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ARTICLE

Petrology and Geochemical Features of Crystalline Rocks in Ora-Ekiti, Southwestern Nigeria

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ABSTRACT

This research investigates and reports on the petrology and geochemical characteristics of crystalline basement rocks in Ora-Ekiti, Southwestern Nigeria. Exhaustive geological investigation reveals migmatite, banded gneiss, granite gneiss and biotite gneiss underlie the area. In reducing order of abundance, petrographic examination reveals that migmatite contains quartz, muscovite and opaque minerals. Banded geniuses contain quartz, biotite, plagioclase, and opaque minerals. Granite geniuses contain quartz, plagioclase, biotite, microcline and opaque; while biotite geniuses contain biotite, plagioclase, opaque minerals, and quartz. Silica contents in migmatite (69.50%-72.66%; ca. 71.23%), banded gneiss (71.66%-77.1%; ca. 75.23%), biotite gneiss (72.32%-76.18%; ca. 73.83%) and granite gneiss (69.82%-73.15%; ca. 71.95%) indicate the rocks are siliceous. High alumina contents in migmatite (12.18%), banded gneiss (10.28%), biotite gneiss (11.46%) and granite gneiss (9.97%) are comparable to similar rocks in the basement complex. All the rocks show Ba, Sr and Rb enrichment. Harker diagrams of Al_2O_3 versus SiO_2 and CaO versus SiO_2 show negative trends while Na_2O versus SiO_2, K_2O versus SiO_2 and TiO_2 versus SiO_2 plots showed positive trends. This variation probably depicts extensive crystal fractionation in the magmatic systems that produced the rocks prior to metamorphism or partial melting of the precursor rock. SiO_2 versus (Na_2O + K_2O) classifies the rocks as granite to granodiorite. The rocks are high K-calc-alkaline and calc-alkalic on SiO_2-K_2O plot. This shows the rocks are potassic meaning that they are formed from a potassium-rich source. The plot of Al_2O_3/(Na_2O + K_2O) versus Al_2O_3/(CaO +Na_2O + K_2O) reveals the crystalline rocks are orogenic and originated from granitoid with meta luminous affinity. The rocks consist of gneisses of no economic minerals, but the petrology reveals them as common rocks typical of metamorphic terrains and geochemical features of the rocks reveal they are felsic and of granitic composition.

Keywords: Ora-Ekiti; Crystalline basement rocks; Petrology; Metaluminous affinity

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1. Introduction

The study area lies within the basement complex of southwestern Nigeria (**Figure 1**) and its regional geology has been described in segments by different authors. Rahaman [1] noted that southwestern Nigeria as part of the extensive basement terrain contains crystalline rocks of heterogeneous lithologies and complex structural features. The segment of this basement that falls within Ekiti State contains the migmatite gneiss complex, the Schist belts, and Pan-African granites. Researchers [2,3] confirmed that on a regional scale, older tectonic imprints associated with the rocks in this domain are grossly overprinted by newer ones. The study area consists of rocks that are typical of Precambrian terrain in Nigeria. The main lithologic units in Ora-Ekiti have been generally categorized as undifferentiated migmatite basements by the Geological Survey of Nigeria [4]. However, in the current study, detailed geological mapping revealed four main lithologies. These are migmatite, banded gneiss, biotite gneiss and granite gneiss (**Figure 2**).

1.1 Migmatite

Migmatite covers the northern part of the study area and extends towards the west underlining most of the newly developing areas of the town along Ido-Ekiti Road. This rock unit has been described as similar to those in and Ado-Ekiti [5]. Migmatite in the study area consists of gneissic (mafic) and granitic (felsic) components (**Figure 3a**). It is a coarse-grained composite rock comprising granitic components (dominantly quartz + feldspar ± muscovite) (leucosome) and gneissic components (biotite + hornblende ± magnetite) which constitute the melanosome. In many parts of Nigeria's basement, migmatite forms the country rock. The structural attribute of Ora-Ekiti migmatite includes strong axial plane foliations and folds which show copious evidence of shearing. Structures such as joints, foliations, lineation, folds, quartz veins, pegmatitic, aplitic and dolerite dykes were also observed on many outcrops. This rock is poorly banded which makes it structurally distinct.

1.2 Banded gneiss

This gneiss is unique for its conspicuous bands which form lenses of varying mineralogical composition. Banded gneiss outcrops in Ora-Ekiti occur as residual hills with elevation which ranges between 535-575 m. A typical example occurs around Eliju where the rock has fine grain texture. Some of these bands (or lenses) contain granular minerals that are bound together in interlocking textures. The most distinct feature of the rock is compositional banding which depends largely on the interlaying of minerals having various colors. Dark and light bands alternate due to the segregation of mafic and felsic minerals (**Figure 3b**). Banding also arises from sorting differing grain sizes of the same minerals. Sometimes, the bands are distributed into beadlike structures resembling pinch and swell or boudins.

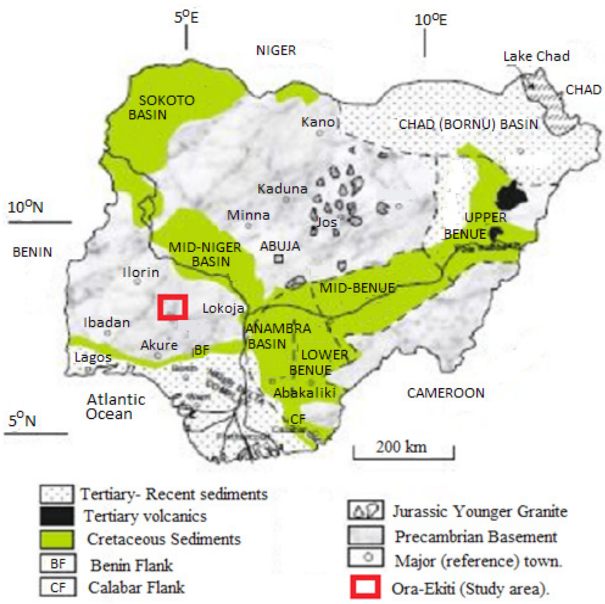

Figure 1. Geological map of Nigeria showing location of the study area within the Precambrian Basement of Southwestern Nigeria (Modified after [6])

1.3 Biotite gneiss

Biotite gneiss in Ora-Ekiti occupies the southern segment of the study area. It is highly foliated with darkish tints imposed by biotite impregnations alongside felsic minerals including quartz and feldspar. Biotite gneiss occupies both sides of Aye-Ora Road. It is medium to coarse-grained foliated with a preponderance of biotite blades and acicular chlorite minerals (**Figure 3c**). The outcrops contain overwhelming evidence of pegmatite dykes and secondary structures like fold, joints, quartz veins, which sometimes crosscut each other in some locations, and exfoliations. Biotite-gneiss in Ora-Ekiti occurs as a rock with low altitude masses.

