BAUXITE MINING ACTIVITIES: CONCERNS OF RESIDENTS OF BUKIT GOH TO RADIATION EXPOSURE

NORSHUHADAH HAYAT, BSc
DEPARTMENT OF DIAGNOSTIC IMAGING AND RADIOTHERAPY, KULLIYYAH OF ALLIED HEALTH SCIENCES, INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA, KUANTAN CAMPUS, 25200 KUANTAN, PAHANG, MALAYSIA
shuhadahhayat@yahoo.com

INAYATULLAH SHAH SAYED, PhD (CORRESPONDING AUTHOR)
DEPARTMENT OF DIAGNOSTIC IMAGING AND RADIOTHERAPY, KULLIYYAH OF ALLIED HEALTH SCIENCES, INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA, KUANTAN CAMPUS, 25200 KUANTAN, PAHANG, MALAYSIA
inayatullah@iium.edu.my

ABSTRACT

Introduction: Bauxite mining in Kuantan district of Pahang has raised health concerns of communities residing near the mining areas. Bauxite mining and transportation activities have contributed a lot to the pollution of environment. There is a fear among the residents of the areas that whether the soil is free from naturally occurring radioactive substances or not. Therefore, the objective of this study was to detect the presence of natural radioactive elements in the soil of bauxite mining field at Bukit Goh, Kuantan. **Methods:** Soil samples were gathered from various locations of Bukit Goh. These samples were dried for twenty-four hours and cleared of stones and pebbles. The soil then was crushed and ground to a fine powder, and heated in the oven for two hours to ensure the soil was dried completely. Samples were packed/sealed in plastic bags, labeled and stored for a month to achieve secular equilibrium. The Advanced Nuclear Spectroscopy System with UCS 30 Universal Computer Spectrometer Software and High Sensitivity Gamma Spectroscopy Model SE-9764 with WinDas Software were used for recording the energy spectrum of each soil sample. **Results:** Comparison of the spectra of all soil samples was made with the background measurement and no difference was found from each other. **Conclusion:** No naturally occurring radioactive substances were found in the soil of bauxite mining area at Bukit Goh, Kuantan. Therefore, the soil poses no radiation exposure related health hazards to the residents of the areas of Bukit Goh, Kuantan.

KEYORDS: Bauxite mining, Natural radioactive substances, Soil, Health concerns, Environmental pollution

INTRODUCTION

Natural radioactive elements are present in rocks, air, water and other environmental media which is around us (Yussuf et al., 2012). Natural environmental radioactivity depends on the earth's physical structure & substance, geographical features, and appears at dissimilar levels in the soils of each different geological region (UNSCEAR, 2000). The natural environmental radiation arises primarily from the radioactive substances which exist since the creation of the universe, for example, potassium-40 (K-40), thorium-232 (Th-232) and uranium-238 (U-238), which are found at trace levels in all ground formations (Tzortzis et al., 2004). In addition, naturally occurring radioactive substances may arise from mining activities and processes, gas and oil exploration which are needed to be monitored (UNSCEAR 2000; IAEA 2005). Studies conducted by O'Connor et al., 2013, and Alashrah et al., 2017 show the presence of naturally occurring radioactive materials in the bauxite mining zones of Darling Range of Western Australia and Az Zabirah city in Saudi Arabia, respectively.

Mainly the humankind is exposed to natural terrestrial radiation that is present in the upper 300 mm of the soil. Furthermore, another source of radiation exposure to humans is the contamination of the food chain, where the radioactive materials are directly deposited on the leaves of plants, radionuclide uptake by roots from the soil or water and the direct ingestion of contaminated water. Ahmed et al., (2005) studied and reported the presence of natural radioactivity in the farm soil and phosphate fertilizers at Qena governorate area, Upper Egypt.

The higher measured values of radioactive materials of the farm soil were found than the estimated worldwide terrestrial radiation. In Northern India, Mehra et al., (2011) carried out the study to measure radioactivity of uranium (U-238), radium (Ra-226), thorium (Th-232) and potassium (K-40) in the soil of various geological origins, such as; Bathinda, Amritsar, Pathankot and Dalhousie.

Bauxite mining in Malaysia was started in 2015 in two states, Terengganu and Pahang. A recent study conducted by Inayatullah et al., (2016) to detect the presence of any natural radioactive elements in the soil of the bauxite mining areas of Dermaga 6 at Kuantan Port, Sungai Karang and Indera Mahkota 5, Kuantan. No naturally occurring radioactive substances were detected from the soil. Therefore, in this study soil samples of other area Bukit Goh of the district Kuantan were studied to ascertain that whether the natural radioactive substances are present or not.

