The University of Chicago

THE PLEISTOCENE HISTORY OF THE LOWER WISCONSIN RIVER

A DISSERTATION

SUBMITTED TO THE FACULTY
OF THE OGDEN GRADUATE SCHOOL OF SCIENCE
IN CANDIDACY FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

DEPARTMENT OF GEOLOGY

BY

PAUL MacCLINTOCK

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THE PLEISTOCENE HISTORY OF THE LOWER WISCONSIN RIVER[1]

PAUL MacCLINTOCK
University of Chicago

INTRODUCTION

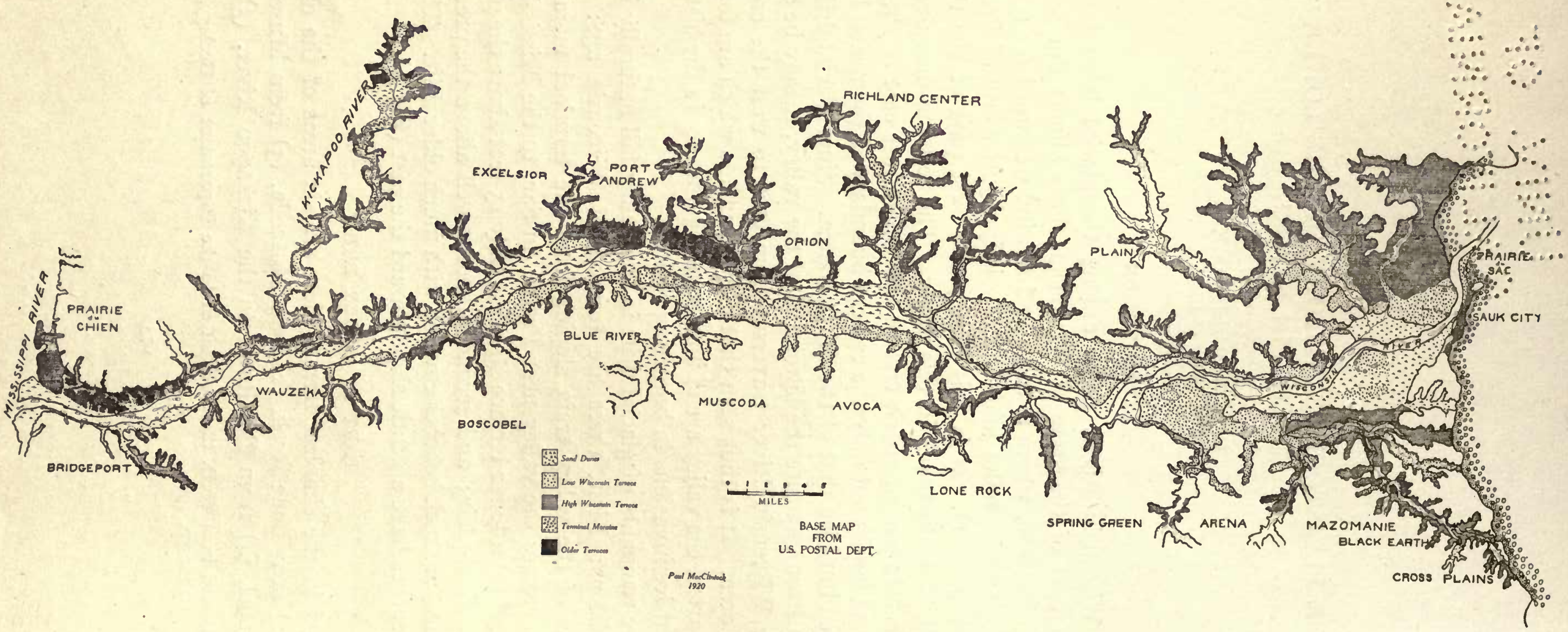
The Wisconsin River, rising among the glacial lakes in the northern part of the state of Wisconsin, flows almost due south nearly to Portage, where it turns and flowing westward for a distance of about 80 miles joins the Mississippi just south of Prairie du Chien (Fig. 1). It is this lower, east-west part of the river valley which is discussed in this paper. The terminal moraine of the Wisconsin glacial epoch crosses the valley just east of Prairie du Sac and marks not only the eastern boundary of the region here considered but also that of the driftless area. Since glacial drift is found in Iowa opposite the lower end of the valley, it may be said that the Wisconsin River traverses from east to west the entire driftless area. It is thus seen that drift remnants which are found in this part of the valley are of important significance in the history of ancient ice invasions in bordering regions.

