

BURIED SOILS OF GLOBE HILL, UPPER OHIO VALLEY

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A terrace, 5 mi downstream from Wellsville, Ohio, standing about 200 ft above the Ohio River, was recently excavated for the construction of a new highway, exposing several different layers of soil which record a part of the history of the Pleistocene Epoch. It is located about one mi south of Moscow and two and one-half mi north of New Cumberland, Clay Township, Hancock County, West Virginia. (Wellsville, Ohio, W. Va., Pa., quadrangle map of the U. S. Geological Survey). The site of the excavation is near the Globe Hill archeological site (Mayer-Oakes, 1955, p. 132) and this report will refer to the terrace as Globe Hill because its surface is dissected and in part hilly and in part sloping.

The region near Globe Hill has an upland surface which is a part of the unglaciated Allegheny Plateau. The ridgetop remnants of the dissected surface have a general elevation of about 1240 ft. Several terraces at general levels of 1020 to 960 ft, 850 to 800 ft, 760 to 740 ft and 720 to 680 ft elevation are developed near the river. The Ohio River, here at about 650 ft elevation, has a very narrow flood plain. The river flows over a bed of sand and gravel, about 45 ft thick, and the rock floor of the Ohio Valley is at 602 ft elevation.

PREVIOUS WORK

The terraces in the Upper Ohio Valley have been mentioned by Leverett (1902, pp. 88-98, pp. 121-125; 1929, p. 229; 1934, pp. 101-102), Stout and Lamb (1938, pp. 68-70), Stout (1953, pp. 183-189), Hubbard (1954, pp. 365-370) and Ireland (1940, 1943). However, no detailed investigation has yet been made using modern methods of pedology, of stratigraphy, or of morphology as determined from air photos or from really detailed topographic maps. The study of the soils of varying development shows the terraces are of varying ages and it is hoped will lead to similar pedologic observations elsewhere. It is hoped that these will eventually contribute, along with other required detailed studies, to an elucidation of the Pleistocene history of the Upper Ohio Valley.

TOPOGRAPHY OF GLOBE HILL

Globe Hill was formerly a nearly level to gently sloping surface as is evidenced by the horizontal layers of sand and gravel underlying it. This surface has been strongly dissected by small tributaries of the Ohio River to a series of ravines and sloping interfluvus at 838 to 820 ft elevation, and in part a sloping terrace whose outer escarpment stands at 855 ft elevation. The edge of this escarpment is 205 ft above the river.

THE SOILS AND BURIED PALEOSOLS OF GLOBE HILL

The surface soil of Globe Hill is a 2 in. thick layer of black silt loam containing a few fragments of angular sandstone and pebbles of igneous rocks. Where this surface and underlying material have been gullied, a pavement of these stones litters the sides and bottoms of the gullies. Part of Globe Hill contains an Indian mound built of *Unio* shells.

Beneath the surface soil, a layer of silty material occurs at most places, which lacks pebbles, coarse sand and is not layered or bedded as alluvial soils are. It ranges from a few feet to several feet thick as at site WV-1. It may be wind deposited material.

The silt is lacking at a few places. It is underlaid, at Site WV-1, by the paleosol of Gravel I and at Site WV-3, by the paleosol of Gravel II and a paleosol of the Sandy Alluvium. The soil profile descriptive terminology used below follows usage of the U. S. Dept. Agriculture, Soil Survey Manual, Handbook 18, 1951, except that a Roman numeral is added to designate a paleosol.

