Proceedings of the Indiana Academy of Science
(1987) Volume 97 p. 489-496.

Some Properties of Glacial Till and Till-derived Soil Horizons in East Central Indiana

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Introduction

Indiana recently completed a 10-year accelerated soil survey program which resulted in every county in the state being mapped. During this time of intensive study, soil scientists gained considerable knowledge about most of the soils which enabled them to make more accurate soil interpretations. Some series concepts have been narrowed to better reflect these interpretations which have made soil surveys more useful to farmers, homeowners, land use planners and other users of soils information. As a consequence of defining soil series more specifically, some similar soils were assigned different names in nearby counties. Now that the field work has been completed for all the modern surveys we have the opportunity to integrate the information in the individual surveys by examining the geography of soils from a regional viewpoint, rather than by counties, and by using the same definitions for all soils.

In the glaciated region, many soil differences are related to the nature of the glacial till on which they formed. To learn how the till varied regionally, Franzmeier et al. (1985) summarized existing information about properties of the till by geographic areas. That summary showed that there could be major differences among the tills of east-central Indiana where several glacial lobes came together. Most of the till of the region was deposited by the East White sublobe of the Ontario-Erie glacial lobe, but the eastern part of it (areas 6 and 8 in Franzmeier et al.) was deposited by the Miami sublobe. However, the number of observations in this area was too small to characterize the patterns accurately.

The objectives of this study were to run additional transects and analyses (1) to characterize the geographic differences, if any, in several properties of the glacial tills in east-central Indiana, (2) to characterize the geographic differences in the clay content of the till-derived B horizons, and (3) to examine the relationship to the clay content of the B horizons to that of the underlying till.

Methods and Materials

Two transects were laid out through Madison, Hancock, Delaware, Henry, Randolph, and Wayne Counties (Figure 1). These transects are all in the Cartersburg Till member of the Trafalgar formation (Wayne, 1963). The transect region had been subdivided into five areas in the previous study (Franzmeier et al., 1985) to look for possible differences in till due to the origin of the glacier that deposited it.

Along each transect a potential site was located on the summit position of the local landscape in every section. This site was sampled if the soil were formed in till and if permission could be obtained from the property owner. Most of the sites

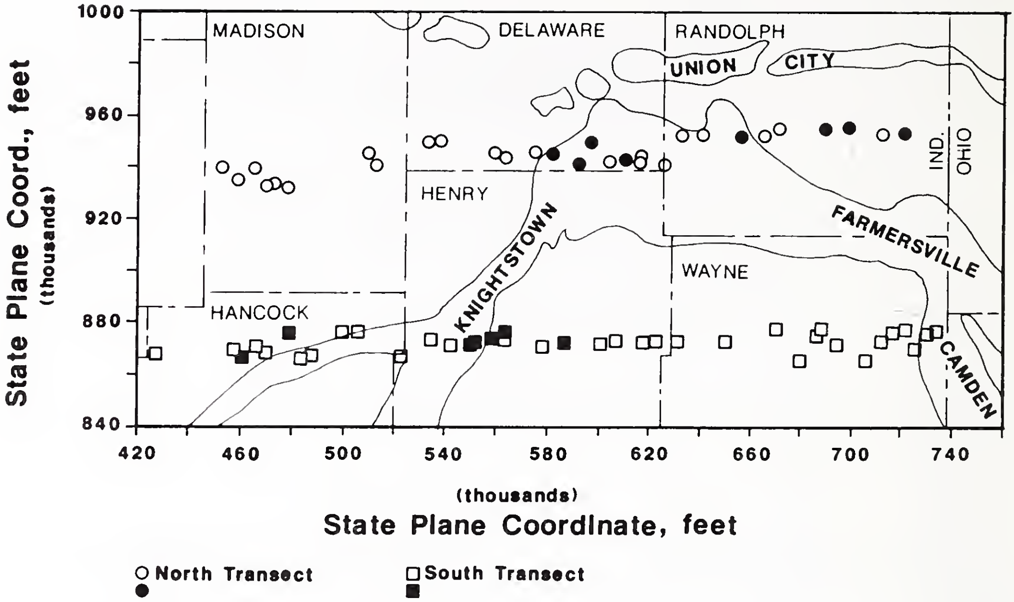

FIGURE 1. Map of east-central Indiana showing the locations of the moraines and sampling sites in the Indiana state plane coordinate system, east zone. The solid symbols represent the sites in which the glacial till contained more than 20% clay.

