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DUST STORMS AND THEIR ENVIRONMENTAL IMPACTS AT THE NORTHWEST PART OF ARABIAN GULF (A REVIEW)

Abdul- Mutalib H. Al-Marsoumi * **Maher M.M. Al-Asadi***

***University of Basrah- College of Science – Department of Geology**

e-mail: abdmars@yahoo.com,

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Abstract:

Aeolian deposits and dust storms have wide geographic distribution in Iraq and northeastern part of Arabian Gulf, this phenomenon get an overtaken interest owing to their environmental impacts on economic activity and human health. Most of aeolian deposits are in the form of dunes. Burchan is the dominant type of sand dunes at Najaf area initiated by the uni-directional northwesterly winds action, nevertheless; dome-shaped and elongated types of dune (Fixed dune) were also reported at Nasiriyia and Samawa. Dust storm phenomena are common in central and southern Iraq and northwest Arabian Gulf. Aeolian deposits are concentrated south of Baghdad, Karbula, Najaf, Nasiriya, Basrah as well as Kuwait. The major source area of dust is Baher el-Najaf sands, and ancient sediments of Dibidbba, Injana, and Rutba Formations cropping out of western Iraq, as well as, alluvial deposit of Tigris and Euphrates Rivers. The mineralogical analysis indicated higher percentage of light minerals in comparison with heavy one. Furthermore, the heavy and light mineral assemblages of the studied sand dunes proved that their materials have been derived from rocks cropping near by, as well as, the Tigris- Euphrates alluvial deposits contribute to the source materials. The mean values for Pb, Cd, Fe, Cu, and Ni heavy metals in dust fall over Thi-Qar governorate are:149, 8, 7569, 72 and 212 ppm respectively. These values indicate that vehicles engines besides agricultural activities form major sources of these metals.

العواصف الترابية و تأثيراتها البيئية في شمال غرب الخليج العربي (مراجعة عامة)

عبد المطلب حسون المرسومي* **ماهر منديل مهدي الاسدي***

***جامعة البصرة- كلية العلوم - قسم علم الأرض**

الكلمات المفتاحية: العواصف الترابية، الخليج العربي، التحليل المعدني، الترسبات الريحية، المعادن الثقيلة.

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المستخلص

الرواسب الهوائية و العواصف الترابية من سمات المناطق القاحلة وشبه القاحلة ، هذه الظاهرة ذات توزيع جغرافي واسع في شمال شرق الخليج العربي بسبب سيادة المناخ الجاف والتجوية الفيزيائية. نالت هذه الظاهرة اهتمام متزايد بسبب تأثيراتها البيئية على الصحة العامة و النشاط الاقتصادي.تعد الظروف الجوية المؤثر الحقيقي على انبعاث و نقل الغبار التي تهدد النشاط الزراعي و تحول المناطق إلى أراضي بور او أراض ذات إنتاجية قليلة.

الرواسب الهوائية تنتشر بشكل كثبان رملية بنوعيها المتحرك بهيئة البرخان (النجف) الناتج من حركة الرياح الشمالية الغربية و الثابت بهيئة ألقبيي و الطولي (السماوة و الناصرية). مصدر رواسب الكثبان الرملية هي بحر الرمال في النجف و التكوينات الجيولوجية: الدبدبة و الانجانة و الرطبة و الرواسب الفيضية لدجلة والفرات. العواصف الغبارية ظاهرة مألوفة وسط و جنوب العراق و شمال غرب الخليج العربي. اثبت التحليل المعدني للرواسب الهوائية ان نسبة المعادن الخفيفة يفوق الثقيلة. وان مصدرها مكاشف صخرية قريبة فضلا عن الرواسب الفيضية لدجلة و الفرات. إن معدل تركيز العناصر الثقيلة: الرصاص و الكادميوم و الحديد و النحاس و النيكل في الرواسب الغبارية يبلغ ١٤٩ و٨ و٧٥٦٩ و٧٢ و١٢١ ج م م على التوالي. هذه التراكيز تعزى إلى حركة المركبات وعوادمها بالإضافة إلى النشاطات الزراعية في محافظة ذي قار.

Introduction:

Dust storms are significant weather phenomena in Iraq which represent a form of serious natural hazards. Such phenomena have a wind speed of at least 25 mile/hour, playing an active role in transporting and deposition of materials of different sizes led to change in earth's surface. The significance of dust storms lies in the amount of deflation and wind deposition, as well as their effect on the public health (Respiratory diseases). In many arid and semi- arid regions, the number of days in which dust storm occur is considerable. Idso 1967 listed five major regions whence dusts originate: the Shara, the southern coast of Mediterranean Sea, Sudan, Arabian Peninsula, & Lower Volga.

