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Regional geodynamic context for the Mesoproterozoic Kibara Belt (KIB) and the Karagwe-Ankole Belt: Evidence from geochemistry and isotopes in the KIB

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ABSTRACT

The Mesoproterozoic Kibara Belt and Karagwe Ankole Belt formed between the Congo Craton and the Tanzania-Bangweulu Block in central Africa. The subduction model proposed for the Kibara region is difficult to reconcile with the simultaneous intracratonic transtension in Karagwe Ankole at c. 1380 Ma. Nonetheless, our whole rock petrochemical and Sr–Nd isotope data reinforces earlier evidence for a subduction setting for the Kibara Belt. Model ages for the mafic samples associated with the 1380 Ma event indicate crustal residence times of c. 2.7 Ga, suggesting derivation from evolved subcontinental lithospheric mantle with minor juvenile input. The latter is analogous to an active continental margin. In combination with the petrochemical evidence, this favors a subduction setting, the bimodal nature of the magmatism notwithstanding.

The Kibara Belt granites are weakly metaluminous to strongly peraluminous, with low Ba – high Rb contents and restitic micaceous enclaves indicating an origin by metapelite dehydration melting. Two previously recognized granite suites around 1380 Ma and 1000 Ma in the Kibara Belt are, to an extent, distinguishable geochemically. The age-corrected Nd isotope ratios from Kibara Belt metapelites and granites are similar, confirming that the strongly peraluminous Kibara Belt granites are mostly derived from similar metapelites. The Kibara Belt granites show depleted mantle Nd model ages (T_{DM}) of at least 2.4 Ga. Some granites have model ages in excess of 3.0 Ga, which can be attributed to multi-stage Nd evolution.

Finally, a comparison with the contemporaneous magmatism in the adjacent Mesoproterozoic Karagwe-Ankole Belt indicates similar geochemistry of subordinate mafic dykes, yet reveals distinct differences with the 1370 ± 40 Ma Lake Victoria Dyke Swarm and the 1403 ± 14 Ma–1374 ± 14 Ma layered (ultra)mafic intrusives of the Kabanga-Musongati lineament. We propose that this corresponds to a regional transition toward a collisional setting, related to amalgamation of the proto-Congo Craton. In the Karagwe-Ankole Belt, convergence is superimposed on asthenospheric upwelling, as evidenced by the Lake Victoria Dyke Swarm. Magmatism along the Kabanga-Musongati lineament initiates at 1403 ± 14 Ma, and these layered (ultra)mafic intrusives, and is here attributed to preferential upwelling along a transcrustal fault zone. Subordinate mafic to intermediate units interlayer the sediments and could relate to mantle delamination or (back) arc magmatism. Subsequent collision then accounts for the strongly peraluminous granites in the western part of this belt. At c. 1000 Ma, strongly peraluminous granites intruded in both belts. Together with similar deformation styles in both adjacent belts, this suggests a regional convergent setting between the Congo Craton and the Tanzania-Bangweulu Block, possibly related to the pan-Rodinian Orogeny.

1. Introduction

The Archean and Paleoproterozoic blocks that constitute Central African Cratons are separated by various Paleoproterozoic (Ubende, Rusizi) and Mesoproterozoic (Kibara, Karagwe-Ankole) belts. Based

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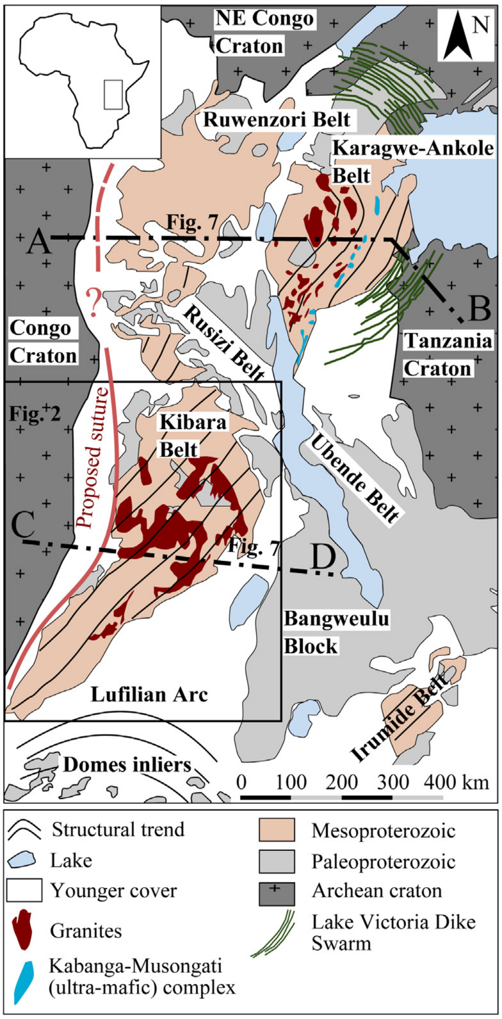

Fig. 1. Simplified geological map of the Kibaride Belt region. Modified from Fernandez-Alonso et al. (2012), Koegelenberg and Kisters (2014) and Tack et al. (2010).

on the architecture of these belts in combination with similarities in regional distribution and timing of sedimentary successions, De Waele et al. (2008) postulated that the Central African Cratons were amalgamated into a proto-Congo Craton since at least c. 1380 Ma. The Proto-Congo Craton comprises the NE Congo-Uganda, Bangweulu-Tanzania and Kasai terranes. Fernandez-Alonso et al. (2012) extended this period and envisage a purely intracratonic scenario in Central Africa from ∼1800 Ma onwards.

