

Early and Late Mineralization of the Intrusive Rocks in Lokpaukwu, Southern Benue Trough, Nigeria

Onwualu-John, J. N.

Department of Geology, Faculty of Science, University of Port Harcourt
Port Harcourt, Nigeria

Uzoegbu M. U.

Department of Geology, Faculty of Science, University of Port Harcourt
Port Harcourt, Nigeria

ABSTRACT

The intrusive rocks (dolerites) in Lokpaukwu were studied to evaluate the kind of mineralization in them. The dolerites erupted at three regions in the Lokpaukwu area (Eziama, Eluama, Umuchieze). The results of the petrographic studies show that the dolerites in Eziama, Eluama, are characterized by olivine, pyroxene, plagioclase, biotite, hornblende, hematite. The first pattern of mineralization of the dolerites at Lokpaukwu appears to start from the Eziama or Eluama region, the dolerites of these two regions conforms to the mineralization of dolerites that exist in some other parts of the southern Benue trough. Umuchieze dolerites have some peculiarities that differentiate it from other dolerites of the Southern Benue trough. The second pattern of mineralization exist in dolerites of umuchieze which are characterized by quartz, pyroxene, plagioclase, biotite, and hematite. These phenomena indicate that two types of dolerites exist in Lokpaukwu area, the Olivine dolerites and the quartz porphyry dolerites. The interaction of the magma with sedimentary host rocks or hydrothermal influx or late stage of crystallization of magma probably played vital roles in the formation of the quartz porphyry dolerites, whereas the olivine dolerites may have originated from early stage of crystallization of basaltic magma. The basaltic magma that gave rise to these rocks (dolerites) probably has a single source region but erupted at different rifts which gave opportunity for some magmatic evolutionary processes (fractionation, contamination, assimilation) to play major roles.

Key Words: Olivine dolerites, quartz porphyry dolerites, mineralization, southern Benue trough.

INTRODUCTION

Lokpaukwu is a sedimentary environment that host mostly doleritic rocks and some other few extrusive igneous rocks (basalts and pyroclastics). The petrogenesis and geotectonics of rocks in Lokpaukwu have been studied by Onwualu-John and Ukaegbu, 2009; Etuk et al, 2008; The rocks are of basaltic origin. O'Hara, 1965 stated that magma is characterized by their constituent elements/minerals. These basaltic rocks intruded the oldest sedimentary rocks of the study area.

Lokpaukwu lies within the Southern segment of the Benue trough. Benue trough is an aulacogen that occurred in the Cretaceous when South America separated from Africa. It is a failed arm of a triple rift (RRR) that occurred during the separation. The tectonism that resulted to the rifting was accompanied by magmatism which led to the emplacement of igneous rocks in the regions. The tectonism resulted to the folding of pre- Santonian sediments which gave rise to the Abakaliki Anticlinorium. The Abakaliki Anticlinorium is characterized by two flanks, Anambra basin by the western flank and Afikpo basin by eastern flank. Lokpaukwu is within the Anambra basin. Kogbe (1976) documented that the marine transgression in Nigeria started in the middle Albian and the outcrop of the Albian age is exposed in the Anambra basin while marine regression was in the Cenomanian. The geology of the southern Benue Trough has been studied by Amajor and Offoegbu (1988). The information on the patterns of mineralization in the intrusive rocks of the study area (LokpaUkwu) is scarce.

The Scope of this research is to study and evaluate the pattern of mineralization in the intrusive rocks that occurred in Lokpaukwu using the geo-physical and petrographic information.

