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GEOLOGY AND GEOCHEMISTRY OF PEGMATITES OF OGODO – ODOBOLA, NORTH CENTRAL NIGERIA: A STATUS REVIEW

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ABSTRACT

Pegmatites are an extremely, coarse-grained igneous rocks of granitic composition, constituting of mainly large crystals of quartz, feldspar and mica. Their occurrence cut across various formations, but mostly around granitoids. They are known to host industrial, rare metals, exotic minerals and gemstones of economic value. Due to the continuous demands and recently discovered uses of some of these minerals, its continuous exploration can never be over-emphasized. Pegmatites occurrence in Nigeria were formerly confined to certain quadrants but resent research has proved they also exist in other zones too. Its occurrence in Ogodo-Odobola area is a recent discovery with scantily available literature. The Few available research work conducted on pegmatite of the Ogodo-Odobola area in Kogi State, North central Nigeria has been reviewed. The works focused on its feldspar content for economic value and the latter attempted the mineralization potential of the pegmatites. The area is revealed to be underlain by schistose and granitic lithologies and intruded by the pegmatite dykes of various dimensions. However, recent studies on granitic pegmatites have evolved just as the pegmatites, not only concentrating on their industrial potentials but also on rare metal mineralization potentials which presently are a key to unlocking the future technologically. A few of those relevant and recent studies in the field were also reviewed to bring forth new ways of dealing with this present world cake to geoscientists. White micas are a useful mineral for determining the degree of evolution in pegmatites. This was achieved in the research work using K/Rb ratios paired with incompatible elements such as Cs. Decreasing K/Rb and increasing Cs is a signs of increasing evolution. The modeling of fractional crystallization of white micas in pegmatites using these trace elements determined that the pegmatites are a result of 99% to 99.99% crystallization of a granitic melt.

Keywords: Pegmatites, Ogodo-Odobola, White Mica, Kogi State, North Central, Nigeria

INTRODUCTION

Pegmatites are an extremely slowly-cooled igneous rock resulting from the very last stage crystallization of magma, rich in volatiles and rare elements (King, 2016). .Crystallization of magma is a complex process because mag.ma is a complex substance and cert.ain magmas such as tho.se that form granit.es contain too much water. When this magma cools, the first minerals to .crystallize tend to be anhydrous minerals like feld.spar and so leaving the residual magma increasingly .water-rich. Certain rare chemical elements such as Li, N.b, Ta, Be, W and Sn which do not readily enter into an atomic substitution in the main granitic minerals (quartz, feldspar, muscovite, biotite) become concentrated in the water-rich residual magma and form minerals such as spodumene, niobite, tantalite, beryl, wolframite, cassiterite and columbite. Pegmatites eventually form when such residual magma crystallizes.

Pegmatites occur on all .continents and provide an impor.tant fraction of the world's Li, Be, Cs, Nb and Ta. Pegmatites are exceptionally coarse-grained intrusive. igneous rocks that can range in composition from mafic to granitic to syen.itic (Arkenstone, 2016). They are the most captivating rock with interesting features that take the attention of all geologists, most especially, petrologists, mineralogists, and economic geologists to study. They occur as intrusions in many different geological settings usually as irregular masses, lenses, sills or dykes with sizes ranging from a few metres to many kilometres across (Arkenstone, 2016). Crystal size is the most appealing feature of pegm.atites, with crystals usually over 3cm in size. Individual crystals over 10 me.tres across have been found, and the world's largest crystal was found within a pegmatite (United State Geological Survey (USGS), 2009). Most pegma.tites are composed of quartz, feldspar, biotite and muscovite; in essence, granite differs from other igneous rocks by its extremely large but variable grain size (London, 2008). In addition, they can also contain significant amounts of Li_2O, Rb_2O, B_2O_3, F and Cs_2O in their composition (.Simmons, 2007; Pezz.otta and La.urs, 2011). Muscovite amongst other industrial minerals present in pegmatite is an excellent insulator making it suitable for manufacturing of specialized parts of electrical equipment (Shehu and Yelwa, 2022).

The quantitative measurements of mineral proportions and chemical composition of the whole rock pegmatites are virtually impossible to acquire. Thus, conventional criteria such as bulk compositions and modal mineralogy used for the classifications of igneous rocks simply cannot be applied to pegmatites. An alternative is the use of mineralogical and chemical attributes of K-rich feldspar, the only mineral that is omnipresent in pegmatites (San.chez-Mun.oz *et al.*, 2017). Pegmatites in Nigeria a.s in the world at large are characterized by pneumatolytic ore deposits such as tin, lepidolite, tantalite and columbite, and gemstones. As such has generated lots of interest to study because of the various metals they host among other industrial minerals.