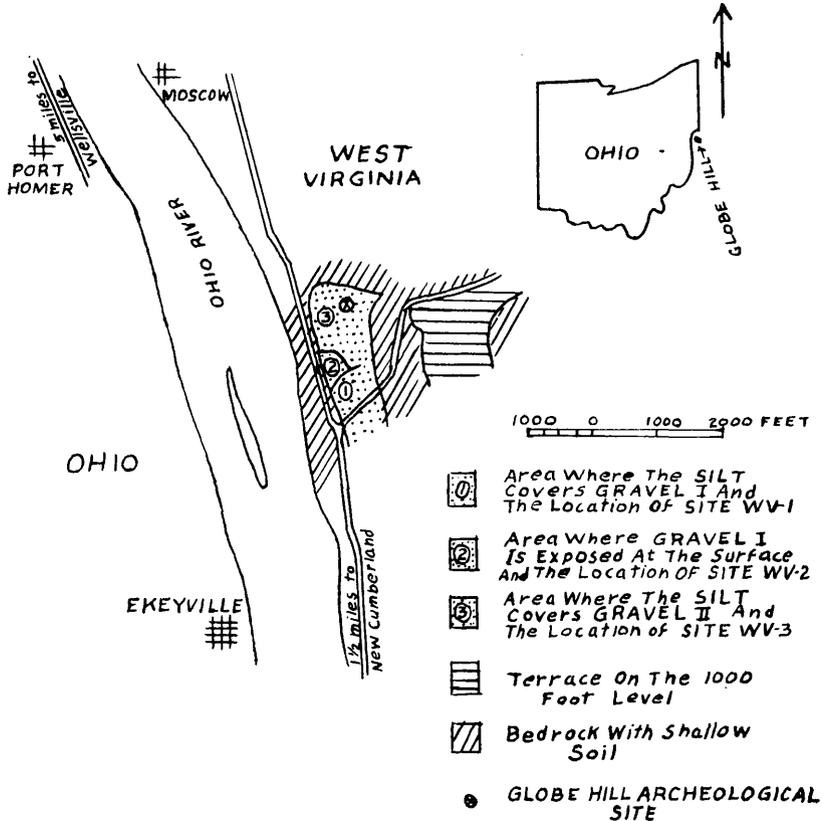


FIGURE 1. Surface map of Globe Hill.

Soil and Paleosol at Site WV-1

Location, 820 ft north of junction of new highway and dirt road, 2 1/2 mi north of New Cumberland, W. Va.; slope 8%, convex, at crest of interfluv; 838 ft elevation; dissected terrace; well drained.

Depth and Profile Description (moist colors in Munsel notations, moist consistence).
Horizon

0-1 in. Black N 2/0 silt loam; moderate very fine granular structure; extremely acid, pH 4.4; friable; very few pebbles of crystalline rocks and channers of sandstone; colluvium from upper slopes.
A₁₁

1-2 in. Very dark gray 2.5yr 3/1 silt loam; massive in place, breaking to weak fine granular peds; very strongly acid, pH 4.6; firm in position; pebbles as in A₁₁; colluvium from upper slopes.
A₁₂

