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Preliminary Geological Mapping, Petrographic, and Structural Studies of Precambrian Basement Complex Rocks in Part of Chulwe-Matale, South Kivu, DR Congo

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Abstract

A geological map is a veritable planning tool for the economic development of any nation. This map contains the distribution of various types of bedrock in the area. A geological map of Congo's geographic landmass has been produced since 1974 with the recently updated map of Kivu (Eastern part of Congo) in February 2018. This map largely omits some local geology of interest, possibly owing to its large area coverage. Thus, local geologic mapping must be encouraged to bridge this lacuna; the focus of this study. Field traversing and rock sample collections were carried out and thin sections of the different rock types were prepared and mounted on glass slides for microscopic observation. Geological mapping revealed that the study area is made of ferruginous, graphitic sandstone schists and quartzite with interbedded metadoleritic sills. The petrographic studies revealed the mineral assemblages of quartz-feldspars-muscovite and olivine-pyroxene and plagioclase feldspars respectively for the first and the second group geological units. The structural investigations come out of two deformation phases: the strike-slip type would be at the origin of the cleavages and folds. It's related to the D1 of the Kibarian orogeny. The second is an extensive phase responsible for the NW-SE fracturation mapped in the study area. The Matale discordance crosses all these lithologies, a later phase is possible. This discontinuity would have acted in the region studied by switching the lithology units from NE-SW to ENE-WSW orientation. This research recommends that the Chulwe-Matale formations would be typical of the Lower Kibarian (Bugarama group) but the geochronology and geochemical data are lacking to confirm this hypothesis.

Keywords: Geological map, petrographic studies, formations, Chulwe-Matale, lower Kibarian.

Introduction

Located in Ninja, Kabare district within the South Kivu province, in the Eastern DR Congo, the Chulwe-Mutale areas emphasized several gold occurrences that are essentially subjected to artisanal small-scale mining. However, despite the economic significance of this zone, its geology is still not very well known. The latest geological map of Kivu (eastern DR Congo) obtained from geological data from various sources shows many local geological complexes with differentiated lithologies, an improvement over the old map (Lepersone 1974; Laghmouch et al., 2018). An attempt has also been made to distinguish and make relationships between different rock types even though some local geological realities were still largely omitted as in the case of the area under study. For many decades, several investigations tried to specify some geological contrast of the Kivu supergroup in the zone underlined the study area but their investigation stopped at the regional description of some features which should be developed to be understood clearly. For example, in the neighborhood Chulwe-Matale, the geological map of Kivu (Fig.1) (Laghmouch et al., 2018). shows the outcropping geological units in the Chulwe-Matale are composed of the Kivu supergroup geological formations that includes two sub-groups, namely the Bugarama and the Nyangezi groups (Villeneuve, 1977). but does not specify the lithostratigraphic subdivision to Chulwe-Matale geological units belong. (Lefévère ,2003). Using remote sensing identified a probable intrusion at 500 meters of the south Chulwe-Matale. The same intrusion has been later reported on the recent geological map of Kivu as a granitic intrusion. However, the mapping investigations carried out by the Banro mining company (Banro, 2015). Revealed the existence of concordant mafic intrusions without to mention any probable existing granite rocks. Considering the above hypothesis, the kibara in the study area may have recorded a bimodal magmatism. This work deals with the study of the lithological units, a detailed description of the rock types both in hand specimen and thin section (petrography) to emphasize the lithostratigraphic classification of the Chulwe-Matale area with comparison to the characteristics of each Kibarian's subdivision as described by (Villeneuve ,1977). (Rumvegeri, 1987).(Villeneuve et al., 2019). this work tries to highlight the structural inputs as well.

Geological Background

The geological formations of the DR Congo are divided into two large structural groups separated by a discordance and/or a significant gap. These are Precambrian and Phanerozoic (Villeneuve, 1977; Rumvegeri, 1987). The Precambrian formations were deformed and metamorphosed several times. This stable and rigid base which hardly recorded any deformations until the late Mesozoic when the first movements related to the East African rift appeared (Villeneuve, 1977). Precambrian terrains in the Kivu region include the Ruzizi supergroup (Paleoproterozoic), the Kivu supergroup (Mesoproterozoic) and the Itombwe supergroup (Neoproterozoic). While those of the Phanerozoic in the region are represented by sedimentary and volcanic rocks. The Kivu supergroup belongs to the Kibara metallogenic chain which is an orogenic chain of the Mesoproterozoic age that outcrops over a large area within the Kivu region (Fernandez-Alonso et al., 2015). The Kibara Chain (Kibarides) is orogenic in Central Africa measuring about 1700 km located between the Congo and Tanzanian cratons. It extends from Katanga in the south to Uganda in the north. There are three sections: the southern section or Kibaride belt (KIB), the Kivu belt (KVB) west of the Great Lakes, and the Karagwe-Ankole belt (KAB), east of the Great Lakes, which extends from Burundi to Uganda via Rwanda (Villeneuve et al., 2019). The Kibarian was subdivided into three subunits for the first time between 1976 and 1980 by Villeneuve through his work in the hills of Nyangezi. Using structural data and degree of metamorphism, he defined the lower, middle, and upper Kibarian (Rumvegeri, 1987). With a thickness of about 4000 m, this group is located directly above the Ruzizian. The absence of a discrepancy between this group and the Ruzizian formations (Villeneuve, 1977). is the subject of controversy and leads some authors to doubt the existence of the latter. The work of (Villeneuve & Guillonez-Benaize 2004). And (Villeneuve & Chorowicz 2006). Allowed them to conclude that this subunit is observed in the Bugarama group. Most of its lithology consists of schists, arkoses, sandstones, quartzites, and conglomerates, at the base; intruded by S-type granites and mafic rocks. The two were discovered by (Villeneuve, 1980) under the Nyangezi group which discords with the Bugarama group. With a thickness of about 2900 m, it contains shales-arkoses, sandstones, quartzites, conglomerates, and dark pelites; all intruded by tinbearing granites. This group may have been set up near the continent as evidenced by the petrographic characters of the formations. Structurally, the main direction of Kibarian folding is north-east south-east in Katanga, North Kivu, South Kivu, and Maniema, with frequent North-West turns, particularly in the West of Lake Kivu and Maniema. Current data on the Kibarian chain indicate four phases of deformation (Villeneuve, 1977; Rumvegeri, 1987). The first phase (D1) was responsible for the structures oriented North-East South-West such as isoclinal folds, foliations parallel to stratification, and was accompanied by the syn-D1 barrow type metamorphism found in Bunyakiri. The second phase (D2): is the paroxysmal phase, marked by isoclinal folds trending North-West to South-East. The related Syn-D2 metamorphism reached anatexia and led to the formation of granulites. The third phase (D2') corresponds to a late shear episode to post-D2 that generated structures subparallel to those formed by phase D2. A fourth phase (D3) was defined by Pohl and (Günther, 1989). And (Günther, 1990). And was related to the acid magmatism that carried the tin group mineralization. The Kibara chain is interesting because its fourth granite group (Granite G4) contains deposits related to pegmatites and quartz veins mineralized in tin group metals (Sn, W, Ta, Be, Li, Nb) and gold. This group of post-orogenic granites concerning Kibarian deformations belongs to the category of S-type granites (Kokonyangi et al., 2004). The local geological settings inputs according to the geological maps made in the region by (Villeneuve, 1977). (Rumvegeri (1987). (Laghmouch et al., (2018). the Chulwe-Matale area is positioned in the Kibarian chain.

