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INVESTIGATIONS ON RADIOELEMENTS OCCURRENCES IN ROCKS IN KAKURI AREA OF KADUNA NORTH WEST, NIGERIA.

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ABSTRACT

Detailed investigations on Radioelements occurrences in rocks in Kakuri Area Kaduna North West Nigeria were carried out in this work using Geochemical ground follow-up methods. The methods employed include Atomic Absorption Spectrometric (AAS) and Assay of rock samples from the area. Fresh rock samples were collected with hammer and identified as follows: Granite gneiss, Granite, Migmatites and Gneiss. Analysis was made on the powdered rock samples and histograms were plotted to determine the activity of Radioelement concentrations: Potassium, Thorium and Uranium in each of the samples analyzed. Results of the investigations showed high concentration of potassium (^{40}K) and other Radioelements, thorium and uranium in the area. Generally, the results delineate the three Radioelements in terms of their anomaly pattern within the study area.

KEYWORDS: Geochemical Survey; Aeroradiometric Anomaly; Fresh Rocks; Radioelements and Kakuri Area.

1.0 INTRODUCTION

In exploration programs, geochemical techniques are generally integrated with geophysical surveys. Several factors contributed to the rapid development of geochemical prospecting during 20th century (Ancher and Main, 1971). It was found that most metallic mineral deposits are surrounded by halos of abnormal trace elements concentration in the adjacent and enclosing rocks. Also, high trace-elements concentration in material such as glacial sediment soil, spring or stream water, and stream sediment were recognized as being derived from the weathering of mineral deposits (Coope, 1973). Precise and rapid methods of chemical analysis suitable for the detection of low concentrations (a few parts per million, or even parts per billion) of elements and compound in natural media were developed (Derry, 1971). These methods include use of the Atomic Absorption Spectrometry, Emission Spectrograph, Specific and Sensitive Calorimetric reagents, Gas Chromatography, Alpha and Gamma Spectrometry, and development of Polythene Laboratory Equipment. The effectiveness of geochemical exploration has been greatly enhanced by the use of computer-aided statistical techniques for processing and evaluation of data (Derry, 1971).

As far back as 1921, the Nigerian Geological Survey has discovered some unusual granite having quartz, albite, perthite, and riebeckite as essential minerals and cryolite and pyrochlore as somewhat common accessories (Mackay and Beer, 1952). Geological and Geophysical surveys in search of uranium deposits could be said to have started in Nigeria in 1947 when the mineral pyrochlore, containing substantial amount of uranium was discovered by the Geological Survey Department in small granite bodies

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on the Jos-plateau. In 1949, Mackay who was in Nigeria on a thorium investigation considered that it would be worthwhile to examine some of these granitic bodies in order to see whether the pyrochlore was present in sufficient amount to provide a likely source of uranium or thorium.

In Nigeria Already, the initial stage in the large scale exploration for the radio-element was launched when high sensitivity aero-radiometric surveys were carried out in 1975. the survey covered the lower Benue area, the middle Niger and the Sokoto are conducted by Fairly Surveys Ltd. and Hunting Geology and Geophysics Ltd., respectively, on behalf of the Federal Ministry of Mines and Power. Although intensive ground follow-up surveys have been carried out in some area since 1977 (for example the Nigeria Uranium Mining Company (NUMCO), the Nigerian Mining Corporation, the Geological Survey of Nigeria and by the University of Ife), there is very little information on Uranium occurrences in Nigeria. The little available information on uranium occurrences in Nigeria are mainly from individuals who have analyzed a few rock samples and uranium ores from some locations around the Nigerian younger granite province. However, the work of Uwah (1984), Dewu (1986), and Ahmed (1994) who carried out detailed investigation of radiometric anomalies in the Sokoto Basin, Bisichi and Jingir areas of Sokoto, and the plateau states respectively, form, a very important step for a large scale exploration of uranium and allied minerals.

The investigation was carried out with the aim of geochemical ground follow-up of an Aeroradiometric anomaly on the occurrence of Radioelements in terms of its U, Th & K prospects within Kakuri area because of the great number of these anomalies within the Younger Granite Province, a large reserve of Radioelements may exist, hence the need for this Ground follow-up survey to study one of such anomalous activity in the area. Thus the results obtained from this study can be used to determine the activity of potassium, thorium, and uranium in each of the samples analyzed (Fig. 1).

