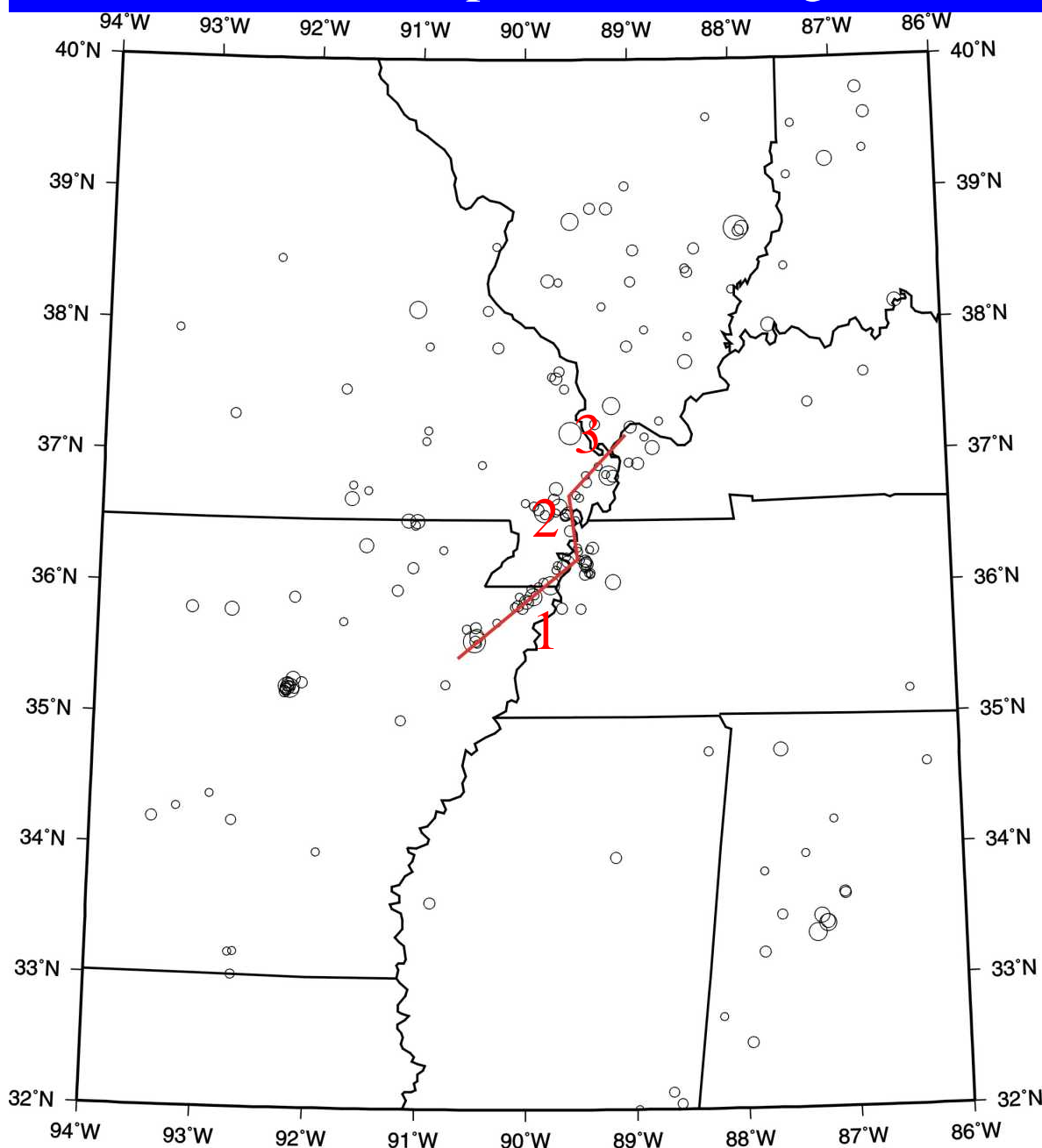


Temporal Clustering of 1811-12 type earthquakes



Used recurrence time of 500 years. Used entire trace when calculating ground motions, with variability. This will produce same median ground motions as each segment rupturing separately.

However, this neglects effects of variability of ground motions from earthquakes on the individual segments.

You can't just add frequencies of exceedances assuming each segment ruptures independently, since the earthquakes are dependent events (Toro and Silva, 2001)

Probabilistic ground motions from clustered earthquakes on the New Madrid zone (slightly modified from Toro and Silva, 2001)

Annual probability of exceeding ground motion U at each site=

(annual prob. of cluster) x (probability earthquakes on segment 1 or 2 or 3 will produce ground motions that exceed U at that site | cluster occurs)

