Perceiving and Defining Soils on Disturbed Land

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ABSTRACT

This study outlines and applies a procedure for mapping and classifying soils on surface-mined land. Soils are mapped by defining soil units and then delineating corresponding bodies as they exist on the landscape. For a given landscape, soil unit concepts are most useful if they facilitate grouping soils that are alike and separating soils that are different. Soil units on the surface-mined land were defined by considering premine soil and overburden characteristics, method of mining, and method of soil construction. Considering these historical factors provides clues to soil characteristics and geographic patterns of the soils much as applying geomorphic and conventional soil genesis concepts do for natural soils. Four series were mapped on surface-mined land. The Morristown, Lenzburg, Schu- line, and Swanwick series are Typic Udorthents. Particle size class, which included rock fragments, and reaction class of the control section are the main differences among the series. The approach to defining soil units used in this study is an effective method for perceiving order on surface-mined land so that the soils can be mapped and classified.

Additional Index Words: soil mapping and classification, surface mine reclamation, coal mining, minesoils.


About 2000 hectares of Illinois land is surface-mined for coal each year. By 1981 about 85,000 ha had been mined. Demands are being made for soil information on these disturbed lands. Until recently, however, little effort has been made to identify and map soil differences on disturbed land.

For many years, areas affected by surface-mining were delineated on soil maps and identified only as mine dump or strip mine. Soil surveys completed during the 1970’s generally identified the mined land as Orthents. In some instances the graded mine spoil was separated from the ungraded spoil, as in the St. Clair County, Illinois, soil survey (Wallace, 1978); or the acid spoil was separated from the nontoxic spoil, as in the Saline County, Illinois, soil survey (Miles and Weiss, 1978). Texture modifiers were also used in some instances. No attempt was made to define soil series concepts for the areas disturbed by surface mining. The present policy of the USDA Soil Conservation Service is to define soil series for soils on surface-mined land and to map phases of series.

The term soil unit is used in this paper for a soil class concept that is not bound by taxonomic constraints which apply to “taxons” such as “soil series” and is free of the cartographic implications and categorical impurity associated with “soil mapping units.” Soil units are conceptual constructs which define soil bodies. Taxons are soil units, but soil units in the following discussion is used in a more general sense such that they may transgress limits between taxons and hence include a complex of taxons. Taxonomic homogeneity may be sacrificed to achieve conceptual unity in relation to some soil genetic (or soil construction) model which aids one in perceiving geographic order in soil variability. Relaxing taxonomic constraints allows better fit of soil units to the landscape, but perceived order is normally still more cartographically complex than what can be mapped at convenient scales. Hence, mapping units would normally include more than one soil unit. Soil series and soil mapping units are brought into the discussion where their respective constraints are applied.

Soils are mapped by defining soil units and then delineating (to the degree cartographically feasible) corresponding bodies of soil on the landscape. For a given landscape, soil units would be most useful if they facilitated grouping soils that are alike and separating soils that are different. Conceptual soil units designed to fit the landscape and based on a conceptual model that relates to a pattern of geographic order can make it easier for a soil surveyor to perceive and depict a meaningful pattern of soil variability.
Pedologists have been slow to define and separate different soils within disturbed land areas because these soils seemed inherently too variable; mappable patterns of order were not apparent. On undisturbed land, the soil genesis model provides a basis for expecting order and enables a trained pedologist to readily perceive it. But in areas disturbed by surface-mining, the soil genesis model applied in the usual way does little to help one perceive spatial order. The time is so short that the active factors of soil formation have had little effect. Lacking an applicable conceptual model, one commonly finds the apparent complexity overwhelming, and fails to perceive order.

In man-made soils, it is reasonable to study the soil construction process for clues to soil characteristics and geographic patterns. Knowledge of the characteristics of premine soils and the premine geologic column, as well as of the material selection and material handling procedures during soil construction, provide a basis for expecting geographic order. This knowledge provides the basis for an applicable conceptual model to help one perceive order in postmine constructed soils so that appropriate conceptual soil units can be defined and effectively mapped.

Two previous studies (Schafer, 1979; and Indorante and Jansen, 1981) address the nature of soil variability on mined and undisturbed lands. Schafer's sampling design was independent of conceptual soil units, whereas Indorante and Jansen began by identifying conceptual soil units and stratifying their sampling design accordingly. Schafer observed more soil variability over short distances for the minesoils than for the undisturbed soils studied in a sedimentary upland landscape; yet Indorante and Jansen, working in a loess veneer landscape, observed that there were significant differences in more soil properties among conceptual soil units on the mined land than was true on the undisturbed land. Both studies indicate that minesoil properties are related to mining and reclamation methods.

