Up by Roots: Healthy Soils and Trees in the Urban Environment

Soil science and tree biology:

Physical Soil Properties

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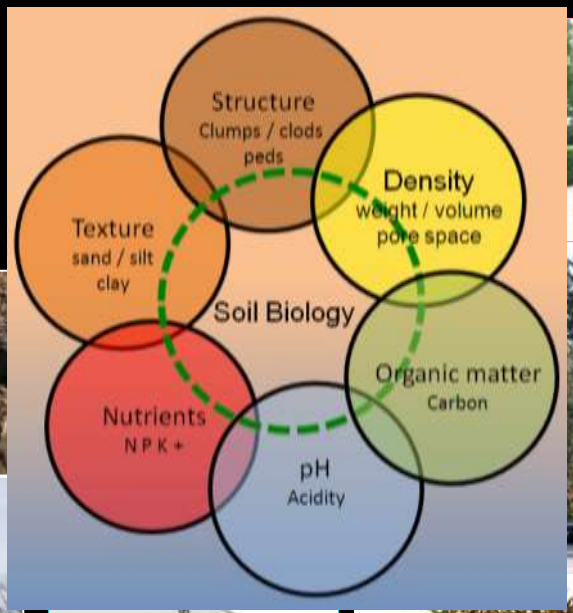
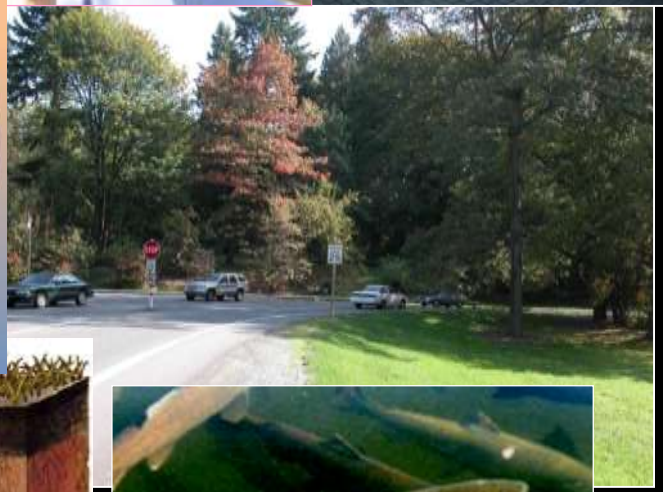
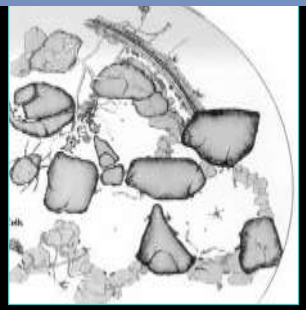
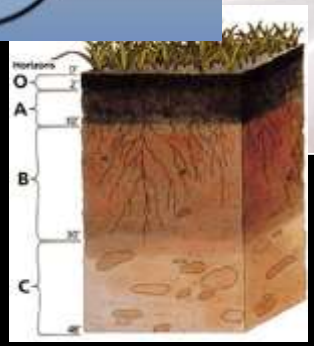


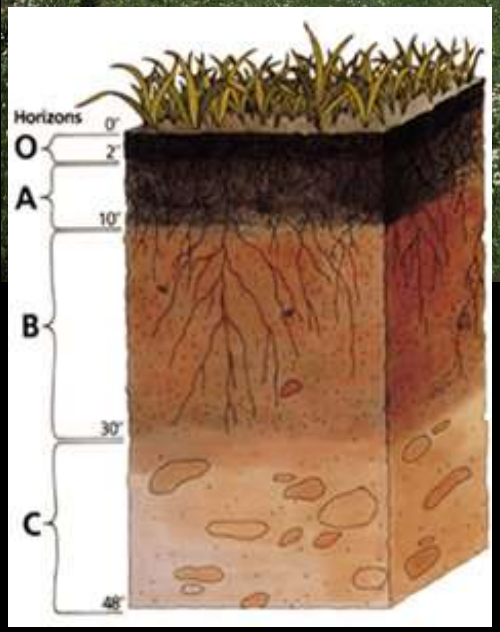






Natural soils vs. Disturbed urban soils

- Uniform across site
- Natural horizons
- Adequate OM, nutrients, structure for native plants



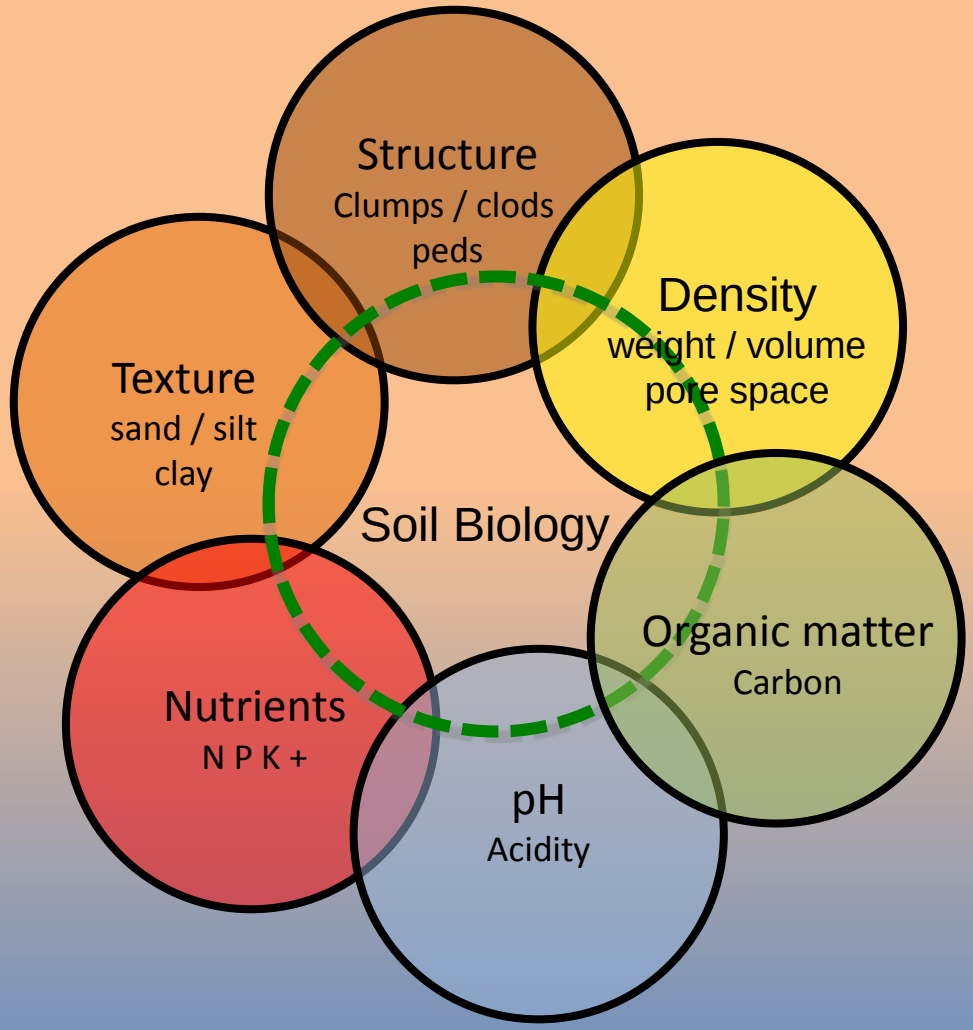
- Vary across site
- Topsoil layer removed
- Compaction, low OM
- Subsoil (or worse) fill layers
- Debris, toxins?

Water (& Air) Movement through the Soil

Root excavation for tracking disease in Washington (photo by Bob Edmonds)

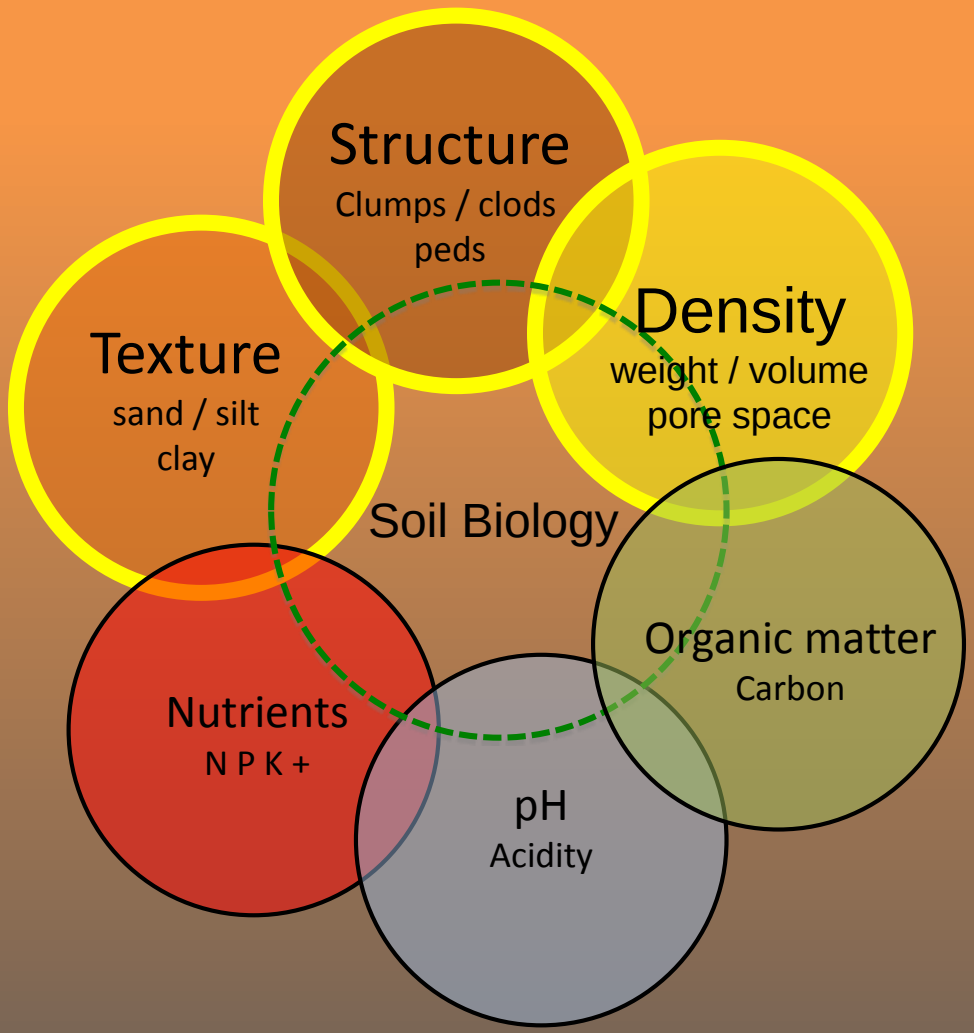
Most fine roots of trees are located close to surface where many of the nutrients that limit tree growth are found

Critical Aspects of Soil



Air and water movement / soil profile

Physical properties of soil



Air and water movement / **Soil Profile**

Soil science and tree biology:

Physical Properties

- Parent soil
- Texture
- Structure
- Profile
- Compaction
- Water / soil relationships

Soil Parent – natural processes of soil formation

Igneous

Sedimentary

Alluvial

Wind deposited

Glacial

Sub-Soils in the Puget Sound Basin: Leftovers from glaciers & volcanoes

glacial till: unsorted, unstratified mixtures of clay, silt, sand, gravel, and boulders; deposited under ice, or in moraines

hardpan: till compacted under glacier

outwash & alluvial soils: layers sorted by particle size by water - sand / gravel / rocks

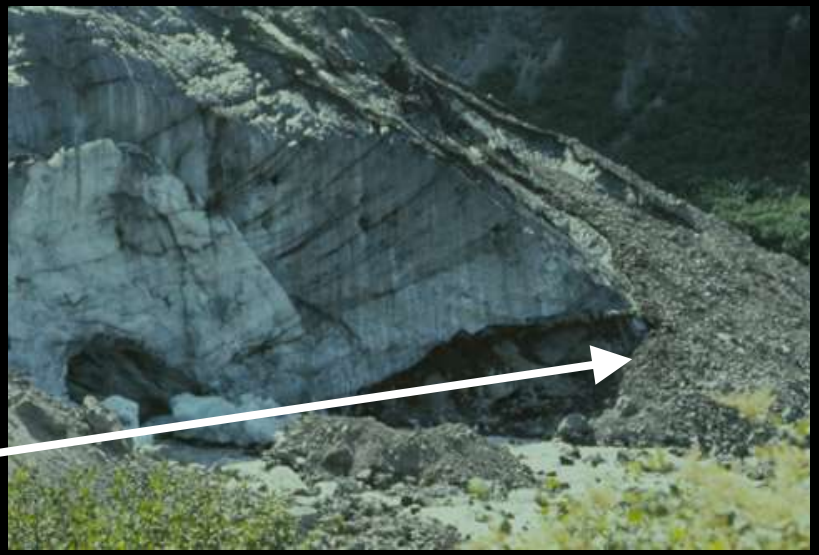
lake/marine bed soils: clay or silt that settled out in lakes & estuaries

volcanic ash: light, fertile, holds moisture - mostly blown east of Cascades

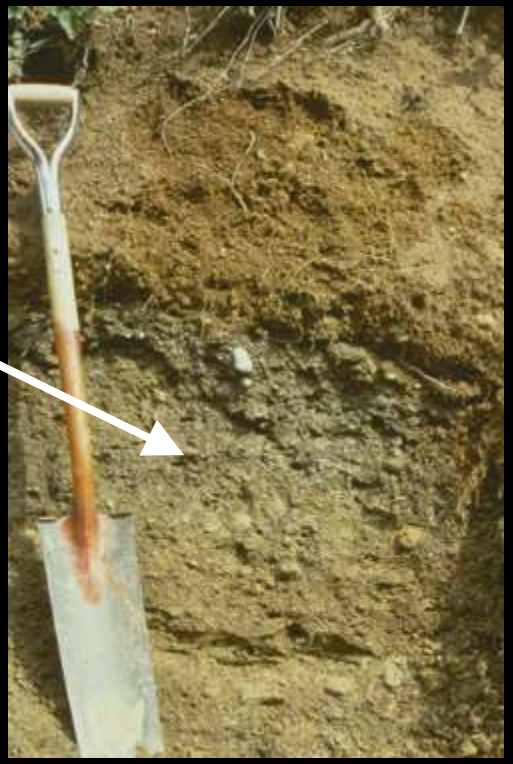
mudflows: mixed size, compact - like till