From Toro and Silva (2001), based on probability of union of sets

Annual probability of exceeding U = (annual prob. of cluster) x
($P_1 + P_2 + P_3 - P_1P_2 - P_2P_3 - P_1P_3 + P_1P_2P_3$)

where

P_1 = probability of exceeding U if earthquake occurs on south
segment

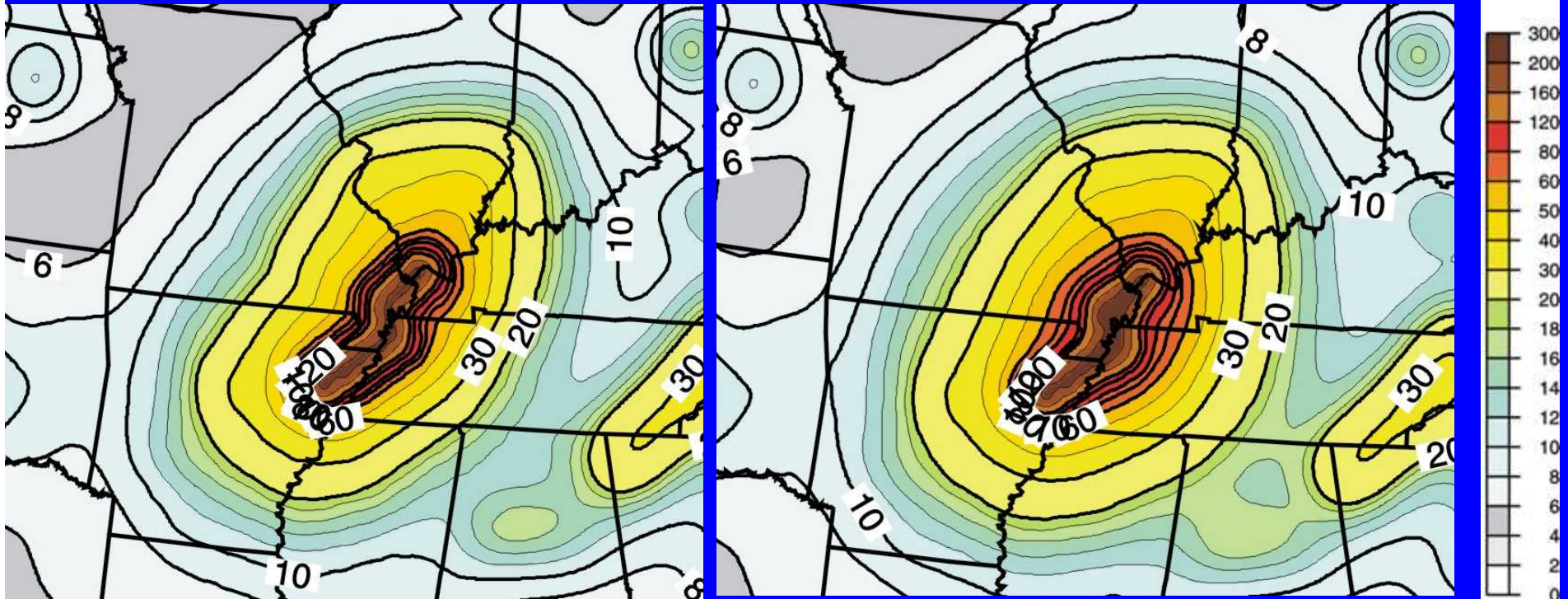
P_2 = prob. of exceeding U if earthquake occurs on middle segment

P_3 = prob. of exceeding U if earthquake occurs on northern
segment

Annual cluster prob. ~ cluster rate = 1/500

1 source

temporal cluster



PGA (%g) with 2% PE in 50 years

caveats

- Perhaps clustered earthquakes have similar stress drops in each cycle. This would reduce interevent variability for each segment.
- Perhaps there is correlation of ground motion variability between earthquakes on each segment caused by similar rupture propagation directions (e.g., Izmit-Duzce, Joshua Tree-Landers)

Logic Tree for New Madrid Characteristic Sources

1. Characteristic magnitude
2. Recurrence Time
3. Geometry (northern arm? width; length)

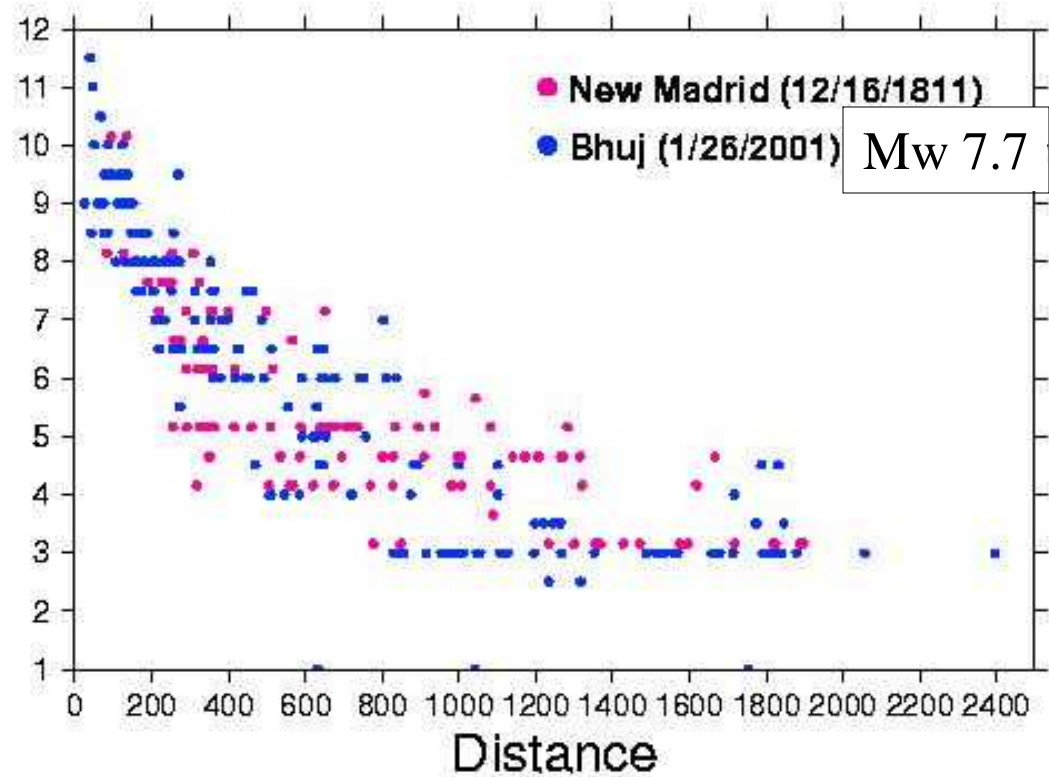
Mchar logic tree for New Madrid used in 2002 maps

