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Centennial fault, Red Rock Lakes section (Class A) No. 643b

Last Review Date: 2010-12-09

Compiled in cooperation with the Montana Bureau of Mines and Geology

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Synopsis	**General:** Until recently, most published discussions on this fault were based on the data of Witkind (1975 #296). Petrik (2008 #7031) completed a comprehensive fault reconnaissance study, which included relocating the fault using field GPS measurements, geologic mapping, and analysis of fault scarps. This recent work identifies scarps on Holocene and upper Pleistocene deposits preserved along most of the Centennial fault. Revised age categories are based on the most recent work. Earlier published data often cited conflicting evidence regarding the recency and rate of activity of this fault.

	Sections: This fault has 4 sections. Three segments of the Centennial fault are shown in the original mapping of Witkind (1975 #296), and other authors (Johns and others, 1982 #259; Stickney and Bartholomew, 1987 #85; Ostenaa and Wood, 1990 #318) have retained the nomenclature. However, it is unclear if the original intent was to identify independent seismogenic segments. Thus, sections of the fault that have similar characteristics are discussed here. Section boundaries are located where scarps on distinctly different age deposits are present or where the fault trace takes echelon steps. The Centennial Valley segment of Witkind (1975 #296) is divided into 2 sections in this compilation, and Witkins's Red Rock Pass and Henrys Lake segments are discussed as 2 additional sections.
Name comments	**General:** The source of the name is probably Pardee (1950 #46), who describes the fault as extending from near Monida, Montana, eastward to Henrys Lake basin. The fault, as shown here, extends from about 2 km southwest of Mud Lake eastward to 2 km east of the southeastern shore of Henrys Lake. The extent of fault has been shown in various forms in previous compilations. **Section:** Shown as the Red Rock Lakes segment of Stickney and Bartholomew (1987 #242; written commun. 1992 #556). Section includes approximately the eastern one-half of Centennial Valley segment of Witkind (1975 #296) and number 1 (Centennial Valley segment) of Johns and others (1982 #259). It extends from near 7 L Ranch (0.6 km east of Curry Creek) eastward to Tom Creek. **Fault ID:** Refers to fault number 4 (Centennial fault) of Witkind (1975 #317); fault numbers 1 (Centennial fault-Centennial Valley segment) and 35 (Centennial fault-Red Rock Pass-Henrys Lake segment) of Johns and others (1982 #259); fault number 9 (Centennial fault) of Stickney and Bartholomew (1987 #85); and Centennial fault of Stickney and Bartholomew (1987 #242; written commun. 1992 #556).
County(s) and State(s)	BEAVERHEAD COUNTY, MONTANA
Physiographic province(s)	NORTHERN ROCKY MOUNTAINS
Reliability of location	Good Compiled at 1:24,000 scale.

	Comments: Location is based on Petrik (2008 #7031) 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. Petrik (2008 #7031) shows numerous faults that extend into bedrock; this compilation only shows the major range-bounding fault.
Geologic setting	High-angle, down-to-the-north, range-front normal fault bounds the north side of Centennial Mountains. The eastern and western parts of the Centennial fault are expressed by nearly continuous scarps on bedrock and Quaternary deposits; whereas the central part of the fault is composed of left-stepping echelon faults. Ross and Nelson (1964 #249) speculate that this fault continues to the east-trending intrabasin scarps formed during the Hebgen Lake earthquake south of Hebgen Lake [659] through Targhee Pass, which they contend is a modified structural depression; however, Fraser and others (1964 #628) argue to the contrary, citing the diminishing amount of displacement from west to east that appears to die out near Henrys Lake, an interpretation supported by Petrik (2008 #7031). Available gravity data suggest that the Centennial fault terminates in the Madison Valley (Schofield, 1981 #314). Sonderegger and others (1982 #297) report a minimum offset of 1.5-1.8 km of the 2-Ma Huckleberry Ridge Tuff and possibly 3 km of vertical displacement in the past 10 m.y.
Length (km)	This section is 20 km of a total fault length of 62 km.
Average strike	N81°W (for section) versus N78°W (for whole fault)
Sense of movement	Normal *Comments:* (Witkind, 1975 #296; Petrik, 2008 #7031)
Dip Direction	N
Paleoseismology studies	
Geomorphic expression	Most of the fault is buried along this section, but scarps as high as 10 m with 35? maximum slope angles are locally reported (Witkind, 1975 #296; Petrik, 2008 #7031).
Age of faulted	Lower Holocene (?) alluvial-fan deposits (Witkind, 1975 #296) at

surficial deposits	eastern end of section, but no other Quaternary deposits are shown as faulted.
Historic earthquake	
Most recent prehistoric deformation	latest Quaternary (<15 ka) *Comments:* Early publications define the age of the most recent movement as either Holocene (Johns and others, 1982 #259; Pierce and Morgan, 1990 #222; 1992 #539) or late Quaternary (Stickney and Bartholomew, 1987 #85; 1987 #242; written commun. 1992 #556). Holocene (?) alluvium is shown as faulted; however, nearby upper Pleistocene (Pinedale) till is unfaulted and scarps are poorly preserved along this part of the fault (Witkind, 1975 #296). Myers and Hamilton (1964 #250) state that shorelines near Upper Red Rock Lake, thought to be altithermal in age (B.C. 1800), but certainly late Pleistocene (post-Pinedale) deposits are faulted and warped by at least 18 m. Assigned age category is based on Petrik (2008 #7031).
Recurrence interval	>65?45 k.y. *Comments:* Mason (1992 #463) suggests this recurrence interval for unspecified period of time based on data from Stickney and Bartholomew (1987 #85).
Slip-rate category	Between 0.2 and 1.0 mm/yr *Comments:* Slip rate category assignmentis based on six scarp profiles, Petrik (2008 #7031) estimates that the average slip rates for the western part of the Centennial fault is 0.76 mm/yr if young offset deposits are assumed to be 12 ka or 0.65 mm/yr if young offset deposits are assumed to be 14 ka. Pierce and Morgan (1992 #539) report a maximum slip rate of 1.3 mm/yr (<15 ka) for the eastern and central parts of the fault, which is based on as much as 20 m of offset of 15 ka deposits from data of Witkind (1975 #296). A slip rate of greater than 0.75 mm/yr in the past 2 Ma (Pierce and Morgan, 1992 #539) is based on 1.5-1.8 km minimum offset of Huckleberry Ridge Tuff. Sonderegger and others (1982 #297) indicate that an average displacement rate of 0.3 mm/yr is reasonable for this part of the fault. Reilinger and others (1977 #479) show a vertical crustal velocity of approximately 1 mm/yr in this area based on leveling data from 1934 and 1964 surveys.
Date and	2010

Compiler(s)	Kathleen M. Haller, U.S. Geological Survey
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#242 Stickney, M.C., and Bartholomew, M.J., 1987, Preliminary map of late Quaternary faults in western Montana: Montana Bureau of Mines and Geology Open-File Report 186, 1 pl., scale 1:500,000.

#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.

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