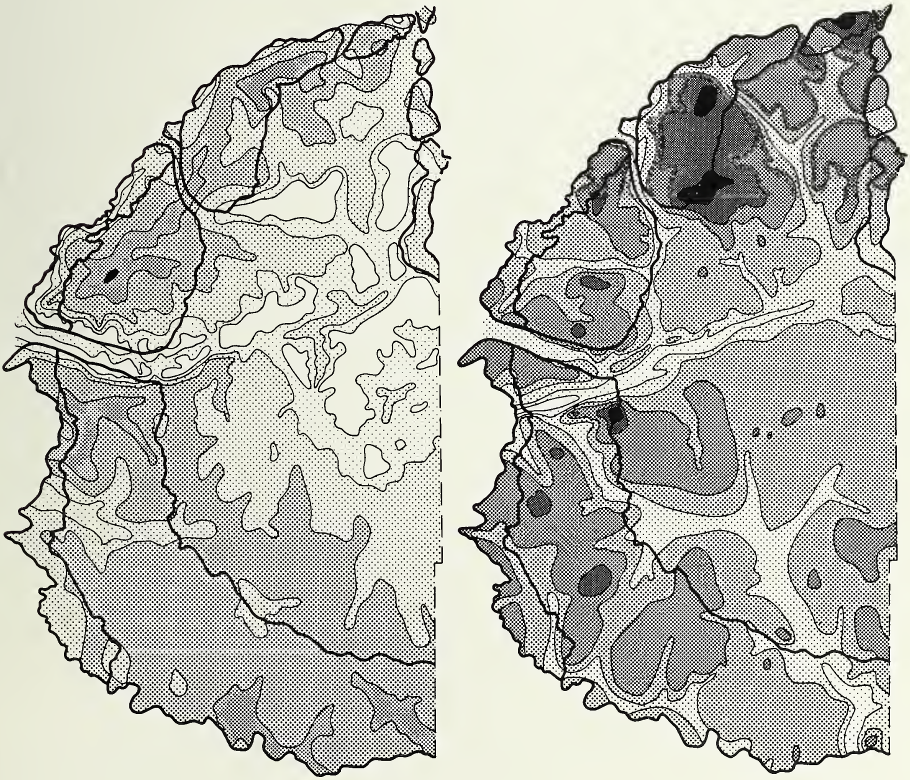
THE DWIGHT MINERALOGICAL ZONE OF THE YORKVILLE TILL MEMBER, NORTHEASTERN ILLINOIS

Myrna M. Killey



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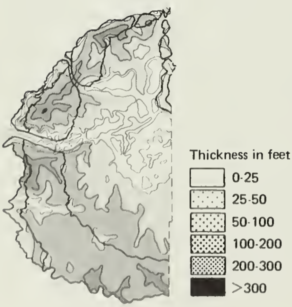
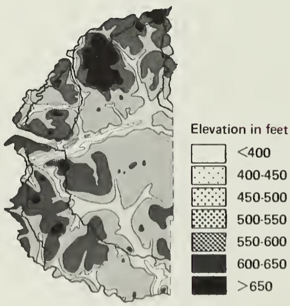


DRIFT THICKNESS



BEDROCK TOPOGRAPHY

THE DWIGHT MINERALOGICAL ZONE OF THE YORKVILLE TILL MEMBER, NORTHEASTERN ILLINOIS

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ABSTRACT

A distinct mineralogical component occurs in the upper part of the Yorkville Till Member of the Wedron Formation of Wisconsinan age in northeastern Illinois. This upper unit, here named the Dwight mineralogical zone, exists within the area of, but is not bounded by, the older Marseilles Morainic System and the younger, overriding Minooka Moraine. To identify, compare, and differentiate till of the Dwight mineralogical zone from till of the remainder of the Yorkville Till Member (herein called lower Yorkville), samples from 99 locations were analyzed for matrix grain size, clay mineral composition, carbonate content, and color.

The Dwight mineralogical zone is mainly a grayish-brown, silty clay till; it averages 76 percent illite and has a dolomite-calcite ratio of 2:1. The lower Yorkville is mainly an olive-gray, silty clay till; it averages 81 percent illite and has a dolomite-calcite ratio of 4:1. Results of this study indicate that: (1) the Dwight mineralogical zone is separable and mappable with the aid of laboratory data; (2) the lower Yorkville makes up the bulk of the Marseilles Morainic System; (3) the Dwight is thin between the moraines and constitutes the till of the Minooka Moraine; and (4) the Dwight apparently represents a readvance and a concurrent change in source material.

This study confirms the importance of consistent application of analytical laboratory data from subsurface sampling to regional studies for purposes of stratigraphic correlation.

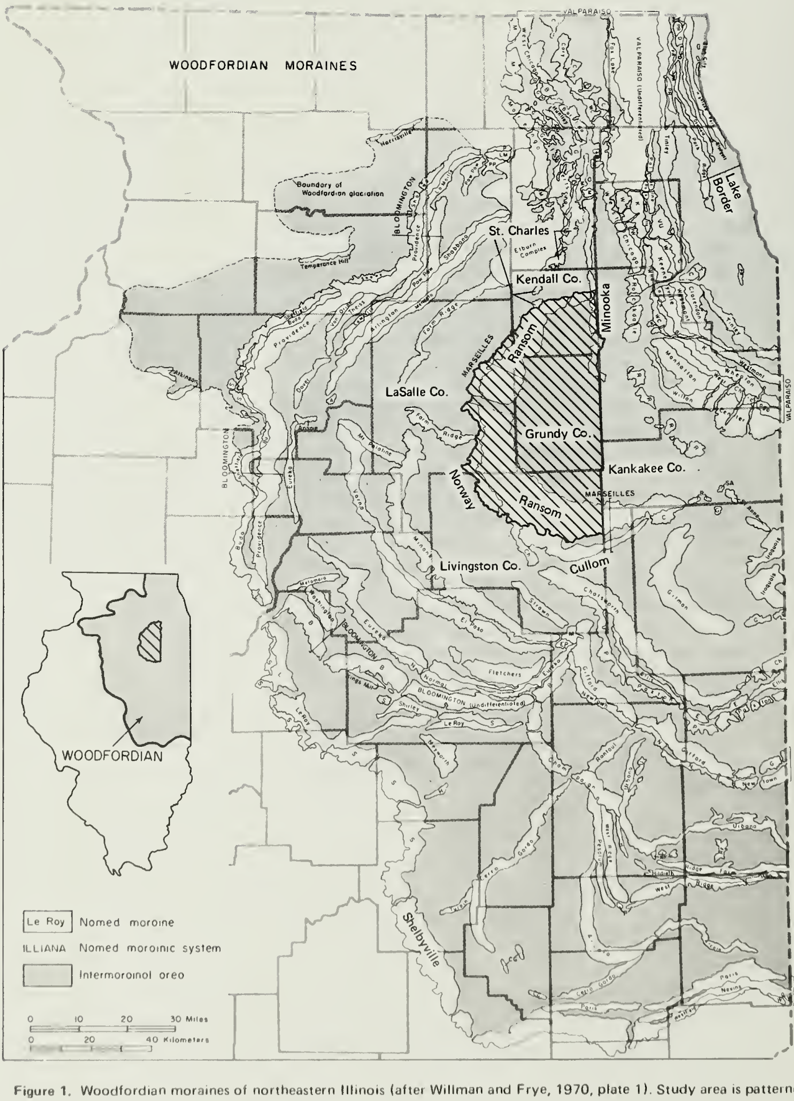

Figure 1. Woodfordian moraines of northeastern Illinois (after Willman and Frye, 1970, plate 1). Study area is patterned.

INTRODUCTION

Pleistocene studies in Illinois have evolved over the years from examination of geomorphic features and surface deposits to detailed analysis of subsurface borings. Similarly, classification of glacial sediments has advanced from a system based on the genetic relationship between surface deposits and associated landforms to a system utilizing rock-stratigraphic units defined on the basis of observable lithology both at the surface and in the subsurface. Rock stratigraphic classification has been supplemented by analytical data on grain size, clay mineral composition, and carbonate content. The systematic collection and utilization of such analytical data over large areas of Illinois have greatly increased understanding of the nature and occurrence of glacial sediments. This report provides an example of the use of subsurface data to correlate glacial deposits in an area of northeastern Illinois where the surficial deposits have been the subject of varying interpretations over the years.

This project originated from findings in a 1975-1976 reconnaissance study by J. P. Kempton, M. M. Killey, and H. D. Glass, conducted in part to define the boundary of the gray, clayey Yorkville Till Member of the Wedron Formation in Livingston, Woodford, and Marshall Counties, Illinois. Analyses of several cores taken in the vicinity of Dwight, in Livingston County, revealed that a component mineralogically distinct from the material below existed in the uppermost part of the Yorkville Till Member. This upper till unit was differentiated from the rest of the Yorkville primarily on the basis of clay mineral and carbonate data. The project upon which this report is based had two basic goals:

- To define the clay mineral and carbonate composition of the upper till unit more precisely; to determine the unit's texture and textural variations, if any; to determine to what degree the unit can be differentiated from the Yorkville Till Member; and to define the areal extent of the till unit in the region of the Marseilles Morainic System and the Minooka Moraine in northeastern Illinois.
- To explore the significance and implications of this till unit for (a) interpretation of the area's glacial history and (b) eventual resolution of the stratigraphic status of similar depositional units in the Illinois classification of Pleistocene strata.

