

Seismic images of the accretionary prism of the Hikurangi margin, New Zealand, reveal its structural variations and influences on seismogenic character

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Abstract

The Hikurangi margin of New Zealand exhibits contrasting slip behavior from south to north. Whereas the southern Hikurangi margin has a locked plate boundary that can potentially produce large megathrust earthquakes, the northern section of this margin accommodates plate motion by creep and episodic shallow slow-slip events. To investigate these different modes of slip we examine the geometry of the plate boundary and consolidation state of the materials along the plate interface.

We use marine seismic reflection data from the SHIRE project to image the reflectivity and seismic velocity structure along 20 profiles across the accretionary wedge of the Hikurangi subduction zone of New Zealand. These active-source seismic data were gathered in 2017 with the R/V Marcus Langseth using a 6,600 in³ seismic source and 12 km long receiver array. We carried out streamer tomography on the SHIRE profiles where we integrated seismic velocity constraints from stacking the reflection data along all SHIRE transects. The seismic velocity images and prestack depth migrations together characterize the nature of incoming basement, sediment subduction and accretion, and faulting and compaction of the accretionary wedge.

Our seismic velocity models show that a layer of sediment, with seismic wavespeeds of ~ 3.0 km/s, is entrained beneath the accretionary prism in the southern Hikurangi margin, but there is no coherent subducted sediment layer to the north. This is a significant result, because it implies that the sediment layer covers basement roughness and forms a smoother plate boundary in the south. In addition, the deepest sediments on the incoming plate in the southern Hikurangi margin are believed to be quartz-rich turbidites, which are prone to unstable slip along the plate boundary. In contrast, the accretionary prism of the northern Hikurangi margin exhibits more variation in accretionary wedge thrust geometry due to interactions with large seamounts on the downgoing oceanic basement. These findings are consistent with the geodetically locked nature of a smooth, quartz-rich plate boundary along the southern Hikurangi subduction zone, and the creeping nature of a heterogeneous plate boundary along the Hikurangi margin to the north.

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