American Journal of Engineering Research (AJER)
e-ISSN : 2320-0847 p-ISSN : 2320-0936
Volume-02, Issue-09, pp-224-227
www.ajer.org

Research Paper Open Access

Measurement of Natural Radioactivity in Soil Along the Bank of River Kaduna – Nigeria.

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***Abstract*: -** Gamma-ray spectrometry of natural radioactivity was carried out in soil along the bank of river Kaduna Nigeria using EDXRF techniques. The activity concentration in Bq/kg for ^{40}K and ^{232}Th were calculated from the % weight of K and Th determined in the soil samples. The mean activity concentration of ^{40}K was found to be 1168.13 ±94.67Bq/kg in range between 810.62 ± 21.91 to 1765.32 ± 31.30 Bq/kg. The mean activity concentration of ^{232}Th was found to be 18.76 ± 2.51Bq/kg in range between 8.12 ± 2.44 to 33.70 ± 6.90 Bq/kg. The highest values of ^{40}K and ^{232}Th were found in samples obtained from GRA 2 and this can be attributed to the increase anthropogenic activities going on in the area. The mean activity concentration of ^{40}K in the study area is higher than world average value while that of ^{232}Th is lower than world average value.

Keywords: - *Natural Radioactivity, Radionuclides, Activity Concentration, Bq/kg, ^{40}K and ^{232}Th.*

I. INTRODUCTION

A knowledge of various radionuclide in soil and rocks plays an important role in health physics and geo-scientific research. The naturally occurring radionuclide ^{226} Ra, ^{232}Th and ^{40} K are the main sources of radiations in soil and rocks from which traditional building materials are derived. These radionuclides pose exposure risk externally due to their gamma-ray emissions and internally due to radon and its progeny which emit particles[1]. Even though depend on the local geological conditions and as such they vary from place to place.

In many developing countries like Nigeria soils are affected by mine waste disposal, acid deposition, sewage, sludge and other anthropogenic activities. Radioactive materials can enter water in several ways by being deposited in surface water from the air, by entering ground water or surface water from the ground through erosion, seepage, or human activities such as mining, farming, storm water and industrial activities and by dissolving from underground mineral deposits as water flows through them [2]. The environment contains in abundance of man made and natural radionuclide as well as polluting heavy metals. Their accumulation and the inevitable impact on human health is a matter of serious international concern. There are several ways in which humans can come into contact with this radionuclide: inhalation from the passing cloud external exposure in contaminated soil surface and ingestion due to food chain transfer of radionuclide. The types of diseases that can occur include leukemia, thyroid, bone, breast, lung and others. As at 1988, there were 237 confirmed cases of illness resulting from this incident as well as 31 fatalities in the Soviet Union [3]. Similarly, in Nigeria over 400 children died of lead poisoning in Zamfara State due to artisanal mining activities [4].

