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Some Observations of the Paha of Northeast Iowa [1]

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The loess capped ridges associated with the Iowan glacial drift plain in northeast Iowa have been called "paha" by McGee (2)*, a term used by the Dakota Indians to describe these peculiar geological formations. The paha have been described (2) as "the elongated swell of soft and graceful contour, standing apart on the plain, or else connected with its fellows sometimes in long lines, again in congeries, and locally merging to form broad plateaus." The occurrence of paha in the Iowan drift plain of northeast Iowa has been reported by several authors (1, 2, 4, 5, 6, 7, 9). Most of the paha were said to occur in and around the periphery of the Iowan drift border adjacent to the loess covered Kansan drift (4).

In the course of field operations in the study of soils, a considerable number of local loess accumulations well within the borders of the Iowan drift have been encountered, in addition to similar areas near the drift borders. Many of these loess areas are removed from the Iowan-Kansan drift border contacts a matter of 30 miles or more. These local loess areas on the Iowan drift plain were found to be either isolated on the drift plain or immediately adjacent to a stream. Some of the latter perhaps should not be designated as paha, since they occur on the east banks of streams parallel to the stream and do not have the prevalent northwest-southeast (south 45 to 60° east) trend of their longer axes as do the paha. Others have this orientation.

Fig. 1 shows the distribution of paha known to the authors. It is certain that there are a considerable number of paha not shown on this map. This is especially true of the area at the periphery of the Iowa drift. Only those loess areas which have been mapped in the field or are known specifically to the authors have been shown.

Paha loess is of interest to workers in soils as well as those in Pleistocene geology. The origin of the paha has been difficult to explain because while having approximately the shape and configuration of longitudinal dunes, they are more silty than sandy. Since silt does not move by saltation a silt dune is not easily ex-

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2 Soil Scientist and Principal Soil Correlator, respectively.

* Figures in parenthesis refer to Literature Cited, p. 9.

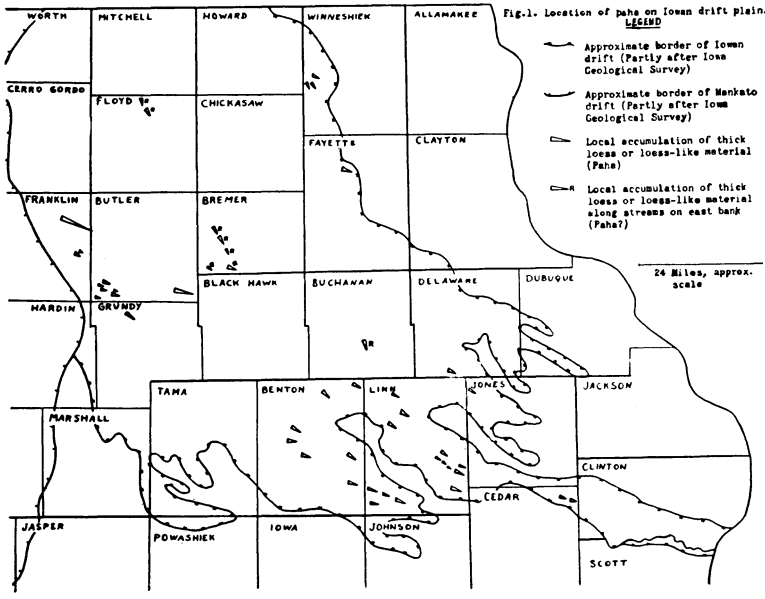

Figure 1

plained. From a soils viewpoint the study of paha is important because of the differences in soils developed on the paha and those developed on the adjacent drift plain. The morphology of the loess derived soils on the paha in some instances is comparable to soils developed in the coarse loess of western Iowa and northwestern Illinois.

A lone paha, located in the northwestern part of Grundy county, has been studied in some detail. This paha is surrounded by Iowan drift and is very prominent upon the landscape. The Prairie soils on this particular paha resemble the Monona series of western Iowa and the Port Byron series of northwestern Illinois. The Lithosols resemble the Ida series of western Iowa. A profile description of the soil found on the center of the north slope of the paha is as follows:

A_1 0.12″ Very dark brown* (10YR 2/2, moist) friable silt loam with a medium crumb structure.

B_1 12-20″ Brown (10YR 4/3 moist) to dark yellowish brown (10YR 4/4 moist) friable silt loam, having weakly developed fine nuciform structure.