METHODS

Soil Sample Collection and Preparation

The soil samples were gathered from three different locations of mining areas at Bukit Goh, Kuantan (Location no.1: 3°52′37.9″N 103°15′37.4″E, Location no. 2: 3°52′18.9″N 103°15′35.1″E and Location no. 3: 3°52′35.9″N 103°15′40.4″E). Samples were labelled as I, II, and III. Soil samples were dried in air for twenty-four hours in the laboratory and cleared of stones and pebbles. Then the soil was crushed and ground to a fine powder (Figure 1), and heated in the oven at 110°C for two hours to ensure the soil was dried completely. All soil samples were further divided into eighteen small packets and air tight packed in thin plastic bags and labeled accordingly for recording the spectra. The weight of each packet was approximately 40 gm. Following the method as mentioned in the article of Darwish et al., 2014, soil samples were packed/sealed and kept for a month to achieve secular equilibrium. The total length of time, i.e., soil sample collection and data analysis was about four months.

Figure 1 *Crushed and ground soil sample.*

Soil Sample Spectroscopy

Two radiation detection systems, the Advanced Nuclear Spectroscopy System with UCS 30 Universal Computer Spectrometer Software and High Sensitivity Gamma Spectroscopy Model SE-9764 with WinDas Software were used. The spectroscopy software attached with a personal computer provides the recording of the radiation emission from a wide variety of samples. Energy spectra of background and soil samples can be analysed using the spectroscopy software. In addition, high resolution, real-time live colour display of spectral

data can be produced. Peak-labelling features of the ISOMATCH software was used by selecting a radionuclide from the library and selected radionuclides' emission lines superimposed on the spectrum along with isotope and energy information. Both spectroscopy systems use NaI scintillation detector. High Sensitivity Gamma Spectroscopy consists of a cylindrical NaI crystal with height of 5 cm and diameter 5 cm. The detector has high sensitivity (67% confidence level). The WinDas software presents the detected energy distribution in histogram form which represents the spectrum of the energy. The recorded spectra can be stored in the computer for analysis. For calibration purpose, two radioactive materials were used, Cesium (Cs-137) and Cobalt (Co-60). The calibration of the detectors was performed to ensure the proper and accurate functioning of detectors.

Both radiation detection systems were set far from each other to avoid any errors in reading samples. The spectrum of background radiation was obtained for both radiation detection systems by keeping the systems on for 24 hours. The soil sample packed in a small-thin plastic container was positioned closer to the detector without contact to avoid contamination. Furthermore, the same procedure was applied for measuring the spectra of soil samples as that for the background measurements.

Analysis of Spectra

In this study the focus was given to analyse the data to detect Th-232, K-40, Ra-226 and U-238 radioactive substances in the collected samples of the soil. The Ra-226 was identified on gamma ray emissions of Pb-214 (295.21 and 352 keV), Bi-214 (609 keV) and U-238. Th-232 was determined based on the emitted radiation energy of Pb-212 (238.6 keV), Tl-208 (583.1 keV) and Ac-228 (911.2 keV). The K-40 was found on the basis of emission energy of radiation at 1461.8 keV.

RESULTS

The results of this study on the presence or absence of naturally occurring radioactive substances in the soil of bauxite mining field at Bukit Goh mining is presented in Figure 2 and 3 for both detection systems, i.e., Advanced Nuclear Spectroscopy System and High Sensitivity Gamma Spectroscopy System, respectively. Comparison of the energy spectra of all soil samples were made with the energy spectrum of the background radiation. Results of all measured energy spectra showed similar pattern as that was recorded without placing the soil sample (background) in the tray. There were no additional energy peaks displayed different than energy peak shown in the spectra of background measurements. This observation reflects the absence of radioactivity in all soil samples taken from the Bukit Goh bauxite mining area.

