

Correlation of the Three Tills of Logan County, Ohio¹

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ABSTRACT. The author identified three Late Wisconsin tills in Logan County in 1956, related them to soils in 1965, and named them the Marysville, Bellefontaine, and Pickrelltown in 1967, but included no correlations, which have since become established and are reported here. The Marysville Till is the youngest, is clay-rich and almost pebble-free, and has a shallow soil (Morley-Blount). Next older (south) is the Bellefontaine, with a loamy, pebbly texture and also a shallow soil (old Miami 6A). Oldest and southernmost is the loamy, pebbly Pickrelltown Till, which has a deeper soil with a B3 horizon (old Miami 60).

Correlation with other tills is based on field tracing of associated textures, soils, and end moraines. In western, high-lime terrain, the Marysville Till correlates with Gooding's (1963) Union City till and Goldthwait's (1965) "Hiram" Drift, later named Olentangy (Goldthwait 1989). The Bellefontaine Till correlates with Gooding's (1963) Bloomington till, later renamed the Knightstown Till by Gooding (1973) and Stewart (Goldthwait and Stewart 1981) in the Miami Lobe, and with Goldthwait's (1965, 1969) Darby in the Scioto Lobe. The Pickrelltown Till correlates with Gooding's (1963) Champaign till, later renamed the Crawfordsville Till by Gooding (1973) and Stewart (1981), and with Goldthwait's (1965) older Darby Drift, which he later renamed the Caesar Till (1969).

Correlation with low-lime tills in eastern Ohio was more difficult, except for the clay-rich Marysville Till, which clearly correlates with White's (1967, 1982) Hiram Till. However, continuous tracing of the two loamy tills (Bellefontaine and Pickrelltown) and their related characteristics around the Scioto Lobe led to my identification (in Root et al. 1961) of two Late Wisconsin tills (unnamed) in Knox County. The two Late Wisconsin tills were associated with two phases of the low-lime Alexandria soil there, the "Centerburg" (younger) and "Mount Liberty" soils, with contrasting characteristics very similar to those of the two soils in the Bellefontaine and Pickrelltown Tills, and also to the soils in White's (1967, 1982) Hayesville and Navarre Tills in northeast Ohio. (White's different correlation [1982, Table 2] is interpreted to be a simple error, because White was a competent scientist, fully aware of the unique clay-rich nature of his Hiram Till, that could only correlate not with my loamy Centerburg till but with the clay-rich tills of western Ohio, Goldthwait's "Hiram"/Olentangy and my Marysville.)

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CORRELATION OF THE THREE TILLS OF LOGAN COUNTY, OHIO

More than three decades ago, as a graduate student at Ohio State University, I mapped the glacial geology of Logan County in western Ohio, and identified three "Late Wisconsin" (Woodfordian) tills there (Forsyth 1956). Correlation of these tills with soils (as defined by soils scientists at that time) was subsequently published (Forsyth 1965), though the tills remained unnamed. These tills were later formally named in a publication on the glacial geology of the East Liberty Quadrangle in southeast Logan County (Forsyth 1967), with local names being used because of the uncertainty then about their correlation with other tills elsewhere in Ohio. Now, many years later, the correlation of these Logan County Wisconsinan tills with others, both within the state and beyond, seems fairly well established and deserves to be reported.

The Three Tills of Logan County

The three tills originally identified in Logan County (Forsyth 1956) and named in the quadrangle report (Forsyth 1967) are, in order of increasing age, the Marysville, Bellefontaine, and Pickrelltown Tills. These tills were distinguished from each other on the basis of their

geographic position, their textures in both the parent till and the B horizon of the related soil, and other soil characteristics (as reported in Forsyth 1965, though the tills were not named there).

The Marysville Till occurs to the north, on and north of the Powell End Moraine, and is characterized by a clayey (clay to clay loam) texture with relatively few pebbles. It has a Morley-Blount soil (once called Miami 6B by soils scientists) developed in it, a soil with a clay texture leached to depths of about 60 cm (24 in), and lacking any clear-cut B3 horizon (Forsyth 1965). Because of the high clay content of the till, surfaces of roadside exposures commonly exhibit a poorly developed "mud-crack" pattern.

