When and Why have Earthquakes Propagated to the Seafloor at the Japan Trench?

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In 2011 a large magnitude, shallow slip earthquake, known as Tohoku-Oki, took place in the Japan trench. This devastating magnitude 9 event was one of the largest recorded earthquakes in human history, understanding this earthquake provides a unique opportunity to make models of large, rare earthquakes. The Japan Fast Drilling Project (JFAST, Exp 343) expedition took place in 2012 with the goal of taking core samples as quickly as possible after the rupture (Chester F. M., 2013).

We selected 16 samples from core C0019E, with a particular focus on those from the plate boundary fault zone where prior work has identified evidence for earthquake-related heating (Rabinowitz et al, 2020, Nature Communications). Mineralogy of bulk samples was characterized using a benchtop x-ray diffractometer. We then applied a size separation approach to separate clay formed during faulting (authigenic illite, which tends to be finer) from inherited wallrock clay (detrital illite, which tends to be coarser). Additionally we are processing the separations for K/Ar ages. Within the fault zone, samples are illite rich, making them amenable for K/Ar dating. The <0.2 μm size fraction consistently contains lower concentrations of radiogenic ^{40}Ar40 (^{40}Ar40*) then bulk samples, and samples are being processed for K concentrations. This difference in ^{40}Ar* concentration is particularly pronounced in samples where heating signatures were reported by Rabinowitz et al., suggesting a correlation between loss of ^{40}Ar* and earthquake heating which will later be expanded upon.

Our new record of mineralogy and K/Ar ages from the fault zone will improve our understanding of when and why pre-historic large earthquakes have propagated to the seafloor in the Japan Trench.