Lithostratigraphic position and petrographic characteristics of R.A.T. ("Roches Argilo-Talqueuses") Subgroup, Neoproterozoic Katangan Belt (Congo)

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Abstract

The Neoproterozoic Katangan R.A.T. ("Roches Argilo-Talqueuses") Subgroup is a sedimentary sequence composed of red massive to irregularly bedded terrigenous-dolomitic rocks occurring at the base of the Katangan succession in Congo. Red R.A.T. is rarely exposed in a continuous section because it was affected by a major syn-parallel décollement during the Lufilian thrusting. However, in a number of thrust sheets, Red R.A.T. is in conformable sedimentary contact with Grey R.A.T. which forms the base of the Mines Subgroup. Apart from the colour difference reflecting distinct depositional/rocks conditions, lithological petrographical and geochemical features of Red and Grey R.A.T. are similar. A continuous sedimentary transition between these two lithological units is shown by the occurrence of vantage-type xenoliths R.A.T. in L. Strat. "Johannes Strataigne" formation of the Mines Subgroup conformably overlies the Grey R.A.T. In addition, a transitional gradation between Grey R.A.T. and D. Strat. occurs in most Cu-Co mines in Katanga and is marked by interbedding of Grey R.A.T.-type and D. Strat.-type layers or by a progressive petrographic and lithological transition from R.A.T. to D. Strat. Thus, there is an unquestionable sedimentary transition between Grey R.A.T. and D. Strat. and between Grey B.A.T. and Red R.A.T.

The R.A.T. Subgroup stratigraphically underlies the Mines Subgroup and therefore R.A.T. cannot be comprised of syn-genetic sediments deposited upon the Kalandunga (formerly "Upper Kalandunga") Group as suggested by Wendt et al. (2000). As a consequence, the Grey R.A.T. Cu-Co mineralisation definitely is part of the Mines Subgroup Lower Orebody and does not represent a distinct deposition of stanniferous Cu-Co sulphide mineralisationfraction from the Bazon orebodies.

Keywords: Lithostratigraphy; Petrography; R.A.T.—Mines Subgroup; Sedimentary rocks; Copperbelt; Congo

1. Introduction

The Neoproterozoic Katangan R.A.T. ("Roches Argilo-Talqueuses") Subgroup is a sedimentary sequence of red massive to irregularly bedded silty dolomitic rocks at the base of the Katangan succession in the Democratic Republic of Congo, simply called Congo in this paper (Table 1). Thrusting and nappe tectonics linked to the Lufilian orogeny (Kimpunzu and Calieux, 1999) led to the décollement of the R.A.T. Subgroup from its pre-Katangan basement (Franchon, 1973; Calieux, 1994). Despite this tectonic complexity, the relations between R.A.T. Subgroup and the other Katangan lithostratigraphic units, especially those hosting the ore deposits, were thoroughly documented.
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because of the stratigraphic control of the orebodies. The formal Katangan lithostratigraphic column is shown in Table 1 (François, 1973; Caillet, 1994).

Wendt (2000) claimed that Red and Grey R.A.T. (Table 1) are syn-orogenic sedimentary rocks younger than the Roon Group and deposited in the Katangan foreland basin after the deposition of the Nguba Group. The major arguments put forward to justify this interpretation are: (1) speculative existence of a tectonic break between R.A.T. and dolomites of the Mines Subgroup; (2) occurrence of R.A.T. breccias at the base of thrust stacks; (3) geochemical data supposedly indicating a very high maturity of R.A.T. rocks achieved during a syn-orogenic recycling of Katangan sedimentary rocks to generate R.A.T. rocks. In this interpretation, several facts were distorted and the author ignored critical field observations against this interpretation. The objective of this paper is to present field evidence showing that the R.A.T. Subgroup cannot be younger than the Mines Subgroup, being stratigraphically located under the Mines Subgroup. In a companion paper, Kampanza et al. (2005) show that petrochemical data also do not support the interpretation of Wendt (2000).

