THE NEOPROTEROZOIC WEST CONGO AND KATANGA SUPERGROUPS: SIMILARITIES AND DIFFERENCES

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Geological setting

The Congo Craton (Fig. 1), which is defined here as the central African large landmass that amalgamated at the time of Gondwana assembly at ~ 550 Ma, consists of several Archaean nuclei supposedly welded together around 2.1 Ga and later exhumed around 1.8 Ga as a result of Eburnean-aged collisional orogeny during the "Columbia" (also called "Nuna") supercontinent amalgamation (Fernandez et al., 2011; Tait et al., 2010). Since the late Paleoproterozoic, the precursor of the Congo Craton (termed proto-Congo Craton by De Waele et al., 2008) has stabilized and remained a united entity throughout the Meso-Neoproterozoic (Tack et al., 2008). It underwent only intra-cratonic tectonic events (e.g., rifting, basin development, sedimentation, magmatism, etc), which never evolved into the formation of juvenile oceanic crust and break-up of the craton. As a result of Rodinia supercontinent fragmentation, several Neoproterozoic sedimentary basins developed in and around the Congo Craton. During Gondwana amalgamation, the Craton became bordered by Pan African collisional high-grade terranes to the N ("Central African Orogenic Belt") and E ("East African Orogenic Belt"), while the W and SE rim acted as foreland domain for respectively the "Araçuai/West Congo" and "Katanga/Zambezi" (also called Lufilian Arc/Belt and/or Copperbelt) Pan African accretionary belts. In both forelands, Neoproterozoic tabular sedimentary sequences were largely preserved and define respectively the West Congo and Katanga Supergroups.

Lithostratigraphic correlation between the West Congo and Katanga Supergroups

Both lithostratigraphic columns are reported in Fig. 2 and correlated on the basis of recent radiometric age constraints (obtained by several methods) controlling the emplacement of some key marker beds. The ages provide a timing for the emplacement of these beds and result in a chronostratigraphic correlation between both Supergroups. Obviously, more radiometric data are needed to refine our correlation attempt.
Interestingly, rock types in both Neoproterozoic units are sometimes very comparable because depositional conditions around the Congo Craton were relatively similar during the Neoproterozoic, albeit diachronous.
A fine example illustrating the fact that similar basin conditions resulted in similar deposits not (necessarily) of the same age is given by stromatolitic and silicified oolitic rocktypes that developed respectively in the West Congo region in the upper Schisto-Calcaire Subgroup (C4 and C5 units; Kisantu oolite) and - about 200 Ma earlier ! - in the Katanga region in the Roan Group (Mines Subgroup; Mwashya oolite).
Alternatively, similar rocktypes may have formed under similar basin conditions apparently simultaneously, as is illustrated by the following three examples: 1) the two superposed diamictites (inferred to be respectively Marinoan and Sturtian in age) of both lithostratigraphic columns, 2) the cap carbonates on top of both Marinoan diamictites but lacking above both

Sturtian diamictites and 3) the tholeiitic fissural basaltic volcanism (with feeder dykes and sills) interlayered in the Sturtian diamictites. Finally, in both the West Congo and Katanga regions onset of sedimentation and basin infill started at ca. 900 Ma (910 Ma in the West Congo and 880 Ma in Katanga).

