GLOBAL JOURNAL OF GEOLOGICAL SCIENCES VOL. 2, NO. 2, 2004: 255 - 264
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PRELIMINARY INVESTIGATION ON INDUSTRIAL PROPERTIES OF THE OLODE-FALANSA PEGMATITE, SOUTHWESTERN NIGERIA.

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(Received 19 August, 2003; Revision Accepted 18 May, 2004)

ABSTRACT

In Olode-Falansa area, which is part of the southwestern basement complex of Nigeria near Ibadan, the major rock types are granite gneiss, quartzite, medium-grained granite and pegmatite. In particular, the pegmatites which occur as low-lying bodies, with a mineralogy dominated by pinkish-white microcline perthite, quartz, muscovite and plagioclase plus accessory constituents of garnet, beryl and tourmaline have been investigated for their distribution, physical, chemical and mineralogical characteristics in order to evaluate their industrial qualities.

Chemical analysis shows variations in the major elements contents of the main minerals. In particular, quartz samples have 94.02 to 97.30% SiO_2; 0.86 to 2.60% Al_2O_3; 0.05 to 1.02% K_2O; and 0.13 to 1.29% Fe_2O_3, while the feldspar samples are 61.37 to 67.83% SiO_2; 16.85 to 18.40% Al_2O_3; 11.35 to 14.32% K_2O and 0.04 to 0.11% Fe_2O_3 respectively. The total alkalis (Na_2O+K_2O) indicate K-feldspar composition. The specific gravity for quartz ranges from 2.60 – 2.63, while that of feldspar is from 2.55 –2.58. Water absorption capacity is higher for quartz (25.10 – 27.10%) than feldspar (4.61 – 5.80%). Compressive strength of selected pegmatite minerals indicates values from 133.24 to 223.84MN/m^2.

This investigation shows that the pegmatites have good potential for industrial uses. They can be used directly as raw materials or after beneficiation. In particular, the quartz and feldspars can find application in the refractory, glass, ceramic and abrasive industries. They can also be found useful in minor construction works especially in homes and offices. Muscovite can be used as thermal and electrical insulators, while the beryl can be useful as ornaments. The associated rocks such as gneisses, quartzites and granites can be useful in interior and exterior decorations as well as in tiles manufacturing.

KEYWORDS: Olode Pegmatite, K-feldspar, Quartz, Raw Materials

INTRODUCTION

The extent and sophistication of industrial rock and mineral mining and quarrying usually depends on the degree of industrial development of a nation. In U.S.A., where there is major extraction of metal ores and energy sources as well as industrial rocks and minerals, the volume of production of the latter category far exceeds that of the others because of the importance of construction. In Western Europe, and especially Britain, industrial rocks and minerals are also a major extractive industry (Scott, 1984).

The current trends in industrial development support the necessity for concerted investigation of mineral occurrences in Nigeria, particularly the non-metallic raw materials (Elueze and Dosumu, 1987). These include pegmatites, which are widely distributed throughout the Basement Complex of Nigeria, forming a SSW-NNW, trending from Ibadan through Iregun, Ijero, Egbe, to the Wamba district, and terminates at Jemma (Jacobson and Webb, 1946). Okunlola and Ogedengbe, (2003), in highlighting the investment potential of gemstone occurrences in southwestern Nigeria, described the pegmatite as the most important rock as far as mineralisation is concerned and serve as the main host rock for precious and semi precious minerals.

Matheis et al. (1982) carried out trace element distribution in the tin-bearing pegmatites of the southwestern Nigeria to determine the extent of mineralisation pattern. They concluded that Sn, Nb, Ta, enrichment increases northeastward along the metallogenic belt. Other workers on pegmatites in southwestern Nigeria include: Kayode, (1971); Matheis and Cean-Vachette, (1983); Emofurieta, (1984); Emofurieta et al. (1988).

The incentive to carry out this investigation is drawn from the fact that the Ibadan pegmatites around Olode - Falansa area have not been studied in detail. From unpublished works, the pegmatites are known to be extensive and host a variety of economic minerals such as gemstones, mica, feldspar, lepidolites, and quartz among others. As in most developing countries, these deposits are commonly quarried indiscriminately by illegal miners sourcing for gemstones and provision of construction materials, and this is without adequate awareness and precaution for conservation and environmental protection. Okunlola and Ogedengbe (2003) reported that in the Olode area, approximately 3,000kg of aquamarine of different grades were mined between 1991 and 2000, though the top-most grade control accounted for only about 125kg.

