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Distinct Isotopic and Sedimentary Signatures of Tsunamigenic Earthquakes, Japan Trench Subduction Boundary

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Abstract Text:
The largest known earthquakes ruptured megathrusts at subduction boundaries. The largest among these ruptured the entire seismogenic depth range up to the seafloor and have generated enormous regionally destructive tsunamis. This type of rupture that breaches the sea-floor is fortunately rare, but, as a result, the most recent ones, M9.2 Sumatra in 2004 and the M9.0 Japan in 2011, were unexpected and thus caused great damage. We don't know where and when they can occur again. Our approach has been to compare earthquake event deposits in various ocean settings (IODP Expedition 386, Japan 2021; Jamaica Passage 2022; Bay of Bengal 2024) and to study the entrainment processes (shaking tank experiments) and search for distinguishing features in the depositional record.

We are now revealing techniques that involve the use of isotopes and chemistry to characterize earthquake related event deposits. We identified thick, acoustically homogeneous layers "homogenites" that have homogeneous radiogenic isotope (Nd, Sr, Pb) signatures, unlike the background sediments. Additionally, TOC%, N% and $d^{13}C$, $d^{15}N$, show distinct signatures relative to the background. These isotopic signatures correspond perfectly well with lithology, physical properties and X-CT scans in the thick homogenites. Using these techniques we recognize the 1454 AD Kiatoka and 869 AD Jogan events in the Japan Trench that were tsunamigenic and possibly ruptured the seafloor. While each of these events has unique signatures, there are common threads and these findings lay the groundwork to go back in time and better characterize older Mw9.0 ruptures.

One of the most significant contributions to this effort is the recognition of M9.0 2011 Tohoku tsunamigenic earthquake in the Japan Trench. Short-lived radioisotopes help to document the extent of the remobilized sediment. This event has provided unique insights due to the Fukushima nuclear reactor radioisotopes measured in the Japan Trench as far as ~200km from its source. The use of these techniques provides tools for recognizing tsunamigenic earthquakes in other subduction boundaries such as Cascadia.

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T009. Insights into the Cascadia Subduction Zone: From Fundamental Scientific Processes to Societal Resilience

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