Journal of Geosciences and Geomatics, 2022, Vol. 10, No. 2, 81-88
Available online at http://pubs.sciepub.com/jgg/10/2/2
Published by Science and Education Publishing
DOI:10.12691/jgg-10-2-2

Petrographic and Structural Assessment of the Gounbela Area (Meiganga, Cameroon): An Approach for the Comprehension of the Geodynamic Context of the Adamawa-Yadé Emplacement

Mana Bouba Christian[1,2,*], Ismaïla Ahmadou[1,2], Ipan Antoinette Solange[1,3], Issac Bertrand Gbambie Mbowou[4], Yingyang Wanbitching Raoul[2], Sep Nlonngan Jean Paul[1], Dili-Rake Jacques[5], Bomolomo Michel Vanessa[2,6], Safianou Ousmanou[7], Bello Bienvenue[2]

[1]Centre for Geological and Mining Research, P.O Box 333, Garoua, Cameroon,
(Institue of Geological and Mining Research, Cameroon)
[2]Department of Earth Sciences, University of Ngaoundere, P.O Box 454 Ngaoundere, Cameroon
[3]Departement of Earth Sciences, University of Yaounde I, P.O Box 812 Yaounde, Cameroon;
[4]School of Geology and Mining of Meiganga (EGEM), University of Ngaoundere, Cameroon
[5]Research Centre for Geophysics and Volcanology, P.O Box 370 Buea, (Institue of Geological and Mining Research, Cameroon)
[6]Mineral processing laboratory, Institue of Geological and Mining Research, 4110 Nlongkak Yaounde Cameroon
[7]Laboratory of Environmental Geology, University of Dschang P.O Box 67, Dschang Cameroon
*Corresponding author: manaboubachristian@yahoo.com

Received March 25, 2022; Revised April 29, 2022; Accepted May 08, 2022

Abstract A petrographic and a structural study of the Gounbela region (Adamawa-Yadé) basement have been made. This included a macroscopic and a microscopic approach. The lithology is made up of biotite-amphibole gneisses and amphibolites (belonging to the amphibolite facies); of biotite-muscovite and pink granites with a porphiryc granular texture showing a syn-to late tectonic character of rocks. The Gounbela tectonic present four deformational phases; D_1, D_2, D_3, D_4. D1 is materialized by the S1 foliation; D_2 is marked by the S_2 schistosity resulting from the tranposition of S_1 foliation. D_3 is charasterized by F_3 folds and C_3 shear planes. The D4 deformational phase is made up of veins and faults. The major faults directions N130-N140 are similar to those belonging to the Lamé cretaceous Serie in Tchad, suggesting that they may have been occurred during the Atlantic opening.

Keywords: *Gounbela, Adamawa-Yadé, Amphibolites facies, plutonic rocks, deformational phases*

Cite This Article: Mana Bouba Christian, Ismaïla Ahmadou, Ipan Antoinette Solange, Issac Bertrand Gbambie Mbowou, Yingyang Wanbitching Raoul, Sep Nlonngan Jean Paul, Dili-Rake Jacques, Bomolomo Michel Vanessa, Safianou Ousmanou, and Bello Bienvenue, "Petrographic and Structural Assessment of the Gounbela Area (Meiganga, Cameroon): An Approach for the Comprehension of the Geodynamic Context of the Adamawa-Yadé Emplacement." *Journal of Geosciences and Geomatics*, vol. 10, no. 2 (2022): 81-88. doi: 10.12691/jgg-10-2-2.

1. Introduction

The NE-SW trending of the Central African Orogenic Belt forms part of a several thousand kilometres long continent collision zone, from Brazil to Sudan [1]. This belt is considered to have formed by the Pan-African collision of several cratonic blocks, including the Congo Craton [2-9] (Figure 1a). In the Cameroonian section, the Central African Orogenic Belt can be subdivided in three geological domains (Figure 1b) from north to south: 1) the Northern domain which consists of neoproterozoic volcano-sedimentary formations (Poli and Mayo Kebbi series) intruded by abundant calc-alkaline plutons related to neoproterozoic magmatic arcs, which developed in the 780-560Ma rang [9-13]; 2) the Southern napes are made up of low to high grade metamorphic units thrusted south-eastwards onto the Congo Craton during the Pan-African orogeny [14-19]; 3) the Adamawa-Yadé domain which consist of various low-to high grade metamorphic rocks and abundant Pan-African granites, bearing Archaean to palaeoproterozoic isotopic signatures [20,21,22] suggested that the Adamawa-Yadé domain could represented a microcontinent that has been detached from the Congo Craton during the early neoproterozoic lifting. [23] suggested that the Adamawa-Yadé domain represents an Archaean/paleoproterozoic micro continent, which was detached from the northern margin of the Congo Craton in the early Neoproterozoic, but became reactivated together with the mayo Kebbi (magmatic) arc during the Pan-African orogeny.

