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DUSTSTORMS IN THE SOUTHWEST[1]

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During the last few months there have many duststorms in the southwestern part of the United States. Almost every day the newspapers have carried stories of these disturbances. It is difficult to tell whether or not these storms are becoming more frequent than they were in the early days, since accurate records of their occurrence and severity are of recent origin. However, there are some very definite reasons for thinking that they are becoming more frequent. Dust clouds are drifting into sections of the country that have never known them before. No matter what conclusion may be reached as to their relative frequency at the present and in years past, it is certain that as the present deflation is going on over a wide region at a rapid rate, and rapid deflation means that a desert is in formation, and this makes the matter one of national concern. Undoubtedly much of the trouble has been brought about by putting land into cultivation that should have remained covered with the native plant life.

When men tamper with the natural balance of climate, plant life, and animal life, a balance that has been brought about through thousands of years of evolution, they are

[1] The author is indebted to the Air Port Station of Dallas for the data used in making the maps; to Dr. Edwin J. Foscue of the Geography Department, Southern Methodist University, for drawing the maps; and to Dr. E. W. Shuler, of the Geology Department, Southern Methodist University, for data concerning the size and nature of the dust grains.

taking a chance at producing something unexpected and undesired. Perhaps the most delicate balance of climate and life is to be found in that country that lies east of the foot-hill of the front range of the Rocky Mountains, a country that should receive the most intelligent and far-seeing care. It should never be exploited by the ignorant, the unthoughted, or the unconcerned, for within its bounds there lies, to a great extent, the heritage of the Nation.

It is not the purpose of this paper to discuss duststorms and deflation in a general and broad sense, but rather to call attention to some interesting facts that were observed during recent duststorms.

The dust that has drifted over Dallas and the surrounding country, has in all cases come from a long distance, perhaps three to six hundred miles to the northwest; it has been composed of very small particles, and as a rule it has extended from the surface of the earth to a very great height, however, in a few instances the lower air has been perfectly clear, while that overhead has been obscured as if covered with rain clouds. A microscopic examination reveals but little variation in the size and composition of the particles found in the different storms, and this in spite of the fact that the clouds have produced rather varied effects. The diameter of the dust as measured in two storms, ranged from 0.03 mm. downward to about one-tenth of that value, the average being about 0.01 mm. (0.01 mm. equals 1/2500 inch). It is of interest to note that there was a definite lower limit, as well as upper limit, to the size of the particle. The most abundant substance found was quartz. Other materials present included calcite, iron oxide, gypsum, and volcanic ash. Some of the fragments showed but little evidences of wear, but the majority were well rounded.

The data used in making the maps were obtained from Air Port Station in Dallas. This station receives, every four hours, reports from the cities shown on the maps, giving the usual weather data including visibility. The latter was used in making the maps. Visibility as defined by the Air Port Station, is the distance in miles or fractions of a mile that the observer is able to see at a given time, and

ranges from zero to about forty or fifty miles in clear mountain atmosphere. The shaded areas on the maps represents localities where the visibility is two miles or less. At the center of these shaded areas visibility is at zero or near zero in all cases. The lines on the maps are drawn through localities that have equal visibility. The writer is suggesting that these lines be called *Isophaneric*[2] lines. Dashes have been used rather than continuous lines, to indicate that the information is not sufficient to determine their exact location. Figure 1 represents the storm that began on February the 21st, and shows its location at four-hour intervals. Figure 2 represents the one that began three days later. The maps indicate that both of these storms had their origin in the western part of Kansas and from there the development was southward and eastward. This, it seems, has been true of nearly all these disturbances that have occurred in recent months. It should be stated, however, that there has been considerable variation in the direction of movement, some storms turning eastward before they reach as far south as Dallas. The isophaneric lines that are above six miles have but little value in locating dust.

The duststorm illustrated in Figure 1 reached Dallas at 5:30 on the morning of the 22nd. At that time visibility dropped to less than one-half of a mile, and the dust extended from the earth surface to a great height, and appeared much like rain clouds. About ten o'clock in the morning the sun became visible as a silver white disc that appeared so much like a full moon that for a moment the writer wondered how a full moon could be seen at that time of the day. Thinking that something of interest might appear, a six-inch refracting telescope was directed on the sun without the protection of either sun diagonal or colored glass. Fortunately a few sun spots were turned toward the earth and these could be seen with unusual clearness. It was an ideal time to look for sun spots.

