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GLACIAL GEOLOGY OF THE DAWES ARBORETUM, LICKING COUNTY, OHIO¹

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ABSTRACT. Detailed mapping of the glacial deposits on the properties of The Dawes Arboretum and immediately adjacent landowners, done at the invitation of the arboretum director, revealed a landscape of Wisconsin end moraine and ground moraine, underlain by Mississippian Logan Sandstone throughout the 7.8 km² area. The resulting mapping shows the Wisconsin Terminal Moraine winding generally north-south across the eastern edge of the area, with 2 other early retreatal Wisconsin end moraines farther west. The Jacksontown Moraine of this report extends northeast across the area, locally overlapping the Terminal Moraine west of Fairmount Church hill. The Dawes Moraine of this report, also with a northeastward trend, lies west of the Jacksontown Moraine in the south, but merges with it farther north. Readvance to the Jacksontown Moraine blocked a small stream flowing northwestward off the Terminal Moraine east of Jacksontown, causing lake silts to accumulate in its upper basin, south of Rt. 440, and forming a new stream, Quarry Run, flowing northward across Rt. 440 through the sandstone hills of the arboretum's eastern properties.

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INTRODUCTION

Detailed mapping of the glacial deposits of The Dawes Arboretum and adjoining property was done as a result of an invitation to spend 2 weeks (21 November-6 December 1980) as a guest of the arboretum, studying the glacial features there. The results of that study are presented here.

The arboretum is located about 8 km south of Newark and 1.6 km north of Jacksontown on Ohio Rt. 13. The property includes not only the major arboretum grounds west of Rt. 13, but also 3 large parcels of land east of the highway (fig. 1). These eastern lands, in which lies the deep rocky valley of Quarry Run, together with intervening properties owned by others, were all included in this study.

The arboretum lands lie among hills of Mississippian sandstone near the boundary

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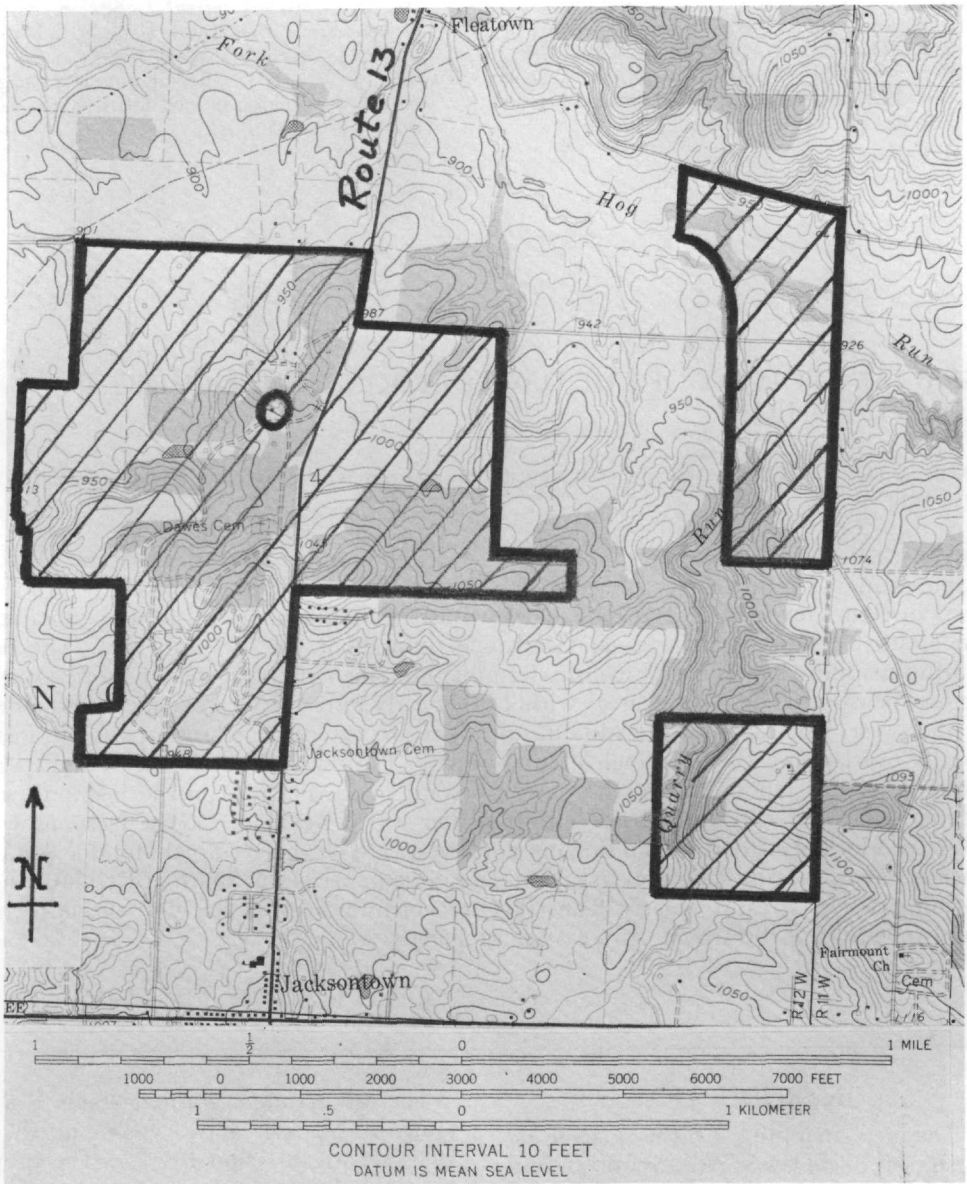


