

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](#).

Golden fault (Class B) No. 2324

Last Review Date: 1998-04-22

Compiled in cooperation with the Colorado Geological Survey

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Synopsis

The Golden fault was first suggested as Quaternary fault by Scott (1970 #1141) based upon evidence in a clay exploration trench about 210 m east of the trace of the Golden fault as previously mapped by Van Horn (1972 #2780). The exploration trench, located about 1.2 km northwest of downtown Golden, exposed a graben that Scott (1970 #1141) described as offsetting the Verdos Alluvium (pre-Kansan), an overlying colluvial deposit containing Pearlette-like volcanic ash, and a Yarmouth (?) soil by about 1.5 m. Kirkham (1977 #2706) and Kirkham and Rogers (1981 #792) later logged two trenches that they excavated across the graben and described evidence for two fault ruptures that offset the Kansan (?) Verdos Alluvium and overlying Yarmouth (?) soil. The

latter rupture also displaced a 0.6 to 0.7 Ma volcanic ash subsequently correlated with the Lava Creek B ash by Izett and Wilcox (1982 #1708). Because 1) the zone of deformation associated with the Golden fault is very wide, 2) the nearest exposures of the fault were over 1.6 km away, and 3) Scott (1970 #1141) related the graben to the Golden fault, Kirkham (1977 #2706) and Kirkham and Rogers (1981 #792) concluded that the trenched graben [2326] was part of the Golden fault zone and then inferred the Golden fault had moved during the Quaternary. The Golden fault was later studied in detail for a seismic hazards investigation for the U.S. Department of Energy's Rocky Flats Plant. The complete results of that investigation were published in Dames & Moore (1981 #2683) and summaries of it are reported in Darrow and Krusi (1981 #2684; 1982 #2672). Dames & Moore (1981 #2684) excavated six trenches across the Golden fault at three sites. They concluded there was no evidence to indicate the Golden fault had moved since deposition of the Verdos Alluvium. Several anomalous features were observed in their trenches, including "tongues" of bedrock within Quaternary deposits and normal faults in Quaternary alluvium. They interpreted these features as being non-tectonic in origin. Technical reviews of the Dames & Moore (1981 #2684) report by the Colorado Geological Survey (W.P. Rogers, 1981, written commun. to Dames & Moore) and the U.S. Geological Survey (S.M. Colman and others, 1981 written commun. to Dames & Moore) questioned whether or not the Golden fault had moved during the Quaternary. Since there is controversy about the origin of this structure, it is herein considered to be a Class B fault.

Name comments

The Golden fault is one of the several structures that bound the eastern side of the Front Range near the city of Golden, Colorado.

Fault ID: This fault was previously mapped as a potentially active Quaternary fault 166 of Kirkham and Rogers (1981 #792) and fault number Q74 of Widman and others (1998 #3441).

County(s) and State(s)

JEFFERSON COUNTY, COLORADO

Physiographic province(s)

SOUTHERN ROCKY MOUNTAINS

Reliability of location

Good
Compiled at 1:100,000 scale.

	<p><i>Comments:</i> The Golden fault was mapped at a scale of 1:24,000 (VanHorn, 1972 #2780; 1976 #2781), 1:100,000 by Trimble and Machette (1979 #2760), and 1:250,000 by Bryant and others (1981 #2645). The trace used herein is from Trimble and Machette (1979 #2760).</p>
Geologic setting	<p>The Front Range is defined by a 500- to 1,000-m-high, east-facing escarpment that is both a tectonic and erosional feature. The Golden fault forms the east flank of the Front Range near the town of Golden. It is a west-dipping, high-angle, range-front, thrust fault (Weimer and Ray, 1997 #2784) that was mainly active in the Neogene. Estimations of Neogene offset across the Front Range are as little as 30 m to as much as 2,200 m. Scott (1970 #1141), Epis and Chapin (1975 #2688), and Trimble (1980 #2759) suggested much of the topographic relief across the escarpment is related to Neogene fault activity. Jacob and Albertus (1985 #2702), Leonard and Langford (1994 #2715), and Steven and others (1997 #3477) indicated that Neogene fault activity only accounts for a minor amount of topographic relief across the escarpment. Steven and others (1997 #3477) noted anomalies in paleo- and modern, range-front stream flow directions that they interpreted to indicate tilting of the Front Range off the northeast flank of the Rio Grande rift during the Miocene, and regional uplift during the early Pliocene and possibly early Quaternary. Jacob and Albertus (1985 #2702) and Chapin and Kelley (1997 #2674) argued that the Front Range escarpment is primarily a product of differential erosion.</p>
Length (km)	31 km.
Average strike	N23°W
Sense of movement	<p>Thrust</p> <p><i>Comments:</i> Style of deformation along the Golden fault has been debated, but most current researchers believe it was predominately thrust (Weimer and Ray, 1997 #2784) when most of the displacement occurred.</p>
Dip	<p>50°-70° W</p> <p><i>Comments:</i> Weimer and Ray (1997 #2784) estimated the Golden fault dips on average 50–70° W. Surficial dips are commonly steeper, 65–90°.</p>

Paleoseismology studies

The fault was studied in detail for a seismic-hazards investigation for the U.S. Department of Energy's Rocky Flats Plant. The complete results of that investigation were published in Dames & Moore (1981 #2683) and summaries of it are reported in Darrow and Krusi (1981 #2684; 1982 #2676). Dames & Moore (1981 #2683) excavated six trenches across the Golden fault at three sites (GF-1 through GF-3). They concluded there was no evidence to indicate the Golden fault had moved since deposition of the Verdos Alluvium (ca. 500 ka). Several anomalous features were observed in their trenches, including "tongues" of bedrock within Quaternary deposits and normal faults in Quaternary alluvium. They interpreted these features as being non-tectonic in origin but could not definitively rule out a tectonic origin. The three trench sites are labeled on the map that accompanies this database, from north to south, as sites 2324-1, 2324-2, and 2324-3.