The study area is located in Grundy County and in contiguous parts of southern Kendall, eastern La Salle, and northern Livingston Counties (fig. 1). It is bordered on the north, west, and south by the outer margin of the Marseilles Morainic System and on the east by the Minooka Moraine and an arbitrary boundary extending along the eastern borders of Grundy and Livingston Counties. The Marseilles Morainic System, composed of the adjacent fronts of the Norway and Ransom Moraines, and the Minooka Moraine enclose a broad topographic basin referred to in this study as the Morris Basin (fig. 2) after Culver (1923). The Illinois River approximately bisects the study area, running nearly west-southwest from the southern tip of the Minooka Moraine through the Marseilles Morainic System. In the northwestern part of the Morris Basin is a northeast-trending ridge composed of bands of sand and gravel having a uniform dip of 10 degrees to the northwest. This feature is referred to in this study as Central Ridge, after Willman and Payne (1942).

Acknowledgments

This report is adapted from a Master's thesis in geology submitted to Ball State University, Muncie, Indiana. I am grateful to Dr. Harlan H. Roepke of Ball State University and to Dr. John P. Kempton of the Illinois State Geological Survey for supervision of the study and for their many helpful suggestions. Dr. Herbert D. Glass of the Illinois State Geological Survey provided the clay mineral analyses and aided significantly in developing the stratigraphic interpretations and relationships established in this study. I thank David Swartz of Emington, Illinois and Bill Sproull of Verona, Illinois for allowing me to conduct exploratory drilling on their properties. I also wish to acknowledge the support provided by the Illinois State Geological Survey and the assistance of numerous staff members during the course of the project.

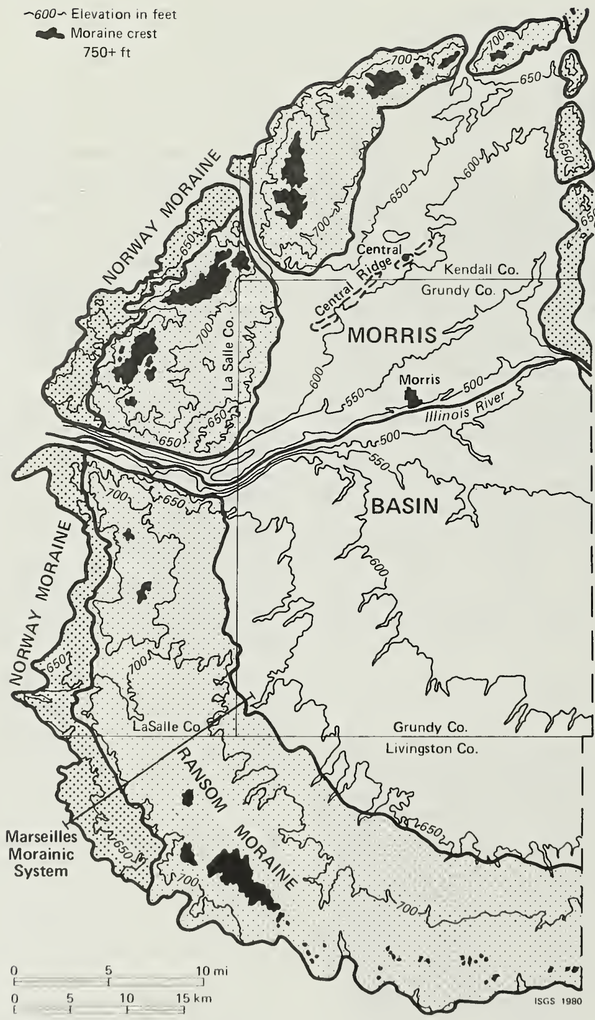

Figure 2. Generalized topographic map of study area (after Willman and Frye, 1970, plate 1).

The bedrock underlying the southern two-thirds of the study area consists of Pennsylvanian shale, coal, sandstone, and limestone. Ordovician cherty dolomite, sandstone, and shale underlie most of the northern third of the area, and the bedrock along the area's northeastern border consists of Silurian dolomite. Bedrock topographic highs of more than 600 feet (183 m) above mean sea level occur in general alignment with the northern two-thirds of the Marseilles Morainic System. Natural bedrock exposures are concentrated primarily along the Illinois River and its tributaries, but heavy strip mining in the east-central part of the area has exposed Pennsylvanian-age bedrock.

Glacial deposits in the study area range in thickness from 0 to more than 300 feet (91 m), with the thickest deposits located along the moraines and the thinnest drift in the central part of the basin. Most of the drift is of Woodfordian age, but older pre-Wisconsinan drifts exist in the vicinity of the Marseilles Morainic System.

Methods

Samples from 57 subsurface borings were analyzed for matrix grain size (texture), clay mineral composition, and carbonate content, and samples from 42 outcrop or hand auger locations were analyzed for grain size and clay mineral composition. Results of the textural analyses were compiled as percentages of sand (2.00 to 0.62 mm), silt (0.62 to .004 mm), and clay (<.004 mm).

Clay mineral composition of the <2-μm fraction was determined using an oriented aggregate x-ray diffraction method. Results of the clay mineral analyses were compiled in terms of percentages of expandable clay minerals, illite, and kaolinite plus chlorite. Additional useful parameters derived from x-ray analyses were relative amounts of calcite and dolomite as indicated in counts per second, color of slides prepared of the <2-μm fraction, and a comparison of first-order illite and first-order chlorite-vermiculite diffraction peak heights, expressed as a "vermiculite index." This index, developed by H. D. Glass at the Illinois State Geological Survey, is obtained by measuring the value in millimeters by which the first-order chlorite-vermiculite peak (14 Å) is greater than or less than the first-order illite peak (10 Å) on an x-ray diffraction diagram. This index has proven helpful in characterizing glacial units in Illinois.

Carbonate content of the <74-μm fraction of the till matrices was determined using the Chittick gasometric method; results were compiled as percentages of calcite and dolomite. All core samples and logs used in obtaining the results of this study are on open file at the Illinois State Geological Survey.

Previous studies

Early investigations of the glacial deposits in the study area were made by Worthen et al. (1870) and Leverett (1899), who described the topography and the surficial deposits. Culver (1923) studied the geology and mineral resources of the Morris Quadrangle and derived an interpretation of glacial history in the quadrangle from detailed examination of topography and surficial sediments. Willman and Payne (1942) investigated the geology and mineral resources of the Marseilles Quadrangle and presented an interpretation of the area's glacial history by examination of surficial deposits.

Leighton (1960) based his definition of the Tazewell and Cary Substages of the Wisconsinan Stage on the geomorphic angular relationships of the Marseilles and Minooka Moraines, interpreting their discordancy as representing a major retreat, reorientation, and readvance of the glacial lobe. His conclusions were based upon extensive examination of topography and surficial deposits without the advantages of deeper borings and analytical data from subsurface samples.

Frye and Willman (1960) defined the Woodfordian Substage to include the entire sequence of progressively younger moraines extending from the Shelbyville to the Lake Border Morainic Systems (fig. 1); the Woodfordian includes Leighton's Tazewell and Cary Substages. Willman and Frye (1970) and Willman et al. (1975) outlined the Pleistocene stratigraphy of Illinois, using multiple stratigraphic classifications. They discussed the moraines of the study area and mapped the surficial till of the entire area as the Yorkville Till Member of the Wedron Formation in rock stratigraphic classification. The Yorkville includes the tills of the Marseilles Morainic System and the Minooka Moraine. Willman and Frye (1970) noted that the till of the Minooka Moraine contains fewer pebbles than that of the Marseilles Morainic System.

Recent mapping of the area (Lineback, 1979) also shows that the Yorkville Till Member is the surficial till over the entire study area, except in small areas of the east central portion of the basin where the underlying Malden Till Member has been exhumed by erosion.

