Subject offered for a contract starting in October 2013

SUBJECT TITLE: ***Seismic Interferometry for Reservoir Characterisation***

Advisor: Nikolai Shapiro
Second Advisor/ Supervisor: James Martin
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

Passive seismology is an alternative way of probing the Earth's interior using noise records only. The main idea is to consider seismic noise as a wavefield produced by randomly and homogeneously distributed sources when averaged over long time series. In this particular case, cross-correlation between two stations yields the impulse response (Green's function) between these two points. In the case of the Earth, most ambient seismic noise is generated at the surface. The surface wave part of the Green's function is most easily extracted from cross-correlations of the noise, enabling very efficient noise-based surface wave tomography methods (Shapiro et al, 2005). Extracting reflected and refracted body waves from noise remains more challenging, but is essential if interferometric inversion methods are to be used to reliably characterize hydrocarbon reservoirs (Edme et al, 2012). Inversion of ambient noise could be used to characterize and monitor shallow reservoirs. Particularly, low frequency noise signals can be used to augment the higher bandwidth of seismic data recorded using active seismic sources, to provide additional, valuable constraints for acoustic impedance inversion for reservoir characterisation and full waveform inversion for the velocity/depth model.

The student will explore and characterise the noise recorded by modern, very densely distributed seismic networks composed of thousands of receivers from either the marine or land environments. The desired part of the noise field, that which propagates directly between the particular chosen pair of sensors, is only a fraction of the total incident noise recorded by the sensors. The student will determine how best to eliminate the unwanted noise prior to the interferometry inversion step, thus dramatically improving the signal-to-noise ratio of the resulting estimate of the Green's function. The student's focus will not only be on the application of multi-channel and multi-component algorithms to attenuate unwanted noise, but also on the instrumentation and field technique necessary to eliminate unwanted noise modes while enabling the recording high fidelity low frequency seismic data.

By computing the Green's function between all possible stations, every receiver can be converted into a virtual source recorded by all others resulting in numerous dense virtual short gathers. These gathers will be processed and analyzed with novel array based methods to filter out the dominant surface-wave component of the wavefield to extract the desired body waves. Comparison will be made with images from seismic data using active seismic sources, and the benefits of adding the low frequency signal from interferometry inversion to the active source seismic data for acoustic impedance inversion will be investigated.

The method outlined in this project is aimed at enabling more accurate and efficient reservoir characterization and monitoring using ambient noise recording and is a potential game changing technology for reservoir monitoring applications.

Students with a strong background in physics, mathematics, numerical modelling (finite difference modelling) and signal processing are encouraged to apply. The student will receive training in seismic data acquisition, seismic data processing and interferometric methods, and their application to geophysical problems from GPX in collaboration with industrial partners. The student will contribute to and participate in synthetic data simulations and field experiments as part of their project. They will also integrate into the dynamic GPX group and will actively participate in the broad range of research carried out at IPG, Paris.

References:

Shapiro, N.M, M. Campillo, L. Stehly, and M.H. Ritzwoller, 2005, High resolution surface wave tomography from ambient seismic noise, Science. 307, 1615-1618.

Edme, P. and Halliday, D.F., 2012, Near-surface Imaging from Point-receiver Ambient Noise, 74th EAGE Conference.