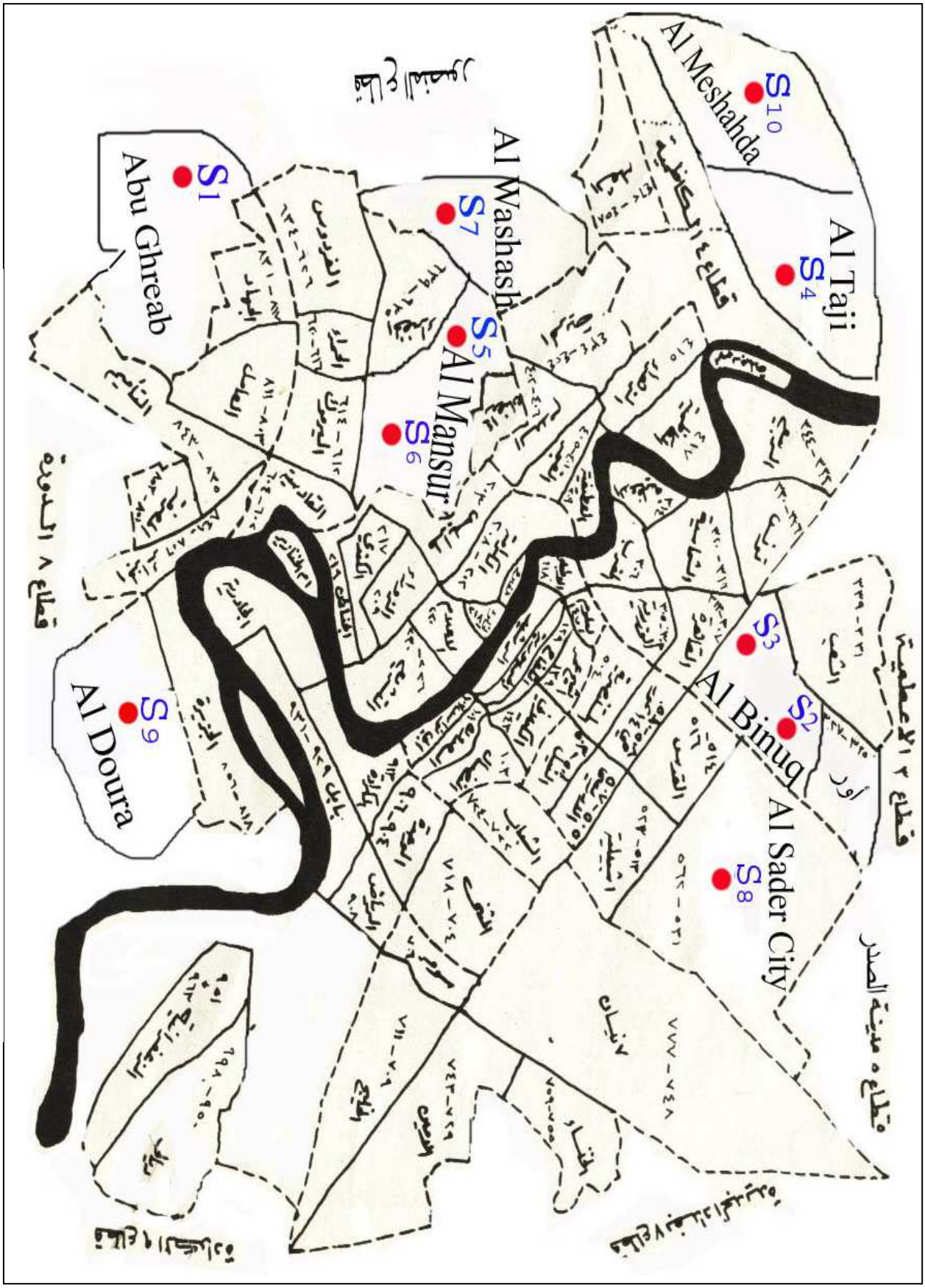

Fig. (3.1) The locations of collected soils samples from different sites in Baghdad city [92] .

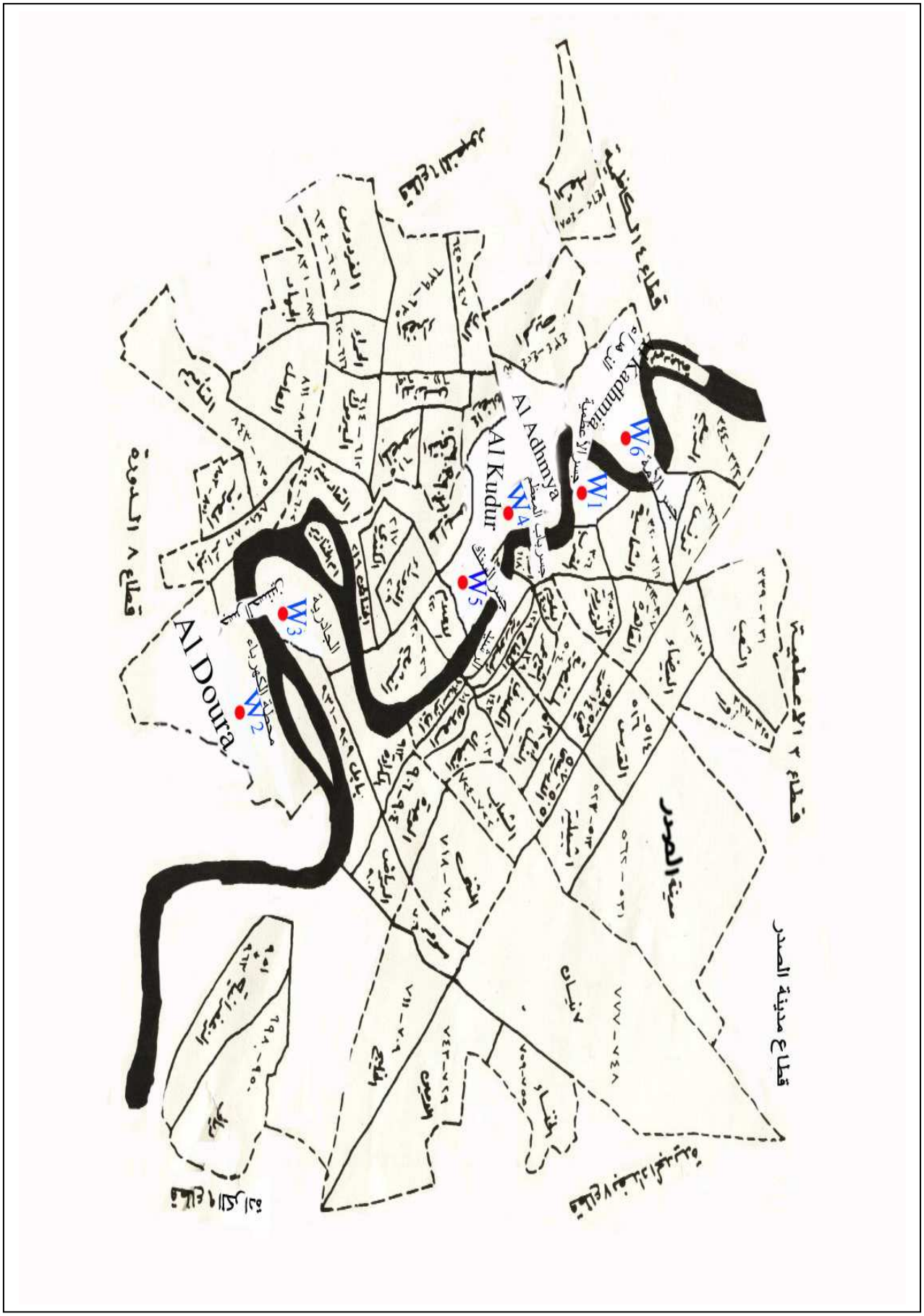

Fig. (3.2) The locations of collected water samples from different sites in Baghdad city (Tigris river) [93].

Fig. (3.3) The locations of collected soils samples from different sites in Karbala city [94] .

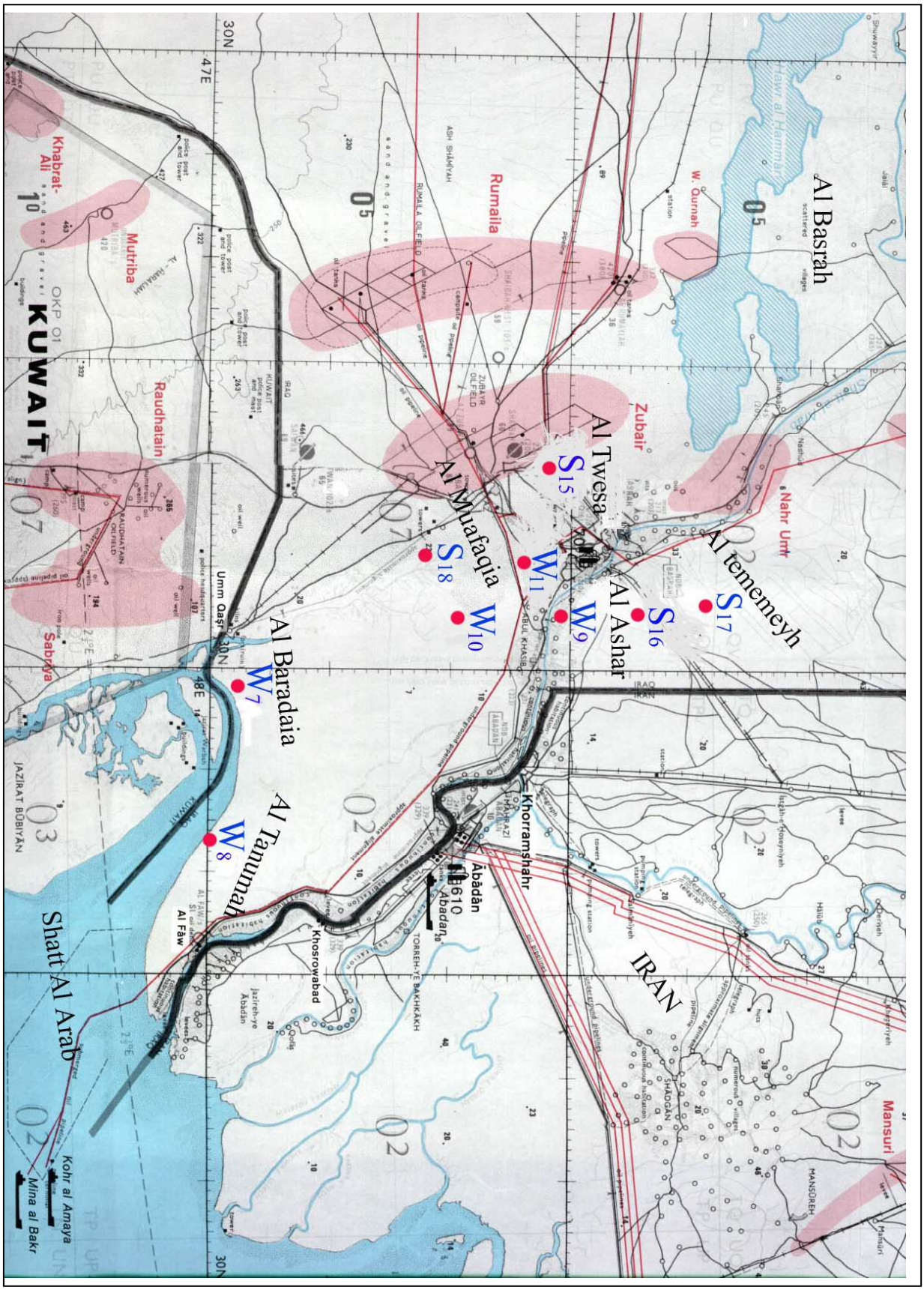

Fig. (3.4) The locations of collected soils and water samples from different sites in Basrah city [95].

