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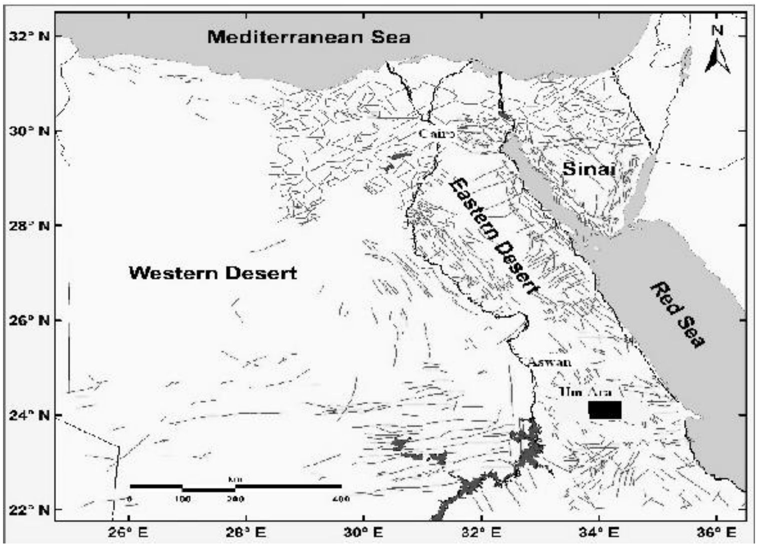

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RESEARCH ARTICLE

ESTIMATION OF RADON CONCENTRATION FOR GRANITE ROCKS SAMPLES USING LR-115 DETECTOR

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ABSTRACT

Solid state nuclear track detectors have become an important tool in every investigation of radon levels in the surrounding environment. In the present work radon concentration and radon exhalation rate were measured using an alpha track detector (LR-115 type II) in forty three samples of different types of granite rocks were collected from Um Ara, South Eastern Desert, Egypt. From the obtained results the average values of radon concentrations for Western Trenches ranged from 4051.67 ± 98.87 to 16396.15 ± 154.54 Bqm^{-3} and the average values of radon concentration varied from 4638.68 ± 82.54 to 13381.30 ± 174.65 Bqm^{-3} for the Eastern Trenches. The obtained results show that the radon concentrations of the samples are higher than the recommended world limit of ICRP. The present study is important to detect any change in radioactivity background level in the studied area and to establish a data base for granite rocks.

INTRODUCTION

Radon is a natural noble gas has three main natural isotopes namely, radon (^{222}Rn) decay product of ^{238}U series, thoron (^{220}Rn) produced from decaying of ^{232}Th series and ^{219}Rn a decay product from the chain originating with ^{235}U (Karim *et al*., 2012). Radon and its daughter products may pose a significant health hazard, especially when concentrated in some enclosed areas such as underground mines, caves, and cellars or poorly ventilated and badly designed houses (Singh *et al*., 2006). Terrestrial radiation is due to various radioactive nuclides that are present in soil, water, air and their abundance changes depending on the geological and geographical features of the region (UNSCEAR, 2000). Lung cancer, skin cancer and kidney diseases are the hazards caused by the inhalation of radon decay products. The radiological impact caused by nuclides is due to radiation exposure of the body by the gamma rays and irradiation of the lung tissues from inhalation of radon and its progeny (Shoeib and Thabayneh, 2014). Igneous rocks such as granite contain high quantities of natural radionuclides ^{232}Th, ^{238}U, ^{40}K and small quantities are associated with sedimentary rocks. Granitic rocks mainly composed of coarse grains of quartz, K-feldspar, plagioclase and mafic minerals like biotite and amphibole. In addition, there are other common accessory minerals in granites, namely zircon, sphene, apatite and allanite (Pourimani *et al*., 2014). Granite's durability and decorative appearance make it a popular building material in homes and buildings. Any type of rock could contain naturally occurring radioactive elements like radium, uranium and thorium. Some pieces of granite contain more of these elements than others, depending on the composition of the molten rock from which they formed (Uosif *et al*., 2015). Granite like other natural rocks contain ^{238}U which decay producing ^{222}Rn by emitting alpha and the radon is launched into the pore spaces and enters into the internal environment. It is a form of igneous rock, which is composed primarily of Quartz, Alkali and Feldspar. Its characteristically contains more than 70% silica and relatively high soda and potash, which ranges from 5 to 12% MgO content is usually lower than 1% (Rafique *et al*., 2013).

