Buried Pinchout of Saginaw Lobe Drift in Northeastern Indiana[1]

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Abstract

Subsurface data for Allen County, Indiana, indicate that the till of the Saginaw Lobe (unnamed member of the Lagro Formation) is a discrete unit separable from the superjacent clayey till of the New Holland Till Member of the Lagro Formation, and from hard loamy till units below that are presumed to include the Trafalgar Formation. The till of the Saginaw Lobe has sandy loam to loam texture, stiff consistency, and contains fragments of coal, tillite, and jasper conglomerate. Although the unit is mappable, a consistent means of petrographically differentiating this till from underlying hard tills of similar texture has not yet been found.

The extent of Saginaw till beneath till of the Erie Lobe can be mapped. This onlap-underlap condition in northeastern Indiana has been recognized since the late 1800's, but its great extent has been documented only recently. The Saginaw Lobe till extends southeastward from its areas of outcrop to northwestern Allen County, where its buried feather edge roughly parallels the Eel River sluiceway. The unit is exposed at several places in Cedar Creek canyon.

Although the Saginaw drift (and ice?) was subsequently covered by ice and drift of the Erie Lobe, Saginaw-drift topography was not obliterated, and it influenced the piracy of Cedar Creek from the Eel to the St. Joseph drainage. The topography of buried Saginaw drift may have been the dominant influence on the surface relief and local morainal topography in northwestern Allen County and perhaps elsewhere in northeastern Indiana.

Introduction

The lobate character of the glacial deposits in the Midwest is evident from the shape of certain topographic trends. The Lake Michigan Lobe, the Erie Lobe, and the Saginaw Lobe were all present in Indiana during Wisconsinan time, and possibly one or more was active during Illinoian, Kansan, or earlier time as well. The deposits of the Packerton Moraine (12, 15) record a close association of the Saginaw Lobe and the Erie Lobe during the last advances.

Saginaw Lobe deposits consist of a sandy loam till (unnamed till member of the Lagro Formation) (16) and large amounts of ice-contact stratified outwash. Coal brought from the Pennsylvanian rocks of Michigan is uniquely found in the Saginaw Lobe drift. The youngest deposits of the Erie Lobe consist of a silty clay loam till (New Holland Till Member of the Lagro Formation) (16).

The overlap of the clayey Erie Lobe drift onto the sandy Saginaw Lobe drift in northeastern Indiana has been recognized for a number of years. But this recognition has involved the assumption that the Saginaw Lobe till is truly distinct from the sandy till of the Trafalgar Formation, the surface till of central Indiana, and the till that underlies the Erie Lobe drift in east-central Indiana. The stratigraphic unit responsible for the relief and the local morainal topography of the

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Packerton Moraine in north-central Indiana and for the Mississinewa and Salamonie Moraines as mapped in northeastern Indiana has not been determined.

In addressing these questions, we will discuss the history of the recognition of the extent of overlap of the Erie Lobe drift onto the Saginaw Lobe drift, the nature of the till units, and the extent and significance of the southern underlap of the Saginaw Lobe drift below the Erie Lobe drift.

History of the Interlobate Concept

Historically, the discussion of the Saginaw-Erie relationship began when T. C. Chamberlin in 1883 considered the Packerton, which he did not name, to be "the eastern arm of the Saginaw Morainic loop," and termed it: "a joint intermediate moraine," (5). He was, thus, the first to advance the interlobate concept.

Charles Redway Dryer (6) mapped the overlap of the Erie Lobe drift on the north end of the Packerton Moraine, mostly on a morphological basis. He thought that only the Saginaw Lobe was truly interlobate and that, although it had preoccupied northern Indiana, it was still in place when the Erie ice overrode it. The Erie Lobe was inhibited on the north side, in his opinion, and thus the moraine pattern of the Erie Lobe is asymmetric. The Erie Lobe moraine (Mississinewa Moraine) in the interlobate area was, according to Dryer, strictly a terminal moraine with the Erie Lobe drift constituting the bulk of the material (6).

