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Lost River fault, Pass Creek section (Class A) No. 601e

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Compiled in cooperation with the Idaho Geological Survey

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Synopsis	**General:** The Lost River fault is a 130-km-long, southwest-facing, normal fault along the southwestern base of the Lost River Range. Most investigators agree that the main fault has six segments, but the extent to which large ruptures of various ages have crossed or stopped at the various segment boundaries remains unresolved. Accordingly, the Lost River fault was divided into sections based on mapping, morphological study, dating, and trenching of scarps and the surfaces they offset—the six sections (a–f) correspond to the segments that make up the main fault. The seventh section consists of a complex of

	discontinuous scarps [601g] that link the main Lost River fault to the smaller, antithetic Lone Pine normal fault [604] to the west. Work during the years following the 1983 Borah Peak earthquake concentrated on the northern sections where surface ruptures formed during the earthquake, whereas work during the late 1960s and 1970s, followed by additional studies during the 1990s concentrated on the southern sections. All but the northernmost and the two southernmost sections show evidence of latest Quaternary surface ruptures. The few determinations of individual recurrence intervals of large surface ruptures vary from 1 to nearly 100 k.y. Slip rates determined at specific points along the fault vary between less than 0.1 mm/yr to approximately 0.2 mm/yr, and the southern sections appear to have had slower late Quaternary rates than the middle sections. Paleoseismic data suggest that the three central parts of the fault possibly ruptured within a few thousands of years of each other during the early Holocene. **Sections:** This fault has 7 sections. Scott and others (1985 #76) defined segmentation of Lost River fault and is the source of section names except northernmost segment [601a], which was renamed by Crone and others (1985 #18; 1987 #19) to be consistent with other segment names. Scarps formed during Borah Peak earthquake across Willow Creek hills [601g] are included as part of this fault. The on-trend, discontinuous scarps south of range (as mapped by Kuntz and others, 1984 #293) are described separately as part of the Idaho Rift systems fault [3501].
Name comments	**General:** Anderson (1934 #595) first reported that the southwest side of the Lost River Range was bounded by a fault. However, Baldwin (1951 #427) later recognized Basin and Range style faulting in this area, as well as recent movement and large amounts of throw across this and nearby faults. Baldwin's 1951 article is probably one of earliest to use the name Lost River fault for this structure, which extends along the entire length of the southwest flank of Lost River Range from near Arco, Idaho, on the south to near Challis, Idaho, on the north **Section:** Defined and named by Scott and others (1985 #76) as extending from near Lower Cedar Creek to approximately 3-km north of King Canyon. Both boundaries have been the subject of further investigation, and Janecke (1993 #6550) suggested that the location of the northern boundary should coincide with a prominent bedrock salient and structural complexity in the

	footwall at Swauger Gulch. The southern boudary is thought to be at Ramshorn Creek (Crone and others, 1987 #19; Janecke, 1993 #6550; Olig and others, 1995 #1278); although it is clear from the morphology of the range that King Mountain (which lies south of Ramshorn Creek) is significantly higher than the Arco Hills to the south. This section spans a large embayment in the range front that Janecke suggests is not a barrier to rupture propagation.
County(s) and State(s)	BUTTE COUNTY, IDAHO CUSTER COUNTY, IDAHO
Physiographic province(s)	NORTHERN ROCKY MOUNTAINS
Reliability of location	Poor Compiled at 1:24,000 scale. *Comments:* Location of the fault is based on 1:24,000-scale maps of Crone (unpublished data), 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). Section has discontinuous scarps, inferred location of fault is at the bedrock-alluvial contact.
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 Lost River fault is a high-angle, down-to-the-southwest, range-front normal fault, with a minor sinistral component of slip. The fault bounds the southwest side of the Lost River Range and separates the range from Round Valley, Antelope Flat, Thousand Springs Valley, Barton Flat, and the Big Lost River. In its north-central portion, the Lost River fault is joined from the west by the much shorter, northeast-dipping Lone Pine fault [604]. The two normal faults bound an intervening graben. The much greater length and larger topographic relief of the Lost River fault indicate that it is probably the master fault, and that the Lone Pine fault probably terminates against it at depth. Hypocentral locations and focal mechanisms of earthquakes in 1983 and 1984 and their numerous aftershocks support this suggestion (Doser and Smith, 1985 #276; Jackson, 1994 #833). Densmore and others (2005 #7016) suggest that maximum throw across the Lost River fault is 4–6 km.

