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Research Paper

Study of the Natural Radioactive Pollution Caused By Radon in Some Houses of Irbid Governorate and Measure Radon From Building Materials

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ABSTRACT: *In this study the author studied the radioactive pollution in some houses of Irbid governorate and focused on the variation of radon gas concentration depending on the type of building materials by using SSNTDs technique.*
The study was conducted in summer season, 2015. The dosimeters had been distributed on the study area from June, 2, 2015 to September, 2, 2015. After 90 days dosimeters were collected for chemically etched under the conditions (30% solution of KOH at a temperature of 70 C° for 8 h). An optical microscope was used to count track densities on the detectors surfaces.
It was found that the concentration of radon in the air of houses in Irbid governorate distributed on nine regions was 31 Bq/m^3 for Irbid region, 33 Bq/m^3 for Ar Ramtha region, 40 Bq/m^3 for Der Abi saeed region, 26 Bq/m^3 for Sama Al-Rousan region, 59 Bq/m^3 for North Shuneh region, 24 Bq/m^3 for Al-Hisn region, 20 Bq/m^3 for Mazar Shamali region, 35 Bq/m^3 for Taybeh region and 34 Bq/m^3 for Kufr Asad region. The average concentration of radon gas for these regions was 34 Bq/m^3.
The study also showed that the concentration was relatively high (65 Bq/m^3) in buildings made of stones, while it was low (38 Bq/m^3) in buildings made of blocks. In general, the average radon concentrations in the air of Irbid governorate houses is lower than the national average (39 Bq/m^3) and lower than the international average (200 Bq/m^3). Finally, the concentration of radon in the governorate of Irbid is less than the allowable international concentrations; therefore we can say that the governorate of Irbid is an unaffected area by radiation.

Keywords: *pollution- radon- houses- building materials- houses radon*.

I . INTRODUCTION

The radiations that cause radioactive pollution are emitted by radioactive decay of unstable heavy atoms nuclei. Exposure of these radiations can cause damage to environment. The concern about radioactive pollution has increased after the discovery of artificial radioactivity, the development of nuclear weapons and the installation of nuclear reactors for generating electricity.

Radiation is energy that comes from a source and travels through some material or through space. Also it is defined as a stream of particles or electrons or protons or neutrons or alpha particles or high energy photons, or a combination of us [1].

Most people do not know that the greatest exposure to pollution is caused by natural radioactivity which comes from radon and its progeny or radon daughters. The problem of indoor radon has attracted the world's attention [2]. The author studied the radioactive pollution in some houses of Irbid governorate and focused on the variation of radon gas concentration depending on the type of building materials by using SSNTDs technique.

Radon is not produced as a commercial product. Radon is a naturally occurring radioactive gas and comes from the natural breakdown (radioactive decay) of uranium. It is usually found in igneous rock and soil, but in some cases, well water may also be a source of radon. The real danger of radon gas does not come from the gas itself, but comes from radon gas daughters (See Fig. 1).

$$^{222}_{86}Rn \xrightarrow{\alpha} {}^{218}_{84}Po \xrightarrow{\alpha} {}^{214}_{82}Pb \xrightarrow{.\beta} {}^{214}_{83}Bi \xrightarrow{.\beta} {}^{214}_{84}Po \xrightarrow{\alpha} {}^{210}_{82}Pb \xrightarrow{\beta} {}^{210}_{83}Bi \xrightarrow{.\beta} {}^{210}_{84}Po \xrightarrow{\alpha} {}^{206}_{82}Pb$$

Fig. 1: shows Decays of (^{222}Rn) into solid daughters.

During the recent years, several reports have appeared to demonstrate the ever increasing interest in monitoring the radon level in the environment all over the world. The topography, house construction type, soil characteristics, ventilation rate, wind direction, atmospheric pressure and even the life style of the people, have significantly influence in the radon concentration [3][4][5][6], which emphasizes the importance of long term integrated measurement, thus indicating the importance of the SSNTDs techniques in these measurements.

The data indicate that some materials such as aerated concrete with alum shale and phosphor-gypsum from sedimentary ores have significantly higher radium concentration than others and cause enhanced radon concentration indoors. Radon exhalation from building materials has been the subject of many studies [4] [7] [8] [9].

Radon gas is the largest contributor to human exposure to natural radiation sources. The dose exposure from radon and its daughter's represents about (50%) of the total dose of human exposure per year from all natural sources [10]. This dose varies according to location, height above sea level, the nature of the soil neighboring to the residence, type of dwelling and other factors. Here, the author find the importance of studying radioactive pollution level in some houses of Irbid governorate due to radon gas and focused on the variation of radon gas concentration depending on the type of building materials by using SSNTDs technique.

