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QUATERNARY STRATIGRAPHY OF RICHFIELD TOWNSHIP, SUMMIT COUNTY, OHIO[1]

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ABSTRACT. Borings and measured sections were used to trace 3 Wisconsinan tills in Richfield Township of Summit County in northeastern Ohio. Various fluvial and glaciofluvial deposits were found underlying, overlying, and between the tills. The tills were differentiated upon the basis of stratigraphy, texture, and mineralogy. Generally, the tills grade from coarse-grained with high quartz/feldspar and alkali feldspar/plagioclase values as their age decreases. The Early Wisconsinan Mogadore Till is identified by its sandy nature and dolomitic carbonate content and may have been deposited by either the Grand River lobe or the Killbuck lobe. An unnamed till of indeterminable age has nearly equal amounts of calcite and dolomite. Not enough evidence has been acquired to determine if this till represents a readvance of Mogadore ice or a facies of the Kent (Navarre) Till. The Late Wisconsinan Lavery Till is characterized by black shale fragments. Both may have been deposited by the Cuyahoga lobe.

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INTRODUCTION

In northeastern Ohio, glaciations have subdued topography by veneering uplands and filling valleys with till, fluvial and lacustrine silts, sands, and gravel; by widening valleys; and by eroding bedrock highs (Miller 1970, Szabo et al. 1981). The tills are extremely variable in composition, thickness, and extent over both short lateral and vertical distances. The thin veneer of till on the uplands as opposed to thick deposits in the valley also makes correlations of units difficult and complicates the determination of the glacial history of an area.

Previous studies include the monograph of Leverett (1902), which was one of the first comprehensive studies of glacial drift in northern Ohio. He described properties, thickness, and extent of drift, as well as geomorphic and topographic features related to glaciations. White (1951, 1960, 1961, 1971) published numerous articles involving classification, correlation, naming, and relative dating of glacial deposits throughout northeastern Ohio and northwestern Pennsylvania. His studies also encompassed the naming and determination of the extent of various ice lobes in the region (White 1979). Other studies concern evaluation of groundwater resources of Summit County (Smith and White 1953), Cuyahoga County (Winslow et al. 1953), and Portage County (Winslow and White 1966). These include information about glacial deposits, pre- and post-glacial drainage, and underlying Paleozoic bedrock.

Several studies concerning various aspects of till were undertaken. Shepps (1953) used grain size to characterize tills throughout northeastern Ohio. Totten (1960) investigated quartz-feldspar content of many northeastern Ohio tills. A comprehensive review of mineralogy of tills including quartz-feldspar data, carbonates, heavy minerals and clay minerals was conducted in northwestern Pennsylvania by White et al. (1969).

Other reports of more local nature include the Summit County Soil Survey (Ritchie and Steiger 1974), which was instrumental in delineating both surficial and

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underlying parent materials of the Richfield area. Wittine (1970) studied lacustrine silts and clays of the Cuyahoga Valley, and Gardner et al. (1974) investigated engineering properties of deposits of the valley. Ryan (1980) did an intensive study of neighboring Northampton Township and included correlation of tills using physical stratigraphy, textural analysis, and mineralogic analysis. Field reconnaissance by Clarke and Szabo (1981) and Angle and Szabo (1981) in Furnace Run Basin on the eastern side of the study area showed 3 tills and numerous silts extend northwestward from Northampton Township.

Reconnaissance work (Szabo 1979) suggested the Cuyahoga Valley was composed of a multileveled erosional landscape. Szabo and Ryan (1981) discussed the glacial stratigraphy of an area on the east side of the valley. Further investigations by Szabo et al. (1981) implied the Quaternary stratigraphy was continuous across the Cuyahoga Valley.

The purpose of our study is to correlate glacial deposits from the west side of the Cuyahoga Valley to those of the east side and to illustrate their complexity. The availability of a large number of borings provided a way to develop a 3-dimensional picture of glacial stratigraphy.

