Measurement and Analysis of Specific Activities of Natural Radionuclides ($^{40}$K, $^{226}$Ra and $^{232}$Th) in Beach Sand Samples from Talo Kapo Beach of Yaring District in Pattani Province using Gamma Ray Spectrometry

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Abstract. The Specific Activities of $^{40}$K, $^{226}$Ra and $^{232}$Th were studied and determine for 30 beach sand samples collected from Talo Kapo beach of Yaring district in Pattani province. Experimental results were obtained by using a high-purity germanium (HPGe) detector and gamma spectrometry analysis system. The IAEA-SOIL-6 reference materials obtained from the International Atomic Energy Agency were also used to analyze and compute the $^{40}$K, $^{226}$Ra and $^{232}$Th specific activity in all 30 beach sand samples. The measuring time of each sample is 10,000 seconds. It was found that specific activity range from 1805.37 – 3323.05, 40.96 – 2137.36, 38.63 – 4329.28 Bq/kg for with mean values of $^{40}$K, $^{226}$Ra and $^{232}$Th, respectively. Moreover, the results were also compared with research data in the south of Thailand, the Office of Atoms for Peace (OAP) annual report data and the recommended values which were proposed by United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR,)

1. Introduction
Natural radioactivity is wide spread in the earth’s environment and it exists in various geological formations in soil, sand, rocks, plants, water and air. The natural radioactivity in sand comes from U and Th series and natural K. The radiological implication of these radionuclides is due to the gamma ray exposure of the body and irradiation of lung tissue from inhalation of radon and its daughters. Therefore, the assessment of gamma radiation dose from natural sources is of particular importance as natural radiation is the largest contributor to the external dose of the world population [1]. The measurement of natural radioactivity due to gamma rays from the dose rate is needed to implement precautionary measures whenever the dose is found to be above the recommended limits. The growing worldwide interest in natural radiation exposure has lead to extensive surveys in many countries. In the present work, 30 beach sand samples collected from Talo Kapo beach area of Yaring district in Pattani province in the south of Thailand. All beach samples were used to determine the specific activities of natural radionuclides ($^{40}$K, $^{226}$Ra and $^{232}$Th) with the main objective to measure the radiation exposure from the nature to the people who lived this area. Moreover, the experimental...
results were also compared with Office of Atoms for Peace (OAP) research data, Thailand and global radioactivity measurement and evaluations.

2. Materials and Methods

2.1 Sample Collection and Preparation

30 surface beach sand samples were collected along the Talo Kapo beach of Yaring district in Pattani province in the south of Thailand. All beach sand samples were prepared with standard procedure in Nuclear and Material Physics Research laboratory, Department of Physics, Faculty of Science, Thaksin University (TSU). Each sample was homogenized and sieved through 2–mm mesh sized to remove stone pebbles and other macro-impurities. Then, the sample was taken to oven dried at a temperature of 100 °C for 5 hours to remove the moisture. The PVC containers were used to keep the sand sample, sealed and stored about 30 days in order to reach equilibrium of the radionuclides before the laboratory measurement.

2.2 Calibration and Measurement by Gamma Spectrometry

The specific activities of $^{40}$K, $^{226}$Ra and $^{232}$Th in 30 beach sand samples were measured and carried out by using a high-purity germanium (HPGe) detector and gamma spectrometry analysis system at laboratory research building, Office of Atoms for Peace, Bangkok. Gamma ray radioactive standard sources $^{137}$Cs and $^{60}$Co were used to calibrate the measurement system. The well-known reference materials (IAEA-SOIL-6) obtained from the International Atomic Energy Agency was used to analyze and compute the $^{40}$K, $^{226}$Ra and $^{232}$Th specific activity in all of the beach sand samples. The spectra were analyzed using program Gamma Vision V32. The specific activity of $^{226}$Ra and $^{232}$Th were determined by their decay products $^{214}$Pb (351.9 keV) and $^{212}$Pb (238.6 keV), respectively. The specific activities of $^{40}$K was determined from its 1460.8 keV gamma spectrometry line. Counting time for each sample was 10,000 seconds. The background spectrum was recorded immediately after or before the sample counting.

