Fluid reservoirs of the Hikurangi Plateau and their implications for subduction processes

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Abstract

New Zealand's Hikurangi margin is known for recurring shallow slow slip, numerous forearc seeps, and a productive volcanic arc. Fluids derived from the subducting slab are implicated in these processes. However, prior studies lacked evidence of basic crustal structure of the slab, or of its water content that would allow an assessment of fluid budgets. We review several recent studies that place bounds on the fluid reservoirs within the subducting Hikurangi Plateau that could be released between the forearc and backarc regions. Subducting sediments are thickest (> 1 km) in the southern Hikurangi margin, where there is a unit of turbidites beneath the regional proto decollement. These subducting sediments begin draining near the deformation front, resulting in a 20-30 % loss of volumetric fluid content. In contrast, the central and northern Hikurangi margins lack a continuous unit of subducting sediment. Here, lenses of poorly drained sediment underthrust the forearc in the wakes of seamount collisions. The Hikurangi Plateau's crustal structure resembles normal oceanic crust with a doubled upper crust of basalt and diabase. Above this upper crust is a ~1.5 km thick unit of hydrated volcaniclastic conglomerates. Seamounts can locally increase the upper crust's thickness by an extra ~1-3 km, raising the amount of porous, altered volcanic material. Finally, P-wave velocity models of the slab's upper mantle show velocity changes that could indicate moderate differences in serpentinization. Active bend-faults that could circulate fluids to the upper mantle are sparse prior to subduction. However, upon subduction the upper mantle seismic velocities of the Hikurangi Plateau are significantly less in the north compared to the south, possibly due to enhanced slab faulting beneath the forearc. Separate thermo-petrologic models for the shallow forearc and deeper subduction system suggests that fluid release from volcaniclastic units and the thickened Hikurangi Plateau upper crust is expected to occur over a range of depths extending from ~12 km to ~130 km, providing fluids for onshore seep systems and hydrous melting of the mantle wedge, whereas dehydration of serpentinite is greatest beyond the arc front. Subducting sediments and volcaniclastic units are the most readily available source of fluids for shallow slow slip.

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