STUDY AREA

A study area of 24 km^2 was chosen in Richfield Township in northwestern Summit County, Ohio (West Richfield Quadrangle, 1:24,000), where previous studies of Quaternary stratigraphy have been limited. Wthin this area, samples, borehole logs, and base maps were available from the Richfield Sanitary Sewer Project. In addition, many outcrops were sampled in the valley of Furnace Run east of the study area (Szabo et al. 1981). This area is drained by Furnace Run, which eventually flows into the Cuyahoga River just east of the margin of the West Richfield Quadrangle. Glaciations altered paleodrainage of this area (Smith and White 1953), and glacial deposits still predominantly control drainage of the area.

METHODS AND MATERIALS

Karl R. Rohrer Associates furnished 230 samples from 87 boreholes, drilling logs, and base maps from the Richfield Sanitary Sewer Project. Samples were recovered by means of a split-spoon, at intervals varying from 1.07 to 1.53 m. We drilled 7 hand-augered holes to augment the split-spoon samples. The sampling interval for each hand-augered hole varied from 20 cm to 1.2 m. Several sections were described at exposures along I-77 and were sampled at 20–cm intervals.

In the laboratory, textural analyses were performed using sieve and pipette methods of Folk (1974). The results were used to calculate the matrix texture (<2 mm) of till samples. Calcite, dolomite, and total carbonate percentages were determined gasometrically for the less than 74μ fraction of samples using a Chittick Apparatus (Dreimanis 1962). Quartz/feldspar (Q/F) and alkali feldspar/plagioclase (A/P) determinations were made for the fine-sand fraction (.125-.250 mm) of most till samples using a cathodoluminescent technique described by Ryan and Szabo (1981). Approximately 300 grains were counted on one slide of each sample.

RESULTS

Early Wisconsinan Mogadore Till forms surficial material in the Akron area and is found at the surface at few locations in northern Summit County. It is correlative with the Titusville Till of northwestern Pennsylvania (White 1960) and with the Millbrook Till of the Killbuck lobe (White 1961) just to the west of the study area. The Mogadore Till is found in outcrops along Furnace Run (Szabo et al. 1981) and in the Mud Brook area (Ryan 1980) just southeast of the study area. It is generally dark gray, very firm, and unweathered. In some outcrops it exhibits dark brown zones of weathering along joints, fractures, and the contacts with other unconsolidated deposits. The till averages 2.7 m thick, appears to be much more extensive laterally, and is generally closer to the surface in the Richfield Heights area (traverses G-G' through M-M', fig. 1) than in any other part of the study area. The Mogadore Till was not found in any of the measured sections IC, 77N, and 77S (fig. 1). Its absence indicates erosion in the area or simply implies the Mogadore Till lies deeper in this area, which can only be confirmed by data from deep borings. The Mogadore Till may be underlain by bedrock, silts,

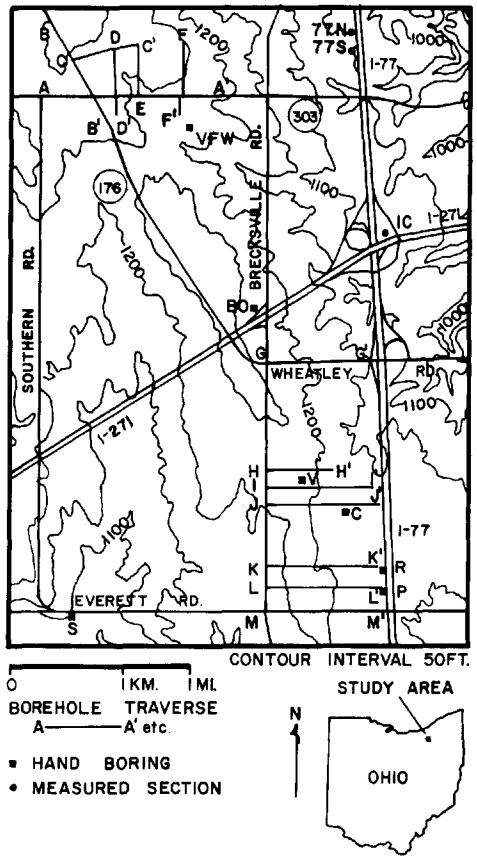

FIGURE 1. Study area in Richfield Township, Summit County, Ohio. Traverses A-A′ through F-F′ are in Richfield Village and traverses G-G′ through M-M′ are in Richfield Heights. Contours are redrawn from the West Richfield Quadrangle (1:24,000).

sandy silts, and sand and gravel (fig. 2); lenses of the unconsolidated materials are common near the base of the till.

