COMPOSITION AND ORIGIN OF DUST IN THE FALL OF BROWN SNOW, NEW HAMPSHIRE AND VERMONT, FEBRUARY 24, 1936

By W. O. ROBINSON

[Bureau of Chemistry and Soils, Washington, D. C., April 1936]

During the night of February 24 and early morning of February 25, 1936, rain, sleet, and snow fell over the region of New Hampshire, Vermont, and northern New York; and at many localities the precipitation was strongly colored brown by admixed dust particles.[1]

Several samples of the dust were submitted to the Bureau of Chemistry and Soils: R. P. Haywood of Keene, N. H., was asked to gather and melt the snow that contained the brown dust and to evaporate the water to obtain the sediment. He kindly did this and sent the samples, but the quantity was too small to permit anything except microscopical examination and certain qualitative tests. Simultaneously with the receipt of Mr. Haywood's sample, two others collected from the same fall of snow were sent in by the Weather Bureau. One of these was from Wells River, Vt., sent by Wendell P. Smith, and the other from Peterboro, N. H., sent by C. L. Whittle. Mr. Smith's sample weighed about a gram and was large enough to permit of the following mechanical analysis by T. M. Shaw of the Bureau of Chemistry and Soils:

	Percent
Larger than 50μ	2.2
Between 50 and 20μ	.7
Between 20 and 10.7μ	28.4
Between 10.7 and 6.6μ	27.6
Between 6.6 and 5.0μ	7.7
Between 5.0 and 3.1μ	18.8
Between 3.1 and 2.0μ	9.2
Less than 2.0μ	5.4

I. C. Brown of the same Bureau reports the following results of mineralogical examination:

1. *Silt of Wells River, Vt., sample.*—Quartz abundant; biotite, opaline material, iron oxide present; few feldspars; organic matter abundant.

2. *Entire quantity, Peterboro. N. H., sample.*—Quartz and feldspars abundant; tourmaline and hypersthene present; also opaline material and silicified organic material characteristic of midwestern soil material. Soil material comparatively undecomposed.

3. *Entire quantity of Keene, N. H., sample.*—Quartz and feldspars abundant; titanite and rutile scarce; opaline and silicified organic remains characteristic of midwestern soils; soil minerals comparatively undecomposed.

Samples 2 and 3 resemble each other closely; the particles are largely of colloidal size. The Wells River sample is comparatively coarse and contains relatively small quantities of colloidal matter (less than 2 μ). It would appear that the meteorological conditions operating caused an air elutriation or mechanical separation of the particles present in the original dust storm, with the result that the larger particles settled around Wells River and the finer particles at Keene and Peterboro. The fall in St. Johnsbury, Vt., was estimated at 10 tons to the square mile. The fall at Keene, N. H. was apparently very much lighter.

The colloidal matter separated from the Wells River sample was analyzed, with the following results:

	Percent
SiO_2	48.9
Al_2O_3	20.4
Fe_2O_3	6.1
CaO	5.4
MgO	3.2
Loss on ignition and undetermined	16.0

The molecular ratio $\frac{SiO_2}{Al_2O_3+Fe_2O_3}$ of soil colloids is a distinguishing soil characteristic, and this ratio varies from above 4 in the pedocals of the west to less than 1 in the lateritic soils of the South. Byers, Alexander, and Holmes (U. S. D. A. Tech. Bul. 484) give a full discussion of the significance of this ratio as differentiating the soils of the various soil groups.

The $\frac{SiO_2}{Al_2O_3+Fe_2O_3}$ ratio of the colloid of the Wells River sample is 3.3. This fact, combined with the high content of lime and the presence of calcium carbonate in all three samples, makes it almost certain that the dust deposited in the storm orginated no farther east than the Missouri River.

The Peterboro sample gave 15.0 percent loss on ignition.

On the basis of an estimated fall of 10 tons to the square mile at St. Johnsbury, Vt., the quantity of elements useful to plants that is transferred by these dust storms is of considerable importance. Qualitative examination of the coarser particles of the Wells River sample indicated that the coarser fractions contain fully as much lime as the colloidal fraction. Assuming that the whole mass of dust contained 5.3 percent CaO, than a fall of 10 tons would enrich a square mile by 1,060 pounds of lime.

[1] See, e. g., H. I. Baldwin, The Fall of Brown Snow in New Hampshire, Science, Apr. 17, 1936, p. 371.

METEOROLOGICAL HISTORY OF THE BROWN SNOWFALL OF FEBRUARY 1936

By HORACE R. BYERS

[Weather Bureau, Washington, D. C., April 1936]

The trajectory of the dust-laden air that was involved in this storm may easily be traced back to the "dust bowl" in the neighboring parts of the five States, Colorado, New Mexico, Texas, Oklahoma, and Kansas. An examination of the pilot-balloon observations and the displacements of the pressure systems shows that the air reaching northern New England on the night of February 24–25 started from the above-mentioned area on February 23, at a time when severe dust storms occurred there.

An almost steady current of air from the dust-source region to New England prevailed from February 23 to 25. When the velocities of the wind, which were of the order of magnitude of 50 to 60 miles per hour, are considered, the movement of this air from the vicinity of the Texas Panhandle on February 23 to New England on the 25th is easily accounted for. Air at Amarillo, Tex., at 5 p. m. eastern time on February 23 would have reached central Iowa 12 hours later, would have passed over the

lower Great Lakes during the day and reached the vicinity of Buffalo at 5 p. m. on the 24th. This motion would carry the air to New Hampshire by about midnight. The path indicated goes northeastward through Iowa, and gradually curves eastward over the Lower Great Lakes region, approaching New England from west-northwest.

