Measurements of Radon- 222 concentrations in dwellings of kirkuk city, Iraq.

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ABSTRACT:

Inhalation of indoor has been recognized as one of The health hazards . Building materials, natural gas and underground – derived water supply are considered The major sources of indoor radon and its Daughters . In This work a set of radon measurements was carried out, using CR-39 solid state nuclear track detector , in different compartments of dwelling in kirkuk built of The same type of building materials . The results showed that Bathrooms and cellar have higher radon concentrations levels compared with living rooms ,bedroom, kitchen room and the out door levels. The results were within universally permitted levels .

KEY WORDS: Radon**,** solid state nuclear track detectors**, CR**-39, Pollution radiation

INTRODUCTION:

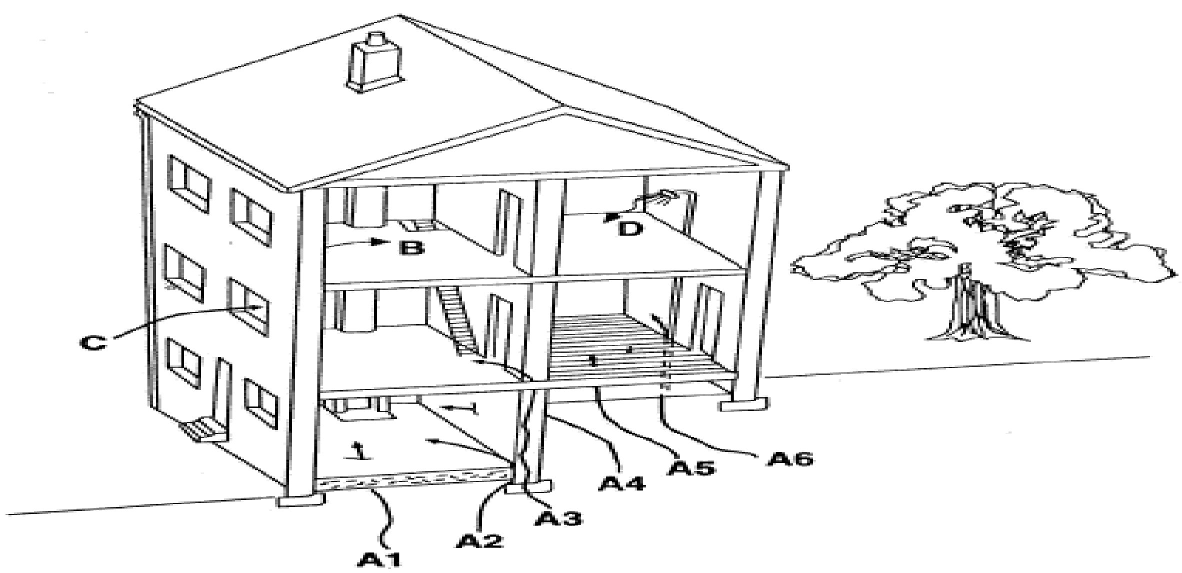
Public exposure to radon and its radioactive daughters present in the environment results in the largest contribution to the average effective dose received by human beings (UNSCEAR,1986). Recently It has been clearly recognized that elevated levels of ^{222}Rn could be present in certain types of human dwellings. Under specific conditions, such as those existing in the Uranium mining environment, the lung dose arising from the inhalation of ^{222}Rn daughters can be sufficiently high as to cause an increase in lung cancer occurrence .It has been suggested that the indoor ^{222}Rn concentration in the USA is responsible for about 10% of the total risk of lung cancer (FARID S.M ,1992). As far as human dwellings are concerned the possible enhanced risk could be expected only in a rather small fraction of homes depending essentially on the building materials, ventilation features and soil characteristics. These factors are directly responsible for enhanced input and subsequent stagnation of 222Rn in indoor air (Subba etal 1990).Several countries have initiated large scale measurements of prevailing indoor ^{222}Rn levels in houses and the reported levels range from a low of 9 $Bq.m^{-3}$ to a high value of the order of 200 $Bq.m^{-3}$ table(1)(**Bochicchio F** etal 1996). The aims of present work to Measurements of Radon-^{222} concentrations in dwellings of kirkuk city, Iraq

