THE KANSAN GLACIATION IN SOUTHEASTERN INDIANA[1]

ANSEL M. GOODING

Earlham College, Richmond, Indiana

ABSTRACT

Buried Kansan drift and Yarmouth soil beneath Illinoian drift are described from three locations south of the Wisconsin drift border in southeastern Indiana. The occurrence in Kansan drift of bright red, clayey, non-calcareous, limestone-derived soil inclusions, and abundant residual chert cobbles from the local Silurian Laurel Limestone suggest that the Kansan ice may have been the first to reach this area. The scattered upland erratics in northern Kentucky, therefore, seem more certainly to be Kansan in age, as suggested originally by Leverett.

The Townsend Farm section provides a basis for geologic-climate subdivisions of the Kansan Stage in southeastern Indiana, named as follows:

Kansan Stage
Columbia Stade
Garrison Creek Interstade
Alpine Stade

The slightly greater depth of leaching of the Yarmouth soil in the Townsend Farm section as compared to depths in similar buried Sangamon soils in southeastern Indiana suggests that the Yarmouth interglacial interval was slightly longer than the Sangamon interglacial interval in this area.

INTRODUCTION

Leverett (1929, p. 33–50) first suggested the possibility that Kansan ice covered southeastern Indiana and southwestern Ohio. He interpreted scattered erratics on uplands in northern Kentucky as remnants of a drift older than the extensive Illinoian drift sheet that covered uplands north of the Ohio River. Other workers also have inferred pre-Illinoian glaciation of the area on the basis of apparent drainage changes most logically explained as the effects of a pre-Illinoian glacial advance (Thornbury, 1937, p. 98–100; Flint, 1947, p. 280–281; MacClintock, 1933, fig. 3). Wayne (1958, p. 9–15) described occurrences of Kansan drift and Yarmouth soil at several localities in south-central and southwestern Indiana. Durrell (1956; 1961, p. 57–58) suggested the existence of exposed Kansan drift in the Cincinnati region on the basis of depths of leaching of surface soils greater than is common in unquestioned Illinoian drift in the area.

The above inferences for Kansan glaciation in southeastern Indiana and southwestern Ohio are supported by the discovery at three localities south of the Wisconsin drift border in southeastern Indiana (fig. 1) of Kansan drift and Yarmouth soil buried beneath Illinoian drift. This paper describes and interprets the stratigraphic data in these sections.

SECTION DESCRIPTIONS

Osgood section

Road construction in 1959 exposed the Osgood section (Figs. 1 and 2) in a fresh cut on the south side of State highway 350, 3.5 miles east of the junction of State highway 350 and U. S. highway 421 at the town of Osgood, Ripley County, Indiana. The location is in the SW corner, Sec. 7, T. 8 N., R. 12 E., on the Pierceville, Indiana, Quadrangle.

---

[1]Manuscript received April 15, 1964.

Unit	Thickness in feet	Description
		Top of section on moderately eroded ridge below upland.
	Illinoian Stage and post-Illinoian soil	
9	0–1.0	Silt—non-calcareous, clayey, yellowish-brown; probably weathered loess in part.
8	19–20.0	Till—upper 5–6 ft. non-calcareous, clayey, reddish-brown; contains calcium carbonate concretions at bottom; lower 14 ft. calcareous, buff (oxidized). Open joints extend through the till into underlying sand, with till adjacent to joints being cemented with limonite.
7	6.0	Sand—grading down into cherty gravel. Upper 4 feet leached and cemented with limonite below joints in overlying till. Lower 2 feet calcareous.
6	14.0	Till—calcareous, buff (oxidized).
	Kansan Stage and Yarmouth Soil	
5	0–3.0	Sand—non-calcareous, clayey, reddish-brown.
4	12.0	Till—upper 4 feet non-calcareous, clayey, mottled yellowish-brown and gray; lower 8 feet calcareous, buff (oxidized), and containing abundant cobbles of white and gray chert. Joints extend through the till into underlying clay.
3	10.0	Clay—calcareous, laminated. Upper 8 feet buff (oxidized) and jointed; lower 2 feet gray (unoxidized).
2	10.0	Covered—road fill.
1	3.0+	Ordovician limestone and shale in creek bed.

