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Several Wisconsin Loess sections were described before the Iowa Academy of Science in 1953 (1), and data for in-place density and particle size were presented. The thickest of these sections was exposed in a newly opened quarry near Crescent City, Iowa (Fig. 1). This section was of particular interest because it showed several zones of clay concentration at different depths, and at that time

Fig. 1. Photograph of the Crescent City Section, 1952. Upper samples were obtained by augering horizontally into the hill. Later excavation removed much of the hill.

it was suggested that the clayey zones might be related to lulls in deposition of the Wisconsin loess. The clayey zones divide the loess into four units which could supposedly correlate with the four advances of Wisconsin glaciation (Appendix A).

It was also pointed out that whereas a histogram showed an approximate normal statistical distribution of samples with regard to their sand content, the histogram for clay content showed a decided skewing, as indicated in Fig. 2. According to the 1953 paper, "The skewed clay content distribution is probably related to the origin

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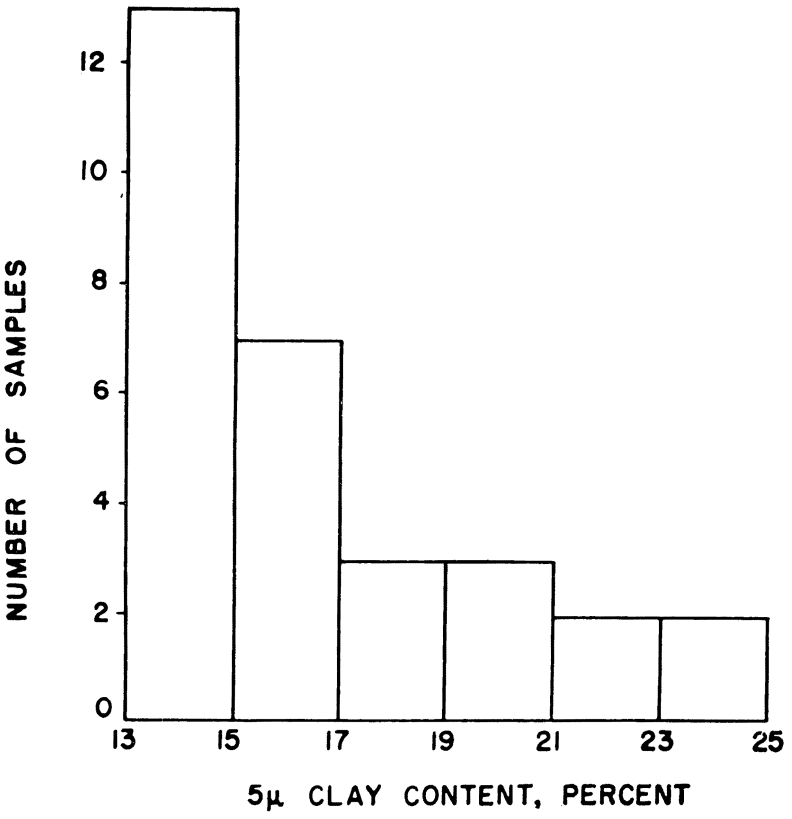

Fig. 2. Histogram showing frequency distribution of Crescent City Section loess samples with regard to their clay content.

of the loess and might conceivably indicate lulls from a sustained maximum rate of deposition. If this is true, carbonate data not yet obtained may verify it, or migration of carbonates may have obliterated any trends." The present paper presents carbonate and organic matter data to support this original interpretation.

Test Methods

Carbonate contents were calculated on the basis of calcium ion content determined by a versenate method (2), and are probably high by one or two percent due to cation exchange with clay. Organic matter contents were measured by oxidation with potassium dichromate and back titration with ferrous sulphate solution to determine the unused dichromate.

Results

Carbonate and organic matter data are presented in Table 1 and plotted in Fig. 3. An interesting correlation can be seen; zones high in clay are in general high in organic matter and low in car-

Table I

Clay, carbonate, and organic matter contents of Crescent City Section loess samples.

