IJAAR PUBLISHING®
DOI: 10.46654

Engineering Research Journal | ISSN: **2782-8212**
Vol. 2, Issue 10 (October, 2022) | www.ijaar.org/erj

ECONOMIC VIABILITY OF THE ABUNDANT GRANITE AND ASSOCIATED BASEMENT CRYSTALLINE ROCKS OF LOKOJA AND ITS ENVIRONS

Murtala Ibrahim
Social Science Department,
School of Preliminary Studies,
Kogi State Polytechnic, Lokoja

Omejeh, Timothy Enejoh
Minerals and Petroleum Resources Engineering
School of Engineering
Kogi State Polytechnic, Lokoja

Adino Ernest Ojone
Civil Engineering Department
School of Engineering
Kogi State Polytechnic, Lokoja

ABSTRACT:
Lokoja and its environs are naturally blessed with intrusive and extrusive rocks, majorly Granite. Outcrops of these rocks are seen littered everywhere in and around Lokoja with or no consideration for the economic viability of these massive and abundant resources. Granites to some countries are a major source of foreign exchange not to talk about the local consumption and usage of this rock. Countries that have made great economic gain by exportation of granite include: China, India, Italy, Brazil, Canada, Germany, Sweden, Spain and the United States (Parmodh, 2009). This research work is intended to critically evaluate this rock and its physical and chemical properties, mineralogical compositions, petrological structure and of course its usefulness in boosting the economic growth of Kogi state and Nigeria in general. An analysis of employment generation possibilities, industrialization potentials, revenue generation through local and international consumption, its usage as cheap alternatives for ornaments, gems and its recreational potentials are subjects of this research.

Keywords: Granite, Petrology, Basement Crystalline Rocks, Economic Viability.

INTRODUCTION

Granite is a medium to coarse-grained, light-colored intrusive igneous rock that primarily consists of quartz, alkali, feldspar, and plagioclase. It may also contain other minerals such as biotite, hornblende, muscovite, cordierite, magnetite, ilmenite, apatite, zircon, and titanium dioxide (sphene) (www.geol.lsu.edu). The most frequent intrusive rock in the Earth's continental crust is granite, which is best known as an ornamental stone with pink, white, grey, and black flecks. It might be coarse- to medium-grained in terms of size. Its three main constituents are feldspar, quartz, and mica, which can be found in the forms of dark biotite, silvery muscovite, or both (www.geol.lsu.edu).

Granite is primarily a granular, phaneritic igneous rock that is both intrusive and extrusive. A petrographic examination is necessary to identify particular types of granitoids because the term "granitoid" is a general, descriptive field term for lighter-colored, coarse-grained igneous rocks. Depending on their origin and mineralogical makeup, granitoids can be predominantly white, pink, or grey in color. (Geology.about.com). The term "granite" comes from the Latin word granum, which meaning "a grain," and refers to the totally crystalline rock's coarse-grained structure (Read, 1943). Granite is an igneous rock that typically contains between 20% and 60% quartz, at least 35% feldspar, and a few other ancillary minerals. Rare granitic rocks that contain more than 60% quartz are referred to as quartz-rich granitoid, or quartzolite if they are practically completely quartz (Blatt, 1996).

Granite outcrops frequently take the shape of rounded massifs and "tors." Some granites are generated by the metamorphic aureole or hornfels and are found in circular depressions surrounded by a range of granitic hills. They also occur in batholiths, which are frequently connected to granitic-orogenic mountain ranges, as small stock masses or boulders that are less than 100 km2. Granitic intrusions are frequently seen in association with small granite composition dikes known as "aplites." In some places, masses of highly coarse-grained pegmatite coexist with granite (Twidale, 1982).

Granite's chemical make-up consists of 70–77% silica (SiO_2), 11–13% alumina (Al_2O_3), 3%–5% potash (K_2O), 3%–5% soda (Na_2O), 1% lime (CaO), 2-3% total iron, and less than 1% each of magnesia (MgO) and titania (TiO_2). In terms of volcanic equivalents to the QAP diagram, rhyolite and rhyodacite roughly correspond to the less and more calcium-rich equivalents of granite (ss), respectively. Dacite corresponds to granodiorite and tonalite, quartz latite to quartz monzonite, and basalt and andesite correspond to diorite, quartz monzodiorite, and gabbro, with the higher silica volcanics (> 52

Basement rocks are defined as crystalline rocks that are located below sedimentary platforms or covers, or more broadly, any rock that is metamorphic or igneous in nature and is located below sedimentary rocks or basins. Moreno et al. (2007), referenced in Ozulu et al. 2019 (Moreno et al. The physical makeup, chemical composition, and causes and effects of loads on these crystalline rocks that form the Earth's foundation are all subjects of research for basement rocks in terms of their petrology, geology, and structural interpretation (Ozulu et al., 2019).

