STATE OF OHIO
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL SURVEY
RALPH J. BERNHAGEN, CHIEF

REPORT OF INVESTIGATIONS NO. 62

GLACIAL GEOLOGY OF WAYNE COUNTY, OHIO

by

George W. White

COLUMBUS
1967

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Price $2.00

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CONTENTS

ILLUSTRATIONS

Plate

Figures

TABLES

INTRODUCTION

This report describes the glacial drift which is the surface material overlying the bedrock in all of Wayne County. The deposits form several rock-stratigraphic units. The location, extent, composition, and surface features will be discussed.

The drift at the surface of the county is Wisconsin in age. Most of the volume of the drift is of that age or probably of that age, although some of the drift in the lower part of thick deposits, especially in valleys, is probably pre-Wisconsin. The Wisconsin drift was deposited during several separate advances and retreats of the ice, each of which laid down drift of distinctive character. Much of the drift is till ("boulder clay"), an unsorted, unstratified mixture of clay, silt, sand, pebbles, cobbles, and boulders, but some of the drift is stratified sand and gravel deposited by water from the melting ice.

Acknowledgments

The field assistance of Dr. S. M. Totten in western Wayne County is gratefully acknowledged. Dr. J. L. Rau was helpful on several occasions in the field and Dr. H. G. Multer and Dr. C. B. Moke accompanied the writer to important localities in the county. Discussions with Dr. Multer were particularly helpful because of his knowledge of all parts of the county. Mr. Marvin Bureau, of the Wooster office of the Soil Conservation Service, provided extensive information on the soils of Wayne County, made manuscript soil maps available, and contributed valuable discussion in the field and in the office on the relation of soils to drift distribution. Dr. Nicholas Holowaychuk generously and most helpfully discussed soil distribution and paleosols, and accompanied the writer in the field on several occasions.

The map of the glacial geology of Wayne County (pl. 1) was produced as an outgrowth of the statewide program of water resources investigation conducted by the Ohio Department of Natural Resources, Division of Water, in cooperation with the U.S. Geological Survey. The author is grateful to Mr. S. E. Norris, district geologist, U.S. Geological Survey, for many helpful discussions concerning the map.

Special thanks are due Mr. C. P. M. Heath, who as graduate research assistant to the author made the textural and mineralogic analyses of the tills, made the computations for the tables, and assisted in other ways in computing the measurements. Miss Kathryn Christ checked numerical computations and assisted most helpfully in preparation of tables and manuscript.

The writer is grateful to the University of Illinois Research Board for grants which enabled Dr. Totten to serve as his graduate research assistant in the field in the summer of 1961 and Mr. Heath to serve as graduate research assistant in the laboratory during the academic years of 1961-62 and 1962-63.

Previous Work

Observations of the drift in northeastern Ohio were made by Whittlesey (1866), Newberry (1874), and Chamberlin (1883, p. 339). Read (1878, p. 529, 530) made a brief reference to "pre-glacial channels" and to "drift clay" in Wayne County. Leverett (1902, pl. 2, 13, and 15) included the Wayne County area in his monograph on the glacial deposits of the Ohio and Erie basins. He noted the extent of the Wabash moraine in Wayne County (p. 436, 551) and described the drift near Fox Lake (p. 403). He paid particular attention to the morainic topography in southern Wayne County (p. 383, 391) and divided it into three separate belts; more modern mapping, aided by air photos, indicates a single, diffuse, wide belt of morainic topography related to lowlands rather than separate morainic ridges.

An early study of the soils of most of Wayne County (Caine and Lyman, 1905) discussed the influence of glacial drift of various kinds on soil types. Although the mapping is generalized and the soil names have now been superseded, it is interesting to note that the area mapped as "Miami clay" (corresponding in part to the Rittman soils of present classification) coincides approximately with the extent of the Hayesville Till and that the patchy distribution of this soil in the central and southern part of the county reflects the discontinuous extent of the Hayesville Till in that area. Eastward into Stark County, the map shows that the eastern margin of this soil unit corresponds in a general way to the margin of the Hayesville Till in western Stark County. The area in northeastern Wayne County where the Mogadore Till is at the surface is shown as "Miami stony loam soil" and it is noted that this soil is different from the somewhat similar soil in the Wooster region which was called "Volusia silt loam" (approximately equivalent to Wooster of the present terminology). The areas of lacustrine clay and silt are well shown as areas of "Waverly clay." Areas of sand and sandy gravel outwash at lower levels in the valleys are shown as "Miami gravelly loam soils."

A detailed study of the glacial deposits of Wayne County was made by Conrey (1921, p. 23-41), who described the surface forms of the drift and showed them on a colored map (map V). He regarded the deposits as a single unit of late Wisconsin age, although he thought a lower till which he observed in a few places might be of pre-Wisconsin age. He observed no leached or oxidized zone at the top of the lower till and thought that "both tills may belong to the same ice invasion . . . . Further study of the northeastern Ohio as a whole will be

necessary before a definite conclusion as to the existence or non-existence of a pre-Wisconsin drift sheet can be reached" (p. 25). Following Leverett, Conrey regarded the tracts of morainic topography across the southern part of the county as a part of the "main morainic system" associated with the margin of the ice which lay to the south in Holmes County and he described these tracts in detail. He mapped and described the Wabash moraine in the northwestern part of the county. He described certain "small isolated areas with moraine topography" or areas of weak morainic topography as "minor morainic areas on the ground moraine." He noted the frequent association of constructional topography with valley sides and said of these morainic tracts: "a majority . . . are confined to the pre-glacial valleys and cannot be traced onto the upland" (p. 34). Conrey's mapping of the morainic tracts is "conservative" and a comparison of his map (map V) with the glacial map of this report (pl. 1) will show that in the present report the areas of morainic topography are interpreted as more extensive than shown by Conrey. Conrey did not have the advantage of aerial photographs by means of which ground observations can be checked and extended.

Conrey described the outwash deposits of sand and gravel in detail, particularly in the central and northern parts of the county. His mapping of lake deposits and of the alluvium along the valleys is very precise.

It is curious that Conrey, who was pedologist as well as geologist, did not describe or discuss the composition or other characteristics of the till. Although he was aware that the soils in the northwestern part of the county were quite different from those in the central and southern parts, he did not mention the role the difference in parent material played in the origin of these soils.

Hubbard (1908) described lake beds in the valleys of Killbuck Creek, Muddy Fork, Chippewa Creek, and Newman Creek. He gave the name of "Lake Craigton" to the body of water in which were deposited the clays of the Muddy Fork valley and its extension southward into the wide abandoned valley in southwestern Plain and northwestern Clinton Townships. He interpreted the outwash deposits, which have normal southward gradient along the sides of this valley, as beach deposits which had been tilted and raised to the north (Hubbard, 1914). Later, Hubbard and Rockwood (1942, p. 246) recognized the outwash origin of the marginal deposits and stated that their "revised mapping was done by silts across the lake bed, deposited indiscriminately over morainic outwash, and other valley filling, and not by remnants of shoreline features."

Ver Steeg (1930, 1931, 1934) presented data on drift thickness in Wayne County and in surrounding counties; he included data for some of the drift-filled valleys.

The glacial deposits of Holmes County, adjoining Wayne County on the south, have been described in a report that deals almost entirely with the morphology of the surface of the drift (White, 1949). The field work upon which that report was based was essentially completed in 1933 and at that time it was not realized that the drift could be separated into several till sheets and the units treated as rock-stratigraphic formations.

A recent report on the glacial deposits of Stark County, to the east of Wayne County (White, 1963), describes units which extend into Wayne County. The strata and their correlation in the Killbuck lobe, which covered Wayne County, have recently been summarized (White, 1961). This is the classification which will be used in the present report.

GLACIAL EROSION

The first ice to advance over Wayne County passed over a maturely to submaturely dissected plateau which had a relief of 200-400 feet. The southern part of the county was rugged and hilly and the northern part was in large part composed of wide rolling uplands. The various ice sheets eroded the uplands to some extent, but the thickness of rock removed is believed to have been generally less than 20 feet. Some of the sandstone hills in the eastern part of the county were eroded to a more or less "streamlined" shape. Spurs on valley sides were trimmed and some valleys—especially those parallel to ice motion, such as the Killbuck and Little Chippewa—show evidence of widening and deepening by glacial erosion. The U-shape and straight course of the Killbuck valley from Wooster to Burbank, especially striking as seen from a plane at an altitude of 10,000 feet or more, are the results of glacial modifications of a stream valley.

Very few striations have been observed on the bedrock in the county. Few bedrock ledges are exposed and much of the bedrock records striations very poorly or not at all. In the eastern part of the county seven locations of striations are recorded by Conrey (1921, p. 25); their directions range from S. 27°E. to S. 50°E.

GEOMORPHOLOGY OF THE DRIFT

Introduction

The surface expression of the drift is not the result of a single advance or retreat of the ice, but has been produced at different times by several ice advances, each of which laid down a more or less continuous sheet of drift, the later ones superimposed upon the earlier. The separate constructional features, and particularly the larger ones, do not owe their origin to the deposition of material by the last ice sheet (White, 1962). For this reason, the geomorphology of the drift surface in Wayne County will be described here and in another section the character and arrangement of the material will be discussed. The glacial map (pl. 1) shows the geomorphic units by colors and the age of the surface material by an overprint.

Ground Moraine

In a large part of Wayne County the surface of the drift on the uplands is smoothly rolling, but with minor undulations impressed upon it. These undulations are low swells covering several acres interspersed with lower, poorly drained, shallow sags. Where the swells become more accentuated, they pass over to low knolls and the topography takes on a more or less strongly constructional appearance; as the height of the knolls increases further the topography becomes morainic. The ground moraine is generally on the uplands as shown by its distribution relative to the bedrock surface contours (pl. 1).

Over much of the upland the till cover ranges from less than 10 to about 25 feet in thickness, although at places it may be thicker. The ground moraine topography is therefore a masked bedrock erosional topography with irregularities superimposed upon it by the thin glacial drift.

The largest expanse of ground moraine topography occurs in the northern part of the county: in the southwestern part of Milton Township, the southern part of Canaan Township, much of Green Township, almost all of Wayne Township, much of Chester Township, the northern and central parts of Plain Township, the uplands of Wooster Township both east and west of the Killbuck valley, and the western and northern parts of East Union Township. Over this area the bedrock topography beneath the drift at places shows undulations several miles in extent and without deeply incised valleys. Upon this widely rolling bedrock topography is superimposed a finer-grained rolling drift topography in which the undulations are measured in fractions of a mile.

In central and southern Canaan Township and in northern Wayne Township, it is possible from study of air photographs to divide the ground moraine topography into two kinds occupying about equal areas: a strongly undulating topography separated by smoother, less undulating tracts. This differentiation is difficult to see on the ground and has not been shown on the map.

The ground moraine in Chippewa Township, on the upland upon which Doylestown is situated, northeast of Chippewa Creek valley, has a distinctive character, because here the surface drift is Mogadore in age and was not covered by the younger Navarre or Hayesville ice advances. The surface is more generally rock controlled than in the area of the younger drift to the southwest and west and undulations due to glacial constructional features are much less evident. Bedrock more commonly crops out along the roads and drift thickness on the uplands is in general less than in the northern and central parts of the county. This subdued ground moraine is an extension of that on the Mogadore Till to the east and northeast in Summit County (White, 1953b, p. 18, pl. 9A).

Ground moraine areas are restricted in southern Plain, in Clinton, and in Salt Creek Townships, which are more generally occupied by large irregular tracts of end moraine, part of the belt of end moraine topography that sweeps around the south margin of the Killbuck lobe.

The ground moraine in Paint Township is a little less undulating and a little less definitely constructional in appearance than in the rest of the county because Paint Township is beyond the limits of the ice sheet that deposited the Hayesville Till. Because the till on the uplands is in general quite thin, the topography is bedrock controlled, except in the northwestern corner of the township where the drift is thicker and the topography of the ground moraine is more obviously constructional.

End Moraine

Areas of more or less strongly expressed constructional topography, commonly called "morainic topography," present an irregular and hummocky appearance with hillocks of 1 or 2 acres to 10 acres or more in area rising 10-20 feet above their bases. The till in these areas is generally thicker than the till of adjacent ground moraine. In the northwestern part of the county two morainic ridges, the Wabash and Ft. Wayne moraines, from 1 to 3 miles wide, extend in a general east-west direction. In the southern part of the county, a broad, diffuse, discontinuous belt of morainic topography is part of a still wider unnamed belt that extends around the margin of the Killbuck lobe in Richland, Ashland, Holmes, Wayne, and Stark Counties. Elsewhere in Wayne County irregular patches of moraine occur along the sides of valleys and at the heads of tributary valleys, and extend across the upland in a few places.

Ft. Wayne moraine.—The Ft. Wayne moraine, which has been traced from Indiana across a large part of Ohio by Leverett (1902, p. 566), lies mostly in Medina County and only the southern margin of this moraine extends south into Wayne County, for about a mile into northern Congress Township (pl. 1). Farther east it joins the Wabash moraine between Burbank and Creston in north central Canaan Township, and the joined moraines extend past Creston to Seville in Medina County, and thence northward as a single feature. The front of the Ft. Wayne moraine in Wayne County is best shown north and northeast of West Salem, where in a distance of ¼-½ mile the moraine rises 50 feet or more above the ground moraine to the south.

The moraine presents a hummocky surface composed of knolls and swells rising 10-20 feet above their bases. Just north of the county line shallow kettle holes, a few acres in extent, are common in the moraine west of Killbuck Creek. North of Killbuck Creek from Burbank to Creston, but mainly in Medina County, kettle holes occupy about half the area of the moraine. These kettle holes are much larger than those to the west; some are a mile or more in their largest dimension and are the sites of extensive swamps.

The moraine influences stream locations. Killbuck

Creek, which rises in southern Canaan Township and flows northward to the county line about 1½ miles west of Creston, turns west to follow the elongate ridges of the Ft. Wayne moraine along the county line, past Burbank, and thence for 2 miles parallel to the front of the moraine to the ancient valley in sec. 2 of Congress Township, where the stream takes a southward course. A smaller, eastward-flowing tributary to Killbuck Creek follows the front of the moraine in secs. 4 and 3.

Wabash moraine.—The Wabash moraine has been traced across Ohio from the Indiana line by Leverett (1902, p. 545). It enters Wayne County from Ashland County, extends across Congress Township to the valley of Killbuck Creek, thence northeast across northwestern Canaan Township where it joins the Ft. Wayne moraine in north central Canaan Township and passes northward into Medina County. Conrey (1921, p. 30-31) interpreted the moraine as being formed of one mass of till and so, by implication, did Leverett. It is now known that this moraine consists of several layers of till and that the last one is both discontinuous and very thin (White, 1962, p. 96). It is appropriate, therefore, to discuss its morphology separately from its composition.

As shown on the glacial map (pl. 1), the Wabash moraine is now interpreted as being somewhat wider than shown by Conrey (1921, map V). The moraine ranges from 1 to more than 2 miles in width. Over a distance of a few hundred yards, its southern margin rises from 30 to 80 feet above the ground moraine to the south and forms a striking topographic feature. The slope of the north edge of the moraine is more gentle and presents less of a contrast to the territory to the north. Within the moraine, separate knolls, many of them elongate east-west, rise 10-15 feet above the general level. Some kettle holes, from 1 to 10 acres or more in extent, may be seen, but in general these are shallow and more obvious on air photographs than they are from the ground. Their presence is reflected in the more poorly drained soils occurring in them.

The Killbuck valley is excavated across the moraine and it is interesting to note that, while the moraine extends part way down the valley sides, it does not plug the valley. There is some suggestion that the valley was re-excavated between each episode of glaciation and each addition of material to the moraine.

The position of the moraine controls, in part, the drainage in Congress Township. A tributary of Muddy Fork follows the front of the moraine from just west of Congress westward for several miles past Pleasant Home to join Muddy Fork at the Ashland County line. West of Canaan a part of the upper course of Killbuck Creek in Canaan Township follows the front of the moraine eastward through secs. 17, 16, and 15, thence northeast and north through a gap in the moraine, and westward along the Medina-Wayne County line past Burbank.

Marginal moraine belt of the Killbuck lobe.—Irregular areas of morainic topography occur in a belt 6-12 miles wide along the outer part of the Killbuck lobe. The belt extends from Richland County across southern Ashland, northern Holmes, southern Wayne, and western Stark Counties. A larger proportion of the marginal area is occupied by morainic topography than is shown on the glacial map of Ohio (White, in Goldthwait, White, and Forsyth, 1961); later mapping included use of air photographs and more extensive morainic tracts are recorded in more recent maps of Stark County (White, 1963) and Richland County (Totten, 1962), as well as in the present map of Wayne County (pl. 1).

The bedrock surface is much more dissected in southern Wayne County than in the central and northern parts. The valley areas are, therefore, much more extensive in the south and the drift is thicker. The thicker the glacial drift, the more likely the topography is to be constructional and morainic in appearance. In this marginal belt each glacier advanced and retreated several times over short distances before its final retreat. As drift of several ages is known to be present, the whole belt is a composite structure owing its volume to several glaciations.

This marginal morainic topography occupies over half the area of Clinton Township and a large part of the southern half of Plain Township. The hummocky topography present in the Spring Valley-Millbrook region of southern Plain Township and extending southward toward Shreve is a reflection of the great thickness of drift in this part of the county, particularly in the abandoned valley east and west of Shreve and in the almost completely filled depression near Millbrook. The constructional features of the moraine are prominent in eastern Franklin and throughout central and eastern Salt Creek Townships, both in some of the valleys and on the uplands. Knolls rise 15-60 feet above the general level, but kettle holes are not conspicuous.

In Paint Township the strongly constructional topography is confined to the valleys around the borders of the township because the central part, upon which Mount Eaton is built, is a high rock area extending above the moraines of the valleys. In Stark County, just east of Paint Township, the moraine is particularly rugged in the valley of Sugar Creek and kettle holes are prominent (White, 1963, pl. 2).

Irregular areas of morainic topography.—In addition to the Ft. Wayne and Wabash end moraines and the wide, irregular belt of marginal end moraine in the southern part of the county, scattered tracts of morainic topography occur elsewhere in Wayne County. These range in area from a fraction of a square mile to several square miles. In the central part of the county they occur as isolated tracts in valleys, at valley heads, and along valley sides, and the general aspect of this part of the county is that of ground moraine which includes small isolated areas of more strongly constructional topography. On the other hand, the southern part of the county is more generally an end moraine tract through which protrude high bedrock knobs and ridges with ground moraine upon their summits.

The irregular topography along the sides of the valley of Muddy Fork in western Plain Township and in southwestern Chester Township is mapped as moraine. In Plain Township it grades into the marginal moraine of the southern part of the county.

In central and southeastern Chester Township, the valley bottom and the valley sides of Little Killbuck Creek and its parallel tributary, Rathburn Run, exhibit constructional topography in which some knolls are more than 20 feet high.

Hummocky drift is found along the sides of Killbuck valley from Wooster south into Holmes County. In southwestern Franklin Township this drift is part of the marginal belt of end moraine. Some of this irregular topography, particularly at lower levels, is a reflection of buried kame terraces along the sides of the valley. Northwest and north of Wooster the Killbuck valley is much narrower than it is to the south and the valley sides are generally even and not hummocky, in contrast to the valley sides south of Wooster.

The marginal morainic area in Salt Creek Township extends as a separate tract into southern and central East Union Township forming a morainic area of many square miles just east of the village of Apple Creek. The drift here is thick and buried kames probably contribute to the irregular topography.

Tracts of morainic topography about a mile in width lie on either side of the valley of Sugar Creek in Sugar Creek Township. The valley of Newark Creek in Sugar Creek and Baughman Townships is occupied for a width of ½-1 mile by morainic topography. Sharp knolls are most prominent in that part of the valley from Dalton to Burton City.

Irregular tracts of hummocky topography occur on either side of the valley of Little Chippewa Creek in Green Township and extend southward across the divide into the lowland at Orrville and east of Orrville. This is a buried valley area and the thickness of the drift contributes to the irregular surface. Several shallow kettle holes have an area of 10-15 acres.

Large tracts of morainic topography lie on the south side of Chippewa Creek in eastern Milton Township and extend southward into Baughman Township past Fox Lake to join the tract in the headwaters of Newman Creek. The sharp knolls in the part of the tract along the township line and to the north are buried kames that have been exposed in several gravel pits which have been opened through the till cover.

North of Chippewa Creek, in Chippewa Township, a narrow but distinct band of morainic topography extends westward from the Stark County line along the north side of the valley past Easton to the Medina County line in the northwestern corner of Chippewa Township. This moraine is a true end moraine because it marks the margin of two drift sheets, the Navarre Till and the Hayesville Till. From Chippewa Township, this moraine continues into the northeast corner of Milton Township, just north of Rittman, where the River Styx valley is choked by high drift knolls.

Outwash Plains and Valley Trains

More or less extensive tracts of smooth-surfaced or pitted gravel or sand washed out from the melting ice sheets occupy part or all of some of the valleys in the county. If the tract is large and extensive, it is generally called an outwash plain, but if it is obviously confined to a valley and can be traced along the valley, the name valley train is applied. Most of the valley trains have been dissected by streams so that only remnants remain as terraces along one or both sides of the valley.

East of Creston a flat outwash plain 3 miles wide extends southward past Sterling to the junction of Little Chippewa Creek with Chippewa Creek. Farther downstream in Chippewa Creek, in the central and eastern parts of Milton Township, the outwash plain is closer to stream level and passes over into a lacustrine plain. In this outwash plain are many depressions ranging in size from a few acres to a very large one south of Creston with an area of 1½ square miles. These are interpreted as kettle holes, formed by the melting out of ice blocks separated from the glacier and buried in the original outwash. Their margins are generally blunted and blurred by later deposits of outwash and lacustrine clay and the shallowest ones are more easily seen on air photos than on the ground.

One mile south of Sterling, in sec. 17, Milton Township, a tract of less than a square mile rises a few feet above the general level of the rest of the outwash plain. It may be a remnant of an earlier outwash plain that is surrounded by later outwash material, or it may be material that was deposited in a large hole in the ice, allowing accumulation to a level higher than that of the surrounding material.

On either side of the valley of Little Chippewa Creek, in secs. 3, 10, 2, and 11 in the northern part of Green Township, low terraces rise 10-20 feet above the depression in the bottom of the valley. Their tops are either quite level or slope gently from the valley sides to the central depression. These terraces may be remnants of a valley train or may be low kame terraces; perhaps some elements of each are present.

Similar low terraces extend from Smithville southeastward for 2 miles along Sugar Creek. The terraces are generally less than a fourth of a mile in width and rise only a few feet above the central depression in which the creek flows. They are interpreted as remnants of a valley train which once extended down the Sugar Creek valley.

In the south part of Wooster, just north of Apple Creek, a low terrace rises about 10 feet above the valley flat; in the southeastern part of Wooster, between the railroad and Apple Creek, another remnant of gravel terrace rises 10-20 feet above the flood plain of Apple Creek.

