Extracting the Deep Marine Record of Earthquakes from the Japan Trench Margin Sediments

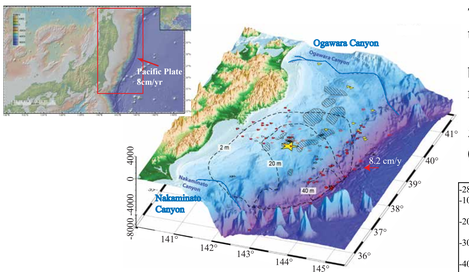
Jamie Asan[1], Cecilia McHugh[1,2], Leonardo Seeber[3], Michael Strasser[4], Toshiya Kanamatsu[5], Sharif Mustaque[1,6]

[1]Earth and Environmental Sciences, Queens College, City University of New York, 65-30 Kissena Blvd. Flushing, NY 11367,USA,
[2]Marine Geology and Geophysics, Lamont-Doherty Earth Observatory of Columbia University, Rt. 9W. PO.Box 1000, Palisades 10964,USA,
[3]Seismology Geology and Tectonophysics, Lamont-Doherty Earth Observatory, 61 Route 9W, PO Box 1000, Palisades, NY 10964-8000
[4]Institute of Geology, University of Innsbruck. Innsbruck, Austria, [5]Marine Geology and Geophysics, JAMSTEC, 2-15 Natushima-cho, Yokosuka, 237-0061, Japan, [6]Auburn University Dept. of Geosciences, S College St, Auburn, AL 36849-0001

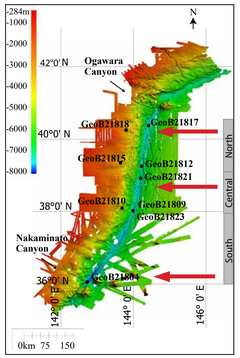
Objectives

-To document what is known about the 2011 Tohoku event deposit
-To learn from the lithology so as to characterize the history of paleo-earthquakes in the Japan Trench and other settings
-To document the processes by which homogenites are deposited and their link to the 2011 Tohoku earthquake
Homogenites are thick (1-7 m), lithologically homogeneous that lack
-bioturbation and are acoustically transparent (McHugh et al., 2020)

Background



Tectonics, plates, and rates:
The catastrophic Tohoku earthquake and tsunami M 9 event occurred on March 11, 2011 in the Japan Trench. The Pacific plate subducts beneath the Okhotsk plate at 8.2 cm/year. The rupture reached the trench and slip increased up-dip. The rupture caused for the plate to move 50 m horizontally and about 7 m vertically (Fujiwara et al., 2011)



Study Area: During the 2016 R/V Sonne 251expedition cores were extracted from the two depositional environments in the Northern, Central and Southern regions near the rupture and the area of maximum slip.
- Cores that were studied: GeoB21818, GeoB21815, GeoB21810, GeoB21817, GeoB21812, GeoB21821, GeoB21809, GeoB21823, and GeoB21804

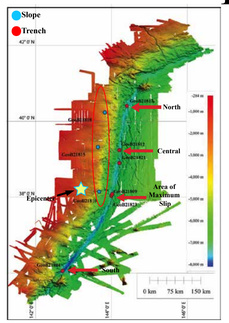
Ages from short-lived radioisotopes:
Short-lived radioisotopes were used to track earthquake event deposits. With normal slow deposition offshore Japan, $xs^{210}Pb$ is preserved only in the upper few centimeters of sediment. The $xs^{210}Pb$ we measured in the event deposits had a high concentration and therefore the event deposited was related to the 2011 Tohoku earthquake. $xs^{210}Pb$ decays in 150 years because of its short half-life.

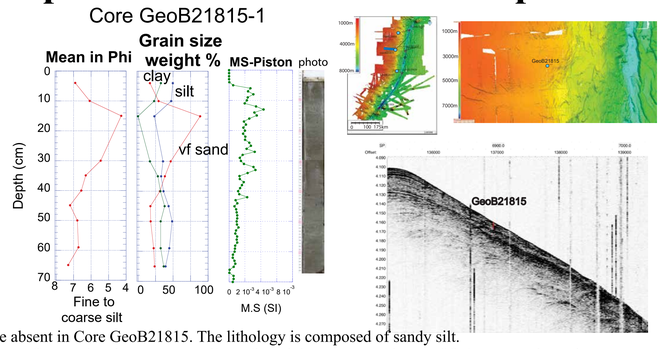
Fukushima Dai-ichi Nuclear power plants accident:
^{137}Cs and ^{134}Cs (half-life 2 years) entered ocean and sediments (e.g., Buesseler et al., 2011; Aoya et al., 2012; Kusakabe et al. 2013) ^{137}Cs was also put out into the atmosphere by nuclear testing that peaked in mid-1960's. When the sediments preserve a peak concentration of ^{137}Cs, only then it is interpreted as having been deposited in 1960's. If ^{137}Cs and ^{134}Cs are together they reflect Fukushima disaster. ^{134}Cs has a half-life of 2 years so only traces are found today.

