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QUATERNARY STRATIGRAPHY OF THE LOWER MUD BROOK BASIN, NORTHAMPTON TOWNSHIP, SUMMIT COUNTY, OHIO[1]

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Abstract. Three major and two minor Wisconsinan tills occur in the lower Mud Brook Basin in Northampton Township, Summit County, Ohio where deposits of two ice lobes may overlap. We distinguished these tills on the basis of stratigraphy and mineralogy. Of the major tills, the Lavery Till and the Unnamed Till occur on the uplands, and the Titusville (Mogadore) Till is in deep valleys. In general, the tills grade upward from coarse-grained, feldspar-poor, and plagiosclase-dominant older tills to fine-grained, feldspar-rich, and alkali feldspar-dominant younger tills. Dolomite is the dominant carbonate mineral in the Early Wisconsinan Titusville (Mogadore) Till. The Late Wisconainan Lavery and Hiram tills contained nearly equal amounts of calcite and dolomite. Mineralogy of these tills reflect variations in source areas and in local materials of the lobes that glaciated northern Summit County. The Titusville (Mogadore) Till and Unnamed Till were probably deposited by the Grand River Lobe, and the Lavery and Hiram (?) Tills were probably deposited by the Cuyahoga Lobe.

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A majority of the surficial materials in northeastern Ohio is of Wisconsinan age and is composed of several stratigraphic units, some of which are tills. The ice sheets that glaciated northeastern Ohio were topographically controlled, and the resulting till deposits reflect the paleotopography of the area. A given till can range in elevation, thickness, and texture over the area, complicating the problem of correlation.

A study area of 7 km^2 was chosen in Northampton Township, Summit County, Ohio where deposits of two ice lobes may overlap (fig. 1). The glacial drift in the eastern part of southern Summit County is thought to be from the Grand River Lobe and the drift of southwestern Summit County from the Killbuck Lobe (Smith and White 1953). The drift of the northern part of the county may be a result of a small sublobe of the Killbuck Lobe, named the Cuyahoga Lobe (Winslow *et al* 1953). Also within the field area, studies have been few, and conclusions have been based on a limited number of samples taken from scattered localities. Within the township are numerous exposures of glacial deposits along the valley of Mud Brook and its tributaries (fig. 2). The entire area displays

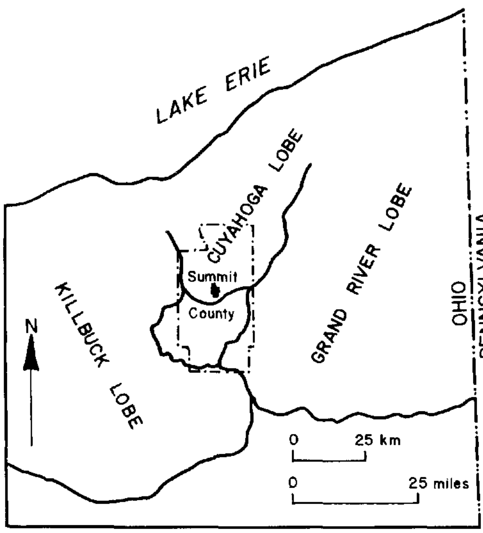

FIGURE 1. Location map and distribution of lobes that glaciated northeastern Ohio during the Late Wisconsinan (Modified from Shepps 1953). Study area in Summit County is shown in black.

