Constraints on Opening of the Gulf of Mexico from Seafloor-Spreading Magnetic Anomalies*

Dennis L. Harry[1] and Philip K. Eskamani[1]

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Abstract

Opening of the Gulf of Mexico is poorly constrained due to a lack of recognized seafloor-spreading magnetic anomalies and an absence of drilling to constrain ocean-floor composition and ages. Recently identified lineated magnetic anomaly patterns in the eastern Gulf between Yucatan and Florida provide new evidence of the age and pattern of seafloor spreading. The magnetic anomalies correlate with chrons M21n to M10r, indicating creation of ocean floor at a full spreading rate of 17 mm/yr between 148-134 Ma. The oldest anomalies are located against stretched continental crust beneath the western Florida shelf on the east and the Yucatan shelf on the west. The youngest anomalies form a conjugate pair that mark the location of an extinct spreading ridge between Yucatan and Florida. Paleogeographic restoration of the magnetic anomaly pattern indicates a 4-phase model for opening of the Gulf. During phase 1 (Early Permian-Late Triassic), Yucatan and associated tectonic blocks that now comprise eastern Mexico were translated eastward from the Pacific realm into positions near the modern western Gulf. During phase 2 (Late Triassic-ca. 160 Ma) Yucatan and the South Florida block were translated southeastward relative to North America, rotating 6.7° counterclockwise about a pole located at 34°N, 74°W. This resulted in ca. 430 km of southeastward extension on the North American coastal plain, 120 km of southward extension on the northern Yucatan shelf, and displacement of the South Florida Block from a pre-rift position on the northwest Florida shelf to its modern position. During phase 3 (ca. 160-149 Ma), Yucatan rotated counterclockwise 46° relative to North America about a pole located at 27.6°N, 84.0°W. Phase 3 may have coincided with seafloor spreading in the central and western Gulf, but predated seafloor spreading in the eastern Gulf. During phase 4 (148-134 Ma), Yucatan moved southwestward relative to North America, rotating counterclockwise 2.2° about a pole located at 17.6°N, 74.2°W and completing opening of the Gulf.

Selected Reference

Lawver, L.A., Dalziel, I.W.D., Norton, I.O., and Gahagan, L.M., 2009, The PLATES 2009 Atlas of Plate Reconstructions (750 Ma to Present Day), PLATES Progress Report No. 325-0509, University of Texas Technical Report No. 196. Website accessed July 24, 2014. http://www.ig.utexas.edu/research/projects/plates/recons.htm

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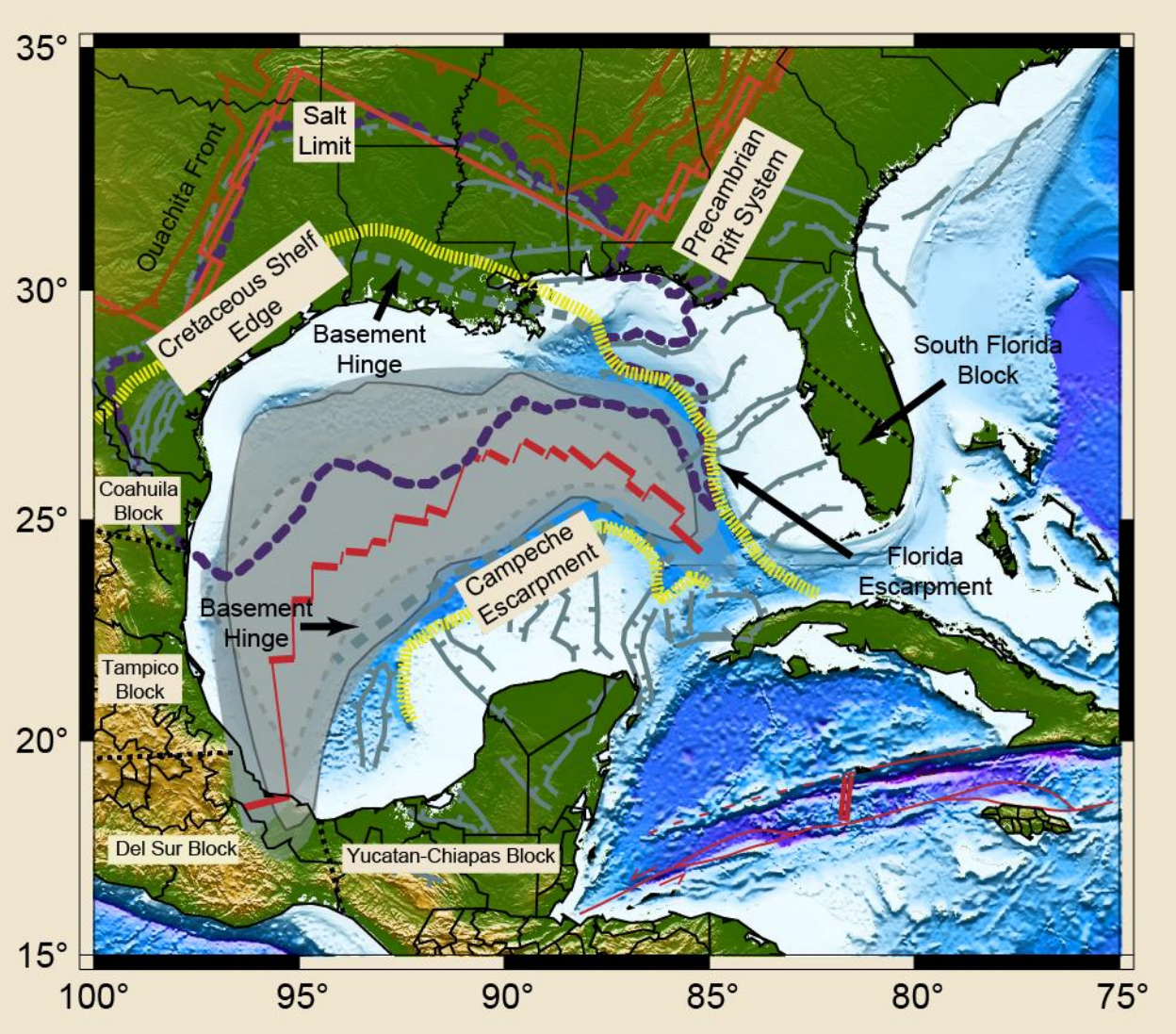
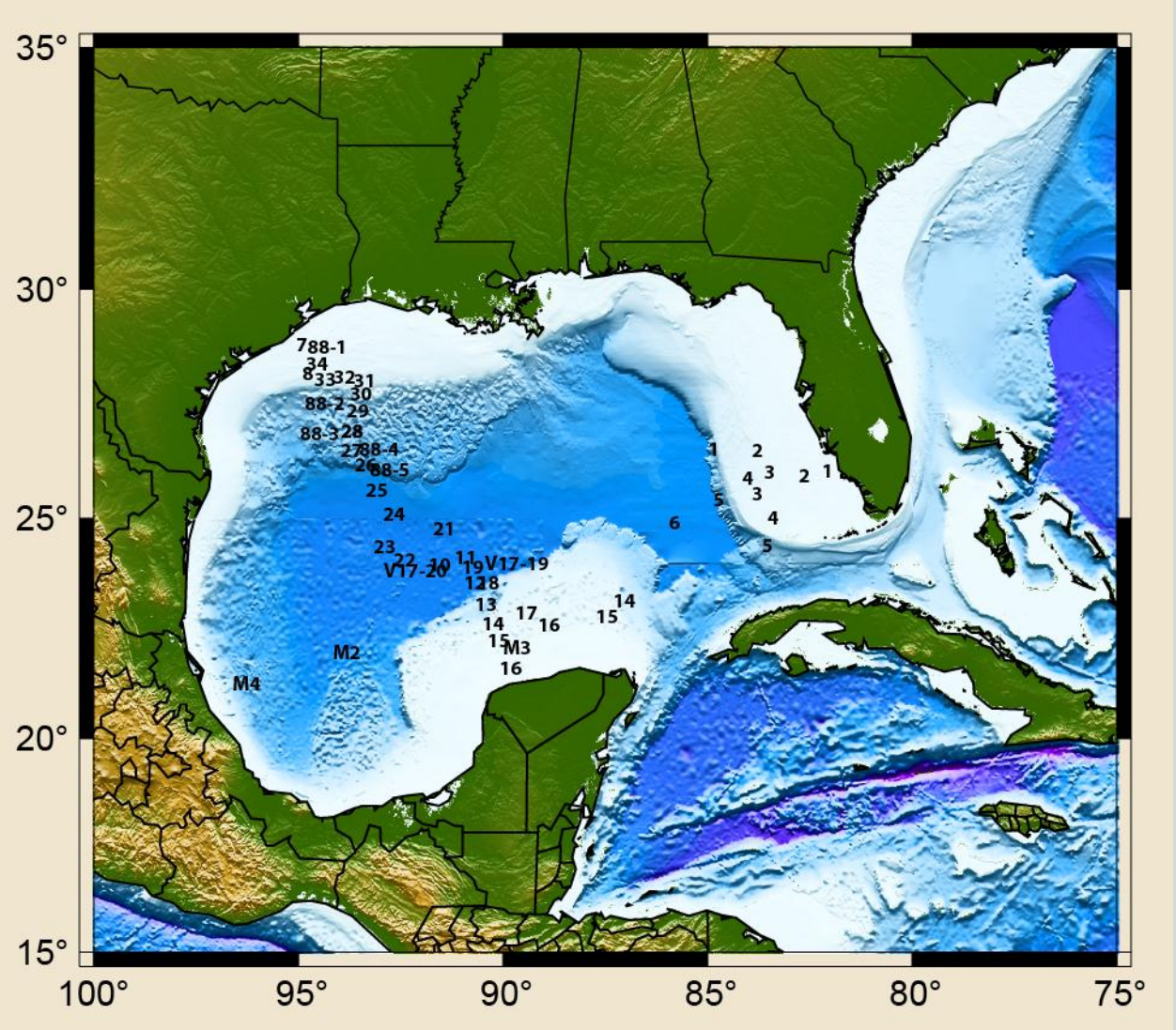
Department of Geosciences
Colorado State University

Tectonic Elements of the GOM Region



Challenges

Limited deep seismic refraction



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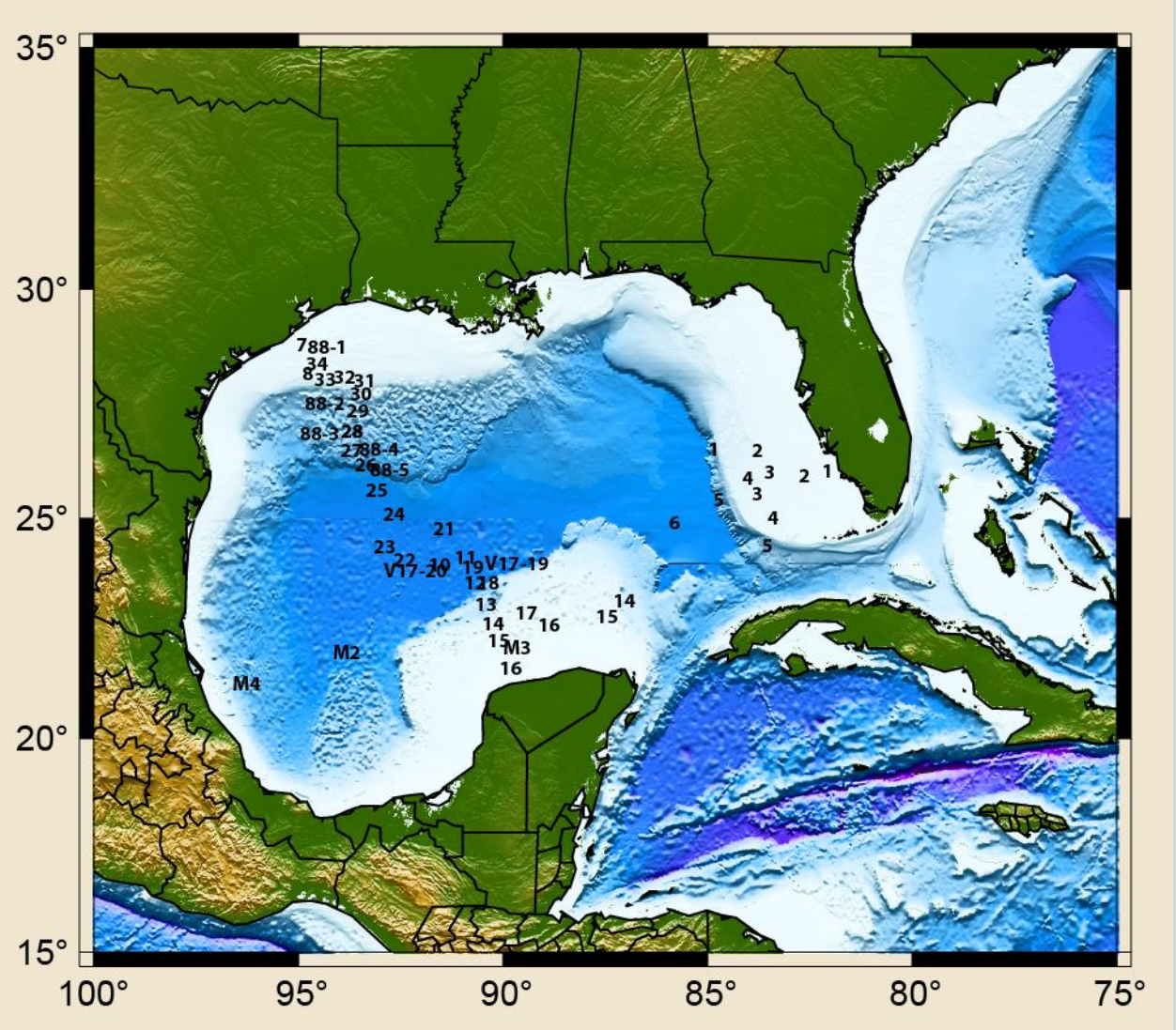
No basement drillholes



