STATE OF OHIO
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF GEOLOGICAL SURVEY
Horace R. Collins, Chief

Report of Investigations No. 123



# GLACIAL GEOLOGY OF SUMMIT COUNTY, OHIO

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George W. White

Columbus
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Photocopy composer: Jean M. Lesher
Cartographer: James A. Brown

# PREFACE

This report is a revision and amplification of the glacial geology portion of a 1953 Ohio Division of Water publication, *Ground water resources of Summit County, Ohio,* by R. C. Smith and G. W. White. In 1953, Pleistocene stratigraphy of northeastern Ohio was just beginning to be understood. The glacial part of the 1953 report is less than 10 pages long and of generally "summary" character. The present report is based on continued observations since 1953 of deposits revealed in outcrops in the construction of the extensive system of interstate and other superhighways and of other excavations in northeastern Ohio. The surface morphology has been studied in further detail by field observation and in particular by use of recent air photos. The comprehensive and detailed soil survey (Ritchie and Steiger, 1974) for Summit County has provided important additional information and insights. The reports on the glacial geology of the surrounding counties published and in press (see p. 9) have been useful in confirming correlations in Summit County.

As Smith and White's 1953 bulletin is now out of print and not readily available, this report is prepared with the assumption that the reader will not have the other report at hand. However, the treatment in this report is different from that of the other report and there is little duplication.

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# GLACIAL GEOLOGY OF SUMMIT COUNTY, OHIO

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## ABSTRACT

Summit County is covered by deposits of several ice sheets and associated meltwater. At various times, ice sheets advanced into the county in the Grand River lobe from the east, the Cuyahoga lobe from the north, and the Killbuck lobe from the west. Erosion by the ice sheets was selective. The valleys between the hills were deepened several hundred feet, but the hills, capped by sandstone, were only rounded and streamlined.

Deposits of one or more very early ice sheets are exposed in a very few places. These deposits are very coarse and sandy and contain sandstone boulders. Their age cannot be determined. A coarse till exposed in a few excavations is correlated with the Mapledale Till of probable Illinoian age. The Mogadore Till of early Wisconsinan (Altonian) age (about 40,000 years before present) is present throughout Summit County. It is concealed beneath later till in northern Summit County and in extreme eastern and southern Summit County. In Akron and most of the southern half of the county the Mogadore Till is at the surface. The Mogadore Till is correlated with and is continuous with the Titusville Till of the Grand River lobe in eastern Ohio and northeastern Pennsylvania and with the Millbrook Till of the Killbuck lobe west of Summit County. The Titusville-Mogadore-Millbrook Tills are the thickest tills of northeastern Ohio and northwestern Pennsylvania. They are associated with large amounts of gravel in kames and kame terraces, which are the source of practically all the commercial gravel in northeastern Ohio.

The earliest Woodfordian (late Wisconsinan) till is the Kent Till (24,000 years before present) of the Cuyahoga lobe in northern Summit County and the margin of the Grand River lobe in extreme eastern Summit County. The Kent Till is generally thin and may be absent in some areas. The silty Lavery Till (19,000 years before present) of the Cuyahoga lobe covers northern Summit County as far south as Akron, but is at the surface only in a small area. The clayey Hiram Till (17,000 years before present) of the Cuyahoga lobe also covers northern Summit County and conceals the Lavery Till except along the margin of the Hiram Till. The Hiram Till is generally very thin, so that the underlying Lavery Till is generally exposed in shallow roadcuts and excavations or even at the surface.

A very complex series of outwash deposits in stream valleys in Summit County consists of clayey silt, sand, and gravel interbedded with till and lacustrine clayey silt. The lacustrine and associated deposits of the Cuyahoga River valley are especially noteworthy.

The engineering geology of the deposits in the valleys and along the valley sides—especially along the Cuyahoga River valley—is complicated. Construction above and below ground is perilous if appropriate precautions and measures are not taken to accommodate the deposits and the possibility of rapid variations.

The variety of erosional and depositional forms in Summit County provides varied environmental areas for housing, parks, roads, and industry. Water supply is abundant from the lakes in glacially formed depressions and from ground water in permeable material, chiefly of Altonian age. The areas of clayey till produce distinctly less water. Waste disposal, both solid and liquid, ranges from favorable to very unfavorable.

## INTRODUCTION

Summit County, Ohio (fig. 1), covers an area of 419 square miles in northeastern Ohio. Akron, the county seat, and contiguous smaller cities and villages cover approximately half the county. Much of the remainder of the county is undergoing rapid suburban development. Akron is about 30 miles south-southeast of Cleveland and Lake Erie, and about 50 miles west of the Ohio-Pennsylvania state line.

The oldest bedrock in the county is shale of Devonian age (fig. 2) and is almost entirely below the level of the valley fill in the deeper bedrock valleys. Mississippian-age rocks in Summit County consist of sandstone, siltstone, and shale. The youngest strata in the county are of early Pennsylvanian age and consist mainly of sandstone and shale with a few thin beds of limestone, coal, and clay.

### PURPOSE AND SCOPE

This report describes the glacial drift—the surface material overlying the bedrock—in Summit County. Stratigraphy of the deposits and morphology of the landforms are described and correlated with deposits and surface features in adjacent counties. Economic resources of the deposits are considered and suggestions are made for their utilization and conservation. The influence of the geology on the environment is particularly considered.

This report will be of interest to various groups and individuals—highway engineers, construction firms, sand and gravel operators, architects, city planners, and soil scientists. Citizens who are or who will be responsible for planning and shaping the future of Summit County for agriculture, urbanization, and recreation will find this report useful for making their decisions.

Plate 1 shows the various kinds of glacial drift at the surface in Summit County. The map is based on field study at various times from 1949 to 1976. Outcrops along newly constructed highways, especially the interstate highways, and in other excavations, including gravel pits, and augering provided information on which the map and the description of subsurface units are based. The 1:24,000 (7½-minute) series of topographic maps provided information about topography indicative of various kinds of glacial deposits and have been most useful. Of great importance have been the recent detailed soil maps of Summit County (Ritchie and Steiger, 1974).

In the city of Akron, the areas of gravel (kames) were determined on the basis of material in outcrops and from soil. The distinction between areas of constructional topography other than kames and areas of ground moraine with little constructional topography is difficult in places where buildings cover much of the surface, and the boundaries between these two are placed with some lack of assurance.

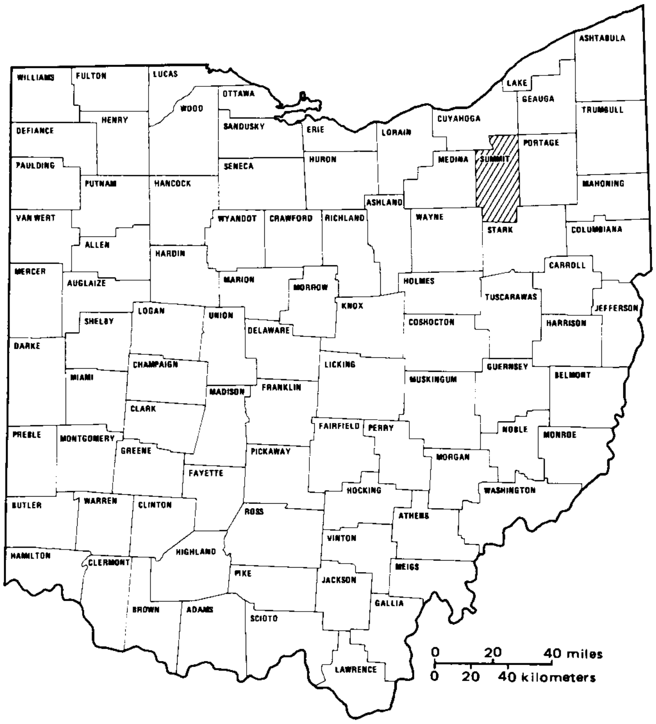



FIGURE 1.—Location of Summit County, Ohio.

Perhaps it would have been easier to map some areas as "urban," as is done on the soil maps (Ritchie and Steiger, 1974), without designating the topographic form. Areas completely covered by large buildings such as factories and areas which have been seriously modified by cutting or by filling so that the original topography has been obliterated are mapped as "made land." These areas have been determined from visual examination, from air photos, and from the soil maps of Ritchie and Steiger (1974). The rights-of-way of interstate and other superhighways are disturbed, but they are so narrow at the scale of the map that they have not been distinguished as "made land." The interchanges are all cut or filled but are not shown as "made land" as they are so prominent on the topographic base.

A very early photograph (daguerrotype) of Akron taken in 1853 from "West Hill" across the valley that extends from Summit Lake to the Cuyahoga River has been reproduced in a recent history of Akron by Nichols (1976, end papers and p. 10-11). It shows the as-yet undisturbed sharp kames on the west side of the valley and the irregular surface on the east side of the valley on which the city of that time was located. The degree of present-day modification of the surface, especially on the west side, is striking.

## PREVIOUS INVESTIGATIONS

The earliest geological reference to Summit County is by Hildreth (1836, 1837, 1838), who mentions coal beds in the county. A reference of considerable interest is Samuel St. John's *Textbook of geology*, published in Hudson in 1851, which was the first Ohio textbook of geology and probably the first such textbook published west of the eastern seaboard. St. John's contribution to glacial theory, his illustrations, his mention of Summit County, and the importance of his book are noted in White (1967a). A report on Summit County by J. S. Newberry (1873) is a fine summary of the geology of the county, including the glacial deposits. It is interesting to note that Newberry was from Tallmadge. He attended Western Reserve College, then at Hudson, where he was a student of St. John.

The lake deposits of the Cuyahoga River valley were noted by Claypole (1887), who published a series of maps to show the location of the lakes he proposed. Claypole at that time was a professor at Buchtel College, which later became the University of Akron. The great monograph of Leverett (1902) included Summit County and showed the location of morainic areas and especially showed for the first time the great morainic tract ("interlobate moraine") of eastern Summit, western Portage, and northern Stark Counties. Leverett (*in* Cushing, Leverett, and Van Horn, 1931) later revised the mapping of moraines in northern Summit County and showed the extension of the Defiance Moraine into the Cuyahoga River valley as far south as Peninsula. The 1953 report of Smith and White has been mentioned earlier.

Summit County is included in a paper by White (1969) on the glacial geology of the Allegheny Plateau. The stratigraphic classification of the glacial deposits in Summit County is included in a general summary for northeastern Ohio (White, 1960). The glacial deposits of Summit County are shown on the glacial map of Ohio (Goldthwait, White, and Forsyth, 1961). On this map the boundaries of the Kent, Navarre, and Hiram Tills are shown, but are not named. The Hiram boundary of that map is actually a composite for Hiram and Lavery. The detailed sedimentological character of some of the glacial deposits on the east side of the Cuyahoga River valley north of Akron has been described by Bain and Bain (1975). In recent years Szabo and his students at the University of Akron have investigated the tills of Summit County (see Szabo and Angle, 1983; Szabo and Ryan, 1981). The glacial geology of Summit County is included in the report and map by White (1982) on the glacial geology of northeastern Ohio.

## ACKNOWLEDGMENTS

This report is based on data secured between 1949 and 1952 in an investigation of the glacial and ground-water geology of Summit County by the U.S. Geological Survey in cooperation with the Ohio Department of Natural Resources, Division of Water. In succeeding years, investigation of the glacial geology of other counties of northeastern Ohio provided opportunities to review the glacial geology of Summit County. At various times in the summers of 1970 through 1975 further investigation of the glacial geology of northeastern Ohio by the Ohio Geological Survey included work in Summit County.

Grants from the National Science Foundation to the Pleistocene laboratory of the University of Illinois at Urbana provided funds for studies of composition of tills in northeastern Ohio and northwestern Pennsylvania. Later analyses were performed in the laboratories of the Ohio Geological Survey under the direction of David A. Stith. Stanley M. Totten accompanied the writer in the field to examine exposures in Summit County, and his comments and suggestions have been very helpful. Mr. Totten also reviewed the map and text in their final stages of publication. Robert G. Van Horn, of the Ohio Geological Survey, has shared his knowledge of waste-disposal possibilities and of gravel resources and made helpful comments in the field and in the office. The editorial staff of the Survey has made much appreciated contributions to the final form of the report. Horace R. Collins, State Geologist, has taken a continued interest in the development of this map and report and has provided valuable support and encouragement.

## PHYSIOGRAPHY

Summit County is in the northwestern part of the Appalachian Plateaus Province; the part of this province in Ohio and northwestern Pennsylvania is known as the "Allegheny Plateau."

The northwestern third of the county is deeply dissected, into high, narrow hills and steep-sided deep valleys. The Cuyahoga River has cut a deep gorge into the unconsolidated glacial deposits north of Akron, and several picturesque waterfalls occur in the tributary valleys east of the main gorge. The remainder of the county consists mostly of gently rolling uplands, broad flat valleys, and gentle hills with a few steep-sided hills in Franklin Township. The highest elevation in the county, near West Richfield, is 1,320 feet above sea level. The lowest area, only 8 miles away, in the extreme northeast corner of Northfield Township, is slightly more than 600 feet above sea level.... In the northwestern third of the county the valley floors range in elevation from 600 to 800 feet, the hilltops range from 1,100 to 1,200 feet above sea level. Local relief exceeds 200 feet. Elsewhere in the county the valley floors are, on the average, about 1,000 feet above sea level and the hilltops range from 1,100 to 1,200 feet above sea level.
Summit County is drained by two major streams separated by a drainage divide that extends northwest-southeast through the southern part of Akron. North of Akron the drainage is into Lake Erie by the Cuyahoga River, which enters the county from the east near Cuyahoga Falls. South of Akron the drainage is by the Tuscarawas River, which rises in southern Springfield Township and western Green Township and flows into the Ohio River by way of the Muskingum. (Smith and White, 1953, p. 4).

The key to the topographic expression and indeed the control of the character of the ice advances and their deposits is the presence of elongate high rock areas in most of the county, except in the more extensive continuous high bedrock areas in the central-eastern and southeastern part.

The physiographic units of Summit County have such irregular boundaries and are so varied in size that a map to show these has not been attempted. The various kinds of physiographic units have already been described in a general way and further description would coincide with later descriptions of ground moraines, end moraines, kames, and outwash areas.

However, one distinctive physiographic feature merits description here—the ravines. The ravines are well shown on the glacial map (pl. 1), and on the waste-disposal map of Van Horn (1976) and the soil maps of Ritchie and Steiger (1974). Along the valley sides of Furnace Run and the Cuyahoga River from Akron northward into Cuyahoga County, a very striking type of topography has developed. Closely spaced ravines, in some cases oriented almost at right angles and others at various angles, are directed with a northerly component toward the Cuyahoga River valley. These ravines descend from uplands at elevations as high as 1,100 feet to the valley bottom of the Cuyahoga River at an elevation of 700 feet, in a distance ranging from less than a mile to as much as 3 miles. The ravines are actively eroding headward into the upland surface. Thus a belt 1 to 3 miles wide along the eastern side of the Cuyahoga River valley from Akron northward to the northern part of Boston Township is chopped up into a veritable wilderness with ravines and narrow divides. It is along these divides that highways are located. These narrow ridges preserve some of the original glacial depositional surface, both that of the Defiance Moraine north of Peninsula and the hummocky topography of the Summit County morainic complex south of that village. These deposits indicate that the ravines were cut after the deposition of Hiram Till, about 17,000 years ago. They are therefore very young geological features.

On the western side of the Cuyahoga River valley, the ravines are generally shorter and the intervening upland areas wider. On either side of the valley of Furnace Run in northeastern Richfield and southeastern Boston Townships, smaller ravines dissect the upland surface. Those of the south-southwest side are noticeably longer than those of the northeast, probably because the northeast side has bedrock closer to the surface.

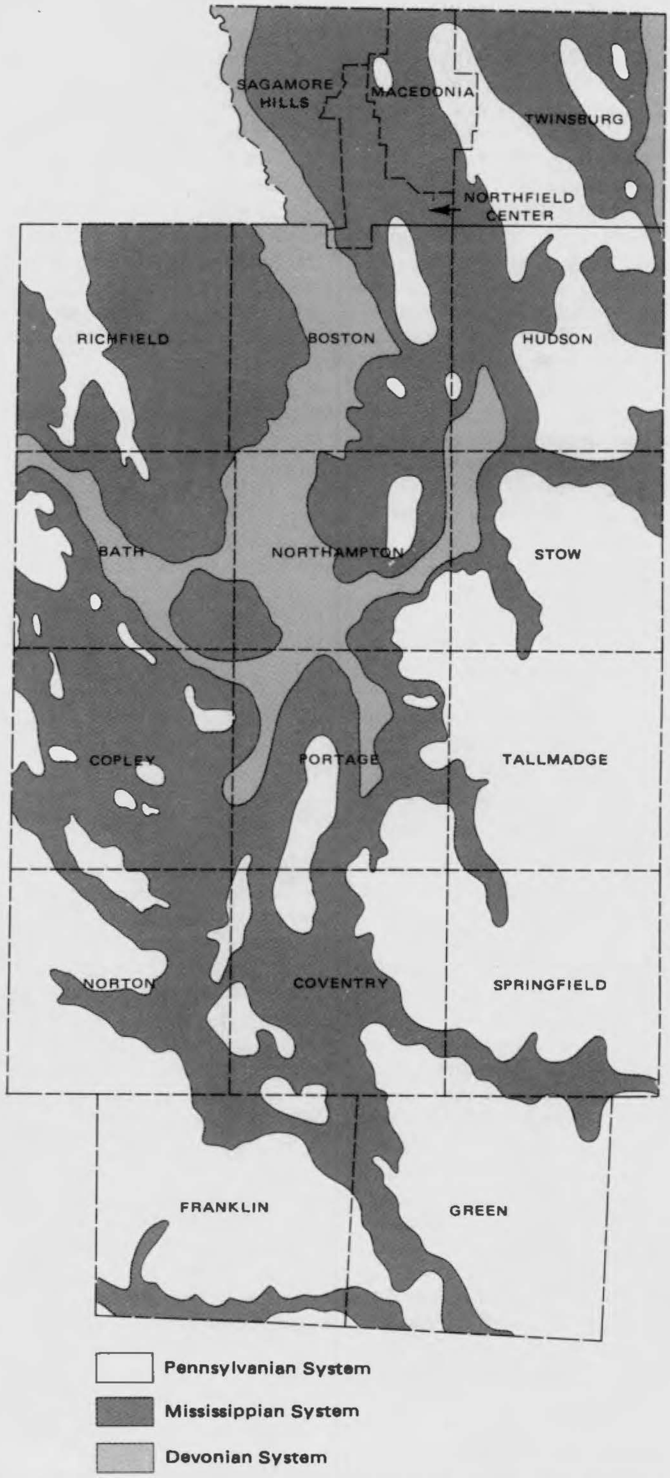



FIGURE 2.—Generalized bedrock geology of Summit County (modified from Smith and White, 1953, pl. 5). Resistant rock forms the uplands, separated by deep valleys, now partly buried.

