Soil Structure and its Importance

VCE Soil Webinar Series
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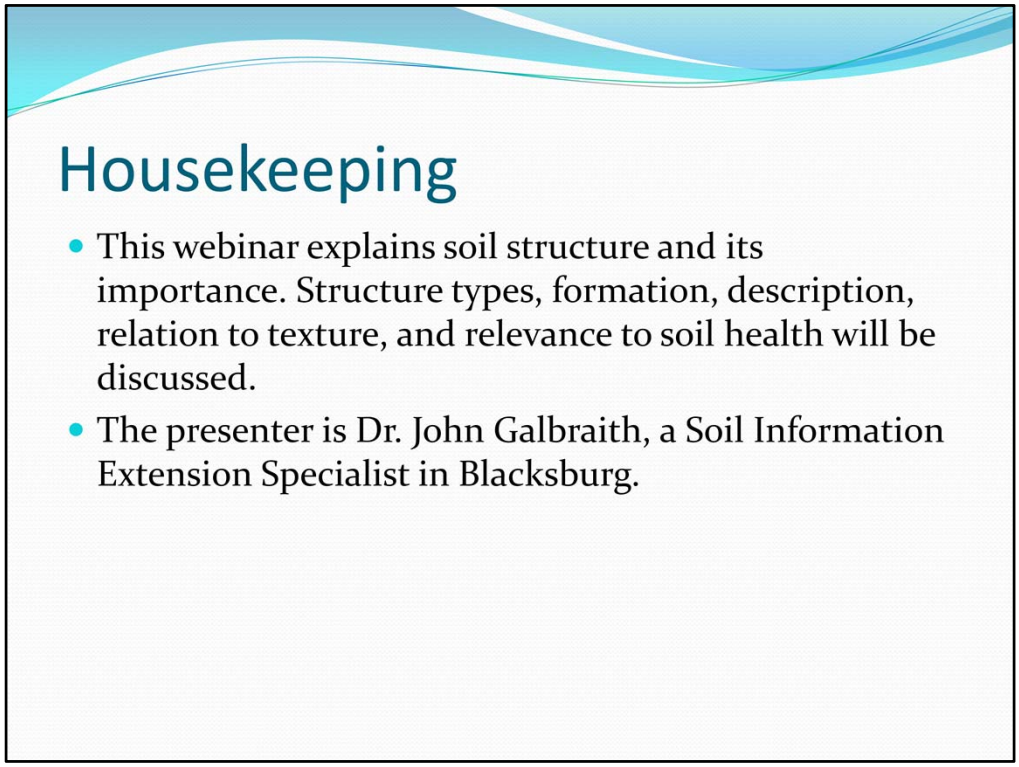
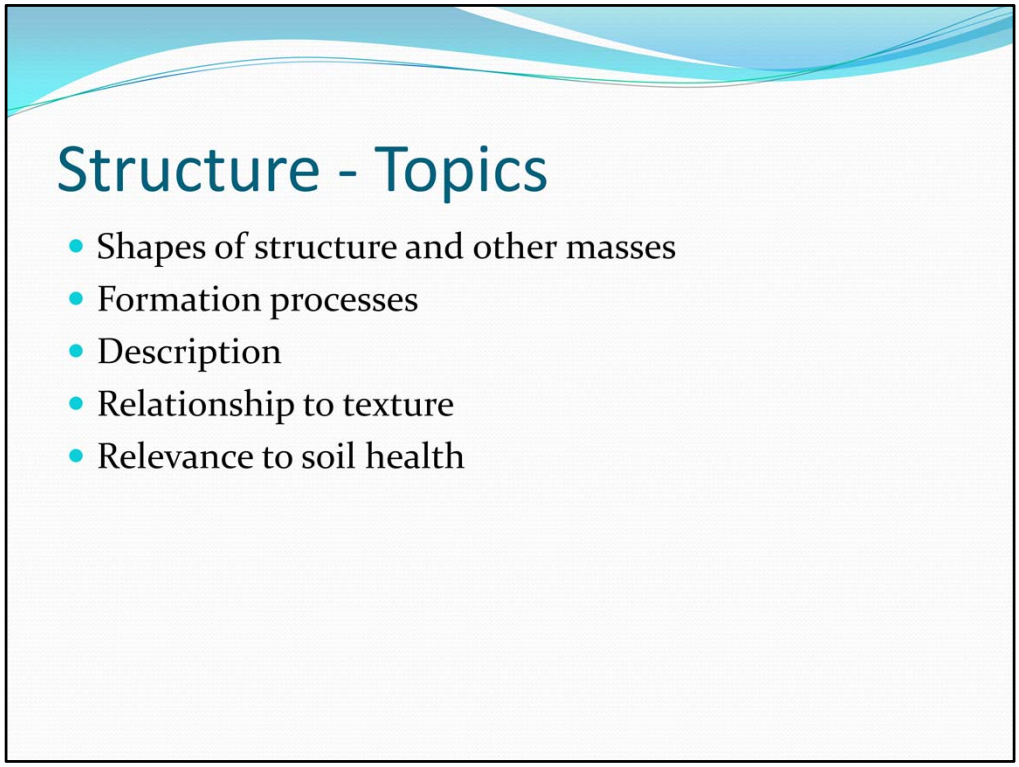