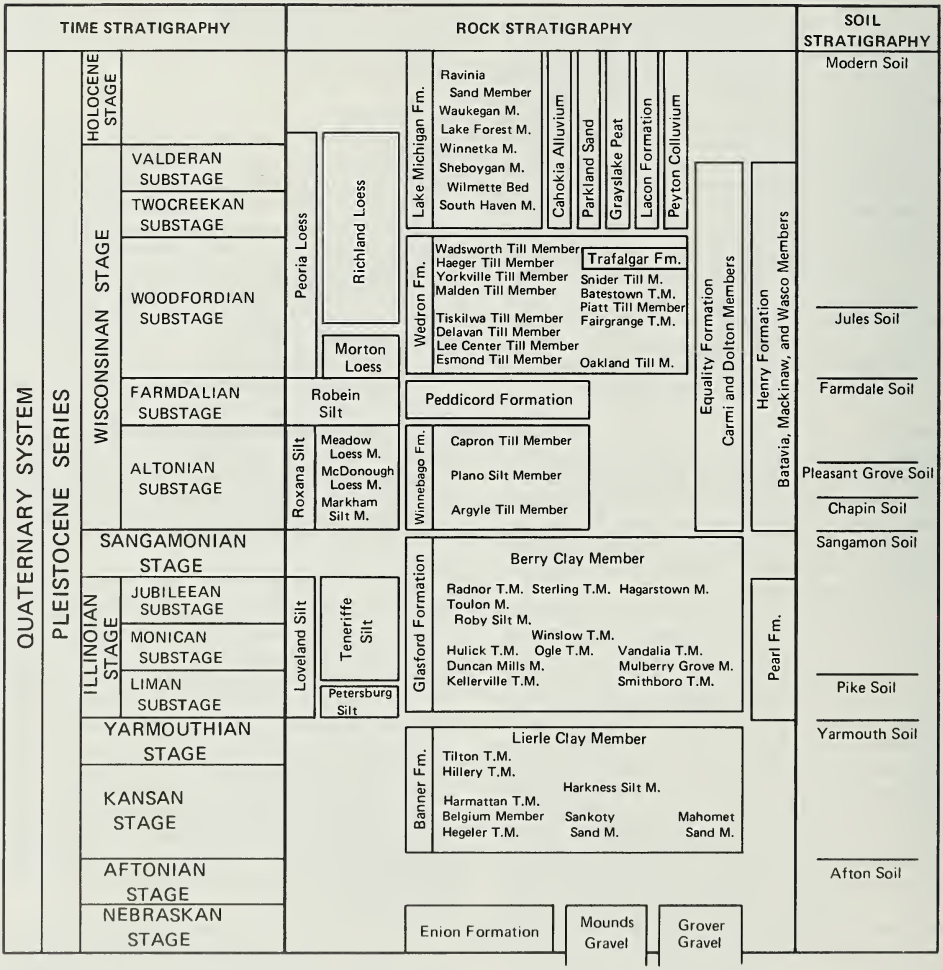

Figure 3. Stratigraphic classification of the Quaternary deposits of Illinois (from Willman et al., 1975, and Lineback, 1979).

As Culver noted in his 1923 study of the Morris Quadrangle (p. 177-178):

> The time elapsing between these two events [the deposition of the Marseilles and Minooka Moraines] can be determined in the broadest terms only. As compared with the other interglacial stages of Wisconsin time, it probably was of short duration. As pointing to this conclusion, there is no indication of the development of an interglacial soil. Indeed, the distinction between the two tills is by no means clear in some places.

The lack of a weathering horizon or other field-identifiable stratigraphic boundary between the tills of the two moraines of the study area, and the presence of gray clayey till over the area of both moraines, account for the current mapping of the Yorkville Till Member over the entire study area.

STRATIGRAPHIC FRAMEWORK

Wedron Formation

The Wedron Formation consists mostly of glacial till and intercalated beds of silt, sand, and sand and gravel deposited during the Woodfordian Substage of the Wisconsinan Stage (Willman et al., 1975; Lineback, 1979) (fig. 3). In the study area, members of the Wedron Formation which have been encountered in subsurface borings include the Yorkville Till Member, the Malden Till Member, and the Tiskilwa Till Member.

Yorkville Till Member

The uppermost till of the study area, and the focus of this study, is the Yorkville Till Member; its type section is located in the northern part of the Ransom Moraine. The Yorkville is described by Willman et al. (1975) as a clayey, greenish-gray to dark-gray till. Its areal extent, as mapped by Lineback (1979), is shown in figure 4. Willman and Frye (1970) reported that samples from this area had an average matrix grain size of 12 percent sand, 38 percent silt, and 50 peicent clay, and an average clay mineral composition of 6 percent expandable clay minerals, 78 percent illite, and 16 percent kaolinite plus chlorite. The Yorkville shows the lowest calcite content (as indicated in counts per second) of all Woodfordian tills.

Malden and Tiskilwa Till Members

The Yorkville Till Member is underlain by the gray-tan to yellow-gray, silty to sandy Malden Till Member, with illite content intermediate between the Yorkville and the underlying Tiskilwa Till Member. The Tiskilwa is a pink-tan to reddish tan-brown, sandy till, less illitic (about 65%) than most other Wedron tills. The areal extent of the Malden and Tiskilwa Till Members is indicated in figure 4. Both tills are preserved locally in stratigraphic sequence in much of the area of the Marseilles Morainic System.

Equality Formation

Lake-bottom sediments related mineralogically to the Yorkville Till Member occur in numerous borings in the study area. Where these sediments occur as the surficial unit or are overlain only by loess, they are classified as part of the Equality Formation established by Willman and Frye (1970) and mapped as such by Lineback (1979). Most of these lacustrine deposits are fine grained and, on this basis, are classified as part of the Carmi Member of the Equality Formation. Lacustrine sediments occurring in the subsurface belong stratigraphically to the till member in which they are found or, in the case of lacustrine units between tills, to the till with which they are associated mineralogically.

LITHOLOGIC AND MINERALOGICAL VARIATIONS IN THE YORKVILLE TILL MEMBER

The upper part of the Yorkville Till Member investigated in this project is here named the Dwight mineralogical zone because of its initial discovery in cores near the town of Dwight in Livingston County. The Dwight mineralogical zone is composed mostly of till with lenses and beds of lacustrine sediments. The part of the Yorkville Till Member underlying the Dwight remains undifferentiated and is here referred to as lower Yorkville. The lower Yorkville also is composed primarily of till with lenses and beds of lacustrine deposits.

In the cores where its presence was first noted, the Dwight mineralogical zone was differentiated primarily by its clay mineral composition and carbonate content. Analytical data from one of these cores are shown in figure 5. Table 1 shows averages of grain size, clay mineral, and

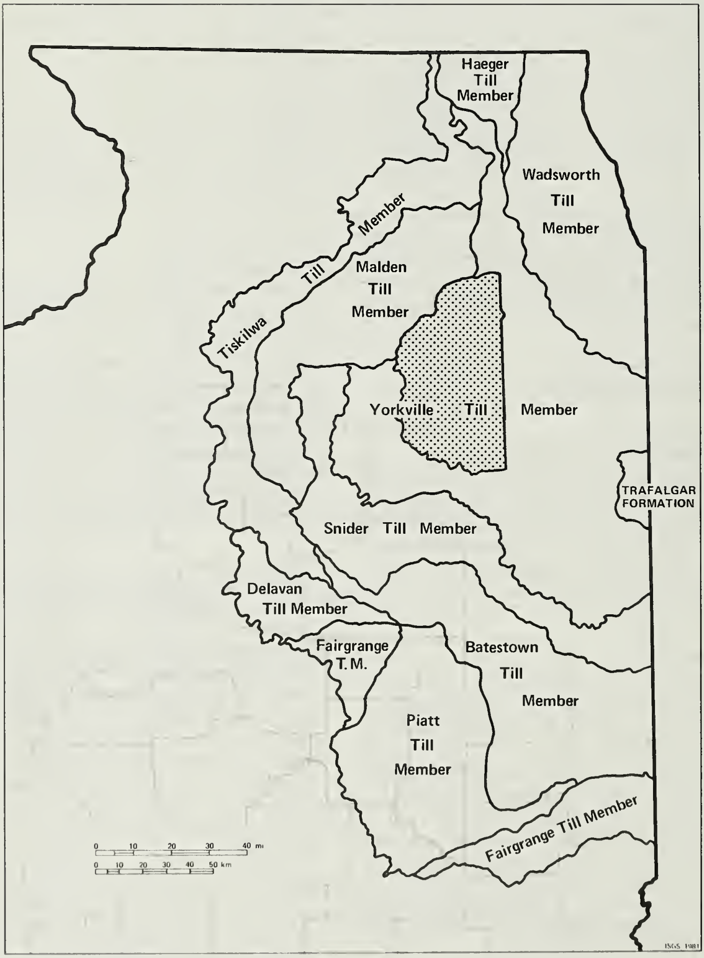

Figure 4. Areal distribution of Wedron Formation till members and of Trafalgar Formation (after Lineback, 1979).

Boring: Livingston-25, boring 2; location: center Sec. 8-30N-7E; elevation: 642 ft ETM

Depth (ft)	Depth (m)	Unit	Log	Grain size: Gr	Sd	St	Cl	X-ray data: VI	Exp	I	K + C	Cal (cts/sec)	Dol (cts/sec)	Chittick: Cal (%)	Dol (%)	Slide color
1½-3	0.5-0.9	Dwight till		2	7	51	42	8½<	3	84	13	28	30			yellow-tan
4-5½	1.2-1.7	- - ? - -		4	7	42	51	14 <	3	84	13	31	51			olive-tan
6½-8	2.0-2.4	Dwight till and lac		2	5	24	71	23½<	3	77	20	38	49			violet-gray
9-10½	2.7-3.2			1	5	26	69	20 <	2	76	22	45	31	7	11	violet-gray
11½-13	3.5-4.0							20 <	2	75	23	51	31			violet-gray
14-15½	4.3-4.7			1	3	22	75	21½<	2	76	22	40	40			violet-gray
16½-18	5.0-5.5	lower Yorkville till		5	11	37	52	39½<	1	83	16	6	32			olive
19-20½	5.8-6.2			5	9	40	51	36 <	1	82	17	14	34	5	14	gray
21½-23	6.6-7.0			3	9	27	64	32½<	1	81	18	24	33			gray
24-25½	7.3-7.8			2	11	36	53	31½<	1	81	18	20	23			gray
no samples																
31½-33	9.6-10.1	lower Yorkville till		2	9	34	57	32½<	1	81	18	16	31			pearl-gray
34-35½	10.4-10.8			3	14	42	44	38 <	1	83	16	11	25			pearl-gray
36½-38	11.1-11.6							34 <	1	83	16	14	24			pearl-gray
39-40½	11.9-12.3			3	11	38	51	30 <	1	82	17	—	23			pearl-gray
no samples																
44-45½	13.4-13.9			6	8	43	49	32½<	1	82	17	14	22			pearl-gray

EXPLANATION OF ABBREVIATIONS

ETM = (elevation) estimated (from) topographic map

Unit: lac = lacustrine

Grain size:
Gr = gravel as % of total sample
Sd = % sand in sample matrix
St = % silt in sample matrix
Cl = % clay in sample matrix

X-ray data:
VI = vermiculite index
Exp = % expandable clay minerals
I = % illite
K + C = % kaolinite plus chlorite
Cal = calcite in counts per second
Dol = dolomite in counts per second

Chittick:
Cal = % calcite in < 74-μm fraction
Dol = % dolomite in < 74-μm fraction

Results of analyses on boring Livingston-25, showing data differences between Dwight mineralogical zone and underlying lower Yorkville till.

