Estimation of Radioecological Parameters of Soil Samples in Phosphatic Area

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Introduction

Phosphate rocks contain relatively high concentration of naturally occurring radioactive materials from the uranium and thorium decay series (Hamdy, A., 2002).

Objectives

- Content measurements of the naturally occurring radioactive materials (NORM) Ra-226, Th-232 and K-40 in soil
- Calculation of radium equivalent activity
- Calculation of dosimetric parameters
- Calculation of radiation hazard indices
- Recommendations

Area under investigation

Material and methods
Sample collection and preparation

- Thirty-one samples were collected from different locations - El-Sebaya - Egypt.
- Systematically random sampling was carried out with profile depth ranges from 0-30 cm.

Gamma Spectrometry

- The specific activity in Bq/kg of Ra-226, Th-232, K-40 were measured by using HPGe detector.
- The relative efficiency was 40% and energy resolution of 2 keV at gamma ray energy of 1332 keV of $^{60}$Co.
- LABSOCS efficiency calibration software, mathematical efficiency calibration software and software program (Genic 2000) are installed. By using this software, the activity concentrations of the samples were calculated. The natural background level was subtracted.

Calculations

1. Activity concentrations $A_{IE}$

$$A_{IE} = \frac{N_{IE}}{I_p \times \varepsilon_E \times m_s \times T}$$

2. Radium equivalent $Ra_{eq}$

$$Ra_{eq} = (A_{Th} \times 1.43) + A_{Ra} + (A_k \times 0.077)$$

3. Absorbed Dose rate $D(nGy/h)$

$$D(nGy/h) = 0.462A_{Ra} + 0.604A_{Th} + 0.042A_k$$

4. Annual effective dose rate outdoors and indoors $D_{out/in}$

$$D_{out/in} = D \times C_f \times C_T$$
5) External radiation hazard index $H_{ex}$

$$H_{ex} = \frac{A_{Ra}}{370} + \frac{A_{Th}}{259} + \frac{A_{K}}{4810} \leq 1$$

6) Internal radiation hazard index $H_{in}$

$$H_{in} = \frac{A_{Ra}}{185} + \frac{A_{Th}}{259} + \frac{A_{K}}{4810} \leq 1$$

7) Representative level index $I_{\gamma}$

$$I_{\gamma} = \frac{A_{Ra}}{150} + \frac{A_{Th}}{100} + \frac{A_{K}}{1500}$$

Results and Discussion

![Ra-226](image1.png)

![Th-232](image2.png)

![K-40](image3.png)

Table 1: Activity concentration in soil samples in El-Sebaya and other different countries (Bq/kg)

<table>
<thead>
<tr>
<th>Country</th>
<th>$^{226}$Ra</th>
<th>$^{232}$Th</th>
<th>$^{40}$K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Egypt</td>
<td>17</td>
<td>18</td>
<td>320</td>
</tr>
<tr>
<td>India</td>
<td>5-64</td>
<td>2-96</td>
<td>29-570</td>
</tr>
<tr>
<td>Ghana</td>
<td>13-6</td>
<td>24-32</td>
<td>47-352</td>
</tr>
<tr>
<td>Serbia</td>
<td>39.6</td>
<td>51.5</td>
<td>545</td>
</tr>
<tr>
<td>Armenia</td>
<td>21.5-31</td>
<td>42-66</td>
<td>36-73</td>
</tr>
<tr>
<td>Egypt</td>
<td>215-53</td>
<td>27.4-49</td>
<td>504-764</td>
</tr>
<tr>
<td>Egypt</td>
<td>22.2</td>
<td>23.2</td>
<td>218.6</td>
</tr>
</tbody>
</table>

Ref. [current study.]

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Radium equivalent activity (Ra$_{eq}$)

The obtained values of Ra$_{eq}$ ranged from 53.58±7.94 Bq/kg to 95.75±6.04 Bq/kg with an average of 70.35±7.15 Bq/kg. The minimum and maximum values are SW7 and SE21, respectively. All soil samples recorded radium equivalent levels far below the limit (370 Bq/kg) (OECD, 1979). Therefore, the soil is safe and suitable for use for agriculture and building materials.

Table 2: the absorbed dose rate from soil samples are compared with those published worldwide.

<table>
<thead>
<tr>
<th>Country</th>
<th>Absorbed dose rate (nGy/h)</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jordan</td>
<td>40.12</td>
<td>Abu-Haita, O., 2012</td>
</tr>
<tr>
<td>Malaysia</td>
<td>88</td>
<td>Almayahi, B., 2012</td>
</tr>
<tr>
<td>India</td>
<td>71.5</td>
<td>Mahur, A., et al, 2012</td>
</tr>
<tr>
<td>UK</td>
<td>85.3</td>
<td>Santawamatre, T., et al, 2011</td>
</tr>
<tr>
<td>Egypt</td>
<td>32.6</td>
<td>Current results</td>
</tr>
</tbody>
</table>

Conclusions and recommendations

1. Thirty one soil samples with different texture collected from El-Selyea, Aswan, revealed clear concentrations of natural radionuclides ($^{226}$Ra, $^{232}$Th and $^{40}$K).
2. The radioactivity concentrations of $^{226}$Ra, $^{232}$Th are close to the results published by UNSCEAR 2000 for soil samples from Egypt.
3. The radium equivalent is less than the limit (370 Bq). Therefore, the soil is safe and suitable for use for agriculture and building materials.
Recommendation

- Although there are no significant values but it is highly recommended to continue investigating this area to study the dynamics and the variation of the background radiations due to the existence of phosphate industries around.
- From the point of view of radiation protection, the human health hazards due to the exposure of low doses from ionizing radiations should be considered from long-term irradiation due to the mining operations.

Thanks for your attention

Any Query?