Frank Leverett considered the Packerton to be a moraine of the Huron-Erie Lobe but basically agreed with Dryer's placement of the boundary of the Mississinewa Moraine. Leverett, drawing upon his experience in Michigan (13), suggested that perhaps both the Packerton Moraine and the moraines associated with the Erie Lobe were draped over a pre-existing ridge of older glacial deposits (11). This, in fact, may be partly true (1) but still would not explain the differences in local topography exhibited.

The Packerton Moraine was not really named until Clyde A. Malott wrote his section of the *Handbook of Indiana Geology* in 1922 (12). He considered it to be a moraine of the Saginaw Lobe but felt that it might have been partly moved or overridden by the Erie Lobe which entered the area somewhat later.

W. J. Wayne, in his 1958 compilation of the *Glacial Geology of Indiana* (15), did not differentiate lobes but showed a significant ice-marginal position along the distal edge of the Mississinewa Moraine, essentially the same boundary Dryer had mapped. At that time Wayne believed that the Mississinewa represented the outer margin of the drift of the Erie Lobe. Later, J. H. Zumberge argued for the correlation of the Union City and Packerton Moraines even though he recognized that field evidence showed the Erie Lobe to be superposed on drift of the Saginaw Lobe (19). He felt that Erie Lobe drift extended to the Union City Moraine but that the Mississinewa represented a significant readvance.

The Union City Moraine was later recognized as the boundary of the clayey till by Wayne (17). Allan F. Schneider, formerly of the Indiana Geological Survey, continued to trace the extent of the Erie Lobe overlap, extending it beyond the north limb of the Mississinewa Moraine (unpublished field notes).

We have found clayey-textured till at the surface in southeastern Elkhart County, and the soil survey of Elkhart County shows an extensive area of Blount-Pewamo soils there (10). These soils typically form on poorly to moderately drained silty clay loam tills. The rest of the county is dominantly underlain by soils of the Riddles-Crosby-Miami association which form on loamy till. Soil surveys now underway in nearby counties will undoubtedly show additional areas of the clayier soils.

The morainal symmetry suggests that these occurrences of clay-rich material could be the northern equivalent of the Union City Moraine. The conclusion that the Union City has a northern limb is logical, inasmuch as the southern limb marks the farthest extent of the New Holland Till Member and of the Erie Lobe during the last major glacial advance.

Nature and Distribution of Saginaw Lobe Drift in Allen County

The till stratigraphy in Allen County (fig. 1) includes the upper, clayey till of Erie Lobe origin (New Holland Till Member of the Lagro Formation) and the lower, hard sandy till of presumed Erie Lobe origin (Trafalgar Formation) (2, 3). The buried surface of the Trafalgar Formation rises markedly northwestward to a distinct buried ridge in northwestern Allen County (1). The unit of Saginaw Lobe till sandwiched between these main till sheets (fig. 1) was first mentioned in that source (1).

The Saginaw Lobe till is relatively soft and sandy in comparison to other drift in the Fort Wayne area. Hand penetrometer measurements on split-tube cores from Survey drill holes yielded values in the medium- to stiff-consistency range. This contrasts with stiff to very stiff consistency of the overlying clayey till of the New Holland Till Member of the Lagro Formation and the hard consistency of the lower sandy till (2). The till typically is of loam texture (30 to 50 percent sand; 15 to 25 percent clay) and is very similar to the presumed Saginaw Lobe tills in counties to the north and to the lower till (Trafalgar Formation) in Allen County. The presumed Saginaw Lobe till cannot at this time be differentiated petrographically from the till of the Trafalgar Formation in Allen County. The tills are similar not only in texture but also in carbonate content and clay mineralogy. Both may contain traces of kaolinite, as do the Saginaw Lobe tills sampled to the north, apparently in relation to Pennsylvanian rocks eroded by the ice in Michigan. Coal chips, fragments of the Lorrain quartzite (jasper conglomerate of Precambrian age) and tillite of the Gowganda Formation (Precambrian) were found in the till in Cedar Creek exposures and are together highly suggestive of a Saginaw Lobe origin. Traceability on the basis of stratigraphic position and consistency are the only unique physical characteristics of the Saginaw Lobe till.

