[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.

Gulf-margin normal faults, Alabama and Florida (Class B) No. 2654

Last Review Date: 1998-08-11

citation for this record: **Wheeler, R.L., compiler, 1998, Fault number 2654, Gulf-margin normal faults, Alabama and Florida, 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	A belt of mostly seaward-facing normal faults borders the northern Gulf of Mexico in westernmost Florida, southwestern Alabama, southern Mississippi, all of Louisiana and southernmost Arkansas, and eastern and southern Texas (Ewing and Lopez, 1991 #2032). For the purposes of his compilation, the Gulf Coast faults are divided in four large groups because they number in the hundreds. To reflect regional differences in the characteristics of the faults, those in Florida and Alabama (described here) are evaluated together in a single group, as are those in Mississippi, those in Louisiana and Arkansas, and those in Texas. Because numerous individual faults are combined into a single group for this compilation, it is not possible to provide to provide digital information about the azimuth, length, and dip of each individual fault. The gulf-margin normal faults in Alabama and Florida are assigned as Class B structures because their low seismicity and

	because they may be decoupled from underlying crust, making it unclear if they can generate significant seismic ruptures that could cause damaging ground motion.
Name comments	
County(s) and State(s)	BALDWIN COUNTY, ALABAMA CHOCTAW COUNTY, ALABAMA CLARKE COUNTY, ALABAMA ESCAMBIA COUNTY, ALABAMA MOBILE COUNTY, ALABAMA MONROE COUNTY, ALABAMA WASHINGTON COUNTY, ALABAMA ESCAMBIA COUNTY, FLORIDA SANTA ROSA COUNTY, FLORIDA
Physiographic province(s)	COASTAL PLAIN
Reliability of location	Poor Compiled at 1:2,500,000 scale. *Comments:* Most of the area was evaluated with regional maps at scales of 1:2,500,000 because no individual faults have sufficient evidence of seismic slip to justify singling it out for attention here at a larger map scale. Faults in areas having abundant drill-hole data may be better located in the subsurface than at the surface.
Geologic setting	A belt of mostly seaward-facing normal faults borders the northern Gulf of Mexico. These gulf-margin faults face southwest in westernmost Florida, southwestern Alabama, and southern Mississippi; south in Louisiana and southernmost Arkansas; and southeast in eastern and southern Texas (Ewing and Lopez, 1991 #2032). In early to middle Mesozoic time, the opening of the Gulf of Mexico formed a south-facing, rifted, passive margin at the southern edge of North America (DuBar and others, 1991 #2010; Salvador, 1991 #2019; Salvador, 1991 #2020). Subsequently, the rifted margin was buried beneath the thick, Middle Jurassic, Louann Salt and an overlying, carbonate and clastic, marine sequence that continues to accumulate today. This post-rift sequence thickens seaward (Salvador, 1991 #2020). It is at least 2 km thick everywhere in the belt of gulf-margin normal faults. At the coastline, the sequence is at least 10 km thick west of the Mississippi River and at least 5 km thick farther east. Thicknesses

exceed 12 km under coastal Texas and southern Louisiana and perhaps 16 km offshore Louisiana.

Rapid deposition and the resulting enormous thickness of the post-rift sediments caused them to collapse and spread seaward. Salt flowed southward and pierced upward, and the overlying sediments extended on listric, normal, growth faults that flatten downward into detachments in the salt and in overpressured shales (Ewing, 1991 #1994; Nelson, 1991 #1995). These listric normal faults, their splays, and their antithetic and transfer faults make up the belt of gulf-margin normal faults described here.

Regional fluctuations in the overall deposition rate divide the belt of gulf-margin faults into two parts with different main ages of faulting and different degrees of Quaternary faulting. (1) The Interior zone of Ewing (1991 #1994) includes the entire belt except southern Louisiana, coastal Texas, and their offshore extensions. Triassic-Jurassic rifting and sedimentation, including deposition of the Louann Salt, led to Mesozoic growth faulting and salt tectonism. A line of large grabens approximates the landward limit of Jurassic salt, and Cenozoic faulting is sparse in the Interior zone (Ewing, 1991 #1994; Salvador, 1991 #2019; Ewing and Lopez, 1991 #2032). (2) The Coastal zone of Ewing (1991 #1994) covers southern Louisiana, coastal Texas, and their offshore extensions, and is separated from the Interior zone by the Early Cretaceous shelf edge (Ewing, 1991 #1994; Ewing and Lopez, 1991 #2032). Late Cretaceous and especially Cenozoic clastic sediments prograded southward led to abundant Cenozoic and continuing growth faulting and salt tectonism (for example DuBar and others, 1991 #2010, p. 584-585; Salvador, 1991 #2019). The post-rift sequence as a whole is at least 9-11 km thick throughout the Coastal zone (Salvador, 1991 #2020). Calculations show that the crustal load from rapid Quaternary sedimentation may aid Quaternary normal faulting and reactivate Tertiary faults of the Coastal zone by imposing extensional bending stresses on the post-rift sequence; older extensional stresses imposed by the Mesozoic sediment load have had time to relax (Nunn, 1985 #2215).

