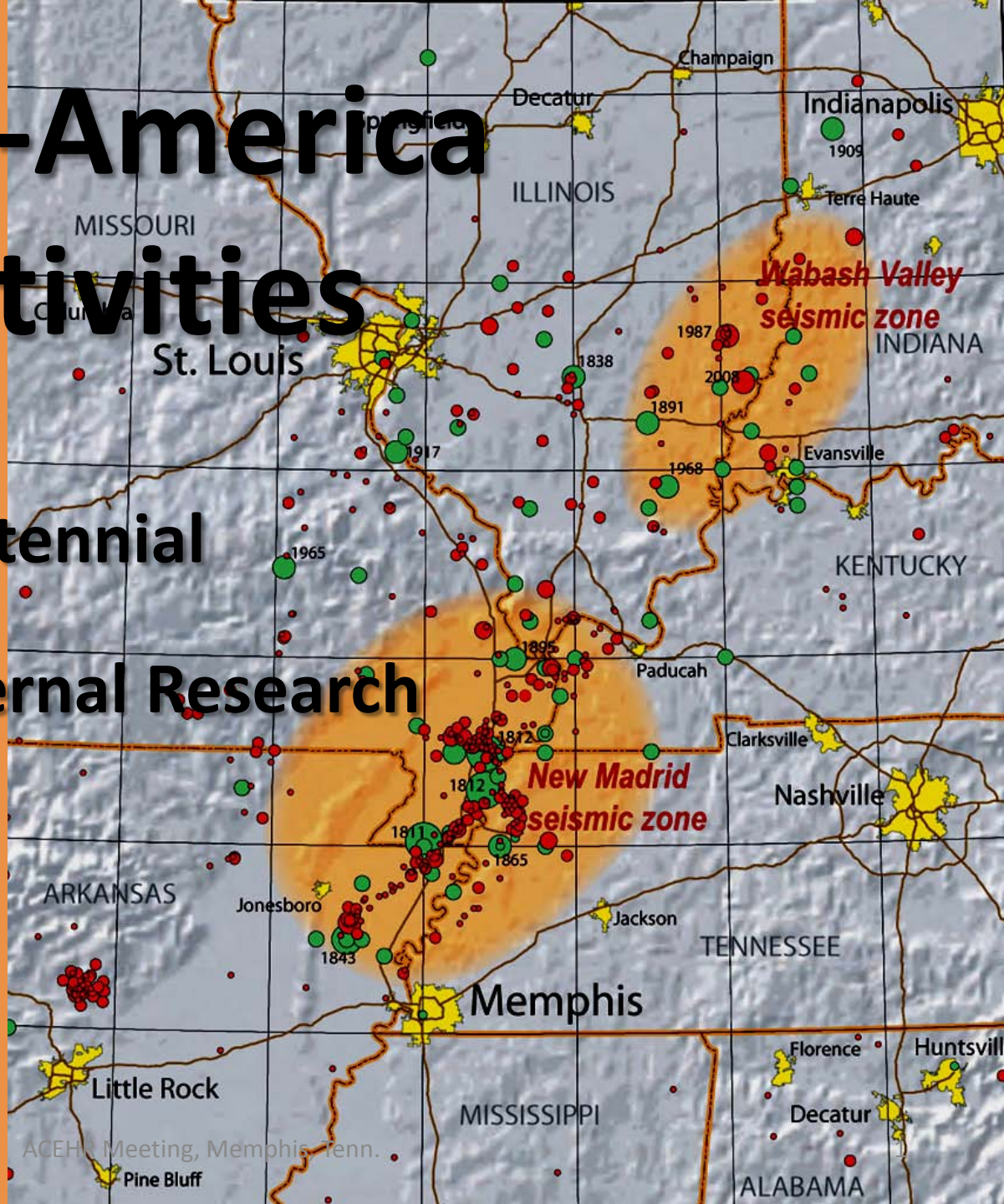
USGS Mid-America NEHRP Activities

- **1811-1812 Bicentennial**
- **Internal and External Research**



Robert Williams, USGS, Golden, CO
Presented to ACEHR
November 10, 2010
Memphis, Tennessee

USGS

http://newmadrid2011.org/

Communicating the Earthquake Science……

2010-2012 New Madrid Bicentennial Plans

Public Events/Meetings

Missouri Emerg. Mgr conference Oct, 2010

Earthquake Insight Field Trip, Oct. 6-8, 2010

Kickoff @ EQ Means Business, Feb. 11, 2011

Earthquake Awareness month - February

ShakeOut (CUSEC), April 28, 2011 at 10:15 AM

National Level Exercise, May 16-20, 2011

Professional Meetings

2011 Geodesy workshop (hosted by USGS)

SSA, Memphis, April 12-16, 2011

Eastern SSA, Little Rock, AR, Oct 2011

NEC (EERI) Memphis , April2012

Communicating the Earthquake Science……

2010-2012 New Madrid Bicentennial Plans

<u>Evansville, Indiana, and St. Louis Area Urban Hazard Maps</u>

Early 2011 Evansville maps public release

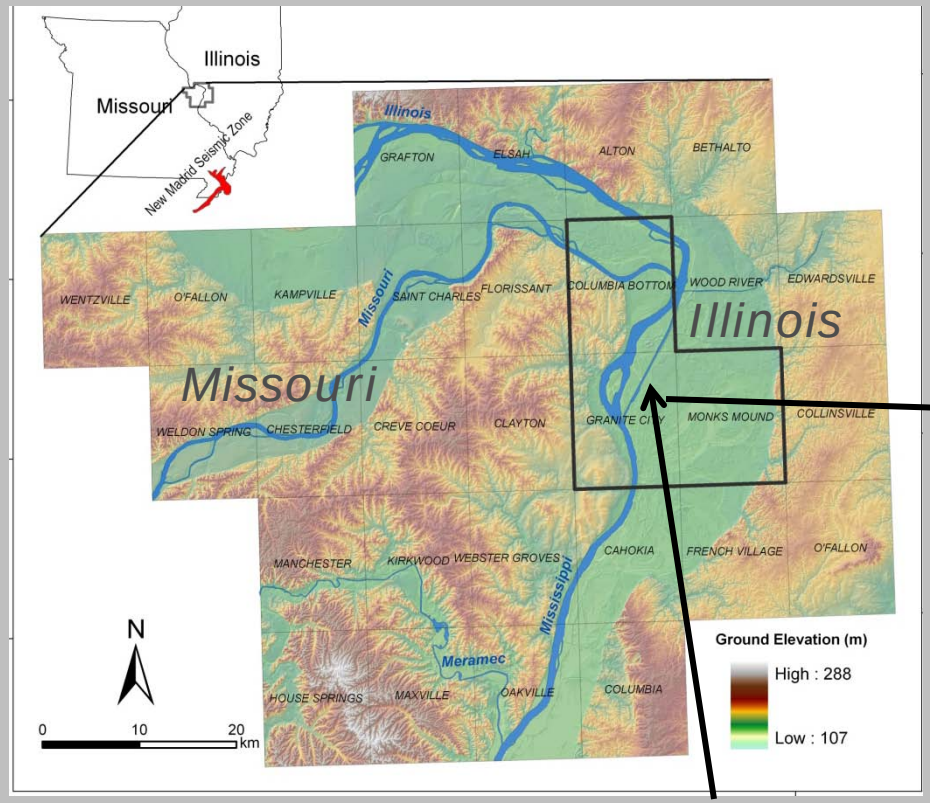
Early 2012 St. Louis Area (eastern half) maps release

