PETROCHEMICAL CHARACTERISTICS AND INDUSTRIAL FEATURES OF TALCOSE ROCK IN IJERO-EKITI AREA, SOUTHWESTERN NIGERIA

Okunlola, A.O.[1], Akinola, O.O.[2] and Olorunfemi, A.O.[3]

1. Department of Geology, University of Ibadan, Ibadan Nigeria.
2. Department of Geology, University of Ado-Ekiti, Ekiti State, Nigeria
3. Department of Geology, Obafemi Awolowo University, Ile Ife, Nigeria

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(Corresponding email: gbengaokunlola@yahoo.co.uk)

ABSTRACT

Talc bodies occurring in association with mafic and ultramafic rocks, gneisses, quartzite, and schistose rocks of Ijero-Ekiti area were investigated with a view to determining their compositional characteristics and industrial potentials. The talcose rocks which outcrop as rounded crudely lensoidal bodies, averagely extends for about 3 km along the strike and 200 m wide. They vary in colour from white to greyish and in places from light brown to light green. Petrographic studies indicate that the talc bodies are dominated by talc (ca. 38.70%), tremolite (ca. 27.50%), chlorite (ca. 16.70%) with subordinate actinolite (ca.8.9%) and anthophyllite. (ca.6.8%) Mean chemical composition show that SiO_2 (ca. 56.03%), MgO (ca. 27.74%), Fe_2O_3 (ca. 7.11%), Al_2O_3 (ca. 2.25%) and CaO (ca. 2.61%) constitute the major oxides composition. Generally, Na_2O, K_2O, Cr_2O_3 and P_2O_5 altogether account for less than 1% of the bulk composition. Results of physical parameters: Water Absorption Capacity (ca. 12.28%), loss on ignition (ca. 3.81%), pH (8.06), Fired shrinkage (ca. 1.86%) and Petrochemical characteristics indicate that the talcose rock is essentially low grade and is suitable as raw material for use in the manufacture of only rubber, and textiles, if appropriately beneficiated. Compositionally however, it falls short of requirements as raw material for paints, pharmaceutics, paper and refractory industries.

Keywords: Talcose, Composition, Physical, Chemical, Beneficiation, Industries

INTRODUCTION

Talc is a universal industrial mineral commonly employed in the manufacture of ceramics, cosmetics, pharmaceuticals, paper, paint, rubber, roofing sheets, insecticides, fertilizers and a host of other products (Clarke, 1979). It is a hydrothermal product of basic and ultrabasic rocks (Hess, 1993; Highley, 1974) and is essentially a hydrous magnesium silicate with chemical formula $Mg_3Si_4O_{10}(OH)_2$. It belongs to a subclass of phyllosilicates in a larger group called clays.

In south-western Nigeria, talc-bearing rocks occur within the schist belts of the basement complex. Within this region, four compositional varieties have been reported namely: talcose, tremolite, anthophyllite and chlorite types (Elueze and Akin-Ojo, 1993). Okunlola and Anikulapo, (2006) Localities within which notable occurrences are found include Iseyin District (Durotoye and Ige, 1991); Obaluru-Araromi (Akin-Ojo, 1992); Baba-Ode (Okunlola et al., 2002); Erin-Omu (Okunlola and Anikulapo, 2006), Oke-Ila (Bolarinwa, 2001) and Esie (Olorunfemi et al., 2009).

The Ijero talcose rock being studied for its compositional and industrial suitability for the first time is an addition to the list of talc occurrences notably within the Ife-Ilesha schist belt of the Basement Complex of south-western Nigeria.

MATERIALS AND METHODS

The study involves systematic geological mapping on a scale of 1:25,000, collection, thin section and X-Ray Diffraction study of 10 fresh representative samples of the talcose rocks. In this case, the Phillips-PW 1011 diffractometer was used. The diffractograms were recorded using a scanning rate 1^0 2/min/cm with a Ni-filtered Fe-K alpha radiation. X ray diffraction curves were interpreted by comparing peaks of notable intensities with those of standard minerals established by Carrol (1971). Quantitative determinations were by the areal method. For the geochemical investigations, collected samples were dried at 60°C, crushed, pulverized and sieved to -80 mesh. A 0.2g sample aliquot was weighed into a graphite crucible and mixed with 1.5 g of $LiBO_2/LiB_4O_7$ flux. The flux /sample charge was heated in a muffle furnace for 30 minutes at 980°C. The cooled bead was then dissolved in 100ml of 5% HNO_3 (ACS grade Nitric acid in de-mineralized water). An aliquot of the solution was poured into a propylene test tube. Calibration standards and verification standards are included in the sample sequence. Sample solutions are aspirated into an ICP mass spectrometer (Perkin-Elmer Elan 9000) for the determination of major and trace elements at the Acme Laboratories in Vancouver Canada. Quality control protocol

incorporates a sample preparation blank (G1) as the first sample in the procedure, which is carried through all stages of preparation to analysis. Also, the procedure incorporates a pulp duplicate to monitor analytical precision, a reagent blank to measure back ground and aliquots of in house reference material STD SO-18.

The physical properties determined are thermal characteristics, water absorption capacity, linear shrinkage, colour and pH. Sample pellets of the talcose rocks were prepared using a standard press. These pellets were fired in the laboratory Muffle furnace at1000°C for 24 hours. The loss on ignition was determined from the weight difference between the unfired and fired pellets. The linear shrinkage was calculated as percentage decrease in diameter after firing. Water absorption capacity was estimated for each pellet as percentage weight increase after 24 hours of immersion in water. Bleaching test was carried out on the samples by soaking 2g of the pulverised samples in 5 ml. of HCl with concentrations ranging from 0.5 to 3.0 M.HCl.

