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Analysis of Radioactivity Levels and Hazard Assessment of Black Sand Samples from Rashid Area - Egypt

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Abstract

The aim of this study is to evaluate the radioactivity levels and radiological impacts of representative black sand samples collected from different locations in the Rashid area, Egypt. These samples were prepared and then analyzed using the high resolution gamma ray spectroscopy technique with a high-purity germanium (HpGe) detector. The Activity Concentration (A_c), the Minimum Detectable Activity (*MDA*), Absorbed Gamma Dose Rate (AGDR), External Hazard Index (H_{ex}), Annual Effective Dose Rate Equivalent (*AEDRE*), Radium equivalent, External and Internal Hazard Index (H_{ex} and H_{in}) were estimated based on the measured radionuclide concentration of the ^{238}U(^{226}Ra) and ^{232}Th decay chains and ^{40}K. The activity concentrations of the ^{238}U, ^{232}Th decay series and ^{40}K of these samples were varied from 45.11±3.1 to 252.38±34.3 Bq/kg Bq/kg, 64.65±6.1 to 579.84±53.1Bq/kg and from 403.36±20.8 to 527.47±23.1 Bq/kg respectively. The activity concentration of the ^{232}Th in sample-1 has the highest value compared to the other samples; this value is also higher than the worldwide mean range as reported by the UNSCEAR 2000. The total absorbed gamma dose rate and the annual effective dose for these samples were found to vary from 81.19 to 497.81 (nGy/h) and from 99.86 to 612.31 (μSv/y) which are higher than the world average values of 59 nGy/h and 70 μSv/y, respectively. The External Hazard Index values were also calculated and found to be 3.02, 0.47, 0.63, 0.87, 0.87, 0.51 and 0.91. It was found that the calculated value of H_{ex} for Sample-1 is significantly higher than the international acceptable limit of < 1. The results are tabulated, depicted and discussed within national and international frameworks, levels and approaches.

Keywords: Gamma spectrometry, Radioactivity levels, Radiological hazards assessment, black sand, Environmental impact

1. Introduction

There are naturally occurring radioactive series that have been in existence since the earth was created. Each of these is headed by a very long-lived parent such as ^{238}U (4.5×10^9 years) and ^{232}Th (1.39×10^9 years). In each chain, the nuclides decay by emitting α or β particles until stable lead is reached [1]. As a matter of fact, different locations worldwide are naturally rich in uranium or thorium minerals. Based on IAEA publications, the highest known reserves of thorium are contained in the beach and inland placer deposits of monazite, a mixed phosphate mineral; Egypt has potential and feasible estimated thorium reserves [2]. The Rashid area in Egypt is considered a promising site for high abundance black sand- monazite minerals [3].

Non-destructive technique gamma spectrometry is an effective and essential tool to analyze different materials and matrixes containing natural and/or anthropogenic radionuclides. The concept of dose equivalent and External Hazard Index is used to assess radiological hazard for different kinds of radiation of various radionuclides.

2. Experimental work

i) Sample Preparation

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