Glacial till

- May be piled, uncompressed and unsorted, in *moraines* at edge or terminus of glacier



- *Basal till* from under the glacier (1/2 mile of ice over Seattle!) has been compressed into **hardpan**

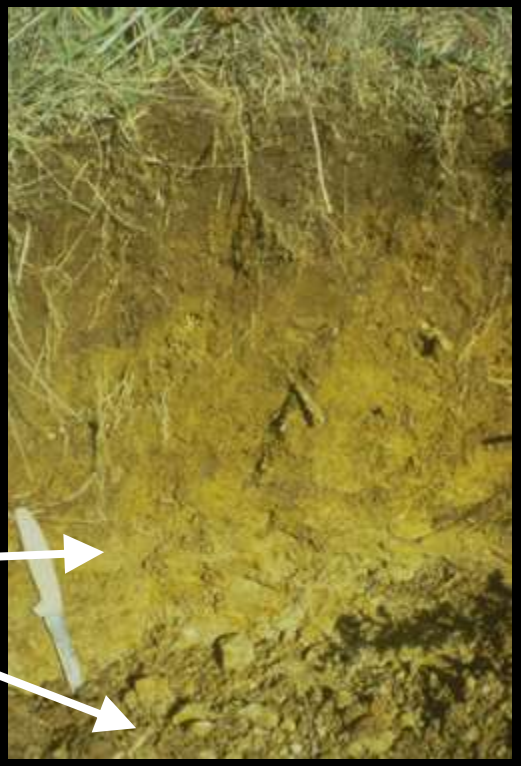


- Good for foundations, but low permeability and hard for roots to penetrate

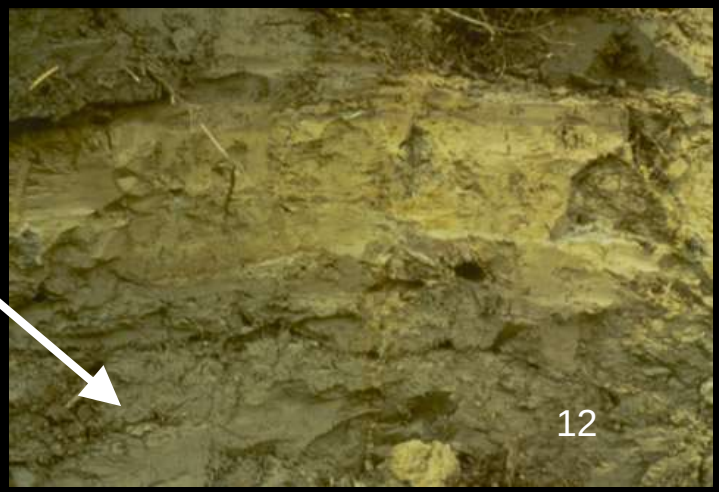
Glacial outwash

- May be sorted boulders, gravel
- …sand and fines…..
- Or a mix!

Lake beds, lenses, and layers



- Silts and clays settle out…
- And then may be overlain in lenses with sand or gravel from succeeding outwash
- Grey-yellow color when saturated and anaerobic
- Great for farming, (best nutrient capacity) but unstable in slopes or foundations!



Volcanic ash or mudflows

- *Tephra* (ash) – light, fertile, holds moisture, erodable

- Mudflow – compact, mixed fines and boulders, low permeability, looks and acts like basal till, but more fertile

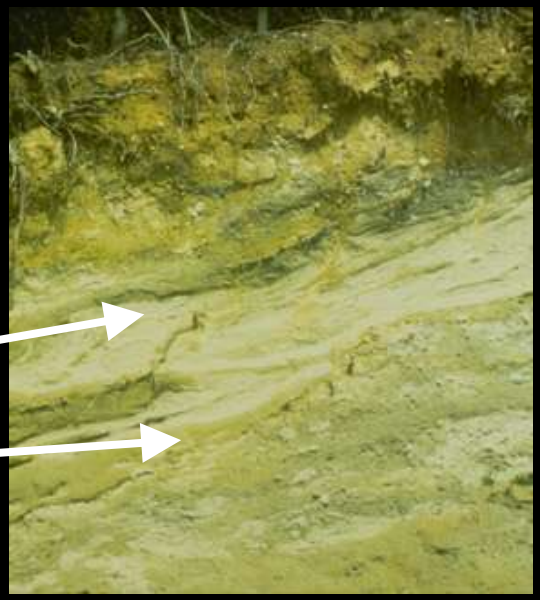
Alluvial soils

- Flat, loamy deposits in river floodplains (or ancient rivers)

- Best for farming, often wasted on development because they’re flat

Layers *upon* layers…
ignore them at your peril !!

- Sandy outwash over compacted basal till hardpan
- Thin soil over bedrock
- Clay lenses over hardpan, or inter-layered with sand (unstable!)

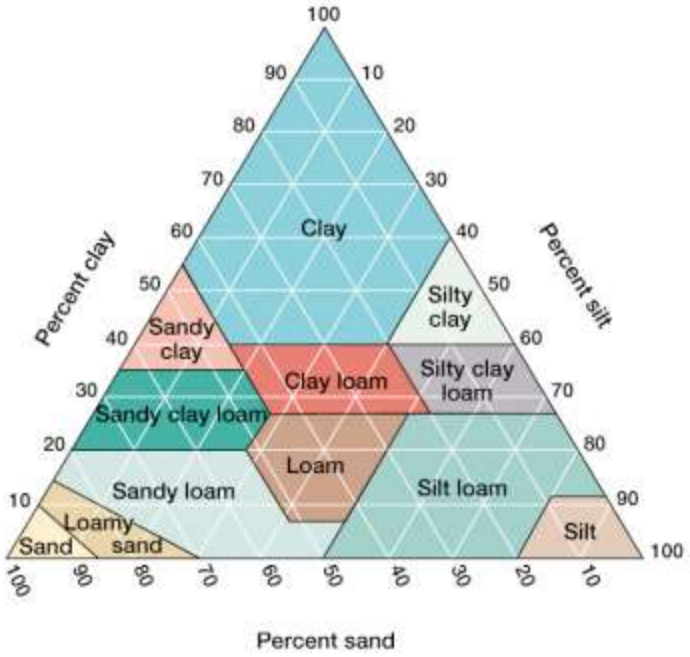


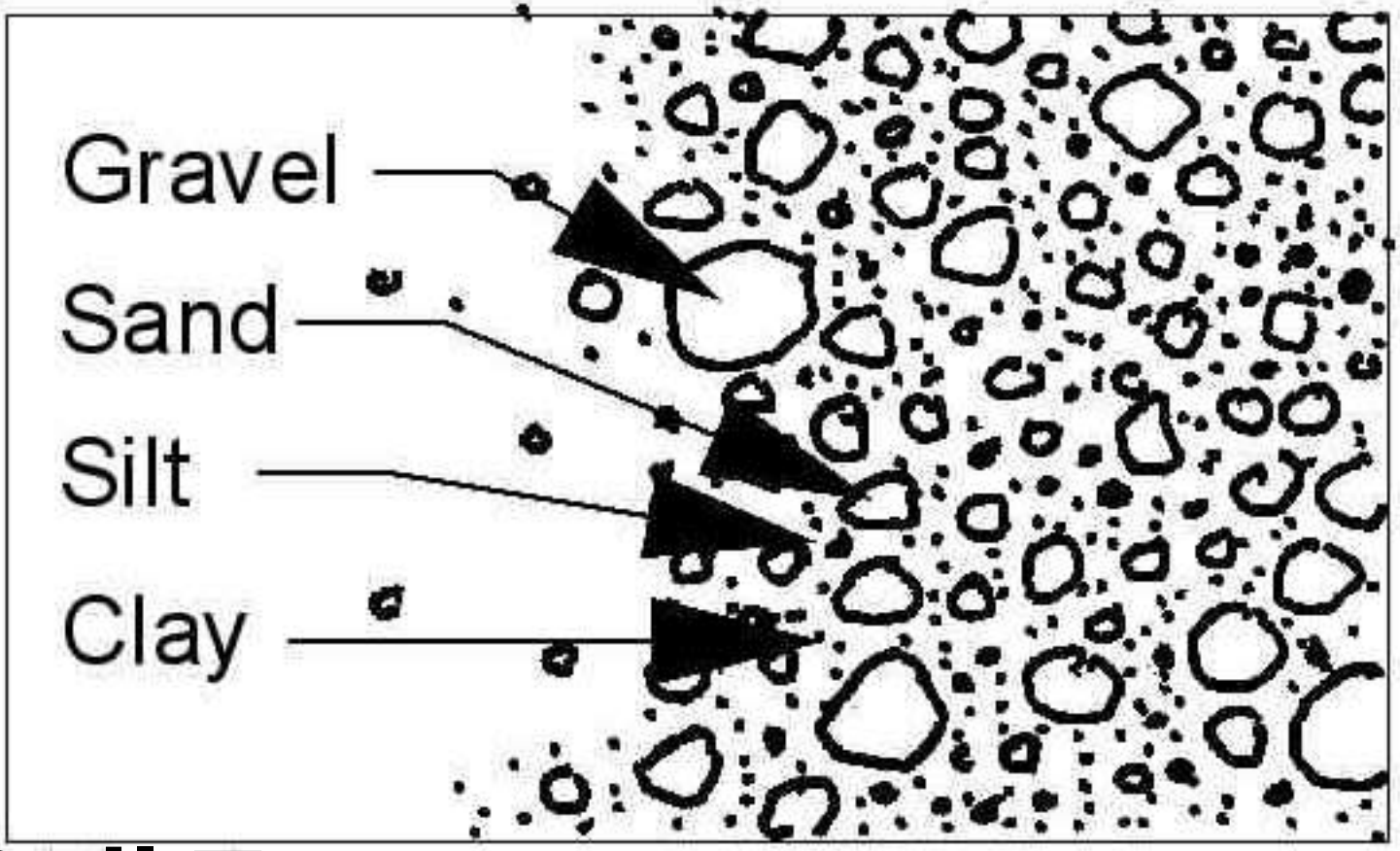
Soil formation -Human forces

Disturbed soils in urban areas

- Topsoil layer removed
- Compaction
- Subsoil (or worse) fill layers.
- Debris or toxins?

Texture

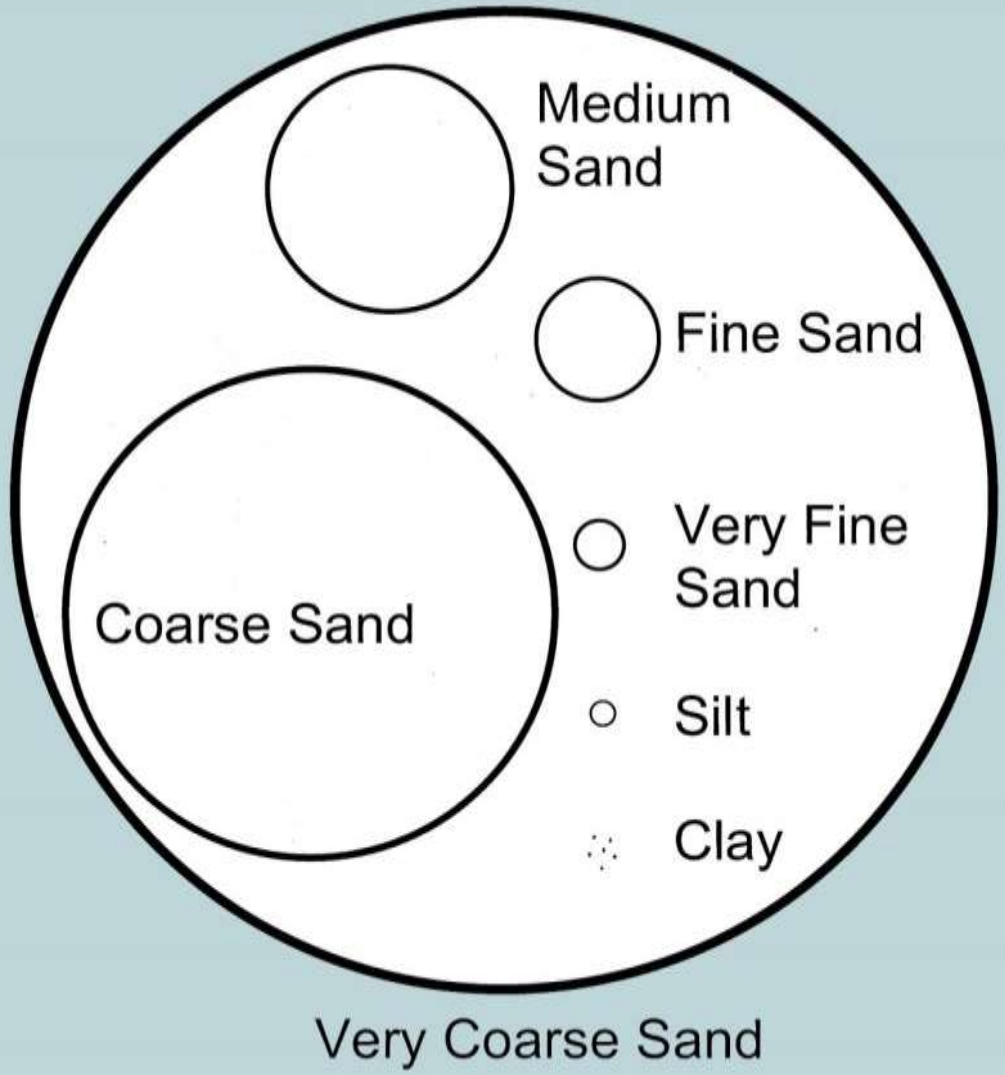

Percent clay
Percent silt
Percent sand
Clay
Silty clay
Sandy clay
Clay loam
Silty clay loam
Sandy clay loam
Loam
Sandy loam
Silt loam
Loamy sand
Sand
Silt