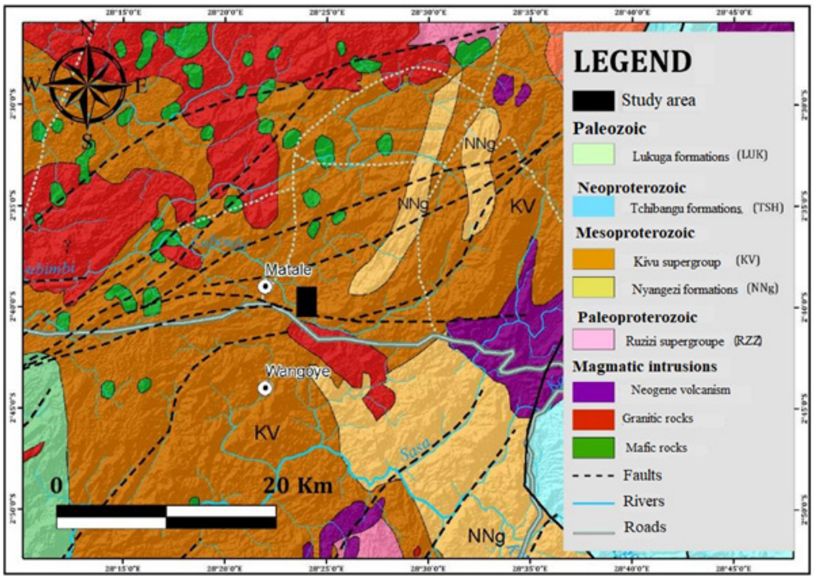

Figure 1: Geological map of Kivu modified after (Laghmouch, et al., 2018).

Methodology

In the field, a methodical strategy of mapping along profiles from one outcrop to another while noting river channels that showed subsurface lithology was adopted. While climbing ridges and hills, structural measurements were taken, and computer software was utilized to create a lineament map and a rose plot. Fresh rock samples were collected, and coordinates were labeled using a GPS and a pencil. Rocks were given field names and a megascopic description of each rock sample (texture, color, composition) in hand specimen form. The rock samples were cut into chips for the petrographic studies using a micro-cutting machine and then polished on a glass ground plate with carborundum to obtain the required thickness and a perfectly smooth surface. The cut rock samples were then mounted on a clean glass slide with adhesive at the thin section at the Department of geology, University of Burundi (Bujumbura, Burundi). The prepared slides were examined under the petrological microscope at the Université Officielle de Bukavu to identify the mineralogical features of the rock samples on a microscopic scale. Maps were made in ArcGIS software using the UTM zone 35S projected coordinate system for reliability because the study area was too small. The dips software was used for the presentation of stereonets and the deformation regime was identified by using Win-tensor software. The relative magnitude and direction of the stress axis are represented by four parameters extracted from the complete six components of a symmetric stress tensor: the directions of principal stresses, $\sigma 1$, $\sigma 2$, and $\sigma 3$ ($\sigma 1 \geq \sigma 2 \geq \sigma 3$), and the stress ratio $R = (\sigma 2 - \sigma 3)/ (\sigma 1 - \sigma 3)$ ($0 \leq R \leq 1$). We used one stress inversion method which is rotational optimization (Delvaux & Sperner, 2003). To determine the stress tensor using Win-Tensor software (Delvaux et al., 1997). (Delvaux & Sperner, 2003). The stress regime index (R′) was used in Win-Tensor to clarify the stress regime range, which determines a specific stress regime over a range of values. The rotational Optimization inversion process uses a 4-D grid search with finite rotation around the three principal stress axes. The rotation angle for each principal stress axis is calculated by reducing the value of the F5 function to get the R-value. By repeating this process, the three principal stress axes are justified and then the R-value is determined. This procedure should be recurrent until the stress field of the inversion becomes stable.

