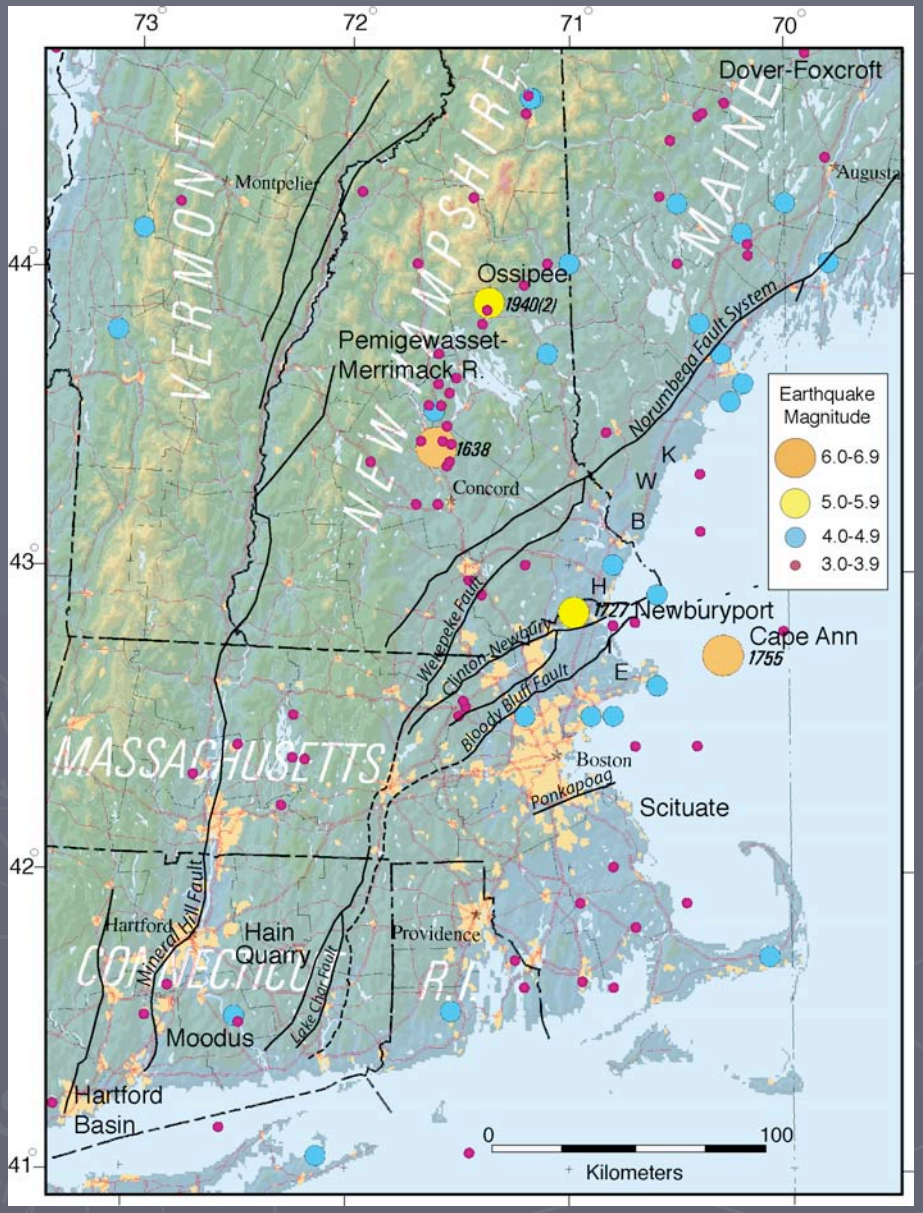
Paleoseismology Studies in New England



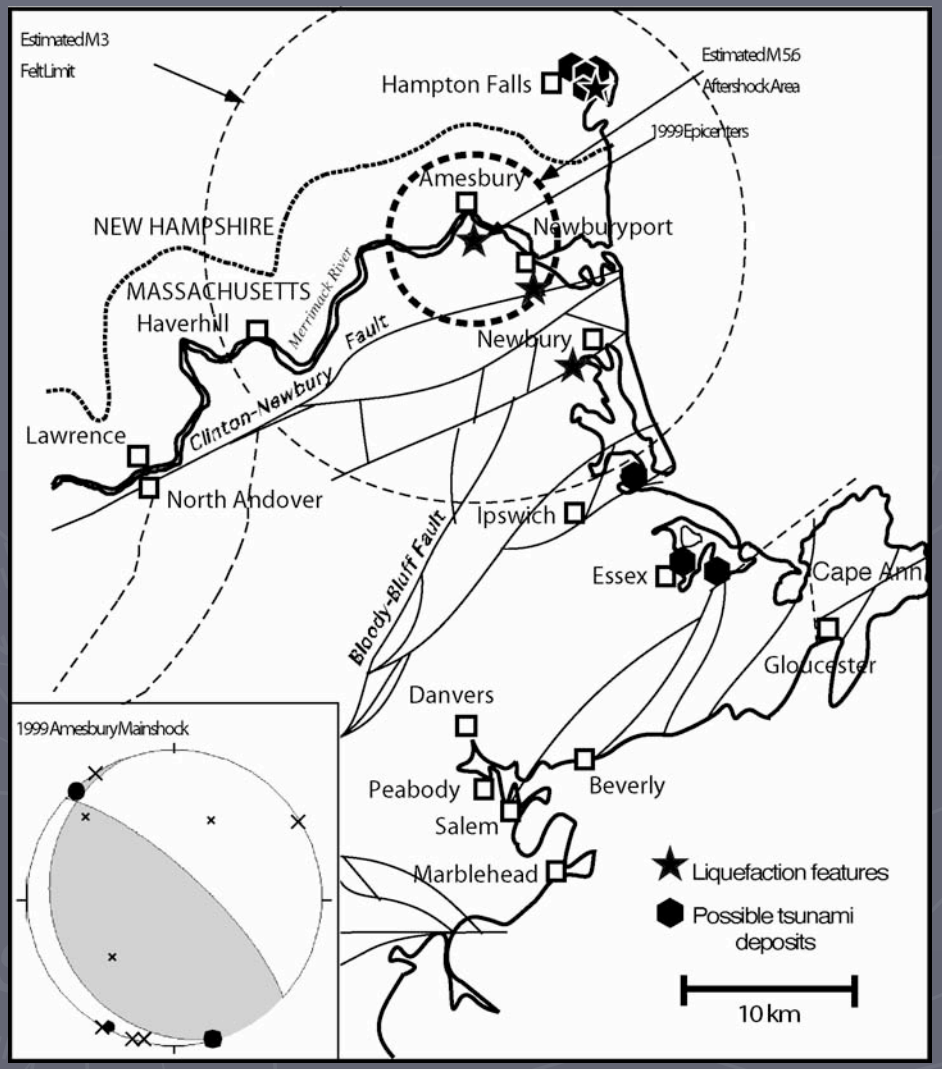
After Ebel and Spotilla, 1999; Wheeler et al., 2001

- **1979 Thompson:** Passamoquaddy Bay Norumbega post glacial offsets
- **1986 Thorson, Clayton & Seeber:** Hain Quarry deformation features
- **1990 Tuttle et al:** 1989 Saguenay and earlier earthquake liquefaction features
- **1991 Tuttle & Seeber:** Newburyport area recon and trenching
- **1994 Gelinas et al:** Newburyport and Moodus reconnaissance & Lake Ossipee coring
- **1996 Roy:** Dover-Foxcroft recon for earthquake-related deformation
- **1999 Thompson & Varekamp:** Eastern border fault of Hartford Basin
- **2000 Tuttle, Sims & Roy:** Scituate 1755 liquefaction site & river recon
- **2003-2005 Tuttle, Ebel, Witkowski, Myskowski, & Efros:** Revisit Newbury-port; reconnaissance in Hampton & other coastal marshes

Paleoseismology Ain't Easy in New England

- Glaciated terrane scrapped clean and buried by glacial, glacio-fluvial, -lacustrine, and -marine deposits
- Soft-sediment deformation structures common in these deposits
- Great vertical and lateral variability in surficial deposits (not MRV)
- Region is heavily forested and water table high resulting in poor exposure
- In many areas, geologic record is disturbed or destroyed by human activity
- Liquefaction features and fault offsets appear to be small

