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COMPOSITION FEATURES AND INDUSTRIAL APPRALSAL OF THE BABA ODE TALC OCCURRENCE, SOUTH WESTERN NIGERIA

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ABSTRACT

The Baba Ode talc with a preliminary quantitative estimation of 3 million tons, occurs in close association with a mafic complex. This complex is surrounded by a series of compositionally variable gneisses, syenites, phillytes and mica schists, granites and coarse pegmatites all of the Iseyin-Oyan schist belt.
This study aims at assessing the petrographic, chemical and physical composition of the talc body in order to appraise its industrial suitability.
Two petrographic varieties, a white talcose, and a fibrous light grayish tremolitic variety characterize the body. X- ray and petrographic studies show that mineralogically they comprise mainly of talc, tremolite and chlorite with subordinate quartz and muscovite. Chemical analysis of representative samples using Atomic Absorption Spectrometer (AAS) instrumentation methods show that the tremolitic variety is higher in Si_20 (53.97%) and Al_20_3. (1.9%) than in the talcose. Fe (t) as Fe_20_3 (4.35%) and Ca0 (1.7%) content in the two varieties are non-variable. While Mg0 values in the talcose (33.25%) is higher than in the tremolitic type (31.39%). Concentration of $Ti0_2$, $Mn0_2$, Na0 and P_20_5 for both varieties do not exceed 0.25%.
Firing characteristics reveal an average loss on ignition (L.O.I) of 4.21% for the two types. Linear shrinkage (L.S.V) average 1.35% while average water absorption capacity is 4.1%. A flat to gently undulating topographic configuration and easy accessibility enhance the mineability of body. The talc body therefore with some beneficiation will be useful in paper, paint, roofing and ceramic manufacturing.

Key words: Talc occurrence, petrographic, chemical, industrial.

INTRODUCTION

Talc, a hydrous magnesiuim silicate is a versatile industrial mineral with a very wide range of uses. Talc bearing rocks area found within the Precambrian schist belts which are largely confined to the western part of the Nigerian basement (Oyawoye 1964, 1972: Mccurry 1976). In the southwest, they occur notably in localities around Iseyin district (Rahaman 1973, Elueze 1982), Apomu area, (Ige, 1985) Kumaru (Durotoye and Ige 1991) Obaluru Araromi (Ife-liesha group) (Akin-Ojo, 1992). Extensive work has been done on these occurrences by these workers. This present occurrence, which is being reported for the first time, is believed to be addition to the growing list of talc occurrences within the Iseyin Oyan schist belt, southwestern Nigeria.

The study of Baba Ode talc occurrence which lies within long. 8° 13^N 8° 18^{1N} and Lat 3°

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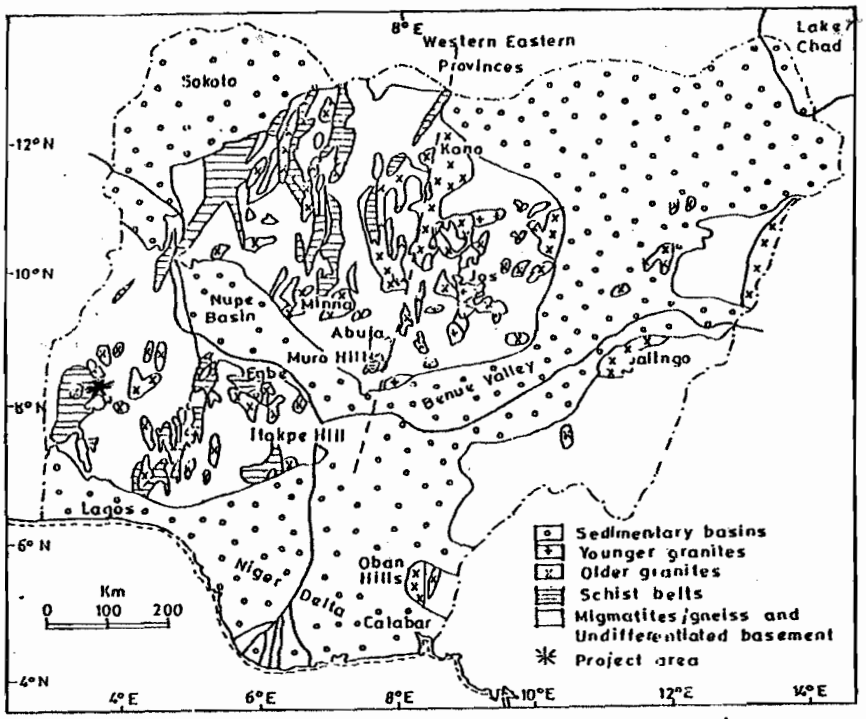


Fig. 1 Outline geological map of Nigeria showing location of project area.

