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CLASSIFICATION OF THE WISCONSINAN STAGE IN THE LAKE MICHIGAN GLACIAL LOBE

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ABSTRACT

The revised time-stratigraphic classification of the Wisconsinan Stage of the Lake Michigan lobe as used by the Illinois State Geological Survey consists of the following substages in descending order: Valderan, Twocreekan, Woodfordian, Farmdalian, and Altonian. Extrapolation from presently available radiocarbon dates suggests that Wisconsinan time started 50,000 to 70,000 radiocarbon years ago and terminated approximately 5,000 radiocarbon years ago. More than half of this time falls within the Altonian, the oldest of the substages. New rock-stratigraphic names introduced are Roxana silt, Morton loess, and Richland loess. A new category of units based on surface form of the deposits is introduced as morphostratigraphic classification.

GENERAL STATEMENT

New data, derived largely from radiocarbon dates and from detailed stratigraphic studies during the past few years, require a reconsideration of the time-stratigraphic classification of the Wisconsinan Stage in the region of the Lake Michigan glacial lobe. The former classification of this stage as used by the Illinois State Geological Survey is, in descending order, as follows: Mankato, Cary, Tazewell, Iowan, and Farmdale. As shown in figure 1, the revised classification of the Illinois Survey, in descending order, consists of the following substages: Valderan, Twocreekan, Woodfordian, Farmdalian, and Altonian.

Among the new data and concepts that have led to this reclassification, the following are of prime importance:

1) Radiocarbon dates (Ruhe, Rubin, and Scholtes, 1957; Ruhe and Scholtes, 1959) indicate that the till of the type Iowan of Iowa is older than the type Farmdale of Illinois rather than younger. This reverses the relative position of these two units, but the dates from the Iowan till are greater than 35,000 years and do not define the age of the till or indicate its placement within the Illinois glacial succession.

2) In the middle and lower parts of the Illinois River Valley and in the Mississippi River Valley of southern Illinois, a few radiocarbon dates and detailed stratigraphic work by us and A. Byron Leonard demonstrate the presence of extensive deposits much older than and genetically distinct from type Farmdale.

3) In extreme southern Wisconsin, Black (1958) has reported a radiocarbon date from till, generally agreed to belong within the Wisconsinan glacial stage, that is older than type Farmdale.

4) Radiocarbon dates indicate that the till in the type area of the Mankato is older (Wright and Rubin, 1956; Ruhe and Scholtes, 1959) than the Valders till and Two Creeks forest bed of Wisconsin, rather than equivalent in age to the Valders till as previously correlated.

