Iraqi Journal of Science

Some Geochemical, textural and Radioactive Characteristics of the Sandstorms Loads Blown over Baghdad and Ramadi Cities, Middle Iraq

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Abstract

The present study examined the characteristics of dust from sandstorms that occurred over Baghdad and Ramadi cities, middle of Iraq, from February 2009 to July 2010. The texture of the dust samples were ranged from sandy silty clay (71.4%) to sandy clayey silt (28.6 %).The mineralogical composition of the sand fractions included Quartz (52.2%,), feldspar (6.4%,), calcite (33%,), gypsum (5.6%,), dolomite (1.5%,) and heavy minerals (1.3%,). The clay minerals present included Chlorite, Illite, Montmorillonite, Palygorskite and Kaolinite. The results of heavy minerals analyses indicated that they were opaque heavy mineral, pyroxene, hornblende, zircon, chlorite, epidote and garnet.

The Uranium concentration average absorbed dose and average external effective dose were calculated for dust of sandstorm at 2-4/7/2009 and 3-4/4/2010 for both cities Baghdad and Ramadi. The results for specific activity of uranium were in range of (5.43-9.56 Bg/kg) and the absorbed dose range (2.19- 5.46 nGy/h)for sandstorm at 2-4/7/2009 and the average specific activity of uranium was in range of (7.32- 18.96 Bg/kg) and the average absorbed dose (3.27- 8.98 nGy/h) for sandstorm 3-4/4/2010. All the results were lower than critical dose level, but the culmination of the dose of more than one sandstorm may have a damage effect.

Keywords: Sandstorm, Geochemistry, mineralogy, Radioactive Characteristics.

بعض الخصائص الجيوكيميائية والحجمية والاشعاعية لحمولات العواصف الرملية الهابة على مدينتي بغداد والرمادي – وسط العراق

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الخلاصة:

اظهرت دراسة بعض الخصائص الجيوكيميائية والحجمية والاشعاعية لحمولات العواصف الرملية الهابة على مدينتي بغداد والرمادي للفترة من شباط ٢٠٠٩ ولغاية تموز ٢٠١٠ بان المعدل الحجمي للدقائق كان يتراوح بين اطيان غرينية رملية بنسبة 71.4% الى غرين طيني رملي بنسبة 28.6% وكانت تتكون من معادن الكوارتز والفلدسبار والكالسايت والجبسوم والدولومايت ونسبة بسيطة من المعادن الثقيلة بحدود ١ % تتمثل بالمعادن المعتمة والبايروكسين والهورنبلند والزركون والكلورايت والايبيدوت والكارنت ، وان المعادن الطينية تتكون من الكلورايت والالايت والمونتموريلونايت والباليكوروسكايت والكاولينايت

ان تراكيز اليورانيوم تم تحديدها وكانت جميعها اقل من الحدود الخطرة ولكن تراكمها في حمولات عاصفة واحدة يمكن ان يعتبر ذو تاثير خطر.

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1-Introduction

Dust and sand storms are seasonal events in Iraq and other countries in the Middle East. Dust storms that affect Iraq are of two types, firstly, local dust storms (rising and suspended dust storms) that raise from the inside Iraqi regions secondly, regional dust storms that reached Iraq from cross neighboring countries such as the effects of North African storms and Middle East storm . The dust particles consist mainly from clay, silt, sand particles and organic matter. The dust storms had bad effects on health of human life. These sandstorms comprise particulate matter of natural and anthropogenic origins. The fine particulate matter (less than 50 microns in diameter) affects the environment and human health to varying degrees.

Al-Farrajii (1) concluded that Dust storms in Iraq occur more frequently during spring and summer, with an average of 20 days per year, by Northerly and northwesterly winds, where wind velocity may exceed 100 km/h, which raises dust storms. Wind speeds may reach their maximum by midday in July (average 3.3 m/s). Mineralogy and geochemistry of dust storm particles may be more diagnostic of their sources (2). Winds that blow over the soil will pick up a variety of dissolved and Suspended substances including salts, organic compounds, soil particles and substances that are potential pollutants. Suspended solids are important pollutions which consist of suspended minerals and other suspended solids such as soil, Wash off plowed fields, fertilizers and construction urban areas.

