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Lemhi fault, Fallert Springs section (Class A) No. 602e

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Compiled in cooperation with the Idaho Geological Survey

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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:** he name "Fallert Springs segment" is used by Turko and Knuepfer (1991 #227). Haller (1988 #27) gives precise locations of the northern and southern section boundaries, respectively approximately midway between Williams and Horse Creeks and

	North and South Creeks. The more generalized locations of other reports are consistent with those of Haller (Turko, 1988 #4642; Crone and Haller, 1991 #186; Turko and Knuepfer, 1991 #227). The Fallert Springs section contains the 12-km-long Boulder Creek scarp of Stickney and Bartholomew (1987 #85) and corresponds to the #2 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:* Locations 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	(for section) versus N51W (for whole fault)
Sense of movement	Normal
Dip Direction	SW
Paleoseismology	Hemphill-Haley and others (1992 #623) reported on three

studies	trenches at two sites on the Fallert Springs section. The two Coyote Springs trenches (site 602-7) are in the central part of the section, 0.6 km south of Coyote Springs in possible early Pinedale-age alluvial gravels (20-30 ka). The longer trench crosses a 9-m-high scarp that faces west, at the east edge of a graben. The shorter trench crosses a smaller, antithetic scarp at the west edge of the graben. Trenching revealed structural and stratigraphic evidence of three surface ruptures on the main fault. The antithetic fault ruptured during the penultimate earthquake but not the most recent one. Alluvial gravels are offset across the main fault zone and reveal a cumulative vertical displacement of 5.5-6 m for the three events. The maximum thicknesses of the three corresponding colluvial wedges are 1.2 m (antepenultimate event), 1.8 m (penultimate event), and 1.5 m (most recent event), for a total minimum displacement of 4.5 m, which is consistent with the offset of the gravels. The Camp Creek trench (site 602-8) is near the south end of the Fallert Springs section, 1.6 km south of Camp Creek in probable early Pinedale-age alluvial deposits (20-30 ka). The trench crosses the younger of two scarps; the older, untrenched scarp is approximately 30 m farther uphill. Trenching showed evidence of two surface ruptures, with a possible third, older rupture on the uphill scarp being inferred from distal colluvium exposed in the trench. The latest two earthquakes produced a minimum cumulative vertical displacement of 3.5-4.5 m, presumably inferred from offset strata. The maximum thicknesses of the two corresponding colluvial wedges are 2.5-3.75 m (penultimate event) and 2.5 m (most recent event), for a total minimum displacement of 5.0-6.25 m.
Geomorphic expression	Faulting is expressed as discontinuous scarps that are slightly better preserved than on the Howe section to the south, particularly in the southern part of the Fallert Springs section where a large graben contains several fault strands (Haller, 1988 #27). One Holocene alluvial surface is offset on a scarp 1- to 2-m high (Hemphill-Haley and others, 2000 #4673).
Age of faulted surficial deposits	Holocene and upper and middle Pleistocene alluvial-fan deposits and colluvium, and Pleistocene fan alluvium (Scott, 1982 #278). Hemphill-Haley and others (1992 #623) summarized previous work indicating that faults cut late Pleistocene alluvial gravels that are correlated with the Bull Lake glaciation (140-150 ka), latest Pleistocene alluvial-fan gravels that were deposited during the Pinedale glaciation (10-35 ka), and late Pleistocene loess that

	was also deposited during the Pinedale glaciation (10-35 ka); sparse Holocene deposits are generally unfaulted. However, Hemphill-Haley and others (2000 #4673) noted that at least one Holocene surface has a 1- to 2-m-high scarp. The Camp Creek trench (site 602-8) is in probable early Pinedale deposits (20-30 ka), and the Coyote Springs trenches (trenches 602-7) are in possible early Pinedale alluvial gravels (20-30 ka) (Hemphill-Haley and others, 1992 #623).
Historic earthquake	
Most recent prehistoric deformation	latest Quaternary (<15 ka) *Comments:* The fault displaces late Pleistocene (15-30 ka) deposits, and movement on this section may be slightly younger than on the Howe section to the south, as indicated by slightly more extensive scarp preservation and similar or slightly steeper maximum slope angles as measured in scarp profiles (Haller, 1988 #27; Crone and Haller, 1991 #186). However, Hemphill-Haley and others (2000 #4673) reported evidence of a Holocene (4 ka or slightly older) surface rupture at site 602-7 (Coyote Springs), and noted a 1- to 2-m-high scarp on a nearby Holocene surface.
Recurrence interval	6-20 k.y. (<20-30 ka) *Comments:* Stratigraphy at sites 602-7 (Coyote Springs) and 602-8 (Camp Creek) suggest three paleoearthquakes (Hemphill-Haley and others, 1992 #623; 2000 #4673) that constrain recurrence intervals of 6-20 k.y. At the first locality, 6 k.y. or less separated the antepenultimate and penultimate earthquakes, which were followed by 20-14 k.y. before the most recent event at 4 ka or slightly earlier. At the second locality, the first two ruptures occurred approximately 6 k.y. apart, but there was no Holocene rupture. Thus, recurrence intervals were 6 k.y. and 14-20 k.y.
Slip-rate category	Between 0.2 and 1.0 mm/yr *Comments:* Slip-rate category is assigned on the basis of the trench descriptions of Hemphill-Haley and others (1992 #623). At the Camp Creek site (602-8), the most recent surface rupture produced 1.5 m of minimum vertical displacement after strain had accumulated from the penultimate earthquake at 24.5 ?3.0 ka to the most recent event at 19.0 ?3.0 ka. At the Coyote Springs site (602-7), three stacked colluvial wedges overlie a soil dated at 16.0

	?2.5 ka, 17.5 ?2.0 ka, and 20.0 ?4.0 ka. The cumulative vertical displacement from all three events is 5.5-6 m from offset colluvial gravels. Collectively, mean maximum and minimum values calculated from these data fall within the assigned slip-rate category. 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 the results of campaign GPS surveys, and they furthermore 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
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