The particular character of these ravines is due to the thick, easily eroded drift material. The drift in the Cuyahoga River valley is very complex stratigraphically and consists of a series of till deposits interbedded with lacustrine clays. The lower, earlier tills are sandy and more resistant, but the great thickness of the upper part of the drift is clayey, silty tills interbedded with lacustrine clays and silts of different ages. The tills are in places so clayey and silty that it is difficult to distinguish them from lacustrine deposits. This whole mass of fine-grained material is easily eroded by storms and by mass movement down the unstable slopes.

The total length of slopes of ravines tributary to the Cuyahoga River, Furnace Run, Yellow Creek, and Sand Run is hundreds of miles. These unstable slopes range in height from a few tens of feet to 300 feet. The unsuitability of these areas for construction is everywhere evident. Scars of ancient landslides are abundant. Large structures built on or along such slopes have had a hapless history. Their propensity for instability is now recognized by engineers and planners. The instability and danger for construction cannot be overemphasized.

This intricately dissected area is similar to other areas, generally in the semi-arid western United States, called "badlands." The difference between the Summit County badlands and the western badlands is that the Summit County areas are heavily covered with vegetation (forest or brush), whereas the western ones are bare of vegetation. These heavily eroded areas of Summit County are now mostly parkland of the Cuyahoga Valley National Recreation Area.

The intricate erosion was probably initiated soon after the last ice left the region, when small streams advanced rapidly headward from the level of the Cuyahoga River because of the potential relief of several hundred feet. In early post-glacial time, before the area was vegetated, erosion would have been very rapid and soon would have presented a true badland aspect.

## GLACIAL LOBES AND ICE ADVANCES

During the Pleistocene Epoch, ice advanced from the Erie basin into Ohio in a generally southward direction as the Erie Lobe. Early ice sheets covered all the hills and other surfaces of northeastern Ohio and the margins eventually reached a more or less east-west line across Columbiana, Stark, Holmes, Ashland, and Richland Counties. In the later Pleistocene, the ice advances were retarded by the highlands and flowed into the basins between them. Thus a series of smaller sublobes, hereafter referred to as lobes, was formed (fig. 3). The Grand River lobe occupied a wide area in northwestern Pennsylvania and in northeastern Ohio as far west as eastern Summit County. The Killbuck lobe occupied an area from northern and western Summit County westward to Richland County. At times in the late Pleistocene, a small sublobe, the Cuyahoga lobe, covered northern Summit County between the Grand River lobe and the Killbuck lobe (Shepps, 1953). This juxtaposition of two lobes and at times three lobes in Summit County resulted in an unusual variety of deposits, both in morphology and composition. Not only were the ice-laid deposits from different directions, but also the water from the melting ice of the different lobes at different times formed different patterns of outwash deposits of great interest and economic importance.

## GLACIAL-EROSIONAL FORMS

At the beginning of the Pleistocene, or glacial time, the northwest margin of the Allegheny Plateau was a scarp

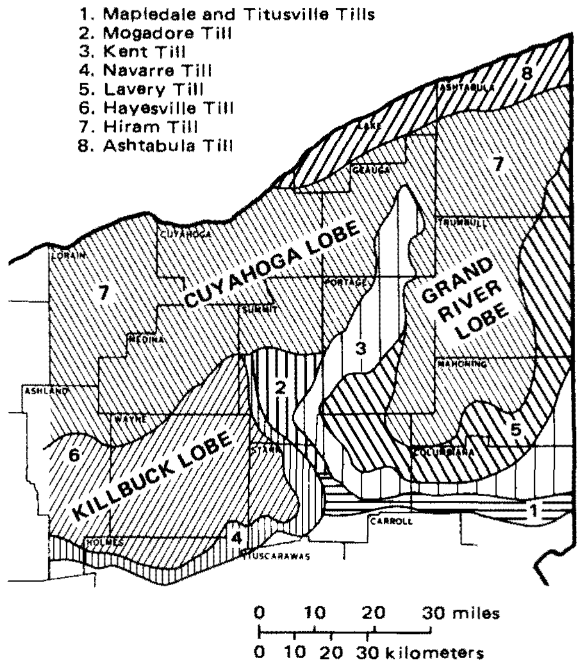



FIGURE 3.—Glacial lobes and tills in northeastern Ohio.

several hundred feet high, paralleling the south shore of Lake Erie to about Cleveland and trending southwestward across Cuyahoga, Medina, northern Ashland, and northern Richland Counties, and thence southward to central Ohio. The escarpment was indented by valleys draining north and northwestward. South of a major divide across Columbiana, Stark, and Holmes Counties, drainage was to the south and southeast.

The southward advance of the ice more or less coincided with the "grain" of the area, so that the advancing ice was funneled into the lower areas between the higher divides of resistant sandstone of early Pennsylvanian age. The advance of the ice deepened the lowlands, especially where these coincided with the direction of ice advance (Sugden, 1974). These deepened valleys are a conspicuous feature of the Summit County landscape (fig. 2). They are even more impressive when it is realized that they are as much as several hundred feet deeper than they appear on the surface, because they are partly filled by glacial drift (fig. 4). The rock hills were molded into rounded oval forms. The ground-moraine areas (pl. 1) in northern, central, and western Summit County show very well the oval shape of the highland areas. In these areas the drift is very thin and bedrock crops out in many places.

The effect of glacial erosion was to remove some of the bedrock and incorporate it into the advancing ice. Incorporation of bedrock fragments was more common in the Altonian and earlier ice sheets, the deposits of which are notably sandy and coarse. The later (Woodfordian) ice sheets entering Summit County eroded very little of the bedrock; they chiefly eroded the silty clayey materials in the lowlands.

## GEOMORPHOLOGY OF THE GLACIAL DRIFT

The surface of Summit County is an expression of the glacial drift that covers the bedrock from depths of a few feet to several hundred feet. A variety of surfaces occurs in the

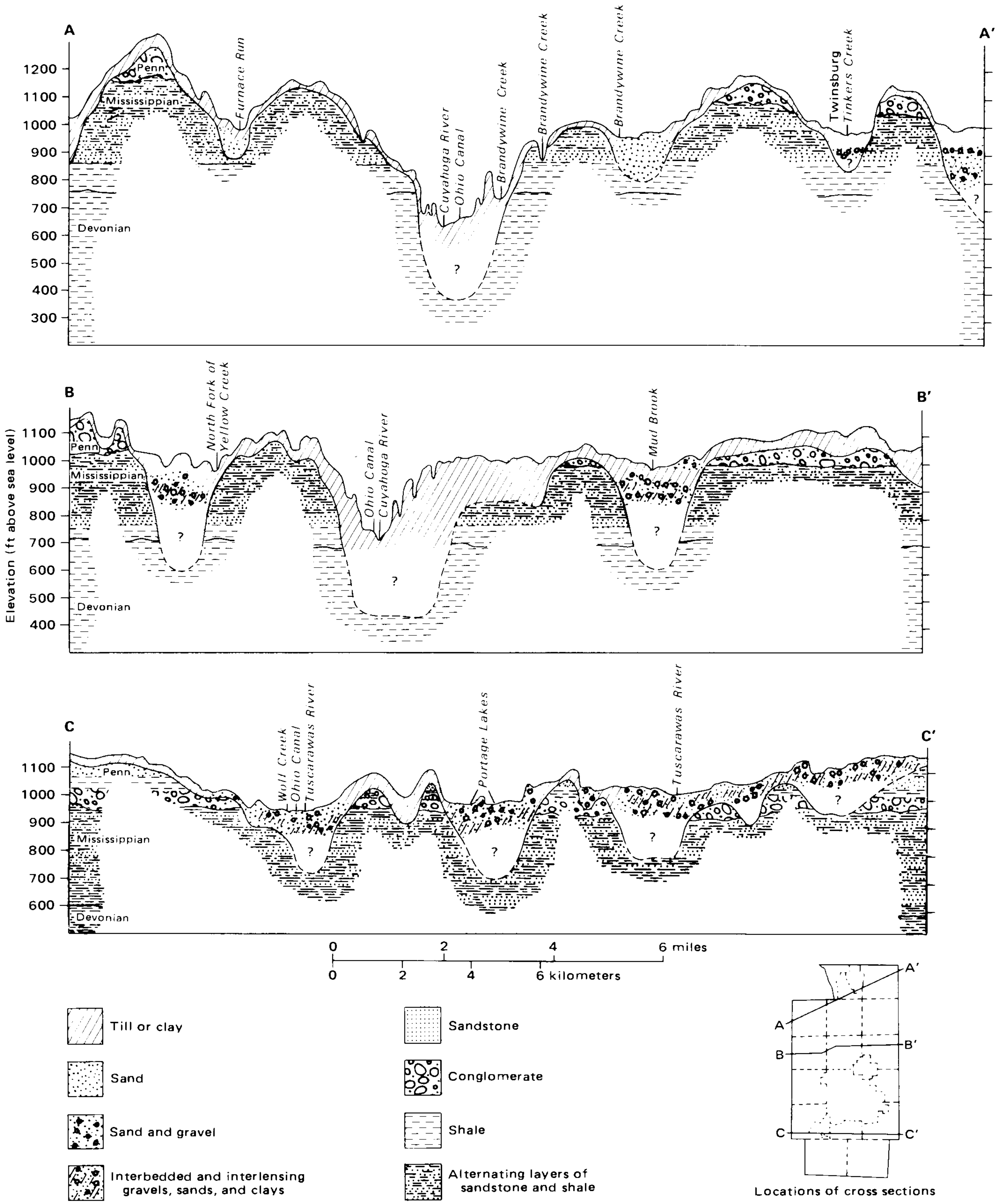



FIGURE 4.—Generalized cross sections across Summit County showing bedrock geology, deep preglacial and interglacial valleys, and drift cover (modified from Smith and White, 1953, pl. 7).

county, ranging from relatively smooth, almost level ground-moraine surfaces, to hummocky drift, to exceedingly hummocky kame and kame-terrace areas with sharp knolls and deep depressions.

## GROUND MORAINE

Areas of ground moraine occur in the uplands and have a smoothly rolling surface with minor undulations. Ground moraine in Summit County is in large part a masked bedrock-erosional topography with some irregularities superimposed on it by the thin glacial drift, which is generally less than 10 feet thick and seldom more than 20 feet thick.

As shown on plate 1, the largest areas of upland ground moraine are in Twinsburg, Macedonia, Richfield, and Franklin Townships, although significant areas occur in Norton, Copley, and Tallmadge Townships and in Akron. A large part of Akron east of the Summit Lake-Ohio Canal depression and south of the Little Cuyahoga River consists of ground-moraine topography.

The ground moraine in northern Summit County is a bit less undulating than that in the southern part, probably because the Hiram Till characteristically forms smoother topography than the Mogadore Till.

## AREAS OF HUMMOCKY TOPOGRAPHY

In contrast to the smoother ground-moraine areas are irregular areas of hummocky topography. Some areas are in valleys and along valley sides. However, across the county north of Akron are very extensive areas in the uplands as well as along the valley sides.

### SUMMIT COUNTY MORAINIC COMPLEX

West of Summit County, distinctive linear areas from a fraction of a mile to almost 2 miles wide are characteristic features. These features are well shown in central and western Ohio on the glacial map of Ohio (Goldthwait, White, and Forsyth, 1961). As can be seen on White's (1982) glacial map of northeastern Ohio, in Ashland and western Medina Counties the ridgelike belts are closer together, and in eastern Medina County the belts overlap each other in a more or less confused mass, which extends eastward into Summit County across Bath, Northampton, and Stow Townships and into northwestern Portage County. This confused mass of hummocky topography represents a compression of the Wabash, Fort Wayne, and associated end moraines. These moraines, which are distinctly separate farther west, are impossible to map as separate entities in Summit County, and the end-moraine area is referred to as the Summit County morainic complex.

The surface of this confused end-moraine area is very hummocky, made up of knolls 20 to 40 feet high with depressions (kettle holes) between the knolls. Some of the depressions are drained; others are at the water table as swamps; still others extend below the water table and contain lakes.

The Summit County morainic complex, as are the discrete end moraines to the west, is made up of Mogadore Till (equivalent Millbrook Till west of Summit County) with a thin veneer of later tills—Kent, Lavery, and Hiram. Below the clayey Hiram and silty Lavery Tills, the coarser, sandy Kent and Mogadore Tills contain much gravel, and some of the buried knolls are actually kames. Such areas are shown on plate 1 as "gravelly moraine." The largest area is north of Silver Lake on either side of the Wyoga Lake-Silver Lake depression. In these areas, gravel kames are so close to the surface that they may actually crop out and in places have been sites of gravel pits. Well records give abundant evidence of the gravel which lies below the surface covering of clay till (see logs of wells in Smith and White, 1953, pls. 22A-N).

### DEFIANCE MORAINE

The most northerly end moraine which crosses all of Ohio is the Defiance Moraine. It is a discrete, linear, irregular, ridgelike feature extending from northwestern Ohio into northeastern Medina County and then northeastward into Cuyahoga County, southward down the Cuyahoga River valley into Summit County to just beyond Peninsula, northward to re-enter Cuyahoga County, and across Geauga, Trumbull, and Ashtabula Counties into Pennsylvania (Shepps and others, 1959). The Defiance Moraine in Summit County lies on the slopes of the Cuyahoga River valley and extends part way onto the upland. The moraine, which crosses the Cuyahoga River valley just south of Peninsula, has been deeply dissected by ravines tributary to the Cuyahoga River, and the original hummocky topography has been preserved only on the upland surfaces between the ravines, as shown on plate 1. The marked contrast of the Defiance Moraine with the adjacent gravelly Summit County morainic complex, particularly on the west side of the moraine just below the upland margin, is well shown at the northern boundary of Summit County and to the north and northwest into Medina and Cuyahoga Counties.

It should be emphasized that the Defiance Moraine does not mark the limit of advance of a till sheet. It is a recessional moraine of Altonian age. The margin of the Hiram Till, the youngest till in the region, is about 7 miles south of the south margin of the Defiance Moraine. The Hiram Till is a thin, in places discontinuous, veneer over the Defiance Moraine, as is the Lavery Till, the next youngest till to the Hiram. Drift thickness in the end-moraine areas is in general much greater than in ground-moraine areas and may be over 25 feet, in places exceeding 100 feet.

### KENT MORAINE

The Kent Moraine is a great belt of hummocky topography which is not an obvious linear feature in Summit County. Across Geauga, Portage, Stark, Columbiana, and Mahoning Counties, and extending across northwestern Pennsylvania to southwestern New York, the Kent Moraine is a marginal belt of the Grand River lobe as much as 10 miles wide. It is not a discrete ridge or series of ridges, but is rather a belt of thicker drift with marked hummocky topography. The drift of the Kent Moraine contains large masses of gravel, much of it in the form of kames. The eastern 2 to 5 miles of southern Summit County is occupied by the western part of the Kent Moraine, which appears as a mass of irregular hummocky topography. However, the main mass of the moraine is to the east in Portage County.

### BUCK HILL MORAINE

On the east side of the Killbuck lobe in southwestern Summit and western Stark Counties is a tract of very hummocky topography, similar to that of the Kent Moraine, known as the Buck Hill Moraine (White, 1982, p. 16). The Buck Hill Moraine has an east-west trend in southwestern Summit County and extends as a narrow belt less than a mile wide on the north side of the Chippewa Creek valley from Clinton westward into Wayne County. It was formed by ice of an eastern protrusion of the Killbuck lobe as far as the West Branch valley in central Stark County. In northwestern Stark and southwestern Summit Counties the ice was actually moving north.

In southwestern Summit County east of Clinton and south into Stark County the Buck Hill Moraine consists almost entirely of rugged kames, some as much as 100 feet high. This topography is similar to that of the Kent Moraine to the east. The boundary between the two moraines is arbitrarily drawn from the Stark-Summit County line to the northeastern limit of the Buck Hill Moraine. In most of southern Summit County the Buck Hill and Kent Moraines form a continuous area of kame-moraine topography and may be regarded as an interlobate area.

The topography of the Buck Hill Moraine in Summit County is one of pronounced kames and kettle holes. Many lakes are present in the kettle holes; the most prominent are the well-known Portage Lakes.

### AREAS OF HUMMOCKY TOPOGRAPHY WITHOUT LINEAR TREND

South and west of Akron are hummocky areas of thicker till, generally at lower elevations along valley sides, but in a few localities on the uplands. These tracts are not end-moraine areas, but, as in the end-moraine areas, the drift is generally thicker than in the ground-moraine areas. These tracts are interpreted as deposits of a waning ice sheet that had lost most or all of its forward motion.

### KAMES AND KAME TERRACES

Some of the finest examples of kames and kame terraces in Ohio are found in Summit County. With the exception of the Cuyahoga River valley north of Akron, almost all the valleys have irregular, hummocky marginal terraces which are not fluvial in origin, except in the lower levels, but which were deposited along the masses of ice left in the deep valleys after the ice had melted from the uplands. Meltwater flowing between the valley sides and the mass of remnant ice in the valley centers deposited irregular masses of sand and gravel, which were left as kame terraces along the ice margin as the ice disappeared. These kame terraces range from level to rugged. When the last ice blocks finally melted, irregular depressions, some of considerable depth, were left in the valleys. Some of these depressions are large and are occupied by lakes. Water also accumulated in kettle holes in the kame terraces, the depth of water depending on the depth of the kettle hole, some of which are quite deep.

