

THE RELATIVE AGES OF THE IOWAN AND ILLINOIAN DRIFT SHEETS.

GEORGE F. KAY.

INTRODUCTION.

The most generally recognized classification of the Pleistocene of the Mississippi Valley includes five glacial stages and four interglacial stages. The glacial stages, from the oldest to the youngest, are the Nebraskan, the Kansan, the Illinoian, the Iowan, and the Wisconsin stages; the interglacial stages, in the same order of age, are the Aftonian, the Yarmouth, the Sangamon, and the Peorian stages.

From time to time within the last twenty years, doubt has been expressed by some students of the glacial deposits as to whether or not there is sufficient evidence to justify the continuance of the recognition of the Iowan glacial stage. If not, the classification of the Pleistocene in America would include not five but four glacial stages. Moreover, if the deposits which have been considered to belong to the Iowan glacial stage can be shown to have been deposited during a late part of the Illinoian glacial stage, as has been suggested recently by Leverett,¹ then again our classification would include only four glacial stages.

It is the purpose of this paper to restate the evidence which has been given in support of the existence of an Iowan drift sheet in Iowa and to present evidence in addition to that which has been presented by other geologists to prove that the Iowan drift sheet should not be correlated with the Illinoian drift sheet. The new evidence in favor of the interpretation that the Iowan glacial stage was an independent stage from the Illinoian is the presence of a widespread weathered loess which is post-Illinoian, pre-Iowan in age.

As a background for a proper understanding of the discussions of the Iowan and Illinoian drifts, brief statements will be made regarding the development of our present knowledge of these drifts and of closely associated glacial and interglacial deposits.

¹Leverett, Frank, The Pleistocene Glacial Stages: Were There More Than Four? Proc. Am. Phil. Soc., 65, No. 2, 1926.

McGee's Upper Till and Lower Till.

Previous to 1880 McGee had found evidence of two tills in northeastern Iowa, and in 1881 he² referred to them as the upper till and the lower till, each having its own distinctive characteristics. In some places his upper till was the surface till and in other places the lower till was at the surface. He was able to map both the tills areally. Where both tills were present in a section they were separated, in many places, by a forest bed or its stratigraphic equivalent, "hardpan" or "gumbo", which he stated was the modified upper portion of his lower till. At this time, McGee interpreted the widespread loess of northeastern Iowa as being equivalent in age to his upper till. In his final report on northeastern Iowa, based upon investigations which extended over many years, McGee³ described in detail the topographic and lithologic character, the stratigraphic relations, and the geographic extent of his Upper Till and his Lower Till. He pointed out that his Upper Till was younger than the gumbo-surfaced drift (present Kansan drift) of southern Iowa, and older than the till of the Des Moines lobe (present Wisconsin drift). McGee did not differentiate in northeastern Iowa a third drift (present Nebraskan drift) which has no mappable surface distribution within his area but which has been exposed in a few places within his area, in railroad cuts and in road cuts, and has been penetrated in well drillings.

The Names Kansan and Iowan.

About the year 1895 the names Kansan and Iowan, which were given first to two tills in the Afton Junction region in southwestern Iowa and which were thought to be the equivalents of McGee's Lower and Upper tills, respectively, were applied to these tills in northeastern Iowa. These names have continued to be used for the two surface tills of McGee's area in northeastern Iowa. There has been some question with regard to the propriety of the names Kansan and Iowan for these two tills but it would serve no useful purpose to enter into a discussion of that question here. This paper deals chiefly with the characteristics and relationships of the till of

² McGee, W J, *The Relations between Geology and Agriculture: Iowa Horticultural Soc., Trans.*, 16, 227-240, 1881.

³ McGee, W J, *The Pleistocene History of Northeastern Iowa: U. S. Geol. Surv. 11th Ann. Rept.*, 195-568, 1891.

northeastern Iowa which has been called Iowan and of the Illinoian till of southeastern Iowa.

Illinoian Drift Sheet Discovered.

In 1895 Chamberlin⁴ presented a classification of the glacial deposits of the Mississippi Valley in accordance with the best evidence of that time. Here he included the Illinoian till sheet which had been determined by Leverett to be the product of an ice invasion into southeastern Iowa from the east at some time between the Kansan glacial epoch and the Iowan glacial epoch. In this paper Chamberlin gave a system of time ratios based upon his impression of the relative amounts of erosion and weathering of the drifts. With regard to the Iowan and the Illinoian, he stated that if the time since the close of the Wisconsin is taken as one unit, then the time since the Iowan would be represented by five units and since the Illinoian in Iowa by eight units.

Leverett's Yarmouth, Sangamon, and Peorian.

In 1898 the names Yarmouth, Sangamon, and Peorian were introduced into the classification of the Pleistocene deposits in the Mississippi Valley by Leverett.⁵ The name Yarmouth was applied to the soil and weathered zone at the junction of the Illinoian and the Kansan till sheets in the region of overlap between Davenport, Iowa, and Quincy, Illinois. Leverett stated: "The presence of this soil horizon was first brought to the writer's notice by a well section at Yarmouth in Des Moines county, Iowa. For this reason and because the name of this village is less likely to be confusing than names which are common, it seems appropriate to apply the name Yarmouth to this weathered zone. There is also at Yarmouth not only a soil horizon but apparently a pronounced erosion between the Illinoian and Kansan sheets."

The name Sangamon was applied to the soil horizon between

⁴ Chamberlin, T. C., The Classification of American Glacial Deposits: Jour. Geol., 3, 270-277, 1895.

⁵ Leverett, Frank, The Weathered Zone (Yarmouth) between the Illinoian and Kansan Till Sheets: Jour. Geol., 6, 238-243, 1898; Proc. Iowa Acad. of Sci., 5, 81-86, 1898.

