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Deciphering key events of Neoproterozoic orogenesis in Madagascar: insights from structure and multiple thermochronometers

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The assembly of central Gondwana occurred along the Neoproterozoic–Cambrian East African Orogen. In Madagascar, this major orogenic event occurred by at least two separate orogenies, the eastern Malagasy Orogeny, associated with the closure of the "Betsimisaraka Suture" and the East African Orogeny, associated with the closure of a suture in south-western Madagascar. Two significant age peaks in the available published geochronology data for Madagascar indicate two key tectonic events – one at c. 650 Ma and one at c. 550 Ma. Attributing each of these ages to one of the sutures is difficult, largely due to the close proximity of these suture zones and the difficulty in recognising early metamorphism that may be overprinted by later events.

Current interpretations for metamorphism in Madagascar are based predominantly on zircon rims and relatively high temperature metamorphic minerals such as monazite. However, to unravel the thermal and overprinting effects of these two, spatially distinct, but partially overlapping orogenies we undertook laser ablation single crystal analysis of lower temperature thermochronometers. These included, U-Pb apatite and laser QQQ-ICPMS analysis of Rb-Sr in both muscovite and biotite from central Madagascar.

Gneisses and undeformed granitic rocks from an E-W transect through central Madagascar yield crystallisation ages (based on zircon U-Pb) ranging from c. 2500 Ma to c. 550 Ma. Mid-temperature thermochronometers that date temperatures between ∼300–550°C yield ages from c. 650 Ma to c. 500 Ma, indicating that these samples were all thermally reset in the late Neoproterozoic. Here I will present structural and spatial patterns in the thermochronology that suggest that the effects of the different orogenies can be identified from the structural and thermochronological data.

By using different thermochronometers, we can unravel different stages of orogenesis in Madagascar and the likely timing for each of the proposed sutures. This has broader implications for how supercontinent Gondwana amalgamated.