GEOLOGICAL SETTING AND FIELD OCCURRENCE

The study area lies within latitudes 7°46'- 7°53' North and longitudes 5°00'- 5°07' East and. The town is located at about 42 km northwest of Ado-Ekiti (Fig. 1). Ijero-Ekiti area which is located around the eastern margin of Ife-Ilesha Schist belt, underlain by Precambrian Basement Complex rocks (Fig. 2). Systematic geological mapping carried out on the study area revealed that the talc body occurs in association with mafic and ultramafic rocks, schists, gneisses, quartzites and granite pegmatite. Details of the lithological and petrographic characteristics of these associated rocks are contained in Okunlola and Akinola, (2010). The talcose rocks occur in the southern part of Ijero town, along Ijero-Ajeje road. It underlies the central low-lying depressions intercalated with biotite schist and amphibole schist within prominent quartzite and gneissic rocks and extends for about 3 km along the strike and about 200 meters across (Fig. 3). A road cut exposes a section of the rock. On either sides of the road are slippery boulders of the rock with colour varying between brown, grey and white. The variation in colour is attributable to varying degrees of weathering. The rock is restricted to a narrow N-S trending lensoid strip characterised by low-lying discontinuous outcrops. Fresh hand specimen displays its softness and characteristic soapy feel and a dull to pearly lustre.

Petrographic Features

Petrographic examination indicates that the Ijero talcose rock contains talc, (ca. 38.7%); tremolite, (ca. 27.5%); anthophyllite, (ca. 6.8%); actinolite, (ca. 8.9%) and chlorite, (ca. 16.7%) while the opaque minerals (ca. 1.4%) constitute the subordinate mineral (Table 1). Talc occurs as thin colourless fibrous minerals, tremolite also occurs as long, thin, grains showing some evidence of preferred orientation of the long axes, while chlorite

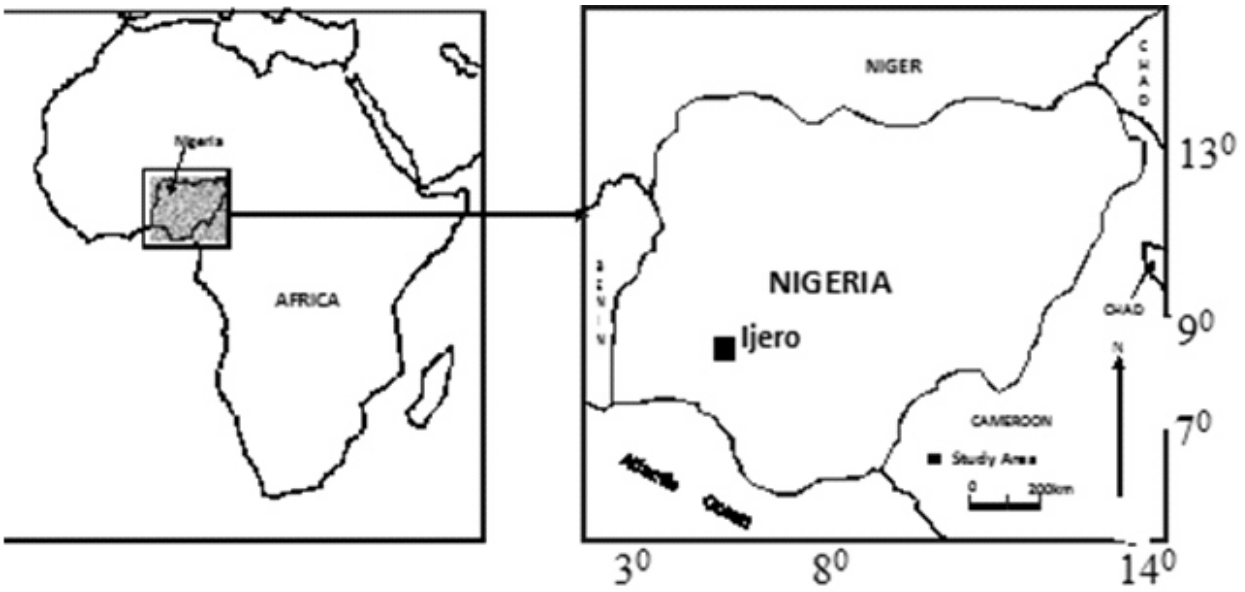

Fig.1: Location Map of Study Area within Africa and Nigeria.