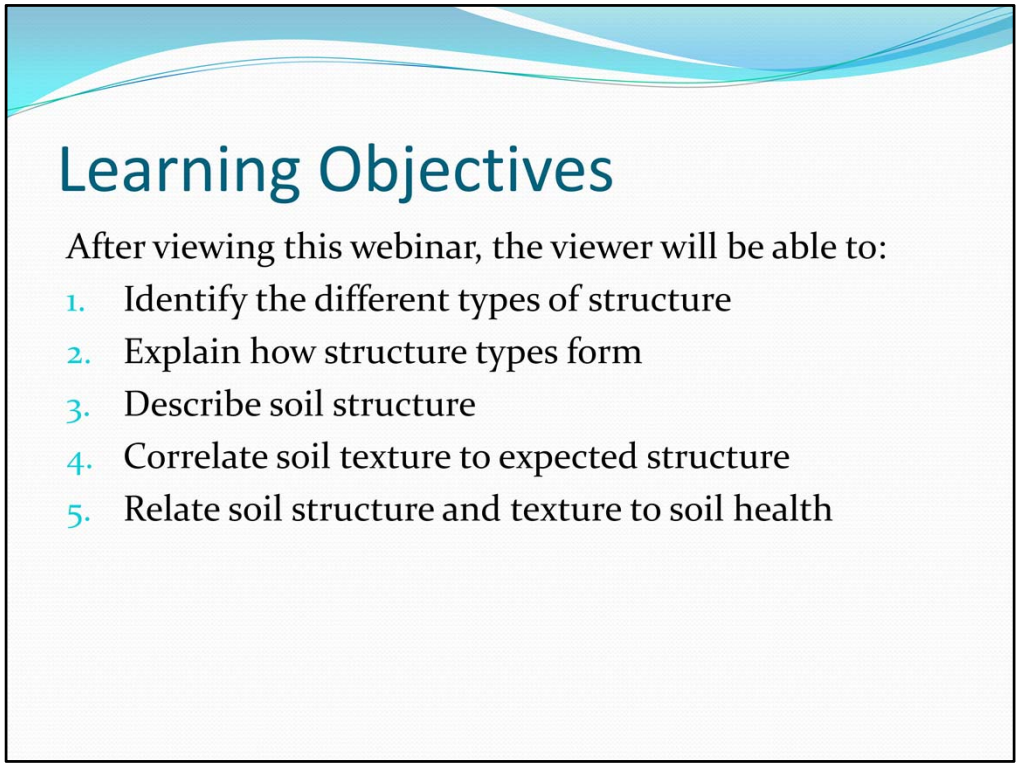
My name is Dr. John Galbraith. This webinar is part of the webinar series given at the Introductory level, May 28, 2015. Today's topic is "Soil Structure and its Importance".