Results

Petrography

The geological formations observed in the area consist of metasediments with moderately marked cleavage composed of various schist facies and quartzite. Concordant mafic intrusive rocks have also been mapped in the area.

Metabasites

The metabasites bear resemblance to the surrounding layers and run parallel to the cleavage. It is probably a type of intrusion referred to as a sill (fig.2). The rock has undergone significant modification in multiple places and is exposed in varying thicknesses ranging from centimeters to meters. On a larger scale, the fresh rock appears darker with white stains that are likely feldspars and/or quartz, while the altered parts of the rock have a dark greenish tint due to the abundance of melanocratic minerals (Fig.2a). petrographic studies revealed fine minerals aligned in a specific direction and embedded in mesostasis, while other minerals exhibit large crystals arranged parallel to the former. The rock has a grano-lepidoblastic texture, and the alignment of minerals suggests a slightly pronounced cleavage in the rock (fig 2c and 2d). The minerals identified in the rock are composed of pyroxenes (Px), which either have a euhedral or subhedral shape. Coarser euhedral crystals are likely to originate from an earlier crystallization phase. Few embedded crystals olivine in mesostasis with few subhedral crystals feldspars.

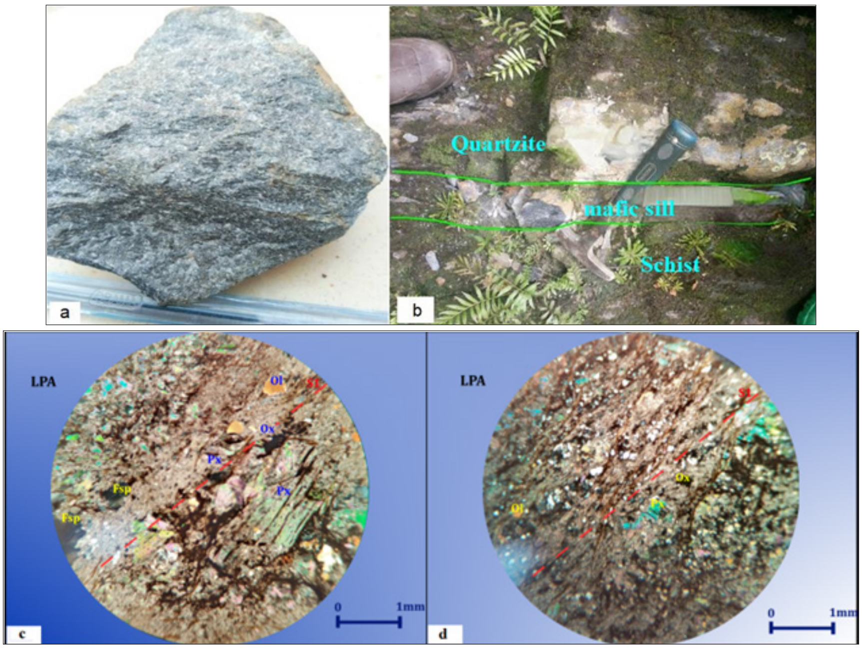

Figure 2: Sample of metadolerite (a) and its outcrop in sill (b), Microphotograph of metadolerites in (c and d)).. Px : Pyroxène, Ol : olivine, Fsp : Feldspar.(minerals abbreviqtion by (Whitney & Evans, 2010)

Quartzite

It is a rock flush in the form of laminated benches separated by laminating joints. The rock is whitish and greyish in some places (fig.3a). This rock is fresh and very resistant to hammer hits but, in some places, it is less hard because of enhanced alteration. It consists mainly of quartz minerals (fig. 3b). The petrographic investigation revealed granoblastic texture with minerals of similar sizes mainly quartz and white micas with blunt contours and automorphic to sub-automorphic forms. Quartz up to more than 70% (fig.3c and d), the rock also contains more white micas which the polarization hue is of the third order. The micas are elongated in one direction which may reflect the expression of cleavage within the rock (fig.3d) and sometimes not presenting any orientation direction (fig.3d). The cement binding the grains is mainly feldspathic, siliceous with mixture of iron oxides. Micas make up 10 to 15% of the rock.

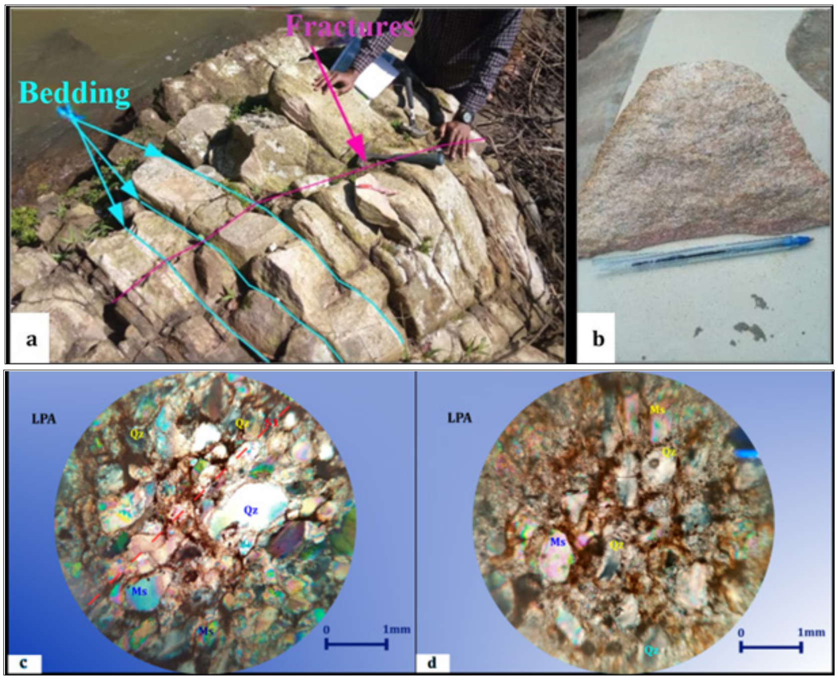

Figure 3: Outcrop of quartzite (a) and its sample (b), photographs of two quartzite samples, one of which shows an alignment of minerals following the trend of cleavage (c) and the other of undeformed minerals (d). Ms: muscovite, Qz: Quartz. (minerals abbreviqtion by (Whitney & Evans, 2010)