This study examines the field relationships and the petrographic characteristic of the pegmatites and associated rocks. It further highlights the industrial prospects based on physical, chemical and mineralogical attributes in order to provide a database for preliminary evaluation of their economic potential.

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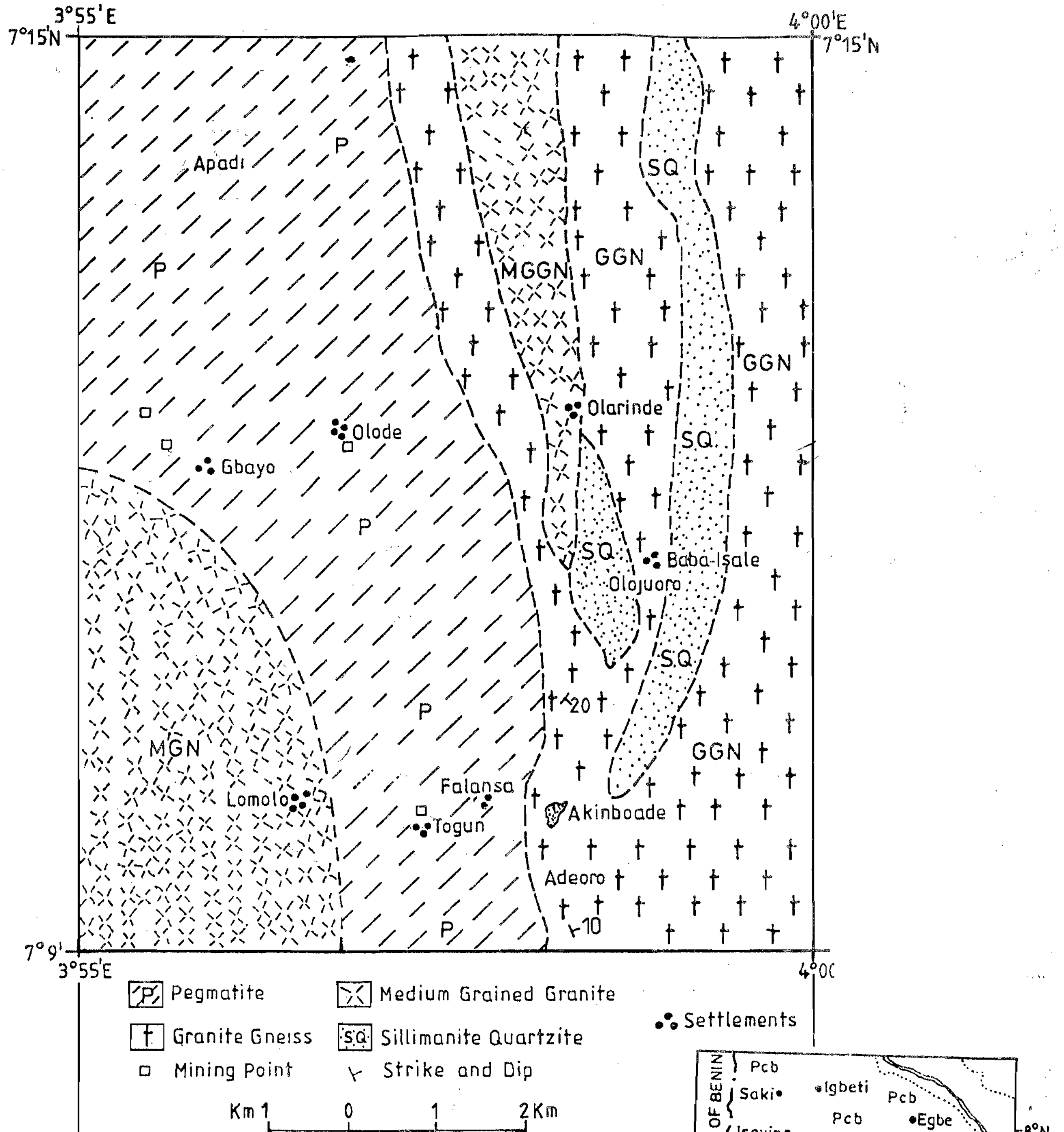

