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LITHOSTRATIGRAPHIC STUDY OF THE MPIOKA GROUP AND THE INKISI GROUP IN THE NTADI AND NDUMBA/KONGO CENTRAL AREA

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SUMMARY

The lithological sequence of the upper part of the Mpioka Group, essentially pelitico -arenaceous, includes an alternation of sandstones and argillites. The hues generally observed in these formations are salmon and brownish red, green, wine red at the top, the major constituents of these rocks are quartz, feldspars, mica, opaque minerals and lithic debris. Quartz grains are coarse and cracked. The sandstone beds result from rapid sedimentation of medium-density debris flows; on the other hand, the argillite beds are deposits resulting from the suspensions of low density turbidity currents. The succession of green and red coloring of the shales testifies that during the deposit of the Mpioka Group , we pass from oxidizing conditions to reducing ones and to a return to initial conditions. The origin of the sediments is established on the basis of detrital grains such as quartz, feldspars, micas, zircon and rock fragments.

Keywords: bedding, lithology, inkisi, mpioka, sandstone, shale

INTRODUCTION

During the geological survey of a given area, a very good description of the rocks encountered is of great importance given that the geological formations of the study area will remain unchanged regardless of the genetic hypotheses that may be derived from them, ideas which, moreover, are in perpetual evolution. In sedimentology, the facies of a sedimentary rock is the set of its figures, its coloring, its biological and lithological characteristics. This facies requires both a macroscopic and microscopic description in order to determine the nature and number of the chemical and detrital phases that compose it, the shape of the grains and their origin; ultimately its petrographic type according to the lithological classifications in vogue.

The objective of this work is to determine the petrographic types of the rocks constituting the upper and lower part respectively of the formations of the Mpioka group and that of the Inkisi .

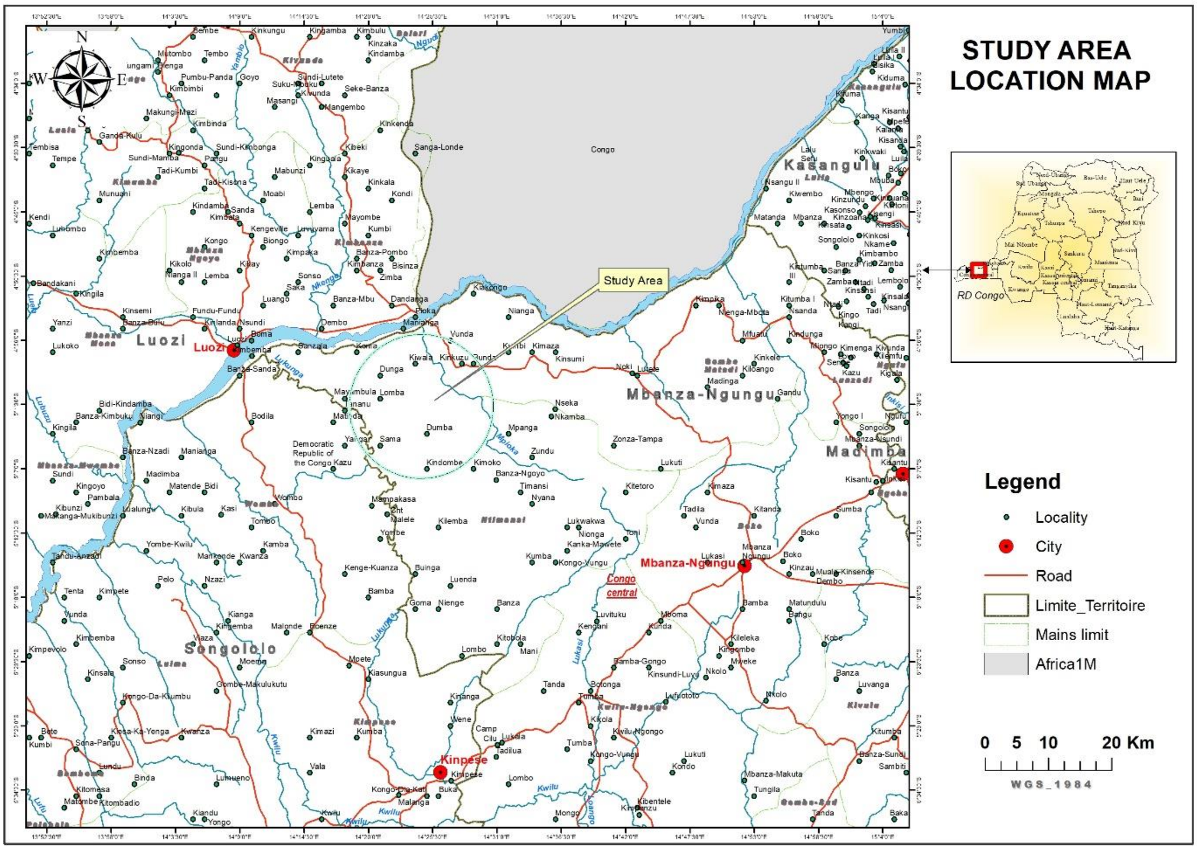
Its interest lies in the fact that this sector is the only one to have easy access where the contact between the two formations is visible; hence the advantage of proving the break, both tectonic and sedimentological , which exists between these two consecutive detrital units of the unit formerly called " Schisto -sandstone".

