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Cottonwood Mountain fault (Class A) No. 806

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Synopsis	The Cottonwood Mountain fault is a northwest-trending, down-to-the-northeast normal fault located along the gently sloping eastern margin of Cottonwood Mountain. The fault offsets Miocene and Pliocene ash-flow tuffs and tuffaceous lacustrine rocks. The fault trace is marked by prominent fault scarps that offset alluvial fans east of Cottonwood Mountain. Small scarps (0.5–1 m high) on Holocene deposits and larger scarps (2–13 m high) on mid to late Pleistocene deposits indicate recurrent late Quaternary movement. The most recent surface faulting event on the Cottonwood Mountain fault may have occurred in the late Holocene.
Name comments	Parts of the Cottonwood Mountain fault were mapped by Brooks and others (1976 #3573) and Brown and others (1980 #3571); previously used names include the Bully fault or Bully Creek fault (Brown and others, 1980 #3571; Hawkins and others, 1989

	#3551) and the Hope Butte fault (Geomatrix Consultants Inc., 1989 #1310), but herein we retain the name "Cottonwood Mountain fault" used by Simpson and others (1993 #3596) after nearby Cottonwood Mountain. The fault has been the subject of numerous reconnaissance Quaternary fault investigations and compilations (Geomatrix Consultants Inc., 1989 #1310; Hawkins and others, 1989 #3551; Pezzopane and Weldon, 1993 #149; Pezzopane, 1993 #3544; Simpson and others, 1993 #3596; Knudsen and others, 1994 #3594; Madin and Mabey, 1996 #3575; Wood, 1999 #4042; Weldon and others, 2002 #5648). **Fault ID:** This structure is part of fault number 17 of Pezzopane (1993 #3544) and fault number 64 of Geomatrix Consultants, Inc. (1995 #3593).
County(s) and State(s)	MALHEUR COUNTY, OREGON
Physiographic province(s)	COLUMBIA PLATEAU
Reliability of location	Good Compiled at 1:100,000 scale. *Comments:* The fault trace is from 1:100,000-scale mapping of Knudson and others (1994 #3594) and Weldon and others (2002 #5648).
Geologic setting	The Cottonwood Mountain fault lies along the east flank of Cottonwood Mountain, a broad highland consisting of Miocene to Pliocene volcanic and sedimentary rocks that unconformably overlie an allocthonous Devonian to Jurassic island arc basement terrane consisting of volcanic and sedimentary rocks (Brooks and others, 1976 #3573; Walker and MacLeod, 1991 #3646). Numerous northwest-trending normal faults in the vicinity of the Cottonwood Mountain fault have been included in the Vale zone; these structures have been attributed to deep seated dextral shear between east-west extension in the Basin and Range province to the south and more stable terranes to the north and west (Lawrence, 1976 #3506), driven by interactions of the Juan de Fuca and North American plates (Robyn and Hoover, 1982 #3781; Pezzopane and Weldon, 1993 #149; Mann and Meyer, 1993 #3535). A more recent interpretation is that these faults are simply northwest-trending normal faults that do not represent regional shearing (Knudsen, 1994 #3527; Knudsen and others,