Series of research works have been carried out on Nigerian pegmatites by different authors (Anthony, 2022; Tanko and Dzigbodi-Adjimah, 2021; Tanko *et al.*, 2020; Aderogbin and Okunlola (2020). Pegmatites possess unique petrology and mineralogy making these rock bodies interesting to study and economically important to our society. They have since been primary sources of the world's largest and most valuable gem and some economically important rare metals such astantalum (Ta), niobium (Nb), beryllium (Be), lithium (Li),

tin (Sn), tungsten (W), caesium (Cs) and to a lesser extent, uranium (U), thorium (Th), and rare earth elements (REEs). Single pocket within pegmatite has yielded several millions of dollar worth of "gem-rough" (Kristen, 2011). In the world over, there is an increasing interest in albite-spodumene pegmatites as a significant source of Li, Ta, Nb, Cs, Sn, Be and in addition to other rare elements. Large deposits of albite-spodumene pegmatites are located in Canada, USA, Australia, China, Brazil, Russia, Nigeria, Zimbabwe and other countries throughout the world (Brown et al., 2017). This work therefore, seeks to review the present status of pegmatites of Ogodo-Odobola area, Kogi State, North Central Nigeria to bring forth the level of research done in the area despite its potential.

Regional Geological Setting of Nigeria

The African continent is underlain by three large cratons; the Congo, Kalahari and West African cratons, and are separated from each another by series of mobile belts that are active during the late Proterozoic times. However, the Nigeria Basement Complex lies to the east of the West African Craton, to the South-East by the Congo craton and the North by the Tuareg Shield in a mobile belt affected by the Pan-African Orogeny (600 ± 150 Ma). These rocks outcrop majorly in the northcentral and southwestern parts, and to a lesser extent in the southwest and northeast parts, particularly around the Obudu and Oban-massif areas (Ekwueme, 2000).

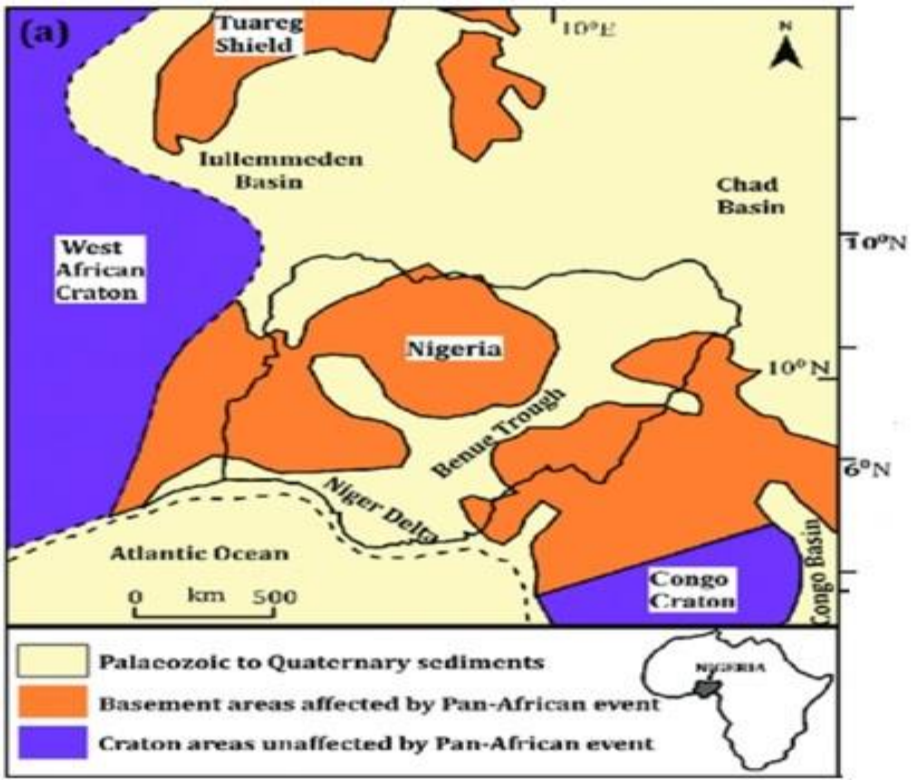

Figure 1: Regional geological map of Nigeria within the Pan-African mobile belt between West African and Congo Cratons (modified after Woakes *et al.,* 1987)