It is worth to mention Sahara that wind affects many economical activities. They affect on determining the sites of industrial establishments and where its waste damps should be located: on city construction and agricultural productivity along with exploiting wind in various field such as using it in generating energy (Hussein, 2002).

Many authors have paid their attention to study dust storm phenomenon via various means, for instance they utilized satellite observations to describe the large scale dust loading of the atmosphere over Africa. This technique was also employed in northeastern part of Arabian Gulf by Vinogradov *et al.*, 1973 cited in Foda *et al.*, 1985, and Al-Dousari (1997). Al-Najem, (1975), found two regions striken by dust storms, one is centered over Baghdad and the other is centered west of Basrah, as well as the Southern Desert being the major dust source while Northern Desert playing a secondary role. Most of authors agreed that the northwestern winds play an active role in transportation and deposition of dust in various amounts (Table-1) Al-Sayegh studied the Dust fallout over Mosul in 1976 statistically. He found that the average rate of fallout is 9.76 ton/km2/ month. Aeolian dune dimensions and sedimentological aspects in Najaf, Samawa, and Nasiriya were studied by Al-Ani, 1979. Salman and Saadallah (1986) found the rate of dust deposition increases from Baghdad toward Nasiriya, then decreases toward Safwan. It is worth mentioning that the maxima and minima of dust fallout in Kuwait were recorded in July 1979 (1002.7 tones/ km2) and November 1979 (9.8 tones/ km2, respectively (Khalaf, and Al-Hashash, 1983). Suspended particles in air are recognized as major pollutant which can have an obvious effect on the health of the population and the quality of the environment; Akhter and Madany, 1993, found that the dust in urban area (Manama-Bahrain) of both types street and house dust could form a source of pollution by heavy metals derived from three main sources; industrial, automobile activities, and weathered material, (Manama city- Bahrain State) via the concentration of Pb, Zn, Cd, Ni and Cr in street and household dust. Whereas, in Baghdad, Yousif 2007 found the average concentrations of Pb, Zn, and Fe 0.86, 0.105, and 10.88 $\mu g/m^3$ respectively. Al-Ali, 2000, showed that Mesopotamia deposits contributed Aeolian deposits supplement. Furthermore, the field measurement of these deposits showed significant amounts in July than other months by 71% especially at height 5 cm due to the increase in the deposit particles by saltation and this was cleared out at Umm Qaser station. In north western Arabian Gulf, Al- Khalefa, 2001 attempted to study the effect of dust deposits on characteristics of fruit and leaves of date palms (*Phoenix dactelefera* L. C.V. Hallawi) at Abu-Al-Khaseb, Al-Hartha, and Shatt Al-Arab- Basrah governorate. He found a close relationship between dust deposits and the chlorophyll contents of leaves, besides the deterioration of fruit characteristic and decrease in date palm productivity.

According to risk created by sand dune and dust storms, such phenomena have been subjected to various studies. The task of this study is to undergo a comparative reevaluation of sand dune and dust storm in the light of geologic and environmental available data in order to illustrate their environmental and human health impacts.

Table-1: The rate of dust fallout reported at different areas.

AREA	AUTHOR	RATE OF DUST FALLOUT
Central Iraq	Kukal and Saadallah, 1970	2.1 cm/year
Mosul	Al-Sayegh, 1976	9.7 ton/Km^2/month
Northwest Arabian Gulf	Foda et al., 1985	0.88 mm/year
Kuwait	Khalaf and Al-Hashash, 1983	July, 1979 1002.7 ton/km^2 November 1979 9.8 ton/Km^2
Central-Southern Iraq	Salman and saadallah, 1986	0.15 cm/year
Basrah	Al-Ali, 2000	July 1999, 10.73 gm/m^2

Study area:

Mesopotamia plain is located between Zagros mountains to the east and west Plateau (Fig.1) The surface of study area is generally slightly sloped gradually northeastwards, with an average gradient of 2 km^{-1}(Al-Dousari *et al.*, 2000) (In Kuwait). In Iraq the study area is sloped towards northeast.

The eastern part of Arabian Peninsula is covered by various types of recent sediments. The recent surface sediments in this area are: 1- Mesopotamia flood plain;2- Dibdibba plain; and 3-Western Desert. Lithologically, the sediments filling up Mesopotamian plain represented by gravels, sand and especially south of Baghdad prevalently silts (Buday, 1980), whereas, the lower Mesopotamian plain is mostly covered by muddy sediments, (Buringh, 1960). Gypcrete is abundant in the sandy gravely horizon at the upper part of Dibdibba formation.

