Characterization of Quartz and Calcite Particle size Presents in Local Dust Fell on Baghdad on June 2009

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Abstract

Dust samples have been collected from three areas in Baghdad during dust storm occurred in 18th of June 2009 to characterize elemental particle size and composition by different techniques. The x-ray diffraction detected six minerals those are calcite, and quartz, present as a major components, dolomite, kaolinite, gypsum and plagioclase present as miner components .EDX detected some normal elements presented in local soil except traces of lead , nickel, and chromium. The particle size analysis by a set of sieves have revealed that the majority particle distribution was between (32 and 45)μm . To isolate the aerosol size, PM_{10} buoyancy method of powder in water showed a signifying amounts of particulate size .Scheerer's method was applied to estimate the sizes of those particulate for quartz and calcite mineral .The estimation crystallite size of those separated particle was occur between (30 -55) nm for quartz and between (10 – 20) nm for calcite .Those sizes are highly affected the respiratory system of the human and even the animals . PH measured values gave slightly alkaline (PH=7.8), and this value might affect on the plant nutrition.

Keywords
Quartz and Calcite
Particle size

Article info
Received: Mar. 2010
Accepted: Apr. 2010
Published:Nov. 2010

خصائص حجم حبيبات الكوارتز والكلس الموجود في الغبار المحلي الساقط على مدينة بغداد في حزيران ٢٠٠٩

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الخلاصة

عينات الغبار جمعت من ثلاث مناطق في بغداد خلال العاصفة الغبارية التي حدثت في الثامن عشر من حزيران ٢٠٠٩ لتمييز حجم وتركيب الجسيمات العنصرية بتقنات مختلفة. حيود الاشعة السينية اكتشف ستة مواد هي: الكلسايت والكوارتز،وجدت كمواد رئيسة،والدولومت وكائلونايت والجبسم و البلوجكليس وجدت كمواد ثانوية. EDX اكتشف بعض العناصر الطبيعية الموجودة في التربة المحلية ما عدا اثار الرصاص والنيكل والكروميوم. تحليل حجم الجزيئة بواسطة مجموعة من المناخل كشف ان اعظم توزيع للجسيمات كان بين (٣٢-٤٥) مايكرومتر. لعزل الاحجام المتطايرة طريقة باونسي PM10 للباودر في الماء بينت كميات الحجم الجزيئي. طبقت طريقة شيرر لتخمين حجوم جسيمات الكوارتز والكلسايت.تخمين الحجم البلوري للجسيمات المنفصلة حصل بين (٣٠-٥٥) نانومتر للكوارتز وبين (١٠-٢٠) نانومتر للكالسايت. هذه الحجوم تؤثر بشدة على الجهاز التنفسي للانسان وحتى الحيوانات.قيم قياسات PH اعطت قلوية قليلة (PH=7.8) يمكن ان تؤثر هذه القيمة على تغذية النبات.

Introduction

Air pollution is an atmosphe-ric condition in which substances are present at concentration high enough above their normal ambi-ent level to produce a Measure-able effect on man, animals, vegetations or materials (1).

Fig.1 Dust storm occurred in 18th of June 2009 in Baghdad.

These substances are natural such as dust, or man made chemical elements or compounds capable of being airborne and may exist in the atmosphere as gases, liquids drops, or solid particles .More re-cently, attention has been shifted toward the characterization of particles mass (PM) either PM_{10}, and to a lesser extent, $PM_{2.5}$ (par-icles less than 10 and 2.5 μm in diameter) . It is known that part-iculate matter that is co-mposed of various materials is mainly res-ponsible for air pollution and stro-nger associations with health [2]. In general if the air drawn into the lung containing foreign particles, the body may remove them by various mechanisms as a function of their size. Particles those are smaller than 10μm can penetrate as far as the terminal bronchiole and alveoli, thereby adversely aff-ecting the lungs function .One of these dangerous particles is cry-stalline quartz, this mineral has high physical properties such as hardness, solubility ,and chemical reaction, so when this mineral invades the inner lung tissue can-not be removed and has been linked to several pulmonary dis-eases of which silicosis is just one of them [3].There are three main crystalline forms of silica, quartz, crys-tobalite, and trydimite .Occu-pational exposures to the three substances are regulate by Occu-pational Safety and Health Adm-inistration (OSHA),a regulatory co-ntrol body based in the USA, which requires that any product containing 0.1 %or greater quartz must be labeled as a potential carcinogen[3].Other fine powders are less harmful to human health such as calcite, which reported that excess of such compound causes irritate in the mucus membranes of the eyes, nose, throat, and the upper airways, coughing, and sneezing and nasal irritation . But the high contain of calcite in the PM2.5 fraction suggests that pot-entially toxic effect and may be also extend into the smaller airw-ays and then lung parenchyma [5].Recently reported that CO_3^{2+} present in the atmosphere could buffer the acidic species like NOx and SO_4^{2-}[4].