The Weathered Zone (Sangamon) between the Iowan Loess and Illinoian Till Sheet: Jour. Geol., 6, 171-181, 1898; Proc. Ia. Acad. of Sci., 5, 71-81, 1898.

The Peorian Soil and Weathered Zone (Toronto formation?) Jour. Geol., 6, 244-249, 1898.

the Illinoian till sheet and the Iowan loess. The first recognition of the occurrence of this definite soil horizon was reported by A. H. Worthen. In his report on Sangamon county, Illinois, made in 1873, he called attention to a soil found at the base of the loess in Sangamon and neighboring counties. The name Sangamon was taken from this locality where the soil was first reported.

The name Peorian was applied to the weathered zone at the contact between the Iowan loess, which was correlated with the Iowan till, and the Wisconsin till in the region of Peoria, Illinois. In an exposure east of Peoria, there was evidence of an interval between the deposition of the loess which was correlated with the Iowan till and the Shelbyville till sheet, which appeared to be the earliest of the Wisconsin series.

The Illinois Glacial Lobe.

In 1899 Leverett's monograph⁶ on the Illinois Glacial Lobe appeared. In this publication his new terms were used in connection with the classification of the Pleistocene deposits of the Mississippi Valley. The classification given is as follows, from the oldest to the youngest:

(1) Oldest recognized drift sheet, Albertan of Dawson, and sub-Aftonian of Chamberlin; (2) Aftonian; (3) Kansan drift; (4) Yarmouth interval; (5) Illinoian drift; (6) Sangamon interval; (7) Iowan drift and main loess deposit; (8) Peorian, possibly equivalent to Toronto of Chamberlin; (9) Early Wisconsin morainic drift; (10) unnamed interval shown by shifting of ice lobes; (11) Late Wisconsin morainic drift; (12) (13) (14) and (15) stages of Lake Chicago as given in an earlier publication.

Students of glacial deposits in Iowa and adjacent states were at this time agreed that there was evidence of five distinct ice invasions, the Albertan or sub-Aftonian, the Kansan, the Illinoian, the Iowan, and the Wisconsin; and that there were four distinct interglacial epochs, the Aftonian, the Yarmouth, the Sangamon, and the Peorian.

The Iowan Drift Described by Calvin.

In 1899 Calvin⁷ published a paper in which he described fully the features of the Iowan drift of northeastern Iowa. It is

⁶ Leverett, Frank, *The Illinois Glacial Lobe*: U. S. Geol. Surv., Mon. 38, 1899.

⁷ Calvin, Samuel, *Iowan Drift*: Bull., Geol. Soc. Amer., 10, 107-120, 1899.

of interest to note that in this paper Calvin stated that he believed that the Kansan drift was certainly fifteen and possibly fifty times as old as the Iowan, and that judging by the changes that had been wrought in the surface of the Illinoian before the loess was laid down on it, this sheet of till was at least five or six times as old as the Iowan.

For some years it was thought that the main loess deposit of the Iowan area in northeastern Iowa and of the Illinoian area of southeastern Iowa was of the same age as the Iowan drift and was aqueous in origin. It was called Iowan loess. But detailed studies soon showed that the main loess deposits were eolian and not aqueous in origin.⁸ The loess continued to be considered genetically related to the Iowan drift. In recent years it has been interpreted to represent "the early part of the Peorian stage of deglaciation."⁹

The Iowan Drift Questioned by Leverett.

About the year 1907 the reality of the Iowan drift of northeastern Iowa began to be questioned. Leverett¹⁰ in a paper in which he discussed the application of weathering and erosion to the correlation of drifts questioned the existence of the Iowan drift. He expressed the view that the topography of the Iowan area in northeastern Iowa was of the erosional type such as characterizes the Kansan drift but that in northeastern Iowa tabular divides are lacking and none of the drift is fresh. He believed that filling of the valleys by slope wash in the Iowan area accounted for the difference in topography of this area and that of the Kansan of southern Iowa.

Leverett's skepticism of the Iowan followed field study in the Iowan area, one of the objects of which study was to determine whether or not the Iowan drift was in reality Illinoian drift from the Keewatin field. He concluded that the surface material was not different from the weathered Kansan drift and that if any post-Kansan drift was present it was probably of Illinoian age. His views were influenced possibly by his

⁸ Shimek, Bohumil, Papers on the loess, Loess and the Lansing man, Loess and the Iowan drift: Univ. of Iowa, Lab. of Nat. Hist., 5, 298-381, 1904.

⁹ Alden, W. C., and Leighton, M. M., The Iowan Drift—a Review of the Evidences of the Iowan Stage of Glaciation: Iowa Geol. Surv. 26, 158.

¹⁰ Leverett, Frank, Weathering and Erosion as Time Measures: this Journal, 27, 349-368, 1909.

studies of the glacial deposits of Europe. There, only four distinct drift sheets had been established by students of the Pleistocene, and in comparing with the American section it was only natural that an earnest effort should be made to analyze and interpret the American deposits in terms of four rather than five glacial drifts. His views are given in a paper¹¹ in which the North American and European glacial deposits are compared. In referring to the Iowan drift he used the expression "so-called Iowan of the Keewatin field (Illinoian)."

Calvin's Defense of the Iowan.

Calvin¹² came to the defense of the Iowan. He and his associates on the Iowa Geological Survey believed that the evidence favored strongly the argument that the Iowan drift was distinct from both the Kansan drift and the Illinoian drift. They had for many years mapped the Iowan drift in many counties and were agreed that this drift was the drift which McGee described as his Upper Till. In that part of Calvin's paper which deals with the evidence of the reality of the Iowan drift and its geological relations, he expressed surprise at the attitude taken by Leverett with regard to the Iowan, and presented strong evidence in support of each of the following affirmations: (1) The Iowan drift is. (2) The Iowan drift is young as compared with the Kansan. (3) The Iowan drift is not a phase of the Kansan. (4) The Iowan drift has very intimate relations to certain bodies of loess. (5) The Iowan drift is not related to the Illinoian.

