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LITHOLOGIC FEATURES AND URANIUM POSSIBILITIES OF THE GRANITES OF PUPULE, ADAMAWA MASSIF N.E. NIGERIA

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ABSTRACT

Preliminary lithologic and uranium investigation conducted in Pupule and environs to investigate further the area of uranium mineralisation in the neighbouring district revealed that the area is not attractive for further uranium search. Geologic field mapping shows that the area like most other parts of the region is underlain predominantly by fine-grained granites, equigranular granites and porphyritic granites. Data obtained from the radiometric investigation indicate fairly enhanced radiometric values of only 200 cps above the background counts of 100 cps. Data treatment and interpretation of the result suggest that the fairly enhanced radioactivity in the fine-grained granite, southeast of Pupule, may be related to high background values rather than concentration of uranium minerals in this rock that may justify further more detailed investigation.

KEYWORDS: Uranium, Granite, Geology, Pupule, Nigeria

INTRODUCTION

Nigeria does not only lie in the same region with countries in which uranium exploration has produced encouraging results but shares common boundary with these countries. For instance, Nigeria is bordered by Niger Republic in the northern part and by Chad Republic in the northeasthern part (Fig. 1). In both countries, uranium exploration has led to economic discoveries. For instance, according to a Joint Report by the Organisation for Economic Co-operation and Development (OECD) (2014), uranium exploration began in Niger Republic in 1956 in the Arlit area and by 1957 it has yielded the first discovery in the sandstone at Azelik. Encouraged by this discovery, further studies of the sandstone resulted in the discoveries of Abokurum, Madaouela, Arlette, Ariege, Artois and Taza, Imouraren and Akouta deposits. By 1971, production from the Arlette deposit had commenced by open-pit mining. Production from Arkouta and Akola deposits started in 1974 by underground operation. In 2004, COGEMA (now AREVA) and the government of Niger signed an agreement to undertake a major exploration programme and in subsequent years previously discovered deposits have been delineated and evaluated. In 2006, the China National Nuclear Corporation (CNNC) signed an agreement to develop the Azelik-Abokurum deposit and by the end of December 2010, first production was reported. All uranium deposits in Niger are located within the Mersoï Basin similar to the sedimentary basins in Nigeria.

In the Chad Republic, an area of about 10,000km^2 in the south western part of the country was covered by aerial radiometric and magnetic surveys between 1972 and 1980. As a result, several radiometric anomalies were found in both granitic and sedimentary terrain and vein-type uranium mineralization in the Lere alkaline granite. In 1978, a UNDP-supported project resulted in the discovery of uranium mineralization in the syenitic Mayo-kebbi area near the border with Cameron Republic which also shares its western border with Nigeria.