TABLE 1. Parameter averages for Dwight and lower Yorkville till samples.

Sample	Unit	Sand	Silt	Clay	Expandables	Illite	Kaolinite + Chlorite	Vermiculite Index	Calcite	Dolomite
Liv-25	Dwight	5.0	25.0	70.0	2.5	76.5	21.0	21.8<	7.0	11.0
	L. Yorkville	10.1	37.1	52.7	1.0	81.9	17.1	33.4<	5.0	14.0
Liv-20	Dwight	4.7	43.0	52.3	3.0	76.0	21.0	19.3<	7.0	10.0
	L. Yorkville	9.7	38.2	51.8	1.5	81.2	17.3	33.6<	4.0	15.0
LaS-4	Dwight	8.3	35.3	56.3	2.3	77.0	20.7	20.7<	7.0	15.0
	L. Yorkville	12.5	34.5	53.0	2.0	80.5	17.5	33.3<	4.0	17.0
Gr-6	Dwight	9.0	55.0	36.0	2.0	78.0	20.0	20.5<	7.0	15.0
	L. Yorkville	10.8	50.4	38.5	1.7	82.3	16.0	38.4<	5.0	23.0
Ken-2	Dwight	30.5	52.0	17.5	3.0	77.0	20.0	21.0<	12.0	37.0
	L. Yorkville	25.3	46.3	28.3	1.7	81.3	17.0	33.5<	ND	ND
MMK-46	Dwight	6.0	29.0	64.7	2.7	77.0	20.3	20.3<	8.0	11.7
	L. Yorkville	8.5	41.5	50.0	2.0	82.5	15.5	30.5<	3.5	16.5
MMK-47	Dwight	13.0	41.0	46.0	3.0	77.0	20.0	16.0<	7.5	19.0
	L. Yorkville	15.0	45.5	39.5	1.7	83.2	15.2	32.2<	4.7	21.3
MMK-50	Dwight	6.0	35.5	58.5	2.0	74.0	24.0	20.5<	8.5	12.5
	L. Yorkville	8.0	35.0	57.0	1.0	80.0	19.0	38.0<	4.0	14.0

ND = No data.

TABLE 2. Clay mineral data for unweathered Dwight and lower Yorkville till samples.

Till	Expandables				Illite				Kaolinite + Chlorite				Vermiculite Index			
	X	S	N	R	X	S	N	R	X	S	N	R	X	S	N	R
Dwight	3.02	1.48	49	2-5	76.35	2.16	49	72-81	20.84	2.26	49	15-25	20.42<	2.87	49	14½-26
Lower Yorkville	*1.55	0.51	141	1-3	*81.47	1.65	141	77-85	*16.99	1.66	141	13-22	*32.89<	4.54	140	21-47

X = mean; S = standard deviation; N = number of samples; R = range.

* Means are significantly different at a 95% level of confidence.

TABLE 3. Chittick carbonate data for unweathered Dwight and lower Yorkville till samples.

Till	Calcite (%)				Dolomite (%)			
	X	S	N	R	X	S	N	R
Dwight	7.24 *	1.76	21	4-12	15.86 *	5.83	21	10-37
Lower Yorkville	5.27	1.86	49	2-10	19.43	5.97	49	10-40

X = mean; S = standard deviation; N = number of samples; R = range.
* Means are significantly different at a 95% level of confidence.

carbonate data for Dwight and lower Yorkville till samples from key borings in the southern two-thirds of the study area. In this study, borings throughout the study area repeatedly showed similar relationships, with some variations concentrated primarily in borings from the northern part of the study area.

Table 2 shows clay mineral data for unweathered samples of Dwight till and lower Yorkville till, excluding lacustrine sediments. Analytical data generally show an illite percentage in the middle 70s for Dwight till and in the low 80s for the lower Yorkville till. The same values occur in Dwight lacustrine sediments. In a few borings, illite content is not diagnostic, but other data in those borings are generally consistent and facilitate differentiation of Dwight till from lower Yorkville till.

In x-ray analyses of the two tills, calcite content as expressed in counts per second is an equally useful means of differentiating the two tills. In Dwight till, values ranging from the high 20s to the 40s are found, whereas in lower Yorkville till there is a sudden, consistent drop to values ranging from less than 10 to the lower 20s.

The ratio of dolomite to calcite, using Chittick values, proved to be an additional dependable parameter in differentiating the Dwight mineralogical zone: in Dwight till, the ratio of dolomite to calcite averages about 2:1, whereas in lower Yorkville till, the dolomite to calcite ratio averages about 4:1 (table 3). The average dolomite-calcite ratio for Dwight lake sediments is 1:1, whereas it is 3:1 in lower Yorkville lake sediments.

Tills of the Dwight and lower Yorkville are indistinguishable in matrix grain size, although both show a considerable range in each size fraction (table 4). The distribution of grain size in samples of both tills along the Ransom Moraine (fig. 6) clearly substantiates the fact that the two tills cannot be differentiated by use of texture. Grain size analyses of Dwight and lower Yorkville lacustrine units revealed that Dwight lake sediments are uniformly high in clay (averaging about 1% sand, 29% silt, and 70% clay), whereas lower Yorkville lake sediments occurring at the contact between the two tills are high in silt (averaging about 5% sand, 68% silt, and 27% clay).

A dependence of carbonate content upon grain size has been proven to exist in the Yorkville Till Member and other Woodfordian tills (McKay, 1975; Kemmis, 1978; Killey, 1980). However, the similarity of matrix grain size of both Dwight and lower Yorkville tills appears to confirm

TABLE 4. Matrix grain size data for unweathered Dwight and lower Yorkville till samples..

Till	Sand (%)				Silt (%)				Clay (%)			
	X	S	N	R	X	S	N	R	X	S	N	R
Dwight	10.33	5.75	48	4-31	43.15	8.14	48	24-57	46.52	12.18	48	12-71
Lower Yorkville	13.02	6.65	132	2-36	43.49	6.99	132	19-68	43.55	10.62	132	17-70

X=mean; S = standard deviation; N = number of samples; R = range.

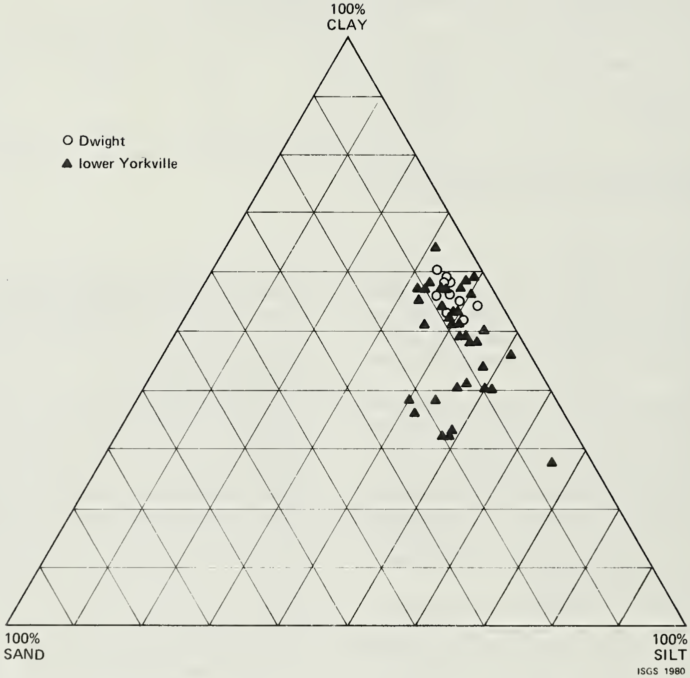

Figure 6. Grain-size distribution of Dwight and lower Yorkville till samples along Ransom Moraine.

that the data from Chittick carbonate values in the <74-μm fraction and x-ray analytical values in the <2-μm fraction are dependable parameters by which the two units can be reliably differentiated and mapped.

Color differences between the Dwight and lower Yorkville till samples are slight. The Munsell color designation for Dwight till samples is predominantly 5Y4/1 (dark gray) and 2.5Y3/2 (very dark grayish-brown), whereas the color designation for lower Yorkville till samples is in the 5Y4/1 (dark gray) and 5Y4/2 (olive-gray) categories. The same color designations also apply to lacustrine sediments associated with the two tills.

