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Petrographic and Structural Studies of the Guintéguéla Formations (Northwest of Côte d'Ivoire)

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Abstract

Côte d'Ivoire is currently experiencing strong growth in the mining sector. Identifying the formations present in our subsoil is therefore essential for mining recovery. It is in this context that we conducted studies on the formations present in the locality of Guintéguéla. It is located in the northwest of Côte d'Ivoire in the bafing region. The aim of this work was to determine the petrographic and structural characteristics of the formations of the area. The methodology began with documentation and then followed petrography and structural analysis work on the macroscopic and microscopic levels. We observed six groups of rocks: granitoids, amphibolites, orthogneiss, quartzites (poor and rich in magnetites), volcano-sediments and filonian rocks. Metamorphism is of amphibolite to granulite facies. However, volcano-sediments must be associated with the green schist facies. With regard to the structural, structures and microstructures such as foliation; fractures; sigmoidal figures reveal that the studied area was affected by ductile and also brittle tectonics whose main directions are oriented along the shear corridor, so N-S to NNW-SSE.

Keywords

Mining, Petrography, Structural, Metamorphism

1. Introduction

It is generally accepted that the African continent consists of three cratons the craton of the Congo, the craton of the Kalahari and the West African craton [1]. The West African craton, a large portion of the continental lithosphere Palaeoproterozoic, afleures in two dorsales, Man and Réguibat [2]. The Ivory Coast located in the Man Ridge includes the Archaean and Paleoproterozoic domains. This area belongs to the Archaean domain of the Man Ridge and was affected by the Leonian and Liberian orogeny. The rocks are mainly composed of gneiss (para and ortho-derivatives), quartzites associated with amphibolites, amphibolo-pyroxenites, trundhjemitics, charnockites, granulites, magnetite banded quartzites and biotite migmatites [1] [3] [4] [5]. The most important structure in western Côte d'Ivoire is the N-S-oriented Sassandra fault, which separates the Archaean domain to the west and the Paleoproterozoic domain to the east [2]. Indeed, this flaw has been repeated several times throughout its history, either dexterously or senestre with varying intensities of importance. The tectonic events that prevailed in this region gave rise to a very complex structural scheme [6].

Côte d'Ivoire is experiencing strong development in the mining sector. And it is in order to discover areas with economic potential that several sectors have been studied, notably segregated in the north [7], in central Côte d'Ivoire [8] [9] [10], in the west [5]. However, it is necessary to report the lack of significant information on certain areas. The Guintéguéla sector located in the northwest of the country is part of it. The geological formations of this sector highlight several questions, namely: 1) what are the petrographic characteristics of the formations encountered? 2) What deformations and metamorphisms have affected this region and 3) what will be the geological map of the region? The aim of this work is therefore to identify the rocks on our permit and the structures associated with them. This study will allow us to update the cartographic data both in the context of mining exploration and academic research.

2. Geological Context

The sub-prefecture of Guintéguéla belongs to the Touba region in the Archean domain of Côte d'Ivoire (**Figure 1**). Granito-gneiss, granulite, pink granulite, charnockite, peridotites, amphibolites, quartzites and amphibolo-pyroxenites are found in this region [5] [11]-[17]. It should be noted that these rocks, most of which are affected by hydrothermal alteration, are derived from granulite facies [11]. Structurally, the structures and microstructures such as foliation, fractures and sigmoidal figures reveal that the area studied was affected by ductile and brittle tectonics, the main directions of which are N-S (**Figure 2**). The first magmatic events recorded in the northern part of the region correspond to grey tonalitic gneisses with a minimum age of around 3.05 Ga (Leonian event). A subsequent major phase of igneous and metamorphic activity around 2.8 Ga (Liberian event) is recorded throughout the Archean terrain without any evidence of new accretion [4].

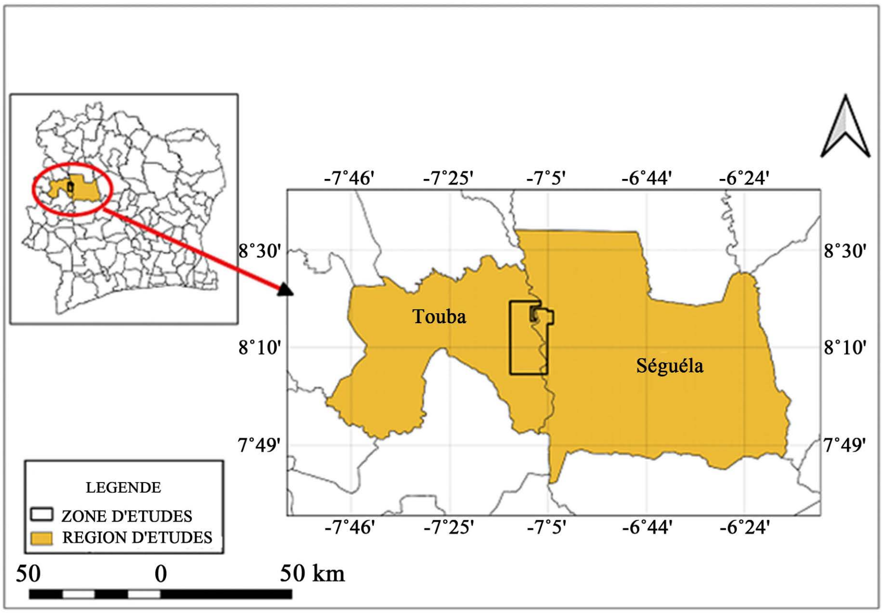

Figure 1. Geographical map of the study area.

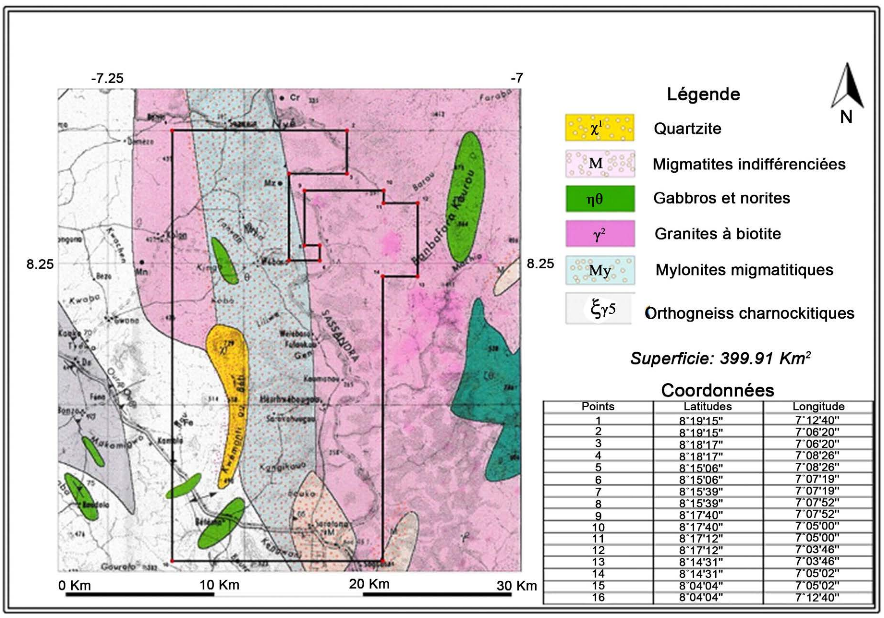

Figure 2. Local geological map of the Touba permit.

