Assessment of Natural Radionuclides in Soil samples and Estimation of Radiation Doses around the proposed Phosphate Mining area in Oshosun, Ogun-State.Nigeria.

A.B Ogunremi, A.O Mustapha, V Makinde and O.A Idowu

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OUTLINE OF PRESENTATION

- Introduction
- Problem Statement
- Aims and Objective
- Materials and Methods
- Results and Discussion
- Conclusion
- References

INTRODUCTION

PHOSPHATE MINING

Phosphate rock refers to mineral assemblage that occurs naturally with an exceptionally high concentration of phosphate minerals (RMRDC, 2010).

It is the major resource mined to produce phosphate fertilizers which are key factor in sustaining the world's agricultural output.

It may be derived from a number of sources, but the most common is the one that contains high concentration of phosphates in nodular or compact masses

During mining, different wastes like heavy metals, overburden, toxins and acids are significantly released into the environment causing air and water pollution (Ledin *et al.*,1996).

Radioactive substances that enter rivers, lakes, seas and oceans are absorbed by aqueous plants and animals both directly from the water and from the preceding link in the food chain

STATEMENT OF PROBLEM

There are possibilities that phosphate mining might commence in Oshosun soon

Pollution of the environmental matrix like soil through the use of chemicals and heavy machines during mining can never be ruled out and monitoring the radiological and environmental consequence after commencement of operation is always difficult.

Therefore, there is need to carry out baseline assessment of the area before mining activities began.

AIM AND OBJECTIVES

This work is aimed at assessing the natural radionuclides in soil samples and estimation of radiation doses around the proposed Phosphate Mining area in Oshosun. The specific objectives are to,

1. establish baseline values of activity concentration due to ^{40}K,^{226}Ra and ^{232}Th in samples of soil from the site.

2. calculate the associated doses using generic and specialized models (RESRAD).

3. provide results that will compliment data required for setting of guidelines on radiological safety for soil

LOCATION OF THE STUDY AREA

Oshosun is located in Ifo local government area of Ogun State. The town Oshosun is between Latitudes 6° 49' to 6° 55'N and Longitudes 3° 14' to 3° 19'E. It occupies an area of about 521km^2.

Oshosun area is underlain by the Ilaro formation found in the Benin (Dahomey basin) (Enikanselu, 2008).

The Ilaro formation is made up of both marine and continental, massive yellowish consolidated sandstone.

