Determination of Radon Exhalation Rates in Basrah Governorate (Iraq) using CR-39 Solid State Nuclear Track Detector (SSNTD's)

I.J. M. Alkhalifa and H. Bakr

Physics Department, College of Education, Basrah University, Basrah, Iraq

Abstract:

Radon emanation from ground of Basrah Governorate (Iraq) has been studied by using CR-39 solid state nuclear track detectors (SSNTD's) for the emitted α- particles. The "Can Techniques" were applied for 90 days, 20 stations have been taken at different places for this investigation. The measurements of radon exhalation rates shows significant variations in radon levels among the different areas. The highest value (0.34) Bq m-2 h-1 was found in Abulkhaseeb and the lowest value was found in Almaamra region (0.02) Bq m-2 h-1 . The influence of radon source on the radon emanation rates is also discussed.

قياس انبعاثية الرادون في محافظة البصرة (العراق) باستخدام تقنية الكواشف الاثر الصلبة النووية (SSNTD's)

عيسى جاسم محمد و حمزة بكر سلمان

جامعة البصرة- كلية التربية – قسم الفيزياء، بصرة – العراق

الخلاصة:

تمت دراسة انبعاثية الرادون في اماكن مختلفة من محافظة البصرة (العراق) باستخدام كواشف الأثر الصلبة النووية (SSNTD's). استخدم الكاشف CR-39 الذي يسجل آثار جسيمات α الناتجة من انبعاث غاز الرادون.تم اختيار 20 محطة قياس في اماكن مختلفة لهذه الدراسة ولفترة تعرض استغرقت 90 يوماً. اثبتت الدراسة بأن معدل الانبعاثية تتغير بشكل كبير من منطقة الى اخرى. أعلى قيمة له وجدت في منطقة ابو الخصيب (0.34 Bq m-2 h-1) وأقل قيمة له في منطقة المعامرة (0.02 Bq m-2 h-1). نوقشت كذلك تأثيرات مصادر الرادون على معدل الانبعاث الاشعاعي له.

Introduction:

Radon 222Rn, originates from the decay of radium, 226Ra, which itself is a member of the Uranium (U238) decay series. Although radium occurs in virtually all type of rocks and soil, its concentration varies with the specific site and geological material.

The assessment of radiological risk related to inhalation of radon and radon progeny is based mainly on the integrated measurements of radon (Ramola et al 2006). Radon migrates through pores in soil, fractures in rocks and along other weak zone, such as shears, faults, thrust, etc. (Salonon and Hukkanen, 1997; Wiegand, 2001) . Migration of radon in geological structure is governed by two mechanisms: diffusion and connection, several studies on radon and its correlation with geology have been carried out in different parts of the world (Gundersen et al, 1992; Choubey,1994) .Radon emission from soil, rocks and degassing from water are of significant interest due to the source of radon in houses and geological mapping. Terrestrial radiation is emitted from natural radio-nuclides present in varying amounts in soil, air, water and other environmental materials (UNSCEAR, 2000). The levels of radioactivity in soil are important mainly because of two principle radiological effects. The first is internal irradiation of lungs by alpha-emitting short-lived decay products of radon and thoron and the second is the external irradiation of the body by gamma rays emitted from radio-nuclides present in the area (ICRP, 1993; UNSCEAR, 2000).The usual method for measuring the radon emanation is to place plastic detectors inside cups and to bury these at small distance below the surface of the soil in a grid pattern covering the area to be measured. Alpha-particles tracks recorded in the polymer CR-39. There is evidence that the radon transport is faster than can be accounted for the simply on the basis of diffusion of the emanation and some bulk of radon-bearing air must be occurring (Fleischer and Mogro-Campero, 1977).

This study presents the results of a radon/thoron emanation in different places of Basrah city-Iraq.