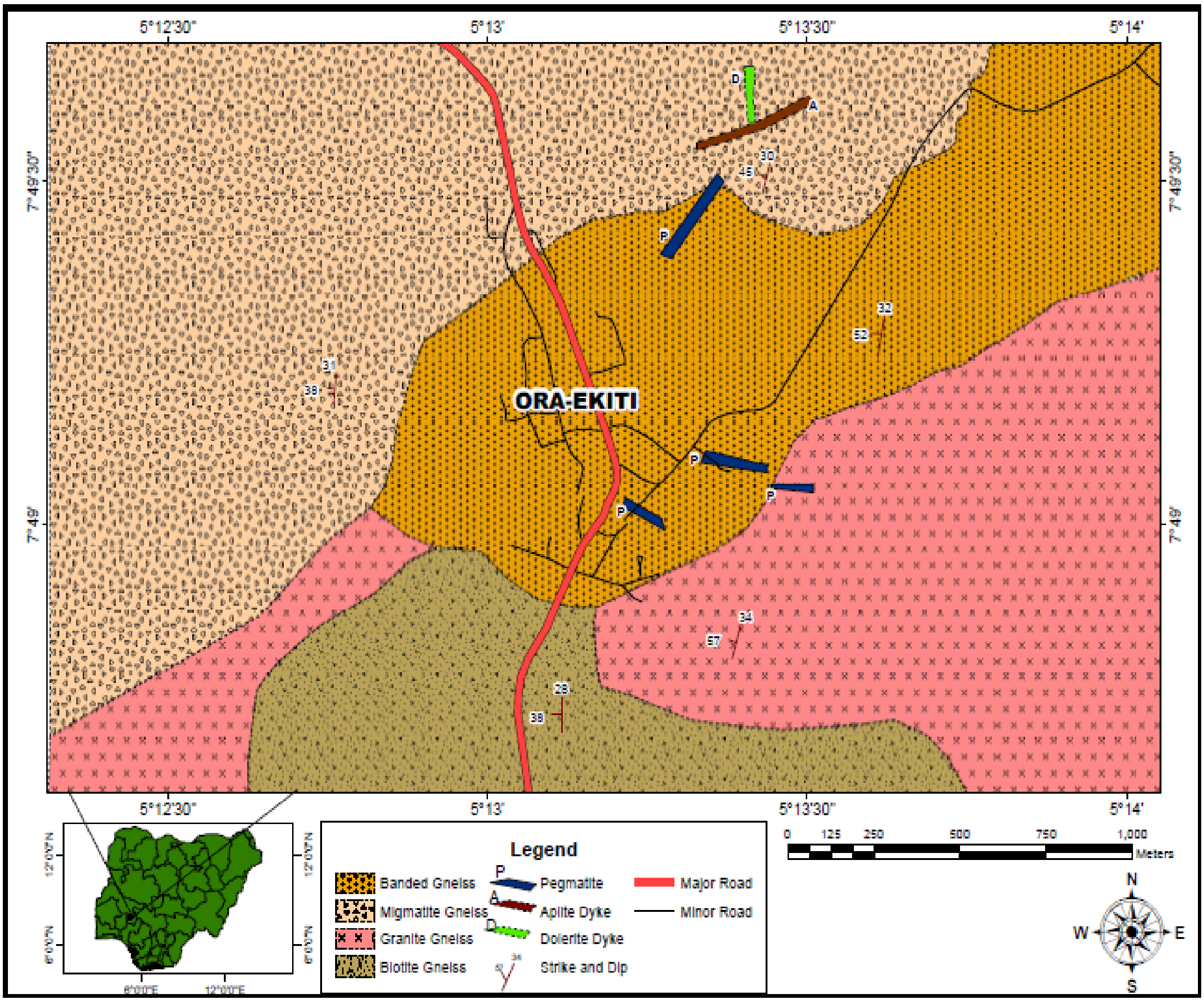

Figure 2. Geological map of Ora-Ekiti.

1.4 Granite gneiss

Granite gneiss in the study area occupies the eastern and southwestern corners of the study area. It is a felsic rock (granitic) that has suffered metamorphism, the rock has changed in mineralogy and texture through the action of intense heat and pressure but still retains its granitic nature. Granitic gneiss has a mineralogical composition similar to that of granite except that it now shows evidence of metamorphic recrystallization such as translational fabrics and decussate textures. Some outcrops exhibit tortuous veins and ptygmatic folds (**Figure 3d**). Granite gneiss in the study area is a coarse-grained rock composed mostly of quartz, alkali feldspar and plagioclase and a few phyllosilicate minerals largely represented by biotite. Granite gneiss outcrops in Ora-Ekiti are extensive but of average height. Typical of this unit is an outcrop behind the King's palace in Ora-Ekiti. The grain size of granite gneiss is finer than the migmatite.

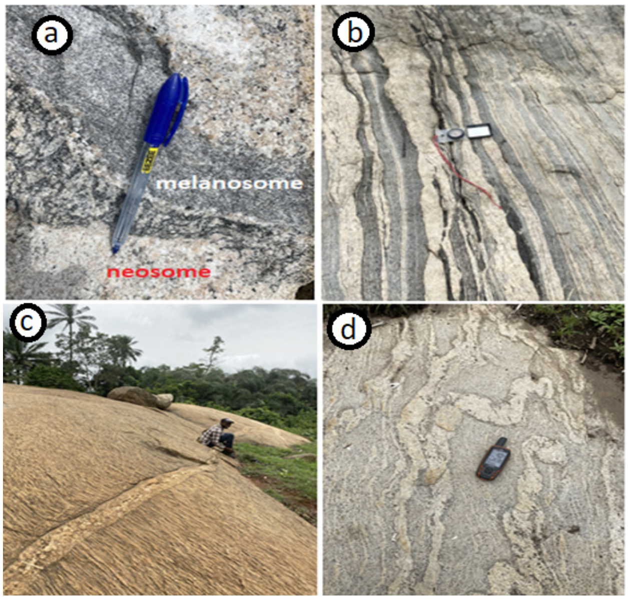

Figure 3. (a) Migmatite from Oke-Iyila area of Ora-Ekiti exhibiting melanosome (dark) and neosome (light) portions. (b) Banded-gneiss from Ora-Ekiti with mineralogical banding. Mafic (ferromagnesian) and light-colored (quartzo-feldspartic) minerals components are parallel to each other (c) Biotite-gneiss outcrop intruded by a pegmatite dyke at Ori Oke-Aanu along Aaye road, Ora-Ekiti, (d) Granite-gneiss from Ora-Ekiti showing quartz veins that are distorted and folded.