These remnants of glacial drift in the valley fall naturally into two divisions: First, there are terraces of Wisconsin age: (*a*) remnants of the valley train sloping from the terminal moraine, where it crosses the valley near Prairie du Sac, to the Mississippi River, and (*b*) a lower terrace standing only 15 feet above the present river flood-plain; and second, standing well above the preceding terrace, are rock benches covered with much older drift. These upper benches have a gentle slope toward the east (Fig. 2).

PART I. OLDER DRIFT

Stated in the simplest terms, there are six areas of the older drift: (1) near Lone Rock, (2) near Muscoda, (3) from Muscoda to Boscobel, (4) from Boydtown to the Kickapoo River, (5) at

[1] Condensed from Ph.D. thesis submitted to the Department of Geology, the University of Chicago, 1920.



MISSISSIPPI RIVER
PRAIRIE du CHIEN
BRIDGEPORT
WAUZEKA
KICKAPOO RIVER
BOSCOBEL
EXCELSIOR
PORT ANDREW
BLUE RIVER
MUSCODA
ORION
AVOCA
RICHLAND CENTER
LONE ROCK
PLAIN
SPRING GREEN
ARENA
WISCONSIN RIVER
MAZOMANIE
BLACK EARTH
CROSS PLAINS
SAUK CITY
PRAIRIE du SAC
Sand Dunes
Low Wisconsin Terrace
High Wisconsin Terrace
Terminal Moraine
Older Terraces
MILES
BASE MAP FROM U.S. POSTAL DEPT.
Paul MacClintock 1920

FIG. 1

Wauzeka, (6) at Bridgeport. The first four of these are similar in topography, constitution, and amount of weathering, while the last two differ from the others in that they contain not only much striated material (at Bridgeport) but also a large percentage of calcareous material.

I. SUBDIVISION

It appears from the evidence that the older drift is not all of the same origin or age.

a) A lithologic study of some 300 characteristic rock specimens collected from the different exposures, and examined in the laboratory, shows 37 common to Wauzeka and Bridgeport, 17 common to

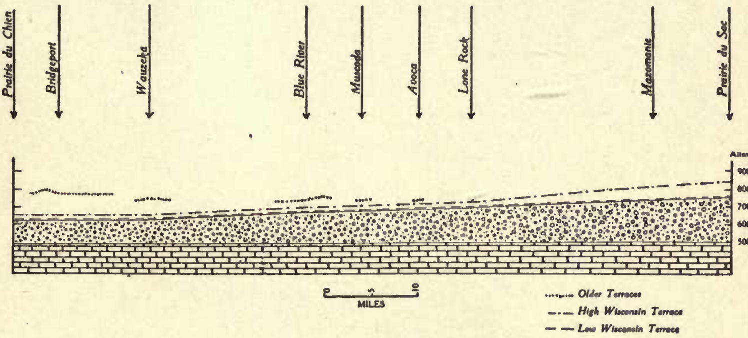


FIG. 2.—Profile of the Wisconsin River Valley from Prairie du Sac to Prairie du Chien showing the bedrock, the drift partly filling the valley, and the levels of the three terraces.

Orion (Port Andrew) and the nearest Illinoian drift at Verona, 9 miles southwest of Madison, 27 common to Orion and Wauzeka, and 25 common to Bridgeport and Iowa (near McGregor). These facts show that there is close similarity between the drifts of Illinoian age and that at Orion on the one hand, and between the drift at Wauzeka, Bridgeport, and Iowa on the other.

b) The drift at Wauzeka and Bridgeport contains much limestone and dolomite, while farther up the valley there is neither. Since the Illinoian and pre-Illinoian drifts east of the region contain calcareous material, it is likely that these terrace deposits in the mid-course of the valley originally contained the carbonates which have been subsequently leached.

c) There is well-developed cross-bedding at Blue River dipping westward, while at Wauzeka, less well-developed but still recognizable cross-bedding in sandy layers dips eastward (Fig. 3).

d) While there are numerous bowlders in the drift of the mid-course of the valley, there are more to be seen at Wauzeka and Bridgeport.

