

Distribution of Radionuclide Concentration with Proximity to the Lagoon in Lagos State, Southwestern Nigeria

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Abstract

The radioactivity of Lagos State in the Southwestern Nigeria was determined using an HpGe based, low level passive gamma-counting system. The main radionuclides analyzed in the samples were the progenies of ^{238}U and ^{232}Th . The other two isotopes were the naturally occurring ^{40}K and the anthropogenic ^{137}Cs . The results of the study showed that the average specific activity concentration of ^{238}U , ^{232}Th and ^{40}K have consistent values with published data for many other countries in the world. The presence of the fission product ^{137}Cs could be traced to the fallout of the nuclear tests in the Sahara desert and probably, some effects of the more recent nuclear reactor accident at Chernobyl in 1986.

Keyword: radionuclide, concentration, radioactivity, contamination, soil

1. Introduction

Naturally occurring radioactive materials are present in air, food and water as well as the ground from which human settlements are built. (Ciezkowski and Przylibski, 1997), the dumping of large amount of waste materials in sites from oil facilities, and the discharge of waste chemical products from industry and agricultural practices without adequate measure of soil protection result in soil surface and ground water pollution (Cothorn and Lappenbusch, 1983). However soil radioactivity depends on the types of rock from which soil is derived (Holkko and Liukkonen, 1992), but slight variation of radioactivity content in soil can occur with different locations and depth, depending on the type of soil, soil formation and transport processes (McAulay and Marsh, 1992). Contaminated soil serves as a direct source of radionuclide contamination of all agricultural products (Banwo et al 1990). Sediment in water may be a source of contamination of aquatic organisms. The input of radionuclides to the environment is derived from soil and atmospheric diffusion (Papp and Daroczy, 2002).

Accurate estimation of the occurrence of radionuclides in an environmental matrix such as soil will provide information from which estimates of average radiation exposures of the public from these sources can be made.

2. Materials and Method

A total of 35 soil samples were collected, five samples were collected from each of these locations, Ojota, Ikoyi, Berger, V.I, Agege, Obalende and Owode all in Lagos State, Southwest Nigeria. The sampling locations were chosen based on factors such as population density market centers, industrial location, ocean proximity, population density and metal scrap dump site.

The soil samples were cored from the surface horizon (60mm depth) representing the root depth for most vegetables. The types of soil found in this area is made up of sand. The samples were obtained by first cleaning the surface of vegetation and dead organic matters. In each location, five one-meter squared grids were drawn randomly at different

spots in the entire area covered by the location. This was done to obtain five representative samples describing the soil from each location. Samples from each grid were put in a polyethylene bag and five samples from each location grouped together. All the samples collected were dried in free air at an average temperature of 30°C and 80% relative humidity until a constant weight was obtained. The dried soil sample were then ground and sieved to pass through 2mm mesh. The roots and organic matter remains were separated from the soil. Approximately 1 kg of these samples were then placed in 1 litre Marinelli beaker ready for measurement. Gamma-counting of the samples were performed on a low level gamma-ray spectrometer consisting of a stream-lined, vertical cryostat HpGe semi-conductor detector coupled directly to a pre-amplifier. The detector was then connected to a power supply, the output to a spectroscopic amplifier, an analogue to digital converter (ADC) and an S100 multi-channel analyzer (MCA) card hosted in an IBM-PC. All these instruments were Canberra products. Each sample was counted for 36000 seconds. Spectrum analysis was based on the output of a PC based Genie 2K spectrometry software, version 2.1, also from Canberra.

3. Results and Discussion

Table 1 shows the various radionuclides detected and measured as well as their specific activities in the various soil samples obtained from the sampling locations.

Each value represents the average of five samples from a given location. The activity concentration of ^{40}K ranged from $44.74 \pm 3.41 \text{ Bq kg}^{-1}$ at Berger to $489.96 \pm 11.35 \text{ Bq kg}^{-1}$ at Owode (average $204.02 \pm 7.00 \text{ Bq kg}^{-1}$). The activity concentration of ^{214}Bi ranged from $1.20 \pm 0.45 \text{ Bq kg}^{-1}$ at Obalende to 55.30 ± 1.43 at Owode (average $23.21 \pm 0.92 \text{ Bq kg}^{-1}$). For ^{208}Tl , the activity concentration ranged from $2.18 \pm 0.25 \text{ Bq kg}^{-1}$ at V.I to $60.33 \pm 1.39 \text{ Bq kg}^{-1}$ at Owode (average $22.84 \pm 0.78 \text{ Bq kg}^{-1}$). The activity concentration of ^{235}U ranged from $0.57 \pm 0.23 \text{ Bq kg}^{-1}$ at Obalende to $5.67 \pm 1.82 \text{ Bq kg}^{-1}$ at Owode (average $2.70 \pm 0.72 \text{ Bq kg}^{-1}$). The activity concentration of the fall out radionuclide ^{137}Cs ranged from $0.03 \pm 0.28 \text{ Bq kg}^{-1}$ at Agege to $2.15 \pm 0.20 \text{ Bq kg}^{-1}$ at Ikoyi (average $0.37 \pm 0.1 \text{ Bq kg}^{-1}$). A relatively high concentrations of all the radionuclides, ^{40}K , ^{24}Bi (^{238}U), ^{208}Tl (^{232}Th), ^{235}U and ^{137}Cs were obtained from Owode. This may be partly due to the fact that Owode is a centre for metal scraps dump. The mean activity concentration values obtained for these radionuclides are fairly less than the values published for other parts in the southwestern Nigeria probably because Lagos State is not characterized by rocks (Obisesan, 2004).