- 2-9 in. Dark grayish brown 10yr 4/2 coarse silt loam; weak medium platy structure; very strongly acid, pH 4.6; very friable; pebbles and coarse sand absent; weathered Silt (wind deposited).
A₂
- 9-12 in. Yellowish brown 10yr 5/4 coarse silt loam; weak fine subangular blocky structure; very strongly acid, pH 4.6; friable; pebbles and coarse sand absent; weathered Very Fine Sand.
B₁
- 12-35 in. Dark yellowish brown 8.75yr 4/4 fine silt loam faintly mottled in lower part yellowish brown 10yr 5/4; moderate medium subangular blocky structure; very strongly acid, pH 5.0; friable, firm in position; pebbles and coarse sand absent; weathered Silt.
B₂₁
- 35-43 in. Strong brown 8.75yr 5/8 silt loam distinctly mottled reddish brown 6.25 yr 4/4; strong medium subangular blocky structure, thin light yellowish brown 1.25yr 6/3 ped faces; strongly acid, pH 5.2; firm; pebbles and coarse sand absent weathered Silt.
B₂₂
- 43-54 in. Brown 7.5yr 4/4 silt loam prominently mottled light brownish gray 2.5yr 6/2; fragipan with strong very coarse prismatic structure breaking to strong medium subangular blocky peds, light brownish gray 2.5yr 6/2 loamy ped faces 3 mm thick; very strongly acid, pH 4.8; firm; pebbles and coarse sand absent; leached Silt.
B_{31m}
- 54-78 in. Mottled brown 8.75yr 4/4 and light yellowish brown 1.25yr 6/4 silt loam; weak coarse subangular blocky structure, light yellowish brown 1.25yr 6/4 loamy ped faces 3 mm thick; very strongly acid, pH 4.8; friable; pebbles and coarse sand absent; upper part is leached Silt, lower part possibly includes a IA_b horizon of buried paleosol I.
B₃₂
- 78-90 in. Dark brown 10yr 4/3 gravelly silty clay loam faintly mottled pale brown 10yr 6/3 and with prominent black Mn stains; moderate medium angular blocky structure, thin yellowish brown 10yr 5/4 clay skins; firm; strongly acid, pH 5.4; pebbles 50% of soil mass, rotted so that only chert and quartz remain intact, forms of other pebbles form silty clay loam when rubbed; deeply weathered B₂ horizon of paleosol formed from Gravel I.
IB_{2b}
- 90-114 in. Distinctly mottled strong brown 7.5yr 5/8 and light brownish gray 10yr 6/2 gritty clay loam; structure not determined, sampled with bucket auger; acid, pH 5.8; friable when disturbed; pebbles 50% of soil mass, weathered strongly but not as much as in horizon IB_{2b}; paleosol formed from Gravel I.
IB_{3b}
- 114-168 in. Dark yellowish brown 10yr 4/4 gravel; acid, pH 5.8; noncoherent; pebble count, 630 pieces: sandstone and siltstone most pieces weathered 42%, hard quartz pebbles 11%, quartzite slightly weathered 10%, granite soft and weathered 6%, chert hard 31%; weathered Gravel I.
IC_{1b}
- 168 in. Sandstone bedrock.
D

The buried paleosol of Site WV-1 is formed from glacial outwash because crystalline rocks are not residual in the Upper Ohio Valley.

Soil and Paleosol at Site WV-2

Location, 920 ft north of junction of new highway and dirt road, 2½ mi north of New Cumberland, W. Va.; slope 8%, convex, 100 ft from creast of interfluv, 832 ft elevation; well drained.

Depth and Profile Description (moist colors in Munsel notations, moist consistence).
Horizon

- 0-1 in. Black N 2/0 silt loam; moderate very fine crumb structure; extremely acid, pH 4.4; very friable; few pebbles.
A₁

- 1-9 in. A₂ Brown 10yr 4/3 silt loam; moderate fine granular structure; extremely acid, pH 4.4; friable; pebbles absent; possibly a thin layer of wind deposited soil.
- 9-28 in. B₁ Dark brown 8.75yr 4/4 silt loam with few Mn stains; strong medium subangular blocky structure, dark brown 7.5yr 4/4 ped faces; very strongly acid, pH 4.8; friable; few deeply weathered pebbles; weathered Gravel I.
- 28-43 in. B₂₁ Strong brown 7.5yr 4/6 fine silt loam, coarsely mottled with few light yellowish brown 10yr 6/4 stains; strong coarse subangular blocky structure, dark yellowish brown 10yr 4/6 ped faces; strongly acid. pH 5.2; firm; many rotted pebbles; weathered Gravel I.
- 43-48 in. B₂₂ Reddish brown 5yr 4/4 sandy clay loam with frequent black Mn stains; strong coarse subangular blocky structure, dark brown 6.25yr 4/4 thin clay skins on ped faces; strongly acid, pH 5.4; firm; deeply weathered pebbles 30% of soil mass; weathered Gravel I.
- 48-63 in. B₂₃ Strong brown 7.5yr 4/8 gravelly clay loam with frequent coarse Mn stains; strong medium subangular blocky structure; strongly acid, pH 5.4; friable; pebbles and cobbles weathered so that granites are rotted, 50% of soil mass; weathered Gravel I.
- 63-74 in. B_{3en} Black N 2/0 gravel with little coarse sand; massive structure, weakly cemented with Mn when moist, strongly cemented when exposed and dry; strongly acid; pH 5.2; pebbles entirely coated with Mn stain, 85% of soil mass; Gravel I.
- 74-91 C₁ Dark brown 7.5yr 4/4 gravelly sandy loam mottled with dark reddish brown 5yr 3/4 and yellowish brown 10yr 5/4; massive structure; acid, pH 5.6; very friable; pebbles coated with clay 75% of soil mass; pebble count similar to horizon IC_{1b} of Site WV-1; Gravel I; rests unconformably partly on horizon D₁ and partly on horizon D₂ (fig. 2).
- 91 in. + D₂ Gray sandstone bedrock.
- and
- 91-92 in. D₂ or IA_{1b} Black silt loam with fossil organic matter on buried surface; buried paleosol formed from Gravel I.
- 92-100 in. IA_{2b} Grayish brown loam; few small pebbles; buried paleosol formed from Gravel II.
- 100-124 in. IB_b Yellowish brown loam; few small pebbles; buried paleosol formed from Gravel II.

