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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.

Frenchman Hills structures, Frenchman Hills fault (Class A) No. 561a

Last Review Date: 2016-05-20

citation for this record: **Lidke, D.J., compiler, 2003, Fault number 561a, Frenchman Hills structures, Frenchman Hills 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	**General:** The east-trending Frenchman Hills structures include the Frenchman Hills and Lind Coulee faults that show evidence suggestive of Quaternary offset (West and Shaffer, 1988 #5549; Shaffer and West, 1989 #5551; Geomatrix Consultants Inc., 1990 #5550). The Frenchman Hills anticline and related folds and some faults of the Frenchman Hills uplift, however, are only known to deform rocks of the Miocene Columbia River Basalt Group. Quaternary age growth or tightening of other folds in the Yakima fold belt, and perhaps of the Frenchman Hills folds, has been suggested and inferred from several local and regional geologic relations in the Yakima fold belt (Campbell and Bentley, 1981 #3513; Reidel, 1984 #5545; Reidel and others, 1994 #3539). Contemporaneous contraction across the region suggests that the Yakima folds are favorably oriented in the current strain field and accommodate the strain through active folding and possibly faulting (Pratt, 2012 #7397; Bjornstad and others, 2012 #7394 citing unpublished Zachariasen and others, 2006). As summarized

	by Bjornstad and others (2012 #7394), global positioning system (GPS) "data indicate relatively low (<1 mm/yr) but non-zero convergence across the Yakima fold belt…. In general, these rates are higher than those calculated on Quaternary faults." Based on the growing consensus that the Frenchman Hills folds are cored by one or more buried Quaternary faults, the faults are reassigned to Class A as opposed to the prior Class B classification. **Sections:** This fault has 3 sections. Sections defined here differ in lateral extent from the fault sources prescribed by Coppersmith and others (2014 #7402). Their western section is longer than section 561c.
Name comments	**General:** **Section:** Refers to exposed and inferred faults and to fault-related features mapped along most of the north flank of the easterly trending Frenchman Hills and Frenchman Hills anticline (Grolier and Bingham, 1971 #5542; West and Shaffer, 1988 #5549; Geomatrix Consultants Inc., 1990 #5550; Schuster and others, 1997 #3760). These structural features are called the Frenchman Hills fault in Geomatrix Consultants Inc. (1990 #5550) and that name is used herein; earlier usage of this name is not known. The Frenchman Hills fault, as discussed by Geomatrix Inc. (1990 #5550) extends along the north flank of the Frenchman Hills from the Columbia River, eastward to just south of the southeast tip of Potholes Reservoir. The geologic map compiled by Schuster and others (1997 #3760), suggests that the fault may continue west of the Columbia River where it is exposed entirely in Miocene, Columbia River Basalt Group units. Quaternary offset along the fault west of the Columbia River has not been described or suggested and it is shown and included with the folds and other faults of the Frenchman Hills anticlinal uplift [561c].
County(s) and State(s)	GRANT COUNTY, WASHINGTON
Physiographic province(s)	COLUMBIA PLATEAU
Reliability of location	Good Compiled at 1:100,000 and 1:250,000 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 1:100,000-scale map by Gulick (1990 #5561), Reidel and Fecht (1994 #5565), and 1:250,000-scale map of Schuster and others (1997 #3760).

Geologic setting	The Frenchman Hills are in the northeastern part of the Yakima fold belt, a structural-tectonic sub province of the western Columbia Plateaus Province (Reidel and others, 1989 #5553; 1994 #3539). The Yakima fold belt consists of a series of generally east-trending narrow asymmetrical anticlinal ridges and broad synclinal valleys formed by folding of Miocene Columbia River basalt flows and sediments. In most parts of the belt the folds have a north vergence with the steep limb typically faulted by imbricate thrust faults. According to Reidel and others (1989 #5553) these frontal faults are typically associated with the areas of greatest structural relief. In the few places where erosion exposes the frontal faults deeper in the cores of the anticlinal ridges the faults are seen to become steeper with depth (as steep as 45–70°). Along their lengths the anticlines are commonly broken into segments ranging between 5 and 35 km long with boundaries defined by abrupt changes in fold geometry. Anticlinal ridges of the Yakima fold belt began to grow in Miocene time (about 16–17 Ma), concurrent with eruptions of Columbia River basalt flows, and continued during Pliocene time and may have continued to the present (Reidel and others, 1989 #5553; 1994 #3539). The south-dipping Frenchman Hills and Lind Coulee faults are thrust faults that cut the north limbs of the Frenchman Hills anticline and Lind Coulee flexure, which are the principal folds of the Frenchman Hills anticlinal uplift. This uplift forms one of the many anticlinal ridges that comprise the Yakima fold belt in south-central Washington. The Frenchman Hills and Lind Coulee faults show evidence for Quaternary faulting events, but the folds and other faults of the Frenchman Hills uplift are only known to deform rocks of the Columbia River Basalt Group (Miocene).
Length (km)	This section is 51 km of a total fault length of 123 km.
Average strike	N87°W (for section) versus N83°W (for whole fault)
Sense of movement	Thrust *Comments:* The Frenchman Hills fault is mapped as an exposed, but mostly buried, thrust fault (Grolier and Bingham, 1971 #5542; Gulick, 1990 #5561; Reidel and Fecht, 1994 #5565; Schuster and others, 1997 #3760).
Dip	20–60° *Comments:* Geomatrix Consultants Inc. (1996 #4676) used fault dips of 30°, 45°, and 60° to estimate slip rates for the main fault underlying the Frenchman Hills. West and Shaffer (1988 #5549) and Shaffer and West

