

WISCONSIN AGE FORESTS IN WESTERN OHIO

I. AGE AND GLACIAL EVENTS

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BACKGROUND

Twenty-nine dates have been determined by radiocarbon analysis for buried wood materials in western Ohio and immediately adjacent areas. This is an attempt to fit known stratigraphy to the dates. Since the dates are internally consistent, their accuracy is not challenged. Interpretation of the stratigraphy of each collecting site and a careful study of the nature and condition of the former vegetation are combined in this pair of papers (Parts I and II).

Most of the study of the glacial drifts in this part of the state is under the geological program of the Water Division, Ohio Department of Natural Resources. It was begun in 1946 and has been pursued by field study from one to three months of each year and supplemented by master's and doctorate studies at The Ohio State University. All C^{14} dates were determined by the University of Chicago Institute for Nuclear Studies (Arnold and Libby, 1951; Libby, 1951, 1954), the U. S. Geological Survey's Radiocarbon Laboratory (Suess, 1954; Rubin and Suess, 1954, 1956), the Yale University Geochronometric Laboratory, the Michigan University Radiocarbon Laboratory (Crane, 1956), or Lamont Geological Observatory (Broecker, Kulp, Tucek, 1956). The botanical study of the dated wood and other buried forest litter was initiated in July, 1954, and continued in July-August, 1956, by Dr. Burns for the Ohio Water Division.

Logs have been recovered from the glacial drift of Ohio by well-digging operations during more than a century. A few old samples are retained in museums, but most are lost. Well drillers today turn in reports of buried wood at the rate of nearly one a month. With the advent of radiocarbon dating these take on new importance so all finds are being reviewed and some old samples dated. However, most samples must be found by visiting known localities, old and new, where stream or road cuts expose forest material. Thousands of excavations in till have been searched by the detailed mapping of 17 counties but these netted only 10 new localities. On the other hand, where buried wood is found there are usually a great many logs.

The 26 dated deposits in and near western Ohio fall into three groups, more or less as classified by Flint and Rubin (1955). These are (1) those which are greater than 32,000 years old and fall generally beyond the limit of accurate C^{14} dating. They always lie completely *underneath* one or more till sheets. Then, (2) a large group falls scattered over a period 16,600 to 27,500 years ago, and the materials are found *within* multiple till sheets. And finally, (3) a group in the upper washed drift or in bogs and lakes *on top of* till dates from 14,500 to 8,500 years ago. Each group is separated from the other by a void of 2,260 years or more, yet within each group nearly every one thousand years is represented by a specimen or two. The periods devoid of samples probably represent ice cover either stable or in retreat.

OLDEST MATERIALS

C^{14} Date	Number	County	Village	Landmark	Collector*
>40,000	W-152	Clark	N. Hampton	E. Br. Honey Crk.	Brown
>37,000	W-415	Shelby	Kirkwood	Brush Creek Cut	Forsyth
>34,000	W-96	Montgomery	Germantown	Twin Creeks Cut	Orton?
>37,000	W-263	Franklin	Gahanna	Rocky Fork Cut	Goldthwait
>32,000	W-100	Elgin, Ont.	Port Talbot	L. Erie bluff	Dreimanis
>33,000	L-185A	" "	" "	" "	Dreimanis
>38,000	L-217A	" "	" "	" "	Dreimanis

*In published C^{14} lists the man who submitted the sample is listed; here the original collector is noted if possible.

DRIFT STRATIGRAPHY

These five scattered localities (circle spots on fig. 1) are similar in one way. Each one represents a separate interstadial bed—not material swept up in till, as were most mid-Wisconsin logs. Each one lies below two to four thick till layers. At Port Talbot (W-100, etc.) there is a gyttja containing pollen of jack pine, spruce, larch, and birch (Dreimanis, 1953, p. 1414) with two widespread till sheets over it. At Kirkwood (W-415) thin peat lies on leached and reduced gravel soil 3 to 5 feet deep. At Gahanna (W-263) spruce wood is in cross-bedded (late glacial ?) sand overlain by two distinct tills. At Germantown (W-96) the bed is peat 3 to 20 feet thick, which continues at 30 to 90 feet depth from well to well for as much as one and two miles away. Until about 1900 this peat was visible