Table (1) previous internationally studies

Country (region) of study	Number of houses	Period	Duration of exposure	Average of Radon concentration Bq/m^3
Australia	3413	1989-1990	1 year	11
Belgium	٣٠٠	1984-1990	3month to 1 year	٤٨
Canada	١٣٤٥٧	1977-1980	summer	٣٣
Czechoslovakia	١٢٠٠	1982	1 year	١٤٠
Denmark	٤٩٦	1985-1986	6month in winter and 6month in summer	٤٧
France	٣٠٧٤	1990-1991	1 year	١٢٣
Germany	٦٦٠٠	1978-1983	3month	٥٠
Greece	٥٧١	1987-1994	6monthagp	٩٢
Hungary	١٢٢	1985-1987	2.5 year	٥٥
Italy	٤٨٠٠	1989-1993	1year	٧٧
Japan	٦٣٠٠	1985-1991	1year	٢٠
Luxemburg	٢٥٠٠	1991	1year	٦٥
Norway	٧٥٢٥	١٩٩١-١٩٨٧	6months	٥٤
Netherlands	١٠٠٠	١٩٨٤-١٩٨٢	1year	٢٩
Portugal	٤٢٠٠	1989-1990	1year	٨١
Egypt	٢٥٦	٢٠٠٦-٢٠٠٥	3month	٧٤
Present work (Iraq)	١١٠	٢٠٠٨	1month	٦٠

Large scale measurements have been carried out to identify dwellings concentration in excess of 190 Bq.m-3,which is the intervention level suggested by the U.S.Environmental Protection Agency (EPA) (Subba Ramu MC and etal 1990)

The story of radon as a cause of lung cancer is a long one with historical accounts documenting a fatal lung disease centuries ago in miners working in the Erz Mountains of Eastern Europe . Over a century ago, the miners were found to have thoracic malignancy, later identified as primary lung cancer. By early in the 20th century, levels of radon in the mines in this region were measured and found to be quite high; the hypothesis was soon advanced that radon was the cause of the unusually high rates of lung cancer. Although not uniformly accepted initially, as the findings of epidemiologic studies of underground miners were reported from the 1950s on, there soon was substantial evidence showing that radon was a cause of occupational lung cancer (Jonathan M. Samet,2000). In fact, the more recent concern about radon in the air of homes was initially driven by the strong evidence that radon causes lung cancer in underground miners. Radon is a noble and inert gas resulting from the decay of naturally occurring uranium-238. With a half-life of over 3 days, radon has time to diffuse through rock and soil after it forms and before undergoing further decay into its particulate progeny. In mines, it enters the air from the ore or is brought into the mine dissolved in water. In homes, the principal source is soil gas, which penetrates through cracks or sumps in basements or around a concrete slab,figure 1 (EUR 16123-1995) Because uranium-238 is universally present in the earth, radon is a ubiquitous indoor air pollutant, and it is also



A Entry of radon from soil through:
A1 - Cracks in solid floors
A2 - Construction joints
A3 - Cracks and cavities in walls
A4 - Cracks in walls below ground level
A5 - Gaps in suspended floors
A6 - Gaps around service pipes

B Radon exhalation from building materials
C Entry of radon with outdoor air
D Radon released from water

Figure 1 . Typical radon sources and entry routes

Radon is an alpha emitter that decays with a half-life of about 3.5 days to a short-lived series of progeny (Figure 2) (*1*). Unlike radon, the progeny are solid and form into small molecular clusters or attach to aerosols in the air after their formation. The inhaled particulate progeny may be deposited in the lung on the respiratory epithelium; radon by contrast is largely exhaled, although some radon is absorbed through the lung. Radon itself is not responsible for the critical dose of radioactivity delivered to the lung that causes cancer. While radon was initially thought to be the direct cause of the lung cancer in the miners, Bale and Harley recognized in the early 1950s that alpha particle emissions from radon progeny and not from radon itself were responsible for the critical dose of radiation delivered to the lung. Alpha decays of two radioisotopes in the decay chain, polonium-218 and polonium-214 (Figure 2), deliver the energy to target cells in the respiratory \epithelium that is considered to cause radon-associated lung cancer (National Research, 1991,). Alpha particles, equivalent to a helium nucleus, are charged and have a high mass. Although their range of penetration into tissues is limited, they are highly effective at damaging the genetic material of cells. As reviewed in the report of the BEIR VI Committee, passage of even a single alpha particle through a cell can cause permanent genetic change in the cell.