Abundance and importance of organic matter during the Neoproterozoic

In the West Congo region, recent research in the Schisto-Calcaire Subgroup has shown the remarkable preservation of connected, dichotomous and jelly calcified cyanobacterial filaments indicating the important role of microbes in the formation of dolomite rocks (Delpomdor, 2007; Delpomdor et al., 2008). Microbial mediation (bacterial sulphate reduction) was also involved in the sulphate and framboidal pyrite formation during early diagenesis with enrichment of disseminated sulphide flakes (including Fe, Cu, Pb, Zn, Ni, …) in preferential beds (Antun, 1968). The carbonate formation indicates marine shallow subtidal to supratidal environments with development of stromatolites and cyanobacterial mats evolving to lagoonal hypersaline conditions (Préat et al., 2010, Tait et al., 2010). The study of Delpomdor et al. (2008) confirms thriving conditions for primitive life (microbial mats) already in upper Neoproterozoic times with abundant production of organic matter. Such biogenic processes may have played an up to now underestimated role in the generation of hydrocarbon potential (e.g. source rocks in the Congo River Basin (WCB) or "Congo Cuvette") and/or in early metal trapping (e.g. stratabound deposits of the Katanga Copperbelt as indeed described by Muchez et al. (2008).
In the Copperbelt of Zambia the participation of microbial mats in the deposition of "ore formation" in the sediment-hosted Roan Group has just been evidenced under comparable tidal conditions (Porada and Druschel, 2010). Also, the leading role of shungite controling the genesis of the ~ 450 Ma old Kipushi polysulphide deposit has been stressed (Heijlen et al., 2008).

Timing and structure of the Pan African orogeny in the West Congo and Katanga regions

Along the western margin of the Congo Craton, the early Neoproterozoic was marked by rifting related to the break-up of Rodinia and opening of the Adamastor Ocean. Overlying the ca. 1000-910 Ma Zadinian and Mayumbian Groups, composed of predominantly magmatic rocks with subordinate siliciclastics testifying for the break-up event (Tack et al., 2001), the West Congolian Group corresponds to further rifting evolving into passive margin siliciclastic and carbonate platform deposits (Fig. 2). The rock sequences are well developed in the foreland part of the West Congo Belt (WCB) where they are only gently folded and unmetamorphosed. The western margin of the Congo Craton collided with the active São Francisco margin, thus forming the Araçuai-West Congo Orogen (AWCO), including the Brasiliano Araçuai belt, now preserved adjacent to the São Francisco Craton in Brazil (Pedrosa-Soares et al., 2008) and the Pan African WCB in central Africa (Fig. 1). Opening of the Atlantic ocean during Cretaceous times split the Araçuai-WCB into two parts, the Brazilian side of which inherited two thirds of the AWCO including all Neoproterozoic ophiolitic slivers, the entire magmatic arc, suture zone and syn (~ 585-560 Ma)- to post (~ 530-490 Ma)- collisional magmatism (Pedrosa-Soares et al., 2008). Interestingly, the AWCO's evolution illustrates convincingly the relatively short time span of orogenic processes (i.e. some tens of Ma) in this case. Moreover, it allows to constrain the AWCO's paroxysm around 550 Ma, an age close to the Neoproterozoic-Palaeozoic boundary of 542 Ma.
In Katanga the timing and duration of the orogenic processes are sometimes still a matter of debate although most geologists constrain the age of the orogeny around 560-530 Ma referring to its synorogenic magmatism.
Interestingly and as already evidenced by Kanda Nkula et al. (2004), the structure of both orogenic belts is very similar including a foreland domain to the belt with unmetamorphosed

rocks, an external fold-thrust belt of greenschist facies metamorphism and a more internal amphibolite facies domain where the Paleoproterozoic basement to the Pan African belt has been thrusted onto the Neoproterozoic sequences along a major detachment fault (Tack et al., 2001; Key et al., 2001).

Post-Neoproterozoic tectonic reactivation and base metal mineralisation

Post Neoproterozoic tectonic reactivation events are documented in both the West Congo and Katanga regions. The ca. 1000m thick Redbed-facies sequence (formerly considered as uppermost unit of respectively the West Congo and Katanga Supergroups) form the “Inkisi” and “Plateaux (also known as Kilungu-Lupili or Biano)” (Sub)Groups. It has been shown that these Redbeds overlie unconformably the folded Neoproterozoic sequences of the Pan African West Congo and Katanga belts, but have been deposited before the Karoo Supergroup (Kanda Nkula et al., 2009; 2011; Tack et al., 2009). They are thus post ~ 550 Ma and pre ~ 320 Ma and may no longer be considered as Neoproterozoic, but are Palaeozoic in age.
Finally, later post Neoproterozoic reactivation events are at the origin of the emplacement of fault-related lens-shaped base metal deposits, a number of them yielding attractive high-grade mineralisation and/or some metals of special interest including Au, Ag, Ge, Ni, U, … In the West Congo region they are represented by the Bamba Kilenda type deposits (intruding a.o. the Inkisi Redbeds and thus post-Inkisi in age) forming several small-sized bodies in the Popular Republic of the Congo, in the Democratic Republic of the Congo and in Angola (Kanda Nkula et al., 2003; 2004) whereas in the Katanga region, they may form major deposits, e.g. Kipushi (emplacement at ~ 450 Ma; Schneider et al., 2007) or Dikulushi (“ …young fluid event possibly ca. 100 Ma ago …”, Haest et al., 2010).