Schist

Several facies of schists have been identified in the Chulwe area. These facies are clearly differentiated by their macroscopic aspects, their mineralogical compositions as well as the types of alteration. All these facies are moderately altered. They show a moderately to strongly marked cleavage usually parallel to the stratification. These different facies are sometimes intersected by veins, veins of quartz and hematite irregular or of the same appearance as the orientation of the layers. According to their mineralogical composition, Chulwe-Matale Schists has been classified into three varieties: a staining graphitic schist rock consists of fine grains. The rock has blackish and greyish colorations probably due to the presence of graphite (fig.4a). Ferruginous schist is dominated by ferrous minerals that give them a brownish and reddish coloration due to an abundance of hematite, goethite, and limonite. They are sometimes intersected by quartz-hematite veins (fig. 4b). The rock has a lepidoblastic texture and the rock shows a penetrative cutting that reflects the cleavage of the rock. The petrographic study shows discrimination between clear and brownish beds. Within the light beds, the rock displays a higher proportion of quartz and sericite grains than the brownish beds. The matrix of light portions is essentially made of siliceous cement while brownish owe their coloration to their cement. This grayish coloration would be due to the presence of clay minerals associated with iron oxides that may have resulted from sedimentary processes or post-sedimentary alteration processes (supergene). Among these minerals, sericite is an assemblage of fine muscovite crystals recognizable by their very bright hues in Cross Polar Light and colorless in Plane Polar Light (fig.4e). The sandstone schist consists of rough grains composed mostly of quartz grains. This type of schist displays a well-marked cleavage parallel to stratification (fig.4c) with whitish to grayish coloration due to the abundance of silica (quartz) (fig.4d). Microscopic observation of sandstone schist-defined heterometric clastic texture with clearly visible crystals and fine minerals that are difficult to identify, the interstices left by these minerals are occupied by an amorphous matrix shape of siliceous and feldspathic nature. Further examination defined some minerals aligned within a matrix which defines an expression of cleavage in the schist. (fig.4e and f).

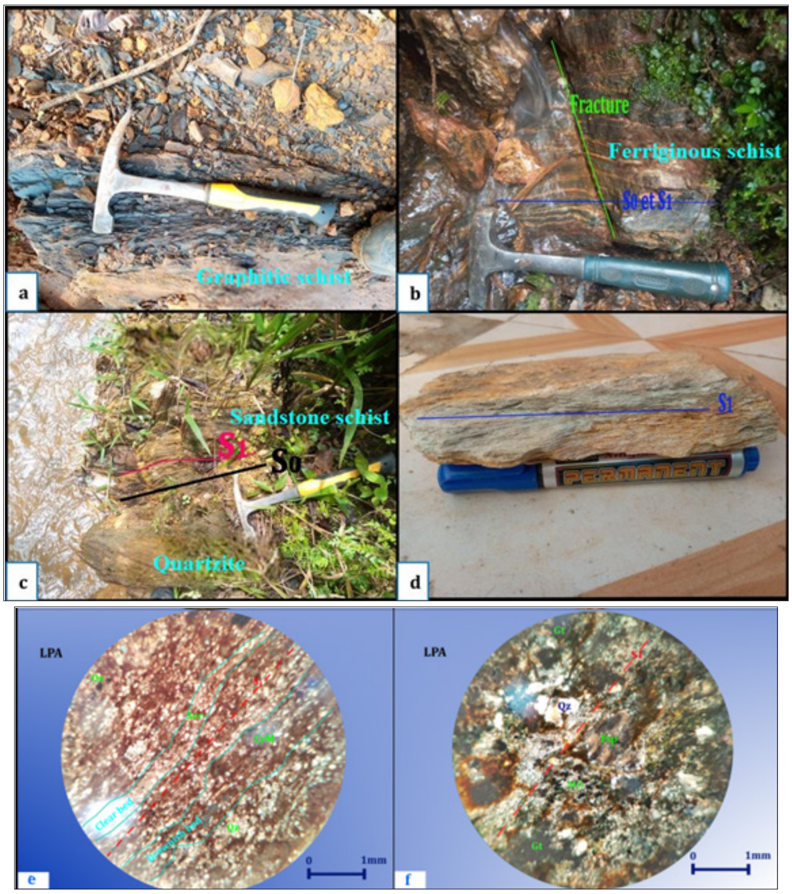

Figure 4: The different schists facies at the outcrop (a, b and c) and hand-specimen (d) and microphotographs (e and f). Gt: garnet, Qz: Quart, CyM : Clay mineral, Ser: Sericite, Fsp: Felspar (minerals abbreviation by (Whitney & Evans, 2010).

Structural Studies

Structural studies of the Chulwe-Matale zone revealed some structural elements that are markers of stratification, ductile strain, and brittle deformation.

