Orogeny, deformation, rifting, and sediment burial on the Texas Gulf Coast: An EarthScope target

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The Texas Gulf Coast margin, located at the southeastern edge of Laurentia, has recorded a broad range of geological events, including rifting, subsidence, broad sedimentation, and uplift. However, despite its complex history and great interest to the oil and gas industry, it has not been subjected to intensive studies at deep crustal and mantle depths. The interaction between asthenospheric and lithospheric processes and their roles in the margin’s evolution are therefore unclear. This is also the case for most passive margins, which are broadly distributed throughout the world.

Potential field data reveal a large magnetic maximum coupled with a Bouguer gravity high running parallel to the coast of Texas. Due to the depth of sediment on the Texas Gulf Coast, magnetic studies in the region have not shown as clear a view of the anomalies associated with the margin as may be present. Based largely on potential field modeling, Mickus et al. (2009) suggested that the Gulf Coast is a volcanic rifted margin with a triple junction to the south and extends to a non-volcanic margin to the east. Previous studies reached inconsistent conclusions regarding active vs. passive rifting models. For example, Skogseid (2001) showed no volcanic activity while Menzies (2002) showed volcanic dominance.

Recent work done with magnetic intensity data has shown that the Gulf Coast magnetic anomaly is not one anomaly but two distinct anomalies, with one portion trending northward through central Texas, conforming to the Balcones Fault Zone and the eastern trace of the Ouachita Deformation Front, and the other following the coastline into Louisiana. How the existence of two magnetic anomalies conforms to the hypothesis, currently popular, that the Gulf of Mexico was created as a result of the Yucatan peninsula rifting away from the Texas coast, is unclear. Given the margin’s deep sedimentary cover, geophysical methods are needed to probe the lithosphere; the Texas Gulf Coast region—the shortest distance between true oceanic crust in the Gulf of Mexico and the relatively undeformed Laurentia on the Edwards Plateau—is therefore an excellent target for EarthScope tools and studies.

Some preliminary work is underway. In summer of 2010, 21 broadband seismographs were installed at 16-18 km spacing along a transect running from Junction, TX (on the Edwards Plateau) to Matagorda Island. The deep sediment package creates a challenge for broadband receiver functions but modeling suggests that beamforming techniques will create useful images of the upper mantle, at least. Results from the seismic survey, combined with a vector magnetic survey scheduled for summer of 2011, will hopefully yield information needed to interpret the interplay between, for example, the asthenosphere-lithosphere boundary, the mantle flow, and crustal thinning associated with ocean-continental transition zones.