CHARLESTON, S.C.

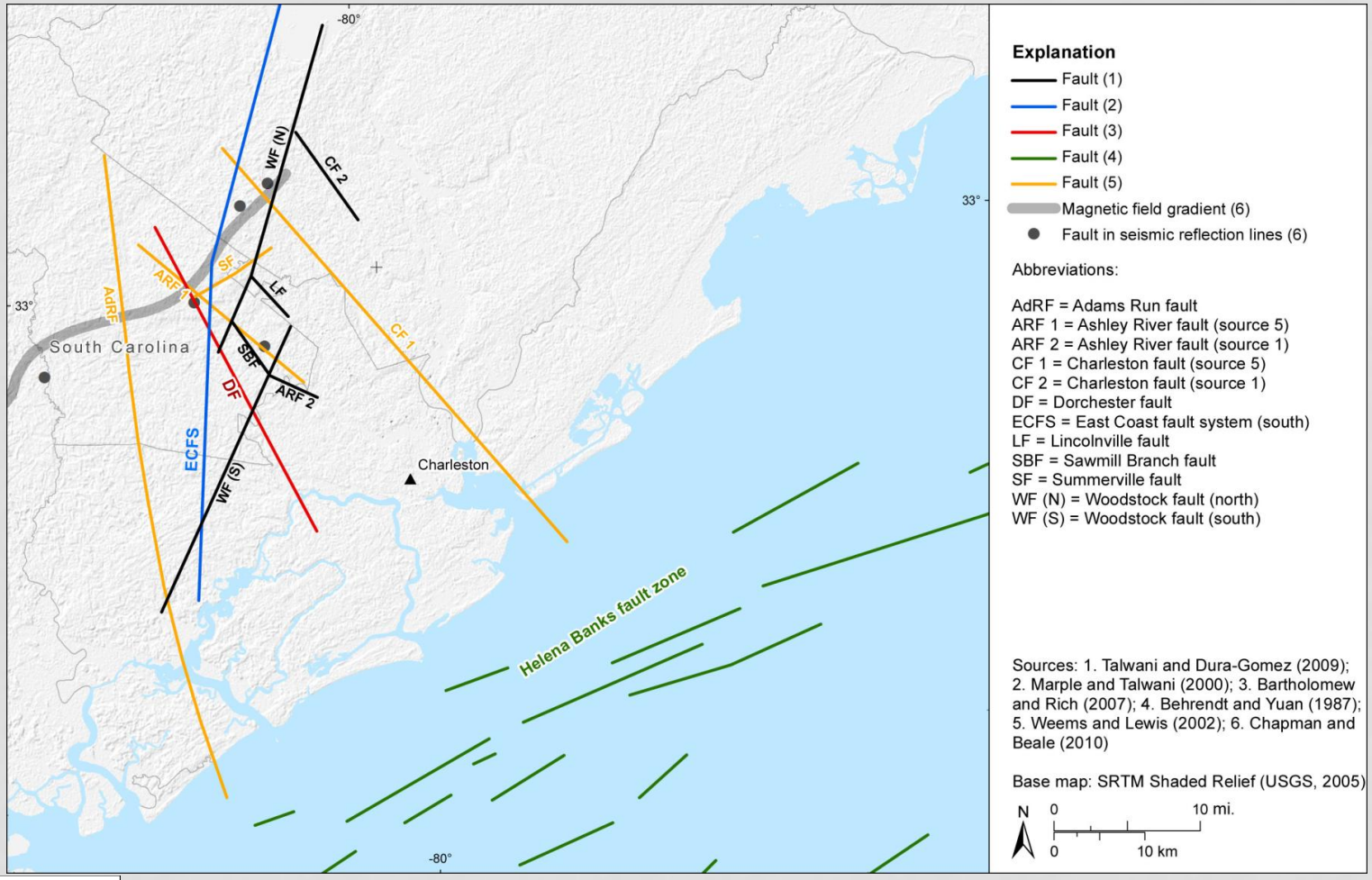

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Fig 6.1.2-4
CEUS SSC report

CHARLESTON RECENT PUBLICATIONS

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- Talwani, P., Hasek, M., Gassman, S., Doar, W. R., III, and Chapman, A., 2011, Discovery of a Sand Blow and Associated Fault in the Epicentral Area of the 1886 Charleston Earthquake: Seismological Research Letters, v. 82, no. 4, p. 589-598.
- Chapman, M.C., and Beale, J.N., 2010, On the geologic structure at the epicenter of the 1886 Charleston, South Carolina, earthquake: *Bulletin of the Seismological Society of America*, v. 100, no. 3, pp. 1010-1030.
- Dura-Gomez, I., and Talwani, P., 2009, Finding faults in the Charleston area, South Carolina: 1. Seismological data: *Seismological Research Letters*, v. 80, no. 5, pp. 883-900.
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- Chapman, M.C., and Beale, J.N., 2008, Mesozoic and Cenozoic faulting imaged at the epicenter of the 1886 Charleston, South Carolina earthquake: *Bulletin of the Seismological Society of America*, v. 98, pp. 2533-2542.
- **Abstracts**
- Gassman, S., Talwani, P., and Hasek, M., 2009, Maximum Magnitudes of Charleston, South Carolina Earthquakes from In-Situ Geotechnical Data: Abstracts Volume from Meeting of Central and Eastern U.S. Earthquake Hazards Program, University of Memphis, Memphis, TN, October 28-29, p. 19.
- Talwani, P., Dura-Gomez, I., Gassman, S., Hasek, M., and Chapman, A., 2008, Studies related to the discovery of a prehistoric sandblow in the epicentral area of the 1886 Charleston SC earthquake: Trenching and geotechnical investigations: *Program and Abstracts, Eastern Section of the Seismological Society of America,* p. 50.

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CHARLESTON SOURCE, S.C. USGS AND CEUS SSC COMPARISON

	2008 USGS	CEUS SSC
Source	Narrow 1,400 km^2 (0.5) Broad 22,000 km^2 (0.5)	Narrow 1,900 km^2 (0.3) Local 5,000 km^2 (0.5) Regional 39,000 km^2 (0.2)
Characteristic M	M6.8 (0.2) M7.1 (0.2) M7.3 (0.45) M7.5 (0.15)	M6.7 (0.1) M6.9 (0.25) M7.1 (0.3) M7.3 (0.25) M7.5 (0.1)
Recurrence	550 yr	480 yr (0.8) 480 yr (0.04) 770 (0.06) 910 yr (0.06) 1100 yr (0.04)
Earthquake occurrence model	Poisson	Poisson (0.9) Brownian Passage Time (0.1)

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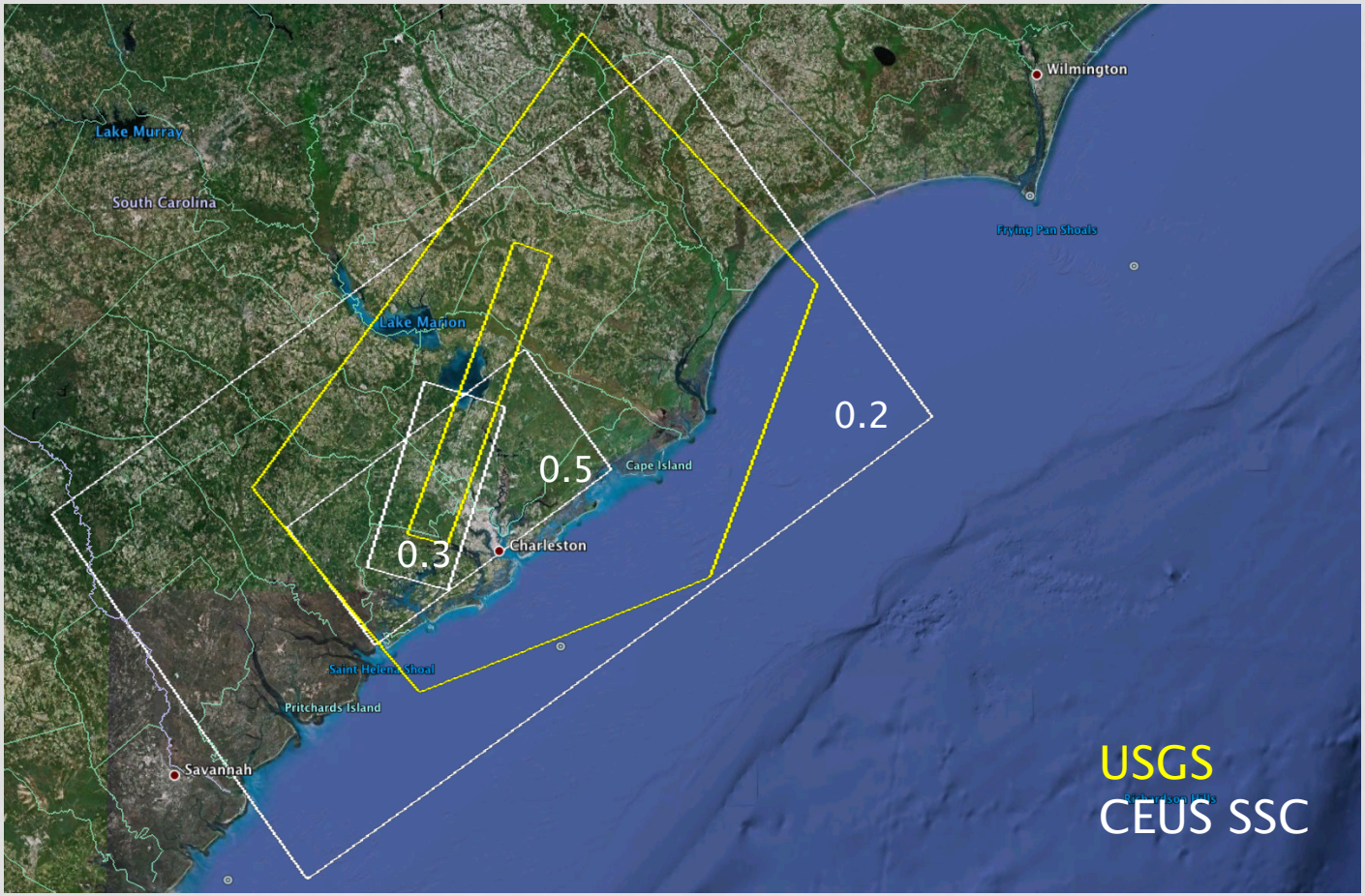
CEUS SSC VS. USGS CHARLESTON SOURCE, S.C.