B_3 20-40″ Brown (10YR 5/3 moist) to yellowish brown (10YR 5/4 moist) friable silt loam, having weakly developed coarse blocky structure.

* Colors according to Munsell color designation.

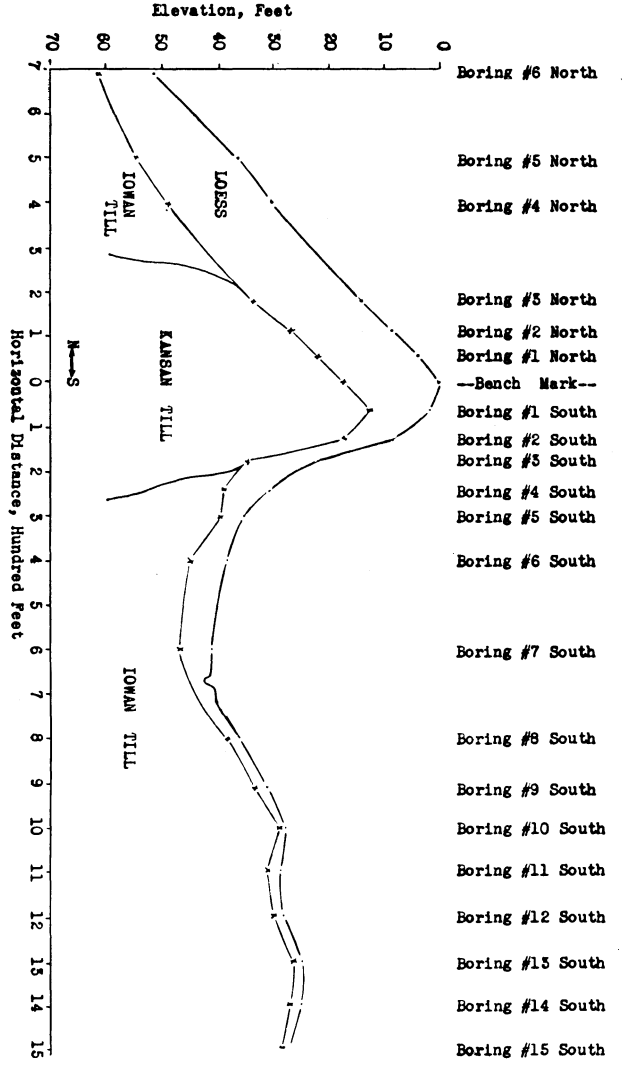

Fig. 2. Cross section of paha and adjacent area in Grundy County, showing elevation, thickness of loess and character of pre-loess topography.

C 40″ + Light yellowish brown (10YR 5/6-5/8 moist) silt loam becoming calcareous at about 80″ in depth. Faint mottlings of yellowish gray and reddish brown are present.

Morphologically, this soil resembles both the Monona soil of western Iowa and the Port Byron soil of northwestern Illinois. However, detailed laboratory study is necessary before it can be properly classified.

The soils on this paha are surrounded by soils formed from Iowan drift materials. There are morphological differences between soils formed from the paha loess and the surrounding soils. The soils on the paha are lower in clay content, better oxidized, and have less well-developed profiles than most of the adjacent soils. Variations in plant available nutrients have not been studied but differences in potash and phosphate would be expected.

Borings were made on a traverse** across the paha to obtain information regarding the depth to carbonates, the thickness of the loess and/or eolian mantle, and the nature of the underlying material. The traverse was initiated at the high point on the paha, designated herein as the bench mark, and extended along a north-south road a distance of 700 feet north and 1500 feet south. The paha was bisected at its lee or southeastern end by the traverse which extended to the level of the drift plain on the north and to the local high point of the drift plain on the south. Surface elevations were obtained at each boring site by using a level and elevation rod. The results are shown in Fig. 2. The core of the paha, like most others investigated to date, consists of strongly weathered till, or gumbotil, interpreted to be Kansan in age. The high point of the Kansan inlier is about 15 feet above the high point of the adjacent Iowan drift on this traverse, but may be higher in the northwest part of the paha. With the loess mantle over the Kansan drift the total rise of the paha above the high point of the Iowan till is only about 25 feet. However, the rise of the paha above the level of the Iowan drift plain to the north is more than 50 feet. The loess mantle is not coextensive with the Kansan drift nucleus in this paha, but is larger, which conforms to an observation made by McGee about paha in general.

