Jump to Navigation

Quaternary Fault and Fold Database of the United States

As of January 12, 2017, the USGS maintains a limited number of metadata fields that characterize the Quaternary faults and folds of the United States. For the most up-to-date information, please refer to the interactive fault map.

Pembroke faults (Class B) No. 2652

Last Review Date: 1998-05-26

citation for this record: **Wheeler, R.L., compiler, 1998, Fault number 2652, Pembroke faults, in Quaternary fault and fold database of the United States: U.S. Geological Survey website, https://earthquakes.usgs.gov/hazards/qfaults, accessed 01/04/2021 10:24 AM.**

Synopsis	Five faults in terrace deposits of probable Quaternary age were reported but not named by Bollinger and others (1992 #1800) and Law and others (1992 #1850). Mills (1994 #1864) referred to the faults collectively as "the Pembroke fault". The faulted locality is along the north side of the New River Valley, between Pembroke and Pearisburg, Virginia, approximately 1 km west of Pembroke. These are probable Quaternary faults that overlie a steeply dipping, tabular zone of hypocenters. However, it has not yet been determined whether the faults are tectonic or the result of solution collapse.
Name comments	
County(s) and State(s)	GILES COUNTY, VIRGINIA

Physiographic province(s)	VALLEY AND RIDGE
Reliability of location	Good Compiled at 1: scale. *Comments:* The faulted locality is shown on a 1:24,000 topographic base in figure 25 of Dennison and Stewart (1998 #2029).
Geologic setting	The faults are in terrace deposits of the New River, which flows northwestward across the Valley and Ridge province. The New River crosses the Giles County seismic zone at Pearisburg and Pembroke. The terrace deposits are underlain by N. 60° E.-trending, folded and thrust faulted, Ordovician carbonate rocks of the southern Appalachian Valley and Ridge province (McDowell and Schultz, 1990 #1974; Virginia Division of Mineral Resources, 1993 #1952). The terrace deposits are arched into a broad anticline, approximately 100 m wide, that trends N. 64° E. and has limb dips up to 30° (Law and others, 1993 #1851; 1998 #2045). Hundreds of small extensional faults cut the terrace strata with individual dip separations that typically are less than 30 cm (Law and others, 1997 #1852; 1998 #2045). In addition, reverse faults on both limbs of the anticline dip inward under its crest with slips of several decimeters (Law and others, 1994 #2044). In contrast to the small extensional and reverse faults, five extensional faults have dip separations measured in meters. Law and others (1992 #1850; 1993 #1851; 1994 #2044; 1997 #1852; 1998 #2045) excavated new benches and trenches across the Pembroke faults and the anticline, and reported analyses and descriptions of the structures. Results of seismic-refraction, electrical, gravity, and magnetometer surveys traced the fault system that is exposed in an embankment southwestward at least 100 m from its exposure, into a hay field (Law and others, 1994 #2044; Robinson and others, 1994 #1887; Law and others, 1998 #2045; Peavy and Sayer, 1998 #1878). Law and others (1992 #1850; 1994 #2044; 1997 #1852; 1998 #2045) suggested that the faults might be tectonic, but alternatively that they might have formed above solution collapses or slumps. Seismic-reflection and ground-penetrating radar results indicate that the anticline and extensional faults might both be caused by stratal drape over an underlying reverse fault (Williams and Callis, 1996 #1917; Callis

	and Williams, 1997 #1805). Law and others (1997 #1852) interpreted all the data together in terms of the exposed graben system being nested in the center of a larger, subsurface graben.
Length (km)	km.
Average strike	
Sense of movement	Normal, Right lateral *Comments:* The exposed faults may be caused by either subsurface dissolutoio or tectonic faulting. The causal fault, if any, remains unknown and uncharacterized. The five largest extensional faults have dip separations of 1.0 to at least 8.5 m (Law and others, 1993 #1851; 1998 #2045). The five faults bound two grabens and one half-graben in or near the hinge of the anticline, strike N. 46–80° E., dip 46–70° NW. and SE., and have slickenlines that plunge 37–70° W. to SW., thereby indicating normal slip that slightly exceeds dextral and sinistral strike slip (Law and others, 1992 #1850; 1993 #1851; 1994 #2044; 1997 #1852; 1998 #2045). Smaller reverse faults dip toward each other.
Dip Direction	NW; SE *Comments:* The five extensional faults bound two grabens and a half-graben and are reported to dip 54–72°. The exposed faults may be caused by either subsurface dissolution or tectonic faulting. The causal fault, if any, remains unknown and uncharacterized.
Paleoseismology studies	No paleoseismological studies have been reported of the anticline and faults in the terrace deposits near Pembroke. However, more regionally, Mills (1985 #1981) found no evidence of seismic shaking, faulting, or surface rupture along the New River in two trenches in the Giles County seismic zone and 18 trenches near the zone.
Geomorphic expression	The faults near Pembroke have no geomorphic expression, having been discovered in an embankment produced by excavations for landfill material (Bollinger and others, 1992 #1800; Law and others, 1992 #1850; 1998 #2045). On a more regional scale, Mills (1986 #1863; 1994 #1864) and Mills and Bartholomew (1986 #1865) examined elevations of stream terraces for several tens of kilometers along the New River, within and upstream and