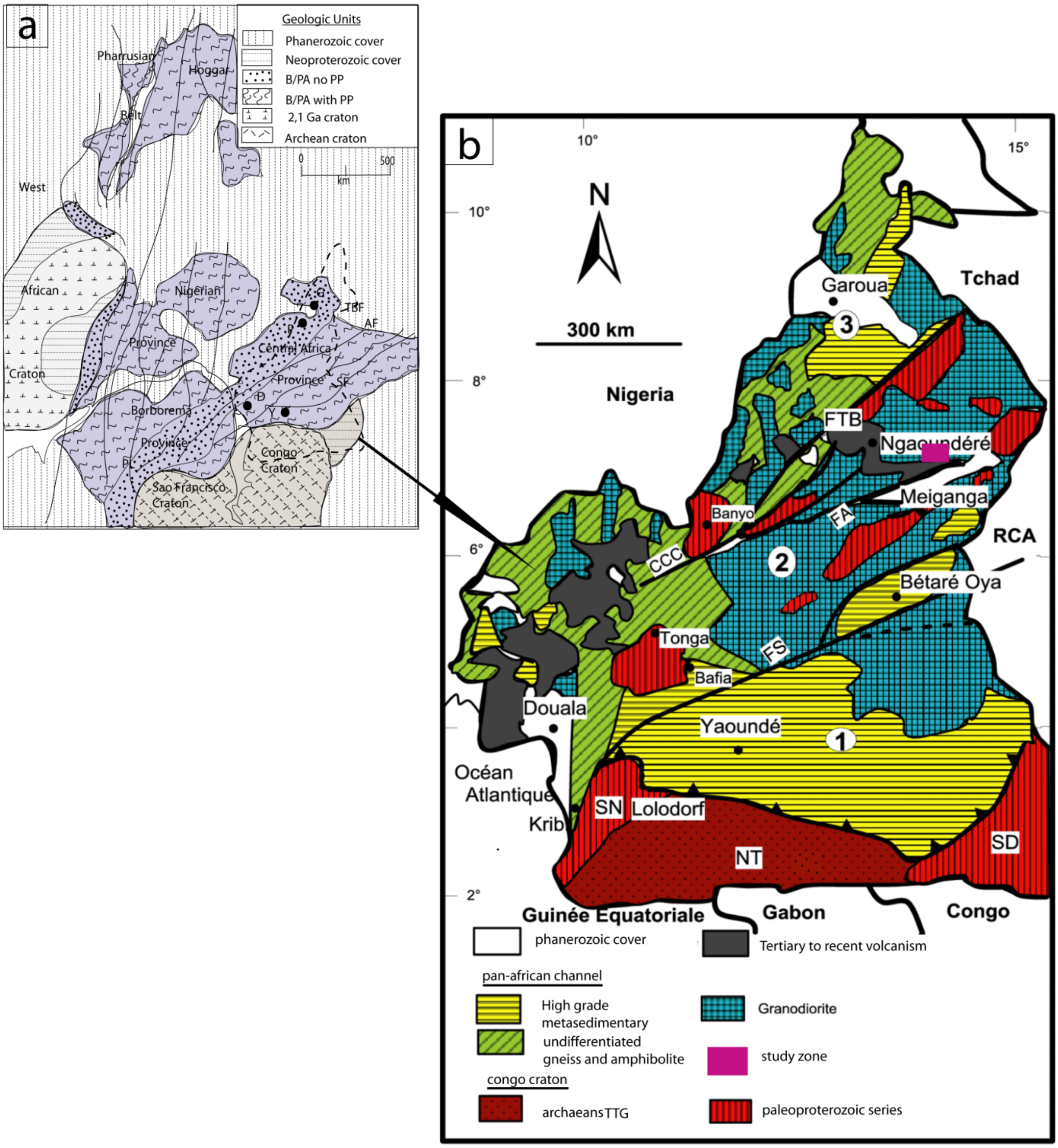

Figure 1. a- Genelized geologic map for West- Central Africa and northeastern Brazil in a Gonwana (Pre-drift) configuration. Dashed outline denotes approximate boundary of Cameroon. Modified from [4,24,20]. AF: Adamaoua Fault; PL: Pernambuco Lineament in Brazil; SF: Sanaga Fault; TBF: Tchollire-Banyo Fault; archean cratons may include Paleoproterozoic fold belts, B/PA with PP refers to regions of Brasiliano-Pan African deformation with large amounts of reworked paleoproterozoic basement; B/PA no PP refers to regions of Brasiliano-Pan African deformation in which paleoproteroaoic basement is absent or only present as small isled blocks. Cities in Cameroon, D: Douala; G: Garoua; P: Poli; Y: Yaounde**.** **b**- Geological map of Cameroon edit from [25] showing the main lithological domains: (1) South domain; (2) central domain; (3) North domain; CCC: Central Cameroonian Shear; FS: Sanaga Fault; FTB: Tchollire-Banyo Fault; NT: Ntem complex; SD: dja series; SN: Nyong series; FA: Adamaoua Fault

The study area named Gounbela belong to the adamawa-Yadé domain, which is situated betwen the “Tchollire-Banyo shear Zone’’ and the “Sanaga Fault’’ (Figure 1b). A few is known about the possible correlations between these two accidents and the Adamawa-Yadé put in place. The aim of this study is to provide a petrographic and structural study of the Gounbela area to help in the comprehension of the geodynamic context of the Adamawa-Yadé domain put in place.

2. Geological Setting

The Gounbela area is situated in the Meiganga region in Cameroon, between longitudes 14°07’-14°12’ and latitudes 6°39’-6°42’. The Adamawa-Yadé is limited to the north by the Tchollire-Banyo shear zone, and extends to the Sanaga fault in the South (Figure 1b). Several age groups ranging from archaean to palaeoproterozoic and neoproterozoic were found in the eastern part of the Adamawa-Yadé domain, notably in metasediments of the

Meiganga area [21] and metaquartzite of the Lom series [20]. In the Foumban area, Nd isotopic data obtained on a calco-alkaline orthogneiss demonstrated that it includes an inherited archean: palaeoproterozoic component [26]. The presence of a palaeoproterozoic inheritance was also shown for rocks from the northern part in the Banyo and Tchollíré areas [21,27]. To resume, the Adamawa-Yadé domain is made up of: (a) metasediments and orthogneiss of archaean to palaeaoproterozoic age [20,28,29]; (b) schists of Lom Series made up of metasediments, volcano clastic felsic rocks, Pan-African metamorphic rocks of amphibolites facies [30,31] (c) syn-to-late tectonic granitoids [20,30,31,32].

3. Methodology

3.1. Field Study

Field study was carrying out with the aid of standard field equipment's. The various rocks types of the area were identified by using the hammer prospection. Rocks were systematically described using observable field parameters (colour, mineralogy and structure) and sampled. Structural elements were also identified and measured. The relative chronology of tectono-metamorphic and magmatic events was also established.