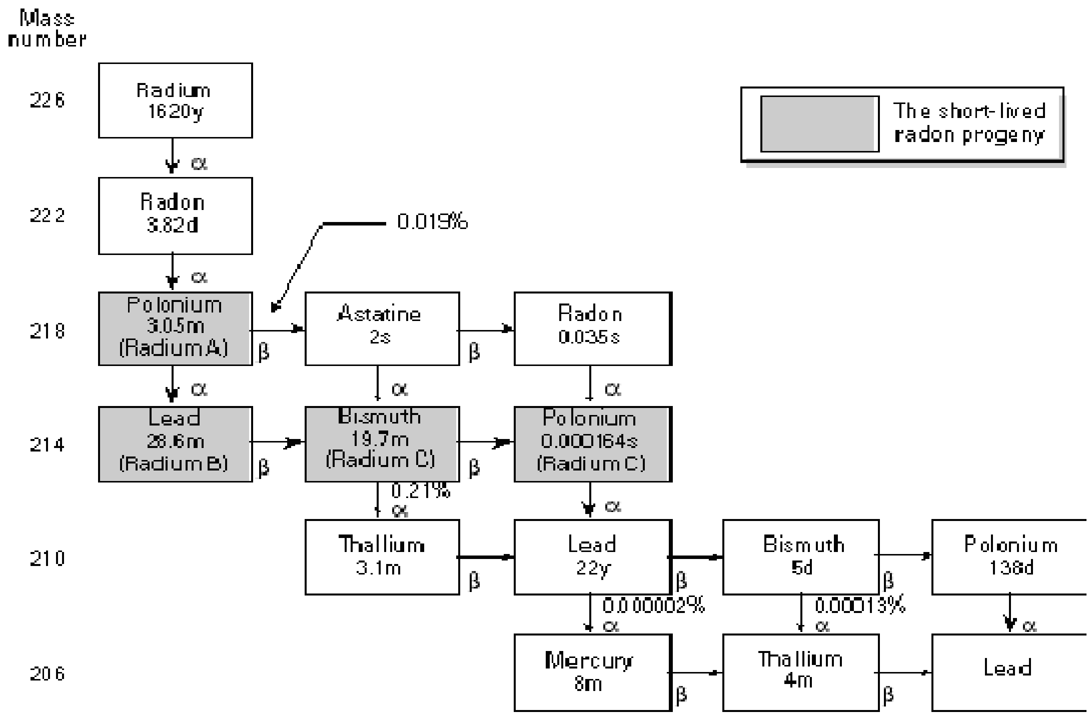


Figure 2.

The radon-decay chain. An arrow pointing downward indicates decay by alpha-particle emission; an arrow pointing to the right indicates decay by beta-particle emission. Modified from the National Research Council)(National Research, 1998).

Although radon progeny are now a well-recognized occupational carcinogen, radon became a topic of controversy again in the 1970s and 1980s because it was found to be a ubiquitous indoor air pollutant in homes, and recommended control strategies in the United States and other countries included testing of most homes and mitigation of those levels exceeding suggested guidelines (Cole LA, ,1993). Indoor air is a dominant exposure for humans, where more than half of the body's intake during a lifetime is air inhaled in the home. Thus, most illnesses related to environmental exposures stem from indoor air exposure

(Sharma N,Virk H S,2001). All building materials that originate from minerals may contain amounts of radionuclides such as uranium and thorium, which are created from their radioactive decay chains. Of these, the most significant is radium (Ra-226). Presence of Ra-226 in building materials affects persons living in dwellings either by inhalation of radon daughters, that decay from radium and are released from the building materials to the indoor air, or by hard gamma radiation released from the building material as a consequence of the radioactive decay of the natural radionuclides (Sundal AV,strandt ,2004). In addition to the building materials, the natural gas used domestically , the underground-derived water supply and the cracks(EUR 16123-1995) Building materials are generally the second main source of radon indoors .

Solid State Nuclear Track Detectors (SSNTDs) have been widely used for the measurement of time integrated radon levels in dwellings under different conditions. The track detector used for this purpose must be calibrated for concentrations of radon and its daughters likely to be found in dwellings. The CR-39 plastic detector used in the present study is sensitive to alpha energy up to 40 MeV,

METHOD AND MATERALES:

This study includes indoor radon measurements in different compartments (living room, bedroom, seller , outdoor, bathroom and kitchen) of(6) houses.

All apartments have the same architectural design and finishing style,. The CR-39 nuclear track detector with $250x10^{-6}$m was used in this work. The detector was fragmented into squares (1x1 cm), lightly cleaned with absolute alcohol and then mounted in cans.110 CR-39-containing cans were used in triplets. Five sets (20 cans) were placed in the living room, bedroom, kitchen, bathroom, cellar and the balcony (as an outdoor) of each house. After one month exposure, cans were collected, detectors were removed and then etched in 6.25N NaOH solution at 70ºC for 3 hours. The track density was determined microscopically. To determine radon concentration.