MATERIALS AND METHODS

Sample collection and Spectra set-up

- Soil samples collection and preparation

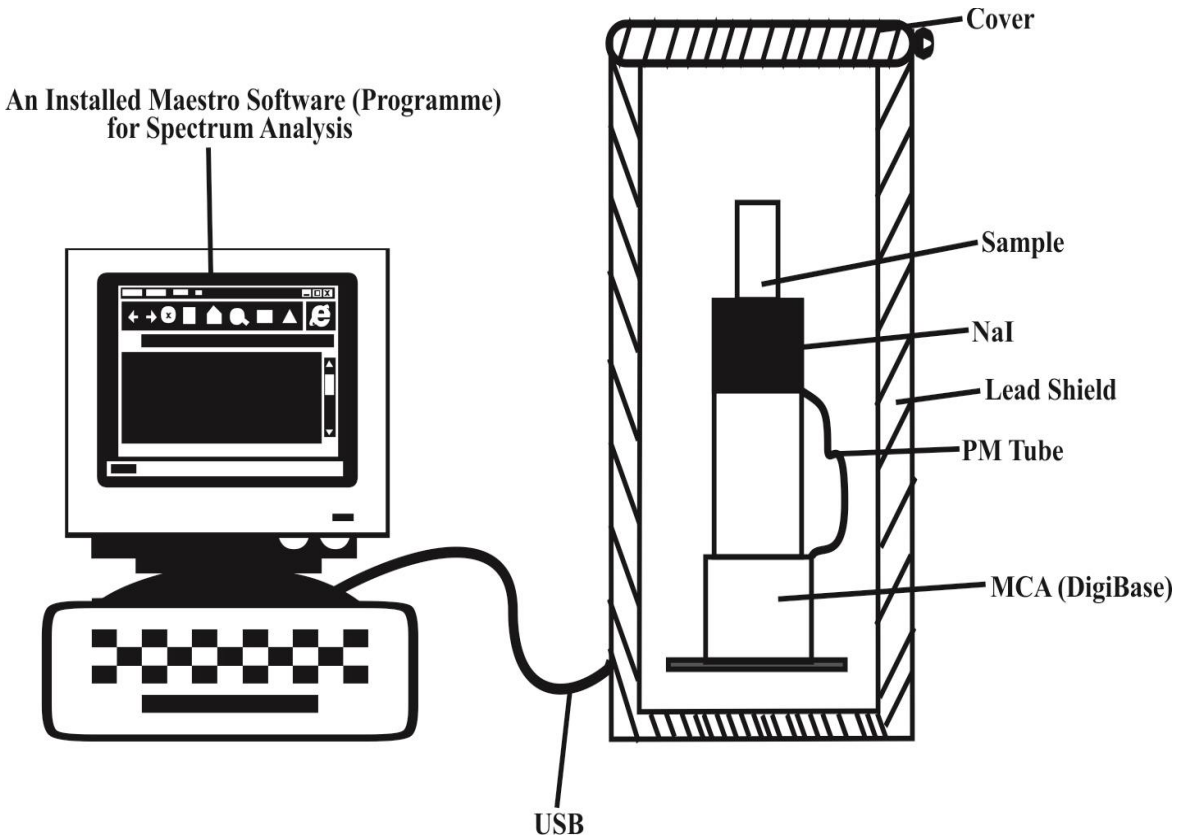

Fig1. Block diagram of ORTEC Digibase of Sodium Iodide Detector

MATERIALS AND METHODS CONTD.

Counting with Sodium Iodide Detector

After the calibration of the detector, each sealed sample was placed on the detector for counting.

The counting time was set at 10,800s (3hrs) as was considered adequate and to reduce error in measurement.

Individual radionuclides identified by their gamma energies

To maintain reproducible counting geometry, almost equal volume of samples and standards were used by careful placing of sample on detector during counting

Background counting obtained by filling clean plastic container with distilled water

MATERIALS AND METHODS CONTD.

The activity concentrations in the samples were obtain using by (Akinloye and Olomo, 2000)

$$C(Bq/kg) = \frac{C_n}{\epsilon P_y M_s} \quad (1)$$

Where C is the activity concentration(Bq/kg)

C_n is the count under the photopeak

ϵ is the detection efficiency at the specific γ-ray energy

P_y is the absolute transition probability of the γ-ray

M_s is the mass of the sample (kg)

MATERIALS AND METHODS CONTD.

Absorbed dose Calculation

Gamma radiation levels of the site and its environs was obtained by

$$D\ (nGy/h) = 0.427C_{Ra}+0.662C_{Th}+.0.043C_{K} \quad (2)$$

Annual Effective Dose (AED)

AED was determined by the equations below.

$$AED\ (Outdoor)\ (\mu\ Sv/y) = D\ (nGy/h) \times 8760hr \times 0.7\ Sv/Gy \times 0.2 \times 10^{-3} \quad (3)$$

MATERIALS AND METHODS CONT'D

DOSES CALCULATION USING RESRAD

RESRAD helps to determine how humans may be affected by radioactive waste or other types of contaminants buried in the soil as well as radiation doses and excess lifetime cancer risk to exposed on-site receptor.

OPERATION OF RESRAD

RESRAD program allows the user to specify many features of a site and to select the exposure pathways that will be important.

The value of any parameter in the model can be changed by using popup windows accessed through the "Modify Data" button on the far left of the RESRAD screen.

After clicking on "Modify Data," a series of 12 buttons will appear in a new panel. Each of these 12 buttons will, when clicked, launch a popup data entry window in which you can modify the associated parameters.

MATERIALS AND METHODS CONT'D

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Table 4.0 Activity Concentration, Absorbed and Effective Doses due to ^{40}K, ^{226}Ra and ^{232}Th in the Soil Samples from Oshosun.

