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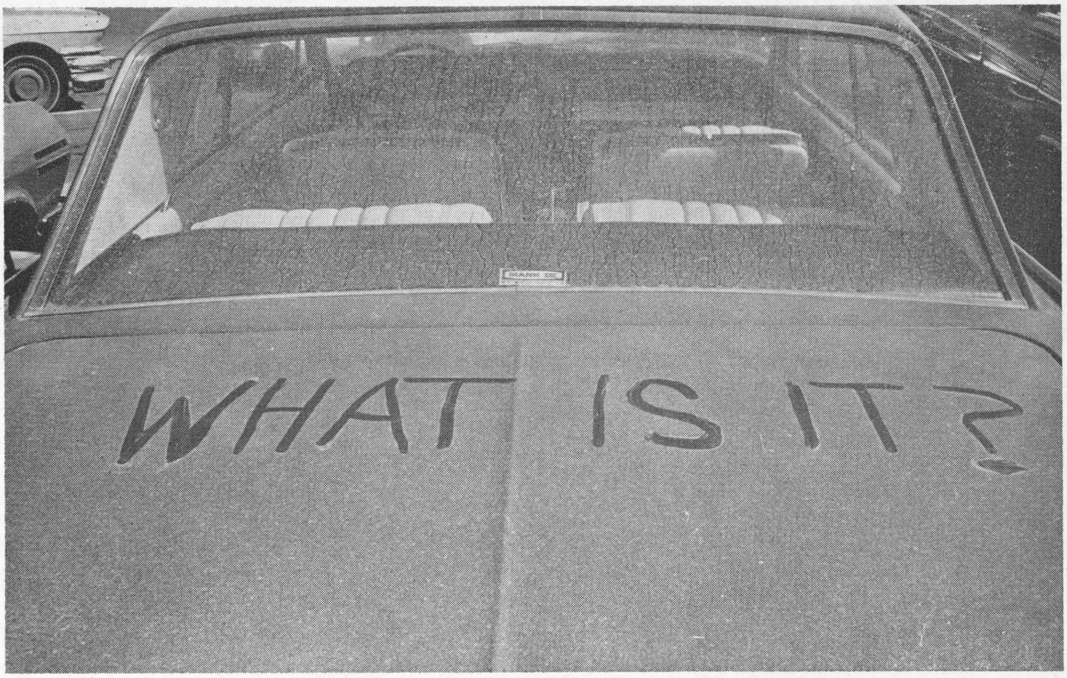
Dust Deposition and Weather



It is dust—a layer deposited at Topeka, Kansas, during the night of 2–3 March 1966. Photo courtesy of Perry Riddle, *Topeka State Journal.*

Dust Deposition and Weather

MERLE J. BROWN, RONALD K. KRAUSS, AND R. M. SMITH *

DURING the "dust bowl" years of the 1930's dust deposition was studied by a number of investigators of the U. S. Weather Bureau, and a more recent study was conducted by Iowa engineers. These investigations, however, were for short intervals involving only a few locations, and dust quality determinations either were not made or were incomplete.

Dust trapping stations were established at 15 locations east of the Rocky Mountains in the contiguous United States from 1963 to 1967. Data from these sites have been collected to study the amount and quality of earth material that settles from the atmosphere over extensive areas. Also investigated were the relationship of deposition rates to climate, superficial earth material, land use, and geographic locations.

Instrumentation

After considering several possible designs, the overflow cylinder of the ESSA-Weather Bureau, standard 8-inch, non-recording gage was chosen as the dust trap for the study. E. R. Miller had used this gage previously to determine quantities of dust in rainfall.

To minimize contamination of trapped dust by birds, insects, and plant fragments, two 8-inch diameter screens were installed in the top of the overflow cylinder. Openings in the bottom screen were 1 mm square; those in the top screen, 6.35 mm square. The 8-inch overflow cylinder was mounted in the same manner as a standard precipitation gage.