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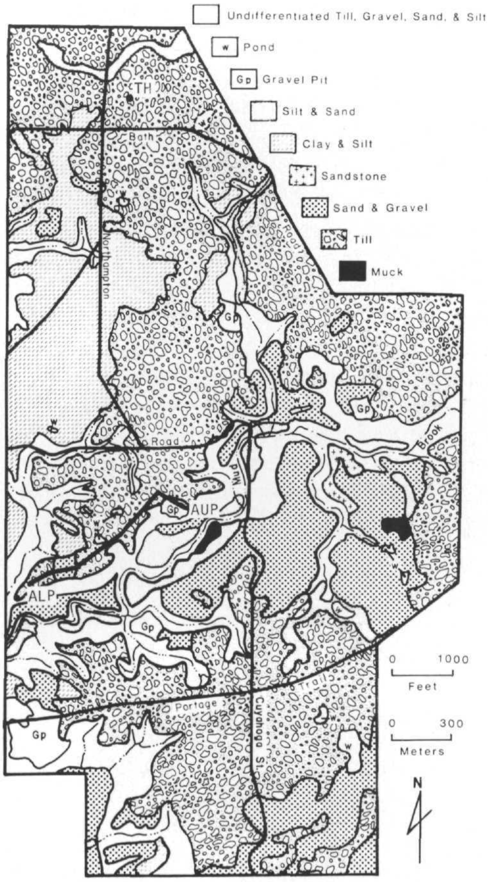

FIGURE 2. Parent material map of the study area (Modified from Ritchie and Steiger 1974). AUP—ALP is a borehold traverser on the property of Alden Sand and Gravel Company. AUP is the upper gravel pit and ALP is the lower gravel pit. TH is the location of the Townhall Section.

the topography of the dissected Wabash Moraine.

Claypole (1887) and Leverett (1902) conducted early investigations of the glacial deposits in the area. G. W. White and his students have done considerable work on the Pleistocene deposits of northeastern Ohio and northwestern Pennsylvania. White (1960, 1961 and 1979) also determined the extent and relative ages of the glaciations in northeastern Ohio. A general description of the glacial deposits of Summit County is found in Smith and White (1953), and detailed work in the county includes a study of glacial Lake Cuyahoga (Wittine 1970). The county soil survey (Ritchie and Steiger 1974) provides insight in the location of materials in the area (fig. 2). Bain (1975) described the terraces and their deposits along the Cuyahoga River and its major tributaries. White (1977) examined and sketched one of the outcrops in the area, and Szabo (1979) has done considerable reconnaissance work in the valley of Mud Brook. Mangun (1980) determined the depth to bedrock in the Cuyahoga Valley in Northampton Township, and Ryan (1980) studied the stratigraphy and mineralogy of the tills in the study area.

In this study, we examined the glacial deposits both in the field and in the laboratory. Nine sections were measured and described in active and inactive gravel pits, in stream valleys, and in roadcuts. These sections were sampled at 20 cm intervals where feasible. In addition, we bored six holes using hollowstem augers, Shelby tubes, and split-spoon samplers. Cores were described and sampled in the laboratory. Five hand-augered holes were drilled and sampled at several locations to improve the correlation between drilled and measured sections. Textural and mineralogical analyses were performed on 303 samples. The mineralogical analyses included the determination of quartz-feldspar ratios and alkali feldspar percentages in the fine sand fraction of the samples using cathodoluminescence. A Chittick apparatus were used to determine the carbonate content of the finer than 0.074 mm fraction of the samples. All laboratory analyses were plotted against depth for all sections, cores, and auger borings (Ryan 1980).

QUATERNARY STRATIGRAPHY

The names of the units in this study are in accordance with those presently accepted for Pleistocene rock-stratigraphic units of either the Killbuck or Grand River lobes (White 1960 and 1961). The most complete measured stratigraphic section is located in the upper gravel pit of the Alden Sand and Gravel Company 300 m south of the east-west part of Northampton Road (fig. 2). This pit was examined by Wittine (1970) and Bain (1975), who found only one till, and by White (1977), who also measured the upper part of the section. The upper 16.24 m were measured on the east wall of the pit; the remaining 38.26 m were measured down a south-trending ravine. The general stratigraphy of the area is best illustrated by figure 3.