The most extensive areas of kames and kame terraces are in the Cuyahoga River valley from Cuyahoga Falls east and in the Tuscarawas River valley from Barberton to Portage County. Other large areas are north of the Springfield Lake-Ohio Canal depression and on the east side of the Little Cuyahoga River and northward along the Cuyahoga River to the west edge of Cuyahoga Falls.

Other significant areas of kames and kame terraces are in Stow Township north of the Cuyahoga River extending west and northwest from Silver Lake to Wyoga Lake, and in the vicinity of Meadowbrook Lake. In these areas there are considerable numbers of kettle holes, the deeper ones lakes, the shallower ones swampy areas.

In western Hudson Township northwest into Northfield Center Township, irregular low kame terraces occur along the valley sides of Brandywine Creek. These terraces, which are not shown on plate 1, are lower than most of the kame terraces in the southern part of the county and are composed of fine gravel and sand; the terraces in the south are characterized by medium to coarse gravel. Similar low terraces are found along the sides of valleys in Twinsburg Township. The central depressions are larger in proportion to the area of the deposits and are occupied by swamps, connected by a very sluggish stream.

### PORTAGE LAKES

The Portage Lakes area is a well-known and extensive geomorphic form that deserves special mention. In the ancient valley that extends from southern Akron to the Stark County line is an intricate network of eskerlike crevasse fillings, sharp kames, and very large kettle holes. The depressions which form the basins of the lakes are the molds of the last ice blocks, remnants of the Mogadore ice sheet, to melt. The bottoms of the depressions are below the water table of the region and are filled with water to that level to form the present lakes.

In pioneer days the Portage Lakes were important for transportation and then as a source of water for lockage of the Ohio-Erie Canal. From early days the picturesque topography of the kames and terraces has provided attractive sites for homes. The Wooster and Chili soils are well drained and many prosperous farms and orchards were located here. At the present time the very popular Portage Lakes State Park comprises an area around Turkeyfoot Lake. Private marinas have been established at various places. The area is now almost completely one of suburban and exurban development, as many of the earlier farms have been subdivided. The Portage Lakes area is indeed a geomorphic region of economic and esthetic value to Summit County.

### VALLEY TRAINS AND OUTWASH PLAINS

After the disappearance of the ice in the valleys, or after it had melted down very considerably, deposition changed from irregular kame-gravel deposits at higher levels to more level finer grained deposits—sands and silts—in the lowest parts of the valleys. These lower level silt and sand deposits are shown as outwash on plate 1. Even in these areas ice blocks remained and did not melt until deposition had ended, so that great kettle holes are the record of the last ice blocks to disappear.

Some of these depressions are very large and are, or have been, sites of bogs. The largest area is in the lowland formed by Pigeon Creek, Wolf Creek, and Shocalog Run surrounding the bedrock highland on which the town of Copley lies. This area includes the site of the famous Copley Bog and its thick peat deposits. Other large areas of outwash occur elsewhere in Copley Township, in Portage Township (Akron), in western Hudson Township, in Northfield Center Township, and in Twinsburg Township. Small areas occur in Green Township. Discontinuous terraces along the Tuscarawas River valley from Akron south to the Stark County line are remnants of the valley train deposited in that valley.

### LAKE PLAINS

In the lowest areas, lakes were formed at the waning stages of each ice advance. Because it is difficult to separate lake deposits from the lowest outwash deposits, the lake deposits are included with the outwash deposits on plate 1. In the western part of the Copley Bog area it is particularly difficult to determine whether the sandy and silty deposits are the result of slowly falling water levels of sluggish meltwater streams or the result of an irregular lake. It is probable that this area was covered by shallow water from the melting ice to the north. This meltwater had a very sluggish current moving southward through Barberton, both on the east and the west sides of the bedrock hill just north of Barberton. The area was indeed intermediate between a slowly falling wide stream and a shallow lake with slow currents. Similar situations existed in western Hudson northward into Northfield Center Township and in the lowland areas of Twinsburg east and west of the bedrock highland between Pond Brook and Tinkers Creek. After the last ice blocks melted, the depressions still held water, as many of them do today. Some remain lakes, such as the Portage Lakes, but most became bogs as organic material accumulated, as in the thick peat deposits of Copley Bog, described and shown on the map by Dachnowski (1912, p. 123-129). These early descriptions are particularly valuable because since the study by Dachnowski most of the bogs have been artificially drained and are now sites of intensive vegetable growing.

### LAKE SURFACES IN THE CUYAHOGA RIVER VALLEY

Lake surfaces of a character different from those already described are found in the Cuyahoga River valley as far south as the central part of Akron as terraces along the valley sides. The lake deposits are covered in many places by clay till, but in some places, particularly in Boston Township, the surface is composed of lacustrine materials. The stratigraphic complex of till and thick lacustrine clay is described later. Again, however, the lake deposits are mapped with the outwash deposits on plate 1.

One lake surface has been mapped separately—the Lake Maumee gravel terrace in extreme northwestern Sagamore Hills Township. The Lake Maumee gravel terrace in Summit County is a southward extension of the main Lake Maumee terrace in Cuyahoga County. This surface grades southward into outwash at a higher level.

One of the topographically important lake terraces associated with the Cuyahoga River valley is that along the west side of the Little Cuyahoga River valley south of the junction of the Little Cuyahoga and the Cuyahoga River and extending about 3 miles south into the central part of Akron. The surface of sand, sandy silt, and silt passes southward to a more hummocky surface of kame-terrace character. The origin of the whole series of lakes that existed in the Cuyahoga River valley during various times during the Pleistocene is described in more detail in the section on Pleistocene history.

### BOGS AND FLOODPLAINS

The surfaces of the extensive bogs in Summit County are distinctive features. The bogs were formed in depressions, generally kettle holes, that were originally lakes which became filled by organic matter, which is now peat or muck. All gradations may be seen from fairly deep lakes, such as the Portage Lakes and Silver Lake, to lakes which have a swampy marginal zone of vegetation, to former lakes now completely filled by organic matter. In times of heavy rainfall, bogs may become shallow lakes for a time, and at times of drought shallow lakes may become bogs. As the kettle holes are in valleys, streams flow from one kettle hole to the next. The distinction between filled kettle holes and stream floodplains is not made on plate 1; they are well distinguished on the detailed soil maps of Summit County (Ritchie and Steiger, 1974).

The largest bog is the well-known Copley Bog; remnants can be found in the valleys of Pigeon Creek and Wolf Creek in southeastern Copley Township and to the northwest in the Shockalog Run valley in northeastern Copley Township. The bogs, especially the Copley Bog, are the sites of market gardens, in which specialized crops are grown. The bog soils and their uses are discussed by Ritchie and Steiger (1974, p. 5-6, 7).

Floodplains are more or less level tracts in the bottoms of the valleys. Some streams have cut down below the level of the alluvial deposits, which are now preserved as terraces along the valley sides. The streams meander across the floodplains and change their courses from time to time, leaving poorly drained crescentic depressions, which are especially obvious on air photos. In times of heavy rainfall and high water, the streams overflow the floodplains and terraces. Above the floodplains may be higher terraces of valley-train outwash. The soils and general character of the floodplains are discussed in Ritchie and Steiger (1974, p. 6).

## PLEISTOCENE STRATIGRAPHY

Four major glacial stages of the Pleistocene Epoch, separated by warmer interglacial intervals, are generally recognized in the central United States. These divisions, their representation in Summit County, and the postglacial episode are shown in table 1.

The ice which advanced into Ohio several times during the Pleistocene Epoch directly deposited till, an unsorted mixture of clay, silt, sand, pebbles, cobbles, and boulders.

TABLE 1.—*Glacial stages of the Pleistocene Epoch*

| Epoch | Glacial and interglacial stages | Deposit in Summit County |
|---|---|---|
| Holocene (Recent) | | Stream deposits (alluvium); swamp deposits (peat, muck) |
| Pleistocene | Wisconsinan | Most drift of Summit County; several divisions, see table 2 |
| | Sangamonian | Period of weathering and erosion; rare buried soils (paleosols) |
| | Illinoian | Some lower tills are probably of this age |
| | Yarmouthian | Long period of weathering and erosion |
| | Kansan | None definitely identified in Summit County |
| | Aftonian | Period of weathering and erosion |
| | Nebraskan | None known in Summit County |

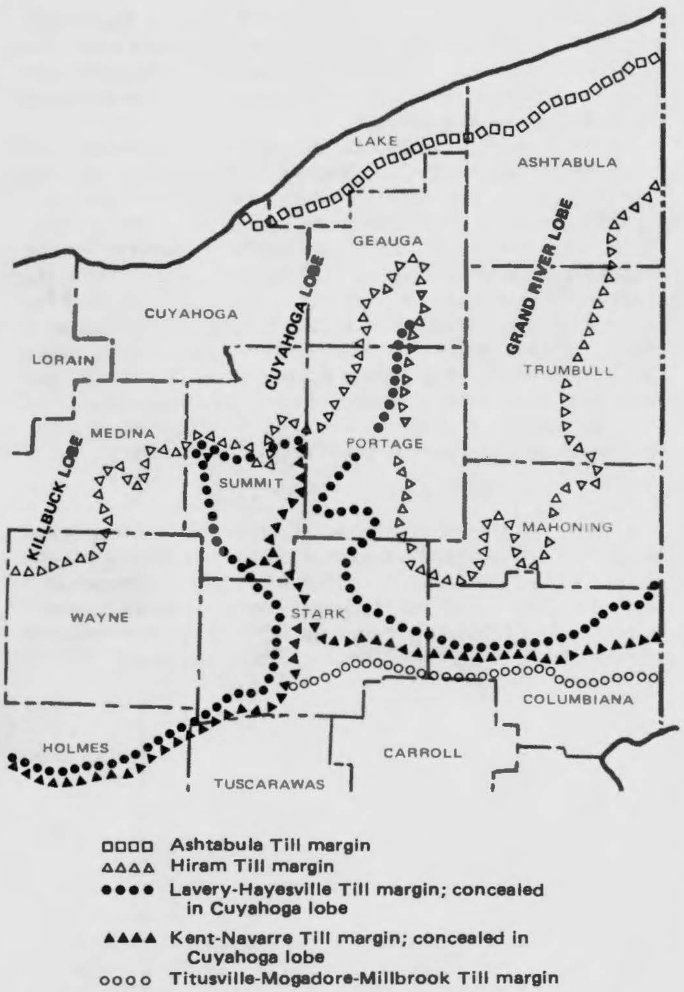



FIGURE 5.—Ice-sheet margins in northeastern Ohio. Lavery and Hayesville margins are approximate owing to the 5 to 10 miles of discontinuous drift extending beyond the continuous drift.

Water flowing from the melting ice carried some of the finer material a greater or lesser distance from the ice front. This meltwater-transported material was laid down as stratified and sorted outwash deposits, generally in the valleys in which the meltwater streams flowed.

During each advance, ice flowed southwest through the Erie basin from the Erie lobe into the lowlands south of Lake Erie (fig. 3). The extent of the ice in Summit County at different times is shown on figures 5 and 6.

## CHARACTER AND COMPOSITION OF THE TILL

The various tills in northeastern Ohio differ among themselves in texture, mineralogic and lithologic composition, color, and weathering horizons. These characters are dealt with in more or less detail in published reports describing the glacial geology of the Allegheny Plateau in general (White, 1969), northeastern Ohio (White, 1982), and individual counties—Ashland (White, 1977), Ashtabula (White and Totten, 1979), Lake (White, 1980), Portage (Winslow and White, 1966), Richland (Totten, 1973), Stark (DeLong and White, 1963), Trumbull (White, 1971b), and Wayne (White, 1967b). Manuscripts have been completed and are awaiting publication by the Division of Geological Survey for Columbiana (White and Totten), Cuyahoga (J. P. Ford), Geauga (Totten), Lorain (Totten), Mahoning (Totten and White), and Medina (Totten) Counties.

In Summit County, tills of the four latest ice advances form the surface drift; at places where a later till is thin or missing, an earlier till may be exposed at the surface in small areas. Earlier tills are exposed in a few ravines and excavations. The thickest drift is present in the deep bedrock valleys. The till of the uplands is thin in most places. The stratigraphy and characteristics of the tills in Summit County are unusually varied and complicated because they were deposited by three different lobes and at different times.

### TEXTURE

Tills in northern Ohio range from quite sandy tills with low clay content to clayey tills with low sand content. The texture of each till is reasonably constant over a large area. The tills at the surface in northern Summit County are clayey or silty with few cobbles and rare boulders, but some sandy till is found below these fine-grained tills. The tills in southern Summit County are generally coarse and sandy, with cobbles and boulders. The statistical analyses of till textures in Stark County (DeLong and White, 1963, p. 132-147), adjacent to Summit County, are applicable to Summit County tills.

### MINERAL COMPOSITION

Tills differ in content of quartz, feldspar, and carbonate minerals. The quartz and feldspar contents of Summit County tills have not been investigated, but some assumptions can be made on the basis of the percentage of these minerals in the tills of adjacent areas, where quartz ranges from 68 to 94 percent, being highest in the older tills, and feldspar ranges from 6 to 32 percent, being highest in the youngest tills (Gross and Moran, 1971). The carbonate content of Summit County tills ranges from less than 1 percent to more than 15 percent and is composed of both calcite and dolomite.

### COLOR

Unaltered tills are various shades of gray. Exposures of unoxidized till may be seen along steep valley walls and in deep excavations. The oxidized tills are brown in color, ranging from dark brown to dark yellow brown to yellowish brown to olive brown. The oxidized tills of northern Summit County are generally dark brown, tending toward chocolate brown. The oxidized tills of southern Summit County are yellow brown or olive brown.

### WEATHERING HORIZONS

Where the upper part of a till has not been removed by erosion or the work of man, tills can be divided vertically into five distinct horizons, based on degree of weathering, as shown in figure 7. In the weathering of till the first minerals to be attacked are the iron-bearing minerals, especially pyrite. These are oxidized, furnishing the brown color to the weathered till. Carbonates are leached, and the most resistant minerals, the silicates, are degraded.

Horizon 5 is the unaltered till; the iron-bearing minerals have not been oxidized, and the carbonates have not been leached. This horizon is sometimes called "blue clay with stones," but the color is actually some shade of gray rather than blue. Its top is 8 to 18 feet below the surface.

Horizon 4 is calcareous till similar to that of horizon 5, except it is oxidized to a brown color. The top of horizon 4 is also the depth of leaching, which ranges from less than 2½ feet below the surface in the Hiram Till to as much as 8 feet in the Mogadore Till.

Horizon 3 is similar to horizon 4, except that in horizon 3 the carbonates have been leached. Iron oxide and manganese stains may be present along the joints.

Horizon 2 (essentially the B3 horizon of soil scientists) is the zone of decomposed till underlying the main part of the true soil. This horizon is not only oxidized and leached, but is also considerably weathered, and some of the pebbles and cobbles may have been decomposed. Some clay material has accumulated in the joints, and soil-forming processes are advanced. The material is not so completely weathered, however, that it cannot be identified as having once been till. The color of the upper part is generally 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 β soil horizons of soil scientists. The characteristics of the soil differ with drainage and slope, as well as with parent material. The soils of Summit County are dealt with in great detail in Ritchie and Steiger (1974).

## TILL DEPOSITS

The greatest bulk of the glacial deposits of Summit County is of the Wisconsinan Stage, the latest stage in glacial history (table 1). However, at places below the Wisconsinan tills is found thin, much-weathered, very coarse till. Deposits of the several advances of the Wisconsinan ice are sufficiently distinctive to be separated in the exposures where they may be seen (figs. 8-12, 14).

It is to be expected that, in any very large exposure showing considerable thickness of glacial material, the glacial material will have been deposited by more than one ice advance and will differ more or less in character. The Hiram ice sheet, the last to invade northern Summit County, may have deposited little or no till in some places, so that the surface till is not Hiram, but the earlier Lavery Till. If the Lavery Till is very thin, even earlier till may be very close to the surface and will be encountered in excavations. The tills of the three lobes, Grand River, Killbuck, and Cuyahoga, have been given separate rock-stratigraphic (formation) names, for reasons explained later (see p. 13). The correlation of tills between lobes is shown in table 2.

## PRE-WISCONSINAN TILLS

At several places in Summit County, till occurs below Mogadore Till (early Wisconsinan). At other places, till of a character different from the Mogadore Till is exposed in a situation that permits interpretation of a pre-Mogadore and thus possible Illinoian or even earlier age for the material.