Sample No.	Depth, ft.	% 5μ Clay	% RCO_3[a]	% Organic Matter	Age[b]
1	0-½	20.0	14.6	1.59	(Recent)
2	2-2½	18.0	13.9	0.63	
3	5-5½	17.2	11.3	0.51	Mankato
4	10-10½	16.4	13.3	0.61	
5	15-15½	15.0	17.2	0.56	
6	20-20½	13.0	20.5	0.34	
7	25-25½	17.8	6.3	0.37	(Post-Cary)
8	30-30½	16.0	18.0	0.30	Cary
9	35-35½	14.3	22.0	0.27	
10	40-40½	14.8	21.0	0.52	
11	45-45½	24.5	3.1	0.44	(Post-Tazewell
12	50-50½	22.6	2.6	0.30	
13	60-60½	15.5	13.0	0.20	
14	65-65½	15.2	11.7	0.12	Tazewell
15	70-70½	16.6	10.4	0.17	
16	75-75½	24.0	1.9	0.18	(Post-Iowan)
17	80-80½	20.3	1.9	0.17	
18	85-85½	20.9	8.8	0.16	
19	90-90½	19.4	10.0	0.10	Iowan
20	95-95½	14.3	9.6	0.03	
21	100-100½	14.1	9.1	0.00	
22	105-105½	15.1	8.7	0.00	
23	110-110½	13.3	8.8	0.00	
24	115-115½	13.3	7.9	0.01	
25	120-120½	14.0	8.0	0.07	
26	125-125½	14.1	8.7	0.09	
27	135-135½	13.0	9.0	0.08	
28	140-140½	13.4	8.2	0.07	
29	150-150½	14.1	8.0	0.05	

[a]Calculated as $CaCO_3$

[b]Periods of weathering and soil formation are indicated by brackets.

bonates. The organic matter correlation is poorest near the surface of the ground, where fresh roots raise the organic matter content. content.

Carbonate Movement

Below each zone of low carbonate may be seen a zone of higher than average carbonate content. (Fig. 3). An exception is the lowest leached zone; here the only underlying zone of carbonate enrichment consists of heavy concretions almost 80 feet below. These are not represented in the graph. This would suggest leaching with subsequent precipitation related to the lower permeability of the next underlying clay-rich zone. Carbonate precipitation under such circumstances is a commonly seen field relationship, as in permeable materials overlying Kansan till.

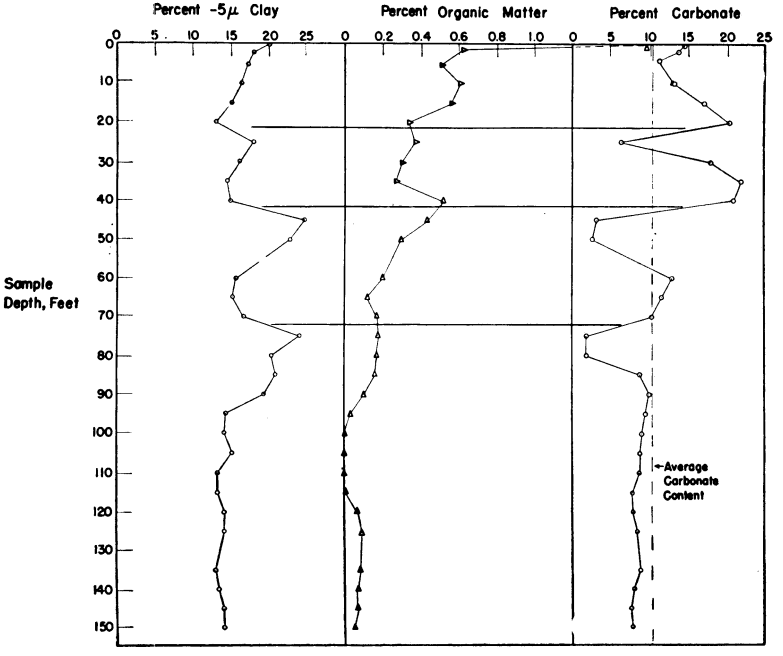

Fig. 3. Loess zonation indicated by clay, organic matter and carbonate contents in the Crescent City Section.

