ZANCO Journal of Pure and Applied Sciences
The official scientific journal of Salahaddin University-Erbil
https://zancojournals.su.edu.krd/index.php/JPAS

ISSN (print):2218-0230**, ISSN (online):** 2412-3986**, DOI: http://dx.doi.org/10.21271/zjpas**

RESEARCH PAPER

Measurement of Radon Activity Concentration in Soils Samples of Shaqlawa Region in Erbil City/ Iraqi Kurdistan Using RAD7 Detector

Yusra Mala Yousif Muhammad[1], Preshan Khder Fatah[2], Sardar P. Yaba[3]

[1&2]Department of Physics, College of education Shaqlawa, Salahaddin University-Erbil, Erbil,Iraq.
[3]Department of Physics , College of Education ,Salahaddin University-Erbil, Erbil ,Iraq.

ABSTARCT:

The radon concentration of soil samples from several places in the Shaqlawa city/Iraqi Kurdistan area has been determined by using RAD7detector. The soil samples are gathered from different geological formations. Maximum and minimum radon concentrations were (88.3 ± 9.4) and (51.1 ± 7.1) Bq/m^3 in the regions of Kawanian and Darband , respectively. The average radon concentration in soil samples from the city of Shaqlawa was (63.15 ± 16.94) Bq/m^3, which was below the ICRP-recommended threshold (1991).

KEY WORDS: Soil Radon; RAD7; Shaqlawa; Radium Content; Alpha particles.
DOI: http://dx.doi.org/10.21271/ZJPAS.35.2.7
ZJPAS (2023) , 35(2);58-62

1. INTRODUCTION:

Radon-222 is formed by the radioactive decay of radium-226, which is found in uranium ores, phosphate rock, shale, igneous and metamorphic rocks like granite, gneiss, and schist, and to a lesser extent in common rocks like limestone (Hussein et al., 2013, Mancini et al., 2018). Each square mile of surface soil, down to a depth of six inches, contains approximately one gram of radium, which emits radon in minute quantities. On a global basis, it is predicted that (20×10^{14}) curies of radon are released annually from soil (Majeed). Radon is gaseous and easily absorbed into the lungs under normal conditions; it is a human health threat (Ismail, 2011).

*** Corresponding Author:**
Sardar P. Yaba
E-mail: sardar.yaba@su.edu.krd
Article History:
Received: 16/08/2022
Accepted: 09/10/2022
Published: 20/04 /2023

It is frequently the largest contributor to an individual's radiation exposure, but the radon-gas threat varies by location due to regional geological variations. Despite its short lifetime, radon gas from natural sources such as uranium-containing rocks can accumulate in structures, particularly in low areas such as basements and crawl spaces, due to its high density. Radon can also be found in groundwater, including certain spring waters and hot springs (Ismail, 2004, Organization, 2009).

As one of the primary sources of indoor radon gas, soil radon gas significantly impacts risk. So, monitoring soil radon gas and indoor radon gas is necessary radon emanates from rocks and soils and accumulates in confined locations such as mines and homes. Soil gas infiltration is considered the most significant source of radon in homes (Mancini et al., 2018). Other sources, such as building materials and water drawn from wells, are often less critical. As radon gas rises from the soil, air pressure differences can bring it into the home (Ismail, 2007, Ismail and Haji, 2008). Typically, the air pressure inside the house is lower than the earth pressure around the foundations and basement floor slab. Due to this disparity in air pressure, the home functions as a big vacuum, sucking in radon gas via

any crack in the foundation or basement floor. In most instances, radon entering the home through water poses a lower risk than radon entering through the soil (Organization, 2009). Due to its lack of reactivity, radon inhaled into bodily tissues is not chemically bonded. In addition, due to its limited solubility in biological tissues, the radiotoxicity of inhaled radon is comparatively modest compared to that of inhaled non-gaseous radionuclides, such as radon daughters (Ismail and Jaafar, 2010). In contrast, inhaled radon daughters are deposited in the respiratory system. Due to their short half-lives, most deposited daughter atoms, the daughter of ^{218}Po, decay in the respiratory tract (after accumulation), primarily affecting the bronchial epithelium (Ismail, 2011). Because some of these daughter atoms are alpha emitters, alpha radiation's relatively high biological efficacy must also be considered (Ismail, 2021, Ismail and Sola, 2022). The cells at risk for lung carcinogenesis are situated in the tracheobronchial epithelium's basal and mucus cell layers and in the alveolar tissue (Ismail et al., 2012). Consequently, lung dosimeters for inhaled radon daughters must primarily relate to two target tissues. This includes the tracheobronchial epithelium and the pulmonary area, which comprises the alveoli and non-ciliated terminal bronchioles (Tirmarche et al., 2010).