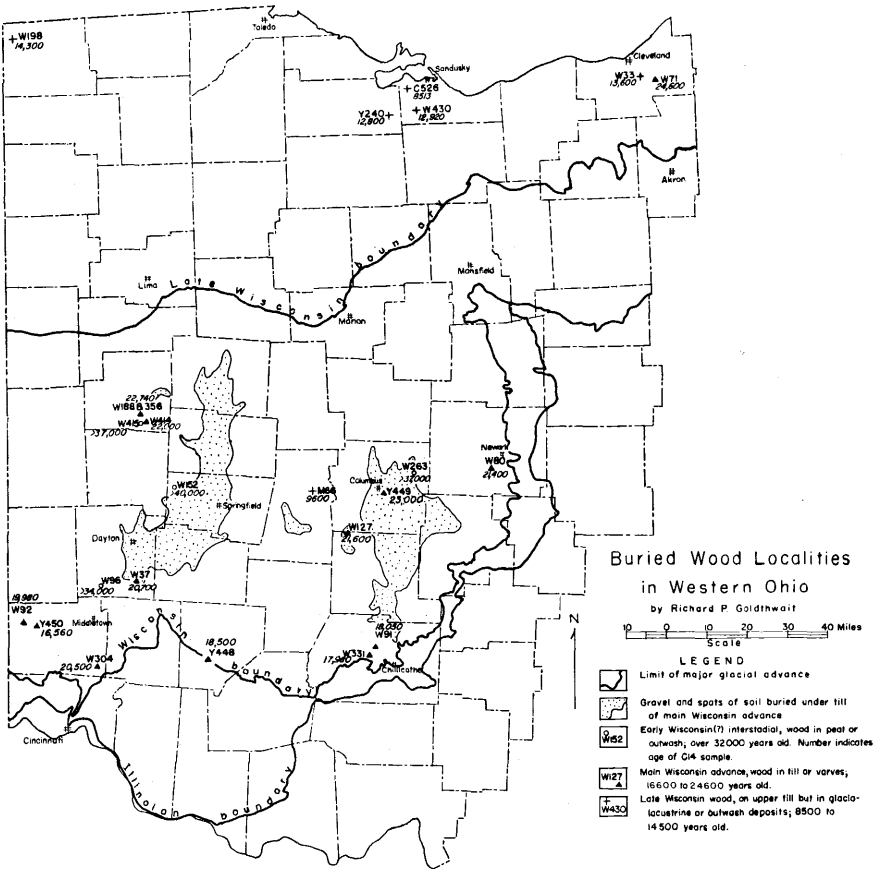


FIGURE 1. See text.

lying on two feet of blackish soil, leached, and grading to gravels with ghost dolomite pebbles below—evidently a gley soil. Based on similarity of development and condition, it is tempting to say that these four represent one and the same interstadial time; until shown otherwise that is the simplest hypothesis.

Two of these sites yield only trees indicating moist, cool climate (pp. 220-21). However, the vegetation in North Hampton (W-152) lacustrine beds and German-town peat suggests these were warmer (pp. 220-21). The superposition of the till

is in question at North Hampton, too, since it is not exposed above the lacustrine beds, but only over sand 70 feet north and on higher slopes. At the Germantown locality (W-96), Orton (1870) quotes nonexpert identification of ash, hickory, and sycamore wood with grape and beech leaves. These two sites mark distinctly warmer conditions which might stem from an earlier part of the same interglacial time, or from an earlier interglacial time.