3.2. Laboratory Study

After collecting samples in the field, we cut the sugar from the rocks at the litholamelage laboratory of the Center for Geological and Mining Research (CRGM) in Garoua. From its sugars we had made the thin sections at the litholamelage laboratory of the Geological and Mining Research Institute (IRGM) of Nkolbisson, (Yaoundé-Cameroon). Its thin sections were observed in the laboratory of the "School of Geology and Mines of Meiganga (EGEM)" (Cameroon) to determine the mineralogical composition. The structural data allowed the realization of the stereograms. To do this we used the "Stereo 32" software to materialize the linear and stereo net elements and COREL DRAW to materialize the plans. Its different processing of structural measurements allowed us to classify and interpret the different phases of deformation that affected the area.

4. Results

4.1. Petrography

The Gounbela Region basement is made up of metamorphic and plutonic rocks, according to their nature and mode of occurrence on the field.

4.1.1. Metamorphic Rocks

Metamorphic rocks appear as metric accessible outcrops. They include biotite-amphibole gneisses and amphibolites that have been observed in macroscopic and microscopic scales. Biotite-amphibole gneisses appear as irregular flags, and as centimetric enclaves in granites (Figure 2a and b). They display millimetric to centimetric alternating quartz-feldspar and ferromagnesian rich layers (Figure 2a). They also present schistosity which is mostly parallels to the foliation. At microscopic scale, they show a grano-lepidoblastic texture represented by quartz, biotite, amphibole, feldspars, muscovite. Quartz is xenomorph (Figure 2c) and appears as microlites inclusions in feldspars, while feldspars are seen as phenoblasts. Biotite is seen as elongated sticks, while amphiboles appear as phenoblasts. Muscovite is xenomorph (Figure 2d). Accessory minerals comprise apatite and oxides.

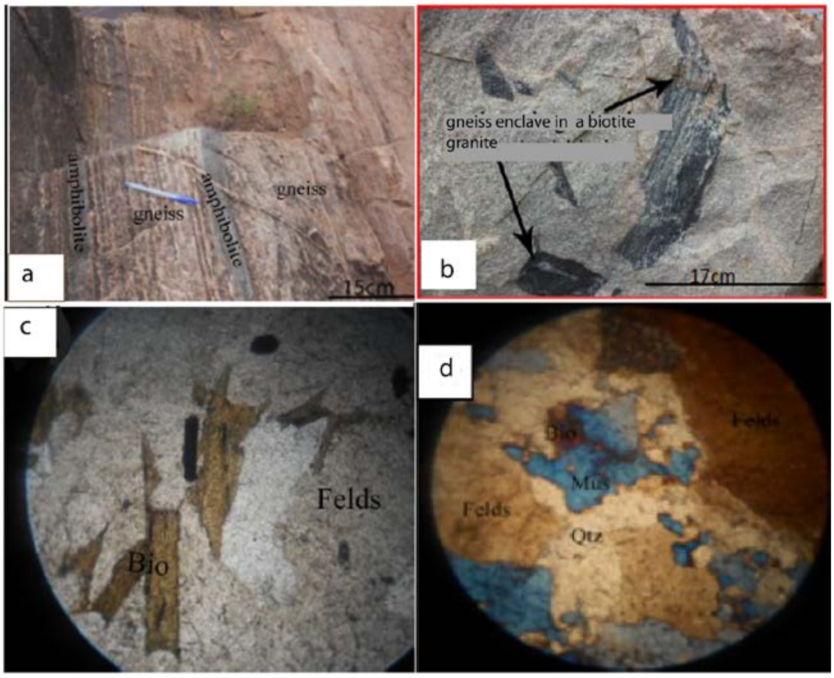

Figure 2. a- gneiss slab outcrop in the bed of the Gbassoum stream; **b-** Gneiss enclave in a biotite granite at the Gounbela quarry; **c-** Thin section of gneiss showing a granolepidoblastic texture of the rock; **d-**Thin section showing muscovite phenocrysts associated with quartz and feldspar phenocrysts with an inclusion of biotite in muscovite

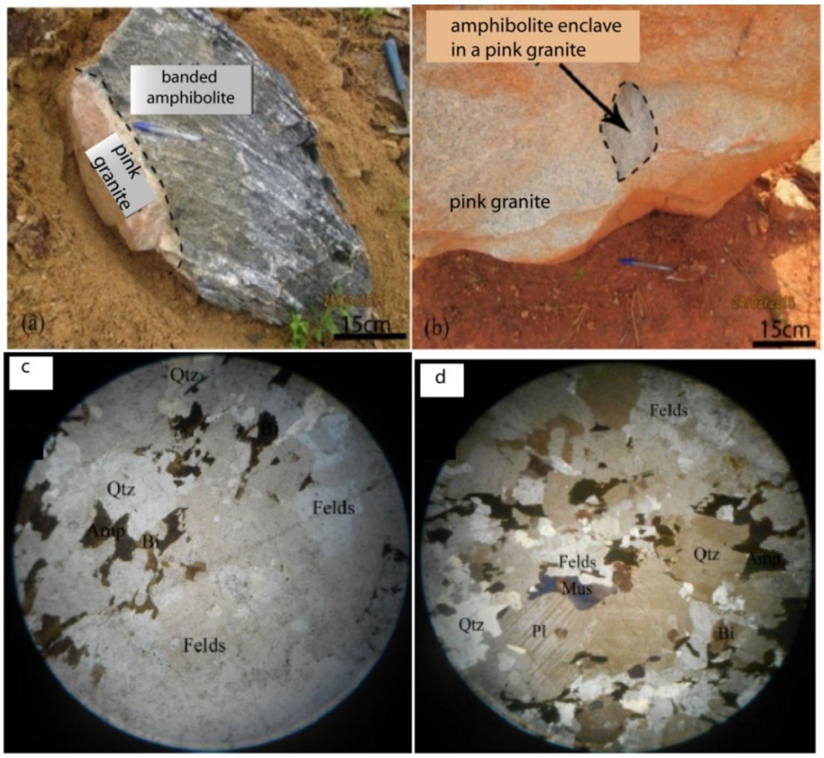

Figure 3. a- Banded amphibolite block at the Gounbela quarry; **b-** Massive amphibolite enclave in a pink granite at the Gounbela quarry; **c-** Granoblastic texture of massive amphibolite; **d-** Granoblastic texture of massive amphibolite showing simple plagioclase twins