The Bellefontaine Till is found farther south, from south of the Powell End Moraine to as far south as the southern boundary of the Farmersville End Moraine. Typically, this unweathered till has a loam texture and is quite pebbly. The soil developed in it is characterized by a clay texture and a somewhat sticky consistency, and also lacks a B3 horizon. This is the only one of the three tills in which the increase in clay content from the parent till to the soil B horizon is especially great, a feature interpreted by Wilding et al. (1971) to be the result of intense leaching of this very limy till, a process which removed a significant amount of bulk from the soil while concentrating the residual clay in the soil B horizon, increasing its stickiness. This would also explain the relatively shallow depth of leaching of this soil, which averages only about 62 cm (25 in), almost the

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same as that of the younger Marysville Till. The soil in the Bellefontaine Till was called the Miami 6A in the older soils classification (Forsyth 1965), though present soils terminology combines this soil and the deeper soil formed in the Pickrelltown Till, the old Miami 60, into the modern Miamian Soil.

The Pickrelltown Till occurs to the south of both of the other tills and is not related to any end moraine in the Logan County/East Liberty area (though correlation beyond this area to the east would relate it to the Cuba Moraine). This till, like the Bellefontaine Till, has a loam texture and is quite pebbly, but the soil formed in this till (the old Miami 60 [Forsyth 1965] or Miamian of the modern soils classification) is significantly deeper (90 cm [30–40 in]), has a well-developed B₃ horizon, and generally lacks the stickiness of the Miami 6A soil (Forsyth 1965). Despite all these contrasting characteristics, I would not be able to distinguish between the Bellefontaine and Pickrelltown Tills without reference to their associated soils, though the more southerly location and the distinctly deeper, more weathered soil found in the Pickrelltown Till are clear indications that this till is indeed a separate and somewhat older Woodfordian unit than the Bellefontaine Till.

When work was done preparatory to publishing the East Liberty Quadrangle report (Forsyth 1967), it was also noted that the species of trees in mature woodlots appeared to differ somewhat on the three different tills, though this distinction was not striking nor definitive, especially in light of the scattered occurrence of mature woodlots in the area, so this characteristic was not used as a basis for mapping the tills, though in places it did provide a suggestion as to their identities. The woodlot contrast observed showed swamp-forest species (elm, ash, red maple) occurring characteristically on the poorly drained, heavy clays of the Marysville Till; almost pure sugar-maple stands on the Bellefontaine Till; and tuliptree, sugar maple, and beech on the Pickrelltown Till.

CORRELATION WITH TILLS IN NEIGHBORING AREAS OF HIGH-LIME TILLS

With all the more recent studies and mapping done in western Ohio by R. P. Goldthwait and his associates, correlation of the Logan County tills with tills in neighboring counties to the east is generally obvious, though terminology has varied somewhat. Basis for this correlation is continuous field tracing of tills, associated soils, and related end moraines, and also of overall regional patterns.

The tills in west-central Ohio were first named by Goldthwait in 1965 (Goldthwait and Forsyth 1965) as the "Hiram" (a name already in use by George White for a clay-rich till in northeast Ohio [DeLong and White 1963]) for the clay-rich till on and north of the Powell Moraine and the Darby (south of the Powell Moraine). This terminology was expanded by Goldthwait and Rosengreen (1969), working in the Scioto Lobe east of Logan County, using definitions based on till textures and geographic positions, by limiting the name Darby to the till on and north of the Reesville Moraine (and south of the Powell Moraine), and introducing the name Caesar for the till south of the Reesville Moraine. Correlation of the Logan County tills with these tills named by Goldthwait and

Rosengreen (1969) equates the clay-rich Marysville Till with their "Hiram" Till, the Bellefontaine Till with their Darby Till, and the Pickrelltown Till with their Caesar Till (Table 1).

