Advances in Physics Theories and Applications
ISSN 2224-719X (Paper) ISSN 2225-0638 (Online)
Vol 13, 2013

Radioactivity in the Soils of Akoko Area of Ondo State Southwestern Nigeria

T.J Ojo[1]* K.A.J Gbadegesin[1]
1. Physics Unit of Science Technology Department, Federal Polytechnic, P.M.B 5351, Ado-Ekiti, Nigeria
*E-mail: talk2ojotj@yahoo.com.

Abstract

The average concentration of the radioactivity in soil of Akoko area of Ondo State Nigeria, 20years after Chernobyl nuclear power plant accident have been, measured by means of a well-calibrated high-purity germanium detector. The photo-peaks observed with reliable regularity belonged to the naturally occurring series-decay radionuclides headed by ^{238}U and ^{232}Th as well as the non-series decay type ^{40}K. Twenty years after the nuclear accident, ^{137}CS was detected in all the sampled areas of Ondo State, with an average of 1.12±0.38 Bq kg^{-1}, the time interval being two-third the ^{137}Cs half life (30.2years). The mean activity concentration values of 39.24±1.12, 52.86±1.40 and 445.02±12.24 Bq kg^{-1} for ^{238}U, ^{232}Th and ^{40}K respectively were obtained for the state.
Keywords: radioactivity, radionuclides, concentration, exposure, radiation

1. Introduction

The naturally occurring radionuclides, ^{238}U, ^{232}Th and ^{40}K are present in soil and rocks but are not uniformly distributed all over the world. The knowledge of the distribution of these radionulides in soils and rocks plays an important role in radiation protection measurements (Cross et al, 1985). The level of radionulides in soils is a major cause of external and internal exposure. Outdoor radiological hazard to human health can be assessed from the determination of radioactivity level in the soil (Hess et al, 1983). The production of man-made radionuclides was a result of fission process and/or by accelerating electrically charged sub nuclear particles such as protons, deuterons, tritium and alpha particles to very high energies and directed onto a target material thereby causing nuclear reactions that results in the formation of radionuclides. During these processes, some of these artificially produced radionuclides usually get released into the global environment thereby undoubtedly adding to the levels of the natural radiation (Joshi, 1991). When this radiation interacts with biological system in the body, energy is deposited or absorbed in the material leading to ionization of some of the atoms of the cell. These can lead to a breakdown of the cell structure and its components (Joshi, 1991).

2. Materials and Methods

35 samples from 7 townes in Ondo State were collected. In these towns, 5 locations were randomly selected across the entire area covered by each of the towns where a sample was taken each.
250 g sample was collected between depth of 6cm and 10cm. the collected samples were first sun dried and then oven dried at 110^0C to constant weight. The samples were pulverized and sieved using 2mm wire mesh to obtain a fire texture.
The well prepared samples were packaged in well labeled cellophane bags. Gamma spectroscopy measurements were carried out on the packaged samples using coaxial-type high purity Germanium (HPGe) detector (Canberra Industries Inc) with 50% relative efficiency and having a resolution of 2.4 keV at 1.33 MeV. The detector was properly shielded in lead castle. Calibrations of the measuring systems were carried out with certified reference standards for various radinouclides.
Spectral analyses were performed with Genie 2K spectrometry software, version 2.1 (Canberra Industries Inc).
Each sample was counted for 24 hours to achieve minimum counting error. Specific activity of each radionuclide in the soil samples was expressed in Bq kg^{-1} of dry mass of soil and corrected for the time elapsed since the samples were collected in the field.

3. Results and Discussion

The towns surveyed for the levels of radionuclides in the state were Oba, Ugbe, Ogbagi, Owo, Ikare, Ogbese and Irun.

Table 1a: Radionuclide concentration (Bq $kg^{-1)}$

Location	^{40}K	^{137}Cs	^{208}Tl	^{210}Pb	^{212}Bi	^{212}Pb	^{214}Bi	^{214}Pb
Oba	1358.60±28.54	3.95 ±0.87	150.76 ±3.19	140.92±10.97	520.11± 19.37	465.34± 10.66	86.86 ±2.29	94.10±3.34
Ugbe	292.49 ±11.13	1.18 ±0.58	50.46 ±1.56	36/16± 10.86	184.87± 11.1	170.73± 8.36	ND	39.81±
Ogbagi	449.46 ±13.22	0.32 ±0.15	27.20 ±0.87	13.58± 12.91	98.22±6.41	91.60 ±4.54	22.92± 0.85	25.97±1.48
Owo	102.33 ±4.18	0.33 ±0.16	5.35± 0.34	ND	18.44±3.52	19.35± 0.75	8.63± 0.48	9.11±0.61
Ikare	323.76± 9.57	1.48 ±0.26	91.05± 2.14	8.57±11.79	302.80± 13.94	327.43± 6.74	96.21 ±2.05	112.45± 2.79
Ogbese	282.22± 9.91	0.28 ±0.33	17.87± 0.83	49.89±15.36	56.33±6.59	68.79 ±2.08	33.39 ±1.22	37.25±1.66
Irun	306.30 ±9.16	0.29 ±0.31	27.34 ±0.84	37.65±3.82	98.28±6.22	90.57± 2.02	26.66 ±0.94	29.48±0.88
Average	445.02 ±12.24	1.12 ±0.38	52.86 ± 1.40	40.9 ± 9.39	182.72±9.68	176.26±5.02	39.24±1.12	42.6±1.72

