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Seismic structure of the southern part of Madagascar determined by waveform inversion

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The assembly of past supercontinents is mainly based on fitting the edges of continental shelves and linking pre-existing trans-continental fracture zones. Madagascar, located in the middle of the Gondwana supercontinent (Figure 1), occupied a unique geological position between west Gondwana (Africa and South America) and east Gondwana (Australia, Antarctica, India, Sri Lanka). It provides a suitable locale to investigate the signature of major Pan-African shear zones that were activated during the assembly and dispersion of Gondwana and address several important geodynamic questions. To what extent do major episodes of suturing or rifting overprint ancient fabrics? To what extent does the ancient fabric affect the mode of breakup? What is the influence of paleo-structures on recent and current continental drift?

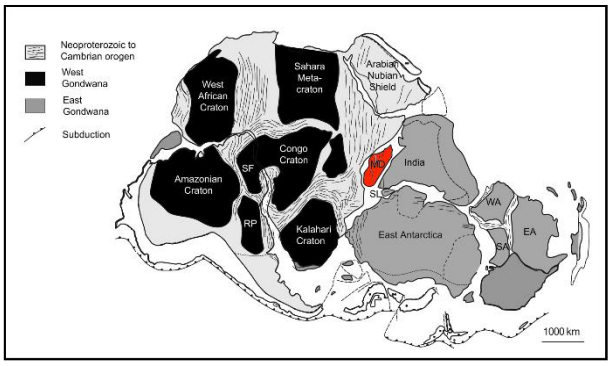

Figure 1: Gondwana reconstruction showing the location of Madagascar (after Satish et al. [1])

Large shear zones in southern Madagascar, which reflect ductile deformation during the Pan-African orogeny, follow two trends: N0-20E for the Beraketa shear zone, and NW-SE for the Bongolava-Ranotsara (Martelat et al. [2]). Collins and Pisarevsky [3] described the large parts of the central metamorphic units of Madagascar as the remnants of a separate continental fragment.

In this study we investigate the lithospheric structure of southern Madagascar using data acquired by a passive seismic experiment that was deployed from 2012 to 2014. A profile of broadband stations crossed all major geologic provinces in the south of the Island and also crossed the Neo-Proterozoic Ranotsara shear zone at a high angle. Although Madagascar is located in the African plate, earthquakes of magnitude 5 and larger are occasionally observed. Broadband displacement waveforms from the 25 January 2013 M5.3 earthquake are modelled and inverted to derive a crustal and upper mantle model

that crosses the shear zones in the southern part of Madagascar. The source and structural model successfully reproduces the observed displacement amplitudes of all phases in the data.

References:

[1] Satish-Kumar M (2008) Geol. Soc. 308, 1-20

[2] Martelat et al. (2000) Precambrian Res. 102, 1–20

[3] Collins A S and Pisarevsky S A (2005) Earth Sci. Rev. 71, 229-270.