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Editorial

We start this pioneering work, which do not seek perfection as much as aiming to provide a scientific window that opens a wide area for all the distinctive pens, both in the University of Sabratha or in other universities and research centers. This emerging scientific journal seeks to be a strong link to publish and disseminate the contributions of researchers and specialists in the fields of applied science from the results of their scientific research, to find their way to every interested reader, to share ideas, and to refine the hidden scientific talent, which is rich in educational institutions. No wonder that science is found only to be disseminated, to be heard, to be understood clearly in every time and place, and to extend the benefits of its applications to all, which is the main role of the University and its scholars and specialists. In this regard, the idea of issuing this scientific journal was the publication of the results of scientific research in the fields of applied science from medicine, engineering and basic sciences, and to be another building block of Sabratha University, which is distinguished among its peers from the old universities.

As the first issue of this journal, which is marked by the Journal of Applied Science, the editorial board considered it to be distinguished in content, format, text and appearance, in a manner worthy of all the level of its distinguished authors and readers.

In conclusion, we would like to thank all those who contributed to bring out this effort to the public. Those who lit a candle in the way of science which is paved by humans since the dawn of creation with their ambitions, sacrifices and struggle in order to reach the truth transmitted by God in the universe. Hence, no other means for the humankind to reach any goals except through research, inquiry, reasoning and comparison.

Editorial Committee

Notice

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Publications are arranged according to technical considerations, which do not reflect the value of such articles or the level of their authors.

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Publication instructions

The journal publishes high quality original researches in the fields of Pure Science, Engineering and Medicine. The papers can be submitted in English or Arabic language through the Journal email (jas@sabu.edu.ly) or CD. The article field should be specified and should not exceed 15 pages in single column.

All submitted research manuscripts must follow the following pattern:

- Title, max. 120 characters.
- Author Name, Affiliation and Email
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- Keywords, max. 5 words.
- Introduction.
- Methodology.
- Results and Discussion.
- Conclusion.
- Acknowledgments (optional).
- References.

Writing Instructions:

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Invitation

The Editorial Committee invites all researchers "Lectures, Students, Engineers at Industrial Fields" to submit their research work to be published in the Journal. The main fields targeted by the Journal are:

- Basic Science.
- Medical Science & Technology.
- Engineering.

Refereeing

The Editorial Committee delivers researches to two specialized referees, in case of different opinions of arbitrators the research will be delivered to a third referee.

Editorial Committee

CONTENTS

ASSESSMENTS OF RADIOACTIVITY CONCENTRATION LEVELS FOR NATURAL RADIONUCLIDES IN SOIL SAMPLES FROM ZLITEN

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Abstract

The aim of this study is to determine the activity concentration of the natural radionuclides ^{40}K, ^{232}Th, and ^{226}Ra in Zliten City, Libya, using gamma spectrometry based on a High Purity Germanium (HPGe) detector. Eight samples from different locations in the study area were randomly collected and measured. The activity concentrations of natural radionuclides were found to vary from 168.399 to 678.529 Bq/kg with an average of the measured concentrations for ^{40}K, and vary from 21.876 to 228.222 Bq/kg with an average Bq/kg for ^{232}Th, and for ^{226}Ra ranged were vary from 7.672 to 29.069 Bq/kg with an average Bq/kg. the average absorbed dose rate in air 103.60nGh^{-1}, the average value of radium equivalents was 246.132 Bq.Kg^{-1}, the average value of the external hazard indices was 0.252 and the average value of the internal hazard indices was 0.709. The results of the present study were discussed and compared with internationally recommended values.

Keywords: Radioactivity; High Purity Germanium (HPGe) detector; Gamma Ray Spectrometry.

Introduction

Since the beginning of time, humans have been exposed to natural radiation, which is present in all environmental materials, including soil. The presence of radionuclides in soil can originate from various sources, including natural processes and human activities such as nuclear testing, industrial applications, medical practices, and nuclear technology (Khan A.J, et al, 1992).

This radioactivity originates from the decay of naturally-occurring radioactive isotopes, such as potassium-40, thorium-232, and uranium-238. the radioactivity and their daughter in soil and building materials product dangers effect to the human health (R. Obid Hussain, E.Kadum. Abbas, 2010). Monitoring and studying the behavior of the natural radiation in soil helps assess the potential radiation exposure to human (N. M. Hassan, et al, 2018).

