Chapter 4

Physiography, Geology, and Soil Classification

Ralph E. J. Boerner[1] and Elaine Kennedy Sutherland[2]

[1] Ohio State University, Department of Evolution, Ecology, and Organismal Biology, Columbus, Ohio
[2] USDA Forest Service, Rocky Mountain Research Station, Missoula, Montana

Abstract

The four study areas, located within the Unglaciated Allegheny Plateau of southern Ohio, are underlain predominantly by sandstones and shales of Pennsylvanian Age. The bedrock underlying the Arch Rock (AR), Watch Rock (WR), and Young's Branch (YB) study areas also contain economically important coal strata, while those of the Bluegrass Ridge (BR) study area have significant interbedded limestone layers. The soils include inceptisols, alfisols, and ultisols, and are predominantly loams and silt loams formed in residuum and colluvium. The soils of AR and WR are dominated by the Steinsburg-Gilpin Association, those at YB by soils of the Steinsburg-Shelocta Association, and those at BR by the Upshur-Gilpin-Steinsburg Association.

Physiography and Geology

The study sites are located within the Unglaciated Allegheny Plateau of southern Ohio. Each site is underlain by sedimentary strata of Pennsylvanian age. Although acidic sandstones, shales, and coals comprise the large majority of these strata, narrow, discontinuous bands of limestone are scattered throughout (King 1979). The topography of the region is dominated by highly dissected ridge and valley complexes with relative relief of 90 to 150 m (Gordon 1969). The relative relief is greater and the slopes steeper where relatively erosion-resistant sandstones cap the ridges than where the ridges are capped by the softer shales (King 1979).

The bedrock underlaying the two Vinton County sites — Arch Rock (AR) and Watch Rock (WR) located within the Vinton Furnace Experimental Forest, are members of the Allegheny Group, the most economically important group of strata in Ohio (Denton et al. 1961). Most of this bedrock complex is composed of sandstones and shales of marine origin that are interbedded with several thin layers of limestone and at least six major coal strata. These mineable coal strata account for over half of Ohio's mineable coal reserves. In the portion of Vinton County that includes AR and WR, the bedrock is dominated by Lawrence sandstone, Vanport shale, and Clarion sandstone. Some areas also have small amounts of Vanport limestone (Denton et al. 1961).

Young's Branch (YB), located on a portion of the Wayne National Forest in Lawrence County, is located on bedrocks belonging to the Allegheny group. By contrast, Bluegrass Ridge (BR), the other study area in Lawrence County, is underlain by sedimentary strata of the Connemaugh group. The bedrock complex includes a combination of sandstones, sandy shales (or siltstones), and clay shales (Denton et al. 1961). Significant coal strata are much less common here than in Vinton County as the Connemaugh group accounts for less than 5 percent of Ohio's coal reserves. Interbedded limestone layers appeared more common in the area surrounding BR than near the other study areas. The thickness of these limestone layers varies considerably even over small distances. Thus, the degree to which these limestone layers might influence soil properties depends on the local thickness within each study site.

Soil Series and Complexes

Natural Resource Conservation Service maps for the study areas suggest that the soils of most of the 108 vegetation plots (27 per study area) are dominated by silt loams derived from colluvium and residuum generated by a combination of sandstone, siltstone, and shale (Table 1). Complexes or associations that included Gilpin and/or Steinsburg series soils were mapped as occurring in 98 percent of the vegetation plots at YB and BR. Steinsburg series soils are inceptisols with a shallow, weakly developed, moderately acidic A horizon derived from sandstone (Table 2). At YB and BR, the Steinsburg soils are most common on upper slopes and ridgetops. At YB, the Steinsburg soils often were

associated with ultisols of the Latham and Shelocta series in midslope positions. These latter two soil series have deeper, more developed A horizons than the Steinsburg soils. At BR, the Steinsburg soils most often are associated with Gilpin series soils on mid slopes. Gilpin series soils are well developed ultisols with strongly acidic, shallow A horizons.

There also are areas on mid to upper slopes at BR, particularly in the control unit (CONT), that are underlain by Upshur series soils formed predominantly from limestone. These alfisols have a deeper A horizon and higher pH than the surrounding associated Steinsburg and Gilpin soils, and were easily differentiated in the field on the basis of color and apparent clay content. These scattered pockets of less acidic Upshur alfisols within the matrix of acidic ultisols and inceptisols constitute the primary source of edaphic diversity within BR. At YB, one lower slope vegetation plot is underlain by Stendahl silt loam, an entisol derived from recent alluvium (Tables 1-2).