The Precambrian peg.matites of Nigeria occur majorly as dykes which vary. from a few metres to several kilometres in length and a few centimetres to metres in width within the Basement Complex rocks (gneisses, migmatites, schists, amphibolites and granitoids) (Okunlola and Ocan, 2009). The pegmatites evolved during the period of 600 to 530 Ma, indicating the latter periods of Pan-African magmatism. They were initially believed to have been confined to a broad 400km long NE–SW trending belt stretching from Wamba in central Nigeria to Abeokuta in Southwestern Nigeria (Jacobson and Webb, 1964; Matheis and Caen-Vachette, 1983). However, recent studies contradict this confine as their occurrences have been discovered in Northwest and Southeastern parts of Nigeria, notably around Obu.du hills and were presumed to extend into Northeast Brazil (Garba, 2003; Akintola *et al*, 2012; Oden *et al.*, 2013). Oku.nlola (2005) revealed that at least 300.0 sizeable bodies ranging between 10 – 15.00 m in length and up to 50 m in width were distributed across and beyond the earlier defined belt with diverse structural orientations and varied morphological compositions. The Ogodo-Odobola pegmatite bodies in the study area are part of pegmatites outside this famous 400 km NE-SW trending pegmatite belt in the western basement complex of Nigeria. They occur among schists and granites as part of the basement complex in Ajaokuta, North Central Nigeria (Abdulraheem, unpublished thesis (2019)).

The P.recambrian rocks of Nig.eria are grouped into three prin.cipal subdivi.sions. These are the ancient mag.matite complex, the L.ow grade sch.ists and the plutonic series togeth.er with affiliated minor ro.cks which bear imprints of Lib.erian (in 2700 Ma), Eburnean (in 2000 Ma), and Pan-African (in 650 Ma) tectonic events. The latter being the most wide.spread. How.ever, older ages > 3.0 Ga have recently been reported in some areas such as the Kaduna Migmatites (Dada & Briqu.eu, 1996) and this reinforces the view that this migmati.te-gneiss complex may belong to an Archean Protoshield subjected to the Prote.rozoic thermot.ectonic process (Elu.eze, 1992) and subsequent evolvement of the Pha.nerozoic basins. Overlying the older assemblages are sedimentary sequences of Cretaceous to Tertiary ages deposited in five basins notably the Mid-Niger basin, Benue Trough, Anambr.a Basin all of the Cretaceous ages and the

Sok.oto, Chad and the Niger- Delta basin of Tertiary and Tertiary to Recent ages respectively.

Similarly, K.ogi State where the present review is centered has two main rock types, which is, the basement complex rocks of the Preca.mbrian age in the western half extend.ing slightly eastwards beyond the lower Niger Valley and the sedimen.tary rocks in the eastern half. The various sedimentary rock groups extend along the banks of River Niger and Benue and Southeast wards through Enugu and Anam.bra States, to join the Udi Plateau (A.ko and Onod.uku, 2013). One of the characteristic features of the Precambrian Basement Complex of Nigeria is the occurrence of pegmatite bodies with rare metal mineralization potentials. .These occurrences of rare metals in Nigeria is broadly divided into two episodes of mineralization, that is, the tin-niobium mineralization associated with Mesozoic anor.ogenic Younger granites of central northern Nigeria and Older (≈5.50. Ma) T.a – Nb – S.n – L.i – Be mineralization in the pegm.atites associated with the Pan-African Oro.geny (.Kinna.ird, 1984). Many research works have been conducted on Nigerian pegmatites by different authors (Okunlola and Ocan, 2009; Ade.tunji and O.can, 2010; Agunlet.i *et al.*, 2014).

Available Research Works on Pegmatites of Ogodo-Odobola Area, North Central Nigeria

Ako and Onoduku (2013) were the first authors to have worked on an aspect of the pegmatites in Odobola-Ogodo area of North Central Nigeria. Their work was centered on the feldspar resource of the area about its geology and economic viability employing geological, geochemical and geophysical methods. The area is underlain by sch.ists, and grani.tic and peg.matitic intrusives in addition to the weathered sediments from these rocks. The granites and pegmatite in the areas serve as the main host to the feldspar, the mineral target of the research. It shows that the Odobola-Ogodo area have high potential to host economic deposits of feldspar, quartz, tourmaline and tantalite.