Markers of Stratification

Stratification Plans

Despite the strong alteration of geological formations, 54 stratification planes (S0) were measured. Their statistical processing indicates orientations from NE-SW to ENE-WSW (Fig. 5a). The modal class is N40-50°E (Figure 5b) with high dip angles showing a modal class of 80-85° (Fig. 5c). This coincides with main orientation of Kibarian formation which is NE-SW.

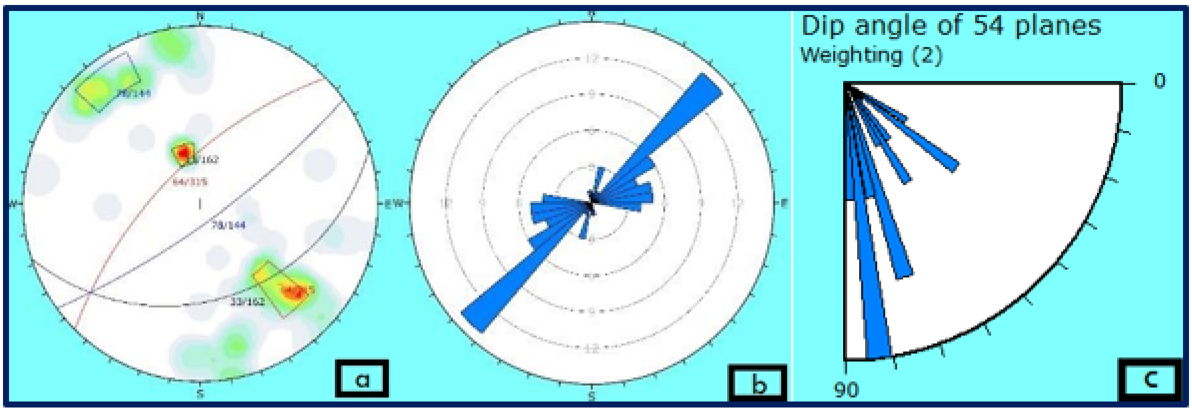

Figure 5: Stereonets of cyclograms (a) and directional poles and rose diagram (b) and dips (c) of all stratification planes.

Given their similar strikes but different opposite dip angles, there is likely in the area a folding-oriented NE-SW whose descriptive elements are as follows: The dip sidewall towards the NW has a preferential orientation between 40° and 50° with dip values between 70° and 75°. His flank has an average statistical orientation of N49°/74°NW (Fig. 6a). The dip to the SE sidewall has a preferential orientation between 40 and 50° with sub-vertical dip values (80-85°). The flank has an average statistical orientation of N62°/70°SE. (Fig. 6b). The axis of the fold would be oriented N55°/24° SW and the axial plane N55°/80°NW.

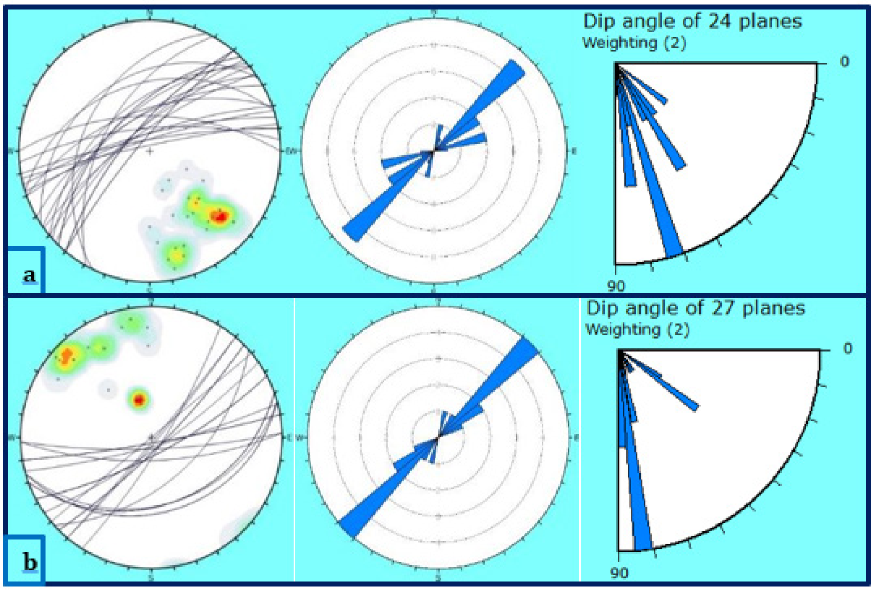

Figure 6: Stereonets of cyclograms and directional poles and rose diagram and dips of stratification planes: northwest flank (a) and southeast flank (b)

From the abovementioned results and based on the geological map (Fig. 10), it appears that this fold is of antiform type whose axis plunges at 24 ° towards the SW and slightly discarded vergence towards the SE. On the Fleuty diagram, it is like a straight fold with a slightly plunging axis.

Markers of Ductile Tectonics

Cleavage Plans

Field observations revealed that cleavage planes are generally parallel to stratification. Only one type of cleavage has been identified in the field, it's the flux cleavage. It's also noted that cleavage is well-marked in schists and basic rocks in some places but weakly marked or non-existent in quartzites. Their plot led to the identification of two main orientations similar to the two flanks of stratification planes. The stress tensor leads to the identification of NW-SE-oriented compression followed by NE-SW-oriented extension. The stresses $\sigma 1$ and $\sigma 3$ are sub-horizontal. R = 0.25 and R' = 1.75. The constraints are oriented N147°/80°SE, N035°/70NE and N240°E/18°SW respectively for $\sigma 1$, $\sigma 3$ and $\sigma 3$ (Fig. 7). According to the standard world map, these orientations are typical of à strike-slip regime.

