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Quaternary Fault and Fold Database of the United States

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Willapa Bay fault zone (Class A) No. 592

Last Review Date: 2017-01-17

citation for this record: **McCrory, P.A., compiler, 2003, Fault number 592, Willapa Bay fault zone, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, https://earthquakes.usgs.gov/hazards/qfaults, accessed 12/14/2020 03:04 PM.**

Synopsis	The Willapa Bay fault is a 2-km-wide zone that trends north-northwestward through the central portion of Willapa Bay and either extends onshore in northwestern Willapa Bay or turns westward to connect with fault strands mapped near Cape Shoalwater (unnamed fault zones offshore of mouth of Willapa Bay [590] and Cape Shoalwater [591]; McCrory and others, 2002 #5864). Available single-channel, seismic reflection data indicate that this 40-km-long fault zone offsets a latest Quaternary erosional surface. The regional tectonic setting favors reverse or transpressional motion on these faults, however to date only dip-slip displacement has been documented.
Name comments	Wolf and others (1998 #6218) first recognized and mapped the Willapa Bay fault zone based on USGS seismic reflection profiles collected in 1974 (Hill and others, 1981 #6306). The location of the northern strands was revised in McCrory and others (2002

	#5864) based on new USGS seismic reflection data (Cross and others, 1999 #6302) collected in 1998. McCrory and others (2002 #5864) also named the fault. The Willapa Bay fault zone includes several mapped, north-northwest-striking fault traces that occur in Willapa Bay; some of these faults extend onshore.
County(s) and State(s)	PACIFIC COUNTY, WASHINGTON
Physiographic province(s)	PACIFIC BORDER
Reliability of location	Good Compiled at 1:250,000 scale. *Comments:* The fault-trace locations are based on mapping of Wolf and others (1998 #6218) and McCrory and others (2002 #5864). These studies used high-resolution seismic reflection data to map the location of offset stratigraphic reflectors. Owing to overall shallow water depths, tracklines were limited to tidal channels within the bay. Additional fault strands may exist, but remain undetected because of the restricted nature of the survey.
Geologic setting	Willapa Bay is situated adjacent to a boundary between two major forearc blocks-the Oregon Coast Range block and the Olympic Mountains block. Relative motion between the forearc blocks is modest (not to exceed 8 mm/yr)(Mazzotti and others, 2002 #6304) based on modeling of geodetic observations. Block kinematics predicts transpressional shear where the block boundary trends north-northwest through Willapa Bay, and north-northwest-directed contraction where the boundary trends east-northeast near Grays Harbor. Well data suggest an east-dipping thrust contact for the boundary beneath Willapa Bay (Rau and McFarland, 1982 #6308; Snavely and Wagner, 1982 #6310; Parsons and others, 1999 #6307). McCrory and others (2002 #5864) interpret the Willapa Bay faults to be within the upper plate of this thrust boundary. The Willapa Bay fault zone defines an uplifted ridge of older Pleistocene strata beneath the bay floor (Wolf and others, 1998 #6218; McCrory and others, 2002 #5864). The fault zone displaces a latest Quaternary erosional surface up to 12 m. Available seismic reflection profiles do not image strata deeper than about 75 m below the bay floor, so offset of older stratigraphic units has not been assessed. Sparse seismicity along the zone suggests ongoing fault activity (McCrory and others, 2002 #5864).

Length (km)	37 km.
Average strike	N22°W
Sense of movement	Thrust *Comments:* The central strand of the three northern strands projects onshore near Cape Shoalwater, where late Quaternary (MIS 5) marine-terrace deposits are offset in a series of minor thrust faults (McCrory and others, 2002 #5864). Dip-slip offset is depicted in seismic reflection profiles of the strands beneath Willapa Bay; strike-slip offset, if any, is not resolvable with available data (Wolf and others, 1998 #6218; McCrory and others, 2002 #5864). Individual structures of this zone are inferred to be principally transpressional features that may include oblique-slip, strike-slip, thrust and reverse faults, as well as related folds. This interpretation is based on the orientation and position of this fault zone relative to the tectonic framework of this region, the association of this zone with offshore anticlines or with thrust and reverse faults and anticlines mapped onshore, and offsets of a buried erosional surface that contains closed depressions and disrupted channel courses reminiscent of active strike-slip fault systems onshore. The actual fault planes of the faults beneath Willapa Bay, however, cannot be resolved with available seismic reflection data.
Dip Direction	W; E *Comments:* Minor, onshore thrust faults present near the apparent northern end of a northern strand of the fault zone (McCrory and others, 2002 #5864) suggest low-angle dips along some strands or subsidiary faults. However, these thrust faults occur at the northern end of the fault zone, where the trend of this zone may be bending to the west to connect with more westerly striking faults of the unnamed fault zone offshore of Cape Shoalwater [591] (McCrory and others, 2002 #5864). Consequently, low-angle dips of these thrust faults may not be indicative of dips along strands farther south in Willapa Bay. Seismic reflection data indicates down-to-the-east and -west vertical offsets along individual fault strands in Willapa Bay (McCrory and others, 2002 #5864). These faults are inferred to be, at least in part, reverse faults that dip to the west and east, respectively, perhaps at moderate to steep angles if these faults also have components of strike-slip. The vertical exaggeration of seismic reflection data,