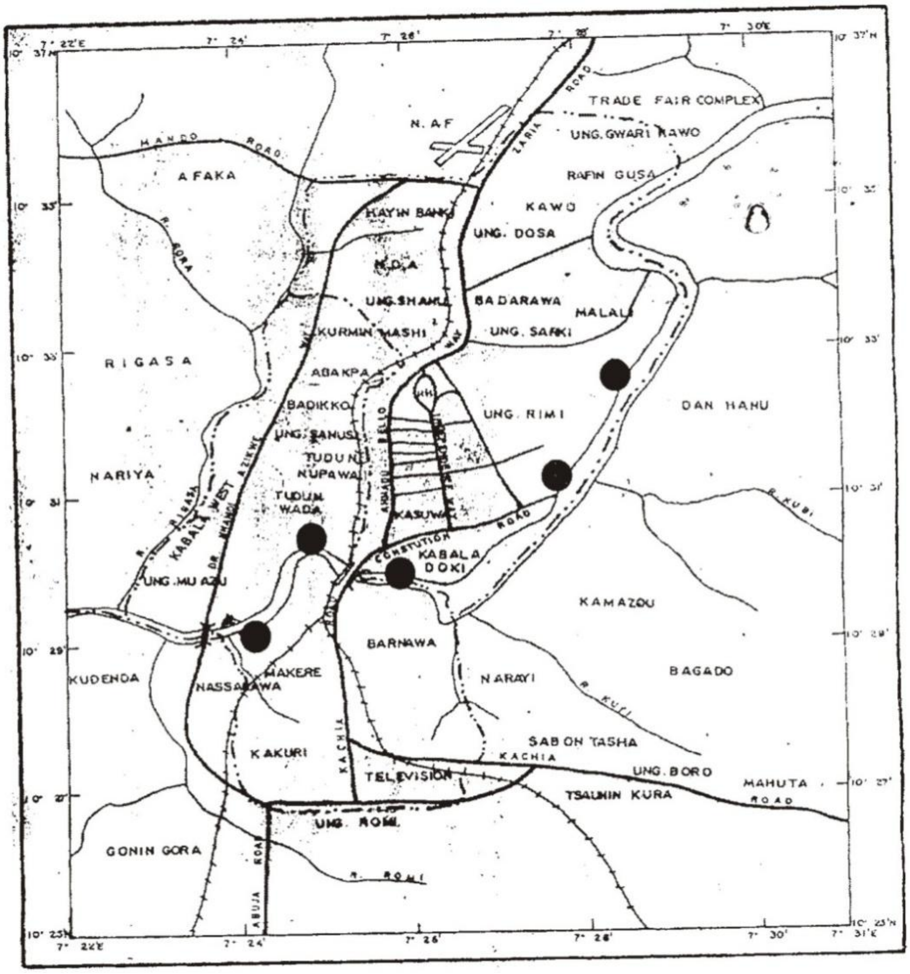
The International Basic Safety Standards (BSS) for protection against ionizing radiation and the safety of radiation sources [5] specify the basic requirement for the protection of health and the environment from ionizing radiation. These are based on the latest recommendations of the International Commission on Radiological Protection on the regulation of Practices and interventions [6]. The BSS is applied to both natural and artificial sources of radiation in the environment and the consequences on living and non-living species.

Irradiation of the human body from external sources is mainly by gamma radiation from radionuclides of the ^{235}U and ^{232}Th decay series and from ^{40}K. These radionuclides may be present in the body and irradiate various organs with alpha and beta particles as well as gamma rays [7,8,9].

In this research, the activity concentration of ^{40}K and ^{232}Th in soil samples obtained from five locations along the bank of river Kaduna Nigeria were determined using EDXRF techniques.

II. MATERIALS AND METHOD

Ten (10) soil samples were collected at five (5) different locations along the bank of river Kaduna, Nigeria namely; Gamji Recreational Area (GRA), Kabala Costain (KC), Nasarawa (NS), Unguwan Rimi (UR) and Zango (Zg) as shown in figure -1, at 10cm depth using a mechanical digger. The 10cm depth was carefully chosen as the appropriate depth to obtain the samples in line with the facts established that these pollutants are highly absorbed to clayed materials and organic matters in the study areas[10].



LEGEND

	Road
	Railway line
	Local governemnt boundary
	River Kaduna
	Sampling location

Figure- 1: Map of kaduna metropolis showing the sampling locations

The Ten (10) soil samples collected from the sampling locations were pretreated by oven drying them at a regulated temperature of 50^0c for 48 hours. After drying, a series of mesh size 35µm was used to remove large undesirable particle sizes [10]. The dry test samples were analyzed using the energy dispersive X-ray florescence (EDXRF) minipal (4) model to determine the concentration of the metals pollution in the soil samples.

The activity concentration in Bq/kg for ^{40}K and ^{232}Th were calculated from % weight of K and ppm (mg/kg) of Th using IAEA 2003 conversion of radio element concentration to specific activity (1%k in soil = 313Bq/kg of ^{40}K and 1ppm of Th in soil = 4.06 Bq/kg of ^{232}Th).