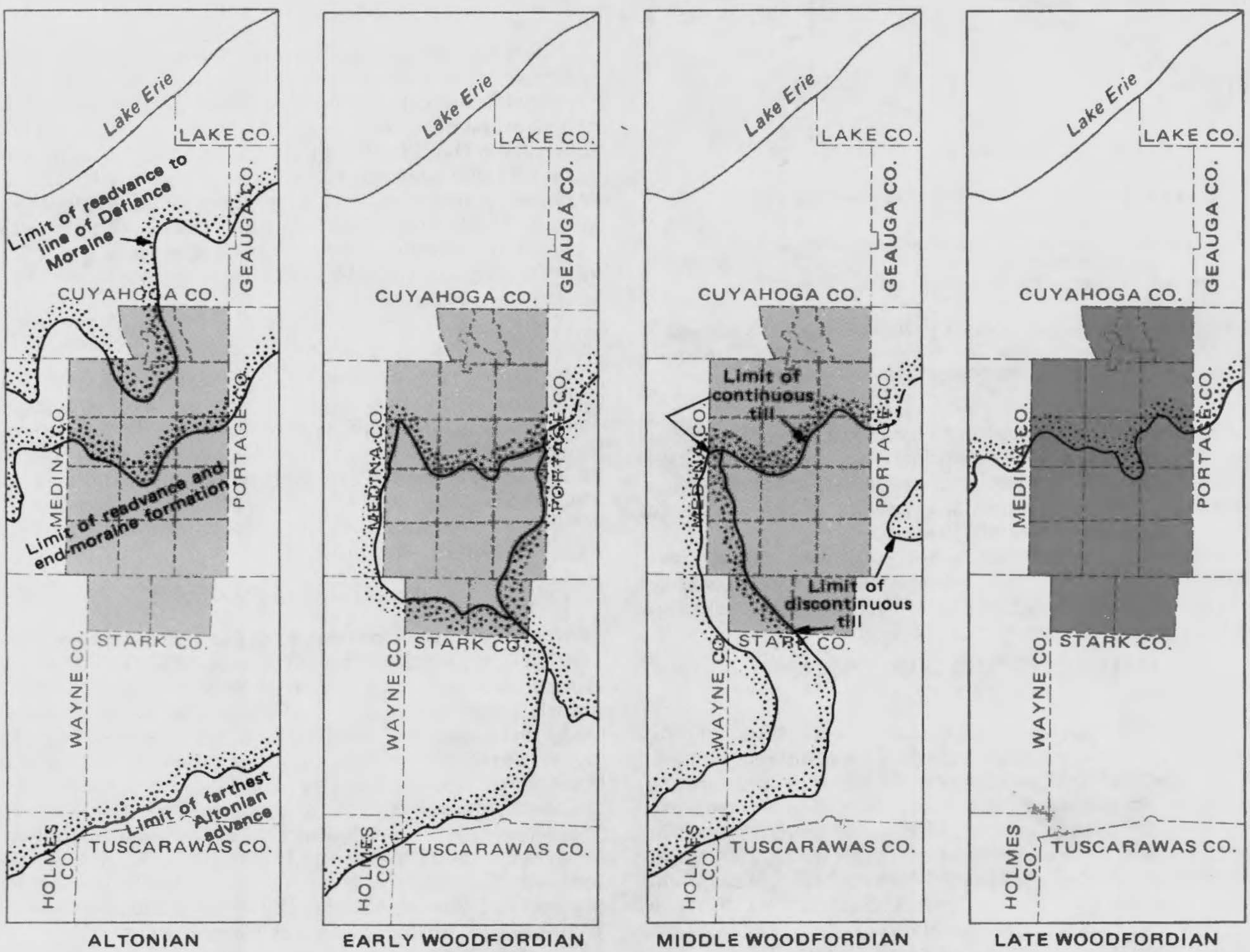



FIGURE 6.—Successive ice margins in Summit County and surrounding counties. Altonian drift is covered by later tills except in central and southern Summit County. Note the ice-free area in southern Summit County during Early Woodfordian time and the position of the Cuyahoga lobe.

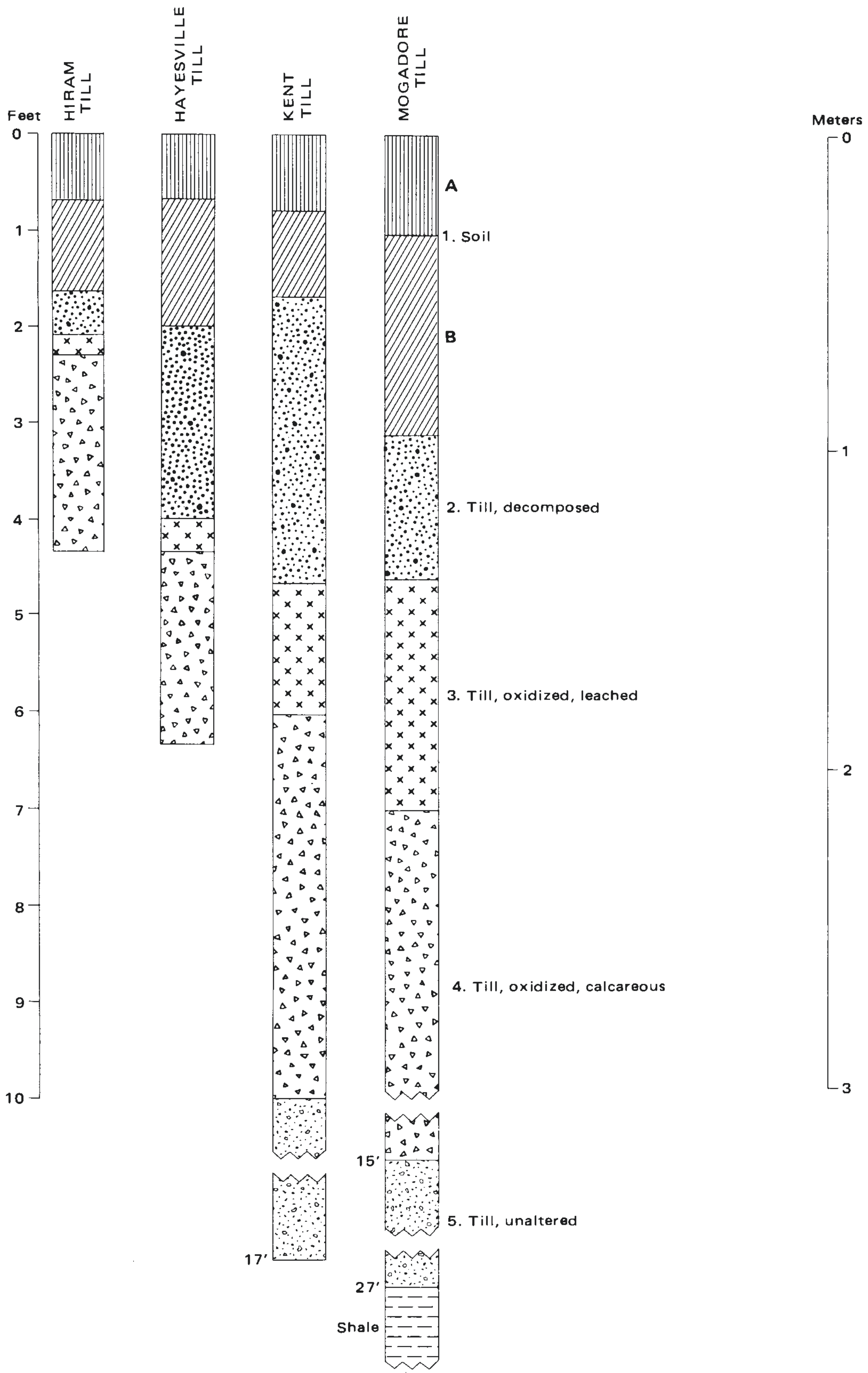



FIGURE 7.—Weathering horizons of tills in Summit County. Mogadore Till from shale pit 1 mile west of Mogadore (type section). Kent Till from excavation for Ohio Route 2, 2 miles east of Stow Township line. Hayesville Till from roadcut on Ohio Route 18, ½ mile west of Bath-Copley Township corner. Hiram Till from roadcut on east line of Stow Township 2 miles south of north line.

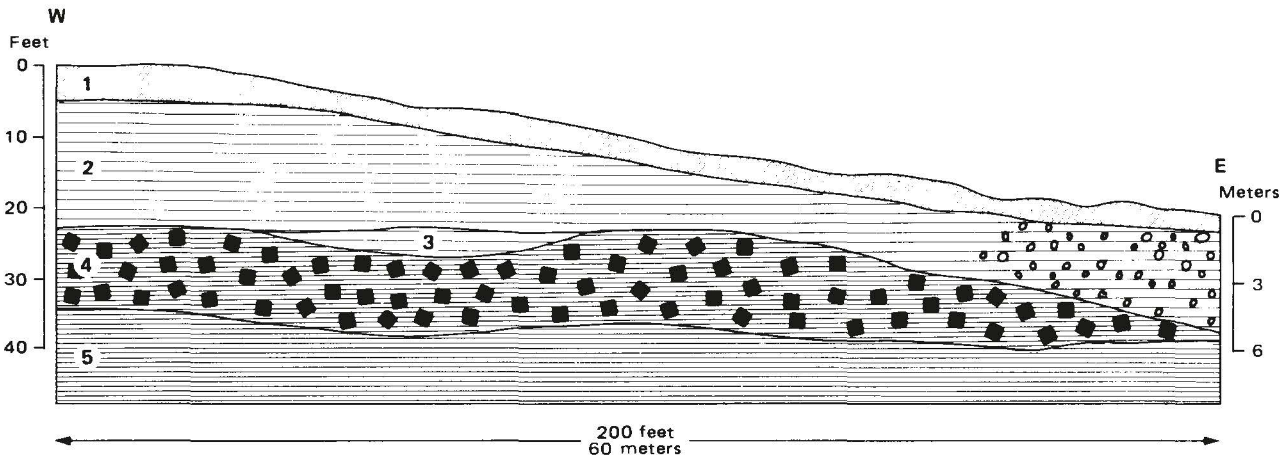
TABLE 2.—*Correlation of tills in northeastern Ohio*

| | | | | | |
|---|---|---|---|---|---|
| WISCONSINAN | WOODFORDIAN | *Erie lobe:* Ashtabula Till | | | |
| | | *Scioto lobe* | *Killbuck lobe* | *Cuyahoga lobe* | *Grand River lobe* |
| | | Centerburg Till<br>Mt. Liberty Till<br>Knox Lake Till | Hiram Till<br>Hayesville Till<br>Navarre Till | Hiram Till<br>Lavery Till<br>(concealed) | Hiram Till<br>Lavery Till<br>Kent Till |
| | FARMDALIAN | Paleosol | | | |
| | ALTONIAN | Jelloway Till | Millbrook Till | Mogadore Till | Titusville Till |
| SANGAMONIAN | | Paleosol | | | |
| ILLINOIAN | | Butler Till | unnamed till | unnamed till | Mapledale Till<br>(subsurface only) |

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 noncalcareous or 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. The oxidized till ranges from yellow brown to olive brown. Joints are prominent and strong rusty stains coat the joint faces.

Till of this character is exposed in an excavation on Gilchrist Road in East Akron (fig. 8) and in the base of the pit of Rubber City Sand and Gravel Co. in Green Township (fig. 9). Similar coarse till is exposed in the base of the Alden gravel pit in Northampton Township (fig. 10). This coarse stony till resembles the Mapledale Till of northwestern Pennsylvania (White, Totten and Gross, 1969, p. 15), which has been traced into Columbiana County, Ohio, by White and Totten (in manuscript).

A pre-Mogadore till of a character different from the coarse Mapledale Till was observed at a very few places in Summit County. Very silty calcareous yellow to olive-brown till was exposed in an excavation for U.S. Route 224 (I-76) northwest of Barberton (fig. 11). This till underlay a paleosol below Mogadore Till. The relation of this silty till to Mapledale Till is uncertain.




1. Soil and weathered till
2. Till, yellow-brown to olive-brown, sandy; grades into cobby gravel to east. MOGADORE
3. Till, bright-gray, sandy, coarse, calcareous. MOGADORE
4. Till, almost all sandstone blocks. MAPLEDALE
5. Till, brownish-gray, sandy, fresh but noncalcareous. MAPLEDALE

FIGURE 8.—Section exposed in excavation for parking lot on the north side of Gilchrist Rd. just west of the I-76 underpass, East Akron, 2½ miles north-northwest of Mogadore.

## EARLY WISCONSINAN (ALTONIAN) DEPOSITS

The presence of drift older than Woodfordian (late Wisconsinan)—sometimes called "Classical Wisconsinan"—was first recognized in northeastern Ohio and in the southern half of Summit County. It was first called "Tazewell," and the age assignment was "early Wisconsin-Tazewell" (Smith and White, 1953, p. 18). The type section for the Mogadore Till was an excellent exposure above the bedrock in the shale pit of Universal Clay Products Corp. in Springfield Township 1 mile west of the center of Mogadore. This till was recognized in the subsurface in adjacent counties (White, 1960, p. 84).

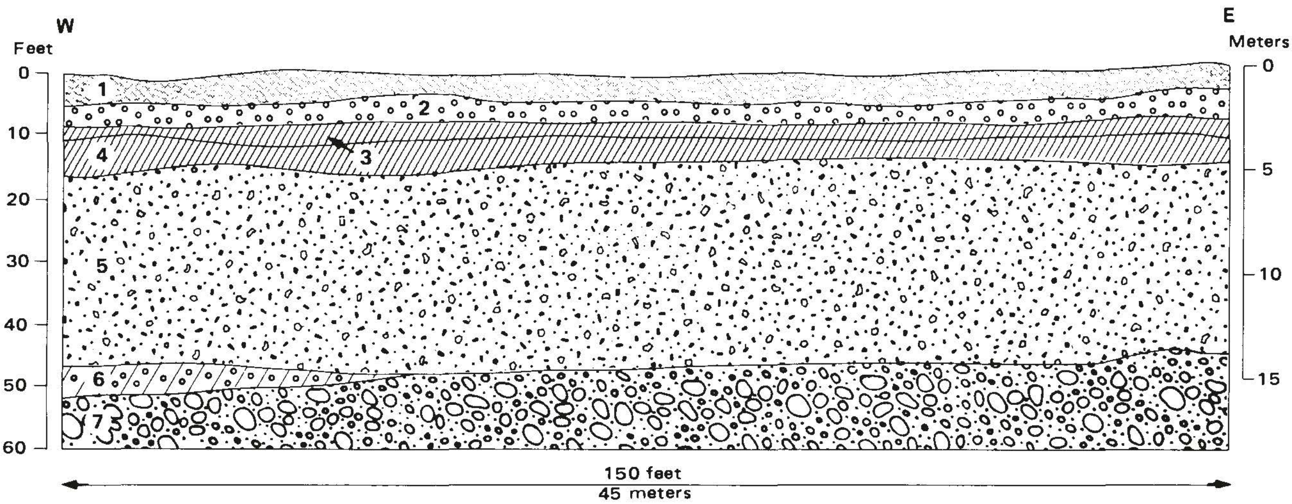
Work in the Grand River lobe in northwestern Pennsylvania, more than 100 miles east and northeast of Summit County, Ohio, disclosed the presence of a belt of older till, which was at first called "Inner Illinoian" (Shepps and others, 1959). Still older till in a belt to the east was called "Outer Illinoian." It was definitely much more eroded and weathered than the Wisconsinan till to the west. The till called "Inner Illinoian" was named "Titusville" for the type section near Titusville, Pennsylvania (White and Totten, 1965). Wood found in association with this till had a carbon-14 date of about 40,000 years (White, Totten, and Gross, 1969, p. 30). This date showed that the Titusville Till was of Wisconsinan age rather than Illinoian and was correlative in age with Altonian-age tills in Illinois. It was suspected that the Titusville Till was correlative with the Mogadore Till in Summit County, but the distance between these areas was so great that the separate rock-stratigraphic name was preferred.

Later work in northwestern Pennsylvania (White, Totten, and Gross, 1969) showed that throughout most of the area in which the surface material was Woodfordian drift, the Titusville Till actually composed the major part of the drift column. The extension of the field study from western Pennsylvania into eastern Ohio showed that Titusville Till could be traced into Trumbull, Mahoning, and Columbiana Counties (White, 1971b; Totten and White, White and Totten, in manuscript). The Titusville Till was traced farther west from these counties into Stark and Portage Counties, where it became evident that the Mogadore Till traced from the outcrop eastward was indeed the same as Titusville.

Work in Ashland and Wayne Counties (White, 1977, 1967b) in the Killbuck lobe disclosed the general presence of a coarse sandy till older than tills of Woodfordian age. This till was believed to be correlative to the Mogadore Till, but had not yet been traced in the subsurface. The till was called "Millbrook," for Millbrook, Plain Township, Wayne County (White, 1961). Later work confirmed the suspicion that the Millbrook Till was traceable eastward to Summit County and was indeed correlative with the Mogadore Till.

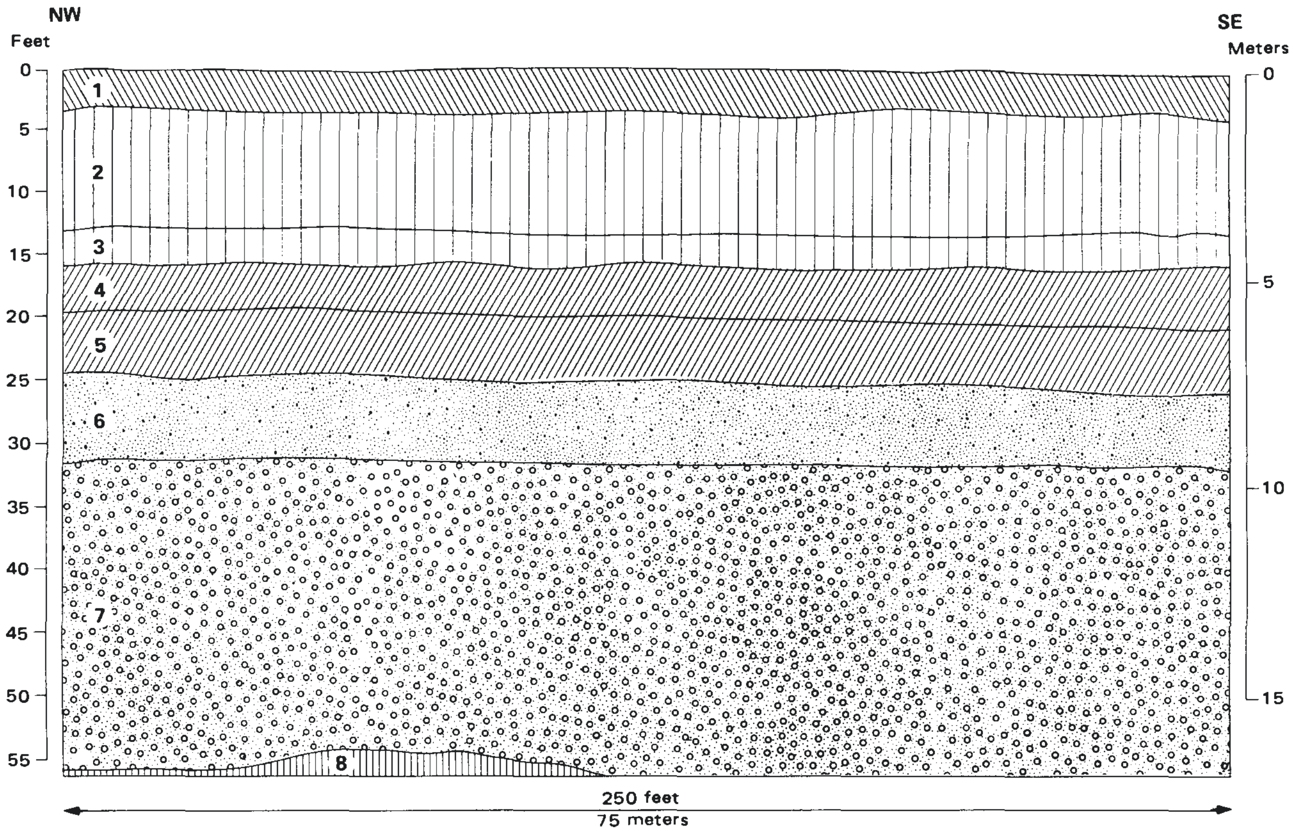
Inasmuch as tills of the same approximate age in different lobes may be somewhat different in composition and may not be strictly synchronous in deposition, Pleistocene stratigraphers generally prefer to use different rock-stratigraphic names in different lobes, but to point out the correlative terms in other lobes. Although the term "Titusville" has now assumed wide usage in Pleistocene stratigraphic literature, it is actually a term applicable to Altonian-age till in the Grand River lobe. As the Altonian-age till in Summit County is between the Grand River lobe and the Killbuck lobe, the name Mogadore Till will be used for the Summit County till correlative with Titusville Till on the east and Millbrook Till on the west.