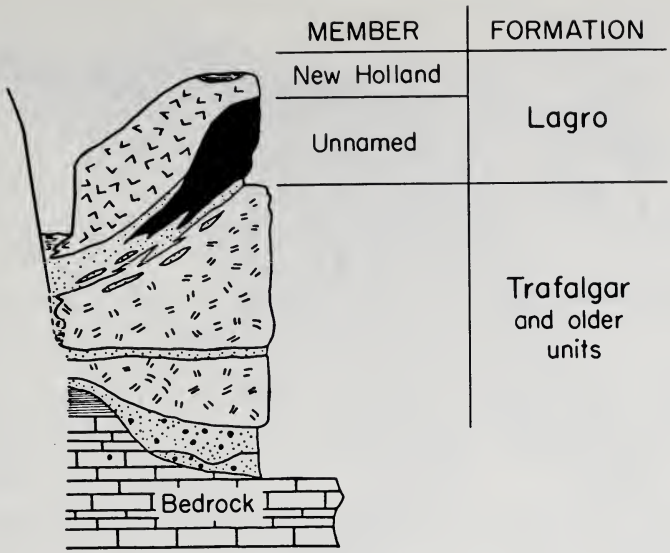

FIGURE 1. *Generalized geologic section, Allen County, Indiana, showing unconsolidated materials and identification of major units (revised from Bleuer and Moore, 2).*

This Saginaw Lobe till unit is present in an area mostly north of the Eel River drainage (figs. 2 and 3). However, the feather edge of the unit is just south of, but parallel to, the Eel River lowland.

The Eel River lowland (fig. 2) may have been essentially an ice-marginal drainageway in Allen County, just as it appears to have been in north-central Indiana at the front of the Packerton Moraine. Its course was probably determined either by ice of the Saginaw Lobe or by the surface of an even older drift sheet. Tills of the Saginaw Lobe and Erie Lobe overlie a thick confined sand body in the area a few miles north of the present Eel River. This sand seems to be continuous with the lower part of that thick unconfined sand section in the present Eel River axis and is part of the valley fill of an earlier, wider Eel River valley (fig. 3).

The recognition of Saginaw Lobe drift in northwestern Allen County awaited clear definition of the primary till units mentioned above, but its presence was suggested much earlier by several lines of evidence.

One line of evidence is the distribution of the Miami soil type, a forest soil developed on calcareous loam till, which has been mapped by the Soil Survey (9) over several small areas in northwestern Allen County (fig. 2). The Miami soil areas are on gently to strongly sloping low uplands on the north edge of the Eel River drainageway. These patches of Miami soils are the only extensive surface outcrops of the otherwise buried Saginaw Lobe drift in Allen County. Another line of evidence is that the area under which Saginaw Lobe drift is now known to be present is an area of much greater local relief and of more rugged and diverse morainal character than areas immediately