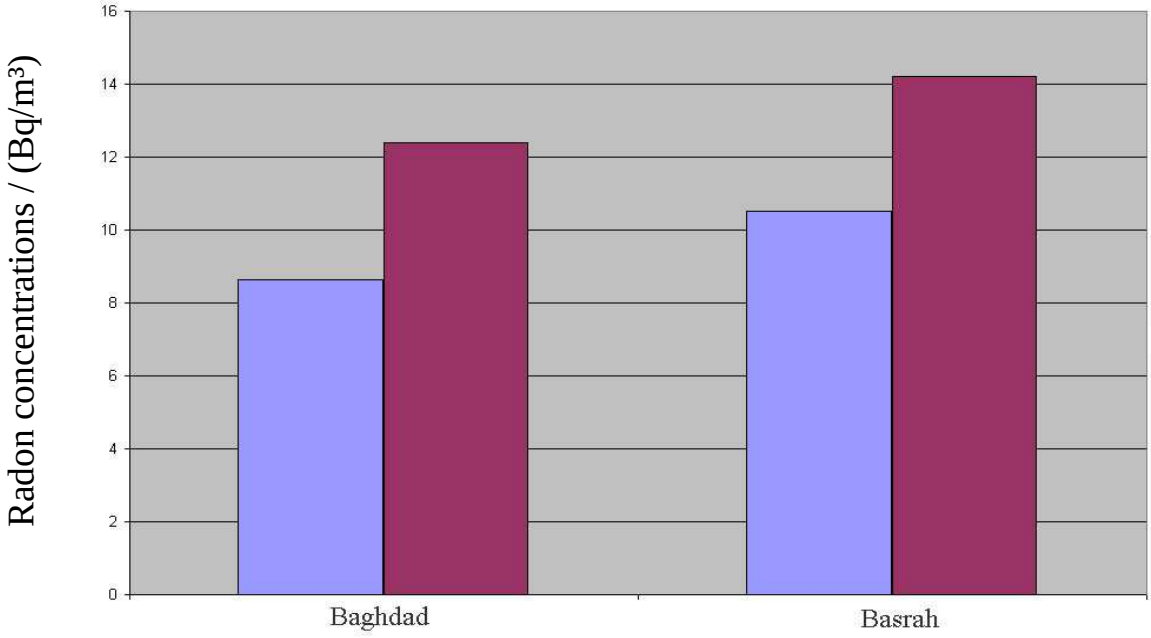

Fig. (4.8) Min. and Max. of radon concentrations in water samples.

4.3. Conclusions

The discussion of the results, which are obtained from this study leads to the following conclusions :

1- The uranium concentration varies from 1.57 to 2.73 ppm and from 0.67 to 2.12 ppm in soil and water samples respectively and less than the allowed limit (11.7 ppm).

2- The radon gas concentration varies from 226.89 to 665.56 Bq/m^3 and from 8.64 to 14.20 Bq/m^3 in soil and water samples respectively and less than the limit recommended (100 Bq/m^3).

3- The maximum uranium concentration in soils was (2.73 ppm) and in water (2.12ppm) in the Al-Taji and Al-Ashaar regions respectively .

4- The maximum radon gas concentration in soils was (665.56 Bq/m^3) and in water (14.20 Bq/m^3) in the Al-Taji and Al-Ashaar regions respectively .

5- Radionuclides (^{222}Rn and ^{238}U) had high concentration in site (S_4) and in site (W_9) because these sites are a field of a military operations during the war against Iraq in 2003.

4.4. Suggestions and Future Orientations

1- Study the radioactivity in soil and water by using γ-ray spectroscopy technique.

2- Study the uranium concentrations in biological samples for people living at these regions.

3- Study the uranium and radon gas concentrations for some weapons materials were using in military operations.

جمهورية العراق
وزارة التعليم العالي والبحث العلمي
جامعة النهرين
كلية العلوم

دراسة النشاط الأشعاعي لنماذج من التربة والماء في بغداد وكربلاء والبصرة

رسالة
مقدمة الى كلية العلوم، جامعة النهرين كجزء من متطلبات نيل شهادة الماجستير علوم في الفيزياء
من قبل

مصطفى عرب بداي البيضاني
بكالوريوس - جامعة النهرين
(٢٠٠٣)

جمادي الأولى ١٤٢٧هـ
حزيران ٢٠٠٦م

Examination Committee Certificate

We certify that we have read the thesis entitled "***Determination of Radioactivity in Soil and Water in Baghdad, Karbala and Basrah Samples***" and as Examining Committee, examined the student ***Mustafa Arab Badai Al-Baidhani*** in its contents and what is related to it, and that in our opinion it is adequate as standard of thesis, with ***Excellent*** standing of degree of Master of Science in Physics.

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References

[1] Silk, E.C. and Barnes, R.S. "***Phil.Mag***.", **4**, (1959), 970.

[2] Price, P.B. and Walker, R.M. "***Phys.Rev.Lett.***", **8,** (1962), 217.

[3] Price, P.B. and Walker, R.M. "***Appl.Phys.***", **33,** (1962), 3400.

[4] Fleischer, R.L. and Price, P.B. "***Science***", **140,** (1963), 1221.

[5] Fleischer, R.L. , Price, P.B. , Walker, R.M. and Hubbard, R.L. "***Phys.Rev.***" , A **133**, (1964), 1443.

[6] Fleischer, R.L. , Price, P.B. and Walker, R.M. "***Nuclear Tracks in Solids: Principles and Applications***", Pergammon Press, Berkeley (1975).

[7] Durrani, S.A. and Bull, R.K. "***Solid State Nuclear Track Detection: Principles, Methods and Applications***", Pergammon Press, U.K. (1987).

[8] Durrani, S.A. "***Nuclear Track Detection***", Pergammon Press, London (1976).

[9] Granzer, F. , Paretze, H.G. and Schopper, E. "***Nucl.Inst.Meth.***", **147,** (1977), 1.

[10] Benton, E.V. and Mekeever, S.W.S. "***Radiation Measurement***", Proc. of the 20th Inter. Confer. on Nucl. Tracks in Solids, **34,** (2001), 1-6.

[11] Fleischer, R.L. and Lovett, D.B. "***Giochim. Cosmochim.***", **32,** (1968), 1126.

[12] Hashimoto, T. "***Analy.Chim.Acta.***", **56**, (1971), 347.

[13] Fleischer, R.L. and Delany, A.C. "***Analy.Chim.***", **48,** (1976), 642.

[14] Espinosa, G. , Moreno,A. and Golzarri,J.I. , "***Proc. of the 11th Inter. Confer. on SSNTDs***", Lyon, (1981), 591-595.

[15] Ritter, W. , Mark, T.D. , Bertagnolli,E. and Vartanion, R. , "***Proc. of the 20th Inter. Confer. on SSNTDs***", Lyon, (1981), 605-607 .

[16] Yegingil, Z. and Goksu, Y. "***Nucl. Track & Radia. Meas.***" **6** No.1, (1982), 46-48.

[17] Gamboa, I., Espinosa, G., Moreno, A., Golzarri, J. & Castillo, F. "***Uranium Determination in Mineral Rocks by SSNTD***", Nucl. Track & Radia. Meas., **8** No.1-4, (1984), 443-445.

[18] Singh, N.F., Singh, M., Singh, S. and Virk, H.S. "***Nucl. Tracks and Radia. Meas.***" **8**, (1984), 483 .

[19] Ellis, W.R. and Ahsanullah, M. "***Nucl. Tracks and Radia. Meas.***" **8,** (1984), 437.

[20] Yanchou, L.U., Jingzhao, Z., Jun, X. and Xueli, W. "***TL Dating of Pottery Sherds and Backed Soil frpb the Xian Terracotta Army Site, Shaanxi Province, China***", Nucl. Track & Radia. Meas.,**14** No.½ , (1988), 283-286.

[21] Tawfiq, N.F. "***Determination of Uranium Concentrations in Rocks by Using (SSNTDs)***", M.Sc. thesis, University of Baghdad, (1989).

[22] Marouf, B.A., Al-Haddad, I.K., Tomma, N.A., Mahmood, J.A. and Tawfiq, N.F. "***Monitoring of Environmental Radioactivity Around the Tuwaitha Site***", Environmental Management and Health, **3** No.3, (1991), 14-17.

[23] Tawfiq, N.F. "***Study Comparssion in Some of Organic and Inorganic Track Detectors and Applications in Environment***", Ph.D thesis, University of Al-Mustansiriyah, (1996).

[24] Abdul-Hussain, Sh. "***Determination of Radioactiv Materials Concentration in Soil by Using Spectral Analysis Technique for Gamma Ray***", M.Sc. thesis, University of Baghdad, (1996).

[25] Omar, A.A. "***Determination of Uranium Concentrations in Yamen Rocks Samples by Using Nuclear Techniques***", Ph.D thesis, University of Baghdad, (2000).

[26] Abdul-Hussain,S. "***Determination of Radon Concentrations in Sand for Maysan City by Using Nuclear Track Detector (CR-39)***", M.Sc. thesis, University of Baghdad, (1986).

[27] Saied, B.M. "***Determination of Radon Concentrations in Buildings by Using Nuclear Track Detector (CR-39)***", M.Sc. thesis, University of Baghdad, (1998).

[28] Chuscielewski, W. and Kaminski,Z. "***Occup.Medic.Environ.Health***", **12**, (1999), 229.

[29] Auff, A.M. "***Determination of Radon Concentrations in Limited Regions in Al-Mausul City by Using Organic Nuclear Track Detector (CR-39)***", M.Sc. thesis, University of Al-Mustansiriyah, (1999).

[30] Al-Ani, D.F. "***Measurement the Radioactivity of Emission Radon from Some of Building Materials***", M.Sc. thesis, University of Al-Mustansiriyah, (2000).

[31] Jamil, K., Ali, S. and Dogar, A., "***Proc. Of the 20th Inter.Conf. on SSNTDs***" , Slovenia, (2000), 42.

[32] Murtazaev, K., Michel, M., Vladimir,P and Murtazaev, A. "***Proc. Of the 20th Inter.Conf. on SSNTDs***" , Slovenia, (2000), 74.