Amphibolites are not very wide- spread in the area. They appears as centimetric striped blocks (Figure 3a and b), and present medium to fine grain size. Under the microscope, they present a grano-nematoblastic texture and are composed of green amphibole, biotite plagioclases, k-feldspar, quartz, muscovite (Figure 3c and d); secondary minerals (sphene and apatite). Green amphibole is xenomorph to elongated; biotite is xenomorph and pleochroic, some crystals are chloritized; plagioclases are xenomorph and presents polysynthetic macles. They presents apatite and fluids inclusions (Figure 3d). Quartz is xenomorph, and sometimes present as inclusion in biotite and amphibole; K-feldspars are xenomorphs and contains amphiboles microlites inclusions.

4.1.2. Plutonic Rocks

Plutonic rocks consist of biotite and/or muscovite pink granite. They extend as centimetric to metric blocks, and as metric flags (Figure 4a). Under the microscope the biotite and/or muscovite granite present a porphyroic granular texture (Figure 4e), and is made up of quartz, K-feldspars, plagioclase biotite, amphibole secondary minerals (chlorite) and accessory minerals (zircon) (Figure 4f). Quartz is xenomoph and as inclusion; K-feldspars are widely spread; plagioclases are elongated and present polysynthetic macles; they are present as inclusion in K-feldspars; biotite is elongated and present chlorite and quartz inclusions; amphiboles are xenomorph or elongated and present as inclusion in biotite and K-feldspars.

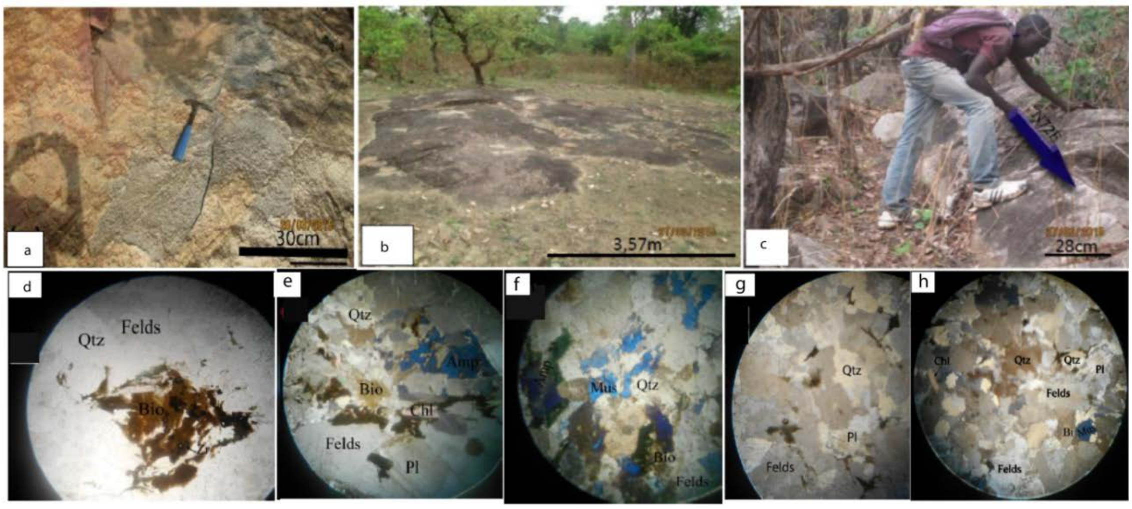

Figure 4. a- Biotite granite slab; **b-** Pink granite slab; **c-** Slab of pink granite oriented ENE-WSW; **d-** Thin section of biotite granite showing zircon inclusions in biotite; **e-** Thin section of biotite granite showing the mineral lineation of biotite and the transformation of some biotite crystals into chlorite; **f-** Thin section of biotite-muscovite granite showing muscovite crystals substantially aligned; **g-** Thin section of pink granite showing the grainy porphyroic texture; **h-** Thin section of pink granite with porphyroic grainy texture

Pink granites present a porphyroic granular texture and is made up of Quartz, K-feldspar, amphibole, biotite, muscovite, accessory minerals (chlorite, apatite, opaque minerals) (Figure 4g). K-fedspars are xenomorphs to sub-automorphs (Figure 4h) and contains quartz, apatite, biotite and amphibole inclusions. quartz is xenomoprph and present a rolling extinction; biotite is pleochroic, clear to dark brown in color, with elongated ticks form, and present many inclusions; amphibole present the basal section elongated, and present many inclusions (biotite, K-feldspar and chlorite).

4.2. Structural

4.2.1. The Brittle Tectonic

Gounbela formations are cross-cut by various size scales of quartz (Figure 5a), aplite (Figure 5c) and pegmatite's veins (Figure 5b), and faults. Quartz veins have a N060E to N170E direction (Figure 6e and f) Normals to sinistrals faults cross-cut rocks (Figure 5d). Present a normal to normal-sinistral fault, striking N159E and dipping 74°WSW. The brittle tectonics forms the D4 structures.

