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An Investigation of Natural Radioactivity around Gold Mining Sites in Birnin Gwari North Western Nigeria

Abdulkarim M.S. and Umar S.
Physics Section, Department of Applied Science, Kaduna Polytechnic, Kaduna, NIGERIA
Department of Physics, Ahmadu Bello University Zaria, Kaduna, NIGERIA

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Abstract

Twelve soil samples from gold mining site of (colonial,jiniya,and katsinasg) tsofon- gwari around kaduna state were analyzed for potassium activity (K40), thorium activity (Th-232), radium activity (Ra-226). The activity concentration was determined using NaI Tl detector. Most of these mining site were discovered to have a combined Ra226 and K40 activity concentration below standard Ra226 .77± .11 to 5.68 ± .03 Bq/kg with an average value of 2.39 and K40 19.75 ± 6.22 to 862.21 ± 13.99 Bq/kg with an average value of 390.95, which is below average. Most of these samples contained insignificant amounts of Ra-226. The activity of radium found in all of the samples was below international standard and Th232 33.30±2.28 to 84.83±14.82 Bq/kg with mean value of 51.98 which is above average.

Keywords: Radionuclide's; soil; mining; activity concentration; Kaduna.

Introduction

The material of the earth was created in a series of nuclear processes which began with the big bang origin of the universe, continued relative quietly in the cores of burning stars, then violently in stellar explosions which distributed the product in to space to be available for planet formation. Many of the nuclides formed were radioactive. Most have decayed away, but a few of them have half –lives longer than or comparable with the age of the earth and remain in varying amount to this day. They constitute the bulk of natural radioactivity in the environment. Which is a major source of the background radiation we experience throughout our lives. Several of this radioisotopes such as K40 decay directly to a stable daughter but many , especially very heavy nuclei (A > 208), decay into other active isotopes as part of a decay chain or radioactive series. There are three naturally occurring radioactive series , which have existed since the earth was formed about $4.5x10^9$ years ago. Each is headed by a very long lived parent (238_u 235_u 232_{TH}) which controls the decays of the active daughter all of which have much shorter half –lives[1]. Among 2500 known nuclides fewer than 300 are stable. The others are unstable structure that decay to form other nuclides by emitting particles and electromagnetic radiation a process called radioactivity. Nearly 90% of the 2500 known nuclides are radioactive they are not sable but decay in to other nuclides when unstable nuclides decay in to different nuclides they usually emit α and β particle The nuclides in each chain decay by emitting α or β particles until a final (stable) nuclide is reached[2]. Gold production is associated with contribution to hazardous pollution, thirty tonnes of used ore is dumped as waste for producing one finger ring of gold. At higher levels, long-term exposure to radionuclide's in drinking water may cause cancer. In addition, exposure to uranium in drinking water may cause toxic effects to the kidney[3].

Material and Methods

Sample Collection and Preparation: Sample Collection: Soil samples were collected from the following locations within the mines and the surrounding communities including; colonial, jiniya, katsina located on the kushaka north-east of birnin-gwari. In order to ensure representative samples were taken from the area for the analysis, initial survey was carried out in the area to determine the sampling points. The selection of the sampling locations was based on the accessibility to the public and proximity to the mine. In addition, the geological map of the area was used to identify the locations where samples will be taken. Based on these criteria, 12 locations were identified for the soil samples analysis. Within the mines, soil samples were collected at ore stockpiles, tailings dams, heap leach pads, wastes dumps and open pits 1Kg of soil were collected from each location. The sampling locations were marked using a Geographical Positioning System (GPS), Geo Explorer II.

The sampling strategy that was adopted for the soil samples was random. At each identified location samples were arbitrary collected within defined boundaries of the area of concern. The soil samples were taken using a coring tool to a depth of 5-10 cm. At each sampling location, samples of soil were taken from different sections of the area into labeled plastic bags. One kilogram (1 kg) of each sample was collected for analysis. The samples were transported to the laboratory for preparation and analysis with Sodium Iodide Thallium NaI(Tl) detector[4].

