Jump to Navigation

Quaternary Fault and Fold Database of the United States

As of January 12, 2017, the USGS maintains a limited number of metadata fields that characterize the Quaternary faults and folds of the United States. For the most up-to-date information, please refer to the interactive fault map.

Gore Range frontal fault (Class A) No. 2302

Last Review Date: 2014-12-09

Compiled in cooperation with the Colorado Geological Survey

citation for this record: **Haller, K.M., and Widmann, B.L., compilers, 2014, Fault number 2302, Gore Range frontal 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 03:00 PM.**

Synopsis	The Gore Range frontal fault bounds the eastern margin of the Gore Range is also known as the Blue River fault and the Frontal fault. Evidence for Quaternary surface rupture is incomplete because much of the fault is under heavy forest cover and is generally inaccessible except on foot. Early studies reported geomorphic features along the fault trace as evidence for Quaternary movement; however, some of the landforms may be attributed to normal alpine mass movement and other erosional processes. LiDAR (Light Detection And Ranging) data reveal evidence of faulting at a number of locations resulting the current interpretation that the fault has experienced multiple episodes of late Quaternary movement. The timing of the most recent

	paleoevent on the Gore Range fault is latest Quaternary based on cosmogenic-radionuclide (CRN) dating of faulted deposits at South Rock Creek.
Name comments	The fault was originally referred to as the Blue River fault and later as the Frontal fault (Tweto and others, 1970 #2768). The name used here is from Derouin and others (2010 #7206), which represents the most comprehensive study to date. **Fault ID:** Fault 50 in Kirkham and Rogers (1981 #792), fault 181 in Witkind (1976 #2792), and fault number Q51 of Widman and others (1998 #3441).
County(s) and State(s)	SUMMIT COUNTY, COLORADO PARK COUNTY, COLORADO EAGLE COUNTY, COLORADO
Physiographic province(s)	SOUTHERN ROCKY MOUNTAINS
Reliability of location	Good Compiled at 1:250,000 scale. *Comments:* Early mapping of the Gore Range frontal fault includes West (1977 #2787) at a scale of 1:12,000, Tweto and others (1970 #2768) at a scale of 1:48,000, Tweto (1973 #2762; 1973 #2763) at a scale of 1:62,000 by, and Tweto and others (1978 #2770) at a scale of 1:250,000. The trace used here in is from Tweto and others (1978 #2770). The interpretation of LiDAR (Light Detection And Ranging) data acquired in 2008, which should improve locating the fault by revealing fault scarps currently is not published.
Geologic setting	The Gore Range frontal fault is a high-angle, left-stepping, en echelon, down-to-the-northeast fault. The fault is also part of the Precambrian Ilse-Gore fault system (Kirkham and Rogers, 1981 #792).
Length (km)	75 km.
Average strike	N24°W
Sense of movement	Normal *Comments:* Sense of movement on the fault is predominately normal, but in some locations reverse (Behre, 1953 #2582).

Dip Direction	W *Comments:* Behre (1953 #2582) reports two dip measurements for the fault, although the exact location of the field measurements is unknown. He measured a normal section of the fault as dipping 78° W., and a reverse section of the fault as dipping 83° E.
Paleoseismology studies	
Geomorphic expression	The Gore Range frontal fault has produced a major bedrock scarp up to 610 m high near Boulder Creek. Interpretation of LiDAR data has identified geomorphic features suggestive of tectonic faulting and field reconnaissance has provided surface offset data (1–18 m, Derouin, 2014 #7274) along with preliminary stratigraphic relations to improve the characterization of Quaternary movement on the fault. Early work by Tweto and others (1970 #2768) and West (1977 #2787) also identified scarps up to 18 m high on glacial moraine deposits, ridge-top springs, gouge boils as much as 12 m high, landslides, aligned drainages, and other topographic and vegetation lineaments. Unruh and others (1993 #2777) described nickpoints in drainages and a 5- to 7-m-high, northeast-facing scarp along the fault trace. An early report by Derouin and others (2010 #7206) document surface offset (between 2 and 6 m) at seven major sites along the fault. Although independent rupture segments may be present along the main trace, Derouin and others (2010 #7206) and Derouin (2014 #7274) suggest there is little evidence to support this hypothesis. Nowhere along the fault does the height of the fault scarps on similar-age deposits systematically decrease suggestive of the ends of surface rupture (Anderson, 2007 #7275) as previously suggested by Unruh and others (1996 #7276). The scarp at South Rock Creek is on the youngest dated offset deposit (Derouin and others, 2014 #7274).
Age of faulted surficial deposits	Early work on the Gore Range frontal fault yielded somewhat ambiguous evidence for Quaternary tectonic activity. Tweto and others (1970 #2768) reported glacial moraines as being offset by the fault and suggested historic movement on the fault based on an earthslump that occurred in 1920 and created scarps and a ridge top stream north of Boulder Creek. West (1977 #2787) argued that Miocene-Pliocene deposits are tectonically offset by the fault but that displacement of Quaternary deposits is a result