High concentrations of inorganic trace elements occur in soils. These trace elements pose a threat to human health. Recent surveys of winds have shown that trace and radioactive metals concentrations can be elevated and appear to be strongly associated with the geologic setting of the irrigated area.

The source of heavy metals can be divided into two sources, natural and artificial. The source of heavy metals in dust storms are mainly natural, include geologic sources such as rocks formation, soils, and transported sediments by winds and dust storms, while the artificial sources include industrial sources that supply the heavy metals to the air and causing contamination of the atmosphere.

Many workers and writers dealt with the problem of dust storms over Iraq. They concluded that the trace matels should be a priority for evaluation in all dust storms studies, and , considered that the study of dust storms is important and vital in Iraq ,(3,4,5).

Inhalation is the most important pathway for public exposure toradioactive elements such as uranium compounds. Marouf (6), estimated that the annual effective dose equivalent due to the inhalation of uranium compounds contaminating the soil. He concluded that the dose is less than the annual dose limit of the public recommended by the IAEA. The heavy metals of the most importance that designated as priority pollutants by USEPA and the Uranium concentration average absorbed dose and average external effective dose were studied in this research for dust of sandstorm blown on Baghdad and Ramadi cities.

Exposure to uranium and its compounds can cause adverse health effects due to its chemical toxicity and radiologic hazard caused by absorption of radiation emitted from uranium and its decay products. At high levels, uranium may cause chemical toxicity. The low level of radioactivity emitted causes less concern. Exposure to uranium and other heavy metals in large doses can cause changes in renal function, resulting in renal failure, (7,8,9,10,11).

The aims of the present work were to study Some Geochemical, textural and Radioactive Characteristics of dust from sand storms that occurred over Baghdad and Ramadi cities, middle of Iraq, from February 2009 to July 2010. Dust samples were collected form dust storms at different places throughout Baghdad and Ramadi cities. The samples were thoroughly, mixed and analyzed for the heavy, light, clay minerals, trace metals, grain size analyses, as well as measuring of the Uranium concentration average absorbed dose and average external effective dose for dust of sandstorm for both cities Baghdad and Ramadi.

