

Western Kentucky Seismicity and Neotectonics:

Integrated Geophysical and Geological Solutions

KRCEE Scientific and Technical Conference

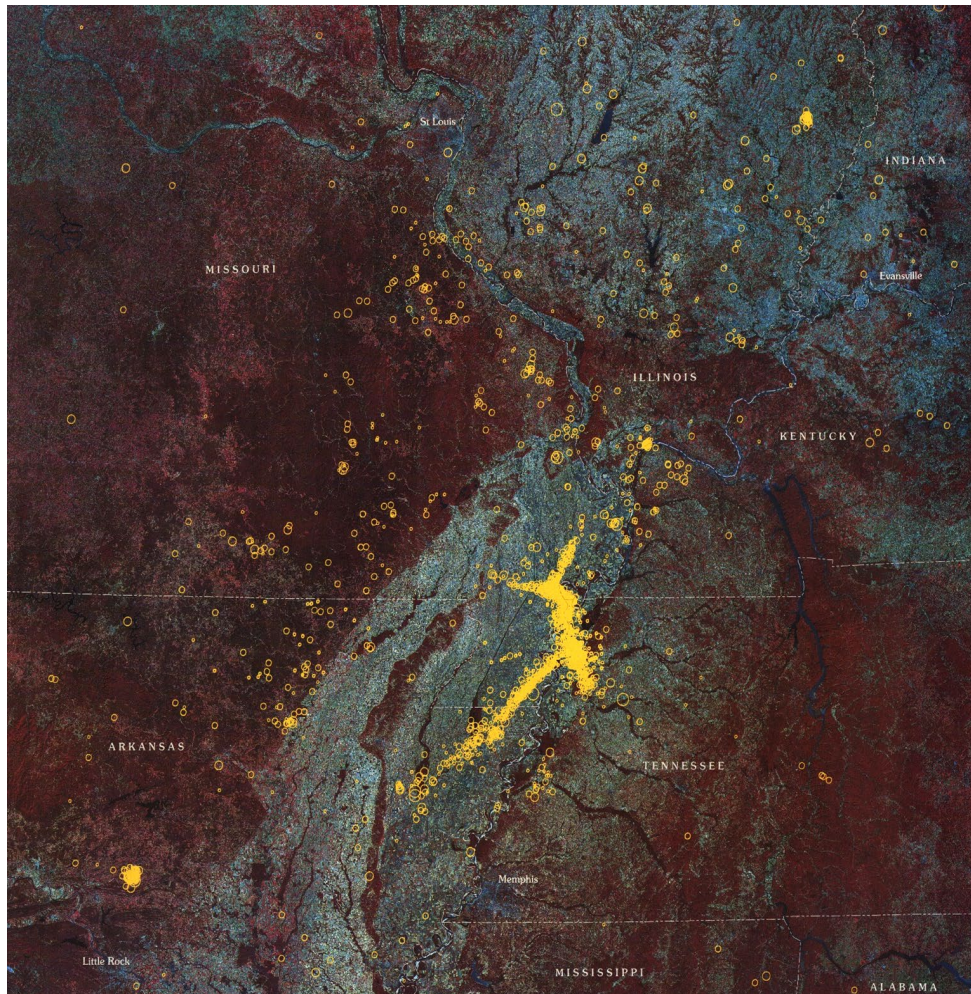
October 30-31, 2007

Lexington, Kentucky

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University of Kentucky
Department of Earth and Environmental Sciences/
Kentucky Geological Survey*



Problem



- Except for the central NMSZ where seismicity has been linked to neotectonic structure, contemporary seismicity outside this area cannot definitively be associated with known geologic structure.
- Where is northern NMSZ boundary??

(modified from USGS)

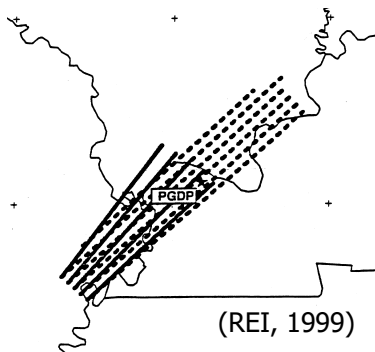
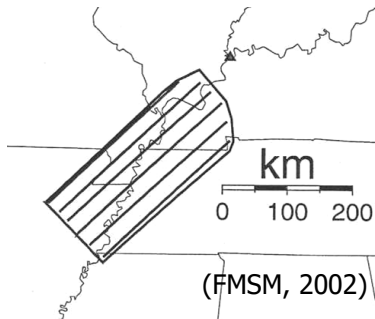
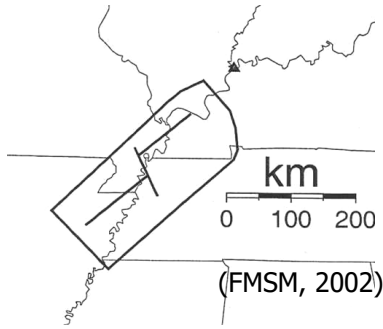
Cause



(courtesy USGS)

- Lack of surface expression
 - Thick, mechanically weak, sediment don't allow significant surface manifestation
 - Features eroded due to long recurrence interval for large events
- Historically, no systematic investigation of faults in the northern embayment