The southern part of Mesopotamia has simple topographic features; the regional slope is about 26.7 cm/km with a general southeast trend towards the Arabian Gulf, while, the general slopes of Dibdibba plain is toward the northeast (Al-Khait, 2002). Sand dunes form a common phenomena in southern Iraq; Najaf, Samawa, Nasiriya, and Basrah. From geomorphologic point of view, there are two types of dunes including the mobile dunes (barchan) in Najaf and Nasiriyah areas, that formed by uni-directional wind action and fixed dune in Samawa area, which contains the dome-shaped and elongated types of dunes, that are formed due to variation in the prevailing wind direction (Al-Ani,1979) (Fig, 2).

In Kuwait area, barchan dunes are prevalent. Individual dunes cover more than 60% of some dune belt. The barchan dunes occur near their source in the peripheral areas of the Bahar Al-Najaf, particularly downward, beyond advancing tips of linear dunes (Skocek and Saadallah, 1972) (Fig, 2). It is worth mentioning that some barchan dunes were also reported from Artawi and Umm-Qaser west and south west of Basrah city.

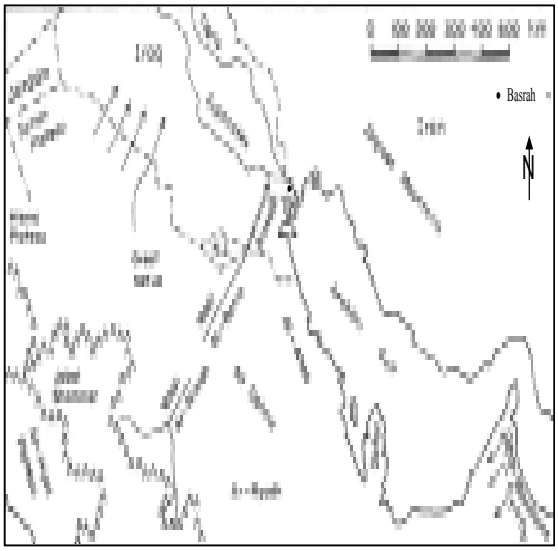

Figure -1: Map showing physiographic province of the northern part of Arabian Peninsula after khalf and Al-Hashash (1983).

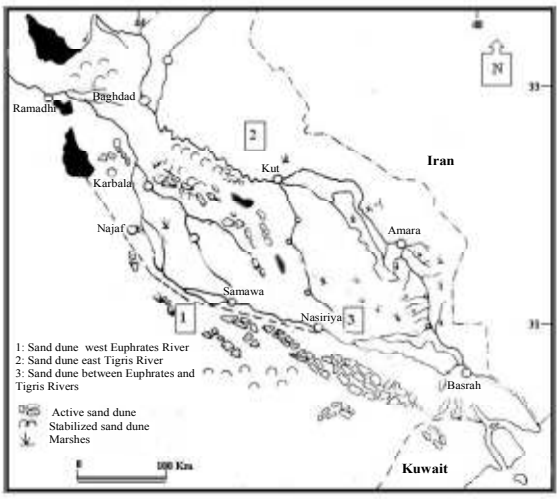

Fig-2: Distribution of sand dunes in Iraq and NW Arabian gulf (modified after Al-Rayhani, 1986)

Meteorology:

Metrological parameters, such as wind speed, atmospheric pressure, humidity and temperature play a prominent role in evolution of dust storms. In this study we emphasis on the wind, among the basic factors which controlled the initiation of dust storms, since wind play an active role in the process of erosion and deposition. There is a close relationship between climate and geographical location of Aeolian deposits, for instance, latitude determine the intensity and duration of sun light, that reach the earth surface and raises its temperature and also increase rates of evaporation with little or no rain fall. The north eastern part of Arabian Peninsula includes the northwestern part of Arabian Gulf, Iraq, and the north- eastern corner of Saudi Arabia. This region is affected by four semi-permanent pressure systems, the cold Siberian anticyclone, traveling depressions, the extension of Sudan depression, and the Indian Monson depression (Al-Kulaib, 1977). The studied area is under the effect of depressions and most effective ones in its climate are the Mediterranean and the Atlantic in winter, and the Indian Monson in summer (Dari, 1988).Wind blows from two main directions, either the north-west or, to a lesser extent, the south-east (Fig.3). The climate of the area under study is characterized by generally dry, hot, windy climate with wide range of diurnal and scanty rain summer, cold wet winter, with two transitional seasons of spring and fall which are generally short – lived. The north and northwest wind directions are mostly prevailing. The total mean is about 100 mm/year in Kuwait and 140 mm /year in Iraq (Khalaf, 1983; Al-Khait, 2002, and Al-Dousari and Pye, 2005).

