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Tracking past earthquakes along the Japan Trench: Fresh initial results from the IODP Japan Trench Paleoseismology Project

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Short historical and even shorter instrumental records limit our perspective of earthquake maximum magnitude and recurrence, and thus are inadequate to fully characterize Earth's complex and multiscale seismic behavior and its consequences. Examining prehistoric events preserved in the geological record is essential to reconstruct the long-term history of earthquakes and to deliver observational data that help to reduce uncertainties in seismic hazard assessment for long return periods. Motivated by the mission to fill the gap in long-term records of giant (Mw 9 class) earthquakes such as the Tohoku-Oki earthquake in 2011, International Ocean Discovery Program (IODP) Expedition 386, Japan Trench Paleoseismology, was designed to test and further develop submarine paleoseismology in the Japan Trench.

Earthquake rupture propagation to the trench and sediment remobilization related to the 2011 Mw 9.0 Tohoku-Oki earthquake, and the respective structures and deposits are preserved in trench basins formed by flexural bending of the subducting Pacific Plate. These basins are ideal study areas for testing event deposits for earthquake triggering as they have poorly connected sediment transport pathways from the shelf and experience high sedimentation rates and low benthos activity (and thus high preservation potential) in the ultra-deep water hadal environment. Results from conventional coring covering the last ~1,500 y reveal good agreement between the sedimentary record and historical documents. Subbottom profile data are consistent with basin-fill successions of episodic muddy turbidite deposition and thus define clear targets for paleoseismologic investigations on longer timescales accessible only by deeper coring.

In 2021, IODP Expedition 386 successfully collected 29 Giant Piston cores at 15 sites (1 to 3 holes each; total core recovery 831 meters), recovering 20 to 40-meter-long, continuous, upper Pleistocene to Holocene stratigraphic successions of 11 individual trench-fill basins along an axis-parallel transect from 36°N – 40.4°N, at water depth between 7445-8023 m below sea level. The cores are currently being examined by multimethod applications to characterize and date event deposits for which the detailed stratigraphic expressions and spatiotemporal distribution will be

analyzed for proxy evidence of giant versus smaller earthquakes versus other driving mechanisms. Initial preliminary results presented in this EGU presentation reveal event-stratigraphic successions comprising several 10s of potentially giant-earthquake related event beds, revealing a fascinating record that will unravel the earthquake history of the different along-strike segments, that is 10–100 times longer than currently available information. The data set will enable a statistically robust assessment of the recurrence patterns of giant earthquakes as input for improved probabilistic seismic hazard assessment and advanced understanding of earthquake-induced geohazards globally.

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