Maps Include Site Effects

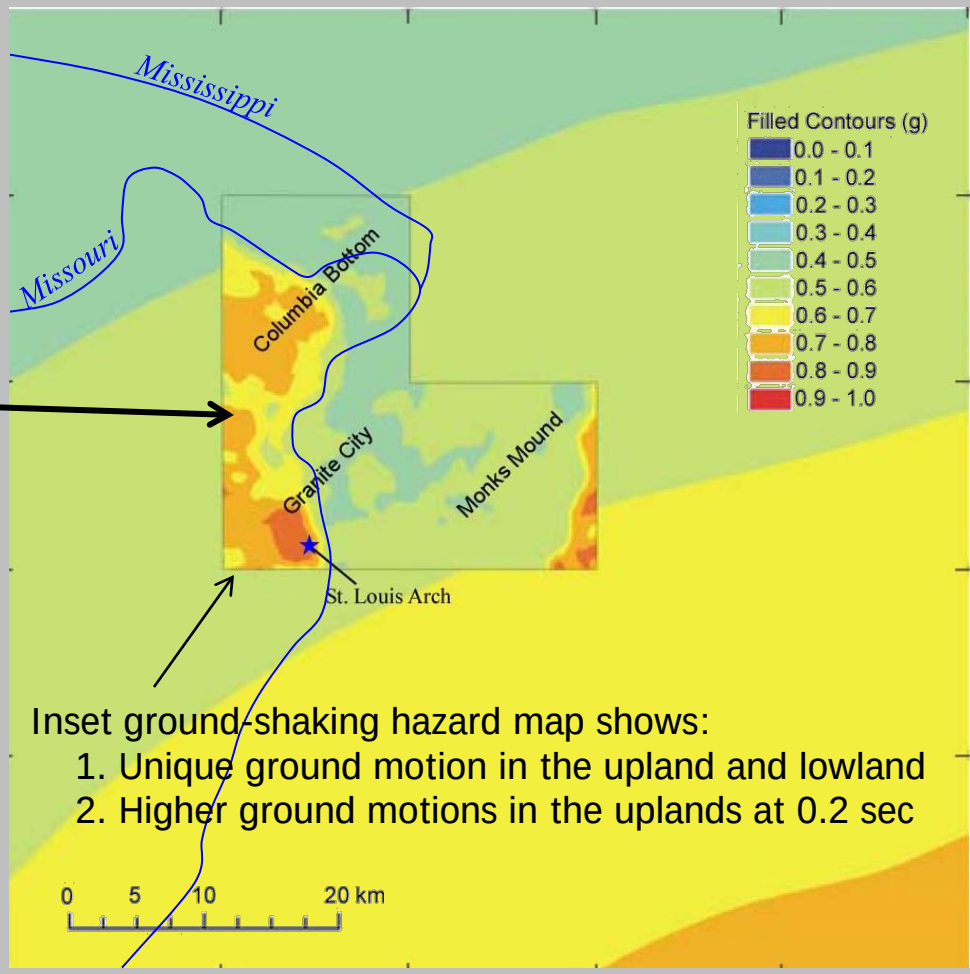
St. Louis Urban Hazard map example:

0.2 sec spectral acceleration, 2% probability of exceedance in 50 years

Comparison to USGS National Seismic Hazard Map



Preliminary results for <u>pilot study area</u> covering 3 of 29 quadrangles: Columbia Bottom, Granite City, and Monks Mound.



Inset ground-shaking hazard map shows:

1. Unique ground motion in the upland and lowland
2. Higher ground motions in the uplands at 0.2 sec

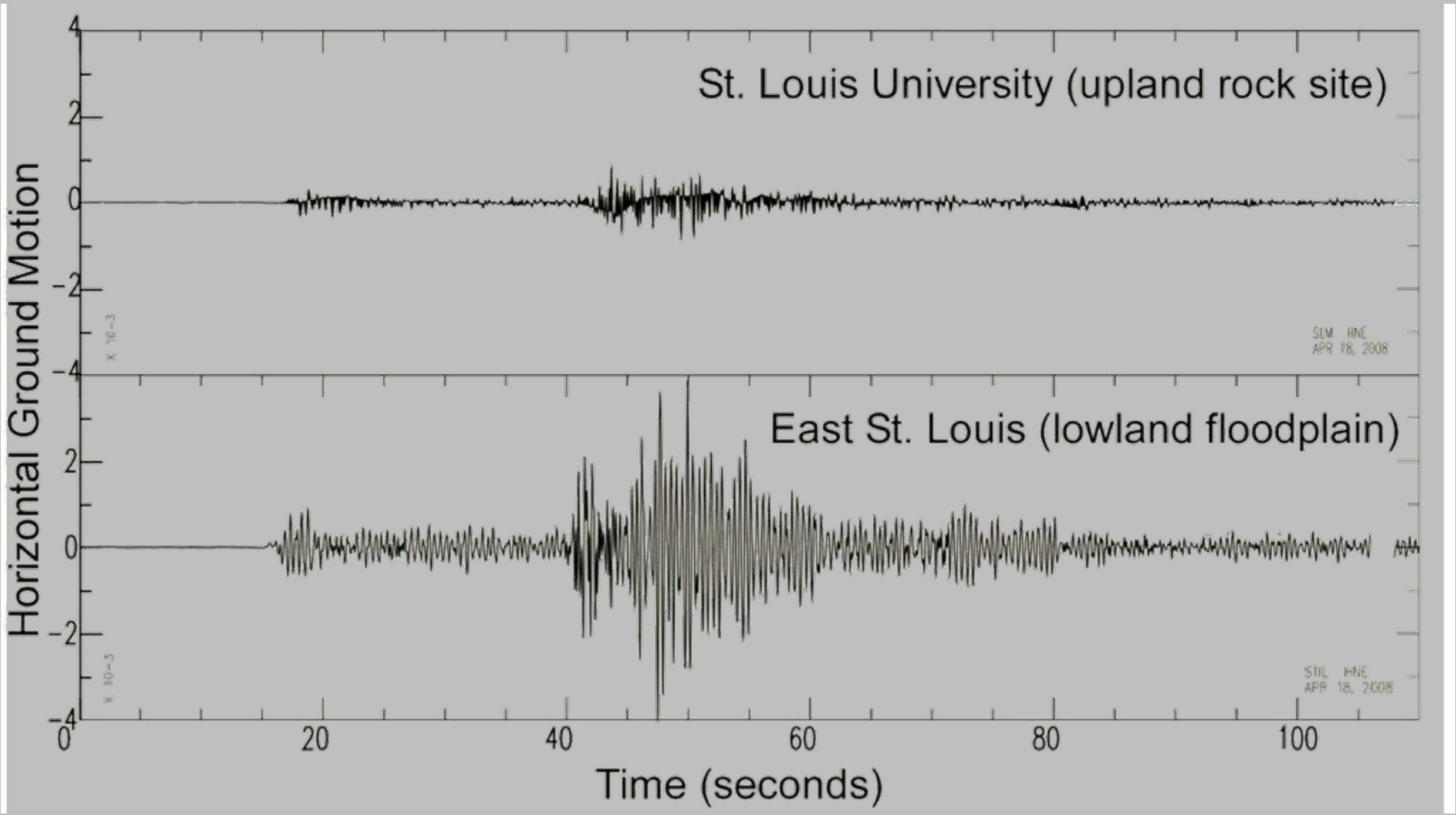
After Keradeniz, 2007

USGS

SLAEHMP

St. Louis Urban Hazard map example:

ANSS stations recordings in St. Louis of M5.2 Mt. Carmel earthquake



Communicating the Earthquake Science……

<u>Videos – Podcasts – Web features</u>

Preparedness Now video by Theo Alexopolous

National Geographic special on New Madrid

History Channel video on New Madrid

5-min New Madrid “scientists in the field” web videos

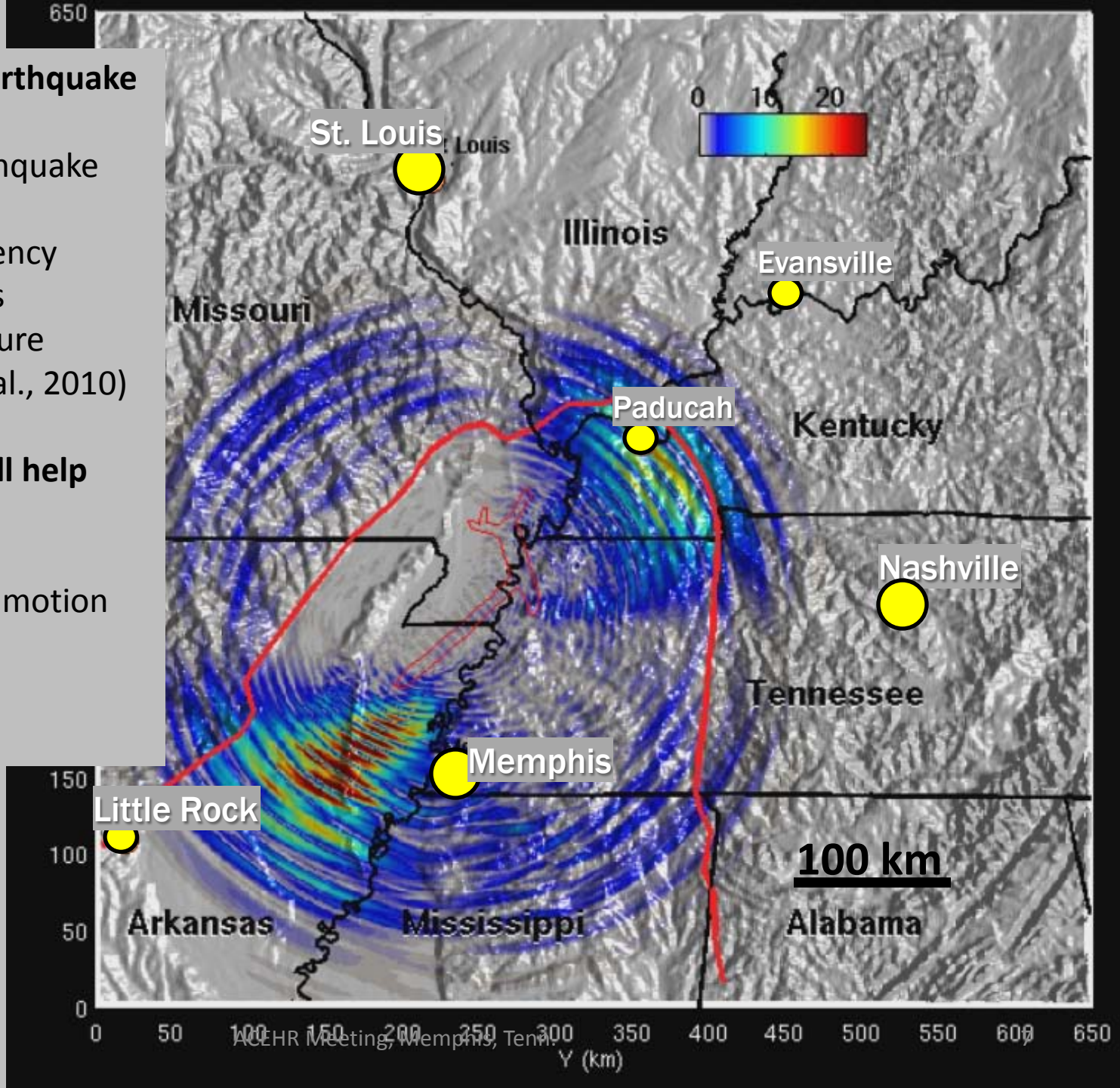
1811-12 Earthquake ground motion simulations

Preliminary USGS Earthquake Simulation

M7.4, Strike-Slip earthquake
Southern Arm
1 Hz maximum frequency
Minimum Vs=350 m/s
65 seconds after rupture
(Ramirez-Guzman et al., 2010)

These simulations will help constrain:

- 1811-12 magnitudes
- Variability of ground motion
- Shaking duration
- Liquefaction impacts
- Building damage



USGS

Communicating the Earthquake Science……

USGS General Information Products

Update of Central U.S. Seismicity Map (done)

Central U.S. ***Putting Down Roots***

Seismicity maps for Ark. and Mississippi

Seismicity and Personal Accounts Poster with National Park Service

Web-based 1811-12 quake sequence Timeline

Nat. Level Ex. (NLE) May 16-20, 2011

9 am May 16, M7.7 on southern axial trend, 34 second shaking time

Loss PAGER and other USGS-NEIC simulated earthquake pages provided

Deploy USGS personnel to EOC's/Clrnghse

Develop PSMAs (pre-scripted mission assignments)

Participate in regional FEMA post-earthquake planning meetings

2009-Present NEHRP ***External*** Research *~$950K/yr*

Central US – Seismic Imaging

- B. Magnani (CERI-Memphis): Tracking faults from Miss River reflection data (also supported by US Army Corps of Engineers)