were on nearly level landscape swells with a thin (< 20 inches) loess cap. The soils at these sites were in the Crosby series (Aeric Ochraqualf, fine, mixed, mesic). Some sites were on gently sloping steeper summits, had a thinner loess cap, and were well drained. These soils were mainly in the Miami series (Typic Haplaudalf, fine-loamy, mixed, mesic).

Samples were collected with a truck-mounted hydraulic probe to a depth a few feet into the calcareous till. The core samples were wrapped in freezer paper in the field and described and subsampled a few days later indoors because of rainy weather at sampling time. Samples were taken of the unaltered till, usually about 12 to 20 inches below the upper boundary of calcareous material, and of the major portion of the B horizon formed from till. If none of the B horizon were formed in till, it was not sampled. In these soils all of the B horizons formed in loess, in inclusions of outwash, or in both of these materials. Bulk samples were collected from B and C horizons. In addition an undisturbed section of the core of the C horizon was coated with Saran resin for determination of bulk density. The average depth of sampling of the C horizon was 46.2 inches across both transects.

The bulk samples were dried, crushed, and passd through a 2-mm sieve. Bulk density measurements were corrected to the <2-mm basis by subtracting the weight and volume of coarse fragments from the measurements made on the whole sample. It was assumed the coarse fragments had a density of 2.65 g/cm^3. Particle-size distribution was determined on all samples by the pipet method. In addition C horizon samples were analyzed for calcium carbonate equivalent (CCE) by acid neutralization. The procedures are described in detail in Franzmeier et al. 1977.

Results and Discussion

For both transects the <2-mm glaical till contained an average of 38% sand, 44% silt, and 18% clay (Table 1) that placed it near the center of the loam texture class. It is very similar to the till on the Camden moraine and north of it to the

TABLE 1. Average particle-size distribution of B and C horizons.

Horizon	Coarse Fragments	vcS	cS	ms	fS	vfS	cSi	fSi	Total C	Total Si	Total S	Number of Samples
		Particle-Size Class (% of < 2mm)										
North transect												
B		1.2	2.2	4.9	10.3	6.7	11.4	25.9	37.4	37.3	25.3	24
C	12.6	4.4	5.1	6.8	12.2	8.7	17.2	27.0	18.6	44.2	37.2	30
South transect												
B		1.5	2.9	6.4	11.6	7.1	10.3	23.3	36.9	33.6	29.5	33
C	9.6	4.1	5.8	8.2	12.8	8.5	18.2	24.9	17.5	43.1	39.4	38

Union City moraine in Ohio, which contained 42% sand, 40% silt, and 18% clay (Steiger and Holowaychuk, 1971). For the same till in Indiana, however, Gooding (1973) reported 37% sand, 40% silt, and 23% clay. The till we studies averaged around 40% calcium carbonate equivalent, and nearly 2.0 g/cm^3 bulk density (Table 2).

TABLE 2. Average bulk density and calcium carbonate equivalent of C horizons.

Transect	Bulk Density: Whole Soil	Bulk Density: < 2mm	Bulk Density: Number of Samples	Calcium Carbonate Equivalent: CCE	Calcium Carbonate Equivalent: Number of Samples
	g/cm^3			%	
North	1.99	1.94	22	40.5	30
South	2.01	1.96	24	41.1	38

The clay content of the C horizon increased slightly from west to east in the north transect, but over all, no geographic trends were noted (Figure 2). There appeared to be a natural separation between those sample with more than 20% clay and those with less. In order to learn if the higher-clay tills were related to some geographic feature, the locations of sites in which the soil contained more than 20% clay were plotted on a map (Figure 1) using filled circles and squares. The open symbols in that figure represent samples with <20% clay. The high-clay sites were fairly randomly located, except that most of them were on or near the end moraines. In Figure 1 the location of the named moraines is from Wayne (1965). The moraine across Hancock County was taken from an old map by Mallott (undated). It was not mapped by Wayne.