W-263 (>37,000) Franklin Co., Gahanna	W-96 (>34,000) Montgomery Co., Germantown
Rocky Fork Crk. SE $\frac{1}{4}$ SW $\frac{1}{4}$ Section 2	Twin Creeks SE Section 18
2 $\frac{1}{2}$ -4' soil, Miami A, B	8' soil, Miami A, B, C
10-15' till, brown, sandy NNE source, 28-44% ss, sh sandstone boulder pavements	18-29' till, mostly gray
14-25' till, gray, silty WNW source, 33-49% dolomite	5-6' till, yellow, lenticular silt lenses along outcrop
12-21' sandy gravel, outwash? wood 1' from top upper: 4' rusty sand, cross bedded middle: coarse, cross bedded, gravel bottom: sand	20-40' till, blue gray (other yellow tills described by Leverett)
9-18' till, blue gray, clay rich NW source, 22-33% ls	*(0-20' peat, saucer shaped lens 225' long, compressed logs)
20' bedrock, red, Bedford shale west end only	(2' soil, black top, ghost dolomites leached)
W-100 (>32,000), L-217A (>38,000) etc. Elgin (Ont.) Port Talbot	(10'+ gravel, calcareous)
2" soil	W-152 (>40,000) Clark Co., N. Hampton Marquart Rd. at St. Paris Rd.
19' clay, lacustrine	E. Branch Honey Crk.
8' = till, clay rich, pale brown local SE source, 5-9% Pre- Cambrian	0-36' silty clay till on slope
12' clay, lacustrine	3-5' medium coarse sand poor laminations
45' = till, sandy, pebbly, olive gray (wood, 12' below top at Plum Point) NE source, 17-25% Pre-Cambrian	2 $\frac{1}{2}$ ' fine sand and silt sand lenses 5 layers of leaves and twigs
$\frac{1}{2}$ ' gyttja, W-100 silt, calcareous (varved clay and till)	$\frac{1}{4}$ " medium coarse sand
	3'+ limestone bedrock
	*Layers in parentheses not visible in the last decade.
	W-415 See section listed for W-414

Two of these localities rest on significant gley soils. Each is developed in gravel, and pebbles are well rotted, but each soil is thin and only weakly acid. There is no sign of long interglacial time as is implied by this typical Sangamon soil in a ditch at New Martinsville, Clinton Co.:

- 2 $\frac{1}{2}$ ' silt, loess, Wisconsin with weathered profile, brown
- 3 $\frac{1}{2}$ ' clay, humic gley soil, gumbotil, gray, acid
- 2 $\frac{1}{2}$ ' weathered till, yellow, leached
- 1'+ till, calcareous, gray

Since the capping peat is present on three of these dated sites, there was no mass removal of the A zone by ice here, and we are forced to the conclusion that this was a mostly cool moist interval of perhaps 5 to 15 thousand years duration.

THE AGE ARGUMENT

Both the absolute age and the glacial stage name to be applied to these lower glacial gravels and tills have been questioned. On the one hand, there are dates on the earliest *known* Wisconsin materials from Illinois to the west which suggest the Farmdale is 22,000 to 25,000 years old, or the Tazewell is 16,000 to 22,000 (Horberg, 1955; Ruhe and Scholtes, 1955). No matter which assignment is more nearly correct, these do not account for a Wisconsin substage glaciation before 30,000 years ago. On the other hand, dating of high lake levels in southwestern United States, dating of soils in the Rocky Mountains (Richmond, 1955), dating of glacier advances in Alaska (Karlstrom, 1957), dating of the cooler sea floor layers (Ericson and Wollin, 1956), and many European "Wurm" datings indicate two cold periods in post Sangamon time, the earlier of which is more than 35,000 or 40,000 years ago.

The crucial questions in Ohio are: How long a time is represented by the buried soil? Are the buried soil and associated layers distinctive enough to be recognized as one common soil everywhere, or do they represent several soil-forming episodes? Only the most brief summary of ten seasons of stratigraphic study is possible here.

The first outstanding fact is that from Columbus to Circleville, down the Scioto Valley, east into Licking County, west around London, and down the Mad River-Miami Valleys from Logan County to Butler County there are 1,200 square miles where every well and many exposures reveal till over gravel (stippled areas on fig. 1). The till-smearied rolling surface near Bellfontaine clearly expresses kames and kettles underneath; half-exposed kames and eskers are known southeast of Columbus and Circleville. Where wells go deep enough, thin till layers sometimes occur in the gravel and till is usually present below it, but closely related in time. So many hundreds of well records are available at the Water Division that the general continuity of the gravels in the till "sandwich" can hardly be questioned. These are traceable in wells to the gravels which bear wood over 37,000 years old at Gahanna. Clearly the ice came once, leaving lower till, and then poured out gigantic outwash deposits as it left, for these buried esker, kame, and outwash forms surpass anything elsewhere in Ohio glacial drift. Then ice returned for its main and final call of several pulsations shown by several upper tills, well dated at 24,600 to 16,600 years ago (next section).

