Crustal Structures beneath Bathymetrists Seamounts from Isostatic Modeling

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Abstract

The Bathymetrists Seamounts (BSM) are located in the Atlantic Ocean north of the Sierra Leone Rise. The age and the origin of the BSM are not fully determined. The current spreading direction of the African plate contradicts the northeast to southwest trend of the seamounts. The depth and thickness of crustal layers for the Sierra Leone Rise (SLR) and Sierra Leone Basin (SLB) were determined in the seismic refraction experiment of Jones et al. (2015). The crust beneath the Sierra Leone Basin is normal oceanic (6.5 km), while the Sierra Leone Rise crustal block is anomalously thick (16 km) and has over 6 km of magmatic underplating. However, that refraction experiment was unable to map the depth to Moho beneath BSM. Therefore, the primary objective of this study is to determine the crustal structures beneath the Bathymetrist Seamounts from isostatic modeling.

Isostatic modeling implies balancing pressures exerted by lithospheric blocks at a given depth in the upper mantle (thicknesses and densities of individual crustal layers are model parameters). The refraction experiment of Jones et al. (2015) serves as a framework for two calibration models over SLB and SLR. The Sierra Leone Basin model includes 5 layers, while the Sierra Leone Rise requires an additional layer for magmatic underplating. Modeling of these two structures yielded the following densities: sediment (2.3 g/cc), extrusive upper crust (2.65 g/cc), intrusive lower crust (2.85 g/cc), and magmatic underplating (3.0 g/cc). Densities of water and upper mantle were assumed as 1.0 g/cc and 3.3 g/cc respectively. The isostatic model was then extended to the BSM crustal block, resulting in Moho depth of 20 km and up to 7 km of magmatic underplating.

Our analysis suggests a similar crustal architecture of Sierra Leone Rise and Bathymetrists seamounts crustal blocks, leading to the hypothesis about their common origin. This implies a right-lateral fault striking northeast to southwest between these blocks that displaced BSM block at least 100 km. The fault would be younger than the magmatic underplating, but was potentially active at the time of formation of the Bathymetrists seamounts. The next step to understand the formation of the Bathymetrists seamounts is to validate this hypothesized fault by using seismic data and integrated 2D modeling of gravity and magnetic fields.