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Evidence of a Volcanic Rifted Margin: A Velocity Model for the Gulf of Mexico Basin Opening Seismic Refraction Project

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The Gulf of Mexico Basin Opening marine seismic refraction project (GUMBO) is a study of the lithological composition and structural evolution of the Gulf of Mexico (GoM) that uses Ocean Bottom Seismometer (OBS) data from four transects in the Northern GoM. Our analysis focuses specifically on line 4, the easternmost transect which extends over ∼500 km from the continental shelf near Gainesville across the Florida Escarpment to the deep water GoM. Shear-wave first arrivals are picked from eleven out of the 39 OBS shot records in order to perform a tomographic inversion. The resulting shear-wave velocity model is used in conjunction with a previously constructed P-wave model to plot Vs as a function of Vp. We compare the Vp-Vs relationship with empirical velocities from the literature for the purpose of constraining lithological composition along GUMBO Line 4, and we make an interpretation of the structural evolution of the eastern GoM.

The crust landward of the Florida Escarpment appears from our comparison with external data to be normal continental crust. Velocities plot within ∼100 -200 m/s from compilations of seismic velocities (Vp = 6.2 – 7.0 km/sec; Vs = 3.8 – 4.0 km/sec) of felsic crystalline basement. Seaward of the escarpment, velocities in the oceanic crust are anomalously high (Vp = 6.5 – 7 km/sec; Vs = 4.0 – 4.6 km/sec). A possible explanation for this is that early-Jurassic basaltic sheet flows formed subaerially, reducing the vesicularity found in basalts that have cooled rapidly underwater. An increased magnesium and iron content could also account for these high velocities, and would suggest that the oceanic crust formed at higher mantle potential temperatures than previously thought. Geometrically, the transition from thick to thin crust near the Florida Escarpment on GUMBO line 4 is relatively narrow, which may be explained by rapid continental breakup with little stretching of continental crust. Alternatively, this margin may also have experienced a significant component of strike slip.