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Seismic anisotropy of the lithosphere-asthenosphere system beneath southern Madagascar

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Madagascar is considered as a key region with respect to the assembly and break-up of the supercontinent Gondwana. Following the collision between East- and West-Gondwana (∼700-650 Ma), its position was central to the Panafrican orogenesis. Madagascar then separated from East Africa and later from the Indian and Antarctic plates until these processes came to a halt about 69 Ma ago. Today, Madagascar consists of different tectonic units; the eastern parts (two thirds of the island) are composed mainly of Precambian rocks, whereas the western part is dominated by sedimentary deposits. Furthermore, southern Madagascar is characterized by several NS to NW-SE trending shear zones.

Madagascar has been the target of a number of geological studies, but seismological investigations of the presumed complex lithosphere-asthenosphere system and of deeper upper-mantle structures are sparse. To increase our understanding of these structures and related tectonic processes, we installed a dense temporary seismic network in southern Madagascar. It consisted of 25 broadband and 25 short-period stations, which were in operation for up to 2 years between 2012 and 2014. The broadband stations crossed the island along an east-west profile; the eastern section was supplemented by a network of short-period stations.

Here we present results from shear-wave splitting analyses to infer the seismic anisotropy of the lithosphere-asthenosphere system in response to deformational processes. The polarization of the fast shear wave and the delay time between the fast and slow waves provide constraints on the anisotropic fabric. For our study, we use SKS-phases from up to 12 events recorded at the temporary stations and from 10 events at the permanent GEOFON station VOI. We first apply a single-event splitting analysis by minimizing the transverse component. For stations that do not show a significant azimuthal dependence of the splitting parameters, we also apply a joint inversion involving all recorded SKS waveforms. Our preliminary results exhibit delay times between 0.4 and 1.5 s. In the center of the E-W profile, fast axes are mainly oriented NNW-SSE, whereas east of the Ranotsara shear zone, fast axes are oriented NE-SW. Additionally, we will apply splitting analysis of Ps phases as well as waveform modelling to resolve the possible influence of the crust on the anisotropy inferred from the SKS phases.