The composition of the Mogadore Till averages 43.1% sand, 38.6% silt, and 18.3% clay (table 1). It is the coarsest till in the study area, and its texture is comparable to other locations in northeastern Ohio (White 1960, Totten 1960, and Ryan 1980). The Mogadore Till has a much lower total carbonate percentage and higher Q/F than the other tills in the study area (table 1), which is common for older tills (Ryan 1980, White et al. 1969).

The till referred to as the unnamed till was found throughout the study area and appears to be correlative with a similar till in Northampton Township (Ryan 1980). Unnamed till was found in all of the hand borings, measured sections, and many boreholes. It forms the surficial material in many parts of Richfield Heights. Oxidized samples of this till are dark brown to dark yellowish brown. Fresh samples are usually dark gray. Olive brown weathered zones occur along joints penetrating unweathered portions of the till. Black dolomite pebbles are also commonly found in the unnamed till that averages 2.2 m thick and ranges from 1.3 to 4.9 m thick. Figure 2 illustrates the complex nature of the unnamed till, the Mogadore Till, and the associated glacio-fluvial deposits.

Unnamed till is intermediate in texture between Mogadore Till and Lavery Till (table 1). The Q/F and A/P values average 5.2 and 1.9, respectively. The unnamed till was found to have the highest carbonate content of any of the tills in the study area, averaging 4.3% calcite and 5.7% dolomite.

The Lavery Till (White 1960) is commonly the surficial material in the study area, being overlain only by fill material. It generally is found on gentle slopes. Its absence on the east side of the study area (Szabo et al. 1981) may be due to erosion in the low areas, leaving only a "cap" on the interfluves. No unweathered till was found in the area. Lavery Till weathers dark brown to dark yellowish brown and averages 2.4 m thick, ranging from 1.1 to a thickness of 4.2 m in the Richfield Village area (traverses A-A′ through F-F′, fig. 1). It is almost always underlain by the unnamed till, but it is underlain by bedrock at several locations in the village.

The Lavery Till is the finest-grained till in the area, and its texture compares favorably to analyses of the till throughout northeastern Ohio. Sand content averages 21.2%, silt 43.6%, and clay 35.2%; the Q/F is 5.2 and the A/P is 2.4. The carbonate content of the Lavery Till is only slightly

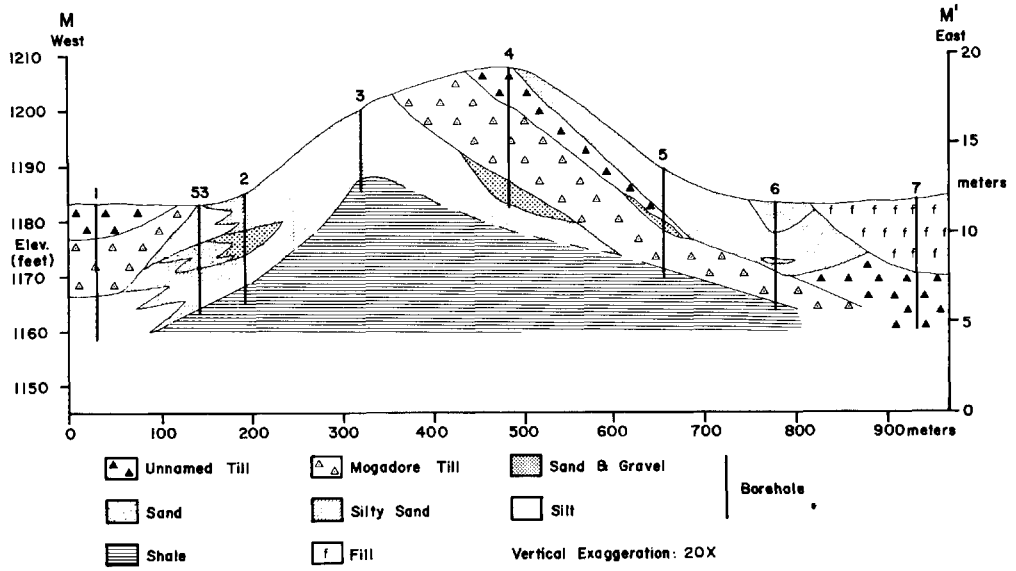

FIGURE 2. Traverse M-M′ (fig. 1) shows the complexity of the Quaternary stratigraphy.

lower than the unnamed till (table 1).