Experimental Method:

CR-39 manufactured by Pershore Moulding Ltd. (U.K.) were fixed in the bottom of cylindrical plastic container of diameter (5.5 cm) and high (4 cm), ground was digging in different place of Basrah governorate and the can buried up side down and covered by the same soil. All dosimeters left in position for almost three months. After this period the dosimeters were collected and the detectors were taken out of the dosimeters and then the films were etched in NaOH solution of optimum conditions of etching, ensuring good sensitivities of the solid state nuclear track detector

(SSNTD) and a good reproducibility of registered track density rates (6.25N at (70 ± 2 0C) for (6 h) Jackson and French , 1997 . After this chemical treatment, the track densities registered on CR-39 were measured by using an optical microscope type Litze. Background on the CR-39 detectors were evaluated by etching CR-39 detectors unburied under the same condition of etching and counting the resulting track density were subtracted from buried one. The track density was converted into radon concentration in Bq/ m3 using the calibration factor obtained at Bristol University ,Al-kofahi et al 1992. This calibration states that every 22.4 track per cm2 on CR-39 detectors corresponding to an exposure of 1KBq / m3 per hour for the activity of radon gas and its daughter. The overall uncertainty in the counting system has been estimated to be between 10– 20 (Jackson and French , 1997).The exhalation rate was calculated using the following equation (Durrani and Ilic, 1997)

$$E_x = \frac{CV\lambda / A}{T + (e^{-\lambda T} - 1) / \lambda}$$

Where Ex is exhalation rate , C is the integrated exposure measured by the detector, λ decay constant, T is the exposure time , V is the volume of the can and A is the surface area covered by the can.

Results and Discussions:

In this investigation the governorate of Basrah is considered as the first place for the radon survey to establish radon map of Iraq. Twenty station at different location have been taken to cover the most areas of Basrah Governorate in Iraq.

Fig. 1(a) shows the map of Iraq's governorates, while Fig. 1(b) shows the location of the stations of radon measurements sites. As you see we did our best to cover most of the governorate of Basrah area.

Table 1. presents the results of radon exhalation rate in the study area, as well as the location of the stations measurements, and these results are shown in Fig. 2. The radon exhalation rate was found to vary from 0.02 to 0.34 Bq m-2 h-1 .The lower value was recorded at Station 9 , while the high value recoded at Station 12. The high values of radon exhalation rate may be attributed due to the presence of high uranium concentration in the soil observed in Abul-Kaseeb by (Al-Khalifa et. al. ,1998). The variation emanation is also depending on the litho logical formation of the area (Ramola et al , 2006).

Conclutions:

The radon exhalation rates using passive measuring technique showed a period of three months would be sufficient for the investigation . There are significant variation in radon levels (i.e radon exhalation) among the different areas Abul-khaseeb has the highest value (0.34) Bq m-2 h-1 , while Al Maamra is characterised by the lowest one (0.02) Bq m-2 h-1.

The emanation of radon from soil has direct relationship with the indoor radon concentration and high indoor radon concentration observed in some place of study area (Al-Khalifa et. al. ,1998).

The technique of SSNTD has the advantage of being simple, accurate, inexpensive, and non destructive . The study also shows the radiation emanation from ground depends on the soil nature of the aquifers .The study of another governorates are in progress.

References:

Al-Khalifa I. J. M., A. AL-Saad Al- Hindas and Bakr H. Indoor radon measurements in Basrh city (Iraq) using solid state nuclear technique. J Basrah Researcher, 10 (1998) 5.

Al- Kofahi M , M, Khader B. R. , Lehlooh A. D. Kullab M. K. , Abumurad K. M. and Batania B. A. , Measurements of radon -222 in Jordanian dwelling, Nucl. Tracks Radiat. Meas. 20 (2) (1992)377.

Choubey V.M. Ramola R.C. Sharma K.K. , Soil gas and indoor radon studies in Doon vallege, Nucl. Geophys., 8(1994)49.

Durrani S.A. and Ilic R (Eds), Radon measurements by etch track detectors: Applications to radiation protection. Earth Sciences and Environment. Word scientific, Singapore ,(1977).

Fleischer R.L. and Morgro-Campero A. Mapping of integrated radon emanation for detection of long-distance migration of gases with the earthy Techniques and principles, J. Geophys. Res. 83(1977)3539.

Gundersen L.C.S. , Schumann, R.R. Otton, J.K. Dubiel R.F., Owen D.E. Geology of radon in united state . In Gates, A.E. Gundersen L.C.S. (eds).Geological control of Radon Geol. Soc. Am. 271(1992)1.

ICRP, Protection against Radon-222 at Homes and at works ICRP, Publication 65, Pergamon Press, Oxford.

Jackson M. and Franch A. P. Analysis of acceptances testing data for more than 800 sheets of CR-39 plastic assist for DRTS dosimetery Rad. Prot. Dosim. 70 (1-4) (1997) 139.