Calcium carbonate equivalent (CCE) also showed no trends across the transects (Figure 3). Most of the samples had 35 to 45% CCE. Bulk density, likewise, showed no trends (Figure 4). The values were very high, mainly between 1.9 and 2.1 g/cm^3.

The clay contents of the Bt horizons mainly ranged from 30% to 45%, but showed no geographic trends (Figure 5). Most of the samples with more than 40% clay are scattered in the central part of the study area (Figure 6). The average Bt horizon was near the center of the clay loam class (Table 1) and contained 37% clay, more than twice as much as the average C horizon. In a similar soil in Ohio, Smeck et al. (1968) attributed most of the clay increase in the Bt horizon to loss of carbonates. In the C horizon, most of the carbonate minerals were in the sand fraction and as these minerals weathered the clay percentage increased due to loss of the "diluting" coarser fraction.

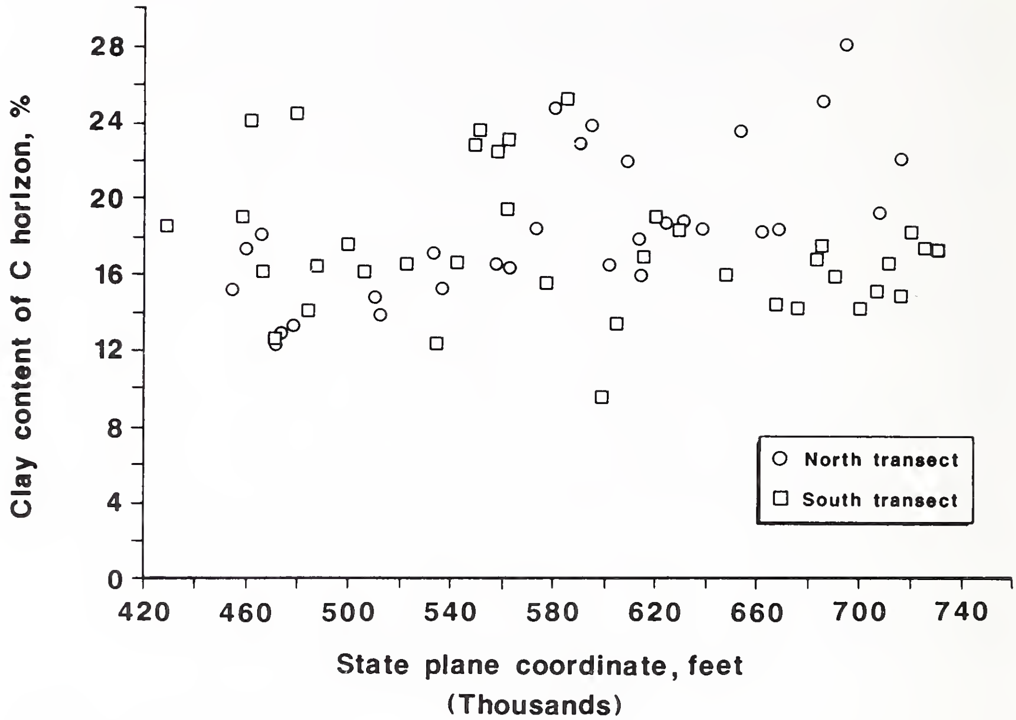

FIGURE 2. Relation of the clay content of glacial till C horizons to distance along the transects.

