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A Summary of New Observations of the Lower Crust and Upper Mantle Structure beneath the Gulf Coastal Plain from Passive and Active Source Seismic Data

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ABSTRACT

The lithosphere of Texas and surrounding regions has been deformed by most of the major orogenic events that occurred in North America in the past 2 billion years. Onlyrecently, however, have geophysical investigations probed depths beyond those of the sedimentary basins. EarthScope's broadband seismic array and a broadband profile conducted by Baylor and Texas Tech facilitated seismic modeling such as tomography (body wave and Pn/Moho head waves); modeling of P-to-S and S-to-P converted phases from the crust and uppermost mantle (Ps and Sp receiver functions, respectively); and SKS measurements of the orientation of seismic anisotropy in the lithosphere. These new models have led to a better understanding of the region's lithosphere. High P and Svelocities observed in upper mantle tomography models indicate lithospheric thicknesses of ~200 km beneath Central Texas. Negatively polarized events in Sp receiver functions suggest that the 100–200 km depth interval beneath the Gulf Coastal Plain (GCP) features a lithosphere-asthenosphere transition zone (LATZ) that is characterized by layered mantle flow. This interpretation is supported by the presence of high Vp/Vs ratios in the velocity models at these depths and large SKS anisotropy measurements in the lithosphere beneath the GCP and Balcones Fault System (BFS). Fast Pn (upper mantle) velocity anomalies in Central and East Texas are, unexpectedly, oriented perpendicular to the BFS, which are in contrast to the orientation of velocity anomalies in the body wave tomography models which are at least semi-parallel to the BFS throughout the LATZ. Receiver function imaging reveals a remnant of subducted crust beneath the Gulf Coastal Plain south of Houston, which contrasts with the thinned, or absent, continental crust beneath the northern GCP at the Texas-Louisiana border. Low P and S velocities are observed beneath the Southern Oklahoma Aulacogen (SOA) region to the north in Pn and body wave tomography that may indicate flow of warm mantle material from the Rio Grande Rift toward the GCP. These new results reveal that the lithosphere of the region is more complex than previously believed and adds to the numerous unresolved issues that will require additional, higher resolution data, as well as geodynamicmodeling to determine the roles of these geophysical features in the geological evolution of the GCP and surrounding regions. Despite current uncertainties, remnant structures in this region are generally well-separated geographically and better preserved than in other parts of North America making the Gulf Coast an ideal laboratory to study the impact of major tectonic events in the development and preservation of the lithosphere.