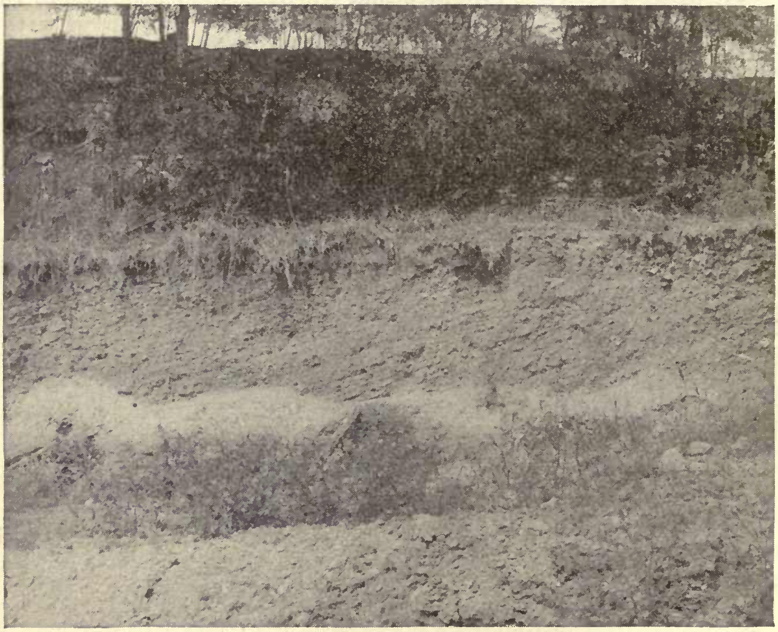


FIG. 3.—Westward dipping gravel on the high terrace two miles northeast of Blue River.

e) On the Bridgeport terrace the stones are not only more angular than elsewhere in the valley, but numerous subangular and striated ones are found. In fact these glaciated stones are as numerous on this terrace as in the till either in Iowa or at the eastern end of the region.

The suggestion from this evidence is that the drift in the mid-course of the valley is fluvio-glacial and from the east, while that at Bridgeport is glacial, and that at Wauzeka is fluvio-glacial and both the latter are from the west.

2. MID-COURSE DRIFT

a) *Origin.*—The cross-bedding at Blue River makes it evident that the drift in the mid-course was brought in from the east (Fig. 3). This being the case, the upper surface of these terrace deposits should slope conspicuously toward the west, for, while large bowlders so common in most of the exposures may have been carried in bergs, the mass of the material is fluvial and must have been transported by a glacial river—a river having powerful current and fairly steep gradient. A steep gradient may well be postulated for such a glacial river, for there appears, if the bedrock floor of the valley be considered, to have been down-warping at the eastern end of the region. The bedrock in the valley bottom near Prairie du Sac has an altitude of something less than 500 feet,[1] while at Prairie du Chien, near the mouth, its altitude is 490 feet, making a gradient of only two inches to the mile (Fig. 2). The preglacial river with so low a gradient as this could not have eroded so deep and narrow a valley as the rock bottom of this part of the Wisconsin Valley appears to be. The unavoidable inference is that the eastern end of the region must have been higher in preglacial and possibly early glacial times, and must have subsided before the last glacial advance. Data from neighboring regions also suggest that such warping has taken place.[2]

b) *Age.*—Old drift has been described on the eastern margin of the driftless area by Leverett, Weidman, and Alden,[3] and called by them pre-Illinoian in age. The absence of calcareous material in the old drift in the mid-course of the Wisconsin Valley, even where seen 10 and 12 feet below the surface, suggests that it is as old as Kansan and probably older, i.e., the outwash from the first ice advance.

3. WESTERN DRIFT

a) *Origin.*—The drift on the Bridgeport terrace must be either glacial or fluvio-glacial in origin. The large number of striated and

[1] W. C. Alden, *U.S. Geol. Surv. Prof. Paper 106* (1918), Plate II.

[2] W. C. Alden, *op. cit.;* F. Leverett, *Journal of Geology*, Vol. III (1895), p. 740; E. W. Shaw, *Bull. Geol. Soc. Amer.*, Vol. XXVI (1914), p. 67.

[3] F. Leverett, *U.S. Geol. Surv. Monograph 38* (1899), pp. 109–10; S. Weidman, *Wis. Geol. Surv., Bull. 16* (1907), p. 433; W. C. Alden, *op. cit.*, p. 168.

subangular stones found nowhere else in the outwash material of the valley, together with the patchy character of the drift, suggests deposition directly by the ice. If this view is correct the glacier must have extended from Iowa across the Mississippi into the lower end of the Wisconsin Valley.