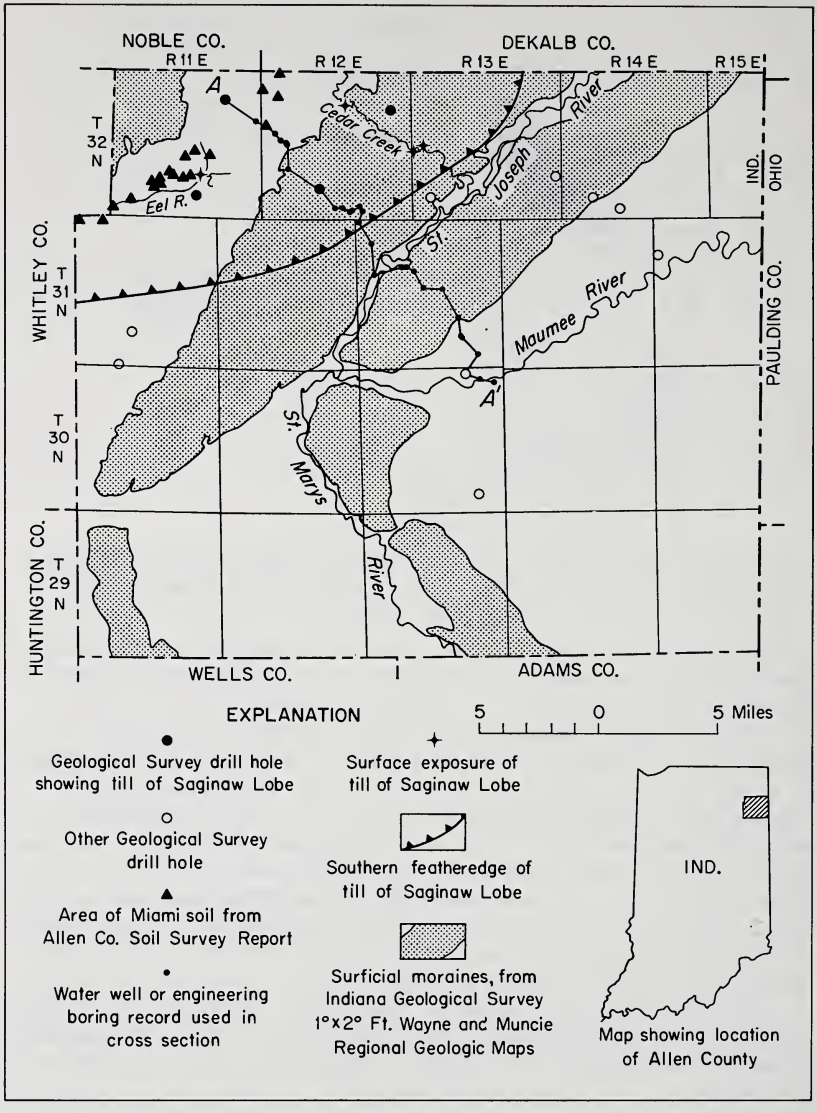

FIGURE 2. *Map of Allen County, Indiana, showing major moraines (from Burger and others, 4, and Johnson and Keller, 9), deep drill hole data points, areas of Miami soils, exposures and distribution of Saginaw Lobe till and lone of cross section A-A'.*

to the south. This distinction is obvious in comparisons of topographic quadrangle maps of areas north and south of the Saginaw Lobe boundary. This distinction is the basis for our mapping of the buried pinchout of the Saginaw Lobe drift (fig. 2). The extreme, massive morainal character of the northwestern part of Allen County, which includes abundant linear features, closed depressions, and wildly de-

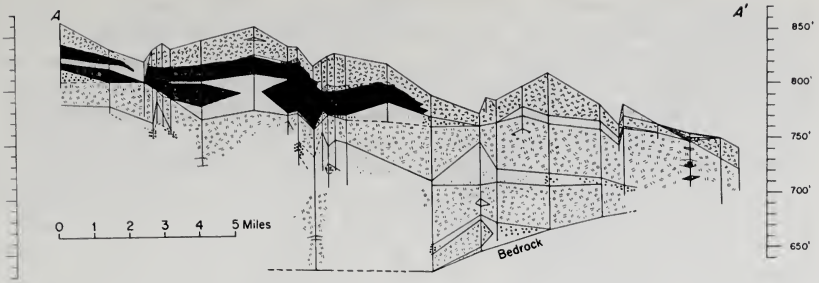

FIGURE 3. *Geologic cross section A-A' (see Fig. 2 for section location, Fig. 1 for explanation), showing the vertical distribution of tills in northwestern Allen County.*

ranged drainage, is much like the topography on the presumed Saginaw Lobe deposits in counties to the north, and the area's classification as a southward continuation of Chamberlin's "joint intermediate moraine" by Dryer (7) was fitting.

