The isotopic signature of remobilized sediment by Tohoku 2011 and prior earthquakes: Japan trench and slope

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The 2004 Sumatra (Mw9.3) and the 2011 Tohoku-Oki (Mw9.0) earthquakes and associated tsunamis were catastrophic events with devastating societal consequences, in part because these tsunamigenic earthquakes were much larger than thought possible at those locations. A few similar prior events are known (M9.4 Alaska 1964, M9.6 Chile 1960, Cascadia 1700 AD) but historic records are too short to characterize megaquake occurrence and impacts. The urgent challenge is reconstructing and characterizing such events from their submarine geologic signature to constrain where such events are possible, where they may occur in the future, and how to differentiate them from smaller and more frequent ones. Well-studied recent earthquakes provide precious ground truth, and progress is being made as a result of recent surveys to the Japan trench and trench slope. Forty sediment cores, multibeam bathymetry and subbottom profiles acquired with Parasound were collected during R/V Natsushima 13-02, 13-19 and R/V Sonne 251 permitting to characterize the sediments remobilized by the 2011 Tohoku and prior earthquakes on the trench and trench slope.

Short-lived radioisotopes identify sediment associated with the Tohoku 2011 Mw9, which is characterized for its thickness and spatial distribution from 600 to 8000 m of water depth. In the southernmost basin of the Japan Trench, an ~2m thick homogeneous deposit was linked to the 2011 earthquake. Similar, up to 7m thick homogeneous deposits that likely resulted from M9 paleoearthquakes, were documented in other trench cores. Sr, Nd and Pb isotopic ratios reveal a shift to more mantle like values, most likely because arc materials are concentrated in these homogeneous deposits. In contrast, the isotopic signal of smaller, younger and older turbidites, has a more negative epsilon Nd and more radiogenic Sr, consistent with an older continental crust. These new findings derived from turbidites recovered from the Japan Trench indicate that there is along trench and downcore variability in isotope ratios. This variability has the potential to identify sediment sources and along-strike extent of historic and prehistoric ruptures.

Keywords: Japan Trench margin, 2011 Tohoku-oki earthquake, remobilized sediment, short-lived radioisotopes, Sr. Pb, epsilon Nd isotopes, paleoearthquakes