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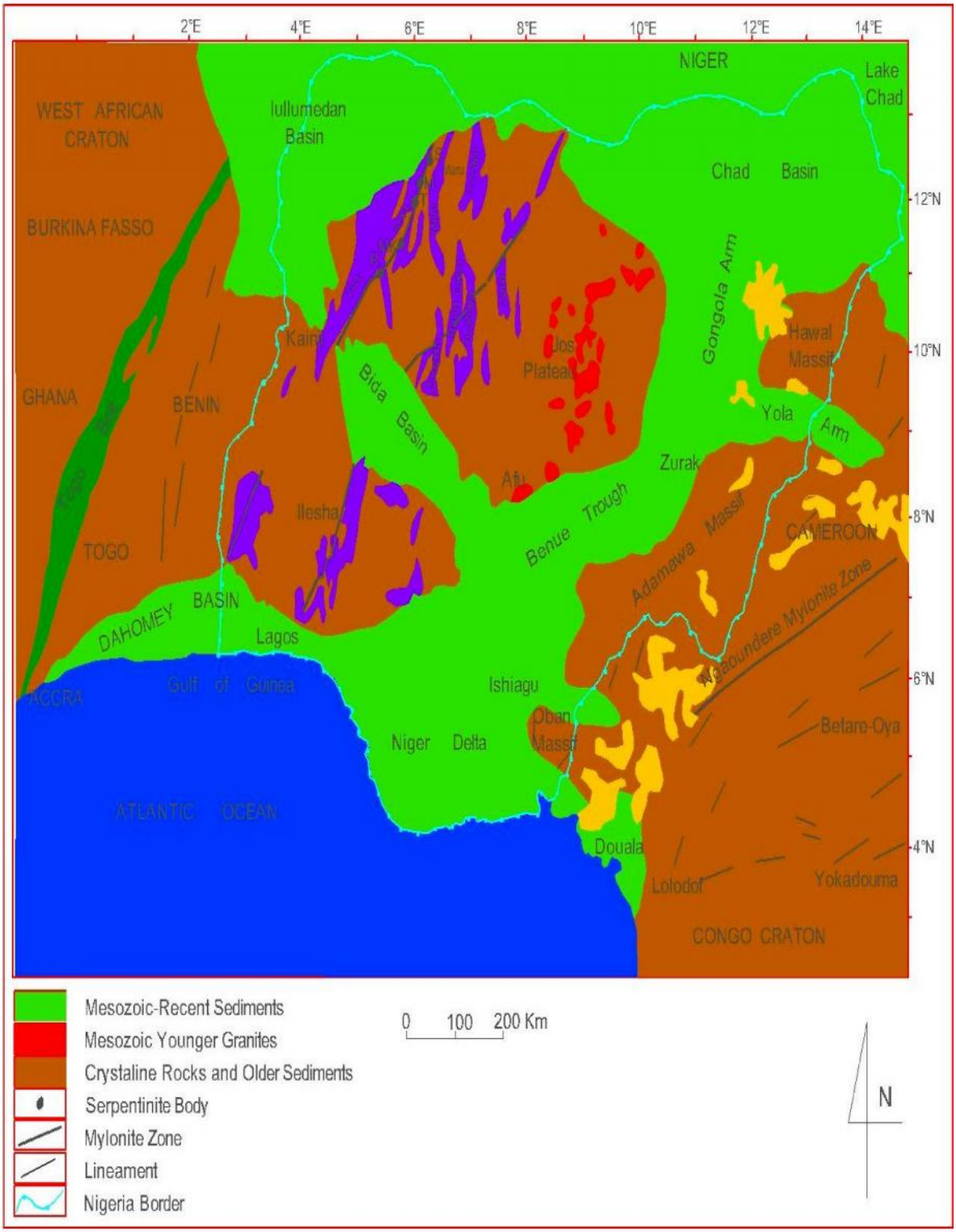

Fig. 1: Geology of Nigeria and the adjoining areas (modified after Geological Survey of Nigeria, Geological Survey of Nigeria, 1974)

In Nigeria, regional survey in the early 1980s involving airborne radiometry for the entire national territory was carried out. The result of the survey lent fresh direction and impetus for uranium exploration and identified the northeastern part of the country as the potential region for further uranium prospecting. Subsequent investigations and geological mapping led to the discovery of some vein-type and sediment-hosted uranium occurrences. These include the Mika deposit, Ghumchi deposit; Zona deposit and the Kanawa deposit (Okujeni and others, 1988; Funtua et al., 1992; Ogunleye and Okujeni, 1993; Funtua and Okujeni, 1996). This result, coupled with the geological similarity and proximity of Nigeria to the aforementioned countries with economic uranium deposits, suggest that further exploration work, especially in areas with uranium prospects may reveal more and better deposits.

In recent years, Haruna et al., (2011a), Haruna et al., (2011b), Haruna et al., (2011c), Haruna et al., (2012a), Haruna et al., (2012b), lunched a ground radiometric programme in the vicinity of some of these previously discovered occurrences and other promising areas to see if the existing occurrences can be expanded or new ones discovered. The results were encouraging as they revealed indications of radiometric anomalies that may be followed up with more detailed investigations. The present work is a continuation of the programme. It examines the lithologic features and uranium possibilities of the granites of Pupule and environs.