10[1E] 3° 12[0E] and with a preliminary quantitative estimation of 3 million tons. (Okunlola, in prep.) is focused on determining its mineralogical, chemical and industrial properties in order to evaluate its economic potentials.

FIELD RELATIONSHIPS AND PETROGRAPHY

The Baba ode talc occurs within a shear zone characterized by an amphibolite complex of massive and schistose varieties, which are surrounded by a series of compositionally variable gneisses, syenites, granites and pegmatites.

The talc, which occurs mainly as lensoid bodies are conspicuously intruded by isolated pegmatitic rocks. This relationship defines a low but undulating topographic configuration especially north of Ofiki river. (Fig. 2) The talc bodies in places occur as slippery boulders with colour varying from grey to whitish grey.

Thin section examination show that talc, tremolite and chlorite are the main minerals (Table 1). Two varieties were distinguished on the basis of their talc and tremolite content, the talc rich and the tremolite rich varieties. Talc content range from 14 – 72% and occurs as columnar and fibrous aggregates and sometimes as platy laths, with content varying between 10 – 70% (Table 1). Tremolite occurs as prismatic grains sometimes acicular and greenish in colour exhibiting faint pleochroism with moderate birefringence, very few crystals do exhibit twinning. They may be up to 51% in tremolite rich samples. Chlorite, which is subordinate in occurrence to both tremolite and talc, is usually greenish with weak pleochroism and usually characterized by a high relief.

X-ray diffraction analyses (Fig.2) of representative samples of the talc body determined at a scan rate of 2^0 2θ per minute show conspicuous peaks of talc, chlorite and tremolite in agreement with optical studies

Table I **Modal analyses [%]**

	1	2	3	4	5	6	7	8	9	10
Talc	72	75	81	69	32	19	14	20	27	30
Tremolite	23	18	10	12	40	48	40	48	47	51
Chlorite	4	3	4	12	15	16	21	20	15	7
Anthophyllite	1	3	2	6	3	12	14	8	6	8
Actinolite	-	-	2	1	1	4	4	3	3	3
Opaques	-	1	1	-	-	1	-	1	2	1
Total	100	100	100	100	100	100	100	100	100	100

Samples 1 - 4 talcose variety

5 – 10 tremolite variety

Table 2 **Chemical analytical data (%)**

	1	2	3	4	5	6	7	8	9	10
SiO_2	57.01	56.31	57.21	57.02	51.11	52.11	54.65	49.15	51.11	53.91
TiO_2	0.52	0.52	0.41	0.54	0.51	0.49	0.52	0.51	0.51	0.31
Al_2O_3	2.52	2.31	2.35	2.65	3.25	3.85	3.18	4.61	4.01	4.01
Fe_2O_3	4.81	4.51	4.81	4.41	7.01	6.35	6.81	7.11	6.21	6.15
MnO	0.09	0.08	0.08	0.07	0.18	0.15	0.17	0.15	0.17	0.17
MgO	30.95	31.09	30.62	30.81	26.15	25.21	24.12	23.12	28.81	25.11
CaO	0.04	0.03	0.04	0.06	6.80	6.21	5.91	6.01	6.01	6.05
Na_2O	0.05	0.06	0.05	0.08	0.05	0.06	0.07	0.07	0.07	0.08
K_2O	0.14	0.14	0.14	0.13	0.16	0.12	0.11	0.11	0.15	0.13
P_2O_5	0.04	0.03	0.02	0.03	0.02	0.05	0.04	0.04	0.04	0.04
L.O.I	4.35	4.25	4.35	4.41	3.57	3.91	3.65	3.51	3.61	3.73
Total	99.72	99.63	99.98	99.91	99.01	99.51	99.65	99.39	100.5	99.69

Table 3 **PH Values**

	1	2	3	4	5	6	7	8	9	10
PH	8.01	8.02	8.21	8.11	8.51	8.72	8.81	8.91	8.11	8.31

CHEMICAL COMPOSITION

Representative samples of both petrographic varieties were crushed and pulverized in a disc mil. They were subjected to instrumental analysis using Atomic Absorption Spectrophotometer (PYE UNICAM SP 1900). At the Geological Survey of Nigeria main laboratories Kaduna. Only major oxides were determined.