The oldest till in the study area is the

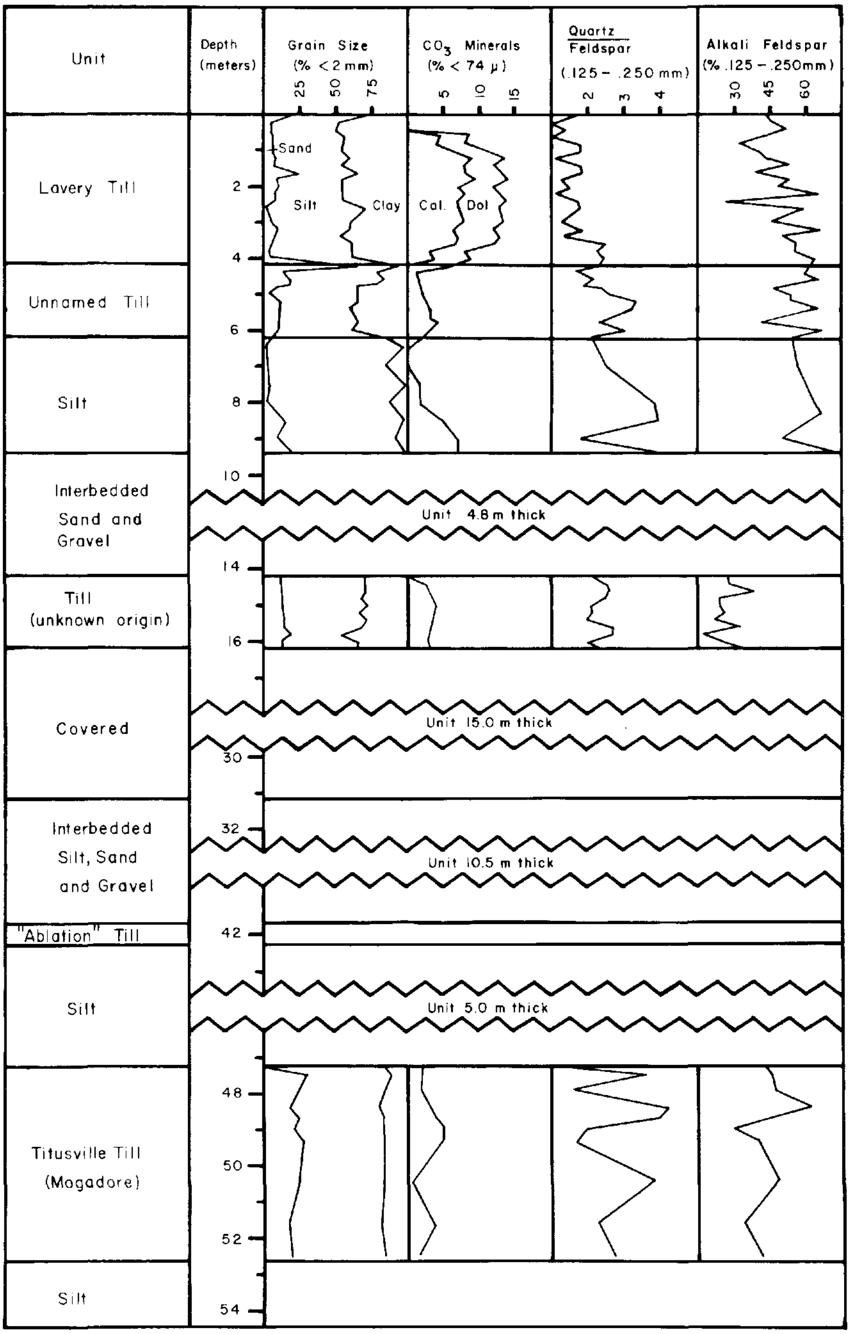

FIGURE 3. Measured section and laboratory analyses of the AUP Section located on the north side of Mud Brook (see fig. 2).

