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Quaternary Fault and Fold Database of the United States

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Caballo fault, central section (Class A) No. 2088b

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Compiled in cooperation with the New Mexico Bureau of Geology & Mineral Resources

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Synopsis	**General:** This down-to-the-west normal fault bounds the north-trending, east-tilted Caballo block, south of Truth or Consequences, New Mexico. The fault forms part of the eastern margin of the Palomas Basin, an eastward-tilted, sediment-filled half graben. The fault probably began to uplift the Caballo Mountains in the Miocene, but uplift continued into the Pliocene and Quaternary. The geometry and general movement history of the fault suggest that it has four discrete sections: Holocene fault scarps are present on the Williamsburg (northwestern) and central sections of the Caballo fault. Deposits of the Palomas Formation

	(Pliocene-Pleistocene) and middle Pleistocene to Holocene piedmont-slope deposits are offset along the Williamsburg and central sections of the fault. The northern and southern parts of the fault appear to be of pre-Quaternary age, and thus are not included in the following discussion. About 35 topographic profiles have been measured on the Quaternary age sections to characterize the fault scarp morphology, and two exploratory trenches have been excavated to document the timing of fault movement. **Sections:** This fault has 2 sections. Sections are defined on the basis of geometry, apparent timing of faulting, range-front morphology, and gaps in fault continuity. The Williamsburg (northwestern) and central sections clearly have repeated Pleistocene and Holocene movement, whereas the northern and southern sections do not appear to displace Quaternary deposits, at least as seen in reconnaissance studies. Therefore, only the two Quaternary-age sections [2088a, 2088b] are discussed herein.
Name comments	**General:** The fault is named for the Caballo Mountains. The name appears to have been in common usage by the 1940s and is cited in Kelley and Silver (1952 #1072). However, we have been unable to document the first usage of this fault name. This description includes the Gordon fault, a mountainward fault associated with the Caballo according to Seager and Mack (2005 #1257). **Section:** This section was named the central segment of the Caballo fault by Machette (1987 #960) and Foley and others (1988 #991); this is the only active section of the three main range-bounding sections along the Caballo Mountains. The central section extends from its intersection with the Williamsburg section [2088a] south to Caballo Canyon, where it appears to merge with the Red Hills fault [2087] as originally suggested by Kelley and Silver (1952 #1072). The northern (inactive) section of the Caballo fault merges with the Hot Springs fault [2100] east of Truth or Consequences and joins the central section north of Palomas Gap Creek (Red Canyon). The central section includes the Gordon fault of Seager and Mack (2005 #1257). To the south at Flordillo Canyon, the central section of the fault branches off from the southern (pre-Quaternary) section, which continues southeastward as the inactive range-bounding fault of the southern Caballo Mountains (Seager and Mack, 1998 #1258; Seager, 1995 #1259).

	Fault ID: Referred to as fault 9 in Machette (1987 #960) and fault 2 in Machette (1987 #847).
County(s) and State(s)	SIERRA COUNTY, NEW MEXICO
Physiographic province(s)	BASIN AND RANGE
Reliability of location	Good Compiled at 1:24,000 scale. *Comments:* The location of the fault is from detailed (1:24,000 scale) reconnaissance mapping by Machette (1987 #960) and Foley and others (1988 #991), and from 1:24,000-scale geologic maps of Seager and Mack (2005 #1257) and Seager (unpub. mapping of Palomas Gap 7.5-minute quadrangle). Seager and others (1982 #626) showed the generalized trace of the fault at 1:125:000 scale in the Las Cruces 1° x 2° quadrangle, which includes the southern half of this section. This generalized trace was based on mapping published by Seager and Mack (2005 #1257). The geologic map of Kelley and Silver (1952 #1072) does not show the central section of the Caballo fault as joining the Red Hills fault [2087].
Geologic setting	This down-to-the-west normal fault bounds Precambrian, Paleozoic, and Tertiary rocks that are uplifted in the north-trending, east-tilted Caballo block. The fault forms part of the eastern margin of the Palomas Basin, an eastward-tilted sediment-filled half graben. The Caballo fault abuts and truncates the Hot Springs fault [2100] on the north and joins the Red Hills fault [2087] on the south. Quaternary movement on the fault appears to have followed different paths than earlier in the Cenozoic. As a result, the active trace of the Caballo fault is concave to the west, rather than to the east as reflected in the shape of the Caballo Mountains. The Caballo, Hot Springs [2100], Red Hills [2087], and Derry [2086] faults form the western, tectonically active margin of the Caballo uplift (Caballo Mountains, Red Hills, Derry Hills, Round Mountain, and Red House Mountain). Sediment of the Palomas Formation and middle Pleistocene to Holocene piedmont-slope deposits are offset along the northern and central sections of the Caballo fault indicating young movement, whereas the southern section appears to be of pre-Quaternary age.
Length (km)	This section is 13 km of a total fault length of 21 km.

