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THE CONCEPT OF "BURIED" VERSUS "ISOLATED" PALEOSOLS: EXAMPLES FROM NORTHEASTERN KANSAS

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This paper offers an alternative to the current definition of a buried soil (Soil Survey Staff 1975), stressing criteria that are more amenable to paleopedology. We suggest that any measurable depth of sediment buries a soil and that the soil remains buried until pedogenesis "welds" the overlying sediment to the buried solum. Complete welding is accomplished when no observable material, interpreted taxonomically as a C horizon, is present between the buried and burying profiles. A special type of buried soil, the *isolated paleosol*, is not currently affected by surface pedogenic processes. The lower limit of these surficial processes is called the *depth of isolation*. All isolated paleosols are buried below this depth, which varies depending upon local conditions. We present a theoretical model that uses paleosol characteristics to predict the depth of isolation. Data from 29 buried and exhumed paleosols in Kansas suggest that isolated paleosols do exist, although at greater depths than originally anticipated.

A paleosol has been defined as a soil that formed on a landscape of the past (Ruhe 1956, 1965). Three types of paleosols are reported: relict, exhumed, and buried (Ruhe 1965, 1969; Working Group 1971; Valentine and Dalrymple 1976). In this paper we focus on the latter two types of paleosols and intend to (1) redefine and clarify the term *buried* paleosol, so as to distinguish between welded and unwelded versions; (2) introduce and define a subtype of buried paleosol that is so deeply buried as to be unaffected by present pedogenesis—the isolated paleosol; and (3) present data on Late Sangamon soils in northeastern Kansas, United States, that can be fit to these definitions.

BURIED PALEOSOLS AND WELDED SOILS

The Soil Survey Staff (1975, p. 2) defines a buried soil as one having a "surface mantle of new material that is 50 cm or more thick or if there is a surface mantle between 30 and 50 cm thick, ... the thickness of the mantle must be at least half that of the named diagnostic horizons that are preserved in the buried soil." It later defines the surface mantle of new material as being essentially unaltered by pedogenesis. Many pedons exist, however, with a thinner surface mantle of material that is pedogenically not a part of the buried solum. In our opinion, these soils are buried. Conversely, Bos and Sevink (1975) suggest that much thicker accumulations of sediment are necessary for a soil to be "buried." They define buried soils as those with a cover of sediment so thick as to isolate the soil from "external conditions" (we will later define this type of soil as an *isolated* soil). We, however, strongly suggest that depth of burial need not be a primary criterion in the definition, and that from a paleopedological point of view, any buried soil should be recognized as such.

Our redefinition of "buried" soil in no way diminishes the importance of *Soil Taxonomy*'s definition (Soil Survey Staff 1975). That definition is essential for soil classification and mapping; otherwise, for example, a soil scientist mapping in the field might have to classify a Hapludult with a 10-cm-thick covering of recent silts as an Orthent. We also recognize the concise nature of *Soil Taxonomy*'s definition. This study proposes to alter present thinking about buried soils because of the value it may have for paleopedology. We assume that it will not be found useful by all pedologists.

Soils that are buried by only a thin cover of sediment are likely to become "welded" (Ruhe and Olson 1980) after some time. Ruhe and Olson define soil welding as "the formation of the solum of a ground soil through a thin cover sediment and mergence with the solum of a buried soil . . ." (p. 132). The welded soil concept is not new. It was introduced by Hunt (1972) as a "superimposed soil profile" and Bos and Sevink (1975) as a "polypedomorphic soil," and suggested by Bryan and Albritton's (1943) term "composite soil." We recognize the insight of early work on this topic, yet choose to use the

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term *welding* for the suite of processes that genetically link two sola, one buried and one surficial.

An example is used to illustrate the concept of soil burial and welding. A Hapludoll at the base of an 11% slope is suddenly buried by a 40-cm-thick accumulation of slopewash material. The new mantle is largely BC and C horizon material from Udorthents upslope, although inclusions of A and Bw material are present within. The Hapludoll is now a buried paleosol. The surface mantle is not pedogenically "linked" to the solum below. The processes of "linkage," or welding, begin as the first wetting fronts move through the mantle and enter the buried solum, carrying solutes and colloids. Likewise, welding may begin when the first earthworm moves out of the Hapludoll into the sediments above.