Goldthwait used these same names four years later in two different publications (Dreimanis and Goldthwait 1973, Goldthwait 1976), these papers adding names for two younger tills in the area lying north of Logan County: the Tymochtee Till occurring immediately north of the Hiram Till, and the Lake Till occurring still farther north (in the area of the Hoytville/St. Clair soils [Forsyth 1965]). In a more recent publication (1989), Goldthwait, apparently unsure of the true correlative of White's clay-rich Hiram Till in western Ohio, used a different name, Olentangy Till, for the till he had previously called "Hiram" (equivalent to my Marysville Till in Logan County). (Goldthwait also, in the abstract for that same 1989 paper, mistakenly associates the "St. Clair" [Hoytville-St. Clair] soils with his Tymochtee Till, though those soils do not extend south of the Defiance End Moraine, their distribution being limited to the area of his Lake Till [Dreimanis and Goldthwait 1973], while it is moderately clay-rich Morley-Blount soils that occur associated with his Tymochtee Till.)

Some have questioned correlations that involve, along with other methods, tracing of tills along end moraines (Totten 1969). George White, Stanley Totten, and others working with them in glaciated eastern Ohio have shown that many tills there are thin, occurring as thin veneers over pre-existing glacial features, where end-moraine topography is commonly inherited from an earlier glacial event (White 1962). Cut after cut in eastern Ohio supports this interpretation, so that using end moraines as a basis for correlation of surface tills there would indeed produce erroneous results. Indeed, I made the same interpretation for the Johnstown Moraine in Knox County, based on the pattern and distribution of the tills there and the massive nature and regional implications of this moraine.

In western Ohio, however, deep cuts reveal thick surface tills, while the existence of inherited end moraines thinly covered by later tills has not been demonstrated anywhere, despite the published warning about them (Totten 1969). Indeed, all exposed sections, well records, and regional patterns of tills in western Ohio uniformly support the interpretation that end moraines there were formed by the till found at their surface; thus, use of end-moraine tracing is indeed a viable tool in the regional correlation of tills there.

Even so, evidence of a regional Woodfordian stratigraphy of thick till units does exist in western Ohio. The surface distribution of a younger clay-rich till (Marysville) to the north and a slightly older, more loamy, pebbly till (Bellefontaine-Pickrelltown) to the south in west-central Ohio is duplicated in a stratigraphic section exposed along the Auglaize River in northwest Ohio (Forsyth 1960). There, below up to 3 m (10 ft) of alluvial and lacustrine sediments, a clay-rich till about 6 m (18 ft) thick overlies a loamy, more compact, pebbly till about 3 m (8 ft) thick lying on bedrock (Devonian Ohio Shale). The two tills are separated by a well-developed but somewhat discontinuous pavement of dolomite and crystalline boulders and cobbles, all with their upper surfaces strongly beveled and striated

TABLE 1

Correlation of Logan County Tills with High-Lime Tills in Ohio and Eastern Indiana.

Gooding, 1963	Gooding, 1973	Goldthwait and Stewart, 1981	Forsyth, 1967, 1989	Goldthwait and Forsyth, 1965	Goldthwait and Rosengreen, 1969	Goldthwait, 1989
West: Miami Lobe (Indiana and western Ohio)			Logan County Interlobate	East: Scioto Lobe (central Ohio)		
—	Union City Till	—	Marysville Till	Hiram Drift	Hiram Till	Olentangy Till
Bloomington till	Knightstown Till	Knightstown Till	Bellefontaine Till	Darby Drift	Darby Till	Darby Till
Champaign till	Crawfordsville Till	Crawfordsville Till	Pickrelltown Till		Caesar Till	Caesar Till

(striations oriented S 53–62 W). The same textural stratigraphy is reported from most water-well logs in northwest Ohio: a surficial “clay” (till), generally about 3 to 6 m (10–35 ft) thick, lying on “hardpan” (compact, pebbly, more loamy till), suggesting that this Auglaize-River-section glacial stratigraphy is widespread in northwest Ohio.

