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

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Please check if this is Mission proposal ☐

Title:	**Multiphase Drilling Project: Unlocking the Secrets of Slow Slip by Drilling at the Northern Hikurangi Subduction Margin, New Zealand**
Proponent(s):	**Laura Wallace, Stuart Henrys, Philip Barnes, Demian Saffer, Harold Tobin, Nathan Bangs, Rebecca Bell, 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*)

Over the last decade, the discovery of episodic slow slip events (SSEs) at subduction margins around the globe has led to an explosion of new theories about fault mechanics and subduction interface deformation mechanisms and rheology. ***The northern Hikurangi margin is the only place on Earth where well-documented SSEs occur on a subduction interface within range of existing drilling capabilities.*** Drilling, down-hole measurements, sampling, and monitoring of the northern Hikurangi SSE source area provides a unique opportunity to definitively test hypotheses for the properties and conditions leading to SSE occurrence, and ultimately, to unlock the secrets of slow slip. Furthermore, ***northern Hikurangi SSEs recur every two years***, and thus provide an excellent setting to ***monitor changes in deformation rate, in situ conditions, and rock physical properties*** within and surrounding the SSE source area throughout a slow slip cycle.

We propose to drill the northern Hikurangi SSE source area with a 3 phase approach:
(1) Seven shallow (~400-1200 m below the seafloor) riserless sites to collect samples and geophysical logs of the overriding and subducting plates, and strategically install observatory equipment to monitor near-surface changes in deformation, seismicity and physical properties throughout a SSE cycle and characterize the distribution of SSE slip with very high fidelity.
(2) A deep riser hole (~6 km below the sea floor) that penetrates the subduction interface and ***directly samples rocks from the SSE source region***, collects logs across the fault zone(s), and measures temperature, fluid pressure and chemistry, and stress.
(3) Installation of a long-term borehole ***monitoring*** system to detect changes in deformation rate, and physical and chemical properties ***at the SSE source*** during a complete SSE cycle.

Sampling material within the SSE source area and incoming plate section (protolith for fault zone rock deeper down) ***will reveal the frictional, lithological and structural character*** of the interface in an active SSE source region. Observatory facilities to monitor changes in hydrology, strain rate and seismicity near and above the SSE source area throughout a two-year SSE cycle will elucidate the role that short-term variations of physical conditions play in the occurrence of aseismic vs. seismic slip. Comparison of properties of the interface at northern Hikurangi (dominated by aseismic creep and moderate, shallow subduction thrust events) and the Nankai margin (where stick-slip behaviour over large regions produces great megathrust earthquakes) may help solve the mystery of why some subduction margins rupture in megathrust earthquakes while others do not.

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Scientific Objectives: (*250 words or less*)

Drilling, sampling, downhole logging and measurements, and instrumenting the proposed riserless and riser 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) occur under highly elevated fluid pressures? **(2)** What is the role of fault strength and rock frictional properties in facilitating slow slip? **(3)** What are the rock compositions and fault zone architecture associated with slow slip? **(4)** Do short-term hydrological variations facilitate SSEs or is there no relationship? **(5)** How do fluid chemistry, pressure, temperature, and fluid flux (near the surface and at the SSE source) vary in response to SSEs? **(6)** What control does temperature have on the down-dip limit of the seismogenic zone and the depth to slow slip events? **(7)** Is the structural character and frictional properties of the subduction interface dominated by aseismic slip and moderate subduction thrust earthquakes (i.e., Northern Hikurangi) fundamentally different from that of subduction interface faults characterized by stick-slip behaviour and great megathrust earthquakes (such as Nankai)?

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

Completion of the objectives will require development of one or more long-term borehole monitoring systems, based on existing CORK and LTBMS designs for both JOIDES Resolution and Chikyu drilling. Non-standard downhole measurements using the MDT (Modular Dynamic Tester) or similar for in situ pore pressure, stress, and permeability data may be required.

Proposed Sites:

SEE INDIVIDUAL PROPOSALS FOR EACH PHASE OF THE PROJECT FOR SITE DESCRIPTIONS