IODP Proposal Cover Sheet

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Hyuga-Nada Observatory

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Title	Drilling and monitoring in Hyuga-Nada: Unveiling effects of ridge subduction and segmentation on slow earthquakes
Proponents	Rie Nakata, Masataka Kinoshita, Yoshitaka Hashimoto, Laura Wallace, Eiichiro Araki, Tianhaozhe Sun, Yusuke Yamashita, Aitaro Kato, Patrick Fulton, Yohei Hamada, Hiroko Kitajima, Serge Lallemand, Seiichi Miura, Kimihiro Mochizuki, Kazushige Obara, Demian Saffer, Yuzuru Yamamoto, MIkiya Yamashita, Yusuke Yokota, Takashi Tonegawa
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Area	Hyuga-Nada offshore Kyushu Japan

Proponent Information

Proponent	Rie Nakata
Affiliation	University of Tokyo
Country	Japan

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Abstract

Shallow slow earthquakes, which last minutes to years, have become an important indicator for seismic coupling, slip behavior and future seismic potential in seismogenic zones. Key parameters controlling plate coupling and seismic slip style include the geometry of subducting plate ("roughness" such as seamounts), the age/thermal structure of incoming plate, and the frictional properties of incoming sediments. The Hyuga-Nada region offshore Kyushu, Japan is an outstanding locale for a drilling and observatory experiments to investigate their relationships. The subducting chain of seamounts (Kyushu-Palau-Ridge, KPR) accompanied by slow earthquakes provides excellent opportunities to explore the effects of roughness onto geomechanical/hydrological properties, and ultimately onto seismic coupling. Frequent (~1 year) periodical slow earthquakes and a planned permanent network (N-Net) enable sustainable long-term monitoring with high-fidelity. Correlation between a major transition in seismic coupling and a drastic segmentation suggests that the site is optimal to explore the influence of along-strike variations of the incoming plate in physical properties (temperature/surface roughness).

We propose to drill and install observatories at three primary locations in Hyuga-Nada to address our three hypotheses: (1) Seamount subduction modulates stress fields and pore pressure, creates fracture networks, and strongly influences the distribution and style of slip behavior on the plate interface. (2) Rough crust subduction influences the thermal state of the margin and controls the slip behavior of the plate interface. (3) The majority of plate motion at Hyuga-Nada is accommodated by slow earthquakes, the spatiotemporal distribution of which is influenced by seamount subduction and thermal state.
We drill two holes ito the accretionary wedge, measure physical properties and describe deformation by LWD, APCT-3, and core analysis to characterize in-situ stress state, fracture development, heat flow and pore fluid flow in the wedge disrupted by the KPR and the rough subducting crust. We reveal their spatial variations by comparing results from the holes north and west of the KPR located in the different segments, and establish robust geomechanical, hydrological, and thermal models. At the last drill site, we aim to penetrate the plate interface where slow earthquakes have occurred, and directly investigate their frictional properties. Observatory equipment will be installed at least at one site and connected to the N-Net node, to monitor slow earthquake activities using pressure and strain sensors, and associated transient heat/fluid flow. Fully characterizing slow earthquake episodes will reveal the degree to which slow earthquakes accommodate plate motion, and whether strain is accumulated for future earthquakes.

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Scientific Objectives

We drill, core, and install observatories at three primary drill sites, four alternate sites, and three contingency sites to address scientific questions;
- What is the stress and hydrological state at the leading edge of the subducting Toi Seamount of the KPR? How is the ridge subduction disrupting the upper plate? How does the chain of seamounts lead to a range of stages in the disruption?
- Is temperature on the plate interface lower or higher where the older West Philippine Basin crust is subducting, compared to further east where the younger Shikoku Basin is subducting? Does subduction of rough crust increase frictional heating, leading to higher temperatures on the plate interface in the west? How does advective fluid circulation affect the overall thermal regime?
- What portion of the plate motion budget do recurrent slow slip evens accommodated in Hyuga-Nada? Where do the slow slip events occur in space and time relative to observed tremors and very low frequency earthquakes? What are the frictional properties of the plate interface that generate slow earthquakes?

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

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Proposed Sites (Total proposed sites: 10; pri: 3; alt: 7; N/S: 0)

Site Name	Position (Lat, Lon)	Water Depth (m)	Penetration (m)			Brief Site-specific Objectives
			Sed	Bsm	Total	
SKP-01A (Primary)	31.4146 132.3414	2109	700	0	700	Core and log sedimentary section in middle slope of wedge in the eastern side of a subducting seamount for lithology and physical properties. Establish a DAS-CORK borehole observatory to measure time series of pore fluid pressure, temperature and strain.
SKP-02A (Primary)	30.9152 132.2612	2815	700	0	700	Core and log sedimentary section in middle slope of wedge in the western side of a subducting seamount for lithology and physical properties. Establish a DAS-CORK borehole observatory to measure time series of pore fluid pressure, temperature and strain.
SKP-03A (Primary)	31.4405 133.2454	4431	1200	0	1200	Core and log sedimentary section and decollement zone in frontal slope of wedge in the eastern side of a subducting seamount for lithology and physical properties. Establish a DAS-CORK borehole observatory to measure time series of pore fluid pressure, temperature and strain.
SKP-04A (Alternate)	31.0012 132.8218	4841	770	0	770	Core and log sedimentary section in the incoming plate for a reference of lithology and physical properties.
SKP-05A (Alternate)	30.9691 132.6599	4187	50	50	100	Core and log sedimentary section and basaltic basement in incoming plate at top of a small seamount for a refelence of lithology and physical properties.
SKP-06A (Alternate)	31.2968 132.9776	3723	700	0	700	Core and log sedimentary section in frontal slope of wedge in the eastern side of a subducting seamount for lithology and physical properties. Establish a DAS-CORK borehole observatory to measure time series of pore fluid pressure, temperature and strain.
SKP-07A (Alternate)	31.1889 132.3120	1704	700	0	700	Core and log sedimentary section in middle slope of wedge in the western side of a subducting seamount for lithology and physical properties. Establish a DAS-CORK borehole observatory to measure time series of pore fluid pressure, temperature and strain.
SKP-08A (Alternate)	31.1103 132.1840	2099	700	0	700	Core and log sedimentary section in middle slope of wedge in the western side of a subducting seamount for lithology and physical properties. Establish a DAS-CORK borehole observatory to measure time series of pore fluid pressure, temperature and strain.
SKP-09A (Alternate)	31.4140 132.1452	1715	700	0	700	Core and log sedimentary section in middle slope of wedge in the western side of a subducting seamount for lithology and physical properties. Establish a DAS-CORK borehole observatory to measure time series of pore fluid pressure, temperature and strain.
SKP-10A (Alternate)	30.5571 132.5904	3567	700	0	700	Core and log sedimentary section in a frontal wedge in the western side of a subducting seamount for lithology and physical properties. Establish a DAS-CORK borehole observatory to measure time series of pore fluid pressure, temperature and strain.