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Southern Sangre de Cristo fault, Urraca section (Class A) No. 2017b

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Synopsis	**General:** The Southern Sangre de Cristo fault is a west-dipping fault that in New Mexico forms the border between the Sangre de Cristo Mountains and the San Luis basin. In Colorado, the fault forms the border between San Pedro Mesa to the east and San Luis Valley to the west. At an embayment in the Sangre de Cristo Range, at the New Mexico/Colorado border, faulting steps eastward to the Northern Sangre de Cristo fault [2321]. The Southern Sangre de Crist fault has subdued geomorphic expression compared to the Northern Sangre de Cristo fault.

	Sections: This fault has 5 sections. The four sections in New Mexico are better exposed and have been studied in more detail than the single section in Colorado. Menges (1988 #1120; 1990 #1116; 1990 #1387) defined 4 geometric segments and 13 subsegments of the Southern Sangre de Cristo fault in New Mexico on the basis of physiographic and geomorphic expression of the fault zone and the morphology of the Sangre de Cristo range front in New Mexico, but did not investigate the part of the fault that extends north into Colorado. The trace of the fault in Colorado is mainly buried by Quaternary landslide debris. On the basis of fault scarp geomorphic expression, morphometric analyses of scarps, and surficial mapping, Ruleman and Machette (2007 #7252) suggest combining the Urraca and Questa sections into the Latir Peaks section of the fault. The original sectioning of the fault is retained in this update because of the lack of robust understanding of the timing of the most recent event, vertical-displacement rates, and recurrence intervals along the fault.
Name comments	**General:** The Sangre de Cristo fault system borders the eastern margin of the San Luis basin, which extends from Poncha Pass, Colorado, to near Taos, New Mexico. This description addresses only the southern part of the fault system, which extends from the north end of San Pedro Mesa Creek south to its intersection with the Embudo fault at TalpaRancho, about 8 km south of Taos. Upson (1939 #1142) first mapped the fault in Colorado and northern New Mexico. The Southern Sangre de Cristo fault, as used by Menges (1988 #1120; 1990 #1116; 1990 #1387) and herein, includes the Sangre de Cristo fault zone of Lipman and Mehnert (1975 #1955), the Taos fault of Dungan and others (1984 #1181), and the Cedros Canyon, Urraca Ranch, Taos Pueblo, and Cañon faults of Machette and Personius (1984 #1113) and Personius and Machette (1984 #1124). Ruleman and Machette (2007 #7252) suggest the Sangre de Cristo fault system (including the Northern Sangre de Cristo [2321] and the Southern Sangre de Cristo, herein) is more appropriately divided into northern, central, and southern based on tectonic activity that has shifted from the southern and northern parts of the fault system to the central part during the late Quaternary. The southern fault zone of Ruleman and Machette (2007 #7252) coincides with what we call the Southern Sangre de Cristo fault. **Section:** This section corresponds to segment 1 of Menges (1988 #1120; 1990 #1116; 1990 #1387), but a new name is used to avoid numerical section designations. This section includes the

	Cedro Canyon and Urraca Ranch faults of Machette and Personius (1984 #1113) and Personius and Machette (1984 #1124). The northern termination of the section is at Costilla Creek, which marks the southern edge of a large re-entrant of the Sangre de Cristo Mountains. The southern end of the section is at Rito Primero, which coincides with a moderate salient in the range front and is the northern end of segment 2 of Menges (1988 #1120; 1990 #1116; 1990 #1387). Ruleman and others (2013 #7252) group the Urraca and Questa sections into the Latir Peaks section. **Fault ID:** Segment 3 of Menges (1988 #1120; 1990 #1116; 1990 #1387).
County(s) and State(s)	TAOS COUNTY, NEW MEXICO
Physiographic province(s)	SOUTHERN ROCKY MOUNTAINS
Reliability of location	Good Compiled at 1:250,000 scale. *Comments:* Menges (1988 #1120) mapped fault traces from aerial photography at scales of 1:15,780 to 1:70,000, and presents mapping at a scale of about 1:400,000. Machette and Personius (1984 #1113) mapped fault traces at a scale of 1:250,000.
Geologic setting	The Southern Sangre de Cristo fault is part of a major rift-margin structure of Neogene age that borders the eastern margin of the Rio Grande rift in south-central Colorado and north-central New Mexico. The entire Sangre de Cristo fault system generally forms the boundary between the San Luis basin to the west, a narrow (10–25 km wide), east-tilted, asymmetrical half-graben on the west, and the Sangre de Cristo Mountains to the east. There is 7–8 km of structural relief on Precambrian basement rock across the Sangre de Cristo fault zone (Lipman and Mehnert, 1975 #1955). The western margin of the San Luis basin has comparatively little displacement, and no evidence of late Quaternary displacement. The southern end of the fault merges with or intersects the north-down, sinistral Pilar section of the Embudo fault [2007a] near the village of Talpa, New Mexico; geologic mapping shows there is not a distinct boundary between the Embudo and the Southern Sangre de Cristo faults (Bauer and Kelson, 2004 #7250). Wong and others (1995 #1155) note that a few well-located earthquakes

