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Determination of the size and forms of dust particles of some dust storms that were exposed to Salah al-Din Governorate - Iraq by FESEM

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Abstract:
Preserving the environment and vital systems is necessary from this section This study came to highlight the levels of dust falling over Salah Al-Din Governorate during 2022-2023, as (6) samples were collected from the dust storms that the study area was exposed to, and these samples were prepared and prepared for measurement by scanning electron microscopy, and dust particles appeared in different shapes between the sharp pointed cylindrical shape and the rectangular shape with sharp heads and between the circular shape as well as salt shapes. Dust particles are characterized by being very small, as their sizes ranged as follows: A (48.67-56.57), B (44.70-52.03), C (44.80-62.36), D (51.69-64.46), E (48.67-56.37), F (44.80-62.36) nm. Therefore, these molecules have mechanical effects on the natural barrier of the human respiratory system, as well as injury to the eyes, skin and ear with diseases that are several of these results were within the permissible limits according to the World Health Organization, but you should avoid leaving the house at the time of the dust storm, not at the time of necessity due to health risks to the respiratory system.

Keyword: Size particles, Dust, FESEM.

Introduction :

Clean air is an essential element for life on the planet for all living assets of plants, animals and microorganisms, and fresh air is called a mixture of gases, which is composed approximately of 78% nitrogen, 21% oxygen and 1% of the rest of the other gases, and the air is polluted when any change occurs in its chemical composition due to an increase in the concentrations of its elements or compounds or the entry of foreign substances in concentrations higher than the permissible limits Air pollution is defined as anthropogenic emissions of chemicals Harmful that change the chemical composition of the natural atmosphere and have a negative impact on the health of living organisms, and affect industrial or natural materials and reduce the extent of atmospheric visibility and was also defined as the presence of one or more substances in the air in concentrations or for a period of time above their normal levels, with the possibility of causing negative effects (1).

Air pollution is the presence of harmful substances in the atmosphere that cause the deterioration of air quality and its impact on public health and the environment, and these harmful substances include gases emitted from factories, vehicles, forest fires, smoking and others, including solid particles suspended in the air, as these substances affect the respiratory system, heart and blood vessels and can lead to respiratory diseases, blood vessels and skin diseases, and also affect the environment in general, including their impact on animals, plants and soil. In order to reduce air pollution, some preventive and curative measures can be followed, such as the use of clean technology in factories and vehicles, encouraging the use of environmentally friendly means of

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transportation, improving the quality of the fuel used, increasing environmental awareness, educating about the harms of air pollution, and encouraging an increase in agricultural cover and afforestation in both the summer and winter seasons (2).

Environmental pollution occurs naturally, such as gases and dust resulting from the eruption of volcanoes, forest fires, storms, hurricanes, droughts and other natural factors that disrupt the natural balance of the components of the environment, this pollution may continue for a long or short time and occurs intermittently or seasonally depending on the control of geographical, geological and climatic factors, or environmental pollution may be produced industrially as a result of human activities on the surface of the earth and this source appeared with the advent of the industrial era, which brought the world today to The current level of civilizational, scientific and technological development, but the tax of this development comes at the expense of the environment and the most important of these sources are: the use of fossil fuels in industry, means of transportation and electricity generation, and the waste of laboratories, factories, mining, mines and other products and requirements that have become necessary for the sustainability of human life (3).

The air contains many solid nanoparticles called aerosols and most of them reach a diameter of (0.1 μm) so they are not visible, except when they gather in huge quantities and many aerosol particles come to the air from active volcanoes, and from car exhaust, forests, fires and factory smoke The wind also raises sand and dust particles from the surface of the earth to the air and also includes aerosol particles suspended in the air Tree pollen, sea salts, meteorite particles and objects A micro-snake called microbes and over time aerosol particles continue to be added to the atmosphere, but they do not remain suspended in the air forever as rain and ice remove them from the air as the air becomes fresh after rain and snow The other part of the aerosol gradually falls on the surface of the earth The amount of aerosol particles in the air near the earth varies from one place to another, as a cubic meter of air over the oceans contains one billion particles, While a cubic meter of air over major cities contains about 100 billion particles, due to the lack of aerosols in the upper atmosphere, the air is usually purer (4).

Varieties of particles according to their origin:

1. Primary atoms are injected directly into the atmosphere through human activities and natural processes It is estimated that the particles or atoms injected into the atmosphere and the atoms or secondary particles of various types and sizes are formed in it at about (2523) million tons per year.
2. Secondary atoms are formed from chemical and photochemical reactions that take place between the gases in it or by coagulation of small particles on each other, especially when there is high air humidity, or produced by fine dust particles that remain suspended in the air for a long time, so their physical and chemical properties are modified due to their exposure to sunlight and because of the alternation of condensation and evaporation processes taking place on them and are called particles or secondary atoms and it is estimated that about 200 million tons are injected into the atmosphere from natural processes from Volcanoes and natural fires Dust and sand storms and marine salt atoms resulting from the scattering and evaporation of wave water droplets and from the remnants of meteorite combustion (5).