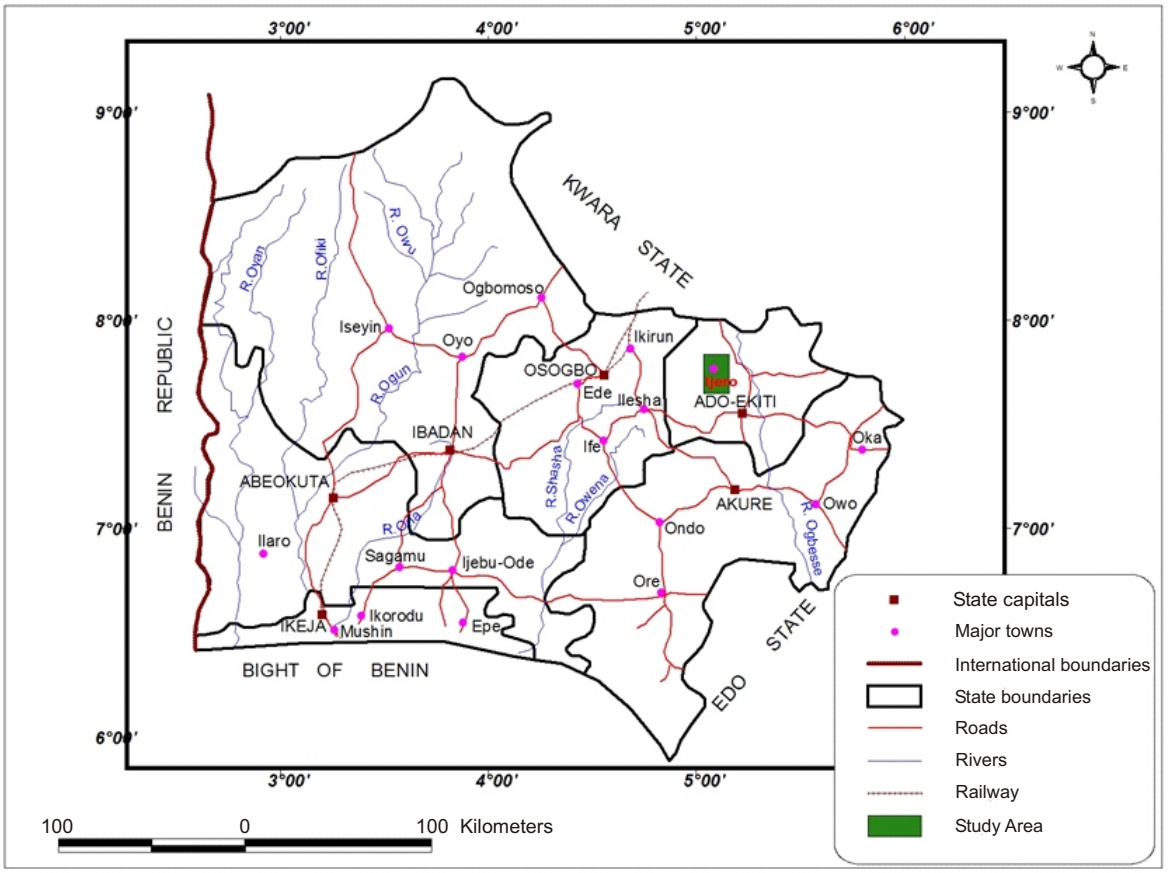

Fig. 1b**: Map of South Western Nigeria Showing Location of the Study Area.**

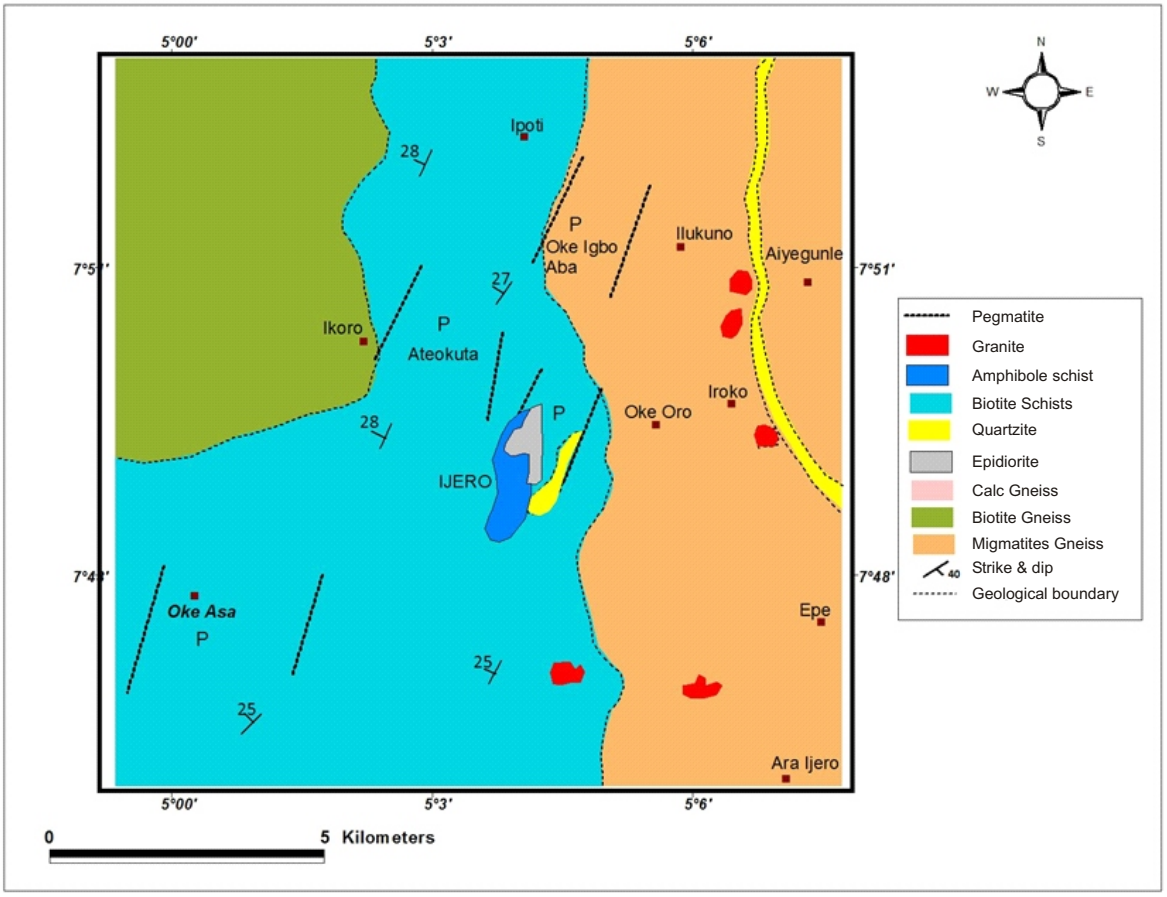

Fig. 2: Geological Map of the Study Area (After Okunlola and Akinola, 2010).