Townsend Farm Section

The Townsend Farm section (figs. 1 and 2) is located in a stream bank on the south side of the North Branch of Garrison Creek in Fayette County, Indiana, in the northwest corner of Sec. 20, T. 13 N., R. 12 E., Alpine, Indiana, Quadrangle.

Unit	Thickness in feet	Description
		Top of section on eroded slope 100 feet below the upland.
	Illinoian Stage and post-Illinoian soil	
6	20.0+	Till—upper 15.0 feet determined by several auger holes up slope from top of exposure. Top 6.5 feet is non-calcareous, eroded, post-Illinoian soil. Lower 13.5 feet calcareous, buff (oxidized) till.
5	0.5	Clay—calcareous, buff (oxidized) to gray (un-oxidized), with white streaks of secondary calcium carbonate in places; with blocky structure.
	Kansan Stage and Yarmouth Soil	
4	1.0–2.0	Silt—non-calcareous, black, organic-rich; possibly weathered loess or fine colluvium.
3	21.0	Till—upper 6–7 feet non-calcareous, very clayey, grayish-brown, containing many chert pebbles and cobbles and limonite concretions, with a 4-inch reddish-brown limonite-cemented layer at bottom. The soil is a humic-gley. Lower 16 feet calcareous, gray (un-oxidized), containing abundant chert cobbles. Wood occurs in lower part.
2	0.5–2.0	Sand—calcareous, buff (oxidized). In places a 2- to 4-inch, calcareous, gray to black silt, containing abundant finely divided plant remains and twigs, occurs at top; no mollusks found.
1	18.0+	Till—calcareous, gray (un-oxidized), containing abundant chert cobbles. In basal 10 feet occur sand and gravel pockets, and large inclusions of chert pebbles in a bright red, non-calcareous clay matrix, probably from a local, residual, pre-Kansan limestone soil. Wood occurs throughout till.
		Creek bed.

Handley Farm Section

The Handley Farm section (figs. 1 and 2) is located on the south bank of the North Branch of Garrison Creek in Fayette County, Indiana, in the northwest corner of the SW ¼, Sec. 28, T. 13 N., R. 12 E., on the Alpine, Indiana, Quadrangle.

The upper two units of this stratigraphic section are better displayed, and hence described, from a road cut 1200 feet northeast of the main section.

Unit	Thickness in feet	Description
		Top of section is on an eroded ridge.
	Illinoian drift and the post-Sangamon Soil	
8	4.0–8.0	Clayey silt—reddish-brown, non-calcareous; believed to be weathered loess.
7	15.0	Till—calcareous, except for the top 1–4 feet, which are leached in places. The rest of the unit is calcareous and buff (oxidized), except for the bottom 2–3 feet which are gray (un-oxidized) in places.
6	30.0	Gravel and sand—calcareous. The upper 5–10 feet of this unit is firmly cemented into a conglomerate which stands out as a ledge on the slope.
5	2.0	Clay—calcareous, finely laminated.
	Kansan drift and Yarmouth Soil	
4	5.5	Till—completely weathered, non-calcareous, brown to reddish-brown, very clayey. Chert fragments *very* abundant in clay matrix.
3	15.0	Clay—lacustrine, upper 1 foot leached; remainder calcareous, gray to buff, massive, well jointed. Along the joints calcium carbonate, iron oxide, and manganese oxide precipitation has formed hard wedges. In some places the clay shows good laminations and possibly crude varves. The face of the clay exposure shows good conchoidal fractures. Bottom 6 feet of unit is black with finely divided organic matter and abundant ostracod valves.
2	10.0	Clay—lacustrine, calcareous. This unit is separated from the above lacustrine clay by a sharp erosional contact, above and below which are many circular to elliptical, finely laminated and iron oxide-cemented "liesegang" features. This unit also contains several lenticular red-clay inclusions full of chert fragments, and some slabs of local Ordovician limestone, completely surrounded by the lacustrine clay. These inclusions must have been rafted from the shore zone and dropped in the lake. In places the lacustrine clay contains finely divided organic matter and abundant small snails and clams.
1	7.0+	Ordovician bedrock.
		Creek bottom.