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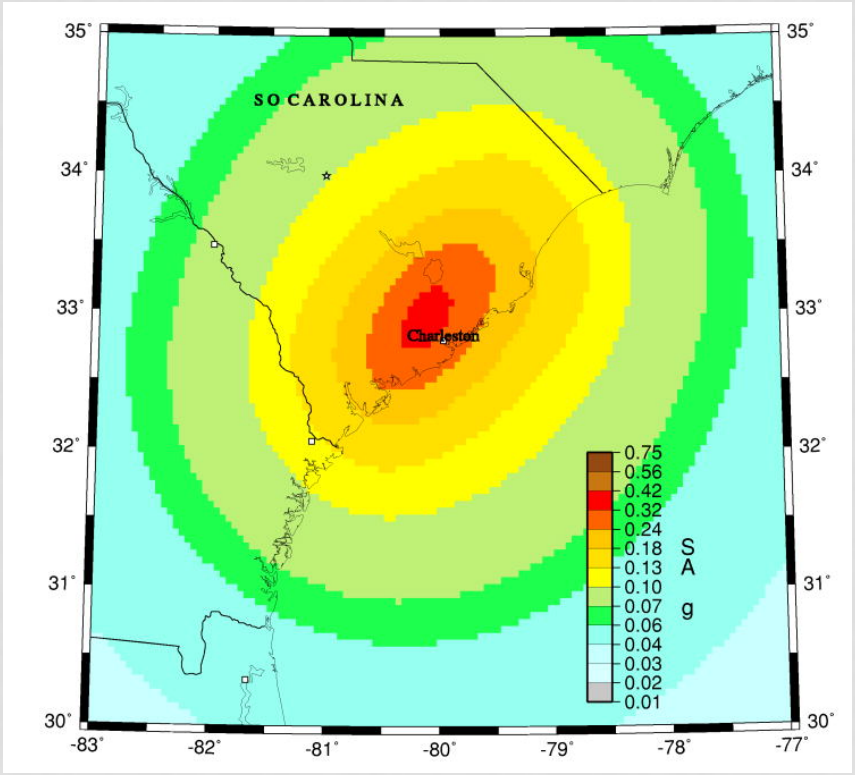
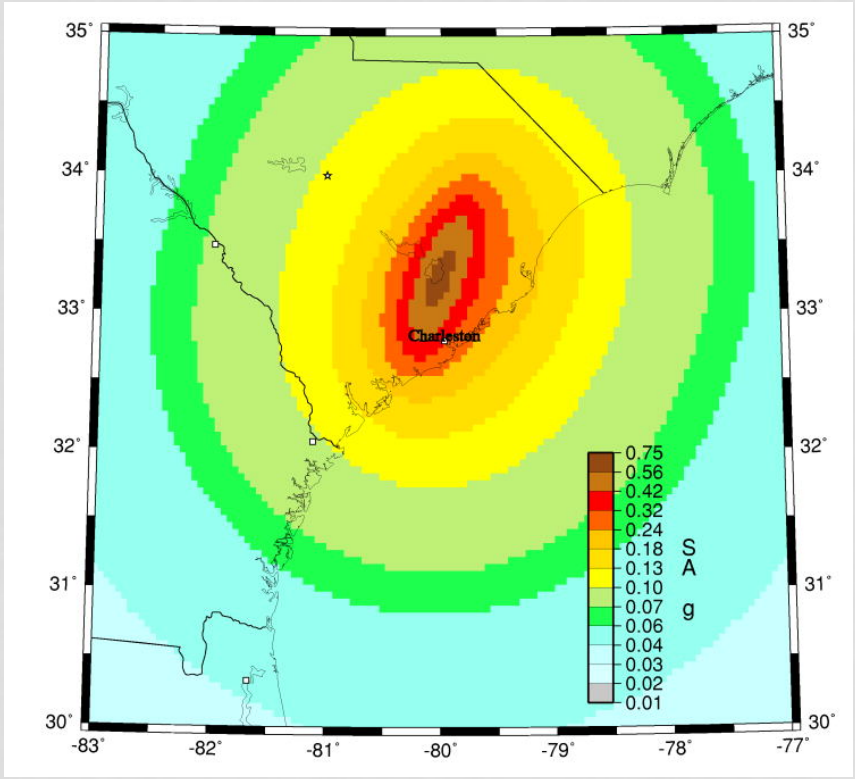
1-HZ SPECTRAL ACCELERATION 2% PE IN 50 YR

CEUS SSC zones



USGS zones



Vs30 760 m/s

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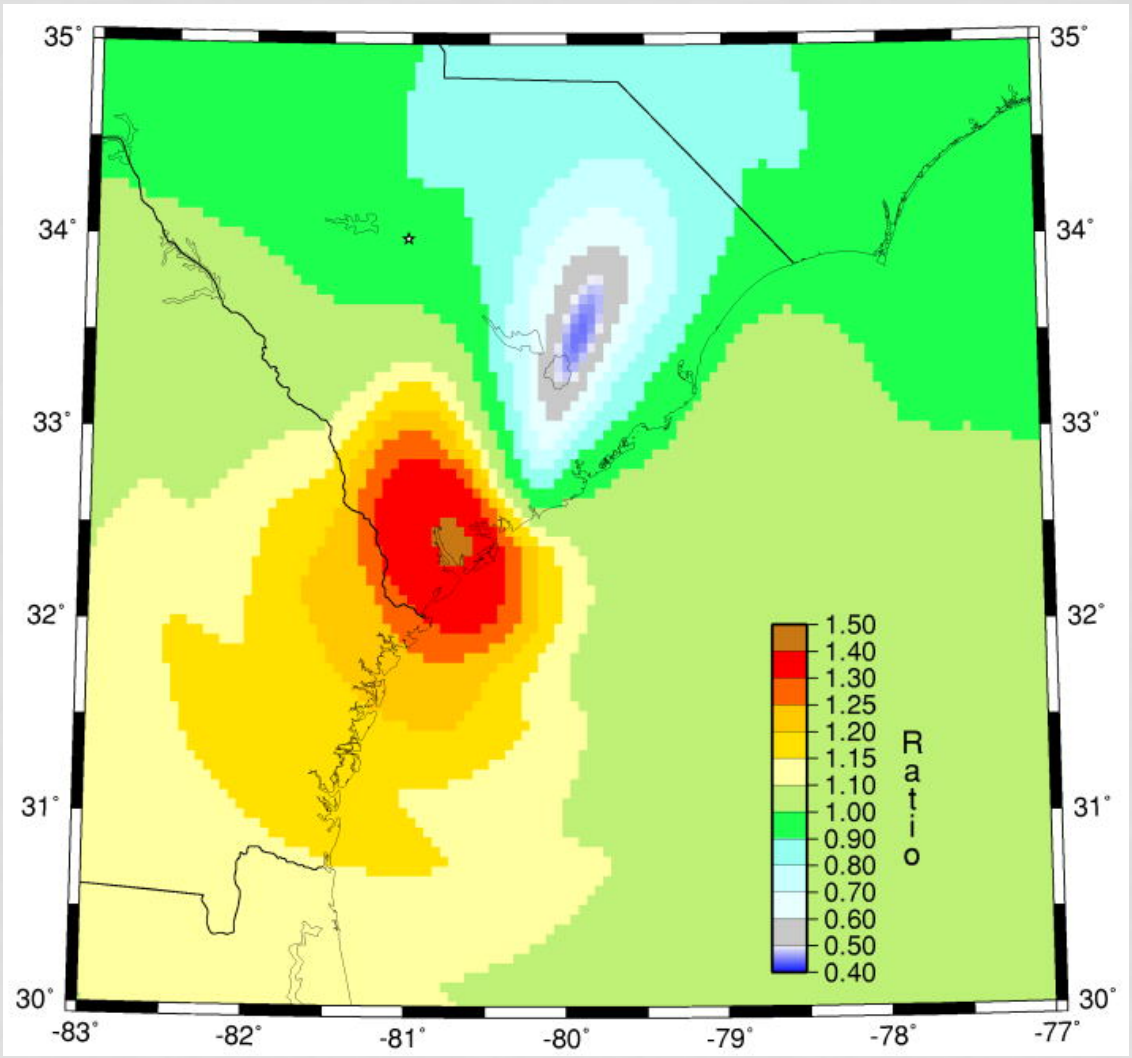
RATIO MAP
CEUS SSC/USGS