Varieties of particles according to their size:

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Particle sizes vary a lot, ranging in diameters between (0.0001) and several tens of micrometers and about some of them (100µm) and the fact does not remain suspended in the atmosphere for a significant period except for what the lengths of their diameters are less than (30 µm) and particles are usually classified according to the lengths of their diameters as follows.

1) Large atoms (particles): The lengths of the diameters of these particles are much more than (10 µm), and they are not present in large quantities in the atmosphere except during dust storms and their distance and when volcanoes erupt or near human sources of pollution in cities, industrial sites, construction sites, plowing agricultural land and during the movement of vehicles on paved and unpaved roads and other natural and human activities, but soon these large particles find their way to the surface of the earth under the influence of their gravity and gravity.
2) Medium atoms (particles): lengths of diameters less than (10 µm), known as (PM10) short for (Particulates Matter Of 10 micrometers in diameter). It is formed by the same processes as large dust particles and their concentration remains relatively low in the air, and between 25-30 particles/ cm^3 have been observed.
3) Soft atoms (particles): lengths of diameters less than (2.5µm) and known as (PM 2.5), which is an abbreviation for the phrase (Particulates Matter Of 2.5 micrometers in diameter). These atoms are accurate and can only be seen by electron microscopy and are usually caused by various combustion processes, including the combustion of vehicle engines, power plants, home heating, forest combustion, agricultural residues and some industrial processes.
4) Aitken atoms (particles): The lengths of the diameters of most of these particles are less than (1µm), and they are usually known as Aitken Nuclei nuclei in relation to the British physicist who discovered them and showed their role in the processes of condensation and the formation of clouds and precipitation in the atmosphere. So they are also known as condensation nuclei (Condensation Nuclei). These particles have lengths of diameters greater than (1µm) and are known as etken nuclei or giant condensation nuclei, and their concentration ranges between 1-10 particles/cm^3(6 and 7).

In a study carried out by the researcher (Alhesnawi , 2018), which started from March 2017 to the end of February 2018 to find out the concentrations of falling dust, its physical properties, chemical and biological contents, concentrations of suspended particles and some heavy elements in the air, the results of the study showed high concentrations of falling dust in all sites and the annual rate was 36.74 g / m^3, which exceeded the British determinants, and most of the particles of dust falling under the scanning microscope were found in irregular shapes, some round and spherical with some organic components ranging The prevailing minute sizes are between 2-50 microns and are very dangerous to health (8).

The researchers (Talbi, et al 2018) examined the concentration of particles ranging in diameter (1, 2.5, 10 µm) and their heavy metal contents at two different stations, urban and roadside in Algiers (Algeria). Sampling was carried out over two years Heavy metals associated with particulate matter (PM) were estimated by X-ray analysis (XRF). The average annual concentration of PM1, PM2.5 and PM10 at both stations was (18.24, 32.23 and 60.01 µg/ m^3) respectively. Roadside concentrations of PM1, PM2.5 and PM10 ranged from 13.46 to 25.59 µg/ m^3, 20.82-49.85 µg/ m^3 and 45.90-77.23 µg/ m^3 respectively. In the urban station, concentrations of PM1, PM2.5 and PM10 ranged from 10.45 to 26.24 µg/ m^3, 18.53-47.58 µg/ m^3 and 43.8-91.62 µg/ m^3. Nineteen elements of human and natural origin have been confirmed (9).

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The preservation of the environment and vital systems is necessary from this section, the researcher (Al- Saraifi, 2021) shed light on the levels of dust falling over Basra Governorate by monitoring the amount of dust and indicating its type, as well as knowing the chemical compounds from which the dust is composed and the heavy elements absorbed on its folds and the size of dust particles, and dust particles have appeared in different shapes between the sharp pointed cylindrical shape and the rectangular shape with sharp heads and between the circular shape as well as salt shapes. Dust particles are characterized by being very small, as their sizes ranged between (14,876 - 56,812) nm and therefore can turn into suspended dust, which carries with its various types of heavy toxic and carcinogenic elements(10).