A very extensive valley train extends from the vicinity of the Wabash moraine at Pleasant Home in southwestern Congress Township downstream for 15 miles,

past Blachleyville to Craigton in Plain Township. Only the most northerly and the most southerly parts lie in Wayne County, the main part lying in the Muddy Fork valley in Ashland County to the west. The valley train has a width of little over a mile at Pleasant Home and maintains this width for 8 miles to the south into the corner of Plain Township near Reedsburg, where it disappears beneath lacustrine deposits. The surface declines from an elevation of about 1,060 feet at Pleasant Home to 980 feet at Reedsburg, 8 miles to the south. This is interpreted as a normal downstream slope of a deposit made by an overloaded southward-flowing meltwater stream. The terrace remnants of this train are not flat, but slope 20-40 feet from their margins against the valley wall to the depression through which Muddy Fork flows. The terraces are about ¾ mile wide in the southwestern corner of Congress Township, but are ¼-½ mile wide in Ashland County. In addition to the central depression through which Muddy Fork flows, there exist kettle holes from 100 yards to ¼ mile in length. Some of these are low enough below the terrace surface to intersect the water table and to contain swamps. South of Reedsburg, discontinuous terraces along the valley sides are kame terraces rather than valley train remnants. The outwash plain which slopes southward from the Wabash moraine to Reedsburg declines in elevation more steeply than does the gradient of Muddy Fork, so that at Reedsburg the valley train intersects the flood plain—the lacustrine plain of the valley bottom. Drill records show that the valley train does continue southward, but is buried beneath the lacustrine plain.

A valley train occupies the lower part of the valley of Salt Creek in Salt Creek Township. It continues down Salt Creek for 6 miles, from 1 mile north of Fredericksburg to Holmesville in Holmes County. North of Fredericksburg it grades into an area of kames.

Kames and Kame Terraces

Kames are hills of gravel and are formed by gravel being washed into a hole in the glacial ice. When the ice melts the filling of gravel is left as a hill. Special examples of such fillings are the series of generally straight, roughly parallel gravel ridges which were apparently crevasse fillings.

Closely allied to kames are kame terraces which are also composed of gravel. They somewhat resemble valley train terraces in appearance, but were never continuous across a valley as were valley trains. Kame terraces were deposited along the sides of valleys between the valley wall and ice masses which remained after the main mass of the ice had melted from the uplands. Elongate tongues of ice several miles in length may have forced the melt water to flow between them and the valley sides, the gravel deposited by these streams forming the kame terraces. Kame terraces differ from valley train terraces in having an irregular inner margin, which is a cast of the ice edge, and in having a more irregular and hummocky surface. Because a kame terrace was deposited in part by water flowing between ice in the valley wall and in part by material slumping from the ice, irregular kames were formed along the ice edge; where these are prominent the terraces are very hummocky. Where kames are low or absent, the terraces are difficult to differentiate from erosional remnants of valley trains, but because the kame terraces represent fill to a level controlled by the height of the adjoining ice, they may lack the matching elevations characteristic of valley train terraces.

Some of the kame terraces are "blurred" and obscured because of till cover; in some places as many as three till sheets have been observed to cover kame terrace gravel and sand. Where the till is thin or where excavations have been made, the gravelly character of the underlying material confirms kame terrace origin. In places where only till can be seen at the surface, one can only have a suspicion that the terrace is a gravel kame terrace buried by later till. The assumption can be proved only by drilling or by other excavation.

Low kame terraces on either side of the Muddy Fork valley at Blachleyville may be traced discontinuously southward as far as Craigton in northern Clinton Township. The terraces on the west side of the valley, where Muddy Fork leaves the ancient valley at Funk to join Lake Fork one mile farther west, are part of the very extensive kame terrace complex in the Jerome Fork valley in Ashland County. This area extends for 12 miles from Ashland downstream past Jeromesville to the vicinity of Funk and thence southward along the valley of Lake Fork to its junction with the ancient valley in northeastern Washington Township, Holmes County. From Blachleyville to Craigton, the terrace on either side of the valley is narrow and discontinuous, and declines about 40 feet in the 3-mile distance. Away from the valley sides at Craigton and for 1½ miles north, a few tracts of 3-15 acres rise above the swampy valley bottom to form little flat-topped islands in the otherwise swampy terrain. These are related to the kame terraces on either side of the valley. The flat valley bottom from Reedsburg past Blachleyville to Craigton is a lacustrine plain and will be discussed under that heading.

A low, irregular kame terrace lies in the west part of Wooster in the southern part of sec. 5 and the northeastern corner of sec. 8 of Wooster Township. This tract, almost a mile long and half a mile wide, is an undulating terrace rising 10-30 feet above the valley flat of Killbuck Creek. The northeast side of the terrace is marked by an elongated kettle hole, and a series of kettle holes separates the northeast part of the terrace from the main mass to the southwest so that the northeastern part forms a linear ridge which has the character of a crevasse filling. It somewhat resembles an esker in appearance.

The somewhat undulating to hummocky terraces that rise 20-80 feet above the valley bottom on either side of the Killbuck valley in Franklin and Clinton Townships are kame terraces. Kettle holes, some of large size,

exist in the terraces. Terraces continue southward into Holmes County where they have very extensive development. The wide till-covered terrace southeast of Shreve in secs. 18, 19, and W. sec. 20, Franklin Township, may be a deeply buried kame terrace; its continuation southward into Holmes County is known to be a buried kame terrace.

A very irregular kame terrace occurs in the abandoned valley west of Shreve in the southwestern part of Clinton Township where several square miles in secs. 19, 20, 21, 16, 17, and 18 exhibit a very hummocky and irregular surface. About half of the tract is composed of swampy anastomosing large kettle holes above which rise hummocky kame areas. The full extent of the kame terrace is not known because only the part near Big Prairie has a thin enough till cover to disclose gravel. It is believed that, over much of this corner of the township, the terracelike feature is a kame terrace more or less deeply buried by till. This terrace, with a discontinuous till cover, continues to the west for several miles across Holmes County to Loudonville in Ashland County (White, 1949, p. 35).

In the southeastern part of Apple Creek in East Union Township, a tract of somewhat less than a square mile is composed of low kames. It has a covering of later till over it.

A low kame terrace is located on either side of North Branch of Salt Creek in sec. 6 in the northwestern corner of Salt Creek Township, but south of sec. 6 the valley bottom is entirely occupied by low kames to a point 1 mile north of Fredericksburg, where the kame area passes into a valley train. Irregular low kame terraces occur 2 miles east of Fredericksburg, chiefly in sec. 21 of Salt Creek Township. Salt Creek flows through large kettle holes which separate the two parts of the terrace.

Lacustrine Plains

Narrow, long, flat, generally swampy tracts in some of the valleys are plains composed of lake deposits. Most of these formerly very swampy tracts are now drained by extensive systems of ditches. No distinction has been made on the glacial map between the parts of valleys that are of lacustrine-plain origin and those that are of flood-plain origin through stream erosion and deposition; the two grade into one another so that a firm distinction is not possible. In general, the wider, more sinuous tracts which slope several feet per mile down the valley are of flood-plain origin.

One of the most extensive of these lacustrine plains includes the valley bottom of Chippewa Creek and extends up the valley of Little Chippewa Creek. This plain ranges in width from half a mile to more than a mile and extends across Chippewa Township into the central part of Milton Township. That part in the Little Chippewa valley extends from the central part of Milton Township southward to the Milton-Green Township line.

The lowland now drained by the Orrville ditch and extending from Orrville eastward across Baughman Township to the Stark County line is a lacustrine plain. This lake flat ranges in width from a quarter of a mile to almost a mile near Orrville. It is a flat swampy tract now drained by a series of ditches.

In the headwaters of Sugar Creek in Green Township, a flat lacustrine plain area extends from 1 mile southeast of Smithville for 5 miles southeast to the common corners of Green, East Union, Baughman, and Sugar Creek Townships. The width of this plain ranges from a little less than a quarter of a mile to three quarters of a mile at its widest part in sec. 35 of Green Township, in the part of the plain where the Orrville Brick and Tile Company has its clay pits for tile manufacture.

The bottom of the Killbuck valley, from a point northwest of Wooster southward into Holmes County and far south across that county, is a long, narrow lacustrine plain. The down-valley slope is less than one foot to a little more than one foot per mile. Before the ditching and straightening of the channel of Killbuck Creek, floods spread over the valley and persisted for weeks or even months (Conrey, 1921, pl. 3-B), turning the valley into a lake, and restoring for a time the appearance the valley must have had in late glacial times.

A large lacustrine plain, the material of which was deposited in a body of water which has been called "Lake Craigton" (Hubbard, 1914), is present in the ancient bedrock valley that extends from Reedsburg in northwestern Plain Township to Craigton in northern Clinton Township. Muddy Fork flows sluggishly southward in the northern part of the plain, but the central and southern parts are drained northward by ditches to Muddy Fork. This lake plain ranges in width from a little less than a mile to almost 2 miles in the central part. The surface is a featureless plain, except in the southern part where some low outwash swells rise a few feet above the surface. The surface in Wayne County has an elevation of about 960 feet to about 950 feet. The area was a flat swamp until it was drained in the last century. Because of the recent Muskingum Conservancy District flood control measures, the basin again becomes a lake during times of high rainfall when the waters are backed up by a flood control dam 2 miles east of Mohicanville in Ashland County.

STRATIGRAPHIC CLASSIFICATION

Glacial Lobes

The glacial deposits of Ohio were laid down by ice sheets which entered the Lake Erie basin from the northeast to form an Erie lobe, from which a series of smaller lobes, controlled by the position of lowland and highland areas, spread southward. The limit of ice advance in this part of the State lies from 6 to 12 miles south of Wayne County in Holmes County. The limit of ice advance and the locations of the lobes in Ohio are shown in figure 1. The Killbuck lobe advanced southward into

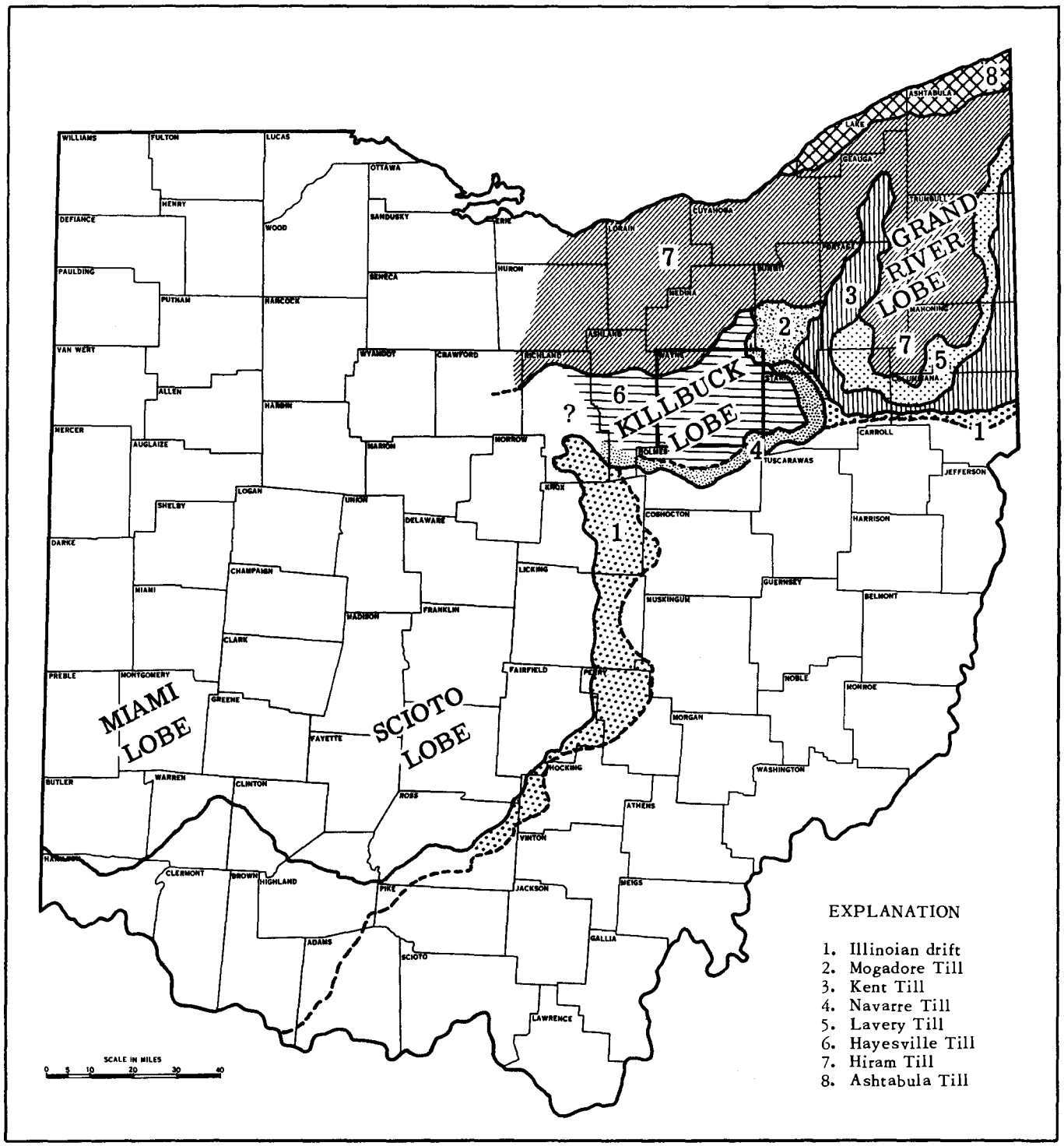


FIGURE 1.–Map showing glacial lobes in Ohio and surface extent of Illinoian drift and Wisconsin rock-stratigraphic units in the Killbuck and Grand River lobes.

TABLE 1.—*Glacial deposits in Wayne County*

Epoch	Stage	Substage	Killbuck lobe		Grand River lobe	
			Unit	Material	Unit	Material
Pleistocene	Wisconsin	Late (Woodfordian)	Hiram Till	Dark-brown clayey till	Grand River lobe tills of these ages do not extend into Wayne County	
			Hayesville Till	Dark-brown silty till		
			Navarre Till	Yellow-brown sandy till		
		Early (Altonian)	Millbrook Till	Olive-brown sandy till, with buried weathered surface	Mogadore Till (Chippewa Township only)	Yellow-brown coarse sandy till
	Illinoian		Lower till(s) in a few places may be of this age			
	Kansan		Not positively identified in Wayne County			
	Nebraskan					

the lower land between the Summit-Geauga County upland on the east and the Richland County highland on the west. The name is given from the Killbuck valley which occupies a central position in the area covered by the lobe. The Scioto lobe lies west of the Killbuck lobe. The limit of ice advance is much farther north in the plateau in eastern Ohio than it is in central and western Ohio, where lower land allowed the ice to flow much farther southward. Although the direction of ice movement in the Killbuck lobe was generally southward, the ice in the eastern part of the lobe moved eastward from eastern Wayne County into western Stark County in an eastward protrusion so that, in a small area in northeastern Wayne County and northwestern Stark County, the ice actually had a northward component of motion.

To the east of the Summit-Geauga County upland was the lowland into which the Grand River lobe advanced. One of the earlier drift sheets of the lobe, the Mogadore Till, is the only deposit of that lobe that is found in Wayne County; it occurs in the northeastern part of the county, occupying about half of Chippewa Township. The drift of the remainder of Wayne County belongs to the Killbuck lobe.

Stages and Substages

In each of the four stages of the Pleistocene Epoch, glacial ice formed in Canada, moved into the United States, fluctuated over longer or shorter distances, and then disappeared. During the interglacial stages, when ice was absent, the climate became milder, vegetation flourished, and soils were formed.

Details of the fluctuations of the earlier glacial stages in the United States are lacking. Deposits of the last stage, the Wisconsin, consist of a succession of drift sheets, showing that the ice advanced and retreated several times, some of the fluctuations involving distances of hundreds of miles. In northeastern Ohio, each major advance carried forward material of different texture and composition from that of the preceding advance. As a result, each drift sheet can be differentiated on the basis of texture and composition and can be traced for considerable distances through parts of several counties. It is convenient, therefore, to treat these Wisconsin deposits as rock-stratigraphic units or formations and to give them separate names for purposes of description and discussion (White, 1960, 1961). Table 1 shows the classification of glacial deposits in Wayne County.

Identification of Tills

The till sheets of Wayne County are differentiated on the basis of texture, mineral and lithologic composition, color, and weathering horizons.

Texture.—Texture is an especially important characteristic of tills because, unlike weathering characteristics, it can be used to identify tills buried by younger deposits. Each of the tills of northeastern Ohio and of northwestern Pennsylvania has been shown by many mechanical analyses to have a characteristic texture (Shepps, 1953; Shepps and others, 1959; White, 1963). Analyses from Wayne County are listed under the descriptions of the tills; in addition, the percentages of sand and clay are given opposite many of the tills illustrated in the columnar sections. The average compositions of the tills are shown in table 2. The locations of measured sections and of samples are shown in figure 2.

Mineral composition.—Tills vary in quartz, feldspar, and carbonate mineral content (Totten, 1960; Heath, 1963). The mineral content of some of the samples from Wayne County is given in the discussion of the tills and the average compositions are shown in table 2. Clay minerals in the tills in eastern Ohio are mainly illite and chlorite and some of the older tills contain kaolinite (Droste, 1956a; Droste, White, and Vatter, 1958), but the clay mineral content of tills in Wayne County has not yet been studied in detail.

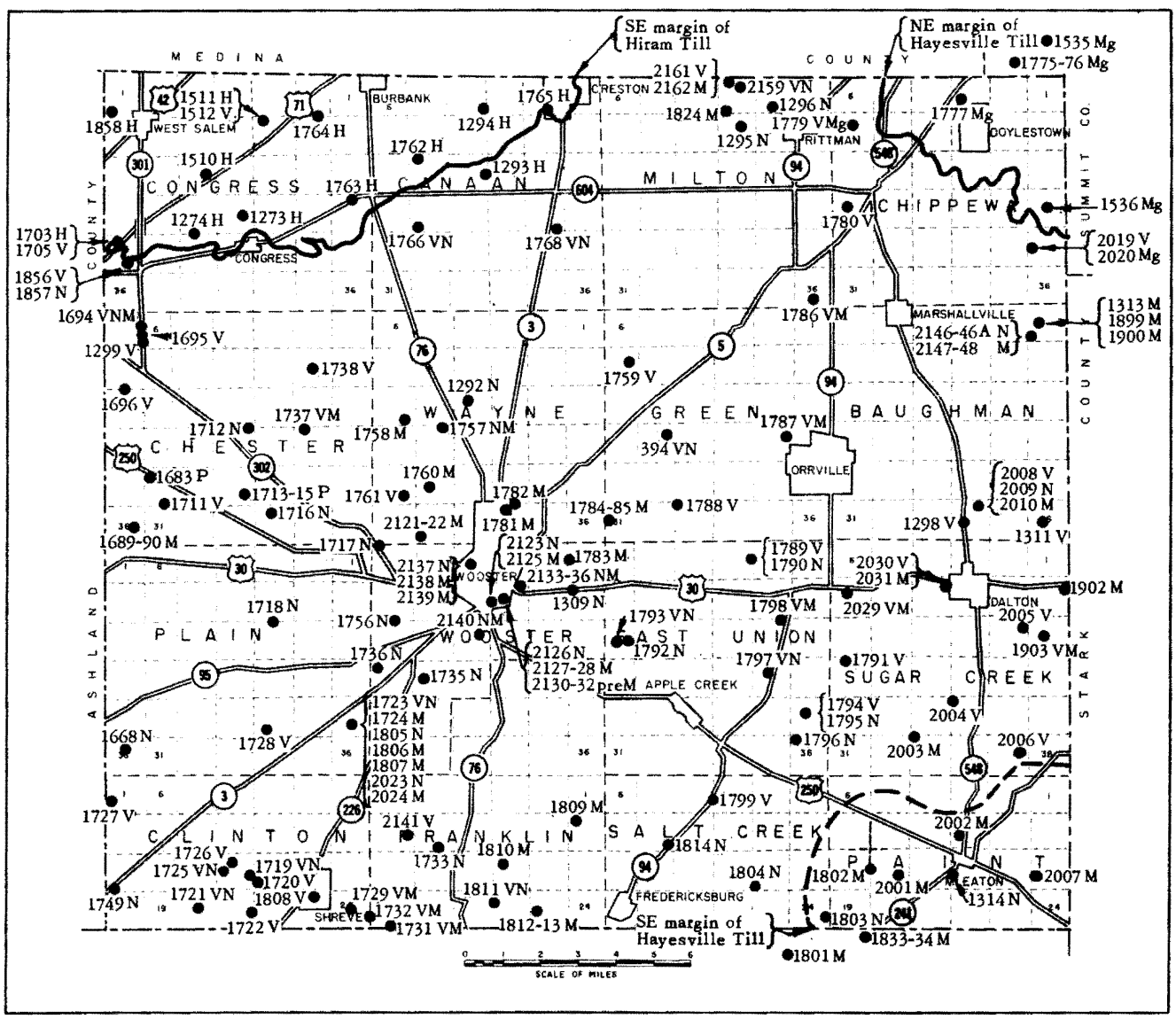


FIGURE 2.—Map of Wayne County showing sample and measured section locations. Tills identified as: H, Hiram; V, Hayesville; N, Navarre; M, Millbrook; P, unknown, probably pre-Millbrook; Mg, Mogadore. More than one letter following field number of sample indicates more than one till present.

TABLE 2.—*Average compositions of tills in Wayne County*

Till	No. of samples	Sand	Silt	Clay	Sand/clay	Quartz	Orthoclase	Plagioclase	Quartz/plagioclase	Quartz/feldspar	Carbonate
Mogadore	6	47.2	39.2	13.6	3.47	83.4	6.6	10.0	8.34	5.02	2.4
Millbrook	48	43.6	41.6	14.8	2.95	75.1	10.0	14.9	5.04	3.02	2.6
Navarre	37	41.4	41.9	16.7	2.48	75.1	10.8	14.1	5.33	3.02	5.1
Hayesville	23	25.7	45.7	28.6	.90	78.1	8.5	13.4	5.83	3.57	3.0
Hiram	12	26.1	46.1	27.8	.94	73.9	11.6	14.5	5.09	2.83	13.2

Color.—The unaltered tills are various shades of gray, but color variations are subtle and exposures of unoxidized till are too few to provide many data for study. Color differences of the oxidized tills are more obvious and can be specified numerically by use of the standard Munsell Soil Color Chart (1954). The calcareous, oxidized tills range from dark brown (10YR 4/3 or 10YR 4/2.5) through dark yellow brown (10YR 4/4) or yellowish brown (10YR 5/4 or 5/6) to olive brown (2.5YR 4/4).

Weathering horizons.—The Wisconsin tills of northeastern Ohio can be divided vertically into five distinct horizons based on weathering. In weathering of till, first the iron-bearing minerals (especially pyrite) are oxidized, then the carbonates are leached, and next silicates are degraded. In each horizon, characteristic degradational changes also take place in the clay minerals (Droste, 1956b). The weathering horizons are shown graphically for each of the tills in Wayne County and sections showing average thicknesses for each till are illustrated in figure 3.

Horizon 5 is the unaltered till. Because the iron-bearing minerals have not been oxidized and the carbonates have not been leached, this horizon is dark gray. Its top is 10 feet or more below the surface and most exposures are not deep enough to reveal it.