- M7.3 (0.15 wt)
- M7.5 (0.2 wt)
- M7.7 (0.5 wt)
- M8.0 (0.15 wt)
- Based on determinations of moment magnitudes from intensity observations of the 1811-12 sequence (Johnston, 1994 M8.0; Hough et al., 2000 M7.4-7.5; after 2002 maps released: Bakun and Hopper, 2004 M7.5-7.8) plus comparison of intensities with M7.7 Bhuj earthquake

Do we want to change this logic tree?

Do we want to have different Mchar's for the different Arms?

Intensity Distribution



From Hough et al. (2002)

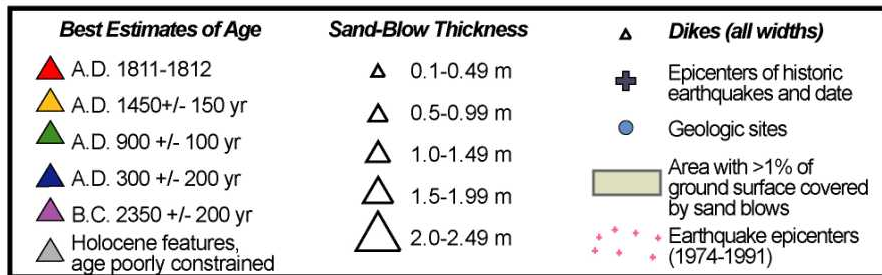
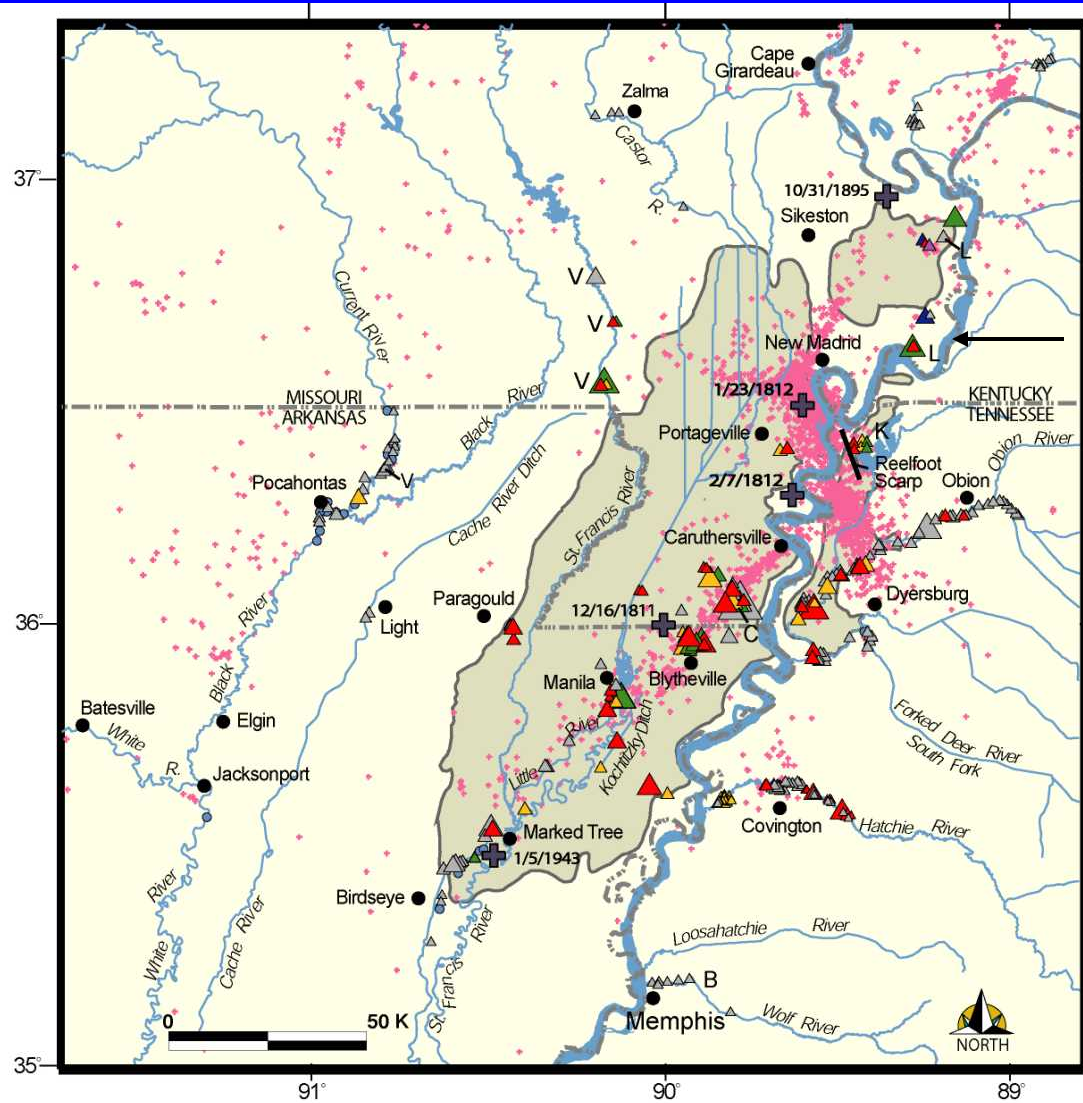
Note: Singh et al. (2004) found Q in Indian Shield similar to that in ENA