Saginaw Lobe drift can be recognized in a few road-cut exposures and in a few isolated cutbanks along Cedar Creek (fig. 2). The till is exceptionally loose and is oxidized in the surface exposures. In one Cedar Creek exposure, the contact between the Saginaw Lobe till and the overlying clayey till is sharp and not marked by intervening stratified sediments, a situation similar to many examples seen in counties to the north. In the other Cedar Creek exposures, the Saginaw Lobe till overlies sand and gravel that extends to creek level—regional correlation of well data places the top of the hard lower till, the Trafalgar Formation, just below creek level.

The Saginaw Lobe drift was encountered in 4 of 13 Indiana Geological Survey drill holes, which were intended to confirm the position of the top of the Trafalgar Formation (fig. 1). Rotary drilling was combined with split-tube sampling and rotary diamond coring in these tests. The holes were located in problem-correlation areas with respect to the top of the Trafalgar Formation and so not in the best possible lines with respect to mapping the Saginaw Lobe drift that was encountered.

Because stratified sediments commonly are not present between the tills of the New Holland Till Member and this unnamed member (of Saginaw Lobe origin) of the Lagro Formation, water-well records are not very useful in documenting the extent of this boundary.

Considering both the surface of the lower till (1) and the surface of an added wedge of Saginaw Lobe drift, the elevation of the present morainal landscape in northwestern Allen County (and perhaps much of northeastern Indiana) seems to be mostly inherited. In addition, some of the local relief and extremes of morainal topographic form characteristic of northwestern Allen County (including an incipient Cedar Creek canyon) possibly were inherited, either from drift or stagnant ice of the Saginaw Lobe. Detailed boring traverses are needed to substantiate these interpretations.

The buried margin of the Saginaw Lobe drift may be evident through its influence on the geomorphic features developed in the overlying drift of the Erie Lobe. An example of this influence on an isolated feature may be found in the piracy of the headwaters of the Eel River by the lower section of what is now Cedar Creek. Regionally, lakes, bogs and other depressions formed when the stagnant ice of the Saginaw Lobe melted now fairly well delimit the eastern and southern extent of the drift of the Saginaw Lobe. Although lakes and bogs are concentrated along the Packerton and Mississinewa Moraines, many are scattered throughout the area of the Saginaw Lobe (west of the Maxinkuckee Moraine are many areas of internal drainage formed by sand dunes, which are excluded from consideration here). Moreover, many depressions are aligned northeast-southwest and southeast-northwest, probably along former fracture trends in the ice of the Saginaw Lobe.

Piracy of Cedar Creek

The valley of Cedar Creek in the north-central part of Allen County is one of the most striking physiographic features in the area. It cuts almost perpendicularly across the Wabash Moraine and carries water from upper Cedar Creek to the St. Joseph River instead of to the Eel River, into which it once flowed. This canyon, as it is locally called, is a classic example of stream piracy.

Although the piracy occurred after the deposition of the New Holland till, the straight upstream half of Cedar Creek canyon may follow a course dictated by strain patterns in the Saginaw Lobe ice. The straight segment may be seen on the Cedarville 7½-minute topographic quadrangle map (T. 32 N., R. 12 E.). It is the only drainage channel to reach more than half-way across the Wabash Moraine from the west. A sharp bend at the point where State Route 427 crosses the stream marks the division between the two contrasting sections of the canyon. Downstream from this bridge the canyon follows a much more meandering course to its junction with the St. Joseph River, just below Cedarville (T. 32 N., R. 13 E.).

Outcrops of Saginaw Lobe drift were found at the State Route 427 bridge and just upstream (NW¼ sec. 10, T. 32 N., R. 12 E.) and just downstream (SW¼ sec. 18, T. 32 N., R. 13 E.) from it. On the Fort Wayne Regional Geologic Map (9), the upstream section of the valley is shown to be underlain by alluvium, whereas the downstream section is shown to be floored by outwash sand and gravel. The edge of the buried Saginaw Lobe drift, as deduced from topography (see below) (fig. 2), passes through the Wabash Moraine just southeast of the State Route 427 bridge.

We therefore propose the following hypothetical sequence of events for the piracy of Cedar Creek (fig. 4A-F).

