The 1.000 m thick Redbeds sequence of the Congo River Basin (CRB): a generally overlooked testimony in Central Africa of post-Gondwana amalgamation (550 Ma) and pre-Karoo break-up (320 Ma)

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The present-day Congo River Basin (CRB) is a continent-scale feature corresponding to a gravity low. It consists of a pile of less than 2.000 m thick loose and/or poorly consolidated sedimentary rocks, spaced in time between the base of the Karoo Supergroup (ca. 320 Ma) and the Holocene. These cover sequences rest on a pre-Karoo basement, which is known in outcrop along the edge of the CRB.

The CRB has been suggested to be part of a larger cratonic block encompassing several Archaean nuclei, that have been welded together between 2.1-1.8 Ga, as a result of Eburnean-aged collisional orogeny. Throughout the late-Palaeoproterozoic and Mesoproterozoic this block remained united. As a result of Gondwana amalgamation at ca. 550 Ma, the block was bordered by Pan African collisional high-grade terranes to the N ("Central African Orogenic Belt") and to the E ("East African Orogenic Belt").

The W and the SE rim of the CRB form foreland domains of respectively the "Araçuai/West Congo" and "Katanga/Zambezi" Pan African orogenic accretionary belts. In both forelands, Neoproterozoic tabular sedimentary sequences were largely preserved and define, respectively, the West Congo and Katanga Supergroups. In both cases, the uppermost unit of the Supergroups is made up of a ca 1.000 m thick Redbed facies sequence, respectively the "Inkisi" and "Plateaux" Subgroups (the latter recently renamed "Biano", although also known as "Kilungu Lupili"). In places, the Redbeds overlie unconformably the folded underlying Neoproterozoic sequences of the Pan-African West Congo and Katanga belts and are thus post ca. 550 Ma (paroxysm of Pan African orogeny). Therefore, they can no longer be considered as Precambrian but are Phanerozoic in age. In both forelands, the Redbeds are themselves overlain by the ca. 320 Ma Karoo tillite (base of the Karoo Supergroup).

Around and/or in the CRB, other tabular or moderately deformed Neoproterozoic sedimentary sequences are also exposed in several intracratonic aulacogenes. Each of these sequences has been referred to as a separate Supergroup (e.g. the Mbuji-Mayi Supergroup in the DRC Kasai region). The most prominent, however, is the Lindi/Ubangi Supergroup exposed to the N and NE of the CRB. The "Banalia Arkoses", uppermost unit of the Lindi Supergroup, are also ca. 1.000 m thick.

The Inkisi, Biano and Banalia Redbed units are siliciclastic and comprise a large volume of reddish-violet arkoses. Conglomerate lenses are frequently observed as well as flagstone intercalations including detrital muscovite. Cross-bedding, ripple-marks and wavy-lamination at various scales are the most prominent sedimentary structures.

The Neoproterozoic subtabular sequences exposed in the Lindi/Ubangi – Katanga and West Congo regions of the CRB rim are thus blanketed by ca. 1.000 m thick, jointed, Redbeds. They dip under the CRB cover deposits. This is confirmed by various geophysical exploration

works and four drillholes in the CRB (including the ca. 2.000 m deep, cored Samba- and Dekese drillholes). Thus, as evidenced in the Dekese drillhole, Redbeds overlie also in the CRB Neoproterozoic sequences and are themselves overlain by the Karoo Supergroup. Estimates of the ca. 1000 m Redbed thicknesses observed at the edge of the CRB compare well with the minimum 871 m given in the Samba core.

Re-interpretation of the abundant seismic reflection profiles obtained in the 1970-ies and early 1980-ies in the framework of hydrocarbon exploration programmes in the CRB (Kadima et al., 2008) indicates that the Redbed sequences and overlying Karoo Supergroup together form a single seismo-stratigraphic unit, bound by regional unconformities thus indicating a similar geodynamic history.

