Analecta Technica Szegedinensia

Vol. 18, No. 4 ISSN 2064-7964 2024

CONTRIBUTION TO THE PETROGRAPHIC STUDY OF THE GEOLOGICAL FORMATIONS OF THE MBANGA SECTOR AND ITS HEADWATERS IN THE TSHELA TERRITORY (CENTRAL KONGO, DRC)

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Received: 8th November	*Accepted: 11th December*

ABSTRACT

In order to fill the glaring gaps in the geological data for the Mbanga region and surrounding area, in the Province of Kongo-Central in DR Congo, geological investigations were carried out in the field over a three-week period. The results obtained, coupled with those from the laboratory, led to the identification of eight different lithofacies in the study area, namely: metaryolites, sericite schists and biotitose schists, all with grey to greenish grey facies. This work consists of a detailed petrographic study to identify the different facies of the West Congo Supergroup belonging to the Mayumbian Group and the Zadinian Group. The geology of the Mbanga sector and its surroundings is made up of metamorphic layers of volcanic and sedimentary origin. The various rock formations in our study area are grouped into two West Congo Supergroup groups; the metarhyolite formation belongs to the Tshela/Seke-Banza Group (Mayumbian) and the others belong to the Matadi Group (Zadinian).

Keywords: Lithofacies ; Analysed Polarised Light ; petrography; central Kongo; macroscopic; lithological.

1. INTRODUCTION

In the Democratic Republic of Congo, studies and research in the field of geology remain of undeniable importance. The first information on the geological make-up of Central Kongo came from the major reconnaissance traverses carried out by [1], [2] [3]. On the basis of work carried out in our study area by [4];[5],[4], who define the Mayumbian as a volcano-plutonic sequence with sedimentary intercalations, and specify that its internal lithostratigraphy varies from one place to another and that stratigraphic correlations are also difficult; the same applies to the Zadinian, which shows a strong lateral variation in facies [4];[5].These assertions tend to demonstrate that,on the one hand, the studies carried out by the authors were significant contributions to our knowledge of the geology of Central Kongo, but were not totally exhaustive and, on the other hand, that detailed studies are necessary for greater precision.The new discoveries do not contradict the authors, but make a contribution to their work and to our knowledge of the geology of this region of the country.

2 STUDY AREA

2.1 Localization

The study area is located in the province of Central Kongo, specifically in the territory of Tshela. It is bordered to the north by the Republic of Congo, to the north-west by the enclave of Cabinda (Angola), with the Shiloango river forming the natural border, to the south by the territory of Lukala and to the east by the

DOI: https://doi.org/10.14232/analecta.2024.4.45-56

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territory of Seke-Banza.It extends along the following geographical coordinates:4°58'30‘’and 5°03'30‘’south latitude and 12°59'42‘’ and 13°07'20‘’ east longitude (Fig.1).

2.2 Morphology

The relief of the study area is made up of gentle hills with peneplain side plateaux. The slopes of the Mayumbian range contrast with the low-lying western part, whose eastern edge features peaks of metamorphic and eruptive bedrock.

2.3 Geological and structural context

The geological formations in the target region virtually follow the morphology of the province, with the coastal plain occupied by Mesozoic and Cenozoic terranes of generally marine origin in horizontal and subhorizontal formations, while in the east, the plateaux are composed of sub-tabular Mesozoic and Cenozoic layers of generally continental origin found throughout the central basin of the Congo Basin.