The Hiram Till was not found in the study area. This till may have been thin and removed by erosion (White et al. 1969). Many borings were taken along roads or in allotments where man may have removed the till during construction. The till may exist on summits of undisturbed hills on uplands.

Other unconsolidated deposits in the study area include silts, sandy silts, sand, gravel, and fill. These deposits (excluding the fill) are commonly found beneath, between, or on top of the various tills except for the Lavery Till, which is at the surface. These deposits generally occur in the form of lenticular deposits and are not usually laterally extensive (fig. 2). One exception is a thick, extensive, blanket-type sandy silt underlying the Mogadore Till (Angle 1981).

DISCUSSION

The stratigraphic sequence of tills in the study area as compared to the classical stratigraphic sequence for the Cuyahoga sublobe is illustrated in table 2. No evidence of pre-Wisconsinan deposits was observed in the area. The oldest till, the Mogadore Till, is underlain by extensive silts or bedrock. No radiocarbon dates were obtained, but the correlative Early Wis-

TABLE 1

Summary of laboratory analyses of till samples from Richfield Township.

Unit	No. of Samples	Grain-Size			Mineralogy		Chemical	
		Sand %	Silt %	Clay %	Q/F	A/P	Cal. %	Dolo. %
Lavery Till	109	21.2	43.6	35.2	5.2	2.4	3.7	5.7
Unnamed Till	170	26.0	43.1	30.9	6.5	2.7	4.3	5.7
Mogadore Till	58	43.1	38.6	18.3	10.7	3.0	0.5	3.7

TABLE 2

Diagram showing the stratigraphic sequence of tills for the Cuyahoga sub-lobe and for the study area. Substages of Wisconsinan glacial stage and relative ^{14}C dates are also included (modified from Dreimanis and Goldthwait 1973).

Accepted Till Sequence for the Cuyahoga Sub-lobe	Till Sequence for the Richfield Township Study Area	^{14}C Dates (in yrs. B. P.)
	WOODFORDIAN SUBSTAGE	
Hiram Till	Hiram Till (?)	15,000
Lavery Till	Lavery Till	17,000
Kent Till	Unnamed Till (?)	24,000
	ALTONIAN SUBSTAGE	
	Unnamed Till (?)	
Mogadore (Titusville) Till	Mogadore Till	45,000

consinan Titusville Till has been dated ca. 40,000 years B.P. in northwestern Pennsylvania (White et al. 1969).

The unnamed till either overlies the Mogadore Till or fluvial or glaciofluvial deposits. The till has a thin weathered zone, suggesting a short period of exposure. It may represent either a readvance of the ice sheet which deposited the Mogadore Till or a facies of the Kent (Navarre) Till (Ryan 1980). Not enough evidence has been collected to support either hypothesis.

The Late Wisconsinan Lavery Till commonly overlies the unnamed till except in areas of bedrock highs in the village where it rests on sandstone. Another Late Wisconsinan glaciation, which deposited the Hiram Till, may have affected the area to a lesser extent. Meltwater streams probably produced the last glacially-related deposits in the area. Present streams have continued to downcut since deglaciation (Clarke and Szabo 1981).

General trends for grain size, carbonate content, and Q/F and A/P values were consistent with previous data for the region (White et al. 1969, Gross and Moran 1971, Ryan 1980). Gradations within and between each till unit are probably related to several factors, especially the variations in underlying surficial materials during the time of glacial advances (White et al. 1969).

Laboratory analyses indicate a definite decrease in the sand content and an increase in the silt and clay content in successively younger tills in the study area. This fining upwards sequence conforms to previously reported trends for tills in northeastern Ohio (White 1960, Ryan 1980), and may be partially due to the decreasing influence of sandstone, as the amount of exposed sandstone decreased with each successive glaciation (Shepps 1953). The increase in the fine component results from the reworking of previously deposited fluvial and lacustrine silts or tills by each successive glacial readvance (White 1951). These retreats and advances of ice sheets in the area also may have incorporated friable Devonian shales common to the Lake Erie Basin (White 1951, Ryan 1980).

