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GLACIAL GEOLOGY OF HOLMES COUNTY, OHIO

by
GEORGE W. WHITE

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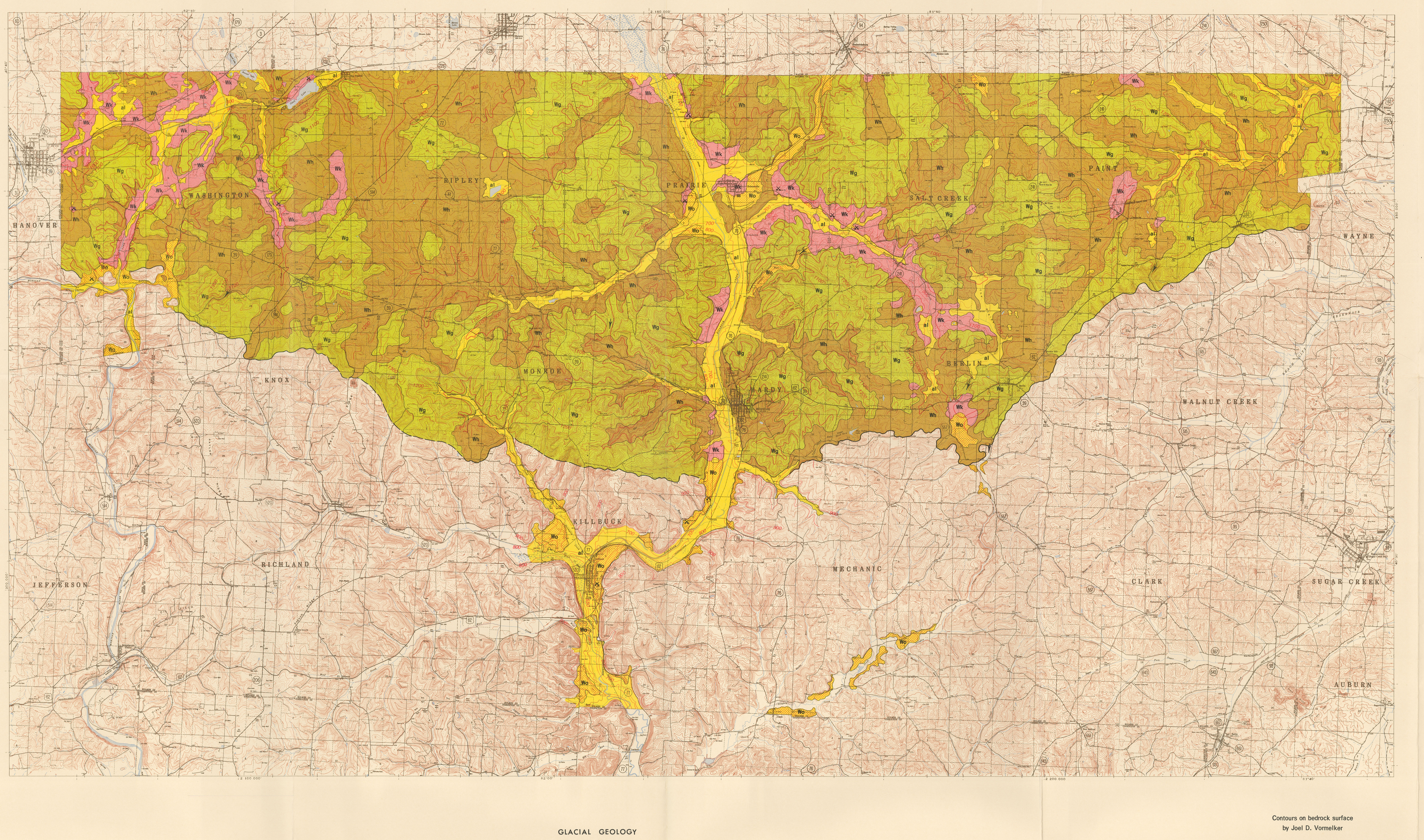
OHIO DIVISION OF GEOLOGICAL SURVEY
REPORT OF INVESTIGATIONS NO. 91
GLACIAL GEOLOGY OF
HOLMES COUNTY, OHIO



EXPLANATION

QUATERNARY

Recent

al

Silt and other alluvium. In floodplains and kettle holes kettle holes, some now incorporated in floodplains may contain peat or muck.

