Hikurangi Ocean Bottom Investigation of Tremor and Slow Slip (HOBITSS) - Revealing the environment of shallow slow slip

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The 2014-15 HOBITSS deployment of twenty-four ocean bottom pressure sensors and fifteen ocean bottom seismometers (OBSs) at the northern Hikurangi margin, New Zealand, captured a M7.0 slow slip event (SSE). The vertical deformation data collected were used to image one of the best-resolved slow slip distributions to date, and indicated slip very close, if not all the way to the trench (Wallace et al., 2016). We used the seismic data collected during this experiment to evaluate the spatiotemporal relationship between seismicity (both earthquakes and tremor) and the slow slip event and the role that seismic structure plays in controlling slip behavior. Significant results include:

1. Creation of a catalog of local earthquakes consisting of about 2300 events ranging in magnitude between 0.5 and 4.7 that reveals two NE-SW seismicity bands with a 20-km wide gap between them. This gap, beneath the inner forearc wedge, locates at the downdip edge of the slow slip patch.

2. Most earthquakes are within the subducting slab rather than at the plate interface.

3. Template matching reveals "burst-type" repeating earthquakes occur coincident with tremor on an upper-plate fracture network above a subducted seamount. This activity locates at the edge of the slow slip patch, but begins just after the SSE. We propose that during the large plate-boundary SSE, fluids migrated from downdip overpressurized sediments imaged in seismic reflection data, into the fracture network, diverting aseismic slip to multiple faults in the upper plate. Thus, seamount subduction appears to play a key role in controlling the mechanics of shallow slow slip and microseismicity at the northern Hikurangi margin.

4. Changes in principal stress ratios, obtained from focal mechanism inversions, prior to slow slip events represent the accumulation and release of fluid pressure within overpressured subducting oceanic crust, the episodicity of which may influence the timing of slow slip event occurrence on subduction megathrusts.

5. Overall temporal variations in VP/VS and shear wave splitting delay times observed during slow slip are consistent with fluid pressurization below a permeability barrier and movement of fluids during the build-up to and rupture of slow-slip patches. ■

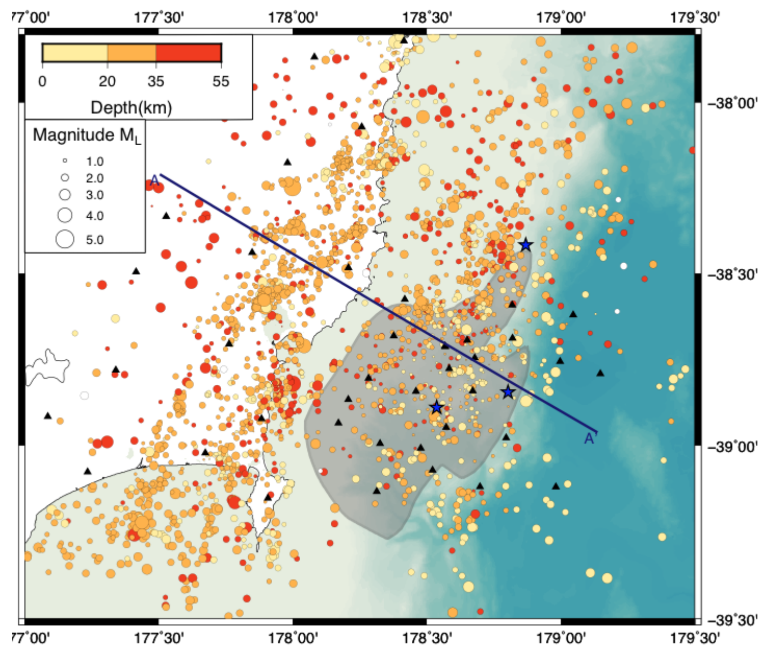

Figure 1. Hypocenters determined using Bayesloc and onshore and OBS stations (triangles). Event symbol is scaled by local magnitude size and colored by depth. Gray shaded area encloses the 2014 slow slip area. Figure modified from Yarce et al. (2019). Seismicity at the northern Hikurangi Margin, New Zealand, and investigation of the potential spatial and temporal relationships with a shallow slow slip event.

Right page: Rough seas off the shores of New Zealand during the HOBITSS deployment in 2014. Photo credit: Justin Ball.

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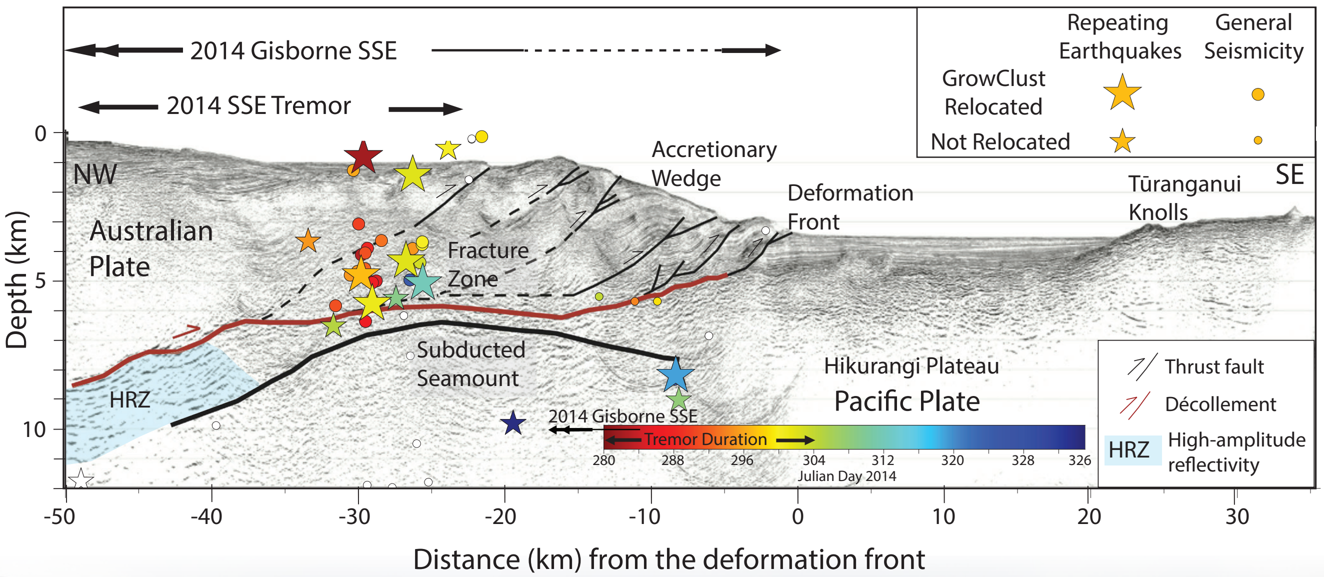

Figure 2. Seismic reflection profile 05CM-04 modified from Barker et al. (2009), Bell et al. (2010), and Bell et al. (2014). Bottom: Depth-converted interpretation. Repeating earthquakes (stars) and all seismicity within 10 km of reflection profile are colored by time. Large stars and circles are relocated with GrowClust. Figure from Shaddox and Schwartz (2019).