From 2017 to 2019, the multinational, multidisciplinary Seismogenesis at Hikurangi Integrated Research Experiment (SHIRE) collected data along the Hikurangi margin offshore North Island, New Zealand with the goal to investigate the feedbacks between subducting plate interface slip behavior, solid and fluid fluxes, and long-term plate-boundary mechanics that all may reflect driving processes connecting forearc uplift, sediment transport and underplating, plate-boundary strength, and seismogenesis. As part of this ambitious project, an active-source onshore-offshore seismic survey was conducted from trench to backarc to assess the physical mechanisms that control slip behavior and uplift of the northern Hikurangi margin. The Hikurangi margin is a prime target to geophysically image the characteristics of subduction margins, given the subduction interface's shallow depth. Here we present initial results from the onshore-offshore wide-angle seismic experiment. Using crustal refractions and interface reflections and refractions we image the incoming oceanic plate, accretionary prism, subduction interface, slab, overriding continental crust and backarc. In addition to these active source phases, earthquake P-wave arrivals detected by applying an automated procedure to the densely spaced SHIRE array were incorporated to provide improved ray coverage in the lower continental crust, slab, and upper mantle.

Travel time tomography provides a preliminary V_P model extending to 50 km depth (Figure). Velocities in the incoming plate increase with depth smoothly from 2.5-7.5 km/s. A similar gradient is observed in the backarc. Upper crustal velocities increase east to west, representing a transition from Neogene to Cretaceous units. Slab dip below 13 km is initially estimated to be 12°. Our model reveals low velocities in the lower crust beneath the Raukumara Range at a depth near the intersection of the overlying plate Moho and subducting Pacific slab, similar to what has previously been imaged beneath other portions of the North Island Axial Ranges that run the length of the Hikurangi margin. We currently consider two alternative interpretations that are both associated with uplift of the Raukumara Range (northern Axial Ranges). First, subducted sediments with or without high porosity and fluid pressure would have lower velocities than surrounding lower crust. Negative buoyancy of these underplated sediments could potentially drive uplift of the Raukumara Range. A similar mechanism has been proposed in the southern Axial Ranges, where low velocities, high attenuation, and high amplitude reflections point towards imbricated sequences of sediments. Second, externally caused uplift of the Axial Ranges could require basal infilling of crustal material that would have elevated temperatures through advection and hence lower seismic velocities. Further data analyses using seismic reflectivity and attenuation information plus SHIRE-team geodynamical modeling will help test these interpretations.

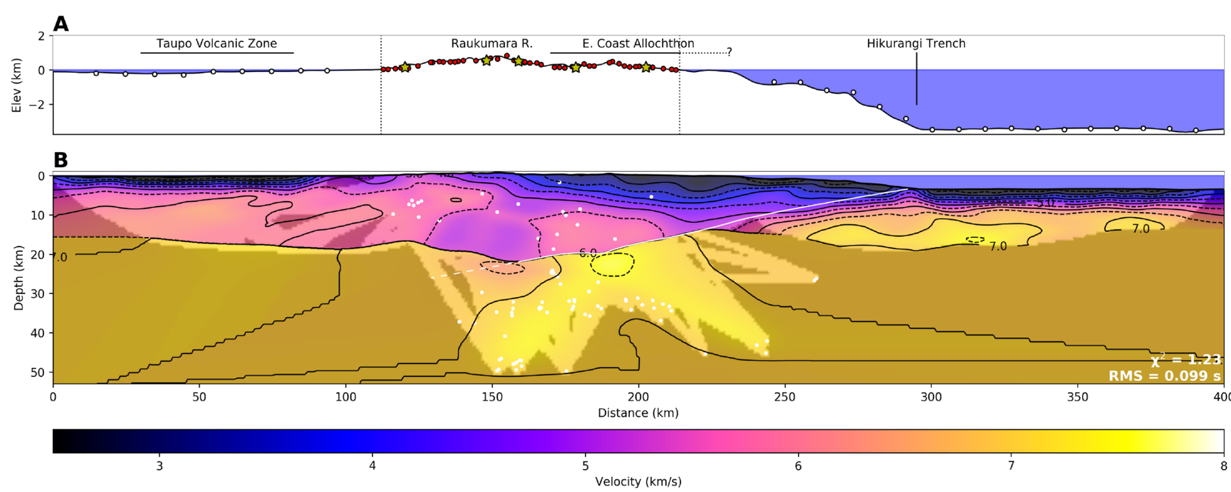

Figure: SHIRE seismic transect across Hikurangi margin. A: Elevation profile showing land (red circles) and OBS station locations (white circles) and onshore explosion sources (stars), as well as relevant geologic features. B: V_P velocity model using onshore-offshore active-source data and earthquake P-wave arrival phases. Earthquakes used in this inversion are marked with white circles. This initial model has a χ^2 of 1.23 and an RMS error of 0.099 s. Contours are plotted at 0.5 km/s intervals. Interpreted subduction interface marked with a white line.