Horizon 4 is calcareous till similar to horizon 5 except that it is oxidized to a brown color, the shade of which is different for each till. The top of horizon 4 is also the depth of leaching, which ranges from less than 2½ feet below the surface in the younger tills to more than 9 feet in the older tills.

Horizon 3 is similar to horizon 4 except that the carbonates have been leached. Iron oxide and manganese stains may occur along joints but are not nearly as striking as in the overlying horizon 2.

Horizon 2 is the zone of decomposed till underlying the main part of the true soil. It is not only oxidized and leached, but is also considerably weathered and some of the pebbles and cobbles have been decomposed. Some clay material has accumulated in joints and soil-forming processes are advanced. The material is not so completely weathered, however, that it cannot be identified as once having been till. Thus, it represents what the

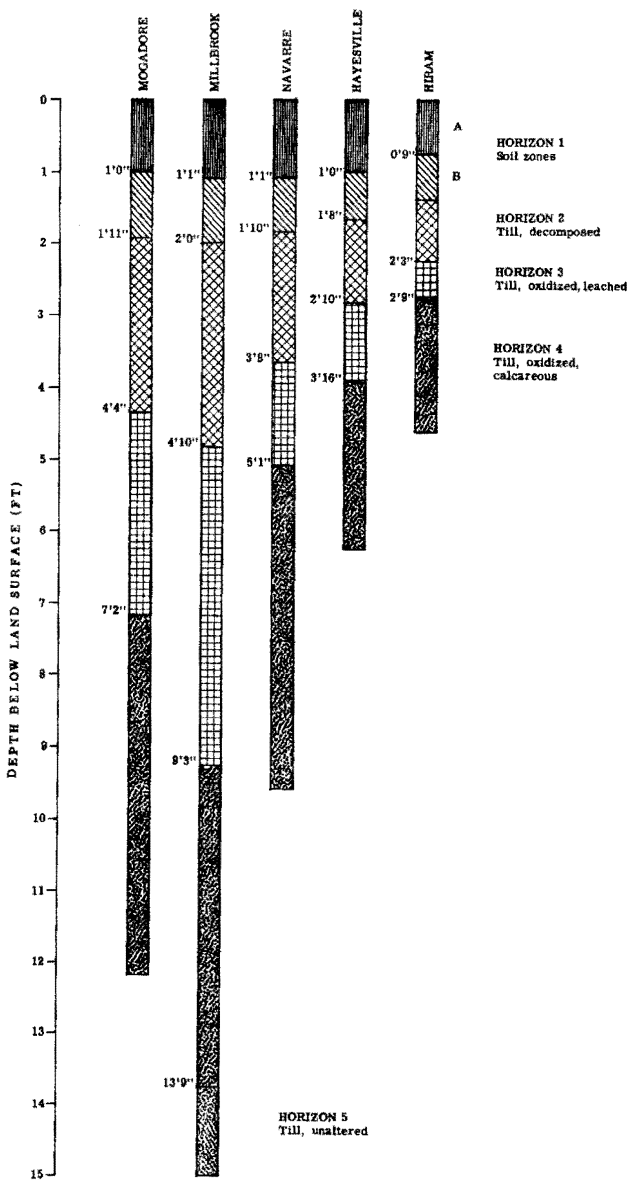


FIGURE 3.—Sections showing average thicknesses of weathering horizons of tills in Wayne County.

soils scientists would call the B_3 horizon (Morse and Bone, 1959). The color of the upper part is usually a mixture of buff, gray, and brown. The lower part may have dark stains along the joints.

Horizon 1 is the soil, divided into the A and upper B soil horizons of pedologists. The characteristics of the soils vary with drainage and slope as well as with parent material. The soils are also affected by the presence or absence of a silt layer, from a few inches to as much as 2 feet in thickness, which overlies the tills in some parts of Wayne County.

OLDER TILL DEPOSITS

At several places in Wayne County till occurs below Millbrook Till, or till of a character different from the Millbrook Till is exposed in a situation that permits interpretation of a pre-Millbrook and thus possible Illinoian or even earlier age for the material. These supposedly older tills cannot be traced over any considerable distance, but they do have some features in common. Most of them are very hard, compact, very stony, and have a very sandy matrix. They are only weakly calcareous. Many of the cobbles are angular fragments of sandstone and siltstone. The unoxidized material, seen in only a very few places, ranges from dark gray to olive gray in color. The oxidized till ranges from yellow brown to olive brown. Joints are prominent and strong rusty stains coat the joint faces.

From 2 feet to as much as 6 feet of strongly weathered till rests upon the bedrock and below the gravel at the Zollinger gravel pit 2½ miles southeast of Rittman in NW¼ sec. 19, Chippewa Township (fig. 6, section 1780). The till is so deeply weathered that it resembles old residual mantle derived from bedrock, but it does contain a few very resistant erratic pebbles, mostly of quartzite. The age of this material cannot be determined, but it is probably pre-Millbrook.

Till lying below Millbrook Till was exposed in a cut for highway relocation in the south part of Wooster and is illustrated in figure 4. This "lower till" is very sandy and olive gray in color. It contains 2- to 3-foot inclusions

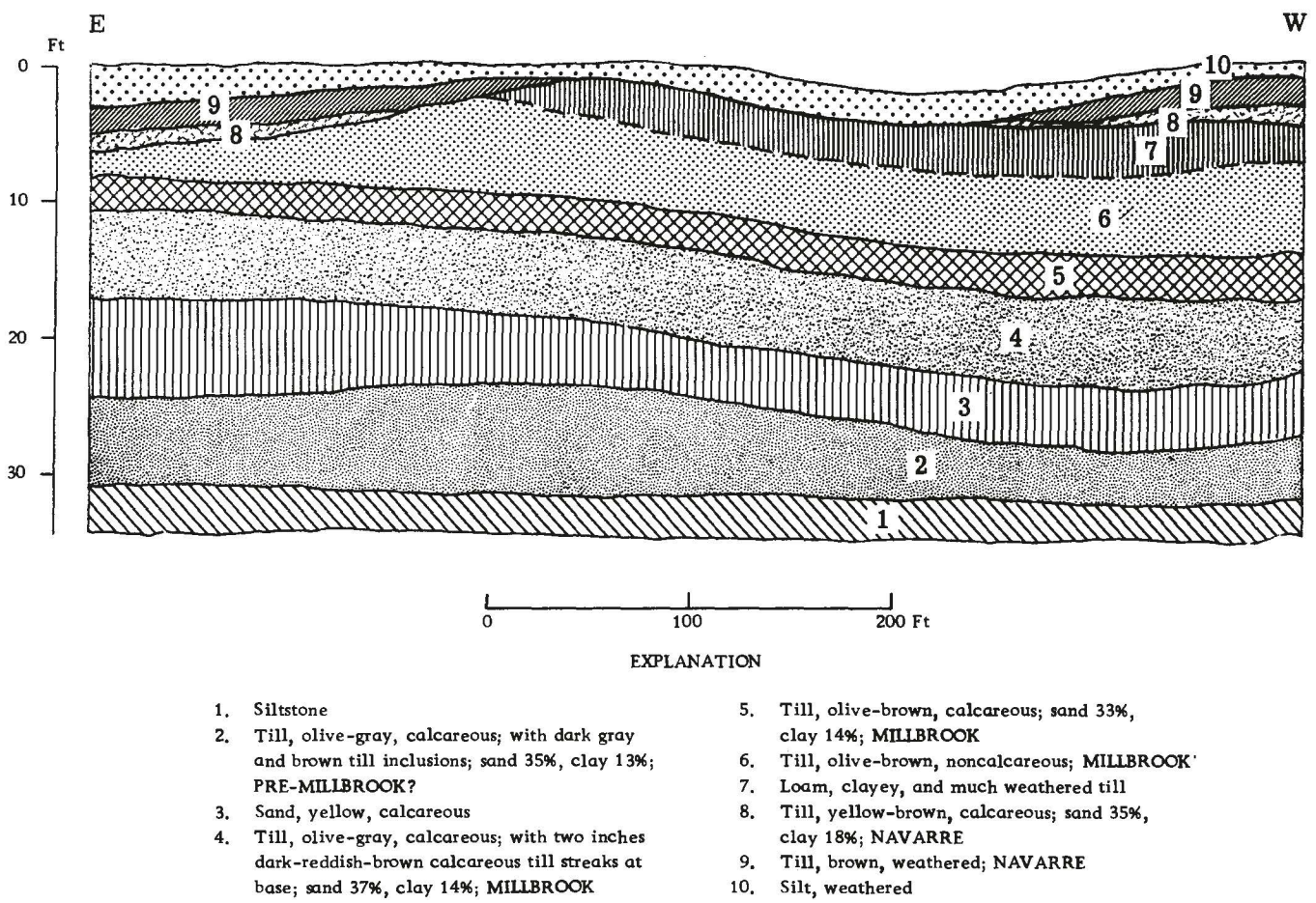


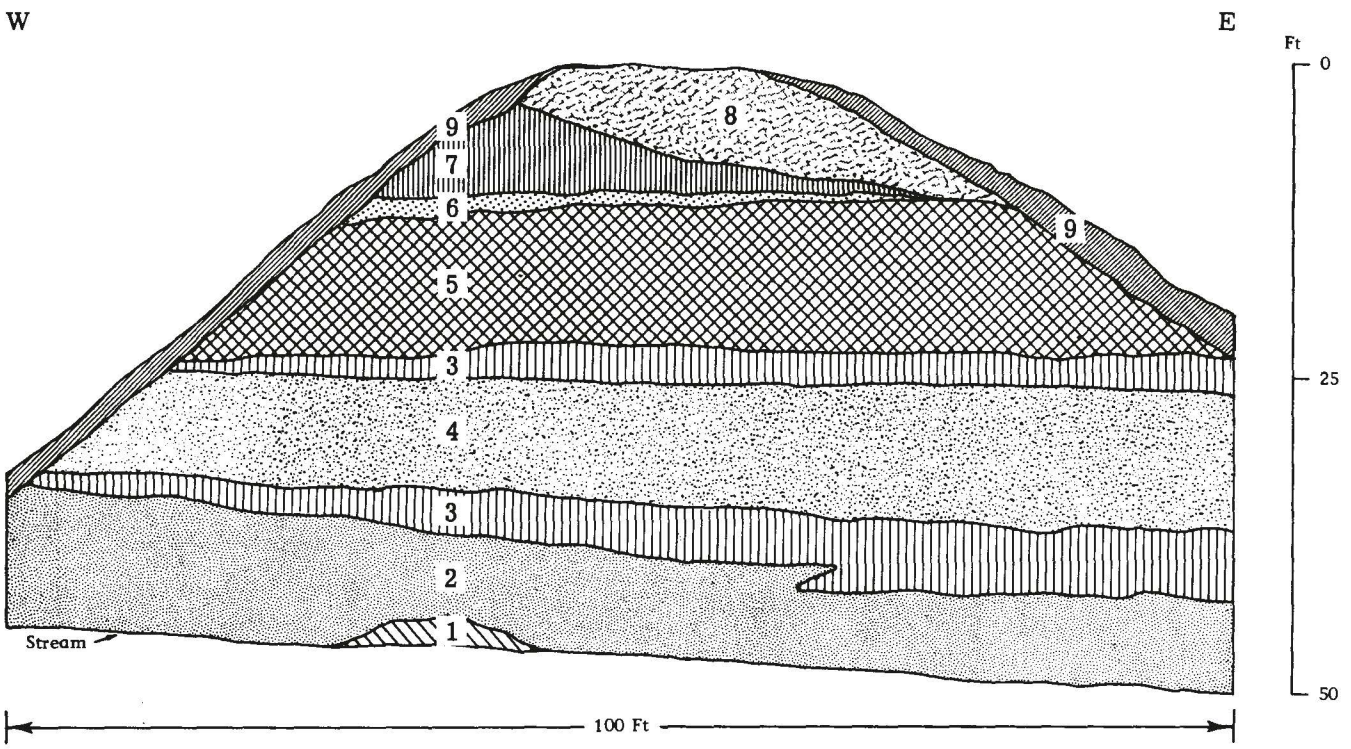
FIGURE 4.—Sketch of drift units in cut for superhighway, U.S. 39, ½ mile east of Ohio Route 76, south part of Wooster, Wayne County.

of bluish-gray and yellow-brown to olive-brown till masses: the till is only moderately pebbly and, unlike most other "earlier tills," very angular stones are not conspicuous.

Very stony, hard till, probably pre-Millbrook in age, crops out near the valley bottoms at a few places northeast and northwest of Wooster. Very coarse till is exposed in the cutbank of Clear Creek, 200 yards north of the highway bridge in SW¼ sec. 32, Wayne Township, where the following section was measured:

	Ft	In
Gravel, coarse, leached	5	0
Gravel, cobbly and bouldery; base uneven; strongly cemented with $CaCo_3$; very massive, forms a ledge from which 20-foot slabs break loose and migrate down slope	5	0
Sand, with stones	1	6
Till, coarse, stony, weakly calcareous, olive-brown (2.5Y 4/4); very rusty along joints; 38 percent sand, 48 percent silt, 14 percent clay	3	0
Till, very stony, weakly calcareous, olive-gray (5Y 4/2); 41 percent sand, 44 percent silt, 15 percent clay	5	0
Till, poorly exposed and slumped, may include some gravel	20	0
Level of Clear Creek		

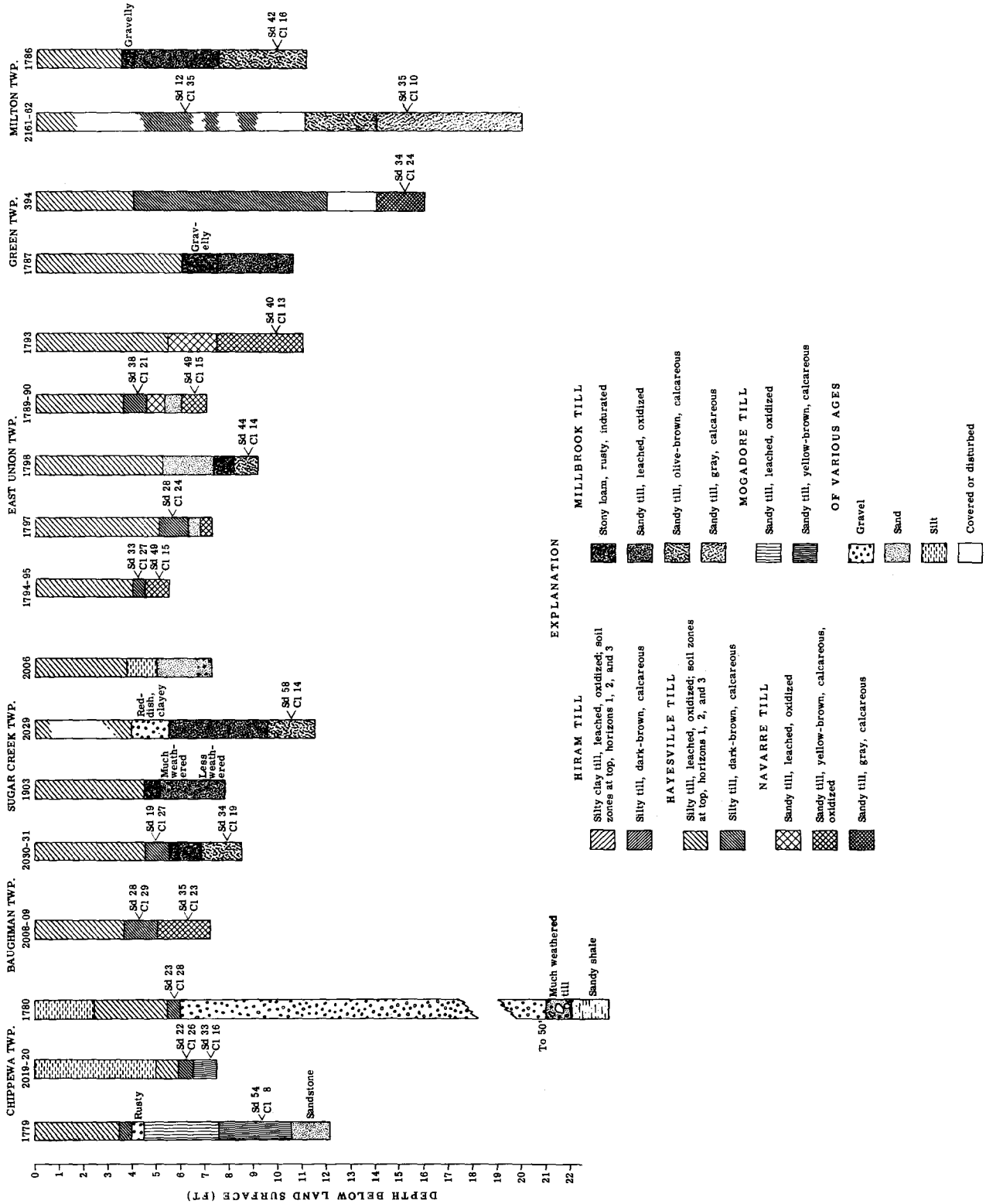
Twelve feet of hard, very stony till crops out in a road ditch below the cemetery half a mile northwest of New Pittsburg in sec. 30, Chester Township. The upper part has inclusions of coarse gravel and silt, probably a result of colluviation down the slope; the lower few inches, exposed in the bottom of the ditch, are very weakly calcareous. The till is olive brown and is marked by conspicuous dark stains along the joints.



EXPLANATION

1. Till, olive-gray, calcareous; sand 43%, clay 12%
2. Till, light-olive-brown, calcareous; sand 41%, clay 10%
3. Gravel, coarse, rubbly, stony
4. Till, brown, calcareous, very stony
5. Till, brown, calcareous
6. Gravel
7. Till, olive-gray, calcareous; sand 42%, clay 10%; MILLBROOK?
8. Till, brown, partly leached; less stony than lower in bank; MILLBROOK?
9. Colluvium

FIGURE 5.–Sketch of high bank of tributary to Little Killbuck Creek at highway bridge, NE¼SE¼ sec. 28, Chester Township, Wayne County.


CHIPPEWA TWP.
BAUGHMAN TWP.
SUGAR CREEK TWP.
EAST UNION TWP.
GREEN TWP.
MILTON TWP.
1779
2019-20
1780
2008-09
2030-31
1903
2029
2006
1794-95
1797
1798
1789-90
1793
1787
394
2161-62
1786
Rusty
Sd 54 Cl 8
Sandstone
Sd 22 Cl 26
Sd 33 Cl 16
Sd 23 Cl 28
Sd 28 Cl 29
Sd 35 Cl 23
Sd 19 Cl 27
Sd 34 Cl 19
Much weath-ered
Less weath-ered
Red-dish, clayey
Sd 58 Cl 14
Sd 33 Cl 27
Sd 49 Cl 15
Sd 28 Cl 24
Sd 44 Cl 14
Sd 38 Cl 21
Sd 49 Cl 15
Sd 40 Cl 13
Grav-elly
Sd 34 Cl 24
Sd 12 Cl 35
Sd 35 Cl 10
Gravelly
Sd 42 Cl 16
To 50'
Much weathered till
Sandy shale
DEPTH BELOW LAND SURFACE (FT)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
EXPLANATION
HIRAM TILL
Silty clay till, leached, oxidized; soil zones at top, horizons 1, 2, and 3
Silty till, dark-brown, calcareous
HAYESVILLE TILL
Silty till, leached, oxidized; soil zones at top, horizons 1, 2, and 3
Silty till, dark-brown, calcareous
NAVARRE TILL
Sandy till, leached, oxidized
Sandy till, yellow-brown, calcareous, oxidized
Sandy till, gray, calcareous
MILLBROOK TILL
Stony loam, rusty, indurated
Sandy till, leached, oxidized
Sandy till, olive-brown, calcareous
Sandy till, gray, calcareous
MOGADORE TILL
Sandy till, leached, oxidized
Sandy till, yellow-brown, calcareous
OF VARIOUS AGES
Gravel
Sand
Silt
Covered or disturbed

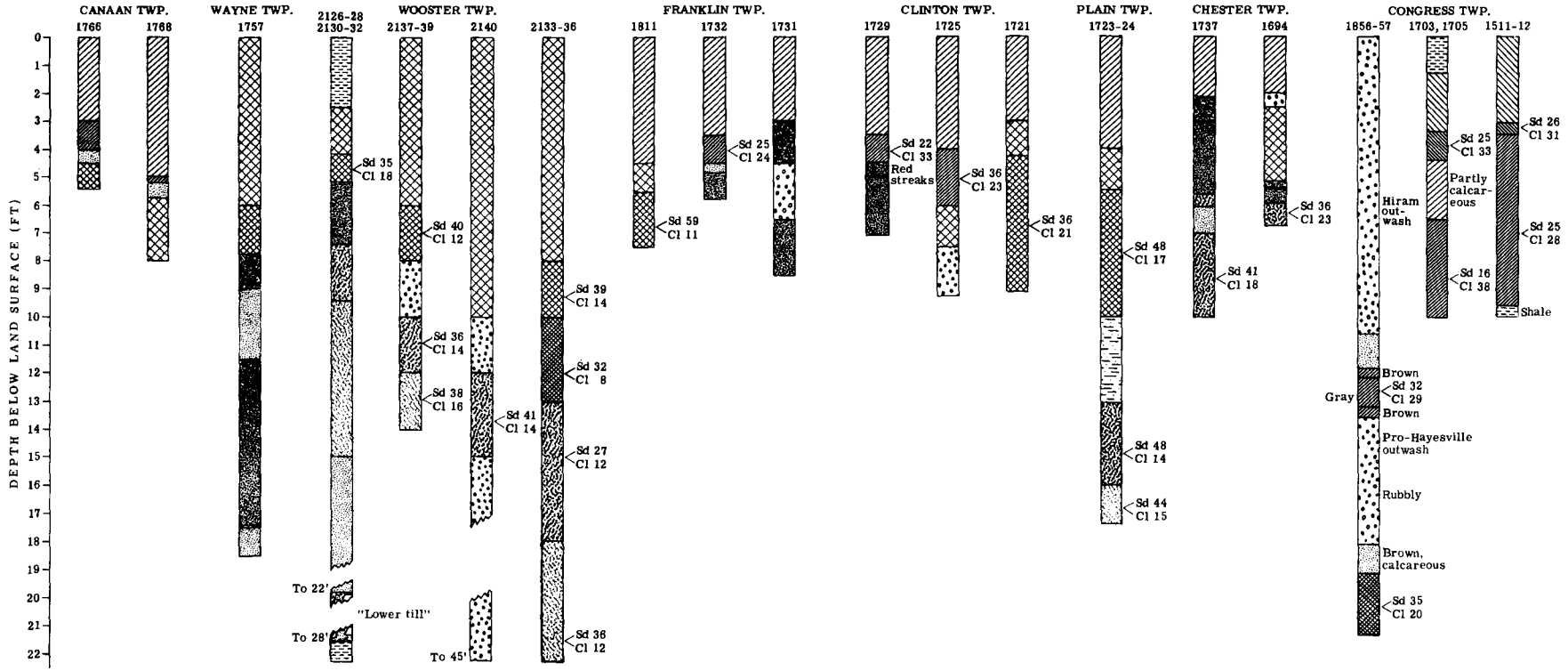


FIGURE 6.—Sections of tills and other drifts of more than one age in Wayne County showing percentages of sand (Sd) and clay (Cl) in samples collected at points indicated in sections. Percentage of silt=100–(Sd+Cl). See fig. 2 for locations of samples.

