CLASSIFICATION OF MINESOIL SERIES AS NOOSOLS[1]

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Abstract. Proposals for a separate order of Noosols have been advanced to include soils where anthropogeomorphic processes predominate. Although several soil series for minesoils are established in the United States, these soils have been not been fully incorporated in the U.S.D.A. taxonomic system. Problems in separating minesoils from "natural" soils remain, and these soils are inevitably placed in Entisols (Orthents or Arents). Proposals for recognizing a separate suborder of Spolents have not been approved, while attempts to distinguish minesoils at the subgroup level seem inconsistent with family criteria. Classification of established minesoil series is discussed, and suggestions made to reclassify these as Spolnos in the new soil order. Proposed subgroup taxa for Spolnos are presented, which have more affinities with those in Arents. Specific family criteria are then introduced, following normal protocol; dominant lithology may be indicted where relevant in parentheses after particle-size class.

Key words: Minesoils, Noosols, Spolnos, anthropogeomorphology, anthropedogenesis

Introduction

Attempts to establish a special suborder for minesoils in Entisols (Spolents) in the American system have not been formally approved (Ammons and Sencindiver 1990, Sencindiver and Ammons 2000). At present, most minesoils are classified as Orthents or Arents, and limited subgroup categories have been developed for established soil series (Soil Survey Staff 1999). Fundamental problems dealing with the classification of minesoils in the American system, however, have not been resolved, and these soils have not been fully incorporated in the present soil taxonomy. Partly, of course, this reflects the morphogenetic bias of the American soil taxonomy, and it illustrates, if more examples are need, the intractable nature of the problem given the system's exclusive reliance on soil morphology. In any case, it does not seem possible at present stage of knowledge to arrive at unambiguous criteria separating these soils from other Entisols, and an expanded list of soil properties (some more useful than others) seems at best only a temporary solution.

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[1]Paper was presented at the 2003 National Meeting of the American Society of Mining and Reclamation and the 9th Billings Land Reclamation Symposium, Billings MT, June 3-6, 2003. Published by ASMR, 3134 Montavesta Rd., Lexington, KY 40502.

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Proceedings America Society of Mining and Reclamation, 2003 pp 602-615
DOI: 10.21000/JASMR03010602

https://doi.org/10.21000/JASMR03010602

Previously it was suggested that a more radical approach is required to fully incorporate minesoils in the American soil classification system (Kosse 2001). As seems to be case, problems in separating "natural" from "artificial" soils inevitably intrude in any attempt to develop a taxonomic system that depends exclusively on morphogenetic criteria. Proposals to recognize a new order of Noosols for soils resulting from anthropogeomorphic processes were advanced, and suborders proposed to accommodate the full range of these soils. A separate suborder of Noosols (Spolnos) was proposed to accommodate most minesoils. Only a few examples for minesoils were presented to illustrate the utility of the approach, and it remains unclear how the system would be applied in the case of established soil series. Partly to remedy this I have tentatively reclassified most of the established minesoil series in the United States as Noosols, taking the classification to the family level.

Current proposals should not be confused with earlier proposals to create a separate order of Anthrosols to accommodate soils occurring in areas of old cultivation where traditional agricultural practices have radically transformed the soils (Kosse 1990). Such soils are seen as the product of unique pedogenic processes (*anthropedogenesis*), and it is precisely to distinguish these anthropogenic soils from other soils where anthropogeomorphic processes predominate that a new soil order of Noosols is proposed. It may seem extravagant to propose a new soil order when the acceptance of the Anthrosols order is hardly assured, but it would be consistent with the logic of the American soil classification system since orders are held to reflect distinct pedogenic processes (or their lack).

Noosols

It is important to distinguish soils where anthropogeomorphic processes predominate from Anthrosols since in most cases insufficient time has elapsed for full pedogenetic expression or the development of diagnostic horizons. Use of the term noosphere to refer to the realm of the human mind was held by Vernadsky (1945) to usher in a new epoch in earth's geological history. As a technical term, it is gaining currency among earth scientists in referring to human impact on the environment (Westerbroek 1991, Smil 2002); but its original definition referring specifically to human agency as a geological force seems more apt in this context. Recognition of a separate domain of anthropogeomorpholgy may seem a radical step, but it is an established subdiscipline of geomormophology (Brown 1970, Demek 1973). Other technical terms, such as Neosols, may seem equally appropriate, but they do not necessarily carry the implication of human agency. Other neologisms have been bandied about, including Farbrisols or Technosols, but they either imply purposeful activity or are commonly used in a more restrictive context.