The second pertinent observation is that at more than 45 separate actual exposures (in the areas of dots on fig. 1) there is a buried "soil" on the gravel, consisting of 0 to 4 feet of *leached* and red-clay-enriched upper gravel. It is horizontally extensive, but discontinuous, right under the upper *calcareous* tills. Dozens of soils experts and many geologists have inspected these; the concensus is that many of them are genuine buried soils. If some are, all may be. Extensive laboratory tests are being run and will be reported later, but the depth, clay content and texture are very similar to that for modern postglacial Fox soils in gravel. Only at the Sidney cut (W-188) found by Forsyth is this underlying soil developed in till. Here it is leached $1\frac{1}{2}$ to 4 feet and is much like some Miami soils in clay-content, acidity, structure, and depth. Forsyth has shown that it differs markedly from the Illinoian soils (Forsyth and LaRocque, 1956). While these might be truncated by later ice advance, they still do not resemble lower parts of Sangamon soils in southern Ohio (p. 211). The similarity of stratigraphic position of all these soils, their thinness, the like gravels in which they are developed and the continuity of the gravels suggest that these represent one and the same period. The soils do not demonstrate a long interglacial period and circumstantial

evidence favors the simplest hypothesis that they represent one interstadial period occurring during 5 to 15 thousand years between two long major glacial advances of the Wisconsin stage.

Another line of evidence tests this hypothesis. In the Hocking Valley, Kempton (1956) found a terrace level, traceable for 40 miles. It is well above known Wisconsin terraces (4' deep Fox soils), but well below Illinoian terraces (15' deep Hocking soils), and it can be identified by its high count (38%) of clastic local pebbles, and its 6 to 8 ft leached brown soil. The lower Wisconsin terrace, on the other hand, is correlated with the 20,000 year old drift at Lancaster, Ohio (Conley, 1956), so this older higher post-Illinoian terrace must be "early" Wisconsin.

MID-WISCONSIN FORESTS

C^{14} Date	Number	County	Village	Landmark	Collector
27,500±1,200	W-177	Elgin, Ont.	Tyrconnell	Plum Point	Dreimanis
26,000±1,000	L-185B	"	"	" "	"
24,600±1,500	L-217B	"	"	" "	"
24,600±800	W-71	Cuyahoga	Cleveland	Clev. S. & G. Co.	White
23,000±850	Y-449	Franklin	Columbus	4th St. at Long	Goldthwait
23,000±800	W-188	Shelby	Sidney	B & O RR cut	Forsyth
22,400±800	W-356	"	"	"	Rubin
22,000±1,000	W-414	"	Kirkwood	Brush Crk.	Forsyth
21,600±1,000	W-127	Pickaway	Harrisburg	U S Rt. 62	Frye, J. (?)
21,400±600	W-88	Licking	Newark	Kaiser I.A Co.	Mahard
*(> 16,100±850	C-893	"	"	")
20,700±600	W-37	Montgomery	Southern Hills	Hole's Crk.	Goldthwait
(> 17,000	C-508	"	"	")
20,500±800	W-304	Butler	Westchester	E. Fk. Mill Crk.	Rich
19,980±500	W-92	"	Oxford	Bull Run	Goldthwait
(> 15,000	C-456	"	"	")
18,500±420	Y-448	Clinton	Cuba	Faris Rd.	Sanderfur
18,050±400	W-91	Ross	Chillicothe	Biers Run	Goldthwait
17,980±400	W-331	Ross	Anderson	Anderson Run	"
16,560±230	Y-450	Butler	Darrtown	Fourmile Crk.	"

* (Those in parentheses considered less reliable for calculations.)

Stratigraphy.—These 14 sites (triangle spots on fig. 1) have many features in common. The logs are all in till, mostly near the base of a till layer, except W-71 in varved proglacial clays. There are bedded sand or gravel lenses with limonite-hematite staining in the till near every group of logs. These masses often have low dips or are contorted, suggesting that they were picked up frozen and twisted. The logs themselves are bent and in some cases doubled back like oxbows indicating powerful differential twisting within the ice-till mass itself. Only casual measurement of pebble orientation has been attempted and these indicate a strong till fabric. In every case except two (W-188 and W-177) the discovery log led to the finding of many more pieces nearby; in other words, logs come in groups. Part II will show that the pieces represent one uniform kind of cold-weather forest.

