

The Charleston earthquake source model

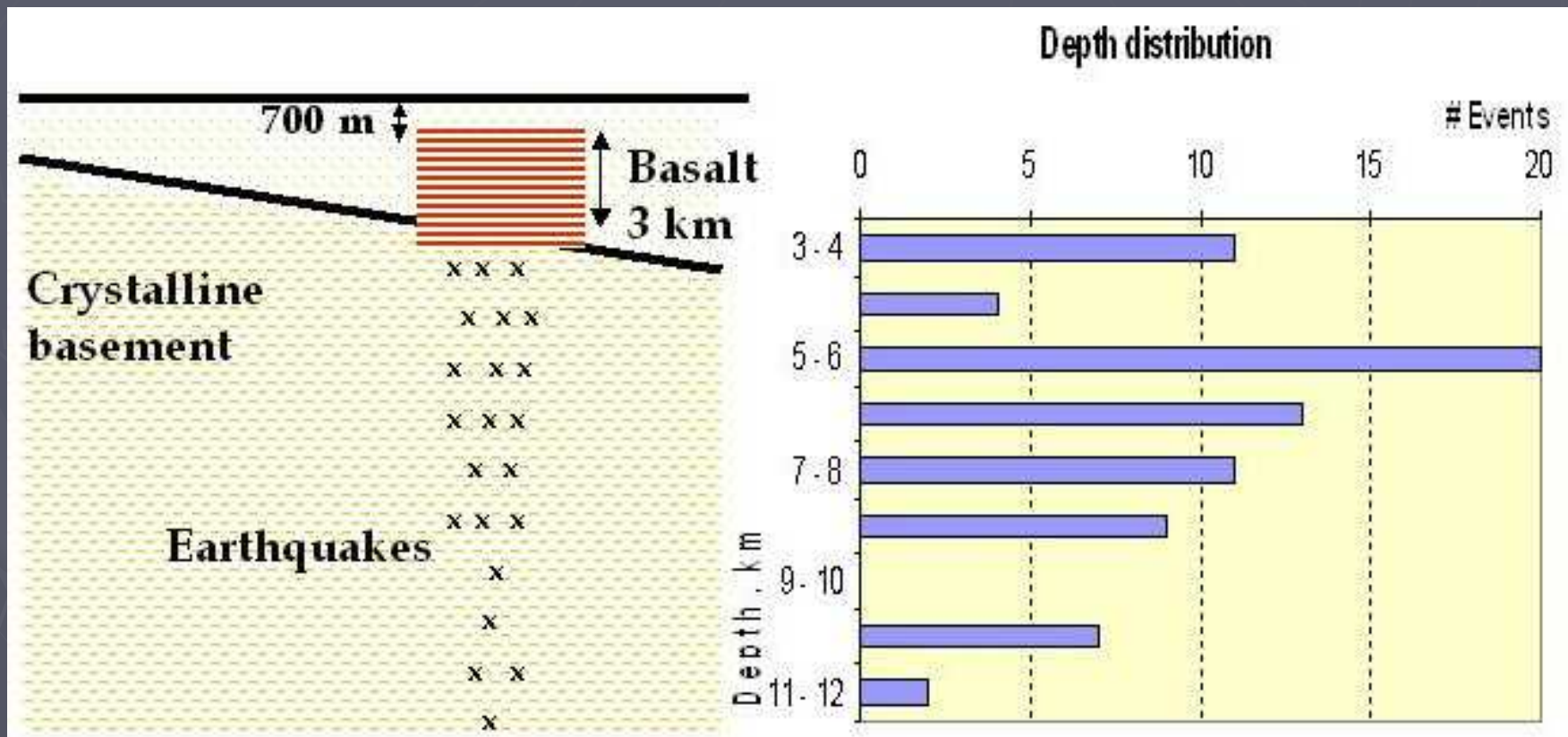


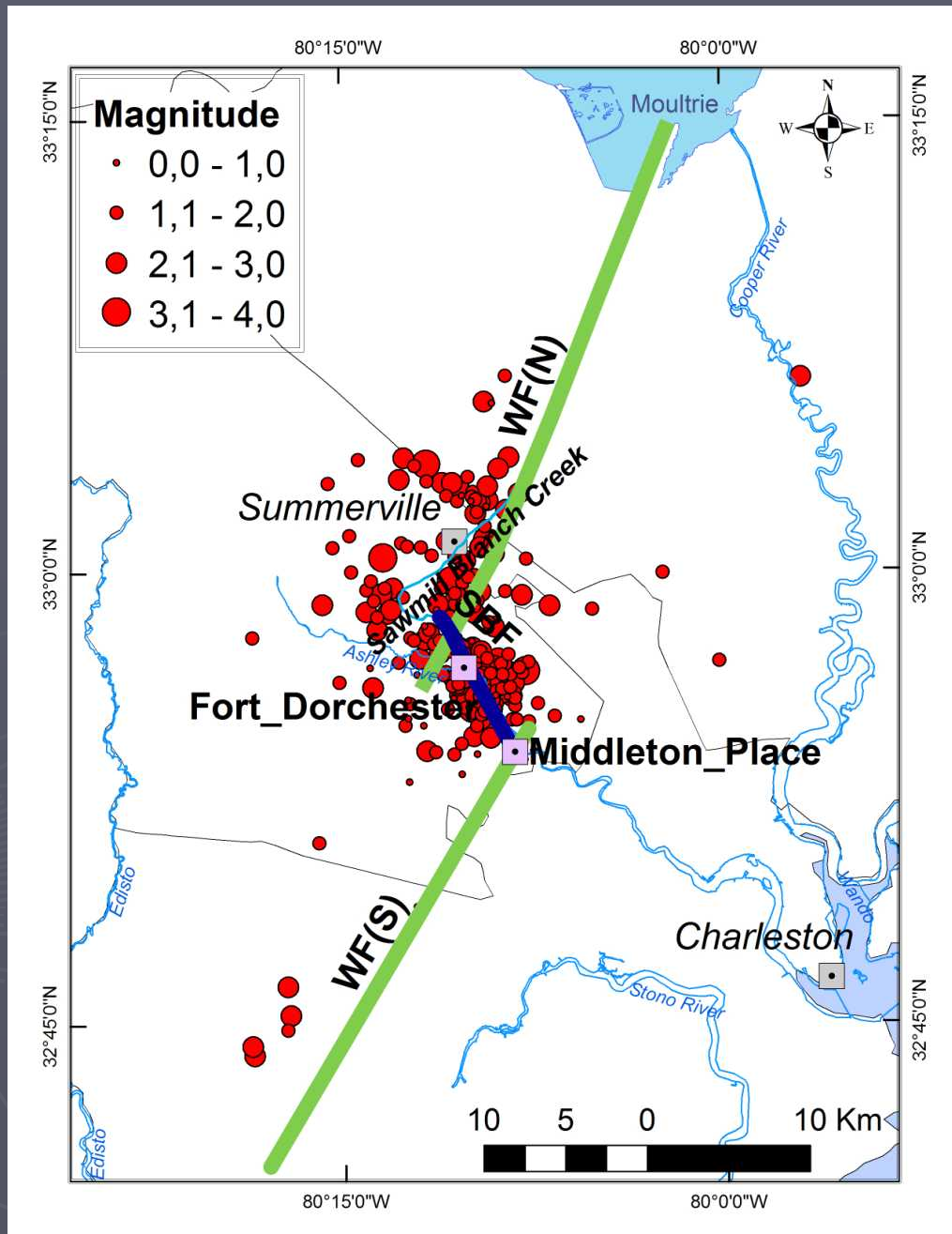
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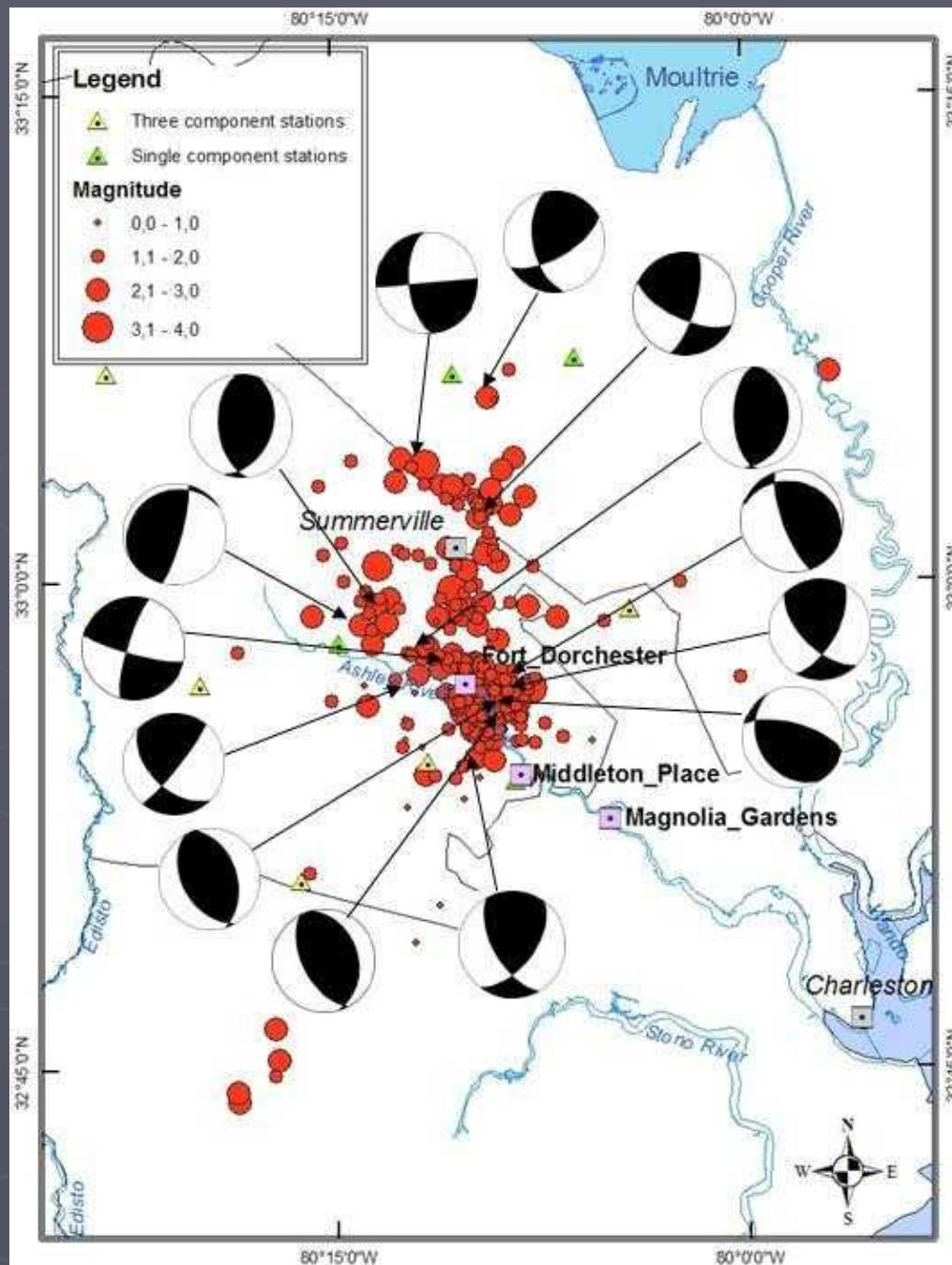
OUTLINE

