New Observations Suggest the Need for Revised Tectonic Reconstructions of the Gulf of Mexico

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Abstract

Tectonic history of the Gulf of Mexico (GOM) remains poorly understood despite more than a century long exploration activities and colossal number of datasets acquired to study the basin. The recent lift of the exploration moratorium by the Mexican government lead to multiple seismic campaigns in the southern GOM that have revealed a series of new facts challenging the majority of accepted tectonic models of the basin: The seaward dipping reflectors (SDRs) are evident in seismic data in the Yucatan margin, although the SDR province is not adjacent to oceanic crust. Instead, there is a pre-salt sedimentary basin between oceanic crust in the north and the SDR province to the south. A similar SDR province bounding pre-salt basin has been mapped in the northeastern GOM. Integrated geophysical analyses in both southern and NE GOM suggested magmatic origin of the rocks within SDR provinces, which is consistent with findings from the old DSDP well drilled in the northeastern Yucatan. The pre-salt sedimentary basins are undoubtedly mapped from seismic data along the western Yucatan margin, but are absent in the NW and central GOM - the regions that are considered to be conjugates by the majority of currently accepted tectonic models. The pre-salt sediments are imaged in seismic data in the NE GOM. Uncontrolled, salt-supported downward flow of the post-salt Jurassic section is concluded from seismic in the northern Yucatan. As this local depocenter is coeval with adjacent newly formed oceanic crust, the thermal isostasy of this margin requires further investigation. The thickness of oceanic crust along the Yucatan margin derived from vintage refraction data and from recent reflection surveys is 5 to 6 km,

which is more consistent with slow and mama-poor spreading. Similar crustal thicknesses are observed in NE GOM, while the initial spreading rates there are estimated to be ultra-slow. We postulate temporal variability of magmatic regime during basin formation that ranged from CAMP (~200 Ma) presumably responsible for the observed SDRs to an ultra-slow amagmatic spreading at the initial stage of the GOM opening (~ 160 Ma), followed by a major ridge reorganization (~ 150 Ma) associated with increased magmatic supply. These variations in magmatic regime combined with apparent mismatches in geological structures on “conjugate” margins demand some revisions of the currently accepted tectonic models for the GOM.