It is characteristic that the lack of outdoor air quality is responsible for significant health and climatic issues. The aim of the study by the researchers (Marina-Montes , et al 2023) was to investigate the air quality in the city of Zaragoza (Spain) through the characterization of atmospheric particles (PM10) during two seasons (winter and spring). PM10 samples were collected in 2022 in quartz filters through a low-volume sampling device and chemically analyzed by various analytical techniques where the results of the daily concentration PM10 measured in our study revealed (4.71 - 43.39 µg/m^3 (average 25.56 µg/m^3) and (11.68 - 30.79 µg/m^3) (average 22.23 µg/m^3) during winter and spring, respectively The results obtained from this research are of particular interest to take into account future studies on air quality, in particular those aimed at reducing air pollution in cities (11).

Dust Storms:

Dust storms play an important role in polluting the environment in general, as the winds associated with these dust storms, which go parallel to the surface of the earth, carry large quantities of desert soil, because they do not find an obstacle to prevent them from doing so, and there is no vegetation cover that protects this soil and leads to its cohesion, and these strong winds may carry sand and dust to very long distances to fall on cities and agricultural lands and may affect their industrial facilities, Dust storms occur when the wind speed exceeds (45 m/ s) and the visibility during it deteriorates to less than one kilometer, which means that the amount of particles carried by the air reaches more than (56,000) micrograms/ m^3, The study area is exposed to the maximum frequency of dust storms in the spring, where it reached (58) days, or (45%) of the annual total of dust storms, followed by the summer season by (26) days, which amounted to (28%) of the annual total, then the winter season, which reached (21) days, which amounted to (16%) of the annual total, and the least frequent recorded in the autumn semester by (20) days and (12%) of the annual total. The study area has witnessed a significant increase in recent years with the occurrence of storms Dust, as the region was exposed to (14) dust storms during the month of April of the year / 2022, and (11) storms during the month of May / 2022, as the number of storms doubled more than ten times from what they were during previous years, due to the lack of rain, drought, lack of vegetation cover and human activities, and the consequent negative effects on the health of the population and the environment.

Sample Collection: The samples mentioned in Table (1) were collected randomly from the administrative areas of Salah al-Din Governorate during the governorate's exposure to a number of dust storms and all the data on the storm were recorded from the date of the storm, visibility, storm intensity, samples were sieved by a sieve with appropriate openings to get rid of large impurities that are stuck with dust particles

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Table (1) shows the samples studied in the thesis

Dust code	data	Characteristics of a storm
A	5/5/2022	A dust storm of medium intensity with visibility less than or slightly more than 500 m the sample was taken from the city of Samarra.
B	16/5/2022	The strongest dust storm during the year 2022 with a high dust density with visibility not exceeding 100 m the government disrupted government institutions, closed schools and universities, and suspended exams in them, as the Iraqi government declared the same day an official holiday due to the severity of the storm the sample was taken from the city of Tikrit.
C	3/6/2022	A dust storm of high intensity, inclined to the medium, the visibility range is less than or slightly more than 400 m, its dust is reddish in color, samples were taken from the Albu Dor area, south of Tikrit.
D	15/6/2022	A dust storm of medium intensity, visibility range less than or slightly more than 500 m, the sample was taken from the city of Baiji.
E	25/6/2022	A dust storm of medium to severe intensity, visibility less than or slightly more than 300 m, the sample was taken from the city of Dujail.
F	10/8/2023	A dust storm of medium intensity with visibility of less or slightly more than 500 m the sample was taken from the city of Al-Sharqat.
G	25/5/2023	A dust storm of high intensity with visibility of less than or slightly more than 200 m the sample was taken from the city of Al-Sharqat.

Dust particle size measurement using FESEM:

The size and shapes of dust particles were measured using high-resolution scanning electron microscopy (FESEM) of selected dust samples treated in 2.5% glutaraldehyde and cacodilate solution (0.05M) and dried in ethanol chain. The electron microscopy (SEM) was performed using a model scanning microscope (JEOL JMS-840A 20 kV equipped with the Oxford ISIS 300 Energy Dispersive Microscopy (EDS) system and the software required for point microanalysis, linear microanalysis and chemical mapping of the surface under examination. The operating conditions were an accelerated voltage of 20 kV, an electric current of 45 nA and a time of 60 seconds. The samples were coated with carbon, using a vacuum evaporator (Jeol EE-4X) both of the The upper and lower surfaces of dust particles, and microscopic images were taken at different magnifications. Figure (1) and (2) show the main parts and principle of operation of FESEM (12 and 13).