	of alpine fluvial and colluvial processes rather than tectonic processes. Unruh and others (1993 #2777) conducted detailed studies at two sites on the fault that were not trenched. They described as much as 7 m of offset in late Pleistocene (Pinedale) fluvial deposits. They concluded that Holocene sediment is in depositional contact with the fault and is not faulted; however, cosmogenic-radionuclide (CRN) dating of faulted deposits shows that Holocene deposits are offset at South Creek and late Quaternary or pre-Bull-Lake equivalent deposits are displaced 3–18 m at seven additional locations.
Historic earthquake	
Most recent prehistoric deformation	latest Quaternary (<15 ka) *Comments:* The timing of the most-recent surface rupture remains poorly constrained. Field reconnaissance of suspected fault scarps provide definitive evidence for recurrent late Quaternary surface displacement (Derouin and others, 2010 #7206). This study documents the presence of scarps on rounded landforms that are probably glacial deposits 125 and 300 m above drainages inferred to by late Quaternary (<130 ka) in age. At South Rock Creek, the fault offsets a lateral moraine that is 60 m above the drainage; cosmogenic-radionuclide (CRN) dating constrains at least the most recent surface rupture to younger than 9–13 ka (Derouin, 2014 #7274). Studies by Unruh and others (1993 #2777) revealed that Pinedale glacial deposits. Earlier, Tweto and others (1970 #2768) indicated faulting of middle to early glacial deposits but also suggested historic movement on the fault based on a 1920 earth slump. West (1977 #2787; 1978 #2788) argued that all of the geomorphic features that Tweto and others (1970 #2768) attributed to young faulting are the result of normal alpine fluvial and colluvial processes and are not tectonic in origin. He suggested that the latest movement on the fault occurred during the Miocene or Pliocene. Kirkham and Rogers (1981 #792) suggested that the most recent movement on the fault occurred prior to the Bull Lake glaciation, possibly during the early Quaternary. Howard and others (1978 #312) and Colman (1985 #1953) indicated the most recent paleoevent on this fault occurred during the Quaternary.
Recurrence interval	

Slip-rate category	Less than 0.2 mm/yr *Comments:* Assigned slip-rate category based on Derouin and others (2010 #7206) Derouin (2014 #7274) vertical-displacement rates from surface offset and estimated age of the faulted deposit. Reported rates in the most recent study (Derouin, 2014 #7274) at South Rock Creek are based on cosmogenic-radionuclide (CRN) dates and yield high displacement rates compared to estimates for older, offset deposits (presumed to be about 70–190 ka based on regional relations). Table 5 in Derouin (2014 #7274) presents possible vertical displacement rates for 11 scarp profiles that range from 0.003–0.25 mm/yr. The large uncertainty is due to the poorly constrained ages for older deposits, which are not currently constrained by conventional age dating. The deposits are assumed to be either Bull Lake (70–190 ka) or pre Bull Lake (300–1,000 ka) deposits based on similar position in the landscape, topographic position, and surficial expression. The reports suggest different preferred vertical displacement rates of 0.04 mm/yr (Derouin and others, 2010 #7206) and 0.15 mm/yr (Derouin, 2014 #7274) derived from measured displacement at the South Rock Creek site and age assumptions at the time of the report. Earlier studies suggested higher, but also poorly constrained, vertical displacement rates. Tweto and others (1970 #2768) reported an 18-m-high scarp on young glacial deposits and recent landslide deposits, but did not indicate how much of the scarp is on glacial deposits versus bedrock. Unruh and others (1993 #2777) reported 5–7 m of offset in Pinedale deposits (13–35 ka).
Date and Compiler(s)	2014 Kathleen M. Haller, U.S. Geological Survey Beth L. Widmann, Colorado Geological Survey
References	#7275 Anderson, L., 2007, Field reconnaissance for the Gore Range frontal fault, September 10¬–14, 2004, to address Safety of Dams recommendation 2005-SOD-A for Green Mountain Dam, Colorado: Bureau of Reclamation, Memorandum to B. Fielder, dated September 26, 2007, 5 p. #2582 Behre, C.H., 1953, Geology and ore deposits of the west slope of the Mosquito Range, Colorado: U.S. Geological Survey Professional Paper 235, 176 p. #1953 Colman, S.M., 1985, Map showing tectonic features of late Cenozoic origin in Colorado: U.S. Geological Survey Miscellaneous Geologic Investigations I-1566, 1 sheet, scale