2. Geological background

The Neoproterozoic Katangan sedimentary basin stretches on both sides of the Congo-Zambian border and defines a north-directed thin-skinned thrust-and-fold orogenic system resulting from the convergence between the Congo and Kalahari cratons (Fig. 1). The Katangan supracrustal succession is subdivided into three lithostratigraphic units (François, 1974, 1995; Caillet, 1994, 2003; Caillet et al., 1984): Roon (code R), Nguba (code N; formerly Lower Kandulungu and Kandulungu (code K; formerly Upper Kandulungu) Groups (Table 1). The unconformity between the Roon Group and the Mesoproterozoic pre-Katangan basement is exposed in the N'zilo area, near Kolwezi (Fig. 1).

The Roon Group sedimentary rocks were deposited in a rift basin, that evolved from a continental rift basin filled by a siliciclastic and carbonate sequence (starting with a basal conglomerate), to a proto-oceanic rift basin filled dominantly with dolomitic shales (Buffard, 1988; Kampanza et al., 1991, 1994; Caillet et al., 1994). The widening of the basin during late Roon and Nguba deposition corresponds to a major phase of extensional tectonics and normal faulting marking the transition to

![Fig. 1. Location of the main ore deposits in the Central Africa Copperbelt (modified from François, 1974; Caillet, 1994).](image-url)
a Red Sea-type proto-oceanic stage (Kampunzu et al., 1993, 2000).

This basin closed during the Lufilian Orogeny leading
to the development of predominantly north-verging
tectonic folds, thrusts and nappes. In Congo, except for the Ni-
lo basin conglomerate, all exposed Roan sandstone
to Red Beds (Kantezhe, 1975; Brown and Charnmand,
1986). R.A.T. is a distinctive name for these rocks be-
cause fresh R.A.T. rocks lack primary mineralogy
preserved are devoid of talc and consist mainly of
diagenetic chlorite-dolomite and variable amounts of
silica minerals (detrital and diagenetic quartz, chert).
These three components represent >85% in R.A.T.
Talc a secondary mineral reported only in the oxidized
zone.

The reference lithostratigraphic section of the Red
A.T. Subgroup was selected on the basis of the investi-
gation of underground sections and a large number of
exploration boreholes drilled in the footwall of the
Masonzi copper deposit (Kabwe mining district), and
described by R. Oosterbooth in internal Geomines
mining reports before being synthesized and formalized
by Françoix (1973, 1974). The Katangan geologists used
this as the reference lithostratigraphic section because
the succession does not contain any breccia intercalations
and displays a 2.5 m thick continuous Red R.A.T.
sedimentary succession (Françoix, 1973, 1974). From top
to bottom it includes:

1. R. 1.1 (50 m): pink-lilac, massive, silty (5%)
   quartz, chlorite- (30–50%) and dolomite-rich
   (20–40%) rocks containing up to 5%
   hematite. More sandy and irregularly bedded
   lithologies mark the lower part of the succession
   where a marker unit called “grès oolitique” occurs.
   This marker unit includes interbedded sand-
   stones/siltstones with clay layers in the lower part
   (Fig. 2a).

2. R. 1.2 (45 m): pink to purple-grey, irregularly bed-
   ded chlorite-rich (45–55%) siltstones (30–40%)
   quartz with minor dolomite (10%) and hematite
   (5%); a pink silicified dolomite with local stromat-
   olites occurs at the top (Fig. 2b).

3. R. 1.3 (40 m): chlorite-rich (up to 50%) or sandy
   (up to 40% quartz) purple-red to pale orange ir-
   regularrly bedded siltstones (Fig. 2c) containing
   in addition hematite (10%) and minor dolomite (5%).

A critical observation from this continuous succes-
sion of Red R.A.T. is that the amount of dolomite in-
creases upwards (from 5% in R. 1.1 up to ~40% in R.
1.3), whereas hematite modal content decreases (from
10% in R. 1.1 down to 5% in R. 1.3).