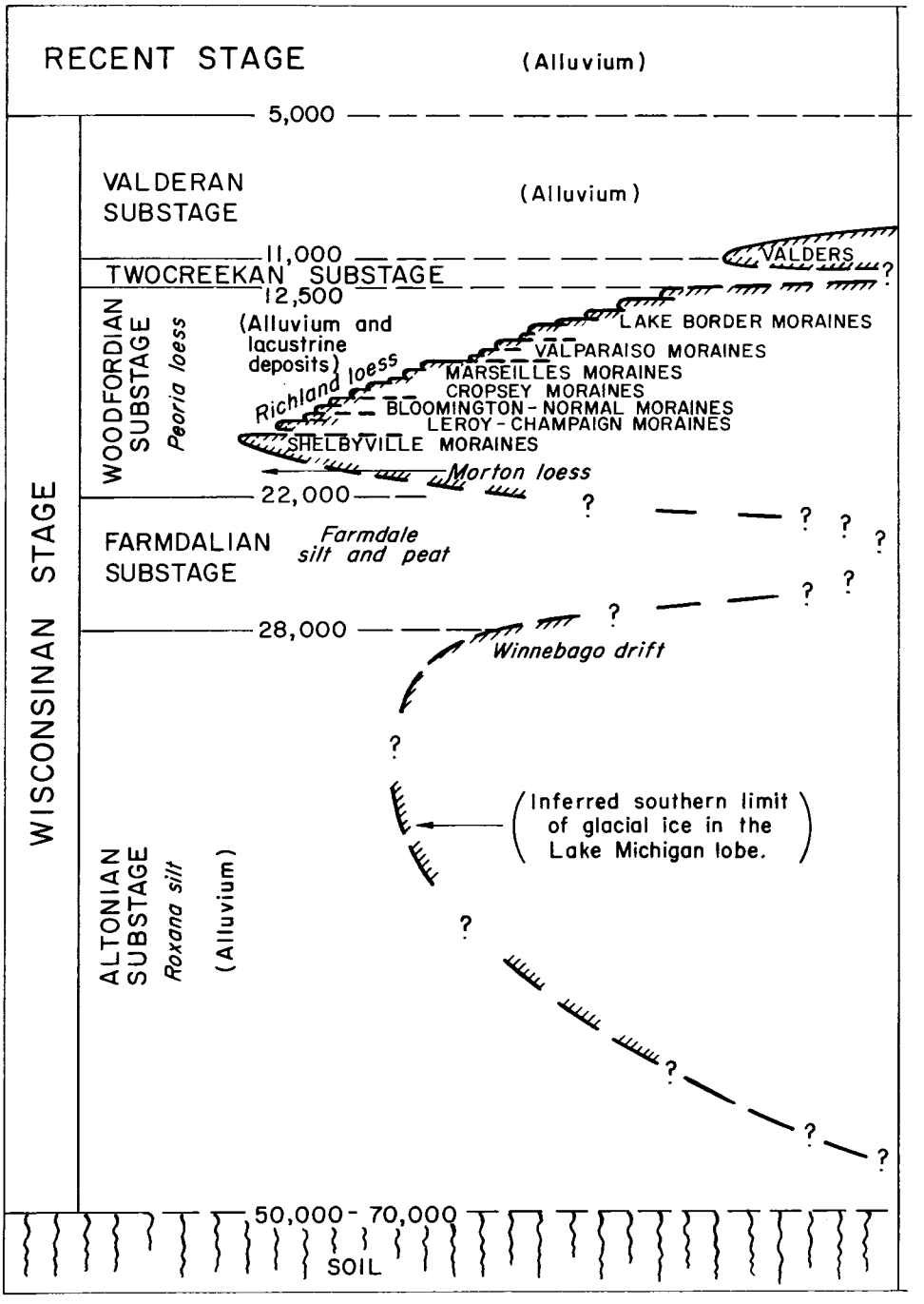
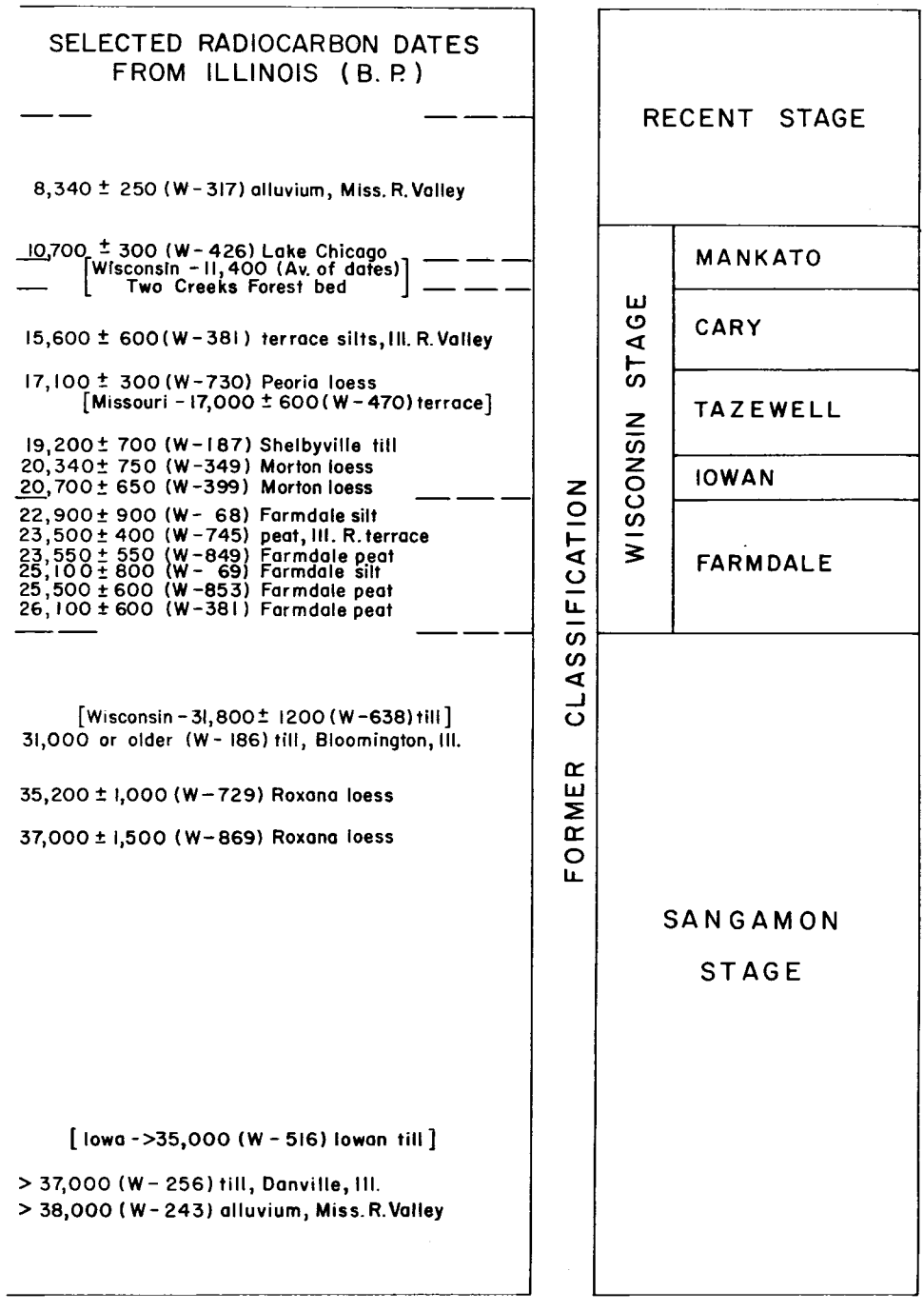