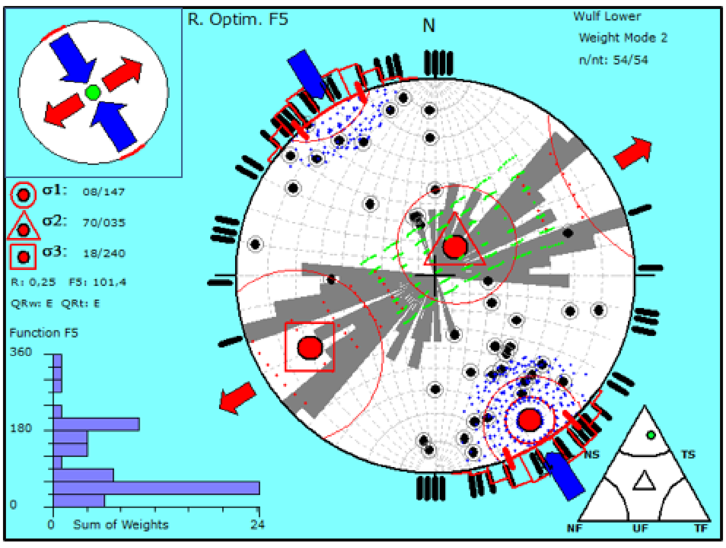

Figure 7: Stress tensor including the directional rose diagram, both related to the cleavage.

Markers of brittle tectonics

Fractures

The processing of fracture measurements taken in the field led to the identification of a preferential orientation of NW-SE (modal class 150-160°) with an average dip value ranging from 70° to 75°. (Fig.8a and 8b). The stress tensor leads to the identification of an NE-SW extension. The stresses σ2 and σ3 are subhorizontal, σ1 subvertical, and R = R' = 0.64 (Fig.8c).

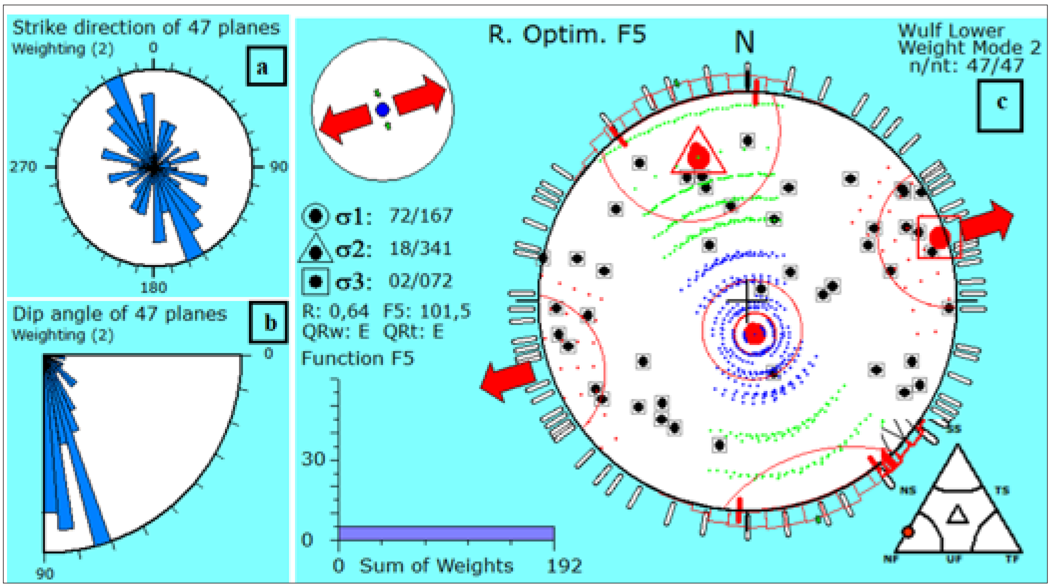

Figure 8: Directional rose diagram (a) and dips (b) fracture planes and stress tensor (c).

Veins

The quartz veins don't exhibit any preferential direction; some are parallel to the stratification while others intersect various lithologies. Their thicknesses vary from few millimeters to few centimeters. A particular quartz vein has been mapped near the Lubimbe River (Fig. 9a and b) with coarse pyrite crystals. This type of vein is encountered within outcropped silica-rich quartzite. A very limited number (9 veins) of veins rich in quartz and mixed in some places with iron oxides were mapped in the area, so their structural measurements did not allow a reliable structural analysis. However, their stress tensors have yielded some geological considerations, even though they are less reliable. The structural data taken on quartz veins can be divided into two categories based on their directions. The first one shows directions varying from 150° to 160° with various dips angles and the second presents direction values varying from 60° to 80° with subvertical dips. This may explain the existence of sills and dykes in the study area.

