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Investigation of Radium Content and Radon Exhalation Rates in Archeological Areas in Luxor Governorate

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***Abstract*-In this study, long –term technique for alpha guard have been used to count radium content and radon exhalation rate in archaeological specimens.Specimens collected from Elkebash street, west bank, Luxor and Elkarnak temples. The values of radium contents were ranged from 181.12 to 236.04 with average value 207.919,from 89.41 to 151.84 with average value 122.42, from 121.68 to 217.856 with average value 167.89and from 66.46 to 106.75 with average value82.26 for Elkebash, luxor temple,west bank and ELkarnak temple respectively.In the other hand the Mass Exhalation Rate (EM)were from 0.99 to 1.78 with average value 1.5 ,from 0.67 to 1.14 with average 0.92 from 0.91 to 1.64 with average value 1.27 and from 0.50 to 0.80 with average value 0.62 for Elkebash, Luxor temple ,west bank and ELkarnak temple archaeological specimens while the Area Exhalation Rate (EX)for Elkebash, Luxor temple ,west bank and ELkarnak temple were from 8.39 to 15.04 with average value 12.65 ,from 8.39 to 14.04 with average 11.77 , from 7.4 to 13.3 with average value 10.23 and from 5.48 to 6.9 with average value 6.2 respectively.**

***Keywords*-Archeological, Alpha Guard, Can Technique, ODCD, Radium Content, Radon Exhalation**

I.INTRODUCTION

Uranium (U-238) is the main source for Rn-222 which is existing in all kinds of rocks and soil in part per million. Radium has considered one member from Uranium (u-238) radioactive series, which have found in everywhere in the crust of earth, and because of radon is the daughter of radium it is also have found in everywhere [1] in natural environment, Radon has three radioactive isotopes:

1-Rn-219 (t1/2=3.96S) in U-235 series
2-Rn-220(t1/2=55.6S) in Th-232 series
3-Rn-222(t1/2=3.82d) in U-238 series

Rn-220 and Rn-219 have short half-live so they are neglected but Rn-222 is most important isotopes because of it is long half-live [2-6]. Radon have found in outdoor and indoor air so its amount in soil may vary over wide range depending on weather conditions and soil kinds [7]. There is a process called emanation, which express for escape Rn-222 atom from soil to air or water filled pore space [8-9]. Radon atoms transport within the soil, until they undergo radioactive decay or have been released into the atmosphere this have been called exhalation process and radon exhalation rate can be known as the amount of activity of releasing radon per unit surface area per second. Radon can enter into a dwelling from soil to gas influenced by some parameters [10] such as:

- Focus of radon in soil
- Moisture of soil
- Soil permeability [11]

The level of indoor radon has depended on the intrinsic activity concentration of radium of the materials in question and their bulk permeability to radon gas [12], with the most significant parameters being the effective diffusion range, the effective surface area emission and the superficial structure [13].

II. EXPERIMENTAL METHOD

41 archaeological specimens have been taken from Elkebash Street, west bank, Luxor and Elkarnak temples. They are archaeological areas in Upper Egypt. In the present investigations, ‘‘accumulation chamber’’ technique has been used to study the radium content and radon exhalation rates, the specimens have been taken from different regions of archaeological areas in Luxor governorate. Figure (1) shows the experimental arrangement. The specimen has been placed at the bottom of cylindrical sealed can 10Cm height and 7Cm diameter. The LR-115 type -11 plastic track detectors at the top inner surface has been used to cover and fitted the mouth of the cylindrical can [14-16]. The tracks of α-particles have been emitted by radon gas produced through α-particles decay of radium content of the specimens have been recorded by the detector.