FIGURE 1. Distribution of lands owned by The Daves Arboretum. Visitor center is shown by heavy circle.

of the Wisconsin glacier. Thus, mapping of the glacial deposits represented a challenge to distinguish end moraines from hills of sandstone thinly capped by till (ground moraine), in an area of cultivated

fields and woodlots where exposures and water-well records were almost entirely lacking. As a result, mapping had to be based almost entirely on subtle topographic variations, methods that are

inexact and subjective. Fortunately, agreement in orientations and historical implications between small separate areas of mapping inspired confidence in the final results. Documenting the successful conclusion of this challenge (to map such a small area with limited factual data) is the second purpose for this paper.

GEOLOGIC SETTING

Bedrock in this area is dominantly the Mississippian Logan Formation (Hyde 1953, Franklin 1961). This formation is composed mainly of fine-grained sandstone, though some siltstone and shale are also present, as are a few thin layers of conglomerate. The formation has been divided into 4 members, which are, in ascending order, the Berne, Byer, Allensville, and Vinton (Hyde 1953, Franklin 1961). Thicknesses of these units vary from place to place, but measured sections from the large Quarry Run south of Newark provide values that probably apply to the arboretum area as well (sections provided by Hyde (1953) and Franklin (1961) from whom all the bedrock data used here were drawn).

The basal Berne Member is characteristically a quartz-pebble conglomerate that here is about 1.5 m thick. The Byer is basically a buff fine-grained sandstone ("freestone") that tends to be more massive in the upper layers and is about 8.5 m thick. The Allensville varies in lithology, with a basal 30.4 cm-thick yellow-stained sandstone, overlain by about 3 m of shale, in places containing some fossils of the clam *Allorisma* and locally including a 30.4 cm layer of conglomerate in the middle, all overlain by 4.2 m of buff fine-grained sandstone. The top member, the Vinton, is composed of about 25.8 m of siltstone, shale, and fine-grained, thin-bedded sandstone. The entire Logan Formation is underlain by the Cuyahoga Formation, also Mississippian in age, which here is a thin-bedded, fine-grained sandstone that has been called Black Hand (the name normally reserved for a coarser facies of the Cuyahoga), and is overlain by

the Pennsylvanian Coal Measures (Franklin 1961).

