Jump to Navigation

Quaternary Fault and Fold Database of the United States

As of January 12, 2017, the USGS maintains a limited number of metadata fields that characterize the Quaternary faults and folds of the United States. For the most up-to-date information, please refer to the interactive fault map.

Darrington-Devils Mountain fault (Class A) No. 574

Last Review Date: 2016-11-29

citation for this record: **Johnson, S.Y., Blakely, R.J., Brocher, T.M., Haller, K.M., and Barnett, E.A., compilers, 2016, Fault number 574, Darrington-Devils Mountain fault, 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 03:03 PM.**

Synopsis	The Darrington-Devils Mountain fault zone extends from southwest of Darrington to west of Whidbey Island where it may connect with the Leach River fault (Dragovich and DeOme 2006 #7643) or San Juan faults on Vancouver Island, B.C. (Johnson and others, 2001 #4749). The Devils Mountain fault terminates in northwest-trending en-echelon folds and faults, a map pattern strongly suggesting that it is a left-lateral, oblique-slip, transpressional structure (Johnson and others, 2001 #4749). Aeromagnetic anomalies coincide with both the trace of the Darrington-Devils Mountain fault and en-echelon structures (Blakely and others, 1999 #4747; Johnson and others, 2001 #4749). Quaternary strata are deformed on nearly all seismic-reflection profiles crossing the fault in the eastern Strait of Juan de Fuca, and onshore subsurface data suggest offset of upper Pleistocene strata across the fault (Johnson and others, 2001 #4749).

	Trenching confirms at least one Holocene coseismic surface rupture (Personius and others, 2014 #7644).
Name comments	Geologic mapping by Norbisrath (1939 #4760) and Hobbs and Pecora (1941 #4758) documented a west-trending fault zone in the western Cascade Range foothills east of Mount Vernon, Washington. Lovseth (1975 #4759) conducted subsequent mapping and named this zone the Devils Mountain fault, as used in later reports (*e.g.*, Whetten, 1978 #4764; Johnson and others, 2001 #4749). This compilation follows Tabor (1994 #4762) and subsequent reports (Haugerud and others, 2003 #6211;per 2014) that link the Devils Mountain fault with the Darrington fault zone of Vance and others (1980 #6242) farther east and uses the name Darrington-Devils Mountain fault zone.
County(s) and State(s)	SKAGIT COUNTY, WASHINGTON SAN JUAN COUNTY, WASHINGTON (offshore) SNOHOMISH COUNTY, WASHINGTON ISLAND COUNTY, WASHINGTON
Physiographic province(s)	PACIFIC BORDER CASCADE-SIERRA MOUNTAINS
Reliability of location	Good Compiled at 1:24,000 scale. *Comments:* Location of fault from GER_Seismogenic_WGS84 (http://www.dnr.wa.gov/publications/ger_portal_seismogenic_features.zip, downloaded 05/23/2016) attributed to Dragovich and others (2002 #7638, 2003 #7639, 2003 #7640, 2004 #7641, 2005 #7600) and Dragovich and DeOme (2006 #7643)
Geologic setting	The Darrington-Devils Mountain fault is located at the northern boundary of the northward-migrating portion of the forearc region of the Cascadia convergent continental margin (Wells and others, 1998 #4742; Miller and others, 2001 #4732). Geodetic studies (*e.g.*, Khazaradze and others, 1999 #4734) indicate about 4–5 mm/yr of north-south crustal shortening in western Washington, some of which is accommodated by slip on the Darrington-Devils Mountain fault zone (Johnson and others, 2001 #4749). Largely based on seismic tomography (Brocher and others, 2001 #4718; Ramachandran, 2001 #4761; Zelt and others, 2001 #4767), the western part of the Darrington-Devils Mountain fault zone in the eastern Strait of Juan de Fuca has been proposed to form the southern limb of a structural pop-up cored by the San Juan Islands (Brocher and others, 2001 #4718). Onland to the east, the fault forms the northern boundary of the Tertiary-to-Quaternary Everett basin (Johnson and others, 1996 #4751; 2001