Length (km)	This section is 26 km of a total fault length of 127 km.
Average strike	N45°W (for section) versus N35°W (for whole fault)
Sense of movement	Normal *Comments:* (Scott and others, 1985 #76)
Dip Direction	SW
Paleoseismology studies	Trench 601-12, the Jaggles Canyon trench (Olig and others, 1995 #1278), is 0.8 km north of Jaggles Canyon. The main scarp is 25-m high and faces southwest; 30-45 m farther southwest, a zone of small, northeast-facing, normal faults form the other edge of an intervening backtilted graben. The graben-bounding faults offset a 140-220 ka alluvial-fan surface. Two overlapping trenches 1.8-4.8 m deep crossed the entire graben. Analyses of stacked, faulted colluvial wedges led Olig and others (1995 #1278) to conclude that seven to nine events offset the fan surface, with the earliest two expressed on the small normal faults that bound the graben on the southwest, and the later five to seven events occurring on the main fault. The last four or five events are younger than 21 ka based on thermoluminescence ages (three of these events occurred between 17?4 and 18?3 ka).
Geomorphic expression	Scarps on Quaternary deposits are generally discontinuous, not well preserved and have been significantly modified by erosion and burial (Olig and others, 1995 #1278); most scarps on alluvium are high (>20 m). The best-preserved scarps are between Maddock Canyon and Big Burnett Canyon. Range-front morphology is similar to that along adjacent sections, including a steep faceted front and high structural relief. Section spans a major embayment in the range front at Elbow Canyon. Displacements per event average 2.0-2.6 m (range <1 m to >4 m) (Olig and others, 1995 #1278).
Age of faulted surficial deposits	Most of the surficial deposits along the range front are thought to be younger than 15 ka (Scott and others, 1985 #76; Crone and Haller, 1991 #186). A buried alluvial fan surface that was exposed in the Jaggles Canyon trench is 140-220 ka (Olig and others, 1995 #1278).
Historic earthquake	
Most recent	late Quaternary (<130 ka)

prehistoric deformation	*Comments:* Early regional studies infer that most recent faulting event probably occurred 30-50 ka (Scott and others, 1985 #76) or prior to 15 ka (Crone and Haller, 1991 #186) due to the general absence of scarps on young alluvial deposits. However, Olig and others (1995 #1278) concluded that the Pass Creek section has had 4-5 surface ruptures since 21 ka, but were unable to further constrain the date of the most recent paleoevent. They were also unable to explain the apparent discrepancy between the high rate of occurrence of late or latest Quaternary faulting and the subdued geomorphic expression of the fault. The late Quaternary age category is assigned in this record because the timing of the youngest event is not known to be less than 15 ka.
Recurrence interval	3.6-5.3 k.y. (<21 ka) *Comments:* Recurrence intervals appear to be highly variable at the only trenching site on this part of the Lost River fault. Based on evidence found in the Jaggles Canyon trench, Olig and others (1995 #1278) concluded that the Pass Creek section ruptured 7 to 9 times, and that 6 to 8 of these events occurred since deposition of an older alluvial fan surface at 140-220 ka. However, recurrence intervals have been much shorter since approximately 21 ka than before 21 ka. Specifically, Olig and others (1995 #1278) concluded that the average recurrence interval since 21 ka has been 3.6-5.3 k.y., whereas it was 40-100 k.y. during 140-220 ka. Overall, the average recurrence interval since 140-220 ka has been 18-37 k.y. Dates of individual earthquakes could not be determined.
Slip-rate category	Less than 0.2 mm/yr *Comments:* Assigned slip-rate category is based on the preferred rates with the exception of Olig and others (1995 #1278) highest rate of 1.1 mm/yr. The preferred interpretation of the Jaggles Canyon trench site (601-12) demonstrates that both the amount of slip per event and the recurrence interval are highly variable (Olig and others, 1995 #1278). Olig and others (1995 #1278) report a number of vertical slip rates for various periods of time: 0.096 mm/yr for the past 180 k.y., 1.1 mm/yr for the period between 13 and 21 ka, and 0.04-0.06 mm/yr for the period between 21 and 140-220 ka. Total slip at Jaggles Canyon trench site (601-12) is estimated to be 13.1-18.2 m with the preferred value of 17.2 m, which yields the low long-term slip rate. 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 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 Kathleen M. Haller, U.S. Geological Survey Russell L. Wheeler, U.S. Geological Survey, Emeritus
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