The least values of ^{24}Bi , ^{208}Tl , ^{40}K and ^{137}Cs were obtained in obalende and V.I. This may be due to the closeness of these locations to water bodies (Atlantic ocean and the Lagoon) into which most of these radionuclides are deposited during rainfall (ICRP, 1991) since some of the radionuclides are moderately soluble in water. The soil of these locations is purely sand with high porosity thereby allowing transportation and redistribution of these radionuclides by erosion (Delaune et al, 1986).

It is noteworthy to mention that ^{137}Cs was detected in some of the surveyed locations of the state, its presence could be due to the fallout primarily during the Chernobyl nuclear accident or as a result of the weapon test in the Sahara region.

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Table 1 : Radionuclide Concentrations (Bq kg⁻¹) in soil samples from Lagos State Nigeria

Location	⁴⁰ K	¹³⁷ Cs	²⁰⁸ Tl	²¹⁰ Pb	²¹² Bi	²¹² Pb	²¹⁴ Bi	²¹⁴ Pb	²²⁸ Ra	²²⁸ Ra	²²⁸ Ac	²³² Th	²³⁸ Pa	²³⁸ Th	²³⁵ U
Ojota	54.45±6.02	ND	32.24±1.29	29.20±7.30	115.99 ± 9.34	104.87± 3.51	26.51 ± 1.33	29.03 ± 1.60	93.19 ± 9.25	67.06 ± 8.53	88.69 ± 3.42	129.99 ± 12.61	ND	72.04 ± 3.93	4.11 ± 0.52
Ikoji	318.91±9.37	2.15±0.20	16.75±40.69	399.36±76.32	67.36 ± 5.36	53.75± 2.32	37.08 ± 1.23	41.60 ± 1.58	35.93 ± 7.59	57.59 ± 25.46	47.65 ± 1.79	187.44 ± 16.46	ND	103.59 ± 5.93	2.37 ± 1.51
Beger	44.74±4.41	ND	21.69±0.72	3.46±4.66	69.01± 4.90	75.09± 1.85	18.20 ± 0.74	21.53 ± 0.6	ND	45.38 ± 5.84	56.86 ± 1.75	94.19 ± 7.41	ND	51.41 ± 2.49	2.75 ± 0.36
V. I	±3.51	ND	2.18±0.25	6.22±2.96	±2.62	0.50	0.35	0.46	ND	14.64 ± 3.20	5.72 ± 0.57	ND	ND	ND	0.20
Agege	364.40±10.60	0.03 ± 0.28	24.13±0.86	39.67±1.55	4.40 ± 6.14	89.04± 2.25	20.10 ± 0.91	23.22 ± 0.88	ND	40.22 ± 6.84	63.78 ± 2.30	ND	ND	53.63 ± 2.39	2.47 ± 0.42
Obalende	95.60±4.69	ND	2.54±0.28	12.65 ± 3.28	12.66±3.7	9.04± 0.42	1.20 ± 0.45	1.19 ± 0.45	11.52 ± 2.78	9.28 ± 3.73	7.40 ± 0.73	ND	ND	8.97 ± 1.24	0.57 ± 0.23
Owode	489.96±11.35	0.38 ± 0.23	60.33 ± 41.39	58.44 ± 5.50	201.95 ± 3.20	185.38 ± 11.3	55.30 ± 1.43	57.59 ± 2.65	165.45 ± 24.93	30.11 ± 30.57	176.29 ± 5.13	273.08 ± 19.24	34.28	53.71 ± 6.48	5.67 ± 1.82

ND = No detection

Table 2 : Mean specific activity concentration (Bq kg⁻¹)

State	⁴⁰ K	¹³⁷ Cs	²⁰⁸ Tl	²¹⁰ Pb	²¹² Bi	²¹² Pb	²¹⁴ Bi	²¹⁴ Pb	²²⁸ Ra	²²⁸ Ra	²²⁸ Ac	²³² Th	²³² Pa	²³² Th	²³⁸ U
Lagos	204.02 ± 7.00	0.37 ± 0.1	22.84 ± 0.78	78.79 ± 14.51	78.07 ± 5.75	75.09 ± 3.23	23.21 ± 40.92	25.47 ± 4.20	43.3 ± 6.36	37.8 ± 12.02	63.77 ± 2.31	97.89 ± 7.96	7.67 ± 4.90	7.67 ± 3.21	2.7 ± 0.72

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