	Activity Concentration(Bq/kg)			Absorbed dose(nGy/hr)	Effective dose (mSv/yr)
Location	^{40}K	^{226}Ra	^{232}Th		
Balogun	130.61±41.18	59.22±41.72	19.89±41.62	44.82	0.05
Abebi	233.61±15.70	65.60±32.91	290.25±32.81	215.36	0.26
Osoba 1	177.16±16.89	48.23±25.23	1.81±45.18	30.76	0.04
Asaagun	289.07±18.49	48.59±36.38	161.85±35.28	132.26	0.16
Oke Pata C.H.S	16.72±28.41	71.98±33.79	0±33.69	33.95	0.04
Near Asegun Well	211.82±16.60	60.64±32.63	160.04±32.53	133.52	0.16
Baamu 1	461.39±13.64	72.69±34.31	484.66±34.21	345.56	0.42
Leerin 1	26.62±26.69	103.17±25.28	158.24±25.18	144.35	0.18
Railway Crossing	27.61±24.34	48.94±50.15	73.24±50.05	68.00	0.08
Olomu	538.64±20.32	28.03±70.24	42.50±70.14	61.08	0.07
Opposite Adeoye	137.54±23.25	54.61±45.72	0±45.62	30.97	0.04
Adeoye	185.08±22.07	58.16±39.84	0±39.74	34.59	0.04
Kelemu	442.58±13.25	76.94± 33.56	330.94± 33.46	253.89	0.31
Orisun Imisi	170.22±24.21	41.85± 55.86	0±55.76	26.43	0.03
Farm Land	257.38±21.32	37.25± 64.28	32.55± 64.18	47.60	0.06
K.K Fabulus	325.71±20.56	85.10± 27.51	382.48±27.41	283.91	0.35
Strong Tower	390.09±20.90	75.17± 34.81	496.41± 34.71	350.83	0.43
Ogo-mi-da Rd	371.27±14.80	57.45± 31.28	309.24± 31.18	228.8	0.28
Near King's palace	387.11±16.24	50.01± 43.15	0±43.05	39.25	0.05
Maternity	181.12±29.17	40.44± 53.34	25.32± 53.24	41.53	0.05
Community Centre	421.78±19.00	43.27± 46.08	206.16±45.98	162.1	0.2
Agbegise	245.49±27.05	54.61± 37.38	386.10± 37.28	268.67	0.33
Agbegise Square	845.66±19.00	60.64± 32.12	0±32.02	63.28	0.08
African Chu Sch	171.21±22.34	76.94± 40.14	252.27± 40.04	195.06	0.24
Osoro	102.88±21.10	52.13± 44.92	0±44.82	28.38	0.03
Oke Pata H.Centre	91.98±22.18	42.92±40.99	25.32± 40.89	38.96	0.05
Ebiti 1	158.34±25.68	48.94±43.44	26.22±43.34	45.05	0.06
Ebiti 2	143.48±25.56	64.54±40.20	52.44± 40.10	67.48	0.08
Seleru	127.64±24.91	55.32± 33.61	190.79± 33.51	146.12	0.18
Baamu 2	132.59±27.24	42.21± 52.67	59.68± 52.57	61.07	0.07
Leerin 2	204.89±25.32	77.65± 27.52	182.65±27.42	154.74	0.19
Range	16.72- 845.66	28.03-103.17	1.81-496		
Mean	**245.40± 6.3**	**58.17 ± 11.60**	**140.36 ±11.6**	**121.88**	**0.15**

RESULT CONTD.

