IODP Proposal Cover Sheet

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Hikurangi Megathrust Along-Strike Variability

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Title	Probing the physical controls on a locked vs. creeping megathrust with ocean drilling, Hikurangi Subduction Margin, NZ
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Area	New Zealand

Proponent Information

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Abstract

The Hikurangi subduction margin, New Zealand, exhibits a sharp and profound along-strike transition from interseismic locking and potential for large earthquakes, to a dominantly aseismic segment hosting some of the shallowest slow slip events (SSEs) on Earth, despite similarities in slab age and convergence velocities. IODP Expeditions 372 and 375 drilled, logged, and sampled input sediments and a shallow splay fault in northern Hikurangi, to specifically target the materials that may host SSEs. The proposed sampling and logging programme builds on existing data to undertake a direct comparison between the materials hosting creeping and locked megathrust segments along a single subduction margin. Laboratory deformation experiments on recovered materials will shed further light on the importance of frictional and physical properties, as well as in situ conditions, in controlling seismic style. The results will illuminate controls on slip style of subduction thrusts, applicable to other subduction margins globally.

We propose to drill the Hikurangi margin inputs and frontal décollement to cover the range of materials hosting creep and interseismic locking:
(1) The locked megathrust in southern Hikurangi is at a more constant stratigraphic position than the creeping megathrust in the north. This stratigraphic level, as well as surrounding materials, can be reached by drilling the input sequence on the incoming Hikurangi Plateau, where seismic ties to the active locked megathrust exist or can be obtained.
(2) The northern Hikurangi plate interface accommodates displacement in episodic slow slip events around small areas of interseismic locking, and is characterised by a variable position within a heterogeneous input sequence. While this is known from 2D and recent 3D seismic data, and IODP drilling of a condensed section on the flank of a seamount, we propose to further characterise this heterogeneity by drilling a) the pelagic sequence away from seamounts, and b) the pelagic sequence and basaltic material on top of a seamount.
(3) A frontal thrust that branches from the plate-boundary décollement in the creeping northern Hikurangi is identified from 2D and recently collected 3D seismic data, and tied to pelagic inputs from borehole and core observations in IODP Expeditions 372 and 375. This fault hosted within pelagic sediments is likely to be representative of the deeper, dominantly creeping, megathrust fault where SSEs are known to occur, and provides a key comparison to the splay fault in hemipelagic sediments investigated by IODP Expeditions 372 and 375.

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Scientific Objectives

Drilling, sampling, logging, and post-cruise experiments will discriminate between competing hypotheses regarding the mechanics of subduction interface thrusts. Key questions include: (1) Is the transition from creeping to locked interseismic slip behaviour related to material properties, and if so, which properties lead to what behaviour? (2) What are the rock compositions and fault zone architectures associated with creeping and locked subduction thrusts? (3) What is the character of the frontal décollement in a creeping subduction margin, and how does it compare to an intraprism splay fault? (4) How is deformation partitioned between the frontal thrust and the intraprism splay? (5) Are there detectable differences in fluid budget and thermomechanical properties between the creeping and locked segments?

Non-standard measurements technology needed to achieve the proposed scientific objectives

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Proposed Sites (Total proposed sites: 6; pri: 4; alt: 2; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
HSI-01A (Primary)	-41.0256 178.9284	3130	1200	0	1200	Sample and log the input sequence to the locked, southern Hikurangi megathrust. These samples will be used to characterise the reflector (R7) which can be tied to the interface at depth, and evaluate the composition, compaction behaviour and fluid budget of the materials at and surrounding this reflector. This site will likely be replaced with a number of shallower sites after a new site survey
HSI-02A (Primary)	-37.9565 -178.5000	3540	750	0	750	Sample and log the pelagic and upper Hikurangi Plateau input sequence to the heterogeneous northern Hikurangi margin away from seamounts
HSI-03A (Primary)	-39.2859 -178.5000	2322	120	130	250	Sample and log the top of a seamount and its sedimentary cover – preliminarily sited on Palmer seamount, site to be refined.
HSI-04A (Primary)	-38.8316 178.9352	3020	1200	0	1200	Intersect the frontal thrust rooted in the creeping megathrust to sample and log the fault zone materials and establish the fault zone architecture. To be refined when NZ3D seismic reflection data are processed.
HSI-05A (Alternate)	-41.9679 178.9199	2532	1200	0	1200	Alternate to HSI-01A - To sample and log subduction zone input sediments to the locked, southern Hikurangi plate interface
HSI-06A (Alternate)	-38.8764 178.9323	2930	1200	0	1200	Alternate to HSI-04A - To sample and log the frontal thrust rooted in the northern, creeping Hikurangi plate interface