The role of the Hikurangi Plateau in the dynamics of the Hikurangi Subduction Margin

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The collision of the Hikurangi Plateau with the Hikurangi Subduction Zone coincides with a change from extension to shortening in the overriding Australian Plate. The 15km thick oceanic Hikurangi Plateau is juxtaposed with Chatham Rise at the southern edge of the subduction margin, possibly extending an unknown distance beneath the Chatham Rise. We explore the influence of the Hikurangi Plateau and its size on subduction dynamics using a series of 3D visco-elastic Underworld models with free slip boundary conditions. The models rely on negative slab buoyancy to drive subduction, with the buoyant oceanic plateau altering the dynamics. The models are benchmarked against New Zealand GPS velocities, paleomagnetic rotations, and fault zones. Both the overriding and subducting plates have undergone significant rotation since 23Ma with ∼90° clockwise rotation of the overriding plate relative to the subducting plate. Distinctive fault zones have also been created with the Marlborough Fault Zone facilitating escape tectonics around the Chatham Rise; the North Island Dextral Fault Belt allowing lateral movement between the fore and back-arcs; extension in Taupo Volcanic Zone assisting back-arc extension; and active N-S extension in the Chatham Rise adjacent to the Hikurangi Plateau. In a model without an oceanic plateau, the subduction zone undergoes roll-back along its entire margin. Extension occurs along the overriding plate adjacent to subduction, with shortening limited to the collision of the Chatham Rise. Rotation rates adjacent to the Chatham Rise are extremely high, and decrease rapidly northward and there is no rotation of the subducting plate. When an oceanic plateau is included in the model, shortening occurs at the southern margin of the subduction zone as subduction shallows with the entry of the bouyant plateau. Rotation starts in the subducting plate as the plateau enters the subduction zone. This rotation is attributed to a decrease in slab pull southward resulting in differential subduction velocities. N-S extension begins in the Chatham rise as the oceanic plateau beings to delaminate from the adjacent continental plateau as a result of the rotation of the subducting oceanic lithosphere and curvature down-going slab edge. In a model where the Hikuragni Plateau is extended a further 250km underneath the Chatham Rise the positive buoyancy of the plateau results in slab break-off and accreation along the front of the oceanic plateau, moving the slab-edge northward.