Pleistocene (Wisconsinan)

Wo

Outwash. Low terraces, valley trains. Generally sand, which may be silty; till or clay may underlie the sand.

Wk

Kames and kame terraces. Gravel and sand in knolls or in terraces; may be overlain by thin till.

Wg

Ground moraine. Till, generally less than 20 feet in thickness; may be much less. Mainly sandy Navarre Till, but may have a thin discontinuous upper layer of silty Hayesville Till up to 3 or 4 feet in thickness.

Wh

Hummocky moraine. Till, up to 40 feet or more in thickness. Sandy Navarre Till generally overlying Millbrook Till; may have very thin silty Hayesville Till at surface in some places.

Boundary of deposit, *dashed where approximate*

Glacial boundary, *dashed where approximate*

1000

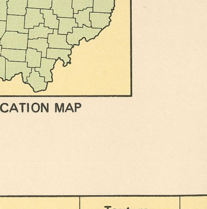
Contour on bedrock surface, *dashed where approximate, contour interval 100 feet (shown to within approximately ½ mile of glacial boundary)*

Spillway, outlet of glacial meltwater

Gravel pit

Gravel pit, small or abandoned

Contours on bedrock surface
by Joel D. Vormelker



LOCATION MAP

BASE COMPILED FROM THE FOLLOWING 7½-MINUTE U.S. GEOLOGICAL SURVEY TOPOGRAPHIC QUADRANGLE MAPS

Baltic	Greer	New Bedford
Berlin	Holmesville	Shreve
Brinkhaven	Killbuck	Spring Mountain
Fredericksburg	Loudonville	Sugarcreek
Glenmont	Millersburg	Wilmot

1 ½ 0 1 MILE
4000 2000 0 4000 FEET

CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

10,000-foot grid based on Ohio coordinate system, north zone

Cartographic drafting by Leslie R. Lewis

GLACIAL GEOLOGY

INTRODUCTION

Holmes County, in the western part of the Allegheny Plateau in northeast-central Ohio, is underlain by almost horizontal beds of Mississippian and Pennsylvanian age; these beds are predominantly shales and sandstones, with some beds of coal, limestone, and clay (White, 1949). At least three and possibly four ice sheets entered the northern part of the county. The next-to-last ice sheet extended the farthest: the southern margin of its deposits is the glacial boundary. This boundary extends in an arcuate form from the line between Washington and Knox Townships in the northwestern part of the county in a general east-southeasterly direction across Knox, Monroe, and western Hardy Townships to the Killbuck valley, thence in a general easterly to northeasterly direction across western Hardy, Berlin, and Paint Townships. The drift of Holmes County represents deposits of the central part of the Killbuck Lobe, which is named for the Killbuck valley and is one of the sublobes of the larger Erie Lobe (fig. 1).

The glaciated northern part of the county, with its higher proportion of rather level uplands and its smoother, more rounded ridges and hills, contrasts with the more angular hills and ridges of the unglaciated southern part of the county. The soils of the glacial drift are markedly different from those derived from bedrock in the unglaciated part.

All the present drainage of the county finds its way to the south, either directly or indirectly, but the preglacial drainage was north and south from an ancient divide across the central part of the county. The various ice advances reversed the northward drainage and the major streams, Killbuck Creek, Lake Fork of the Mohican River, and Doughty Creek, now flow through the old divide (for details see White, 1949, p. 11-17). The old valleys have rock floors as much as 200 feet below the present valley bottoms. These valleys are partly filled with glacial and alluvial materials of various ages. One of the largest of these ancient valleys, now without a stream, extends from Loudonville across northern Washington Township to Big Prairie in Ripley Township. Lake Fork of the Mohican River cuts across it at right angles.