First, the Saginaw Lobe advanced into Allen County from the northwest. At one point it drained along an ice-marginal fracture (A).

When Saginaw ice melted or was overridden, this drainage feature was preserved as a buried trough (B). Eel River, formed along a marginal position of Saginaw ice, was also buried.

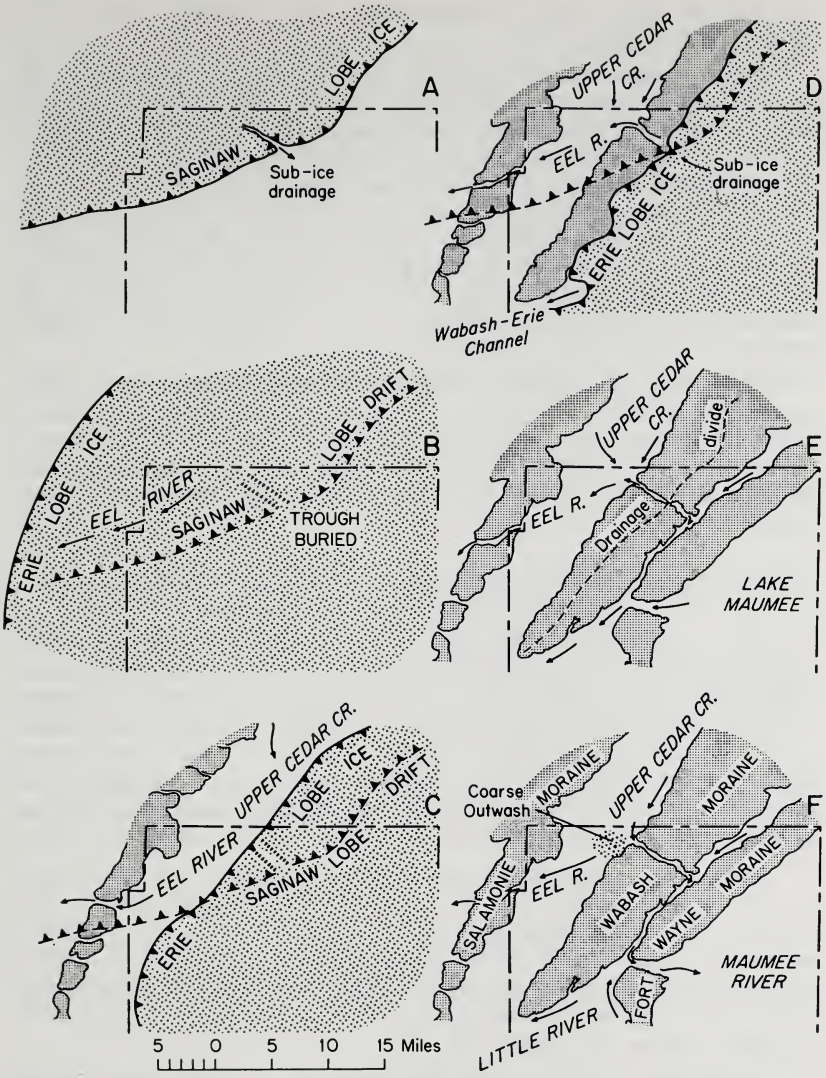

FIGURE 4. *Maps showing the sequential development of the Cedar Creek canyon. Allen County outlined.*

At the time the Erie Lobe occupied the position of the Wabash Moraine, the Eel River sluiceway was reactivated and included Upper Cedar Creek (C). Upper Cedar Creek formed as a stream along the Erie Lobe margin. The Eel River sluiceway was reactivated along the retreating Erie Lobe margin.

As the Erie Lobe front melted back to the position of the Fort Wayne Moraine, subice drainage followed the pre-existing sag left by

the Saginaw drift as well as continually using the main outlet of the Wabash-Erie Channel (D).