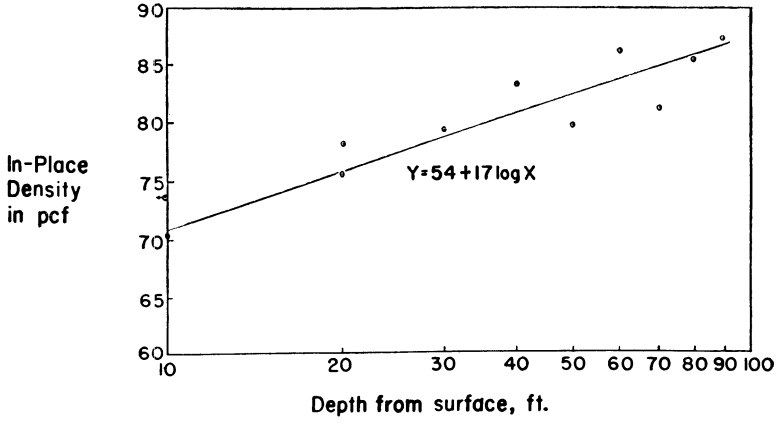

Fig. 4. Relation of in-place density (y) to depth (x) in a loess cut at Turin, Iowa.

Another indication of carbonate movement in the Crescent City Section is the presence of small concretions in nearly all samples, regardless of clay content. This probably accounts for the previous description of all samples as being calcareous, and serves to point up the importance of care with the acid bottle. Chemical data do show that all samples are calcareous, but the slight amount of carbonate present in the clay zone samples may all be secondary. Gypsum rosettes described from the basal part of the Crescent City Section indicate sulfate movement (3).

Stratigraphy

The above data could obviously be interpreted in a number of ways, depending on one's outlook, altitude and viewpoint. If the suggestion for periodic loess deposition be accepted (4, 5), the relative amounts of loess deposited during Wisconsin substages can possibly be estimated. It should be pointed out that basal relationships in the section are still problematical, and during the early sampling expeditions the basal part was not exposed. Later cuts revealed the presence of a continuous Pearlette ash layer 6 inches to a foot in thickness. This excellent marker is believed to originate in north-central New Mexico (6). In the Crescent City Section it occurs as a layer within a compact, gray silt, and volcanic ash nodules are contained in the over-lying silt. This probably correlates with that referred to by Kansas and Nebraska Surveys as the Sappa silt, late Kansan in age. It was difficult to find a break between the Sappa and the overlying loess except by the difference in ease of erosion. The stratigraphy appears much the same as that described at the Harrison-Monona County Line Section in the Little Sioux River valley (5).

Relocation of the Cut

Unfortunately the limestone company has not nurtured any loving care for the Pleistocene, the company being mainly interested in what is underneath, and in the time since the first sampling the loess cut has suffered a number of setbacks. The section was first visited in September, 1952; a few months later almost half the hill was gone. Some composite samples were collected from the relocated cut in November, 1953, and the section was re-examined.

In the section exposed in 1953, the second and third leached zones had coalesced into a thick unit extending from 52 to 74 feet. Secondary carbonates were found in the middle of this unit, but no definite break could be found. Careful examination revealed that the unit on the whole was more brown in color and also harder and obviously higher in clay. On the basis of field evidence it would probably be identified as an anomalously thick Brady Soil. It therefore appears that the Brady Soil, ordinarily thought of as Post-Tazewell, may in most places represent a superposition of a

Post-Tazewell profile on a post-Iowan. It should be noted that this section has one of the greatest *vertical* thicknesses yet described in the United States, yet the thickness indicated for the Tazewell loess is scarcely enough to prevent such an overlapping.