Soil Sample Preparation: The collected samples (i.e. soil or sediment) brought into the laboratory were left open (if wet) for

a minimum of 24hrs to dry under ambient temperature. They were ground into a fine powder with the use of a table ceramic mortar and pistil and then a pulverizer. The process was followed by packaging into radon impermeable cylindrical plastic containers of height 7cm by 6cm in diameter. This satisfied the selected optimal sample container height (Ibeanu, 1999) i.e the detector geometry. Each container would accommodate approximately 300g of sample. A 3–stage sealing system was made for each of the packaging to prevent Ra – 222 from escape. This include, smearing of the inner rims of each container lid with Vaseline, filling the lid assembly gap with candle wax to block the gaps between lid and container and tight – sealing lid – container with a masking adhesive tape. The prepared sample were then stored for period of 30 days to allow radon and its short – lived progenies to reach secular radioactive equilibrium prior to gamma spectroscopy measurements[5].

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.

Table-1
Activity Concentration of k-40, Ra-226 and Th-232

Site name	K40	Ra226	Th232
CJKSG1	402.3328 ± 9.95	1.5527 ± .04	59.0650 ± 1.25
CJKSG2	524.8834 ± 12.44	5.6779 ± .03	65.4504 ± 1.14
CJKSG3	264.8523 ± 10.88	1.4021 ± .02	35.8039 ± 1.14
CJKSG4	196.1120 ± 6.22	.7764 ± .11	50.8552 ± 3.42
CJKSG 5	169.5179 ± 10.88	1.0429 ± .09	44.1277 ± .68
CJKSG 6	303.4215 ± 9.33	1.6918 ± .26	41.2771 ± 1.82
CJKSG 7	207.7760 ± 4.66	2.6651 ± .46	38.7685 ± 1.14
CJKSG 8	862.2084 ± 13.99	4.2874 ± .39	84.8347± 14.82
CJKSG 9	419.4401 ± 7.77	1.4600 ± .01	51.3113 ± 2.28
CJKSG 10	19.7512 ± 6.22	1.1587 ± .11	69.5553 ± 1.14
CJKSG 11	673.4059 ± 7.77	3.8702 ± .34	49.4869 ± 1.36
CJKSG 12	647.7449 ± 11.04	3.1518 ± .69	33.2953 ± 2.28

Table-2
Statistical Analysis

SITE ID	N	Minimum	Maximum	Mean
K-40	12	19.75	862.21	390.95
Ra-226	12	.77	5.68	2.39
Th-232	12	33.30	84.83	51.98