This webinar explains soil structure and its importance. Structure types, formation, description, relation to texture, and relevance to soil health will be discussed.



List of topics.



Learning objectives of this webinar.

The Importance of Structure

- Soil structure influences the rate and amount of roots, air and water movement through soils
- Poor aggregate stability causes crusting, impedes seedling emergence, and increases erosion and runoff
- Better soil structure means better soil health

This picture of a thick crust impeding seedling emergence illustrates the importance of good structure, water stable aggregates.

Structure Shapes

- At the soil surface, granular and subangular blocky
- Just beneath the surface, subangular blocky and platy
- In the subsoil, prismatic, columnar, subangular blocky, angular blocky, wedge, and thick platy

The most common occurrence of different shapes.

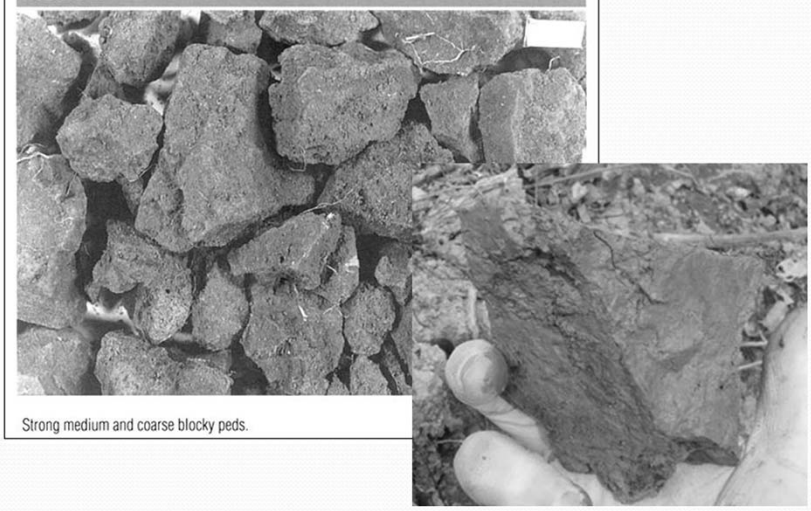
Granular

FIGURE 3-30

Strong fine and medium granular peds.

Subangular and Angular Blocky

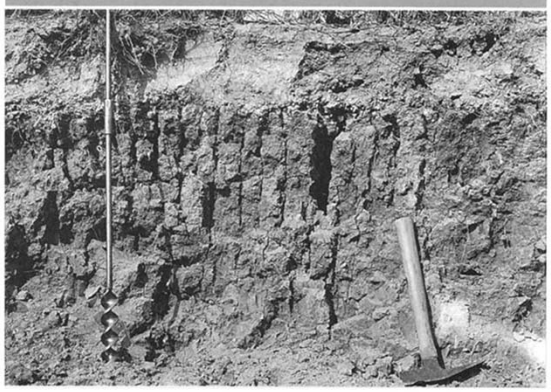
FIGURE 3-29



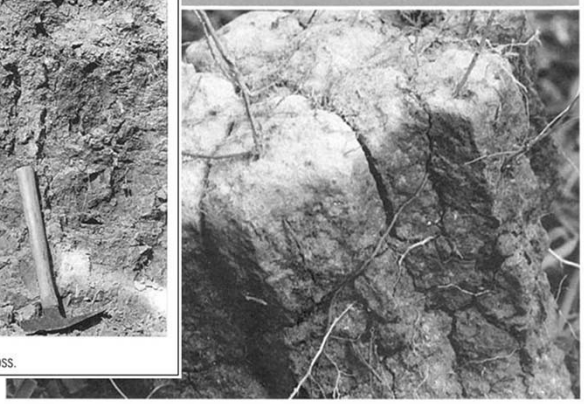
Strong medium and coarse blocky peds.