TABLE 3.—*Composition of Mogadore Till*

Sample no.	Township	Sand	Silt	Clay	Sand/clay	Quartz	Orthoclase	Plagioclase	Carbonate
1536	Chippewa	39.7	42.1	18.2	2.18	81.6	6.1	12.3	3.7
1775	*	55.1	33.0	11.9	4.64	84.2	5.3	10.5	3.0
1776	*	53.8	33.0	13.2	4.07	82.8	6.1	11.1	1.0
1777	Chippewa	47.1	39.1	13.8	3.41	88.0	5.0	7.0	2.5
1779	Chippewa	54.3	37.5	8.2	6.62	84.0	8.0	8.0	4.0
2020	Chippewa	33.2	50.6	16.2	2.05	79.6	9.1	11.3	.4
	Average	47.2	39.2	13.6	3.47	83.4	6.6	10.0	2.4

*Located just north of Chippewa Township, in Summit County.

Other exposures of similar very hard, stony till were seen 2 miles west of Wayne County in NE¼ sec. 33, Perry Township, Ashland County; both olive-brown and bluish-gray till were exposed along Glenn Run, 2 miles northeast of Jeromesville. This very stony till contains few foreign pebbles and cobbles, the stones being mainly sandstone. The till is exceedingly hard and rocklike and breaks out along the stream channel in bricklike fragments. It is very weakly calcareous at a few places.

Still farther west of Wayne County, similar till has been noticed near Savannah in northern Ashland County, where it underlies Millbrook and later tills. It has been found by Totten (1962) at several places in Richland County.

A series of several tills whose ages cannot be satisfactorily determined is well exposed in the high bank of a tributary to Little Killbuck Creek at the highway bridge in NE¼SE¼ sec. 28, Chester Township, as illustrated in figure 5. The fact that unoxidized till of unit 7 overlies deeply oxidized till of units 3 and 2 may indicate that the lower tills are considerably older than the unoxidized till above. The upper units are probably Millbrook and the lower ones are probably older than Millbrook. The lower till is very stony and may be the same as the very stony till farther east near Wooster. All these tills have a very high silt content, ranging from 45 to 49 percent.

The lower till, encountered 120 feet or more below the present surface in exploratory drilling in the Killbuck valley at Wooster (Wooster, Ohio, Water Improvements Rept., June, 1958, by Jones, Henry, and Williams, pl. 28), is probably pre-Millbrook in age. At some places it lies directly upon bedrock, but at others a few feet of gravel separates the till from the rock. The samples available from the drilling do not permit definite characterization of the till.

So far it is not technically possible to determine the age or correlation of these lower tills. They are possibly of different ages. Except at the Little Killbuck Creek exposure, no weathered zone has been observed where the till lies below later tills. These tills may be Illinoian, and some of the lowest ones may be even pre-Illinoian. Their correlation and age assignment must await more information as additional samples from drilling are available, or as fortuitous deep cuts are made in highway or other excavations.

DRIFT OF THE GRAND RIVER LOBE

The drift of a part of Chippewa Township in extreme northeastern Wayne County was deposited by the Grand River lobe of ice. The drift of this area north and northeast of Chippewa Creek is continuous with the drift of the Grand River lobe in Summit, Stark, Portage, Trumbull, and Mahoning Counties. The Mogadore Till, of early Wisconsin age, is the only drift sheet of this lobe that has been identified in Wayne County; later Wisconsin drift sheets of the Grand River lobe do not extend so far southwest.

Mogadore Till

Location and extent.—The Mogadore Till, named from outcrops near Mogadore, Summit County (White, 1960, p. 3), is the surface till in part of southern Summit County, in a small part of southeastern Medina County, and in the northeastern half of Chippewa Township, the northeastern township of Wayne County. It lies beneath younger till in western Pennsylvania (Shepps and others, 1959, p. 29) and in Portage, Trumbull (White, 1960, p. 4), and northern Stark Counties (White, 1963, p. 129) in northeastern Ohio. In Wayne County this till has been observed beneath younger drift in western and southern Chippewa Township (fig. 6, section 2019). Just north of Chippewa Township, in Wadsworth Township, Medina

County, the Mogadore Till is exposed in the shale pit of the Wadsworth Brick and Tile Company and is seen to pass beneath the Navarre and Hayesville Tills of the Killbuck lobe (fig. 7).

Composition.—The Mogadore Till is a weakly calcareous, sandy, pebbly till in which cobbles and boulders are common. Six samples have an average composition of 47.2 percent sand, 41.6 percent silt, and 14.8 percent clay (table 3). The clay minerals of the till matrix are mainly illite and chlorite, but kaolinite is always present in small amounts (Droste, 1956a, p. 189; Droste, White, and Vatter, 1958). The carbonate content of the fresh till ranges from less than 1 to 4 percent, averaging 2.6 percent.

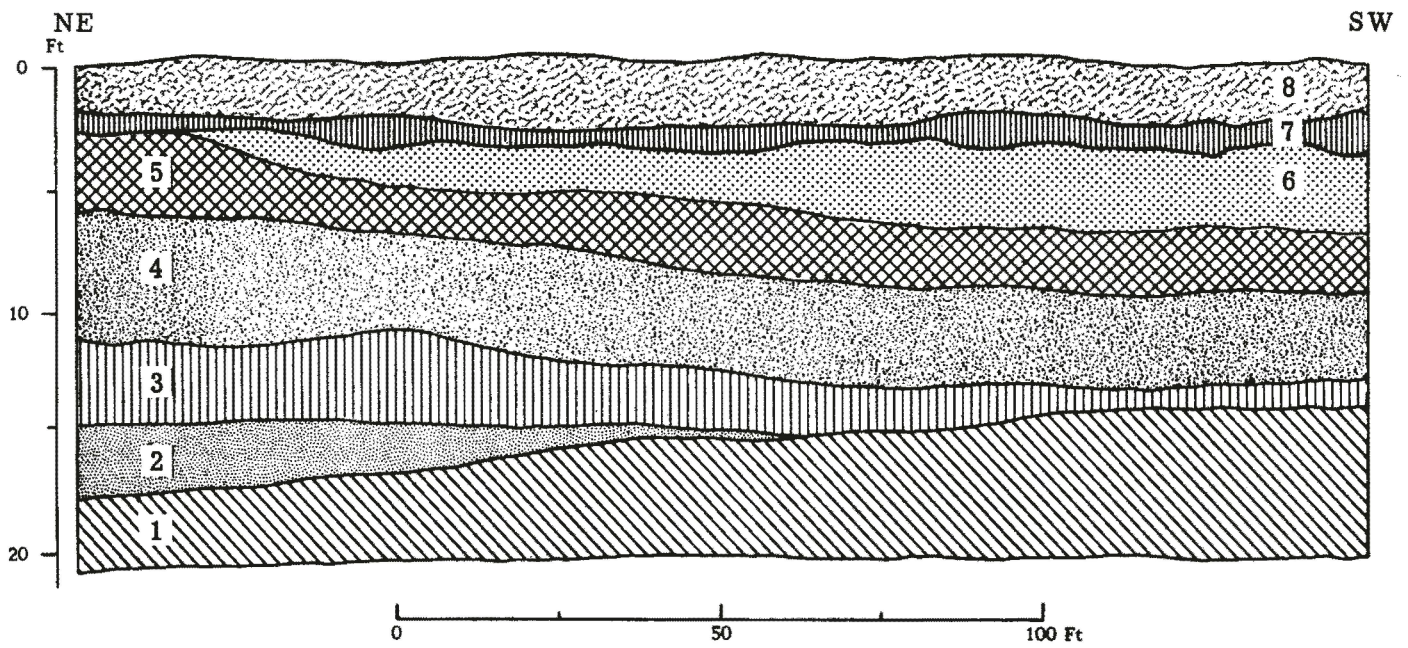
Weathering horizons.—The weathering horizons of the Mogadore Till are shown graphically in figure 8. They may be compared with those of other tills in figure 3. The unaltered till of horizon 5 is dark gray. The calcareous, oxidized till, horizon 4, is yellow brown (10YR 4/4). The depth of oxidation, the base of the horizon, ranges from 11 to 13 feet below the surface.

Horizon 3, the oxidized, leached till that has otherwise been little altered, resembles horizon 4 in appearance, except that stronger manganese and iron oxide stains may occur on joint surfaces. The base of horizon 3, the depth of leaching, ranges from 6½ to almost 8 feet below the surface; it may vary almost 2 feet over short distances.

Horizon 2, the zone of decomposed till, is thoroughly weathered. Its color is brown, buff, and gray, intermixed at many places. Many of the pebbles and cobbles are rotten. Very dark staining along the joints is conspicuous. Clay skins are moderately well developed on the joint blocks (peds).

Horizon 1, the soil, is loam to sandy loam. It resembles the Wooster loam and closely approaches it, but detailed soil investigations may show it to be sufficiently different to warrant separate designation. Caine and Lyman (1905) regarded the soil as different from that near Wooster.

Age and correlation.—The Mogadore Till in Summit County was originally called "Tazewell" (White, 1953b, p. 18) and when this till was given the rock-stratigraphic designation "Mogadore" it was regarded as Tazewell in



EXPLANATION

1. Shale
2. Till, gray, calcareous; sand 36%, clay 20%; MOGADORE
3. Till, light-olive-brown, calcareous; sand 44%, clay 12%; MOGADORE
4. Till, olive-brown, noncalcareous; MOGADORE
5. Sand and silt, yellow-brown, fine
6. Till, yellow-brown, weathered; NAVARRE
7. Gravel, reddish-brown, clayey, indurated (colluvium)
8. Till, dark-brown, weathered; upper one foot pebble-free silt loam; HAYESVILLE

FIGURE 7.—Sketch of upper part of pit of Wadsworth Brick and Tile Company, 1¾ miles southwest of Wadsworth Square, Medina County.

age (White, 1960, p. 2). Later studies have shown that at some localities where the Mogadore Till lies below later calcareous till a weathered zone is preserved in the top of the Mogadore Till (fig. 6, section 1779). The weathered zone is the lower part of an old soil, the upper part of which has been removed. No complete weathered section has yet been discovered and it is thus impossible to specify the exact amount of weathering that took place before the advance of the ice that deposited the overlying till. The weathering appears to be more extensive and intense than would have been produced in a short interval between Tazewell and late Wisconsin time and the interpretation now preferred is that the weathering took place in pre-Tazewell time on till of pre-Tazewell but "early" Wisconsin age. Tills in western Ohio with somewhat similar truncated buried weathering profiles have been assigned an "early" Wisconsin age (Forsyth, 1957).

The recently described Titusville Till of northwest Pennsylvania (White and Totten, 1965), which has been determined by radiocarbon dating to have an age of more than 31,000 years, has been correlated with the Mogadore Till. In terms of classification proposed by Frye and Willman (1960) for Lake Michigan lobe drifts, the Titusville Till is therefore of late Altonian (early Wisconsin) age. The relation of the Mogadore Till to the Millbrook Till will be discussed in the section on the latter till.

DRIFT OF THE KILLBUCK LOBE

The drift of all of Wayne County, except for part of Chippewa Township in the northeastern corner of the county, is a part of the deposits of the Killbuck lobe, which extend also over the western part of Stark County, the northern part of Holmes County, Ashland County, Medina County, and part of Richland County.

Millbrook Till

Location and extent.—The Millbrook Till is named from an exposure in SE¼ sec. 25, Plain Township, near the village of Millbrook, 4 miles southwest of Wooster (White, 1961, p. 71). It has been traced from Wayne County into Stark, Holmes, Ashland, and Richland Counties, and has been observed in almost every township of Wayne County. It is generally overlain by the Navarre Till, which is in turn overlain by the Hayesville Till, as at the type locality near Millbrook (fig. 6, section 1723). At some localities the Navarre Till is absent and the Hayesville Till lies directly upon the Millbrook Till. Measured sections in which the Millbrook Till has been observed below younger tills are shown in figure 6. At some places, especially in the southern part of the county, Millbrook Till is the surface material or is overlain by such a thin deposit of later tills that they are incorporated in the soil and the Millbrook Till appears to be the surface material. The bulk of the drift exposed in most deep sections in the central southern parts of the county is Millbrook Till, as the overlying units are generally thin.

The material beneath the Millbrook Till may be bedrock, gravel, or still earlier till. Till beneath the Millbrook crops out at so few places that it is not possible to correlate with confidence this pre-Millbrook till from place to place. In northeastern Baughman Township and along the Killbuck Valley near Wooster large gravel deposits lie beneath the Millbrook Till and this arrangement is maintained southward into Holmes County as far south as Millersburg.

Composition.—The Millbrook Till is a weakly calcareous, sandy, pebbly till. It contains many cobbles and

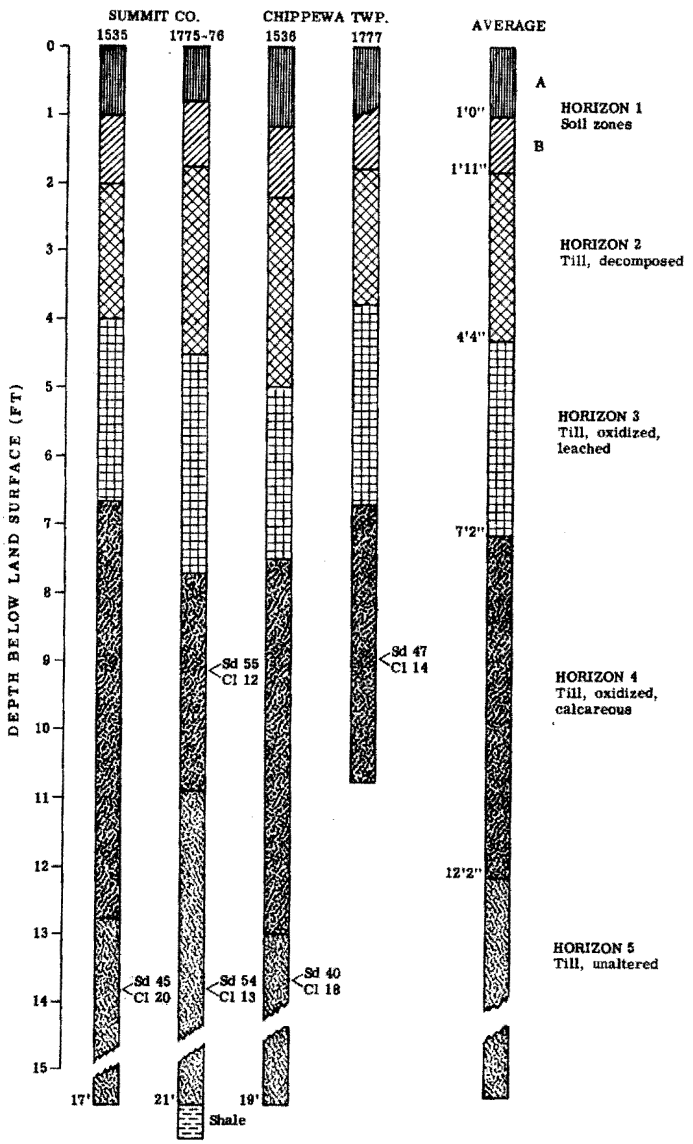


FIGURE 8.—Sections of weathering horizons of Mogadore Till showing percentages of sand (Sd) and clay (Cl) in samples collected at points indicated in sections. Percentage of silt=100–(Sd+Cl). See fig. 2 for locations of samples.

TABLE 4.—*Composition of Millbrook Till*

Sample no.	Township	Sand	Silt	Clay	Sand/clay	Quartz	Orthoclase	Plagioclase	Carbonate
1313	Baughman	53.7	34.3	12.0	4.48	84.7	5.1	10.2	5.0
1899	Baughman	40.7	47.4	11.9	3.42	83.9	5.4	10.7	
1900	Baughman	45.8	40.5	13.7	3.34	80.9	7.2	11.9	
2010	Baughman	41.9	39.9	18.2	2.30	78.0	11.1	10.9	4.2
2147	Baughman	54.7	37.2	8.1	6.75	82.8	7.4	9.8	
2148	Baughman	49.7	34.9	15.4	3.23	78.7	10.4	10.9	
1689	Chester	39.4	44.0	16.6	2.37	74.6	14.5	10.9	4.8
1690	Chester	39.9	42.8	17.3	2.31	77.0	8.2	14.8	
1798	East Union	43.6	42.5	13.9	3.13	81.6	9.3	9.1	.4
1809	Franklin	45.3	35.5	19.2	2.36	81.4	8.8	9.8	
1810	Franklin	46.4	38.3	15.3	3.03	71.4	9.3	19.3	2.2
1812	Franklin	44.1	38.3	17.6	2.51	76.0	6.3	17.7	2.0
1813	Franklin	43.9	36.4	19.7	2.23	79.2	5.2	15.6	2.0
1784	Green	49.0	39.8	11.2	4.37	75.2	11.1	13.7	1.1
1785	Green	50.7	35.9	13.4	3.78	75.7	9.8	14.5	1.0
1786	Milton	41.5	42.7	15.8	2.63	80.1	8.1	11.8	2.6
1824	Milton	30.4	48.8	20.8	1.46	80.2	5.5	14.3	2.0
2162	Milton	34.5	55.5	10.0	3.45	80.2	7.6	12.2	
1802	Paint	44.7	38.0	17.3	2.58	82.5	10.1	7.4	.4
1833	*	40.2	43.0	16.8	2.39				
1834	*	43.9	40.9	15.2	2.88				
2001	Paint	57.8	30.0	12.2	4.74	85.0	7.9	7.1	3.8
2002	Paint	41.7	39.7	18.6	2.24	78.2	10.0	11.8	2.7
2007	Paint	56.9	29.8	13.3	4.27	80.7	8.5	10.8	1.0
1724	Plain	49.0	37.7	13.3	3.68	71.1	13.1	15.8	2.2
1806	Plain	48.2	37.8	14.0	3.44	70.0	8.9	21.1	2.0
1807	Plain	44.1	40.8	15.1	2.92	72.6	7.4	20.0	2.0
2024	Plain	46.7	38.3	15.0	3.11	73.9	11.6	14.5	
1801	**	45.4	35.2	19.4	2.34	78.1	8.2	13.7	4.2
1902	Sugar Creek	45.7	39.8	14.5	3.16	75.8	12.0	12.2	3.0
2003	Sugar Creek	42.1	39.8	18.1	2.33	74.6	15.0	10.4	5.0
2029	Sugar Creek	58.4	27.8	13.8	4.23	84.5	6.3	9.2	
2031	Sugar Creek	34.0	47.3	18.7	1.82	83.4	8.0	8.6	2.7
1758	Wayne	45.4	37.5	17.1	2.65	69.5	9.5	21.0	3.7
1760	Wayne	48.3	37.8	13.9	3.48	76.9	9.4	13.7	
1781	Wayne	69.9	17.2	12.9	5.41	74.9	11.6	13.5	
1782	Wayne	42.4	51.1	6.5	6.51	76.1	10.3	13.6	
1783	Wooster	34.6	48.8	16.6	2.10	72.5	12.8	14.7	
2124	Wooster	33.6	52.5	13.9	2.42	80.6	9.2	10.2	
2125	Wooster	38.4	46.6	15.0	2.56	78.7	10.1	11.2	
2127	Wooster	33.0	52.6	14.4	2.29	74.8	11.7	13.5	
2128	Wooster	36.7	49.2	14.1	2.60	76.2	10.9	12.9	
2135	Wooster	27.3	61.1	11.6	2.35	74.6	13.5	11.9	
2136	Wooster	35.7	50.9	13.4	2.66	71.0	14.3	14.7	
2138	Wooster	35.7	50.1	14.2	2.51	77.6	12.5	9.9	
2139	Wooster	37.8	46.4	15.8	2.39	72.2	12.4	15.4	
2140	Wooster	41.0	45.2	13.8	2.97	71.2	13.8	15.0	
	Average	43.6	41.6	14.8	2.95	75.1	10.0	14.9	2.6

*Located just south of Paint Township, in Holmes County.

**Located just south of Salt Creek Township, in Holmes County.

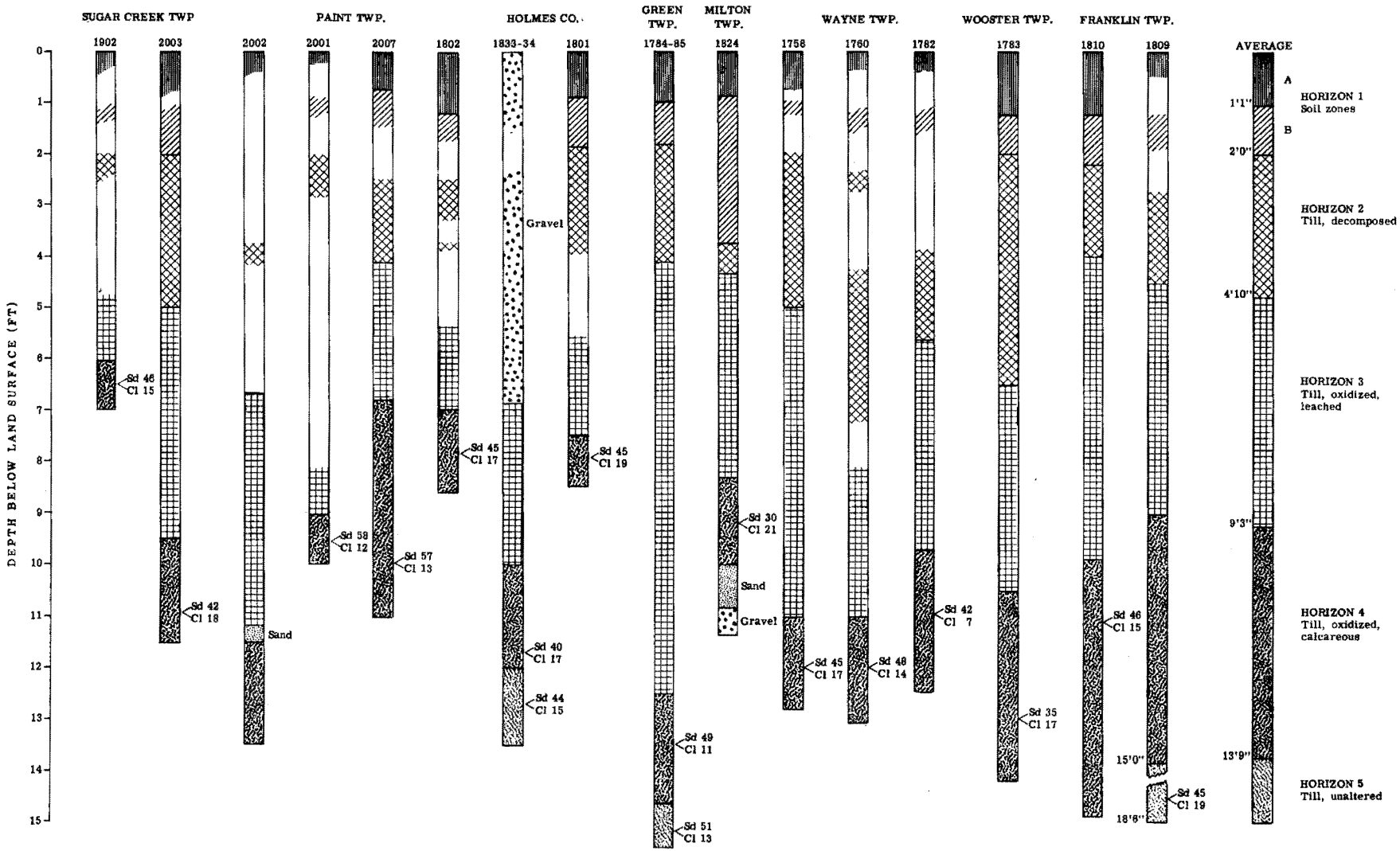


FIGURE 9.—Sections of weathering horizons of Millbrook Till showing percentages of sand (Sd) and clay (Cl) of samples collected at points indicated in sections. Percentage of silt=100–(Sd+Cl). See fig. 2 for locations of samples.

boulders. Sandstone and coarse siltstone fragments are prominent. The composition of 47 samples is shown in table 4. The average content of the matrix is 43.6 percent sand, 41.6 percent silt, and 14.8 percent clay. The quartz/feldspar ratio is 3.0. The average carbonate content is 2.6 percent.

