Title: *Fluids control along-strike variations in the Alaska seismogenic zone and mantle wedge processes*

Fan Wang[1], S. Shawn Wei[1], Julie L. Elliott[1], Jeffrey T. Freymueller[1], Connor Drooff[1], Natalia A. Ruppert[2] and Haijiang Zhang[3]
1. Department of Earth and Environmental Sciences, Michigan State University, East Lansing, MI 48824, USA
2. Alaska Earthquake Information Center, University of Alaska Fairbanks, Alaska, USA
3. School of Earth and Space Sciences, University of Science and Technology of China, Hefei, Anhui, China

Abstract: The seismogenic zone usually displays high interseismic coupling between the downgoing slab and the overriding plate. The highly coupled seismogenic zone is bounded by creeping transition zones in both up-dip and down-dip directions. However, more complexities beyond this 2D model are observed, suggesting varying sizes and properties of seismic asperities on the plate interface. The Alaska Peninsula shows large along-strike variations from the fully coupled Kodiak segment in the northeast to the weakly coupled Shumagin segment in the southwest. Changes in seafloor fabrics, slab hydration states, and sediment thickness have been proposed to explain the variations of slab coupling along the trench. However, the controlling factors of the interface slip behaviors have not been fully understood. Here we image high-resolution 3D V_P/V_S structures along the Alaska Peninsula using the newly available onshore/offshore seismic data. The overriding plate and the plate interface display distinct changes in the V_P/V_S signature across different segments. The weakly locked Shumagin segment exhibits high fluid contents at the plate interface and in the overriding plate, whereas the moderately-to-highly locked Chignik and Chirikof segments that host M>8 earthquakes appear to be dry. The Kodiak segment ruptured by the 1964 M9.2 Great Alaska earthquake is fully locked near the trench, containing a fluid-rich plate interface but a low-porosity overriding plate. The V_P/V_S ratio in the overriding plate is anti-correlated with the variations of slab coupling. This striking anti-correlation suggests that free fluids, particularly in the overriding plate, play an important role in controlling slab slipping behaviors. In addition, we image low V_P and high V_P/V_S anomalies in the mantle wedge, indicative of sub-arc melting. The V_P/V_S variations in the mantle wedge can shed light on the distribution of free fluids and help us better understand mantle wedge processes.