1.1 GENERAL GEOLOGY OF THE STUDY AREA

The area is in Guinea Savannah region of Nigeria, which has a vegetation cover consisting of orchard bush and scattered shrubs. The distribution of vegetation has been adversely affected by human activities, climate and topography. Vegetation is dense and tall along the valley but short and scattered along slopes and hills (Fig.1).

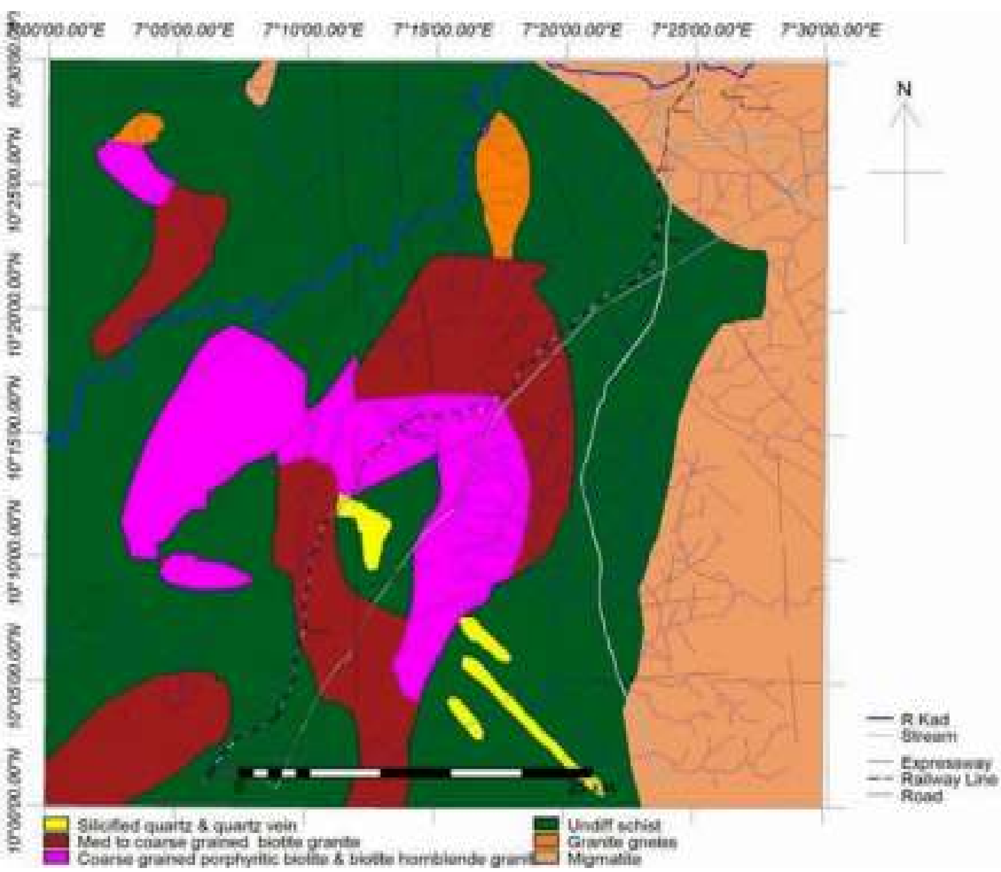

Figure.1: Geological Map of the Study Area (Goke *et al.,* 2011).

The climate of the area has distinct wet and dry seasons. The wet season starts around May and becomes heavy in August and September, but ends in October. While the dry season occupies the rest of the year, the Hammatan sets in during December and last until February. Hammatan is characterized by haze caused by dust transported from the Sahara. Topography is made up of hills with rock comprising of Granite, Granite gneiss, Migmatites and Gneiss, slopes with scattered orchard bush and shrubs and valley with dense and tall vegetation.

2. MATERIALS AND METHOD

As earlier mentioned, a geochemical method was used in this work. There are various geochemical methods that are used to analyze Radioelements and they include Atomic Absorption Spectrometry, Emission Spectroscopy, Fluorimetry, X-ray Fluorescence, Sodium Iodide Scintillation (Ancher and Main, 1971). The specific geochemical method which was used for this research is Atomic Absorption Spectrometry (AAS) and Assay of Rock Samples

2.1 ATOMIC ABSORPTION SPECTROMETRY

Atomic Absorption Spectrometry, commonly referred to as (A.A.S) is a relatively new technique having been suggested as an analytical method. It has profound effects not only in exploration geochemistry, but also in environmental control, metallurgy, water quality studies, biology, agronomy and other fields in which inexpensive, accurate, precise and rapid method for the determination of large number of elements at low levels of detection (high sensitivity) are necessary. The method is especially applicable to the determination of trace quantities of an element in geochemical samples, and the precision and accuracy are comparable to most other methods. One special appeal of atomic absorption in exploration geochemistry is the fact that, from one sample digestion, many elements can be determined, thus resulting in a considerable saving in costs while at the same time providing a wealth of information (Angino and Billing, 1972).

