Challenges in Seismic Hazard Assessment for PGDP

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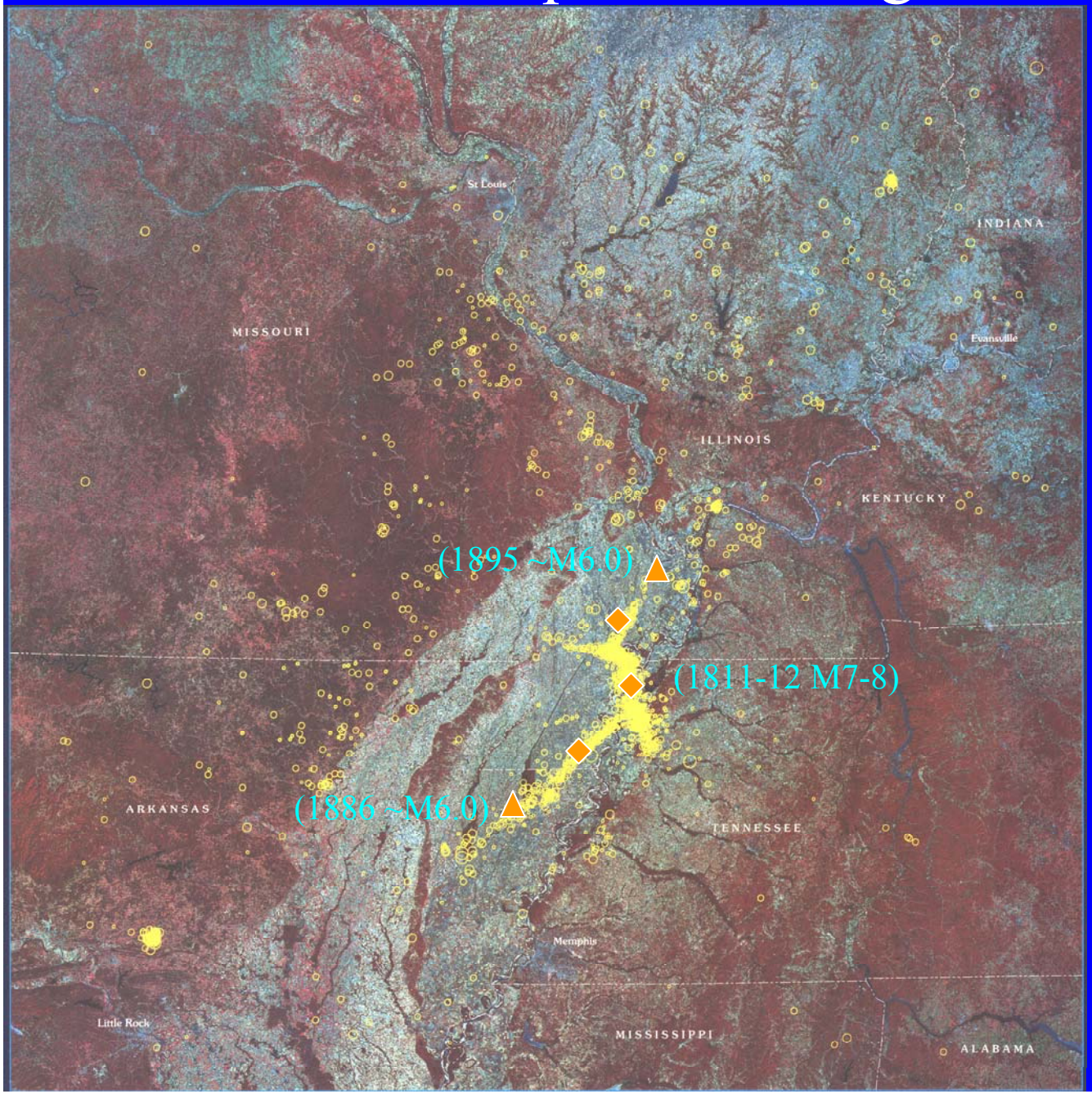
Seismic Hazard Assessment

- The goal:
  - determining a level of hazard (ground motion and its occurrence frequency) for engineering design and other consideration

- The Challenges:
  - What do we know about earthquakes?
  - How do we define seismic hazard and risk?
  - How do we assess seismic hazard and risk? (second presentation)