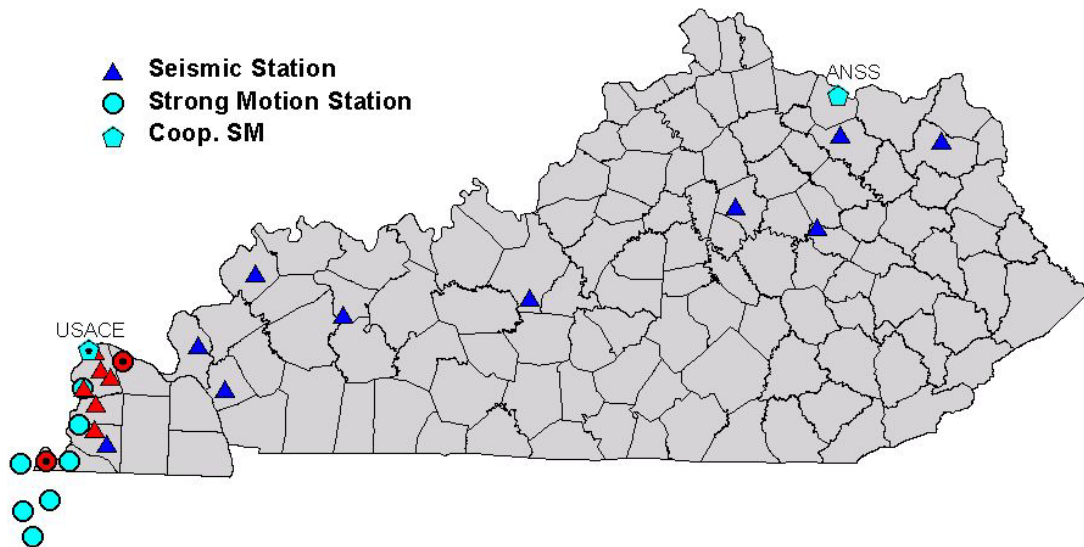
Consequences



- The “seismic source” is one of the three critical input parameters for seismic hazard assessment
- Poorly-defined seismic source boundaries result in greater uncertainty and ultimately in over- or underestimated seismic design loads

Solution 1: Passive Seismic Observation

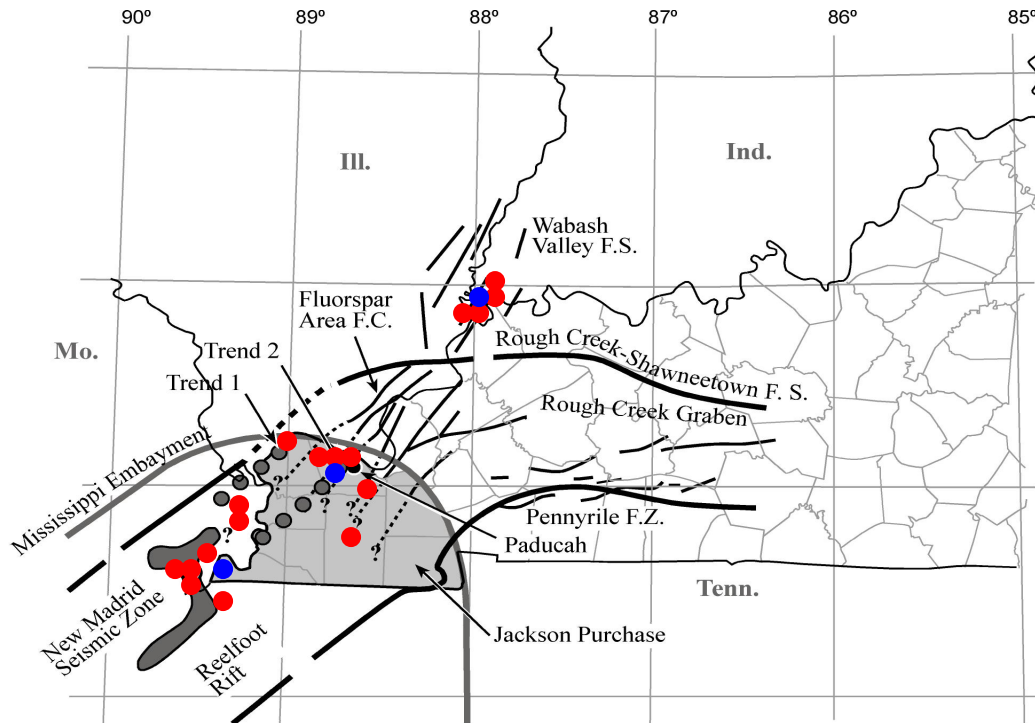
Kentucky Seismic and Strong Motion Network



- Gain accurate location and focal mechanical measurements.
- Low rates of seismicity require long-term study and network financial commitment.
- Duplication of national network??
NO!

Solution 2:

Active Geophysical/Geological Field Studies

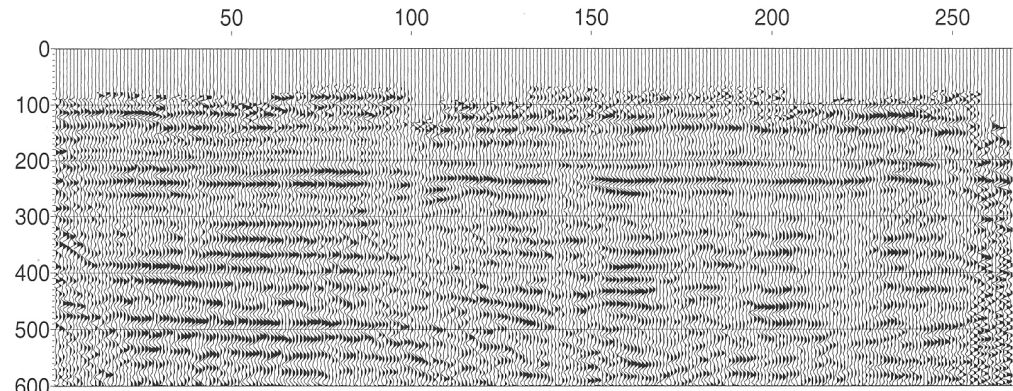
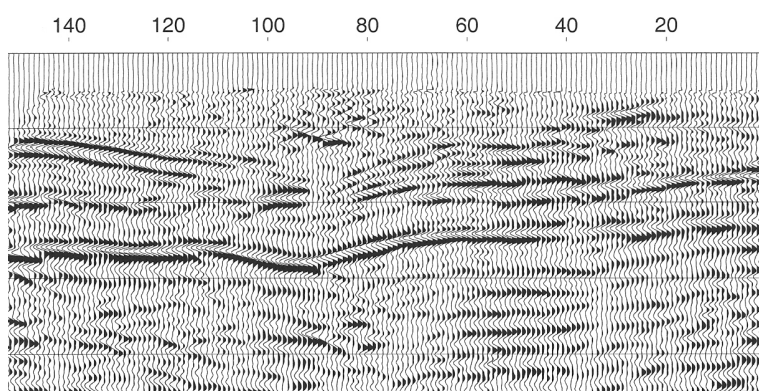
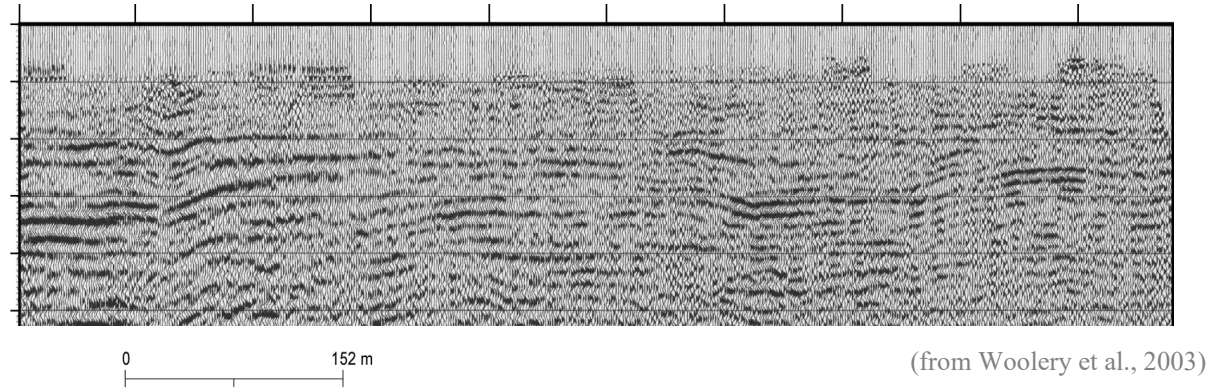
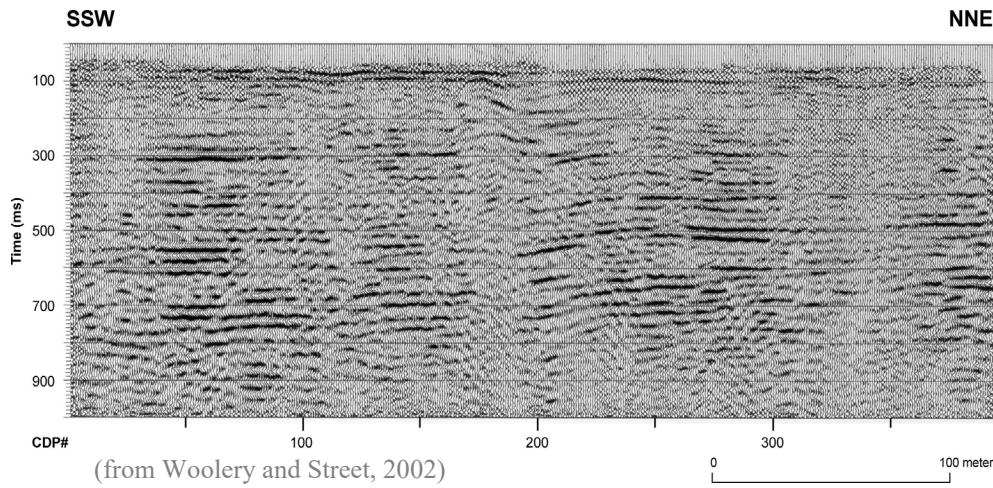


(modified from Kolata and Nelson, 1997)

- Ongoing Surveys
- Past Surveys

- Geophysics
 - Seismic Refraction/Reflection
 - ER
 - GPR
 - Microgravity
- Geological
 - Drilling and paleoseismological trenching for more precise age determination.

Examples



Observed Seismicity in the Jackson Purchase Region of Western Kentucky Between January 2003 and June 2005