Since natural radiation is the largest contributor of external dose to the world population, gamma radiation dose from natural sources is important. The concentration of ^{232}Th, ^{226}Ra and ^{40}K varies considerably depending on the type of soil formation (Saleh, A. M., et al, 2013). So, the measurements of natural radioactivity in soil samples are required to determine any changes of natural background activity with time as the result of any nuclear activity (IAEA, 1989). Numerous researchers have studied natural radioactivity in soil (G. Chinnadurai, et al, 2021; S.Y.L Mouandza, et al, 2018; Gyuk,P.M, et al, 2017). The aim of this work is to determine the activity concentration of the natural radionuclides ^{40}K, ^{232}Th, and ^{226}Ra in soil samples collected from different areas of Zliten city Libya

Materials and Methods

Sample Collection and Preparation

A total of eight soil samples were collected from randomly chosen locations across Zliten City. Zliten is located approximately 160 km west of Tripoli, the capital city of Libya. The samples were collected from the soil surface at a depth of 2–3 cm, and the coordinates of the sampling locations were recorded using a Global Positioning System (GPS). The details of these coordinates are presented in Table (1).

Table (1): GPS Location of the Sampling Points.

Sample no.	Sample ID	Latitude	Longitude
1	A	32.449642N	14.590818E
2	B	32. 43216N	14.699759E
3	C	32.361691N	14.583635E
4	D	32.2078217N	14.5026458E
5	E	32.0978002N	14.3156710E
6	F	32.317459 N	14.493403E
7	G	32.418188N	14.479722E
8	H	32.477162N	14.501761E

All of the soil samples were weighed and then dried in an electric oven for 24 hours at 120°C. The samples were placed in Marinelli beakers and stored for 45 days to achieve secular radioactive equilibrium.

Energy and Efficiency Calibrations of the Detector

The activity concentration of ^{40}K, ^{232}Th, and ^{226}Ra in soil samples were determined by using High Pure Germanium Detector (HPGe) with relative Efficiency 25 %, and an energy resolution of 1.92 keV for the 1332.5 keV of ^{60}Co gamma lines.

The energy calibration of the detector was carried out by using ^{137}Cs (661.62 keV), and ^{60}Co (1173.23 and 1332.51 keV) point sources. The detector efficiency calibration curve as a function of energy for solid matrix is shown in Figure (1).

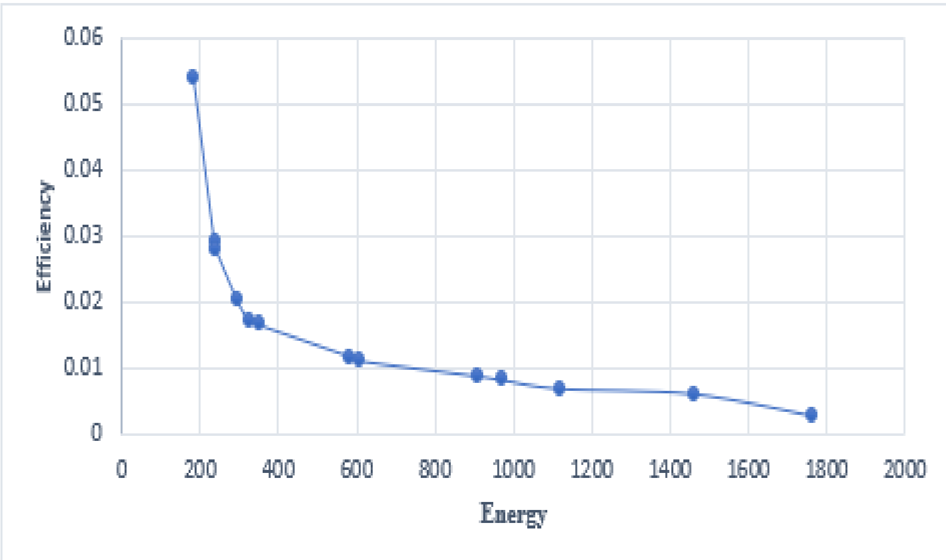

Figure (1): The Efficiency Calibration Curve for HPGe Detector as a Function of Energy.