FIELD PROCEDURE

The field work involved rock sample collection, rocks description and radiometric measurements along traverses. Fresh rock samples were collected at stations with noticeable changes in texture, structure, mineralogy and colour. Weathered rock samples were also investigated for uranium minerals. The collected fresh samples were properly labelled in the field and subsequently transported to the petrology laboratory of the department of geology, Modibbo Adama University of Technology for thin section preparation and petrographic study.

Radiometric survey was carried out using a McPhar model TC-33A portable gamma ray scintillometer (specifically designed for use in uranium prospecting) and a Global Positioning System (GPS) Receiver for taking coordinates. Before the commencement of the actual radiometric measurement in the study area, measurements of radioactivity in granitic rocks outside the study area were made in order to have an idea of background values. Subsequently, traverses were made in the study area with the scintillometer turned on and held about 1m above the ground.

RESULTS

Lithology and field characteristics

The predominant rock units of the study area were found to be equigranular medium-grained granites and porphyritic granites with subordinate fine-grained granite (Fig. 2). Although texturally different, these rocks show no significant variation in mineralogy.

Fine-grained Granite

The fine-grained granites like most rocks in the area are massive having practically no linear or planar structures. The rock is fine-grained and show very little or no variation in texture. The colour is generally brown with grey patches in a few locations. Inclusions are clearly lacking. This is in sharp contrast with similar rocks with inclusions occurring as irregular bodies and as vein-like lenses within the equigranular granite having sharp contact relationship around Monkin in the far southern part of the study area.

Fine-grained granite is of restricted occurrence in the study area. It occurs as a low-lying intrusive only in south-eastern part of the study area. Here, the rock occupies a linear stretch of land that extends for about three kilometres in a SE-NW direction. Mineralogy of the fine-grained granite is similar to those of other rock units in the area. It consists essentially of microcline, K-feldspar, quartz, plagioclase, biotite and accessory apatite, zircon sphene, and opaque (Table 1).