In regard to the lack of relationship of the Iowan to the Illinoian, Calvin stated:

"It is scarcely necessary to discuss the suggestion that the Iowan may be correlated with the Illinoian. Parenthetically it may be said that if the Iowan and the Illinoian represent the same stage of glaciation, the name Illinoian becomes a synonym for Iowan, and we shall be reduced to the painful necessity of referring to one of our most beloved drift sheets as the 'so-called Illinoian.' But no such calamity awaits the Illinoian. The Iowan is much the younger of the two. As indicated by the structural and genetic relations above noted, the Iowan—a little later probably than its maximum stage—is practically contemporaneous with the loess; and as the Berlin paper, with noteworthy lucidity, cor-

¹¹ Leverett, Frank, Comparison of North American and European Glacial Deposits: *Zeits. für Gletscherkunde*, B. 4, 241-295, 321-342, 1910.

¹² Calvin, Samuel, The Iowan Drift: *Jour. Geol.*, 19, 577-602, 1911.

rectly states on p. 299; 'the Sangamon interval separates the loess from the Illinoian stage of glaciation so widely that there would seem to be no relation between loess deposition and Illinoian outwash.' The same long interval, the same wide separation, exists between the Iowan and the Illinoian stages of glaciation. The two drifts are not related in time or in any other way."

Alden and Leighton's Review of the Evidences of the Iowan Stage.

After the death of Calvin in 1911 it seemed highly desirable to have a review of the evidence bearing upon the Iowan problem, and hence with the hope that a satisfactory solution to the question in controversy might be reached, the writer, Calvin's successor as State Geologist of Iowa, asked the United States Geological Survey to undertake the investigation in co-operation with the Iowa Geological Survey. It was agreed that W. C. Alden of the Federal Survey should be assigned to this work and that he should be assisted by M. M. Leighton of the Iowa Survey. Field work was carried forward during two seasons and in the office careful study was given to published and unpublished material related to the Iowan problem. The results of the investigations of Alden and Leighton were published in Volume XXVI of the reports of the Iowa Geological Survey.¹³ In the Introduction to this report, page 56, it is stated:

"It is a pleasure to report that the conclusion has been reached that there is what seems to the writers to be good evidence of the presence of a post-Kansan drift sheet in northeastern Iowa and that this drift appears to be older than the Wisconsin and younger than the Illinoian drift. The writers are, therefore, in the main in agreement with the late State Geologist, Dr. Samuel Calvin, in regard to the Iowan drift. There is, therefore, warrant for continued use of Iowan drift and Iowan stage of glaciation as major subdivisions of the Pleistocene classification."

The chief lines of evidence which caused Alden and Leighton to reach the conclusion that the Iowan drift is a reality and is distinct from other drifts were the following:

(1) *The topographic character of the Iowan area.* It is pointed out that the topography of the Iowan area is not that

¹³ Alden, W. C., and Leighton, Morris M., *The Iowan Drift, A Review of the Evidences of the Iowan Stage of Glaciation: Iowa Geol. Surv.* 26, 49-212, 1917.

of a normally eroded surface like the typical Kansan surface of southern Iowa, but rather it is a drift mantled, erosional topography. There are surface irregularities which are the result of glacial deposition rather than differential erosion. Distinct moraines associated with which are kames of fresh gravels are cited. Examples are given of valleys which are cut deep in the Kansan area and which flatten out where they head in the Iowan area where cutting is in drift and not in bed rock. The Iowan area as a whole lacks the accordance of upland levels of the tabular divides so characteristic of the erosional Kansan area of southern Iowa. The lack of accordance in the Iowan area seems to be due to unequal mantling by glacial drift, which is confirmed by the presence in many places of relatively fresh drift on gumbotil which can be proven to be Kansan gumbotil.

(2) *The character of the uppermost till of the Iowan area.* It is shown that the degree and depth of oxidation, depth of leaching and other evidences of weathering indicate that the drift of the Iowan area is much younger than the drift of the Kansan area.

(3) *The gumbotil.*¹⁴ Gumbotil is widespread at the top of the Kansan till in southern Iowa where tabular divides are preserved.¹⁵ The topographic position of the Kansan gumbotil is such that it has been possible to trace remnants of it into the Iowan area. And wherever the Kansan gumbotil has been found in the Iowan area it is overlain by a thin mantle of drift which is the Iowan drift.

(4) *The loess.* After having made detailed studies of the loess in the Iowan, Kansan, and Illinoian areas, Alden and Leighton reached the following general conclusions: (a) that the deposition of the uppermost till of the Iowan drift area occurred but a short time prior to the accumulation of the main sheet of loess which borders and overlaps it; (b) that the Illinoian till was deposited at a time considerably before this epoch of loess deposition; and (c) that the Kansan drift was deposited considerably earlier than the Illinoian till and much earlier than the loess was formed, or in other words, this line of evidence also supports the view that the Iowan stage of glaciation was distinct from, and later than either the Kansan or Illinoian stages of glaciation.

¹⁴ Kay, Geo. F. Gumbotil, a new term in Pleistocene geology: Science, N. S., 44, 637-638, 1916.

¹⁵ Kay, Geo. F., Some Features of the Kansan Drift in southern Iowa: Bull. Geol. Soc. Amer. 27, 115-117, 1916.

In connection with the discussion of the age of the Iowan drift, Alden and Leighton presented evidence for their belief that the Iowan drift is a distinct drift from the Illinoian drift. They stated:

“From these various observations it is evident that the Illinoian drift has been modified much more by weathering and erosion than has the Iowan. It also appears that most of the modification occurred prior to the formation of the main deposit of loess. It appears clear therefore that the Iowan drift is entirely distinct from and considerably younger than the Illinoian drift.”