Activity concentrations

The Activity concentrations of ^{40}K, ^{232}Th, and ^{226}Ra in eight soil samples were determined by using a Gamma ray spectrometry system using a High Purity Germanium HPGe detector. The activity concentration of ^{40}K were determined directly from the 1460 keV gamma line, but for ^{232}Th the activity concentration was determined using the 238.6 keV photopeaks of ^{212}Pb, 583.14 keV photopeak of ^{208}Tl, and 911.07 keV, and 968.9keV photopeaks of ^{228}Ac. The activity concentration of ^{226}Ra were determined by using the 295.2 and 351.9 keV photopeaks of ^{214}Pb, the 609.3, 1120.3, 1764.51 keV photopeak of ^{214}Bi.

The activity concentration of all soil samples was determined by using the following formula (S. Harb, et al, 2008).

$$A((Bq\text{Kg}^{-1}) = \frac{C_a}{Eff.m.I_\gamma} \qquad (1)$$

Where A is the activity concentration, C_a is the net gamma counts per second, Eff is the efficiency of the specific gamma-ray, I_γ is Absolute intensity of the gamma ray, and m is the mass of the soil sample in kilograms.

Absorbed dose rate in air

The Absorbed dose rate in air calculated at 1 meter above the ground level by using the measured activity concentrations of ^{226}Ra, ^{232}Th, and ^{40}K by the following equation (UNSCEAR, 2008; Varshney R, et al, 2010):

$$\mathbf{D_r(nGyh^{-1}) = 0.462\ A_{Ra} + 0.604\ A_{Th} + 0.0417\ A_K} \qquad (2)$$

Where $\mathbf{D_r}$ is the dose rate, 0.462, 0.604 and 0.0417 are the dose conversion factors for naturally (DRCF), A_{Ra}, A_{Th}, and A_K are the activity concentrations of ^{226}Ra, ^{232}Th, and ^{40}K in Bq. kg^{-1}, respectively.

Radium Equivalent Activity

The radium equivalent activity $\mathbf{R_{eq}}$ calculated by following equation (José A., et al, 2005):

$$\mathbf{R_{eq}}\ (Bq.Kg^{-1}) = \mathbf{A_{Ra} + 1.43A_{Th} + 0.077A_K} \qquad (3)$$

The risk of specific activity could be estimate by using the radium equivalent activity.

External and Internal Hazard Index

The external and internal hazard index for each sample was calculated by following equation (Xinwei L, 2005; Beretka, J.; Mathew, P. J., 1985):

$$\mathbf{H_x} = \frac{A_{Ra}}{370} + \frac{A_{Th}}{259} + \frac{A_K}{4810} \leq 1 \qquad (4)$$

$$\mathbf{H_{in}} = \frac{A_{Ra}}{185} + \frac{A_{Th}}{259} + \frac{A_K}{4810} \leq 1 \qquad (5)$$

Where $\mathbf{H_x}$, $\mathbf{H_{in}}$ are the external and internal hazard index, respectively.

Results and Discussion

The varying distribution of the assessed activity concentrations in radionuclides in soil samples in the Zliten City are presented in Table (2). The activity concentration of ^{40}K, ^{232}Th and ^{226}Ra in the soil samples ranges from (168.40±6.74 to 678.53±27.14) Bq/kg, (21.88±0.88 to 228.16±9.13) Bq/kg and (7.67±0.3 to 29.07±1.16) Bq/kg respectively.

The average of the soil samples was 435.92±17.44 for ^{40}K, 137.11±5.49 for ^{232}Th, and 14.43±0.66 for ^{226}Ra. Which show that the ^{40}K radionuclide is most predominant followed by the is ^{232}Th and then ^{226}Ra. This shows that the trend in the activity concentrations is ^{40}K> ^{232}Th>^{226}Ra.

Table (2): The Specific Activity of Natural Radionuclides of ^{232}Th, ^{226}Ra, and ^{40}K for a Total of 8 Soil Samples.