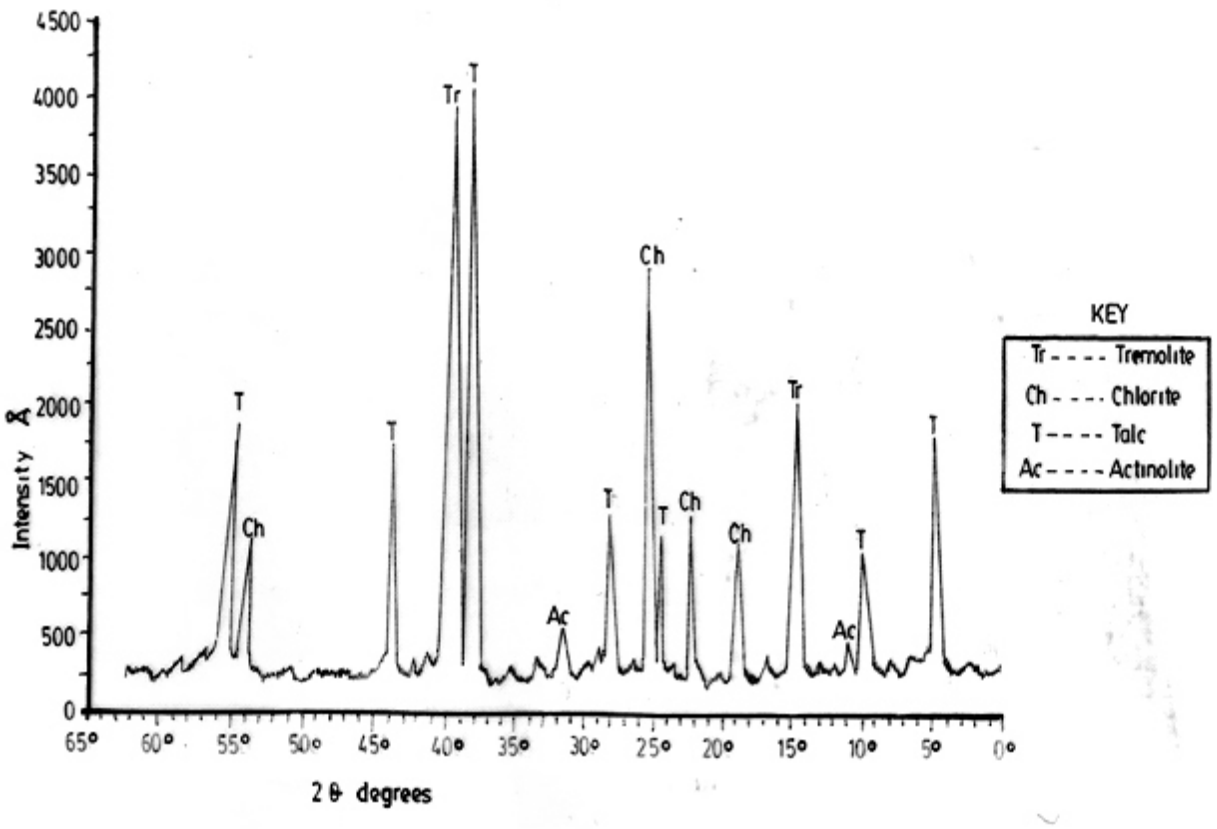

Fig. 3: X-ray Diffractogram of Ijero Talc Sample.

Table 1: Modal Composition of Ijero Talcose Rock

Minerals	s(1)	s(2)	S(3)	s(4)	s(5)	s(6)	s(7)	s(8)	s(9)	s(10)	Range	Average
Talc	38.0	41.2	40.3	36.5	39.1	37.8	39.5	40.0	35.8	39.8	35.8- 41.2	**38.7**
Tremolite	27.2	29.0	26.8	25.3	28.4	29.0	28.1	26.2	27.5	28.5	25.3- 29.0	**27.5**
Actinolite	8.3	9.1	8.7	10.3	9.6	8.8	10.4	7.7	7.9	8.2	8.2- 10.4	**8.9**
Chlorite	16.0	17.4	17.0	16.8	19.1	19.3	15.6	16.7	14.2	15.9	14.2- 19.3	**16.7**
Antophyllite	6.5	2.3	5.2	9.1	3.8	5.1	6.3	7.0	8.6	6.6	2.3- 9.1	**6.8**
Opaques	3.7	1.0	1.8	2.0	-	-	-	2.0	5.0	-	1.0- 5.0	**1.4**
Total	99.7	100	99.8	100	100	100	99.9	99.6	99.0	99.0	99.0-100	**100**

occurs as fine grained, scattered green, pleochroic minerals with moderate relief (Fig. 4). This mineralogical composition, when compared with pharmaceutical and industrial grade varieties of Luznac, France talc deposit (Table 2) (Luzenac Mines limited, 1998) shows that the talc content of the Ijero occurrence is comparatively very low, while the tremolite, chlorite and antophyllite content is much higher. However, it compares marginally favourably in terms of talcose content with the low grade industrial variety of Petchbury deposit, Thailand, being utilised for rubber and cordierite ceramics manufacture, (Grogan and Montgomerry 1973) and the Lumphurm province, west of Bangkok, deposit being utilised for paints and textile manufacture (Macmillan,1970). Also, the talc content (ca. 38.7%) of Ijero talcose rock when compared with those of other similar occurrences in Nigeria, that are been explored as raw materials for varied industrial applications notably plastic, paints and ceramic show that it is lower than those of Iseyin (ca. 52%), Oke- Ila (ca. 57%) and Erin-Omu (ca. 59%). However, the value is slightly higher than the talc component of Igbo-Agbon talcose rock (ca. 35%) (Table 2) and the tremolite talc around Baba-Ode area (Okunlola, et al., 2002). The tremolite-actinolite content of Ijero talc samples is higher than those for Erin-Omu talc (Okunlola and Anikulapo, 2006), Oke-Ila (Bolarinwa, 2001) and those of Iseyin area (Elueze and Awonaiya, 1989). The mean chlorite value (16.7%) is marginally higher than that of Igbo-Agbon talc bodies (Ayemo, 2003), but comparable to Baba-Ode tremolite talc (ca. 16%) (Okunlola, et.al, 2002). The value is higher than the average of 7% recorded for the Erin-Omu talc (Okunlola and Anikulapo, 2006), and Igbo-Agbon talcose rock

(Ayemo, 2003). All in south western Nigeria.
X-Ray diffraction study (Fig. 3), method also confirms the optical examination and, reveals that Ijero talcose rock is composed mainly talc (39%), tremolite (28%), chlorite (17%), anthophyllite (7%), actinolite (9%) and opaque minerals (1%).