Noogenic Soil Materials

In creating a new order of Noosols where anthropogeomorphic processes are dominant, the intention is to restrict these to the *direct* effects of man as a geological agent. Other workers have made a similar distinction between the direct and indirect effects of man as a geological agent, but for our purposes it matters little if the direct effects are incidental or intentional (Brown 1970). While indirect effects, such as soil erosion, may be more important on a worldwide scale, it is probably advisable to exclude such anthropogenic deposits from consideration in Noosols. Classification schemes have been proposed for anthropogenic landforms, and in some regions these may cover a large portion of the earth's surface (Demek 1973). Characteristic landscapes are produced, particularly in the case of mining activities, which are not difficult to recognize, although soils in these areas may elude classification. Usually these areas are mapped as complexes or miscellaneous areas without rigorous attempts to characterize the soils (Soil Survey Division Staff 1993).

Several types of noogenic soil materials may be recognized, following the lead of Fanning and Fanning (1989). While these are seen to reflect important anthropogeomorphic processes, they differ significantly in the kinds of noogenic soils material produced (Table 1). Garbic and urbic soil materials are relatively easy to distinguish. Cultural debris and artifacts are incorporated in the soil matrix, and in the case of garbic soil materials these consist dominantly of organic materials. Use of soil properties in this case will mean that in some cases garbic fill material will be found in urban context and vice versa. The distinction between spolic and aric soil materials is perhaps more difficult to grasp since cultural debris and artifacts are not as common, but it is necessary to distinguish between local disturbance and large-scale movement of soil materials.

Table 1. Noogenic soil materials

Garbic	Organic waste materials; land fill containing dominantly organic waste products
Urbic	Earthly materials containing cultural debris and artifacts (>35 percent by volume)
Spolic	Earthy materials resulting from industrial activities (mining, river dredging, highway construction, etc.)
Aric	Soil material mixed *in situ* (>50 cm) containing recognizable fragments of diagnostic horizons

Noosol Suborders

Several Noosol suborders are recognized (Table 2), which follow logically the scheme introduced for noogenic soil materials although with some differences in nomeclature. Depth of noogenic soil materials as overburden is usually > 50 cm. Garbinos are composed dominantly of garbic soil materials, while Urbinos quite logically are composed mostly of urbic soil materials. Spolnos consist dominantly of spolic materials, including replacement of the original soil after stockpiling, and are not limited solely to minesoils. Soil fragments where present in the control section are not usually locally derived and may involve considerable earth moving. (A separate suborder for soils developed in dredged materials is not recognized although these may be included in Spolnos at a lower taxonomic level. Soils resulting from the removal or scalping of surface layers are not separately recognized but could be included in Entisols.) Arenos are usually locally derived and are associated with land reclamation or agricultural activities; soil fragments where present remain largely *in situ* although this may involve drastic disturbance of the subsoil.

Most of these soils have not had sufficient time for diagnostic horizons to develop with the exception of ochric or umbric eipedons. Subsequent pedogenesis may place them in other soil orders, such as Inceptisols or Alfisols, depending on the presence or absence of certain diagnostic horizons. It is problematic whether to retain these soils in Noosols or to include them in other soil orders if diagnostic horizons are present (Soil Survey Staff 2000). Probably it would create less violence with the system if they were introduced at the subgroup level, using a subgroup prefix (e.g., Spolic Hapludepts, Urbic Haplustalfs); but other constructions are possible. Special great groups could also be introduced, for example, using the same convention, where it was felt noogenic soil properties were overriding (e.g., Typic Spoludepts, Typic Urbiustalfs). It would, of course, be possible to retain them in Noosols, if this was considered desirable by simply using a subgroup modifier (e.g., Inceptic Udispolnos, Alfic Ustiurbinos); but I suppose this would require an exclusionary clause.