Average strike	N7°E (for section) versus N4°W (for whole fault)
Sense of movement	Normal *Comments:* Kelley and Silver (1952 #1072) considered the fault as normal, but suggested that lateral drag of fabric within Precambrian rocks of the Caballo Range may reflect left-lateral movement on the fault. If such movement occurred, it may date from Cenozoic or older deformation.
Dip	80°–90° W *Comments:* Approximate dip of fault zone as measured in exposures along an arroyo that cuts across the scarp about 1 km south of Granite Canyon (Foley and others, 1988 #991, fig. 2.9).
Paleoseismology studies	Site 2088-2. Foley and others (1988 #991) excavated the southern wall of an arroyo across the main-range bounding scarp about 1 km south of Granite Canyon (trench 2 of Foley and others, 1988 #991). This exposure revealed evidence for two surface-faulting events that produced a total of 3–4 m of offset in the past 50–150 k.y. Each event yielded a net offset of 1.5–2 m, as evidenced by the thickness of fault-generated scarp colluvium. The soil on the youngest (unfaulted) colluvium is poorly developed and appears to be similar to soils on the Fillmore alluvium (Holocene) near Las Cruces. Calculations of the amount of secondary carbonate in this young soil yields soil accumulation times of 5–7 k.y. There is no soil associated with the colluvium from the older faulting event, which suggests that it has been either removed or did not have time to form between the two faulting events.
Geomorphic expression	This section of the fault is marked by nearly continuous west-facing scarps that are formed on locally derived sediment of the Camp Rice Formation, on younger piedmont-slope deposits that cut across the Camp Rice, and on alluvial terraces inset within these deposits. The scarps are 27–44 m high on the oldest Quaternary deposits (Palomas Formation, equivalent to fanglomerate facies of the Camp Rice Formation), and become progressively smaller on younger deposits, indicating a long history of recurrent movement on the fault. Scarps are well developed between Red Canyon and Ash Canyon, but access is difficult and only five scarp profiles have been measured in this area. The fault is easily accessed by road between Ash Canyon and Flordillo Canyon, where Machette (1987 #960) and Foley and

	others (1988 #991) measured 25 scarp profiles. Most of these profiles indicate that the scarps are the product of multiple faulting events (scarp heights from 5–43 m). Six of the profiles had young slope elements that may relate to a single faulting event or the most recent faulting event. The scarp-morphology data (Machette, 1987 #960, table 1) suggested that the most recent faulting event occurred during the past 5 ka. The youngest and steepest element of the scarps are 2.8–4 m high and have maximum slope angles of 16°–22° (respectively). At the southern end of the section, young fault scarps turn southwestward (toward the Red Hills fault [2087]) and bifurcate from the main trend of the fault. The south to southeast continuation of the fault does not appear to have young scarps, and thus is designated as a different (southern) section.
Age of faulted surficial deposits	This section of the fault displaces sediment of the Palomas Formation, and piedmont-slope deposits associated with the Tortugas (150–250 ka) and Picacho (50–150 ka) alluvium, according to Foley and others (1988 #991). The compiler (Machette) prefers to use slightly different ages of 250±50 ka for the Tortugas and 100±30 ka for the Picacho. Mack and others (1993 #1020) suggest that the Cuchillo surface is probably 700–900 ka. Finally, Foley and others (1988 #991) demonstrated that Holocene colluvium is offset in an exposure along an arroyo 1 km south of Granite Canyon.
Historic earthquake	
Most recent prehistoric deformation	latest Quaternary (<15 ka) *Comments:* The most recent event is considered to be 4–5 ka on the basis of scarp-morphology studies (Machette, 1987 #960), and the degree of soil development on unfaulted alluvium (Foley and others, 1988 #991).
Recurrence interval	100 k.y. *Comments:* The most recent recurrence interval could range from as little as several thousand years (i.e., no soil between two young colluvial wedges) to as much as 150 k.y. (the oldest age for the Picacho alluvium, which has been faulted twice). However, better estimates of the longer-term average recurrence interval are derived from the amount of offset associated with scarps on the

	older surfaces (>150 k.y.). Machette (1987 #960) suggested long-term (average) recurrence intervals of about 100 k.y.
Slip-rate category	Less than 0.2 mm/yr *Comments:* Machette (1987 #960) suggested slip rates of 0.02–0.03 mm/yr for the post-250 ka surfaces (5–8 m of offset), and 0.05–0.08 mm/yr for the constructional surface of the Palomas Formation based on an assumed age of 500–600 k.y. Mack and others (1993 #1020) later suggested that age of the Cuchillo surface (top of the Palomas Formation) is more likely 700–900 ka, which yields a slightly lower long-term slip rate.
Date and Compiler(s)	2016 Michael N. Machette, U.S. Geological Survey, Retired Andrew P. Jochems, New Mexico Bureau of Geology & Mineral Resources
References	#991 Foley, L.L., LaForge, R.C., and Piety, L.A., 1988, Seismotectonic study for Elephant Butte and Caballo Dams, Rio Grande Project, New Mexico: U.S. Bureau of Reclamation Seismotectonic Report 88-9, 60 p., 1 pl., scale 1:24,000. #1072 Kelley, V.C., and Silver, C., 1952, Geology of the Caballo Mountains: University of New Mexico Publications in Geology 4, 286 p., 9 pls. #847 Machette, M.N., 1987, Preliminary assessment of paleoseismicity at White Sands Missile Range, southern New Mexico—Evidence for recency of faulting, fault segmentation, and repeat intervals for major earthquakes in the region: U.S. Geological Survey Open-File Report 87-444, 46 p. #960 Machette, M.N., 1987, Preliminary assessment of Quaternary faulting near Truth or Consequences, New Mexico: U.S. Geological Survey Open-File Report 87-652, 40 p. #1020 Mack, G.H., Salyards, S.L., and James, W.C., 1993, Magnetostratigraphy of the Plio-Pleistocene Camp Rice and Palomas formations in the Rio Grande rift of southern New Mexico: American Journal of Science, v. 293, p. 49–77. #1259 Seager, W.R., 1995, Geologic map of Alivio quadrangle, Sierra and Doña Ana Counties, New Mexico: New Mexico Bureau of Mines and Mineral Resources Open-File Geologic Map 204, scale 1:24,000.

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Questions or comments?