[33] Aharmim, B., Marah, H. and Sabir, A. "***Proc. Of the 20th Inter.Conf. on SSNTDs***" , Slovenia, (2000), 111.

[34] "قياس تركيز غاز الرادون في التربة"، مسعود صالح خليفة، صالح محمد عبد السلام
مركز البحوث النووية، تاجوراء-ليبيا http://www.tnrc.org/index.htm

[35] Baradacs, E., Hunyadi, I., Dezso, Z., Csige, I. and Szerbin, P. "***Radia. Measur.***" **34,** (2001), 385.

[36] Singh, S., Malhotra, R., Kumar, J., Singh, B. and Singh, L. "***Radia. Measure.***" **34**, (2001), 472.

[37] Hunyadi, I., Csige, I., Hakl, J., Baradcs, E. and Dezs, Z. (2001), http://www.atomaki.net .

[38] Cameron, J.R. and Skofronick, J.G. "***Medical Physics***", New York, Canada, United State of American, John Wiley and Sons, Inc., (1992), 386-388.

[39] Durance, M.E. "***Radioactivity in Geology***", John Wiley and Sons, New York, Elsiever, (1986).

[40] Chase, G. and Rabinowitch, J. "***Principle of Radioisotope Methodology***", 3rd edition, Mineapolis, Burgess publishing Co., (1967).

[41] Knoll, G.F. "***Radiation Detection and Measurement***", John Wiley and Sons, USA, (1979).

[42] United Nations Unvironmental Programme, UNEP "***Radiation Doses, Effects, and Risks***", United Nations, (1985).

[43] Chapman, N.A. and McKinley, I.G. "***The Geological Disposal of Nuclear Waste***", John Wiley and Sons, UK., (1987).

[44] United Nations Scientific Committee on the Effects of Atomic Radiation, UNSCEAR "***Sources, Effect, and Risks of Ionizing Radiation***", Report to the general Assembly with Scientific Annexes, United Nations, (1993).

[45] Zajic, V.S. "***Review of Radioactivity, Military Uses and Health Effects of Depleted Uranium***", July, (1999).

[46] Martin, A. and Harbison, S.A "***An Introduction to Radiation Protection***", 3rd edition, Great Britain, London, Arrow Smith Ltd., Bristol, (1986).

[47] Friedlander, G., Kennedy, J.W. and Miller, J.M. "***Nuclear and Radiochemistry***", 2nd edition, John Wiley and Sons Inc., (1964).

[48] International Commission on Radiological Protection, ICRP: "***1990 Recommendations of ICRP***", Publication 60, Pergamon Press, Oxford and New York, 1990.

[49] Eisenbud, M. "***Environmental Radioactivity***", 4th edition, Academic press Inc, London, (1997).

[50] Scharama, S.C.L. and Metha, G.K. "***Nucl. Instr. Meth.***", **178**, (1980), 217.

[51] Cieslak, E., Piekarz, J. and Akrzewski, J.Z. "***Nucl. Instr.Meth.***", **39,** (1966), 244.

[52] Vater, P., Becker, H.J., Brandt, R. and Freiesleben, H. "***Phys. Rev. Lett.***", **39,** (1963), 594.

[53] Gore, D.J., Thorne, M.C. and Watts, R.H. "***Phys. Med. Bio.***", **23,** (1978), 149.

[54] Fews, A.P. and Henshaw, D.L. "***Proc. of the 10th Inte. Confer. on SSNTDs***", Bristol, (1979), 705 .

[55] Henshaw, D.L., Fews, A.P. and Webstar, D.J. "***Proc. of the 11th Inte. Confer. on SSNTDs***", Lyon, (1981), 649-654.

[56] Fleischer, R.L., Price, P.B. and Walker, R.M. "***Geochim.Cosmochim.Acta.***", **29,** (1965), 161.

[57] Seal, S. "Cancer", **17**, (1964), 549.

[58] Tress, G., Ellinger, M., Khan, E.U., Khan,H.A., Vater, P., Brandt, P. and Kadner, M. "***Nucl.Tracks***", **6,** (1982), 87.

[59] Al-Ani, Z.K., "***A Study of Transter Factor of Radio Nuclides from Soil to Plant***", M.Sc. thesis, University of Al-Nahrain, (2000).

[60] Kobayashi, T. and Fujii, M. "***Nucl. Tracks***", **15,** (1988), 175.

[61] Nichulas, T., "***Measurement and Detection of Radiation***", Pergammon Press, University of Missouri-Rolla, U.K., (1987).

[62] Fischer, B.E. and Sphor, R. "***Rev.Mod.Phys.***", **55,** (1983), 129.

[63] Benton, E.V. "***Radia. Effec.***", **2,** (1970), 273.

[64] Fleischer, R.L., Price, P.B. and Walker, R.M."***Ann.Rev.Nucl.Sci.***", **15,** (1965), 1.

[65] Fleischer, R.L., Price, P.B. and Walker, R.M. "**Science**", **149,** (1965), 383.

[66] Fleischer, R.L. and Price, P.B. "***Appl.Phys.***", **34,** (1963), 2903.

[67] Hushemi, S.R. and Durrani, S.A. "***Nucl.Tracks***", **5,** (1981), 189.

[68] Fremlin, J.H. and Wilson, C.R. "***Nucl.Instr.Meth.***", **173,** (1980), 201.

[69] Hepburn, C. and Windle, A.H. "***Material Sci.***", **15,** (1980), 279.

[70] Price, P.B., Lai, D., Tamtance, A.S. and Perelygin, V.P. "***Earth Planet Sci.Lett.***", **19,** (1973), 377.

[71] Fleischer, R.L., Price, P.B. and Woods, R.T. "***Phys.Rev.***", **88,** (1969), 563.

[72] Yammamoto, M. and Yasuda, N. "***Radia.Measur.***", **28,** (1997), 227.

[73] Blanford, G.E., Walker, R.M. and Wefel, J.P. "***Radia.Effects***", **3,** (1970), 267.

[74] Marouf, B.A. "***Gamma Radiation Dose to the Iraqi Population due to the Chernobyl Accident***", Radiation Protection Dosimetry, **42** (1992).

[75] United Nations Environmental Program, UNEP "***Depleted Uranium in Kosovo***", Scientific Mission to Kosovo, post–conflict environmental assessment, (2001).

[76] Fahey, D. "***Collateral Damage: How U.S. Troops were Exposed to DU during the Gulf War***", DU education project, Metal of Dishonor, International Action Center, New York, (2003).

[77] Durakovi, A. "***Medical Effects of Internal Contamination with Uranium***", Department of nuclear medicine, George town University School of Medicine, Washington D.C., USA, **40** No.1, (1999).

[78] Rosalie, B. "***The Host Response to Depleted Uranium***", (2000).

[79] Guenther, S.H.: "***Uranium Projectiles: Severely Maimed Soldiers, Deformed Babies and Dying Children***", Documentation of the aftermath's of the Gulf War, Ahriman-Verlag, Germany, (1993-1995).

[80] Kolhatkar, S. "***Depleted Uranium: A Review of its Properties, Potential Danger and Recent Use in Yugoslavia***", (2000).

[81] Army Environmental Policy Institute, AEPI "***Health and Environmental Consequences of Depleted Uranium Use by the U.S Army***", US.AEPI, Technical Report, June, (1995).

[82] Neboysha, L. "***Environmental Impact on Humans During the Gulf War***", Text Report of Internet Communication Between Prof. Neboysha and Prof. Sharma, (1999).

[83] Caldicott, H. "***A New Kind of Nuclear War***", DU education project, Metal of Dishonor, International Action Center, New York, (1997).

[84] World Health Organization, WHO "***Depleted Uranium Sources, Exposure and Health Effects***", (2001).

[85] Hoskens, E. "***Depleted Uranium Shells Make the Desert Glow***", DU education project, Metal of Dishonor, International Action Center, New York, (2003).

[86] Lymburner, D. "***Another Human Experiment***", DU education project, Metal of Dishonor, International Action Center, New York, (2003).

[87] Gayb, D.H. "***Measurement of Alpha Emitters Concentration in Tigris River Water in Baghdad City Using CR-39 Plastic Track Detector***", M.Sc. thesis, University of Al-Nahrain, (2002).

[88] Berger, M. "***Nuclear Technology***", **19,** (1973), 188.

[89] Al-Jobori, S.M., Tawfiq, N.F. and Al-Saji, A.W. "***Effedt of the Use of DU***", Proc. of Inter.Conf., Baghdad, **1,** (2002), 64-70.

[90] Amalds, O., Custball, N.H. and Nielsen, G.A. "***Cs-137 in Montarq Soils***", Health Physics, ***57*** No.6, (1989), 955-958.

[91] Bansal, V., Azam, A. and Prasad, R. "***Health Physics***", **27,** (1989), 985.

[92] http://www.maps of world.com/iraq/Baghdad-city_map.html.

[93] http://www.maps of world.com/iraq/Baghdad-Tigris river_map.html.

[94] http://www.mapquest.com/maps/map.adb?city=karbala & state=Iraq & zoom=5.

[95] http://www.mdtravelhealth.com/external_5/iraq_2.html.

[96] World Health Organization, WHO "***Guidelines for Drinking-Water Quality***", 2nd ed., Geneva, (1993).

[97] Harigel G.: "***Depleted Uranium Weapons-A Threat to Human Health?***" 2002.

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Symbol	Description
Am-Be	Americium –Beryllium Source
Bq	Bequerel
ºC	Degree Centegrate
C_S	uranium concentration of standard sample
C_X	uranium concentration of unknown sample
D	diameter of the etch pit
DU	Depleted uranium
E_B	Activation Energy of the Bulk Etching
E_T	Activation Energy of the Track Etch
EPA	Environmental Protection Agency
h	thickness of the surface removed by etching
IAEA	International Atomic Energy Agency
ICRP	International Committee of Radiation Protection
k	Boltzman constant = 1.38×10^{-23} j mol /K
KOH	Potassium Hydroxide
L	length of the latent track
LSA	Low Specific Activity
n	neutron
N	Normality
NaOH	Sodium Hydroxide
ppm	Part Per million

R	Length of track at the removed surface
R.O.	Reverse Osmosis
S	Soil sample
SSNTDs	Solid State nuclear track detectors
t	etching time
T	Temperature of the etching solution
UNEP	United Nation Environment Program
UNSCEAR	United Nation Scientific Committee on the Effects of Atomic Radiation
V	volume of distilled water
V_B	bulk etch rate
V_T	track etch rate
w	the weight of NaOH
W	Water sample
w_{eq}	equivalent weight of NaOH
WHO	World Health Organization
Z	Atomic Number

Symbol	Description
α	Alpha particle
Ø	Incident angle
$Ø_C$	Critical angle
η	Etching efficiency
ρ	Track Density
ρ_S	track density of standard sample
ρ_X	track density of unknown sample
µm	micrometer
µg	microgram

3.1. Introduction

This chapter describes the methods for estimation of depleted uranium and radon gas concentrations for the different samples of soil and water (natural and standards) from different sites in Iraqi regions .The materials and the apparatus which used included.