In the present study, granite rock samples were collected from the surface of locations in Um Ara area is a part of the Eastern Desert about 180 Km southeast Aswan city, west the Red Sea as shown in (Fig. 1). These samples were collected randomly according to color and texture of the rocks from different regions. The sampling locations divide into two parts; West Trenches (T1, T2, T3, T4, T5, T6, T7, T8, T9 and T10) and Eastern Trenches (T11, T12, T13, T14, T15 and T16) are shown in (Fig. 2). The passive technique (Alpha track detector) is widely applied for measuring the total indoor radon level. LR-115 detector has several characteristics, very sensitive to

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alpha particles only, can be used for short-term and long-term, insensitive to environmental changes such as humidity and suitable for radon measurements in stagnant or flowing water and in oil (Nidal *et al*., 2007).

The present study is aimed to determine the radon concentrations, radon exhalation rate and annual effective dose of granite rock samples were collected from Um Ara area, south Eastern Desert, Egypt. In order to detect any harmful radiation that would affect the radioactivity background levels this, can be used as reference information to assess any changes in the radioactive background level.

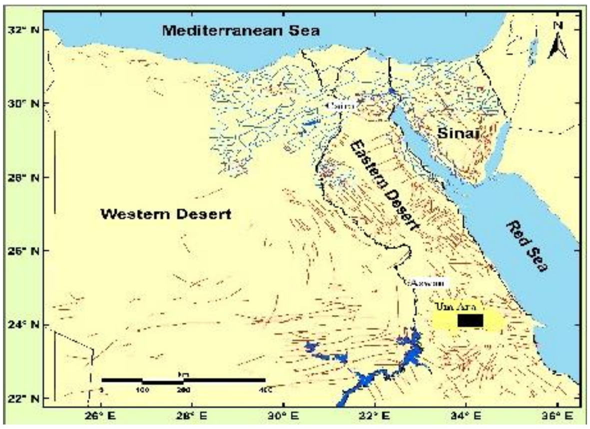

Figure 1 The location map of Um Ara area, south Eastern Desert, Egypt

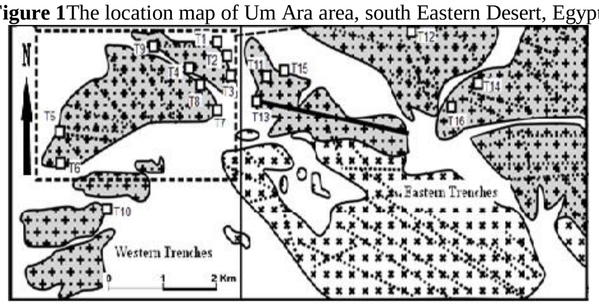

Figure 2 The location map of the Eastern and Western Trenches of Um Ara area

MATERIALS AND METHODS

Passive technique (Can technique) with LR-115 type II detector was used to determine the radon concentration, radon exhalation rate annual effective dose of forty three samples of different types of granite rocks was collected from Um Ara, South Eastern Desert, Egypt. The samples collected from Western Trench, which consists of 30 samples and Eastern Trench, which consists of 13 samples. Worth area of study cover ten Km^2 and the distance between each sample and other about 100 to 300 meters.

The samples were crushed to a grain size 1 mm, dried in oven at 110°C for 4 hours, minced and sieved. The samples were weighted, placed into sample containers and carefully sealed for 60 days in of plastic containers with dimensions of 16 cm in depth and 9.5 cm in diameter. The plastic container of the sample was capped tightly by an inverted cylindrical plastic cover as shown in (Fig. 3). A piece of LR-1115 type II detector of area (1.5 x1.5) cm^2, the detectors were fixed on the bottom of the lid of each container with tape such that sensitive side of the detector faced the specimen. After the exposure time the detectors were collected and etched in NaOH solution 2.5N at 60°C for 1hr.

