Reports

Status of the Pleistocene Wisconsin Stage in Central North America

Abstract. *A brief review of the history of the Wisconsin Stage in Pleistocene stratigraphy and of research since 1950 shows that post-Sangoman glacial drift older than the Wisconsin drift reported in the older literature is present in central North America. Known and possible stratigraphic positions of the relevant units are shown.*

The name Wisconsin was applied by T. C. Chamberlin in 1895 to a complex body of glacial drift of late-Pleistocene age, occurring in the central United States and marked by many end moraines. Because of its moraines the Wisconsin drift stands out clearly on a large map (see *1*). In later years this drift was gradually subdivided into stratigraphic units, each of which was defined in terms of an end moraine that constituted its outer limit. The subdivisions, which are still used by many authors, include the Iowan, Tazewell, Cary, and Mankato units, in order of decreasing age. As stratigraphic names came into increasingly formal use, the Wisconsin sediments came to be thought of as a stage—a major subdivision of the Pleistocene Series—and its subdivisions were considered substages. The corresponding time units were named ages and sub-ages.

The base of the Wisconsin Stage was widely regarded as being marked by the top of the weathering zone developed in the Illinoian till, or by the correlatives of that zone. The weathering zone and its correlatives were, and still are, correlated with the Sangamon Interglacial Stage. The Wisconsin sediments that overlie that zone were thought to represent a single major expansion of the Laurentide (North American) Ice Sheet, but with many fluctuations of unknown duration. This is the classical concept of the Wisconsin glaciation, implicit in all the literature antedating 1950 and in some literature of later date. The stratigraphy of the Pleistocene Series as developed prior to 1950, is shown in Fig. 1.

Because it was later shown that the Wisconsin drift of the older literature does not represent the entire post-Sangamon glacial record but is underlain by older post-Sangamon sediments, Flint (*2*) temporarily designated the Wisconsin drift of the older literature "classical Wisconsin drift," to distinguish it from the post-Sangamon sediments that lie below it. That designation has served its purpose and in most regions can be replaced by local names, representing new units recognized within recent years. It is used in this report for convenience, to represent the sequence generally recognized as Wisconsin before about 1950.

Prior to the development of the carbon-14 dating technique the existence of post-Sangamon, pre-classical Wisconsin sediments was almost unknown. The earliest recognition of sediments in this stratigraphic position was the placing, by Leighton and Willman (*3*), of the Farmdale silt (loess) at the base of the Wisconsin sequence rather than at the top of the Sangamon, the position it held earlier. The application of C^{14} measurement to upper Pleistocene sediments, which began in 1950, produced a large number of dates derived from wood buried in glacial drift, peat interbedded with drift, snail shells in loess, and other materials that occurred in significant stratigraphic relation to glacial sediments. When a large number of these dates had been assembled, two generalizations were drawn from them (*4*): (i) The oldest Wisconsin drift recognized prior to 1950 is not much more than 25,000 years old; (ii) a glaciation or glaciations older than that drift, but believed to be of post-Sangamon age, occurred more than 30,000, and probably more than 40,000, years ago.

Series	Stages	Substages
Pleistocene	Wisconsin glacial	Mankato Cary Tazewell Iowan
	Sangamon interglacial	
	Illinoian glacial	
	Yarmouth interglacial	
	Kansan glacial	
	Aftonian interglacial	
	Nebraskan glacial	
Pliocene		

Fig. 1. Stratigraphy of the Pleistocene Series as developed prior to 1950.

These generalizations are still valid. Since 1955 many occurrences of glacial drift (till, in most instances) believed to be of post-Sangamon, preclassical Wisconsin age have been identified, not only in central North America but in New England, the Rocky Mountains region, the Pacific Coast, and Alaska. The most detailed record yet developed of sediments in this stratigraphic position is that from southern Ontario, summarized in an important paper by Dreimanis (*5*). Another paper (*6*), on the sequence in Illinois, is especially significant in that it recognized in that state, where the classical Wisconsin stratigraphy had mainly been developed, an earlier post-Sangamon sequence of complex character. Similarly, post-Sangamon, pre-classical Wisconsin drift has been recognized in Iowa (*7*). This drift is, at least in part, the Iowan till of the older literature, which is shown, on the basis of C^{14} dates, to be much older than the "Iowan" loess of that literature in Illinois. The "Iowan" loess belongs to the classical Wisconsin drift sequence and is represented, at least in part, by the Morton loess of the current literature.

