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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.

unnamed faults along the Grand Hogback monocline (Class A) No. 2340

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Synopsis	This group of unnamed faults consist of closely spaced, parallel, bedding-plane faults near the crest of the Grand Hogback monocline, west of Carbondale. Evidence of displacement on the faults includes topographic scarps up to 30 m high on Miocene basalts and Quaternary-mantled pediments.. Down-to-the-west movement on the faults is attributed to unfolding or relaxation of the Grand Hogback monocline that occurred as salt migrated and dissolved from beneath the monocline. Trenching revealed unexpected evidence of repeated late Quaternary faulting events, each resulting in more than 1 m of vertical displacement on the bedding-plan faults. The current understanding of these faults is they might have the potential to generate moderate-size earthquakes.

Name comments	The unnamed faults, initially mapped by Soule and Stover (1985 #2745), Stover (1986 #2751) and Kirkham and others (1996 #3465), are described collectively due to the close spatial association of the faults **Fault ID:** Fault number Q43 and Q44 of Widman and others (1998 #3441); fault numbers 2294 and 2295 in version 1 of the U.S. Quaternary fault and fold database. The records are merged and the faults are reclassified as Class A based on Gutiérrez and others (2014 #7278). The data presented by Gutiérrez and others (2014 #7278) suggest that evaporate dissolution–induced movement on flexural-slip faults related to the Grand Hogback monocline might have the potential to generate magnitude 5.5 or greater earthquakes.
County(s) and State(s)	GARFIELD COUNTY, COLORADO
Physiographic province(s)	SOUTHERN ROCKY MOUNTAINS COLORADO PLATEAUS
Reliability of location	Good Compiled at 1:24,000 scale. *Comments:* The faults, as shown, were mapped at a scale of 1:24,000 by Carroll and others (1996 #7280), Kirkham and others (1996 #3465), and Bryant and others (2002 #7279). Earlier mapping includes Stover (1986 #2751) and a scale of 1:50,000 and Soule and Stover (1985 #2745).
Geologic setting	The down-to-the-west faults are thought to be normal and shallow with depth (listric). Most of the faults are parallel to the Grand Hogback monocline, which is underlain by more than 2.5 km of halite and other evaporite deposits. The faults offset late Tertiary to Quaternary deposits and are thought to be due to unfolding or relaxation of the monocline as salt migrates and dissolves from beneath the monocline (Stover, 1986 #2751; Unruh and others, 1993b; Kirkham and others, 1996 #3465; 1997 #2710). Murray (1969 #2727) proposed a similar origin for late Cenozoic faults along the monocline north of this locality. Increasing scarp heights on deposits of increasing age suggests the faults move recurrently (Stover, 1986 #2751; Kirkham and others, 1996 #3465).
Length (km)	km.

Average strike	
Sense of movement	Normal *Comments:* These faults were shown as normal bedding-plane faults on a cross section by Kirkham and others (1996 #3465).
Dip	45° W *Comments:* A near-surface dip of about 45° is shown on a cross section by Kirkham and others (1996 #3465). The faults flatten with depth (listric geometry) as they approach the axis of the Grand Hogback syncline.
Paleoseismology studies	Stratigraphic relations exposed in two trenches reveal evidence of multiple, late Quaternary episodic displacements on the flexural-slip faults associated with the Grand Hogback monocline in contrast to the expectation of finding evidence of displacement through slow creep. Site 2340-1 (Trench 1, Gutiérrez and others, 2014 #7278) is located near Fourmile Creek and exposed evidence of a minimum of three faulting events between 1.5 ka and 32.4 ka, based on seven radiocarbon ages. The trench crossed only one of the eight mapped faults at this latitude; therefore the reported amount of displacement is underrepresented. The most recent event exposed by the trench occurred between 5.6 and 1.5 ka and resulted in at least 1.6 m of vertical displacement. The penultimate event occurred between 32.4 and 28 ka with estimated vertical offset of about 1 m. At least one event older than 32.4 ka generated an uphill-facing fault scarp northeast of the trench with a minimum vertical displacement of 2.4 m. Site 2340-2 (Trench 2, Gutiérrez and others, 2014 #7278) is located located southeast of Hughes Reservoir and east of Threemile Creek exposed evidence of a minimum of four Quaternary faulting events. The deformation history is less certain in trench 2 than in trench 1; the timing of the faulting events and the age of the exposed section are constrained by optically stimulated luminescence (OSL) ages. Gutiérrez and others (2014 #7278) conclude that at least three events occurred before 20 ka and the most recent event could be younger than 20 ka. Per-event displacement is at least 1 m.

Geomorphic expression	Scarps as much as 30 m high on late Tertiary to early Quaternary deposits are present along these faults, most of which are associated with prominent vegetation lineaments and linear swales (Kirkham and others, 1996 #3465, 1997 #2710); half-graben depressions bounded by uphill-facing fault scarps that parallel the underlying bedding planes in the monocline.
Age of faulted surficial deposits	High-level basaltic gravel deposits of late Tertiary to Quaternary age are offset by these faults. The gravels have been offset by as much as 30 m (Kirkham and others, 1996 #3465).
Historic earthquake	
Most recent prehistoric deformation	latest Quaternary (<15 ka) *Comments:* The age-category assignment is based on the timing of the most recent event, interpreted in Trench 1 (site 2340-1) as Holocene (between 5.6 and 1.5 ka, Gutiérrez and others, 2014 #7278).
Recurrence interval	*Comments:* The trenches by Gutiérrez and others (2014 #7278) provides information to loosely constrained the timing of the three most recent late Quaternary displacements to older than 32.4 ka, 32–28 ka, and 5.6–1.5 ka.
Slip-rate category	Less than 0.2 mm/yr *Comments:* The poorly constrained chronology does not permit calculating meaningful single-event displacement rates. However, Gutiérrez and others (2014 #7278) suggest a minimum vertical throw of 3.2 m in the last 32.4 k.y. and a minimum apparent slip rate of 0.1 mm/yr at trench 1 (site 2340-1). The reported rate only includes displacement across one of at least eight sub-parallel faults. The lowest slip-rate category is assigned until additional information is available.
Date and Compiler(s)	2015 Kathleen M. Haller, U.S. Geological Survey Beth L. Widmann, Colorado Geological Survey
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