This buried paleosol was removed by excavating machinery before a more detailed soil description could be made. Its buried surface was steeply sloping and it butted against sandstone bedrock beneath the C₁ horizon.

Soil and Paleosols at Site WV-3

Location, 1800 ft north of junction of new highway and dirt road, 2½ mi north of New Cumberland, W. Va.; slope 10%, convex, on crest of sloping interfluv; 820 ft elevation; well drained.

- | Depth and Horizon | Profile Description (moist colors in Munsel notations, moist consistence). |
|---------------------------|---|
| 0-27 in. | Colluvial A ₁ horizon underlain by soil of the Silt, similar to those horizons described at Site WV-1. |
| 27-34 in. IA _b | Coarsely mottled yellowish brown 10yr 5/4 and strong brown 8.75yr 5/6 fine silt loam with few large black Mn stains; strong medium angular blocky structure, pale brown 1.25yr 6/3 ped faces; strongly acid, pH 5.2; firm; pebbles 10%, rotted so that only quartz and chert remain; buried paleosol formed from Gravel II. |

- 34-52 in.
IB_{2mb} Faintly mottled yellowish brown 10yr 5/4 and light yellowish brown 10yr 6/4 silty clay loam with large coarse Mn stains; fragipan with strong very coarse angular blocky structure garding to strong very coarse prismatic in lower part; thin red 3.75yr 5/8 silty clay skins in upper part and dark gray 10yr 4/1 vertical silty clay faces 3 mm thick in lower part; strongly acid, pH 5.2; very firm; pebbles 10%, rotted except those of quartz and chert; buried paleosol formed from Gravel II.
- 52-63 in.
IB_{31mb} Strong brown 7.5yr 5/6 loam coarsely mottled gray 10yr 6/1 and grayish brown 10yr 5/2; fragipan with moderate very coarse prismatic structure, reddish brown 6.25yr 4/4 silty clay ped faces 5 mm thick; strongly acid, pH 5.2; very firm; pebbles 10%, rotted except those of quartz and chert; buried paleosol formed from Gravel II.
- 63-72 in.
IB_{32mb} Reddish brown 6.25yr 4/4 loam with few coarse light gray 10yr 7/1 mottles; weak fragipan with moderate coarse prismatic structure, verticle light gray 10yr 7/1 silty clay loam ped faces 20 mm thick; strongly acid, pH 5.4; firm; pebbles 5%, pebbles count, 67 pieces: hard chert 23%, weathered quartzite 16%, rotted granite 8%, unidentified ghosts 13%; buried paleosol formed from Gravel II.
- 72-80 in.
IIA_{mb} Faintly mottled yellowish brown 10yr 5/4 and pale brown 10yr 6/3 fine silt loam with many yellowish red 5yr 4/8 mottles and small black Mn stains; strong fragipan formed so that previous structure is obscure; firm; medium acid, pH 6.0; pebbles absent; buried paleosol formed from Sandy Alluvium.
- 80-94 in.
IIB_{2km} Gleyed gray 10yr 6/1 silty clay with coarse streaks of yellowish red 5yr 4/8 silty clay loam in center of peds and many black Mn stains; strong fragipan formed so that former structure is obscure; very firm; slightly acid, pH 6.2; pebbles absent; buried paleosol formed from Sandy Alluvium.
- 94-113 in.
IIB_{31mb} Coarsely mottled reddish brown 6.25yr 4/3, strong brown 7.5yr 4/6 and light brownish gray 10yr 6/2 fine silt loam with large black Mn stains; strong fragipan with verticle gray 10yr 6/1 silty clay streaks 30 mm thick; neutral, pH 6.6; very firm; pebbles absent, gritty; buried paleosol formed from Sandy Alluvium.
- 113-126 in.
IIB_{32mb} Yellowish red 5yr 4/8 silty clay loam with streaks of gray 10yr 6/1 clay 50 mm thick forming 50% of soil mass, few black Mn stains appear in pattern of fine roots; strong fragipan, massive; neutral pH 6.6; no pebbles; buried paleosol formed from Sandy Alluvium.
- 126-135 in.
IIB_{33mb} Light brownish gray 10yr 6/2 silty clay loam; fragipan with strong very coarse angular blocky structure, thin yellowish brown 10yr 5/4 loam ped faces; neutral, pH 6.6; very firm; pebbles absent; buried paleosol formed from Sandy Alluvium.
- 135-168 in.
IIC_{1b} Light brownish gray 10yr 6/2 very fine sandy loam with few very coarse yellowish red 5yr 4/8 mottles; structure massive; hard when dry, non-coherent when moist; neutral, pH 7.0; pebbles absent; Sandy Alluvium.
- 168 in. +
D Sandstone bedrock, 804 ft elevation.