How do we estimate magnitudes of 1811-12, 1500, and 900 A.D. earthquakes?

- Compare isoseismal areas of 1811-12 events with more recent stable continental region earthquakes with measured magnitudes: In 1996, preferred magnitude of 1811-12 events was moment magnitude 8.0 (Johnston, 1996).
- Re-analysis of isoseismal data with site corrections yields M7.4-7.5 (Hough et al. 2000). **June 2000 workshop concluded M7.5-8.0.** New method of using intensities yields M7.5-7.8 (Bakun and Hopper, 2004)
- 1500 and 900 A.D. earthquakes have similar magnitudes as 1811-12 sequence, based on similar liquefaction areas, width of dikes

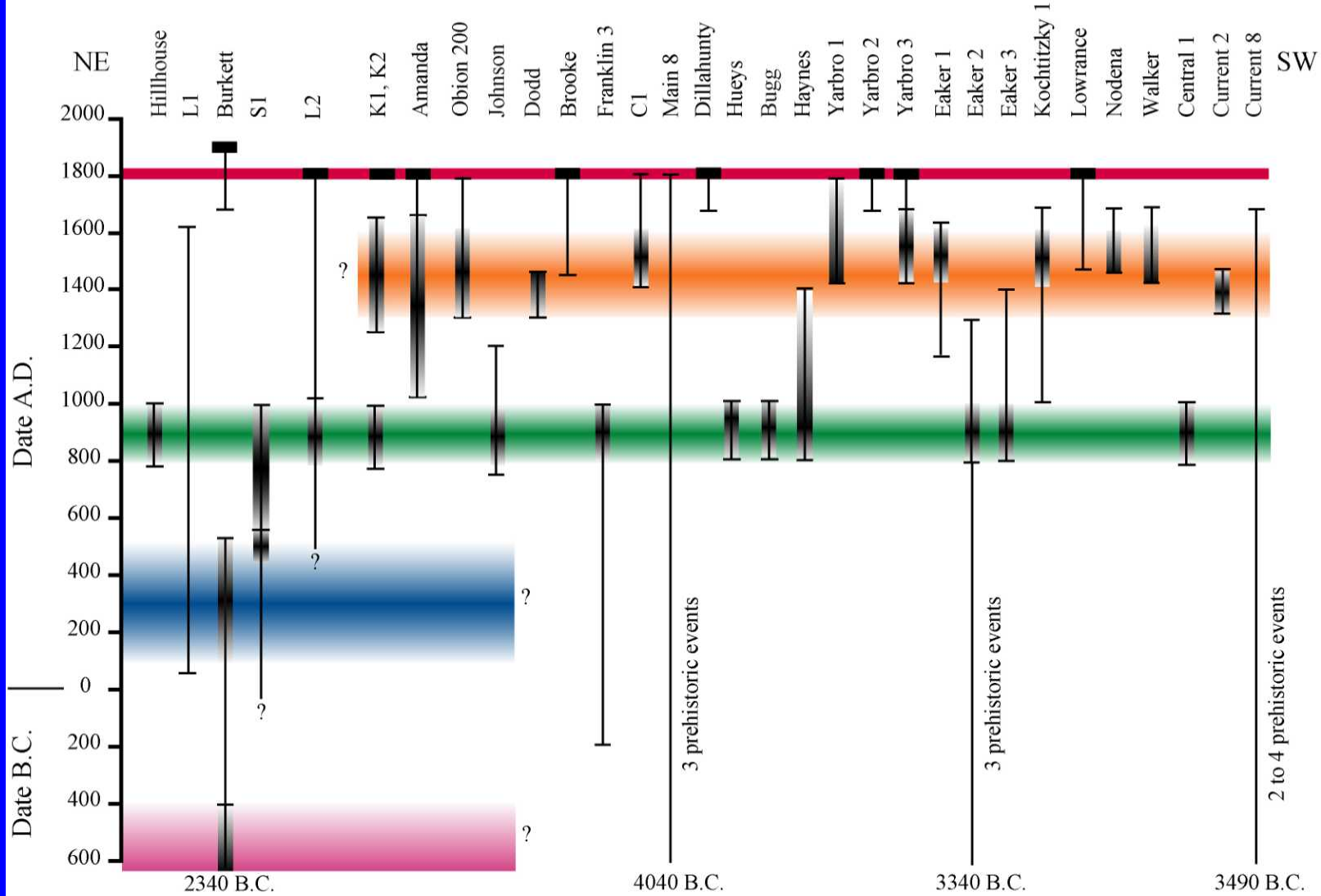
Recurrence Time for 1811-12 type earthquake sequences

- Mean recurrence time: 500 years to 550 years?
- Same recurrence time for each arm?
(Blytheville Arch, Reelfoot, northern arm)
- Do we believe the northern arm is a source for 1811-12 type earthquakes?
- Standard deviation of recurrence time (COV of 0.5?)