Study of Recent Exposures within the Iowan Area.

The last field work done by Alden and Leighton within the Iowan area was in 1915. During a part of each field season since that time the writer has seen all the important exposures which have been made in that area in connection with Iowa's extensive road grading program. Detailed studies of the many widely distributed cuts have strengthened the interpretations of Alden and Leighton. Exposures showing Iowan till underlain by Kansan gumbotil have been found in nearly every county of the Iowan area and in some counties many outcrops of this character are known. The locations of known exposures of Kansan gumbotil overlain by Iowan till are shown in Fig. 4. This is the most impressive evidence within the area in support of the existence of a post-Kansan drift, the Iowan.

Perhaps the best exposure showing the Kansan till and the Iowan till separated by Kansan gumbotil is near the middle of the north line of the northeast $\frac{1}{4}$ of section 16, Windsor township, Fayette county. The elevation of the gumbotil here is about 1,200 feet, and it is seen at the same elevation in several cuts along the road to the east within the few miles to West Union. The section made in the main cut (Fig. 1) is as follows:

- | | | |
|----|---|-----------------|
| 5. | Loess (Peorian), buff, mealy; unleached; some concretions, fossil shells found | 2 feet |
| 4. | Till (Iowan), dark buff on a dry surface, yellowish brown to brown when damp; cuts readily with the hoe; sandy; few if any concretions; all unleached .. | 7 feet |
| 3. | Loess (Loveland), gray with considerable chocolate colored stain; <i>leached</i> ; laminated; puttylike when wet; free from grit and no pebbles found in it | 2 feet 6 inches |
| 2. | Gumbotil (Kansan), dark gray on a dry surface; leached; no concretions seen; very few pebbles of any | |

- kind, and those present are silicious; upper one foot and a half has much carbonaceous matter which shows as a distinct soil band through the cut 5 feet 6 inches
- i. Till (Kansan), oxidized and leached, grades into the gumbotil; pebbles abundant; exposed for 4 feet 6 inches

It will be observed that in the above section beneath the Iowan till there is more than 2 feet of Loveland loess. Reference will be made later to the significance of Loveland loess.



Fig. 1. Road cut near the middle of the north line of the northeast $\frac{1}{4}$, Section 16, Windsor township, Fayette county, showing Kansan gumbotil overlain by Loveland loess, overlain by Iowan till, overlain by Peorian loess.

Study of the road cuts has emphasized the wide distribution of thin loess overlying a distinct pebble band at the surface of the Iowan till. Thick loess which is apparently genetically related to the Iowan till is uniformly present at the borders of the Iowan. This loess thins with distance from the Iowan and furthermore the constituent particles of the loess are largest at the borders of the Iowan and smaller and smaller as distance increases from the border. Some deposits of loess are along river valleys draining from the Iowan drift area.

A most impressive fact is the relation of the depth of leaching of the Iowan till to the thickness of the overlying loess. Where loess is absent the till is leached to a depth of three or

four feet. Where loess overlies the till and is sufficiently thick to be unleached in its lower part the Iowan till is unleached to its surface. Where the loess is thin and leached, the till below is also leached, the combined leaching of the loess and till not exceeding five or six feet. This relationship holds consistently. It is the best evidence in support of the view that the loess was laid down on the Iowan till before the till had been exposed for a sufficient time to be leached. This kind of evidence was



Fig. 2. Road cut between sections 1 and 2, Fremont township, Cedar county, showing thin pebble band with Iowan till below and Peorian loess above.

presented most effectively by Alden and Leighton in their report on the Iowan drift area.

Although the pebble band is on the Iowan till and beneath the loess it is thought that no great length of time was involved in its formation. The writer agrees with the view expressed by Alden and Leighton that the pebble band is probably the residue from wash and wind erosion of the upper part of the till.

One of the best exposures in the whole Iowan area showing the line of pebbles with Iowan till below and loess above was observed in the middle of the line between sections 1 and

2 Fremont township, Cedar county (Fig. 2). The section is as follows:

1. Loess (Peorian), brownish, leached 4 feet
2. Pebble band, a thin row of pebbles.
3. Till (Iowan), grayish-yellow to yellow color, sandy, contains sand pockets, jointed, not strongly oxidized, no ferretto; upper 1 foot 3 inches leached, lower part unleached 5 feet

Some of the fragments of rock in the pebble band show wind polish (Fig. 3).

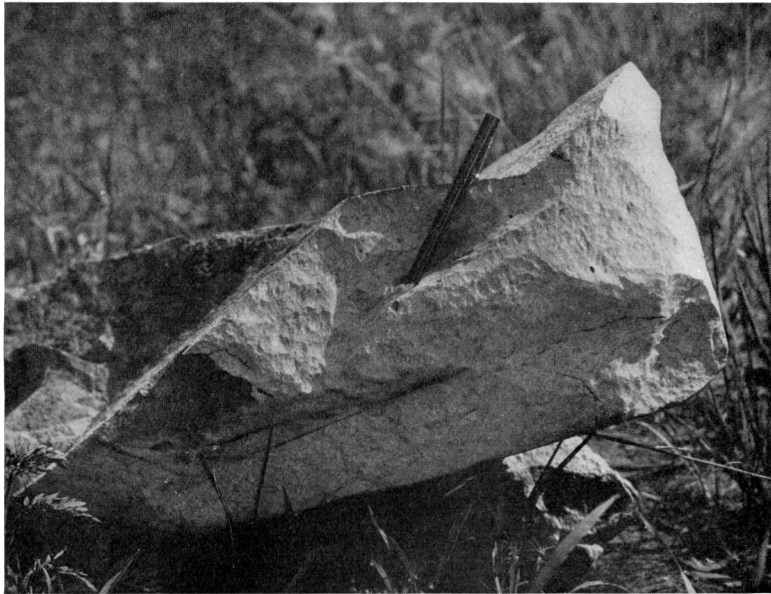


Fig. 3. One of the rock fragments of pebble band underlain by Iowan till and overlain by Peorian loess.