Sample no.	Soil simple	Activity		
		^{40}K (Bq.kg^{-1})	^{232}Th (Bq.kg^{1})	^{226}Ra (Bq.kg^{-1})
1	A	168.40±6.74	95.76±3.83	7.67±0.3
2	B	292.19±11.68	177.13±7.09	14.36±0.57
3	C	571.73±22.87	218.22±8.73	16.66±0.67
4	D	514.9±20.60	228.16±9.13	16.68±0.67
5	E	499.46±19.98	21.88±0.88	23.46±0.94
6	F	678.53±27.14	41.25±1.65	29.07±1.16
7	G	391.4±15.65	168.77±6.75	13.29±0.53
8	H	370.71±14.83	145.70±5.83	10.92±0.44
Average± S.D		435.92±17.44	137.11±5.49	14.43±0.66

From Table (2), it was found that the specific activities of ^{40}K for A, B, G and H samples were less than the worldwide average (UNSCEAR, 2008), and for C, D, E, and F samples were found to be higher than the worldwide average (420 Bq/kg) (UNSCEAR, 2008). While it is clear that the specific activities for ^{232}Th, with the exception of E, and F samples were found to be higher than the worldwide average (45 Bq/kg) (UNSCEAR, 2008). While all values of specific activity of ^{226}Ra were less than the worlds average activity that recommended by UNSCEAR 2008 (32 Bq/kg) (UNSCEAR, 2008).

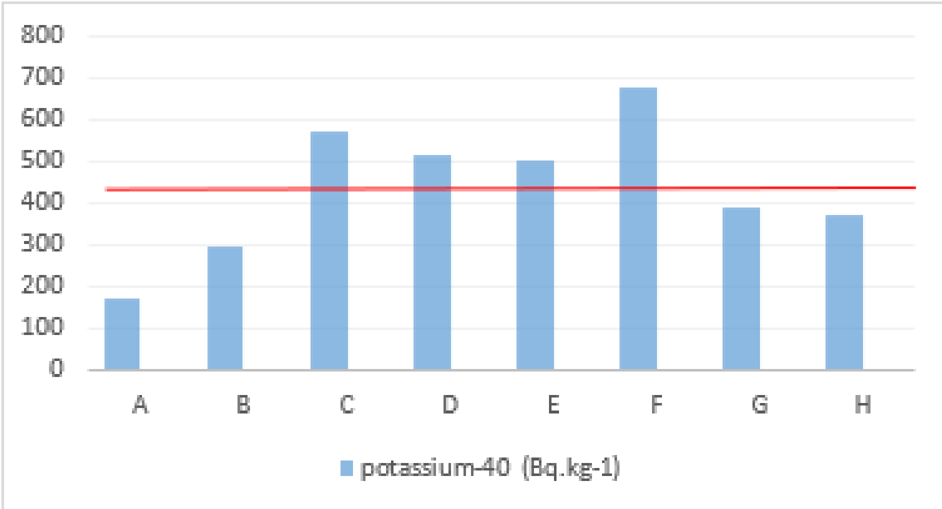

Figure (2): Comparing of Specific Activity for ^{40}K in All Soil Samples.

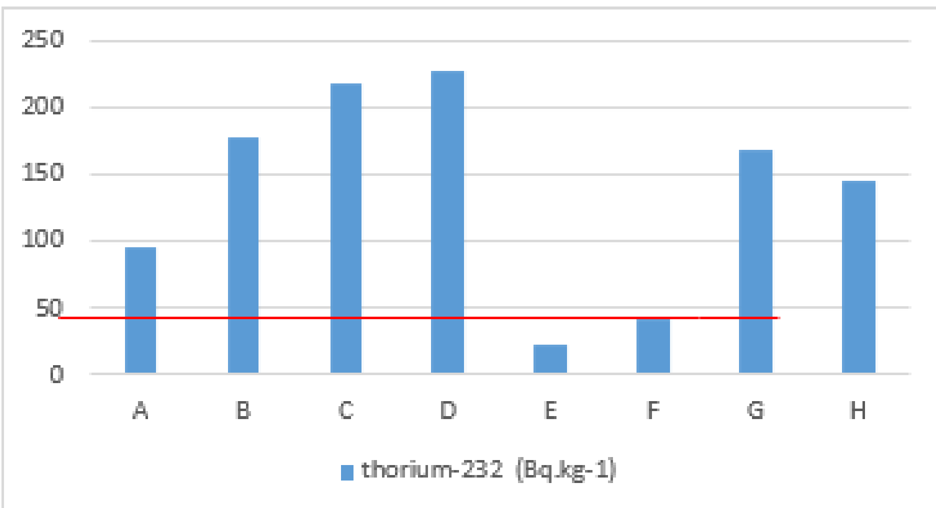

Figure (3): Comparing of Specific Activity for ^{232}Th in All Soil Samples.