Site 2324-1 (GF-2): Two trenches and three test pits were excavated at this site in the emergency spillway area at the northern end of Ralston Reservoir Dam. The Upper Cretaceous Pierre Shale is on both sides of the fault and is overlain by Verdos-age (ca. 500 ka) debris-flow deposits and stream deposits. Bedding in the Pierre Shale dips 60–80° W. and three shear zones marked by clay gouge 0.5 m to 1.0 m thick, dip 85–90° W. The bedrock/alluvium contact is not displaced by the Golden fault indicating no movement on the fault for at least 500 ka.

Site 2324-2 (GF-3): Two trenches were excavated at this site on Coors property near the mouth of Clear Creek Canyon. Precambrian metamorphic rocks and Pennsylvanian Fountain Formation were observed on the west in fault contact with Upper Cretaceous Pierre Shale on the east, and all were overlain by unfaulted Verdos gravel and pre-Pinedale (50 ka) colluvium and/or eolian deposits. The fault dips 65° E. and is marked by a 20- to 30-m-wide gouge zone. A 5-m-wide shear zone was found east of the fault in Pierre Shale. Tongues of Pierre Shale were reported to project into overlying Quaternary alluvium but were not found to be bound by faults or shears. Dames & Moore (1981 #2683) concluded the tongues were non-tectonic in origin and were related to plastic deformation of the shale in response to unloading of overburden or downslope creep.

Site 2324-3 (GF-1): Two trenches and two test pits were excavated at this site located west of U.S. Highway 6 and Tripp Road. The Jurassic Morrison Formation was observed on the west

	<p>in fault contact with the Upper Cretaceous Pierre Shale on the east, and both were overlain by unfaulted Verdos-age alluvium, debris-flow deposits, and sheetwash. The fault dips 15° W. and is marked by a 10-cm-wide gouge zone; Morrison Formation bedding is overturned 20° W. Tongues of Morrison Formation were reported to project into overlying Quaternary alluvium but were not found to be bound by faults or shears. A cumulative displacement of about 15 cm was reported in gravel lenses displaced along down-to-the-west (normal) shears. Dames & Moore (1981 #2683) concluded "while a tectonic origin cannot be precluded, the tongues are interpreted to represent bedrock surface deformation due to downslope creep" and normal displacement along shears appears to be related to the tongues.</p>
Geomorphic expression	<p>The Golden fault does not have any noticeable or youthful expression of activity.</p>
Age of faulted surficial deposits	<p>Rocks ranging in age from Precambrian to Paleocene are clearly cut by the Golden fault (Scott, 1970 #1141; VanHorn, 1972 #2780), but the age of the most recently faulted deposits is debated. Post (?) Kansan-age Verdos Alluvium (ca. 500 ka) and the 620 ka Lava Creek B ash from the Yellowstone Caldera in Wyoming are offset by the graben near Golden, which lies about 0.2 km east of the Golden fault. However, the structural relationship between this Quaternary graben and the Golden fault is disputed (Kirkham, 1977 #2706; Kirkham and Rogers, 1981 #792; Dames & Moore, 1981 #2683). The origin of anomalous features in basal Verdos Alluvium near the Golden fault exposed in trenches by Dames & Moore also is debateable (Dames & Moore, 1981 #2683; W.P. Rogers, 1981, written commun. to Dames & Moore).</p>
Historic earthquake	
Most recent prehistoric deformation	<p>undifferentiated Quaternary (<1.6 Ma)</p> <p><i>Comments:</i> The Golden fault was first suggested to be a Quaternary fault by Scott (1970 #1141) based upon evidence in a clay exploration trench in a graben about 210 m east of the trace of the Golden fault. Kirkham and Rogers (1981 #792) classified the Golden fault as a Quaternary fault based on its possible association to this Quaternary graben [2326]. Trenching investigations by Dames & Moore (1981 #2683) revealed that the bedrock/alluvium contact at all three trench sites was not offset by</p>

the Golden fault. However, they did find several anomolous features in basal Verdos Alluvium that may indicate Quaternary movement on this fault. Dames & Moore (1981 #2683) concluded that these features resulted from downslope creep, but they also stated that a tectonic origin could not be precluded. They further indicated that the Golden fault had not moved for at least 500 ka (since deposition of Verdos Alluvium). Technical reports by the Colorado Geological Survey (W.P. Rogers, 1981, written commun. to Dames & Moore) and the U.S. Geological Survey (S.M. Colman and others, 1981 written commun. to Dames & Moore) questioned the Dames & Moore (1981 #2683) conclusions regarding possibility of Quaternary movement on the Golden fault. Based on the debateable origin of anomolous features in Quaternary deposits the Golden fault is herein considered to be a feature of suspect origin that may have moved during the Quaternary.

Recurrence interval

Slip-rate category

Less than 0.2 mm/yr

Comments: Any estimate of the Quaternary slip rate is highly speculative lacking a consensus on whether or not the Golden fault has Quaternary activity. Inasmuch as the structure does not have any noticeable or youthful expression of activity, Widmann and others (1998 #3441) placed this fault in the <0.2 mm/yr slip-rate category.

Date and Compiler(s)

1998
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