Glacial drift overlies the bedrock with varying thickness. At places ledges crop out; at other places, mainly in the larger valleys, the drift may be more than 200 feet thick. On the uplands and on the upper valley sides, the drift generally ranges from less than 10 feet thick to 20 feet or a little more. The thinner drift has a relatively smooth aspect; it simply mantles the underlying bedrock surface, so that the major relief is due to the irregularity of that surface. Thicker drift generally has a more irregular, hummocky surface form.

GEOMORPHOLOGY OF THE GLACIATED AREA

Ground moraine

Large tracts of upland and upper valley sides have a generally smooth to gently undulating surface, which is mapped as ground moraine. The till of these areas ranges in thickness from a very few feet to 10 feet or more. Except on some uplands, which may have shallow undrained depressions, the ground moraine areas are generally well drained.

Hummocky moraine

Large areas of irregular and hummocky topography are found along lower valley sides and at places on upper valley sides and on the uplands. The largest such upland areas are in Ripley Township. The hummocky character is mainly a function of drift thickness: the thicker the drift, the more opportunity for variation in thickness and therefore for irregularity of the surface. The constructional topography may have a relief of 10 to 20 feet, with some knolls rising higher. A few undrained depressions occur in these areas.

Two ridgelike features, which are described elsewhere in detail (White, 1949, p. 26, 27-28), extend across the valley of Doughty Creek at the glacial boundary two miles south-southwest of Berlin and almost across the valley of Killbuck Creek just south of Holmesville. These features were deposited at ice margins. Other areas of hummocky topography, however, do not mark ice edges; the term "hummocky moraine" is therefore preferred to "end moraine," a term that was used previously for such areas in Stark and Wayne Counties (White, 1963, 1967).

The drift of the hummocky moraine areas is largely till, but some gravel may be associated with it, especially low on the valley sides. In some of the larger valleys the moraine topography assumes a terrace form similar to that of kame terraces. A particularly good example is the terrace in Prairie Township on the west side of Killbuck valley; this terrace extends from opposite Holmesville north to the county line. Part of this hummocky terrace is underlain by gravel at some depth, and very likely almost all of the terrace has gravel in it. The irregular topography is thus a record of buried irregular kame terrace topography. Similar very hummocky topography, mapped as moraine because its surface material is till, is almost certainly underlain by gravel in the ancient valley extending from Loudonville to Big Prairie and thence across southern Wayne County to Shreve, and in Salt Creek and Berlin Townships in a belt north and east of The Plains.

Kames and kame terraces

Kames are irregular conical knolls of gravel. They may be separate features or they may be closely aggregated along valley sides to form irregular, pitted, and hummocky kame terraces. Such terraces, with some till intermixed at places, are conspicuous features in many of the valleys in the glaciated part of Holmes County (White, 1949, p. 34-40); they are present discontinuously in the Killbuck valley and are very extensive in the valley of Martins Creek, the valley of Lake Fork, and in the abandoned valley in northern Washington Township. The terraces, situated from less than 20 feet to more than 100 feet above stream level, were deposited by meltwater flowing between the valley wall and ice blocks remaining in the center of the valley after the main ice sheet had melted from the uplands. After the terraces were formed, ice blocks buried in the gravel melted, forming depressions called kettle holes. At most places till, ranging in thickness from less than 1 foot to more than 10 feet, overlies the gravel of the terraces, showing that the gravel is related to an ice advance earlier than that which deposited the till (for similar situations in Stark and Wayne Counties see White, 1963, 1967). The till may be so thick that the gravel is obscured; in such places the terrace is mapped as hummocky moraine. The prominent terrace on the west side of the Killbuck valley is interpreted as a kame terrace, but till at the surface conceals the lower material and the feature is mapped as moraine.

Other tracts of kames interspersed with some kettle holes are not related to valleys. Examples are found on either side of the Washington-Ripley Township line two miles north of Nashville, in Paint Township two miles east of Mt. Hope, and at scattered other localities.