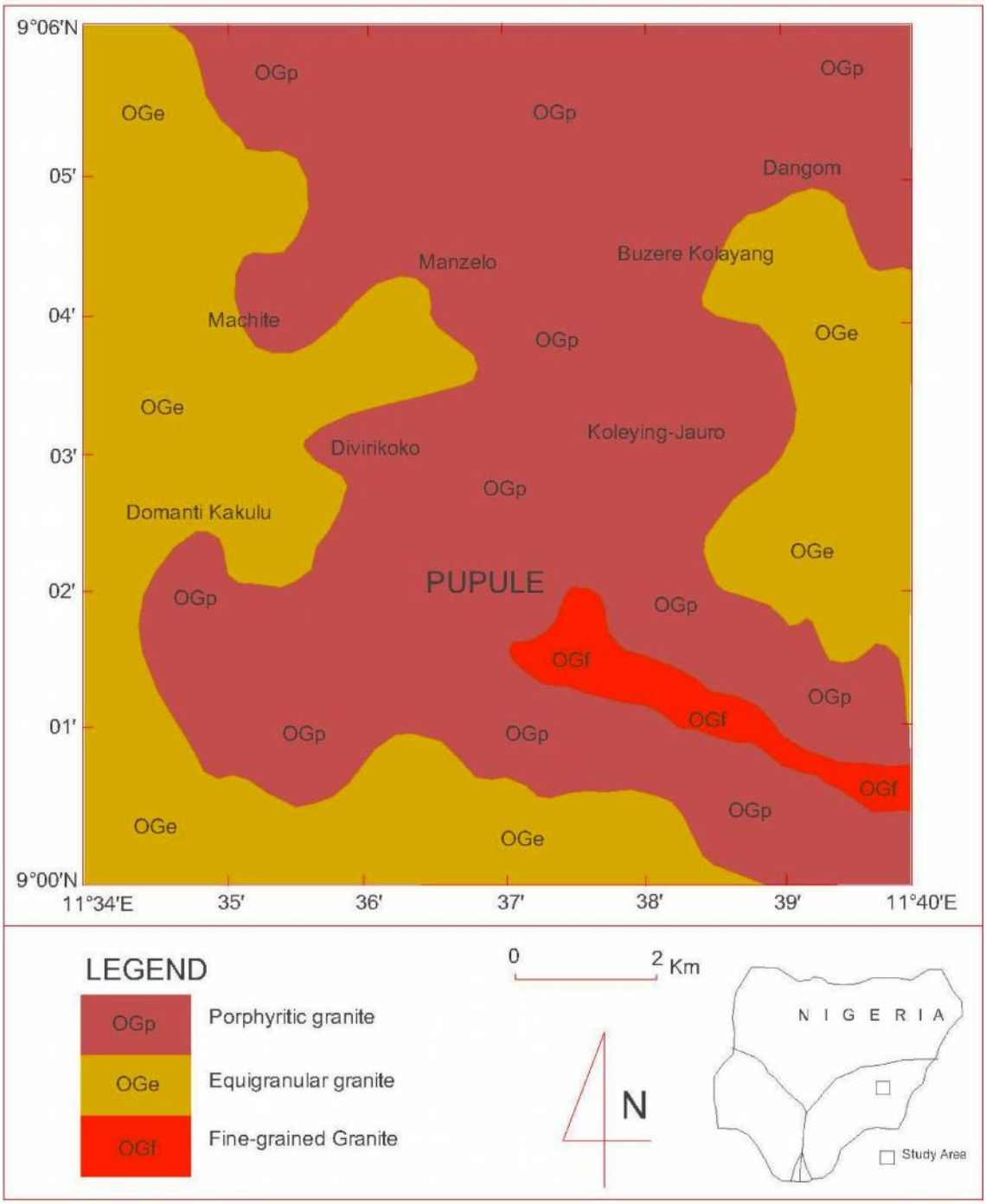

Fig. 2: Geology of Pupule (present work)

Equigranular Granite

The equigranular granites, like the fine-grained granites are massive with practically no structures. They are predominantly medium-grained but vary from this texture to coarse-grained in some places especially towards their boundaries with the porphyritic granites. In a few, locations the equigranular granites are slightly foliated with the foliation marked by feldspar and biotite crystals. Mafic inclusions, irregular in shape are sporadically observed in a few places. Quartz-feldspar pegmatites are common probably representing late fluid segregation. Contacts between the equigranular granites and the fine-grained granites are both sharp and transitional. In terms of colour, two varieties of equigranular granites are distinguishable in the field. These are the pink and the grey varieties. Both are texturally similar but only slightly variable in mineralogy.

The equigranular granites are wide spread in the area, occupying a vast expanse of land from the eastern to southern and western parts of the study area. In these areas, they occur as low-lying subcircular plutons except in the north-western part where they form a chain of hills in a west-east direction.

Identifiable minerals in the equigranular granites include: potassium feldspar, microcline, quartz, plagioclase, biotite with accessory sphene, zircon and opaques (Table 1).

Porphyritic Granite

The porphyritic granites consist of phenocrysts of microcline (measuring about 15mm x 25mm to about 30mm x 35mm) set in a medium- to coarse-grained texture ranging in size from about 1.5mm x 2mm to about 3mm x 3.5mm. They are relatively homogeneous, but like the equigranular granites, two varieties are distinguishable in the field: these are the pink and grey varieties. Although the two varieties are slightly variable in mineralogy, they have the same gradational contact relationship with the equigranular varieties. The transition from equigranular granite to porphyritic granite is marked by gradual increase in the number of microcline phenocrysts.

