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Mineralogical composition of the talcschists of the Dola in Gabon

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ABSTRACT:
The geological formations of the Neoproterozoic orogenic belt of Western Congo, outcrop in the department of Tsamba Magotsi in Gabon. These formations are talcschists. Observations made in an old prospecting well show interstratified talc in a formation made up of fine, more or less white clayey sand covered by laterite. A valuation study of these talcschist mineral materials was carried out. Samples, taken from an outcrop 2 to 3 meters deep, were the subject of a fine characterization in order to identify the minerals associated with talc. The results of X-ray diffraction on whole rock, infrared transmission and diffuse reflection, chemical analyzes (major and traces), were analyzed. The predominant mineral phases are quartz and talc. The material is a non-swelling fine sand clay talcschist, which could support applications in refractory ceramics.

Keywords: Gabon, Dola, Talcschists, Minerals, Non-swelling fine sand.

I. INTRODUCTION

Indications of the existence of a talc deposit in the Nyanga Synclinerium date from the 1940s through prospecting work carried out by [1] who mention the existence of steatite. Research focused on talc in the Nyanga basin began with the impetus of the work carried out by [2], on the north-eastern flank near Ndendé, demonstrating the existence of piles in economic volume but of average quality. In the vast Nyanga synclinorium, the talc level is located in the upper part of the Schisto-limestone succession, [2]. It is present continuously, but masked by a lateritic cover, over a cumulative length of 600 km and a width of a few kilometres. Nyanga talc is present continuously all around the synclinal structure, suggesting a sedimentary or diagenetic origin [3]. In the syntheses of [4], we chose to focus on the mineralogical characterization of the cardinal phases of talcschist deposits in superficial and accessible zones. This interest was motivated by the construction of the bridge over the Banio in Mayumba and the prospect of the construction of the port of Mayumba in deep water for the delivery of service products to the outside of the country. The talc level is located in the upper part of the Schisto-Calcaire succession (SCIII). In the Dola, the geological times characteristic of the geological formations are the Neoproterozoic of the Nyanga basin which includes the upper terrigenous unit marked by the sandstone. The older formations are linked to the specific Paleoproterozoic of Francevillian shreds, and those of the plutonic and metamorphic basement to the Archean marked by Mesoarchean granitoids (~ 3000-2850 Ma). The talc level is continuous (Figure 1). Also, a synthesis of talc from the Nyanga syncline is demonstrated in the writings of [5].

