Abstract

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IDENTIFYING FAULTS AND THEIR RECENT MOTION IN EASTERN STRAIT OF JUAN DE FUCA.

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Multi-channel seismic reflection data, acquired in the SHIPS (Seismic Hazards Investigation in Puget Sound) survey are used to interpret the faulting and structure of the eastern Strait of Juan de Fuca. A number of major fault zones, including the Devils Mountain, a left-lateral transpressional fault zone, and the Southern Whidbey Island fault zone, underlie the region of large prehistoric earthquakes. Numerous Pleistocene glaciations and associated erosion and deposition have resulted in the surface masking of faults, which are now most easily investigated using seismic data. In this study, first arrival tomographic velocity models derived from the seismic data are used to accurately characterise the shallow P-wave velocity structure across fault zones and aid in the identification of potentially active faults, which may pose a significant seismic hazard to local communities.

Seismic reflection data from SHIPS lines JDF-1, JDF-2, JDF-3. JDF-4 JDF-5, JDF-6, PS-2 and SG-1 were reprocessed, using variable shot spacing geometry, to improve the quality of seismic images and allow for more detailed interpretation of the near surface. First arrival tomographic inversion velocities were calculated using an iterative two-dimensional inversion algorithm based on a finite-difference solution to the eikonal equation. With far offsets of approximately 2600 m, a high density of subsurface raypaths and a velocity grid spacing of 25 m, a high-resolution estimate of P-wave velocity structure is calculated for depths in the range of 500-1200 m. These P-wave velocity models provide information on the variation of physical properties with depth and across faults, which when overlain directly upon seismic profiles significantly aid in the interpretation.

Seismic reflection profiles, of the Devils Mountain fault, suggest that primary pre-Quaternary motion to the east of 122.95° W was transferred to a large fault scarp identified on profiles south of the mapped E-W trend on the DMF. This fault scarp appears to be related to the westward extension on the Utsalady Point fault, which shows a similar, although slightly smaller scarp west of Whidbey Island. More recent deformation has been experienced on the eastward continuance of the DMF, which east of 122.95° W affects a shallow pre-Tertiary basement and thin overburden far north of the primary fault scarp. However, Quaternary deformation associated with the primary fault scarp appears to be of as large a magnitude as faulting on the DMF to the northeast.