This path is verified by observational evidence of dustfalls. Dust was observed to spread over central Kansas and aloft over the eastern portion of that State on the 24th, appearing at high levels even at North Platte, Nebr. During the airplane observation at Omaha, begun at 4 a. m. on the 24th, dust was observed between 2,230 and 3,430 meters. From that station eastward to Buffalo, no observation of the dust was noted, because general cloudiness prevailed without precipitation; and the obscuring effect of the dust, which at this time was only aloft, could not be distinguished from that of the clouds. The dust became apparent in northern New York when rain which had mixed with the dust to produce mud was observed.

The conditions in the "dust bowl" on February 23 when this dust began to be raised are described in the report of Glen H. Phillips, Weather Bureau observer at Pueblo, Colo. He writes:

> Black, swirling clouds of dust rolled over practically every county [in Colorado] south of the 40th parallel and east of the 105th meridian. The air was heavily laden with dust over this area, reducing the visibility to practically nothing in many localities and completely halting motor traffic. Pueblo experienced the worst storm since the St. Patrick's Day "black blizzard" of 13 years ago. Semidarkness enveloped the entire southeastern portion of the State and artificial light was used during midday.

Similar conditions were reported in western Oklahoma, the Texas Panhandle, northeastern New Mexico, and at Dodge City, Kans.

The reports from northern New York give an interesting account of how the dust was precipitated late the following day out of the upper air along with the raindrops. At Buffalo, light dust had been observed in the afternoon by airplane pilots, who reported it as occupying a layer between 6,000 and 10,000 feet altitude. In the evening, between 7 and 8:15 p. m., the dust was brought down with a misting rain, which produced a thin coating of mud visible on polished objects such as automobiles. At Oswego, at 5:30 p. m. the sky was darkened by heavy clouds of a yellow color. Breaking of the clouds shortly after sunset showed the yellow color quite prominently. Subsequently reports were received of a small deposit of dust on automobiles which had been out between 5 and 7 p. m. The dust was reported at the following stations in the vicinity: Watertown, Tupper Lake, Alexandria Bay, and Willsboro.

At Canton, N. Y., there was a light fall of dust with the rain which occurred late in the afternoon and in the evening. H. E. Heyer, Weather Bureau official at Canton, writes:

> Motorists report that the windshields of their cars became so heavily streaked with mud as to interfere seriously with vision, making it necessary, in some cases, to stop and clean off the mud deposit.

The dust-laden air from the southwest was acting along a warm front against a colder air mass to the east. Over northern New England the air rising upward along the sloping warm front surface had reached a height such that snow was formed instead of rain. This snow showed the presence of dust just as had the falling rain. Falling with the snow, the dust produced a striking effect in the peculiar brown color it gave to the snow.

DUSTSTORMS OF FEBRUARY AND MARCH 1936 IN THE UNITED STATES

By R. J. MARTIN

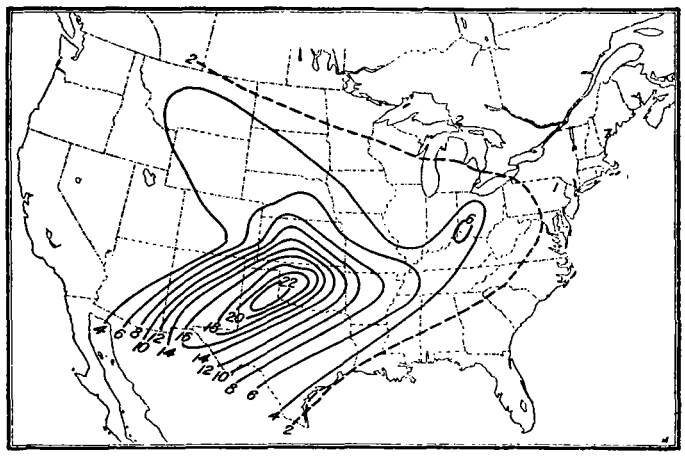
[Weather Bureau, Washington, D. C., April 1936]

The *Weekly Weather and Crop Bulletin* for the week ending February 4, 1936, carried the following statement: "The soil continues much too dry in the southwestern Plains, centering in southwestern Kansas and southeastern Colorado, with strong probability of drifting and duststorms unless more moisture is received soon."

Moisture sufficient to relieve the droughty conditions failed to materialize; and numerous and severe duststorms occurred over southeastern Colorado, northeastern New Mexico, western Kansas, and western Oklahoma in February. Late in the month, dust was reported as far east as Missouri, and some cooperative observers in Texas reported crop damage. In western, and some central, sections of Kansas the storms were of marked intensity; and on the 22d, visibility was so reduced by dust in portions of Colorado that pedestrians collided with one another in attempting to get about during the height of the storm. On the 24th, dusty conditions prevailed in portions of northern New York. These last two storms are described in the February 1936 MONTHLY WEATHER REVIEW.

The accompanying chart shows the number of days with duststorms or dusty conditions in March 1936, and is based only on reports from first-order stations of the Weather Bureau. It will be seen that the greatest number occurred in the persistently dry area centering over the Southern Great Plains, the frequency decreasing rather uniformly with distance from this droughty source—the "Dust Bowl."

Early in March, duststorms were reported in eastern New Mexico, where conditions were more favorable for their inception than in the preceding year, and in most



Number of days with duststorms, or dusty conditions, March 1936.—W. A. M

other sections of the dry southwestern area, especially in the Oklahoma Panhandle and southeastern Colorado. During the week ending March 24 severe storms, some of them the worst reported so far this year, occurred in several southwestern States. Dust from western Kansas was carried through the air to the eastern part of the State, but here the storms were not so severe as those of March