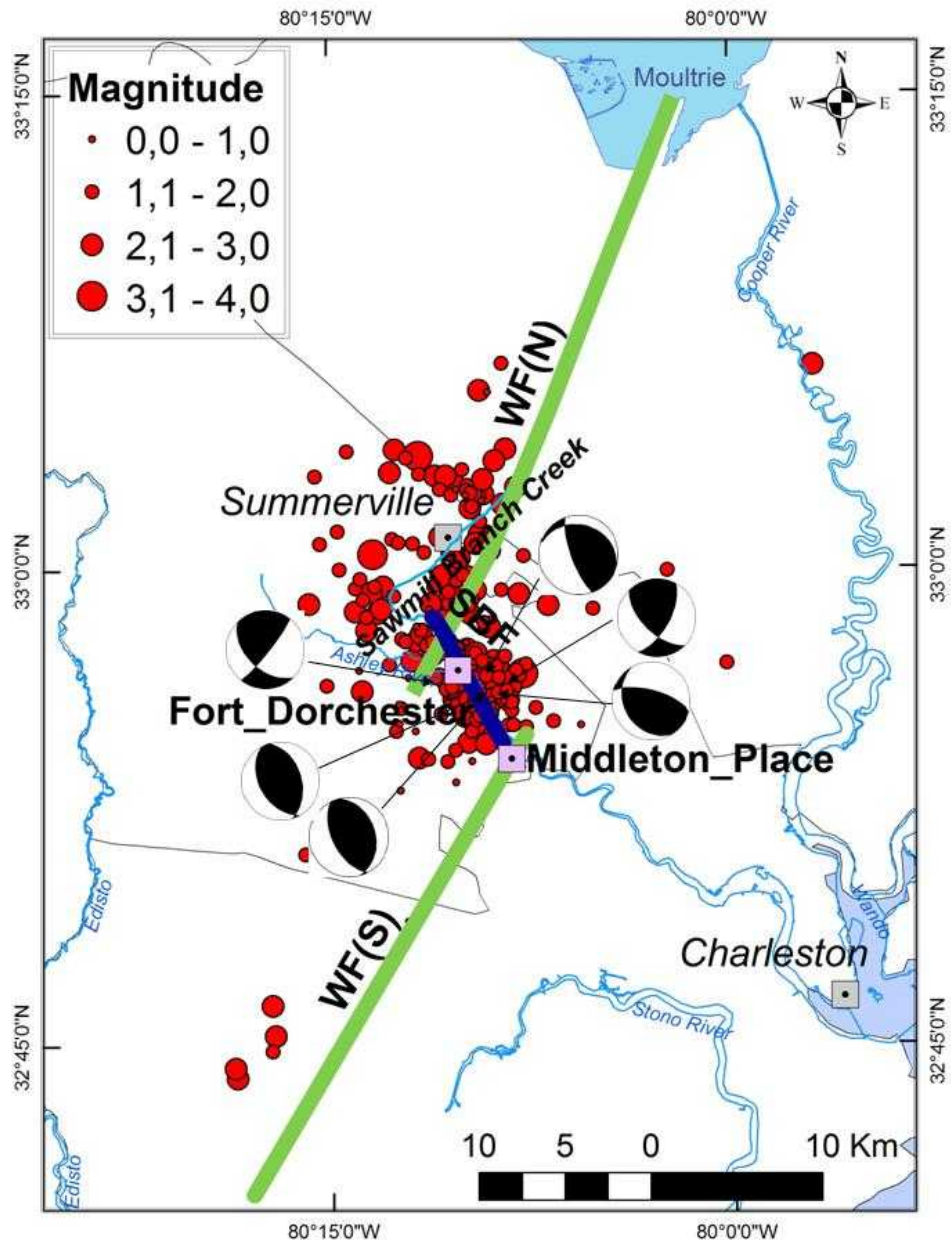
- > Source zone: ~50 km long
 - From seismotectonic studies (Dura-Gomez and Talwani 2006 –in preparation-)
- > Recurrence time: ~500 years
 - From paleoseismicity (Talwani and Schaffer 2001)
- > Modeling and GPS observations are consistent with source model
- > Maximum magnitude: 7.0 or lower(?)
 - From back calculation of in situ geotechnical data at paleoliquefaction locations (Leon et al., 2005)