The study area, Lokoja and its surroundings, is located at 7° 47' 48.77" N, 6° 44' 25.73" E, and has an abundance of this rock type. The area is made up of Basement Complex rocks, highly migmatized gneisses, and granodiorite (Biotite Hornblende Granodiorite, Biotite Hornblende Granite, Porphyritic Biotite Granite, and Muscovite Biotite).

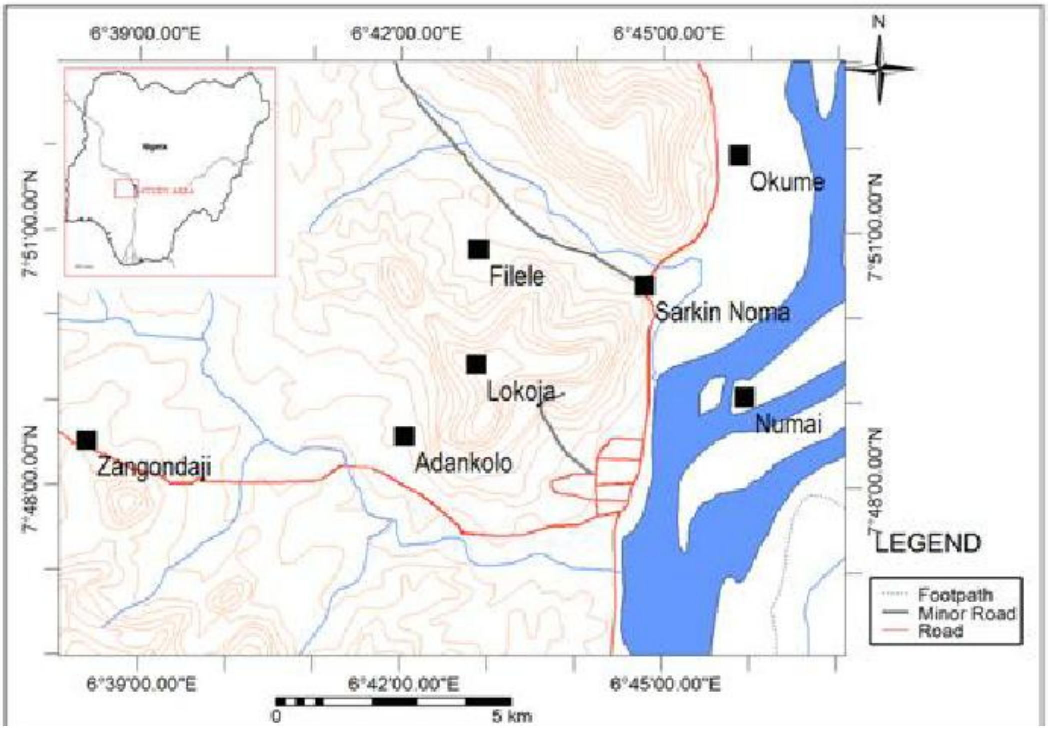

FIG 1: Topograpic map of lokoja

MATERIALS AND METHODS

Three major research methods were used in carrying out this work. These are:

- ❖ Selective Field Mapping and Sampling
- ❖ ii)Laboratory Analyses and
- ❖ iii)Desk-top Interpretation

The first objective of this study was to carry out a detailed reconnaissance survey of the study area by traversing (physically and visually investigating outcrops and rocks) through to determine the types. This was then followed by sampling, laboratory analyses (to determine the petrological properties, tensile and compressive strength test) and desk-top interpretation. Rock types were identified and megascopic studies were carried out. Structural features were observed at the various outcrops and these were recorded in the field notebook. 24 fresh rock samples were chosen from around the whole study area, out of which a total of four (4) rock samples were taken for petrological studies.

Fresh representative samples were collected at designated locations and lithologic units using clean black cellophane paper. Samples from these locations were designated with specific codes as E1-E4. Rocks were sampled on the road cut along the New Okene-Abuja highway, Ibaji quarters, and Salem University, for detailed petrographic study. Megascopically (in hand specimen) describing the rock samples was done in the field, and thin sections preparation was done in the lab. Care was taken while collecting the samples to ensure that they were truly representative of the conditions that existed as at the time of collection. This certainly, was to prevent possible contamination before the actual analyses.