Irbid governorate (study area) is one of the governorates of Jordan. It is located north of Amman (Jordan capital) at latitude 32° 30' 0 N and longitude 35° 49' 59 E. The capital city of the governorate of Irbid is the city of Irbid. It has the second largest population in Jordan after Amman governorate, and the highest population density in the country. Irbid governorate consists of (9) regions, Irbid, Ar Ramtha, Kora, Bani Kanana, Al- Aghwar Shamaliyyeh, Bani Obaid, Mazar Shamali, Tayybeh, and Wastiyyeh (See Fig.2).

In addition to the geophysical importance of Irbid governorate, it has a lot of minerals and rock sediment that may play a role in the production of radon gas. The author hopes to get results that would increase the awareness of health risks of radon gas in houses, because of its negative effects on citizens and because of the fatal diseases that it causes such as lung cancer, leukemia and liver diseases, and to contribute a radon map of Jordan.

The rock characteristics of the study area belong to a number of limestone rock formations. These various rocks spread over a number of configurations that show AL-Balqa group, which can be seen in the study area [11] [12].

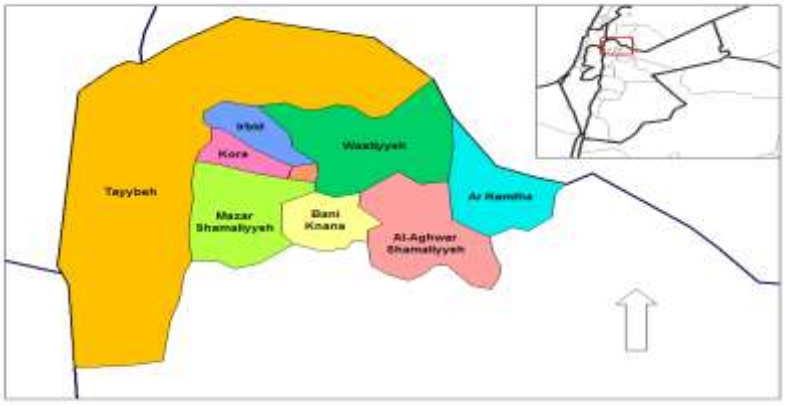

Fig. 2: shows map of Jordan and the regions that have been studied.

Measuring procedures

The current study focused on studying radioactive pollution level in some houses of Irbid governorate due to radon gas and the author studied the variation of radon gas concentration depending on the type of building materials by using Solid state nuclear track detectors (SSNTDs). These detectors are very durable, with no great handling problems, and are not fogged by exposure to light or affected by moderate degrees of heating. Their simplicity and durability make them particularly valuable and their robustness enables them to be used in personal dosimetry. SSNTDs Easy to construct and use, Small in size and cheap in price, Detect alpha but not gamma or beta radiations, Can integrate radon over any length of time (from few days to one year), Little or no dependence on environmental conditions such as temperature and humidity [13].

After completing the dosimeters preparation, it was distributed to the study area (Irbid governorate). The study was conducted in summer season, 2015. The dosimeters had been distributed on the study area from June, 2, 2015 to September, 2, 2015.

For the purpose of studying the radioactive pollution level in some houses of Irbid governorate due to radon gas, (1026) dosimeters were distributed in random houses from the study area (Irbid governorate). The study area is divided into nine regions according Department of Statistics, 2009, North territory estimates, where the dosimeters were distributed in the center of each region; three dosimeters have been distributed in each house (See Table. 1).

Table. 1: shows numbers of distributed, collected, and lost dosimeters and the percentage for lost dosimeters distributed in the houses of the study area.

Regions	Center	Distributed	Collected	Lost	Percentage
Irbid	Irbid	153	146	7	4.58 %
Ar Ramtha	Ar Ramtha	123	116	7	5.7 %
Kora	Der Abi saeed	117	111	6	5.13 %
Bani Kanana	Sama Al-Rousan	99	95	4	4.04 %
Aghwar Shamaliyyeh	North Shuneh	117	109	8	6.84 %
Bani Obaid	Al-Hisn	108	101	7	6.48 %
Mazar Shamali	Mazar Shamali	102	97	5	4.9 %
Taybeh	Taybeh	102	95	7	4.95 %
Wastiyyeh	Kufr Asad	105	102	3	2.86 %
Total	-	1026	972	54	5.3 %

These dosimeters have been left in the houses for 90 days, the study conducted from January, 2, 2015 to April, 2, 2015. After the expiration of the exposure period (t), dosimeters were collected for chemically etched under the conditions (30% solution of KOH at a temperature of 70 C° for 8 h). An optical microscope was used to count track densities on the detectors surfaces.