Fig. 1. Time-stratigraphic subdivision of the Wisconsinan Stage in the Lake Michigan glacial lobe. Names in italics are rock-stratigraphic units, and named moraines are morphostratigraphic units. Only part of the named moraines in Illinois are shown. The inferred limit of glacial ice through time is shown diagrammatically on a vertical scale



in radiocarbon years. The base of the Wisconsinan is plotted at 55,000 B.P. (Before Present), however, it is judged to be at least 50,000 and perhaps as much as 70,000 B.P. Under former classification, because the Roxana silts were not then known to be older than the Farmdale, the Sangamon was considered to end at about 28,000 B.P.

5) The transposition of the term Mankato within the Lake Michigan lobe (Leighton, 1957a, b; Wright, 1957) from the till above the Two Creek forest bed to the till below the Two Creeks forest bed, introduces a complicating modification of both Mankato and Cary, produces an unneeded substage, and retains a name from outside of the Lake Michigan lobe.

6) Within the Wisconsinan sequence several discordances in alignment of moraines are of comparable significance to the one on which the Tazewell-Cary boundary is based, whereas the Twocreekan and Farmdalian represent major interruptions of the glacial succession that are widely recognized.

7) Growing evidence favors the recognition of pre-Farmdalian Wisconsinan glaciation in other parts of North America (for example, Goldthwait, 1958; Ruhe, Rubin, and Scholtes, 1957; Dreimanis, 1958; Black, 1959) as well as in Europe.

Revision of the entire stratigraphic classification of the Pleistocene of Illinois to conform to new Survey policies (Willman, Swann, and Frye, 1958) is under study. The present report revises the time-stratigraphic classification of the Wisconsinan. The names of the Wisconsin, Sangamon, and Yarmouth Stages of previous usage are here changed to the adjectival endings Wisconsinan, Sangamonian, and Yarmouthian to make them consistent to the form long used for the Nebraskan, Aftonian, Kansan, and Illinoian Stages. Time-stratigraphic units are capitalized to conform to Illinois Survey policy, but the lithologic designations of rock-unit names are not capitalized pending decision as to their ranking in the rock-stratigraphic classification.

Acknowledgments

With the exception of a few dates for the Two Creeks forest bed in Wisconsin, all radiocarbon dates used in this discussion were determined in the Washington laboratory of the U. S. Geological Survey (Suess, 1954; Rubin and Suess, 1955, 1956; Rubin and Alexander, 1958; and previously unpublished dates).

We wish to thank our colleagues, George E. Ekblaw and R. E. Bergstrom of the Illinois State Geological Survey, Paul R. Shaffer of the University of Illinois, A. Byron Leonard of the University of Kansas, and Meyer Rubin of the U. S. Geological Survey, who furnished data and have read and criticized the manuscript.

WISCONSINAN STAGE

The Wisconsinan Stage embraces the deposits made during the last major episode of Pleistocene continental glaciation. The stage is based on the deposits of the Lake Michigan glacial lobe in eastern Wisconsin and their southward extension into Illinois. The deposits of the Wisconsinan type region were studied and named during the past century (Chamberlin, 1894, 1895; Leverett, 1899) and their classification has been a subject of continuing investigation (Alden, 1918; Leverett, 1929; Leighton, 1931, 1933, 1957a; Kay and Leighton, 1933; Thwaites, 1946; Horberg, 1955).

