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Gamma ray spectroscopy of soil samples from apple orchards in Lamingo Dam and Vom area in Jos, Plateau State, Nigeria

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ABSTRACT

Five samples each were collected from the apple orchards in Lamingo dam and Vom area of Jos East and Jos South local government areas respectively. The samples were allowed to decay for three weeks to ensure efficiency in acquiring the radionuclides. The samples were analyzed using Gamma Ray spectroscopy. Barium- 204 (^{204}B) with gamma activity energy level 1765.50keV was used to check the presence of Uranium-235 (^{235}U) in the samples. The results showed that samples Lams 2,3,4 and Voms 1,4,5 had high gamma activity energy levels of 2436.356keV, 1837.24keV 2928.37 keV and 1656.32keV, 1635.48keV, 2351.87keV respectively as compared to (^{204}B). While lams 1,5 and Voms 2,3 had relatively lower gamma activity energy levels of 1325.23KeV, 1272.73keV and 1462.61KeV, 1183.24keV respectively. The samples with high gamma activity energy levels imply that radionuclide in the form of $^{,35}U$ is present in trace amounts in the sampled areas. This can affect the output of apples cultivated in such areas as the chemical composition or structure of plants will be altered.

Keywords: Radioactivity, Gamma ray spectroscopy, Radionuclide, Barium-204 , Uranium-235

INTRODUCTION

Radioactivity can be simply put as a chemical reaction which involves the bombardment of unstable nuclei by a neutron emitted from a neutron source which leads to a nuclear instability of the compound. Ever since the discovery of radioactivity in 1898 by Marie Curie, man has continually devoted resources to minimizing the threat it poses to the environment and life upon exposure. In an apple and coffee orchard; just as in any other farmland, the spraying of pesticides and insecticides, use of inorganic fertilizers are normal practiced for enhancing and boosting food productivity. These pesticides and fertilizer' contain elements like potassium, which are naturally radioactive because they contain U^{-238} (Kharter et al., 2002). Chromium G is another radioactive substance contained in some of the aerosols, used to vent our farmlands. These radioactive substances settle on soil surfaces, and areas prone to erosion allows for these elements to be washed off the top layer of the soil, and some sip into the soil and settle below the eroded surface (DEFRA, 2003). Most of these orchards are usually sited close to water bodies or their distributaries for easy access to water for irrigation. These eroded parts take its path though the water or its distributaries. Communities close to these orchards that usually use this water as their main source of drinking water and for other domestic purposes are at risk of radioactive poisoning (Shaw, 1999).

This action thereby poses great health risk to the livelihood of both water organisms and the populace residing within such an area is put in harm's way (NCRP, 1987). Exposure to cosmic rays (charged particles in space that come from the stars, including our sun) also constitutes health risk (Bock et al 2008). Chemical elements in soils and rocks emit uniquely identifiable signatures of energy in the form of gamma rays. The gamma ray spectroscopy system looks at the signatures or energies, coming from the elements present in the target soil, it is then possible to calculate the abundance of various elements and how they are distributed within the surface. The energies determine which elements are present while gamma rays emitted from the nuclei of atoms, show up as sharp emission lines (spectral lines) in the instruments spectrum output (Ely and Yardley, 1988). This spectrum is analyzed in detail and used in the determination of the identity and concentration of gamma emitters present in a radioactive experiment is characteristic of the gamma-emitting nuclides. The intensity of the spectrum relates the elements concentrations.

THE GEOLOGY OF THE JOS AREA

The geology of Nigeria can simply be grouped into the crystal basement rocks and the sedimentary formations, each constituting nearly an equal proportion- Granite rocks dominate the crystalline basement and two distinct groups of granites, which differs considerably in age, structure, and mode of origin, have been recognized as the Older granites and the Younger Granites. The Older Granites are a suite of syn- and late tectonic granites, diories and granidiorites that marked the intrusive phase of the late Pan African Orogeny dated 620 +10 Ma (Gram, 1971, McCurry, 1976, Rahaman. 1976, Van Breemen et al., 1977). The Younger Granites are discordant, high level, magmatic intrusions with strong alkaline affinities that cut the basement rocks. The Younger Granites are Jurassic in age and occur as ring-structures with a common sequence of an early volcanic phase followed by a series of granitic intrusions.