2. Geological setting

Ekiti State, which is one of the six states that constitute southwestern Nigeria, is entirely underlain by crystalline rocks of igneous and metamorphic origin. A literature search reveals geological investigation on Ora-Ekiti and the environment is very scanty. However, a few geological investigations have been undertaken around Ado-Ekiti and Ijero-Ekiti which lies 25 km SE and 25 km northwest of Ora-Ekiti respectively. The entire region represents the reactivated domain that resulted from the collision between a passive continental margin of the West African craton and the active Pharusian continental margin [7,8]. The basement has been reworked by cycles of orogeneses resulting in widespread deformation, metamorphism and remobilization during the Liberian (2,700 Ma), the Eburnean (2000 Ma), the Kibarian (1,100 Ma), and Pan-African (600 Ma). The last episode was characterized by widespread deformation, regional metamorphism, migmatisation, granitization and gneissification processes which produce syn-tectonic granites and gneisses [9]. The emplacement of late tectonic granites, granodiorites and dykes represent the final stages of the Pan-African orogeny. The end of the orogenic phase was marked by faulting and fracturing [10,11]. Migmatite is the most extensive unit in the basement of Ekiti State. It is an aggregation of migmatite, nebulitic and stromatolitic migmatite, orthogneisses, paragneiss and other varieties such as augen gneiss and calc-gneiss. The Pan-African tectonic-thermal activities were largely responsible for the recrystallization and reworking of the basement rocks. Migmatite unit belongs to upper amphibolite facies metamorphism and has ages ranging from Archean to Proterozoic in Nigeria [1,8]. The unit constitutes about 75% of the surface area of Ekiti State and about 30% of the total, some of surface area of Nigeria. Migmatite covers a substantial part of the eastern segment of Ekiti State. Quartzite unit occurs towards the western corner of the state covering Effon-Alaye, Okemesi and Ogotun area. In literature, this lithologic unit has been referred to as Effon Psammite [12]. Even though some quartzite units occur around Ado-Ekiti, they are not mappable at the scale of the geologic map.

The schist belts are Proterozoic supra crustal rocks that have been in-folded into the migmatite gneiss-quartzite complex. It contains coarse to fine-grained clastic rocks, pelitic schist, phyllite, banded iron formation, carbonate rocks (marble/dolomite) and meta-igneous rocks (amphibolite). Other authors believed the schist belts are fragments of ocean floor material from small back-arc basins. The Ife-Ilesha schist belt extends into the northwestern corner of Ekiti State (**Figure 4**) covering Ijero, Odo-Owa and Ipoti-Ekiti. Falconer [13], distinguished a group of concordant/semi-concordant deeply rooted granite within the basement complex which he called Older Granite. This granite type is distinct from the high-level, discordant, tin-bearing granites of Northern Nigeria which he referred to as Younger Granite. The Older granites are pre-tectonic, syn-tectonic and post-tectonic rocks that intruded both the migmatite gneiss complex and schist belts. The granite range between 750-450 Ma in age and some authors referred to them as Pan-African granite. The rock unit varies in composition from tonalite to granodiorite to adamellite and true granites, and it represents the magmatic cycle of the Pan-African orogeny. Charnockite forms an important rock group emplaced during this period and is anatectic in origin [14]. The use of the term Pan African Granitoid for the older granites not only on the merit of age and not being available at the time they were named older granites is contended [8], but opined that it should be used because it covers several important petrologic groups formed at the same time. Older granite occurs together with charnockite along a narrow strip around Ikere-Ekiti and Ado Ekiti while a few outcrops dotted Ilupeju and Ayede areas in the north-central part of the state.

3. Materials and methods

The methodological approach adopted includes systematic geologic mapping and sampling of rocks. The method includes fieldwork, sampling, and laboratory procedures.

3.1 Fieldwork and sampling

The fieldwork essentially entails geologic mapping, identification, and description of outcrop exposures. It also involves describing their structural features. A thorough and careful traversing of the study area was done on foot with a hand-held Global Positioning System (GPS) following the major roads, minor roads, and bush paths. Traverses are made to outcrops that are not assessable through these roads. The area is divided into grids, each of which is mapped separately, and grid-controlled sampling was adopted. Useful information about the names of localities where good outcrops were found was made possible by people in the host communities.