3. Methodology

This project was carried out in two-month stages, including the field and laboratory stages. Respective methods for each of these steps have been developed.

3.1. Bibliography

This phase consisted of collecting existing data on the study area and other data similar to my theme. To do this, we conducted a bibliography that allowed us to have information on the regional geology of the study area. Thus, it was carried out by consulting Master's theses; doctoral theses, articles etc.

3.2. Geological Mapping

It consists of browsing the entire site in order to discover and describe the granitic plutons and their enclosures that appear there. Thus, to travel the roads and tracks were made in vehicle of type 4 × 4 and to walk. Upon discovery of an outcrop, the coordinates of it will be recorded using the GPS. It followed the description of the outcrop including lithological facies, structures (nature, measures of directions and dips for planar elements, directions and dips for linear elements), illustrations (diagrams and photos) and finally, sample collection. This description of the lithological facies takes into account the appearance, color, texture, mineralogical composition, alterations and probable name of the rock, as well as the presence of veins or enclaves. The rock outcrops will then be marked or reported on the terrain map materialized on graph paper to scale according to their geographical coordinates. Colors are assigned to each lithological facies and symbols to each structure taking into account their orientations.

3.3. Petrography and Microstructural

An observation on the sections of thin or polished blades was made to determine the characteristics of the minerals of the different rocks studied in natural and polarized light. The various criteria of description allow eventually to identify the rocks and to assign them a name. The identification and characterization of the microstructures present in these thin strips was followed. These microstructures are the witnesses of deformations identified or not during the field mission.

4. Results

The results obtained come from geological reconnaissance work carried out in our zone.

4.1. Lithology

Geological recognition revealed six (6) major lithological units: 1) an undifferentiated orthogneiss unit, 2) a granitic to granitic pegmatitic and granodiorite unit, 3) a magnetic quartzite unit and BIF, 4) a volcano-sedimentary unit and finally, 5) an amphibolo-pyroxenite unit. However, one distinguishes a unit formed of filonian rocks 6).

4.1.1. Undifferentiated Orthogneiss Unit

Orthogneiss occupy most of the western half of the site. Magnetite and/or BIF pyroxenites and quartzites are associated. These rocks are defined by foliation in the form of clear bands containing quartz-feldspar minerals and dark bands made of ferromagnesians (amphiboles-pyroxenes) (**Figure 3**). However, when poor in ferromagnesian minerals, foliation is expressed rather by an alternation of light bands with slight proportions of ferromagnesians that cannot consist of real dark bands. Orthogneiss sometimes contain fragments of mafic rocks

Figure 3. Macrophotography of the orthogneiss.

subparalled to foliation. Under the microscope, it has a granoblastic texture and the alternation of light and dark bands (foliation) is slightly more pronounced. We can also note the presence of quartz veins. The minerals clear as dark are difficult to identify except a few grains of quartz and biotite which are still large in places (**Figure 4**, **Figure 5(A)**).

4.1.2. Granite unit with Pegmatitic and Granodioritic Granite

Two traces of granitic rock, occupying the eastern half of the permit and separated by the Sassandra River, form this unit: granites and pegmatitic granites. The granites usually appear as domes in the Gbétéma and Ladjibougou sectors (**Figure 5(B)**). Granites have a massive appearance or have low deformation gradients (**Figure 5(C)**). They have a normal grainy texture and are formed of quartz minerals, feldspars, biotite and sericites (**Figure 6**). As for pegmatitic granites, they have a pegmatitic grainy texture marked by the presence of large quartz crystals (**Figure 5(D)**). To this is added the granodiorites whose outcrop was observed in the south in the sectors of Ladjibougou (**Figure 7(A)**). They contain enclaves of surrounding rocks (**Figure 5(E)**). Granodiorites also have a grainy texture and are composed in addition to the minerals already mentioned, amphiboles and pyroxenes (**Figure 7**). Microscopically, they are dominated by quartz (in phenocrysts in pegmatitic granites). In addition, microclines, sericites biotites, amphiboles, pyroxenes, plagioclases and garnet.

4.1.3. Magnetic Quartzite Unit and BIF

The quartzites form the large north-south mountain range that occupies the southwest of the permit. These quartzites appear under two facies: magnetite-poor facies and a magnetite-rich quartzite facies. Magnetite-poor quartzites: this facies is essentially composed of metamorphosed silice and feldsparths with very low magnetites, usually observed as porphyroblasts (**Figure 8**). Under the microscope, these quartzites have a granolepidoblastic texture. It is essentially composed of quartz. To this are added some minerals of sericites and magnetites (**Figure 9**). Magnetite-rich quartzites: these are quartzites containing high magnetite levels almost in the form of hematite. There are grey or dark brown hematite

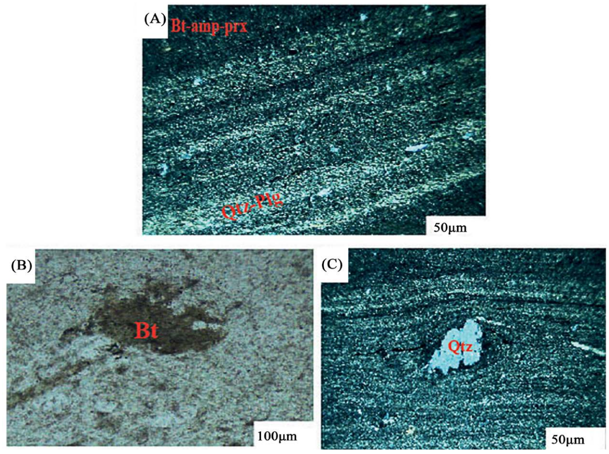

Figure 4. Microscopic appearance of gneiss. (A) Foliation in LPA, alternation of clear quartz (Qtz) and plagioclases (Plg) and dark bands of biotites (Bt) of amphiboles (Amp) and pyroxenes (Prx); (B) Biotite (Bt) contained in orthogneiss in LPNA; (C) Quartz (Qtz) boudin and foliation in LPA.

Figure 5. Orthogneiss and granite: (A) Orthogneiss with heterogeneous foliation; (B) Granite dome; (C) Granite with normal grained texture; (D) Granite with pegmatitic grained texture and (E) Granite with embedding rock enclaves.

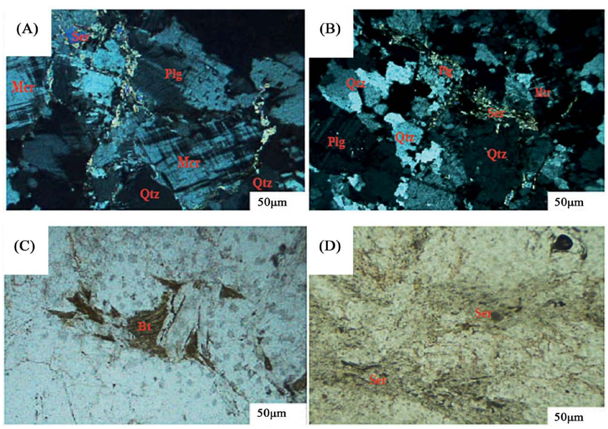

Figure 6. Microscopic appearance of granite. (A) and (B) Quartz ores (Qtz) Plagioclases (Plg) and Sericite (Ser) of granite in LPA; (C) Biotite mineral (Bt) in LPNA; (D) Sericite (Ser) in LPNA.