Result (Table 2) show that Si_20 ranges from 49.15%-57.21%. This is comparable to values of the Ife –Ilesha group (Akin –Ojo, 1992) but clearly greater than unaltered peridotitic rocks. Al_20_3 values are generally less than 4.01% and show general depletion in Al_20_3. Mg0 contents range from 24.11% to 31.09%, with the highest values recorded in the talc rich varieties. Fe_20_3 is generally less than 7.11% with the highest values in the tremolitic varieties. Ca0

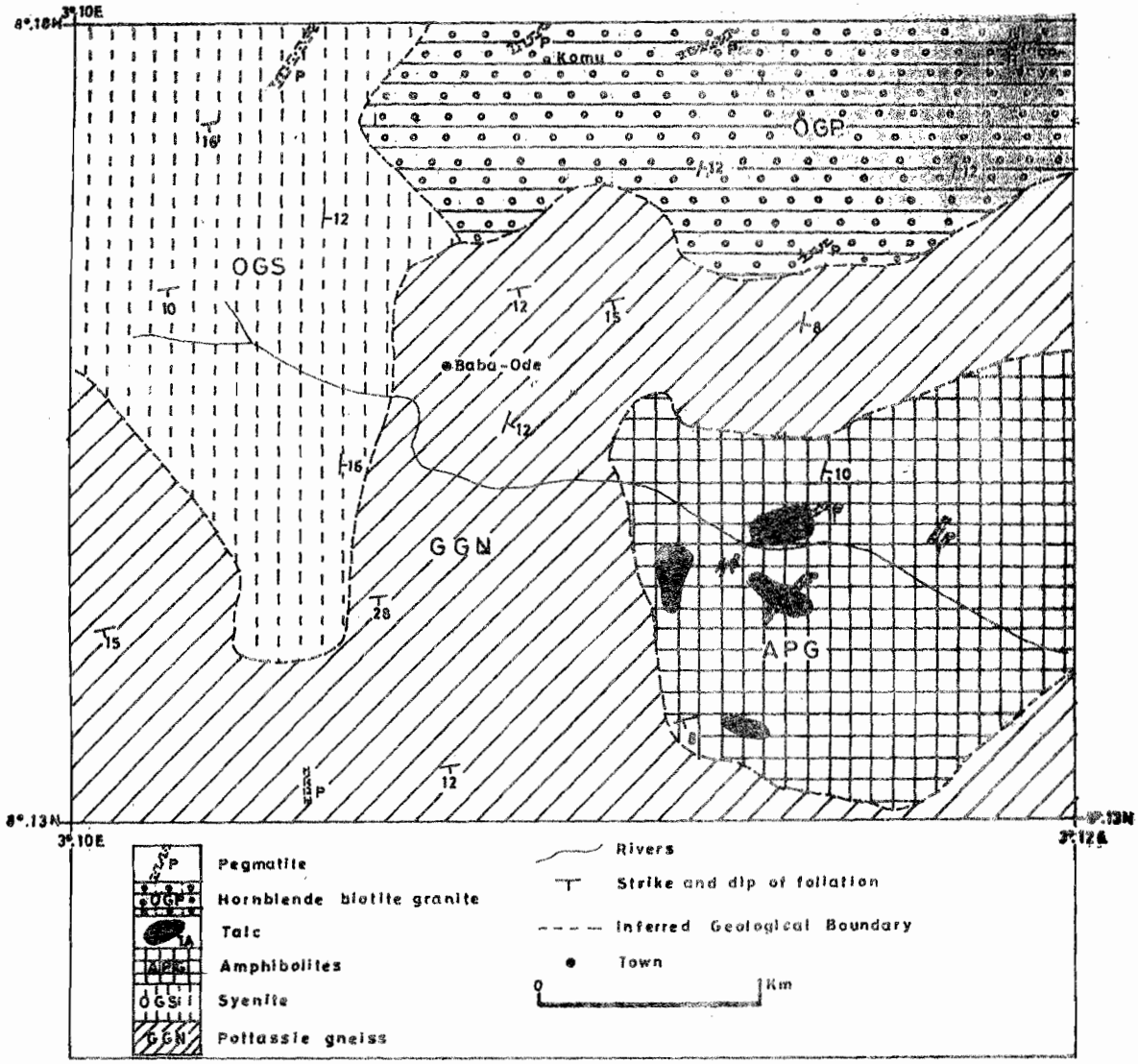


Fig. 2: Geological map of the study area (Baba-Ode).

range from 0.04 – 6.01%. The Ca0 values are comparable to the Kumaru talc body (Durotoye and Ige, 1991). P_2O_5, Na_20, K_20 and $Ti0_2$ values are all less than 0.52%.