	#4749).
Length (km)	123 km.
Average strike	N81°W
Sense of movement	Left lateral, Thrust *Comments:* Numerous geologic relationships and seismic-reflection profiles indicate north-side-up thrust/reverse faulting (Lovseth, 1975 #4759; Whetten and others, 1988 #4766; Johnson and others, 1996 #4751; 2001 #4749). The distribution of geologic units on opposite sides of the fault zone (Lovseth, 1975 #4759; Whetten, 1978 #4764) and the geometry of en-echelon faults and folds (Johnson and others, 2001 #4749) suggests a component of left-lateral slip. Trenching studies suggest right-lateral displacement is the predominate sense of slip in the late Holocene (Personius and others 2014 #7644).
Dip	45–90° N *Comments:* Johnson and others (2001 #4749) reported north dips ranging from 45° to 75° N (61°±10°) based on interpretation of seismic-reflection profiles in the eastern Strait of Juan de Fuca, with the steepest dips to the east in profiles flanking Whidbey Island. Whetten and others (1988 #4766) include a cross section from the Cascade Range foothills in which the fault zone of the Darrington-Devils Mountain fault (3-km-wide zone of 6 faults) is interpreted as vertical and faults in trench exposures are near vertical (Personius and others, 2014 #7644).
Paleoseismology studies	Johnson and others (2001 #4749) mapped and described the western part of the fault zone across Whidbey Island and the eastern Strait of Juan de Fuca using seismic-reflection profiles, high-resolution aeromagnetic data (Blakely and others, 1999 #4747), stratigraphic analysis of water well logs, and outcrop mapping. Lovseth (1975 #4759) and Marcus (1980 #4765) conducted structural and stratigraphic studies along the fault zone in the Cascade Range foothills. Site 574-1, Lake Creek study site (Personius and others 2014 #7644) is located southeast of Mount Vernon, Washington. This study consisted of three-dimensional trenching of prominent fault scarps and coring of the adjacent wetland (Boomer Marsh) that results in a record of one and possibly two paleoearthquakes on the central Darrington–Devils Mountain fault zone since deglaciation of the Puget Lowland in the latest Pleistocene. The Aplodontia and Springboard trenches were about 25 m apart and crossed a 1-m-high south-facing scarp. The trenches exposed

	Vashon Stade glacial sediments (14,725±470 radiocarbon yr BP Dragovich and DeOme, 2006) buried by Holocene sediments. The Boundary trench, about 125 m west of the Springboard trench, crossed a 1.5-m-high scarp. The trench exposed highly sheared bedrock eroded into and overlain by a sequence of glacial-fluvial, glacial-lacustrine, and till sediments deposited at the basal glacier-bedrock contact. Offset determined from faulted glacial features is 2.25±1.1 m of right-lateral displacement and 0.6±0.1 m north-side-up vertical displacement or right-lateral oblique net slip of 2.3±1.1 m plunging 14° west on a vertical fault striking 286°. In addition, Personius and others excavated two trenches across scarps that cross Whitman bench; the trenches did not expose evidence of tectonic deformation so Personius and others (2009 #7644) concluded that the scarp is a glaciofluvial channel margin.
Geomorphic expression	The Darrington-Devils Mountain fault coincides with a prominent 30-km-long topographic lineament in the western foothills of the Cascade Range (fig. 4 in Johnson and others, 2001 #4749). This lineament coincides with segments of several stream drainages and with the axis of the elongate, 4.5-km-long Lake Cavanaugh. Detailed geologic mapping from Whidbey Island on the west to near Darrington on the east document abundant evidence of Quaternary displacement along the fault zone (see summary in Dragovich and DeOme, 2006 #7643).
Age of faulted surficial deposits	Eocene strata of the Chuckanut Formation and the Oligocene rocks of Bulson Creek (Marcus, 1980 #4765; Whetten and others, 1988 #4766) are juxtaposed along the Darrington-Devils Mountain fault in the Cascade Range foothills. On offshore seismic-reflection data, inferred Quaternary strata are both folded and faulted by strands of the Darrington-Devils Mountain fault (Johnson and others, 2001 #4749). Dragovich and others (2002 #7638, 2003 #7639, 2003 #7640, 2004 #7641, 2005 #7600) and Dragovich and DeOme (2006 #7643) locally show faulted Quaternary deposits.
Historic earthquake	
Most recent prehistoric deformation	late Quaternary (<130 ka) *Comments:* Analysis of water-well logs from northern Whidbey Island indicate offset of the late Quaternary (80–125 ka; stage 5 interglacial) Whidbey Formation (Johnson and others, 2001 #4749). Trench excavations revealed evidence of a single earthquake, radiocarbon dated to 2 ka, but extensive burrowing and root mixing of sediments within 50–