From these facts of situation, it is highly probable: (1) that these record the last major glacial *advance* with pulsations across western Ohio; (2) that here and there the ice pushed into extensive patches of living forest; (3) that these forests developed in cool pro-glacial climate like north central Ontario; (4) that the same ice picked up masses of already sorted sand and gravel, so the forests were closely associated with outwash materials now found beneath the upper tills; and (5) that the ice squeezed and contorted the till, gravel and logs by differential shearing motions or fluxing currents of ice.

The specific stratigraphic situation varies from site to site. The group of 5 simplest sites lie under gently undulating smooth till surface mapped as ground

moraine. The wood occurs near a contact with a gravel lens. Inasmuch as the wood was alive when picked up these represent the time of last recorded ice advance at these spots.

W-91 (18,050±400) Ross Co., Chillicothe Biers Run, ½ Mile NW of US 35	10-28'	<i>till</i> , gray sand lenses 1-3' thick <i>wood</i> near base abundant
8'	(0-3'	<i>peat</i> , lens 45' long now covered or gone)
<i>soil</i> , Miami A, B, C in bank above floodplain	(25'+	<i>till</i> , now covered)
10-25'		<i>till</i> , gray, compact where creek cuts high bank
		otherwise, 2-3" <i>sand</i> , alluvial, silty, where creek has migrated
3-7'+	W-127 (21,600±1,000) Pickaway Co., Harrisburg Route US 62 cut ¼ mi. S of Harrisburg	
<i>till</i> , gray, compact numerous sand lenses to 20' long laminated, some contorted limonite crusted <i>logs</i> (over 200 seen) some against gravel twisted black pods of forest litter	(6'	<i>soil</i> shallow Miami A, B, C in region)
	15'	<i>till</i> , gray with sand lenses, <i>wood</i> at base
Y-449 (23,000±250) Franklin Co., Columbus 2 blocks NW of Capitol 4th St. at Long St.	(5'±	<i>gravel</i>)
(? <i>soil</i> removed in previous building)	W-88 (21,400±600) Licking Co., Newark Ramp Crk. at NYCRR Kaiser Aluminum Corp. ¼ mi. W of Ohio 79	
15'		<i>till</i> , gray <i>wood</i> at very base partially replaced by pyrite
50'±		<i>gravel</i> , bedded
Y-450 (16,560±230) Butler Co., Dartrtown Fourmile Creek cut SE¼ SE¼ Section 31 Lane's Mill (and ½ mile NE)	5-15'	<i>sand-gravel</i> , outwash fan of Ramp Crk.
	60'+	<i>till</i> , dark gray, sticky twigs and <i>logs</i> at 45-60' film of marcasite in cracks.
9'	(200'±	more <i>till</i> on bedrock in old Newark Valley, wells nearby)
<i>soil</i> , except to NE on low bank under floodplain, 5-8' silty gravel instead		

Four other sites involve wood in thick till lying on a buried soil or vegetation mat. The Sidney railroad cut log (W-188) is right on an excellent leached and clay-enriched soil where it probably grew. At Oxford (W-92), there are 6 inches of leached tan sands or reduced blue green lacustrine clays under a very thin layer (or layers) of leaves, twigs, insect wings, etc. At Kirkwood (W-414) and at Plum Point (W-177) the tills containing logs are traced to where they overlie older peat or gyttja over 32,000 and 37,000 years old. (Actually Dreimanis [1953, p. 1414] describes 2 tills separated by lacustrine clay, and logs are in the lower one, so the last advance was multiple or pulsating in the Erie Basin.) Thus, it seems most likely that the peat and soils are considerably older on the average than this last glaciation, and the ice merely picked up the last live trees to grow on that surface. Thus the underlying peat and soil is identical with that discussed already under "Early Wisconsin."