Such minerals are found in three modes of occurrence, with each containing not less than two of these aforementioned minerals;

- The unweathered granitic rock which favour primary deposits of sod.ium felds.par, pot.assium feldspar and q.uartz
- Unwe.athered pegmatite that intr.udes both schistose and gra.nitic bodies favouring these minerals' occurrence.
- Weathered granitic and pegmatitic rocks which are favourable for residual deposit of clay that contains quartz, feldspar, tantalite and tourmaline

The intrusive granitoids of Pan-African age refer to the Older granite in Nigeria (Obaje, 2009) that occupy a large portion of the study area. This granitic lithology falls within the granodiorite, ada.mellite, ton.alite and gra.nite with main mineral constit.uents of k-feldspar, qu.artz, and muscovite wi.th minor to trace epidote and garnet respectively. Pegmatites are extremely coarse-gained igneous rocks, often granodioritic or grani.tic compos.ition. In th.e study ar.ea intrude granite and schist and are presently exposed to the surface due to extensive effect of weathering. In part of the study area, th.ey meas.ure mo.re than 100 m long, 10 m wi.de and 5 m high. In some pits where artisans are already mi.ning gemsto.nes, very lar.ge crystals of k-feld.spar, quar.tz and muscovite become well exposed. Schist is the oldest basement complex rock that underlies the study area onto which Pan-A.frican granites and peg.matites have intruded. They are hig.hly folia.ted and ban.ded; the foliation is chara.cterized by the developm.ent of dark-.coloured bands (ferromagnesian minerals) alternating with white coloure.d (quartzo-.feldspathic minerals).

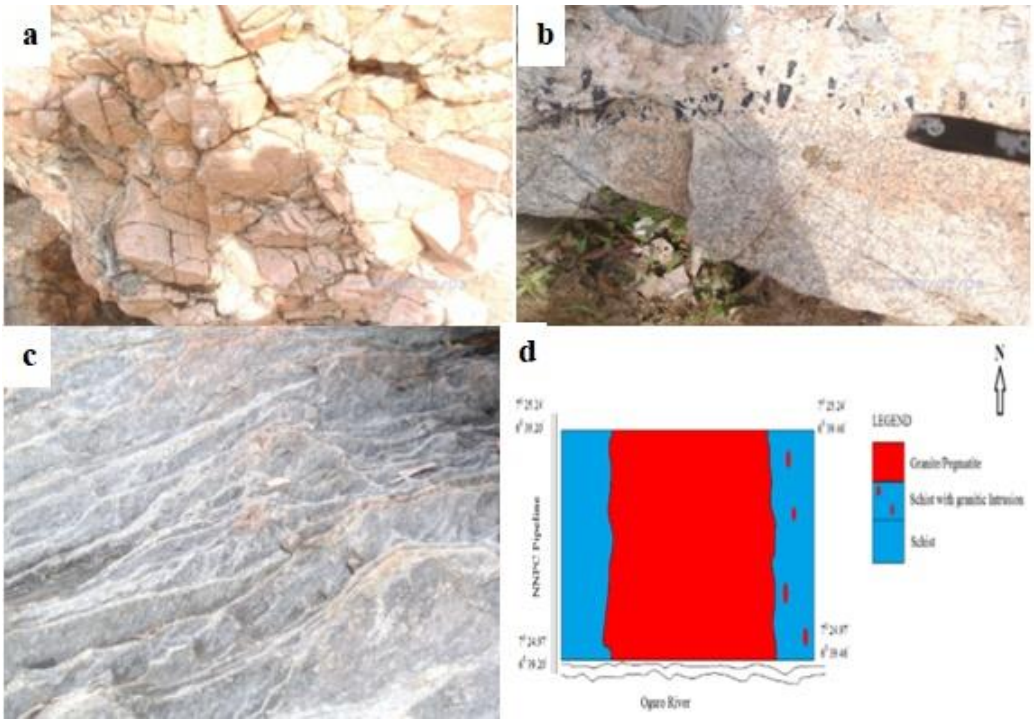

Figure 2: Photographs: (a) Pegmat.ite with large crystals of feld.spar (orthoclase, pink) (b) Granitic rock show.ing quartz (white), orthoclase, (pink.), musco.vite (white) and tourmaline (black) (c) Schist sho.wing the ferromagne.sian minerals (dark colour) and the quartzo.-feldsparthic minerals (wh.ite) reve.aling the schistose structure (d) Geological sketch map of the study area (Modified After Ako and Onoduku, 2013)

The intrusive granitoids of Pan-African age refer to the Older granite in Nigeria (Obaje, 2009) that occupy a large portion of the study area. This granitic lithologies falls within the granodiorite, ada.mell.ite, tona.lite and granite with principal mineral constituents of k-feldspar, quartz, and muscovite with minor to trace epi.dote and garnet respectively. Pegm.atites are extremely coarse grained igneous rocks usually granodio.ritic or granitic composition. In the study area intrude granite and schist and are presently exposed to the surface due to the extensive effect of weathering. In part of the study area, they measure more than 100m long, 10m wide and 5m high. In some pits where artisans are already mining gemstones, very large crystals of k-feldspar, quartz and muscovite becomes well exposed. Schist is the oldest basement complex rock that underlain the study area onto which Pan-African granites and pegmatites have intruded. They are highly foliated and banded; the foliation is chara.cterized by the development of dark-col.oured bands (ferromagnesian .minerals) alternating with white-co.loured band (quart.zo-feldspathic minerals). General trending is NE - SW with a dip range of between 35 – 60°W. Mineral-wise, they contain feldspar, quartz and mica though not in economic concentration.