Table 2. Noosols suborders

Sanitos	Soils developed in garbic soil materials
Urbinos	Soils developed in urbic soil materials
Spolnos	Soils developed spolic soil materials
Arenos	Soil developed in aric soil materials

Established Minesoil Series

Presently some 42 minesoil series have been established in the United States (Table 3). These are mostly concentrated in the eastern part of the country, and with the exception of Texas no minesoil series have been recognized in the western United States. With one exception, all minesoils are included in the Entisol order, with most classified as Udorthents or Udarents at the great group level (Table 4). Although difficult to document, there seems to be an increasing tendency to place minesoil series in Arents, which perhaps reflects some degree of intellectual dissatisfaction with earlier classification schemes. The Conquista series classified as an Entic Haplustoll should probably be more appropriately included in Mollic Udarents. The large number of minesoil series in Alfic Udarents (15) probably only reflects regional interest where research has been concentrated and should not necessarily be taken as typical. It is perhaps worth mentioning that in spite of the barely tangible criterion for Arents[3] most of the minesoil series in Arents do not mention soil fragments occurring in the typifying pedon descriptions.

Table 3. Established minesoil series with current classification and as Noosols.[a]

Barkcamp	loamy-skeletal, siliceous, acid mesic Typic Udorthents loamy-skeletal (arenolithic†), acid, mesic Typic Udispolnos	Ohio (1978)
Bethesda	loamy-skeletal, mixed, active, acid, mesic Typic Udorthents loamy-skeletal, mixed, active, acid, mesic Typic Udisponos	Ohio (1978)
Bigbrown	fine-silty, mixed, nonacid, thermic Typic Ustorthents fine-silty, mixed, nonacid, thermic Typic Udispolnos	Texas (1986)
Blocker	loamy, mixed, nonacid, thermic, shallow Alfic Udarents loamy, mixed, nonacid, thermic, shallow Alfic Udispolnos	Oklahoma (1989)
Brazilton	fine, mixed, nonacid, thermic Mollic Udarents fine, mixed, nonacid, thermic Mollic Udispolnos	Kansas (1983)
Briery	loamy-skeletal, mixed, active, nonacid, frigid Typic Udorthents loamy-skeletal (tegulithic‡), mixed, active, nonacid, frigid Typic Udispolnos	West Virginia (1986)
Brilliant	loamy-skeletal, mixed, nonacid, thermic Typic Udorthents loamy-skeletal, mixed, nonacid, thermic Typic Udispolnos	Alabamba (1977)
Cartersville	loamy, mixed, nonacid, thermic, shallow Alfic Udarents loamy, mixed, nonacid, thermic, shallow Alfic Udispolnos	Oklahoma (1989)
Cedarcreek	loamy-skeletal, mixed, active, acid, mesic Typic Udorthents loamy-skeletal, mixed, active, acid, mesic Typic Udispolnos	West Virginia(1984)
Coalgate	fine-silty, mixed, nonacid, thermic Alfic Udarents fine-silty, mixed, nonacid, thermic Alfic Udispolnos	Oklahoma (1989)
Conquista	fine-loamy, mixed, superactive, hyperthermic Entic Haplustolls fine-loamy, mixed, superactive, hyperthermic Mollic Udispolnos	Texas (1989)
Emachaya	fine, mixed, nonacid, thermic Alfic Udarents fine, mixed, nonacid, thermic Alfic Udispolnos	Oklahoma (1989)
Enoch	loamy-skeletal, siliceous, acid, mesic Typic Udorthents loamy-skeletal (limolithic*), acid, mesic Typic Udispolnos	Ohio (1984)
Fairpoint	loamy-skeletal, mixed, active, nonacid, mesic Typic Udorthents loamy-skeletal, mixed, active, nonacid, mesic Typic Udispolnos	Ohio (1978)
Farmerstown	fine-loamy, mixed, acid, mesic Typic Udorthents fine-loamy, mixed, acid, mesic Typic Udispolnos	Ohio (1987)
Fiveblock	loamy-skeletal, mixed, semiactive, nonacid, mesic Typic Udorthents loamy-skeletal (arenolithic†), mixed, semiactive, nonacid, mesic Typic Udispolnos	West Virginia (1984)

