International Journal of Scientific Engineering and Research (IJSER)
ISSN (Online): 2347-3878
Impact Factor (2022): 7.741

Mineralogy of Doussiegoussou Marble (North-West) of Tchibanga and its Use in Housing in Gabon

Jean-Eudes Boulingui[1]

[1]Laboratory of Life and Earth Sciences, Ecole Normale Supérieure, B. P.17009 Libreville, Gabon
eudhny[at]yahoo.fr

Abstract: ***The Doussiegoussou marble is located in the heart of the Neoproterozoic terrains in the Nyanga Province in southwestern Gabon and east of the Atlantic Gulf of Guinea. The macroscopic study of the marble outcrops represented by three samples BTM1, BTM2 and BTM3 revealed a coloration varying from dark grey, passing from white to light grey, thus making it possible to designate three materials. The three samples of marble in the context of uses in the habitat were subject to a treatment aimed at the manufacture of floor covering tiles. Also in order to know the mineralogical phases present in the three mineral materials, X-ray diffraction analyzes were carried out on the three samples. The characteristic mineral phase of the three marble rocks is calcite identified at the main peak at 3.03 Å. Other minerals with low intensities of the main peaks are present in the three rock samples, namely quartz at 3.34 Å, illite at 9.97 Å in the BTM3 material than in the BTM1 and BTM2. Doussiegoussou marble can be mined industrially and used in construction, for the manufacture of earthenware, tiles or even decoration.***

Keywords: Marble, Doussiegoussou, Mineralogy, Habitat, Decoration

1. Introduction

Marble is a grainy metamorphic rock derived from limestone and dolomite [1]. Housed in the Schisto-Limestone 1 (SC1) group of the Nyanga basin, the Doussiegoussou marble is located in terrains dating from the Neoproterozoic according to the geological interpretations provided by the work of ([2]; [3]). The marbles come in layers of very variable thicknesses. They behave quite ductile at high pressure. Their internal structure is therefore finely pleated [4]. Calcic marbles are obtained after metamorphism of pure limestone and dolomitic marbles come from metamorphism with a high magnesium content of carbonates. When the protholitic rock includes horizons rich in iron, colored banded marbles are observed according to the degree of oxidation of the iron characteristic of the colors green in the case of reduced iron, red for oxidized iron, ocher and beige for iron combined with hydroxides. For limestone containing clay or quartz impurities, so-called intense metamorphism occurs following a mineralogical modification. These marbles are called mineral marbles [4]. The uses of marbles depend on the brightness, the color, the homogeneity or not [5]. A pure white marble resulting from the metamorphism of a calcite will be used in sculpture while a colored or dolomitic marble will be used in ornament, coating. Depending on the grain sizes, marble aggregates are used in the manufacture of tiling. Pure marble colors (white, red, black) are widely used in powder form in different fields of industry [5]. Marble powder ground into fine grain size is a sought-after mineral filler for its uses in paint, in stationery to give density and shine, as a neutral pH additive for plastics, cosmetics, pharmaceuticals and animal feed.

This study is based on the observation and description of marble outcrops in the Doussiegoussou region. Also, the characteristic minerals that make up the marble formation of the SC1 group of the Nyanga syncline will be identified. In this field, the floor tiles will be formulated. In the manuscripts of ([6]; [7]; [8]), mention is made of descriptions of talc and talcschist mineral materials in the Nyanga Synclinal which would have applications in the field of housing in Gabon.

2. Geological Context and Sampling

In Gabon, there are four main well-defined geological units according to their age. They are characterized by the Archean basement, the Paleoproterozoic mobile belt of West Central Africa or Paleoproterozoic formations, the Neoproterozoic Nyanga basin or the Neoproterozoic orogenic belt of West Congo and the Phanerozoic sets [9].

The Neoproterozoic basin is marked by the schisto-limestone of the Nyanga syncline which is part of the vast West-Congolian orogenic belt which was affected by the Pan-African orogeny around 540 Ma. This Pan-African orogeny is accompanied by magmatic activity intrusive alkaline [10].