Although, Red R.A.T. is rarely exposed in a contin-
uous section similar to the one exposed at Masonzi,
the reconstruction of Red R.A.T. lithostratigraphy from
all Katangan thrust sheets and nappes led to a consistent
distribution of the three R.A.T. formations identified
above. Several variations of facies have been observed

![Fig. 2.](image-url)

(a) "Grès oolitique" at the base of R. 1.3.1 Formation (Red R.A.T. 1) showing interbedded sandstones and siltstones with clay layers (dark), sample from Kako mine (Françoix, 1973); (b) siltstone pink dolomite with stromatolites, top of R. 1.2 Formation (Red R.A.T. 2), sample from beehive Kako at 30 m, Kako mine (Françoix, 1973); (c) R. 1.1 Formation (Red R.A.T. 1) showing irregularly bedded siltstones with minor
dolomite, sample from Kako mine (Françoix, 1973).
(Oosterbosch, 1962, François, 1973), e.g. pebbly sandstones occur in R. 1 at Tomboło (north of Kolwezi) whereas dolomite beds were documented in R. 1.3 at Kalonwe (south of Kolwezi). Regionally, a subaerial R.A.T. lithofacies occurs to the north whereas a chlorite-dolomite rich R.A.T. lithofacies marks the southern regions of the Lufilian Arc in Zambia.

Rocks forming the R. 1.3 Formation at Kamoto (Kolwezi mining district) and Kambove contain 25–40 vol.% detrital minerals consisting mainly of quartz. Accessory detrital minerals (<1 vol.% include green chlorite, red greenish chlorite (pseudomorph after biotite), muscovite, tourmaline, ilmenite, and ilmenite (Oosterbosch, 1962; Kateshia, 1975; Cailleux, 1983). No sorting of detrital minerals was observed in these rocks. Albite (3–6 vol.%) was reported in R.A.T. from Fungurume (Oosterbosch, 1950, 1962) but it is not yet known if it is diagenetic/metamorphic or detrital. However, detrital muscovite represents an important rock component (2–5 vol.%) at Fungurume (Oosterbosch, 1950, 1962) and is the only feldspar (<1 vol.%) at Kamoto (Kateshia, 1975). These observations contradict the assertion of Wendt (2000) that “feldspars are absent in R.A.T. rocks”.

Detrital minerals include dolomite, Mg-chlorite II pseudomorph after detrital minerals (Mg-chlorite I and biotite), chlorite/paragonite and quartz overgrowing detrital quartz, tourmaline overgrowing detrital tourmaline, monzonite, apatite, dolomite, hematite and detrital hematite converted to leucoxene-rutile (Cailleux and Dimanche, 1975; Kateshia, 1975; Lefebvre, 1976; Cailleux, 1978, 1983). Kateshia (1975) suggested that the detrital hematite in R.A.T. originated from diagenetic transformation of detrital ilmenite. Metamorphic minerals include mainly phengitic muscovite.


Grey R.A.T. ("R.A.T. greis") is a 1–8 mm thick dolomite or chloritic siltstone or silty dolomite (5–55 vol.% dolomite, 5–35% quartz, 30–55% diagenetic chlorite) occurring at the base of the Mine Groups. Red R.A.T. contains quartz (detrital and diagenetic overgrowths), chlorite, diagenetic Mg-chlorite and dolomite as the main rock-forming minerals (>90 vol.%). Accessory detrital and diagenetic minerals include tourmaline, green chlorite, muscovite, monzonite, apatite, dolomite, leucoxene-rutile and sulphides. Metamorphic minerals include mainly phengitic muscovite and phlogopite in the southern part of the Congo. Therefore, the main rock-forming and accessory minerals (detrital, diagenetic and metamorphic) are identical in Red and Grey R.A.T. The individual mineral compositions are also similar (e.g. Audouin, 1982; Olitaudj, 1989). The only difference between these rocks is their colour and the relative proportion of detrital and diagenetic minerals.

Red R.A.T. always contains a substantial amount of detrital minerals whereas the amount of these minerals is highly variable in Grey R.A.T., with some samples devoid of detrital fraction (e.g. Grey R.A.T. exposed at Tetoile, Lefebvre and Cailleux, 1975).

Except for its grey colour and the occurrence of sulphides, both indicating the deposition of the Grey R.A.T. sedimentary rocks in a reduced environment, other lithological characteristics such as the grain size, the mineral and whole rock compositions of Grey R.A.T. and Red R.A.T.—1.3 are similar at Shinkolobe, Kamoto, Fungurume, Kamonde, Kaboko and Kambove (Oosterbosch, 1950, 1962; Kateshia, 1975; Lefebvre, 1976; Cailleux, 1978, 1983; Moine et al., 1986). This led Katangan geologists to consider Grey R.A.T. as the topmost part of the R.A.T. succession deposited in an anoxic environment (Oosterbosch, 1950, 1962; Bartholomew et al., 1972; Cailleux, 1978, 1983, 1994).