II . RESULT AND DISCUSSIONS

Most of the building materials in the study area (Irbid governorate) like cement, concrete blocks, steel, rocks, etc, are locally manufactured. Radon levels (radioactive pollution) obtained need to be compared with the average national radon level and with the action levels set by different countries and organizations. After collecting the essential information about the places where we installed the dosimeters in, the author studied the radioactive pollution in some houses of Irbid governorate and focused on the variation of radon gas concentration depending on the type of building materials.

That radon concentration in North Shuneh is the highest for the reason for this might be due to the nature of soil and to the low geographical level compared to other regions of study. In addition to that, most of the residents in North Shunah houses are employees, so the houses are closed most of the time, besides that these houses are surrounded by trees which prevents the proper ventilation of houses. It was also noted that the highest concentration of radon was in Der Abi Saeed despite the high altitude of Der Abi Saeed above sea level (radon concentration decreases with height above sea level); the reason is that houses in Der Abi Saeed are modern with gardens where radon leaks from the soil of these gardens into houses, because the thickness of the soil in some places in this area is light, and because of the sedimentary rock layer uncovered where these rocks may contain uranium element which contributes to the increasing of the concentration of radon in the soil and thus increases it in the air of houses. Besides, a number of houses in this area are built with stones, which as mentioned earlier reduce radon gas exchange between houses air and the atmosphere (See Table. 2 & Fig. 3).

Table. 2: shows the average radon concentration (Bq/m^3) in different houses for each study area.

Regions	Center	Mean (Bq/m^3)
Irbid	Irbid	31
Ar Ramtha	Ar Ramtha	33
Kora	Der Abi saeed	40
Bani Kanana	Sama Al-Rousan	26
Aghwar Shamaliyyeh	North Shuneh	59
Bani Obaid	Al-Hisn	24
Mazar Shamali	Mazar Shamali	20
Taybeh	Taybeh	35
Wastiyyeh	Kufr Asad	34
Mean (Bq/m^3)	-	34

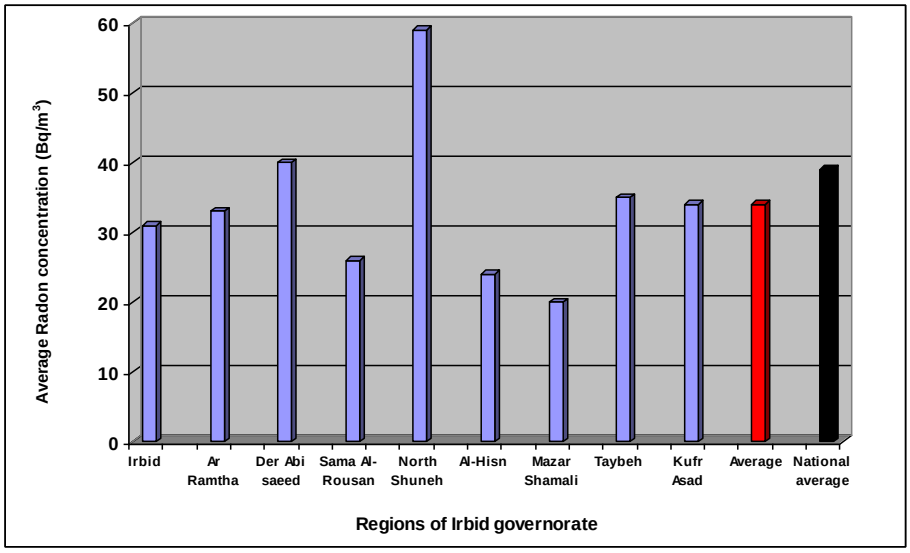

Fig. 3: shows a comparison of the radon concentration inside houses of the study regions with average global concentration and average concentration for Irbid governorate houses (study area).

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Fig. 3 represents a comparison between the radon concentration inside the houses with the average global concentration and the average concentration of areas that have been studied. The average global concentration of radon gas in the air of houses is (39 Bq/m^3) which is less than the concentration of North Shuneh area (59 Bq/m^3) and (40 Bq/m^3) in Der Abi saeed area, but it is higher than the average concentration of study areas (34 Bq/m^3).

For compare the radon concentration with the types of building materials, the ground floor in all the studied houses was chosen. The average radon concentration in the houses which were built with stones with (65 $Bqlm^3$), concrete (56 Bq/m^3), and blocks (38 Bq/m^3). The high radon concentration was noticed in the stone houses. This might be due to the low porosity of stones, which do not allow the exchange with outside air. The low average level was recorded in the houses built with blocks. This could be due to the high porosity, low thickness of blocks in comparison with concrete and stones (See Table. 3 & Fig. 4).

Table. 3: shows the variation of radon concentrations (Bq/m^3) with the type of building materials.