Central US – Earthquake Simulations

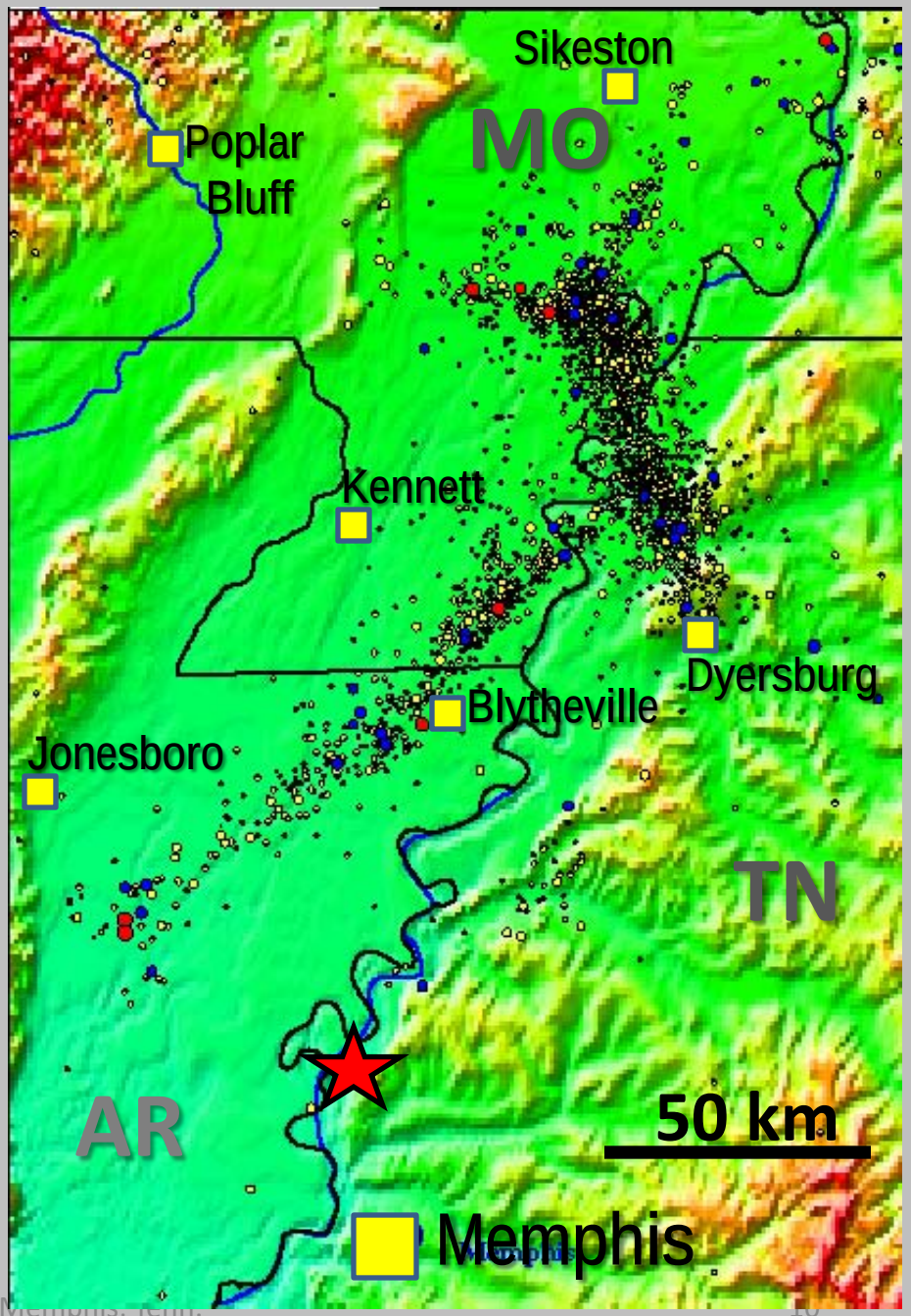
- K. Olsen (San Diego State): 1811-1812 dynamic rupture models
- P. Somerville and R. Graves (URS and USGS): kinematic rupture
- Steve Horton: Effects of shallow 3D structure in the Miss. Embayment

Central US – Paleoseismology

- Randel Cox: liquefaction, Holocene faulting near the Saline River, Ark.
- John Baldwin: Tamms fault, southern Illinois

Progressive understanding of faults……

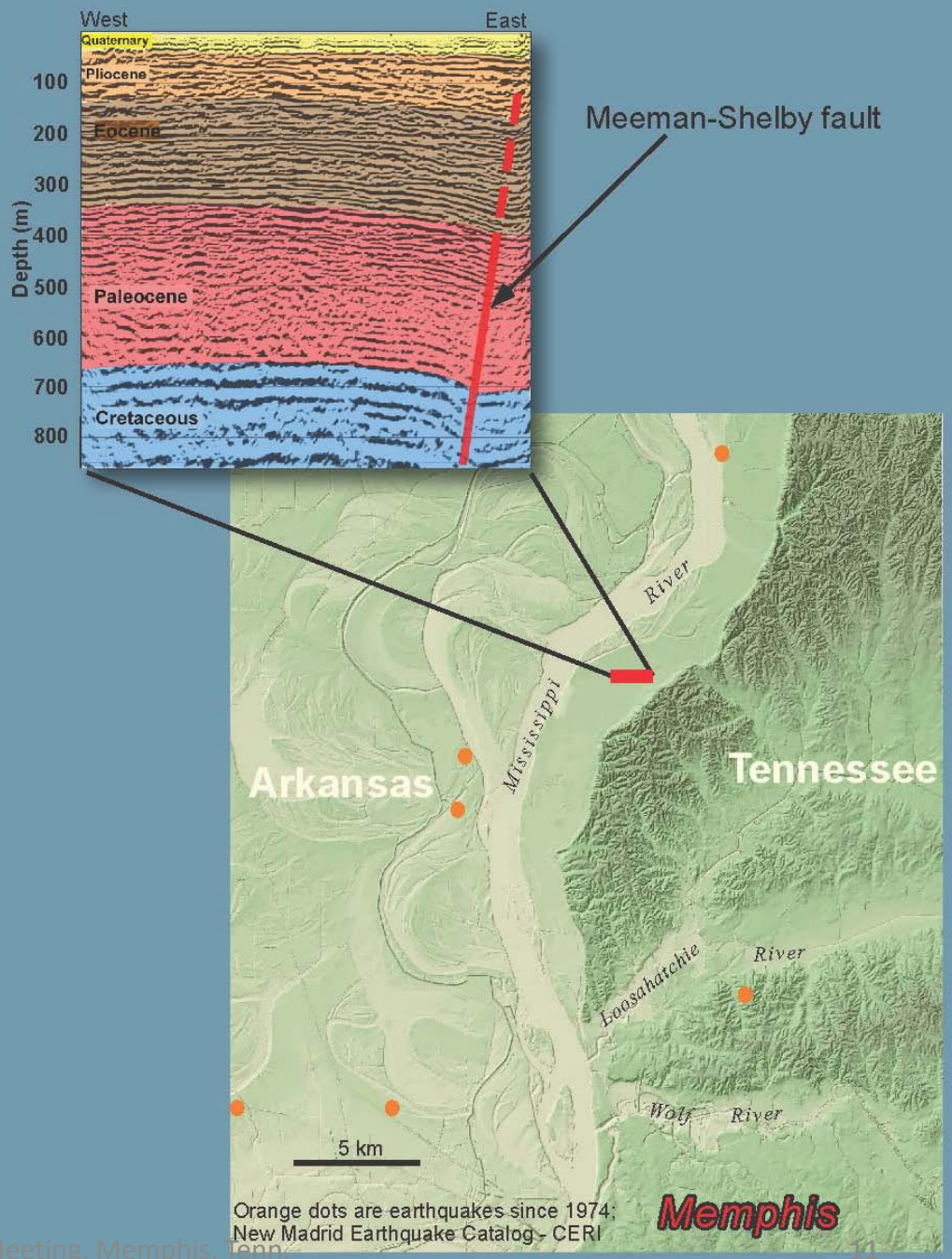
Meeman-Shelby Fault



Progressive understanding of faults……

Meeman-Shelby Fault

- Reverse fault first imaged in 2002
- Located 20km north of Memphis
- Near the eastern margin of the Reelfoot rift
- Increasing displacement with depth suggests fault may have been active for millions of years.