After etching the LR-115 detectors were washed in distilled water and wash time make a final rinse in distilled water and ethyl alcohol solution (1:1) during 2 minutes at room temperature and dried in air. The track density was determined using an optical microscope with magnification 640, which calibrated before usages. The background of LR-115 track detector was counted using an optical microscope and subtracted from the count of all detectors. Radon concentration in the samples was calculated using the following formula (Hafez *et al*., 2001; Hesham *et al*., 2015):

$$C_{Rn} = \frac{\rho}{\eta T} \quad (1)$$

Where, C_{Rn} is radon concentration (Bqm^{-3}), ρ is the track density (track.cm^{-2}), T is the exposure time (day) and η is the calibration coefficient of LR-115 detector in (α-tracks cm^{-2}day^{-1}/Bqm^{-3}) of radon (Sarma , 2013). The surface exhalation rate (Bqm^{-2}h^{-1}) in the building material samples was calculated using the following formula:

$$E_A = \frac{CV\lambda}{AT_{eff}} \quad (2)$$

Where, E_A is the surface exhalation rate in (Bqm^{-2}h^{-1}), C is the integrated radon exposure in (Bqm^{-3}h), λ is the decay constant of radon (h^{-1}), V is the effective volume of the cup (m^3), A is the cross section area of the can (m^2) and T_{eff} is the effective exposure time (Mohamed, 2012; Hesham *et al*., 2015). The mass exhalation rate (Bqkg^{-1}h^{-1}) in the building material samples is calculated using the following formula:

$$E_M = \frac{CV\lambda}{MT_{eff}} \quad (3)$$

Where, E_M is the mass exhalation rate in (Bqkg^{-1}h^{-1}) and M is the mass of the sample (kg) (Mohamed, 2012). Working levels are used to express the concentrations of radon daughters in underground mines for compliance sampling. It is calculated by the general formula:

$$WL = \frac{C.F}{3700} \quad (4)$$

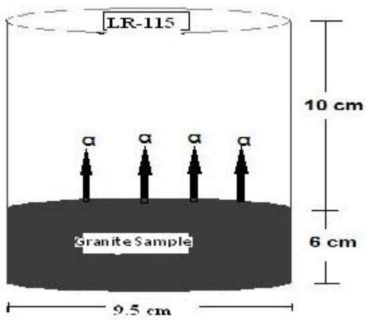

Figure 3 The sample container

Where, C is radon concentration in Bqm^{-3} (Mamta *et al*., 2011) and F is the equilibrium factor and the value of F was taken to be 0.4 as recommended by (UNSCEAR, 2000).

RESULTS AND DISCUSSION

The values of radon concentration depend on many physical properties of the sample, like the chemical composition, porosity and bulk density of the samples. The values of radon concentration, surface exhalation rate, mass exhalation rate and working level for the granite samples were calculated using LR-115 detector as shown in Table 1, for the samples of Western Trenches. Also Table 2, gives the values of radon concentration, surface exhalation rate, mass exhalation rate and working level for the granite samples of Eastern Trenches. But the average values of radon concentration, surface exhalation rate, mass exhalation rate and working level of the Eastern and Western Trenches are given by Table 3. Where the average values of radon concentration for the Western Trenches varied from 4051.67 ± 98.87 to 16396.15 ± 154.54 Bqm^{-3} and the mean value equal 8001.84 ± 136.76 Bqm^{-3}, surface exhalation rate ranged from 4.71 ± 0.11 to 19.08 ± 0.22 $Bqm^{-2}h^{-1}$, mass exhalation rate varied from 48.48 ± 0.98 to 197.00 ± 2.50 $mBqkg^{-1}h^{-1}$ and the average values of working level ranged from 0.44 ± 0.012 to 1.77 ± 0.025. (Fig. 4), shows the relation between trench number and the average values of radon concentration for the Western Trenches of Um Ara area. From the figure we find that the average values of radon concentration in trench (T3) is high. This means that the values of radon concentration high in this position due to increasing the values of uranium concentration, so that we can save costs and the dig time and concern the dig in this position because, its rich by granite has high uranium concentration and not the trench safe for human, so that the workers must use personal protective masks to protect themselves from inhalation radon. But and trench (T2) has a low value of radon concentration due to this point has a low value uranium concentration. This means that the granite rocks in this position are possible to use as a building material. The correlation relation between the average values of radon concentration and the surface exhalation rate for the Western Trenches given by (Fig.5) and equal (R^2=1). It is a good agreement between measurements of radon concentration and surface exhalation rate. The correlation coefficient is linear because the values of exhalation rate depend on radon concentration since the volume of Can, the area of the sample and decay constant of radon are the same for all samples. A positive correlation has been observed between radon concentration and the exhalation rate in granite samples. Study of radon exhalation is important for understanding the relative contribution of the material to the total radon concentration found in the granite samples and helpful to study radon health hazard. (Fig.6), gives the correlation relation between the average values of radon concentration and the mass exhalation rate for the Western Trenches and equal (R^2= 0.99).