Based on space image, Vinogradov *et. al.*, 1973, cited in Foda *et al.*, 1985 showed that dust storms and dust-sand storm are seen distinctly over the Mesopotamia low-land and the north part of Arabian Gulf in the form of four sub-parallel strips (wind streams) of various wide and long (Fig.4A). Moreover, the space image analysis shows that dust storm originate in Mesopotamian low land south of lake El-Milh and Al-Tharthar where a series of vortices are observed. Here the wind velocity sharply increases which leads of the abundant capture by wind flows of the dust particles from the loess like alluvium and irrigation deposits, as well as, from rock exposures.

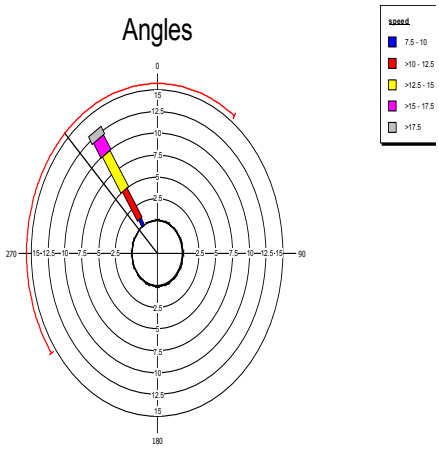

Fig.-3: Wind rose in Iraq based on Al-Khait,(2002) meteorological data

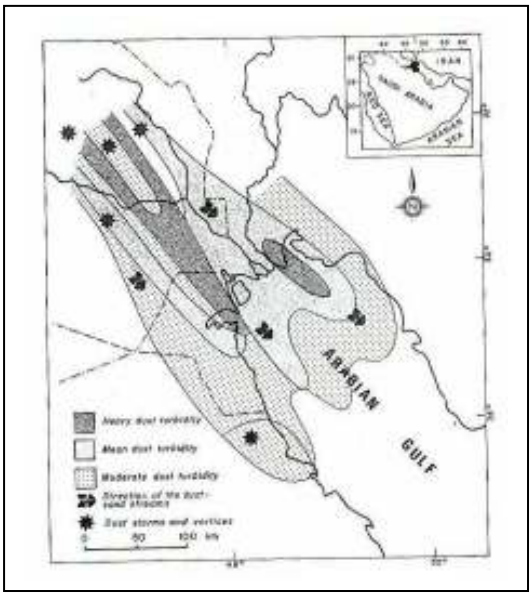

Fig.-4A: Satellite image of Arabian Gulf during a dust storm (after Vinogradov *et. al.*,1973 cited in Foda *et.al.*,1985)

Aeolian deposits:

Dust storms in Iraq play a major role in transportation and deposition of dust. Wind blown deposits of the Mesopotamia Plain are confined to three belts (Fig.5). The NE belts the most extensive, extending from Baiji in the NW to Al-Tib E of Amara in the SE. The Aeolian deposits in this belt (mainly in Baladruz and Al-Tib area) were derived from alluvial fans. The central belt lies between the Tigris and Euphrates Rivers and is generally rich in gypsum and clay crusted grains derived from the Sabkha and depression deposits on which they are often located. The SW belt is located along the SW margin of Mesopotamia plain at the contact with rocky desert outcrops. This belt comprises narrow longitudinal dune fields, often controlled tectonically splays of the Euphrates Boundary Fault. Many of the dunes are active but in places where they are fixed by vegetation due to seepage of relatively saline water (Jassim and Goff, 2006). Wind can move sediments particles by rolling along the surface, by saltation, or in suspension. Aeolian sand deposits besides of Iraq and neighboring countries, these sediments are believed to be the source of dust storms.

Dune initiation and movement still needs more efforts for better understanding of Aeolian process. Moreover, dunes can form of sediment of different sizes. These dunes have begun to form when sediments-bearing winds encountered obstacles that slow them down. With reduced velocity, the wind begins to drop the coarsest, heaviest fraction of its load. Dune shapes vary with the relative importance of sediments supply, wind action, and presence of vegetation.