Earthquakes – Magnitude

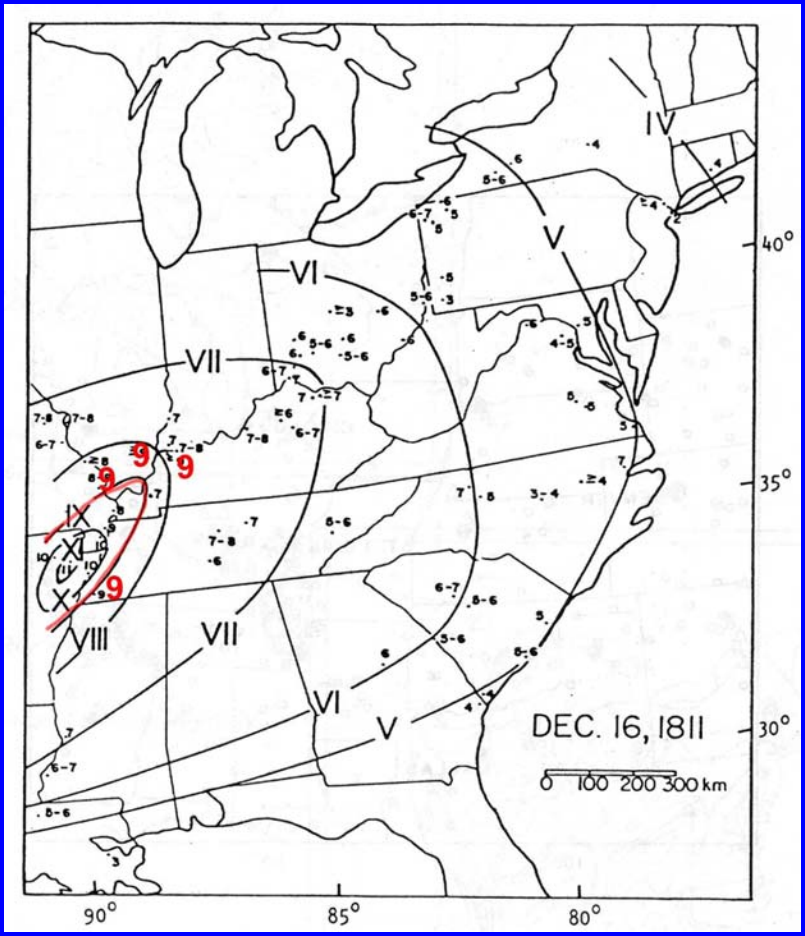


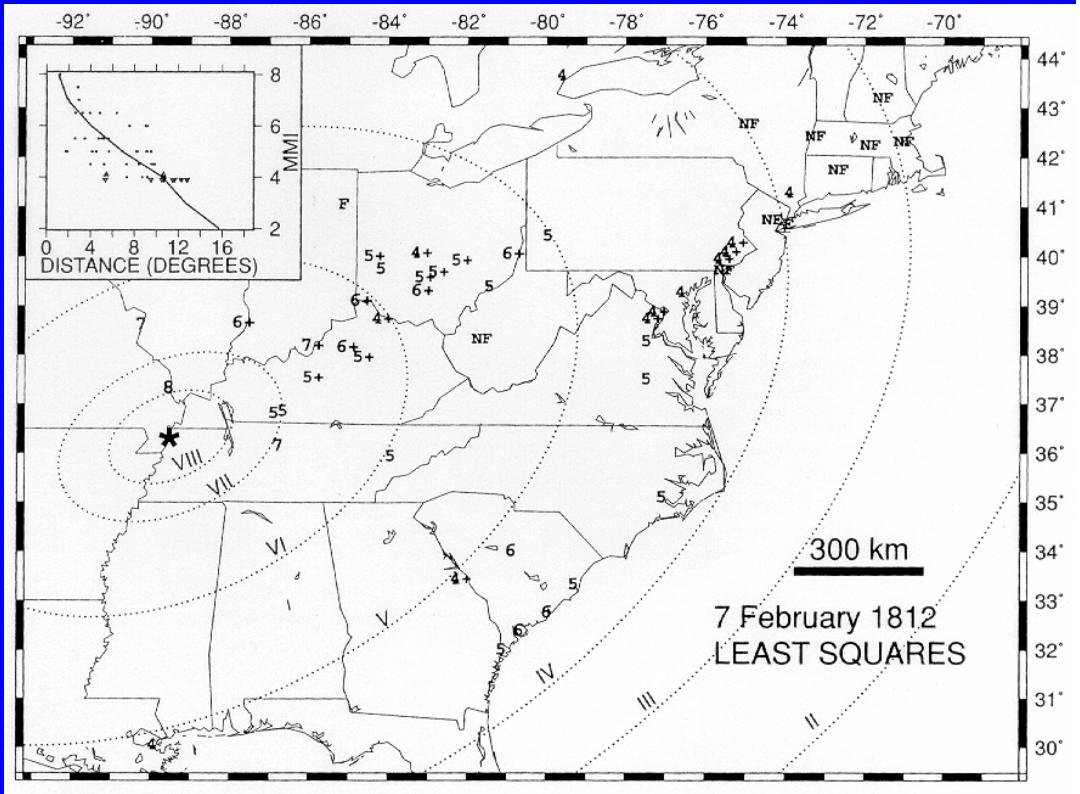
New Madrid Seismic Zone

1) At least three large earthquakes occurred in 1811-1812 (M7.0-8.0)

2) Two ~M6.0 (1886 and 1895)

Earthquakes – Ground Motion





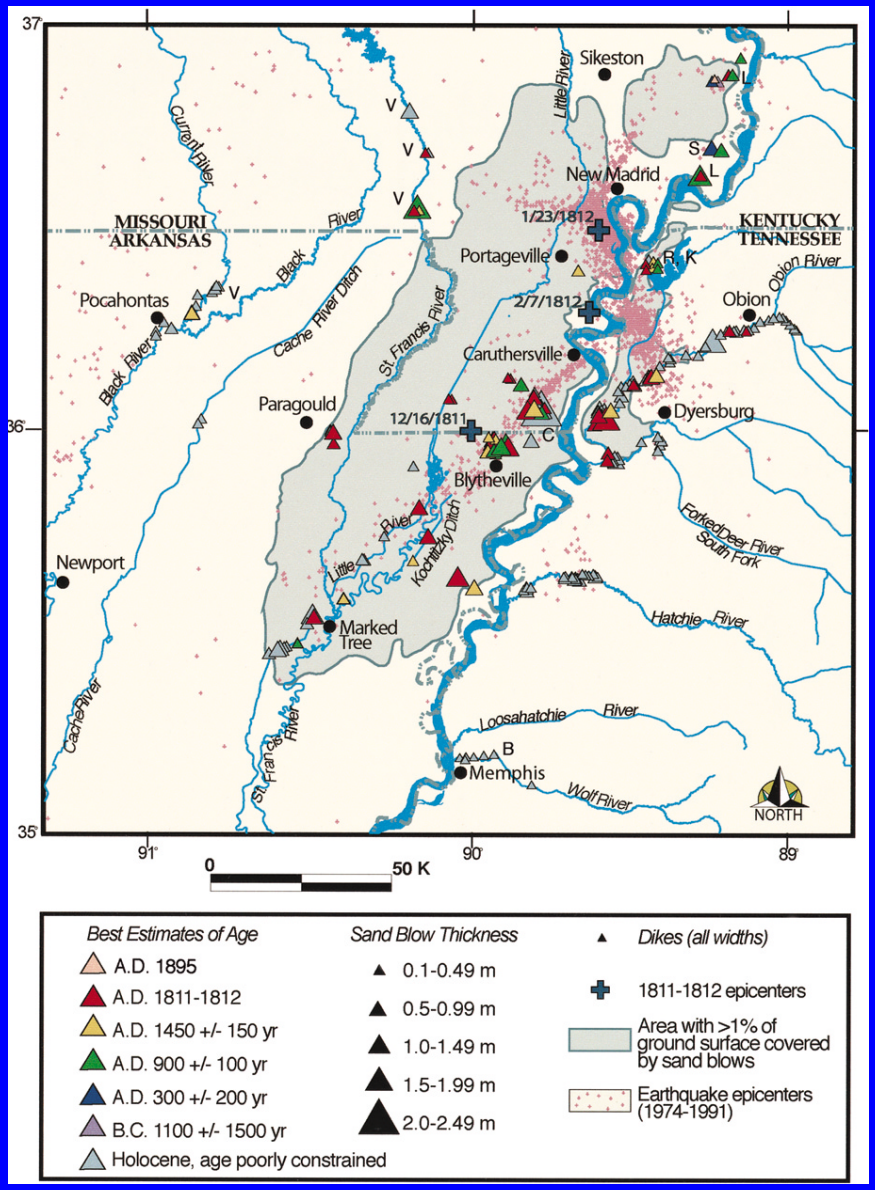
MMI at PGDP: ~XIII (0.3g PGA)

