Pockmarks, fluid flow, and sediments outboard of the deformation front at the Cascadia Subduction Zone from analysis of multi-channel seismic and multi-beam sonar data

Details

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Abstract

Evidence of active fluid flow and the nature of the sediment section near the Cascadia deformation front are explored using multi-channel (MCS) seismic and multi-beam sonar data collected in summer 2012 using the R/V Marcus G. Langseth during the Juan de Fuca Ridge to Trench Survey. The MCS data were collected along two full plate transects (the “Oregon” and “Washington” transects) and one trench parallel line using a 6600 cubic inch source, and an 8 km streamer with 636 channels (12.5 m spacing). The MCS data pre-stack processing sequence includes geometry definition, trace editing,

F-K filter, and deconvolution. Velocity analysis is performed via semblance and constant velocity stacks in order to create a velocity model of the sediments and upper oceanic crust. The traces are then stacked, and post-stack time migrated. The sonar data were collected using the R/V Langseth's Kongsberg EM122 1°x1° multi-beam sonar with 288 beams and 432 total soundings across track. Using MB-system the sonar data are cleaned, and the bathymetry data are then gridded at 35 m, while the backscatter data are gridded at 15 m. From the high-resolution mapping data 48 pockmarks varying in diameter from 50 m - 1 km are identified within 60 km outboard of the deformation front. The surface expression of these large features in an area of heavy sedimentation is likely indicative of active fluid flow. In order to gain sub-seafloor perspective on these features the MCS data are draped below the bathymetry/backscatter grids using QPS Fledermaus. From this perspective, specific locations for detailed velocity and attribute analysis of the sediment section are chosen. Sediment velocity and attribute analysis also provide insight into apparent differences in the sediment section and décollement formation along the Oregon and Washington plate transects. While both lines intersect areas of dense pockmark concentration, the area around the Oregon transect has been shown to contain a continuous positive polarity sedimentary layer that is capping fluid expulsion above a reverse polarity protodécollement (e.g. Cochrane et al., 1994, JGR, 99, pp. 7033-7043). A décollement within the sediment section is not present along the Washington line (e.g. Gutscher et al., 2001, Geology, 29, pp. 379-382). However, this line does intersect the "Bare" outcrops to the west, which have been shown to provide fluid recharge and discharge pathways for convective cooling of the crust (e.g. Fisher et al., 2003, Nature, 421, pp. 618-621). Detailed velocity models constructed from the MCS data will be used to investigate these regional differences. The location of the pockmarks and corresponding sediment properties will also be explored relative to regional variations in the structure of the deformation front and location of intraplate and interplate faulting.

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