At this point, although pedogenesis has begun, the solum is not welded per se. Ruhe and Olson (1980) include under the term, or concept, *soil welding* those processes that result in the formation of the upper solum. As a corollary, we suggest that welding processes can be divided into two subtypes: (1) those that function by developing and then increasing the depth of the upper solum, and (2) those that pedoturbate material between surface and buried profiles. Examples of the former include lessivage, all forms of leaching, and surficial weathering processes. Pedoturbation between profiles, undoubtedly the most important set of welding processes where surficial mantles are thin, may take many forms (Wood and Johnson 1978; Johnson et al. 1987).

Welding processes and pedogenesis must progress for some time before the superposed soils become welded. First, a thin solum must develop in the upper mantle. Additional horizons develop and thicken with time, downward toward the buried solum. Nonetheless, if the two sola are separated by material that has not been sufficiently altered by pedogenesis at the site, they are not welded. Ruhe and Olson (1980) suggested that intervening "C horizon" material must be present between the two sola to identify separate soils, and we concur. We recognize the continuum nature of the welding processes and the soils that result from these processes. Enrichment in organic matter, iron, and aluminum or phosphorous; continuity of structure; loss of carbonates; alteration of geologic to pedologic fabric; or other criteria could be used to demonstrate the alteration of C horizon material, depending on local soils and their pedogenic regimes. Further research is required, probably including analysis of thin sections, before definitive, objective criteria can be advanced about what constitutes "C horizon" or "pedogenetically unaltered" material (Follmer 1984). In this paper we use a select few such parameters that reflect some, but not all, possible universes. In the end, the decision about whether or not a soil is welded is perhaps arbitrary, as are many such "field calls."

THE ISOLATED PALEOSOL

In shallowly buried soils, pedogenesis and welding processes quickly integrate the overlying material into the solum, resulting in a thicker, welded (Ruhe and Olson 1980) or cumulic soil (Riecken and Poetsch 1960; Soil Survey Staff 1975). In deeply buried soils, welding is assumed to take longer or may not occur. Where the buried soil occurs at great depth, pedogenesis of the overlying sediment cannot be viewed under the universe of welding processes because of the improbability that the two sola would ever become welded.

Shallowly buried paleosols and those with welded profiles are strongly influenced by near-surface pedogenic processes, whose combined influence diminishes as burial depth increases. Theoretically, a depth of burial exists, below which pedogenic influence of the surface is effectively zero and where only diagenic processes act to slowly alter the buried soil. We define soils that are buried below this depth as being *pedogenically isolated.* These paleosols are both buried soils and *isolated* soils (Fig. 1). Determining whether a buried paleosol is also an isolated paleosol is difficult, primarily for three reasons: (1) depth needed for isolation differs with landscape position, overlying sediment, drainage class, and other local factors; (2) direct measurement of pedogenic process activity with depth is difficult, if not impossible, to perform over statistically valid lengths of time; and (3) the effects of diagenesis alone are difficult to separate from the effects of weak pedogenesis (at depth) plus diagenesis. For these reasons, the concept of the *isolated paleosol* may be indeterminable.

Depth of pedogenic isolation varies greatly with environment, being greatest in the humid tropics and minimal in cold and dry landscapes.

