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Determination of Natural Radioactivity levels using Gamma-ray Spectrometry.

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ABSTRACT: *Natural radioactivity in tsofon-gwari (Tsofon-gwari,abuja) old mining sites from birnin gwari in Kaduna state, Nigeria was measured by means of gamma-ray spectrometer with NaI (Tl) detector to establish a data for activity concentration of potassium40 (40K),Radium (226Ra) and Thorium (232Th). The highest activity concentration of 40K, 226Ra and 232Th were found in soil collected from location SGA3 (860.3 Bq/kg), SGA6 (3.59 Bq/kg) and SGA4 (102.62 Bq/kg), respectively, where the mean activity of 40K (620.99 Bq/kg)is higher than the world average of 420 Bq/kg and the mean activity concentrations of Th232 (82.3 Bq/kg) is above the world average of 50 Bq/kg . 226Ra have the lowest mean activity concentration of 2.45. Results from the twelve field samples analyzed also indicated that the activity concentration due to 40K in the soil samples ranked highest against the lowest value obtained from 226Ra below average.*

KEYWORDS: *Radionuclide's; soil; mining; activity concentration; tsofon-gwari, Kaduna.*

I. INTRODUCTION

Uranium is a naturally occurring element that has been in rocks since the earth was formed. Not all rocks contain uranium, but there are some places in Montana where uranium is in the bedrock and in valley fill sediments that have eroded from the bedrock of the adjacent upland or mountainous areas. Uranium breaks down (decays) very slowly into other elements including radium and radon gas. These other elements are part of a sequence formed through a transformation (decay) process that begins with the most prevalent form of "natural" (unprocessed) uranium (U-238).[1] The world is naturally radioactive and about 90% of human radiation exposures arise from natural sources such as cosmic radiations, exposure to radon gas, and terrestrial radiations. Significant naturally occurring radionuclides present in the soil are 238U, 232Th and 40K [2]. Since these radionuclides are not uniformly distributed, the knowledge of their distribution in soils and rocks play an important role in radiation protection and measurement. Some of the exposures are fairly constant and uniform for all individual persons everywhere, for example, the dose acquire from ingestion of 40K in foods. However, other exposures vary widely depending on location. Cosmic rays, for example, are more intense at higher altitudes and concentrations of uranium and thorium in soils are elevated in localized areas. High levels of uranium and its decay products in rock and soil, and thorium in monazite sands are the main sources of high natural background radiations that have been identified in several areas of the world [3]. Radiation exposures arise in the mining and mineral processing industries through three principal pathways. These are external gamma radiation from ores, inhalation of dusts containing long-lived alpha-emitting radionuclides and inhalation of the short-lived decay products of radon. Inhalation of radon decay products in poorly ventilated underground mines can lead to exposures in excess of current radiation exposure limits, and this could cause high incidence of lung cancer in the mine workers. There is consequently a need to adopt careful radiological control measures in mining and mineral processing operations involving radioactive ores, in order to protect those involved and to meet dose limits.

Exposure of workers to naturally occurring radioactive material (NORM) continued to be an emerging industrial issue, for example in the extraction of rare earths, the zircon and zirconium industries, coal-fired electricity generation and the phosphate industry [4].

II. MATERIALS AND METHODOLOGY

2.1. Sample Collection and Preparation

Twelve field samples of 1 kg each for soil within the area of consideration were collected at random, initially filled into polyethylene bags separately for respective points in equal measures and labeled accordingly for benchmarking purposes.