On the other hand, at no place where this older drift occurs was a glacial pavement seen. The drift lies in most places on deeply eroded and weathered dolomite, while at other places several inches of blue-black clay, weathered from the bedrock, lies at the base of the brown drift. It is not strange that, in exposures so limited, no pavement was seen; none has been found in Iowa in this vicinity, where the ice is known to have stood to the very edge of the Mississippi Valley. It seems probable that if a tongue of ice projected into the Wisconsin Valley for a distance of 4 miles—a condition called for by this hypothesis—it would have been at least as wide as the mouth of the valley (1½ miles) so that its shoulders would have rested against the valley walls near the mouth, and have left there glacial material. Some material of this kind is seen for a distance of 1½ miles north of the lower end of the Wisconsin Valley. It is however small in size, meager in quantity, and found not strictly on the shoulders but on the lower slopes at heights of never more than 100 feet above the flood-plain. Glacial material on slopes so steep as the shoulders present would not have remained there but would have soon been washed to the flat below.

The crucial points are: (1) the Bridgeport drift is much higher in altitude than any of the older drift farther up the valley, (2) it is composed of striated, subangular, and grooved material, and (3) it is both stratified and unstratified—the latter material indistinguishable from till. The conclusion then is that this drift is glacial in origin and was deposited by a tongue of ice. It seems clear that the drift at Wauzeka is the outwash material from the same ice invasion, for it is closely akin to the Bridgeport drift in many ways, has the lense and pocked structure of outwash material, and has a suggestion of eastward dipping cross-bedding (Fig. 4). None of this calcareous drift is found farther up the valley because the decline of this old valley train would have brought its top below the level of the rock benches where drift is now found.

This hypothesis involves a damming of the Mississippi River by the ice tongue at the mouth of the Wisconsin. Under this condition the Mississippi must then have flowed between this ice tongue and the northern wall of the Wisconsin Valley and thence eastward to the Rock River or more probably the Lake Michigan Basin. Such an eastward flowing river, if the bedrock divide near Portage had about the present altitude of 600 feet,[1] would have

FIG. 4.—View of the outwash material on the high terrace at Wauzeka showing lenses of sand in the gravel.

had a gradient of about 2.5 feet per mile, or a foot per mile greater than that of the present Wisconsin River. This suggests that the down-warping of the eastern part of the area, mentioned above, had already taken place. It seems, in fact, quite probable that this eastern part of the region was lower than it is at present, for post-Champlainic uplift and warping in the Great Lakes area probably raised the divide from some lower elevation to its present altitude. Since such down-warping as first mentioned has been found in

[1] W. C. Alden, *op. cit.*, Plate II.

neighboring regions, it seems well to note it here, and by so doing possibly to fix the date of the warping—after the first ice invasion at the east of the area and before the second invasion on the west.

Additional evidence of such a displacement of the Mississippi might be expected in old channels. In the eastern part of the valley, Wisconsin glaciation has destroyed any possible trace, while at the west the river was either displaced for so short a time, or subsequent erosion has been so great that there is no evidence of a channel occupied during the displacement. No channel is found in Jo Daviess County, Illinois, where a similar tongue of ice pushed across the Mississippi Valley from Iowa and left drift near Hanover.[1]

b) *Age.*—Two drift sheets, the Kansan and the pre-Kansan, are thought to be present in Iowa near the mouth of the Wisconsin River.[2] The western drift in the Wisconsin Valley must be correlated in age with one of these. The former drift sheet is less weathered than the latter, which is represented, according to present determinations, only by scattered and very much weathered erratics. Judging from the thickness (20 to 50 feet), and from the large content of limestone and dolomite, it seems most probable that the Bridgeport and Wauzeka drift is of Kansan age.

PART II. WISCONSIN DRIFT

1. The terminal moraine of the last glacial invasion extends southward from the Baraboo Range, crossing the Wisconsin River $1\frac{1}{4}$ miles northeast of Prairie du Sac. On the south side of the river it maintains a southerly direction to Black Earth Creek which it crosses $1\frac{1}{4}$ miles east of Cross Plains. North of the river this moraine is a belt showing morainic topography, while south of the river it is in most places a narrow distinct ridge strewn with bowlders. Where it crosses the river the section shows 60 feet of cross-bedded sand with small lenses of fine gravel, overlain, with a sharp contact, by 30 feet of till. The sharp contact shows no weathering. This sand may be outwash from an early Wisconsin moraine farther east or may be the outwash deposited in front of the advancing late Wisconsin ice.