During petrographic analysis, each rock sample was cut into a thin section using the Thin Section Machine (Hillquist Model). The Sorby (1882) method, which was cited by Reed and Mergner (1945), was followed. Rock samples were examined with a Petrographic Microscope (Carl/Zeiss/JENA Model) using Plane Polarized Light (PPL) and Cross Polarized Light after the thin section processing (XPL). The main objective was to properly identify the rock types and ascertain their mineralogical composition. The modal composition was determined to know the individual mineral constituents present in the individual rock samples.

For the compressive strength test, Crushed granite (aggregate) was used in a trial mix (concrete mix), to know its strength, when used for construction purposes. This concrete mix was poured in the 15cm x 15cm x 15m. In order to eliminate and prevent any voids, the mold must be properly tempered. Molds were removed after 24 hours, and test specimens were then placed in water that was at room temperature for curing.

After seven and 28 days of cure, these specimens are evaluated using a compression testing equipment.

For the Desk-top interpretation, a laptop with installed Autocad was used to construct the topographic map.

RESULTS AND DISCUSSON
AREA OF STUDY.

Lokoja as a whole is composed of abundant basement crystalline rocks with an overburden of soft rocks. Basement rocks which include highly-migmatised granite, Basaltic rocks, medium-coarse grained igneous rocks, and as a result, lots of solid minerals are located deeply embedded in both the soft rocks and in the veins of the crystalline rocks.

PETROGRAPHY

Following the steps outlined by Sorby (1882) in Reed and Mergner (1945), the petrographic analysis was prepared for. After the thin section was created, it was examined with cross and plane polarized light using a petrographic microscope.

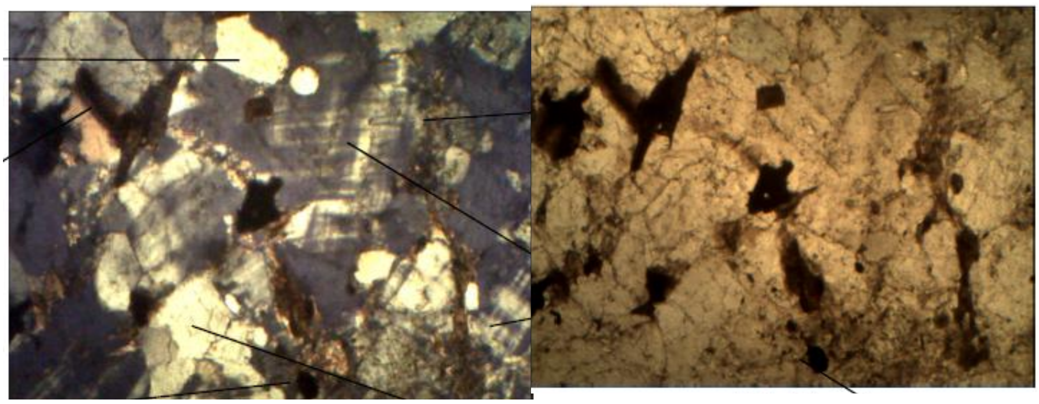

Plate 1: Photomicrograph of granite of E1 in (a) Cross Polarized Light (b) Plane Polarized Light, x10

Minerals found in E1, Quartz, Microcline, Feldspar and Hornblende under the Crossed Polarised Light while it appeared opaque under PPL.

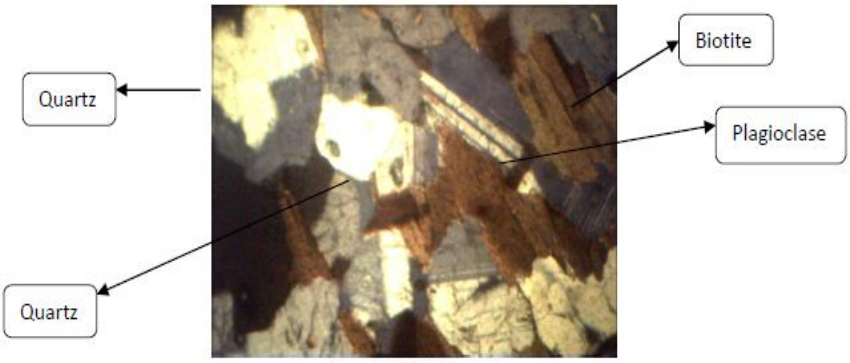

Plate 2: Photomicrograph of granite of E2 under Crossed Polarised Light.