At AR and WR, nearly 90 percent of the vegetation plots were mapped as Gilpin series soils or as associations with a major Gilpin component (Table 1). At AR and WR, Gilpin ultisols were predominantly on ridgetops and upper shoulder slopes, often in association with Rarden and/or Germano series soils lower on the slopes and Steinsburg series soils on the ridges. Seven of the lower slope vegetation plots at these two study sites are underlain by Chagrin loams. Chagrin soils, inceptisols formed in recent alluvium, have both higher pH and water-holding capacity than the ultisols higher on the slopes. It is likely that vegetation plots underlain by Chagrin series soils will remain moist even during periods of drought in midsummer.

Overall, the soils of the mid to upper slope and ridgetop portions of the four study areas are dominated by acidic ultisols and inceptisols derived from combinations of sandstone, siltstone, and shales. At BR, and perhaps at WR, scattered pockets of alfisols derived from thin, discontinuous limestone beds add significant edaphic diversity. On lower slope positions, soils with high water-holding capacity derived from recent alluvium dominated.

Literature Cited

Denton, G. H.; Collins, H. R.; DeLong, R. M.; Smith, B. E.; Sturgeon, M. T.; Bryant, R. A. 1961. **Pennsylvanian geology of eastern Ohio.** In: Guidebook for field trips: New York: Geological Society of America: 131-206.

King, C. C. 1979. **Hill country.** In: Lafferty, M. B., ed. Ohio's natural heritage. Columbus, OH: Ohio Biological Survey: 160-181.

Gordon, R. B. 1969. **The natural vegetation of Ohio in pioneer days.** Bulletin of the Ohio Biological Survey. 113 p.

McCleary, F. E.; Hamilton, S. J. 1990. **An inventory of Ohio soils: Lawrence County.** Columbus, OH: Ohio Department of Natural Resources, Division of Soil and Water Conservation. 36 p.

Lemaster, D. D.; Gilmore, G. 1993. **The soils of Vinton County, Ohio.** Columbus, OH: Ohio Department of Natural Resources, Division of Soil and Water Conservation. 36 p.

Table 1—Soil series mapped on 108 vegetation plots in the four study areas (based on USDA Soil Conservation Service maps published by the Ohio Department of Natural Resources).

Site	Lawrence County			
	Upshur-Gilpin-Steinsburg Association	Upshur-Gilpin Association	Steinsburg-Shelocta Association	Latham Steinsburg Complex
Young's Branch	0	0	23	3
Bluegrass Ridge	22	5	0	0
	Vinton County			
	Steinsburg-Gilpin Association	Germano-Gilpin Complex	Gilpin-Rarden Complex	Chagrin Loam
Arch Rock	20	1	1	5
Watch Rock	14	9	2	2

Table 2.—Chemical and physical characteristics of soil series mapped in the study areas. Data adapted from McCleary and Hamilton (1990) and Lemaster and Gilmore (1993).

Soil Series	Parent material	Texture	A-horizon depth	pH	Indicator species
Steinsburg	Sandstone	Loam	5	4.5-5.5	Northern red oak, Yellow-poplar
Gilpin	Sandstone, shale, and siltstone	Loam to silt loam	5	3.6-5.5	Red oak, Yellow-poplar, Virginia pine
Shelocta	Sandstone, shale, and siltstone	Loam to silt loam	10-15	4.5-5.5	Shortleaf pine, Virginia pine, Yellow-poplar
Germano	Siltstone and sandstone	Sandy loam	5-7	3.6-5.5	Northern red oak, Yellow-poplar
Rarden	Siltstone and sandstone	Silt loam to sandy loam	3-6	3.6-5.5	Red, black, and white oak
Latham	Shale and siltstone	Silt loam	5-7	3.5-6.5	Red, white, and black oak, Virginia and shortleaf pine
Upshur	Limestone	Loam to silt loam	5-10	4.5-6.5	Yellow-poplar, Redbud
Chagrin	Alluvium	Loam	25	5.6-7.3	Red and white oak, Sugar maple, Black cherry
Stendal	Alluvium	Silt loam	25	4.5-6.5	Pin oak, Sweetgum, Yellow-poplar, White ash, Slippery elm