Like the porphyritic granites of other parts within this region, the porphyritic granites of this area occur as massive intrusions in which the acidic composition grades into a fairly basic variety at the margins of the intrusions. Ferromagnesian minerals are mainly biotite. Composition and texture of porphyritic granite changes as one traverses the intrusions from the center to the margins. At the center, feldspar phenocrysts are crowded and gradually changes towards the edges where they are less crowded, few and scattered.

Acid segregation such as quartz-feldspar pegmatites, common in the equigranular granites, are scarce in the porphyritic granites. The rock contains less enclaves but within the marginal facies, inclusions of basic rocks (probably patches of migmatites) are frequently seen.

Porphyritic granites are widespread and extensive in the central to northern parts of the study area. The greater portion of the range of hills in the northern part of Pupule is underlain by porphyritic granites.

The porphyritic granites consist principally of microcline, quartz, plagioclase, K-feldspar and biotite (Table 1).

Table 1: Modal composition of fifteen (15) granite samples from Pupule area

	Equigranular Granite	Porphyritic Granite	Fine-grained Granite
Quartz	17	23	20
Microcline	12	9	8
K-Feldspar	42	40	47
Plagioclase	18	15	14
Biotite	4	5	5
Muscovite	3	2	-
Apatite	-	2	1
Zircon	1	1	2
Sphene	2	1	1
Opaque	1	2	2

Radiometric Data Treatment and Presentation

The data obtained from the survey were presented in appendix I and summarised in Table 2. To provide a clear and pictorial view of the result, a chart and Isorad map of same data were also presented (Fig.3 and Fig. 4).

Table 2: Percentage Frequencies of Radioactivity Values (cps) in the granites of Pupule Area

Class of Radioactivity (cps)	Number of Frequency	Percentage Frequency
00-50	164	75.58
51-100	45	20.74
101-150	3	1.38
151-200	5	2.3
201-250	0	0
Total	217	100