Ramola R.C., Choubey V.M., Yogesh Prasad, canesh prosad and Bartarya S.K. terrestrial gamma radiation dose rate in the relation to the

litho logy in southern part of rumaon Himalaya, India. Radiation measurement 41(2006)714.

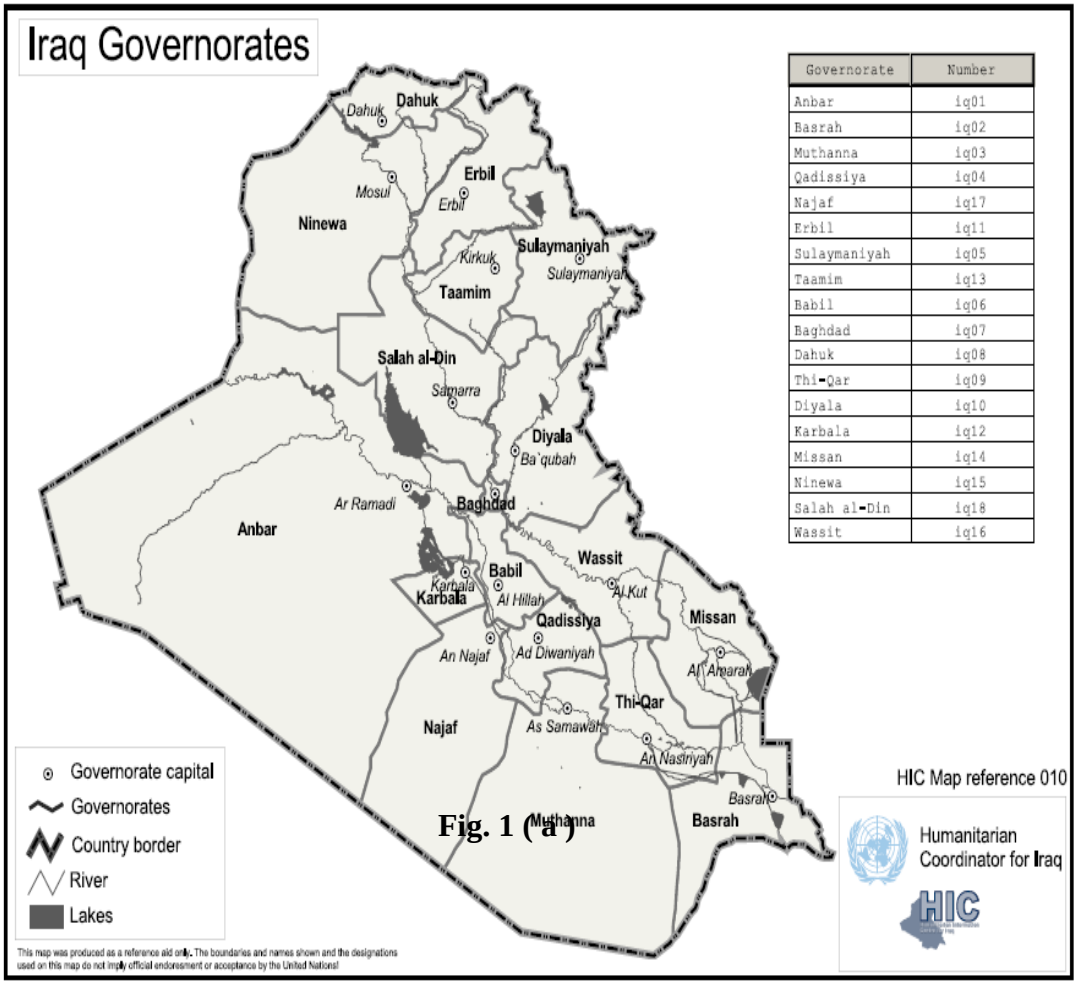
Salonen L., Hukhanen H., Advantages of Low-back ground liquid scintillation alpha-spectrometry and pulse shape analysis in measuring Ra222, uranium and Ra226 in ground water samples, J., Rational Nucl. Chem. 226(1997)67.

UNSCEAR, 2000 United Nations Scientific Committee on the Effect of Atomic Radiation Exposure from Natural Radiation Sources United Nation, New York.