Titusville (Mogadore) Till (White 1960 and 1979). This till does not form the surficial material anywhere in the study area except in small exposures in and along deep valleys. The till ranged in thickness from 5.4 m to 22.9 m. Stratigraphically, the Titusville (Mogadore) Till occurs alone in a section or is overlain by one to three other tills, silts, and sand and gravel. It overlies both silts and bedrock. This till is unweathered, gray, and very dense in most places. The typical oxidized color, olive brown, of the till was observed in thin bands along sand and silt contacts with it and along fractures in it. Within the area the till averages 26.7% sand, 56.7% silt, and 16.6% clay (table 1). It has the coarsest texture of all the tills in the study area.

to dark gray in its dense unweathered part. Laboratory analyses show that the Unnamed Till has the lowest sand percentage of all tills in the area (table 1). The till resembles silt, but the presence of pebbles, characteristically gray and brown dolomites, and the increased resistance during augering distinguish it from silt.

The Unnamed Till makes up the core of the moraine in the northern part of the study area. It is found in a cut along a dirt road 240 m northeast of the Northampton Townhall at the intersection of Bath and Northampton Roads (fig. 2). This section, named the Townhall Section, is illustrated in figure 4. In this section, the younger tills reflect the constructional topography of the moraine built of Unnamed Till.

TABLE 1

Summary of textural and mineralogical analyses.

Unit	No. of Samples	Sand %	Silt %	Clay %	Quartz / Feldspar	Alkali Feldspar* %	Total Feldspar %	Calcite %	Dolomite %
Hiram Till	4	19.0	48.0	33.0	1.03	54.8	44.5	5.2	5.0
Lavery Till	74	10.1	48.4	41.5	1.40	55.1	40.3	8.2	7.1
Unnamed Till	99	7.2	52.7	40.1	2.00	56.6	33.9	3.3	6.0
Till (Unknown Origin	11	13.0	54.2	32.8	2.34	27.3	29.8	0.0	2.9
Titusville Till (Mogadore)	34	26.7	56.7	16.6	2.53	30.5	30.5	0.0	3.3

*Alkali feldspar content is percent of the total feldspar.

Above the Titusville (Mogadore) Till (fig. 3) is a deltaic sequence of silts, sands, and gravels (Bain 1975). Within this sequence are two minor tills, the lowest of which is a yellowish brown "ablation" till. This till is contorted and interbedded with sand and gravel. Higher in the section in the floor of Alden's upper gravel pit (fig. 3) is a discontinuous, gray, plastic till of unknown origin. The characteristics of this till are summarized in table 1.

The deltaic sequence underlies another till termed the Unnamed Till, which was found in almost every section. It is not the surficial material anywhere in the study area except possibly on the slopes of deep valleys. The maximum thickness of the till is 10.3 m, but it averages 3.8 m. In most places, the Unnamed Till is oxidized olive brown to dark yellowish brown but grades

The Lavery Till forms the surficial material over much of the study area. Its thickness, 2.5 m, is relatively constant over the area. The Lavery Till is separated from the underlying Unnamed Till by a thin silt or sand layer and appears to be limited to the uplands. Erosion probably removed the Lavery Till where present valleys exist. The till weathers yellowish brown to dark yellowish brown. It displays a "sheet" structure and has secondary carbonates filling the fractures. Sand and clay percentages are only slightly higher than those of the Unnamed Till (table 1).

The Hiram(?) Till occurs at only the Townhall Section (fig. 4). Its distinction from the Lavery Till is based on the stratigraphic position of the till, its lower carbonate content and feldspar percentage, and on the difference in its physical appearance.