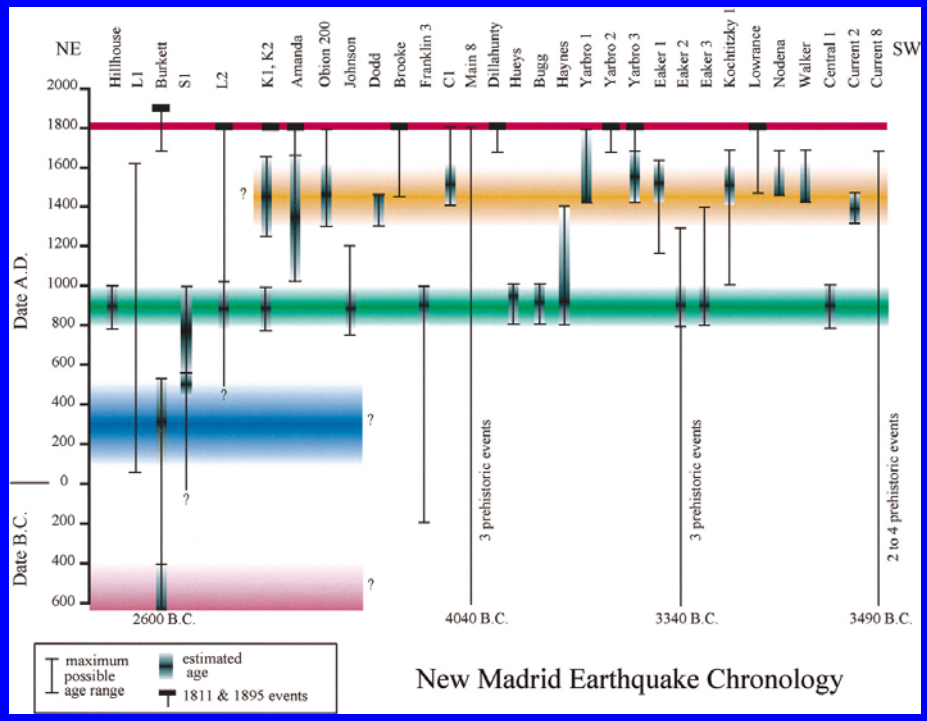
Modified Mercalli Intensity Scale

INTENSITY	EFFECTS	AVE. PEAK ACCELERATION
VI	Strong	0.06–0.07g — Felt by all. Damage slight.
VII	Very Strong	0.10–0.15g — Everybody runs outdoors. Considerable damage to poorly designed buildings.
VIII	Destructive	0.25–0.30g — Considerable damage to ordinary buildings.
IX	Ruinous	0.50–0.55g — Great damage to ordinary buildings
X	Disastrous	>0.60g — Many buildings destroyed.
XI	Disastrous	Few, if any, structures remain standing

(Simplified from Bolt, 1993)