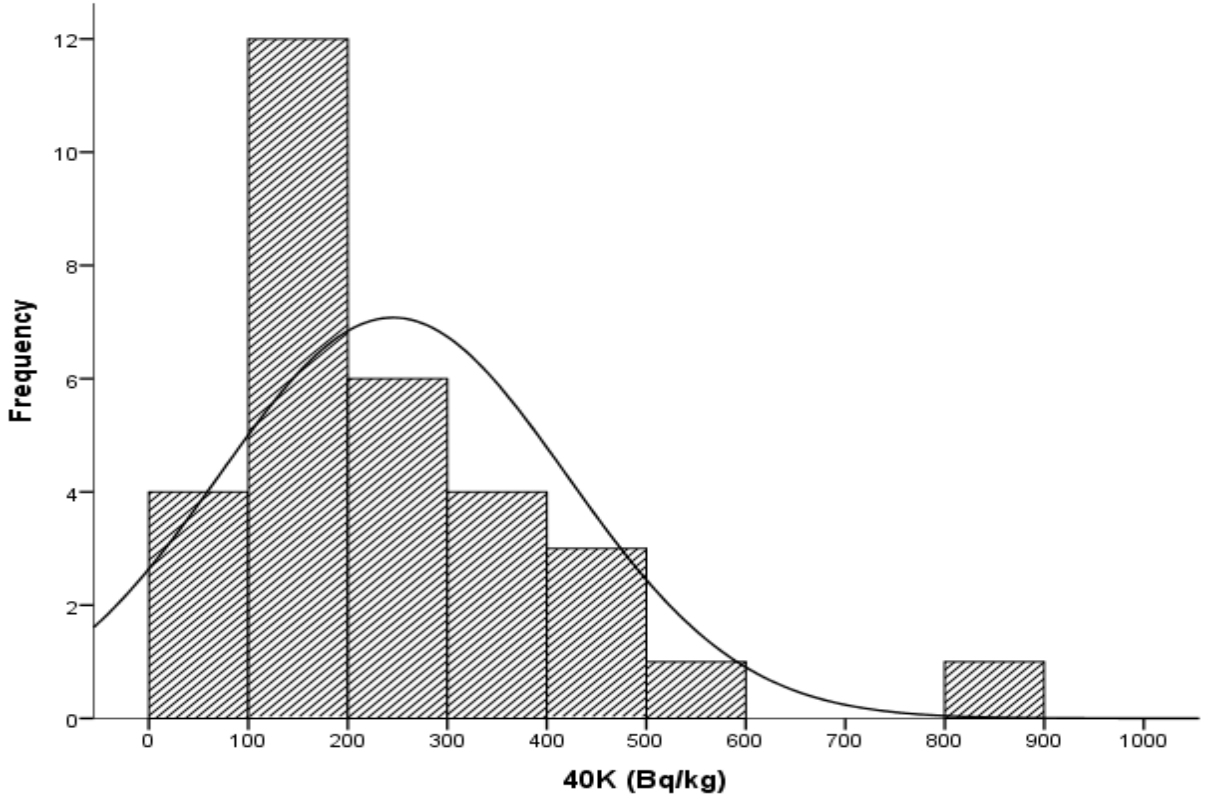

Figure 2: Frequency distribution of activity concentration due to 40 K in soil sample from Oshosun

RESULT CONTD.

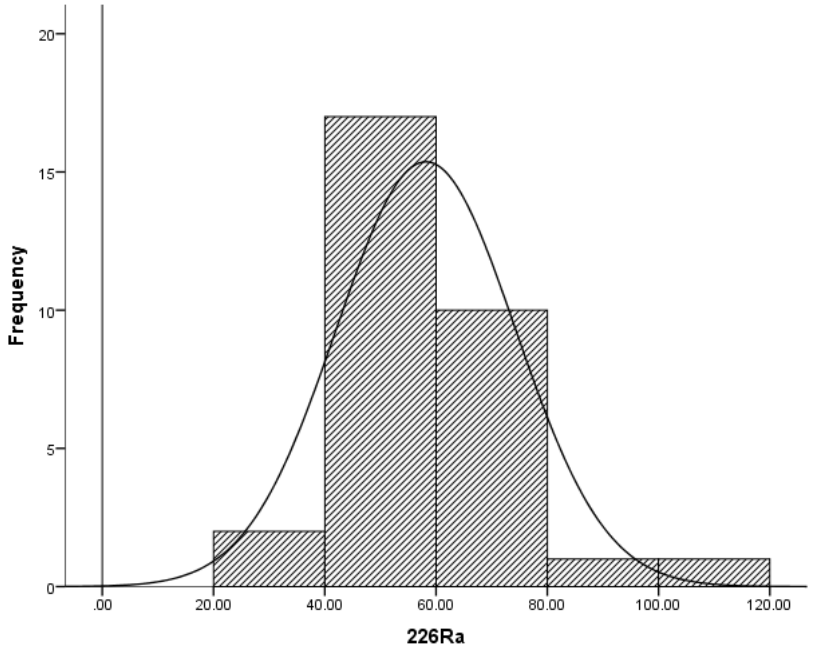

Figure 3: Frequency distribution of activity concentration due to ^{226}Ra in soil sample from Oshosun .