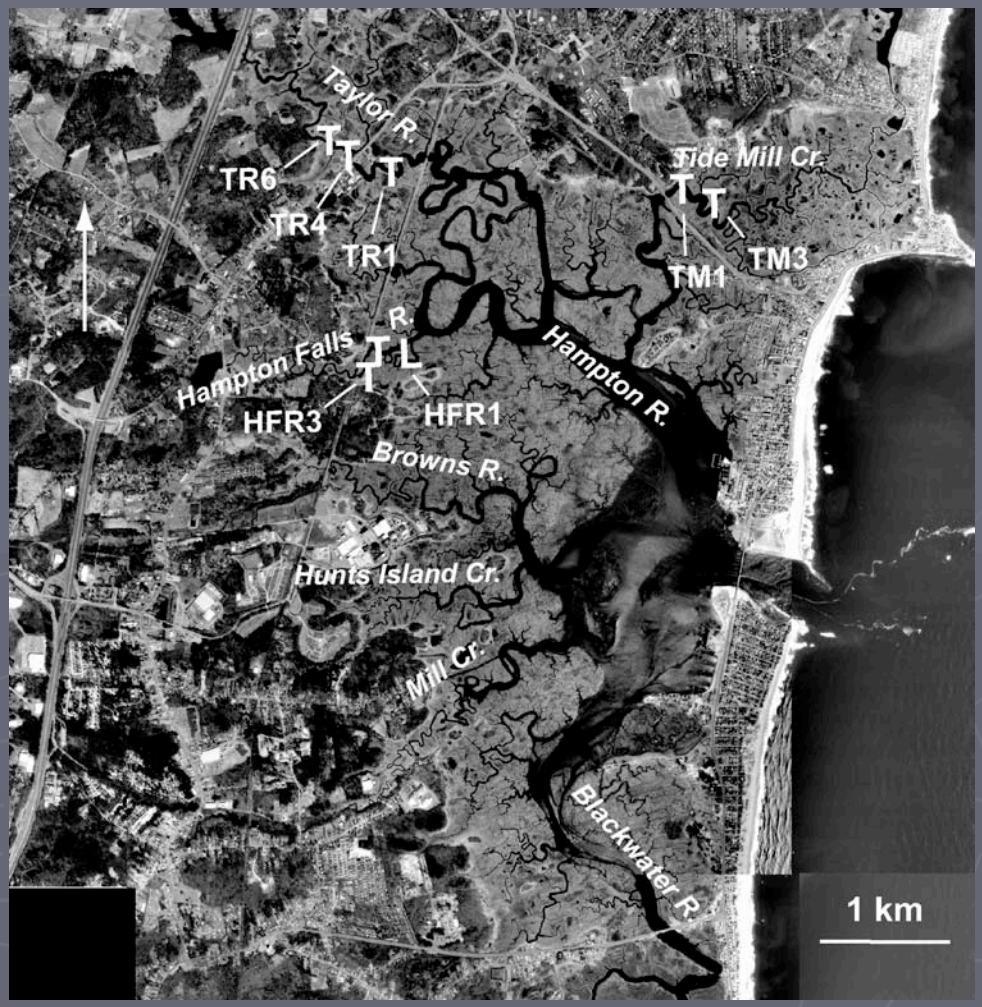
Newburyport Paleoseismology Studies



From Ebel, 2000; faults from Zen et al., 1983

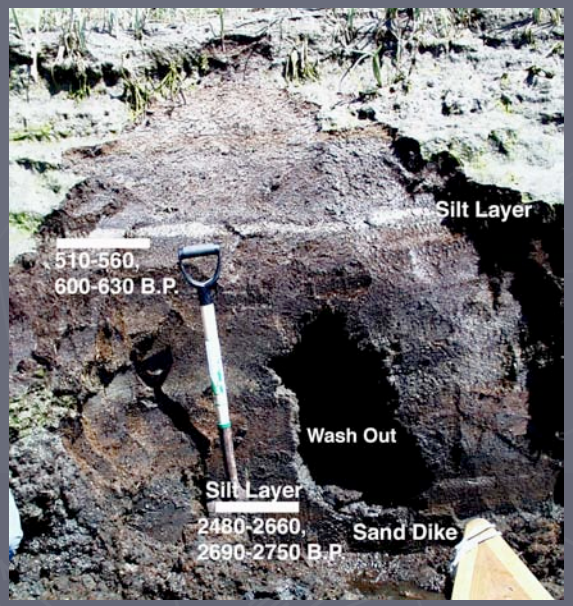
- Historical research (wills, deeds, maps) identified likely locations of liquefaction-related ground failures
- GPR surveys, augering, trenching, and radiocarbon dating led to discovery of two generations of liquefaction features (historic and prehistoric) in past 4,000 years
- Geophysical surveys and trenching of another site and reconnaissance of Little and Parker Rivers yielded no additional liquefaction features
- Examination of previously mapped faults found small offsets (few cm) of glaciated bedrock surface across northwest oriented fractures