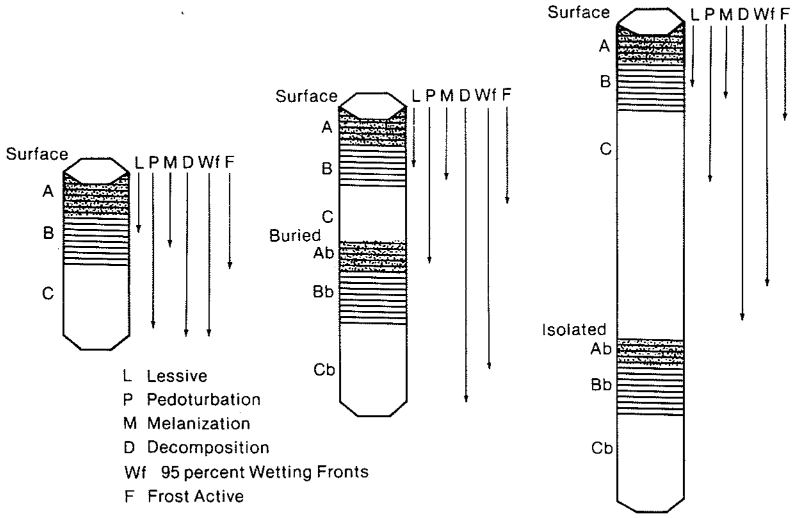

FIG. 1. Idealized model of the relative depth of burial of paleosols and their alterations by pedogenic processes acting from the surface. The figure shows the relationship of surface, buried, and isolated paleosols to depth of pedogenic influence.

It also depends on the soil process examined. A buried soil may be partially isolated, in that it is not influenced by surficial processes that incorporate organic matter into the solum, yet be episodically influenced by deep clay illuviation.

The effects of groundwater and movements of deep wetting fronts on buried paleosols is of special concern. Groundwater alteration of buried paleosols is a diagenic process; therefore, it alone will not violate the definition of an isolated soil. Deep wetting fronts that move from the overlying soil into a buried soil provide a link to surface pedogenic processes. If such moisture moves into a buried soil, it is not isolated, by definition. If, however, the buried soil is sufficiently indurated or fine-textured, it may act as an aquiclude and allow primarily lateral flow across the surface. In this case the soil may be isolated.

Many physical and chemical properties of soils are the products of pedogenic processes. Therefore, some of these properties can be used as indicators of the depth required for isolation. Such characteristics as pH quickly reach new equilibrium values throughout a paleosol, even when shallowly buried, despite the buffering ability of most soils to resist changes in pH. Texture, however, which is a slowly changing or persistent property (Valentine and Dalrymple 1976; Mausbach et al. 1982), may remain unaltered for extended periods even in exhumed soils or in those buried at shallow depths.

Calculating the depth of isolation, therefore, can be accomplished in two ways: (a) measuring the depth to which individual pedogenic processes (e.g., lessivage, pedoturbation, decomposition of primary minerals) operate in the pedon (Fig. 1); or (2) measuring paleosol properties where a given soil is buried at different depths and can be traced laterally on the landscape. Such measures, coupled with their being fitted to a predictive model, can aid in determining a potential depth of isolation. This study uses the latter method to determine the depth of isolation for a Late Sangamon soil in northeastern Kansas.

The model we employed assumes that changes in paleosol properties, e.g., FeO content, pH, *Q/F* ratios, reflect surface pedogenesis, and therefore should be systematic (linear or curvilinear) as burial depth increases because of the gradual lessening of pedogenic influence with depth. For each soil property, this change, or rate of change with depth, should diminish to zero, defining the depth of isolation for that particular property and, hence, a pedogenic process or suite of processes. When several major soil properties are analyzed, a depth of isolation for the paleosol may be determinable. We assume that (1) diagenesis is negligible, (2) all samples are taken from pedons of similar characteristics before burial, (3) diagenesis due to postburial groundwater effects are minimal, and (4) the properties analyzed reflect the depth to which most major surficial processes operate. Because only upland sites on the Late Sangamon backslope surfaces were sampled in this research, all of which are well above the regional water table even in wet years, several of these assumptions are held. Preburial variation on the paleolandscape may have been substantial; inclusions of paleosols from more than one polypedon type cannot be avoided. These inclusions, however, will not act to invalidate the model or the predicted depth of isolation as much as they will weaken the statistical confidence of the conclusions. Diagenesis is believed to be minimal, as the deepest buried soil was only 4 m below the surface.

STUDY AREA AND SOILS

In Brown County, Kansas, a paleosol crops out on hillsides and is mapped as the Morrill series (fine-loamy, mixed, mesic Typic Argiudolls), though not formally recognized as an exhumed paleosol (Eickelberry and Templin 1960). Immediately upslope it is buried by Wisconsinan loesses to depths approaching 6 m, while downslope, erosion has truncated or removed the paleosol (Bayne and Schoewe 1967). Exposures and corings indicate that the buried soil is or was a Paleudoll or Hapludult.