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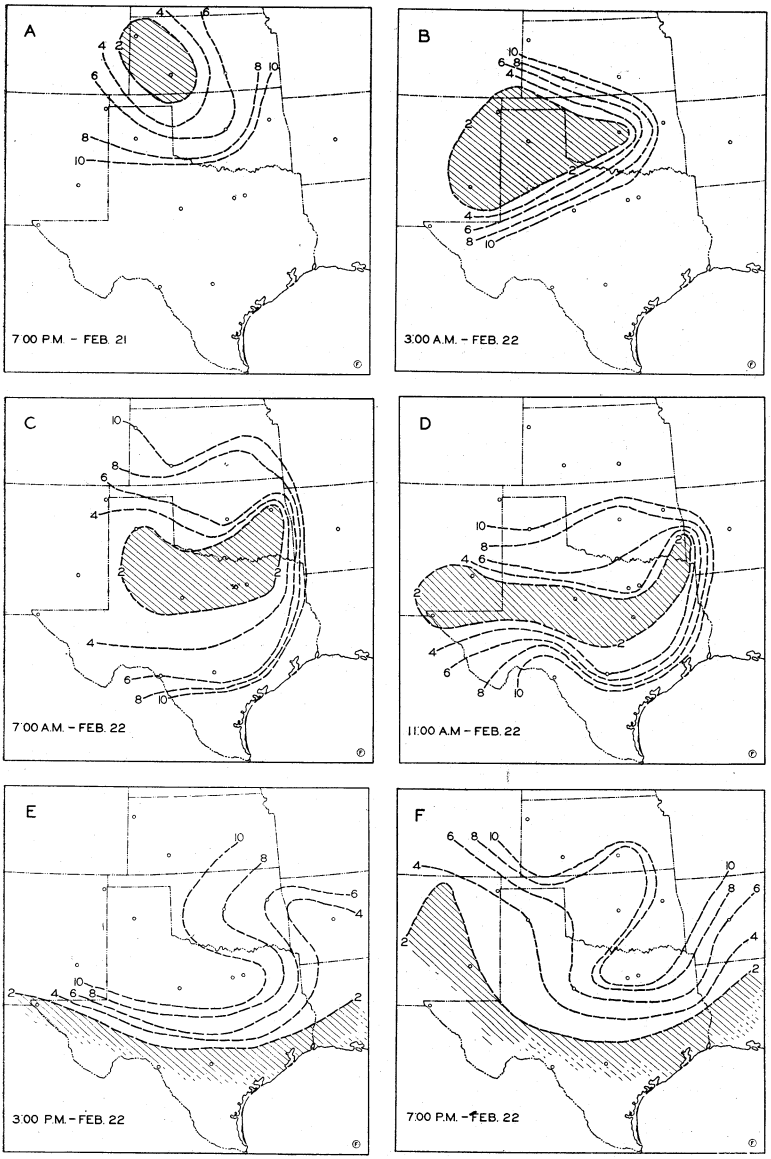
[2] The use of this word has been indorsed by a number of Greek scholars. It is derived from the Greek *isos*, equal, and *phaneros*, visible.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E
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Figure 1

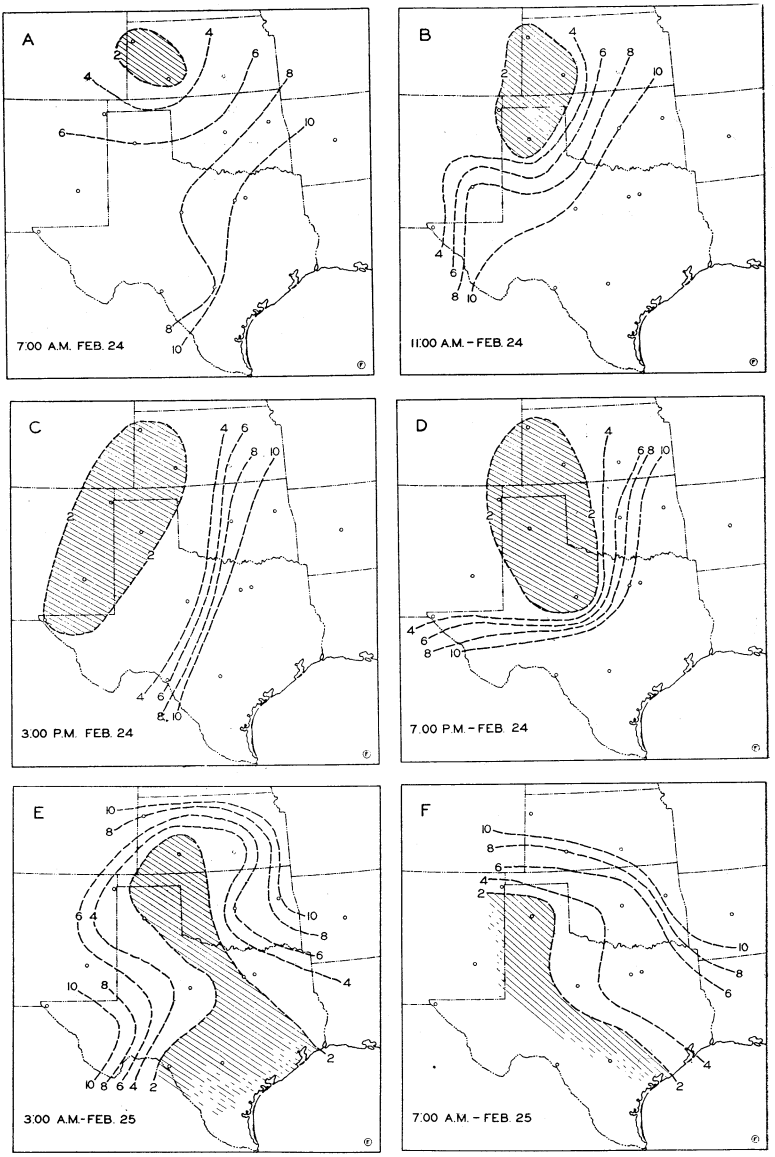
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Figure 2