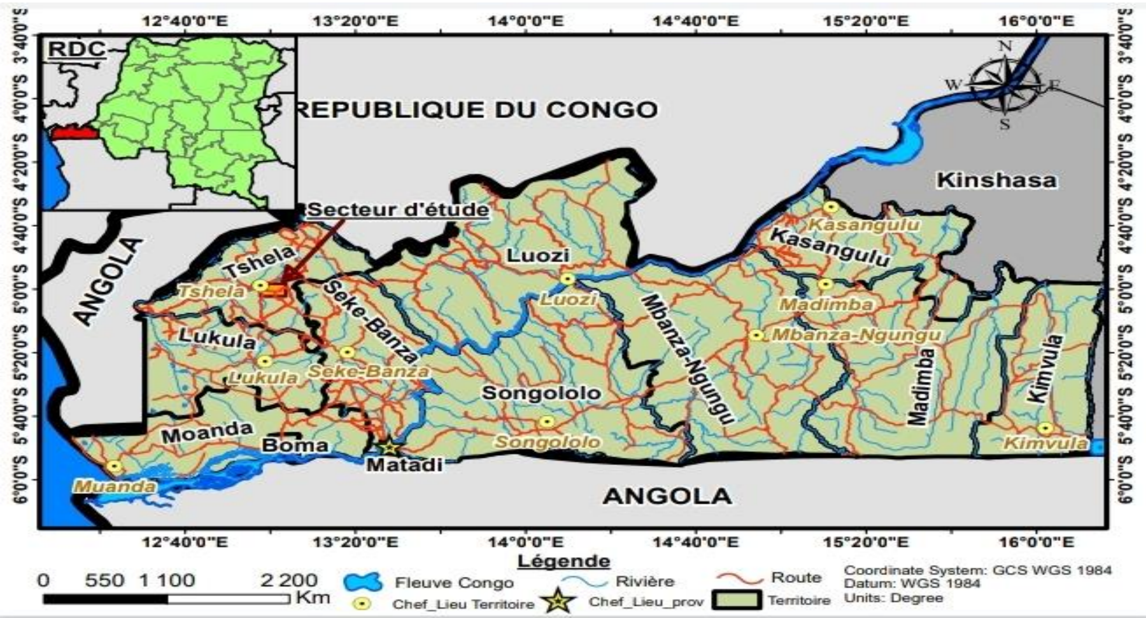

Figure 1: Location map of the study area in the Province of Central Kongo

3 METHOD, TECHNIQUE AND MATERIALS

Apart from the documentation phase, this work went through the following two major stages in any geological investigation:

3.1 Field stage

Over the course of a month's stay, an exhaustive geological survey was carried out in the area, to maximise the chances of encountering the outcrops in place, to orientate the structural elements, to sample and number the samples by giving them a number preceded by the initial WI, and to photograph the outcrops and structural elements. Finally, we photographed the outcrops and structural features, using basic geological equipment (including a hammer, compass with clinometer, GPS, notebook with pencils, camera, etc.) and a 1:50. 000 of the target region, we located outcrops, described and collected rock samples, took structural measurements (azimuth, direction and dip of planar and linear structural elements) and took photographs of certain interesting geological details observed in situ.

3.2 Laboratory stage

This stage includes:(1) the selection of representative samples with a view to the preparation, at the Geosciences Laboratory of the University of Kinshasa, of thin slides intended for the description of the rocks under a polarising microscope (Optika brand); the determination of the minerals was based on the criteria established by [6],[7]. (2) The production of geological sections to illustrate the spatial layout of the rocks, sampling and geological maps using software (Adobe Illustrator 2017, sas planet, ArcGIS (ArcMap), Office 2019. [6]. [17].

4. RESULTS AND DISCUSSION

4.1 Geological survey

The fieldwork led to the production of a map showing the location of the observation and sampling stations (with the initials WI) followed by a number according to the order of sampling, as shown in Figure 2.