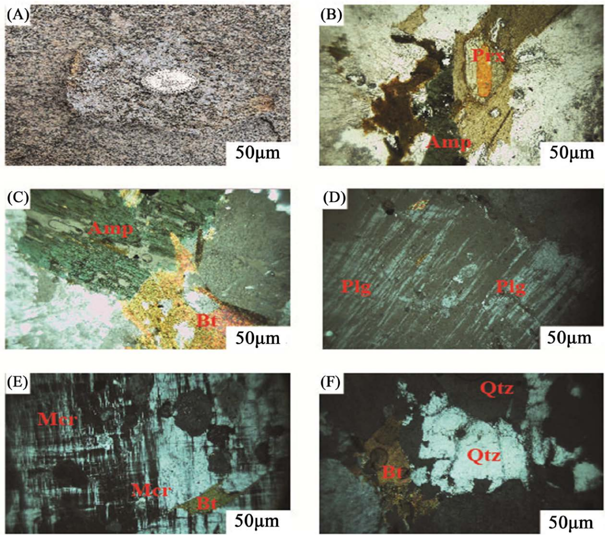

Figure 7. Macroscopic appearance of granodiorite (A) Granodiorite macro photography; (B) Pyroxene (Prx) and amphibole (Amp) in LPA contained in granodiorite; (C) Biotite (Bt) and amphibole (Amp) in LPA of granodiorite in LPA; (D) Plagioclas (Plg) of granodiorite; (E) Microcline (Mcr) and biotite (Bt); (F) Quartz (Qtz).

Figure 8. Magnetite-poor quartzites: (A) Quartzite afleurement; (B) Quartzite with quartzo-feldspathic bands; (C) Quartzite with magnetite porphyroblasts.

beds, which alternate with red or orange silica beds to form BIF (Banded Iron Formation) or banded iron ore (**Figure 10**).

They have a granoblastic texture under the microscope. We also notice an alternation of band of hematites, ferromagnesian minerals (amphibole and pyroxene) and quartz (**Figure 11**) this Rock is rich in oxide including hematite which gives it the name of BIF.

4.1.4. The Volcano-Sedimentary

Rocks occupy the central part following the North-South direction. The coiled and asymmetrical shape of this unit indicates that it has undergone non-coaxial

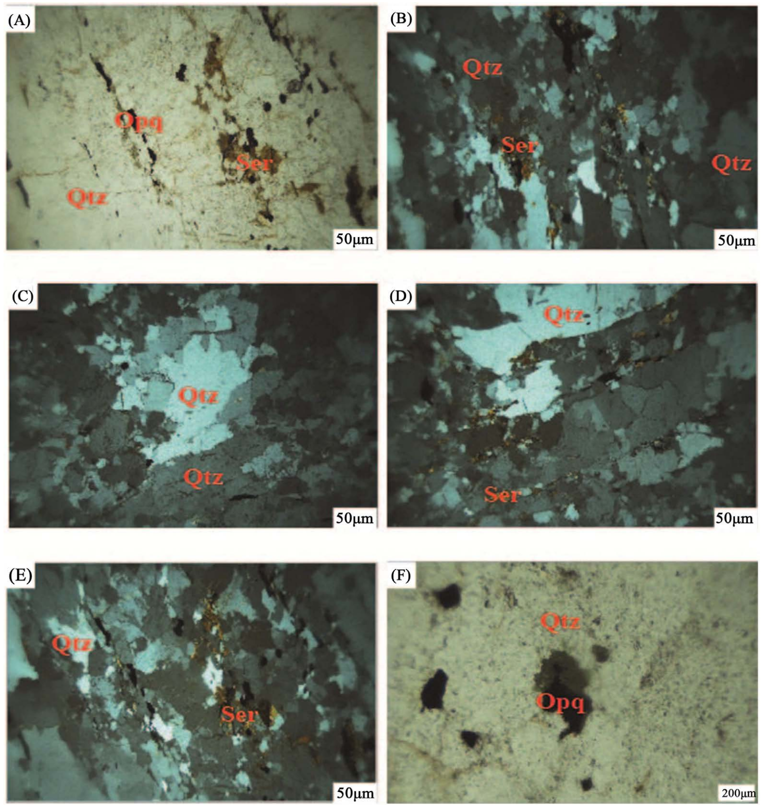

Figure 9. Microscopic appearance of magnetite-poor quartz. (A) Sericite minerals present in quartz in LPNA; (B), (C), (D) and (E) Quartz minerals (Qtz) and sericite (Ser) in LPN.

Figure 10. Magnetite-rich quartzites: (A) outcrop of BIF; (B) BIF oxidized to hematites, goethite and limonite; (C) Alternation of magnetite beds (hematites) and silica beds.

deformation. These volcano-sediments contain pyroclastic rocks and metasediments, usually intensely deformed and hydrothermally altered (Figure 12(A) and Figure 12(B)). Pyroclastites show a vacuolar texture, with carbonate porphyroblasts

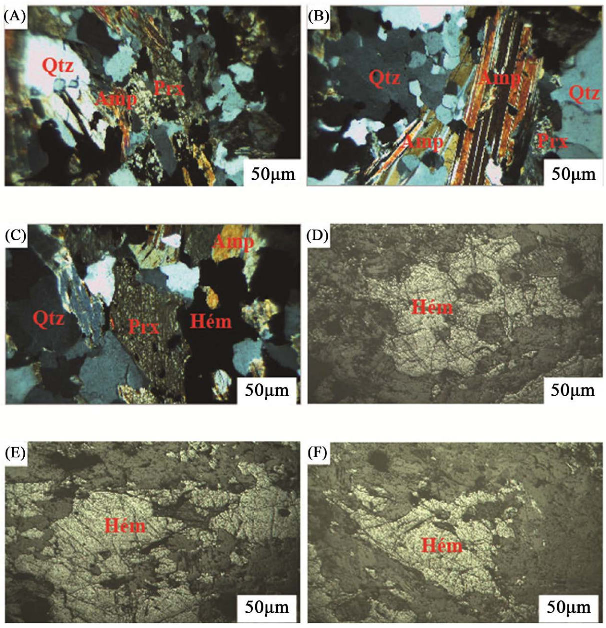

Figure 11. Microscopic appearance of BIF; (A), (B) and (C) Amphibole (Amp), Pyroxene (Prx) and Quartz (Qtz) present in BIF in LPN; (D), (E) and (F) Hematite (Hemi) contained in the Volcano-sedimentary unit.

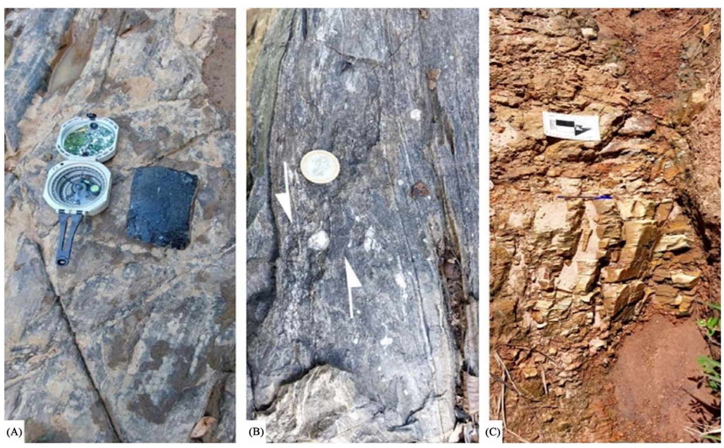

Figure 12. Volcano-sedimentary rocks: (A) Silicified and carbonated pyroclastite in a shear zone oriented N-S; (B) Carbonated pyroclastite with vacuolar texture in a shear zone orientated senile N-S and (C) Volcanocallyshistozed and altered sediments, a penetrative schistosity (N180, 70˚W).