III. RESULT AND DISCUSSION

The soil samples collected were analysed using EDXRF where the percentage weight of all the elements present in the sample were obtained. The percentage weight of Th was converted to mg//kg (ppm) as shown in table 1.

Table 1: % weight of K and concentration Th mg/kg

S/No	Location	%K	Th ppm (mg/kg)
1	GRA 1	3.5 ± 0.08	4.60 ± 0.7
2	GRA 2	5.64 ± 0.01	8.30 ± 1.7
3	KC 1	4.71 ± 0.01	4.70 ±1.1
4	KC 2	3.08 ± 0.08	2.00 ± 0.6
5	NS 1	3.06 ± 0.08	3.06 ± 0.6
6	NS 2	2.59 ± 0.09	7.60 ± 0.8
7	UR1	3.83 ± 0.09	3.40 ± 0.6
8	UR 2	4.49 ± 0.09	4.20 ± 0.8
9	ZG 1	3.58 ± 0.08	4.70 ± 0.6
10	ZG2	2.4 ± 0.0	3.1 ± 0.7

The activity concentration of ^{40}K and ^{232}Th in Bq/kg were calculated based on IAEA 2003 conversion factor. Inferential statistics was used to compare the activity concentration of ^{40}K and ^{232}Th across the sampling locations. The one way ANOVA at the 5% level of significance was applied for the analysis. The mean activity concentration of ^{40}K and ^{232}Th are shown on table- 2.

Table 2: Activity concentration for ^{40}K and ^{232}Th in Bq/kg

S/No	Location	^{40}K	^{232}Th
1	GRA 1	1095.50 ± 25.04	18.68 ± 2.84
2	GRA 2	1765.32 ± 31.30	33.70 ± 6.90
3	KC 1	1474.23 ± 31.30	19.08 ± 4.47
4	KC 2	964.404 ± 25.04	8.12 ± 2.44
5	NS 1	957.78 ± 25.04	14.62 ± 2.44
6	NS 2	810.62 ± 21.91	30.86 ± 3.25
7	UR1	1198.79 ± 28.17	13.0 ± 2.44
8	UR 2	1405.37 ± 28.17	17.05 ± 3.25
9	ZG 1	1120.54 ± 25.04	19.08 ± 2.44
10	ZG2	888.92 ± 25.04	12.57 ± 2.4
	Mean	1168.13	18.76
	StdErr	94.67	2.50

Activity Concentration of ^{40}K

From the result of the analysis the mean activity concentration of ^{40}K is 1168.13± 94.67 Bq/kg in range between 810.62 ± 2191 to 1765.32± 31.30Bq/kg with the highest activity concentration in GRA 2 as shown in Fig. 1.

