Quaternary Fault and Fold Database of the United States

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Lost River fault, Thousand Springs section (Class A) No. 601c

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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). Extends from Willow Creek hills southeastward to Elkhorn Creek. The southern boundary of this section is at a rangefront salient; a complex set of northwest- and older northeast-striking faults is mapped in the bedrock of the footwall (Susong and others, 1990 #196).

County(s) and State(s)	CUSTER COUNTY, IDAHO
Physiographic province(s)	NORTHERN ROCKY MOUNTAINS
Reliability of location	Good Compiled at 1:24,000 scale. *Comments:* Location of scarps is based on 1:24,000-scale maps of Crone and others (1985 #18; 1987 #19), 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.
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 24 km of a total fault length of 127 km.
Average strike	N24°W (for section) versus N35°W (for whole fault)
Sense of movement	Normal *Comments:* Crone and others (1987 #19) report about 17 percent of slip component was sinistral at the surface, which agrees with

	small component of sinistral slip inferred from the fault-plane solution (Doser and Smith, 1985 #276).
Dip	45°±3° SW *Comments:* Dip of the fault is based on the mainshock focal mechanism of the 1983 Borah Peak earthquake (M 7.3), the three-dimensional distribution of aftershock hypocenters, and the downward projection of the surface ruptures of the Thousand Springs segment to the mainshock hypocenter. All lines of evidence suggest that the fault dips approximately 45?, from the surface to the mainshock at a depth of 16 km (Doser and Smith, 1985 #276).
Paleoseismology studies	Four trenches and an excavation that did not cross the fault, have been excavated along the Thousand Springs section. No datable material was recovered at any of these sites. Dating of prehistorical event comes from Vincent (1995 #902). One, and in some cases two, prehistorical events were recognized. Many of the prehistorical structures were reactivated in 1983 in terms of style and amount of displacement (Schwartz and Crone, 1985 #74; Crone, 1985 #275). These studies concentrated on the West Spring, Doublespring Pass road, and Rock Creek areas. West Spring. Trench 601-6 about 0.8 km northwest of West Spring was excavated by Cochran (1985 #274) about1984. Doublespring Pass road. The earliest trench (601-2) on this section was excavated by Hait in 1976 and predates the 1983 Borah Peak earthquake. This site (601-7) was re-excavated by Schwartz and Crone in 1984 following the earthquake. Both the 1976 and 1984 trenches, which are documented in Crone (1985 #275), were about 65 m northwest of Doublespring Pass road, which is near middle of the section. Another trench (601-8) excavated in 1984 by Schwartz and Crone (Schwartz and Crone, 1985 #74; Crone, 1985 #275) is 0.5 km southeast of Doublespring Pass road. Although it was not logged, stratigraphic relations suggest two prehistorical events (Crone, oral commun., 1993). Rock Creek. Excavation 601-9, about 250 m northwest of Rock Creek access road, by Cochran about 1984 did not cross the fault but contained Mazama ash (about 6.7 ka), which provides a maximum limiting age because of its position in colluvial section (Cochran, 1985 #274). Three faulting events are inferred since 40

	ka (including 1983), but results are preliminary and 40-ka limiting age is not substantiated by numerical dating methods. Elkhorn Creek. Vincent (1995 #902) mapped the area where the range-front strand of the 1983 surface rupture follows an older surface rupture across Elkhorn Creek. Both surface ruptures offset a 1-m-thick sandy gravel that is underlain by a dark, charcoal-bearing A horizon. The charcoal was dated at 11.0 ka (11,950-10,279 cal yr BP, 2 sigma).
Geomorphic expression	Continuous historic fault scarps having discontinuous but prominent free face are present along the southwest front of Lost River Range. Locally, faulting is expressed in numerous subparallel scarps across zones up to 140 m wide. Vincent (1995 #902) mapped small scarps that extend approximately 5 km farther southeast than Elkhorn Creek, on mountain slopes as much as 700 m above the mapped range-front surface rupture at and near Elkhorn Creek. Vincent argued that some of the small, high-elevation scarps are surficial ground failures, but that most are tectonic surface ruptures. The average throw across the fault during the 1983 Borah Peak earthquake was 0.8 m but the maximum was 2.7 m, which occurred near the middle of the Thousand Springs section.
Age of faulted surficial deposits	Holocene and older alluvium, locally bedrock.
Historic earthquake	Borah Peak earthquake 1983
Most recent prehistoric deformation	latest Quaternary (<15 ka) *Comments:* Although timing of most recent prehistorical event is not well constrained, most topical studies concur that pre-1983 faulting occurred during the middle to early Holocene. Trenching studies document evidence of only one prehistorical surface-faulting event in deposits considered about 12-15 ka, on basis of degree of soil development and position in the landscape. The pre-1983 event is probably Holocene in age because faulted alluvial surface was stable for several thousands of years prior to the prehistoric event (Scott and others, 1985 #76). Morphology of pre-1983 scarps also point to same conclusion (R.C. Bucknam, pers. commun cited in Scott and others (1985 #76)), Hanks and Schwartz (1987 #193), Salyards (1985 #273), and Vincent (1985

	#90). Scarps at the northern end of section that were not offset historically, the "1983 Gap" in Crone and others (1985 #18; 1987 #19), are older than Holocene, but are probably younger than late Quaternary (<130 ka). At the southern end of the 1983 surface rupture, Vincent (1995 #902) mapped an area where the range-front strand of the 1983 surface rupture follows an older surface rupture across Elkhorn Creek. Both surface ruptures offset a 1-m-thick sandy gravel that is underlain by a dark, charcoal-bearing A horizon. The charcoal was dated at 11.0 ka (11,950-10,279 cal yr BP, 2 sigma). Vincent (1995 #902) argued that the pre-1983 surface ruptures that he dated at the Elkhorn Creek and Dickey Peak sites represented the same earthquake. If that is correct, then the earthquake occurred after about 11.0 ka (12.0-10.3 ka) and before about 10.0 ka (10.2-9.9 ka). Thus, multiple lines of evidence indicate that the most recent prehistoric rupture occurred sometime since 15 ka.
Recurrence interval	6-15 k.y. (<15 ka) *Comments:* Most investigators agree that the recurrence interval between the past two events was probably about 6-8 k.y.; however, it could be as long as 10.5 ka as suggested by Vincent (1995 #902). Although poorly constrained, the timing of prehistorical event is certainly younger than 15 ka. Thus, the most recent interval is less than 15 k.y.
Slip-rate category	Between 0.2 and 1.0 mm/yr *Comments:* 0.18-0.3 mm/yr. Hanks and Schwartz (1987 #193) indicate that slip rate may be 0.18-0.25 mm/yr based on displacements of 1.5-2.0 m occurring every 8 k.y. Scott and others (1985 #76) calculate a slip rate of 0.3 mm/yr based on 3.5-4.5 m total offset during the past 15 k.y., which includes 1.5-2.0 m in 1983. The later published slip rate is regarded as too high because the full interval prior to the earliest event is not included. Trenching on the Thousand Springs section showed that 2.1 m of vertical offset in 1983 released strain that had been accumulating since 10-11 ka (Vincent, 1995 #902) or 8 ka as Scott and others (1985 #76) suggest. The calculated result based on these data falls within the bounds of the assigned slip-rate category; the errors on this rate, however, are probably large and all possible slip rates span the defined lower limit of the assigned slip-rate category.
Date and Compiler(s)	2010 Kathleen M. Haller, U.S. Geological Survey

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