(calcite). Those subject to alteration show carbonate departures, leaving empty hollows in the rock. Apart from carbonation, silicification and pyritization are also noted. Volcano sediments are sometimes marked by flux schistosity or are altered into sericitoschists (**Figure 12(C)**). Under the microscope, they have a granolepidoblastic texture and are composed of quartz, plagioclases, sericites, epidote, microclines and some biotites. There are also opaque minerals (**Figure 13**).

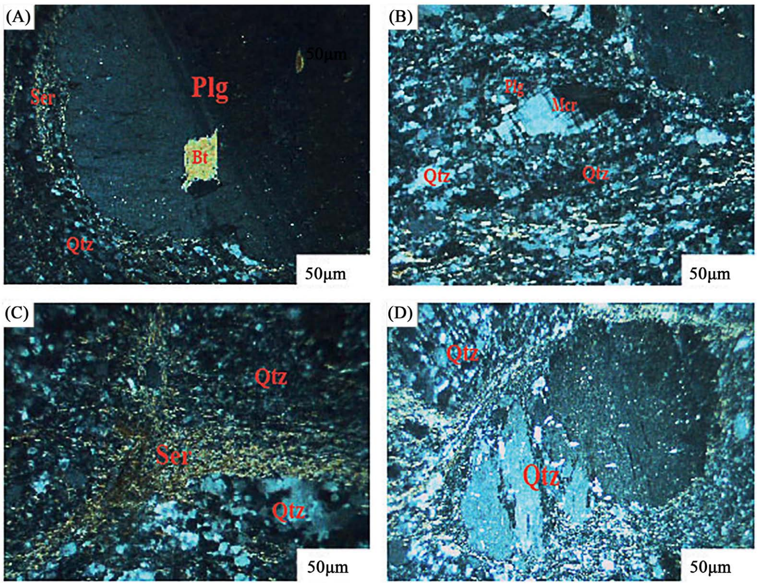

Figure 13. Microscopic appearance of volcanosediment. (A) Biotites (Bt) included in a porphyry of plagioclases (Plg) in LPA; (B) Microcline (Mcr) and quartz (Qtz) of volcanosedimentation in LPA; (C) LPA sericite range; (D) Boudin quartz in LPA sedimentation.

4.1.5. Amphibolo-Pyroxenite Unit

This unit contains on the one hand pyroxenites and on the other hand amphibolites. These are formations with limited contours or extensions that appear as intrusive in the western and southern parts of the permit. The pyroxenites, of gray-greenish color, show a foliated structure with a dominance of the dark bands rich in amphibole pyroxenes on the light bands mainly composed of quartz-feldspar (**Figure 14(A)**). They also contain garnet minerals of millimetre to centimetre size (**Figure 14(B)**). They outcrop to the North and South of the great chain of hills and constitute with the orthogneiss the encaissantes of the BIF. Amphibolites on the other hand show an aspect similar to the equante structure (**Figure 14(C)** and **Figure 14(D)**). They consist mainly of amphiboles (green hornblende) and plagioclase feldspars. Flush south of the permit in the Gbétéma and Sorotona sectors, they seem more or less associated with granites. Under the microscope, they have a granoblastic and sometimes granolepidoblastic texture. They are composed of pyroxene amphiboles, quartz, plagioclases, epidote, microcline, garnet and opaque minerals (**Figure 15**). We also observe some amphiboles from the hydration of pyroxene.

4.1.6. Unit formed of Filonian Rocks

The microgranite veins associated with orthogneiss and pegmatite veins described in pegmatitic granites constitute the filonian unit (**Figure 16(A)** and **Figure 16(B)**). The microgranites, of decimetric to metric size and formed of quartz, feldspars and biotite, intersect in almost E-W direction (N110, 90˚S) the foliation. The pegmatites appear impressively in the village of Ladjibougou. They are formed by large quartz crystals, feldspars (orthosis) and biotite. However,

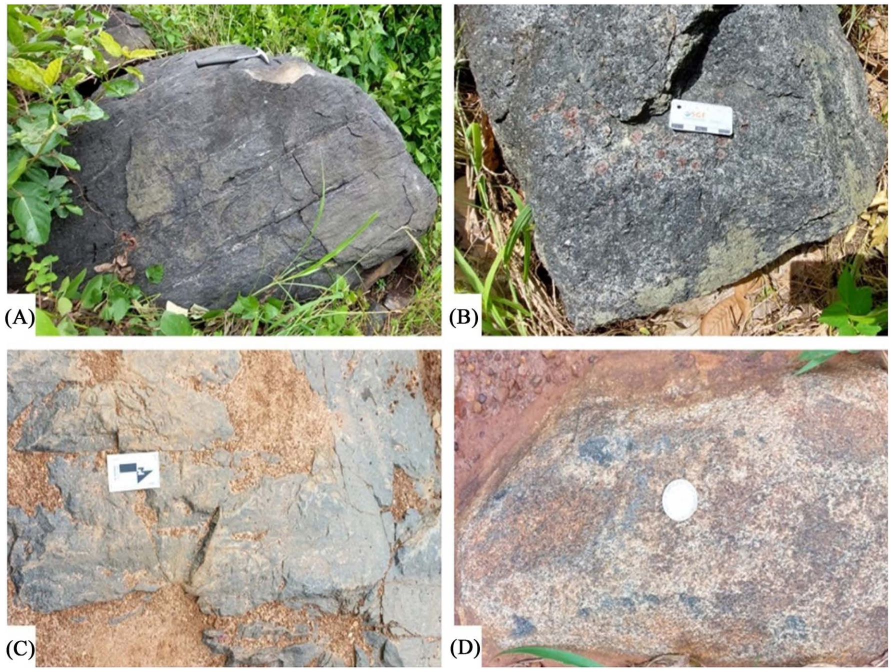

Figure 14. Amphibolo-pyroxenites: (A) Pyroxenite with foliated structure; (B) Pyroxenite with fine to coarse garnet minerals; (C) Amphibolite more or less silicified and (D) Amphibolite.

