LAYERED CRUSTAL AND UPPER MANTLE STRUCTURE BENEATH BOTSWANA

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Although considered to have a relatively low seismicity, Botswana is thought to host a south westerly extension of the East African Rift System, a region where the African plate is splitting into two. This rift extension is postulated by various researchers to be in northern and central Botswana, where the most and the largest earthquakes in the country have been observed. Due to a sedimentary coverage of about 75% (Haddon, 2005) and other limitations, understanding the crustal structure in order to explain the seismicity has been a challenge. This has seen limited literature on Botswana’s crustal and upper mantle structure, as well as contrasting ideas on the causes of seismicity and faulting observed in the country.

Providing a better definition of the crustal structure enables earthquakes to be better located and improves our understanding of seismic wave speed variations associated with the upper lithosphere. In contrast to previous crustal structure studies which were area focused and or assumed a simple crust, this research aims to define a countrywide layering in the crust beneath Botswana and to study the relation between the structure, tectonics and seismicity in the country.

To do this, P-to-S receiver functions were produced from 176 teleseismic events recorded by 21 NARS-Botswana stations as well as 116 teleseismic events recorded by 18 stations of the SAFARI project located within Botswana using the extended-time multitaper receiver function estimation technique (Helffrich, 2006; Shibutani et al., 2008). Waveforms of events at epicentral distances between 30 and 85 degree were used, with magnitudes Mw>5.8 to ensure good signal to noise ratios of the receiver functions. We carried out a further quality assessment of receiver functions based on visual inspection and quantifiable signal to noise ratio to select only the best quality receiver functions.

We performed a preliminary analysis of the receiver functions, stacked in 20 degrees back azimuth bins and 0.02 s/km slowness bins, to obtain preliminary results to guide further analysis. The results reveal the crust beneath Botswana to be layered, uniform with back-azimuth at some stations and with a back-azimuthal variation at others. Delayed first peaks at some stations suggesting the presence of a sedimentary cover are observed as expected due to the 75% sedimentary cover over Botswana. We also observe what could be a shallow low velocity layer within the crust, if not a reverberation within the top sedimentary layer at some stations.

We are further grouping and stacking the receiver functions based on waveform similarity, which signifies similar structure, and relative difference in slowness. These groups of receiver functions are inverted for one-dimensional shear wave velocity models using a genetic algorithm inversion technique (Sambridge and Drijkoningen, 1992; Shibutani et al., 1996). The resulting models give much detailed information about the thickness of the crust and intra-crustal layers and their corresponding shear wave velocities.