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Hazardous parameters associated with natural radioactivity exposure from black sand

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ABSTRACT

Black sand samples collected from Baltim beaches (Kafr El-Sheikh governorate) in Egypt on the Mediterranean Sea shore were analyzed radiometrically and evaluated using a nondestructive gamma ray spectroscopic techniques. The natural radionuclides of ^{226}Ra, ^{232}Th and ^{40}K in the black sand samples were identified and quantified. It is found that the activity concentrations for ^{226}Ra, ^{232}Th and ^{40}K in different eleven sites (S1−S11) were found within the ranges of 28–322, 91–308 and 81–339 Bq/kg, respectively. Moreover, different radiological hazardous parameters (absorbed dose rate, annual effective dose equivalent, radium activity, annual gonadal dose equivalent and excess lifetime cancer risk) were calculated. The results show that these values are greater than the permissible values due to increasing the activity concentrations of the primordial radionuclides ^{226}Ra, ^{232}Th and ^{40}K. The dose rate for radiation emitted at 1 m from the surface of land was measured directly and the results shown that all sites emit radiation doses more than the international permissible value (57 nGy/h) especially at three sites which around 340 nGy/h. These values are important to establish baseline levels of this environmental radioactivity to detect any upcoming change for the local population and resorts people. The relatively high dose rate will be considered as a spa for the physical therapy such as treatment of some skin diseases and rheumatoid.

1. Introduction

Every time people are exposed to the ionizing radiation originating mainly from naturally occurring radionuclides. The control of these levels of radiation is important not only to evaluate the dose given at the place where you live, but also setting up baseline levels of the environmental radioactivity in order to detect any abnormal changes. Natural radioactivity is mainly due to the activity concentrations of original radionuclides ^{232}Th, ^{238}U (^{226}Ra) and ^{40}K. The measurement of the natural radioactivity concentrations in soil, sand and rock, which depend upon the local geology of each region in the world, has been carried out in many parts of the world mostly for the assessment of the dose and the risk resulting from them. It is also important to assess the concentrations and the distribution of natural radionuclides in the coastal zone in order to evaluate those provided by the ebb and flow tides of the sea (Arnedo et al., 2013). Analysis of radioactivity in touristic beaches plays an interesting role.

On the other hand, they are a natural system with a high population of bathers exposed to natural ionizing radiation, which needs to be evaluated, and also, they are easily accessible places for the study of the influence of the ocean on the coastal environmental radioactivity by means of analyzing sand samples from the intertidal zone. Many articles have reported the natural activity concentrations of sands from various beach zones in the UK, Egypt, India, China, Australia, Brazil, Pakistan and Libya (Copplestone et al., 2001; El-Bahi et al., 2005; Harb, 2008; Eissa et al., 2011; Uosif et al., 2008; Ramasamy et al., 2004, 2009; Kannan et al., 2002; Mohanty et al., 2004; Sulekha et al., 2009; Lu and Zhang, 2008; De Meijer et al., 2001; Freitas and Alencar, 2004; Veiga et al., 2006; Carvalho et al., 2011; Malik et al., 2010; El-Kameesy et al., 2008). The assessment of these doses from natural materials is important as external radiation exposures Due to it has contributed 50% of the average annual dose to humans from all radiation sources (UNSCEAR, 2000, 2008). Such investigations can be useful both for the assessment of public dose rates and as well as to keep reference data records, to ascertain possible changes in the environmental radioactivity because of nuclear, industrial and other human activities. Beach sands are mineral deposits, which may have come to their site after transport by wind, rivers and glaciers, and are deposited on the beaches by the actions of waves and currents. The natural radioactivity percent in beach sands are a source of external exposure that contributes to an increase in the environmental dose (De Meijer et al., 2001). In most coasts around the world, many people visit these places

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for recreation and spend good time and also for treating from some diseases. Therefore, in the Atlantic coasts of Brazil are covered by the sand with radioactivity which came back with the ebb and flow tides the wave from sea (De Meijer et al., 2001). The radioactivity was originated from the mountains, rich in zirconites and monazites along the coast. Many people visit the beach with black sands, which are radioactive, for sea swimming and treatment of rheumatoid. The city has developed as a number one resort in Brazil with a population of 70,000. I think that when asked some people who buried their bodies in the sands of the beaches “How do you feel in the sand?” They said: “We feel very warm. We do not know the effect, but it is sure that it becomes warmer and warmer in the sand. We found something different from other places (Harb, 2008).

In Baltim region, Egypt requires periodic radiological assessments of the natural radionuclides due to their geographical location, high density of traffic by sea and owing to being one of the most important local population and resorts peopledestinations in a world. The total population of Baltim is approximately 500,000 persons with approximately one million tourists per year. The main objective of this study is to determine the levels of the naturally occurring ^{226}Ra, ^{232}Th and ^{40}K in the most common seashores of Egypt and to estimate the radiological hazards due to the natural radionuclides contents of the beach sands in these resorts to assess any health risks.