The paleosol is believed to correlate with soils in north-central Missouri that are buried by similar loesses (Guccione 1983). Likewise, the rock and soil stratigraphic sequence in northeastern Kansas (Frye and Leonard 1952; Bayne and O'Connor 1968) and northwestern Missouri (Bayne et al. 1971) suggests that the paleosol is Late Sangamon in age. Yarmouth-Sangamon soils, which occur rarely beneath flat ridge crests, were not sampled. Their presence, however, provides further evidence that the late Quaternary history here is similar to that of southern Iowa, where extensive research has documented a Late Sangamon erosion episode with concomitant paleosols on backslope positions (Ruhe 1956, 1969).

The paleosol in the study area is developed mainly in pre-Illinoian till, Loveland loess (Illinoian) or both. Loveland loess caps the till on interfluves and in turn is overlain by later loesses of Wisconsinan age (Roxana silt, as well as Peoria and Bignell loesses). The thickest loess unit is believed to correlate with Peoria loess.[2] In deeply buried locations, the paleosol exhibits a thick, welded profile developed in Loveland loess above older till, very similar to the stratigraphy described for north-central Missouri (Guccione 1983). This stratigraphic relationship suggests slow accumulation of Loveland loess, allowing upward migration of the soil surface during deposition, or a brief period of rapid loess deposition followed by complete welding. Where the paleosol is exhumed or shallowly buried, the Loveland member is commonly absent, due to the Late Sangamon erosion episode. Here the paleosol is developed solely in till containing occasional interstratified lenses of outwash. This till may correlate with Guccione's (1983) McCredie formation. A zone of mixing, or a pedisediment layer (Ruhe 1956), is common at the contact of the paleosol and the overlying Wisconsinan loesses, presumably due to (1) pedoturbative mixing during and after burial (Hall 1973, Leonard 1952, Valentine and Dalrymple 1976), or (2) slopewash effects, respectively. We postulate that the paleosol began forming during Yarmouth time, according to its stratigraphic position. The Late Sangamon erosion cycle (Ruhe et al. 1967; Guccione 1983) eroded many of the paleosols down to the underlying till on shoulder and backslope positions, while those on ridge crests remained intact. Profile similarities among the Late Sangamon soils within the study area strongly suggest parallel development subsequent to this time. Where the paleosol exhibits a welded profile (Loveland loess over till), evidence that distinctive soils have formed in the till and loess is lacking, leading to the interpretation that soils developed in both parent materials are genetically comparable.

The study area spans approximately 20 km^2 in northeastern Brown County, where this particular stratigraphic sequence is preserved (Fig. 2). The Missouri River floodplain, the presumed source of the loess (Frye and Leonard 1952; Guccione 1983), is only 15–25 km to the east and north. Toward the river the loess thickens, and the paleosol is found only in buried positions, even in tributary valleys. To the west and south, away from the river, loess thickness decreases. It is here that the Late Sangamon soil is exhumed in some localities, very shallowly buried in others, or in many cases, totally removed (Fig. 2).

MATERIALS AND METHODS

Exhumed and buried Late Sangamon paleosols were sampled along seven transects, beginning at the exhumed paleosol and progressing upslope normal to the contour. Core samples 5.1 cm in diameter were taken with a Giddings coring machine. Where the paleosol was buried,

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[2] F. C. Caspall, 1970, The spatial and temporal variation in loess deposition in northeastern Kansas, Ph.D. thesis, Univ. of Kansas.