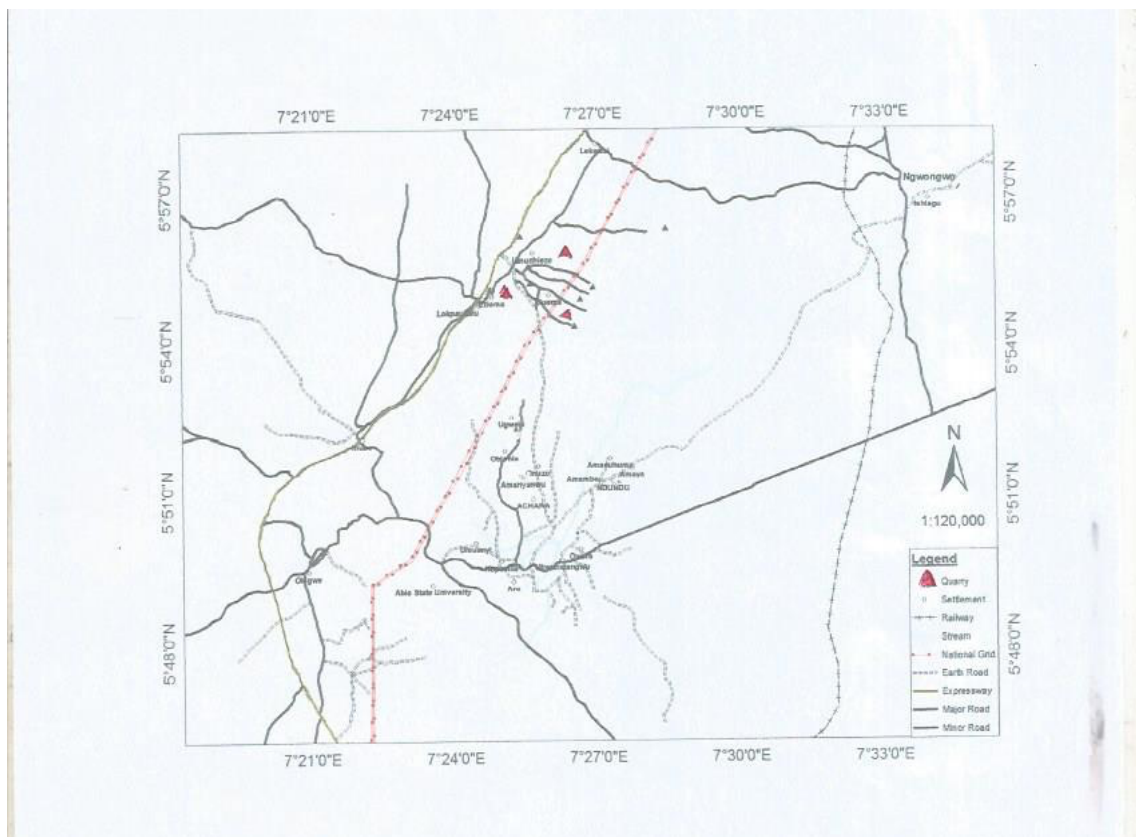


Figure 1. Map showing the study areas around environ.

GEOLOGIC SETTING

The geologic setting of Lokpaukwu is Asu River Group (Albian), which consist of shales and sandstones. Nkporo Shales (Late Turonian) which consist of dark shales, sandy shales and sandstones and Mamu Formation (Middle Maastrichtian) which is overlain by Ajali Sandstone (Upper Maastrichtian). The Ajali sandstone is whitish in colour, friable and has slight intercalation of white clay. The uppermost part of the Ajali sandstones is ferruginized. The

sedimentary sequence in the LokpaUkwu is intruded by dolerites. The topographic high in Lokpaukwu is the Abakaliki Anticlinorium, dolerites form the moderate relief while the sedimentary rocks form the valley.

SAMPLING TECHNIQUES

Intrusive igneous rocks were collected at different pockets of the igneous suite at the quarries in the Lokpaukwu. Twenty-four fresh rock samples of dolerites were collected; thin sections were prepared and described using petrological microscope and viewed under plane polarized light and cross polarized light.

Thin Section Procedures

The rocks samples were cut with cutting machine and polished on a flat surface that contains carbonrandom mixed with water. The rock is polished until the thickness reduced to 0.033mm (thickness which is capable of allowing light to be transmitted into the rock). The glass slide is polished in order to create rough surface for sticking the rock samples. Araldite are applied on the glass slides and the rock samples are glued to the glass slide. The glass slides with the glued rock samples are placed on the hot plate to dehydrate the water bubbles that are trapped in the slide during the preparation of the slides. The rock slide is then studied under polarized light of a petrological microscope.

PETROLOGY

The dolerites which intruded the Asu River Group in the study area occur as dyke while in some other places, the dolerites occur as sills. The occurrence of two groups of dolerites in Lokpaukwu (The olivine dolerites and the quartz porphyry dolerites) indicates that there are two patterns of mineralization in intrusive rocks at Lokpaukwu. Most probably, the first mineralization started in the olivine dolerites while the second mineralization is in the quartz porphyry dolerites. The olivine dolerites show features of rocks that crystallized at the early part of basaltic magma eruption while the quartz porphyry dolerites show signatures of basaltic magma alteration. Dmitri et al (2002), stated that mineralization features through metasomatism may be achieved through batch crystallization, melt fractionation in conduits and chambers, melt or fluid percolation.

Olivine dolerites

Olivine dolerites are exposed at two localities in Lokpaukwu (Eziama, Eluama). They composed mostly of femic minerals. The mineral paragenesis is olivine+pyroxene+plagioclase+biotite+hornblende+hematite. The average mineral compositions in the dolerites at Eziama are olivine (20%), pyroxene (25%), plagioclase (35%), hornblende (10%), biotite (5%), and hematite (5%). The average mineral compositions of dolerites in Eluama are olivine (15%), pyroxene (20%), plagioclase (30%), hornblende (15%), biotite (10%), and hematite (8%). The olivine dolerites are melanocratic in colour, the textures are moderate in sizes. The feature of the olivine dolerites reflects that the rocks were formed under high to moderate thermotectonic environment. Plate 1 and 2 shows the olivine dolerites of the study area.