Dust storms and dunes:

Dust storm commonly occurring in the Iraqi governorates located below lat. 35˚ north. The natural conditions represented by geographic position at the eastern fringe of western desert, rarity of vegetation cover, low rainfall, and the flatness of such area for a long distance, speeded up the winds. The major source area of dust is situated north of Nasiriya and Samawa, it is an area characterized by major dune fields. In general the rate of dust deposition increases from Baghdad to Nasiriya where it reaches maximum value, then decreases toward Safwan (Salman and Saadallah, 1986). Dust storm could be defined as large air masses blown with 25 km/h or 7m/sec. with high dust intensity, where the visibility is reduced to less than 1000m. Nevertheless, the dust storm may be so thick that visibility is much reduced. Some times thick dust storms arrive in form of a big wall of dust and debris. It is believed that dust storms covering the southern area of Iraq and the coastal area of Kuwait are originated from the southern Mesopotamia Desert in Iraq (Fig. 4A)(Foda, *et al*., 1985), and covered a parts of Saudi Arabia too(Fig 4B).

Dust fallout in Basrah area is predominantly sandy clay and sandy silt (Al-Ali, 2000). And is mostly composed of light minerals, Based on Al-Awadhi, 2005, the occurrence of sand size particles is attributed to erosion and land degradation of

local surface deposits possibly Didibba Formation.

characterized by the high durability, so they can survive more than one cycle of erosion

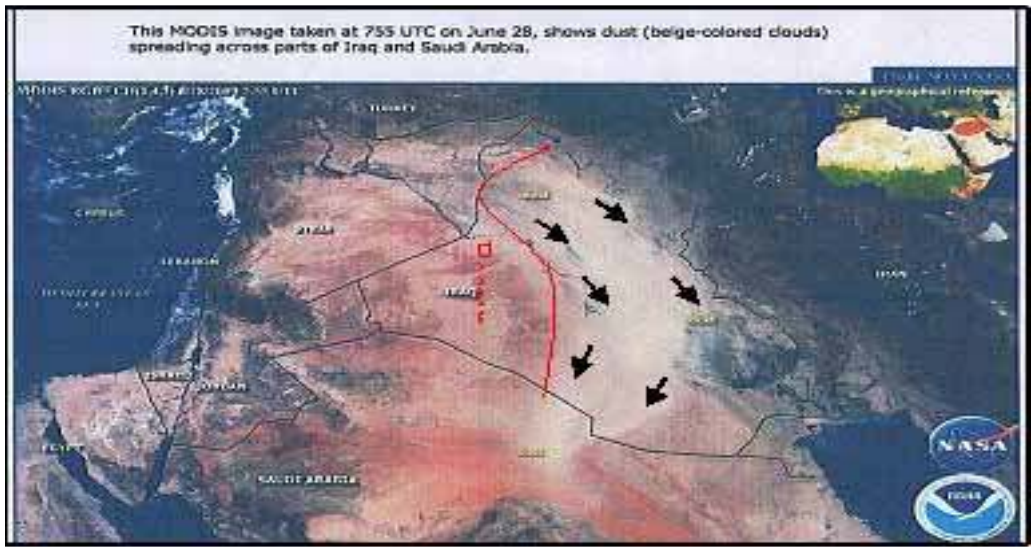

Fig.-4B: Satellite image of Arabian Gulf during a dust storm (NASA, NOAA, 2009)

Mineralogical analysis:

A total of 90 samples of sand dune collected from Najaf, Samawa, and Nasiriya were examined (Al-Ani, 1979). The average percentage of heavy minerals in the above studied are shown in table (2). Twelve heavy minerals were identified in the dune sands of the studied areas, they include; pyroxene, amphibole, epidote, opaque minerals, celestite, flake minerals, ultra stable minerals, garnet, apatite, staurolite, kyanite, and few unidentified coated minerals. The distribution of the heavy minerals shows variety among the Najaf, Samawa, and Nasiriya dune fields (Fig,5). This variation is attributed to the variation in the amount and stability of the transported heavy minerals and in the differences in wind direction. On the other hand, light mineral analysis revealed quartz to constitute the highest percentage compare to feldspar and rock fragments due to its high stability (Table-3). The occurrences of hornblende and pyroxene in dust fall out refers to:1- rapid erosion under dry climate which promote the physical weathering rather than chemical ones, 2- the Aeolian deposits derived from source area near by. Zircon, tourmaline, and garnet these minerals are