Weathering horizons.—The weathering horizons of Millbrook Till where it forms the surface material, or where overlying material is so thin it cannot be identified in the weathered upper part of the Millbrook, are shown graphically in figure 9. The average thicknesses of the horizons may be compared with the averages of those of other tills in figure 3.

The unaltered till, horizon 5, is dark gray. The calcareous oxidized till, horizon 4, is olive brown (2.5Y 4/4). This olive-brown color of the oxidized till is distinctively different from the "brighter" yellow brown (10YR 4/4) of horizon 4 of the overlying Navarre Till. The base of the horizon, the depth of oxidation, was observed at only a few exposures, but it appears to be about 14 feet below the surface.

Horizon 3, the oxidized, leached till, has otherwise been little altered and resembles horizon 4 in appearance, particularly in color, except that conspicuous rusty stains are present along the joints and clay skins coat some of the joint blocks. Dark brownish-black manganese stains are present along some of the partings. The base of horizon 3, the depth of leaching, ranges from 6 feet to 11 feet and averages 9 feet 3 inches below the surface (fig. 9). It is possible that at places where leaching is shallow, part of the upper horizons of the till has been removed by later ice advance and in these places the shallow leaching represents a time of weathering shorter than that from the end of Millbrook time to the present.

Horizon 2 is decomposed and thoroughly weathered till. It is 3 feet or more in thickness. Many of the pebbles and cobbles are quite rotten. Its color is generally a mixture of brown, yellow brown, buff, and gray. Dark stains are conspicuous and clay skins are well developed.

Horizon 1, the soil, is loam to sandy loam, and resembles the Wooster loam. It appears to be quite variable because of probable mixing with later till and because of incorporation of later silt in the upper part of the profile at some places.

Where the Millbrook Till is not at the surface, the covering of later material may be so thin that the Millbrook is encountered in auger borings or in shallow excavations, and may in some cases be erroneously identified as the parent material of the present soil.

Beyond the limits of the Hayesville Till in Paint Township, the southeastern part of the county, outcrops in strip mines and other excavations show the Millbrook Till well and in only a few places is the Navarre Till above it thick enough to be identified. The variation in thickness of the different weathering horizons is well shown by the sections presented graphically in figure 9.

No complete buried weathering profile on the Millbrook Till has been observed in Wayne County, although farther west in Ashland County almost complete buried profiles have been seen at two places. At many places in Wayne County the lower portion of the leached and weathered part of the profile is preserved below overlying calcareous till. This is well shown in a section 50 yards south of the water tower in Dalton, Sugar Creek Township (fig. 6, sections 2030-31). At many exposures the upper part of the weathered Millbrook material, ranging in thickness from 3 inches to almost 2 feet, is very hard dark-reddish-brown clayey loam, the lower part of which contains many fragments of angular sandstone and siltstone ("channers") as much as 3 inches in length. This material is usually so stony that it cannot be penetrated by an auger. The layer may be in part ancient colluvium upon the Millbrook Till. The stony material has some resemblance to the "lag-gravel erosion pavement (stone line)" with "pedi-sediment" above it described by Ruhe (1956, p. 442) in Adair County, Iowa, as well as elsewhere (Ruhe, 1959, p. 229; 1960, p. 167). In northwestern Pennsylvania, similar stony material at the top of a sandy till which lies below a later till was interpreted by Shepps and others (1959, p. 30) as of periglacial origin.

Age and correlation.—The Millbrook Till was originally designated as either Wisconsin(?) or Illinoian(?) (White, 1961, p. 71). A considerable time interval was necessary to produce the weathering of the till before the overlying material was deposited. This weathering may have taken place in Sangamonian time, the interval between Illinoian and Wisconsin glacial stages, but studies farther west in Ashland County, and particularly in Richland County (Totten, 1962), indicate a post-Millbrook weathering period of shorter duration, appropriate to that which could have existed between early Wisconsin and late Wisconsin time. The preferred interpretation at present is that the Millbrook Till is a very early Wisconsin drift. Very early Wisconsin drifts have been identified in western Ohio (Forsyth, 1957), in Illinois (Frye and Willman, 1960; 1963, fig. 2; Kempton, 1966), in Ontario (de Vries and Dreimanis, 1960), and in Pennsylvania (White and Totten, 1965).

The spatial relations and the stratigraphic similarities invite the interpretation that the Millbrook Till of the Killbuck lobe is correlative with the Mogadore Till of the Grand River lobe. The weathering profiles of the Millbrook Till are somewhat thicker than those of the Mogadore Till. The Millbrook Till is slightly less sandy and contains less quartz and more feldspar than does the Mogadore Till. The carbonate content is about the same. Perhaps the differences between the two tills are no greater than would be expected in till of the same age deposited by separate but adjacent lobes. The oxidized Millbrook Till is a distinct olive brown and the Mogadore is yellow brown. The reason for the color difference is not yet known, but it is possibly due to difference in amount or kind of pyrite in the two tills. It is hoped that further superhighway construction and other excavations in Medina, Summit, and Wayne Counties will provide

TABLE 5.—*Composition of Navarre Till*

Sample no.	Township	Sand	Silt	Clay	Sand/clay	Quartz	Orthoclase	Plagioclase	Carbonate
2009	Baughman	35.4	41.7	22.9	1.54	73.0	13.2	13.8	2.8
2146	Baughman	46.1	42.4	11.5	4.01	84.9	6.5	8.6	
2146A	Baughman	48.7	38.4	12.9	3.78	80.5	8.9	10.6	
1694	Chester	36.4	40.7	22.9	1.59	79.3	8.3	12.4	
1712	Chester	40.3	39.6	20.1	2.01	73.1	10.4	16.5	
1716	Chester	35.0	46.3	18.7	1.87	71.2	14.6	14.2	
1737	Chester	40.7	41.3	18.0	2.26				
1721	Clinton	36.3	43.1	20.6	1.73	75.7	10.1	14.2	
1749	Clinton	42.4	40.9	16.7	2.54	65.4	17.3	17.3	
1857	Congress	35.2	44.1	20.7	1.70	78.6	6.1	15.3	4.0
1790	East Union	43.8	41.0	15.2	2.88	76.8	6.3	16.9	2.0
1792	East Union	42.8	40.1	17.1	2.50	74.6	10.5	14.9	
1793	East Union	39.9	47.4	12.7	3.14	76.4	11.1	12.5	
1795	East Union	48.8	36.3	14.9	3.27	73.7	7.1	19.2	3.0
1796	East Union	47.9	39.0	13.1	3.66	80.4	9.1	10.5	
1733	Franklin	38.0	42.7	19.3	1.97	79.0	11.9	9.1	
1811	Franklin	58.7	30.2	11.1	5.30	79.2	9.2	11.6	
1295	Milton	30.7	45.8	23.5	1.32	81.6	14.1	4.3	
1296	Milton	45.3	39.2	15.5	2.92	71.9	7.3	20.8	5.9
1314	Paint	38.6	39.6	21.8	1.77				
1668	Plain	38.6	41.9	19.5	1.98	71.5	13.4	15.1	
1718	Plain	47.1	38.8	14.1	3.34	69.1	14.4	16.5	
1723	Plain	47.9	35.3	16.8	2.85	77.4	9.6	13.0	6.9
1805	Plain	50.7	34.6	14.7	3.46	72.3	5.3	22.4	6.0
2023	Plain	51.6	23.1	25.3	2.04	82.2	7.9	9.9	12.7
1803	Salt Creek	45.6	37.3	17.1	2.67	76.1	8.5	15.4	
1804	Salt Creek	56.1	31.0	12.9	4.27	78.8	8.3	12.9	7.0
1814	Salt Creek	36.7	47.2	16.1	2.80	75.6	8.6	15.8	2.1
1292	Wayne	43.1	45.9	11.0	3.92	78.7	12.6	8.7	
1757	Wayne	23.0	44.8	32.2	.71	59.8	9.3	30.9	1.0
1309	Wooster	34.7	44.0	21.3	1.63	72.7	12.8	14.5	
1717	Wooster	39.1	48.6	12.3	3.18	61.2	16.0	22.8	
1735	Wooster	50.1	43.5	6.4	7.83	76.6	11.6	11.8	6.9
1736	Wooster	42.3	39.4	18.3	2.25				
1756	Wooster	32.8	45.7	21.5	1.53	83.2	7.8	9.0	6.5
2123	Wooster	40.3	49.1	10.6	3.80	74.3	12.3	13.4	
2126	Wooster	35.2	46.7	18.1	1.94	67.3	21.8	10.9	
2133	Wooster	38.9	47.6	13.5	2.88	73.3	13.5	13.2	
2134	Wooster	32.1	60.2	7.7	4.17	77.1	11.1	11.8	
2137	Wooster	40.0	48.3	11.7	3.41	76.4	12.8	10.8	
	Average	41.4	41.9	16.7	2.48	75.1	10.8	14.1	

evidence upon which to base a firmer conclusion about the relation of the Millbrook Till to the Mogadore Till.

Navarre Till

Location and extent.—The Navarre Till has been named from exposures near Navarre in Stark County (White, 1961, p. 72). It occurs in western Stark County (White, 1963), in all of Wayne County except a small area in the northeastern corner, in northern Holmes County, throughout much of Ashland County, and it has been traced through a part of Richland County. It is concealed beneath the Hayesville Till in much of Wayne County, but crops out beneath the Hayesville in excavations and along streambanks. In places, especially in central Wayne County and particularly in the vicinity of Wooster, the Hayesville Till is thin or absent and the Navarre Till is the surface material.

The discontinuous character of this till was well shown in a cut for the new section of U.S. Highway 30 in the south part of Wooster. Beneath a thin mantle of silt, the Navarre Till was exposed at both ends of the cut but was absent in the central part where weathered Millbrook was the uppermost till (fig. 4). No Hayesville Till could be identified over the Navarre Till at this locality, although it is possible that the weathered Navarre Till does include a small amount of Hayesville Till in the upper part.

An almost continuous deposit of till, which lies from 15 to 20 feet below the surface in the Killbuck valley at Wooster, has a thickness of 10-18 feet (Wooster, Ohio, Water Improvements Rept., June, 1958, by Jones, Henry, and Williams, p. 106). This is probably Navarre Till, but the few samples available are not clear enough to rule out the possibility of another age.

Composition.—The Navarre Till is calcareous, sandy, and moderately pebbly. It contains cobbles and boulders. The composition of the matrix is shown in table 5. The average composition is 41 percent sand, 42 percent silt, and 17 percent clay. It contains a little less sand and a little more clay than the Millbrook or Mogadore Tills. The quartz/feldspar ratio is 3.0. The average carbonate content is 5.1 percent.

Weathering horizons.—The weathering horizons of the Navarre Till are illustrated in figure 10. With the exception of one from Paint Township, these sections occur in areas that were covered by the Hayesville Till, and they may include some unrecognized thin Hayesville Till in the upper parts. However, as they are similar to sections in Paint Township beyond the limit of Hayesville Till, it is believed that they have been little modified either by addition of Hayesville Till or by removal of the top of the Navarre Till by advance of the Hayesville ice.

The unweathered till of horizon 5 is dark gray. The till of horizon 4 is "bright" yellow brown (10YR 4/4) in contrast to the olive brown of the corresponding horizon of the Millbrook Till and to the more drab brown colors in this horizon of the Hayesville Till. The top of horizon 4, the depth of leaching, averages 5 feet 1 inch below the surface. Horizon 3 resembles horizon 4 except that some staining appears along the joints and the carbonates are leached.

Where the Navarre Till is at the surface, the soil developed in it is mainly Wooster and Canfield loam or silt loam. Such areas may be reasonably extensive or quite restricted in places where the Navarre Till crops out as small areas surrounded by Hayesville Till, in which the soil is somewhat different. This patchy surface outcrop of the Navarre Till is reflected in the soils map of the county, which shows isolated areas of Wooster soil interspersed with areas of other soils derived from Hayesville Till (personal communication, Marvin Bureau, 1961).

Age and correlation.—The Navarre Till is correlative with the Kent Till of the Grand River lobe (White, 1961, p. 73; 1963). The Kent Till has a minimum age of 14,000 years (Droste, White, and Rubin, 1960) and is probably somewhat older. The Kent and Navarre Tills may be correlative with the Tazewell drift of the Mississippi valley succession, but positive determination must await discovery in the till of wood or other organic matter that can be dated by radiocarbon assay.

The Navarre Till overlies the Millbrook Till, which at places retains weathered material at its top. The Navarre Till is, therefore, considerably younger than the Millbrook Till. At only one or two places has any weathering been observed at the top of the Navarre Till and below the Hayesville Till (fig. 6, section 1789). At a few places in Ashland County, west of Wayne County, a thin leached zone occurs at the top of the Navarre Till where it lies below the Hayesville Till. The time between deposition of the Navarre Till and deposition of the Hayesville Till was sufficient to allow the ice to retreat a considerable distance; the Hayesville ice readvance brought material of distinctly different composition into Wayne County.

Hayesville Till

Location and extent.—The Hayesville Till, named from exposures near Hayesville in southern Ashland County (White, 1961, p. 73), has been traced from western Stark County across Wayne, southeastern Medina, northern Holmes, and Ashland Counties to Richland County. It forms a generally thin and in part discontinuous surface mantle over older drift in all of Wayne County except for Paint Township and for a few square miles in northeastern Chippewa Township, where it is not present. In the northern two-thirds of Congress Township and the northwestern half of Canaan Township the Hayesville Till is overlain by the later Hiram Till. The Hayesville Till is generally thicker and more continuous in the northern part of Wayne County and much less continuous and thinner in the central and southern parts. However, the Hayesville Till is somewhat more continuous in those parts of southern Wayne County where it overlies

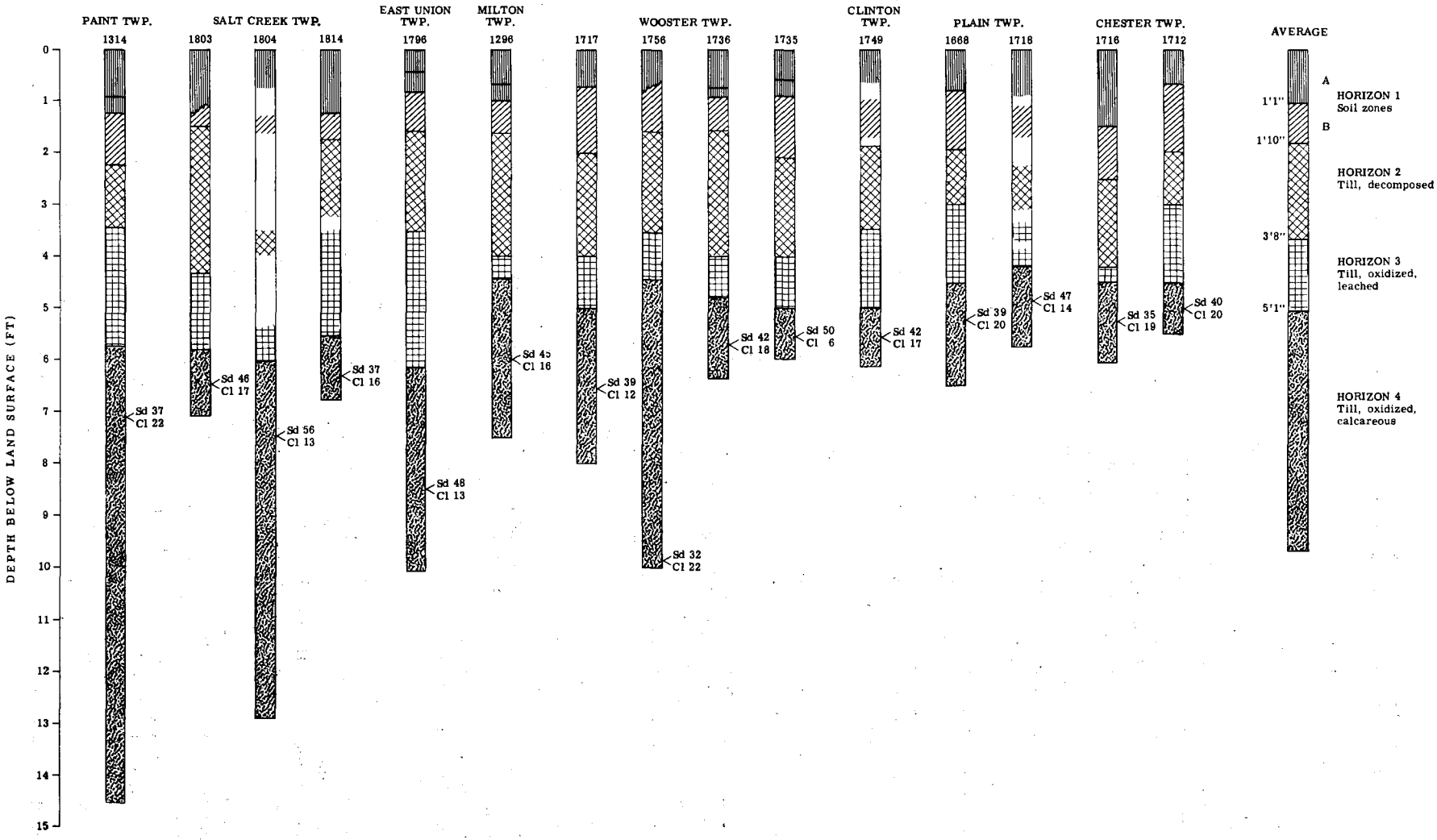


FIGURE 10.–Sections of weathering horizons of Navarre Till showing percentages of sand (Sd) and clay (Cl) of samples collected at points indicated in sections. Percentage of silt=100–(Sd+Cl). See fig. 2 for locations of samples.

TABLE 6.—*Composition of Hayesville Till*

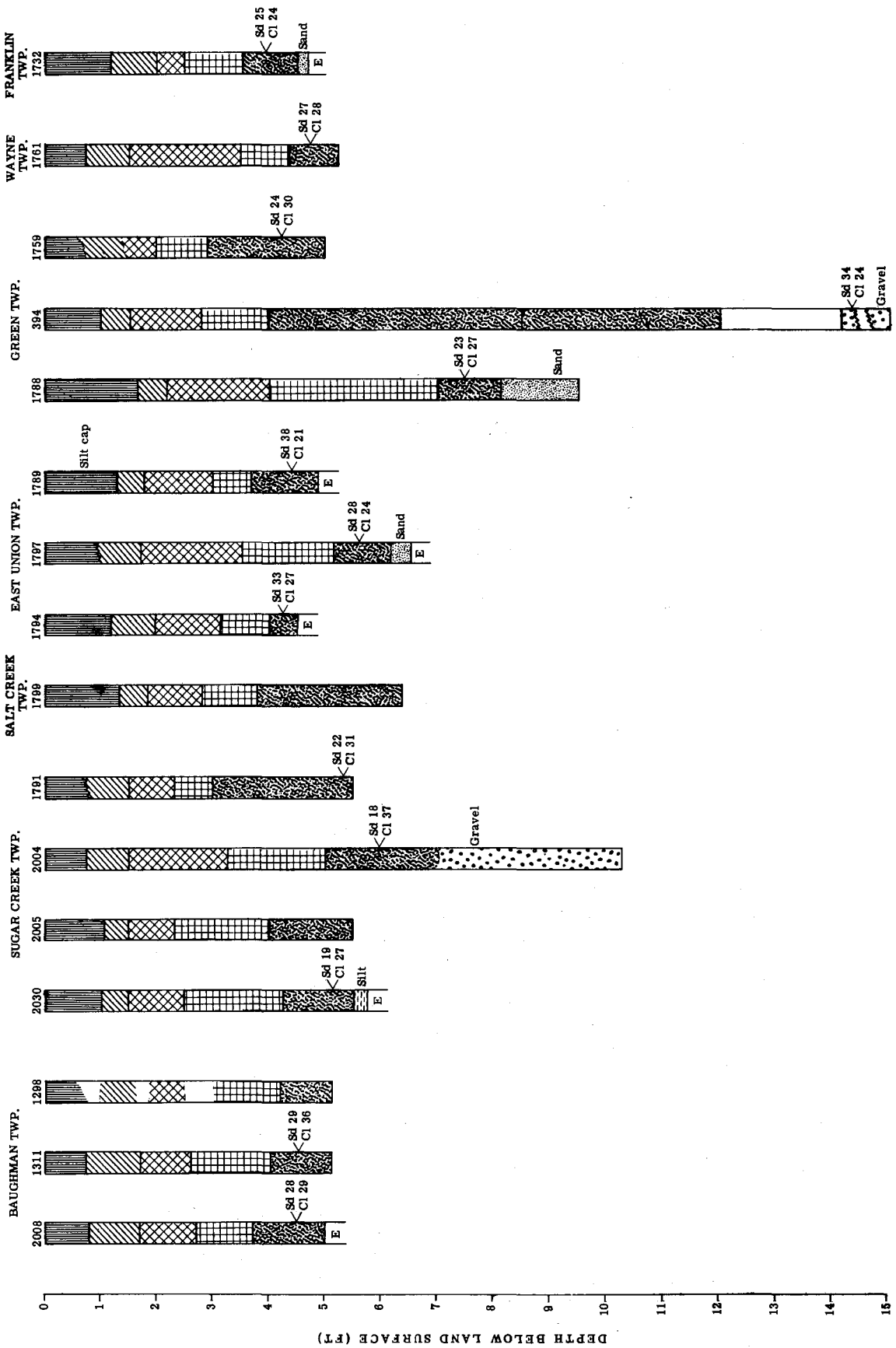
Sample no.	Township	Sand	Silt	Clay	Sand/clay	Quartz	Orthoclase	Plagioclase	Carbonate
1311	Baughman	28.7	35.1	36.2	.79	83.3	6.3	10.4	2.7
2008	Baughman	28.2	43.3	28.5	.99	82.4	8.5	9.1	1.3
1299	Chester	24.3	26.8	48.9	.50	83.8	4.0	12.2	3.0
1695	Chester	32.8	45.6	21.6	1.52	83.9	7.4	8.7	
1696	Chester	33.3	40.8	25.9	1.28	84.7	3.8	11.5	
2019	Chippewa	22.4	51.5	26.1	.86	79.1	8.2	12.7	2.7
1720	Clinton	15.9	48.4	35.7	.45	83.6	5.7	10.7	
1722	Clinton	21.9	51.8	26.3	.83	73.2	11.8	15.0	7.8
1725	Clinton	35.7	41.4	22.9	1.56	83.0	7.1	9.9	
1726	Clinton	32.6	42.0	25.4	1.28	82.5	8.1	9.4	
1729	Clinton	22.2	45.1	32.7	.68	79.0	7.3	13.7	
1789	East Union	37.8	41.1	21.1	1.79	74.5	4.1	21.4	6.0
1794	East Union	32.5	40.3	27.2	1.19	73.7	8.1	18.2	5.0
1797	East Union	28.3	47.8	23.9	1.18	76.6	11.8	11.6	1.3
1732	Franklin	24.9	51.3	23.8	1.05	76.8	8.8	14.4	
2141	Franklin	21.4	55.8	22.8	.94	71.2	11.5	17.3	
1759	Green	23.7	46.0	30.3	.79	67.4	8.7	23.9	2.0
1788	Green	23.3	49.3	27.4	.85	76.3	9.4	14.3	.5
2159	Milton	29.5	49.2	21.3	1.38	77.7	9.7	12.6	
2161	Milton	11.8	53.6	34.6	3.41	84.0	7.8	8.2	
1791	Sugar Creek	21.5	47.3	31.2	.69	74.1	11.6	14.3	3.1
2004	Sugar Creek	18.2	44.8	37.0	.49	71.9	12.0	16.1	2.3
2030	Sugar Creek	19.3	53.8	26.9	.72	72.4	14.7	12.9	1.2
1761	Wayne	27.0	45.0	28.0	.96				
	Average	25.7	45.7	28.6	.90	78.1	8.5	13.4	

gravel, in the lowlands near Shreve in Clinton Township and near Moreland in Franklin Township. At many places the Hayesville Till is less than 5 feet thick and in other places it is so thin that it is incorporated into the soil upon earlier drift and is thus difficult to identify.