[1] E. W. Shaw and A. C. Trowbridge, *Ill. State Geol. Surv. Bull. 26* (1916), p. 87.

[2] A. C. Trowbridge, *Bull. Geol. Soc. America*, Vol. XXVI (1914), p. 76.

2. Sloping gently westward from the moraine north of the river a sandy outwash plain extends to an irregular boundary against the sandstone hills of the country rock. The western edge is irregular, for the fluvio-glacial material is found up the valleys of Honey and Otter creeks. Of special interest are the erratics found in the south branch of Honey Creek as far west as Blackhawk and Plain. They lie on an upper terrace, corresponding in elevation to that of the outwash plain across the mouth of the creek at its eastern end. This position, 17 miles beyond the terminal moraine, implies that the bowlders were carried to their positions while frozen in blocks of ice floating on a lake.

Such a lake may have been formed in one of two ways:

a) The edge of the ice may have extended beyond the terminal moraine and dammed the mouth of Honey Creek. No evidence was found to substantiate this possibility.

b) As the outwash plain was being built, the glacial waters issuing from the ice-front between Prairie du Sac and the South Range swept their load southward across the mouth of Honey Creek. Outwash material may thus have dammed the mouth of Honey Creek, forming a lake upon which icebergs may have floated the bowlders. While this suggestion involves the difficulty of getting the bergs swept across the outwash plain and into the lake, it still seems the more probable of the two.

3. The valley train, now represented by terrace remnants, once filled the bottom of the valley from the terminal moraine to the Mississippi River. It was 90 feet above the present flood-plain near the terminal moraine, 30 feet in mid-course, and 40 feet at the western end of the valley. As this outwash deposit was growing, the glacial waters constantly deposited material across the mouths of the tributary valleys, causing them in turn to aggrade their channels. Terrace remnants of these slack-water deposits are to be seen in most of the tributary valleys, serving to project the level of the valley train even where it has been removed from the main valley by subsequent erosion.

The most easterly remnant of the original valley train lies near Mazomanie at the mouth of Black Earth Creek. It is an irregular area a mile wide by 6 miles long, separated from the south bluffs by Black Earth and Halfway Prairie creeks. The surface of this area is gently rolling and marked here and there by patches of low sand dunes. This terrace level extends eastward into Black Earth and Halfway Prairie valleys while the two intervening shorter valleys have this high fill only at their very mouths. This relationship is of importance in connection with the problem, later to be considered, of the age of the terrace.

From Mazomanie for a distance of 30 miles to the west, the upper part of the valley train has been entirely removed from the main valley. The terrace level is, however, present in most of the tributary valleys; notably Blue Mounds, Wyoming, Otter, Pine, Eagle, and Kickapoo creeks. But there are several tributary valleys (see Fig. 1) lacking this terrace level, a fact whose significance is later to be considered.

The remnants of this level, the high Wisconsin terrace, are again found in the main valley near Muscoda and Blue River where the bench is protected by a subjacent ledge of sandstone against which the river is at several places flowing. At Boscobel a large terrace remnant lies against the south wall of the valley. In these latter terrace patches the material is smaller in size and contains fewer limestone pebbles than farther up the valley.

4. Twelve to 15 feet above the Wisconsin River flood-plain and extending short distances up the valleys of many of its tributaries there is an extensive sandy terrace—the low Wisconsin terrace. From the terminal moraine at Prairie du Sac to Wauzeka, a distance of 65 to 70 miles, it is nearly continuous in the main valley on one side of the river or the other, while from Wauzeka to the Mississippi it occurs only in small detached areas. Remarkable uniformity in height above the river is one of its most notable characteristics, for the variation is not more than a foot or two throughout the whole distance. A second notable feature is that the material, where seen in shallow cuts, is uniform in size and constitution through the whole length of the valley, being mostly sand with small pebbles scattered rather uniformly through the mass. The surface of this terrace is in general very flat, but in detail it is seen to have irregularities produced by the wind, such as sand dunes and "blow-holes." Considerable dune areas are found in the neighborhood of Lone Rock and Spring Green. In fact, the whole terrace is so

sandy and so poor as farm land that it is called locally "Prairie" or "Barrens."

There are three possibilities to be considered in discussing the origin of the low terrace: It is either the valley train of the late Wisconsin ice advance or was cut from the early Wisconsin valley train by waters from a glacial lake, or is a combination of the two.