Building material	Minimum (Bq/m^3)	Maximum (Bq/m^3)	Mean (Bq/m^3)	Standard deviation (Bq/m^3)
Concrete	20	69	56	10
Stones	27	72	65	12
Blocks	15	49	38	8

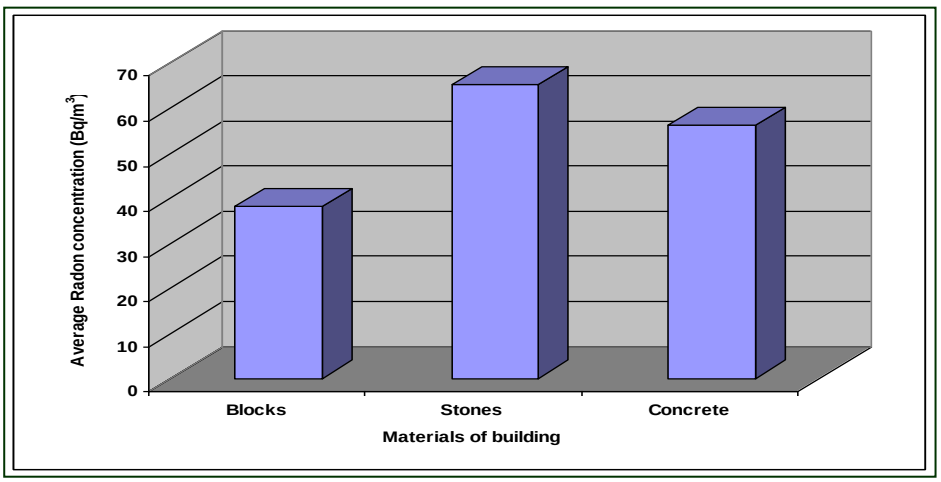

Fig. 4: shows the relation between the radon concentrations and the building materials.

III. CONCLUSION

The present study focused on studying radioactive pollution level in some houses of Irbid governorate due to radon gas and the author studied the variation of radon gas concentration depending on the type of building materials by using Solid state nuclear track detectors (SSNTDs). The average radon concentration in the air of houses in Irbid governorate has been found to be within general low and acceptable level (34 Bq/m^3), with few high concentrations in some special places; this may be attributed to the geological and geographical nature. It was noticed that the average radon concentration in the regions of Irbid, Ar Ramtha, Kora, Bani Kanana, Al- Aghwar Shamaliyyeh, Bani Obaid, Mazar Shamali, Tayybeh, and Wastiyyeh were close together. It was found that North Shuneh had the highest average radon concentration (59 $Bq/m^{3)}$ and Mazar Shamali had the lower one (20 Bq/m^3).

Generally, low radon concentration in the air of Irbid governorate where the reason that this study was conducted in the summer, which is characterized by drought, lack of humidity and the high temperatures which help to provide an opportunity for good ventilation rates. It should be noted that some of the houses contain relatively high concentrations of radon gas, which is much lower than the concentrations allowed by the United States (See Fig. 5), which amounts to (150 $Bq.m^{-3}$). In addition, the concentration of radon gas was relatively high (65 Bq/m^3) in building made of stone, while radon concentration was low (38 Bq/m^3) in building made of blocks. We conclude from the foregoing that there is no justification for the fear of the radiation harm coming from the radioactive radon gas in the study area.

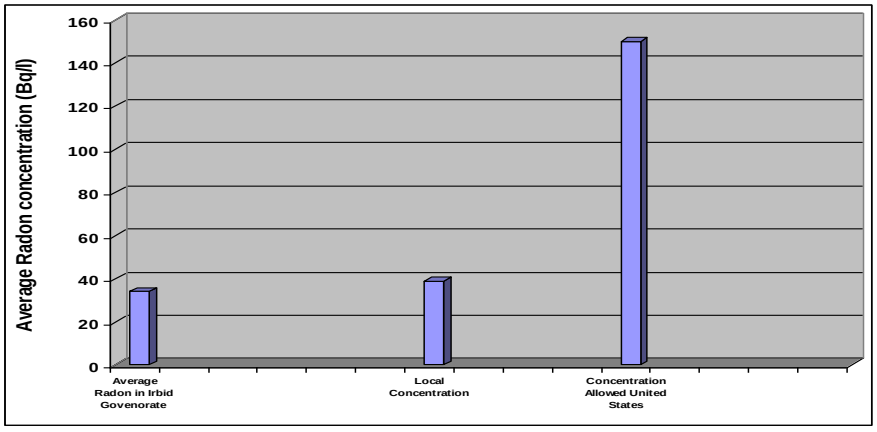

Fig. 5: shows that average radon concentration is less than local concentration and is much lower than the concentrations allowed by the United States.

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