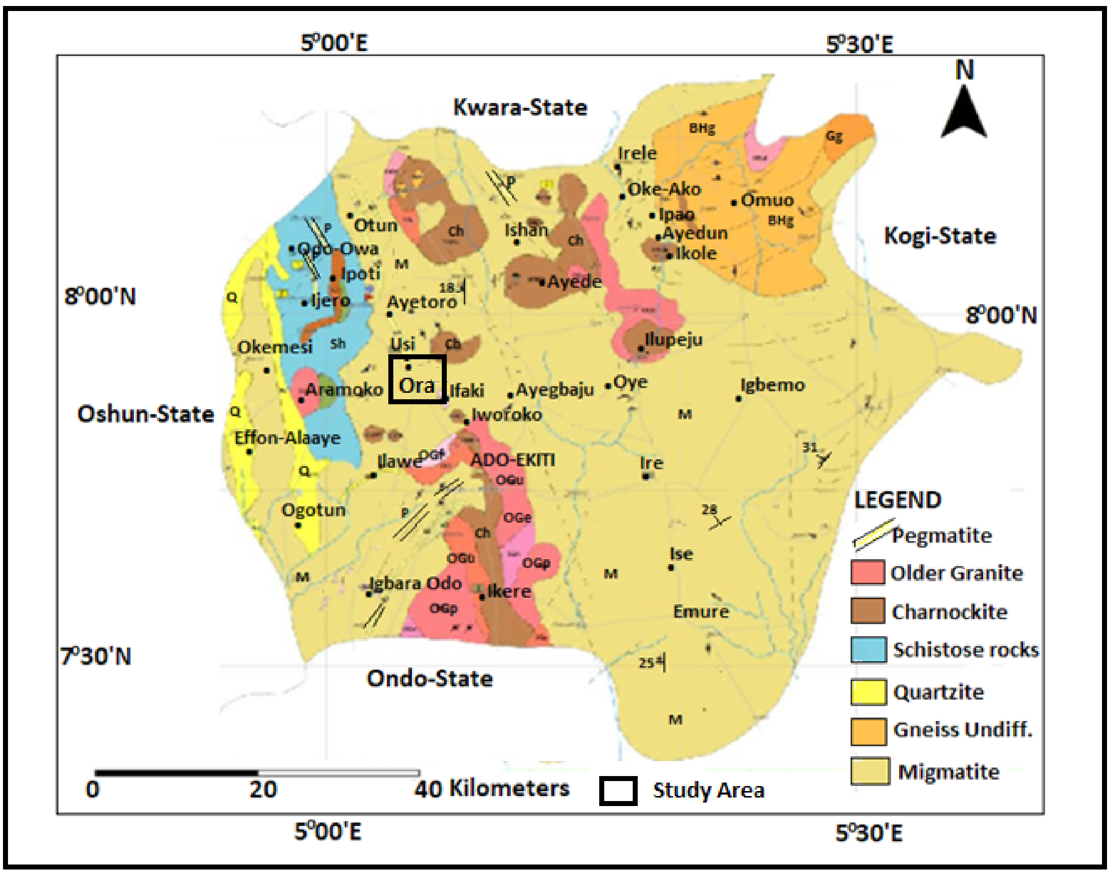

Figure 4. Geological map of Ekiti State and the location of the study area (after NGSA [14]).

In this study, only fresh samples are considered for analysis and are safely put in sample bags. It was observed during the field exercise that the lithological boundaries do not have clear-cut demarcations but grade into each other. Photographs of the rocks *in situ* positions were captured using a (Nikkon Coolpix L80) digital camera. Twenty samples of each of the four rock types were collected during fieldwork. Fresh samples with sizes ranging between 4-5 kg were hewed from rock exposures using a sledgehammer. The rock samples are kept in sample bags and labeled. The points where the samples were obtained in the field were translated into the corresponding positions on the topographic base map. This procedure was repeated at each location, strike and dip values were indicated as appropriate. The sample locations are Oke-Iyila, Olokowu, Oke-IIekan and opposite Ora Community High School among others.

3.2 Laboratory procedures

Samples collected are subjected to laboratory procedures to determine the petrology of the basement rocks, the mineralogical composition and microstructures which help to confirm the rock's name as well as the metamorphic grade are noted. In addition to outcrop examinations, the petrographic study was based on a visual examination of thin sections.

Preparation of thin section

After reducing the samples to the desired size (2 cm × 1 cm × 0.5 cm) using a cutting machine, the smooth surface of the rocks was glued to a glass slide and ground down on the lapping machine. Silicon carbide was put on the lapping glass which was placed on the lapping table with some water and the equipment was activated and observed until the surface becomes very smooth. After lapping, the rock specimen was washed with water and mounted on a thermo plate switched to 120 °C for an hour to remove excess water from the specimen. This baking process is important as it prevents excess bubbles from appearing on the slide. Thereafter, the specimen was removed from the hot plate and allowed to cool down to room temperature. The specimen was later mounted into a prepared glass slide by using araldite and taken to the cutting machine for size reduction. The reduced specimen was taken to the lapping machine via lapping jig for final reduction to the required thickness of 0.5 mm which is the standard thin section thickness. Once the thickness is achieved the specimen is then removed and washed properly to remove excess slurry around it. After washing, the specimen is allowed to dry and then covered with glass slips using Canada balsam and washed with methylated spirit (or acetone) and detergent. The specimen was then rinsed with water and allowed to dry in the air and then labeled accordingly for microscopic analysis.

Petrography

For petrographic investigation, thin sections of the rock samples were prepared. The slides were examined under petrological microscopes.

Analytical procedure

Twelve fresh samples selected from those obtained from outcrop exposures during geological mapping were subjected to analytical procedures. Major elements (SiO_2, $A1_2O_3$, Fe_2O_3, MnO, MgO, CaO, K_2O, Na_2O, P_2O_5, and TiO_2) and trace elements (Nb, V, Cu, Ba, Ni, Rb, Sr and Zr, Mo, Ag, Ta, Pb and Th) analyses were conducted on X-ray Fluorescence equipment (Phillips PW 1404/10) and ICP-MS respectively. The analytical procedures were undertaken at the Bureau Veritas Laboratories, Vancouver, Canada. The accuracy of trace element analyses is within ± 5 parts per million (ppm) and major elements ± 0.5%. (Analytical procedure for the research followed [15]. Analytical results are presented in **Tables 1** and **2**.

4. Results

The results of this research are presented in the order: Petrography and geochemistry.

4.1 Petrography

Migmatite

Petrographic examination reveals Ora-Ekiti migmatite (in reducing order) contains quartz, muscovite, and opaque minerals (**Figure 5a**). Quartz being the most abundant mineral reflects the siliceous nature of Ora-Ekiti migmatite. Quartz grains occur as a discretely clear mineral with a well-defined outline. It is well-distributed within the rock while in some slides it forms clustered aggregate. The preponderance of quartz in the rock may be attributed to remobilization during metamorphic recrystallization or high silica content attributable to late-stage magmatic crystallization in the precursor rock. Under plane-polarized light, muscovite has whitish colour but with a diagnostic bird-view appearance. It forms tabular crystals usually six-sided or is sometimes irregular in outline. Some plates form six-sided prisms elongated parallel to the c-axis. Opaque minerals are mainly iron oxide of irregular shapes.

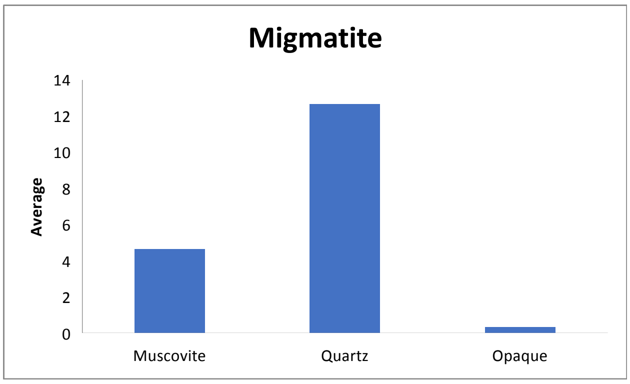

Figure 5a. A chart showing the average composition of the migmatite in the study area.

Banded gneiss

Petrological investigation reveals banded gneiss from the study area in order of reducing abundances contains quartz, biotite, plagioclase feldspar and opaque minerals (**Figure 5b**). That quartz is the most abundant mineral in all the slides is a reflection of the high degree of stability of the mineral and this may indicate that the rock is of acidic antecedent. The mineral quartz is colorless under the plane-polarized light, biotite shows grey to brown coloration with characteristic bird view structure and bladed appearance. Crystals of plagioclase are colorless in plane polarized light exhibiting first order grey color under cross polars.