The samples were brought into the laboratory and left open for over twenty four (24) hours under ambient temperature. Following thorough drying the soil were pulverized to fine power and packed to fill

cylindrical containers of height 7cm by 6cm in diameter which is the same as the geometry of the counting detector. Each container accommodated approximately 300 g of sample. [5]

2.2 Analysis of Samples for Background activity

The major nuclear technique employed in the analysis of sample for background activity is the Gamma spectrometry using NaI (Tl) detector

III. RESULT AND DISCUSSION

Table 3a. Activity concentration k-40.Ra-226 and Th-232

SITE ID	K40(Bq/Kg)	Ra226(Bq/Kg)	Th232(Bq/Kg)
ASG1	738.88±18.81	3.22±.39	74.57±3.64
ASG2	593.93±9.33	2.02±.19	58.15±1.14
ASG3	860.34±15.39	2.63±.15	51.88±4.50
ASG4	788.33±13.68	2.89±.38	102.62±1.93
ASG5	538.72±2.02	1.49±.46	30.78±1.36
ASG6	797.97±10.88	3.59±.39	90.30±2.28
ASG7	601.39±6.53	2.72±.18	29.98±1.14
ASG8	218.04±3.26	2.23±.32	32.26±2.28
ASG9	533.59±7.46	1.94±.42	63.85± 2.39
ASG10	738.88±18.81	3.23±.40	75.71±2.50
ASG11	593.93±9.33	2.14±.20	49.48±1.36
ASG12	447.90±6.84	1.36±.04	20.06±1.25

Table 3b. statistical analysis

SITE NAME	N	Minimum	Maximum	Mean	Std. Deviation	Std. Error Mean
k40	12	218.04	860.34	620.99	179.13	51.71
Ra226	12	1.36	3.59	2.45	.70	.20
Th232	12	20.06	102.62	56.64	25.88	7.47
Valid N (listwise)	12					