3. Results

The ranges and mean values of specific activities of $^{40}$K, $^{226}$Ra and $^{232}$Th in 30 sand samples collected from Talo Kapo beach of Yaring district in Pattani province, Thailand were calculated and presented in Table 1. The isotope type found in sand samples presented in Figure 1.

Table 1. Ranges and mean values of specific activities of $^{40}$K, $^{226}$Ra and $^{232}$Th in 30 beach sand samples collected from Talo Kapo beach of Yaring district in Pattani province, Thailand

| Talo Kapo beach (30 samples) | $^{40}$K (Bq/kg) | $^{226}$Ra (Bq/kg) | $^{232}$Th (Bq/kg) |
|-------------------------------|------------------|-------------------|-------------------|
| **Range**                     | 1805.37–3323.05  | 40.96–2137.36     | 38.63–4329.28     |
| **Mean Values**               | 2242.79±117.40   | 250.18±8.21       | 458.42±7.68       |
Figure 1. The isotope type found in sand samples.

The comparison between the mean values of the specific activities of $^{40}$K, $^{226}$Ra and $^{232}$Th radionuclides in 30 beach sand samples collected from Talo Kapo beach of Yaring district in Pattani province with research data in the south of Thailand, Office of Atoms for Peace (OAP) annual report data and global radioactivity measurement and evaluations were shown in Table 2.

Table 2. Comparison of the mean values of specific activities of $^{40}$K, $^{226}$Ra and $^{232}$Th in 30 sand samples collected from Talo Kapo beach of Yaring district in Pattani province with research data in Songkhla Province, Office of Atoms for Peace (OAP) annual report data and global radioactivity measurement and evaluations.

| Locations        | $^{40}$K (Bq/kg) | $^{226}$Ra (Bq/kg) | $^{232}$Th (Bq/kg) |
|------------------|------------------|--------------------|--------------------|
| OAP data         | 511.04±7.04      | 211.19±1.98        | 171.55±3.13        |
| Worldwide mean   | 400              | 35                 | 30                 |
| Maharaj beach    | 921.98±123.93    | 46.28±3.52         | 47.35±2.40         |
| Sai Kaew beach   | 716.37±114.68    | 25.70±2.81         | 23.74±1.98         |
| Samila beach     | 1127.61±148.62   | 54.46±4.90         | 52.48±2.71         |
| Chalatat Beach   | 575.11±111.28    | 57.29±4.84         | 70.38±2.78         |
| Sakom beach      | 1021.37±128.29   | 41.90±3.55         | 39.26±2.26         |
| Soisawan beach   | 1983.32±187.39   | 42.67±4.00         | 37.98±2.71         |
| Talo Kapo beach  | **2242.79±117.40** | **250.18±8.21**   | **458.42±7.68**   |
4. Conclusion
From Table 1, the ranges and mean values of specific activities of $^{40}$K, $^{226}$Ra and $^{232}$Th in 30 beach sand samples collected from Talo Kapo beach of Yaring district in Pattani province, Thailand were calculated and range from 1805.37 – 3323.05, 40.96 – 2137.36 and 38.63 – 4329.28 Bq/kg for $^{232}$Th with mean values of 2242.79 ± 117.40 Bq/kg, 250.18 ± 8.21 Bq/kg and 458.42 ± 7.68 Bq/kg for $^{40}$K, $^{226}$Ra and $^{232}$Th, respectively. From Table 2, the mean values of specific activities of $^{40}$K, $^{226}$Ra and $^{232}$Th in Talo Kapo beach in Pattani province were **higher** than research data in the south of Thailand, the Office of Atoms for Peace (OAP) annual report data and the recommended values which were proposed by UNSCEAR[5-7].

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