Original Research Article

PETROGRAPHIC ASSESSMENT OF SOME INDUSTRIAL MINERALS IN SELECTED PART OF SOUTHERN BENUE TROUGH, NIGERIA.

Some part of the Southern Benue Trough (Afikpo and Anambra Basins) has been mapped to determine the areas of occurrence of industrial minerals and to determine their lateral extent. The result shows that Southern Benue Trough is enriched with mostly industrial minerals of sedimentary and magmatic origin. The magmatism that occurred in the study area and its evolutionary processes led to mineralization of the study area. Interaction of the magma with host rocks gave rise to mineral genesis. The contamination and assimilation processes that occurred in the magmatic stage resulted to enrichment of minerals in the study area. The contact relationship of the magma with the host rock created a contact aureole though the resultant minerals (metamorphic minerals) of the contact aureole are not significant and exposed. The repetitive transgressive-regressive sedimentary cycle that occurred in the Southern Benue Trough probably resulted to the massive deposition of industrial minerals of sedimentary origin. The dominant and significant industrial minerals in Afikpo and Anambra Basins are sandstones (ferruginized sandstone, calcareous sandstones and carbonaceous sandstones), clay mineral (kaolinite), pebbles, igneous rocks of diverse levels of emplacement(intrusive/ extrusive), olivine , hematite, Feldspar, mica and quartz.

Key words: Industrial, Rocks, Minerals, Benue Trough.

INTRODUCTION

Benue Trough is a failed arm of triple rift (RRR) that formed in the Santonian during the separation of South America from Africa. Ford (1981) documented Benue Trough as a rift structure that originated during the opening time of South Atlantic Ocean, and forming an extension of that original fracture system but failing to open into a true ocean basin .Onwualu – John and Ukaegbu (2009) stated that Benue Trough was formed as a result of series of tectonism, accompanied by magmatism and repetitive sedimentation in the Cretaceous during the separation of South America from Africa. The tectonism/magmatism resulted to the emplacement of magmatic rocks in the Benue Trough. The magmatic rocks in the Southern Benue Trough (Anambra and Afikpo Basins) are mostly basaltic to intermediate in nature. Benue Trough is subdivided into three segments, the Southern Benue Trough, the Middle Benue Trough and the Northern Benue Trough. The Southern Benue Trough is enriched with lots of industrial minerals.

The Southern Benue Trough is enriched with industrial minerals ranging from syenitic-dioritic rocks and basaltic rocks (Onwualu-John and Ukaegbu 2009), sandstones, kaolinitic clay, pebbles. Sediment thickness in Benue Trough is estimated 6500m (Kogbe, 1974) which were generated by repetitive transgressive-regressive sedimentary cycle which also suffered deformation in the Santonian. The deformation of the pre Santonian sediment gave rise to Abakaliki Anticlinorium which has two synclines (Afikpo basin and Anambra Basin). Most of the previous works in Southern Benue Trough have not address the industrial minerals but this research is to ascertain the industrial minerals and uses in some part of the Southern Benue Trough.

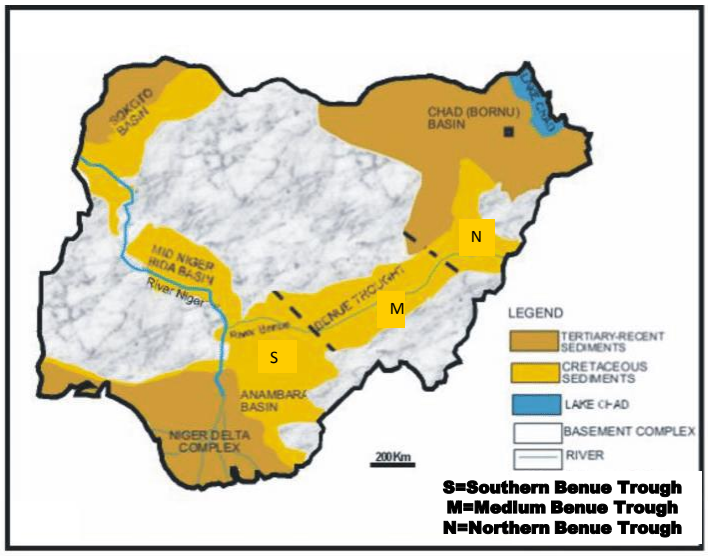

Figure 1: Geologic Map of Benue Trough showing the case study: The Southern Benue Trough (modified from Shettima et al, 2017)

FIELD CHARACTERISTICS AND GEOLOGIC SETTING

The Southern Benue Trough is characterized by pre Santonian and post Santonian Sediments (Onwualu-John and Nwozor, 2016). In the Anambra Basin, the geologic Formation are the Asu River Group, Nkporo Formation, Mamu Formation, Ajali Sandstone, Nsukka Formation and some magmatic rocks which were emplaced during Santonian tectonism.

