In order to maximize interpretive skills!

basal stonelayers and Mima mounds as upper soil biomantles: What happens when...?

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Can we explain soils beyond the 5 factors model? Yes, by drawing on biodynamic principles with embedded biomantle and process vector concepts.

We compared the biomantles of Mima mounds at Diamond Grove Prairie, Missouri, with those at Mima Prairie, Washington State (a work in progress).

Gravel size is key:

All the mounds have gravel sizes that will pass through a 8.5 mm sieve. Note that the gravel sizes are the same or smaller. Pedologists previously have analyzed them for their gravel sizes in order to maximize interpretive skills!

Borrow Pit at Mima Prairie. Black arrows point to the two mounds studied. Note light-colored gravel, 14,000-year-old outwash gravels (parent material). Dark-colored bioturbated gravel. All small gravel in mounds have been mixed through the biomantle probably many times by gophers (Thomomys flavescens).

Mima Prairie. The mounds in Washington formed in young gravelly outwash associated with the nearby Vashon lobe of ice that terminated some 14,000 years ago. Mima mounds are produced by small vertebrates that bioturbate in shallow soil over hardpan, bedrock, or high water tables. They are point-centered, locally thickened biomantles. The mounds at both Diamond Grove and Mima Prairie are gravelly, and thus formed in gravelly soils (Johnson, 1990). Offsite descriptions very somewhat from our sampled mounds. The mound soils in both areas are very gravelly and comprise entire-soil, two-layered biomantles (Horwath and Johnson, 2005). But these soils – and the scolors of which they are a part – have experienced far more complex pedologic and biomantle histories than is conveyed by these otherwise useful soil biomantle descriptors.

Diamond Grove Prairie. The mounds lie 200 km southwest of the glacial boundary on the Springfield Plateau, a very old surface, which during the Pleistocene received several ice ages. (Horwath 2002). Before the ice receded, Mima mounds were once common throughout much of the western Missouri basin, and intermittently across the eastern North America. Pocket gophers (Geomys bursarius) are active in many parts of Missouri, including this region, but are now locally absent at Diamond Grove.

The evolution of Mima-type mounds at Diamond Grove Prairie, Missouri.

Process Vector Analysis. The diagrams, upper left & above, demonstrate the usefulness of the graphic-conceptual aspects of process vector analysis (pva). In the upper left graphic, 4 stages show our hypothesized evolution of the Springfield Plateau landscape in southwestern Missouri.

Stage 1: The pre-Geomys landscape. Biomantle consists of A, E, and two-layered (primarily) biomantle. Bt horizon is a claypan that is an aquifer when dry and an aquiclude when wet. (Landscape is periodically wet.) In terms of pva for bioturbation, horizonation > bioturbation; for Bt horizon, horizonation > bioturbation.

Stage 2: At beginning of stage, pocket gophers (Geomys) arrive and choose deep ground for nesting-food storage (activity centers). Because of their territoriality and centripetal burrowing style, they begin forming mounds at activity centers. In terms of pva for bioturbation, horizonation > bioturbation, and horizonation > bioturbation = infiltration bioturbation = infiltration bioturbation; for Bt horizon, horizonation = bioturbation.

Stage 3: End member version of Stage 2. Vertical post now seasonally present: all fine and small gravels now on mounds and mixed throughout, large clasts mainly (loam) between mounds, mounds now maximally developed as point-centered, two-layered biomantles. In terms of pva as Stage 2.

Stage 4: post-Geomys (present) landscape. New horizons are forming in mounds (cf. above). Mounds will become intermound areas. Now, incipient (active) biomantles now forming via infiltration bioturbation with upper (secondary) biomantle in old (inactive) Mima-type mound. In terms of pva: similar to Stage 1.

