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Quaternary Fault and Fold Database of the United States

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Black Rock fault zone (Class A) No. 1485

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Synopsis	The Black Rock fault zone has been studied through detailed analysis of aerial photography, studies of detailed scarp morphology and trench investigations. This long, gently arcuate fault zone has different positions with respect to the range front and surficial expression. They include: (1) a range-front fault bounding the west front of the northern Black Rock Range; (2) continuous piedmont faults traversing the Black Rock Desert; (3) a zone of nearly continuous intrabasin faults scarps that cross the floor of the Black Rock Desert; and (4) two isolated short scarps on piedmont-slope deposits northwest of Jackson Reservoir. These faults represent late Quaternary reactivation of a much older fault zone. Inception of faulting was contemporaneous with late Miocene volcanic activity that began about 14–16 Ma; progressive northwest-directed extension has tilted bedrock in the Black Rock Range 30° eastward. There is a prominent, 5- to 7-km-wide right-stepover of the fault zone between Hardin City Hot

	Springs and Double Hot Springs that ruptured during the most recent event, which produced coseismic surface rupture along almost the entire fault zone south of about Clapper Creek as revealed by trenching and extensive scarp morphology studies. Paleoseismic studies of the Black Rock fault zone concluded that four earthquakes have ruptured the Black Rock fault zone in the past 25 k.y. The earliest event occurred between deposition of the 25 ka Wono tephra and 23 ka Trego Hot Springs tephra. The next event occurred after deposition of the Trego Hot Springs tephra (23 ka) and before about 5 ka. The penultimate event occurred between 5 ka and 1.1 ka, and the most recent event occurred after 1.1 ka. Nearly all faults in the Black Rock fault zone are expressed by nearly continuous scarps on alluvium and those on late Pleistocene piedmont-slope deposits are as much as 8.7 m high. Characteristics of single-event scarps on late Holocene alluvial-fan deposits generally include sharp breaks in slope at crest and base of scarps and lack gullying.
Name comments	The Black Rock fault zone extends along west front of the northern Black Rock Range southward as continuous piedmont faults traversing the Black Rock Desert and as nearly continuous intrabasin faults that cross the floor of the Black Rock Desert. Also includes two short isolated scarps on piedmont-slope deposits northwest of Jackson Reservoir in the northwest corner of the Black Rock Desert. The southern limit of the fault zone is on the western flank of a lone mountain about 2 km southwest of Trego Hot Springs. These faults were mapped by Willden (1964 #3002), Slemmons (1966, unpublished Vya 1:250,000-scale map), Dodge (1978 #2466, 1982 #2463), Dohrenwend and Moring (1991 #281), Dohrenwend and others (1991 #285), and Ramelli and dePolo (1993 #2855). Several recent workers have referred to it as the Black Rock fault zone (*e.g.*, Dodge, 1982 #2463; dePolo, 1998 #2845), as usage that we accept herein. The frontal fault along the northern Black Rock Range was not included in Black Rock fault zone of Dodge (1982 #2463). **Fault ID:** Refers to faults V8A and V8B of dePolo (1998 #2845).
County(s) and State(s)	PERSHING COUNTY, NEVADA HUMBOLDT COUNTY, NEVADA
Physiographic province(s)	BASIN AND RANGE
Reliability of	Good

location	Compiled at 1:100,000 scale. *Comments:* Fault locations from a point about east of Wheeler Reservoir southward are primarily based on 1:24,000-scale maps of Dodge (1982 #2463); mapping was based on photogeologic analysis of 1:30,000-scale black-and-white and color-infrared and 1:24,000-scale low-sun-angle photography transferred to 1:24,000-scale topographic maps. In the vicinity of the Quinn River and southward, fault locations include those of Ramelli and dePolo (1993 #2855), which are from photogeologic mapping transferred to 1:24,000-scale maps. The 1:250,000-scale reconnaissance photogeologic maps of Dohrenwend and Moring (1991 #281) and Slemmons (1966, unpublished Vya 1:250,000-scale map) were used along the front of the northern Black Rock Range; mapping by Dohrenwend and Moring (1991 #281) is based on photogeologic analysis of 1:58,000-nominal-scale color-infrared photography transferred directly to 1:100,000-scale topographic quadrangle maps enlarged to scale of the photographs and then reduced and transferred to 1:250,000-scale topographic maps. Mapping by Slemmons (1966, unpublished Vya 1:250,000-scale map) is from analysis of 1:60,000-scale AMS photography transferred to mylar overlaid onto a 1:250,000-scale topographic map using proportional dividers.
Geologic setting	Inception of faulting was contemporaneous with late Miocene volcanic activity that began about 14-16 Ma (Noble, 1972 #2334). This faulting and associated extension has tilted the Black Rock Range 30° eastward during late Cenozoic time (Stewart, 1978 #2866; Dodge, 1982 #2463). Late Quaternary movement of the fault zone is expressed as by frontal fault of the northern Black Rock Range, by continuous piedmont and intrabasin faults of the Black Rock Desert, and by two isolated short scarps on piedmont-slope deposits northwest of Jackson Reservoir.
Length (km)	69 km.
Average strike	N8°E
Sense of movement	Normal *Comments:* Normal movement has been widely reported in the literature (Willden, 1964 #3002; Slemmons, 1966, unpublished Vya 1? X 2? sheet; Dodge, 1982 #2463; Dohrenwend and Moring, 1991 #281; Ramelli and dePolo, 1993 #2855)

