Imaging the Cascadia Subduction Zone using a Dense Nodal Geophone Array

Kevin M. Ward[1] Yadong Wang[1], Fan-Chi Lin[1], & Brandon Schmandt[2]

[1]Department of Geology and Geophysics, University of Utah, Salt Lake City, Utah, USA
[2]Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, NM, USA

In the summer of 2017, the University of Utah in collaboration with the University of Arizona, the University of Oregon, the University of New Mexico, and the PASSCAL Instrument Center deployed 174 3-component 5-Hz nodal geophones in central Oregon. The east-west, approximately trench perpendicular line started on the coast in Waldport, OR and traversed the Coastal Range, the Willamette Valley, and the Western Cascades with ~500-meter station spacing and recorded continuous data for ~40 days. The specific array design was chosen to be comparable to a previous broadband deployment with ~5-kilometer station spacing that recorded continuous data for ~1 year. Scientific motivations for the nodal geophone deployment were two-fold. First, we wanted to see if new instrument technology that afforded greater station density (0.5 km vs. 5 km) but poorer temporal sampling (40 days vs. 300 days) could reproduce some of the results derived from the original broadband deployment. Second, we wanted to explore what new features could be recovered by the denser station spacing provided by the geophones.

The results from our receiver function analysis show remarkable agreement with first-order features interpreted as the subducting slab, the slab Moho, a hydrated mantle wedge, and the continental Moho seen in previous studies. We develop a new pre-stacking method to ameliorate the effects of limited deployment duration and reduce noise before calculating receiver functions. The new processing method is simple but emphasizes laterally continuous and robust conversions. We also employ double beamforming of the interstation cross-correlations to extract Rayleigh wave phase velocities and invert them for the crustal shear-wave velocity structure. Between the two methods, we interpret both the top and eastward extent of the accreted Siletzia terrane. Smaller scale features observed in our receiver function results along the subducting slab interface seem to correlate with down-dip tremor density in the study area; however, at this time, any systematic links remain speculative. Cumulatively, the preliminary results illustrate how this deployment strategy could be scaled for detailed 3-D imaging of a subduction zone interface patch either in a well-studied subduction zone or for rapid characterization in a subduction zone system where less is known. We envision hybrid deployments with many (Large-N) nodal geophones and a backbone of broadband seismometers as a transformative component of the SZ4D Initiative.

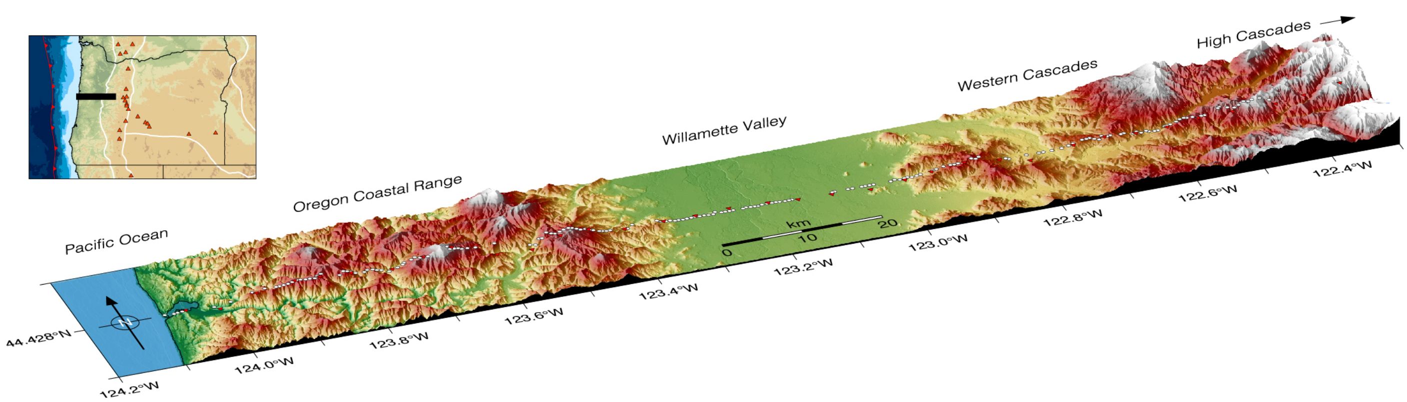

Figure 1. Cascadia 2017 nodal station location map with topography. Nodal locations shown as small white circles with the previous broadband station shown as inverted red triangles. Inset box shows the location of the deployment in its broader tectonic context with Holocene volcanic activity shown as red triangles and the major tectonic provinces outlined by white lines.