

MT+, Integrating Magnetotellurics and Ambient Noise Tomography to Determine the Structure and Evolution of the Weakly-Extended Malawi Rift

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SUMMARY

While continental rift models and observations highlight the importance of magma intrusion during rift initiation in cold and thick lithosphere, few observations inform the distribution of magma in early-stage rifting. We integrate electromagnetic and seismic constraints from the weakly-extended, Miocene-recent Malawi rift of East Africa to image the distribution of magma, if present, at depth and assess the role of magma in extension and early-stage rift evolution. The Malawi rift formed within a series of Proterozoic orogenic belts sandwiched between thick lithosphere of the Tanzanian and Bangweulu cratons. The rift is structurally segmented along its length into a series of border fault-bounded half-graben basins, with the only surface manifestation of magmatism being the ~25-0 Ma Rungwe Volcanic Province (RVP) located at the north end of the rift. We use wideband magnetotelluric (MT) data recorded by 85 MT stations and ambient noise signals continuously recorded for ~ 2 years by 61 broadband seismic stations to invert for 3D resistivity and shear wave velocity models, respectively, of the RVP and the northern and central rift basins. In our 3D models, shallower depths of ≤ 7 km have high conductivity values of $\leq 10 \Omega.m$ and 12-16 % Rayleigh wave velocity reduction, which spatially coincide with syn-rift sediments in the Malawi rift basin and pre-rift sedimentary units within remnant basins of the Phanerozoic Karoo rifting event. Beneath the RVP, the 10 $\Omega.m$ isosurface to depths of ≤ 12 km is underlain by the 5-7 % Rayleigh wave velocity reduction at mid-lower crustal depths possibly imaging active magma intrusions; these inferred zones of magma intrusions extend beyond the volcanic province's surface manifestation of magmatism. Future work will involve the quantification of melt percent in relation to magnitude of electrical conductivity values and the reduction of seismic wavespeeds beneath RVP.

Keywords: Weakly-extended, Lithosphere, Rift, Magma, Modification
