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Quaternary Fault and Fold Database of the United States

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Portland Hills fault (Class A) No. 877

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Synopsis	The northwest-striking Portland Hills fault forms the prominent linear northeaste margin of the Tualatin Mountains (Portland Hills) and the southwestern margin o Portland basin; this basin may be a right-lateral pull-apart basin in the forearc of t Cascadia subduction zone or a piggyback synclinal basin formed between antifor uplifts of the Portland fold belt. The fault is part of the Portland Hills-Clackamas structural zone, which controlled the deposition of Miocene Columbia River Basa Group lavas in the region. The crest of the Portland Hills is defined by the northw striking Portland Hills anticline. Sense of displacement on the Portland Hills faul poorly known and controversial. The fault was originally mapped as a down-to-th northeast normal fault. The fault has also been mapped as part of a regional-scale of right-lateral oblique slip faults, and as a steep escarpment caused by asymmetr folding above a southwest-dipping blind thrust. Reverse displacement with a righ lateral strike-slip component may be most consistent with the tectonic setting, ma geologic relations, aeromagnetic data, and microseismicity in the area. No fault s on surficial Quaternary deposits have been described along the fault trace, but sor geomorphic (steep, linear escarpment, triangular facets, oversteepened and

	knickpointed tributaries) and geophysical (aeromagnetic, seismic reflection, and ground-penetrating radar) evidence suggest Quaternary displacement.
Name comments	The Portland Hills fault was not shown on early geologic maps of the region (Pip 1942 #4064; Trimble, 1963 #4062; Hart and Newcomb, 1965 #4063), despite its prominent geomorphic expression along the linear northeast margin of the Tualat Mountains, which are locally known as the Portland Hills. The fault was first sho maps by Schlicker and others (1964 #4019) and Schlicker and Deacon (1967 #40 who described this fault as a major structure of regional significance. The fault is shown on maps of Schlicker and Finlayson (1979 #4166). Balsillie and Benson (1 #4005) apparently were the first to use the name "Portland Hills fault" in print, in discussion of this fault. The fault is part of the Portland Hills-Clackamas River structural zone of Beeson and others (1985 #4022; 1989 #4023), is included in th Portland Hills fault zone of Blakely and others (1995 #4021), and is referred to as Frontal fault zone by Yelin and Patton (1991 #4020).. **Fault ID:** This structure is included in fault number 3 of Pezzopane (1993 #3544 is fault number 20 of Geomatrix Consultants, Inc. (1995 #3593).
County(s) and State(s)	COLUMBIA COUNTY, OREGON MULTNOMAH COUNTY, OREGON CLACKAMAS COUNTY, OREGON
Physiographic province(s)	PACIFIC BORDER
Reliability of location	Good Compiled at 1:24,000 and 1:50,000 scale. *Comments:* Location of fault from ORActiveFaults (http://www.oregongeology.org/arcgis/rest/services/Public/ORActiveFaults/MapS downloaded 06/02/2016) attributed to Madin (2004 #7779), Madin and Niewendo (2008 #7782) and Madin and others (2008 #7783).
Geologic setting	The northwest-striking Portland Hills fault forms the northeastern margin of the Tualatin Mountains and the southwestern margin of the Portland basin; this basin be a right-lateral pull-apart basin in the forearc of the Cascadia subduction zone (Beeson and others, 1985 #4022; Beeson and others, 1989 #4023; Yelin and Patto 1991 #4020; Blakely and others, 1995 #4021; Blakely and others, 2000 #4333), c piggyback synclinal basin formed between antiformal uplifts of the Portland fold (Unruh and others, 1994 #3597; Unruh and others, 1994 #4007). The fault is part Portland Hills-Clackamas River structural zone of Beeson and others (1985 #402 1989 #4023), which controlled the deposition of Miocene Columbia River Basalt Group lavas in the region. The crest of the Portland Hills is defined by the northw striking Portland Hills anticline. A gravity gradient coincides with the Portland H