Plate 3: Photomicrograph of granite at E3 and E4 under cross and Plane Polarised Light.

TABLE 1: MINERAL COMPOSITION OF SAMPLED GRANITE.

SAMPLE CODE	*MINERALS IN PERCENTAGE (%)*	*TOTAL*
E1	Quartz-89.47, Feldspar-1.75, Microcline-3.52, Hornfels-5.26	100
E2	Quartz-66.10, Microcline-13.56, Biotite-10.17, Plagioclase-6.78, others-3.39	100
E3	Quartz-35, Hornfels-10, Biotite-10, Plagioclase-20, Orthoclase-25	100
E4	Quartz- 25, Hornfels-20, Biotite-10, Plagioclase-20, Orthoclase-25.	100

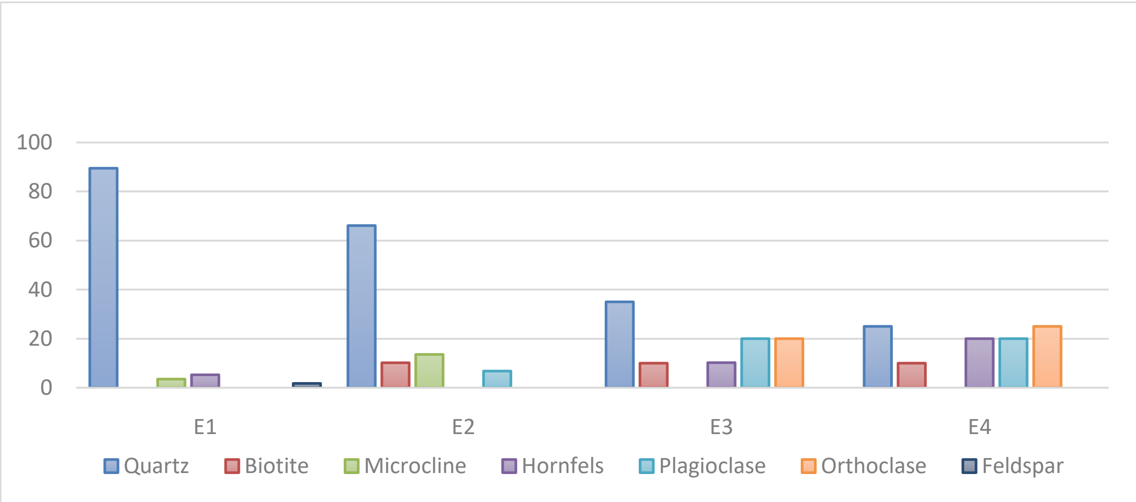

Fig 2: Chart Comparing Mineral Composition of Rocks from Study Area.

COMPRESSIVE STRENGTH ANALYSIS:

Compressive testing demonstrates how a material will respond to compression. Compression testing can assess a material's plastic flow behavior and ductile fracture limits as well as the behavior or response of the material under crushing loads.

The load applied at the point of failure to the cross-section area of the face on which load was applied is the formula for compressive strength for any material.

Load / Cross-sectional Area determines compressive strength.

Table 2: Compressive strength Analysis after 7 and 28 days of curing.

	Test cube A	Test cube C	Average	Test cube B	Test cube D	Test cube E	Average
Early strength	7 days			28 days			
Weight of cubes	8.127	8.043	8.1	8.024	8.094	8.126	8.1
Unit weight	2.408	2.383	2.4	2.377	2.396	2.408	2.4
Force	850	750	800	1010	1040	990	1013.0
CS Area		150x150					
Compressive strength	38.0	33.0	35.5	45.0	46.0	44.0	45.0

PHYSICAL PROPERTIES OF GRANITE:

From all physical and laboratory test carried out on granites from the study area, we can infer the following;

- ❖ It contains a lot of silica. The rock has a lot of silica because it is mostly composed of silica from magma.
- ❖ Resistance to decay; the high silica content of granite makes it resistant to decay…little wonder structures made of granite are long-lasting and usually withstand the test of time.
- ❖ The grain sizes make it easy to be used for different purposes.
- ❖ Granite is composed of few mineral assemblages and hence makes it reasonably resistant to fire.
- ❖ The volcanic nature of granite makes it exceptionally polishable for use in construction, as a hard, polished surface may persist comparatively longer than that of other stones.
- ❖ Just like in the case of fire resistance, granite is also relatively resistant to frost due to its few mineral assemblage.
- ❖ Fractures generally do not occur on granite.
- ❖ Granite is easily quarried stone as a result of its mural joint.

