Earthquake, deformation and thermal modeling studies have been instrumental in advancing knowledge of megathrust earthquake rupture areas, recurrence rates, subduction fault segmentation, strain accumulation, and 3D spatial distribution of interplate coupling. Despite these advances, current estimates about the extent and location of the locked zones on the subduction thrusts are only regionally accurate, and there is a need for alternative methods for improved characterization of seismic hazards in subduction zones. A recent study of the northern Cascadia subduction interface (*Nedimovic et al.,* 2003) revealed an intriguing spatial correlation between the seismic reflection character of the megathrust and its mechanical behavior. In the seismogenic, locked portion of the megathrust located primarily offshore, the thrust is characterized by a single reflection event, or a very thin reflection package. In the transition zone downdip of the locked zone, however, where the megathrust behavior is thought to gradually change to slow slip that occurs during recently discovered episodic tremor and slip events, the megathrust reflection package thickens dramatically and exhibits a more complex signature. Reflection images from Alaska, Chile and Japan show a similar megathrust signature to the one observed at Cascadia margin, suggesting that reflection imaging may be a globally important predictive tool for determining at high resolution the location of the downdip limit of the locked zones that rupture during great subduction earthquakes.

The eastern Alaska-Aleutian subduction zone is an ideal setting for testing the hypothesis on the correlation between the megathrust reflection signature and its long-term mechanical behavior. This area is globally unique because the shelf is wide and fully accessible to relatively inexpensive marine mapping of the locked and transition zones, and partial mapping of the slow slip zone. Current coupling on the megathrust does not only vary downdip, but also laterally across the whole spectrum, from free slip to fully locked. Comparative analysis of the reflection mapping results and the downdip rupture limit defined by aftershocks and co-seismic geodetic data can be carried out because during the past century virtually the entire Alaska-Aleutian megathrust has ruptured in large to great earthquakes. The seismic reflection results can also be compared to estimates of the downdip limit of the locked zone that are based on geodetic post-seismic uplift data and thermal modeling. Particularly well suited for a controlled source seismic experiment is a 500 km-long stretch of the Alaska-Aleutian megathrust that extends from the freely slipping Shumagin segment, across the variably coupled Semidi segment that ruptured in the 1938 earthquake, to the strongly coupled Kodiak asperity that ruptured in the 1964 Good Friday earthquake. This study area has never been probed with deep controlled source seismic investigations and is of great topical interest because megathrust rupture repeat times for the Semidi segment appear to concentrate within the 50 to 75 year range, and 68 years have passed since the last, 1938 earthquake.