The earlier uncertainty of correlation is well illustrated by the assignment of the outermost narrow belt of older drift (the "fringe drift") in Columbiana and Stark Counties to an Illinoian age (White, 1951; 1960, p. 82, fig. 1). At that time there was no thought of correlating this till with the coarser till of Summit County later named the Mogadore Till. In 1960 and later, the Titusville Till was traced on the surface from its outcrop near Titusville, Pennsylvania, showing that the



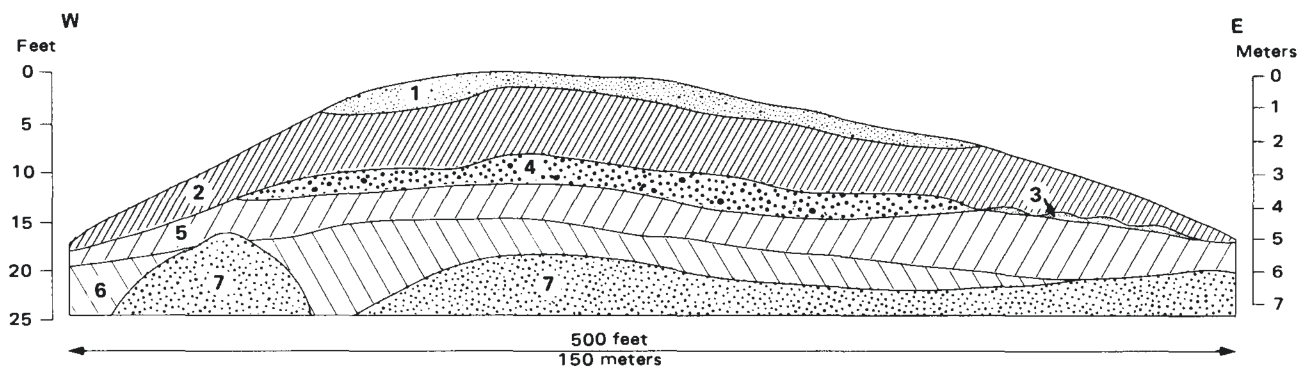

1. Soil and weathered yellow-brown till with gravel streaks. KENT
2. Gravel, brown, coarse, loose. KENT
3. Till, brown, rusty, hard, noncalcareous. MOGADORE
4. Till, gray, hard, stony, moderately calcareous. MOGADORE
5. Gravel, gray, calcareous, evenly bedded in part, in part cut-and-fill bedded, in part "kame bedded." MOGADORE
6. Till, dark-olive-gray, pebbly, very slowly calcareous
7. Gravel, brown, cobbly, with some boulders, slowly calcareous

FIGURE 9.—Section exposed in pit of Rubber City Sand and Gravel Co. in northeastern Green Township, ½ mile north of Myersville and 1 mile west-northwest of Uniontown.




1. Till, dark-brown, clayey, very few pebbles, leached 1 ft 10 inches. HIRAM
2. Till, brown, silty, coarser than above, calcareous, 1- to 2-inch rusty zone at top. LAVERY
3. Till, as above, gray. LAVERY
4. Till, olive-brown, hard, coarse, stained; 2-inch layer of hard, brown, calcareous silt at top. MOGADORE
5. Till, as above, gray, sandy. MOGADORE
6. Silt, brown; bedding "curled" and twisted; lower part gray, sandy, with some pebbles; sharp contact at base
7. Gravel, coarse to sandy, calcareous; 6 inches of very hard cemented gravel at top
8. Till, gray, coarse, very weakly calcareous; may not be continuous. MAPLEDALE(?)

FIGURE 10.—Section exposed in R. A. Alden gravel pit, 1.1 miles south of Northampton Center.




1. Silt, loessial
2. Till, coarse, stony, weathered. MOGADORE
3. Silt loam, dark-reddish-brown; old soil, on discontinuous much-weathered sandy till, 0 to 1 ft
4. Gravel and sand, leached
5. Till, very silty, yellow to olive-brown, calcareous, except upper 1 ft; 21% sand, 57% silt, 22% clay
6. Till, silty, gray, calcareous; 16% sand, 67% silt, 17% clay
7. Sand and fine gravel, calcareous

FIGURE 11.—Section exposed on south side of excavation for relocation of U.S. Route 224 (I-76) 0.2 mile east of interchange with Cleveland-Massillon Rd. and 2 miles northwest of Barberton City Hall.

fringe drift in Columbiana and Stark Counties, Ohio, was Titusville Till of early Wisconsinan age and not Illinoian. Inasmuch as the correlation was made by tracing from Titusville into Ohio, that name has been retained in county reports for this till in the Grand River lobe in Ohio (White, 1971b, 1980; White and Totten, 1979).

### Mogadore Till

*Location and extent.*—The Mogadore Till is the surface material in most of the southern half of Summit County (pl. 1). Small thin patches of silty clayey Hayesville Till overlie the Mogadore Till in western Copley, Norton, and Franklin Townships, but these areas are so inconspicuous that the surface material is over 95 percent (probably 99 percent) coarse Mogadore Till. In easternmost and southernmost Summit County, respectively, the Kent and Navarre Tills are at the surface. Again, however, these tills are thin and Mogadore Till composes most of the surface material.

North of the surface outcrop the Mogadore Till continues throughout the northern half of the county and constitutes the main bulk of the drift in most places. The Titusville Till of the Grand River lobe has a median thickness of 16 feet (White, 1971a). The Mogadore Till in Summit County appears to have a similar thickness, which is more than three times the median thickness of the Kent Till and four times the median thickness of the Lavery and Hiram Tills.

*Composition.*—The Mogadore Till is a coarse sandy stony till; it is very hard and compact and picks with some difficulty. The matrix retains the imprint of pebbles after they have been removed. At the type locality the Mogadore Till contains 60 percent sand and 13 percent clay, but at most places the sand content is generally not over 50 percent and the clay content not much less than 19 percent.

From the few data available, the feldspar content is about 10 percent and quartz about 90 percent. It is probable that the feldspar content decreases and the quartz content increases from north to south (Gross and Moran, 1971, fig. 2). The Mogadore Till contains enough carbonate to react visibly with hydrochloric acid. From the few data available, the carbonate content is about 4 percent.

*Weathering character.*—The weathering horizons of Mogadore Till are shown in figure 7. Unweathered Mogadore Till is olive gray. Oxidation has penetrated along the joints and horizontal partings in the upper part of the gray till. The upper part of the Mogadore Till is oxidized to an olive-brown color with conspicuous darker stains along the joints and around pebbles. The olive-brown oxidized Mogadore Till contrasts with the yellow-brown Kent Till and the dark-brown Lavery and Hiram Tills. The depth of leaching is variable; at the type locality it is 6 feet 10 inches, but elsewhere the depth of leaching ranges from 6 to 9 feet. Weathering of the Mogadore Till yields a well-drained friable soil of the Wooster Series in well-drained locations, the Canfield Series in moderately well drained locations, and the Ravenna Series in poorly drained locations (Ritchie and Steiger, 1974).

In the northern part of the county, where later tills overlie Mogadore Till, truncated weathering profiles are present in a few places, but no complete paleosol has been discovered. At a few places below later tills, the upper part of the Mogadore Till is a very hard red-brown clay loam, the lower part of which contains many fragments of sandstone and siltstone (channers). This material has been seen in several counties in Ohio and Pennsylvania and is a distinctive feature when present (see White, 1967b, p. 21).

*Stratigraphic position.*—The Mogadore Till is underlain by Mapledale Till in a very few places (fig. 8) but more generally by bedrock. In some places in northern and eastern Summit County the Mogadore Till is overlain by Kent Till; in other places the Kent Till is thin or missing and the Lavery Till lies directly on Mogadore Till. At perhaps half or more of the outcrops in northern Summit County the material directly overlying the Mogadore Till is Lavery Till. In the western part of the county small thin patches of Hayesville Till overlie the Mogadore Till, and in the southernmost part of the county thin Navarre Till is at the surface.

*Age and correlation.*—The age of the Mogadore Till is based on its correlation with the Titusville Till. The age of the Titusville Till determined from carbon-14 analyses of peat associated with the till at Titusville is about 40,000 years (White, Totten, and Gross, 1969, p. 30). It is therefore Altonian—early Wisconsinan—in age. Mogadore Till is correlative with the Millbrook Till of the Killbuck lobe (White, 1967b; Totten, 1973) and the Jelloway Till of the Scioto lobe (Totten, 1973).

The Titusville Till at Titusville is very close to the outer margin of this drift. The Mogadore Till is 20-30 miles north of the outer margin of the Titusville Till in Stark County, so that age assumption based on the Titusville determination can be only approximate.

The Titusville-Mogadore-Millbrook episode of glaciation produced two contrasting types of deposits. South of a line at the southernmost margin of a series of end moraines, a little north of the middle of Summit County (fig. 6, Altonian), the deposits consist of ground moraine on most uplands and areas of thicker drift of hummocky topography along valley sides. These areas have no linear trends. The valleys are occupied in part by kames and kame terraces. The Mogadore drift is markedly hummocky in the southern part of the county, where the deposits consist of a high proportion of gravel aggregated in a conspicuous kame moraine (Buck Hill and Kent Moraines). North of the end-moraine line in Summit County and in all the counties to the west of Summit County, the type of deposit is much different; the Titusville-Mogadore-Millbrook drift is aggregated in a series of linear belts or end moraines. The belts are discrete and obvious as separate entities to the west, but in central and eastern Medina County and in Summit County these belts are compressed into a confused aggregate, producing a belt of hummocky topography 5 to 8 miles wide. In extreme northern Summit County the Defiance Moraine is a separate, definable end moraine. This part of the county has clayey-silty Hiram Till, clayey Lavery Till, and in places thin sandy Kent Till over the Mogadore drift. This belt represents a readvance of the Titusville-Mogadore-Millbrook ice and a different style of deposition from the earlier one. How much time intervened between the two episodes is not known.

### Mogadore outwash

As shown on plate 1, a high proportion of the southern half of Summit County consists of kame deposits mostly of Mogadore age. The topography of these areas has already been described. Some of the major areas of these great deposits of gravel are along the Tuscarawas River in Springfield, Coventry, and Norton Townships and in the great depression south of the Tuscarawas River extending to the Stark County line, including the Portage Lakes area. Other large deposits extend northwest from Springfield Lake along the Little Cuyahoga and Cuyahoga River valleys and from the Summit-Portage County line west and northwest to Silver and Crystal Lakes. Another large area extends from Barberton north and northwest into Copley and southern Bath Townships. Large areas of Mogadore-age kames are buried beneath later drift in Bath, Northampton, northern

Stow, and southern Hudson Townships. In the latter two townships the kames are either at the surface or the overlying till is very thin.

### Mogadore-age valley trains

In the lower parts of some of the valleys, particularly the Tuscarawas River valley south of Barberton, parts of the Portage Lakes lowland, and the lowlands surrounding the Copley Bog, deposits of sand and some gravel are present. Some of these deposits are those of the last melting phase of Mogadore ice, when meltwater flowed southward. However, some of the material is of later age, when the Kent, Lavery, and Hiram ice sheets were disappearing. Some of the material mapped as outwash, especially in Copley Township and in west Akron, was deposited in very shallow lakes formed in the last stage of glaciation.

## LATE WISCONSINAN (WOODFORDIAN) DEPOSITS

### Kent Till

*Location and extent.*—The Kent Till, which has a high proportion of gravel, is the surface till along the extreme eastern margin of the county in southeastern Stow, eastern Tallmadge, eastern and southern Springfield, and eastern Green Townships. This drift is the western margin of the Grand River lobe (figs. 3, 6). The Kent Till is present beneath the later Hiram and Lavery Tills in almost all of the northern half of Summit County, but its exact southern extent in the subsurface is unknown. It is probably very close to the outer margin of the Lavery and Hiram Tills (fig. 6).

The Kent Till is generally thin and not everywhere present, so that the underlying Mogadore drift is at or very close to the surface.

*Composition.*—The Kent Till is sandy and pebbly to stony. It contains more sand than clay, but not quite as much sand as the Mogadore Till. The Kent Till is mealy and not nearly as hard as the Mogadore Till. The feldspar content of the few available samples of Kent Till is slightly higher than that of the Mogadore Till; the quartz content is therefore lower.

*Weathering character.*—The Kent Till is seldom thick enough to preserve unweathered and unoxidized till, and weathering generally has extended through the Kent Till into the underlying Mogadore Till. The contact between the two oxidized tills is shown by the contrast of the yellow-brown Kent Till with the olive-brown Mogadore Till and the much greater hardness of the Mogadore Till. The depth of leaching of the Kent Till is generally between 5 and 6 feet (fig. 7).

*Stratigraphic position.*—The Kent Till is underlain by Mogadore Till and Mogadore gravel (fig. 9). In the northern half of Summit County, where the Kent Till was a deposit of the small Cuyahoga lobe, the Kent Till appears to be less gravelly and quite discontinuous.

*Age and correlation.*—The Kent Till has been traced from its type locality at Kent, Portage County, a few miles east of Summit County (White, 1960, p. 5), to its margin in Summit County. It is correlated with the Navarre Till of the Killbuck lobe. The Kent Till has a probable age of about 24,000 years at Cleveland (White, 1968, p. 750).

### Kent outwash

Much of the Kent drift was deposited by meltwater near the edge of the ice. Inasmuch as the Kent outwash was deposited over the underlying Mogadore gravels, the distinction between the two is not always clear. Generally, however, the Kent gravel is visibly much thinner than the Mogadore gravel and generally more rubbly and not as cleanly washed.

### Navarre Till

The Navarre Till of the Killbuck lobe is present in a narrow belt in southern Franklin and southwestern Green Townships (pl. 1; fig. 6) and is correlative to the Kent Till of the Grand River lobe (White, 1961). The Navarre Till is very similar to the Kent Till and therefore need not be specifically described.

### Lavery Till

*Location and extent.*—The Lavery Till has been traced from its type locality at Lavery, Pennsylvania (Shepps and others, 1959, p. 38), across the Grand River lobe in northwestern Pennsylvania and eastern Ohio. The Lavery Till of northern Summit County is actually a deposit of the Cuyahoga lobe, but is clearly related to the Lavery Till of the Grand River lobe. The Lavery Till is largely a subsurface unit in Summit County, but is at the surface in a small area in northern Stow Township (pl. 1).

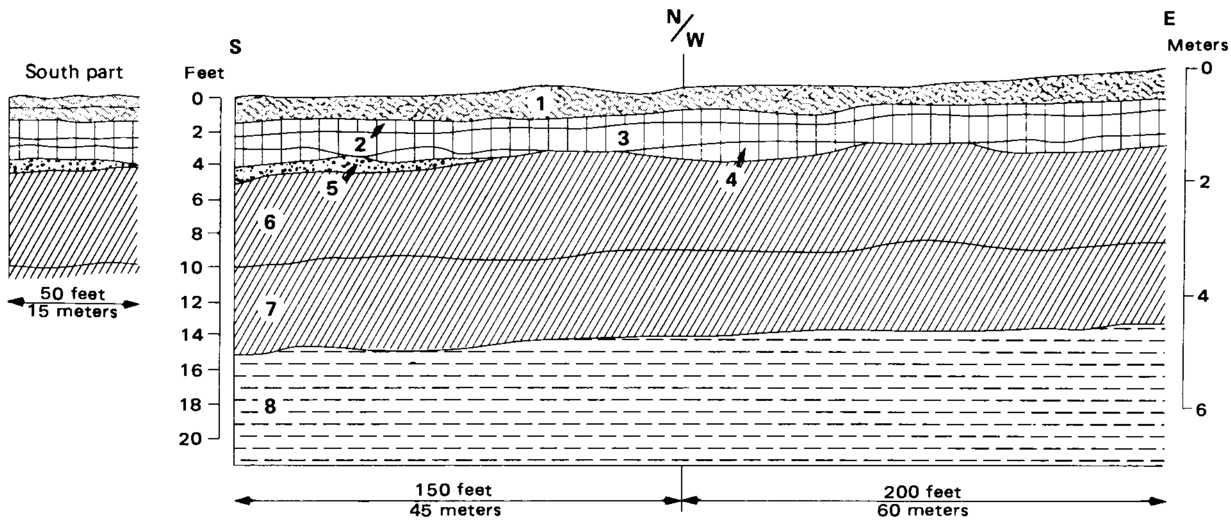
An unusual feature of the Lavery Till of the Grand River lobe is the presence of a belt about 3 miles to almost 10 miles beyond the continuous Lavery Till in which the Lavery Till consists of widely scattered, very small, and very thin patches. These areas are so inconspicuous that many of them do not even appear on the soil maps. The area of continuous Lavery Till in the western part of the Grand River lobe is east of Summit County in Portage County, but scattered tiny patches of Lavery Till extend beyond the margin of continuous Lavery about 1 mile into Summit County near Mogadore, where a small thin deposit of Lavery Till overlies Mogadore Till (fig. 12). This area is not shown on plate 1 because its extent is so small.

