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Supplementary Materials for

# The Role of the Ocean Observatories Initiative in Monitoring the Offshore Earthquake Activity of the Cascadia Subduction Zone

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**FIGURE S1.** The remotely operated vehicle (ROV) arm placing a broadband seismometer into a vault installed in seafloor sediments. The pipe is then backfilled with glass beads. Power is provided to the seismometer, and data are returned to shore and to a backup recording system via the orange cable.

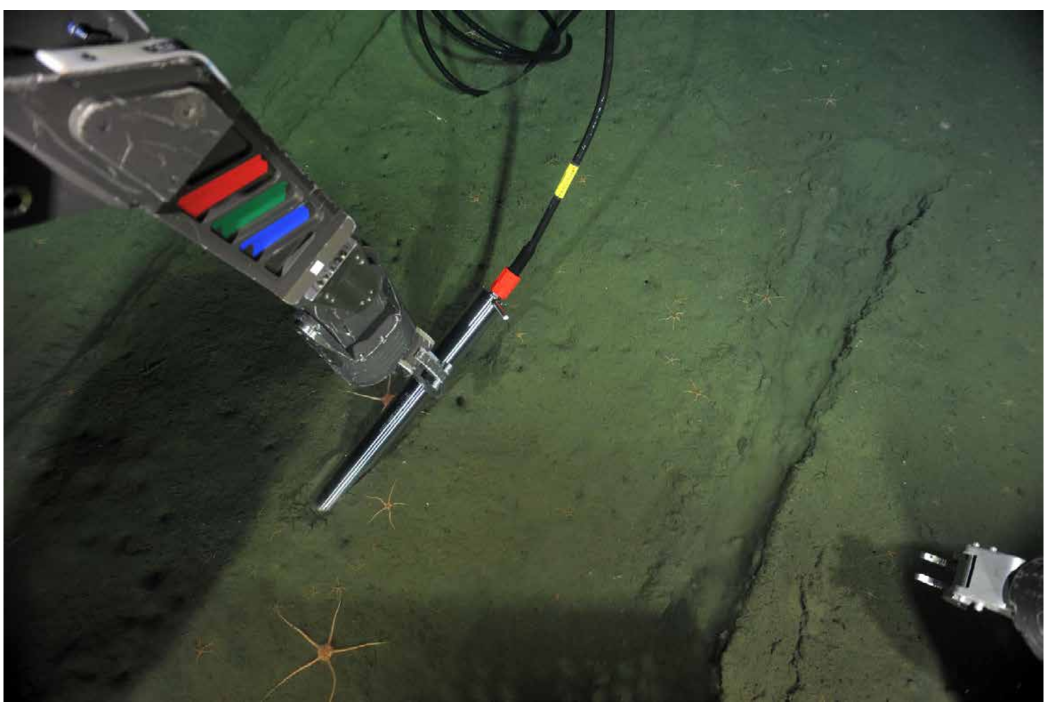

**FIGURE S2.** The ROV placing a short-period seismometer into a groove on the seafloor.

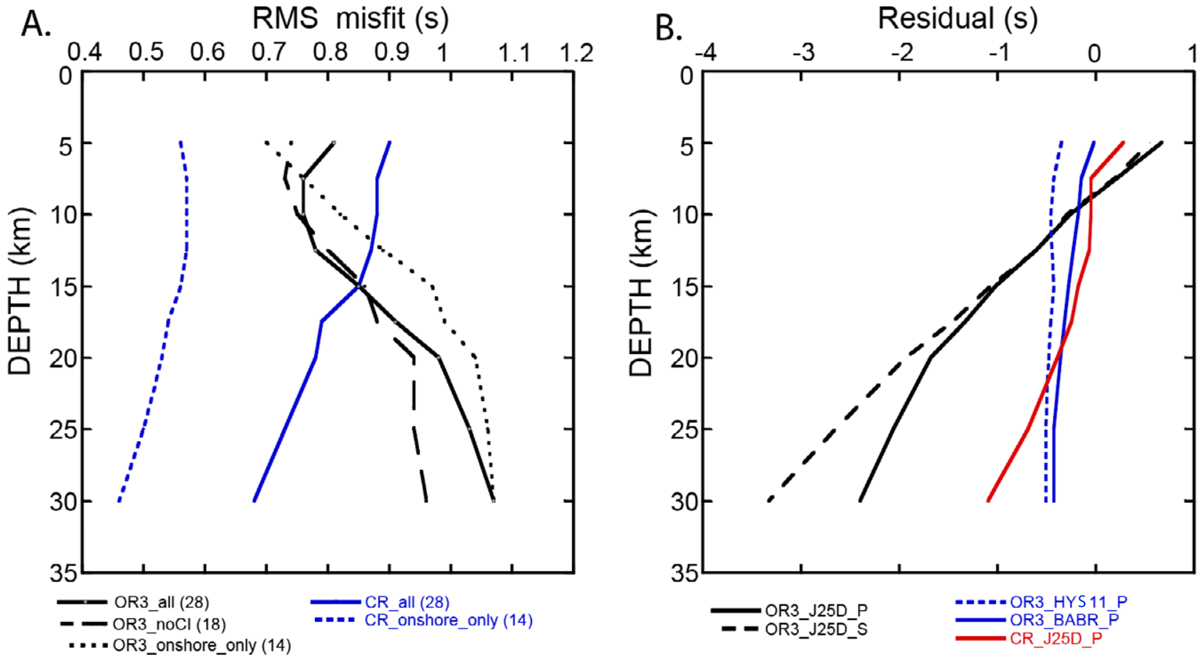


**FIGURE S3.** (A) Root mean squared misfit as a function of depth for different velocity models and station combinations for an earthquake on June 25, 2015, at 20:25. "OR3" refers to the P velocity model at the location labeled OR3 on Figure 3B, with an assumed $V_p/V_s$ ratio of 1.77, which is a typical value for crustal rocks. "CR" refers to a velocity model for the Coast Range, similar to the model used by the Pacific Northwest Seismograph Network (PNSN) for this region. Numbers in parentheses indicate the total number of travel time picks used: 28 for solutions using Cascadia Inititative, Ocean Observatories Initiative (OOI), and onshore stations; 18 for OOI and onshore only; and 14 for onshore stations only. Because OOI stations HYS11-14 are so close together, only picks for HYS11 were included in these solutions. Only stations within 100 km of the earthquake were used and all P-wave arrival time picks were given the same weight. S-wave picks were weighted by a factor of 0.7 relative to P arrivals because of the higher precision of P arrival time picks. Although the smallest misfit is obtained for model CR with only onshore stations, controlled-source experiments indicate that the CR velocity model is not appropriate for the source region. Moreover, the misfit increases for model CR and is comparable to that for model OR3 when data from OBSs and OOI are included. (B) Residuals as a function of depth for selected stations. For model OR3, station J25D is very sensitive to the source depth and has a large residual for both P- and S-waves for all but shallow depths. Other stations are not very sensitive to depth. This illustrates the importance of close stations for resolving earthquake depth.