The increase of Q/F values is related to the higher sand content with increasing age. Totten (1960) suggested this trend of increasing Q/F values with age is probably due to an increase of sedimentary quartz by changes of source area during earlier glaciations. The increased percentage of quartz associated with the increase in sand content of the early till may be a result of more extensive outcrops of sandstone during earlier stages of the Wisconsinan (Szabo et al. 1981, Ryan 1980). These outcrops may have become eroded or covered during each successive glaciation, thereby restricting the imput of fresh quartz-rich material. The fact that A/P values also increase with age probably reflects the greater stability and resistance to weathering of

the alkali feldspars when exposed to surficial processes (Faure and Taylor 1981).

The general trend of increasing carbonate content with decreasing age may be attributed to several factors (Gross and Moran 1971, Ryan 1980). One possible explanation is the younger tills have incorporated carbonate-rich Devonian shales, limestones, and dolomites of the Lake Erie basin during periods of ice sheet retreat and advance. Slight increase of carbonate content going from Lavery Till to unnamed till may reflect secondary deposition of leached carbonates found in the silt fraction of joints which are common to the unnamed till. Increased carbonate content in the unnamed till also may be a result of sampling. Many of the samples of Lavery Till are from within 1.5 m of the surface. Thus, many of these samples may be partially leached. The carbonate averages for the Lavery Till (table 1) may not be representative of its actual carbonate content.

The results of the laboratory analyses suggest the unnamed till and Lavery Till probably share the same source areas as their Q/F and A/P values and carbonate contents are similar. This differs from results for the Northampton area (Ryan 1980) in which the unnamed till seemed to be more closely related to the Mogadore Till. Further studies are needed to determine whether the unnamed till is one unit which exhibits extensive lateral variations between the townships or is actually 2 separate tills. In the Richfield area, the Mogadore Till differed texturally from finer-grained Lavery and unnamed tills which may have been deposited by the Cuyahoga lobe, a sub-lobe of the Killbuck lobe (Winslow et al. 1953, Ryan 1980). Whether this indicates a different source area for the Mogadore Till or simply is a result of several cycles of retreat and advance which incorporated local materials has yet to be determined. This problem can only be resolved by conducting more studies throughout the region or perhaps by studying the microfabric or heavy mineral content of tills in the region. Based on carbonate content, the Mogadore Till is similar to that associated with the Grand River lobe (White et al. 1969). But based on the Q/F values, it also may be related to the Millbrook Till of the Killbuck lobe (Totten 1960). More work remains to be done on determining the source of the Mogadore Till.

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LITERATURE CITED

Angle, M. P. 1981 Quaternary stratigraphy of part of Richfield Township, Summit County, Ohio. Unpubl. M. S. Thesis, Univ. of Akron, OH 155 p.

——— and J. P. Szabo 1981 Quaternary stratigraphy of Furnace Run Basin, Richfield Township, Summit County, OH. Ohio J. Sci. (abstr. issue) 81: 42.

Clarke, B. G. and J. P. Szabo 1981 Geomorphology of Furnace Run Basin, Summit County, Ohio. Ohio J. Sci. (abstr. issue) 81: 38.

Dreimanis, A. 1962 Quantitative gasometric determination of calcite and dolomite by using a Chittick Apparatus. J. Sed. Pet. 32: 520–529.

——— and R. P. Goldthwait 1973 Wisconsin glaciation in the Huron, Erie, and Ontario lobes. *In*: R. F. Black, R. P. Goldthwait and H. B. Willman (eds.) The Wisconsinan stage. Geol. Soc. Amer. Mem. 136: 71–106.

Faure, G. and K. S. Taylor 1981 Feldspar fractionation by glaciers. Ohio J. Sci. (abstr. issue) 81: 43.

Folk, R. L. 1974 Petrology of sedimentary rocks. Hemphill Publ. Co. Austin, TX 182 p.