Hampton Paleoseismology Studies



- Accounts of liquefaction in the Hampton area during 1727 event
- Reconnaissance of several rivers in Hampton estuary

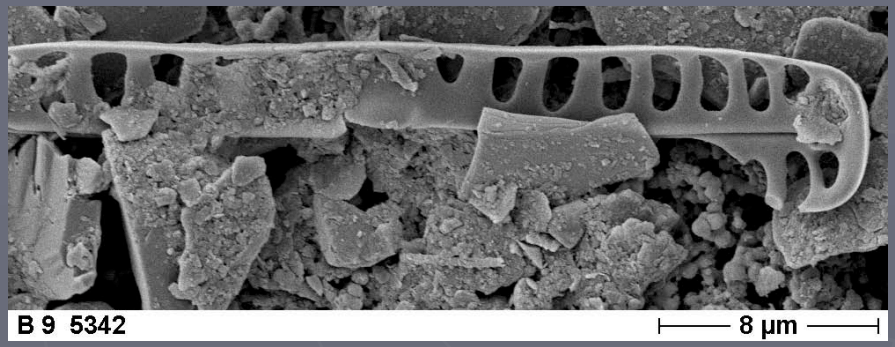
Hampton Paleoseismology Studies

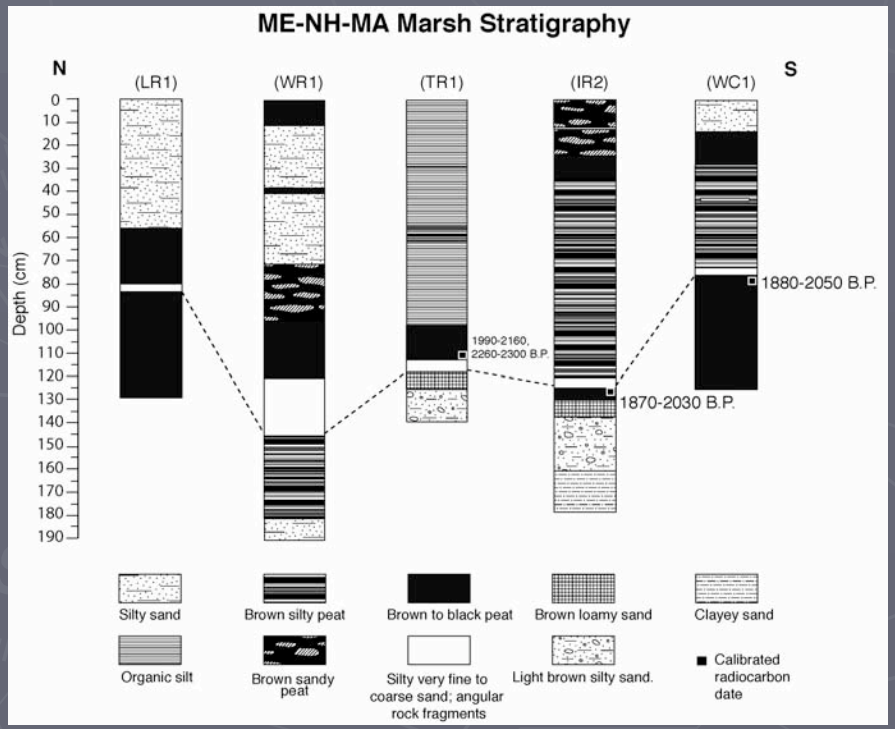


Sand Dike

- Found one small sand dike whose termination was washed out. Dating of adjacent peat indicates that it formed since 2750 B.P.
- Also found a distinctive sand layer in association with killed trees reminiscent of tsunami deposits in the PNW
- Dating of possible tsunami deposit indicates it formed ~2 ka; sand dike could have formed during same event
- Also conducted reconnaissance in other coastal marshes in ME and MA and found distinctive sandy layers of similar age