From Tuttle et al. (2002)

From Tuttle et al. (2002)



I maximum possible age range
 ■ estimated age
 T 1811 & 1895 events

New Madrid Earthquake Chronology

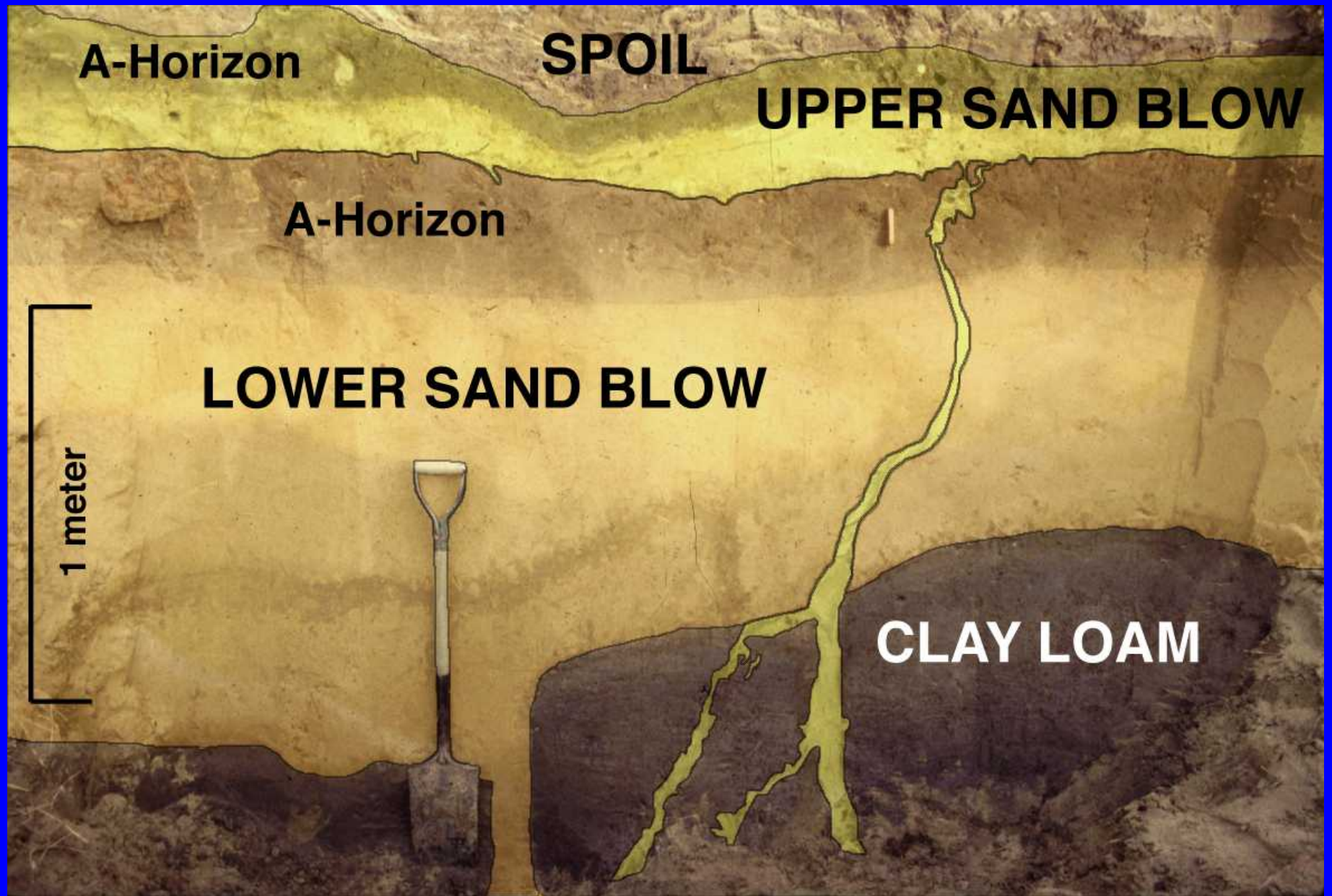
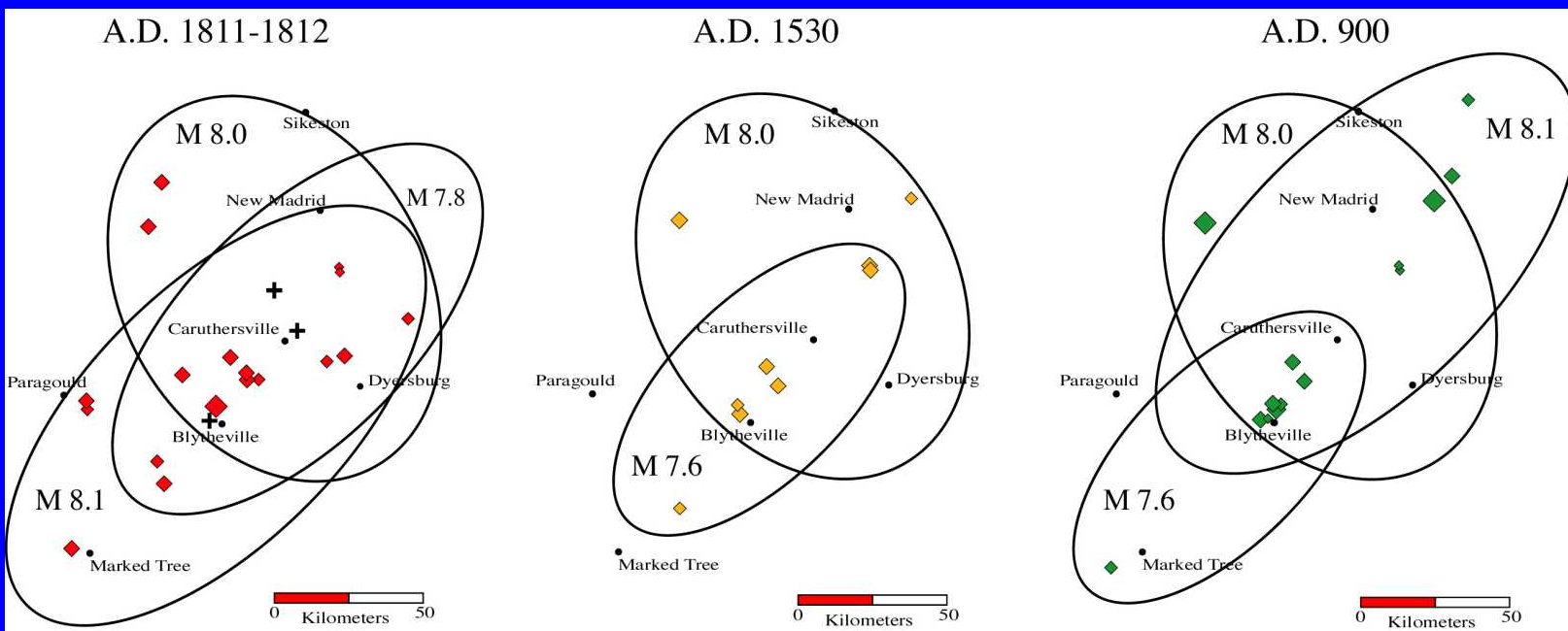