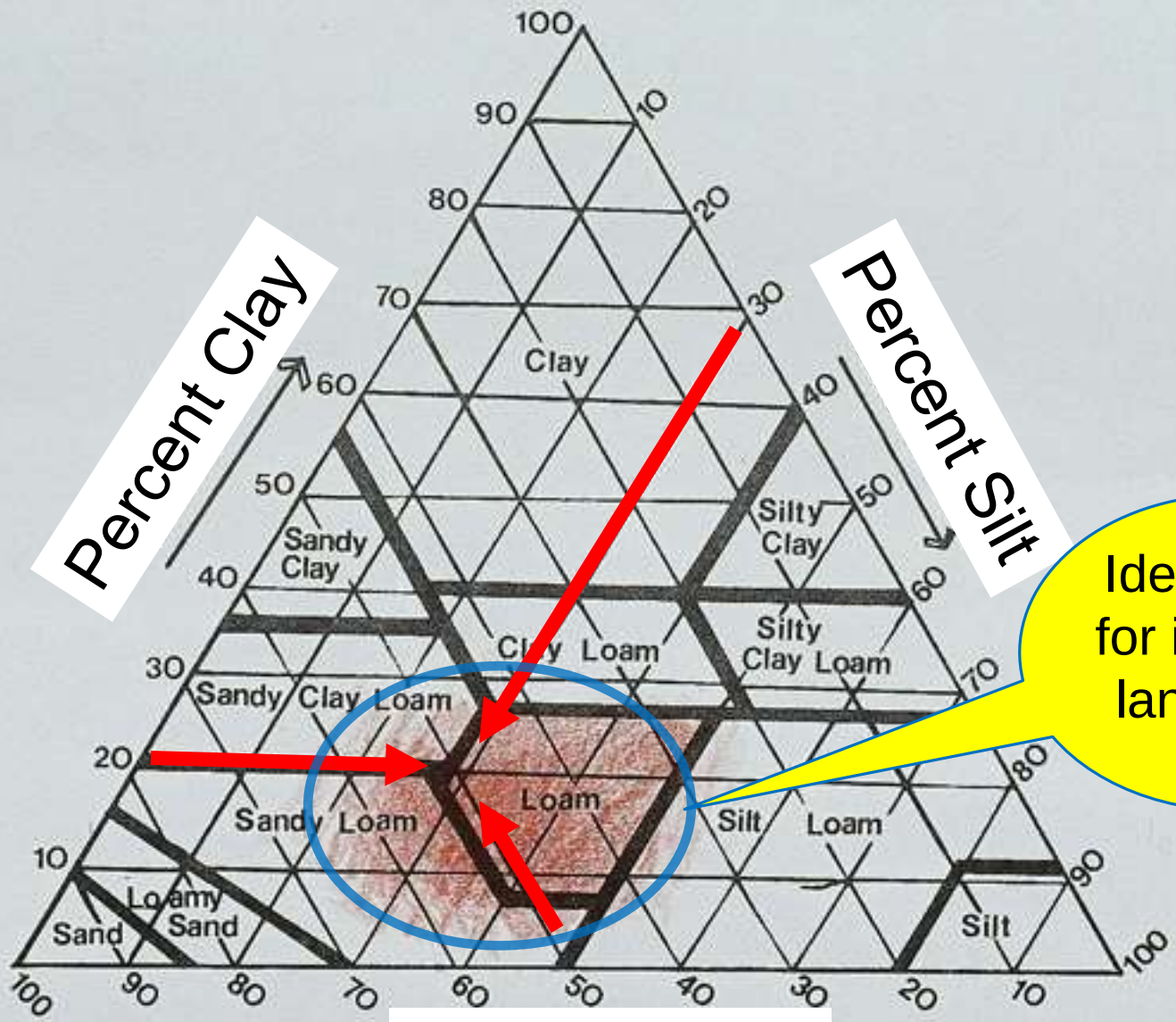


Soil Texture (= mineral particle size)

Proportion of sands, silts & clays

Soil Material	Size (mm)
Clay	<0.002
Silt	0.002 - 0.05
Silt, fine	0.002 - 0.02
Silt, coarse	0.02 - 0.05
Sand	0.05 - 2.00
Very fine sand	0.05 - 0.10
Fine sand	0.10 - 0.25
Medium sand	0.25 - 0.50
Coarse sand	0.50 - 1.00
Very coarse sand	1.00 - 2.00
Gravel	2.0 - 75.0
Cobbles	75.0 - 250.0
Stones	250 - 600
Boulders	> 600

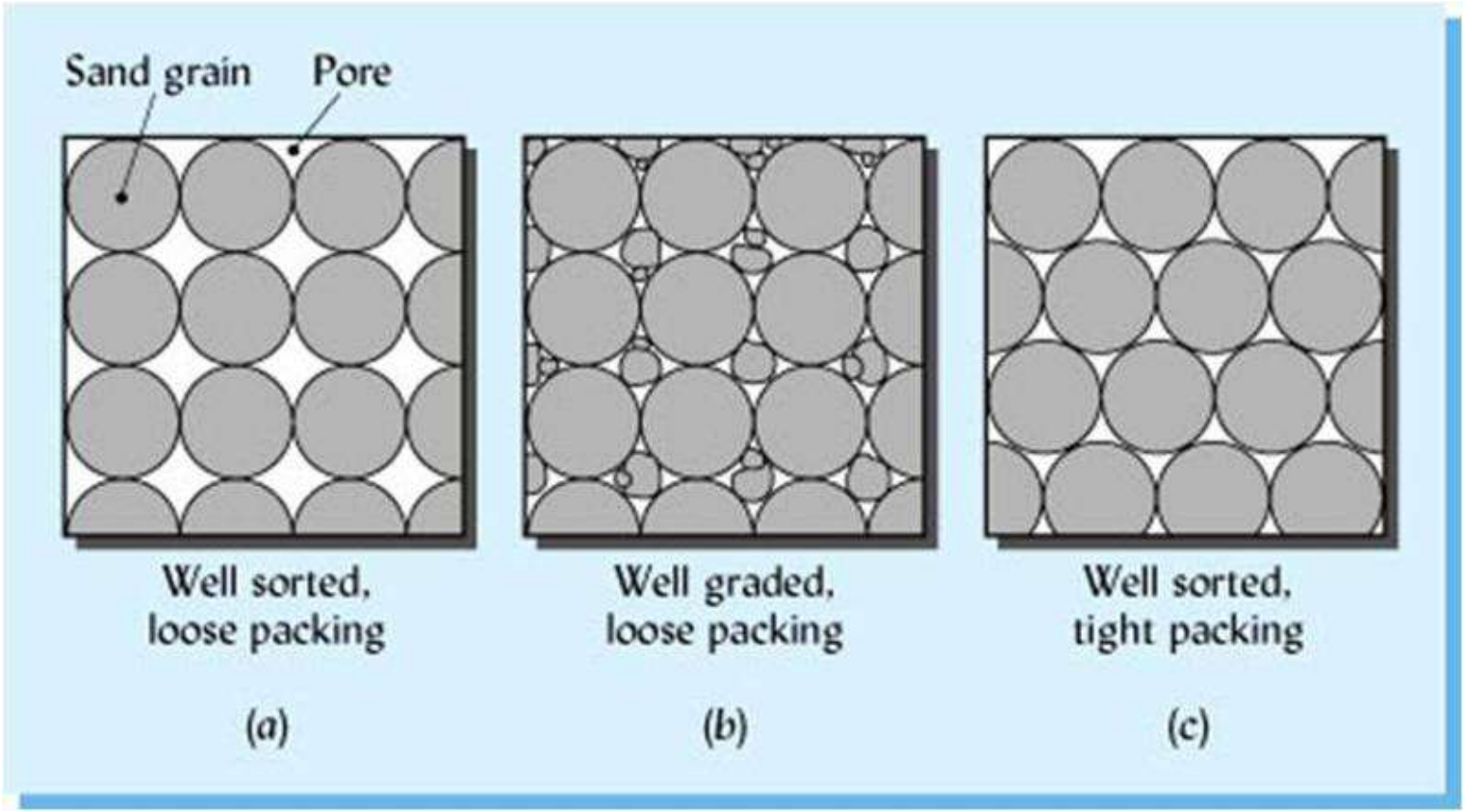




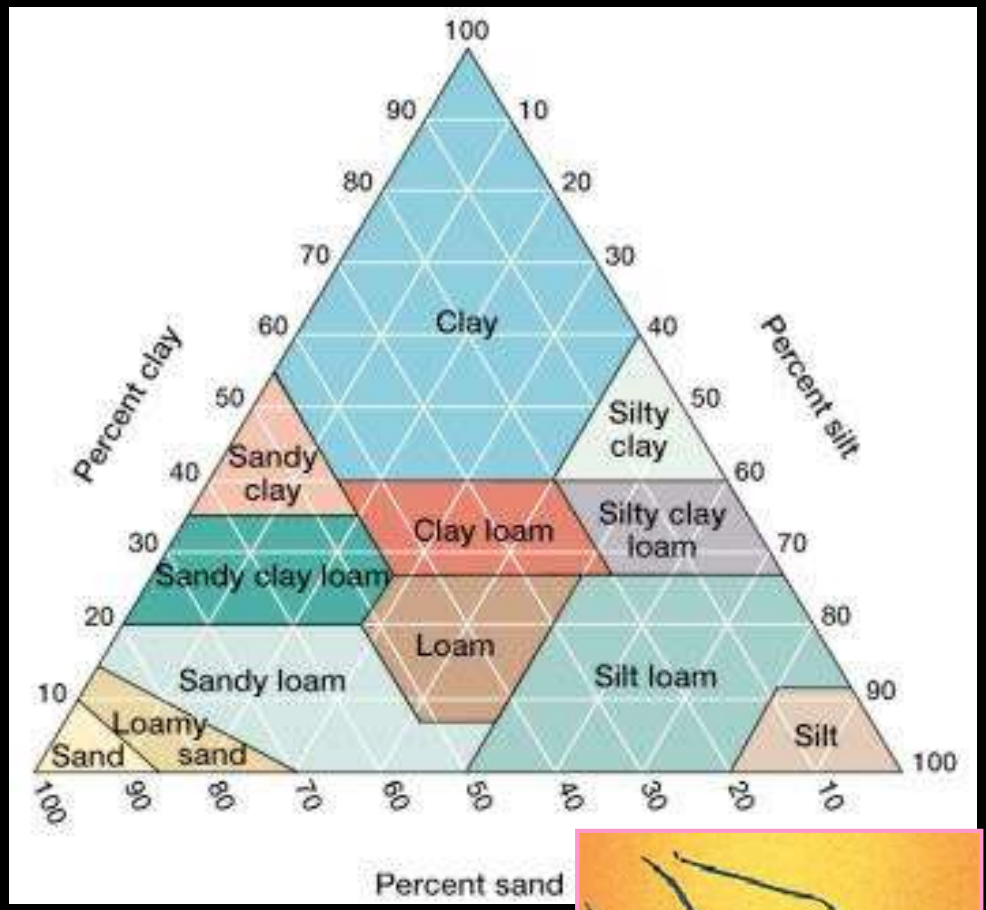
The soil textural triangle.

Importance of knowing your **soil texture**:

Pore Spaces affected by particle sizes and arrangement



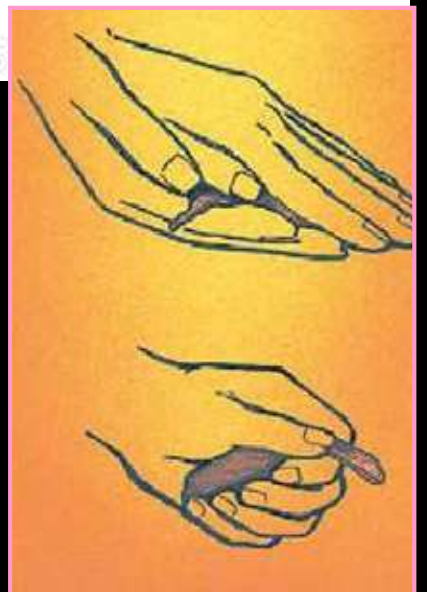
Soil Texture Test



Ribbon+feel test:

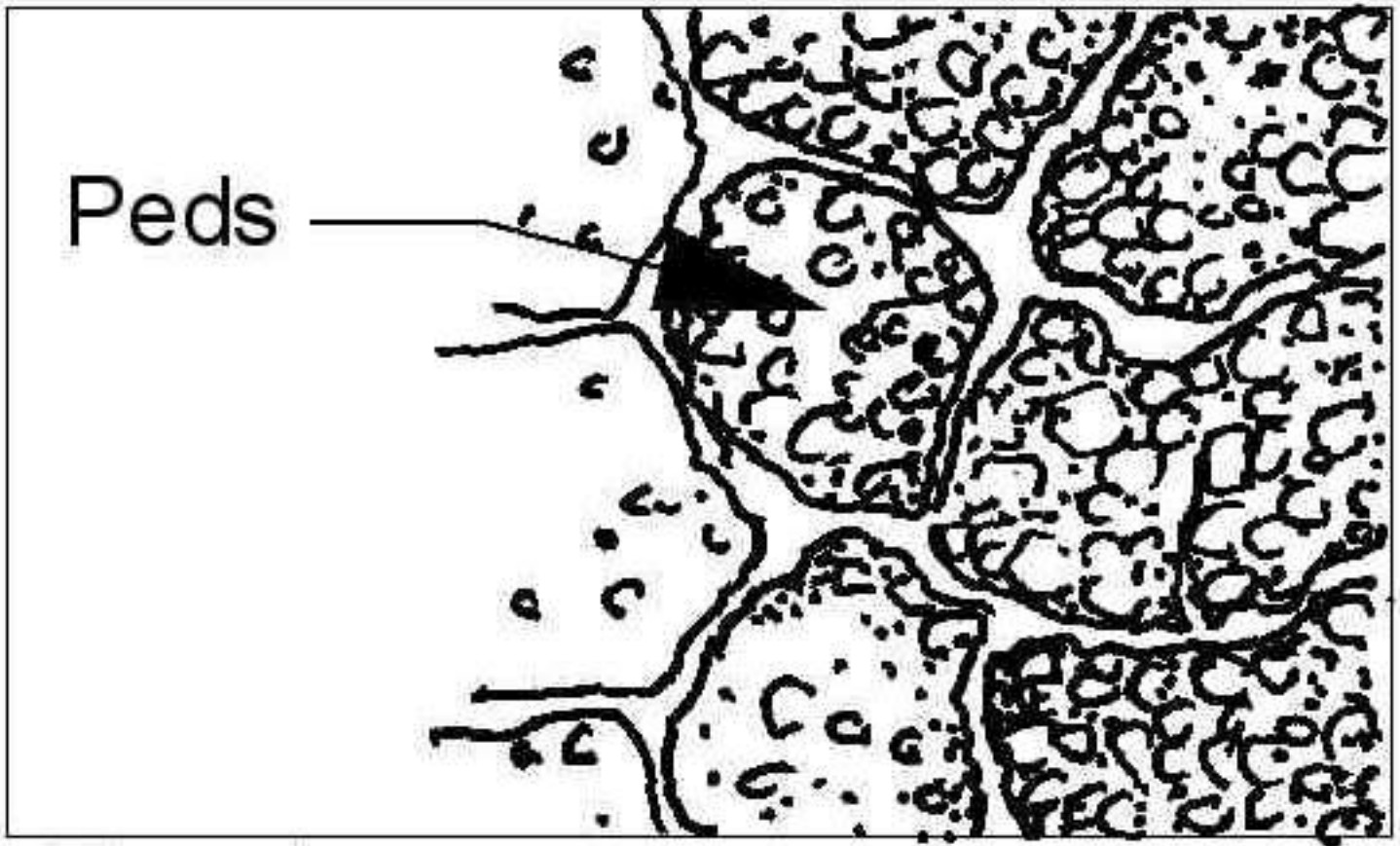
Moisten soil, roll between hands, then squeeze out with thumb:

- Sand: no ribbon, grainy
- Sandy loam: ½ inch ribbon
- Loam: thick 1 inch ribbon
- Silt: makes flakes rather than ribbon
- Silty clay loam: thin, breaks easily, has floury feel
- Sandy clay loam: stronger, has grainy feel
- Clay: long (3 inch) ribbon, has smooth feel



SOIL STRUCTURE

The arrangement of soil particles into various aggregates (or peds)



Structure

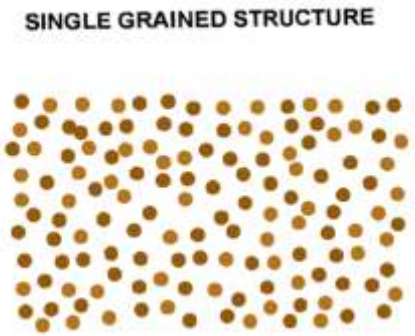
Don't grind up your soil! Mix loosely to preserve the peds.

