The impact of permeability and elastic properties on seismicity in the central Hikurangi margin

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Abstract

The Hikurangi Margin (HM) is a subduction zone along the east coast of the North Island of New Zealand where varying instances of slow slip events (SSEs) and earthquakes occur. These SSEs occur at different time scales and depths when comparing the northern and southern ends of the margin. Previous studies show that the rock comprising the accretionary wedge of the northern margin have low permeabilities, which could induce overpressures and modulate the occurrence of SSEs. Permeability rises when an SSE fractures the rocks within the deep wedge promoting fluid flow and thus dissipating the overpressures along and above the décollement. As fractures heal and permeability recovers overpressures build up once again. Although this cycle may explain the occurrence of SSEs along northern Hikurangi, it is not yet clear how intrinsic permeability varies in rocks above the décollement elsewhere along the margin. To better understand the disparity in SSE occurrence, rock samples from the northern and central part of the margin have been tested for permeability and elastic properties. We tested samples from the Weber, Whangai, Dannevirke and Wanstead formations, which are representative of the lithologies above the décollement in the central margin, and range in age from the Cretaceous to the mid to late Paleogene. We found that the Weber (PQ) and Whangai (PO) formation samples from central HM have higher permeability than northern HM rocks from the same formation in the north. This study provides insight into the mechanisms that lead to significantly fewer SSEs along the central HM. In the near future, we plan to conduct a suite of physical experiments that will include permeability recovery after fracturing, compaction, and ultrasonic velocity analysis to help further understand the stark differences in slip behavior observed along the margin.

AGU Fall Meeting 2024, held in Washington, D.C., 9-13 December 2024, Session: Mineral and Rock Physics / Crustal Deformation and Heterogeneity from Laboratory Experiments to Large Earthquake Cycles I Poster, Poster No. 3076, id. MR41B-3076.