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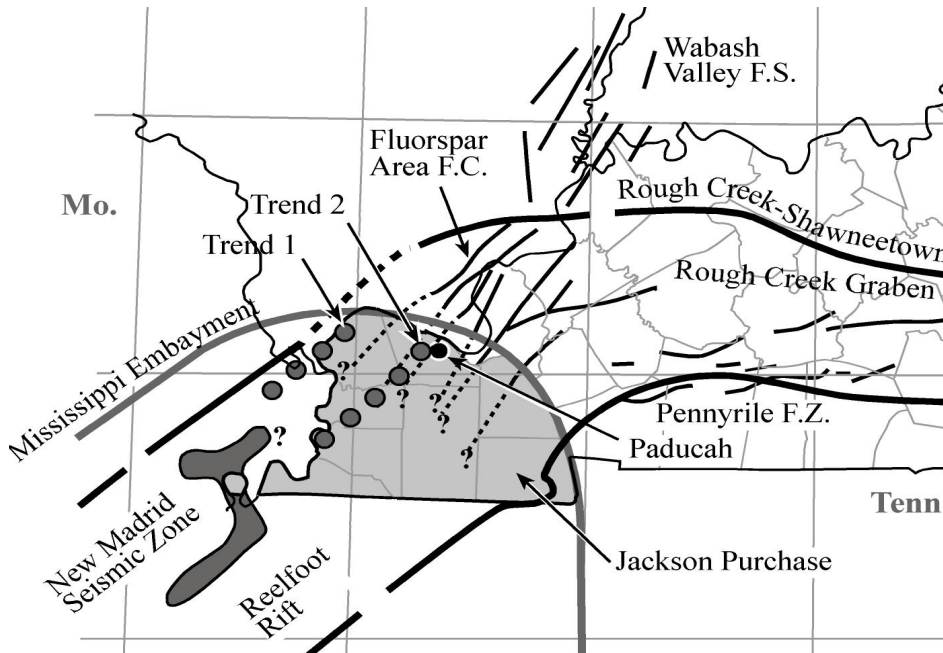
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Problem



(modified from Kolata and Nelson, 1997)

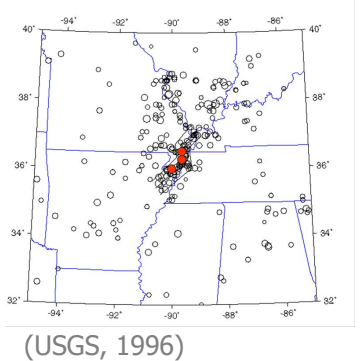
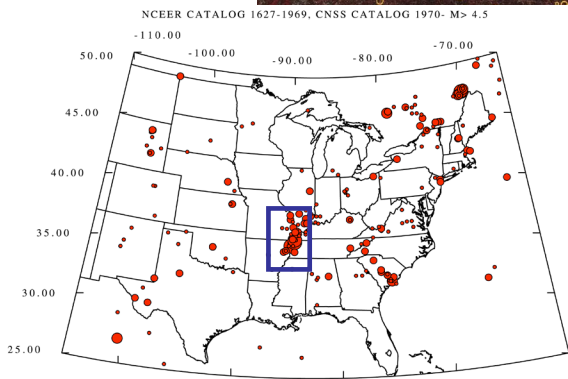
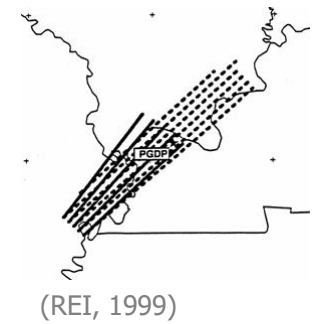
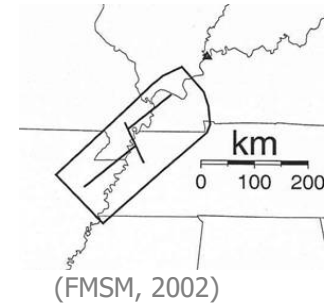
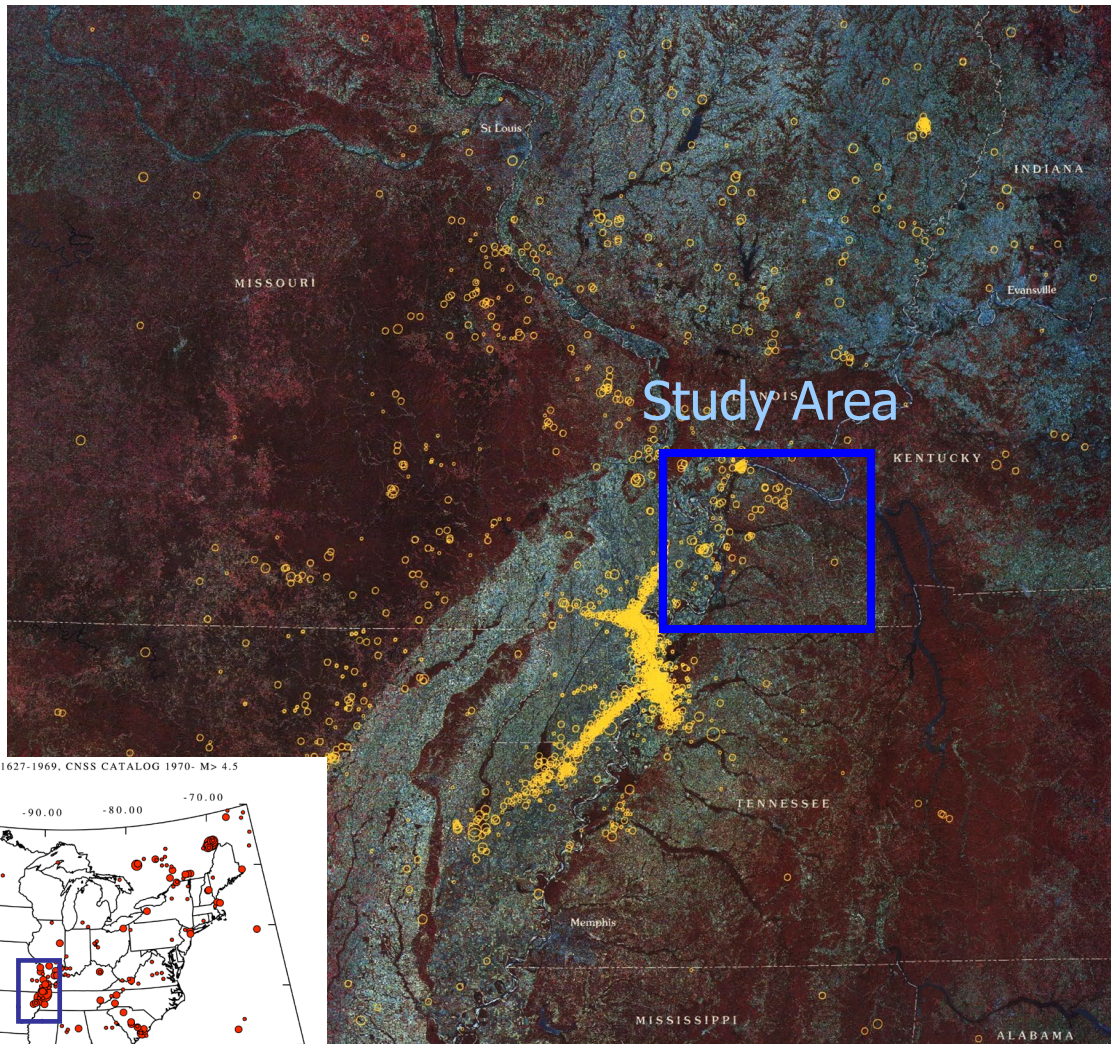
- Northeastern boundary for New Madrid Seismic Zone (NMSZ) is uncertain
- The postulated extension of the NMSZ into the Jackson Purchase study area has led to high seismic hazard estimates