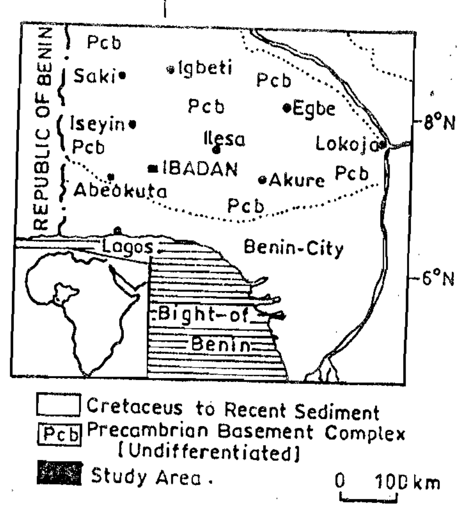

1. Geological map of study area. Inset is location of Ibadan, southwestern Nigeria (Modified from Okunlola et al. 1998)

LOCATION OF STUDY AREA AND GEOLOGIC SETTING

The study area is located in parts of Ibadan, which lies within the southwestern basement complex of Nigeria. It is between the grid reference Latitudes 7°9'N and 7°15'N and Longitudes 3°55'E and 4°00'E (Fig. 1). It covers an area of about 105m^{2}and includes the following settlements: Olode, Olojuoro, Akinbode and Gbayo among others (Fig.1). The geology of the southwestern Basement Complex of Nigeria has been documented in literature (Jones and Hockey, 1964; Odeyemi, 1976; Rahaman, 1976, Elueze, 1982).

The major rock types encountered in the area include granite gneiss, sillimanite quartzite, medium grained granite and pegmatite. The granite gneiss occupies the eastern half of the area, striking north-south. It is weathered in most parts with alternating bands of felsic and mafic minerals. Texturally, they are medium to coarse grained.

Sillimanite quartzite constitutes a small hill to the east and west of Olojuoro (Fig.1). This rock is generally dissected and the contact with the granite gneiss is gradational. In the field, two sillimanite quartzite ridges can be distinguished based on mineralogy. The ridge to the west of Olojuoro is rich in sillimanite and poor in quartz, while the one to the east is quartz-rich and sillimanite-poor.

Medium grained granites occur in the southwestern and north central portions of the study area (Fig.1). They are generally low-lying with felsic and mafic minerals without foliation or preferred orientation of mineral alignment.

The pegmatites are complex in composition and occur as low-lying bodies from the northwestern part, through the central, to the southern part (Fig.1). They are intrusive bodies associated with medium grained granites and granite gneisses. Various sizes of the pegmatites ranging in length from few metres to more than 70m are found around Gbayo. The width ranges from a few centimetres up to about 30m or more. Generally the pegmatite bodies trend NE-SW with majority occurring as dykes. Presently, the muscovite associated with the pegmatites is being mined at Gbayo. In hand specimen, the mineralogy is dominated by pinkish-white microcline perthite, quartz, muscovite and plagioclase, while tourmaline, garnet, beryl, occur in accessory amounts. Quartz veins are not prominent in the area but a few cross-cut the trend in a NW-SE.

MATERIALS AND METHODS

About 30 representative samples, weighing 1kg each were collected from outcrops, abandoned mining sites and functioning mining sites where blasting has just commenced. Preliminary studies entailed hand specimen description while subsequent studies include physical tests such as compressive strength, water absorption capacity and specific gravity. Thin section petrography and major element determination have been undertaken to relate the mineralogy with the geochemistry

Physical Analysis

Hand specimen observations were conducted to examine the colour, mineralogy and texture. Thin section petrography was carried out on rocks and minerals. The samples were cut and mounted on slides with araldite and canada balsam and examined under the flat stage of a petrographic microscope. Photomicrographs of features of interest were taken.

Compressive strength tests were carried out on selected feldspar samples from Olode, Gbayo and Falansa areas with a load testing machine model Ele. The machine is calibrated from 0 to 2,000 KN. The surface areas of the samples were estimated before the test. The value of the stress at which the samples break is given as the compressive strength. These values are shown in Table1.