At each one of the 22 boring sites a complete log was made. A few of the logs are shown here to indicate the manner of interpretation.

Boring at Bench Mark. (Highest point in surface elevation of paha on the traverse.)

0- 14″ Very dark brown silt loam, leached.

** Traverse located along west edge of SW¼ Sec. 7, T89N R17W.

14- 40″ Brown friable silt loam grading into a yellowish brown heavy silt loam, leached.
40- 66″ Yellowish brown leached silt to silt loam.
66- 80″ Light yellowish brown, coarse calcareous sand.
80-214″ Light yellowish brown calcareous silt to silt loam.
214-250″ Dark gray calcareous silt to silt loam, with considerable grit.
250″ + Light gray, leached, very plastic silty clay to clay gumbotil.

Interpretation

1. Modern soil profile developed in loess to a depth of 40″.
2. Depth to carbonates = 66″.
3. Thickness of loess or loess-like material= 214″.
4. Buried soil encountered at 214″, with old A horizon probably represented to depth of 250″.
5. Kansan gumbotil encountered at 250″ which is probably B horizon of old buried soil on the Kansan.

Boring #2 south

0- 12″ Very dark brown friable silt loam, leached.
12- 38″ Brown friable silt loam grading into a yellowish brown heavy silt loam, leached.
38- 60″ Light yellowish brown silt loam to silt, leached.
60-105″ Light yellowish brown calcareous silt loam to silt with occasional gray mottling and iron stains.
105-123″ Dark gray silt, calcareous in small patches, with considerable grit.
123″ + Dark brown, heavy silty clay, leached glacial till.

Interpretation

1. Modern soil profile to 38″.
2. Depth to carbonates = 60″.
3. Total loess thickness = 105″.
4. A horizon of buried soil on Kansan till at depth of 105 to 123″.
5. B horizon of buried soil on Kansan till at 123″ +.

Boring #4 south

0- 16″ Very dark brown friable silt loam, leached.
16- 44″ Brown friable, leached silt loam, grading into a leached yellowish brown silt loam.
44- 80″ Light yellowish brown silt loam, leached.
80-100″ Light yellowish brown, coarse leached sand.
100-106″ Dark brown, leached, heavy silty clay glacial till.
106-112″ Light yellowish brown, coarse leached sand.
112″ + Yellowish brown, calcareous sandy clay loam glacial till.

Interpretation

1. Modern soil profile to a depth of 44″.
2. Depth to carbonates = 112″.
3. Thickness of loess and wind blown material = 100″.
4. Incorporated Kansan glacial till boulder in Iowan till 100 to 106″.
5. Iowan glacial till.

A paha northeast of Hampton, Iowa, in Franklin County, Fig. 3, is one of the larger ones observed. This is a congerie of a number of loess ridges. It is about 10 miles long and varies from one-half to more than one mile in width. Samples of calcareous material were taken from this area at depths of 1 to 10 feet. Mechanical analyses were made of the samples by the pipette method with sieves used to determine sands. Results are given in Table 1.

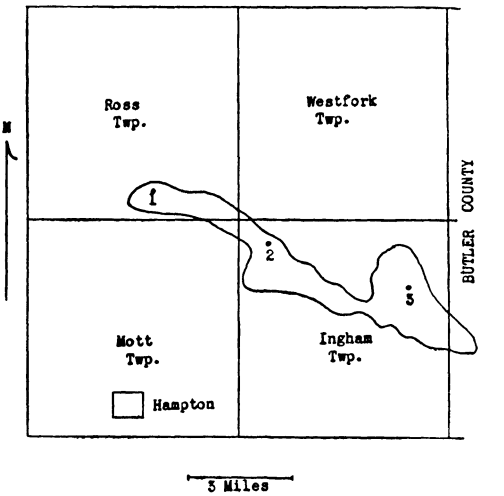

Fig. 3. Calcareous loess from Paha in Franklin County, Iowa: 1, sample taken at depth of 10 feet; 2, sample taken at depth of 1 foot; 3, sample taken at depth of 8 feet.

Analyses of loess from the Illinois River in central Illinois taken at increasing distances from the river and reported by Smith (10) are included for comparison. Additional analyses for Iowan and Mankato till from Iowa as reported by Riecken, et al (8) are included in Table 1 for comparison.