- Network coverage has been insufficient in defining the extent of the NMSZ

Objectives

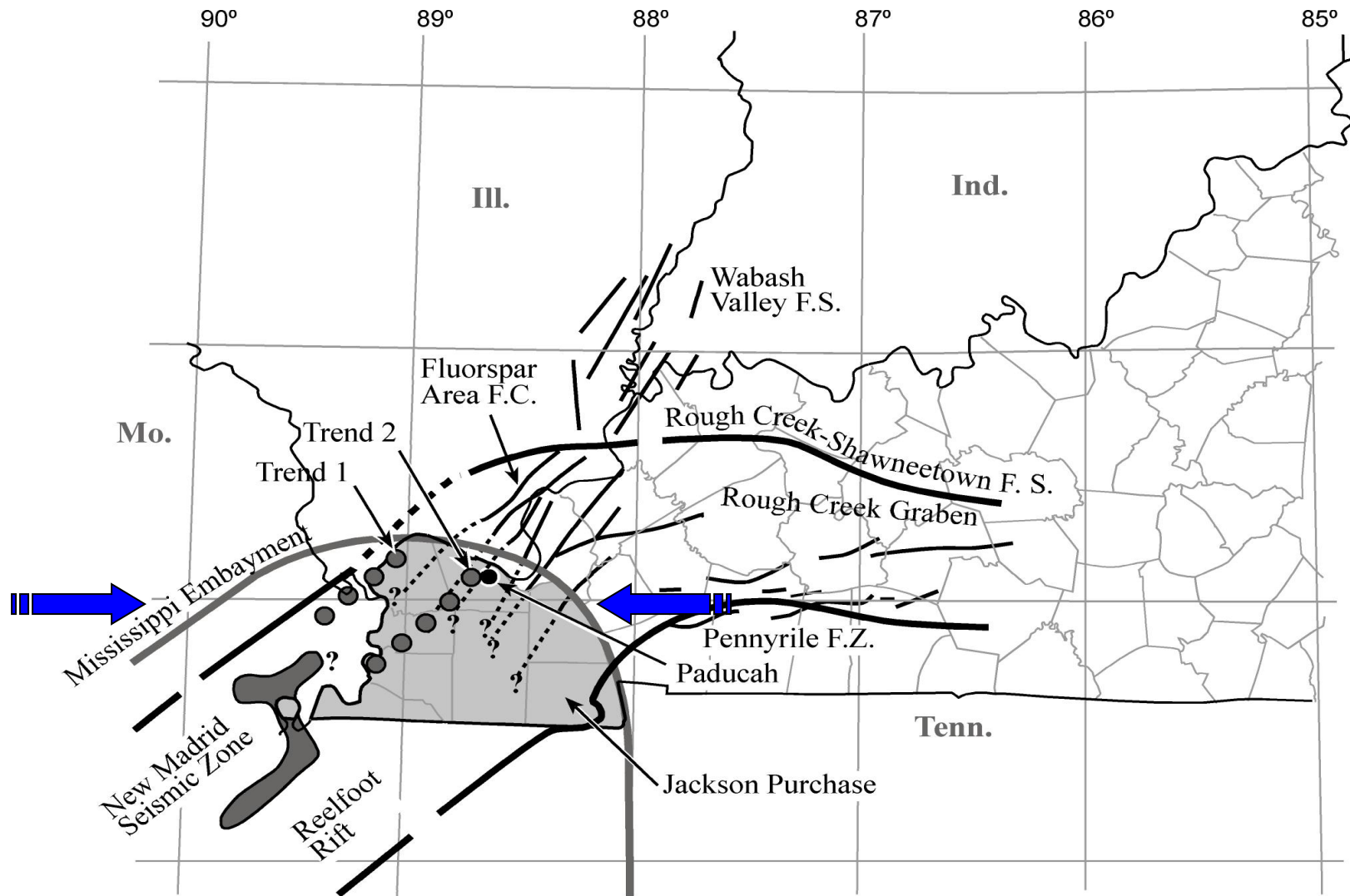
- Define the nature of seismicity present in the Jackson Purchase Region
- Determine the relationship between the study area and the New Madrid Seismic Zone

