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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.

Newbury liquefaction features (Class A) No. 2651

Last Review Date: 1998-04-10

citation for this record: **Wheeler, R.L., and Tuttle, M.P., compilers, 1998, Fault number 2651, Newbury liquefaction features, 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	The evidence for Quaternary faulting at this locale in northeastern Massachusetts consists of (1) eyewitness reports of liquefaction during an earthquake of MMI VII (moment magnitude M 4.8) in 1727, (2) sand dikes found in trenches and attributed to the 1727 earthquake, and (3) mid- to late Holocene sand dikes and a sand sill that is cut by the 1727 dikes. These liquefaction features are evidence of strong shaking, but they do not identify the specific fault or faults that caused an earthquake or earthquakes. Because individual Quaternary faults remain unidentified, it is not possible to define and measure specific attributes (azimuth, length, dip, etc.) for the Newbury liquefaction features.
Name comments	

County(s) and State(s)	ESSEX COUNTY, MASSACHUSETTS
Physiographic province(s)	NEW ENGLAND
Reliability of location	Poor Compiled at 1:117,000 scale. *Comments:* The liquefaction was recognized as the type that is caused by strong ground motion (Tuttle and Seeber, 1991 #1911), and the strong ground motion is presumed to have been caused by slip on a preexisting fault (for example Hamilton, 1981 #2035). However, despite the presence of large, mapped faults in the vicinity (Tuttle and Seeber, 1991 #1911), the fault responsible for the liquefaction remains unidentified.
Geologic setting	The study site in northeasternmost coastal Massachusetts is within the area in which liquefaction occurred during an earthquake of MMI VII in 1727 (Tuttle and others, 1987 #2061). Johnston (1994 #2042) estimated the moment magnitude as M 4.8. This part of New England has been seismically active during and since colonial times (Ebel and Kafka, 1991 #2008). The area is underlain by Paleozoic and Precambrian metamorphic and igneous rocks that were folded and juxtaposed by slip on numerous mapped faults during the assembly of the northern Appalachians (Zen and others, 1983 #1960). However, the locations of both earthquakes and faults at depth have large uncertainties. Thus, to date no New England earthquakes have been convincingly associated with known faults.
Length (km)	km.
Average strike	
Sense of movement	No data *Comments:* The 1727 earthquake is known only from reports of shaking and of liquefaction. No other deformation is known from this or any older earthquake at the site.
Dip Direction	Unknown *Comments:* The causative fault remains unidentified and uncharacterized.

Paleoseismology studies	The only paleoseismological study is that of Tuttle and Seeber (1991 #1911). During reconnaissance of sand and gravel pits and other excavations in late Pleistocene glacial deposits in northeastern Massachusetts and southeastern New Hampshire, Tuttle and Seeber (1991 #1911) found abundant soft-sediment deformation features, but none of the features could be attributed solely to earthquakes. However, accounts of the 1727 earthquake described several areas of ground failure typical of earthquake-induced liquefaction. Tuttle and Seeber (1991 #1911) relocated these areas by studying family genealogies, transfer of property through wills and deeds, and old maps. They then excavated trenches at these sites. In one or more trenches at a single site [2651-1], they observed that dikes of white, very fine-grained sand cut the Late Pleistocene, glaciomarine clay and a sandy soil B horizon. The glaciomarine clay also contains reddish, medium-grained sand domains that Tuttle and Seeber (1991 #1911) suggested are remnants of dikes older than those of the white, fine-grained sand. At a second site 5 km away [2651-2], the sandy B horizon contains a basal layer of gray, silty, virtually unweathered sand, which Tuttle and Seeber (1991 #1911) interpreted as a sill emplaced beneath possibly frozen ground. Some dikes appear to feed the sill, whereas other dikes cut it. Tuttle and Seeber (1991 #1911) interpreted the sill and the dikes that cut it as evidence of two episodes of liquefaction. Tuttle and Seeber (1991 #1911) suggested that the younger liquefaction episode was caused by the 1727 earthquake. A separate reconnaissance of riverbank and marsh outcrops in northeastern Massachusetts and nearby New Hampshire found no evidence of liquefaction in salt marsh deposits that are 1500-3000 years old and underlain by highly liquefiable sands (Gelinas and others, 1993 #1826).
Geomorphic expression	The geomorphic expression is chiefly liquefaction features: sandblows at the surface and sand dikes in excavations (Tuttle and Seeber, 1991 #1911). In addition, two new springs formed in 1727, and localized elevation of marshland at the same time might have been caused by a lateral spread (Tuttle and others, 1987 #2061).
Age of faulted surficial deposits	The location of the fault is unknown. The area is underlain by late Pleistocene, glaciomarine deposits: clay at the surface is underlain by sand and then bedrock (Tuttle and others, 1987 #2061). The sand is very susceptible to liquefaction. Tuttle and Seeber (1991

	#1911) presumed the sand to be the source of the sand dikes.
Historic earthquake	
Most recent prehistoric deformation	latest Quaternary (<15 ka) *Comments:* Accelerator mass spectrometric (AMS) dates on wood samples that are stratigraphically related to the sand dikes constrain both liquefaction episodes to between 110 and 4,430 yr BP.
Recurrence interval	4 k.y. (4,430yr BP—AD 1727) *Comments:* From the AMS dates, Tuttle and Seeber (1991 #1911) suggested a maximum recurrence interval of approximately 4,000 years for earthquakes large enough to cause liquefaction in the study area.
Slip-rate category	Insufficient data *Comments:* No dated fault offset is known, so no slip rate can be calculated.
Date and Compiler(s)	1998 Russell L. Wheeler, U.S. Geological Survey, Emeritus Martitia P. Tuttle, M. Tuttle and Associates
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