Some Types of Soil Structure

Granular

Blocky

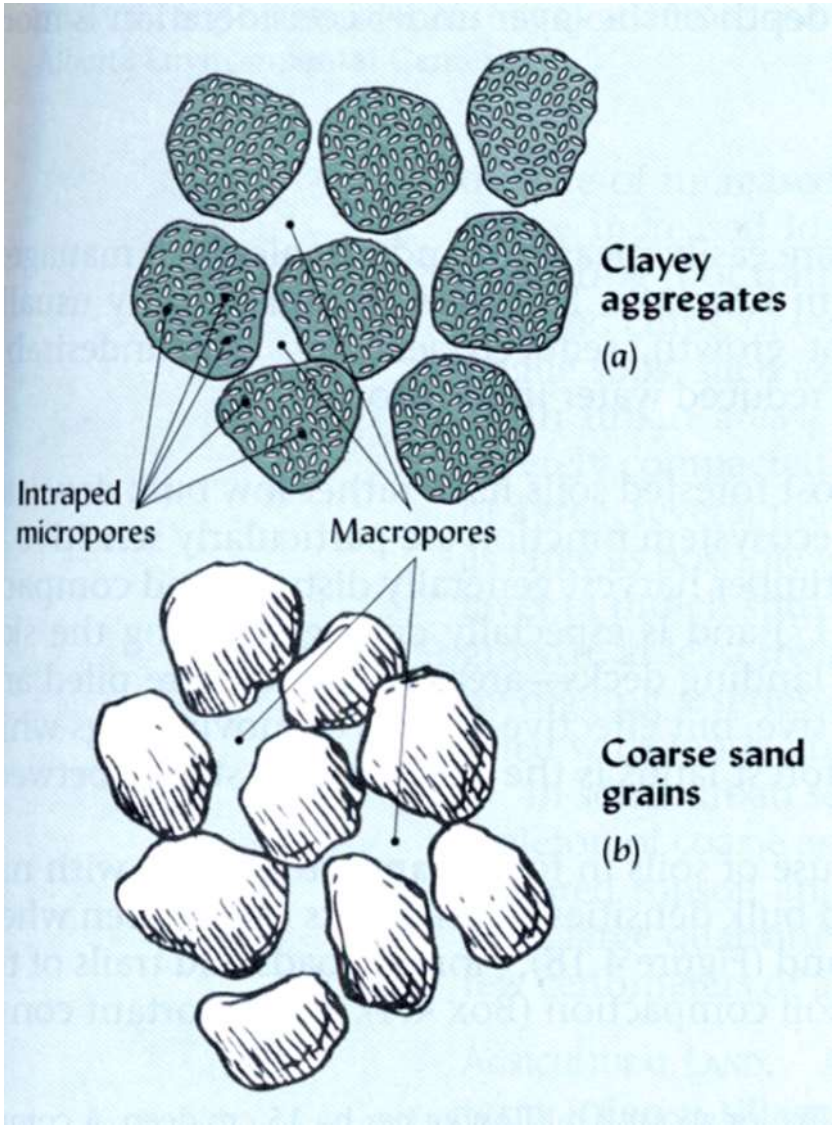
Columnar & Prismatic



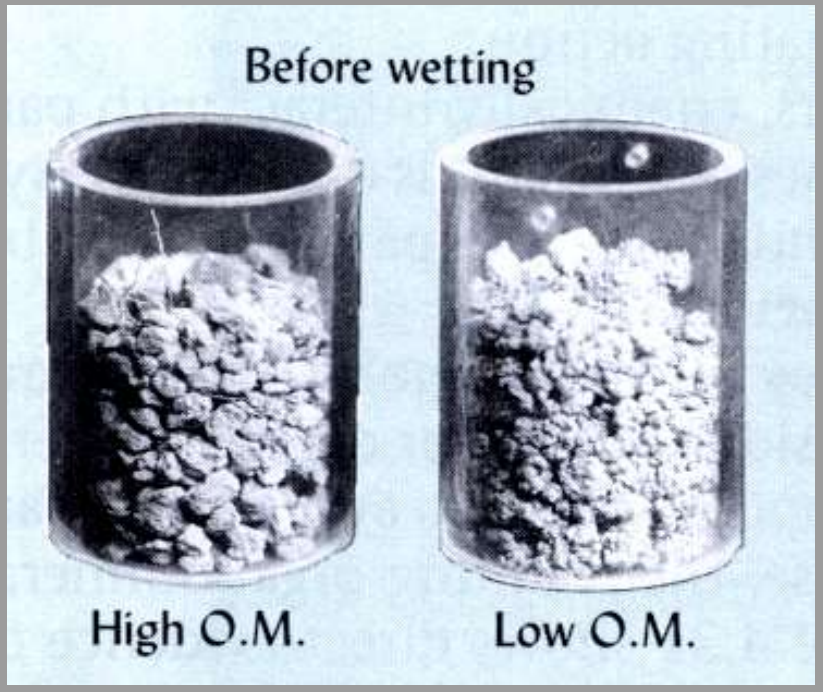
Platy

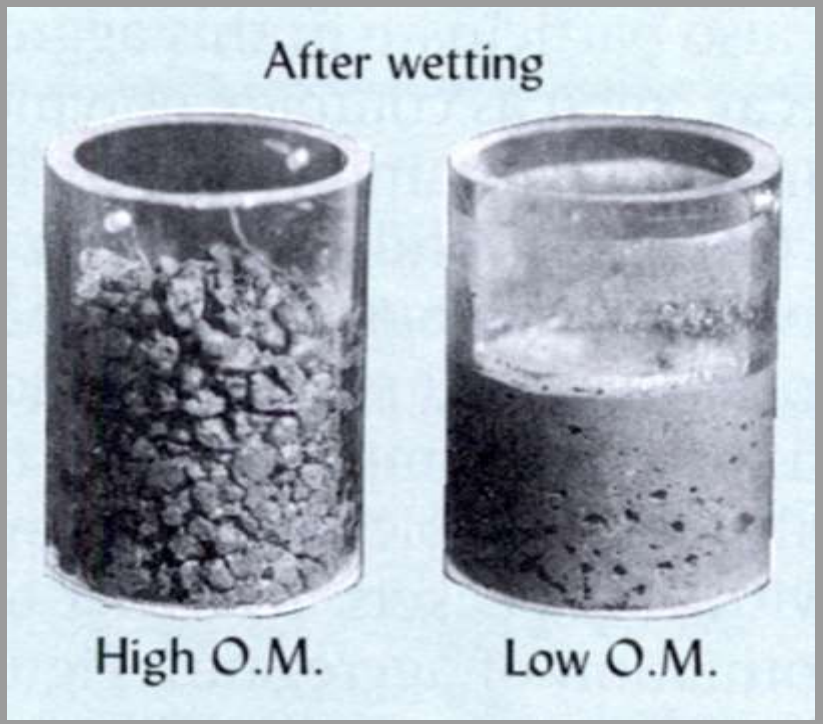
Why is Structure Good??

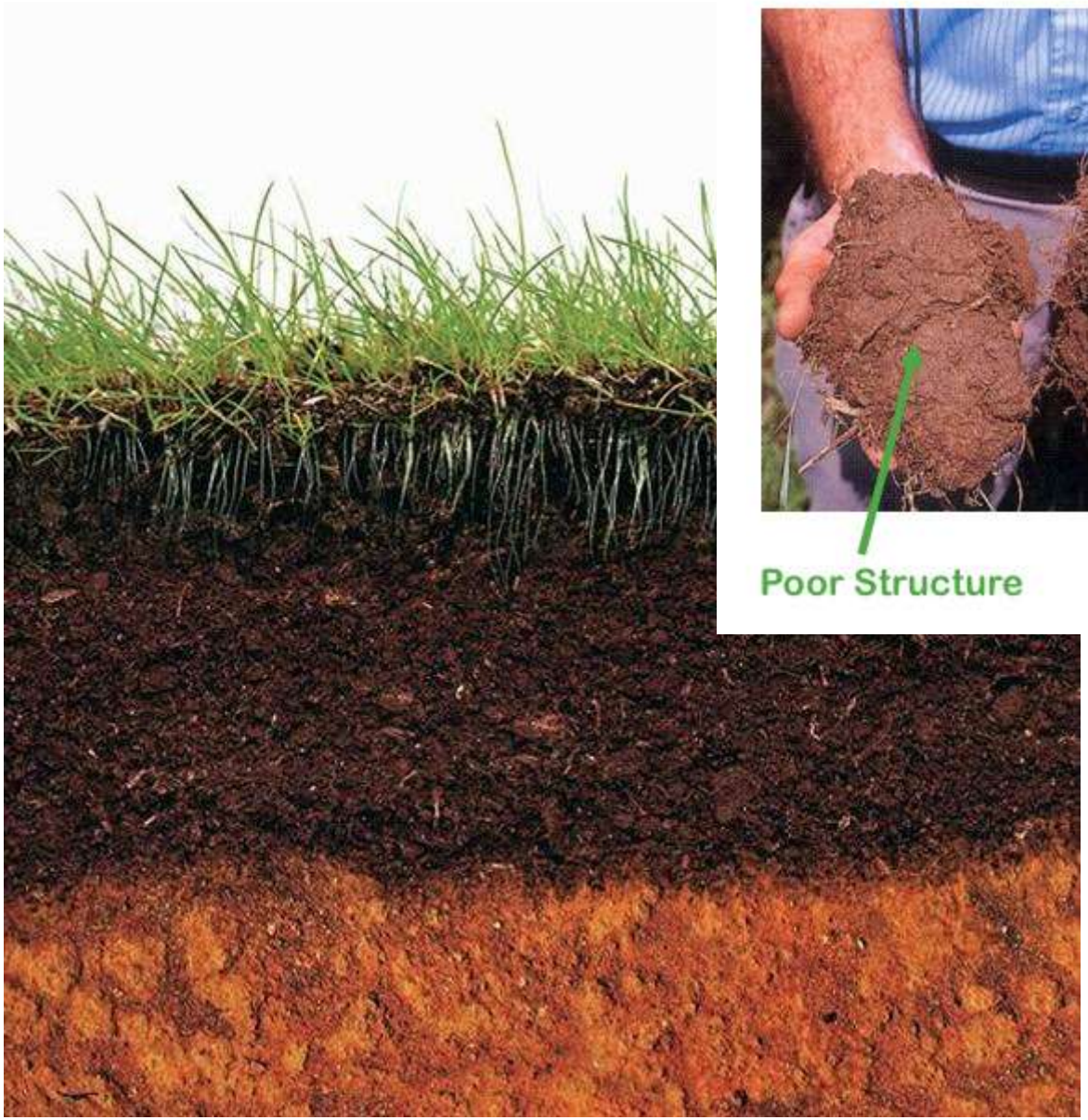
- Large pores **fill** readily BUT also **drain** easily,
- Small pores **retain** water against quickly draining BUT also **slowly fill** up