The Wisconsinan Age includes the time since the end of the last major interglacial interval and was terminated by the final dissipation of the North American continental ice cap. Extrapolation of existing radiocarbon dates indicates that the Wisconsinan Age started at least 50,000 and perhaps as much as 70,000 radiocarbon years ago. Other dates suggest that it ended about 5,000 radiocarbon years B. P. (Before Present). In terms of stratigraphic sequence the stage includes all deposits above the Sangamon soil and below the Recent alluvium. Although this

extends the definition of the stage to include deposits now known to be older than the type Farmdale loess, these deposits had previously been included within the Wisconsinan.

Altonian Substage

The Altonian Substage is named for the city of Alton, in southwestern Illinois, located on the bluff of Mississippi River Valley below the mouth of Illinois River. The rock-stratigraphic unit on which the substage is based crops out in the Alton Quarry (Willman and Frye, 1958) at the northwest edge of the city and has been studied extensively in exposures in the Mississippi Valley bluffs down stream as well as along the Illinois River Valley up stream from its mouth (Geol. Sec. Nos. 1, 3, 4).

This rock-stratigraphic unit consists of a distinctive succession of silts below the Peoria loess and above a well developed buried soil. These silts are named the Roxana silt from exposures in the Mississippi Valley bluffs east and southeast of the town of Roxana, Madison County, Illinois. The type section is designated the exposures at Pleasant Grove School and is described in the accompanying measured section (Geol. Sec. No. 1). The silt is also well exposed southward along Mississippi Valley (Geol. Sec. No. 4), northward along the bluff at Peters, east of St. Pauls Church, at Alton, and along the Illinois Valley northward to the vicinity of Beardstown (Geol. Sec. No. 3).

In the type area the Roxana silt rests upon a well developed soil. In its basal part locally occurs gray, noncalcareous colluvial silts (Geol. Sec. No. 3) with some sand and rare pebbles. Gradationally above this thin colluvial zone (or in its absence, as the basal unit), is a gray, noncalcareous, massive silt, locally containing humus streaks in the upper part. This gray silt unit is overlain by a weakly calcareous, pink to pinkish tan, massive silt containing a sparse fauna of large snail shells. Snail shells collected from this unit in the Pleasant Grove section were dated 35,200±1,000 (W-729) and from the Gale section were dated 37,000 ±1,500 (W-869) by the Washington laboratory of the U. S. Geological Survey.

The pink unit grades upward into a weakly calcareous, massive, gray silt, sparsely fossiliferous in the lower part, which in turn is overlain by another pink, massive silt, noncalcareous in the upper part and commonly noncalcareous and nonfossiliferous throughout. This second pink silt unit constitutes the uppermost bed of the Roxana silt and is separated by a distinct contact from the overlying gray to yellow-tan, calcareous, fossiliferous Peoria loess.

Also assigned to the Altonian Substage is the till and outwash in northern Illinois described by Shaffer (1956) as occurring stratigraphically below a loess below Shelbyville till and younger than Sangamon soil. Shaffer, in accordance with the then current concept that the Farmdale represented the earliest Wisconsinan glacial advance, assigned this drift to the Farmdale Substage. Data subsequently acquired, including a radiocarbon date (Black, 1958) older than type Farmdale from similar deposits in extreme southern Wisconsin, favor its assignment to the newly defined Altonian Substage. The rock-stratigraphic unit described by Shaffer is here named, with his concurrence, the Winnebago drift, after Winnebago County, Illinois, in which it is extensively exposed and from which it was described in detail by Shaffer (1956, p. 18-19).

Abundant radiocarbon dates in the deposits immediately younger than those included within the Altonian serve to establish 28,000 years B. P. as the approximate end of the substage. The age of the beginning of the Altonian in radiocarbon

years is more difficult to determine as no dates are available from the lower part of the Roxana silt. Extrapolation from the dates that are available suggests an age of 50,000 to 70,000 radiocarbon years B. P. as the beginning of the Altonian. The Altonian is judged to include half or more of the total duration of the Wisconsinan Age.

Glacial deposits near Danville (Ekblaw and Willman, 1957) and Bloomington (Ekblaw, 1946) which appear to be younger than Sangamonian but older than Woodfordian may be of Altonian age. It is also possible that the Lemont drift in the Chicago area, which has been variously assigned to the Wisconsinan or Illinoian (Bretz, 1955, p. 57-69; Horberg and Potter, 1955) is Altonian in age. As the substage may include several pulses of ice advance, these deposits may be assignable to the Altonian but still not be contemporaneous with the Winnebago. The differentiation of the Roxana silt into well defined and widely recognized lithologic zones suggests the possibility of repeated pulsations of the ice.