Another most interesting fact brought out by recent studies in the Iowan area of northeastern Iowa is the relative depths of leaching of upland Iowan gravels and upland Kansan gravels. Whereas in places the Kansan upland gravels are leached to depths of more than twenty feet, the Iowan upland gravels, where they overlie Kansan gumbotil (and hence there can be no doubt regarding their age), are leached to a depth of less than five feet. Moreover, the depth of leaching of

upland Iowan gravels, as of Iowan till, is dependent upon the depth of leaching of the overlying loess.

Field Conference in Northeastern Iowa in 1925.

On July 20, 1923, Frank Leverett in a letter written to T. C. Chamberlin, W. C. Alden, M. M. Leighton, and the writer, with regard to an appropriate name to be given to the loess overlying the Iowan and Illinoian tills, stated: "I still regard the occurrence of a drift such as outlined by Calvin (i.e., Iowan drift) as unsettled." Since Mr. Leverett had not been in northeastern Iowa for several years prior to the time this statement was made, and hence had not seen the strong evidence in favor of the Iowan drift which had been made available for study in the many road cuts and other exposures which were made in connection with new road grading within the Iowan area, the writer invited Mr. Leverett to accompany him into northeastern Iowa in the summer of 1925. He accepted the invitation and together we examined some of the most significant exposures within the Iowan area. Paul MacClintock of the University of Chicago and my assistant, E. T. Apfel, accompanied us. Agreement of interpretation was reached on all important matters with the exception of the significance of the pebble band on the Iowan till. Mr. Leverett contended that the pebble band was the result chiefly of erosion by running water and that much time had been involved in its formation. He favored the view that the till on which the pebble band had been formed was the result of an ice sheet from the Keewatin field and equivalent in age to a late phase of the Illinoian drift. He was of the opinion that the time between the retreat of the ice from the Iowan area and the deposition of the overlying loess was comparable to the time between the retreat of the Illinoian ice from southeastern Iowa and the deposition of the loess overlying the Illinoian drift, which loess is of the same age as that overlying the Iowan drift. He would make the Iowan drift the product of a late phase of the Illinoian stage of glaciation and would give the name Sangamon to the interval between the Iowan drift and the overlying loess as well as to the interval between the Illinoian drift and the loess which overlies it.

This interpretation of Leverett's could not be accepted by the writer. The evidence which had been presented by Calvin and later by Alden and Leighton was emphasized in support

of the view that the Iowan drift is young in comparison with the Illinoian and hence should be retained as a separate glacial

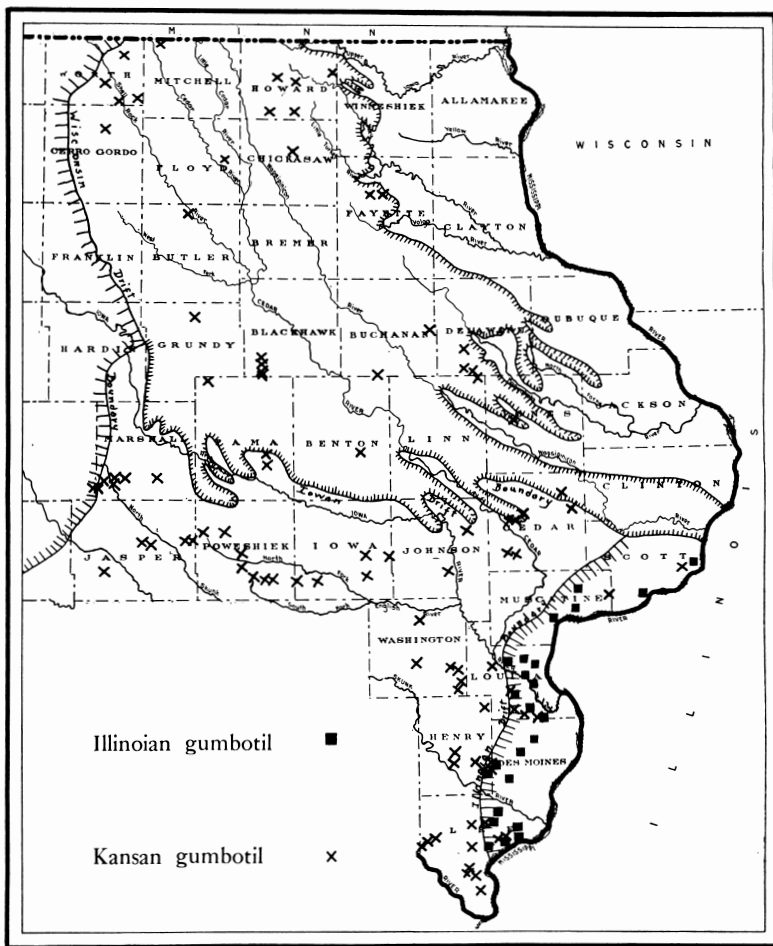


Fig. 4. Map showing locations of known exposures of Kansan gumbotil underlying Iowan till, in the Iowan drift area of northeastern Iowa and underlying Illinoian till in the Illinoian drift area of southeastern Iowa; also the locations of some of the known exposures of Illinoian gumbotil on the Illinoian till.

stage in our classification. It was pointed out that the strongest argument in support of the Iowan drift being younger than the Illinoian drift is the presence over wide areas in south-

eastern Iowa and Illinois of from three to four feet of Illinoian gumbotil on the Illinoian till and beneath the Peorian loess, whereas in the Iowa area the Iowan till is leached only to a depth of a few feet and is so young comparatively that gumbotil has not yet been developed anywhere on this till, not even where the topographic position of the Iowan till is very similar to the topographic position of the Illinoian till, e.g., on the uplands. Fig. 4 shows the locations of known exposures of Kansan gumbotil underlying Iowan till in the Iowan drift area and the Illinoian till in the Illinoian drift area; also the locations of some of the known exposures of the Illinoian gumbotil on the Illinoian till; no gumbotil has been developed on Iowan till.