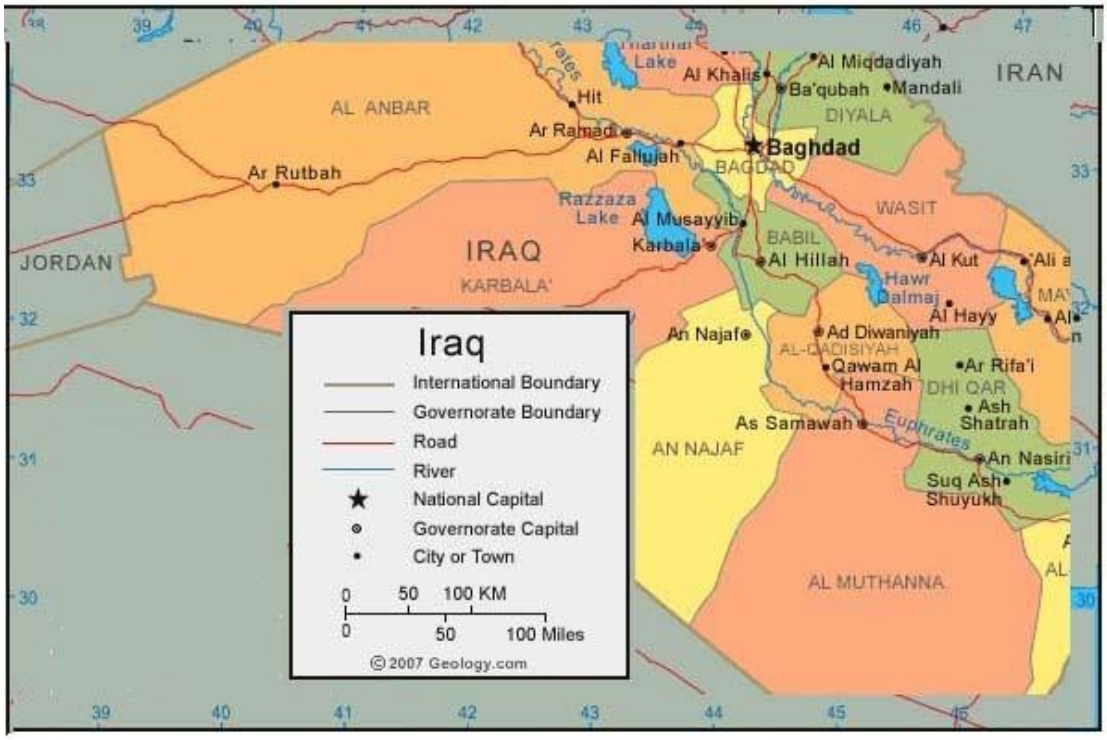

Figure 1- Location map.

2-Materials and Methods

2.1 Dust samples

The dust samples were collected for the period from February 2009 to July 2010 from Baghdad and Ramadi cities, Figure 1. The total number of studied dust storm was 20 during (2009- 2010),11 in 2009,and 9 in 2010, Table 1.

The samples were collected from the roofs of buildings (> 3m from the earth's surface) using either large-volume plastic basins or using the cyclone, with 1.65 meter high by rotating the air inside the instrument using an electrical motor to pull and suck the air inside the instrument, (12). The weights of the collected samples varied from 250 to 1500 g. The collection time varied, depending on the duration of each sandstorm, from 8 h to more than 24 h.

Table 1- The studied regional dust storms over Iraq for the years (2009-2010)

No.	Date of dust storm	No.	Date of dust storm
1	17-2-2009	11	30-7-2009
2	20-2-2009	12	3-4-2010
3	27-2-2009	13	٤-4-2010
4	9-3-2009	14	13-5-2010
5	9-6-2009	15	١٤-5-2010
6	17-6-2009	16	6-٦-2010
7	28-6-2009	17	23-6-2010
8	2-7-2009	18	٢٤-6-2010
9	4-7-2009	19	19-7-2010
10	29-7-2009	20	٢٠-7-2010

2.2 Textural and mineralogical analyses:

Grain size analyses of the collected samples were performed using sieving and pipetting methods following Folk (13) ,to determine the sand, silt, and clay fractions . Microscopic examination by applying Carver(14) method to study the light minerals and heavy minerals, and X-ray diffraction method were used to identify the different minerals present.

2.3 Heavy metal content:

The heavy metals: Pb, Zn, Cd, Ni, Cu, Co, and Fe were analysed for all dust samples by using the Atomic absorption spectrophotometry.

2.4 Radioactive Characteristics

The Uranium concentration average absorbed dose and average external effective dose were calculated for dust of sandstorm at 2-4/7/2009 and 3-4/4/2010 for both cities Baghdad and Ramadi, according to Mahdi ,et al, (15) and Marouf (6) methods.

3-Results and Discussion

3.1 Dust sample texture:

Grain size analysis was performed by using standard sieves and hydrometer after washing samples on sieve No. 230 by distilled water, (table 2). The results of the particle size analyses for both cities, indicate that the texture of the dust samples according to Folk's classification (13), were ranging from the higher percentages of sandy silty clay (71.4%), to the relatively less common sandy clayey silt (28.6 %). Where, in Baghdad, the dust samples comprised mainly clay (min=26%, max= 65%, mean=51.1%), silt (min=27%, max= 51%, mean= 35.6%), and sand(min=8%, max= 18%, mean=12.4%) , while ,in Ramadi , the dust samples comprised mainly clay (min=20%, max= 71%, mean=55%), silt (min=18%, max= 63%, mean= 32%), and sand(min=8%, max= 18%, mean=13%).