Hampton Paleoseismology Studies

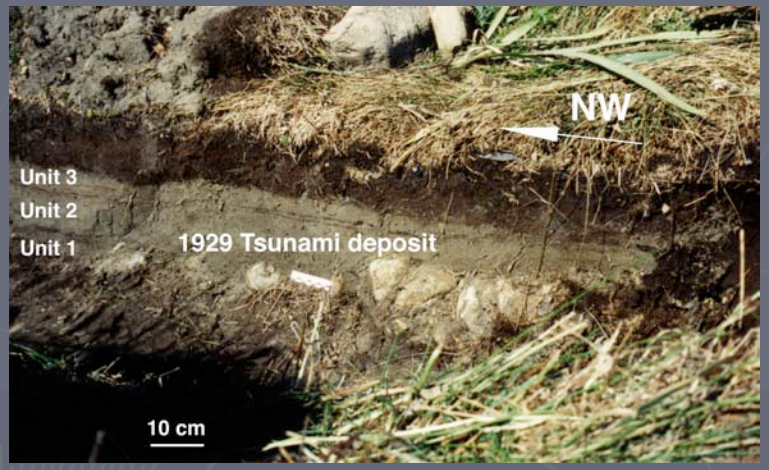




- Conducted diatom analysis of sand layer and of vertical sections
- In layer, found many species of diatoms, with broken valves, from various environments consistent with tsunami origin
- Diatom assemblages suggest abrupt change in environment possibly related to subsidence.
- Questions remain whether it's a tsunami deposit or something else; alternative hypothesis - fringing beach deposit

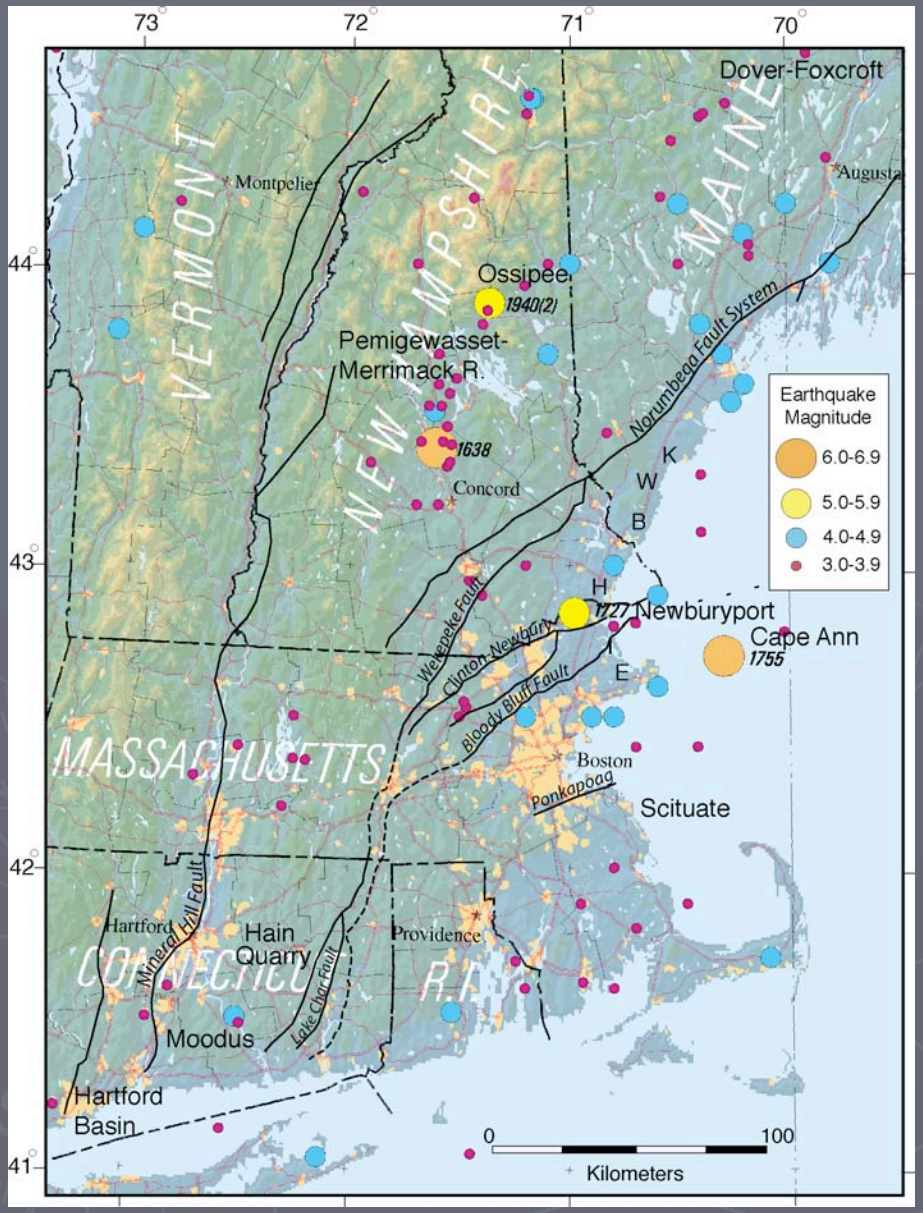
Tsunami Deposits as Paleoearthquake Indicators

