An Optimized and Focused Lithospheric Deformation Model for Reconstructing the Mesozoic Evolution of the Gulf of Mexico Basin

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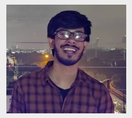
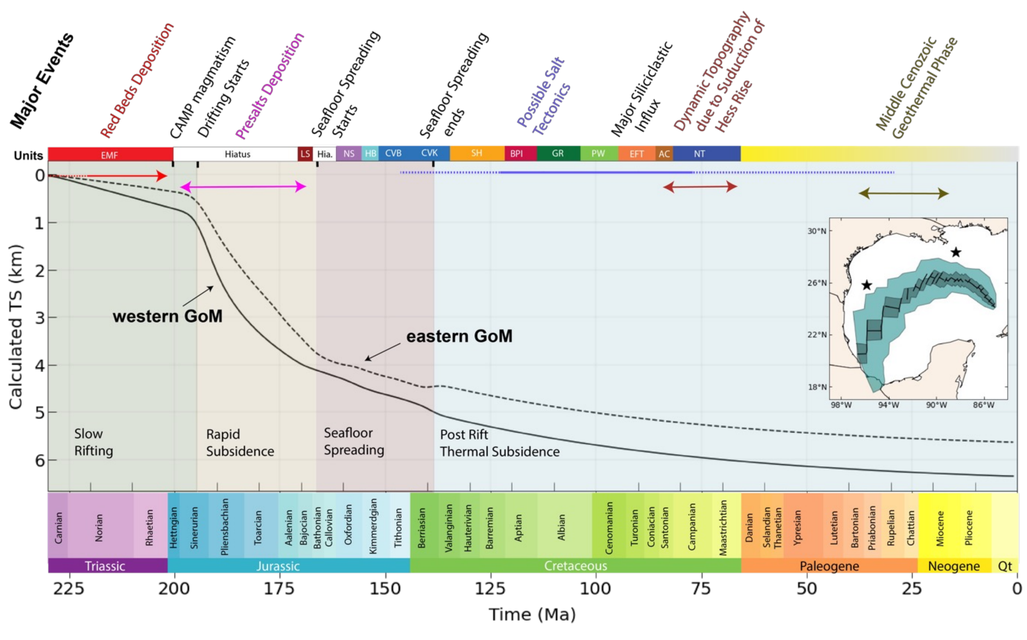
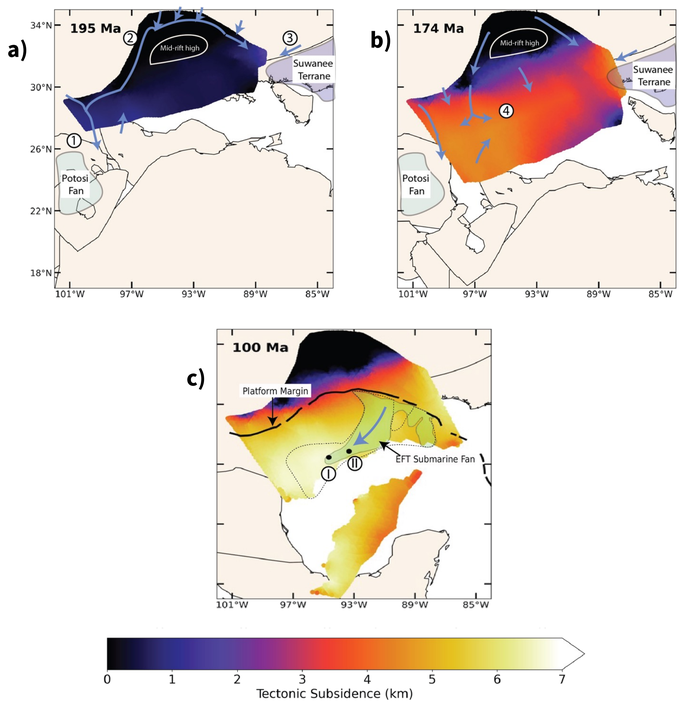


Highlights

- An optimised deformable plate model for Gulf of Mexico (GoM) is introduced that dynamically adjusts stretching factor during rift evolution.
- The ~40 Myrs gap in northern GoM's Mesozoic strata is due to rapid subsidence, shifting red bed deposition beneath Jurassic salt formations.
- The GoM basin transitioned from a magma-rich to a hyperextended margin with possible mantle exhumation.
- The westward deflection of the Cenomanian-Turonian sandy submarine fan is a result of increased differential tectonic subsidence from eastern to western GoM and may extend further west.

