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Measurements of natural radioactivity level in black sand and sediment samples of the Temsah Lake beach in Suez Canal region in Egypt

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ABSTRACT

The level of natural radioactivity in 20 black sand and 20 sediment samples collected from **Temsah Lake** beaches of **Suez Canal district,** Egypt was investigated. The gamma-ray spectrometry system with hyper-pure germanium (HPGe) detector has been used to determined radioactivity concentrations. Mathematical model is used to estimate the activity concentrations of ^{222}Rn in the air with the activities of ^{226}Ra. The activity concentrations of the sediment and black sand samples range from 4.29 ± 1.66 to 30.06 ± 8.80 and 4.29 ± 0.68 to 18.52 ± 5.22 Bq/kg) for ^{226}Ra. The ranges of radioactivity concentration of ^{232}Th vary from 6.69 ± 1.54 to 39.24 ± 9.80 and 4.56 ± 1.07 to 18.65 ± 5.27 Bq/kg. The effective annual dose rate in the samples under study varies from 0.01 to 0.05 mSv/y for sediment samples and from 0.01 to 0.05 mSv/y for black sand samples. The concentrations of radon gas in the air were determined as well as the activity concentrations of ^{226}Ra. Radon ^{222}Rn doses from gas inhalation for humans were estimated to be in the range of 0.13–13.09 μsv/y for all samples. The activity concentrations of all samples, which were measured in the present work, were compared with the values in other countries in the world, and it was found they were within the permissible limits, which indicates that the study area was radiologically safe for humans.

1. Introduction

Background radiation levels are from a mixture of ground (from ^{40}K, ^{232}Th, ^{226}Ra, etc.) and cosmic radiation (photons, muons, etc.). The level is fixed to some extent all over the world, being 8–15 μrad/hour, despite the fact that there are some densely populated areas that have high levels of background radiation. The levels were found at the highest level in the first place in Brazil, India and China (UNSCEAR, 1993a, 1993b). It is due to high concentrations of radioactive minerals in the soil of high radiation levels. One of these minerals, monazite, is a non-high-soluble rare earth mineral that is found in the sands of the beach with the mineral ilmenite, which gives the distinctive color of sand. Home radionuclides in monazite are of ^{232}Th series, but there are also some descendants of uranium and radium. On the other hand, the soil works as a medium for migration for transfer radionuclides to the biological system, and therefore, it is the primary indicator of radioactive contamination in the environment. Natural radionuclides in river sediments generate important elements of background radiation exposure of the population (Suresh, Ramasamy, Meenakshisundaram, Venkatachalapathy, & Ponnusamy, 2011b). Therefore, the knowledge of the concentrations and distribution of radionuclides in the samples deposited is of great importance because it provides useful information on environmental pollution and its effects on human health are associated with the monitoring of natural radioactivity.

The main process for the deposition of the net from the sandy sediments suspended is overbank deposition in floodplains and the sea/tidal waves (Walling, Quine, & He, 1992). The amount of deposition depends on the survival of the water at the seaside and the concentration of the sand from the seashores at the time. Natural radioactivity in the sand and sediment from the seashore

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may cause exposure to people living or working near the beach or the tourists who come for a tour of this charming place (Akram, Qureshi, Riffat, Ahmad, & Solaija, 2007). The accumulation of these substances in the marine coastal environment raises many problems concerning the safety of the vital creatures, food chain, and ultimately humans. To address these problems, and assess the concentration of radioactivity in the marine environment is essential.

Black sand concentrates consist of ilmenite, magnetite, zircon, rutile, garnet, and monazite. A previous studies showed that at least 25 million tons of heavy metal black sand contains approximately 200,000 tons of monazite. It consists mainly of sand beach of quartz, feldspar, and other corrosion-resistant metals. They are the product of a combination of weather factors, fragmentation and degradation (Pettijohn, Potter, & Siever, 1987, p. 553). Beach placer or "black sand" deposits are globally known for their economic concentrations of heavy metals such as monazite, zircon, ilmenite, rutile, garnet, sillimanite and allanite (Alam et al., 1999). The main objective of the marine radiological investigations is to contribute to the creation of the scientific basis for predicting the effect of radioactive isotopes (natural or synthetic), which can be released into rivers, lakes and seas on marine ecosystems. Black sand deposits at the Temsah Lake beach of the Suez Canal have received the attention of geologists, physicists, and other scientists for the last decades (Marwa Saad El-Din et al., 2013; Mohamed Zein Alabdein Nassar et al., 2014; El-Sherif, Ahmed, El-Danasoury, & El-Nwishy, 2009; Mohamed, 2013). But none of these studies evaluated the radiological environment of Temsah Lake. Accordingly, the aim of the present work is to reinvestigate the radioactivity concentrations in sand and sediments collected from Temsah lake beaches in Suez Canal region, Egypt. And to be exact, parameters of a health hazard are thoroughly discussed. It can be concluded that there is still a need for the implementation of environmental management practices in the Temsah Lake to protect these ecosystems from the most pollutants that can affect human health and the environment.