	downstream of the Giles County seismic zone and the Pearisburg-Pembroke area. Mills (1986 #1863) noted that terraces downstream (northwest) of the seismic zone were higher above modern river level than those upstream (southeast) of the zone. He noted that the location and sense of the change in terrace elevation was what would be expected from seismic slip in the seismic zone. However, later Mills and Bartholomew (1986 #1865) and Mills (1994 #1864) found evidence of a prehistoric course change in the New River, which could also explain the change in terrace elevation without recourse to earthquakes. Nonetheless, Granger and others (1997 #2199) used a novel application of 26 Al/10 Be dating to estimate rates of New River downcutting on both sides of the Giles County seismic zone. Granger and others (1997 #2199) suggested faster downcutting downstream (northwest) of the seismic zone, consistent with the observation of Mills (1986 #1863).
Age of faulted surficial deposits	Early Quaternary to latest Pliocene (1.5±0.4 to 2.0±0.4 Ma: $^{26}Al/^{10}Be$ burial ages of D. Granger, reported by Law and others, 1997 #1852; 1998 #2045).
Historic earthquake	
Most recent prehistoric deformation	undifferentiated Quaternary (<1.6 Ma) *Comments:* Folding and faulting followed deposition of the terrace deposits near Pembroke. The deposits could be as old as latest Pliocene, so probably the deformation is Quaternary in age.
Recurrence interval	 *Comments:* The ages of the faults are constrained only by the age of the terrace deposits, and no information indicates the relative ages of the individual faults. If the folding and faulting were contemporaneous (Law and others, 1997 #1852), then all of the faults might be of similar ages. More fundamentally, until it can be determined whether the faults are tectonic or due to near-surface processes, any question about earthquake recurrence is premature.
Slip-rate category	Insufficient data *Comments:* The exposed faults may be caused either by subsurface dissolution or tectonic faulting. The causal fault, if

	any, remains unknown and uncharacterized. The largest slip calculated for any of the exposed faults is 11.4 m of normal dextral slip; the other calculated slips are 1.1–11.1 m (Law and others, 1993 #1851; 1998 #2045). The 11.4 m has accumulated during the duration of the faulting, which is constrained only by the 1.1–2.4 Ma age of the faulted terrace deposits. These values yield a possible average slip rate much less than 0.2 mm/yr. The rate could be greater if the faults are considerably younger than the terrace deposits, but in order for the rate to equal 0.2 mm/yr all the faulting would have to date from the last twentieth or less of the history of the faulted terrace deposits. This is possible but unlikely. More fundamentally, no such slip rates are meaningful until it can be demonstrated whether the exposed faults are of tectonic or surficial origin.
Date and Compiler(s)	1998 Russell L. Wheeler, U.S. Geological Survey, Emeritus
References	#1802 Bollinger, G.A., and Wheeler, R.L., 1980, The Giles County, Virginia, seismogenic zone: Geological Society of America Abstracts with Programs, v. 12, no. 7, p. 389. #1803 Bollinger, G.A., and Wheeler, R.L., 1983, The Giles County, Virginia, seismic zone: Science, v. 219, p. 1063-1065. #1968 Bollinger, G.A., and Wheeler, R.L., 1988, The Giles County, Virginia, seismic zone—Seismological results and geologic interpretations: U.S. Geological Survey Professional Paper 1355, 85 p. #1800 Bollinger, G.A., Law, R.D., Pope, M.C., Wirgart, R.H., and Whitmarsh, R.S., 1992, Geologically recent near-surface faulting in the Valley and Ridge province—New exposures of extensional faults in alluvial deposits, Giles County, SW Virginia: Geological Society of America Abstracts with Programs, v. 24, no. 1, p. A152. #1805 Callis, J.G., and Williams, R.T., 1997, Geophysical images and geologic models for Quaternary faults near Pembroke, Virginia, using seismic reflection and ground penetrating radar [abs.]: Seismological Research Letters, v. 68, p. 815. #2029 Dennison, J.M., and Stewart, K.G., eds., 1998, Geologic field guide to extensional structures along the Allegheny Front in Virginia and West Virginia near the Giles County seismic zone:

Guidebook, March 28-29, 1998, 102 p.

