Soil Conditions and Dust Production

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The process of soil aerosol production requires silt and clay particles to be broken away from the soil surface by saltating particles. Dust aerosols ejected by saltating particles.
Factors that control the process of soil aerosol production

- **Climate**
  - Wind velocity
  - ET
  - Rainfall

- **Soil Erodibility**
  - Texture
  - Structure
  - Organic matter
  - Moisture

- **Vegetation cover**

- **Length of field along prevailing wind direction**

- **Roughness of soil surface**

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Blue = inherent factors
Green = manageable factors
• Soil structure is the arrangement of soil sand, silt, clay particles into stable secondary units or aggregates
• Aggregates are composed sand, silt, and clay particles, cemented together by clays or organic matter
• Structure influences water infiltration, drainage, water holding capacity, aeration, salinity, erodibility
Water, roots move in macropores between aggregates

Dispersed soil plugs macropores
If soil is dispersed

1. Water can’t soak into soil
2. Water accumulates, along with dissolved salts
3. Water evaporates, leaving salts behind
4. Soil becomes saltier
5. Plants die, leaving bare erodible soil
Bare soil is susceptible to wind erosion
vegetation cover protects the soil surface

In dispersed soils:
accumulated salts reduce or eliminate vegetation
particles are not bound in aggregates
soil is susceptible to wind erosion
Flocculation versus Dispersion

- Flocculation is controlled by salt concentration and cation properties (charge and hydrated radius)

<table>
<thead>
<tr>
<th>Ion</th>
<th>Relative Flocculating Power</th>
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<tbody>
<tr>
<td>Sodium</td>
<td>Na(^+)</td>
</tr>
<tr>
<td>Potassium</td>
<td>K(^+)</td>
</tr>
<tr>
<td>Magnesium</td>
<td>Mg(^{2+})</td>
</tr>
<tr>
<td>Calcium</td>
<td>Ca(^{2+})</td>
</tr>
</tbody>
</table>

1.0 1.7 27.0 43.0

Sumner and Naidu, 1998

- Soil cations vary in their ability to flocculate particles
Soil Aggregate Stability

EC (electrical conductivity) is a measure of total salinity: EC \times 640 = \text{ppm}

Rainwater standing on a non-absorbent soil along I-10 North of Picacho. This is typical of sodium-affected soils.

\[
\text{SAR} = \sqrt{\frac{[\text{Na}^+]}{[\text{Ca}^{2+}] + [\text{Mg}^{2+}]}}
\]
TIME = 10 min

Dispersed soil

Water

Water & Gypsum

$\text{(CaSO}_4 \cdot 2\text{H}_2\text{O)}$
TIME = 24 hours

Water

Water & Gypsum
This soil has poor structure because of sodium accumulation.

Over 50 years, this land has not re-vegetated.

The low areas (where water accumulates) have the highest sodium levels; water does not soak in, and soils are nearly bare.
Summary

Keys to wind erosion

– **Soil cover**
  - Moisture
  - Tillage
  - Soil salinity
  - Soil sodicity

– **Soil structure**
  - Organic matter
  - Soil salinity
  - Soil sodicity
  - Moisture

– **Wind speed**
  - Surface roughness
  - Vegetation