INTERNATIONAL OCEAN DRILLING PROGRAMME

# PROPOSAL 1120-PRE

## Exploring Slow Slip to the Trench in the Nankai Subduction Zone (NankaiSST)

# IODP$^3$ Proposal Cover Sheet

### Proposal Title:
Exploring Slow Slip to the Trench in the Nankai Subduction Zone (NankaiSST)

### Broad Geographic Area of the Proposal
Nankai Trough subduction zone, southwest Japan

### Project Abstract
Borehole observations in the Nankai subduction zone offshore Kumano demonstrate that episodic slow slip events (SSEs) have recurrently propagated to the trench, up dip of the locked seismogenic portion of the megathrust. However, it remains unknown how strain is partitioned within the frontal accretionary prism, whether slow slip on the megathrust induces off-fault permanent inelastic deformation, and how much plate convergence is accommodated by these processes. Resolving these questions is essential for evaluating shallow strain accumulation and the slip budget for future tsunamigenic megathrust earthquakes.

Informed by data from IODP Expeditions 316 and 358 we propose deep-sea borehole experiments that penetrate the frontal accretionary prism and into the plate boundary fault to directly capture slow slip propagation near the trench with unprecedented spatiotemporal resolution. Distributed Optical Fiber Sensing with optical fiber cables installed in boreholes and seafloor fiber-optic cables will be integrated with existing submarine cable networks and a suite of complementary borehole sensors to study slow slip and other interseismic transient deformation. To characterize fault zones hosting slow slip and inelastic off-fault deformation within the prism, continuous coring will be conducted from the seafloor down to the plate boundary fault, including intervals where localized shear (slip) has been detected or implied from high-resolution local strain profiles from distributed optical fiber sensing.

The Nankai subduction zone offshore Kumano has been an important natural laboratory for studying shallow slip, owing to its rare capacity for direct monitoring and sampling of active shallow fault zones that regularly host SSEs every 12–18 months. By combining borehole distributed optical fiber and fluid pressure observations with coring, this project will elucidate: (1) the distribution of active slow slip and associated deformation within the prism, (2) fault zone architecture, deformation mechanisms, and frictional and elastic properties associated with slow slip, and (3) the coupled fluid-slip interaction, including the role of fluids in promoting trenchward slip propagation and the role of slip in enhancing fluid-flow pathways. These results will allow a quantitative assessment of the partitioning of plate convergence between slow slip and permanent deformation in the accretionary prism, providing a critical framework for evaluating the shallow (near-trench) slip budget for future megathrust earthquakes. The proposed efforts are timely given the urgent need to assess seismic and tsunami hazards at the Nankai margin, which is known to host historical large earthquakes (M>8) and is >80 years into its average interseismic stage of 100-150 years.

### Scientific Objectives
The proposed drilling program addresses the following key scientific objectives:
(1) Determine whether slow slip propagates trenchward along the plate boundary fault and/or if slip is distributed on imbricate thrusts branching from the plate boundary fault.
(2) Quantify the fraction of plate convergence accommodated by slow slip and associated permanent inelastic off-fault deformation within the accretionary prism, and assess the fault slip budget which can potentially drive shallow coseismic displacement during future megathrust earthquakes.
(3) Identify the deformation mechanisms and frictional and elastic properties associated with slow, transient slip behavior.
(4) Test whether slow slip is accommodated throughout shear zones that are meters to several tens of meters thick, in contrast to localized slip on principal slip surfaces, and characterize the internal structure, architecture, and strain distribution of fault zones hosting slow slip.
(5) Assess the potential feedback processes between fluids flow (e.g., fluid pressure anomaly and fluid migration) and slow slip propagation.

### Science Communication Plain Language Summary
Offshore Japan, the Philippine Sea Plate is pushed underneath the Japanese islands along the Nankai subduction zone. Sliding of the ‘subducting’ ocean plate under the overlying continent does not occur steadily. Instead, it happens in earthquakes, and in ‘slow slip events’, which are slower than earthquakes. Slow slip events are not

felt on the Earth’ s surface, but can be detected by seafloor instruments. Slow slip is not well understood – we do not know how this slip is distributed within the rocks and sediments of the plate boundary, whether it occurs on faults above the plate boundary or how much slip really happens in slow slip events. We do not know the relation between slow slip and tsunamigenic large earthquakes, and also between slow slip and flow of water along the plate boundary. This project will address these unknowns by seafloor drilling to sample deformed sediments and install borehole observatories.

The area chosen for this project offers a unique scientific opportunity because slow slip has been observed, in detail, with borehole sensors. Unlike other places, the source area of slow slip here is known to be shallow enough to reach with a borehole. Previous studies here also provide background information on geology, deformation, and past history of slow slip and earthquakes. This is therefore the best place to study slow slip and associated deformation of the plate boundary and surrounding sediments. A major hazard in Japan is shallow earthquake slip to the trench, which can generate damaging tsunamis. This work will advance understanding of how shallow, slow slip occurs, how much energy it releases, and how much energy remains stored that may instead be released in a large earthquake. The project will contribute to forecasting for shallow slip in future large earthquakes, and the observatory will be used for long-term monitoring of the Nankai Trough megathrust and for assessing the current state of seismic hazard.