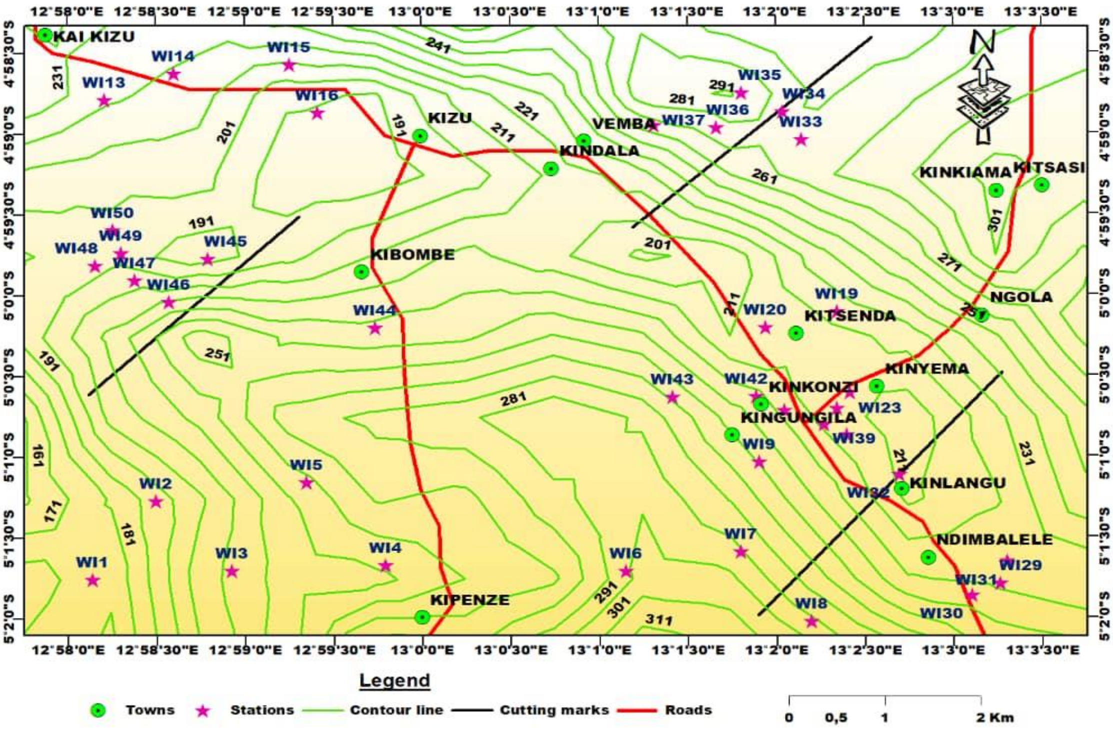

Figure 2. Location map of observation and sampling stations.

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Petrographic analysis

For our study area as a whole, we made 3 sections that cut across the area from north to south-east:

- ✓ Section 1: Kinkonzi village: Kitsenda village;
- ✓ Section 2: Kitsasi village: Kinyema village;
- ✓ Section 3: village Vemba: village Kibombe

From a lithological point of view, eight lithofacies have been defined in the study area, as follows:

4.2.1. Section of the Kinkonzi village in Kitsenda

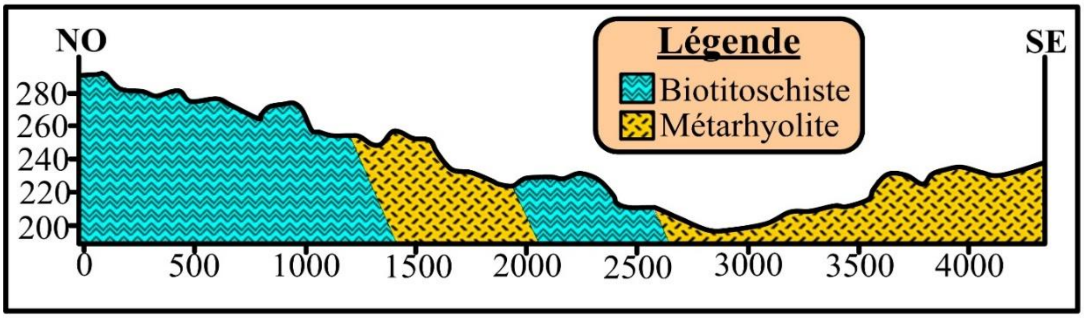

Figure 3. *Cross-section of the Kinkonzi village in Kitsenda*

4.2.2. Lithofacies of biotitoschist (Ech.WI 01)

Macroscopically, the rock has a greenish colour.. It is cut in plates; rich in micas sheets which are accompanied by quartz with a little feldspar. Coordinates: S 5° 13‘ 31’‘ and E 13°38'11" Direction and dip: N 130°/56° SW (photo 1).

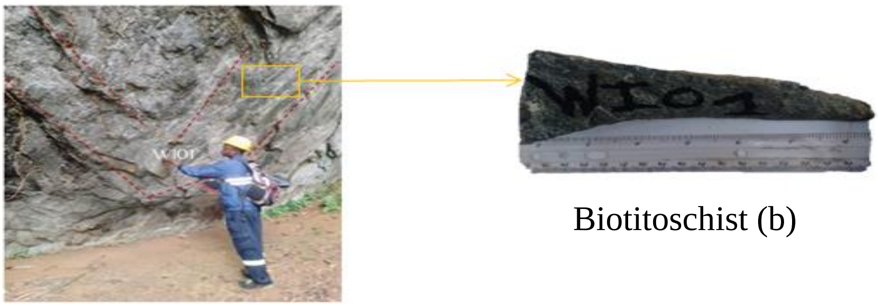

Figure 4. *Outcrop view of biotitoschist (a) sample WI 01 (b)*

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Microscopically, the rock has a lepidoblastic texture. This is highlighted by the intercalation of small sections of brownish biotite (LPA and LPNA) between small xenomorphic and subautomorphic crystals of white or grey (LPA) and colourless (LPNA) quartz. Alongside these schistosities, elongated quartz crystals can be seen (Figure5).