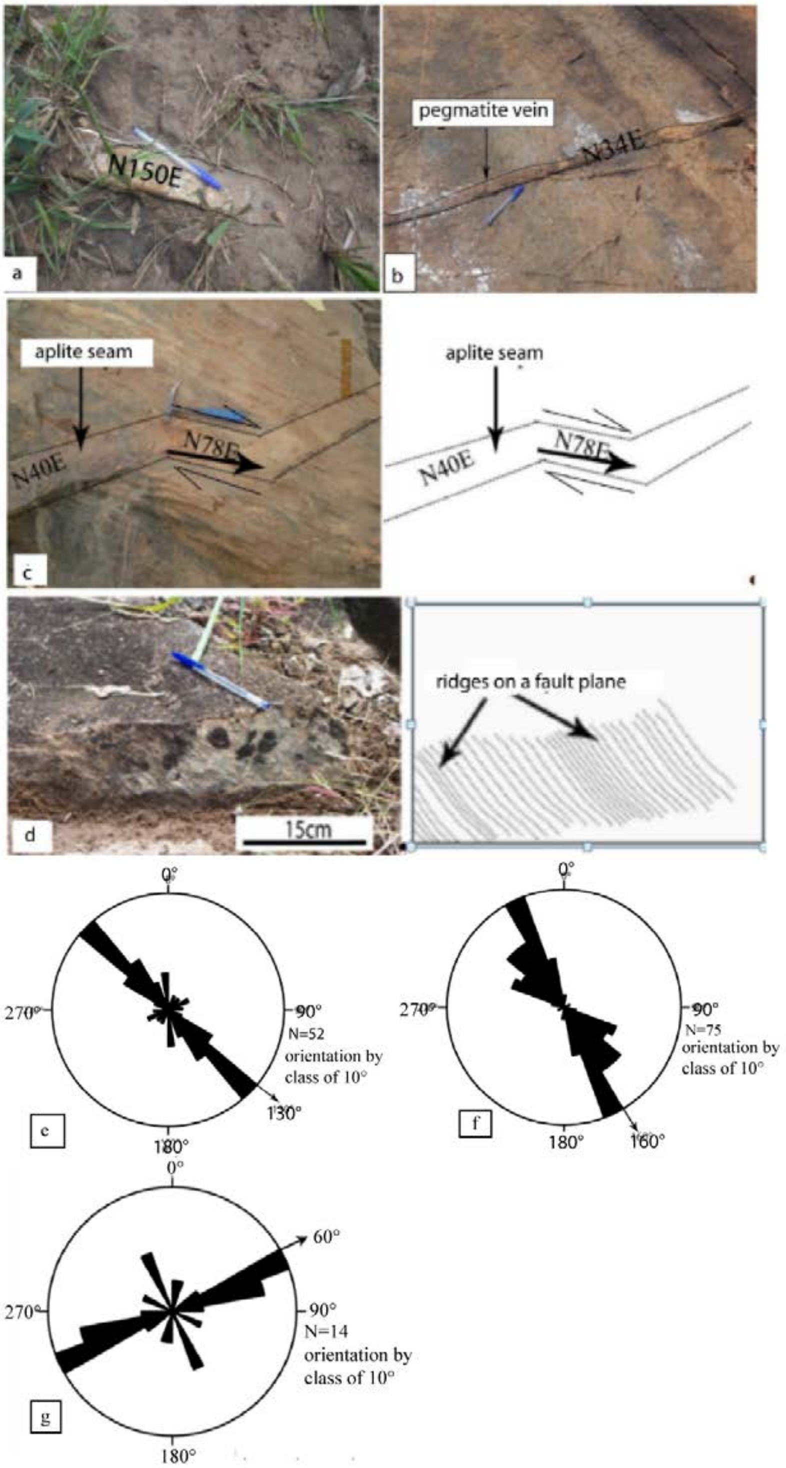

Figure 5. a- Quartz vein on the ground at the Gbassoum River; **b**- Pegmatite vein on a gneiss slab at the Gbassoum river Shear on aplite vein; **c**- aplite seam; **d**- ridges of fault plan; **e**- Rosette of distribution of the directions of the Gbassoum quartz veins; **f**- Rose window showing the directions of the quartz veins from the Gounbela quarry; **g**- Rosette of distribution of the directions of the veins of the pegmatites of the Gounbela zone

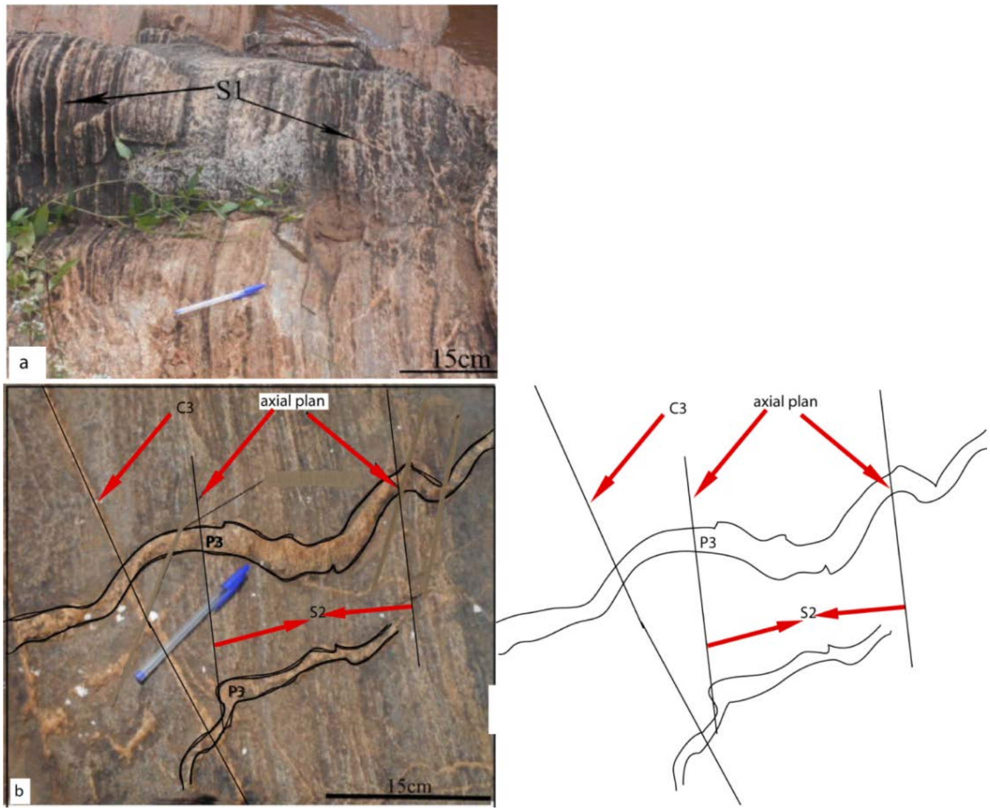

Figure 6. a- Gneiss slab in the bed showing the S1 foliation of the Gbassoum river; **b-** Schistosity S2 on a slab of gneiss on the banks; Folds on a slab of gneiss on the banks and shear C3 of the Gbassoum river

4.2.2. The Ductile Tectonic

D1 structures are scarce, and associated only to gneisses. They present centimetric felsic and ferromagnesian layering (Figure 6a). S_1 foliation range between N02E to N088E and mostly dips to the NW.

