Constraints on Faulting and Basin Architecture in the North Basin of Lake Malawi from Active-Source Seismic Data

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The East African Rift System (EARS) is actively extending as evidenced by seismicity and volcanic activity, and it has long been considered a great example of continental rifting. The western branch of the EARS consists of a series of rift basins bound by 100-km-long border faults, with Lake Malawi being the southernmost. Many of the previous studies on Lake Malawi have suggested that the border faults of the Malawi basin accommodate most of the crustal extension and account for most of the seismicity. However, the occurrence of the 2009 Karonga earthquake sequence and other seismicity on intrabasinal faults suggest that they may also be important for crustal extension and hazards. This study uses active-source reflection and wide-angle refraction data from the Study of Extension and maGmatism in Malawi and Tanzania (SEGMeNT) experiment to constrain detailed basin architecture, shallow velocities, and fault structures of the North Basin of the Malawi Rift. Here we present results from the main reflection/refraction dip line across the North Basin along which 7 lake bottom seismometers (LBS) were spaced at 7 km. The largest volume shots were produced from a 2580 cu in air gun array and shot every 250 m. We recorded multichannel seismic data (MCS) along the same line with a 1500-m-long streamer and a smaller source volume of 1540 cu fired every 37.5 m. The LBS recorded both the large-volume and small volume shots along this line. We picked sedimentary and crustal refractions and reflections using recordings from both shot volumes. We utilized the First Arrival Seismic Tomography (FAST) software package to obtain a smooth velocity model using the first arrivals, and iterative forward modeling was done using the RAYINVR software package to produce layered model using both first and later arrivals. Concurrently, the coincident seismic reflection profile was processed using the SeisSpace software package. Preliminary results show sediments in the North basin are thickening from West to East, reaching a thickness of over 4 km adjacent to the Livingstone border fault on the eastern side of the lake. Sediments here are characterized by velocities of ~2-3 km/s. The largest intra-basin fault has a substantial vertical displacement of 2.4 km, and it appears to offset the youngest sediments, indicating that it is active. We will combine seismic reflection and refraction data to estimate the amount of extension that can be accounted for by intrabasinal faults and the border fault. These results indicate that significant total extension has occurred on the intra-basin faults.