The water absorption capacity is the weight difference expressed as the percentage between a fired pellet at 1100°C and the same immersed in water for 24 hours. In this study, quartz and feldspars from the different locations were analysed for their water absorption capacity. These values are shown in Table 2 and detailed methodology is documented in Itiola (1998).

The specific gravity was determined using a pyconometer (specific gravity bottle). Powdered samples (ground to –100 mesh) were used for this study. The

Table 1: Compressive strength of selected pegmatite minerals

Sample No		Compressive strength (MN/m^2)
1	30KN/45 cm^2 = 30,940.15lb/ in^2	213.18
2	28KN/45 cm^2 =28,878.38lb/in^2	198.97
3	20KN/48 cm^2 =19,338.73lb/in^2	133.24
4	24KN/40 cm^2 = 27,845.22lb/in^2	191.85
5	28KN/40cm^2 = 32,487.61lb/in^2	223.84
6	26KN/48cm^2 = 25,137.16lb/in^2	173.20

Note: 1 psi = 6.89 x 10^{-3} MN/m^2

1. Microcline feldspar, Olode pegmatite
2. Plagioclase feldspar, Olode pegmatite
3. Plagioclase feldspar, Gbayo pegmatite
4. Perthite feldspar, Gbayo pegmatite
5. Microcline feldspar, Falansa pegmatite
6. Plagioclase feldspar, Falansa pegmatite

Table 2: Water absorption capacity and specific gravity for quartz and feldspar in study area.

Sample No.	Mineral type and location	Water absorption (%)	Specific gravity
1	Feldspar, Olode	5.80	*2.58(2.55-2.61)
2	Quartz, Olode	26.40	*2.63(2.60-2.66)
3	Feldspar, Gbayo	4.61	*2.55(2.49-2.61)
4	Quartz, Gbayo	27.10	*2.60(2.54-2.66)
5	Feldspar, Falansa	4.90	*2.56(2.54-2.58)
6	Quartz, Falansa	25.10	*2.61(2.59-2.63)

* Average specific gravity value

mass of the empty specific gravity bottle (xgm) was determined using a metler balance, model P1210. The bottle was then partly filled with the powdered sample and the mass of both bottle and sample determined as ygm. The bottle with the sample was then filled with water and the mass was determined as z gm. The content of the bottle was emptied, washed and filled with water only. The mass (both bottle and water) was taken as m gm. The specific gravity then is expressed as SG = {y-z/ (y-m)-(x-z)}. Values obtained are shown in Table 2

Chemical Analysis

About 10 samples made up of feldspar, quartz and muscovite selected from Olode, Gbayo and Falansa were analysed for the major elements. Two analytical techniques were employed i.e. the NIS/NIR Spectrophotometer and Atomic Absorption Spectrophotometer (AAS).

Spectrophotometer model PU8670 VIS/NIR was used to determine Al_2O_3, Fe_2O_3, and CaO. In this case, 0.5g of each pulverised sample was weighed into a clean empty crucible and 7.5g of NaOH pellet was added. These were fused on a burnsen burner to obtain a mobile melt. The crucible was then rapidly cooled in cold water. As the soon as the melt solidified, it was transferred into a polypropylene beaker where boiling water was added. The content of the beaker was poured into a 500ml volumetric flask containing 40ml of 5.5N HCl. An additional 20ml of 5.5N HCl was added into the crucible to dissolve any residue on the wall of the crucible and emptied into the flask. The flask was then cooled to room temperature for about 10 minutes and made to mark and mixed. The solution from the sample preparation was analysed for SiO_2, Al_2O_3, Fe_2O_3, and CaO. The analysis was conducted at the Geochemical Laboratory, West African Portland Cement Plc, Shagamu

An Atomic Absorption Spectrophotometer model Pye Unicam Sp 2000 was used to determine TiO_2, MgO, Na_2O, K_2O and P_2O_5. 0.5gm of part of the pulverised sample was weighed into Teflon beaker. The samples were then moistened with little distilled water and 5ml of hydrofluoric acid (HF) was added, followed by 5ml of 3.2 $HNO_3/HClO_4$. The mixture was then placed on hot plate in a fume cupboard and evaporated to dryness. The residue for each sample was then leached with 10ml of 6N HCl into a test tube. The solution was made up to 20ml with distilled water and the elements were determined in the Atomic Absorption Spectrophotometer. The values of SiO_2 were obtained by subtraction from the analyses of all the major elements. The Atomic Absorption Spectrophotometry was conducted at the Centre for Energy Research and Development, Obafemi Awolowo University, Ile-Ife The results of the elemental oxides are shown in Table 3. Details of all analytical procedures are documented in Itiola (1998).