RESULT CONTD.

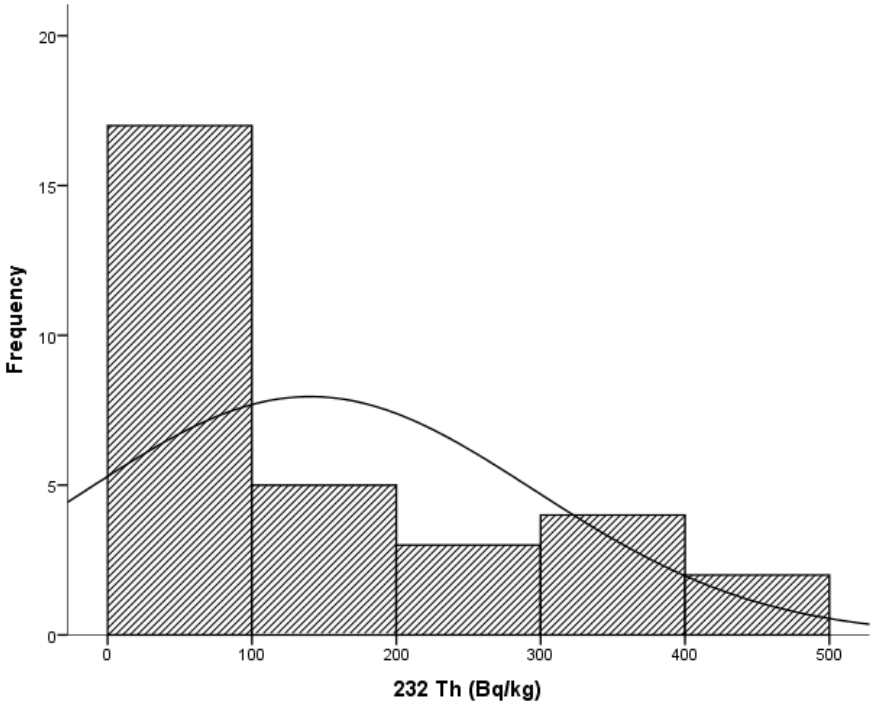

Figure 4: Frequency distribution of activity concentration due to ^{232}Th in soil sample from Oshosun .

RESULT CONTD.

Table 2: Effective Dose from RESRAD analysis of soil samples

				Eff.Dose(10^{-2} rem/y)			
S/N	**Ground**	**Inhalation**	**Plant**	**Meat**	**Milk**	**Soil**	**Total**
1	0.220	0.002	0.245	0.106	0.045	0.003	0.621
2	0.537	0.021	0.817	0.199	0.091	0.023	1.688
3	0.276	0.000	0.290	0.143	0.059	0.001	0.769
4	0.539	0.011	0.710	0.239	0.104	0.013	1.616
5	0.040	0.000	0.034	0.014	0.006	0.001	0.095
6	0.425	0.011	0.586	0.177	0.078	0.013	1.290
7	0.993	0.035	1.475	0.389	0.175	0.038	3.105
8	0.156	0.012	0.292	0.027	0.016	0.013	0.516
9	0.095	0.005	0.160	0.025	0.013	0.006	0.304
10	0.837	0.002	0.926	0.436	0.183	0.004	2.388
11	0.218	0.003	0.225	0.111	0.047	0.009	0.613
12	0.289	0.003	0.301	0.149	0.063	0.011	0.816
13	0.875	0.024	1.213	0.369	0.163	0.026	2.670
14	0.264	0.000	0.276	0.138	0.057	0.008	0.743
15	0.413	0.003	0.463	0.209	0.088	0.003	1.179
16	0.732	0.028	1.105	0.276	0.126	0.030	2.297
17	0.894	0.036	1.379	0.332	0.152	0.038	2.831
18	0.751	0.022	1.065	0.310	0.138	0.024	2.310
19	0.589	0.000	0.622	0.313	0.130	0.001	1.655
20	0.295	0.002	0.331	0.147	0.062	0.003	0.840
21	0.763	0.015	0.989	0.348	0.150	0.017	2.282
22	0.608	0.028	0.979	0.211	0.099	0.029	1.954
23	1.278	0.000	1.355	0.683	0.284	0.002	3.602
24	0.422	0.018	0.662	0.147	0.068	0.02	1.337
25	0.165	0.000	0.169	0.083	0.035	0.009	0.461
26	0.162	0.002	0.189	0.075	0.032	0.003	0.463
27	0.263	0.002	0.297	0.129	0.055	0.003	0.749
28	0.259	0.004	0.315	0.118	0.051	0.005	0.752
29	0.316	0.014	0.497	0.109	0.051	0.015	1.002
30	0.245	0.005	0.306	0.107	0.047	0.005	0.715
31	0.431	0.013	0.610	0.172	0.077	0.015	1.318
Mean	0.463	0.010	0.609	0.203	0.089	0.013	1.386