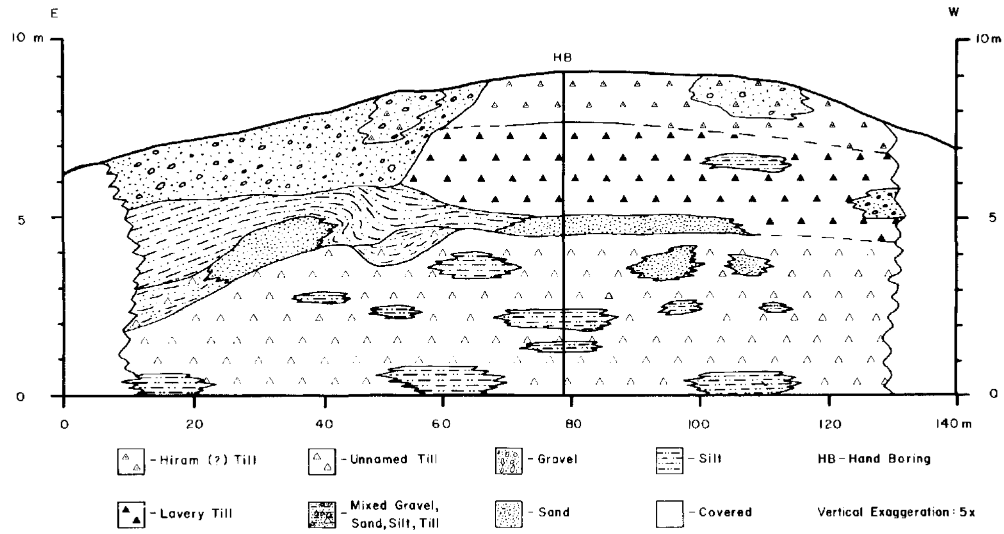

FIGURE 4. Cross-section showing the variability of materials in the Townhall Section (fig. 2).

The Hiram(?) Till weathers yellowish brown and contains almost twice as much sand as the Lavery Till. The Hiram(?) Till is separated from the Lavery Till by sand in some places but directly overlies it in other places in the roadcut (fig. 4). The Hiram(?) Till is present there on a hilltop in a moraine, which may explain why it is missing in all the other sections. In this exposure, the till is 1.6 m thick and thins laterally. Erosion probably has removed the Hiram(?) Till on most slopes except for the highest divides.

SEQUENCE OF DEPOSITION

The sequence of deposition during the Wisconsinan glaciation is best illustrated by figure 5. The bedrock of the uplands is nearly everywhere covered by Wisconsinan deposits, but in the valleys, the bedrock may be overlain by silts, sands, gravels, and tills that may range in age from Early Pleistocene to Recent. Although no material thought to be older than Wisconsinan was observed in the area, it has been suggested that the Nebraskan and Kansan glaciations may have at least affected the drainage in the area, and that Illinoian drift may be found in some of the deeper buried valleys (White 1960; Winslow and White 1966).

The Titusville (Mogadore) Till is underlain by a lacustrine silt in one section (fig. 5) and by bedrock in other locations. No radiocarbon dates were obtained for this till, but it has been dated in Pennsylvania at approximately 40,000 years before the present (White *et al* 1969). This is the oldest till found in the study area.

Overlying the Titusville (Mogadore) Till are silts and interbedded sands and gravels. The sands and gravels are cross-bedded and are 5.0 to 10.0 m thick in most places. Bain (1975) has described a number of terraces in the area and has determined these deposits to be part of a kame delta complex. She states that the pro-delta sediments consist of clays and silts. Progradation of the delta occurred by the deposition of silts and sands; as the delta extends itself, higher energy streams flowed farther out into the complex and deposited sands and gravels. This sequence was interrupted at least twice by readvances of ice that deposited the "ablation" till and till of unknown origin (fig. 5)

Silts generally are between the sands and gravels and the Unnamed Till. The glacier that deposited the Unnamed Till probably overrode the uplands and valleys that had