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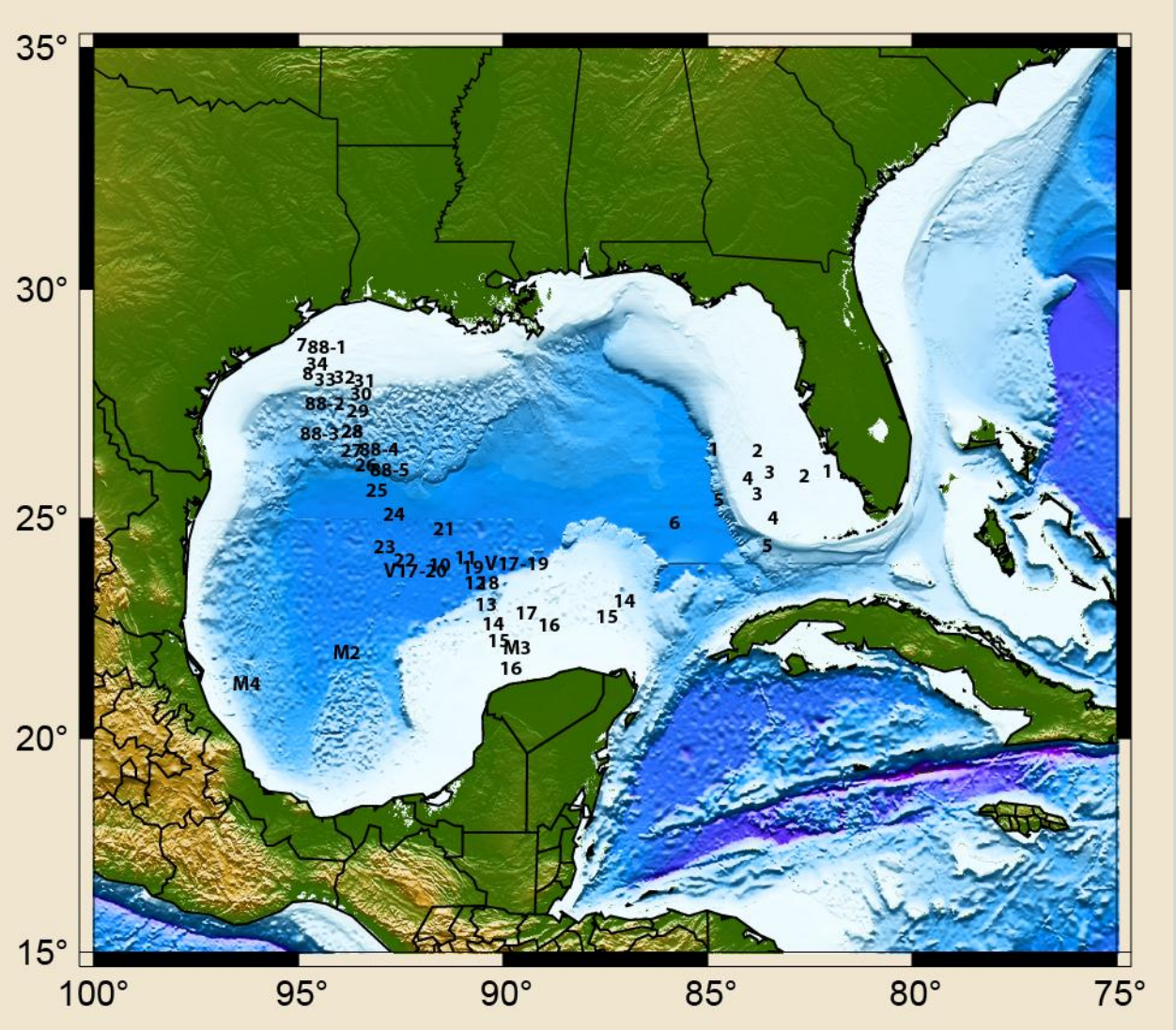
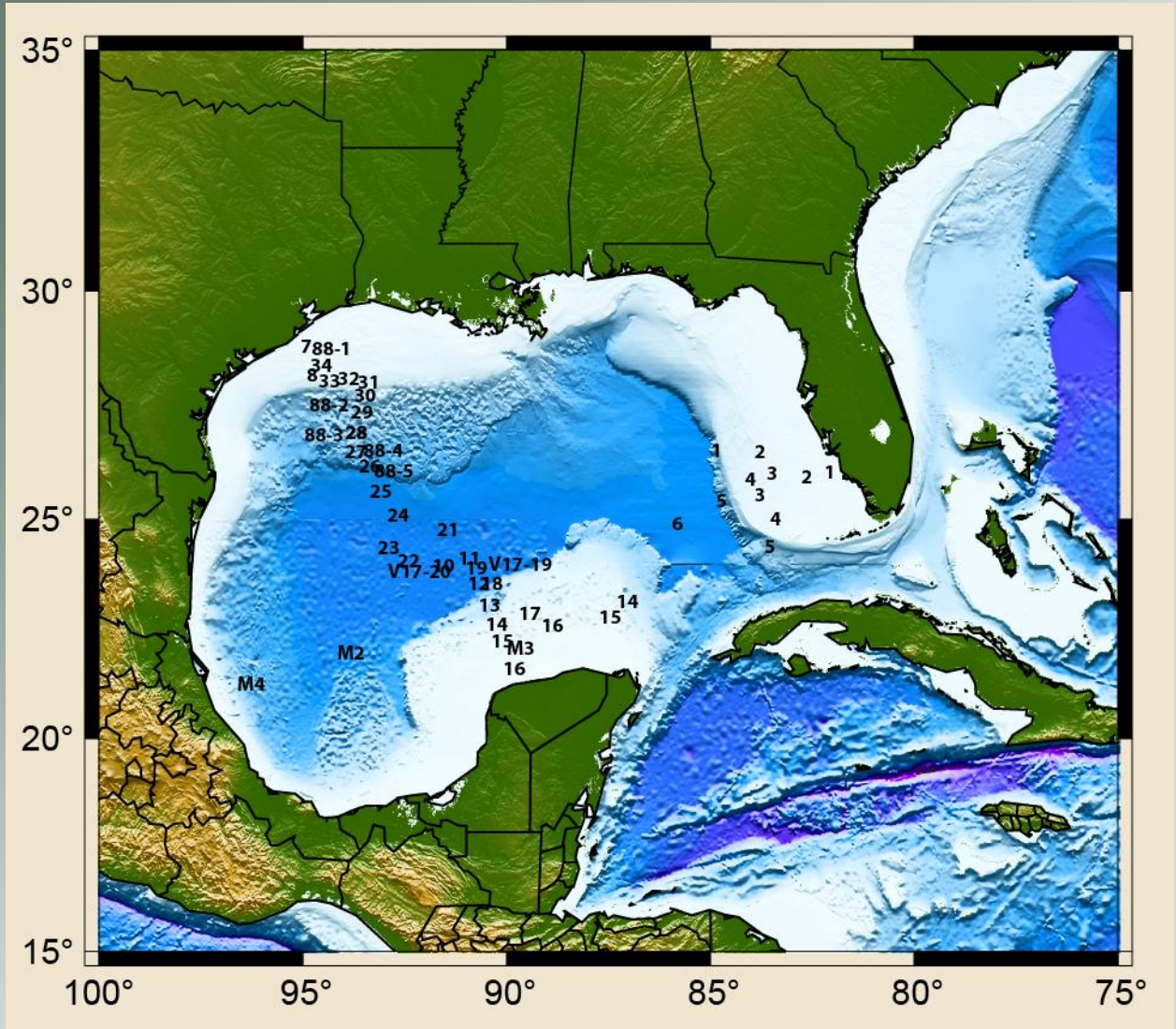
No basement dredging



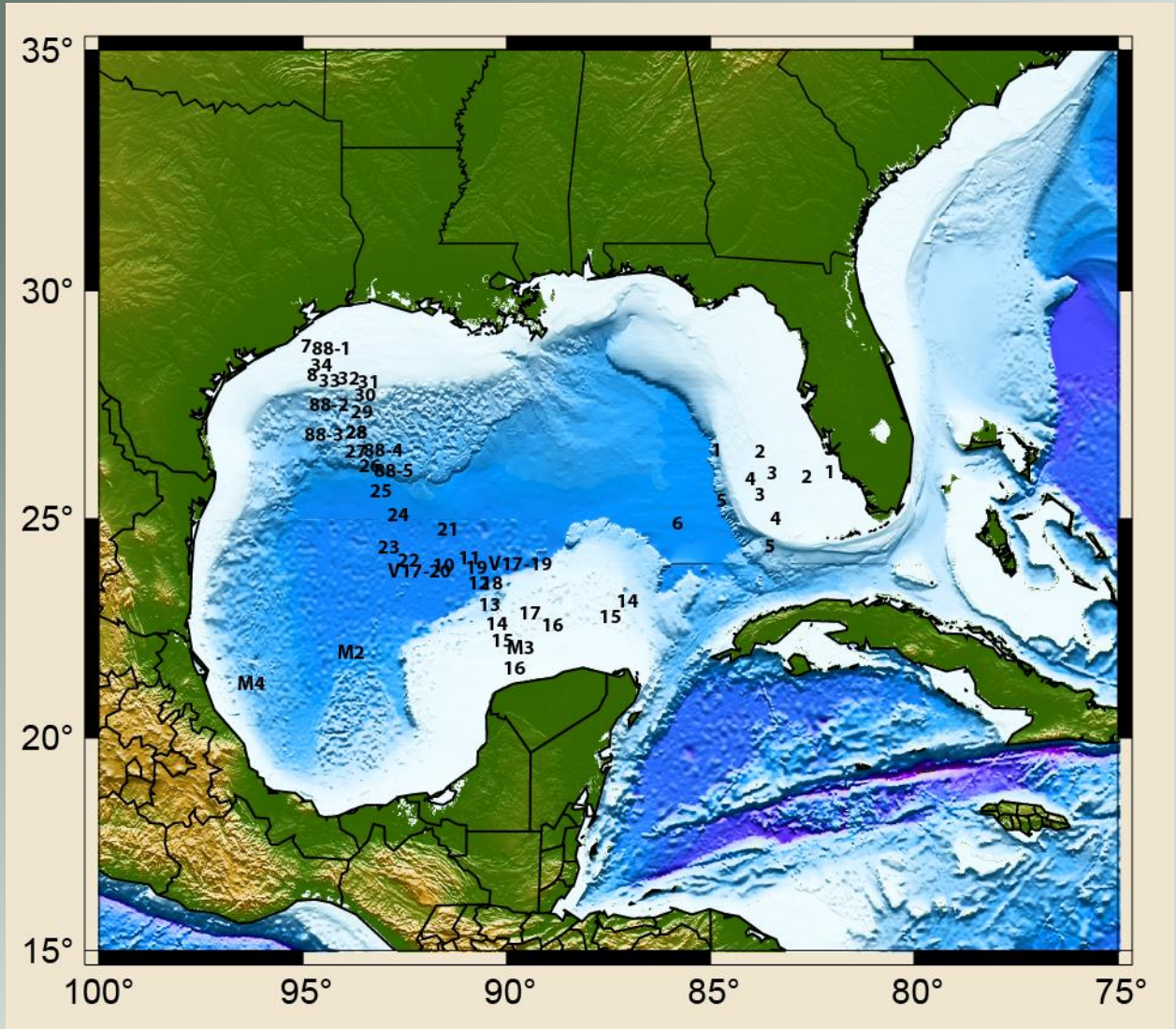
Challenges

- Limited deep seismic refraction
- No basement drillholes
- No basement dredging
- No recognized seafloor-spreading magnetic anomalies



Challenges

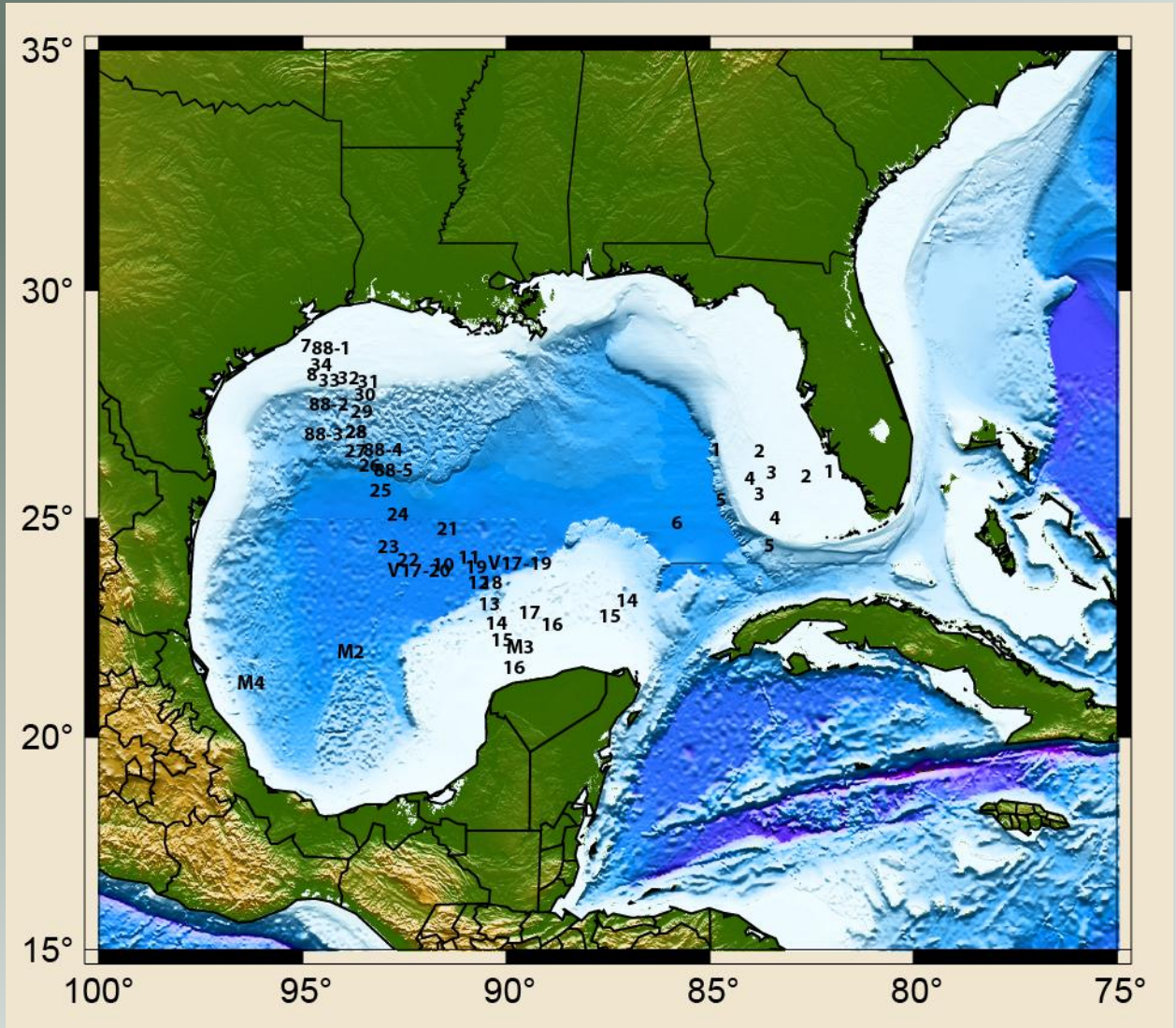
⇒No ages!



Challenges

⇒No ages!

⇒No composition!

