ÉCOLE DOCTORALE SCIENCES DE LA TERRE

Subject offered for a contract starting in October 2013

SUBJECT TITTLE: ***Time-lapse 3D elastic full waveform inversion using injected grid method for monitoring of reservoir***

Advisor: Satish Singh

Second Advisor/ Supervisor: Nobuaki Fuji

Host lab/ Team : **GPX**

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

Full waveform inversion (FWI) is a powerful tool to quantify Earth properties of the subsurface from seismic data, and has become a major area of research. The idea is based on minimizing the difference between observed and modelled data using an adjoint state technique. Compared to conventional methods, FWI allows to take into account the full information contained in seismic data. Because of very high computational cost, FWI has so far been used for either 2D full elastic media (Sears et al. 2010) or 3D acoustic (Plessix and Perkins, 2010), and 2D time-lapse mode (Quisser and Singh, 2012). However, the Earth is three-dimensional, elastic and highly heterogeneous, therefore requiring a full 3D elastic inversion. Recently, we have developed a full waveform inversion in the time lapse using an injected grid method (Borisov and Singh, 2013). The Grid Injection Method (GIM) is well suited for time-lapse seismic studies since it allows for efficient calculation of synthetic seismograms after model alterations within a localized area where changes occur only inside a reservoir. The method is based on the principles of superposition and continuity of wavefields along a boundary and only requires calculations in the sub-volume and its neighbourhood, but its application in limited to a synthetic data and small model. The method has also has application to determine high-resolution imaging of reservoir by inverting higher frequencies (60 Hz) for the reservoir.

In this project, we propose to apply this inversion algorithm to a real 4D data set (Norne) acquired for Statoil using Q-Marine technology of Schlumberger; we have access to these data. The application of waveform inversion to real data will pose several challenges, e.g. determination of background velocity, source wavelets, inversion of the 3D first vintage, and then time-lapse image. One has to consider the large computation requirement.

A student with strong background in geophysics and interests in large-scale computing are encouraged to apply. The student will receive training in seismic modelling and inversion of seismic data and will work closely in collaboration with the GPX industry partners. They will integrate in the dynamic GPX group and will actively participate in broad range of research carried out at IPG Paris.

References:

Borisov, D. and Singh, S.C. (2013). Time-lapse Elastic 3D Full Waveform Inversion using Grid Injection Method, EAGE Expanded Abstract.

Queisser, M, and Singh, S.C. (2012). Full waveform inversion for time lapse quantitative monitoring of CO2 storage, *Geophysical Prospecting*, DOI: 10.1111/j.1365- 2478.2012.01072.x

Sears, T., Barton, B.J., Singh, S.C. (2010). Elastic full waveform inversion of multi-component ocean bottom cable seismic data: Application to Alba Field, UK North Sea, *Geophysics*, **75**, R109-R119.