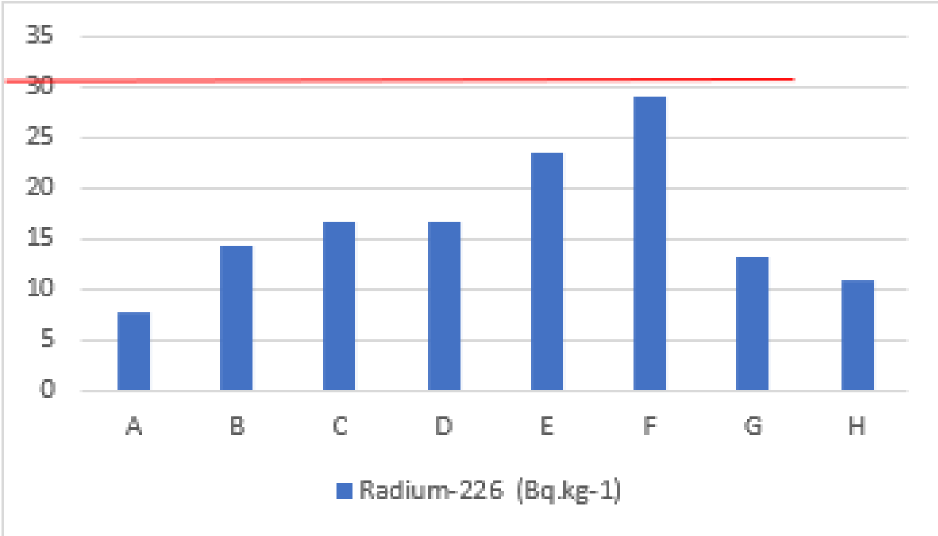

Figure (4): Comparing of Specific Activity for ^{226}Ra in All Soil Samples

The absorbed dose rate in air $\mathbf{D_r}$, the radium equivalent activity $\mathbf{R_{eq}}$, the external hazard index $\mathbf{H_x}$ and internal hazard index $\mathbf{H_{in}}$ were calculated and presented in Table (3), and Figures (5), (6).

Table (3): The D_r, R_{eq}, H_x, and H_{in} for a Total of 8 Soil Samples.

Sample no	Code sample	D_r(nGyh^{-1})	$R_{eq}\left(Bq.kg^{-1}\right)$	H_x	H_{in}
1	A	68.40	157.574	0.425	0.446
2	B	125.81	290.155	0.783	0.822
3	C	141.89	372.738	1.006	1.051
4	D	166.99	382.527	1.033	1.078
5	E	26.14	93.207	0.252	0.315
6	F	66.64	140.304	0.379	0.457
7	G	124.40	284.738	0.769	0.805
8	H	108.51	247.816	0.669	0.699
Average		103.60	246.132	0.665	0.709

The maximum value of the absorbed dose rate in air 166.99 nGyh^{-1}, and the minimum value was 26.14 nGyh^{-1} with an average 103.60 nGyh^{-1}. The maximum value of the radium equivalents was 382.527 Bq.Kg$^{-1,}$ and the minimum value was 93.207 Bq.Kg^{-1} with an average 246.132 Bq.Kg^{-1}. The maximum value of the external hazard indices was 1.033, and the minimum value was with an average 0.252. The maximum value of the internal hazard indices was 1.078, and the minimum value was 0.315 with an average 0.709.