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Figure (1) The principle of operation of the FESEM device

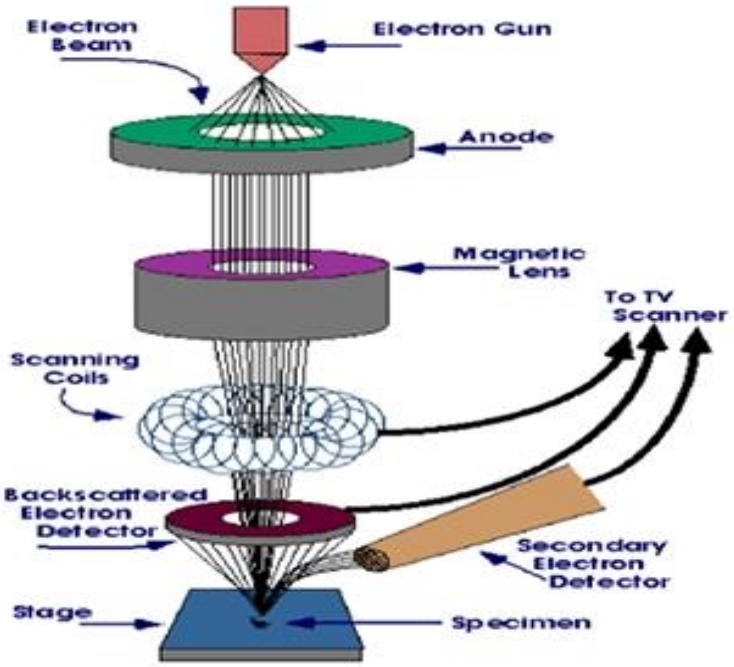

Figure (2) FESEM Diagram

Statistical Analysis (14)**:** The results were analyzed statistically using the Analysis of Variance (ANOVA) test (F-Test). The arithmetic averages of the coefficients were compared using the Dunkin' polynomial test and with a probability level P ≤ 0.05. According to the statistical program Minitab- Ver-19 .

Results and discussion:

1: Size of dust particles (15):
The size of dust grains was calculated using the equation (Debay - Scherrer)

$$D=\frac{K\lambda}{\beta hkl\ cos\theta}$$

where it represents: D: grain size coefficient (nm),
λ: x-ray wavelength (1.5406A) for copper target
βhkl: Maximum width at the middle of intensity.
K: form factor and its value are about (0.94-0.9).
θ: angle of incidence of X-rays.

The dust minutes falling over Salah al-Din Governorate are dangerous minutes due to their small size, which ranges in storm: A (48.67-56.57), B (44.70-52.03), C (44.80-62.36), D (51.69-64.46), E (48.67-56.37), F (44.80-62.36) nm. It is clear from the above the danger of the particles of falling dust and the heavy elements that suck over it with a clear and significant excitation in living vital systems, foremost of which is humans, as they enter the human body and part of them are

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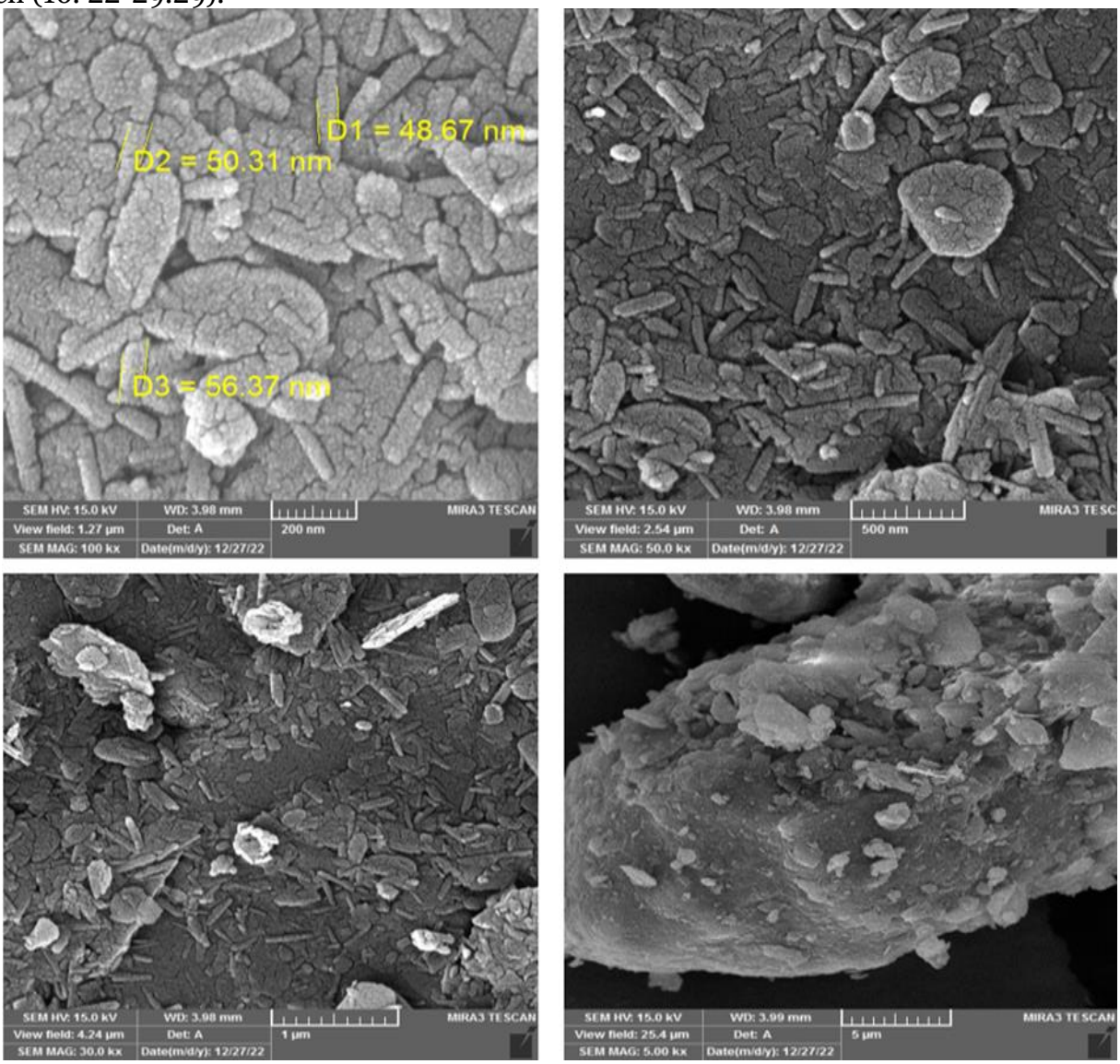
deposited in the airways and the other section reaches the pulmonary alveoli and thus may infect humans with serious diseases such as respiratory diseases and lung fibrosis, as well as cancerous diseases.