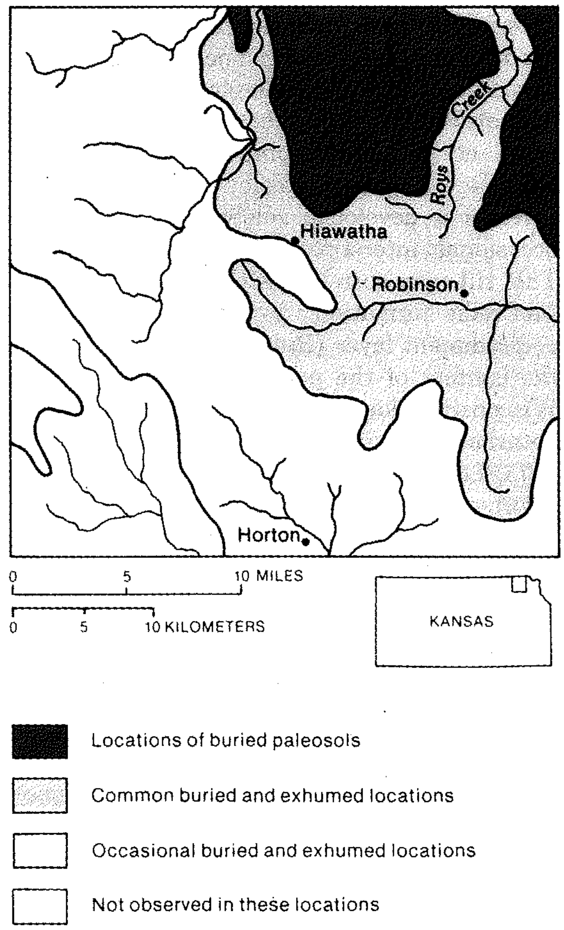

FIG. 2. Location of the study area.

the surface soil and intervening loess were sampled in addition to the buried soil. In all, 29 pedons were cored. Five contained the exhumed paleosol, and 24 had the paleosol at burial depths ranging from 5–400 cm.[3] We define *burial depth* as the vertical distance from the surface to the first 7.5 YR or redder hues, because the top of the paleosolum often could not be determined from structure or morphology alone.

Samples from the cores, at approximately 25-cm intervals, were analyzed for pH, texture, and organic matter content, using standard analytical methods (Black 1965; Day 1965). Quartz/feldspar ratios of the 44–62-μ fraction from the Btb horizon of maximum clay content in each paleosol were determined by comparing heights of peaks at 4.2 Å and 3.2 Å from x-ray diffraction patterns. Several additional samples were selected for clay mineral determinations from five categories, as follows: (1) clay from the Bt horizon of a representative surface soil formed in loess (Marshall silt loam; fine-silty, montmorillonitic, mesic, Typic Hapludolls), (2) clay from loess below the solum, but midway between it and the underlying buried paleosol, and, finally, clay from the "maximum Btb" of the paleosol, where developed in (3) till, (4) Loveland loess, and (5) sandy lenses or inclusions within the till. Clays were fractionated into fine (<0.2 μ) and coarse (0.2–2.0 μ) components by centrifugation. Untreated, heated, and glycolated treatments were utilized.

Simple linear and polynomial regression techniques were performed on the soil data.

RESULTS AND DISCUSSION

We assumed that the original pH of the buried paleosol had been altered due to postburial enrichment by bases, including carbonates, from the overlying loess (Ruhe 1965). Data from our study verify this contention and document a depth of burial below which pH values essentially become static in the buried soils. Below about 1.5 m, the pH of buried paleosols varies within a narrow 6.3–6.5 range, which is similar to that of the surrounding geologic materials. In more shallowly buried soils the pH at the top of the paleosols is more acidic (Table 1), and the surface pH of the exhumed paleosol varies according to local environmental conditions, including the liming practices of individual farmers. In terms of the pH profile, the rate of change with depth drops to 0 at approximately 150 cm, suggesting that this may be the depth of isolation for this soil property.

Studies of organic matter content in paleosols generally indicate postburial losses, rather than inheritance of the original organic characteristics (Stevenson 1969; Gerasimov 1971; Turchenek et al. 1974; Hallberg et al. 1978), and rates of decomposition vary. Total decomposition of organic material within buried paleosols is seldom attained, and several minor organic maxima within the sola are common. The amount of organic matter present within buried soils is the difference between original content plus additions (illuvial humus, root additions, worm casts, etc.) minus losses (oxidation, mineralization, leaching). In shallowly buried paleosols the former processes predominate, though in deeply buried soils losses through the centuries allow for only small organic "preservation peaks."

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[3] R. J. Schaetzl, 1983, Postburial alteration in paleosols and their influence on surface soils, Brown County, Kansas, M.A. thesis, Univ. of Kansas.