RESULTS

In hand specimen, the samples are generally phaneritic in texture and leucocratic in colour. Mica and accessory minerals of tourmaline, garnet, and beryl are present. There are also samples of pure feldspar (microcline and perthite), quartz and beryl. The feldspars show colours varying from creamy white to pink. They occur as pure microcline and perthite with some having muscovite flakes. In thin section, the feldspars exhibit both cross-hatched and polysynthetic twinning (Fig. 2). These indicate that the feldspars are mainly microcline. The pegmatites have coarse-grained texture showing graphic intergrowth of feldspar and quartz (Fig. 3)

Quartz varies in colour from white, through milky white to light pink. Some varieties occur as pure quartz, while others are in association with accessory minerals such as tourmaline and muscovite. A lot occur as intergrowth with feldspar. In thin section, quartz occurs

Fig. 2: Photomicrograph in crossed nicols of cross-hatched twining in feldspar x40 Q = Quartz; P = Plagioclase feldspar

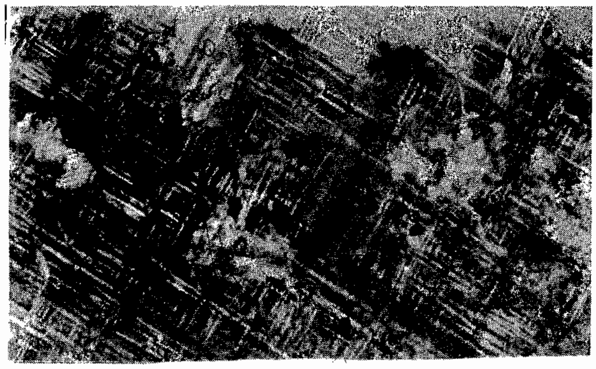

Fig. 3: Photomicrograph in crossed nicols of graphic intergrowth of feldspar and quartz x40

as euhedral and anhedral crystals in groundmass of feldspar.

Muscovite ranges from colourless to yellowish green in hand specimen. In thin sections, it occurs as elongated specks with other subhedral quartz crystals. The tourmalines are either black or green in colour while the beryl occurs as hexagonal crystals and range in colour from blue to tinted green; some of which are of gem quality. They occur as accessory minerals.

The specific gravity data for quartz and feldspar from the study area are shown in Table 2. It can be observed that the feldspars from Olode, Gbayo, and Falansa have average values 2.58, 2.55,and 2.56 respectively while quartz have correspondingly; 2.63, 2.60 and 2.61. Read (1970) has given a range of 2.5 – 3.00 for the specific gravity of feldspar while quartz has 2.65. In this study, the average specific gravity values of the feldspars and quartz are within the standard ranges for these minerals as reported by Read (1970).

The specific gravity shows how dense a substance is and constitutes an important physical property of any industrial mineral. Also, there is a direct relationship between the strength of a rock and its density. The denser a rock, the higher its mineral compressive strength. Factors such as chemical composition, depth of crystallization, porosity, texture, as well as mineralisation affect rock density. However, in minerals, the specific gravity depends on the atomic weight of the elements and the arrangement of atoms in the crystal structure.

The result of water absorption capacity is (W. A. C.) also shown in Table 2. From the study, quartz has higher values with a range from 25.10 - 27.10% while feldspars are between 4.61 and 5.80%. For the different locations, W. A. C. values for quartz are 25.10%, 26.40% and 27.10 % respectively for Falansa, Gbayo and Olode. The higher values for quartz suggest higher temperature of vitrification while relatively less is needed by feldspar to attain it. The water absorption also signifies that porosity is dependent on grain size, shape and packing. Generally, the tendency to attain fusion is enhanced by fineness in grain size. However, the high water absorption capacity of the quartz reflects the quantity of pore spaces between the grains.

