THE SOUTHERN IRUMIDE BELT OF ZAMBIA

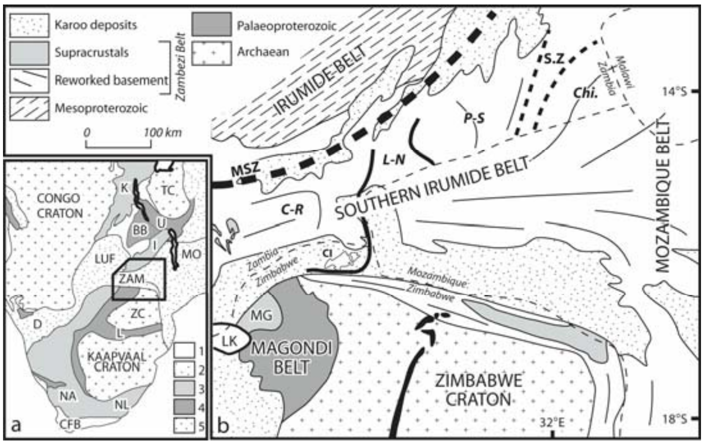
Johnson, S. P.[1]; De Waele, B.[2] & Tembo, F.[3]

[1] Institute for Research on Earth Evolution, JAMSTEC, 2-15 Natsushima-cho, Yokosuka-shi, Kanagawa-ken. Japan 237-0061; sjohnson@jamstec.go.jp

[2] Tectonics Special Research Centre, School of Earth and Geographical Sciences, The University of Western Australia, Crawley 6009, Australia

[3] School of Mines, Geology Department, University of Zambia, PO Box 32379, Lusaka, Zambia.

The Irumide Belt (IB) and Southern Irumide Belt (SIB) of Zambia comprise a series of predominantly Mesoproterozoic terranes along the southern margin of the central African Congo Craton, specifically the Archaean-Palaeoproterozoic Bangweulu Block. The presence of Karoo-aged grabens and a Neoproterozoic megashear (the Mwembeshi Shear Zone) between the two provinces precludes direct correlation and could potentially mask a suture between the two.



a) 1 = Post Pan-African basins; 2 = Pan-African belts; 3 = Mesoproterozoic belts; 4 = Palaeoproterozoic belts; 5 = Archaean Cratons. ***b)*** *CI = Chewore Inliers; MSZ = Mwembeshi Shear Zone; Southern Irumide Belt subdivisions- C-R = Chewore-Rufunsa Terrane; L-N = Luangwa-Nyimba Terrane; P-S = Petauke-Sinda Terrane; S.Z = Shear Zone; Chi = Chipata Terrane.*

The SIB is a new term introduced by Johnson et al. (2005) to describe a wide variety of variably-metamorphosed igneous and sedimentary lithologies that are distinct from, and occur to the south of the monotonous granitoids of the IB. Traditionally this region has been referred to simply as ‘reworked basement’ since little was known about the age of emplacement of the igneous bodies or their tectonic significance. Limited geochemical, structural and geochronological investigations in the Zambian portion of the belt (Mapani et al., 2001) have led to the recognition of several distinct terranes, all of which are bounded by discrete shear zones. We have embarked on an extensive U-Pb zircon SHRIMP geochronological investigation of these terranes and, combined with geochemical and isotopic information, provide further evidence to support and refine the terrane subdivisions of Mapani et al. (2001). The data also form the basis for a geotectonic scenario explaining the development and juxtaposition of the IB and SIB.

Chewore-Rufunsa (C-R) Terrane: This terrane is comprised of a wide variety of upper amphibolite facies calc-alkaline mafic to felsic gneisses, metavolcanic rocks and associated sediments. The plutonic and volcanic rocks have crystallisation ages between 1105-1040 Ma; have $\varepsilon_{Nd}(T)$ values between +2 and –10 and have trace and REE patterns consistent with them forming in a continental-margin-arc. The presence of a ca. 1393 Ma marginal basin ophiolite in the Chewore Inliers of northern Zimbabwe (Oliver et al., 1998) indicates the possible longevity of supra-subduction-magmatism in this terrane. Whole-rock isotopic model ages and inherited zircons extracted from the arc-lithologies indicate that the arc was built predominantly within Palaeoproterozoic crust with a minor Archaean component. Metamorphic zircon overgrowths on older igneous cores are dated at ca. 575 Ma indicating that this terrane was intensely overprinted during the Zambezi Orogeny.

Luangwa-Nyimba (L-N) Terrane: This terrane is dominated by supracrustal rocks including pelitic migmatites and quartzites. Igneous lithologies are rare and both the upper and lower contacts are interpreted to be ductile thrusts. Detrital zircons extracted from a pelitic migmatite indicate Late Archaean and Mid Palaeoproterozoic sources for the sediments and low Th/U metamorphic zircon overgrowths constrain the timing of high-temperature migmatisation to ca. 1060 Ma.