3.2. Collection of Samples

Two types of samples (soils and water) were collected from different sites in Baghdad city and other regions of Iraq ,as shown in Fig. (3.1),(3.2),(3.3) and (3.4) .

3.2.1. Soil Samples

Samples of soils were collected from different sites in Iraq regions (bombardment regions during the war agianst Iraq in 2003) from depth (5 cm),as shown in Table (3.1) and Fig. (3.1),(3.3) and (3.4) from Baghdad, Karbala and Basrah cities respectively .Then the samples dried and cleaned from the doping grinds by using special sieve (0.27 mm in diameter) .

3.2.2. Water Samples

Samples of water were collected from different sites in Iraqi regions . One litter volume of water was collected from some projects of water refinement on the rivers (Tigris and Shatt Al –Arab) , also collected from different houses (drinking water), as shown in Table (3.2) and Fig. (3.2) and (3.4) from Baghdad and Basrah cities respectively .

Table (3 –1) Locations of soils samples in Baghdad city and south regions .

Date of samples	Number of samples	Symbol	City	Location
22-11-2004	1	S_1	Baghdad	Abu Ghreab
22-11-2004	2	S_2	Baghdad	Al Binuq
22-11-2004	3	S_3	Baghdad	Al Binuq (Civilian Advocate ship)
25-11-2004	4	S_4	Baghdad	Al Taji
28-11-2004	5	S_5	Baghdad	Al Mansur
28-11-2004	6	S_6	Baghdad	Al Mansur (Al Mamoon communications)
28-11-2004	7	S_7	Baghdad	Al Washash
15-12-2004	8	S_8	Baghdad	Al Sader City (Destroyed Houses)
5-1-2005	9	S_9	Baghdad	Al Doura (Electrical Station)
14-1-2005	10	S_{10}	Baghdad	Al Meshahda (Al Ishaqi Company)
20-2-2005	11	S_{11}	Karbala	Al Abbas Street
20-2-2005	12	S_{12}	Karbala	Al Abbas Street
20-2-2005	13	S_{13}	Karbala	Industrial Region
20-2-2005	14	S_{14}	Karbala	Al Quzwinia
12-3-2005	15	S_{15}	Basrah	Al Twesa
13-3-2005	16	S_{16}	Basrah	Al Ashaar
13-3-2005	17	S_{17}	Basrah	Al Tememeyh
13-3-2005	18	S_{18}	Basrah	Al Muafaqia (Residentieal Region)

Table (3 –2) Locations of water samples in Baghdad city (Tigris river) city and south regions (Shatt Al-Arab) .

Date of samples	Number of samples	Symbol	City	Location
4-1-2005	1	W_1	Baghdad	Al Adhmya (Al Adhmya Bridge)
5-1-2005	2	W_2	Baghdad	Al Doura (Electrical Station)
5-1-2005	3	W_3	Baghdad	Al Hasanian Bridge
4-1-2005	4	W_4	Baghdad	Maqam Al Kudur region (Bab Al muadham Bridge)
4-1-2005	5	W_5	Baghdad	Al Sinaq Bridge
4-1-2005	6	W_6	Baghdad	Al Kadhmia (Al Aemaa Bridge)
13-3-2005	7	W_7	Basrah	Al Baradaia (Shatt Al Arab)
13-3-2005	8	W_8	Basrah	Al Tanumah (Shatt Al Arab)
13-3-2005	9	W_9	Basrah	Al Ashaar (Shatt Al Arab) (near the Ports)
14-3-2005	10	W_{10}	Basrah	Al Muafaqia (Drinking Water of Houses)
14-3-2005	11	W_{11}	Basrah	Petrochemical Factory (Drinking Water of R.O.)

3.3. Materials and Apparatus

3.3.1. The Track Detectors

Commercially available sheets of CR-39 plastic which are presently known to be the most sensitive SSNTD and also characterized by low background were used in the present work.

These detector sheets of 250 μm thick where cut into small piece each of 1cm × 1cm area. The present sheets of CR-39 were made by Pershore Moulding LTD Company, U.K. The detector sheets were stored at normal laboratory conditions.

3.3.2. The Etchant Solution

Sodium hydroxide solution with 6.25 normality has been used for the etching process. The preparation of normality is using [86]:

$$w = w_{eq} \times N \times V \qquad \ldots(3.1)$$

where:

w = the weight of NaOH needed to prepare the given normality.

w_{eq} = equivalent weight of NaOH = addition of the atomic weight of Na, O and H = 40.

N = normality = 6.25.

V = volume of distilled water = 250 ml.

The etchant compartment has a volume of about 250 ml contains the NaOH solution with 6.25 N. This apparatus is closed assembly, except for small vent at the top of the condenser tube, which prevents any change of etchant normality (concentration) during the experiment due to evaporation. The etching was performed at 60^0C while the etching time was 6 hours.

3.3.3.The Water Bath

An etching bath of the type "Labsco" (Germany) was used in the present work. It includes a thermostat, which can be operated over a range of 20^0C to 110^0C. However, in this study the chemical etching was carried out at 60^0C as, suggested previously [21]. The accuracy of regulation of temperature is better than $\pm 0.1^0$C.

3.3.4.The Optical Microscope

The counting of all the chemically etched tracks was carried out using an optical microscope. It is a standard transmission type binocular research microscope (Bausch & Lomb, Japan). It is capable of giving magnifications of up to 400 x .

3.3.5. The Irradiation Source

For the irradiation test, an (Am–Be) source with flux $5x10^3$ n/cm^2.s was used. It emits fast neutrons from the (α, n) reaction such as:

$$^{9}Be + \alpha \longrightarrow {}^{12}C + {}_0^1n + 5.76\ MeV \qquad \ldots(3.2)$$

This source consists of a rod of (Am–Be) surrounded by a paraffin wax. This wax is usually used for moderating the fast neutrons to thermal energies [87].

3.4. Experimental Details for Uranium Concentration Measurement

In the present work, the methods for measurement of uranium concentrations of the samples (soil and water), which is called the irradiation methods are :

3.4.1. Experimental Procedure for Soils Samples

Soil samples were taken from locations in Iraqi regions , as shown in Table (3-1) and Fig. (3.1),(3.3) and (3.4) . Soil samples were dried and cleaned from the doping grinds using special sieve (0.27 mm in diameter).

0.5g of soil samples were mixed with 0.1g of methylcellulose powder $(C_6H_{10}O_5)_n$ used as a binding material . The mixture was pressed into a pellet of 1cm diameter and 1.5mm thickness.

The pellets were covered with (CR-39) detector and put in a plate of paraffin wax at a distance of (5 cm) from the neutron source (Am-Be) as shown Fig. (3.5), with flounce of thermal neutron (3.024×10^9 $n.cm^{-2}$) and flux (5×10^3 n cm^{-2} s^{-1}), to obtain induced fission fragments from the equation (3.3) [88] :

$$^{235}U + {}_0^1n \text{ thermal} \longrightarrow {}^{236}U + \text{fission fragments} \quad \text{.....(3.3)}$$

After the irradiation time (7 d) , (CR-39) detectors were etched in (6.25N) NaOH solution at temperature of 60 ^{0}C for (6 h) , then the induced fission tracks density were recorded using the optical microscope.

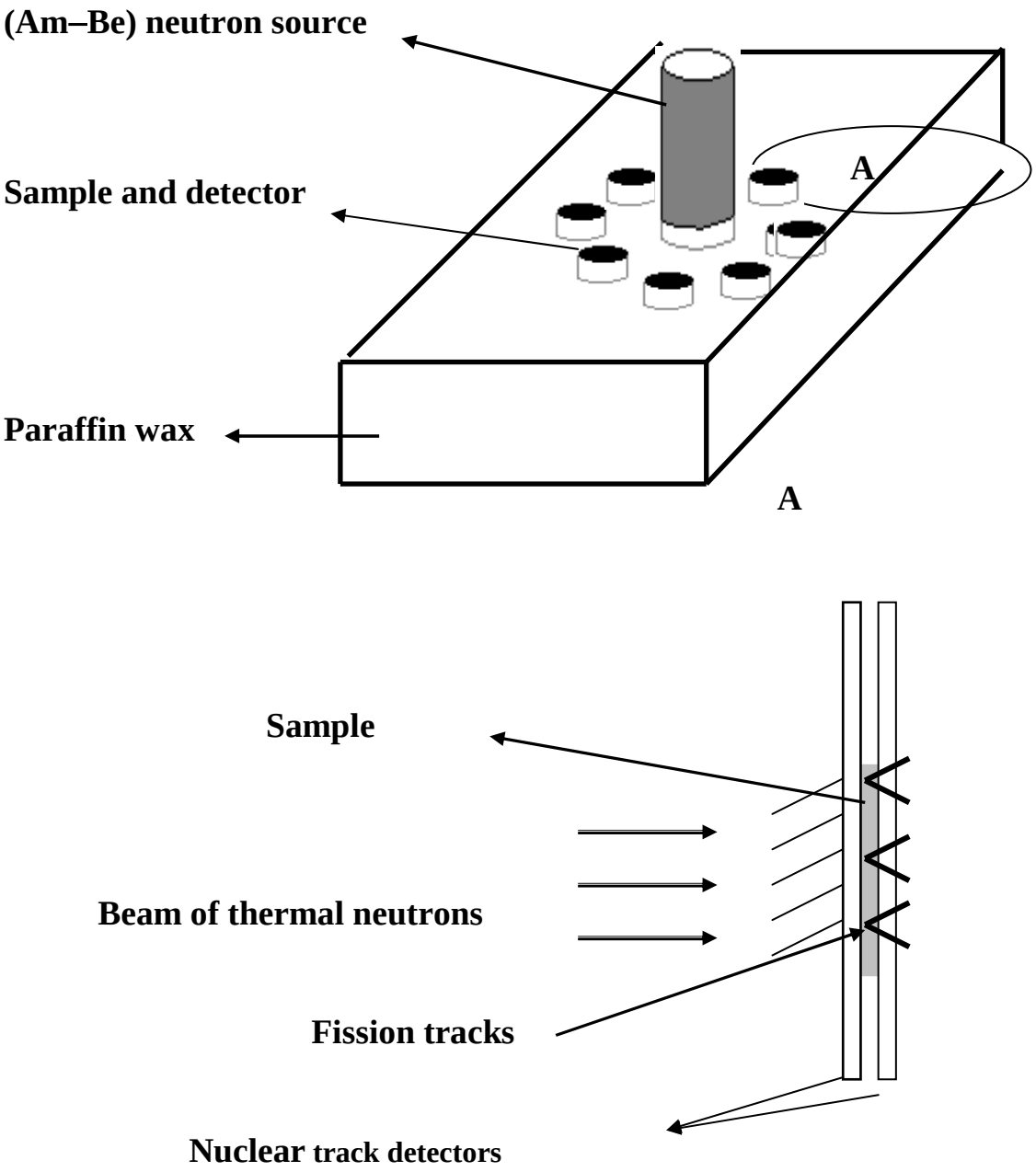

Fig. (3.5) The irradiation of the detectors and samples to the neutron source [89].