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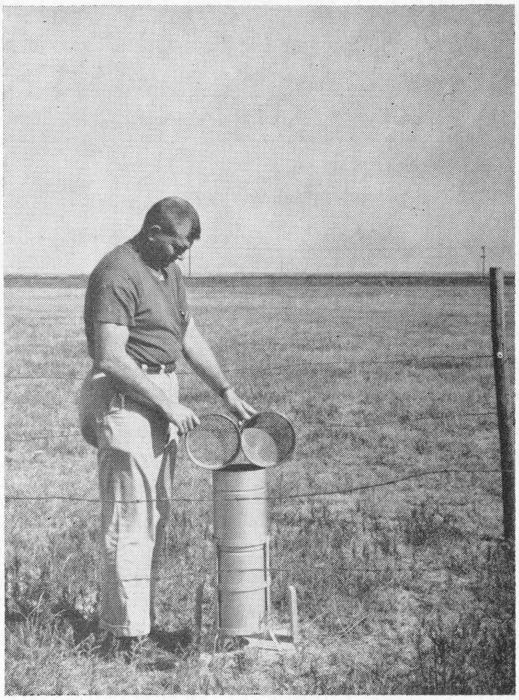
When installed, the screens added about 4 inches height to the dust trap, so the top of the trap stood about 34 inches above ground level. Depending on the season of the year, either water or an antifreeze solution was maintained in the gage to trap the dust collected. The two screens were removed for the snow season to prevent possible capping of the gage by snowfall.

The traps were exposed much the same as is a standard 8-inch rain gage. Vegetative areas, as free as possible from local dust sources, were chosen as sites for dust traps; nearby weeds or grass were maintained at or below 34 inches high. An installation is illustrated.



Standard dust gaging station at Tribune, Kansas, showing the components of trap: overflow can and screens.

Station Network and Collection of Data

The locations of the 15 installations were selected by nearby cooperators in agricultural research. Data were generally collected once a month. Suspensions from each trap were removed at the end of each calendar month, and samples were forwarded to Kansas State University for laboratory processing. Colors and quantities of oven-dry dust were determined, pH was obtained, relative percentage of clay and sand plus silt were computed, and various other data recorded.

Some information about monthly deposits at Manhattan, Kansas, is shown in table 1. Here, oxidized dust represents the weight of a dust sample after it was repeatedly treated with a 30 per cent solution of hydrogen peroxide to remove most raw organic matter such as insect parts, seed coats, and plant fibers.

Complete removal of soil organic matter would require acid treatment. To preserve carbonates and cemented aggregates for optical identification, acid treatments were not used.

Sites of dust gaging stations.

TABLE 1

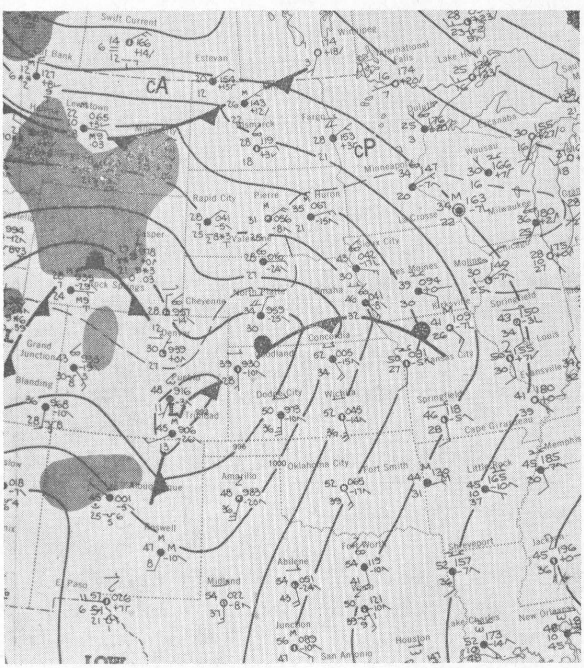
Monthly Determinations of Oxidized Dust (lbs./ac.) at Manhattan, Kansas, for June 1963–December 1966