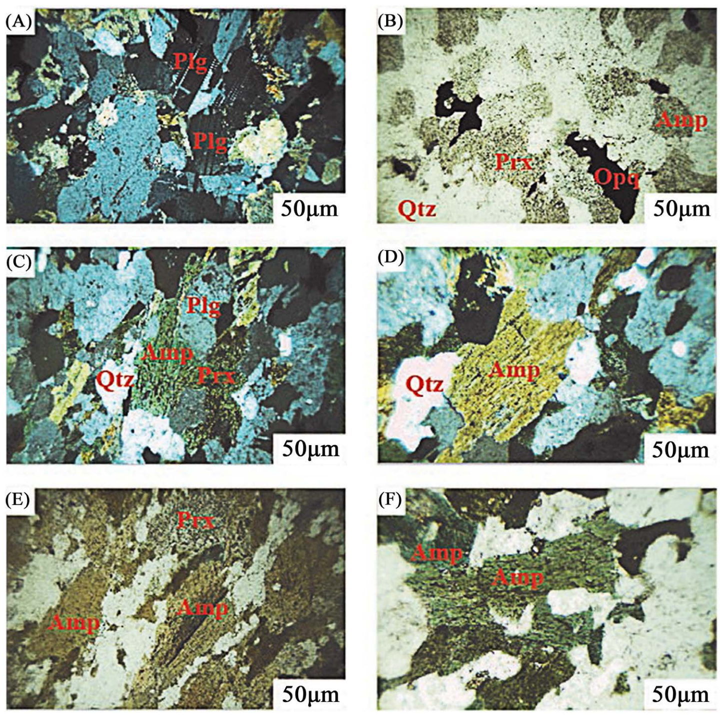

Figure 15. Microscopic appearance of an amphibolite. (A) Plagioclases (Plg) present in amphibolo-pyroxenites in LPA; (B) Amphiboles (Amp) and pyroxenes (Prx) of pyroxenites in LPNA; (C) and (D) Minerals of amphiboles (Amp) and pyroxenes (Prx) in LPA; (E) and (F) Amphibole and pyroxene in LPNA; Ept: epidote, Plg: plagioclase, Qtz: quartz, Amp: amphibole, Prx: pyroxene.

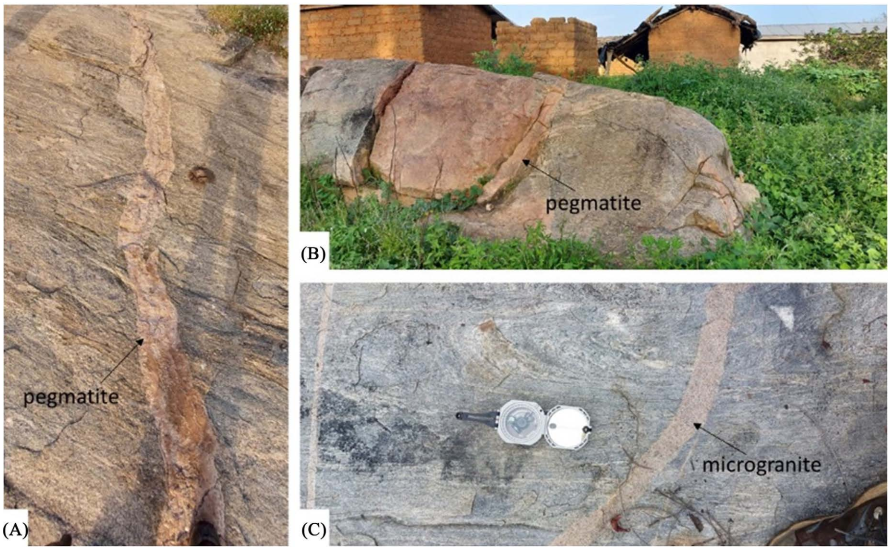

Figure 16. Filonian rocks: (A) Decimal pegmatite vein in the Ladjibougou pegmatite granite and (B) Metric pegmatite vein in the Ladjibougou pegmatite granite, (C) Decimal microgranite vein intersecting the orthogneiss.

their overall pinkish coloration is probably related to the presence of orthosis in significant proportions.

4.2. Lithostructural Data

Different tectonic structures, as well as stratification, were recorded and described on the study site: schistosity, foliation, shearing, folds, faults, joints and fractures, etc. These structures describe different phases of deformation that affected the lithologies.

4.2.1. Stratification

S0 stratification was observed only in quartzites. It is more or less clear than in magnetite-poor quartzites (**Figure 17(A)**). It is oriented (N20, 80˚W). In magnetite-rich BIF or quartzites, it is confused with alternating beds of dark grey or brown hematite and silica beds (**Figure 17(B)** and **Figure 17(C)**). Tectonised, the beds are subparalled to S1 schistosity and have a strong dip to the west or are subvertical (80˚ - 90˚).

4.2.2. Schistosity

Schistosity is generally associated with magnetite quartzites, volcanosediments and amphibolitic schists. Magnetite quartzites are dominated by disjunct schistosity at a low angle of 10˚ - 15˚ with stratification (**Figure 18(A)**). It is orientation (N00-10, 80˚W). However, in BIF, stratification and schistosity give way to alternating dark and light beds rich respectively in magnetite (hematite) and silica (**Figure 18(B)** and **Figure 18(C)**). This S0-S1 structure shows variable orientations from north-south to north-west (N140, 80˚NE). The schistosity is also well visible in the volcanosediments and orientation (N180, 70˚W) (**Figure 11(B)** and **Figure 11(C)**). The schistosities associated with magnetite quartzite

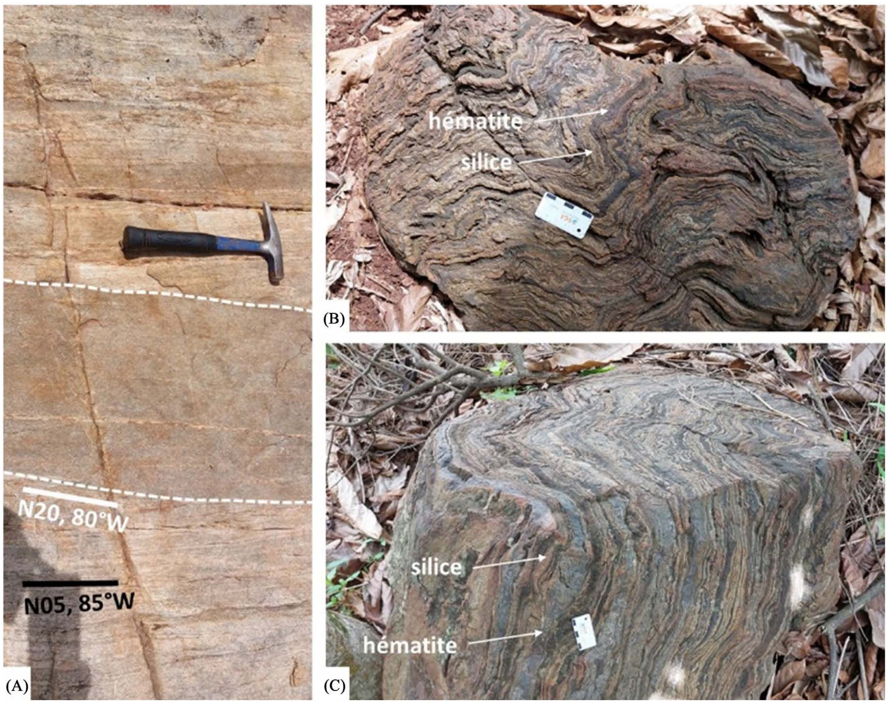

Figure 17. Stratification and mesostructure: (A) Stratification and disjoint schistosity; (B) and (C) BIF with alternation of dark hematite beds and light silica beds (structure S0 - S1).

