Subject offered for a contract starting in October 2014

SUBJECT TITTLE: Elastic and anelastic structure of Northeastern Japan inverting active seismic reflection data

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Financing: GPX or École doctorale IPGP

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The Northeastern Japan subduction zone is one of the most seismically active zones on our planet and has recently experienced a M>9 earthquake on the 11th March 2011 producing a devastating tsunami which killed more than 15,000 lives and unaccountable loss of properties. In order to understand the earthquake and subduction zone processes, and/or to mitigate the seismic and tsunami risks in the region, it is urgently needed to explore detailed seismic structure of the region.

In this region, the Pacific plate is subducting beneath the land area and the volcanic front runs through the middle of the arc. There are strong contrasts between the fore-arc and back-arc sides. Regional passive seismic surveys revealed the existence of an inclined low-velocity zone in the mantle wedge, interpreted as a mantle upwelling flow induced by the subduction of the Pacific plate (e.g., Hasegawa et al., 1991; Nakajima et al., 2001). In order to detail furthermore the structure, one has to visit active-source seismic reflection data. JAMSTEC (Japan Agency for Marine-Earth Science and Technology) carried out over 200 multi-channel seismic reflection surveys in the region using a 5 km-long streamer since 1997. In this project we will focus on several reflection datasets acquired in the subduction zone in northeastern Japan (e.g., TH03-07) to infer detailed elastic and anelastic structure (Vp, Vs, Qp, Qs).

Seismic attenuation provides additional insights into magmatic processes in subduction zones, since higher temperature environments or the existence of fluids may have different effects from seismic velocity (e.g., Karato, 2003; Cammarano & Romanowicz, 2008). We might thus be able to strongly constrain composition, temperature, water content, eventually the dynamics. Nakajima et al. (2013) obtained a regional long-wavelength Qp model using t* measurements from passive data in the region of our interest. However, it is very difficult to extract anelastic information from seismological records since the amplitude loss due to partitioning of energy between P- and S-wave is much stronger than intrinsic attenuation, one thus has to take care of the scattering effect (e.g., Gung & Romanowicz, 2004; Fuji et al., 2010).

Here in this project, we propose to develop an objective and efficient methodology for simultaneous inversion of seismic reflection waveforms for elastic and anelastic structure, using real active-source datasets acquired in northeastern Japan region. We might first extend wave equation tomography (finite frequency tomography: e.g., Montelli et al., 2004; Wang et al. 2014) to anelastic structure, measuring t*, in order to obtain a good initial model for waveform inversion. We propose to use an algorithm for visco-elastic waveform inversion developed in IPG Paris (e.g., Shipp & Singh, 2002; Belahi et al. 2014) for the final inversions.

Students with strong background in mathematics, physics and interest in numerical methods are invited to apply. The project will be funded through IPGP GPX program or IPGP doctoral school. The students will work closely with our academic and industry partners.

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