2. Experimental technique

2.1. Geological study area

Crocodile Lake, also known as Temsah Lake, is a lake in Egypt on the Nile delta. It lies in a basin developed along a fault extending from the Mediterranean Sea to the Gulf of Suez through the Bitter Lakes region with coordination's 30.56667°N 32.28333°E .(12) In 1800, a flood filled the Wadi Tumilat, which caused Tomah's banks to overflow and moved water south into the Bitter Lakes about 14 km away. The lake was filled with waters from the Red Sea, in 1862. Lake Temsah lies within a depression that spans the isthmus between the Red Sea and the Mediterranean Sea. The lowest points of the depression form shallow natural lakes, of which Temsah is one. The surface area of Lake Temsah covers 5.4 square miles. Most of the lake is marshy and depth rarely exceeds 3 feet (1 m). 1863, the city of Ismailia arose on Lake Tomah's northern bank. Several beaches overlook the lake. Lake Temsah is a brackish lake that experiences significant variations in salinity (see Fig. 1). It was a significant event for the local community, since the lake is of economic importance to the city and its fishermen. In 2003, a number of groups attempted to relieve the lake of pollution (El-Rashidi, 2009, pp. 04-09).

2.2. Sample collection and preparation

Black sand and sediment samples in the present study are obtained from rich deposits of black sands, which occur along beaches of the TEMSAH LAKE on the Suez Canal region. The areas where the deposition of these sands is favored are near the Mediterranean Sea and Read Sea. Each sample containing with grain weighing about 250 g was stored and after drying in an oven at 115 °C, it in standardized polyethylene containers. It was closed containers to avoid any potential for radon gas out and leave for 28 days to ensure that the samples have achieved a balance between radiations ^{226}Ra with its decay products of uranium in the series. It was supposed to ^{238}U is in the case of secular equilibrium with ^{226}Ra.

2.3. Measurements of radioactivity

Measuring the activity concentrations of naturally occurring radionuclides from ^{226}Ra, ^{238}U^{232}Th, and ^{40} K in the black sand and sediment samples, was by using high-purity germanium (HPGe) spectrometer-based detection of gamma rays with the relative efficiency of 40%. HPGe detector coupled with Canberra multichannel analyzer (MCA). The resolution of the spectrometry system was 1.8 keV at 1332 keV gamma-ray line of ^{60}Co. Spectrum were Accumulation collected for each sample in 54000 s (15 h. Spectrum analysis was performed with the computer programs and activity concentrations of U, Ra, Th and K natural

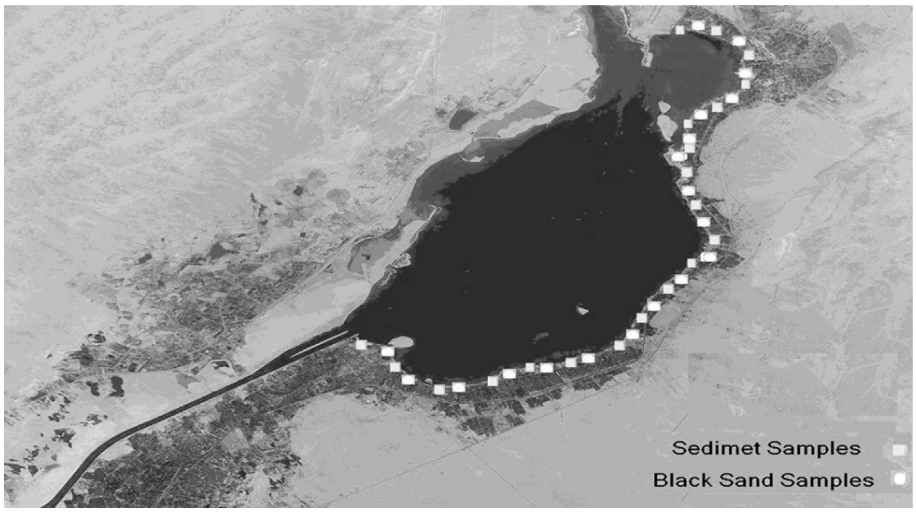

Fig. 1. Map of temsah lake beaches in suez canal, **Egypt.**

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