Epicenter maps show only sparse, low-magnitude seismicity within the fault belt (Engdahl, 1988 #1959; Stover and Coffman, 1993 #1986). The only damaging earthquakes reported through 1989 in this huge tract of land are four MMI VI earthquakes in westernmost Florida (1780), southern Louisiana (1930), and eastern Texas (1891, 1932) (Stover and Coffman, 1993 #1986). This level of seismicity is even less than that of sparsely seismic North and South Dakota, which together cover approximately the same area as the belt of gulf-margin faults and which had seven earthquakes of MMI VI since 1909 (Stover and Coffman, 1993 #1986). Furthermore, some of the sparse seismicity in the normal-fault belt may be artificially induced. Earthquakes of mbLg 3.4 and 3.9 and M of 4.0 and 4.7 in southeastern Texas and M 4.9 in southwestern Alabama may have been induced by extraction of oil and gas or injection of fluids for secondary recovery (Pennington and others, 1986 #1876; Chang and others, 1998 #1806; Gomberg and others, 1998 #1828; Gomberg and Wolf, 1999 #3440). Therefore, the natural seismicity rate in the normal-fault belt might be even less than the recent historical record would indicate.

The post-rift sequence and its belt of gulf-margin normal faults may be mechanically decoupled from the underlying crust. The stress field is extensional throughout the post-rift sequence in both the Interior and Coastal zones of the normal-fault belt, as determined mostly from drill-hole data that demonstrate fault slips and well-bore breakouts (Zoback and Zoback, 1991 #2006). The orientations of Shmin are radial to the Gulf of Mexico, in contrast to the east-northeast trends of SHmax that characterize most of North America east of the Rocky Mountains; the stress field in the crust beneath the thick post-rift sequence is unknown (Zoback and Zoback, 1991 #2006). Consistent with the stress field in the post-rift sequence, the normal-faulting focal mechanism of the 1997, M 4.9 earthquake in southwestern Alabama indicated south-southwest extension (Chang and others, 1998 #1806). The presence of the normal faults throughout the post-rift sequence from westernmost Florida to southern Texas (Ewing and Lopez, 1991 #2032) demonstrates that the sequence is sliding and extending seaward on detachments in weak salt and overpressured shales.

In summary, the belt of gulf-margin normal faults in from Florida through Texas has strikingly low historical seismicity; the stress field and seismogenic potential of the underlying crust are unknown; and, therefore, the ability of the fault belt to generate significant seismic ruptures that could cause damaging ground motion is unclear. Accordingly, the fault belt is assigned to class B.

Length (km)	km.
Average strike	
Sense of movement	Normal *Comments:* In addition to the normal faults, a few strike-slip faults might form transtensional links between the normal faults.
Dip Direction	SW; NE *Comments:* Dips vary, but faults are generally steeper in their upper parts and shallow downward. Dips are dominantly southwestward, with southwesterly and northeasterly dips paired in grabens.
Paleoseismology studies	
Geomorphic expression	Scarps and drainage, topographic, and tonal lineaments (DuBar and others, 1991 #2010).
Age of faulted surficial deposits	Eocene to Holocene (Szabo and Copeland, 1988 #1946; DuBar and others, 1991 #2010).
Historic earthquake	
Most recent prehistoric deformation	undifferentiated Quaternary (<1.6 Ma) *Comments:* A belt of mostly seaward-facing normal faults borders the northern Gulf of Mexico (Ewing and Lopez, 1991 #2032). Ewing (1991 #1994) and Ewing and Lopez (1991 #2032) divided the faults into an Interior zone and a Coastal zone, which are separated by a boundary that begins in southeastern Louisiana and runs westward across Louisiana and Texas approximately 100 km inland from the coast. In the Interior zone, which includes southwestern Alabama and westernmost Florida, little Quaternary slip is documented (DuBar and others, 1991 #2010, fiure 3). However, probably many or most faults in the Interior zone have the potential for Quaternary to present-day slip. As explained in "Geologic setting", it is unclear whether such slip was or is likely to occur seismically. In contrast, the Coastal zone contains more abundant evidence of Quaternary slip, but this slip may be even less likely to occur seismically than slip in the Interior zone.