Regional Seismicity



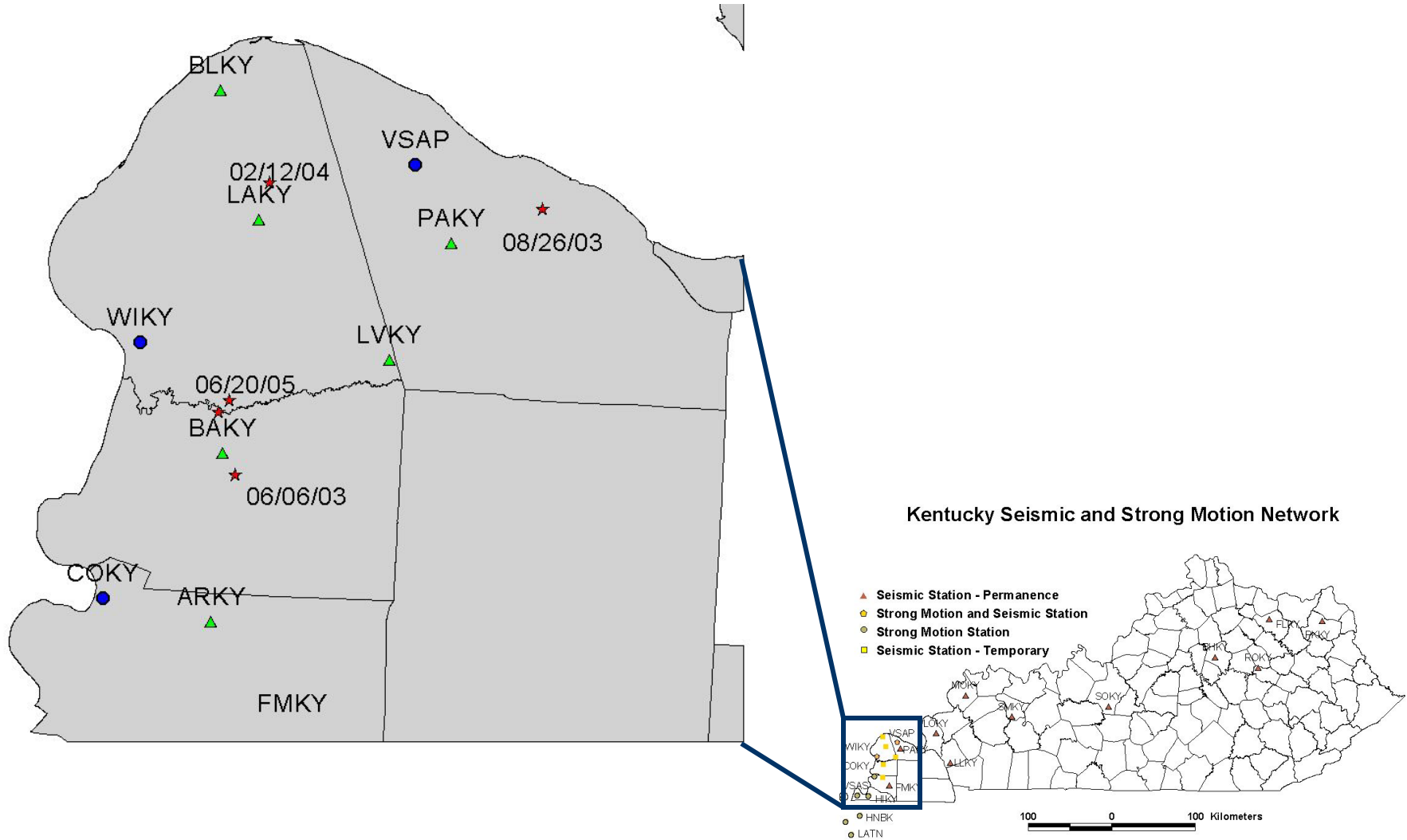
(modified from USGS)

Regional Geology

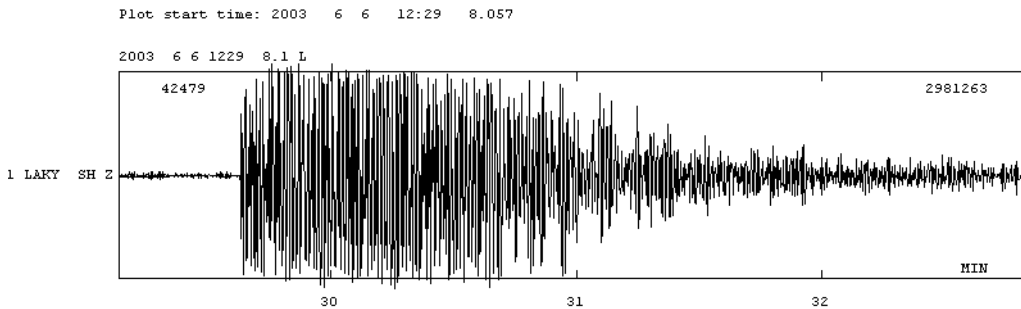
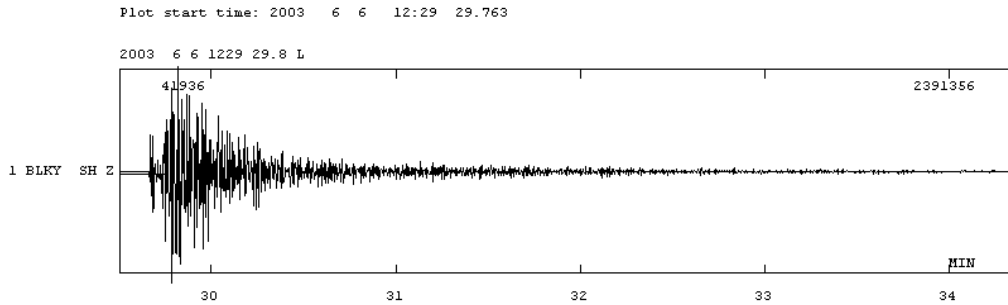