The concern of this study is to show the comparison from all points of view that exists between these two litho-stratigraphic units having led to confirming or invalidating the break between the West-Congo Super group (Mpioka Group) and the Super group of the Congo . ' Inkisi (Inkisi Group).

I. GEOGRAPHICAL FRAMEWORK OF THE STUDY AREA

Located in the cataracts district, Mbanza-Ngungu territory , Kongo Central province, the Ntadi and Ndunga sector is between 14° 21' and 14° 26' East longitude; and between 5° 00' and 5° 06' South latitude.

The province of Kongo Central is characterized by a tropical Sudanese climate whose dry season generally extends from May 15 to September 15 and that of the rain from September 15 to May 15; the average annual temperature oscillates around 25°C. In the same month, the amplitude of the variations does not exceed 10°C.



Source: National Geographic Institute

In the region where the Lombo and Luwa rivers flow, the dominant morphological features are the Bangu plateau as well as the Schisto -limestone depression. The average altitude varies between 550 and 700 m.

II.GEOLOGICAL FRAMEWORK OF THE STUDY AREA

Located in the foreland of the West Congo chain (Lepersonne 1973, square degree S6/14 B5.33.9), the Bangu plateau includes the stratigraphic units below (according to the notice of the geological map of Kongo Central reviewed by CRGM -RMCA, 2013, square degree S6/14) of bottom and top:

- The Basement of Kasai-Angola (Archean);
- The West-Congo Super-Group (Neo-Proterozoic);
- The Inkisi Supergroup (Post-Proterozoic);
- Recent superficial formations.

➢ The West-Congo Super Group:

Mpioka sub-group

Mpioka Subgroup is composed of alternating sandstone -clayey sediments with a recurrent feldspathic character and common conglomeratic intercalations. The dominant color is variegated red and green. It is composed of two Formations: that of Lianzama-Kibuzi (P II) which has two members and the Vampa Formation (PI) which also has two members. The thickness of all the Formations of the Mpioka Group has was estimated at around 1000m. This is a maximum figure and we could not control the real thicknesses of all the Formations but it is obvious that at the cliff of Mont Bangu , the Mpioka Group resting on the Lukala Group at its base and headed by the erosion plane of the Inkisi at the top is not 1000m.

Formation of the Lianzama – Kubuzi (P II)

Alternating locally carbonated red to gray-green argillites (member of the Liansama), in the lower part of the formation, with variegated felspathic quartzites with locally pebbles of shale and chert , and a few levels of micro breccia with carbonate elements, and locally a conglomeratic level at the base (member of the Kubuzi).

Formation of the Vampa (PI)

Gray to red argillites and silts with intercalations of locally feldspathic gray quartzites (member of the Vampa), with some levels or conglomeratic or even brecciated lenses with schistose or calcareous elements. A conglomeratic level may be present at the base (member of the Bangu and the Niari) comprising elements, locally cephalic , typically coming from the underlying formations (Lukala subgroup).

Lukala sub-group

The notion of " schist -sandstone" having been dismantled by the with drawal of the Inkisi from the Cataracts Group, it seemed useful to us to also replace the term " schist -limestone" by a more appropriate name linked to the region of the stratigraphy and thus the name of the village of Lukala, place of the cement plant, and at the heart of the Subgroup was taken to designate this Subgroup. The Sub-group comprises four essentially carbonated Formations with clay-carbonate intercalations and rare slightly sandstone past. Stromatolites are regularly present there. The Sub-group totals a thickness of around 1200m.

