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Research Paper

Radiometric Survey to Determine the Terrestrial Gamma Radiation Levels: A Case Study of Sagamu and Abeokuta, South Western Nigeria

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Abstract: *Gamma ray radiation alert monitoring 4 was used to determine the variation of terrestrial gamma radiation levels in some parts of Ogun state, South Western Nigeria. The study revealed that there is variation in the value of absorbed dose on ground surface and a metre above the ground surface. The value recorded on the ground for sedimentary terrain, basement complex and suspected transition zone across the study area are higher than the values recorded above the ground surface. On compares of the absorbed dose recoded, the ranges of values for both on ground and above the ground for basement complex are (between 32.79 and 42.58) and (between 26.71 and 38.25) higher than in sedimentary terrain (between 23.79 and 23.83) and (between 20.37 and 21.32) respectively. The suspected transition zone in the study area was delineated through the average values obtained on ground surface (32.83) and 1metre above the surface (28.18) which lies between the values recorded for both sedimentary terrain and basement complex. Based on the major peak and troughs of the radioactivity graph, the different formations in the study area were clearly delineated and these correspond approximately to the geological boundaries in the area, lithological characterization of the formations revealed the concentration of radioactive elements in rock varies. The uranium and thorium content of rocks generally increases with acidity, with the highest concentrations found in pegmatite's and granites (basement complex) and lowest concentrations found in shale and clay (sedimentary terrain). Because terrestrial gamma rays emanate from the ground surface and not from a height, hence, radiometric survey, unlike aeromagnetic method measure what lies on the ground surface rather than above the surface.*

Keywords: Absorbed dose, Gamma ray radiation alert monitoring 4, radiometric survey, South Western Nigeria.

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1. Introduction:

Radiometric surveys detect and map radioactive emanations gamma rays from rocks and soils. All detectable gamma radiation from earth materials come from the naturally occurring radionuclide's that is uranium (U-238), thorium (Th-232) and potassium (K-40).

The basic purpose of radiometric surveys is to determine either thee absolute or relative amounts of uranium, thorium and potassium in the surface rocks and soils which are of importance in geologic mapping and mineral exploration (Urquhart, 1988 and Faure, 1977).

In radioactivity decay law, each radioisotope has a characteristic rate of disintegration, which is proportional to the number of nuclei (N) present.

That is, $dN/dt = -\lambda N \ldots\ldots\ldots (1) \therefore N = N_o e - \lambda t$ where λ *is the* decay constant, N_o is the number of radionuclides present at time t = o.

The three main types of radiation arising from radioactive decay are alpha, beta and gamma rays. The emission of an alpha or beta particle usually leaves the new nucleus in an excited state and the surplus energy is radiated as gamma rays (Minty, 1997). These are quanta or photons of energy which are neither very penetrating because they posses neither charge nor mass. The major assignment of a structural geologist in the field is to delineate as correctly as possible the rock units existing in the field (Amadi et al, 2012).

One of the ways to achieve greater accuracy in facies delineation is by the use of radiation (alpha, beta and gamma) emanating from the decay of radioactive element contained in the rock unit. The most useful of these radiations in radiometric survey are gamma radiations.

The aim of this study is to determine the variation of terrestrial gamma radiation emanating from radioactive element contained in rocks formation in sedimentary terrain, basement complex and suspected transition zone across the study area.

2. Materials and Methods:

The study areas are Sagamu town (Sedimentary terrain), Abeokuta town (Basement complex) and along Abeokuta – Sagamu road, Kobape Area (Suspected transition zone). The study area lies on the Western part of Nigeria between latitude $6^0 30^1$N and $7^0 30^1$N of the equator and longitude $3^0 00^1$E and $6^0 30^1$E of the green which Meridian (Figure 1).

