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Quaternary Fault and Fold Database of the United States

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Grays Harbor fault zone (Class A) No. 589

Last Review Date: 2017-01-17

citation for this record: **McCrory, P.A., compiler, 2003, Fault number 589, Grays Harbor 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 Grays Harbor fault zone is a 2.5-km-wide zone of reverse faults and back thrusts within a broad anticlinal fold (McCrory and others, 2002 #5864). This multi-strand fault zone is at least 27 km long, and if it continues eastward along a prominent aeromagnetic anomaly (Finn and others, 1998 #6316), then it extends for at least another 12 km beneath northern Grays Harbor for a combined length of 39 km. The upward extent (and apparent youth) of individual fault strands varies from profile to profile. On some profiles, the strands appear to die out in lower Pleistocene strata. On other profiles, strands breach and offset the seafloor.
Name comments	Snavely (1987 #6311) first mapped the Grays Harbor fault zone based on sparse seismic reflection data collected by the USGS and University of Washington on 3 cruises between 1967 and 1977. McCrory and others (2002 #5864) named the fault and substantially revised the orientation and location of specific fault

	strands based on new USGS high-resolution seismic reflection data (Cross and others, 1998 #6303; Foster and others, 1999 #6317; 1999 #6318; 2001 #6319) and sidescan-sonar data (Twichell and others, 2000 #6312; McCrory and others, 2003 #6324; 2003 #6325) collected in 1997 and 1998. The location and interpretation of recent activity on late Cenozoic faults previously mapped in the offshore area (Grim and Bennett, 1969 #6320; Wagner and others, 1986 #5670; Wolf and others, 1997 #6305) have been superceded by these more recent publications (McCrory and others, 2002 #5864). Fault strands of this zone form an east-northeast-trending zone of faults offshore and north-northwest of the mouth of Grays Harbor.
County(s) and State(s)	GRAYS HARBOR COUNTY, WASHINGTON (offshore)
Physiographic province(s)	PACIFIC BORDER (offshore)
Reliability of location	Good Compiled at 1:250,000 scale. *Comments:* The fault-trace locations are based on mapping of McCrory and others (2002 #5864) from seismic reflection profiles with 3- to 5-km grid spacing. The westward extent of the Grays Harbor fault zone has not been determined, as high-resolution data are not available for the outer continental shelf (>70-m water depth). The fault zone projects into northern Grays Harbor, and may cross the bay to extend onshore. Available data are not sufficient to determine the full eastern extent of the zone.
Geologic setting	The Grays Harbor fault zone occurs near the leading northwestern edge of the Oregon Coast Range forearc block. This forearc block traverses coastal Washington, where it abuts subduction-complex rocks of the Olympic Mountains block to the north. Block kinematics of this region predicts north-northwest-directed contraction where the boundary trends east-northeast near Grays Harbor, Washington. Crustal deformation observed near and north of Grays Harbor is consistent with north-northwestward motion of the Oregon Coast Range block. Deformation is localized within the more ductile subduction-complex rocks of the Olympic coast rather than the more rigid basaltic rocks that underlie the Oregon Coast Range block (McCrory and others, 2002 #5864). Seismic-reflection and sidescan-sonar data image several zones of faults and folds that trend east-northeast on the inner continental shelf

	between Grays Harbor and Cape Elizabeth, across an area about 40 kilometers wide from south to north. Some of these structures extend onland to the east where Quaternary reverse faults have been mapped (McCrory, 1997 #6323). The primary mode of deformation appears to be folding, however the seismic reflection data do not penetrate deeply enough (<200 m) to rule out buried thrust faults beneath the anticlines. In fact, one nearshore well that penetrated an anticline in this region, did encounter a reverse fault at depth (Rau and McFarland, 1982 #6308). Furthermore, multiple thrust or reverse faults are known to occur on the flanks of the anticlines offshore. Onshore, multiple thrust faults also occur in the upper plate of an inferred master thrust fault (McCrory, 1997 #6323). Quaternary folds range in length from 3 to 15 kilometers and have amplitudes as great as 160 m. Of the seven primary zones of faults and associated folds imaged in this coastal region, the southernmost zone appears to be the largest and most active. This southernmost zone, the Grays Harbor fault zone, vertically offsets a late Pleistocene datum by up to 40 m, and displaces the seafloor several meters.
Length (km)	22 km.
Average strike	N77°E
Sense of movement	Thrust *Comments:* Seismic reflection data suggests significant, or pure, dip-slip offset along nearly all of these offshore faults and they are inferred to be thrust or reverse faults because of their association with offshore anticlines or with thrust and reverse faults and anticlines mapped onshore (McCrory and others, 2002 #5864). The actual fault planes of the offshore faults, however, cannot be resolved with available seismic reflection data.
Dip	<45° *Comments:* Seismic reflection data implies down-to-the-south dip-slip offsets along three fault strands of this zone and down-to-the-north dip-slip along one strand (Plates 1A, 2J, and 2K in McCrory and others, 2002 #5864); the remaining strand does not have an offset specified. These offshore faults are inferred to be thrust or reverse faults, based on these apparent dip-slip offsets and their association with mapped thrust and reverse faults and anticlines nearby (McCrory and others, 2002 #5864). Offset directions discussed above, therefore suggest that these faults dip

	mostly to the north, perhaps at low angles (<45?). The vertical exaggeration of seismic reflection data, however, precludes accurate determination of fault dip (all strands with dips >30? appear to have vertical dips).
Paleoseismology studies	
Geomorphic expression	The Grays Harbor fault zone is emergent on the seafloor along its associated anticlinal axis. Twenty km west of Grays Harbor, the fault zone vertically displaces the seafloor 12 m over a 1.7-km-wide zone (McCrory and others, 2002 #5864). Two km west of Grays Harbor, the fault vertically offsets a late Pleistocene erosional surface by more than 40 m, and the long, central strand displaces the seafloor a few meters (Figure 19B in McCrory and others, 2002 #5864).
Age of faulted surficial deposits	The age of deposits at the seafloor varies across the continental shelf. The age of faulted seafloor deposits are as young as Holocene in areas of active sediment accumulation.
Historic earthquake	
Most recent prehistoric deformation	latest Quaternary (<15 ka) *Comments:* Seafloor displacement along the central and longest fault strand (Figure 19B in McCrory and others, 2002 #5864) is considered Holocene in age, however seafloor sediments have not been dated directly at this location. The two strands directly north and south of the central strand are late Quaternary (<150 ka); two other peripheral strands are Quaternary (<1.8 Ma). These ages of fault activity offshore in this area are based on (1) offset or deformation of the seafloor, estimated to have formed less than 20 ka in areas of active sedimentation, or (2) disruption of a late Pleistocene erosional surface, estimated to have been cut between 150 and 20 ka (McCrory and others, 2002 #5864). Herein these strands are also assigned, respectively, to latest Quaternary, late Quaternary, and Quaternary age categories. However, the upper age limits of these categories as shown herein are, respectively, <15 ka, <130 ka, and <1.6 Ma.
Recurrence interval	

Slip-rate category	Less than 0.2 mm/yr *Comments:* At this time, no information has been reported on rates of slip for these faults. Based mostly on this lack of information, a conservative rate of <0.2 mm/yr is tentatively assigned herein. However, given the substantial offset of the late Pleistocene surface, the slip rate could fall within the 0.2-1 mm/yr category.
Date and Compiler(s)	2003 Patricia A. McCrory, U.S. Geological Survey
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