Textures of these two tills exposed along the Auglaize River agree strikingly well with those of the Marysville and Bellefontaine/Pickrelltown in Logan County. They also match the textures of the Hiram (“Late Cary”) and Navarre (“Tazewell”) Tills of eastern Ohio (Shepps 1953), and those of the two tills (clayey Port Stanley Drift over the more loamy, pebbly Catfish Creek Drift) found along the north shore of Lake Erie in Ontario (Dreimanis and Reaveley 1953, Forsyth 1960). Despite this widespread till stratigraphy, there is no place in western Ohio between this Auglaize River cut and Logan County where the lower, loamy till is exposed; the younger surface till is too thick. Despite the remarkable uniformity of this till stratigraphy across a broad region of the midwest, tills in western Ohio give no evidence of forming the thin veneers over older end moraines that is so characteristic of eastern Ohio, so correlation based in part on tracing of tills in relation to associated end moraines, together with related till and soils characteristics, appears to be sound in western Ohio.

Correlation of the Logan County tills westward is readily accomplished by direct tracing of till characteristics, related soils, and associated end moraines. Terminology to the west originated with Gooding’s work in adjacent Indiana (Gooding 1963, 1973), where tills were first named for their related end moraines, names that were later changed (Gooding 1973) before being extended eastward and used, with modification, by Stewart and his students (Goldthwait and Stewart 1981).

The westward equivalent of the Marysville Till of Logan County, still clay-rich and occurring on and north of the Union City End Moraine (the western, Miami-Lobe equivalent of the Scioto-Lobe Powell Moraine to the east), was called Union City till by Gooding (1973), though Goldthwait, in that same year, suggested the equivalence

of this clayey till to the “Hiram,” as he was using this name at that time (Dreimanis and Goldthwait 1973) (Table 1). South of the Union City (Powell) Moraine is another till, similar in character and position to the Bellefontaine Till of Logan County, called the Bloomington till by Gooding (1963), later renamed the Knightstown (Gooding 1973, Goldthwait and Stewart 1981). The western equivalent of the Pickrelltown Till is composed of two units, the more northern (younger) Champaign till (Gooding 1963), later renamed the Crawfordsville Till (Gooding 1973, Goldthwait and Stewart 1981), and the (older) Shelbyville till (Gooding 1963, 1973; Goldthwait and Stewart 1981) (Table 1). Whether the Pickrelltown till is actually equivalent to both of these units or just to the younger one is not clear, but, because the area of the Pickrelltown till in Logan County and East Liberty quadrangle is small, it probably just equals the younger unit. Though the Crawfordsville and Shelbyville Tills differ in their sedimentary characteristics and their geographic positions, the age differences between them are not great, as was pointed out both by Gooding (1963) and by Stewart (Goldthwait and Stewart 1981). All of these authors also identify older Late Wisconsinan tills, which are not mentioned here because equivalent units are lacking in the Logan County area.

CORRELATION WITH LOW-LIME TILLS IN EASTERN OHIO

Glacial tills in east-central and northeastern Ohio contain much less lime than do the western-Ohio tills, which changes both their composition and their associated soils. This change occurs because the tills are closely related in character to the underlying bedrock, which, on the eroded surface now buried beneath the extensive glacial cover, forms long, broad, north-south bands, created by preglacial stream erosion cutting across the gently dipping Paleozoic sedimentary rocks that make up Ohio’s bedrock. Dominant in western Ohio are early Paleozoic carbonate rocks, mostly Silurian dolomites west of the Bellefontaine Devonian Outlier and mostly Devonian limestone east of the Outlier (creating the basis for

Goldthwait's pebble-count distinction in western Ohio between tills deposited by the western, Miami Lobe, and by the eastern, Scioto Lobe [Goldthwait 1955]). Eastern Ohio is dominated by late Paleozoic clastics, the Mississippian sandstones creating a significant, if locally glacially obscured, escarpment representing the western margin of the Appalachian Plateaus, a topographic feature clearly evident in Cleveland Heights, the higher land east of Columbus, and the hills north of Chillicothe. Immediately west of this escarpment are acid Devonian shales. Thus, a distinct boundary is created, along a generally north-south line passing roughly through the center of the state, separating mostly limy carbonate bedrock to the west and acid shales and sandstones to the east, which results in high-lime tills in western Ohio and low-lime tills in northeastern Ohio.