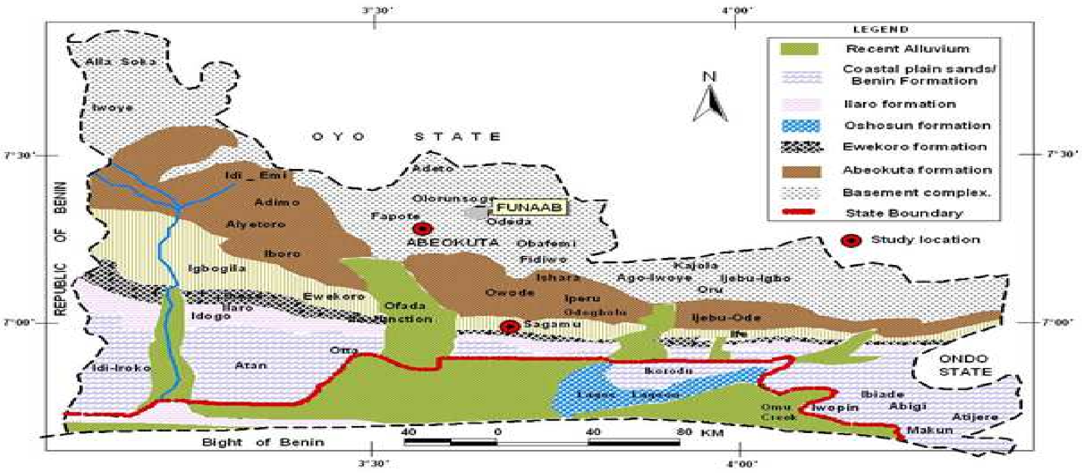

Figure 1: The geological map of Ogun State showing the study locations

The area has low-lying undulating planes broken at intervals by low-lying hills. The climatic conditions of the area fall into the sub-equatorial type with characteristic heavy rainfall, usually between the months of April and September while the dry season is between months of October and March. According to Jones, 2002, the mean annual rainfall is between 150cm and 187cm while the mean annual relative humidity is over 80% and the mean annual temperature is greater than 21^0C.

Reading were taken at intervals of 5m; 3 readings were taken at each point and the average values were used in count per minute (CPM). The instrument used for the measurement is a highly portable hand held detector (Radiation Alert Monitoring 4). The data recorded on the field were computed using statistical packages for social science (SPSS) to determine the mean value of the absorbed dose and to plot the radioactivity graphs.

3. Results and Discussion:

The result of absorbed dose on surface and at 1metre above ground in sedimentary terrain is shown in Table 1.

Table 1: Absorbed dose on surface and at 1m above ground in Sedimentary Terrain

S/N	**DISTANCE (m)**	**ABSORBED DOSE (nGy/hr)**			
		On ground surface at RRS	At 1m above ground at RRS	On ground surface at GRA	At 1m above ground at GRA
1	0	24.6	22.8	29.4	24.2
2	5	25.4	22.8	27.5	20.2
3	10	27.6	18.4	24.5	19.8
4	15	24.2	23.2	21.3	17.7
5	20	26	22.4	24.6	21.1
6	25	27.6	23.6	20.4	18.8
7	30	25.2	22.8	26.7	20.2
8	35	24.6	21.2	21.3	19.2
9	40	26.8	24.8	25.4	20.8
10	45	28.6	23.6	23.9	23.6
11	50	26.4	22	21.7	22

12	55	23.4	19.5	25.3	19.5
13	60	24.9	21.3	24.9	21.3
14	65	20.8	17.7	22.5	17.7
15	70	22	18.4	20.2	18.4
16	75	25.8	22.5	23.5	22.5
17	80	23.3	20.4	21.7	20.4
18	85	27.6	23.8	25.8	23.8
19	90	21.2	16.6	20.1	16.6
20	95	24.4	20.9	23.3	20.9
21	100	26.9	19.2	25.6	19.2
	MEAN	**23.83**	**21.32**	**23.79**	**20.37**

The mean value of the absorbed dose measured on ground surface in two locations (RRS and GRA) presented in the sedimentary terrain are higher than the mean value recorded a metre above the ground surface. The range of value on ground surface is very close, approximately between 23.79 and 23.83 while at 1 metre above ground between 20.37 and 21.32. Figure 2 gives the pictorial view of the absorbed dose.