Dip	55° W. to 90° *Comments:* Dodge (1982 #2463) reported near-surface dips of faults in unconsolidated lacustrine and alluvial-fan deposits exposed in several trenches: faults exposed at the northern trench site (1485-1) near Double Hot Springs dip 65–80° W.; approximately 1.5 km southward faults in one trench dip 90° to 55° W. (site 1485-2) and in another dip 75° W. to 90° (site 1485-3); about 2 km further south (site 1485-4) a single 70° W.-dipping fault was exposed; approximately 3.5 km north of the Quinn River (site 1485-5) the fault dips 60° W.; and about 2.5 km south of the Quinn River (site 1485-6) the main fault dips 72? W.
Paleoseismology studies	Seven backhoe trenches were excavated by Dodge (1982 #2463) in unconsolidated lacustrine and alluvial-fan deposits at six sites on the Black Rock fault zone; one trench collapsed before it could be logged in detail. Tephra beds exposed in five trenches were correlated to known and dated tephra, including the approximately 25-ka Wono, 23-ka Trego Hot Springs, and 18-ka Black Rock Desert tephra beds (Davis, 1978 #5672). Site 1485-1, North of Double Hot Springs (Dodge's trench 5). Trench was excavated approximately 1 km north of Double Hot Springs across a west-facing scarp, which exposed an 11-m-wide fault zone. Stratigraphic relations suggest that the earliest event post-dates the 25 ka Wono tephra, a second event post-dates the 23 ka Trego Hot Springs tephra, and a third event offsets a soil (Toyeh soil) estimated to be about 5 ka (Dodge, 1982 #2463). Sites 1485-2 and 1485-3, East of Double Hot Springs (Dodge's trenches 4A and 4B, respectively). Trenches were excavated about 0.5 km east of Double Hot Springs and exposed the Wono, Trego Hot Springs and Black Rock Desert tephra beds. Trench 1485-2 exposed a 6-m-wide zone of vertical and near-vertical faults that vertically offset the 25 ka Wono tephra bed approximately 2.5 m. Trench 1485-3 exposed a single fault that offsets Lahontan lacustrine (Sehoo Formation) and post-Lahontan alluvial-fan deposits (Fallon Formation) about 2 m, and shows possible evidence of liquefaction (Dodge, 1982 #2463). Sites 1485-4, South-southeast of Double Hot Springs (Dodge's trench 3). Trench was excavated approximately 1.5 km south-southeast of Double Hot Springs and exposed faulted post-Lahontan alluvial-fan deposits.

	Site 1485-5, North of Quinn River (Dodge's trench 2). Trench was excavated about 3.5 km north of the Quinn River and exposed a 7-m-wide zone of generally high-angle faults cutting pre-Lahontan subaerial deposits and lacustrine sediment containing the Wono and Trego Hot Springs tephra beds; vertical offset on tephra beds is more than 4 m (Dodge, 1982 #2463). Site 1485-6, South of Quinn River (Dodge's trench 1). Trench was excavated across a 1- to 2-m-high scarp about 2.5 km south of the Quinn River and exposed a 72?W-dipping main fault and a broad zone of steeply dipping normal faults having well-developed dip-slip slickensides. In addition to brittle offset, the Marble Bluff tephra bed (lower Sehoo Formation) showed evidence of semi-plastic rotational deformation (Dodge, 1982 #2463).
Geomorphic expression	Dodge (1982 #2463) reported that the Black Rock fault zone is expressed by a 55-km-long zone of scarps marking piedmont and intrabasin faults based on detailed photogeologic and field mapping of surficial deposits and of the fault zone and about 100 scarp profiles. Multiple-event scarps on late Pleistocene piedmont-slope deposits are as much as 8.7 m high, whereas multiple-event scarps on early to mid-Holocene deposits are as much as 3.5 m high and commonly have rounded crests, poorly defined breaks in slope at base, and are incised by gullies. Single-event scarps on late Holocene alluvial-fan deposits are as much as 1.8 m high and generally have sharp breaks in slope at the crest and base of scarps and lack gullying. Trenching studies showed that late and latest Pleistocene fault scarps in several locations have been completely removed by erosion related to pluvial Lake Lahontan (Dodge, 1982 #2463). Faults are also expressed as vegetation lineaments, spring alignments including fault-controlled geothermal springs, sag ponds, offset drainages, and spring-fed sumps. Piedmont faults are marked by scarps on late Pleistocene pluvial Lake Lahontan deposits, on wave-cut terraces (Dodge, 1982 #2463, figs. 26 and 29) related to the high-stand of pluvial Lake Lahontan (~13 ka, Adams, 1997 #3003), and on post-Lahontan alluvial-fan deposits. The range-front fault is expressed as an abrupt front of the northern Black Rock Range along which upper piedmont-slope deposits appear to be faulted against Tertiary bedrock (Slemmons, 1966, unpublished Vya 1:250,000-scale map; Dohrenwend and Moring, 1991 #281). Slemmons (1966, unpublished Vya 1:250,000-scale map) reported scarps east of Jackson Reservoir