Geochemical Features:
. The result of the chemical analyses (Table 3) generally reflects the mineralogical composition. Compared however with global occurrences, the overall geochemical appraisal of the Ijero talcose rocks show that it is comparable with the low rubber and textile grade Pitchbury (Grogan and Montgomery, 1973) and Lumphurm (Macmillan,1970) deposits but is of low chemical quality in comparison with the

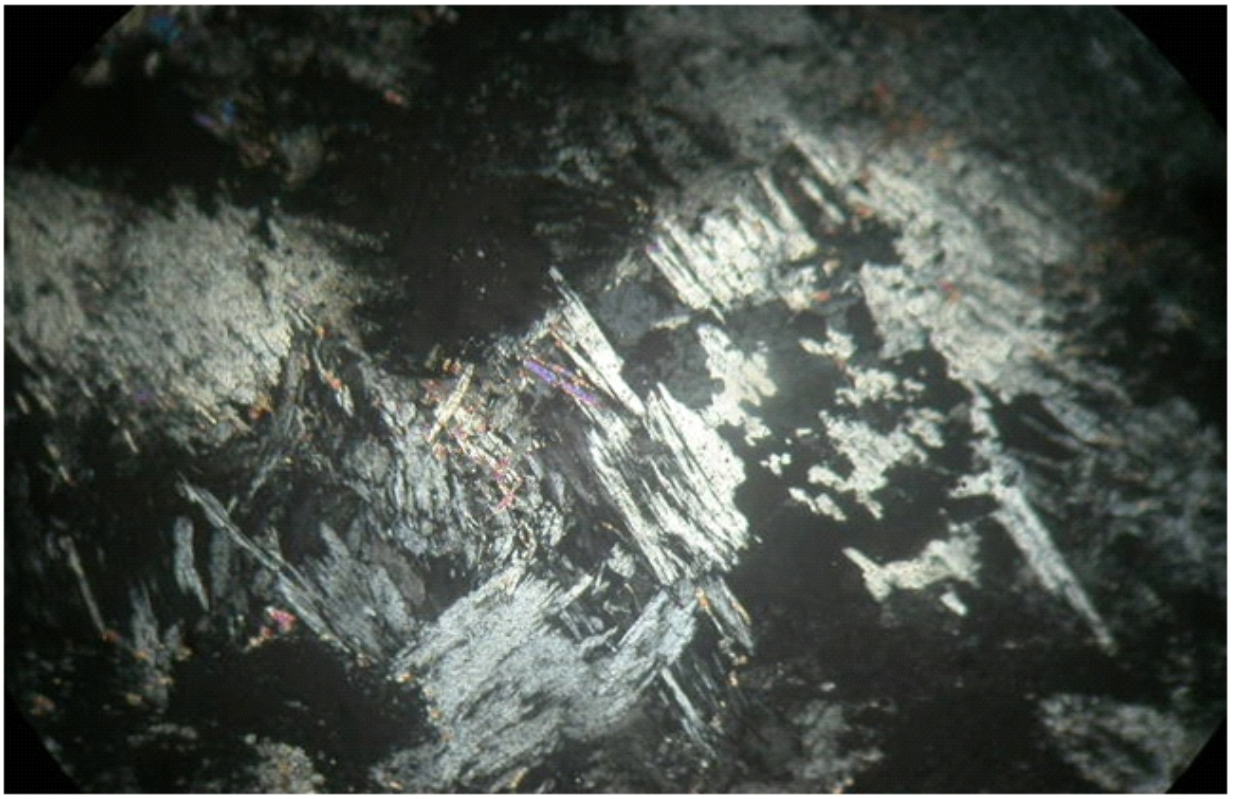

Fig. 4: Photomicrograph of Ijero Talcose Rock in Plane Polarised Light Showing Talc (T), Tremolite (R), and Chlorite (C).

Table 2: Comparison of Average Modal Compositions of Ijero Talcose Rock with Similar Rocks from Other Locations.

	Present Study	**Reference samples (Mean %)**									
Minerals	Ijero	Erin-Omu	Baba-Ode (TAL)	Baba-Ode (TRE)	Oke-Ila	Iseyin (TTCS)	Igbo-SAgbon	1	2	3	4
Talc	38.7	59	74	24	57	52	35	91	65	43	41
Tremolite/Actinolite	36.4	24	7	48	12	29	53	-	-	33	31
Anthophyllite	6.8	6	3	9	-	-	--	-	-	6	4
Muscovite	-	2	6	-	-	-	-	2	-	-	2
Chlorite	16.7	7	-	16	24	18	10	1	6	13	12
Others(Opaques)	1.4	-	-	1-	2	2	2		3	3.5	4
Dolomite	-	-	-	-	-	-	-	3.5	15	1.7	-
Total	100	100									