DISCUSSION

Osgood Section

The Osgood section is in the area of Illinoian surface drift, and is more than 10 miles south of the Wisconsin till boundary. The weathered zone (units 8 and 9) at the top of the section constitutes an eroded, slope phase of the Cincinnati soil (Rogers et al., 1950), which is the dominant soil type on the Illinoian till surface in the area.

The zone of leaching in the sand (unit 7) beneath the surface Illinoian till is clearly a secondary "pseudo-soil" of the type found elsewhere at many localities in sand and gravel beneath surface tills of various ages (Gooding et al., 1959; Gooding and Gamble, 1960; Gooding, 1963). Open joints, with limonite-cemented walls, extend visibly from the surface soil through the calcareous Illinoian till (unit 8) and into the underlying sand and gravel (unit 7). Leaching and limonite cementation in the sand (unit 7) thus occurred as a downward extension of the surface soil, after deposition of the overlying till (unit 8). Deep, open joints in calcareous Illinoian till below the Sangamon zone of weathering are common at several localities in southeastern Indiana (Gooding, 1963).

The zone of weathering through sand (unit 5) and into till (unit 4) is interpreted as the B horizon remnant of a deep and well developed soil that has been truncated. The A horizon was probably removed by the Illinoian ice which deposited the

overlying till (unit 6). The character and thickness of the preserved B horizon, and the deep extension of open joints and oxidation into the underlying lacustrine clay (unit 3), record clearly an interglacial episode of weathering, logically of Yarmouth age.

The laminated Kansan clay (unit 3) is believed to be of lacustrine origin. Its surface, at approximately 885 feet above sea level, is 55 feet above the bottom of nearby Laughery Creek valley, and still higher above the bottoms of larger valleys