	(1989 #5551) reported dips of 21–40° for the Lind Coulee fault [561b], which is present directly east of the Frenchman Hills fault.
Paleoseismology studies	
Geomorphic expression	Just east of the Columbia River, the west end of the Frenchman Hills fault is exposed in Miocene basalt of the Columbia River Basalt Group (Grolier and Bingham, 1971 #5542; Geomatrix Consultants Inc., 1990 #5550; Reidel and Fecht, 1994 #5565; Schuster and others, 1997 #3760). Farther east, but still near the Columbia River, Grolier and Bingham (1971 #5542) show the fault juxtaposing Miocene rocks of the Columbia River Basalt Group on Quaternary sediments. More recent geologic maps by Reidel and Fecht (1994 #5565), Gulick (1990 #5561), and Schuster and others (Schuster and others, 1997 #3760) show these same sediments as Pliocene to Miocene sediments and do not show a fault at the locality where Grolier and Bingham (1971 #5542) showed the faulted Quaternary sediments. For this same locality Geomatrix Consultants Inc. (1990 #5550) reported that the locality had been greatly disturbed by agricultural activity after 1982, and they also reported that examination of 1982, color IR photographs of this locality showed numerous strongly expressed lineaments. The central and eastern parts of the Frenchman Hills fault are mapped as a buried thrust fault overlain by Quaternary loess deposits (Reidel and Fecht, 1994 #5565; Schuster and others, 1997 #3760). Geomatrix Consultants Inc. (1990 #5550) reported, and portrayed in their figure 3-5, numerous photogeologic lineaments along the central and eastern parts of the fault; they indicated that these lineaments consisted of tonal contrasts and breaks in slopes.
Age of faulted surficial deposits	Geologic maps show Miocene rocks of the Columbia Plateau Basalt Group faulted along the west end of the fault and show the central and eastern parts of the fault buried by Pleistocene-Holocene loess deposits (Grolier and Bingham, 1971 #5542; Reidel and Fecht, 1994 #5565; Schuster and others, 1997 #3760). The geologic map by Grolier and Bingham (1978 #5543) also shows faulted Quaternary sediments along the western part of the fault, but more recent geologic maps (Gulick, 1990 #5561; Reidel and Fecht, 1994 #5565; Schuster and others, 1997 #3760) show these same sediments as unfaulted Miocene to Pliocene units. According to Geomatrix Consultants Inc. (1990 #5550), 1982 color IR photographs show numerous lineaments in these sediments along the western part of the fault, which are now obscured by post-1982 agricultural activity. Geomatrix Consultants Inc. (1990 #5550) reported, and portrayed in their figure 3-5, numerous photogeologic lineaments along the central and eastern parts of the fault, which are the parts of the

	fault that are shown as buried by Quaternary loess deposits on the geologic maps mentioned above. Geomatrix Consultants Inc. (1990 #5550) also reported that some of these lineaments are present in late Quaternary flood deposits and may suggest late Quaternary faulting, but they noted that they did not conduct detailed studies of these linear features.
Historic earthquake	
Most recent prehistoric deformation	undifferentiated Quaternary (<1.6 Ma) *Comments:* No definitive evidence of Quaternary displacement has been described along the Frenchman Hills fault. Studies by Geomatrix Consultants Inc. (1990 #5550) identified photogeologic lineaments in Pleistocene-Holocene loess deposits and late Quaternary flood deposits along what has been mapped as a buried trace of the fault. Geomatrix Consultants Inc. (1990 #5550) noted that the photogeologic lineaments they identified were not studied in detail, but they suggested some were probably fault-related and implied Quaternary, or perhaps late Quaternary, offset along the Frenchman Hills fault.
Recurrence interval	*Comments:* Geomorphic or stratigraphic data needed for recurrence estimates directly related to the Frenchman Hills fault have not been reported. Piety and others (1990 #3733) used uplift rates calculated from 13.5 Ma volcanic rocks to estimate recurrence intervals of 1,220–61,100 years based on displacement per events of 0.02–1.0 m.
Slip-rate category	Less than 0.2 mm/yr *Comments:* No slip data in Quaternary deposits are available for the Frenchman Hills fault. Some data is available on uplift rates of Miocene volcanic rocks across the Frenchman Hills anticline and related folds. Piety and others (1990 #3733) report 221 m of uplift of 13.5 Ma volcanic rocks, which yield uplift rates of 0.02 mm/yr. Geomatrix Consultants Inc. (1995 #3593) used uplift of 200 m and horizontal offset of 300 m of 10.5 and 16.0 Ma volcanic rocks along estimated fault dips of 30°, 45°, and 60° to estimate long-term slip rates of 0.008–0.067 mm/yr for an inferred principle fault underlying the Frenchman Hills.
Date and Compiler(s)	2003 David J. Lidke, U.S. Geological Survey
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