The Jos Plateau area (Fig. 1) is the centre of the Younger Granite and is dated 164$\pm$4 Ma (van Breemen et al., 1975). The rocks are predominantly SiO_2 saturated consisting of granites and rhyolites (>90 Vol. %) accompanied by quartz-bearing syenites, gabbros and dolerites. Three major types of granites have been recognized and are classified as hornblende-pyroxene-fayalite granites, biotite granites and riebeckite granites (McLeod et al., 1971).

The range of chemical compositions, among the granites is .small, but minor chemical changes result in important differences in mineral assemblage and composition (Turner, 1968). The hornblende-fayalite granites are slightly lower in SiO_2, content and higher FeO than the other two groups. The molecular ratio (Na_2O – K_2O)/$A1_2A_3$ is close to 1.0 in most of the granites. In the riebeckite granites, however, there is always (Na_2O+K_2O)>$A1_2O_3$, whereas the reverse relationship holds in the case of the biotite-granite. The biotite-granite is the most abundant and widespread rock type in the Younger Granite province. In the study area, (fig. 1), the biotite granites are divided into three groups. Group 1 consists of coarse-grained biotite granites, generally pink in colour with widely spaced jointing. Group 2 are medium-grained granites with pink colour, and in Group 3 occur white evenly textured, medium-grained granites, In all granites, biotite occurs as separate flakes rather than in clusters.

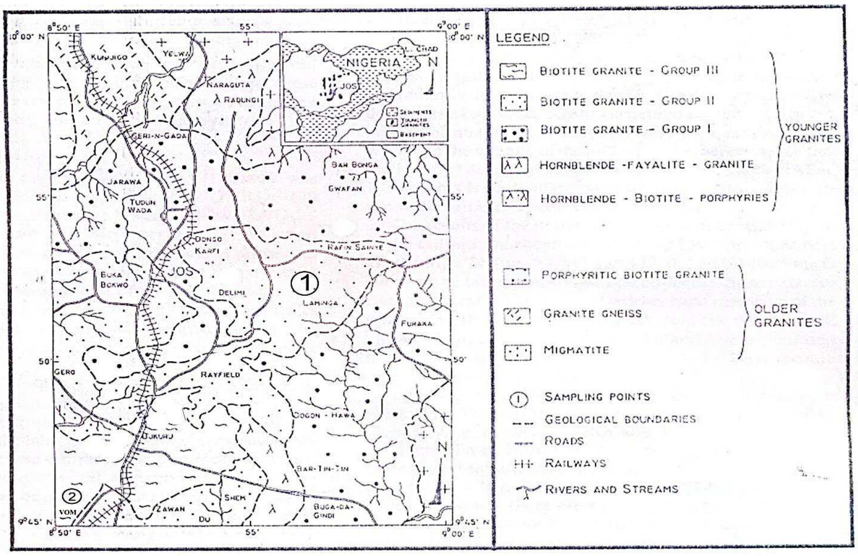


Fig. 1: location map of Jos , central Nigeria and sample location and geology of the area (Mcleod et al, 1979;Funtua, 2001)

