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.

Lemhi fault, Howe section (Class A) No. 602f

Last Review Date: 2010-11-09

Compiled in cooperation with the Idaho Geological Survey

citation for this record: **Wheeler, R.L., compiler, 2010, Fault number 602f, Lemhi fault, Howe section, 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 03:02 PM.**

Synopsis	**General:** The Lemhi fault is a 135-km-long, southwest-facing, normal fault along the southwestern base of the Lemhi Range. Several workers have defined differing numbers of segments; thus, the extent to which large ruptures of various ages have crossed or stopped at the various proposed segment boundaries remains undetermined. Accordingly, the Lemhi fault was divided into six sections based on mapping, morphological data, dating, and trenching of scarps and the surfaces they offset. The four southern sections are better studied than the two northern sections. All but the two end sections are known to have had Holocene or postglacial surface ruptures. The few determinations of individual recurrence intervals of large surface ruptures vary

	from approximately 6 to 20 k.y. The central part of the fault appears to have had higher slip rates than the end parts. **Sections:** This fault has 6 sections. Numerous investigators have attempted to define segments of Lemhi fault based on a variety of methodologies. Baltzer (1990 #432) defines four segments along the northern 80 km of fault based on trenching studies and mapping of Quaternary deposits, Turko (1988 #4642) and Turko and Knuepfer (1991 #227) define a minimum of six to nine segments based on analysis of scarp-morphology data, Haller (1988 #27) and Crone and Haller (1991 #186) define six segments based on scarp-morphology studies, and Stickney and Bartholomew (1987 #85) provide descriptions of scarps at six localities. The segmentation model of Baltzer (1990 #432) is used in this compilation for the northern part of fault because of its recency and level of detail of the investigation. The middle section boundary of the Lemhi fault, that between sections 602c (Big Gulch) and 602d (Warm Creek), was located in essentially the same place by Haller (1988 #27), Turko (1988 #4642), and Baltzer (1990 #432). South of that section boundary, the three section names of Turko and Knuepfer (1991 #227) and Baltzer (1990 #432) are used. However, for the southern boundaries of these three sections (602d, 602e, and 602f), the locations of Haller (1988 #27) are used, because they are described in the greatest geographic detail and are, therefore, the easiest to identify on topographic maps and in the field for future study and testing. These locations, which Haller (1988 #27) showed on a 1:250,000-scale topographic base, are consistent with those of Turko and Knuepfer (1991 #227) within the spacing of their data points along the Lemhi fault.
Name comments	**General:** Both Anderson (1934 #595) and Baldwin (1951 #427) recognized Basin and Range style of faulting in this area, as well as large amounts of throw across this and nearby faults and the recency of their movement. Baldwin (1951 #427) is probably one of the earliest to use the name Lemhi fault for this structure. The fault extends entire length of Lemhi Range, although study area of Baldwin did not encompass entire fault. **Section:** The name "Howe segment" is used by Turko and Knuepfer (1991 #227). Haller (1988 #27) gives precise locations of the northern and southern section boundaries, respectively, as approximately midway between North and South Creeks, and at a southwest-facing embayment in the 5,000 ft topographic contour line at the southern tip of the Lemhi Range (Idaho Falls

	1:250,000-scale topographic map). The more generalized locations of other reports (Turko, 1988 #4642; Crone and Haller, 1991 #186; Turko and Knuepfer, 1991 #227) are consistent with those of Haller. The Howe section contains the 9-km-long Howe scarp of Stickney and Bartholomew (1987 #85) and corresponds to the southern segment of the Montana Bureau of Mines and Geology digital database (Stickney, written commun., 1992). **Fault ID:** Refers to number 115 ("unnamed series of faults along southwest flank Lemhi Range") in Witkind (1975 #320).
County(s) and State(s)	BUTTE COUNTY, IDAHO
Physiographic province(s)	NORTHERN ROCKY MOUNTAINS
Reliability of location	Good Compiled at 1:24,000 scale. *Comments:* Location of the scarps is based on 1:250,000-scale maps of Haller (1988 #27; original mapping at 1:24,000 or 1:62,500), further constrained by satellite imagery and topography at scale of 1:24,000. Reference satellite imagery is ESRI_Imagery_World_2D with a minimum viewing distance of 1 km (1,000 m).
Geologic setting	This part of east-central Idaho and southwest Montana is made of Precambrian and Paleozoic rocks that were shortened by folding and faulting and were thrust northeastward during the late Mesozoic. Mid- to late Cenozoic extension broke the thrust complex into northwest-trending basins and ranges and continues today. The Lemhi fault is a high-angle, down-to-the southwest, range-front normal fault that separates the Lemhi Range to the northeast from the Pahsimeroi and Little Lost River valleys to the southwest.
Length (km)	This section is 17 km of a total fault length of 136 km.
Average strike	N54°W (for section) versus N51W (for whole fault)
Sense of movement	Normal
Dip Direction	SW
Paleoseismology	Malde (1971 #6537; 1985 #37; 1987 #38) and Hemphill-Haley