1-Hz SA
2% PE in 50 yr
Vs30 760 m/s

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CHARLESTON PALEOLIQUEFACTION

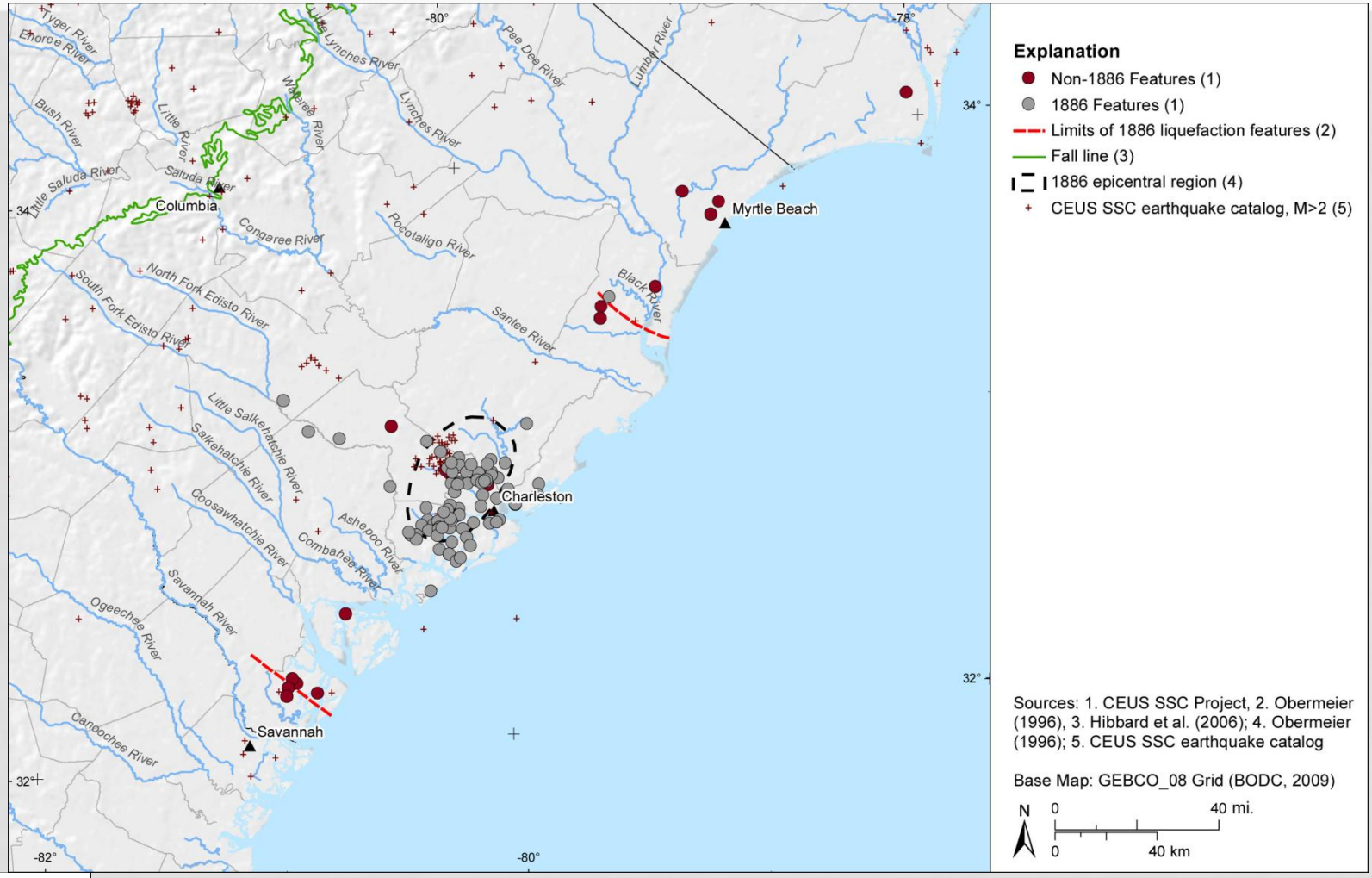

Fig E-36
CEUS SSC report

CEUS CHARLESTON SPACE-TIME DIAGRAM

Contemporary ages only

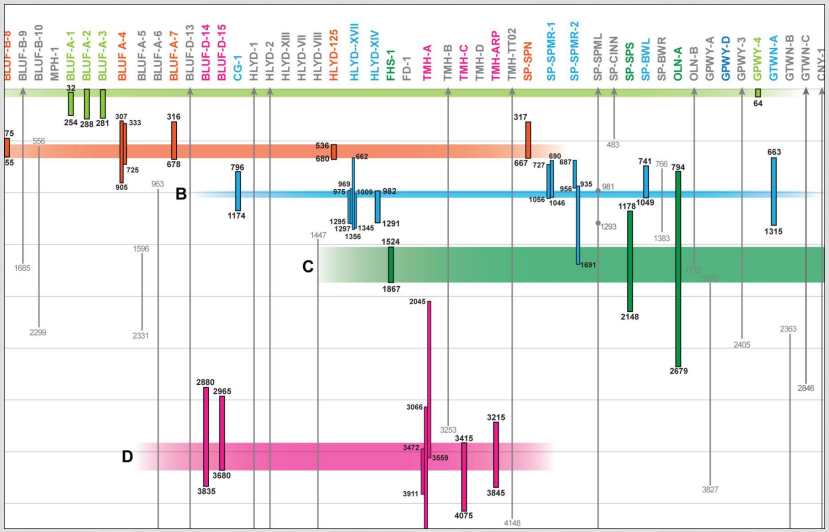

Fig 6.1.2-7

All ages

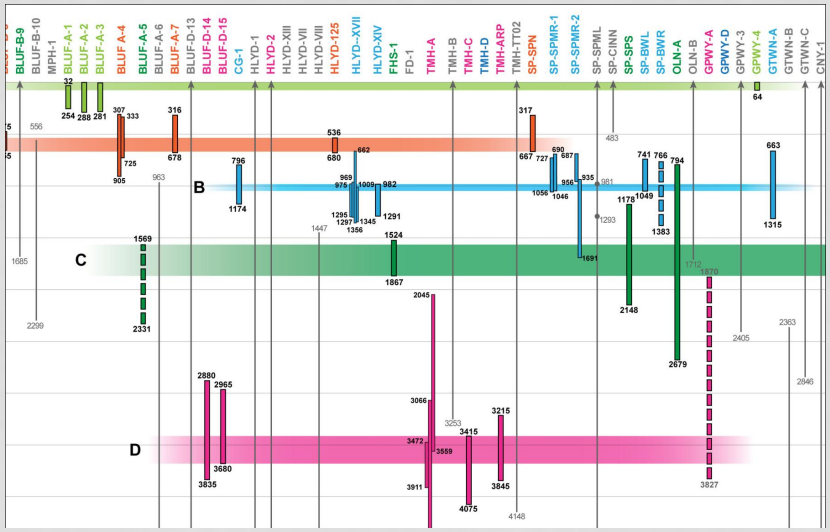

Fig 6.1.2-8
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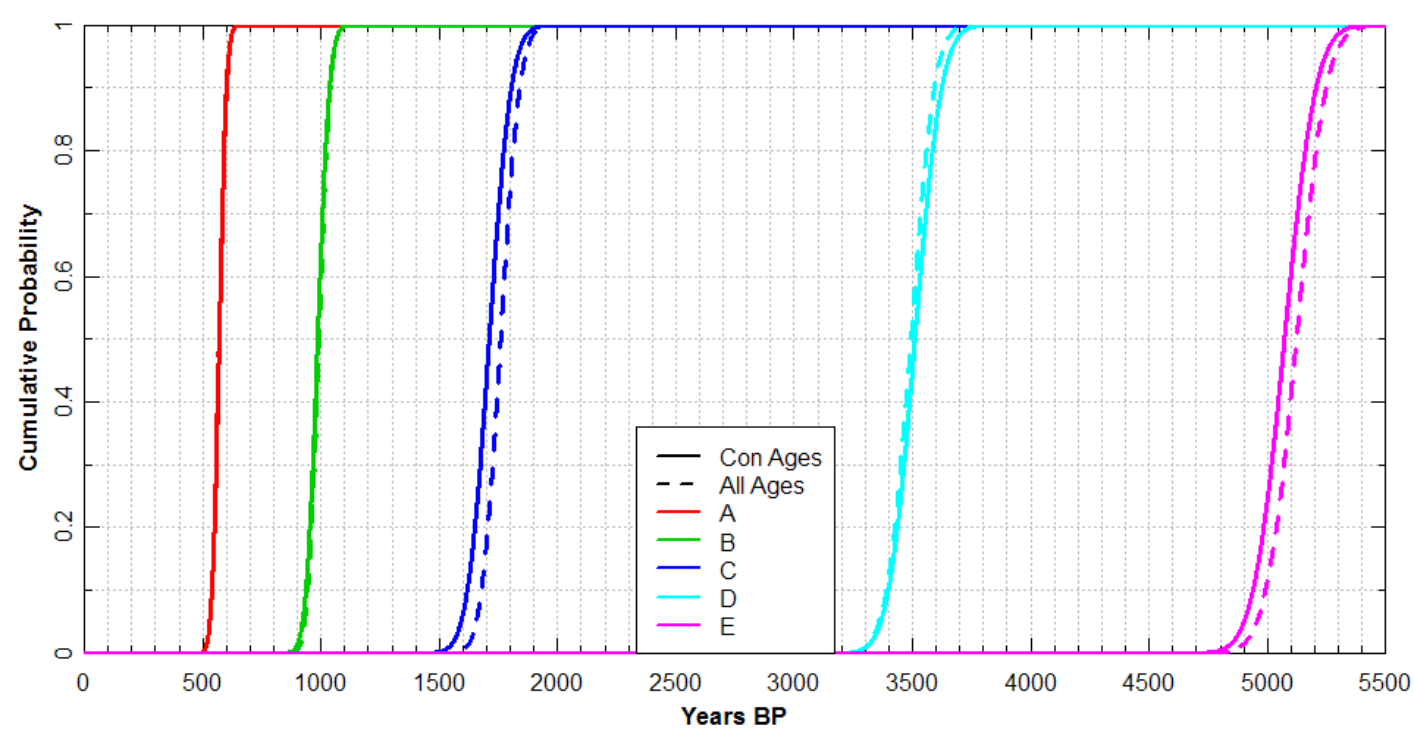