In the case of the Eastern Trenches, the average values of radon concentration varied from 4638.68 ± 82.54 to 13381.30 ± 174.65 Bqm^{-3} and the mean value equal 8665.72 ± 89.75 Bqm^{-3}, surface exhalation rate ranged from 5.40 ± 0.11 to 14.23 ± 0.32 $Bqm^{-2}h^{-1}$, mass exhalation rate varied from 58.70 ± 1.14 to 153.60 ± 2.54 $mBqkg^{-1}h^{-1}$ and the average values of working level ranged from 0.50 ± 0.01 to 1.44 ± 0.04. (Fig.7), shows the relation between trench number and the average values of radon concentration for the Eastern Trenches of Um Ara area.

Table 1 The values of radon concentration (C_{Rn}), surface exhalation rate (E_A), mass exhalation rate **(**E_M) and working level (WL) for the Western Trenches of Um Ara area

Trench No.	Sample No.	C_{Rn} (Bqm^{-3})	E_A ($Bqm^{-2}h^{-1}$)	E_M ($mBqkg^{-1}h^{-1}$)	WL
	1	6651.27 ±124.19	7.74 ± 0.14	79.18 ± 1.48	0.72 ± 0.014
T1	2	18468.16 ±190.04	21.49 ± 0.24	225.00 ± 2.44	1.99 ± 0.021
	3	4302.28 ± 98.76	5.01 ± 0.12	52.04 ± 1.20	0.46 ± 0.010
	4	629.51 ± 36.75	0.73 ± 0.05	7.44 ± 0.46	0.07 ± 0.004
T2	5	2521.66 ± 76.14	2.93 ± 0.09	29.01 ± 0.86	0.27 ± 0.007
	6	9003.85 ± 136.14	10.48 ± 0.17	109.00 ± 1.74	0.97 ± 0.015
	7	24230.91 ± 224.87	28.20 ± 0.27	296.00 ± 2.85	2.62 ± 0.022
T3	8	12806.12 ± 165.34	14.91 ± 0.19	150.00 ± 2.01	1.38 ± 0.018
	9	12151.43 ± 157.32	14.14 ± 0.19	145.00 ± 2.00	1.31 ± 0.017
	10	1316.58 ± 52.12	1.53 ± 0.06	15.56 ± 0.64	0.14 ± 0.005
T4	11	920.88 ± 35.23	1.07 ± 0.05	11.83 ± 0.57	0.10 ± 0.004
	12	28324.50 ± 267.89	32.96 ± 0.28	337.00 ± 2.90	3.06 ± 0.022
	13	11665.80 ± 158.87	13.57 ± 0.18	129.00 ± 1.76	1.26 ± 0.017
T5	14	8964.28 ± 143.34	10.43 ± 0.16	101.00 ± 1.54	0.96 ± 0.015
	15	3161.96 ± 79.54	3.68 ± 0.10	38.02 ± 1.02	0.34 ± 0.008
	16	11018.30 ± 157.64	12.82 ± 0.18	128.00 ± 1.56	1.19 ± 0.016
T6	17	575.55 ± 34.23	0.66 ± 0.04	6.52 ± 0.39	0.06 ± 0.003
	18	2302.22 ± 69.75	2.67 ± 0.08	28.05 ± 0.86	0.24 ± 0.007
	19	12309.71 ± 164.43	14.32 ± 0.19	150.00 ± 2.01	1.33 ± 0.017
T7	20	1050.39 ± 44.12	1.22 ± 0.06	11.31 ± 0.45	0.11 ± 0.004
	21	2831.01 ± 79.62	3.29 ± 0.10	32.80 ± 0.87	0.30 ± 0.008
	22	10378.00 ± 143.29	12.07 ± 0.18	121.00 ± 1.73	1.12 ± 0.016
T8	23	899.30 ± 43.53	1.04 ± 0.05	11.88 ± 0.56	0.10 ± 0.004
	24	3028.86 ± 81.14	3.52 ± 0.10	34.56 ± 0.88	0.32 ± 0.008
	25	2241.07 ± 69.52	2.60 ± 0.08	28.18 ± 0.82	0.24 ± 0.007
T9	26	309.36 ± 25.14	0.36 ± 0.03	5.20 ± 0.39	0.03 ± 0.002
	27	16763.00 ± 198.19	19.51 ± 0.22	193.00 ± 2.19	1.81 ± 0.020
	28	4280.69 ± 98.56	4.98.00 ± 0.12	50.09 ± 1.14	0.46 ± 0.010
T10	29	24698.55 ± 225.67	28.74 ± 0.27	296.00 ± 2.78	2.67 ± 0.054
	30	2266.25 ± 76.14	2.63 ± 0.07	24.73 ± 0.70	0.24 ± 0.007

