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Detection of Natural Radioactive Materials in the Soil of Bauxite Mining Areas of Kuantan, Pahang, Malaysia

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Abstract: **Natural radionuclides, such as, Uranium (U-238), Thorium (Th-236), Radium (Ra-226) and Potassium (K-40) are present in the soil. In this study the detection of natural radioactive materials in the soil of bauxite mining areas in Kuantan was determined. Soil samples were collected from three different places. Advanced Nuclear Spectroscopy System with UCS 30 Universal Computer Spectrometer Software and High Sensitivity Gamma Spectroscopy Model SE-9764 with WinDas Software were used. Background radiation energy spectra and soil samples were obtained and compared. The spectra obtained by measuring all samples show the similar pattern as recorded from the background radiation measurement. Therefore, this study evidenced the absence of radioactive elements in the collected soil samples of bauxite mining areas. However, results cannot be generalized for all bauxite mining areas of Kuantan district.**

Keywords**: Natural radioactivity, Bauxite, Gamma spectroscopy, Soil.**

I. INTRODUCTION

Humankind is always exposed to the radiation present in the environment, e.g., air, soil and industrial activities, such as; mining. It is well established that the exposure of radiation causes health hazards to the public. Thus, it is important to monitor the environment in terms of the presence of the level of radiation. Radiation monitoring means detection and measurement of radioactivity. The radioactivity of our natural environment varies depending on conditions, such as; geological and geographical. The radioactivity appears at different levels in soil of different geological regions [1]. The type of rock formation under earth's crust is related with geological setting at the place. The composition of rock and soil also contribute towards the terrestrial component of the natural background [2]. Usually, all kind of rocks, soil and minerals contain the natural radioactivity such as Uranium (^{238}U), Thorium (^{232}Th), Potassium (^{40}K) and their progeny. Many studies have been done to investigate the presence of radionuclides in the soil, [2], [3], [4], [5].

Literature survey shows that, the presence of bauxite in the vicinity of Kuantan was recognized almost eight decades ago in 1937 (Fitch 1952) which was reported by [6]. Further, the results of the geological survey conducted in 1979 (reconnaissance auger prospecting) confirmed the deposits of ferruginous bauxite with a commercial value. The term bauxite has been described differently by various authorities; however, most widely accepted definition was given by [7]as: "The term *bauxite ore* is applied to *bauxites* which are economically mineable at present or in the foreseeable future, containing not less than 40-50% $Al_2 O_3$, and not more than 20% Fe_2O_3 and 3-5% combined silica." According to this definition and chemical analysis of bauxite samples from the areas of Kuantan showed the low or medium grade, however, some of the samples were graded as of commercial potential [6]. Bauxite shows various textures, near the surface of the ground it looks in brick-red color.

Recently, in Malaysia bauxite mining grew rapidly and reached to the top supplier to China for the aluminum industry. However, mining, transportation and environmental pollution issues angered the public in general and the population living near the bauxite mining areas in particular showed their concern relating to the health and safety hazards. Along

with other problems, speculations about existence of radioactive materials surfaced in the electronic and social media and caused the panic to the residents of mining areas and also Kuantan town. Therefore, this study was undertaken to detect the presence of any natural radioactive material in the soil of the bauxite mining areas.

