CORRELATION BETWEEN GROSS ALPHA AND BETA ACTIVITY CONCENTRATION IN SOIL SAMPLES WITH DOSE RATE IN ISKANDAR MALAYSIA, JOHOR, MALAYSIA.

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Abstract. The objective of this study was to determine the gross alpha and gross beta activity concentrations in soil samples collected in Iskandar Malaysia, Johor, Malaysia. A total of 32 soil samples were collected and the dose rates at the location were measured 1 m above the ground. The gross alpha activity concentration ranged from 140 to 2,010 Bq kg^{-1} with the mean value of 796 ± 70 Bq kg^{-1}. The gross beta activity ranged from 40 to 2,300 Bq kg^{-1} with the mean value of 837 ± 30 Bq kg^{-1}. The results of analysis show strong correlation between gross alpha activity concentration and dose rate (R = 0.90) and gross beta activity concentration and dose rate (R = 0.84).

Keywords Terresterial gamma radiation dose rate**,** soil, gross alpha, gross beta

1.0 INTRODUCTION

The objective of this study was to determine the gross alpha and gross beta activity concentrations in the soil samples in Iskandar Malaysia, Johor, Malaysia. Natural radioactivity is associated mainly to primordial nuclides, including the elements belonging to the ^{238}U, ^{232}Th and ^{40}K series [1]. The presence of these radionuclide in soil give significant contributor to the background radiation exposure[1]. Radionuclide from ^{238}U and ^{232}Th series are responsible for majority of alpha and beta activity concentration. ^{40}K also contribute some of the activity concentration for beta [2].

2.0 EXPERIMENTAL

2.1 Survey

Portable survey meter manufactured by Ludlum model 12S was used to perform gamma dose rate measurement. This survey meter uses 2.54 cm x 2.54 cm NaI crystal doped with thallium for optimum performance in counting low level gamma radiation with accuracy of ±10 % [3]. It can detect reading from1 μR h^{-1} (~8.7 nGy h^{-1}). It is suitable for environmental gamma measurement because of its low response to high energy gamma radiation. This implies that a contribution from cosmic sources is not considered [4]. This instrument was calibrated by Nuclear Malaysia Agency, a certified institution for instrument calibration.

2.2 Sample Preparation

Iskandar Malaysia located between latitudes 1° 15’ and 1° 47’ North, and longitudes 103° 22’ and 104° 2’ East. A total of 32 samples were collected and their dose rates from 1 m above the ground were measured using survey meter. Soil samples were taken from a depth of 10 cm from the surface [4]. All samples were dried by placing in an oven at 110 ^{o}C for 24 hours and then crushed and ground to fine powder. The samples were sieved through a 200 mm test sieve/150

microns to be size homogenized [6]. About 2 g of soil was weighted in stainless steel planchet. Glass rod was used to spread the soil evenly in the planchet then the surface of the soil was spread with diluted UHU glue and aceton. The sample was put under the infrared lamp until dry. ^{241}Am for gross alpha and ^{90}Sr for gross beta were used as standard samples for measurement [7].

2.3 Counting System for Gross Alpha and Gross Beta

Gross alpha and gross beta activity concentrations for 32 soil samples were measured by using Series 5 XLB Automatic Low Background Alpha Beta detector. The detector has 80 mg cm^2 windows with a 2π geometry gas flow proportional counter, and is manufactured by the Canberra Company (USA) [7].

3.0 RESULTS AND DISCUSSION

3.1 Gross Alpha and Gross Beta Activity Concentration

Table 3.1 shows the comparison of results for gross alpha and beta activity concentratioan (Bq kg^{-1}) in the soil samples from Iskandar Malaysia and other studies. The gross alpha activity concentration ranged from 2,010 to 140 Bq kg^{-1} with mean value of 796 ± 70 Bq kg^{-1} . The gross beta activity ranged from 2,300 to 40 Bq kg^{-1} with mean value of 837 ± 30 Bq kg^{-1}.

Table 3.1: Comparison of results for gross alpha and beta activity concentratioan (Bq kg^{-1}) in the soil samples from Iskandar Malaysia, Johor and other studies [2].

Location	Mean gross alpha activity (Bq kg^{-1})	Range (Bq kg^{-1})	Mean gross beta activity (Bq kg^{-1})	Range (Bq kg^{-1})	References
Iskandar Malaysia	796	140-2010	837	40-2300	Present study
Kinta	1558	15-9634	1112	142-6173	Lee et al.
Segamat	1143	<MDA-1710	1071	70-4690	Saleh et al.

