Structure and physical characteristics of the Hikurangi subduction zone derived from seismic full waveform imaging

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Slip behavior along the megathrust has been shown to be closely related to the evolution of pore fluid pressures at the plate interface. Fluids released due to mineral dehydration and tectonic loading may play an important role in the onset of seismogenesis, and elevated pore fluid pressures appear to be a key environmental factor promoting shallow transient slip phenomena such as very-low-frequency earthquakes, episodic tremor and slow sleep events.

In recent years, seismic attributes and velocity images obtained from active source seismic data have provided a promising opportunity to infer porosity, fluid pressure and effective stress at the plate interface and within the overlying accretionary wedge. However, due to the limitations underpinning traditional velocity analysis and ray-based tomography approaches, the resolution and accuracy of existing velocity models remain limited. Full waveform inversion (FWI) is a powerful alternative to those traditional approaches. It uses the phase and amplitude information contained in seismic data to produce structurally accurate high-resolution physical models of the Earth.

Here, we applied elastic FWI along a 90-km-long 2D multichannel seismic profile crossing the southern Hikurangi convergent margin, New Zealand. Our processing sequence included: (1) a downward continuation of the seismic data to the seafloor, (2) 2D traveltime tomography, and (3) full waveform inversion of both refracted and reflected energy. Our final model provides exceptional constraints concerning the structure and physical properties of this convergent margin. We will describe the implications of our results for the first-order structure of the overthrusting plate, the distribution of high pore-fluid pressures and the distribution of slow-slip events along the southern Hikurangi margin.

Keywords: convergent margin, subduction zone, Hikurangi margin, full waveform inversion, pore fluid pressure, slow slip events

