BULLETIN OF THE GEOLOGICAL SOCIETY OF AMERICA
VOL. 71, PP. 511-514 APRIL 1960

LEACHED, CLAY-ENRICHED ZONES IN POST-SANGAMON DRIFT IN SOUTHWESTERN OHIO AND SOUTHEASTERN INDIANA: NEW OBSERVATIONS AND DATA

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Gooding, Thorp, and Gamble (1959) recently presented evidence showing that leached, clay-enriched zones in outwash beneath calcareous till, widespread in southwestern Ohio and southeastern Indiana, are not remnants of a paleosol of regional extent as interpreted by several workers (*see* references listed in Gooding *et al.*, 1959; Goldthwait and Burns, 1958; Kempton and Goldthwait, 1959; Goldthwait, 1959) but are downward extensions of the present surface soils through cracks and joints in the overlying calcareous till. These zones have been observed at various stratigraphic levels in the drift of the area wherever there is good drainage through jointed surface till underlain by sand and gravel. We implied, therefore, that the interpretation of these zones as remnants of a paleosol, and their use as a basis for stratigraphic correlations in Ohio, has led to erroneous conclusions about the Pleistocene history of this area. We believe that the evidence at hand does not support the interpretation of a post-Sangamon–pre-classical Wisconsin glaciation and soil-forming interval in this area, although we do not deny the possibility of such events.

This paper describes two similar pseudo buried soils outside the Ohio-Indiana area and presents C_{14} data on the leached, clay-enriched zones in outwash beneath calcareous till at two sites near Richmond, Indiana, which we believe support our earlier conclusions.

In addition to having observed these soil-like zones in many places and at several stratigraphic levels in the drift of southwestern Ohio and southeastern Indiana (Gooding *et al.*, 1959), we observed during the 1959 Eastern Section meeting of the Friends of the Pleistocene what we believe to be the same phenomenon developed in a thin layer of sand and fine gravel beneath a thin clayey till in the vicinity of London, Ontario, Canada (Dreimanis and Packer, 1959, Stop 12, unit 3, p. 23). Dreimanis (1958, p. 81) suggested a correlation of the clayey till that overlies the leached, clay-enriched zone with the till that was deposited by the glacial advance which reached beyond the Defiance moraine in eastern Ohio. White (1951, p. 976) suggested that this till is middle to late Cary in age.

Although clay-filled joints in the thin till overlying the leached, clay-enriched zone were not well displayed at Dreimanis and Packer's Stop 12, other evidences showed that the soil-like zone could not be a remnant of a paleosol. In places, the entire sand and gravel zone and a few inches of the top of the underlying till are leached and enriched with clay. In other places, however, the top of the leached, clay-enriched zone is irregular. It crosses the stratification of sands, leaving calcareous, clay-free "lenses" over the leached zone, and in some places the leaching and clay enrichment extend a few inches up into the base of the overlying clayey till. The last feature demonstrates beyond reasonable doubt that the leaching occurred after the upper clayey till was deposited. Dreimanis and Packer had asked the question: "Is this a paleosol or the result of underground water leaching?" (1959, p. 23). Dreimanis now agrees with us on its secondary origin (personal communication).

This apparent "buried soil" beneath probable middle to late Cary till in Ontario is clearly of the same origin as those occurring beneath tills of various earlier Wisconsin subages over wide areas of Ohio and Indiana.

Another new observation of particular significance has just been made by James Thorp in Africa. He reported recently on the occurrence of a similar weathered zone, with dark-brown clay skins, beneath the topmost volcanic ash deposit near Nanyuke, northwest of Mt. Kenya, Kenya. He has stated in a personal communication: "I thought at first it was a buried soil, but close examination showed that it connects, along cracks and joints in the ash, with the soil at the present surface. Furthermore, there is no A horizon."

The above two new observations suggest to us that an understanding of the origin of these false "buried soils", and the criteria by which they are recognized, may be of more far-reaching importance than just with respect to the

Ohio–Indiana Pleistocene problem. When workers find soil B horizonlike material on sand and gravel beneath calcareous till, or other material beyond drift regions, evidence for a connection with the present surface soils through cracks and joints should be sought. It is essential, also, to find at least a remnant of an A horizon in position before such zones are finally identified as paleosols and given stratigraphic status.

C_{14} dates have been obtained recently on leached, clay-enriched zones in outwash beneath calcareous till from two sections near Richmond, Indiana (the Middle Fork section is Fig. 1 in Gooding *et al.*, 1959, p. 922) which tend to support our previous conclusions on the secondary origin of these soil-like zones (discussed in detail in Gooding *et al.*, 1959) and show a valuable means of testing the validity of questionable "buried soils" in other areas.

Chemical analyses of the B horizon of the present surface Miami Family of soils in southwestern Ohio and southeastern Indiana show considerable colloidal organic material intimately mixed with the illuviated B horizon clay (Brown and Thorp, 1942, Table 8, p. 38). Samples of the leached, clay-enriched material in outwash beneath calcareous till from two sections were analyzed and found to contain colloidal organic matter in quantity similar to that present in the B horizons of the surface soils. We reasoned that, if the colloidal organic matter in these leached, clay-enriched zones beneath calcareous till could be extracted in large enough quantity, a C_{14} date on these zones would shed light on their true nature. If these zones are actually remnants of a true buried paleosol, C_{14} dates on their colloidal organic matter should be older than C_{14} dates on wood found in overlying till (providing the wood was not picked up from still older drift). On the other hand, if these zones are downward extensions of the present surface soil through cracks and joints in the overlying calcareous till, as we contend, C_{14} dates on their colloidal organic material should be more recent than dates on any wood found in the till which overlies them. Furthermore, if our interpretation of these zones is correct, the C_{14} dates on the colloidal organic matter from these zones would be expected to vary from one site to another, because the colloidal organic material might well be a mixture of different proportions of that which collected at various periods as soil formation advanced. The proportions of this mixture of older and younger colloidal organic matter in the illuviated zones on outwash beneath calcareous till would naturally vary from place to place.