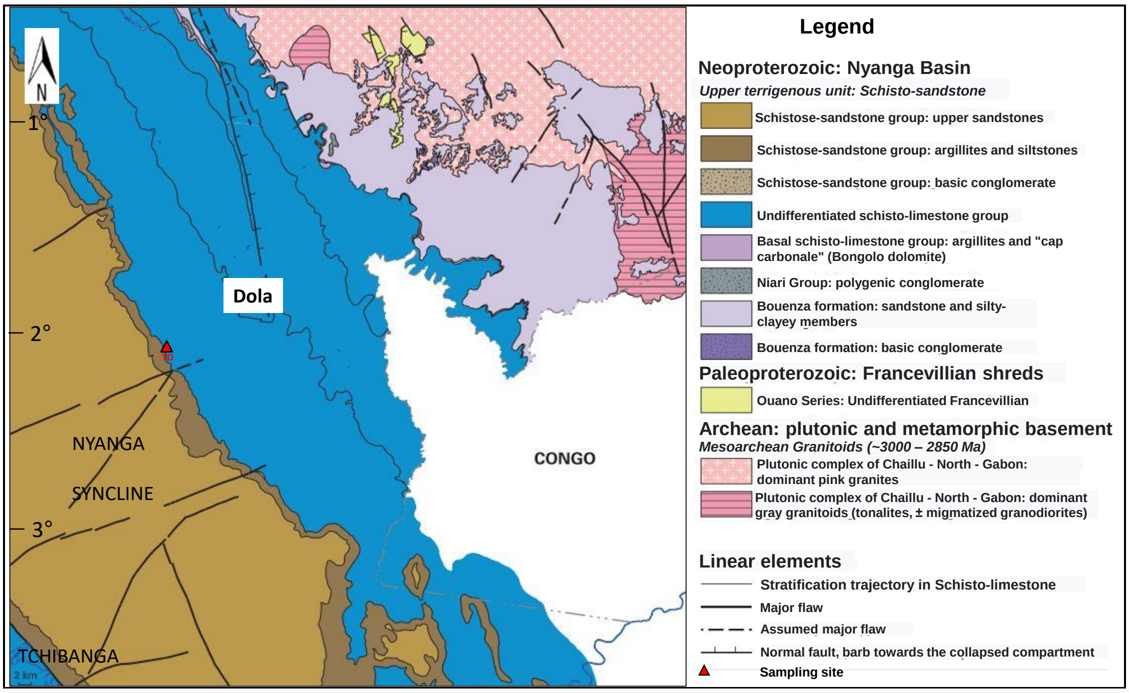

Figure 1: Extract from the lithostratigraphic map of the location of the talcschist material (TD) of the Dola in Gabon

II. MATERIALS AND METHODS

The operating mode and the use of topographic and geological information are available in the literature ([6]; [7]; [8]). Two powder fractions were isolated with sieves (≤ 250 µm and ≤ 50 µm) for laboratory analysis. The name given to the sample of fine whitish talcschist material is TD, recalling the talc of La Dola. The rock is not very cohesive and crumbles by hand. The sample is dried in an oven at 60°C for 24 hours, ground to 500 micrometers, packaged in duly referenced plastic bags. The characterization analyzes of the samples by X-ray diffraction on whole rock, by infrared spectroscopy with transmission and diffuse reflection and by chemical analyzes (major and traces), as well as calculations of modal composition, were carried out.

2.1. X-ray diffraction (XRD)

The operation by X-ray diffraction (XRD) was carried out on the disoriented talcschist powder using a Bruker D8 advance diffractometer operating by reflection under the incidence of Kα1 radiation from cobalt (λ=1.789) without a monochromator physical. 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). The fraction below 250 µm was selected for analysis. The diffractograms were recorded over the range 0-60°(2θ), with a step size of 0.034608°(2θ) and a counting time per step of 0.32 s.

2.2. Infrared with diffuse transmission and reflection

Infrared spectroscopy is carried out in diffuse reflection between 600 and 4000 cm-1 on a powder dilution of 50 mg of sample in 270 mg of KBr, using a Bruker IFS 55 spectroscope. using the vibration frequencies of their functional groups [9].

2.3. Chemical analysis

Whole rock chemical analysis was performed to determine the amount of major and trace elements in the lower fraction of the samples (≤ 250µm). The preparation consisted of an alkaline fusion followed by an acid attack to dissolve the powders. The major elements were quantified with an ICP-AES coupled to a Jobin-Yvon 70-P quantometer while the trace elements were measured with an ICP-MS coupled to a Perkin Elmer Elan 500 instrument.

2.4. Weight content calculations

Modal composition calculations were performed to determine the percentage of each phase in the TD sample. To do this, a multi-linear method developed by ([10]; [11]) was used using this formula:

$T(a) = \sum_1^n Mi$ x Pi(a)

where T(a) represents the content (%) of the chemical element « a » in the rock; the content (%) of the mineral « i » in the rock and Pi(a) the proportion of the element « a » in the mineral « i ». Only the theoretical mineral compositions were used for the calculations.

III. RESULTS AND DISCUSSIONS

The macroscopic observation of the mineral deposits of the talcschists of the Dola and its surroundings show massive stratified outcrops made up of fine sands more or less clayey of whitish colors on the whole for altered levels (Figure 2). It is a question of the valorization of the mineral material of the talcschist of the Dola in the perspective of the uses of the probable deposit. Given the layout of the schisto-sandstone formation, the Dola TD mineral material is located east of the Nyanga Synclinal (Figure 1).

Figure 2: The white talcschist level of the Dola

The dissolution of dolomite by weathering has a more interesting economic potential than that of the underlying unweathered part [12]. From an economic point of view and due to the presence of two types of primary and secondary deposits, the need to differentiate the part close to the surface (down to depths of 10 to 30 m) led to a fine characterization in order to identify minerals associated with talc.

Looking at the results in Figure 3a, we note the presence of talc, characterized by the main peaks identified by X-ray diffraction on whole rock in comparison to existing databases [13]. In the Dola material, the main talc peak is at 9.32 Å. The whole rock X-ray diffractogram shows the only major minerals, talc and quartz (Figure 3a). The minerals identified by whole-rock X-ray diffraction have reticular talc equidistances: 9,32 Å; 3,12Å; 4,66 Å; 4,56 Å and quartz: 3,34 Å; 4,25Å; 1,82 Å; 2,46 Å; 2,28 Å; 2,13 Å; 2,24Å; 1,98 Å. From these results, we say that the talc-shale material is composed of fine sand (Figure 2).

