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Crust and uppermost mantle structure of Madagascar.

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Crustal and uppermost mantle structure beneath Madagascar has been investigated by analyzing teleseismic receiver functions recorded at 36 broadband seismic stations. In addition to the five permanent broadband seismic stations that exist in Madagascar, three-component teleseismic data recorded from the recent deployment, between 2011 to 2014, of 32 temporary seismic stations from two different projects, the MACOMO (Madagascar-Comores-Mozambiques) project (Wyssession et al., 2012) [1] and SELASOMA (SEismological signatures in the Lithosphere/Asthenosphere system of SOuthernMAdagascar) experiment (Tilmann et al., 2012) [2], permit us to conduct the study.

We obtained radial and tangential receiver functions by deconvolving the vertical component from the radial and tangential components using an iterative time domain deconvolution procedure. Radial receiver functions were then stacked and the arrival times of P-to-S conversion and their reverberated phases were migrated to depth to estimate the thickness and Poisson's ratio of the bulk crust in the Precambrian core of Madagascar. Furthermore, we applied forward modeling of receiver function to determine the basin and crustal thickness of the sedimentary basin in the western part of the island. Finally, receiver functions were jointly inverted with Rayleigh wave phase-velocity dispersions in order to improve the location of different discontinuities and the shear-wave velocities of each layer.

Our study reveals a sedimentary basin that thins out northwards (~8 km to ~4 km thick) and dips toward the west (from ~2 km to ~8 km thick). The crustal thickness for the island varies from 18 km to 46 km. The thinnest crust is ~18 km in the northernmost part of the sedimentary basin of Madagascar, and the deepest Moho (~46 km) is in the central part, beneath the high plateau of Madagascar. The crust is estimated at ~18 km to ~36 km thick in the sedimentary basin which thickens towards east. It changes from ~33 km to ~46 km in the Precambrian crust. A change in Poisson's ratio from 0.23 and 0.28 is observed across the Precambrian crust. The overall average crustal shear-wave velocity is between ~3.5-3.8 km/s, and the mafic layer at the bottom of the crust changes between 3 km to 18 km in thickness.

These findings contribute to an understanding of the geological history of Madagascar since the dispersal of Gondwana. The dipping basin in the western part recorded the direction of the opening towards north and east that preceded the separation from Africa. Thin crust in the western part, contrary to the thick crust across the central part of Madagascar, shows the crustal stretching produced by the separation and drifting. Similar estimation of the thickness of Archean and Proterozoic crust

provides small evidence for secular variation in Precambrian crustal structure. The Precambrian crust of Madagascar is likely composed of more felsic to intermediate lithologies.

References:

[1] Wyssession, M et al. (2012) In: Investigating Mantle Structure with Broadband Seismic Arrays in Madagascar and Mozambique, AGU Fall Meet. Abstr.,p. B2591.

[2] Tilmann, F et al. (2012) In: SELASOMA Project, Madagascar 2012-2014,doi:10.14470/MR7567431421.