Correlation eastward of the glacial tills and their related soils in western Ohio has been hampered by this high-lime/low-lime boundary, a difficulty increased by the topographic effects of the Mississippian escarpment and associated sandstone hills on the nature and distribution of the glacial deposits and the glacial motion that created them. End moraines in western Ohio are generally classic, linear, easily followed, hummocky-surfaced ridges of high-lime till but, traced into the low-lime sandstone landscapes of eastern Ohio, they degenerate into hard-to-correlate pockets of "hummocky moraine" (a useful term coined and used extensively by George White [White 1977]) composed of low-lime till. Correlation of the different ages of glacial tills from the flat, high-lime terrain of western Ohio into the hilly, low-lime terrain of eastern Ohio is thus truly challenging. Compounding the problem of correlation is the fact that two different groups of mappers, both composed of competent and dedicated scientists, have been working in the two areas: George White, Stanley Totten, and their cohorts in eastern Ohio; and Dick Goldthwait and his associates in western Ohio. Trying to trace the different tills, the different related soils, and the different landscape features from which the glacial history is interpreted across this no-man's-land of changing till textures, changing soil characteristics, scattered glacial deposits, and thin till covers over pre-existing moraines, plus different approaches to the glacial interpretations, has created a problem in correlation that is still not fully resolved.

Tracing of the Logan County tills eastward across the carbonate plains of the Scioto Lobe in central Ohio was relatively easy and was reported above. It was on the east side of this lobe, east of Columbus, Delaware, and Marion, where the change to more acid, more resistant bedrock modifies the composition of the tills and the character of the related soils, and creates hilly topography that breaks up the orderly end moraines into scattered pockets of hummocky moraine, that the eastward correlation of the Logan County tills became difficult. Even there, the clay-rich Marysville Till (Goldthwait's "Hiram" or Olentangy Till) was fairly easy to follow, since its clay-rich texture persists eastward, and its boundary has been followed into central Morrow County (Table 2).

Tracing of the other two Logan County tills eastward was more of a problem. The two soils associated with these tills, the old Miami 6A and Miami 60 (now combined

TABLE 2

Correlation of Logan County Tills across Scioto Lobe to Low-Lime Tills in Northeastern Ohio.

Logan County Interlobate	Scioto Lobe (east-central Ohio)			Killbuck Lobe (northeast Ohio)
Forsyth, 1967, 1989	Goldthwait and Rosengreen, 1969	Goldthwait, 1989	Root, Rodriguez, and Forsyth, 1961	White, 1982
Marysville Till	Hiram Till	Olentangy Till	—	Hiram Till
Bellefontaine Till	Darby Till	Darby Till	Centerburg ("soil") till	Hayesville Till
Pickrelltown Till	Caesar Till	Caesar Till	Mount Liberty ("soil") till	Navarre Till

by soils scientists into the Miamian soil), followed eastward, together become the low-lime Alexandria soil, so existing soils mapping provided no help. As a result, while working at the Ohio Geological Survey during 1956-1960, I did extensive field work trying to trace these tills into eastern Pickaway and southeastern Franklin Counties, carefully following the differences in the two high-lime soils eastward into the area of low-lime Alexandria soil, and ultimately producing a personally satisfying boundary line, within the area of the low-lime Alexandria soil, that separated two low-lime variations in the Alexandria soil whose differences were similar to and on the same order of magnitude as the Miami 6A and 60 soils to the west (mapped in Figure 37 of the Knox County bulletin [Root, Rodriguez, and Forsyth 1961]).

This identification of the eastward equivalents of the old Miami 6A and Miami 60 soils, and thus of the correlatives there of the Bellefontaine and Pickrelltown Tills, within the area of the low-lime Alexandria soil, was subsequently extended northward into Knox County (Root, Rodriguez, and Forsyth 1961). Here two different tills were identified, characterized by two different "soils" developed in them. The tills were not named, but names were given to the "soils": "Centerburg" for the shallower soil developed in the younger till and "Mount Liberty" for the deeper soil occurring in the older till. The Centerburg "soil" was loamy and generally 75-110 cm (30-45 in) deep, was weakly developed, and lacked both a B3 horizon and a silt cap (Goldthwait had already shown that, in western Ohio, silt caps tended to occur only on older tills [Goldthwait 1968]). In contrast, the Mount Liberty "soil," which was also loamy, was about 90-150 cm (38-60 in) deep, showed moderately strong soil development, and had both a B3 horizon and a silt cap (for more complete "soils" data, see Table 13 in Root, Rodriguez, and Forsyth [1961]). In terms of geographic location, the younger Centerburg till in Knox County lay, not to the north of the older one, but to the west of it, because this region lies on the eastern margin of the Scioto

Lobe; as that ice lobe advanced southward and enlarged, its eastern margin expanded eastward up over the Mississippian escarpment and on beyond to across the sandstone hills in Knox County.