2.1.2 ASSAY OF ROCK SAMPLES

A total of 50 samples were collected from the exposures in the area. At each site 4 fresh rock samples were knocked off randomly from the outcrops with a hammer and marked with sample identification number, the four (4) samples were collected and analyzed for their Radioelements content and other elements commonly associated with uranium (U), thorium (Th), potassium (K), sodium (Na), lead (Pb) and copper (Cu). The rocks samples in the study area were classified into four categories according to their occurrence namely:

1. Granite Gneiss
2. Granite
3. Gneiss and
4. Migmatite

Table 3.1 shows the activity concentration of Potassium, Thorium and Uranium in each of the aforementioned Assay of Rocks Samples.

No.	Grid Spacing (m)	Samples	^{40}K (Bq/Kg)	^{232}Th (Bq/Kg)	^{238}U (Bq/Kg)
1	50	GR1	694.0	49.6	16.7
2	100	GR2	766.6	36.9	9.0
3	150	GR3	566.1	10.9	36.7
4	200	MIG1	376.1	16.7	6.5
5	250	MIG2	654.0	48.0	12.8
6	300	GG1	725.1	43.0	10.9
7	350	GG2	700.1	15.4	2.1
8	400	GG3	499.9	35.4	6.7
9	450	G1	778.0	31.5	12.0
10	500	G2	642.0	29.3	5.0

3.0 RESULTS AND DISCUSSION

3.1 DATA REDUCTION

The data were corrected for background and were plots-contoured using the Microsoft Excel and surfer program. The uncertainties attached are the 70% confidence limits of the mean activities. Histogram maps of the rock samples for Granite-Gneiss, Granite, and Gneiss as well the contour map of the three Radioelements activity from different rock samples within the area of study are shown in Figures 2, 3, 4 and 5, 6, 7 respectively. The counts were generally higher at site 3. One prominent peak anomaly centered at (10.18N, 7.12E) at site 3 and two prominent peaks anomalies centered at (10.06N, 7.06E) and (10.80N, 7.04E) were observed. No such defined anomalies were observed for site 2 (Figure 3). The anomaly at site 3 is broader and more pronounced. The observation in the field was that areas of high activities coincided with areas with Granite-Gneiss while areas depicting the lowest activities correlate with migmatite areas. These anomalies observed may be significant in terms of radioactive mineralization.

3.1.2 DATA ANALYSIS

Geologic formations are not necessarily uniform in radioactivity. Therefore calculations of average values of field activities and of standard deviations can be in error if an attempt is not made to unify them. The gross count contour maps can be used to delineate areas of radioactive mineralization. According to Uwah 1984, a better method of determining the average value of activity for a geologic unit is to plot a frequency distribution of the number of data points with a given activity versus the activity. Figures 2, 3 and 4 show such frequency distribution curves for site 1, 2 and 3. The mean activity is the mode of the frequency distribution. The following are the data reduction for the activity concentration for potassium, thorium and uranium concentration are in Becquerel/Kilogram:

For Potassium we've

Potassium = X / X_{STD} x Concentration of ^{40}K

Where X is Specific activity of Potassium

X_{STD} is Standard specific activity of Potassium

Conc. of ^{40}K = 560 $BqKg^{-1}$ (Figure 2)

For Thorium we've

Thorium = Y / Y_{STD} x Concentration of ^{232}Th

Y is Specific activity of Thorium

Y_{STD} is Standard specific activity of Thorium

Conc. of ^{232}Th = 49.6 $BqKg^{-1}$ (Figure 3)

For Uranium we've

Uranium = Z / Z_{STD} x Concentration of ^{238}U

Z is Specific activity of Uranium

Z_{STD} is Standard specific activity of Uranium

Conc. of ^{238}U = 13 $BqKg^{-1}$ (Figure 4)