Note: A fragipan is a dense brittle soil layer developed beneath a B₂ or textural B horizon. The fragipan horizons of the buried soils, mentioned above, are believed to be a result of secondary soil development process taking place after those horizons were buried by overlying soils. The above fragipan horizons are unusually thick and are believed to have been developed during several stages of the Pleistocene.

The 1000 Foot Terrace

A terrace at 1000 ft elevation occurs about 900 ft east of Globe Hill (fig. 1). Its surface is mantled with several feet of the Very Fine Sand and there are no excavations from which to study the paleosol of the gravelly material beneath. The gravelly material of this terrace appears to be similar to other terrace ma-

terial at a level of 1020 to 960 ft in the Upper Ohio Valley, except that elsewhere the mantle of Silt is much less conspicuous or has not been seen. Crystalline pebbles indicate its glacial origin.

Soils of the 1020 to 960 ft terrace at Vulcan and East End, Ohio, are now in process of study.

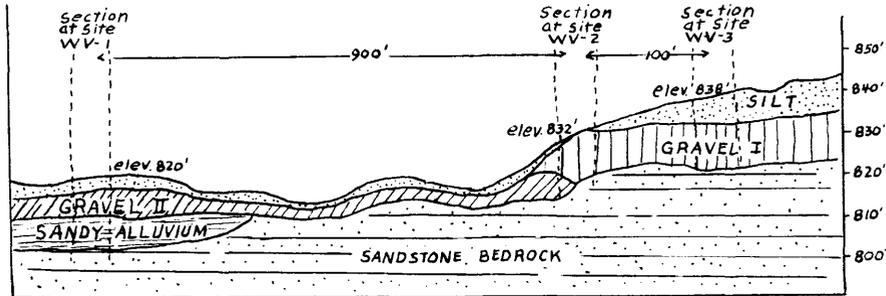


FIGURE 2. Cross section of Globe Hill looking eastward from the Ohio River.

DISCUSSION

The material of the 1000 ft terrace is presumably the oldest in the sequence and probably very early Pleistocene. Discussion of its composition and soils must await completion of investigations now underway at good exposures at Vulcan and East End.

The paleosols of site WV-3 are the most highly weathered, the most deeply buried and at the lowest elevation of the soils described. The Gravel II of paleosol I at site WV-3 is more weathered than the Gravel I at site WV-2. The buried paleosol II at site WV-3 is logically older yet, because it is buried by paleosol I. The fragipan horizons here are usually thick and may indicate very great age and a long period of soil development.