	January	February	March	April	May	June	July	August	September	October	November	December
1963						20	50	40	22	32	35	22
1964	28	33	51	101	99	37	56	59	27	24	24	15
1965	20	26	32	73	77	77	44	52	35	26	16	10
1966	7	7	48	39	44	137	48	25	38	42	23	19

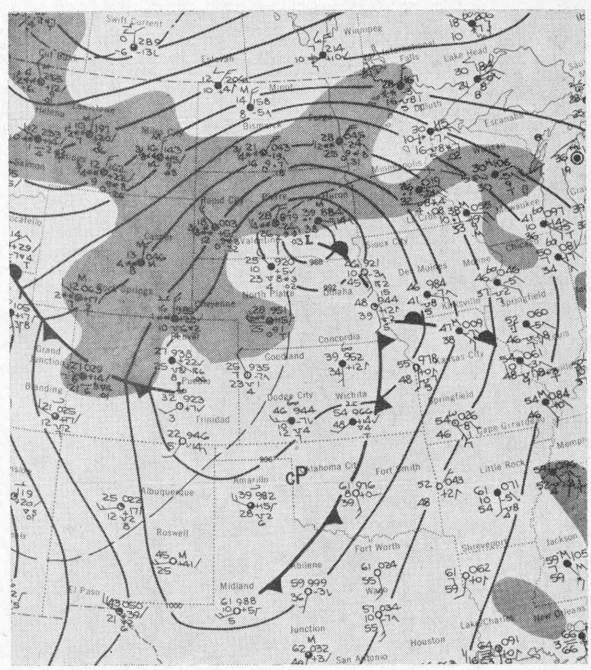
Example of Heavy Dust Deposition

Ordinarily, quite small quantities of dust collects in a trap during several weeks. Thus, it is usually not practicable to attempt to obtain daily or weekly dustfall measurements. During certain weather situations, however, quantities of dust collected can be relatively large as was the case over central United States the first few days of March 1966. At 0000C on 2 March a surface low was centered over southeastern Colorado. The weather map situations are shown on the accompanying charts. Southerly and southwesterly winds over Texas, Oklahoma, eastern New Mexico, and Kansas increased considerably during daytime hours and blowing dust was reported over portions of those areas. The dust was subsequently carried northeastward by strong upper-air winds. At Dodge City, surface wind gusts reached 50 mph at 1636C with visibility reduced to 2.5 miles in blowing dust. Locations in Texas with blowing dust on March 2d included El Paso, Lubbock, and Wichita Falls.

A surface cold front moved across Kansas during the night of 2–3 March. Lower-level winds decreased after the front passed and considerable dust settled over northeastern Kansas during the morning hours. The accompanying photograph shows the relatively thick layer of dust that accumulated on cars parked outside. Visibility at Topeka was 5 to 6 miles in dust from 0730C to 1000C on March 3d.



Surface weather map, 0000 CST, 2 March 1966. ESSA map.



Surface weather map, 0000 CST, 3 March 1966. ESSA map.

Due to the relatively high atmospheric dust content during the first week of March 1966, a special observation was made on March 8th at Manhattan, Kansas. Thus, dust samples were available for 2–8 March and for 9–31 March. Table 2 contains some of the information with reference to sand and silt, i.e., soil particles with a diameter of 0.002 mm to 2.0 mm. The clay particles listed in the bottom half of the table had a diameter of less than 0.002 mm (clay is made up of small crystals, of which montmorillonite, illite, and kaolinite are the most abundant in soils).

The relatively high percentage of phytoliths and feldspars during 2–8 March indicates that dust collected at Manhattan probably originated in southwestern Kansas, the Oklahoma and Texas panhandles, and northeastern New Mexico. Meteorological data for 2–3 March also indicate those origins of the dust.