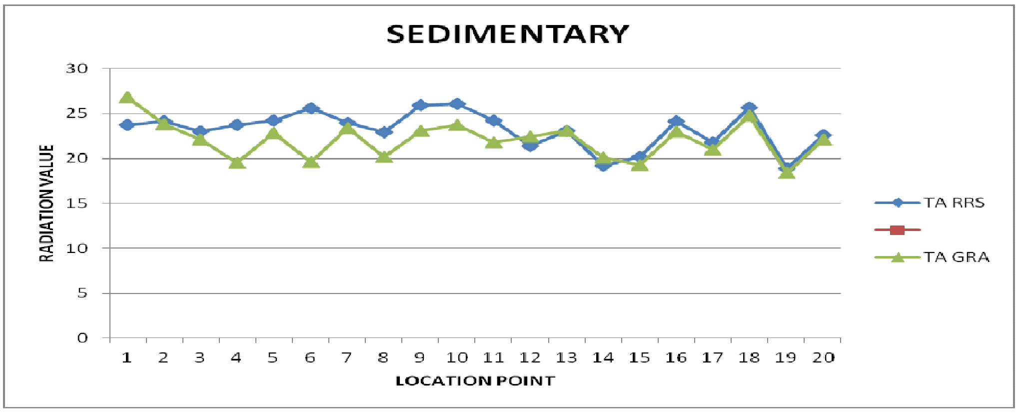

Figure 2: The graph of gamma radiation against distance / location point for RRS and GRA locations

Table 2: Absorbed dose on surface and at 1m above ground in Basement Complex

S/N	DISTANCE (m)	ABSORBED DOSE (nGy/hr)					
		On ground surface at COLNAS	At 1m above ground at COLNAS	On ground surface at NLT	At 1m above ground at NLT	On ground surface at METRO	At 1m above ground at METRO
1	0	42.5	36	37	33	36.5	31
2	5	47	39	38	30	35	30
3	10	47.5	40	39	31	37	29.5
4	15	44	38.5	39.5	33	38	30.5
5	20	42	36	41	31.5	39.5	38.5
6	25	44	43	39	35.5	40	33
7	30	41	38	43	30	41	32
8	35	45	40	38	35	39	31
9	40	40	38	36	32	36	30
10	45	41	39	41	35.5	30.5	25

11	50	40.5	38.5	39.5	30.5	29.5	23.5
12	55	42.5	39	39	27	28	25.5
13	60	46	38	37	29.5	27	21.5
14	65	40.5	38.5	34	30	24	20
15	70	42	38	36	31	25	23
16	75	39	35	39	28	27.5	23
17	80	40	36	37	25	31.5	21
18	85	41	37	34	27	28	24
19	90	45	40.5	35.5	30	33	25
20	95	42	37	32.5	30.5	30	27
	MEAN	**42.58**	**38.25**	**37.75**	**30.75**	**32.8**	**27.2**

The result presented in Table 2 shows that the value of the absorbed dose on ground surface for three locations recorded in the basement complex Metro, NLT and Colnas are (32.79 37.75 and 42.58) respectively are higher than the absorbed dose values at 1metre measured above the ground which are 27.2, 30.75 and 38.25 respectively. This gives the range of values on ground surface between 32.79 and 42.58; and 1 metre above the ground surface between 27.2 and 38.25. Figure3 shows the graph of gamma radiation against distance for Metro, NLT and Colnas locations.

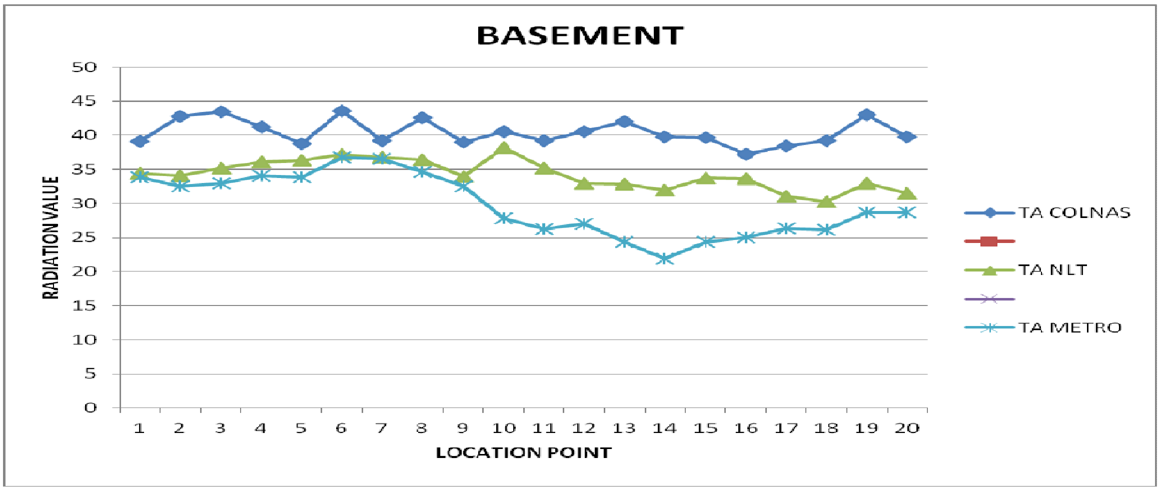

Figure 3: The graph of gamma radiation against distance / location point for METRO, NLT and COLNAS locations