	fault (McPhee and others, 2014 #7371).
Length (km)	49 km.
Average strike	N37°W
Sense of movement	Reverse, Right lateral *Comments:* Sense of displacement on the Portland Hills fault is poorly known and controversial. The fault was originally mapped as a down-to-the-northeast normal fault, based on offset of Columbia River Basalt Group rocks and on the location of November 1962 Portland earthquake (Schlicker and others, 1964 #4019; Balsillie Benson, 1971 #4005), which was located several kilometers east of the fault in the Portland basin (Yelin and Patton, 1991 #4020). The fault was mapped as a steeply southwest-dipping, right-lateral fault by Schlicker and Finlayson (1979 #4166). The fault is also mapped as part of the Portland Hills-Clackamas River structural zone Beeson and others (1985 #4022; 1989 #4023), a regional-scale zone of right-lateral strike-slip faults, and may define the western margin of a pull-apart basin as a right oblique-slip fault (Beeson and others, 1985 #4022; Beeson and others, 1989 #4023; Yelin and Patton, 1991 #4020; Blakely and others, 1995 #4021; Blakely and others, 2000 #4333; McPhee and others, 2014 #7371). Unruh and others (1994 #3597) attributed the steep escarpment along the Portland Hills to asymmetrical folding and a southwest-dipping blind thrust. The Portland Hills fault is also mapped as a near vertical dip-slip fault with a down-to-the-northeast displacement direction (Beeson others, 1989 #4047; Madin, 1990 #4067; Beeson and others, 1991 #4048). Blakely others (1995 #4021; 2000 #4333) used aeromagnetic data to infer a steeply southwest dipping reverse geometry for the fault. Shallow seismic reflection data suggest northeast-side-up displacement that could reflect strike-slip or northeast-side-up dip-slip displacement (Pratt and others, 2001 #5136). The Portland Hills fault is modeled as both a 70° northeast-dipping reverse or reverse-oblique fault by Geomatrix Consultants, Inc. (1995 #3593), and as a steeply southwest-dipping to vertical fault Wong and others (1999 #4073; 2000 #5137). Reverse displacement with a right-lateral strike-slip component is consistent with the tectonic setting, mapped geologic relations, aeromagnetic data, and microseismicity in the area (Beeson and others, 1989 #4023; Yelin and Patton, 1991 #4020; Blakely and others, 1995 #4021; Blakely and others, 2000 #4333).
Dip Direction	SW *Comments:* Schlicker and Finlayson (1979 #4166) mapped the fault as a steeply southwest-dipping, right-lateral fault. Blakely and others (1995 #4021) use aeromagnetic data to infer a southwest-dipping reverse geometry for the fault, and Wong and others (1999 #4073; 2000 #5137; 2001 #7705) modeled the Portland Hills fault as a steeply, southwest-dipping reverse to vertical fault in their earthquake hazards analysis of the Portland metropolitan area. Dip direction from Schlicker a

