Crustal Structure From 3-D Tomography in the Main Ethiopian Rift

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The Main Ethiopian Rift (MER) is an ideal location to study the transition between continental rifting and oceanic seafloor spreading. A 3-D refraction and wide-angle reflection survey was completed in the MER as part of the Ethiopia-Afar Geoscientific Lithospheric Experiment (EAGLE) in January, 2003. Approximately 680 Texans were deployed in a region 100-km in diameter, 231 exclusively for the 3-D survey and over 450 as part of two 400-km-long 2-D profiles that intersected at the center of the 3-D array. Nineteen borehole shots, two lake shots, and two quarry blasts were recorded, fourteen of which have been used in a 3-D tomographic inversion. Shot spacing was ~50 km and station spacing was nominally 2.5 km for the 3-D array and 1 km for the instruments on the 2-D profiles.

The 3-D survey was centered at the intersection of the Boset and Fantale magmatic segments. Primary targets include crustal magma chambers and/or crustal modifications related to recent magmatic activity, crustal structure between the two magmatic segments, determination of the depth to which segmentation persists, and structure and reflectivity of the Moho.

Preliminary results indicate a correlation between the surface expression of the rift and deeper structures both in the upper and lower crust. In the upper crust, linear, 60-km-wide low-velocity regions (3.5-4 km/s) are imaged to depths of 5 km, likely associated with rift sediments along the axis of the rift. These sedimentary basins are separated between the Boset and Fantale magmatic segments by ~20 kilometers in a right-lateral sense. At greater depth, the 6.5-6.7 km/s lower crust appears to be upwarped beneath the rift axis. Moho reflectivity has been mapped and suggests that reflectivity is greatest beneath the northwestern and southeastern rift shoulders, also the regions of greatest elevation. Future inversions will include intracrustal and Moho reflections to map the 3-D structure of these discontinuities.