D2 structures include the S_2 foliation (Figure 6b). It results from the tectonic transposition of the S1 foliation. S2 is also observed in gneisses and range between N56E and N102E with dips comprised between 40° to 84° in the NNW.

D3 structures are made up of P3 folds and C3 shear planes. P3 folds are dissymmetric (Figure 6b) with axial planes ranging between N056E and N102E with low dipping angles. The C3 shear planes (Figure 6b) have a N06E to N116E orientation and transpose S2 foliations in Gneisses.

5. Discussion

5.1. Petrography

Metamorphic rocks are made up of biotite-amphibole gneisses and amphibolites. Biotite-amphibole gneisses paragenesis is composed of Bio+Amp+Qtz+Musc±Ap, and is characteristic of amphibolites facies. [21] Shows that igneous rocks of archaean to paleoproterozoic and of early neoproterozoic ages contributed to the detritus of biotite-amphibole gneisses. Amphibolites are characterized by the assemblage Amp + Bio + Felds + musc ± Sph ± Ap ± Chl ± Qtz ± Op, characteristic of high-grade amphibolite facies [33]. These facies are typical of MP-HT metamorphism, and show the probably exhumation of old rocks during a continues subduction.

Plutonics rocks are made up of two types of rocks: biotite-muscovite granite and pink granite. Biotite-muscovite granite present a porphyroic granular texture poorly oriented; that show the syn-to late tectonic character of this granite [34]. The rolling extinction of quartz show that rocks haves suffered from tectonics efforts after their put in place. The presence of chlorite can be link to and hydrothermal process leading to the chloritisation of biotite. Pink granites are characterized by Flds + Qtz + Bio + amp + Musc ± Ap ± Op ± Chl assemblage. They have been put in place by the same process that leaded to the formation of biotite-muscovite granites.

5.2. Structural

Four deformational phases are present in the study area: D_1, D_2, D_3, D_4. D1 is characterized by the S1foliation which is the tectonic transposition of S0 primitive surface represented by contacts between the gneisses and intercalated amphibolites [33]. D_2 is marked by the S_2 schistosity resulting from the tectonic transposition of S_1 foliation. The F3 folds are related to the regional shortening [34]; C3 transpose S2 schistosity; the D4 deformational phase is characterized by veins and faults. N130E and N140E faults directions are similar to those who border the Lamé cretaceous Serie in the south of Pala in Tchad, and may correspond to the atlantic opening [35,36]; the N60E pegmatite veins directions can be correlated to the tcholliré-Banyo fault direction [37,38]. The N70E veins direction may correspond to the

Adamawa and Sanaga faults directions [39,40]. The major veins directions (N130E and N140E) can also be attributed to the major directions of gold veins of the precambrian basement of the pala region in Tchad [41], and to the Garga-salari and Bétaré-Oya gold mineralisation in Est Cameroon [42].

6. Conclusion

The Gounbela rock basement and structural features were studied macroscopically and microscopically, to help in the comprehension of the geodynamic context of the Adamawa-Yadé domain put in place. The lithology is made up of metamorphics rocks (biotite-amphibole gneisses and amhibolites) which belongs to the high-grade amphibolite facies; this show the probably exhumation of old rocks during a continues subduction. Plutonics rocks (biotite-muscovite granite and pink granite) porphyroic granular texture presents a syn-to late tectonic character; these rocks have suffered from tectonic efforts after their put in place. The Gounbela tectonic display four deformational phases: The D_1 is characterized by the S_1 foliation; D_2 is marked by S_2 schistosity resulting from the tectonic transposition of S_1; F_3 folds are related to the regional shortening. The D_4 deformational phase is characterized by veins and faults. Major faults directions are similar to those seen in the Lamé cretaceous Serie in Chad, and may correspond to the Atlantic opening. The major veins directions can be correlated to the major directions of gold veins of the Precambrian basement of the Pala region in Chad and to Garga-Salari and Bétaré-Oya gold mineralization direction in the East Cameroon.

Acknowledgments

The authors thank Mbowou Issac for his supervision during initiation to research and all the people who brought the recommendations for the corrections of the document.

References

[1] Van Schmus W.R., Oliveira E.P., Da Silva Filho A.F., Toteu S.F., Penaye J. and Guimaraes I.P., 2008. *Proterozoic links between the Borborema Province, NE Brazil, and the Central African Fold Belt.* In: Pankhurst R.J., Trouw R.A.J., Brito Neves B.B. and De Wit M.J. (Eds) West Gondwana: Pre-Cenozoic Correlations Across the South Atlantic Region. Geological Society, London, Special Publications, 294, 69-99.

[2] Poidevin, J.L., 1983. *La tectonique pan-africaine à la bordure nord du craton congolais: l'orogenèse des Oubanguides.* 12th Colloquium on the African Geology, p. 75.

[3] Toteu, S.F., Bertrand, J.M.L., Penaye, J., Macaudière, J., Angoua, S., Barbey, P., 1991. *Cameroon: a tectonic keystone in the Pan-African network.* In Lewry, J.F., Stauffer, M.R. (Eds), The Early Proterozoic Trans-Hudson Orogen of North America. Geol. Assoc. Canada Spec. Paper 37, pp. 483-496.

