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Quaternary Fault and Fold Database of the United States

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Northeastern Boundary fault system (Class A) No. 2309

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Compiled in cooperation with the Colorado Geological Survey

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Synopsis	The Northeastern Boundary fault system forms the northeastern margin of the upper Arkansas Valley graben between Leadville and Buena Vista. The graben is a major Neogene structure that is the northernmost topographically prominent feature of the Rio Grande rift. The graben developed along the axial crest of the Laramide age Sawatch anticline. Several fault traces are marked by west-facing scarps in Quaternary landslide deposits. Pre-Bull Lake glacial drift and Kansan (?) alluvium is mapped as offset by the fault. The fault system was previously considered to be a late Cenozoic feature (e.g., Tweto, 1978 #1956 ; Kirkham and Rogers,

	1981 #792; Colman, 1985 #1953) despite Quaternary offset shown on maps by Scott (1975 #2733) and Tweto and others (1978 #2770). Subsequent reports by Unruh and others (1992 #2776), Unruh and others (1993#2777) and Lettis and others (1996 #) indicated late Pleistocene fault activity within this system. The most recent paleoevent on the Northeastern Boundary fault system is herein considered to have occurred during the middle and late Quaternary.
Name comments	This group of eight northwest-trending faults forms the northeast margin of the upper Arkansas Valley graben and is the southern extension of the Mosquito Fault (Unruh and others, 1993 #2777) between Leadville and Buena Vista. The northernmost fault is called the Iron fault whereas the fault extending from the south end of the Iron fault is the Dome fault (Behre, 1953 #2582). The Iron and Dome faults were collectively known as the Union fault (Tweto and Case, 1972 #2769). The fault that splays to the southeast from the Iron fault was referred to as the Mike fault by Behre (1953 #2582) and Tweto (1974 #2765) but was called the Weston fault by Tweto and Case (1972 #2769), Chronic (1974 #2675), and Tweto (1974 #2765). All of these faults, as well as the Mosquito fault, were collectively referred to as the Northeastern Boundary fault system by Unruh and others (1993 #2777) because the faults form the northeastern boundary of the upper Arkansas Valley. **Fault ID:** Fault 161 in Kirkham and Rogers (1981 #792) and fault number Q57 of Widman and others (1998 #3441).
County(s) and State(s)	CHAFFEE COUNTY, COLORADO LAKE COUNTY, COLORADO PARK COUNTY, COLORADO
Physiographic province(s)	SOUTHERN ROCKY MOUNTAINS
Reliability of location	Good Compiled at 1:250,000 scale. *Comments:* The fault system was mapped at a scale of 1:62,500 by Tweto and Reed (1973 #2772), Tweto (1974 #2765), and Scott (1975 #2733), at 1:125,000 by Tweto and Case (1972 #2769), and at 1:250,000 by Tweto and others (1978 #2770), Unruh and others (1992 #2776), Unruh and others (1993 #2777), and Lettis and others (1996 #4453). The trace used herein is from Tweto and

	others (1978 #2770) and Lettis and others (1996 #4453).
Geologic setting	The Northeastern Boundary fault system forms the northeastern margin of the upper Arkansas Valley graben, a west-tilted Neogene structure that is the northernmost topographically prominent feature of the Rio Grande rift. The graben developed along the axial crest of the Laramide age Sawatch anticline. Faults in this system are typically high-angle normal and down to the west, with step-down displacement toward the upper Arkansas Valley.
Length (km)	49 km.
Average strike	N18°W
Sense of movement	Normal *Comments:* Most of the faults are normal faults (e.g., Behre, 1953 #2582; Tweto and Case, 1972 #2769, Kirkham and Rogers, 1981 #792; Unruh and others, 1992 #2776). The Mike fault (the northernmost fault) has reverse movement (Behre, 1953 #2582; Tweto and Case, 1972 #2769).
Dip	67° E - 80° W *Comments:* Most of the fault planes dip to the west. The Dome and Iron faults dip 67? W and 68? W according to Behre (1953 #2582). The Mike fault is the only one that dips to the east (80? E) (Behre, 1953 #2582).
Paleoseismology studies	
Geomorphic expression	This fault system is marked by west-facing scarps and lineaments in Quaternary landslide deposits. The scarps occur at the base of a west-facing escarpment in the Miocene-Pliocene Dry Union Formation (Unruh and others, 1993 #2777).
Age of faulted surficial deposits	The Miocene-Pliocene Dry Union Formation is offset by this fault system. Tweto and others (1978 #2770) mapped offset pre-Bull Lake glacial drift along the westernmost faults, and Scott (1975 #2733) mapped offset Kansan (?) alluvium. Scarps are developed ion late Pleistocene landslide deposits, but Bull Lake and Holocene deposits are not deformed across the fault (Unruh and