Gibbonscreek	fine-loamy, mixed, nonacid, thermic Typic Ustorthents fine-loamy, mixed, nonacid, thermic Typic Ustispolnos	Texas (1988)
Grayrock	fine-silty, mixed, active, nonacid, thermic Typic Udorthents fine-silty, mixed, active, nonacid, thermic Typic Udispolnos	Texas (1984)
Hollybrook	fine-loamy, mixed, active, nonacid, mesic Alfic Udarents fine-laomy, mixed, active, nonacid, mesic Alfic Udispolnos	Indiana (1996)
Ironbridge	fine, mixed, active, nonacid, thermic Alfic Udarents fine, mixed, active, nonacid, thermic Alfic Udispolnos	Oklahoma (1989)
Itmann	loamy-skeletal, mixed, semiactive, acid, mesic Typic Udorthents loamy-skeletal (carbolithic**), mixed, semiactive, acid, mesic Typic Udispolnos	West Virginia (1984)
Janelew	loamy-skeletal, mixed, calcareous, mesic Typic Udorthents loamy-skeletal, mixed, calcareous, mesic Typic Udispolnos	West Virginia (1988)
Kanima	loamy-skeletal, mixed, active, nonacid, thermic Alfic Udarents loamy-skeletal, mixed, active, nonacid, thermic Alfic Uidspolnos	Oklahoma (1972)
Kaymine	loamy-skeletal, mixed, active, nonacid, mesic Typic Udorthents loamy-skeletal, mixed, active, nonacid, mesic Typid Udispolnos	West Virginia (1984)
Latimer	fine, mixed, nonacid, thermic Alfic Udarents fine, mixed, nonacid, thermic Alfic Udispolnos	Oklahoma (1989)
Lenzburg	fine-loamy, mixed, active, calcareous, mesic Haplic Udarents fine-loamy, mixed, active, calcareous, mesic Aric Udispolnos	Illinois (1981)
Lenzwheel	fine-loamy, mixed, active, calcareous, mesic Alfic Udarents fine-loamy, mixed, active, calcareous, mesic Alfic Udispolonos	Illinois (1995)
Lequire	loamy, mixed, nonacid, thermic shallow Alfic Udarents loamy, mixed, nonacid, thermic, shallow Alfic Udispolnos	Oklahoma (1989)
Marclay	fine, mixed, nonacid, thermic Typic Udorthents fine, mixed, nonacid, thermic Typic Udispolnos	Texas (1985)
Marklake	fine-loamy, siliceous, active, acid, thermic Alfic Udarents fine-loamy, siliceous, active, acid, thermic Alfic Udispolnos	Texas (1987)
Minnehaha	fine-loamy, mixed, active, nonacid, mesic Alfic Udarents fine-loamy, mixed, active, nonacid, mesic Alfic Udispolnos	Indiana (1996)
Morristown	loamy-skeletal, mixed, active, calcareous, mesic Typic Udorthents loamy-skeletal (calcolithic***), mixed, active, mesic Typic Udispolnos	Ohio (1978)
Myra	loamy-skeletal, mixed, calcareous, mesic Typic Udorthents loamy-skeletal, mixed, calcareous, mesic Typic Udispolnos	Kentucky (1985)
Palmerdale	loamy-skeletal, mixed, acid, thermic Typic Udorthents loamy-skeletal (tegulithic[‡]), mixed, acid, thermic Typic Udispolnos	Alabama (1974)

Pinegrove	mixed, mesic Typic Udipsamments mixed, mesic Psammentic Udispolnos	Ohio (1988)
Pirkey	fine-loamy, siliceous, semiactive, acid, thermic Utlic Udarents fine-loamy, siliceous, semiactive, acid, thermic Ultic Udispolnos	Texas (1989)
Putco	fine, mixed, superactive, calcareous, mesic Typic Udorthents fine, mixed, superactive, calcareous, mesic Typic Udispolnos	Missouri (1989)
Rapatee	fine-silty, mixed, superactive, nonacid, mesic Mollic Udarents fine-silty, mixed, superactive, nonacid, mesic Mollic Udispolnos	Illinois (1983)
Schuline	fine-loamy, mixed, superactive, calcareous, mesic Alfic Udarents fine-loamy, mixed, superactive, calcareous, mesic Alfic Udispolnos	Illinois (1983)
Sewell	loamy-skeletal, mixed, semiactive, acid, mesic Typic Udorthents Loamy-skeletal (arenolithic[†]), mixed, semiactive, acid, mesic Typic Udispolnos	West Virginia (1984)
Swanwick	fine-silty, mixed, active, nonacid, mesic Alfic Udarents fine-silty, mixed, active, nonacid. mesic Alfic Udispolnos	Illinois (1983)
Whitefield	fine, mixed, nonacid, thermic Alfic Udarents fine, mixed, nonacid, thermic Alfic Udispolnos	Oklahoma (1989)

[a]Descriptions for established minesoil series courtesy of Henry R. Mount, Soil Scientist, National Soil Survey Center (Lincoln).