2: The shape of dust particles:

For the purpose of standing on the shape of dust particles and surface formation of samples using scanning electron microscopy (SEM) technology and using a working distance of (4.90 – 5.90) mm and a magnification power of (100kx) and an accelerated voltage (10 kv) and using the program (Imag-j), which is one of the programs that are used to analyze images under the microscope, as it includes the average area of the particles present for the image shown under the scanner image (1), so it is clear through pictures of the particles of falling dust that the width of dust particles ranged between (16. 22-29.29).



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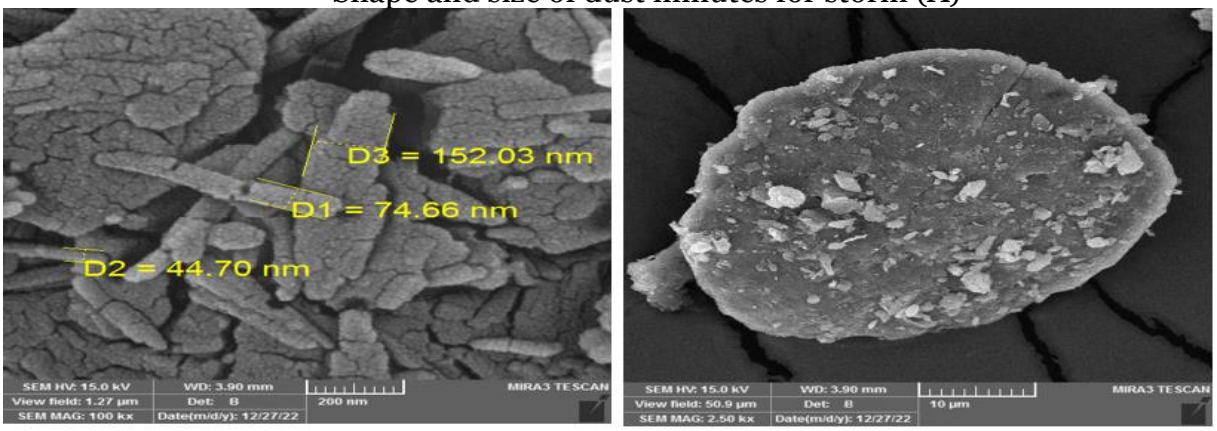
Shape and size of dust minutes for storm (A)



Shape and size of dust minutes for storm (B)