A simple visual examination of slides prepared for x-ray analysis of the <2-μm fraction provides more subtle color discrimination than that obtained by Munsell color chip comparison. Slide samples from unweathered sediments of the Dwight mineralogical zone are generally a distinct violet-gray; unweathered lower Yorkville slide samples are a steel-gray. An olive-tan to yellow-tan color in weathered lower Yorkville contrasts subtly with a peach-tan to bufftan in weathered Dwight samples. These color differences in slide samples suggest both a possible stratigraphic discontinuity and therefore a potential mineralogical difference in the clay (<2-μm) fraction of the matrices of the two tills. In one boring, Livingston-25 (fig. 5), the slide color and calcite loss shown in the x-ray data at the top of the lower Yorkville may indicate an incipient weathering profile.

During field and laboratory examination of cores, color was not a useful tool for differentiating the Dwight mineralogical zone from lower Yorkville sediments, particularly in unweathered parts of the cores. An exception was the physical description of a core (MMK-45) from the southwestern part of the study area. This description, based on both visual examination of core color and Munsell color comparison, accurately pinpointed the contact between Dwight and lower Yorkville sediments solely by color differentiation within the weathered part of the profile.

With the notable exception of boring Livingston-25 (fig. 5), most borings show no evidence of an oxidation zone between the Dwight and lower Yorkville, either in direct examination of core samples in the laboratory or by examination of slides from each boring laid out in sequence. This fact implies that the Dwight and lower Yorkville depositional events were so close in time that a noticeable weathering zone did not develop on lower Yorkville sediments before Dwight sediments were deposited.

To summarize, data in this study confirm the presence of a distinct mineralogical component in the upper part of the Yorkville Till Member. The average percentage of illite is 76 percent in the Dwight mineralogical zone and 81 percent in the lower Yorkville component. The average vermiculite index is 20< in the Dwight and 33< in the lower Yorkville. The ratio of dolomite to calcite percentages is 2:1 in Dwight till and 1:1 in Dwight lacustrine sediments, whereas the ratio is nearly 4:1 in lower Yorkville till and 3:1 in lower Yorkville lacustrine sediments. The Dwight till averages 10 percent sand, 43 percent silt, and 47 percent clay; lower Yorkville till averages 13 percent sand, 43 percent silt, and 44 percent clay. In lacustrine sediments associated mineralogically with the two tills the Dwight tends to be high in clay, whereas the lower Yorkville, where it occurs at the contact between the two units, is high in silt. These facts suggest a retreat and readvance between episodes of lower Yorkville and Dwight till deposition, with a concurrent change of source material.

The Dwight, as just defined, is a mineralogical zone occurring in the upper portion of the Yorkville Till Member within part of the study area. Both Dwight and lower Yorkville are informal stratigraphic units. However, these informal units can be treated using rock-stratigraphic principles, with the understanding that they are differentiated by laboratory data only.

FORM AND AREAL DISTRIBUTION OF DWIGHT MINERALOGICAL ZONE

The Dwight mineralogical zone can be mapped and correlated from one area to another using laboratory data. Figure 7 shows the locations of borings in which Dwight sediments have been identified, the thickness of the sediments in each boring, and an isopach map based upon these data. Figure 8 shows sampling locations and lines of selected cross sections in the study area, and figures 9 through 11 illustrate one north-south cross section, one west-east cross section, and one cross section along the crest of the Ransom Moraine.

The Dwight mineralogical zone, as a rock-stratigraphic unit within the study area (fig. 7), has several characteristics. (1) It displays a lobate form that conforms closely to the shape of the Marseilles Morainic System in the southern two-thirds of the study area. (2) It has three areas of notable thickness, one along the Minooka Moraine in the northeastern part of the study area, one in the southwest part of the study area along the inner margin of the Ransom Moraine, and one in the southeastern corner of the study area, centered near the crest of the Ransom Moraine. (3) Along the western border of the study area, it extends up onto the proximal slope and, in places, over the crest of the Ransom Moraine (figs. 10, 11). It gradually thins northward, both in the Morris Basin and along the crest of the Ransom Moraine. Its absence in the Illinois River valley is probably due to erosion by later surges of meltwater from glaciers to the north and northeast. (4) The Dwight is absent north and northwest of Central Ridge in the northern quarter of the study area (fig. 9).

The Dwight and lower Yorkville generally have a till-on-till contact in the northern part of the study area (figs. 9, 10, 11) whereas, in the southern part, lacustrine sediments intervene between the two tills. The Minooka Moraine is formed almost entirely of Dwight till and

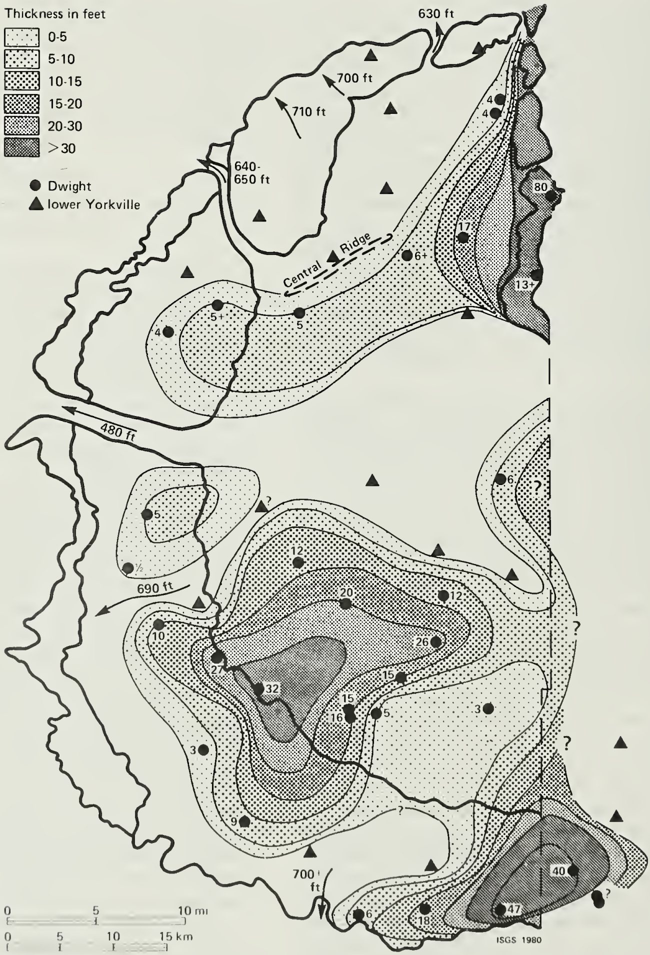

Figure 7. Isopach map of Dwight mineralogical zone. Circles indicate localities with Dwight as surficial unit; triangles indicate localities with lower Yorkville as surficial unit (excluding loess). Arrows and adjacent elevation figures indicate principal and inferred meltwater channels (see fig. 2).

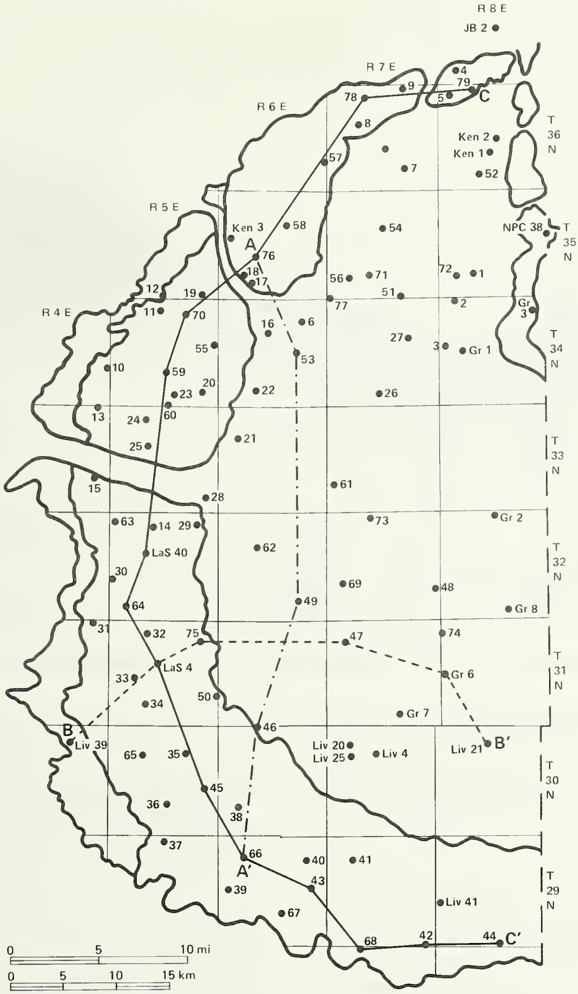

Figure 8. Map of study area showing all sample locations and lines of three cross sections.