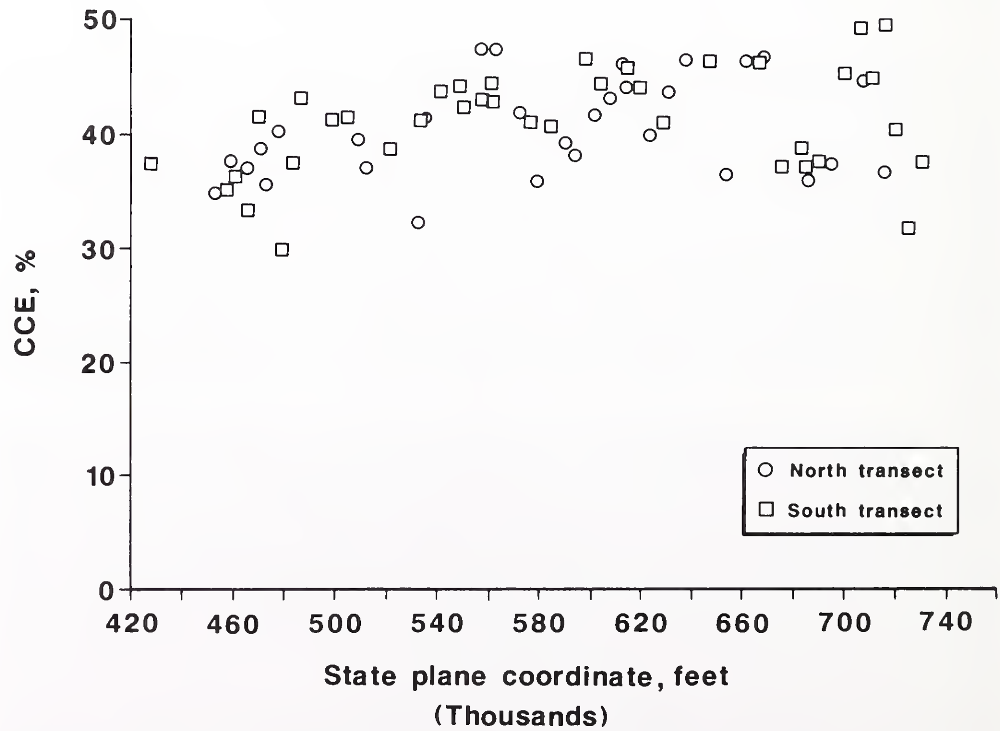

FIGURE 3. Relation of the calcium carbonate equivalent (CCE) of C horizons to distance along the transects.

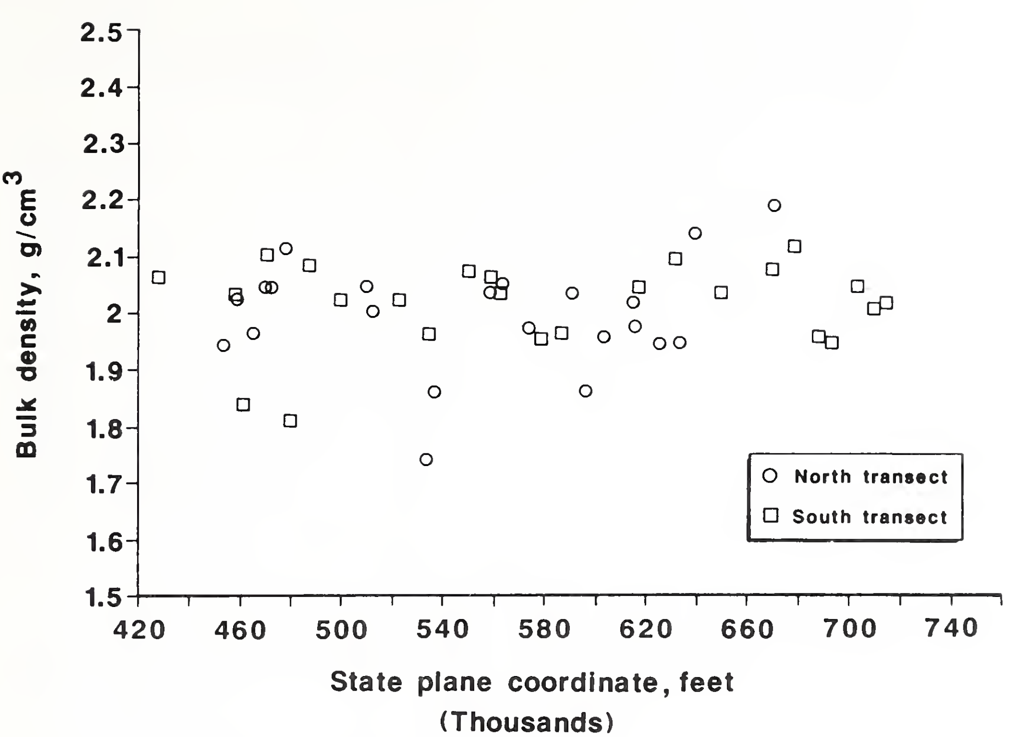

FIGURE 4. Relation of bulk density of C horizons to distance along the transects.