Evidence that the drift underlying the classical Wisconsin sequence is post-Sangamon is drawn from C^{14} dates only rarely, because only a very few finite dates within the range 30,000 to 66,000 years ago exist; examples are cited by Dreimanis (*5*, pp. 112, 113, 116, 117). Representative lines of evidence other than C^{14} dates are these: (i) The drift in question directly overlies a weathering zone believed to be of Sangamon age; (ii) the drift overlies an older drift which, by lithologic or other correlation is shown at other localities to be Illinoian. In addition,

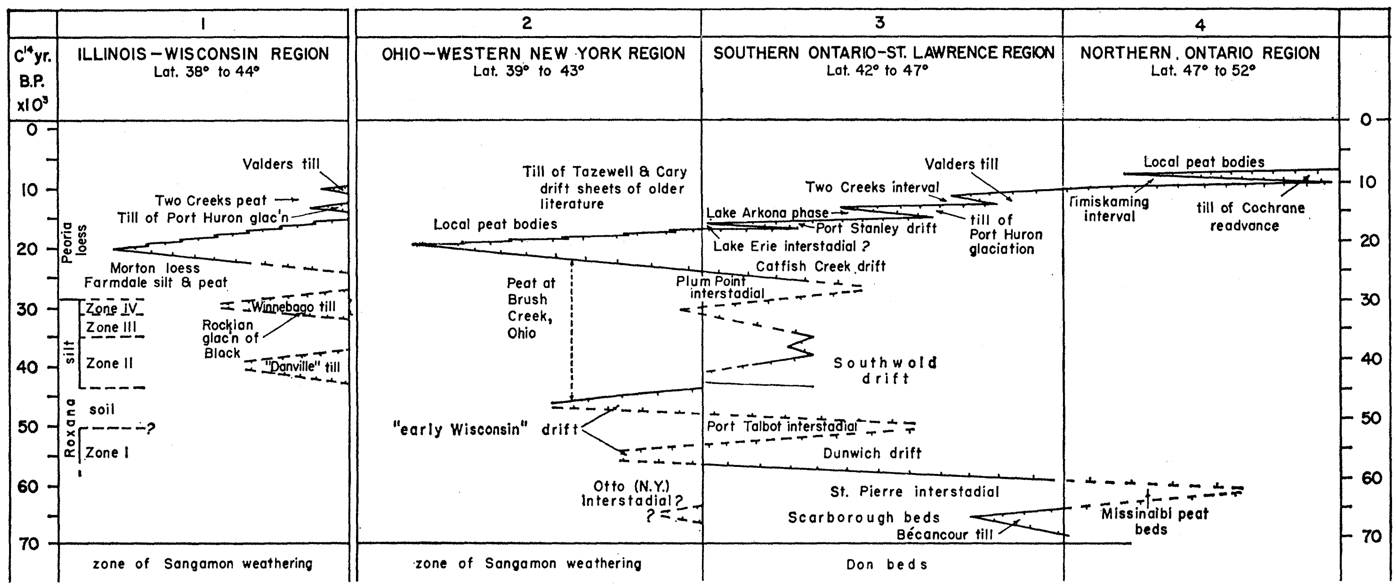

Fig. 2. Chart showing the present status of the stratigraphy of the Wisconsin stage, in four selected regions, in its relation to glacial and nonglacial conditions. The stratigraphic units shown are mainly local, their names are for the most part, informal, and the whole scheme is subject to revision, especially in its lower, older part. The references cited are, in general, sources of data rather than authorities for the particular arrangements shown in the chart. [Column 1: Frye and Williams (*6*); Frye; Glass, and Willman (*18*); Black (*12*). Column 2: Goldthwait (*19*); Forsyth (*20*); Forsyth and La Rocque (*21*). Column 3: Dreimanis (*5, 22*); Terasmae (*23*); de Vries and Dreimanis (*24*). Column 4: Prest (*14*); Terasmae and Hughes (*25*)]

Dreimanis (*5*) showed that a widespread drift of relatively early Wisconsin age has a different lithology and was derived from a source different from that of its successor.