Cross-section of wedge with basalt flows

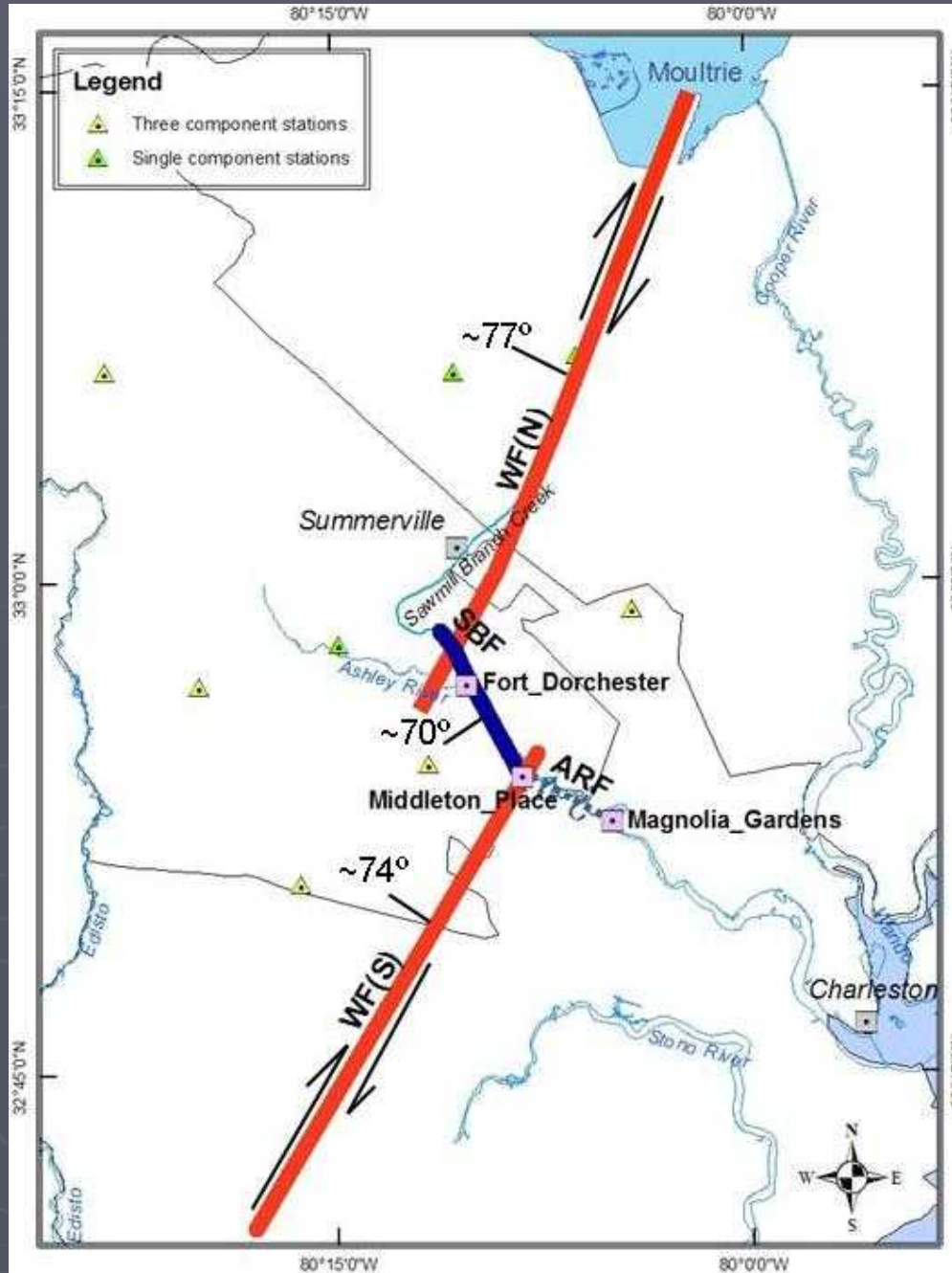




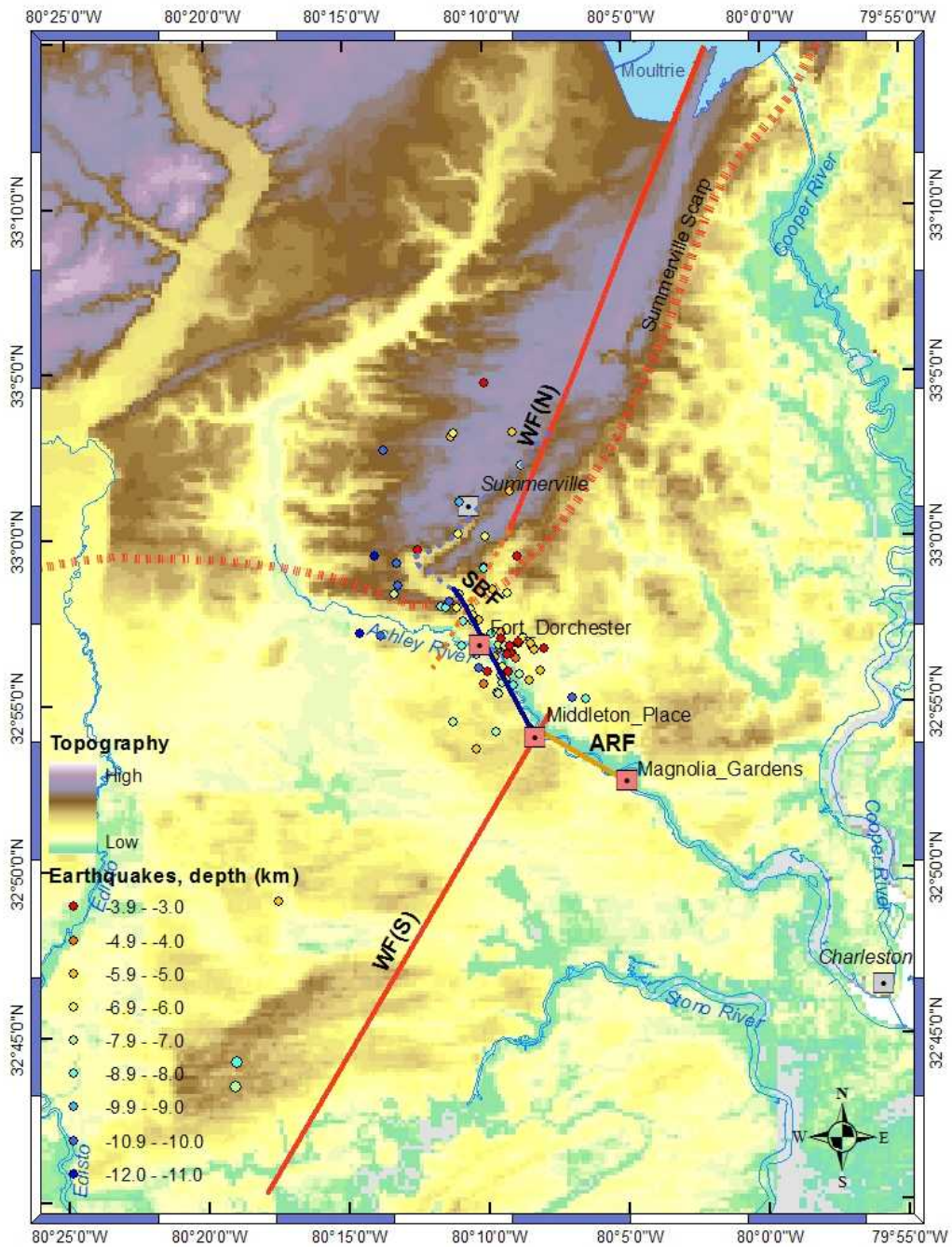




SEISMOTECTONIC FRAMEWORK



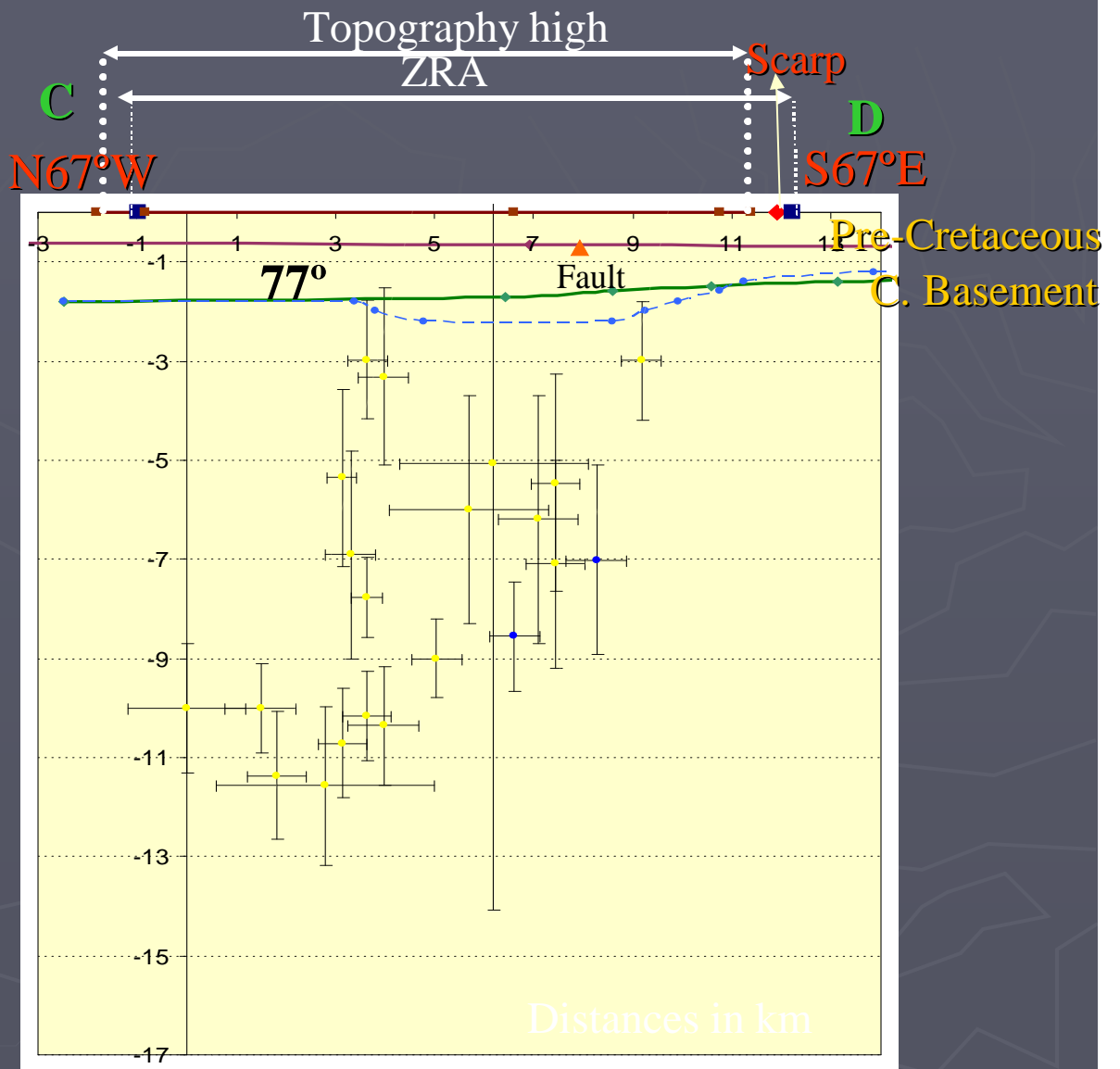
Dura-Gomez,
2004



NORTH WOODSTOCK FAULT: N23°E

Fault zone inferred from seismicity data is consistent with:

- ☉ NNE trending ~13 km wide *topographic high* on the NW side, coincident with *ZRA*
- ☉ Summerville Scarp being the *southeastern edge* of the topographic high.
- ☉ Fault from seismic reflection data with *NW side upthrown*.
- ☉ *Down warping* of the *crystalline basement* into the Jedburg basin .



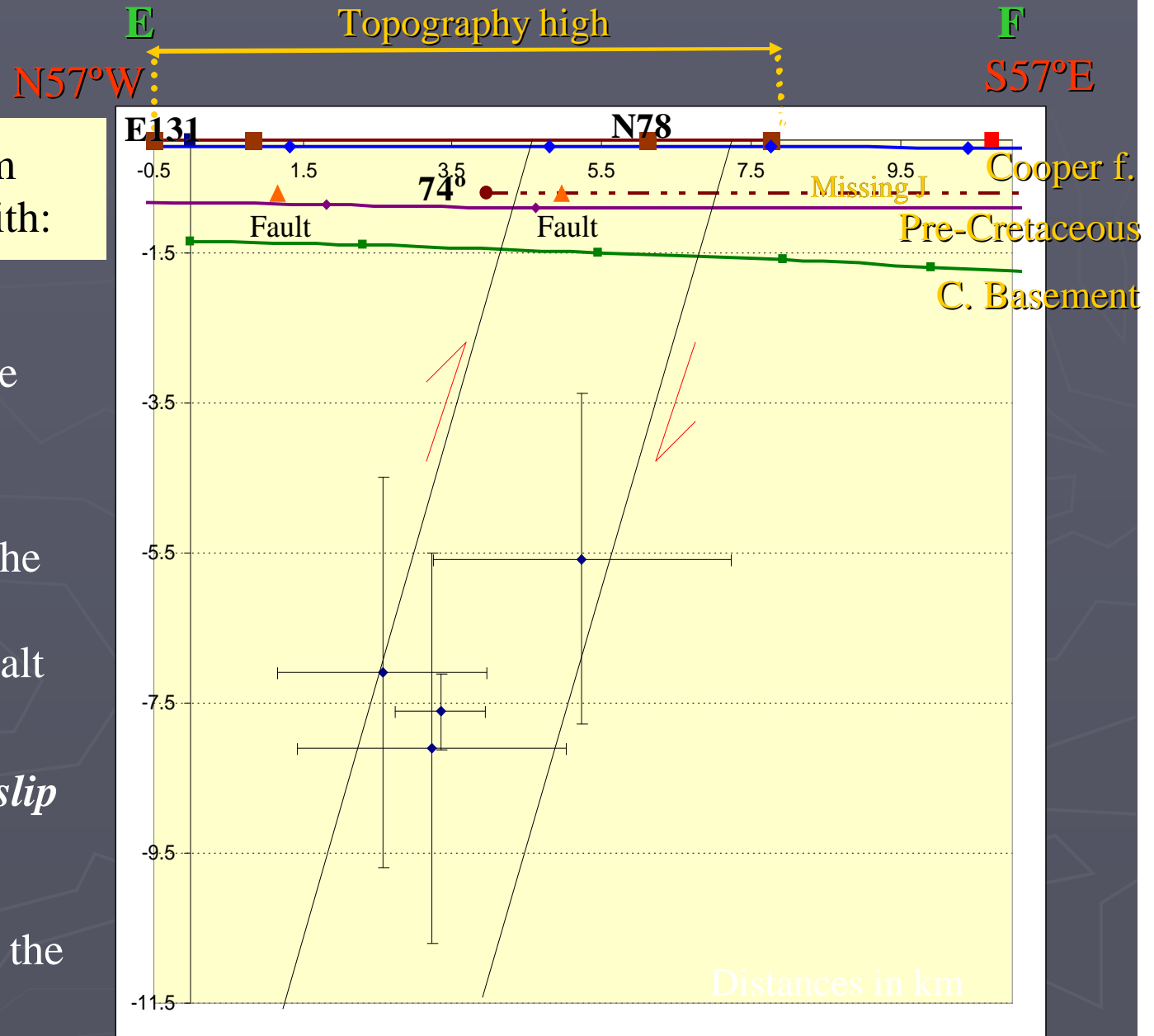
SOUTH WOODSTOCK FAULT: N33°E

Fault zone inferred from seismicity consistent with:

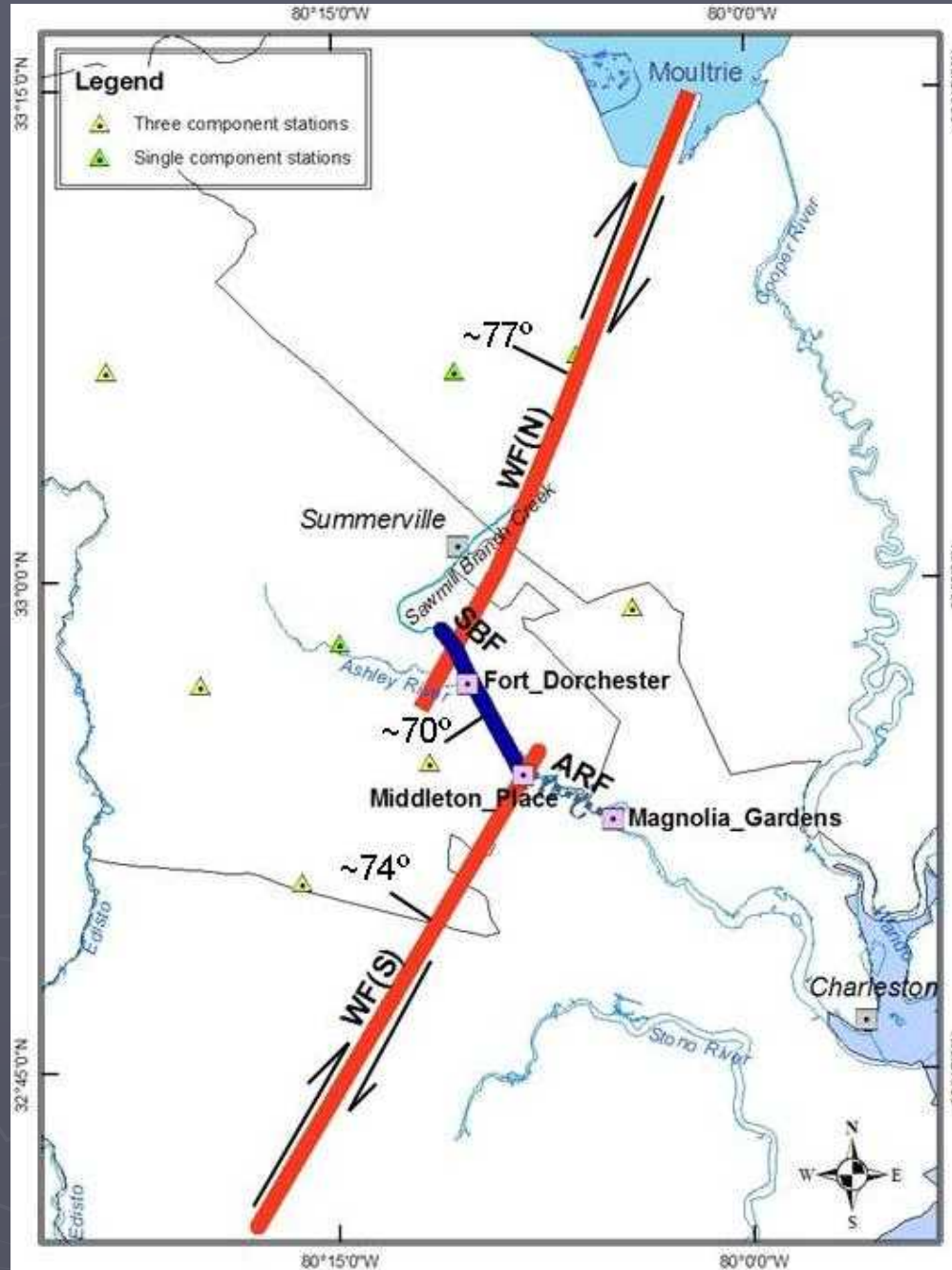
- ⊙ *Fault* from *seismic reflection data* above the *fault zone* inferred from seismicity

- ⊙ *Faulting* inferred on the *NW side* of the *zone of missing J* and in the basalt horizon.

- ⊙ *Oblique right lateral slip* on WF(S) that caused *upwarping* to the *NW* (NW side upthrown and the SE side downthrown)



SEISMOTECTONIC FRAMEWORK

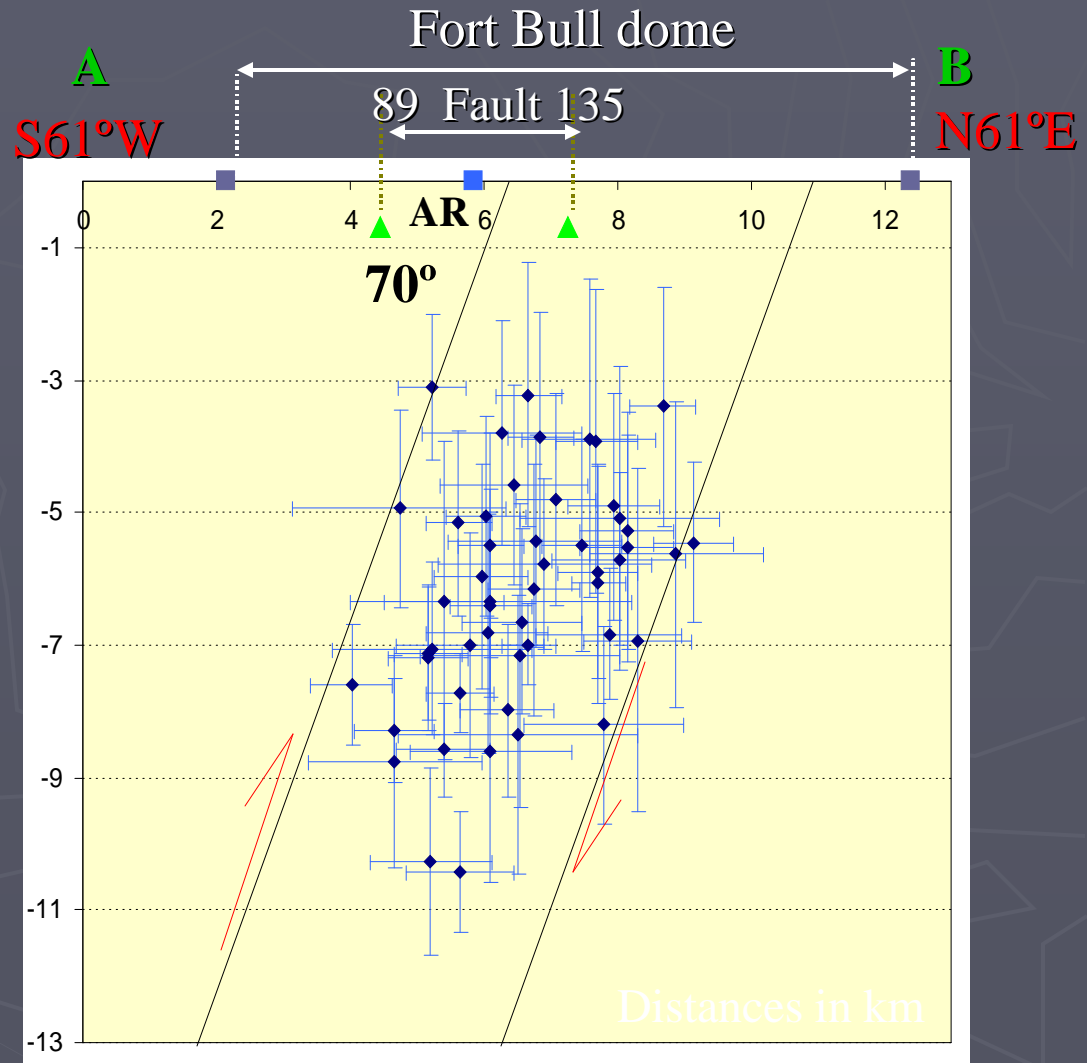


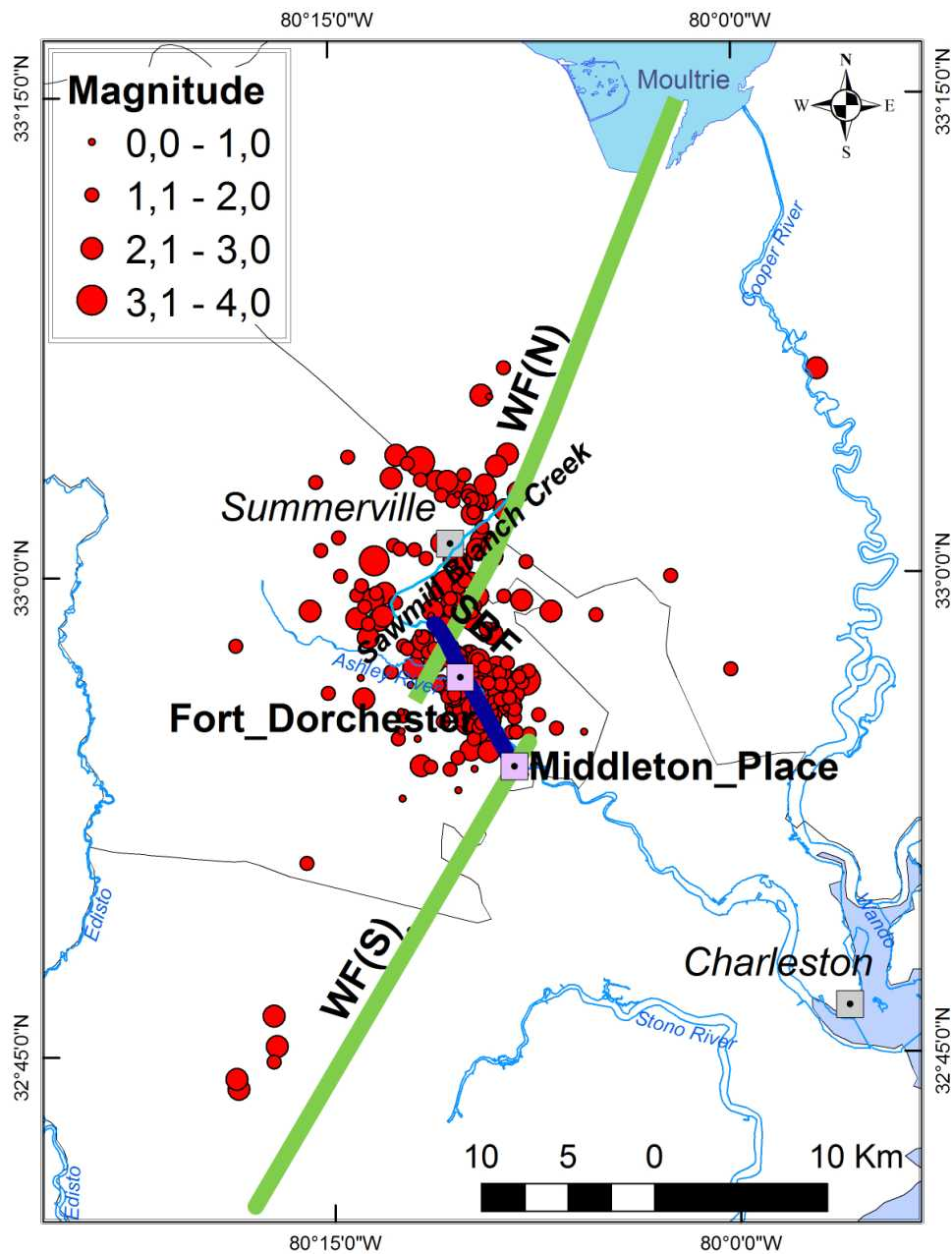
Dura-Gomez,
2004

SBF-ARF system

Fault zone inferred from seismicity data is consistent with:

- ⊙ Inferred fault along line 3 between stations 89 and 135
- ⊙ Ashley River being fault controlled.
- ⊙ Eocene age Fort bull dome (at a depth of ~9 m) originated by reverse slip on SBF zone.