Wiegand J. A guide line for the evaluation of soil radon potential based on geogeric and anthropogeric parameters. Environ, test 40(2001)949

Station No.	Location	Radon Exhalation Rates Bq m^{-2} h^{-1}
1	Al Qurnah	0.12
2	Al Ez	0.18
3	Telha	0.09
4	Al mdayna	0.27
5	Al Nashwa	0.22
6	Al Dear	0.18
7	Al Hartha	0.27
8	Al Tanuma	0.04
9	Al Maamra	0.02
10	Al Basrah centre	0.08
11	Al Zubear	0.06
12	Abul khaseeb	0.34
13	Al Seeba	0.09
14	Al Barjesia	0.17
15	Dour Al Petro	0.13
16	Umm Qasr	0.16
17	Safwan	0.10
18	Khoor Al Zubear	0.22
19	Al Behar	0.09
20	Al Faw	0.13

Table -1-



Governorate	Number
Anbar	iq01
Basrah	iq02
Muthanna	iq03
Qadissiya	iq04
Najaf	iq17
Erbil	iq11
Sulaymaniyah	iq05
Taamim	iq13
Babil	iq06
Baghdad	iq07
Dahuk	iq08
Thi-Qar	iq09
Diyala	iq10
Karbala	iq12
Missan	iq14
Ninewa	iq15
Salah al-Din	iq18
Wassit	iq16

Fig. 1 (a)

Fig. 1(a)