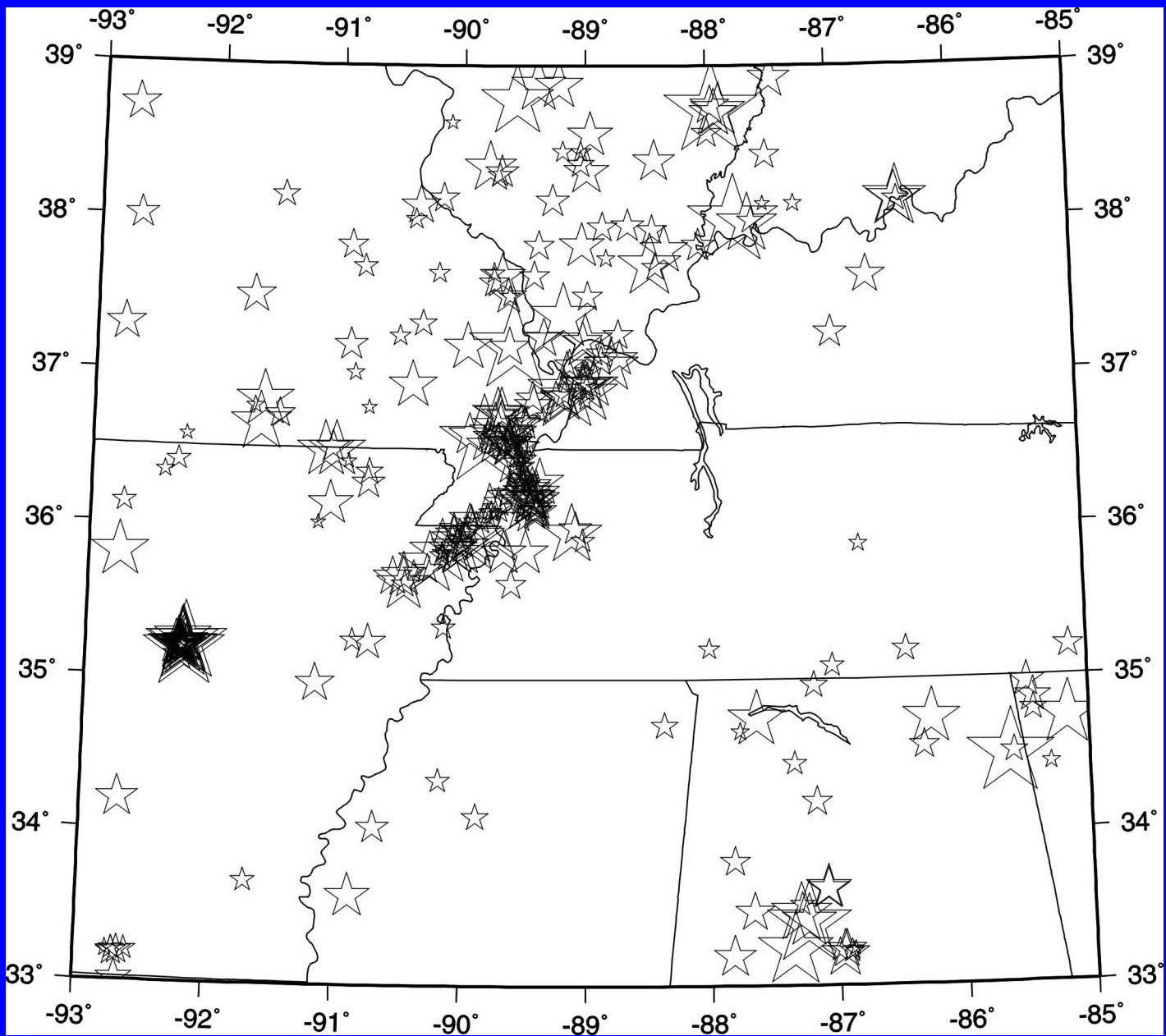
photo from Li et al. (1998)