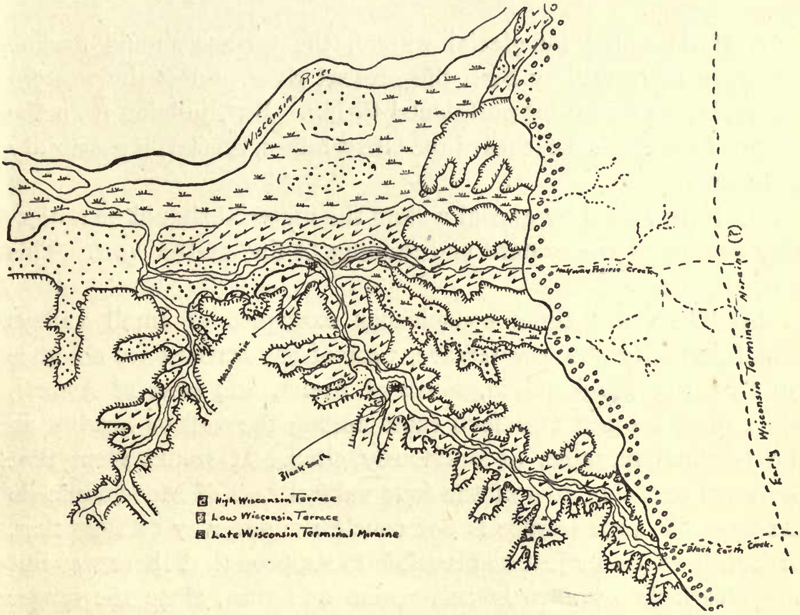


FIG. 5—Diagram showing the relation of the terraces in the four valleys east of Mazomanie. Black Earth and Halfway Prairie creeks contain the high terrace while the two shorter valleys do not.

a) Alden is of the opinion that the low terrace is the result of deposition by glacial waters from the late Wisconsin invasion, while the upper terrace resulted from the early Wisconsin advance.[1] The evidence is as follows: Of the four small valleys east of Mazomanie, the two longer ones contain the upper terrace while the shorter ones do not.[2] This, Alden interprets as meaning that the ice of the early Wisconsin invasion did not reach the heads of the shorter valleys, discharging its waters only through the longer ones and building in them the high terrace (Fig. 5).

[1] W. C. Alden, *op. cit.*, pp. 191–93 and 244–45.

[2] The northern one does contain several small patches (see Fig. 5).

Following the retreat of the early Wisconsin ice came a period of erosion during which part of the fill was cut away. The late Wisconsin ice advanced farther and stood across the heads of all four valleys, building valley trains at the level of the low terrace. At the same time the low terrace was being built in the main valley.

Evidence adverse to this suggestion must be summarized under several heads:

i) If deposited by glacial waters, the terrace should decline westward more rapidly than the present river, unless the western end had been raised by postglacial tilting. But, judging from the tilting of the glacial beaches of the Great Lakes, this latter possibility is unlikely.

ii) If deposited by glacial waters the material should be noticeably coarser at the eastern end grading to fine at the west. This is not the case.

iii) There are three conspicuous examples of small valleys containing only the low terrace, west of the farthest ice advance (just west of Black Earth, south of Arena, and west of Avoca), while there are but two such cases among the valleys heading in the terminal moraine, as previously cited. It would seem that the mere fact that two of the four valleys east of Mazomanie do not have the high terrace is not conclusive one way or the other. In fact, it would be just as plausible to suppose that there was but one Wisconsin advance in this region and that, since the longer valleys drained the ice both earlier and later than did the shorter ones, they received more outwash, and so were more aggraded. The thin terminal moraine crossing the valleys means a short stay of the ice-edge at this place, or poverty of débris in the glacier.

iv) No evidence was seen of weathering of the stratified drift underlying the till of the terminal moraine, as would be expected somewhere in the region if it were early Wisconsin and the till were late Wisconsin, since this interglacial interval is considered by many to be fairly long. The stratified drift may as well be outwash deposited by waters which flowed out in advance of the oncoming ice.

v) The evidence from the larger amount of leaching of the outwash plain, suggested by Alden and Weidman,[1] as showing that

[1] W. C. Alden, *op. cit.*, p. 192.

the high terrace is older than the terminal moraine and outwash of the low terrace, was not verified. For cuts on and directly west of the moraine show about the same amount of leaching as do the exposures farther west on the high fill.