(modified from Kolata and Nelson, 1997)

Methodology: Dense Seismic Network



Time History: 06/06/2003 M 4.0

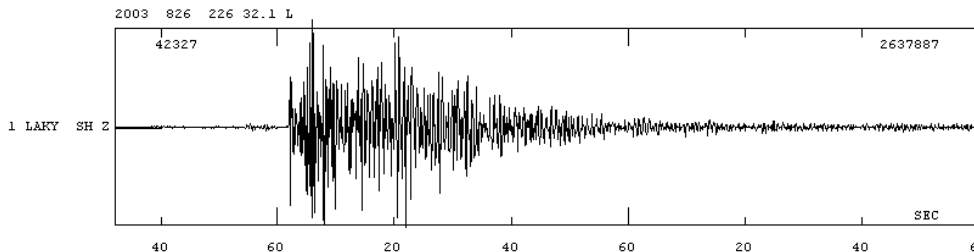
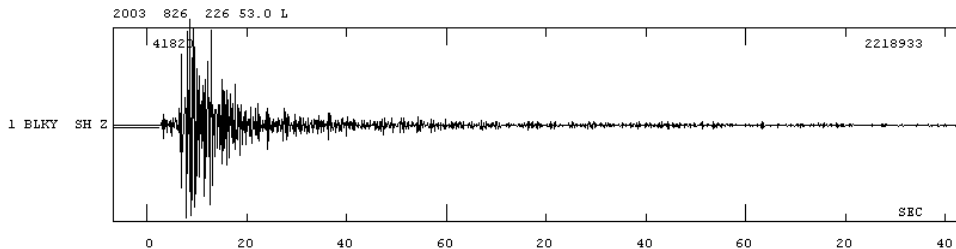
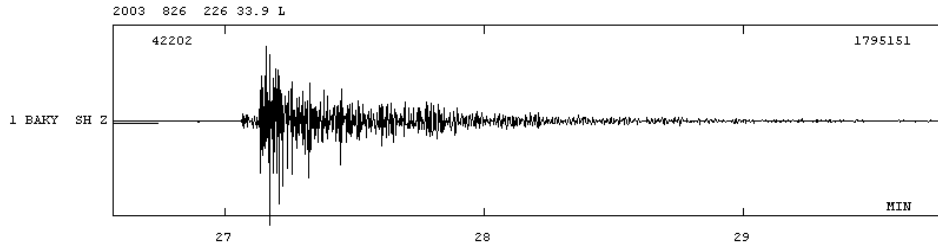


Station	P-Wave Arrival	S-Wave Arrival
BLKY	39.80 sec	44.30 sec
LAKY	38.05 sec	43.60 sec

Determined Depth:
1.5 km

Time History: 08/26/2003 M 3.1

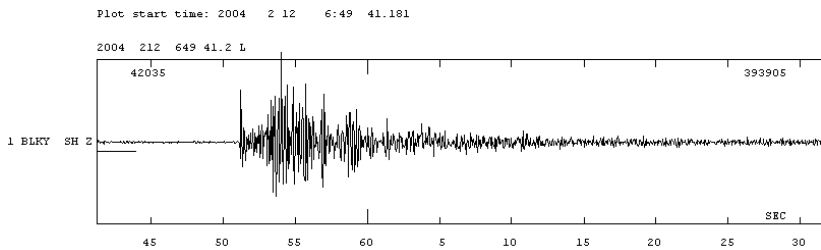
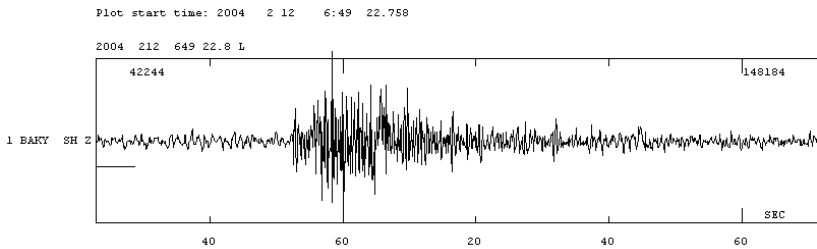
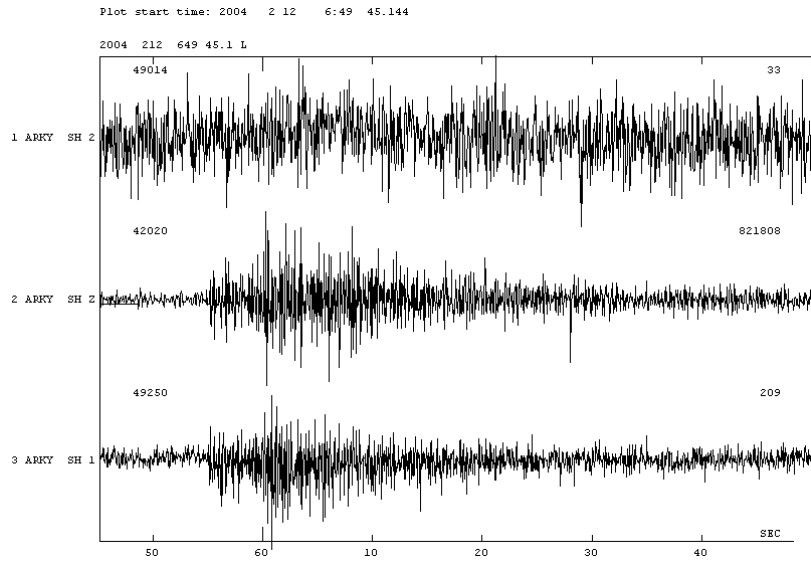
Plot start time: 2003 8 26 2:26 33.877