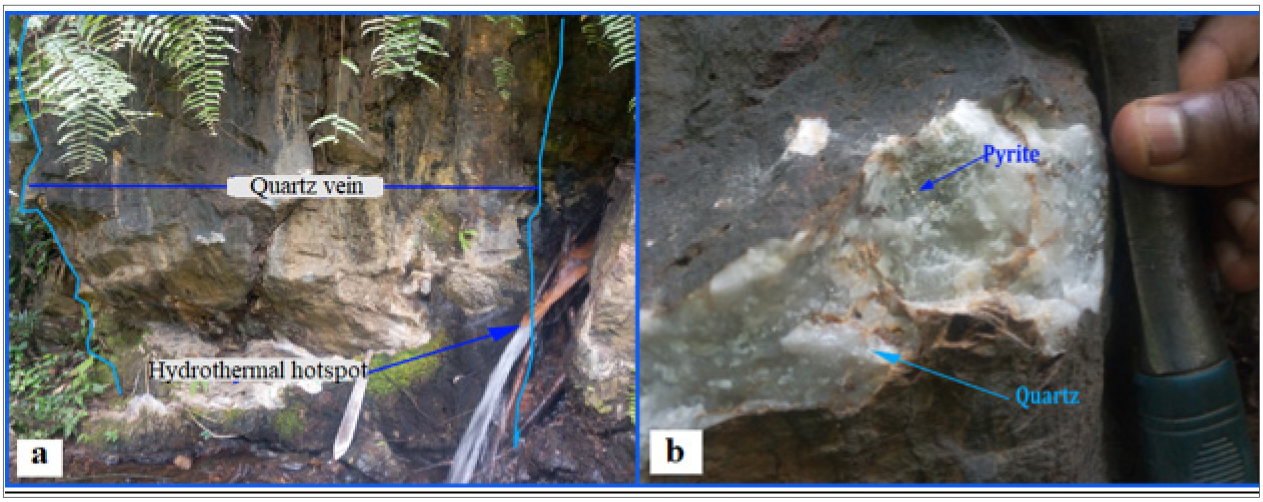

Figure 9: Outcrops of quartz vein hosting py (b) and its position near the hydrothermal hospot (a).

Tectonic Phases

From the description of the different structures observed and measured in the field, the statistical processing of the data, their orientation, and their relationships to each other, we were able to describe a compressive phase of deformation by using bedding and cleavage planes (Fig. 6 and Fig. 7). An extensive phase of NE-SW orientation is also identified and would be responsible for the generation of NW-SE-oriented fractures (Fig. 8).

The Fig.10 shows the map of outcrops listed in the study area. As a result, rock outcrops are most concentrated in erosion areas, particularly along rivers (Kitafwa River in the North) and roads (Central Region). The lithological units have the same orientation as shown in Fig. 5 and Fig.6.

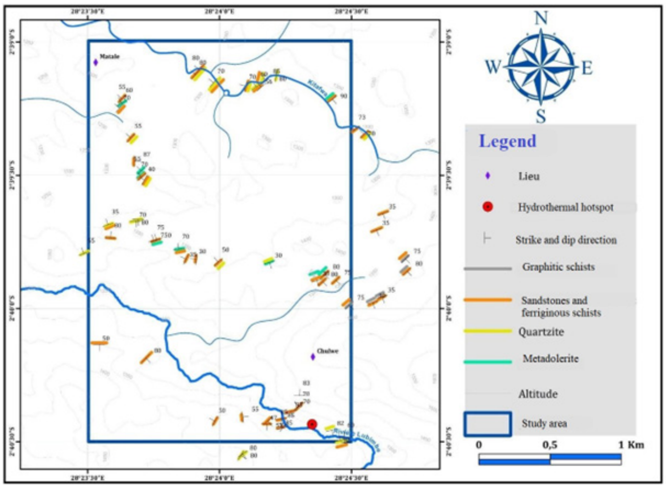

Figure 10: Map of geological outcrops of Chulwe-Matal

The geological map (Fig. 11) shows that the dominant rocks in the Chulwe-Matale region are quartzites and schists. There are three varieties of schists including sandstone schist, ferruginous schists and graphitic schists. All these rocks are intruded by doleritic sills that underwent a late metamorphic deformations (metabasites). The abrupt change in the preferential pattern of the lithologies and the discrepancy between the plots of these lithological units in the southern part of the study area could explain the existence of a major discordance in the vicinity. This discordance is reported in the literature by several researchers including (Lefevere, 2003). as Matale discordance. The directions of the dips of the lithologies confirm the hypothesis of the existence of a folding previously mentioned and the axis of the fold may present the same orientation as presented in the structural part of this work.

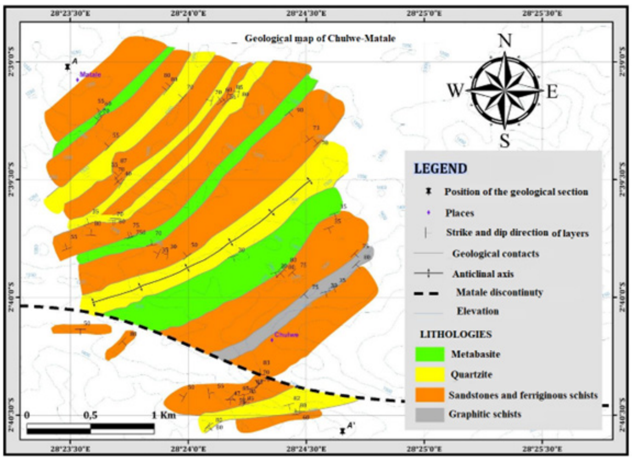

Figure 11: Geological map of Chulwe-Matale

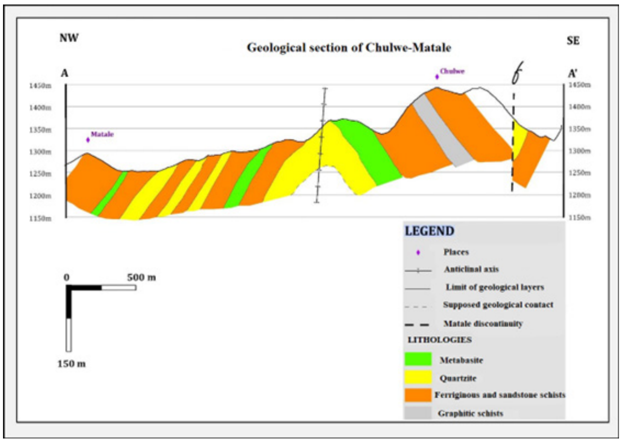

Figure 12: NW-SE oriented geological section in the Chulwe-Matale region.