	others, 1992 #2776; Unruh and others, 1993 #2777; Lettis and others, 1996 #4453). The western faults are primarily in Precambrian to Pennsylvanian bedrock with Quaternary deposits mapped along less than 5 percent of the fault trace. The eastern faults downdrop Precambrian and Tertiary deposits into the upper Arkansas Valley graben.
Historic earthquake	
Most recent prehistoric deformation	middle and late Quaternary (<750 ka) *Comments:* Tweto (1978 #1956) mapped this system of faults as Neogene in age. Kirkham and Rogers (1981 #792) indicated late Cenozoic movement on this fault system based on recognized offset of the Miocene-Pliocene Dry Union Formation. Likewise, Colman (1985 #1953) did not report Quaternary movement on this system. However, Scott (1975 #2733) and Tweto and others (1978 #2770) both mapped offset Quaternary deposits on the westernmost faults. Based on the presence of linear scarps on late Pleistocene deposits, Unruh and others (1992 #2776; 1993 #2777) and Lettis and others (1996 #4453) suggested late Quaternary movement within the fault system. Unruh and others (1992 #2776; 1993 #2777) and Lettis and others (1996 #4453) were careful to note that the scarps could be related to landsliding, although they favored a tectonic origin. The most recent movement on this fault system is herein classified as middle and late Quaternary based on offset of deposits related to the Kansan and pre-Bull Lake glaciations.
Recurrence interval	
Slip-rate category	Less than 0.2 mm/yr *Comments:* Widmann and others (1998 #3441) placed this fault system in the <0.2 mm/yr slip-rate category.
Date and Compiler(s)	1997 Beth L. Widmann, Colorado Geological Survey
References	#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. #2675 Chronic, J., 1964, Geology of the southern Mosquito Range, Colorado: The Mountain Geologist, v. 1, no. 3, p. 103-

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#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.

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

#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.

#2733 Scott, G.R., 1975, Reconnaissance geologic map of the Buena Vista quadrangle, Chaffee and Park Counties, Colorado: U.S. Geological Survey Miscellaneous Field Studies Map MF-657.

#2765 Tweto, O., 1974, Reconnaissance geologic map of the Fairplay West, Mount Sherman, South Peak, and Jones Hill 7 1/2-minute quadrangles, Park, Lake, and Chaffee Counties, Colorado: U.S. Geological Survey Miscellaneous Field Studies Map MF-555.

#1956 Tweto, O., 1978, Northern rift guide 1, Denver-Alamosa, Colorado, *in* Hawley, J.W., ed., Guidebook to Rio Grande rift in New Mexico and Colorado: New Mexico Bureau of Mines and Mineral Resources Circular 163, p. 13-27.

#2769 Tweto, O., and Case, J.E., 1972, Gravity and magnetic features as related to geology in the Leadville 30-minute quadrangle, Colorado: U.S. Geological Survey Professional Paper 726-C, 31 p.

#2772 Tweto, O., and Reed, J.C., Jr., 1973, Reconnaissance geologic map of the Mount Elbert 15-minute quadrangle, Lake Chaffee, and Pitkin Counties, Colorado: U.S. Geological Survey Open-File Report 73-5279.

	#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. #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.