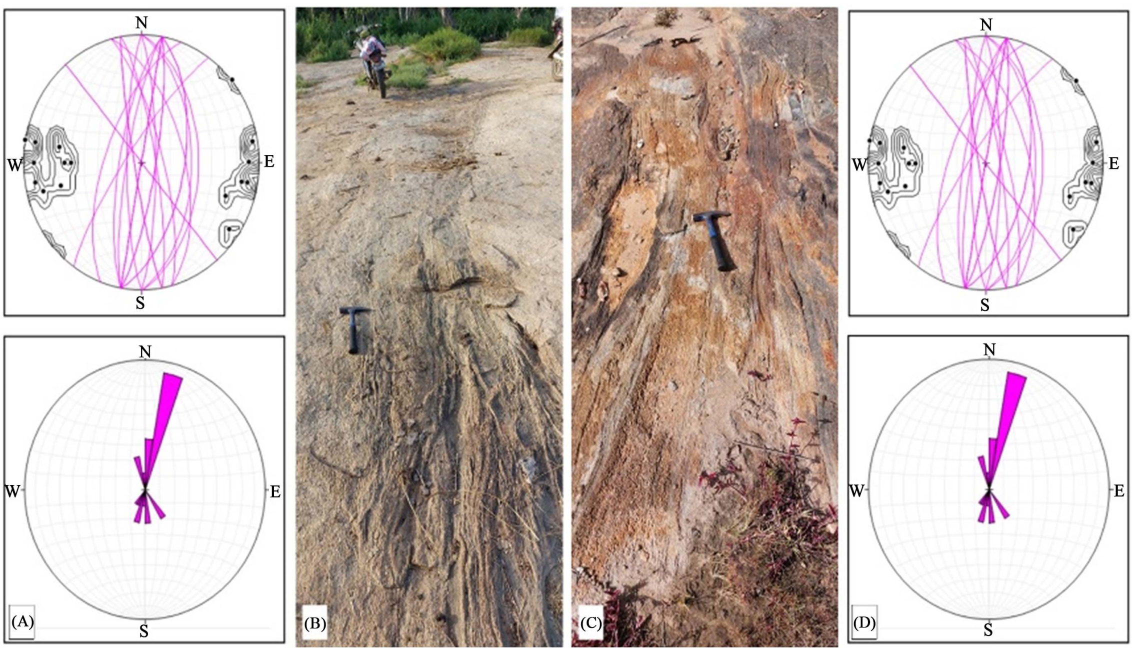

Figure 18. Mesostructures and stereographic projections: (A) Orientations and schistosity; (B) Slewing shear (N10, 90˚) affecting Ladjibougou pegmatitic granite; (C) Slewing shear oriented (N15, 80˚E); (D) Slewing shear orientation.

formations or BIF and volcano-sediments are due to the establishment of the Sassandra fault. On the other hand, the schistosities described in the amphibolitic schists could be linked to the Eburnean cycle.

4.2.3. Foliation

It characterizes orthogneiss that occupy the entire western portion of the site and is manifested by alternating light and dark bands, the former being quartz-feldspars and biotite-amphibole. Foliation is also present in pyroxenites. It has an orientation that evolves from an NNE-SSW to NNW-SSE direction via the N-S direction, with strong or subvertical dips (**Figure 14(A)**; **Figure 19(A)** and **Figure 19(B)**; **Figure 20(B)** and **Figure 20(D)**).

4.2.4. Shearing

Several shear corridors have been distinguished, the main one occupying the central part of the permit. It extends over 5 km and crosses the entire permit from South to North, moving respectively from N-S to NNW-SSE. Smaller shear corridors of NNE-SSW to NE-SW, NNW-SSE and ENE-WSW orientations were also distinguished (**Figure 19(B)** and **Figure 19(C)**). The different structural elements suggest that the main shear is senelar as are the NNW-SSE and ENE-WSW orientation shears, while those oriented NNE-SSW to NE-SW are dextrous. Among these structures, we can distinguish isoclinal folds, shear bands, C/S factories, drive folds, microplis or crenulations (very marked in BIF), winding figures, intrafoliar folds, sheath folds, foliation or schistositydefelections, sulking, etc. (**Figure 19**). Mylonites or cataclases are associated with different shear zones; their characteristics vary according to the petrographic nature of the protolith. Protomylonites and mylonites are distinguished from orthogneiss and pegmatitic granites (**Figure 21**).

4.2.5. Faults and Fractures

Faults and diaclases, joints and fractures are the elements of brittle deformation that have been highlighted. These structures are generally associated with shear zones. However, there are late fractures that cross all lithologies and structures. Overall, they are oriented NW-SE, N-S and ENE-WSW (**Figure 22**); however, NE-SW fractures were rarely observed.

4.2.6. Quartz Veins

Some fractures or joints filled with quartz form veins. However, quartz veins were rarely observed on this permit. Those observed are centimetric in size and generally oriented N-S to NNW-SSE and NE-SW (**Figure 23(A)**). The veins N-S to NNW-SSE are the most abundant. There are shear- or foliation-sub-allel veins, extension veins and tension veins (**Figure 23(C)**, **Figure 23(D)**, **Figure 20(A)**).

4.3. Metamorphism

The different lithologies encountered on the Touba permit are intensely deformed and metamorphosed. The petrographic description reveals the following mineral compositions: 1) Orthogneiss: quartz-plagioclase-biotite-amphibole-garnet; 2) Pyroxenites: amphibole-plagioclase-pyroxene-garnet; 3) Amphibolites: Amphibole-plagioclase-quartz; 4) Volcano-sediments: chlorite-sericite-carbonates

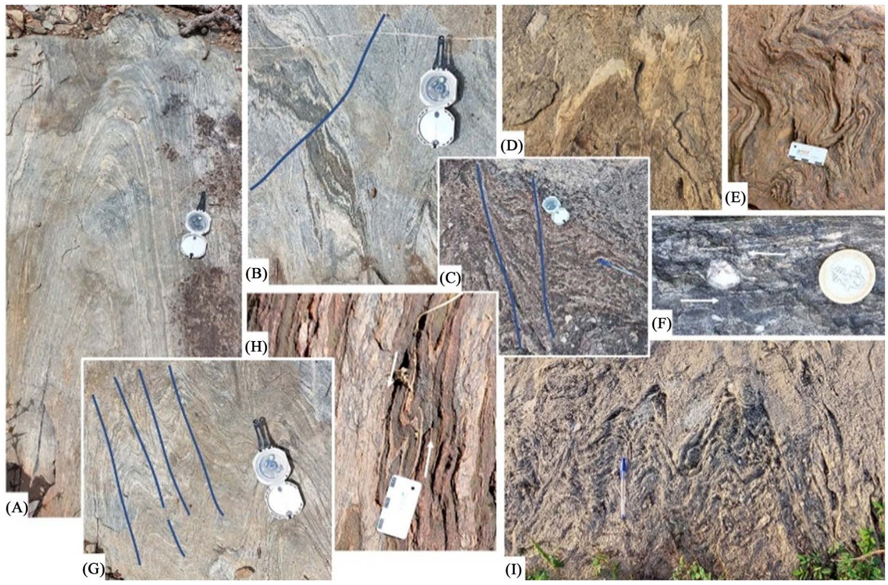

Figure 19. Shear-related structural elements: (A) Isoclinal fold; (B) Dexter shear band, (C) C/S mills (dexter shear); (D) Drive folds; (E) Microplis; (F) Senelar backlash figure, (G) C/S mills (seneschal shear); (H) Intrafoliar folds in the form of "S" (senelar shear) and (I) Sheath folds.