Ngandu formation (C IV)

argillites, silts and calc -argillites with some intercalations of gray to green clay-sandstone limestones.

Bangu formation (C III)

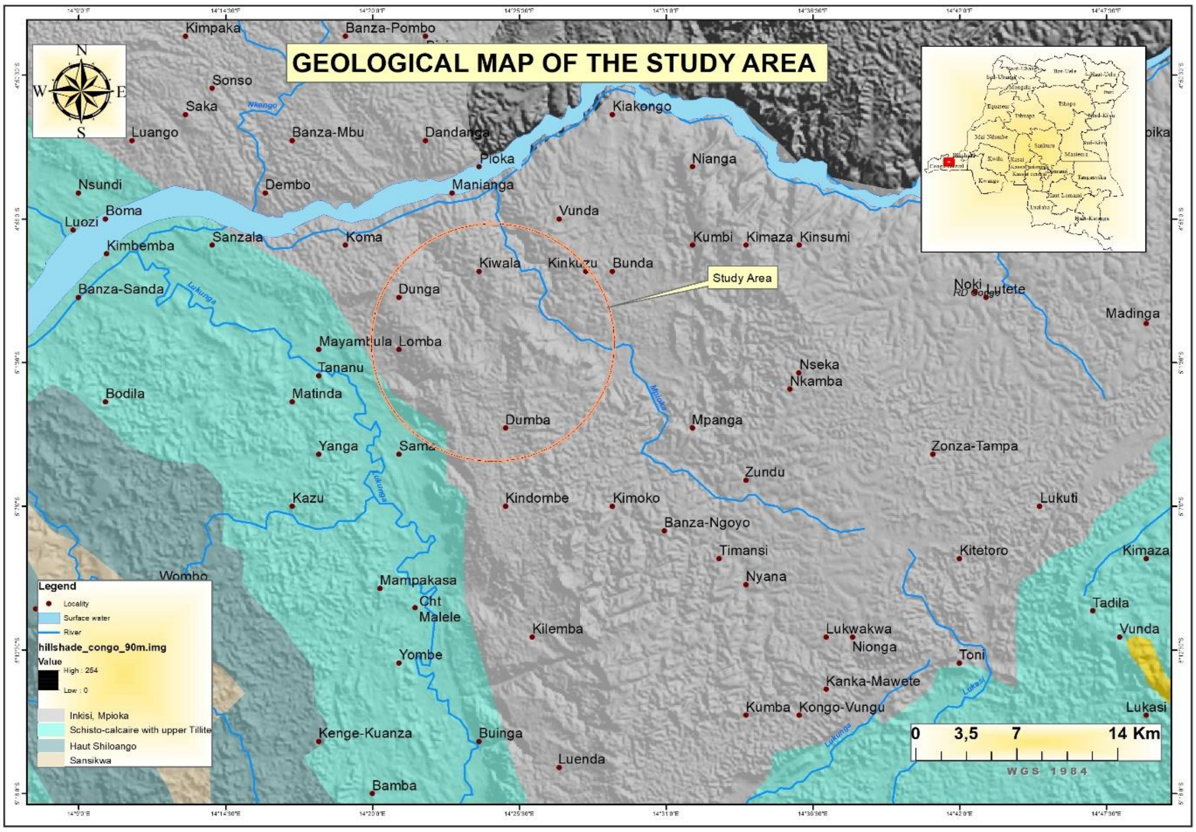
Massive limestone or light gray clay with cherts and oolitic levels, dark dolomitic limestone with intercalations of argillites and gray calc -argillites, black dolomites with oolite lenses (Kisantu); locally conglomerates and calcareous breccias at the base. Stromatolites are regularly present in the formation.

Lukunga formation (C II)

Alternation of gray to purplish calc -argillites with very abundant cherts with dark gray to gray-mauve limestones and dolomites, macignos ; locally with layers of oolites and stromatolites . The base and top of the formation are more clayey with argillites and calc -argillites, but with very abundant cherts and macignos at the top.

