Natural radioactivity and its associated radiological hazards at Seila area south eastern desert, Egypt

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Introduction

During the whole life, humans are exposed to various risks from environmental contaminants. Natural and anthropogenic sources are part of these risks. Permanent and unavoidable risk is associated with natural (terrestrial and cosmic) radiation. Terrestrial radiation consist the primordial radionuclides present in the Earth's crust (^{238}U and ^{232}Th, and ^{40}K) and cosmic radiation produces cosmogenic radionuclides (^{3}H, ^{14}C, ^{7}Be and ^{22}Na) in interactions with nuclei in Earth's atmosphere. U, Th and K, is significantly higher than from other radiation sources (cosmic or anthropogenic), the activity concentrations of these radionuclides are used for radiological risk estimation. The behavior of these radionuclides give rise to internal and external radiation exposures, both indoor and outdoor. Human activities such as mining and exploitation of natural resources may result in technologically enhanced NORM (TENORM), which can influence exposure to natural sources of radiation. Estimates of the total radiation dose to the world population have shown that a fraction of about 96% is from natural sources, while 4% is from artificial sources. Sediments is an important environmental material used, e.g., for building raw materials and products, for streets and playgrounds, and for land filling. If they occur in building raw materials, those naturally occurring radionuclides add to the indoor exposure.

Studied area

Gabal El Seila area is located in southeastern desert of Egypt, between latitudes 22o 13′ 48″–22o 18′ 36″ N and longitudes 36o 10′ 12″–36o 18′ 36″ E (Fig. 1).

The studied area is characterized by a barrage grass green so resorted to most of the shepherds and camels around this area. The area is inhabited by local pastoral activities belonging to El Bishariya tribes, who practice their traditional life style in harmony with the environment. On the other hand, Seila area is one of the promising localities for U- occurrences in the granites of the south eastern desert of Egypt. The stream sediments at Seila area are originated from the processes of airiation, weathering and fracturing of the bed rocks at the different Wadis and tributaries.

Fifty-one locations were distributed in the studied area at Seila area (Fig. 1). The site has an area of 1.75 × 1.25 km^2. These locations were chosen to measure terrestrial radionuclides content in the stream sediments..

Fig.1: Geological map of Seila area, Southeastern desert, Egypt, showing the studied area.

Materials and methods

A RS-230 BGO spectrometer (1024 channels) was used to measure the wide range of potential radiation concentrations during the uranium exploration process. The RS-230 depends on a 6.3-in.3 (103 cm3) higher density bismuth germanate oxide (BGO) detector. This device provides a readout of the concentration of uranium and thorium in ppm and the percentage of potassium in the medium after a 30 s measurement time (used in this work).

Activities and hazard indices

The present study was carried out to determine:
the activity concentrations of 238U, 232Th and 40K in surface of stream sediments at seila area, south eastern desert of Egypt. The results are compared with representative values from other parts/regions of the world, and are used to assess the potential radiological hazards associated with these sediments:

1- the external hazard index (H_{ex}),
2- internal hazard index (H_{in}),
3- external and internal level indices (Iγ, Iα),
4- activity index (I),
5- radium equivalent activity (Ra_{eq}),
6- absorbed dose rates in air (DR),
7- the annual effective dose.

Also, other parameters like the annual gonadal dose (AGED) for a resident of a house, excess lifetime cancer risk (ELCR) in mSvy^{-1} and clark value ^{232}Th/^{238}U concentration ratio are presented and discussed. Finally, based on these results, the effective dose rate delivered to the particular organs (Lungs, Ovaries, Bone marrow. Testes and Whole body) from air dose indoor and outdoor are estimated

Results and discussions

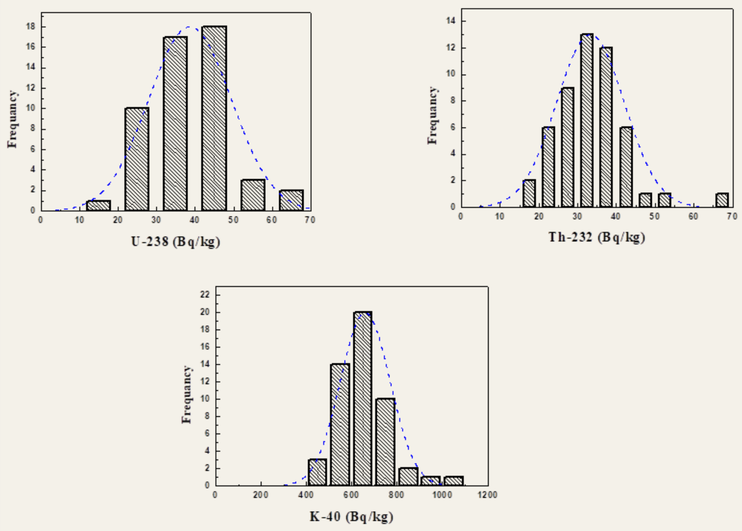

Fig 2: Normalized histograms for the measured specific activities of ^{238}U, ^{232}Th, and ^{40}K.

