RECURRENT REWORKING IN THE IRUMIDE BELT OF ZAMBIA.

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Introduction: The Irumide Belt of Zambia represents a continuous northeast-oriented orogenic belt, marking late Mesoproterozoic convergent tectonism along the southeastern margin of the central African Congo Craton. This orogenic belt comprises various magmatic and supracrustal units including : (a) a complex of Palaeoproterozoic crystalline basement (2.05 - 1.93 Ga ($G1_{a-b}$)), with a minor Archaean component (2.73 Ga (G_0)) (De Waele, 2005); (b) the Manshya River/Kanona Group psammo-pelites, unconformably /structurally overlying Archaean/Palaeoproterozoic basement, and including rare thin mafic and felsic volcanic units dated between 1.88 and 1.85 Ga (G_{1b})(De Waele and Mapani, 2002); (c) a minor suite of anorogenic plutons dated between 1.66 and 1.55 Ga (G_2)(De Waele et al., 2003) and (d) voluminous K-feldspar porphyritic granitoids intruded between 1.05 and 0.95 Ga (G_4), coincident with the climax of Irumide tectonism dated at 1.02 Ga (MP-HT metamorphism)(De Waele and Mapani, 2002; De Waele et al., 2003; in press). In this contribution, we present whole rock geochemical and isotopic data, characterising the various magmatic suites identified in the Irumide Belt, and propose a tectonic model for the development of the strongly reworked southeastern margin of the Congo Craton.

Geochemistry: Whole-rock geochemical data for the various magmatic suites brings out overall strong similarities (see also Tembo et al., 2002). The two most voluminous groups (G_{1a-b} and G_4), emplaced at ca. 2 and 1 Ga respectively, share a high-K calc-alkaline character and strongly similar trace element patterns, suggesting a relatively similar source at depth and, in the case of G_4 magmatism, potential derivation through reworking of G_{1a-b} basement. G_{1c} dacites-rhyolites in the Irumide Belt have very similar geochemistry to contemporaneous granites and dacites present in the Bangweulu Block, and both show dominant high-K calc-alkaline character and trace element patterns overlapping with

G_{1a-b} granitoids. These features would be compatible with derivation of these volcanics through reworking either of a homogenous Archaean-Palaeoproterozoic crustal or G_{1a-b} basement source at depth. Anorogenic G_2 plutons are more enriched in most of the incompatible elements than the former groups and geochemically correspond to A-type granitoids. Their particular A-type character could be ascribed to a significant mantle component or, more probably, to a lower degree of partial melting of the Archaean-Palaeoproterozoic crust.

Rb-Sr and Sm-Nd isotope geochemistry: Rb-Sr isotopic data for all the magmatic units in the Irumide Belt record significant disturbance, ascribed to mobility during Irumide and possibly Pan-African tectonism. This effect renders previously reported whole rock Rb-Sr dates on deformed lithologies within the Irumide Belt suspect.

G_{1a-b} granitoids have Nd T_{DM} model ages between 3.2 and 3.1 Ga, with $\varepsilon_{Nd}(T)$ values between -9.2 and -7.8, suggesting a significant crustal component in their generation. The narrow range of crustal residence ages strongly suggests a relatively homogenous cryptic Archaean source terrane across the entire Irumide Belt.

G_{1c} granitoids and volcanic rocks, both on the Bangweulu Block and in the Irumide Belt, display Nd T_{DM} ages between 2.9 and 2.3 Ga and $\varepsilon_{Nd}(T)$ values between 0.0 and -7.0. The highest $\varepsilon_{Nd}(T)$ values were recorded in the mafic volcanic units of the Irumide Belt, but these samples still record Nd T_{DM} model ages between 3.1 and 2.5 Ga. These results indicate variable mixing between Archaean/Palaeoproterozoic crust and a limited juvenile mantle component.

G_2 granitoids have Nd T_{DM} model ages between 3.2 to 2.8 Ga and $\varepsilon_{Nd}(T)$ values between -10.0 and -8.0, supporting derivation from a preponderant Archaean crustal source.

G_4 granitoids record Nd T_{DM} model ages between 3.3 and 3.1 Ga, similar to those for G_{1a-b}. Their $\varepsilon_{Nd}(T)$ values are however extremely negative (-15.2—14.4) in keeping with their longer crustal residence, but the data supports derivation from a similar source as G_{1a-b}, if not reworking of G_{1a-b} basement itself.

Nd isotopic data clearly indicate that a cryptic Archaean to Palaeoproterozoic crust is present throughout the entire Irumide Belt. The various (tectono-)thermal events therefore do not appear to have added significant new material to the crust in the region. The geochemical/isotopic characteristics of all magmatic suites are dominated by the nature of the cryptic crust, rendering deductions on geotectonic environments tenuous at best.

Discussion: The data presented above show that the Irumide Belt represents the reworked southern margin of the cryptic Archaean to Palaeoproterozoic Bangweulu Craton. Two main episodes of crustal reworking were recognised at ca. 2 and 1 Ga. The tectonic setting of the former is unclear at

present, but the latter event corresponds to convergent tectonism during the Irumide Orogen. This event generated amphibolite to granulite facies rocks, but also preserved greenschist-facies 1.88-1.85 Ga supracrustal and volcanic rocks, suggesting thin-skinned tectonics and an important contribution of vertical block tectonics. No active margin (juvenile) rocks have been observed in the Irumide Belt, while just to the south, on the other side of a Neoproterozoic megashear (the Mwembeshi Shear Zone), ca. 1 Ga juvenile and mature arc terrains are known (Johnson et al., 2005). Crustal reworking during the Irumide event is therefore suggested to have been triggered by partial subduction of the southern margin of the Bangweulu Craton below a southern collider, resulting in thin-skinned thrusting, but mainly inducing fracturing of the cratonic boundary and intrusion of crustal granitoids in response to asthenospheric upwelling along subvertical shear zones. A similar scenario could be applied for the generation of crustal melts at ca. 2 Ga to generate the crust-dominated G_{1a-c} suites.

Keywords: Congo Craton, Crustal Recycling, Granite Geochemistry, Irumide Belt, Mesoproterozoic

De Waele, B., 2005. The Proterozoic geological history of the Irumide belt, Zambia. PhD Thesis, Curtin University of Technology, Perth, 468 pp.

De Waele, B., Kampunzu, A.B., Mapani, B.S.E. and Tembo, F., in press. The Irumide Belt of Zambia. Journal of African Earth Sciences.

De Waele, B. and Mapani, B., 2002. Geology and correlation of the central Irumide belt. Journal of African Earth Sciences, 35(3): 385-397.

De Waele, B., Wingate, M.T.D., Mapani, B. and Fitzsimons, I.C.W., 2003. Untying the Kibaran knot: A reassessment of Mesoproterozoic correlations in southern Africa based on SHRIMP U-Pb data from the Irumide belt. Geology, 31(6): 509-512.

Johnson, S.P., Rivers, T. and De Waele, B., 2005. A Review of the Mesoproterozoic to early Palaeozoic magmatic and tectonothermal history of south-central Africa: implications for Rodinia and Gondwana. Journal of the Geological Society of London, 162: 433-450.

Tembo, F., De Waele, B. and Nkemba, S., 2002. Syn- to post-orogenic granitoid magmatism in the Irumide belt of Zambia: Geochemical evidence. African Geology Reviews, 9(1): 1-17.