TABLE 2

DUST DEPOSITION AT MANHATTAN, KANSAS, FOR MARCH 2–8, AND MARCH 9–31, 1966

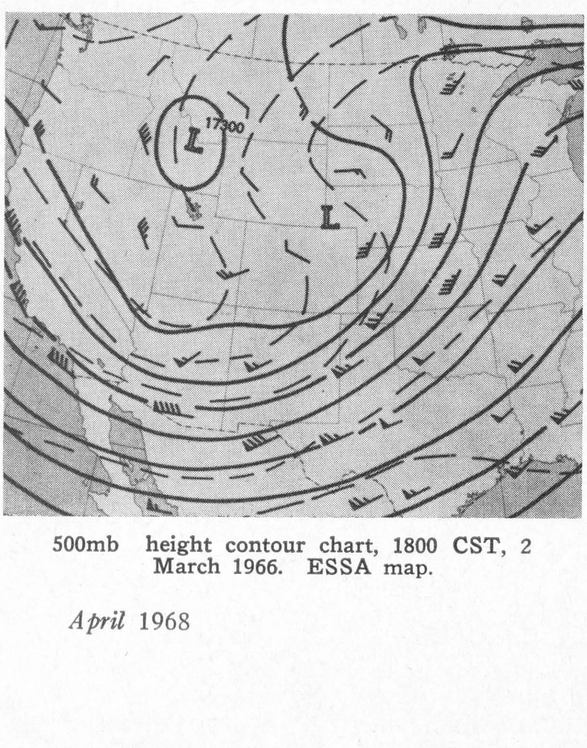
	Sand & silt mineralogy	
	March 2–8	March 9–31
Mineral	Per cent of sample	Per cent of sample
Quartz	81.8	78.6
Phytoliths	13.2	9.0
Calcite	0.0	0.5
Aggregates	4.9	11.9
Total	100.0	100.0
	Mineralogy of clay sized particles	
Mineral	Relative per cent* (March 2–8)	Relative per cent* (March 9–31)
Montmorillonite	10	10–25
Illite	25–50	25–50
Kaolinite	10–25	25–50
Chlcrite	10	10
Quartz	10	10–25
Feldspars	25–50	10

* Per cent of clay sized material considered to be 100% made up of indicated minerals.

General Statistical Relationships

In establishing the network of dust trapping stations, it was considered desirable to select at least one site near the "dust bowl" region of the Great Plains, as that area might be the source of much of the dust that settles from the atmosphere over central and eastern United States. The site selected was near the Kansas-Colorado border, 15 miles west of Tribune, Kansas.

During 1963–1966, mean monthly dust deposition at the 15 sites ranged from 15 to 410 pounds per acre. Deposition rates were significantly lower during late fall and winter than during late spring and summer. The greatest dust deposition was at the site of Tribune, Kansas. There, monthly deposition has been as high as 3616 pounds per acre (May 1964) and as low as 2 pounds per acre (November 1965). Coshocton, Ohio, has had the lowest monthly average deposition of the 15 sites.



500mb height contour chart, 1800 CST, 2 March 1966. ESSA map.

Dust deposition data were correlated with certain weather variables by using electronic computers. Dust deposition at a particular site correlated positively with average monthly wind speed in the vicinity of the site and/or with average monthly winds in western Kansas. Rainfall variables, i.e., total monthly precipitation and number of days with 0.01-inch, 0.10-inch 0.25-inch of precipitation, tend to correlate positively with dust deposition at most stations, suggesting that appreciable earth material is "washed down" by precipitation. Dust deposition data also correlated positively among the 15 sites. For example, the linear correlation coefficient between monthly dust deposition at North Platte, Nebraska, and Manhattan, Kansas, was 0.725. Thus, the meteorological variables

(*Continued on page 94*)

that produced varying dust deposition rates at North Platte were responsible for part of the variation in dust deposits at Manhattan.

Data now collected indicate that quantities of dust influx are large enough to be of agricultural, historical, and scientific interest. Measuring dust deposition with a network of stations for an extended time likely would contribute to a better understanding of soil genesis and soil renewal. Also, a procedure to identify the source of dust deposited at the earth's surface might be developed.

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