Although there is no well-established method for calculating radon levels in individual dwellings based on soil radon data, it is believed that the radon concentration in homes roughly relates to that in the soil. There are direct relationships between the amounts of uranium, radium, and radon in soil gas and radon in indoor air. Reimer (Reimer, 1992) also proposed that geology and soil gas radon are excellent markers of indoor radon concentration. Radon enters homes due to a high concentration gradient between the house and bedrock or soil. Even though there is no well-established method for calculating radon levels in individual buildings based on soil radon data, the radon concentration in houses is likely quite similar to that in the soil. There are direct relationships between the amounts of uranium, radium, and radon in soil gas and radon in indoor air. The values within buildings vary on structural factors, ventilation rates, aerosol concentration, central heating, building materials, and occupant behavior (Alharbi and Abbady, 2013).

Alghamdi and Diab (Alghamdi and Diab, 2016) found a significant association between the uranium-238 and radon-222 concentration values obtained by CR39NTDs and RAD7 detectors for all samples. Solen et al. (2018) discovered a positive association between the passive approach employing the LR-115 nuclear track detector and the active method employing the RAD7 radon monitor. Using an LR-115 nuclear track detector, Gullchin et al. (2018) examined the activity of radon concentration in the soil of Harer and Khalefan cities; the results ranged from (105.8 to 204.7 Bq/ m^3). Ali et al. (Hasan et al., 2011) investigated the radon concentration in the soil gas in Al-Najaf –Al-Ashraf City, Iraq, using RAD7; the results range from (9 to 1210 Bq/ m^3). In response to earlier research on soil radon gas, the objective of the present study is to identify and evaluate the radon activity concentration in soil samples from the mountain region (Shaqlawa) / Erbil- Iraqi Kurdistan using a RAD7 detector for short-term measurements.

2. Methodology

2.1 Area under study

Four distinct locations have been chosen in Shaqlawa, a historic city and hill station in the Erbil Governorate in Iraqi Kurdistan. Shaqlawa, a town of about 25,000 inhabitants, is located 51 kilometers northeast of Erbil, near the base of Safeen Mountain. It is located between Safeen Mountain and Sork Mountain at an elevation of 1066 meters above sea level (Wikipedia Shaqlawa).

2.2 Experimental procedures

To assess the activity concentration of radon gas in soils, four different geological localities in the city of Shaqlawa were chosen: Kawaniean, Bitrma, Safin Mountain, and Darband (Fig.1). The soil samples were taken using a core method with a 10-centimeter depth and a weight of roughly 120 grams. The samples were dried in an electric oven at temperatures ranging from (120 ^{0}C). Each dry sample was reduced to a fine powder and sieved to generate a soil sample with fine-grained components. To prevent the radon from escaping, the fine-grained samples were wrapped tightly in plastic bags. The samples were sealed and kept for approximately 45 days (Ismail, 2004) to establish secular equilibrium between the radium and its daughter radionuclides. After the interval, RAD7

radon activity measurements were performed on each sample (Fig.2).

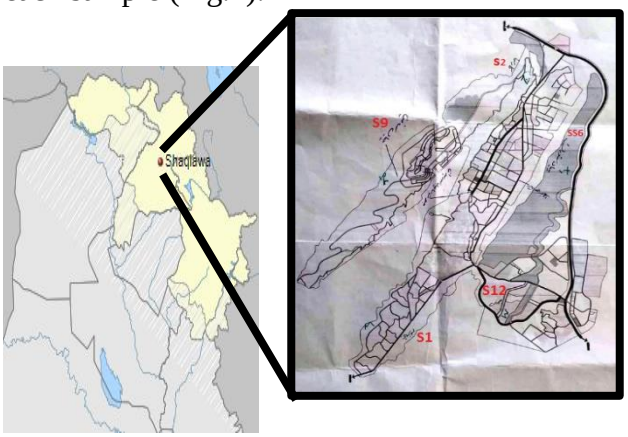

Fig. 1. Sketch map of the studied region.

Fig. 2. Experimental setup for measuring soil radon with RAD7.