The Mesoproterozoic Kibaride Belt separates the Archean to Paleoproterozoic Congo Craton from the Archean to Paleoproterozoic Bangweulu-Tanzania Block (Fig. 1). Widespread magmatism occurs throughout this region at ∼1375 Ma and around 1000 Ma (Kokonyangi et al., 2006). In the southern part, the 1417–1376 Ma magmatic event is generally interpreted as an active continental margin (Kokonyangi et al., 2004, 2005, 2006), while simultaneously an intracratonic basin was proposed for the northern part (Klerkx et al., 1987; Fernandez-Alonso and Theunissen, 1998). The tectonic context of the voluminous peraluminous granites that intruded at c. 1000 Ma along the entire region is currently not well constrained (Pohl et al., 2013). Some propose a relationship with far-field stresses from the Irumide Orogeny (Fernandez-Alonso et al., 2012), while others envisage a full-scale orogeny with E-W directed convergence (Koegelenberg and Kisters, 2014; Kokonyangi et al., 2001). The Kibaride Belt was recently subdivided into the northern Karagwe-Ankole Belt (KAB) and the southern Kibara Belt (KIB), because of the independent basin development and the discontinuity represented by the Paleoproterozoic Rusizi Belt (Fernandez-Alonso et al., 2012; Tack et al., 2010).

The active continental margin model in the KIB (Kokonyangi et al., 2004, 2005, 2006) is in contradiction with a Paleoproterozoic amalgamation of the proto-Congo Craton (Fernandez-Alonso et al., 2012). The continental margin model was challenged because of the lack of preserved ophiolites and an interpreted lack of deep marine sediments in the KIB (Fernandez-Alonso et al., 2012; Tack et al., 2010). The proposed association between basin development and magmatism at c. 1370 Ma (Fernandez-Alonso and Theunissen, 1998) is currently in need of modification, because sediment deposition turned out to be significantly older than previously thought and because of the regional hiatus in the sedimentary record starting at the 1380 Ma Kibaran event (Buchwaldt et al., 2008; Fernandez-Alonso et al., 2012; Westerhof et al., 2014). Moreover, the giant arcuate Lake Victoria Dyke Swarm (LVDS) at the border between the Tanzania Craton and the KAB was recently dated at 1370 ± 40 Ma (Mäkitie et al., 2014). This contemporaneity has major implications for the Mesoproterozoic evolution in the KAB, and could significantly influence continent-scale Mesoproterozoic plate tectonic reconstructions (Ernst et al., 2013).

Here, we present new petrochemical and Sr–Nd isotope data of granites from the c. 1380 Ma and c. 1000 Ma magmatic suites in the KIB, along with metabasic and metasedimentary units. Crustal residence times from depleted mantle model ages provide new constraints for renewed juvenile input during the main magmatic events. Finally, we extend this toward a regional comparison with contemporaneous magmatic phases in the adjacent KAB, to evaluate the tectonic implications in the context of the proto-Congo Craton formation (De Waele et al., 2008) and the onset of the pan-Rodinian Orogeny (Pohl et al., 2013).

2. Geological setting

2.1. Regional geological context of the Kibara Belt

The Kibara Belt *sensu lato* is a 1300 km long, NE-SW trending Mesoproterozoic belt, cross-cut by the NW-SE trending Paleoproterozoic Rusizi terrane (Fig. 1). To the northeast of the Rusizi terrane, a Mesoproterozoic intracontinental extension model is inferred (Klerkx et al., 1984, 1987). The southwestern part is generally seen as a Mesoproterozoic active margin (Kokonyangi et al., 2004, 2005, 2006, 2007). Kampunzu et al. (1986) and Rumvegeri (1991) proposed a belt-wide active margin model, and interpreted the mafic and ultramafic units of the Kabanga–Musongati (KM) alignment as ophiolites. This model was refuted by Deblond (1994), who recognized these units in the northeastern part of the belt as intrusive mafic and ultramafic Bushveld-type complexes.

The Kibaride Belt was recently subdivided into the Karagwe-Ankole Belt (KAB) in the northeast and the Kibara Belt (KIB) in the southwest, mainly because of the discontinuity represented by the Rusizi terrane (Tack et al., 2010; Fig. 1). This subdivision is supported by the lack of layered Bushveld-type complexes and Eburnian molasse deposits in the KIB and different sedimentation hiati in both regions (Fernandez-Alonso et al., 2012). Nonetheless, the most recent compilation of radiometric ages confirms a simultaneous 1380 Ma 'Kibaran Event' in both regions (Fernandez-Alonso et al., 2012; Pohl et al., 2013). Based on broad regional similarities in igneous ages, sediment distribution and timing in the KIB, KAB and Tanzania-Bangweulu (De Waele et al., 2008), it was postulated that these regions belong to a single terrane, the proto-Congo Craton, at the latest since 1380 Ma. Recently, Fernandez-Alonso et al. (2012) extended this to the Late