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Extreme event archived in the geological record of the Japan Trench: New results from R/V Sonne Cruise SO-251 towards establishing J-TRACK paleoseismology

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Our perspective of subduction zone′s earthquake magnitude and recurrence is limited by short historical records. Examining prehistoric extreme events preserved in the geological record is essential towards understanding large earthquakes and assessing the geohazard potential associated with such rare events. The research field of “subaquatic paleoseismology” is a promising approach to investigate deposits from the deep sea, where earthquakes leave traces preserved in stratigraphic succession. However, at present we lack comprehensive data set that allow conclusive distinctions between quality and completeness of the paleoseismic archives as they may relate to different sediment transport, erosion and deposition processes vs. variability of intrinsic seismogenic behavior across different segments.

Initially building on what sedimentary deposits were generated from the 2011 Magnitude 9 Tohoku-oki earthquake, the Japan Trench is a promising study area to investigate earthquake-triggered sediment remobilization processes and how they become embedded in the stratigraphic record. Here we present new results from the recent R/V Sonne expedition $SO_2$51 that acquired a complete high-resolution bathymetric map of the trench axis and nearly 2000 km of subbottom Parasound profiles, covering the entire along-strike extent of the Japan Trench from 36° to 40.3° N, and groundtruthed by several nearly 10m long piston cores retrieved from the very deep waters (7 to 8 km below sea level): Several smaller submarine landslide (up to several 100’s m of lateral extent) can be identified along the trench axis in the new bathymetric data set. These features were either not yet present, or not resolved in the lower-resolution bathymetric dataset acquired before 2011. Sub-bottom acoustic reflection data reveals striking, up to several meter thick, acoustically transparent bodies interbedded in the otherwise parallel reflection pattern of the trench fill basins, providing a temporal and spatial inventory of major sediment remobilization events along the Japan Trench with potential quantitative constraints on volumes and mass fluxes of material mobilized during each event. Also the cores from the southern and northern part of the Japan Trench confirm previous findings from the central part near the Tohoku-oki epicenter, that the small deep-sea trench-fill basins, that are associated with very high sedimentation rates, comprise repeated thick turbidite sequences to be further tested for correlation to historic earthquakes. Eventually, the results of Cruise $SO_2$51 will be integrated with cores and data from various other cruises to provide a solid base for later long-coring efforts and scientific drilling, as proposed within the IODP JTRACK initiative, towards potentially producing a fascinating record unravelling an earthquake history that is 10 to a 100 times longer than currently available information.