1:1,000,000.

#7274 Derouin, S.A., 2014, Revised fault characterization for Green Mountain Dam seismic hazard analysis: Bureau of Reclamation Technical Memorandum No. 85-833000-2014-05-A, 49 p.

#7206 Derouin, S.A., Piety, L.A., and Feng, S., 2010, Evaluation of the Gore Range frontal fault and revised probabilistic seismic hazard analysis for Green Mountain Dam, Colorado: Bureau of Reclamation Seismotectonic Report 2010-01, 89 p.

#312 Howard, K.A., Aaron, J.M., Brabb, E.E., Brock, M.R., Gower, H.D., Hunt, S.J., Milton, D.J., Muehlberger, W.R., Nakata, J.K., Plafker, G., Prowell, D.C., Wallace, R.E., and Witkind, I.J., 1978, Preliminary map of young faults in the United States as a guide to possible fault activity: U.S. Geological Survey Miscellaneous Field Studies Map MF-916, 2 sheets, scale 1:5,000,000.

#792 Kirkham, R.M., and Rogers, W.P., 1981, Earthquake potential in Colorado: Colorado Geological Survey Bulletin 43, 171 p., 3 pls.

#2762 Tweto, O., 1973, Reconnaissance geologic map of the Dillon 15-minute quadrangle, Summit, Eagle, and Grand Counties, Colorado: U.S. Geological Survey Open-File Report.

#2763 Tweto, O., 1973, Reconnaissance geologic map of the Mount Powell 15-minute quadrangle, Grand, Summit, and Eagle Counties, Colorado: U.S. Geological Survey Open-File Report 73-286.

#2767 Tweto, O., 1979, The Rio Grande Rift system in Colorado, *in* Rio Grande Rift—Tectonics and magmatism: American Geophysical Union, p. 33-56.

#2768 Tweto, O., Bryant, B., and Williams, F.E., 1970, Mineral resources of the Gore Range-Eagles Nest primitive area and vicinity, Summit and Eagle Counties, Colorado: U.S. Geological Survey Bulletin 1319-C, 127 p.

#2770 Tweto, O., Moench, R.H., and Reed, J.C., 1978, Geologic map of the Leadville 1° x 2° quadrangle, northwestern Colorado:

	U.S. Geological Survey Miscellaneous Geologic Investigations I-999. #2776 Unruh, J.R., Sawyer, T.L., and Lettis, W.R., 1992, Seismotectonic evaluation of Green Mountain Dam, Shadow Mountain Dam, Grandby Dam, and Willow Creek Dam, Colorado-Big Thompson Project: Technical report to U.S. Bureau of Reclamation, Denver, Colorado, 78 p. #2777 Unruh, J.R., Wong, I.G., Bott, J.D.J., Silva, W.J., and Lettis, W.R., 1993, Seismotectonic evaluation, Rifle Gap Dam, Silt Project, Ruedi Dam, Fryingpan-Arkansas Project, northwestern Colorado: U.S. Bureau of Reclamation, 154 p. #2787 West, M.W., 1977, A preliminary evaluation of the Quaternary geology, reported surface faulting, and seismicity along the east flank of the Gore Range, Summit County, Colorado: Golden, Colorado School of Mines, M.S. thesis T-1828, 195 p. #2788 West, M.W., 1978, Quaternary geology and reported surface faulting along east flank of the Gore Range, Summit County, Colorado: Colorado School of Mines Quarterly, v. 73, no. 2, p. 66. #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. #2792 Witkind, I.J., 1976, Preliminary map showing known and suspected active faults in Colorado: U.S. Geological Survey Open-File Report 76-154.