studies	and others (1992 #623; 2000 #4673) reported results from three trenches at three sites on the Howe section. Trench 602-1: a trench opened in 1969 on the north-central part of the Howe section approximately 140 m east of the creek in Black Canyon, shows evidence of at least five surface ruptures that produced a total of more than 15 m of vertical displacement. The last surface rupture produced more than 3 m of vertical displacement before 15 ka. The 24-m-high scarp is no older than 600 ka (Malde, 1987 #38). Trench 602-9: the Black Canyon trench is on the north-central part of the Howe section, 120 m west of the creek in Black Canyon (Hemphill-Haley and others, 1992 #623). The trench crossed a 4.5-m-high scarp on earliest Pinedale alluvial deposits (30-40 ka) and exposed three colluvial wedges that are buried by reworked loess. Cumulative vertical displacement of a soil horizon offset by all three surface ruptures is 5.25 m, which is consistent with the sum of minimum vertical displacements that were measured as the largest thicknesses of the three colluvial wedges: 2-3 m (antepenultimate event), 2 m (penultimate event), and 1.5 m (most recent event), for a total of 5.5-6.5 m. Trench 602-10: the East Creek trench is on the south-central part of the Howe section, 0.8 km east of East Creek (Hemphill-Haley and others, 1992 #623). The trench was excavated in early to middle Pinedale-age gravels (20-30 ka), crossed a 3-m-high scarp and extended partway across a graben. The trench exposed three colluvial wedges. Cumulative vertical displacement of a gravel offset by all three surface ruptures is 4.5 m, consistent with the sum of minimum vertical displacements that were measured as the largest thicknesses of the three colluvial wedges: 2.0 m (antepenultimate event), 2.6 m (penultimate event), and 1.3 m (most recent event), for a total of 5.9 m.
Geomorphic expression	Scarps on older alluvium are high but generally discontinuous because of burial by younger fans and because of incision and erosion by streams (Haller, 1988 #27).
Age of faulted surficial deposits	Late Pinedale and younger (Turko and Knuepfer, 1991 #227). Hemphill-Haley and others (1992 #623) summarized previous work indicating that faults cut late Pleistocene alluvial gravels correlated with the Bull Lake glaciation (140-150 ka), latest Pleistocene alluvial-fan gravels deposited during the Pinedale

	glaciation (10-35 ka), and late Pleistocene loess also deposited during the Pinedale glaciation (10-35 ka); sparse Holocene deposits are generally unfaulted. The East Creek trench (trench 602-10) is in early to middle Pinedale gravel (20-30 ka), and the Black Canyon trench (trench 602-9) is in early Pinedale gravel (30-40 ka) (Hemphill-Haley and others, 1992 #623).
Historic earthquake	
Most recent prehistoric deformation	late Quaternary (<130 ka) *Comments:* Based on trenching studies, the most recent event is thought to have occurred between 18 and 15 ka (Hemphill-Haley and others, 1992 #623). Earlier reconnaissance studies suggested the most recent event occurred between 15 and 30 ka (Haller, 1988 #27). The earliest work suggested faulting occurred before 15 ka (Malde, 1987 #38).
Recurrence interval	*Comments:* Hemphill-Haley and others (1992 #623; 2000 #4673) concluded that three surface ruptures had occurred within approximately 7 k.y., followed by 24-17 k.y. of quiescence, at the site of trench 602-9. At trench 602-10, the age control was poor but the results were consistent with surface ruptures that formed during the occurrence of two of the three clustered earthquakes from trench 602-9.
Slip-rate category	Less than 0.2 mm/yr *Comments:* There are no published slip rates for this part of the fault. However, the 24-m-high scarp at site 602-1 (Malde, 1987 #38) is on deposits that are thought to be more than 100 k.y. old (Gorton, 1995 #4643); the resulting slip-rate estimates would fall within the assigned slip-rate category. In addition, nearby scarps on middle Pinedale surfaces (25-30 ka) are generally 2- to 5-m high. Gorton (1995 #4643) used thicknesses of carbonate rinds, aided by the relative surface elevations and morphologies of fan surfaces combined with thermoluminescence dates, to map and estimate ages of seven groups of fan surfaces along sections 602d-f of the Lemhi fault. Payne and others (2008 #7017) report high rates of right-lateral shear resulting from high strain rates in the undeforming Snake River Plain to low strain rates north of the central part of the Lost River and Lemhi Ranges and the

