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IODP Proposal Cover Sheet

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■ **New** ☐ **Revised** ☐ **Addendum**

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Please check if this is Mission proposal	☐
Title:	**Unlocking the secrets of slow slip by drilling at the northern Hikurangi subduction margin, New Zealand: Riserless drilling to sample and monitor the forearc and subducting plate**
Proponent(s):	**Demian Saffer, Philip Barnes, Laura Wallace, Stuart Henrys, Mike Underwood, Marta Torres, and the Hikurangi margin working group**
Keywords: *(5 or less)*	slow slip events, subduction margin, Hikurangi, fault mechanics, fluids
Area:	New Zealand

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Permission to post abstract on IODP Web site: ■ Yes ☐ No

Abstract: (*400 words or less)*

Slow slip events (SSEs) at the Northern Hikurangi subduction margin, New Zealand are among the best-documented shallow SSEs on Earth. This proposal is the riserless component of a recently submitted Multi-phase Drilling Project (MDP) proposal that outlines a plan for IODP drilling to discern the mechanisms behind subduction zone slow slip events (SSEs) by drilling at northern Hikurangi. Sampling of the upper plate and subducting section via shallow drilling (400-1200 m), and installation of borehole observatories are key components of this project.

Northern Hikurangi subduction margin SSEs recur every two years, and thus provide an excellent setting to ***monitor changes in deformation rate and associated chemical and physical properties*** surrounding the SSE source area throughout a slow slip cycle. Sampling material from the sedimentary section and oceanic basement of the subducting plate, and from the primary active thrust in the outer wedge near the trench ***will reveal the rock properties, composition, and lithological and structural character*** of the material that will be transported downdip to the known SSE source region. If we find that SSEs propagate all the way to the trench, the shallow fault zone target may even lie within the SSE rupture area, providing riserless access to the SSE source.

We propose seven riserless boreholes to **collect samples, geophysical logs, make downhole measurements, and install observatories**. These riserless boreholes are designed to address three fundamental scientific objectives: (1) characterize the *state* and *composition* of the incoming plate and shallow plate boundary fault near the trench, which comprise the protolith and initial conditions for fault zone rock at greater depth; (2) characterize material properties, thermal regime, and stress conditions in the upper plate above the SSE source region; and (3) install borehole observatory instruments to monitor a transect of holes above the SSE source, to measure temporal variations in deformation, fluid flow, and seismicity. The proposed borehole observatories focus on monitoring deformation, seismicity and evolution of physical and chemical properties throughout the SSE cycle. Together, data from these riserless boreholes and observatories will test a suite of hypotheses about the fundamental mechanics and behavior of slow slip events, and their relationship to great earthquakes along the subduction interface.

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Scientific Objectives: (*250 words or less*)

Drilling, coring, downhole logging, and instrumenting these sites will resolve competing hypotheses and key questions regarding the generation of slow slip and the mechanics of subduction interface thrusts. **Major questions that will be addressed are:**

(1) Do slow slip events (SSEs) propagate all the way to the trench? **(2)** Does high fluid pressure at the plate interface influence the occurrence of SSEs, and what role do mineralogical dehydration transformations play in the supply of fluids to the SSE source area? **(3)** What are the lithologies hosting slow slip, and do they promote conditional stability? If so, does fast seismic slip and slow aseismic slip occur in the same location on the interface? **(4)** Is there a full range of slow slip events and associated slow seismic behavior (e.g., tremor, low frequency earthquakes) in terms of magnitude and duration? **(5)** How do fluid chemistry, pressure, temperature, and fluid flux (near the surface and at the SSE source) vary in response to SSEs?

Please describe below any non-standard measurements technology needed to achieve the proposed scientific objectives.

Completion of the objectives will require development of two or more long-term borehole monitoring systems, based on existing CORK and LTBMS designs for riserless IODP drilling.

Proposed Sites:

Site Name	Position	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
HSM-01A	38º 43.637'S 178º 36.854E	994	1180		1180	Upper plate physical properties and composition in SSE source region; SSE monitoring; pilot hole for proposed deep riser hole.
HSM-07A	38º 47.526'S 178º 45.120'E	998	400		400	Upper plate physical properties and composition above SSE source region; SSE monitoring
HSM-05A	38º 58.164'S 179º 07.935'E	3538	1005	195	1200	Characterize sedimentary sequence on incoming plate
HSM-04A	38º 51.299'S 178º 53.187'E	2449	950		950	Shallow fault zone properties, composition, and conditions; hydrologic and geochemical monitoring of fluid flow in SSEs
HSM-06A	38º 39.318'S 178º 27.720'E	135	400		400	Upper plate physical properties and composition above SSE source region; SSE monitoring
HSM-09A	38º 51.918'S 178º 27.720'E	687	400		400	Upper plate physical properties and composition in SSE source region; SSE monitoring to assess along-strike variation in SSE processes
HSM-08A	39º 01.32'S 179º 14.76'E	2908	<20	380	400	Characterize igneous basement on subducting plate
Alternate site: HSM-10A	38º 52.658'S 178º 56.105'E	2870	950		950	Shallow fault zone properties, composition, and conditions; hydrologic and geochemical monitoring of fluid flow in SSEs. **Possible alternate site for HSM-04A**