➤ The results of seismotectonic studies show that the source zone associated with the Charleston earthquake is ~50 km long.

RESULTS OF PALEOSEISMOLOGICAL STUDIES

MAGNITUDE 7+

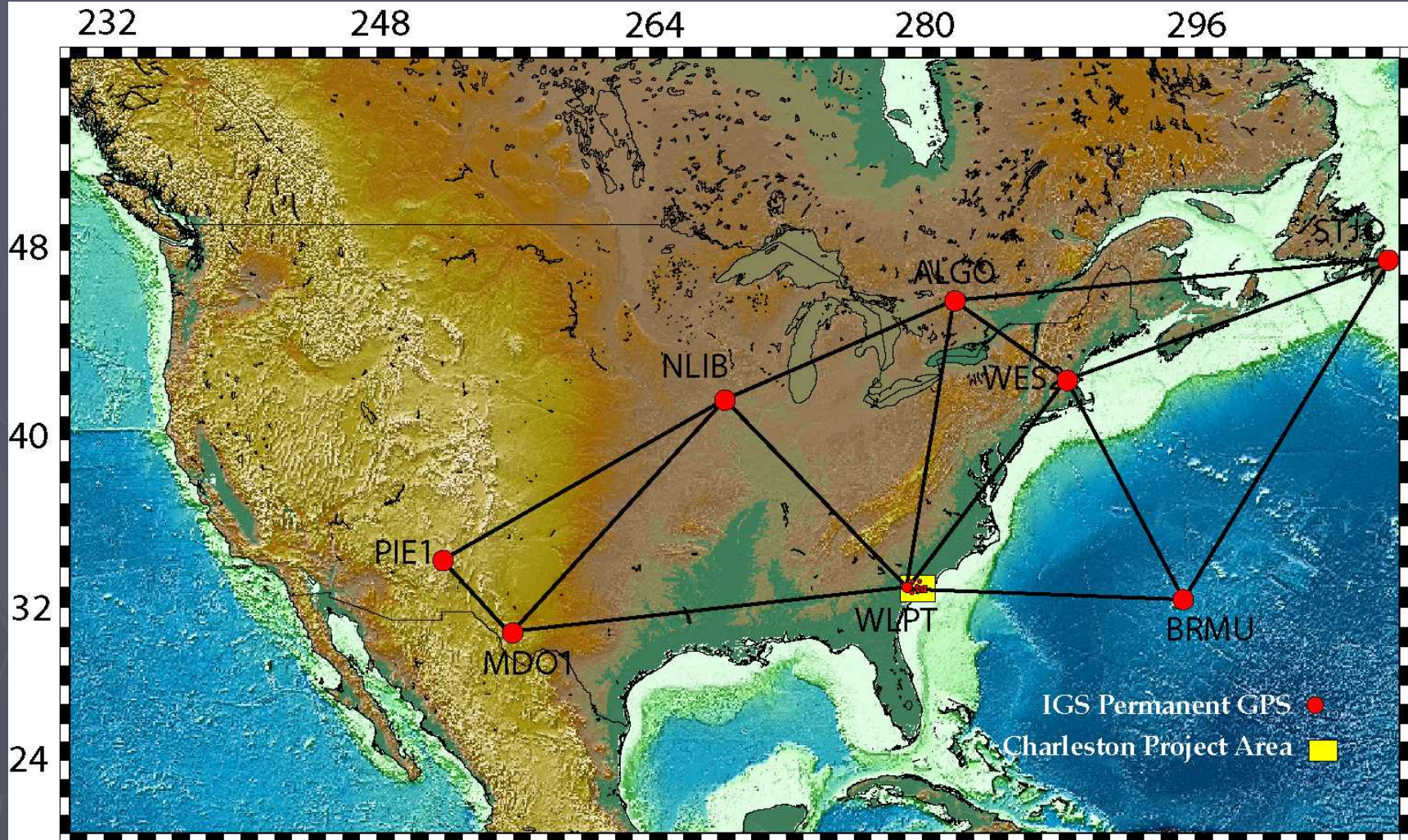
CHARLESTON EARTHQUAKES OCCUR

EVERY 500 YEARS

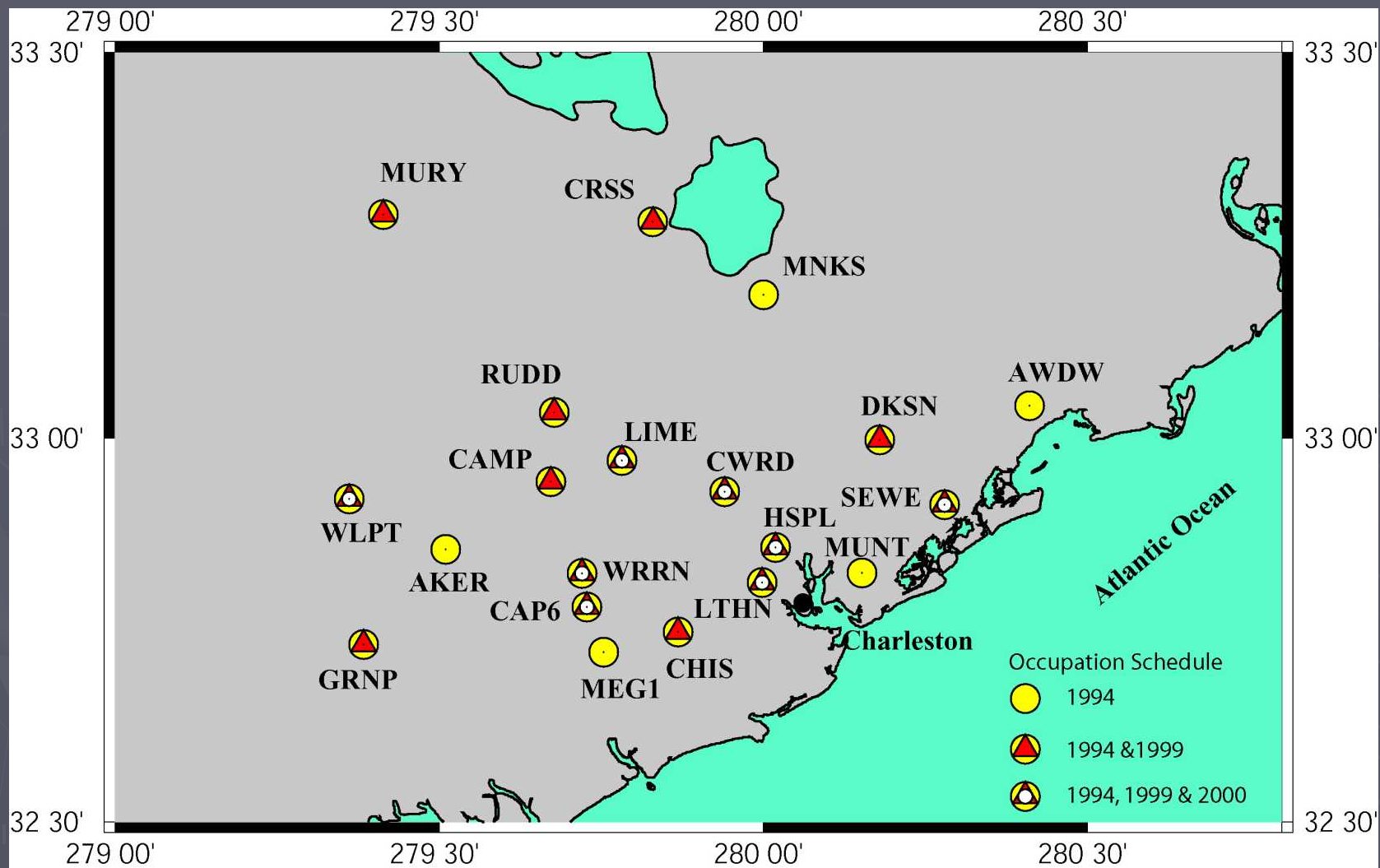
Talwani and Schaffer 2001

- > The seismicity in the Charleston seismic zone is concentrated near fault intersections.
- > Simple 2D and 3D modeling shows that these intersecting faults can explain the observed seismicity (Gangopadhyay and Talwani, 2005, 2006)

