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Size is everything: reconstructing the East African Orogen—a Gondwanan supermountain—as a critical step to modelling the Neoproterozoic earth system

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A reconstruction of the shape of the earth surface is essential to test hypotheses and model the solid-earth/earth surface interface in Deep Time. We can only progress our understanding of how the deep earth effected the climate, the budget of bio-available nutrients, the oxidation of earth surface systems and major ecological evolutionary changes by rebuilding the tectonic geography of the planet. The innovation of full-plate tectonic reconstructions back into the Proterozoic is an important development (Merdith et al. 2021; Collins et al. 2021), but at present, these do not include continental topography.

Here we present the first reconstruction of the changing topography of a trans-Gondwanan mountain belt (the East African Orogen). We inverted metamorphic pressure–time data into a compositional isostatic equilibrium equation. This gives an approximate elevation of the mountain belt relative to the modern-day elevation. There are significant assumptions and simplifications, including the assumption of isostatic equilibrium, no thermal isostatic component included, no post-orogenic modification of the crustal column etc. However, by incorporating these data into a full plate model, a first-pass paleo-geographic topographic reconstruction is presented through the final amalgamation of Central Gondwana. The Arabian Nubian Shield (accretionary orogenesis from ~750–600 Ma) produced elevations of up to ~3 km peak elevation. In the Mozambique and India/Madagascar belts much higher elevations of up to ~8 km, are predicted from ~650 –530 Ma; elevations similar to the current day Himalaya.

A major limitation is the lack of good pressure-time data. We present a reconnaissance study to address this using garnets from a well-characterised transect across Southern India, which we dated using the novel laser Lu–Hf LA-ICP-MS/MS technique (Simpson et al. 2021). Quartz inclusions within these were then analysed using RAMAN spectroscopy to determine their trapping pressures. These produced results of up to ~12–15 kbar at ages ~600 to 540 Ma (peak conditions) which agree with conventional pressure-time studies and demonstrate the potential of this workflow.

References:

Collins et al. (2021) Commun Earth Environ, Vol. 2, 75.
Merdith et al. (2001) ESR, Vol. 241, 103477.
Simpson et al. (2021) ChemGeol, Vol. 577, 120299