In the fine Proterozoic succession which constitutes the major part of the Nyanga basin (Figure 1) is the schisto-limestone series whose lower layers are the group (SC1) consisting of a large fraction of magnesian limestone. The group (SC1) consists of three members. The lower limb (Nsc1a) indurated and compact composed of marmoreal dolomite with fine and regular zoning, pink, beige or gray. The middle member (Nsc1b) with a thickness of 300 m, is a set of dolomitic marbles zoned white, gray, bluish, black, of compact gray, reddish or black dolomitic marbles, of beige, gray, bluish dolomitic marbles where one finds calcschists in fractured zones, folds in zoned beds and quartz stringers. The upper member (Nsc1c) 150m thick is formed of limestone marbles with a cryptocrystalline or saccharoid texture, almost pure white or light gray, often silicified. At the base are marbles and cipolins with magnesia, white, beige, or pink with sinuous zonation. In the writings of [2]; [3], it is assumed that the southwestern flank of the basin underwent a phase of fairly strong folding forming very elongated anticlinal and syncline structures with axes more or less parallel to the main axis of the Nyanga syncline, more or less 140-120°. The outcrops of mineral to marble material are chosen for their easy access to sample collection. These are the sites located on the Tchibanga-Mayumba axis in the Doussigeoussou village and its surroundings from which the marble samples noted BTM1, BTM2 and BTM3 were taken (Figure 1). The observation of these outcrops suggests that the marble of the syncline of the Nyanga are formed of layers of strongly straightened structures almost vertically, and form long cuestas often raised in the landscape rather dominated by the grassy savannah.

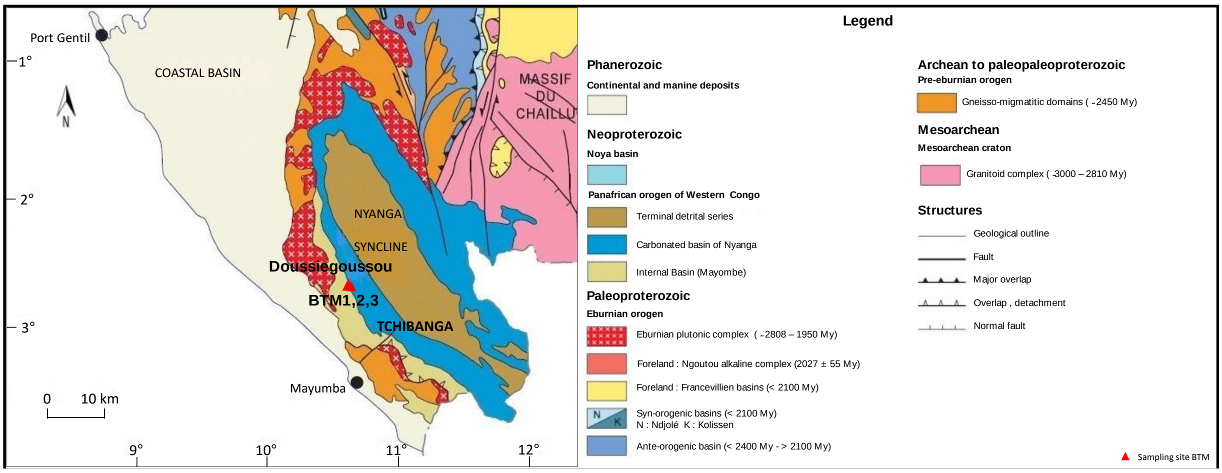

Figure 1: Lithostratigraphic map (Thiéblémont et al., 2009) of the location of the samples BTM (1; 2 and 3) from the marble of Doussiegoussou to the North-West of Tchibanga