*Composition.*—The Lavery Till is a clayey-silty till and in general contains about 30 percent sand and 28 percent clay. It is sparingly pebbly and contains only a few cobbles and boulders, in marked contrast to the older Kent and Mogadore Tills. A high proportion of the pebbles in the Lavery Till are flat, angular pieces of shale and siltstone. On weathered banks the concentration of these pebbles is noticeable, giving the impression that the till is far more pebbly than is actually the case.

The feldspar content of the Lavery Till is higher than that of the Mogadore and Kent Tills, but is lower than that of the Hiram Till. In adjacent counties, the feldspar content is about 28 percent and the quartz content about 72 percent (Totten, 1960); it is probable that the quartz and feldspar content of Lavery Till in Summit County is similar. The Lavery Till is markedly calcareous.

*Weathering character.*—Unweathered Lavery Till is dark gray; weathered Lavery Till is dark brown, in contrast to the yellow-brown oxidized Kent Till and olive-brown oxidized Mogadore Till. The depth of leaching of the Lavery Till is generally about 3½ feet, but ranges from 3 feet to a little more than 4 feet. Just at the base of the leached till a zone of calcite accumulation extends 1 to 3 inches into the top of the calcareous till. The accumulation is highest along the joints. On the surface of a bank which intersects this zone of concentration the calcite appears as very irregular, rather flat, small, hard, white or gray concretions, which look like small gray pebbles and which may be mistaken for shale fragments. Farther back in the bank, these calcite concentrations are soft and almost clayey, rather than hard crystalline fragments, as they are at the surface.

The soils developed in the Lavery Till are the Rittman silt loam in moderately well drained areas and the Wadsworth




1. Soil; dark-gray silt loam in upper 8 inches; yellow and gray mottled clayey silt loam in lower 10 inches
2. Till, very much weathered. LAVERY
3. Till, dark-brown, some gray stains, silty, few pebbles. LAVERY
4. Till, dark-brown, silty, weakly calcareous. LAVERY
5. Paleosol, cobbly, channery, rusty, hard. "Pedisediment"
6. Till, yellow-brown, sandy, very weakly calcareous. MOGADORE
7. Till, gray, sandy, calcareous. MOGADORE
8. Shale

FIGURE 12.—Section exposed on north end and south wall of inactive shale pit of U.S. Concrete Pipe Co. (formerly Robinson Clay Products Co.), northwestern Mogadore.

silt loam in somewhat poorly drained areas (Ritchie and Steiger, 1974).

*Stratigraphic position.*—The Lavery Till is underlain by the Kent Till, or where the Kent Till is missing, by the Mogadore Till (fig. 10). The contrast between the dark-brown Lavery Till and the yellow-brown Kent Till or olive-brown Mogadore Till is striking. The difference between the silty texture of the Lavery Till and the coarser texture of the lower tills is noticeable.

North of the area of outcrop the Lavery Till is overlain by the clayey Hiram Till. In many places the Hiram Till is very thin, in some places so thin that it is incorporated into the present soil, so that the Lavery Till is so close to the surface that the soils are Rittman-Wadsworth, rather than Ellsworth-Mahoning.

*Age and correlation.*—The Lavery Till has been traced from its type locality in Pennsylvania (Shepps and others, 1959, p. 38) on the surface and in the subsurface into Summit County. It is correlated with the Hayesville Till of the Killbuck lobe (White, 1961). Its exact age is not known, but it may be about 19,000 years.

### Lavery outwash

Lavery outwash is scanty and inconspicuous—only the most meager gravel deposits of this age were formed. A small amount of gravel at the county line in Twinsburg Township may be of Lavery age. South of the Lavery Till area, some of the silty material from Fairlawn south to Barberton may be of Lavery age.

### Hayesville Till

The Hayesville Till of the Killbuck lobe is correlative to the Lavery Till and has a similar character of two phases of deposition (fig. 6, Middle Woodfordian). The margin of the more or less continuous Hayesville Till is just east of the Medina-Summit County line in southwestern Bath and northwestern Copley Townships (pl. 1). In western Summit County in a belt 1 to 5 miles wide east of the margin of thicker Hayesville Till, scattered small patches of Hayesville Till are present. These areas are so discontinuous and so small that their presence was only recently discovered. Although the Hayesville ice of the Killbuck lobe actually extended along a line through Copley, Norton, and Franklin Townships, it had so little effect on the underlying Mogadore drift and on the Navarre drift in southern Franklin Township that the surface is composed primarily of these tills, and the soils are those appropriate to the Mogadore and Navarre Tills. The outer margin of discontinuous Hayesville Till is shown as a dashed line on plate 1, and, although the area west of the line is labelled as Hayesville, it must be kept in mind that the material is predominantly older, underlying till.

### Hiram Till

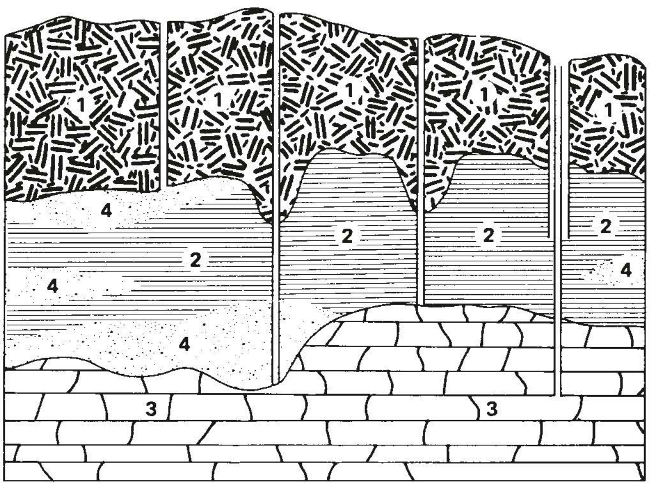
*Location and extent.*—The Hiram Till is present at the surface in the northern half of Summit County (pl. 1). The Hiram Till is generally thin (fig. 10) and not everywhere present, so that the underlying Lavery Till is at or very close to the surface. At some places the Hiram Till is so thin that it is incorporated into the present soil, so that the soil appears to have been formed from the Lavery Till. The thinness of Hiram Till in Summit County is similar to that reported by Totten (in manuscript) in nearby Medina and Lorain Counties, where the Hiram Till ranges from 0 to 5 feet thick, but is generally less than 3 feet thick.

*Composition.*—The Hiram Till is a silty clayey till with very few pebbles and rare cobbles and boulders. Detailed analyses from adjacent counties can be found in Winslow and White (1966, p. 34) and in Totten (Medina County manuscript). In the adjacent counties, the clay content of the Hiram Till is around 40 percent, and the sand content around 15 percent, the remainder being silt. The Hiram Till in Summit County appears to be similar in composition.

The feldspar content of the Hiram Till is the highest of all tills in Summit County. In northeastern Ohio, feldspar composes about one-third of the 0.125-0.177-mm size fraction of the Hiram Till, and quartz about two-thirds, giving a quartz/feldspar ratio of 2.1 (Totten, 1960, p. 15, 19-21). Two samples from Summit County had Q/F ratios of 1.8 and 2.1, respectively (Totten, 1960, pl. 4).

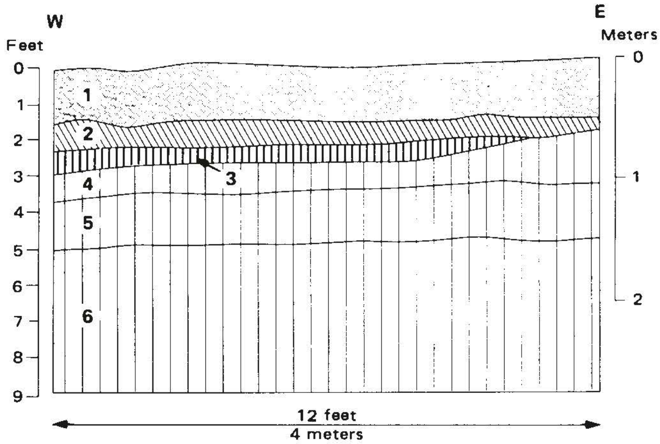
*Weathering character.*—Where the Hiram Till is thick enough to preserve unweathered material, the oxidized till is dark gray. However, the Hiram Till is generally thin and at many places weathering has extended through the Hiram Till into underlying till. Oxidized Hiram Till is dark brown, but with a slightly different tone from the dark brown of the Lavery Till. When these two tills are seen separately, it is difficult to identify them on the basis of weathered color, but when they are in contact, the difference is evident. Where they are in contact, the higher clay content of the Hiram Till contrasts with that of the Lavery. The depth of leaching of the Hiram Till is generally less than 3 feet, and it may be as little as 2 feet. It is generally leached about 12 inches less than the Lavery Till. The soils on the Hiram Till are the Ellsworth Series of silty clay loams in moderately well drained areas, the Mahoning Series in somewhat poorly drained areas, amd the Trumbull Series in poorly drained areas (Ritchie and Steiger, 1974).

The character of the weathering of clayey tills was recognized at least 100 years ago. Earlier, and to some extent even later, the oxidized brown ("yellow") upper part of the till was regarded as a different deposit from the unoxidized gray till below. The astute lawyer-naturalist-geologist M. C. Read of Hudson recognized (1880) that the upper part of clay till was weathered to a yellow color and below an irregular boundary was the unaltered gray till. He also noted the "joints" which are characteristic of the unoxidized and




1. Yellow clay, with many fragments of local and transported rocks
2. Blue clay, with similar rock fragments
3. Rock surface, in many places grooved and polished by the action of ice
4. Bands of sand and gravel, in patches, and most commonly found at the bottom of the clay

FIGURE 13.—"Succession of material" in "clay-drift" in northern Summit County (modified from Read, 1880, p. 491). Probably thin Hiram Till and underlying Lavery Till are included.




1. Soil and weathered till
2. Till, clayey, dark-brown (10YR 4/4), calcareous. HIRAM
3. Clay, very dark gray to black, noncalcareous except along joints (secondary $CaCO_3$); old swamp soil
4. Till, silty, brown and gray mottled, very weakly calcareous to noncalcareous. LAVERY
5. Till, silty, clayey, brown (10YR 3½-4), noncalcareous. LAVERY
6. Till, as above, except very calcareous. LAVERY

Elsewhere Lavery Till gray 9-10 ft below surface.

FIGURE 14.—Section exposed in northwest corner of shopping-center excavation at boundary of Covenant Church yard, 850 yds west of intersection of Ohio Routes 91 and 303 in Hudson.

oxidized clay tills of northern Summit County and which divide the lower part of the soil into small blocks. Read's illustration, figure 13 of this report, is a diagrammatic sketch of northern Summit County drifts, perhaps at a locality north of Hudson where the bedrock is close to the surface.

*Stratigraphic position.*—The Hiram Till is the uppermost till in Summit County. It is underlain by the Lavery (or Hayesville) Till (fig. 14). The only evidence of weathering in the interval between Lavery and Hiram deposition is an old swamp soil at Hudson (fig. 14).

*Age and correlation.*—The Hiram Till has been traced from its type locality in Portage County (White, 1960, p. A-8) eastward into Pennsylvania and westward into Summit County and thence west across Medina, Ashland, and Richland Counties. The Hiram Till is common to the Grand River, Cuyahoga, and Killbuck lobes, and can be traced on the surface continuously across the three lobes, in distinction to the earlier tills.

The Hiram Till is late Woodfordian in age; the Ashtabula Till of far northeastern Ohio is the only till in Ohio that is younger. The Hiram Till was deposited about 17,000 years ago.

### Hiram outwash

No gravel deposits of Hiram age have been positively identified. However, the meager sandy gravel in northern Twinsburg Township at the Summit-Cuyahoga County line may be partly Hiram outwash. This material is very sandy and largely composed of shale particles and is quite different from Kent and Mogadore outwash. The silt deposits in the level area south of Fairlawn in the western part of Akron and some of the silt deposits in the Shockalog lowland and south to Barberton may represent deposits of water from the margin of the Hiram ice, which reached a point just north of the Lavery boundary. The silt and fine sand deposits in the long depression in Northfield Center Township southeast through Hudson Township and those in the linear depression extending southeast across Twinsburg Township and along the eastern margin of Twinsburg Township may represent silty sandy outwash of Hiram age that has a strong component of lacustrine origin.

An interesting deposit related to the Hiram ice consists of very thin silty clay and clayey silt on some of the uplands in the northeastern part of Summit County. This pebbleless material overlies the Hiram Till, but the contact is in most places gradational. This material appears to have been formed on top of the waning Hiram ice and let down upon the underlying till when the ice finally disappeared. The Geeburg silt loam is developed upon this material (Ritchie and Steiger, 1974, p. 79-80).

## PLEISTOCENE HISTORY

The Paleozoic sedimentary rocks of northeastern Ohio were uplifted at the end of the era and erosion took place for about 200 million years, during the whole of Mesozoic and Tertiary time. At the end of the Tertiary Period, lower temperatures and persistence of snow ushered in the Pleistocene or Glacial Epoch. The Pleistocene began possibly as much as 2 million years ago. At least four times during the Pleistocene, ice sheets formed over Labrador and spread out from this center. Ice flowed southwest into the basin of the Great Lakes and spread south into northeastern Ohio from the Erie basin.

Between each of the glacial stages the ice completely disappeared as the climate warmed, and weathering and erosion of the glacial deposits took place. During the last glacial stage, the Wisconsinan, the ice front fluctuated, advancing and retreating for distances of a few miles to several hundred miles. Similar advances and retreats in the three earlier glacial stages, the Nebraskan, Kansan, and Illinoian, also took place in the Mississippi Valley, but the evidence for such fluctuations in Ohio is not as clear.

The history of the advances and retreats in northeastern Ohio is determined from the deposits of the successive ice sheets and from the weathered zones upon the deposits. Later Pleistocene history, especially that of the Wisconsinan Stage, can be determined with a considerable degree of confidence because the deposits are more or less preserved. On the Allegheny Plateau, the pre-Wisconsinan deposits are thin and discontinuous, and hence the history of these stages is more conjectural than that of the Wisconsinan Stage. In contrast, in the central Mississippi Valley, early (pre-Wisconsinan) Pleistocene deposits separated by interglacial deposits are well preserved in many places, and the history there is much firmer, although still not as detailed and secure as that of the later Pleistocene.

On the Plateau, of which Summit County is a part, the early ice advanced into an area of considerable relief; after deposition of the earliest deposits a great deal of erosion took place, removing much of the material and leaving only the most meager remnants. The early Pleistocene deposits cannot be traced continuously, as can deposits of the later Pleistocene. The discussion of the earlier Pleistocene stages for Summit County can therefore only be tentative, based on the materials and observations in the county as well as in adjacent areas of Ohio and Pennsylvania (White, Totten, and Gross, 1969, p. 54-59; White, 1982).

### PRE-ILLINOIAN STAGES

There is no direct evidence of glaciations earlier than Illinoian in Summit County. However, erratics and high-level silt and outwash deposits south of Summit County indicate glacial ice covered northeastern Ohio during the Kansan and Nebraskan Stages, or even earlier (White, 1982, p. 61). Weathering and erosion during the Aftonian and Yarmouthian Interglacial Stages deeply affected the deposits of the earlier glaciations.

### ILLINOIAN STAGE

Ice advanced into northeastern Ohio at least once and probably more than once during the Illinoian Stage. In a very few exposures in Summit County, Mapledale Till lying under deposits of later age is evidence of the advance of this ice. This ice sheet advanced south of Summit County to essentially the same position as that of the earliest Wisconsinan advance, and may in some places have advanced as much as a mile or more beyond the farthest Wisconsinan boundary. To the east in Pennsylvania the Illinoian ice which deposited the Mapledale Till did advance a mile to several miles beyond the Wisconsinan boundary (White, Totten, and Gross, 1969).

### SANGAMONIAN STAGE

A long period of warmer climate known as the Sangamonian Stage followed the retreat of the Illinoian ice. This interglacial interval is represented by weathering developed on the Mapledale Till and associated deposits. Its length is indicated by the erosion of a large part of the Illinoian deposits before the next ice advance. No interglacial deposits, such as lacustrine silts and peat, have been discovered in Summit County.

### WISCONSINAN STAGE

#### ALTONIAN SUBSTAGE

The Mogadore Till was deposited by ice which advanced out of the Erie basin about 40,000 years ago. Unlike later ice advances, the ice of this advance was able to overcome topographic irregularities to advance to a general east-west line across Columbiana, Stark, Holmes, Ashland, and Richland Counties. It was this advance which deposited the thickest drift on the Allegheny Plateau. Very large quantities of gravel were deposited in the form of kames and kame terraces; essentially all commercially exploited gravel in the Allegheny Plateau is of Altonian age.

A second episode in the advance of the Altonian ice came after an unknown time of ice retreat had taken place by downmelting and stagnation. The Altonian ice readvanced to a line across northern Richland, northern Ashland, northwestern Wayne, southeastern Medina, north-central Summit, northwestern Portage, central Trumbull, and southwestern Ashtabula Counties. The deposits of this pulse are in marked contrast in style and topography to the deposits of the earlier advance. In the earlier advance, the drift formed an irregular, hummocky, nonlinear topography; in the second advance the drift formed end moraines in the outer 10-15 miles. West of Summit County these end moraines are discrete and have been given separate names. In northeastern Medina and northern Summit Counties the end moraines are so close together and overlapping that separate elements cannot be distinguished and in Summit County are referred to as the Summit County morainic complex. This episode ended with a final surge, which produced the Defiance Moraine. Unlike the earlier end moraines, the Defiance Moraine is a discrete element in Summit County (pl. 1).

It must be kept in mind that the Defiance Moraine and the Summit County morainic complex on the north, the Kent Moraine on the east, and the correlative Buck Hill Moraine in the extreme south have a covering of till of later ages. Wherever outcrops of sufficient thickness are available, it can be seen that the later tills that form the surface of the end moraines are only a more or less thin veneer over the main mass of Altonian-age tills forming the cores of the moraines (Totten, 1969). This multiple character of the end moraines is becoming more and more evident in other areas from more detailed subsurface work in drilling and excavation (see Wickham, 1977).