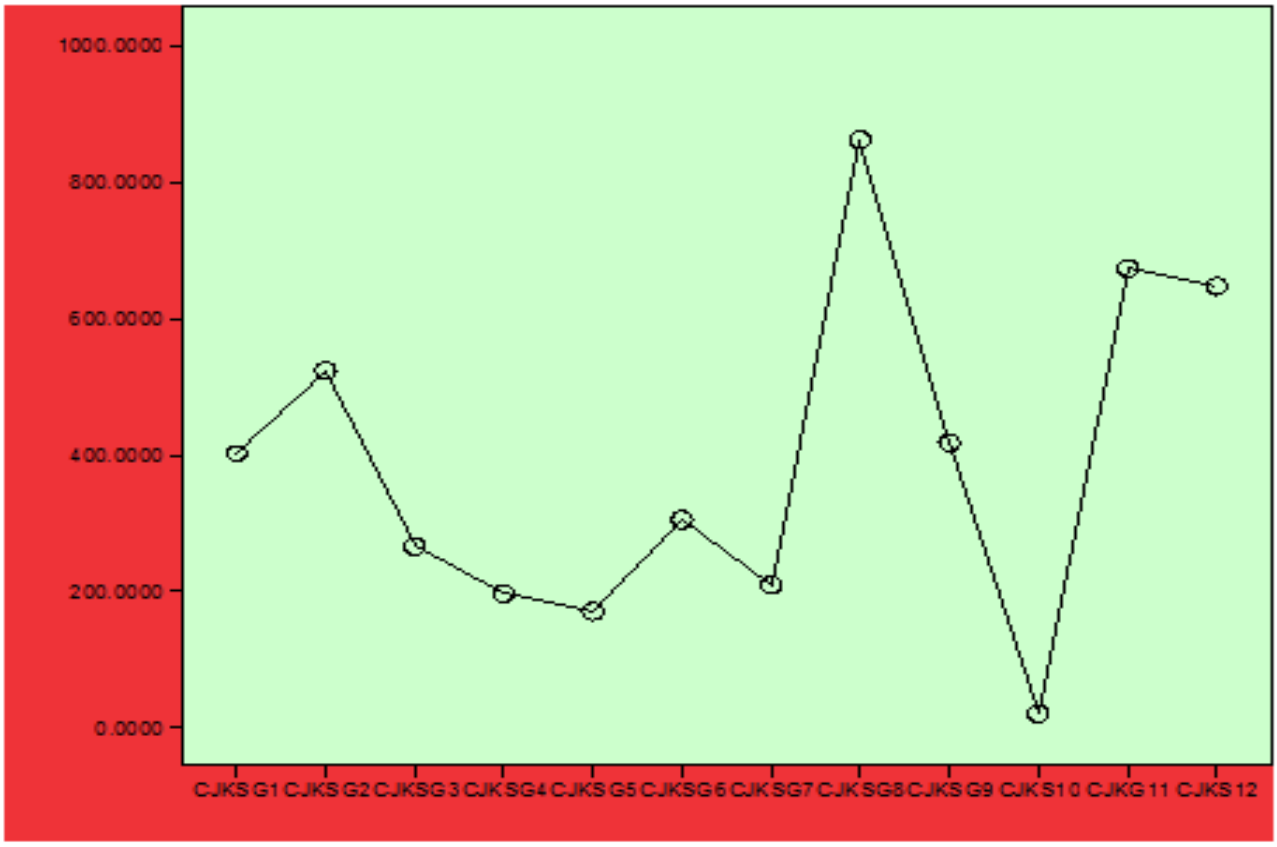

Figure-1
A graph of activity concentration for soil samples with average of 390.95 -K40

