Classification of the Sloping Soils of the West Baden Group in Monroe County, Indiana

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Introduction

There are over 15,500 acres of sloping soils formed on the West Baden Group (Chesterian Series, Mississippian System) in Monroe County, Indiana. The purpose of the field and laboratory study was to collect information that would help classify these soils according to the latest soil classification (8), to determine the composition of each landscape unit within the West Baden Group, and to show if any correlation between the landscape and soil series could be made. The study was also needed to determine which soils have a high shrink-swell potential, what causes the shrinking and swelling to occur, and what percentage of the landscape is made up of these high shrink-swell soils.

Soils that formed on the West Baden Group also occur in Crawford, Green, Harrison, Lawrence, Orange, Owen, and Washington Counties (2, 9). In those counties they were classified as Baxter, Berks, Corydon, Crider, Gilpin, and Wellston series in past surveys. In some areas they were mapped in complexes with the Berks, Gilpin, and Weikert series. In all the surveys, clayey soils with high shrink-swell potential have been considered inclusions within the mapping units that occur on the West Baden Group. All these soils developed under forest vegetation that consisted of oak, hickory, dogwood, tulip poplar, and cherry (4, 5, 10).

Geologic setting

Western Monroe County is a part of the Crawford Upland, the most rugged physiographic province in Indiana. Locally the relief exceeds 250 feet. The area has broad rounded ridgetops and broad valleys with gentle slopes. The most characteristic feature of the Crawford Upland is the great diversity of topographic forms produced by differing lithology and susceptibility to erosion of the underlying formations. The drainage is not always continuous because some streams disappear into sinkholes in the valleys.

Extensive areas in the Crawford Upland are underlain by the West Baden Group. This group is 100 to 140 feet thick and consists of the following formations in ascending order: Bethel Formation, Beaver Bend Limestone, Sample Formation, Reelsville Limestone, and Elwren Formation. The group consists primarily of gray and varicolored shale, sandstone, and discontinuous beds of limestone of variable thickness. Its predominantly clastic nature and the irregularity of its limestone formations distinguish it from groups above and below (1, 6).

The West Baden Group is underlain comformably by a sequence of limestone formations, the Blue River Group (Valmeyeran Series, Mississippian System). It is overlain comformably by the Stephensport Group (Chesterian Series, Mississippian System) and, where the Stephensport Group has been removed by pre-Mansfield erosion, unconformably by the Mansfield Formation (Morrowan Series, Pennsylvanian System). The Stephensport Group includes about equal parts of limestone, gray shale, and thin-bedded to cliff-forming sandstone; the Mansfield Formation includes principally thin-bedded to cliff-forming sandstone and gray shale and is distinguished by scattered thin beds of coal (1, 6).

Method of study

A series of nine transects were made on sloping landscapes underlain by the West Baden Group. Detailed soil descriptions were made in representative areas wherever a change in the landscape occurred or within a distance of 100 to 175 feet. The soils were classified, their extent within the landscape unit was determined, and correlations were established between positions on the landscape and specific soils.

Two different kinds of landscape were distinguished on the basis of slope and soil composition. The major soil in both landscapes is a clayey soil that did not classify into existing soil series. To obtain additional data on the Ebal soil, a backhoe was used to expose a representative profile and the soil was sampled and described in detail. Bedrock at the site has been determined to be shale of the Sample Formation, West Baden Group (Henry H. Gray, personal communication, 1978).

Physical and chemical properties of the samples were determined at the Purdue Soil Characterization Laboratory, Purdue University, West Lafayette, Indiana 47907. Clay mineralogy was determined at the USDA Soil Conservation Service (SCS), National Soil Survey Laboratory, Lincoln, Nebraska. Standard laboratory procedures were used in these determinations (7).

Results and Discussion

Soil series on West Baden Group

Established soil series that have been mapped on formations of the West Baden Group include Baxter, Berks, Caneyville, Corydon, Crider, Gilpin, Hagerstown, Wellston, and Weikert series. The Ebal series is proposed as a result of this study.

The Baxter series is a fine, mixed, mesic Typic Paleudalf. It has less than 20 inches of loess over limestone residuum, and bedrock occurs at 60 to more than 120 inches. Chert content in the solum ranges from 15 to 35 percent.

The Berks series is a loamy-skeletal, mixed, mesic Typic Dystrochrept. It has sandstone, siltstone, or shale bedrock within 20 to 40 inches of the surface and contains more than 35 percent coarse fragments within the solum. It does not contain an argillic horizon.

The Caneyville series is a fine, mixed, mesic typic Hapludalf. It has limestone bedrock within 20 to 40 inches of the surface and contains up to 10 percent coarse fragments within the solum.

The Corydon series is a clayey, mixed, mesic Lithic Argiudoll. It has less than 20 inches of loess over limestone residuum and has limestone bedrock within 20 inches of the surface. It has a mollic epipedon and contains an argillic horizon.