## FARMDALIAN SUBSTAGE

After the retreat of the Mogadore ice, a period of weathering and erosion lasting several thousand years followed. The warmer interval began about 28,000 years ago, according to carbon-14 dates from Cuyahoga County. In Summit County no datable wood, organic silt, or peat from this interval has been discovered. The evidence for a period of warmer climate after the disappearance of the ice is the weathered upper surface of the Mogadore Till, preserved in part in some places where it is covered by later deposits.

## WOODFORDIAN SUBSTAGE

The Farmdalian Substage was brought to a close by readvance of ice from the Erie basin about 23,000 years ago. This earliest Woodfordian advance in northeastern Ohio was in separate lobes. The western margin of the Grand River lobe was in extreme eastern Summit County and north and central Stark County. The eastern margin of the Killbuck lobe was in eastern Medina County, extreme northeastern Wayne County, extreme southern Summit County, and east-central Stark County. The margins of these two lobes joined in extreme southeastern Summit County and northern Stark County. It may be noted that in southern Summit County and northwestern Stark County the ice of the Killbuck lobe was actually moving northward toward the margin of the lobe.

South-central Summit County was not invaded by this earliest Woodfordian ice advance, leaving a window in the Summit County region in which the Altonian drift was never covered by later deposits. The surface till in this area is the Mogadore Till.

### Kent-Navarre advance

The Kent Till, deposited by the Grand River lobe, and the Navarre Till, deposited by the Killbuck lobe, are correlative, but the exact synchronism of advance cannot be established. It is possible that in the interlobate area where the two lobes joined, one advanced a bit earlier than the other, so that there may never have been a time in which an open space existed between the two lobes to form a true interlobate moraine. The Kent and Navarre Tills (earliest Woodfordian) are generally thin, so that the bulk of the drift is actually pre-Woodfordian. The Kent Moraine has a covering of Kent Till, but the main mass of till and gravel in the moraine is pre-Woodfordian.

The margin of the Navarre Till in Summit and Medina Counties lies beneath the later Hayesville Till, but inasmuch as the latter till is very thin and discontinuous, the margin of the Navarre Till can be quite well determined. The margin of the earliest Woodfordian till in the small Cuyahoga lobe is within the margin of later tills; it cannot be determined much closer than 1 or 2 miles.

The Kent and Navarre Tills apparently were deposited by an ice sheet which was dissipating over a considerable marginal belt. Meltwater drained along the sides of ice masses and deposited sand and gravel, which are associated with the much larger kame terraces of Mogadore age. It is generally possible to distinguish between the two gravels. The later deposits are much thinner and overlie the earlier thicker gravels. The Kent-Navarre ice disappeared about 20,000 years ago, retreating at least into the Erie basin.

### Lavery-Hayesville advance

The time of the next Woodfordian advance, the Lavery-Hayesville, is not precisely known, but it may have taken place about 19,000 years ago. This ice advanced in the Grand River, Killbuck, and Cuyahoga lobes. The Lavery-Hayesville advance stopped 1 to 5 miles short of the earlier Kent-Navarre advance, except in southwestern Summit and southeastern Medina Counties, where the Hayesville ice advanced beyond the margin of the Navarre Till. A notable feature of the Lavery-Hayesville advance was the deposition of a marginal belt of thin discontinuous small deposits, so inconspicuous that their presence was not immediately discovered. The Lavery-Hayesville Tills in this marginal belt are so scanty that earlier material almost everywhere forms the actual surface. From 5 to 10 miles within the margin of thin till, the Lavery-Hayesville Tills are thicker and form a more or less continuous cover over the underlying material. The Lavery-Hayesville ice disappeared without leaving outwash deposits of significance.

### Hiram advance

The time between disappearance of Lavery-Hayesville ice and advance of the Hiram ice was very short, but was sufficient for some accumulation of organic material and partial leaching of the Lavery-Hayesville Tills. The evidence for these processes was found in only one place in Summit County, in Hudson (fig. 14). The Hiram ice sheet did not extend quite as far as the Lavery-Hayesville, except in southern Northampton and northernmost Portage (Akron) Townships, where it extended beyond the limit of Lavery ice as far as Cuyahoga Falls. The Hiram ice deposited a generally thin layer of clay till, in many places so thin that the present soil is actually formed from the earlier Lavery or Hayesville Till.

The Hiram ice dissipated from slow downmelting; meltwater accumulated upon the ice in very shallow ephemeral lakes and ponds in which silt and clay were deposited in thicknesses from a few inches to as much as 2 feet. It is difficult to distinguish this material from the till because soil-forming processes have altered the surficial material. Water from melting Hiram ice deposited almost no sand or gravel; gravels which are sometimes evident in the region of Hiram Till are actually of an earlier age. Meltwater from Hiram ice accumulated in the Cuyahoga River valley and in the area from Fairlawn as far south as Barberton, forming either shallow lakes or very sluggish wide streams in which silt was deposited.

Most of the meltwater from the Hiram ice came from the top of the waning ice in the north-central and northeastern parts of Summit County and not from a definite, clifflike ice front. The meltwater flowed to the Cuyahoga River valley to form a lake at an elevation of 1,000 feet; this lake extended south to the present site of Summit Lake. The silt and fine sand that accumulated in this lake now forms the surface material in much of Akron on either side of the Cuyahoga River and southward through central Akron to Summit Lake. Some silt was carried southward from Summit Lake to the Tuscarawas River valley and thence along the Tuscarawas River far beyond Summit County.

Silty water from the waning Hiram ice in Bath Township flowed southward and southeastward in the Shockalog Run depression to the Tuscarawas River valley by way of the Copley Bog and Wolf Creek depressions to Barberton. The extensive deposits of silt and fine sand in these lowlands filled or partly filled some of the kettle holes in the lowlands, and considerable thicknesses of silt are encountered in borings and excavations. However, some gravel kames of Mogadore age rise above the general 1,000-foot level of the silt deposits. In places where the kames are just below 1,000 feet, large masses of gravel are present below a thin veneer of silt.

After the Hiram ice had dissipated, drainage northward to ancestral Lake Erie was established, and the water in the lake in the Cuyahoga River valley dropped to about 800 feet, the level of early Lake Maumee. This lake at the 800-foot level was an arm or fiordlike extension of Lake Maumee and extended from north-central Akron and the base of the falls of the Cuyahoga northward to Cleveland (Claypole, 1887). Streams flowing down the valley walls to the Cuyahoga River and from the uplands into the lake deposited deltas at the 800-foot elevation; alluvial fans at places rose above the delta proper. These deltas are composed of gravel and sand with some silt layers at places. In the center of the valley, clay and silt accumulated, but in places layers of sand were deposited.

There were also lower post-Hiram water levels in the Cuyahoga River valley; these levels were extensions of Lake Whittlesey and later lakes. Deltas also were formed in these water bodies.

After the disappearance of the Hiram ice, no later ice sheet invaded Summit County. Only extreme northeastern Ohio near Lake Erie between Ashtabula and Cuyahoga Counties was covered by the advance of the Ashtabula ice, which deposited the Ashtabula Till.

### POST-HIRAM LAKES AS A MODEL FOR PRE-HIRAM LAKES IN THE CUYAHOGA RIVER VALLEY

The dissipation of the Hiram ice and formation of a lake at 1,000 feet and later at 800 feet form a model for earlier episodes of lakes in the Cuyahoga River valley. It is now known that earlier lakes in the Erie basin existed at various times in the Pleistocene. Lakes likely formed at each episode of ice disappearance, as did the Maumee, Whittlesey, Warren, and other lakes which followed the waning of the Hiram (and Ashtabula) ice (Totten, 1977; White and Totten, 1979; White, 1982).

It is therefore almost certain that in the waning stage of the Lavery ice, silty material was deposited in a lake in the Cuyahoga River valley, which drained southward through Summit Lake. Some of the sand and gravel at the mouth of the tributaries to the Cuyahoga River may be deltaic deposits of Lavery age. Before Lavery time the disappearing Kent ice probably formed a lake in the Cuyahoga River valley, and before that the waning Mogadore ice probably formed such a lake. As the Mogadore ice carried coarser material than the later Lavery and Hiram ice, some of the gravel encountered at depth in the central part of the Cuyahoga River valley may be of Mogadore age.

Another complication in the history of deposits in the Cuyahoga River valley, and in the valleys to the south which drained southward, is that as the various ice sheets advanced, meltwater was dammed in front of the ice in the Cuyahoga River valley to form ice-front lakes, which were later overwhelmed by the advancing ice. Material deposited by the meltwater flowing southward in the valleys south of the divide, mostly to the Tuscarawas River valley, was then overwhelmed by those ice sheets which advanced that far south.

The deposits in the Cuyahoga River valley, both at depth and along the sides, are therefore made up of proglacial outwash of several advancing and retreating ice sheets and intercalated till deposits of those ice sheets. Erosion took place to a greater or lesser degree between each episode of deposition. The lacustrine silt, clay, and sand would be, as are present silts, susceptible to rapid erosion. The great amount of erosion by streams tributary to the Cuyahoga River valley since the disappearance of the Hiram ice leads to the conclusion that similar extensive stream and gully erosion took place after the disappearance of each earlier ice sheet in the valley. However, perhaps some of the apparent post-Hiram stream erosion is actually cleaning out of pre-Hiram valleys.

At times the level of the successive lakes in the Erie basin was lower than that of present Lake Erie. At such times the Cuyahoga River flowed to a lower base level than at present and hence the river cut below the floodplain surface. With the rise of the lake to a higher level, the Cuyahoga River became an aggrading stream and built up its floodplain to a level comparable to that seen today. Material from the eroding valley walls and from the tributary streams would quickly furnish sediment to build up the valley floor.

The material filling the Cuyahoga River valley is therefore composed of glacial deposits (till), outwash deposits, delta deposits, and ancient floodplain deposits. All of these deposits are of varying thickness, extent, and composition.

### POSTGLACIAL HISTORY

As the climate in Ohio and in Summit County ameliorated during the postglacial period, the vegetation and animal life gradually migrated back into former habitats as the climatic and ecological conditions permitted. Alluvium, consisting mainly of silt and clay, was deposited in most of the valleys, and organic silt and peat accumulated in the kettle holes. Very rapid gully erosion took place in the silty and clayey till and lacustrine material along the margin of the Cuyahoga River valley north of Akron.

The last modification of the surface has been the work of man in excavation and filling, which in some places has noticeably altered the landscape.

## MINERAL RESOURCES

### BEDROCK RESOURCES

The mineral resources of the bedrock in Summit County do not form a part of this report. However, it may be noted that southern Summit County in the 19th and early 20th centuries was an important coal-mining region, but reserves of the very fine quality Sharon (No. 1) coal were soon exhausted (Bownocker and Dean, 1929, p. 8-11, 334), and no coal mines now operate in Summit County. It is interesting to note that coal was mined in Ohio at Tallmadge by Henry Newberry, the father of John S. Newberry, second State Geologist of Ohio, famous western explorer and geologist, and professor at Columbia University.

In the past, Summit County has been an important manufacturer of clay products, for which Pennsylvanian clay and in particular Pennsylvanian shale was mined (Lamborn and others, 1938, p. 76-78, 84-86; Stout and others, 1923, p. 141, 177, 179). At present neither clay nor shale is mined in Summit County. The existing plants in Summit County use clay and shale brought in from outside the county.

The Barberton area is the site of much mining activity, both past and present. Pennsylvanian-age sandstone (Sharon conglomerate) is presently being quarried in the city; there are abandoned quarries throughout the county. Great amounts of limestone of Devonian age have been produced by a shaft mine, no longer in operation, over 2,000 feet underground northwest of Barberton. The great Silurian salt deposits which are worked at Barberton are nationally known. The salt lies at depths of 2,800 feet and is produced by brining rather than mining.

### SAND AND GRAVEL

Large amounts of sand and gravel have been excavated from pits in almost all parts of the county. These pits are shown on plate 1. The largest pits have been in central and southern Summit County and in the Darrowville region in northern Stow and southern Hudson Townships. Some of the largest pits have been within the city of Akron, such as those north and southwest of the Cuyahoga River. Other large pits have been located along the Tuscarawas River valley in northeastern Green and adjacent Springfield Townships.

The sand and gravel of Summit County have been an important resource in the past and will continue to be important. These materials are essential for concrete aggregate, road building, and other uses.

The extensive areas of kames and kame terraces shown on plate 1, as well as some of the areas of outwash deposits at lower levels, contain large amounts of sand and gravel. As Summit County becomes more and more urbanized, the hummocky topography of these kame areas becomes more and more attractive for home sites, and access to such tracts of gravel for commercial pits becomes more and more difficult.

The areas of hummocky topography in Green Township are possible areas for buried gravel deposits. In the buried end-moraine area north of Akron, and particularly in Bath, Northampton, and northwestern Stow Townships, well records indicate that large amounts of gravel exist at depth. The existence of thick gravel below many feet of till is excellently shown at the Alden pit in Northampton (fig. 10). These areas are rapidly becoming settled, but some favorable sites for extraction may still be available.

The exploitation of such buried sand and gravel would require adequate capital for a program of detailed exploration by drilling and geophysical methods and for the acquisition of sufficiently large areas of land for an extensive operation, including disposal of spoil and restoration of the land surface. Any development of sand and gravel resources requires the cooperation of operators and local government and planning agencies so that the best use is made of the land. Planned multiple land use allows extraction of the sand and gravel followed by proper reclamation so that the area is then suitable for recreational or residential use.

## GROUND-WATER RESOURCES

Summit County has abundant supplies of ground water, but these are unevenly distributed. The study by Smith and White (1953) considers the conditions of ground water township by township in Summit County and these observations are still valid and useful. An earlier report by Stout and others (1943, p. 585-594) contains some general information. In the past 25 years many more hundreds of wells have been drilled and the records of the materials encountered are on file at the Ohio Division of Water. A map of the ground-water resources of Summit County has been published by the Division of Water (Schmidt, 1979).

The largest water supplies are in the drift deposits in the buried valleys, some of which are now occupied by streams. If the drift filling is porous and permeable, very large supplies can be obtained, particularly if the present stream at the surface in a valley provides recharge as pumping takes place. However, because the structure of the layers of gravel, sand, silt, clay, and till in the buried valleys is highly variable, there may be considerable variation in yields of wells. Exploratory drilling will disclose the character of this variation.

End-moraine and other hummocky areas have more or less gravel at depth, as shown by the hundreds of sections illustrated by Smith and White (1953). These buried gravels may serve as aquifers. The ground-moraine areas, especially in the northern part of the county, are generally not favorable for water supply.

The water resources of the bedrock also have been studied by Smith and White (1953). A report by Sedam (1973) describes in some detail the water resources of the bedrock in Summit and adjacent counties.

The detailed information from published records and records on file at the Ohio Division of Water furnish guidance for consultants to municipalities and to industry. The glacial map in this report and the data already published (Smith and White, 1953; Schmidt, 1979) can guide individual householders. Developers of housing tracts should realize that in spite of the very favorable water characteristics over much of the county, there are some unfavorable areas. A detailed study of existing well records will indicate such areas. In general, the areas of ground moraine in which the drift is thin do not yield adequate amounts of water, but the rock below the glacial drift may be sandstone capable of supplying satisfactory amounts of water. The character of the water in the shallow deposits of ground moraine in northern Summit County was recognized almost 100 years ago by Read (1880).

## ENVIRONMENTAL AND ENGINEERING GEOLOGY

Engineering geology is concerned with the application of geological information in activities of man, especially activities that deal with alteration of the earth's surface or material. In the preceding descriptions and discussions, the relation of topography and material to use by man has been expressed or implied. All environmental changes involve more or less engineering manipulation of earth materials.

The susceptibility of materials to slumping and landsliding in different topographic and geologic situations is now relatively well understood. The clay- and silt-rich material of the northern part of Summit County requires particularly careful engineering attention based on its geological character. Piping may occur when interfaces separating units are exposed.

As larger and larger structures are built, deeper foundations are required, and the engineer must be concerned with the vertical variations that may be encountered at various depths (White, 1972; 1974, p. 346-347). The conditions that may be encountered in the various areas in Summit County have already been described and are illustrated in some of the diagrams. In metropolitan areas, and soon between such areas, tunneling rather than open cutting is becoming more common for large sewer lines and other purposes. It is necessary to realize that conditions may change laterally as well as vertically, and that these changes will influence the speed of advance and the equipment required.

A feature not previously observed to be well developed in Summit County is boulder pavement that may be present at the interface of two drift units, generally tills. As more and more exposures have been studied elsewhere in deep excavations and in tunnels, it becomes apparent that boulder pavements are far more common than generally realized (White, 1974, p. 336). When boulder pavements are suddenly encountered in tunneling, the tunneling machine generally cannot deal with a continuous layer and the machine may be damaged, seriously delaying the rate of advance.

In planning the material for fill for highways, dams, and other structures, it is necessary to consider that tills differ in many properties. A till at the surface probably does not have the same properties as the tills which make up the bulk of a deposit.

A variety of problems in water supply and control is associated with movement, or retarding of movement, of water through tills. Building a dam upon glacial deposits requires an understanding of the anatomy of the deposits to assure a proper program of exploration, planning, and construction of the dam and its reservoir.

## GORGES AND RAVINES

The deep valley of the Cuyahoga River north of Akron is one of the most extensive scenic areas in northeastern Ohio and also the area with the most severe constraints for buildings and other structures. The interbedded till sheets (mostly clayey and silty till) and lacustrine clays of the Cuyahoga River valley are very unstable on slopes, either natural or manmade. The sides of the valley are dissected by steep, narrow ravines. Some of the ridges (divides) between the ravines are so sharp that no level land is at their crest; other ridges have a narrow strip of level land preserved on which houses and roads are located. The ravines are more or less heavily wooded. The most favorable use for the rugged land in the Cuyahoga River valley is for recreational purposes. The valley between Akron and Cleveland is now the Cuyahoga Valley National Recreational Area.

The largest tributary to the Cuyahoga River is Furnace Run, on the west side of the valley in Richfield and northeastern Bath Townships. The sides of this deep valley are dissected by ravines of the same type as those along the Cuyahoga River valley and provide the same opportunity for park development and the same constraint to construction. Furnace Run Park is developed in a part of this valley.

