Quaternary Fault and Fold Database of the United States

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Great Valley thrust fault system, Laguna Seca (GV 09) section (Class A) No. 28i

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Synopsis	**General:** The Great Valley thrust fault system is a seismically active blind thrust fault and fold belt that marks the boundary between the Coast Ranges and the Great Valley. The Great Valley thrust fault system can be described as a complex system of east vergent, shallow-dipping blind thrust faults and associated west-vergent shallow to moderately dipping backthrust faults. Quaternary deformation in the western Sacramento Valley is characterized by uplift, tilting, asymmetric folding, and, locally, by both west and east-vergent thrust faulting (Unruh and Moores, 1992). Significant seismic events associated with the Great Valley thrust fault system include: 1892 earthquake series (up to Mw6.5 based on shaking intensities) that probably occurred along the Gordon Valley thrust [28d2] (O'Connell and others 2001); 1982 Mw5.5 New Idria earthquake that occurred along the Great Valley 12 section [28l] (Ekström and others 1992); 1985 Mw6.5

	Coalinga earthquake that occurred along the Coalinga section [28m] (Ekström and others 1992); and the 1985 Mw6.1 Kettleman Hills-North Dome earthquake that occurred along the Kettleman Hills-North Dome section [28n] (Ekström and others 1992). Wong and others (1988) summarized these events and additional seismicity along the Great Valley thrust fault system. Slip rate estimates for the thrust fault system generally are based on uplift rates of specific stratigraphic horizons and fault dips, which are sometimes measured from deep seismic reflection lines, and sometimes from structural modeling. A paleoseismic study at the Lone Tree Creek site (403-1) involving trench excavations exposed deformed terraces deposits, but did not expose faulting along the San Joaquin fault [403], which may be the near surface expression of the Orestimba section [28g]. Estimated late Quaternary dip-slip rates along the Great Valley thrust fault system range from about 0.1 mm/yr for the Great Valley 01 section, 1–3 mm/yr for the Mysterious Ridge [28c] section, 0.4–0.6 mm/yr for the Orestimba [28g] section, and about 3 mm/yr for the Kettleman Hills-North Dome [28n] section. **Sections:** This fault has 14 sections. From north to south the section names are: Great Valley 01 [28a], Great Valley 02 [28b], Mysterious Ridge (GV 03) [28c], Trout Creek (GV 04a) [28d1], Gordon Valley (GV 04b [28d2], Orestimba (GV 07) [28g], Quinto (GV 08) [28h], Laguna Seca (GV 09) [28i], Panoche Hills (GV 10) [28j], Great Valley 11 [28k], Great Valley 12 [28l], Coalinga (GV 13) [28m], and Kettleman Hills-North Dome (GV 14) [28n]. The blind Great Valley thrust fault system originally was divided into 14 sections by WGNCEP (Working Group on Northern California Earthquake Potential, 1996) and Petersen and others (1996) in order to model the fault system for purposes of seismic hazard assessment. Subsequent probabilistic seismic hazard assessment models (UCERF 2-Wills and others 2008) revised the sections, replacing GV 05 [028e] with the Mt. Diablo thrust (blind) [353] and GV 06 [028f] with the Midland fault [506] and Pittsburg-Kirby Hills fault zone [246]. Wakabayashi and Smith (1994) first proposed dividing the Great Valley thrust fault system into between 18 and 25 segments, based on structural geology, geomorphology, and historical seismicity.
Name comments	**General:** Refers to the blind thrust fault and fold belt that is located along the west side of the Great Valley. Has been referred to as the Coast Range-Sierra Nevada boundary zone by Wong and others (1988), Coast Range-Central Valley boundary zone by Wakabayashi and Smith (1994) (they also refer to this structure as

	the Coast Range-Central Valley thrust system in their Figure 1), and the Great Valley thrust fault system by WGNCEP (Working Group on Northern California Earthquake Potential, 1996). Great Valley thrust fault system will be used in this compilation. **Section:** Laguna Seca section delineates a 32–42 km long buried thrust fault named the Laguna Seca thrust by Anderson and Piety (2001) for the Laguna Seca Hills. Section extends from the vicinity of O'Neill Forebay south to Little Panoche Creek and generally corresponds with GV 09 of Petersen and others (1996) and WGNCEP (Working Group on Northern California Earthquake Potential, 1996) and segment 12 of Wakabayashi and Smith (1994). **Fault ID:** Refers to numbers GV 01 to GV 14 of WGNEP (Working Group on Northern California Earthquake Potential, 1996).
County(s) and State(s)	MERCED COUNTY, CALIFORNIA FRESNO COUNTY, CALIFORNIA
Physiographic province(s)	PACIFIC BORDER
Reliability of location	Poor Compiled at 1:393,700 scale. *Comments:* Location of fault from Qt_flt_ver_3-0_Final_WGS84_polyline.shp (Bryant, W.A., written communication to K.Haller, August 15, 2017) attributed to Anderson and Piety (2001).
Geologic setting	The Great Valley thrust fault system delineates the boundary between the Coast Ranges and the Great Valley (also referred to as the Central Valley). The Great Valley thrust fault system as defined in this compilation extends for about 475 km along the west side of the Great Valley. The fault system is complex and consists of both shallow west-dipping blind thrust faults and associated east-dipping shallow to moderate dipping thrust and reverse faults. Both fault-bend folding and fault-propagation folding have been hypothesized for the Great Valley thrust fault system and it is likely that one or the other model best explains the data for any specific fault section. For example, the Coalinga section [28m] is best explained by the fault-bend fold model (Namson and Davis, 1990; Guzofski and others 2007), while