Th/U content ratios

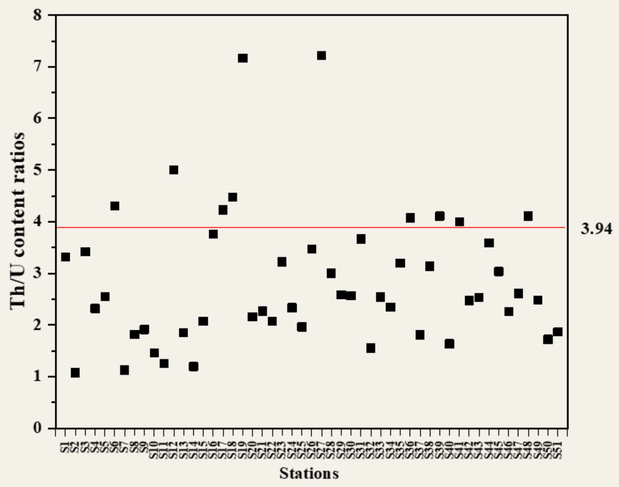

Fig 3.: ^{232}Th/^{238}U content ratios from stream sediments of 51 stations in Seila area. Comparison with the world average (3.94)

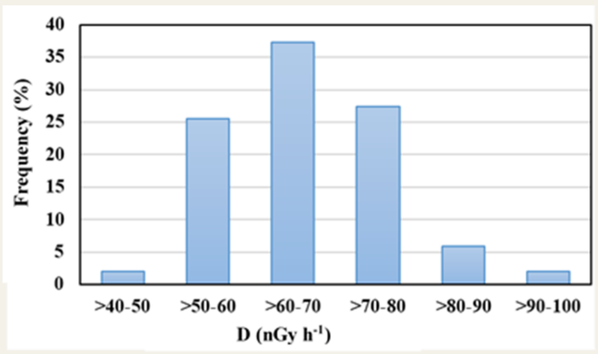

Fig 4: Frequency distribution of the absorbed dose rates of the measured stations in Seila area.

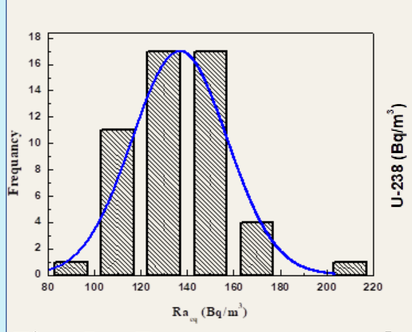

Fig 5: Frequency normal distribution of Raeq for all samples under investigation.

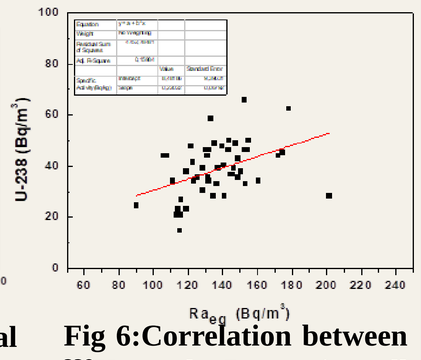

Fig 6:Correlation between ^{238}U and Raeq in all measured sites.

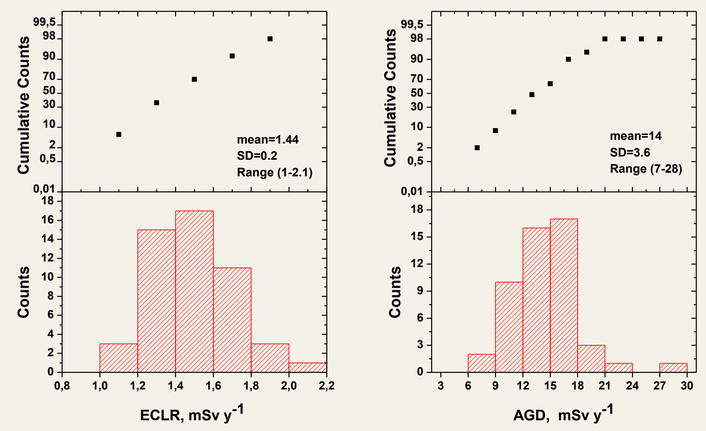

Fig 7: Excess lifetime cancer risk (ELCR) and the annual gonadal dose (AGED) distributions.

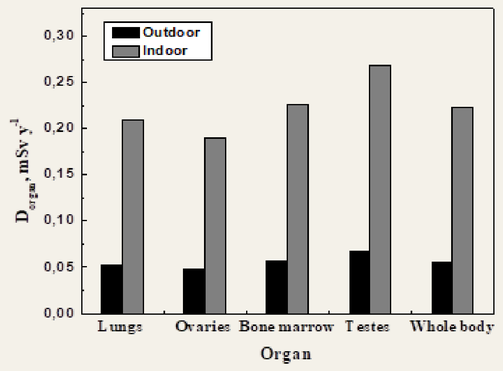

Fig 8: The effective dose rate delivered to the particular organs (Lungs, Ovaries, Bone marrow. Testes and Whole body) from air dose indoor and outdoor.

Risk assessment

In the studied areas, the radiological risk is very low according to the data which showed that the exposure time for public due to natural radioactive over 1 m from the ground. The obtained results were clarified that the average annual effective dose in the studied areas (0.08 mSv) is lower than the reference level 0.3-1 mSv (UNSCEAR, 2010). So, it is safe for the shepherds and camels around this area., population living and can be used as a building raw materials or other human activities without any radiological risk.

Conclusion

From the experimental and computational work on natural radioactivity of Seila area, Egyptian south eastern desert, we can conclude the following;

1. The Seila area, south eastern desert, Egypt contain ^{238}Uand ^{40}K radionuclides with activity concentrations higher and comparable than the set world limits.
2. The ^{232}Th activity concentration is lower than the set world limits
3. The radium equivalent activity is less than the world limit.
4. In general, the hazard indices, not all the level indices and the activity utilization indices are less than the world set criteria.
5. Internal hazard indices (H_{in}) in all measured points are found to be more than unity then it exceeds the upper limit of exposure.
6. Males more affected than females with radiation during the testes have a highest radiation sensitivity while ovaries have a lowest radiation sensitivity

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