AGE UNCERTAINTY FOR CHARLESTON PALEOLIQUEFACTION



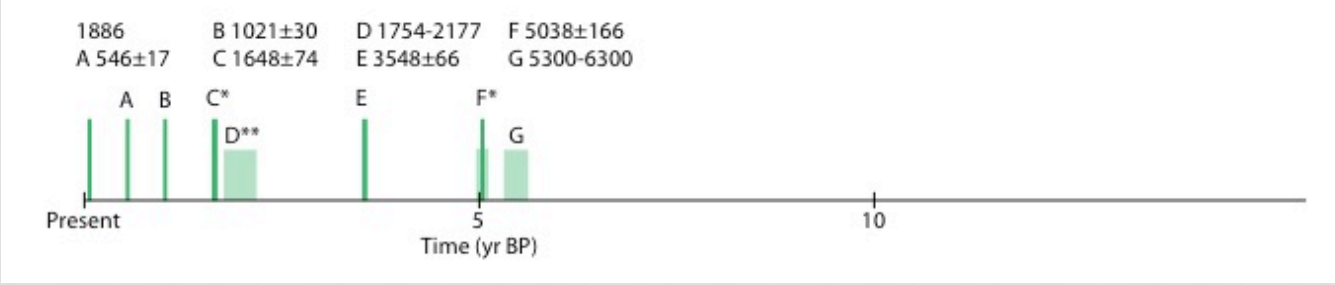


Fig 6.1.2-19
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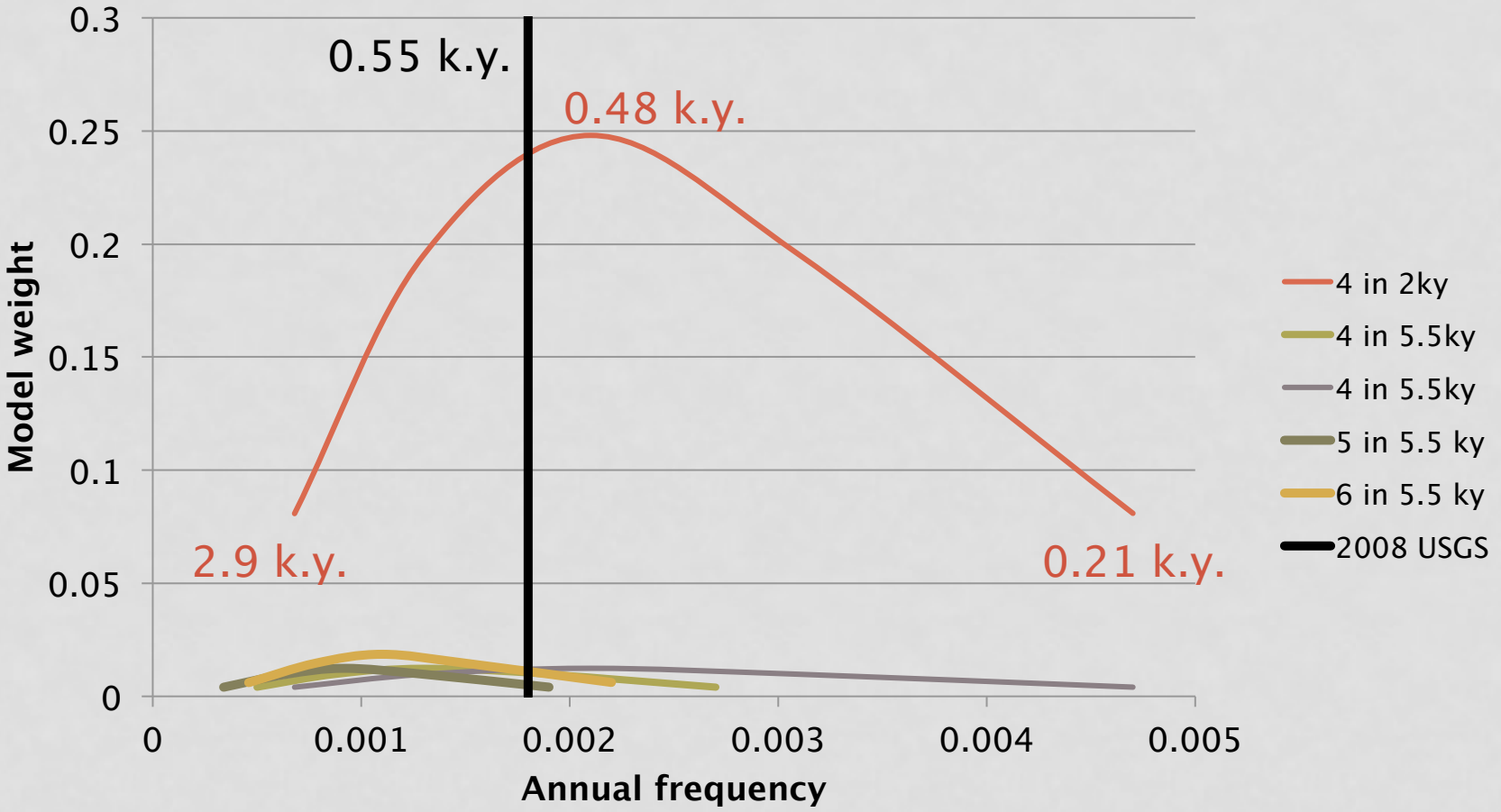
ANNUAL FREQUENCY OF MAXIMUM EARTHQUAKE, CHARLESTON SOURCES



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QUESTIONS

- Should the USGS modify their Broad and Narrow zones that were used in prior maps?
- Is the modeled 550 yr return time appropriate to use in the update?