The density of the fission tracks (ρ) in the samples was calculated according to the following relation [90] .

$$\text{Track density } (\rho) = \frac{\text{Average number of total pits (tracks)}}{\text{Area of field view}} \quad \ldots(3.4)$$

The uranium concentrations in the soil samples were measured by comparison between track densities registed on the detectors of the sample pellet and that of the standard geological sample pellets from the relation [6,7,91] :

$$C_X \text{ (sample)} / \rho_X \text{ (sample)} = C_S \text{ (standard)} / \rho_S \text{ (standard)} \quad ...(3.5)$$

$$C_X = C_S \cdot (\rho_X / \rho_S) \quad ...(3.6)$$

Fig. (3.6) shows this relation , when (slope = ρ_S / C_S) .

Where :

C_X : uranium concentration in unknown sample (ppm).

C_S : uranium concentration in standard sample (ppm).

ρ_X: track density of unknown sample (tracks/mm^2).

ρ_S: track density of standard sample (tracks/mm^2).

.

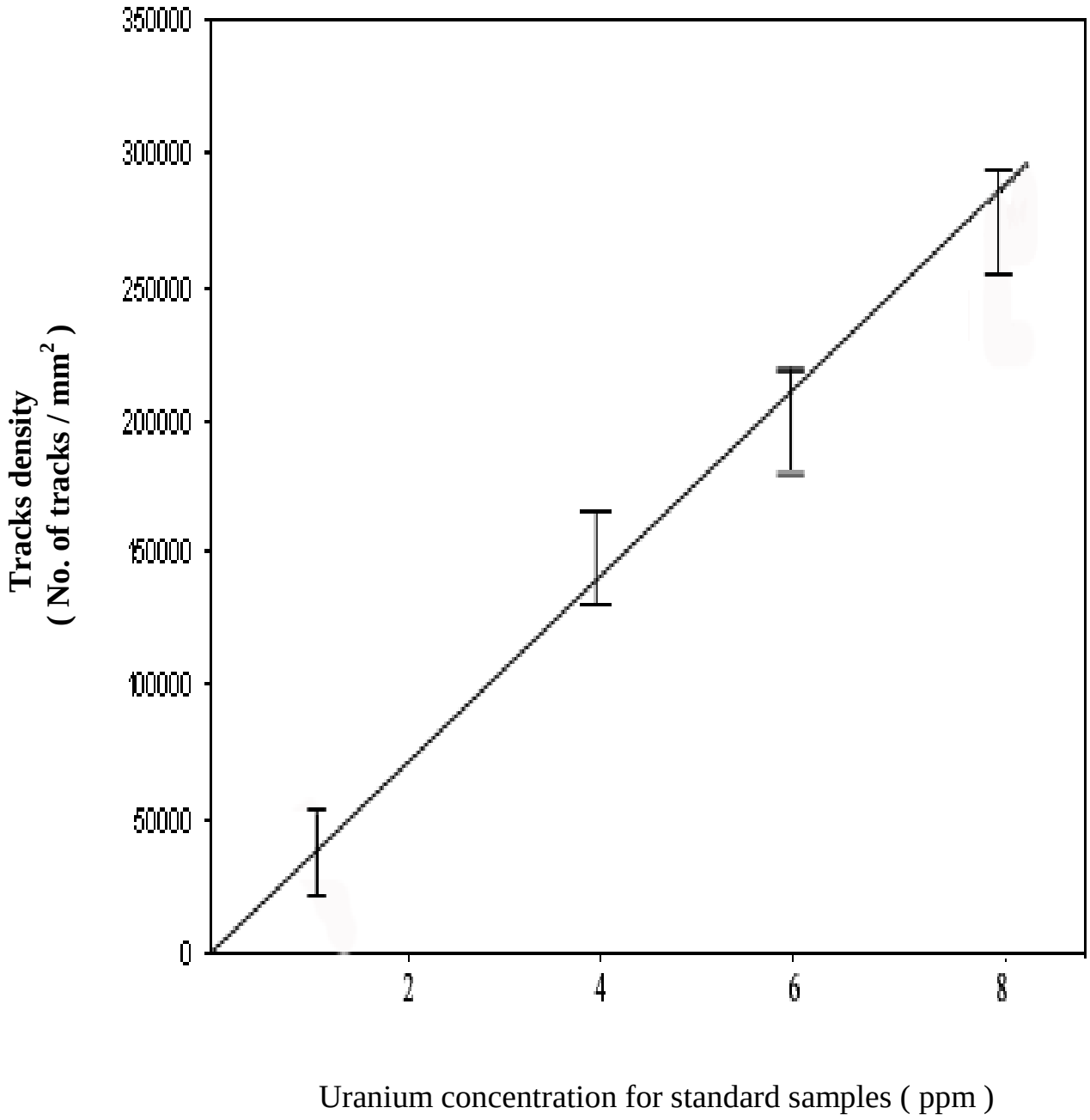

Fig.(3.6) The relation between track density and uranium concentration (ppm) for standard geological soil samples.

3.4.2. Experimental Procedure for Water Samples

Water samples were taken from locations in Iraqi regions , as shown in Table (3-2) and Fig. (3.2) and (3.4) .

Measurement of alpha-emitters in the environmental surface water can be complicated by the presence of a mass of suspended uranium bearing particle [13]. The procedure is to place known volume of water in the form of few drops (2 drops = 0.04 cc) on a track detector materials , water droplets are allowed to evaporate at room temperature , as sketched in Fig. (3.7), this leaves a thin residue of non-volatile constituents, the detector was then covered with a second piece of the detector. Subsequently exposure to (Am-Be) neutron source with flux of thermal neutrons (5×10^3 n/cm^2.s) for (7 d). Fig. (3.5) presents the irradiation of the detectors and the samples to the neutron source.

The detectors base or cover were etched in (6.25N) NaOH solution at temperature of 60 ^{0}C for (6 h) and washed by disttle water , dried and the number of fission tracks produced was then counted by using the optical microscope .

This procedure was done to all samples including the standard samples

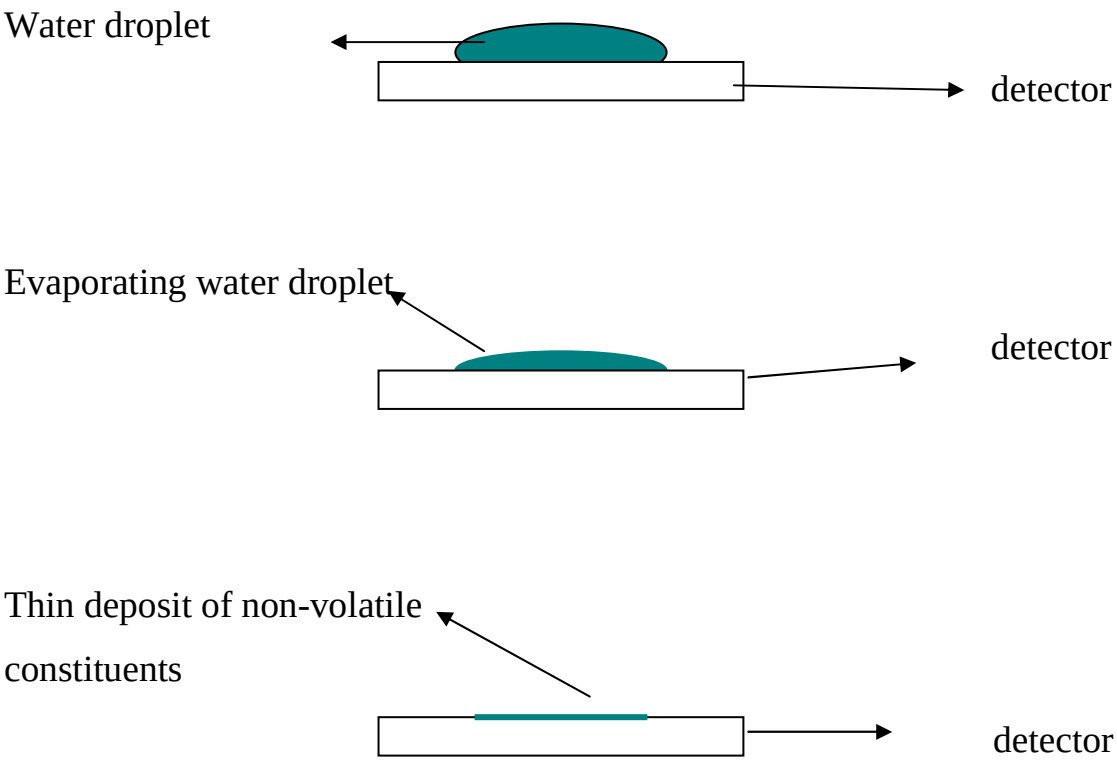

Fig. (3.7) Evaporation of the water droplet and the formation of a thin deposit.

The uranium concentrations in the water samples was measured by comparison between track densities of the water samples and that of the standard solutions from the equation (3.6).

The concentration – track density relationship for the present standard samples are illustrated in Fig.(3.8) .