3. Materials and methods

The test with hydrochloric acid (HCl) diluted to 10% carried out on the samples of marble rocks is positive, the marble effervesces with HCl. The operating mode and the exploitation of topographic and geological information are available in the literature [11]; [12]; [13]. Detailed analyzes are carried out at the University of Lorraine (UL), Nancy (France). The fraction below 250 µm was selected for analysis. The operation by X-ray diffraction (XRD) was carried out on the powders of the disoriented marbles using a diffractometer model X'PERT PRO PAN. The recording conditions are X-rays produced by a copper anticathode fed at 40 KV and 30 Ma. The anode material is Cu, with $\lambda Cu=1.5406$ A°, with the divergence slit, fixed at 0, 5. The diffractogram of the samples recorded over an angular range of 4-100° (2θ) in steps of 0.016. The counting time is 10 s per step, of a theta-2teta configuration goniometer. The determination of the species is carried out by comparison with the data of the "Powder Diffraction File" of the International Center for Diffraction Data (ICDD).

Tile manufacturing tests are carried out using a Makita 235 mm circular saw coupled with a water jet produced at the Geoguide geomaterials laboratory in Libreville, Gabon.

4. Results and discussion

The study based on the different outcrops of marbles observable in the region of Doussiegoussou, consists of a description with the naked eye of the color, the break, the line, the aspect, the texture and the structure.

In the Doussiegoussou region, three outcrops named BTM1, BTM2 and BTM3 are the subject of our study (Figure 2). The BTM1 material, taken from the very heart of its corresponding series, has a massive, dark gray appearance. The line at the break is white and has inclusions of the same color. The discontinuous series of marble is housed in clays. Its color varies from dark gray to light gray and has a significant schistosity 2 to 3m thick (Figure 2 a). With a pleated appearance, this material has a heterogeneous texture as well as a strong inclination. In longitudinal view, there appears a strong fracturing in the line and the whitish break.

Geographically close to BTM1, the BTM2 outcrop has characteristics similar to those of BTM1, although it is clearer. The BTM2 material shows alternating dark and light bands and a very marked schistosity with a white line and break (Figure 2b).

The BTM3 outcrop has a coloring that varies from white to black with a dominance of white (Figure 2 c). We observe an alteration of dark coloring by the break, showing a dark part filled with sulphides which are found in a scattered way at the level of the white coloring.

The BTM3 material is little differentiated from the first two by its color, and the inclusions that could be observed there (Figure 2 c). Indeed, the BTM3 material is a white marble striped in places with a blackish color.

Figure 2: Samples of Doussiegoussou marble northwest of Tchibanga showing fractures and light bands (a), alternating coloring (b) and sulphides (c)

Thus are listed the mineral phases with marble in the three samples BTM1, BTM2 and BTM3. The observation made is that of the correlation of the mineral phases present in the three identical mineral materials. Apart from the heterogeneity observed in the coloring for the three samples (Figure 2), on the mineralogical level, there is an identical superposition of the spikes for the three mineral materials with the exception of the BTM3 material. The latter has a peak at the interreticular distance of 2.96 Å which is that of the carbonates. This observation may suggest the presence of a probable remains of nacrite which, moreover, is a massive and rare mineral, unstable in humid air [14]. In the BTM2 material where the peak at 9.97 Å, specific to an illite, present in the other two materials BTM1 and BTM3, is absent or in very low intensity. The peaks at 3.85 Å and 3.34 Å can be added to the sulphide group as mentioned in the samples (Figure 2 c). Calcite-specific bands are 3.03 Å; 2.29 Å; 1.87Å; 1.92 Å; 2.08 Å; 2.56 Å; 1.60 Å; 1.54Å; 1.45Å; 1.42 Å; 2.87Å; 2.96Å; 1.63Å; and 1.37 Å. The quartz is at 4.30 Å and 1.82 Å and the hematite at 2.70 Å.