Graphical Abstract





Tectonic subsidence (TS) calculation from our model shows four stages can be used to describe the tectonic evolution of the GoM basin.

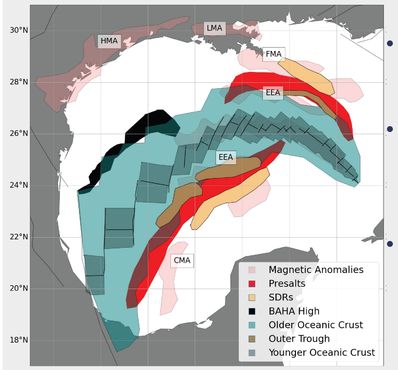
1. Slow rifting Phase: A small amount of tectonic subsidence creates accommodation for infilling the GoM basin with red beds. Sediment routing in **(a)** are based on detrital zircon geochronology analysis (Snedden & Galloway, 2019).

2. Rapid Subsidence Phase: A rapid subsidence followed which resulted in 3-4 km of subsidence. Sedimentation was a continuous process but due to this rapid subsidence, the red bed deposition shifted further south near the Yucatán margin beneath Jurassic salts **(b)**.

3. Seafloor Spreading Phase: The seafloor opening starts first, in the western GoM, followed by the eastern GoM. The evolution of crustal architecture was completed by the end of this phase.

4. Post-Rift Thermal Subsidence Phase: The last stage is marked by conductive cooling of the lithosphere resulting in gradual tectonic subsidence. The westward deflection of Cenomanian-Turonian Eagle Ford-Tuscaloosa (EFT) sandstones might be influenced by the differential tectonic subsidence in east to west direction **(c)**.

Major unresolved issue with GoM's Mesozoic history



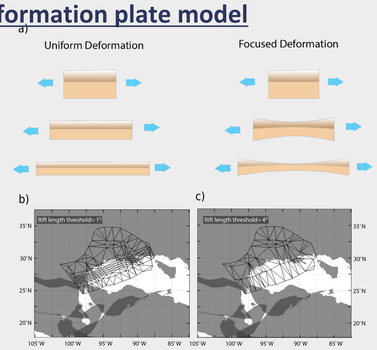
- *Ambiguous model for pre-salt sedimentary strata formation.*
- *Seaward dipping reflector and high magnetic anomalies suggests magma rich margin.*
- *Analogue rock properties of EEA matches peridotite which suggest mantle exhumation, hence a magma poor margin.*

Uniform vs focused deformation plate model

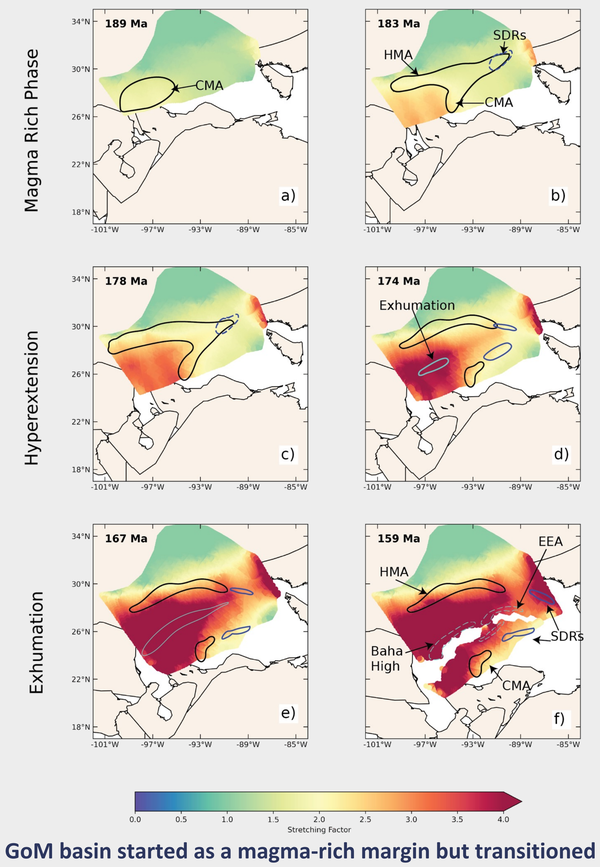
Our method allows for the control of the spatial variation of strain rate in a rift profile using different parameters.

Our model can be used to calculate:

- *Crustal thickness,*
- *Crustal stretching and thinning,*
- *Tectonic Subsidence in deep time.*



Summary of the evolution of the GoM crustal architecture.



➢ **The GoM basin started as a magma-rich margin but transitioned to a hyperextended margin with possible mantle exhumation before seafloor spreading.**