Drilling and monitoring in Hyuga-Nada: Unveiling effects of ridge subduction on slow earthquakes

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Shallow slow earthquakes, which last minutes to years, are important indicators of subduction megathrust slip behavior and future seismic and tsunami potential. Subducting plate roughness and seamounts have been proposed to promote slow earthquakes by inducing local geomechanical and hydrogeological anomalies. The Hyuga-Nada region offshore Kyushu, Japan is an outstanding locale for drilling and observatory experiments to investigate these effects. In this region, slow earthquakes are repeatedly observed on and near the subducting Kyushu-Palau-Ridge, KPR, chain of seamounts thus providing excellent opportunities to explore the effects of seamounts on geomechanical/hydrological/thermal properties, and ultimately seismic coupling. Long-term monitoring enabled by a planned permanent network (N-net) will allow subsurface processes during frequent (~1 year) periodical slow earthquakes and ~M7 earthquakes (~20-30 year interval) to be captured with high fidelity. Drilling, logging, and coring will provide key constraints on stress state, hydrological processes, and sediment physical properties in the region above the ridge. We have originally proposed the drilling and monitoring plan to IODP in 2019 (Nakata et al. 2019). In this presentation, we report the updated proposal plan along with initial processing results of new site survey data acquired with JAMSTEC (Miura et al., 2021, Arai et al., 2021, Ma et al., 2021).

We propose to drill and install observatories at three primary locations in Hyuga-Nada to address two hypotheses: 1) Seamount subduction modulates stress and pore pressure, creates fracture networks and influences the thermal and hydrological state of the margin. 2) The spatiotemporal distribution of slow earthquakes is strongly influenced by seamount subduction through the processes outlined in Hypothesis 1. We will drill three primary distinct sites relative to the seamount, to (1) measure physical properties, and (2) describe deformation by LWD, APCT-3, and core analysis to characterize in-situ stress state, fracture density, heat flow, and pore fluid flow. Spatial variations in the upper plate disruption caused by seamount subduction will be revealed by comparing results from sites in the leading and lateral edges, and top of the currently subducting seamount; and these will constrain geomechanical, hydrological, and thermal models. At two of the sites, we will install a “Fiber-CORK” observatory equipped with conventional pressure and temperature sensors and cutting-edge fiber-optic sensors. One site will be connected to the N-net node for real-time data streaming. The combination will fill a gap in slip durations currently observable in this region with seismic and geodetic instrumentation. Fully characterizing slow earthquakes will reveal the degree to which they accommodate plate motion, and whether strain is accumulated for future earthquakes.

Keywords: Drilling, Monitoring, Hyuga-nada, Slow earthquakes , Nankai