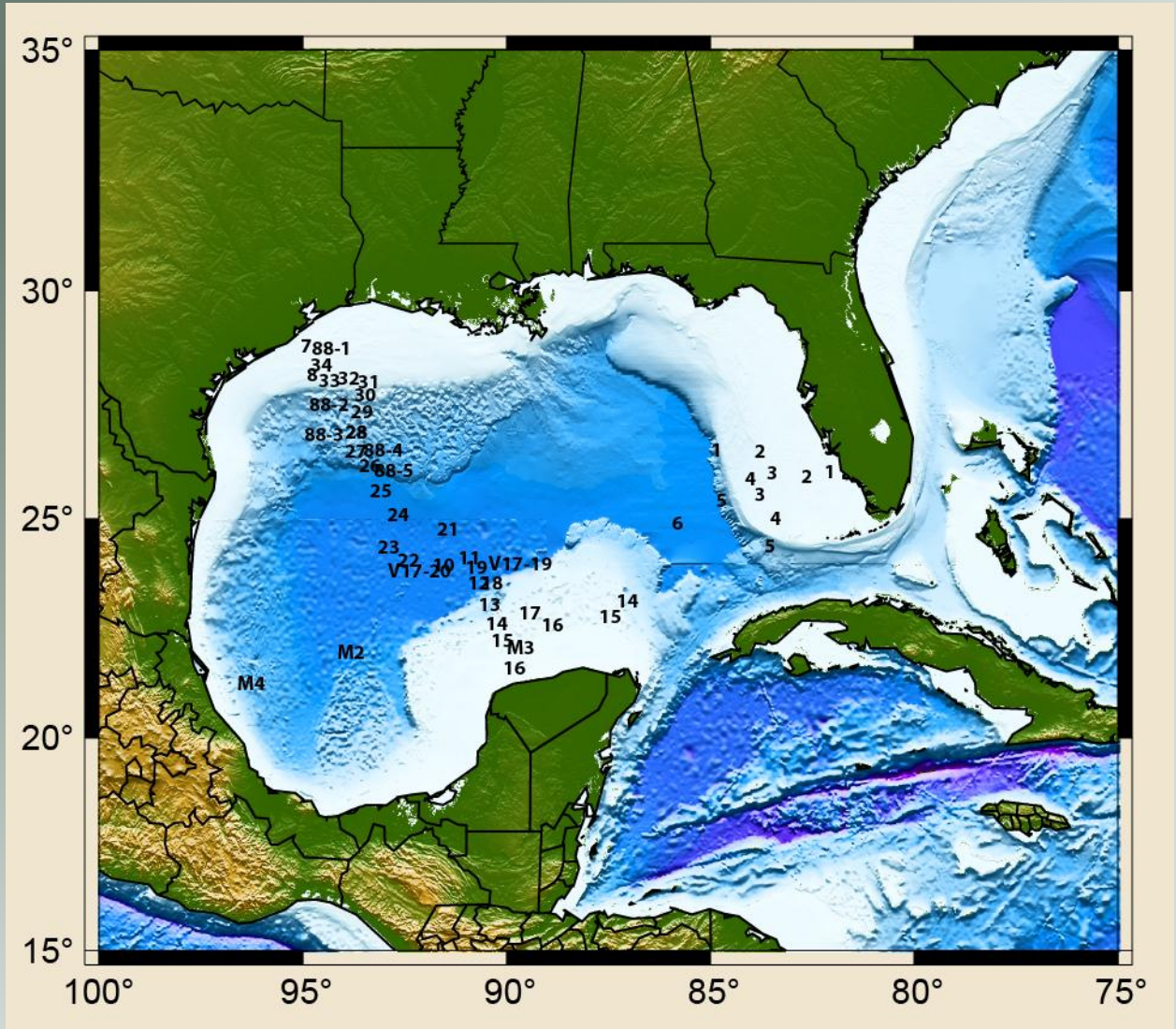


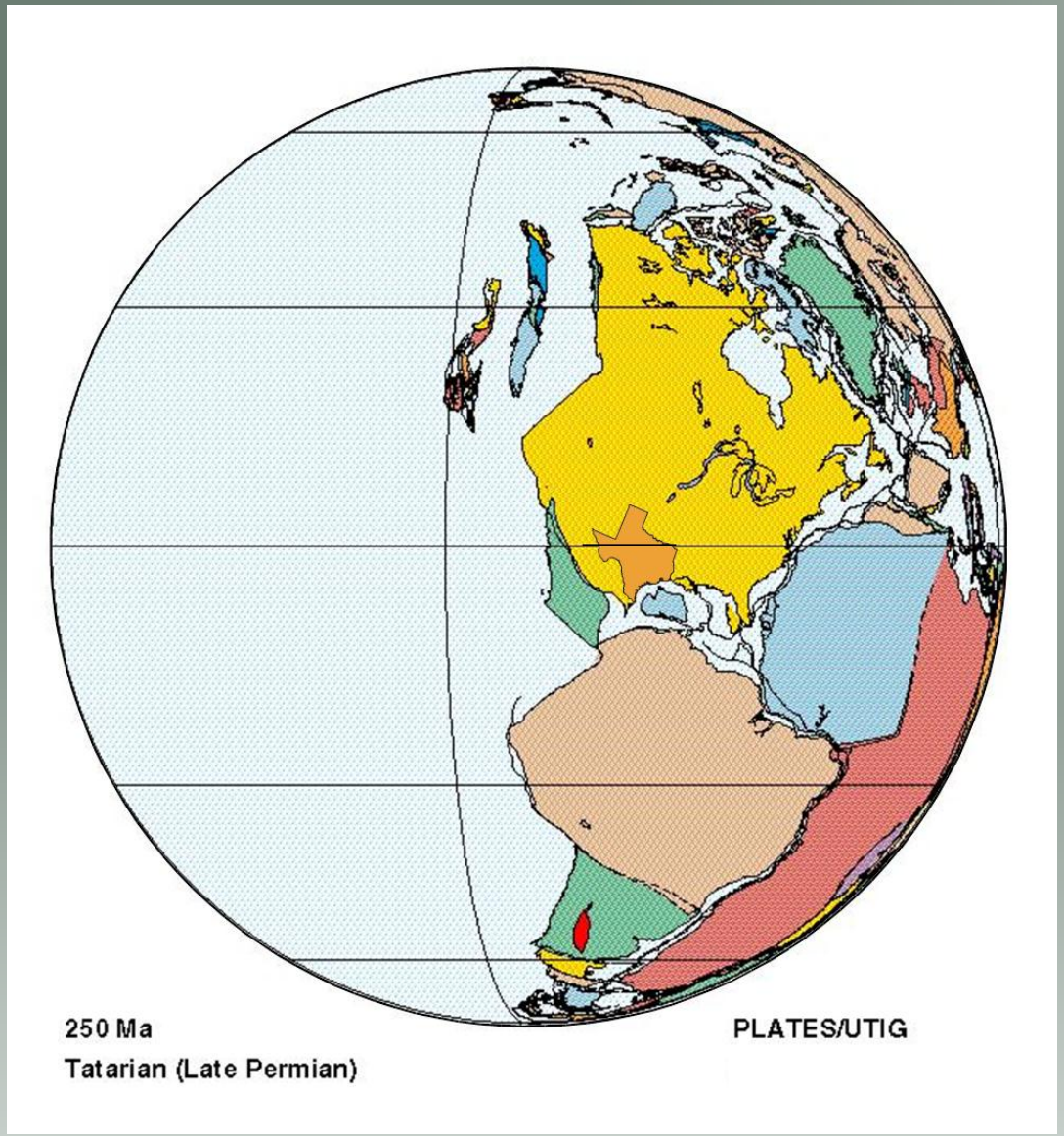
Challenges

⇒No ages!

⇒No composition!

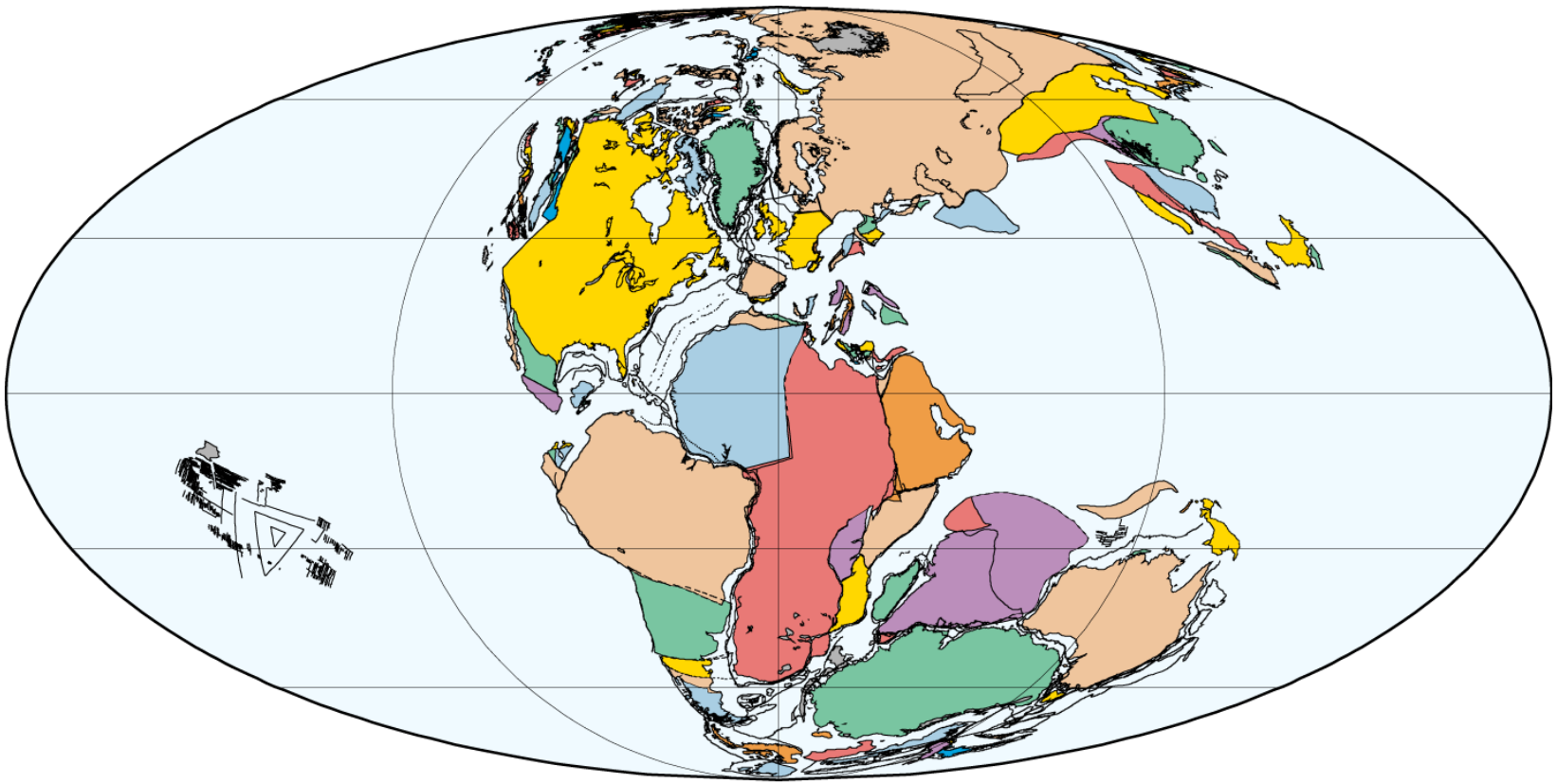
⇒No direct constraint on reconstructing plate motions!