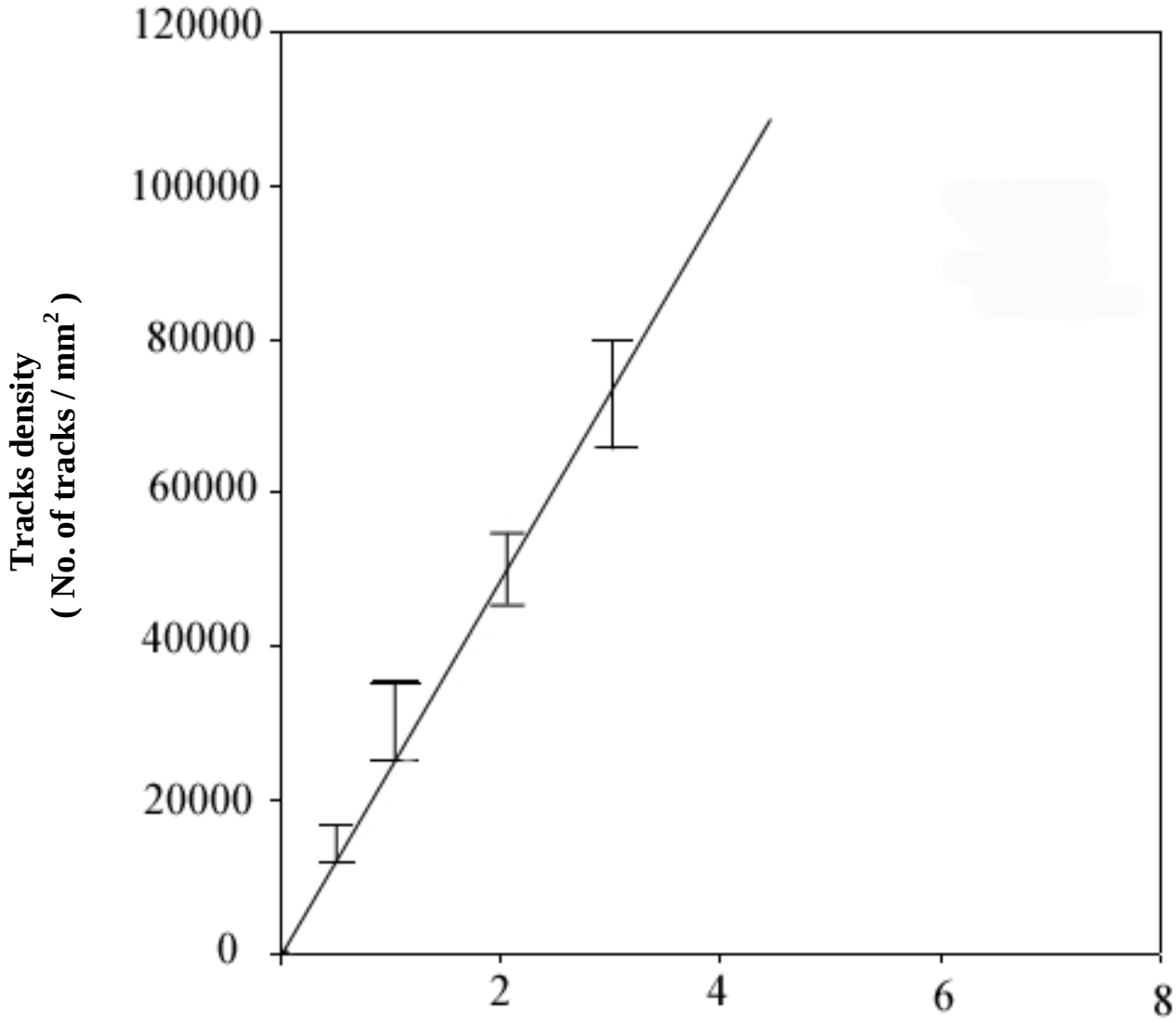

Fig.(3.8) The relation between track density and uranium concentration (ppm) for standard water samples.

3.5. Experimental Details for Radon Concentration Measurements

The radon concentrations in two types of samples(soil and water), were measured using the natural exposure method .

3.5.1. Experimental Procedure for Soils Samples

Soil samples were taken from locations in Iraqi regions , shown in Table (3-1) and Fig. (3.1),(3.3) and (3.4) .

Soil samples were dried and cleaned from the doping grinds by using special sieve (0.27 mm in diameter) . 10 g of soil samples were placed in plastic can. The dimensions of the can minimize the effect of gas thoron. Pieces of (CR-39) track detectors were fixed under the cover of plastic can , which contain the soil samples. The exposure time was (30 d) as shown in Fig. (3.9) .

After the exposure time, (CR-39) detectors were etched in 6.25 N (NaOH) solution at temperature of 60 ^{0}C for (6 h) and washed by disttel water , dried . The tracks density were recorded using the optical microscope with magnification (400 x).

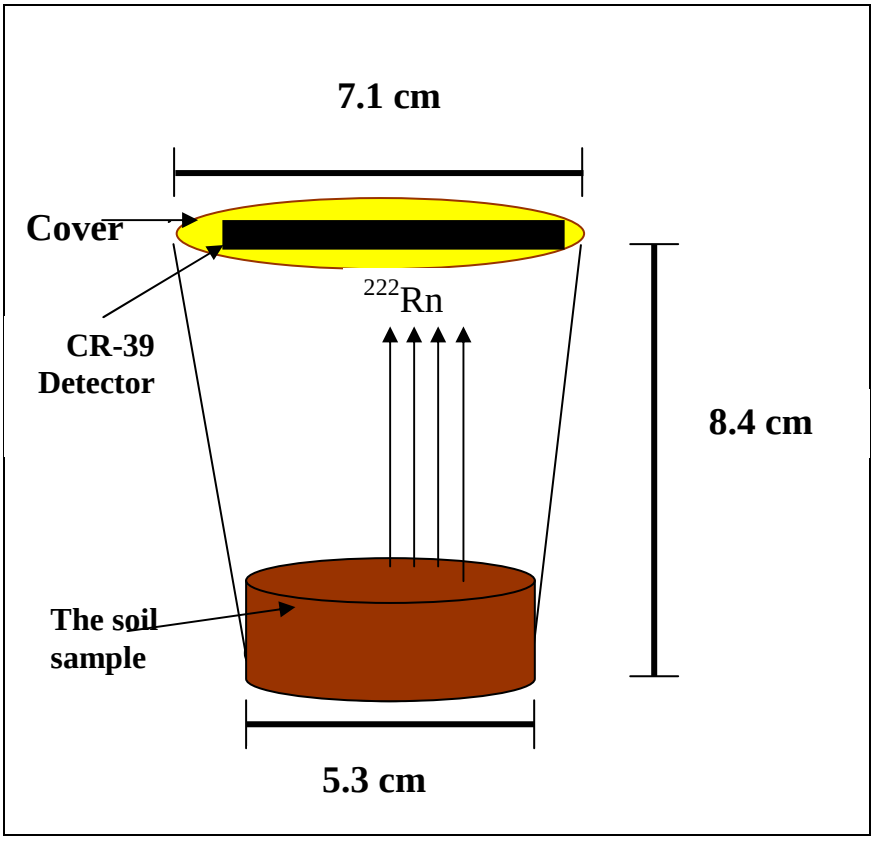

Fig.(3.9)The apparatus of Radon gas (^{222}Rn) estimation by using (CR-39) detector for soil sample .

At the same way in determination of the uranium concentrations , radon gas (^{222}Rn) concentrations in the soil samples was measured from the equation (3.6) by comparison between tracks densities registed on the detectors around the sample and that of the standard geological sample .

Fig. (3.10) shows the relation between the tracks density and radon concentration for the standard samples .

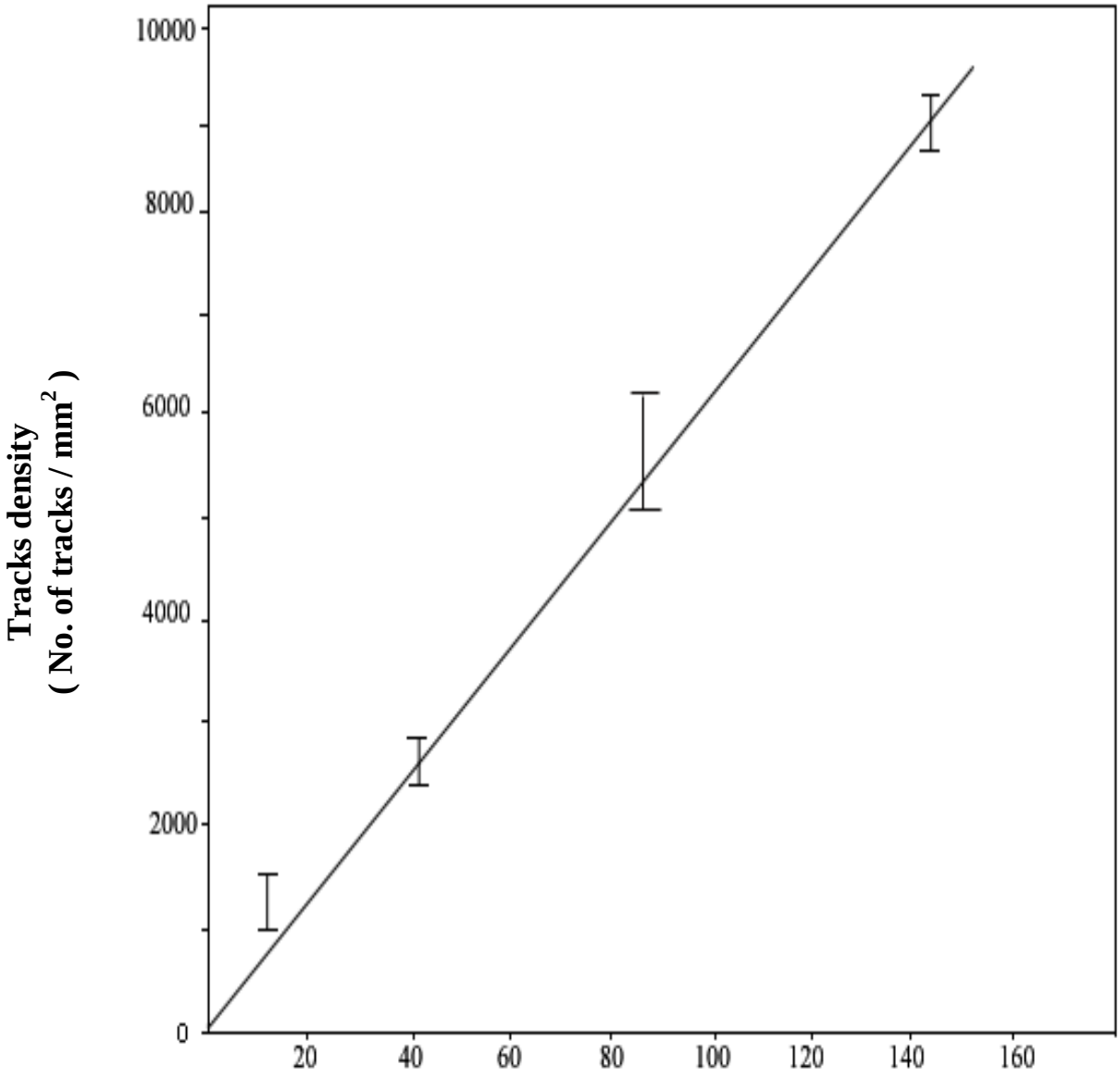

Fig.(3.10) The relation between track density and radon concentration (Bq/m^3) for standard geological soil samples.

3.5.2. Experimental Procedure for Water Samples

Water samples were taken from locations in Iraqi regions , as shown in Table (3-2) and Fig. (3.2) and (3.4) .

The method includes exposing the detectors to the water samples directly for certain period of time.

(250 ml) volume of water samples were placed in plastic can at room temperature . Pieces of (CR-39) track detectors with dimensions (1×1 cm ^{2}) were fixed under the cover of plastic can . The exposure time were (30 days) and the detection geometry was almost 4π, and the experimental set up is shown in Fig. (3.11).

After the exposure period, all the track detectors were etched in (NaOH)solution with 6.25 N at 60 ^{0} C for (6 h). The detectors were then washed in distilled water, dried and were scanned under the optical microscope to record the tracks density .

