1-D layered crustal and uppermost mantle structure beneath Botswana

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Despite a relatively low seismicity, Botswana hosts a south westerly extension of the East African Rift System, postulated by various researchers to be in northern and central Botswana, where most seismicity in the country has been observed. Due to a sedimentary coverage of about 75% (Haddon, 2005) and other limitations, understanding the crustal structure 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, their causes to be delineated and improves our understanding of the associated seismic hazards and risks. In an attempt to provide such a definition, this research aims to define layering in the crust and to study the relation between the crustal structure, tectonics and seismicity in Botswana.

To do this, P-to-S receiver functions are computed from waveform records of teleseismic events from epicentral distances between 30 and 85 degrees recorded at 38 stations located within Botswana, with magnitudes Mw>5.8 to ensure good signal to noise ratios. We carried out a further quality assessment of receiver functions to select only the best quality receiver functions. These receiver functions are then stacked in back azimuth and slowness bins to obtain preliminary results that guide further analysis. The preliminary results reveal a layered crust, uniform with back-azimuth at some stations and with a back-azimuthal variation at others. Delayed first peaks at stations located in sedimentary basins are observed as expected. The receiver functions are then further grouped and stacked based on waveform similarity and relative difference in slowness. A genetic algorithm inversion technique (Sambridge and Drijkoningen, 1992; Shibutani et al., 1996) is then applied to the groups of stacked radial receiver functions to obtain one-dimensional shear wave velocity models for a horizontally layered crust.

The results show lower shallow shear wave velocities in sedimentary basins and a tectonic region average crustal thickness between 32km and 43km. A reduced crustal thickness is observed at stations in the Okavango rift zone in northern Botswana which is attributable to rift related extension that causes seismic activity in the area, while a thickened crust in central-western Botswana may point to a buried ancient craton suggested by Begg et al. (2009). A dipping Moho is suspected where an offset of ˜8km in Moho depth is observed on the NE-to-E side of station NE208 in the Limpopo belt due to the mechanism of its formation. In the western part of Kaapvaal craton, the crust is undisturbed and thinner than in eastern part where it is affected by the emplacement of Bushveld complex correlatives (Nguuri et al., 2001) and proximity to the Limpopo belt. In general, the depth to the Moho beneath Botswana averages ˜39km.