Earthquakes & Their Impacts in Central U.S.

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Earthquakes in the Central U.S.

Why do we have them?
Where do we have them?
What do we know about pre-historic earthquakes?
What controls the location of damage?
What do we expect?
Plate Boundaries and Earthquakes
Intraplate Earthquakes
1:250,000 Scale Maps
1 inch = 4 miles
Earthquake Zones
- Wabash Valley
- New Madrid Seismic Zone
Dam

Water fall

30 ft uplift

Dam - water "runs" backward

Formed Reelfoot Lake

TN.
How do we know about pre-historic earthquakes
Sand Blow

Silt and Clay Layers

Filled Fissure (sand dike)

Liquefied Sand

Earthquake Waves

(after Slms and Garvin)
Sand and gravel vented onto paleosurface
Wabash Valley Area

Large earthquakes recorded in sediments, occurred about:

- 2,000 years ago – M 6.2
- 4,000 years ago – M 6.3
- 6,100 years ago – M 7.1
- 12,000 years ago – M 6.6
- 20,000 years ago
New Madrid Events

Sediments show repeat events occurred about:

- 200 years ago (1811-1812)
- 550 years ago
- 1,100 years ago
- 1,700 years ago
Cahokia Creek
18 miles
NE of St. Louis
MAGNITUDE

Richter Scale

Is a measure of the total energy released.
CHANGES IN MAGNITUDE

Two Unit Rule

4 ➔ 6 ➔ 8

1000 times more energy released
CHANGES IN MAGNITUDE

Two-Tenths Rule

5.2 $\rightarrow$ 5.4

Doubles energy released
Is an evaluation of the effects, observations, and experiences in an area.
6 - Strong - trees sway; loose objects overturn or fall

7 - Very Strong - walls crack; plaster falls

8 - Destructive - masonry cracks; chimneys fall; poorly constructed buildings damaged; water well levels may change

9 - Ruinous - some houses collapse where ground begins to crack; pipes break open
FACTORS AFFECTING GROUND MOTION

- Magnitude
- Distance
- Source mechanism
- Local Soil Conditions
- Condition of rock along transmission path
- Duration of Shaking
What was felt in different cities during the Oct. 31, 1895 Mag. 6.2 Earthquake

- Slight damage to poorly built buildings
  Plaster is somewhat cracked
  Broken dishes, glassware and some windows

- Difficult to stand or walk
  Some damage in well-built buildings
  Considerable damage in poorly built buildings
  Large store front windows break
  Most chimneys are damaged/top of walls fall

- Many people fall or are knocked down
  Major damage to brick buildings
  Some buildings have partial collapse
  Heavy furniture is overturned
SOUTHERN ILLINOIS EARTHQUAKE
Feb. 5, 1994 - Monitored in Paducah, KY

Bedrock
134 Ft.

Sand, Silt, Clay
335 Ft.

Sands & Gravels
Surface

Kentucky Geological Survey &
University of Kentucky
Soft, Wet, Thick Sand = More Earthquake Shaking!

5 to 6 Times Larger Shaking!
Lateral Spreading of Levee
Initial State

SHAKE
Liquefaction Caused Road to Sink
Modified Mercalli Intensity Areas for Central & Eastern verses Western US Earthquakes

San Francisco Earthquake
April 18, 1906
USGS Moment Magnitude 7.8

New Madrid Earthquake
December 16, 1811
USGS Moment Magnitude 8.1

US East of Rocky Mountains
US West of Rocky Mountains

Modified Mercalli Intensity

II - III
IV
V
VI
VII
VIII
IX
X
XI
Hazard probability map. 1 chance in 2,475 to exceed acceleration values in any year. Values in g on BEDROCK.

PGA 2008
Hazard probability map. 1 chance in 475 to exceed acceleration values in any year. Values in g on BEDROCK.

PGA 2008
1 chance in 2,475 in any year

1 chance in 475 in any year
Levee failures from ground liquefaction without amplifying bedrock ground motions

- 0 to 3 failures/100 miles*
- 3 to 10 failures/100 miles
- 15 to 30 failures/100 miles

1 chance in 475 in any year

*Estimates from Sacramento-San JoaQuin Delta levee system not site specific analysis for Central US.
Wabash Scenario
M = 7.1

B/C Boundary
PGA [g]
- < 0.02
- 0.02 - 0.05
- 0.05 - 0.10
- 0.10 - 0.15
- 0.15 - 0.20
- 0.20 - 0.25
- 0.25 - 0.30
- 0.30 - 0.40
- 0.40 - 0.50
- > 0.50

Wabash Fault
M = 7.1

Fault Line Coordinates
P1: 38.35 N  -88.00 E
P2: 37.90 N  -88.20 E
Earthquake Shaking Levels for Structural Damage to Levees

Estimated in recent study at Mid-America Earthquake Center

Slight damage starts at 0.3g
IN THE UNITED STATES

If Indoors – STAY there &

We Drop, Cover and Hold On!
Seattle 2001
Mt Carmel, IL  7 mi (11 km)
Mt Carmel, IL  7 mi (11 km)  photo: ISGS
Mt Carmel, IL  7 mi (11 km)  

photo: ISGS
USGS Revised probabilities for a 50 year window:

- Repeat of 1811-1812 (M 7.5-8.0)
  * ~7 to 10% chance

- Magnitude 6.0 and greater
  * ~25 to 40% chance