and deposition, which indicates that the Aeolian sediments understudy weathered from older clastic formation possibly Dibdibba or Rutbah Formation cropping out west of the studied area (Table-2). The similarity in non-opaque heavy minerals contents between Iraq and Kuwait dust fallout (Table, 4) suggests that the latter is derived from the older sediments cropping out at middle and south of Mesopotamia plain (Al-Awadhi, 2005). Heavy mineral assemblages in aeolian deposits of central and southern Iraq can be correlated with that of Tigris and Euphrates flood plain and older deposits (Philip, 1966 and Ali, 1976). Regarding Kuwait area. The physical properties, fabric, and surface texture of coarse-grained quartz and feldspar grains suggest that they are mostly derived from the sand fraction of Dibdibba Formation clastic deposits which cover southwestern Iraq and northern Kuwait, as well as, from lower Mesopotamia flood plain deposits (Khalaf, 1989). Based on Philip, 1968, the high percentage of opaque heavy mineral in dust fallout in Iraqi Aeolian deposits confirm the role of Tigris–Euphrates alluvial sediments in contribution to the

sediment budget of the Aeolian deposits surface. The heavy mineral suite of the very fine sand and silt of Kuwait is similar to that of lower Mesopotamia flood plain. This confirms that the Kuwait Aeolian deposit is derived from the lower Mesopotamia flood plain. Light mineral analysis showed quartz to constitute the highest percentage compared to feldspar and rock fragments due to its higher stability. On the other hand, the high percentage of carbonate contents in Najaf, Nasiriya, Samawa, and Basrah dunes indicate their origin to be from the distribution Tertiary limestone formations of Dammam, Euphrates, and Fat'ha. Dust storms of Basrah area have revealed the following mineralogical composition,; the surface dust deposits an composed of the following heavy minerals; opaque, alterites, zircon, tourmaline, rutile, Garnet, clinozosite hornblende, pyroxene, barite, chlorite, biotite, siliminite, staurolite. Whereas, suspended dust composed of opaque, alterites, zircon, tourmaline, rutile, garnet, staurolite, epidote, hornblende, pyroxene, chlorite, and barite (Al-Ali, 2000).

Table -2: Heavy mineral concentration in varied governorate of Iraq (Al-Ani, 1979)

		Opaque	Pyroxene	Zircon	Biotite	Hornbland	Epidote	Rutile	Garnet	Chl.	stau	ky.	other
Baghdad	**A**	**63.62**	**4.53**	**4.55**	**13.63**	**7.57**	**1.5**	**1.5**	**1.5**	**0**	**0**	**0**	1.6
	M	**41.89**	**16.36**	**21.18**	**9.09**	**3.64**	**1.82**	**3.66**	**5.45**	**0**	**0**	**0**	0
Karbala	**A**	**40.4**	**5.49**	**23.42**	**6.8**	**8.16**	**4.5**	**2.7**	**3.6**	**0**	**1.8**	**0**	0
	M	**37.37**	**20.55**	**6.54**	**14.95**	**2.8**	**5.6**	**1.86**	**5.6**	**0.93**	**1.86**	**0**	0
Samawa	**A**	**34.69**	**12.24**	**22.44**	**4.08**	**4.08**	**16.32**	**0**	**4.08**	**2.04**	**2.04**	**0**	2.98
	M	**46.53**	**16.83**	**12.87**	**3.96**	**5.94**	**3.96**	**2.97**	**0**	**1.98**	**0.99**	**0.99**	0
Nasriya	**A**	**27.44**	**38.18**	**5.88**	**9.8**	**7.84**	**5.88**	**0**	**0.48**	**1.96**	**0.54**	**0**	3
	M	**19.49**	**26.2**	**7.76**	**9.7**	**10.67**	**9.7**	**0.97**	**0.97**	**3.88**	**3.88**	**0.97**	4.85
Hartha	**A**	**63.38**	**4.21**	**12.67**	**8.45**	**1.1**	**1.4**	**4.25**	**1.4**	**0**	**0**	**0**	0
	M	**53.2**	**4.6**	**20.35**	**12.05**	**9.99**	**8.95**	**2.6**	**0**	**0**	**0**	**0**	0
safwan	**A**	**43.15**	**11.57**	**12.63**	**5.26**	**7.36**	**0.47**	**2.1**	**1.05**	**0**	**6.31**	**0**	1.05
	M	20.58	23.52	17.67	17.67	2.94	4.41	1.41	4.41	0	0	1.47	0