INDUSTRIAL PROPERTIES

The economic potential of talc is largely dependent, not exclusively though, on its physical properties. Physical properties determined are firing characteristics, which include loss on ignition (L.O.I) water absorption capacity (W.A.C), linear shrinkage values (L.S.V.), colour and Ph.
In determining the firing characteristics, sample pellets were prepared using a standard press and fired in a laboratory muffle furnace at 1000^{0C} for approximately two hours. The loss on ignition was determined from weight difference between the fired and unfired pellets. Linear shrinkage was calculated as percentage decrease in diameter after firing. Water Absorption Capacity was estimated for each pellets as percentage weight increase after 24 hours of immersion in water.

Loss on ignition range from 3.51-4.41wt%. There seems, however, not to be much variation in the samples although the tremolitic varieties have slightly lower values. This is comparable to what was observed for the Iseyin talcose bodies. (Elueze and Ogunniyi 1985) and the Ilesha talc bodies (Akin – Ojo 1992). The absence of carbonate mineral in the Baba Ode may indicate that the loss on ignition is generally due to dehydration. The fired shrinkage value (F.S.V.) range from 1.01 – 1.81%. Water Absorption capacity gives a range of 13.72 – 18.25%. This compares favourably with those obtained by Akin Ojo (1992) for the Ilesha talc bodies.

Colour is a vital property in most industrial application of talc and is affected mainly by the presence of Mn0 and Fe_20_3. The samples colours range from grey to off whitish grey before firing. On firing, some still retain that off whitish colour while some turned light brown. The talcose type retained their off whitish colour. The light grey varieties were subjected to bleaching test to ascertain the removability of the colours. In this case, 2g of pulverized powder were soaked in 5ml of 0.5, 1.0,2.0 and 3.0M HCL. They were not bleached by 0.5M, but were slightly bleached by 1.0M and well bleached by 2.0 and 3.0M. Ph values range from 8.01 – 8.91 (Table 3).

ECONOMIC POTENTIALS

Talc is very useful in many industries as extenders, fillers and additives, most especially in ceramics, paper, paints, textiles, plastic and ceramics amongst many others. The usefulness is however dependent on a myriad of specifications.

CERAMICS

In the production of wall and floor tiles, white ware bodies and enamels, talc is employed as an addictive. It is known to promote translucency, and increases the toughness of the products.

Some of the specifications according to (Mitchell 1975) include a good firing colour (good white colour), average Ca0 of 6% so as to act as flux for lowering the maturing temperature of the ware. Only the tremolitic variety is useful for this purpose. Although Fe_20_3 may need to be leached out through beneficiation and improve the firing colour.

Low- loss electro ceramic requires low Fe_20_3 and Al_20_3, Ca0< 1% with good firing colour. Only the talcose variety is useful for this purpose. In electrical insulation ceramics manufacture, $Si0_2$ 60% Mg0 30%, Al_20_3 2.5%, Ca0 1% Fe_20_3 1.5%, $Na_20 + K_20$ 0..4%, L.O.16% are the specifications. Only the talcose variety meets this specification although the Si_20 content is marginally lower than required.

Paints

Powdered or pulverized talc is employed chiefly as inert filler and extender in the manufacturing of paints. It reduces the risk of cracks in the paint film.

Specifications according to payne (1981) include a good white colour, absence of hard particles, and small particles size with at least

Table 4 Firing characteristics of the talc body (%)

	1	2	3	4	5	6	7	8	9	10
Loss on ignition	4.35	4.25	4.35	4.41	3.57	3.91	3.65	3.51	3.61	3.73
Water Absorption capacity	16.98	15.27	15.14	18.25	14.21	13.72	16.11	13.92	14.01	14.28
Fired shrinkage value	1.52	1.35	1.01	1.23	1.51	1.63	1.41	1.81	1.71	1.65

97% passing through 325 mesh. In addition to Al_2O_3 2%, Mgo + Si_2O 75%, LOI 4-8%, and pH 8 - 10. The two talc varieties meet these specification and could thus be useful.

