Subject offered for a contract starting in September 2012

SUBJECT TITTLE: Full waveform inversion of long offset seismic reflection data to quantify fluid along active faults in Sumatra Subduction zone

Advisor: **MARTIN James, PR, jmartin@ipgp.fr**

Second Advisor/ Supervisor: **SINGH Satish, PR, singh@ipgp.fr**

Host lab/ Team: **IPGP- Exploration Geophysics et Geosciences Marines – UMR7154**

Financing: **Doctoral contract with Chaire Industrielle**

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Presentation of the subject: (1 or 2 pages)

The Sumatra subduction zone is one of the most seismically active zones on the earth and has experienced three great earthquakes in the last six years, including one of the largest earthquakes of the 21st century on December 26, 2004 (M~9.3) producing a devastating tsunami in the Indian Ocean region, which took more than 230,000 lives and unaccountable loss of properties. The second earthquake (M~8.7) occurred three months later on March 28, 2005 about 150 km SE of the 2004 event. The Earth waited for three years, and then broke again in September 2007 at ~1300 km SE of the 2004 event producing a twin earthquake of magnitudes 8.5 and 7.9 at 12 hours interval, leaving a gap of ~700 km (Mentawai Islands) between the second and third earthquake. A small part of this patch ruptured on October 25, 2010, Mw=7.8 producing a tsunami up to 8 m high on Pagai Islands. Recent geodetic and seismological studies suggest that this gap is fully locked and may produce a great earthquake up to Mw=9 in the coming future.

In order to understand the earthquake and subduction zone processes, and mitigate the seismic and tsunami risks in the region, we acquired deep seismic reflection data using 15 km long streamer in partnership with CGGVeritas. Initial results show the presence of deep subdcuted seamounts (Singh et al., 2011a), active faults near the subduction front (Singh et al., 2011b) and re-activated backthrust (2011c). However, these results remain qualitative. In this project we propose to perform elastic full waveform inversion to determine the detailed (10-20 m scale) P and S-wave velocity structures of the fluid-rich faults (e.g. re-activated backthrusts after 2004 and 2007 earthquakes, see Singh et al., 2011a), gas hydrate reflectors (e.g. Singh et al., 1993), which could be used for monitoring fluid flow and possible sites for drilling before and after the imminent earthquake in the Mentawai locked zone. We propose to use the full waveform inversion technique that we have developed (Shipp and Singh, 2002, Sears et al, 2008).

Students with strong background in mathematics, physics and interest in numerical methods are

invited to apply. The project is funded through the newly established IPG Paris Industry Chair program (GPX) in partnership with Ecole des Mines de Paris and several industry partners. The students will work closely with our academic and industry partners, and will have opportunity to work in industry during the Ph.D. He/she will receive training in seismic wave propagation, modeling, inversion and analysis of seismic data.

References:

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Shipp, R.M. & Singh, S.C. (2002). Two-dimensional full wavefield inversion of wide-aperture marine seismic streamer data, Geophys. J. Int., 151, 325–344.

Singh, S.C. et al. (2011a). Aseismic zone and earthquake segmentation associated with a deep subducted seamount in Sumatra, *Nature Geoscience* 4, 308-311.

Singh, S.C. et al. (2011b). Seismic images of the megathrust rupture during the 25th October 2010 Pagai earthquake, SW Sumatra: Frontal rupture and large tsunami, *G.R.L.*, 38, doi:1029/2011GL048935.

Singh, S.C., Hananto, N., Chauhan, A. (2011c). Enhanced reflectivity of backthrusts in the recent great Sumatran earthquake rupture zones, *G.R.L.*, 38, L04302, doi:10.1029/2010GL046227.

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