W-92 (19,980±500) Butler Co., Oxford Bull Run, ½ mi. W of US 27 NE¼ SW¼ Section 26	2-3'	<i>soil</i> , clay and sand blue black, ghosts of dolomite pebbles, grades to pH 6.5	
10'	<i>soil</i> , Miami A, B, C	0-3'	<i>gravel</i> , silty, reddish ghost dolomites, leached
25-60'	<i>till</i> , blue gray, compact silt or gravel lenses <i>logs</i> (over 100) from lower half	1'+	<i>till</i> , silty-clay, calcareous
(½')	<i>soil</i> , leaf litter, twigs, bark, smear pale blue gray leached till)	W-188 (23,000±800) Shelby Co., Sidney B&O RR cut, ¾ mi. W of US 25 SW¼ SE¼ Section 14	
(4')	<i>till</i>)		
OR½'	<i>soil</i> , olive brown, with twigs leached 1-5"	2'	<i>soil</i> , Miami shallow, A, B
1'	<i>sand</i> buff, calcareous, lenticular beds	5'	<i>till</i> , brown, clay rich
OR 2-5'	<i>lacustrine</i> silts, laminated greenish gray, rotten smell	5'	<i>till</i> , pebbly, gray boulder pavement at base east-west fabric
15'+	<i>shale</i> , Ordovician, calcareous	0-2'	<i>fine sand</i> , well sorted, bedded
W-414 (22,000±1,000) Shelby Co., Kirkwood Brush Creek, ½ mi. E of US 25 NW¼ NW¼ Section 6	4'	<i>till</i> , clay-rich, brown, pH 7.4 containing silty pods (soil A zone)	
2'	<i>soil</i> , brown		one <i>log</i> at very base
(0-4½')	<i>gravel</i> , silty, alluvial shifting channel, inset into till near bridge)	2-6'	<i>soil</i> leached 1½-4', oxidized reddish, pH 6.4-6.6
2-25'	<i>till</i> , silty-clay rich local sand-silt lenses calcareous <i>logs</i> near base (W-414)	30'	<i>till</i> , gray, compact north-south fabric containing 1' silt lens 25' down structureless 10 species gastropods mostly land pulmonate
0-½'	<i>peat</i> band with twigs, discontinuous (W-415)	W-177	see section for W-100 Plum Point

Finally, with this middle Wisconsin group of dates are four with different stratigraphy because they all occur in slightly higher hummocky belts mapped as end moraine. (W-71. This site is different also. These proglacial lake beds covered by till are described in White, [1953].) At Southern Hills (W-37) and at Westchester (W-304) the till bearing the wood is a continuous layer, compact, and blue gray, but above it are several lumps or lenses of other till, oxidized pale brown and interlayered with silty bedded gravels 10 to 40 feet deep. The lower till layer with wood is interpreted as plastered on beneath the last advancing ice; the overlying hodge-podge of till and poorly sorted gravels without wood is interpreted as a retreatal halt decades or centuries later. However, at Anderson Run (W-331) the masses of tangled wood lie between underlying compact silty gravels and overlying till. At Cuba (Y-448) on the outer Wisconsin moraine the few sticks come from 13 feet down in a surface excavation for a farm pond in till. In these two cases the ice last pushed over any earlier deposits of these end moraines.

W-304 (20,500±800) Butler Co., Westchester E. Fork Mill Crk. NE¼ SW¼ Section 22 Skinner S & G Co.	W-331 (17,980±400) Ross Co., Anderson Anderson Run cuts 1½ mi. S. of US 35
3' soil, A, B	3' soil, A, B
40' outwash, mound-like top, contorted beds coarse gravel to fine sand till masses to 15' diameter	10-30' till, mound-like top, dusty gray contorted lenses sand dipping sharply N logs to 1', pods of needles in lower 3'
5'+ till, gray logs to 1' in bank and creek	0-2' forest, tangled logs, twigs, silt
W-37 (20,700±600) Montgomery Co., Southern Hills Holes Creek bed	5-15' sand-gravel, silty, bedded, cross bedded, compact, part cemented, rusty streaks
2-3' soil, A, B, Miami	(3'+ bedrock Devonian, Ohio shale in creek bed)
2-6' till, brown	Y-448 (18,500±420) Clinton Co., Cuba Farris Rd., Whitson Farm 1.1 mi. SE of Cuba S of Ohio 350
1' sand lens	
5' till gray	4' soil, deep Miami, A, B 48" leaching, gentle slope
3½' silt-fine sand, laminated same layer ½ mi. away has fluvial molluscs	8' till, leached buff in C zone logs near base
5'+ till, sticky blue gray logs in lower 2' exposed	2'+ till, gray with logs