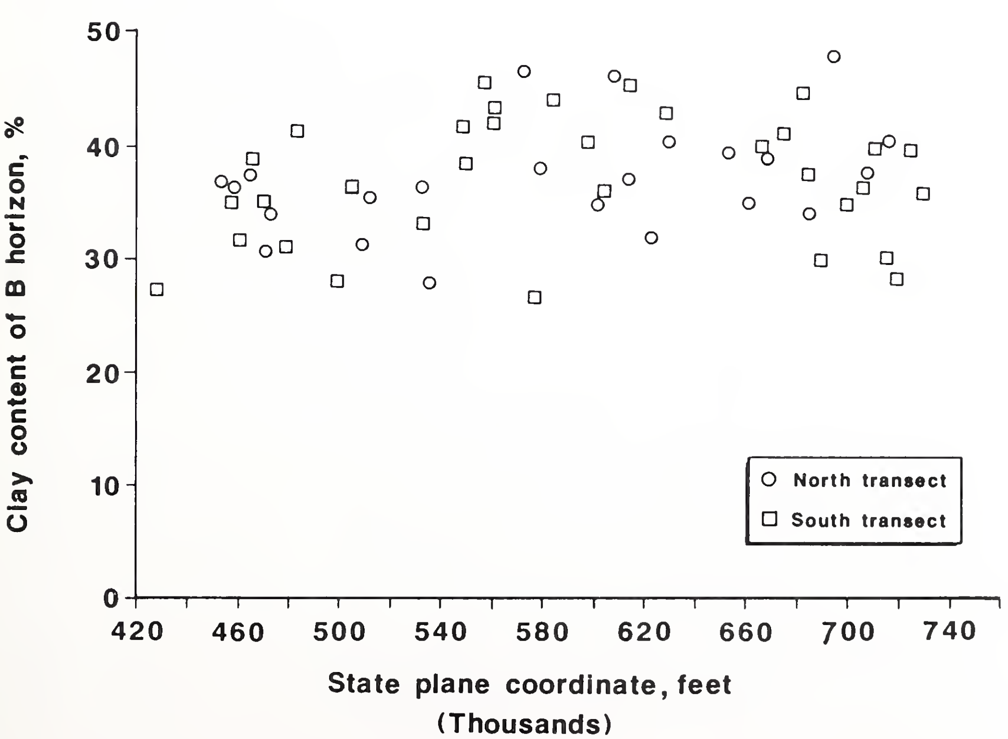

FIGURE 5. Relation of the clay content of till-derived Bt horizons to distance along the transects.