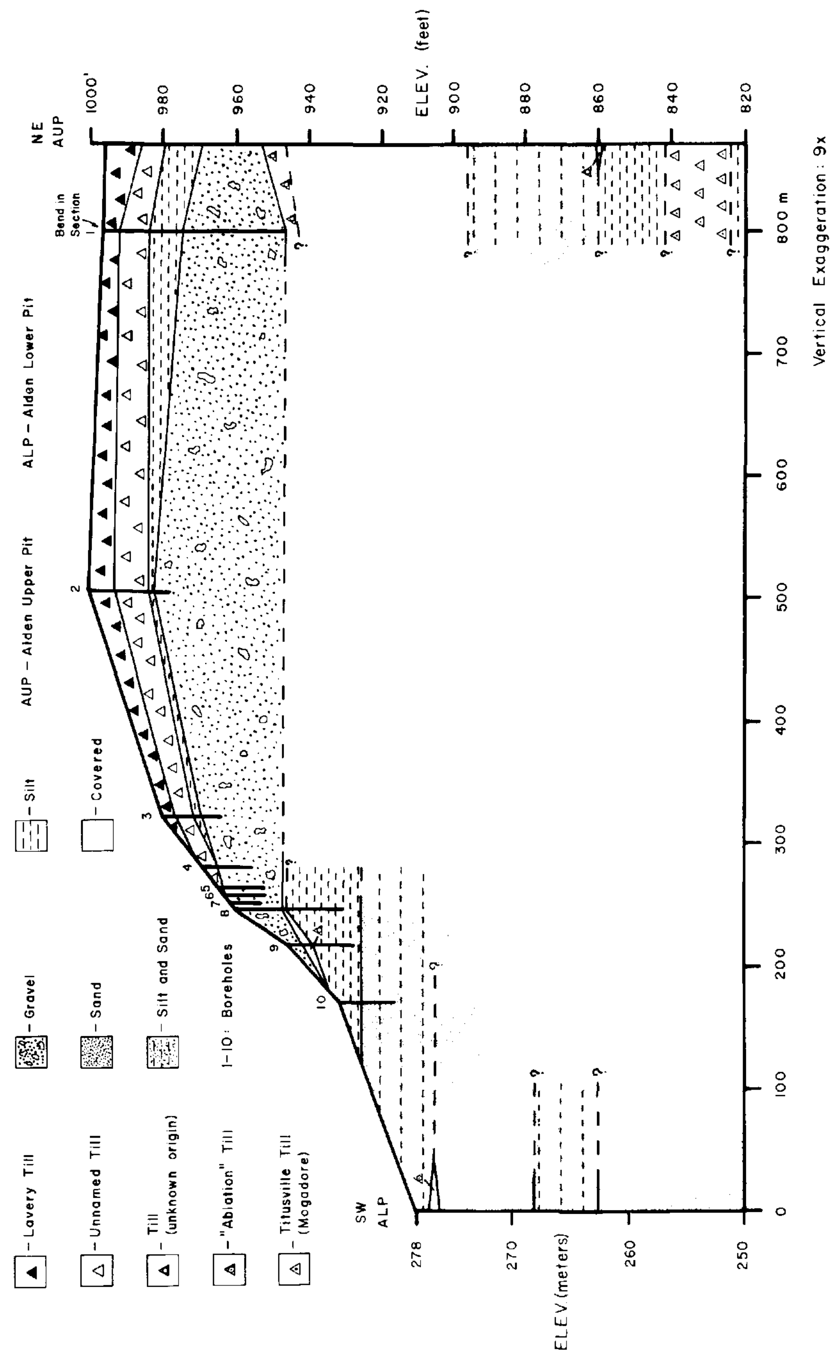

FIGURE 5. Cross-section along borehole traverse AUP—ALP (fig. 2).

been filled with sediment. This overriding is implied by the presence of the till on both sides of major valleys in the area and by the lack of the unit in the lower parts of the valleys. White (1977) has termed this till Titusville Till, where he found it in Alden's pit. The oxidized color, high silt percentage, and high density of the till are similar to those of the Titusville (Mogadore) Till, but it has a much lower quartz-feldspar ratio and much higher alkali-feldspar content than that till. The Unnamed Till is also higher in carbonate content than is the Titusville (Mogadore) Till in this area (table 1).

