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Cascadia Fore Arc Seismic Survey: Open-Access Data Available

The Cascadia subduction zone (CSZ), where the Juan de Fuca and Gorda plates subduct obliquely beneath North America at a rate of about 35 millimeters per year, poses major geological hazards to population centers of the northwestern United States. Despite the importance of the subducting slab in these hazards, the plate boundary is poorly mapped and understood, especially offshore.

A new open-access marine seismic reflection data set has been acquired that will provide new images of the structure of the fore arc and subducting plate off central Washington. This area lies in a segment of the plate boundary that apparently ruptures only in large earthquakes and is approximately equidistant from the major population centers of Seattle and Portland. This data set, funded by the U.S. National Science Foundation, is freely available to help researchers map the position of the poorly understood plate boundary in this critical region.

Cascadia Initiative: Tectonic Context and Current Monitoring Efforts

Despite very limited and localized seismicity on the plate interface [Trehu et al., 2008; Williams et al., 2011], the Cascadia subduction zone is known to be subject to megathrust earthquakes [e.g., Atwater, 1987, 1996; Hyndman and Wang, 1995]. Extensive paleoseismic work illuminates a 10,000-year history of quakes with an average recurrence rate of about 500 years for roughly magnitude 9 events that rupture the entire subduction zone from northern California to the Nootka fault off Vancouver Island [e.g., Goldfinger et al., 2003; Hyndman et al., 2003, and references therein]. The paleoseismic record indicates additional smaller, more frequent events south of 45°N, whereas the margin to the north appears to rupture only in the largest events [Goldfinger et al., 2003, 2012].

The Cascadia margin has recently become the focus of an impressive array of new scientific initiatives and infrastructure investment, including activities by Earthscope’s Transportable Array and Plate Boundary Observatory, the Ocean Observatories Initiative and Canada’s Northeast Pacific Time-Series Undersea Networked Experiments project (NEPTUNE Canada) cable observatories, the SeaJade ocean bottom seismometer (OBS) program off Vancouver Island, and the Geodynamic Processes at Rifting and Subducting Margins (GeoPRISMs) Cascadia Initiative. The latter features OBS deployments and extensive onshore seismometers and geodetic stations, including a concentration of instruments off Grays Harbor, Washington.

Cascadia Initiative

In July 2012 researchers conducted an open-participation, open-access seismic reflection survey of the Cascadia margin off Grays Harbor, Washington (Figures 1a and 1b). The Cascadia Open-Access Seismic Transects (COAST) project consisted of a 2-week cruise of the R/V Marcus G. Langseth, the U.S. National Oceanographic Seismic Facility. Multichannel seismic reflection data were acquired on nine east-west transects that crossed the deformation front; data were also collected along a single along-strike line that linked the cross-margin lines. While each line was intended to extend from the Juan de Fuca plate to the continental shelf, marine mammal sightings prevented landward completion of some lines, especially in shallow water (Figure 1a). In addition to the seismic data a full suite of gravity, magnetic, multibeam bathymetry, and acoustic backscatter data were acquired.

The primary scientific objective of COAST is to determine the position of the offshore plate boundary because every important question regarding subduction processes, earthquake nucleation, and societal hazards in the Cascadia subduction zone requires that knowledge. The COAST seismic data have the potential to address a range of additional questions arising recently in subduction margins, including downdip and along-strike variability in the character and roughness of the subduction interface [e.g., Bangs et al., 2004; Nedimovic et al., 2003], evidence (or lack thereof) of subducting sediment, locations of dewatering and pathways of fluid escape, the locations of potentially high pore pressure zones, and the geological controls on active methane systems related to subduction. Initial findings from shipboard-processed COAST data include (1) strong

Fig. 1. (a) Map of track lines (labeled 1–11) surveyed on the Cascadia Open-Access Seismic Transect (COAST) project, plotted on a multibeam bathymetric grid. (b) Map showing the location of the COAST survey (red box) on the continental margin off Washington state. Bathymetry is contoured at 500-meter intervals. (c) Example of poststack time migration across the deformation front on line 4 (yellow line in Figure 1a). The arrow represents the deformation front; the section east of the deformation front is the outer accretionary wedge. Note the clear folding and landward directed thrust faults in the outer accretionary wedge.

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oceanic basement reflections seaward of the deformation front that become weaker beneath the outer accretionary wedge (Figure 1c; see also Figure S1 in the online supplement to this brief report (http://www.agu.org/journals/eo/o/093/t050/2012EO500002/2012EO500002_supp1.pdf)), (2) an apparent change in slab dip from gently dipping beneath the outer wedge to steeper dips beneath the outer shelf, and (3) abundant slope failures on the deformation front that are particularly well imaged by the multibeam data (Figures 1a and S2).

A Commitment to Public Outreach and Availability

In addition to scientific objectives, the COAST project had unique educational and outreach goals. One was to conduct a cruise where the shipboard scientific staff except for the principle investigators (PIs) were selected via an application process (Figure 1c; see also Figure S1 in the online supplement to this brief report (http://www.agu.org/journals/eo/o/093/t050/2012EO500002/2012EO500002_supp1.pdf)), (2) an apparent change in slab dip from gently dipping beneath the outer wedge to steeper dips beneath the outer shelf, and (3) abundant slope failures on the deformation front that are particularly well imaged by the multibeam data (Figures 1a and S2).

The cruise was the first entirely open-access expedition by the R/V Langseth, following the recommendations of a community workshop in March 2010 (http://bit.ly/OdxhI2). Raw geophysical and seismic data can be downloaded from the Lamont-Doherty Earth Observatory Web site (http://www.marine-geo.org/tools/search/entry.php?id=MGL1212). Seismic sections processed shipboard through poststack time migration can be downloaded from the University of Texas Institute for Geophysics seismic data base (http://www.ig.utexas.edu/sdc/cruise.php?cruise=mgl1212). Interested parties are encouraged to make use of the data, write proposals to process and analyze the data, integrate these data with other recent and ongoing Cascadia initiatives, and incorporate the data and images in the classroom.

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References


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