Farmdalian Substage

The Farmdalian Substage is the time-stratigraphic unit next younger than the Altonian and is based on the Farmdale silt exposed in the Farm Creek area in Tazewell County, Illinois, southeast of Peoria. Deposits in this stratigraphic position have been known since the last century (Leverett, 1899) and for many years were assigned to the late Sangamon.

The deposits were named the Farmdale loess by Leighton (1948) and they were used as the basis for the Farmdale Substage by Leighton and Willman (1950). The rock-stratigraphic unit (Geol. Sec. No. 2), the Farmdale silt, consists of massive silt, noncalcareous, light brown to pale purple, that commonly contains wood fragments and is locally replaced by peat. Although some of the Farmdale silt probably was initially deposited as loess during Farmdalian time, it is our opinion that much of it was derived by water transport and colluvial action from the older Roxana loess.

The Farmdale silt and peat is the most extensively radiocarbon-dated stratigraphic unit in Illinois. The several dates presently available from the Farmdale of Illinois range from 26,150±600 (W-381) to 22,900±900 (W-68). It is on the basis of these dates, their positions within Farmdale deposits, and dates from both younger and older deposits (fig. 1) that we suggest a range of radiocarbon years of 28,000 to 22,000 for the Farmdalian Substage.

The relatively common occurrence of peat in the Farmdale and the common occurrence of wood fragments in the Farmdale silt are the only extensive accumulation of plant remains known within the Wisconsinan deposits of Illinois. The regional stratigraphic occurrence and character of the deposits suggest a period of slow accumulation, of stability of alluvial surface, and of moderate weathering. Although till in several areas (Shaffer, 1956; Ekblaw and Willman, 1957) has been referred to the Farmdale, present data indicate the absence of till of Farmdalian age. We conclude that the Farmdalian is the major interval of glacial withdrawal within the Wisconsinan as developed in the Lake Michigan lobe rather than an episode of glacial advance.

Woodfordian Substage

The Woodfordian Substage is based on the pro-Shelbyville Morton loess, that overlies the Farmdale silt, and the succession of progressively younger moraines extending from the Shelbyville to, but not including, the Valders. It is stratigraphically terminated upward by the Two Creeks forest bed of Wisconsin

(fig. 1). The name is derived from Woodford County, in central Illinois, which is just northeast of the Shelbyville moraine, is crossed by the Bloomington, Metamora, Normal, and Cropsey moraines, and contains excellent exposures of the Farmdale and Morton silts, the contact between them, and of fossiliferous Richland loess.

The pro-Shelbyville loess, formerly called Iowan loess, is here named the Morton loess. It is calcareous, fossiliferous, yellow-tan to gray, massive silt. The type section (Geol. Sec. No. 2) is in the Farm Creek area of Tazewell County where the unit occurs in stratigraphic succession above Farmdale silt and below Shelbyville till. It is named for the town of Morton, approximately six miles southeast of the type section. A name for "Iowan loess" as a rock-stratigraphic unit became imperative because radiocarbon dates have demonstrated that the Morton loess is at least 15,000 radiocarbon years younger than the type Iowan of Iowa.

The loess that lies on the Shelbyville till and successively younger Woodfordian moraines previously has not been assigned a rock-stratigraphic name but has been commonly referred to as Tazewell loess. The name Richland is here proposed from exposures in the east bluff of Illinois Valley north of Richland Creek, in a road cut in the NW$\frac{1}{4}$ SE$\frac{1}{4}$ SW$\frac{1}{4}$ sec. 11, T. 28 N., R. 3 W., Woodford County, Illinois. At this locality there is exposed 8 feet of yellow-tan loess, of which the lower 3 feet is calcareous and fossiliferous. The loess rests on calcareous pink till of Woodfordian age.

Beyond the limit of Shelbyville till the Peoria loess serves as a supplementary type for the Woodfordian Substage. The Peoria loess has been called Peorian, but it is here used as a rock-stratigraphic rather than a time-stratigraphic unit and therefore the adjectival ending is dropped. The original type area is retained (Leverett, 1898; Kay and Leighton, 1933), but no specific type section was designated among the many exposures in the vicinity of Peoria, Peoria County, Illinois. The Peoria loess, like the Morton, stratigraphically overlies the Farmdale silt. The Peoria loess contains the physical continuation of the Morton and Richland loesses beyond the Shelbyville moraine, but these units cannot be generally differentiated within the Peoria.

From the former classification the Woodfordian includes the Iowan Substage of Illinois usage (but not of the type), the type Tazewell and Cary Substages. It includes that part of the Cary that has recently been assigned to the Mankato (Leighton, 1957a, b; Wright, 1957). On the basis of numerous dates the total time span of the Woodfordian is less than 10,000 radiocarbon years (fig. 1).