Rubber

Talc is used as fillers in the making of hard rubber goods. It is known to offer greater tear and abrasion resistance and stiffness. It sometimes also used as dusting agent to lubricate moulds.

The talc according to Severinghus (1975) should be off colour, with no gritty particles, while MnO, CuO must be low. Both varieties meet these specifications. It is however advisable that the talcose varieties be reserved for those usages with more stringent requirements since larger quantities are required.

Paper

Talc is used as filler and extender in paper manufacture. It is also a coating pigment, which allows for smoother and glossier surface for high quality printing paper. The talc, according to Noble (1988) must be white, fine grained, free from mica, very low Fe_2O_3 and CaO <5%. It must also be soft, smooth and free from grit. The talcose variety may be marginally useful on the basis of its softness and smoothness, acceptable CaO content but may still need some beneficiation. However the tremolitic variety will not be suitable because of its relative grittiness, higher than acceptable CaO content and roughness.

Roofing

This product requires relatively low grade, coarsely grained talc as a filler and as inert fire proof over coating in roofing (National paint and coating association,1975). The two varieties are useful but the purer talcose variety could be reserved for other uses.

Textiles

Textile manufacturing require finely ground talc for loading and for beaching rope according to American Textile Manufacturers institute (1975).

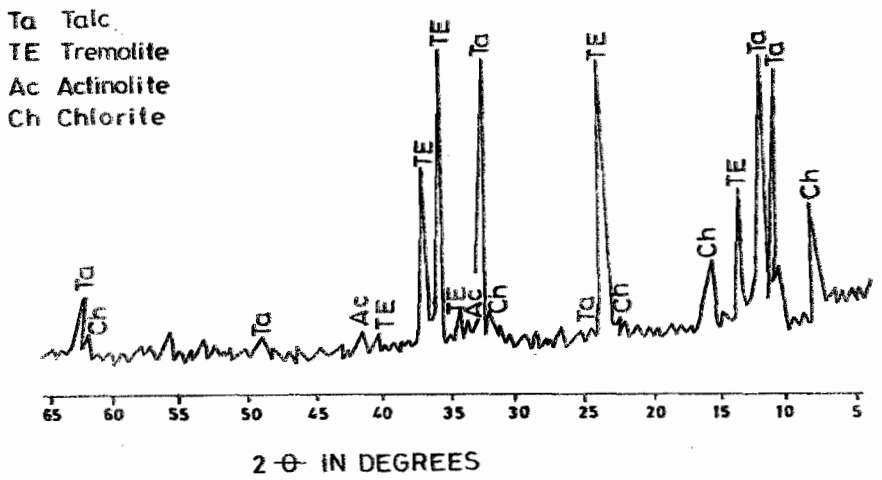
The talc should be free also of hard, gritty impurities such as calcite and quartz. It should have good colour, smooth, greasy feel and the moisture content should be < 0.3%.

Both varieties are free of hard gritty impurities and are soft and greasy. Bleaching will improve the colour. They could thus be used as raw materials for textile manufacturing.

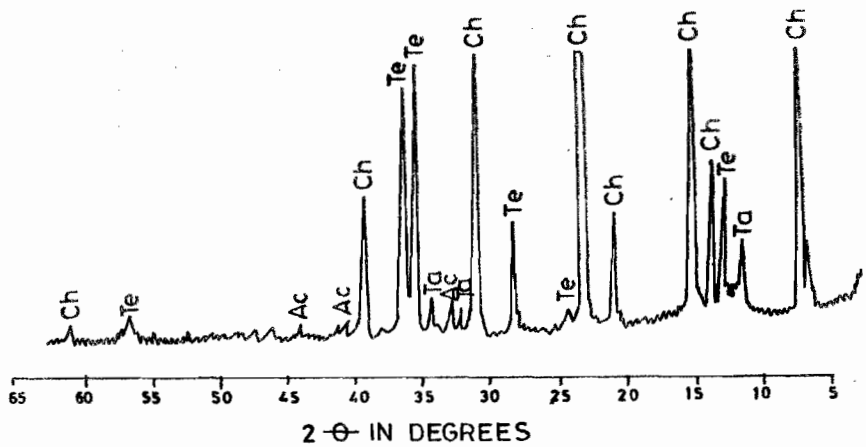
Refractory

Talc when added to alumina and clay and fired to 1250 – 1400^{0C} produces a low thermal expansion, high thermal shock resistance cordierite with good electrical properties. They are used as coil formers, water boiler insulator, fire bans and are burners.