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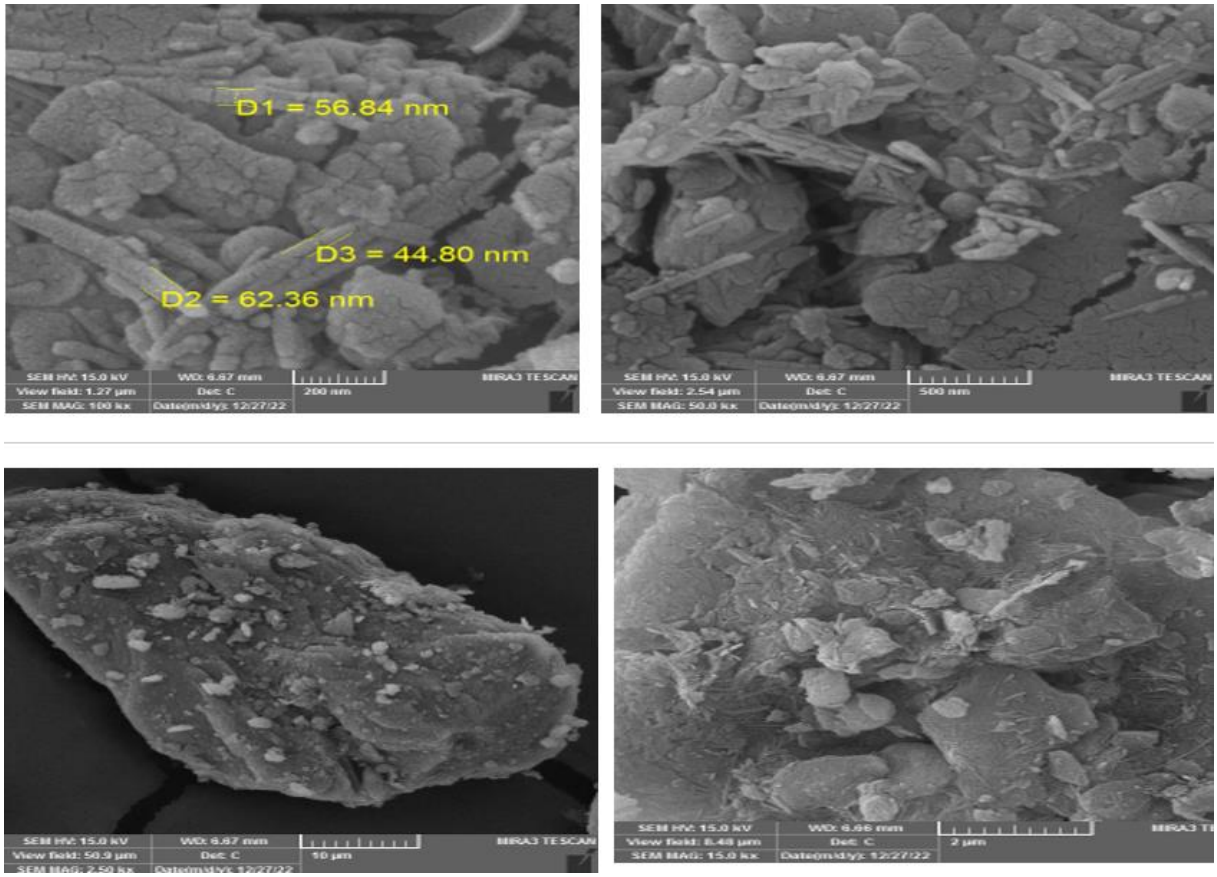

Shape and size of dust minutes for storm (C)