The Crider series is a fine-silty, mixed, mesic Typic Paleudalf. It has more than 20 inches of loess over limestone residuum, and bedrock occurs at 60 to more than 120 inches.

The Frederick series is a clayey, kaolinitic, mesic typic Paleudult. It has limestone bedrock below 72 inches and the solum contains 5 to 15 percent coarse fragments. Its mineralogy is kaolinitic.

The Hagerstown series is a fine, mixed, mesic Typic Hapludalf. It has limestone bedrock within 40 to 100 inches of the surface and contains less than 5 percent coarse fragments within its solum.

The Gilpin series is a fine-loamy, mixed, mesic Typic Hapludult. It has sandstone, siltstone, or shale bedrock at 20 to 40 inches.

The Wellston series is a fine-silty, mixed, mesic Ultic Hapludalf. It has sandstone, siltstone, or shale bedrock at 40 to 72 inches.

The Weikert series is a loamy-skeletal, mixed, mesic Lithic Dystrochrept. It has sandstone, siltstone, or shale bedrock within 20 inches and contains more than 35 percent coarse fragments in its solum.

Proposed Ebal series

The proposed Ebal series is a fine, mixed, mesic Ultic Hapludalf. It is a deep, moderately well drained soil that formed in loess and residuum from interbedded shale and thin layers of sandstone. Permeability is moderate in the upper part of the solum and very slow in the lower part. Slopes range from 10 to 25 percent. This soil is a member of a large family, and no established soil series covers the range of characteristics of the proposed Ebal series. Therefore a new soil series is needed for these clayey shale soils.

The proposed Ebal soil has an argillic horizon with clay films on ped surfaces, which indicates clay movement, and slickensides are present in the IIIB24t horizon (appendix 1). The base saturation at 116 cm by the sum of cations is 55.1 (Table I). A weighted average of the particle size distribution in the control section places the soil in the fine textual class.

The mineralogy is mixed. The IIIB23t horizon has a moderate amount of extremely well crystallized kaolinite, montmorillonite, and mica. The upper part of the IIIB24t horizon contains a moderate amount of montmorillonite, well crystallized kaolinite, and mica; and the lower part contains a moderate amount of well crystallized kaolinite and mica and a small amount of montmorillonite and vermiculite. The presence of the montmorillonite clay in all three horizons explains the high shrink-swell potential.

TABLE I *Laboratory data for Ebal silt loam.*

Depth in cm	Horizon	Sand (2.0-0.05 mm)	Silt (0.05-0.002 mm)	Clay (<0.002 mm)	Coarse Fragments*	pH (1:1 H_2O)	Sum of cations	Base Saturation %	Texture class
0-7	A1	13.4	75.2	13.3	0	5.2	19.3	22.8	silt loam
7-20	B1	12.1	72.4	19.9	10	4.7	13.1	7.8	silt loam
20-33	B21t	17.0	55.2	27.8	23	5.0	14.2	12.2	silty clay loam
33-53	IIB22t	20.5	33.7	45.8	38	5.0	24.1	21.4	clay
53-103	IIIB23t	8.5	30.3	61.2	0	4.7	31.8	27.1	clay
103-153	IIIB24t	5.6	31.0	63.4	0	4.1	30.8	38.9	clay
153-200	IIICr	37.7	28.7	33.6	0	3.8	55.4	72.4	clay loam
116	IIIB24t							55.1	

*Expressed as a percentage of all material at <76 mm.

Ebal series in soil map units

The major map unit on the West Baden Group makes up 10,175 acres in Monroe County. This map unit has been tentatively designated Ebal-Wellston-Gilpin complex, 12 to 18 percent slopes. It consists of strongly sloping, deep and moderately deep, moderately well and well drained soils on breaks that border the ridges of the upland. The unit contains about 50 percent Ebal soils, 20 percent Wellston soils, and 15 percent Gilpin soils. Berks soils are included throughout the unit and make up about 7 percent. On steeper sideslopes are small areas of Caneyville, Corydon, and Weikert soils. Most delineations contain only a few rock outcrops, bedrock escarpments, and short steep slopes. Throughout the unit are areas of Wellston and Gilpin soils that are so small in extent or so intricately mixed with Ebal soils that it was not practical to separate then in mapping. Wellston and Gilpin soils occur widely in south-central Indiana.