The result shows that the mean activity concentration for gross alpha and gross beta for Iskandar Malaysia is lower than Kinta and Segamat district which are high dose area in Malaysia.

3.2 Correlation between Concentration of Gross Alpha and Gross Beta with Dose Rate

From Figure 3.1 and 3.2, the gross alpha and gross beta concentration can be predicted by measuring the dose rate because the graph shows strong relationship in the correlation analysis between both pair.

The correlation coefficient between gross alpha activity concentration, gross beta activity concentration and total gross (alpha + beta) activity concentration and dose rates are found to be 0.90 (R^2 = 0.8111) (Figure 3.1), 0.84 (R^2 = 0.7088) (Figure 3.2) and 0.90 (R^2 = 0.8047) (Figure 3.3), respectively.

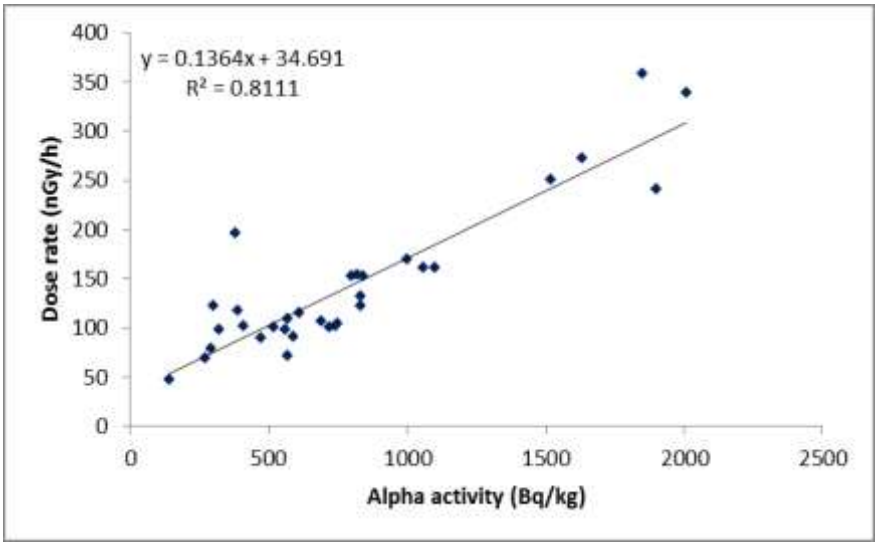

Figure 3.1: Correlation between gross alpha activity concentration and dose rate.

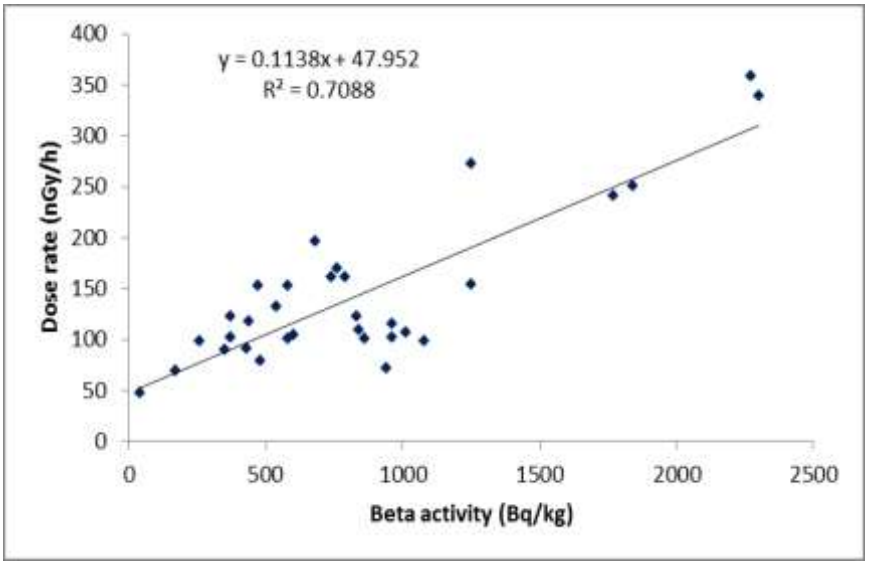

Figure 3.2: Correlation between gross beta activity concentration and dose rate.