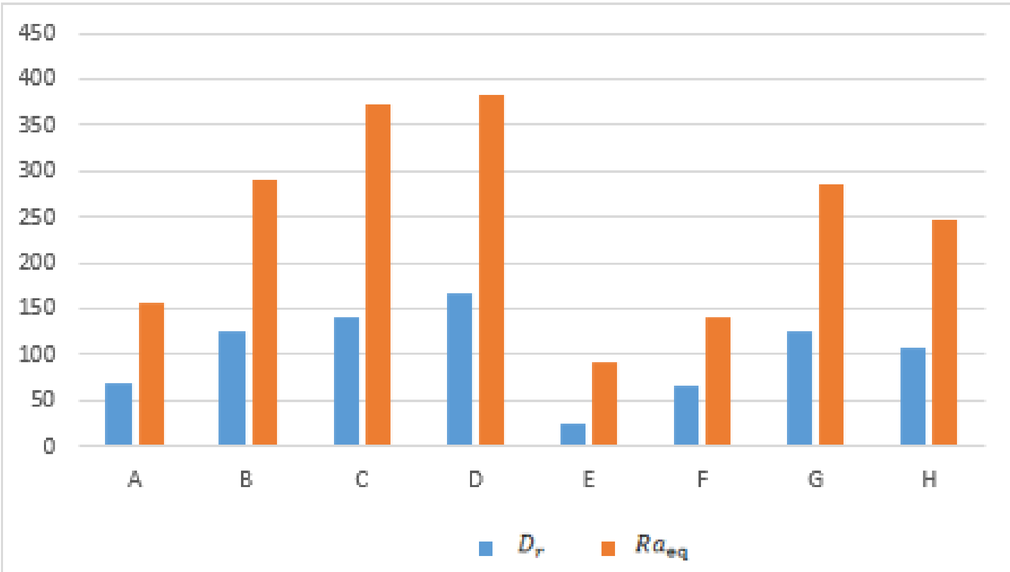

Figure (5): The Dose rate D_r(nGyh^{-1}), and the Radium Equivalent Activity Ra_{eq} (Bq.Kg^{-1}) for the Soil Samples.

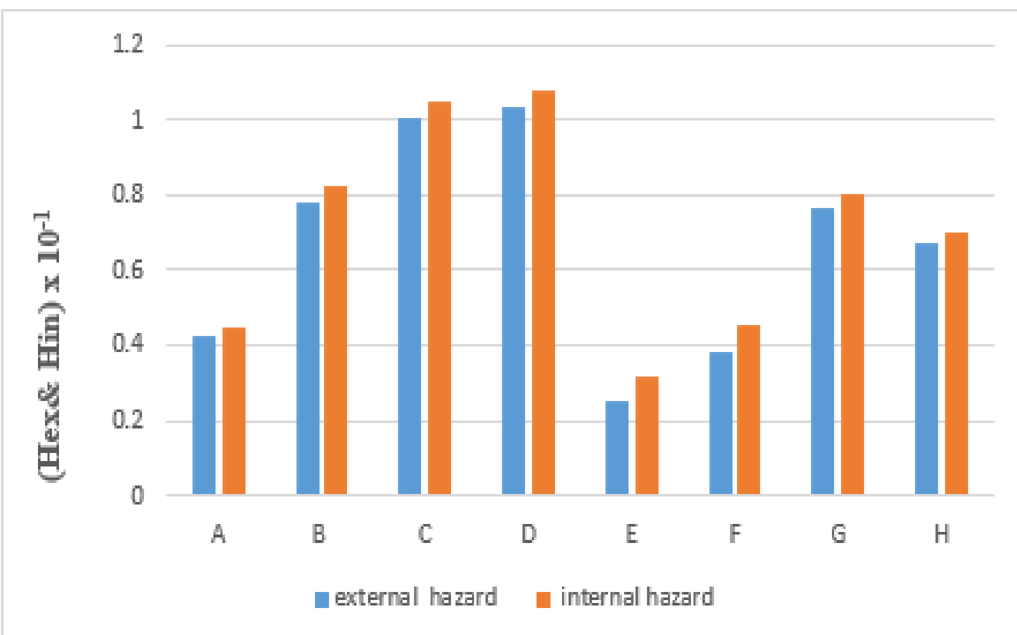

Figure 6: The External and Internal Hazard Index for the Soil Samples

Conclusion

The activity concentrations for soil samples collected from eight locations in different areas chosen randomly around Zliten City were calculated by using High Purity Germanium detector. The activity concentrations of ^{40}K for A, B, G and H samples were less than the worldwide average but for C, D, E, and F samples were found to be higher than the worldwide average (420 Bq/kg), for ^{232}Th only E, and F samples found to be less than the worldwide average (45 Bq/kg), while the activity concentration of ^{226}Ra were less than the worlds average activity that recommended by UNSCEAR 2008 (32 Bq/kg).

Acknowledgements

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