3 e soil samples for the city of Shaqlawa has been examined, and the results are presented in Table 1. The radon activity concentration in soil samples ranged from (51.1 ± 7.1) Bq/ m^3 to (88 ± 9.4) Bq/m^3.

Table 1 Average radon activity concentration in soil samples.

Sample Point No.	Location	Radon activity concentration (Bq/m^3)
Sample 1	Kawanian	88 ±9.4
Sample 2	Bitrma	59.6 ± 7.7
Sample 3	Safin mountain	53.9 ± 7.3
Sample 4	Darband	51.1 ± 7.1

Based on Figure 3, the maximum value of radon activity concentration was identified in a soil sample from the Kawanian location. In contrast, the lowest value was found in a soil sample of the Darband location since the two areas had different geological formations and uranium concentrations (Ismail, 2004). In addition, various physical and chemical parameters of the places varied, including porosity, grain size, soil moisture, and 226Ra concentration. The criteria above depend on the geological and geographical characteristics of the region. (Greeman and Rose, 1996, Chitra et al., 2018, Saad et al., 2018).

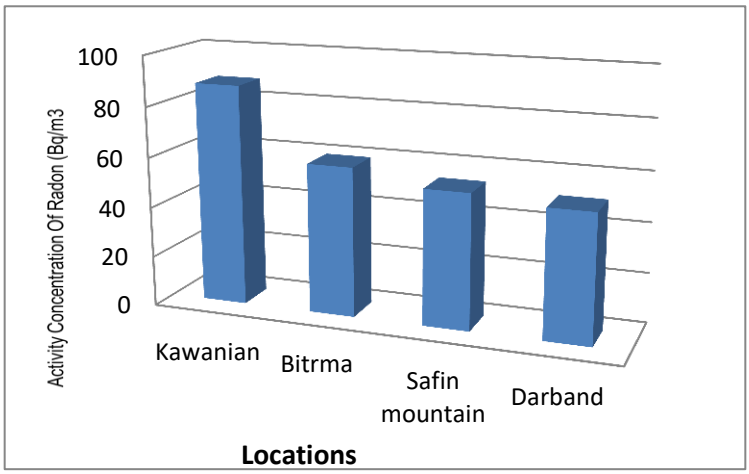

Fig. 3. Radon activity concentration in soil samples from the examined region.

The present study's results for radon activity concentrations in soil samples were compared to those of previous research (Table 2). The results demonstrated that the current findings were in agreement with those of prior investigations.

Table 2 Comparison of the present results with the previous studies.

Country	Activity concentration of radon (Bq.m^{-3}) Min.	Max.	Method	References
Iraq	51.1	88	RAD7	Present Study
Iraq	86.80	261.54	CR-39	(Alenezy, 2014)
KSA	26	126	Alpha Guard	(Alharbi and Abbady, 2013)
Iran	90	90	Alpha Guard	(Fathivand et al., 2014)
Pakistan	17.34	72.52	RAD7	(Ali et al., 2010)

India	107.92	107.92	LR-115	(Fathivand et al., 2014)

4. Conclusions

The average radon concentration of the selected places in Shaqlawa city was below the acceptable limit. The levels of radon gas in the soil samples depended on the geological formation and uranium content. The values of radon activity concentrations varied from location to location. The concentration of radon gas in the soil was higher and lower in Kawanian and Darband respectively.

Acknowledgment

We appreciate the collaboration of the academic staff and lab assistants of the physics department/ Shaqlwa Education College/ Salahaddin University-Erbil.

Conflict of interest: The researcher has no conflicts of interest to disclose.

References

ALENEZY, M. D. 2014. Radon concentrations measurement in Aljouf, Saudi Arabia using active detecting method. Natural Science, 2014.

ALGHAMDI, M. & DIAB, H. 2016. Measurement of radon content in silty sand soil using Rad7 and Cr-39 techniques at Wadi Arar, Saudi Arabia: comparison study. International Journal of Management and Applied Science, 2, 126-132.

ALHARBI, W. R. & ABBADY, A. G. 2013. Measurement of radon concentrations in soil and the extent of their impact on the environment from Al-Qassim, Saudi Arabia.

ALI, N., KHAN, E., AKHTER, P., KHAN, F. & WAHEED, A. 2010. Estimation of mean annual effective dose through radon concentration in the water and indoor air of Islamabad and Murree. Radiation protection dosimetry, 141, 183-191.