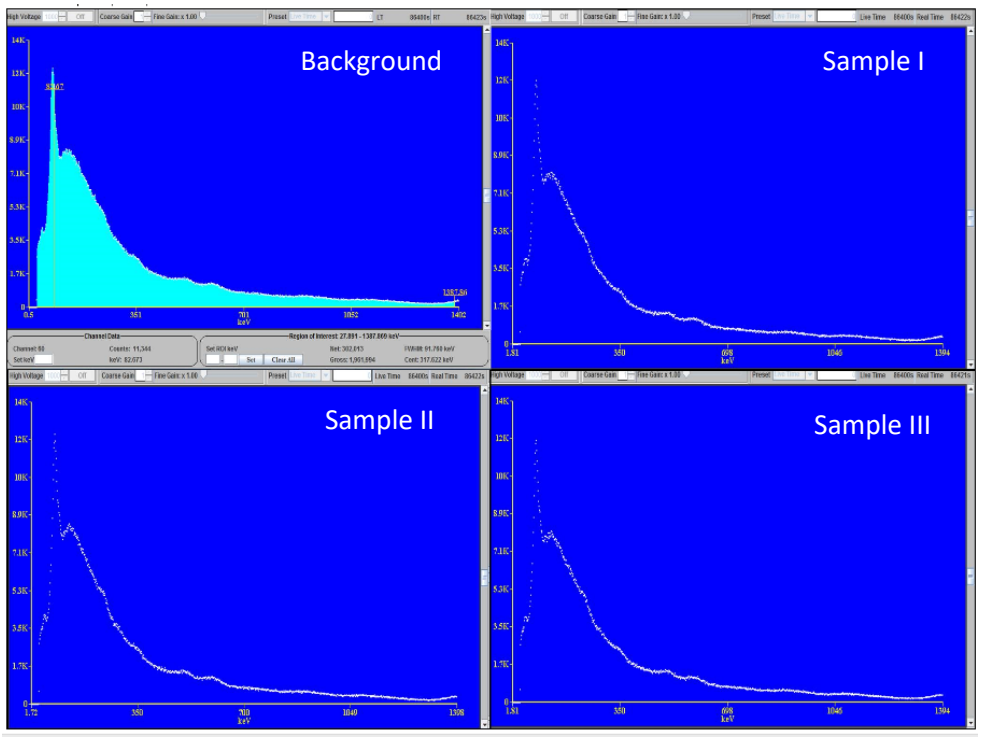

Figure 2 *Shows the energy spectrum of background and spectra of soil samples I, II, and III using the Advanced Nuclear Spectroscopy System with UCS 30 Universal Computer Spectrometer Software.*

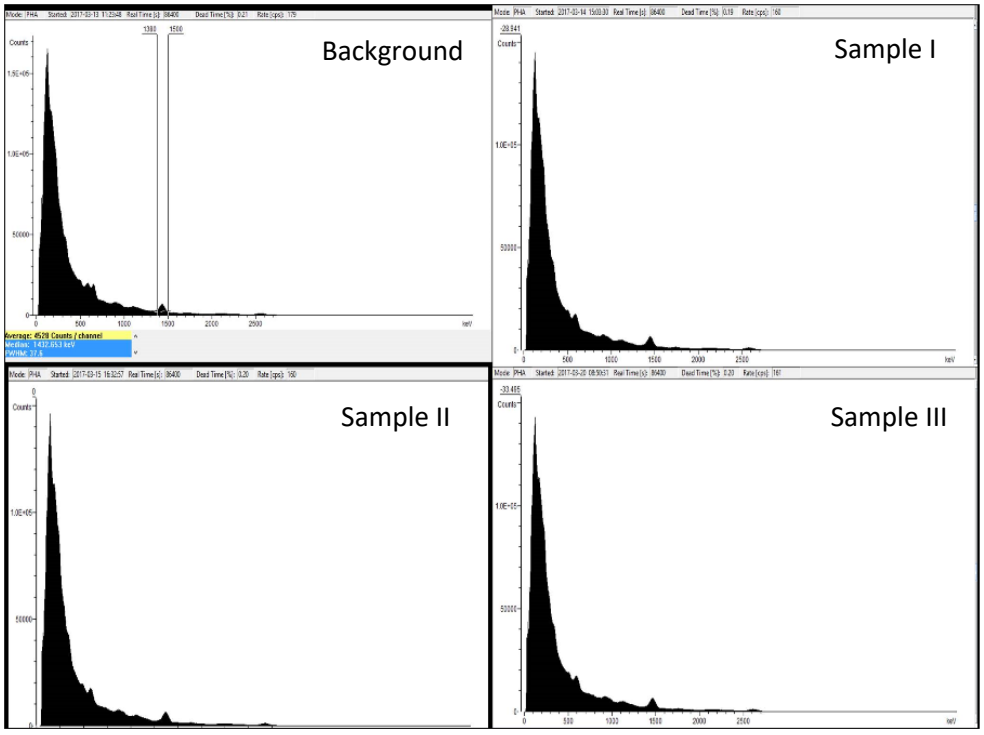

Figure 3 *Shows the energy spectrum of background and spectra of soil samples I, II, and III using High Sensitivity Gamma Spectroscopy Model SE-9764 with WinDas Software.*

DISCUSSION

In the ore of bauxite, red mud, sand and naturally occurring radionuclides are found, such as; uranium, thorium, radium and their progeny as reported by the United States Environmental Protection Agency (2017). Spectroscopy with scintillation detectors is commonly applied for the identification of radionuclides and quantification of the activity of radioactive substances. In our study, spectra of background and soil samples obtained with two different radiation detection systems were investigated. The analysis of spectra of soil samples collected from various areas of bauxite mining filed at Bukit Goh, Kuantan, Pahang revealed the absence of natural radioactive elements. In addition to that, the findings of this study match with the results of the work conducted by Inayatullah and Madihah (2016) on detection of naturally occurring radioactive materials in the soil of other areas of district Kuantan, Pahang, Malaysia. Thus, based on the results of this study, bauxite mining and transportation activities poses no radiation exposure related human health issues to the population residing near the Bukit Goh area of Kuantan. However, further studies with other type of radiation detection systems, such as; ultrahigh resolution detectors are suggested.

CONCLUSION(S)

It is concluded that all soil samples of bauxite mining areas investigated are free from naturally occurring radioactive substances. Therefore, residents of the area have no health hazards in terms of radiation exposure.

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