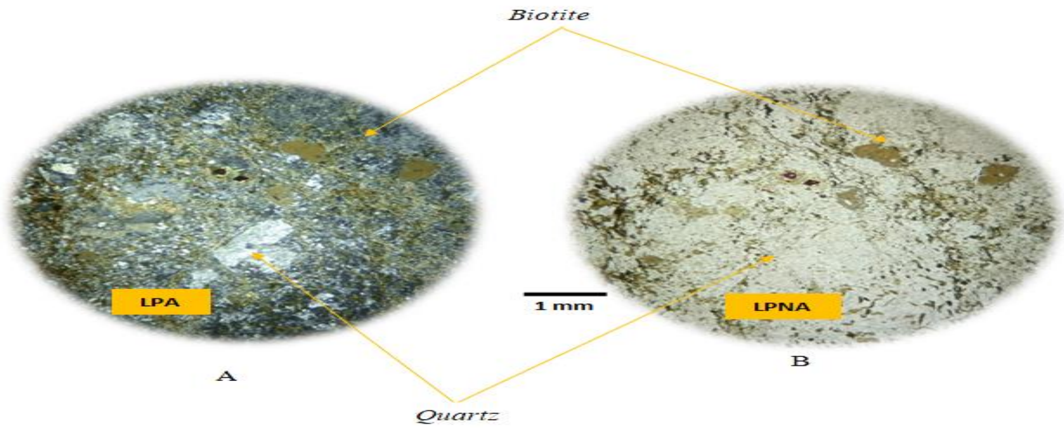

Figure 5. seen under a biotitoschist microscope (A: in LPA; B: in LPNA).

4.2.3. Lithofacies of metarhyolite (Ech. WI 02)

Macroscopically, the rock has a massive structure with frustrated layers of greenish to brownish colouring due to alteration, and a quartz vein 20cm wide: S 5°13'57‘’ and E 13°33'53‘’; direction and dip measurements: N 85°/80°NW (the fault plane) (Figure 6).

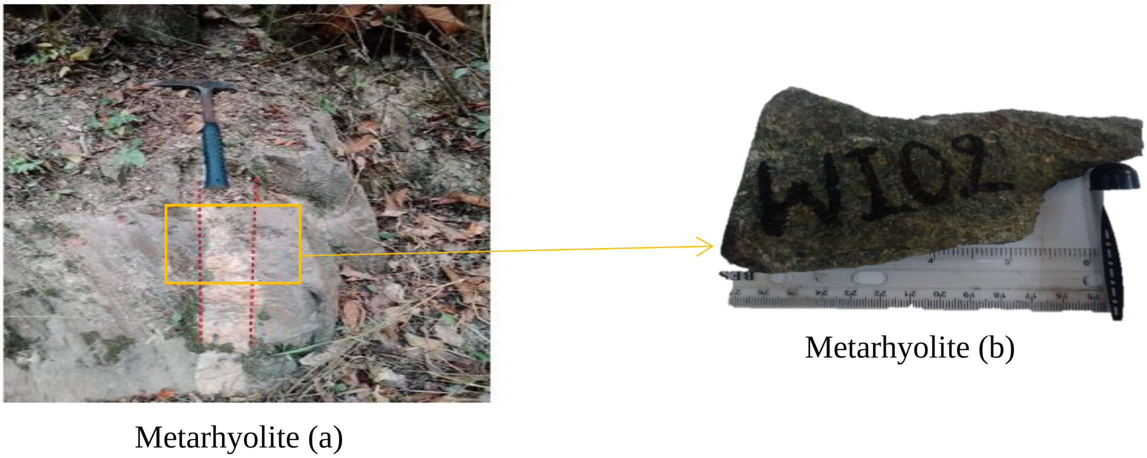

Figure 6. Outcrop view of Metarhyolite (a) sample WI 02 (b)

Microscopically, the rock has a porphyroblastic texture, highlighted by white or grey (LPA) and colourless (LPNA) quartz porphyroblasts embedded in a granular mass of porphyroblasts, and by medium and fine

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quartz crystals between the granules, which are interspersed with elongated greenish sericite crystals (LPA) (Figure7).