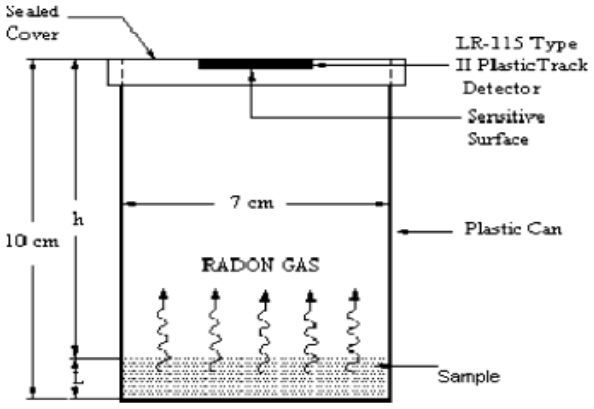

Fig.1 Experiential setup for measuring radium content and radon exhalation rate in archeological specimens

Exhalation rates in terms of area and mass were occurred from the following equations [1,2] [17-18]:

$$Ex = \frac{\lambda VC}{A[t+\lambda^{-1}(\exp(-\lambda t)-1)]} \quad (1)$$

$$Em = \frac{\lambda VC}{M[t+\lambda^{-1}(\exp(-\lambda t)-1)]} \quad (2)$$

$$CRadium = \frac{\rho hA}{kTeM} \quad (3)$$

The radium concentration in soil was calculated using the relation (3) [18-20]:

Where: CRadium is radium content of soil specimen (Bq.kg–1), C is radon concentration measured by CR-39 (Bq.m-3h-1), t is the exposure time (hours), V is the hollow holder volume (m3), λ is the radon decay constant (h-1), A is the surface area from which radon is exhaled (m2) and M is the mass of the specimen (kg), h is the distance between the detector and the top of the soil specimen.

III. RESULTS AND DISCUSSION

In the present study, radium content and radon exhalation rates have been calculated for 41 specimens have been taken from four regions are shown in figs. (2-5). Table I shows (EX)and (EM)for all region The obtained results from the study the radon exhalation rate was found as follows:

In archaeological specimens, the highest radium content, (EM) and (EX) have been found to be 236.04 (Bq.kg-1), 1.7 (Bq.kg-1.h-1) and 15 (Bq.m-2.h-1), respectively. While, the lowest value of the radium content, (EM) and (EX) have been found to be 82.26 (Bq.kg-1), 0.62 (Bq.kg-1.h-1) and 6.2 (Bq.m-2.h-1), respectively. The average value for radium content, (EM) and (EX) for all regions have been 207 (Bq.kg-1), 12.65 (Bq.m-2.h-1) and1.53 (Bq.kg-1.h-1) respectively.

Table 1 Radium Content and Radon Exhalation Rate in Different Region of Archaeological Specimen Using Alpha GUARD.

Region of Specimen	Radium Content ($Bq.kg^{-1}$)	Radon Exhalation ($Bq.kg^{-1}.h^{-1}$)	Area Exhalation Rate ($Bq.m^{-2}.h^{-1}$)
Elkebash	204.4827	1.5459	13.02874
	235.8852	1.7833	15.04535
	195.1351	1.4752	12.43315
	191.2356	0.9949	8.394971
	236.0492	1.7845	13.53712
	204.1602	1.5435	12.73102
	205.1544	1.551	13.07428
	181.1276	1.3693	11.22812
	208.4462	1.5759	12.90349
	208.895	1.5792	13.31965
	216.5455	1.6371	13.47871
Max	236.0492	1.7845	15.04535
Min	181.1276	0.9949	8.394971
Average	207.9197	1.5309	12.65224
Luxor Temple	151.2547	1.143485	14.36438
	89.41367	0.675967	8.491452
	105.1024	0.794574	8.716139
	106.8799	0.808012	10.65055
	122.1046	0.923111	13.14764
	151.8418	1.147924	14.42014
	130.3905	0.985752	12.64456
Max	151.8418	1.147924	14.42014
Min	89.41367	0.675967	8.491452
Average	122.4268	0.925547	11.77641
West Bank	217.8561	1.646992	13.36068
	203.2966	1.536922	12.87567
	166.7847	1.260892	9.882791
	174.5613	1.319684	10.73469
	160.4969	1.213357	9.864427
	158.9088	1.20135	9.703052
	149.9199	1.133394	9.294557
	173.9805	1.315293	10.4139
	121.6817	0.919914	7.420183
	141.6401	1.070799	8.504629
	183.961	1.390745	11.19584
	161.5942	1.221652	9.521191
Max	217.8561	1.646992	13.36068
Min	121.6817	0.919914	7.420183
Average	167.8902	1.273577	10.23097
El karnak Temple	106.7597	0.807103	6.640179
	87.05536	0.658139	6.986608
	66.64914	0.503868	5.482635
	83.272	0.629536	5.791913
	73.64536	0.556759	6.353671
	84.58356	0.639452	6.618529
	73.88363	0.55856	5.583626
Max	106.7597	0.807103	6.986608
Min	66.64914	0.503868	5.482635
Average	82.2641	0.621917	6.208166

