Clues and Impediments to the Understanding of SE US Coastal Plain Soils

Acknowledgments:

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Collaboration of UF Soil and Water Science colleagues.

Florida soil scientists who shared soil photographs.
In memory of two people who enriched my life …

Dr. Vic Carlisle

Dr. Earl Stone
Topics Addressed

• Clues
  – At E-Bt boundaries
  – At E-Bh boundaries

• Impediments
  – Terms that confound communication
  – Terms that mislead
  – Horizon designation mismatch with genetic context
Clues
E-Bt mineral distributions

Florida Soil Survey Data Tell a Story
In effect …

No matter how deep the boundary, clay mineralogy changes there
Example, one of many
Coated vs. Clean Sand Grains

Conclusion: HIV is large proportion of small amount of clay in grain coatings
Coated vs. Clean Sand Grains (cont.)

Lakeland

Coated = high HIV in clay

Myakka

Clean = high quartz, maybe smectite in clay

St. Lucie

Clean

... in Panhandle & N. Central Florida
... no matter how deep or thick
Characteristics of Sand Grain Coatings

- Patchy, not uniform
- About 2-8 % of sandy soil mass
- Contain similar proportions of silt & clay
- Silt – mostly quartz
- Clay – quartz, phyllosilicates, gibbsite, & oxides of Al & Fe
- NOT “iron oxide coatings”, although …
- Al- & Fe oxides largely control P sorption
- Al- & Fe oxides serve as “cement”
Potassium as a Clue ...

HIV-rich silts have platy grains containing K
But despite K, mica evades detection by x-ray diffraction

X-ray diffraction pattern of HIV concentrated in Medium silt
A Glimpse of Ghostly Mica … Finally!

Evidence of occluded mica zones in HIV grains

lattice fringe image of mica in HIV grain
Mica as a Ghostly Clue …

Mica – Metal Oxide – Grain Coating Connections:

Theory to explain HIV-kaolinite distribution

Non-quartz mineral abundance grossly exaggerated for illustration purposes.

(Mica is considered a weatherable mineral, too.)
Mica as a Ghostly Clue …

Theory to explain HIV-kaolinite distribution (cont.)

- Clay dispersed & mobilized
- New clay generated by weathering
- Mica weathers *in-situ*
- Al- & Fe oxides form and bind other components
- Mica products (HIV) & some kaolinite become incorporated into coatings
- HIV less subject to eluviation than kaolinite, explaining depth trend
E-Bt pedological vs lithological issue

- Dominant-sand to total-sand ratio
- Heavy mineral abundance
- Heavy mineral species

Most data I’ve read or collected support pedological
E-Bh and fluctuating water table

Sand grain coatings are again clues …

Initial observations:

- Looks like a coating redistribution
- Bh fades upward as seasonal high water table drops
Morphological & mineralogical evidence of coating redistribution

- Aquod to Psamment sequence moving up from the shore of a sandhill lake
- About a 10-m transect
Florida Soil Survey Program data suggesting Bh is clay-enriched, too

... but why is a fluctuating water table required?
Why is a fluctuating water table required? Some ideas -

• Metal sources for Bh - metal oxides – stable on well-drained landscapes

• Redox partially depletes Fe on poorly drained uplands ("flatwoods")

• Al => less crystalline & more vulnerable to organic complextion

• *Thresholds in frequency & duration of saturation* dissolve Al oxide via
  • Organic acids reach activities & kinetic thresholds
  • Reduced movement and microbial degradation rate

• Al oxide dissolution releases all coating components

• C moves Al, but Al eventually stops C within a finer matrix of colloid origin
Impediments
Horizon designations of Psamments on older landscapes

Examples of Landscape Associations, Psamment and Udult or Udalf:

- Candler and Apopka
  - Candler-Apopka, Levy Co.
- Ortega and Blanton
  - Blanton-Ortega, Lafayette Co.
- Ridgewood and Albany
  - Albany-Ridgewood, Lafayette Co.
- Tavares and Millhopper
  - Tavares-Millhopper, Hillsborough Co.
- Penney and Otela
  - Otela-Penney, Gilchrist Co.
Concept of “inert sand”

Inert sand precluded pedogenesis

Intense pedogenesis produced inert sand

It can’t be both
Family “Coated” – “Uncoated” distinction

**Lake, etc.**
- Has Fe & Al
- Some P retention
- Grains un-stripped
- “Coated”

**Candler, etc.**
- Has Fe & Al
- Some P retention
- Grains un-stripped
- “Uncoated”

**St. Lucie, etc.**
- No Fe & Al
- No P retention
- Grains stripped
- “Uncoated”
Bh and Bt horizons as “hardpans”

Data that do NOT support presumptions of Bh being a “hardpan”

Means of selected data for Bh, Bh1, Bh2, and Bh3 horizons sampled during the Florida Soil Survey Program

<table>
<thead>
<tr>
<th></th>
<th>Saturated Hydraulic Conductivity cm/h</th>
<th>Bulk Density g/cm³</th>
<th>Organic Carbon %</th>
<th>Clay %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Ortstein (vfr or fr)</td>
<td>14.10 n=440</td>
<td>1.50 n=440</td>
<td>1.38 n=466</td>
<td>3.50 n=466</td>
</tr>
<tr>
<td>Ortstein (vfi or fi)</td>
<td>8.05 n=43</td>
<td>1.51 n=42</td>
<td>2.59 n=43</td>
<td>5.71 n=43</td>
</tr>
</tbody>
</table>
Data that do NOT support presumptions of Bh being a “hardpan”

Bh horizon consistence & roots as described on OSDs of Alaquods of large extent

<table>
<thead>
<tr>
<th></th>
<th>Consistence</th>
<th>Roots Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Myakka</td>
<td>Very friable</td>
<td>Many fine &amp; medium roots</td>
</tr>
<tr>
<td>Leon</td>
<td>Firm to friable</td>
<td>Many fine &amp; medium roots</td>
</tr>
<tr>
<td>Immokalee</td>
<td>Friable to loose</td>
<td>Common fine &amp; medium roots</td>
</tr>
<tr>
<td>Wabasso</td>
<td>friable</td>
<td>Common fine &amp; medium roots</td>
</tr>
</tbody>
</table>
Conclusions

- Soil survey data are a powerful resource in understanding soil genesis.
- Sand grain coatings and their distribution are major clues to the genesis of SE USA Coastal Plain soils.
- Horizon designation precedes and remains independent of soil classification.
- Words ill chosen can lead to misunderstanding (e.g., “hardpan”) and hamper communication (e.g., “uncoated”).