360–250 Ma Pangea

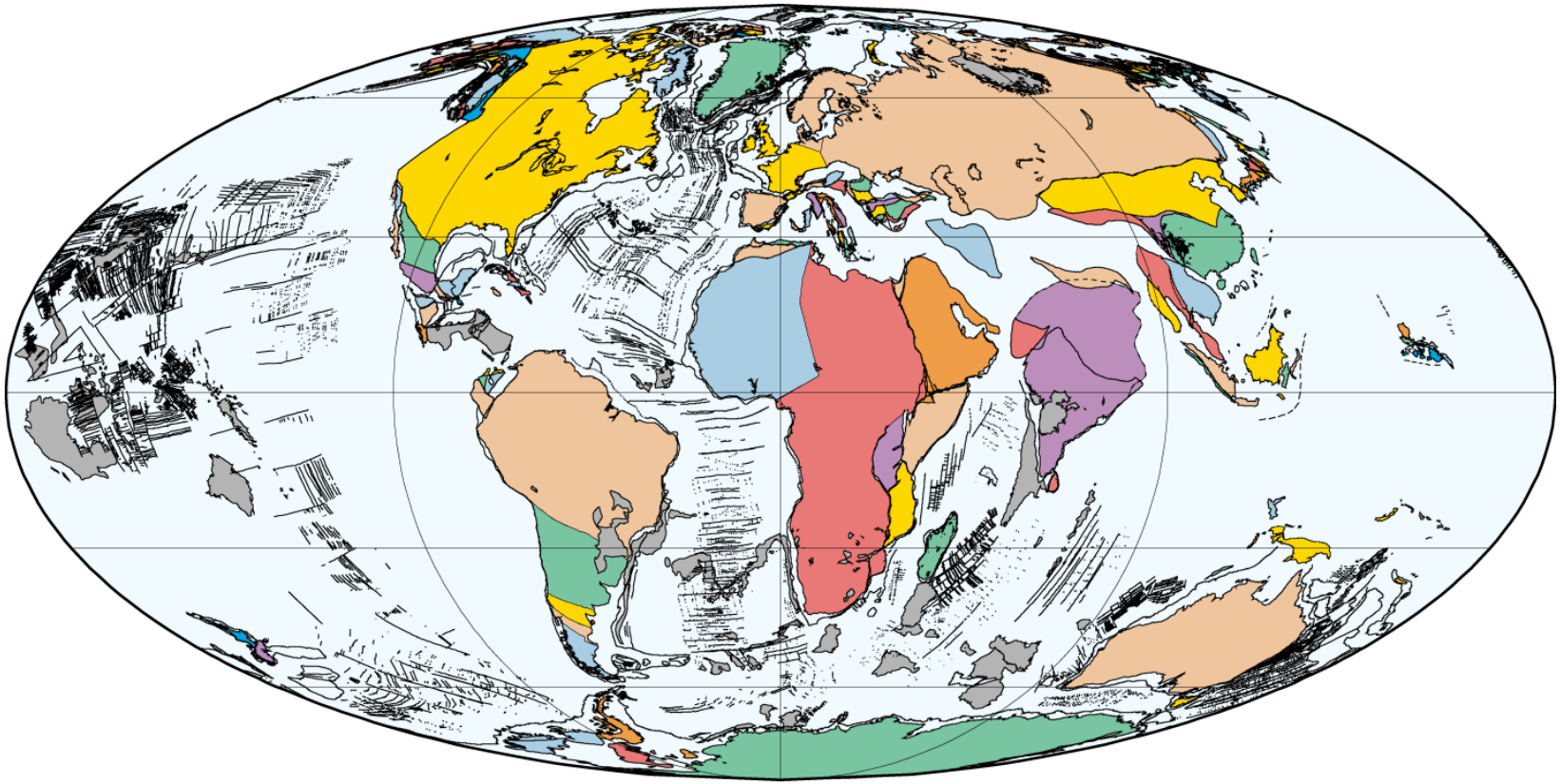
Plates 2002: Lawver et al., UTIG



150 Ma
Volgian (Late Jurassic)

PLATES/UTIG
August 2002

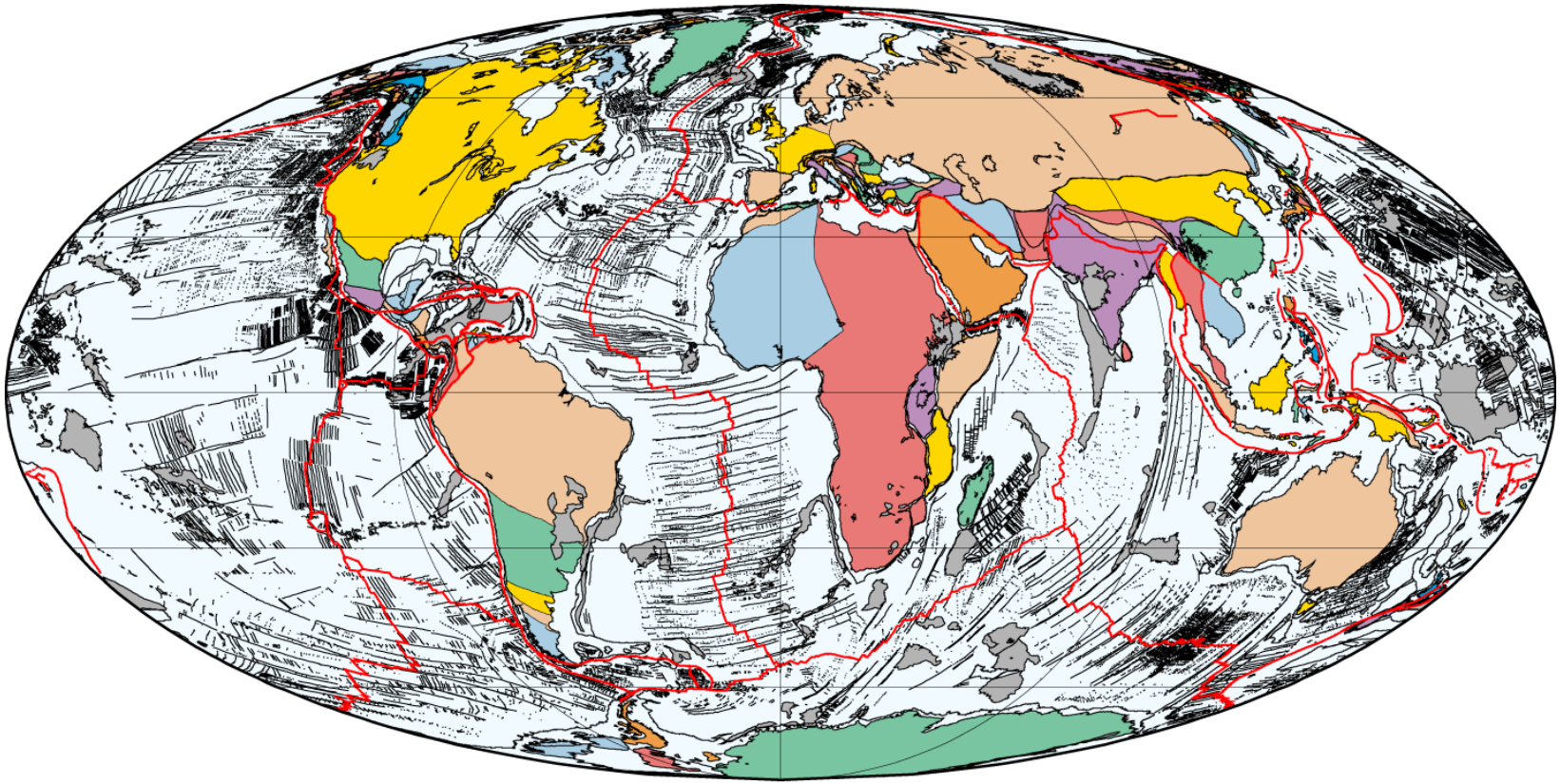
Plates 2002: Lawver et al., UTIG



50 Ma
Early Eocene

PLATES/UTIG
August 2002

Plates 2002: Lawver et al., UTIG

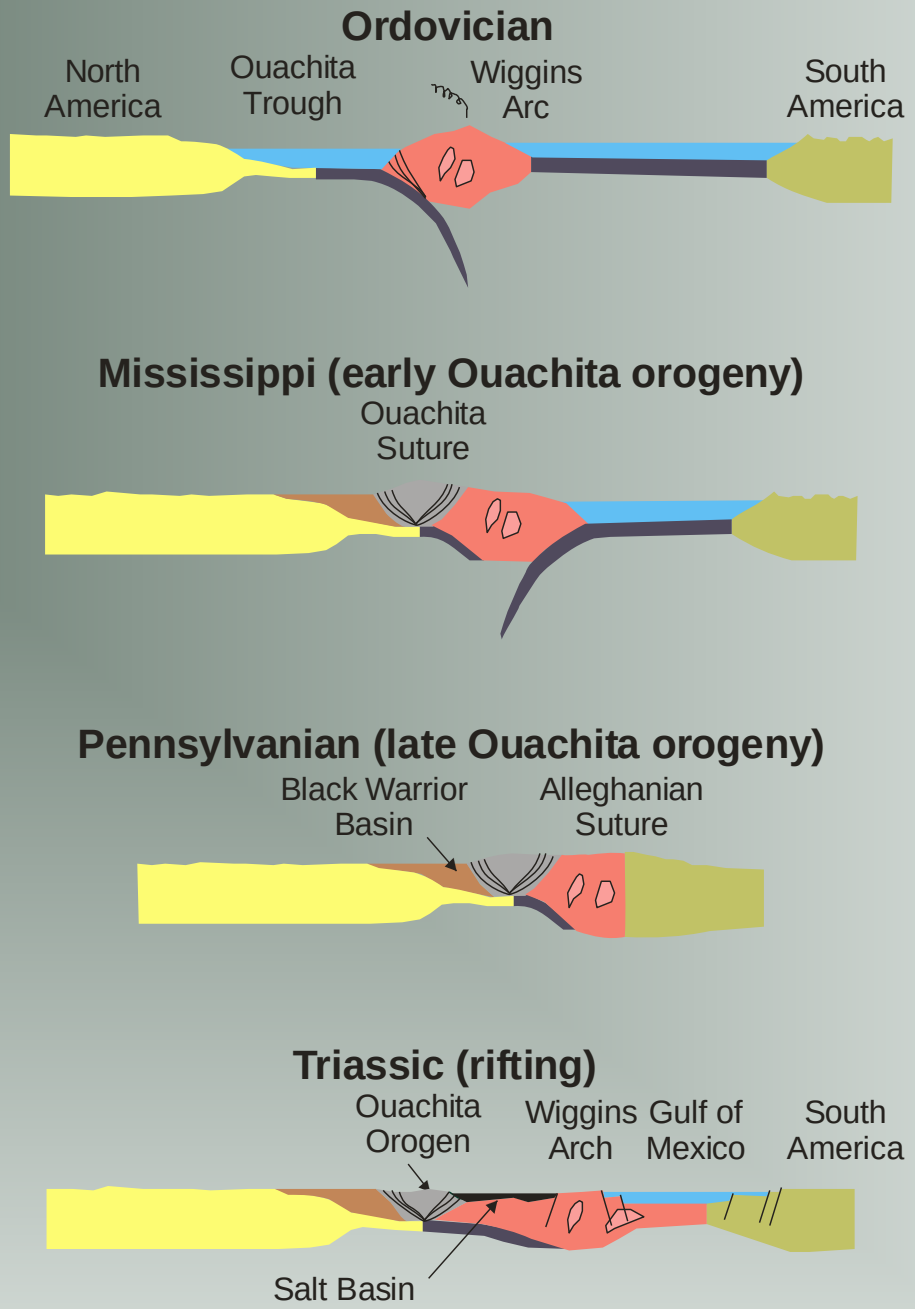


0 Ma
Present Day

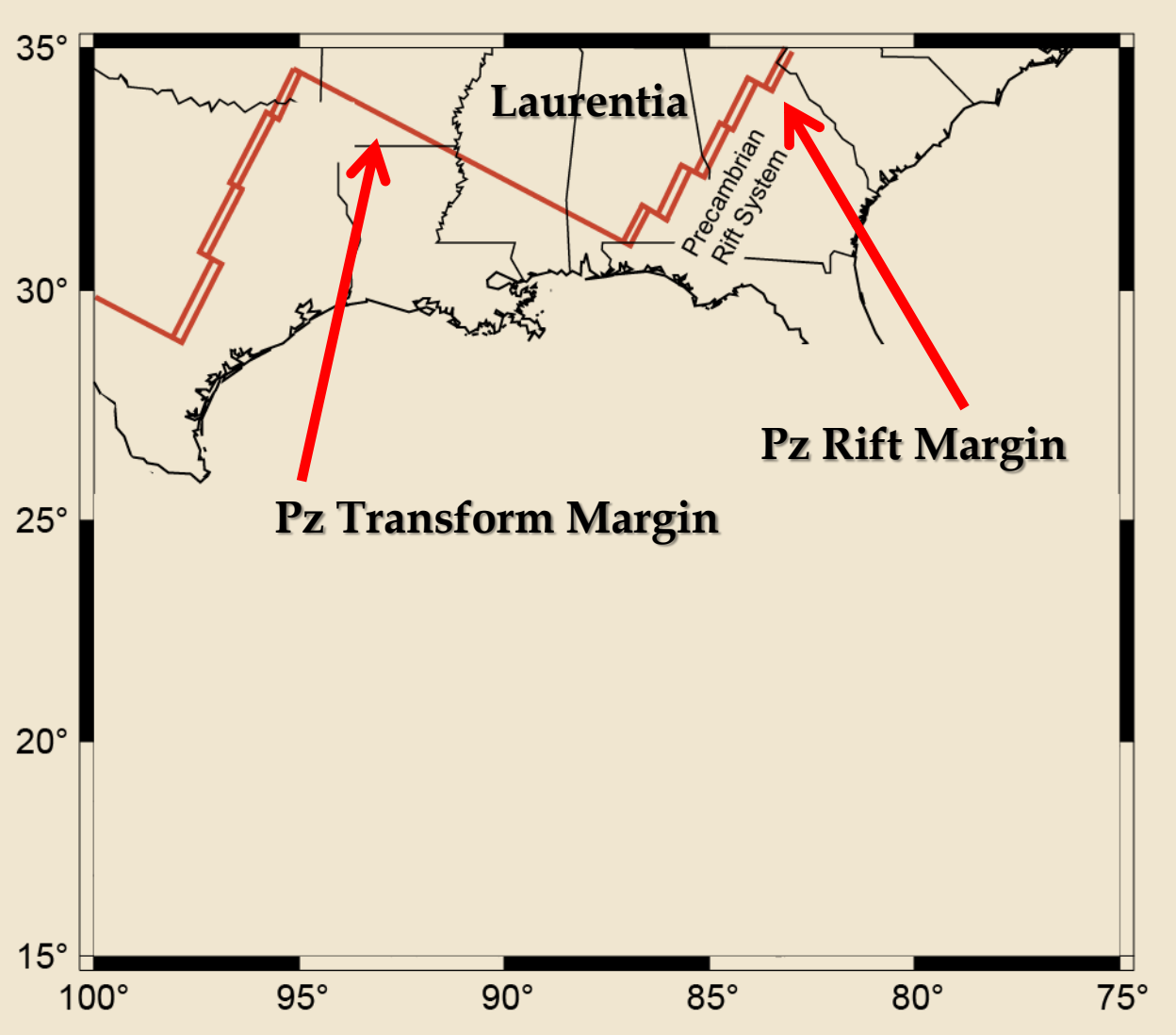
PLATES/UTIG
August 2002

Eastern Ouachitas and Gulf of Mexico

V.E. 2:1



Tectonic Elements of the GOM



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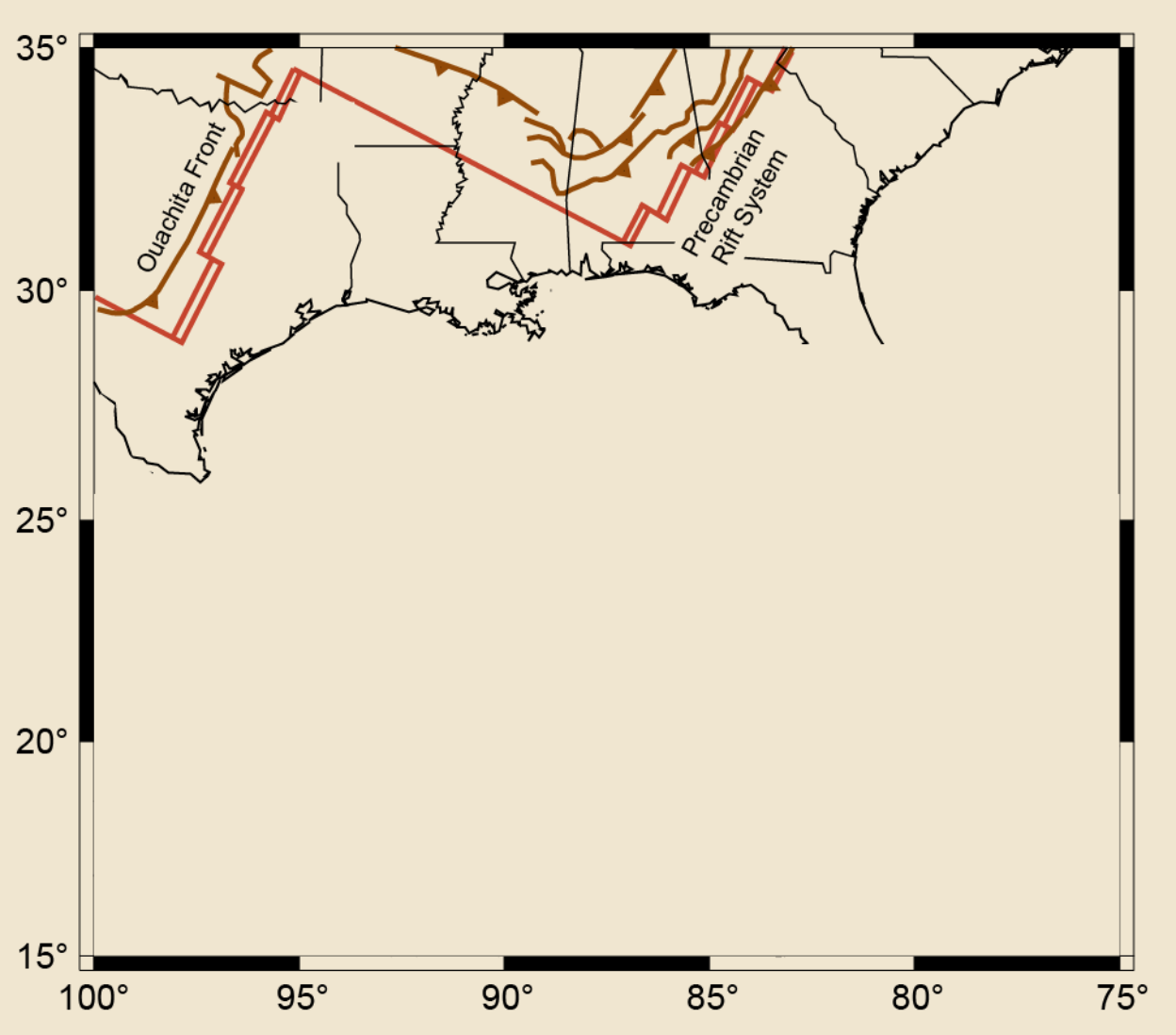