Bedrock is exposed in only a few places in the arboretum area: at 2 cuts along Rt. 13 north of Jacksontown and down within the valley of the small Quarry Run on the arboretum property. Based on careful study of Franklin's (1961) map and Hyde's (1953) measured sections near Newark, I interpret the more northern (higher) of the 2 road cuts along Rt. 13 to be Vinton and the lower one, next to Jacksontown Cemetery, to be Allensville, with its characteristic yellow-stained basal sandstone well exposed. Rock excavated from under the addition to the arboretum visitor center appears to be Byer. Quarry Run, located about 1.6 km east of Rt. 13 and generally down the south-east dip of the strata, contains exposures that are mainly thin-bedded, fine-grained sandstone which I believe to be Vinton, though cuts farther downstream to the north may penetrate Allensville.

Basal Pennsylvanian is interpreted by Franklin (1961) to occur at the top of the hill under Fairmount Church, east of the upper end of Quarry Run. Cuyahoga (Black Hand) Sandstone is believed by Franklin (1961) to be present near the foot of the steep west-facing slope below the arboretum buildings, though it is not exposed there.

This west-facing slope represents the east bluff of a deep buried valley lying directly west of the arboretum. This valley was formed by the Groveport River, a major tributary of the preglacial Teays River, which headed near Wooster and flowed southwest to join the Teays near London, Ohio (Stout et al. 1943). Actually the bluff does not face due west, but northwest, an orientation produced by the presence of the valley of a small ancient tributary from the east, which today contains Hog Run. Thus the view out from the visitor center windows looks north-westward across the mouth of this small tributary valley, though the main, large preglacial valley of the Groveport River farther west can be seen off to the left.

The main Groveport River valley, which is about 4.8 km wide in the arboretum area, is almost filled with about 121 m of glacial drift here, according to water-well records provided by the Division of Water, Ohio Department of Natural Resources. The top of the bluff at the Dawes Arboretum stands more than 30 m above the top of the fill. Thus, before deposition of the glacial materials, this valley must have been at least 151 m deep.

GLACIAL GEOLOGY

The glacial geology of all of Licking County had already been mapped some years ago (Forsyth 1966), mapping which also appears in the lower right-hand corner of most versions of the Glacial Map of Ohio (Goldthwait et al. 1961). That earlier mapping had shown the Wisconsin boundary to lie close to the eastern edge of the easternmost arboretum lands, more or less along Fairmount Road, 1.6 km east of Rt. 13 (fig. 2). Distinction of the Wisconsin till from that of the Illinoian was on the basis of soils (Forsyth 1966), as it is in modern mapping by the Soil Conservation Service (R. Parkinson, Licking Co. Soil Conserv. Serv. soils mapper, pers. comm. 1980). Soils developed in Wisconsin till in well-drained situations (Alexandria soils) are normally about 76–102 cm deep, while soils developed in Illinoian till in well-drained sites (Hanover soils) are more intensively weathered, have thick B3 horizons, and are generally about 178–203 cm deep.

The Wisconsin boundary, as shown on the 1966 map, generally follows the outer (eastern) edge of a more or less continuous terminal moraine. Other segments or irregular masses of Wisconsin end moraine were mapped farther to the west. It was anticipated that, in the detailed work of 1980, these main glacial features would be identified in basically the same positions, perhaps with somewhat better defined margins, though more major modification of that original mapping was not ruled out.

Mapping of the glacial deposits in the 7.8-km² area was done entirely on foot. Actual exposures of glacial materials were rare and uninformative, but extensive observations of the surface soil showed Wisconsin till to be present at the surface almost everywhere; no Illinoian soil was found, and no glacial gravel was observed. Bedrock outcrops were limited to the 2 roadcuts and Quarry Run exposures, with limited water-well data on depth to bedrock available along the roads at the edge of the study area.