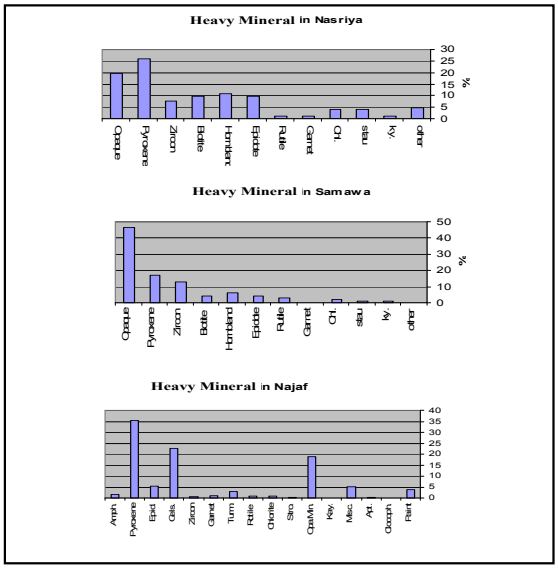

Fig.-5: Heavy minerals in Najaf, Samawa and Nasiriya (Al-Ani, 1979)

Table-3: Light mineral concentration in varied governorate of Iraq (Al-Ani, 1979)

		carbonate	Quartz	feldspar	rock fragment	Mica	Gypsum	other
Baghdad	**A**	**27.72**	**17.82**	**9.94**	**18.89**	**15.84**	**0**	9.79
	M	**24.21**	**31.58**	**22.11**	**8.42**	**2.1**	**8.42**	3.6
Karbala	**A**	**31.32**	**19.28**	**9.69**	**20.48**	**12.05**	**1.2**	6.02
	M	**8.73**	**63.49**	**27.19**	**0**	**0**	**0**	0
Samawa	**A**	**42.1**	**24.06**	**13.53**	**11.28**	**3.76**	**2.26**	3
	M	**27.4**	**25.2**	**9.57**	**20.21**	**3.95**	**2.25**	11.42
Nasriya	**A**	**24.24**	**25.25**	**4.04**	**26.26**	**5.05**	**2.02**	13.13
	M	**34.69**	**24.96**	**5.54**	**20.68**	**8.89**	**0**	5.18
Hartha	**A**	**45.2**	**25.72**	**18.43**	**6.01**	**3.8**	**0.82**	0
	M	**18.1**	**54.29**	**16.9**	**4**	**0.95**	**0**	2.76
safwan	**A**	**18.45**	**51.46**	**16.5**	**7.79**	**1.94**	**0.97**	2.87
	M	25.1	51	18.01	2.21	2	1.04	0.64

Table-4: Concentration of heavy metals in dust samples (mg/kg) in Kuwait (Al-Awadhi, 2005)

Sample No	Cr	Ni	V	Pb
Dust 1	53	62	53	0
Dust 2	49	59	50.6	0
Dust 3	0	54.7	36.5	9.1
Dust 4	0	0	0	9.1
Average	51	58.5	46.7	9.1

Environmental impact:

The environmental effects of dust fallout in the studied area range from air pollution to possible impact on climate, the local economy, and the quality of the life of the population. Dust reduces visibility, which may contribute to a various transportation and navigation safety hazards (Al-Awadhi, 2005). During a strong dust storm, which last for several days (3 – 7 days), the visibility is often reduced to less than 1000m, and occasionally to less than 500m (Al-Sudairrawi *et al.*, 1999), the dust may be so thick that the visibility is much reduced. At Basrah, Iraq, visibility is of less than 50m during heavy summer dust storms has been reported (Anon., 1944 cited in Foda *et al.*, 1985).

A close connection was found between dust storms and the infection by bronchial asthma diseases. The less than 5 micron suspended particles within dust storms causing fit acute asthma. This disease represents one of the common chronic lungs diseases (allergic diseases) in Basrah governorate (Al-Marsoumi, in press). On the other hand, with the increasing of falling dust on the date palm decreasing the leave's constituents of chlorophyll in addition to their infection by dust spider's in all stages of fruit maturity. The spiders get their nutrition from the date palm fruit and hence affect their quality and quantity. Furthermore, the accumulation of dust on the fruit objected some of the physiological processes which controlled the physical characteristics of the fruits such as: fruits weight, seeds weight, core's weight, fruit length and fruit's radius. As well as the accumulation of dust on the date palm leaves reduce their efficiency in carbohydrate synthetic which is required throughout fruit growth and development (Gasim *et al*., 1986).