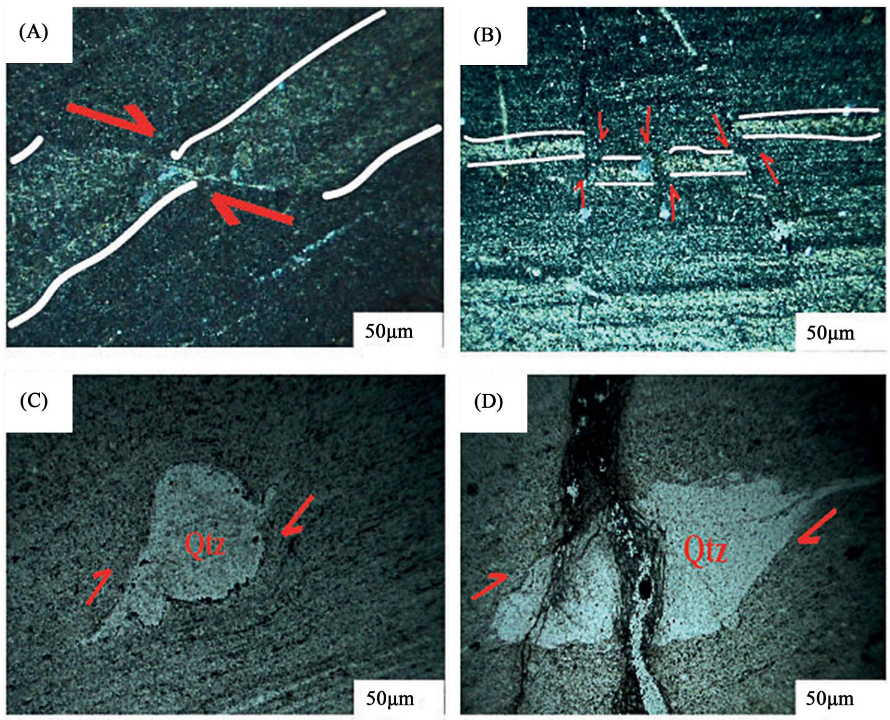

Figure 20. Microstructures, (A) and (B) Dextre and Senexte discontinuities affecting orthogneiss; (C) and (D) Boundin of quartz mineral (Qtz).

(calcite); 5) Granites/Pegmatitic granites: quartz-feldspar-biotite epidote. With regard to the minerals described, the dominant metamorphic facies are amphibolite granulite. However, a green schist facies seems to associate with volcano-sediments.

Figure 21. Mylonitic formation of shear zones: (A) Orthogneiss proto mylonite, (B) Orthogneiss mylonite, (C) Pegmatitic granite protomylonite, (D) Pegmatitic granite mylonite.

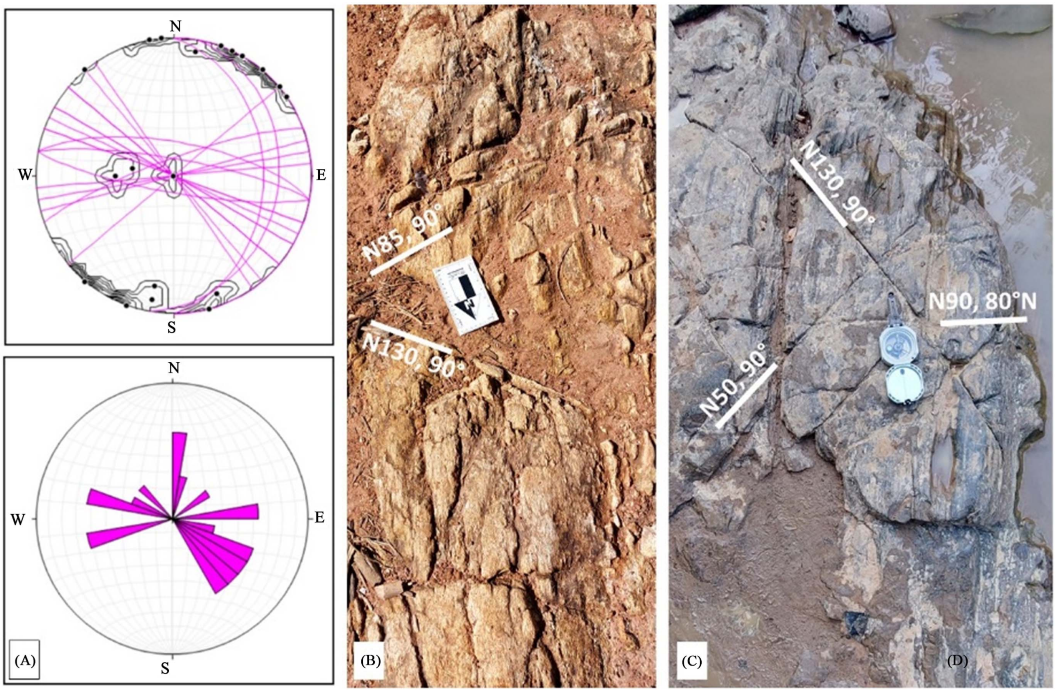

Figure 22. Mesostructures and stereographic projections: (A) Fault orientations and fractures, (B) Fractures affecting orthogneiss (C) Fractures associated with volcano-sediments.

4.4. Sketch of the Geological Map of the Region

This sketch of the geological map of the Touba permit is the result of a compilation of data and maps from previous work and updates made during recent geological survey work (**Figure 24**).

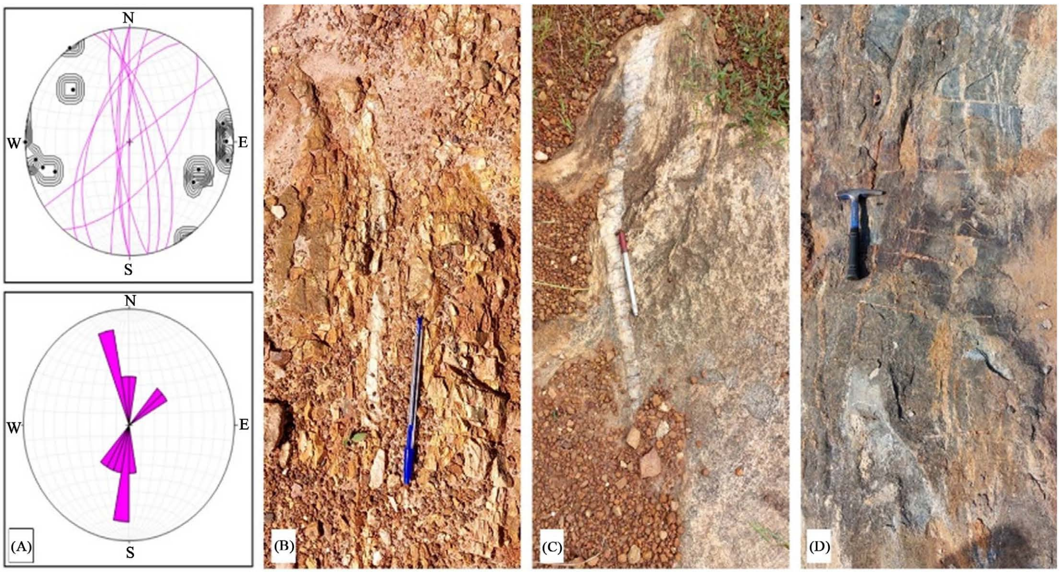

Figure 23. Mesostructures and stereographic projections: (A) Orientations of quartz veins; (B) Quartz veins (N170, 80˚W); (C) Extension veins (N180, 70˚W) and (D) Tension veins (N120, 90˚).