The minor soil map unit on the West Baden Group makes up 5,405 acres in Monroe County. This map unit has been tentatively designated Ebal-Gilpin-Hagerstown complex, 18 to 25 percent slopes. It consists of moderately steep, deep and moderately deep, moderately well and well drained soils on breaks that border the valleys and lower sideslopes of uplands. In the lower topographic positions, this unit formed on limestone of the Blue River Group (Henry H. Gray, personal communication, 1978). The unit contains about 50 percent Ebal soils, 30 percent Gilpin soils, and 16 percent Hagerstown soils. Wellston soils are included throughout the unit. On steeper sideslopes are small areas of Berks, Caneyville, Corydon, and Weikert soils. Most delineations have many large rock fragments on the surface and a few rock outcrops, bedrock escarpments, and short steep slopes. Throughout this unit are Gilpin and Hagerstown soils that are so small in extent or so mixed with the Ebal soils that it is not practical to separate them in mapping. This map unit contains more coarse fragments throughout the solum than the Ebal-Wellston-Gilpin complex. Ebal soils in the Ebal-Gilpin-Hagerstown complex would be taxadjuncts of the proposed Ebal series because they contain more coarse fragments than would be allowed for the proposed series. These soils are classified as clayey-skeletal, mixed, mesic Ultic Hapludalfs, whereas the proposed Ebal series is a fine, mixed, mesic Ultic Hapludalf.

In both map units, soils formed from limestone residuum are generally found only on the lower sideslopes that directly border the valley floors. In the Ebal-Wellston-Gilpin complex, limestone bedrock on the Blue river Group comes into contact with the overlying sandstone, siltstone, or shale in the lower third of the sideslopes. This limestone contact has generally been observed in the field as an eroded area, or slip, about 50 to 150 feet wide, where the limestone bedrock is exposed as rock ledges or outcrops. Soils directly below the limestone contact generally are formed in sandstone colluvium, but the underlying bedrock is limestone. In some areas the soils have formed in both the sandstone colluvium and limestone residuum, and in a few small areas the soils formed entirely in limestone residuum.

In the Ebal-Gilpin-Hagerstown map unit, the limestone contact occurs about halfway up the hillside and soils that formed entirely in limestone residuum are common on the lower part of most of the sideslopes.

In both landscape units, the soils above the limestone contact are intricately mixed because of the interbedding of sandstone, siltstone, and shale in the West Baden Group and because of strong colluvial movement of detached rock materials down the slope. The Ebal soils, which relate to shale bedrock, occur throughout the unit above the limestone contact. The position of the Ebal soils within the landscape depends upon where the strata of shale occur. In most cases, the Ebal soils are on small colluvium-covered benches directly below a short steep slope. This short steep slope usually contains sandstone bedrock exposures in the form of ledges and outcrops. The soils that occur directly below the Ebal soils are steeper than Ebal and formed in colluvium or residuum from sandstone.

Appendix 1
Profile description—Ebal silt loam

Location: Monroe County, Indiana—2,060 feet south and 920 feet east of the northwest corner, sec. 8, T. 7 N., R. 2 W.

Size of Area: 200 acres.

Vegetation: Hardwood forest.

Elevation: 770 feet above sea level.

Description:

A1— 0-7 cm (0-3 in.), dark grayish brown (10YR 4/2) silt loam, light brownish gray (10YR 6/2) dry; moderate medium granular structure; friable; many fine, medium, and coarse roots; strongly acid; clear smooth boundary.

B1— 7-20 cm (3-8 in.), yellowish brown (10YR 5/4) silt loam; weak medium subangular blocky structure; friable; many fine, medium, and coarse roots; 10 percent sandstone fragments, 3 percent greater than 2 mm (3/4 in.) in length; strongly acid; clear wavy boundary.

B21t— 20-33 cm (8-13 in.), yellowish brown (10YR 5/14) channery silty clay loam; moderate medium subangular blocky structure; firm; common fine and medium roots; common discontinuous distinct thin yellowish brown (10YR 5/4) clay films on faces of peds; 23 percent sandstone fragments; very strongly acid; clear wavy boundary.

IIB22t— 33-53 cm (13-21 in.), yellowish brown (10YR 5/4) very channery silty clay; moderate medium subangular blocky structure; firm; common fine and medium roots; common discontinuous distinct thin yellowish brown (10YR 5/4) clay films on faces of peds; 38 percent sandstone fragments; very strongly acid; clear wavy boundary.

IIIB23t— 53-103 cm (21-41 in.), red (2.5YR 4/6) clay; many medium prominent gray (10YR 6/1) mottles; strong medium angular blocky structure; firm; few fine and medium roots; common discontinuous distinct medium gray (10YR 6/1) and yellowish brown (10YR 5/6) clay films on faces of peds; very strongly acid; clear wavy boundary.

IIIB24t— 103-153 cm (41-61 in.), yellowish brown (10YR 5/4) clay; many coarse distinct gray (10YR 6/1) and strong brown (7.5YR 5/8) mottles; strong medium angular blocky structure; firm; few fine and medium roots; common discontinuous distinct medium dark gray (10YR 4/1) and brown (10YR 5/3) slickensides on faces of peds; very strongly acid; gradual wavy boundary.

IIICr— 153-200 cm (61-80 in.), gray (10YR 6/1) clayey shale; many coarse distinct dark brown (7.5YR 4/4) mottles; very strongly acid.

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