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Quaternary Fault and Fold Database of the United States

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Busted Boiler fault (Class A) No. 2274

Last Review Date: 2015-01-06

Compiled in cooperation with the Colorado Geological Survey

citation for this record: **Widmann, B.L., and Haller, K.M., compilers, 2015, Fault number 2274, Busted Boiler fault, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, https://earthquakes.usgs.gov/hazards/qfaults, accessed 12/14/2020 03:02 PM.**

Synopsis	The Busted Boiler fault zone is a short, north-trending structure located at the southwest margin of the Uncompahgre Uplift. It extends north (perpendicular) from the Ridgway fault [2276] on the south to Wildcat Canyon on the north. The Busted Boiler fault zone juxtaposes resistant Dakota Sandstone to the east against easily eroded Mancos Shale to the west and forms 5- to 25-m-high fault scarps. Holocene offset is expressed as abandoned and/or diverted streams and results in ponded alluvium at the toe of the scarp. Trenches revealed faulted unconsolidated deposits suggesting recurrent late Quaternary (<50 ka) surface faulting.
Name	The Busted Boiler fault extends north from and perpendicular to

comments	the Ridgway fault [2276]. The fault dies out to the north between Horsefly Creek and Polores Creek. The fault is northwest of the town of Ridgway and west of Highway 550. **Fault ID:** Fault number Q24 of Widman and others (1998 #3441).
County(s) and State(s)	OURAY COUNTY, COLORADO
Physiographic province(s)	COLORADO PLATEAUS
Reliability of location	Good Compiled at 1:250,000 scale. *Comments:* The fault was mapped by Sullivan and others (1980 #2756), Steven and Hail (1989 #2747) at a scale of 1:100,000, and Tweto and others (1976 #2774) and Lettis and others (1996 #4453) at a scale of 1:250,000. The fault trace used herein is from Lettis and others (1996 #4453).
Geologic setting	The Busted Boiler fault is on the southeast margin of the Uncompahgre Uplift, which is a northwest-trending, east-tilted fault block. and was identified as a potential seismic source by Ake and others (2002 #7273). The fault is part of a 55-km-long, 12- to 15-km-wide, northwest-trending zone of geomorphic features formed by repeated Quaternary fault displacements in the southeastern Uncompahgre Plateau that includes the Log Hill Mesa graben [2275] and the Roubideau Creek fault [2270] (Piety and Ostenna, 2009 #7271).
Length (km)	18 km.
Average strike	N5°W
Sense of movement	Normal *Comments:* The type of fault displacement and direction of fault dip for the southern Busted Boiler fault zone are not known with any certainty (Piety and Ostenaa, 2009 #7271). The Busted Boiler fault zone has been shown on geologic maps as a down-to-the-west normal fault (Steven and Hail, 1989 #2747), but with the exception of two inconclusive exposures, the dip of the fault cannot be ascertained other than it must be fairly steep. In general, the fault was poorly exposed in the trenches (Piety and

	Ostenaa, 2009 #7271) but striations on bedrock in two of the trenches plunge steeply (about 75 degrees), suggesting down-to-the-west normal fault displacement. However, the left-stepping en echelon and marked variation in scarp height along strike may indicate a component of lateral displacement. Lettis and others (1996 #4453) reported normal movement on the fault.
Dip Direction	W *Comments:* The direction of fault dip for the southern Busted Boiler fault zone are not known with any certainty (Piety and Ostenaa, 2009 #7271); Lettis and others (1996 #4453) reported the fault dips to the west.
Paleoseismology studies	Four trenches and four soil pits have been excavated, surveyed, and mapped. Interpretation of the entire data set permits two surface-faulting earthquakes since about 11 ka and older earthquakes back to 50 ka (Piety and Ostenaa, 2009 #7271). Site 2274-1 consists of trench P2 and nearby soil pits on the hanging wall and footwall of the fault near the escarpment along the Ridgway fault (Piety and Ostenaa, 2009 #7271). The trench was excavated across the steep, lower part of the scarp exposing a zone of faults and folds that is at least 8 m wide that juxtaposes Creataceous Dakota Sandstone east of the fault against Mancos Shale on the west. Luminescence analyses of two samples from tectonically warped sediments yielded ages of about 10,000 yr, considered to be a minimum age for the most recent surface-faulting earthquake. The age of the units is assumed to be 30 ka and 21 ka. The timing of the most recent surface-faulting earthquake is older than 4.5- to 5-ka radiocarbon ages from two samples. Site 2274-2 consists of trench P4 and soil pit on the hanging wall of the fault excavated on a low terrace adjacent to South Creek (Piety and Ostenaa, 2009 #7271). The exposed fault zone is 18 m wide and total surface offset is about 7.5 m; the trench did not cross the main fault. Clear evidence for at least one faulting event is preserved in the trench. The 130-ka alluvium exposed is overlain by a 5.5–6 k.y. old deposit based on luminescence analyses of two samples from the lower portion of unit and one radiocarbon analysis. Faulting is interpreted to be the likely reason for deposition of the younger deposit.