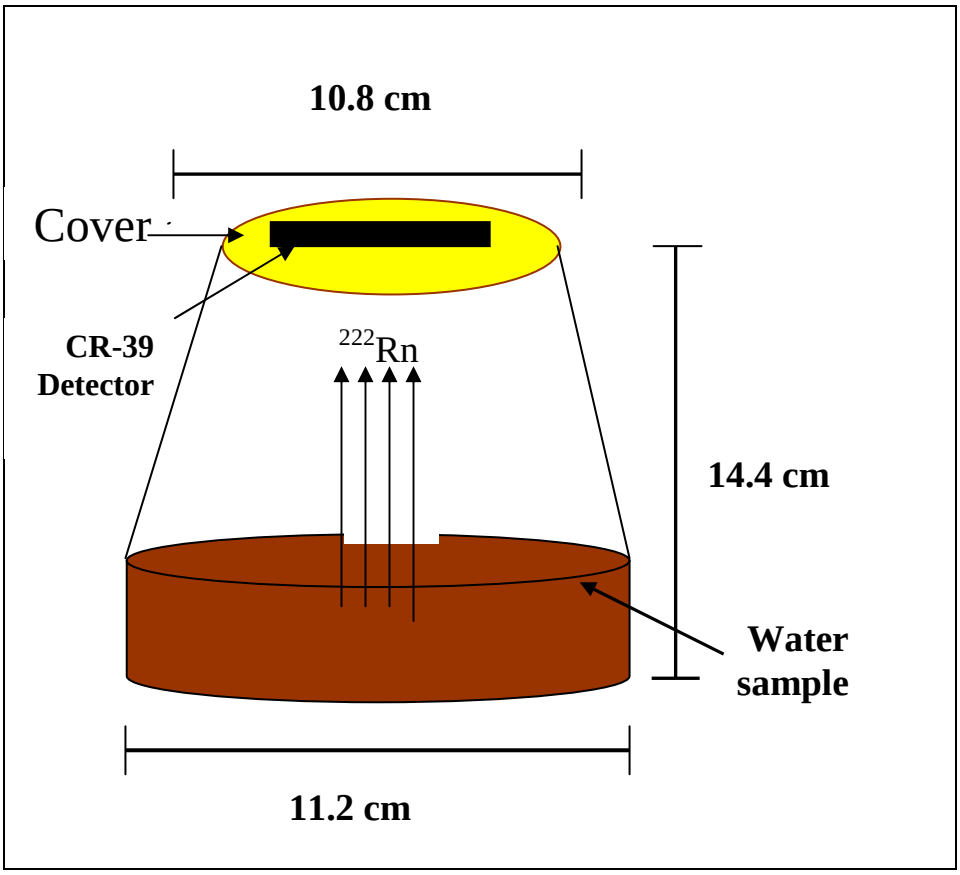

Fig.(3.11) Radon gas (^{222}Rn) estimation by using (CR-39) detector for water sample .

Radon gas (^{222}Rn) concentrations were determined by comparing mean track densities recorded in CR-39 detectors of water samples and with the standard samples from the equation (3.6) .

Fig. (3.12) shows the relation between the track density and radon concentration (Bq/m^3) for standard sample .

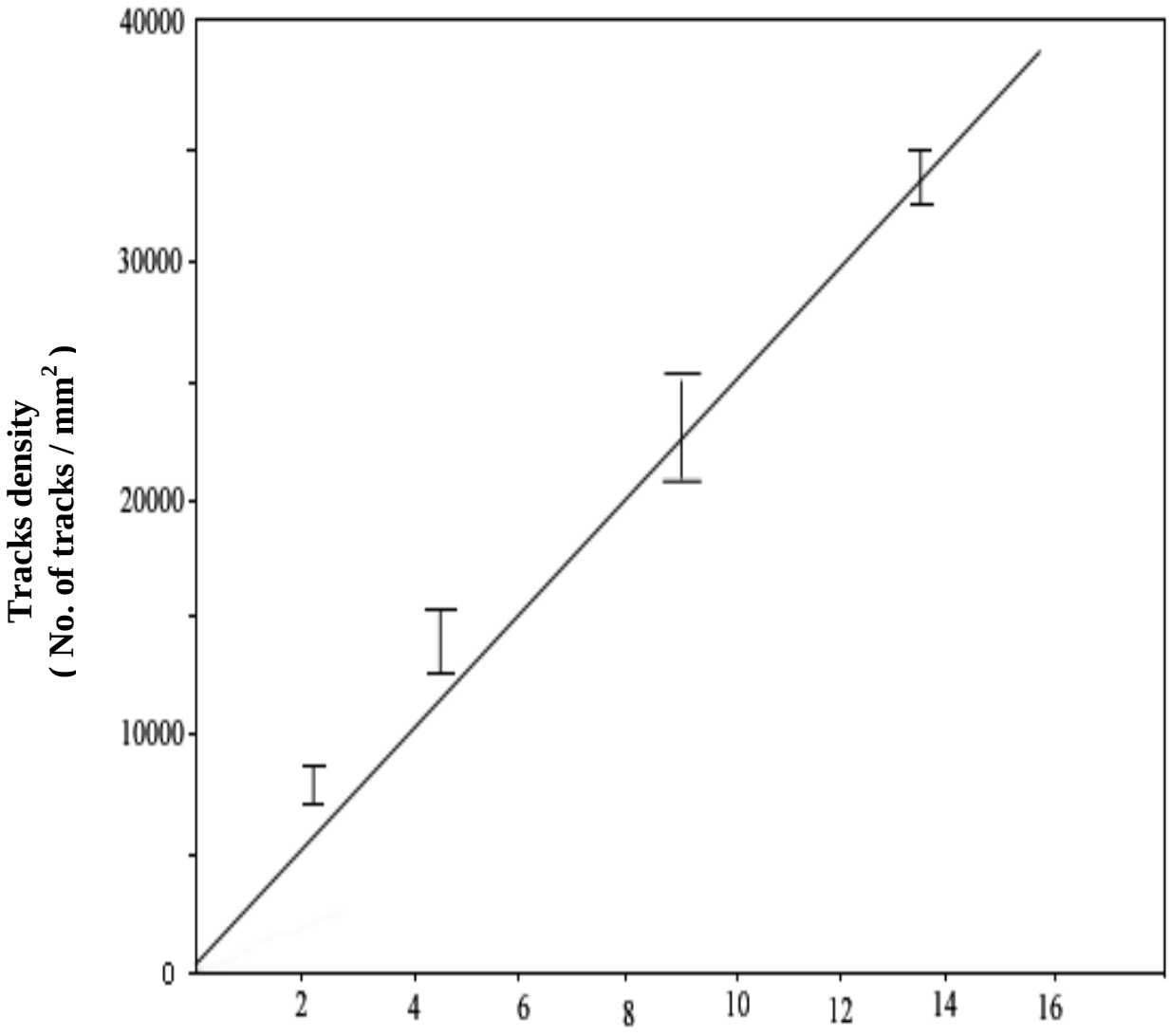

Fig.(3.12) The relation between track density and radon concentration (Bq/m^3) for standard water samples.

Examination Committee Certificate

We certify that we have read the thesis entitled "***Determination of Radioactivity in Soil and Water in Baghdad, Karbala and Basrah Samples***" and as Examining Committee, examined the student ***Mustafa Arab Badai Al-Baidhani*** in its contents and what is related to it, and that in our opinion it is adequate as standard of thesis, with ***Excellent*** standing of degree of Master of Science in Physics.

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References

[1] Silk, E.C. and Barnes, R.S. "***Phil.Mag***.", **4**, (1959), 970.

[2] Price, P.B. and Walker, R.M. "***Phys.Rev.Lett.***", **8,** (1962), 217.

[3] Price, P.B. and Walker, R.M. "***Appl.Phys.***", **33,** (1962), 3400.

[4] Fleischer, R.L. and Price, P.B. "***Science***", **140,** (1963), 1221.

[5] Fleischer, R.L. , Price, P.B. , Walker, R.M. and Hubbard, R.L. "***Phys.Rev.***" , A **133**, (1964), 1443.

[6] Fleischer, R.L. , Price, P.B. and Walker, R.M. "***Nuclear Tracks in Solids: Principles and Applications***", Pergammon Press, Berkeley (1975).

[7] Durrani, S.A. and Bull, R.K. "***Solid State Nuclear Track Detection: Principles, Methods and Applications***", Pergammon Press, U.K. (1987).

[8] Durrani, S.A. "***Nuclear Track Detection***", Pergammon Press, London (1976).

[9] Granzer, F. , Paretze, H.G. and Schopper, E. "***Nucl.Inst.Meth.***", **147,** (1977), 1.

[10] Benton, E.V. and Mekeever, S.W.S. "***Radiation Measurement***", Proc. of the 20th Inter. Confer. on Nucl. Tracks in Solids, **34,** (2001), 1-6.

[11] Fleischer, R.L. and Lovett, D.B. "***Giochim. Cosmochim.***", **32,** (1968), 1126.

[12] Hashimoto, T. "***Analy.Chim.Acta.***", **56**, (1971), 347.

[13] Fleischer, R.L. and Delany, A.C. "***Analy.Chim.***", **48,** (1976), 642.

[14] Espinosa, G. , Moreno,A. and Golzarri,J.I. , "***Proc. of the 11th Inter. Confer. on SSNTDs***", Lyon, (1981), 591-595.

[15] Ritter, W. , Mark, T.D. , Bertagnolli,E. and Vartanion, R. , "***Proc. of the 20th Inter. Confer. on SSNTDs***", Lyon, (1981), 605-607 .

[16] Yegingil, Z. and Goksu, Y. "***Nucl. Track & Radia. Meas.***" **6** No.1, (1982), 46-48.

[17] Gamboa, I., Espinosa, G., Moreno, A., Golzarri, J. & Castillo, F. "***Uranium Determination in Mineral Rocks by SSNTD***", Nucl. Track & Radia. Meas., **8** No.1-4, (1984), 443-445.

[18] Singh, N.F., Singh, M., Singh, S. and Virk, H.S. "***Nucl. Tracks and Radia. Meas.***" **8**, (1984), 483 .

[19] Ellis, W.R. and Ahsanullah, M. "***Nucl. Tracks and Radia. Meas.***" **8,** (1984), 437.

[20] Yanchou, L.U., Jingzhao, Z., Jun, X. and Xueli, W. "***TL Dating of Pottery Sherds and Backed Soil frpb the Xian Terracotta Army Site, Shaanxi Province, China***", Nucl. Track & Radia. Meas.,**14** No.½ , (1988), 283-286.

[21] Tawfiq, N.F. "***Determination of Uranium Concentrations in Rocks by Using (SSNTDs)***", M.Sc. thesis, University of Baghdad, (1989).

[22] Marouf, B.A., Al-Haddad, I.K., Tomma, N.A., Mahmood, J.A. and Tawfiq, N.F. "***Monitoring of Environmental Radioactivity Around the Tuwaitha Site***", Environmental Management and Health, **3** No.3, (1991), 14-17.

[23] Tawfiq, N.F. "***Study Comparssion in Some of Organic and Inorganic Track Detectors and Applications in Environment***", Ph.D thesis, University of Al-Mustansiriyah, (1996).