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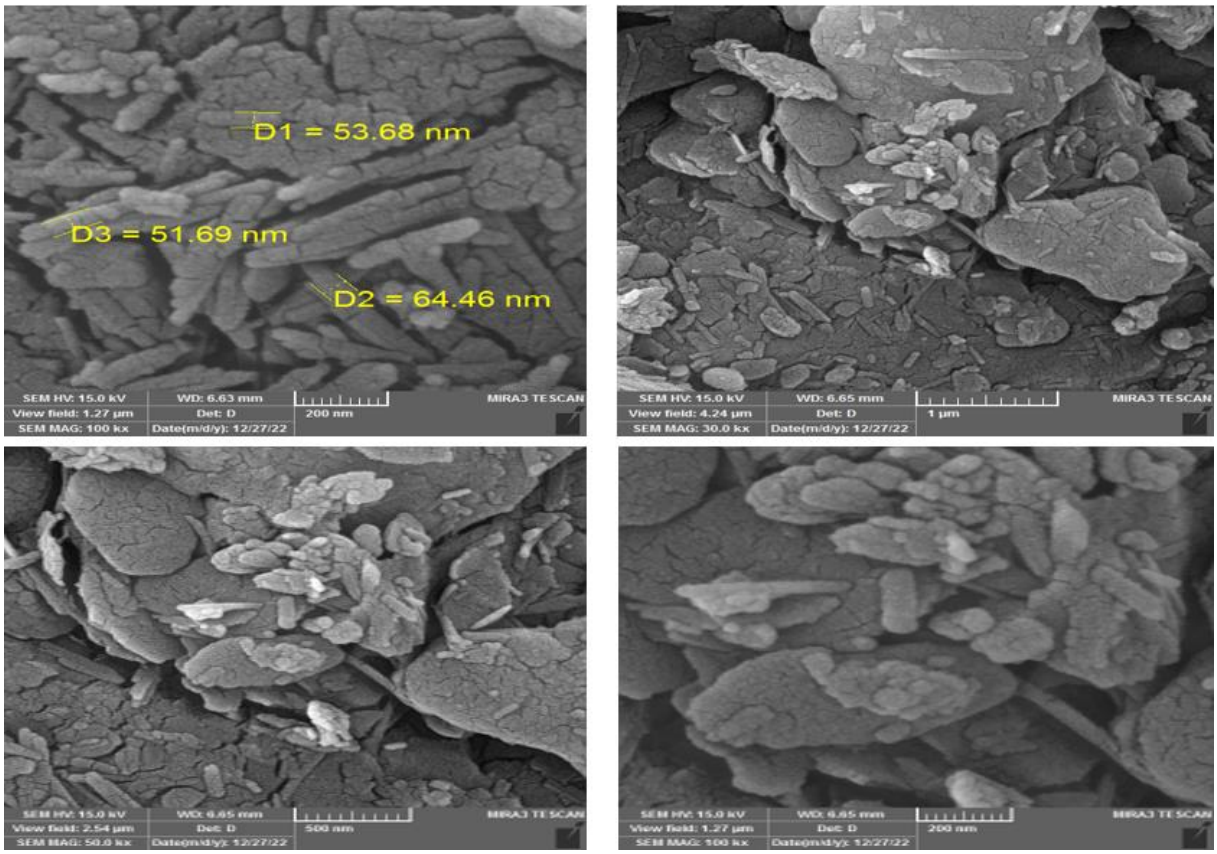

Shape and size of dust minutes for storm (D)

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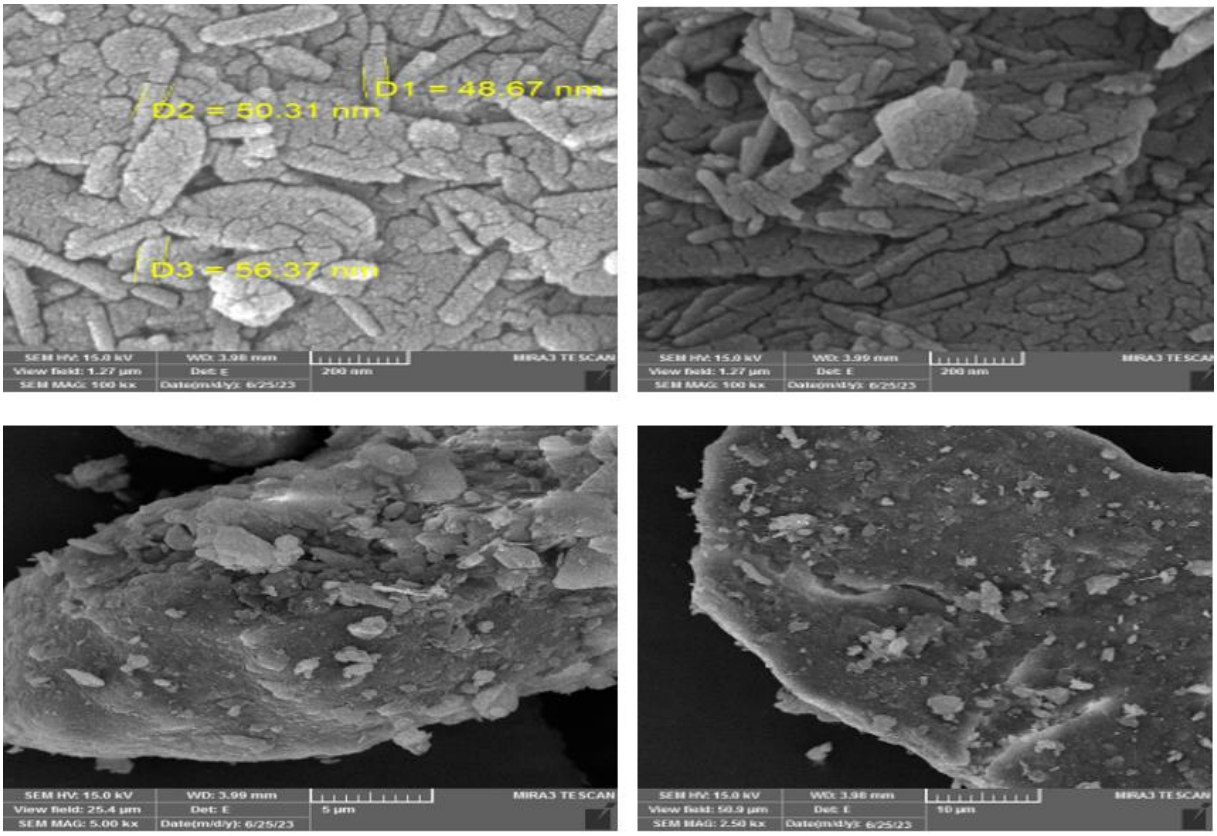