References

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Fig. 1: Geological sketch map of the Congo Craton with localisation of the West Congo and Katanga regions (in Tait et al., 2010, modified after De Waele et al., 2008)

Fig. 2: Barcode-type correlation of lithostratigraphic columns of the West Congo and Katanga Supergroups (Delpomdor, unpubl. data)

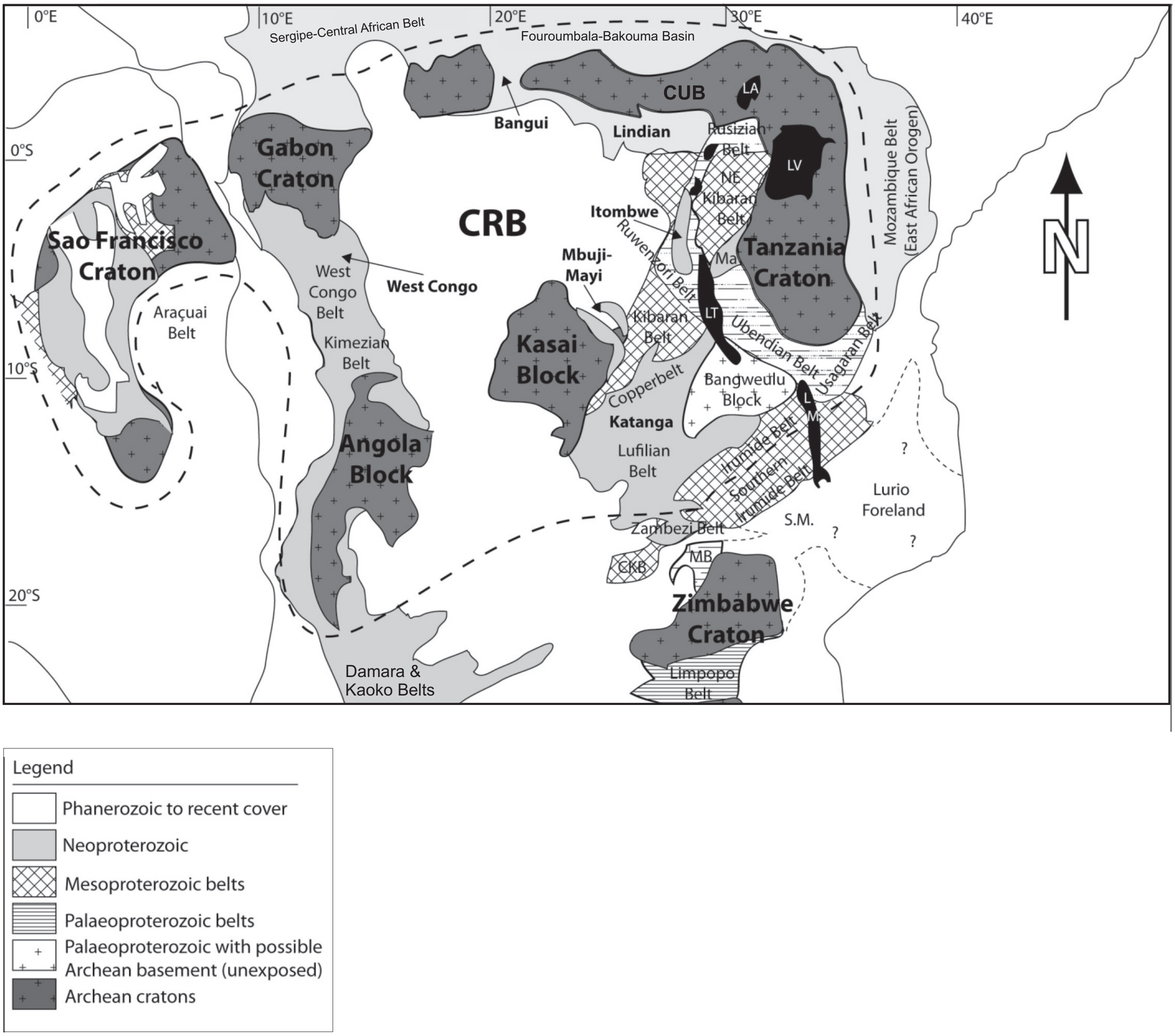
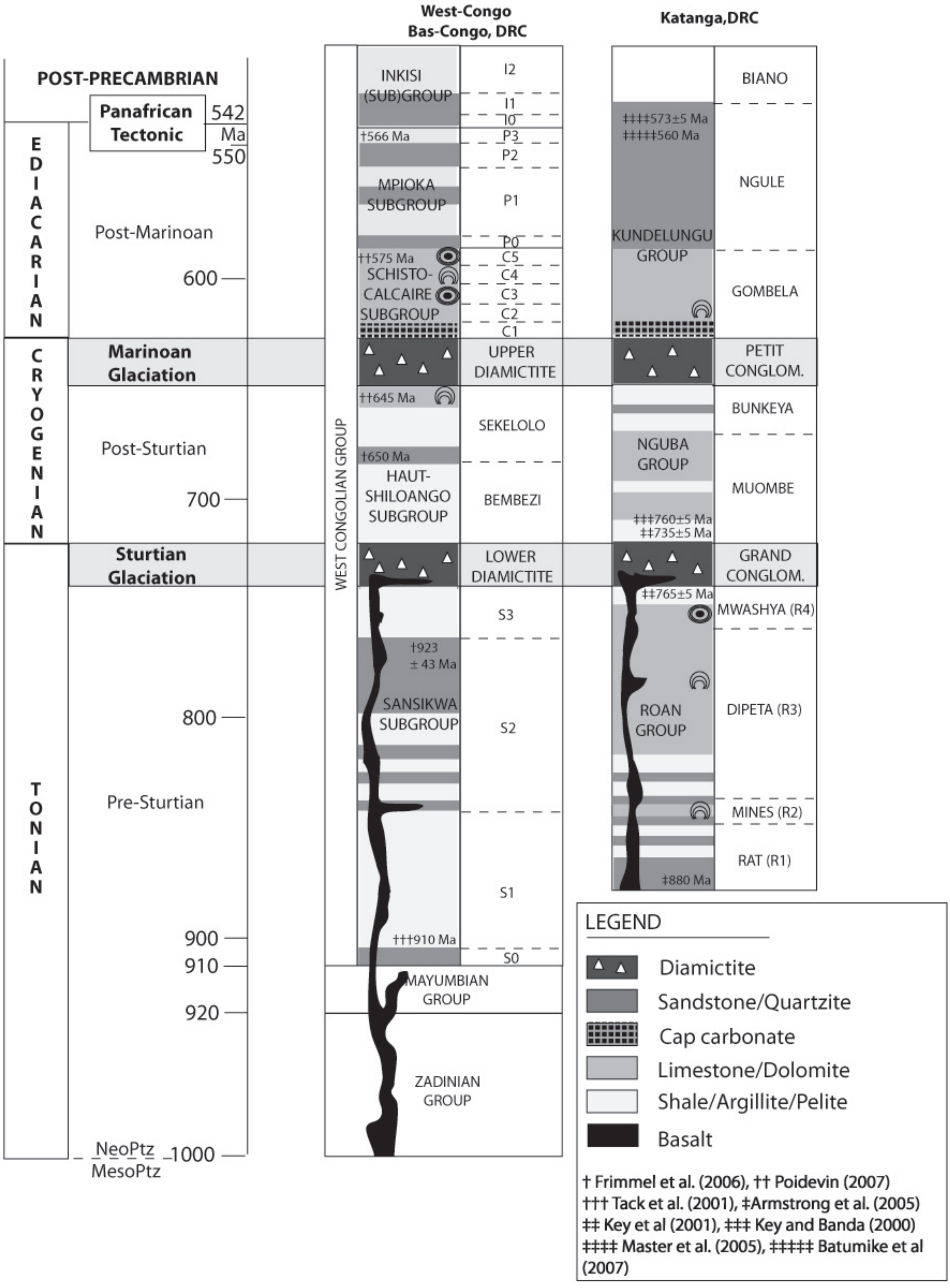