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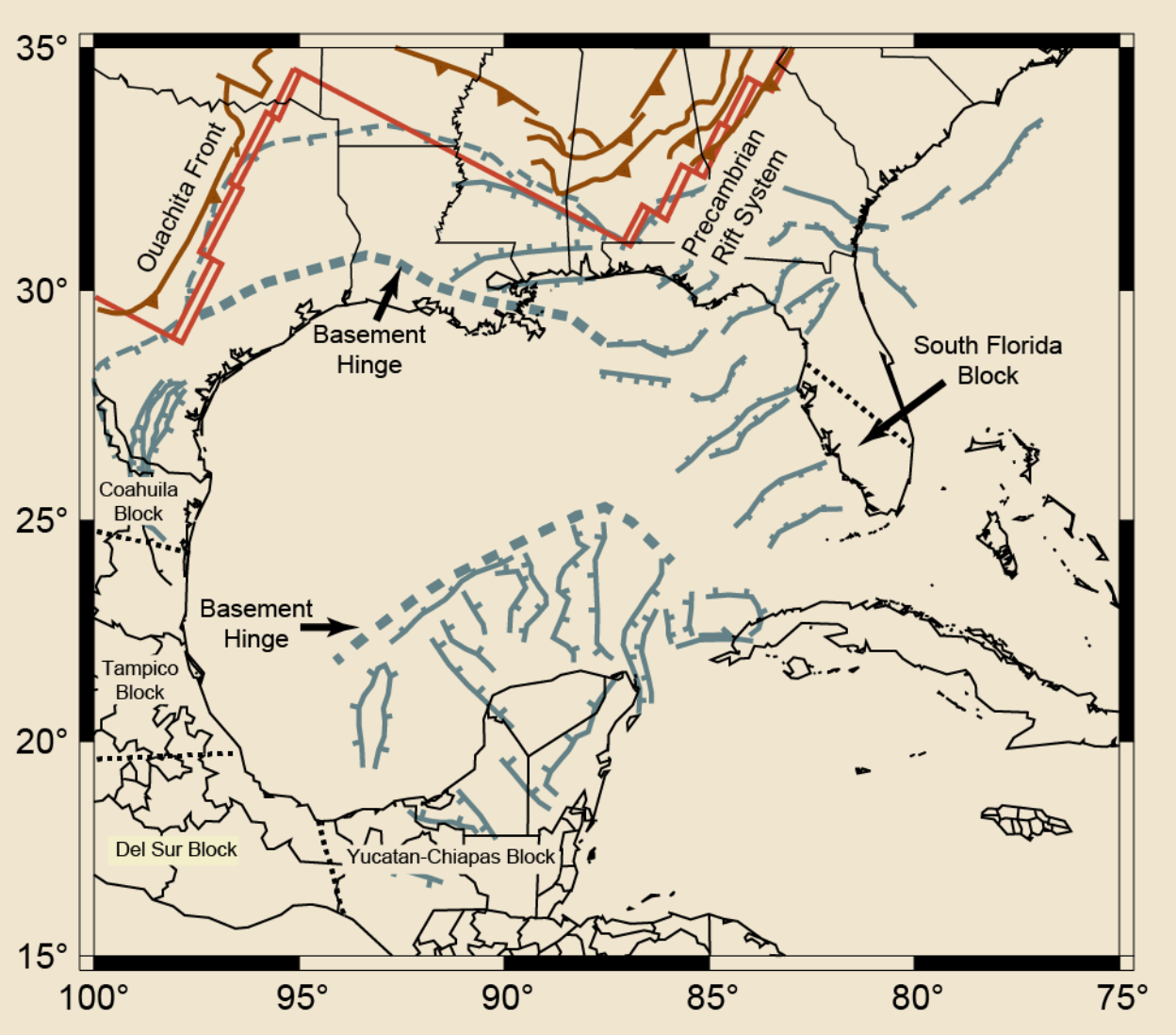

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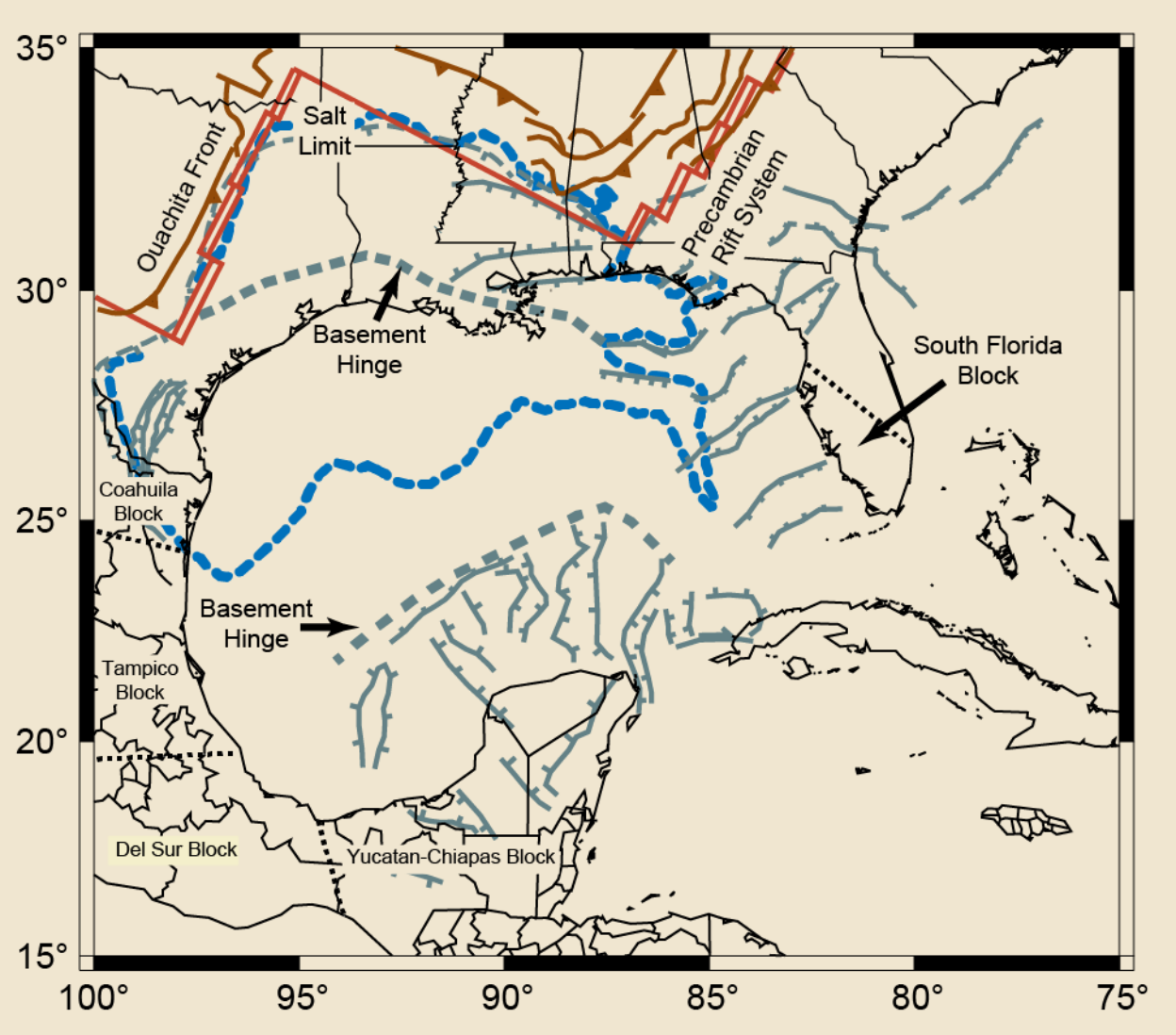

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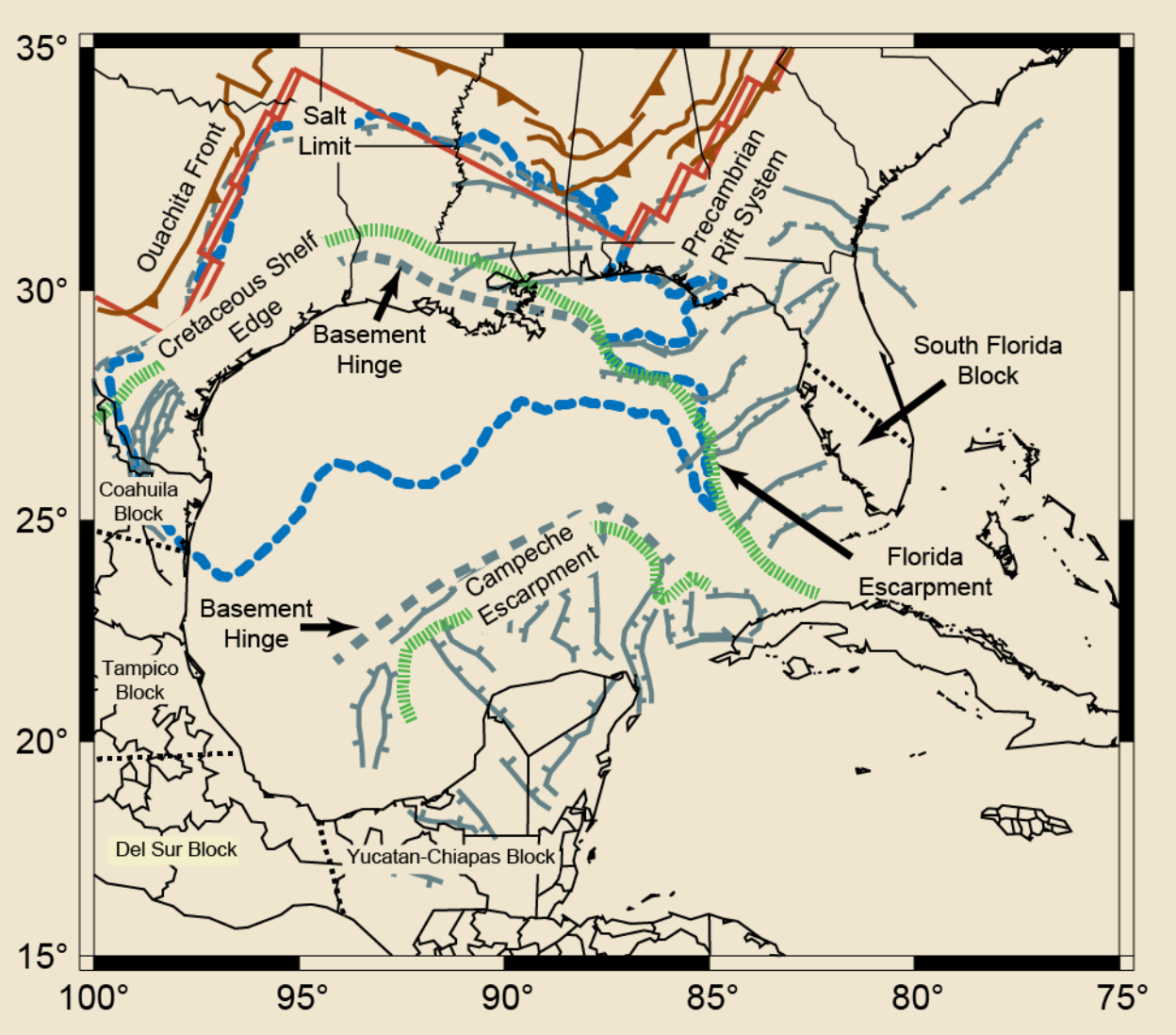

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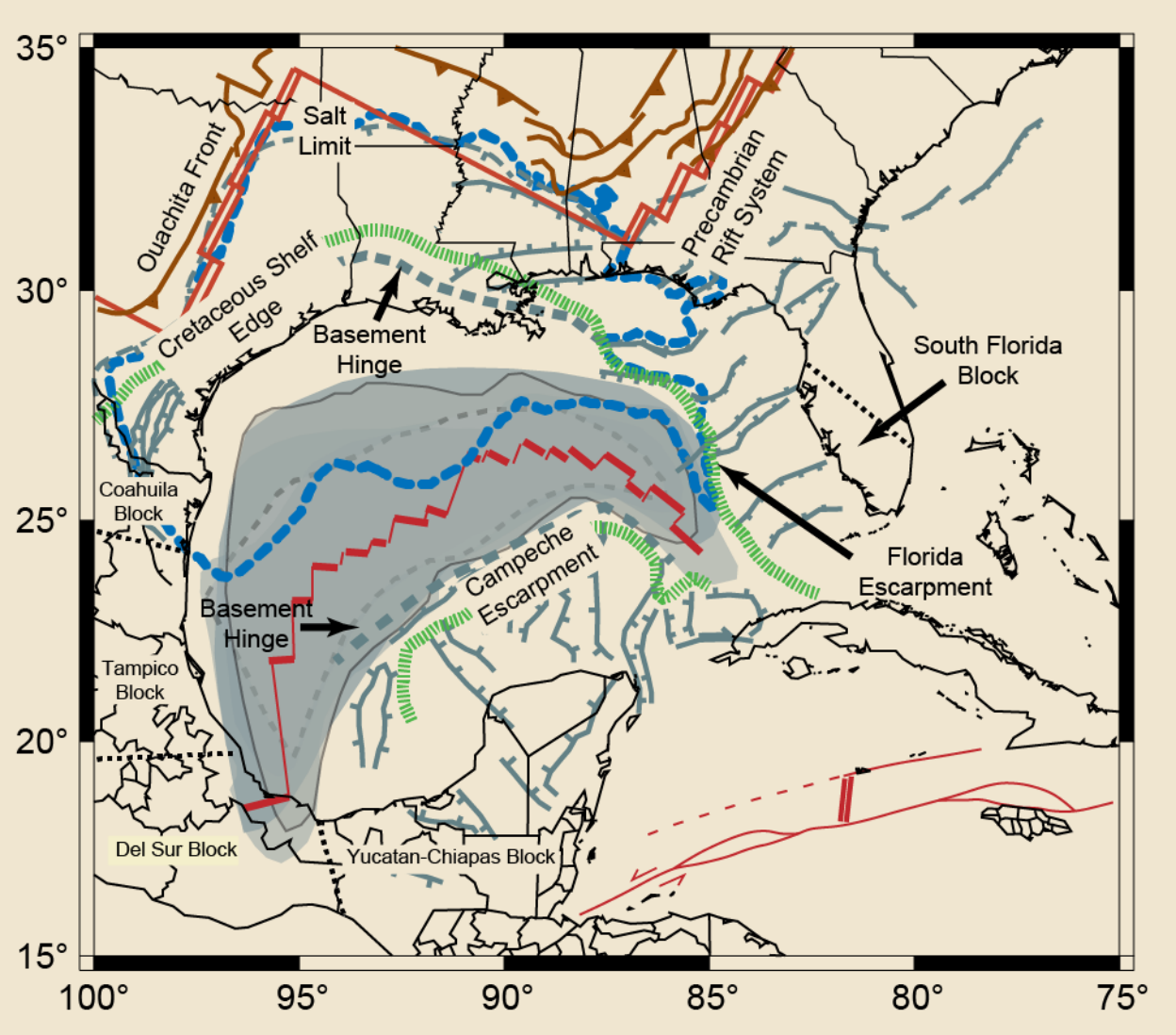

Constraints on Gulf Opening

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Approximate age of onset of rifting (L. Tr. or E. Jr) – dating of redbed deposits in half-grabens surrounding the E, N, NW gulf.