In several places, Grey and Red R.A.T. are separated by breccias assumed to be of tectonic/sedimentary origin by Wendt (2000) and linked to tectonic processes by Cailleux and Kamperzen (1995). Important to stress is that the breccia separating R.A.T. and Mines Subgroups are not the so-called "R.A.T. breccias" of local mining geologists (Cailleux, 1978, 1983, 1994) documented a lithotriigraphic and petrographic continuity between Red and Grey R.A.T. in the Kambove area. The transition zone in this area is made up of 2.5–7 mm thick variegated pink to yellow-green R.A.T. located between red (0.5–3.0 mm thick) and grey (3.0–8.0 mm thick) R.A.T. (e.g. borehole Kya-10, Fig. 3). The progressive change of colour marking this transitional zone reflects a gradual decrease of hematite bound to diagenetic minerals (in dolomite, in quartz, and to tourmaline overgrowths). Along the transition zone between Red and Grey R.A.T., hematite in overgrowths of tourmaline and quartz progressively decrease in abundance. Most traces of hematite are found in the core of dolomite grins in the variegated yellow-green R.A.T. near the Grey R.A.T. There is no hematite in the Grey R.A.T., which instead contains pyrite. Whole rock chemical analyses and the distribution of quartz/chert, chlorite and dolomite indicate that there is no change at the transition zone between Red and Grey R.A.T. (Fig. 4). The progressive transition between Red and Grey R.A.T. is not unique to the Kambove area, since it was also described in borehole cores from Tenke, Kalukundi (ca. 20 km W of Tenke) and Shadi-musoko along the northern flank of the Damaraland Synclinorium between Tenke and Fungurume (Gonnelins unpublished reports).

Grey and variated R.A.T. were deposited in a supratidal-evaporitic environment as indicated by: (1) carbonate–quartz pseudomorphs after gypsum or anhydrite in lamellae of nodules karskafes (Fig. 5), (2)
the original lithological transition (evaporitic variegated R.A.T.) between Red and Grey R.A.T. occur in the same geometrical position beneath the Mines Subgroup and the succession always proceeds from Red R.A.T. (R.1.2 Formation) to Grey R.A.T. and to D. Strat. (Oosterbosch, 1950; François, 1975; Katekeshia, 1975). A section recently exposed in the Luizwani open pit illustrates this succession, starting with ca. 40 m thick Red R.A.T. (R.1.3) overlain by Grey R.A.T. (Fig. 6). The transition zone in this succession is ca. 1.3 m thick breccia including centimetre to decimetre sized clasts of both Red and Grey R.A.T.

There is no doubt that Red and Grey R.A.T. are in stratigraphic continuity and should be grouped together as suggested by all Katangan experts for several decades. Wendhoff (2000) does not question this conclusion, and even groups Red and Grey R.A.T. within a single lithostratigraphic unit as previously discussed by Calleux (1974). In contrast, according to the Katangan geologists, the Grey R.A.T. is part of the Mines Subgroup rather than the R.A.T. Subgroup for three reasons: (1) Grey R.A.T. is conformable with the overlying D. Strat. Formation whereas in most cases it is covered by Red R.A.T. by a tectonic contact; (2) it is a gray unit deposited under anoxic conditions as are the overlying Mines Subgroup units; (3) it is a mappable unit at 1:5000 scale with specific lithological features and thus deserves an individual lithostratigraphic rank. From a lithostratigraphic point of view, it could be taken for the uppermost formation of the R.A.T. Subgroup as suggested by Calleux (1964) and Wendhoff (2000), or as the lowermost unit of the Mines Subgroup (see above).