Three sets of samples were collected for the study, namely; a sample from the host rock, feldspar sample from the pit, and felds.par samples from weath.ered granitic and pegm.atitic rocks.. These samples were done with regard to the targeted mineral (feldspar). Thin sections of these samples were prepared and studied under a petrologic microscope show X-ray Diffraction analyses; while 20 whole rock pegmatites were geochemically analyzed using X.-ray Fluorescence. (anorthite - 0.42, orthoclase - 85.54, and albite - 14.06 in mole % respectively on the average). Representative feldspar samples were subjected to geochemical analysis and reveal a significant K_2O component (k-feldspar). The geochemical result show an average SiO_2 (65.81 wt%), Al_2O_3 (16.67 wt%), Na_2O (5.83 wt%), K_2O (10.76 wt%), TiO_2 (< 0.001 wt%), MgO (0.5 wt%), CaO (0.02 wt%), and Fe_2O_3t (0.26 wt%). Resistivity profile (Werner configuration) and Vertical Electrical Sounding (Hummel configuration) was adopted for the geophysical survey. The resistivity profile reveals the deposit is not laterally continuous, susp.ected to be prese.nt at the profile 105 m; and between 165 m and 195 m concerning the starting point. The result of Vertical Electrical Sounding (VES) delineates four (4) basic geoel.ectric or litholog.ic units; the top silt-sand, weat.hered feldspar, poorly weathered feldspar zo.ne and fresh basement. That the feldspar deposit has an estimated thickness of between 15 – 35 m over the entire area.

Also, the most recent work in the area was conducted by Abdulraheem (unpublished thesis, 2019). The author's work was focused on the geology, geochemistry and mineralization potential of granitic pegmatite in Ogodo-Odobola, North Central Nigeria using thin section petrography, X-ray Diffraction and X-ray Fluorescence techniques. The underlying lithology includes schist, granite and pegmatites with the last two intruding into the schist from field observation. Samples were collected from main pegmatites (4 whole rock pegmatite, 2 feldspar mineral extracts were duplicated for thin sect.ion and