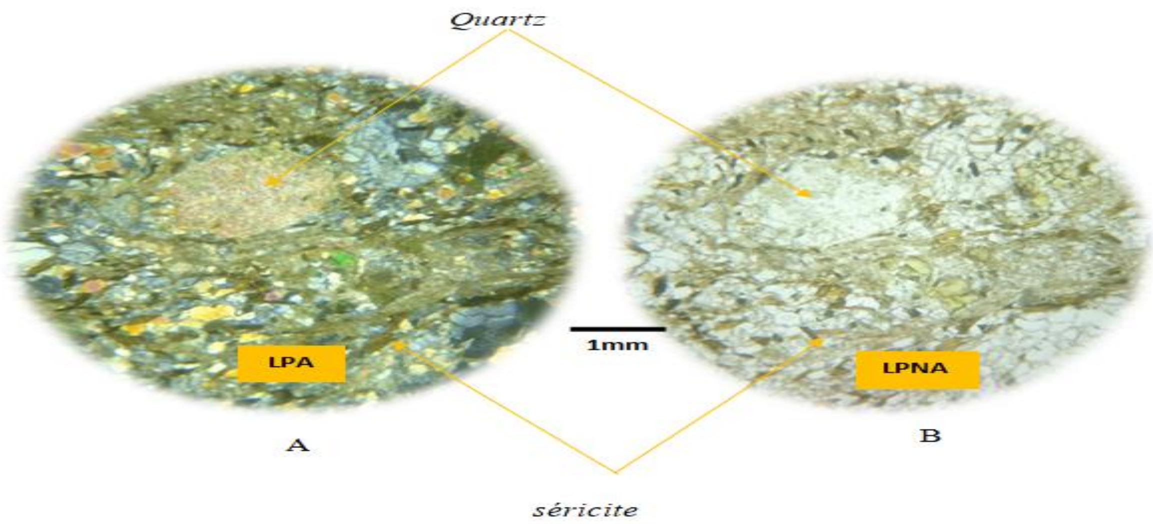

Figure 7. *Microscopic view Metarhyolite lithofacies (A: in LPA; B:in LPNA).*

4.2. Section of the village Kitsasi in Kinyema

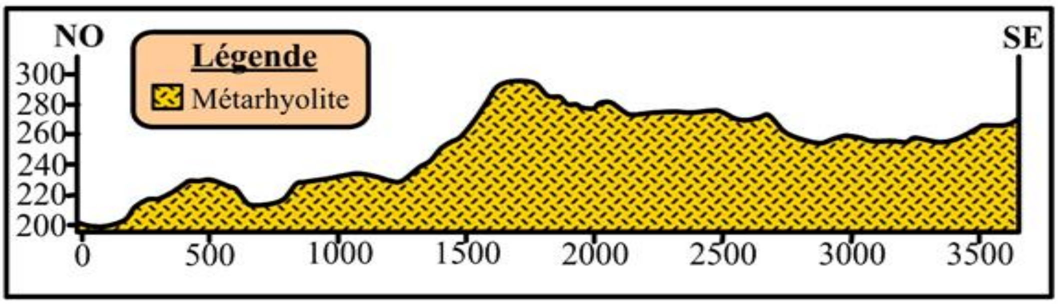

Figure 8. Cross-section of the Kitsasi village in kinyema

4.3.1.Lithofacies of biotitoschist (WI 03)

This is a zone of damage and crushing of the rock. The rock is greenish to blackish in colour. Geographical coordinates: S 5°14'20‘’and E 13°10'40‘’; direction and dip measurements: N146°/52°SW (schistosity plane) (Figure9).

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biotitoschist (b)

Biotitoschist (a)

Figure 9. *Outcrop view of biotitoschist (a) sample WI 03 (b)*

Microscopically, the rock has a lepidoblastic texture. This is highlighted by the intercalation of small sections of brownish biotite (LPA and LPNA). Photo 10.

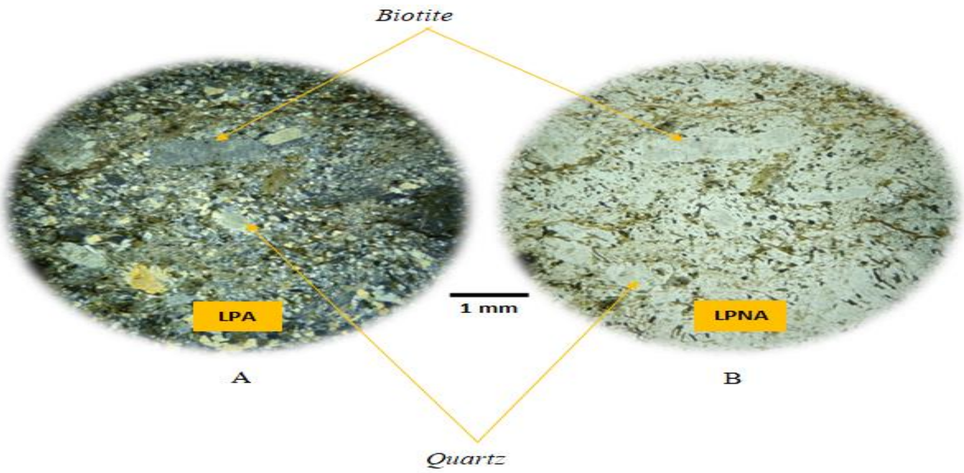

Figure 10 . *Microscopic view biotitoschist lithofacies (A: in LPA; B: in LPNA).*

