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.**

## Frenchman Hills structures, Lind Coulee fault (Class A) No. 561b

**Last Review Date: 2016-05-23**

### *citation for this record:* Lidke, D.J., and Haller, K.M., compilers, 2016, Fault number 561b, Frenchman Hills structures, Lind Coulee 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 03:04 PM.

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| **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the strain through active folding and possibly faulting (Pratt, 2012 #7397; Bjornstad and others, 2012 #7394 citing unpublished Zachariasen and others, 2006).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 |

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| | 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.<br><br>**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:**<br><br>**Section:** Refers to east-striking faults mapped by Grolier and Bingham (1971 #5542), Reidel and Fecht (1994 #5565), and Schuster and others (1997 #3760) located south and southeast of Potholes Reservoir along the northern flank of the eastern end of the Frenchman Hills and Frenchman Hills anticline. The Lind Coulee fault is named after Lind Coulee; the earliest known usage of this name is Grolier and Bingham (1971 #5542) and this fault name is also used in later reports by West and Shaffer (1988 #5549), Shaffer and West (1989 #5551), and Geomatrix Consultants Inc, (1990 #5550). |
| **County(s) and State(s)** | GRANT COUNTY, WASHINGTON |
| **Physiographic province(s)** | COLUMBIA PLATEAU |
| **Reliability of location** | Good<br>Compiled at 1:100,000 scale.<br><br>*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 Reidel and Fecht (1994 #5565). |
| **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) |

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| | 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).<br><br>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 9 km of a total fault length of 123 km. |
| **Average strike** | N88°E (for section) versus N83°W (for whole fault) |
| **Sense of movement** | Thrust<br><br>*Comments:* Most of the strands of the Lind Coulee fault have been mapped as thrust faults (Grolier and Bingham, 1971 #5542; West and Shaffer, 1988 #5549; Reidel and Fecht, 1994 #5565; Schuster and others, 1997 #3760). Several reports describe evidence for thrust or reverse offsets along these faults (Grolier and Bingham, 1971 #5542; West and Shaffer, 1988 #5549; Shaffer and West, 1989 #5551; Geomatrix Consultants Inc., 1990 #5550). |
| **Dip** | 10–40° S<br><br>*Comments:* Grolier and Bingham (1978 #5543) reported a south dip of 10° along an exposed thrust plane in the south bank of Lind Coulee. Shaffer and West (1989 #5551) reported that the exposed main fault planes of the Lind Coulee fault dip south and range from 21–40°. |
| **Paleoseismology** | West and Shaffer (1988 #5549) excavated and mapped three trenches |

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| **studies** | along fault strands of the Lind Coulee fault. In these trenches faulted loess deposits were absent, although faulted loess deposits are present in the footwall along some surface exposures (West and Shaffer, 1988 #5549; Shaffer and West, 1989 #5551; Geomatrix Consultants Inc., 1990 #5550). Fault contacts in the trenches are between Miocene to Pliocene sediments of the Ringwold Formation in the footwall and Miocene volcanic rocks in the hanging-wall. These trenching studies also revealed undisturbed Pleistocene sand deposits, which are locally associated with lacustrine silt and carbonate horizons that overlie the Miocene volcanic rocks along the fault. West and Shaffer (1988 #5549) and Shaffer and West (1989 #5551) assigned an age of about 40–50 ka to these undisturbed Pleistocene sand deposits that locally bury strands of the Lind Coulee fault.<br><br>Western Trench. Trench 561-1 was excavated by West and Shaffer (1988 #5549) and is located near west end of the main fault splay of the Lind Coulee fault as shown on Plate VIII in West and Shaffer (1988 #5549).<br><br>Central and Eastern Trenches. Trenches 561-2 and 561-3 were excavated by West and Shaffer (1988 #5549) and are located about 1km apart along central part of north splay of Lind Coulee fault as shown on Plate VIII in West and Shaffer (1988 #5549). |
| **Geomorphic expression** | West and Shaffer (1988 #5549) and Shaffer and West (1989 #5551) mapped and reported on two thrust faults that are exposed in the Lind Coulee Arm of Potholes Reservoir. They noted that these two faults have fault zones that are 0.3–2.5 m thick and are associated with a fault-line scarp that formed where catastrophic glacial floods eroded the less resistant footwall sediments and the overhanging tip of the hanging-wall Miocene volcanic rocks. Geomatrix Consultants, Inc. (1990 #5550) reported that Lind Coulee fault exposures are aligned with east-trending escarpments. |
| **Age of faulted surficial deposits** | Ages of faulted deposits along the Lind Coulee fault are not tightly constrained. Along fault strands of the Lind Coulee fault, geologic maps show Miocene volcanic rocks faulted on and against Quaternary sediments (Grolier and Bingham, 1971 #5542; Reidel and Fecht, 1994 #5565; Schuster and others, 1997 #3760). West and Shaffer (1988 #5549) and Shaffer and West (1989 #5551) describe these faulted sediments as loess deposits and paleosols. Based on the dominantly reversed magnetic polarity of the faulted loess deposits, these deposits probably have an age greater than 790 ka and probably are late Pliocene to early Pleistocene in age (West and Shaffer, 1988 #5549; Shaffer and West, 1989 #5551). Trenching studies at three localities by West and Shaffer (1988 #5549) revealed unfaulted Pleistocene sands in depositional contact with Miocene |

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| | basalt along the fault. These Pleistocene sands and associated lacustrine silt and carbonate horizons are estimated to be about 40–50 ka (West and Shaffer, 1988 #5549; Shaffer and West, 1989 #5551). |
| **Historic earthquake** | |
| **Most recent prehistoric deformation** | undifferentiated Quaternary (<1.6 Ma)<br><br>*Comments:* The time of the most recent faulting event along the Lind Coulee fault is not tightly constrained. Existing evidence indicates that movement along the Lind Coulee fault has not occurred since deposition of glacial flood deposits across the fault that are interpreted to be 40–50 ka deposits (West and Shaffer, 1988 #5549; Shaffer and West, 1989 #5551). Deformed loess deposits along the fault are interpreted by West and Shaffer (1988 #5549) and Shaffer and West (1989 #5551) to indicate a Quaternary event(s) that occurred sometime after deposition of these late Pliocene to Pleistocene loess deposits and prior to deposition of the 40–50 ka glacial flood deposits. |
| **Recurrence interval** | <br><br>*Comments:* Geomorphic or stratigraphic data necessary for estimating recurrence directly related to the Lind Coulee fault has 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. Evidence indicating no recurrence in the last 40–50 k.y. along the Lind Coulee fault (West and Shaffer, 1988 #5549; Shaffer and West, 1989 #5551), may also indicate that the recurrence interval is 40 k.y. or more. |
| **Slip-rate category** | Less than 0.2 mm/yr<br><br>*Comments:* No slip data in Quaternary deposits are available for the Lind Coulee 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 15 Ma volcanic rocks, which yields an uplift rate of 0.02 mm/yr. Geomatrix Consultants Inc. (1996 #4676) used uplift of 200 m and horizontal offset of 300 m of 10.5–16.0 Ma volcanic rocks along estimated fault dips of 30°, 45°, and 60° to estimate slip rates of 0.008–0.067 for a presumed principle fault underlying the Frenchman Hills. Shaffer and West reported an apparent post-Ringwold (3.4 Ma age reported by Reidel and others, 1994 #3539) vertical offset of about 4.5 m, which suggests low long-term rates of slip. |
| **Date and** | 2016 |

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| **Compiler(s)** | David J. Lidke, U.S. Geological Survey<br>Kathleen M. Haller, U.S. Geological Survey |
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