3.2 DISCUSSION OF RESULTS

It has that using the gamma activity map of a region; the approximate source of the anomalous radiation can be delineated. This was done by calculating the mean range activity for the occurrence of Radioelements value above the half-maximum, which is the contour mid-way between the reference background and the peak intensity. The reference background, which is the mode of the activity counts, obtained from the frequency distribution histogram curve f the readings (Moxham, 1960). In this work, the frequency distribution of the activities of potassium, thorium and uranium in the rock types were determine and shown in the figures below to permit the study of the distribution of activities. The mean activity range for potassium is 450 $BqKg^{-1}$. The increasing activities reflect changes in composition and diversity of the rock types in the studied area. Twenty samples of rocks were obtained and their activity distribution is shown in Fig. 2. The calculated mean for the group is 450 $BqKg^{-1}$. The frequency distribution is positively skewed and the mode of the distribution is 750 $BqKg^{-1}$. The activity histogram of thorium is shown in Fig. 3. The histogram shows a positive skew with a mean activity of 40 $BqKg^{-1}$. The mode of the distribution is 15 $BqKg^{-1}$ and 35 $BqKg^{-1}$ respectively. Also the activity histogram of uranium is shown in Fig. 4, with the mean activity of 25 $BqKg^{-1}$. The mode of the distribution is 5 $BqKg^{-1}$. The activity values for potassium, thorium and uranium show a close approximation of what is indicated on the anomaly map of the area which considerably shows the accuracy of the data (Dewu, 1986). The skewness of the activity histograms of the rock samples could be due to the difference in their mineralogies (Darnley, 1973 and Duval, 1979).

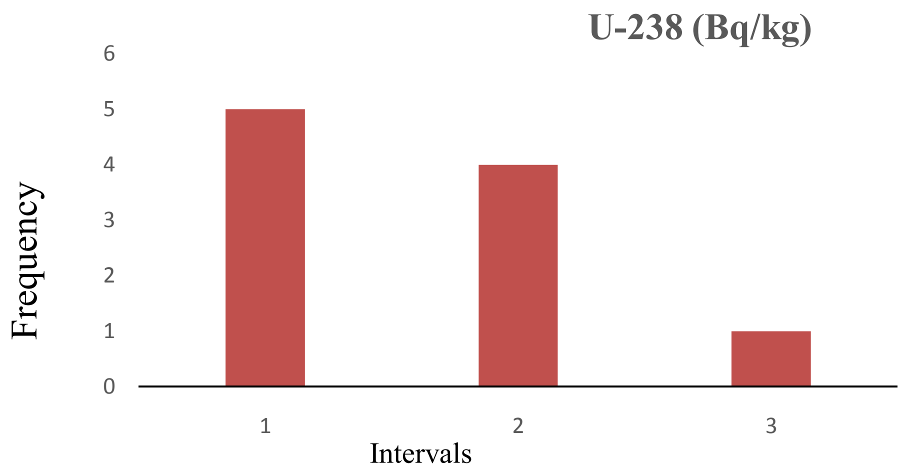

Figure 2: Histogram Plot of Uranium Concentration in (Bq/Kg)

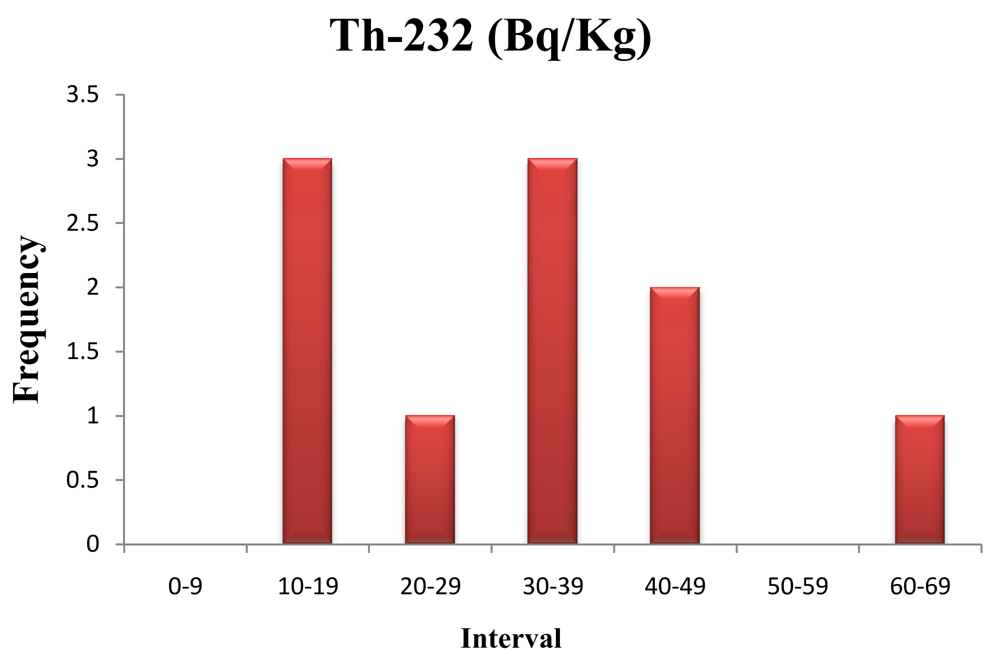

Figure 3: Histogram Plot of Thorium Concentration in (Bq/Kg)