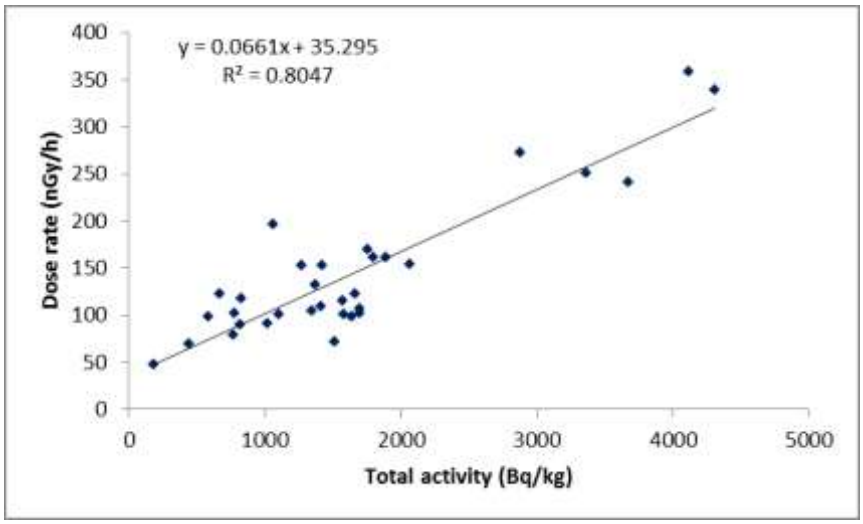

Figure 3.3: Correlation between total gross (alpha + beta) activity concentration and dose rate.

4.0 CONCLUSIONS

This study investigated the activity concentration of gross alpha and gross beta in soil samples collected at Iskandar Malaysia, Johor and their correlation with the gamma dose rate at the location where the samples were collected. The gross alpha activity concentration ranged from 140 to 2,010 Bq kg^{-1} with the mean value of 796 ± 70 Bq kg^{-1} . The gross beta activity ranged from 40 to 2,300 Bq kg^{-1} with the mean value of 837 ± 30 Bq kg^{-1}. By measuring dose rate, alpha and beta activity concentration can be predicted. It was found that the alpha and beta activity concentration for Iskandar Malaysia are lower when compared to higher dose areas in Malaysia such as Segamat and Kinta district.

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REFERENCES

[1] Harb, S., Abbady, A. E, El-Kamel, A. E, Saleh, I. I., El-Mageed, A. I. A. (2012). Natural radioactivity and their radiological effects for different types of rocks from Egypt. *Radiation Physics and Chemistry*. 81, 221-225.

[2] Lee S. K., Wagiran H and Ramli A. T. (2013). A survey of gross alpha and gross beta activity in soil samples in Kinta district, Perak, Malaysia. *Radiation Protection Dosimetry*. 1–6.

[3] Lee, S. K., Wagiran, H., Ramli, A. T., Apriantoro, N. H. and Wood, A. K. (2009). Radiological monitoring: terrestrial radionuclides in Kinta District, Perak, Malaysia. *Journal of Environmental Radioactivity*. 100, 368–374.

[4] Abdul Rahman A.T, and Ramli A. T. (2007). Radioactivity levels of 238U and 232Th, the α and β activities and associated dose rates from surface soil in Ulu Tiram, Malaysia. *Journal of Radioanalytical and Nuclear Chemistry*. 273 (3), 653–657.

[5] Saleh, M. A., Ramli, A. T., Alajerami, Y. and Aliyu A. S. (2013). Assessment of Environmental ^{226}Ra, ^{232}Th and ^{40}K Concentrations in the Region of Elevated Radiation Background in Segamat District, Johor, Malaysia. *Journal of Environmental Radioactivity*. 124, 130-140.

[6] Ramli, A. T., Apriantoro, N. A. and Wagiran, H. (2009). Assessment of radiation dose rates in the high terrestrial gamma radiation area of Selama District, Perak, Malaysia. *Applied Physics Research*. 1(2), 45 - 52.

[7] Saleh, M. A., Ramli, A. T. and Alajerami, Y. (2013). Assessment of environmental 226Ra, 232Th, 40K concentrations in the region of elevated radiation background in Segamat District, Johor, Malaysia. *Journal of Environmental Radioactivity*. 124,130–140.