Table 2 The values of radon concentration (C_{Rn}), surface exhalation rate (E_A), mass exhalation rate (E_M) and working level (WL) for the Eastern Trenches of Um Ara area

Trench No.	Sample No.	C_{Rn} (Bqm^{-3})	E_A ($Bqm^{-2}h^{-1}$)	E_M ($mBqkg^{-1}h^{-1}$)	WL
T11	1	1769.83 ± 65.34	2.06 ± 0.07	22.74 ± 0.78	0.19 ± 0.006
	2	16349.39 ± 187.12	19.03 ± 0.22	185.00 ± 2.14	1.76 ± 0.019
T12	3	1338.16 ± 53.15	1.55 ± 0.06	15.81 ± 0.52	0.14 ± 0.005
	4	9313.21 ± 139.34	10.84 ± 0.16	101.00 ± 1.52	1.01 ± 0.015
T13	5	7726.84 ± 127.37	8.99 ± 0.15	97.32 ± 1.64	0.83 ± 0.014
	6	1550.40 ± 125.78	1.80 ± 0.05	20.01 ± 1.45	0.16 ± 0.013
T14	7	13957.24 ± 176.12	16.24 ± 0.20	163.00 ± 2.09	1.50 ± 0.019
	8	13363.69 ± 175.26	15.55 ± 0.20	159.00 ± 2.09	1.44 ± 0.019
	9	12824.11 ± 169.24	14.92 ± 0.19	139.00 ± 1.75	1.38 ± 0.018
T15	10	1295.00 ± 49.17	1.50 ± 0.04	15.24 ± 0.58	0.14 ± 0.005
	11	13798.96 ± 179.56	16.06 ± 0.21	168.00 ± 2.18	1.49 ± 0.019
T16	12	15655.13 ± 187.13	18.22 ± 0.21	180.00 ± 2.19	1.69 ± 0.020
	13	8431.89 ± 139.23	9.81 ± 0.15	110.00 ± 1.79	0.91 ± 0.013

Table 3 The average values of radon concentration, surface exhalation rate, mass exhalation rate and working level for Western and Eastern Trenches of Um Ara area

Trench	Trench No.	C_{Rn} (Bqm^{-3})	E_A ($Bqm^{-2}h^{-1}$)	E_M ($mBqkg^{-1}h^{-1}$)	WL
Western Trenches	T1	9807.82 ± 138.23	11.41 ± 0.18	118.00 ±1.55	1.05 ± 0.02
	T2	4051.67 ± 98.87	4.71 ± 0.11	48.48 ± 0.98	0.44 ± 0.01
	T3	16396.15 ± 154.54	19.08 ± 0.22	197.00 ± 2.50	1.77 ± 0.03
	T4	10183.33 ± 149.34	11.85 ± 0.18	121.46 ±1.56	1.10 ± 0.02
	T5	7930.41 ± 123.37	9.22 ± 0.16	89.00 ±1.02	0.85 ± 0.02
	T6	4631.66 ± 94.34	5.38 ± 0.12	54.19 ±1.00	0.49 ± 0.01
	T7	5396.66 ± 105.76	6.28 ± 0.13	64.70 ±1.02	0.58 ± 0.01
	T8	4768.33 ± 97.32	5.54 ± 0.12	55.81 ±1.00	0.51 ± 0.01
	T9	6437.66 ± 120.54	7.49 ± 0.14	75.00 ±1.07	0.69 ± 0.01
	T10	10414.66 ± 148.32	12.11 ± 0.21	123.60 ±1.48	1.23 ± 0.02
	Average	**8001.84 ± 136.76**	**9.31 ± 0.17**	**94.72 ± 1.05**	**0.87 ± 0.02**
Eastern Trenches	T11	9059.34 ± 137.24	10.68 ± 0.21	103.87 ± 1.75	0.98 ± 0.02
	T12	5325.50 ± 95.13	6.20 ± 0.12	58.40 ± 1.14	0.58 ± 0.01
	T13	4638.68 ± 82.54	5.40 ± 0.11	58.70 ± 1.14	0.50 ± 0.01
	T14	13381.30 ±174.65	14.23 ± 0.32	153.60 ± 2.54	1.44 ± 0.04
	T15	7546.50 ± 110.7	8.75 ± 0.19	91.62 ± 1.01	0.82 ± 0.02
	T16	12043.00 ± 143.14	14.02 ± 0.31	145.00 ± 2.34	1.30 ± 0.03
	Average	**8665.72 ± 89.75**	**9.88 ± 0.19**	**101.87 ± 1.63**	**0.94 ± 0.02**