USGS
science for a changing world

WABASH VALLEY FAULT SYSTEM

SSC Model: Mmax Zones Branch

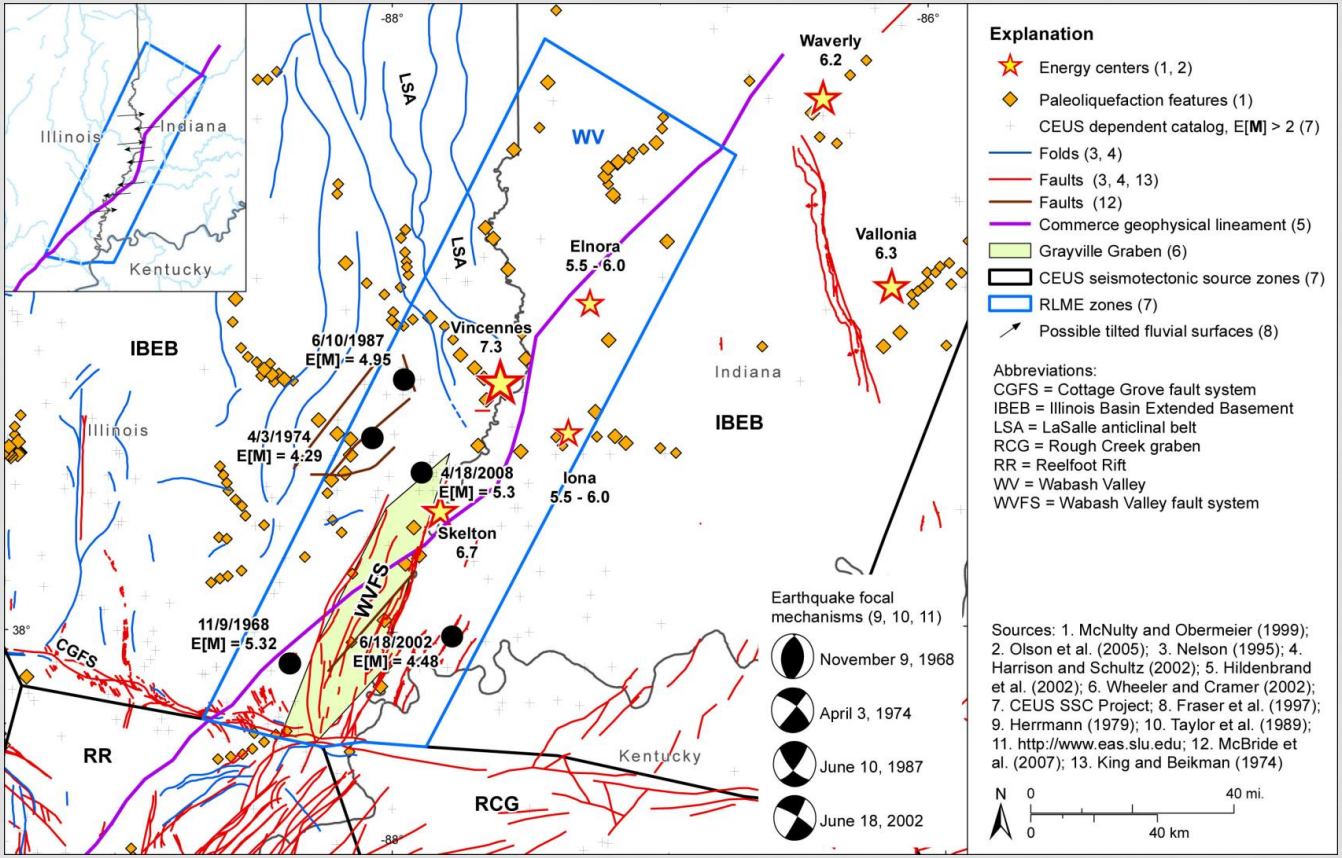

Fig 6.1.9.2
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RECENT WABASH REFERENCES

- Obermeier, S. F., 2009, Using liquefaction-induced and other soft-sediment features for paleoseismic analysis: *International Geophysics*, v. 95, pp. 499-566.
- Van Arsdale, R., Counts, R., and Woolery, E., 2009, Quaternary Displacement Along the Hovey Lake Fault of Southern Indiana and Western Kentucky: NEHRP Final report submitted to the U.S. Geological Survey, External Grant Number 07HQGR0052, 11 pp.
- Counts, R.C., Durbin, J.M., and Obermeier, S.F., 2008, Seismic ground-failure features in the vicinity of the Lower Wabash and Ohio River valleys: in Counts, M.H., and Counts, R.C. (editors), *From the Cincinnati Arch to the Illinois Basin: Geological Field Excursions Along the Ohio River Valley*: Geological Society of America Field Guide 12, pp. 57-79.
- McBride, J.H., Leetaru, H.E., Bauer, R.A., Tingey, B.E., and Schmidt, S.E.A., 2007, Deep faulting and structural reactivation beneath the southern Illinois basin: *Precambrian Research*, v. 157, pp. 289-313, doi:10.1016/j.precamres.2007.02.020.
- **Abstracts**
- Counts, R., Van Arsdale, R., Tuttle, M., Mahan, S. Obermeier, S., and Woolery, E., 2011 Paleoseismology in the New Madrid and Wabash Valley Seismic Zones, central United States [abs.]: XVIII INQUA Bern 2011, link
- Counts, R., Van Arsdale, R., and Woolery, E., 2009b, Paleoseismic Features Within the Wabash Valley Seismic Zone in Western Kentucky: presentation given at meeting of CEUS Earthquake Hazards Program, U.S. Geological Survey, October 28-29, Memphis, Tenn.
- Counts, R.C., Van Arsdale, R.B., and Woolery, E.W., 2009a, Investigation of Quaternary displacement on the Uniontown fault, western Kentucky [abstract]: *Geological Society of America, Abstracts with Programs*, v. 41, no. 1, p. 20.
- Counts, R.C., Woolery, E., and Van Arsdale, R.B., 2008, Quaternary faulting in Union County, Kentucky—Preliminary results: Geological Society of America Abstracts with Programs, v. 40, no. 5, p. 80.
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WABASH PALEOEARTHQUAKES

