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The Stenian-Cambrian Tectonic Evolution of Central Madagascar

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Table of Contents

Abstract

Madagascar occupies an important location in many Proterozoic plate reconstructions. It lies within the East African Orogen, which involves a collage of Proterozoic microcontinents and arc terranes wedged between older cratonic units during Gondwana assembly. Oceanic crust is an important component of palaeogeographic reconstructions that is often overlooked because exposures of in situ oceanic crust older than ~200 Myr do not exist. Therefore, studies of ancient oceanic crust require proxies such as analysing the products of magmatic arcs. The Malagasy basement preserves five magmatic suites emplaced consecutively from ~1100-500 Ma. During this time, the Rodinia supercontinent amalgamated then dispersed and the Gondwana supercontinent formed. This whole-rock geochemical and zircon isotopic study attempts to unravel the Proterozoic tectonic history of central Madagascar using the tectonic setting and duration of various Stenian to Cambrian magmatic episodes. These magmatic suites are the ~1080-980 Ma (Dabolava Suite), ~850-750 Ma (Imorona-Itsindro Suite) and ~650-520 Ma (Kiangara, Ambalavao and Maevarano Suites). Gabbroic and granitoid rocks of the Dabolava Suite combined with the coeval Ikalamavony Group represent a magmatic arc and volcano-sedimentary sequence deposited in an oceanic-arc environment based on isotopic and geochemical characteristics. The Imorona-Itsindro Suite represents contemporaneous emplacement of various lithologies from gabbro to granitoids and syenite. Oxygen and hafnium isotope data have a broad inverse relationship with apparent magmatic cycles occurring on the scale of ~15-40 Ma that emphasize periods of significant supracrustal assimilation evolving to “mantle-like” (or below) signatures. The spatial distribution of isotopic data indicates that the isotopic character of Tonian-aged zircon replicates the basement domain into which the magmas intruded. Samples intruding the Ikalamavony Domain exhibit a less evolved $\varepsilon_{Hf}(t)$ isotopic signature than Tonian-aged rocks intruding the domains to the east, implying melting of different source material. The zircon isotopic dataset emphasises the age range and composition of the Tonian lithosphere beneath central Madagascar. Geochemically, mid-Tonian rocks are calc-alkaline with trace-element characteristics consistent with a continental arc genesis. Radiogenic isotope data show evolved Sr and Nd signatures. Changes in subduction zone dynamics, crustal anatexis and crustal assimilation of the diverse basement domains into ascending magmas contributed to geochemical variations. Prolonged subduction (>100 Myr) provided sufficient time for the arc to mature and a shallow (<100km), metasomatised spinel lherzolite mantle source is preferred. The isotopic and geochemical characteristics of the Imorona-Itsindro Suite argue for a collective genesis in a supra-subduction zone tectonic setting with the Neoproterozoic suture located west of the Ikalamavony Domain. The Ediacaran to Cambrian Kiangara, Ambalavao and Maevarano Suites are post-collisional, mainly granitoid suites emplaced during the final assembly of Gondwana. Magmas incorporated crustal material and isotopic signatures reflect the basement unit in which samples intrude and these rocks are related spatially and temporally with major late-Neoproterozoic deformation episodes. Collectively, these data identify a previously unrecognised and long-lived (~500 Ma) active continental margin correlative to the present-day Pacific Ocean margin. Understanding this large dataset is critical for understanding Madagascar’s tectonic evolution during the Stenian to Cambrian.

List of Figures

List of Tables

Chapter 5

Chapter 6

Appendices

Supplementary Appendices

Declaration

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Journal Articles

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