The Yellow Creek valley in Bath and Northampton Townships and the Sand Run valley in Copley Township have similar features. The latter valley is in part now a park.

The engineering geology problems of these areas are severe. The slopes are unstable, and road construction requires special measures to insure stability where the slopes are cut into different layers of unconsolidated material ("soils" in engineering terms). These materials differ in permeability, and water may flow out at interfaces and localize areas of slumping. If structures are built on the upland too close to a slope margin, very serious, indeed disastrous, slumping may occur. In Cuyahoga County to the north there has been more construction on slopes and slope margins than in Summit County and graphic examples of slumping may be seen.

An added engineering problem in these landslide-prone areas is that material excavated from cuts is high in silt and clay, but in different proportions in the various layers into which the ravines have been eroded. Such materials may have differing rates of compaction, and appropriate measures must be taken to minimize problems that may arise.

## GROUND MORAINE

The areas of ground moraine are on the uplands. The surface ranges from level to slightly undulating, so that surface drainage may be slow. The drift on the uplands is thin and bedrock may be very close to the surface. This factor must be taken into account in excavations. The material of the ground moraine is unsuitable for waste disposal (Van Horn, 1976).

## END MORAINES AND OTHER HUMMOCKY TOPOGRAPHY

The very extensive hummocky areas throughout Summit County are similar in surface form, but differ in drift composition. The surface drainage is good except for the depressions (kettle holes), which may be the sites of bogs or lakes. These rolling areas are attractive home sites, as shown by the widespread suburban development throughout much of the county in these areas. Much of Bath Township can serve as an example of such attractive developments.

The engineering problems in hummocky topography are not severe, but it must be kept in mind that although the drift of these areas in northern Summit County is clayey and silty till at the surface, the material from a very few feet to many tens of feet below the surface may be gravel and coarse till. Thus in an excavation of any depth, different materials, perhaps markedly different, will be encountered. Engineers must realize this possibility and plan the exploratory phase of a project to determine the vertical variation in the material (White, 1974).

The most suitable areas in the county for waste disposal, both solid and liquid (septic tanks), are in some of the hummocky areas where thick silty clay and till, 50 feet or more thick, are present at the surface (Van Horn, 1976). Other areas of hummocky topography are more or less marginally suitable for waste disposal (Van Horn, 1976).

## KAMES AND KAME TERRACES

Summit County is noted for its large areas of kames and kame terraces, mainly in the central and southern part of the county. These hummocky areas of gravel and sand provide a great variety of environments. Kames and kame terraces at lower levels have a high water table, whereas those at higher levels may have a water table a considerable depth below the surface. In general, drainage in areas of kames and kame terraces is good except at lower elevations, where bogs or lakes may be present in depressions.

The engineering problems in kame and kame-terrace areas are related to the position of the water table. Foundation conditions are generally good, but the possible presence of pockets of silt or till should be realized.

Areas of kames and kame terraces are unsuitable for waste disposal because of their high permeability (Van Horn, 1976).

## OUTWASH PLAINS AND LAKE PLAINS

Outwash plains and lake plains are composed of sand and silt, are generally at low elevation, are subject to flooding, and have a high water table. In a few areas at higher elevations, such as the extensive outwash plain in northwestern Akron and Fairlawn, the water table is at some depth and conditions are favorable for buildings and other excavations. These areas are among the most level in Summit County; the rectangular network of streets is a reflection of this lack of relief.

Areas of outwash plains and lake plains generally are unsuitable for waste disposal (Van Horn, 1976).

## BOGS AND KETTLE HOLES

The bottoms of many depressions in the glacial drift of Summit County are at or below the level of ground water; those below ground-water level are lakes and those at ground-water level are bogs. These lakes and bogs represent the filling of once deeper depressions by organic matter, now peat, or muck if mixed with clay and silt. The thickness of peat deposits may be as much as 40 feet. The aspect in 1912 of some of the Summit County bogs is described with accompanying maps, photographs, and analyses by Dachnowski (1912, p. 122-128). He specifically described the Copley Bog and Mud Lake Bog in Hudson Township. Newberry (1873, p. 207) described a bog in Stow Township in which the peat was 30 feet deep and one in Coventry Township "said to be thirty or forty feet deep." These bogs in pioneer days, and some as recently as 50 years ago, were the sites of cranberry marshes or tamarack bogs (Dachnowski, 1912, pl. 4). Almost all have now been drained and are used for growing crops, generally vegetables. Some bogs close to cities and towns have been partly or completely filled by works of man. Some of the bog areas in Portage Lakes State Park are preserved and show the character of the extensive bogs of early days.

The engineering problems of bogs are of a special sort. Construction of highways and railroads across bog areas involves severe foundation problems. Before embarking on construction in a bog area or a filled bog area, it is essential to obtain informed advice. In some places where bogs have been drained and filled in, the fact that the area was originally a bog may not be realized. Construction of buildings in such situations may later have unfortunate consequences.

## WASTE DISPOSAL

In metropolitan counties, the problem of disposal of solid waste becomes ever more pressing. The waste-disposal potential for each of the various drift areas is only mentioned in this report; the detailed map of Van Horn (1976) shows the suitability of various areas. It is especially important to note, as Van Horn (1976, map units 18-23) points out, the unsuitability of the gravel areas—kames and kame terraces—and that abandoned gravel pits should not be used as landfill sites.

In rural areas, septic tanks are a common means of disposing of liquid waste. A few areas in Summit County are still more or less suitable for septic tanks, but much larger areas are not and appropriate arrangements should be made in planning development. The detailed map and descriptions of Van Horn (1976) are useful in such planning, as are the soil maps and descriptions of Ritchie and Steiger (1974). As areas become more urbanized, the municipalities provide central systems for waste-water treatment, and the suitability of the drift for septic tanks is no longer of importance.

## REFERENCES CITED


Bain, L. G., and Bain, R. J., 1975, Kame deltas along Cuyahoga River valley, northeastern Ohio: Geological Society of America Abstracts with Programs, v. 7, p. 715-716.

Bownocker, J. A., and Dean, E. S., 1929, Analyses of the coals of Ohio: Ohio Geological Survey Bulletin 34, 360 p.

Claypole, E. W., 1887, The lake age in Ohio: or, Some episodes in the retreat of the North American glacier: Transactions of the Edinburgh Geological Society, v. 5, p. 421-458.

Cushing, H. P., Leverett, Frank, and Van Horn, F. R., 1931, Geology and mineral resources of the Cleveland District, Ohio: U.S. Geological Survey Bulletin 818, 138 p.

Dachnowski, Alfred, 1912, Peat deposits of Ohio, their origin, formation and uses: Ohio Geological Survey Bulletin 16, 424 p.

DeLong, R. M., and White, G. W., 1964, Geology of Stark County, Ohio: Ohio Geological Survey Bulletin 61, 209 p., 2 maps.

Goldthwait, R. P., White, G. W., and Forsyth, J. L., 1961, Glacial map of Ohio: U.S. Geological Survey Miscellaneous Geologic Investigations Map I-316.

Gross, D. L., and Moran, S. R., 1971, Grain size and mineralogical gradations within the till of the Allegheny Plateau, *in* Goldthwait, R. P., ed., Till, a Symposium: Ohio State University Press, p. 251-272.

Hildreth, S. P., 1836, Observations on the bituminous coal deposits of the valley of the Ohio, and the accompanying rock strata; with notices of the fossil organic remains and the relics of vegetable and animal bodies, illustrated with a geologic map and by numerous drawings of plants and shells, and by views of interesting scenery: American Journal of Science, v. 29, p. 1-154, map.

_________1837, Miscellaneous observations made during a tour in May 1835 to the Falls of the Cuyahoga, near Lake Erie: American Journal of Science, v. 31, p. 1-84.

_________1838, Report (on the coal measures): Ohio Geological Survey 1st Annual Report, p. 25-63.

Leverett, Frank, 1902, Glacial formations and drainage features of the Erie and Ohio Basins: U.S. Geological Survey Monograph 41, 802 p.

Newberry, J. S., 1873, Report on the geology of Summit County: Ohio Geological Survey, Volume 1, Part 1, Geology, p. 201-222.

Nichols, Kenneth, 1976, Yesterday's Akron, the first 150 years: Miami, Florida, Seeman Publishing, Inc., 120 p., mainly illustrations.

Read, M. C., 1880, Water supply of drift-clay land of Ohio: Ohio State Board of Agriculture, 34th Annual Report, for the year 1879, p. 491-498.

Ritchie, Alexander, and Steiger, J. R., 1974, Soil survey of Summit County, Ohio: U.S. Department of Agriculture, Soil Conservation Service, 117 p., 34 map sheets.

St. John, Samuel, 1851, Elements of geology, intended for the use of students: Hudson, Ohio, Pentagon Press, 334 p.

Schmidt, J. J., 1979, Ground-water resources of Summit County: Ohio Division of Water, map with text.

Sedam, A. C., 1973, Hydrogeology of the Pottsville Formation in northeastern Ohio: U.S. Geological Survey Hydrologic Investigations Atlas HA-494, 2 sheets.

Shepps, V. C., 1953, Correlation of the tills of northeastern Ohio by size analysis: Journal of Sedimentary Petrology, v. 23, p. 34-48.

Shepps, V. C., White, G. W., Droste, J. B., and Sitler, R. F., 1959, Glacial geology of northwestern Pennsylvania: Pennsylvania Geological Survey General Geology Report G32, 59 p.

Smith, R. C., and White, G. W., 1953, The ground-water resources of Summit County, Ohio: Ohio Division of Water Bulletin 27, 130 p.

Stout, Wilber, Stull, R. T., McCaughey, W. J., and Demorest, D. J., 1923, Coal formation clays of Ohio: Ohio Geological Survey Bulletin 26, 588 p.

Stout, Wilber, Ver Steeg, Karl, and Lamb, G. F., 1943, Geology of water in Ohio: Ohio Geological Survey Bulletin 44, 694 p.

Sugden, D. E., 1974, Landscapes of glacial erosion in Greenland and their relationship to ice, topographic and bedrock conditions: Institute of British Geographers Special Publication 7, p. 177-195.

Szabo, J. P., and Angle, M. P., 1983, Quaternary stratigraphy of Richfield Township, Summit County, Ohio: Ohio Journal of Science, v. 83, p. 38-44.

Szabo, J. P., and Ryan, D. E., 1981, Quaternary stratigraphy of the lower Mud Brook Basin, Northampton Township, Summit County, Ohio: Ohio Journal of Science, v. 81, p. 239-246.

Totten, S. M., 1960, Quartz/feldspar ratios of tills in northeastern Ohio: University of Illinois, M.S. thesis (unpublished), 35 p., 2 pls.

_________1969, Overridden recessional moraines in north-central Ohio: Geological Society of America Bulletin, v. 80, p. 1931-1946.

_________1973, Glacial geology of Richland County, Ohio: Ohio Geological Survey Report of Investigations 88, 55 p., 2 pls.

_________1977, Sangamonian and Wisconsinan strandlines along the south shore of Lake Erie, northeastern Ohio and northwestern Pennsylvania: Geological Society of America Abstracts with Programs, v. 9, p. 659-660.

Van Horn, R. G., 1976, Land areas in Summit County, Ohio—geologic suitability for solid-waste disposal: Ohio Geological Survey Report of Investigations 98, map with text.

White, G. W., 1951, Illinoian and Wisconsin drift of the southern part of the Grand River lobe in eastern Ohio: Geological Society of America Bulletin, v. 62, p. 967-977.

_________1960, Classification of Wisconsin glacial deposits in northeastern Ohio: U.S. Geological Survey Bulletin 1121-A, 12 p.

_________1961, Classification of glacial deposits in the Killbuck lobe, northeast-central Ohio: U.S. Geological Survey Professional Paper 424-C, p. C71-C73.

_________1967a, The first appearance in Ohio of the theory of continental glaciation: Ohio Journal of Science, v. 67, p. 210-217.

———1967b, Glacial geology of Wayne County, Ohio: Ohio Geological Survey Report of Investigations 62, 39 p., 1 pl.

———1968, Age and correlation of Pleistocene deposits at Garfield Heights (Cleveland), Ohio: Geological Society of America Bulletin, v. 79, p. 749-752.

———1969, Pleistocene deposits of the north-western Allegheny Plateau, U.S.A.: Quarterly Journal of the Geological Society of London, v. 124, p. 131-151.

———1971a, Thickness of Wisconsinan tills in Grand River and Killbuck lobes, northeastern Ohio and northwestern Pennsylvania: *in* Goldthwait, R. P., ed., Till, a Symposium: Ohio State University Press, p. 149-163.

———1971b, Glacial geology of Trumbull County, Ohio: Ohio Geological Survey Report of Investigations 80, map with text.

———1972, Engineering implications of stratigraphy of glacial deposits: 24th International Geological Congress (Montreal), Sec. 13, Engineering Geology, p. 76-82.

———1974, Buried glacial geomorphology, *in* Coates, D. R., ed., Glacial geomorphology: Binghamton, N.Y., 5th Annual Geomorphology Symposium, p. 331-350.

———1977, Glacial geology of Ashland County, Ohio: Ohio Geological Survey Report of Investigations 101, map with text.

———1980, Glacial geology of Lake County, Ohio: Ohio Geological Survey Report of Investigations 117, 20 p., 1 pl.

———1982, Glacial geology of northeastern Ohio: Ohio Geological Survey Bulletin 68, 75 p., 1 pl.

White, G. W., and Totten, S. M., 1965, Wisconsinan age of the Titusville Till (formerly called "Inner Illinoian"), northwest Pennsylvania: Science, v. 148, p. 234-235.

———1979, Glacial geology of Ashtabula County, Ohio: Ohio Geological Survey Report of Investigations 112, 52 p., 1 pl.

White, G. W., Totten, S. M., and Gross, D. L., 1969, Pleistocene stratigraphy of northwestern Pennsylvania: Pennsylvania Geological Survey General Geology Report G55, 88 p.

Wickham, J. T., 1977, Glacial geology of north-central and western Champaign County, Illinois: Geological Society of America Abstracts with Programs, v. 9, p. 666.

Winslow, J. D., and White, G. W., 1966, Geology and ground-water resources of Portage County, Ohio: U.S. Geological Survey Professional Paper 511, 80 p.

STATE OF OHIO
Richard F. Celeste, Governor
DEPARTMENT OF NATURAL RESOURCES
Lt. Gov. Myrl H. Shoemaker, Director

DIVISION OF GEOLOGICAL SURVEY
REPORT OF INVESTIGATIONS NO. 123
PLATE 1

# GLACIAL GEOLOGY OF SUMMIT COUNTY, OHIO

by George W. White

1984

## EXPLANATION

QUATERNARY

Recent

M

*Made land.* Areas of excavation or filling, where the original surface has been completely modified. Only larger areas shown. Includes chemical ponds south of Barberton

*Ravines.* Steep slopes and sharp ravines, in part contiguous glacial material and in part bedrock, in Cuyahoga River valley north of Akron

al

*Alluvium.* Silt and silty sand on floodplains. Includes some bog and marsh deposits, especially in Copley Township

Pleistocene (Wisconsinan)

Wlg

*Lake Maumee gravel terrace.* Small southward extension of main Lake Maumee terrace in Cuyahoga County; grades southward into outwash at a higher level

Wo

*Outwash and lacustrine deposits.* Generally fine sand, silt, and clay in interstratified meltwater-stream valley trains, outwash plains, and lacustrine plains, commonly as terrace remnants. Coarser material in dissected valley-train terraces in Tuscarawas River valley south of Barberton. May include organic material in low depressions

Wk

*Kames and kame terraces.* Gravel and sand in knolls and irregular to level high terraces. May contain included till masses. Overlain by till in places, especially in eastern and northern part of county

Wg

*Ground moraine.* Mainly till, generally thin, forming gently undulating topography on upland surfaces. Bedrock may be very close to or at surface

We

*End moraine.* Clay till and silty clay till, overlying sandy till or gravel, in more or less linear belts of hummocky topography. Gravelly part shown by overprint

Wh

*Hummocky topography without linear trend.* Mainly sandy till in irregular patches and along valley sides, with knolls or marked undulations. Generally in area of Mogadore Till in central and southern Summit County

Whe | Whg

Hiram Till
(all lobes)

Clayey till, generally thin, not everywhere present; at surface in northern Summit County

Whae | Whah | Whag

Hayesville Till
(Killbuck lobe)

Silty till, very thin, in discontinuous small patches in western Summit County; much of surface material may be Mogadore Till

Wlae

Lavery Till
(Cuyahoga and Grand River lobes)

Clayey-silty till, generally thin, at surface in small area in northern Stow Township; present beneath Hiram Till in northern Summit County

Wne

Navarre Till
(Killbuck lobe)

Sandy till, generally thin, present in narrow belt in southern Franklin and Green Townships

Wkee | Wkeg

Kent Till
(Cuyahoga and Grand River lobes)

Sandy till, generally thin, at surface in easternmost Summit County; present beneath later tills in northern half of county

Wmoe | Wmoh | Wmog

Mogadore Till
(Cuyahoga lobe)

Coarse sandy till, generally greater than 15 feet thick, at surface in southern-central Summit County; present beneath later tills in northern part of county

Boundary of deposit, *dashed where inferred*

Till boundary, *dashed where inferred*

500 Contour on bedrock surface, *contour interval 100 feet*

Gravel or clay pit

Gravel or clay pit, small or abandoned

Quarry

Quarry, abandoned

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

| | |
|---|---|
| Akron East (1979) | North Canton (1978) |
| Akron West (1979) | Northfield (1963) |
| Broadview Heights (1963) | Peninsula (1963) |
| Canal Fulton (1958) | Twinsburg (1963) |
| Doylestown (1969) | Wadsworth (1969) |
| Hudson (1963) | West Richfield (1963) |

1 0 1 2 3 miles

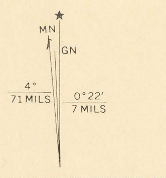
1 0 1 2 3 kilometers

CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

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

CONTOURS ON BEDROCK SURFACE BY JOEL D. VORMELKER

JAMES A. BROWN, CARTOGRAPHER



UTM GRID AND 1970 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

LOCATION MAP