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IODP Proposal Cover Sheet

537B-Full4

☐ **New** ☑ **Revised** ☐ **Addendum**

Please fill out information in all gray boxes

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Title:	CRISP Program B: The Transition from Stable to Unstable Slip at Erosional Convergent Plate Boundaries
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Keywords: *(5 or less)*	Seismogenic zone, fluid flow, subduction erosion
Area:	Central America off Costa Rica

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Permission to post abstract on IODP-MI Web site: ☒ Yes ☐ No

Abstract: (*400 words or less)*

CRISP is designed to investigate the processes leading to seismogenesis at erosional convergent margins in 2 Programs. Each Program will involve sampling, downhole observatories, and laboratory experiments on the recovered materials. Program A focuses on the incoming oceanic plate, the decollement at the margin's front where slip is aseismic, and shallow structure of the overriding plate. Program B will investigate the plate boundary in the transition from stable slip to unstable slip by drilling and monitoring at two sites. One site is located updip, but near, the end of the seismogenic zone, and a second site is drilled into the seismogenic zone.

At least 50% of the world's subduction zones are erosional margins. Erosional convergent margins have a subduction channel containing material removed from the overriding plate mixed with sediment from the incoming plate. The nature and physical properties of this material are currently unconstrained. Similarly, the volume, distribution and chemistry of fluids at erosional plate boundaries are poorly known.

In Program B we propose a detailed investigation of subduction earthquake processes and to sample and monitor the plate boundary where temperatures range ~100-200°C. Previous work indicates that key processes become active in that temperature range and control the onset of seismicity. Drilling will for the first time sample eroded material and fluids in the subduction channel and investigate plate boundary fault mechanisms during tectonic erosion. CRISP Program B will provide the core material for detailed laboratory experiments designed to isolate the processes and physical conditions that control the onset of seismogenesis.

Four Major Goals of Program B Drilling, Monitoring and Laboratory Experiments are:

1) Quantify effective stress and plate boundary migration via focused investigation of fluid pressure gradient and fluid advection across the erosional plate boundary.

2) Determine the structure and fault mechanics of an erosional convergent margin and identify the processes that control the updip limit of seismicity.

3) Constrain how fluid-rock interaction affect seismogenesis by studying fluid chemistry and residence time, basement alteration, diagenesis, and low grade metamorphism.

4) Obtain physical properties of a 3-D volume that spans the seismogenic zone.

The subduction zone offshore Osa Peninsula provides the tectonic setting to reach CRISP goals. The shallow subduction angle and high temperatures bring to shallow depth processes that elsewhere occur at greater depth, beyond the reach of drilling.

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Scientific Objectives: (*250 words or less*)

CRISP Program B will sample and monitor the plate boundary environment to study physical conditions and material properties in the transition into the seismogenic zone. The scientific objectives of Program B are to test five main hypotheses central to understanding structure and seismogenesis at erosional plate boundaries:

1) Landward of the frontal sediment prism, the transition from stable to unstable slip parallels the transition from a fluid-rich and broad fault zone, with distributed slip, to a narrower zone of active deformation with localized shear and fluid compartmentalization.

2) Fluid pressure gradients and fluid advection affect the migration and coupling of erosional plate boundaries both temporally and spatially.

3) The lithology, physical properties, and structure of eroded materials influence fault mechanics and the transition from stable to unstable slip at subduction interfaces.

4) Fluid chemistry, P-T conditions and residence time affect the state of eroded material through basement alteration, diagenesis and low-grade metamorphism.

5) Lateral variability in subducted plate relief, subduction channel thickness, material properties and fluid distribution affect seismogenesis and rupture propagation.

These hypotheses will be tested by A) direct observation of the lithology, physical properties and structure of the plate boundary and surrounding rock, B) monitoring temperature, stress, pore-fluid pressure and chemistry, and seismicity, C) laboratory experiments on core samples, and D) dedicated geophysical surveys designed to expand regionally the results from drilling and monitoring.

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

Riser drilling
Drilling at >100°C and <200°C will require development of tools.

Proposed Sites:

Site Name	Position	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
CRIS-03A	84° 4.77852 W 8° 35.23956 N	530	700	2850	3550	Drilling and monitoring the plate boundary and subduction channel in the area of transition between aseismic and seismic slip and temperatures between 100°-150°C, updip, but near, the end of the seismogenic zone.
CRIS-06A	84° 9.77076 W 8° 45.16602 N	500	1920	4080	6000	Drilling and monitoring the plate boundary and subduction channel in the seismogenic zone at temperatures between 150°-<200°C.