Earthquakes – Recurrence Interval



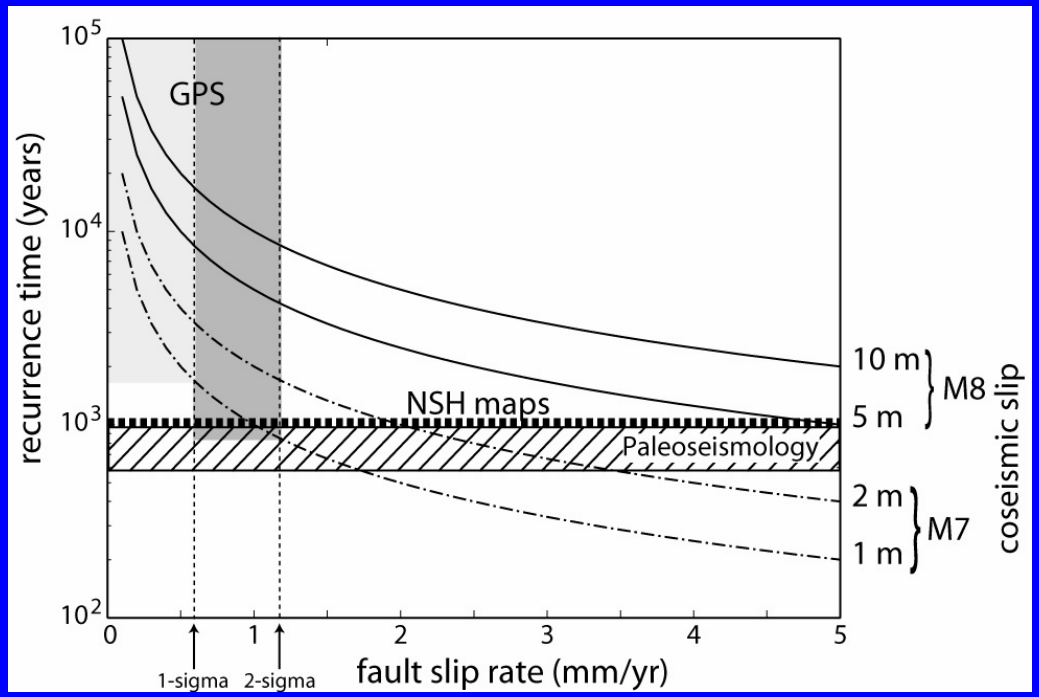


Recurrence interval: ~500 years

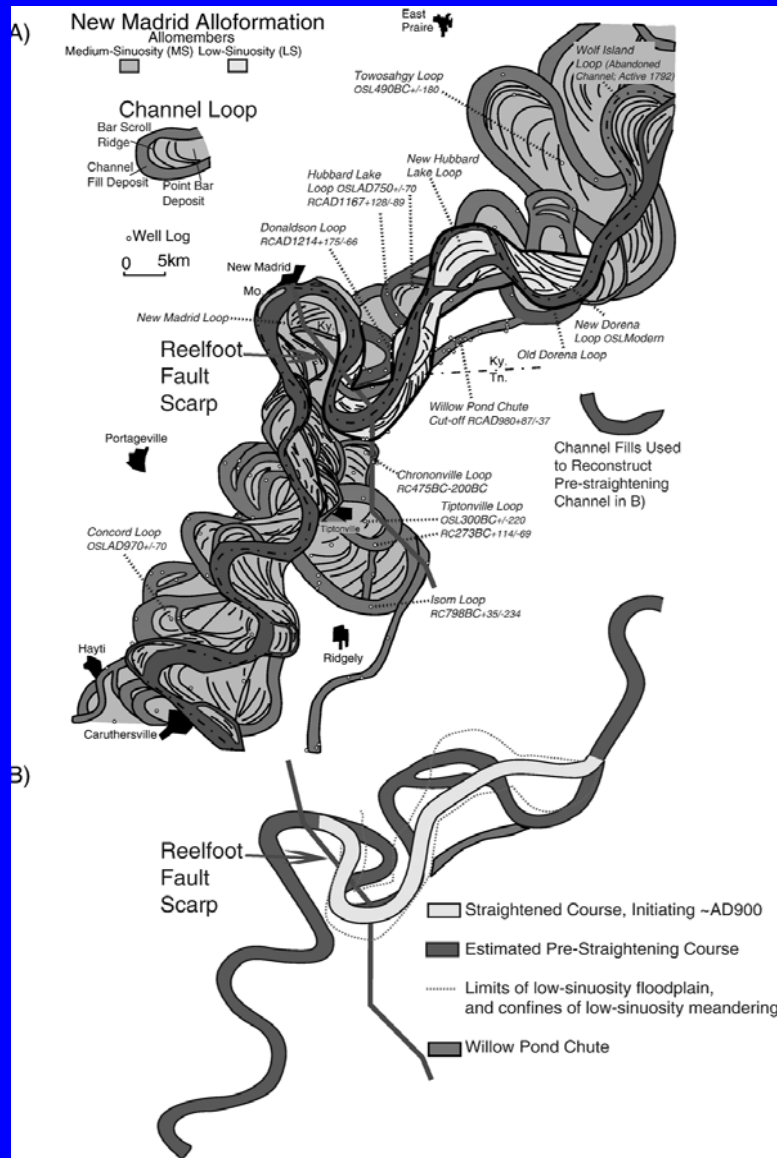
Paleo-liquefaction records (Tuttle and others, 2002)

Earthquakes – Recurrence Interval

Calais and others (2006)

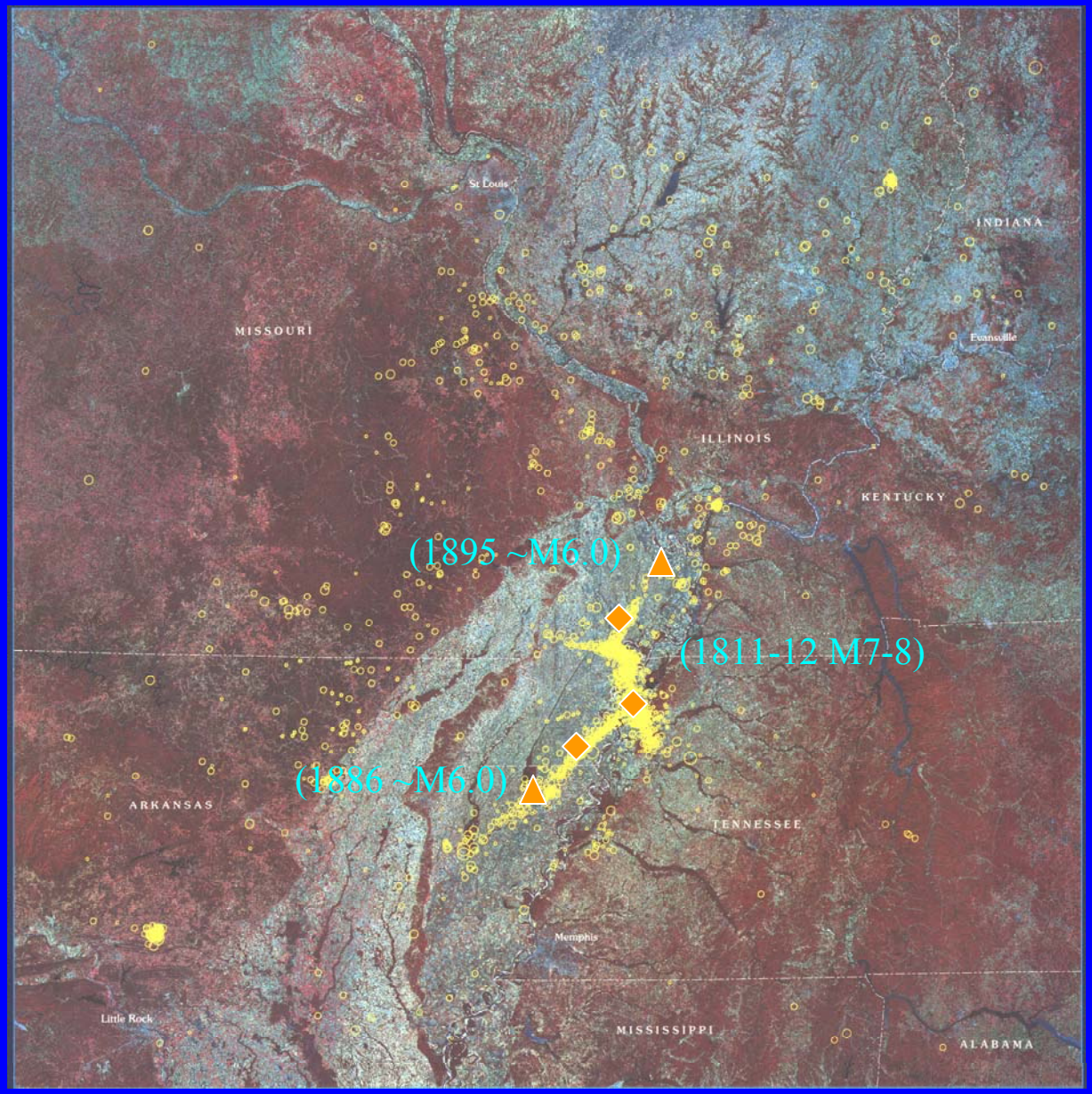


Holbrook and others (2006)