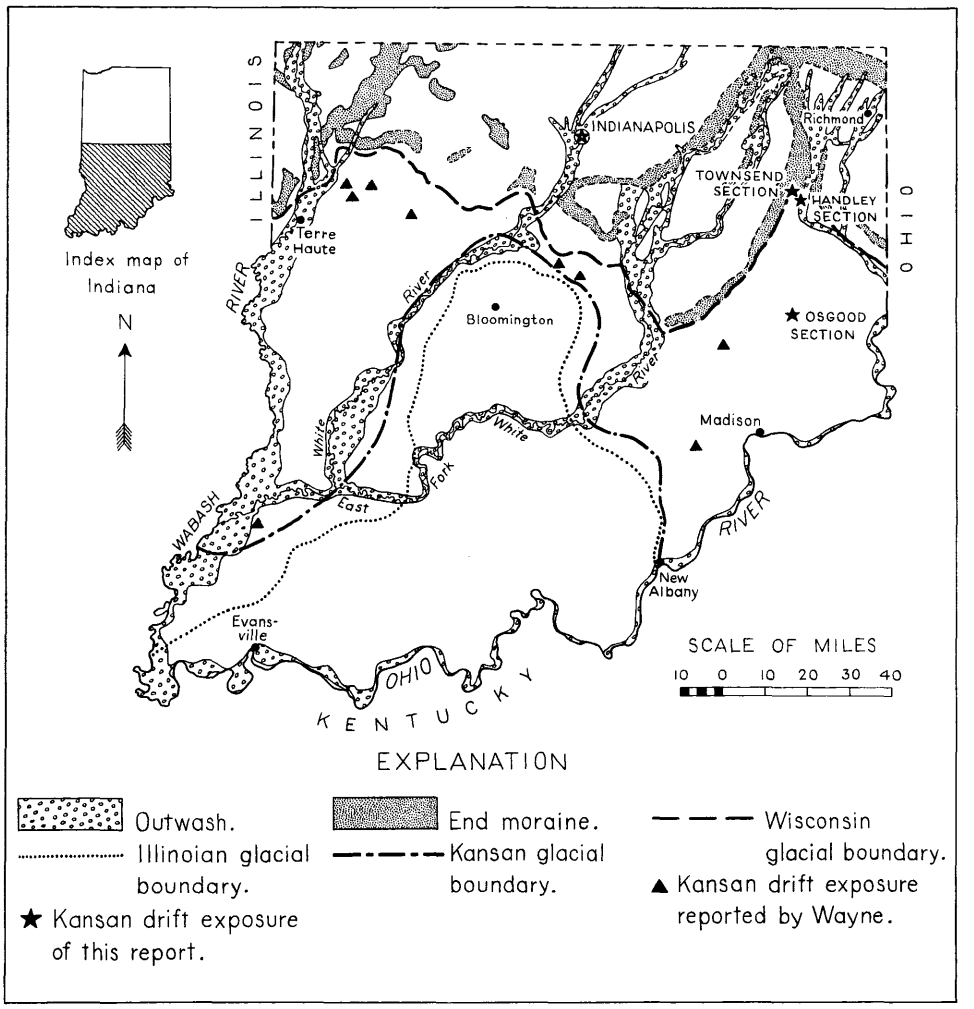

FIGURE 1. Glacial map of southern Indiana showing locations of Kansan drift exposures discussed in this report. Glacial map from Indiana Geological Survey Report of Progress 7.

in the region. The lacustrine clay (unit 3) may have been deposited in ponded waters of a tributary to the north-flowing Teays-age Eagle River, which existed along the Indiana-Ohio State line west of Cincinnati (Durrell, 1961, p. 49, fig. 2) when Kansan ice advanced into the area.

Townsend Section

The outermost Wisconsin (Shelbyville) till boundary crosses the southeast-flowing North Branch of Garrison Creek diagonally a short distance northwest of the Townsend Farm section. The Wisconsin drift-covered side (north) and the Illinoian drift-covered side (south) of the valley near the location of the section contrast both in surface soils and topography. The Wisconsin (north) side of the valley has relatively long gentle slopes up to the Wisconsin drift-covered upland, which is characterized by soils of the Russell catena (Rogers et al., 1950) leached 3–5 feet. The south side of the valley, where the Townsend Farm section is located, has steeper slopes up to the Illinoian drift-covered upland, on which occur Cincinnati soils with depths of leaching of 8–10 feet. In addition, the south

