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# Classification of paleosols: Discussion and reply

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**Notes**

# Classification of paleosols: Discussion and reply

## Discussion

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The classification of paleosols by Mack and others (1993) has a firm foundation in soil science and bears a strong resemblance to the classification of the Food and Agriculture Organization of U.N.E.S.C.O. (Food and Agriculture Organization, 1971–1981). Two fundamental aspects of their proposal, however, limit its usefulness: confusion of genetic versus descriptive classification and lack of a general purpose.

The new classification is urged as superior to paleosol series "requiring much interpretative skill," but this comparison is misleading. Soil series are specifically designed for field-based non-interpretive classification of particular profiles. They can be used as labels for particular paleosols (Retallack, 1990, 1991). It is the identification of a paleosol in a classification of soils, including the new classification of Mack and others (1993), that requires interpretation. Soil classifications include a variety of criteria thought to reflect genetic considerations, and for paleosols additional interpretation is needed to unravel alteration after burial. A paleosol series name is merely a convenient label, like a geological formation such as the Eugene Formation. It does take some skill and field experience to distinguish paleosol series or geological formations from one another, but this is a much less interpretive enterprise than classifying a soil in a soil taxonomy or interpreting the depositional environment of a rock formation. Mack and others (1993) mislead by conflating non-genetic and genetic classification.

My second reservation with the proposal of Mack and others (1993) is concern over its general purpose. My main reason for attempting to classify paleosols in soil taxonomies is to interpret their significance for paleoenvironments. Applying soil taxonomy to paleosols enables one to identify general classes and specific profiles of modern soils that can be compared in detail with a partic-

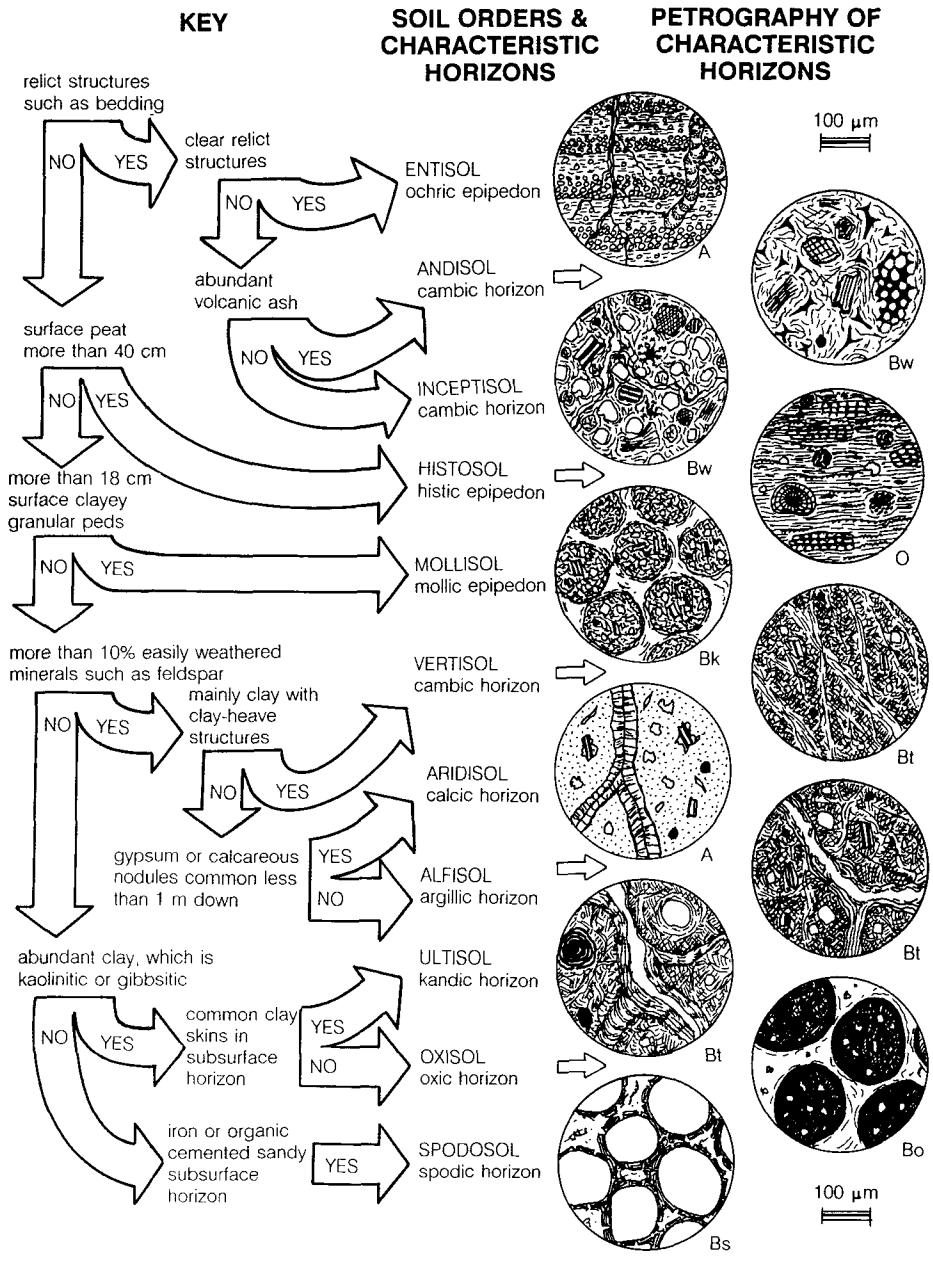


**Figure 1. A simplified key to orders of the United States soil taxonomy for use with paleosols, with emphasis on petrographic and bulk chemical criteria (data from Retallack, 1988, 1990, 1991, 1993). Each order has a characteristic appearance in petrographic thin sections (after Douglas and Thompson, 1985).**