Station	P-Wave Arrival	S-Wave Arrival
BAKY	3.85 sec	7.80 sec
BLKY	3.00 sec	6.30 sec
LAKY	2.05 sec	4.85 sec

Determined Depth:
2.0 km

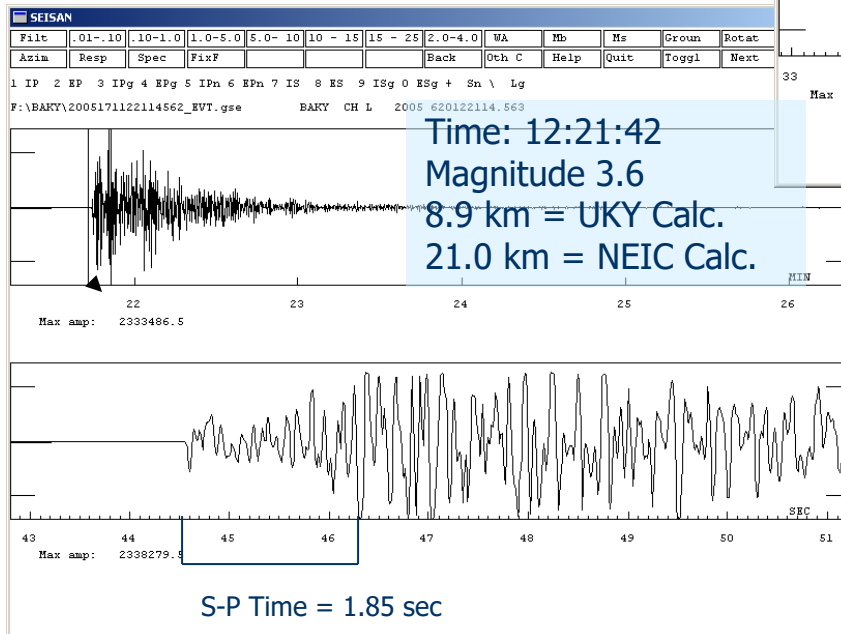
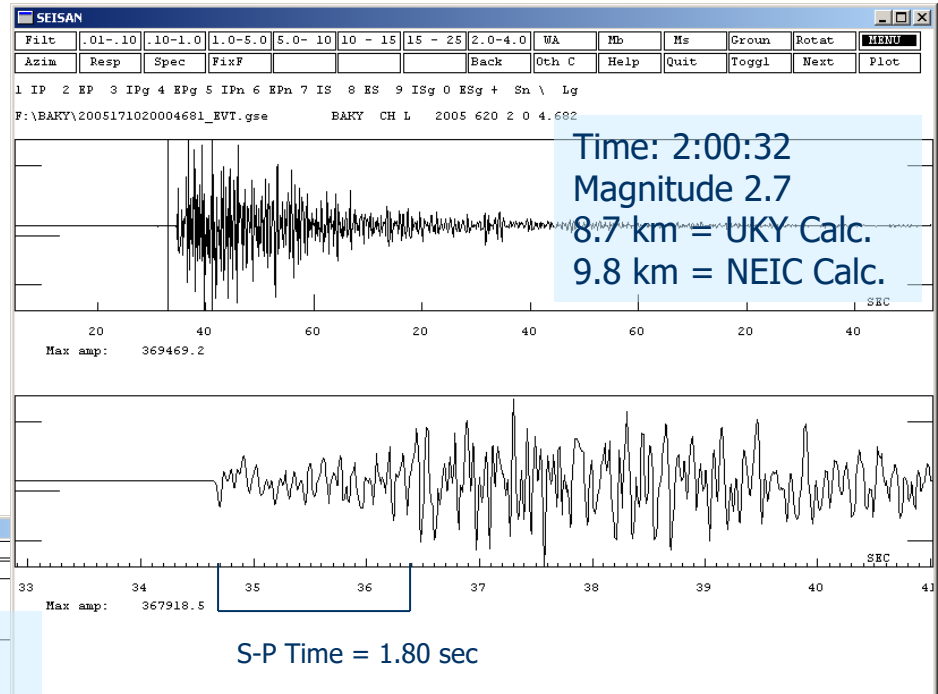
Time History: 02/12/2004 M 2.4



Station	P-Wave Arrival	S-Wave Arrival
ARKY	55.05 sec	59.80 sec
BAKY	52.60 sec	56.40 sec
BLKY	51.15 sec	53.05 sec

Determined Depth:
9.8 km

Time History: 06/20/2005



Epicentral Location:
Lat. 36.930
Long. -88.990

Epicentral Location:
Lat. 36.920
Long. -89.000

Summary/Conclusions

- Earthquakes are relatively infrequent in the study area
- It is necessary to monitor longer in order to achieve statistically reliable results
- Over the short term earthquakes tend to be more shallow than those associated with the NMSZ
- Points to the existence of a boundary between the NMSZ and the study area
- Could affect seismic hazard estimates in the Jackson Purchase Region

Acknowledgements

- Thanks to Prof. Ed Woolery (UK Dept. of Earth and Environmental Sciences), Dr. Zhenming Wang (Ky. Geological Survey) and Andrew Lynch (University of Kentucky)