	100 cm of the ground surface may have destroyed evidence of other earthquakes; coring of the nearby wetland results in possible evidence of an older Holocene surface rupture (Personuis and others, 2014 #7644).
Recurrence interval	6 k.y. (<8 ka) *Comments:* Two recognized earthquakes, dated at 1.9±0.4 ka and 8.1±0.1 ka, yield a single recurrence interval of about 6 k.y. (Personius and others, 2014 #7644).
Slip-rate category	Less than 0.2 mm/yr *Comments:* Personius and others (2014 #7644) report an average slip rate of 0.14±0.1 mm/yr based on 2.3±1.1 m of right-lateral oblique slip (on a vertical fault) that postdates deglaciation of the Lake Creek site, about 16±0.5 ka. However, they consider this a minimum because slip on the southern strand of the fault near the trenches and possible other unmapped fault traces is not included. Stratigraphic analysis of well logs from northern Whidbey Island suggests a vertical displacement rate of about 0.05–0.30 mm/yr (preferred rate is 0.16 mm/yr) over the last 80 ka. Offshore seismic-reflection profiles suggest minimum Quaternary, vertical rates of 0.03 to 0.13 mm/yr. Although the rate given by Personius and others (2014) agrees well numerically with previous studies, sense of displacement from the trenching data is nearly entirely strike slip.
Date and Compiler(s)	2016 Samuel Y. Johnson, U.S. Geological Survey Richard J. Blakely, U.S. Geological Survey, Emeritus Thomas M. Brocher, U.S. Geological Survey Kathleen M. Haller, U.S. Geological Survey Elizabeth A. Barnett, Shannon & Wilson, Inc.
References	#4747 Blakely, R.J., Wells, R.E., and Weaver, C.S., 1999, Puget Sound aeromagnetic maps and data: U.S. Geological Survey Open-File Report 99-514. #4719 Booth, D.B., 1994, Glaciofluvial infilling and scour of the Puget Lowland, Washington, during ice-sheet glaciation: Geology, v. 22, p. 695-698. #4718 Brocher, T.M., Parsons, T., Blakely, R.J., Christensen, N.I., Fisher, M.A., Wells, R.E., and SHIPS Working Group, 2001, Upper crustal structure in Puget Lowland, Washington—Results from the 1998 seismic hazards investigation in Puget Sound: Journal of Geophysical Research, v. 106, p. 13,541–13,564.

#7643 Dragovich, J.D., and DeOme, A.J., 2006, Geologic map of the McMurray 7.5-minute quadrangle, Skagit and Snohomish Counties, Washington, with a discussion of the evidence for Holocene activity on the Darrington–Devils Mountain fault zone: Washington Division of Geology and Earth Resources Geologic Map GM-61, scale 1:24, 000, 1 sheet, 18 p. text.

#7638 Dragovich, J.D., Gilbertson, L.A., Norman, D.K., Anderson, G., Petro, G.T., 2002, Geologic map of the Utsalady and Conway 7.5-minute quadrangles, Skagit, Snohomish, and Island Counties, Washington: Washington Division of Geology and Earth Resources Open File Re port 2002-5, 34 p., 2 plates.

#7600 Dragovich, J.D., Petro, G.T., Thorsen, G.W., Larson, S.L., Foster, G.R., and Norman, D.K., 2005, Geologic map of the Oak Harbor, Crescent Harbor, and part of the Smith Island 7.5-minute quadrangles, Island County, Washington: Washington Division of Geology and Earth Resources, Geologic Map GM-59, scale 1:24,000.

#7639 Dragovich, J.D., Stanton, B.W., Lingley, W.S., Jr., Griesel, G.A., Polenz, M., 2003, Geologic map of the Oso 7.5-minute quadrangle, Skagit and Snohomish Counties, Washington: Washington Division of Geology and Earth Resources Open File Report 2003-11, 1 sheet, scale 1:24,000.

#7640 Dragovich, J.D., Stanton, B.W., Lingley, W.S., Jr., Griesel, G.A., Polenz, M., 2003, Geologic map of the Mount Higgins 7.5-minute quadrangle, Skagit and Snohomish Counties, Washington: Washington Division of Geology and Earth Resources Open File Report 2003-12, 1 sheet, scale 1:24,000.

#7641 Dragovich, J.D., Wolfe, M.W., Stanton, B.W., Norman, D.K., 2004, Geologic map of the Stimson Hill 7.5-minute quadrangle, Skagit and Snohomish Counties, Washington: Washington Division of Geology and Earth Resources Open File Report 2004-9, 1 sheet, scale 1:24,000.

#6211 Haugerud, R.A., Harding, D.J., Johnson, S.Y., Harless, J.L., Weaver, C.S., and Sherrod, B.L., 2003, High-resolution lidar topography of the Puget Lowland, Washington—A bonanza for earth science: Geological Society of America GSA Today, v. 13, no. 6, p. 4-10.

#4758 Hobbs, S.W., and Pecora, W.T., 1941, Nickel-gold deposit near Mount Vernon, Skagit County, Washington, Chapter D of Strategic minerals investigation, 1941, short papers and preliminary reports, Part 1:U.S. Geological Survey Bulletin 931, p. 57-78.