2. Materials and methods

2.1. Sample collection and preparation

Eleven black sand samples (S1−S11) from the of Baltim beaches (Kafr El-Sheikh governorate) on the Mediterranean Sea coast, Egypt were collected during the second term of year 2014. S1 location at Burg El Burullus at longitude 30^0 $48^{\backslash\backslash}$ and latitude 31^0 $12^{\backslash\backslash}$, S2, far from 2 km east from S1, but S3, S4 and S5 far from 7 km east from S1, also S6 and S7 far from 9 km east from S1, S8 at 11 km east from S1, S9 and S10 at 13 km east from S1 and S11 at 19 km East from S1. Fig. 1 illustrates the map for the collected samples sites. To homogenize samples of each location a 1 m^2 area was marked and superficial sand (0–30 cm depth) was mixed in situ and finally representative sample about 5 kg was taken (Harb, 2008). The sample from each location was mixed, and screened in atmospheric air at temperature 25–30 °C. This process is performed to prevent a significant loss of any radionuclides except radon. Also, all samples were dried for a sufficient period, approximately 2 weeks at room temperature to acquire a constant dry weight and permit longer storage time. The dry samples were homogenized. Three samples (50 g for each one) in each location were selected and packaged in a plastic container for one month to attain the secular equilibrium between radon gas and its daughter in the natural decay series of the γ-ray spectroscopic measurements.

2.2. Dose measurements

Gamma dose rate emitted from the black sand was measured directly at distance 1 m from the surface of land on each location using thermo Eber line survey meter (model (ESM FH 40 G-L Radiometer) with detection limit below 10, and energy range of measurements from 30 keV to 4.4 Mev, nan-Seviert per hour (Germany). Measurement of each site (1–10) was repeated ten times (i.e., n = 10). This type of radiation dosimeter (Geiger Muller, GM tube detector) has been used for monitoring the environmental natural and/or artificial radiations in order to control environmental contamination. If the detected dose levels are high, another specific radiation instrument should be used to identify the accurate results. Whereas the radiation dosimeter (GM detector) measures dose emitted from the radiation (natural and/or artificial sources). It has been calibrated by the artificial source, namely, cesium-137.

2.3. Nondestructive γ- spectroscopic analysis

The natural radionuclides present in different samples and the activity concentrations were identified using non destructive nuclear spectroscopic technique. It has been performed by γ-ray spectroscopic system consists of High Purity Germanium (HPGe) detector model GR3019 Canberra with serial number 6419 is a cylindrical crystal with 7.6 cm diameter and 11.3 cm length with 512 cm^3 active volume. The relative efficiency of the detector is 30% with resolution of 1.9 keV at the γ-energy line 1332.5 keV, linear amplifier model TC 2002CSL, multichannel analyzer MCA 16,384 channel and Genie 2000 software. The detector is surrounded by cylindrical lead shield 12.5 cm thickness with movable cover, while the inner part of shield lined with cadmium copper sheets to attenuate X-ray stimulated in the lead shield.

Energy calibration was performed using certified several sealed point sources (Amersham, England) of known gamma-energy lines,

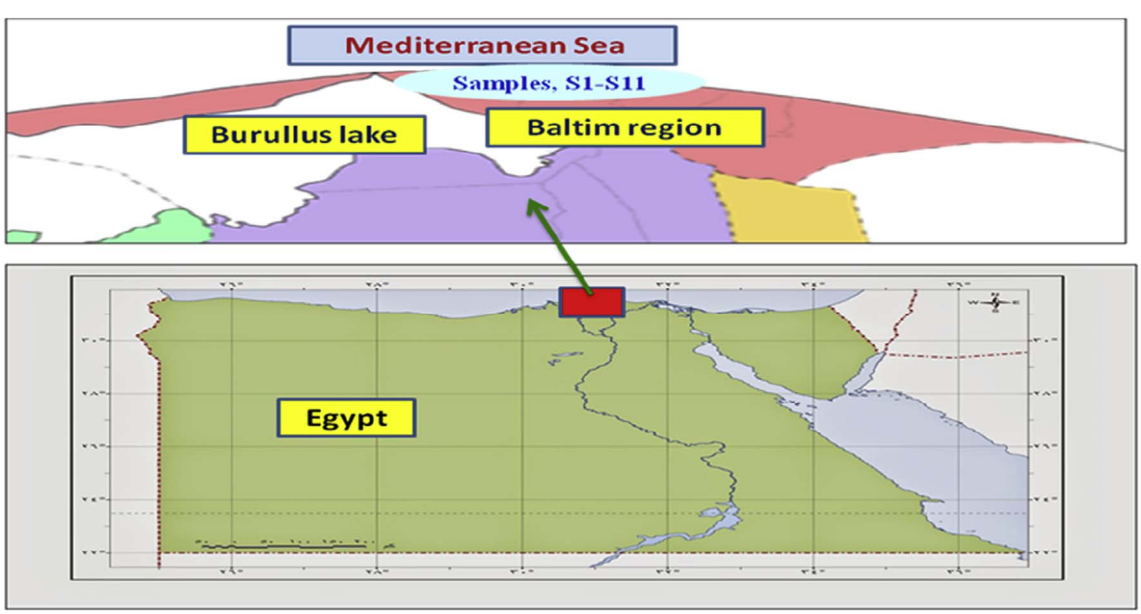

Fig. 1. Map illustrates the location of the collected black sand samples.