining the amount of water in oceanic plates with the desired accuracy is far greater before they cross the trenches because the plates are much shallower and the geometry of geologic structures is much simpler in oceanic basins than in subduction zones. This Ph.D. proposal is focused on: Evolution of the Juan de Fuca (JdF) plate from ridge to trench; Comparison of interplate interface coupling in subduction zones with presubduction characteristics of the incoming oceanic plates.

At the Cascadia subduction zone, the state of the down-going JdF plate is of particular interest as relatively little hydration of this young oceanic lithosphere (~6-9 Ma at the subduction zone [*Wilson,* 2002]) is expected. With the presumed warm state of the plate, hydration of the oceanic lithosphere may be confined to the crust, limiting the potential volume of water bound chemically into the plate [e.g., *Hyndman and Wang,* 1995]. However, intraslab seismicity located below the oceanic crust [*Preston, et al.,* 2003] suggests the presence of water reaching into at least the shallowest mantle of the down-going plate. To understand the contribution of water to subduction zone processes at Cascadia, constraints on the state of hydration of the incoming JdF plate are needed.

1) Determining the evolution of upper crustal layers 2A and 2B with unprecedented detail and accuracy requires 2D waveform tomography on long-streamer MCS data (e.g., Delescluse et al., 2011) spanning the area from the Endeavour ridge segment to the

trench. For this, the Ph.D. candidate will use a 300 km-long profile collected on *R/V Ewing* and *R/V Langseth* in 2002 and 2012 using 6- and 8-km-long streamers, respectively. The first 150 km next to the ridge axis are already preprocessed for waveform tomography with starting P-wave velocity models for inversion already constructed (*Nedimović et al.*, 2008; *Newman et al.,* 2011). The produced results will also facilitate testing of the hypothesis that upflow and downflow zones of hydrothermal cells can be directly imaged using controlled source seismics (*Newman et al.,* 2011).

2) Constraining the evolution of the lower crust and uppermost mantle requires wide-angle OBS data collected on *R/V Langseth* in 2012. First arrival traveltime tomography for long profiles, one along the trench and two from ridge to trench, are currently being constructed. These profiles will determine the changes in velocity of the crust and uppermost mantle as plate evolves. However, accurately relating these velocity changes to the extent of crustal alteration and mantle serpentinization is not possible without separating the effect of the crustal and mantle anisotropy. The Ph.D. candidate will achieve this by analyzing MCS and OBS data collected along short profiles perpendicular to the long ones, as well as by analysis of MCS and OBS data collected by semi-circle (fan) shooting. Both datasets were collected on crust prior and posterior to the previously determined onset of bending-related normal faulting [*Nedimović et al.*, 2009].

3) Global compilations show no clear correlation between plate interface locking at subduction zones and incoming oceanic plate age and convergence speed. However, other factors related to the incoming oceanic plate that may have a significant effect on interplate coupling, such as plate hydration and oceanic plate type (slow/intermediate/fast spread), have not been taken into account. The Ph.D. candidate will expand the global database of parameters characterizing incoming oceanic plates beyond age and convergence speed. He/she will then carry out a comparative analysis between estimated plate coupling and the parameters differentiating incoming plates.

The Ph.D. candidate will work at the ENS Laboratoire de Géologie (under the supervision of M. Delescluse, assisted by C. Vigny and N. Chamot-Rooke) and is expected to be willing to travel to Halifax, Canada, carry out a part of his/her Ph.D. research there, and extensively use the Dalhousie Imaging Group (M. Nedimović) computing facilities, the core of which consist of a computer cluster (600 GHz compute power and 400 GB RAM) and data storage system (>100 TB disk space). Both groups have state-of-the-art industrial and academic software for analysis of MCS and OBS data.

The ideal candidate is expected to have a strong interest in geodynamics and geophysics, good Unix and computing skills, willingness to manage large datasets, and and enthusiasm to improve their English speaking, reading and writing skills.