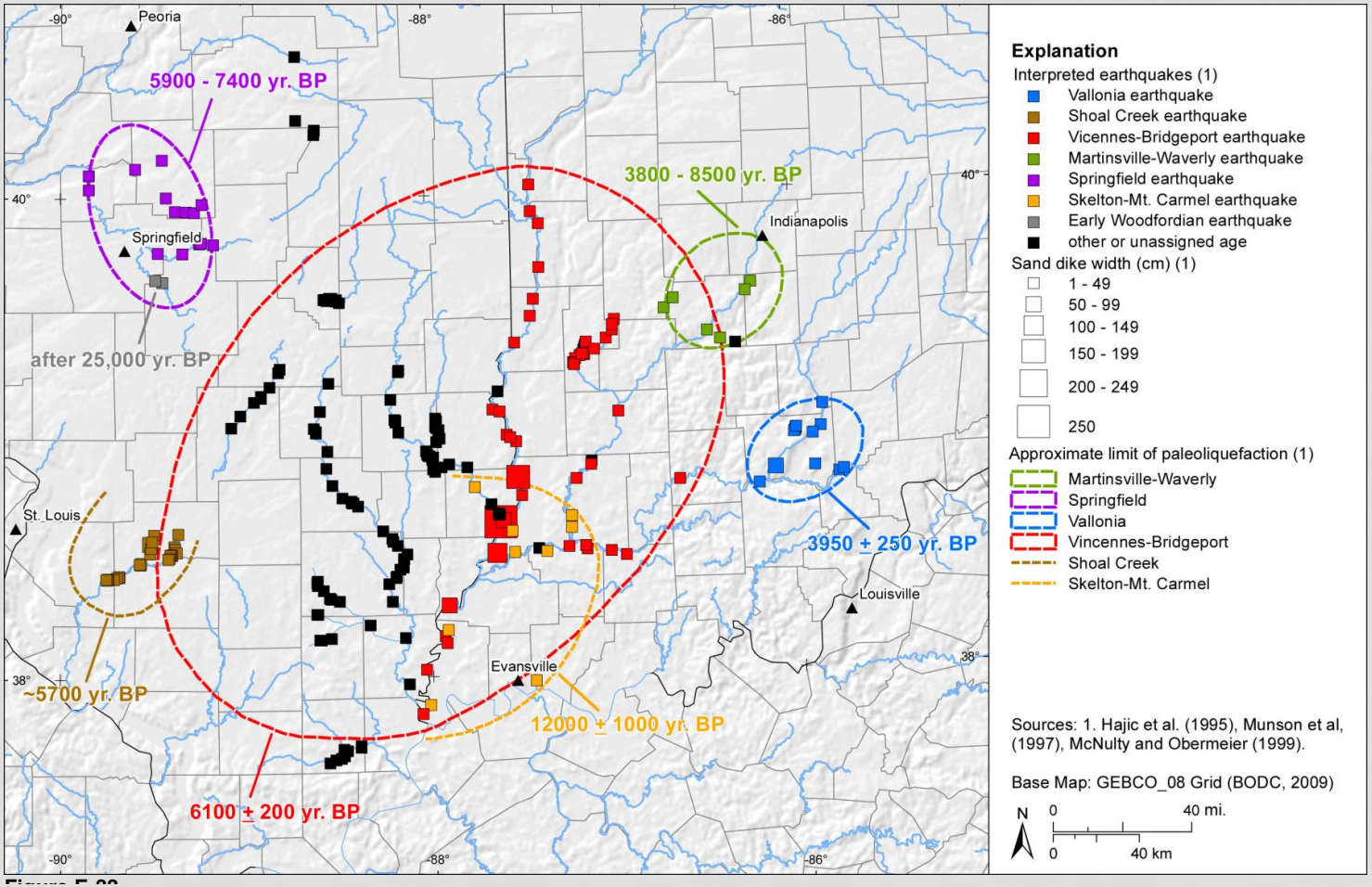

Fig E-33
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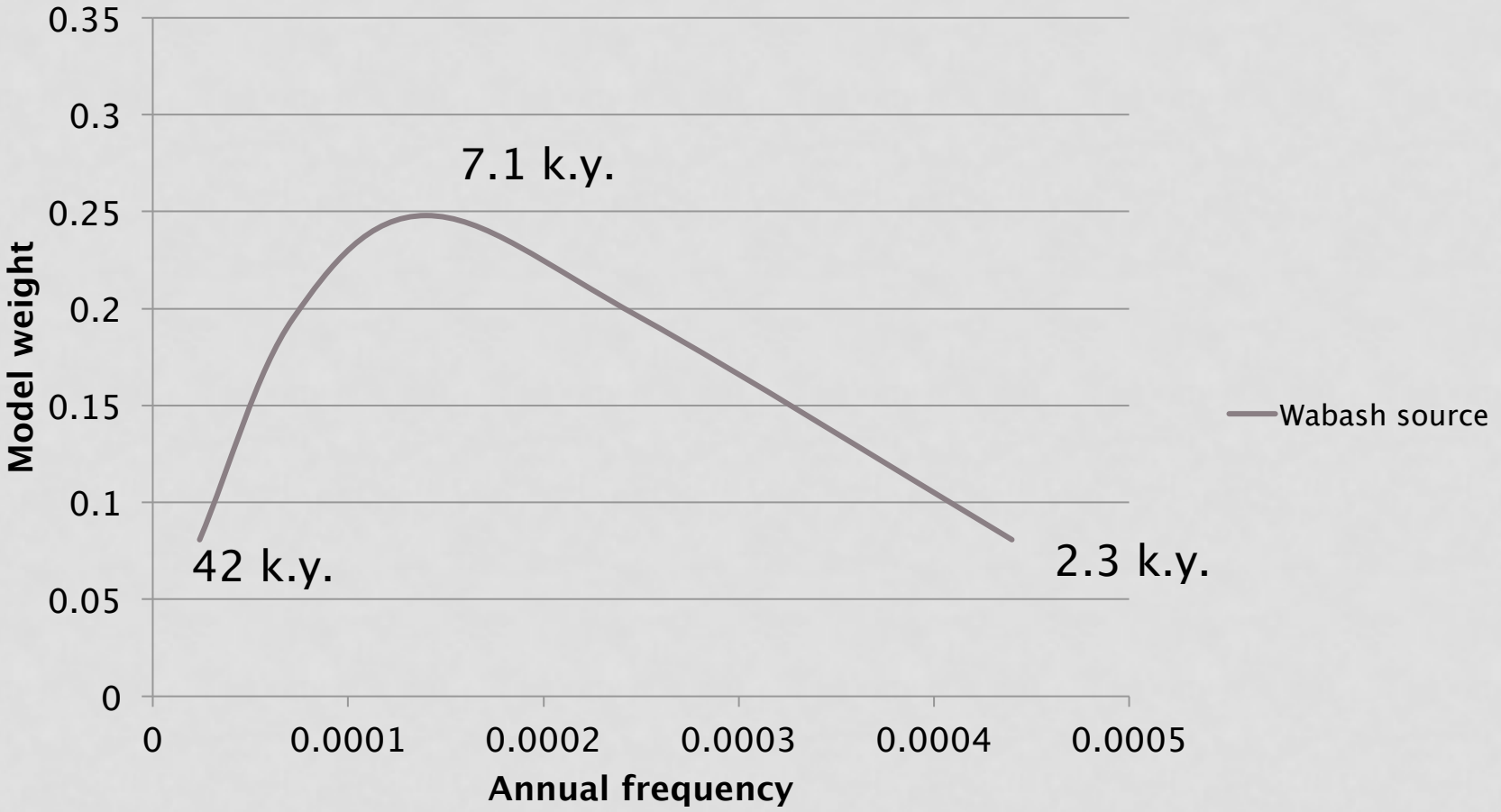
CEUS-SSC WABASH SOURCE



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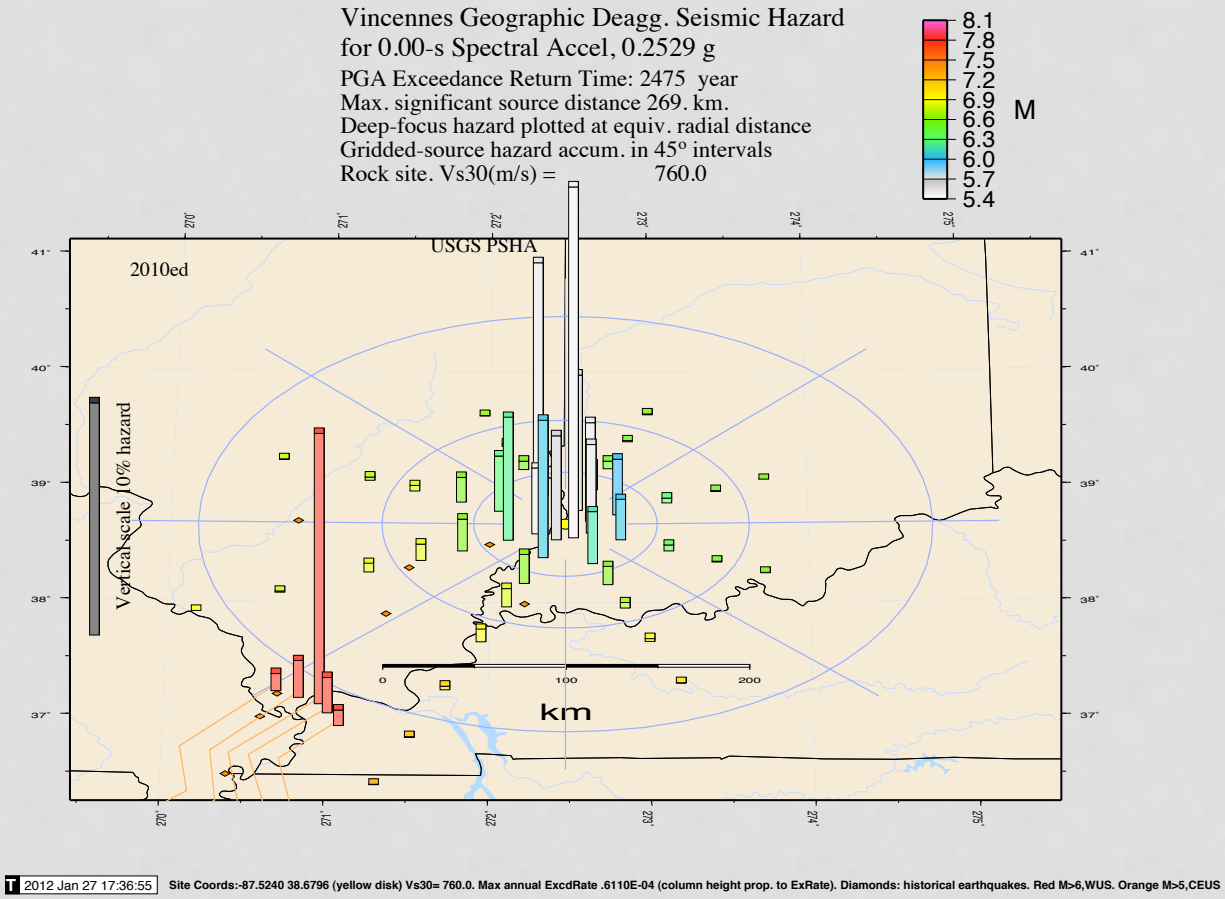
DEAGGREGATION--VINCENNES



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MARIANNA ZONE, ARK.