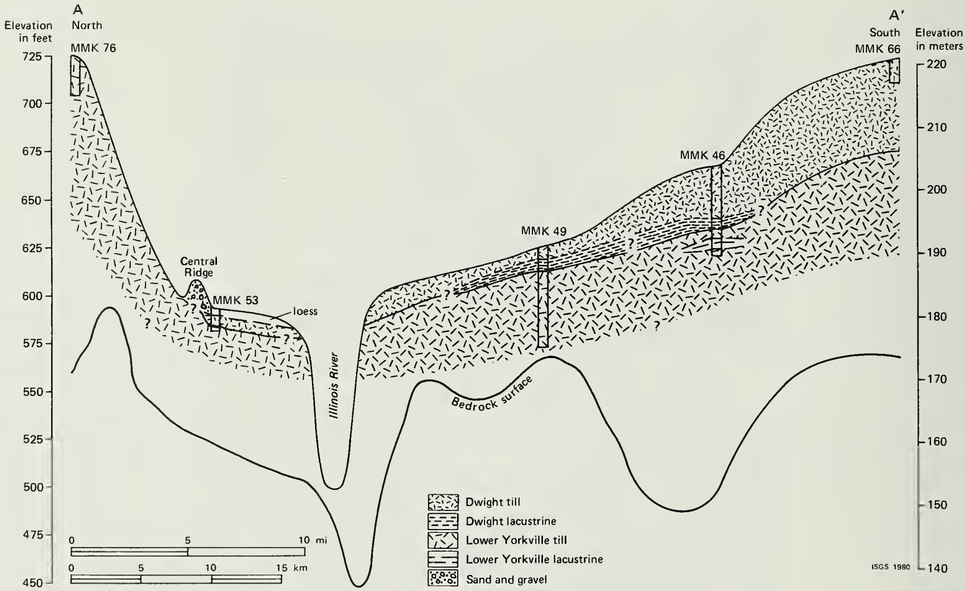

Figure 9. Cross section A-A′, north to south through central part of map area. Vertical exaggeration x 422.4.

Dwight lacustrine sediments and shows no evidence of lower Yorkville sediments, according to a study of samples from boring NPC-38 in the moraine (fig. 8 and appendix). The Norway Moraine and the bulk of the Ransom Moraine are composed of lower Yorkville till (figs. 10, 11).

DISCUSSION

These observations lead to the inference that lower Yorkville ice built most of the Marseilles Morainic System and that the ice surge responsible for deposition of Dwight sediments initially spread out across the Morris Basin either before or during the time it stabilized to form the Minooka Moraine. One possible interpretation of the alignment of the thickest portions of Dwight mineralogical zone sediments along the southern part of the Ransom Moraine (fig. 7) is that they may constitute the remnants of an end moraine deposited by Dwight ice either before or during formation of the Minooka Moraine.

The following points about the Dwight mineralogical zone may help place the unit in proper perspective, in terms of rock-stratigraphy and also in terms of the area's glacial history.

1. The bedrock topography of the study area (Horberg, 1950) constitutes a basin into which glacial ice must have flowed readily after overriding the bedrock highs to the north and east. Bedrock highs within the study area occur in general alignment with the Ransom Moraine, particularly in its northern segment, and a major bedrock valley trends southeastward out of the study area. (Note bedrock valley

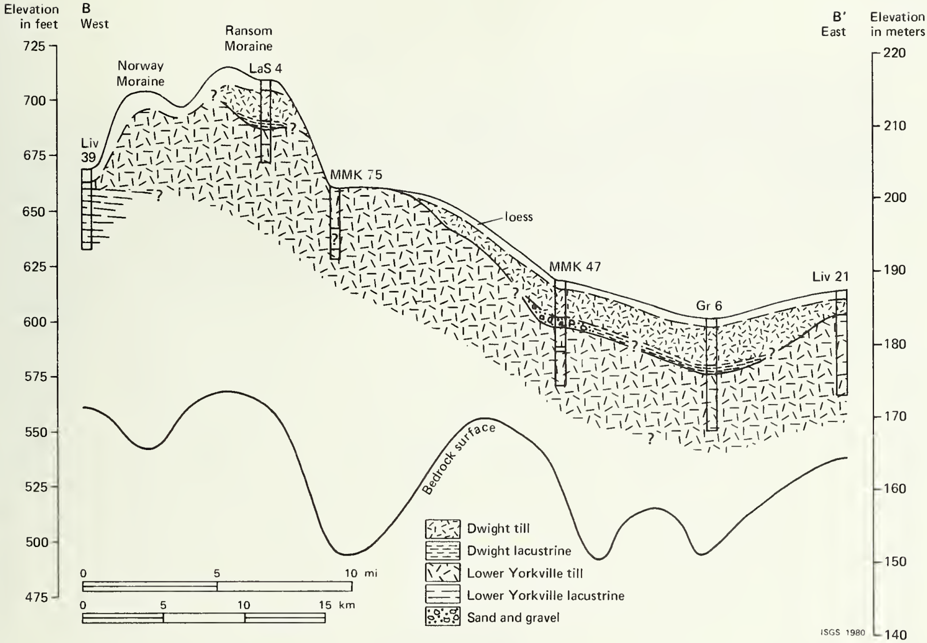

Figure 10. Cross section B-B', west to east across southern part of map area. Vertical exaggeration x 422.4.

at southern end of cross section C-C' (fig. llb). This bedrock topography undoubtedly influenced the direction of glacial flow and was responsible for the greater drift thicknesses in the southwestern and southern parts of the study area.

2. The lobe-like appearance suggested by the Dwight thickness lines (fig. 7) may be due either to a lobe-like configuration to the original Dwight ice pulse or to postglacial erosion along two high-level outlet channels. These channels exist at elevations of approximately 690 to 700 feet (210 to 213 m) in the southern half of the morainic system (figs. 7, 11) and coincide with the areas of thin or absent Dwight sediments. (Although borings are sparse in that area, those that do exist indicate that the Dwight is thin to absent there.)

In the southern part of the Ransom Moraine, thick Dwight sediments occur where both the lower Yorkville surface and the bedrock surface have low elevations (fig. llb). The existence of these lower elevations probably facilitated the flow of ice in a southerly direction. Perhaps of greater influence in the deposition of thicker Dwight sediments in the southern part of the study area may have been a shift in direction of flow of Dwight ice from that of lower Yorkville ice. Earlier geologists have postulated such a shift (Willman and Payne, 1942; Willman and Frye, 1970). In this study, the thicker Dwight deposits toward the south

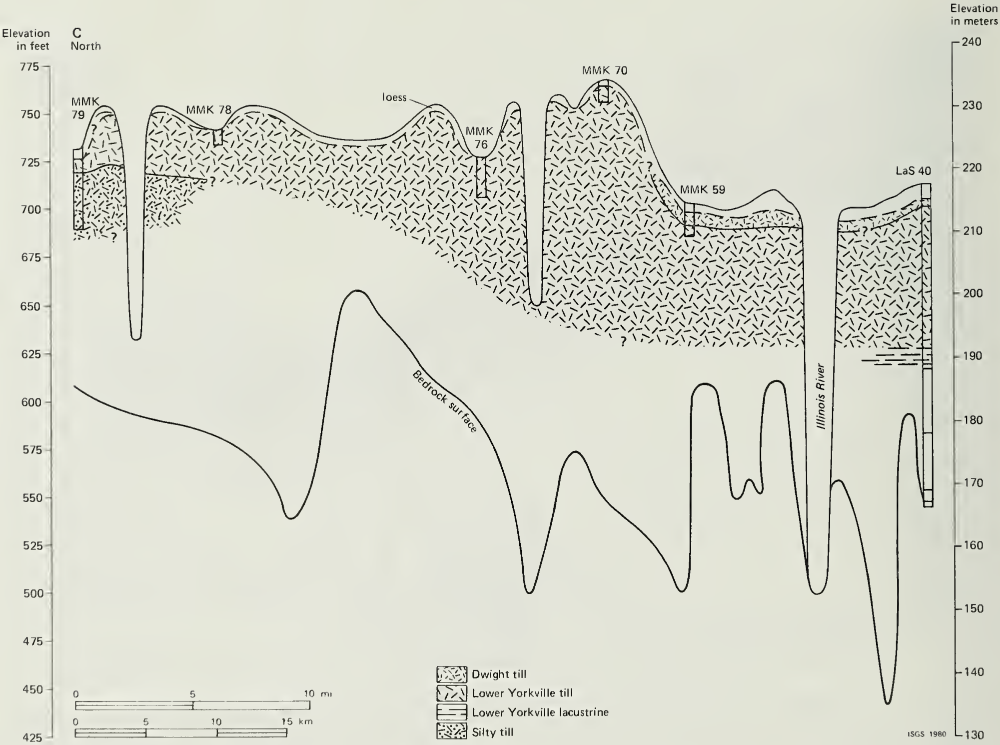

Figure 11a. Cross section C-C', along Ransom Moraine (northern half). Vertical exaggeration x 422.4.

and the north-south orientation of the Minooka Moraine, which is composed of Dwight sediments, provide evidence supporting such a shift. The general direction of ice flow at the time the Marseilles Morainic System was deposited was west-southwest, as indicated by the convexity of the morainic system in that direction. The general direction of ice flow at the time of deposition of the Minooka Moraine and the Dwight sediments apparently was more southerly.