On the other hand, it can hardly be expected that all the occurrences of glacial drift that have been tentatively considered to be of post-Sangamon, pre-classical-Wisconsin age will be proved to lie within that bracket. Some of them may be Illinoian or older, as may be established by stratigraphy or by the discovery of serious errors in the relevant C^{14} dates.

The present status of the Wisconsin Stage can be shown well by graphic charts. The charts of Fig. 2 do not constitute a correlation table in the ordinary sense of the term. They have been modified or adapted from graphic or tabular charts in the literature and have been fitted to a common time scale expressed in C^{14} years. The time scale down to about 30,000 years ago is fairly accurate, but below that level accuracy diminishes rapidly, both because dates are very few and because their accuracy, at very low levels of C^{14} activity, decreases rapidly with increasing age. The base of the columns, at 70,000 years, is derived ultimately from data drawn from deep-sea sediment cores approximating the inception of the last major phase of cold climate (*8, 9*).

Columns 2, 3, and 4 of Fig. 2 are arranged in a general south-to-north sequence so as to make possible a common time-latitude line to denote the changing position of the margin of the ice sheet, as was done in the case of the youngest major Wisconsin glacial sequence (*10*). The region of column 1 should be visualized as parallel to, and west of, that of column 2. When column 1 is placed immediately to the left of column 3 one can judge the extent of agreement between data from the Illinois and the southern Ontario regions.

Most of the stratigraphic names are those used in the relevant original publications. It should be emphasized that the names represent current local usage and that most of them are not generally accepted outside the areas represented in Fig. 2.

Finally, it should be emphasized that no group of stratigraphic charts represents anything firmer than a statement of progress. All such charts are made only to be corrected and remade. Indeed, their publication has often led to specific field studies designed to eliminate obvious disharmonies revealed by the charts. Figure 2 is no exception; it has many shortcomings, which only more field data and more thought can eliminate.

At present, probably the least thinly documented record of post-Sangamon, pre-classical-Wisconsin stratigraphy in central North America is the one shown in Fig. 2, column 2. For the moment, therefore, it can serve as a standard against which the records in other regions can be compared. In Ohio (column 3) there are quantities of data, but most of them are still unpublished. There are many occurrences of till, representing one or more glacial invasions of the state, which are termed "early Wisconsin." Only one of them as yet bears a finite C^{14} date. This till, exposed near Gahanna, has a C^{14} age of 46,000 $\pm$ 2000 years. (*11*). The other dates are infinite, ranging generally between $>$ 30,000 and $>$ 39,000 years. Hence, the stratigraphic positions of these tills are not firmly fixed. The minimum values, taken in conjunction with values for the better-dated glaciations in southern Ontario, prompt the speculation that these till occurrences belong in one or more of the positions shown in Fig. 2 by the dashed lines in column 2. This does not exclude the possibility that some of them may be of Illinoian age.

In the more southerly part of Illinois a portion of the time span under discussion is represented by the Roxana Silt, with finite dates in the range of 35,000 to 37,000 years (*6*). In northern Illinois the Winnebago drift reported by Frye and Willman is older than Farmdale sediments and, according to those authors, correlates with till, in southern Wisconsin, with C^{14} dates in the range of 30,000 to 32,000 years ago (*12*). According to Black, the till represents an extensive glaciation, termed by him Rockian, of the state of Wisconsin. Correlation of the till with the higher part of the Southwold drift in Ontario, reported by Dreimanis (see Fig. 2, col. 3), is permissible on the basis of the stratigraphy and C^{14} dates known at present, but no positive basis of correlation is yet at hand.

There are obvious discrepancies among the sequences in columns 1, 2, and 3 of Fig. 2. For example, the soil between Roxana Silt zones I and II (col. 1), a unit denoting a less cold climate than those preceding and following it, is placed in a time position corresponding to that of till in Ohio and again in southern Ontario. Also, the "Danville" till in Illinois corresponds in time with partial deglaciation in the Ontario sequence. The data at hand do not permit resolution of these conflicts, which in the long run may prove to be apparent rather than real.