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~450 km extension on S. U.S. Coast

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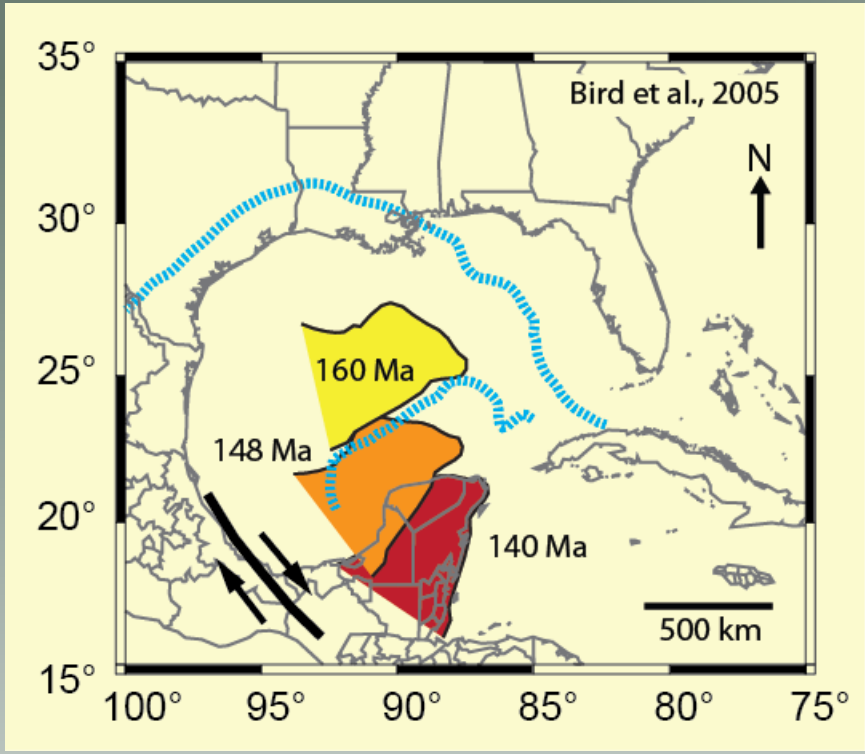
Fit of Pangean continents

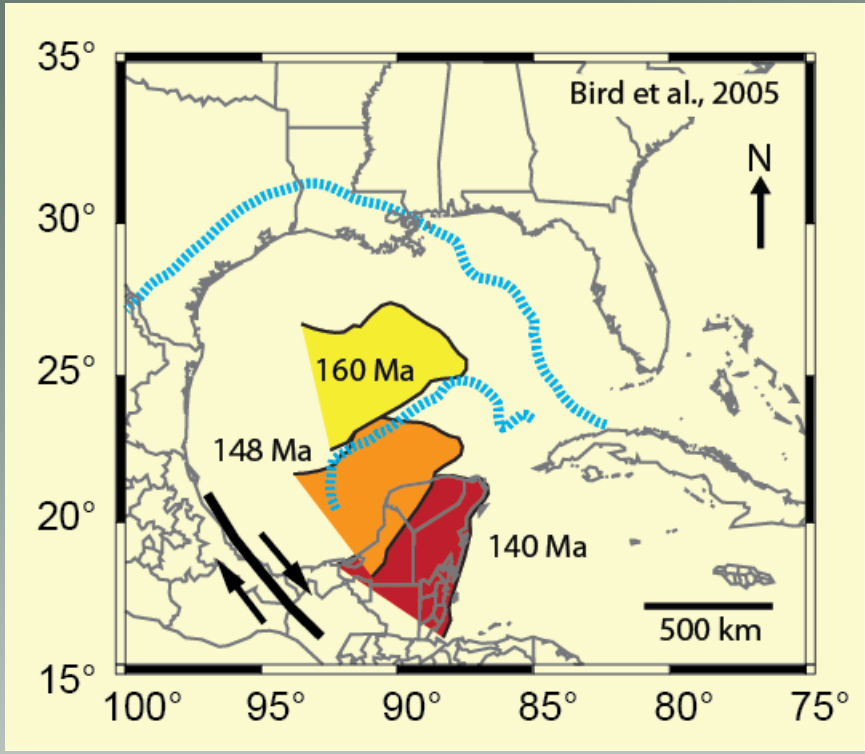
And new data … SFS Anomalies

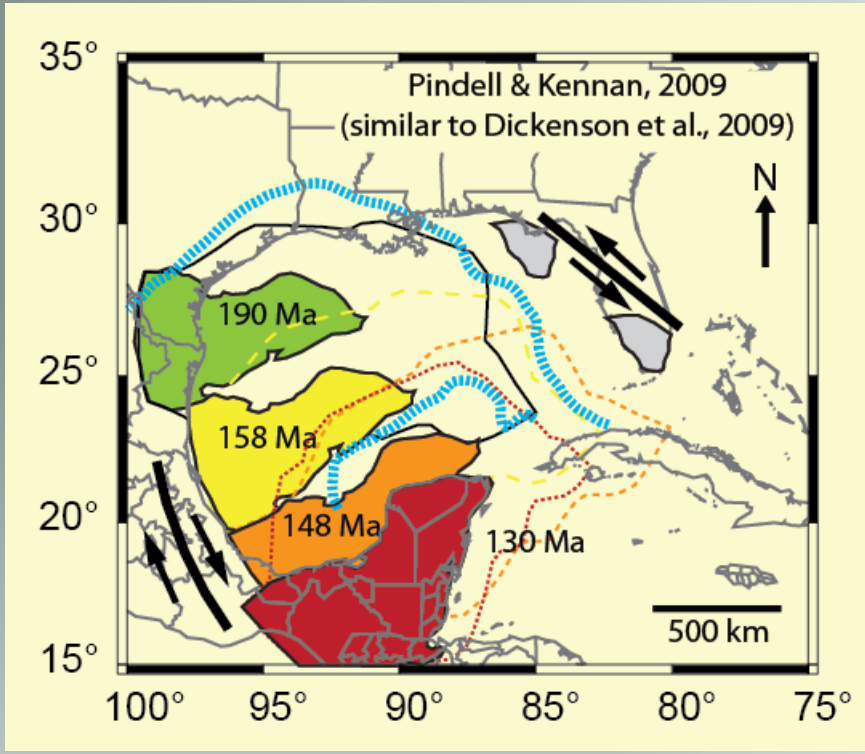
Paleogeography – Central Gulf Origin for Yucatan?



- **Initial Southward rifting**
- **Later counterclockwise rotation**

Paleogeography – Or Western Gulf Origin for Yucatan?





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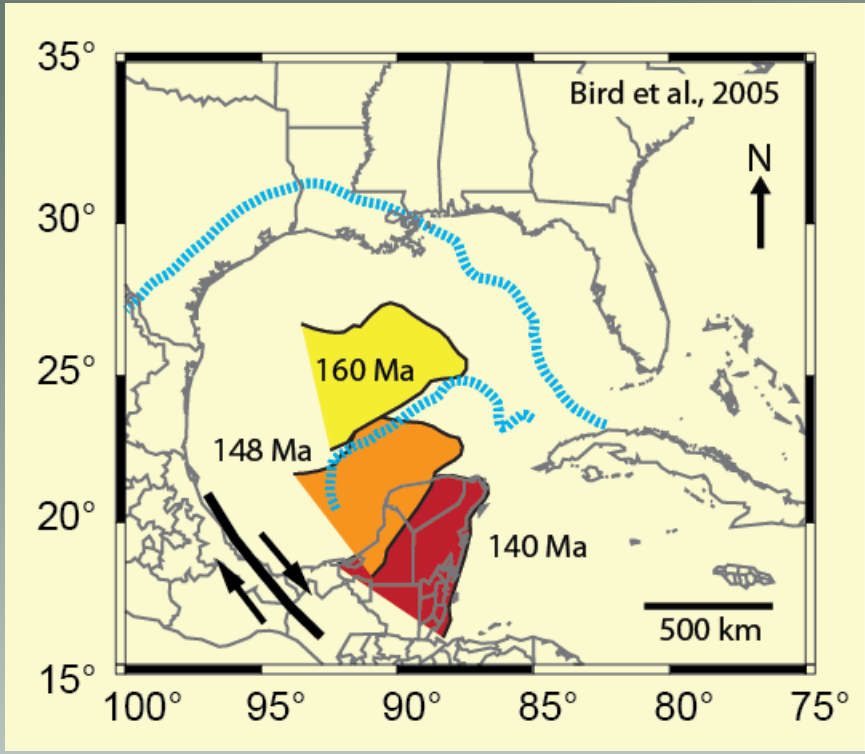
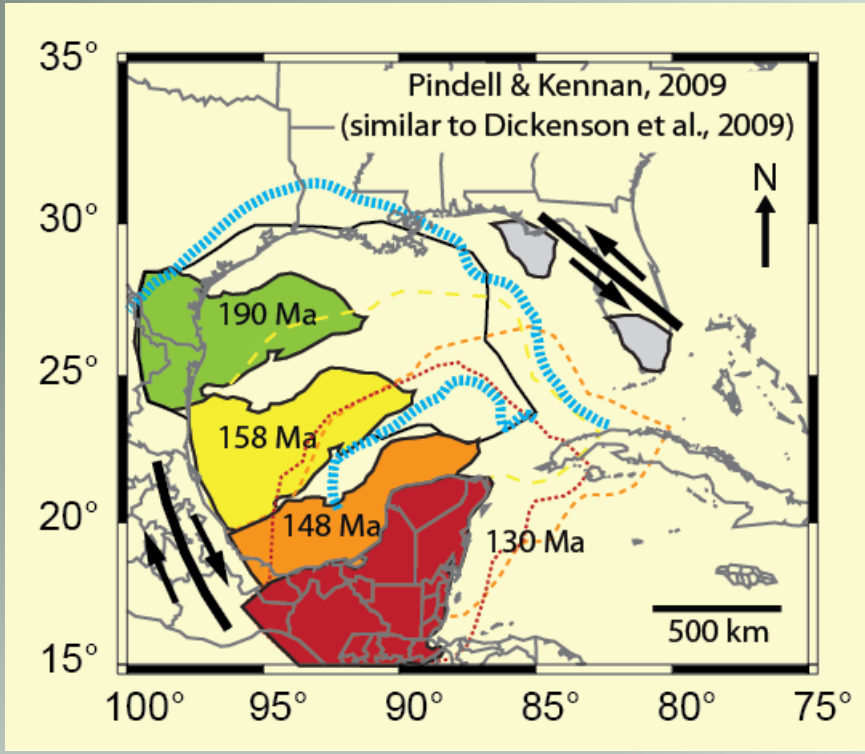
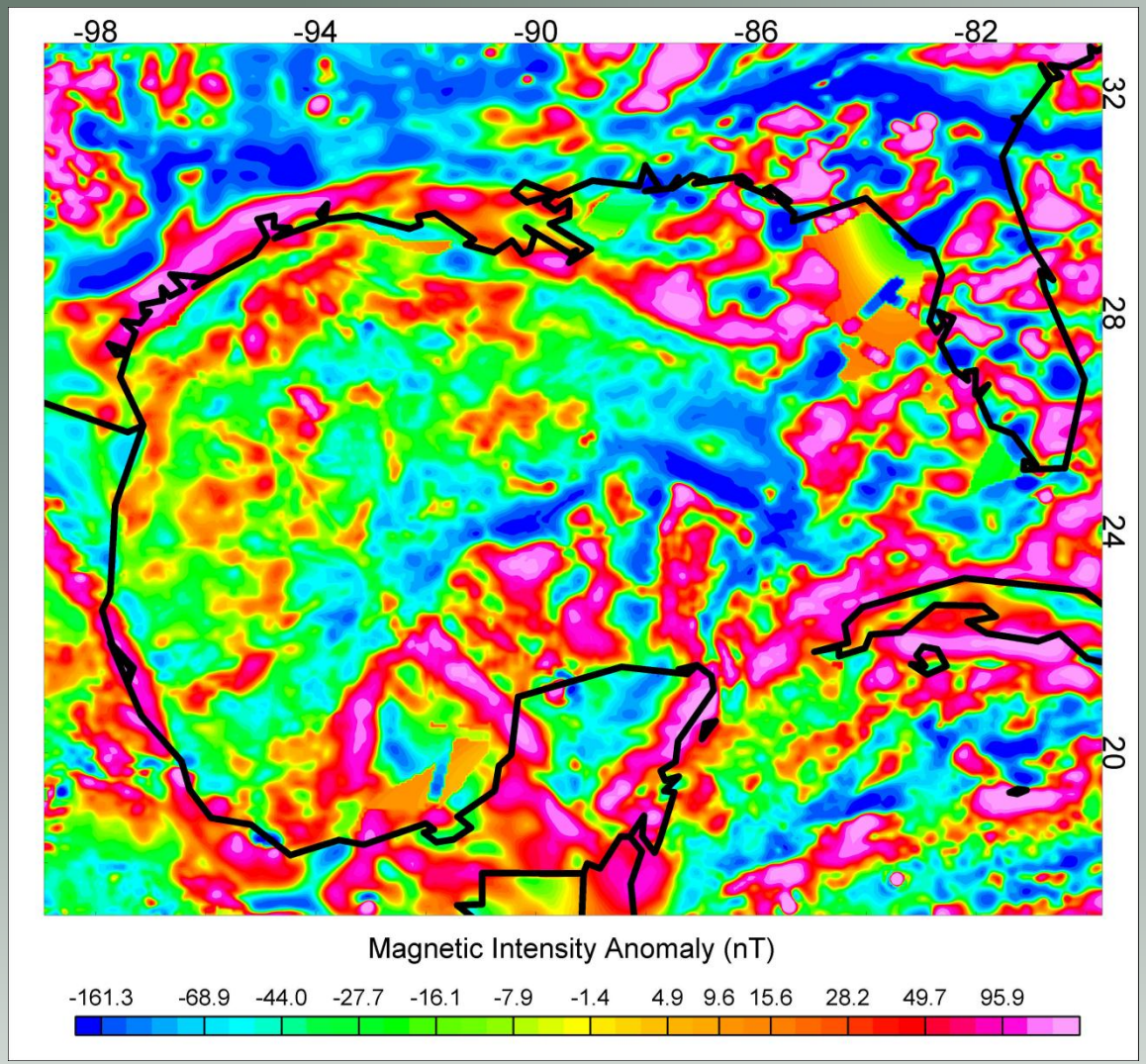


Yucatan starts in central Gulf
(requires rotation pole change)



Yucatan starts in western Gulf
(no rotation pole change)