Structure

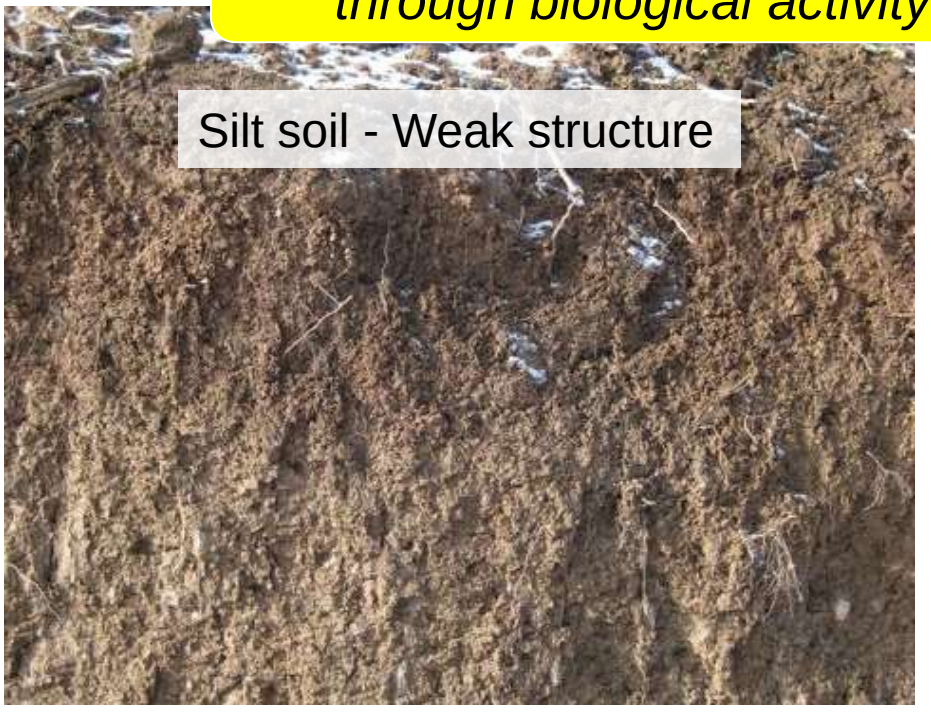


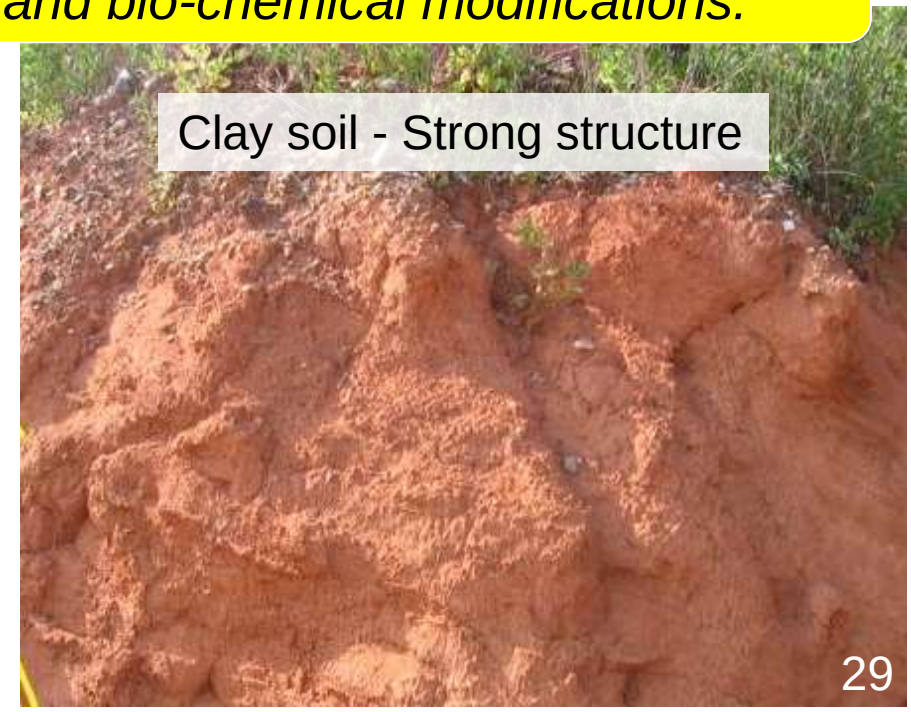




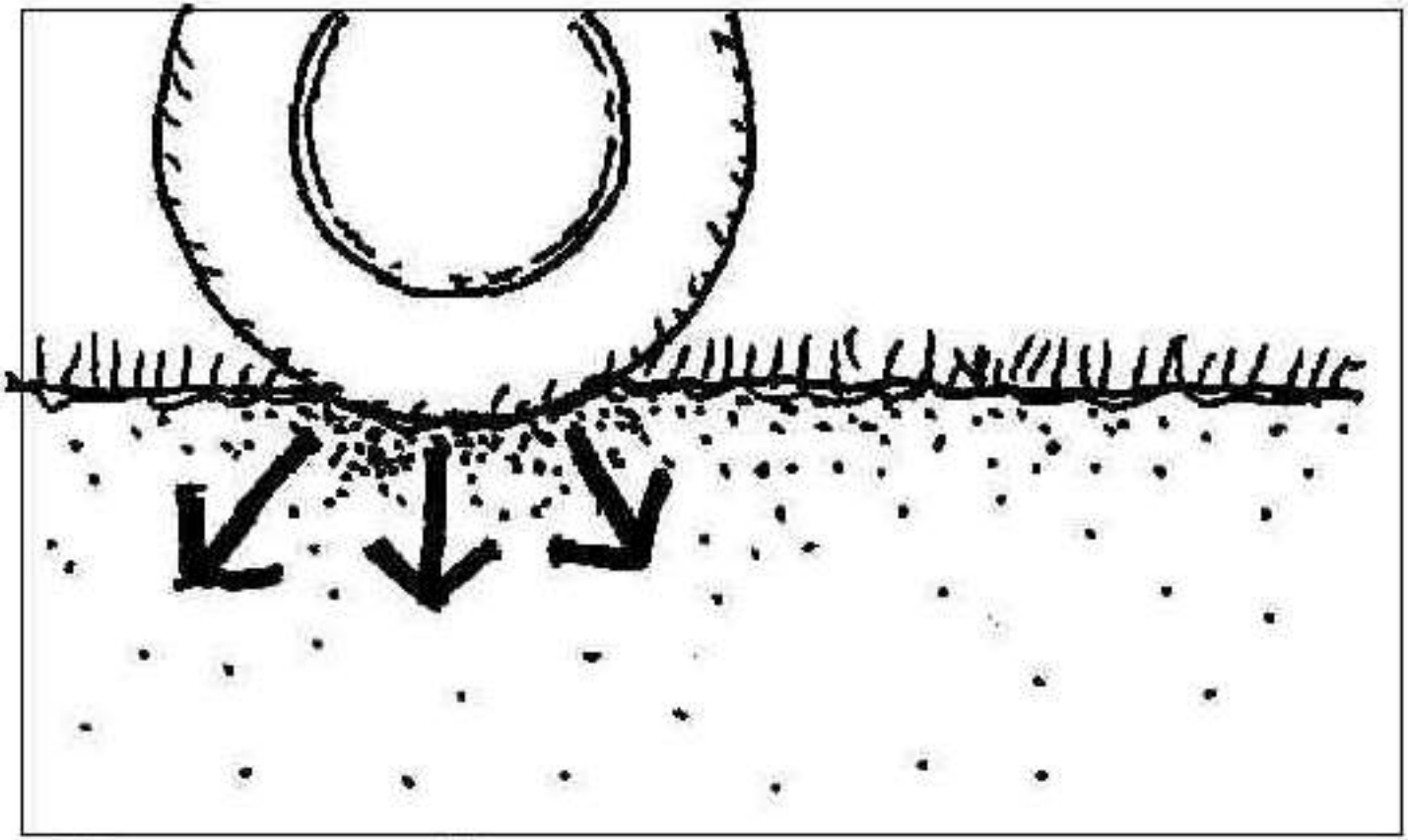
Good Soil Structure!!

Organic amendments (compost) improve structure in all soil types, through biological activity and bio-chemical modifications.





Compaction or Density



Bulk Density

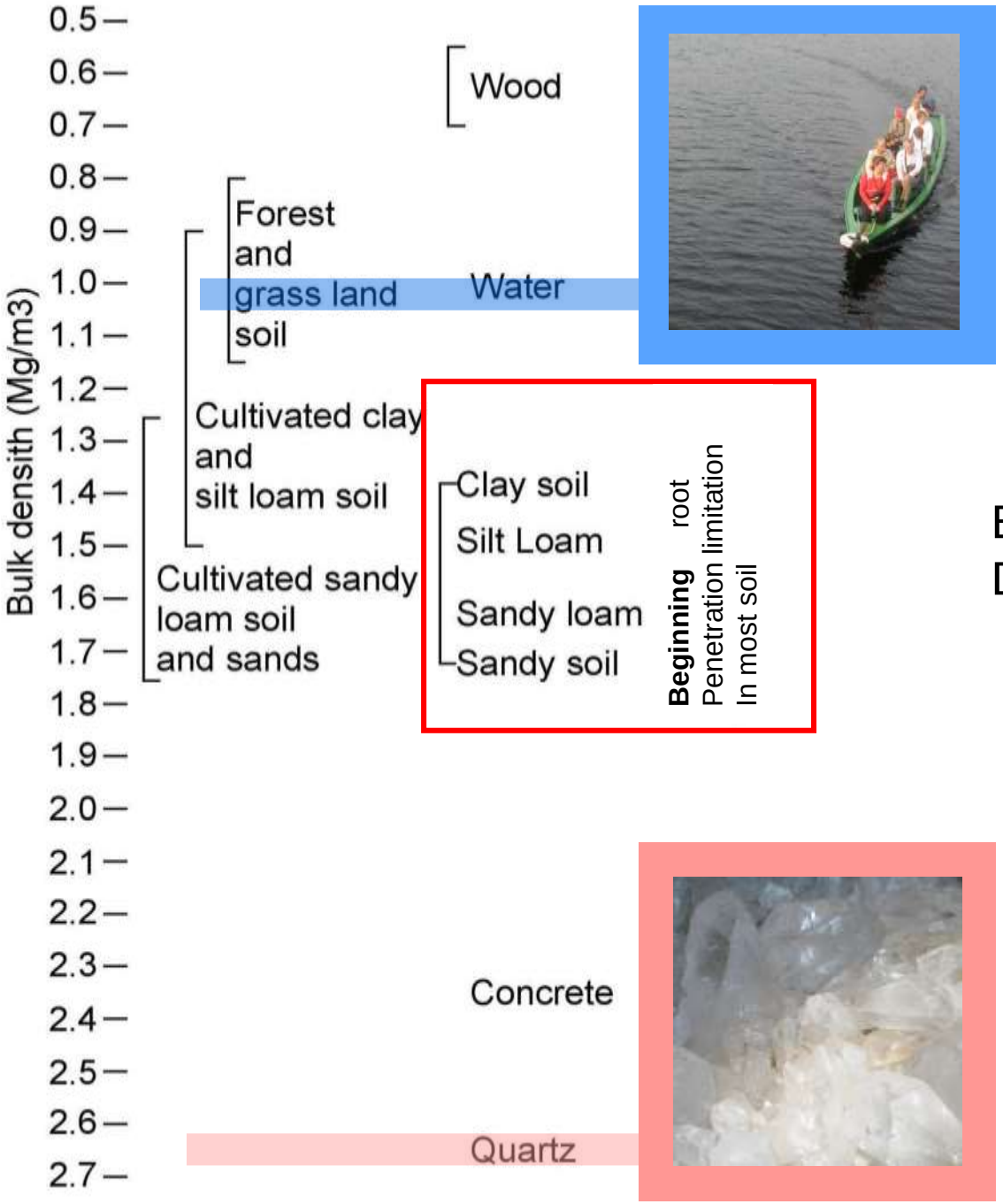
(dry soil mass per field volume)

higher BD = greater compaction

- Affects root penetration
- Affects pore volume - water, air, ???
- Land Use & Management affects BD?
  - negative, positive??

Fine textured soils (pores already small so compaction will decrease even smaller)

Coarse textured soils (pores large so increasing BD will decrease some pores)

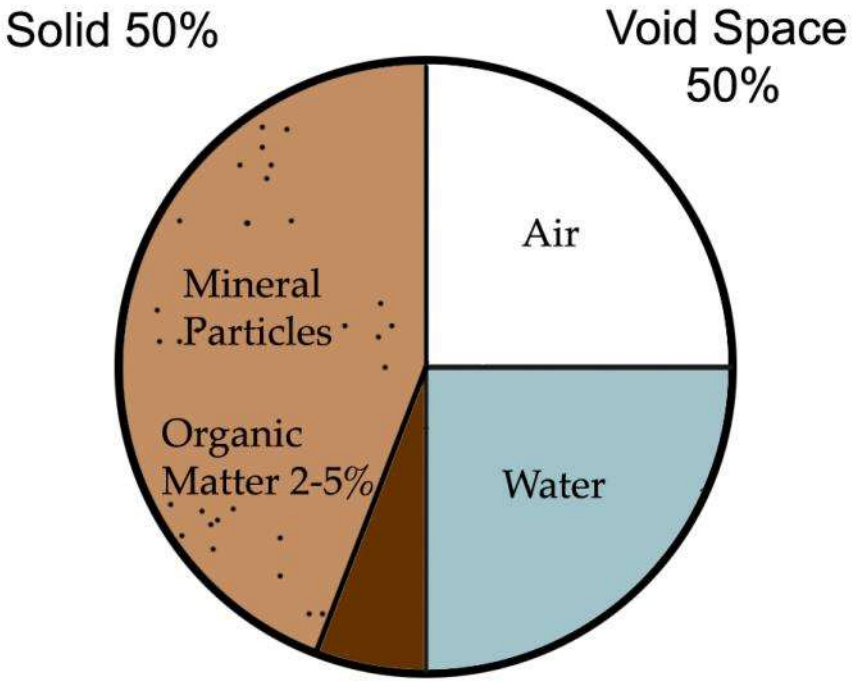


Bulk Density of Different Soils

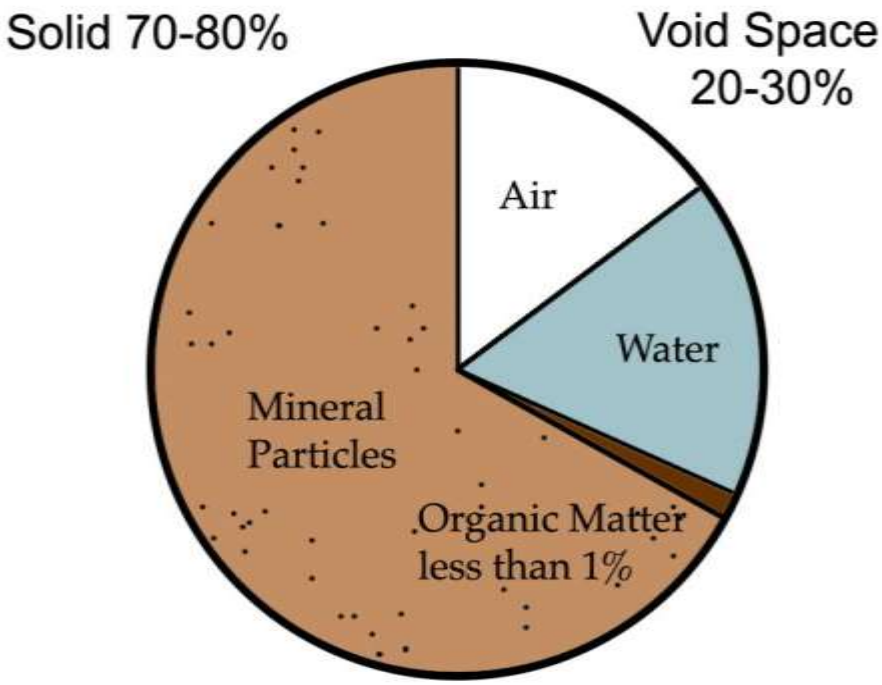
Bulk densities of soil mixes are different for similar natural soil textures.

Compost is very light, while **sand** and **lost structure** tends to make soil test heavier.

You have to test bulk density at a stated Proctor percentage.