Kwilu training (CI)

Alternation of argillites , calco -argillites, sandstone limestones, macignos , clayey quartzite passing in the upper part to blue and light gray limestones, locally oolitic or with stromatolites; a level of finely zonal pink to gray dolomite occupies the extreme base of the formation.



Source: Extract from the geological map of Kongo Central (Ex Bas-Congo) (LAPERSONNE, J., 1973)

III. METHODOLOGY

To achieve this objective, we resorted to the geological survey and the current techniques of petrography, both macroscopic and microscopic.

a) Geological survey
During this phase, we proceeded to collect samples along the Lombo and Luwa rivers . The different samples recorded under a number preceded by the initials LB or LW of the name of the river are positioned on the 1/50,000 map. The taking of digital photos accompanied the macroscopic description of the samples.
b) In the laboratory
The macroscopic and microscopic descriptions allowed the elaboration of the stratigraphic log litho. The inventory of the bedding (photographed in a sawn section) and of the shapes of the quartz grains made it possible, respectively, to restore the hydrodynamic conditions of the placement of the sediments, and the origin of the sands. See table1.

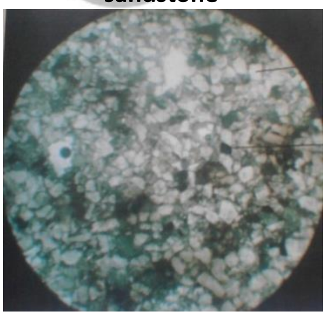
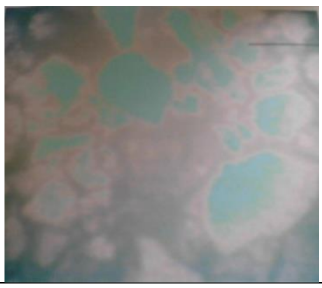
The comparison from all points of view of these two lithostratigraphic units led to confirming or invalidating the break between the West-Congo Super group (Mpioka Group) and the Inkisi Super group (Inkisi Group).

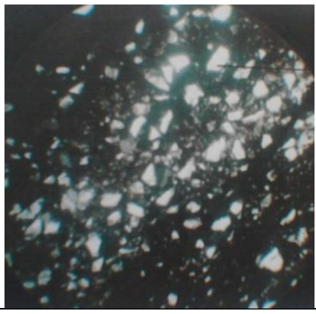
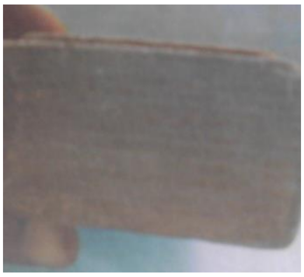
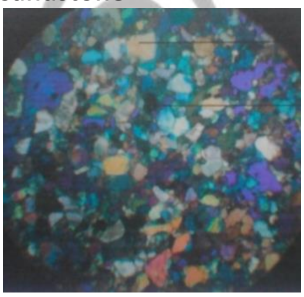
IV. RESULTS AND INTERPRETATION

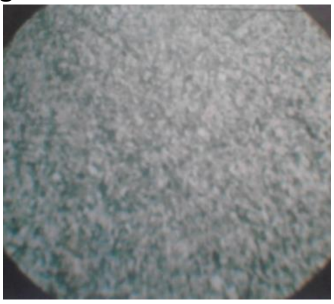
a) RESULTS

From bottom to top we have the following sequence:

Table 1: Macroscopic and microscopic description of lithofacies

No.	SAMPLE	ROCKS (Thin Section or Polished Section)	MACROSCOPIC EXAMINATION	MICROSCOPIC EXAMINATION
1.	LB1	**Heterogranular lithic sandstone** 	- Sandstone benches 50 cm thick - The dips (52° towards SE and 20° towards NW) - Fine-grained rocks - Bedding: uniformly laminated sands - Shades: dark lilac and burgundy	- 80% contiguous quartz grains up to 1 mm in diameter - 15% opaque minerals - ferruginous cement
2.	LB1'	**heterogranular lithic sandstone** 	- Sandstone benches 50 cm thick - The dips (52° towards SE and 20° towards NW) - Fine-grained rocks - Bedding: uniformly laminated sands - Shades: dark lilac and burgundy	- and cracked quartz grains up to 1 mm in diameter - 10% feldspar (plagioclase and microcline) - 10% opaque minerals - ferruginous cement
		Shale	- Bank of very finely bedded shales, - Thickness: 10cm, - Dip: 5° to the NW, - milky white quartz beds , - Finely interlayered bedding ,	This rock has not been analyzed microscopically, because it is soft and friable.