The Post-Cary leaching previously at 25 feet is represented by a discontinuous leached zone at about 30 feet. In most sections this could easily be destroyed or overlooked or obliterated by soil profile development during the Recent

Wisconsin Stage

It would appear that over half (about 55-60 percent) of the Crescent City loess was deposited during the Iowan glacial substage. An additional 10-15 percent was deposited during the Tazewell, another 15 percent during the Cary, and about 15 percent during the Mankato. These figures allow for the increase in density due to compaction* but do not correct for unknown factors of erosion and densification due to soil profile formation.

The hypothesis for downward carbonate movement and precipitation above the next underlying clay zone runs into quantitative difficulties. The amounts of carbonates in the top two peaks (Fig.3) far exceed the amounts available from leaching the overlying zones. A possible explanation is that erosion reduced the overlying leached zones after leaching but prior to deposition of the next loess. This interpretation would be consistant with the weak development of soil profiles. There is also a possibility for general downward or upward carbonate movement.

Acknowledgement

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References

1. Handy, R. L., Davidson, D. T., and Chu, T. Y. Depth studies of Wisconsin loess in southwestern Iowa. I. Particle-size and in-place density. Proc. Ia. Acad. Sci. 60:335-353. 1953.
2. Clare, C. E. Some chemical tests for engineering purposes. Roads and road construction. 27:43-49, 83-86. Feb./Mar. 1949.
3. Roy, C. J. Gypsum rosettes from western Iowa. Oral presentation. Ia. Acad. Sci. 1954.
4. Frye, J. C., and Leonard, A. B. Pleistocene geology of Kansas. Bull. 99,

*Appendix B

Kansas State Geol. Survey. 1952.
5. Condra, G. E., Reed, E. C., and Gordon, E. D. Correlation of the Pleistocene deposits of Nebraska. Bull. 15, Nebr. Geol. Survey. 1947.
6. Swineford, Ada. Source area of the Great Plains volcanic ash. Jour. Geol. 57:3:307-311. 1949.

Appendix A

CLASSIFICATION OF THE WISCONSIN GLACIAL STAGE

Substages	
Glacial	Interglacial
	Post-Mankato or Recent
Mankato	
	Post-Cary
Cary	
	Post-Tazewell
Tarzewell	
	Post-Iowan
Iowan	

Major time-stratigraphic units are the Iowan-Tazewell and Cary-Mankato. Cary-Mankato loess is often called Bignell, and Iowan-Tazewell loess is sometimes called Peoria or Peorian. The name Peoria is also used for Iowan-Tazewell-Cary-Mankato loess where it is undifferentiated, or it is simply called Wisconsin loess. Early Iowan leached loess is known as Farmdale.

Wisconsin interglacial substages are generally considered so brief that except for the post-Tazewell they are unnamed. The post-Tazewell pre-Cary time is usually referred to as the Bradyan interval, and the soil developed in this time is the Brady Soil. The present investigation shows that the Brady soil may be a superposition of Post-Tazewell on Post-Iowan weathering. Where loess is thin the modern soil profiles may envelope two, three, or four of these weathering intervals.

Appendix B

In-place density measurements were not made at the Crescent City Section, but data from other sections show the trends. Data from a loess cut at Turin, Iowa, are plotted in Fig. 4 and may be taken as representative of coarse-textured loess. By use of the equation indicated, the densities for the Crescent City Section are approximated at 88 pfc for the Iowan loess, 84 for the Tazewell, 80 for the Cary, and 74 for the Mankato. Development of a soil profile would cause further densification of the Iowan, Tazewell, and Cary and suggest that a thickness correction should be added. However, the lack of a soil profile on the top of the Mankato indicates that here an extra erosion thickness should be added. Because of difficulty in evaluating these factors the final interpretation is made only relative to the total amount of loess deposited and the factors are ignored. Rather than propose any arbitrary corrections it would seem more desireable to gain comparative measurements from other loess sections.

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