Subject offered for a contract starting in October 2013

SUBJECT TITTLE: ***Joint inversion electromagnetic and seismic waveform to quantify reservoir***

Advisor: Satish Singh

Second Advisor/ Supervisor: Kerry Key (Scripps) a

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

Seismic waveform inversion provides information on P and S-wave velocity structure in fine details (Sears et al., 2010). The P-wave velocity is very sensitive to small amounts of free gas whereas S-wave velocity is sensitive to the presence of fluid in the subsurface. Therefore, it is difficult to quantify the amount of gas or oil from seismic results alone. On the other hand, the resistivity, which can be estimated using electromagnetic (EM) methods, is sensitive to the quantity of oil and gas. However, the resolution of the EM method is an order of magnitude lower than that of the seismic method. We can use the strength of the two methods to get the seismic resolution (Brown et al., 2012) and also to quantify the amount of oil and gas in reservoirs. Further during the extraction of oil and gas from a reservoir, all the other parameters remain the same except the change in resistivity and seismic properties in the extracted part of the reservoir. We propose to invert joint seismic and EM data in the time-lapse mode in order to quantify the extraction of oil and gas from the reservoir over time.

Recently, we have developed a seismically regularised inversion of controlled source EM data (Brown et al., 2012) where the seismic full waveform inversion is first performed to determine P wave velocity, which is used to regularise inversion of EM data. The limitation of the current implementation is that the resolution of two data sets is very different and we have only been able to include P-wave velocity. We propose to use the recently developed wave equation tomography and waveform inversion method (Wang et al, 2012) and performed combined inversion of seismic and EM data and then use these results to further invert fine-scale P and S-wave velocity information along with the resistivity, and hence better provide constrains on the reservoir.

A student with strong background in mathematic, physics, computing, numerical modelling 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, and EM Group at Scripps Institution of Oceanography. They will integrate in the dynamic GPX group and will actively participate in broad range of research carried out at IPG Paris.

References:

Brown, V, Key, K, Singh, S.C. (2012). Seismically regularized controlled source electromagnetic inversion, *Geophysics* 77, E57-E65.

Wang, H, Singh, S.C, Jian, H. and Calandra, H. (2012). Integrated inversion of subsurface velocity structures using wave equation tomography and full waveform inversion, SEG Expanded Abstract.