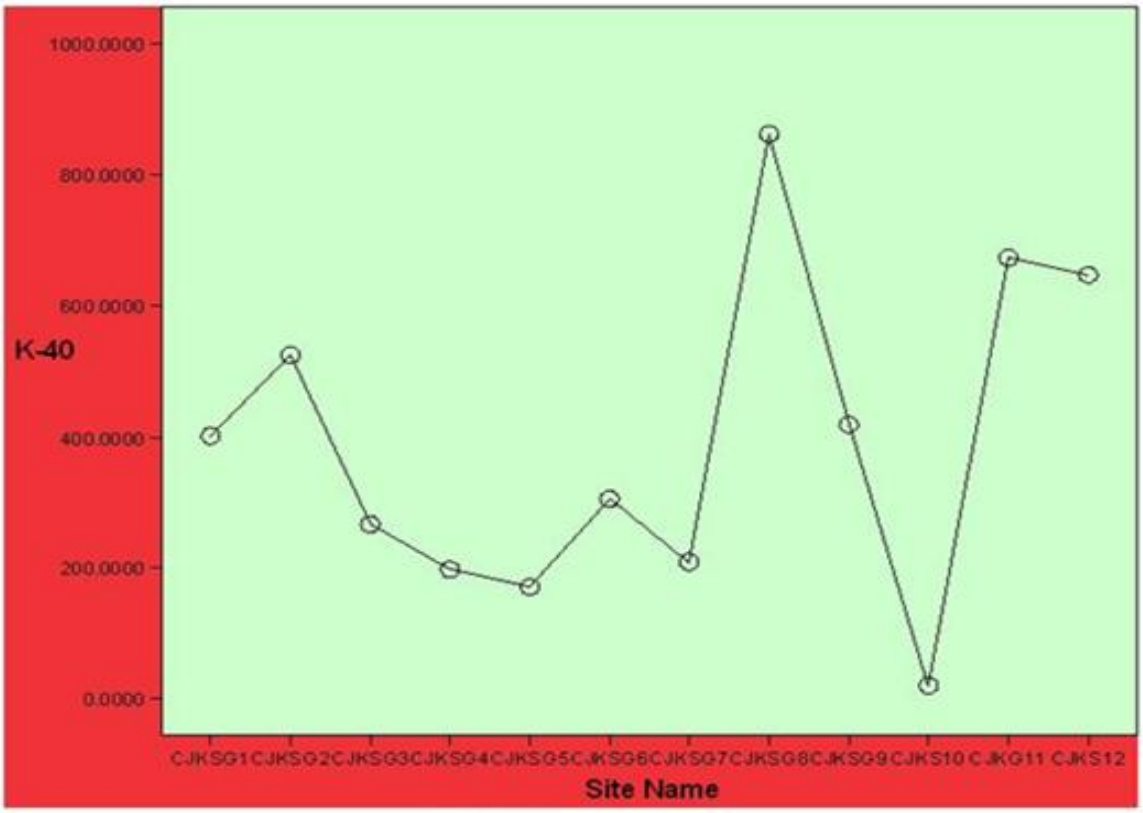

Fig 3a. Line chart for 40K

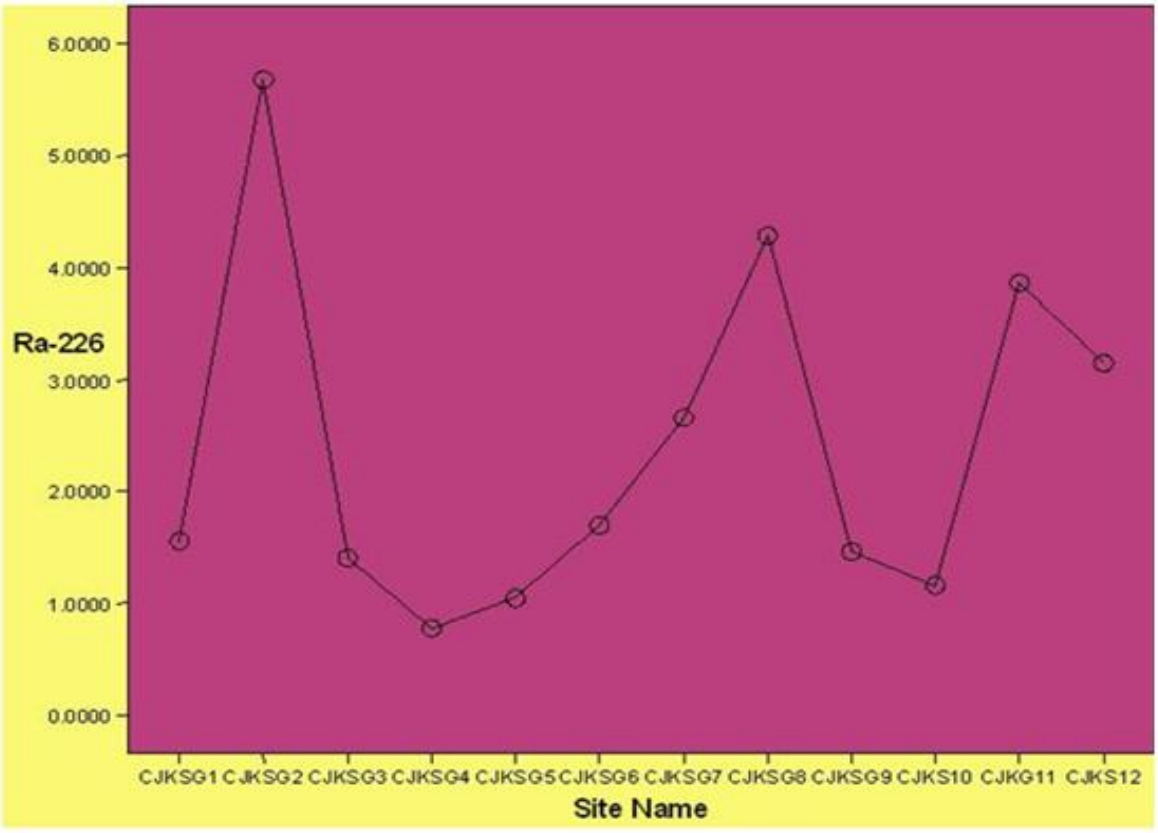

Fig 3b. Line chart for Ra226

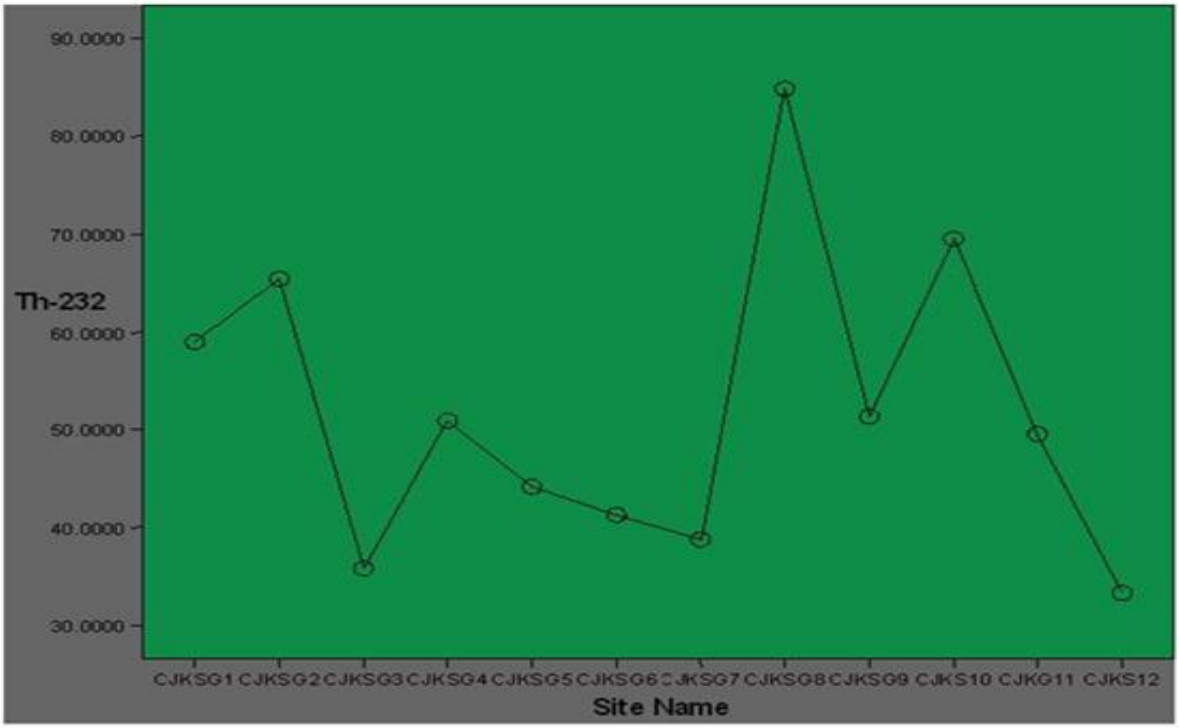

Fig 3c. Line chart for Th232

3.1. Results and Discussion Conclussion

Results show that while activity concentration in the soil samples is highest due to 40K and 232Th.the activity concentration for 40K is 218.04 to 860.34Bq/kg with mean of620 Bq/kg. and for 232Th is 20.06 to 102.62 Bq/kg with mean of 56.64 Bq/kg, the lowest is obtained for 226Ra with concentration of 1.36 to 3.59 Bq/kg with mean of 2.45 Bq/kg. which are well below the world average .

The activity concentrations of 40K, 226Ra and 232Th in the respective samples are presented in "Tables 3a. and statistical analysis in Table3b. "Fig. 1a, 1b,and 1c show line charts showing the deduced activity concentrations for the samples.

The activity concentrations due to the presence of three commonly occurring nuclides; 40K, 226Ra and 232Th were determined within tsofon gwari (abujasg) old mining sites from the birnin gwari kaduna, Nigeria to serve as a baseline data. Results show that only one location out of the twelve sampled, gives activity concentration lower than the world average for 40K in soil also more than halve of the result are above world standard for 232Th . Similarly all other activity concentrations due the 226Ra are well below the world average . From these analyses, it can be inferred that the general distribution of activity concentration in the study areas are above tolerable levels for 40K and 232Th and below for 226Ra . However, for more conclusive assessment of the potential biological effects of the nuclides this result is expected to serve as input to further analysis in the estimation of relevant radiological hazards indices that may guide to setting up of control and radiation protection regimes within the area by relevant competent authorities of government.

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