Taylor's Bay, Newfoundland



Essex Marsh, MA

- Tsunami deposits are playing a major role in identifying paleoearthquakes in the PNW and elsewhere (Atwater and Hemphill-Haley, 1997; Kelsey et al., 2005)
- In the western Atlantic, 1929 Grand Banks earthquake and submarine slides produced a tsunami that came onshore in southern Newfoundland, where it destroyed villages and deposited a layer of sand
- In New England and along the Atlantic Seaboard where conditions are less than ideal for finding liquefaction features and active faults, tsunami deposits could be a very useful

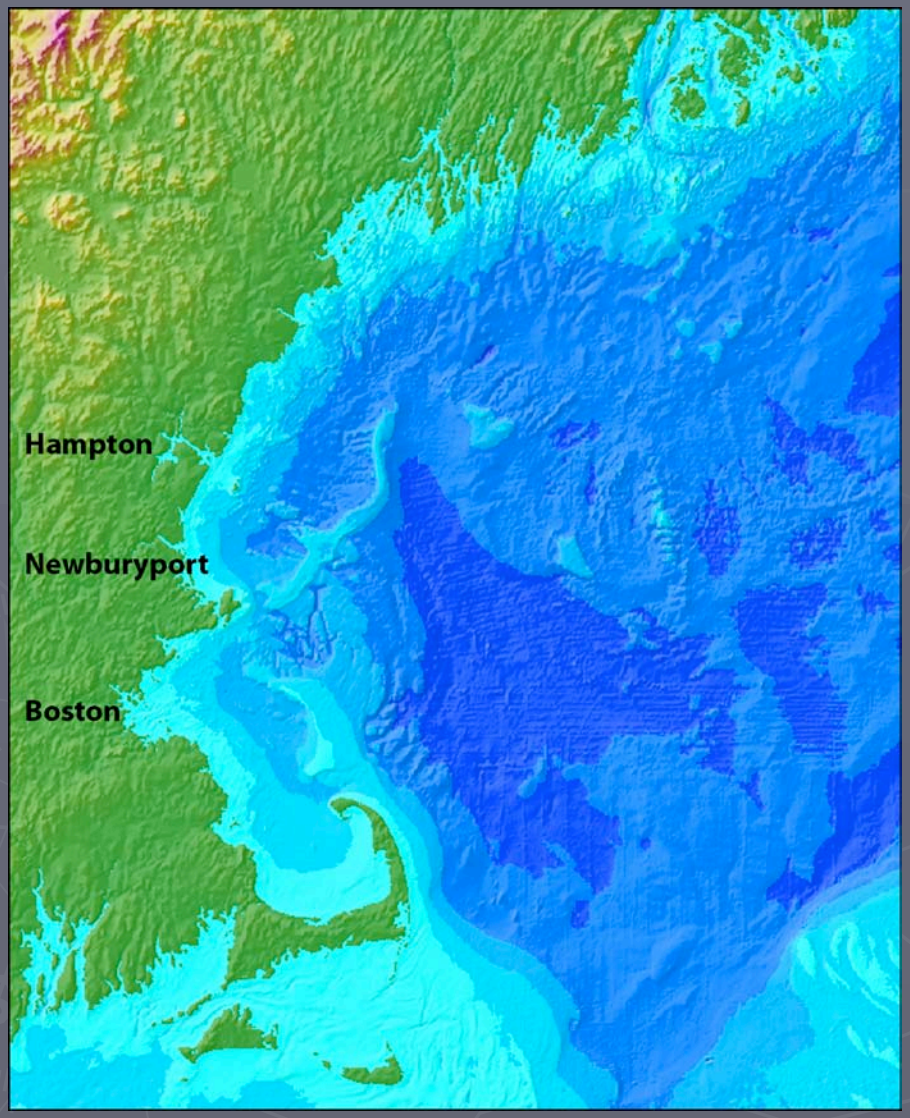


After Ebel and Spotilla, 1999; Wheeler et al., 2001

What Have We Learned in New England?