TABLE 1

Characteristics of buried and exhumed paleosols

Depth of burial, cm	pH[a] 1:1H_2O	Organic matter, %[b]	Organic index[c]	Texture[d]	Clay, %[e]	Q/F[e]	Parent material[f]
Exhumed	6.1	2.2	4.1	sicl	39	1.32	L
Exhumed	6.1	2.5	3.9	sicl	40	2.46	P/T
Exhumed	5.9	1.2	1.8	cl-c-sicl	41	1.39	P/T
Exhumed	5.4	2.5	4.7	sicl	36	1.39	P/T
Exhumed	6.3	2.9	4.6	sicl	38	ND	L
5	6.2	3.2	5.5	sicl	38	1.81	L
35	6.0	1.4	4.1	sicl	39	2.46	P/L
35	6.1	2.2	4.1	sicl	38	0.99	P/L
40	5.7	0.7	1.9	cl-sicl-sc	44	2.45	P/T
40	6.4	0.9	2.3	sicl-cl	40	2.66	P/T
40	6.0	1.8	4.5	sicl-cl	35	2.04	P/T
85	6.5	0.7	2.6	sicl	38	1.69	P/T
100	6.4	0.6	2.2	sicl	40	1.81	P/L
100	6.0	0.4	1.5	sicl	ND	1.26	P/T
100	6.2	0.6	2.4	sicl	ND	1.84	P/T
130	6.2	0.6	1.9	sicl	38	1.33	P/L
135	6.4	0.4	1.1	sil-sicl-cl-c	44	1.15	P/T
150	6.1	0.4	1.0	cl-c	43	1.56	P/T
150	6.5	0.5	1.9	sil-1	36	1.37	P/T
160	6.4	0.5	1.3	sicl	39	1.85	P/T
175	6.5	0.6	2.6	sicl	35	1.70	P/T/O
205	6.3	0.7	1.8	sicl	38	1.68	P/L
215	6.6	0.8	2.8	sicl	ND	0.96	P/L
215	6.4	0.3	1.5	sil-cl	37	1.97	P/T
290	6.6	0.8	2.7	sicl	37	1.30	P/T
310	6.4	0.2	0.8	cl-scl	36	1.12	P/O
330	6.6	0.6	2.9	sicl	ND	1.30	P/L
390	6.5	0.3	2.2	sicl	33	0.56	P/T/O
400	6.5	0.5	2.3	sil-cl	32	1.57	P/T

[a] At top of paleosol.

[b] Value at Btb_{max}.

[c] See text for definition.

[d] Over upper meter of paleosol. sil = silt loam; sicl = silty clay loam; cl = clay loam; c = clay; l = loam; scl = sandy clay loam.

[e] At Btb_{max}.

[f] Parent materials of paleosol. P = Peoria and other undifferentiated Wisconsinan loesses; L = Loveland loess; T = pre-Illinoian till; O = Sandy inclusions within the till. P/T would suggest a paleosol developed in till with a mixed zone extending upward into the loess; P/L and P/O, the same.

Therefore, the organic matter content of paleosols, buried for some length of time, reaches a new equilibrium dependent on depth of burial.

The distribution of organic matter with depth in surface soils is generally logarithmic, and the same is true for the geologic column containing buried paleosols. In this study, only those paleosols that are shallowly buried have high total amounts of organic matter or a high *organic index*. Organic index is herein defined as the sum of four organic matter percentage values, spaced 25 cm apart, within the upper meter of the paleosol. More deeply buried soils contain considerably less organic matter, i.e., lower organic indexes, and vary more in total content (Fig. 3). The organic indexes in buried paleosols reach minimum values in paleosols buried below about 100 cm. Indexes of soils buried below this depth are equally likely to be greater or less than the values predicted by the least-squares regression line. It would appear that paleosols buried deeper than 100 cm are unlikely to lose or gain significant amounts of organic matter over time, and that interpedon variability subsumes the importance of burial depth in predicting organic index. These paleosols are at or below the depth