Erin-Omu (Okunlola and Anikulapo, 2006)
Iseyin Talc -Tremolite -Chlorite Schist (TTCS), (Elueze and Awonaiya, 1989)
Baba-Ode Talcose Variety (TAL) (Oku nlola, et. al. 2002)
Baba-Ode Tremolite Variety (TRE) (Okunlola, et al. 2002)
Oke-Ila Talcose Rock (Bolarinwa,2001)
Igbo-Agbon Talc (Ayemo, 2003)
1 LuzenacTalc , Pharmaceutical grade (Luzenac Mines report ,2003)
2Luzenac Talc , Industrial grade (Luzenac M ines report, 2003)
3Pitchbury Talc , rubber Grade, (Grogan and Montgomery, 1973)
4Lumphurm Deposit, Textile Grade (Macmillan,1970)

Table 3: Chemical Composition of Ijero Talcose Rocks Major Elements (wt%), Trace Elements (ppm)

Oxide	1	2	3	4	5	6	7	8	9	10	Average
SiO_2	54.51	56.31	55.63	56.59	56.39	56.31	55.99	56.38	55.75	56.42	56.03
Al_2O_3	2.20	2.22	2.23	2.28	2.28	2.24	2.25	2.26	2.26	2.28	2.25
Fe_2O_3	6.89	7.12	7.02	7.35	7.25	7.11	7.09	7.07	6.97	7.20	7.11
MnO	0.19	0.19	0.19	0.18	0.18	0.19	0.19	0.19	0.19	0.18	0.19
MgO	27.31	28.21	27.81	27.8	27.68	28.09	27.76	27.8	27.26	27.71	27.74
CaO	2.62	2.6	2.62	2.56	2.6	2.61	2.63	2.61	2.62	2.59	2.61
Na_2O	0.1	0.1	0.1	0.09	0.07	0.08	0.11	0.11	0.09	0.07	0.09
K_2O	0.09	0.07	0.01	0.08	0.2	0.01	0.05	0.02	0.01	0.04	0.04
TiO_2	0.089	0.077	0.084	0.081	0.085	0.077	0.083	0.074	0.074	0.082	0.081
P_2O_5	0.02	0.02	0.02	0.02	0.01	0.01	0.02	0.02	0.02	0.01	0.02
LOI	4.03	4.0	4.05	3.99	4.05	4.04	4.10	4.09	4.02	4.05	4.04
Total	98.04	100.9	99.7	101	100.6	100.8	100.3	100.6	99.24	100.6	
Trace Elements											
Cr	3380	3590	3750	3700	3910	3600	3900	4050	3740	3500	3712
Ag	0	0	0	0	0	1.7	0.6	0	0	0	0.23
Co	86	87	89	83	84	94	87	91	84	77	86
Zn	160	140	140	160	140	150	160	160	150	140	150
Cu	10	0	10	0	10	10	0	10	10	10	7
Ni	1360	1420	1390	1360	1310	1460	1380	1440	1360	1250	1373
Cs	1.8	2.4	1.9	2.0	2.8	1.8	1.5	2.8	2.2	1.2	2.0

Luzenac deposit (Luzenac Mines Report, 2003). A closer assessment especially in relation to other known occurrences in Nigeria shows that the mean SiO_2 value of Ijero talcose rock is 56.03%. This value is similar to the Baba-Ode talc-tremolite-actinolite schist (Okunlola, et al, 2002), and talc-tremolite/actinolite schist of southwestern Nigeria (Elueze, 1982, Elueze and Ogunniyi, 1985). However, the body contains slightly lower mean SiO_2 value when compared to Erin-Omu talcose rock (Okunlola and Anikulapo 2006). The value is also higher than the Baba-Ode tremolite variety (Okunlola, et al. 2002), Oke-Ila talc bodies (Bolarinwa, 2001) and Igbo-Agbon talcose rocks of Iseyin district (Ayemo, 2003).

Al_2O_3 content of Ijero talcose rock (ca. 2.25%) is also comparable to those of Baba-Ode talc-tremolite-actinolite schist, Iseyin (Elueze, 1982; Elueze and Ogunniyi, 1985). The value is however higher than that of Erin-Omu talc. Mean Fe_2O_3 content (ca. 7.11%) is comparable to Erin-Omu talcose rock (Okunlola and Anikulapo 2006), but marginally higher than Iseyin talc tremolite-chlorite schist (Elueze and Awonaiya, 1989) and Baba-Ode tremolite talc (ca. 6.61%) (Okunlola, et al., 2002).

The MgO content of the talcose rock (ca. 27.74%) is comparable to Iseyin -talc tremolite chlorite schist of southwestern Nigeria (Elueze and Awonaiya 1989).

The Mean value of Na_2O of Ijero talc (ca. 0.09%) is comparable to Igbo-Agbon talcose bodies (Ayemo, 2003). These have mean values that are higher than other talcose rocks found in south western Nigeria. Trace element analyses (Table 3) show that Ijero talcose rock has a higher Co (ca. 86ppm) compared to either the Erin-Omu talc body, (ca. 62ppm) (Okunlola and Anikulapo, 2006); Iseyin tremolite talc chlorite schist, (ca. 71ppm) (Elueze and Awonaiya, 1989); or the Oke-Ila talc (ca. 66 ppm) (Bolarinwa, 2001). The Cr content (ca. 3712 ppm) of Ijero talcose rock is higher than the values recorded for all other talcose rock from south western Nigeria. The Ni content of the talc body (ca. 1373 ppm) is lower than (ca. 1500 ppm) recorded for talc-tremolite-actinolite schist of south western Nigeria, (Elueze 1982; Elueze and Ogunniyi, 1985). This value

however, is higher than the mean values of (1278 ppm) for talc chlorite schist of Iseyin (Elueze and Awonaiya, 1989) and (774 ppm) recorded for Oke-Ila talcose rock (Bolarinwa, 2001). The Zn content (ca. 150 ppm) of Ijero talc is higher than other talc bodies in southwestern Nigeria. (Table 4).