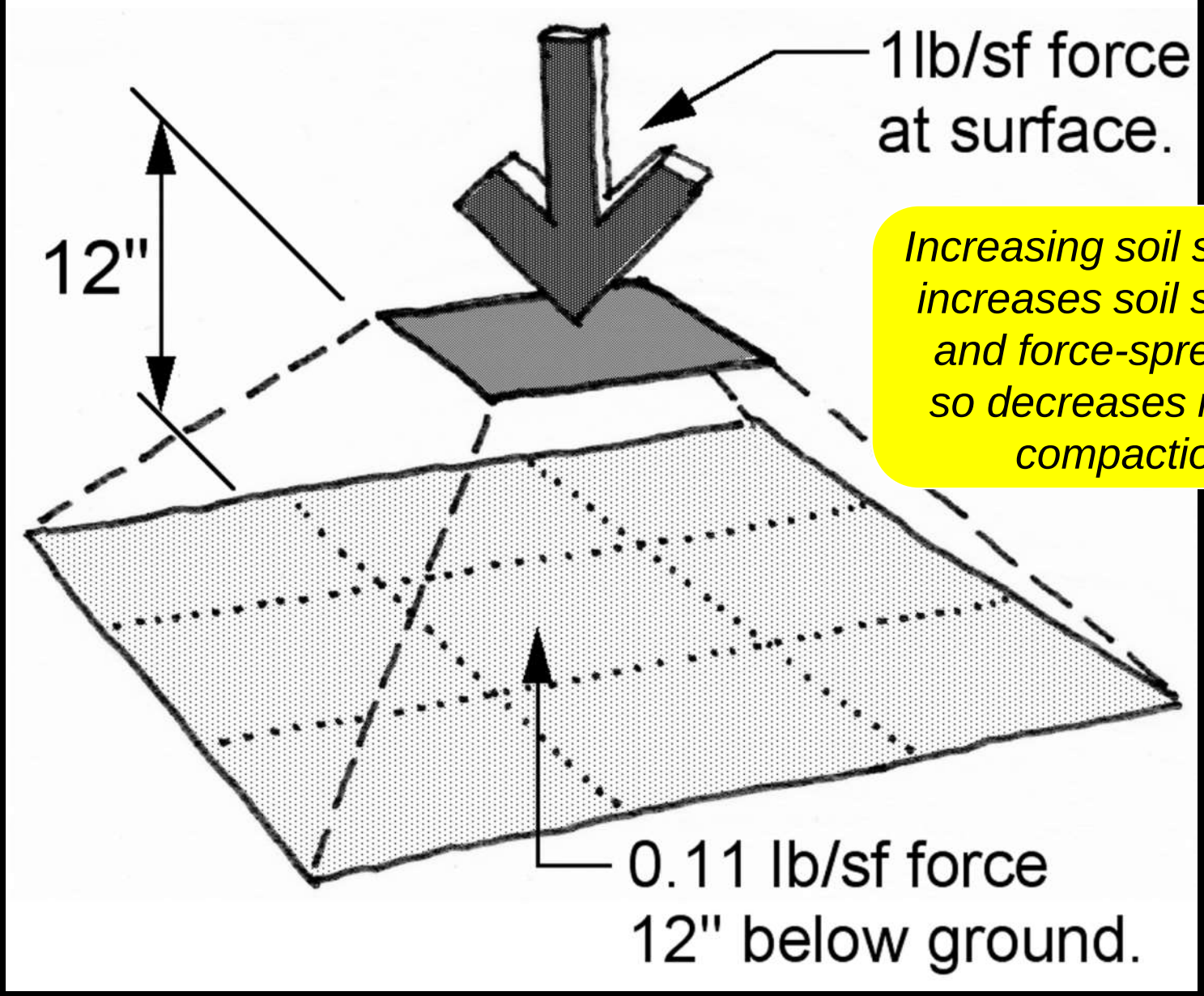


IDEAL FOREST SOILS



URBAN SOILS

As compaction increases, pore space for water and air decreases



Increasing soil structure increases soil strength and force-spreading, so decreases net soil compaction.

There is a decrease in compaction with depth as the compaction force spread out into the soil in a cone shaped wave.

Units
% maximum bulk density standard proctor or Bulk density Lb/CF Dry weight

Densitometer

Moderately slow 10 minutes
Accurate
Expensive
Must calibrate to soil.
Readings impacted by OM
Soil service only

Units
PSI LB pressure per Sq Inch

Penetrometer

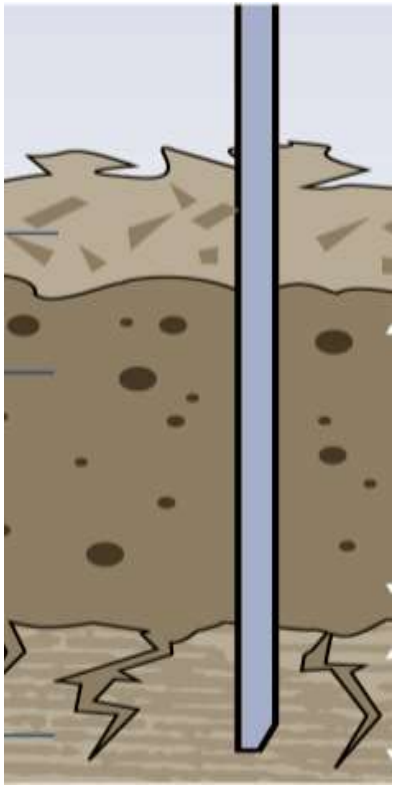
Fast less than one minute
Not very accurate
Soil moisture limited
Inexpensive
Anyone can operate

Units
Bulk density Lb/CF Dry weight

Bulk density cores

Slow one day
Accurate
Somewhat expensive
LA or soil service

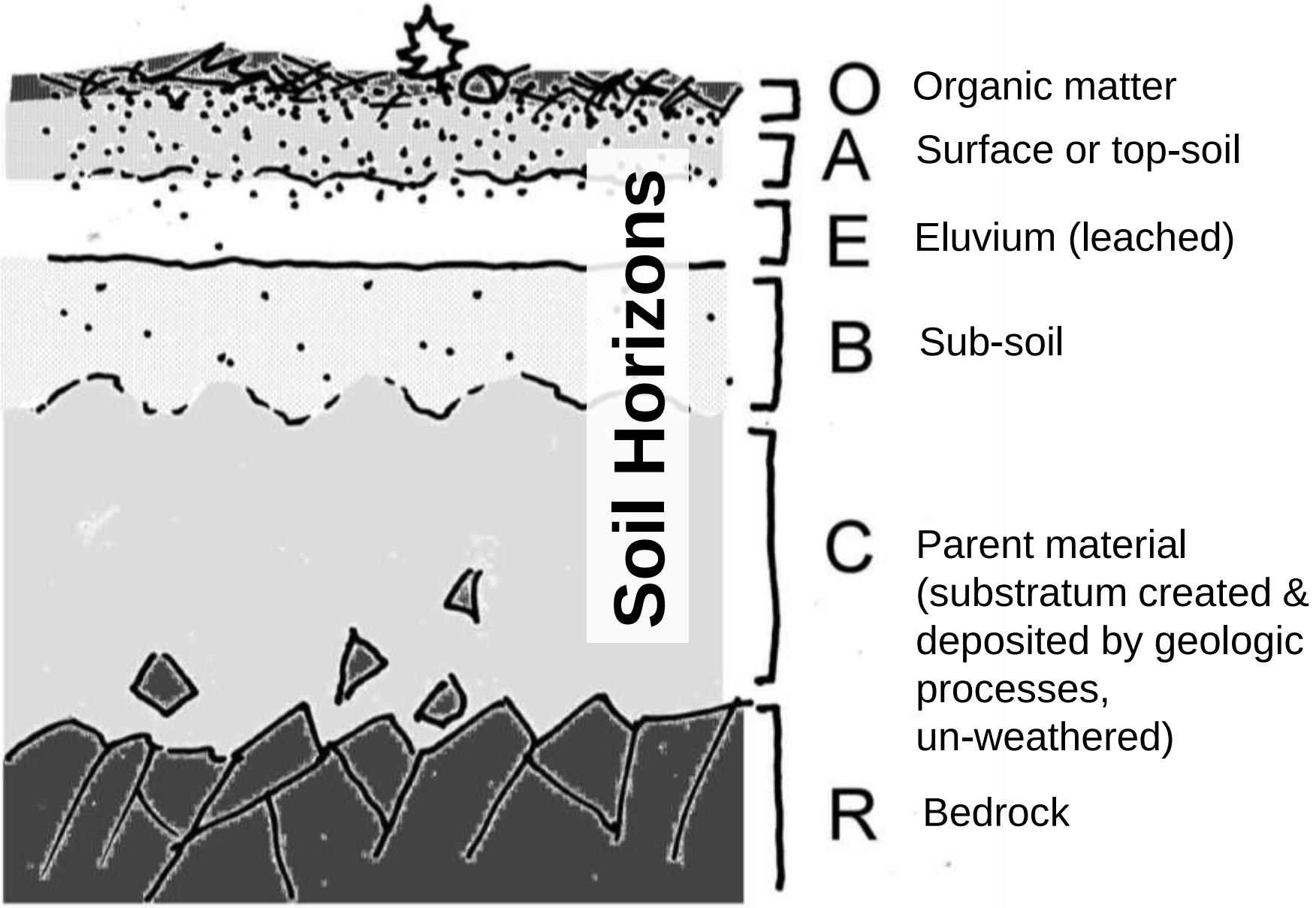
No Units
Comparative feel only



Rod penetrometer

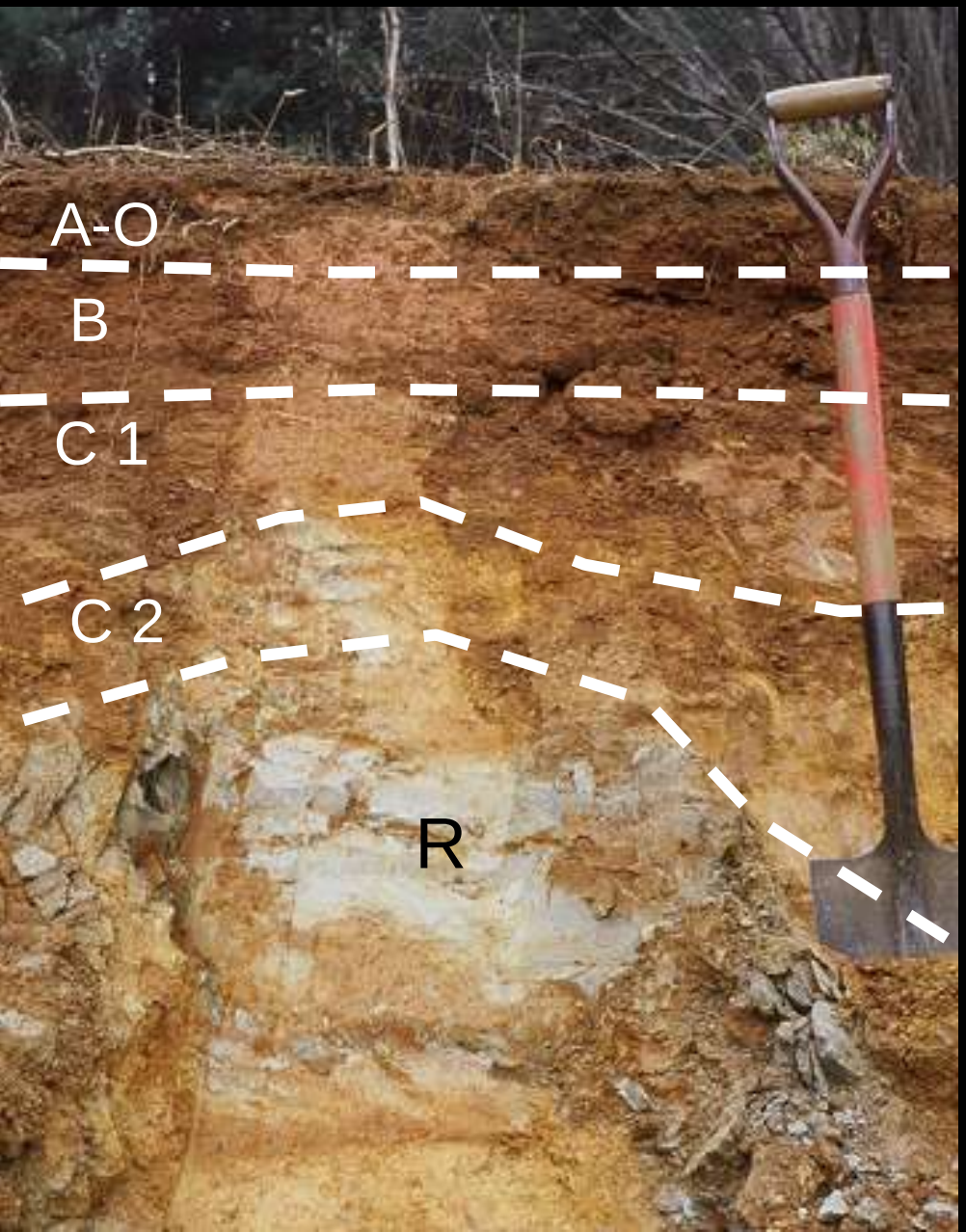
Inexpensive 3/8” bar with T-handle, driven by inspector’s weight:
Inaccurate, but gives comparative feel for compacted or uncompacted conditions