Discussions

Two types of geological formations have been identified, including metasedimentary rocks that cover a large area of the study area, intruded by magmatic rocks. The lithologies observed are schists (graphitic, ferruginous and sandstone), quartzites, and basic rocks (metadolerite). Regionally, these are the lithological types reported in the Lower Kibarian (Rumvegeri, 1987) and are similar to those of the Bugarama group (Villeneuve, 1977). Precisely in the Kamanyola formations (Villeneuve et al., 2019). The Kamanyola and Keshenie formations show a “flysch” facies and numerous doleritic sills parallel to the stratification corroborate the hypothesis of a flysch environment (Villeneuve et al., 2019). These rocks show a mineral assemblage that consists of quartz-feldspars-±sericite-±Muscovite-±opaque minerals in the pelitic sequence while the basic sequence presents olivine and pyroxenes. These different assemblages have similarities with the metamorphic paragenesis reported by (Villeneuve, 1977). in the Kibarian. In the Kibarian metasedimentary sequences, there is a multitude of sills and thin mafic rocks known in the literature as metabolites (Jung & Meyer, 1990). The metadolerites have been mapped generally in the contact quartzites-schist. These sills have been folded and deformed with metasedimentary rocks and have stratigraphic characteristics similar to those found in the intrusive province of Kabanga-Muzingati (KM) in Burundi by (Evans et al., 2000). Schist, metadolerite, and quartzites all show elongated and aligned minerals materializing the flux cleavage generated by the D1 tectonic phase similar to that of Kamanyola formation rocks mapped by (Villeneuve et al., 2019).

The structural studies revealed that two tectonic phases have been identified in the Chulwe-Matale geological formations. Among these phases, there is one that characterizes a strike-slip regime related to the Kibarian orogeny and an extensive phase that is responsible for the fracturation occurring in the formations. The strike-slip phase is a transpressure type with a strong NW-SE compressive component orientation that leads to the implementation of folding. The flux cleavage S1 is associated with this folding and the flanks of the antiform are oriented NE-SW like the cleavage planes. This coincides with

(Rumvegeri's, 1987) postulate that subduction in Kibarian terrains is associated with sinistral sliding movements. In terms of structural orientation and type of cleavage, this deformation (cleavage S1) is close to phase D1 revealed by (Rumvegeri , 1987) which affects the Bitale Group in the Bunyakiri region. It corresponds to the D1 phase identified by (Villeneuve, 1977) in the Bugarama group. This phase is recognized as the oldest tectonic phase in the Kibara chain in which the cleavage generated in metasediments is distorted in some places in the form of crenulations by another phase whose cleavage displays NW-SE orientation, as the case of Bikangala (Rumvegeri, 1987) and corresponds to the Kibarian phase at the regional level (Fernandez-Alonso et al., 2012).

Displaying the same structural orientations and tectonic parameters, deformation phases that generated and cleavage planes at Chulwe-Matale would be the same as the D1 recognized in Kibarian terrain. Even if felsic intrusion hasn't been identified in the Chulwe-Matale study area, their out coming during the tectonic events which has affected the region is also probable. That can be supported by the existence of granitic rocks at 500 m around the study area in the southern part according to the regional map done by (Laghmouch et al. 2018) (see Fig. 1), (Lefevere, 2003) as well as by previous work carried out in Kibarian formations by (Pohl,(1993), (Rumvegeri, 1987).

The second phase is an ENE-WSW-oriented extension that sets up the fractures in the area. For (Pohl, 1993). two extensive phases related to basic magmatism are reported in the Kibarian terrain. The first is before all Kibarian orogenic phases and the second is associated with D3 and corresponding granites. The latter would correspond, according to him, to rifting in the Katanga region. Since the markers of D3 have not been identified in Chulwe-Matale lithologies, it would therefore be obvious that the meta-doleritic sills recorded in the region occurred during the extensive pre-D1 phase during the filling of the Kibara basin. This is justified by the orientation of these mafic intrusions in the form of layers parallel to the stratification planes and their deformation during the orogenic phases recorded in the studied area. The variations in the preferential pattern of the Chulwe-Matale formations towards the southern part (fig.10) would be explained by the presence of a major discordance of regional magnitude, the Matale discordance. This would therefore have acted in the region by switching the lithology units from NE-SW to ENE-WSW orientation.

Conclusion

This work was carried out to investigate the Precambrian basement rocks from Chulwe-Matale and to define the connection of the Chulwe-Matale geological formations to the Kibarian lithostratigraphic subdivisions.

- The petrographic and geological mapping revealed that the Chulwe-Matale area is characterized by schists and quartzites intruded by metabasite sills whose microscopy has identified a sample as metadolerite. All these lithologies are intersected by quartz veins and dry fractures. These lithologies show a mineral assemblage that consists of quartz-feldspars-±sericite-±Muscovite-±opaque minerals in the pelitic sequence while the basic sequence presents olivine and pyroxenes.
- Two deformation events are displayed in this zone who's the first is a strike-slip type and its compressive component generated the stratification joints in quartzites, cleavage in almost all lithologies and folds in the study area. The strike slip phase is related to the D1 of the Kibarian orogeny. The second one is an extensive phase that has generated the fractures in the study area. Investigations can be done to enhance a probable link between this fracturation and the post-D1 deformations phases. The Matale discordance overlaps all these lithologies, a later phase is possible. This discontinuity would have acted in the region studied by switching the lithology units from NE-SW to ENE-WSW orientation. This research recommends that the Chulwe-Matale formations would be typical of the Lower Kibarian (Bugarama group) but geochronological and geochemical studies are lacking to refine this hypothesis.

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