The talc should have a low fired shrinkage value, CaO < 1%, Fe_2O_3 < 1.5%, SiO_2 < 6.0%, MgO 30% (Na_2O+K_2O) < 0.4% and L.O.I < 6%. (American society for testing and materials (1973)



(a) Talc rich variety



(b) Tremolite - chlorite variety

Fig. 3: X-ray diffractogram of Talc Samples.

Although the L.O.I is < 6% in all varieties and alkalis are low, only the talcose varieties meets the specifications in terms CaO and Al_2O_3 content. The non talc minerals will however have to be removed by beneficiation.

Plastics

Talc improves the rigidity and stability at high temperatures, during the manufacturing of polypropylene plastics.

Desirable properties of the talc according to Noble (1988), include low specific gravity, fine particle size distribution, softness and good colour. Both talcose varieties are useful, but the colour needs to be improved by bleaching.

Cosmetics, Pharmaceuticals, Food Processing

Talc is used in the manufacture of creams, powders, salves, rouge and soaps. It is also used as a dusting agent for tablets, wounds, and for

Table 5 Evaluation of Economic Potentials of the Talc Occurrence

Industry	Specification	Suitability of Talc Varieties	
		Talcose	Tremolite
1. Ceramics	Good firing colour	√	√
(a) Wall and floor tiles	CaO 6%		
b. low - loss electronics	Low Fe_2O_3		
	Low Al_2O_3	√	
	CaO 15	√	
	Good firing colour	√	
c. Electrical insulations	SiO_2 60%		
	MgO 30%	√	
	Al_2O_3 2.5%	√	
	CaO 1%	√	
	Fe_2O_3 1.50%	√	
	$Na_2O + K_2O$ 0.4%	√	√
	L.O.I. 6%	√	√
2. Paints	Good white colour	√	
	Small particle size	√	√
	Absence of hard particles	√	
	Al_2O 2%		
	$MgO + SiO_2 > 75\%$	√	√
	L.O.I. 4 - 8%	√	√
	PH 8 - 10	√	√
		√	
3. Rubber	White – off white colour	√	
	No gritty particles	√	√
	100% must pass through BS – 100 mesh.		
4. Paper	White colour	√	
	Fine grained	√	√
	Free from mica and iron oxide	√	
	CaO < 5%	√	
	High reflectance		
	Soft, smooth with low density		
5. Cosmetics, pharmaceuticals, Food processing	Odourless,	√	√
	No grits, finely sized	√	√
	Talc 90%		
	Pleasing colour	√	
	Good slip	√	
	L.O.I. 50%	√	
	PH 8 – 10	√	
	CaO 1.5%	√	

6. Roofing	Low grade talc	√	√
	Coarsely grained	√	√
7. Textile	No hard grits	√	√
	Good colour	√	
	Smooth, greasy feel	√	√
	Moisture content < 0.5%	√	√
8. Refractory	Good firing colour	√	√
	Low fired shrinkage	√	√
	$CaO < 1\%$, $Fe_2O_3 < 1.5\%$ $SiO_2 > 60\%$	√	
	MgO 30%	√	
	$Na_2O + K_2O < 0.4\%$	√	
	$Al_2O_3 < 2.5\%$ L.O.I. < 6%	√	
9. Plastic	Fine particle size	√	
	Soft, good firing colour	√	

odour absorption in wounds. Likewise it is used as dusting agent for foods, food colour absorbent and polishing agent in cereal grains.

Since these are highly specialized applications, the talc must be odourless, grit free, finely sized, mineralogically pure (talc 90%), good white colour, L.O.I. 5%, pH 8 –10 and Ca0 1.58%. (American Association of Test and Measurements 1988)

It will require extensive beneficiation to make the talcose variety useful especially in terms of mineralogical purity. However, the tremolite variety is not applicable.

CONCLUSIONS

Results of this study reveal that most samples of the Baba Ode talcose occurrence, which is associated with amphibolites, contain in addition to talc appreciable presence of tremolite and subordinate actinolte and chlorite. This is mostly responsible for its mineralogical and hence chemical variation. The chemical variations and physical properties also reflect to some extent its mineralogical compositions.

The talcose and the tremolitic varieties of the body could be useful in many industries such as ceramics, paint, rubber, paper, plastics, roofing, pharmaceutical and cosmetics.

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