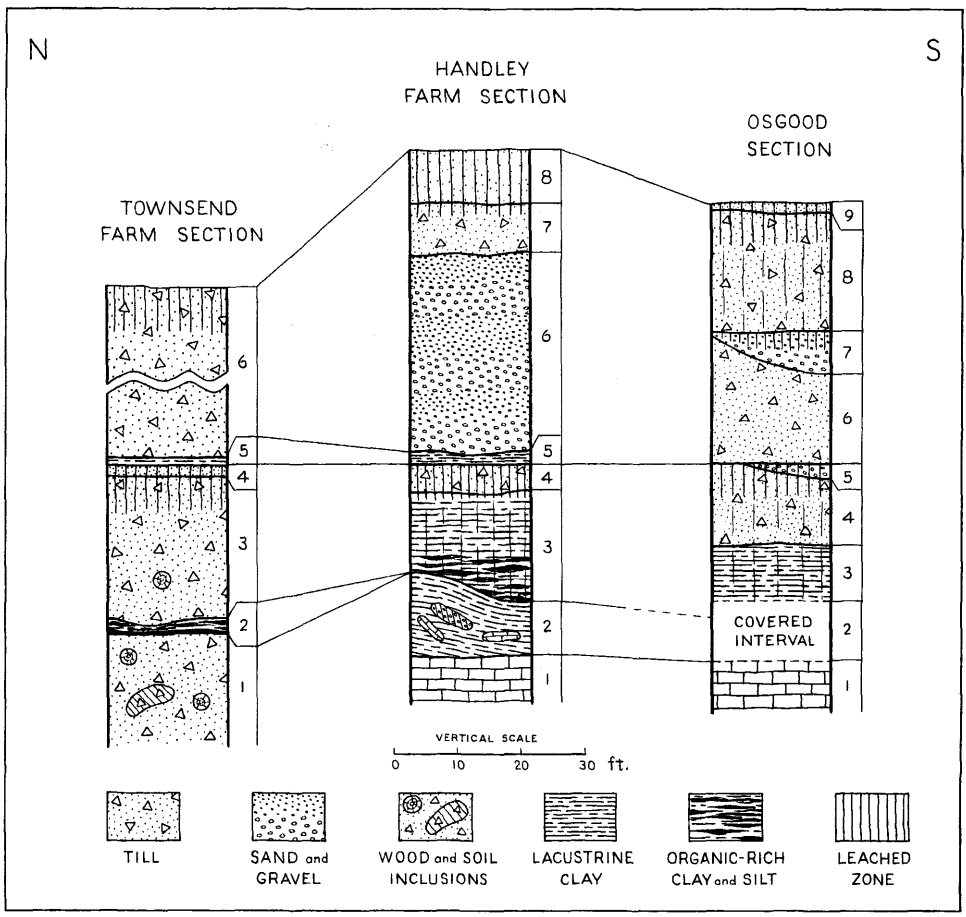

FIGURE 2. Columnar sections showing stratigraphic units and their correlation.

side of the valley in the vicinity of the Townsend section is very badly slumped, with some rotational slump blocks that are probably still active. Slippage of Illinoian drift blocks on the south side of the creek in this area has occurred on the compact, very clayey, buried Yarmouth humic-gley soil. Several slump blocks near the valley wall were augered through, and the buried Yarmouth soil was encountered at a common elevation in each.

Analyses on several samples of Kansan till (units 1 and 3) showed them to be very uniform in texture and carbonate content from top to bottom and laterally over 50 feet of the exposure. At this locality, the Kansan tills are slightly more silty, less sandy and clayey, and have a slightly higher carbonate content than do Illinoian and Wisconsin tills in south-eastern Indiana. Preliminary heavy mineral analyses suggest that the Kansan tills differ from Illinoian and Wisconsin tills in this respect as well. Analyses are needed on Kansan tills at other localities in the area to determine if these differences are regionally significant.

The 7–8 foot zone of weathering, with the organic-rich silt (possibly weathered loess or colluvium) (units 3 and 4) at the top, indicate that the buried Yarmouth humic-gley soil is largely intact. The calcareous clay (unit 5) on top of the Yarmouth soil is interpreted to be a pro-Illinoian lacustrine deposit. Probably a layer of ice (refrozen meltwater) in this poorly drained site protected the Yarmouth soil from the overriding Illinoian glacier.

The calcareous, organic-rich silt layer associated with the sand (unit 2) between Kansan tills (units 1 and 3), although thin and discontinuous, resembles the numerous Illinoian and Wisconsin interstadial deposits in drift farther north (Gooding, 1963), and probably records an interval of ice retreat during Kansan time that was climatically controlled. It is therefore considered to be of interstadial rank.

Kansan till (unit 1) at the base of the Townsend Farm section contains large inclusions of non-calcareous, bright red (Dry-2.5YR 4/4, Wet-2.5YR 3/4; Munsell color notation), very clayey soil that is full of residual chert cobbles. The white and gray chert cobbles are abundant also throughout Kansan tills (units 1 and 3) in the Townsend Farm section, in Kansan till (unit 2) in the Osgood section, and in weathered Kansan till (unit 4) in the Handley Farm section. The chert types in these drift units are identical to bedded and nodular chert in the local Silurian Laurel Limestone, and are believed to have been residual in red soil weathered from the limestone bedrock in the area. The above features at least suggest that the Kansan glacier may have been the first to cover southweastern Indiana.