The arrangement of soils at sites WV-3 and WV-2 (fig. 2) and their parent materials indicates that Gravel II was weathered and partly removed before it was buried by Gravel I.

Gravel I lies over the soil of Gravel II at site WV-2. Thus, Gravel I must be of later origin. However, pebbles in Gravel I of granite and other rocks, except those of chert and quartz, at a 91 in. depth, are weathered so that they are soft or strongly altered. This weathering is more intense than that of Illinoian material several miles to the north, which at such a depth, contain granite pebbles that have only weathered rinds and sandstone pebbles that are oxidized but hard.

The 832 ft elevation of the soil of Gravel I and its degree of weathering are similar to a deposit behind the new supermarket in East End, Ohio (east part of East Liverpool). Here a sandy and gravelly glacial drift is leached more than 40 ft deep where it rests on bedrock.

A time interval is required, between the deposition of Gravel I and the silt, for the formation of paleosol I, formed from Gravel I at site WV-1. Gravel I is strongly weathered beneath the Silt in the IB_{21b} horizon.

While the soil formed from the Silt is the youngest soil here, if the colluvial A₁ horizon is omitted, it is still an old soil. It is leached to over a 71 in. depth, it has structure throughout its entire depth and has a colluvial surface.

The A₁ horizon, surface soil covering Globe Hill is of silt loam and contains sandstone channers and a few pebbles of crystalline rocks.

Colluvial soil layers are prominent in this region where terraces above 800 ft elevation provide a bench for colluvial material to accumulate. Such colluvium however is not prominent on lower terraces.

CONCLUSION

The soils of Globe Hill, except that of the surface colluvium, were formed before the Wisconsin stage of the Pleistocene.

The thin surface soil or A₁ horizon is part of a modern soil which is formed from colluvial material accumulated after other materials of Globe Hill were deposited.

The Silt is wind deposited material upon which is a soil more deeply developed than Wisconsin medium textured soils in the drainage basin of the Upper Ohio River. It is therefore considered to be pre-Wisconsin but not early Pleistocene. It may be Illinoian in age.

The soil formed from Gravel I is derived from glacial outwash that is probably pre-Illinoian in age as it is more deeply weathered than coarse textured Illinoian drift in the drainage basin of the Upper Ohio River.

The paleosol formed from Gravel II is older than the above soils as it is buried by them. Gravel II contains crystalline pebbles. However, it may be reworked, interglacial material rather than glacial outwash. It is older than Gravel I and pre-Illinoian.

The deeply buried paleosol underlying Gravel II is formed from a sandy alluvium that represents a stage of filling to at least 812 ft elevation at this place. It, too, may be an early Pleistocene inter-glacial deposit.

The terrace material 900 ft east of Globe Hill, at an elevation of 1000 ft, is similar to terrace material of glacial outwash at Vulcan and at East End, Ohio at 1020 to 960 ft elevation, except that it is buried by the Silt. This terrace is apparently still earlier and must be very early Pleistocene.

It is tempting to correlate the 1020 to 960 ft terrace materials as Nebraskan, those at 837 ft at Globe Hill (Gravel I) as Kansan, and those under Gravel I (Gravel II) as Aftonian interglacial material. However, positive affirmation must wait until the sequence of lower terraces (not present at Globe Hill, but developed elsewhere in the Ohio Valley) are worked out in detail. The lowest terraces at East Liverpool and elsewhere are certainly Wisconsin, and the soils of a higher terrace at 760 ft seem somewhat older and may be Illinoian in age. However, their soil morphology and correlation is yet to be worked out. It is felt that until the later Pleistocene dating is certain the dating of the still earlier terraces cannot be secure. Indeed, the status of the terms "Kansan," and especially "Nebraskan" is so uncertain in the eastern United States that these may not fit at all in the Ohio Valley, and that for a time local names will be preferable. However, this report infers that there are two, well separated, pre-Illinoian, glacial outwashes in the Upper Ohio Valley.

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