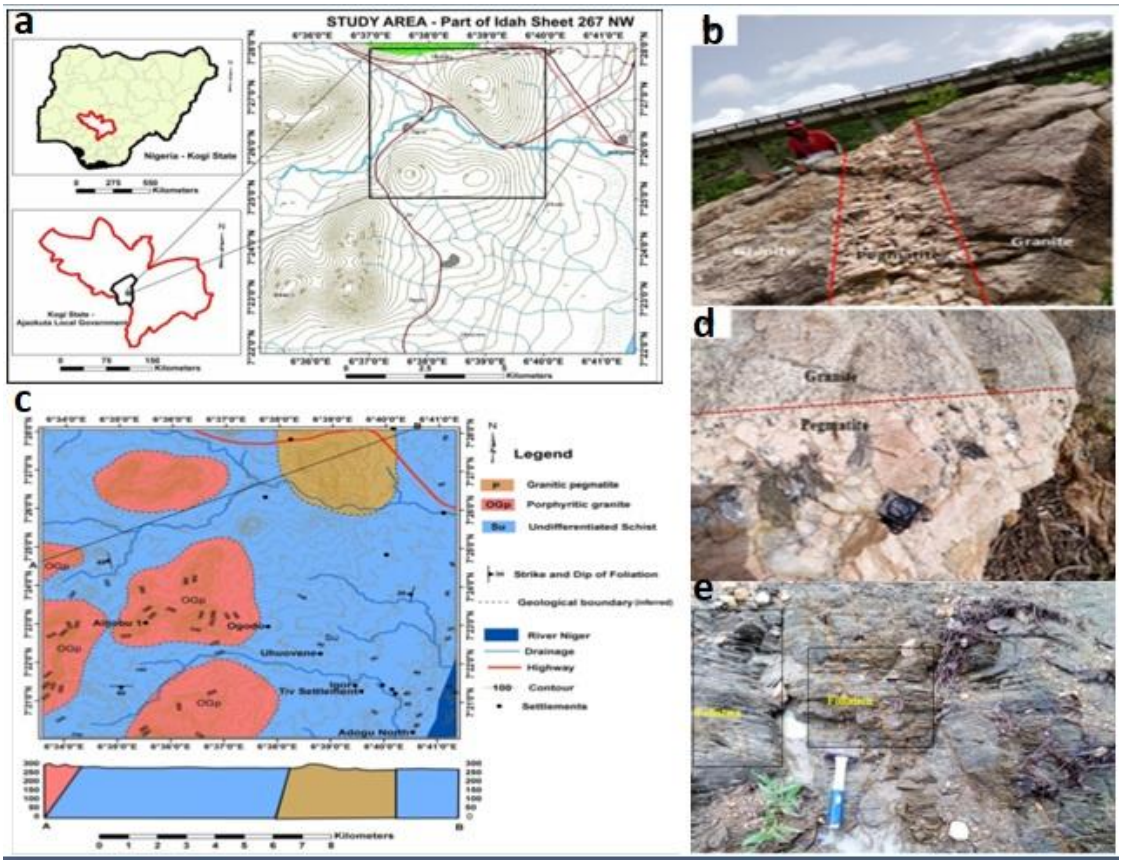

Figure 3: (a) Location Map showing Ogodo – Odobola the Study Area (b) Pegmatite dyke intrusion into granite (red dotted lines show variation in width top-bottom) (c) Geological map of Ogodo-Odobola area, part of Sheet 267 (Idah NW), North-Central Nigeria (d) Clear contact between pegmatite and granite, also show black mica (e) Highly foliated schist undergoing intense weathering (Modified after Abdulraheem (Unpublished Master thesis, 2019)

The mineralogy reveals Feldspar (85%), Quartz (10%), Mica (5%) and negligible accessory mineral compositions from petrography; while XRD shows in addition to (feldspar, quartz and mica), such as lepidolite [$K(Li,A.l,Rb)_2(Al,Si)_4O_{10}(F,OH)_2$)] (0–14 %), tit.anite [$CaTiSiO_5$] (0– 17 %), phlogopite (0-13%), phe.ngite (0–14 %), and annite (0-8%). Microcline, alb.ite and Orthoclase feldspars become more obvious. Geochemistry of the whole rock pegmatite reveals SiO_2 (62.80 – 83.2; average 76.10 wt%), Al_2O_3 (12.70 – 24.00; average 16.10 wt%), Fe_2O_3 (0.20 – 11.40; average 1.80 wt%), Ca.O (0.00 – 1.50; average 0.30 wt%), K_2O (1.00 – 13.40; average 5.30 wt%), Na_2O (0.0 – 0.0; average 0.00 wt%), Mg.O (0.0 – 0.0; average 0.00 wt%), Mn.O (0.0 – 0.20; average 0.0 wt%), P_2O_5 (0.20 – 0.60; average 0.4 wt%).

Ratio indices of SiO_2 Vs Al_2O_3 and K_2O show linear negative correlation indicating fractionation. The low ratio values of K/Rb, and K/Rb Vs Rb reveal these pegmatites are mineralized as they all virtually fall on the mineralized field of the binary plot though with moderate fractionation. Bulk geochemistry of the pegmatites showed a marked enrichment of incompatible elements like Rb (30.20 ppm), Sn (190.90 ppm), Antimony (175.90 ppm) and Molybdenum (32.60 ppm); but are depleted in some compatible elements such as chromium (0.20 ppm), vanadium (1.30 ppm), cobalt (4.10 ppm), tungsten (3.00 ppm) and lead (0.80 ppm) on the averages. The study has rather shown strong evidence of REEs mineralization because of the occurrence of accessory minerals like titanite, lepidolite, phlogopite, phengite and annite.

Related, Relevant and Recent Studies on Pegmatites

Aderogbin and Okunlola (2020) studied Egbe Pegmatite in Southwestern Nigeria with emphasis on its geology, compositional characteristics and possible mineralization potentials which were lacking in the previous work done in the Egbe-Isanlu Pegmatite field which area falls. Samples were collected from whole rock pegmatite and mineral extracts of muscovite and feldspar and were analyzed using Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES). Gneisses, amphibolites, quartzite and schists are the lithologies in the area which have been intruded by pegmatites. Major oxide assessment of the whole rock pegmatites shows the pegmatite is silicious with SiO_4 (79.82 %) and moderately high Al_2O_3 (12.22 %). Fe_2O_3, MnO, MgO are each less than 1.0 % while Na_2O and K_2O contents average 2.87 % and 2.25 % respectively.

