A Journey from Onshore Insights to Offshore Mysteries: Bridging Alaska’s Geophysical Divide

Evans Onyango, University of Alaska Fairbanks

The convergent margin in southern Alaska is arguably the most complex segment of the plate boundary along western North America, characterized by the active subduction of the Pacific plate beneath the North America plate, ongoing collision and accretion of the Yakutat microplate, and accompanying geological formations including the accretionary wedge, the Aleutian and Wrangell volcanic arcs, and major fault systems such as the Denali and Tintina. This region's dynamic geology is a source of diverse earthquakes, both in magnitude and mechanisms, and its rugged, densely forested terrain, subjected to large temperature variations, poses substantial challenges for geophysical study.

We present a two-fold investigation aimed at elucidating the subduction zone dynamics in this complex region: (1) onshore findings from a receiver function study on Kodiak Island, and (2) preliminary results from the development of a 3D velocity model for the Gulf of Alaska. The Kodiak Island study, conducted in May 2019 with the deployment of 398 nodal geophones, including 300 nodes from EarthScope Primary Instrument Center (EPIC, formerly the PASSCAL Instrument Center), targeted the southern asperity of the 1964 M9.2 Great Alaska earthquake. Our analysis identified a coherent, slightly dipping velocity increase at depths of approximately 30–40 km, consistent with the expected slab Moho, and found no evidence of a prominent low-velocity layer that would indicate differing plate interface properties between the northern (Kenai) and southern (Kodiak) asperities.

Expanding our investigation to offshore, we are currently constructing a comprehensive 3D velocity model of the Gulf of Alaska. This initiative seeks to leverage existing high-resolution 2D velocity models from marine studies conducted between the 1980s and 2000s, aiming to significantly advance our understanding of the seismic wavefield, active tectonics, and geodynamics of the subduction system. We intend to compare synthetic waveforms with seismograms from moderate to large earthquakes to validate the model. Upon completion, the final model will be made available through the EarthScope Earth Model Collaboration (EMC) repository.