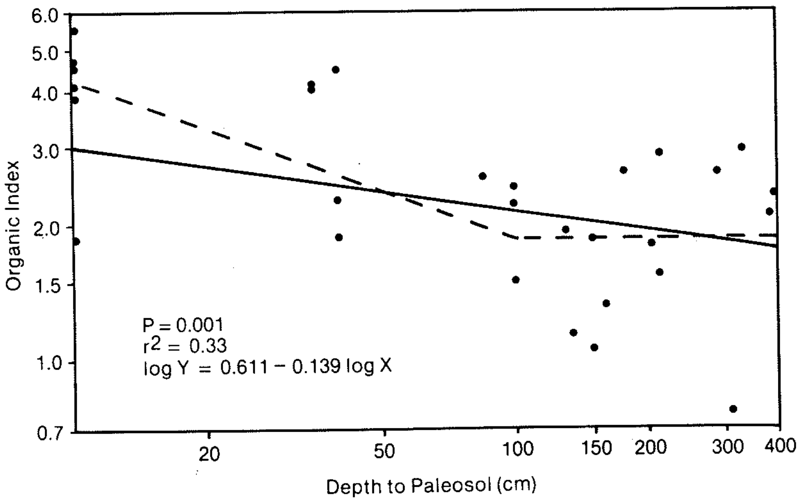

FIG. 3. Relationship between the organic matter index of paleosols and the depth of burial.

of isolation for organic matter. Although they retain some organic matter, the amount is small and highly variable (Table 1). Low levels and high variability in organic index suggest that the broken line in Fig. 3 may be a more realistic model than the calculated regression line.

Clay content is a rough indicator of the age and weathered nature of soils if they have formed from similar initial materials and under a similar climate. *Q/F* ratios give an even better indication of the relative weathering of paleosols (Ruhe 1956; Hall 1973). When the results of these two methods are considered together, the comparative weathered nature of soils can be more accurately assessed.

Figure 4 illustrates the *Q/F* ratios for buried and exhumed paleosols, as well as the clay maxima. A trend line indicates that both soil properties decrease as burial depth increases, suggesting decreased weathering in the deeply buried paleosols, compared with exhumed and shallowly buried sola. This pattern is similar to that reported by Bushue et al. (1974) for paleosols in Illinois. Only the clay-versus-depth data were statistically significant, using simple linear regression. The lack of statistical explanation is probably due to preburial variability on the paleolandscape. In addition, the low slope of the trend line (Fig. 4, top) could be interpreted to mean that the paleosols were strongly weathered prior to burial and that relatively little additional weathering has occurred.

Unlike the pattern for organic matter, no depth of isolation can be determined for primary mineral weathering, even at depths greater than 5 m (Fig. 4). If there is a trend in clay content or *Q/F* with depth, it appears to be linear, and no indication of a break in this trend or an end point is suggested. If isolated soils exist with regard to these soil characteristics, they are at great depths. The methods employed in this study cannot determine a depth of isolation for weathering processes.

Semiquantitative analyses of the clay mineralogy for the paleosols and surface soils were determined on samples taken from the maximal Bt horizon of surface soils and of paleosols, and from relatively unweathered Peoria loess (Table 2). Overall, mixed-layer clays and montmorillonite dominate the clay mineral suite of the Pleistocene deposits in the study area, which agrees well with the findings of Tien (1968) for similar materials in adjacent Doniphan County. Clay from local, least altered, Peoria loess appears to contain no or only small traces of kaolinite and is dominated by montmorillonite and mixed-layer clays. This same loess, where pedologically altered in the Marshall soil, exhibits increased amounts of kaolinite and illite and substantially less montmorillonite in the fine-clay fraction.

Two paleosols, one developed in pre-Illinoian till and the other in Loveland loess, have remarkably similar clay mineral assemblages (Table 2). Montmorillonite and vermiculite are rare in the coarse-clay fraction, kaolinite is present in small to moderate quantities, and illite is well represented in both paleosols. Mineralogically, the major difference between the two is in the amount of mixed-layer clays in the fine fraction. The paleosol formed primarily in sandy material (outwash) exhibits a very diversified clay mineral assemblage. All paleosol samples have as much or more kaolinite than the surface soil

