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Investigating the Lithospheric Structure of Southern Madagascar

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The island of Madagascar occupies a key region in both the assembly and the multi-stage breakup of Gondwanaland, itself part of the super-continent Pangaea. Madagascar consists of an amalgamation of continental material, with the oldest rocks being of Archaean age. Its ancient fabric is characterised by several shear zones, some of them running oblique to the N-S trend, in particular in the south of the island. More recently during the Neogene, moderate volcanism has occurred in the Central and Northern part of the island, and there are indications of uplift throughout Eastern Madagascar over the last 10 Ma. Although Madagascar is now located within the interior of the African plate and far away from major plate boundaries (> 1000 km from the East African rift system and even further from the Central and South-West Indian Ridges), its seismic activity indicates that some deformation is taking place, and present-day kinematic models based on geodetic data and earthquake moment tensors in the global catalogues identify a diffuse N-S-oriented minor boundary separating two microplates, which appears to pass through Madagascar. In spite of the presence of Archaean and Proterozoic rocks continent-wide scale studies indicate a thin lithosphere (<120 km) throughout Madagascar, but are based on sparse data.

We are operating a ENE-WSW oriented linear array of 25 broadband stations in southern Madagascar, extending from coast to coast and sampling the sedimentary basins in the west as well as the metamorphic rocks in the East, cutting geological boundaries seen at the surface at high angle. The array crosses the prominent Bongolava-Ranotsara shear zone which is thought to have been formed during Gondwanaland assembly, although this interpretation has recently been questioned. The array recorded the magnitude 5.3 earthquake of January 25, 2013 which occurred just off its western edge.

In addition, in May 2013 we have deployed 25 short period sensors in the eastern part of the study area, where there is some so-far poorly characterised seismicity. We present preliminary results on the lithospheric crust and mantle structure based on surface wave dispersion and waveform modelling, focussing on the contrast between the metamorphic areas in the east and the presumably stretched regions in the west.

Interstation Green's functions have been obtained from all pairs of vertical broadband records, with coherent Rayleigh waves being identifiable for periods of 3-40 s. In addition, two-station phase dispersion measurements have allowed us to determine phase dispersion between 25 and 60 s. The ambient noise and earthquake data both indicate a slow-down of surface propagation in the western part of the array for periods < 40-45 s, but faster propagation in the western part for periods >45 s.