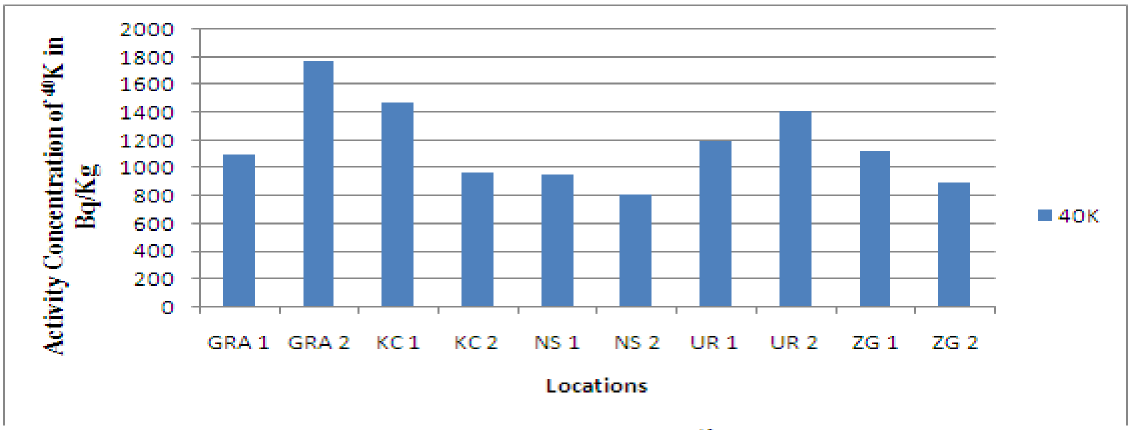


Fig. 1: Plot of Activity Concentration of ^{40}K by Location

The mean activity concentration of ^{40}K obtained in this study is higher than 997.57 Bq/kg obtained from gold bearing soil [11] 641Bq/kg in Zaria Nigeria [12] 682 Bq/kg in Ghana [13] and world average value of 420 Bq/kg[8]. The high activity concentration of ^{40}K in the area can be attributed to anthropogenic activities and geochemical setting of the area.

Activity Concentration of ^{232}Th.

The mean activity concentration of 232Th in the samples was 18.76 ± 2.50 Bq/kg in range between 8.12± 2.44 to 33.70 ± 6.90 Bq.kg. the highest activity concentration was obtained from GRA2 as shown in Fig 2.

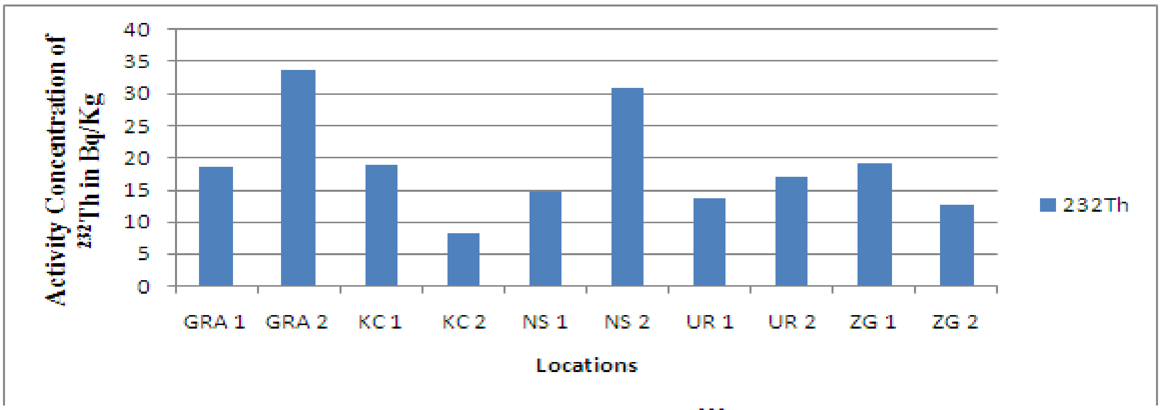


Fig.2: Plot of Activity Concentration of ^{232}Th by Location

The values obtained from this study are lower than 62.69Bq/kg obtained in gold bearing soil [11] 34 Bq/kg in Zaria Nigeria [12] 21 Bq/kg in Ghana [13] and the world average value of 45 Bq/kg [8].
The high activity concentration of 33.70 ± 6.90 Bq/kg obtained from GRA2 can be attributed to anthropogenic activities in the area.

IV. CONCLUSION

The activity concentrations in Bq/kg of ^{40}K and ^{232}Th were measured from the % weight of K and Th determined using EDXRF techniques from soil samples collected along the Bank of River Kaduna, Nigeria the result showed that ^{40}K has a mean activity concentration of 1168.13 ± 94.67 Bq/kg with minimum and maximum values of 810.62 ± 21.91 and 1765.32 ± 31.30 Bq/kg. The mean activity concentration of ^{232}Th is 18.76 ± 2.5 Bq.kg in range between 8.12 ± 2.44 to 33.70 ± 6.90 Bq/kg. The highest values of both ^{40}K and ^{232}Th were obtained in GRA 2. The ANOVA (0.000100.5) showed that there is a significant difference in the relative abundance of ^{40}K and ^{232}Th in the sampling locations. In other words in all the locations the activity concentration of ^{40}K is more than that of ^{232}Th.

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