Progressive understanding of faults……

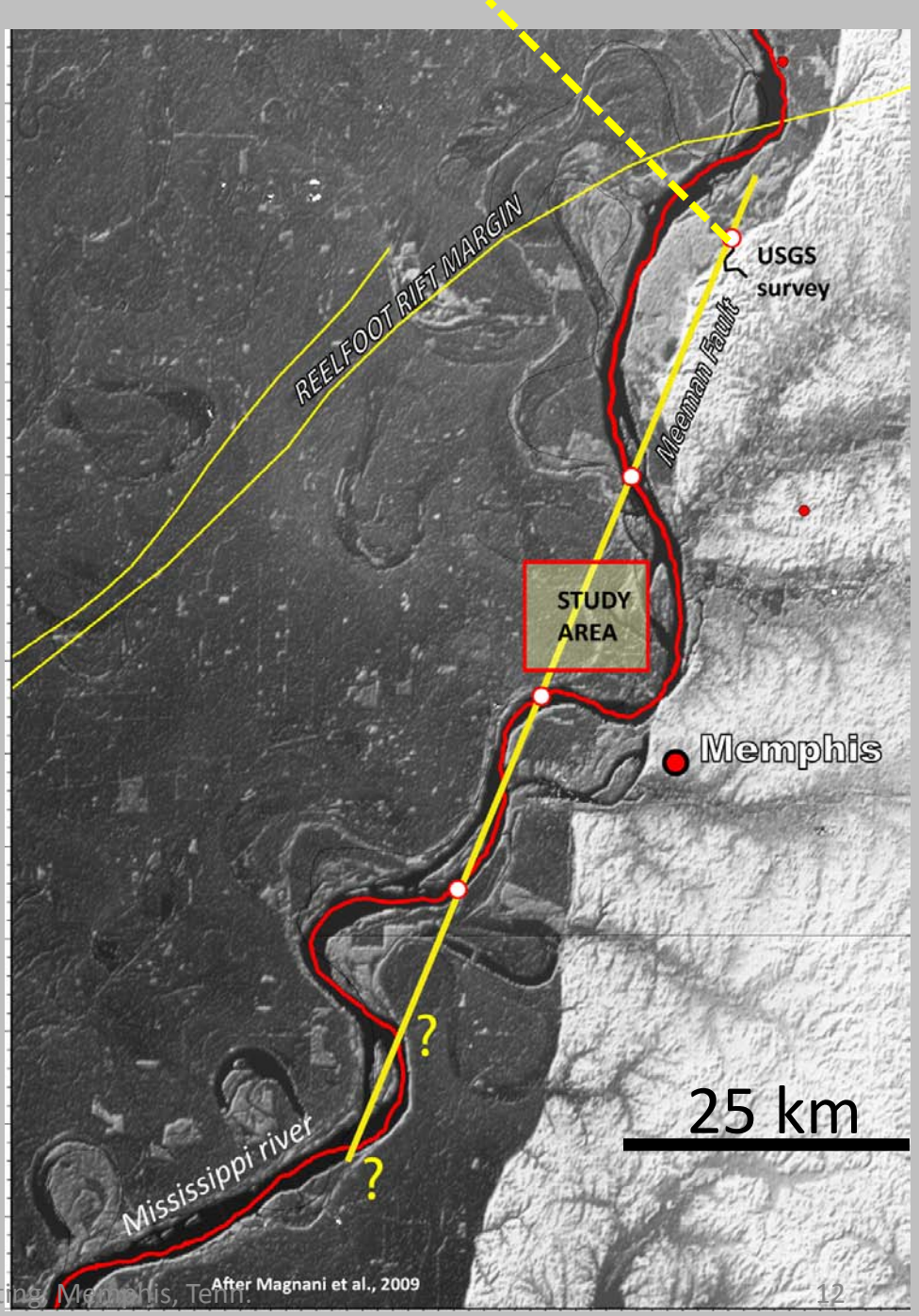
Meeman-Shelby Fault

Cox et al. (2006):

- find Q faulting along a NW trend of collinear scarps
- evidence of strike-slip motion

Magnani et al. (2010)