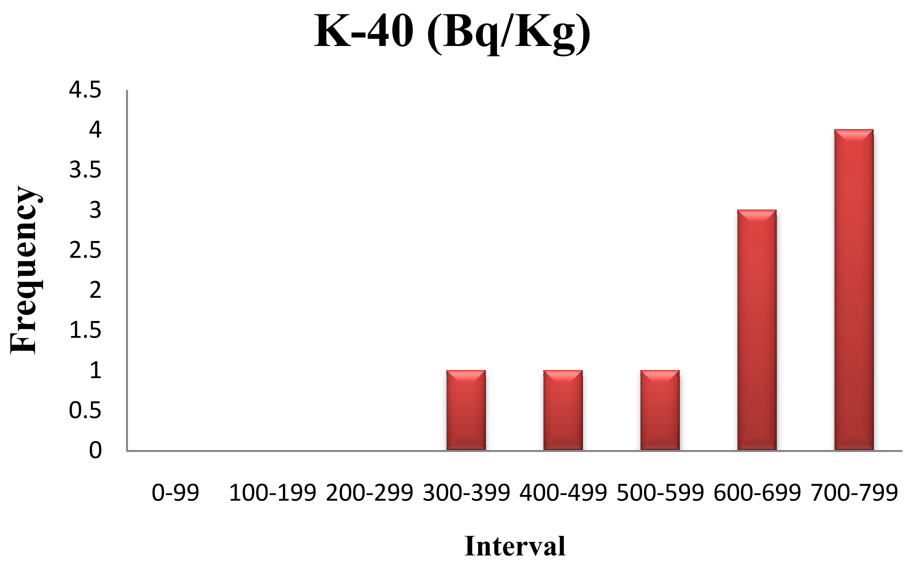

Figure 4: Histogram Plot of Potassium Concentration in (Bq/Kg)

