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Stenian–Tonian arc magmatism in west–central Madagascar: the genesis of the Dabolava Suite

Donnelly B. Archibald[1,2*], Alan S. Collins[2], John D. Foden[2], Justin L. Payne[3], Paul H. Macey[4], Peter Holden[5] & Théodore Razakamanana[6]

[1] Department of Earth Sciences, St Francis Xavier University, Physical Sciences Complex, 5009 Chapel Square, Antigonish, NS, B2G 2W5, Canada
[2] Centre for Tectonics, Resources and Exploration (TRaX), Department of Earth Sciences, The University of Adelaide, Adelaide, SA 5005, Australia
[3] Centre for Tectonics, Resources and Exploration (TRaX), School of Built and Natural Environments, University of South Australia, Mawson Lakes, SA, 5001, Australia
[4] Council for Geoscience, 3 Oos Street, Bellville, 7530, South Africa
[5] Research School of Earth Sciences, The Australian National University, Canberra, ACT, 2601, Australia
[6] Département des Sciences de la Terre, Université de Toliara, Toliara, 601, Madagascar
* Correspondence: darchiba@stfx.ca

Abstract: Madagascar is a complex, composite geological terrane that occupies an important location in Late Proterozoic plate reconstructions. The recognition in one of the Madagascan terranes of a Stenian to Tonian-aged arc magmatic suite (the Dabolava Suite) demonstrates that its host terrane resided at a plate boundary from *c.* 1080 to 980 Ma. Gabbroic and granitoid intrusions of the Dabolava Suite are recognized only in the Ikalamavony Domain in west–central Madagascar. The oxygen isotopic compositions of zircon indicate that the parental magmas involved crustal contributions that were fractionated by a hydrological cycle, whereas hafnium isotopic compositions reflect near depleted-mantle signatures with only minor deflection to more crustal values. Together, these trends suggest mantle derivation of parental magmas coupled with upper-crustal assimilation of Stenian-aged pre-existing plutonic and volcanic rocks. These magmatic rocks, together with the coeval sedimentary rocks of the Ikalamavony Group, are taken to represent a subduction-related magmatic arc that formed in an oceanic-arc tectonic setting in the Mozambique Ocean outboard of the Archaean to early Palaeoproterozoic shield of Madagascar. The arc accreted to the older craton before the initiation of the Imorona–Itsindro Suite magmatism at *c.* 850 Ma that intruded both domains.

Supplementary material: A complete description of the analytical methods and supplementary data are available at https://doi.org/10.6084/m9.figshare.c.3823717

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The Madagascan Archaean–Palaeoproterozoic terrane occupies a central position in many palaeogeographical reconstructions as it lies within the Gondwana-forming collisional zone that forms the Ediacaran to Cambrian East African Orogen (Collins & Pisarevsky 2005; Li *et al.* 2008, 2013; Pisarevsky *et al.* 2014; Merdith *et al.* 2017). In contrast to the dynamic tectonic environment experienced later, late Palaeoproterozoic to mid-Mesoproterozoic times were considered tectonically quiet in Madagascar (Key *et al.* 2011). To the north and west of the stable craton lay an open ocean and continental shelf (Tucker *et al.* 2014). To the east was either the Indian Dharwar Craton in the 'Greater Dharwar Craton' model for Proterozoic Madagascar (Tucker *et al.* 2011*a*), or an open ocean in a hypothesis where central Madagascar formed part of an isolated microcontinent named Azania (Cox *et al.* 2004; Collins & Pisarevsky 2005; Fitzsimons & Hulscher 2005; Collins 2006; Merdith *et al.* 2017). In the Azania model, central Madagascar, along with the Madurai Block of southern India (Plavsa *et al.* 2014; Collins *et al.* 2014), East Africa, Yemen and Saudi Arabia were isolated from both the Dharwar Craton and the central African Congo–Tanzania–Bangweulu Block by oceanic crust (Collins & Pisarevsky 2005). To the south, the shield is considered to have been flanked by the Androyen–Anosyen Domain (now part of southern Madagascar) at this time in the Greater Dharwar model (Tucker *et al.* 2014) or by an open ocean in the Azania model (Collins & Pisarevsky 2005).

During the Proterozoic, several sedimentary sequences including the Itremo, Ambatolampy, Iakora, Maha, Sambirano–Sahantaha and Andrarona Groups (Boger *et al.* 2014; Archibald *et al.* 2015) were deposited on what is now Madagascar. Following, or coeval with, continental basin formation, an active magmatic arc developed to the west of the Malagasy Shield in the Mozambique Ocean (Tucker *et al.* 2014). This arc is represented by magmatic rocks of the Dabolava Suite (1035–982 Ma; Tucker *et al.* 2007) that are found only on the western margin of the Malagasy Shield. This arc magmatism was broadly coeval with the early stages of the amalgamation of Rodinia, a supercontinent that is thought to have formed between *c.* 1300 and 900 Ma and is often modelled to have incorporated all cratonic blocks existing at that time to form a single continental amalgam (Li *et al.* 2008, 2013). However, more recent early Neoproterozoic reconstructions do not include Madagascar, whether part of Azania or the Greater Dharwar Craton, in the Rodinian supercontinent (Merdith *et al.* 2017).

Stenian–Tonian-aged magmatic rocks of the Dabolava Suite form the focus of this paper. The Dabolava Suite was only recently identified (Rakotoarimanana 2001; Tucker *et al.* 2007; CGS 2009*a*), and understanding this magmatic suite is important for determining the tectonic setting of Madagascar at the beginning of the Neoproterozoic. U–Pb, oxygen and hafnium isotope data from zircon provide new constraints on the age of the suite and magma source components. Complementary whole-rock geochemical data