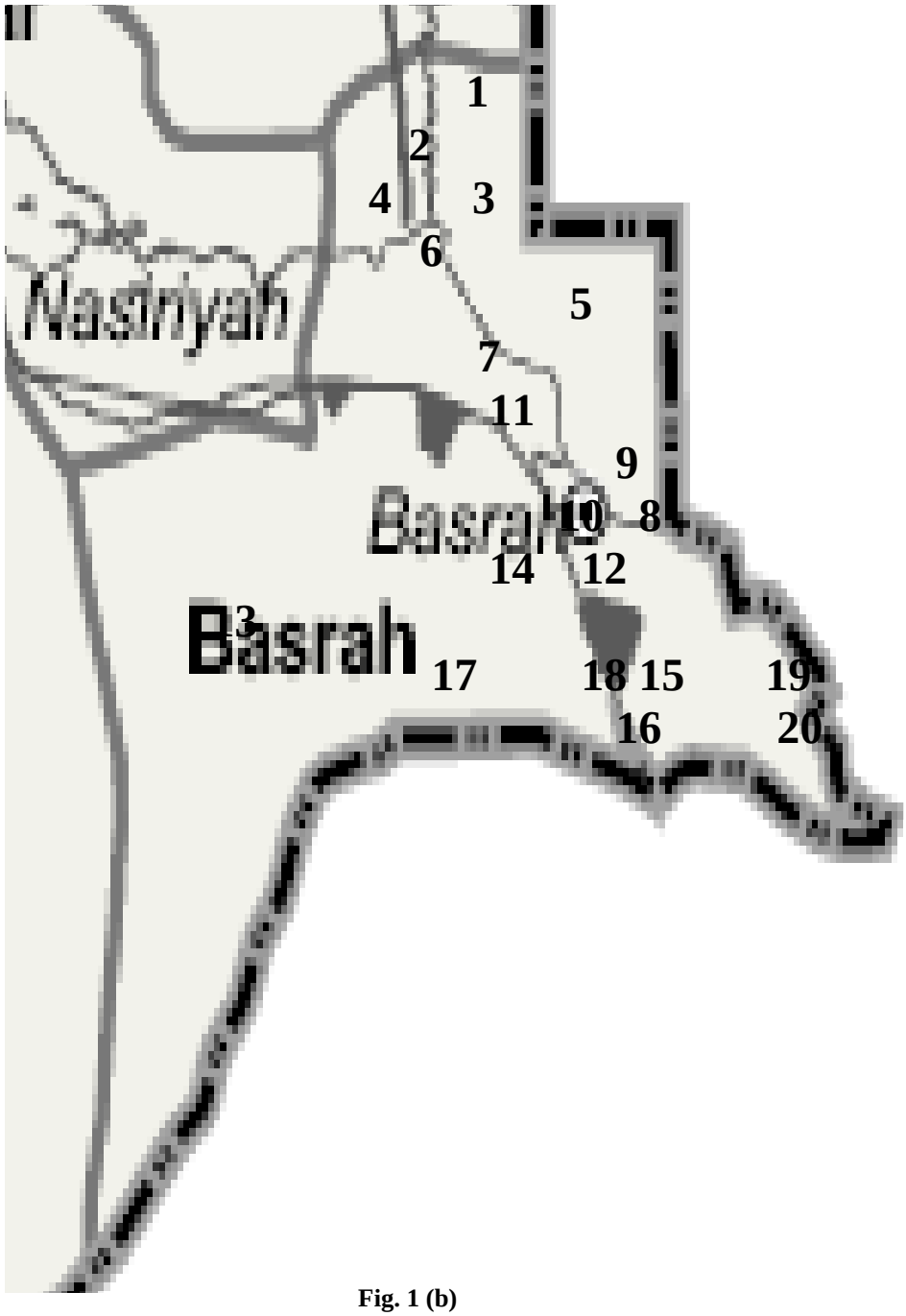

1
2
4
3
6
Nasiriyah
5
7
11
9
Basrah
10
8
14
12
Basrah
13
17
18
15
19
16
20

Fig. 1 (b)

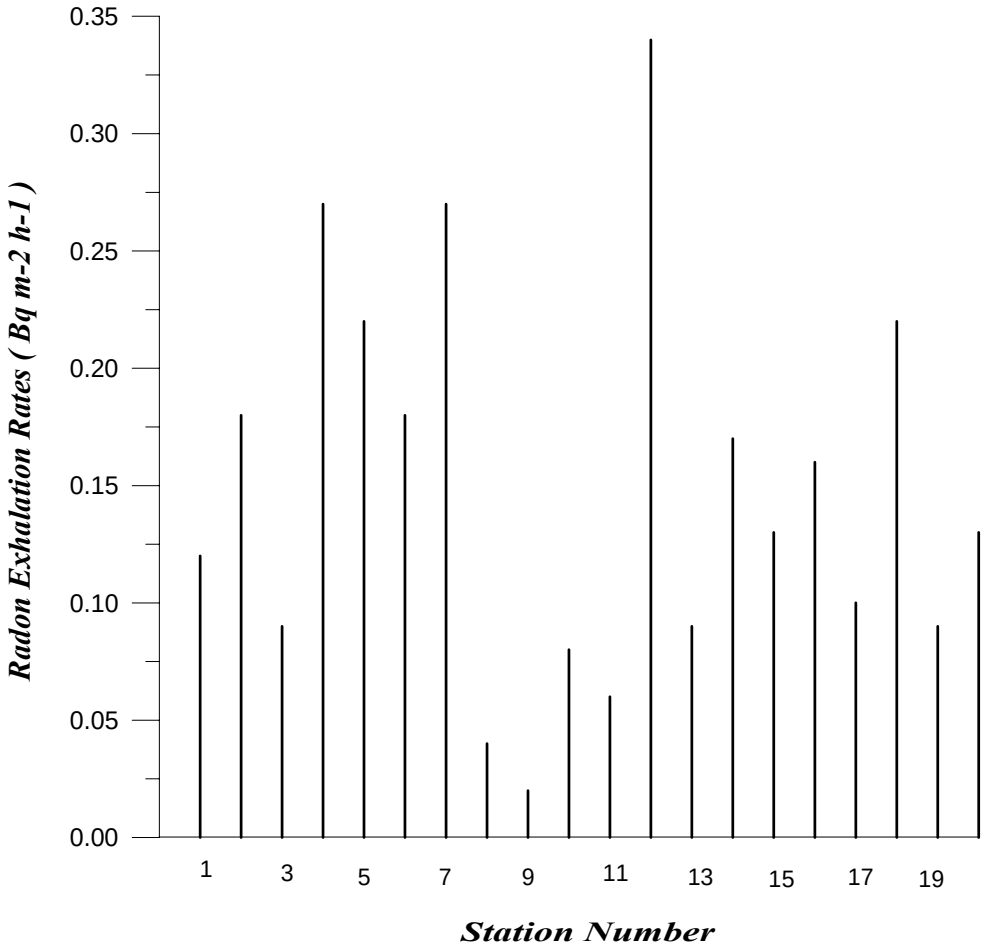


Fig. 2

Figure captions:

Table -1- shows the location of the station measurements as well as the radon exhalation rates.

Fig. 1(a) shows the map of Iraq governorates.

Fig. 1(b) shows the location of the stations of the radon exhalation rates measurements in Basrah governorate.

Fig. 2 shows the radon exhalation rates vs. station number.