

Quaternary Fault and Fold Database of the United States

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Helendale-South Lockhart fault zone, Northern San Bernardino Mountains section (Class A) No. 110c

Last Review Date: 2002-04-06

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Synopsis

General: Major Holocene active dextral strike-slip fault zone located in the Central Mojave Desert. Fault zone is divided into sections for this compilation and includes: the South Lockhart, Helendale, and Northern San Bernardino Mountains sections. Detailed reconnaissance level geologic and geomorphic mapping of the fault zone includes Dibblee (1958 #6627; 1960 #6628; 1960 #6629; 1960 #6630; 1964 #1343; 1967 #1345; 1967 #6614; 1968 #6631), Page and Moyle (1960 #6637), Morton and others (1980 #6636), Manson (1986 #6635), Bryant (1986 #6611; 1987 #6626), and Bryan (1995 #6625). Holocene slip rate has not been determined for the Helendale fault. Clark and others (1984 #2876) reported a long term (Miocene) slip rate of about 1 mm/yr, based

on 1–2 km dextrally offset pluton boundary (Miller and Morton, 1980 #6618). Onset of displacement is poorly constrained between 2 Ma and 20 Ma. Petersen and Wesnousky (1994 #6024) reported a preferred slip rate of 0.8 ± 0.7 mm/yr based on 3 km dextral offset of petrologically distinct pluton reported by Dokka (1983 #6632) and Dokka and Travis (1990 #3188) and assumed initiation of offset between 2 Ma and 20 Ma. Bryan (1995 #6625) excavated three trenches (sites 110-1 and 110-2, herein) across traces of the Helendale fault in the Lucerne Valley and exposed evidence of as many as three earthquakes since about 16.5 ka. Most recent paleoevent occurred post 2.3 ka, based on calibrated ¹⁴C age of offset alluvium reported by Bryan (1995 #6625), perhaps within the last 1–2 ka.

Sections: This fault has 3 sections. There is insufficient data to designate seismogenic segments. Wesnousky (1986 #5305) proposed three segments for the Helendale fault (from north to south: Helendale A, B, and C) and considered the South Lockhart a separate fault. Page and Moyle (1960 #6637) inferred that the South Lockhart fault was the northern-most extension of the Helendale fault. Petersen and others (1996 #4860) combined the Helendale fault zone north of the San Bernardino Mountains and the South Lockhart fault. This compilation will delineate 3 sections: The South Lockhart section, which incorporates the South Lockhart fault; the Helendale section, which includes the principal active traces of the Helendale fault zone; and the Northern San Bernardino Mountains section, which includes the Helendale and North Branch Helendale faults south of the North Frontal thrust system [109].

**Name
comments**

General: Helendale fault first mapped by Vaughn (1922 #5801) and named by Bowen (1954 #6624). South Lockhart fault first mapped and named by Dibblee (1958 #6627; 1968 #6631).

Section: Section name is proposed in this compilation. Northern San Bernardino Mountains sections extends from near the mouth of Cushenbury Canyon southeast when it intersects with the Pipes Canyon fault of Dibblee (1967 #1345) and consists of the Helendale fault (southeast extension) of Jennings (1994 #2878) and an eastern trace Dibblee (1967 #1345; 1967 #6614) referred to as the North Helendale fault. The intersection of the Helendale-South Lockhart fault zone and North Frontal thrust system [109] is complex and there are differing interpretations as to whether the Helendale-South Lockhart fault zone is a through-going dextral strike slip fault or if north-vergent reverse displacement

	<p>along the North Frontal thrust system [109] is dominant (Dibblee, 1964 #1343; Hollenbaugh, 1968 #6634; Sadler, 1982 #6619; Bryant, 1986 #6611; Miller, 1987 #6617). Miller (1987 #6617) and Bryant (1986 #6611) mapped strands of the North Frontal thrust system as continuous across the strike of the Helendale fault [110b].</p> <p>Fault ID: Refers to numbers 365 (South Lockhart fault), 382 (Helendale fault), and 413 (Helendale fault (southeast extension)) of Jennings (1994 #2878) and number 42 (Helendale fault) of Ziony and others (1985 #5931).</p>
County(s) and State(s)	SAN BERNARDINO COUNTY, CALIFORNIA
Physiographic province(s)	BASIN AND RANGE PACIFIC BORDER
Reliability of location	<p>Good Compiled at 1:62,500 scale.</p> <p><i>Comments:</i> Locations are based on digital revisions to Jennings (1994 #2878). Original mapping by Dibblee (1964 #1343; 1967 #1345; 1967 #6614) is at 1:62,500. Mapping by Sadler (1982 #6619) and Bryant (1986 #6611) is at 1:24,000. Local mapping by Hollenbaugh (1968 #6634) is at 1:12,000.</p>
Geologic setting	<p>Major Holocene active dextral strike slip fault zone located in the central Mojave Desert. The northwest-striking Helendale-South Lockhart fault zone is the westernmost of a series of sub-parallel dextral strike-slip faults in the central Mojave Desert and is part of the eastern California shear zone (Dokka and Travis, 1990 #3188). The Helendale-South Lockhart fault zone extends from its presumed junction with the Lockhart fault zone [111] about 10 km northwest of Highway 395 along the South Lockhart fault [110a] south-southeast to about 15 km northwest of Highway 15 where the South Lockhart fault may form a large right step-over to the Helendale fault. The Helendale fault bounds the southwest side of the Sidewinder Mountains, through the Lucerne Valley and into the northern San Bernardino Mountains. The complex junction between the Helendale-South Lockhart fault zone and North Frontal thrust system [109] is poorly understood. Some have mapped the Helendale fault [110b] as through-going into the San Bernardino Mountains, offsetting the North Frontal thrust system [109] (e.g. Dibblee, 1964 #1343; Hollenbaugh, 1968</p>