Shape and size of dust minutes for storm (E)

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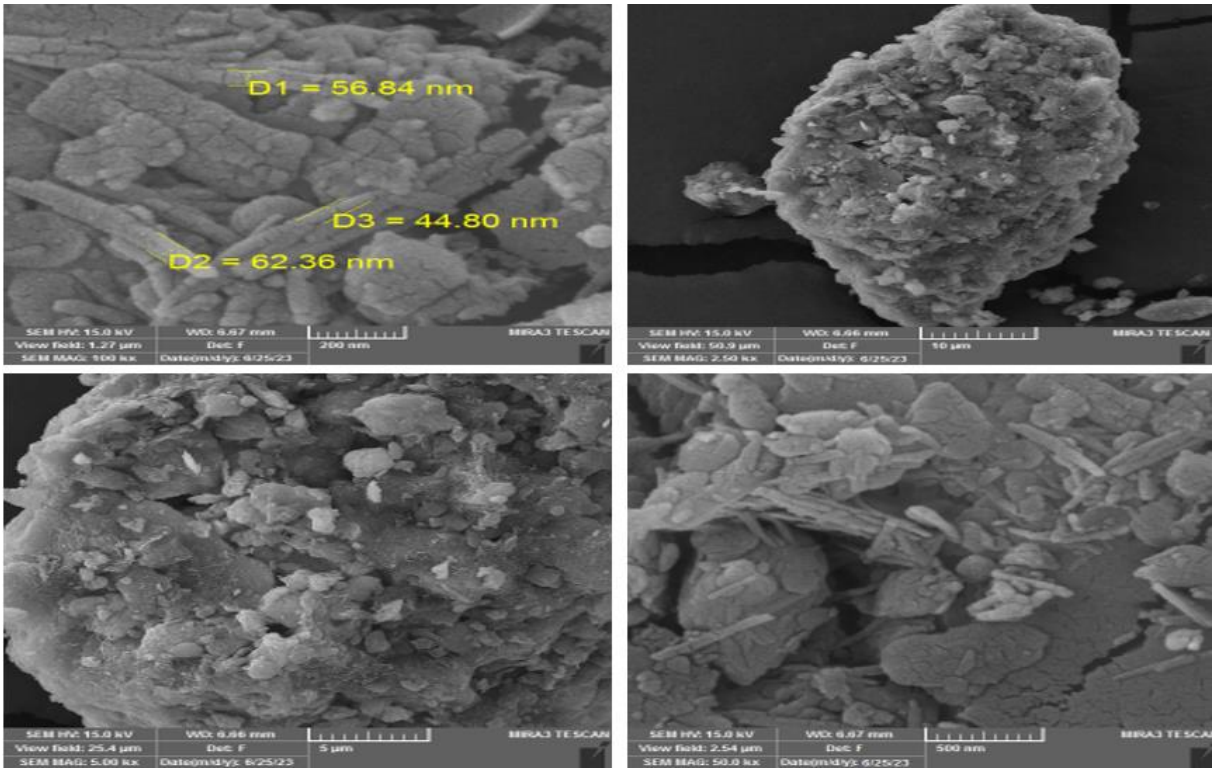

Shape and size of dust minutes for storm (F)

From the foregoing, it is clear that dust particles have differed in their forms when all dust storms studied during the study time have appeared irregular and heterogeneous forms and this is due to the difference in the source of dust and its composition and usually natural dust in irregular forms, as the shape of dust particles often depends on the composition and characteristics of its constituent elements, so the minutes resulting from combustion are usually in a spherical shape, while other irregular shapes are the result of sorting The first or because of the agglomeration processes among them, and many studies have indicated that the dust minutes in Iraq and the study area, including them, are mostly irregular shaped minutes, which means that these minutes are newly formed and resulting from industrial activities or wind erosion of the soils located near the studied sites, either spherical minutes, which were very few if compared to the rest of the forms, can indicate the dimension of their source because the transport operations For more than 100 km It works to make dust particles round and spherical in shape, and the presence of organic matter between the folds of dust atoms has a great impact in inducing allergies, and the appearance of some forms of dust particles with needle and pointed shapes are dangerous to human health because they cause scratching to the tissues that reach them.

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