[†] arenolithic: Dominantly sandstone; from *arena* L., sand.

[‡]tegulithic: Dominantly thin-bedded shale (fissile); from *tegula* L., tile.

*limolithic: Dominantly nonfissile mudstone; from *limosus* L., muddy

**carbolithic: Dominantly highly carbonaceous rock; from *carbo* L., coal

***calcolithic: Dominantly calcareous rock (limestone); from *calx* L., chalk, limestone

Earlier proposals to recognize minesoils as a separate suborder (Spolents) have not been officially approved (Sencidiver and Ammons 2000). It is, of course, notoriously difficult to separate these soils unambiguously from other Entisols, using morphogenetic or morphometric criteria. Proposals to distinguish minesoil series at the subgroup level, using dominant lithology, seems premature (Table 5); but subgroup categories based on lithology at least serve to recognize key features of minesoils which may be important for management. Primarily, of course, this reflects concerns within coal mining areas, and it is not entirely clear that the scheme can be meaningfully used in other regions. It is interesting to note that subgroups are recognized with only ten percent rock fragments, but this seems to conflict needlessly with rock fragment adjectivals in texture class.

Table 4. Subgroups for established minesoil series

Typic Usorthents	2
Typic Udorthents	19
Typic Udipsamments	1
Alfic Udarents	15
Ultic Udarents	1
Mollic Udarents	2
Haplic Udarents	1
Entic Haplustolls	1

[3]Fragments of diagnostic horizons (>3 percent by volume) in one or more layers between 25 and 100 cm below the mineral soil surface arranged in no discernible order.

Table 5. Proposed minesoil subgroups for Udispolents (Sencindiver and Ammons 2000)

Carbolithic	Black, high carbon rock
Fissile	Thin-bedded shale
Kalkig	Limestone or calcareous mudstone
Matric	<10 percent rock fragments
Plattic	Sandstone, predominantly low chroma (gray)
Pyrolithic	Burnt cabolithic material
Regolithic Plattic	Sandstone, predominantly high chroma (brown)
Schlickig	Nonfissile mudstone
Typic	Mixture of rock types

Spolnos Subgroups

Proposed subgroup categories for Spolnos are shown in Table 6, which bear some similarities to the present key (Soil Survey Staff 1999). On superficial examination this does not seem markedly different from current subgroup designations, but it would be a mistake not to realize the radical nature of these proposals. Placement of most minesoils in a single suborder preserves the basic unity of these soils since all reflect the same anthropogeomorphic processes. It does not follow, of course, that all minesoils would be included in Spolnos, either because of subsequent pedogenesis or inclusion of considerable cultural materials. Alfic and Ultic subgroups were previously included in Arents, and I have created another subgroup (Aric) for Spolnos where fragrments from other diagnostic horizons are present. In some cases, mollic epipedons have developed in former spolic soil materials, but use of the term pseudo-mollic (Mollic Udispolnos) is meant to include those soils where reclamation law requires replacement of the original topsoil.

Table 6. Proposed subgroups for Spolnos

Lithic Udispolnos	Lithic contact < 50 cm
Psammentic Udispolnos	Loamy fine sand or coarser (particle-size control section)
Mollic Udispolnos	Pseudo-mollic epipedon
Alfic Udispolnos	Fragments of argillic (bases>35 percent)
Ultic Udispolnos	Fragments of argillic
Aric Udispolnos	Fragments of diagnostic horizons other than alfic or ultic
Typic Udispolnos	Other Spolnos (udic)
Typic Ustispolnos	Other Spolnos (ustic)