The field relation at Afikpo Basin consist mostly of Asu River Group, Eze-Aku Formation, Afikpo Sandstone, clays and igneous rocks of mostly basaltic origin. The magmatic rocks in the Southern Benue Trough are structurally controlled to the Abakaliki Anticlinorium. The magmatic rocks form the minor topographic high in the study area.

METHODOLOGY

Field Study:

Physical description

Ten quarries were visited and the contact relationship of the industrial minerals with the host rocks was studied. The magmatic rocks were collected at different pockets of igneous suites in the quarries of the study area. The Magmatic rocks occur as sills and dykes in some of the areas. The basaltic rocks in the Anambra and Afikpo Basin are aphanitic to phaneritic in texture. The presence of mica (biotite) is visible to unaided eye.

The syenitic –dioritic rocks of the Anambra Basin is porphyritic in texture. Micaceous minerals (muscovite and biotite) are pronounced. Quartz and potassium feldspar are among the megascopic minerals in the rock.

Sandstones are dominant at both Afikpo and Anambra Basin, most of the sandstones are ferruginized(rich in iron), Amasiri-Ibii area of Afikpo Basin has massive deposits of calcareous sandstones, whereas Afikpo central has more of carbonaceous sandstones.

Clay minerals are much at Afikpo Basin. Ibi Oziza has deposits of kaolinitic clay and pebbles.

Laboratory Procedures

Thin section of the magmatic rocks were carried out in the following procedure, the rocks were trimmed with the use of cutting machine. The trimmed rocks and the slides were polished on a glass plate that contains mixture of caborandum and water. The rocks were polished to thickness of 0.03mm as to allow light from the microscope to penetrate the rocks during the interpretation of the minerals in the rocks. The slides were polished to create a rough surface for holding the rocks when it will be glued to the slides.

The polish rocks and slides were placed on a hot plate for twenty minutes to dehydrate the water content in them. Araldite gums were placed on the slides and the polished rocks are mounted on the slides. The glued rocks on the slides are placed back on a hot plate of about 250^0C to dry the gum and also remove air bubbles. After the rock samples and the slides are glued together, Canada balsam is spread on another slide to serve as cover slip over the thin sectioned rock.

The thin section with the cover slip are washed with methylated spirit to remove any remnant of the Canada balsam, after which they are washed with clean water and allow to dry, then labelled for easy identification. These thin sections were then studied using petrological microscope.

RESULTS

Table 1 shows the average mineral compositions of basaltic rocks in Afikpo and Anambra basin. The magmatic rocks in Afikpo and Anambra Basin have mineral assemblage of olivine+pyroxene+amphibole+biotite+plagioclase±quartz.

Table 1. Average mineral composition of minerals in basaltic rocks of Afikpo and Anambra Basins

Samples	Mineral Compositions in %							
	olivine	pyroxene	amphibole	biotite	plagioclase	Iron ore (Hematite)	quartz	Total
AFB	20	12	10	15	35	5	3	100
AFD	15	20	5	10	40	7	2	99
AFG	20	15	10	5	45	5	-	100
ANB	10	25	8	10	37	8	2	100
AND	15	20	10	8	40	7	1	101

AFB= Afikpo Basin Basalt
AFD= Afikpo Basin Dolerite
AFG= Afikpo Basin Gabbro
ANB= Anambra Basin Basalt
AND= Anambra Basin Dolerite

The mineral paragenesis of the syenitic–dioritic rocks of Anambra Basin are potassium feldspar + plagioclase feldspar + amphibole +biotite + muscovite + quartz, (Table2).

Table 2: showing the average mineral compositions of syenitic-dioritic rocks of Anambra Basin

Sample	Mineral Compositions in %							
	Potassium feldspar	plagioclase	pyroxene	Amphibole	Biotite	Muscovite	Quartz	Total
ANS-D	30	15	20	10	5	9	10	99

ANS-D= Anambra Basin syenitic-dioritic rocks.

A

B

C

D

Plate A (Dolerite in Uturu) and B (syenitic-dioritic rocks in Ishiagu) represents outcrop of in Anambra and Afikpo Basin while C and D represents aggregates of the rocks used for construction.

Plate E= Pebbles,F = Pebbly Sandstone having sharp contact with Kaoline and G= Sand, outcrops occurred at Oziza, Afikpo Basin

Plate H and I=Shows the kaolinitic clays of the study area (Oziza, Afikpo Basin)