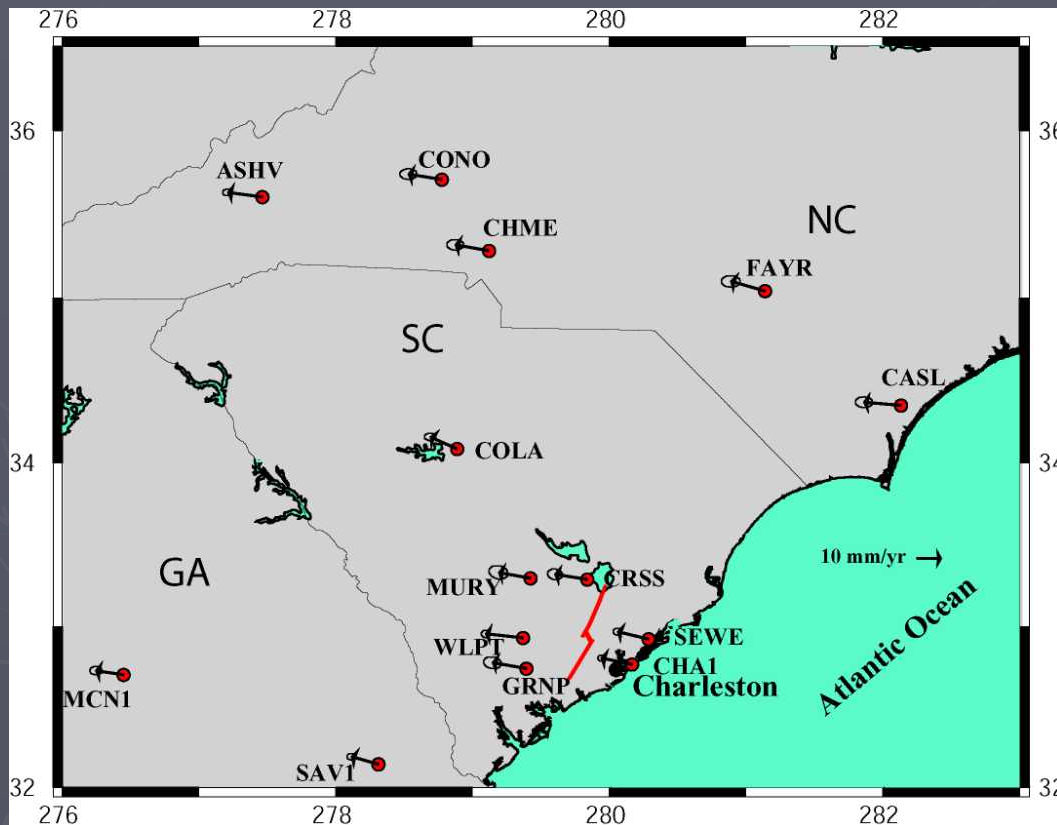
Confirmation from GPS



LOCATION MAP OF GPS STATIONS

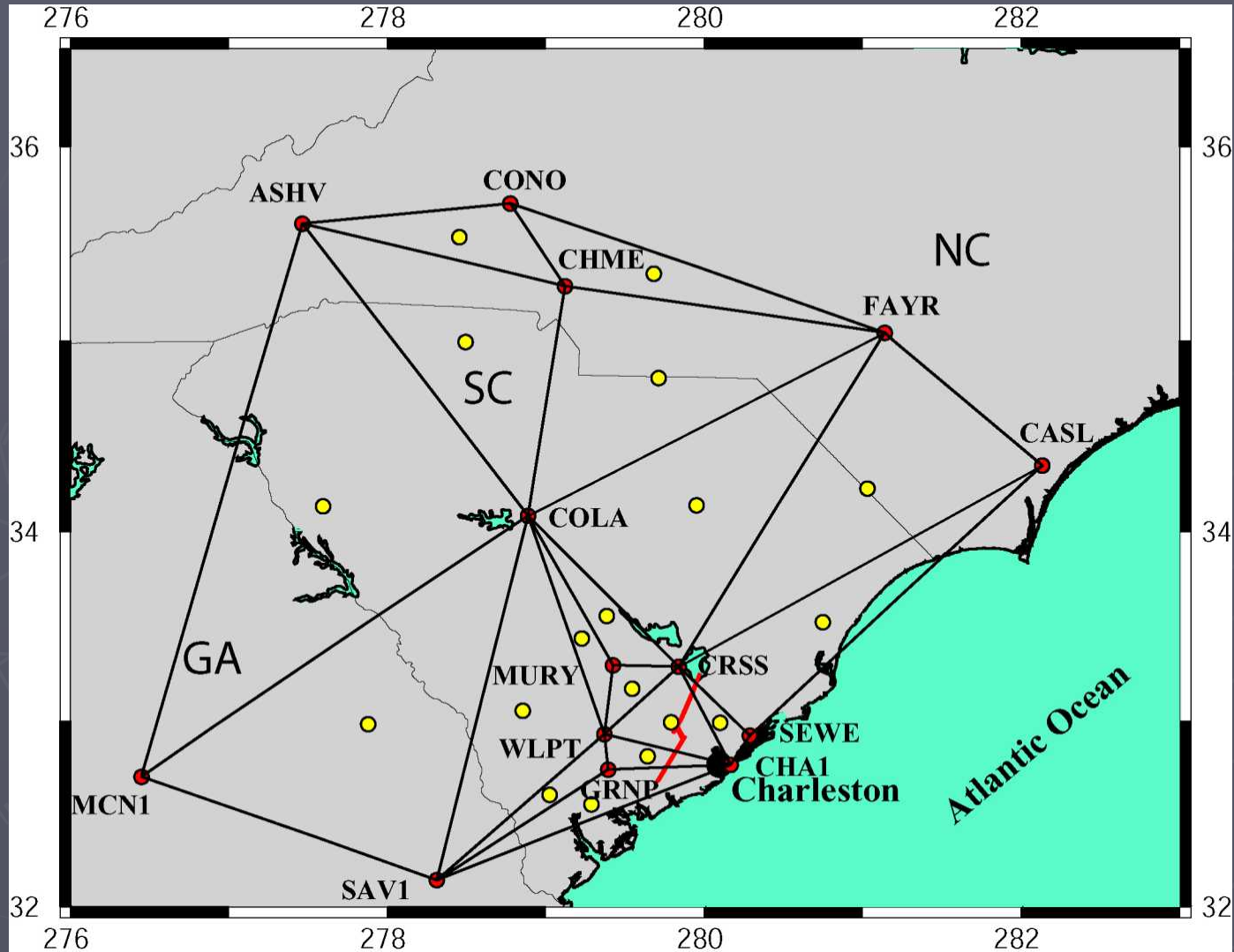


SITE LOCATIONS FOR STRAIN ANALYSIS



- > Campaign sites
- > Outer stations are CORS
- > Positional vectors relative to the ITRF 2000 reference frame used in the strain calculations