II. MATERIALS AND METHOD

In this work soil samples were studied which were collected from different locations of Kuantan mining areas, such as; Dermaga 6 at Kuantan Port, Sungai Karang and Indera Mahkota 5. In this study, two radiation detection systems were used. The Advanced Nuclear Spectroscopy System with UCS 30 Universal Computer Spectrometer Software and High Sensitivity Gamma Spectroscopy Model SE-9764 with WinDas Software. Both systems use NaI(Tl) scintillators. The Advanced Nuclear Spectroscopy System has the ability to detect the radiation of low energy (range until 1024 keV) with UCS 30 Universal Computer Spectrometer (USB). The most important part is the software which has unique features of peak-labeling kwon as ISOMATCH. It enables user to choose a radionuclide from the library and the corresponding characteristics emission lines overlaid on the spectrum along with isotope and energy information. High Sensitivity Gamma Spectroscopy Model SE-9764 with WinDas Software has the ability to measure the radioactive material with high energy peak (range until 2000 keV). Radioactive materials Cesium – 137 (Cs-137) and Cobalt – 60 (Co-60) were used in this study as a radiation source for calibration of detectors. The energy spectra of Cs-137 and Co – 60 determine the accuracy of the detectors. In this study, three soil samples were collected from three different locations of mining areas on random basis which was already dug out and placed over the surface of the ground. The collected soil was heated about 2 hours at 110 degree Celsius which was meshed to small tiny size (about 2mm). The heating process was carried out to remove the moisture from soil completely. Then, it was kept in a small thin airtight plastic container about 30 days to make sure the samples achieved the radioactive equilibrium between Ra-226 with its daughter products in the series of uranium. It was assumed that Th-232 attained the secular equilibrium of Ra-226 as mentioned in [4]. Both of the radiation detection systems were set up in different rooms to avoid the miscalculation of samples. Spectrum of background radiation was determined using both systems to avoid bias in measurement and as comparison between the background and actual result of each sample. Background spectra were recorded by keeping the systems on for 24 hours (86400 seconds) without any radioactive material. Then, both systems were calibrated by using two radiation sources. Cesium-137 was used to calibrate the Advanced Nuclear Spectroscopy System with UCS 30 Universal Computer Spectrometer Software. Cobalt-60 radionuclide was used to calibrate High Sensitivity Gamma Spectroscopy Model SE-9764 with WinDas Software. The calibration was important to ensure the proper functioning of the equipment. Soil sample was placed inside a small-thin plastic container and positioned close to the detector without contact to avoid contamination that may lead to errors in the accuracy of results. Each sample was measured for three times to obtain the accurate data.

III. RESULTS AND DISCUSSION

The energy spectra of background radiation and the bauxite soil samples obtained by applying two different gamma spectroscopy systems which are displayed in Fig. 1. The samples of the soil from bauxite mining areas were collected from three different locations labeled as A, B and C. The comparison was made between all the results with background radiation spectra. The results of all measured energy spectra show the similar outcome and no difference from each other. This reflects the absence of radioactive material in the soil samples which were investigated. If there was the presence of any type of radioactive material in sample, it could have been viewed as the energy peak in the measured spectrum.

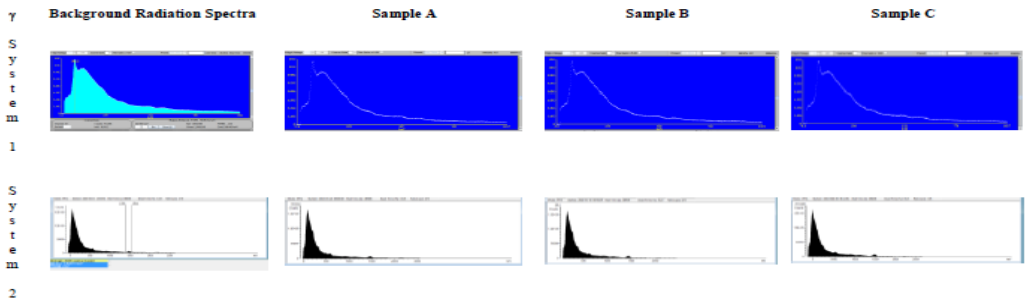

Fig. 1 Show the energy spectra of background radiation and three soil samples (A, B and C) obtained by two gamma spectroscopy systems

IV. CONCLUSION

In conclusion, it was found that there is no radioactive material present in bauxite soil of mining areas in Kuantan which were studied. Measured energy spectra of all samples showed the similar pattern as of the spectra of the background radiation. It is important to mention that results do not represent all mining areas in Kuantan, but, only applicable to the region from where the samples were collected.

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