A 25-pound can of leached, clay-enriched material developed in outwash beneath calcareous till was taken from each of two sites near Richmond, Indiana, and representative samples contained enough organic carbon for C_{14} dating. The organic carbon analyses were made by Mr. Roger Simkin, Earlham College Chemistry major, following the method outlined by Peech *et al.* (1947, p. 5–7). The samples were treated and dated at the Lamont Radiocarbon Laboratory, Columbia University, by Mr. Edwin Olson and Dr. Wallace S. Broecker.

Following are descriptions of the two sections near Richmond, Indiana:

Middle Fork Section: Exposed in 1958 along creek bank in NE 1/4 SW 1/4 Sec. 15, T. 14 N., R. 1 W., Wayne County, Indiana (this is the section shown in Fig. 1 of Gooding *et al.*, 1959, p. 922).

Unit	*Thickness* (Feet)	*Description*
8	1.9	Miami silt loam soil profile developed through 6 inches of loess and into till
7	3.2	Calcareous oxidized highly jointed till; leached brown clay concentrated along vertical joints. Sand inclusion bisected by a joint was leached and enriched with clay; some of till surrounding leached inclusion was also leached.
6	0.5	Leached, clay-enriched gravel with dolomite ghosts; greatest concentration of clay directly below joints. Gooding C_{14} sample No. 20 is from this unit.
5	0.5	Leached medium sand with some brown clay
4	0.5	Calcareous medium sand with irregular leached and clay-enriched lenses at bottom
3	0.5	Partially leached gravel with some brown clay
2	8.0	Calcareous sand and gravel
1	4.0	Calcareous, gray, unoxidized till
		Creek bed

Magaw Gravel Pit Section: Exposed in 1958 in SE 1/4, Sec. 30, T. 14 N., R. 1 W., Wayne County, Indiana.

Unit	*Thickness* (Feet)	*Description*
4	2.6	Miami silt loam soil profile developed through 12 inches of loess and into till
3	5.4	Calcareous oxidized highly jointed till; leached brown clay concentrated along vertical joints that extend through the till
2	1–2.0	Sand and pebble gravel, mostly

leached and containing much brown clay. Some dolomite ghosts remain in rotted gravel. Some fine sand zones and lenses at various levels still calcareous and contain little or no brown clay. Gooding C_{14} sample No. 21 is from this unit.

1 65.0 Calcareous sand and gravel
Bottom of exposure

The C_{14} dates from the above two sections are as follows:

L-474A, 13,300 ± 650, Middle Fork section, unit 6 (Gooding sample No. 20, collected July 1958).

L-474B, 4,800 ± 200, Magaw gravel pit section unit 2, (Gooding sample No. 21, collected July 1958).

Although no C_{14} dates are available in the immediate area on wood from the overlying till, in both cases the locations are south of Leverett and Taylor's (1915) "Bloomington" moraine where the surface till is "Champaign" (till sheet B in Gooding, 1957). A C_{14} date on wood from Bloomington back-water silts behind valley-train outwash in Illinois is 15,600 ± 600 (W-381) (Rubin and Alexander, 1958, p. 1478).

If interpretations in Ohio are correct, however, and the widely occuring leached, clay-enriched zones in outwash beneath calcareous till in this area are remnants of a post-Sangamon–pre-classical Wisconsin soil, C_{14} dates on the colloidal organic matter from these zones should be much older than we have interpreted for the age of the overlying till at the sections herein described. Ohio workers have correlated these soil-like zones in outwash beneath calcareous till with leached zones in till at the Sidney and Brush Creek, Ohio, exposures. Wood reportedly collected from the top of the Sidney, Ohio, buried soil gives a C_{14} date of 23,000 ± 800 (W-188) (Rubin and Suess, 1955, p. 483), and wood collected from the till which overlies the buried soil at Brush Creek, Ohio, gives a C_{14} date of 22,000 ± 1,000 (W-414) (Rubin and Alexander, 1958, p. 1477; La Rocque and Forsyth, 1957, p. 81, 88).

It is true that these dates (L-474A, 13,300 ± 650, and L-474B, 4,800 ± 200) on the leached, clay-enriched zones beneath calcareous till at the sections near Richmond do not prove that the "soil-like" zones are not remnants of a buried soil: they may merely demonstrate contamination of a true buried soil. The geological evidence (*see* Gooding *et al.*, 1959) from these and dozens of other sites, however, suggests that the colloidal organic matter in the dated zones is entirely of post-till age, and that the considerable difference between the dates is due to the expectable variation in the proportions of older and younger colloidal organic matter that has been illuviated during the time of surface soil formation. Additional C_{14} dates on these soil-like zones in Ohio and Indiana, especially those that are interpreted as true buried soils by Ohio workers, might help to clarify the present controversy over their origin and stratigraphic importance.

Acknowledgments

This paper developed out of Pleistocene geology and soil-genesis studies in the Whitewater basin of southeastern Indiana and surrounding areas supported by National Science Foundation Grants No. 997 and No. 3484, the Charles F. Kettering Foundation, and the Soil Conservation Service, U. S. Department of Agriculture.

Dr. James Thorp, Head, Department of Geology and Soil Science, Earlham College, and Dr. Morris M. Leighton, Chief Emeritus, Illinois Geological Survey, on separate occasions visited the Magaw gravel pit section with the writers. Both also read the manuscript critically and made helpful suggestions.

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Manuscript Received by the Secretary of the Society, July 20, 1959