Microscopic updating of the composition of the Redbeds in the Dekese and Samba cores (Delpomdor, 2008) indicate that they are arkosic arenites, often with buried organic matter. The core sequence contains basal red clay mudstones overlain by fine to coarse siltstones and sandstones with successively planar, wavy and cross-lamination. The top presents generally thick conglomerates including moderately to well-rounded fragments of reworked material. The Redbeds are characteristic of lacustrine and fluvio-deltaic (semi)arid palaeo-environments in contact with atmospheric oxygen as indicated by their colour due to iron oxides/hydroxides coating around detrital grains.

The palaeo-depositional history of the CRB Redbeds is still poorly constrained. Sedimentation is ascribed to the development of a subsiding basin under extensional regime after Gondwana amalgamation, spanning the whole CRB and (large parts of) its rim. As such, the Redbeds form a more than 1600 km long intracratonic blanket with remarkable similarities in depositional facies.

Attempts to better constrain a post-Pan African though pre-Karoo age for the Redbeds are subject to controversial interpretations based on the considered scattered data.

In Katanga, one $^{40}Ar/^{39}Ar$ age of 573 Ma on detrital muscovites of the Biano Subgroup (Sharad Master et al., 2005) has been interpreted to support deposition of this Subgroup in a foreland basin of the Lufilian Orogen. On the contrary, Batumike et al. (2007) suggest that "*the absence of any zircons younger than 560 Ma (from a population of 229 zircons !) supports deposition of the Biano Subgroup … during the Pan African Lufilian orogeny*". Preliminary provenance analysis by SHRIMP on detrital zircons for the Inkisi Redbeds of the West Congo belt (one age of 558 Ma; Frimmel et al., 2006) has been considered unsuccessful, i.e. giving a "too old" maximum age of sedimentation, because the Redbeds are composed of (supposedly multiply) reworked material. We suggest a similar interpretation for the Katanga radiometric data.

Anyway, because of the pre-Karoo geological setting of the Inkisi Redbeds in Angola (Tack et al., 2001), a Permian age of deposition - as tentatively proposed by Alvarez et al. (1995) - has to be ruled out.

In the Katanga Redbeds, remnants of a "macrofossil" have been observed (tentatively ascribed to a Placoderm fish species; Mortelmans, 1951). Fish remnants point unequivocally to post-Precambrian times but this old fossil material needs updated reconfirmation. Interestingly, Jelsma (2008, pers. comm.) mentioned a Devonian age for other Placoderm fossil remnants observed recently in Redbeds from the Kasai region. We consider such a Devonian depositional age as quite reasonable for all the envisaged CRB Redbeds although more age constraints are obviously needed.

Post-depositional reactivation episodes under extensional brittle regime (blockfaulting) are locally known in the West Congo belt, where faulted Inkisi Redbeds may be mineralized according to a pinch-and-swell pattern (e.g. Cu-Pb-Zn sulphides veins, lenses and/or impregnations of Bamba Kilenda and other occurrences; Kanda Nkula et al., 2003).

Notwithstanding all these arguments, on the most recent synthetic geological map of the DRC (1974) and on most more recent compilation maps derived from it, the Redbeds of Central Africa are still included in the “upper Precambrian”.

References:

Alvarez et al. (1995) JAES, 20, 2, 119-131.
Batumike et al. (2007) Prec. Res.,156, 195-225.
Delpomdor (2008) unpublished report RMCA (Tervuren).
Frimmel et al. (2006) JAES, 46, 221-239.
Jelsma (2008) personal communication.
Kadima et al. (2008) manuscript in progress.
Kanda Nkula et al. (2003) IGCP 450, Lubumbashi Conference, Abstr. Vol., 150-155.
Mortelmans (1951) Bull. Soc. belge Géol., 60, 78-80.
Sharad Master et al. (2005) JAES, 42, 41-60.
Tack et al. (2001) Prec. Res., 110, 277-306.