Petauke-Sinda (P-S) Terrane: The western portion of this terrane is dominated by amphibolite facies paragneisses and granitic orthogneisses. One of the orthogneisses has provided a crystallisation age of ca. 740 Ma and has low Th/U metamorphic zircon overgrowths that record metamorphism at ca. 530 Ma. A thin volcano-sedimentary sequence known as the Sasare Volcanics occupies the northern part of the terrane. Although we have not managed to date the andesitic volcanics themselves we have dated a porphyritic granite upon which they unconformably rest at ca. 1040 Ma, and a mylonitised K-feldspar-phyric granitoid at ca. 720 Ma which may represent an intrusive counterpart to the volcanic succession. The majority of the P-S Terrane is comprised of undeformed porphyritic granitoids and syenites that have post-Pan-African crystallisation ages of between ca. 510-475 Ma. Mapani et al. (2001) have also recognised a sequence of highly deformed calc-alkaline basement gneisses (Nyanji Gneiss) dated at ca. 1130-1120 Ma (Rivers, pers.comm.) and which are interpreted to have formed in a supra-subduction magmatic arc (Mapani et al., 2001).

Shear Zone: The eastern margin of the P-S Terrane and western margin of the Chipata Terrane are marked by a >30km wide zone of lithologies that have developed intense ductile planar and linear fabrics. This zone contains a collection of differing lithologies at variable metamorphic grade, including isolated gabbroic and ultramafic lithologies, one of which has a MORB-like subalkaline geochemical signature (Mapani et al., 2001). Two pelitic migmatites, which are dominated by Mid Palaeoproterozoic detrital zircons, have low Th/U metamorphic zircon overgrowths indicating migmatisation at ca. 1065 Ma. Highly strained mid-amphibolite facies orthogneisses have crystallisation ages of between 1020-1010 Ma. One further orthogneiss has been dated ca. 650 Ma and contains low Th/U metamorphic zircon overgrowths at ca. 555 Ma.

Chipata Terrane: This terrane is comprised of a variety of variably retrogressed mafic, felsic and pelitic granulites, with subordinate hornblende-biotite gneisses and granitoids. In Madzimoyo Quarry, the granulite lithologies have crystallisation ages of ca. 1076 Ma and contain mafic xenoliths with crystallisation ages of ca. 1977 Ma. The age of granulite-facies metamorphism remains unconstrained but must be younger than ca. 1076 Ma. A highly-deformed amphibolite-facies augen gneiss has a crystallisation age of ca. 1046 Ma, and a range of undeformed, hornblende-biotite gneisses have ages between 1076-1038 Ma demonstrating that granulite-facies tectonometamorphism is heterogeneous throughout this terrane.

Discussion: Our mapping confirms the previously proposed terrane subdivision of Mapani et al. (2001), and unequivocally demonstrates a common ancestry for all terranes, which appear to represent several thrust nappes. Without comprehensive geochemical and isotopic data from the Mesoproterozoic lithologies of the P-S and Chipata Terranes it is not possible to determine the origin of these units; however, considering the synchronicity of magmatism in these terranes with those of the C-R Terrane, it is likely that they all formed as part of a continental-margin-arc. The timing and style of Mesoproterozoic magmatism and metamorphism in the SIB are distinct from those in the IB to the north. Whereas the SIB comprises calc-alkaline continental-margin-arc-related magmatism between ca. 1105-1040 Ma and high-temperature metamorphism and/or migmatisation at ca. 1060-1050 Ma, the IB is characterised by intense crustal reworking at ca. 1020 Ma (De Waele et al., 2003). We suggest that the SIB continental-margin-arc formed on the margin of an unknown continental mass that collided with the Bangweulu Block at ca. 1020 Ma, resulting in cessation of magmatism in the SIB and the initiation of crustal shortening, thrusting and crustal melting in the IB. Late Mesoproterozoic to Neoproterozoic magmatism is confined to the P-S Terrane and may be related to extensional processes that eventually resulted in the separation of the two continental blocks, but leaving the SIB in place. Collisional orogenesis between 570-530 Ma resulted in the reactivation of the SIB terrane boundaries with the production of large crustal-scale shear zones (such as the Mwembeshi Shear Zone) and culminated in voluminous post-tectonic magmatism.

Keywords: Arc magmatism, Congo Craton, Mesoproterozoic, SHRIMP, Southern Irumide Belt

Cox, R.A., Rivers, T., Mapani, B., Tembo, D. & De Waele, B., 2002. Abstr. 11th IAGOD Quadrennial Symposium and Geocongress Windhoek, Namibia.3 p.

De Waele, B., Wingate, M.T.D., Mapani, B. and Fitzsimons, I.C.W., 2003. Geology, 31(6): 509-512.

Johnson, S.P., Rivers, T. and De Waele, B., 2005. Journal of the Geological Society of London, 162: 433-450.

Mapani, B.S.E., Rivers, T., Tembo, F. and Katongo, C., 2001. IGCP 418 4th fieldmeeting. University of Durban-Westville, Durban, South Africa.

Oliver, G.J.H., Johnson, S.P., Williams, I.S. & Herd, D.A., 1998. Geology, 26: 571-573.