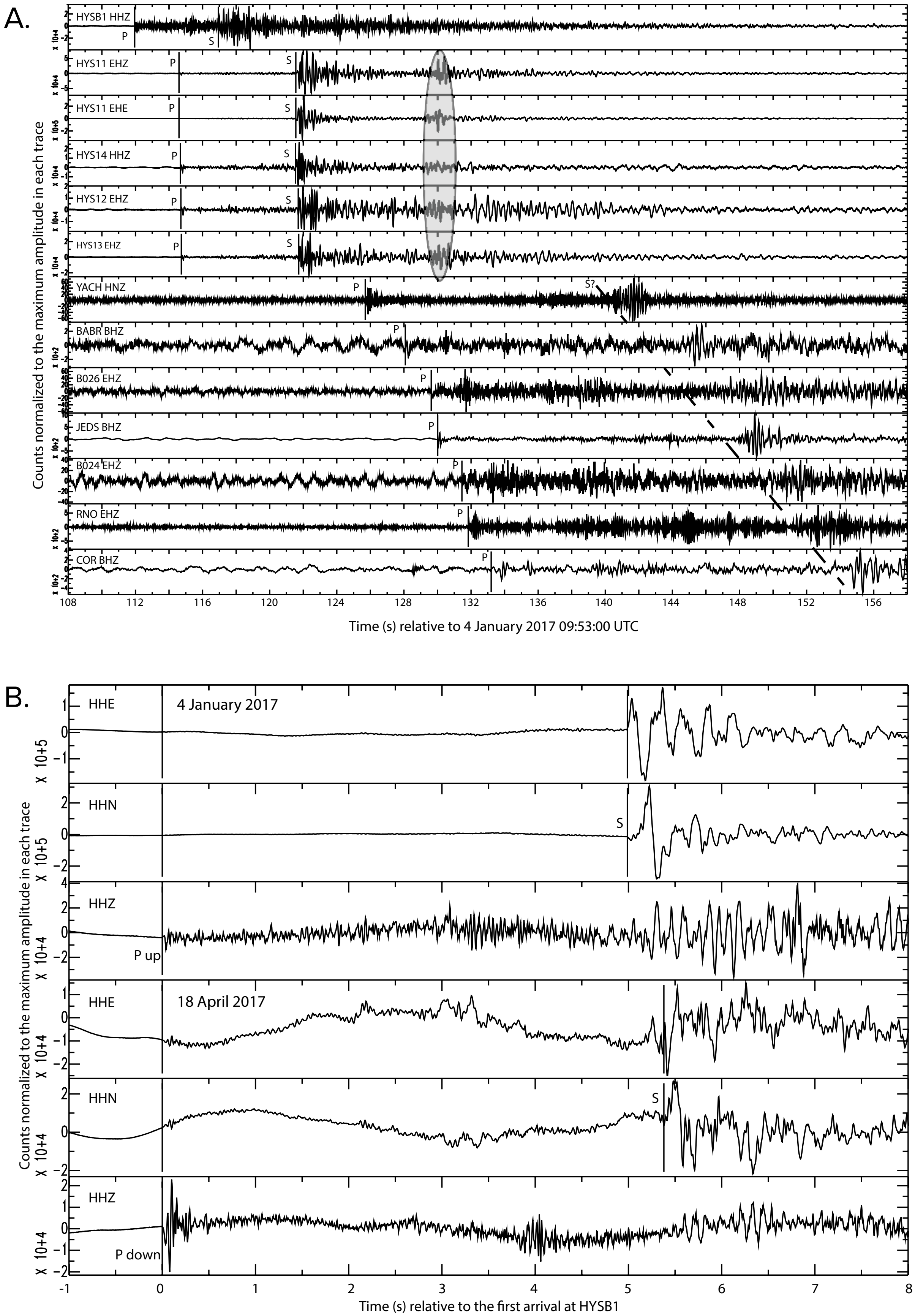


**FIGURE S4.** Examples of two local earthquakes that were recorded by the OOI seismic network but were not reported by PNSN. (A) Vertical component on the OOI Hydrate Ridge network compared to selected onshore stations. Although the January 4, 2017, event can be seen with relatively low signal to noise on some of the onshore stations, this event was not reported by PNSN because it did not meet the threshold for a detection. Dashed line shows approximate arrival for S-waves on onshore instruments. The oval highlights an enigmatic secondary phase on the OOI stations. Modeling of these waveforms has the potential to provide new information on crustal structure. (B) Three-component seismograms from the event in (A) and a similar unreported event on April 18, 2017, as recorded on HYSB1. Seismograms are aligned on the P-wave arrival time. By including data from OOI Hydrate Ridge stations, along with onshore observations, both events can be located ~50 km northwest of HYSB1 within the Juan de Fuca Plate.

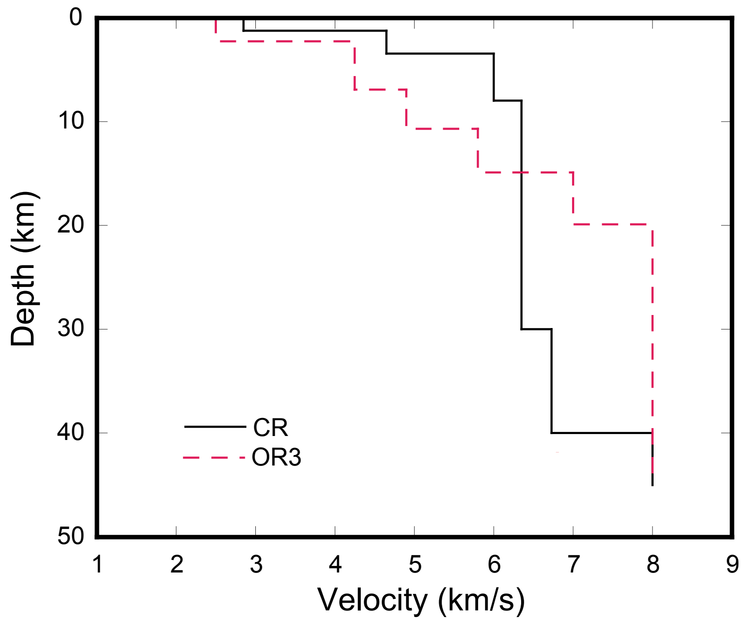


**FIGURE S5.** Velocity models used for earthquake locations. Location of the models is shown in Figure 3.