Reduced to Pole Total Magnetic Field



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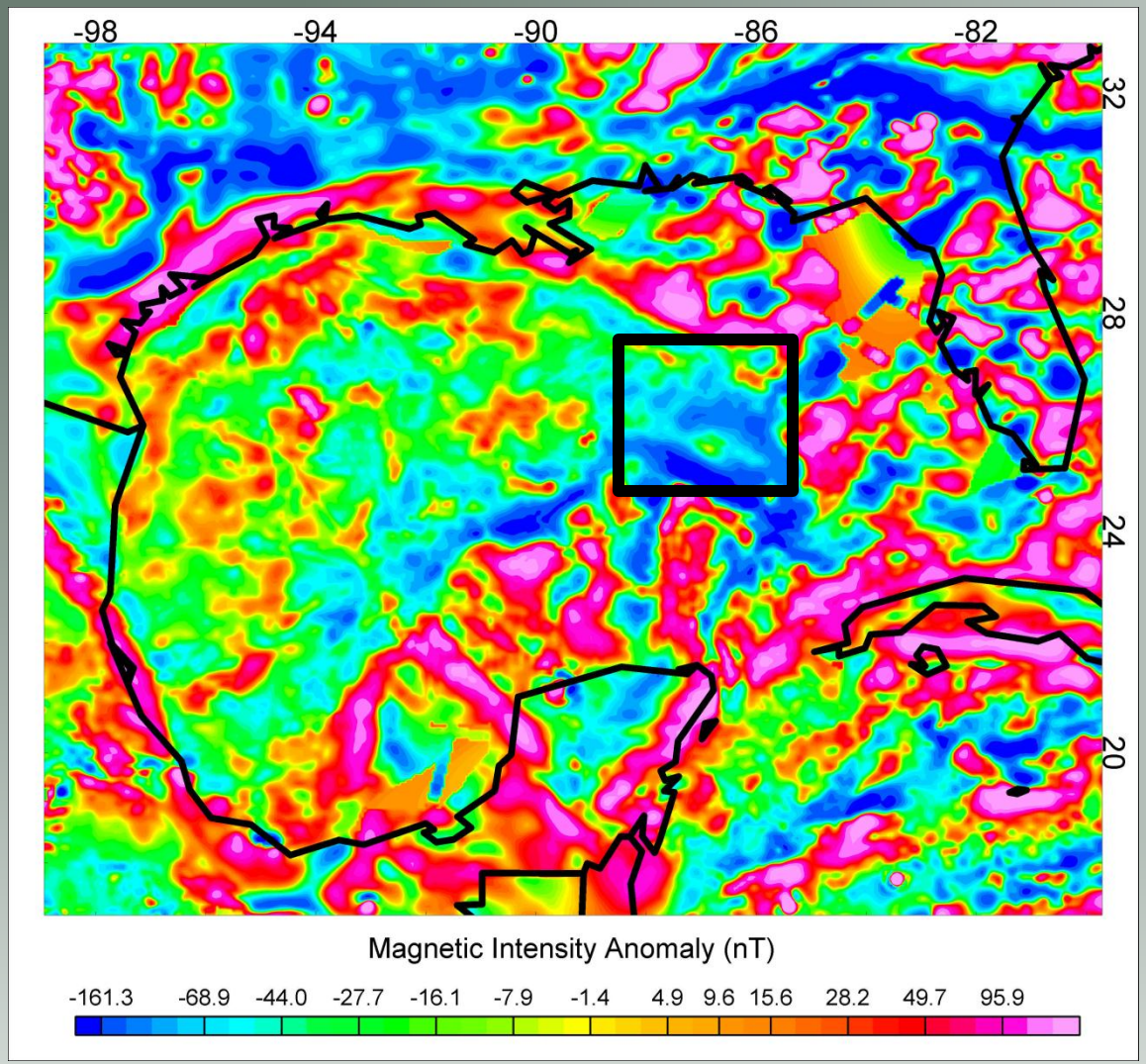
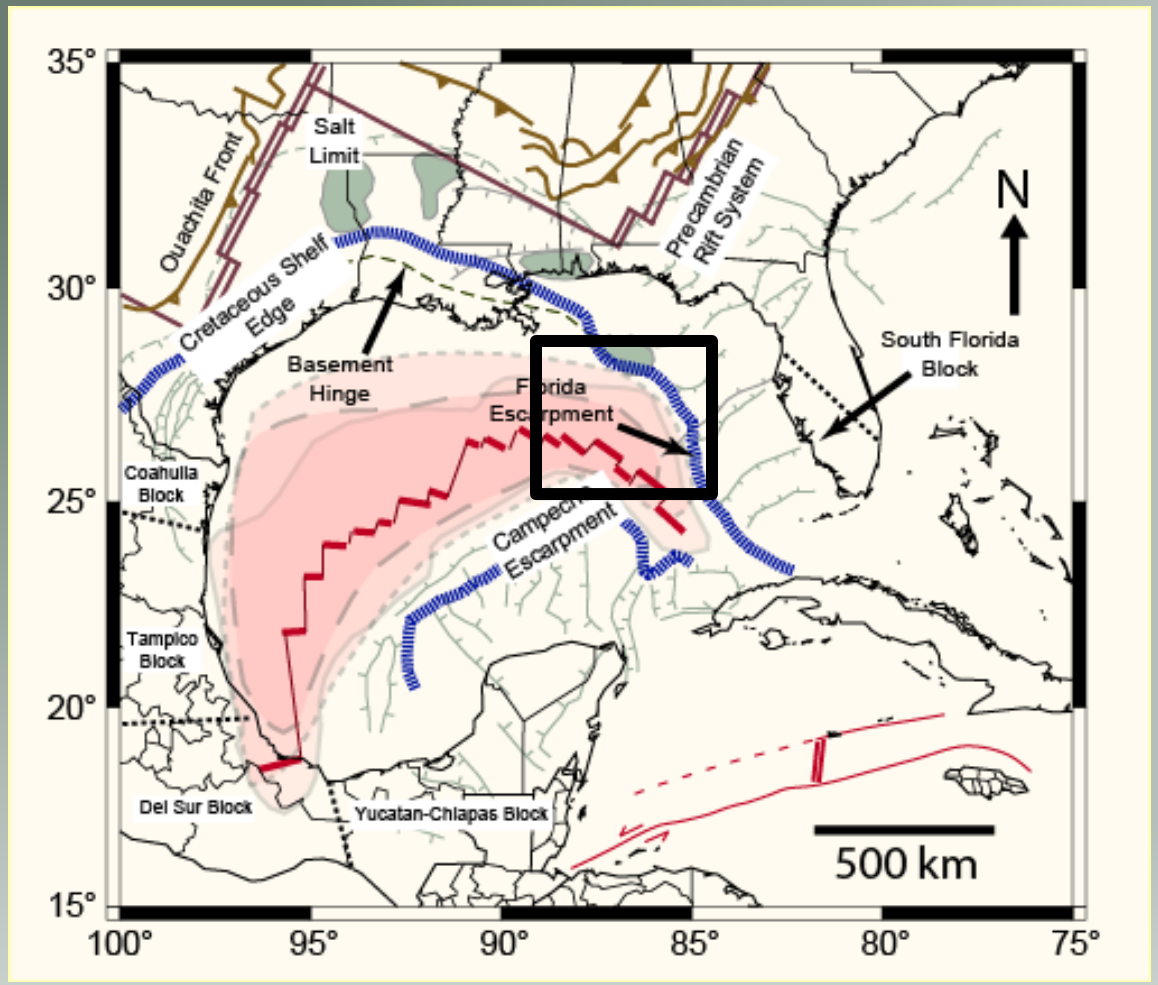
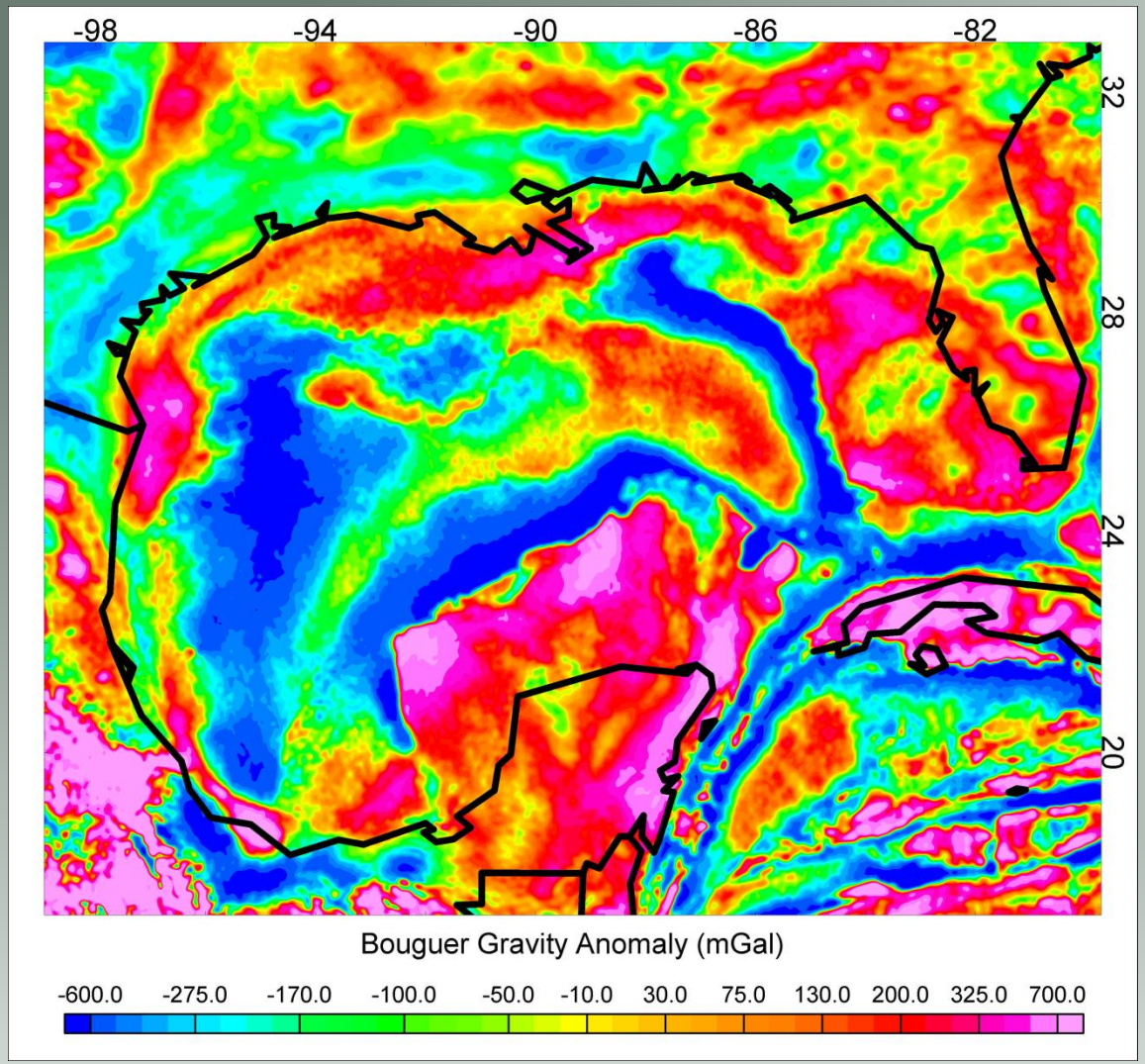
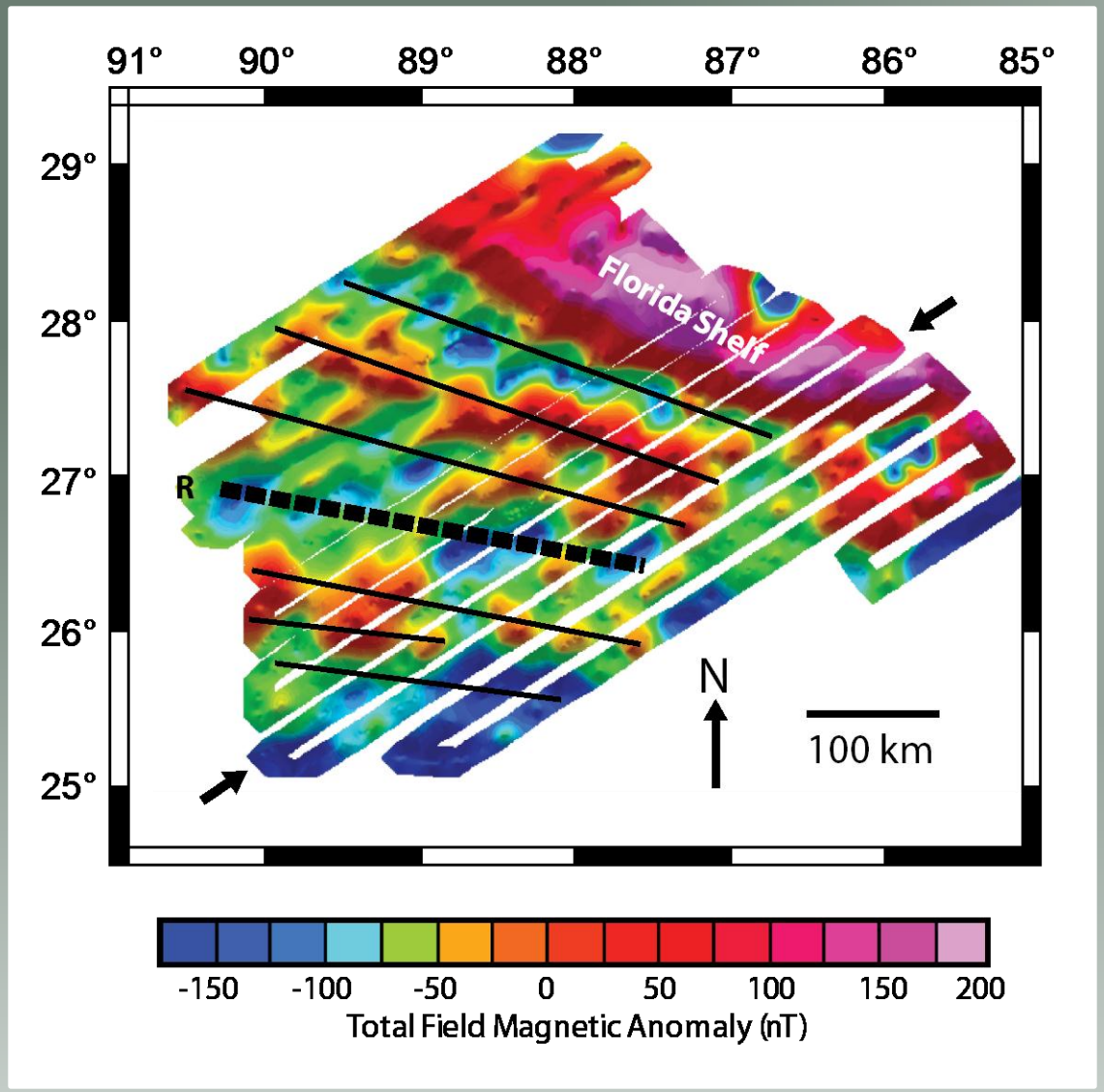


Newly Identified Seafloor-Spreading Magnetic Anomalies



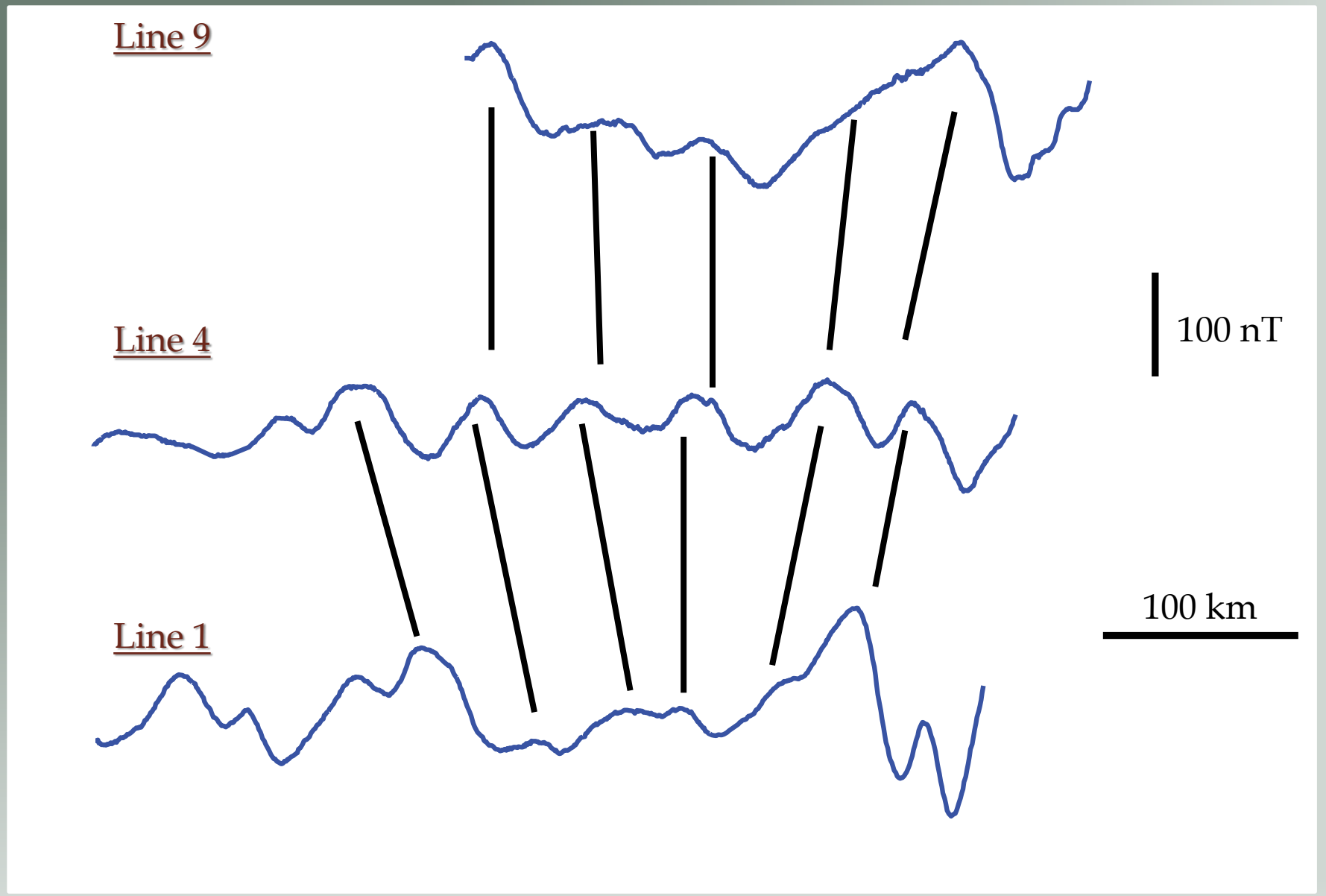
Free Air/Bouguer Gravity Field





Low-Amplitude, Lineated Anomalies

Chron Identification (P&K Model)