Handley Farm Section

The Handley Farm section is located one and one-third miles south of the outermost Wisconsin till boundary (fig. 1). The Wisconsin till boundary is sharply delineated in the area by the Cincinnati-Russell soil discontinuity (Rogers et al., 1950), so there is no question that the section occurs in the area of Illinoian surface drift. Thus, the buried weathered zone in this section (unit 4) is logically the Yarmouth soil.

As indicated in the section description, the two Kansan lacustrine clay deposits (units 2 and 3) are distinct and separated by an erosional unconformity. The two stages of lake filling at this site are probably related to ice or valley-train damming of a valley by the separate ice advances that are recorded by the two Kansan tills (units 1 and 3) separated by interstadial deposits (unit 2) in the nearby Townsend Farm section. This correlation of deposits and interpretation of events is supported also by the similar occurrence, in the lacustrine clay (unit 2) at the Handley Farm section and in the lower Kansan till (unit 1) in the Townsend section, of inclusions of a red, non-calcareous, clayey soil containing abundant chert cobbles. These cherty soil inclusions must have been rafted by ice from the shore of the lake in which the Handley Farm lacustrine clay (unit 2) was deposited.

The Yarmouth zone of weathering (unit 4) in the Handley Farm section is very clayey, and contains abundant angular chert fragments, as well as other pebbles of erratic rock types in various stages of decomposition. Although no unweathered Kansan till was found in this section, the composition of the weathered zone suggests that the parent material was Kansan till. The zone of weathering is interpreted to be entirely the B horizon of the Yarmouth soil, the upper

part of the profile having been truncated by erosion just prior to the deposition of the overlying Illinoian outwash (units 5 and 6).

The single Illinoian till (unit 7) at the Handley Farm site occurs at the top of the section. Although two Illinoian tills are known from sections farther north in the area, it has been suggested that the first Illinoian ice advance in the area did not reach as far south as the Handley Farm site (Gooding, 1963, p. 672). Thus, the Illinoian till (unit 7) at the Handley Farm site may belong to the second, and presumably more extensive, Illinoian ice advance into the area.

The weathered silty and clayey surficial material (unit 8) is typical in character and thickness to the upland surficial material in southeastern Indiana south of the outermost Wisconsin till boundary. It is believed to be largely weathered loess. Its thickness here and elsewhere in the area is greater than the combined thicknesses of the Wisconsin loess sheets to the north, and therefore it must consist in part of Illinoian loess. Although a separation is not possible at the Handley Farm site, elsewhere in the area a disconformity between the Illinoian and Wisconsin loess sheets can be identified stratigraphically.

SUBDIVISIONS OF THE KANSAN STAGE

The three Kansan drift sections herein discussed contain drift units which record two advances of Kansan ice separated by a brief, but significant ice retreat. The Townsend Farm section is designated the type section for the geologic-climate subdivisions of the Kansan Stage, named as follows, from older to younger: The basal till (unit 1) at Townsend Farm, containing inclusions of bright red, non-calcareous, clayey, limestone-derived soil is named the *Alpine Stade;* the organic deposit at the top of the sand (unit 2) records an interval of ice retreat and is named the *Garrison Creek Interstadial;* the second Kansan till (unit 3), in which the Yarmouth soil is developed, is named the *Columbia Stade.* The two stades are named after small towns near the Townsend Farm section, and the interstade is named after the Creek on which the type section is located. Figure 2 shows the correlatives of these drift units in the Handley Farm and Osgood sections.

CONCLUSIONS

Kansan drift and Yarmouth soil buried beneath Illinoian drift are known at three localities south of the Wisconsin drift border in southeastern Indiana. The occurrence in all of the Kansan tills of abundant residual white and gray chert from the local Silurian Laurel Limestone, and the occurrence in the lower Kansan drift units at two sections (Handley and Townsend Farm sections) of bright red, non-calcareous inclusions of a limestone-derived soil, suggest that the Kansan glacier may have been the first to reach southeastern Indiana.