3.	LB2		- Presence of black iron oxide	
4.	LB3	**Sandy claystone.** 	- Benches of finely bedded sandstone -clayey rocks, - 40cm thick, - 5 cm dips 23° NW, - Bedding: uniformly laminated sand,	- Alternating beds: light (1.2 mm thick made up of 20% quartz grains) and dark (1.35 mm thick coarse and fine (0.30 to 0 - Quartz grains disseminated in a clay-ferruginous paste
5.	LB4	**Shale** 	- Bank of very finely bedded shales, - 5cm thick, - Dip of 5° NNW, - *Finely interlayered* bedding	This rock has not been analyzed microscopically, because it is soft and friable.
6.	LB5	**heterogranular lithic sandstone** 	- Bench of strongly diaclased sandstone , - 50cm thick, - Fine-grained milky white quartz, - Slightly layered remarkable for a variation in hue, - *Uniformly rolled sand* " type bedding	- The rock is essentially composed of more than 80% of contiguous quartz grains from 0.03 to 0.5 mm in diameter, we observe - Some linked opaque minerals, - A ferruginous cement
7.	LB6	**Shales**	- Bank of very finely bedded shales 81 cm thick, - Dipping 30°NW showing thick beds of less than 1 mm, - Salmon-coloured and slightly whitish, intercalated between ocher beds whose rhythmic variation in thickness highlights a sequence of deposits: one passes from very thick beds (5 to 10 mm) to less and less thick beds (up to 'at 1 mm), - It is " *finely inter-layered bedding*	This rock has not been analyzed microscopically, because it is soft and friable.

7.	LW3	**green shale** 	- Bench of fine-grained dipping shales, - 45cm thick - Dip 11° NW - Arranged in a stratum and with an elephant skin structure, - Greenish in color with some more or less visible flakes. - The bedding is " *finely inter-layered*	- The rock is made up of very fine quartz crystals (5 to 10%) that can reach 0.15 mm in diameter, - Also 5% of more or less abundant muscovites. - The cement binding these crystals is clayey
8.	LW2	**Shale**	- Alternation of shale beds - Dipping 15°NW, - 50 cm thick and those 30 cm arranged in a stratum, - reddish brown in color, - A few visible flakes of muscovite, - The bedding is finely inter-layered. - By weathering, the rock becomes impregnated with black oxides	This rock has not been analyzed microscopically, because it is soft and friable.
9.	LW1	**Feldspar sandstone** 	- Sandstone bench 80 cm thick - Very coarse-grained quartz, milky white or brownish-red in hue, - Dip 8°NE, - Showing an evenly rolled sand type bedding. - The rock is porous and among the grains, - It weathers into a sandy rock of a brownish hue, - Some flattened pebbles are observed in places	- Microscopic examination shows that the rock is composed of more than 80% of large quartz grains joined together, the diameter can reach 1.3 mm, sometimes cracked, - A few rare weathered feldspar crystals, - Bound by ferruginous cement

b) INTERPRETATION OF RESULTS

The alternation of sandstone and shale beds in the Lombo River can be explained by an intermittency in the speed of the currents: the sandstone beds result from rapid sedimentation of medium-density debris flows; on the other hand, the argillite beds are deposits resulting from the suspensions of low density turbidity currents.

We can think of an episodic reactivation and penetration of the paleo-relief or even of seasonal and much more astronomical causes which would justify the interval of geological times necessary for such deposits.

The shales in the upper part correspond to the mud flat in the subtidal or could it be the bottomset of a delta. Since the rate of aggradation is not the same, the lenticular appearance can be explained by a hiatus in the non-deposition of coarse quartzites and green shales.

The succession of green and red colorations of the shales testifies that during the deposition of the Haute- Mpioka formation , we pass from oxidizing conditions to reducing ones and to a return to initial conditions. The variation in the stratification of the waters (from an epilimnion to a hypolimnion conducive to the precipitation of the green mineral, glaucony and back to an epilimnion) would explain the variations in the oxygen content of the environment and therefore those of green and red tints. .