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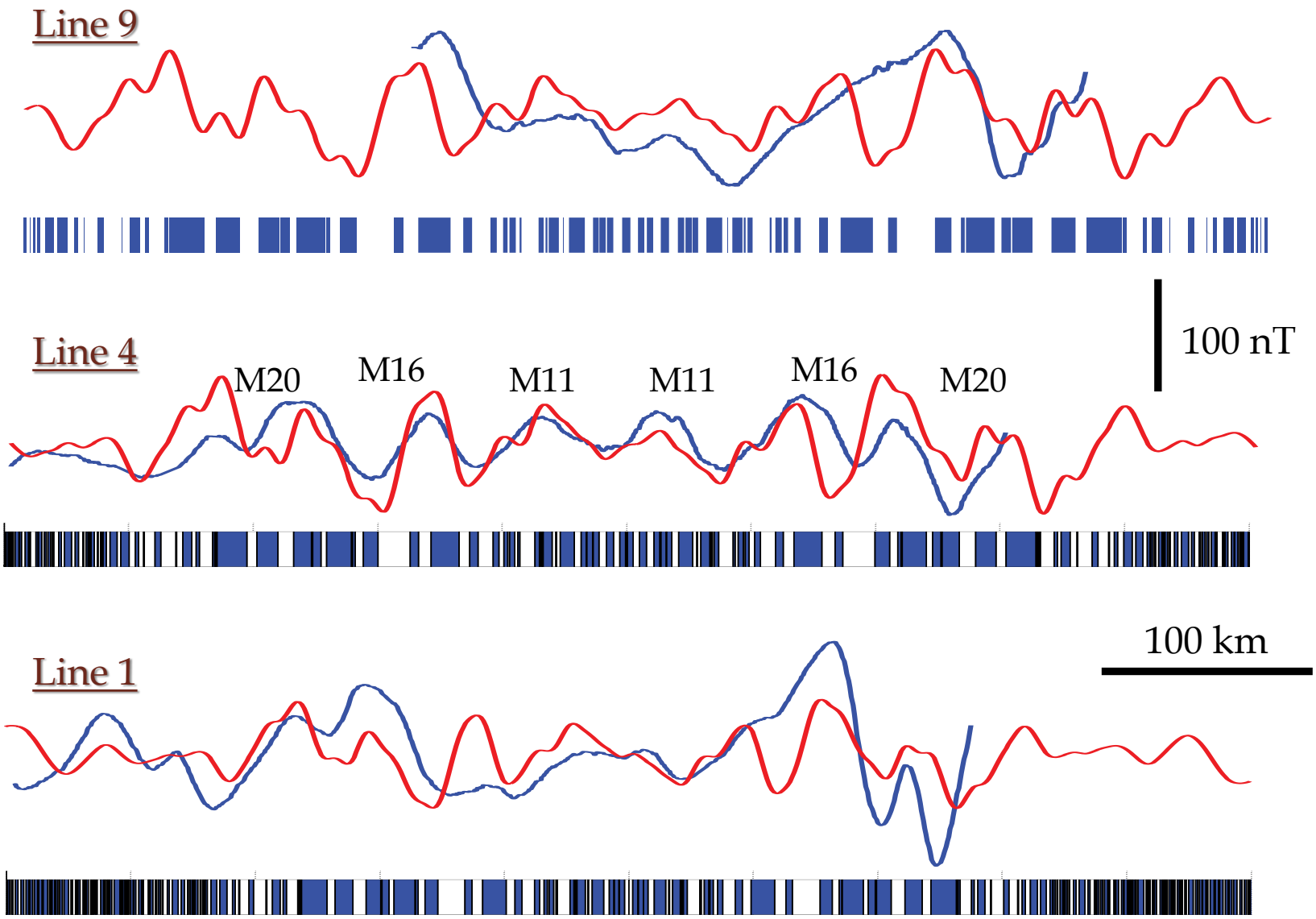
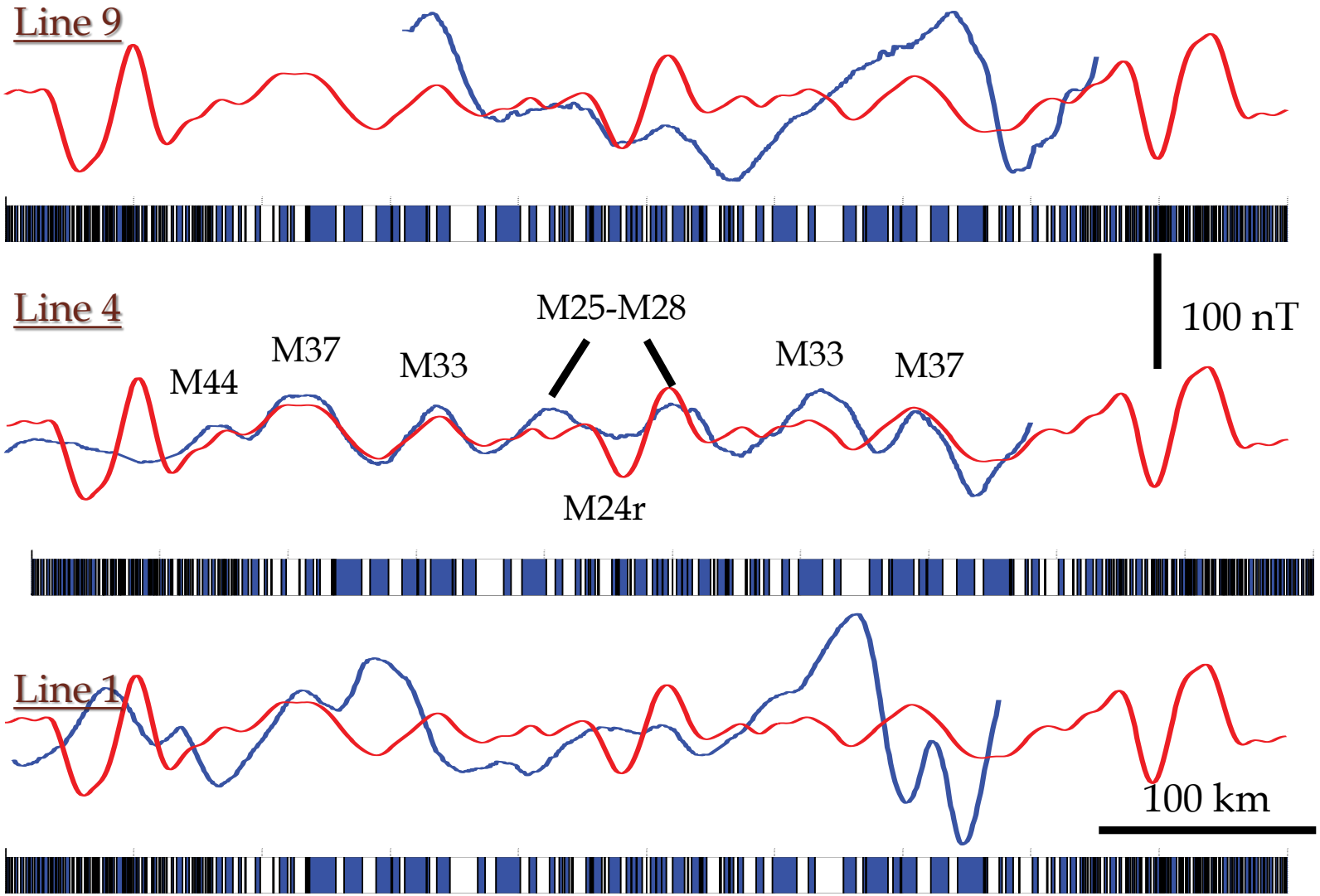
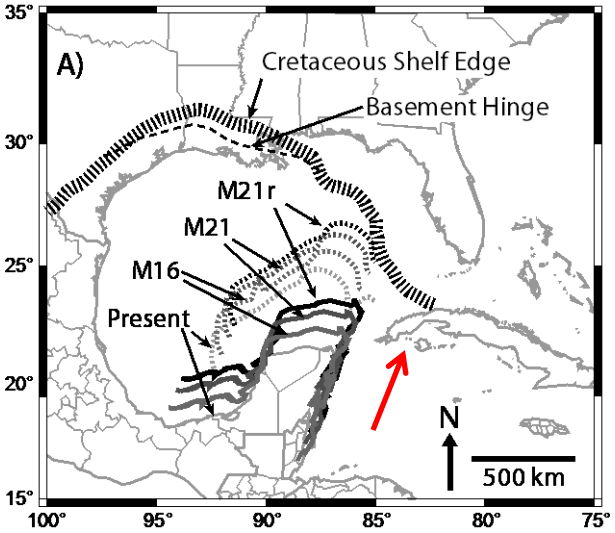


Chron Identification (K&J Model)

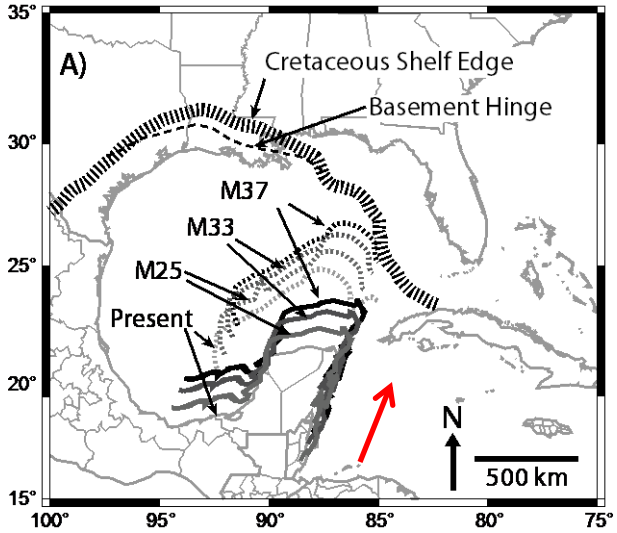


Closing the Eastern Gulf

148-133 Ma



154-170 Ma

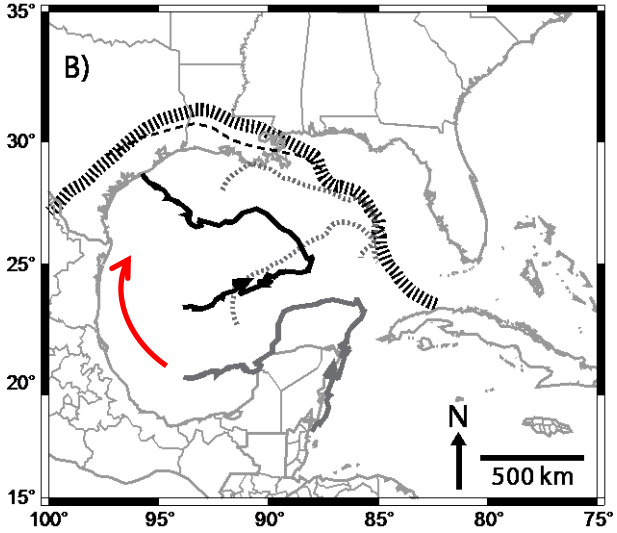


P&K Model

K&J Model

Rotation of Yucatan

E. Jr. – 148/154 Ma



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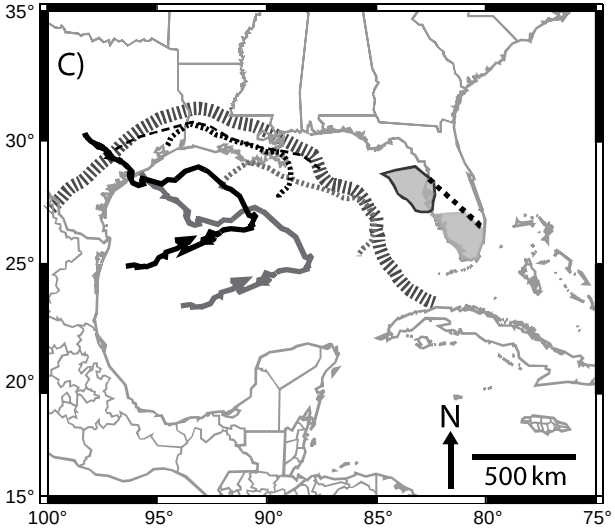

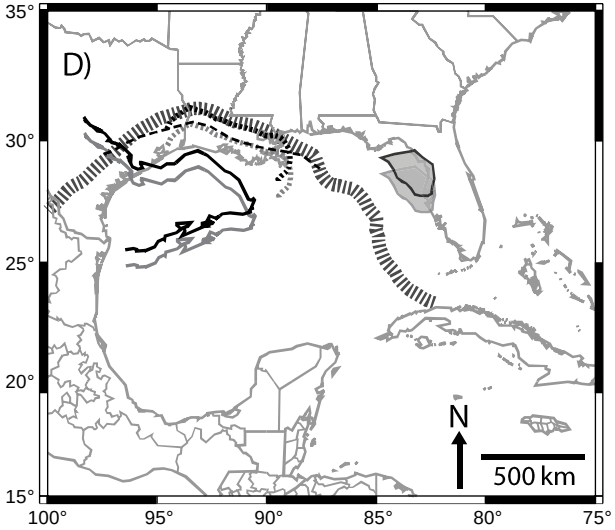

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- Exhumed mantle (low-angle detachment fault, e.g., Iberia/Newfoundland?)

SUMMMARY

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  - **PHASE III (148-134 Ma? Or ~170-154 Ma) – Near Orthogonal spreading between Yucatan and Florida**