The average values of trace elements in the pegmatite are Rb (1083.5 ppm), Nb (109.35 ppm), Ta (52.55 p.pm), Sn (92.3 ppm), Cs (32.12 ppm), Y (9.86 pp.m), Zr (41.27 pp.m), Ba (50.47 ppm), Hf (12.38 ppm), W(2.91 ppm) and Ga (32.12 ppm) and ratios of diagnostic elements are Rb/Cs (65.80), K/Cs (1103.11), K/Rb (30.27), Rb/Sr (298.93), Nb/Ta (55.397), Ta/W (41.81), Zr/.Hf (7.23), Na/.Rb (41.77) and Na/K (92.25). A/CAN > 1 and Al_2O_3 > Ca.O+ Na_2O+ K_2O with enrichment of SiO_2, Al_2O_3, Na_2O, K_2O and depletion of MgO, Mn.O and Fe_2O_3 suggests that Egbe pegmatite is of peral.uminous bulk composition and plots of Rb vs (Y+Nb) and A/NK vs Al/CNK discriminates Egbe pegmatite in the peral.uminous LCT (Li, Rb, Cs, Be, Ga, Nb <, > Ta, Sn, Hf, B, P, F) of synco.llisional to within plate granitic family. The K/Rb vs Rb and K/Rb vs Cs plots for the three sample media further establish the rare–metal nature and mineralization potential of Egbe pegmatite. Overall geochemical assessment is that Egbe pegmatite is a rare metal, highly fractionated Beryl type with a rare metal enrichment trend of Nb>>Sn>>Ta.

Tanko and Dzigbodi-Adjimah (2021) worked on the pegmatites and host rocks in Keffi area of North Central Nigeria to establish with the petrogenetic relationship within the pegmatites and between their surrounding host rocks. The geology revealed pelitic schist-ampbibolite, orthogneisses (granodiorite and augen granodiorite gneiss), granites and pegmatites. Geochemistry of the selected representative samples collected from whole rock pegmatite, its K-feldspar mineral extract, granites, orthogneiss and schist amphibolite host rocks were done using ICP-MS and a few with ICP-ES techniques to reveal their major, trace and rare earth element compositions.

In the Whole Rock of Pegmatites, Granites and Host Rocks samples the major elements are;SiO_2 (64.00 - 73.57 wt%), Al_2O_3 (16.04 - 21.80 wt%), Fe_2O_3 (1.02 - 3.87 wt%), MgO (0.02 - 0.58 wt%), CaO (0.10 - 3.03 wt%), Na_2O (0.49-7.50 wt%), K_2O (2.75 - 6.71 wt%), TiO_2 (0.01 - 0.19 wt%), P_2O_5 (0.07 - 1.70 wt%), MnO (0.06 - 0.42 wt%) and Cr_2O_5 (0.002 - 0.013 wt%). Whilst the trace elements range as Rb (100.10 - 2500.21 ppm), Cs (68.40 - 2100.00 ppm), Li (200.00 - 6400.00 ppm), F (680.00 - 10000.00 ppm), Sr (8.70 - 133.20 ppm), Ba (27.00 - 246.00 ppm), Y (0.30 - 9.10 ppm), Zr (6.80 - 342.20 ppm), K/Rb (0.001-0.010).

The major elements contents in K-.feldspar mineral samples of the pegma.tites are as follows; SiO_2 (61.08 - 67.08 wt%), Al_2O_3 (18.17 - 19.91 wt%), Fe_2O_2 (0.19 - 0.98 wt%), Mg.O (0.01 - 0.32 wt%), Ca.O (0.03 - 2.37 wt%), Na_2O (0.38 - 10.18 wt%), K_2O (0.78 - 15.76 wt%), TiO_2 (0.01 - 0.13 wt%), P_2O_5 (0.04 - 0.83 wt%), Mn.O (0.01 - 0.48 wt%), and Cr_2O_5 (0.002 - 0.004 wt%). Whilst the trace element ranges as follows: Rb (52.00 - 6918.70 pp.m), Cs (18.80 - 2102.10 ppm), Li (100.00 - 1100.00 ppm), F (31.00 - 2701.00 ppm), Sn (1.00 - 659.00 pp.m), Nb (0.60 - 62.40 pp.m), Ta (0.30 - 112.00 ppm), B (4.00 - 561.00 ppm), Sr (9.40 - 94.10 ppm), Ba (14.00 - 268.00 ppm), Y (0.05 - 5.80 ppm), Zr (0.90 - 40.00 ppm), K/Rb (0.0002 - 0.1964).

