Discovery Corridors, Islands, and Megathrust Earthquake Ruptures
aka
The Megathrust Megaswath

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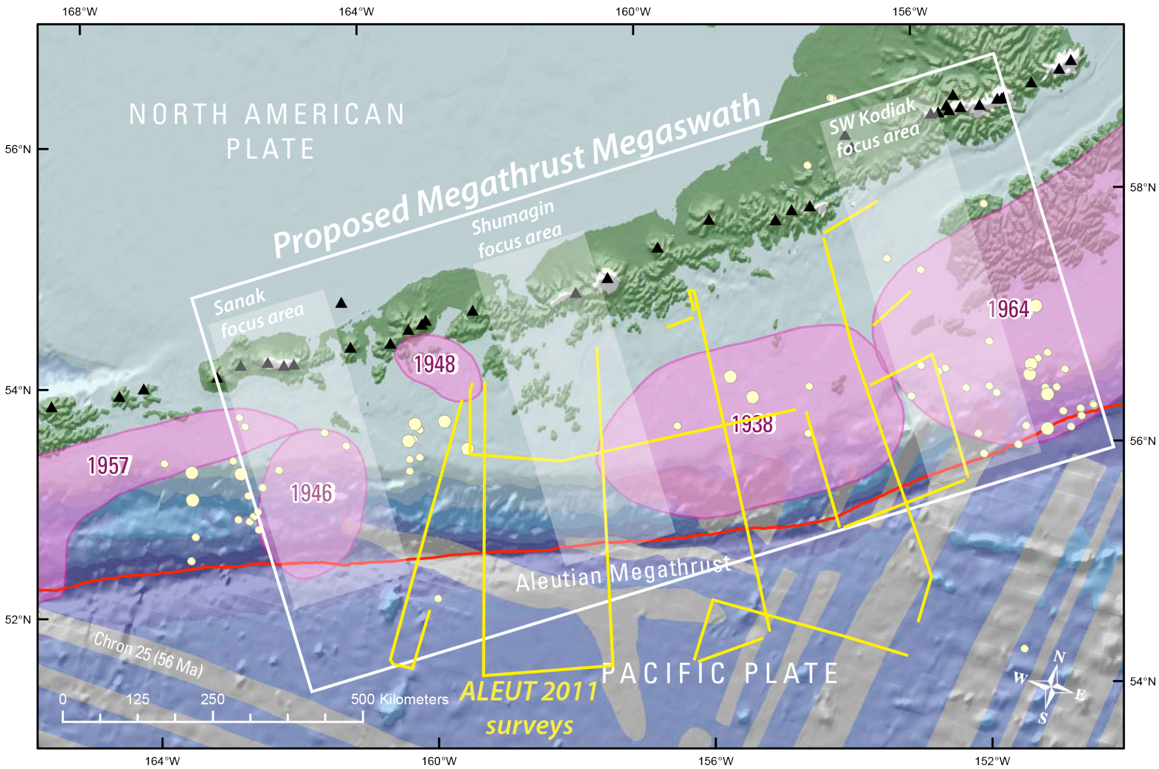
One of the most fundamental earthquake hazard questions associated with subduction zones, is, what controls the extent of megathrust earthquake ruptures? To address this question, we suggest that one of the Alaska GeoPRISMS 'discovery corridors' should not be as narrow as a corridor, but rather it should be a wide swath - or in this case - a 'megathrust megaswath'. Moreover, we need to examine a region with islands located between the arc and trench. Islands allow instrumentation of the modern subduction zone for geodesy and seismology. Islands allow for investigation of paleogeodesy, paleoseismology, and paleotsunamis. And islands allow inexpensive ground truth of what is observed on marine seismic reflection and refraction data: stratigraphy, structure, sedimentology, thermal history, exhumation, and erosion.

We suggest a megathrust megaswath between the southwestern end of the Kodiak Island group and Sanak Island. This region spans the 1964, 1938, 1948, and 1946 megathrust ruptures, the 'tail' of the 1957 rupture, the Shumagin seismic gap, and it likely includes much of a region that ruptured in 1788. It spans megathrust rupture areas in different parts of their cycles. Additional marine geophysical work is needed for understanding structural variations along the megathrust. One or a few traverses of the accretionary prism is not enough to evaluate variations in structural or subduction parameters. Also, this region is a depocenter for glacial and interglacial systems originating in Cook Inlet, as well as a transition in thickness of sediments being delivered to the Aleutian Trench along strike. Moreover, the Zodiak abyssal fan, the Patton-Murray sea mount chain, and the Aja fracture zone are entering the trench in this region, all of which may affect locking and rupture processes. Thus it is an area that would be a good case study for the interaction of surface processes and subduction dynamics.

Past, present, and planned research efforts make this an excellent region for study. Previous work by the USGS in the 1970s and 1980s provided important context and the STEEP and 2011 USGS Extended Continental Shelf data farther north provide information on the sediment inputs. The 2011 ALEUT project collected a backbone of state-of-the-art seismic reflection and refraction data within the "megaswath". The so-called 'Shumagin seismic gap' was identified in the early 1980s and geodetic work in the region has continued to the present day, including PBO continuous stations on some of the islands and on the Alaska Peninsula. Bedrock geology of the islands was mapped by the USGS in the 1970s and 1980s, and there are excellent exposures of rocks from Late Cretaceous through Pliocene time. Although prior paleoseismic and paleotsunami investigations in this region are lacking, there were USGS-led teams to three different outer islands the last two summers. The USGS Alaska earthquake hazards project is committed to future field efforts in the broader region for the next decade.

We suggest subfocus areas southwest of the Kodiak Islands, the Shumagins area, one near Sanak Island, and one or more along-strike deep seismic lines to link these regimes together. Perhaps doubling the density of lines collected by the ALEUT project would yield sufficient resolution. The Sanak area would involve new data collection efforts. This approach would leverage the ongoing work, and allow GeoPRISMS to expand on legacy data collection efforts. By broadening a discovery corridor to a megathrust megaswath, models for barriers to rupture can be tested.

Lastly, rupture barriers imply a characteristic large earthquake distribution rather than a Gutenberg-Richter power-law distribution. However, the recent M=9.0 Tohoku earthquake in Japan ruptured through inferred rupture barriers, and caused some rethinking about the magnitude distribution in the Japan Trench, and subduction zones in general. The magnitude-frequency distribution is crucial to earthquake and tsunami hazard assessment because the rate of moderate to large events can vary dramatically, as can the maximum magnitude. This question is fundamental in seismology, but unfortunately, modern catalog data have not provided a resolution to the issue. When studied comprehensively, the Alaskan subduction megaswath and its many islands has the potential to reveal its hidden paleoearthquake and tsunami history. In combination with structural observations, repeated and cross-referenceable earthquake and tsunami signatures promise an unparalleled opportunity to apply constraints on the regional extent of past and future large ruptures, and thus their tsunami and earthquake magnitude distribution.



Map showing the location of the proposed ‘megathrust megaswath’. Seismic reflection profiles collectud during the summer of 2011 for the ALEUT project are shown in yellow. Red line shows the toe of the Aleutian megathrust. Black triangles are volcanoes with Holocene activity. Pink blobs show areas of megathrust earthquake rupture, with year listed inside. Yellow dots are M5+ earthquakes. Grey bars on Pacific Plate show marine magnetic anomalies.