It will be noted that excluding the sands and gravels the material from the paha is little better sorted than the drift. No consistent relation is apparent between the contents of sand, coarse silt, fine silt or clay. The loess by contrast is very well sorted. The lack of sorting in the paha suggests that the silt and clay sized particles may have moved as aggregates, probably of sand size. With both sand particles, and sand sized aggregates of silt and clay moving by saltation, formation of longitudinal dunes would be quite possible. Presumably the movement must have occurred before vegetation covered the drift plain, and was concurrent with the formation of the ventifacts in the Iowan pebble band. These conclusions are

Table 1

Mechanical Analyses of Paha Eolian Material, Loess and Till Samples

Sample #	Location of Samples	1.0-0.5 mm	.5-.25 mm	.25-.1 mm	.1-.05 m	Total Sand 750m	Coarse Silt 50-20m	Fine Silt 20-2m	Clay < 2u	Clay Silt
1.	Franklin Co., Ia. Paha	--	1.0	13.0	30.8	44.8	27.7	10.4	17.1	45
2.	" " " "	0.5	11.3	27.8	18.7	58.3	23.6	8.2	9.9	31
3.	" " " "	--	0.6	3.2	30.5	34.3	39.3	11.5	14.9	29
Loess (central Ill.) (10)										
Miles from source										
0.6						18.7	66.2	12*	3*	4
1.5						21.5	59.4	15*	4*	5
3.8						.8	64.6	25*	9*	10
4.5						2.7	59.5	30*	9*	10
9.3						--	61.0	32*	6*	6
14.7						--	57.0	33*	9*	10
19.6						--	53.3	37*	9*	10
24.2						--	48.6	42*	8*	9
Iowan till (8)										
506	Chickasaw Co., Ia.					54.0	— 29.0 —		17.0	59.0
488	Howard Co., Ia.					50.0	— 30.0 —		20.0	66.0
490	Mitchell Co., Ia.					30.0	— 49.0 —		21.0	43.0
3052	Black Hawk Co., Ia.					44.0	— 37.0 —		19.0	51.0
Mankato till										
P 49-13	Story Co., Ia.					50.6	— 34.3 —		15.1	44
P 97-11	Dickinson Co., Ia.					37.4	— 45.1 —		17.5	38
485	Wright Co., Ia.					34.0	— 48.0 —		18.0	37
3092	Hamilton Co., Ia.					28.0	— 57.0 —		15.0	26

* Correction has been made for the fraction between 1 and 2 microns by interpolation between the published data for 1 and 10 microns. The method of interpolation has been checked repeatedly and found reliable for soils developed from loess.

entirely consistent with the data on the drifting of soil by wind from bare fields (3). These data show that the drifts, which behave like sand drifts, vary but little in texture from the soil in the fields from which they blew. While some silt and clay are completely removed from the area by the dust storms, the drifts which are formed are only slightly coarser than the original material.

The formation of the paha is related to the existence of pre-Iowan inliers. It seems probable that vegetation, living or dead on these inliers, served as wind breaks and caused the formation of the nucleus of the paha. The existence of frequent pipestems and channels and very rarely a snail shell in the paha near the till contact indicate the presence of vegetation. When the initial core was formed, further accumulation would be expected on all sides from shifting winds, but the principal accumulation would be expected on the less side from the prevailing winds.

Summary

1. Areas of loess, surrounded by Iowan glacial drift, have been recorded to show their location and the trend of their long axes. These loess areas are identified as paha, with the possible exception of some of those which occur along the banks of streams. Such areas of loess are sometimes oriented parallel to the river.

2. Paha were found to exist in most of the counties in the Iowan drift area in varying numbers.

3. Paha occur well within the Iowan drift and are not confined to the border areas of the drift sheet.

4. A traverse of deep borings plus surface elevations shows an isolated paha in Grundy County to have a nucleus of weathered till which the Iowan drift evidently had not over-ridden. The loess which mantled the drift was not coextensive with the nucleus.

5. Mechanical analyses of samples taken from a paha in Franklin County reveal a lack of sorting compared with loess.

6. Further study of the soils on the various paha are needed to show their similarities or dissimilarities to presently recognized soils.

7. It is suggested that the paha may have formed as the result of drifting of sand and sand sized aggregates of silt and clay.

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