Prismatic and Columnar

FIGURE 3-27



Strong medium prismatic structure. The prisms are 35 to 45 mm across.

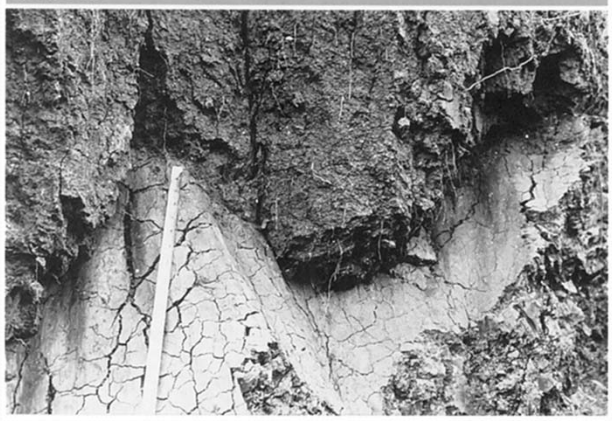


A cluster of strong medium columnar pads. The cluster is about 135 mm across.

Columnar only occurs where the sodium is relatively high in abundance. It is a dense, root-limiting structure.

Wedge

FIGURE 3-32



Wedges are formed when the slip surfaces intersect. (shrink-swell clays)