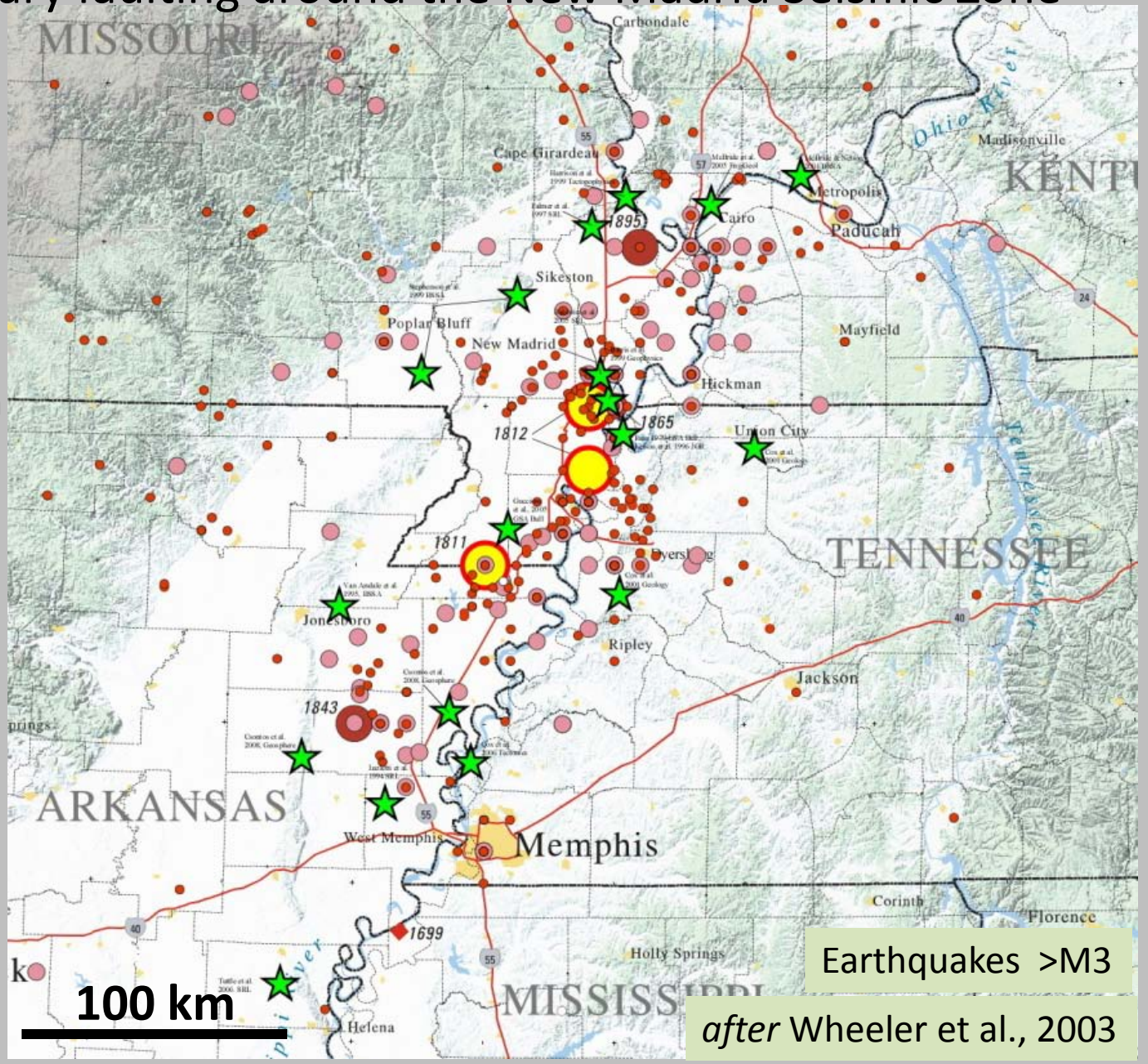
- Quaternary faulting observed in seismic reflection profiles on the Miss. River near Memphis
- Possible extension of the Meeman-Shelby fault bringing it closer to Memphis



★ Quaternary faulting around the New Madrid Seismic Zone

Q faults not just located on the main seismicity trends

Working hypothesis: That faults in this region are turning on and off through time – but paleoseismic record needed to help confirm this is incomplete.



2009-Present NEHRP *External* Research

Central US Velocity Structure and site effects:

- J-Ming Chiu: Miss. Embayment P- and S-wave velocity structure
- Ed Woolery: Wabash Valley site effects from the Mt. Carmel earthquake
- Y. Hashash: site amplification for deep deposits
- C. Langston, H. DeShon: detecting non-volcanic tremor
- C. Langston: Shear-wave path effects in the central US

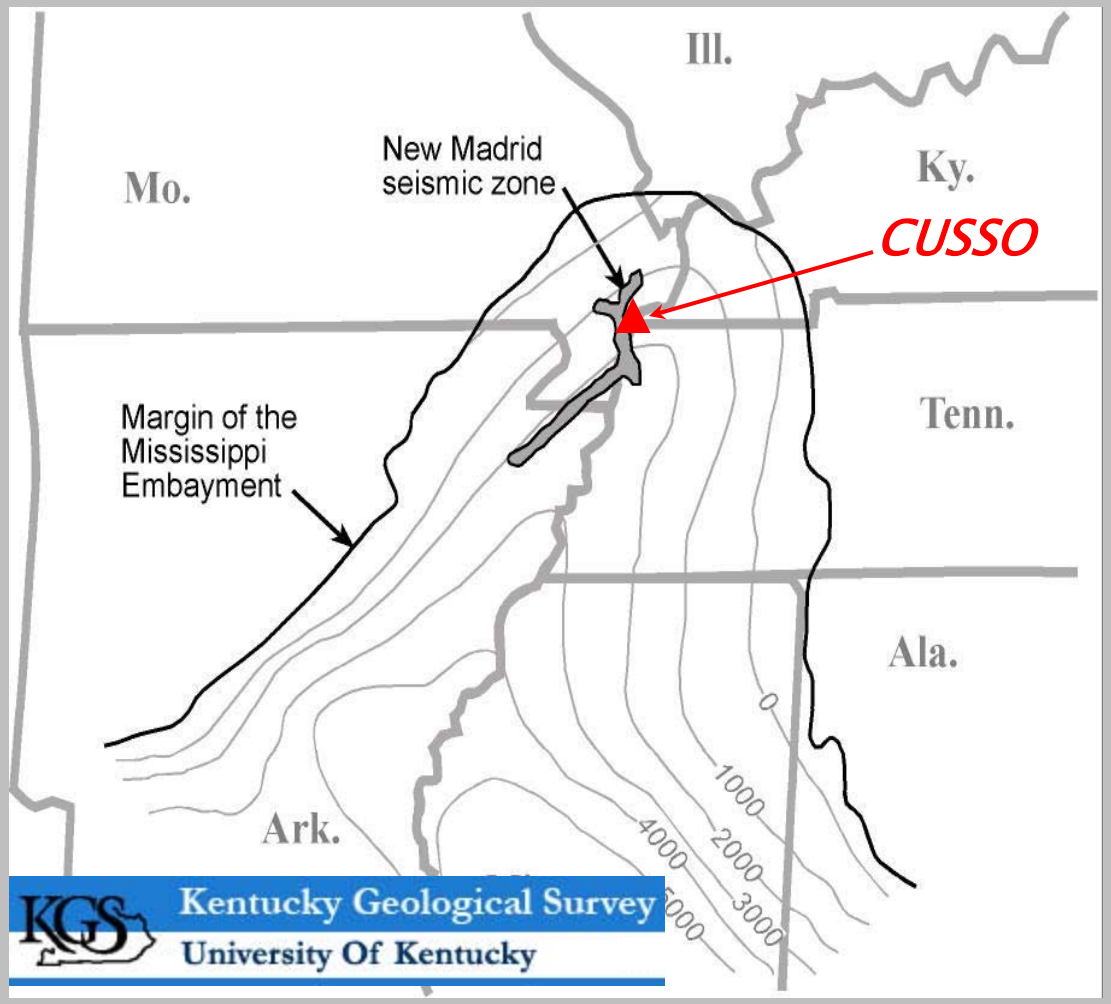
Central US Geodetic studies

- E. Calais and D. DeMets: Stress and Strain in N American interior

Central US Outreach Education

- G. Patterson: CERI - University of Memphis
- CUSEC: Fostering preparedness and awareness of earthquake hazard

Central United States Seismic Observatory - CUSSO



(Figure modified from Woolery and Wang, 2008)

- 595-m deep borehole through sedimentary section into Paleozoic limestone.
- Borehole geophysics completed including Vs and Vp.
- Seismograph installation in limestone at 595-m depth during FY08-09.
- New seismograph will complement existing nearby seismographs at 30-m and 270-m depth.