The REE.s in whole rock and K-feldspar samples of pegmat.ites, and surrounding host rocks were used in plotting Chondrite normalized REE patterns and showed similar characteristics. The REE chara.cteristics of the pegmatite bodies and those of the granitic host rocks show enrichment in Light Rare Earth Elements (LREEs) i.e., La, Ce, Pr and N.d and depletion in Heavy Rare Earth. Elements (HREEs) Ho, Er, Tm, Yb and Lu. They also show sub-horizontal patterns. But the horizontal pattern in K-feldspar samples of pegmatites shows a more closely spaced pattern than those of the whole rock samples of the pegmatites and the combined pegmatites, granites, orthogneisses and pelitic schist-amphibolites. The authors then concluded that a petrogenetic relationship between the pegmatites and surrounding granitoids of Keffi area; from the variation plots of major, trace and REE in whole rocks and K-felspar samples shows a pattern that allows the classification of pegmatites of Keffi into mineralized, intermediate and non-mineralized pegmatites; also deduced from the geochemical characteristics (variation diagrams in major and trace element, REE geochemistry and tectonic environment classification) that a genetic model based on the evolution of melt by partial melting of meta-sedimentary pr.otolith during ultra-metamorphic and deformational activities (anat.exis) is proposed for the granite - pegmatite system of Keffi area.

CONCLUSION

The aspect of pegmatites worked on by Ako and Onoduku (2013) was strictly on the feldspar contents as regards its quality, quantity and economic potential for investment purpose. They used thin section petrography and XRF techniques for the study.

The geochemical result show the feldspar is of high quality. Based on mineral resources and resource estimation, the feldspar resource in the Odobola-Ogodo area is classified as an estimated proven feldspar-bearing reserve of approximately 119 Million tons. The outcome favour the main aim (feldspar deposit) but also reveal that the pegmatites have potential for rare metals and gemstone mineralization with the presence of artisan already mining tantalite and tourmaline in the area.

Abdulraheem (2019) uses petrography, XRD and XRF techniques in the research, and with XRF technique has limitation in detecting some important trace elements such as lithium, beryllium, boron, and rare earth elements; they were only but inferred from mineralogical composition (from XRD result) of the pegmatites. The study shows strong evidence of REEs mineralization because of the occurrence of accessory minerals like titanite, lepidolite, phlogopite, phengite and annite.

Hence, the research recommended the use of white mica (muscovite) mineral extract to further probe into the mineralization potentials as the feldspar content used show evidence of mineralization in the area.

Pegmatites are the main sources of rare metals and REEs, and most especially host multiple potentially economic Li-bearing minerals. Spodumene ($LiAlSi_2O_6$) is the most common Li-aluminosilicate, theoretically containing 7.9 wt% Li_2O. Rare metal pegmatites are divided into two families based on the trace element signatures LCT (Li-Cs-Ta) and NYF (Nb-Y-F) (Černý, 1991a). LCT pegmatites contain muscovite as their primary mica and are affiliated with S-.type granites (Chappell. and White, 2.001; London, 2018). NYF pegmatite contain biotite as the primary mica and is associated with A-type and I-type granites (Černý and Ercit, 2005; London, 2018). White Mica (muscovite) is a tool for tracking pegmatite evolution and hence its usage in Lithium (Li) exploration the most sort rare metal presently because of increased awareness of its diverse usage (Benn, 2022). The widespread use of Li-ion batteries in portable electronic devices, electric vehicles and grid storage is largely responsible for a global surge in demand for Li. Li-ion batteries account for 65% of the annual use of Li (Jaskula, 2020). This is an increase from 35% of the annual Li use in 2014 (Jaskula, 2016). Other uses for Li are ceramics and glass (18%), lubricating greases (5%), polymers (3%), air treatment (1%), and others (9%) including pharmaceuticals, and aluminium production (Jaskula, 2020). Lithium is currently being produced from two primary sources (brines and pegmatites).

Muscovite is the third most abundant mineral present in pegmatites and it is found very useful due to its ability to accommodate a wide range of substitutions at various sites in its crystal structure.. Also, the use of inductively coupled plasma mass spectrometry analytical techniques tends to favour whole rock and mineral extract analyses as far as exploration for rare metals in pegmatite is concerned, this is mainly due to its low detection limit and hence will suites these rare elements determination. This Author therefore, advocates for the use of these techniques in the Ogodo-Odobola area pegmatites deposit to further unravel the level of mineralization and petr.ogenetic relationships between and among the individual bodies and surrounding rocks.

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