vi) The high terrace marks a time of great filling, while the low one is much less important in this respect. Evidence from other regions has led to the generalization that the ice of the late Wisconsin substage was the most energetic of all the ice advances, building higher and more rugged moraines; eroding more deeply and more conspicuously; dumping more sediment into the drainage lines leading away from the ice-front, and so building larger valley trains. This line of evidence would point rather to the late Wisconsin than the early Wisconsin substage as the builder of the high terrace.

vii) Since erratics in Honey Creek Valley rest only on the high Wisconsin terrace, it seems clear that a glacial lake stood in this valley during at least part of the time when the slack-water fill of which these terraces are remnants was being deposited. It would be inferred that the lake was dammed during the maximum extent of the ice, rather than when the ice-edge stood farther east, as it did in early Wisconsin time if the early Wisconsin ice affected this immediate region. This piece of evidence suggests that the high Wisconsin fill in Honey Creek Valley was deposited when the ice-front stood at least as far west as Prairie du Sac.

The weight of this evidence is seriously against the possibility that the low terrace was deposited as a valley train of the late Wisconsin invasion.

b) When the ice-front of the Green Bay lobe had withdrawn east of the Portage divide, the ice-dammed lake, Jean Nicolet,[1] was formed with its outlet down the Wisconsin Valley. These outlet waters were clear, and probably cut the upper part of the valley train down to the level of the low terrace. Evidence that the low terrace was cut by waters from Lake Jean Nicolet follows.

i) The uniform height, 12 to 15 feet, of the terrace above the flood-plain all the way from the terminal moraine to the mouth of the valley, suggests strongly an erosional rather than a depositional origin.

[1] W. Upham, *Amer. Geologist*, Vol. XXXII (1903), p. 330.

ii) The material, in at least the upper few feet of the terrace, throughout the length of the valley is uniform in size, shape, and structure. The river having a uniform gradient would handle sediment of uniform size through its whole length. This would result in the coarser material in the eastern part of the high terrace, when cut by these outlet waters, being buried below several feet of finer re-worked material covering the low terrace.

iii) Its similarity to the Brule–St. Croix outlet of Lake Duluth is noticeable. This latter is also a broad sandy plain with dunes and blowholes upon its surface.[1]

iv) The low gradient, 1.75 feet per mile, for so large a volume of water, would favor a wide rather than a deep cut.

Against this mode of origin the following points may be registered:

i) It would be expected that the upper few feet of the terrace would be re-worked by the running water and the material therefor assorted. But this is, as a rule, not the case, for the pebbles are scattered indiscriminately through the sand.

ii) Weidman states, in relation to the Brule–St. Croix outlet that ". . . . Aside from cutting down a few drift dams that lay across the outlet, there was not much erosion."[2] It is possible, then, that there was not enough cutting by the waters of Lake Jean Nicolet to cut the upper terrace to the level of the lower one. However, the rapidity of cutting, depending upon the volume and the velocity of the river as well as the kind of material cut, may not have been the same in the two cases. So the slight amount of cutting of the Brule–St. Croix outlet would not carry a necessary implication against great cutting in the Wisconsin Valley.

iii) The relation of the terraces in the four tributary valleys just east of Mazomanie, previously discussed, is significant but not conclusive.

From the weight of this evidence, the low terrace appears to be a degradational level cut by waters from the glacial lake.

c) A third suggestion presents itself which combines the first and second in such a way as to obviate many of the difficulties

[1] Moses Strong, *Geology of Wisconsin*, Vol. III (1880), p. 387.

[2] Samuel Weidman, personal communication.

inhering in each. With the advance of the early Wisconsin stage, the outwash valley train was deposited. During the subsequent period of ice withdrawal, the pounded waters of the Fox River Valley flowed across the Portage divide and down the Wisconsin Valley, cutting away a large part of the valley train. This period must have been rather long, or erosion excessively rapid by a large and powerful river, for more erosion took place then than has taken place since the last withdrawal of the ice. This would not appear to be improbable, for, during this partial withdrawal, the ice may have dammed the lake for a much longer period of time than it did in the final deglaciation. Then when the late Wisconsin ice advanced to the region of Prairie du Sac, the outwash partially filled the channel cut below the early fill. Later, as the ice withdrew, the lake was again dammed east of the Portage divide and the waters flowed westward down the Wisconsin Valley, cutting the lower fill to the level of the low terrace. This would involve less cutting at any one stage than the first suggestion, and at the same time would allow the terrace to stand, as it does, at a constant elevation above the present river level, for the waters from the lake probably would cut to the same gradient as do those of the present Wisconsin River.