The results of grain size distribution reflect that most of dust texture are clay and silt with less quantities of sand, actually, the reason that high values of clay and silt depends on the energy of the wind that form the dust storm which carries the grains of less than 63 micron in dryness season. Actually, the results reflect that they are in accordance of other studies results, whom found that the texture of dust storms in Iraq are mostly silt and clay with less amount of sand, and these different quantities depend on the wind speed and the energy of transportation of these fractions.(16,17 ,18,19,20).

Table 2-. Grain size analyses of the studied dust samples during the period from February 2009 to July 2010.

Location	Date of dust storm	% clay	% silt	% sand	Texture*
Baghdad	20-2-2009	62	27	11	Sandy silty clay
	27-2-2009	56	35	9	Sandy silty clay
	9-3-2009	50	32	18	Sandy silty clay
	9-6-2009	38	50	12	Clayey sandy silt
	4-7-2009	65	27	8	Sandy silty clay
	30-7-2009	26	51	13	Clayey sandy silt
	4-4-2010	58	27	16	Sandy silty clay
	14-5-2010	56	34	10	Sandy silty clay
	24-6-2010	60	28	12	Sandy silty clay
	20-7-2010	40	45	15	Sandy clayey silt
Minimum		26	27	8	
Maximum		65	51	18	
Average		51.1	35.6	12.4	
Ramadi	17-2-2009	65	20	15	Sandy silty clay
	9-3-2009	36	50	14	Clayey sandy silt
	17-6-2009	60	23	17	Sandy silty clay
	28-6-2009	20	62	18	Sandy clayey silt
	2-7-2009	60	27	13	Sandy silty clay
	29-7-2009	23	63	14	Sandy clayey silt
	3-4-2010	70	18	12	Sandy silty clay
	13-5-2010	71	21	8	Sandy silty clay
	6-٦-2010	66	24	12	Sandy silty clay
	23-6-2010	65	22	13	Sandy silty clay
	19-7-2010	69	23	8	Sandy silty clay
Minimum		20	18	8	
Maximum		71	63	18	
Average		55	32.0	13.0	

3.2 The Mineralogy of Dust Samples:

Light and Heavy minerals percentages of dust Samples for sand size fraction were studied by using polarized microscope. The result reflects that the light minerals reach 98% of the sand fraction, while the heavy minerals equal to 2% as a maximum. Heavy minerals were separated from light minerals by using bromoform (Sp. Gr. 2.89). Light and Heavy minerals were mounted on slides in Canada balsam and about 300 mineral grains were counted, from random fields, in each slide, in order to study their petrographic and mineralogical characteristics.

The percentages of the different minerals were computed. The light minerals that were recognized in the dust samples are Quartz (52.2 %,), feldspar (6.4%,), calcite (33%,), gypsum (5.6%,), dolomite (1.5%,) and heavy minerals (1.3%,).

The results of heavy minerals analyses indicated that the following percentages were existed,opaque heavy mineral, pyroxene, hornblende, zircon, chlorite, epidote and garnet.

A- Mineralogy of dust samples by using X-Ray Diffraction Analyses:

The dust storms samples were examined by X-Ray diffraction method (XRD).Samples were prepared as (Bulk sample) in order to study non-clay minerals in the 2θ angle range between (2- 40) degree. The results indicate that the recognized minerals are quartz, feldspar, calcite, and gypsum. The results were in agreement with Al- Jannabi and Ali Jawad, (21), Hamparsoum, (22), Al-Sultani, (23), and Awadh ,(24), studies of non-clay minerals in soils, sand dunes and dust storms of Iraq.

The clay minerals in the studied samples are recognized and identified on the basis of special diffraction pattern of each mineral, using the methods for clay sample preparation for XRD analyses.
The results show clay minerals for the different slides were, Chlorite, Illite, Montmorillonite, Palygorskite and Kaolinite.
The presence of Palygorskite and Kaolinite among the clay minerals reflects the arid and semi-arid climatic conditions. The formation of chlorite mineral reflects arid and semi arid climate with alkaline environment, while, the Illite minerals are very common in desert soils. The sources of clay minerals are from the different sediments and rock formations that exposed through the wind rote, (25,16,27). The results of clay minerals are in concordance with other studies of clay minerals in soils, sand dunes, alluvial plain and dust storms, (16,17, 21,28,29,30).