Table 4: Chemical Composition of Ijero Talcose Rock Compared to Similar Rocks from Other Areas.

													A		B		C		D		E	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	Mean	Range	Mean	Rang	Mean	Range	Mean	Range	Mean	Range	Mean	Range
CS	2.81	2.78	2.72	2.69	2.62	2.81	2.73	2.77	2.68	2.59	2.72											
pH	8.06	8.23	8.41	8.36	8.47	8.62	8.11	8.08	8.38	8.45	8.32	8.06-8.62			8.08	8.01-8.21	8.56	8.11-8.91	8.50	7.5-9.5	8.07	8.01-8.21
WAC	12.28	15.03	15.29	17.61	15.48	15.22	16.00	14.36	18.07	13.45	15.28	12.28-18.07	9.04	6.96-1.65	16.41	15.14-18.25	14.38	13.72-16.11	5.11	4.21-5.80	14.82	13.25-16.25
FSV	1.86	1.63	1.71	1.94	1.33	1.24	1.55	1.57	1.70	1.82	1.64	1.24-1.94	1.15	0.25-2.00	1.28	1.01-1.52	1.62	1.41-1.81	3.01	2.45-3.50	1.47	1.01-1.81
LOI	3.81	3.94	3.79	3.65	3.62	3.83	3.08	3.47	3.58	3.64	3.64	3.08-3.94	4.00	1.45-6.03	4.34	4.25-4.41	3.66	3.51-3.91	4.54	3.75-5.28	3.82	2.87-4.11

1-10 = This Study; **A**= Iseyin Talc- Tremolite- Chlorite Schist (TTCS): Elueze and Awonaiya, (1989); **B**= Baba-Ode Talcose variety (TAL), **C**= Baba-Ode Tremolite Variety (TRE): Okunlola et al. (2002); **D**= Oke-Ila talcose rock: Bolarinwa, (2001); **E**= Erin-Omu talc: Okunlola and Anikulapo, (2006).

*This study; Erin-omu(Okunlola and Anikulapo, 2006); Iseyin (Talc-Tremolite-Chlorite Schist, Elueze and Awonaiya ,1989); Baba-Ode Talcose Variety (TAL) (Okunlola, et. al. 2002); Baba-Ode Tremolite Variety (Okunlola, et. al. 2002); Oke-Ila Talcose rock: (Bolarinwa,2001); Igbo-Agbon (Ayemo, 2003); SW Nigeria(Talc-Tremolite Actinolite Schist, Elueze and Awonaiya, 1989). 1. Luzenac Talc, Pharmaceutical grade (Luzenac Mines report,2003) 2. Luzenac Talc, Industrial grade (Luzenac Mines report, 2003) 3. Pitchbury Talc, rubber Grade, (Grogan and Montgomery, 1973) 4. Lumphurm Deposit, Textile Grade(Macmillan,1970)

Physical Characteristics and Industrial Applications:

From the results of these determinations, the Ijero talcose rock have a slightly higher average pH value (8.32) than Erin-Omu samples (ca. 8.07), (Okunlola and Anikulapo, 2006), Baba-Ode talcose variety (8.08). This value is lower than the average of 8.50 recorded for Oke-Ila talc body (Bolarinwa, 2001), and Baba-Ode Tremolite-talc variety (ca. 8.56) (Okunlola et. al., 2002), (Table 5). The mean Loss on Ignition value of 3.64% for the talc body is similar to the Baba-Ode tremolite talc (ca. 3.66%) but lower than 4.0%, 4.34%, and 4.54% values recorded for Iseyin talc-tremolite-chlorite schist (Elueze and Awonaiya,1989); Baba-Ode talcose variety (Okunlola, et.al., 2002) and Oke-Ila talcose rocks (Bolarinwa, 2001) respectively.

Before firing the samples colour ranged from brown, grey, to whitish, but on firing, the white ones retained their colours while the grey ones became cream colour and the brown turned yellowish. From the bleaching tests, the rocks are amenable to bleaching with increasing concentrations of HCl. The water absorption capacity of the samples range from (12.28-18.07%) with a mean value of 15.28% (Table 5). These values are higher than those of the 9.4% recorded for Iseyin talc-tremolite-chlorite schist (Elueze and Awonaiya, 1989) and 5.11% calculated average for Oke-Ila talcose rock (Bolarinwa, 2001). The value is slightly lower than those obtained from Baba-Ode talcose variety (ca. 16.41%). (Okunlola et. al., 2002).

INDUSTRIAL ASSESSMENT

Based on the above determinations of chemical and physical characteristics, the talc bodies are assessed functionally thus:

Ceramics Industry:

In the production of wall and floor tiles, white wares and enamels, talc acts as an additive to promote translucency and to increase toughness of the product. Mitchell, (1975) specified a good firing colour (white)and an average CaO concentration of 6% to act as flux for lowering the maturing temperature of the ware. The talcose rock samples studied do not meet the specifications for this purpose because the average CaO content of. 2.61% is lower than the recommended value of 6.0%.

Table 5: Physical Properties of Ijero Talcose Rock Compared to Similar Rocks from Other Locations.