The shape and dimension of used dosimeters and calibration process of the dosimeters take from the references (Rasas etal ,2005). In these survey, four dosimeters were exposed for 30 day of ^{226}Ra (Radon source)of activity concentration $800 Bq/m^3$. It gives ($2.12*10^4 Bq.day/m^3$) concentration for the total exposure. The rooms Radon gases monitor was a NITON RAD7 2500 number of tracks/cm^2 was found in these calibration detectors Radon concentration throughout pressed work are determined by the following equation (Al-Kofahi M etal 1992 , Khader B. , 1990)

$$C(Bq/m^3) = [\,Co(Bq.d/m^3)\,\rho] \;/\; [T\,\rho_o]$$

C_o = The total exposure of ^{226}Ra(Radon source)in term $Bq.d/m^3$

ρ_o = track density number of track/cm^3 of deter exposed to ^{226}Ra

ρ = track density(number of tracks/cm2)of distributed detectors.

T = exposure Tim (days)of distributed detectors.

RESULTS AND DISCUSSION :

The inhaled radon progeny passes from lungs into the blood and body tissues may indicate many types of soft tissue cancers such as lung cancer, kidney cancer and prostates cancer as well as leukemia, Melanoma and child cancers (Pawel DJ. and Puskin JS. ,2004, Frederic Lagarde and etal 2002,).

Building materials are a potential source of radon. Due to its hazardous effect on the health of man, many reports have investigated the indoor radon concentration (-Songul A and etal , 1999). Considering the difference in the design and finishing materials used indoor, we thought to further investigate radon concentration in different compartments within the same apartments, particularly the ventilation and finishing building materials may vary from one compartment to another.

Radon concentration was measured using triplets of CR- 39-containing cans during summer period. Table 2 shows the numbers of tracks per cm^2 in different location . Figure 3,4 and table 3 show the values of radon concentrations in different compartments (living room, bedroom, bathroom, caller, out door and kitchen) of 5 different apartments. The radon concentrations recorded range from 36.4 to 89.4 Bqm^{-3}, A significant variability, in radon concentrations, was observed among different compartments ($p<0.001$). Compared to the outdoor values all indoor compartments showed a significantly higher radon concentration ($p<0.001$). The mean values of radon concentrations in living rooms, bedrooms (1^{st} floor, 2^{nd} floor, 3^{rd} floor) bathrooms(1^{st} floor, 2^{nd} floor, 3^{rd} floor) , outdoor , caller and kitchens were: 58.088±5.72, (56.9±5.89, 56.89±5.36,57.068±5.58) ,(88.616±4.54 ,76.09±4.19,74.67±3.75) ,37.88±3.40 82.89±5.05, and 65.02±5.56 Bqm^{-3},Also, the results indicate that radon concentrations in some compartments like caller and bathrooms. It has also been noticed that the concentration of radon in lower floors is more than the average of its concentration in upper floors. This may be due to the fact that the average of radon concentration near the surface of the earth is higher than its average when far from it. in all apartments we investigated, were significantly higher ($p<0.001$) than the radon concentrations measured in living rooms out door and bedrooms, whereas no significant difference was observed between kitchens versus bathrooms ($p=0.25$) and bedrooms versus kitchens ($p=0.21$). Although kitchens and bathrooms are constructed mainly from the same skeletal building materials (concrete and cement blocks), the finishing materials used in such compartments, largely differ from that used in other locations within the same apartment. Ceramic, in particular is used extensively to replace the traditional painting materials, commonly used in living and bedrooms . Previous reports have indicated that ceramic is a potential source of radon, from where radon is mainly emerging from the decay of thorium and uranium in these materials (. Kenawy etal, 2000). Another factor explaining the high levels of radon and exhalation rates in these compartments, are the poor ventilation status due to the relatively narrow openings. Using natural gas in houses and supplying kitchens and bathrooms with water originated from underground sources are considered as a potential source for indoor radon (Hayam AbdelL Ghany,2005). Here we exclude the water-derived radon as the houses we investigated were supplied with Nile water.

Table 2 number of track per cm^2 in different location

location	1st house	2nd house	3rd house	4th house	5th house
cellar	415	390	365	370	415
bathroom					
1st floor	400	420	400	420	450
2nd floor	378	350	330	364	370
3rd floor	354	340	322	350	360
kitchen	270	310	300	310	340
living room	250	260	270	270	320
outdoor	160	170	170	190	200
Bedroom					
1st floor	294	250	220	260	290
2nd floor	262	266	238	275	300
3rd floor	240	276	241	284	317

The back ground levels in the nuclear track detector CR-39 is equal to 50 track/cm2