4.2. Section of the Village Vemba to Village Kibombe

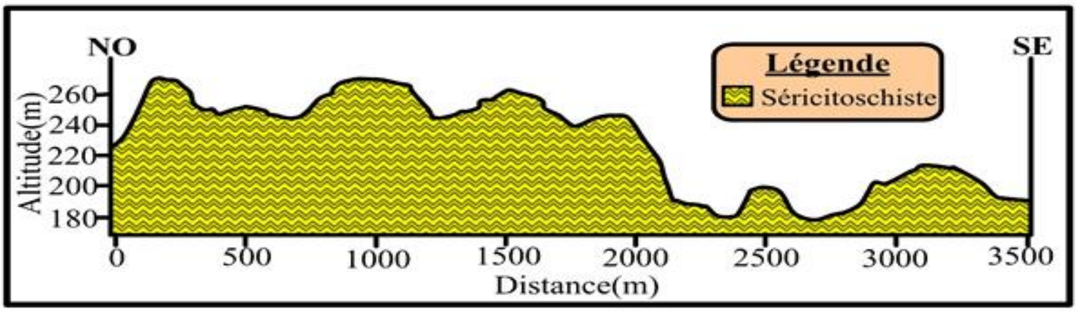

Figure 11. Cross-section of the Vemba village in kibombe

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4.4.1. Lithofacies of sericite schist (WI 27)

Macroscopically, the rock is relatively schistose, with a massive, fine-grained, greenish texture. It is characterised by abundant sericite, quartz crystals and feldspar. The geographical coordinates are S°4 50'32‘’ and E12°27'40‘’; direction and dip measurements: N120°/86°SW (Figure 12).

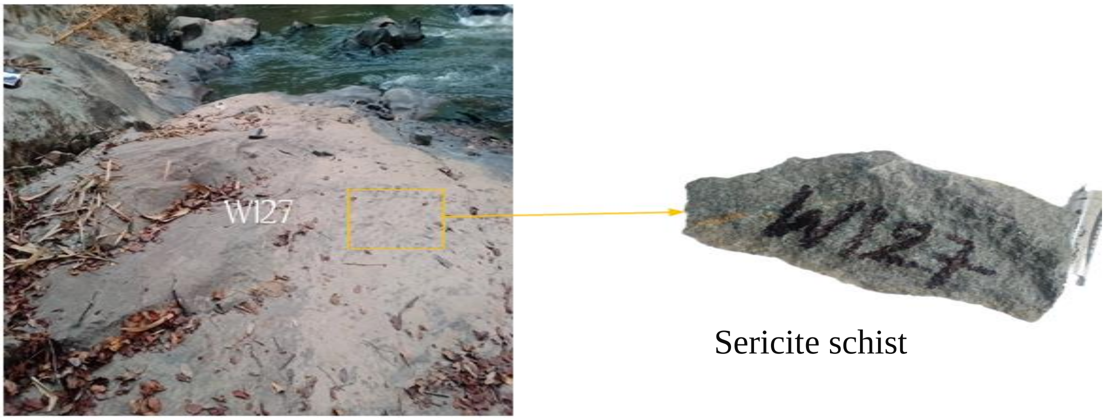

Figure 12.*Outcrop view of Sericite schist (a) sample WI 27(b)*

Microscopically, the rock is schistose, with alternating granoblastic and lepidoblastic levels. The granoblastic levels are made up of white or grey (LPA) and colourless (LPNA) quartz crystals. Between these crystals are elongated plagioclase and medium to coarse quartz. Some crystals are slightly cracked. The lepidoblastic levels consist of needles of brightly coloured sericite of refractive scale order (LPA) and yellowish to greenish (LPNA). Granules and streaks of opaque minerals can also be seen. The alignment of sericite gives the rock a schistosity. (Figure 13).