Soil Compaction Testing

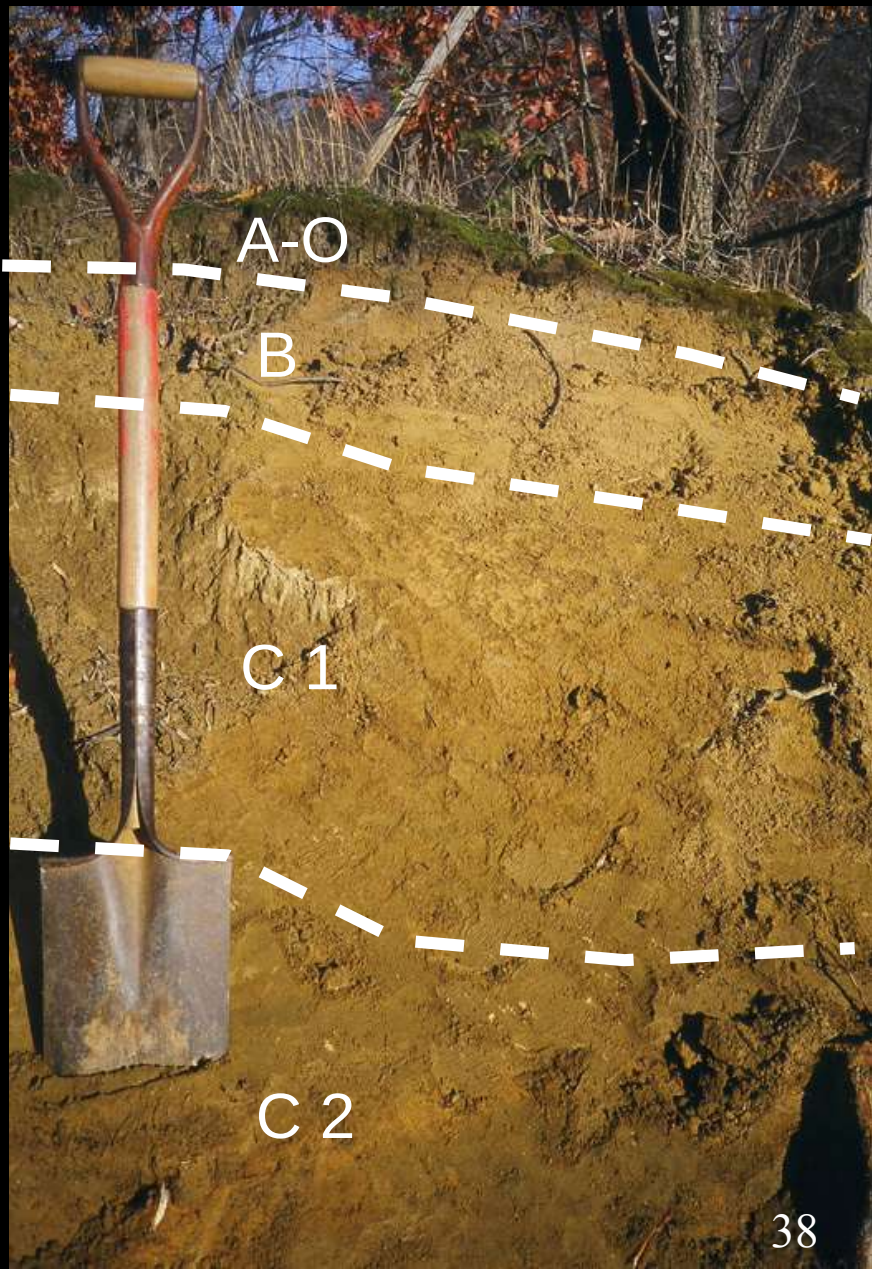


Soil Profile

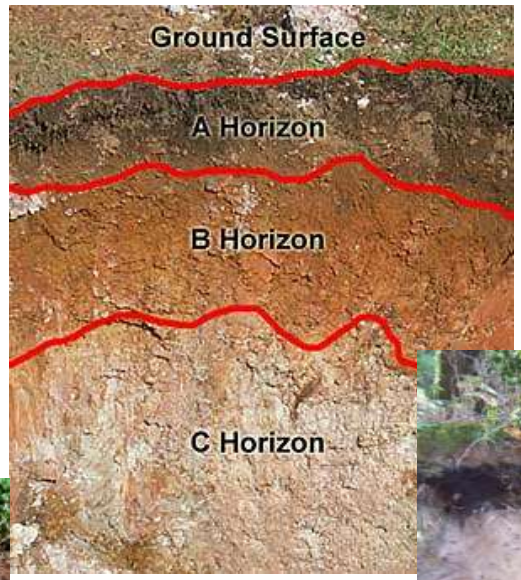
Mountain soil

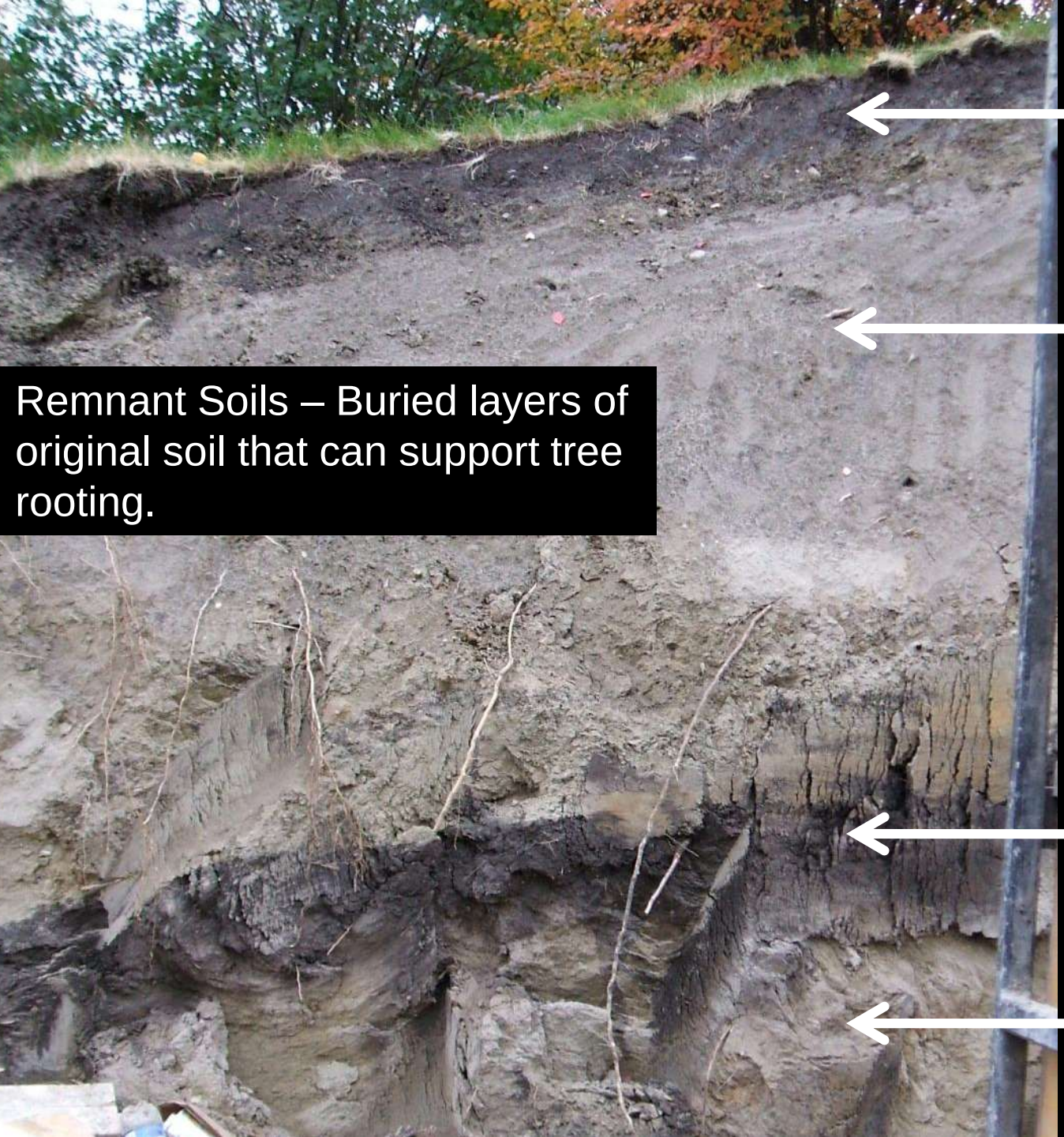


Coastal soil



Different Soil Profiles





Remnant Soils – Buried layers of original soil that can support tree rooting.

Changes in soil type

Examining a soil profile with a Dutch soil auger

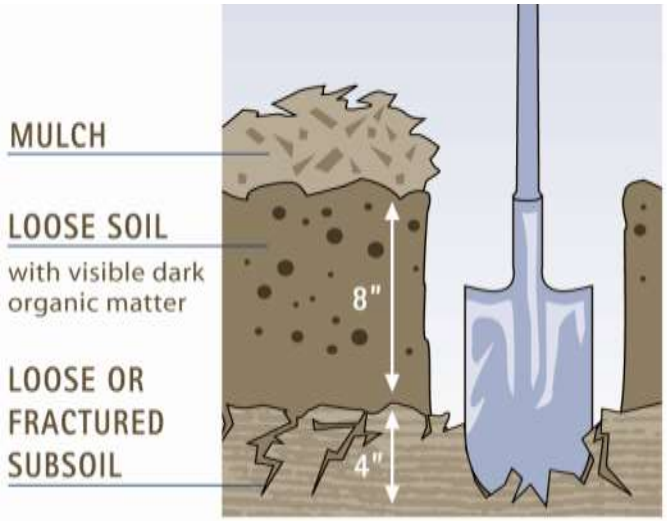
Examining a soil profile with a soil probe / core sampler

Only works 6 -12" deep, so better for lawns than trees.

Compacted vs. Amended

Examining soil profile with shovel

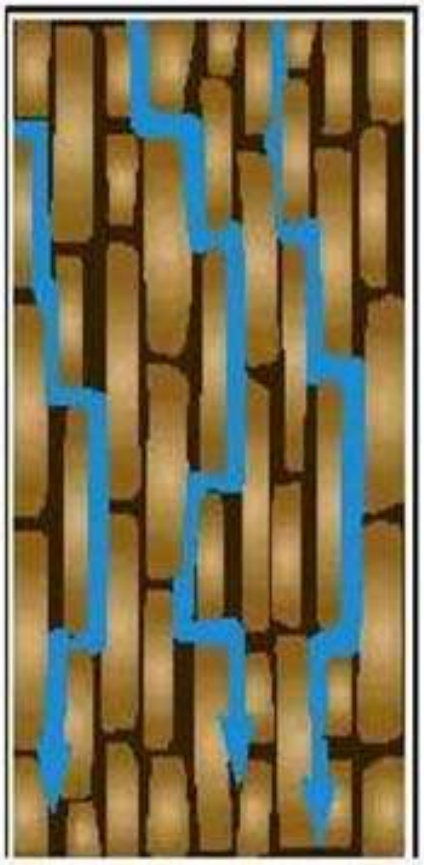
To verify scarification of subsoil and amendment of upper 8" with compost.



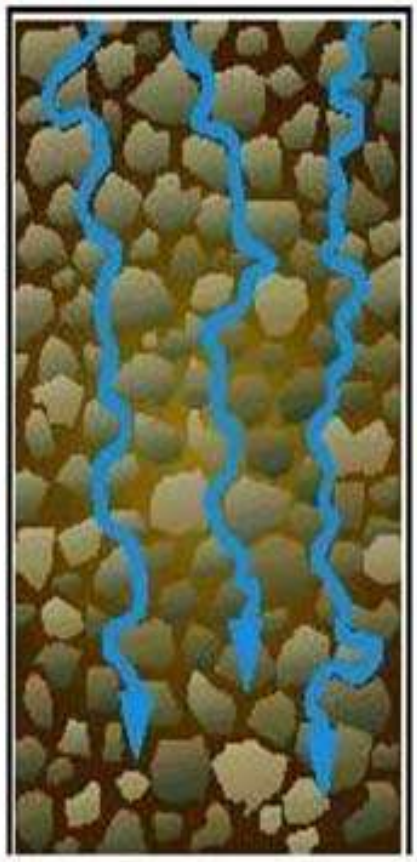
Water and Soil

Gravitational water flow examples through soils containing different *soil structure*.