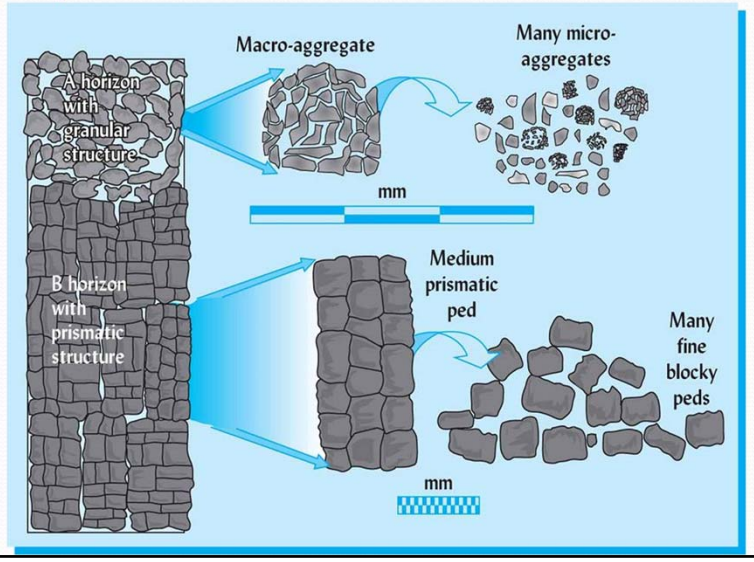
Platy

FIGURE 3-26

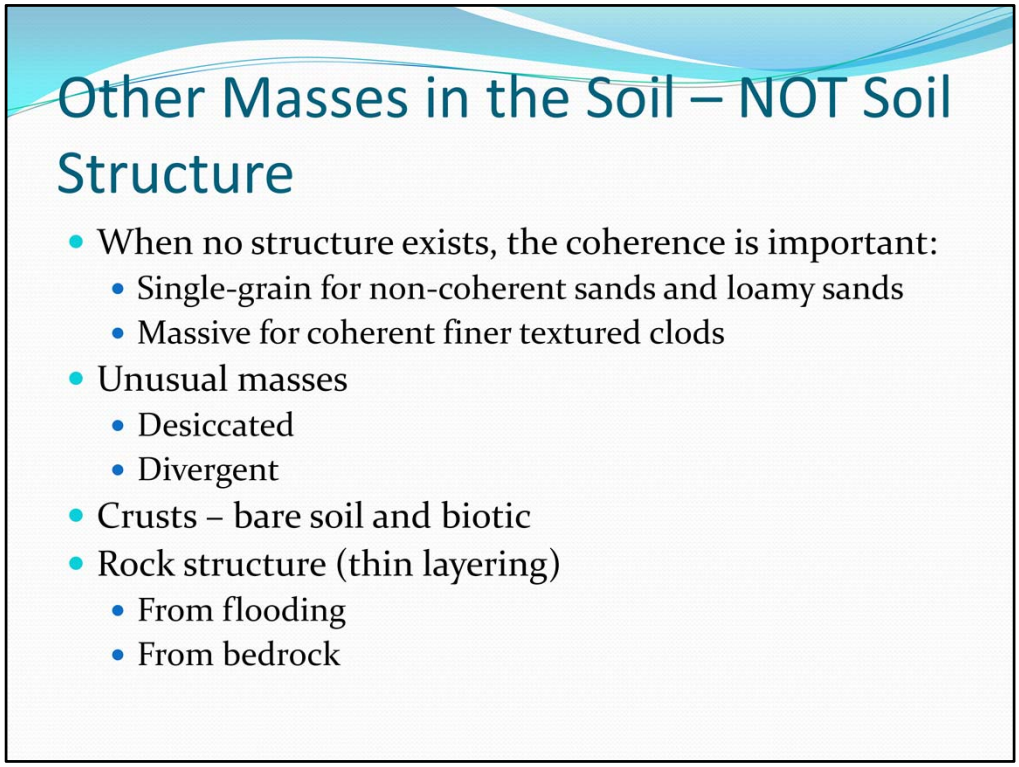
Strong thin platy structure.

Naturally platy structure forms from ice lens compaction. Thick platy forms from compaction by vehicles and tools.

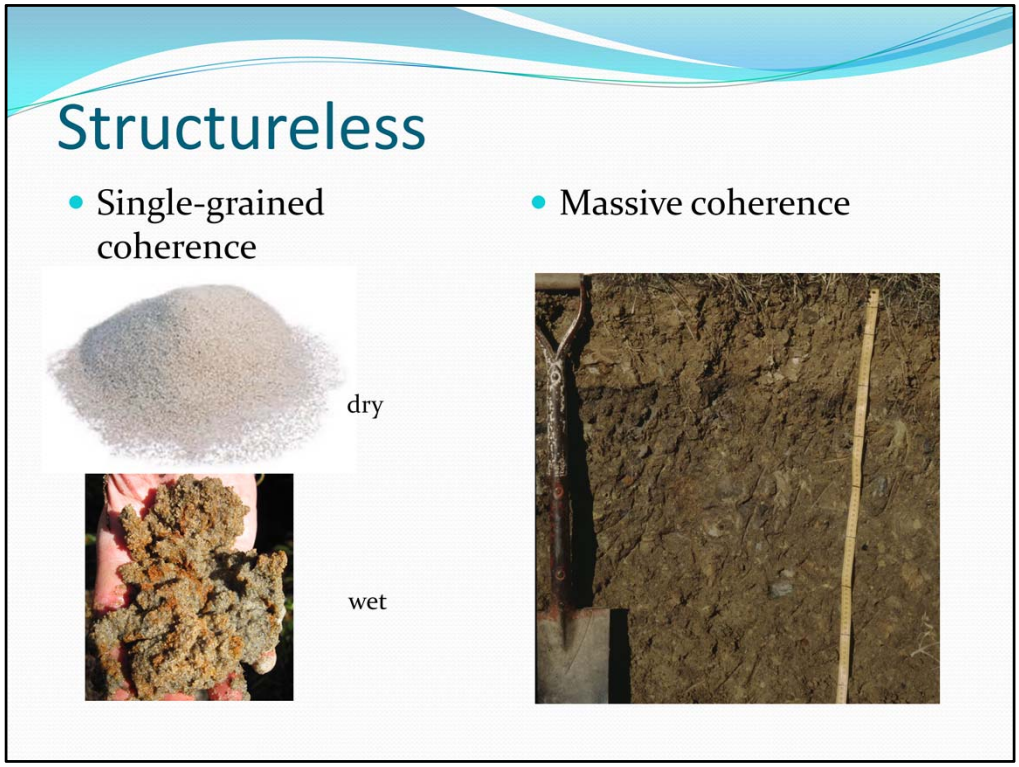
Compound Structure



Most structure is compound – it breaks into smaller units.