With no really informative exposures and very minimal water-well data, topographic expression became the main basis for mapping. Smooth-sided hills were interpreted to be ground moraine, bedrock hills thinly mantled by till. True hummocky landscape, even where the hummocks were low and indistinct and occurred on the gentlest of linear rises, was mapped as end moraine. With these imprecise methods, agreement in orientations and implications of individual areas of mapping encouraged confidence in the final results. Locally, information about thickness of till was even inferred from vegetation. For example, the presence of trees like sassafras, characteristically found on sandstone, suggested that the sandstone bedrock might be shallow under thin till, while abundant mesophytic trees like beech and ash implied that the (water-retaining) till was fairly thick.

The final results of this mapping are shown in fig. 2. The Wisconsin Terminal Moraine is essentially unchanged from the 1966 mapping, being oriented generally north-south but extending eastward up each of the adjacent west-going valleys. However, new mapping of the locations and orientations of other end moraines within this limited area is quite different from that shown on the earlier map (Forsyth 1966). Identification of end moraines is important because these features represent different positions of the glacial margin, which, when related, reveal the glacial history of the area. Because the

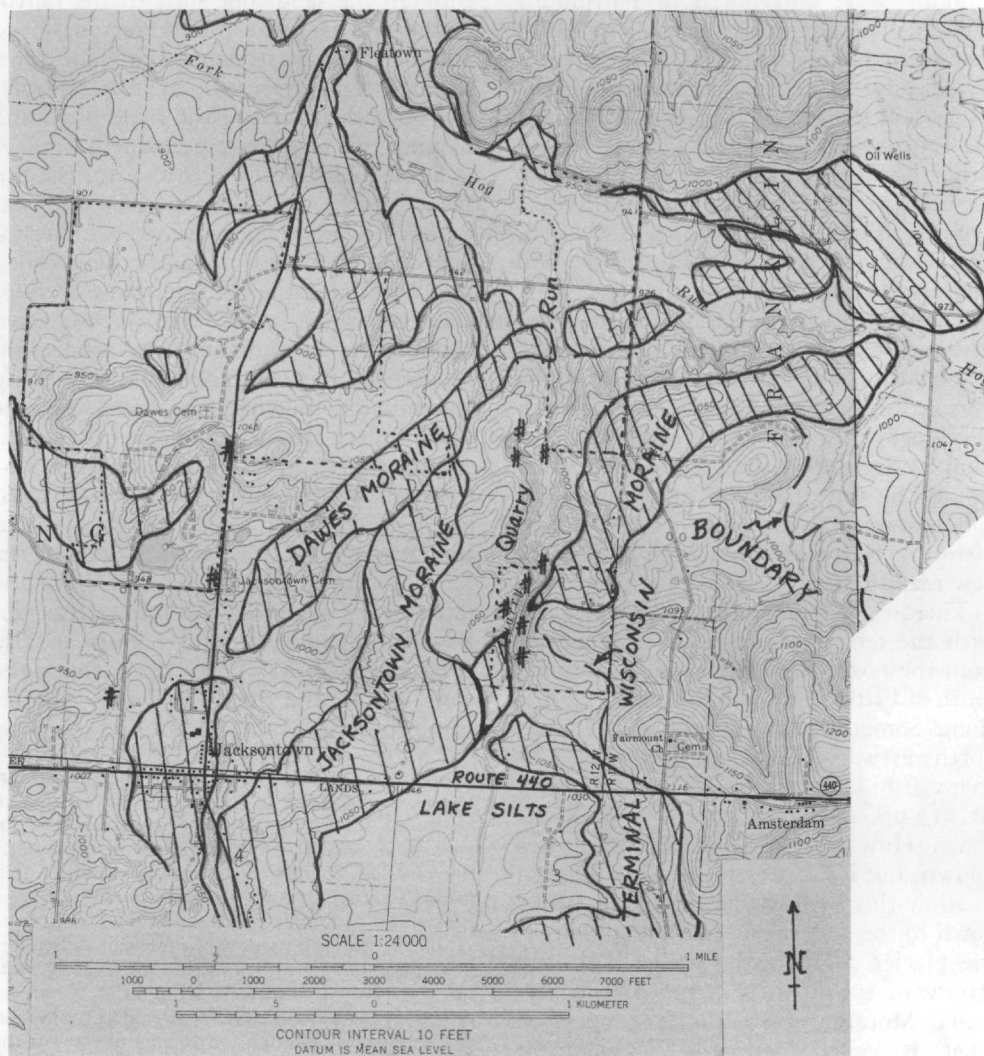


FIGURE 2. Wisconsin End Moraines on the properties of The Dawes Arboretum and adjacent landowners. Land between end moraines is ground moraine, thin till on sandstone hills, except for the southeast corner, where Illinoian ground moraine and lake silts are present. (Wisconsin boundary at east edge of map courtesy of Robert Parkinson, Soil Conservation Service soil scientist in Licking Co.) Locations of bedrock exposures marked by the symbol #.

glacial history implied by the pattern of the end moraines as mapped in this study (fig. 2) seemed to make sense, acceptance of this subjective mapping was encouraged.

One change from the 1966 mapping shown in fig. 2 is not a result of my 1980

work, but has been drawn from the new Soil Conservation Service soils mapping (R. Parkinson, pers. comm. 1980). This is the Wisconsin boundary, which I assumed in my 1980 studies to be at the position mapped earlier (Forsyth 1966), following the outer edge of the Wisconsin terminal

moraine west and north of Fairmount Church. The new soils mapping north of that church shows the Wisconsin boundary bending far to the east, a change in the location of the glacial boundary but not of the Terminal Moraine margin there. Similarly, the steep sandstone hills directly to the north across Hog Run, called Illinoian by Forsyth in 1966, are shown as Wisconsin on the new soils mapping by the Soil Conservation Service.

