PRELIMINARY INVESTIGATION OF THE AMBIENT RADIATION LEVELS OF MINING SITES IN BENUE STATE, NIGERIA

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Abstract

The study of the ambient radiation levels around some mining sites in Benue State has been carried out using radiation meters; Inspector 06250 and Dose Meter 6150AD. A total of four mining sites were selected for measurements. These sites include the Guma salt mine, Makurdi clay mine, Mkar quarry in Gboko and the Otukpo clay mine. The values of the dose equivalent rates obtain ranged from 0.18 to 0.33mSv/yr and the value of the exposure rate range from 0.011 to 0.11mR/hr. Activity values range from 2.7 to 5.1kBq. The results show that the Mkar quarry recorded the highest values of dose equivalent rate of 0.330.003mSv/yr, exposure rate of 0.10.002mR/hr and activity of 2.70.4kBq. Results show that all the mining locations are still within the safety limits of 1.0mSv/yr, as set by the International Commission on Radiological Protection (ICRP).

Keywords: *Ambient, radiation, dose, exposure, activity.*

Introduction

Mining activities have been carried out in Nigeria since the beginning of last century and some of the mines include: tin mining, coal mining, uranium mining, salt mining, clay mining and so on. However, their radiological investigation had started only recently by Sanni, (1970) and Babalola (1981) with a comprehensive analysis of their radionuclide composition (Sanni, 1977; Jibiri and Farai, 1999 and Mangset, 2002).

Every person is exposed daily to a variety of radiation whether he recognizes it or not. The exposure to ionizing radiation in the environment come from numerous sources among which include the cosmic rays and natural radionuclide sources in air, soil, food and drinking water (NCRP, 1976). The radiation from natural radionuclide and cosmic rays constitute the external exposure to humans. In the environment, artificial sources may be present from human activities such as nuclear and atomic bomb testing, nuclear rector explosions, mining activities, industrial waste and effluent from factories. IAEA (1986) estimate of dose contribution in the environment shows that over 85% of radiation dose received by man are derived from the natural radionuclide while the remaining 15% is from cosmic rays and nuclear processes.

Exposure to radiation could cause leukemia, chromosomal breakage, bone necrosis, bone cancer, mutation of genes, cataracts of the eye lens etc (Paul et al, 1979). The main way of saving the cell is to protect it from exposure to radiation. This is why radiation monitoring and measurement are quite essential in our society today.

Adiuku and Ogezi (1991) observed that mining activities cause environmental pollution. This is because most of the accessories minerals are harmful, even in low concentrations, to human beings and animals. The mining of mineral resources also facilitates the release of radioactive materials from the host materials into the environment.

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Subsequent on the above background, the main objectives of this study is to carry out a preliminary measurement of the ambient radiation levels around some selected mining locations within our vicinity in Benue State, and to compare the measured values with the safe level set by the International Commission on Radiological Protection (ICRP). Thus, ascertaining whether or not the sites are radiologically safe and making it possible to take appropriate recommendation regarding radiation protection.

Methods

The radiation meters used in this work for measurements include Inspector 06250 (Manufacturer: S. E. International Incorporation, Summer Town, T.N. 38483-0039) and Dose meter 6150AD (Manufacturer: Automess Atomation Und Messtechnik GmbH Daimterstrass 27D 68526 Ladenburg). The choice of these meters was based on their portability, sensitivity and their response, which are appropriate since the radiation measurement are for low radiation field.

The method of radiation measurement employed in this work, is the direct observation and measurement of radiation levels from the various mining locations visited with the above mentioned detectors. The detectors were held one meter above the mineral surfaces for the mining location visited and readings were taken. Each reading was repeated ten times for measurement location in all the mines, after which, the mean reading and standard error of each measurement was obtained. Finally, the background level was taken 400 meters away from each mine.

Results and Discussion.

Results of the measurement are shown in Tables 1 and 2. The analysis of the measurement is also shown in Figs. 1-3.

The results of the dose equivalent rate (mSv/yr), exposure rate (mR/hr) and activity (kBq) obtained for the various mining locations are shown in Tables 1 and 2.

From the results shown in Table1, the presence of ionizing radiation is established, since the radiation levels from these sites are beyond the background levels as shown in Table 2. A survey of the different mining locations investigated shows that the values of dose equivalent rate range from 0.180.003mSv/yr to 0.330.003mSv/yr as shown in Fig.1. The relatively higher values of 0.330.003mSv/yr recorded at the Mkar Quarry excavation site may be due to presence of some traces of radioisotopes of uranium, potassium and thorium which are normally found in granitic rocks (Jibiri, 1998). These are known as emitters of gamma and beta radiation (Glowaik, 1980). This observation is in good agreement with a previous study by (Navrital et al, 1995) in which higher amount of gamma radiation dose levels were observed from ^{238}U and ^{232}Th mixed with granite formations when compared to sedimentary formations.

From Fig. I, the dose equivalent rate in mSv/yr obtained at excavation site in Guma salt mine had the least observed values of radiation which may contain the radioactive isotope of sodium 22, which is an emitter of gamma and beta radiation (Sanni, 1970).

The dose equivalent rate obtained for Makurdi and Otukpo clay Mines show values of 0.240.003mSv/yr and 0.200.002mSv/yr respectively and could be attributed to an increase silica content of the clay which is rich in potassium 40, and which could rise to the pegmatite stage (Mangset, 2002). The presence of potassium 40, in clay which is an emitter of gamma and beta radiation may be responsible for the observed value which are above the background levels.

The values of exposure rate determined for all the mining locations range from 0.0110.001mR/hr to 0.10.002mR/hr as shown in Fig. 2. The highest exposure rate is from Mkar Quarry excavation site. The high value of 0.10.002mR/hr could be as a result of the radioactivity associated with granitic rocks (Navrital et al, 1995).

