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Marine seismic refraction data indicate Mesozoic syn-rift volcanism and seafloor-spreading in the northwestern Gulf of Mexico

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The Gulf of Mexico is a small ocean basin that formed by continental rifting and seafloor-spreading between North America and the Yucatan Block during the Jurassic to early Cretaceous. The lack of good, deeply-penetrating geophysical data in the Gulf of Mexico has precluded prior reconstructions of the timing and location of the transition from rifting to seafloor-spreading, as well as the degree to which magmatism influenced these geological processes. To illuminate the deep structure of this enigmatic region, we acquired four marine seismic refraction profiles in the northern Gulf of Mexico from the shelf to deep water as part of the Fall 2010 Gulf of Mexico Basin Opening (GUMBO) project. Here, we present the data and resulting seismic velocity structures of two GUMBO profiles in the northwestern Gulf of Mexico. GUMBO Line 1 extends ∼330 km offshore south Texas from Matagorda Island across Alaminos Canyon to the central Gulf. GUMBO Line 2 extends ∼400 km from the shelf offshore western Louisiana across the Sigsbee Escarpment. On both lines, ocean-bottom seismometers at 10-km spacing recorded 150m-spaced airgun shots over offsets up to 80 km. We use travel times from these long-offset reflections and refractions to image seismic velocities in the sediments, crystalline crust, and upper mantle using a tomographic inversion. On average, seismic velocities increase with depth from 2 km/s near the seafloor to 5 km/s near the interpreted base of salt. On both profiles we observe a large amount of lateral heterogeneity in the sediments due to salt tectonics. The deeper seismic velocity structure along GUMBO Line 1 also exhibits substantial lateral heterogeneity (4.5 km/s to 7 km/s) that may be consistent with crystallization of thin, ultraslow-spreading oceanic crust alternating with emplacement of exhumed mantle lithosphere. If the basement here is indeed oceanic, the prominent magnetic anomaly along the Texas coastline may represent the expression of synrift volcanism during the early opening of the Gulf of Mexico. In comparison, GUMBO Line 2 offshore from Louisiana displays higher seismic velocities that suggest thicker, slow- to normal-spreading oceanic crust with less-pronounced lateral variations in crustal structure than on GUMBO Line 1. Therefore, early seafloor spreading in the Gulf of Mexico may have been accompanied by more robust magmatism in the central portion of the basin compared to the west.