	<p>#6634), while others map the North Frontal thrust system [109] as continuous across the Helendale fault [110b] (e.g. Bryant, 1986 #6611; Miller, 1987 #6617). Cumulative dextral displacement across the Helendale-South Lockhart fault zone may total 3 km, based on an offset 75 Ma pluton (Dokka and Travis, 1990 #3188). Miller and Morton (1980 #6618) argue that this offset pluton is dextrally offset only about 1 to 2 km. Garfunkel (1974 #6633) estimated that 10 to 15 km of dextral offset has occurred along the fault zone, based on locations of Paleozoic marine sedimentary rocks north and east of Victorville.</p>
Length (km)	This section is 20 km of a total fault length of 135 km.
Average strike	N42°W
Sense of movement	<p>Reverse</p> <p><i>Comments:</i> Sense of displacement along the Helendale-South Lockhart fault zone south of its intersection with the North Frontal thrust system is not well documented. Dibblee (1967 #6614) indicated that down-to-the-east vertical displacement occurred along the principal trace of the Helendale fault [110b, 110c]. Sadler (1982 #6619) reported that dextral displacement is minimal in the northern San Bernardino Mountains and he mapped several strands as southwest-dipping reverse faults. Miller (1987 #6617) reported that the Helendale fault in the vicinity of the Cactus Flat area (about 5 km south of the range front) is characterized by brecciated rock, but that there is virtually no offset of several plutonic and metamorphic features that cross the zone of brecciated rock.</p>
Dip	<p>30°SW to near vertical</p> <p><i>Comments:</i> Dips are poorly constrained surface measurements. Sadler (1982 #6619) in cross-sections shows dips on thrust faults at about 45°SW, but other faults are depicted with near vertical dips, suggesting a complex zone of dextral-oblique to reverse-dextral oblique slip. Exposures of fault planes in crystalline bedrock indicate that the Helendale fault southeast of its intersection with the North Frontal thrust system [109] is probably west to southwest-dipping, reverse-oblique slip with a component of dextral-slip (Sadler, 1982 #6619; Bryant, 1986 #6611).</p>

Paleoseismology studies	
Geomorphic expression	Fault is generally delineated by a northeast-facing bedrock escarpment. Fault lacks evidence of systematically displaced drainages--both dextrally and sinistrally deflected drainages observed by Bryant (Bryant, 1986 #6611)(1986). Geomorphic evidence of Holocene dextral strike-slip or reverse-oblique slip displacement was not observed by Bryant (1986 #6611), based on air photo interpretation.
Age of faulted surficial deposits	Strands of the Helendale fault offset Mesozoic and Paleozoic crystalline basement rocks and juxtapose crystalline basement rocks against undifferentiated Quaternary alluvium (Dibblee, 1964 #1343; 1967 #1345; 1967 #6614).
Historic earthquake	
Most recent prehistoric deformation	undifferentiated Quaternary (<1.6 Ma) <i>Comments:</i> Age of most recent paleoevent is unknown. Dibblee (1967 #6614) mapped Mesozoic and Paleozoic crystalline plutonic and metasedimentary rocks juxtaposed against Quaternary alluvium.
Recurrence interval	
Slip-rate category	Between 0.2 and 1.0 mm/yr <i>Comments:</i> Geomorphic expression of fault indicates significantly lower activity than central Mojave Desert faults to north and east.
Date and Compiler(s)	2002 William A. Bryant, California Geological Survey Sue Perry, Southern California Earthquake Center/U.S. Geological Survey
References	#6624 Bowen, O.B., Jr., 1954, Geology and mineral deposits of Barstow quadrangle, San Bernardino County, California: California Division of Mines Bulletin 165, 208 p., 8 pls., scale 1:125,000. #6625 Bryan, K.A., 1995, Comparison of brittle vs. ductile surface deformation in an Alquist-Priolo earthquake fault zone- Example from the Helendale fault, San Bernardino County,

California: San Diego, Calif., San Diego State University, unpublished M.S. thesis, 64 p., 3 pls.

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