International Ocean Discovery Program Expedition 405 Scientific Prospectus Addendum

Tracking Tsunamigenic Slip Across the Japan Trench (JTRACK)

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1. Introduction

A new component to the drilling operations has been added to the International Ocean Discovery Program (IODP) Expedition 405 schedule following approval of an Ancillary Project Letter (1013-APL). The new operations involve deploying a borehole observatory into Hole C0019D with a temperature sensor string. This hole and observatory infrastructure (i.e., casing) was previously drilled as part of Integrated Ocean Drilling Program Expedition 343/343T in 2012 (Expedition 343/343T Scientists, 2013). Site C0019 is the same site as Site JTCT-01A, described as part of Expedition 405 in Kodaira et al. (2023). Installation of a new instrument string in Hole C0019D at the beginning of Expedition 405 operations will allow the passive observation of anticipated subsurface hydrologic effects caused by nearby drilling (e.g., Kinoshita and Saffer, 2018). Together, the new drilling around Site C0019/JTCT-01A and the resulting observatory temperature observations in Hole C0019D will constitute a series of cross-borehole experiments that enable the determination of large-scale hydrogeologic properties around the plate boundary fault and overlying damage zone.

The site priorities and drilling and coring strategy at the primary sites for Expedition 405 (Sites JTCT-01A and JTCT-02A) remain unchanged from the original Expedition 405 *Scientific Prospectus* (Kodaira et al., 2023).

2. Scientific objectives

The additional operations and associated science will directly contribute toward addressing the science objectives for Expedition 405. The scientific purpose of reinstrumenting the Hole C0019D observatory is to quantify the large-scale hydrologic properties of the plate boundary fault and overlying damage zone in support of Scientific Objective 3: Characterize the hydrogeology of the plate boundary fault zone and frontal prism.

Estimates of cross-borehole hydraulic diffusivity and by extension permeability are made possible by measuring the hydrologic response to nearby drilling in time-series borehole temperature measurements in Hole C0019D. Constraints on the large-scale hydrogeologic properties between wells will help address the key questions associated with this objective and describe the degree of hydraulic connection spatially within the region above the shallow Japan Trench megathrust.

Ancillary observations made possible by the reinstrumented Hole C0019D observatory will also complement observations within the planned new deeper JTRACK observatory by enhancing the characterization of temporal and spatial variations in hydrogeologic processes and properties over the duration of the sensor deployment and in comparison with observations in Hole C0019D made over a decade earlier between 2012 and 2013 (Fulton et al., 2013; Fulton and Brodsky, 2016).

The data from the reinstrumented Hole C0019D observatory also has the potential to complement observations in the planned new JTRACK observatory in delimiting the temperature anomaly generated by frictional heating on the fault caused by the 2012 M9.0 Tohoku-oki earthquake. This will help address aspects of Science Objective 1 described in the original scientific prospectus as "Characterize the stress state within and around the fault zone that experienced large coseismic slip during the 2011 Tohoku-oki earthquake."

3. Borehole observatory

As part of the new operations during Expedition 405, a temperature sensor string will be deployed in Hole C0019D in addition to the new borehole observatory that is planned to be installed at Site JTCT-01A as part of the original plans for Expedition 405. The observatory casing in Hole C0019D consists of a 4.5 inch diameter steel tubing (i.e., casing) that extends beneath a seafloor wellhead to a depth of 824 meters below seafloor (mbsf) (Expedition 343/343T Scientists, 2013). Similar to the new JTRACK observatory, the sensor string in Hole C0019D will be deployed through drill pipe and into the hole via core line. Access to the observatory during deployment and

eventual recovery at least 1 y later will be made via the D/V *Chikyu* by mating drill pipe and using the core line to both deploy and recover the instrument string through drill pipe.

The instrumentation on the sensor string in Hole C0019D will follow a similar setup to that used during Expedition 343/343T (Fulton et al., 2013). Individual temperature-sensing data loggers will be deployed at various fixed depths along a Vectran line into the cased borehole. The casing contains a check valve at the bottom allowing circulation out the bottom during installation, but together with a top seal/hanger at the top of the sensor string held in place by sinker at the bottom on the line, prevents fluid flow into and along the inside of the observatory.

Similar to the original deployment of 55 sensors in Hole C0019D as part of Japan Trench Fast Drilling Project (JFAST) Expedition 343T, ~57 sensors are planned to be deployed as part of the reinstrumentation of Hole C0019D. The positioning of sensors will focus measurements within the depth interval encompassing the plate boundary fault identified from the core at 819 mbsf and the overlying damage zone, including depth intervals where transient fluid advection was previously observed (Fulton et al., 2013; Fulton and Brodsky, 2016). Depending upon availability of third-party instrumentation, spacing in the fault core at around 819 mbsf and surrounding a known permeable structure at ~792.5 mbsf is anticipated to be 1 m, with 2 m spacing elsewhere from 821 to 750 mbsf and 4 m spacing between ~695 and 750 mbsf (Figure **F1**).

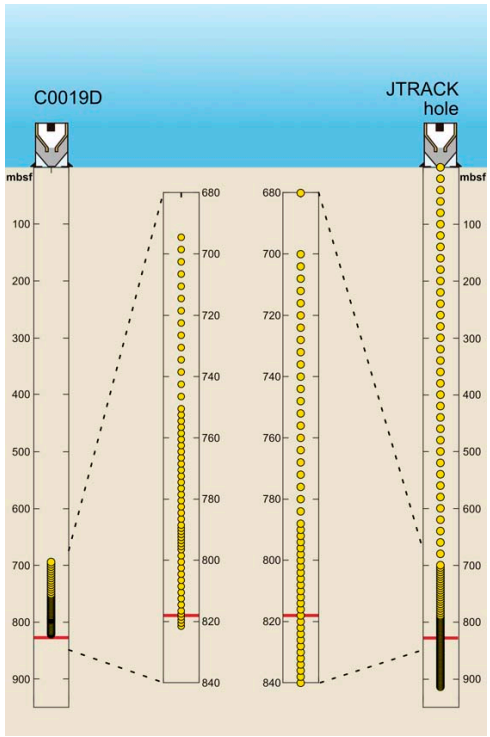

Figure F1. Schematic showing design of observatory with sensors to be deployed in Hole C0019D and new JTRACK observatory hole. Circles = temperature sensors, red lines = approximate position of plate boundary fault.

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