The Woodfordian Substage of Illinois contains about 30 recognized end moraines. Although recording in minute detail the successive configurations of the limit of the glacial ice, the individual moraines cannot be traced with certainty across re-entrants within the lobe. They are not adaptable to treatment as time-stratigraphic units both because of the extremely short time span represented by an individual moraine and their lack of sufficient continuity. Also, because they are identified by their form and not by their lithology, which in many cases in Illinois is not distinguishable from one moraine to the next, they are not normal rock-stratigraphic units.

Although the many Illinois moraines do not constitute an adequate basis for the construction of either a time-stratigraphic or rock-stratigraphic framework, they do form a unique stratigraphic sequence that is highly useful for the determination and mapping of a wealth of local detail. To meet the needs of detailed work we are classifying the moraines in a new category called "morphostratigraphic" units. A morphostratigraphic unit is defined as comprising a body of rock that is identified primarily from the surface form it displays; it may or may not be distinctive litho-

logically from contiguous units; it may or may not transgress time throughout its extent. Each morainal unit of the morphostratigraphic classification consists of the end moraine, ground moraine, and the continuation of the natural unit in the subsurface where recognizable. The named moraines shown on figure 1 as occurring within the Woodfordian Substage are only a few of the named morphostratigraphic units in Illinois.

Groupings of moraines within morphostratigraphic classification can be based on contrasts in morphology, in relative size of moraines, in degree or overriding, and in configuration of morainal fronts. The Tazewell-Cary differentiation at the front of the Minooka moraine was largely based on a change in configuration between the Marseilles and Minooka moraines. Similar discordance of morainic pattern occurs at the Cerro Gordo (LeRoy), Bloomington, Marseilles, West Chicago, and other morainal fronts. These discordances appear to indicate the more significant withdrawals and readvances of the ice front. However, the lack of leaching of carbonates, or even definite surface-related oxidation, indicate that the time intervals represented by the withdrawals must be relatively short, particularly in view of the shortness of time assignable to the entire substage. Perhaps the most significant break is represented by the local evidence of slight leaching of carbonates from the Shelbyville drift prior to deposition of the Cerro Gordo and LeRoy moraines (Ekblaw, 1946; Ekblaw and Willman, 1955).

In northeastern Illinois the outer margin of the Cary drift does not follow one morainal front. At Cary, Illinois, the Minooka moraine is overridden by the West Chicago moraine (at least two moraines younger), and the northward continuation of the West Chicago moraine (Darien and Johnstown moraines) is used as the Cary front in the Wisconsin part of the Lake Michigan lobe. Southeast of the type region, the Minooka moraine becomes weak and the Cary front has been placed successively at the Manhattan moraine and at the prominent front of the Valparaiso moraine which appears to be equivalent to the West Chicago. The Cary front in terms of the type relationship, is not traceable throughout the Lake Michigan lobe.

The desire to recognize relative position within the morainal sequence has resulted in widespread attempts to use the Tazewell-Cary break as a standard of reference in other regions (Frye and Leonard, 1952). Many of these attempts incorrectly assume that the two units are separated by a significant time interval. Although this or other breaks between morphostratigraphic units can be used as the basis for time-stratigraphic classification, the tracing of specific morainal fronts within such closely related sequences, particularly their projection into other lobes, is uncertain. Morphostratigraphic units may eventually be useful as a basis for subdividing the substages here proposed if it can be demonstrated that the climatic pulsations have produced comparable cyclic sequences of moraines in different lobes, or if material for adequate radiocarbon dating can be found.

Twocreekan Substage

The Twocreekan is recognized as the substage next younger than the Woodfordian. It is based on the Two Creeks forest bed of Wisconsin (Thwaites and Bertrand, 1957) and contains the time of a very short-lived, though significant, retreat of glacier ice in the Lake Michigan lobe. Its time span of no more than 1500 radiocarbon years makes it by far the shortest of the substages here recognized within the Wisconsinan.

Nevertheless, this interval is classed as a substage because it contains the most significant interruption in the pulsatory retreat of the post-Farmdalian ice

in the Lake Michigan lobe. Furthermore, the extensive series of radiocarbon dates from the Two Creeks forest bed indicates that it represents an interval of widespread significance. It is correlated with the Allerød of Europe (Flint and Deevey, 1951; Flint, 1956, 1957; Iversen, 1953), and evaluation of available radiocarbon dates (Rubin and Suess, 1956) suggests its correlation with the Bradyan interval of the Great Plains.