Kettle holes

Undrained depressions, formed by the melting of buried ice blocks left behind as the glacier dissipated, remain upon the glacial drift in many parts of the county. These kettle holes range in size from those which are only a few tens of feet in diameter and too small to be shown on the map to those over a mile in length, such as the one which forms the basin for Odell Lake; depth ranges from a few feet to 40 feet or more. If the water table is above the bottom of the kettle hole, a lake is formed; Odell Lake, Bonnett Lake, and a few other smaller bodies of water are examples. If the water table is at the base of the kettle hole, the area is a swamp. If the water table is below the bottom of the kettle hole, the depression is neither lake nor swamp, but may temporarily become a boggy area in periods of high precipitation. Kettle holes are common in northwestern Washington Township, northwestern Berlin Township, and northeastern Hardy Township. The depression called The Plains, north of Berlin, is the largest of these areas. Other kettle holes occur on the kame terraces and in certain of the hummocky moraine areas.

STRATIGRAPHY

The glacial deposits of Holmes County are made up of till—an unsorted mixture of clay, silt, sand, pebbles, cobbles, and boulders deposited directly by the ice—and outwash material—gravel and sand—deposited by streams of meltwater flowing away from the ice or alongside masses of ice in valleys. The deposits comprise several stratigraphic units (table 1) which can be differentiated and traced not only in Holmes County, but for long distances to the northwest in Ashland and Richland Counties, to the north in Wayne and Ashland Counties, and to the northeast in Stark County. The stratigraphy is based almost entirely on a study of the till rather than the outwash sand and gravel. The tills differ in content of sand, silt, and clay, and in mineral content, particularly of the carbonate minerals.

The tills at the surface exhibit several weathering horizons which have different thicknesses in the different tills (fig. 2). The till was originally gray (often called "blue clay with pebbles" when found in excavations). Oxidation of iron-bearing minerals, especially pyrite, takes place most rapidly, and the gray till is changed into some shade of brown. Carbonates are leached to a lesser depth, and the silicates, except the clays, are altered to a still lesser depth.

Unaltered gray till (horizon 5) is generally more than 10 feet below the surface. Where tills are thin no unoxidized material remains, and the whole mass is brown. Above the gray till, the material is oxidized to shades of brown (horizon 4) which are different for each till. In horizon 3, in addition to oxidation, the carbonates have been leached, and iron oxide and manganese stains may occur along the joints. Horizon 2 is a zone of decomposed till underlying the true soil. The colors are variable and mottled in many places, although greatly altered material can still be identified as having been till. Clay has accumulated as "clay flows" in the joints and open spaces. Horizon 1 is the true soil, divided into the A and B horizons of the soil scientist. A till lying below a later till may have all the weathering horizons preserved, but much more commonly the weathered material is partly removed and only the lower horizons are preserved.

Illinoian till

At a very few places in Holmes County a till with remnants of weathered material at the top is found below other tills in such relation that it may be of pre-Wisconsinan age, probably Illinoian. The lower deposits in the buried valleys are probably Illinoian or even older, but no information about them is available. Till believed to be of Illinoian age has been described and illustrated from several places in Wayne County north of Holmes County (White, 1967, p. 12-16).

It is probable that the Illinoian glacier advanced well into Holmes County and may have reached a position close to the present glacial boundary, but there is no indication that any surface drift at the outer margin is Illinoian. The drift in the Killbuck valley south of the glacial boundary is interpreted as outwash that is mainly, perhaps entirely, of Wisconsinan age, rather than as Illinoian till, as was proposed by Hubbard (1941).

Wisconsinan tills

Millbrook Till.—The oldest Wisconsinan till in Holmes County is the Altonian Millbrook Till, which is found in the subsurface except where two later Woodfordian tills are missing, and the Millbrook is the surface material. This till, named for an exposure in Wayne County (White, 1961, p. 71; 1967, p. 18), crops out in Holmes County at many places; it probably forms the bulk of the drift in the county.

The Millbrook Till is weakly calcareous, sandy, and pebbly, with many cobbles and boulders. Sandstone and coarse siltstone fragments are prominent. The average texture and composition of several samples are shown in table 1. The oxidized Millbrook Till is a distinctive olive-brown color, with characteristics the same as those in Wayne County (White, 1967, p. 18-21).