RESULT CONTD.

			ELCR $x10^{-4}$				
S/N	Ground	Inhalation	Plant	Meat	Milk	Soil	Total
1	1.10	0.00	1.24	0.34	0.15	0.01	2.84
2	11.49	0.03	9.84	0.82	0.55	0.10	22.81
3	0.52	0.00	0.92	0.44	0.18	0.00	2.06
4	6.80	0.01	6.26	0.84	0.47	0.05	14.43
5	0.08	0.00	0.09	0.04	0.18	0.00	0.39
6	6.55	0.01	5.83	0.65	0.39	0.05	13.49
7	19.32	0.04	16.77	1.54	0.98	0.16	38.81
8	6.05	0.01	4.89	0.20	0.20	0.05	11.40
9	2.84	0.01	2.34	0.13	0.11	0.02	5.45
10	2.92	0.00	3.89	1.36	0.59	0.02	8.77
11	0.36	0.00	0.68	0.34	0.14	0.00	1.52
12	0.48	0.00	0.91	0.45	0.19	0.00	2.03
13	13.53	0.03	12.07	1.36	0.80	0.11	27.90
14	0.43	0.01	0.83	0.42	0.17	0.00	1.86
15	1.87	0.03	2.23	0.66	0.30	0.01	5.09
16	15.18	0.03	13.05	1.12	0.74	0.13	30.25
17	19.61	0.04	16.78	1.37	0.92	0.16	38.89
18	12.53	0.03	11.07	1.17	0.71	0.10	25.60
19	0.96	0.00	1.88	0.95	0.39	0.00	4.19
20	1.41	0.00	1.64	0.47	0.21	0.01	3.74
21	8.78	0.02	8.23	1.21	0.65	0.07	18.95
22	15.11	0.03	12.77	0.93	0.66	0.13	29.62
23	2.08	0.00	4.10	2.07	0.86	0.06	9.18
24	9.92	0.02	8.40	0.63	0.44	0.08	19.50
25	0.28	0.00	0.51	0.25	0.11	0.00	1.14
26	1.19	0.00	1.21	0.25	0.12	0.01	2.78
27	1.39	0.00	1.56	0.41	0.19	0.01	3.56
28	2.35	0.01	2.28	0.40	0.20	0.02	5.25
29	7.49	0.02	6.34	0.47	0.33	0.06	14.72
30	2.58	0.01	2.44	0.38	0.20	0.02	5.62
31	7.39	0.02	6.48	0.66	0.40	0.06	15.00
Mean							12.48

CONCLUSION

The study showed a highly non-uniform distribution of primordial radionuclides in the samples

The effective dose for six exposure pathways was considered using RESRAD model and their mean values are lower than the regulatory dose limit (25 mrem/yr) adopted by Nuclear Regulatory Council.

CONCLUSION CONTD.

There was no baseline information for radionuclide concentrations in this region before now.

This study has made a significant contribution for setting up reference levels for naturally occuring radionuclides in soil samples for this area.

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