Composition.—The Hayesville Till is a calcareous silty clay till. Pebbles and boulders are not conspicuous. The composition of the matrix is shown in table 6; the average composition is 25.7 percent sand, 45.7 percent silt, and 28.6 percent clay. This till contains noticeably less sand and more clay than the Mogadore, Navarre, or Millbrook Tills. The carbonate content is quite variable, ranging from less than 1 percent to as much as 8 percent; the average is 3 percent. The quartz/feldspar ratio is 3.57.

Weathering horizons.—No exposures were seen in Wayne County of the unoxidized till of horizon 5. At all places where the base was seen, the till was so thin that oxidation had extended throughout the formation (fig. 11). The till of horizon 4 is dark brown to chocolate brown (10YR 4/3), in striking contrast to the "brighter" yellow-brown oxidized Navarre Till or the olive-brown oxidized Millbrook Till. The top of horizon 4, the depth of leaching, averages 3 feet 11 inches below the surface. The top of horizon 3 averages 2 feet 10 inches below the surface.

Where the Hayesville Till is several feet thick, the soils are Rittman-Wadsworth silt loams. In many places the Hayesville Till is so thin that the underlying, more sandy till determines the soil type, which then resembles Canfield or Wooster. The greater thickness of the Hayesville Till in northern and in central eastern Wayne County adjoining Stark County causes a more generally continuous extent of the Rittman-Wadsworth soils than in the rest of the county, as is well shown on the soil map of Ohio (Dotson, 1956). However, even within this area of Rittman-Wadsworth soils, there are smaller areas of Wooster-Canfield soils that have been formed where underlying pre-Hayesville till is at the surface or close enough to the surface to influence soil type. South of this area of Rittman-Wadsworth soils are smaller tracts of these soils in a general area of Wooster-Canfield soils. Across the central part of the county is an irregular belt which is sometimes described as a region of "mixed Wooster-Rittman soils" (personal communication, Marvin Bureau, 1961). In some places where the Hayesville Till would be expected to control the soil type, a silt cap from a few inches to more than a foot in thickness lies


FRANKLIN TWP.
1732
Sd 25 Cl 24
Sand
E
WAYNE TWP.
1761
Sd 27 Cl 28
1759
Sd 24 Cl 30
GREEN TWP.
394
Sd 34 Cl 24
Gravel
1788
Sd 23 Cl 27
Sand
EAST UNION TWP.
1789
Silt cap
Sd 38 Cl 21
E
1797
Sd 28 Cl 24
Sand
E
1784
Sd 33 Cl 27
E
SALT CREEK TWP.
1799
1791
Sd 22 Cl 31
SUGAR CREEK TWP.
2004
Sd 18 Cl 37
Gravel
2005
2030
Sd 19 Cl 27
Silt
E
BAUGHMAN TWP.
1298
1311
Sd 29 Cl 36
2008
Sd 28 Cl 29
E
0
1
2
3
4
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6
7
8
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15
DEPTH BELOW LAND SURFACE (FT)

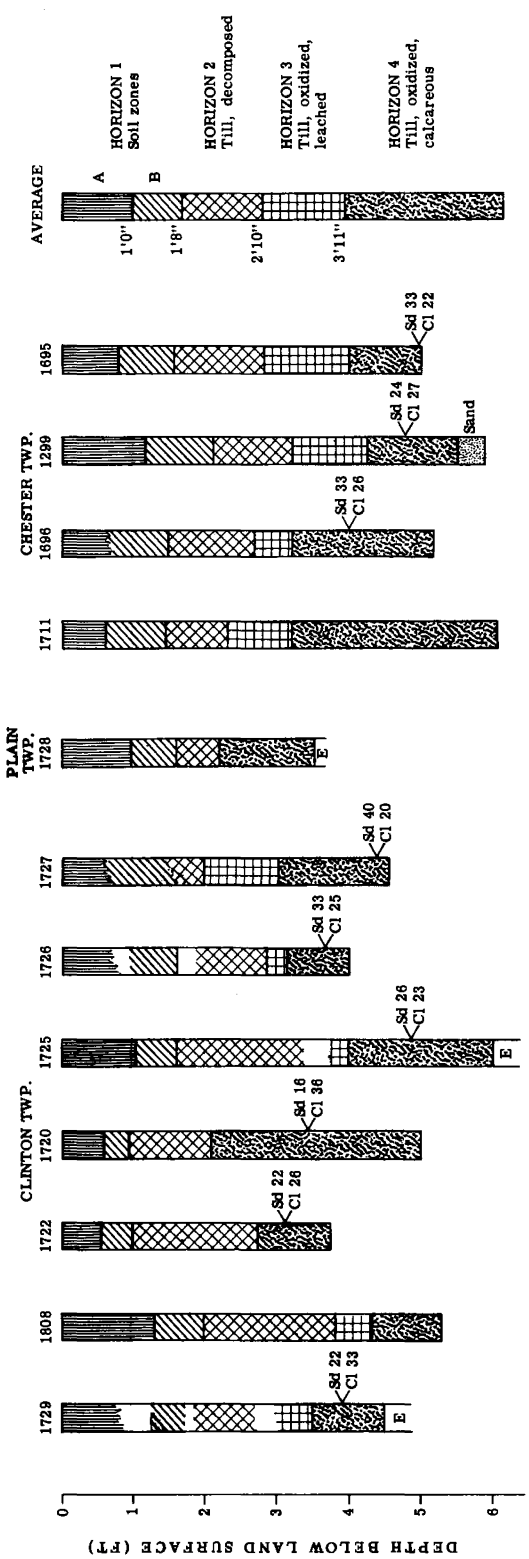


FIGURE 11.—Sections of weathering horizons of Hayesville Till showing percentages of sand (Sd) and clay (Cl) of samples collected at points indicated in sections. Percentage of silt=100—(Sd+Cl). See fig. 2 for locations of samples.

upon the till and contributes to the formation of soil which is very close to Wooster in character.

Age and correlation.—The Hayesville Till is correlated with the Lavery Till of the Grand River lobe (White, 1961, p. 73; 1963, p. 147) and resembles that till in general composition, weathering profile, and soil types. The Hayesville Till is markedly different from the Navarre Till in texture, in color of the oxidized till, and in soils. It was deposited, therefore, after a time interval long enough for the Navarre ice to retreat a considerable distance, so that the readvancing Hayesville ice could bring forward material of different character from that transported by the Navarre ice. The Hayesville Till resembles more closely the younger Hiram Till, and is believed to be only slightly older than that till.

Hiram Till

Location and extent.—The Hiram Till is named from exposures near Hiram in Portage County (White, 1960, p. 8). This till, unlike earlier ones, can be traced continuously on the surface from the Grand River lobe into the Killbuck lobe, and has been traced from Ohio across Pennsylvania into New York (Shepps and others, 1959, fig. 4). It has been identified in Ashtabula, Trumbull, Portage, Mahoning, Geauga, Cuyahoga, Summit, Medina, Ashland, and Richland Counties in Ohio. It occurs in the northwestern part of Wayne County: in the northwestern one-half of Canaan Township and in the northern two-thirds of Congress Township.

The southern margin of the Hiram Till in Wayne County coincides with the Wabash moraine. This till, however, does not make up the bulk of the moraine, but only forms a veneer upon its surface (White, 1962, p. 96). The Wabash moraine, which at the time of Hiram ice advance had almost the same volume as it has now, formed a barrier beyond which the Hiram ice did not extend.

The Hiram Till forms a discontinuous, thin mantle over the underlying Hayesville Till in northern Congress and northwestern Canaan Townships. Its variation in thickness was well displayed in fresh cuts for Interstate Highway 71 across Congress Township, particularly north of Pleasant Home. In these cuts, especially those across the Wabash moraine, variation in thickness from 0 to 12 feet could be seen to take place over distances of 50-200 feet.

Composition.—The Hiram Till is a very calcareous silty clay. Pebbles and boulders are not conspicuous. The composition of the matrix is shown in table 7. The average composition is 26 percent sand, 46 percent silt, and 28 percent clay. The quartz/feldspar ratio is 2.83; the Hiram Till has the highest proportion of feldspar of any of the tills. The carbonate content averages 13.2 percent; the Hiram Till is the most calcareous of all the tills in Wayne County.

Weathering horizons.—No exposures were seen in Wayne County of the unoxidized till of horizon 5 (fig.

TABLE 7.—*Composition of Hiram Till*

Sample no.	Township	Sand	Silt	Clay	Sand/clay	Quartz	Orthoclase	Plagioclase	Carbonate
1293	Canaan	25.8	53.0	21.2	1.22	65.0	21.0	14.0	
1294	Canaan	30.7	45.8	23.5	1.32	69.4	12.9	17.7	
1762	Canaan	27.1	44.9	28.0	.98	75.0	9.8	15.2	
1765	Canaan	23.1	45.6	31.3	.74	73.3	16.1	10.6	15.3
1273	Congress	23.0	49.8	27.2	.85	71.7	8.1	20.2	
1274	Congress	17.9	55.3	26.8	.66	71.3	13.6	15.1	11.0
1510	Congress	22.4	45.2	32.4	.69	80.0	9.4	10.6	
1511	Congress	24.6	47.4	28.0	.88	86.5	5.7	7.8	13.4
1703	Congress	25.0	42.0	33.0	.76	71.6	12.5	15.9	
1763	Congress	35.8	38.3	25.9	1.38	70.6	11.0	18.4	
1764	Congress	35.8	38.9	25.3	1.42	74.4	10.8	14.8	
1858	Congress	20.9	47.2	31.9	.66	77.9	8.5	13.6	
	Average	26.1	46.1	27.8	.94	73.9	11.6	14.5	

12). The till of horizon 4 is dark brown to chocolate brown (10YR 4/3). It resembles horizon 4 of the Hayesville Till in color, but is strikingly different from the lighter brown of the oxidized Navarre Till. The top of horizon 4, the depth of leaching, averages 2 feet 9 inches below the surface and is thus more than a foot shallower than the top of this horizon in the Hayesville Till and several feet shallower than the corresponding level in still earlier and more sandy tills.

Horizon 3, leached but otherwise little altered till, is very thin and at places difficult to identify. It ranges in thickness from 2 or 3 inches to 12 inches.

Horizon 2 is very dark brown, very much weathered till with a very clayey consistency.

Where the till is of considerable thickness, the soils of the Hiram Till are Mahoning and Ellsworth silty clay to clay loam, as indicated in a general way for a part of Congress Township on the soil map of Ohio (Dotson, 1956). At other places within the area of Hiram Till, the soils are similar to the Rittman-Wadsworth sequence because the Hiram Till is so thin that the Hayesville Till is the parent material of the soil, or because enough silt is incorporated in the upper part of the profile to produce a silt loam rather than a silty clay loam.

Age and correlation.—The Hiram Till is the youngest till in the county and, aside from the still younger Ashtabula Till of extreme northeastern Ohio (White, 1960, p. 10), is the youngest till in Ohio. It extends throughout the Erie lobe as far east as New York State.

OUTWASH DEPOSITS

Introduction

The morphology of the outwash deposits has already been described; in this section the character of the material will be discussed. Outwash materials laid down by water from the melting ice may be proglacial or ice-contact deposits. Proglacial deposits were laid down beyond the ice margin, where the melt water flowed over plains or in valleys. The sand and gravel carried out from the ice was deposited at greater or less distances within Ohio, whereas the clay and silt were generally carried much farther by the southward-flowing waters, into the Ohio and Mississippi valleys and some as far as the Gulf of Mexico. Thus, proglacial sand and gravel is generally low in silt and clay and is "clean" material. Some of the sand and gravel was spread out over plains to form outwash plains, but most was restricted to valleys and formed valley trains that partly filled the valleys. Later stream erosion has dissected some of the valley trains and the remnants remain as terraces along the valley sides.

Ice-contact deposits were formed by melt water flowing into cracks, holes, depressions, or channels in or adjacent to the thin and dissipating marginal ice. These deposits are composed of irregularly bedded and poorly sorted gravel and sand in the form of knolls, called kames; elongate ridges, called crevasse fillings; or valley-side terraces, called kame terraces. These deposits, unlike proglacial deposits, may include some till masses, which slumped from the nearby ice and were buried in the accumulating gravel, and may include clay and silt layers and deposits.

Kame terraces more or less resemble stream-cut terraces, but are not erosional. These ice-contact deposits were laid down along a valley side between dissipating ice in the center of the valley and the ice-free side of the valley. Such deposits are a combination of stream deposits, made in the temporary valley between the ice and the uncovered wall of the valley, and of kames and other material deposited directly from the edge of the

waning ice in the valley. Upon the complete disappearance of the ice from the center of the valley, the deposit is left along the valley side as a terrace with an irregular surface and with an irregular margin which is a cast of the former ice mass in the valley. The material ranges from well sorted, horizontally bedded sand and gravel to very irregularly bedded, poorly sorted material, which may include till masses and clay and silt layers.

Some of the outwash gravel and sand in the county occurs at the surface, but much of it exists beneath a covering of later till. Gravel below a till cover is the source of supply for the largest gravel pits in the county and at these pits more or less overburden must be removed. The major gravel resources in the county, therefore, are of earlier age than the till at the surface. It should be understood that beneath the surface till, generally Hayesville in age, there may be other and lower tills between the Hayesville Till and the gravel.

The outwash deposits are almost all related to valleys and they will be discussed in the sections on the various valley systems. Some attempt will be made to interpret the age of the material, but in many places the age assignment cannot be precise, as the relation to tills of known age is not always clear.

Chippewa Valley

The outwash deposits in the Chippewa Creek valley are made up of gravel and sand of various ages. Some lie at the surface without till cover and some are covered by till. The deposits will be described in order from the county line at Creston across Milton Township and Chippewa Township to the Stark County line.

The deposits in the ancient valley at the county line at Creston are as much as 300 feet in thickness, but not all of this valley fill is outwash material, as till and lacustrine material are known to be included. The material at the surface in northeastern Canaan Township and across northwestern Milton Township is fine gravel with much sand intermixed. Although the upper part is Hayesville in age and a small amount may be Hiram, much of the material is believed to be Navarre in age and at depth it is probably of Millbrook and earlier ages.

In a tract of part of a square mile in area, one mile south of Sterling in sec. 17, Milton Township, the outwash is coarser than the surrounding material.

From ¼-¾ mile east of Easton in southwestern Chippewa Township coarse gravel appears in a few places beneath till. Its extent and age is not known because exposures are so poor.

Gravel as much as 50 feet in thickness is exposed at the Zollinger gravel pit 2½ miles southeast of Rittman in NW sec. 19, Chippewa Township. The gravel in this deposit is sandy and contains almost no cobbles. From 3 to 12 feet of clayey silt and Hayesville Till overlie the gravel. Because of the more sandy and variable character of this gravel compared with gravel found elsewhere beneath till, it is believed to be of a different age, probably younger, than the gravel farther east.

Along the south side of the Chippewa Creek valley irregular gravel deposits extend for 2 miles northwest from the Stark County line. The exact northwestward limit and the thickness are unknown because of limited and poor exposures. This gravel is part of a very much larger deposit which extends southeastward along the valley of the Tuscarawas River as far as Massillon, in Stark County, near which large pits have been excavated (White, 1963, p. 150). Tills of Hayesville and Navarre

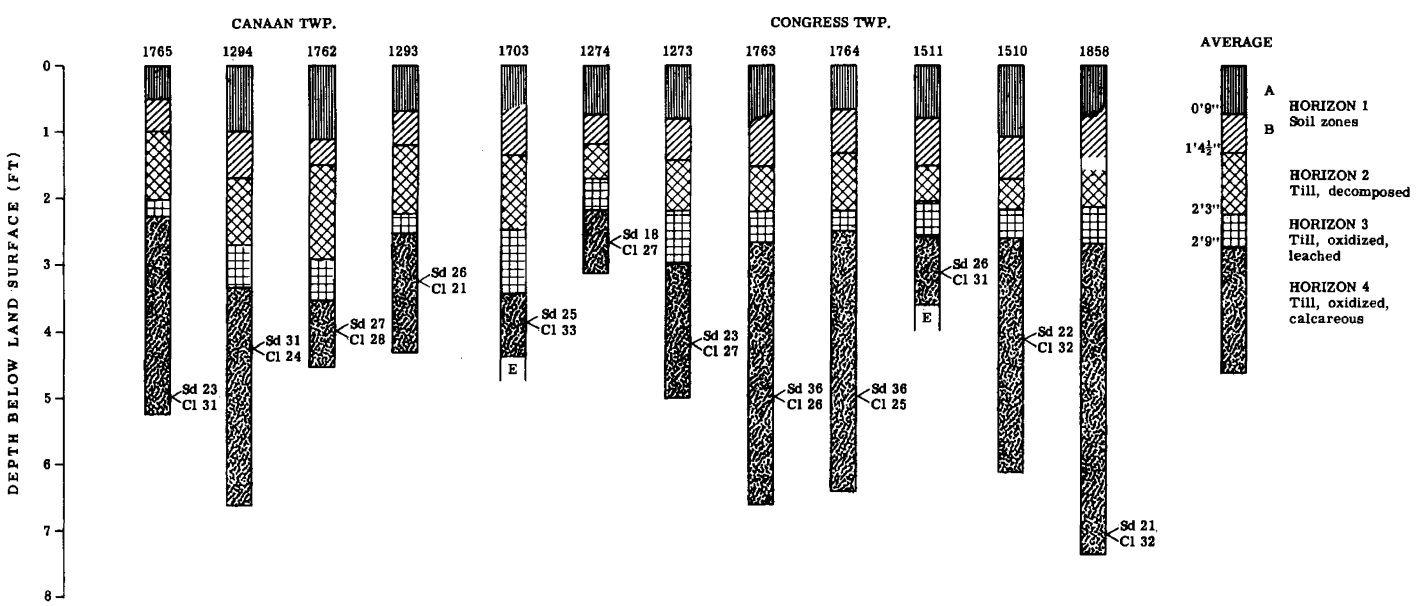
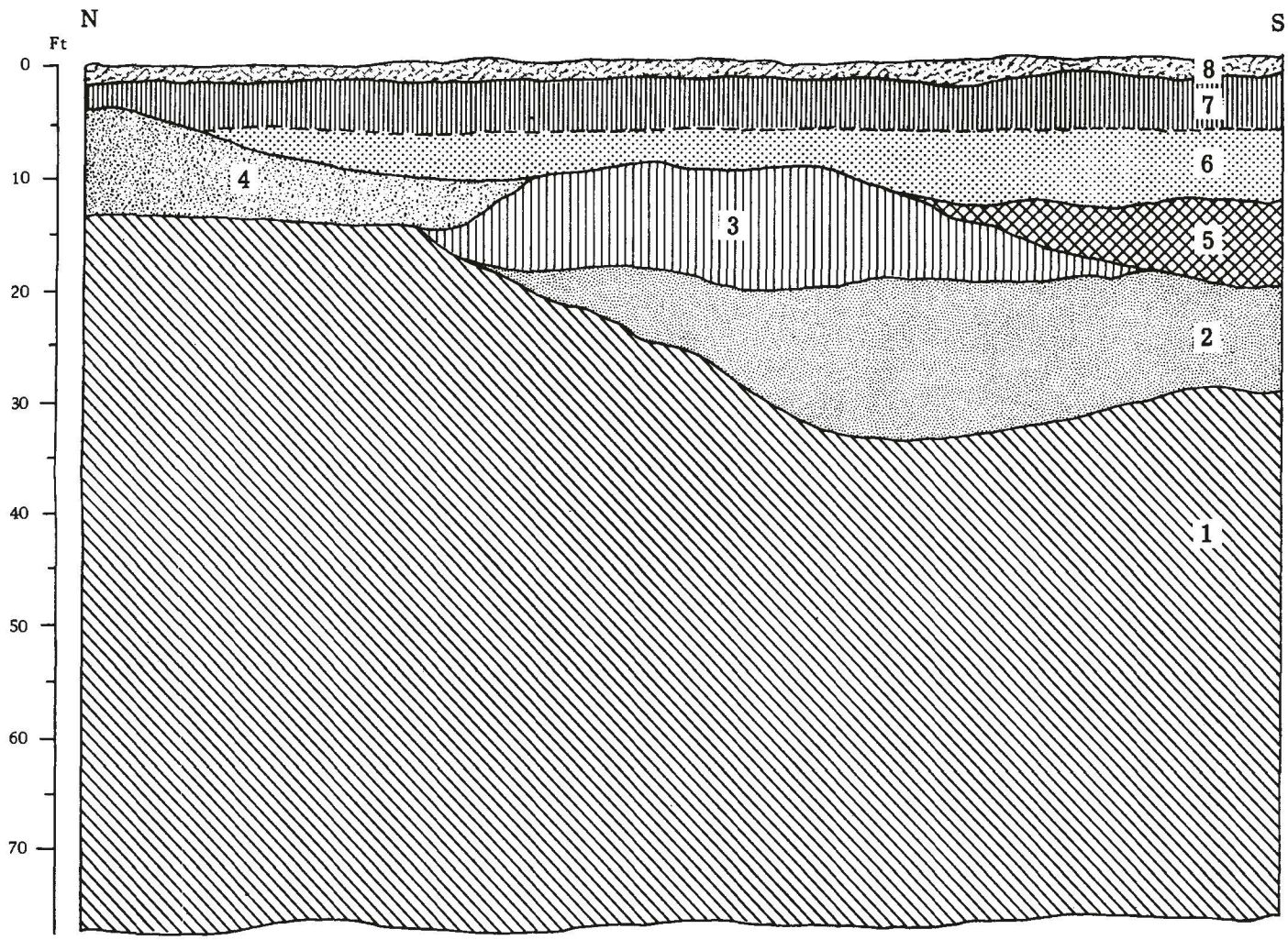


FIGURE 12.—Sections of weathering horizons of Hiram Till showing percentages of sand (Sd) and clay (Cl) of samples collected at points indicated in sections. Percentage of silt=100–(Sd+Cl). See fig. 2 for locations of samples.

ages overlie the gravel in places, and it is probable that some till of Millbrook age is also present and that the deposit is, therefore, pre-Millbrook.