Some authors suggested that the breccia between Red and Grey R.A.T. could be a sedimentary conglomerate deposited from the erosion of the Red R.A.T. sediments, before the deposition of Grey R.A.T. This interpretation was based on an inferred erosional surface at the top of Red R.A.T. and on a presumed monogenetic composition (Red R.A.T.) of breccia clasts in the Kamoto mine (Bartholomé et al., 1972; Katekeshia, 1975). However, laterally the same breccia becomes polygenetic (Fig. 7), with clasts of Red and Grey R.A.T., D. Strat. and R.S.F. "Roches Siliceuses Fanélières" (Calleux, 1978; Calleux and Kampanzu, 1995). This invalidates a pre-Grey R.A.T. sedimentary origin for this conglomerate.

The major issue still to be resolved here is the linkage between Red and Grey R.A.T. and the rest of the Katangan lithostratigraphic units. As there is an agreement that Red and Grey R.A.T. are in stratigraphic continuity, the discussion will focus on the relationships between Grey R.A.T. and the rest of the Katangan lithostratigraphic units; and the conclusion drawn from this discussion then applies equally to the R.A.T. Subgroup.
5. Relationships between Grey R.A.T. and Mines Subgroup

Experts of Katangan lithostratigraphy (e.g. Oosterbosch, 1962; François, 1973, 1974; Calleux, 1994; Calleux et al., 1994) located the R.A.T. Subgroup stratigraphically beneath the Mines Subgroup on the basis of two critical observations, ignored by Wendorff (2000). These critical constraints are briefly reviewed below.

5.1. Conformable sedimentary contact between Grey R.A.T. and D. Strat. Formations

The Grey R.A.T. is always conformably overlain by alcy dolomitic of the D. Strat. “Dolomies Stérilisées” Formation (Mines Subgroup), Wendorff (2000), disturbing published data of Calleux (1973), claims that the contact R.A.T.-D. Strat. is brecciated and/or tectonically affected. However, what this author did not realise is that the tectonic contact commonly occurs between Grey and Red R.A.T., sometimes within the Red R.A.T. in areas where a continuous succession Red-Varnished-Grey R.A.T. was documented, or between other Mines Subgroup lithological units (e.g. D. Strat.) and Red R.A.T. where the tectonic break cuts across the Mines Subgroup succession (ramps), but there is usually no tectonic break between Grey R.A.T. and D. Strat. The contact between these two lithostratigraphic units is always a “clean” conformable sedimentary contact (Oosterbosch, 1959, 1962; Densamentaer et al., 1983; François, 1973, 1987; Katkechea, 1975; Lefèvre and Calleux, 1975; Lefèvre, 1976; Calleux, 1978, 1983).

5.2. Evidence for a lithological transition between R.A.T. and D. Strat. rocks

Wendorff (2000), misquoting previously published data, claims that “feldspars are absent in the R.A.T.
Fig. 6. (a) Panoramic view of the relationships between Red R.A.T.--Mines Subgroup Formations (Grey R.A.T. -- D. Strat.) normal stratigraphic succession, Luwiwezi ore deposit; (b) breccia at the contact between Red and Grey R.A.T. including both Red and Grey R.A.T. fragments.

Fig. 7. Breccia between Red R.A.T. and Mines Subgroup--formations containing Red R.A.T., Grey R.A.T. and Kamono Formation (e.g. R.S.F) clasts; borehole Kala-342, Kalaonda (Cailleux, 1974, 1983).
Calleva, 1978, 1983). In the Kambone area, the base of D. Strat. is marked by a substantial amount of detrital quartz (20 vol.%) and, sometimes, by millimetre- to centimetre-sized soft clasts of Grey R.A.T (Calleva, 1978, 1983; Fig. 8). These clasts indicate that unconsolidated Grey R.A.T. was eroded and re-deposited in the younger D. Strat. dolomites. This requires a tectonically active sedimentary depocentre and this interpretation is supported by the occurrence of erosional surfaces in the D. Strat. dolomites (Fig. 8a). The most important conclusion from this observation is that R.A.T. was deposited before D. Strat. dolomites.

A continuous sedimentary transition between Grey R.A.T. and D. Strat. is exposed in the Luwiwishi-Etoile area. In most Cu-Cu deposits in Katanga, millimetre to decimetre-thick Grey R.A.T-type layers are interbedded in the Kamboto Formation, from D. Strat. up to R.S.C “Roches Silicéseuses Cellulaires” (Oosterbeek, 1962; Belliere, 1976; Calleva, 1978, 1983). These layers are reminiscent of varves and could mark seasonal variations in the sedimentary basin (Fig. 9).