On compares of the absorbed dose values measured in sedimentary terrain with the one recorded in basement complex, the ranges of values for both on ground surface for basement complex is higher in values than in sedimentary terrain.

Table 3: Absorbed dose on surface and at 1m above ground in a suspected Transition Zone

S/N	**DISTANCE (m)**	**ABSORBED DOSE (nGy/hr)**	
		On ground surface	At 1m above ground
1	0	23.6	21.3
2	5	25.8	19.2
3	10	21.2	18.4
4	15	24.5	21.6
5	20	22.4	20.3

6	25	25.3	23.6
7	30	23.2	21.2
8	35	25.6	23.9
9	40	23.7	19.2
10	45	25.9	20.4
11	50	20.6	18.7
12	55	24.3	21.6
13	60	22.4	20.3
14	65	25.1	23.6
15	70	23.2	21.2
16	75	25.6	23.2
17	80	34.8	30.7
18	85	29.2	26.3
19	90	22.4	20.4
20	95	27.9	25.1
21	100	40.6	32.4
22	105	26.3	23.7
23	110	32.2	30.4
24	115	30.8	28.8
25	120	38.8	32.8
26	125	44.8	34.8
27	130	40.4	37.4
28	135	39.6	30.9
29	140	41.2	36.7
30	145	43.2	40.7
31	150	42.8	39.4
32	155	46.2	41.9
33	160	41.4	30.7
34	165	43.9	34.9
35	170	38.7	33.2
36	175	40.2	31.4
37	180	41.7	35.7
38	185	43.3	32.1
39	190	45.5	40.4
40	195	40.4	37.8
	MEAN	**32.83**	**28.18**

The result of the absorbed dose for the suspected transition zone is presented in Table 3 and the value recorded on ground surface is 32.83 higher than the value obtained 1 metre above the ground surface which is 28.18 (Figure 4). The two values falls within the range of values recorded for both the sedimentary terrain and basement complex and thus follows the same pattern.

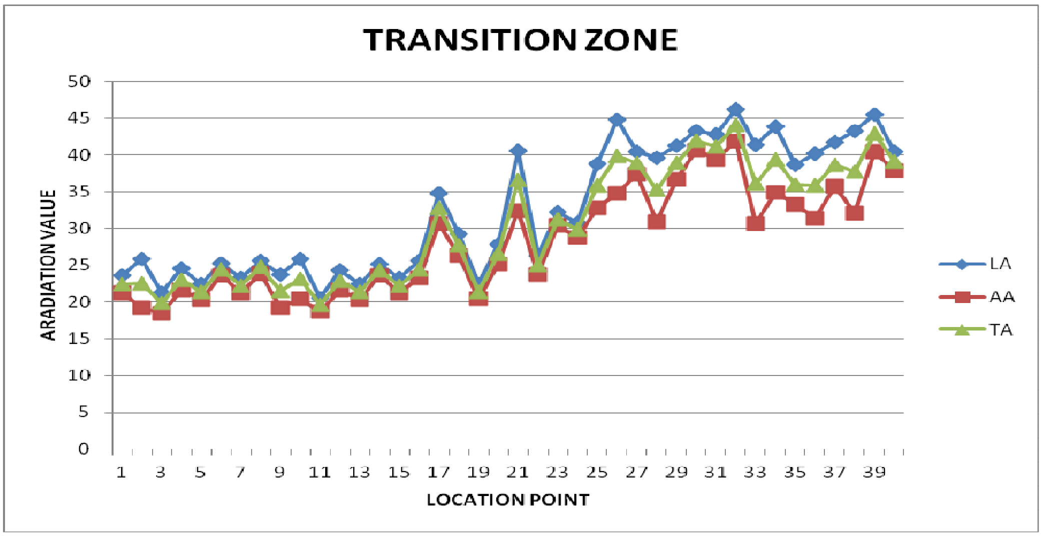

Figure 4: The graph of gamma radiation against distance / location point for Suspected Transition Zone location