Figs. (2-5) show radium content (Bq.kg-1), (EM)(Bq.kg-1.h-1) and (EX)(Bq.m-2.h-1) for archaeological specimens collected Elkebash street, west bank, Luxor and Elkarnak temples.

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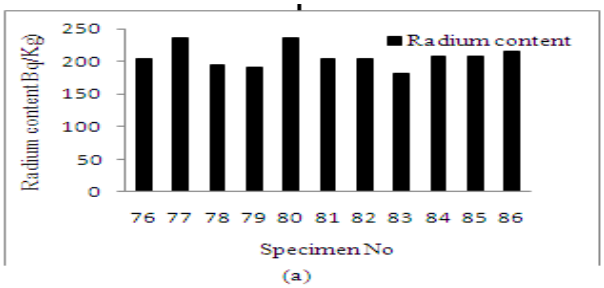
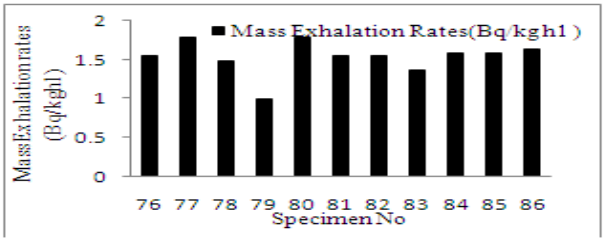


(a)



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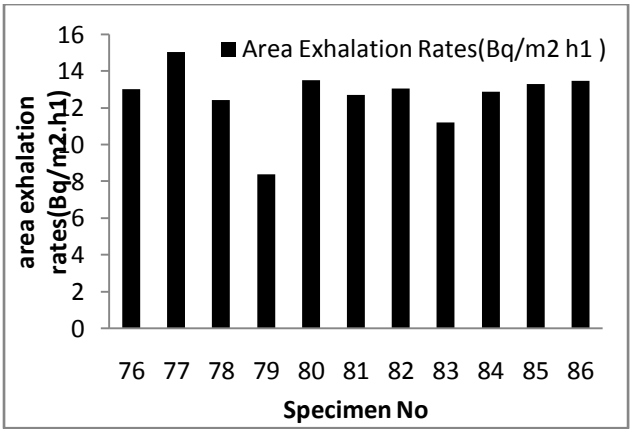
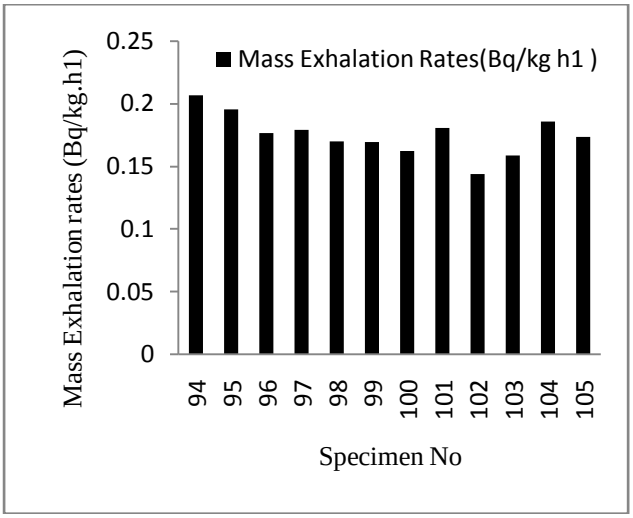