The St. Joseph valley was an ice-marginal drainageway as the glacier receded from the Fort Wayne Moraine (E). A short tributary probably developed along the lower course of Cedar Creek canyon, while the upper part of the canyon remained tributary to the Eel. The St. Joseph emptied into the Wabash-Erie Channel, which was also carrying meltwaters from glacial Lake Maumee. Occasionally lake discharge may have been great enough to back up the St. Joseph and cause floodwaters to flow over the divide in the Wabash Moraine. The presence of easily eroded Saginaw Lobe till, as opposed to the tight clayey New Holland or the very hard Trafalgar tills, facilitated erosion of a through-flowing channel.

By the time the Maumee drainage reversal had taken place, meltwater flow in the St. Joseph and especially in the Eel had substantially diminished (F). No longer competent to move coarse outwash at the northwest end of Cedar Creek canyon, the Eel was ponded and occasionally spilled through the canyon. Thus, the piracy was quickly completed.

Lakes, Bogs and Closed Depressions as Regional Indicators of the Extent of Deposits of the Saginaw Lobe

The morphologic characteristic most commonly associated with drift of the Saginaw Lobe is a rolling, hummocky surface of extreme irregularity. The rugged knob and kettle topography most associated with end moraines is found only on the northern limbs of the Mississinewa, Salamonie and Wabash Moraines and in areas north of and including the Packerton Moraine. Lakes, bogs and closed depressions abound in the area of Saginaw Lobe drift, scattered amongst numerous irregular hillocks of sand and till.

Because the typical loose sandy Saginaw Lobe till has been found as far southeast as the crest of the Wabash Moraine, we propose that the strong swell-and-swale morainal topography is the result of chaotic deposition during final melting of the stagnant Saginaw Lobe. Where this topography is found in the north limbs of the Mississinewa, Salamonie, and Wabash Moraines, the clayey till of the New Holland member is but a thin veneer (fig. 3).

The extent of such topographic expression and the extent of the Saginaw deposits can be visualized from parts of the Chicago, Fort Wayne, Danville, and Muncie Regional Geologic Maps published by the Indiana Geological Survey (14, 8, 18, 4). Nearly all the areas mapped as open lake (light blue, excluding, of course, man-made reservoirs) and muck and peat (Qmp, purple), when plotted, are shown to be north of the Eel River and thus within the area surrounded by the Packerton and Maxinkuckee Moraines. Those west of the overlap of the Packerton Moraine by the Mississinewa Moraine are shown to be north of the Eel River. East of the Mississinewa overlap boundary, the depressions are distributed in a broad tongue beyond the Eel River that extends into Allen and Dekalb Counties (fig. 2).

Conclusions

The sandy till of the Saginaw Lobe is a discrete body that is separable from underlying sandy till of the Trafalgar Formation and from the overlying clayey till of the New Holland Till Member of the Lagro Formation (figs. 1 and 3). The Saginaw Lobe on the southeast extended to the Eel River and, in Allen and Dekalb Counties, a few miles beyond (fig. 2). It left loose sandy loam till in a hummocky ice-disintegration topography that, along with remaining ice masses, was subsequently covered by the Erie Lobe bearing the silty clay loam till of the New Holland Till Member. This later till extended over much of the northeastern end of the Packerton Moraine of the Saginaw Lobe and perhaps reached as far northwest as Elkhart County. The elevation of the present morainal landscape in northwestern Allen County (and perhaps much of northeastern Indiana) seems to be mostly inherited (fig. 3).

The New Holland is thin and simply mantles the rugged topography developed on the Saginaw drift and does not interfinger with it (fig. 3). The Saginaw Lobe material is not contemporaneous with New Holland till, and because they were deposited by different lobes they are not depositionally continuous.

Apparently, members of Wayne's (16) Lagro Formation should no longer be considered as a part of a single depositional unit, and similarly they do not have enough common characteristics to be regarded as members of a single formation. The distinct units which have been aggregated into the Lagro Formation should, with this newer information, be defined and named on a physical basis, which is beyond the scope here.

Finally, the concept of a northeastern Indiana interlobate moraine needs reappraisal, inasmuch as no evidence suggests more than the clean overlapping of one drift sheet by another.