3. The thin overlap of Dwight sediments along the crest of the Ransom Moraine in the western part of the study area contrasts with thicker Dwight sediments to the south, providing additional confirmation that the main thrust of Dwight ice was to the south, not west-southwest. The Dwight ice apparently maintained enough impetus to flow unimpeded across the lowland of the Morris Basin and up the backslope of the Ransom Moraine in the southern two-thirds of the study area, but it did not have sufficient lateral thrust toward the west to deposit till along the western portion of the moraine's crest. The ice may instead have sheared up upon itself at the position of the Minooka Moraine.

4. Willman and Payne (1942) postulated the existence

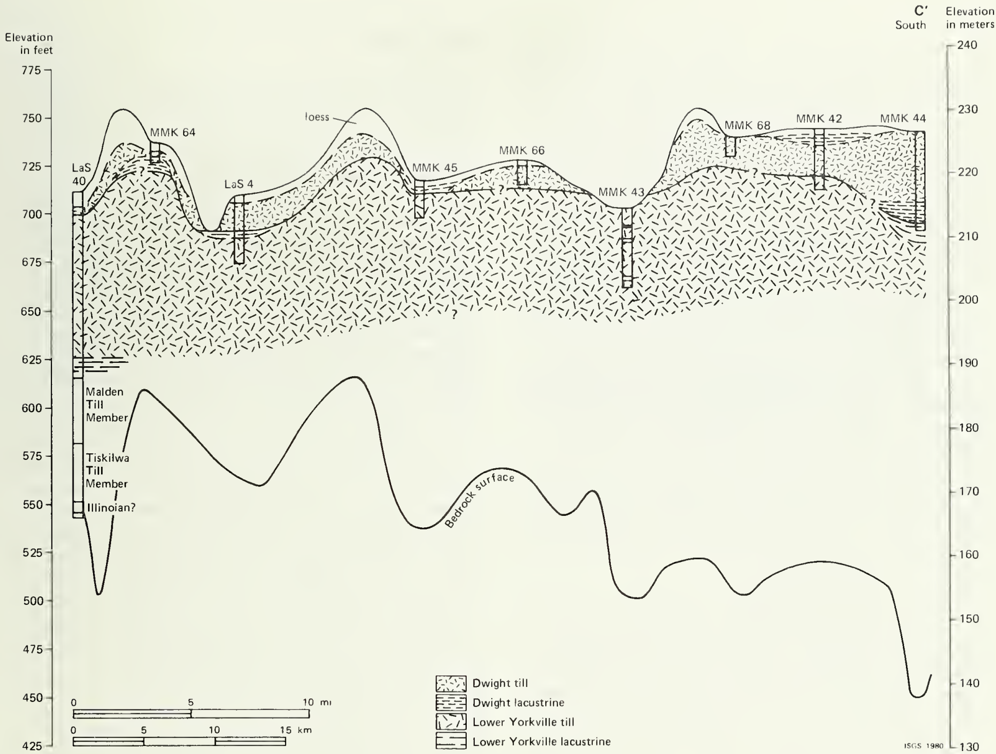

Figure 11b. Cross section C-C' (southern half). Vertical exaggeration x 422.4.

of a short-lived lake (Lake Lisbon) at about 700 feet (213 m) maximum elevation during the retreat of the ice front from the Ransom Moraine; the deposits of Central Ridge were attributed to "deltas" formed by the temporary stand of the ice front at that position. In the present study, the sand and gravel deposits of Central Ridge lie along the northern border of the Dwight as mapped (fig. 7); this suggests that Willman and Payne's Lake Lisbon may have existed at the time of maximum advance of the Dwight ice pulse. Dwight sediments also probably existed in the central part of the Morris Basin at one time but were eroded away by periodic surges of meltwater through the Illinois Valley.

5. The area north of Central Ridge presents an interesting problem in that almost all the data from that area are inconclusive as to whether Dwight or lower Yorkville sediments or even older units exist there. Most of the data appear to indicate that the till in that area is lower Yorkville. However, the vermiculite index is lower (from about 20< to 24<) than that normally seen in lower Yorkville deposits. Samples from a few borings show that the amount of illite or the carbonate ratio of the till is intermediate

between Dwight and lower Yorkville. Because these data are concentrated in (but not necessarily limited to) the northern quarter of the study area, a hypothesis is here advanced that the Dwight ice pulse may have incorporated some of the lower Yorkville till after lower Yorkville ice had disappeared from the area. Alternatively, if the westward shift in the glaciation center was reflected in the more southerly direction of ice flow postulated earlier, the area may represent a mixing zone between lower Yorkville and Dwight deposition. Additional evidence that the Dwight ice might have been contemporaneous or mixed with lower Yorkville in the north but was more of a separate pulse in the south is the fact that lacustrine sediments often occur between the two tills in the south, whereas in the north a till-on-till contact between the two units is usual. Such a theory also explains why the "typical" grain size and clay mineral data published for the Yorkville Till Member in Willman and Frye (1970) appear to be a composite of the Dwight and lower Yorkville as defined in the present study. (The samples from which those averages were derived were taken from throughout the region mapped as the Yorkville Till Member by Willman and Frye [1970].) The type section of the Yorkville Till Member, as currently and formally defined, is located in this area of anomalous data.

Till of Dwight mineralogical composition exists north of the study area between the St. Charles Moraine and the Minooka Moraine (fig. 1), and till of the St. Charles Moraine is lower Yorkville in clay mineral composition (H. D. Glass, 1980, personal communication). Therefore, it would appear that the Dwight ice surge may have advanced into the area north of the Ransom Moraine as well as south of it before stabilizing to form the Minooka Moraine. The cross section shown in figure 11 indicates areas of comparatively high bedrock elevations in the northernmost segment of the Ransom Moraine, and also shows an older, silty till underlying thin lower Yorkville till in boring MMK-79, about two miles (3.2 km) west of where the Minooka Moraine overrides the northern end of the Ransom Moraine. These circumstances suggest that the Ransom Moraine may have constituted a topographic obstacle to the flow of Dwight ice there, deflecting it southwestward along the line now marking the northern limit of Dwight sediments in the Morris Basin (fig. 7).

CONCLUSIONS

The Dwight mineralogical zone occurs (1) as a thin veneer of material in lobate form over the central part of the Marseilles Morainic System and the Morris Basin between the moraines; (2) as a thicker unit in the southern part of the Marseilles Morainic System and Morris Basin; and (3) as nearly the entire thickness of the Minooka Moraine. The depositional pattern, general lack of oxidation between the Dwight and lower Yorkville, and lack of field evidence to differentiate the two indicate that the Dwight is a mineralogical zone representing a readvance and concurrent change of source material within the main glacial depositional regime of the region, with a short interval of time between ice depositional events. The presence of water-laid sediments between the Dwight and lower Yorkville in the southern part of the area confirms that there was a readvance of ice into the area after the main body of the Yorkville ice melted.

The difference in mineralogical composition between the Dwight and lower Yorkville may be part of a larger sequential trend within progressively younger tills of Woodfordian age. In the study area, the trend may begin with the reddish-brown to pink, lower illite (about 65%), Tiskilwa Till Member (fig. 11), and progress to the "pure" olive gray, high illite (80%), lower Yorkville type. The overlying Dwight then represents the first stage of a return, in upward stratigraphic succession, to the reddish, lower-illite sediments of the Lake Michigan Basin found northeast of the study area and in Lake Michigan.

Detailed mapping of the Dwight mineralogical zone by means of subsurface data indicates that the unit spans the area of the Marseilles Morainic System and the discordant, overriding Minooka Moraine, thereby emphasizing that moraine configuration alone provides insufficient evidence for proper interpretation of a regional sequence of glacial events. This study verifies that consistent application of analytical laboratory data to regional studies can aid in delineating till units for regional stratigraphic correlation. Such correlation yields important clues to glacial history and may provide a means for predicting the occurrence of materials units.

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APPENDIX. Information on selected borings drilled for this study, borings made for other projects, and routine highway and foundation borings in the study area.

Field designation number	Location	Drilled for	Drilled by	Date	Sample interval	Sample type	Core file number
MMK-42*	Livingston SW-SW-SE 36-29N-7E	This study	ISGS	9-18-78	18-in. samples every 2½ ft; below 10 ft every 5 ft; TD = 31½ ft**	ST, SS***	C-12554
MMK-43	Livingston SW-SW-SW 13-29N-6E	This study	ISGS	9-18-78	18-in. samples every 2½ ft; below 10 ft every 5 ft; TD = 41½ ft	ST, SS	C-12555
MMK-44	Livingston SW-SE-SE 34-29N-8E	This study	ISGS	9-19-78	18-in. samples every 5 ft; TD = 51½ ft	SS	C-12556
MMK-45	Livingston NW-NW-NW 24-30N-5E	This study	ISGS	9-19-78	Continuous core; TD = 20 ft	SS	C-12557
MMK-46	Grundy SW-SW-SW 33-31N-6E	This study	ISGS	9-20-78	18-in. samples every 5 ft; TD = 46½ ft	SS	C-12558
MMK-47	Grundy NE-NE-NE 7-31N-7E	This study	ISGS	9-21-78	18-in. samples every 2½ ft; below 10 ft every 5 ft; TD = 46½ ft	ST, SS	C-12559
MMK-48	Grundy NE-NE-NE 25-32N-7E	This study	ISGS	9-21-78	18-in. samples every 5 ft; TD = 30½ ft	SS	C-12560
MMK-49	Grundy SE-SW-SW 26-32N-6E	This study	ISGS	9-22-78	18-in. samples every 5 ft; TD = 51½ ft	SS	C-12561
MMK-50	La Salle NE-NE-NE 25-31N-5E	This study	ISGS	9-22-78	18-in. samples every 5 ft; TD = 31½ ft	SS	C-12562
MMK-51	Kendall SW-SW-SW 35-35N-7E	This study	ISGS	10-17-78	TD = 9 ft****	ST	C-12563

*MMK-42 through 50 and 72 through 79 drilled with Mobile B-30S rig; MMK-51 through 70 with Giddings soil probe.
**TD = total depth
***ST = soil tube; SS = split spoon; SH = Shelby tube; CA = continuous auger
****Sample intervals irregular with soil tube on Giddings rig.