Methods

-Previously collected Parasounds, subbottom profiles and bathymetery
-Ten meter long cores collected from the R/V Sonne 251 in 2016
-Core descriptions and photos
-Grain size variability using the sedigraph data for fine components

Depositional Environment: Slope





Signature of the 2011 event deposit in steep parts of the slope (3,000-4,000m):

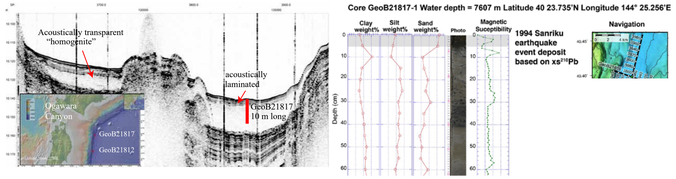
-We identified areas where the 2011 event was deposited because the sediments either contained short-lived radioisotopes or not.
-Steep areas of the slope didn't preserve the 2011 event deposit.
-Acoustic images coupled to core data indicate more indurated, presumably older strata, exposed at surface.

Shortly-lived radioisotopes were absent in Core GeoB21815. The lithology is composed of sandy silt.
The grain size is dominated by very fine sand and coarse to medium silt and there is no evidence of fining upwards to clay.

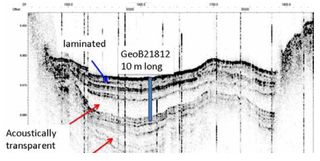
Depositional Environment: Trench: Four Segments

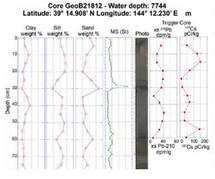
2011 Event Deposit Absent

Northern Trench



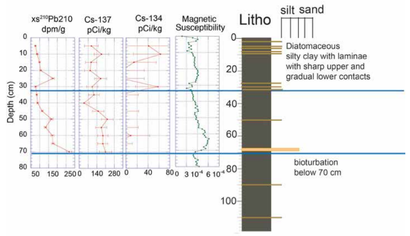
Central Trench



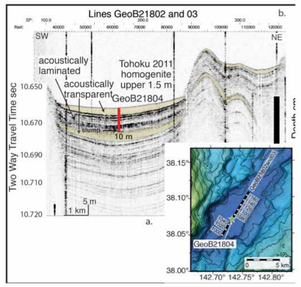


2011 Event Deposit Present

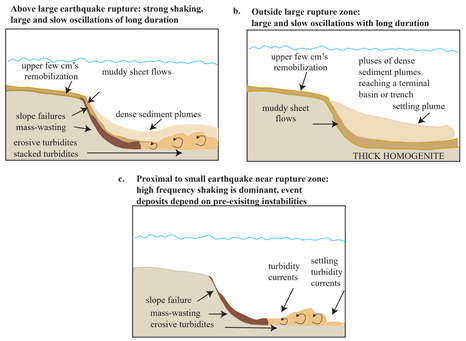
Downslope of area of maximum slip



Southern Trench terminal basin



Discussion: Proposed Processes



Conclusions

2011 Tohoku earthquake event deposit:
-Absent from steep areas of the slope
-Present downslope of the area of maximum slip and in the southern segment of the Japan Trench Terminal basin.
-It is absent from the Northern and Central segments of the Trench distal from the area of maximum slip
Grain size variability:
-Slope lithology contains 25-50% sand
-Trench lithology is finer grained and composed of silt (40-60%) sand (20%), clay (20%)
Grain size differences between homogenites and turbidites:
-Homogenites are composed of silt and clay
-Turbidites are composed of sand and silt normally graded.
International Ocean Discovery Expedition 386 will take place in 2021-2022 to continue to test this hypothesis.

Awknowledgments

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