A period of weathering followed deposition of the Millbrook Till. A part of the weathered material (paleosol) is preserved at some places where later tills overlie the Millbrook Till, but such occurrences are not as common as in Wayne County to the north (White, 1967, p. 21).

The Millbrook Till is overlain by the sandy yellow-brown Navarre Till and, where that is missing, by the chocolate-brown Hayesville Till. Where these overlying tills are very thin, they may be so weathered and incorporated in the present surface soil that the Millbrook Till appears to be at the surface.

The Millbrook Till is correlated with the Titusville Till of the Grand River Lobe; the Titusville was deposited about 40,000 years ago, as shown by C^{14} analyses of associated peat at Titusville, Pennsylvania (White, Totten, and Gross, 1969).

Navarre Till.—The Navarre Till, the oldest till of Woodfordian age, is the surface material of much of the glaciated part of Holmes County because the later Hayesville Till is so discontinuous. The Navarre Till is calcareous, sandy, and moderately pebbly (table 1) and contains cobbles and boulders. In texture and composition it resembles the Millbrook Till, but it is more calcareous than the Millbrook and its oxidized color is yellow brown rather than olive brown. The weathering horizons of the Navarre Till are illustrated in figure 2. The depth of leaching averages 5 feet 11 inches and ranges from 5 to 7 feet. In most places the Navarre Till is not thick enough to retain the unoxidized material, and the material below is either bedrock or Millbrook Till.

The Navarre Till is correlated with the Kent Till of the Grand River Lobe. The Kent was deposited by ice which invaded Ohio about 23,250 years ago, as determined from C^{14} analyses of wood from near Cleveland (White, 1968, p. 9-22); the Navarre Till in Holmes County is at least several hundred years younger than the Kent Till at Cleveland.

Hayesville Till.—The Hayesville Till, named from exposures near Hayesville in southern Ashland County (White, 1961, p. 73), is a silty clay till, quite different from the more sandy Navarre and Millbrook Tills. Pebbles and boulders are much less common than in the older tills, and the carbonate content is much higher. The till is a characteristic chocolate to dark brown in color in contrast to the yellow brown of the underlying Navarre Till or the olive brown of the Millbrook Till and is leached about 42 inches (fig. 2). Generally, however, the Hayesville is so thin (White, 1971, fig. 3; p. 156) that all carbonates have been leached from it.

As in southern Wayne County, the Hayesville Till is discontinuous and occurs as irregular small patches, or is so thin that it is incorporated in the soil and is difficult to identify. As a result, the general impression is that the surface till of much of the county is the sandy yellow-brown Navarre Till. The Hayesville Till is most continuous in northern Ripley and northwestern Prairie Townships, as shown by areas of Rittman soil, characteristically formed on this till (U.S. Soil Conservation Service, map). Figure 3 shows the locations where this till has been observed. The southern margin of the Hayesville Till cannot be mapped with certainty because of its patchy character. The ice which deposited the Hayesville Till advanced almost to the drift limit in the county.

The Hayesville Till is correlated with the Lavery Till of the Grand River Lobe. Its actual age is not yet known, but it is probably several thousand years younger than the Navarre Till.

Anomalous red till.—At several places streaks and shreds up to 2 inches in thickness of a distinctive clayey very calcareous maroon till were observed in the upper parts of the Navarre and the Millbrook Tills (fig. 4, C). Similar small masses have been seen in other counties to the north and northeast (White, 1967, fig. 5) and in Pennsylvania (White, Totten, and Gross, 1969, p. 26-27). The origin of this anomalous material is unknown.