- geologic record of earthquake induced liquefaction older than NMSZ features
- northwest-trending lineament defined by (1-4-m-wide) sand blows near Daytona Beach ••possibly fault controlled 17 km (M6.5)
- 3 or 4 Holocene earthquakes between 5 and 9.6-10.2 ka
- some sand blows are comparable to NMSZ
- M6.7-7.7
- Default to background 0.5

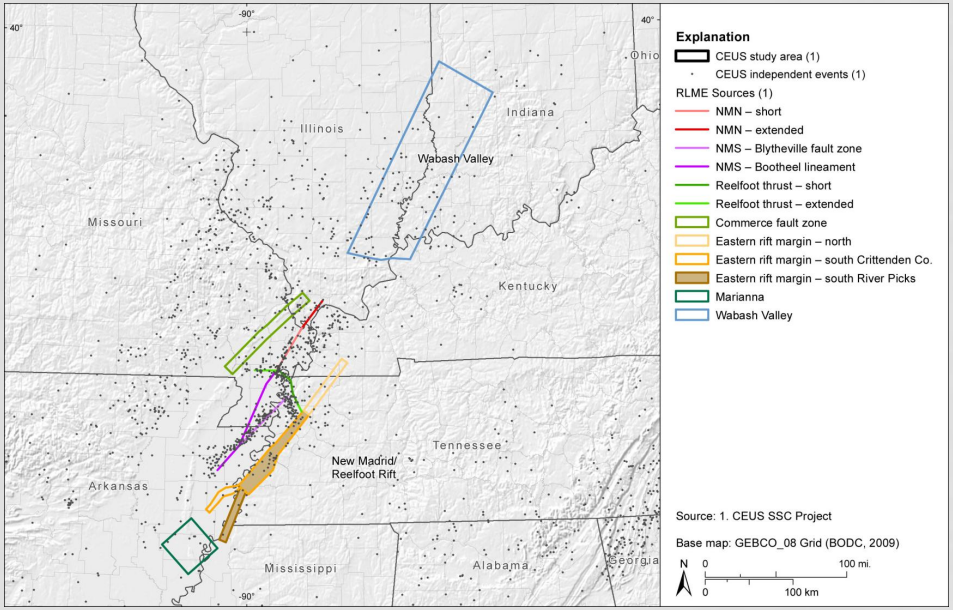

Fig 6.1.2b
CEUS SSC report

RECENT PUBLICATIONS

- **Recent abstracts**

- **2010s**
  Al-Qadhi, O., 2010, Geophysical investigation of paleoseismological features in eastern Arkansas, USA: Ph.D. dissertation, University of Arkansas, Little Rock, 277 p.
- **2000s**
  Al-Shukri, H., Mahdi, H., Al Kadi, O., and Tuttle, M., 2009, Spatial and temporal characteristic of paleoseismic features in the southern terminus of the New Madrid seismic zone in eastern Arkansas: Final Technical Report Submitted to the U.S. Geological Survey under USGS External Grant Number 07HQGR0069, 24 p.
- Csontos, R., Van Arsdale, R., Cox, R., and Waldron, B., 2008, Reelfoot rift and its impact on Quaternary deformation in the central Mississippi River valley: *Geosphere*, v. 4, no. 1, pp. 145-158.
- Tuttle, M.P., 2008, Paleoseismological investigations at the East Site, The Gilmore/Tyronza Mitigation Project: in *Data Recovery at the Tyronza Sites, Poinsett County, Arkansas, The East Site (3P0610)*, technical report to Arkansas State Highway and Transportation Department, v. 4, pp. 259-277.
- Al-Shukri, H., Mahdi, H., and Tuttle, M., 2006, Three-dimensional imaging of earthquake-induced liquefaction features with ground penetrating radar near Marianna, Arkansas: *Seismological Research Letters*, v. 77, pp. 505-513.
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- Al-Shukri, H., Lemmer, R.E., Mahdi, H., and Connelly, J.B., 2005, Spatial and temporal characteristics of paleoseismic features in the southern terminus of the New Madrid seismic zone in eastern Arkansas: *Seismological Research Letters*, v. 76, pp. 502-511.

USGS science for a changing world

PRELIMINARY CONCLUSIONS

- Five generations of sand blows and related feeder dikes in Marianna area
- Weathering characteristics, stratigraphic and structural relations of features, and dating of buried soils suggest that liquefaction features formed during paleoearthquakes ~ 4.8, 5.5, 6.8, 9.9, and 9.9–38 ka
- Marianna sand blows are likely due to local, not New Madrid, earthquakes:
  - Very large size of liquefaction features
  - Lack of similarly large features that formed in AD 1811–1812, 1450, and 900

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DAYTONA BEACH LINEAMENT

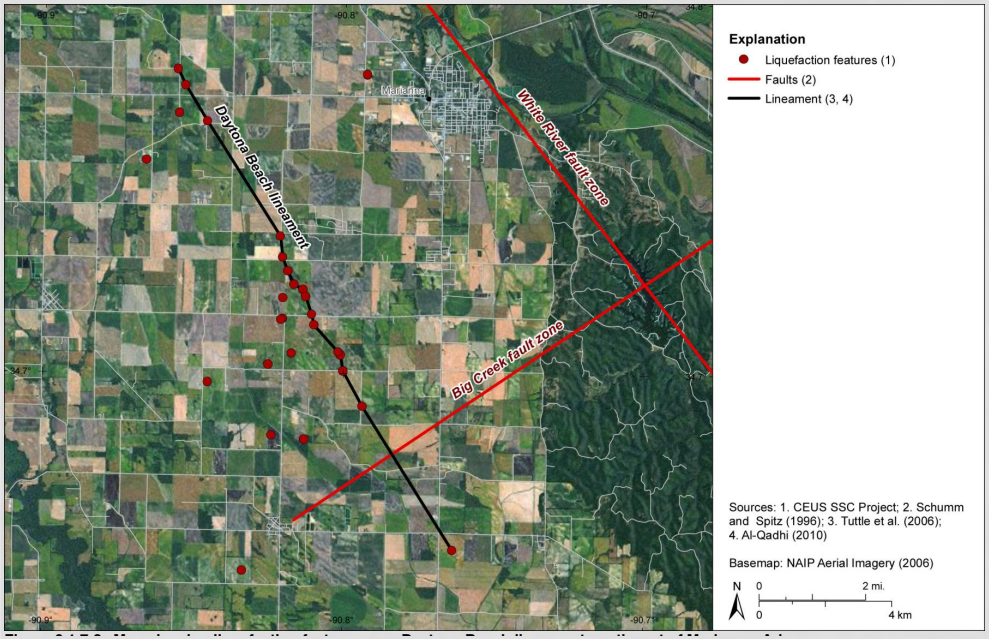

Fig 6.1.7-3
CEUS SSC report

- many large sand blows
- severe ground failure
- may be surface expression of fault at depth; perhaps western member of White River FZ

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PRELIMINARY CONCLUSIONS

- Marianna sand blows are likely due to local, not New Madrid, earthquakes:
  - Very large size of liquefaction features
  - Lack of similarly large features that formed in AD 1811–1812, 1450, and 900
- Some liquefaction evidence of complex faulting perhaps involving White River FZ and Eastern Margin Reelfoot Rift FZ
- Marianna paleoearthquakes were probably very large ($M \geq 7$); but warrants further study
- Findings suggest max average recurrence time of ~1.7 k.y. and clustered behavior with minimum active period of ~5 k.y.
- Implication – currently "quiet" members of Reelfoot Rift fault system may produce very large earthquakes in future

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MARIANNA PALEOLIQUEFACTION

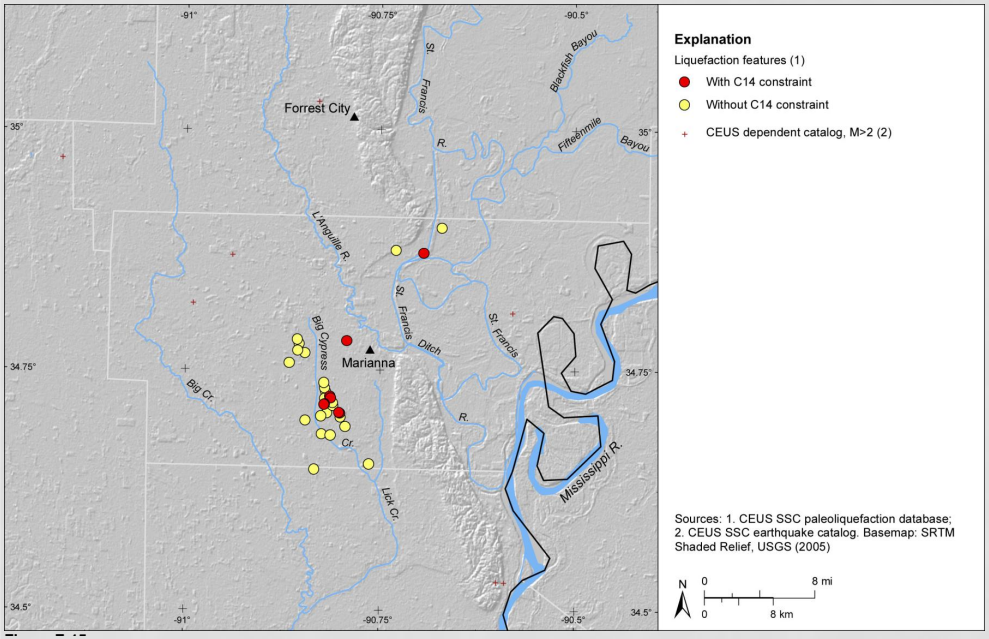

Fig E-15
CEUS SSC report

- Five generations of sand blows and related feeder dikes in Marianna area
- Field identification degree of weathering stratigraphic & structural relations dating of buried soils
- Paleoliquefaction formed about 4.8, 5.5, 6.8, 9.9, and 9.9–38 ka