The objective of this study was to outline and apply a procedure to map and classify soils on surface-mined land. The procedure is to define conceptual soil (landscape) units as described by Jansen and Arnold (1976) and as applied to surface-mined land by Indorante and Jansen (1981). The conceptual soil landscape model, which forms the basis for the soil unit concepts and for perceiving geographic order, postulates a relationship between postmine soil character and: (i) mining methods, (ii) reclamation (soil construction) procedures, (iii) premine soils, and (iv) premine geologic column.

METHODS

The study was conducted in southern Illinois, particularly Perry County. The soils of Perry County have formed in loess, glacial till, alluvium, lacustrine sediments and residuum. Approximately 17% of Perry County's 114,826 ha has been affected by surface-mining for coal. Surface-mining has been going on in the county since 1929.

This study was done as part of the Perry County soil survey. Soil series concepts for most of the undisturbed soils in the county were well developed before the survey began because of many years of past soil investigations in that part of the state. Little was known about the soils in those areas that had been disturbed by surface-mining for coal.

The first step in mapping soils on surface-mined land was to gather information concerning the premine and postmine overburden character and the different mining and soil construction methods. The main sources of information were recent aerial photographs and historic land use information and field investigations. Aerial photographic interpretation was used as an aid in mapping. Certain patterns on the photographs were tied to some soil properties directly or to specific types of mining and soil construction processes which in turn have some bearing on soil properties.

Mine history information about mining and reclamation methods used is helpful in defining soil unit concepts to group soils that are similar and separate soils that are different. This field testing determines the effectiveness of the soil unit concepts to group soils that are similar and separate soils that are different.

RESULTS AND DISCUSSIONS

The premine geologic column, which overlies the coal, varies throughout Perry County, but in general the upland of the area is blanketed with 1 to 2 m of silty, leached loess. Most of the soils in the county were formed in this material. Underlying the loess is Illinoian glacial till 4 to 9 m thick. This material is generally acid in the upper part, calcareous in the lower part, and firm throughout. Underlying the glacial till and overlying the coal are varying thicknesses of limestone and calcareous shale.

Mining shovels, draglines, mining wheels, scrapers, and bulldozers are the main types of equipment used in the mining and soil construction processes. A mining shovel or a dragline tends to deposit sizeable masses of spoil; in contrast, the material from the resulting high, more-or-less repeating, soil variability over short distances. A mining wheel tends to blend
material from the various layers of unconsolidated material from the geologic column and commonly produces a soil that is quite homogeneous on a pedon scale. A scraper can effectively segregate the various layers of unconsolidated material but commonly induces compaction that inhibits root growth when materials are handled moist. Bulldozers are used mainly to level the materials used for soil construction.

The conceptual soil units perceived and defined on the basis of known premine materials, mining methods, and reclamation practices, as well as field morphology provided clues to soil character and geographic patterns on surface-mined land. Perceived soil units were characterized and soil series were defined to correspond as closely as possible to each (Table 1). Gray colors were not considered to be an indication of wetness because all soil colors were assumed to be inherited from the material from which the soil was constructed.

The four series identified, The Morristown, Lenzburg, Schuline, and Swanwick, are Typic Udorthents (Soil Survey Staff, 1975). Particle size class, which includes rock fragments, and reaction class of the control section are the main morphological differences among the series (Table 2–5). The soil mapping units, which were developed from the soil units, and the corresponding landscape symbols are given in Fig 1.

Two of the soils, the cobbly Morristown and the gravelly Lenzburg, are the result of mining efforts before the 1975 Illinois reclamation law. Reclamation to rowcrop standards after 1975 has generally produced one of the other two soils, Schuline or Swanwick. Schuline soils are commonly the end product where reclamation has been accomplished by grading wheel spoil with bulldozers. The mining wheel typically blends the loess and glacial till materials, yielding loamy textures. Swanwick soils are usually the end product where silty loess has been selectively handled, typically by scrapers, and used to build the new soils. These soils typically are silty and also have a somewhat more compacted physical condition caused by traffic of earthmoving equipment during soil construction.

Some land reclaimed before 1975 also consists of Schuline soils. This happened where the mining and reclamation methods used resulted in good quality, relatively stone-free material being placed near the surface, even though such was not then required by law.

The conceptual soil landscape model approach greatly aided in the design of soil mapping units that could be identified consistently in the field (Fig. 1). The different mapping unit phases were also designed to supply survey users with information needed for conservation and land use planning. Information in the mapping unit description in the survey report includes texture, slope, drainage, rock fragment per-
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CONCLUSIONS

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