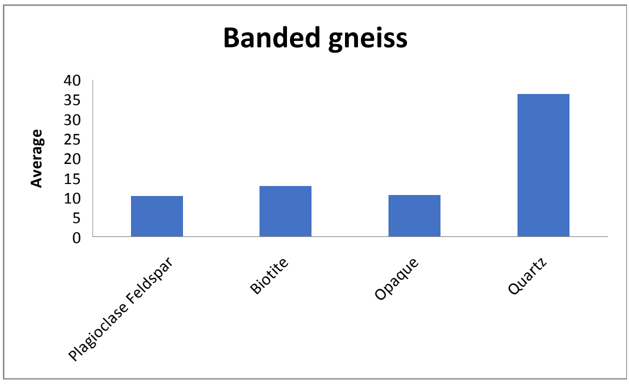

Figure 5b. A chart showing the average composition of banded gneiss in the study area.

Granite gneiss

Optical microscopy reveals Granite gneiss contains quartz, plagioclase feldspar, biotite, opaque minerals and microcline (**Figure 5c**). Quartz is the most abundant mineral in all the slides. Quartz is colorless under the plane-polarized light and subangular. Biotite shows a red to brown color with subhedral to anhedral habit. The crystals of plagioclase are colorless in plane-polarized light with weak birefringence. It can be distinguished from other types of feldspar by its polysynthetic twinning. Opaque minerals occur in subordinate amounts and are mainly magnetite.

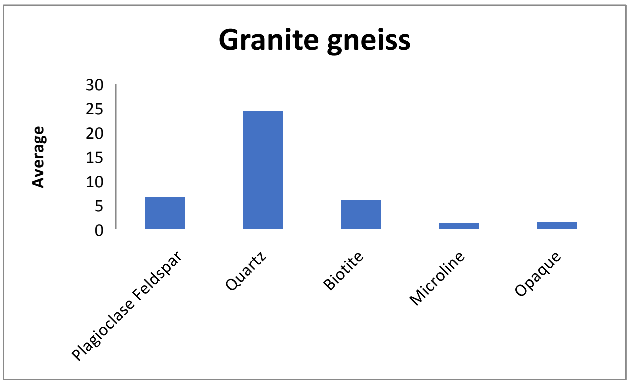

Figure 5c. A chart showing average composition of Granite gneiss.

Biotite gneiss

Biotite gneiss in Ora-Ekiti in the same order, contains biotite, plagioclase feldspar, opaque minerals and quartz (**Figure 5d**). Quartz occurs as clear mineral grains, few are however cloudy and fractured. Quartz is the least abundant mineral; it is made of grains that have no cleavage or plane of weakness. Its presence in all the rocks may be consequent on quartz being one of the most stable minerals in siliceous igneous rocks. Many siliceous rocks when subjected to metamorphic transformation have abundant quartz. Biotite shows grey to brown coloration with subhedral to anhedral habits. The crystals of plagioclase are colorless in plane-polarized light but exhibit first-order grey color under cross polars.

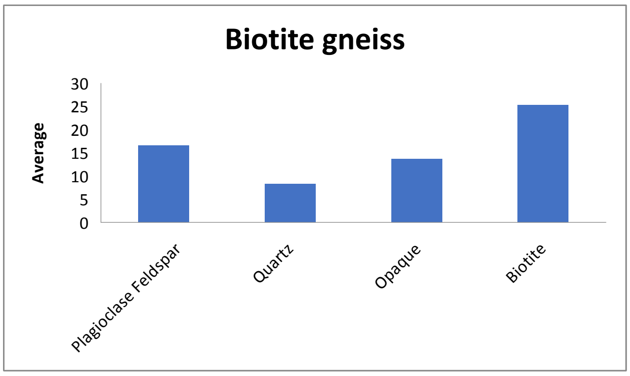

Figure 5d. A chart showing average mineralogical composition of Biotite gneiss in the study area.

4.2 Geochemistry

Results of the major chemical composition of rocks from Ora-Ekiti are presented (**Table 1**). From the analytical results, SiO_2 contents in migmatite range from 69.50%-72.66% with an average of 71.23%. Similarly, SiO_2 contents in banded gneiss (range: 71.66%-77.1%; ca. 75.23%), biotite gneiss (range: 72.32%-76.18%; ca. 73.83%) and granite gneiss (range: 69.82%-73.15%; ca. 71.95%) clearly indicate the crystalline rocks in Ora-Ekiti are siliceous. Average alumina contents in migmatite (12.18%), banded gneiss (10.28%), biotite gneiss (11.46%) and granite gneiss (9.97%) are high. The mean Fe_2O_3 contents in these rocks are 4.86%, 3.56%, 3.55% and 4.08% respectively. Average K_2O and Na_2O contents in migmatite (2.99%, 3.10%), banded gneiss (3.94%, 3.44%), biotite gneiss (4.09%, 3.28%) and granite gneiss (4.46%, 3.46%) falls within acceptable limits for this kind of rocks and makes them similar to granitoid. A number of schemes based on chemical composition have been applied in the classification and determination of the evolutionary trends and geotectonic setting of rocks in Ora-Ekiti. Harker variation plot of major oxides against SiO_2 and its correlation is useful for the prediction of post-magmatic phenomena that may be related to the rock's protolith. Binary plots of Al_2O_3 versus SiO_2 (**Figure 6a**) and, CaO versus SiO_2 (**Figure 6b**) reveal negative trends with increasing SiO_2. However, Na_2O *versus* SiO_2 (**Figure 6c**) and K_2O versus SiO_2 (**Figure 6d**) show positive trends with SiO_2 which indicates an increase in K_2O produces a corresponding increase in SiO_2 contents. Positive trends in K_2O and Na_2O may indicate albitization processes in the protolith prior to metamorphism or metasomatic alteration during metamorphic remobilization. The plot of TiO_2 versus SiO_2 (**Figure 6e**) also demonstrates a positive trend with SiO_2. Harker diagram of MgO versus SiO_2 (**Figure 6f**) reveals a negative trend symbolizing that as the major elements (anions) are taken from silicate melts, their quantities reduce with time. High alumina contents in the rocks might have resulted from a preponderance of aluminosilicates which forms the principal component of most rock-forming minerals like plagioclase, hornblende, and mica. These values are comparable to similar migmatite gneiss rocks in other parts of Nigeria. Substantial amounts of these oxides might have been contributed by ferromagnesian minerals like biotite, and hornblende and opaque minerals like magnetite. This range of value is comparable to those recorded for granitoid; this may equally indicate the rocks probably have granitic antecedents.