Recurrence interval: ~1,000 years

Earthquakes - Summary



New Madrid Earthquake

1) Magnitude: M7.0-8.0 (how big)

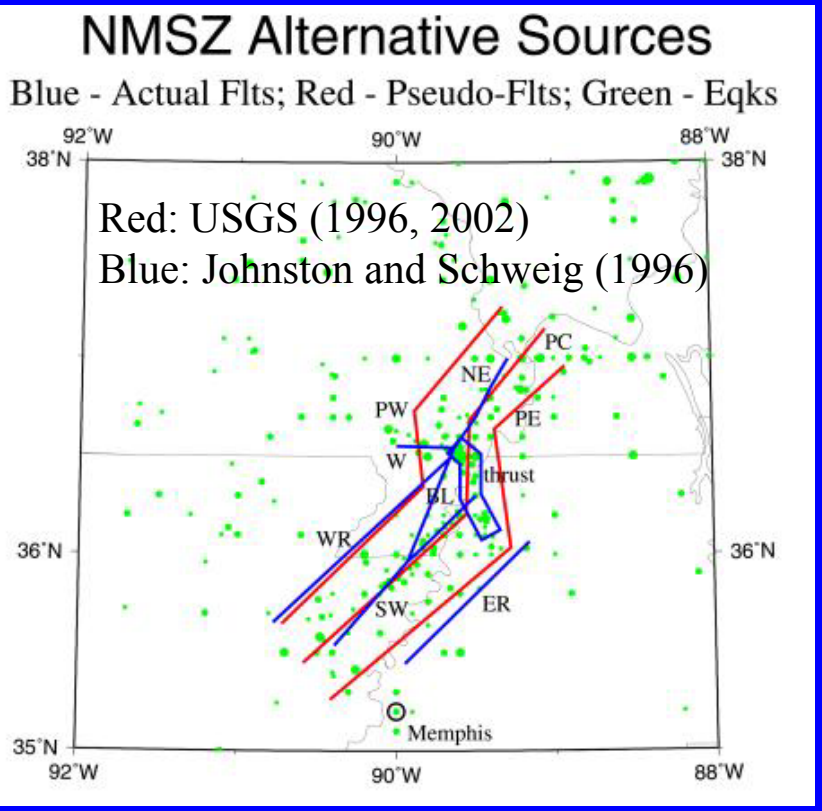
2) Recurrence interval: 500~1,000 years (how often)

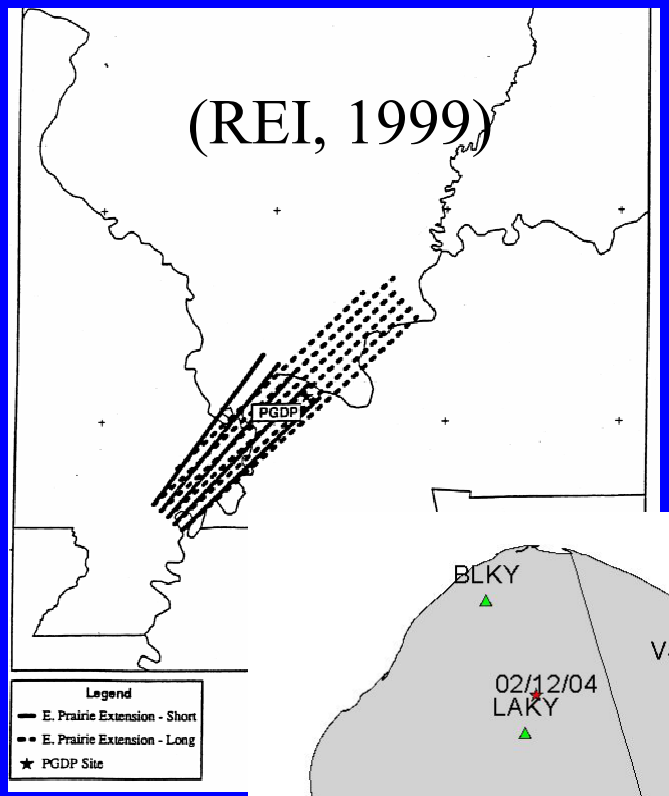
3) Location: consistent with current seismicity (where)

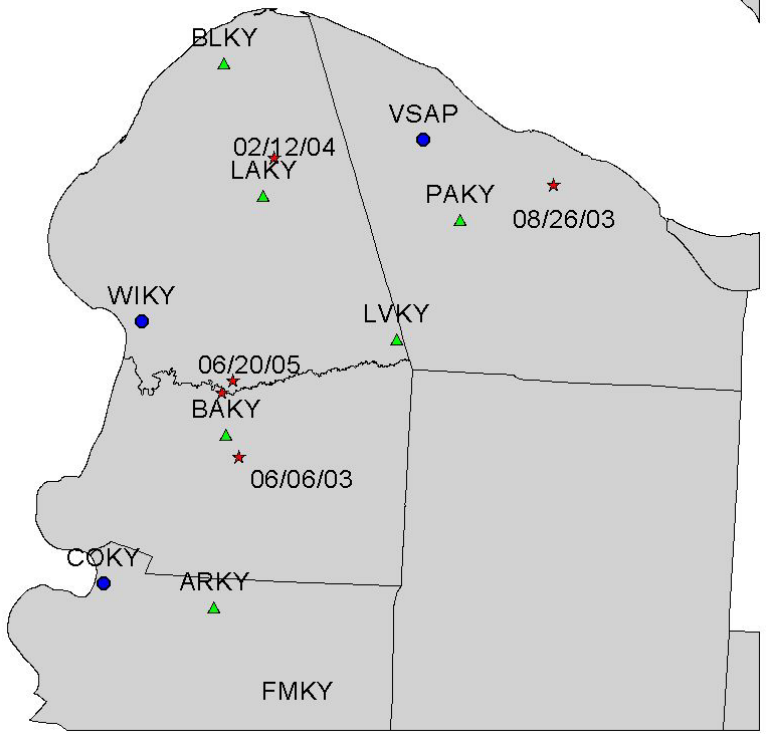
4) At PGDP: ~VIII MMI (0.3g PGA) (how strong)

<u>With large uncertainties</u>

Where are the New Madrid faults?