At the head of Red Run, a tributary to Chippewa Creek, about 60 feet of medium-grained, gray, calcareous gravel is exposed in the pit of the Rupp Construction Company in NW sec. 1, Baughman Township. The gravel is in generally horizontal beds, although some cut-and-fill structure is exhibited. The gravel is of the same appearance as that in the large pits in the Tuscarawas valley to the east in Stark County. As excavation in the pit and removal of the overburden progresses, the complexity of the material lying over the gravel is well shown. In the face of the excavation in the summer of 1961, Navarre and Millbrook Tills were both exposed overlying the gravel (fig. 13). At other places, in other



EXPLANATION

1. Gravel, medium, clean, "bright," horizontally bedded
2. Till, olive-gray, calcareous; sand 50%, clay 15%; MILLBROOK
3. Till, olive-brown, calcareous; sand 55%, clay 8%; MILLBROOK
4. Gravel, coarse, cobbly, dirty
5. Till, dark-gray, calcareous; sand 49%, clay 13%; NAVARRE
6. Till, dark-yellow-brown, calcareous; sand 46%, clay 12%; NAVARRE
7. Till, yellow-brown, noncalcareous, weathered; upper part much weathered, may include weathered HAYESVILLE Till
8. Silt, weathered

FIGURE 13.–Sketch of glacial deposits in east wall of Rupp Construction Company's gravel pit SE¼NW¼ sec. 1, Baughman Township, Wayne County.

years, Navarre Till has been seen directly on the gravel; at still other places, Millbrook Till has been encountered in that position. At one stage of the excavation, several feet of Hayesville Till was exposed at the surface. At some places in the pit as much as 15 feet of much coarser and more rubbly gravel overlies the main deposit. Similar material in Stark County pits was interpreted as pro-Navarre gravel (White, 1963, p. 150). This age is confirmed at the Rupp pit where, as shown in the sketch, the rubbly gravel at one place lies below Navarre Till, but overlies Millbrook Till.

The sand and gravel in the low terraces that extend along both sides of Little Chippewa Creek from the north line of Green Township southeast for about 3 miles is sandy and fine-grained at most places and in some places is actually sand. Thin till cover is present at places, but at other places the sand or gravel appears at the surface. The till cover appears to be Hayesville Till and the gravel is probably Navarre in age.

Killbuck Valley

From its headwater area in northeastern Canaan Township Killbuck Creek flows north to the county line, and thence west along the county line to northeastern Congress Township. Here the stream enters an ancient bedrock valley and flows southward across Wayne County.

In the headwaters of Killbuck Creek, just west of Creston and extending along the county line in sections 2, 3, and 4 of Canaan Township, gravel occurs in the kames associated with the Ft. Wayne Moraine. The great bulk of the gravel lies north of the Wayne County line in Westfield Township, Medina County, where large pits are present. In Medina County, the gravel is extremely variable in texture, ranging from horizontally bedded medium to cobbly clean gravel to very irregularly bedded, poorly sorted, bouldery gravel closely associated with many till masses. The gravel here is partly of Hayesville age and partly of Navarre age; probably some of the deeper gravel is even older than Navarre. The complexity of the gravel of various ages is a good indication of the stratigraphic complexity of the Ft. Wayne moraine.

In the western part of Wooster and in the southeastern part, just within the valley of Apple Creek where it joins Killbuck valley, the gravel in the low terraces is medium to cobbly and is horizontally to irregularly bedded. In the south part of Wooster, just north of Apple Creek, a small volume of gravel was excavated in the construction of the new section of U.S. Highway 30.

A large amount of gravel occurs in the buried kame terraces of Killbuck valley at Wooster and further south. Gravel is known to be present beneath a more or less thick till cover on the southwest side of the valley west of Wooster, but its extent is not known. The stratigraphic succession on the east side of the valley is well shown in the pit of the Jones Road Materials Company 1 mile south of Wooster in SE¼NE¼ sec. 16, Wooster Township (fig. 14). At this pit, 30 feet of medium to coarse gravel lies below Millbrook Till and Navarre Till, whose combined thickness is 12 feet or more in places. Any evidence that Hayesville Till might have been present has been removed in stripping of the overburden. The gravel is interpreted as pre-Millbrook in age, because it is covered by Millbrook and later tills. Gravel may extend south of this pit along the east side of the valley, but no openings exist to provide information.

Sand and fine gravel occur below till in the discontinuous terraces on either side of the Killbuck valley in Franklin Township. No recent pits exist from which clear measurements can be obtained. South of Wayne County, in Holmes County, the gravel is more extensive, particularly on the west side of the Killbuck valley; near Holmesville, 3 miles south of Wayne County, 80 feet of gravel, lying beneath 4-10 feet of till, is exposed in a large pit. The extent of these terraces has been shown on a map of the glacial deposits of Holmes County (White, 1949, map 4). It should be noted that an earlier description of the Holmes County deposits (White, 1949, p. 37) did not take into sufficient account the till overlying the gravel and did not interpret the gravel in the terraces as being much earlier than the till covering it.

In the center of the Killbuck valley near Wooster, gravel is encountered below 10-20 feet of clay. The gravel being excavated below stream level at the large plant of the Prairie Sand and Gravel Company in NW sec. 28, Franklin Township, is gray, clean, and well washed, and presumably lies in reasonably horizontal beds. It is medium in texture, although it includes some cobbles and rare boulders. The thickness is not known, but it is reported that 35 feet of gravel is present and that clay lies below. There is some indication that more gravel lies below the clay. In Killbuck valley just south and southwest of Wooster, borings by the State Highway Department have encountered gravel and sand, from a few feet to 20 feet in thickness, beneath lacustrine clay (Ohio State Highway Dept. Testing Lab., Wayne County, WAY-3-9.90, 8/13, 1960). In the borings for water supply exploration in NW sec. 8 and NE sec. 7 of Wooster Township 2 miles west of Wooster, and in sec. 16 south of Wooster, gravel has been encountered at various places up to depths of 130 feet. It appears that several gravel units lie between till layers. The character of the gravel as shown by the records ranges from "gravel coarse, clean," through "gravel and sand" to "gravel, coarse, dirty." The logs of the wells show that in some places the upper layer of gravel is from 5 to about 30 feet in thickness and lies under 20-30 feet of clay and till (Wooster, Ohio, Water Improvements Rept., June, 1958, by Jones, Henry, and Williams, pl. 15, 16, 28; p. 107).

Salt Creek, Apple Creek, Sugar Creek Valleys

In Salt Creek Township, from Fredericksburg north to the township line, the gravel in the low kame terraces on both sides of the North Branch of Salt Creek is very irregularly bedded and variable in texture. Few details

are at hand because of the lack of good exposures. The gravel is mixed with till and at some places till covers the gravel. From Fredericksburg southward along Salt Creek as far as Holmesville in Holmes County, the outwash of the valley train is Navarre in age and is predominantly sand and sandy gravel.

The medium-grained sandy gravel in the small outwash plain in the southern part of the valley of Apple Creek, southeast of Apple Creek village in East Union Township, is believed to be Navarre in age. The gravel at places has a discontinuous cover of Hayesville Till. Elsewhere, the Apple Creek valley is very poor in outwash material.

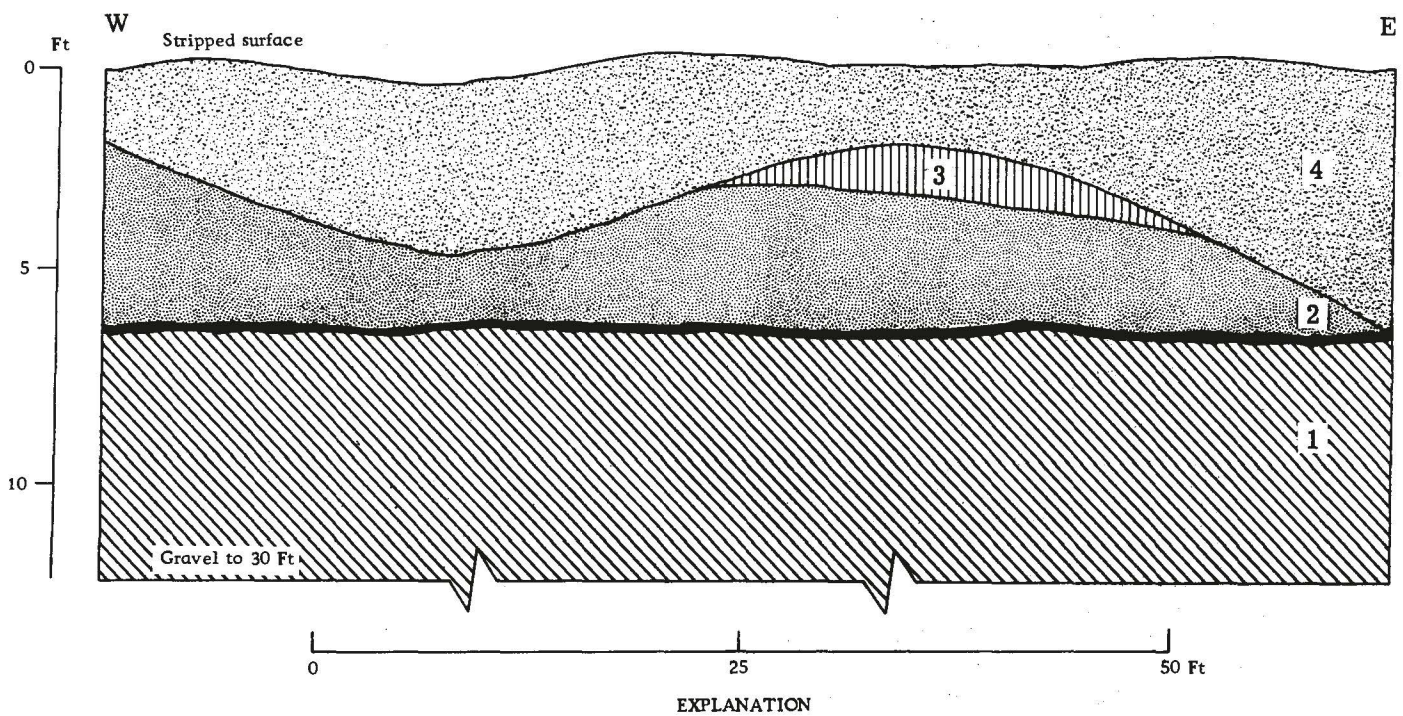
In the low terraces along Sugar Creek valley in Sugar Creek Township from about the center of the township in sec. 17 southeastward to the Stark County line, the gravel is generally sandy and fine-grained. Its thickness is not known because only a few very small pits exist, but it is believed to be thin. At places the gravel appears at the surface, but at other places it is covered by a thin layer of brown Hayesville Till; in some places a layer of silt lies upon the till. Similar fine-grained gravel with thin Hayesville Till overlying it makes up the low terraces in the North Fork of Sugar Creek in northern Paint Township. The gravel is probably Navarre in age in both of these valleys.

The gravel in the low terraces in the headwaters of Sugar Creek near Smithville, secs. 17, 20, and 21, Green Township, is very sandy. In places a thin covering of Hayesville Till lies over the gravel and the outwash is believed to be Navarre in age.

Muddy Fork Valley

The gravel and sandy material of the outwash plain and valley train terraces in Muddy Fork is of several ages. These deposits are found from the south edge of the Wabash moraine near Pleasant Home, southwestern Congress Township, and the adjacent southeastern corner of Jackson Township, Ashland County, southward across the eastern part of Perry Township, Ashland County, to the northwestern and western part of Plain Township, Wayne County. Some of the outwash heads at the moraine, but some of it appears from beneath the moraine and is of earlier age than the uppermost tills of the Wabash moraine. A small amount of the uppermost part of the outwash may be Hiram in age.

In an instructive outcrop on the north bank of the



EXPLANATION

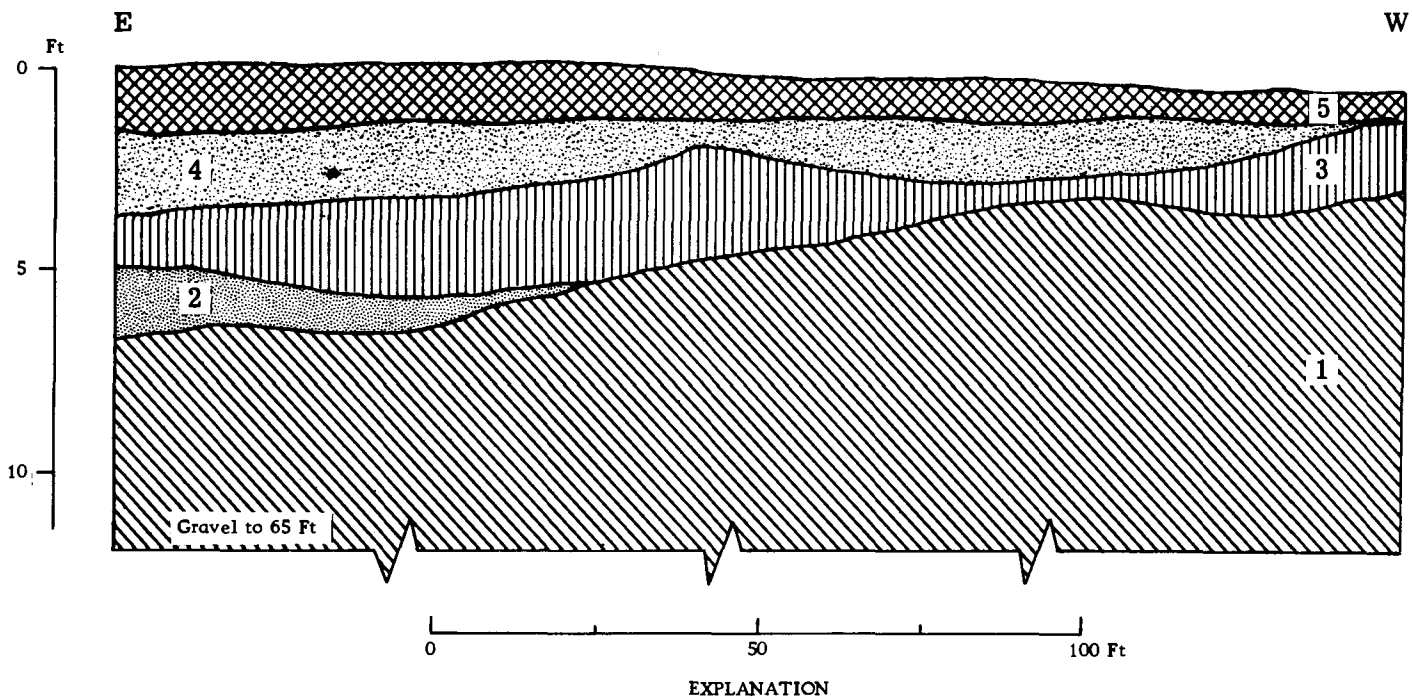
1. Gravel, medium to coarse; stands in vertical face; upper few inches, shown by heavy line, is somewhat cemented
2. Till, olive-brown, calcareous; sand 41%, silt 45%, clay 14%; MILLBROOK
3. Gravel, very coarse; with very many sandstone boulders mixed with sand
4. Till, stony, leached; and cobbly gravel; NAVARRE

FIGURE 14.—Sketch of upper part of pit of Jones Road Materials Company 1 mile south of Wooster in SE¼NW¼ sec. 16, Wooster Township, Wayne County.

stream just west of the road and 300 yards northwest of the church in Pleasant Home (fig. 6, section 1856) two layers of outwash, separated by Hayesville Till, may be distinguished. The lower layer is very rubbly and is interpreted as pro-Hayesville outwash; this was overwhelmed by the advance of the Hayesville ice which deposited thin till. The material above is interpreted as Hayesville outwash deposited by melt water from the ice after it had retreated north of this locality. It is possible that some of the material at the very top of the section represents Hiram outwash, but as the Hiram Till is thin on the Wabash moraine, it is believed that the Hiram outwash is small in amount.

The gravel in several pits, both east and west of the county line, from ½ to 1½ miles west of Pleasant Home, is horizontally bedded medium to sandy gravel. Farther southwest, near the junction of Muddy Fork and Red Haw Creek in Ashland County, the texture of the gravel is coarser and this coarser gravel continues downstream for several miles. It is believed to be Navarre gravel with a much thinner veneer of Hayesville gravel lying over it.

A most interesting gravel deposit occurs at Funk, in sec. 25, Plain Township. In the large pit of the Funk Sand and Gravel Company, 60 feet of bright-gray calcareous gravel is exposed and it is reported that an additional 65 feet of gravel lies below the floor of the pit. A thin layer of till overlain by silt covers the gravel (fig. 15). The till cover thickens to the south and southeast. The area of gravel is probably larger than that shown on plate 1, but no exploration has yet been made in this direction. The gravel extends from the bottom of the valley to the top of the ridge and thus represents a very large and high kame area which was covered by later till deposits. It is possible that similar areas occur along the west side of the ancient valley southeast of Funk. West of Funk, in Ashland County, similar high kames in which the gravel is covered by till occur in Mohican Township, where "hilltop gravel pits" exist in secs. 27, 34, and 21. These deposits are of considerable size, but they are not as thick or as continuous as the Funk deposit. As shown by the stratigraphic succession in Ashland County, the gravel is pre-Millbrook in age.



EXPLANATION

1. Gravel, medium to sandy, calcareous; mainly in westward dipping beds
2. Gravel, dark-reddish-brown, clayey, much weathered
3. Till, yellow-brown to olive-brown, sandy, much weathered; 4-inch pebble band at the top; MILLBROOK
4. Silt, dark-brown to reddish-brown, compact, weathered (more weathered than overlying silt)
5. Silt and silt loam, gray-brown and tan

FIGURE 15.–Sketch of upper part of pit of Funk Sand and Gravel Company at Funk, SE¼NW¼ sec. 25, Plain Township, Wayne County.

Abandoned Millbrook-Craigton-Big Prairie-Shreve Valley

Contours on the bedrock surface in Clinton Township show an abandoned valley that extends from the Killbuck valley at Millbrook westward to Craigton where it joins another valley extending southward from Craigton to Big Prairie; this in turn joins another valley extending from the Killbuck valley westward past Shreve to Big Prairie. This ancient valley complex is almost completely concealed by drift between Millbrook and Craigton, but is less completely filled in the remainder of the complex. The material at the surface between Millbrook and Craigton is till, but some gravel is known to be present at depth. Some gravel is present at depth near Shreve and for 2 miles to the southwest, from which point to Big Prairie gravel is closer to the surface and crops out at some places from beneath a till cover. The gravel seen in roadside outcrops and in one or two small or abandoned pits is irregularly bedded and ranges from fine to coarse in texture. It appears to have been deposited as kames associated with till and to have been covered by till of later age. It is likely that the gravel is of different ages; that nearest the surface is probably Navarre in age as it has a discontinuous cover of thin Hayesville Till.

LACUSTRINE DEPOSITS

The material on the floor of the wider valleys and larger depressions in the surface of Wayne County is, in part, of lacustrine origin. This material was laid down in lakes which existed at various times during the advances and retreats of the various ice sheets. The material at the surface which was deposited in the latest lakes—very late glacial or just postglacial in age—is actually small in amount. Most of the lacustrine material appears to be of Hayesville, Navarre, and earlier ages, because wherever there are borings of sufficient depth to show the stratigraphic succession, till sheets or gravel deposits separate sheets of lacustrine clay.

Chippewa Valley

Lacustrine deposits constitute a discontinuous blanket on the till and other drift up to an altitude of about 980 feet in the Tuscarawas valley just east of Wayne County, from Canal Fulton in Stark County to Clinton in Summit County (White, 1963, p. 155). They continue into Wayne County and are found in the Chippewa Creek valley from Clinton to some point west of Rittman, where they occur at an altitude of as much as 1,030 feet. The deposits extend south from the Chippewa valley into the depression now occupied by Fox Lake, 1 mile west of the Wayne-Stark County line in secs. 1, 2, 11, and 12 of Baughman Township. They also extend south into the valley of Little Chippewa Creek in Green Township as far as a point about 2½ miles north of Orrville.

The lacustrine clay of Chippewa Creek valley composes the plain of the flat valley bottom and also extends up the sides of the valley as much as 60 feet above the valley bottom. Only the thicker and more continuous lacustrine deposits in the central part of the basin are shown on the glacial map (pl. 1) as the deposits near the margin are too thin and discontinuous to conceal the earlier till and outwash.

These deposits are silty clay and silt and range in thickness from a few inches to more than 8 feet. They are dark brown in color, but at depths of 12 feet or more are bluish gray. In the lower parts of the basin the thickness appears to be greater, but exposures are too shallow to reach the base of the silt. Exposures in gravel pits in SE¼NW¼ sec. 1, Baughman Township, show 2-8 feet of silt and silty clay lying on the gravel and rising to an altitude of about 1,030 feet on flanks of the hills in which the pits are located.

During the construction of the new section of State Route 5, the clay was well exposed half a mile west of Doylestown, Chippewa Township. It overlay coarse Mogadore Till and rose on the valley sides to an elevation of 1,120 feet. The clay was silty and dark brown. Farther west, in excavations for bridge piers at the crossing of Mill Creek at the line between sec. 8 and sec. 17, Chippewa Township, as much as 20 feet of silty clay was encountered. The upper part was dark brown, but the lower part was bluish gray.

Lacustrine clay and silt lie both above and below Hayesville Till, as shown in the following section which cropped out in a borrow pit just north of the new highway location in the northern part of the village of Easton:

	Ft	In
Silty clay loam and silt	2	0
Dark-brown till, sparingly pebbly, HAYESVILLE	4	0
Till, with red streaks	0	6
Sand and yellow-brown silt	8	0
Gray silt and fine sand	4	0
Base of pit		

At many places at lower levels in the Chippewa valley, Hayesville Till is known to overlie silt and clay which was laid down in an earlier lake than that in which the surface silt was deposited. No doubt a whole succession of lake deposits, till sheets, and sand and gravel deposited as outwash when the drainage was unimpeded, makes up the more than 200 feet of fill in the valley.

Although the surface material of the wide flat west of Rittman, which extends past Sterling to Creston and to Seville in Medina County, is outwash sand and fine gravel, earlier lake deposits lie below the outwash. These lower lake deposits are coarser than those at depth farther east. The buried lacustrine deposits may extend northward under the Wabash-Ft. Wayne moraine to be continuous with the deeper lacustrine deposits in the Chippewa Lake basin in Medina County.