The elevation of the top of pro-Kansan lacustrine clay at the Osgood section suggests that the clay may have been deposited in an ice-dammed tributary valley of the pre-glacial north-flowing Teays-age Eagle River (Durrell, 1961, p. 49, fig. 2), which existed along the Indiana-Ohio State line west of Cincinnati.

If the above interpretations are correct, the scattered erratics on uplands in northern Kentucky are Kansan in age, as originally suggested by Leverett (1929, p. 33–50).

The occurrence, in the Townsend Farm section, of a thin organic-rich deposit between two Kansan tills and, in the Handley Farm section, of two Kansan lacustrine deposits separated by an erosional disconformity, indicate two pulsations of the Kansan ice. These features provide the basis for the geologic-climate subdivisions of the Kansan Stade, named the (older) Alpine Stade, the Garrison Creek Interstadial, and the (younger) Columbia Stade.

The undisturbed humic-gley Yarmouth soil at the Townsend Farm section must have been protected from the overriding Illinoian ice by a layer of refrozen pro-Illinoian meltwater. The 7–9 feet of leaching in the Townsend Farm Yar-

mouth soil is perhaps a foot or two greater than the average depth of leaching of similar buried Sangamon soils in the area. This suggests that the Yarmouth interglacial interval may have been slightly longer than the Sangamon interglacial interval in this area.

ACKNOWLEDGMENTS

This paper is a partial result of Pleistocene studies in southeastern Indiana supported by National Science Foundation Grants G–3484 and G–11403.

The following Earlham College students assisted at various times with work reported here: Alfred Kerler, Michael McKean, Richard Louden, Andrew Merritt, Dan Derr, Peter Beidler, Julia Beaman, and William Johnson.

REFERENCES CITED

Durrell, Richard H. 1956. Illinoian boundary in southwestern Ohio and northern Kentucky (abstr.). Geol. Soc. Amer. Bull. 67: 1751.

———. 1961. The Pleistocene geology of the Cincinnati region. *In* Geol. Soc. Amer. Guidebook for Cincinnati Meetings. p. 57–58.

Flint, R. F. 1947. Glacial Geology and the Pleistocene Epoch. John Wiley and Sons, Inc., New York. 589 p.

Gooding, A. M., James Thorp, and **Erling Gamble.** 1959. Leached, clay-enriched zones in post-Sangamonian drift in southwestern Ohio and southeastern Indiana. Geol. Soc. Amer. Bull. 70: 921–925.

Gooding, A. M., and **Erling Gamble.** 1960. Leached, clay-enriched zones in post-Sangamon drift in southwestern Ohio and southeastern Indiana: New observations and data. Geol. Soc. Amer. Bull. 71: 511–514.

Gooding, A. M. 1961. Illinoian and Wisconsin glaciations in southeastern Indiana. *In* Geol. Soc. Amer. Field Trip guidebook, Cincinnati meetings.

———. 1963. Illinoian and Wisconsin glaciations in the Whitewater basin, southeastern Indiana, and adjacent areas. J. Geol. 71: 665–682.

Leverett, Frank. 1929. The Pleistocene of northern Kentucky. Kentucky Geol. Survey 31: 1–80.

MacClintock, Paul. 1933. Correlation of the Pre-Illinoian drifts of Illinois. J. Geol. 41: 710–722.

Rogers, O. C., A. J. Vessel, G. M. Brune, and **T. E. Barnes.** 1950. Soil Survey of Franklin County, Indiana. U. S. Dept. Agr., Bur. Chem. and Soils. 128 p., 1 map, 5 pls., 15 tables, 4 figs.

Thornbury, W. D. 1937. Glacial geology of southern and south-central Indiana. Ind. Dept. Conserv., Div. Geol. 138 p.

Wayne, William J. 1958. Early Pleistocene sediments in Indiana. J. Geol. 60: 8–15.