

Geological and Geophysical Constraints Guide New Tectonic Reconstruction of the Gulf of Mexico

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Abstract

The Gulf of Mexico is a prolific petroleum basin with more than a century-long exploration history. Tectonic models proposed for the basin vary dramatically in many aspects, ranging from the pre-rift locations of the crustal blocks, the timing of the break-up to even the order of tectonic events. The reason for these disagreements is in a thick and complex overburden that obscures seismic imaging of crustal structures. To overcome that, we integrated seismic data with gravity and magnetic fields to determine the crustal architecture in different parts of the basin, as well as to map the location of the key tectonic features. The subsequent spatial analysis of potential fields allowed us to trace the tectonic structures outside of seismic coverage. As a result, a set of new geological constraints was derived including the Triassic rifts, regions of Seaward Dipping Reflectors (SDR), and Jurassic pre-salt sedimentary basins in the eastern Gulf of Mexico and along the Yucatan margin, and two distinct crustal zones in the oceanic domain.

We ensure the pre-breakup alignment of the crustal blocks based on the mapped geological features on the conjugate margins. Our tectonic reconstruction takes into account an apparent temporal variability of the magmatic regime during basin formation that ranged from CAMP (~200 Ma) to an ultra-slow amagmatic spreading during the initial stage of the GoM opening (~ 165 Ma). Our reconstruction also includes a major ridge reorganization (~ 152 Ma) associated with increased magmatic supply. This second phase of oceanic spreading ceased at early Cretaceous (~ 135 Ma) based on published correlation analysis of seismic and well data. Overall, the tectonic reconstruction presented here takes into account previously known and newly derived geological constraints and integrates various geophysical datasets, namely seismic, gravity, and magnetics.