**Plate 1****Plate 2****Plate 1 and 2: Olivine Dolerites of Lokpaukwu Study area**

Quartz porphyry dolerites

The quartz porphyry dolerites of Lokpaukwu are enriched with quartz and plagioclase feldspar. The quartz and feldspar form the phenocryst in the rock. The phenocrysts are whitish and cloudy in colour. The mineral paragenesis of the quartz porphyry dolerites in Umuchieze Lokpaukwu are quartz+ pyroxene+ plagioclase +biotite +hematite. The average mineral compositions of the quartz porphyry dolerites are quartz (35%), pyroxene (20%), plagioclase (30%), biotite (10%), and iron oxide (5%). The dolerites have porphyritic texture (textures whereby phenocrysts are set in groundmass of finer crystals). The quartz porphyry dolerites exhibited the features of rocks formed under temperatures of high to low thermotectonics environment. Fractional crystallization of the basaltic magma that have undergone series of magmatic evolution could attribute to the formation of the quartz porphyry dolerites. Vasyukova,(2011) stated that fractional crystallization enriches the level of water and ore metals in a residual melt. The constituent minerals in rocks can be used to describe/deduce the thermo tectonic environment and also the hydrothermal components in respect to mineralization. Increase of fluid /rock ratio signifies changes in metasomatising agent's composition either from SiO₂ undersaturated to SiO₂ over saturated magma (Coltorti and Gregoire,2008). Pilet, et al (2016), mentioned that several models have been suggested to prove that metasomatism can refertilize portions of lithospheric mantle, and that metasomatism could be initiated by tectonic processes. Metasomatic processes could be a contributing factor to the origin of the silica over saturated dolerites (Quartz porphyry dolerites) of the study area. Pneumatolytic metamorphism of the host rocks could result to the dispersion/ migration of elements from the host rocks to any other rock it comes in contact. This elemental migration may result to infilling of cracks.

**Plate 3****Plate 4****Plate 3 and 4: Quartz porphyry dolerites**

THE OPTICAL PROPERTIES OF THE MINERALS

The quartz exhibited prismatic crystal shape and euhedral form. It shows colourless to whitish colour and has no cleavage. Pyroxene shows pale green with pleochroic colour of brownish green. The cleavage in pyroxene is well developed and basal with an euhedral crystal form. Plagioclase shows twinning and exhibited white color which shows pleochroic color of reddish brown. The optical properties of the biotite are black colour and shows pleochroic color of brown. The crystal form is subhedral and has perfect cleavage. Hornblende has greenish color and a pleochroic colour of brown with anhedral crystal form. Olivine exhibited olive green with a pleochroic color of brown. The crystal form is subhedral. Hematite is reddish brown with no distinct cleavage when viewed in the microscope

The trend of mineralization in the intrusives of Lokpaukwu could be that the initial eruption of the basaltic magma started from any of the two localities (Eziama or Eluama) in Lokpaukwu and as the magma evolved and fractionated, it started getting mineralized / enriched with quartz which could assimilate into the fractionating magma through the conduit or channel in which the magma evolved or through the sedimentary host rocks or through hydrothermal deposits. The quartz porphyry dolerites probably originated from the alteration of the magma. Onwualu-John and Offodile (2020) stated that the quartz in the dolerites of Umuchieze Lokpaukwu appear as products of pneumatolytic actions. The mineralization of the intrusives at Umuchieze could be that during the tectonism that occurred in the study area, other satellite rifts were created and the magma that formed the quartz porphyry dolerites erupted from one of the rifts. Ying et al 2017 documented that presence of quartz, sericite, sulfide, carbonate, and chlorite are indications of hydrothermal alteration assemblage.

CONCLUSION

Lokpaukwu intrusive are characterized with two patterns of mineralization which occurred at different thermotectonics. The mineralization of the intrusives can as well be grouped into early mineralization and late mineralization. The olivine bearing intrusive can be grouped into the early mineralized rocks because the component minerals of the rocks showed that the rocks crystallized at the early part of magmatic eruption. The peculiarity of the quartz porphyry dolerites indicated that the quartz porphyry dolerites could be a product of late crystallization of magma as quartz crystallizes or fractionates late in magmatic episodes. When hydrothermal fluid that contains quartz comes in contact with a fractured intrusive rock, there is every tendency that the quartz settles in the fracture to form quartz veins or fill up the cavities in the rock. Quartz in the dolerite (quartz porphyry dolerites) could be a product of late and secondary mineralization in the intrusive rocks. Patent metasomatism could be a contributing factor for the formation of the quartz porphyry dolerites.

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