A review of the geochronology of the Irumide Belt, Zambia

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Z ambia contains a series of Palaeoproterozoic, Mesoproterozoic and Neoproterozoic orogenic belts that suture the Congo, Kalahari and Tanzanian cratons (Figure 1). Mesoproterozoic orogenic events are preserved in the Irumide Belt, which extends from northeast Zambia, where it is truncated by rejuvenated Neoproterozoic shear zones within the Palaeoproterozoic Ubendian Belt, southwest to central Zambia, where it is overprinted by Neoproterozoic (Pan-African) events in the Zambezi and Mozambique Belts and the Lufilian Arc. The Mesoproterozoic Choma-Kalomo block may represent the southwest continuation of the Irumide Belt across the Zambezi Belt. Geochronological constraints on the evolution of the Irumide Belt are based largely on Rb-Sr and K-Ar data, with limited U-Pb results. In this contribution, we summarise the available geochronology of the Irumide Belt and present some of our own preliminary SHRIMP U-Pb results.



Figure 1: Simplified geological map of the Irumide Belt and other Proterozoic orogenic belts in Zambia, showing geological units, localities and dates discussed in the text.(modified from Mining Consultants Ltd.)

Introduction

Mesoproterozoic sediments occur in three different places in northern Zambia. The most extensive sedimentary package occurs in the Irumide belt itself, where it is known under a variety of different local names. Recent authors (De Waele & Mapani, 1998) have correlated them into the Kanona Group, which can be traced all along the axis of the belt. To the North of the Irumide belt, the coeval Kasama Formation occurs in a subbasin on top of the Bangweulu Block and can be correlated with the Manshya River Group, which in turn directly correlates with the Kanona Group (Daly, 1986). Sediments of the Mporokoso Group, occurring on the northern side of the Bangweulu Block, also form part of Post-Ubendian sedimentation in Northern Zambia, and have by earlier authors been correlated with the Kasama and Mpanshya River Group, based on their poorly defined chronological constraints. Daly (1986) defines the Muva Supergroup to contain the Mporokoso Group, Kasama Formation and Mpanshya River Group sediments.

The Kanona Group of the Irumide belt consists of a metasedimentary succession of pure quartzites and pelites (De Waele & Mapani, 1998). The sediments show mature continental characteristics, and are interpreted as extensive beach deposits with a sediment source to the northwest (Andersen and Unrug, 1984). The absence of extensive carbonates in the Kanona Group indicates that the Irumide basin never attained great depth nor stable character (Daly, 1986). Sedimentary characteristics, coupled with the presence of older calc-alkaline basement and apparent absence of obducted oceanic crust, suggests an intracratonic setting. However, carbonates and metabasites, currently under investigation in the Mozambique Belt, may represent deeper facies and remnant Mesoproterozoic oceanic crust.

The Kanona Group is intruded extensively by syn- and post tectonic granites. Preliminary geochemistry has so far not recognised A-type granites (Tembo et al., 2000). The metamorphic grade in the belt ranges from upper amphibolite facies towards the core in the southeast, to greenschist facies towards the foreland in the northwest (Mapani, 1999).

The Irumide Basin and its basement

In the northwest, the Palaeoproterozoic Bangweulu Block forms the basement to the Irumide Belt. The Luapula metavolcanics and an unfoliated granodiorite yielded Rb-Sr whole-rock (WR) ages of 1816 ± 11 Ma ((A¹)Brewer et al. 1979) and 1869 ± 20 Ma ((B)Cahen et al., 1984), respectively. The Bangweulu Block is overlain by the Mporokoso Group, which consists of a 5 km thick sequence of continental sediments and volcaniclastic rocks. The Mporokoso rift basin formed soon after the emplacement of Bangweulu Block granites (after 1869 ± 20 Ma) and before emplacement of the Lusenga Syenite at ~1135 Ma ((C)Brewer et al., 1979). The volcaniclastic sediments in the Mporokoso Group, and in the Kanona Group, indicates that Bangweulu Block magmatism continued during, and well after, formation of the Mporokoso Basin.

The Irumide Basin formed during a widespread rifting event on the southeast side of the cratonised Bangweulu Block. Whereas palaeocurrent directions in the Mporokoso Group to the northwest of the Bangweulu Block indicate south to north sediment transport, and the Kasama Formation sediments indicate a source to the northwest, the Kanona Group in the Irumide basin has its source in the north. Folded Muva sediments in the Mpika and Chinsali areas contain a single layer of rhyolitic tuff (Daly, 1986) for which a preliminary SHRIMP U-Pb zircon age of ~1820 Ma (D) was obtained, indicating that the Kanona Group and Mporokoso Group are approximately equivalent in age.