	however, precludes accurate determination of fault dip for strands in Willapa Bay (all strands with dips >30? appear to have vertical dips).
Paleoseismology studies	
Geomorphic expression	The mapped traces do not disrupt the bay floor. However, an older buried bay floor is vertically offset several meters (Wolf and others, 1998 #6218; McCrory and others, 2002 #5864). This buried surface contains closed depressions and disrupted channel courses reminiscent of active strike-slip fault systems onshore. Western strands with down-to-the-west displacement and eastern strands with down-to-the-east displacement form an uplifted bedrock ridge in Willapa Bay (McCrory and others, 2002 #5864).
Age of faulted surficial deposits	Sediments directly beneath the floor of Willapa Bay are not faulted. However, fault strands in Willapa Bay offset a buried erosional surface that yielded a radiocarbon date of <20 ka (Smith and others, 1999 #6309). A series of minor thrust faults near Cape Shoalwater, near the apparent northern end of the fault zone, offsets late Quaternary marine terrace deposits (McCrory and others, 2002 #5864).
Historic earthquake	
Most recent prehistoric deformation	latest Quaternary (<15 ka) *Comments:* Latest Quaternary (<20 ka) for the three northern strands based on offset of erosional surface estimated to have been cut less than 20 ka (Plate 1A in McCrory and others, 2002 #5864). Age of erosional surface is constrained by radiocarbon dates where it crosses beneath Long Beach peninsula (Smith and others, 1999 #6309). The southern strand is late Quaternary (<150 ka). The central strand of the three northern strands also projects onshore near Cape Shoalwater where late Quaternary (MIS 5) marine-terrace deposits are offset 1 m in a series of minor thrust faults (McCrory and others, 2002 #5864). Herein these strands are also assigned, respectively, to latest Quaternary and late Quaternary age categories. However, the upper age limits of these categories as shown herein are, respectively, <15 ka and <130 ka.
Recurrence	

interval	
Slip-rate category	Between 0.2 and 1.0 mm/yr *Comments:* McCrory and others (2002 #5864) calculated a 0.5-mm/yr vertical displacement rate along the main strand and noted that this rate may represent an actual slip rate of 1 mm/yr if the fault is a thrust fault dipping 30?.
Date and Compiler(s)	2003 Patricia A. McCrory, U.S. Geological Survey
References	#6302 Cross, V.A., Twichell, D.C., and Parolski, K.F., 1999, Archive of seismic-reflection data collected aboard RV CORLISS cruise CRLS98014 in the Columbia River Estuary, Willapa Bay, and off Washington inner continental shelf: U.S. Geological Survey Open-File Report 99-307, 3 CD-ROM set. #6306 Hill, G.W., Phillips, R.L., and Clifton, H.E., 1981, Seismic profiles of Willapa Bay, Washington: U.S. Geological Survey Open File Report 81-1315, 3 sheets. #6304 Mazzotti, S., Dragert, H., Hyndman, R.D., Miller, M.M., and Henton, J.A., 2002, GPS deformation in a region of high crustal seismicity—N. Cascadia forearc: Earth and Planetary Science Letters, v. 198, p. 41-48. #5864 McCrory, P.A., Foster, D.S., Danforth, W.W., and Hamer, M.R., 2002, Crustal deformation at the leading edge of the Oregon Coast Range block, offshore Washington (Columbia River to Hoh River): U.S. Geological Survey Professional Paper 1661-A, 47 p., 2 pls. #6307 Parsons, T., Wells, R.E., and Fisher, M.A., 1999, Three-dimensional velocity structure of Siletzia and other accreted terranes in the Cascadia forearc of Washington: Journal of Geophysical Research, v. 104, no. B8, p. 18015-18039. #6308 Rau, W.W., and McFarland, C.R., 1982, Coastal wells of Washington: Washington Department of Natural Resources Report of Investigations 26, 4 sheets. #6309 Smith, D.G., Meyers, R.A., and Jol, H.M., 1999, Sedimentology of an upper-mesotidal (3.7 m) Holocene barrier, Willapa Bay, SW Washington, U.S.A.: Journal of Sedimentary Research, v. 69, p. 1290-1296.

	#6310 Snavely, P.D., Jr., and Wagner, H.C., 1982, Geologic cross-section across the continental margin of southwestern Washington: U.S. Geological Survey Open-File Report 82-459, 10 p. #3579 Walsh, T.J., Korosec, M.A., Phillips, W.M., Logan, R.L., and Schasse, H.W., 1987, Geologic map of Washington-southwest quadrant: Washington Division of Geology and Earth Resources Geologic Map GM-34, 28 p. pamphlet, 2 sheets, scale 1:250,000. #6218 Wolf, S.C., McCrory, P.A., and Hamer, M.R., 1998, Investigations of late Quaternary geologic features in Willapa Bay, Washington: U.S. Geological Survey Open-File Report 98-0589, 1 sheet, scale 1:125,000.