Infrared spectroscopy (Figure 3b and 3c) of the mineral material of the Dola shows characteristic bands of OH elongation, hydration and elongation of OH, hydration and deformation of HOH, traces of carbonates, Si-O stretches, Si-O strains, OH strains, and MgO stretches. The recognition of the characteristic bands is done according to the attributions proposed by [14].

The infrared spectrum in transmission is shown in figure 3b. The bands at 3697 cm^{-1}, 3676 cm^{-1}, 3651 cm^{-1} and 3620 cm^{-1}, are those of OH elongations probably clay minerals such as kaolinite other than talc and quartz. The band at 3437 cm^{-1} is attributed to hydration and elongation of OHs. The band at 1624 cm-1 that of HOH hydration and deformation. The 1080 cm^{-1} and 1024 cm^{-1} bands are those of SiO elongations. The assignments of the other bands are 918 cm^{-1} (OH strain), 796 cm^{-1}, 779 cm^{-1}, and 694 cm^{-1} (SiO strain); 669 cm^{-1} (OH deformation); 530 cm^{-1} (elongation of MgO). The small bands around 2950 cm^{-1} would correspond to the proton elongations of the organic matter.

The characteristic infrared bands in diffuse reflection have OH elongations in the 3697 cm^{-1}, 3676 cm^{-1}, 3653 cm^{-1} and 3620 cm^{-1} domains

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(Figure 3c) unlike those for the same domain in Figure 3b of the TD material. Thus, in figure 3c, the assignments of the bands at 3400 cm^{-1} and 3435 cm^{-1} (elongation and hydration of OH); minor bands 2238 cm^{-1} and 2135 cm^{-1} could correspond to organic matter. The bands at 1683 cm^{-1}, 1610 cm^{-1}, 1527 cm^{-1} and 1491 cm^{-1} (hydration and HOH deformation); 1276 cm^{-1}, 1159 cm^{-1}, 1115 cm^{-1} and 1012 cm^{-1} (elongation of SiO); 914 cm^{-1} (OH deformation); 799 cm^{-1} and 695 cm^{-1} (SiO deformation); 668 cm^{-1} (OH deformation). The well-resolved small band on the broad band of proton elongation of molecular water is thought to be attributable to gibbsite.

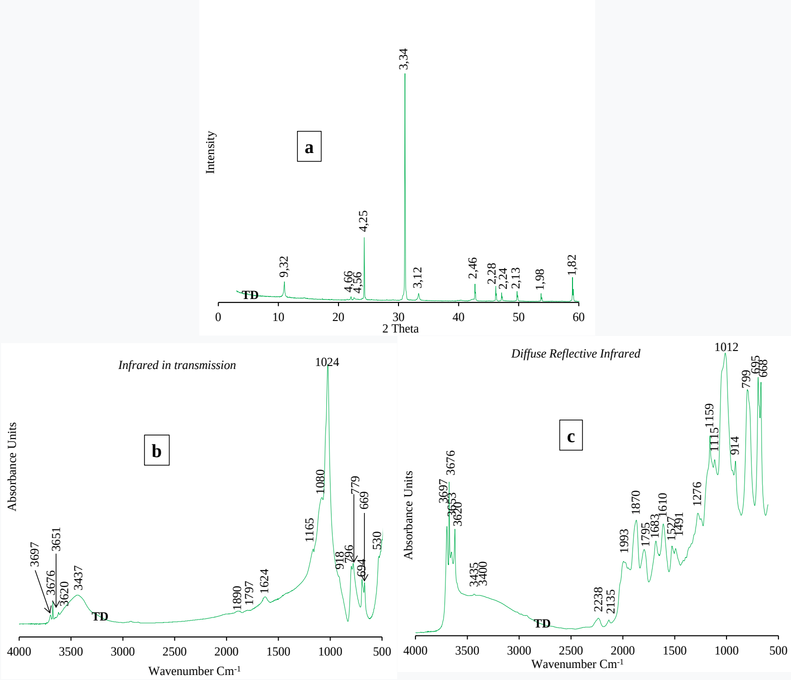

Figure 3: Diffractogram (a), infrared spectrum in transmission (b) and infrared spectrum in diffuse reflection (c) on total rock of the Dola

