Rain Water Basin Soils – Development, Morphology, and sedimentation tactics

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1) Vocabulary and

2) Fundamentals...
   1) Soil Forming Factors
   2) Soil Properties
   3) Soil Morphology
   4) Soil Horizons
   5) Rain Water Basin Geomorphology
Soil = $F(\text{Cl}, \text{O}, \text{R}, \text{P}, \text{T}, \ldots)$

*Hans Jenny, 1941*
Climate:
Precipitation & Temperature

Figure 4.3. Mean annual total precipitation, illustrating the gradient of moisture from lower in the western Great Plains to higher in the east. (From Bryson and Hare [1974], with permission of Elsevier)
Organisms

- Vegetation...
- Grazers...
- Burrowers; from ants to badgers...
- Microbes and fungi...
Relief & Aspect (Microclimate)

Upper Mississippi River valley near Red Wing Minnesota
Parent Materials

NE Parent Materials
Need a period of stability to form a soil!

On a regional scale and in geological time, the last (Wisconsinan) glacial period that ended ~ 10,000 ybp was a time of landscape instability.
Time: Don’t forget, distinguish between age of parent material and age of the soil!

- **Bedrock**: 3MYA, 100-70 MYA
- **Glacial till in eastern Nebraska**: ~ 500,000 ybp
- **Loess deposits in Nebraska**
  - Loveland: 130,000 ybp, Illinoian Glaciation
  - Gilman Canyon: 27,000-22,000 ybp
  - Peoria: 22,000-12,000 ybp
  - Bignell: < 9000 ybp
- **Aeolian sand**: Widespread activity 700-800 ybp
- **Alluvium and Colluvium**: Much is Post-settlement
What are the “…” factors?
Soil Properties: *Strongly influenced by parent materials*

**Texture**

![Texture Triangle](image)
Soil Structure
Describing soils: Soil Morphology

- Texture
- Color
- Structure
- Mottling
- Skeletal fragments
- Consistence
- Reaction (pH)
- Horizons
Soil Horizons

- A
- B
- C
- E

Modifiers
- p
- t
- g
- c
- w
- Vegetative litter
- Brown colors from decomposing organic matter
- Clay % increases and structure develops as clays move downward and weathering occurs when there is excess precipitation and soil wets-dries & freezes-thaws, producing soil structure.
- “Parent material”
- Plowed (disturbed) or High clay
Soil Genesis Cont.

- g
  - Gleyed (wet)
- c
  - Carbonate concentrations
- w
  - Some development in the B horizon
Holdrege Soil Profile
Surface layer: dark grayish brown silt loam
Subsoil - upper: dark grayish brown silty clay loam
Subsoil - middle: light brownish gray silty clay loam
Subsoil - lower: light gray silt loam
- Hastings – Upland
- Butler – Near upland
- Fillmore – SWP drained
- Scott – P drained
- Massie VP or P drained
  - BT depths – landscape scale
  - E horizon development
  - Variability between counties
Rain Water Basin Catena
Playa Hydrology – Aquifer Recharge
Basin Origin

- The wetlands were primarily formed by wind action and generally the long axis of the basin runs in a northeast to southwest orientation (Kuzila and Lewis 1993).
- There frequently is a hill (lunette) located immediately south or southeast of the wetland where the windblown loess was deposited.
- Big Nell (Holocene recent 1000 ybp) – Peorian (14,000 ybp) – Gilman Canyon (20k ybp) – Loveland loess (35 ybp) – Sand and gravels (42 YBP)
Clay County Map Sheets 32 & 37
Findings from Kuzila

- Particle size and mineralogic data indicated the possibility of a lithologic discontinuity at a depth of approximately 60 cm in all of the pedons studied.

- Stratigraphic data indicated that eight to twenty-eight feet of loess, covered old landscapes that were marked by buried paleosols dating from 19,890 to 26,670 years before present.

- The soil parent materials above the paleosols were identified as Peoria and Bignell loesses
  - Kuzila, Mark Steven, "Genesis and morphology of soils in and around large depressions in Clay County, Nebraska" (1988). ETD collection for University of Nebraska - Lincoln
Work locations for Kuzila findings
Rainwater Basin stratigraphy

Mark Kuzila
RWB formation

- Sand is beneath the loess
- Old braided river (Platte?) channel
- Depressions formed in the sand
- Sand rims formed on east and south
- Several loess deposits drape pre-existing depressions
- Age?
  - Gilman Canyon soil < 20,000-25,000 ybp
OSL ages, sand below surficial loess

<table>
<thead>
<tr>
<th>Sample</th>
<th>Depth(^1) (m)</th>
<th>Age</th>
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<tbody>
<tr>
<td>BZ-1</td>
<td>3.7</td>
<td>35.9±3.6</td>
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<tr>
<td>BZ-2</td>
<td>4.2</td>
<td>64.5±3.4</td>
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<tr>
<td>BZ-3</td>
<td>4.4</td>
<td>71.9±6.2</td>
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<tr>
<td>BZ-5</td>
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<td>45.1±2.3</td>
</tr>
<tr>
<td>BZ-7</td>
<td>3.3</td>
<td>59.0±4.3</td>
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</table>

\(^1\)Depth of sample below current land surface.
Conservation & Survey Division
### Field Tactics

<table>
<thead>
<tr>
<th>Stop #</th>
<th>HOR</th>
<th>DEPTH</th>
<th>COLOR</th>
<th>TEX/frag</th>
<th>Component Name</th>
<th>NOTES</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Ap</td>
<td>8&quot;</td>
<td>10YR 2/1</td>
<td>SIL</td>
<td>Crete</td>
<td>Thick A horizon - likely due to years of vegetative cover. Had a small area of transition (1&quot;) but not a full BA horizon, as is typic.</td>
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<tr>
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<tr>
<td></td>
<td>Bt 1</td>
<td>16&quot;+</td>
<td>10YR 3/3</td>
<td>SIC</td>
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</tr>
<tr>
<td>2</td>
<td>Ap</td>
<td>4&quot;</td>
<td>10YR 2/1</td>
<td>SIL</td>
<td>Crete</td>
<td>A - MIXED with fill AB - some fill mixing</td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>15&quot;</td>
<td>Mixed</td>
<td>Fill SIL - SICL</td>
<td></td>
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<tr>
<td></td>
<td>AB</td>
<td>19&quot;</td>
<td>10YR 2/2</td>
<td>SICL</td>
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<td>28&quot;</td>
<td>10YR 3/3</td>
<td>SIC</td>
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<tr>
<td></td>
<td>Bt 2</td>
<td>30&quot;</td>
<td>10YR 4/2</td>
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<tr>
<td>3</td>
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<tr>
<td>4</td>
<td>A</td>
<td>9&quot;</td>
<td>10YR 3/1</td>
<td>SIL</td>
<td>Fillmore</td>
<td>NOTES: Thin A and E. Site possibly scraped when area was leveled.</td>
</tr>
<tr>
<td>Mixed F</td>
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<tr>
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Thanks!

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Chuck Markley and Rebecca Hodges Resource Soil Scientist in Nebraska
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