900 A.D. and 1811-12 events

Interpretations of size distribution of liquefaction features



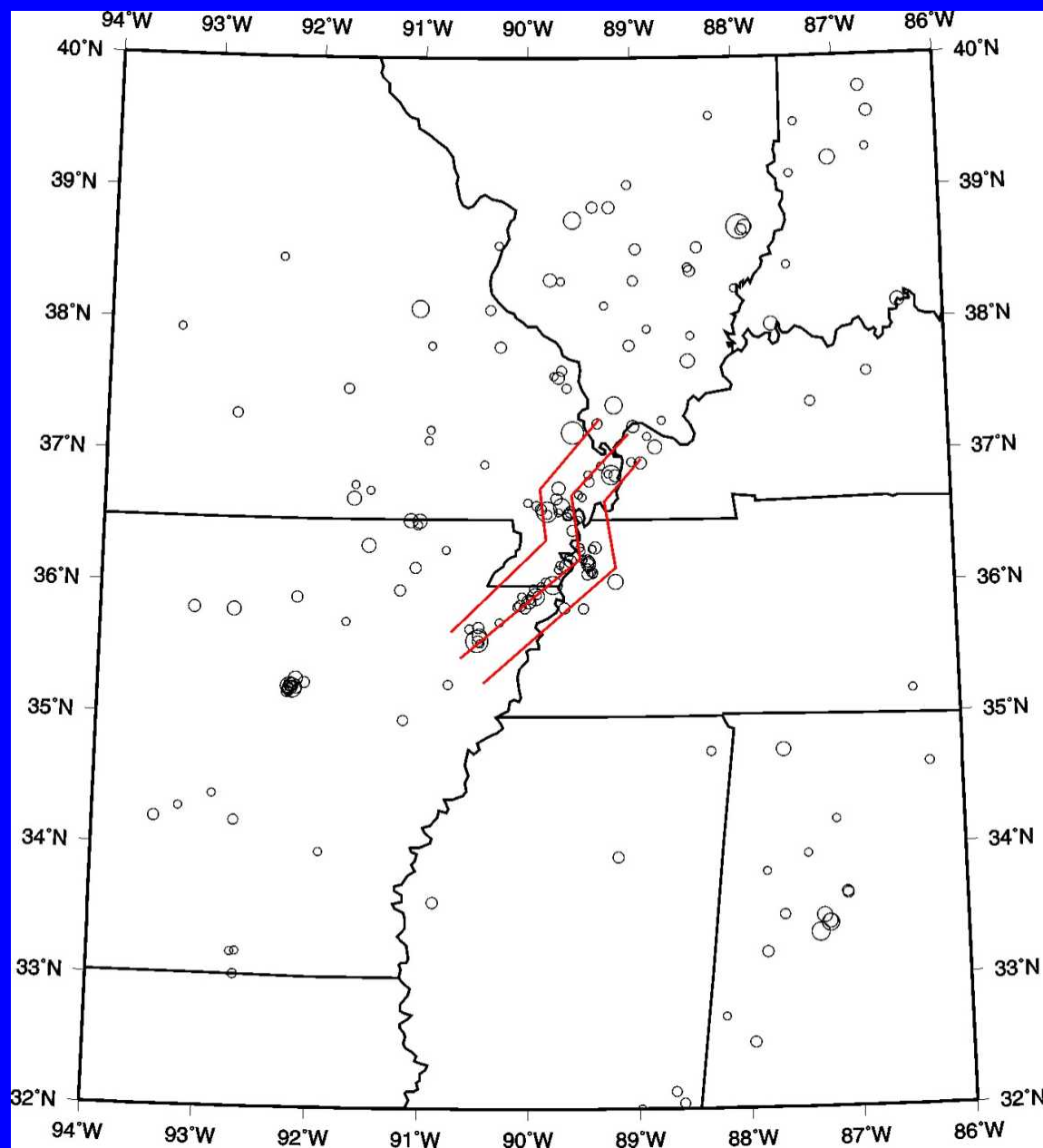
From Tuttle et al. (2002)



mb 2.5
Since 1980

The hypothetical faults

Hypothetical faults used in 1996 and 2002 maps



Middle fault given twice the weight of the outer faults

Should we change geometry?