Results of the compressive strength of selected pegmatite minerals are shown in Table 1. The compressive strength capacity of the Olode feldspar shows values between 198.97 and 213.18MN/m^2, with average value of 206.08 MN/m^2 while that of Falansa and Gbayo range respectively from 173.20 to 223.84NM/m^2 and 133.24 to 191.85MN/m^2. These imply average values of 198.10MN/m^2 and 162.43MN/m^2 respectively for Falansa and Gbayo. From the result in Table 2, it can be seen that there is a slight correlation between the specific gravity (S.G.) and the compressive strength of a mineral or rock. It can be observed that the S.G. of the feldspar is highest at Olode with a value of 2.58. At Falansa and Gbayo the values show slight decrease of 2.56 and 2.55 respectively. Quartz follows a similar trend with average S.G. values of 2.63, 2.61 and 2.60 respectively for Olode, Falansa and Gbayo. Though the compressive strength of quartz was not determined for this study, it can be inferred that near similar trends may uphold.

Krynine and Judd (1957) presented the compressive strength for some rock types as shown in Table 4. It is necessary to highlight that reported works abound in the literature on determination of geotechnical property such as compressive strength on soils (Adeyemi et al., 2003) and rock aggregates (Elueze and Okunlola, 2003a). However as rocks are aggregate of minerals, it can be established from this study that the compressive strength of feldspar (Table 1), is comparable to the range 172.25 to 275.60MN/m^2 as the majority; having related rock types such as fine-grained granites, diorites, basalt, compact well-cemented sandstones, limestone and quartzite. The Gbayo pegmatite can be accommodated in the 68.90 to 172.25MN/m^2 range with associated rock types such as sandstones, limestones, medium and coarse-grained granites and gneisses (Krynine and Judd, 1957; Table 4).

Results of elemental oxides from the different locations are shown in Table 3. It can be observed that the same minerals from different locations show little or no variations in their elemental abundances. Within the feldspars, SiO_2 ranges from 61.37 to 67.83 %. Na_2O and K_2O show ranges from 1.95 to 3.30 % and 11.35 to 14.32 % respectively. Al_2O_3 is from 16.85 to 18.40 % while Fe_2O_3, MgO and CaO are very low. In comparison to the works of Carroll et al. (1983, Table 5), the feldspars are typically K-feldspar in composition. The perthite shows relatively higher SiO_2 values ranging from 72.29 to 77.24% when compared to that of pure feldspars (Table 3). The chemical composition of quartz indicates SiO_2 values from 94.02 to 97.30 %, which is

2. Photomicrograph in crossed nicols of cross-hatched twining in feldspar x 40
Q= Quartz; P= plagioclase feldspar

3. Photomicrograph in crossed nicols of graphic intergrowth of feldspar and quartz x40

Table 3: Comparative average major element composition of selected minerals from Olode-Falansa pegmatite with related rocks

Elemental oxides (%)	1	2	3	4	5	6	7	8	9	10	*11	+12
SiO_2	94.02	67.83	58.78	72.92	97.30	61.37	71.29	97.00	64.89	77.24	64.22	63.87
TiO_2	nd	nd	0.30	0.21	0.02	0.04	0.29	0.03	nd	0.10	0.03	-
Al_2O_3	2.60	16.85	25.80	14.91	1.60	18.40	14.49	0.86	17.77	12.30	18.48	18.81
Fe_2O_3	2.29	0.11	1.80	0.07	0.41	0.04	1.42	0.13	0.10	0.04	0.19	0.34
MnO	nd	0.04	nd	0.03	0.01	nd	0.03	Nd	nd	0.02	0.02	-
MgO	0.68	nd	1.10	0.81	0.08	0.95	0.18	0.38	0.95	0.08	0.13	-
CaO	0.20	0.05	0.34	1.40	0.07	.96	1.20	0.26	1.16	0.90	0.34	0.01
Na_2O	0.06	3.30	2.58	3.36	0.36	2.91	3.46	0.34	1.95	2.40	2.22	0.80
K_2O	0.02	11.35	9.29	5.89	0.05	14.32	7.60	0.31	13.16	6.70	14.00	15.53
P_2O_5	nd	nd	nd	0.05	nd	0.30	0.03	Nd	0.20	0.06	-	0.02
Total	99.87	99.53	99.99	99.65	99.90	99.29	99.99	99.31	100.18	99.84	99.63	99.28