[24] Abdul-Hussain, Sh. "***Determination of Radioactiv Materials Concentration in Soil by Using Spectral Analysis Technique for Gamma Ray***", M.Sc. thesis, University of Baghdad, (1996).

[25] Omar, A.A. "***Determination of Uranium Concentrations in Yamen Rocks Samples by Using Nuclear Techniques***", Ph.D thesis, University of Baghdad, (2000).

[26] Abdul-Hussain,S. "***Determination of Radon Concentrations in Sand for Maysan City by Using Nuclear Track Detector (CR-39)***", M.Sc. thesis, University of Baghdad, (1986).

[27] Saied, B.M. "***Determination of Radon Concentrations in Buildings by Using Nuclear Track Detector (CR-39)***", M.Sc. thesis, University of Baghdad, (1998).

[28] Chuscielewski, W. and Kaminski,Z. "***Occup.Medic.Environ.Health***", **12**, (1999), 229.

[29] Auff, A.M. "***Determination of Radon Concentrations in Limited Regions in Al-Mausul City by Using Organic Nuclear Track Detector (CR-39)***", M.Sc. thesis, University of Al-Mustansiriyah, (1999).

[30] Al-Ani, D.F. "***Measurement the Radioactivity of Emission Radon from Some of Building Materials***", M.Sc. thesis, University of Al-Mustansiriyah, (2000).

[31] Jamil, K., Ali, S. and Dogar, A., "***Proc. Of the 20th Inter.Conf. on SSNTDs***" , Slovenia, (2000), 42.

[32] Murtazaev, K., Michel, M., Vladimir,P and Murtazaev, A. "***Proc. Of the 20th Inter.Conf. on SSNTDs***" , Slovenia, (2000), 74.

[33] Aharmim, B., Marah, H. and Sabir, A. "***Proc. Of the 20th Inter.Conf. on SSNTDs***" , Slovenia, (2000), 111.

[34] "قياس تركيز غاز الرادون في التربة"، مسعود صالح خليفة، صالح محمد عبد السلام
مركز البحوث النووية، تاجوراء-ليبيا http://www.tnrc.org/index.htm

[35] Baradacs, E., Hunyadi, I., Dezso, Z., Csige, I. and Szerbin, P. "***Radia. Measur.***" **34,** (2001), 385.

[36] Singh, S., Malhotra, R., Kumar, J., Singh, B. and Singh, L. "***Radia. Measure.***" **34**, (2001), 472.

[37] Hunyadi, I., Csige, I., Hakl, J., Baradcs, E. and Dezs, Z. (2001), http://www.atomaki.net .

[38] Cameron, J.R. and Skofronick, J.G. "***Medical Physics***", New York, Canada, United State of American, John Wiley and Sons, Inc., (1992), 386-388.

[39] Durance, M.E. "***Radioactivity in Geology***", John Wiley and Sons, New York, Elsiever, (1986).

[40] Chase, G. and Rabinowitch, J. "***Principle of Radioisotope Methodology***", 3rd edition, Mineapolis, Burgess publishing Co., (1967).

[41] Knoll, G.F. "***Radiation Detection and Measurement***", John Wiley and Sons, USA, (1979).

[42] United Nations Unvironmental Programme, UNEP "***Radiation Doses, Effects, and Risks***", United Nations, (1985).

[43] Chapman, N.A. and McKinley, I.G. "***The Geological Disposal of Nuclear Waste***", John Wiley and Sons, UK., (1987).

[44] United Nations Scientific Committee on the Effects of Atomic Radiation, UNSCEAR "***Sources, Effect, and Risks of Ionizing Radiation***", Report to the general Assembly with Scientific Annexes, United Nations, (1993).

[45] Zajic, V.S. "***Review of Radioactivity, Military Uses and Health Effects of Depleted Uranium***", July, (1999).

[46] Martin, A. and Harbison, S.A "***An Introduction to Radiation Protection***", 3rd edition, Great Britain, London, Arrow Smith Ltd., Bristol, (1986).

[47] Friedlander, G., Kennedy, J.W. and Miller, J.M. "***Nuclear and Radiochemistry***", 2nd edition, John Wiley and Sons Inc., (1964).

[48] International Commission on Radiological Protection, ICRP: "***1990 Recommendations of ICRP***", Publication 60, Pergamon Press, Oxford and New York, 1990.

[49] Eisenbud, M. "***Environmental Radioactivity***", 4th edition, Academic press Inc, London, (1997).

[50] Scharama, S.C.L. and Metha, G.K. "***Nucl. Instr. Meth.***", **178**, (1980), 217.

[51] Cieslak, E., Piekarz, J. and Akrzewski, J.Z. "***Nucl. Instr.Meth.***", **39,** (1966), 244.

[52] Vater, P., Becker, H.J., Brandt, R. and Freiesleben, H. "***Phys. Rev. Lett.***", **39,** (1963), 594.

[53] Gore, D.J., Thorne, M.C. and Watts, R.H. "***Phys. Med. Bio.***", **23,** (1978), 149.

[54] Fews, A.P. and Henshaw, D.L. "***Proc. of the 10th Inte. Confer. on SSNTDs***", Bristol, (1979), 705 .

[55] Henshaw, D.L., Fews, A.P. and Webstar, D.J. "***Proc. of the 11th Inte. Confer. on SSNTDs***", Lyon, (1981), 649-654.

[56] Fleischer, R.L., Price, P.B. and Walker, R.M. "***Geochim.Cosmochim.Acta.***", **29,** (1965), 161.

[57] Seal, S. "Cancer", **17**, (1964), 549.

[58] Tress, G., Ellinger, M., Khan, E.U., Khan,H.A., Vater, P., Brandt, P. and Kadner, M. "***Nucl.Tracks***", **6,** (1982), 87.

[59] Al-Ani, Z.K., "***A Study of Transter Factor of Radio Nuclides from Soil to Plant***", M.Sc. thesis, University of Al-Nahrain, (2000).

[60] Kobayashi, T. and Fujii, M. "***Nucl. Tracks***", **15,** (1988), 175.

[61] Nichulas, T., "***Measurement and Detection of Radiation***", Pergammon Press, University of Missouri-Rolla, U.K., (1987).

[62] Fischer, B.E. and Sphor, R. "***Rev.Mod.Phys.***", **55,** (1983), 129.

[63] Benton, E.V. "***Radia. Effec.***", **2,** (1970), 273.

[64] Fleischer, R.L., Price, P.B. and Walker, R.M."***Ann.Rev.Nucl.Sci.***", **15,** (1965), 1.

[65] Fleischer, R.L., Price, P.B. and Walker, R.M. "**Science**", **149,** (1965), 383.

[66] Fleischer, R.L. and Price, P.B. "***Appl.Phys.***", **34,** (1963), 2903.

[67] Hushemi, S.R. and Durrani, S.A. "***Nucl.Tracks***", **5,** (1981), 189.

[68] Fremlin, J.H. and Wilson, C.R. "***Nucl.Instr.Meth.***", **173,** (1980), 201.

[69] Hepburn, C. and Windle, A.H. "***Material Sci.***", **15,** (1980), 279.

[70] Price, P.B., Lai, D., Tamtance, A.S. and Perelygin, V.P. "***Earth Planet Sci.Lett.***", **19,** (1973), 377.

[71] Fleischer, R.L., Price, P.B. and Woods, R.T. "***Phys.Rev.***", **88,** (1969), 563.

[72] Yammamoto, M. and Yasuda, N. "***Radia.Measur.***", **28,** (1997), 227.

[73] Blanford, G.E., Walker, R.M. and Wefel, J.P. "***Radia.Effects***", **3,** (1970), 267.

[74] Marouf, B.A. "***Gamma Radiation Dose to the Iraqi Population due to the Chernobyl Accident***", Radiation Protection Dosimetry, **42** (1992).

[75] United Nations Environmental Program, UNEP "***Depleted Uranium in Kosovo***", Scientific Mission to Kosovo, post–conflict environmental assessment, (2001).

[76] Fahey, D. "***Collateral Damage: How U.S. Troops were Exposed to DU during the Gulf War***", DU education project, Metal of Dishonor, International Action Center, New York, (2003).

[77] Durakovi, A. "***Medical Effects of Internal Contamination with Uranium***", Department of nuclear medicine, George town University School of Medicine, Washington D.C., USA, **40** No.1, (1999).

[78] Rosalie, B. "***The Host Response to Depleted Uranium***", (2000).

[79] Guenther, S.H.: "***Uranium Projectiles: Severely Maimed Soldiers, Deformed Babies and Dying Children***", Documentation of the aftermath's of the Gulf War, Ahriman-Verlag, Germany, (1993-1995).

[80] Kolhatkar, S. "***Depleted Uranium: A Review of its Properties, Potential Danger and Recent Use in Yugoslavia***", (2000).

[81] Army Environmental Policy Institute, AEPI "***Health and Environmental Consequences of Depleted Uranium Use by the U.S Army***", US.AEPI, Technical Report, June, (1995).

[82] Neboysha, L. "***Environmental Impact on Humans During the Gulf War***", Text Report of Internet Communication Between Prof. Neboysha and Prof. Sharma, (1999).

[83] Caldicott, H. "***A New Kind of Nuclear War***", DU education project, Metal of Dishonor, International Action Center, New York, (1997).

[84] World Health Organization, WHO "***Depleted Uranium Sources, Exposure and Health Effects***", (2001).

[85] Hoskens, E. "***Depleted Uranium Shells Make the Desert Glow***", DU education project, Metal of Dishonor, International Action Center, New York, (2003).

[86] Lymburner, D. "***Another Human Experiment***", DU education project, Metal of Dishonor, International Action Center, New York, (2003).

[87] Gayb, D.H. "***Measurement of Alpha Emitters Concentration in Tigris River Water in Baghdad City Using CR-39 Plastic Track Detector***", M.Sc. thesis, University of Al-Nahrain, (2002).

[88] Berger, M. "***Nuclear Technology***", **19,** (1973), 188.

[89] Al-Jobori, S.M., Tawfiq, N.F. and Al-Saji, A.W. "***Effedt of the Use of DU***", Proc. of Inter.Conf., Baghdad, **1,** (2002), 64-70.

[90] Amalds, O., Custball, N.H. and Nielsen, G.A. "***Cs-137 in Montarq Soils***", Health Physics, ***57*** No.6, (1989), 955-958.

[91] Bansal, V., Azam, A. and Prasad, R. "***Health Physics***", **27,** (1989), 985.

[92] http://www.maps of world.com/iraq/Baghdad-city_map.html.

[93] http://www.maps of world.com/iraq/Baghdad-Tigris river_map.html.

[94] http://www.mapquest.com/maps/map.adb?city=karbala & state=Iraq & zoom=5.

[95] http://www.mdtravelhealth.com/external_5/iraq_2.html.

[96] World Health Organization, WHO "***Guidelines for Drinking-Water Quality***", 2nd ed., Geneva, (1993).

[97] Harigel G.: "***Depleted Uranium Weapons-A Threat to Human Health?***" 2002.

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the Degree of Master of Science in
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By
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