Recurrence interval	*Comments:* Estimates of recurrence interval are premature because it is not yet clear whether these faults can generate significant tectonic earthquakes, as explained under "Geologic setting".
Slip-rate category	Less than 0.2 mm/yr *Comments:* The slip rate is unknown. However, a slip rate of 0.2 mm/yr would produce 320 m of slip during the 1,600,000 years of the Quaternary. It is unlikely that any single fault in the gulf-margin belt of normal faults has such a large Quaternary offset. Therefore, probably the long-term rate is less than 0.2 mm/yr.
Date and Compiler(s)	1998 Russell L. Wheeler, U.S. Geological Survey, Emeritus
References	#1806 Chang, T.M., Ammon, C.J., and Herrmann, R.B., 1998, Faulting parameters of the October 24, 1997 southern Alabama earthquake [abs.]: Seismological Research Letters, v. 69, p. 175-176. #2010 DuBar, J.R., Ewing, T.E., Lundelius, E.L., Jr., Otvos, E.G., and Winker, C.D., 1991, Quaternary geology of the Gulf of Mexico Coastal Plain, *in* Morrison, R.B., ed., Quaternary nonglacial geology; conterminous U.S.: Boulder, Colorado, Geological Society of America, The Geology of North America, v. K-2, p. 583-610. #1959 Engdahl, E.R., compiler, 1988, Seismicity map of North America: Boulder, Colorado, Geological Society of America Continent-Scale Map 004, 4 sheets, scale 1:5,000,000. #1994 Ewing, T.E., 1991, Structural framework, *in* Salvador, A., ed., The Gulf of Mexico basin: Boulder, Colorado, Geological Society of America, The Geology of North America, v. J, p. 31-52. #2032 Ewing, T.E., and Lopez, R.F., compilers, 1991, Principal structural features, Gulf of Mexico basin, *in* Salvador, A., ed., The Gulf of Mexico basin: Boulder, Colorado, Geological Society of America, The Geology of North America, v. J, pl. 2. #3440 Gomberg, J., and Wolf, L., 1999, Possible cause for an

improbable earthquake—The 1997 Mw 4.9 southern Alabama earthquake and hydrocarbon recovery: Geology, v. 27, p. 367-370.

#1828 Gomberg, J., Wolf, L., Raymond, D., Raymond, R., Barnes, A., Carver, D., Bice, T., Cranswick, E., Meremonte, M., Frankel, A., Overturf, D., Hopper, M., Rhea, S., and Eckhoff, O., 1998, A noteworthy earthquake in an unlikely place [abs.]: Seismological Research Letters, v. 69, p. 175.

#1876 Pennington, W.D., Davis, S.D., Carlson, S.M., DuPree, J., and Ewing, T.E., 1986, The evolution of seismic barriers and asperities caused by the depressuring of fault planes in oil and gas fields of south Texas: Bulletin of the Seismological Society of America, v. 76, p. 939-948.

#2019 Salvador, A., compiler, 1991, Cross sections of the Gulf of Mexico basin, *in* Salvador, A., ed., The Gulf of Mexico basin: Boulder, Colorado, Geological Society of America, The Geology of North America, v. J.

#2020 Salvador, A., compiler, 1991, Structure at the base and subcrop below Mesozoic marine section, Gulf of Mexico basin, *in* Salvador, A., ed., The Gulf of Mexico basin: Boulder, Colorado, Geological Society of America, The Geology of North America, v. J.

#1986 Stover, C.W., and Coffman, J.L., 1993, Seismicity of the United States, 1568-1989 (revised): U.S. Geological Survey Professional Paper 1527, 418 p.

#1946 Szabo, M.W., and Copeland, C.W., Jr., 1988, Geologic map of Alabama, southwest sheet: Geological Survey of Alabama Special Map 220, 1 sheet, scale 1:250,000.

#2006 Zoback, M.D., and Zoback, M.L., 1991, Tectonic stress field of North America and relative plate motions, *in* Slemmons, D.B., Engdahl, E.R., Zoback, M.D., and Blackwell, D.D., eds., Neotectonics of North America: Boulder, Colorado, Geological Society of America, Decade Map Volume 1, p. 339-366.