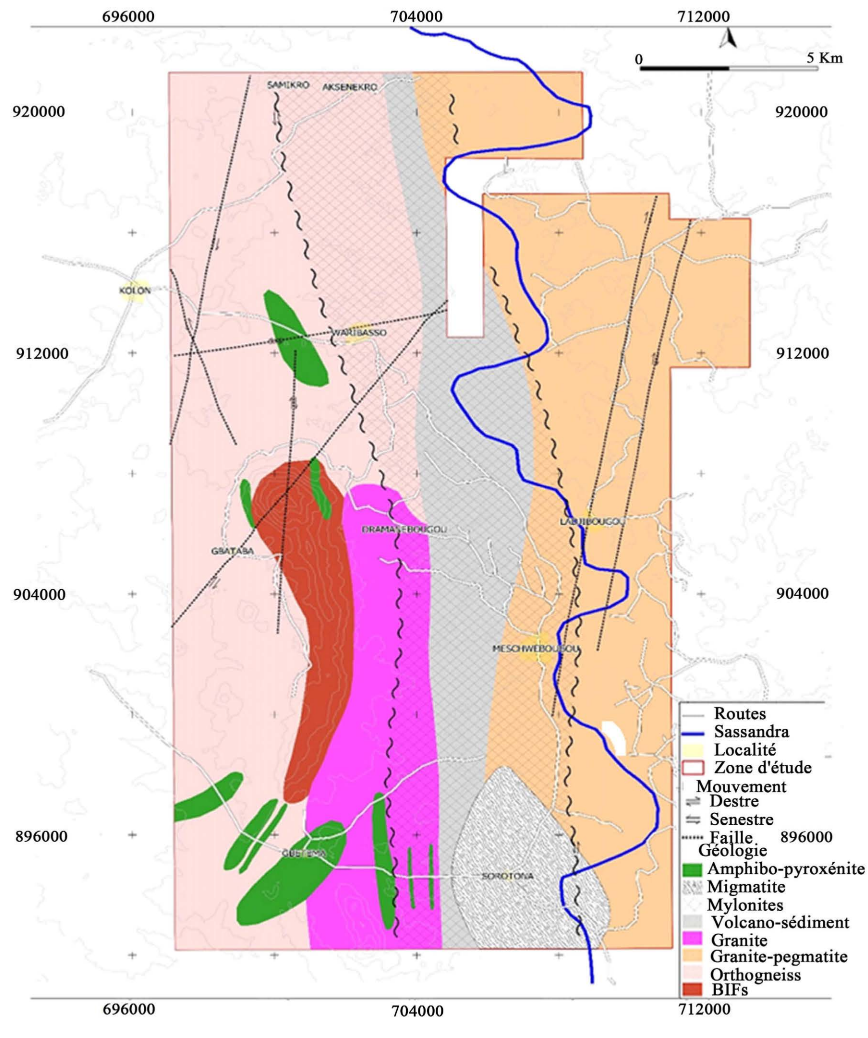

Figure 24. Study area lithostructural map.

5. Discussion

5.1. Petrographically

Lithologically, the study area consists largely of metamorphic rocks to which are added magmatic intrusions and pegmatite veins. The metamorphic rocks are: orthogneiss, amphibolo-pyroxenites, rich quartzites (BIF) and poor in magnetites. Magmatic rocks are granites, pegmatitic granites and diorites. The volcano sediments constitute an enclave in the orthogneiss which makes it possible to say that it is anterior to this one. The unity of granites, pegmatitic granites and diorite gave birth to the series of orthogneiss observed in the field by catazonal metamorphism. The magnetite quartzites observed in the region are similar to those found at the Yepleu-Bounta complex, Mount Klahoyo and Tia, they are of the itabirite type [5] [18]. However, there are some differences, notably the presence of amphibole in Guintéguéla quartzites. Amphibolo-pyroxenites have also been observed on our permit. [14] [19] have reported the presence of these formations in the SASCA domain. It is also noted that magnetite quartzites from the Yepleu-Bounta sector are associated with a granulitic complex, while those from the Klahoyo and Tia Mountains are associated with migmatites and aluminous gneiss [18]. While those of Guintéguéla are associated with orthogneiss and amphibolo-pyroxenites. These mineral parageneses characterize the facies of granulite amphibolites, thus a mesozoal to catazonal metamorphism. These formations subsequently underwent a retromorphosis resulting in the transformation of pyroxenes into amphibole (horneblende). [5] had observed metamorphism on Bounta metabasites ranging from amphibolitic facies to granulite facies. A metamorphosis of granulite facies followed by a retromorphosis that is expressed by the transformation of orthopyroxene into grünerite, a uralization of clinopyroxenes and an actinolization of brown hornblende was described by [20] at the Klahoyo and Tia Mountains.

5.2. Structurally

The main structural elements observed on the Guintéguéla permit show that the area is affected by brittle and ductile deformations. The deformations observed in the study area are schistosity, flanges, mineral stretching lineations, dropouts, quartz veins and vein, pegmatite veins, sigmoid figures, fractures and intrafoliar folds, C/S structures. Structures similar to such deformations were revealed by [5] on granulitic rocks in the Biankouma-Sipilou region and by [21]. They indic 1 ate the presence in the study area of shear corridor. According to [22] the evidence for the existence of a shear corridor is: Sigmoid structures; Shear joints or veins; Puddles; Associations of shear-schistosity planes (C/S structure); Folds. The structures encountered in the study area generally have a preferential N-S or neighbouring direction, reflecting a compressive deformation whose stress kinematics is oriented E-W. These same types of deformations were encountered by [11] in his study on the hosts of the mafic and ultramafic intrusions of Yepleu. The structures found in these enclosures have a NW-SE orientation. This is in fact contrary to the regional direction defined by [5] but partly consistent with the phase of fragile deformation of directions (NE-SW, NW-SE, N-S) which has also been described in the Ebournian area in eastern Côte d'Ivoire and West Africa [23]. We note the presence of gneiss, amphibolo-pyroxenites and magnetite unit in the region that show structures (folding, regional foliation N-S with subvertical dip) that are accompanied by the formation of large shear zones. Finally, particular structures such as step slits, schistosity, quartz and pegmatite veins, flanges, mineral stretching lineations, dropouts, sigmoid figures, quartz veins, fractures, and intrafoliar folds [22], so we can say that our study area is a potential area for mineral exploration.

6. Conclusion

The studies conducted on the Guintéguéla permit allowed us to highlight the petrographic and structural characteristics of the formations present in the area. Thus, thanks to macroscopic and microscopic petrography, we were able to highlight six lithological units namely, a unit formed of undifferentiated orthogneiss; a unit formed of magnetite quartzites and BIF; a unit formed of granites, Pegmatitic granites and diorites; a unit formed of amphibolo-pyroxenites; a unit formed of volcano-sediments and a unit formed of vein rocks. All these formations are affected by a regional metamorphism characteristic of the amphibolite facies with granulite materialized by the assembly of quartz-orthopyroxene-clinopyroxene-amphibole. Note also the green schist facies in volcanosediments. Most of these rocks are subject to hydrothermal alteration which is essentially materialized by quartz veinlets on the one hand and on the other hand by chloritization, uralitization, sericitization and silicification. Different deformation phases were highlighted in the study area, testifying to ductile and fragile tectonics. These include foliations, folds, fracture schistosities and fractures. All these deformations have NNW-SSE, NNE-SSW and N-S directions overall.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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