Comments on “Calcisols in Central Texas: I. Parent Material Uniformity and Hillslope Effects on Carbonate-Enriched Horizons”

West et al. (1988) studied soil formation on bedded limestones in central Texas. One of their major conclusions was that additions of eolian dust played little or no role in the genesis of surface soil horizons; they based this conclusion primarily on comparisons of the particle size and grain morphology of soil A horizons with those of modern dust samples. The data they present for particle size and grain morphology, in addition to that given for the major-element composition of the silt fractions of the soil horizons, also permit the opposite interpretation.

West et al. (1988) noted that soil surface horizons and dust samples had similar amounts of the <0.002-mm size fraction but dissimilar amounts of the 0.002 to 0.02-mm and the >0.02-mm fractions. They suggested, based on these differences, that “dust has not been incorporated into these horizons to an appreciable extent.” In fact, these comparisons demonstrate only that the surface soil horizons are not formed solely from eolian dust; eolian dust could be admixed with coarser material derived from colluvium or from weathering of limestone fragments.

Sharp-edged, conchoidally fractured silt-sized grains were commonly observed in the dust samples, but were rarely found in the soil A horizons. West et al. (1988) rejected the hypothesis that weathering altered the morphology of such grains because “the present soil environment is not conducive to quartz and feldspar weathering.” They concluded that the scarcity of conchoidally fractured grains in the A horizons reflected a lack of eolian additions to the soils. Yet the scanning electron micrographs (their Fig. 4) clearly show rounded and pitted feldspar and quartz grains in the A horizons. Hence, weathering is capable of modifying such grains, although a considerable length of time may be required. Moreover, it is possible that mechanical mixing in the surface horizons may be capable of abrading and smoothing the sharp edges of quartz and feldspar grains.

Concentrations of stable major elements do not support the conclusion that the soils formed solely by weathering of stratified parent materials. Zirconium concentrations of the A horizons are about two times greater than those of the R or Cr horizons (their Table 2). In addition, Zr concentrations are greater in nearly all of the horizons above the unaltered bedrock, and they show a progressive decrease with depth. These trends are in sharp contrast to the reported concentrations of Ti, which appear to be random with depth. Titanium and Zr are contained primarily within rutile and zircon, minerals that are very resistant to chemical weathering (Raeside, 1959). If the soils had formed solely by weathering of bedded limestone or colluvium over limestone, the depth trends of Ti and Zr concentrations should be parallel. The gradual decrease of Zr concentration with depth in the soils can be accounted for if the soils have incorporated Zr-rich eolian dust. This hypothesis cannot be readily evaluated without major-element analyses of the modern dust in the study area.

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References


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Dr. Reheis’ comments on our paper (West et al., 1988b) concern our conclusion that eolian dust has not substantially accumulated in soils in central Texas and has not significantly impacted the genesis of the soils. We are aware that eolian dust has been reported to be an important parent material for soils in other areas of the southwestern USA (Reeves, 1970; Gardner, 1972; Gile and Grossman, 1979). Results from these studies prompted us to include eolian dust as a potential parent-material amendment for soils in the area we studied.

Because our study was designed to evaluate hillslope effects on soils and carbonate-enriched horizons, most of the sites were on geomorphically unstable, sloping landscapes. Because of this landscape instability, loss of surficial materials through erosion was recognized as an important factor in the genesis of soils and carbonate-enriched horizons in the region (West et al., 1988a,b). Eolian dust currently is being added to the surface of these soils at a rate equivalent to 1 to 2 mm of thickness per 100 yr. Because surface soil material is being continually removed by erosion, however, little of the dust falling to the surface would be expected to accumulate on these geomorphically unstable landscapes. Comparisons between dust samples and soil surface horizons generally supported this conclusion.

Particle-size differences between dust collected in the region and soil surface horizons were not considered to be highly diagnostic for evaluating dust additions, even though differences were observed. As Dr. Reheis points out, considerable amounts of dust could be admixed with the soil without the soil and the dust having similar particle-size distributions. Particle-size differences with depth that might be expected if fine dust was added to a coarse soil surface horizon were difficult to evaluate because of stratified parent materials for these soils. Two pedons did have uniform parent material for the three upper horizons, however, and the particle size through these horizons did not vary more than the normal variation expected within a pedon.

We recognized the dominant grain morphology in both dust and soil-surface-horizon samples to be “rounded grains with rough, irregular, sometimes pitted surfaces”, and our interpretation of this morphology was that these grains had been weathered. The absence of the conchoidally fractured quartz in surface horizons could be because the grains weathered rapidly and became rounded and pitted. As Dr. Reheis stated, however, “a considerable length of time may be required” for such weathering to occur. We maintain that the present soil environment is not conducive to weathering.