Advance of the glacier.—When these Wisconsin C¹⁴ dates are plotted on the map of Ohio (fig. 1), it becomes evident that they form a consistent sequence from old at the north to young in the south. As the first C¹⁴ dates began coming in one hesitated to jump to this conclusion in view of the several potential errors in the radiocarbon method (such as the assumption that C¹⁴ content of trees 20,000 years ago was the same as that today). Each new date fitted the picture until the sequence seems firm beyond probable limits of laboratory error. Even if absolute dates are assumed incorrect, we must conclude that these dates show the gradual spread of the last ice southward. This leads to two conclusions contrary to traditional thinking: (1) The till sheets of the ground moraine in western Ohio are deposited in the main by *advancing* ice, (not retreating ice). (2) Between 24,600 and 16,600 years ago the retreats in Ohio, if there were any, were short-lived. The biggest gap in chronological record is between the Lake Erie region 24,600 years ago and Central Ohio 23,000 years ago; this may well involve ice edge pulsations, but such advances did not reach Shelby and Franklin counties where trees grew until 22,000 and 23,000 years ago.

The rate of average advance may be calculated in round figures. Only the average of many figures covers time span sufficient to disregard the probable error, but each individual segment between pairs of C¹⁴ dates has been figured to arrive at the most reliable average. Only dates in the same ice lobe have been compared and distances were measured along the line of average ice flow, which is fairly well known from striae, grooves, crag-and-tail, some 500 stone counts in till, and a few fabric measurements.

Area	C ¹⁴ dates used	Distance ice advanced in miles	Average rate in feet per year
Upper Scioto lobe	W-71 to W-88, 127, Y-449	137-142 mi.	310
Upper Miami lobe	W-71 to W-188, 414	146	390
Lower Scioto lobe	Y-449 to W-91, 331, Y-448 & W-127 to the same	40-54 29-47	53
Lower Miami lobe	W-188 to W-37, 92, 304, Y-450 and W-414 to the same	38-58 37-58	108

Disregarding unknown but possible short retreats falling in the C¹⁴ time gaps, the overall rate was an average advance of 350 feet per year through northern Ohio and 83 feet per year in the southwestern quarter of Ohio. Individual values ranged from 223 to 481 feet per year in northern Ohio and 41 to 204 in southwestern Ohio. The average rate in southwestern Ohio is influenced strongly by the low age determination for Y-450 which may simply represent one of the oscillations of the ice near its maximum between 20,500 and 16,600 years ago. These oscillations correspond in C¹⁴ time scale to the Bloomington Moraine and other later moraines in Illinois.

LATE WISCONSIN FORESTS

C ¹⁴ Date	Number	County	Village	Landmark	Collector
14,300±450	W-198	Williams	Edon	Ohio Turnpike	Rubin
12,380±370	W-57	Steuben, Ind.	Fremont		Wayne
13,020±400	W-65	"	"		Wayne
12,600±600	M-350	"	"		Zumberge
13,600±500	W-33	Cuyahoga	Cleveland	Canal S & G Co.	White
12,920±400	W-430	Erie	Pakertown	Turnpike at Rt. 4	Forysth
12,800±250	Y-240	Sandusky	Bellvue	NW¼ Sec. 10	Campbell 1953
(8,420±400)	M-66	Madison	W. Jefferson	Orleton Farms	Baby)
(8,460±400)	"	"	"	"	"
9,600±500	"	"	"	"	"
8,513±500	C-526	Erie	Castalia	Medusa Cem. pit	Goldthwait

(Those dates in parentheses are considered less reliable.)

Surface deposits.—Two of these "young" dates come from deposits associated with the Wabash Moraine. They lie on top of all till involved in the moraine and so post-date the last ice there. At Fremont in Steuben Co., Indiana (W-57, 65, M-350), the material is peat almost directly on the upper till. Is this sandy calcareous gravel overlying it deposited by meltwater from ice? Many geological visitors agree that it is glacial gravel, but that it may be redeposited in this swale-lowland situation cannot be denied. Therefore, it represents the minimum date for ice at Wabash Moraine, but it is likely it formed soon after the ice since it is at the base of several post-glacial layers. In the second case, Edon (W-198), the problem is similar. The wood is in lacustrine silts on high topography on top of the moraine. The silts are local, suggesting a small pool in an ice block hole. Thus, the readvance to Wabash Moraine dates from about 15,000 years ago, or, in any case, more than 14,300. This may well correspond to Cary substage or a part of what is now called Cary in Illinois.