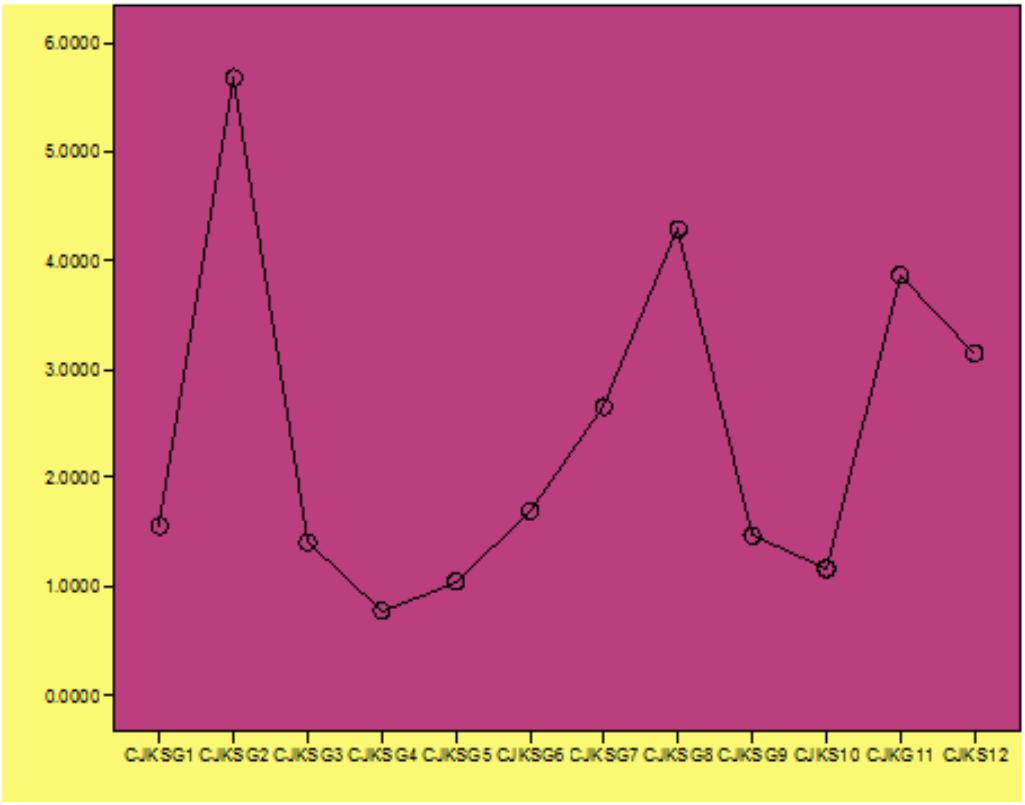

Figure-2
A graph of activity concentration for soil samples with average of 2.39- Ra226

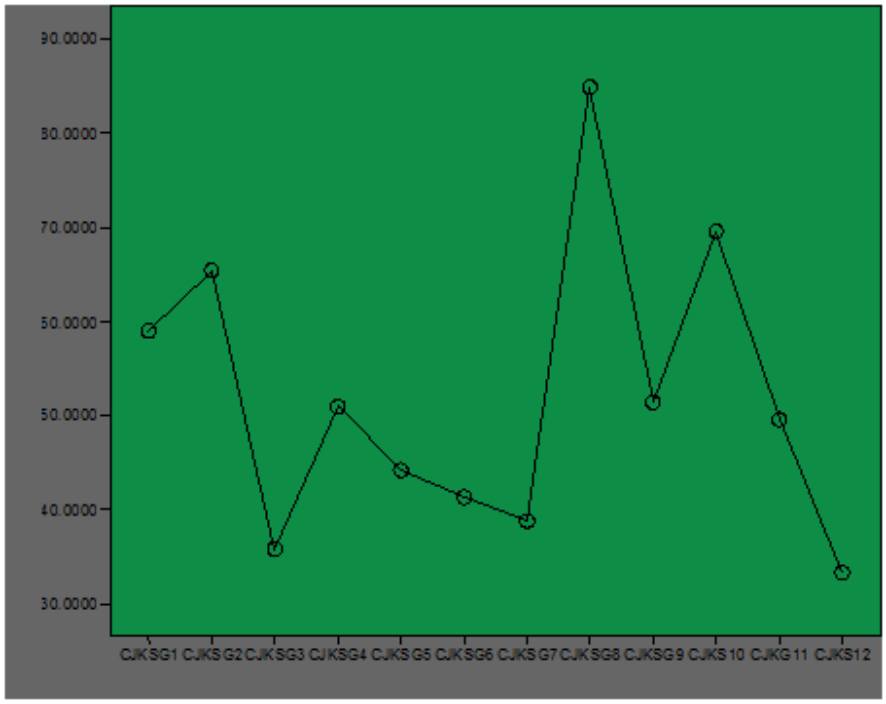

Figure No. 3
A graph of activity concentration for soil samples with average of 51.98 -Th232

Results and Discussion

Results from the twelve field soil samples analyzed indicated that the activity concentration due to 40K with the highest values ranged from 19.75±6.2 to 862.20±13.9 Bq/kg with mean value of 390.95, thorium 33.30± to 84.83± Bq/kg mean value of 51.98 and Radium .78± to 5.68± Bq/kg mean value of 2.39 as shown in Table 3a. the highest radioactivity concentration of 40K was found in soil sample CJKSG8 and the lowest activity concentration from CJKSG 10 and the minimum and maximum activity concentration was deduce from the graph figure 1, 2 and 3.

Conclusion

Generally, Table-1 is the result of the activity concentration due to K-40,Ra-226 and Th-232 there was slightly high activity concentration in Th-232 but lower in K-40 and Ra 226 in the soil. The mean activity concentration of Th-232 51.98± above average which could be dangerous to the health of the miners and the people around the place but due to K-40 is below average. The activity concentration of Ra-226 is very low and the mean 2.39± far below average. Table-2 is the statistical analysis and the graph figure 1, 2 and 3 indicate the line chart of activity concentration due to K-40, Ra-226 and Th-232 respectively.

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