Internal Research

- Frankel et al. new assessment of **geodetic data** (submitted to journal)
- O. Boyd et al. **geodetic modeling** (SSA presentation)
- T. Pratt: Strike-slip **sand-box model fit** to NM seismic zone (2010 GSA presentation)
- Ramirez-Guzman: *(post doc ending Sept 2011)* 1811-12 **Earthquake simulations**
- Williams: Marianna, Ark. **Reflection profiling** (GSA poster)

NRC funded

- Hough et al. on **New Madrid magnitudes** (submitted to journal)
- T. Holzer: **New Madrid mags**. from liquefaction (GSA abs 2010)
- Tinsley: **Paleoseismic evidence** for earthquake history from cave explorations

Guide to future CEUS Research

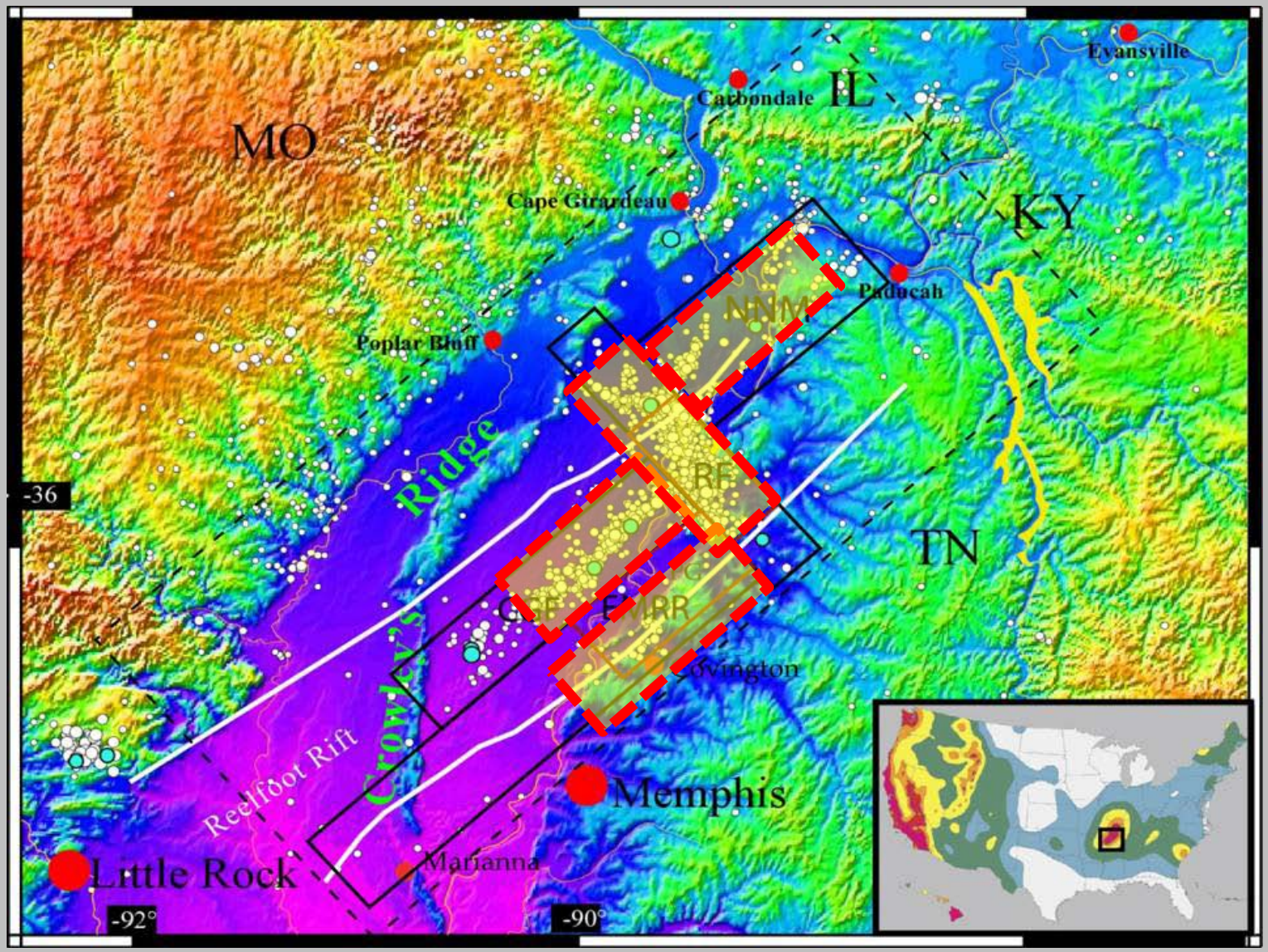
Charting a Way Forward in the Earthquake Hazards Program

Memphis Workshop, October 28 – 29, 2009 (Tuttle, Boyd, McCallister, McCarthy)

Breakout Sessions

- Earthquake Sources and Magnitudes
- Ground Motion, Near-Surface Velocity Structure, and Site Amp.
- Geodoesy and Modeling Ground Deformation
- Intraplate Earthquake Processes
- Community Velocity Model and Earthquake Simulations
- Seismic Hazard Mapping
- Education, Outreach, and the New Madrid Bicentennial
- EarthScope and the Earthquake Hazards Program