Table 3 radon concentration in unit Bq/m^3 in different location

location	1st house	2nd house	3rd house	4th house	5th house

cellar	**87.98**	**82.68**	**77.38**	**78.44**	**87.98**
bathroom					
1st floor	**84.8**	**89.04**	**84.8**	**89.04**	**95.4**
2nd floor	**80.13**	**74.2**	**69.66**	**78.02**	**78.44**
3rd floor	**75.04**	**72.08**	**68.62**	**74.2**	**76.32**
kitchen	**57.24**	**65.74**	**63.6**	**65.72**	**72.8**
living room	**53.0**	**55.12**	**57.24**	**57.24**	**67.84**
outdoor	**33.92**	**36.4**	**36.4**	**40.28**	**42.4**
Bedroom					
1st floor	**62.32**	**53.0**	**46.64**	**55.12**	**61.48**
2nd floor	**55.54**	**56.59**	**50.45**	**58.3**	**63.6**
3rd floor	**50.88**	**58.51**	**51.09**	**60.20**	**67.20**

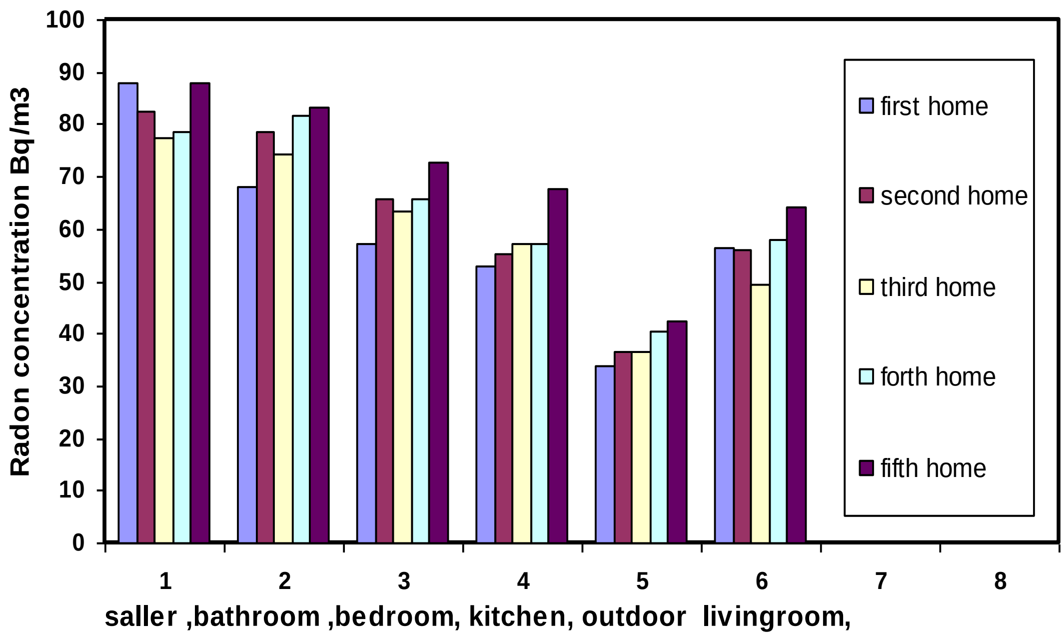


Figure 3 The radon concentration in different location of different houses

Figure 4 The radon concentration in different location

CONCLUSIONS :

This work reports that bathroom and caller have relatively high radon content compared to other compartments of the same dwelling. And the average of radon concentration near the surface of the earth is higher than its average when far from it, It is suggested that improvement of ventilation in such compartments is easily possible by simply reducing radon content of their ambient air.

قياس تراكيز الرادون في مساكن مدينـة كركوك

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الملخص:

يعد استنشاق غاز الرادون واحدا من المخاطر الصحية ، فمواد البناء والغاز الطبيعي والماء الموجود في باطن الأرض تشكل مصادر رئيسية لغاز الرادون ووليداته ، في هذا العمل تم قياس تراكيز الرادون في أبنية مدينة كركوك باستخدام كاشف الأثر النووي للحالة الصلبة CR-39 في أماكن مختلفة لمساكن مدينة كركوك وكانت نوعية مواد البناء متشابهة ، النتائج بينت إن مستويات تراكيز في الملاجئ والحمامات هي أعلى من مستوياتها في غرف المعيشة وغرف النوم والمطابخ وخارج البيت كما بينت الدراسة أيضا إن مستويات الرادون في الأماكن القريبة من سطح الأرض (الطوابق السفلى) هي اكبر مقارنة بالأماكن ولبعيدة من سطح الأرض (الطوابق العليا) وبينت الدراسة أيضا ان النتائج التي حصلنا عليها هي ضمن المستويات المسموح فيها عالميا لهواء المساكن .

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