Methods

All the samples were collected within Baghdad city area, on June 2009 .The selected three location areas are Al-Sadder city(1), Hay-Aljamiaa(2) and Al-Rashidia city(3) .First of the samples have been sieved through sieve size 63 μm to release any unusual thinks then a 100gm from each sample were sieved through a set of sieves(63 – 10) μm in order to measure the distribution of particle size as weight percent. To isolate the particles less than 10μm, Jean method dealing with settling velocities as a function of particle size was applied to the sample in water .A 10gm of the measured sample were placed into a tall Water filled measuring cylinder, and shacked very well for few minutes and left for 24h to settle all the coarse particles, then a glass slide was attached to thin wire and immersed at a depth of 10cm and left for 168h .Then removed and dry at room temperature .X-ray diffraction analysis was used to qualitatively determine the presence of any crystalline compounds in the dust samples .The PM63 (particulate matter) sample was side drifted into an aluminum, holder and mounted into the Philips Pw1410 diffractometer .The

generator set at 35kv and 30mA generated x-ray from copper tar-get x-ray tube . Intensities were collected by proportional detec-tor .Peak were collected in the range $2\theta = 3$ to 60 degree. For sample isolated from water, Scherrer method was applied to estimate the crystallite size of the fine powder.EDX current with Pd tube applied to detect the light and heavy elements.

Result and Discussion

Particles size distribution

The mass weight of particles size distribution of the three bulk dust samples are shown in Table 1.It is obviously clear that the particle size distribution varies from area to area, because of the direction of the storm and as it is known that the coarse particles will fallen first depending on the wind speed, while the finer particle taking long time to settle depending on its size. However, the size domain was between (32-45) um as shown from Table 1.The sizes which affect the respiratory system seem to be in low concen-tration in precipitated dust, but this doesn't mean that this size is the real amount present in local atmosphere as airborne .

Table.1 Particle size (μm) di-stribution % for dust storm of 8 June 2009.

Area -location	>63	63-45	-45 32	-32 28	28-10	<10
1	5	6	66	7	11	1
2	6	12	62	7	5	1
3	8	10	69	5	2	1

X-ray diffraction

To determine the phase's pres-ent in the bulk dust, x-ray diff-
raction pattern of the entire sa-mple studied are shown in Fig.2 .
The results showed that the bulk dust PM63 containing : quartz (SiO_2), Calcite ($CaCO_3$), Dolomite ($CaMg(CO_3)_2$) , kaolinite($Al_2Si_2O_5(OH_2)$) and plagioclase ($NaAlSi_3O_8$-$CaAl_2si_2O_8$).