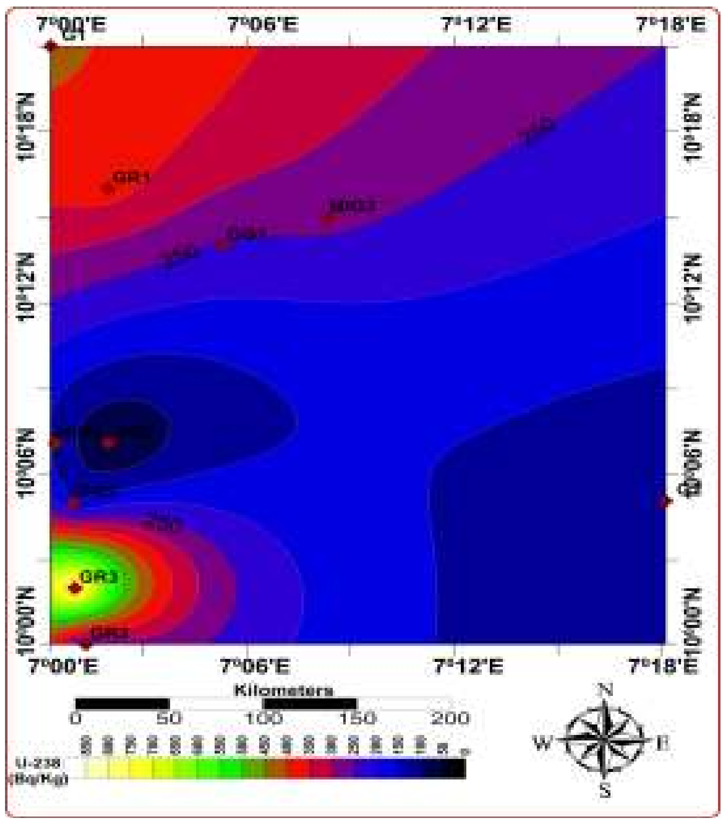

Figure 5: Contour Map of Count Rates for U-238 Bq/Kg, contour interval is 50 cps

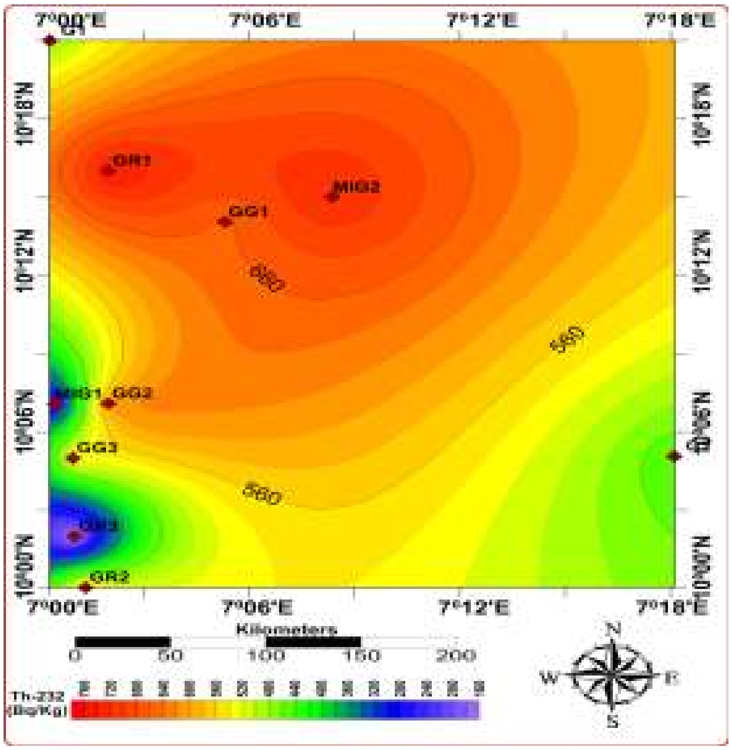

Figure 6: Contour Map of Count Rates for Th-232 Bq/Kg, contour interval is 40 cps

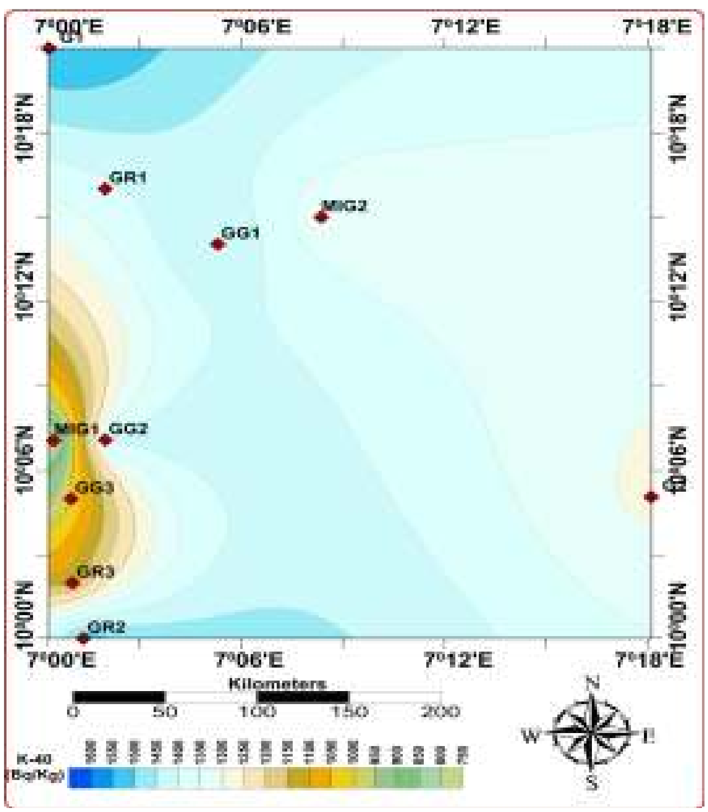

Figure 7: Contour Map of Count Rates for K-40 Bq/Kg, contour interval is 50 cps

4.0 CONCLUSION

The results revealed that potassium is more abundant followed by thorium and the least uranium which corresponds to the anomaly map of the area. At U-238 Bq/Kg of 50 cps and above, which was more than the mode of 40 cps for Th- 232 Bq/Kg area of (Figure 6) was measured only at that point. No defined anomalies were detected at 40 Bq/Kg, activities of 50 cps. This means that the anomaly delineated at Th-232 Bq/Kg, has high radioactive potential. Consequently, the two results show to a great extent that the Radioelements present in the rock samples at Kakuri hill using the anomaly map is a precise and could be used to compare other analysis that most likely would be carried out later in the area.

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