- Newburyport: Two earthquakes in past 4,000 yr large enough to induce liquefaction; appears to be a source in this area capable of at least M~5.5 every 2,000 yr
- Branford: Repeated 20-30 cm offsets in past 1,200 yr across eastern border of Hartford Basin; M 4-5 every 200-300 yr
- Coastal marshes north of Boston:
  Possible 2ka tsunami deposit that may correlate with liquefaction features in Hampton and Newburyport; large event located offshore or capable of triggering submarine slide

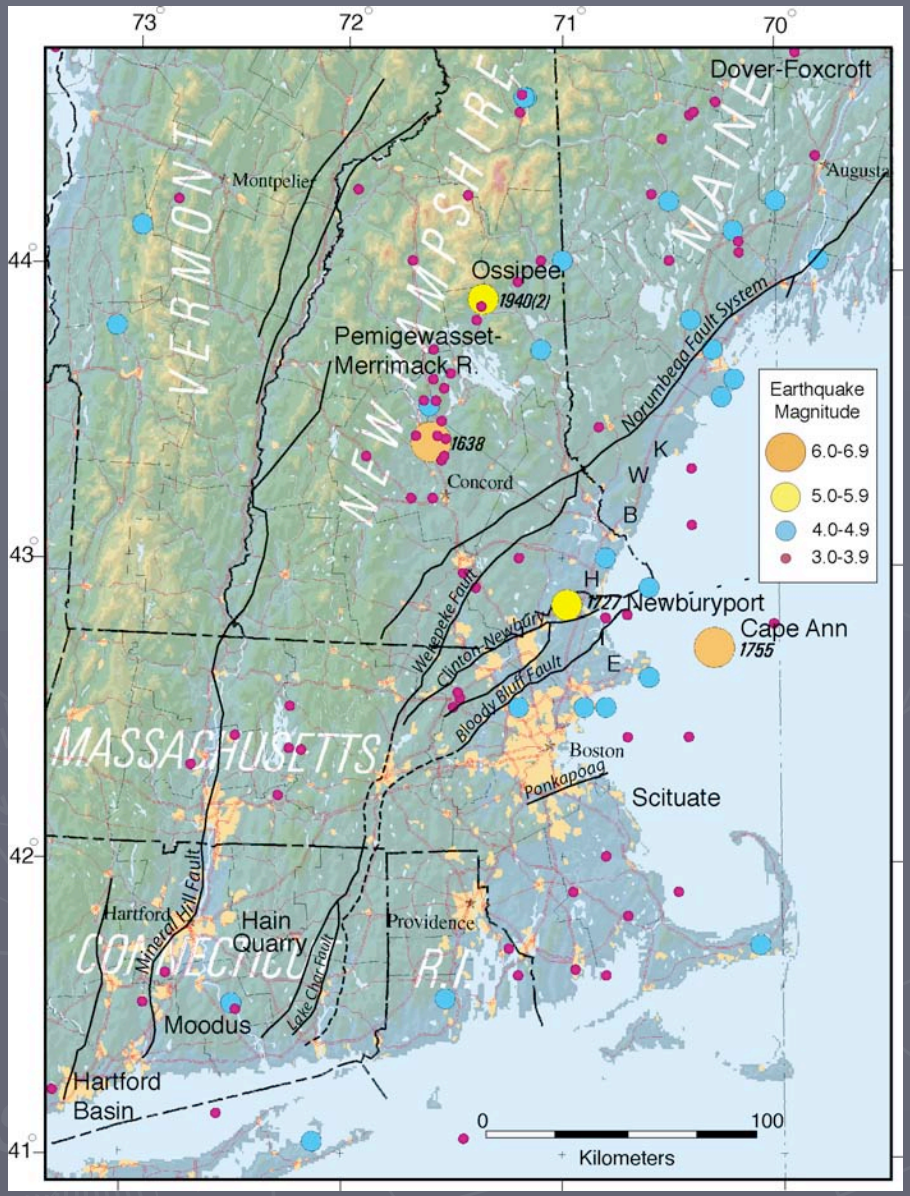
What Are the Outstanding Questions?