[4] Castaing, C., Feybesse, J.L., Thiéblemont, D., Triboulet, C., Chévremont, P., 1994. *Paleogeographical reconstructions of the Pan-African/Brasiliano orogen: closure of an oceanic domain or intracontinental convergence between major blocks?* Precambrian Res. 69, 327-344.

[5] Abdelsalam, M.G., Liégeois, J.P., Stern, R.J., 2002. *The Saharan Metacraton*. J. Afr. Earth Sci. 34, 119-136.

[6] Liégeois, J.P., Latouche, L., Boughara, M., Navez, J., Guiraud, M., 2003. *The LATEA metacraton (central Hoggar, Tuareg shield, Algeria): behaviour of an old passive margin during the Pan-African orogeny*. J. Afr. Earth Sci. 37, 161-190.

[7] Liégeois, J.P., Abdelsalam, M.G., Ennih, N., Ouabadi, A., 2013. *Metacraton: nature, genesis and behavior*. Gondwana Res. 23, 220-237.

[8] Oliveira, E.P., Toteu, S.F., Araujo, M.N.C., Carvalho, M.J., Nascimento, R.S., Bueno, J.F., Mc Naughton, N., Basilici, G., 2006. *Geologic correlation between the Neoproterozoic Sergipano belt (NE Brazil) and the Yaounde Belt (Cameroon, Africa).* J. Afr. Earth Sci. 44, 470-478.

[9] Ngako, V., Affaton, P., Njongfang, E., 2008. *Pan-African tectonics in northwestern Cameroon: implication for the history of western Gondwana.* Gondwana Res. 14, 509-522.

[10] Toteu S.F., Michard A., Bertrand J.M. and Rocci G. 1987. *U-Pb dating of Precambrian rocks from northern Cameroon, orogenic evolution and chronology of the Pan-African belt of central Africa*. Precambrian Research, 37: 71-87.

[11] Pouclet, A., Vidal, M., Doumnang, J.C., Vicat, J.-P., Tchameni, R., 2006. *Neoproterozoic evolution in the Southern Chad: Pan-African ocean basin closing, arc accretion and late- to post-orogenic granitic intrusion.* Journal of African Earth Sciences 44, 543-560.

[12] Penaye, J., Kröner, A., Toteu, S.F., Van Schmus, W.R., Doumnang Mbaiggane, J.C., 2006. *Evolution of the Mayo Kebbi region as revealed by zircon dating: an early (ca. 740 Ma) Pan-African magmatic arc in southwestern Chad*. Journal of African Earth Sciences 44, 530-542.

[13] Isseini, M., André-Mayer, A.S., Vanderhaeghe, O., Barbey, P., Deloule, E., 2012. *A-type granites from the Pan-African orogenic belt in south-western Chad constrained using geochemistry, Sr–Nd isotopes and U–Pb geochronology*. Lithos 153, 39-52.

[14] Ball, E., Bard, J.P., Soba, D., 1984. *Tectonique tangentielle dans la catazone du Cameroun: les gneiss de Yaoundé*. Journal of African Earth Sciences 2, 91-95.

[15] Nzenti, J.P., Barbey, P., Macaudière, J., Soba, D., 1988. *Origin and evolution of late Precambrian high-grade Yaounde gneisses*. Precambrian Research 38, 91-109.

[16] Mvondo Ondoa, J., 2009. *Caractérisation des événements tectoniques dans le domaine Sud de la Chaîne Panafricaine au Cameroun: Styles tectoniques et géochronologique des séries de Yaoundé et Bafia. Ph.D.* thesis, Université de Yaoundé I, 207p.

[17] Owona, S., Schulz, B., Ratsbacher, L., Mvondo-Ondoa, J., Ekodeck, G.E., Tchoua, F., Affaton, P., 2011. *Pan-African metamorphic evolution in the southern Yaounde Group (Oubanguide Complex, Cameroon) as revealed by EMP-monazite dating and thermobarometry of garnet metapelites.* J. Afr. Earth Sci. 59, 125-139.

[18] Owona, S., Tichomirowa, M., Ratschbacher, L., Ondoa, J.M., Youmen, D., Pfänder, J., et al., 2012. *New igneous zircon Pb/Pb and metamorphic Rb/Sr ages in the Yaounde Group (Cameroon, Central Africa): implications for the Central African fold belt evolution close to the Congo Craton. Intern.* J. Earth Sci. 101, 1689-1703.

[19] Yonta-Ngouné, C., Nkoumbou, C., Barbey, P., Le Breton, N., Montel, J.M., Villiéras, F., 2010. *Geological context of the Boumnyebel talcschists (Cameroon): inferences on the Pan-African belt of Central Africa.* Comptes Rendus Geoscience 342, 108-115.

[20] Toteu, S.F., Van Schmus, W.R., Penaye, J., Michard, A., 2001. *New U–Pb and Sm–Nd data from north-central Cameroon and its bearing on the pre-Pan African history of central Africa.* Precambrian Research 108, 45-73.

[21] Ganwa A.A., Siebel W., Frisch W., Shang C.K. and Ekodeck G.E. 2011. *Geochemistry and geochronology of the Méiganga metadiorite: implications on the timing of D2 deformational phase in Adamawa Yadé Domain in Cameroon*. Int. J. Biol. Chem. Sci., 5(4): 1754-176.

[22] Nkoumbou, C., Barbey, P., Yonta-Ngouné, C., Paquette, J.L., Villiéras, F., 2014. *Pre collisional geodynamic context of the southern margin of the Pan-African fold belt in Cameroon*. J. Afr. Earth Sci. 99, 245-260.

[23] Tchakounté, J., Eglinger, A., Félix Toteu, S.F., Zeh, A., Nkoumbou, C., Mvondo-Ondoa, J., Joseph Penaye, J., Martin de Wit, Pierre Barbey, P., 2018. *The Adamawa-Yadé domain, a piece*

of Archaean crust in the Neoproterozoic Central African Orogenic belt (Bafia area, Cameroon). Precambrian Research 299, 210-229.