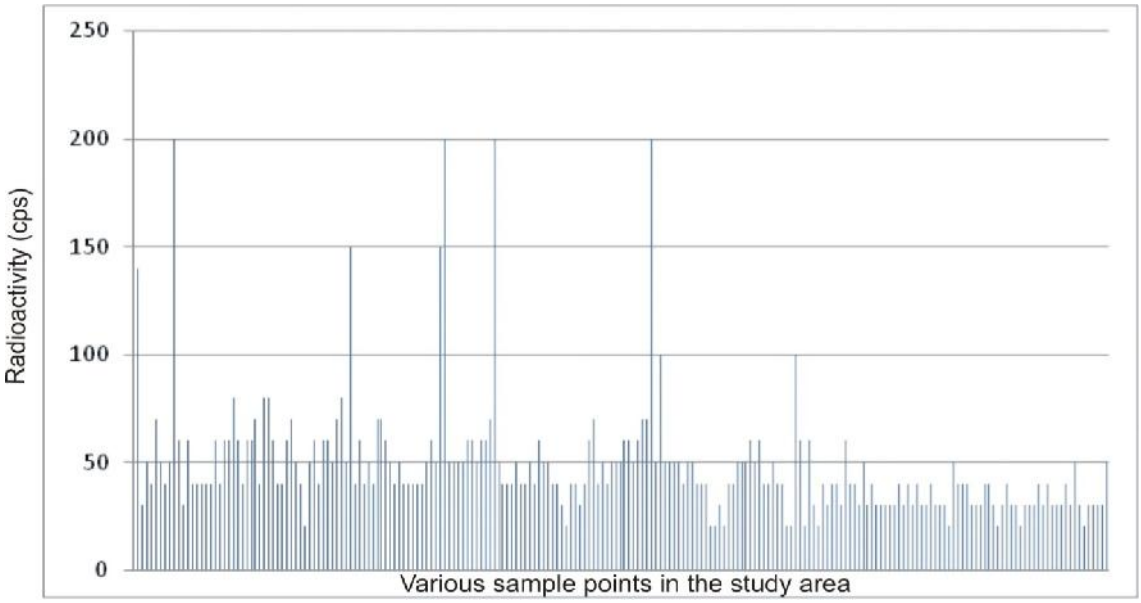

Fig. 3: Bar Chart of distribution of radioactivity in the study area

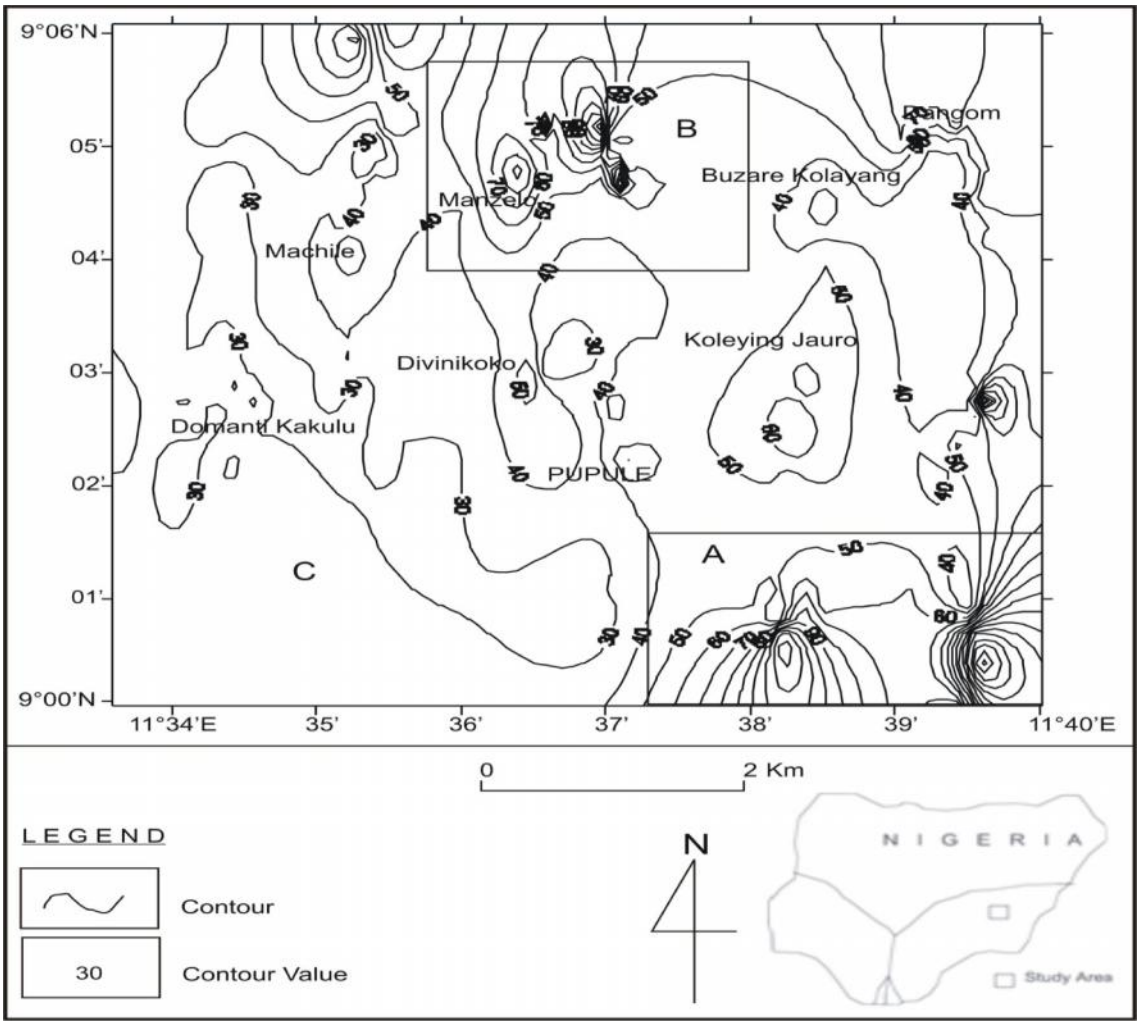

Fig. 4: Isorad map of Pupule. The contour lines show lines of equal radioactivity