Both of these "soils" are mapped as Alexandria soil by soils scientists, though Donald Urban (regional soils mapper for the Soil Conservation Service there at that time, personal communication, 1959) also recognized these distinctions between them. However, because the "soils" that I recognized and the names that I gave them were not officially defined soils series, properly described by soils scientists, all references to these "soils" are enclosed in quotation marks, here and in the original bulletin, even though this makes for awkward reading, especially when the tills themselves were not named (for which I apologize) (Root, Rodriguez, and Forsyth 1961).

Correlation of these two tills in Knox County with the Bellefontaine and Pickrelltown Tills of Logan County seems justified for two reasons. First, careful continuous field tracing of the two Logan County tills, together with their associated soils and end moraines, has been done all the way around the Scioto Lobe to Knox County (mapping shown in Figure 37 of the Knox County report [Root, Rodriguez, and Forsyth 1961]). Secondly, though the Knox County tills are different chemically from the Logan County tills, the nature and order of magnitude of the differences between the soils developed in the two tills in each area (depth, intensity of soil formation, presence or absence of a B3 horizon, and so forth) are very similar, so this correlation seems truly sound.

Knox County lies immediately adjacent to northeastern Ohio counties mapped by White and his associates, specifically Wayne (White 1967), Ashland (White 1977), and Richland counties (Totten 1973). Thus, this area should help to provide a solution to the correlation problem between northeastern and western Ohio. Certainly for me, the clay-rich till on and north of the Powell Moraine in the Scioto Lobe (my Marysville Till, Goldthwait's "Hiram" or Olentangy Till) neatly matches the nature and northern location of White's Hiram Till in the Killbuck Lobe of northeast Ohio (White 1961, 1967, 1982) (Table 2). Nowhere else farther south, in either eastern or western Ohio, is there any such clay-rich till present (except for a small area northwest of the town of Marysville in Union County, where the till was locally clay-enriched because of immediately adjacent lake clays).

The two Knox County tills, the Centerburg and the Mount Liberty (and their counterparts in Logan County, the Bellefontaine and Pickrelltown Tills), seem to me to match very well the nature, textural characteristics, and regional relationships of the Hayesville and Navarre Tills in the Killbuck Lobe of northeast Ohio (White 1961, 1967, 1977, 1982; Totten 1973) (Table 2). Even though this correlation seems to fit extremely well, it is not the correlation presented in White's summary publication on the glacial geology of northeast Ohio (White 1982, Table 2), where his clay-rich Hiram Till is shown as correlating with my loamy Centerburg till, and his shallow, loamy Hayesville Till is shown as equivalent to my more deeply weathered Mt. Liberty till. Actually, textural and weathering characteristics of his Hayesville Till are remarkably like

those of my Centerburg till, and his Navarre Till looks very much like my Mount Liberty till, all of these tills lying far to the south and east of the clay-rich till (White's Hiram, Goldthwait's "Hiram" or Olentangy, my Marysville) (and my Knox Lake till, oldest Knox County Wisconsinan till, is so much more deeply weathered than the other Wisconsinan Knox County tills, that both Don Urban, soils scientist in the county then, and I had difficulty in distinguishing it from soil in Illinoian till). George White's work throughout his life has consistently been sound, perceptive, and impeccable, so I cannot believe that this was the correlation that he really intended. Rather I would guess that this was just a mistake that crept in as the volume was being completed, an easy thing to have happen, and I feel sure that if this fine gentleman were able to see this awkward correlation in his otherwise outstanding summary volume, he would agree with my suggested revised correlation of his Hiram Till with the "Hiram" / Olentangy and Marysville Tills to the west, and much of the present controversy would be resolved.

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