In Fig. 3, the activity for all the mining locations range from 2.70.4kBq to 5.10.8kBq with Mkar quarry excavation site having the highest value of 5.10.8kBq. This is in good agreement with the associated high values of the dose equivalent rate and exposure rate for granite rocks. This may be due to the presence of some traces of Uranium, Potassium and Thorium associated with granitic rocks and which are emitters of gamma and beta radiation (Glowaik, 1980).

In Guma salt mine, the presence of sodium salt which may contain the radioactive isotope of sodium 22 which is an emitter of gamma and beta radiation (Sanni, 1970) may be responsible for the activity values above the background levels. In Makurdi and Otukpo clay mines, the possible presence of potassium 40 in clay which is an emitter of gamma and beta radiations may be responsible for the activity values above the background levels (Mangset, 2002).

Table 1: Dose equivalen t rate (mSv/yr), exposure rate (mR/hr) and activity (kBq) for the various mining locations.

Locations	Dose equivalent rate (mSv/yr).	Exposure rate (mR/hr)	Activity (kBq)
Guma salt mine at Escavation site	0.18±0.003	0.011±0.001	2.7±0.4
Guma salt mine at Processing site	0.21±0.002	0.013±0.001	3.7±1.0
Makurdi clay mine	0.24±0.003	0.029±0.002	4.4±0.9
Mkar quarry at Escavation site	0.33±0.003	0.109±0.002	5.1±0.8
Mkar quarry at Crushing site	0.21±0.008	0.020±0.002	4.3±0.8
Otukpo clay mine	0.24±0.002	0.018±0.002	4.0±0.8

Table 2: Background radiation for the various mining locations .

Locations	Dose equivalent rate (mSv/yr).	Exposure rate (mR/hr)	Activity (kBq)
Guma salt mine	0.05±0.003	0.008±0.003	2.4±0.2
Makurdi clay mine	0.15±0.003	0.009±0.001	3.0±0.4
Mkar quarry Gboko	0.18±0.002	0.010±0.002	3.3±0.4
Otukpo clay mine	0.16±0.002	0.009±0.001	1.4±0.3

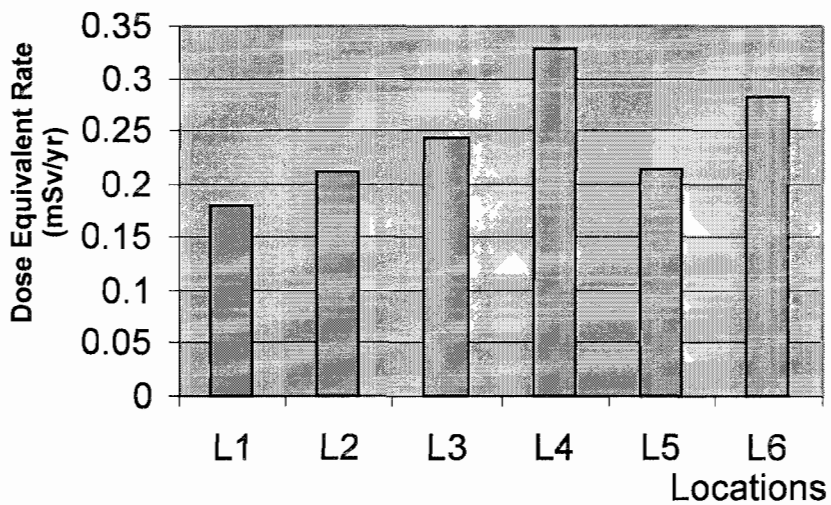

Fig. 1: Dose equivalent rate

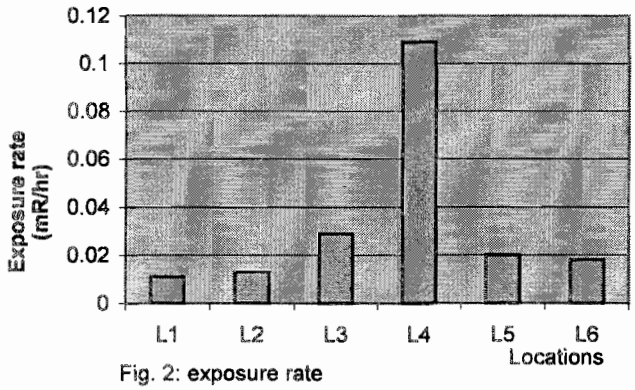

Fig. 2: exposure rate

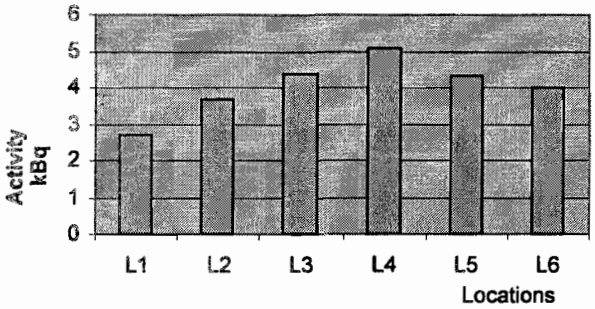

Fig. 3: Activity at the various mining location

Conclusion

This research work has established the presence of ionizing radiation from all the mining locations considered, since the ambient radiation levels from these sites are above the background values. However, the highest dose equivalent rate of 0.33 ± 0.003mSv/yr associated with the Mkar quarry excavation site is still within the safety limit of 1.0mSv/yr as set by the International Commission on radiological protection (ICRP) for the general public, since these quarry workers can not be considered as radiation workers. This information obtained will provide a background information on environmental radioactivity monitoring in these mine sites. Equally, the information is essential for planning purposes regarding radiation levels and related hazard in these mines and the environment.

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