The Two Creeks peat presents a special problem. It has been obvious for several years that the average date for the top of the peat, 11,200 years ago (*13*), is about 400 years earlier than the better-documented date for the transition from Pollen Zone II (Alleröd) to Zone III (Younger Dryas) in northern Europe, although the two dates represent what is supposed to be the same time of climatic cooling. The explanation of the discrepancy must await reassessment of the Two Creeks dates and related stratigraphy.

The chief stratigraphic problem in northern Ontario (Fig. 2, col. 4) concerns the 70-mile readvance of the ice-sheet margin to the Bell Moraine at Cochrane, Ontario, an event long known as the Cochrane readvance. That event occurred before, but probably not long before, about 6800 years ago. The area north of the zone of readvance is believed to have been covered by the ice sheet continuously from at least as early as 38,000 years ago, and probably from as early as 53,000 years ago—the minimum dates for the underlying Missinaibi peat beds, through the Cochrane episode. Prest (*14*) cited an opinion of H. de Vries on the date of those beds as the basis of their placement on the chart (col. 4).

In Fig. 2 no separation is made between Pleistocene and Recent or Holocene, because there is no general agreement on where a boundary between these stratigraphic entities should be placed, should they become universally adopted. That there were climatic fluctuations in post-Cochrane time is evident from studies made in Alaska, where fluctuations of glaciers, some of them dated by the C^{14} method, have continued into modern times. The beginning of the Postglacial (within the north-European meaning of the term) in Minnesota is placed by Jelgersma (*13*) at the base of Pollen Zone IV, equivalent to the Pre-Boreal of the European sequence.

From the data in Fig. 2 it can be inferred that, from a time not long after the close of the Sangamon interglacial until the close of the Cochrane episode, the southern margin of the Laurentide Ice Sheet was in a state of metastability, repeatedly fluctuating through the zone between James Bay and the Great Lakes and at times thrusting far south of the lakes. It achieved its greatest advance at a time more recent than 20,000 years ago, but an extensive advance (or advances) occurred before 40,000 years ago. In the stratigraphic data from sediment cores taken from beneath the ocean floor, generally two major temperature minima are discernible within that part of the sequence considered to represent the post-Sangamon (see for example, *9* and *15*). The later minimum clearly correlates with the glacial climax that occurred less than 20,000 years ago. The earlier minimum is placed at around 60,000 years ago on the basis of dates derived by the Pa^{231}–Th^{230} method (*16*), in good agreement with the age of the Bécancour till (Fig. 2, col. 3). The detailed isotopic-temperature curves developed by Emiliani (*9*) show, between these two major minima, three minor maxima (St. Pierre, Port Talbot, and Plum Point?) separated by two minor minima (Dunwich and lower part of Southwold?). Dating of two or three of these points should indicate whether or not a detailed correlation exists.

The names in Fig. 2 are, in the main, not those of formal stratigraphic units because the aim, in preparing the chart, was to show possible relationships between glacial and nonglacial sediments. Until the framework of physical events represented by the sediments has been erected more firmly, there is little point in using formal stratigraphic names other than very locally. For this reason the formal names used in Illinois have been omitted from column 1 and the names Early Wisconsin and Mid-Wisconsin (spelled with capital *E* and *M*) have been omitted from column 3.

Most of the published papers concerned with post-Sangamon stratigraphy extend the name Wisconsin explicitly or by inference down to the top of the Sangamon. In view of the developing close analogy between the post-Sangamon sequence and the Würm sequence of Alpine terminology, this usage is appropriate; also, it departs as little as need be from the usage that prevailed when the upper part of the sequence shown in Fig. 2 was regarded as directly overlying the Sangamon. One objection to the wide adoption of formal names, in the present state of knowledge, is that some names formerly in wide use may, when redefined, have priority over new ones. A possible example is the name Iowan, as was pointed out by Ruhe, Rubin, and Scholtes (*7*).

Knowledge of the earlier Wisconsin stratigraphy in central North America has developed slowly, primarily because most of that stratigraphy lies buried beneath the later Wisconsin sediments. Research in this field is making steady progress, and it seems only a matter of time until a firm post-Sangamon stratigraphy will be revealed (*17*).

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