It is very difficult to assign a name to the Unnamed Till because of its great differences from tills described in other areas of northeastern Ohio and its similarities to younger and older tills in the study area. It is possible that this till may represent a late phase of Titusville (Mogadore) Till deposited by ice that overrode lacustrine silt and clay (White 1979). It is also possible that this till may be the stratigraphic equivalent of the Kent Till in this area. Some support for this assignment comes from the inferred margin of the Kent Ice being located in this area (Rau 1969).

Deposition of the Lavery Till followed that of the Unnamed Till. There was not much of a weathering profile developed on the Unnamed Till, indicating that there was a short time between its deposition and the advance of the Lavery Ice, or that there was a longer interval and part of the weathered till had been eroded, or that the climate was cold and weathering proceeded slowly. The Lavery Till forms the surficial material in most of the area. It appears to be equal in extent to the Unnamed Till.

The Hiram(?) Till represents the last glaciation in Northampton Township and occurs in a dissected moraine composed of the Unnamed Till. It was not observed in Alden's pit where it was reported by White (1977), but it is possible that the Hiram(?) Till had been stripped away by the time of this investigation. One of the last glacially related events was the formation of the ancestral drainage in the area. Dissection of the uplands continues at the present time.

GENERAL TRENDS

Grain size of the tills in the area show a general decrease in sand content and increase in clay content with a decrease in age of deposition. This fining upward from one till to the next (table 1) may be explained by the mantling of the sandstone and siltstone bedrock by drift of earlier glaciations (Shepps 1953). The increase in clay and silt content could be a result of the incorporation of lacustrine silts and clays as well as Devonian shale fragments (White 1951) as the ice readvanced.

Similar to the sand percentages, the quartz-feldspar ratios decrease with successive tills. This decrease may be in part a function of the decrease in sand because the less sand there is available, the less quartz there will be present. Totten (1960) suggests several possibilities to explain trends in the quartz-feldspar ratios, but regards the most likely ones to be changes in source material, changes in source area, or dilution by sedimentary quartz. The alkali-feldspar content and the total feldspar content tend to increase with decreasing age. Carbonate content also increases with decreasing age. The increase in alkali-feldspar and total feldspar contents may be a result of the higher amount of crystallines present in the younger tills (Ryan 1980). A change in source area to one of a higher alkali-feldspar content might also be indicated. Totten (1960) and Gross and Moran (1971) suggest many hypotheses for these gradations in tills. The increased carbonate content may be a reflection of the incorporation of carbonate-rich shales into the tills of younger age.

Although the values obtained from similar laboratory analyses of tills in other areas are either higher or lower than those of tills in this study, the general trends are similar. Totten (1960) reported an increase in the quartz-feldspar ratios for Late Wisconsinan tills in this area. Areal and vertical gradations in the same till and between tills have been attributed to variations in the amount of bedrock incorporated into the ice and to the distance of transport of the material. Most important to these variations is the variation in the local surficial material at the time of glaciation (White *et al* 1969, Gross and Moran 1971).

Examination of the laboratory analyses of the tills in this area suggests that the Titusville (Mogadore) Till, the till of unknown origin, and the Unnamed Till have similar source area. All three of these tills have similar quartz-feldspar ratios and carbonate content. The Titusville (Mogadore) Till and the till of unknown origin have similar grain sizes and alkali-feldspar percentages. The Unnamed Till contains numerous gray dolomite pebbles, and the Titusville (Mogadore) Till and the till of unknown origin contain several gray sandstone fragments that suggest deposition by the Grand River Lobe (Massaro 1975).

It is probable that the Lavery Till and the Hiram(?) Till are results of ice of the Cuyahoga Lobe, a sublobe of the Killbuck Lobe. The Cuyahoga Lobe glaciated northern Summit and western Portage Counties (Winslow *et al* 1953). The tills of the lobe are higher in clay and silt content than the tills of the neighboring lobes. Contamination of the drift by lacustrine silts and clays in the lobe area would explain the finer texture (Shepps 1953). The abundance of black shale fragments and the higher carbonate content support deposition by the Cuyahoga Lobe.

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