3.3 Toxic Trace Elements Analyses and Their Effect:

Suspended solids are important pollutions which consist of suspended minerals and other suspended solids such as soil, wash off plowed fields, and fertilizers. Inorganic trace elements are commonly present at low levels in nature and there is already a natural level of tolerance. There is, however, a fine division between natural tolerance and toxicity. The trace elements (Pb, Fe, Cu, Co Cd, Ni and Zn), are designated as priority pollutants by many researchers, (23,31,32,33,34,35). In the present research, those seven heavy metals concentration (Pb, Fe, Cu, Co Cd, Ni and Zn), were analyzed by using atomic absorption, from 4، samples of dust storms which have been collected from Baghdad, Ramadi Cities . The results reflect that the maximum mean concentration of trace metals is the Fe (674 ppm for Baghdad and 538.6 ppm for Ramadi) and the minimum is the Cd (11.7 ppm for Baghdad and 14 ppm for Ramadi) (Table 3). Their minimum, maximum, and health effects are discussed as follow:

The maximum and minimum values of Fe were in Baghdad (914 ppm and 472ppm) with mean value of 674ppm and in Ramadi(970 ppm and 134ppm) with mean value of 538.6 ppm. The iron element increment above the allowed level will be harmful to health which means if level increases over (0.3 Mg/ L)(36).

The maximum and minimum values of Pb were in Baghdad (189 ppm and 51ppm) with mean value of 100.4ppm and in Ramadi(193 ppm and 40 ppm) with mean value of 98 ppm. This element causes stimulation to bronchial mucosa of respiratory system which results cause of allergy and asthma and causes bone weakness if its rate increases in human body . The Pb vapors resulting from fuel compounds because of full burn evaporation will complexes in the environment through the vapors produced from cars which get bad negative effects on living.The human body may take the lead through air which ranges between less than (4 Mg /day) and more than (200 Mg/ day) according to area where he lives (31).

The maximum and minimum values of Zn were in Baghdad (155 ppm and 84 ppm) with mean value of 121.6 ppm and in Ramadi(158 ppm and 34ppm) with mean value of 90 ppm. Decrease rate of zinc in males will be going with cardiac chronic diseases.

The maximum and minimum values of Ni were in Baghdad (162 ppm and 31 ppm) with mean value of 95.3 ppm and in Ramadi(166 ppm and 62ppm) with mean value of 106.5 ppm. Zinc element regarded important to human growth and animal growth. The nickel can effect kidneys and causes vertigo, bronchitis, Asthma(31 ,37).

The maximum and minimum values of Cu were in Baghdad (53 ppm and 30 ppm) with mean value of 31.3 ppm and in Ramadi(96 ppm and 21ppm) with mean value of 46 ppm. The Copper element is one of the non important elements to human body and will be poisonous if its rate increases. it's increment in the human blood and liver tissues will cause the Wilson disease which results in changes in tissues of brain and liver and ophthalmic cornea .

The maximum and minimum values of Co were in Baghdad (37 ppm and 8 ppm) with mean value of 21.7 ppm and in Ramadi(35 ppm and 10ppm) with mean value of 15.5 ppm. Cobalt element is important for human and animals. If cobalt rate increase rats will cause disturbances in some important organs (31) .

The maximum and minimum values of Cd were in Baghdad (27 ppm and 4 ppm) with mean value of 11.7 ppm and in Ramadi(25 ppm and 3ppm) with mean value of 14 ppm.

Cadmium poisoning result damages the kidneys and hypertension and takes place the calcium. It has accumulative effect to human body and cause bony damage. The highest level allowed for cadmium in air is (0.05 Mg/m3), (31, 36,37,38,39). The results of the heavy metals concentration are in concordance with other studies of heavy metals concentration in soils, sand dunes, and dust storms, (23, 33,34,35).

Table 3- The concentration of some trace metals (ppm) in dust samples obtained between February 2009 to July 2010.