	1994 #3594, 1996 #3529).
Length (km)	42 km.
Average strike	N33°W
Sense of movement	Normal, Left lateral *Comments:* Knudsen and others (1994 #3594) suggest that some differences in scarp preservation were suggestive of a left-lateral component of slip, but examination of an exposure of the Cottonwood Mountain fault at Morrison Reservoir led Knudsen (1994 #3527) and Knudsen and others (1994 #3594) to conclude that the primary sense of slip on the fault has been normal dip-slip displacement.
Dip	60±10° NE *Comments:* Geomatrix Consultants, Inc. (1989 #1310) used the irregular trend of the fault trace to infer a shallow to moderate dip of 40°. An exposure of the fault zone in surficial deposits near Morrison Reservoir yielded dip measurements of 57°, 65°, and 67° on several strands, and had an average dip of 60±10° (Knudsen and others, 1994 #3594). Simpson and others (1993 #3596) used an estimated dip of 70° and Knudsen and others (1994 #3527; 1994 #3594) and Wong and others (1999 #5654) used an estimated dip of 60° in their analyses of paleo-earthquake magnitudes on the Cottonwood Mountain fault.
Paleoseismology studies	No trench investigations have been conducted along the Cottonwood Mountain fault, but a natural exposure of the active trace of the fault near Morrison reservoir was briefly described by Simpson and others (1993 #3596), and logged and described in more detail by Knudsen and others (1994 #3594). Site 806-1. The south wall of a gully exposure of part of a 13-m-high fault scarp on the north side of Morrison reservoir was examined and logged by Knudsen and others (1994 #3594) in September, 1993. The gully exposed a fault zone consisting of three subparallel fault strands dipping 60±10° to the southeast. Miocene aged, fossiliferous sandstone and siltstone bedrock overlain by Quaternary alluvium and colluvium were exposed in the footwall. The hanging wall consisted of Quaternary alluvium overlying mixed Quaternary colluvium and alluvium; these two units were separated by a buried calcic soil developed in the

	underlying colluvium and alluvium. Knudsen and others (1994 #3594) interpret the relations exposed in the gully as evidence of at least one fault displacement event since the deposition of and soil formation in the late Pleistocene to possibly Holocene colluvial and alluvial unit.
Geomorphic expression	The Cottonwood Mountain fault is located on the gently sloping east flank of Cottonwood Mountain. The fault trace is marked by discontinuous, en echelon fault scarps and lineaments from Pole Creek to about 3 km south of Bully Creek Dam; scarps are about 0.5–1 m high on younger, possibly Holocene, deposits and 2–13 m on older, mid to late Pleistocene deposits (Knudsen and others, 1994 #3594). Larger escarpments located a few kilometers to the west of the most recently active trace may represent an older trace of the Cottonwood Mountain fault (Knudsen and others, 1994 #3594), although other investigators have mapped these traces as active in the latest Quaternary (Pezzopane, 1993 #3544; Simpson and others, 1993 #3596; Weldon and others, 2002 #5648)
Age of faulted surficial deposits	No radiometric dating of faulted deposits has been conducted along the Cottonwood Mountain fault, but the youngest faulted alluvial fan deposits have been assigned Holocene (Geomatrix Consultants Inc., 1989 #1310), probable Holocene (Simpson and others, 1993 #3596), or mid to late Holocene (Knudsen,1994 #3527; Knudsen and others, 1994 #3594) ages, based on geomorphic expression. Scarps are well preserved across all alluvial fan and terrace deposits except the active stream channels (Simpson and others, 1993 #3596; Knudsen and others, 1994 #3594). Larger scarps are also present in older Quaternary fan deposits, indicating recurrent Quaternary displacement.
Historic earthquake	
Most recent prehistoric deformation	latest Quaternary (<15 ka) *Comments:* Most studies conclud that the latest faulting event along the fault probably occurred in the Holocene (Geomatrix Consultants Inc., 1989 #1310; Simpson and others, 1993 #3596). Knudsen and others (1994 #3594) concluded that the youngest event, with an average vertical offset of 0.75±0.25 m, probably occurred in the late Holocene. Weldon and others (2002 #5648) mapped most of these faults as active in the Holocene or post-glacial (<18 ka).

Recurrence interval	3,750–25,000 years *Comments:* Knudsen and others (1994 #3594) estimate a range in recurrence intervals of 3,750-25,000 years based on estimated slip rates of 0.03–0.2 mm/yr and average dip-slip displacement of 1.2±0.25 m for the purpose of seismic hazard analysis.
Slip-rate category	Less than 0.2 mm/yr *Comments:* Knudsen and others (1994 #3594) used numerous fault scarp profiles and estimated ages of late Quaternary deposits to determine a maximum Holocene slip rate of 0.2 mm/yr and long-term slip rates of 0.03–0.15 mm/yr for the Cottonwood Mountain fault. Wong and others (1999 #5654) used a preferred slip rate of 0.15 mm/yr for their analysis of the Cottonwood Mountain fault.
Date and Compiler(s)	2002 Stephen F. Personius, U.S. Geological Survey
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