This suggests a strong linkage between these lithostratigraphic units and this is supported by geochemical investigations (Kampuzi et al., 2005). The conclusions by Wendorff (2000) that there is an abrupt petrographic/lithological change from R.A.T. to D. Strat. and that the contact between these two formations is tectonic, reflect an incomplete understanding of the Katangan geology. There is an unquestionable continuity and sedimentary transition between Grey R.A.T. and the overlying D. Strat. As the same time, all workers agree upon the continuity between Grey and Red R.A.T. As a consequence, applying the principle of stratigraphic superposition, the R.A.T Subgroup has to underlie the Mines Subgroup.


In several places within the Katangan belt (e.g. Kamboto and Kambone-Ouest deposits), Grey or Red R.A.T. is in contact with the Kudelungu Ku 2.1 Formation (e.g. Kolwezi, Kambone: Calleva and Kampuzi, 1995, Table 1). Wendorff (2000) assumes that Red R.A.T. is made of syn-orogenic sediments deposited upon Ku 2.1 Kudelungu rocks through an angular unconformity. But, whenever the contact R.A.T.-Kudelungu was observed, it is a tectonic contact. Shales and siltstones of the Ku 2.1 Formation, and R.A.T. formations display a tectonic fabric near that contact which does not occur within the same lithological unit a few hundred metres away (Fig. 10). Layer-parallel faults and imbricate faults affect the Kudelungu formations along that contact.

Kudelungu Group sedimentary rocks have petrographic features that are distinct from R.A.T. and Mines Subgroup rocks, i.e. they are richer in detrital feldspars and micas (Belliere, 1966; Francais and Calleva, 1981). The Kudelungu succession is well known and mainly siliciclastic. It includes sandy and dolomitic shales lithologically and petrographically distinct from R.A.T. (Fig. 11). To the north of the Lubiliko Arc, the Kudelungu rocks include coarse arenites and three pinkish carbonates forming the marker members Ku 1.2.1, Ku 1.3.1 and a 1 m thick member in the Ku 2.1; these units pinch out southwards (Francais, 1973, 1974). The arenites contain 60–75 vol.% detrital minerals (20–40 vol.% quartz, 5–15% feldspar, 15–35%...
muscovite), 15-25% dolomite, 5% diagenetic chlorite and 5-15% of other minerals, e.g. titanite and tourmaline (François, 1987; Batumile, unpublished data). Detrital titanite is common in Kundelungu rocks whereas it is absent in R.A.T.

7. Geochronological constraints

There are not yet direct geochronological data constraining the age of R.A.T. Subgroup rocks. However, available geochronological data on other Katangan lithological units allow placing preliminary constraints to this debate. The classical lithostratigraphic column places R.A.T. rocks in the lower part of the Katangan sedimentary succession, deposited after ~880 Ma, which is the age of detrital zircons in the lower part of the Katangan sedimentary succession (Armstrong et al., 1999), and before 780 Ma which is the age of Mwashya volcanic rocks (Armstrong et al., 1999; Kay et al., 2001)

located stratigraphically above the R.A.T. Subgroup (Table 1). The Grand Conglomerat, representing a tillite correlated with the 750 Ma worldwide Sturtian glaciation event (Kampanyu and Calleux, 1999) directly overlies the Mwashya Subgroup rocks. According to Wendork’s model, R.A.T. is stratigraphically part of the Kundelungu Group and rests above the Ku 2.1 Formation that is underlain by the Peik Conglomerate Tillite. The age of this second tillite is not yet constrained, but a correlation with the worldwide 620-660 Ma Sturtian glacial deposits is inferred. Therefore, according to this interpretation, the R.A.T. Subgroup is younger than 620 Ma and should be a correlate of the red siliciclastic sedimentary rocks forming the Kundelungu plateau and containing detrital zircons yielding Ar–Ar ages younger than 565 Ma (S. Master, personal communication, 2001). However, in several Katangan Cu-Co deposits (e.g. Shinkolobwe, Luwirishi, Red R.A.T., Grey R.A.T. and overlying Mines Subgroup formations are cut by uranium veins yielding ages >690 Ma at Shinkolobwe and around 625 Ma at Luwirishi (Lorin et al., 1997; Kampanyu and Calleux, 1999). R.A.T. is older than Kundelungu rocks and, therefore, cannot have been deposited upon the Kundelungu Group as suggested by Wendork (2000).