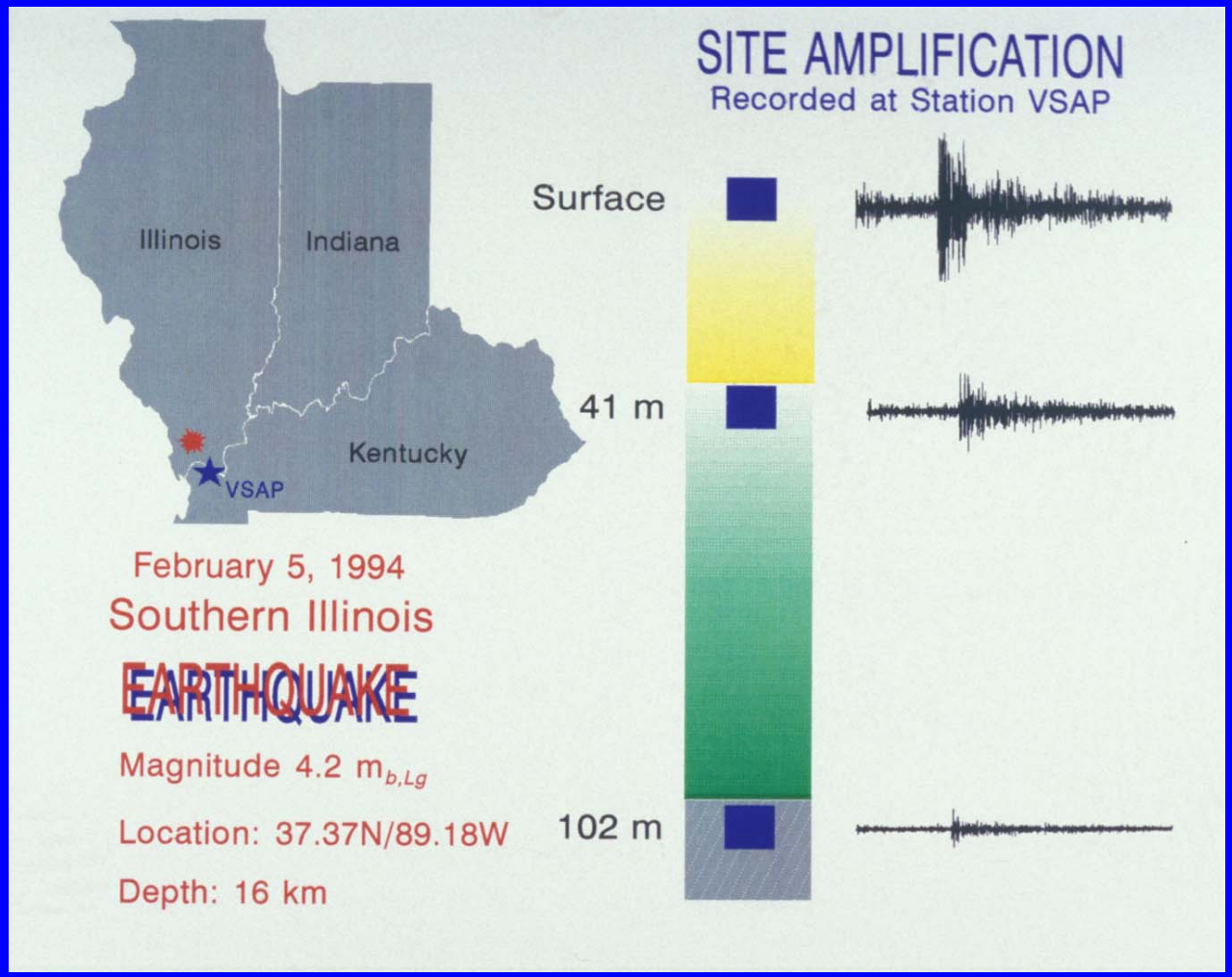




We focus on:

1) Temporary network
2) Neo-tectonics

Site Amplification



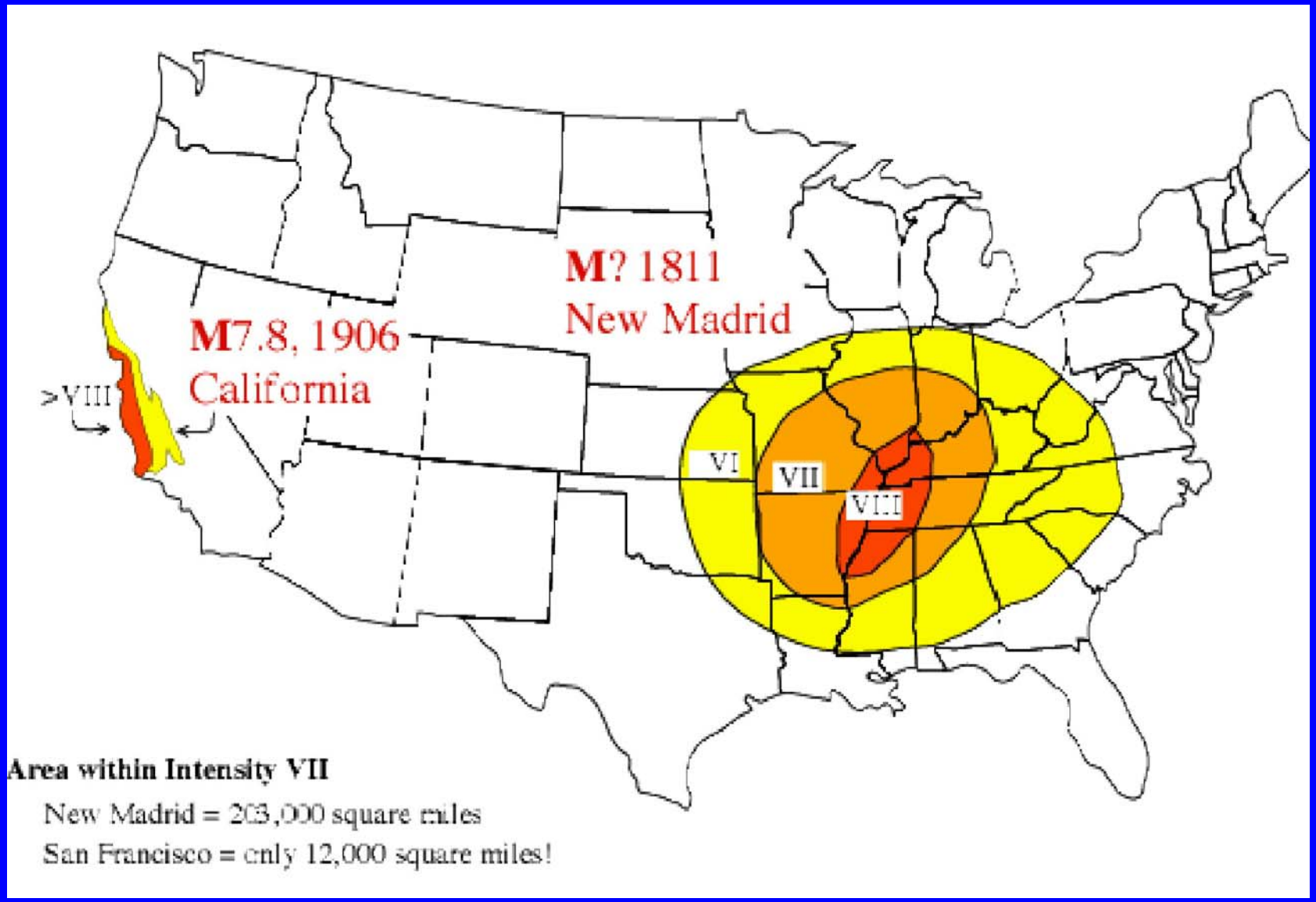
CUSSO - project

Seismic Hazard and Risk

- Hazard
  - Earthquake, ground motion, liquefaction
  - A physical measurement vs. its associated mean recurrence interval (A vs. τ)
  - Natural occurrence (records)
  - May not be useful for policy consideration
- Risk
  - Probability of an earthquake, ground motion or liquefaction
  - Probability that a level of hazard (physical measurement) could be exceeded for a given exposure (time)
  - Subjective (depending on the assumption on the event occurrence and exposure time)
  - Policy consideration

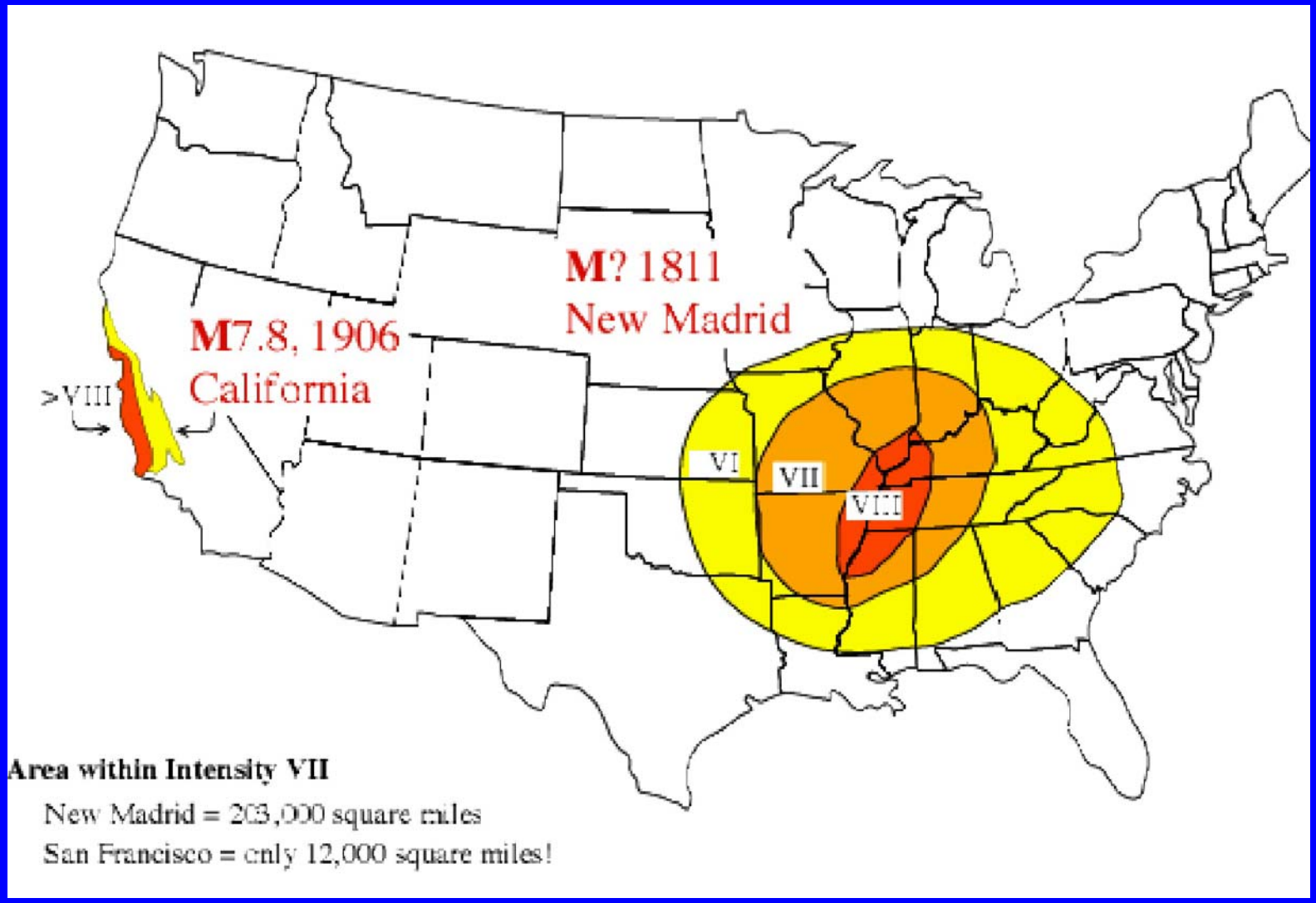
Hazard and risk are two fundamentally different concepts!