The deep rocky gorge of Quarry Run, in the eastern arboretum property, represents a diversion, by a readvance of the Wisconsin glacier, of a small stream that developed after the glacier had retreated from its position at the Terminal Moraine. It was the way the 1980 mapping of the end moraines seemed to fit this inferred history so well that encouraged faith in the new mapping.

The diverted stream began its existence with the retreat of the Wisconsin glacier from the position of its Terminal Moraine south of Fairmount Church (and Rt. 440), along Somerset Rd. This stream flowed northwestward, crossing both Rt. 440 about 0.8 km east of Jacksontown and Rt. 13 about 0.5 km north of Jacksontown. How far the ice retreated is not known, but it had to have been far enough to allow this little stream to cut its valley down to the northwest, but not so far that the glacier could readvance back shortly afterward to within 0.8 km of the Terminal Moraine. Here the ice deposited what is called here the Jacksontown Moraine (fig. 2), which I interpret to overlap the Terminal Moraine just west of Fairmount Church and Quarry Run valley.

The ice and the Jacksontown Moraine together blocked the little stream, ponding it and causing lacustrine silts to accumulate in its upper valley. These silts occur in the broad flat area south of Rt. 440, 0.8 km east of Jacksontown, marked today by Luray silty clay loam soils (R. Parkinson, pers. comm. 1980). The ponded waters, fed by streams from the east and glacial meltwater from the west, must have risen quickly and overflowed by the lowest available route,

through the sandstone hills to the north. Aided by its great meltwater-enhanced volume, the new stream quickly cut down through the surface till into the underlying bedrock, draining the little pond and making this new route permanent.

Subsequent glacial retreat from the position of the Jacksontown Moraine was followed by another readvance, which produced another end moraine, here called the Dawes Moraine. This moraine overlaps and combines with the Jacksontown Moraine in the northeastern arboretum properties, the combined moraine being traceable, somewhat obscurely, up the south side of Hog Run and then back west on the north side before it fades out against the steep sandstone hills northeast of the arboretum. Thus this moraine has the form of a "U" on its side, open to the west, fitting inside the larger "U" of the Wisconsin Terminal Moraine (fig. 2). Patches of later, lower end moraine are also present west of Rt. 13 to the north, to the west, and within the main Dawes Arboretum properties.

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