In our study we ask:

1. What happens to Mima mounds when the small vertebrate bioturbators (e.g., gophers) that dominantly produced them disappear?
2. Does the previously active biomantle now become inactive?
3. Do other bioturbators, like invertebrates (ants, worms, etc.) that were masked by the dominant bioturbator, begin to bioturbate and thus influence the biomantle?
4. And do subsidiary processes beyond biodynamics (e.g., leaching, evaporation, consolidation, precipitation, chemical transformations, biomantle expressions of living and nonliving soil organisms and debris, bioturbation produced by bioclimatic-metabolic processes, and soil volume expansions from Johnson et al., 2005b).

Our data indicate that for both Diamond Grove and Mima Prairie the answers are “yes!”

Soils of Diamond Grove mounds:

The soil mounds in Diamond Grove are mapped as Keenoe very cherty silt loam (partially silty, mixed, mesic Typic Mollisols). Official descriptions vary somewhat from our sampled mounds. The mound soils in both areas are very gravelly and comprise entire-soil, two-layered biomantles (Horwath and Johnson, 2005). But these soils – and the scolors of which they are a part – have experienced far more complex pedologic and biomantle histories than is conveyed by these otherwise useful soil biomantle descriptors.

Our data indicate:

1. That for both Diamond Grove and Mima Prairie, pocket gophers are now locally absent, and have been absent historically, though they occupy nearby areas. The bulk of each mound constitutes an inactive biomantle (a legacy of gopher bioturbation).

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Evidence indicates that Mima mounds are dominantly produced by pocket gophers. These are sausage-shaped members of the Geomyidae family of rodents that regularly burrow outward from their nesting-ground levels. But gophers are extremely gregarious, territorial and supremely adept underground burrowers. They can move enormous volumes of soil per year in some tracks, and their point-centered mounds often reflect a nearest-neighbor pattern formed by the generations. However, at both Diamond Grove and Mima Prairies pocket gophers are now locally absent, and have been absent historically, though they occupy nearby areas. The bulk of each mound constitutes an inactive biomantle (a legacy of gopher bioturbation).

The role of burrowing animals: Evidence indicates that Mima mounds are dominantly produced by pocket gophers. These are sausage-shaped members of the Geomyidae family of rodents that regularly burrow outward from their nesting-ground levels. But gophers are extremely gregarious, territorial and supremely adept underground burrowers. They can move enormous volumes of soil per year in some tracks, and their point-centered mounds often reflect a nearest-neighbor pattern formed by the generations. However, at both Diamond Grove and Mima Prairies pocket gophers are now locally absent, and have been absent historically, though they occupy nearby areas. The bulk of each mound constitutes an inactive biomantle (a legacy of gopher bioturbation).

The man is pointing to the basal (primary) stonelayer that is almost invisible in this photo because it is obscured by organic matter. The primary basal stonelayer, together with the gravel scattered throughout the mound, show that the mound is, in the first instance, a two-layered biomantle. Biosorting by small vertebrates has actually created a basal, though imperfect, barrier to limit vertical burrowing. Krotovina indicate that the

Our operating philosophies:

Biodynamics: Biodynamic pathways of pedogenesis consist of various complex processes, products and conditions, that include: bioturbation (at all scales), biologically mediated physico-chemical transformations, biomantle expressions of living and nonliving soil organisms and debris, bioturbation produced by bioclimatic-metabolic processes, and soil volume expansions from Johnson et al., 2005b).

Biomantles: The mounds are produced by small vertebrates that bioturbate in shallow soil over hardpan, bedrock, or high water tables. They are point-centered, locally thickened biomantles. The mounds at both Diamond Grove and Mima Prairie are gravelly, and thus formed in gravelly soils (Johnson, 1990). Offsite descriptions vary somewhat from our sampled mounds. The mound soils in both areas are very gravelly and comprise entire-soil, two-layered biomantles (Horwath and Johnson, 2005). But these soils – and the scolors of which they are a part – have experienced far more complex pedologic and biomantle histories than is conveyed by these otherwise useful soil biomantle descriptors.