#2199 Granger, D.E., Kirchner, J.W., and Finkel, R.C., 1997, Quaternary downcutting rate of the New River, Virginia, measured from differential decay of cosmogenic 26Al and 10Be in cave-deposited alluvium: Geology, no. 25, p. 107-110.

#2042 Johnston, A.C., 1994, Appendix C—Summary tables, SCR seismicity data base, *in* Schneider, J.F., ed., The earthquakes of stable continental regions—v. 2—Appendices A to E: Technical report to Electric Power Research Institute TR-102261-V2, Palo Alto, California, December 1994, p. C-1-C-46.

#1850 Law, R.D., Pope, M.C., Wirgart, R.H., Bollinger, G.A., and Whitmarsh, R.S., 1992, Geologically recent near-surface folding and faulting in the Valley and Ridge province—New exposures of extensional faults in alluvial sediments, Giles County, SW Virginia [abs.]: Seismological Research Letters, v. 63, p. 609-610.

#1851 Law, R.D., Pope, M.C., Wirgart, R.H., Eriksson, K.A., Carpenter, D., Robinson, E.S., and Bollinger, G.A., 1993, Geologically recent near-surface folding and faulting in the Valley and Ridge province-New exposures of extensional faults in alluvial sediments, Giles County, SW Virginia [abs.]: Eos, Transactions of the American Geophysical Union, v. 74, p. 282.

#2044 Law, R.D., Pope, M.C., Wirgart, R.H., Eriksson, K.A., Robinson, E.S., Sayer, S., Phinney, E.J., and Bollinger, G.A., 1994, Geologically recent near-surface folding and faulting in Giles County, southwest Virginia—New exposures of extensional and apparent reverse faults in alluvial sediments between Pembroke and Pearisburg, *in* Proceedings of the U.S. Nuclear Regulatory Commission, Twenty-First Water Reactor Safety Information Meeting: U.S. Nuclear Regulatory Commission Report NUREG/CP-0133, v. 3, p. 415-432.

#1852 Law, R.D., Robinson, E.S., Cyrnak, J.S., Sayer, S., Williams, R.T., Callis, J., and Pope, M., 1997, Geologically-recent faulting and folding of alluvial sediments near Pearisburg, Giles County, Virginia-Tectonic faulting or karst subsidence in origin? [abs.]: Eos, Transactions of the American Geophysical Union, v. 78, no. 17, supplement, p. S316.

#2045 Law, R.D., Robinson, E.S., Sayer, S., Cyrnak, J.S., Williams, R.T., Callis, J., and Pope, M., 1998, Geologically-recent faulting and folding of alluvial sediments near Pearisburg, Giles County, Virginia—Tectonic faulting or karst subsidence in origin?, *in* Dennison, J.M., and Stewart, K.G., eds., Geologic field guide to extensional structures along the Allegheny Front in Virginia and West Virginia near the Giles County seismic zone: Southeastern Section, Geological Society of America, Charleston, West Virginia, March 28-29, 1998, Guidebook, p. 95-101.

#1974 McDowell, R.C., and Schultz, A.P., 1990, Structural and stratigraphic framework of the Giles County area, a part of the Appalachian Basin of Virginia and West Virginia, *in* Evolution of sedimentary basins—Appalachian Basin: U.S. Geological Survey Bulletin 1839, p. E1-E24, 1 pl., scale 1:125,000.

#1981 Mills, H.H., 1985, Descriptions of backhoe trenches dug on New River terraces between Radford and Pearisburg, Virginia, June, 1981:U.S. Geological Survey Open-File Report 85-474, 63 p.

#1863 Mills, H.H., 1986, Possible differential uplift of New River terraces in southwestern Virginia: Neotectonics, v. 1, p. 75-86.

#1864 Mills, H.H., 1994, Distribution of high-level gravels along the course of the New River in southwestern Virginia—Implications for neotectonics: Geological Society of America Abstracts with Programs, v. 26, no. 4, p. 56.