Throughout the uplands of Illinois, Twocreekan and later deposits are not distinguishable within the surface soil. In the valley areas, Twocreekan erosion is judged to separate two terraces, and some deposits within the Lake Chicago plain may be of this age (Bretz, 1955; Hough, 1958).

Valderan Substage

The Valderan Substage is defined as the youngest time-stratigraphic subdivision of the Wisconsinan Stage in the Lake Michigan lobe (fig. 1). Its base is defined by the base of the Valders till (Thwaites, 1946; Thwaites and Bertrand, 1957) of eastern Wisconsin that overlies the Two Creeks forest bed, and its name is derived from that till. The substage as defined terminated with the final dissipation of the Wisconsinan continental glacier, even though glacial till representative of the entire time span does not occur in Lake Michigan basin. Possible subdivision of this unit by other physical events, notably the stages of the Great Lakes and the Cochrane readvance, are not recognized here because of their lack of utility in Illinois. The Valderan Substage includes alluvial deposits made during the time of rising sea level that is thought to have reached its present position of essential equilibrium approximately 5,000 years ago (Fisk, 1956; 1959).

Deposits of glacial till or of loess of Valderan age are not known to occur in Illinois. However, alluvial deposits of this age are thought to be present in the major valleys of the state, and lacustrine deposits and sand dunes occur locally.

RECENT STAGE

The Recent Stage includes the time since the continental glaciers were dissipated from the North American continent and sea level was stabilized at approximately its present position. In Illinois, deposits of Recent age include alluvium associated with the active floodplains, minor deposits of eolian sand, and lake and pond deposits. The Recent Stage is judged to have started approximately 5,000 radiocarbon years ago.

GEOLOGIC SECTION NO. 1

Pleasant Grove School Section; center SE¼ sec. 20, T. 3 N., R. 8 W., Madison County, Illinois

Measured in 1958 and 1959 by John C. Frye, A. Byron Leonard, and H. B. Willman

	Thickness (feet)
Pleistocene Series	
Wisconsinan Stage	
Woodfordian Substage	
Peoria loess	
10. Loess, coarse, massive to thick-bedded, calcareous, fossiliferous, gray-tan to yellow-tan. (This unit thickens northward along the bluff; shells from sec. 4, T. 3 N., R. 8 W., were dated 17,100±300 years B. P. (W-730) by U. S. Geol. Survey)	15.0
Altonian Substage	
Roxana silt	
9. Loess, coarse, massive, weakly calcareous to noncalcareous, nonfossiliferous, pale pink-tan	11.0
8. Loess, coarse, massive, weakly calcareous, fossiliferous in lower part, gray-tan	12.0
7. Loess, coarse, massive, weakly calcareous, fossiliferous, pink-tan grading upward to gray-tan	10.0
6. Sand, fine, massive, calcareous, light tan, occurs locally in lenses	1.5
5. Loess, coarse, massive, weakly calcareous, pink-tan with dark gray to brown humus streaks in basal part, fossiliferous in upper two-thirds; shells dated 35,200±1,000 years B. P. (W-729) by U. S. Geol. Survey	8.5
4. Silt, coarse, noncalcareous, massive to indistinctly bedded, gray, streaked with humus; contains a weak A-C soil profile at top	4.0
Pre-Wisconsinan	
3. Soil; A-horizon 1.5 feet, tan to dark gray, granular, massive clayey silt, gradational at base; B-horizon, 2 feet, massive clayey silt, light reddish-brown, gradational at base; contains calcium carbonate nodules in lower half (total depth of leaching about 10 feet)	3.5
2. Silt, massive, gray to gray-tan with a few streaks of yellow-brown and buff, locally mottled with brown and dark gray; laterally thickens to a total of 15 feet with lower 4 feet calcareous	7.0
1. Till, with truncated soil at top; 0.1 foot of reddish-brown clayey silt at top; B-horizon developed in till, massive, clayey, brown to dark buff, leached, indistinctly platy in upper part, manganese staining on prismatic surfaces, 1.3 feet; 1.2 feet leached, oxidized, massive, tan to brown; below the soil profile, till, calcareous, sandy, compact, gray-tan to bluish-gray, jointed, with some calcium carbonate accumulation along joints	11.5
Total	84.0

GEOLOGIC SECTION NO. 2

Farm Creek Railroad Cut Section; center sec. 31, T. 26 N., R. 3 W. (one mile south of Farmdale type section), Tazewell County, Illinois
Measured in 1958 and 1959 by J. C. Frye and H. B. Willman

