ÉCOLE DOCTORALE SCIENCES DE LA TERRE

Subject offered for a contract starting in September 2013

SUBJECT TITLE: ***Distributed Fibre Optic Sensor for Borehole Vertical Seismic Profiling and Velocity/Depth Model Calibration***

Advisor: James Martin (IPGP/Schlumberger) & Daniela Donno (Ecole des Mines, Paris)

Second Advisor/ Supervisor: Arthur Hartog (Schlumberger)
Host lab : **GPX / Schlumberger**

Financing: Industry - Schlumberger

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

A new emerging technology is the distributed fibre optic sensor, whose principle is to use a simple optical fibre, of the types often deployed in the telecommunications industry, as a sensor to measure the seismic elastic wavefield every metre over the entire length of the fibre. The simple deployment of a single optical fibre with its tiny cross-sectional area offers much opportunity to make acoustic measurements in boreholes where access for conventional vertical seismic profiling tools will be time consuming and very expensive. A fibre deployed in a well can detect multi-offset and azimuth signals from surface seismic sources from the surface to the deepest depth of the well. These measurements can revolutionise the calibration of the 3D velocity/depth model, essential for the accurate imaging and inversion of 3D and 4D seismic data and their conversion to true depth, (Barberan et al., 2012, Mestayer et al., 2012 and Miller et al. 2012).

The physics of what a distributed fibre actually measures is poorly understood, as are the signal processing approaches needed to extract the most value from such systems within the context of seismic elastic wavefield sampling. The coupling of the fibre to the borehole wall and the optical nature and structure of the fibre itself can also be optimized to deliver more reliable measurements.

The student will study the fundamental physics of how a fibre interacts with the environment into which it is deployed and its sensitivity to the seismic elastic wavefield, through the use of finite element modelling codes and laboratory experiments. The essential signal processing approaches needed to deliver measurements of high fidelity will also be researched. The student will determine the optimum means of making accurate measurements of the seismic elastic wavefield within a borehole. These solutions will be evaluated using controlled field experiments at test sites made available by either GPX or its industrial partners. The student will work with GPX staff and our industrial partners to collect, analyse and interpret experimental field data. The velocity/depth profiles determined from distributed fibre optic sensor will be compared with those from conventional approaches using inversion of surface seismic data and check-shot vertical seismic profiles. The application of the distributed fibre optic sensor measurements to 3D imaging of seismic data will also be evaluated.

Students with a strong background in physics, mathematics, numerical modelling (finite element modelling) and signal processing are encouraged to apply. The student will receive training in fibre optic sensor technology and their application to geophysical problems from GPX in collaboration with industrial partners. The student will contribute to and participate in laboratory 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:

Barberan, C., Allanic, C., Avila, D., Hy-Billiot, J., Hartog, A., Frignet, B., and Lees, G., (2012), Multi-offset Seismic Acquisition Using Optical Fiber Behind Tubing, 74th EAGE Conference.

Mestayer, J., Grandi Karam, S., Cox, B., Wills, P., Mateeva, A., Lopez, J., Hill, D. and Lewis, A., (2012), Distributed Acoustic Sensing for Geophysical Monitoring, 74th EAGE Conference.

Miller, D., Parker, T., Kashikar, S., Todorov, M., and Bostick, T., (2012), Vertical Seismic Profiling Using a Fibre-optic Cable as a Distributed Acoustic Sensor, 74th EAGE Conference.