3D Variations in Sediment Architecture in the Central Basin of Lake Malawi from the SEGMeNT Active-Source Experiment

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A fundamental question in geophysics is how continental rifts evolve from initiation to breakup. Our study aims to elucidate the controls on early-stage rifting utilizing recently collected active-source wide-angle refraction data from the weakly extended Malawi Rift, which is composed of a series of border-fault bound basins whose polarity reverses along strike. Our study focuses on the Central Basin of Lake Malawi. The Central Basin is bounded to the west by the 1,000 m high Central Basin border fault and contains a series of enigmatic structures within the basin. To constrain the thickness of synrift and pre-rift sediments and upper crustal structure associated with intrabasinal structure, we have undertaken 3D velocity modeling of the Central Basin using new active-source data acquired in Lake Malawi (Nyasa) as a part of the SEGMeNT project. We picked first arrivals on shots recorded on 12 “lake” bottom seismometers resulting in over 38,000 unique picks with maximum offsets of 90 km. We then inverted these picks using the First Arrival Seismic Tomography (FAST) package for the 3D structure. The resulting model spans 80 km north to south, 50 km east to west, and 10 km in depth. We also apply strict quality control measures to ensure only robust picks are utilized in the inversion. Starting models are built from smoothed inversion of picks at close offsets to ensure that shallow structure is not mapped to depth. Our results indicate a marked transition in the character of sedimentary basins within the Central Basin. Sediments thicken to the west at the southern end of the Central Basin reaching a maximum thickness of ~ 4.5 km and in contrast, sediments thicken to the east at the northern end near Manda, Tanzania and reach a maximum thickness of ~ 4.0 km. This may indicate that the west dipping border fault that bounds the eastern side of the basin to the north influences the Central Basin at its northern end. We image a linear, high-velocity feature that extends from 2.5 km to below 6 km and spans 70 km from south to north, and we interpret it to represent a horst-like structure that divides the basin along strike. We observe a ubiquitous layer of sediments with velocities between 3 and 5 km/s that may represent the older Permo-Triassic Karoo-group sediments that extend offshore from the Ruhuhu Trough to the east of the Central Basin.