Table 2: Processes and environments for the establishment of different sedimentary structures (Rein Eck and Singh, 1973, 446p)

Structures and implementation process	**Deposition media**
1. Horizontal bedding and uniformly laminated sands - exposure of the sands to the waves - single bed upper wave phase	Beaches shoals shore faces Supra tidal of the beaches
2. Finely inter-layered bedding - flux and reflux of the current-pulsation during the settling of clouds in suspension, -sorting of suspended clouds, -mar changes -seasonal changes	Intertidal Flats Intertidal flats, platforms Intertidal flats, platforms Intertidal flats Very shallow seas to deep standing basins, intertidal

From the comparison between the two successive groups of Inkisi and Haute- Mpioka , we retain three orders of paradox.

- original order paradox

The lower degree of wear of quartz grains in the very coarse feldspathic sandstones of Inkisi suggests a very close origin, probably in the plutonic and metamorphic massif of Chaillu . While the very high degree of wear of quartz grains in the upper part of Upper Mpioka highlights a very distant feeding area with metamorphites and/or plutonites and especially with volcano -sedimentary rocks very probably belonging to the of Mpozo-Tombagadio , granitic massif of Noki or the bedrock of Kasaï-Angola.

To further affirm this opposition between the two groups, we rely on the arguments drawn from the work carried out by *Alvarez* (1990, 340p) on the deltaic cyclicity of the deposits of the Inkisi rocks .

- Depositional paradox

The deltaic cyclicity of the deposits of the Inkisi rocks attested by the position of the median grain growth sequence - fine and clean sands with oblique bedding due to these currents directed towards the south (distal facies of the mouth bar, close to the bar facies of the pro-delta under a preponderant fluvial influence); sandy-clayey, chloritic intercalations in increasingly coarse sands and scattered pebbles (mouth bars, less and less distal, and distributing channels prograding towards the south); thin sand-clay past finer with detrital chlorites of continental origin (deposits of alluvial plain or, more probably, of bays in calm zones located between the outlets of the distributing channels) – between the coarse deposits gullying from the distributing channels (Alvarez *, 1990 341p*) testifying to a deposit in a depressed continental area fed by north-south rivers, opposes the deposit on a tidal flat of Upper Mpioka as demonstrated previously. We can deduce from this a long interval of geological time separating the two units of the unit formerly called schisto -sandstone.

- Deformational paradox

According to Cibambula (2005), the double network of fractures observed in the rocks of Inkisi is due to vertical compression caused by a slow epirogenic movement of subsidence or uplift. On the other hand, the triple network affecting the upper part of the underlying Upper Mpioka formation results from a lateral compression at the origin of the vast Bangu syncline , long before the deposit of the Inkisi rocks . To this end, in the absence of a real erosional surface between these two units, their contact is a cartographic discrepancy to be sought elsewhere.

In short, all these oppositions between these two schisto -sandstone units confirm that these two groups (Mpioka and Inkisi) do not belong to the same lithostratigraphic unit , the West- Congolian Group of the West-Congo supergroup.

CONCLUSION

In the Ntadi and Ndunga sector , the deposit on a tidal flat sometimes mixed, sometimes sandy or muddy of the Mpioka group comprising from bottom to top: sandstone, shale, sandstone-clayey, shale, sandstone, shale, shale, shale , passes successively from an alternation of rapid sedimentation of medium-density debris flows with low-density turbidity currents, to the maintenance of the latter. This rhythm, remarkable even for the types of finely interstratified bedding and uniformly laminated sands, may be linked to short-term causes such as the swinging of the tides; in the medium term, such as seasonal variations in the speed of the waves; or to climatic changes in the astronomical cycle of Milankovitch or to biostatic and rhexistatic episodes of paleo-reliefs.

The oxidation-reduction front highlighted by the transition from red, wine-red to green, and from green to red is a major geological event probably linked to the aerobic photosynthesis of primitive cyanobacteria releasing oxygen during the deposit of brightly colored rocks; and anaerobic photosynthesis releasing sulphur, iron reducer, pigment of dark tints.

The rocks of origin of the sediments are multiple: volcanic for the automorphic quartz grains and with indented borders; plutonic for xenomorphic grains ; metamorphic for quartz mosaics; and sedimentary for the secondary growths inside the grains and the grains with tiny agglomerated crystals.

The break between the groups of Mpioka and Inkisi is justified by the paradoxes of orders: original, depositional and deformational.

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