Gardner, G. D., A. H. Wittine, M. R. McComas, B. B. Miller and R. W. Manus 1974 Engineering and Pleistocene geology of the lower Cuyahoga Valley. *In*: R. A. Heimlich and R. M. Feldman (eds.) Selected field trips in northeastern Ohio. Ohio Geol. Surv. Guidebook no. 2, p. 43–59.

Gross, D. L. and S. R. Moran 1971 Grain-size and mineralogic gradations within tills of the Allegheny Plateau. *In*: R. P. Goldthwait (ed.) Till: a symposium. Ohio State Univ. Press, Columbus, OH. p. 251–274.

Leverett, F. 1902 Glacial formations and drainage features of the Erie and Ontario basins. U. S. Geol. Surv. Monogr. 41, 802 p.

Miller, B. B. 1970 The Quaternary period. *In*: P. O. Banks and R. M. Feldman (eds.), A guide to the geology of northeastern Ohio. Northeast Ohio Geol. Soc. p. 149–163.

Ritchie, A. and J. R. Steiger 1974 Soil survey of Summit County, Ohio. U. S. Dept. of Agriculture. 117 p.

Ryan, D. E. 1980 Quaternary stratigraphy of the lower Mud Brook Basin, Northampton Township, Summit County, Ohio. Unpubl. M. S. Thesis, Univ. of Akron, OH. 140 p.

——— and J. P. Szabo 1981 Cathodoluminescence of detrital sands: a technique for rapid determination of the light minerals of detrital sands. J. Sed. Pet. 51: 669–670.

Shepps, V. C. 1953 Correlation of the tills of northeastern Ohio by size analysis. J. Sed. Pet. 23: 34–48.

Smith, R. C. and G. W. White 1953 Groundwater resources of Summit County, Ohio. Ohio Dept. of Nat. Res. Div. Water Bull. 27, 130 p.

Szabo, J. P. 1979 Stratigraphy of multiple till exposures in Northampton Township, Summit County, Ohio. Ohio J. Sci. (abstr. issue) 79: 32.

——— and D. E. Ryan 1981 Quaternary stratigraphy of the lower Mud Brook Basin, Northampton Township, Summit County, Ohio. Ohio J. Sci. 81: 239–246.

———, M. P. Angle and B. G. Clarke 1981 Geomorphology and quaternary stratigraphy of Furnace Run Basin, Summit County, northeastern Ohio. Geol. Soc. Amer. (abstr. issue) 13: 318.

Totten, S. M. 1960 Quartz-feldspar ratios of tills in northeastern Ohio. Unpubl. M. S. Thesis, Univ. of Illinois, Urbana. 36 p.

White, G. W. 1951 Illinoian and Wisconsin drift of the southern part of the Grand River lobe in eastern Ohio. Geol. Soc. Amer. Bull. 62: 967–978.

——— 1960 Classification of Wisconsin glacial deposits in northeastern Ohio. U. S. Geol. Surv. Bull. 1121-A, 12 p.

——— 1961 Classification of glacial deposits in the Killbuck lobe northeast-central Ohio. U. S. Geol. Surv. Prof. Paper 424-C, p. 71–73.

——— 1971 Thickness of Wisconsinan tills in the Grand River and Killbuck lobes. *In*: R. P. Goldthwait (ed.), Ohio State Univ. Press, Columbus p. 149–163.

——— 1979 Extent of till sheets and ice margins in northeastern Ohio. Ohio Geol. Surv. Note 6 (map).

———, S. M. Totten and D. L. Gross 1969 Pleistocene stratigraphy of northwestern Pennsylvania. Pa. Geol. Surv. 4th ser. Bull. G-55, 88 p.

Winslow, J. D., G. W. White and E. E. Webber 1953 The water resources of Cuyahoga County, Ohio. Ohio Dept. Nat. Res., Div. Water Bull. 26, 126 p.

——— and ——— 1966 Geology and groundwater resources of Portage County, Ohio. U. S. Geol. Surv. Prof. Paper 511, 80 p.

Wittine, A. H. 1970 A study of a Late Pleistocene lake in the Cuyahoga Valley, Summit County, Ohio. Unpubl. M. S. Thesis. Kent State Univ., OH. 64 p.