DELAUNAY TRIANGLES USED IN STRAIN CALCULATIONS



SHEAR STRAIN RATE CONTOURS

For N. America plate
Strain rate 10^{-9} /year



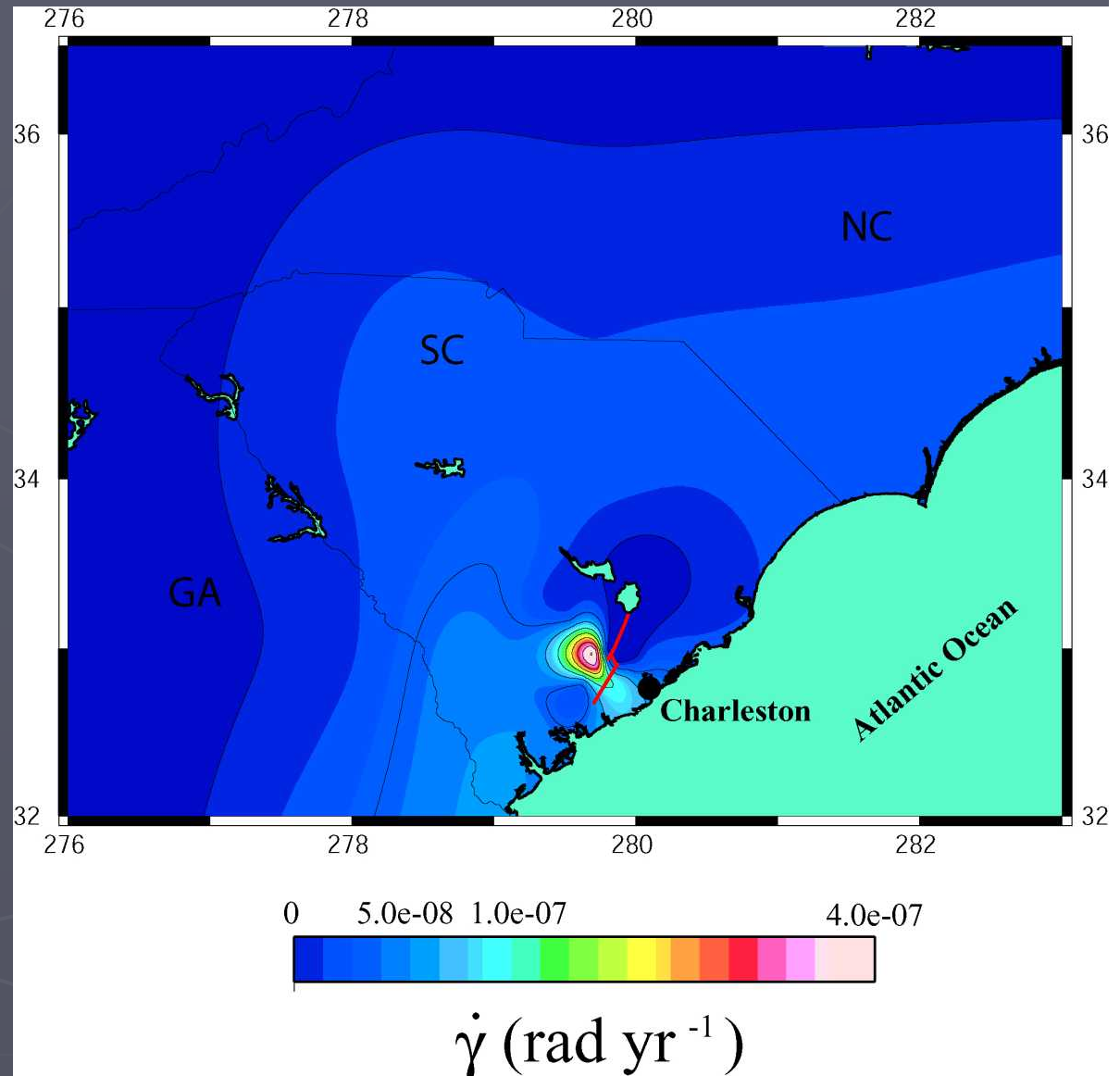
1 mm/ 1000 km

For Charleston
Strain rate 10^{-7} /year

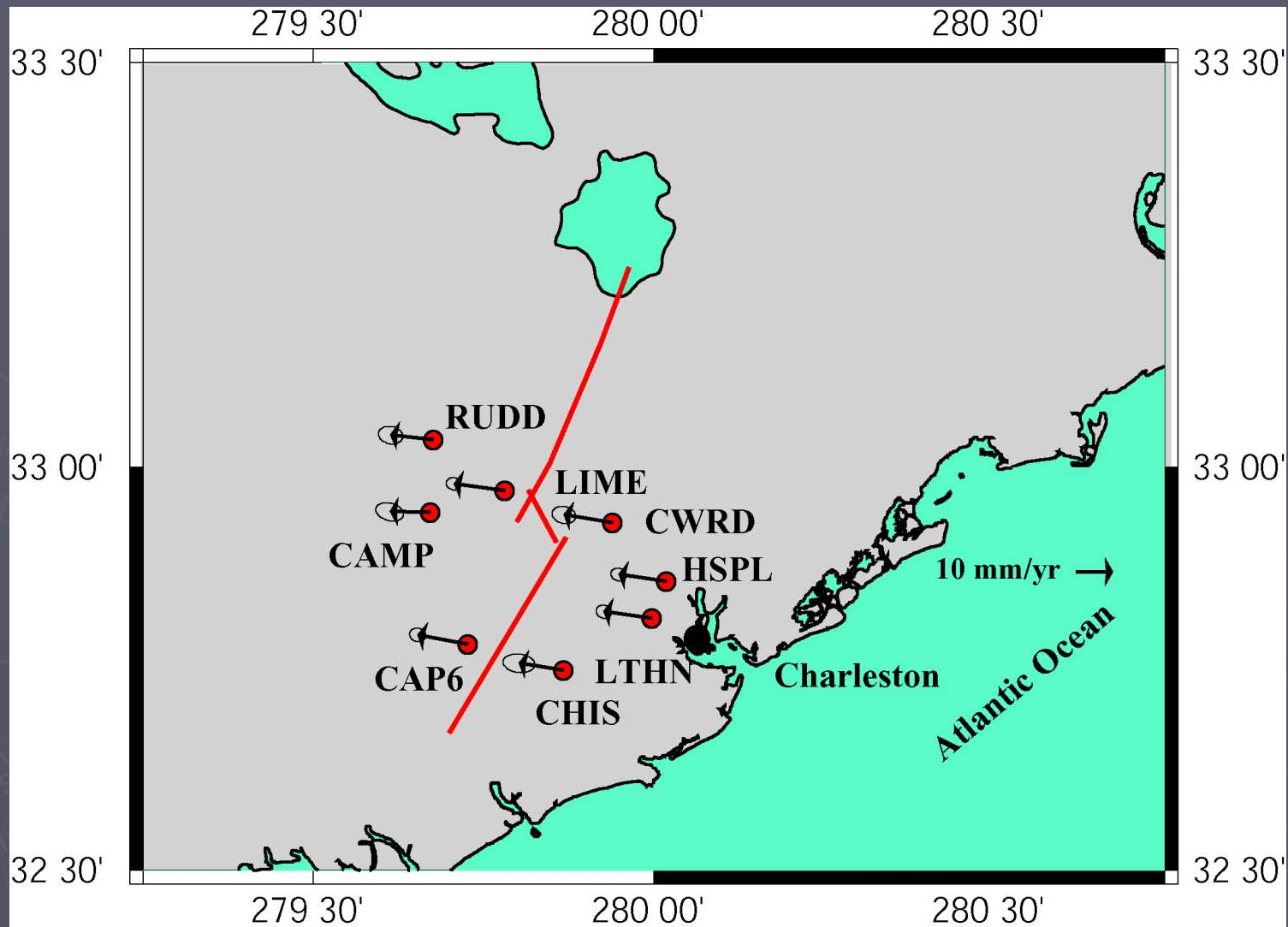


1 cm/ 100 km

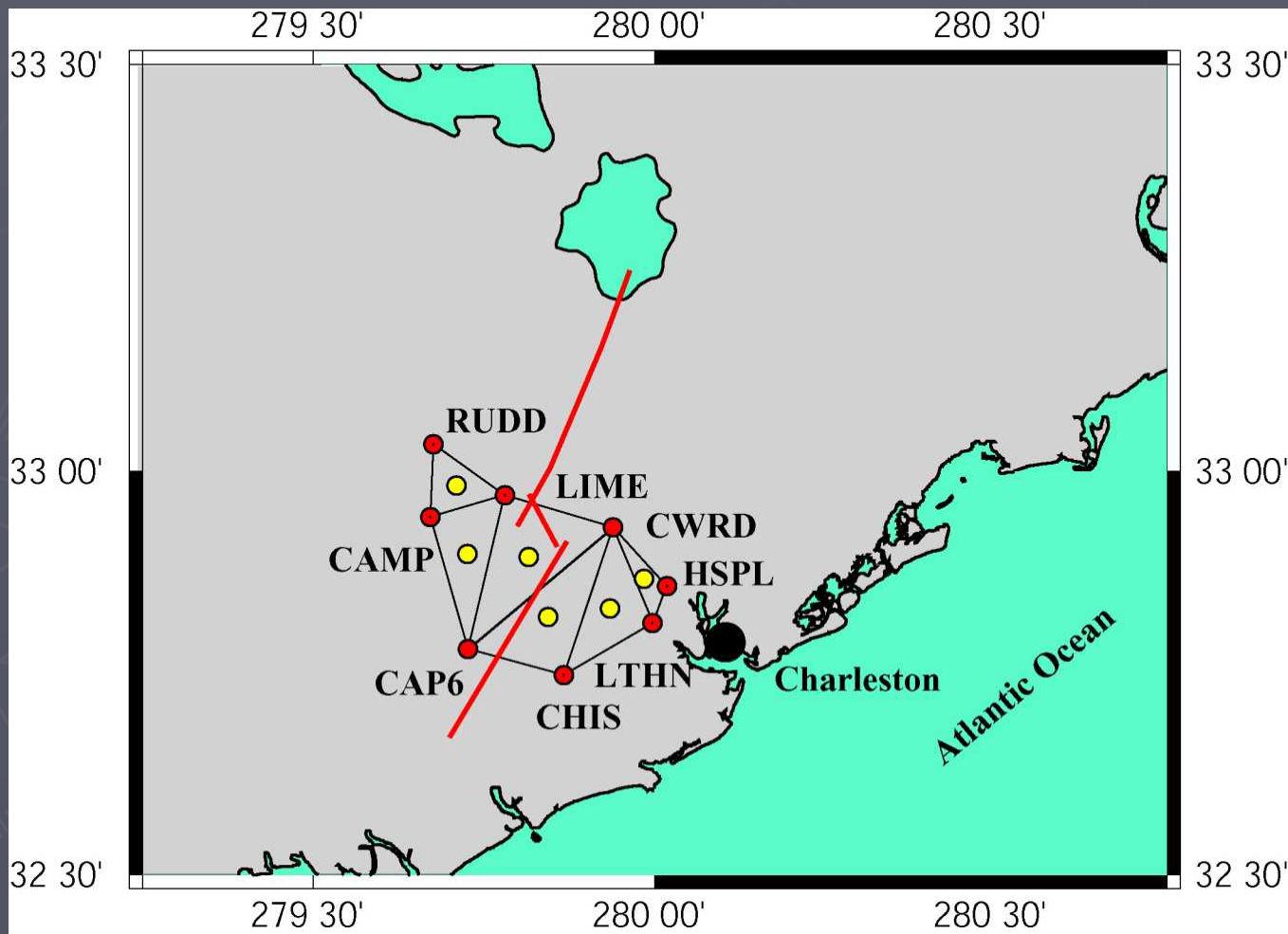
Comparable to strain
rates at plate
boundaries