1. Quartz from Gbayo pegmatite
2. Feldspar from Gbayo pegmatite
3. Muscovite from Gbayo pegmatite
4. Perthite from Gbayo pegmatite
5. Quartz from Falansa pegmatite
6. Feldspar from Falansa pegmatite
7. Perthite from Falansa pegmatite
8. Quartz from Olode pegmatite
9. Feldspar from Olode pegmatite
10. Perthite from Olode pegmatite

*11. Chemical composition of alkaline feldspar from Igbetti augen gneiss (Emofurieta, 1984)

+12. Average chemical composition of microcline feldspar from granitic gneiss in Abeokuta area (Elueze & Bolarinwa, 2004)

Table 4: General values of compressive strengths of rocks (Adapted from Krynine and Judd, 1957)

Compressive strength (MN/m^2)	Rock types
>275.60	Some basalts, diabase, some quartzite
172.25-275.60	Fine-grained granites, diorites, basalt, compact well cemented sandstones and limestones, quartzite
68.90-172.25	Average sandstones and limestones, medium and coarse grained granite, gneiss
34.45-68.90	Porous sandstones and limestones,shales
< 34.45	Tuff, chalk, very porous sandstone, siltstone

typical of good quality quartz. It can be the observed that the feldspars from Gbayo, Falansa and Olode can be comparable to the alkaline feldspar from Igbetti augen gneiss (Emofurieta, 1984; Table 3). However, the Falansa feldspar shows a lower SiO_2 (61.37%) content compared to the rest. The Gbayo feldspar is slightly higher in SiO_2 than the alkaline feldspar from Igbetti augen gneiss, but lower in Al_2O_3 and K_2O, while MnO and TiO_2 are undetectable. Again, apart from MgO, MnO and TiO_2, which are not major constituents of microcline feldspar, others also show similarities of the Gbayo, Falansa and Olode feldspars with that of the granitic gneiss in Abeokuta area (Elueze and Bolarinwa, 2004; Table 3).

DISCUSSION

For quartz and feldspar to be used for glass manufacture, ceramics and abrasives, certain minimum specifications have to be satisfied. According to Scott (1984), specifications are not always easily attainable with the raw material. A rock or mineral from one location may not be able to meet the requirements even though the same material at adjacent site is currently used. Specification can relate to any one or a combination of chemical, physical and mechanical properties.

For glass manufacture, the specification should guarantee a certain minimal purity of raw materials and

Table 5: Chemical specification of principal feldspathic materials (Carrol et al. 1983)

Oxides	Potash Flotation Feldspar (%)	Soda Flotation Feldspar (%)
SiO_2	67.04	67.54
Al_2O_3	18.02	19.25
Fe_2O_3	0.04	0.06
CaO	0.38	1.94
MgO	Trace	Trace
K_2O	12.10	4.05
Na_2O	2.12	6.96

provide limits on critical oxides. Iron oxide is perhaps the most critical chemical component for glass making (Mills, 1983). The removal and control of iron are accompanied through processes such as washing, flotation, magnetic or electrostatic separation, screening, acid leaching etc. Iron control is important because of its effect on glass colour, particularly white or flint glass and in some cases against rust.

Typical chemical specifications of some major glass-making raw materials are shown in Table 6. SiO_2 is an ideal glass-making material and the main raw materials include silica, quartz veins (crushed) and quartz sand. In this study, the SiO_2 content of the quartz is from 94.02 to 97.30 % with Falansa having the highest value. In addition, Fe_2O_3 content of the quartz ranges from 0.13 to 1.29. By comparison of Tables 3 with 6, it can be observed that the SiO_2 and Fe_2O_3 contents of the quartz are close to the requirement for the yellow sand. In addition, Ajayi and Olade (1982) have provided the following specifications for silica refractoriness: SiO_2 > 95%, Al_2O_3 (<1.5%), TiO_2 (<2.5%), Fe_2O_3 (<2.5%) and CaO (<4%). In this study, the quartz from Falansa and Olode pegmatites, and with beneficiation, that of Gbayo, can be used in refractories.

Feldspar (also feldspathic sand) is used in the manufacture of glass as a source of alumina and alkali (Na_2O and K_2O). From the values obtained for feldspar in Table 3, and by comparison with Tables 5 and 6, the Al_2O_3 values are close to the standard as seen from values of 16.85 %, 18.40 % and 17.77 % recorded at Gbayo, Falansa, and Olode respectively.