Table 4 The Comparison between the obtained experimental results of granite rocks samples and the published data in different countries

Country/Org	C_{Rn} (Bqm^{-3})	E_A ($Bqm^{-2}h^{-1}$)	References
Egypt		0.29 - 1.07	Walley et al., 2001
Egypt (Build. Material)	136.19	0.088	Shoeib and Thabayneh, 2014
Turkey		1.30 - 24.80	Ahmet et al., 2013
Spain (Build. Material)	399.13	0.726	Shoqwara et al., 2013
Canada (Build. Material)		1.75	Chen et al., 2010
Greece (Build. Material)		1.24 ± 0.12	Stoulos et al., 2003
ICRP (Workplace)	500-1500		ICRP, 1990
ICRP (House)	200-600		ICRP, 1993
ICRP (Workplace)	1500		ICRP, 2007
Egypt (Rocks)	8665.72	5.40 - 14.23	The present study

From the figure we find that trench (T14) has a high value of radon concentration, this means that the values of radon concentration high in this position because granite is rich by uranium. But trench (T13) has a low value of radon concentration. This indicates that the granite rocks in this position are possible to use as a building material because it has a low value of uranium. The composition of granite rocks varied from one deposit to another.

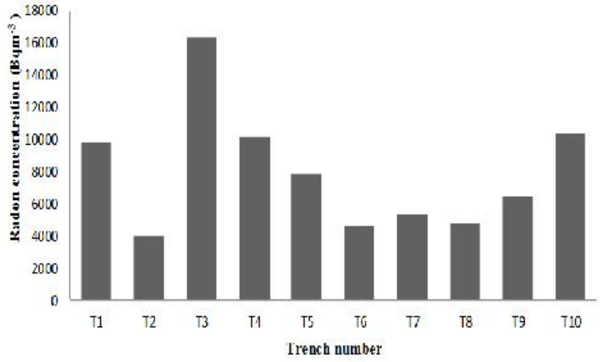

Figure 4. The relation between trench number and the average values of radon concentration of the the Western Trenches

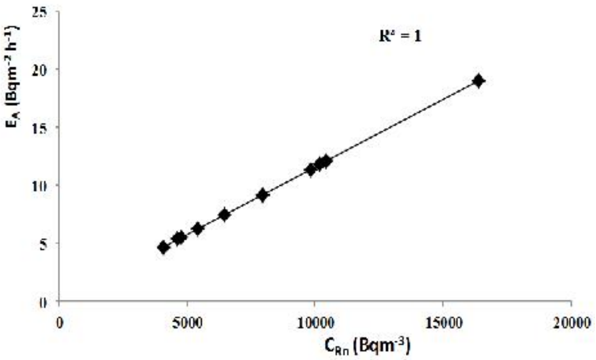

Figure 5. The correlation relation between the average values of radon concentration and surface exhalation rate of the Western trenches

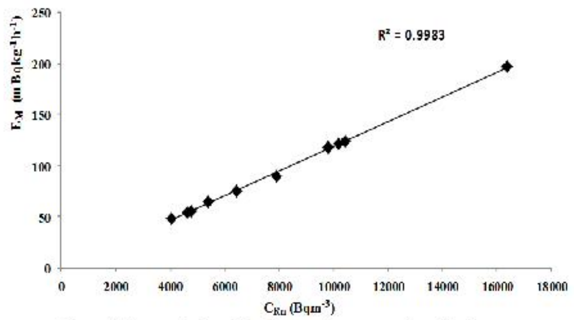

Figure 6. The correlation relation between the average values of radon concentration and mass exhalation rate of the Western Trenches