													A		B		C		D		E	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	Mean	Range	Mean	Rang	Mean	Range	Mean	Range	Mean	Range	Mean	Range
CS	2.81	2.78	2.72	2.69	2.62	2.81	2.73	2.77	2.68	2.59	2.72											
pH	8.06	8.23	8.41	8.36	8.47	8.62	8.11	8.08	8.38	8.45	8.32	8.06-8.62			8.08	8.01-8.21	8.56	8.11-8.91	8.50	7.5-9.5	8.07	8.01-8.21
WAC	12.28	15.03	15.29	17.61	15.48	15.22	16.00	14.36	18.07	13.45	15.28	12.28-18.07	9.04	6.96-1.65	16.41	15.14-18.25	14.38	13.72-16.11	5.11	4.21-5.80	14.82	13.25-16.25
FSV	1.86	1.63	1.71	1.94	1.33	1.24	1.55	1.57	1.70	1.82	1.64	1.24-1.94	1.15	0.25-2.00	1.28	1.01-1.52	1.62	1.41-1.81	3.01	2.45-3.50	1.47	1.01-1.81
LOI	3.81	3.94	3.79	3.65	3.62	3.83	3.08	3.47	3.58	3.64	3.64	3.08-3.94	4.00	1.45-6.03	4.34	4.25-4.41	3.66	3.51-3.91	4.54	3.75-5.28	3.82	2.87-4.11

1-10 = This Study; **A**= Iseyin Talc- Tremolite- Chlorite Schist (TTCS): Elueze and Awonaiya, (1989); **B**= Baba-Ode Talcose variety (TAL), **C**= Baba-Ode Tremolite Variety (TRE): Okunlola et al. (2002); **D**= Oke-Ila talcose rock: Bolarinwa, (2001); **E**= Erin-Omu talc: Okunlola and Anikulapo, (2006).

Paints Industry:

When pulverized talc is added during the manufacture of paints, it reduces the risk of cracks in the paint film; paper and hard rubber goods. It also acts as inert filler and extender. Payne (1987) and Severingus (1975) specified that the talc should have a good white colour, absence of hard particles, and particle size with at least 97% passing through 325 mesh. In addition, Al_2O_3 should be 2%, MgO + SiO_2 (˜ 75%), LOI (4-8%) and pH range (8-10). The talcose rocks do not meet these specifications

Rubber Industry:

Talc offers greater tear and abrasion resistance and stiffness in the manufacture of rubber. It is also a highly valued dusting agent to lubricate moulds. Severinghus (1975) specified that the talc should be off white colour, have no gritty particles, and low MnO and CaO values. The Ijero talcose samples have combined CaO and MnO of 2.8%. With adequate pulverisation and milling to reduce substantially the grits that may be contributed by the amphiboles, Ijero talc meets the above specifications.

Paper Industry:

Talc is useful as filler and extender in paper manufacture. It also acts as coating pigment that allows for smoother and glossier surface for high quality print paper and magazines. For this purpose, Noble (1988) specified that the talc must be white, fine-grained, mica- free, very low Fe_2O_3, and CaO (<5%). The Ijero talc body does not meet these specifications for this purpose as it contains appreciably higher Fe_2O_3 (ca. 7.11%).

Refractory Materials

When talc is added to high-alumina clay and fired to 1250°C-1400°C, it produces a low thermal expansion, high thermal shock resistance and good electrical properties. They are, therefore useful for the production of electrical coils, water boiler insulators, fire barns and burners. For this purpose, American Society for Testing and Materials (1973) specified that the talc should have a low Fired Shrinkage Value, CaO < 1%, Fe_2O_3 < 1.5%, SiO_2 < 6%, MgO < 30%, (Na_2O+K_2O) < 0.4% and L.O.I < 6%. The chemistry of Ijero talcose rock does not meet the narrow limits of the specifications for this purpose as the CaO (ca. 2.61%), and Fe_2O_3 (ca. 7.11%) contents are too high.

Plastics

Talc improves the rigidity and stability of rubber at high temperature during the manufacture of polypropylene plastics. To be desirable, properties of the talc according to Noble (1988), should include low specific gravity, finer particle size distribution, softness and good colour. The Ijero talc body does not fully meet this specification, due to the fibrous amphiboles content, except by intensive milling.

Pharmaceuticals, Cosmetic and Food Industry

Talc is useful in pharmaceuticals, cosmetics and food processing, specifically, in the manufacture of cream, powder and for odour absorption in soap production. It is also useful as dusting agent for tablets, and for dressing wounds, likewise, it is widely used as dusting agent for foods, food colour absorbent, and polishing agent . For this specialized applications, the American Association for Testing and Materials (1988) recommended that the talc must be odourless, grit free and pure (talc, 90%), white colour, a Loss on Ignition of 5%, pH 8-10 and CaO content 1.6%. The Ijero talcose rock, based on its low talc content (ca. 38.7%), and higher contents of heavy metals like Co and Ni does not meet the industrial specification for use in pharmaceutical industry.

Textiles:

Textile manufacturing requires finely ground talc for loading. For this industrial application, the talc

should be free from hard and gritty impurities such as calcite and quartz. It should have good colour, smooth, greasy feel and moisture content should be less than 0.3%. The samples contain no calcite and quartz but the presence of amphiboles means the talcose samples have to be properly milled before it can meet the above industrial specifications. Also, the moisture content (ca. 2.72%) is higher than the expected 0.3%, but this limitation is ameliorable by oven drying at 105° C for some hours.

CONCLUSIONS

Petrographic and X-ray diffraction studies show that the Ijero talcose rocks contain in addition to talc, variable amounts of tremolite, chlorite and actinolite. Anthophyllite is also present in minor amounts. Assessment of the industrial potential of the talcose bodies based on chemical characteristics shows that the total SiO_2 and MgO contents are generally greater than 80%. The loss on Ignition value is less than 5%. It is therefore less likely that dehydration could induce warping that could lead to shrinkage and eventual cracking.. The overall assessment indicate that Ijero talcose rock could be economically viable, if adequately milled, as raw materials for textile, low grade ceramics and plastic industries, but may not be suitable as raw materials in the pharmaceutical, food and cosmetic, high grade ceramics, paints, and refractory industries. It is recommended that detailed exploratory drilling be carried out as a follow-up investigation in order to estimate recoverable tonnage.

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