Fault recognition and active tectonics in the eastern Juan de Fuca Strait, Cascadia forearc region

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Data from marine high-resolution and conventional multi-channel seismic reflection surveys, aeromagnetic mapping, tomographic studies, coastal exposures of Pleistocene strata, and lithologic logs of water wells are used to assess the active tectonics of the eastern Juan de Fuca Strait of the Pacific Northwest. Aeromagnetic data clearly distinguish the Leech River-Southern Whidbey Island Fault system and Devils Mountain Fault systems. Large-scale bathymetric and topographic relief bears little resemblance to this structure, largely because of the impact of numerous Pleistocene glaciations. Faults are recognized in seismic profiles on the basis of truncated, displaced, tilted, or folded reflections and (or) on abrupt changes in reflection dip or seismic facies, such as amplitude, frequency, continuity, and geometry. Faults in coastal exposures are characterized by shear planes that truncate and offset stratigraphic markers, and associated outcrop-scale deformation. Water-well data provide important stratigraphic constraints on amounts of vertical displacement. Clear indications of Quaternary movements on the Leech River-southern Whidbey Island Fault (SWIF), Devils Mountain Fault (DMF), Strawberry Point Fault (SPF) and Utsalady Point Fault (UPF) were noted. The SWIF bends from an E-W trend on Southern Vancouver Island to a NW-SE trend through Puget Sound, with a minimum length of 100 km. Near Admiralty Inlet, folded and truncated reflectors in glacial-marine sediments suggest Late Pleistocene to Holocene displacement. A small rotational failure of Late Pleistocene to Holocene sediments occurs just off Esquimalt Harbour, consistent with strong ground motions along the trace of the Leech River Fault. The DMF extends westward for more than 125 km from the Cascade Range foothills to southern Vancouver Island, possibly merging with the Leech River Fault and forming the Victoria waterfront. Offshore Victoria, the inferred base of the Quaternary section is offset more than 400 m. The DMF is bounded by NW-trending en-echelon folds and faults, in a pattern that suggests it is a left-lateral, oblique-slip, transpressional "master fault". The WNW-trending, subvertical SPF and UPF, cut across Whidbey Island, form the borders of a pre-Tertiary basement horst, and have minimum lengths of 25 km. Collectively, the DMF, SPF and UPF represent a complex, distributed, transpressional deformation zone.