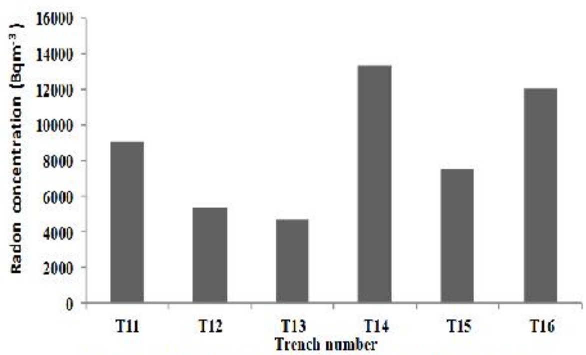

Figure 7. The relation between trench number and the average values of radon concentration of the Eastern Trenches

Therefore, granite rocks from different sources are expected to behave differently in acidification processes. The correlation relation between the average values of radon concentration and the surface exhalation rate for the Eastern Trenches given by (Fig.8) and equal (R^2= 0.98). It is a good agreement between measurements of radon concentration and surface exhalation rate. (Fig.9), gives the correlation relation between the average values of radon concentration and the mass exhalation rate for the Eastern Trenches and equal (R^2= 0.99). From the results we find that the average values of radon concentrations of Eastern Trenches area are higher than the values of radon concentrations of Western Trenches area. The variation in the values of radon concentrations is due to the difference in the chemical composition and the geological formation of the samples. The comparison between the obtained experimental results and the published data in different countries is given by Table 4. The values of radon concentrations of granite rocks samples are higher than the worldwide limit and the obtained results agreement with (Ahmet *et al*., 2013).

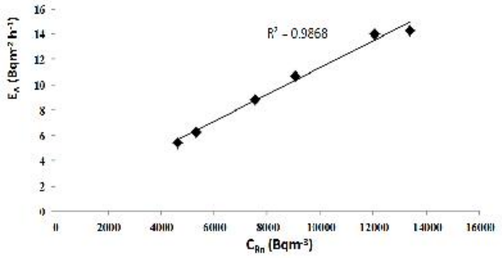

Figure 8. The correlation relation between the average values of radon concentration and surface exhalation rate of the Eastern Trenches

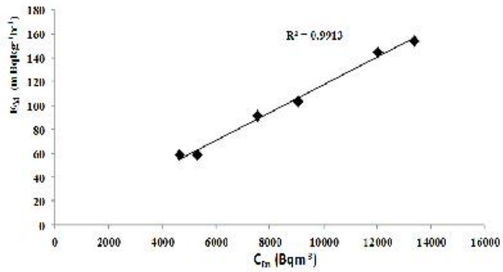

Figure 9. The correlation relation between the average values of radon concentration and mass exhalation rate of the Eastern Trenches

CONCLUSION

This work is important to detect any harmful radiation in the surrounding environment, which, can be used as reference information to assess any changes in the radioactive background level in the studied area because granite is commonly used as building material. The average values of radon concentrations for Western Trenches ranged from 4051.67 ± 98.87 to 16396.15 ± 154.54 Bqm^{-3} and the mean value equal 8001.84 ± 136.76 Bqm^{-3}. In the case of the Eastern Trenches, the average values of radon concentration varied from 4638.68 ± 82.54 to 13381.30 ± 174.65 Bqm^{-3} and the mean value equal 8665.72 ± 89.75 Bqm^{-3}. From the obtained results we find that the average values of radon concentration in Eastern Trench area are higher than the values of radon concentration in Western Trenches area. The variation in the values of radon concentrations is due to the difference in the chemical composition and the geological formations of the samples.

The obtained results of radon concentrations using LR-115 detectors are consistent, while the percentage of errors in LR-115 about 10% and it is referring to the partial sensitivity of the detectors, detector material, track density, the etching and counting techniques. The results of the present study shall help to determine the positions which have the highest and lowest values of radon concentration in granite trenches in the studied area and detect the variation in the concentration of radioactive radionuclides that affect the surrounding environment. The average values of radon concentrations are higher than the range of action levels (200 to 600 Bqm^{-3}), which recommended by (ICRP, 1993) and it generally higher than the reference level in workplaces (500 -1500 Bqm^{-3}), which recommended by (ICRP, 1990; ICRP, 2007).

From the previous discussion, we conclude that the values of radon concentrations in the granite samples are higher than the worldwide limit and not safe for human, so that the workers must use personal protective masks to protect themselves from inhalation radon in the studied area.

