Variations in ground motion amplification on the Cascadia submarine forearc from short-period OBS recordings of intra-Gorda plate earthquakes

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Measuring the seafloor response to shaking during earthquakes is important for linking seafloor seismograph recordings and marine paleoseismic records (e.g., turbidite deposits) to earthquake source mechanisms. This issue is especially important along the submarine forearc of the Cascadia Subduction Zone, where variations in physical properties are still poorly constrained, seismicity rates are low, and large earthquake recurrence models are partly based on the offshore turbidite record. Recently, amplification and tuning of ground motion has been observed directly on the Cascadia submarine forearc using ocean-bottom seismographs (OBS). Those results come from long-term OBS deployments for the Cascadia Initiative and the ONC/NEPTUNE Canada cabled observatory, which recorded numerous regional and teleseismic earthquakes, but are too sparsely distributed to resolve local variations in site response. As part of the CASIE21 controlled-source imaging project, we deployed linear arrays of short-period OBS. These instruments serendipitously recorded three M_w 4.7 to 5.9 intra-plate earthquakes on the Gorda plate, as well as other regional and teleseismic events. Here, we use these data to measure variations in peak ground velocity (PGV) along the submarine forearc offshore Oregon. The measurements show that PGV is more than an order of magnitude stronger on the seaward side of the dynamic backstop inferred from bathymetry and seismic imaging. We suggest this observation is evidence that more recently deformed sediments seaward of the backstop are less consolidated and thus weaker and more prone to shaking by earthquakes, but directivity of the Gorda plate events may also partly explain the difference. Weaker sediments and increased ground motion amplification are both expected to promote slope failures, and the dramatic difference in PGV across the backstop may have implications for site selection and calibration for future earthquake early-warning instrumentation.

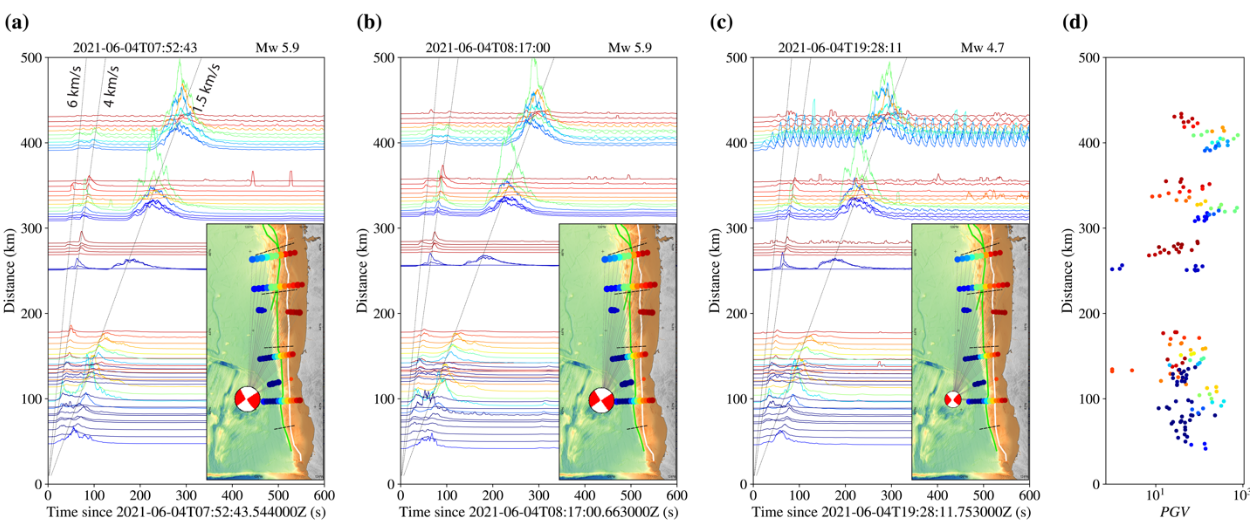

Figure 1. (a-c) 5 s average envelope of vertical geophone recordings of 2021 Gorda plate earthquakes, colored by water depth. Inset maps show event and station locations. (d) Peak ground velocity for events and stations in (a-c), colored by water depth as in the inset maps.