In Figure 4, the relative spacing of the contour lines indicates the relative gradient of the radioactivity. The having radioactivity values within the limits defined by the two enclosing contours. On the map therefore, lines

represented by the highest values, then lines connecting points of next highest radioactivity and so on. However, such values may not be clearly seen when the clustering of lines is intense as is the case of Figure 4, hence the need for a Bar Chart (Fig. 3).

From Figure 4, two populations of data are evident. These are represented by areas 'A' and 'B' in the figure. Area 'A' lies within the fine-grained granite, south of Koleying Jauro while area 'B' is situated within the porphyritic granite west of Buzare Kolayang. Although these areas have the highest radioactivity, the values form only 2.3% (Table 2) of the entire data. The remaining areas marked 'C' contains the background counts. The map shows the location, size and shape of the areas of greatest radioactivity and may therefore provide a clue to probable areas (if any) of radioactive minerals that might be followed up with a more detailed study.

DISCUSSION

The greater part of the study area (marked 'C' on the map) is characterised by background radioactivity. This area covers all of the equigranular medium-grained granites and parts of the porphyritic and fine-grained granites. The slightly high values in the fine-grained granites are consistent with the results of similar studies carried out in other areas within the region that such rocks are uranium-enhanced. For instant, Haruna et al., (2011a) carried out similar work in Monkin and found that the fine-grained granites were enriched in uranium relative to other rock units. Clusters of high values on the isorad map are therefore likely areas for radioactive minerals like uranium. Thus, the elevated readings over fine-grained granites in an area (marked 'A') on the southeastern portion of the study area may be lithological rather than structural. The fine-grained granites of Pupule are massive and lack structures. The radiometric values of 200 cps over these fine-grained granites are far less than the 2400 cps values recorded over the fine-grained granites of Monkin. The difference may be explained by the numerous fractures that characterized the fine-grained granites of Monkin. In Monkin, uranium mineralisation might have been structurally controlled. Such mineralization would commonly involve secondary remobilisation of uranium from the primary ore minerals and concentration of the secondary uranium in fractures in response to low temperature oxygen-bearing water. This leads to higher uranium concentration and therefore high radiometric values. The fairly enhanced radioactivity in the fine-grained granite of Pupule may be related to high background content rather than concentration of uranium minerals that would have justified further more detailed investigation in the area.

Similarly, the fairly elevated values in the porphyritic granites may be due to enclaves of fine-grained granites within these rocks and probably the high background values. All rocks contain minute amount of uranium and pulses are always produced by cosmic rays. Therefore if a scintillometer is turned on, it will always record radioactivity (background) from these sources. Readings of about 150 cps, just above the background values of 100 cps, are probably the result of sparsely distributed minerals of low radioactive content, which because of the mass effect has caused the enhanced readings, but which may be of no significance as an attractive area for further search.

CONCLUSION

Geologic field mapping and radiometric investigation of Pupule and environs does not support the area as promising for a more detailed uranium search. Geologic field mapping shows that the area like most other parts of the region is underlain predominantly by equigranular granites, porphyritic granites and subordinate fine-grained granites. However, data obtained from the radiometric investigation indicate only fairly enhanced radiometric values of 200 cps above the background counts of 100 cps. Data treatment and interpretation of the result suggest that the fairly enhanced radioactivity in the fine-grained granite, southeast of Pupule, may be related to high background values rather than concentration of uranium minerals that would have justified more detailed investigation in the study area.

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