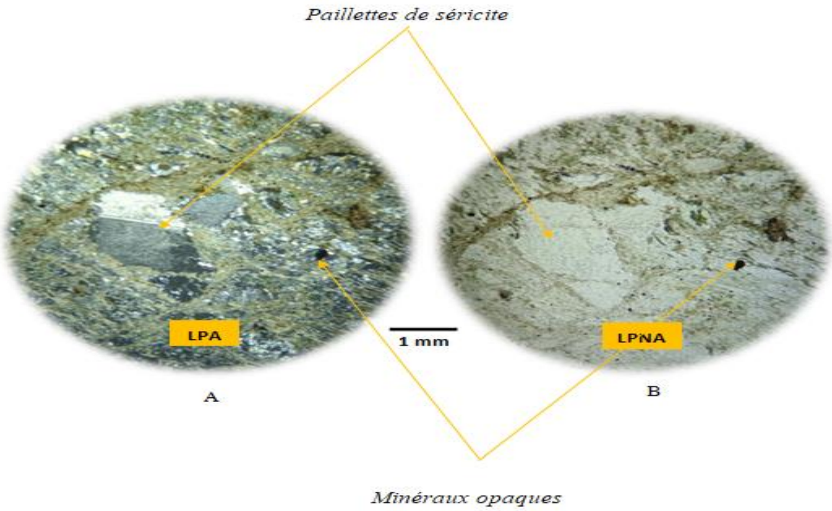

Figure 13. *Microscopic view Sericite schist lithofacies (A: in LPA; B: in LPNA).*

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5. RESULTS AND DISCUSSION

Macroscopic and microscopic observations of the rocks in our study area reveal that the zone is metamorphosed. These are metamorphic rocks resulting from regional metamorphism. They have the following characteristics

- ✓ Variation in colour from light brown to greenish;
- ✓ The presence of schistosity and laminations;
- ✓ Varied quartz morphology;
- ✓ The varied nature of micas and green hornblende;
- ✓ Varied crystal sizes;
- ✓ The presence of sericite.

5.1. Petrographic Context

- ✓ A variation in colour is observed. It consists of a greenish tinge that increases from west to east, and a light brownish colour. Different planes of schistosity can also be seen. The varied nature of micas, hornblende and hydrothermal minerals such as sericite [7].

❖ Colouring

The light colouring observed in the rocks in our study area is due to the presence of light-coloured minerals and also to the presence of silica dispersed in the metarhyolites. The greenish hue diminishes from west to east, where only the metarhyolites are observed.sericite is thought to have been produced by epizonal metamorphism, which means that the western part of our study area can be classified as a 'Greenschist-facies' or green schist metamorphic facies [8], [15].

❖ The morphology and size of quartz and feldspars

The morphology of quartz and feldspar in metarhyolites is a source of information about the cooling of magma of rhyolitic origin [9]. Subautomorphic and automorphic crystals indicate relatively slow cooling in the inner part of the rhyolitic massif, while xenomorphic crystals indicate much faster cooling in the upper part of the massif. In the metarhyolites, the crystals are equidimensiols, which means that we can be certain that this is a metamorphic quartzite [10],[16].The feldspar porphyroblasts with crystallisation tails, combined with other observations, are indicative of the shear zones highlighted in our study area.

❖ The presence of sericite

For metarhyolites that have undergone regional metamorphism and cataclasis.This mineralogical argument supports the existence of two generations of rhyolite, one with an age of 920±8 Ma and the other with an age of 912 ±7 Ma [4]. The green hornblende present in the rocks in our study area is characteristic of the relatively low-temperature range [11].The presence of sericite is thought to be due to sericitisation. Sericitisation results from the partial or total replacement of feldspars and biotite, and is one of the pervasive alterations present in the study area. It is generally very intense in felsites.Sericitisation is a good tracer of mineralised zones [12];[13].

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5.2. Mineral Paragenesis of Various Rocks in The Study Area

❖ Metarhyolite

Metarhyolite is characterised by the presence of high-temperature alkaline feldspars (sanidine) indicating rapid cooling of the source magma, and intermediate-temperature feldspars (orthoclase) with perthites indicating slow cooling, quartz, and also iron minerals (hematite, magnetite and pyrite) probably of hydrothermal origin [9].

❖ Biotitoschist

is characterised by the presence of biotite sheets interspersed between quartz crystals. This suggests that we are still in the greenschist facies, but the absence of chlorite suggests that we are moving towards a facies of relatively high grade.

❖ Sericite schist

is characterised by the presence of xenomorphic, subautomorphic and automorphic sericite crystals.