Literature Cited

1. BLEUER, N. K. 1974. Buried till ridges in the Fort Wayne area, Indiana, and their regional significance. Geol. Soc. America Bull. 85:917-920.

2. ————, and M. C. MOORE. 1972. Glacial stratigraphy of the Fort Wayne area and the draining of glacial Lake Maumee. Proc. Indiana Acad. Sci. 81:195-209.

3. ————, and ————. 1972. Glacial stratigraphy, buried landforms, and early drainage at Fort Wayne, Indiana. Geol. Soc. America Abs. with Programs (North Central Sec.). 4:309-310.

4. BURGER, A. M., J. L. FORSYTH, R. S. NICOLL, and W. J. WAYNE. 1971. Geologic Map of the 1° x 2° Muncie quadrangle, Indiana and Ohio, showing bedrock and unconsolidated deposits. Indiana Geol. Surv. Regional Geol. Map 5.

5. CHAMBERLIN, T. C. 1883. Preliminary paper on the terminal moraine of the second glacial epoch. U.S. Geol. Survey Annu. Rep. 3:291-402.

6. DRYER, C. R. 1894. The drift of the Wabash-Erie region—a summary of results. Indiana Dep. Geol. and Natur. Res. Annu. Rep. 18:83-90.

7. ————. 1889. Report on the geology of Allen County. Indiana Dep. Geol. and Natur. Hist. Annu. Rep. 16:105-130.

8. JOHNSON, G. H., and S. J. KELLER. 1972. Geologic Map of the 1° x 2° Fort Wayne Quadrangle, Indiana, Michigan, and Ohio, showing bedrock and unconsolidated deposits. Indiana Geol. Surv. Regional Geol. Map 8.

9. KIRSCHNER, F. R., and A. L. ZACHARY. 1969. Soil survey of Allen County, Indiana. U.S. Dep. Agric. Soil Cons. Serv., and Purdue Univ. Agric. Exp. Sta. 76 p.

10. ————, and P. MCCARTER. 1974. Soil survey of Elkhart County, Indiana. U.S. Dep. Agric. Soil Cons. Serv., and Purdue Univ. Agric. Exp. Sta. 96 p.

11. LEVERETT, FRANK. and F. B. TAYLOR. 1915. The Pleistocene of Indiana and Michigan and the history of the Great Lakes. U.S. Geol. Surv. Monogr. 53. 529 p.

12. MALOTT, C. A. 1922. The physiography of Indiana. *In* Handbook of Indiana Geology. Indiana Dep. Conserv. Pub. 21:59-256.

13. RUSSELL, I. C., and F. LEVERETT. 1908. Description of the Ann Arbor Quadrangle. U.S. Geol. Surv. Geol. Atlas, Folio 155. 15 p.

14. SCHNEIDER, A. F., and S. J. KELLER. 1970. Geologic Map of the 1° x 2° Chicago quadrangle, Indiana, Illinois, and Michigan, showing bedrock and unconsolidated deposits. Indiana Geol. Surv. Regional Geol. Map 4.

15. WAYNE, W. J. 1958. Glacial geology of Indiana. Indiana Geol. Surv. Atlas of Mineral Resources of Indiana. Map 10.

16. ————. 1963. Pleistocene formations in Indiana. Indiana Geol. Surv. Bull. 25. 85 p.

17. ————. 1968. The Erie Lobe margin in east-central Indiana during the Wisconsin glaciations. Proc. Indiana Acad. Sci. 77:279-291.

18. ————, G. H. JOHNSON, and S. J. KELLER. 1966. Geologic Map of the 1° x 2° Danville quadrangle, Illinois and Indiana, showing bedrock and unconsolidated deposits. Indiana Geol. Surv. Regional Geol. Map 2.

19. ZUMBERGE, J. H. 1960. Correlation of Wisconsin drifts in Illinois, Indiana, Michigan, and Ohio. Bull. Geol. Soc. America. 71:1177-1188.