Sugar Creek Valley

Lacustrine clay and silt in the valley of Sugar Creek extend from a point in central Green Township to the southeastern corner of the township, and thence into Sugar Creek Township. The thickest part of the deposit appears to be 2 miles southwest of Orrville, where as much as 30 feet of silty clay is exposed in the pits of the Orrville Brick and Tile Company; the total thickness of the clay is probably much greater. At places lacustrine clay rises a few feet above the flat plain of the valley bottom. At places in the Sugar Creek valley in Sugar Creek Township, lacustrine clay lies below till, as noted by Conrey (1921, p. 39).

Silty clay makes up the lacustrine plain in the headwaters of Newman Creek in southern Baughman Township, a deposit that extends westward from the Stark County line to the northeastern part of Orrville. The exposures are very shallow and the thickness of the clay here is not known.

Killbuck Valley

Silty clay is known to occur below the flat bottom of the valley of Killbuck Creek from about the Wayne-Wooster Township line southward to the southern boundary of the county. Borings by the State Highway Department across the valley of Killbuck Creek at Wooster show that on the west side of the valley lacustrine clay from a few feet to 20 feet in thickness lies over gravel and sand (Ohio State Highway Dept. Testing Lab., Wayne County, WAY-3-9.90, 8/13, 1960).

Borings for water supply exploration in the valley 2 miles west of Wooster and 1 mile south of Wooster show that the upper 20 feet of valley fill in these locations is clay and silt of lacustrine origin (Wooster, Ohio, Water Improvements Rept., June, 1958, by Jones, Henry, and Williams, pl. 15, 16, 28). Some of the borings are as much as 130 feet in depth and indicate the presence, at various levels, of clay layers up to several feet in thickness and probably of lacustrine origin. These record earlier lakes which existed in the Killbuck valley.

Lake Craigton

Unlike the valley of Killbuck Creek, in which the lacustrine material is mainly concentrated in the upper 15 or 20 feet, the ancient valley through which Muddy Fork now flows appears to contain a larger volume of lacustrine deposits, as shown by recent borings by the State Highway Department across the valley in secs. 18, 7, 12, and 13, Plain Township (Ohio State Highway Dept. Testing Lab., Wayne County, WAY-30-0.00, 5/21, 6/21, 1961). The silt and silty clay includes gravel and till layers, indicating that the lacustrine materials are not those of a single lake, but are the deposits of a whole series of lakes. The lakes formed as the region was uncovered by ice and were extinguished as other ice advances passed back over the area and deposited till and gravel.

At several places in the basin, Hayesville Till was observed to lie below the uppermost few feet of lacustrine clay and, at other places, thin clay and silt was present along the valley sides over sand and gravel deposits. Logs of borings in the central part of the valley show that from a few feet to 10 feet or more of organic deposits lie over the clay and silt.

LOESSIAL SILT

At many places on the uplands in Wayne County, the uppermost material is pebble-free silt, ranging in thickness from 2½ feet to less than 1 foot. This silt shows no bedding and is distinctly different from the lacustrine silt found in lowlands in the county. It resembles windblown loess so common farther west in the Mississippi valley and is interpreted as eolian in origin. Weathering has extended through the silt into the underlying material. Where the silt cap is less than 12 inches in thickness, it is often uncertain whether the silty character of the surface material is a result of the original material being silt or of soil-forming processes that destroyed any pebbles originally present.

The silt cap is not so apparent in the area of the Hiram Till in northwestern Wayne County, but silt does occur here in some places (fig. 12, section 1703). North of Wayne County, in southern Medina County, as much as 15 inches of silt was observed over the Hiram Till in new road cuts between Lodi and Leroy. In Ashland County, as much as 18 inches of silt is exposed in many road cuts.

Silt overlies till in the cut along the new section of U.S. Highway 30 half a mile east of State Route 76 in the south part of Wooster (fig. 4). The silt ranges from a few inches to 2 feet 6 inches in thickness. The greater thickness in shallow depressions, now largely filled, indicates that the deposits there are in part accretion deposits resulting from colluviation at the bases of gentle slopes around the depressions.

The thickest silt cap seen in Wayne County consists of two units. On the upland, in the southwest part of the large gravel pit of the Funk Sand and Gravel Company, on the south edge of the village of Funk in sec. 25, Plain Township, 18 inches of an upper silt overlies 2 feet of a lower silt (fig. 15). The lower silt lies upon weathered Millbrook Till and seems to have been partly weathered before deposition of the upper silt, although weathering in the present cycle has penetrated into the lower silt layer. A similar double silt over weathered till and gravel was observed 3 miles southwest of the Funk gravel pit in the R. C. Meyers gravel pit in NW¼ sec. 34, Mohican Township, Ashland County. The sequence at the two pits records weathering of the Millbrook Till before deposition of the lower silt. The lower silt was deposited upon the weathered Millbrook, was itself weathered, and the upper silt was then deposited. The upper silt is very

likely post-Hiram, but the lower silt is probably pre-Hayesville and possibly pre-Navarre. This lower silt has certain similarities to the lower of two post-Sangamonian loesses near Cleveland (White, 1953c). It would be fortunate if, at some place in Wayne or adjacent counties, a deposit of these silts could be discovered that had sufficient thickness to preserve any carbonates and thus any gastropod shells that may have been present, so that age relations might be determined from faunal study and from radiocarbon assay.

Silt as much as 3 feet in thickness has been observed west of Wayne County on the upland south of Ashland. The silt is thickest in shallow hollows which were cut across in highway construction. The thickness of the silt in these hollows is in part the result of colluviation at the bases of gentle slopes surrounding the hollows.

The weathering of the silt over the till produces soils which are not derived directly from the till. Even where the silt is so thin it cannot be identified with certainty, it is likely that the upper part of the soil is influenced by a silt cap, although the only really identifiable material below the soil is till.

At many places where two or more tills are exposed, from a fraction of an inch to several inches of silt may separate the Millbrook Till from the overlying till. This silt may be the remnant of an eolian deposit or may be waterlaid. Possibly some of the intertill silt is of each origin.

PLEISTOCENE HISTORY

Introduction

The Pleistocene history of Wayne County is determined from the deposits of successive ice sheets, of melt water, and of lakes, and from evidences of weathering and erosion between the episodes of glaciation.

The early Pleistocene history is very obscure. It is probable that early Pleistocene ice sheets of Kansan, and perhaps even earlier ones of Nebraskan age, came into northern Ohio, but as it is not yet possible to identify drifts of this age with certainty, the story of this time is not clear. The early drainage changes in northern Ohio appear to record a series of Kansan and Nebraskan ice advances (Winslow, 1953, p. 42; 1957) and we are justified in assuming that Wayne County was covered by extensive sheets of ice at least once before Illinoian time.

Illinoian Stage

Illinoian ice is known to have invaded northeastern Ohio, for till of this age has been identified in the Grand River lobe (White, 1951; 1963). Some of the lower, pre-Millbrook till in the Killbuck lobe also records the advance of Illinoian ice into Wayne County. Melt water from the Illinoian ice deposited outwash gravels, both in kame terraces and in valley trains. The extensive gravel deposits in the Killbuck valley at Wooster and extending south of Wooster into Holmes County were deposited at this time, as were similar deposits in the Chippewa Creek valley in the northeastern part of the county. The high kame gravels just south of Funk, in Plain Township, were also deposited in Illinoian time. All of these gravel deposits were later covered by till of post-Illinoian ice advances.

Elsewhere in Ohio, a similar history of deposition of very extensive Illinoian gravels has been recorded. In Cuyahoga County near Cleveland, very thick gravels with a well preserved Sangamon soil overlain by Wisconsin drift (White, 1953a; 1953c) show clearly the record of long-continued weathering during the Sangamonian interglacial interval. The Sangamonian weathering interval also follows the Illinoian stage in Wayne County, but the Sangamon soil has been removed by later ice advances.

Sangamonian Interglacial

Evidences of Sangamonian interglacial time are not satisfactorily recorded in Wayne County and indeed are very scanty throughout Ohio. A complete Sangamon soil profile occurs in Cuyahoga County near Cleveland (White, 1953c), but buried soils to record this period of weathering between the Illinoian and Wisconsin glacial stages have not been discovered in Wayne County. Certainly the Illinoian ice retreated out of Wayne County, and out of Ohio, and so allowed soil formation, stream erosion, and other normal processes to take place, although the evidence for these is not preserved.

Wisconsin Stage

Mogadore-Millbrook.—The Mogadore Till of the Grand River lobe records the advance of an ice sheet of early Wisconsin time into northeastern Ohio and at least as far as the extreme northeastern corner of Wayne County.

At the same time as the Mogadore ice was invading northeastern Ohio, the Millbrook ice of the Killbuck lobe advanced into Wayne County and covered all the county except the part occupied by ice of the Grand River lobe. This advance deposited the greatest volume of the till in the county; later deposits are generally thinner than the Millbrook Till. The Millbrook ice advance extended beyond Wayne County into Holmes County to the south.

Millbrook-Navarre interstadial.—The Millbrook ice retreated from the county and probably retreated north of the Lake Erie basin. The Millbrook Till was eroded and soil was formed upon it. Extensive deposits of colluvium were formed by movement down slopes of both fine and coarse remnants from weathering of the till. This material is still preserved at places beneath later till deposits as an irregular pebbly to cobbly deposit upon more or less weathered Millbrook Till.

Navarre.—After the considerable period of erosion and colluviation upon the surface of the Millbrook Till,

the ice of the Killbuck lobe again advanced into and over Wayne County, except for the extreme northeastern corner, and extended southward into Holmes County. A discontinuous and generally thin sheet of sandy till was deposited by the Navarre ice upon the eroded surface of the Millbrook Till, which in places had a layer of soil with colluvium upon its top. At places the advance of the Navarre ice removed all weathered material upon the underlying Millbrook Till so that fresh Navarre Till overlies fresh Millbrook Till.

The Navarre ice retreated north out of Wayne County, probably as far as the north side of the Lake Erie basin. Only a short period of erosion and weathering followed the retreat of the Navarre ice. In Wayne County the upper surface of the Navarre Till, where buried beneath later till, shows little weathering; farther west in Ashland County the Navarre Till at places shows slightly more weathering, suggesting a slightly longer ice-free interval.

Hayesville.—The Hayesville ice advanced from a position as far north as the Lake Erie basin, and possibly farther north than that, southward into the Killbuck lobe area, covering all of Wayne County except the extreme southeastern parts. It extended for several miles into Holmes County. The till left by the Hayesville ice was much more clayey and less sandy than that of the Navarre glaciation. The high proportion of clay may represent material picked up out of the Lake Erie basin. The Hayesville ice spread a generally thin and discontinuous layer of till, which in many places is less than 10 feet in thickness.

After deposition of the Hayesville Till, the ice retreated to a position north of Wayne County, but may not have retreated beyond the Lake Erie basin. Distinctive Hayesville Till is found below later till as far north as northern Medina County and further study may enable it to be distinguished still farther north.

Hiram.—The Hiram ice advanced from a position in the Lake Erie basin into the northwestern part of Wayne County, extending into much of Congress Township and into the northern and northwestern parts of Canaan Township. The limit of advance of the Hiram ice was controlled by the Wabash moraine which formed a barrier the ice could not surmount. The Hiram ice was the last to invade Wayne County.

Lakes

After the retreat of the Hayesville ice and during the advance and retreat of the Hiram ice, lowlands in Wayne County—Killbuck Creek valley, the valley of Muddy Fork of the Mohican River, Chippewa Creek valley, and some other smaller valleys—were occupied by lakes. Some of these were very shallow and may even have been swampy flood plains, but others, particularly the lake in Muddy Fork valley, were several tens of feet in depth. These were not the first lakes that existed in these lowlands, but it is the lacustrine material of these latest lakes that occurs at the surface. The deposits of earlier lakes lie beneath till sheets at various depths in the valleys and the histories of these earlier lakes cannot be worked out on the basis of evidence available at present.

The dams that held in the water are not always obvious. The dam in the Chippewa Creek valley from the Stark County line westward to Milton Township may have been a mass of drift in the Tuscarawas valley in Stark County, or it may be that masses of ice persisted for a time in the region of Canal Fulton in Stark County (White, 1963, p. 155).

The lake that existed in Muddy Fork valley—Lake Craigton—was probably formed by blocking of the southward drainage at the mouth of Lake Fork of the Mohican River where it enters the Mohican River 4 miles southeast of Loudonville, in Ashland County. Here the youngest outwash terraces, which rise to an elevation of 1,040 feet in the Mohican valley at the mouth of Lake Fork, are the remnants of material which once filled the Mohican valley to this level and forced the water to rise to this elevation in the Lake Fork valley. As the bottom of Lake Craigton is now at 980 feet elevation, the water in Lake Craigton had a minimum depth of 60 feet, so that for a time ponded waters extended northward almost to the margin of the Wabash moraine near Pleasant Home.

The presence of a shore line at an elevation of about 1,040 feet is confirmed by two small deposits of irregularly bedded sand and gravel of beach origin. One of them, in SE¼SE¼ sec. 7, Plain Township, is cut by the highway at an elevation of 1,020-40 feet, and another, at the road fork in NE¼ sec. 18, Plain Township, has an elevation of 1,015 feet. Conrey (1921, p. 40) noted a similar deposit in NW¼SW¼ sec. 17, Plain Township.

The lake formed by the blocking of the mouth of Lake Fork was progressively lowered as the Mohican River excavated its valley train, and Lake Fork was cut down to grade where it entered the master stream, thus draining Lake Craigton.

The elongate lake existing in the Killbuck valley was caused by blocking of the mouth of Killbuck Creek by outwash in the Walhonding River valley in Coshocton County. Outwash terraces at the mouth of Killbuck Creek reach elevations of about 830 feet so the outwash originally probably had an elevation of as much as 840 feet. The surface of the lacustrine plain (now also a flood plain) is at an elevation of 837 feet at the south line of Wayne County; 3 miles south of Wooster the elevation is about 840 feet. For a time, there was a very shallow lake in the Killbuck valley in the southern part of the county. North of Wooster the valley was probably occupied by an extremely sluggish stream which could carry and deposit only silt and formed a flood plain which approached a lacustrine plain in composition and appearance.

The lacustrine deposits in the basins occur at various levels, but they do not rise higher in one direction than another and the interpretation that they have a northward rise and thus indicate a northward tilt of the land (Hubbard, 1914; Hubbard and Rockwood, 1942) is not justified.

Eolian Deposition

The loessial silts that occur discontinuously over Wayne County record deposition from winds carrying dust composed of silt and clay picked up from bare expanses of drift. Farther west, in the Mississippi and Illinois valleys, the loess can be related directly to the valley trains from which the prevailing westerly winds picked up the material (Smith, 1942, p. 156). So far, observations in Wayne and adjacent counties do not show thickening in any direction, and it is premature to speculate about the direction of origin of the windblown silt.

The silt near Funk is composed of two thin layers, indicating two episodes of deposition separated by an interval of weathering. The earlier was deposited in post-Millbrook time, and the later probably in post-Hiram time, as silt occurs upon the Hiram Till in places in northwestern Wayne County, as well as in Medina and northern Ashland Counties.

After or during(?) its deposition, the silt was weathered and at places moved downslope to accumulate in greater thickness in shallow depressions. At places this silty colluvium was mixed with other material and may contain pebbles incorporated from the till in the process of colluviation.

Postglacial

After the last ice disappeared from the county, erosion and soil-forming processes began, and have continued to the present. Over the more level parts of the county, stream erosion has modified the surface only slightly, but near valleys more erosion has taken place. In the southern part of the county, erosion by streams and slope wash on hillsides is more extensive than in central and northern parts.

As the lakes were drained, sluggish streams started to flow across the lacustrine plains and silty alluvial material was laid down upon the lacustrine silts and clays; in many places it is difficult to distinguish between the two kinds of deposits.

Kettle holes became the sites of swamps, in which vegetation flourished and organic material was deposited in the form of peat and muck; peat bogs still persist in places.

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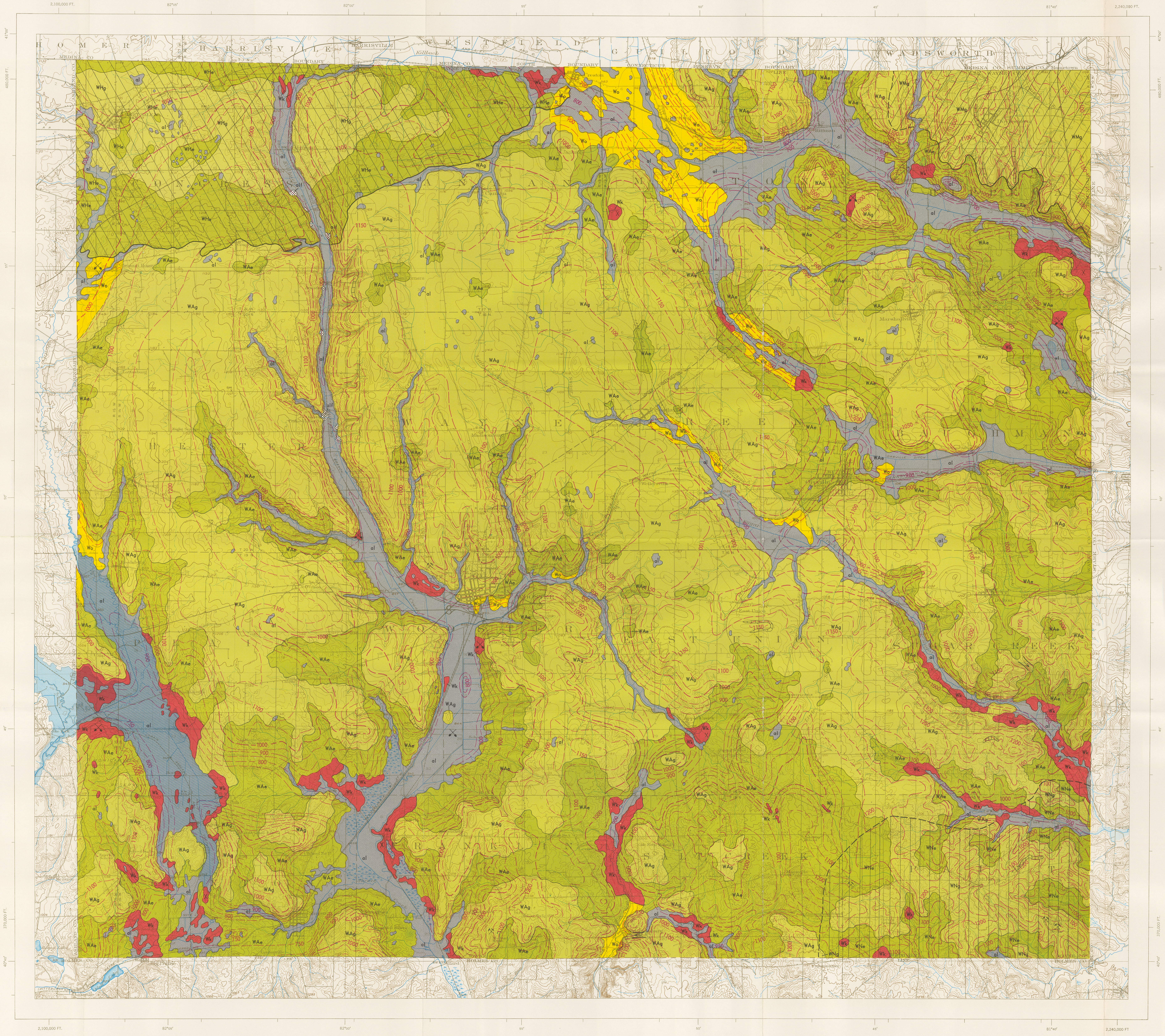
STATE OF OHIO
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL SURVEY

PLATE 1

REPORT OF INVESTIGATIONS NO. 62



EXPLANATION

RECENT

al — *FLOOD PLAINS* and *KETTLEHOLES.* Silt and other alluvium on valley floors, often thin and overlying material of different character. Kettleholes, some now incorporated in flood plains, contain muck and peat.

alf — *ALLUVIAL FANS.* In Killbuck valley northwest of Wooster.

PLEISTOCENE

WISCONSIN STAGE

HIRAM TILL

WHg — *GROUND MORAINE.* Clay till, generally 3-10 feet thick.

WHe — *END MORAINE.* Clay till, generally 5-15 feet thick; surface reflects that of underlying drift.

HAYESVILLE TILL

WAg — *GROUND MORAINE.* Silty till, generally less than 6 feet thick; surface reflects that of underlying drift.

WAe — *END MORAINE.* Silty till, 3-12 feet thick; surface reflects that of underlying drift, which may be gravelly at lower levels in valleys.

NAVARRE TILL

WNg — *GROUND MORAINE.* Sandy till, thickness 5 to more than 30 feet.

WNe — *END MORAINE.* Sandy till; may contain gravel masses.

MOGADORE TILL

WMg — *GROUND MORAINE.* Very sandy till, thickness less than 5 to more than 30 feet.

WISCONSIN UNDIFFERENTIATED

Wk — *KAMES* and *KAME TERRACES.* Gravel and sand in knolls; includes many till masses; in places overlain by thin till; includes crevasse fillings; material generally coarser than that in valley trains.

Wo — *VALLEY TRAINS.* Low outwash terraces; well washed gravel and sand, generally less coarse than that in kames and kame terraces.

SYMBOLS

SPILLWAY. Outlet of glacial melt water.

GRAVEL PIT.

GRAVEL PIT. Small or abandoned.

LEDGES. Sandstone exposed as cliffs or steep slopes with very thin till.

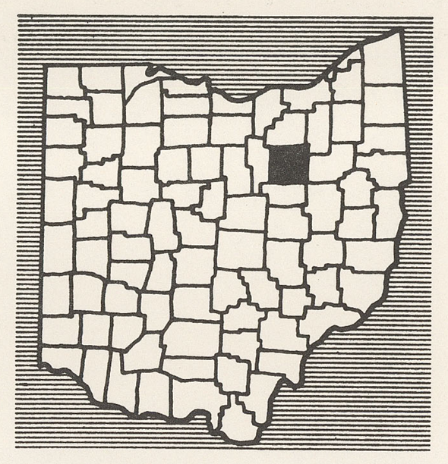
QUARRY or *MINE.*

Boundaries of tills, dashed where approximate.

Boundaries of deposits within tills, dashed where approximate.

Contours on bedrock surface, dashed where approximate; contour interval 50 feet.

LOCATION OF WAYNE COUNTY, OHIO



BASE COMPILED FROM THE FOLLOWING
U.S. GEOLOGICAL SURVEY TOPOGRAPHIC QUADRANGLE MAPS:

LOUDONVILLE	NAVARRE
MASSILLON	WEST SALEM
MILLERSBURG	WOOSTER

STATE OF OHIO
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL SURVEY
Ralph J. Bernhagen, Chief
REPORT OF INVESTIGATIONS NO. 62

GLACIAL DEPOSITS OF WAYNE COUNTY, OHIO

BY

GEORGE W. WHITE
1967

CONTOURS ON BEDROCK SURFACE
BY H. G. MULTER

PUBLISHED IN COOPERATION WITH THE U.S. GEOLOGICAL SURVEY AND THE OHIO DIVISION OF WATER

Scale 1/62500

Contour interval 20 feet
Datum is mean sea level

Cartographic drafting by
James A. Brown