Date of dust storm	location	Trace Metal (ppm)						
		Cd	**Cu**	**Ni**	**Zn**	**Fe**	**Co**	**Pb**
20-2-2009		16	36	102	155	914	12	121
27-2-2009		9	30	162	153	743	23	134
9-3-2009		13	37	148	130	718	34	62
9-6-2009		16	32	108	115	579	37	167
4-7-2009		12	42	31	139	528	19	160
30-7-2009	Baghdad	27	50	134	143	731	32	177
4-4-2010		9	52	102	96	725	18	51
14-5-2010		8	51	107	148	592	8	189
24-6-2010		4	30	31	153	739	22	74
20-7-2010		8	53	128	84	472	22	149
Min		4	30	31	84	472	8	51
Max		27	53	162	155	914	37	189
Mean		11.7	31.3	95.3	121.6	674	21.7	100.4
		Cd	Cu	Ni	Zn	Fe	Co	Pb
17-2-2009		3	66	89	110	175	35	182
9-3-2009		16	23	166	96	635	34	178
17-6-2009		6	21	126	118	567	34	193
28-6-2009		25	54	97	139	542	24	48
2-7-2009		6	46	107	121	134	21	153
29-7-2009	Ramadi	9	59	79	34	884	10	62
3-4-2010		14	31	62	139	678	32	174
13-5-2010		20	35	85	109	562	33	130
6-٦-2010		23	21	**89**	34	316	14	69
23-6-2010		9	52	166	158	562	10	51
19-7-2010		22	96	105	154	970	14	40
Min		3	21	62	34	134	10	40
Max		25	96	166	158	970	35	193
Mean		14	46	106.5	90	538.6	15.5	98

3.4 Radioactivity measurement of selected dust storm samples:

Radio nuclides released to the environment from different sources may enter the atmosphere from soil and affect the human health and environment. There are four chains present in the earth crust of primordial origin namely uranium-238 series (U^{238}), thorium-232 series (Th^{232}),actinium Ac- series and neptunium series (40). Radium R^{226} is one of the most important radionuclide's in U^{238} series due to its long life (1620 years) and it may deposit in bones ,(6,41,42).

The radioactivity was measured in disintegration/second (d/sec) and by using the Curie (Ci) unit, which is the radioactivity of one gram of Radium R^{226} .

, where :

$1\ Ci = 3.7 \times 10^{10}$ d/sec.

In recent years the Curie (Ci) unit is changed by other unit the Bequerel (Bq)

Where :

$1\ Bq = 2.703 \times 10^{-11}\ Ci = 1$ d/sec $= 2.7 \times 10^{-11}$ gm Radium

In this study Uranium concentration average absorbed dose and average external effective dose were calculated for dust of sandstorm at 2-4/7/2009 and 3-4/4/2010 for both cities Baghdad and Ramadi.

Uranium is a hard, ductile, silver-white, radioactive metal, with very high density. In air, it is coated by uranium oxide. The health effects of exposure to uranium compounds are chemical toxicity, because uranium is a heavy metal, and radiation toxicity due to the radiation emitted by uranium compounds following external or internal exposure. It is well established that doses of ionizing radiation much higher than background levels can cause measurable increases in cancers and leukemia after a delay of a few years. The degree of damage caused by radiation depends on many factors, such as dose, dose rate, type of radiation, exposed body part, age, and health history. The unit of measurement is in Bq/Kg, in which $12X10^6$ Bq/Kg of U^{238} is equal to 1 ppm, (40). The results of the activity concentration of U^{238} in selected dust storms were compared with the results of other researchers.

Concentrations of uranium in the world soil ranges from 0.7 to 11 ppm and it may sometimes reach a value of 15 ppm especially in farmland soil due to the extensive use of phosphate fertilizers. Mean and median values of uranium in the world soils are 1 and 2 ppm respectively, (43).

Also, the Absorbed Dose,(D), was measured in the dust samples ,as follow:

$D = \Delta E / \Delta m$

Where:

D = the actual Absorbed Dose (measure in rad unit, 1 rad = 0.01 Joul . kg^{-1}).