A summary of the results for Spolnos is shown in Table 7, using the proposed subgroups for the established series. It should be noted that the previously largest subgroup (Typic Udorthents) remains as typic in Udispolnos although whether this should be considered typical is problematic. It is obvious that the present distribution is simply a reflection of research concentration rather than a representative sample. Former Udarent subgroups are defined by kind and percentage of diagnostic horizon fragments and are easily distinguishable. The preponderance of Alfic Udispolnos preserves the same ordering as in Arents, but Haplic Arents have been replaced by Aric Udispolnos. Brazilton, Conquista, and Rapatee series are classified as Mollic Udispolnos although the mollic epipedon has *not* developed *in situ* (hence pseudo-mollic). While the differences at first glance do not seem substantial, the basic unity of the grouping has been preserved by including them all in Spolnos. The fact that it does not seem to violate the original ordering of the series is perhaps an additional reason to recommend its adoption.

Table 7. Minesoil series subgroups in Noosols.

Lithic Udispolnos	0
Psammentic Udispolnos	1
Mollic Udispolnos	3
Alfic Udispolnos	15
Ultic Udispolnos	1
Aric Udispolnos	1
Typic Udispolnos	19
Typic Ustispolnos	2

Family Differentiae

Family differentiae are appended to meet perceived management needs but also serve to reveal close relationships between series. It does not seem necessary immediately to change family designations for established minesoil series, and for the most part these have been retained in the present proposal. Introduction of dominant lithology, however, should be included as family criteria where this is important for management. It seems somewhat inconsistent to introduce this at the subgroup level, and where required it could be indicated with parentheses following particle-size class. I have provided some examples for minesoil series in loamy-skeletal families (Table 8) where dominant lithology may be important. Of course, the actual limits where dominant lithology intrudes in management considerations need not correspond to particle-size classes. Further research along these lines needs to be undertaken, but there is no inherent reason why dominant lithology should not be recognized at the family level, and this would bring it into conformity with the use of mineralogy classes.

Table 8. Dominant lithology of some loamy-skeletal families in Spolnos

Barkcamp	loamy-skeletal (arenolithic†), acid, mesic Typic Udispolnos
Briery	loamy-skeletal (tegulithic‡), mixed, active, nonacid, frigid Typic Udispolnos
Enoch	loamy-skeletal (limolithic*), acid, mesic Typic Udispolnos
Fiveblock	loamy-skeletal (arenolithic†), mixed, semiactive, nonacid, mesic Typic Udispolnos
Itmann	loamy-skeletal (carbolithic**), mixed, semiactive, acid, mesic Typic Udispolnos
Morristown	loamy-skeletal (calcolithic***), mixed, active, mesic Typic Udispolnos
Palmerdale	loamy-skeletal (tegulithic‡), mixed, acid, thermic Typic Udispolnos
Sewell	loamy-skeletal (arenolithic†), mixed, semiactive, acid, mesic Typic Udispolnos

† arenolithic: Dominantly sandstone; from *arena* L., sand.

‡tegulithic: Dominantly thin-bedded shale (fissile); from *tegula* L., tile.

*limolithic: Dominantly nonfissile mudstone; from *limosus* L., muddy

**carbolithic: Dominantly highly carbonaceous rock; from *carbo* L., coal

***calcolithic: Dominantly calcareous rock (limestone); from *calx* L., chalk, limestone

Summary

Proposals for classifying minesoils as a suborder (Spolents) in Entisols have not been formally accepted, mainly because of difficulties in developed criteria unambiguously separating minesoils from other soils in the same order. Problems remain in separating minesoils from "natural" soils, and these soils have not been fully incorporated in the American taxonomic system. While several minesoil series have been recognized, these are inevitably placed in Orthents or Arents. It is argued that the strong morphogenetic or morphometric bias of the American system renders any effort to properly classify these soils problematic, although soil properties of limited regional applicability have been devised. Proposals to establish a new soil order of Noosols are designed to overcome this impasse, creating a separate order for soils where anthropogeomorphic processes predominate. While this concept has broader implications, recognition of a separate suborder of Spolnos for minesoils and other similar drastically disturbed soils would emphasize the basic unity of this important group of soils. A list of established minesoil series is included in this paper, with suggestions for Spolnos subgroups. While this may seem of only academic interest, it is clear that resolving taxonomic problems in minesoil classification will have a major impact in establishing soil series and aid in devising suitable soil management interpretations. Specific family criteria could then be introduced, following normal protocol, which would allow for the grouping of soil series in useful management categories.

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