	O'Connell and others (2001) consider that the fault-propagation fold model best explains deformation along the Mysterious Ridge [28c], Trout Creek [28d1], and Gordon Valley [28d2] sections. Maximum structural relief is about 7–10 km for the fault sections along the west side of the Sacramento Valley (sections [28c], [28d1 and 28d2]; O'Connell and others 2001).
Length (km)	This section is 50 km of a total fault length of km.
Average strike	141
Sense of movement	Thrust *Comments:* Anderson and Piety (2001)
Dip	20–30° SW. *Comments:* Anderson and Piety (2001)
Paleoseismology studies	
Geomorphic expression	Anderson and Piety (2001), based on mapping by Lettis (1982), reported that the Laguna Seca blind thrust is delineated by steep east-facing range-front scarps located west of Highway I-5 from Ortigalita Creek south to about Wildcat Creek. Elevated Quaternary surfaces within the Diablo Range indicate Quaternary uplift.
Age of faulted surficial deposits	Lettis (1982) and Anderson and Piety (2001) mapped uplifted Los Banos alluvial surfaces. The deformed middle Los Banos surface is estimated to be 250±50 ka, based on soil profile development and relative weathering characteristics (Anderson and Piety, 2001).
Historic earthquake	
Most recent prehistoric deformation	middle and late Quaternary (<750 ka) *Comments:* Timing of the most recent paleoevent is poorly constrained. Anderson and Piety (2001) identified deformed late Quaternary alluvial surfaces equivalent to middle Los Banos surface (250±50 ka) of Lettis (1982).
Recurrence	

interval	
Slip-rate category	Between 1.0 and 5.0 mm/yr *Comments:* Anderson and Piety (2001) derived an uplift rate of 0.4–0. 9 mm/yr for the older Los Banos surface (Qll uplifted about 270 m, 400±100 ka) and 0.3–0.5 mm/yr for the middle Los Banos surface (Qlm uplifted about 94 m, 250±50 ka). Anderson and Piety presented three alternative hypotheses for the apparent discrepancy in the older and younger uplift rates: (1) calculated uplift rates are erroneous due to incorrect age estimates; (2) locus of uplift has migrated westward through time; or (3) uplift rate has decreased through time. They note that measurements of the different aged surfaces were made at different sites and that if the older surface is measured at the same location as the younger surface, the uplift rate of the older Qll surface is 0.4–0.6 mm/yr (180 m), more consistent with the younger Qlm uplift rate. Based on the assumption the fault dips 20–30°, Anderson and Piety estimated a slip rate of 0.6–1.8 mm/yr
Date and Compiler(s)	2017 William A. Bryant, California Geological Survey
References	#8410 Anderson, L.W., and Piety, L.A., 2001, Geologic seismic source characterization of the San Luis-O'Neill area, eastern Diablo Range, California, for B.F. Sisk and O'Neill Forebay dams, San Luis unit, Central Valley Project, California: U.S. Bureau of Reclamation, Seismotectonic Report 2001-2, 76 p., 3 appendices. #8413 Ekström, G., Stein, R.S., Eaton, J.P., and Eberhart-Phillips, D., 1992, Seismicity and geometry of a 110-km-long blind thrust fault—2. The 1985 Kettleman Hills, California, earthquake: Journal of Geophysical Research, v. 97, p. 4843–4864. #8414 Guzofski, C.A., Shaw, J.H., Lin, G., and Shearer, P.M., 2007, Seismically active wedge structure beneath the Coalinga anticline, San Joaquin basin, California: Journal of Geophysical Research, v. 112, B03S05, doi:10.1029/2006JB00446. #2878 Jennings, C.W., 1994, Fault activity map of California and adjacent areas, with locations of recent volcanic eruptions: California Division of Mines and Geology Geologic Data Map 6, 92 p., 2 pls., scale 1:750,000. #5353 Lettis, W.R., 1982, Late Cenozoic stratigraphy of the

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#1216 Working Group on Northern California Earthquake Potential (WGNCEP), 1996, Database of potential sources for

	earthquakes larger than magnitude 6 in northern California: U.S. Geological Survey Open-File Report 96-705, 40 p.

Questions or comments?