Seismic Hazard and Risk



CUS has a higher seismic hazard (*A*: M7.8 or MMI VIII)?

Seismic Hazard and Risk



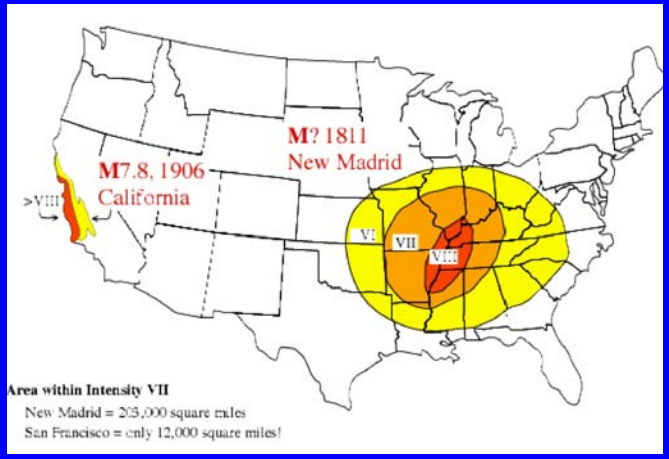
Temporal measure:

The Bay Area: *RI*=~100 years
New Madrid: *RI*=500~1,000 years

Seismic Hazard and Risk

Seismic Hazard:
BA: M7.8 /~100 years
NM: M7.8/500~1,000 years
If loss: $100B (same)

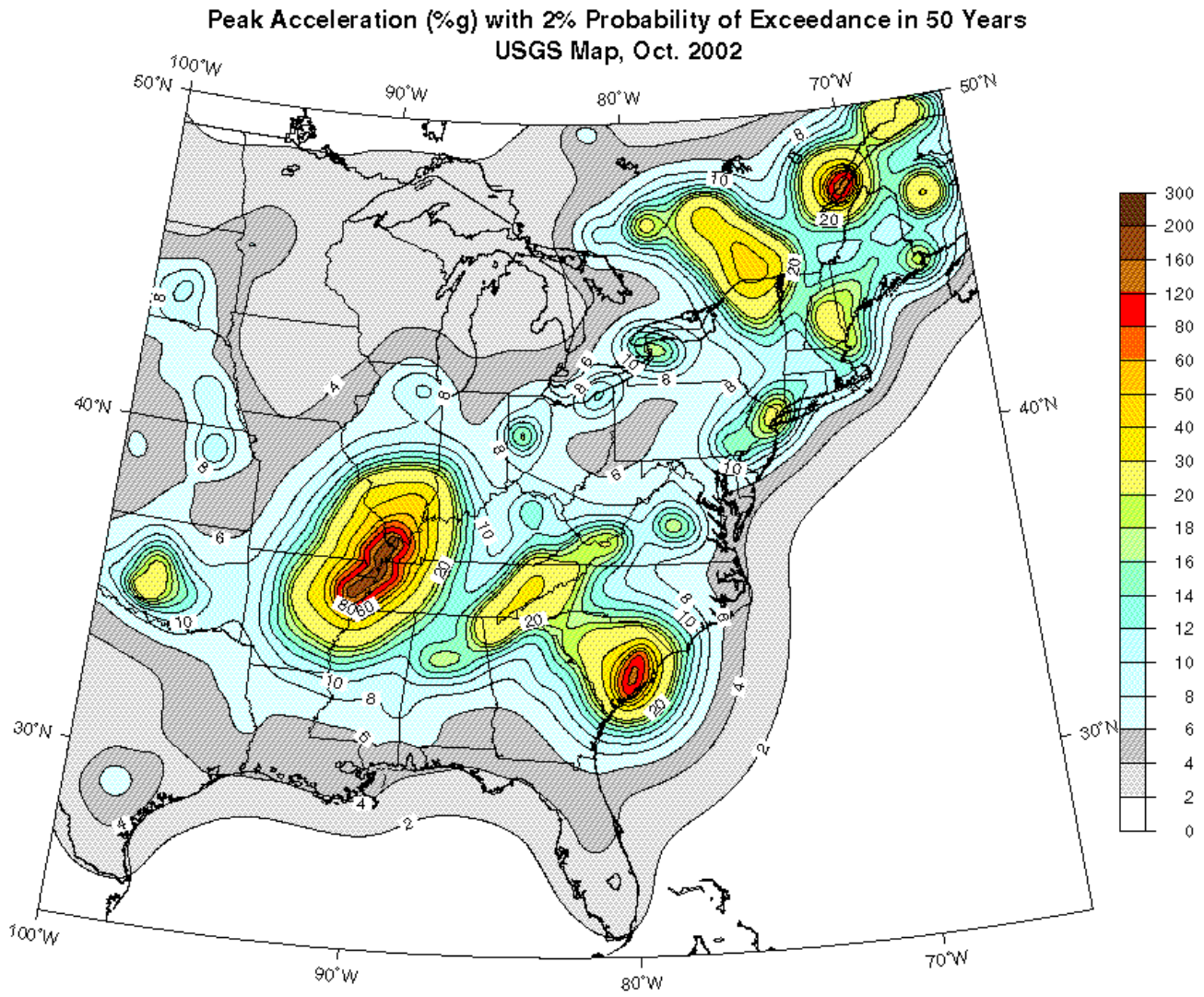
Seismic Risk:
BA: M7.8 with 39% PE in 50 years
NM: M7.8 with 5~10% PE in 50 years
39% Vs. 5~10% for $100B loss/50y



Policy is made based on risk, not hazard. This is why

1) most of resources and efforts goes to CA for seismic hazard mitigation
2) higher design ground motion in Paducah is not scientifically sound policy

What is it? hazard or risk map?



Acknowledgements

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