To the southeast, the Irumide Basin is cut by the Luangwa valley, which contains mid-Paleozoic Karoo sediments. Metasedimentary rocks southeast of the Luangwa Graben have been overprinted extensively during younger events so that the southeastern margin of the Irumide Basin cannot be discerned. In the Mozambique Belt, Irumide structural trends have been largely obliterated during Pan-African tectonothermal events. Granulite facies rocks in the Chipata area of the Mozambique Belt are older than 2000 Ma (Liyungu, pers.comm.), and may represent a remnant of Archean crust that could have formed the eastern basement to the Irumide Basin.

Extensional and compressional events and related magmatism

According to previous authors (Daly, 1986) extension of the crust was accommodated along transverse northwest directed faults. The resulting crustal thinning was accompanied by extensive granite intrusion throughout the Irumide belt. The Mutangoshi gneissic granite in the Chinsali area yielded a Rb-Sr WR age of 1407 \pm 71 Ma ((E)Daly, 1986), and the Siasikabole Granite in the Choma-Kalomo Block, dated by U-Pb zircon at 1352 \pm 14 Ma ((F)Hanson et al., 1988), constrains a similar intrusive event in the southwest. Other granites in the Chinsali, Mkushi, and Serenje areas of east-central Zambia are currently under investigation and may have formed during this extensional event.

A major compressional event occurred in the Irumide belt around 1350 Ma. Evidence includes a Rb-Sr WR age of ~1355 Ma for phyllonitisation of the Ubendian Nyika Granite ((G)Cahen et al., 1984), a K-Ar

¹ Bracketed letters refer to locations on figure 1

hornblende age of 1338 \pm 60 Ma for amphibolite of the Misuku Gneiss in the Mafingi Hills area of NE Zambia ((H)Fitches, 1971) and a Rb-Sr WR age of 1341 \pm 16 Ma for the Mivula syenite which intrudes the Mafingi Group ((I)Tembo, unpubl.).

Other episodes of compression and related granitoid magmatism occurred at ~1180–1040 Ma, and are constrained mainly by resetting of Rb-Sr and K-Ar systems. A four-point Rb-Sr whole rock isochron for the Lwakwa, Mwenga and Wililo granite gneisses in northwest Malawi yielded an age of 1140 ± 54 Ma ((J)Ray, 1974). Cooling ages for late-Irumide intrusions include a K-Ar biotite age of 1129 ± 30 Ma for the Nthonga Granite ((K)Fitches, 1971), a K-Ar age of 1154 ± 61 Ma on lamprophyre ((K)Fitches, 1971), and a K-Ar age of 1135 ± 40 Ma for metadolerite intruding the Mambo Gneiss in the Mafingi Hills area ((K)Ray & Crow, 1975). Resetting of Rb-Sr isotopic systems occurred at ~1100 Ma in the Mwambwa Gneiss near Chinsali (Daly, 1986). U-Pb SHRIMP analysis of zircons from aplites cross-cutting the Mkushi Gneiss yielded cores of 2036 ± 22 Ma and rim of 1088 ± 159 Ma ((L)Robb, pers.comm.). Rb-Sr and K-Ar ages of 1080 ± 31 Ma and 1060 ± 40 Ma on micas are interpreted as emplacement ages for the Phoenix Mine pegmatites in Southern Province ((M)Cahen et al., 1984). The emplacement of the Mpande Gneiss in the Kafue area, dated at 1105.3 ± 3.5 Ma ((N)U-Pb zircon; Hanson, 1999) also occurred during this late orogenic event. Our preliminary SHRIMP zircon analyses for three granites in the Mupamadzi and Serenje areas indicate ages of 1020 to 1040 Ma (O & P).

The Irumide orogeny was followed by a period of uplift and erosion, which generated the arenaceous sediments of the lower Katangan Supergroup, and continued magmatism. Emplacement of the Kaunga granite ((Q) 970 \pm 5 Ma, U-Pb zircon, Daly, 1986), the Lufila Granite ((Q) 947 \pm 89 Ma, Rb-Sr W.R., Daly, 1986), the Lusaka Granite ((R)~843 Ma, Cahen et al., 1984), the Ngoma Gneiss ((S)820 \pm 7 Ma, U-Pb zircon, Wilson et al., 1993), granites intruding the Mpanshya Group near Rufunsa ((T)~959 and ~973 Ma; Barr et al., 1977) and the Kafue rhyolites ((U)879 \pm 19 Ma, M.S. Wardlaw, unpubl. data), reflect this post-Irumide igneous phase. Our preliminary SHRIMP analyses of zircons from a granite in the Chinsali area yielded a maximum crystallisation age of ~800 Ma, with zircon inheritance ranging as old as 2200 Ma (V).

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