In the mineral material of the Dola, talc is the essential mineral associated with quartz. Also, the presence of a small amount of CaO in the TD material clearly shows that there are traces of carbonates in this mineral material. Sodium is present in the material (Table 1). The low aluminum contents indicate that the dioctahedral clay minerals, although present in the material, are in traces (Table 1). The presence, in the region, of schisto-limestone structures of cataclastic systems of crushed and straightened minerals [12], shows that these are formations of weak metamorphism of dolomite in contact with acid rocks [15]. The presence of sandstones explains the high silica content (Table 1). In geology, from the Tchibanga region and its surroundings, to the Eburnean complex (2080-1980 Ma), granites are mentioned on the geological map of Gabon as granites, leucocratic granites, porphyritic granites, granodiorites and tonalites [16] clearly justifying the presence of acid aluminous rocks in contact with the dolomites and limestones, hence the schisto-limestone and the sandstone schisto.

To effectively evaluate the contents of the different phases that make up the talc mineral material of the Dola, we rely on the qualitative knowledge of the different phases provided by X-Ray Diffraction [17] on whole rock, the Scanning Electron Microscopy and use of chemical analysis results. The chemical analyzes of the majors (Table 1) show that the oxides of the major elements are close to the averages of the chemical elements defined by Clarke and Goldschmidt [18].
These values are above the average content of chemical elements found on the surface of the earth [19]. The SiO_2 oxide of the TD material exceeds 59%. The MgO oxides of the TD material, for which the percentage shows low values defined by Clarke and Goldschmidt (3,30%).

The trace elements (<0.1%) show, the presence of Barium at 9,608 ppm sign of potential white alkaline earths, chromium at 12,18 ppm, leading to an attempt to explain the whiteness of fine sand as major component of this talcschistose sandstone of 94,45% SiO_2 (Table 1). The presence of vanadium at 8,642ppm and zirconium at

18,41ppm, as light gray metals, can enhance the brilliance of fine sand in the area. The mineral material of the Dola is a shale-sandstone talcschist, fine white sand more or less clayey.

The calculated mass contents ([10] ; [11]) in the TD material reveal 7,56% talc and 89,66% quartz. The trace minerals and unidentified impurities associated with this quartz-rich talc are in the proportion of so-called Other mass contents at 2,78%.

Table 1: Chemical analysis of talcschist (TD) from the Dola

Sample	% Major oxides		% Trace elements (ppm)							
	SiO_2 %	94,45	**As**	< L.D.	**Eu**	0,023	**Ni**	< L.D.	**Tm**	0,014
	Al_2O_3 %	0,73	**Ba**	9,608	**Ga**	1,4	**Pb**	1,1887	**U**	0,353
	Fe_2O_3 %	0,14	**Be**	< L.D.	**Gd**	0,095	**Pr**	0,198	**V**	8,642
	MnO %	0,00	**Bi**	< L.D.	**Ge**	0,193	**Rb**	< L.D.	**W**	0,557
	MgO %	2,47	**Cd**	< L.D.	**Hf**	0,441	**Sc**	< L.D.	**Y**	1,114
TD	**CaO %**	0,15	**Ce**	1,658	**Ho**	0,029	**Sb**	< L.D.	**Yb**	0,11
	Na_2O %	0,02	**Co**	0,262	**In**	< L.D.	**Sm**	0,115	**Zn**	< L.D.
	K_2O %	<L.D.	**Cr**	12,18	**La**	1,063	**Sn**	< L.D.	**Zr**	18,41
	TiO_2 %	0,12	**Cs**	< L.D.	**Lu**	0,017	**Sr**	4,77		
	P_2O_5 %	<L.D.	**Cu**	< L.D.	**Mo**	0,63	**Ta**	0,226		
	P.F %	1,16	**Dy**	0,133	**Nb**	2,609	**Tb**	0,019		
	Total %	99,23	**Er**	0,09	**Nd**	0,694	**Th**	0,454		

IV. CONCLUSION

Dola talcschists can be used as fluxes (MgO oxide) in ceramics in the manufacture of glasses to lower the melting temperature and increase resistance to chemical agents [20]. MgO can inhibit grain growth when a fine-grained microstructure is desired. Dola talcschists can also be used as raw materials to manufacture refractories because they enter the basic earth sintered magnesia systems with MgO (70-97) [12], CaO (2-20), SiO2 (lower at 20), or Forsterite MgO (39-44) and SiO2 (41-50) as mentioned by [21].

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