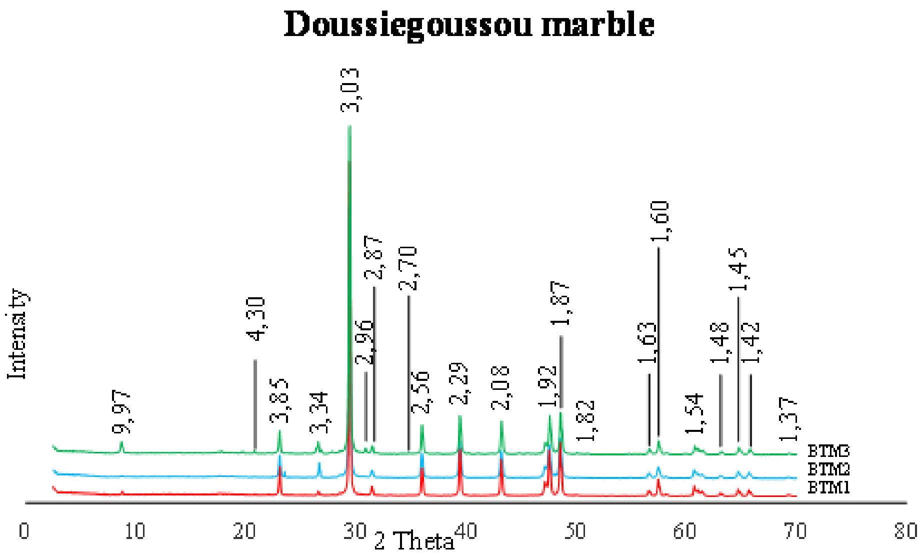

Figure 3: BTM1, BTM2 and BTM3 diffractograms of the Doussiegoussou marble northwest of Tchibanga

The rocks are transported to Libreville in the direction of the geomaterials laboratory in the Geo Guide Company for tests to manufacture floor tiles at the base using a MAKITA 235 mm circular saw coupled to a water jet (Figure 4). The materials BTM1, BTM2 and BTM3 undergo a transformation in the formulation for the elaboration of the floor tiles. Default saw slightly blunt product quality remains to be improved.

The tiles of distinct colorings, corresponding to the series of BTM materials show mosaic sculptures. The objective of this illustration of marbles in the manufacture of floor tiles, presents a decorative potential that is poorly known in Gabon. Depending on the principles of use, these formulations can be predestined for various uses (floor or wall).

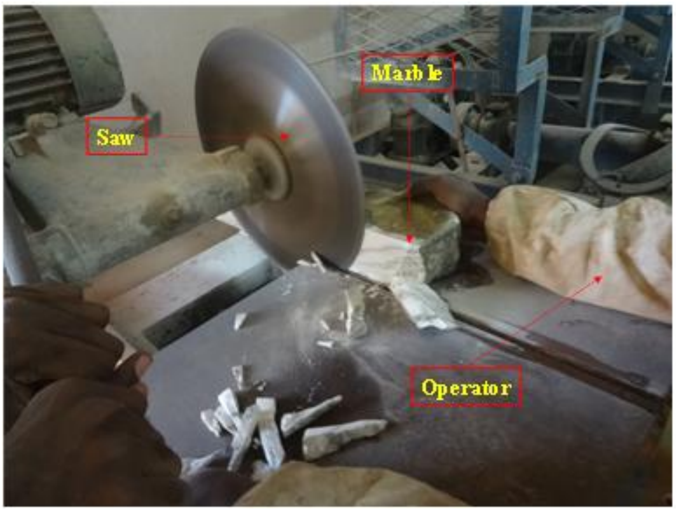

Figure 4: Formulation of floor tiles in materials BTM1, BTM2 and BTM3 of the Doussiegoussou marble northwest of Tchibanga

5. Conclusion

Doussiegoussou marble has a heterogeneous character due to its dominant pale gray color which varies from white to dark gray or even black. However, its massive appearance and its heterogeneity open up the tiling and decoration market to it, as was observed in a residence in the Tchibanga region. The applications of mineral materials in Gabon in housing deserve special attention. The marble of Doussiegoussou, in time exploited should resurface.

Acknowledgments

My thanks go to the directorate of geology and mining research of Gabon, Ecole Normale Supérieure de Libreville for the multifaceted support. Also, Hugues Martial Omanda for proofreading this article.