8. Implications for Cu-Co mineralisation

Two major Cu-Co stratiform orebodies hosted in the Mines Subgroup characterize the world-class ore deposits in the Congolese Copperbelt (Calleux et al., 2005,
and references therein). The Lower Orebody is hosted by rocks of the following sedimentary units: top of Grey R.A.T., D. Strat., R.S.F and base of R.S.C. The Upper Orebody occurs in the following sedimentary units: top of R.S.C, SDB ("Shale Dolomite de Base") and BOMZ ("Black Ore Mineralized Zone"). Wendoff (2000) concluded that the olistostrome horizon includes R.A.T., sedimentary rocks and marks a prominent geochemical change from oxidising to reducing conditions responsible for the origin of syngenetetic diageneric Cu-Co mineralisation in the Grey R.A.T. rocks. In this perspective, the Grey R.A.T. sulphide mineralisation represents a separate mineralisation event emplaced after the deposition of the Kudelunga and related to the development of the foreland basin. The data in this paper indicate that R.A.T. is not younger than Kudelunga and is not related to the development of the foreland basin; its stratigraphic position beneath D. Strat. is confirmed. This implies that the major stratigraphic host of R.A.T. (top of the Grey R.A.T.) connects with the more important mineralisation hosted in D. Strat.-R.S.E-base of R.S.C to form the Mines Subgroup Lower Orebody, as indicated by all previous works (Gosterbosch, 1962; Bartholomé et al., 1972; François, 1973; Ketchmark, 1975; Lefèvre and Cadena, 1975; Ohitotsi, 1989; Loris, 1996). As a consequence, the prominent geochemical change from oxidising to reducing conditions in the R.A.T. rocks (from Red to Grey R.A.T.) explains not only the deposition of syngenic/diagenetic Cu-Co mineralisation in the Grey R.A.T., but also in the whole Mines Subgroup Lower Orebody.

9. Conclusions

The main conclusions of this study can be summarized as follows:

1. Red R.A.T. lithotype exposed in the Kolwezi area does not contain any breccia, and includes three lithostratigraphic formations displaying an increase of dolomite upwards, correlated to a decrease of hematite modal content from R 1.1 to R 1.3. A marker lithostratigraphic unit called "gries oediles" made of interbedded sandstones/siltstones with siltstone layers occurs in the R 1.3. Derival fields characterised in R.A.T. and Mines Subgroup rocks exposed in the northern part of the Luflian Arc. They are absent in correlative rocks from the southern part of the Arc in Congo. Grey and Red R.A.T. have exactly the same mineral composition for both main rock-forming and accessory minerals. The colour difference between these rocks results from their depositional environments, which was oxidising during the deposition of hematite-bearing Red R.A.T. and anoxic for sulphide-bearing Grey R.A.T. and the overlying Mines Group lithologies. A gradual transition marks the progressive change of redox conditions in the Katangan basin during the deposition of R.A.T. is the existence of variegated R.A.T. preserved in few areas where the sedimentation did not affect this transition zone.

2. A well preserved conformable sedimentary transition marks the contact between Grey R.A.T. and the overlying D. Strat. There is un unquestionable sedimentary continuity between Red R.A.T., Grey R.A.T. and D. Strat.; therefore, R.A.T. cannot be taken for a sedimentary unit deposited upon the Kudelunga Group, as suggested by Wendoff (2000).

3. Field relationships and available geochronological data suggest that R.A.T. rocks were deposited between 880 and 760 Ma, whereas Kudelunga rocks (above the Petit Conglomérat) are younger than 630 Ma. All Katangan sedimentary rocks older than 570 Ma were deposited in a rift basin far away from any plate convergence (Kampunzu et al., 1991, 1993, 2000) and therefore, R.A.T. cannot represent a syn-orogenic sedimentary unit originating from erosion of the emergent thrusts fronts and deposited in a foreland basin, as speculated by Wendoff (2000).


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