DISCUSSIONS

The geologic activities in the southern Benue Trough led to the mineralization of industrial minerals in the Southern Benue Trough. Onwe et al, (2017) mentioned that Cretaceous stratigraphy of Southern Benue Trough comprise of sediments deposited in three main marine depositional cycles, Albian to Cenomanian, Turonian to Santonian, and Campano to Maastritchtian. Reyment, (1965) documented that the oldest dated sediments exposed in Nigeria are the Lower Cretaceous (Albian) Asu River Group, and parts of the sediments in the Benue Trough were folded, intruded, mineralized while some were metamorphosed. The oldest sediment in the Trough was intruded by basaltic to intermediate rocks. The magmatic rocks of the Southern Benue Trough contain some industrial minerals (feldspar, quartz, mica, olivine, and hematite). These minerals are embodiment of the magma because magma are characterized by their constituent minerals/elements (O'Hara, 1965) The mineral compositions of the magmatic rocks range from mafic to felsic . The magmatic rocks of the study area can serve as excellent aggregates for construction of buildings, bridges and highways. In the southern Benue Trough, industrial minerals are mostly magmatic and sedimentary origin. The industrial minerals of the study area can be used as filters, abrasives and refractories. Nigeria has about forty –four known major mineral deposits and half of this number is found in Lower Benue Trough (Fatoye and Gideon, 2013)

Pebbles and Sands: At Afikpo area much pebbles are exposed on the landscapes, the pebbles appear as inland pebbles. It could be that the study area was an inland covered by ancient seas but when the seas regresses, the pebbles became landlocked. Most concretes in constructions, decorative stones and roofing slates are made with sands and pebbles. Pebbles are also used to design walkways or drive ways. The pebbles colours range from white to brown.

Sandstones: The sandstones of the southern Benue Trough range from ferruginous sandstones, carbonaceous to calcareous sandstones. The ferruginous sandstones are rich in iron and in some part of Afikpo basin; they contain some pebbles (Plate G). Calcareous sandstones are rich in calcium carbonate while the carbonaceous sandstones have much of carbon. The Sand/or sandstones and pebbles of the Southern Benue Trough are rich in quartz, tables 1 and 2 show also the average concentrations of quartz in the rocks. Quartz is the most abundant mineral in the earth. It is used in glass making, silica bricks, paint and soap scouring (Kogel et.al 2006), jewelry and porcelain making. Quartz is also used in construction industries.

Clays (kaoline): Clays are products of weathering or hydrothermal alteration of rocks containing alumino silicate minerals (Bakari, 2015). Kaolinitic clay is white to reddish brown in colour. Clays are used in ceramics and plastic industries, paint, pharmaceutical and petrochemical industries. Kaolinitic clays are used in making tiles. Clays have been found useful in iron and steel industries and also serve as filters for impurities.

Feldspar: feldspar is the next abundant mineral in the earth after quartz or silica. Most feldspar originates from magma fractionation. The alkaline and alumina content of feldspar is very useful for the industry. Feldspar is used as a constituent in making ceramics, pottery and tiles. It is also used as insulator in electrical industries. Feldspar is used in paint, plastic and rubber industries. Feldspar is used in metallurgical industries due to its resistance to chemical corrosion.

Mica: Mica is a phyllosilicate rock forming mineral. It is mostly associated with magma and hydrous in nature with sheet like structure. Muscovite (potassium mica), biotite (magnesium –ion mica), phylogopite (magnesium mica) are mostly of very high economic values. The rocks of the

study area are made up of biotite and muscovite. Mica is used by electrical industries and can serve as an insulator to electrical appliances. Mica is used in paint industries. Due to the luster nature of mica, it is used in cosmetics industry.

Hematite: hematite is an ore of iron. Iron ore is a raw material in the production of iron. It is used in steel and automobiles industries. Iron ores are also used in construction industries. Hematite is used in paint industries.

Olivine: Olivine is a very high temperature mineral that are seen in basaltic magma. It is the first mineral to fractionate out during the evolutionary stage of magma. Olivine can be magnesium rich (forsterite) or iron rich (fayalite), ($Mg^{2+,}$ Fe^{2+}) 2Sio4. It is a rock forming mineral. Olivine is used as a refractory material, used to make refractory bricks and also used as casting material, (Hobert, 2005). Olivine is as well used in metallurgical industries. Olivine can be used in petrochemical industries. Olivine has been discovered as one of the minerals that can act as a catalyst in converting organic matter to hydrocarbon (Jin, 1988; Mango, 1992).

CONCLUSION

Most of the industrial minerals in the southern Benue Trough are of economic values, With adequate financing, provision of mineral processing equipment and power, few of the industrial minerals that are of sub-economic quantity will be enhance and mined. This research focuses on the surface mapping of the study area and there are evidences of sub surface mineral deposits which are an insight for decision making when selecting sites for industrial applications by large and small scale industries.

The development of the industrial minerals of the study area will enhance the economy of the area/nation and as well help to eradicate/minimize poverty and unemployment. Processing of these minerals into a polish and final products like tiles, ceramics, glasses and bottles, electrical gargets, jewelries will reduced the rate of importation of these articles from western countries.

It is advisable that the government should also empower the local miners by giving them skillful training and assist them to acquire mechanized equipments which can enhance the mining and processing of these minerals. Conclusively, the Southern Benue Trough is enriched with industrial minerals which can be used to develop the wealth of a nation.

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