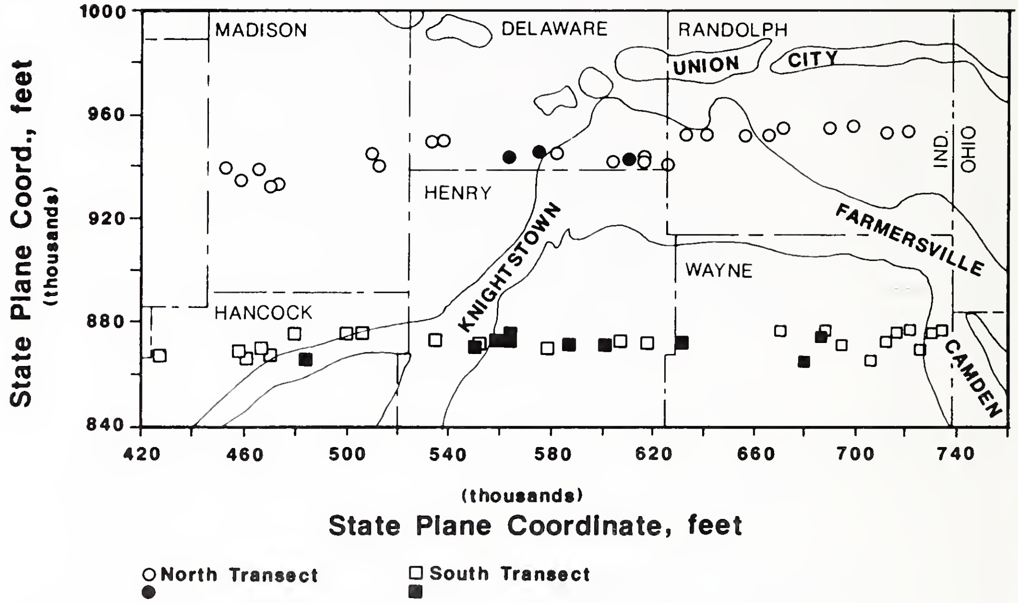

FIGURE 6. Map showing the location of soils in which the Bt horizons were sampled. The solid symbols represent the soils in which the Bt horizons contained more than 40% clay.

The data were also examined to look for possible relationships between the clay contents of the B and C horizons (Figure 7) assuming the other four soil-forming factors—microclimate, topography, vegetation, and time—were similar. There was a slight trend for the clay content of the B horizons to increase with increasing clay in the C horizons ($Clay_B = 29.4 + 0.43 \times Clay_C$, $r = 0.32$). There was insufficient range in the data to obtain the higher correlation reperted by Franzmeier et al. (1985) for a wider range of glaical tills. It is also possible that the B horizons developed in material different from the present-day C horizon. Wayne (1968) reported that in much of the till plain in east-central Indiana the surface deposit consists of loose till mixed with thin layers of crudely water-worked sediments which could be called ablation till. This material could be the parent material of the B horizons. The C horizons, on the other hand, would not be considered to be "loose material" because they have a bulk density of around 2.0 g/cm^3 and have very firm consistence. Morphological evidence also suggests that soil formation does not extend very far into dense till.

The good correlation between clay content of B and C horizons across areas of diverse tills suggests that the upper till layer, from which the Bt horizons formed, and the lower till are generally similar, probably because they were derived from similar sources. This relationship is on a scale compatible with showing relations across the state. The same relations, however, may not apply at a smaller scale, such as a county or a few counties, if the differences in the till are not great.

The data also shed some light on the particle-size classification of the Crosby series, the dominant one sampled. The average clay content of the Bt horizons is 37% (Table 1). This is very near the 35% that separates fine from fine-loamy classes in Soil Taxonomy. The zone sampled to represent the major Bt horizons was thinner and probably contained more clay than the family control section zone, so the control section probably contained somewhat less than 37% clay, even closer to the 35% limit. Thus the Crosby series, as a natural soil-landscape body, is fairly homogeneous,