	Thickness (feet)
Pleistocene Series	
Wisconsinan Stage	
Woodfordian Substage	
Richland loess	
10. Loess, massive, noncalcareous, brown; contains surface soil profile	3.0
Shelbyville till	
9. Till, calcareous except in the surface soil profile, compact, pebbly, gray; pinkish cast in weathered zone at top, a gravel zone occurs about middle	40.0
Morton loess	
8. Loess, massive, compact, tough, calcareous, gray; contains fossil snail shells. (In this area radiocarbon dates of 20,340±750 [W-349], and 20,700±650 [W-399] were obtained from the upper part of the Morton loess)	4.0
Farmdalian Substage	
Farmdale silt	
7. Silt, compact, noncalcareous, light purplish gray to pinkish tan, gradational at base. (In this area a radiocarbon date of 22,900±900 [W-68] was obtained from one foot below the top of the silt)	1.0
6. Silt, compact, noncalcareous, greenish gray, gradational at base	2.0
5. Silt, compact, noncalcareous, dark gray, gradational at top and bottom. (In this area a radiocarbon date of 25,100±800 [W-69] was obtained from 3 to 4 feet below the top of the Farmdale)	0.5
4. Silt with a few pebbles, colluvial, gray, noncalcareous	0.5
Sangamonian Stage	
Sangamon soil	
3. Clay and silt (accretion-gley) with scattered small pebbles, massive, compact, noncalcareous, gray	1.5
2. Weathered till, noncalcareous, brown to gray-tan, some vertical B-horizon structure and manganese pellets, staining on joint surfaces	3.0
Illinoian Stage	
1. Till, massive, compact, pebbly, calcareous, gray to blue-gray	5.0
Total	60.5

GEOLOGIC SECTION NO. 3

Rushville Southeast Section (in new road cuts 0.4 mile west of Illinois Valley bluff)
SW¼ SW¼ NW¼ sec. 23, T. 1 N., R. 1 W., Schuyler County, Illinois
Measured in 1959 by John C. Frye, A. Byron Leonard, and H. B. Willman

	Thickness (feet)
Pleistocene Series	
Wisconsinan Stage	
Woodfordian Substage	
Peoria loess	
8. Loess, massive, calcareous in lower 14 feet, mostly gray to light yellow-tan, light dove-gray mottled with limonite in lower part; top 6 feet in surface soil profile	20.0
Farmdalian Substage	
Farmdale silt	
7. Loess, platy, noncalcareous, lavender to pinkish tan; contains carbonaceous flecks	0.5
Altonian Substage	
Roxana silt	
6. Loess, medium, massive, noncalcareous but containing secondary accumulations of calcium carbonate, pinkish brown grading upward to pinkish tan	3.5
5. Loess, medium, massive, calcareous, gray grading upward to dark gray and brownish gray	6.0
4. Loess, massive, noncalcareous, reddish brown, gradational at base	3.5
3. Silt, colluvial, with some fine sand and few small pebbles, slightly clayey, noncalcareous, gray to brownish gray, gradational contacts	2.0
Pre-Wisconsinan	
2. Colluvium, sand and silt with clay and pebbles, less pebbly upward; a strongly developed soil profile at top with a B-horizon 2 feet thick, red-brown, well structured	8.0
1. Till, gray with some tan mottling, grading laterally into sand and gravel; some calcareous till in basal part	8.0
Total	51.5

GEOLOGIC SECTION NO. 4

Gale Section, center sec. 33, T. 14 S., R. 3 W., Alexander County, Illinois
Measured in 1959 by John C. Frye, A. Byron Leonard, and H. B. Willman

	Thickness (feet)
Pleistocene Series	
Wisconsinan Stage	
Woodfordian Substage	
Peoria loess	
7. Loess, massive, friable, calcareous, gray, fossiliferous	25.0
Altonian Substage	
Roxana silt	
6. Loess, massive, compact, noncalcareous, pale pink, non-fossiliferous	6.0
5. Loess, massive, friable, calcareous, becoming weakly calcareous at the base, gray, fossiliferous. (Shells from the lower part of this bed and the upper part of the bed below were dated 37,000±1,500 [W-869] by the U. S. Geological Survey)	8.0
4. Loess, massive, compact, pink, effervesces very slowly with dilute HCl, fossiliferous	7.0
3. Loess, massive, coarse, noncalcareous, gray-brown, pink and finer grained in the lower part; contains abundant large calcium carbonate concretions	6.0
Sangamonian Stage	
Sangamon soil	
2. Soil, clayey, tough, well structured, reddish brown; grades downward into silty clay and silt, mottled yellow-tan, gray and brown, tough, compact, blocky	3.0
Pre-Sangamonian	
1. Gravel, sand, and silt; gravel is mostly angular to subangular chert of variegated color; base rests on Thebes Sandstone	2.0
Total	57.0

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