However, the positive correlation as indicated on K_2O versus SiO_2 and Na_2O versus SiO_2 (Harker diagrams, **Figure 6c** and **6d**), may imply the crystalline basement rocks may have the same progenitor (source materials) or similar pattern of mobility during metamorphism of the parent rock. The variation may also be indicative of extensive crystal fractionation or partial melting in the magma systems that produced the rocks. This is suggestive that the rocks emanated from the same parent magma. On the SiO_2 versus (Na_2O + K_2O) classification scheme of Middlemost [16] (**Figure 7**), the rocks plots are granitic to granodioritic in composition. The AFM diagram (**Figure 8**, after Irvine and Baragar [17]) classified the rocks of Ora-Ekiti in *Calc-alkaline series*. Further chemical consideration on SiO_2-K_2O diagram (**Figure 9**, after Peccerillo and Taylor [18]), discriminate the rocks into *High-K Calcic-alkali* field.

The plots suggest the rocks are rich in potassium and may equally mean they are formed from potassium-rich rocks that are oxidized. The binary plot of the molecular ratio of alumina to alkalis of Al_2O_3/(Na_2O + K_2O) versus Al_2O_3/(CaO + Na_2O + K_2O) [i.e., A/NK versus A/CNK], of the crystalline rocks from Ora-Ekiti, (**Figure 10**, after Shands [19]) shows the rocks might have originated from a granite having peralkaline chemistry formed during the orogenic activity.

Trace element data (**Table 2**) shows enrichment in Ba, Sr, Rb and Zr while there is depletion in Cu, Nb, V, Ag and Th. With average Ba content of 1238 ppm in migmatite, 2087 ppm in banded gneiss, 2042 ppm in biotite gneiss and 1948 ppm in granite gneiss, these rocks are comparable to similar rocks in the basement complex areas of other parts of Nigeria. The anomalous enrichment in Ba, Sr, Rb and Zr is expected like in granites, and they are mostly concentrated in the upper continental crust of the earth. Low values recorded for Nb, Mo, Ag, Cd, and Pb are related to the geochemical behaviors of the elements as many of them are incompatible with lithophile elements. Hence they are of low concentration in crustal rocks.

Table 1. Analytical result of the basement rocks in Ora-Ekiti.

Oxides	Migmatite			Banded gneiss			Biotite gneiss			Granite gneiss		
	1	2	3	4	5	6	7	8	9	10	11	12
SiO_2	71.53	69.5	72.66	71.66	77.1	76.95	73.00	76.18	72.32	72.9	69.82	73.15
Al_2O_3	11.96	12.94	11.58	11.43	9.65	9.71	12.91	9.24	11.80	10.45	9.51	11.03
CaO	3.32	4.55	3.43	4.05	1.50	1.37	2.29	1.98	3.45	2.24	2.36	2.50
Fe_2O_3	5.09	5.36	4.13	4.45	3.2	3.04	2.66	4.19	3.8	5.42	3.61	3.22
K_2O	3.04	2.65	3.25	2.69	4.55	4.51	5.08	3.8	3.61	4.31	4.46	4.36
Na_2O	3.23	3.10	3.24	3.92	3.19	3.34	3.08	3.55	3.22	3.18	3.24	4.18
MgO	1.08	1.08	0.98	1.13	0.52	0.35	0.46	0.58	1.2	0.45	0.51	0.84
MnO	0.06	0.08	0.06	0.05	0.05	0.04	0.02	0.06	0.05	0.06	0.04	0.05
P_2O_5	0.07	0.07	0.06	0.14	0	0.03	0	0	0.06	0.16	0.04	0.07
TiO_2	0.61	0.63	0.34	0.56	0.24	0.43	0.23	0.35	0.44	0.61	0.46	0.38
Total	99.99	99.96	99.84	99.68	99.99	99.84	99.91	99.93	99.84	99.78	99.97	99.84

Table 2. Trace elements composition of the basement rocks in Ora-Ekiti.

Trace	Migmatite			Banded gneiss			Biotite gneiss			Granite gneiss		
	1	2	3	4	5	6	7	8	9	10	11	12
Nb	13	17	13	17	23	30	41	43	12	41	25	18
V	79	62	58	73	25	63	33	61	67	65	43	56
Cu	8	24	0	11	28	7	0	17	33	11	9	21
Rb	333	202	250	234	256	347	241	303	246	282	251	327
Sr	634	468	389	490	430	266	507	496	522	308	311	289
Zr	86	264	50	87	331	376	391	393	113	241	261	203

Table 2 continued

Trace	Migmatite			Banded gneiss			Biotite gneiss			Granite gneiss		
Mo	28	24	14	17	20	26	19	32	17	173	62	29
Ag	51	49	20	43	15	23	28	27	25	20	32	19
Ba	1647	1063	1005	1254	2663	2344	2426	2382	1318	2477	1863	1504
Ta	0	0	67	0	83	80	135	0	0	88	51	25
Pb	19	14	21	16	28	19	13	19	19	24	8	16
Th	43	0	0	0	40	0	47	0	29	26	38	49