(c)

Fig.2. (a) radium content (Bq.kg-1), (b) (EM)(Bq.kg-1.h-1)) and (c) (EX)(Bq.m-2.h-1) for archaeological specimens collected from ELkebash region



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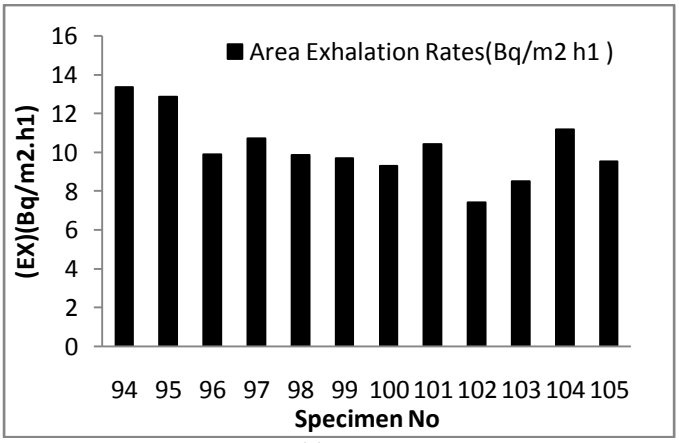
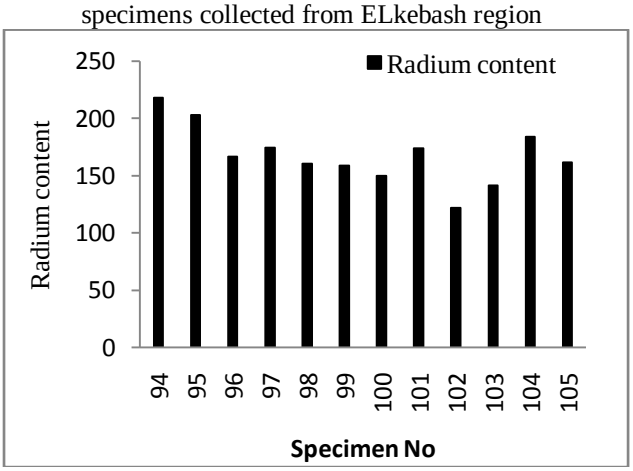


(c)

Fig.3 (a) radium content (Bq.kg-1), (b) (EM)(Bq.kg-1.h-1) and (c) (EX)(Bq.m-2.h-1) for archaeological specimens collected from West bank region



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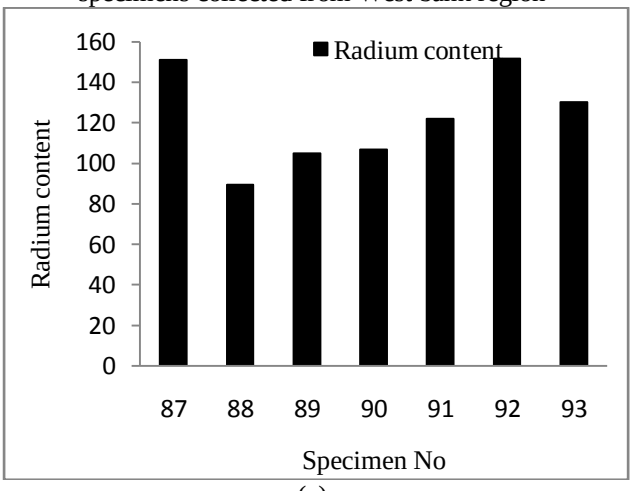