Suggested Correlation of Iowan with Illinoian Till.

All persons who have done field work in northeastern Iowa in recent years are now agreed that there is in that area a post-Kansan till. Moreover, it has been shown in the past few years that a till of the same age is present in northwestern Iowa west of the border of the Wisconsin till. Members of the Iowa Geological Survey are convinced that the tills of both areas are Iowan and much younger than the Illinoian. Mr. Leverett, however, although he is of the opinion that the tills of the two areas are of the same age, suggests that they should be correlated with the Illinoian till. This viewpoint was expressed in our field conference and later in the paper read before the American Philosophical Society in Philadelphia.¹⁶

This is a most admirably written paper in which the author gives a clear and concise statement of his views of the Pleistocene based upon his many years of detailed study. His interpretations are presented in such a convincing manner that they will carry conviction with all persons who have not been actively engaged in recent years in a critical field study of glacial and interglacial deposits in all their relationships. His discussions of the oldest drift, the Jerseyan or Nebraskan, of the second drift, the Kansan, and of the youngest drift, the Wisconsin, are likely to be accepted without adverse criticism. But the part of Mr. Leverett's paper which is open to attack is that part which deals with "the Iowan drift of northeastern Iowan and its probable correlatives." Before presenting his

¹⁶ Leverett, Frank, The Pleistocene Glacial Stages: Were There More Than Four? Proc. Am. Phil. Soc., 65, No. 2, 1926.

reasons for favoring the correlation of the Iowan drift with the Illinoian drift he states: "If it is granted that the Iowan drift stands for a glacial stage between the Illinoian and Wisconsin stages there were five glacial stages in America." The vital question then is, is the evidence which is favorable to the correlation of the Iowan with the Illinoian of sufficient weight to offset the strong evidence in support of the Iowan and Illinoian being considered as independent stages?

Mr. Leverett in his paper calls to the reader's attention the fact that for some time after the Iowan drift was differentiated from the Kansan drift in northeastern Iowa the opinion prevailed that the widespread loess of the area was aqueous in origin and was of the same age as the Iowan. However, in this connection it should not be forgotten that as early as 1904 the view that was accepted quite generally in Iowa was that the loess is not aqueous but is eolian in origin. From that time to the present it has been the judgment of all persons connected with the Iowa Geological Survey, and others, that the loess is not Iowan in age but was deposited a comparatively short time after the retreat of the Iowan ice. This was the view of Calvin in the later years of his life, and the view which was advanced by Alden and Leighton in their report on the Iowan drift in the 1915 Annual Report of the Iowa Geological Survey.

It is to the interpretation that the loess overlying the Iowan till was deposited but a short time after the retreat of the Iowan ice sheet that Leverett takes exception. It is here that he finds his chief basis for suggesting the correlation of the Iowan till with the Illinoian till. He emphasizes the significance of the pebble band which separates the Iowan till from the overlying loess. The pebble band which was seen by Leverett, MacClintock, Apfel and the writer in the summer of 1925 is described in his paper in some detail. Here he states the judgments which he expressed in the field conference to which reference has already been made. He believes that the pebble band is the result of slope wash rather than of wind action. He thinks that a great length of time was necessary for the development of this pebble band, and hence the loess overlying the pebble band must be very much younger than the Iowan till upon which the pebble band lies.

Leverett states in his paper that the Iowan drift "lies wholly within the limits of what has been termed the Keewatin field of glaciation." And then after having presented some facts

with regard to the growth of ice sheets, particularly with reference to the Wisconsin, he applies the same principles to the method of growth of the Illinoian. He states "It seems but natural that westward growth such as we know affected the Wisconsin ice sheet should also have occurred in the Illinoian stage and given the ice movement that brought in the Iowan drift." Here we have his theoretical grounds for thinking that the Iowan drift should be correlated with the Illinoian.

Mr. Leverett gives but brief consideration to the evidence that has been presented by Calvin, Alden and Leighton, the writer, and others in support of the interpretation that the Iowan and Illinoian glacial stages were widely separated in age. He attempts briefly to explain the lack of gumbotil on the Iowan and in places on the Kansan. The absence of gumbotil on the Iowan could be explained, he believes, by the lack of summit flats. In this connection it should be stated that some parts of the Iowan area have the same topographic position and character as the upland flats of the Illinoian area upon which the gumbotil is found. His reference to lack of gumbotil on the Kansan in northwestern Iowa is without significance since he failed to recognize that the writer and others have presented field evidence to warrant the interpretation that gumbotil was developed on the Kansan till in that area, and that in connection with the development of the present topography in that area the gumbotil was eroded, leaving the oxidized and unleached Kansan till with much secondary calcium carbonate at the surface.¹⁷

In closing his discussion of the Iowan in relation to the Illinoian Leverett states:

"In view of all the features of the Iowan drift, taken in connection with the fact that it stands as the third drift of the western district, as the Illinoian does of the eastern, and that each district has but four drifts, the writer raises the question whether there really were more than four Pleistocene glacial stages in North America, or whether the Iowan drift should be regarded as a late phase of the third glacial stage. Features of the Iowan drift and its relation to the loess seem to demand further critical field study."

