ÉCOLE DOCTORALE SCIENCES DE LA TERRE

Subject offered for a contract starting in October 2014

SUBJECT TITLE: ***Stereo-Wave Tomography***

Advisor: CHAURIS, Hervé, PR, herve.chauris@mines-paristech.fr
Second Advisor/ Supervisor:
Host lab/ Team : **GPX, Centre de Géosciences, MINES ParisTech, Fontainebleau**

Financing: GPX/IPGP/Industry

For more information go to http://ed109.ipgp.fr*, section: Offres de these (PhD offer), You must apply on the Doctoral School website*

The determination of the background velocity model remains a challenging task in seismic imaging. It controls the kinematic of the wave propagation and is needed for subsequent full waveform inversion. We propose to investigate a new method, the "Stereo-Wave Tomography" (SWT) approach. This is an extension of Stereo-Tomography (ST). ST is a slope tomography, consisting of fitting the travel times and the slopes at the source and receiver positions (Billette and Lambaré, 1998). It is defined under the ray theory (high frequency approximation) and appeared to be successful on synthetic and real data (Lambaré, 2008).

Complicated models, e.g. in the presence of salt body with a rough interface, may require more advanced approaches: in that context, we propose the Stereo-Wave Tomography. As for ST, the input data set is decomposed into a sum of locally coherent events. This can be for example achieved via a curvelet decomposition (Nguyen and Chauris, 2010). Then the objective function consists of minimizing the misfit between observed and computed data in the curvelet domain. For the modelling part, two-way Green's functions are used, without relying on the high frequency approximation. Potentially, SWT is not limited to reflected data. In principle, SWT is also not restricted to smooth models.

Compared to full waveform inversion, SWT offers the possibility to select part of the input data during the minimization process. This is an important aspect to avoid local minima in the objective function. A strategy should be established during the project to properly define the selection criteria, probably from low to higher frequencies and from long to short offsets. Once the objective function has been defined, the gradient will be obtained through the adjoint state technique. Efficient computation should also be worked out. Applications will be carried out on synthetic and real data sets.

The GPX team (esp. MINES ParisTech) has a long experience on the decomposition of seismic data into curvelets and associated processing tasks such as tomography and velocity estimation (Chauris and Nguyen, 2008).

The candidate must have a research master degree in physics, geophysics or applied mathematics, and be interested in seismic signal processing, seismic modelling and seismic imaging. The candidate should also have experience in programming. Good knowledge of English is essential.

References:

Billette, F.,, Lambaré, G., 1998. Velocity macro-model estimation by stereotomography. *Geophysical Journal International*, **135**(2): 671-680.

Chauris H., Nguyen T. T., 2008, Seismic demigration/migration in the curvelet domain, Geophysics, **73**(2) S35-S46.

Lambaré, G., 2008, Stereotomography, *Geophysics*, **73**(5): VE25-VE34.

Nguyen T. T., Chauris H., 2010, The Uniform Discrete Curvelet Transform. *IEEE Transactions on Signal Processing*, **58**(7), 3618-363.