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ESTIMATED TIME OF PALEOLIQUEFACTION FORMATION

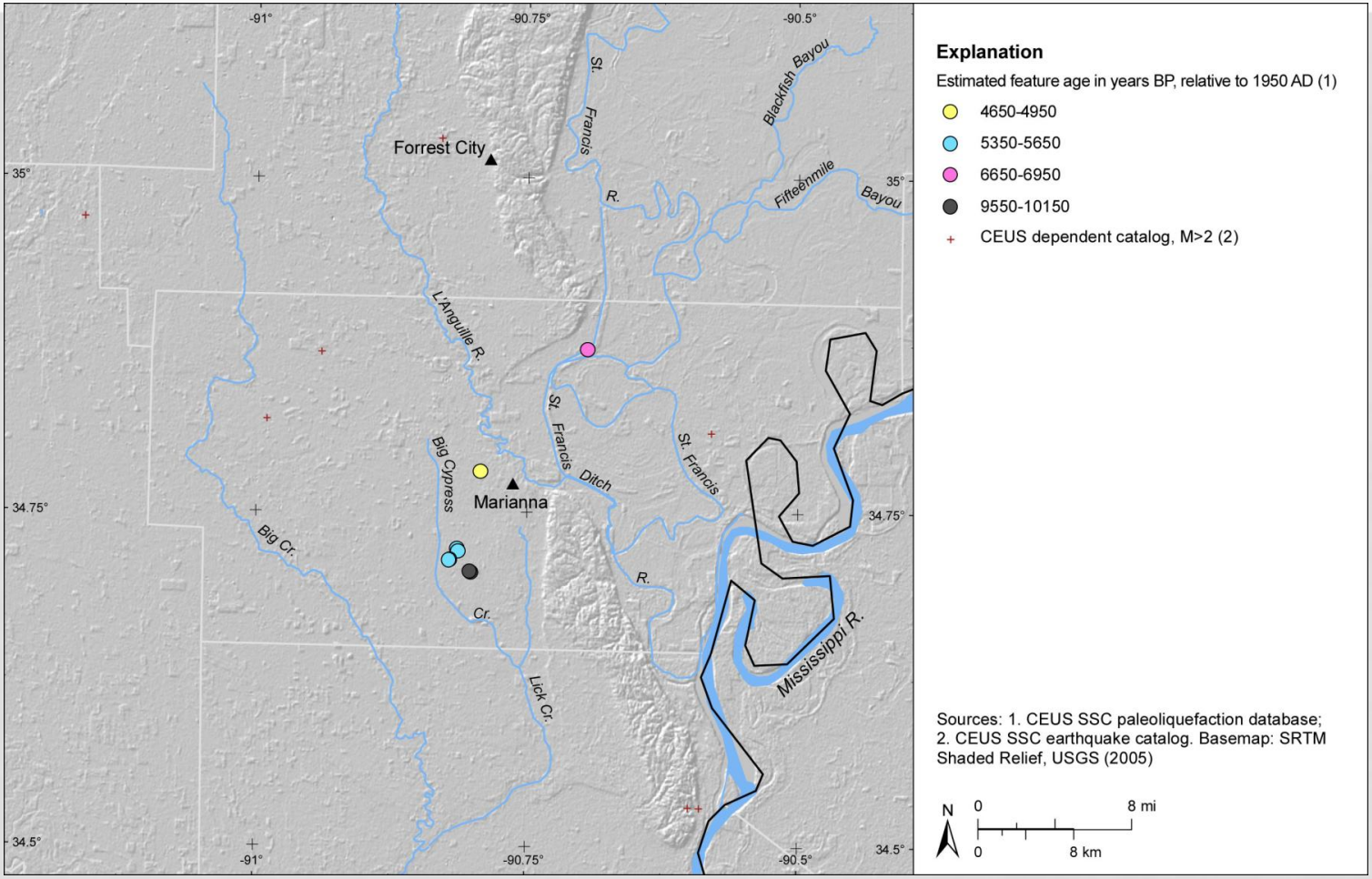

Fig E-17
CEUS SSC report

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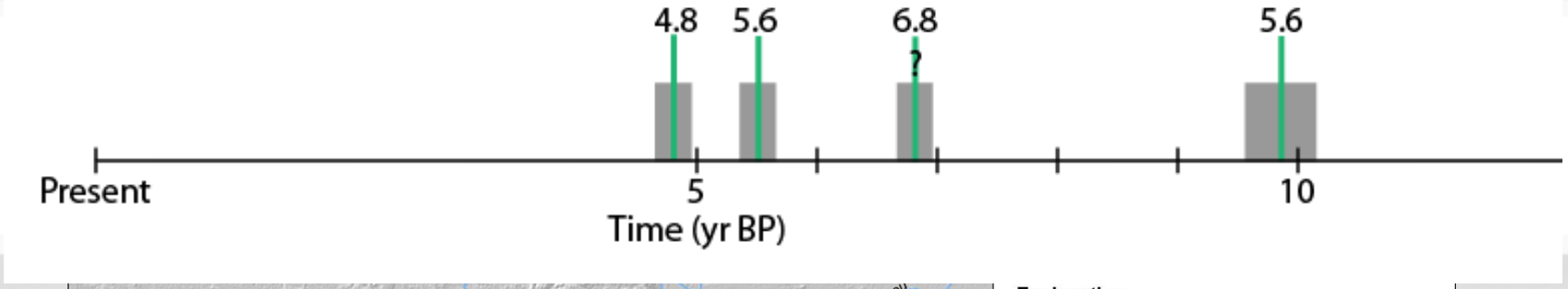

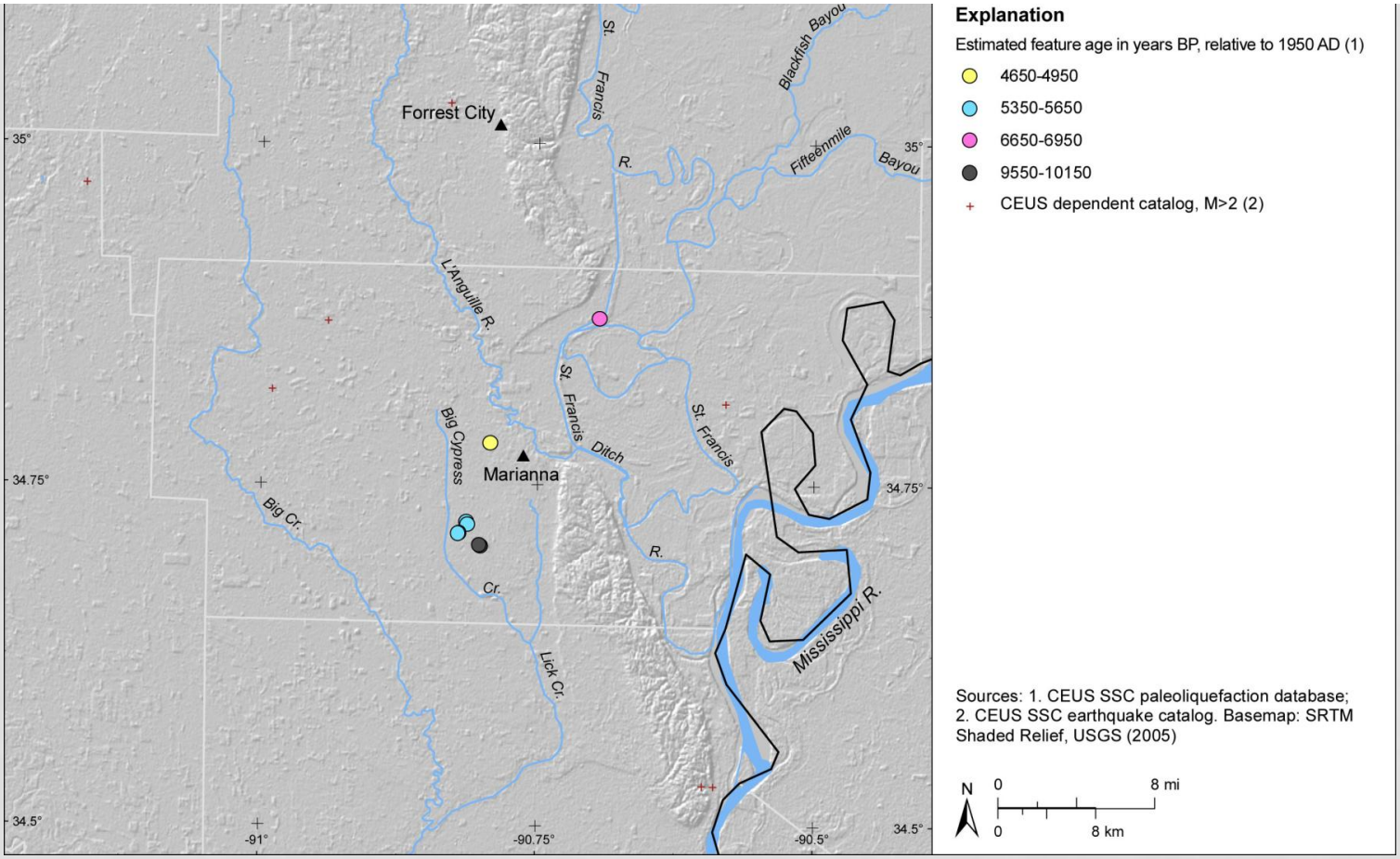

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