MATERIALS AND METHODS

EQUIPMENT/SET-UP FOR GAMMA SPECTROSCOPY

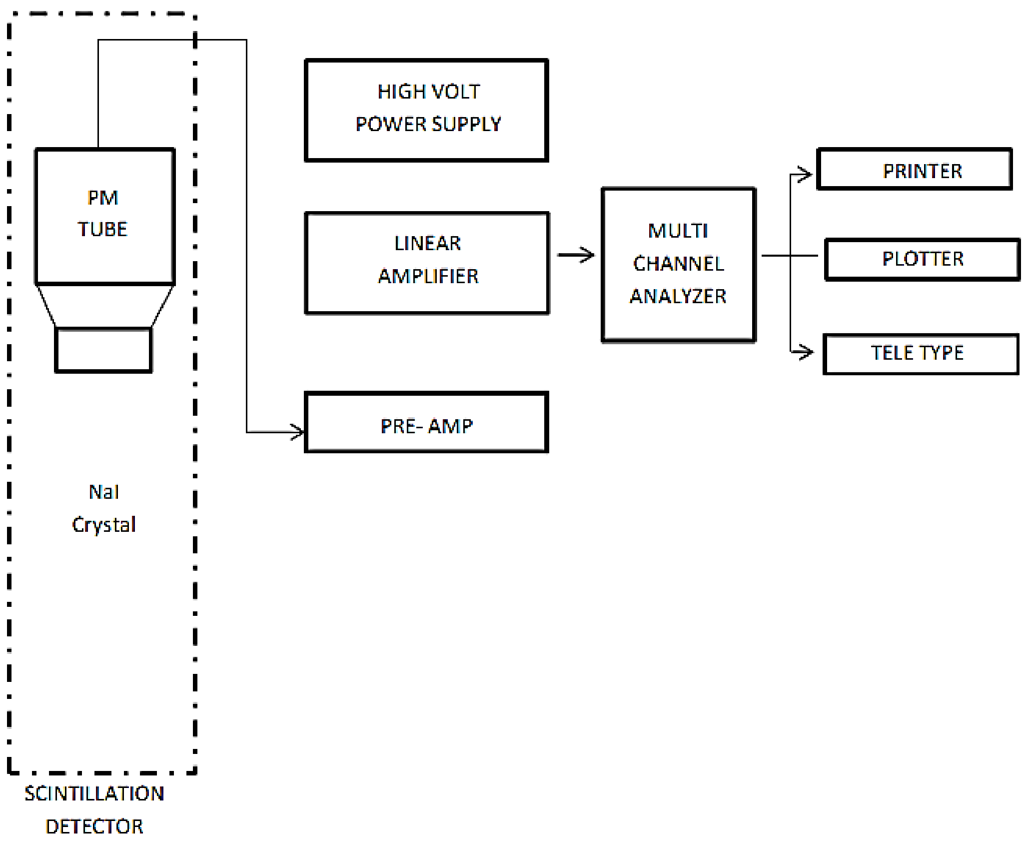
The equipment used in gamma spectroscopy includes, Sensitive radiation defector, a pulse sorter (i.e. Multichannel analyzer) and associated amplifiers and data readout devices. The most common detectors include the sodium Iodide (Nal) scintillation counters and high-purity germanium detectors. A gamma spectroscopy system consists of a detector, electronics to collect and process the signals produced by the detector, and a computer with processing software to generate, display, and store the spectrum. Other components, such as rate meters and peak position stabilizers, may also be included.

The samples were taken from the Lamingo dam area and Vom area of Jos East and Jos South LGA respectively. These samples taken from each of the areas were bagged in black polythenes. Five samples each were taken from each of the apple orchards areas. The samples were taken to the laboratory. Thereafter empty containers were gotten. The samples were then placed in these containers before which the weight of the container was taken and after which the weight of both the sample and container was taken. During sealing, Vaseline was applied to the cover to ensure that radionuclides were trapped at the cover. The samples were allowed to decay for three weeks to ensure efficiency in acquiring the radionuclides.

Gamma Rays Interactions in the Sodium Iodide (Nal) Detector

The intetractions with γ-rays and matter have been illustrated below; the fig. 2 below shows a block diagram of the electrical circuits that is used for all parts of the experiment, however the Plotter and Teletype are now replaced with a PC.

Fig. 2: A Block Diagram of a Typical System for γ-rays Spectroscopy.



RESULTS

Table 1: Sample Collected and Efficiency

SAMPLE ID	WEIGHT OF CONTAINER We(g)	WEIGHT OF SAMPLE Ws + c(g)	TOTAL WEIGHT OF SAMPLE RECOVERED Ws + c - We (g)	EFFICIENCY (%)
LAM1	34. 2000	540. 7000	506. 000	93.67
LAM 2	35. 1000	548. 4500	513.3500	93.60
LA 3	32. 5000	542. 6000	510. 1000	94.01
LAM 4	33. 2000	545". 2000	512.0000	93.91 '
LAM 5	31.1000	540. 5000	509. 1000	94. 19
VOM1	33.3000	550. 8000	517.5000	93.95
VOM2	34. 1000	514.7000	507. 6000	93.90
VOM3	33. 6000	538. 7500	505. 7500	93.76
VOM4	30. 5000	543. 9000	513.5000	94.39
VOM5	31.5000	535.0000	503. 5000	94. 11