¹⁷ Kay, G. F., Pleistocene Deposits between Manilla in Crawford County and Coon Rapids in Carroll County: Iowa Geol. Surv., 26, 218-219, 1917.

Carman, J. E., The Pleistocene Geology of Northwestern Iowa: Iowa Geol. Surv., 26, 332-334, 1917.

It must be kept clearly in mind that Leverett now is suggesting four glacial stages instead of five, not because he questions the existence of the Iowan drift as he did until recently, but for the reason that he believes the Iowan drift may be a late phase of the Illinoian and hence should be correlated with that drift sheet. The task therefore is no longer that of proving whether or not there is an Iowan drift, but of showing even more definitely than has been done thus far the relations of the Iowan drift to the Illinoian drift. Until this has been accomplished there will be confusion in the minds of all persons with regard to a proper classification of the North American glacial deposits, and during this time some persons will reach the judgment quite naturally that four glacial stages should be included in the North American classification and that these four can be correlated with four glacial stages in Europe. This unfortunately has been done already.¹⁸ In recent years H. F. Osborn and Chester Reeds have published several papers in which only four glacial stages are included in their classification of North American glacial deposits.

SIGNIFICANCE OF LOVELAND LOESS.

The writer as a result of recent field studies in the Iowan, Illinoian and other areas of Iowa is now able to present evidence which when combined with evidence already presented would seem to prove conclusively that the Iowan glacial stage is much younger than the Illinoian glacial stage.

The additional evidence is the occurrence of a wide-spread weathered loess, the Loveland loess, which is younger than the Illinoian drift and older than the Iowan drift. In a brief paper now in press the writer¹⁹ states that the relationships of the Loveland loess have been worked out sufficiently definitely by stratigraphic methods in the Iowan and Illinoian drift areas to justify the following conclusion: "The Loveland loess was deposited after the development over wide areas, chiefly by chemical weathering, of a gumbotil more than three feet thick on the Illinoian till. Furthermore, there was sufficient time after the Loveland loess was laid down for this loess to be leached to a depth of several feet before the coming of the Iowan ice sheet."

¹⁸ Hay, O. P., Pleistocene Man in Europe and America: Reprinted from the New York Herald-Tribune of July 1, 1928, with slight changes.

¹⁹ Kay, G. F., Loveland Loess: Post-Illinoian, Pre-Iowan in Age: Science, in press, Nov., 1928.

One of the best exposures showing the Loveland loess beneath the Iowan till of northeastern Iowa is near the middle of the north line of the northeast $\frac{1}{4}$ of section 16, Windsor township, Fayette county. This section was referred to previously in this paper in a discussion of the Iowan till in relation to Kansan gumbotil.

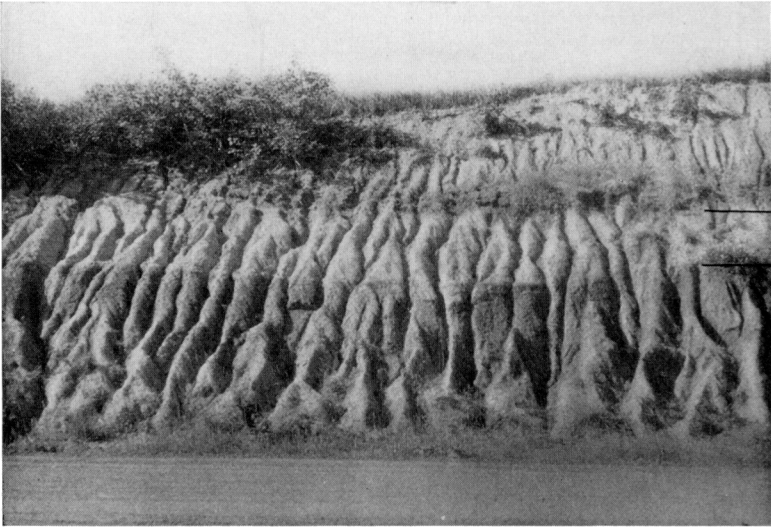


Fig. 5. Road cut near the middle of the north line of the northeast $\frac{1}{4}$, Section 16, Windsor township, Fayette county, showing Loveland loess overlying Kansan gumbotil and underlying Iowan till.

A good section showing the Loveland loess overlying Illinoian gumbotil is in a road cut west of Davenport on Primary road 22. It is less than one mile west of the junction of Primary roads 61 and 22. It is in the south part of section 31, Davenport township, Scott county. The section is as follows:

- | | | |
|----|---|-----------------|
| 5. | Loess (Peorian), buff color, lower part gray and unleached | 8 feet |
| 4. | Loess (Loveland), brown color, leached, some secondary calcium carbonate along joints and root canals | 1 foot 6 inches |
| 3. | Gumbotil (Illinoian) | 3 feet |
| 2. | Till (Illinoian), oxidized and leached | 3 feet |
| 1. | Till, oxidized and unleached to base of cut. | |

Norton in his report on the Geology of Scott County referred to the deposits in the vicinity of Davenport which are now

called Loveland loess as "red loam." Reference was made to these deposits by Leverett also in his monograph on the Illinois Glacial Lobe. In places a soil zone separates the Love-