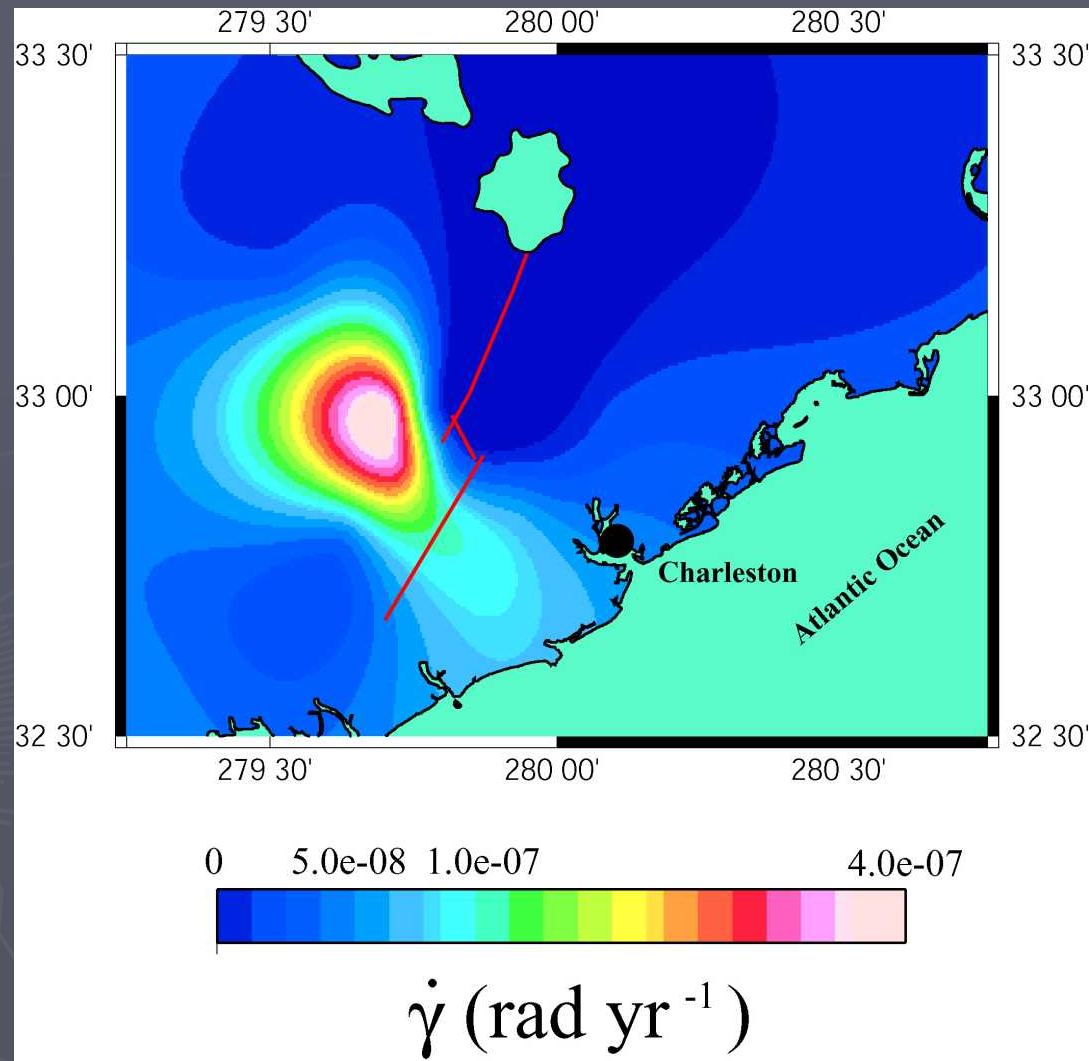
POSITIONAL VECTORS IN EPICENTRAL AREA



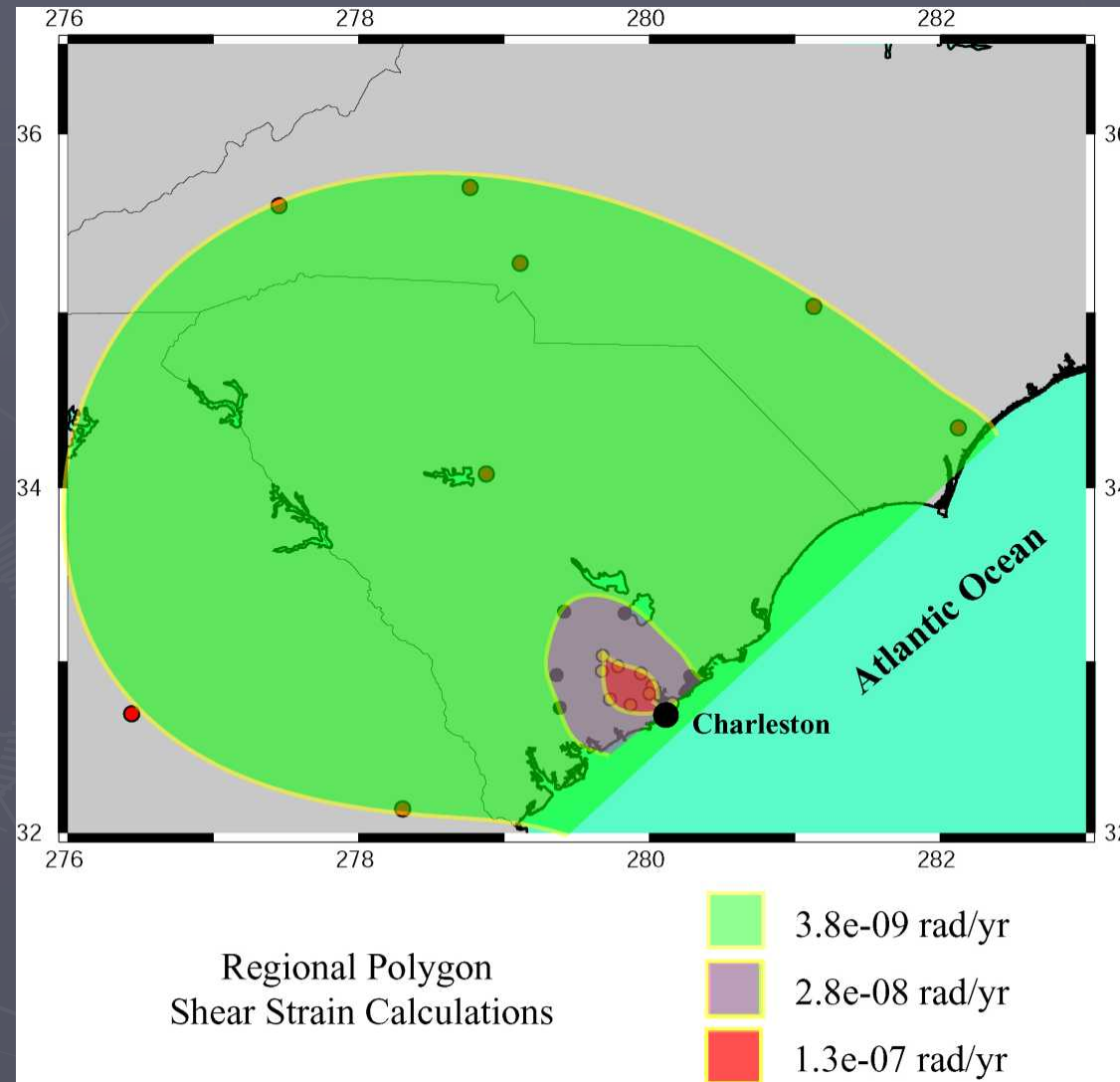
DELAUNAY TRIANGLES IN EPICENTRAL AREA



SHEAR STRAIN RATE CONTOURS



RESULTS OF GPS STUDIES (STRAIN ZONATION)

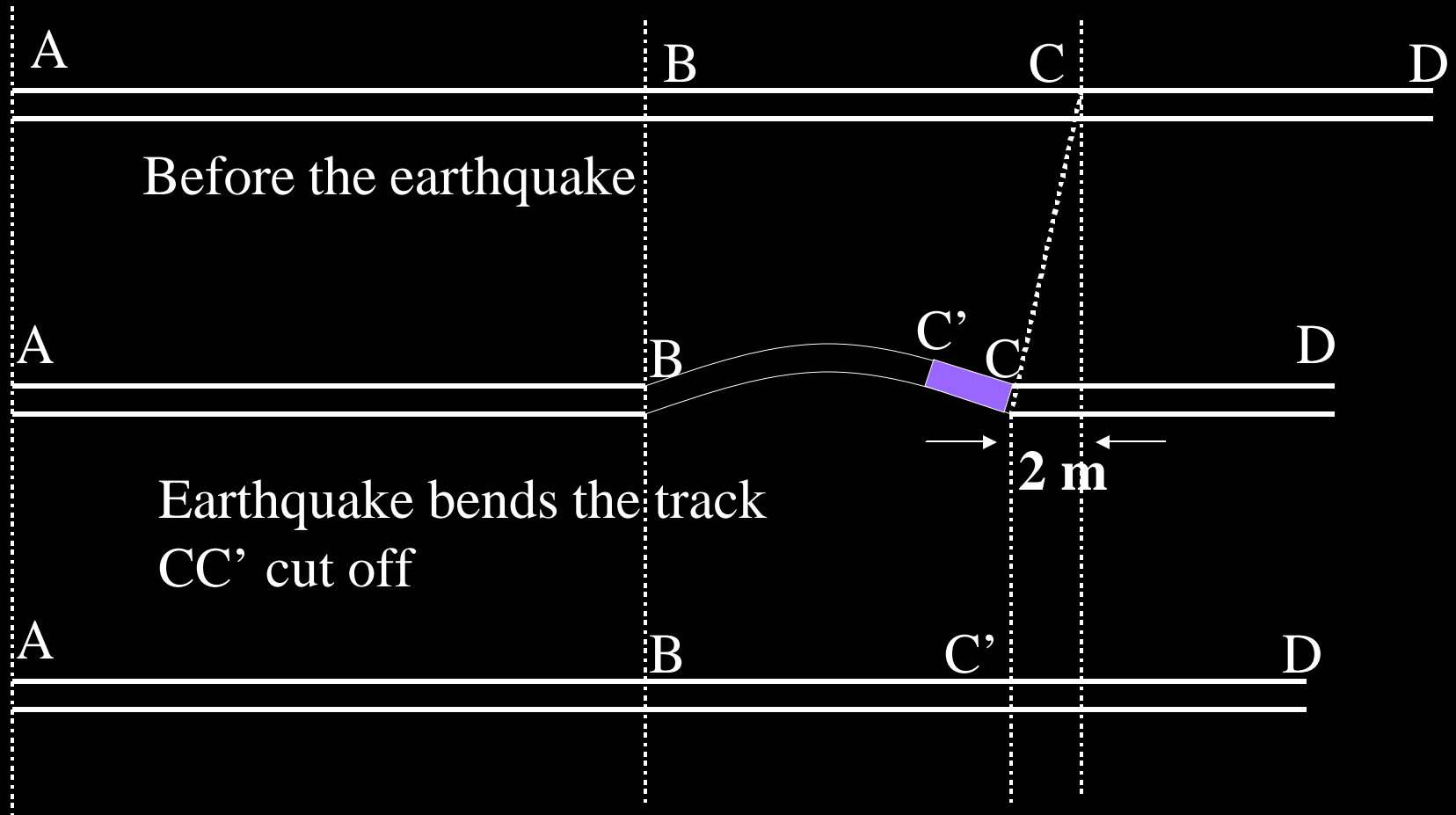


> What do you get when you put it all together?

- The earthquake cycle

BENT TRACKS IN 1886





Coseismic shortening: 2m

EARTHQUAKE CYCLE

Length of the seismic zone ~50 km

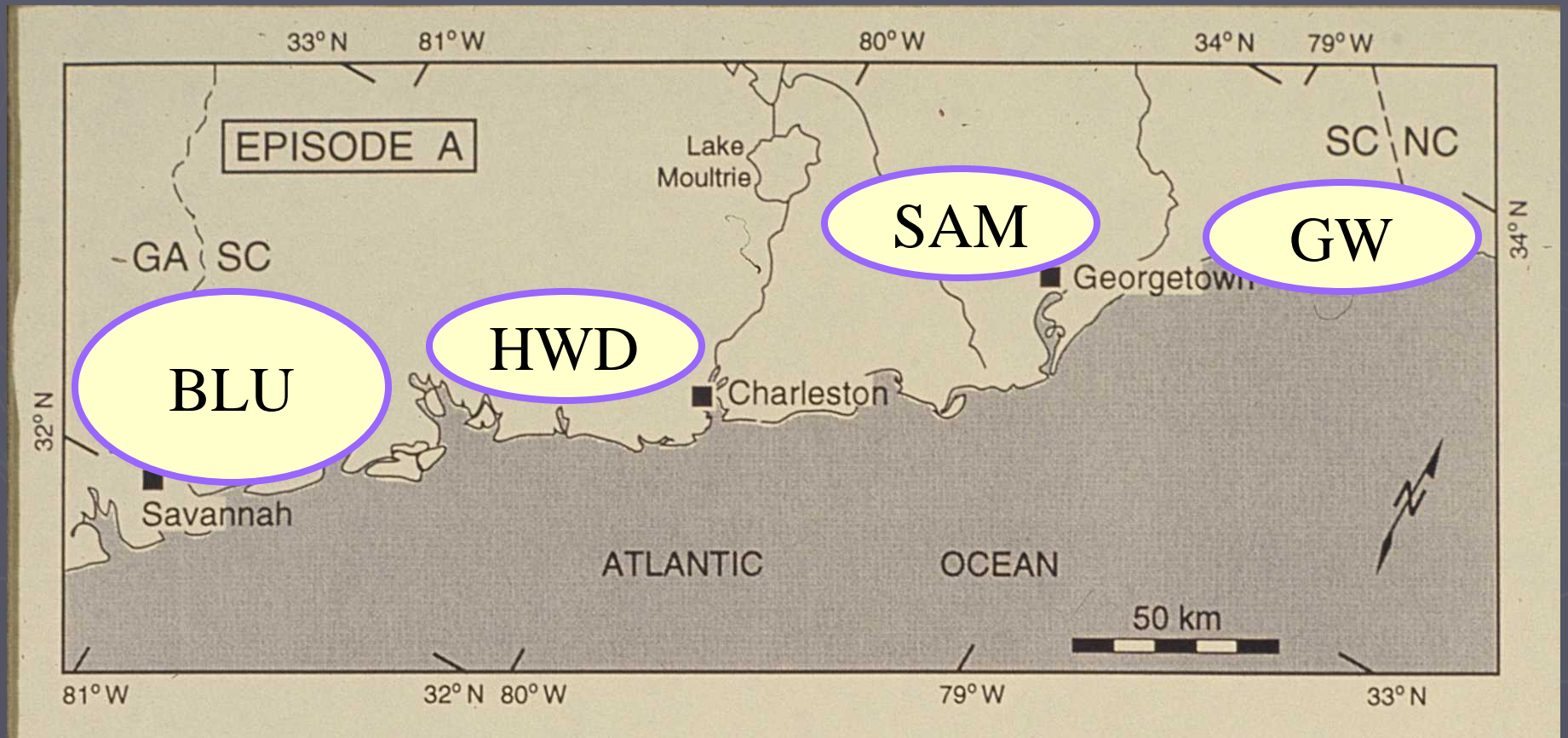
Strain rates ~ 10^{-7} /year (from GPS)

Recurrence rates ~500 years
(from Paleoseismology)

Imply slip in one earthquake cycle ~2.5 m

Comparable to observed coseismic strain
(shortening of railroad tracks)

LOCATIONS OF SANDBLOWS ASSOCIATED WITH CHARLESTON EARTHQUAKES



Magnitude of paleoearthquakes

- > In situ geotechnical data (SPT, CPT and shear-wave) were obtained at paleoliquefaction sites at Sampit and Gapway 100 km from Charleston.
- > Back calculation of magnitudes of responsible paleoearthquakes in Charleston lie in the range of 6.2 to 7.0.

Leon et al., 2005

CONCLUSIONS

- > Source zone: ~50 km long
- > Recurrence time: ~500 years
- > Modeling and GPS observations are consistent with source model
- > Maximum magnitude: 7.0 or lower(?)