#4749 Johnson, S.Y., Dadisman, S.V., Mosher, D.C., Blakely, R.J., and Childs, J.R., 2001, Active tectonics of the Devils Mountain fault and related structures, northern Puget Lowland and eastern Strait of Juan de Fuca region, Pacific Northwest: U.S. Geological Survey Professional Paper 1643, 46 p., 2 pls.

#4751 Johnson, S.Y., Potter, C.J., Armentrout, J.M., Miller, J.J., Finn, C., and Weaver, C.S., 1996, The southern Whidbey Island fault—An active structure in the Puget Lowland, Washington: Geological Society of America Bulletin, v. 108, p. 334-354 and oversize insert.

#4734 Khazaradze, G.Q., Anthony, and Dragert, H., 1999, Tectonic deformation in western Washington from continuous GPS measurements: Geophysical Research Letters, v. 26, p. 3153-3156.

#4759 Lovseth, T.P., 1975, The Devils Mountain fault zone, northwestern Washington: Seattle, University of Washington, unpublished M.S. thesis, 29 p.

#4765 Marcus, K.L., 1980, Eocene-Oligocene sedimentation and deformation in the northern Puget Sound area, Washington: Northwest Science, v. 9, p. 52-58.

#4732 Miller, M.M., Miller, D.J., Rubin, C.M., Dragert, H., Wang, Kelin, Qamar, Anthony, and Goldfinger, C., 2001, GPS-determination of along-strike variation in Cascadia margin kinematics—Implications for relative pl. motion, subduction zone coupling, and permanent deformation: Tectonics, v. 20, p. 161-176.

#7616 Nelson, A.R., Personius, S.F., Sherrod, B.L., Buck, J., Bradley, L-A., Henley, Gary, II, Liberty, L.M., Kelsey, H.M., Witter, R.C., Koehler, R.D., Schermer, E.R., Nemser, E.S., and Cladouhos, T.T., 2008, Field and laboratory data from an earthquake history study of scarps in the hanging wall of the Tacoma fault, Mason and Pierce Counties, Washington: U.S. Geological Survey Scientific Investigations Map SIM-3060, 3 sheets, http://http://pubs.usgs.gov/sim/3060/.

#4760 Norbisrath, N., 1939, The geology of the Mount Vernon area: Seattle, University of Washington, unpublished M.S. thesis, 28 p.

#7644 Personius, S.F., Briggs, R.W., Nelson, A.R., Schermer, E.R., Maharrey, J.Z., Sherrod, B., Spaulding, S.A., Bradley, L-A., 2014, Holocene earthquakes and right-lateral slip on the left-lateral Darrington-

Devils Mountain fault zone, northern Puget Sound, Washington: Geosphere, v. 10, p. 1482–1500, doi:10.1130/GES01067.1

#6237 Porter, S.C., and Swanson, T.W., 1998, Radiocarbon age constraints on rates of advance and retreat of the Puget lobe of the Cordilleran ice sheet during the last glaciation: Quaternary Research, v. 50, p. 205-213.

#4761 Ramachandran, K., 2001, Velocity structure of S.W. British Columbia, and N.W. Washington, from 3-D non-linear seismic tomography: Victoria, University of Victoria, B.C., , 188 p.

#4762 Tabor, R.W., 1994, Late Mesozoic and possible early Tertiary accretion in western Washington state—The Helena-Haystack melange and the Darrington-Devils Mountain fault zone: Geological Society of America Bulletin, v. 106, p. 217-232.

#4763 Tabor, R.W., Booth, D.B., Vance, J.A., Ford, A.B., and Ort, M.H., 1988, Preliminary geologic map of the Sauk River 30' by 60' quadrangle, Washington: U.S. Geological Survey Open-File Report 88-692, scale 1:100,000.

#6242 Vance, J.A., Dungan, M.A., Blanchard, D.P., and Rhodes, J.M., 1980, Tectonic setting and trace element geochemistry of Mesozoic ophiolitic rocks in western Washington: American Journal of Science, v. 280-A, p. 359-388.

#4742 Wells, R.E., Weaver, C.S., and Blakely, R.J., 1998, Forearc migration in Cascadia and its neotectonic significance: Geology, v. 26, p. 759-762.

#4764 Whetten, J.T., 1978, The Devils Mountain fault—A major Tertiary structure in northwest Washington: Geological Society of America Abstracts with Programs, v. 10, p. 153.

#4766 Whetten, J.T., Carroll, P.I., Gower, H.D., Brown, E.H., and Pessl, F., Jr., 1988, Bedrock geologic map of the Port Townsend 30' by 60' quadrangle, Puget Sound region, Washington: U.S. Geological Survey Miscellaneous Investigations Map I-1198-G, scale 1:100,000.

Questions or comments?

Facebook Twitter Google Email
Hazards