	Beaverhead Mountains based on campaign GPS surveys; furthermore they characterize the rate of differential slip within the Centennial shear zone as increasing from 0.9±0.3 mm/yr near the Lost River fault [601] to 1.7±0.2 mm/yr near the Beaverhead fault [603]. The rate of slip may continue to increase northeastward to the Centennial fault [643]. However, Puskas and Smith (2009 #7018) argue against the high velocities; they conclude the differential motion across this boundary is less than 0.5 mm/yr.
Date and Compiler(s)	2010 Russell L. Wheeler, U.S. Geological Survey, Emeritus
References	#595 Anderson, A.L., 1934, A preliminary report on recent block faulting in Idaho: Northwest Science, v. 8, p. 17-28. #427 Baldwin, E.M., 1951, Faulting in the Lost River Range area of Idaho: American Journal of Science, v. 249, p. 884-902. #432 Baltzer, E.M., 1990, Quaternary surface displacement and segmentation of the northern Lemhi fault, Idaho: Binghamton, State University of New York, unpublished M.S. thesis, 88 p., 2 pl., scale 1:62,500. #186 Crone, A.J., and Haller, K.M., 1991, Segmentation and the coseismic behavior of Basin and Range normal faults—Examples from east-central Idaho and southwestern Montana, *in* Hancock, P.L., Yeats, R.S., and Sanderson, D.J., eds., Characteristics of active faults: Journal of Structural Geology, v. 13, p. 151-164. #4643 Gorton, A.E., 1995, Late Quaternary surface displacements and segmentation along the southern Lemhi fault, east-central Idaho: Binghamton, State University of New York, M.A. thesis, 103 p. #27 Haller, K.M., 1988, Segmentation of the Lemhi and Beaverhead faults, east-central Idaho, and Red Rock fault, southwest Montana, during the late Quaternary: Boulder, University of Colorado, unpublished M.S. thesis, 141 p., 10 pls. #623 Hemphill-Haley, M.A., Knuepfer, P.L.K., Forman, S.L., and Smith, R.P., 1992, Paleoseismic investigations of the southern Lemhi fault, Idaho: Technical report to U.S. Department of Energy, under Contract DE-AC07-761D01570, March 1992, 32 p.

#4673 Hemphill-Haley, M.A., Sawyer, T.L., Kneupfer, P.L.K., Forman, S.L., and Wong, I.G., 2000, Timing of faulting events from thermoluminescence dating of scarp-related deposits, Lemhi fault, southeastern Idaho, *in* Stratton-Noller, J., Sowers, J.M., and Lettis, W.R., eds., Quaternary geochronology—Methods and applications: Washington D.C., American Geophysical Union Reference Shelf 4, p. 541-548.

#6537 Malde, H.E., 1971, Geologic investigation of faulting near the National Reactor Testing Station, Idaho: U.S. Geological Survey Open-File Report, 167 p., 2 pls.

#37 Malde, H.E., 1985, Quaternary faulting near Arco and Howe, Idaho, *in* Stein, R.S., and Bucknam, R.C., eds., Proceedings of workshop XXVIII on the Borah Peak, Idaho, earthquake: U.S. Geological Survey Open-File Report 85-290, v. A, p. 207-235.

#38 Malde, H.E., 1987, Quaternary faulting near Arco and Howe, Idaho: Bulletin of the Seismological Society of America, v. 77, p. 847-867.

#7017 Payne, S.J., McCaffrey, R., and King, R.W., 2008, Strain rates and contemporary deformation in the Snake River Plain and surrounding Basin and Range from GPS and seismicity: Geology, v. 36, no. 8, p. 647-650.

#7018 Puskas, C.M., and Smith, R.B., 2009, Intraplate deformation and microplate tectonics of the Yellowstone hot spot and surrounding western US interior: Journal of Geophysical Research-Solid Earth, v. 114, B04410, doi:10.1029/2008JB005940.

#85 Stickney, M.C., and Bartholomew, M.J., 1987, Seismicity and late Quaternary faulting of the northern Basin and Range province, Montana and Idaho: Bulletin of the Seismological Society of America, v. 77, p. 1602-1625.

#4642 Turko, J.M., 1988, Quaternary segmentation history of the Lemhi Fault, Idaho: Binghamton, State University of New York, M.A. thesis, 91 p.

#227 Turko, J.M., and Knuepfer, P.L.K., 1991, Late Quaternary fault segmentation from analysis of scarp morphology: Geology, v. 19, p. 718-721.

	#320 Witkind, I.J., 1975, Preliminary map showing known and suspected active faults in Idaho: U.S. Geological Survey Open-File Report 75-278, 71 p. pamphlet, 1 sheet, scale 1:500,000.