CHITRA, N., DANALAKSHMI, B., SUPRIYA, D., VIJAYALAKSHMI, I., SUNDAR, S. B., SIVASUBRAMANIAN, K., BASKARAN, R. & JOSE, M. 2018. Study of radon and thoron exhalation from soil samples of different grain sizes. Applied radiation and isotopes, 133, 75-80.

FATHIVAND, A., MORADI, M. & KASHIAN, S. 2014. Radiological impact of phosphate fertilizers on the agricultural areas in Iran. Radiation Protection and Environment, 37, 2.

GREEMAN, D. J. & ROSE, A. W. 1996. Factors controlling the emanation of radon and thoron in soils of the eastern USA. Chemical Geology, 129, 1-14.

HASAN, A. K., SUBBER, A. R. & SHALTAKH, A. R. 2011. Measurement of radon concentration in soil gas using RAD7 in the environs of Al-Najaf Al-Ashraf City-Iraq. Advances in Applied Science Research, 2, 273-278.

HUSSEIN, Z. A., JAAFAR, S., ISMAIL, H., AMMAR, A. & BATTAWY, A. 2013. Radon exhalation rate from building materials using passive technique nuclear track detectors. Int J Scientific Eng Res, 4, 1276-1282.

ISMAIL, A. H. 2004. Measurement of Radon Activity concentration in Iraqi Kurdistan Soil by Using CR-39 Nuclear Track Detectors". Salahaddin University-Erbil.

ISMAIL, A. H. 2007. Study of Indoor Radon/Thoron And Its Hazard Inside Kindergartens In Iraqi Kurdistan Using CR39 Nuclear Track Detectors.

ISMAIL, A. H. 2011. Alpha Particles Deposition and Its Effects on Lings, Male Infertility and Blood Components.

ISMAIL, A. H. 2021. Detection of radioactivity for some materials that used in construction and for some area that was exposed to the weapons of depleted uranium and estimating its health risks. Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, 1016, 165729.

ISMAIL, A. H. & HAJI, S. O. 2008. Analysis of radon concentrations in drinking water in Erbil governorate (Iraqi Kurdistan) and its health effects. Tikrit Journal of Pure Science, 13, 2008.

ISMAIL, A. H., HAMAD, M. A. & HARKI, E. M. 2012. Radiation exposure of leukemia blood samples and its impacts on the density of RBC, WBC, and PLT: In vitro.

ISMAIL, A. H. & JAAFAR, M. S. 2010. Relationship between radon concentration, ventilation rate and male infertility: A Case study in Iraqi Kurdistan. International Journal of Low Radiation, 7, 175-187.

ISMAIL, A. H. & SOLA, R. Y. 2022. Fabrication of alpha irradiation technique and study the impact of low alpha particles density on the lymphoblast cells of Leukemia blood samples. Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, 1031, 166494.

MAJEED, H. N. H. Determination of Radon and Uranium Concentrations in soil samples Iraqi cities. Journal of Advances in Physics, 4.

MANCINI, S., GUIDA, M., CUOMO, A., GUIDA, D. & ISMAIL, A. H. Modelling of indoor radon

activity concentration dynamics and its validation through in-situ measurements on regional scale. AIP Conference Proceedings, 2018. AIP Publishing LLC, 020043.

ORGANIZATION, W. H. 2009. WHO handbook on indoor radon: a public health perspective, World Health Organization.

REIMER, G. 1992. Methodology for rapid assessment of the radon potential of soils. Journal of radioanalytical and nuclear chemistry, 161, 377-387.

SAAD, A., ABDALLAH, R. & HUSSEIN, N. 2018. Physical and geometrical parameters controlling measurements of radon emanation and exhalation from soil. Applied Radiation and Isotopes, 137, 273-279.

TIRMARCHE, M., HARRISON, J. D., LAURIER, D., PAQUET, F., BLANCHARDON, E. & MARSH, J. W. 2010. ICRP Publication 115. Lung cancer risk from radon and progeny and statement on radon. Ann ICRP, 40, 1-64.

Gullchin, H.R., Gulnar, J.A., and Hiwa, H.A. (2018) 'A study of radon activity concentration in soil in Harea and Khalefan region in Erbil city using LR115solid state nuclear track detector', Student project, physic department.Education College /Shaqlawa-SalahaddinUnivercity-Erbil.

Solin, M.A.,Sazgar,A.A. and SardarP.Yaba (2018) 'Assessment of radon activity concentration in same cement samples using RAD7radon monitor and LR115solid state nuclear track detector', Student project, physic department.Education College SalahaddinUnivercity-Erbil.