2010 ARRA-funded ("Stimulus") LiDAR acquisition areas

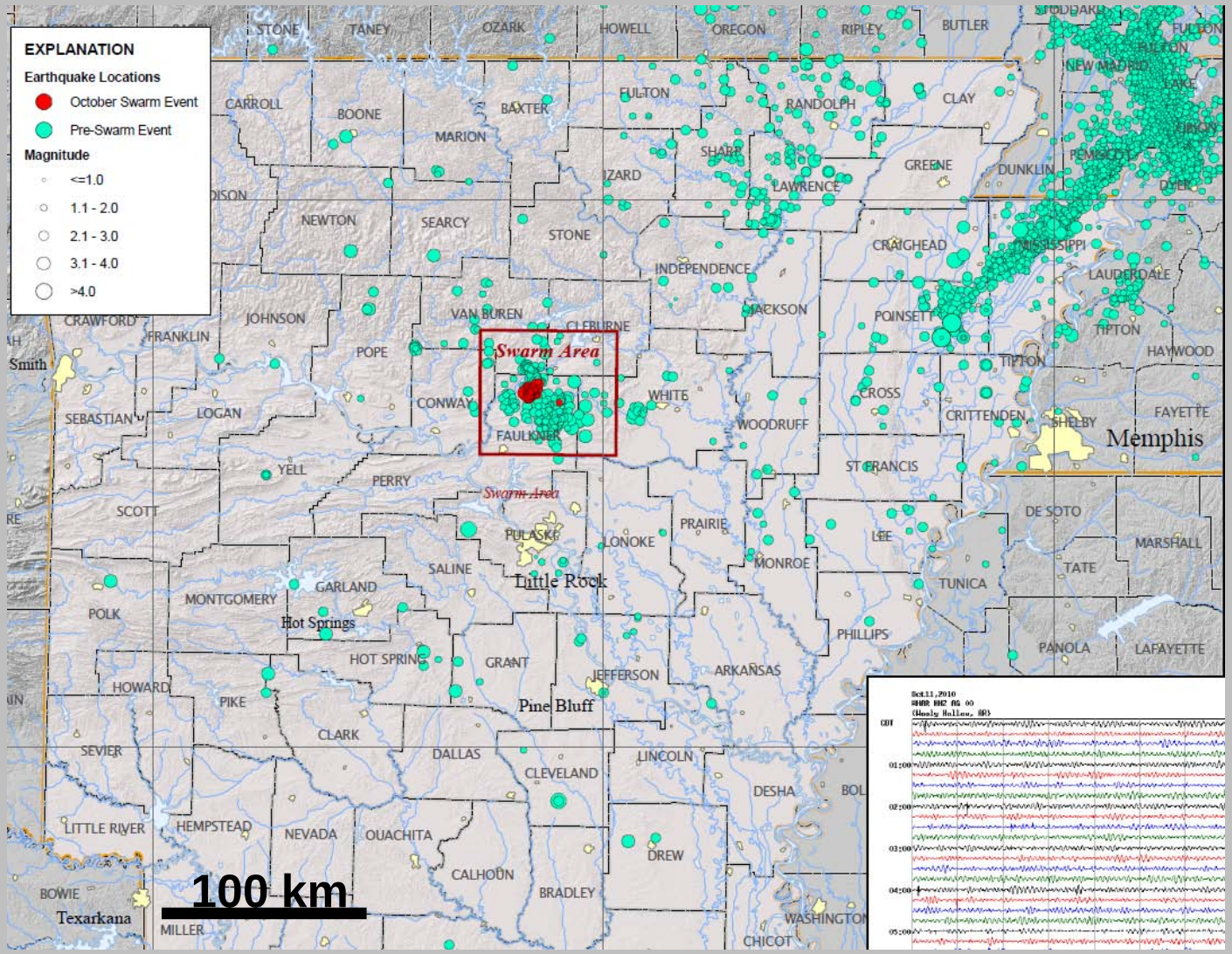


Arkansas Earthquake Swarm – October 2010

- CERI, Ark. Geol. Survey, and USGS, have reported hundreds of small earthquakes, most too small to be felt

- Swarm included a M4.0 and M3.8 on Oct 11 and Oct 15

- CERI and the Ark. Geol. Survey are studying whether there is a link to human activities.



2008-Present Oklahoma Earthquakes

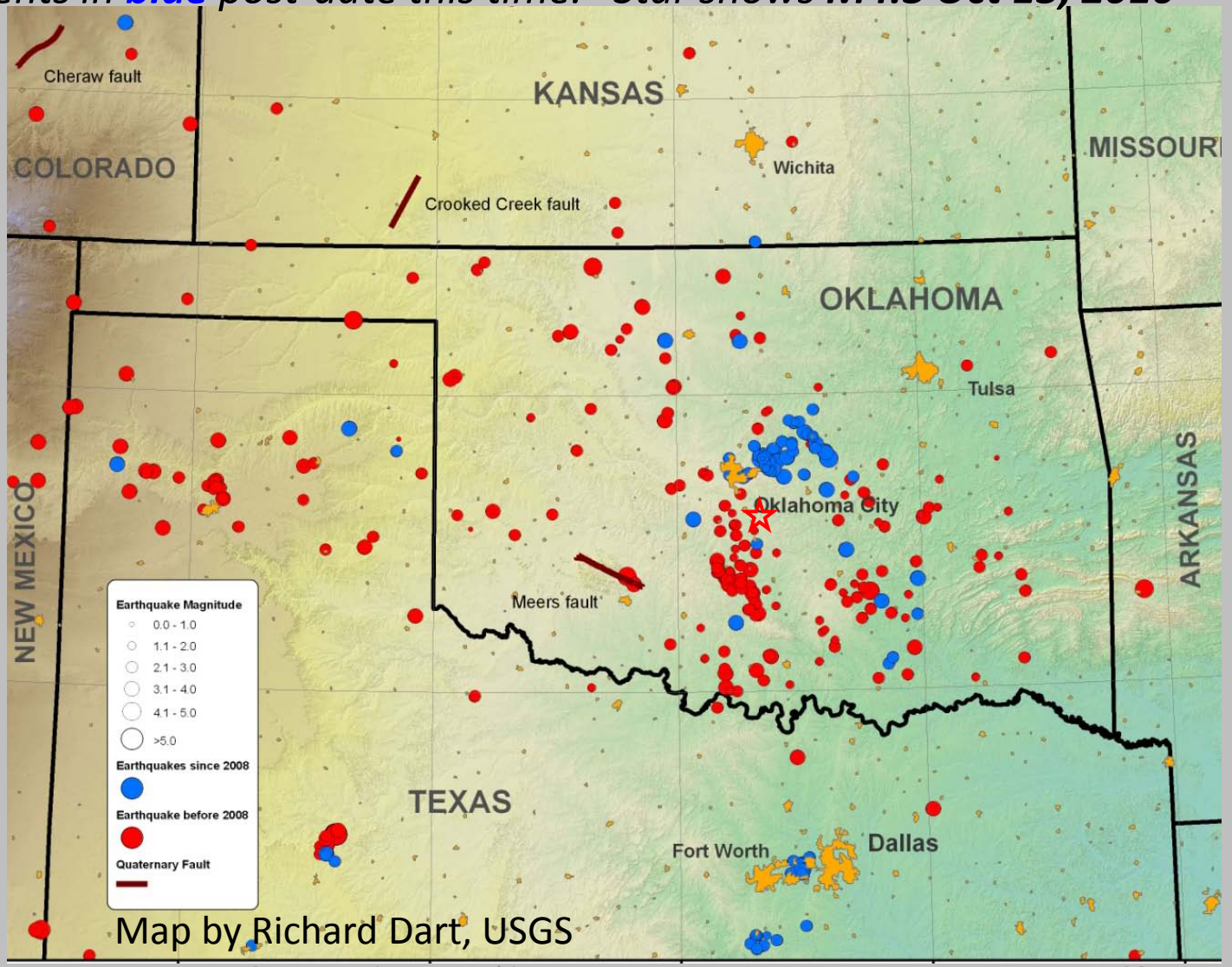
*Seismicity in the Oklahoma region 1936-March 10, 2010. Events shown in **red** pre-date 2008, while events in **blue** post-date this time. Star shows **M4.3 Oct 13, 2010***

.

The events since 2007 have been more clustered in the vicinity just north and east of Oklahoma City

Several events between magnitude 3.0 and 4.1 have been recorded since January of 2010.

Relationship to injection wells unknown at this time



Map by Richard Dart, USGS

We've learned a lot in the last 30 years but we still have a long way to go:

- When did the earthquakes start?
- Do big earthquakes move around the NMSZ?
- Why do big quakes happen here (Earthscope)?
- More Paleoseismology outside the NMSZ
- Will future big quakes repeat on same faults?
- What do recurrence times look like over 20-100,000 years?
- Liquefaction impacts in future large quakes?
- Variability of ground motions

Reelfoot Lake
Tennessee