Granular



Prismatic



Subangular blocky

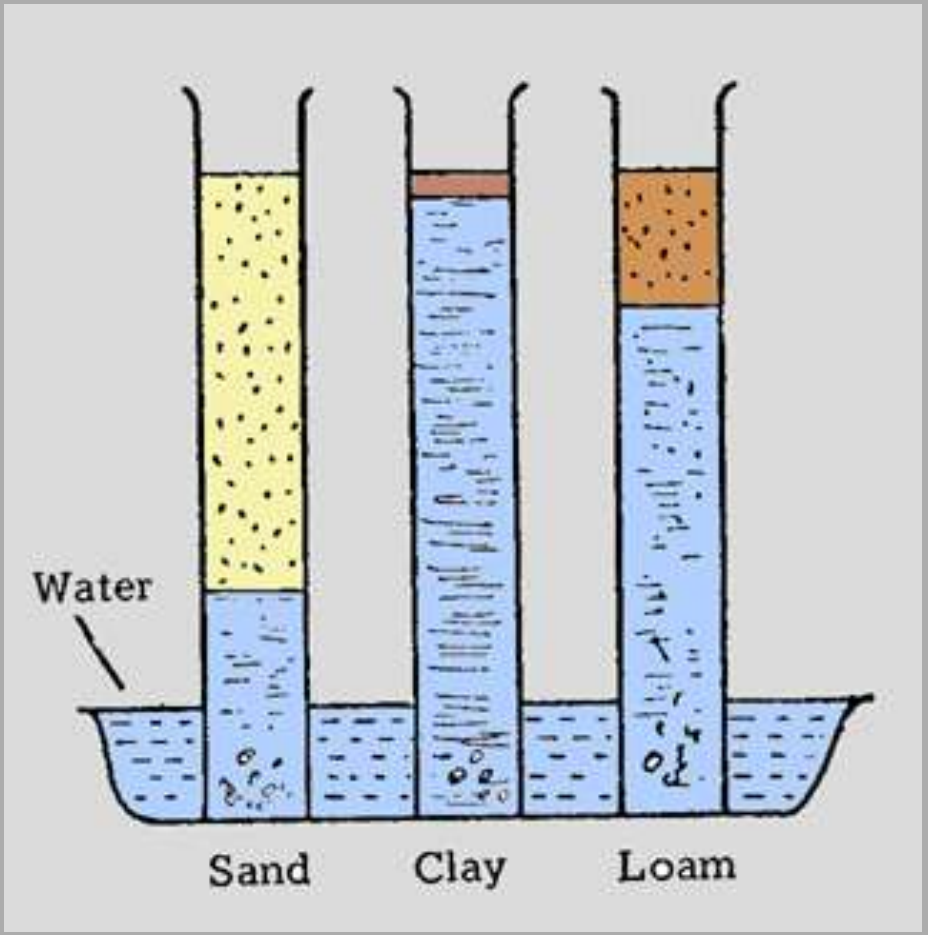
Platy

Modified from http://www.swac.umn.edu/classes/soil2125/doc/s7chp3.htm

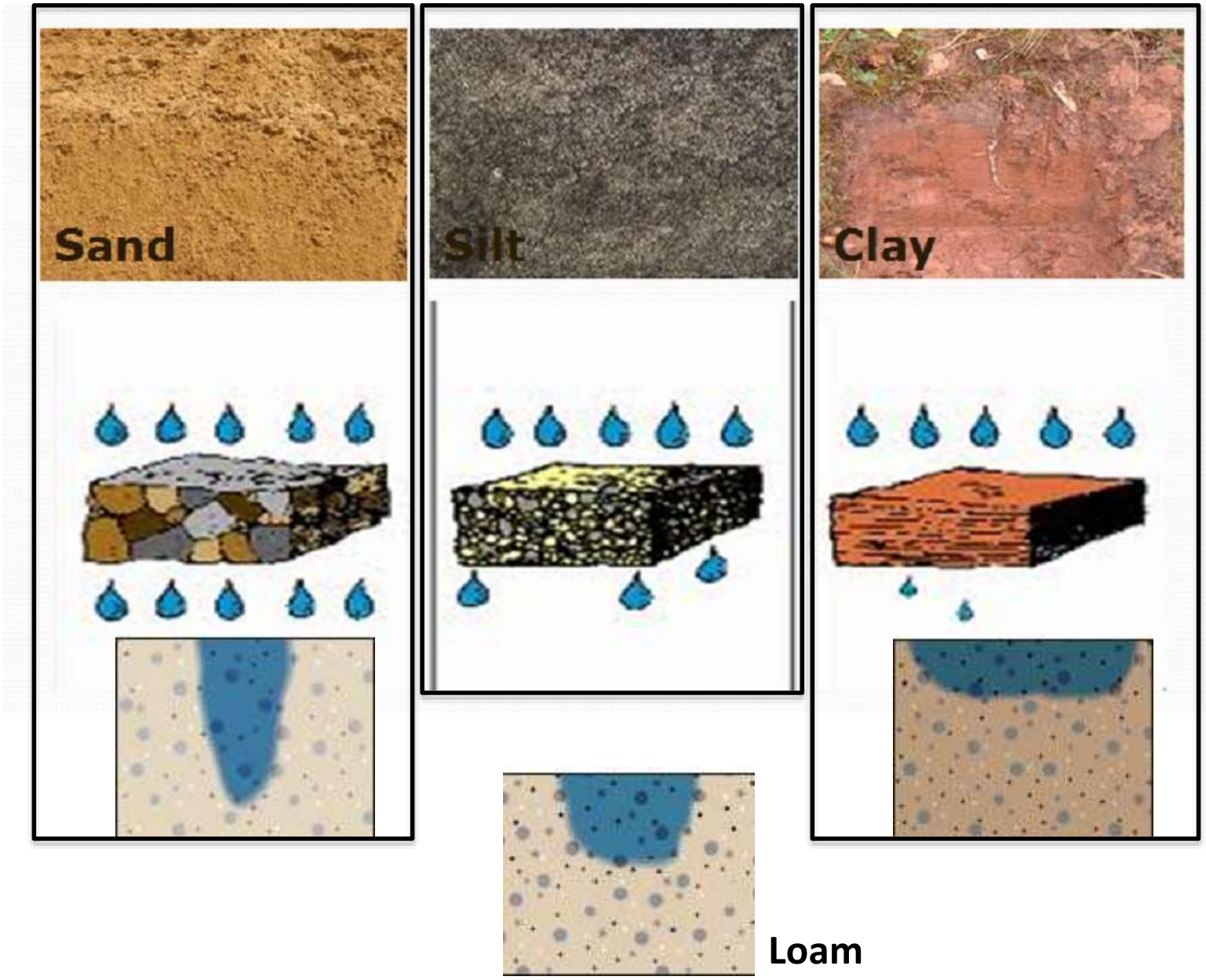
Water and Soil

Gravity & Capillary *Actions* in Soil

- Capillary - the movement of a liquid along the surface of a solid caused by the attraction of molecules of the liquid to the molecules of the solid.

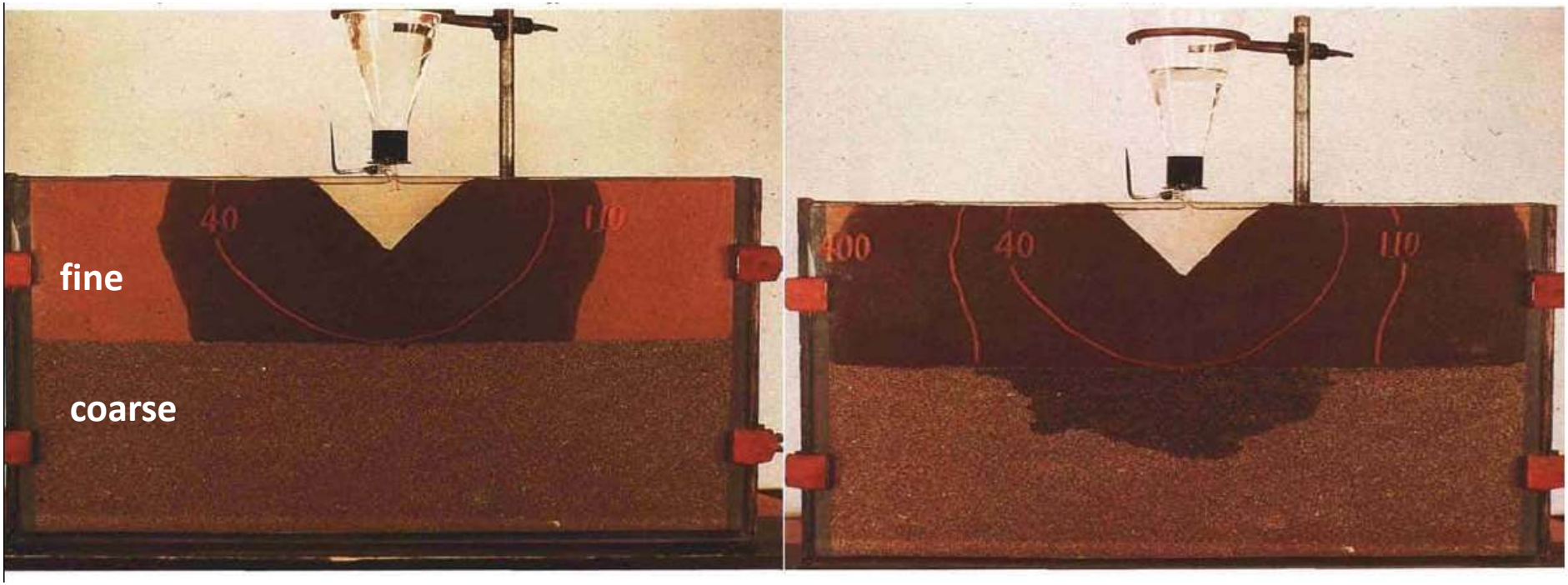


Water and Soil Texture



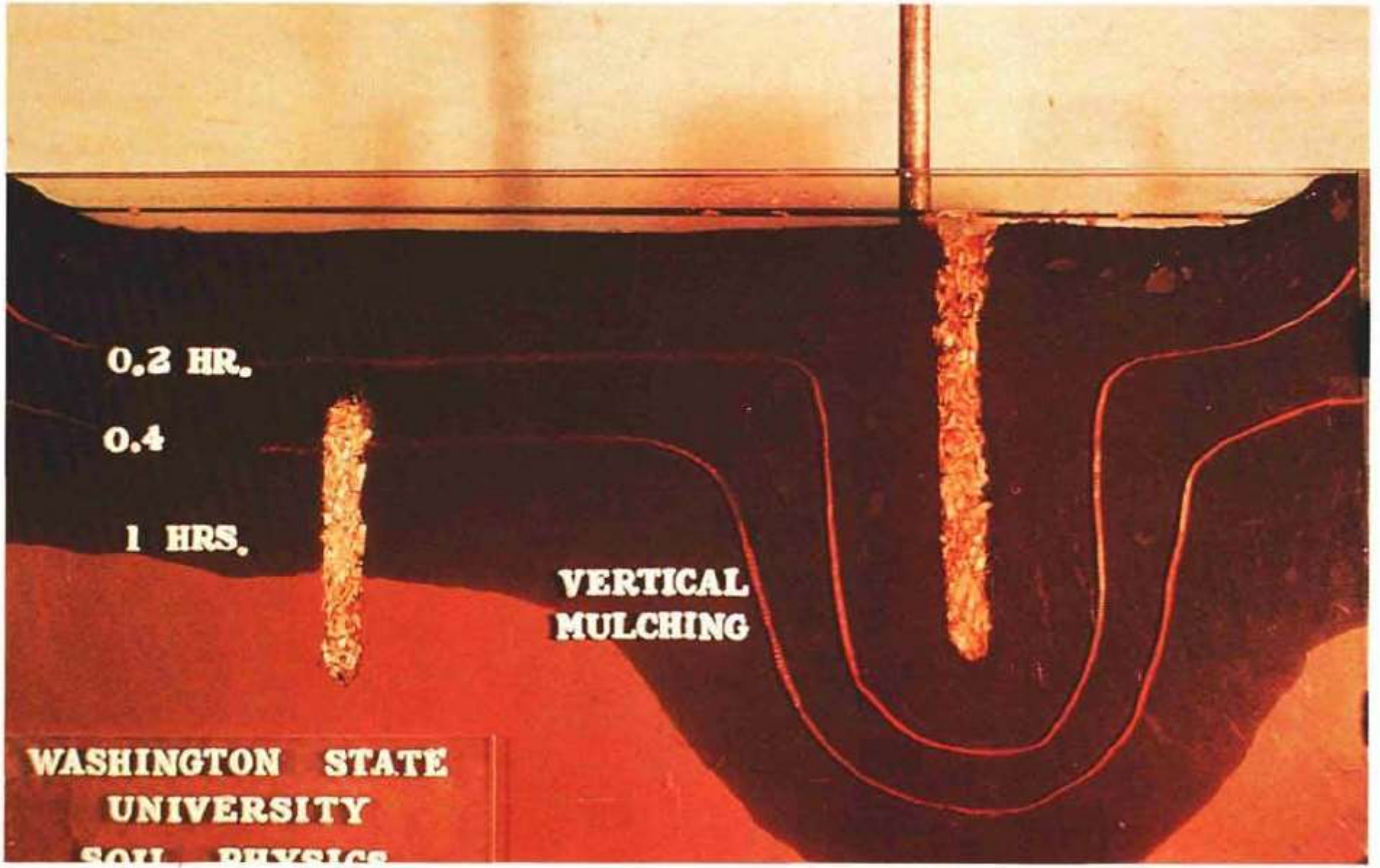
Modified from http://scvh2oprograms.com/soil-types-santa-clarita-valley-0

In a layered soil, water will not move into a **different textured soil** until saturation takes place and gravity affects water movement.



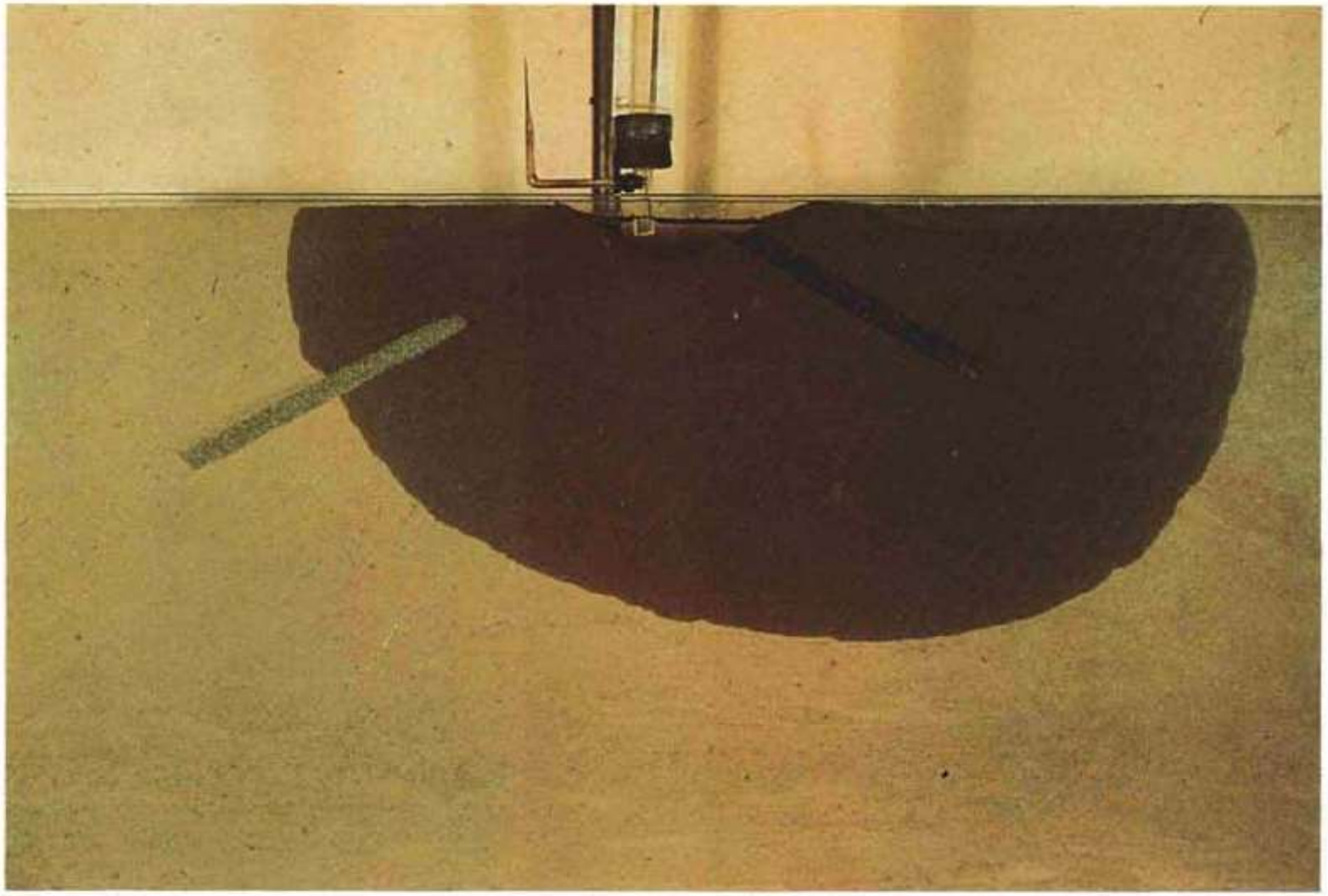
(Walter Gardner - WSU, 1988)

Effect of water percolation related to placement of mulch in the soil



(Walter Gardner - WSU, 1988)

Effect of water percolation related to placement of gravel in the soil



(Walter Gardner - WSU, 1988)

A well Managed Soil is a Live Soil

To manage the soil well you need to be aware of the <u>Physical Soil Properties</u>

- **Parent soil**
- **Texture**
- **Structure**
- **Profile**
- **Compaction**
- **Water / soil relationships**