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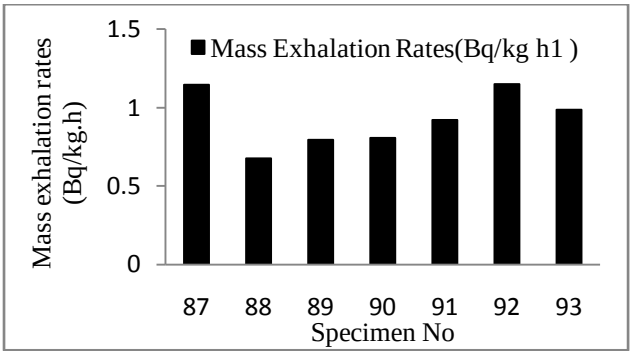

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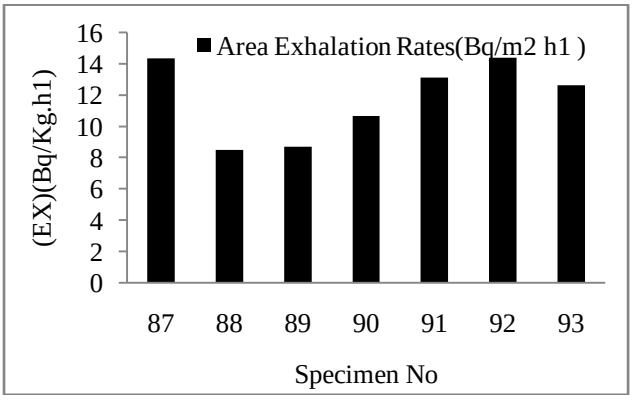
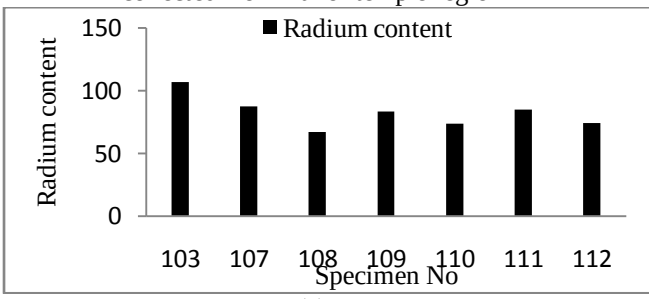


(c)

Fig.4 (a) radium content (Bq.kg-1), (b) (EM)(Bq.kg-1.h-1) and (c) (EX)(Bq.m-2.h-1) for archaeological specimens collected from Luxor temple region



(a)

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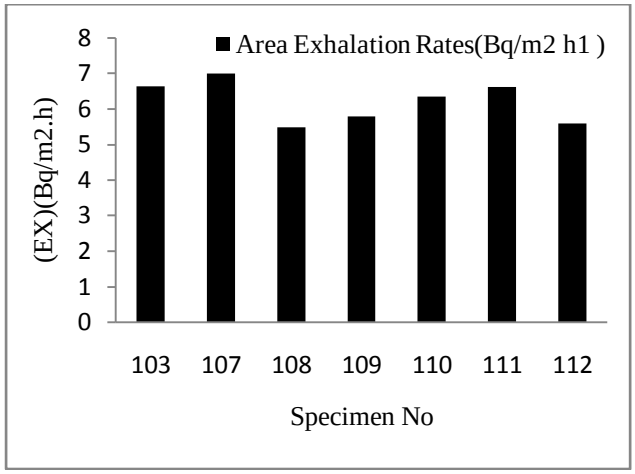