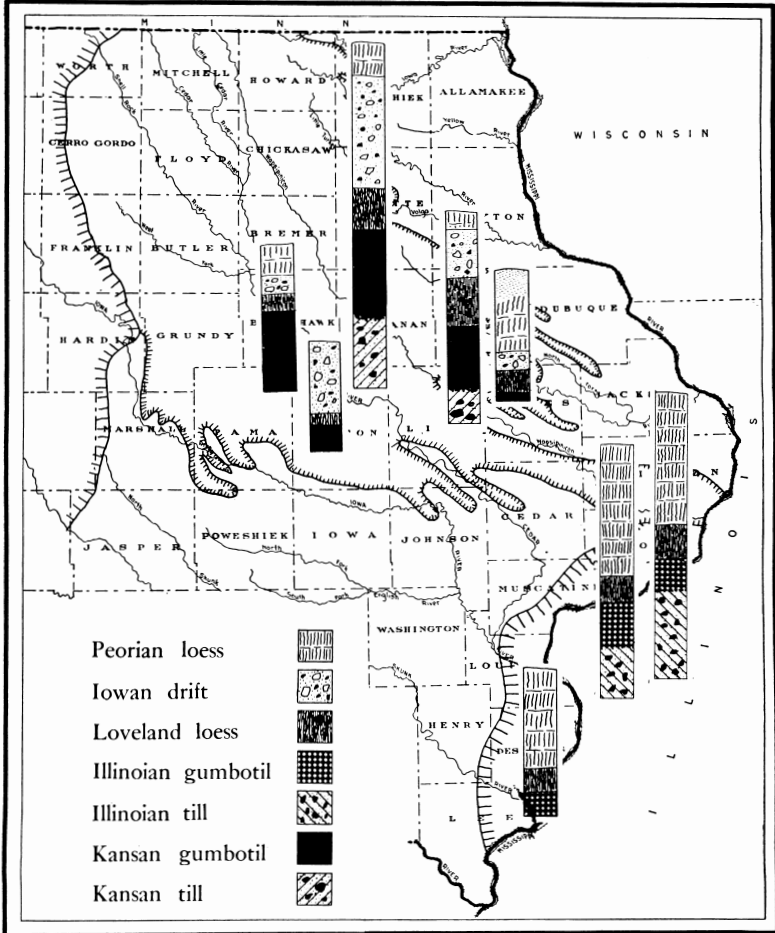


Fig. 6. Shows graphically the relation of the Loveland loess to the Iowan and Illinoian tills in northeastern and southeastern Iowa, respectively.

land loess from the overlying material. In places the Illinoian gumbotil was eroded before the Loveland loess was deposited.

Fig. 6 represents graphically the relation of the Loveland loess to the Iowan and Illinoian tills in northeastern and southeastern Iowa, respectively.

CONCLUDING STATEMENTS.

McGee was the first geologist to describe the till of north-eastern Iowa which for more than thirty years has been called Iowan till. Calvin and his associates on the Iowa Geological Survey studied in detail and mapped the Iowan till in many counties in McGee's type area. Later, when the existence of the Iowan drift was questioned by Leverett, Alden of the United States Geological Survey and Leighton of the Iowa Geological Survey restudied in coöperation the evidences of the Iowan drift, reaching the judgment that there was warrant for continued use of Iowan drift and Iowan stage of glaciation as major sub-divisions of the Pleistocene classification. Still for several years after this time Leverett continued in the belief that the Iowan problem had not been settled. But now he too recognizes that there is Iowan drift.

It is gratifying indeed that a drift about which for many years there was so much controversy as to its existence now has the approval of all geologists who in recent years have studied the field evidence critically. But now there has arisen the question as to whether or not the Iowan drift is distinct in age from the Illinoian drift. Leverett, chiefly on the basis of his interpretation of the significance of the pebble band or thin pebble concentrate on the Iowan till, and on theoretical grounds, suggests the correlation of the Iowan drift with the Illinoian drift. The chief arguments against his interpretation are found in the views of Calvin, Alden and Leighton, and the writer, as expressed in this paper. The strongest of several arguments in favor of a long time interval between the Illinoian and Iowan glacial stages are the occurrence of a gumbotil on the Illinoian in contrast to no gumbotil on the Iowan, and the leached Loveland loess which is post-Illinoian gumbotil, pre-Iowan in age.

The relative ages of the Iowan and Illinoian glacial stages would seem to have been established, and hence five glacial stages and four interglacial stages must continue to be given a place in the classification of the North American glacial deposits. The oldest of these stages is the Nebraskan or Jerseyan, at the surface of the till of which there was developed during the Aftonian interglacial stage a gumbotil with an average thickness in Iowa of more than eight feet. The second glacial stage is the Kansan, on the surface of the till of which there was developed during the second interglacial

stage, the Yarmouth, a gumbotil with a maximum thickness of about fifteen feet and with an average thickness of more than eleven feet. The third glacial stage is the Illinoian. During the third interglacial stage, the Sangamon, a gumbotil was developed widely on the Illinoian till to a depth of more than three feet, and later a loess, the Loveland loess, was deposited over the Illinoian gumbotil and older Pleistocene deposits. This loess in places was leached and a soil formed on its surface before the close of Sangamon time. The fourth glacial stage is the Iowan, now well determined in northeastern and northwestern Iowa. Its characters are just as distinctive as are the characters of other glacial stages. The fourth interglacial stage is the Peorian. During this stage the Iowan till was leached to an average depth of less than five feet. Apparently the widespread Peorian loess was laid down by wind action very soon after the retreat of the Iowan ice, and hence is early Peorian in age. The evidence indicates that the Peorian interglacial stage was by far the shortest of the interglacial stages. The youngest glacial stage is the Wisconsin. The writer wishes to remark that if there be any merit in having four glacial stages rather than five then the two stages which are related the most closely in age are the Iowan and Wisconsin. Peorian loess, which is the most distinctive interglacial material separating the drifts of these two stages, is in part related closely both genetically and in age to the Iowan and, moreover, this loess was not changed greatly by weathering before the coming of the Wisconsin ice sheet. However, at present it seems best to continue to treat the Iowan glacial stage as a stage independent from the Wisconsin. And it has been shown that there is no adequate basis for correlating the Iowan stage with the Illinoian stage.

UNIVERSITY OF IOWA.
IOWA CITY, IOWA.