Table 1b: Radionuclide concentration (Bq $kg^{-1)}$

Location	^{224}Ra	^{226}Ra	^{228}Ac	^{228}TH	^{234M}Pa	^{234}Th	^{235}U
Oba	402.51± 18.45	198.05±13. 79	429.93±12. 10	598.12±40. 26	111.66±58. 82	141.11±6. 76	12.15±0. 83
Ugbe	ND	9.18±11.73	146.84±6.4 4	ND	ND	92.33±6.0 9	4.86±0.7 2
Ogbagi	ND	57.86±6.86	73.74±3.35	131.56±13. 08	ND	33.41±3.6 0	3.55±0.4 2
Owo	ND	12.09±3.35	ND	160.59±14. 14	ND	20.53±1.8 7	0.74±0.2 1
Ikare	ND	71.76±25.7 6	253.61±6.6 7	92.35±7.05	117.05±41. 10	206.10±9. 27	7.97±1.3 9
Ogbese	ND	85.34±8.95	47.57±2.09	ND	ND	40.76±3.3 2	5.24±05 4
Irun	69.23±5.2 8	76.35±63.7 7	77.52±23.1 6	12.48±9.67	ND	50.26±2.6 5	46.85±0. 39
Averag e	67.39±3.39	82.95- ±19.17	147.04±7.6 9	142.16±12. 03	32.67±14.2 7	83.5±4.79	11.62±0 .4

ND: below detectable limit

Tables 1a and 1b show that ^{40}k was detected in all the towns with specific activity varying from 102,33±4.18^{-1}Bq kg^{-1} (in Owo) to 1358.60± 28.50 Bq kg^{-1} (in Oba) (average of 445.02± 12.24Bq kg^{-1}). The activity concentration of ^{214} Bi an indicator for ^{238}U ranged from ND at Ugbe to 96.21± 2.05Bq kg^{-1} at Ikare (average of 39.24± 1.12 Bq kg^{-1}). Also the activity concentration of ^{208}Tl an indicator for ^{232}Th ranged from 5.35 ±0.34 Bq kg^{-1} at Owo to 150.76±3.16 Bq kg^{-1} at Oba (average of 52.86±1.40 Bq kg^{-1}). The activity concentration of ^{137}Cs ranged from 0.28± 0.33 Bq kg^{-1} at Ogbese to 3.95± 0.87 Bq kg^{-1} at Oba (average of 1.12± 0.38 Bq Kg^{-1}). In the sampled area, it was seen that the highest concentration values of ^{40}k, ^{208}TL (^{232}Th), and ^{137}Cs were recorded in Oba, highest concentration values of ^{214} Bi and ^{235}U were recorded at Ikare and Irun respectively. The least concentration values of these radionuclide with the exception of ^{137}Cs were measured in Owo.

The highest activity concentration for the radionuclide recorded in Oba may be due the fact that Oba is situated on Precambrian basement rock. Radioactivity in soil, results from the rock from which it is derived (Tchokossa, 1999). Higher concentration values of ^{40}K were obtained in Oba, Ogbagi, Irun, Ugbe and Ikare probably because these towns are moving towards the guinea savanna, there is need to enhance the soil nutrients by the use of inorganic fertilizer. This may be one of the reasons for high concentration values of ^{40}K in the towns. The higher concentration values of ^{40}K in these towns could also be attributed to the erosion from the weathered surfaces of the potassium rich, igneous rocks which dominate a section of the geology of this areas. The least concentration values of most of the radionuclides were got in Owo probably because Owo is situated in the rainforest region where organic matters from dead wood and leaves are major sources of

soil nutrients. In addition, Owo is close to two major rivers in the state (rivers Osse and Ogbese), during heavy rainfall, the radionuclides may become mobile, transported and deposited in these rivers (Banwo et al 1990).
^{137}Cs was detected in all the surveyed location of the state, the activity concentration value varied from 0.28 ± 0.22 Bq kg^{-1} to 3.95±0.87 Bq kg^{-1}, the highest concentration was detected in Oba probably because is a location characterized by clay. ^{137}Cs is strongly bound to clay mineral in the soil (Wojcieh et al 1993).

4. Conclusion

Because of the incidence of ^{137}Cs in the soils of the sampled areas, it is therefore crucial to carry out regular monitoring exercise on the seasonal variation of this radionuclide in the area.

References

Cross F.T, Harley N.H and Hofmann W. (1985) *Health Physics* 48:649.
Hess C.T, Michael J, Horton T.R, Prichard H.M and Consigliore W.A (1985) *Health Physics* 48:553
Joshi S.R (1991) *Science Total Environment* 100:61
Tchokossa P, Olomo J.B, Osibote O.A (1999) *Nuclear Instruments and Methods in Physics Research* A 422, 784
Banwo A.A, Jimba B.W and Elegba S.B (1990) Proceeding of the 13th Annual Conference, *Nigeria Institute of Physics*
Wojech C, Jerzy W.M and Jolanta S (1993) *Institute of Nuclear Physics* 10:3.