References

[1] Ronald L. B. (2005). Roches et minéraux du Monde. Delachaux et Nestlé SA, Paris. ISBN: 2-603-01337-8, pp.76-79.
[2] Devigne J. -P., Hirtz P. (1958). Carte géologique de reconnaissance de l’A. E. F. au 1/500.000. Notice explicative de la feuille de Mayoumba Est. Brazza. Direction des Mines et de la Géologie A. E. F, p.68.
[3] Boutin P. (1985). Talc du synclinal de la Nyanga (Gabon). Synthèses des travaux fin 1984. Rapport BRGM 85 LIB 003, p.59.
[4] Parriaux A. (2009). Géologie, bases pour l'ingénieur. Deuxième édition, revue et augmentée. Presses polytechniques et Universitaires Romandes, p.604.
[5] Lemoy C. (1969). Contribution à l’étude géologique du massif du Filfila (Algérie Nordorientale). Stratigraphie des unités allochtones; structure et métamorphisme du massif. Thèse de doctorat.3 ème Cycle, université de Nancy, France, p.95.
[6] Boulingui J. -E. (2015). Inventaire des ressources en argiles du Gabon et leurs utilisations conventionnelles ou non dans les régions de Libreville et de Tchibanga. Thèse de Doctorat. Université de Lorraine-Université de Yaoundé I, p.245.
[7] Poirier M., Boulingui J. E., Martin F., Mounguengui M. M., Nkoumbou C., Thomas F., Cathelineau M., Yvon J. (2019). -Mineralogical and crystal-chemical characterization of the talc ore deposit of Minzanzala, Gabon. Clay Minerals, 54. Doi: 10.1180/clm.2019.30. Impact factor ISI 1, 609. ISSN: 1471-8030, pp.245-254.
[8] Boulingui J. E. et KoghouKoudi L. D. (2023). -Mineralogy of talcschist geological formations in the Douigny (South-West Gabon). International Journal of Engineering Research and Applications (IJERA). Vol.13, Issue 1. Doi: 10.9790/9622-13012631. Impact factor ISI 1, 69. ISSN: 2248-9622, www. ijera. com, pp.26-31.
[9] Thiéblemont D., Castaing C., Bouton P., Billa M., Prian J. P., Goujou J. C., Boulingui B., Ekogha H., Kassadou A., Simo Ndounze S., Ebang Obiang M., Nagel J. L., Abouma Simba S., Husson Y. (2009). Carte géologique et des ressources minérales de la République Gabonaise à 1/1 000 000. Editions DGMG - Ministère des Mines, du Pétrole, des hydrocarbures, Libreville, p.384.
[10] Chevallier L., Makanga J. F., Thomas R. J. (2002). Notice explicative de la carte géologique de la République Gabonaise à 1/1 000 000. Editions DGMG Gabon, p.195.
[11] Legros J. P. (1996). Cartographie des sols: de l’analyse spatiale à la gestion des territoires. Presses polytechniques romandes, Lausanne, coll. ≪ Gérer l’environnement≫, p.321.
[12] Frontier S. (1997). Stratégies d’échantillonnage en écologie. Ed. Masson, p.470.
[13] Webster R., Olivier M. A. (2001). Géostatics for Environmental Scientists, Wiley & Sons, Chichester, p.271.
[14] Zubkova N. V., Pushcharovsky D. Y., Ivaldi G., Ferraris G., Pekov I. V., Chukanov N. V. (2002). Crystal structure of natrite, gamma-Na2CO3,

Locality: Mt Koashva, Khibiny alkaline massif, Kola Peninsula, Russia" in NeuesJahrbuch fur Mineralogie, Monatshefte, pp.85-96

Author Profile

Dr. Jean-Eudes Boulingui permanent Teacher-Researcher Geomaterials at the Ecole Normale Supérieure of Libreville (Gabon) in the Department of Life and Earth Sciences (SVT) since September 29, 2009. My activities are focused on the development of research projects, writing of articles and scientific papers, supervision of end-of-cycle Master and CAPES students, follow-up of ENS-Libreville trainees in high schools and colleges: CAPC, CAPES, License, Master.