	on late Pleistocene piedmont-slope deposits and two isolated short scarps northwest of the reservoir on latest Quaternary deposits on the floor of the Black Rock Desert. dePolo (1998 #2845) reports a maximum preferred basal fault facet height of 183 m (171–207 m).
Age of faulted surficial deposits	Holocene; latest Pleistocene; late Quaternary; Tertiary. Holocene and latest Pleistocene (post-Lahontan) alluvial-fan and stream-terrace deposits and wave-cut features, related to the approximately 13-ka (Adams, 1997 #3003) highstand of pluvial Lake Lahontan, are discontinuously faulted along about 55 km of the Black Rock fault zone from the mountain south of Trego northward to about T. 38 N. (Dodge, 1982 #2463). Latest and late Quaternary lacustrine deposits, containing the 25-ka Wono tephra, 23-ka Trego Hot Springs tephra, 18-ka Black Rock Desert tephra, and Marble Bluff tephra bed (Davis, 1978 #5672), were shown to be faulted in several trenches excavated across well-defined scarps near Double Hot Springs and north and south of the Quinn River (Dodge, 1982 #2463). The youngest faulted deposit is eolian sand (about 1.1 ka) on the northern flank of a lone mountain about 2 km southwest of Trego Hot Springs (Dodge, 1982 #2463). The frontal fault of the northern Black Rock Range offsets Tertiary volcanic rocks and Quaternary piedmont-slope deposits (Dohrenwend and Moring, 1991 #281), and Slemmons (1966, unpublished Vya 1:250,000-scale map; 1967, unpublished Lovelock 1:250,000-scale map) reported faulted latest Quaternary deposits northwest of Jackson Reservoir.
Historic earthquake	
Most recent prehistoric deformation	latest Quaternary (<15 ka) *Comments:* Dodge (1982 #2463) reported a late Holocene time (<1.1 ka) based on detailed photogeologic and field mapping, and trench and scarp morphology studies; the most recent event offsets 1.1-ka eolian deposits on the northwest front of a lone mountain about 2 km southwest of Trego Hot Springs. This was preceded by three events that post-date the 25-ka Wono tephra, including an earlier Holocene event and possibly two latest Quaternary paleoevents. These conclusions are generally consistent with fault patterns based on reconnaissance photogeologic mapping of Slemmons (1967 #156) and Dohrenwend and others (1996 #2846). An undifferentiated Quaternary time is suggested for the range-front fault bounding

	the northern Black Rock Range (Slemmons, 1966, unpublished Vya 1:250,000-scale map; 1967, unpublished Lovelock 1:250,000-scale map; Dohrenwend and Moring, 1991 #281; Dohrenwend and others, 1991 #285).
Recurrence interval	*Comments:* Dodge (1982 #2463) and Dodge and Grose (1979 #2465) concluded that four earthquakes have ruptured the Black Rock fault zone between about 1 ka and 25 ka.
Slip-rate category	Less than 0.2 mm/yr *Comments:* Dodge (1982 #2463) reported that the Marble Bluff tephra bed is vertically offset about 4 m based on exposures in trench 1485-6 and hand auguring. Dodge (1982 #2463) inferred that the Marble Bluff tephra is part of the lower Sehoo Formation (presumably about 25–18 ka). The 25-ka Wono and the 23-ka Trego Hot Springs tephra beds are offset in excess of 4 m based on exposures in trench 1485-5 and hand auguring. This tephra bed was offset by 3 earthquakes between 23 ka and 5 ka (Dodge, 1982 #2463), suggesting permissive latest Quaternary vertical displacement rates consistent with the assigned category. dePolo (1998 #2845) reported a "known" vertical vertical displacement rate of 0.23 mm/yr for the northern part of the Black Rock fault zone and a reconnaissance vertical vertical displacement rate of 0.335 mm/yr for the southern part of the fault based on the maximum height of basal fault facets. The source of the data for the "known" rate is not documented. The lowest slip-rate category is assigned because the majority of rates and the average rate calculated from field evidence reported by Dodge (1982 #2463) would fall within the above category.
Date and Compiler(s)	1998 Thomas L. Sawyer, Piedmont Geosciences, Inc. Kenneth Adams, Piedmont Geosciences, Inc.
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