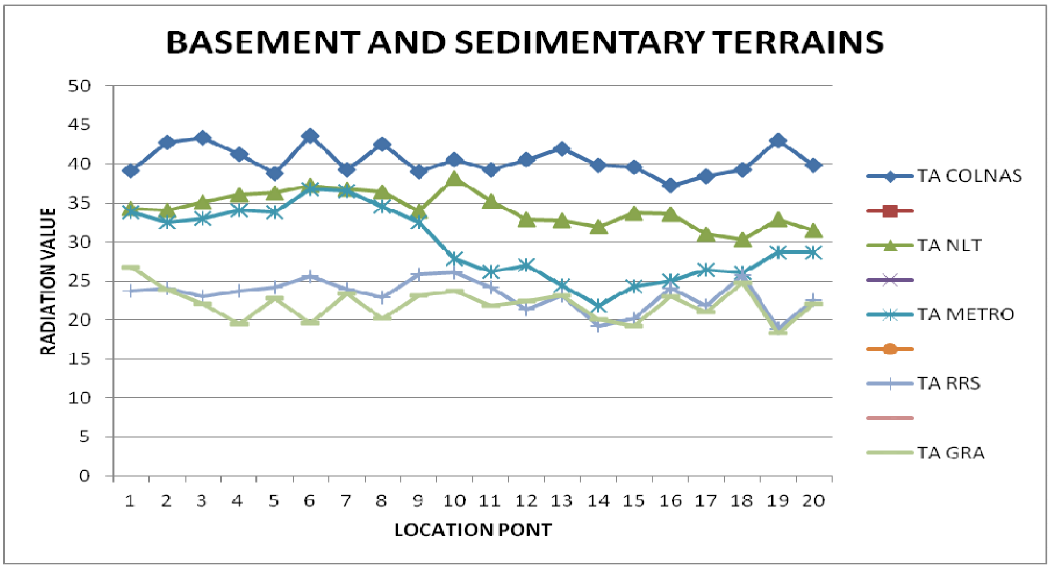

Figure 5: shows the combined locations for both Sedimentary terrain and Basement complex.

According to Urquhart, 1988 it is extremely important to know that terrestrial gamma rays emanate from the ground surface and not from a height. A few inches of over burden, in- cluding soil, are sufficient to absorb 100% of the emissions from the rocks beneath. Therefore, unlike the aeromagnetic method, the radiometric method is capable of having higher gamma radiation values on what lies on the ground surface than above the surface.

The value of radiometric is as a geological mapping device that has the ability to provide chemically information on rock out crop by remote sensing. Even though residual soil which have not been moved retain only some of the elements that were present in their parent rocks, their relative abundances tend to remain indicative of the parent, higher in value in basement complex and the underlying parent rock can sometimes be mapped through a thin layer of residual soil (Urquhart, 1988).

4. Conclusions:

Interpretation of radiometric data is more similar to interpreting the results of a conventional geological survey; understanding how radiometric surveys can be applied to exploration problems requires the consideration of the geological sources of radioactivity (Hansen, 1980).

By this study, it has been established that radiometric survey can be used to determine the variation of terrestrial gamma radiation levels. The results of the absorbed dose shows that, in general, the absorbed dose on ground surface is higher in value than at 1 metre above the ground surface for sedimentary terrain (23.83 > 21.32), basement complex (42.58 > 38.25) and suspected transition zone (32.83 > 28.18).

On compares between the basement complex and sedimentary terrain, the results obtained in basement complex for both on ground surface and at 1 metre above the ground are 42.58 and 38.25 higher in value than the recorded values in sedimentary terrain (23.83 and 28.18). Thus, it is established that the absorbed dose in basement complex is higher than in sedimentary terrain due to lithological characterization of the formations which revealed the concentration of radioactive elements in rocks.

According to Amadi et al; 2012, the uranium and thorium content of rocks generally increases with acidity, with the highest concentrations found in pegmatite’s and granites (basement complex) and lowest concentrations found in shale and clay (sedimentary terrain).

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