IODP Proposal Cover Sheet

947 - MDP

Cascadia Borehole Observatories

Received for: 2019-10-01

Title	CCBO: Cascadia Cabled Borehole Observatories to Investigate Plate Boundary Mechanics and Test Models for Along-strike Segmentation of the Megathrust
Proponents	Harold Tobin, William Wilcock, Earl Davis, Martin Heesemann, Eiichiro Araki, Suzanne Carbotte, John Collins, Shuoshuo Han, Deborah Kelley, Masa Kinoshita, Heidrun Kopp, Kate Moran, Emily Roland, David Schmidt, Evan Solomon, Anne Tréhu, Kelin Wang, Mark Zumberge
Keywords	Subduction Zone, Cascadia, Borehole Observatories
Area	Northeast Pacific - Cascadia Margin

Proponent Information

Proponent	Harold Tobin
Affiliation	University of Washington
Country	United States

☑ Permission is granted to post the coversheet/site table on www.iodp.org

Abstract

The Cascadia subduction zone is now widely accepted as a dominantly locked fault system that is capable of magnitude 9 megathrust earthquakes and associated destructive tsunamis. Despite the lack of historic major events and the fact that it is the planet's quietest subduction zone in terms of megathrust seismicity, there is abundant evidence of repeated, large megathrust events. Onshore geodetic measurements have revealed that the offshore and coastal regions of the plate interface must be locked and accumulating elastic strain toward future earthquakes, to a degree that appears to vary along strike from only partial to essentially 100% of the plate convergence rate, but can't address the locus or extent of locking offshore, nor detect subtle but important transients. The data further suggest distinct along-strike segmentation between truly locked, seismically-quiescent regions off Washington and Vancouver Island, and less-fully locked regions where some seismicity does occur and transients may exist, off central Oregon.

In order to address the central questions regarding the mechanisms of fault locking, strain accumulation and release, and interrelationship between faulting and fluid processes, we seek to drill two transects of boreholes off Oregon and off Vancouver Island near the deformation front to establish cabled borehole observatories for geodynamic studies. The holes will be instrumented to measure fluid pressure, ground motions, and tilt. These observatories will test the hypotheses that (a) the hot and sediment-blanketed Cascadia plate interface megathrust fault is seismically at least partially locked all the way to the trench (the outer deformation front), (b) that variations in apparent degree of locking along strike contrasting Oregon with Vancouver Island are manifested as variations in shallow transient behavior in the plate boundary megathrust, and (c) that loading of the plate interface fault is not steady but that weak mechanical coupling of the oceanic plate with its underlying asthenosphere allows strain pulses from adjacent plate boundaries to propagate efficiently over large distances across the Juan de Fuca plate. Crucially, the proposed borehole transects are located to take advantage of existing seafloor cable access, opening the opportunity for power and telemetry to borehole sensors to build real-time sub-seafloor observatories of this hazardous and enigmatic seismogenic and tsunamigenic zone.

947 - MDP

Scientific Objectives

The two transects each entail 3-5 boreholes extending to 500-600 meters bsf within the incoming sedimentary section and accretionary wedge. Sealed borehole instrumentation will be installed to monitor pore fluid pressure, temperature, and seismic/geodetic activity. The hypotheses will be tested in the borehole observatories by: (1) characterizing the interseismic strain accumulation on the shallow megathrust, (2) detecting transients in strain including slow slip events, shallow tectonic tremor, and low-frequency earthquakes and (3) evaluating how these vary along strike by comparing behavior between the two transects. We also seek to (4) detect transmission of strain events from transients at Juan de Fuca Ridge that propagate across the incoming plate to the subduction zone; and finally (5) establish a real time observational capability by tying the borehole observatories into the two existing seafloor cabled observatory systems off Vancouver Island and Oregon. The long-term time series data from these IODP sites will provide baseline measurements of fault activity and test key hypotheses on the cycles of strain accumulation and release, including investigation of potential subduction zone earthquake precursory phenomena.

Specific objectives include: (1) capturing continuous and/or transient strain signals at each site, ranging from seismic events to slow creep and all time scales in between; (2) making along-strike comparisons of strain accumulation and release based in hypotheses about variable degrees of megathrust locking made from inconclusive land-based observations, and (3) documenting the lithologies, heat flow, and physical properties at each site in order to facilitate interpretation of the strain signals (or lack thereof).

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

Carrying out this MDP project will require the development and installation of 6 to 10 A-CORK style borehole instrumentation systems, based on established existing designs. We envision cased holes with exterior screens for pore fluid pressure and strategically spotted cement. Instrument packages could be deployed into the interior of the casing at the time of drilling or after from a vessel of opportunity. Two of the ACORKS are proposed to include fiber optic strainmeter tubing fixed to the exterior of the casing.

947 - MDP

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

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
N/A						