	Site 2274-3 consists of trench P7 and P8 and soil pit on the hanging wall of the fault about 10 km north of site 2274-2 (Piety and Ostenaa, 2009 #7271). The exposed fault in trench P7 is 3 m wide; the trench revealed evidence of at least one Holocene surface-faulting earthquake. Radiocarbon and luminescence analyses of two samples constrain the timing of faulting to between 8.5–9.5 to 11–21 ka. The exposed fault in trench P8 is 3.5 m wide; Quaternary offset is indicated by 50-ka fissure fill and 9- to 10-ka scarp-derived colluvium. The preferred interpretation is that two surface-faulting earthquakes are recorded in the section. The youngest earthquake occurred before 9–10 ka and the older occurred before 50 ka.
Geomorphic expression	The fault is marked by a prominent, broad west-facing fault scarp that is 5- to 25-m-high (Lettis and others, 1996 #4453). Tectonic features include discontinuous lineaments and scarps, differences in drainage incision and expression, disrupted drainages, fluvial terraces that terminate abruptly at a fault, and possible ponded sediments (Piety, 2004 #7272).
Age of faulted surficial deposits	Sullivan and others (1980 #2756), Lettis and others (1996), and Piety and Ostenaa (2009 #7271) reported offset of late Quaternary sediment. The fault is almost entirely within the Cretaceous Dakota Sandstone, with less than 5 percent of the fault extending through or beneath Quaternary deposits.
Historic earthquake	
Most recent prehistoric deformation	latest Quaternary (<15 ka) *Comments:* All four trenches had evidence of at least one surface-faulting earthquake (Piety and Ostenaa, 2009 #7271). Results of numerical dating suggest that the most-recent event on the southern Busted Boiler fault zone occurred in the Holocene (<11 ka) at all but one trench site. These data support the early conclusions reported by Sullivan and others (1980 #2756) and Lettis and others (1996 #4453) of late Pleistocene and possibly even Holocene movement on the fault.
Recurrence interval	Average about 15 k.y. *Comments:* Correlating the timing of surface faulting between trenches is limited by datable material. Piety and Ostenaa (2009

	#7271) conclude that each trench had evidence of at least one Quaternary surface-faulting earthquake and all but one trench had evidence for older events. The youngest one or two events occurred in the Holocene and older events were spaced a few tens of thousands of years apart. If two distinct faulting events have occurred since about 11 ka, then clustering of seismic events may have occurred, of the recurrence may be as short as a few thousand years; however, the average recurrence interval is about 15 k.y.
Slip-rate category	Less than 0.2 mm/yr *Comments:* Widmann and others (1998 #3441) placed this structure within the <0.2 mm/yr slip-rate category. Piety and Ostenaa (2009 #7271) make no estimates of displacement rate; however, the data they present supports assigning the lowest slip rate category.
Date and Compiler(s)	2015 Beth L. Widmann, Colorado Geological Survey Kathleen M. Haller, U.S. Geological Survey
References	#7273 Ake, J., Ostenaa, D., Mahrer, K., Sneddon, C., and Block L., 2002, Seismotectonic evaluation and probabilistics hazard analysis for Ridgway Dam, Dallas Creek Project, Colorado: U.S. Bureau of Reclamation Seismotectonic Report 2001-4, 132. #4453 Lettis, W., Noller, J., Wong, I., Ake, J., Vetter, U., and LaForge, R., 1996, Draft report, Seismotectonic evaluation of Colorado River storage project-Crystal, Morrow Point, Blue Mesa dams, Smith Fork project-Crawford dam, west-central Colorado: Technical report to U.S. Bureau of Reclamation, Denver, Colorado, 177 p. #7272 Piety, L.A., 2004, Preliminary geomorphic assessment of the Busted Boiler fault and the Log Hill Mesa fault zone, southwestern Colorado: U.S. Bureau of Reclamation, Technical Memorandum D8330-2004-08, 35 p. #7271 Piety, L.A., and Ostenaa, D.A., 2009, Trenching studies on the southern Busted Boiler fault zone, southeastern Uncompahgre Plateau, southwestern Colorado: U.S. Bureau of Reclamation Seismotectonic Report No. 2009-04, 294 p. #7707 Piety, L.A., and Ostenaa, D.A., 2009, Characteristics of a northwest-trending zone of Quaternary tectonic features,

	southeastern Uncompahgre Plateau, southwestern Colorado: U.S. Bureau of Reclamation Seismotectonic Report No. 2009-5, 146 p. #2747 Steven, T.A., and Hail, W.J., Jr., 1989, Geologic map of the Montrose 30' x 60' quadrangle, southwestern Colorado: U.S. Geological Survey Miscellaneous Geologic Investigations I-1939. #2756 Sullivan, J.T., Meeder, C.A., Martin, R.A., and West, M.W., 1980, Seismic hazard evaluation-Ridgway dam and reservoir site-Dallas Creek project Colorado: U.S. Water and Power Resources Service, Seismotectonic Section, report, 43 p. #2774 Tweto, O., Steven, T.A., Hail, W.J., Jr., and Moench, R.H., 1976, Preliminary geologic map of the Montrose 1° x 2° quadrangle, southwestern Colorado: U.S. Geological Survey Miscellaneous Field Studies Map MF-761. #3441 Widmann, B.L., Kirkham, R.M., and Rogers, W.P., 1998, Preliminary Quaternary fault and fold map and database of Colorado: Colorado Geological Survey Open-File Report 98-8, 331 p., 1 pl., scale 1:500,000.