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Structure and evolution of the Gulf of Mexico: New results from the GUMBO marine seismic refraction study

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Plate reconstructions of the Gulf of Mexico suggest that Jurassic rifting in the Gulf of Mexico proceeded with a counterclockwise opening between North America and Yucatan, though the timing is poorly constrained. Seismic reflection data provide a detailed record of salt deposition and post-rift sedimentation, but the underlying basement and Moho has thus far not been imaged in detail. Therefore, the evolution of these rifted margins is not well known.

In the Fall of 2010 we deployed ocean-bottom seismometers (OBSs) along four transects in the northern Gulf of Mexico to obtain much-needed constraints on the crustal structure, as part of the GUMBO (GUlf of Mexico Basin Opening) project. We shot refraction data along these lines with an industry vessel. The four OBS refraction profiles are located 1) offshore south Texas, 2) offshore western Louisiana, 3) offshore Alabama, and 4) offshore western Florida. Each of these seismic transects was oriented perpendicular to the margin from the coast towards the central Gulf of Mexico. The purpose of this experiment design was to capture structural variations in the margins in the approximate rift direction, and to a lesser degree to find evidence for differences in the style of rifting along the strike of the margin. Such east-west variability could indicate a diachronous rifting history, a possible influence of CAMP magmatism in the rifting process, and/or structural control from the preexisting lithospheric fabric in southern North America.

We used the GUMBO OBS data to construct seismic velocity models along the four profiles. Due to the large sediment influx in the western Gulf of Mexico, it is possible that the continent-ocean transition here lies beneath the coastal plain, such that we did not capture this boundary on our two western profiles. However, the crust that lies offshore Texas is clearly thinner than offshore Louisiana, which could indicate an eastward increase in magmatic output during the early opening of the Gulf of Mexico. To the east, the rifted margin offshore Alabama shows a crustal thinning profile and a seaward increase in crustal seismic velocities that is consistent with a history of syn-rift volcanism. In comparison, the seaward edge of the continental crust beneath the Florida Platform shows less evidence for magmatic additions, which may indicate that this continent-ocean transition served as a strike-slip boundary, at least for some period during the opening of the Gulf of Mexico.