While the hypothesis of two Wisconsin advances will explain the presence of the high terrace in two of the valleys east of Mazomanie and its absence from the other two, it will not account for the absence of this high terrace in the tributaries farther down the Wisconsin River. And since it is evident that the former case can be explained on the basis of one advance into this region, the idea of two ice invasions in Wisconsin time may be discarded as needless.

SUMMARY

The terraces of Wisconsin age may be best explained on the hypothesis that they are connected with one glacial advance—that of the late Wisconsin ice-sheet—and that the lower terrace was cut from the higher by waters issuing from Lake Jean Nicolet.

PART III. THE PLEISTOCENE HISTORY

The first glacial invasion in Pleistocene time advanced on the eastern side of the region to a position somewhat east of the Wisconsin terminal moraine. The eastern end of the region at this time stood relatively higher than it does now, so that the glacial waters flowing down the Wisconsin Valley had a steep gradient and transported coarse débris. The glacial drainage from at least a hundred miles of ice-front to the north must have flowed southward to the vicinity of Portage, and then westward down the Wisconsin River. In its course, along the ice margin, the river must have cut against the edge of the ice, at least in places, and must have broken off blocks of débris-laden ice, floating them into the Wisconsin Valley. Here many of them must have grounded and, upon melting, have deposited their loads. The adequate source of bergs, the abundant supply of glacial material, and the swift and powerful glacial river seem sufficient to account for the older drift deposited on the terraces of the mid-course of the valley. After the ice had stood long enough to build a valley train to a height of at least 75 feet above the present flood-plain in the mid-course of the valley, it withdrew and erosion cut away the valley train till all that remained were the terrace remnants on rock benches along the sides of the valley. It is not known how deeply this erosion progressed, but probably the valley was largely re-excavated.

At some time after this first valley train was built and before the next glacial advance, the eastern end of the region was depressed relative to the western end. A depression of 150 to 250 feet would not have been unlikely and would account for the phenomena observed.

The Kansan ice advanced across Iowa, crossed the Mississippi River in the neighborhood of Prairie du Chien, and projected a tongue of ice into the lower end of the Wisconsin Valley. The Mississippi was dammed, diverted into the Wisconsin Valley, and flowed eastward, carrying with it not only great quantities of coarse and fine outwash material, but abundant icebergs broken from the ice-front farther north as it encroached upon the Mississippi Valley. An eastward sloping valley train of coarse material was built. When the ice withdrew, erosion cut away the moraine and valley train, save where remnants are left on rock benches at Bridgeport and Wauzeka. The depth of this erosion is not known accurately, but the valley was probably again re-excavated to about its maximum depth.

There are no terraces in the valley which correspond in age to the Illinoian drift found at the eastern end of the region, so the assumption is that the outwash from this glacial advance did not fill the valley high enough to be above the present surface of the river. The evidence of five well records[1] shows that at one time the valley floor stood, in the main and also the tributary valleys, 30 to 50 feet below its present level long enough to accumulate a bed of peat. It is probable that the outwash from the Illinoian invasion filled the valley only to this level, 30 to 50 feet below the present surface. Then ensued a period during which the vegetation accumulated on the swampy surface of this outwash.

During the Iowan epoch loess was blown on to the western part of the area, burying the drift with a blanket of eolian material.

In Wisconsin time not only the moraine at Prairie du Sac, but the valley train in the Wisconsin Valley, was deposited. As the ice withdrew east of the divide near Portage, ponding produced a lake which drained westward down the drift-filled Wisconsin Valley. This was for a time the main drainage for at least a hundred miles of ice-front lying toward the north, consequently a large quantity of clear water flowed down the valley. The upper part of the fill was largely cut away, leaving remnants which now constitute the upper terrace in the Wisconsin Valley. The down-cutting river reached grade at the level of the top of the lower terrace.

After the ice had withdrawn and the glacial lake was drained, the postglacial Wisconsin River cut away large parts of the lower terrace to form its present flood-plain.

[1] Well records which show peat 30 to 50 feet below the surface; fair grounds at Richland Center; schoolhouse 1½ miles northeast Richland Center; Bear Creek ¾ mile north of junction with Little Bear Creek; Little Bear Creek ½ mile north of junction with Bear Creek ¼ mile southwest of Leland.