ΔE = Average energy

Δm = Unit mass

The rad unit was changed according to the International Standards Units to Gray (Gy) unit,

where: 1Gray = 100 rad

The results for specific activity of uranium was in range of (5.43-9.56 Bg/kg) and the absorbed dose range (2.19- 5.46 nGy/h)for sandstorm at 2-4/7/2009 and the average specific activity of uranium was in range of (7.32- 18.96 Bg/kg) and the average absorbed dose (3.27- 8.98 nGy/h) for sandstorm 3-4/4/2010.

By comparing the activity concentrations of uranium of the studied dust samples, with those of the world average soil, it is clear that the present values are within normal range. Ali,(44), studied the specific activity of uranium of Baghdad soil, the results indicate a range of 7.5 to 15.8 Bq/kg with an average of 12.9 Bq/kg . While Marouf, et al.,(6) , results for their studies of the specific activity of uranium of Baghdad soil, indicate a range of 49 to 80 Bq/kg (with error range of 9 Bq/kg). while, Mahdi, et al,(15), in their study of the specific activity of uranium of dust storms samples in middle and west Iraq during 2007 and 2008, found that the average specific activity (6.475-22.680 Bq/kg) and the average absorbed dose (2.777-9.729 nGy/h) for dusty storm 17/4/2008.and they concluded that all their results were lower than allow level, but the culmination of the dose of more than one dusty storm may have a damage effect.

Moreover, it is believed that the climatic parameters (Temperature, wind speed, wind direction) play an important role in affecting the dust (as in suspended dust, rising dust and dust storm) in the air and consequently the uranium concentration in air. Infact, this finding is in agreement with Al-Ubaidi, (45), conclusion . Therefore ,more monitoring and analysis is in need for early prediction of the accumulation of the radioactive nuclei in air ,also ,the accumulation of such doses for long time has a bad effect on human health comparing with UNSEAR Standards with the range 10- 200 nGy/h).

4-Conclusions

The present study has given rise to the following conclusions:

1) 1- The main texture of most dust samples were sandy silty clay 71.4%, and to less extent sandy clayey silt 28.6%, that depend on the energy and velocity of the wind from the regional dust storm which carries these grains.

2) 2- The light minerals that were recognized in the dust samples are Quartz (52.2 %,), feldspar (6.4%,), calcite (33%,), gypsum (5.6%,), dolomite (1.5%,) and heavy minerals (1.3%,). The results of heavy minerals analyses indicated that the following percentages were existed,opaque heavy mineral, pyroxene, hornblende, zircon, chlorite, epidote and garnet.

3) 3- The presence of Palygorskite and Kaolinite among the clay minerals reflects the arid and semi-arid climatic conditions. The formation of chlorite mineral reflects arid and semi arid climate with alkaline environment, while, the Illite minerals are very common in desert soils. The sources of clay minerals are from the different sediments and rock formations that exposed through the wind rote. Consequently, the stable heavy minerals may reflect such geological formations as the regional dust storms blowing from western desert of Iraq.

4) 4- The trace elements (Pb, Fe, Cu, Co Cd, Ni and Zn), are designated as priority pollutants. The results reflect that the maximum mean concentration of trace metals is the Fe (674 ppm for Baghdad and 538.6 ppm for Ramadi) and the minimum is the Cd (11.7 ppm for Baghdad and 14 ppm for Ramadi). The dust storms loads were depend on the direction of the wind and the geological formations the desert land, different geological formations, Sabkha, irrigated land, agriculture land that were in their path way.

5) 5- Uranium concentration average absorbed dose and average external effective dose were calculated for dust of sandstorm at 2-4/7/2009 and 3-4/4/2010 for both cities Baghdad and Ramadi. All the results were lower than critical dose level, but the culmination of the dose of more than one sandstorm may have a damage effect.

6) 6- During the strong dust storm affected Baghdad, and other Iraqi countries, reports from the Iraqi ministry of health and statistical analyses that have been done by researchers for many cases in many hospitals in Baghdad and the governorates indicated that many people were taken to hospitals after sustaining breathing problems ,asthma, bronchitis and lung diseases.

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