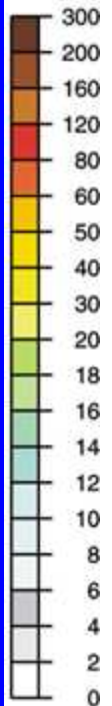
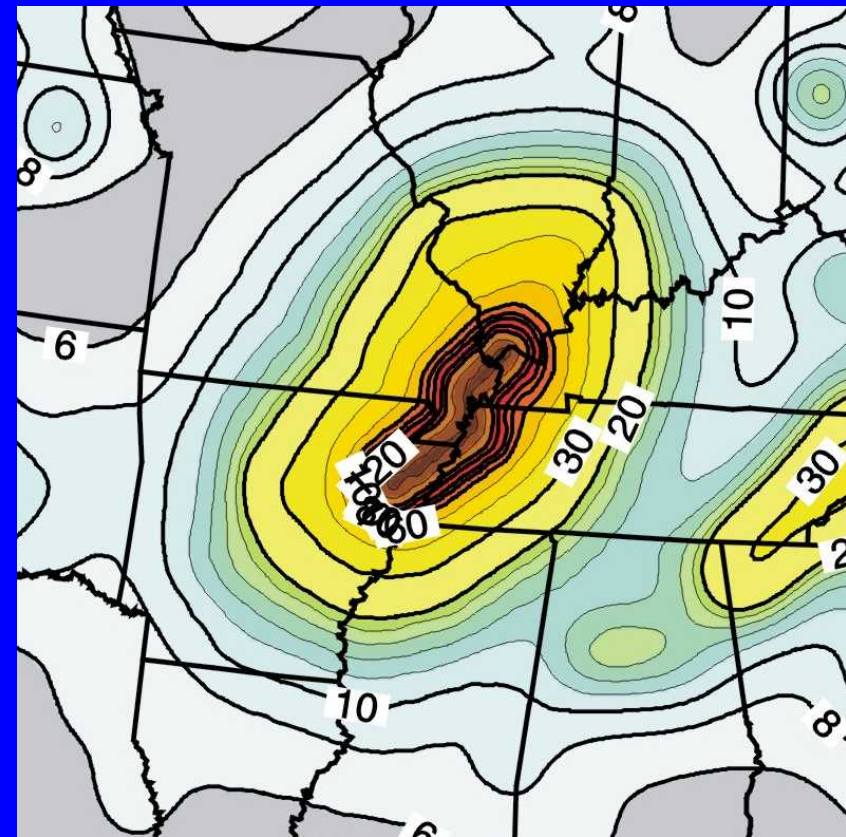
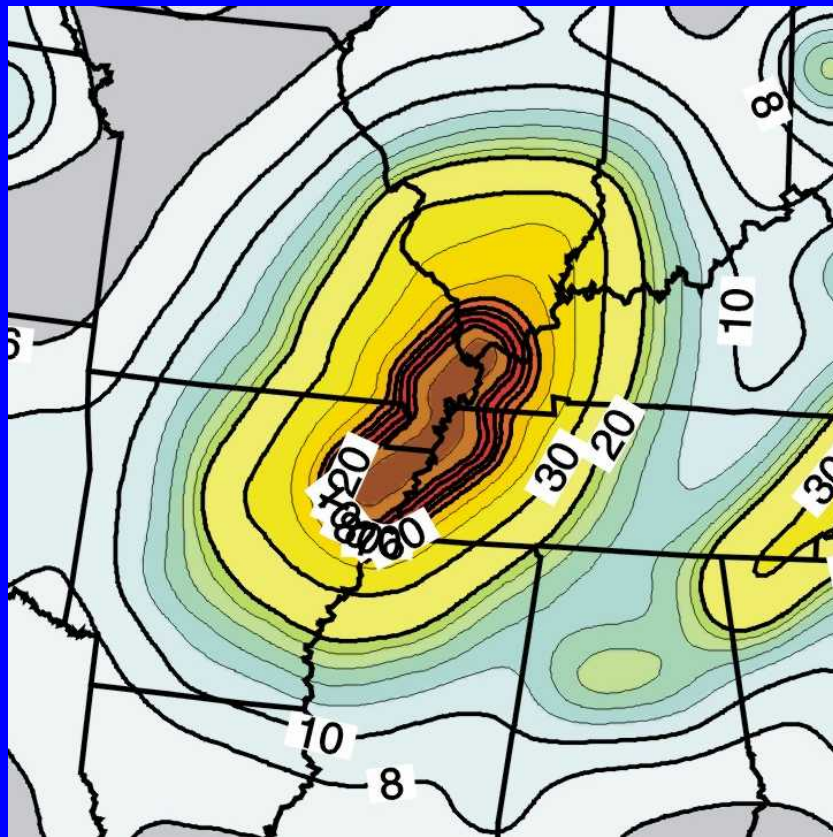
Should we change weighting?

Should we include endpoint variability?

PGA (%g) with 2% PE in 50 Years

3 parallel faults

only central fault



Same total recurrence rate
Same Mchar logic tree