W-57, W-65, M-350 (12,380 to 13,020)
Indiana, Steuben Co.
Fremont
NE¼ NE¼ Section 2

W-198 (14,300±450)
Williams Co., Columbia or Edon
Ohio Turnpike and Rt. 49
NW¼ NW¼ Section 3

1' or (3½')	<i>muck</i> , gray black <i>clay</i>)	3'	<i>soil</i> , brown, C zone, in silt
2'	<i>sandy gravel</i> , brown top leached, ghost pebbles	½'	<i>silt-clay</i> with <i>wood</i> fragments
2'	<i>sand</i> , calcareous, brown clay seen at base	3'	<i>silt-fine sand</i> , interbedded laminae
½'	<i>peat</i> , sandy matrix, <i>wood</i>	8-15'	<i>till</i> , gray, clay-rich
(¾')	<i>marl</i> in places)	½-1½'	<i>clay</i> , plastic, gray
2'	<i>till</i> , gray, calcareous, few small pebbles	3'	<i>sand</i> , gray

Three very closely spaced dates come from samples under well-established Lake Whittlesey deposits. Beneath each sample is till, probably the clay-rich till of a "late Cary" advance, (Winslow, White, and Webber, 1953, pp. 38-41). At Cleveland, near the Cuyahoga River (W-33), the sample lies right on the till at 690 feet elevation, well below the Whittlesey level. This represents the water rise at the end of Lake Arkona recorded here by 10 feet of overlying sandy silts. Its date is so old (13,600±500) as to crowd the intervening events after Wabash Moraine; did the deposition of Ft. Wayne Moraine, Defiance Moraine, and 3 stages of Lake Maumee take only 1,400 years? The Bellevue sample (Y-240), from a well, was simply in the higher beach sand—driftwood at the 735 foot lake level. Parkertown (W-430) is an intricate series of clay, sand, and humus layers right on the last till but underlying a good shingle beach of Lake Whittlesey (elevation 710 feet). These agree very well that Lake Whittlesey existed about 13,000 years ago.

One lake-controlled specimen falls at a much later date. It comes from the famous Castalia marshes (C-526) in a lower forest layer now explored over hundreds of acres (Dashnowski, 1912; Campbell, 1955). This is the only C¹⁴ site where the stumps are clearly rooted in place, so the underlying poorly laminated clays represent the higher (above 630 feet) glacial lake stages ending with Lake Warren (II?). Sands on those clays may represent slow dropping of the shore. Then the trees grew, probably during Lake Lundy time when ice still blocked the St. Lawrence River, but the edge was far away in New York and well up in Ontario. Calcareous shallow pools began to cover things up with marl, and travertine marshes alternated with periods of forest.

W-430 (12,920±400)	C-526 (8,513±500)
Erie Co., Parkertown	Erie Co., Castalia
Ohio Turnpike at Ohio 4	Medusa Cement pit, Ohio 299
NW¼ SE¼ Section 2	SW¼ SE¼ Section 3
4½' gravel, beach shingle	1½' soil, muck, gray
3' sand, brown above, mottled below, calcareous	1½-4' marl, gray to buff molluscs thin black peat beds (2-6")
1' clay, laminated, plastic, gray, wood, needles, cones at base	1-2' travertine, lumpy, buff
1' humus, brown, sandy, noncalcareous	½-1' marl, gray black peat layers to 3"
1½' sand, gray, calcareous gravel at top	1-2½' travertine, lumpy plant casts, molluscs, logs at base
1½' clay, gray, plastic	¼-1' forest bed, logs to 2' stumps in place, middle noncalcareous
2½' till, gray, stony	1-3½' sand, blue gray, sharp
10'+ limestone	(48' clay, plastic, drilled by Ohio Geological Survey)

The final date (W. Jefferson, M-66) is typical of many kettle holes and ponds in west central Ohio. This is the only one studied in detail recently (Goldthwait, 1952; Sears and Clisby, 1952), so it is the only one dated. Like most others, it shows that an early period of open shallow pool (marl on the till) ended about 9,600 years ago when postglacial forests encroached and swamp vegetation became dense. As dated in other states, these were the declining days of the last (Valders, post Alleröd) ice advance.

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