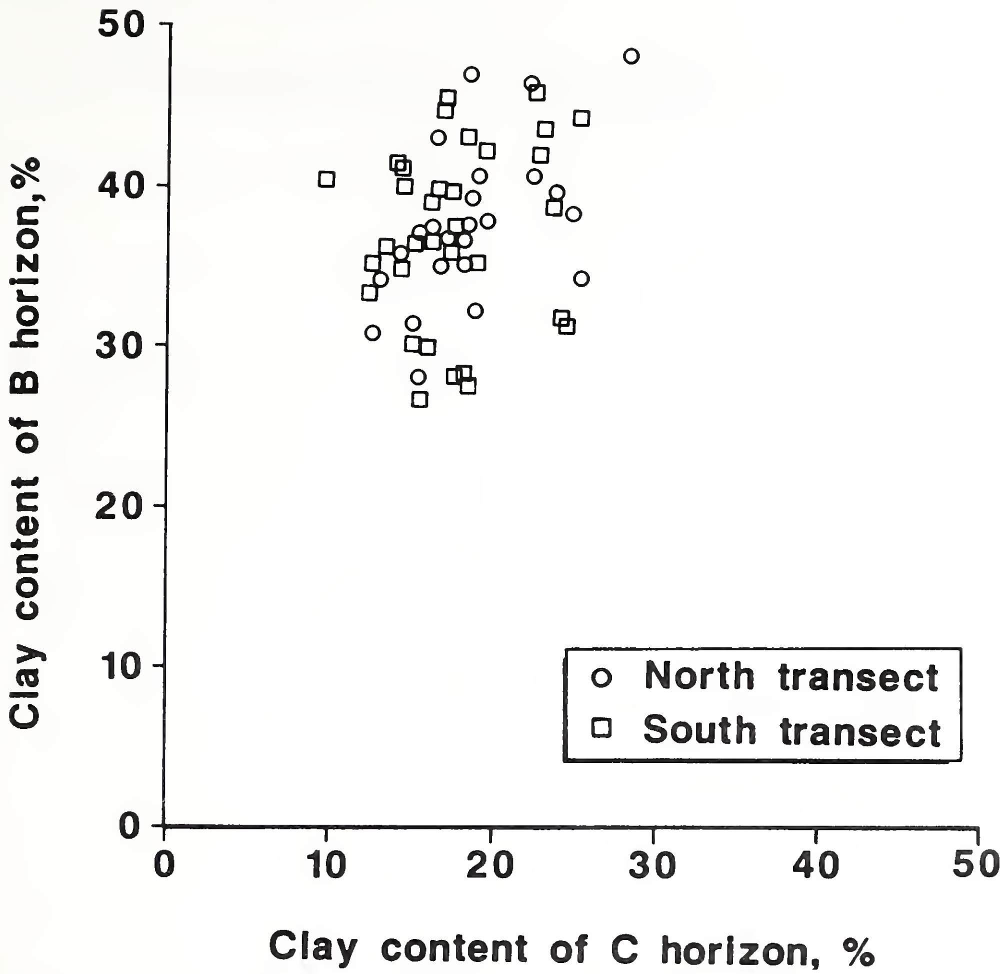

FIGURE 7. Relation of the clay content of the Bt horizons to the clay content of the C horizons.

but it straddles a soil taxonomy boundary. It is not possible to map soils using this separation, so the Crosby series is classified as fine, but the map units are about half fine-loamy.

Conclusions

The Cartersburg till of east-central Indiana is relatively uniform. On the average it contains 38% sand, 44% silt and 18% clay, and it has a calcium carbonate equivalent of 41% and bulk density of 2.0 g/cm^3. There is some variability among the samples but it is random across the study area. It is probably caused by local factors rather than regional ones. The clay content of the Bt horizons also shows a random geographical distribution. It is poorly correlated with the clay content of the C horizons probably because the two horizons formed in different materials. The Bt horizons appeared to have formed in less dense till that was deposited over the more dense till. This upper till material, however, was most likely derived from the same source as the lower material.

Acknowledgment

This work was supported by a grant from the Soil and Water Conservation Committee, Indiana Department of Natural Resources.

References

Franzmeier, D. P., R. B. Bryant, and G. C. Steinhardt. 1985. Characteristics of Wisconsinan glacial tills in Indiana and their influence on argillic horizon development. Soil Sci. Soc. Am. Proc. 49:1481-1486.

Franzmeier, D. P., G. C. Steinhardt, J. R. Crum, and L. D. Norton. 1977. Soil characterization in Indiana: I. Field and laboratory procedures. Purdue Univ. Agric. Exp Stn. Res. Bull. 943.

Gooding, A. M. 1973. Characteristics of late Wisconsinan tills in eastern Indiana. Ind. Geol. Surv. Bull. 49.

Smeck, N. E., L. P. Wilding, and N. Holowaychuk. 1968. Genesis of argillic horizons in Celina and Morley soils of western Ohio. Soil Sci Soc. Amer. Proc. 32:550-556.

Steiger, J. R., and N. Holowaychuk. 1971. Particle-size and carbonate analysis of glacial till and lacustrine deposits in western Ohio. p. 275-289. In R. P. Goldthwait (ed.) Till/A symposium. 1969. Columbus OH Ohio State Univ. Press, Columbus.

Wayne, W. J. 1963. Pleistocene formations in Indiana. Ind. Geol. Surv. Bull. 25.

Wayne, W. J. 1965. The Crawfordsville and Knightstown moraines in Indiana. Ind. Geol. Surv. Rep. Progress 28.

Wayne, W. J. 1968. The Erie lobe margin in east-central Indiana during the Wisconsin glaciation. Proc. Indiana Acad. Sci. 77:279-291.