Chemical composition:

The concentration of heavy metals in dust particles has been used as an indicator

for pollution. Akhter and Madany, 1993 mentioned three sources of pollutants elements: road traffic (automobile), industrial activities and weathered materials. Thi-Qar governorate represents one of the most common area subjected to dust fallout phenomenon in southern Iraq, therefore Many samples of dust collected from different locations within this governorate were chemically analyzed to measure the concentrations of some heavy toxic metals such as Pb, Cd, Fe, Cu, and Ni. It is worth to mention that the selection of these elements is based on their environmental impact on the public health (Ahmed, 2007). The last author indicates that the concentration of heavy metals shows important spatial variations than the seasonal variations. Regarding Pb and Cd, their percentages are stable during the four seasons of the year except in spring there was an increase in the Pb level in compared to the rest seasons (Table, 5). Whereas, the Fe scores is the highest concentration compared to the analyzed elements, possibly due to the dusty storms which has been believed to bring Fe from neighboring countries. Ni and Cu have the same level of concentration over all seasons. The sources of the studied heavy metals is believed to be; Cu is derived from chemical fertilizer and other agricultural activities, Pb, V, and Ni originated to the car exhausted waste. The occurrence of these heavy metals also suggests the possibility of negative health consequence of dust dispersal and deposition.

Al- Awadhi, 2005, found the average trace element contents in dust samples being 51, 58.5, 46.7 and 9.1 mg/ km for Cr, Ni, V, and Pb respectively. The concentration of Pb at Subiyah- Kuwait is low in compared to other Arab Gulf countries (Table, 6). Abnormal concentration of Pb was recorded at Manama. The plausible explanation for this result is that Bahrain can be considered as small country, thus can be considered as one big urban centre with high pollution and traffic density (Akhrter and Madany, 1993).

Conclusion:

The following conclusions could be drawn from the present study;

1- The high carbonate percentage of the dune sand of Najaf, Samawa, and Nasiriya suggest the proximity of these areas to the source rocks which is believed to be Euphrates, Fat'ha and Injana Formations, and Dibdibba Formation for Najaf dunes. Samawa dunes sand is from Fat'ha and Injana Formation besides, alluvial deposits. Nasiriya dune sand is from Dibdibba Formation and alluvial deposits.

2-Dust storms affect the activity of transportation and navigation via reducing the visibility range, making unsafely driving.

3- The accumulation of dust on the date palm effect the physical and chemical characteristic of their leaves, besides reducing the quality and quantity of their fruits.

4-Dust storm represents the main risk on human health, being the main causes of bronchial asthma.

5-The spatial variation in Pb, Cd, Fe, Cu, and Ni concentrations is more effective than the seasonal one.

6- Chemical fertilizer controlled the Cu concentration, whereas, automobile activity controlled the concentrations of Pb, V, and Ni in dust particles.

7- The high concentration of Fe in dust particle proved that such particles are derived from rocks exposed in neighboring countries, and Hussyiniate outcrops inside Iraq.

8- The diversity in heavy minerals assemblages is attributed to variation in the amount and stability of the transported heavy minerals and in the differences of wind direction. Furthermore, the high percentage of opaque heavy mineral in dust fallout in Iraqi and Kuwait Aeolian deposits confirms the role of Tigris – Euphrates alluvial sediments in contribution the sediment budget of the

surface Aeolian deposits.

9- The prevailing wind direction controlled the type of dune; the northwesterly winds controlled the Najaf and Nasiriya Burchan type, whereas, the variation in the prevailing wind direction brought about the dome- shaped and elongated type of Samawa dunes.

Table-5: The concentration of Ni, Cu, Fe, Cd, and Pb in ppm in dust particle Thi-Qar Governorate

A-Summer

Elements	Ni	Cu	Fe	Cd	Pb
Min	77	25	1027.5	0.1	29.8
Max	346.4	268.9	9208.6	18.3	198.7
Mean	204.8381	155.6333	6288.281	9.861905	118.1286

B-Winter

Elements	Ni	Cu	Fe	Cd	Pb
Min	150.8	24.8	6902.5	6.7	84.2
Max	509.7	525.3	9739.2	20.5	304,4
Mean	311.538	75.4619	8963.9	11.8428	148.881

C- Spring

Elements	Ni	Cu	Fe	Cd	Pb
Min	93.3	18	3201.8	1	158.2
Max	167.5	75.5	10843.1	11.9	543.8
Mean	125,481	31.78	6734.933	4.952	270.1619

D- Autumn and annual mean.

Elements	Ni	Cu	Fe	Cd	Pb
Min	121.2	16.6	4607.8	0.1	11
Max	334.9	93.4	13529.7	19.5	109.6
Mean	204.9	22.89	8290.233	6.342	122.8
Annual ♀ mean	212	72	7569	8	149

Table -6:Averages concentrations of heavy metals (mg/Kg) in dust samples of some Arab Gulf countries (after Al-Awadhi, 2005)

COUNTRY	LOCATION	DATE	P	NI	V	CR
Bahrain	Manama	1993	697.2	125.6	-	
Saudi Arabia	Riyadh	1992	66.8	26	-	-

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