

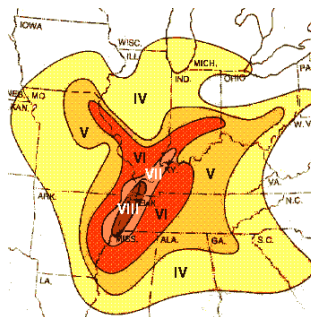
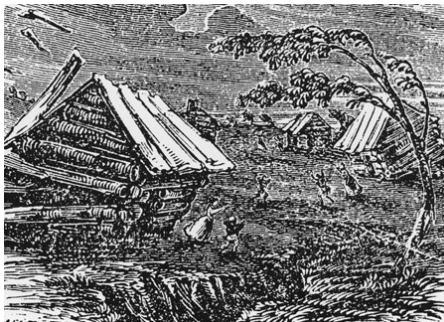
C2.4 Intra-plate earthquakes

- 99% of seismic energy is released at plate boundaries.
- Major earthquakes can occur in the interior of continents.

C2.4.1 New Madrid seismic zone

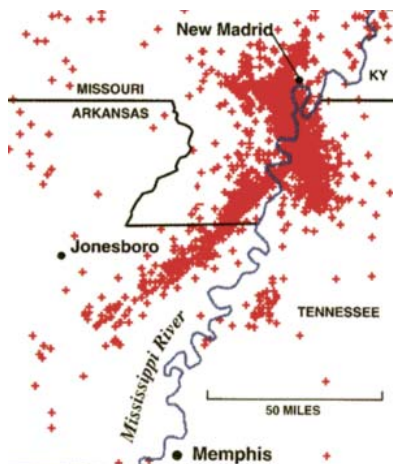
1811-12 earthquakes

- Sequence of four or five M=8 earthquakes from December 16 1811 to February 7 1812
- Extensive sand blows occurred and are still observed today
- The Lake County uplift, about 50 kilometers long and 23 kilometers wide, upwarps the Mississippi River valley as much as 10 meters in parts of southwest Kentucky, southeast Missouri, and northwest Tennessee.
- Course of Mississippi River altered at Revere



- Possible causes
 - stress concentrations
 - zones of previous weakness (failed rift zones)
 - high heat flow (thermally induced subsidence)
 - heterogeneous zone in lower crust that focuses deformation (Fowler p. 130-1)

Modern tectonics



1974-2005 seismicity

- Extensive seismicity
- Modern GPS studies show significant compressional motion occurs across the Reelfoot thrust fault (Smalley et al., 2005)
- Previous earthquakes in
 - 1450 AD±100,
 - 900 ± 100,
 - 300±200,
 - 2350BC±200
- Repeat time around 500 years.
- Next earthquake

More details can be found at :

http://wwwneic.cr.usgs.gov/neis/eq_depot/usa/1811-1812.html

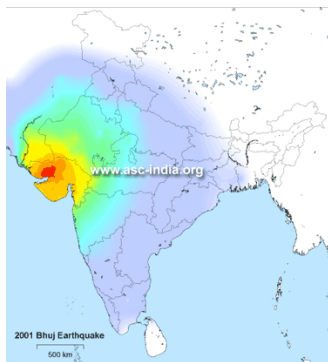
<http://sprg.ssl.berkeley.edu/matt/seismo.html>

http://en.wikipedia.org/wiki/New_Madrid_Earthquake

http://www.eas.slu.edu/Earthquake_Center/SEISMICITY/Nuttli.1973/bssa.html

C2.4.2 Bhuj earthquake, Gujarat 2001

- M=7.7 but no surface rupture.
- Fault plane identified from focal mechanisms and aftershocks
- Caused 20,000 fatalities.
- Occurred in the paleo-rift region of Rann of Kuch on a south dipping reverse fault. Present day north-south compression caused by India-Asia collision. This is an example of **fault re-activation**.
- Explosive soil liquefaction. Results were visible from space



http://earthobservatory.nasa.gov/Newsroom/NewImages/images.php3?img_id=4810

“Field investigations have found abundant evidence of mud volcanos, sand boils, and fissures from which salty ground water erupted over an area exceeding 10,000 square kilometers. Evidence of the expelled water can also be seen on the MISR images. Notice the delicate, dendritic pattern of stream channels throughout many of the salt-flats on the post-earthquake image, especially due north of the epicenter. These carried water brought to the surface by liquefaction during the earthquake “

General information and context

<http://cires.colorado.edu/~bilham/Gujarat2001.html>

References

Mueller, K., S. E. Hough and R. Bilham, Analysing the 1811–1812 New Madrid earthquakes with recent instrumentally recorded aftershocks, *Nature*, 429, 284-288, 2004, doi:10.1038/nature02557.

Rydelek, P.A., and M. Tuttle, Seismology: Explosive craters and soil liquefaction, *Nature* 427, 115-116, 8 January 2004, doi:10.1038/427115a

Smalley, R., M. A. Ellis, J. Paul and R. B. Van Arsdale, Space geodetic evidence for rapid strain rates in the New Madrid seismic zone of central USA, *Nature*, 435, 1088-1090, 2005), doi: 10.1038/nature03642.