The dust illustrated in Figure 2 reached Dallas late in the afternoon, and came just in advance of a rain cloud. In this case the dust was high in the air, the lower atmosphere being perfectly clear. This dust might have gone unobserved if it had not been for the rain cloud that was treading on its heels and washing it down. Over one thousand tons of soil were added to Dallas County by the mud shower that came at that time. On another occasion more than ten thousand tons were added to the county by dust that settled in a few hours time. From measurements made during the past two months it seems that this country has gained approximately thirty-five thousand tons. No one should come to the conclusion, however, that there is a net gain in the fertility of the local soil; far more is being washed away by the rains than winds can bring in.

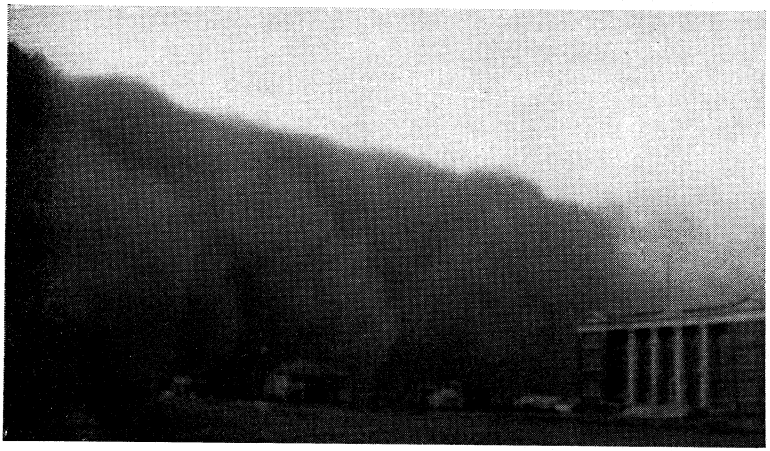
A phenomenon that has attracted a great deal of attention is the fact that the fine dust of these storms has given a blue color to both sun and moon, the color being more pronounced in the case of the sun, which at times has appeared almost as deeply colored as the blue sky. As a rule dust in the atmosphere brings about red suns and sunsets; the effect recently has been different because the particles were much finer than those that produce red sunsets. The observations recorded in this paper were so far removed from the source of the dust that only the finest material could remain aloft. Sunlight is composed of a combination of all colors, but blue, being more readily diffused by small particles, finds its way through these clouds in greater quantities than the other colors, hence the sun and moon appeared blue. In the year 1883 the volcanic eruption of Krakatoa took place, blowing great quantities of volcanic ash into the sky and causing red sunsets around the world for years after. Naturally one would think that this dust must have been very fine, otherwise it would not have remained in the air for so long a time. On the other hand it produced red sunsets and not blue, as fine dust produces. The explanation, no doubt, is to be found in the character of the dust produced by volcanic eruptions. Volcanic ash is composed of thin glassy fragments that offer a great

amount of surface, compared with their weight, for catching the force of the air currents, hence they remain in the air, even though they have surfaces that are large enough to produce red sunsets. The form of the particles is quite different in wind-blown dust, which in almost all instances has undergone a large amount of abrasion wearing them into forms that offer but little opportunity for the air currents to get hold of them; they are stream-lined, hence those that are able to remain in the air are very small.

In speaking of the dust it should be remembered it is composed of rocks, like those that are found scattered over the earth, floating about in the air. The reason that they float is to be found in their size, their shape, and to the velocity and turmoil of air currents. It will be noted that nothing is said about buoyancy, for buoyance plays a very insignificant part in the mad dance of dust in duststorms.

Two equations may be used in the explanation. For simplicity let us suppose that the object supported in the air is spherical in shape. The volume of a sphere is given by the equation of $4/3\ \pi R^3$, the area of the cross section πR^2, where R is the radius. The force of gravity upon this body will vary as the volume, while the force of the wind will vary as the cross section. Let us imagine a sphere that is diminishing in size; it is evident that the volume will decrease more rapidly than the cross section. This means that if a body is made smaller and smaller the ratio of the force of gravity to the force of the wind is a diminishing ratio, and after the size reaches a certain value wind effects become greater than gravity. Another factor enters the problem. If an air current moves perfectly horizontal it will not support dust no matter how great the velocity of the wind may be nor how fine the dust may be. It is the random motion, or turmoil, with its upward components that enables the wind to pick up the dust and carry it along. When the particles become very small and the wind is strong the force of gravity becomes insignificant in comparison with wind pressure. There is a lower as well as upper limit to the size of the particles that settle upon the earth. This means that dust may become too fine to settle; that it may drift to

greater and greater heights and become a part of that innumerable host of fine particles that give the blue color to the sky. Perhaps for the first time the United States is making its full contribution to the blue of the sky. May the time soon come when this blue may be seen more frequently.



A dust storm rolls in over Wheeler, Texas