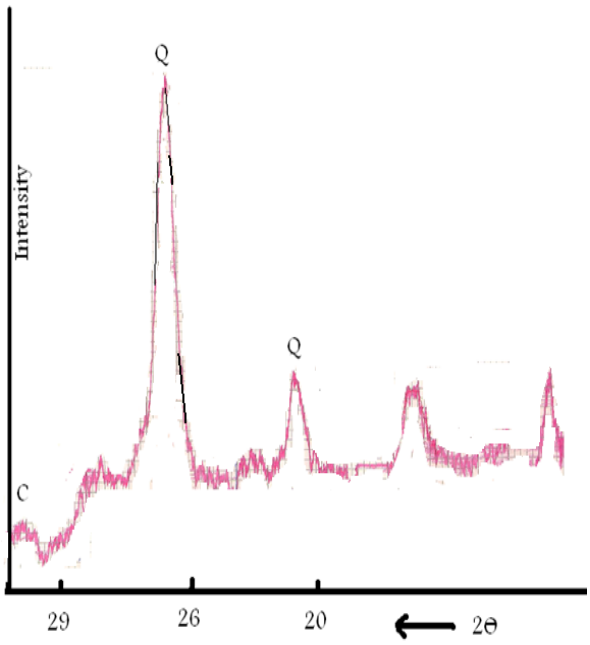

Fig.2 X-ray diffraction of particulate dust,Q=quartz and C calcite

This composition reflects the common minerals in Iraq or within the area [5]. In order to follow the smallest particle size of both silica and calcite, Jean [8] method was used to explain the relation between time and grain size deposed on Teflon sphere at depth of 10cm.The smallest size obtained by this method was 1um at a time of 480m.In this experiment, the dust powder was left suspend in water for 24h,then a glass slid was immersed in the cylinder at a depth of 10cm , and then removed after 168h.The thin film, then dried at room temperature and phases identification of this film by using x-ray diffraction was done .We could realize mainly on the position of the peak in diffraction profile and some extend on the relative intensities of the peak .
The shape of the peaks however, contains additional and often valuable information . The Crysta-llite size can cause peak broad-ening, which makes it possible to satisfy the Bragg condition. Once instrument effects have been excl-uded, the crystallite size is easily calculated as the function Of peak width (specified as the full width) at half maximum peak intensities (FWHM), peak position and wave-length. One of the

famous methods to measure the crys-talline size is Scheerer method [8].

$$b = k\lambda / B_{1/2} \cos\theta_B$$

Where b is the crystalline size, θ is the Bragg angle in radian($\pi/180$), λ is the wave length of the x-ray and k is a constant whose value is typically between 0.85 and 0.99, but usually, the most literatures used 0.9.The $B_{1/2}$ is the full width half max of the peak after correction for peak broadening
which is caused by the diffra-ctometer . One way to represent $B_{1/2}$ is:

$$B_{1/2} = \mathbf{B}_{obs} - Bm$$

Where B_{obs} is the measured peak width and Bm is the peak broa-dening due to the machine .The values of the crystallite size of quartz and calcite are shown in Table2 . These values are less than PM2.5 which means that the air at that time was at risk .

Table.2: the results of Scheerer calculation of sizes for quartz and calcite.

Mineral	Θ2	hkl	Size(nm)
Quartz	83.20	100	30
	66.26	101	55
Calcite	02.23	102	10
	35.29	104	20

EDX analysis

Trace metal pollutant sources in air may be anthropogenic and /
or natural .Metals occurring at trace levels (<0.01 %of the mass
of the organism) are potentially hazardous to biologic system .Several trace elements (Fe, Zn, Cu, and Mn) are considered to be essential to life ,while many others may be toxic .The data of the EDX analysis of the dust samples are quite familiar in local soil such as Si,Ca,Ti,S,Fe,Rb and Sr, (7) but the other are certainly harmful such as lead (pb), nickel, and chromium.These elements mainly came from the vehicle or engine combustion of leaded fuel.

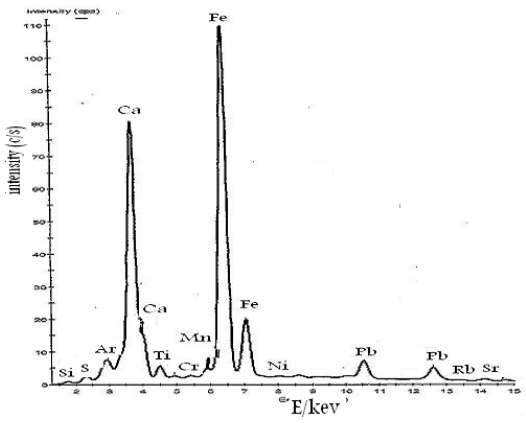

Fig.(1): Typical EDX elemental analysis of dust sample.

PH Effect

The soluble salts of the dust could effect the PH of natural Water, or underground water, or the soil PH .[11]. The PH value of soil is very important as it has a direct influence on the health of the plant .Each plant has its soil PH effects; the availability of nutri-ants within the soil and plants has different nutrient needs .For exa-mple the nutrient nitrogen a very important plant nutrient, is readily
available in soil when the PH value is above 5.5 .Similarly the nutri-ent phosphorous is available when
The PH value is between 6 and 7 .If the plant is placed into the wrong kind of soil it will be lacking in nutrients .In general the best PH value range for soil is approxi-mately 6 or 7 as this the range in which most readily available. The values of the PH of the dusts measured at room temperature are 7.9, 7.6, and 7.7 for dust 1, 2 and 3 respectively. The alkalinity results from carbonate comp-ound (calcite and dolomite) or from gypsum as mineral or as from building material .So if the quantity of those minerals exceeded the natural level، then it will cause damage to some kind of plant .

Recently the airborne carbonate (CO_3^{2+}) in suspended dust has been interested as an atmos-pheric buffer .Cao and his worker suggested that CO_3^{2+}can effect atmospheric chemistry and aero-sol characteristics because its alk-alinity favors the uptake of

SO_2 and NOx and their conversion to SO_4^{2-} and NO_3^- on the surface as well as removal of HNO_3 and H_2SO_4 from the gas phase [10].

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