USGS Coastal and Marine Geology Program

1. Is there a source offshore MA-NH-ME coast capable of earthquakes larger than 1755 Cape Ann event?

- Compare possible tsunami deposit with known tsunami and fringing beach deposits
- Look for tsunami deposits in different environments of deposition such as freshwater ponds
- Evaluate new offshore bathymetry and multi-beam data for evidence of late Holocene faults and submarine slides

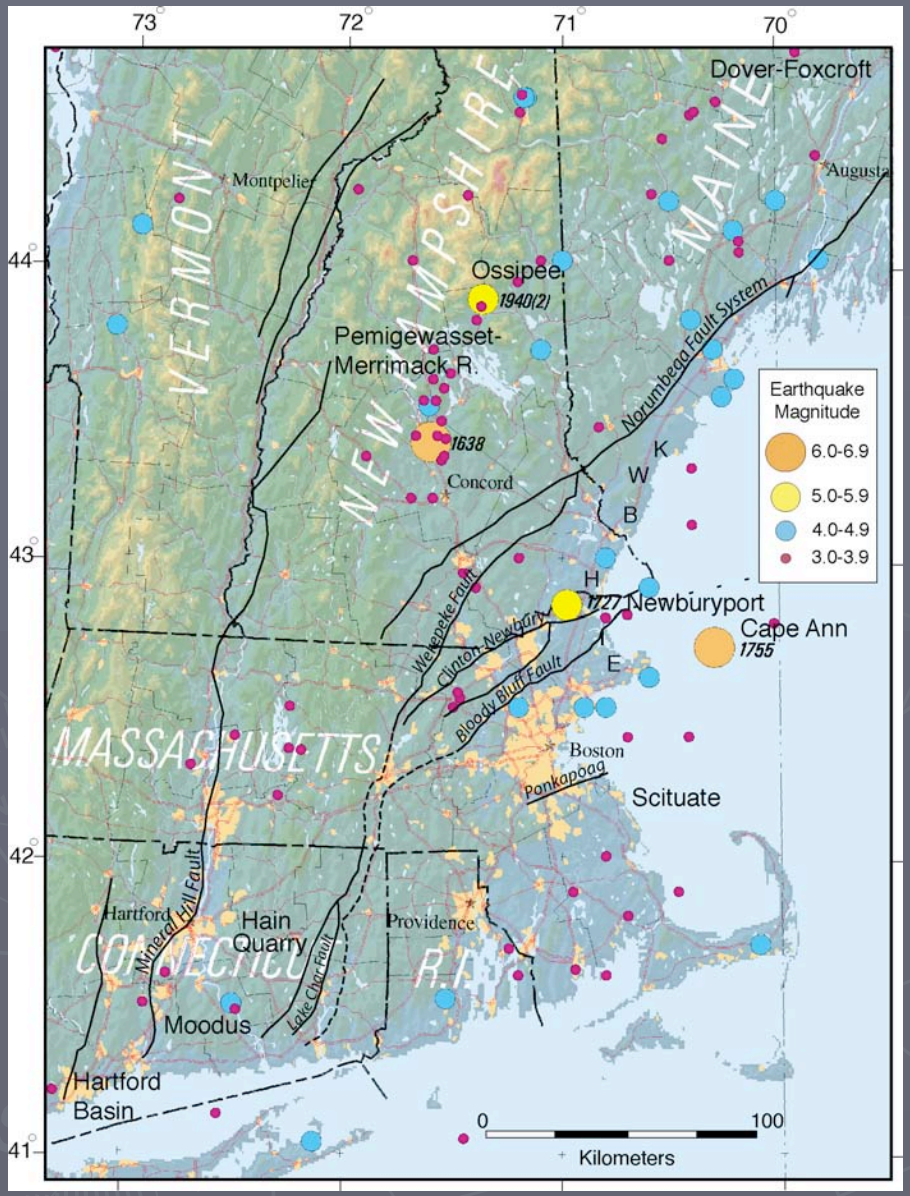


After Ebel and Spotilla, 1999; Wheeler et al., 2001

What Are the Outstanding Questions?

2. Is there a source in southern NH responsible for 1638 and other M~7 earthquakes?

- Look for earthquake-induced liquefaction features from 1638 and prehistoric events along additional stretches of Pemigewasset, Merrimack, and other rivers
- Look for anomalous silt layers in cores of lake sediments (a la Quebec) and synchronous land slides over large area



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What Are the Outstanding Questions?

3. Are there other mapped faults (e.g., eastern border fault of Hartford Basin) that exhibit Holocene displacements and are those faults seismogenic?

- Look for independent evidence of strong ground shaking along faults
- Compare small displacement faults in NE with other intraplate events involving surface rupture (e.g., 1968 Meckering, AU & 1989 Ungava, CA)

The End