APPENDIX *(continued)*.

Field desig-nation number	Location	Drilled for	Drilled by	Date	Sample interval	Sample type	Core file number
MMK-53	Grundy SE-NE-NW 23-34N-6E	This study	ISGS	10-17-78	TD = 9 ft	ST	C-12565
MMK-54	Kendall NE-NE-NE 16-35N-7E	This study	ISGS	10-18-78	TD = 15 ft	ST	C-12566
MMK-55	La Salle NE-NE-SE 13-34N-5E	This study	ISGS	10-18-78	TD = 5 ft	ST	C-12567
MMK-59	La Salle NW-NW-NW 27-34N-5E	This study	ISGS	10-18-78	TD = 16 ft	ST	C-12572
MMK-62	Grundy SW-SE-SW 9-32N-6E	This study	ISGS	10-31-78	TD = 9½ ft	ST	C-12574
MMK-64	La Salle NE-NE-NE 31-32N-5E	This study	ISGS	11-01-78	TD = 6 ft	ST	C-12575
MMK-66	Livingston NW-NW-NE 8-29N-6E	This study	ISGS	11-01-78	TD = 12 ft	ST	C-12577
MMK-68	Livingston NE-NE-NE 5-28N-7E	This study	ISGS	11-01-78	TD = 9 ft	ST	C-12579
MMK-70	La Salle SW-SW-SW 2-34N-5E	This study	ISGS	11-02-78	TD = 10½ ft	ST	C-12581
MMK-72	Kendall SW-SE-SW 29-35N-8E	This study	ISGS	11-07-78	18-in. samples every 5 ft; TD = 22 ft	SS	C-12582
MMK-73	Grundy SE-SE-NW 4-32N-7E	This study	ISGS	11-08-78	18-in. samples every 5 ft, starting at 10 ft depth; TD = 25½ ft	SS	C-12583
MMK-74	Grundy SW-SW-SW 6-31N-8E	This study	ISGS	11-08-78	18-in. samples every 5 ft; TD = 31½ ft	SS	C-12584

APPENDIX *(continued).*

Field designation number	Location	Drilled for	Drilled by	Date	Sample interval	Sample type	Core file number
MMK-75	La Salle NE-NE-NE 11-31N-5E	This study	ISGS	11-08-78	18-in. samples every 5 ft; TD = 31½ ft	SS	C-12585
MMK-76	Kendall NW-SW-SW 21-35N-6E	This study	ISGS	11-09-78	18-in. samples every 5 ft; TD = 20½ ft	SS	C-12586
MMK-77	Grundy NW-NW-NW 6-34N-7E	This study	ISGS	11-09-78	18-in. samples every 5 ft; TD = 21½ ft	SS	C-12587
MMK-78†	Kendall SE-SE-SE 5-36N-7E	This study	ISGS	11-10-78	18-in. samples every 2 ft; TD = 7½ ft	ST	C-12588
MMK-79	Kendall SW-SE-NW 4-36N-8E	This study	ISGS	11-10-78	18-in. samples every 5 ft; TD = 41½ ft	SS	C-12589
Gr-1 (boring 1)	Grundy SW-SW-SE 17-34N-8E	Bridge US 6 over CRI & P RR	IDOT,‡ Div. Highways	9-27-66	18-in. samples every 2½ ft; TD = 40½ ft	SS	C-5008
Gr-2 (boring 4)	Grundy cen E line NW-NW 3-32N-8E	Coal City High School	Layne-Western	4-05-67	18-in. samples every 2½ ft; below 20 ft every 5 ft; TD = 42.3 ft	SS, SH	C-7160
Gr-3 (boring 1)	Grundy SE-SE-SW 1-34N-8E	Foundation test boring	Layne-Western	6-07-68	18-in. samples every 2½ ft; below 10 ft every 5 ft; TD = 16 ft	SH	C-7173
Gr-6 (boring 3)	Grundy NW-NW 19-31N-8E	Bridge FAI-55	IDOT, Div. Highways		18-in. samples every 2½ ft; TD = 50½ ft	SS	C-8208
Gr-7 (boring 1)	Grundy SE-NE 34-31N-7E	Bridge FAI-55	IDOT, Div. Highways	11-10-71	18-in. samples every 2½ ft; TD = 46½ ft	SS	C-9192
Gr-8 (boring 3)	Grundy SE-NE-SE 34-32N-8E	Bridge SBI-4 over Mazon R.	IDOT, Div. Highways	4-10-69	18-in. samples every 2½ ft; below 35 ft every 5 ft; TD = 40½ ft	SS	C-9195
JB-2	Kendall SW-SW-SE 15-37N-8E	J. Brossman	ISGS		continuous to 7½ ft; 18-in. samples every 5 ft below 10 ft; TD = 51½ ft	SS	—

APPENDIX *(continued).*

Field designation number	Location	Drilled for	Drilled by	Date	Sample interval	Sample type	Core file number
Ken-1 (boring 2)	Kendall SW-SW-SW 22-36N-8E	Walker & Schlapp Rds. over Aux Sable Cr.	IDOT, Div. High ways		18-in. samples every 2½ ft; TD = 26 ft	CA, SS	C-4770
Ken-2 (boring 2)	Kendall NE-NE-NW 22-36N-8E	Wheeler Rd. bridge	IDOT, Div. Highways		18-in. samples every 2½ ft; TD = 21 ft	CA, SS	C-4772
Ken-4	Kendall NW-SW-SW 22-36N-7E	Penman Rd. over Middle Aux Sable Creek	IDOT, Div. Highways		18-in. samples every 2½ ft; TD = 51½ ft	SS	C-4913
LaS-4 (boring 2)	La Salle SW-SW-NE 16-31N-5E	Farmers Elevator Co., Ransom	R. K. Morse	5-03-65	18-in. samples every 2½ ft; below 20 ft every 5 ft; TD = 36 ft	SS	C-4979
LaS-40 (boring 4)	La Salle NE cor 17-32N-5E	Power plant	Dames & Moore		Samples every 5 ft; TD = 170½ ft	D & M	C-7815
Liv-4 (boring 2)	Livingston SE-NW-NE 9-30N-7E	Elevated storage tank, Dwight	R. K. Morse	12-10-64	18-in. samples every 2½ ft; below 20 ft every 5 ft; TD = 25½ ft	ST, SS	C-4945
Liv-20 (boring 2)	Livingston SE-SW 5-30N-7E	Bridge, rt 17 over FAI-55	IDOT, Div. Highways	9-17-70	18-in. samples every 2½ ft; TD = 45½ ft	SS	C-8207
Liv-21 (boring 1)	Livingston SW cor 3-30N-8E	Bridge, FA 18 over E fork Mazon R.	IDOT, Div. Highways	10-21-71	18-in. samples every 2½ ft; TD = 46½ ft	SS	C-9191
Liv-25 (boring 2)	Livingston center 8-30N-7E	Bridge, FAI-55 over GM & O RR	IDOT, Div. Highways	9-03-71	18-in. samples every 2½ ft; TD = 45½ ft	SS	C-9201
Liv-39 (boring 2)	Livingston NE cor, NW-SE 3-30N-4E	Grain storage, Missal	Geotechnical Exploration Co.	2-01-77	18-in. samples every 2½ ft; below 25 ft every 5 ft; TD = 36 ft	SS, SH	C-12113
NPC-38	Kendall NE-NE-SE 13-35N-8E	North-eastern Illinois Planning Commission	Layne-Western	1-11-63	18-in. samples every 2½ ft; below 60 ft every 5 ft; TD = 90½ ft	SS	C-4591

†Yorkville Till Member type section (Willman and Frye, 1970)
‡Illinois Department of Transportation

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June 1, 1982
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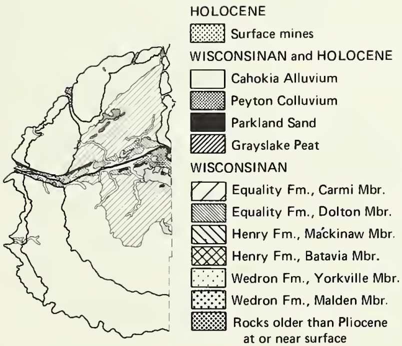

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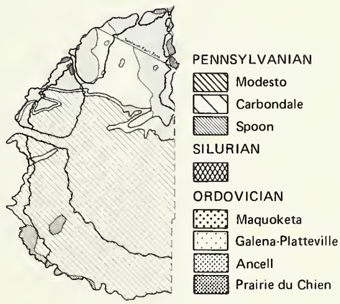

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Sandwich Fault Zone