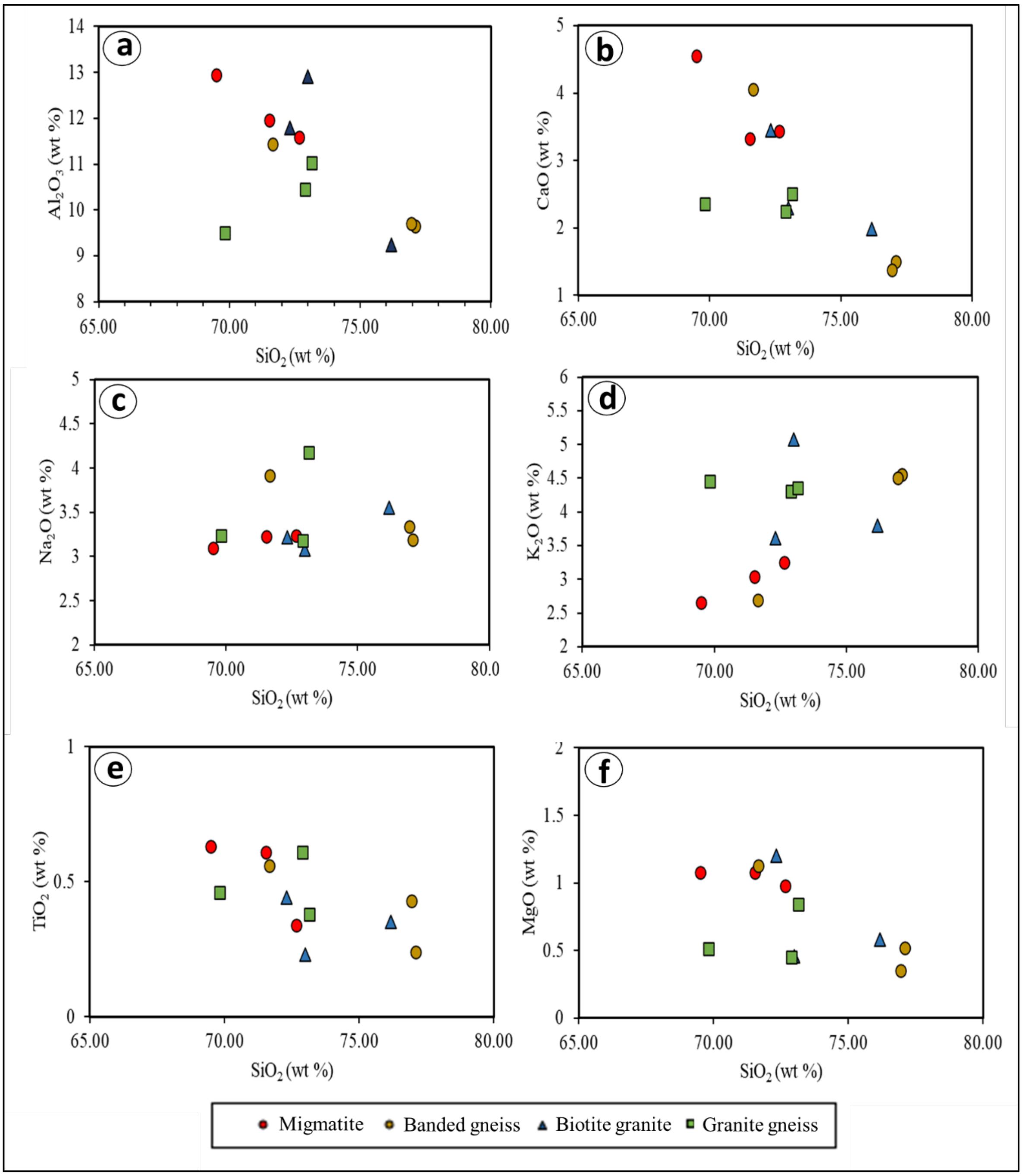

Figure 6. Harker variation diagram of (a) Al_2O_3 versus SiO_2, (b) CaO versus SiO_2, (c) Na_2O versus SiO_2, (d) K_2O versus SiO_2 (e) TiO_2 versus SiO_2 and (f) MgO versus SiO_2. (Symbols as in Figure 7).

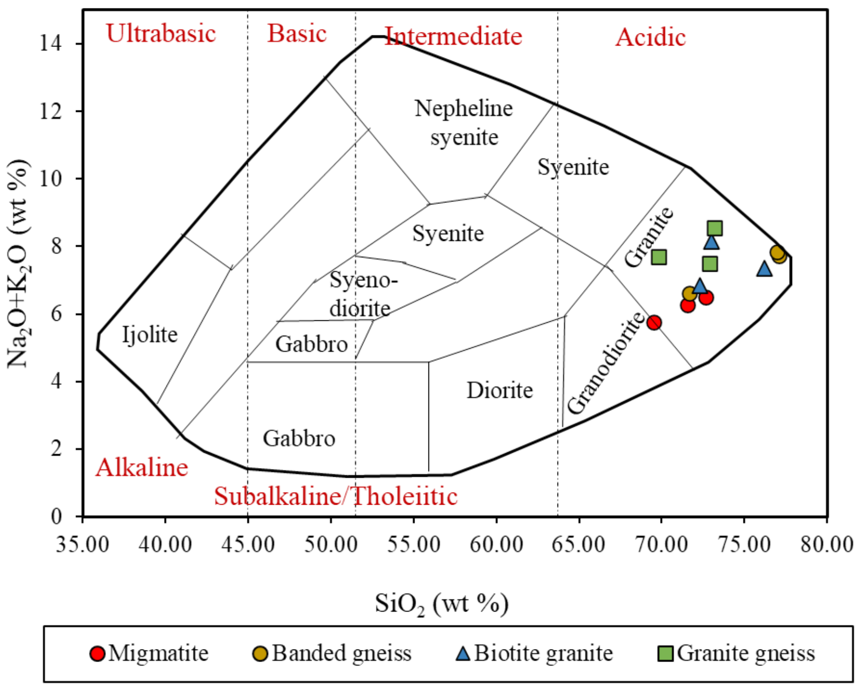

Figure 7. ($Na_2O + K_2O$) versus SiO_2 plot of the crystalline rocks in Ora-Ekiti (after Middlemost [16]).

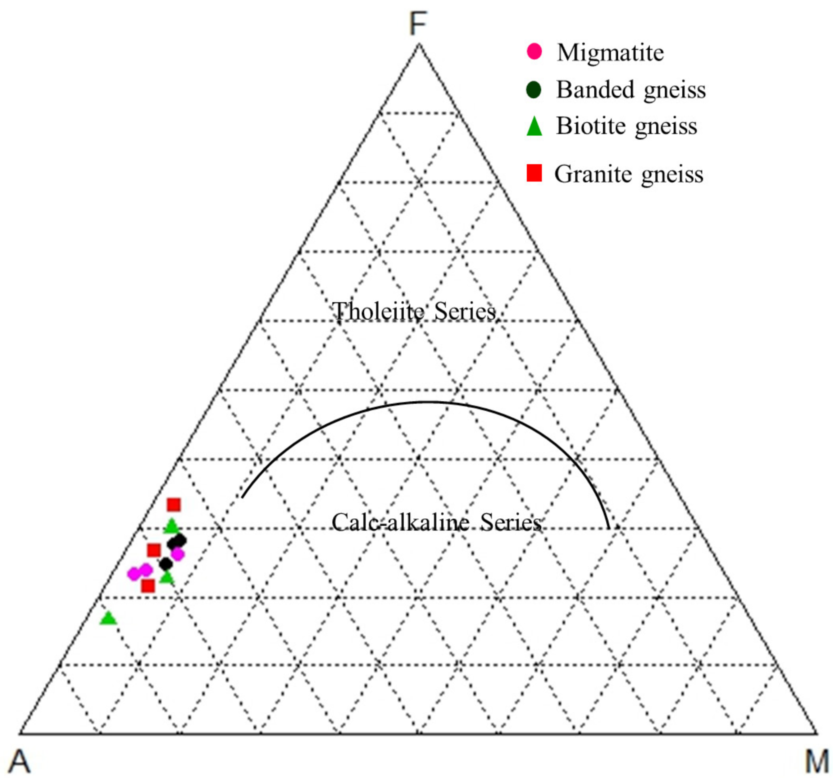

Figure 8. AFM diagram of the rocks in the study area (after Irvine and Baragar [17]).