SAMPLE EFFICIENCY

$$\frac{\text{Weight of sample}}{\text{Total Weight of sample}} \times 100\%$$

$$\frac{Ws + cWc}{We} \times 100\%$$

TABLE 2: ANALYSED GAMMA ACTIVITY ENERGIES (KeV)

SAMPLE ID	WEIGHT OF SAMPLE RECOVERED (g)	TOTAL WEIGHT OF SAMPLE (g)	EFFICIENCY (%)	GAMMA ACTIVITY ENERGIES (KeV)
LAM1	506. 5000	540. 7000	93. 67% ±4	1325.23
LAM 2	513.3500	548. 4500	93. 60% ±4	2436.56
LAM 3	510. 1000	542. 6000	94.01 %±4	1837.24
LAM 4	512.0000	545. 2000	93.91 %±4	2928.37
LAMS	509. 1000	540. 5000	94. 19%±4	1272.73
VOM1	517.5000	550.8000	93.71%±4	1656.32
VOM2	507. 6000	541.7000	93.79%±4	1462.61
VOM3	505. 1500	538.7500	93.76%±4	1183.24
VOM4	513. 4000	543.9000	94. 39%±4	1635.48
VOM5	503. 5000	535. 0000	94. 11%±4	2351.87

^{201}K = 1460 KeV
^{204}B = 1765.50KeV
^{208}Ti = 261.50KeV
^{137}C = 662KeV

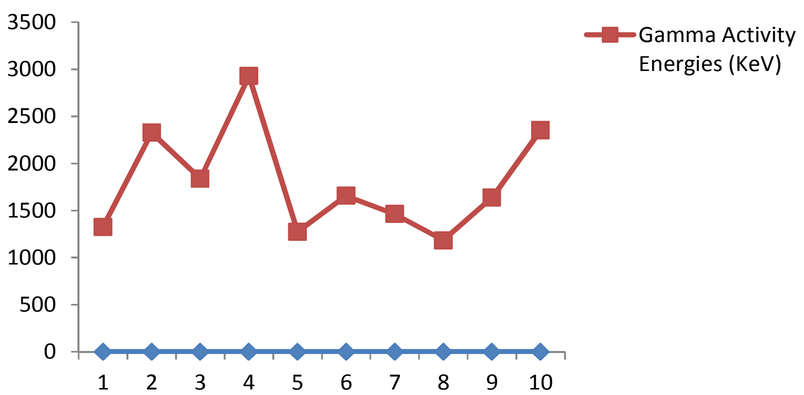


FIGURE 3: Spectrum Line of Gamma Activity Energy for The Surveyed Areas

DISCUSSION

The result above from the plot of Sample ID against Gamma Activity Energy in KeV shows that the Lam 2,3,4 and Vom 1, 4,5 are either close to the energy level of ^{204}B or higher than it as in Fig.3. It could also be observed that Lam 1, 5 and Vom 2, 3are lower energy in gamma activity energy in KeV.The results obtained therefore indicate that the energies of ^{204}B correspond closely to that of our samples. ^{204}B is usually used to check for presence of ^{235}U. This means that trace of Uranium are present within the sampled area Lam 2,3,4 And Vom 1, 4,5. From this research work, we therefore, infer that a radio nuclide in the form of ^{235}U is present in trace amounts in the sampled area. This can therefore; affect the output of our plant cultivation in such areas as the chemical composition or structure will be altered.

CONCLUSION

From the findings of this research work, it is evident that a radionuclide in the form of Uranium is present in trace amount in the sampled areas.

This can affect the output of plants cultivation from these areas as the chemical composition or structure will be altered. The consumers of these plants produce are at the risk of internal exposure to radiation,. It is recommended that the presence of other radionuclides in the areas be checked to promote a safer and healthier environment for all.

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