[24] Van Schmus, W.R., Brito Neves, B.B., Hackspacher, P., Babinski, M., 1995. *U:Pb and Sm:Nd geochronologic studies of the eastern Borbomera province, northeastern Brazil: initial conclusions.* J. South Am. Earth Sci. 8, 267-288.

[25] Nzenti, J.P., Abaga, B., Suh, C.E., Nzolang, C., 2010. *Petrogenesis of peraluminous magmas from the Akum-Bamenda Massif, Pan-African Fold Belt, Cameroon.* International Geology Review iFirst 1, 1-29.

[26] Njonfang, E., Ngako, V., Kwekam, M., Affaton, P., 2006. *Les orthogneiss calco-alcalins de Foumban-Bankim: témoins d'une zone interne de marge active panafricaine en cisaillement.* Comptes Rendus Geoscience 338, 606-616.

[27] Bouyo Houketchang, M., Toteu, S.F., Deloule, E., Penaye, J., Van Schmus, W.R., 2009. *U–Pb and Sm–Nd dating of high-pressure granulites from Tcholliré and Banyo regions: evidence for a Pan-African granulite facies metamorphism in north-central Cameroon.* Journal of African Earth Sciences 54, 144-154.

[28] Ganwa A.A., Frisch W., Siebel W., Ekodeck G.E., Shang K.C., and Ngako V. 2008. *Archean inheritances in the pyroxene-amphibole-bearing gneiss of the Méiganga area (Central North Cameroon): Geochemical and 207Pb/206Pb age imprints*: ComptesRendus Geosciences, 340: 211-222.

[29] Penaye J., Toteu S.F., Tchameni R., Van Schmus W.R., Tchakounté J., Ganwa A.A., Minyem D., Nsifa E.N. 2004. *The 2.1 Ga West Central African belt in Cameroon.* Journal of African Earth Sciences, 39: 159-164.

[30] Soba D., Michard A., Toteu S.F., Norman D.I., Penaye J., Ngako V., Nzenti J.P., Dautel D. 1991. *Données géochronologiques nouvelles (Rb-Sr, U-Pb, Sm-Nd) sur la zone mobile panafricaine de l'Est Cameroun: Age protérozoïque supérieur de la série de Lom.* Compte Rendus Académie Paris des Sciences de Paris, 315: 1453-1458.

[31] Toteu S.F., Yongue Fouateu R., Penaye J., Tchakounte J., Ciriaque S.A., Mouangue, Van Schmus W.R., Deloule E., Stendal H., 2006. *U-Pb dating ofplutonic rocks involved in the nappe tectonic in southern Cameroon: consequence for the Pan-African orogenic evolution of the central African fold belt.* Journal of African Earth Sciences, 44: 479-493.

[32] Tchameni R., Pouclet A., Penaye J., Ganwa A. A., Toteu S.F. 2006. *Petrography and geochemistry of the Ngaoundéré Pan-African granitoids in Central North Cameroon: Implications for their sources and geological setting.* Journal of African Earth Sciences 44/4, 5: 511-529.

[33] Diguim K.A. 2011. *Etude pétrographique et structurale de la région de Kalaldi-Badzer, Sud-Ouest de Meiganga (Centre Cameroun)* Mémoire de Master II, Université de Ngaoundéré, 84p.

[34] Fosso T.P.M. 2012. *Pétrographie et analyse structurale des gneiss de Guider et des schistes de Bidzar (Nord Cameroun).* Mémoire de Master II, Université de Ngaoundéré, 90 p.

[35] Kasser M. Y. 1994. *Evolution précambrienne de la région du Mayo Kebbi (Tchad), un segment de la chaine Panafricaine.* Thèse de Doctorat Musée Nationale d'Histoire Naturelle de Paris, 227p.

[36] Kasser M. Y. 1995. *Evolution précambrienne de la région du Mayo Kebbi (Tchad). Un segment de la chaine panafricaine*; Thèse de Doctorat, 168p.

[37] Penaye J., Toteu S.F., Michard A., Bertrand J.M., Dautel D. 1989. *Reliques granulitiques d'âge protérozoïque inférieur dans la zone mobile panafricaine d'Afrique centrale au Cameroun; géochronologie U-Pb sur zircons.* Comptes rendus de l'Académie desSciences Paris, 309: 315-318.

[38] Toteu S.F., Penaye J., PoudjomDjomani Y. 2004. *Geodynamic evolution of the PanAfrican belt in central Africa with special reference to Cameroon.* Can.Joun. Earth Sci., 41: 73-85.

[39] Ngako V., Jégouzo P., Nzenti J.P. 1991. *Le Cisaillement Centre Camerounais. Rôle structural et géodynamique dans l'orogenèse panafricaine.* Comptes Rendus de l'Académie des Sciences, Paris, 313: 457-463.

[40] Ngako V., Affaton P., Njanko T.H. 2003. *Pan-African tectonique evolution in central and southern Cameroon: Transposition during sinistral shear mouvements.* Journal AfricanEarth Sciences, 36: 207-214.

[41] Deudjimbaye M. 2011. *Etudes pétrographiques et structurales du socle précambrien de la région de Pala au Sud Ouest du Tchad.* Mémoire de Master II, Université de Ngaoundéré, 58p.

[42] Kankeu B. 2008. *Anisotropie de la susceptibilité magnétique (ASM) et fabriques des roches Néoprotérozoïques des régions de Garga-Sarali et Bétaré-Oya à l'Est Cameroun: Implications géodynamiques pour l'évolution de la Chaine Pan Africaine d'Afrique Centrale.* Thèse de Doctorat Thèse de 3ème cycle, Université de Yaoundé I. P: 154-73.

© The Author(s) 2022. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (http://creativecommons.org/licenses/by/4.0/).