The total alkalis (Na_2O and K_2O) for the feldspars are 14.65%, 15.11% and 17.23% for Gbayo, Olode and Falansa respectively (Table 3). These values are slightly above the 11% required as threshold for alkalis in feldspars to be suitable for glass manufacture (Table 6). Fe_2O_3 have corresponding values 0.11%, 0.04% and 0.10 for Gbayo, Falansa and Olode respectively, and satisfy the 0.10% threshold for suitability in glass manufacturing. Equally, Al_2O_3 in the feldspar is close to 19% as reported by Mills (1983) for glass making (Table 6).

According to Mills (1983), the raw materials for the manufacture of glass come primarily from mined minerals and rocks that are selected for their purity and stable composition, or those that may be beneficiated to suitable product. Consequently, the quartz and feldspar from the study area fall within or almost within the specification for glass manufacture. It is known that for the use of any of these minerals in ceramics, as abrasives; the degree of purity could be upgraded by beneficiation.

For abrasives, more importance is attached to the physical rather than their chemical properties. According to Hight (1983), any deposit of massive white quartz is suitable for use as abrasives. The muscovite has chemical composition close to the specification suitable for use as thermal and electrical insulators. The most important in such material is the Al_2O_3 content which has to be high. Here, 25.80% (Table 3) is fairly high. Also, the Fe_2O_3 content has to be low to prevent rusting or heat absorption. In this study the value of Fe_2O_3 is acceptably low, which is 1.80% (Table 3), and the muscovite meets the requirement for use as insulators and can be beneficiated for other uses.

Okunlola and Ogedengbe, (2003), discussed that the price of gem depends largely on colour, clarity and size. In the Olode area, beryl occurs as well formed crystals scattered within the pegmatite and its mineralisation is associated mostly with albite zones that are sometimes weathered (Okunlola and Ogedengbe, 2003). In the area of study, among the beryl, tourmaline and garnet, it is only the beryl (aquamarine) that can be used for ornamental purposes because of its clarity and cuttable sizes, which enable different, ornament sizes to be cut and shaped. The tourmaline and garnet are rather too small in sizes to be of any use in ornamental

Table 6: Typical chemical working specification on glass raw materials (modified from Mills, 1983)

Sample Name	Chemical Composition
White sand	SiO_2 Over 90% ; Fe_2O_3:0.03% max; Cr_2O_3: 0.0003% max.
Yellow sand	SiO_2 : Over 98.5; Fe_2O_3 : 0.25% max.; Cr_2O_3: 0.005 % max.
Feldspar	Al_2O_3 : Over 19%; Alkalis : Over 11%; Fe_2O_3 : 0.10 % max.

purposes or as abrasives.

Elueze (1994) highlighted that the demand for embellishing and aesthetic rock products is considerably high in the country and prospects for exploration are bright. Again, Elueze (1995) demonstrated, based on the physical parameters and characteristics of polished slabs, that gneisses and migmatites, quartzites and granites, which occur within the Nigerian basement complex, can be used for interior and exterior decorations as well as tiles. According to Elueze and Okunlola (2003b), market potential for unfinished rock blocks are favourable, especially in countries where greater emphasis is placed on environmental protection and regulation. In this study, aside from the pegmatites and their associated minerals, other rocks, such as quartzites, granites and gneisses, can be put to similar uses, either as finished or unfinished rock blocks for exportation.

CONCLUSIONS

The results of this investigation show that the Olode-Falansa pegmatites are economically viable and have good potential for industrial uses where they can be applied either as raw materials or after beneficiation. The quartz and feldspars can find application in the refractory, glass, ceramic and abrasive industries. They can also be found useful in minor construction works especially in homes and offices.

The muscovite can be used as insulators. The beryl can be used in ornament-making industry or can be exported to gem-sourcing organization. Generally, for the quartz, feldspars and muscovite to be used in various fields, they would in some cases require appropriate treatment processes to attain the desired qualities.

ACKNOWLEDGEMENTS

The authors are grateful to the staff of the Geochemical Laboratory, West African Portland Cement Plc, Shagamu and the Centre For Energy Research, Obafemi University Ile-Ife for assistance in sample analysis. The two anonymous reviewers are acknowledged for their useful criticisms.

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