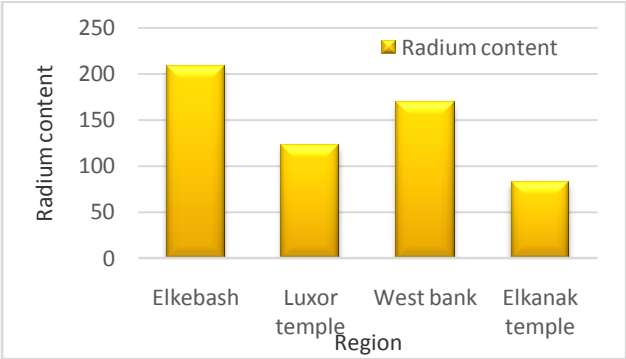
(c)

Fig.5 (a) radium content (Bq.kg-1), (b) (EM)(Bq.kg-1.h-1) and (c) (EX)(Bq.m-2.h-1) for archaeological specimens collected from EL karnak temple region. A. Comparison Between Radium Content and Radon Exhalation Rate in Different Regions of Archaeological Specimens Table 2 shows a comparison between Radium content and Radon exhalation in different archaeological regions.

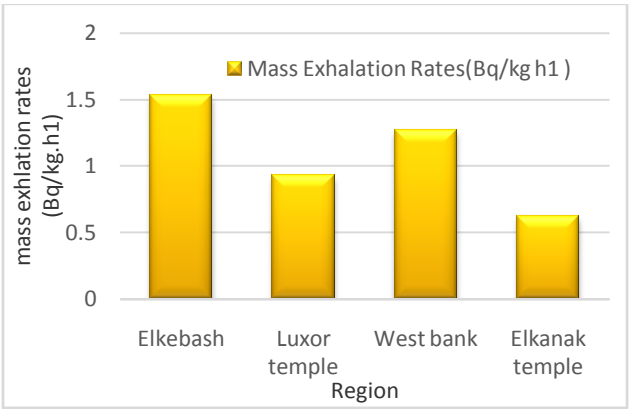
Table 2 Comparison between Radium Content and Radon Exhalation Rate in Different Region of Archaeological Specimen.

Region	Radium Content (Bq/Kg)	Radon Exhalation Rate	
		Mass $Bq.kg^{-1}.h^{-1}$	Surface Area $Bq.m^{-2}h^{-1}$
ELkebash	207.91	1.53	12.65
Luxor Temple	122.42	0.925	11.77
West Bank	167.89	1.27	10.23
Elkarnak Temple	82.26	0.62	6.208

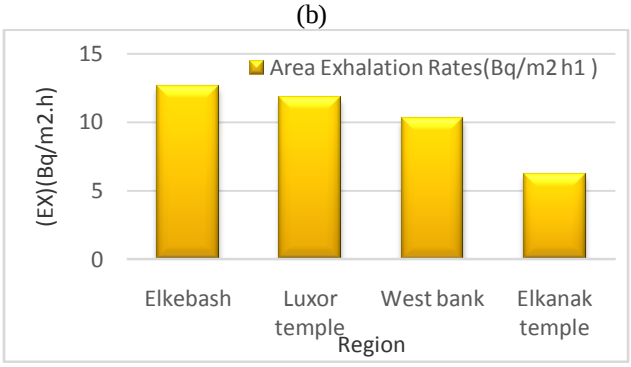
From the table we can notice that Elkebash region have the highest value for Radium content (Bq.kg-1), (EM) and (EX), but the lowest value for Radium content (Bq.kg-1), Radon Exhalation (EM) and (EX)were observed at ELkarnak temple region. Fig.6 shows comparison between Radium contents and radon exhalation rate in different regions of archaeological specimens.



(a)



(b)



(c)

Fig.6 comparison between (a) radium contents and radon exhalation rate in different regions of archaeological specimens

IV. CONCLUSION

- The values of Radium content, (EM) and (EX) varied among specimens may be because of the large of radium and uranium content of some specimens or because of geological characteristics is different.
- The mean radium content, the mean area and the mean mass radon exhalation rates counted in the specimens collected from Elkebash road were slightly higher than those counted in other specimens.
- Average calculations on the effective radium content, area and mass radon exhalation rates, from specimens give normal distributions.

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