Postglacial deposits.—In the extensive kettle holes in the kame areas and in some of the hummocky moraine areas, ancient lakes turned into swamps, many of which are still in existence. The lake deposits are highly variable, consisting of fine sand or silt and in some cases marl. The uppermost material is generally peat, some of which may be of considerable thickness (Dachnowski, 1912, p. 77-78). Present-day streams flow from one depression to the next so that it is almost impossible to separate ancient swamp deposits from present day floodplain deposits in many parts of the county; they are therefore mapped as a unit. In general, the closed depressions are filled with organic material. The linear depressions, through which streams flow unimpeded, have been excavated by the streams and are true floodplains; the distinction is apparent from shape and position. One of the largest of these areas of ancient lakes and present swamp deposits is The Plains in northern Berlin and southern Salt Creek Townships. Other large areas are in northwestern Washington Township.

MINERAL RESOURCES

The glacial drift in certain places is a mineral resource of some importance. Gravel and sand deposits of commercial extent and character exist at various places in the kame terraces along Killbuck valley and in the outwash terraces south of the glacial boundary. A number of large gravel pits have operated in this valley. The gravel ranges from fine to coarse and varies in clay and sand content. The large outwash terrace northwest of Killbuck village was formerly the site of very large gravel operations from which material was shipped by rail for considerable distances. Large amounts of gravel exist in the ancient valley in northern and northwestern Washington Township, some of it in kames which crop out at the surface and some below a till cover of varying thickness. A considerable amount of gravel, many tens of feet in thickness, exists in the kame terrace on either side of Lake Fork in southwestern Washington Township and in the outwash terraces which extend from the glacial boundary down the Mohican valley. In Knox County these terraces are the sites of large gravel operations (Forsyth, 1961). Large gravel pits have been operated in the past in the kame terraces in the valley of Martins Creek southeast of Holmesville, and considerable gravel remains in these deposits. The gravel of the kame terraces is mainly of Millbrook age, as shown by the capping of Navarre and Hayesville Tills at some places, a situation similar to that in Wayne and Stark Counties (White, 1963, p. 150; 1967, p. 30).

In pioneer days till was used in a very small way for brickmaking, but no commercial use has ever been made of it. Because much-superior clays of Pennsylvanian age exist throughout the county, it is unlikely that the till will ever be a source of ceramic material. It is possible that drain tile could be made from some of the clayey silts in the floodplains, but shales are abundant throughout the county and offer superior material for this purpose.

Large supplies of peat are available in northern Washington Township where "more than 19 feet" is reported (Dachnowski, 1912, p. 78). Other peat deposits are present in The Plains area, and smaller deposits occur in kettle holes elsewhere in the county.

The different glacial deposits are the parent materials for soils of widely different characteristics (U.S. Soil Conservation Service map). Not only are the soils developed on till different from those on outwash, but those developed on the Hayesville, Navarre, and Millbrook Tills are different among themselves; little distinction can be made, however, between the soils developed on Navarre Till and those developed on Millbrook Till where the latter is at the surface. The soils of the glacial drift in the northern half of the county are quite different from those of the unglaciated remainder of the county and provide a great contrast in the appearance and agricultural productivity of the two parts of Holmes County.

Each deposit has different engineering and "environmental" properties. Till is far less permeable than outwash, and this must be taken into account in planning excavations, foundations, and tile fields for septic tanks and similar structures. In a locality where the silty Hayesville Till is the surface material, it is certain that at a depth of 3 to 6 feet a much more sandy material, which will have much greater permeability than the uppermost Hayesville Till, will be present. Navarre Till and the underlying Millbrook Till do not differ greatly in texture or permeability; any difference between them will not be significant in ordinary structures, but should be considered for large projects. The two tills may vary somewhat in engineering characteristics when used as fill material. Excavations more than a few feet in depth will generally penetrate more than one till, and the contact between the two tills may have a sand or silt layer which transmits water and creates problems of drainage or of greater permeability in waste disposal operations.

The buried valleys are important reservoirs for ground water, and large supplies have been secured at various places, especially in the Killbuck valley. Of promising potential for large ground-water supplies is the buried valley in northern Washington Township, particularly where it is intersected by Lake Fork. Martins Creek valley and the valley of Middle Fork in Paint Township may offer ground-water possibilities at depth, but no data are at hand to confirm this.