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ular paleosol. If a paleosol is very similar to a modern soil, then perhaps environments similar to those that formed the soil can be inferred for the paleosol (Retallack, 1990). Classification is also a way of navigating the enormous published literature on soils. The classifications of the U.S. Soil Conservation Service (Soil Survey Staff, 1975), of U.N.E.S.C.O. (F.A.O., 1971–1981) and of the Australian C.S.I.R.O. (Stace and others, 1968) are supported by a vast bank of soil profile descriptions, often with chemical and petrographic data. From this perspective, the classification of Mack and others (1993) may simplify communication between paleosol workers, but it does not lead to comparative data on soils useful for interpretation. The new paleosol classification could be harmful in isolating geologists interested in paleosols from soil scientists.

The classification of Mack and others (1993) was urged to "enhance communication and aid in the standardization of terminology," but this has already been achieved by the United States classification (Soil Survey Staff, 1990). As indicated by Mack and others (1993), the differentiating criteria of this classification are not directly applicable to buried soils, and new criteria for delimitation of paleosols are needed. By adopting many of the soil names of soil taxonomy, they have made a valuable contribution to the evaluation of previously proposed (Retallack, 1988, 1990) bulk chemical and petrographic criteria (Fig. 1). In recent work on the relationship between depth to calcic horizons and mean annual rainfall (Retallack, 1993), an uncompacted depth of 1 m or less to the calcic horizon may be a useful criterion for defining Aridisols. Even though the organic matter of Mollisols is seldom preserved at anywhere near original levels in paleosols, granular ped structure and fine root networks can be preserved as evidence of a mollic epipedon (Retallack, 1991). More could be done with modern soils to find and quantify features that are robust enough to be used to identify paleosols within classifications of modern soils. Our soil science colleagues have shown commendable flexibility in allowing soil taxonomy to be modified and grow (Soil Survey Staff, 1990). Now is not the time to settle for our own simplistic classification, but to meld the unique perspective of geological sciences with the established experience of soil sciences for the benefit of both disciplines.

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# Reply

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We appreciate the comments by Greg Retallack regarding our classification of paleosols (Mack and others, 1993). We disagree, however, with his statement that we have in some way confused genetic versus descriptive classification and that we lack a general purpose in our approach. The second paragraph in our introduction clearly addresses these issues (Mack and others, 1993, p. 129). Our purpose is to enhance communication, minimize the need for highly interpretative conclusions to yield names, and partially standardize the large collection of terms associated with paleosols. We have attempted to keep our approach as descriptive as possible while acknowledging the realities surrounding paleosol classification.

As we stated in our original paper, "The paleosol classification presented here may be too simple for some Quaternary or older paleosols that are little modified from their original state. Such pristine paleosols may best be classified using Soil Taxonomy in order to more accurately reflect their characteristics." (Mack and others, 1993, p. 130). Owing to the vagaries of preservation and often the need for knowledge of the specific conditions of soil formation, however, many paleosols do not possess adequate characteristics to allow for proper classification at the order level following Soil Taxonomy. This is a fact. What about the Mollisol and Aridisol examples alluded to in Retallack (1993)? Some paleosols do have some of the characteristics of modern Mollisols, such as preserved fine root structure and granular peds. Unfortunately, such features are generally destroyed during diagenesis. Additionally, such characteristics as granular peds, although a common feature of modern Mollisols, may also be formed in other types of soils. For instance, some Aridisols have granular or crumb peds in their A horizon (Gile and Grossman, 1979). It may indeed be determined that modern Aridisols are dominated by profiles with uncompacted depths to the calcic horizon of $\leq 1$ m (Retallack, 1993). Most ancient calcic profiles, however, have been at least partially truncated by erosion, thus complicating their interpretation. Climate seasonality and parent-material composition and texture must have also played roles in influencing the depth of accumulation of calcium carbonate. Moreover, the evolution of aridland floras very likely contributed to changes in the depth of formation of the calcic horizon given a specific set of precipitation and evapotranspiration conditions. Unfortunately, much interpretation must be done before using even a simple criterion to name a paleosol order.

We agree with Retallack (1993) that series can be used as a descriptive label for soil/paleosol profiles. We did not claim otherwise in our paper.

Mack and others (1993) is not an oversimplified classification scheme for most paleosols; it is a realistic one given preservation potential in the rock record. Some simplification after all may be preferable to paleosol order names constructed like a house of cards, requiring assumptions one built on another. Mack and others (1993) borrows from Soil Taxonomy those soil attributes more applicable to paleosols. In this sense, our classification benefits both the soil and paleosol disciplines while recognizing the realities of the stratigraphic record. Our purpose is clear—construct a classification that is effective for most paleosols encountered in the stratigraphic record. Time will determine if we have been successful.

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