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Marine forearc extension in the Hikurangi Margin: New insights from high-resolution 3D seismic data

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In subduction zones upper-plate normal faults have long been considered a tectonic feature primarily associated with erosive margins. However, increasing data coverage has proven that similar features also occur in accretionary margins, such as Cascadia, Makran, Nankai or Central Chile, where kinematics are dominated by compression. Considering their wide distribution there is, without doubt, a significant lack of qualitative and quantitative knowledge regarding the role and importance of normal faults and zones of extension for the seismotectonic evolution of accretionary margins.

We use a high-resolution 3D P-Cable seismic volume from the Hikurangi Margin acquired in 2014 to analyze the spatial distribution and mechanisms of upper-plate normal faulting. The study area is located at the upper continental slope in the area of the Tuaheni landslide complex. In detail we aim to (1) map the spatial distribution of normal faults and characterize their vertical throws, strike directions, and dip angles; (2) investigate their possible influence on fluid migration in an area, where gas hydrates are present; (3) discuss the mechanisms that may cause extension of the upper-slope in the study area.

Beneath the Tuaheni Landslide Complex we mapped about 200 normal faults. All faults have low displacements (<15 m) and dip at high (> 65°) angles. About 71% of the faults dip landward. We found two main strike directions, with the majority of faults striking 350-10°, parallel to the deformation front. A second group of faults strikes 40-60°. The faults crosscut the BSR, which indicates the base of the gas hydrate zone. In combination with seismically imaged bright-spots and pull-up structures, this indicates that the normal faults effectively transport fluids vertically across the base of the gas hydrate zone. Localized uplift, as indicated by the presence of the Tuaheni Ridge, might support normal faulting in the study area. In addition, different subduction rates across the margin may also favor extension between the segments. Future work will help to further untangle the mechanisms that cause extension of the upper continental slope.