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Post-collisional magmatism in the central East African Orogen: The Maevarano Suite of north Madagascar

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ABSTRACT

Late tectonic, post-collisional granite suites are a feature of many parts of the Late Neoproterozoic to Cambrian East African Orogen (EAO), where they are generally attributed to late extensional collapse of the orogen, accompanied by high heat flow and asthenospheric uprise. The Maevarano Suite comprises voluminous plutons which were emplaced in some of the tectonostratigraphic terranes of northern Madagascar, in the central part of the EAO, following collision and assembly during a major orogeny at ca. 550 Ma. The suite comprises three main magmatic phases: a minor early phase of foliated gabbros, quartz diorites, and granodiorites; a main phase of large batholiths of porphyritic granitoids and charnockites; and a late phase of small-scale plutons and sheets of monzonite, syenite, leucogranite and microgranite. The main phase intrusions tend to be massive, but with variably foliated margins. New U–Pb SHRIMP zircon data show that the whole suite was emplaced between ca. 537 and 522 Ma. Geochemically, all the rocks of the suite are enriched in the LILE, especially K, and the LREE, but are relatively depleted in Nb, Ta and the HREE. These characteristics are typical of post-collisional granitoids in the EAO and many other orogenic belts. It is proposed that the Maevarano Suite magmas were derived by melting of sub-continental lithospheric mantle that had been enriched in the LILE during earlier subduction events. The melting occurred during lithospheric delamination, which was associated with extensional collapse of the East African Orogen.

1. Introduction

The island of Madagascar comprises a collage of Precambrian basement terranes, overlain by Phanerozoic sedimentary basins along the west coast. The Precambrian terranes were juxtaposed during the Neoproterozoic to Cambrian (Pan-African) East African and Malagasy orogenies (Collins and Pisarevsky, 2005). The East African Orogen (EAO; Fig. 1) extends from Egypt in the north to Antarctica in the south (Stern, 1994; Meert, 2003; Jacobs and Thomas, 2004) and represents the collision zone between Neoproterozoic India, the Congo–Tanzania–Bangweulu block, and the Saharan metacraton (Meert, 2003; Collins and Pisarevsky, 2005; Collins, 2006). Madagascar lies in the heart of the EAO, and its basement rocks have been studied from a number of viewpoints including metamorphic histories (e.g. Buchwaldt et al., 2003; Jöns et al., 2006); structural geology (Collins et al., 2003a,b; Tucker et al., 2007; Thomas et al., 2009) and magmatic processes (Nédélec et al., 1995; Paquette and Nédélec, 1998; Meert et al., 2001). In this paper we focus on the post-collisional intrusions of the Maevarano Suite of northern Madagascar, in order to understand the lithospheric processes related to the latter stages of this major orogenic event. Our work is the result of a major World Bank sponsored project, which involved re-mapping and sampling the basement rocks of northern Madagascar, undertaken by a consortium of the British Geological Survey (BGS), the United States Geological Survey (USGS), and GLW Conseil (GLW). The results were presented in the form of geological maps of various scales and an unpublished explanation (BGS-USGS-GLW, 2008).

Voluminous post-collisional granitoids are a major feature of the EAO (Black and Liégeois, 1993; Küster and Harms, 1998; Meert, 2003; Jacobs et al., 2008). They are typically alkaline and metaluminous in composition, and can be broadly characterised as A-type granitoids under the classification of Whalen et al. (1987). In the southern part of the EAO, in East Antarctica and Mozambique, peak metamorphism associated with collision-induced crustal thickening occurred at ca. 555 Ma (Bingen et al., 2009) and post-collisional magmas were emplaced between ca. 530 and 485 Ma, with a pulse of voluminous granitoid and charnockite magmatism at 510–500 Ma (Jacobs et al., 2008). In central Madagascar, alkaline granite sheets (termed 'stratoid

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