0°E
10°E
20°E
30°E
40°E
0°S
10°S
20°S
Sergipe-Central African Belt
Fouroumbala-Bakouma Basin
CUB
LA
Bangui
Lindian
Rusizian Belt
LV
NE Kibaran Belt
Mozambique Belt (East African Orogen)
N
Gabon Craton
CRB
Itombwe
Ruwenzori Belt
Ma
Tanzania Craton
Sao Francisco Craton
West Congo Belt
West Congo
Mbuji-Mayi
Araçuai Belt
Kimezian Belt
Kasai Block
Kibaran Belt
LT
Ubendian Belt
Usagaran Belt
Copperbelt
Bangweulu Block
Katanga
Angola Block
Lufilian Belt
Irumide Belt
Southern Irumide Belt
Lurio Foreland
S.M.
Zambezi Belt
MB
CKB
Zimbabwe Craton
Limpopo Belt
Damara & Kaoko Belts
Legend
Phanerozoic to recent cover
Neoproterozoic
Mesoproterozoic belts
Palaeoproterozoic belts
Palaeoproterozoic with possible Archean basement (unexposed)
Archean cratons

Figure 1



West-Congo
Bas-Congo, DRC
Katanga,DRC
POST-PRECAMBRIAN
Panafrican Tectonic
542
Ma
550
EDIACARIAN
Post-Marinoan
600
CRYOGENIAN
Marinoan Glaciation
Post-Sturtian
700
Sturtian Glaciation
TONIAN
Pre-Sturtian
800
900
910
920
NeoPtz
MesoPtz
1000
WEST CONGOLIAN GROUP
INKISI (SUB)GROUP
†566 Ma
MPIOKA SUBGROUP
††575 Ma
SCHISTO-CALCAIRE SUBGROUP
††645 Ma
†650 Ma
HAUT-SHILOANGO SUBGROUP
†923 ± 43 Ma
SANSIKWA SUBGROUP
†††910 Ma
MAYUMBIAN GROUP
ZADINIAN GROUP
I2
I1
I0
P3
P2
P1
P0
C5
C4
C3
C2
C1
UPPER DIAMICTITE
SEKELOLO
BEMBEZI
LOWER DIAMICTITE
S3
S2
S1
S0
‡‡‡‡573±5 Ma
‡‡‡‡‡560 Ma
KUNDELUNGU GROUP
NGUBA GROUP
‡‡‡760±5 Ma
‡‡735±5 Ma
‡‡765±5 Ma
ROAN GROUP
‡880 Ma
BIANO
NGULE
GOMBELA
PETIT CONGLOM.
BUNKEYA
MUOMBE
GRAND CONGLOM.
MWASHYA (R4)
DIPETA (R3)
MINES (R2)
RAT (R1)
LEGEND
Diamictite
Sandstone/Quartzite
Cap carbonate
Limestone/Dolomite
Shale/Argillite/Pelite
Basalt
† Frimmel et al. (2006), †† Poidevin (2007)
††† Tack et al. (2001), ‡Armstrong et al. (2005)
‡‡ Key et al (2001), ‡‡‡ Key and Banda (2000)
‡‡‡‡ Master et al. (2005), ‡‡‡‡‡ Batumike et al (2007)