USES / APPLICATION OF GRANITE.

One of the hardest materials known to man is granite. Its durability and strength have led to its widespread use for decades;

- **Building monuments;** structures which are supposed to withstand the test of time are made with tough materials like granite, such as monuments, gravestone, temples etc.
- **Making fireplace mantle and floor;** in countries having extreme cold weathers year-round, make use of granite to build their fireplace mantle, making their living space beautiful and attractive. Granite makes a sleek and perfect flooring, as tiles make of granites are made with beautiful pattern, different shape and sizes.
- **Construction purpose**; just as in the compressive strength done above, granite forms part of aggregate used in concrete mix-design, used mainly for construction of bridges (reinforcement blocks to hang and hold the bridge), buildings, dams and roads etc.
- **Production of Jewellery**; due to its process of formation, granite are mostly beautiful as different mineral assemblages are found in its formation, they are used in jewellery making and as ornaments of decoration.
- **Kitchen design**; most houses, especially in Lokoja and environs makes use of granite for their kitchen counter tops, wash-hand basins in their bathroom and even floors as it is easier to clean, durable and strong.
- **Sculptures**; most sculptures are made solely of granite, as their durability is in play, most sculptures done from granite still stands even after decayed, as can be seen in many homes today.
- **Sports**; around Lokoja, granite rocks are used as a form of sport (rock climbing) and entertainment (picnic on rock plateau), granite is one of the rocks most prized by climbers, for its steepness, soundness, crack systems and friction.

CONCLUSION

Granite's industrial and economic viability dates back to early civilization in Ancient Egypt (Nelson, 2009).

Its commercial value is in the following areas: sculpture, carving and memorials, building and construction, gems and ornamentals, dimension stones and flooring tiles and sports (as in rock climbing). Granitic outcrops are located in almost everywhere within Lokoja and its environ, largely overlain with soft rock overburden in some locations and largely visible in others, namely; Nataco, Lokoja-okene road, salem university and environ, Jimgbe community, ganaja community, Kporoko community.

If royalties are to be Paid into the State Government coffers per ton of granite blasted, one can only imagine how much money that would be from the miners to the government, and in turn, how developed the Kogi state would have been. But is there any structure in place for this?

REFERENCE

Ayuba, R., (Et al.,) (2015), Geoelectrical Investigation of Basement Complex Areas of Lokoja, North-Central Nigeria. British Journal of Applied Sciences & Technology, 7(6): 573-584, 2015, Article no. BJAST.2015.573 ISSN: 2231-0843.

Blatt, Harvey; Tracy, Roberrt J. (1996). Petrology: igneous, sedimentary and metamorphic (2nd ed.). New York: W.H. Freeman. P.45. ISBN 0-7167-2438-3.

"Granitoids-Granite and the Related Rocks Granodiorite, diorite and Tonalite" Geology.aboutcom.2010-02-06. Retrieved 2022-08-30.

Https://www.Sciencedirect.com

https://www.Vedantu.com

https://www.geol.lsu.edu/henry/Geology3041/classify/igclassf.htm

Ozulu G.U., Odoma, A.N., Akudo, E.O., and Emmanuel. B., (2019), Petrology and Structural Analysis of Basement Rocks around Ibaji Quarters, Gadumo Area of Lokoja, Central Nigeria. Salem University Journal of Physical Sciences, Vol.1, pp. 1-17, ISBN 97897858775-9-6.

Reed, H.H. (January, 1943). "Meditations on granite: Part One". Proceedings of the Geologists' Association. 54(2): 64-85. Doi:10.1016/S0016-7878(43)80008-0.

Reed, S. R., and Mergner, J. I., (1945), Preparation of Rock Thin Sections. U. S. Geological Survey Report, Washington, D. C. 1184 – 1203. Retrieved from: http://www.mirisocam.org/ammin/am38/am38_1184.pdf.10/06/2015.

Streckeisen, A. L., 1974. Classification and Nomenclature of Plutonic Rocks. Recommendations of the IUGS Sub commission on the Systematics of Igneous Rocks. Geologische Rundschau. Internationale Zeitschrift für Geologie. Stuttgart. Vol.63, p.773-785.

Twidale, C.R. (1982). *Granite landforms.* Amsterdam: Elsevier Scientific Pub. Co. ISBN 0444421165.