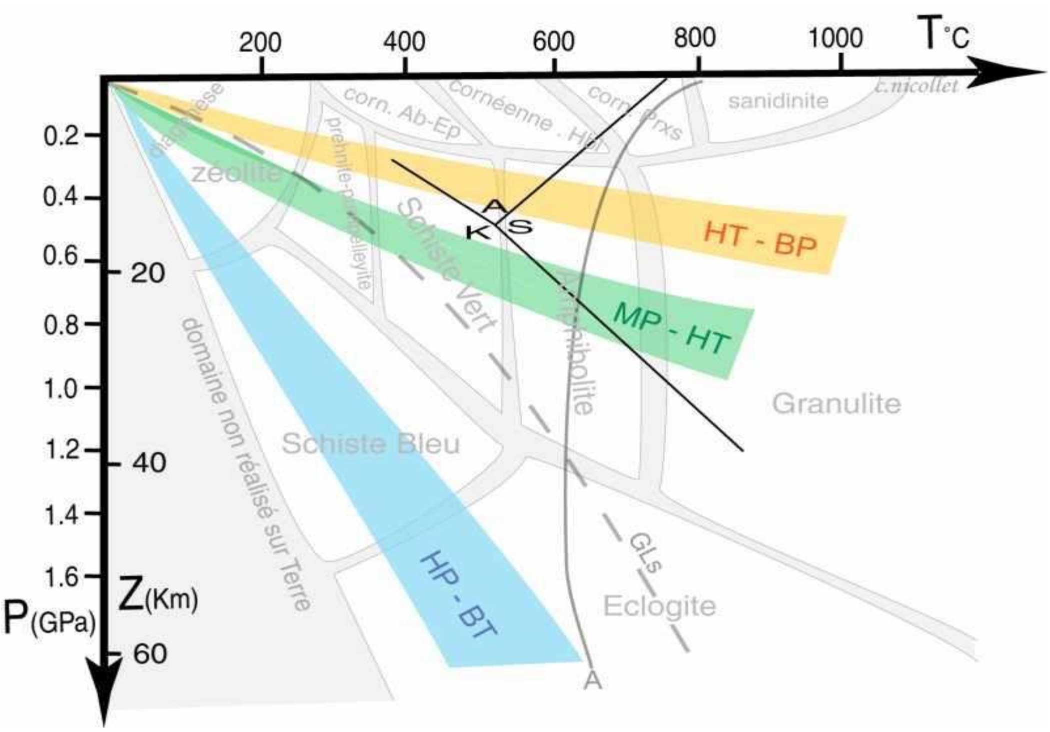

Figure 7. Metamorphic facies: the figure shows a selection of isograd reactions delineating the different metamorphic facies [10].The yellow zone shows the metamorphic facies in our study area.

These different parageneses show that, from west to east in our study area, we move from Epidote-amphibolite facies to greenschist facies, i.e. the degree of metamorphism decreases from west to east, as demonstrated by [4].Thus, we can group the different rock formations in our study area into two Groups of

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the West Congo Supergroup (Table 2). The metarhyolite formation belongs to the Tshela/Seke-Banza Group (Mayumbian) and the others to the Matadi Group (Zadinian).

Table 2: Distribution of formations in and around Tshela-Mbanga within the groups in West Congo.

	FORMATIONS	LIKELY GROUP	AGE
1	Metarhyolite	Mayumbien	Summit 912±7Ma and base 920±8 Ma
2	Sericitoschist	Zadinien	999±7 Ma (Tack et al., 2001)
4	Biotitoschiste		

5.3. On The Metamorphic Level

The formations in our study area have undergone cataclasis, as evidenced by the presence of cracked minerals, the presence of quartz veins and faults oriented preferentially NE-SW.Quartz veins and veins are present in most of the formations encountered (in varying thicknesses and lengths).The quartz vein at Mpangi-Ngabu is a senestial strike-slip fault with a displacement of 22cm.the cracked porphyroblasts of plagioclase in the metarhyolite and those showing recrystallisation tails are characteristic of shear zones. These structures are typical of fault rocks. The recrystallisation tails show that these minerals were present in the rock before deformation, i.e. they are a mineral phase known as ‘antecinematic or antischistose’ [10].The schistosity observed in the samples is formed by the simultaneous action of a localised dissolution process on discrete surfaces and a rigid rotation of the material linked to the folding of the microlithons [14].

6. CONCLUSION

Overall, the geology of the Mbanga sector and surrounding area is characterised by the presence of metamorphic layers of volcanic origin (metavolcanites: metarhyolites) and sedimentary origin (sericite and biotitose) of the Epidote-Amphibolite Facies and Greenschist-facies, from west to east. These rocks formed during the West Congo orogeny underwent cataclasis responsible for faulting and hydrothermal alteration (sericitisation). These rocks formed during the West Congo orogeny underwent the cataclasis responsible for fault rocks and hydrothermal alteration (sericitisation). The lepidoblastic structure is characteristic of rocks formed by lamellar crystals (micas, chlorite) in significant quantities and arranged parallel to one another. The porphyroblastic structure is similar in appearance to the porphyritic structure of igneous rocks. It consists of the presence of a few crystals, generally belonging to the same mineralogical species, of larger dimensions than the other crystals in the rock, which are of average size.

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