Pennsylvanian coal and clay, and the Massillon sandstone, which has been widely quarried for building stone, are important bedrock mineral resources and have been described in detail (White, 1949). Gas and oil have been found at many places in the county and active exploration still goes on (Lamborn, *in* White, 1949, p. 261-284).

Acknowledgments.—This map and report are based in part on data secured in an investigation of the glacial geology and water resources of northeastern Ohio by the U.S. Geological Survey in cooperation with the Ohio Department of Natural Resources, Division of Water. These studies now make possible an extensive revision of an earlier report on glacial geology of Holmes County. This report was published in 1949 as Ohio Geological Survey Bulletin 47, the field work for which was done mainly before 1934. The present map is based on field work using 1:24,000 topographic maps and on air photo study at various times from 1959 to 1967. Petrographic study of the tills was supported by grants from the National Science Foundation and the University of Illinois Research Board. The present report reflects current stratigraphic views, in contrast to the earlier 1949 report, which took almost no account of glacial stratigraphy and did not recognize that till overlies the gravel of kame terraces.

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Epoch	Stage	Substage	Unit	Color (oxidized)	Texture (percent) Sand	Silt	Clay	Mineral composition (percent) Quartz	Feldspar	Carbonate
Pleistocene	Wisconsinan	Woodfordian	Hayesville Till	Dark brown	31	45	24	73	27	7.3
			Navarre Till	Yellow brown	45	37	18	80	20	3.1
			Paleosol							
		Altonian	Millbrook Till	Olive brown	41	42	17	74	26	1.6
			Paleosol?							
	Illinoian		?							

TABLE 1.—Average texture and mineral composition of glacial deposits.

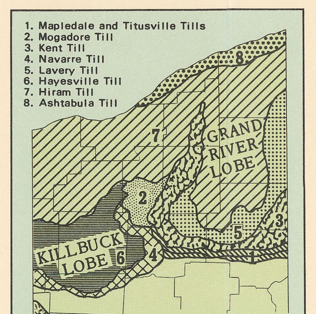

FIGURE 1.—Glacial lobes and tills in northeastern Ohio.

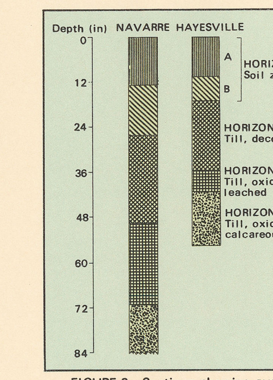

FIGURE 2.—Sections showing average thickness of weathering horizons.

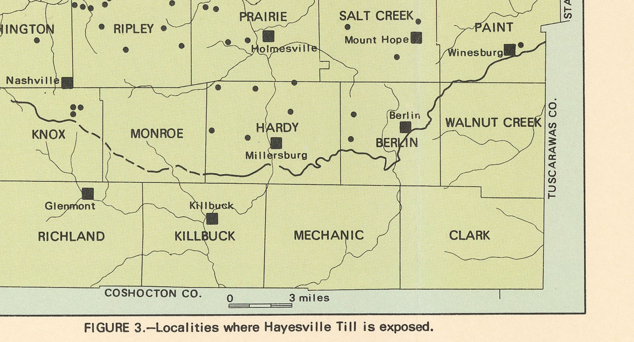

FIGURE 3.—Localities where Hayesville Till is exposed.

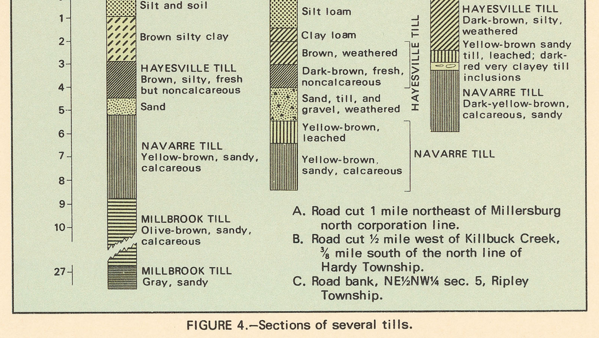

FIGURE 4.—Sections of several tills.

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