

Report on 3-month Short term stay at ERI 12 Sept to 10 Dec 2016

During my 3-month stay at ERI I progressed existing projects in two areas namely, data analysis from the HOBITSS project offshore Gisborne, New Zealand, OBS data interpretation and 3D velocity model from the 2010 SAHKE experiment offshore Wellington, New Zealand. Both of these projects involved instruments and scientists from ERI; HOBITSS; Mochizuki and SAHKE; Sato, Mochizuki, Iwasaki, and Kurashimo. In addition, the stay at ERI facilitated planning for the upcoming 2017 USA/NZ/UK/Japan geophysical experiments onshore-offshore Gisborne and Raukumara Peninsula and also initiated plans for a temporary OBS deployment in Cook Strait following the M7.8 Kaikoura Nov 2016 earthquake.

The recent discovery of tremor and slow slip around shallow seismogenic portions of subduction zones offers the potential of detecting fluctuations in the stress and frictional strength of plate boundary faults. This is important given that such faults may develop to be the nucleus for a larger damaging earthquake along the stronger locked patch of the plate interface. An international collaborative research group from NZ, Japan and USA collected one-year-long ocean-bottom seismic (OBS), geodetic, and electro-magnetic data in the Hikurangi margin during the HOBITSS campaign. The comprehensive geophysical network fortuitously captured a large SSE (Mw 6.8) and associated seismic energy within the network, the second largest known SSE for the region. During my 3 month stay I started to document and archive active source data that was recorded by the HOBITSS OBS data set. These data were acquired when the USA ship, *RV Roger Revelle*, acquired short streamer multichannel seismic data across deployed OBSs in March 2015 – one month before the HOBITSS array was recovered. First arrival picks of the airgun signals on the OBS data will be used to refine the 3D velocity model in the offshore region. This model will be used to back project and image continuously recorded energy radiated from near the megathrust before, during, and after the SSE. We anticipate the back-projections will highlight regions affected by stress changes relating to the SSE process.

This research is also part of a larger NZ Royal Society Marsden Fund Project (PIs Fry, Henrys, Mochizuki) to answer the question of whether slow subduction zone deformation rapidly increase stress on nearby faults. During the stay at ERI I was joined by Bill Fry, for one week, and he introduced his anisotropy methods and results using data from HOBITSS deployment using ERI OBSs. In addition, we discussed with Kimi Mochizuki and his student, Yuriko Iwasaki, the development of a new method to be applied to the continuous OBS records from HOBITSS for detection of tremor. The preliminary result shows detection of possible tremor coinciding with slow slip, although the first indications are that tremor started a couple weeks after the slip was initiated, and continued for three weeks.

As part of the Seismic Array HiKurangi Experiment (SAHKE) project, wide-angle reflection and refraction seismic data were acquired in 2010 using OBSs along a transect across the southern North Island of New Zealand, where the Hikurangi Plateau, an early Cretaceous large igneous province, subducts westward beneath Wellington. The SAHKE project was designed to investigate the physical parameters controlling locking at the plate interface beneath the southern North Island and

characterize slip processes in a major segment of the Hikurangi system. Sixteen OBSs with 5 km spacing off the east coast recorded airgun sources spaced 100 m along a 350 km onshore-offshore transect. Interestingly, we observed P-wave arrivals with very fast apparent Pn velocities (> 8.5 km/s) on the eastern-most OBSs, at offsets larger than ~ 70 km. During this short term stay we have been able to confirm these fast upper mantle velocities by constructing a reverse gather. We are preparing a manuscript that documents this finding.

Finally, I am extremely grateful for the opportunity to stay at ERI and for the kindness and help shown to me by the faculty and staff, especially Mochizuki-san, who hosted my visit.

Workshop attended

- Bangs, N., Bell, R., Kodaira, S., Henrys, S., and Mochizuki, K., 2016, 3D seismic investigation of fault property controls on slow-slip along the Hikurangi megathrust, Joint Workshop on Slow Earthquakes September 13-15, 2016, ERI, University of Tokyo.
- Muramoto, T., Ito, Y., Inazu, D., Henrys, S., Wallace, L., Bannister, S., Mochizuki, K., Hino, R., and Suzuki, S., 2016, Estimation of Small Slow Slip events on the Northern Hikurangi Margin, Joint Workshop on Slow Earthquakes September 13-15, 2016, ERI, University of Tokyo.

Seminar presented

- Savage, M., and Henrys, S., 2016, M7.8 Kaikoura Earthquake 14 November 2016, ERI Seminar, 7 Dec.: University of Tokyo.

Papers in Preparation

- Haijima, D., Mochizuki, K., Henrys, S., Shiobara, H., Yamada, T., Shinohara, M., Fry, B., and Bannister, S., In preparation, Ocean bottom seismic observation in the northern Hikurangi subduction zone offshore North Island, New Zealand.
- Henrys, S., Eberhart-Philips, D., Wech, A., Sato, H., Stern, T., Okaya, D., Iwasaki, T., Savage, M., Mochizuki, K., Kurashimo, E., Sutherland, R., and Evanza, D., In preparation, Three-dimensional Vp imaging across the interseismically locked southern Hikurangi margin, Wellington, New Zealand.
- Mochizuki, K., Henrys, S., Sutherland, R., Shinohara, M., and Chadwick, M., In preparation, Structure of the Hikurangi Plateau from Wide-angle OBS data and gravity modelling, New Zealand.

Stuart Henrys