Rates of Soil Carbon Accumulation and Transformation in a Ponderosa Pine Forest Using High Resolution Chronosequence Analysis

R. C. Graham
University of California, Riverside
Chronosequence Analysis

\[ S = f(t)_{cl,o,r,p} \]

- **S**: soil formation
- **t**: time
- **cl**: climate
- **o**: organisms
- **r**: relief
- **p**: parent material

Hans Jenny
Chronosequence of alluvial fan terraces

Lettis, 1985
Chronosequences in xeric southern California

Scale: 1k - 100 k years
Resolution: 1k - 10 k years
Soil organic carbon studies need a shorter time span and greater resolution.
Mt. Shasta Chronosequence

A = 27 yr
B = 60 yr
C = 205 yr
D = 566 yr
E = 1200+ yr
Carbon accumulation in Mt. Shasta Chronosequence

- Total: 12.9 kg m⁻²
- Soil (0-3s’): 8.6 kg m⁻²
- Forest Floor: 4.3 kg m⁻²
Elevation = 1675 m
MAP = 650 mm
Geologic material: gneissic regolith
Soil texture: loamy sand (5% clay)
Objectives

• Assess the rate of carbon accumulation on a scale of decades.
• Determine the forms of soil organic matter as a function of soil age.
• Interpret the processes of carbon incorporation and storage in the soils.
Initial Field investigations
Initial Laboratory Results
Organic Carbon Storage to 80 cm depth

Organ Carbo (kg m$^2$)

Soil Age (ye)

<0.5 28 97 400

Mineral soil O horizon
<table>
<thead>
<tr>
<th></th>
<th>Mt. Shasta (566 years)</th>
<th>Forest Falls (400 years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Litter</td>
<td>4.3</td>
<td>6.0</td>
</tr>
<tr>
<td>Mineral soil</td>
<td>9.5</td>
<td>4.2</td>
</tr>
<tr>
<td>Total</td>
<td>13.8</td>
<td>10.2</td>
</tr>
</tbody>
</table>

- Mineral soil

Forest Falls (400 years)

Mt. Shasta (566 years)

Litter kg m\(^{-2}\)

Forest Falls

Mt. Shasta
Future Work

• Sample soils on more flow ages
  - especially <200 yr

• Determine changes in forms of SOM
  - C by size fraction
  - solid state $^{13}$C NMR

• Investigate processes
  - litterfall
  - litter decomposition (litter bags)
  - soil fauna (pitfall trapping)
  - fine roots
  - soil respiration
  - microbial characterization (biomass, plfa)
  - soil temperature
  - micromorphology