References

Ahmet S., Aykamıs, S., Eref Turhan, F., Aysun Ugur, Umut N., Baykan and Ahmet M., Kılıc, 2013. Radon exhalation rates and indoor radon concentration of some granite samples used as construction material in Turkey. *Journal of Radiation Protection Dosimetry*, 157, 105–111.

Chen J., Naureen M. R. and Abu Atiya I., 2010. Radon exhalation from building materials for decorative use. *Journal of Environmental Radioactivity*, 101, 317-322.

Hafez, A.F., Hussein, A.S. and Rasheed, N.M., 2001. A study of radon and thoron release from Egyptian building materials using polymeric nuclear track detectors. *Journal of Applied Radiation and Isotopes*, 54, 291-298.

Hesham A. Yousef, A. A. Embaby, A. H. El-Farrash, H. A. Laken, 2015. Radon exhalation rate in surface soil of Graduate's Villages in west Nile Delta, Egypt using Can technique**.** *International Journal of Recent Scientific Research*, 6(4) 3440-3446.

ICRP, 1990. Recommendation of the ICRP. Annals of the ICRP, 21(1-3), Publication 60.

ICRP, 1993. Protection against radon at home and at work. Annals of the ICRP, 23(2), Publication 65.

ICRP, 2007, The Recommendations of the ICRP. Annals of the ICRP, 37(2-4), Publication 103.

Karim M. S., Muhammad Hameed Abdullah and Widad Henou Abass, 2012. Measurement of radon gas concentration in cement samples by using nuclear track detector (CR-39). *Diyala Journal for Pure Sciences*, 8 (3), 2222-2373.

Mamta Gupta, Mahur A. K., Sonkawade and Verma K. D., (2011). Monitoring of indoor radon and its progeny in dwellings of Delhi using SSNTDs. *Journal of Advances in Applied Science Research*, 2(5), 421- 426.

Mohamed Abd-Elzaher.2012. An overview on studying ^{222}Rn exhalation rates using passive technique solid state nuclear track detectors. *American Journal of Applied science*, 9 (10), 1653- 1659.

Nidal Dwaikat, Ghassan Safarini, Mousa El-Hasan and Toshiyuki Iida, 2007. CR-39 detector compared with Kodalpha film type (LR-115) in terms of radon concentration. *Journal of Nuclear Instruments and Methods in Physics Research Section* A, 574, 289.

Pourimani R., Ghahri R. and Zare M. R., 2014. Natural radioactivity concentrations in Alvand granitic rocks in

Hamadan, Iran. *Journal of Radiation Protection and Environment*, 37 (3) 132-142.

Rafique M., and Rathore M. H., 2013. Determination of radon exhalation from granite, dolerite and marbles decorative stones of the Azad Kashmir area, Pakistan. *International Journal of Environmental Science and Technology*, 10, 1083–1090.

Stoulos S., Manolopoulou M. and Papastefanou C., 2003. Assessment of natural radiation exposure and radon exhalation from building materials in Greece. *Journal of Environmental Radioactivity*, 69, 225-240.

Singh A. K., Kumar Ashavani and Prasad Rajendra., 2006. Distribution of radon levels in Udaipur. *Asian Journal of Chemistry*, 18 (5), 3408-3411.

Sarma H. K., 2013. Radon activity and radon exhalation rates from some soil samples by using SSNTD. *International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering*, 2(10), 2320-3765.

Shoqwara F., Dwaikat N, and Saffarini G., 2013. Measurement of radon exhalation rate from building materials. *Research and Reviews Journal of Physics*, 2 (1) 10-19.

Shoeib M. Y. and Thabayneh K. M., 2014. Assessment of natural radiation exposure and radon exhalation rate in various samples of Egyptian building materials. *Journal of Radiation Research and Applied Sciences*, 7, 174-181.

UNSCEAR, 2000. Sources and effects of ionizing radiation, Report to the General Assembly with scientific annexes. United Nations, New York.

Uosif M. A. M., Shams A.M. Issa and Abd El-Salam L.M., 2015. Measurement of natural radioactivity in granites and its quartz-bearing gold at El-Fawakhir area (Central Eastern Desert), Egypt. *Journal of Radiation Research and Applied Sciences*, 8, 393-398.

Walley, N., El-Dine, A., El-Shershaby, F., Ahmed, A.S., Abdel-Haleem, 2001. Measurement of radioactivity and radon exhalation rate in different kinds of marbles and granites. *Journal of Applied Radiation and Isotopes*, 55, 853–860.

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