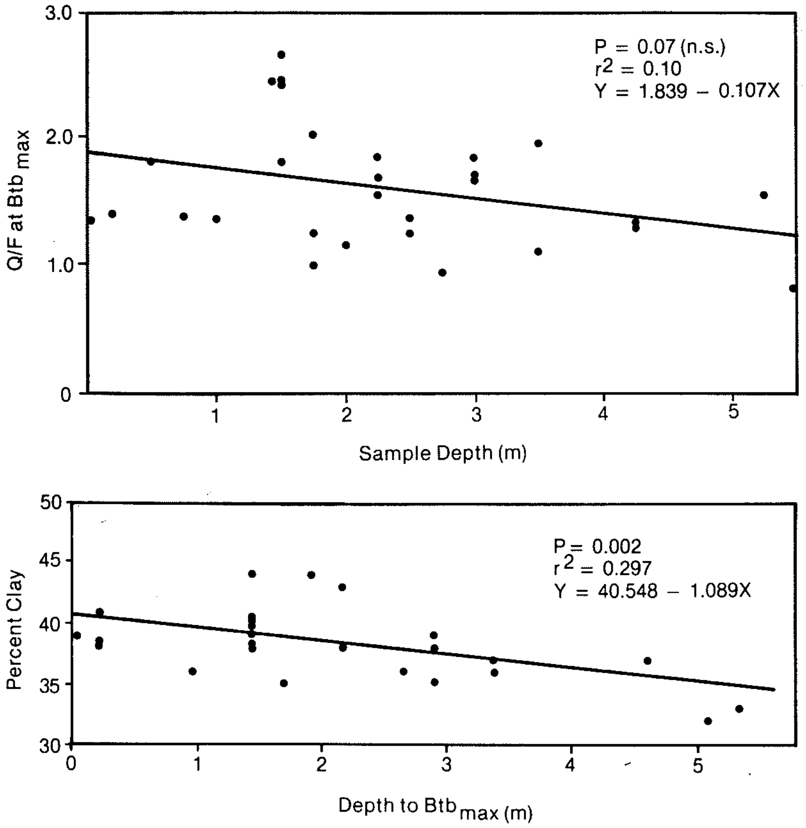

FIG. 4. Relationships between quartz/feldspar ratios within paleosols (top), and maximal clay contents of paleosols and the depth of burial.

TABLE 2

Clay mineralogy for paleosols with different lithology, surface soils, and loess

Pedostratigraphic layer	Horizon[a]	Relative amounts x-ray diffractograms[b]									
		0.2–2μ					<0.2 μ				
		K	M	V	MX	I	K	M	V	MX	I
Till paleosol	2Btb	2	1	1	2	3	2	4	3	3	4
Loveland loess paleosol	2Btb	3	1	1	2	3	2	3	2	5	2
"Outwash" paleosol	3Bgb	3	3	2	4	3	3	5	4	5	4
Peoria loess	C	1	3	2	3	2	1	4	3	4	2
Marshall soil	Bt	2	3	3	3	3	2	2	3	4	3

[a] Estimated for paleosol horizons.

[b] K = kaolinite; M = montmorillonite; V = vermiculite; MX = mixed layers; I = illite mica. 1 = barely detectable; 2 = small; 3 = moderate; 4 = abundant; 5 = dominant.

developed in loess, a finding also noted by others (Ruhe 1956; Ruhe et al. 1974; Ruhe and Olson 1980), suggesting increased weathering of paleosols over that of surface soils.

CONCLUSIONS

This study has redefined the concept of the buried soil, using a definition that has more practical use in paleopedology than in traditional pedology. Although seemingly preferable, this definition represents a slight loss of rigor. Any measurable depth of sediment can bury a soil, and the buried solum remains as such until pedogenic processes "weld" the upper and lower sola together. Welding has occurred when discernible C horizon material no longer exists between the sola, based on morphologic criteria.

An isolated soil (or paleosol) is a buried soil in which the effects of pedogenesis are currently zero, owing to deep burial. Conceptually, the deeper paleosols are buried, the less they are affected by pedogenesis and the more they are affected by diagenesis. The effect of pedogenesis with increasing burial depth reaches an end point, as measured directly or inferred from soil properties, and this depth is defined as the depth of pedogenic isolation, or more simply, depth of isolation.

Evidence from 29 pedons in northeastern Kansas, all of which contained either an exhumed, buried, or isolated paleosol, indicates that the theory used to predict the depth of isolation may be useful. Although this study is preliminary and exploratory, data support the contention that deeply buried paleosols are members of a different set of soils than are shallowly buried and exhumed paleosols, implying that the former are pedogenically isolated.

ACKNOWLEDGMENTS

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