	appear to have occurred near the fault in New Mexico.
Length (km)	This section is 22 km of a total fault length of 96 km.
Average strike	N3°E (for section) versus N6°W (for whole fault)
Sense of movement	Normal
Dip	60° W *Comments:* Deep seismic reflection data and two-dimensional modeling of gravity data near Alamosa, Colorado, suggest that the most likely dip of the Northern Sangre de Cristo fault [2321] is 60° (Kluth and Schaftenaar, 1994 #1183). Tandon (1992 #1390; cited in Chapin and Cather, 1994 #1180) interprets the same data set processed for deeper resolution, and concludes that the fault dips about 60° to at least 26 to 28 km, which is probably below the brittle-ductile transition zone.
Paleoseismology studies	
Geomorphic expression	Prominent west-facing fault scarps are present on late Pleistocene and possibly Holocene alluvial fans derived from the Sangre de Cristo Mountains. Menges (1988 #1120; 1990 #1116; 1990 #1387) documents the presence of truncated ridge spurs and triangular facets along the Sangre de Cristo range front, and interprets these features as products of long-term displacement. Ruleman and Machette (2007 #7252) note that the precipitous range front has sharp, basal, faceted spurs as well as scarps that vertically offset alluvium as much as 7.8 m.
Age of faulted surficial deposits	Machette and Personius (1984 #1113) and Personius and Machette (1984 #1124) identify displaced late Quaternary deposits along the fault, including alluvial-fan deposits interpreted as middle to late Pleistocene and possibly early Pleistocene. These workers note that latest Pleistocene to Holocene alluvial-fan sediments bury the fault at the northern end of this section. Menges (1990 #1116; 1990 #1387), in contrast, notes that this fault section has experienced late Pleistocene to late Holocene movement.
Historic earthquake	
Most recent	latest Quaternary (<15 ka)

prehistoric deformation	*Comments:* The exact timing of the most-recent event on this section is unknown. However, Machette and Personius (1984 #1113) and Personius and Machette (1984 #1124) suggested a late Pleistocene age for the most recent movement based on scarp profile data. Menges (1988 #1120; 1990 #1116; 1990 #1387) conducted a more exhaustive study of fault-related landforms, and suggested the possibility of late to middle Holocene movement along part of the Urraca section. A plot of scarp height versus maximum slope angle for fault scarp profiles along the Latir section suggests that only one Holocene event has displaced latest Pleistocene to Holocene deposits (Ruleman and Machette, 2007 #7252).
Recurrence interval	10 to 50 k.y. *Comments:* Menges (1988 #1120; 1990 #1116; 1990 #1387) estimated recurrence at a given site along the southern Sangre de Cristo fault as 10,000 years and stated that this is compatible with data from the northern part of the Sangre de Cristo fault system (l10 to 50 k.y.) given by McCalpin (1982 #791). Ruleman and others (2013 #7251, 2013 #7253) speculate recurrence intervals are greater than 30 k.y. However, no data exist that are specific to this section.
Slip-rate category	Less than 0.2 mm/yr *Comments:* Menges (1988 #1120; 1990 #1116; 1990 #1387) estimated two different vertical-displacement rates for the southern Sangre de Cristo fault on the basis of fault scarp data: (1) a post-late Pleistocene (post-Bull Lake) rate of 0.03–0.06 mm/yr, and (2) a post-Pliocene (post-4 Ma) rate of 0.12–0.23 mm/yr. Ruleman and others (2013 #7251, 2013 #7253) concur that late Quaternary vertical-displacement rates are low (0.04 mm/year) based on 5.3 m of displacement of a deposit assumed to be 130 ka; furthermore, they propose possible and late middle Quaternary vertical-displacement rates that range from 0.01–0.1 mm/yr based on gross range-front morphology; Ruleman and Machette (2007 #7252) suggest a single vertical-displacement rate of 0.06 mm/yr in the past 100 k.y. All available vertical displacement rates support assigning the lowest slip-rate category.
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