	Finlayson (1979 #4166), Wong and others (1999 #4073; 2000 #5137) and Blakely others (1995 #4021).
Paleoseismology studies	
Geomorphic expression	The Portland Hills fault may be responsible for the linear, 250-m-high escarpmen Miocene rocks of the Columbia River Basalt Group along the northeastern margi the Portland Hills. No fault scarps on Quaternary surficial deposits have been described, but Balsillie and Benson (1971 #4005) described anomalous benches, triangular facets, wineglass (oversteepened) valleys, and knickpoints on tributary streams as evidence of recent movement. Unruh and others (1994 #3597) conduc limited aerial and field reconnaissance along the northeastern margin of the Portla Hills, and found no direct evidence of faulting in Quaternary deposits.
Age of faulted surficial deposits	The Portland Hills fault offsets Miocene Columbia River Basalt Group volcanic r and Miocene to Pliocene sedimentary rocks of the Troutdale Formation (Madin, 1 #4067; Beeson and others, 1991 #4048). No fault scarps on surficial Quaternary deposits have been described along the fault trace, and the fault is mapped as buri latest Pleistocene Missoula flood deposits (Madin, 1990 #4067; Beeson and other 1991 #4048). Schlicker and Finlayson (1979 #4166) and Beeson and others (1989 #4047) show the fault cutting Quaternary alluvial or flood deposits in cross sectio these relationships are due to drafting errors (I.P. Madin, pers. commun., 2000). U and others (1994 #3597) cite the folding of basin-fill sediments interbedded with Boring Lava on the west flank of the Portland Hills as evidence of Quaternary movement on their hypothesized thrust fault underlying the Portland Hills anticli Boring Lava rocks are Pliocene and Pleistocene in age (Conrey and others, 1996 #4025; Fleck and others, 2002 #5149). Recently acquired shallow seismic-reflect and ground-penetrating radar data (Hemphill-Haley and others, 2000 #5138; 200 #5056; Pratt and others, 2001 #5136) across the mapped trace of the Portland Hil fault south of Ross Island suggest possible deformation of unconformities and sediments associated with the latest Pleistocene Missoula floods.
Historic earthquake	
Most recent prehistoric deformation	undifferentiated Quaternary (<1.6 Ma) *Comments:* Madin (1990 #4067) and Beeson and others (1991 #4048) show the Portland Hills fault as buried by Missoula flood deposits, but shallow seismic-and ground-penetrating radar data (Hemphill-Haley and others, 2000 #5138; 2001 #5 Liberty and others, 2003 #7170; Pratt and others, 2001 #5136) suggest possible o of the unconformities and sediments associated with the latest Pleistocene Missou floods. Pezzopane (1993 #3544), Geomatrix Consultants, Inc. (1995 #3593), and Madin and Mabey (1996 #3575) mapped the Portland Hills fault as active in the

	Quaternary (<1.6–1.8 Ma). Unruh and others (1994 #3597) concluded that the Po Hills fault is potentially active, and Wong and others (1999 #4073; 2000 #5137) mapped the Portland Hills fault as a highly probable seismogenic fault. Given the equivocal evidence for faulting and poor geomorphic expression in Quaternary deposits, the Portland Hills fault is mapped as Quaternary herein until more defin studies are conducted.
Recurrence interval	
Slip-rate category	Less than 0.2 mm/yr *Comments:* Cross sections from Beeson and others (1991 #4048) suggest 250–35 of down-to-the-northeast vertical displacement of Miocene Columbia River Basa Group volcanic rocks across the Portland Hills fault; no estimates of strike-slip displacement have been published, but such vertical displacement estimates indic low rates of long-term slip. Pratt and others (2001 #5136) used shallow seismic-reflection data to infer as much as 10 m of down-to-the-southwest vertical offset unconformity underlying 15 ka Missoula flood related sediments across the fault, this sense of displacement is opposite to the long-term slip direction. Unruh and (1994 #3597) used fault-bend fold theory to estimate approximately 1070 m of displacement of Columbia River Basalt Group rocks across their hypothesized th fault beneath the Portland Hills anticline; Geomatrix Consultants, Inc. (1995 #35 used this data to calculate slip rates of 0.07–1.0 mm/yr for one of their models of deformation across the Portland Hills. Geomatrix Consultants, Inc. (1995 #3593) Wong and others (1999 #4073; 2000 #5137) calculated preferred slip rates of 0.0 mm/yr in their analyses of the earthquake hazards associated with the Portland Hi fault, but did not document the basis for these estimates. Given the lack of signifi geomorphic expression in Quaternary deposits along the fault, the lower rates are herein considered more likely.
Date and Compiler(s)	2017 Stephen F. Personius, U.S. Geological Survey Kathleen M. Haller, U.S. Geological Survey
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