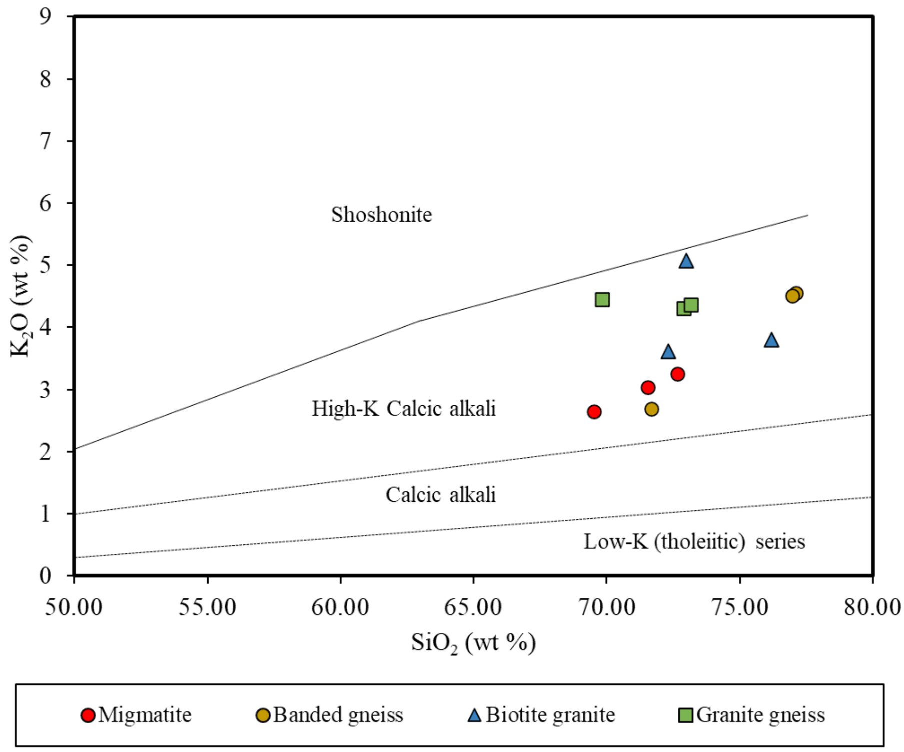

Figure 9. SiO_2 versus K_2O plot showing the geochemical character of the rock samples (after Peccerillo and Taylor [18]).

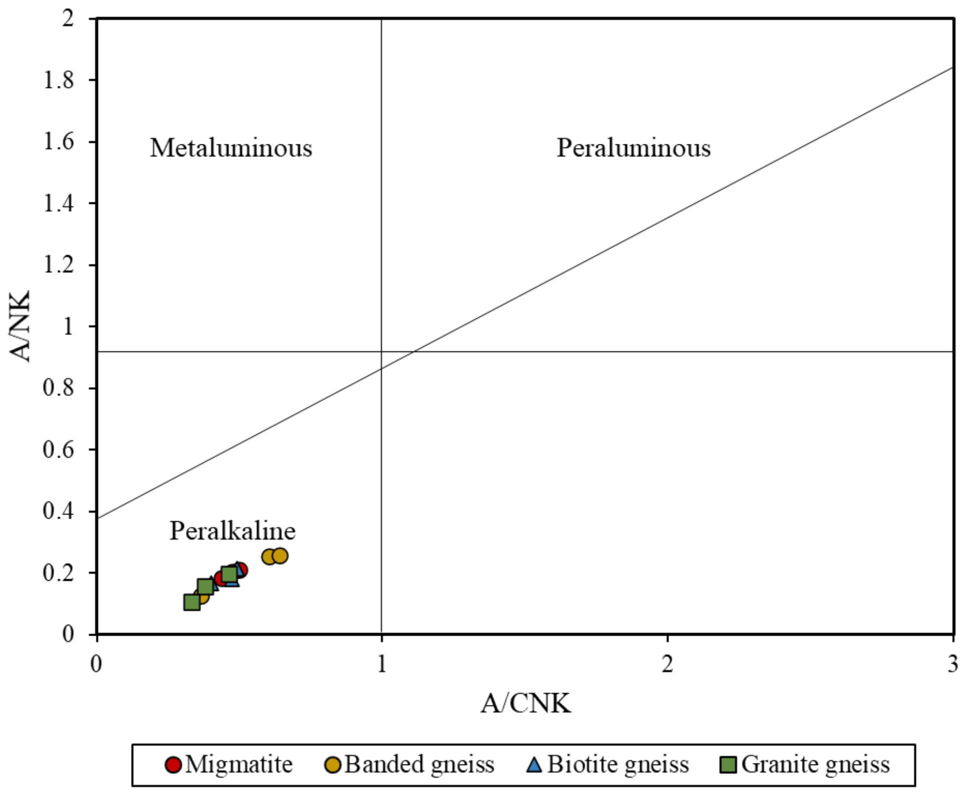

Figure 10. Binary plot of A/NK versus A/CNK (after Shand [19]) for the crystalline rocks in Ora-Ekiti.

5. Summary and conclusions

Exhaustive geological investigation reveals the study area is underlain by migmatite, banded gneiss, granite gneiss and biotite gneiss. Migmatite occupies western and northern parts, banded gneiss underlies Ora-Ekiti town and extends towards the northeast. Granite gneiss underlies the eastern and southwestern corners of the area while biotite gneiss occurs towards the south.

Petrographic examination indicates the rocks are principally dominated by quartz, plagioclase, biotite and opaque each contributing slightly varying percentages to the modal composition.

The rocks have high alumina content with pronounced enrichment in Ba, Sr and Rb. The rocks are dominantly peralkaline in nature. The rocks experienced either crystal fractionation before metamorphic remobilization or partial melting in the precursor rocks. The chemical composition of the rocks depicts they are metaluminous granitoids of calc-alkaline affinity.

Conflict of Interest

There is no conflict of interest.

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