Without soil structure, we have clods in coherent textures, and single sand grains in sandy textures. Desiccated and divergent structure forms are unusual but do exist. Crusts form in two ways. Rock structure is really thin layering from recent or ancient deposition or mineral separation.



Notice the tool marks in the compacted mine soil, because there were no soil aggregates to dig out.

This dredged material or pond-bottom sediment cracks into polygons when drying. Divergent masses have irregular and unpredictable shapes do to shearing.

Crusts

- Like platy structure at the surface, but really a temporary mass.

- Some are biotic

The crust at top is from bare farmed soil and raindrops melting unstable aggregates. Silty soils are the worst. The biotic crust stabilizes the soil from erosion but may indicate excess nutrient application and ponding.

Thin layering fro dredge flooding – left; and from weathered bedrock layering - right.

Quiz

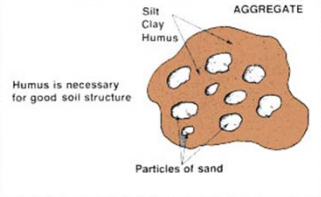
- Are all soil crusts signs of bad soil health?

A. Yes

B. No

Structure Forming Processes

- Materials: Oxides, organic matter and clay (colloids) content are associated with structure formation. These materials bind sand grains to silt to form aggregates, and coat aggregate edges.



This is how sand grains stay together and do not always stay as loose grains. Note the role of OM (humus). The more clay, the more micropores inside the aggregates, macropores on the outsides and open pores (higher total porosity than pure sands).

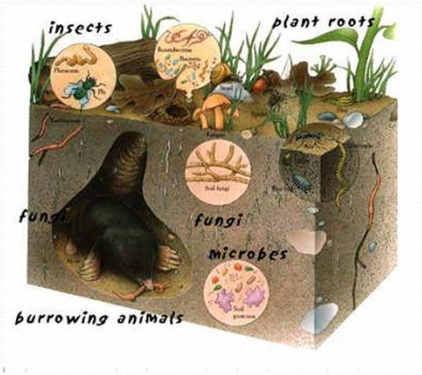
Structure Forming Processes

- Processes: Wetting and drying, freezing and thawing, and shrinking and swelling are all associated with structure formation.

Wetting and drying, freezing and thawing, and shrinking and swelling are all associated with structure formation. They all form macropores.

Structure Forming Processes

- Some structure formation is associated with microbes, earthworms and plant roots.



Humus binds sand grains together and holds clays together. Microbes exude gels and enzymes, roots slough off cells and exude enzymes and hormones. Earthworms exude gels from their skin and excrete small, stable aggregates.

Describing Structure

- Grade – How evident and stable is the structure?

3 - Strong – easily seen, easily sampled, holds together well

2 - Moderate – can be seen, can be sampled, holds together under gentle pressure

1 - Weak – hard to see, hard to sample, breaks easily under gentle pressure

0 – Structureless – has no soil structure

Give it a grade just like a test!

Moderate at top, weaker below

Rock layering

Describing Structure

- Size – How large are the aggregates? Complex

Fine, medium, coarse, very coarse – for rounded shapes

Thin, medium, thick, very thick – for flat shapes

Table 3-13. Size classes of soil structure

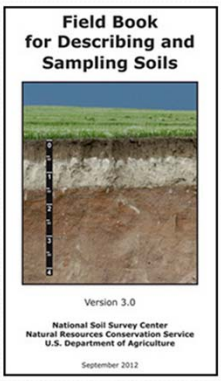
	Shape of structure			
Size Classes	Platy[1] mm	Prismatic and Columnar mm	Blocky mm	Granular mm
1	< 1	< 10	< 5	< 1
2	1 - 2	10 - 20	5 - 10	1 - 2
3	2 - 5	20 - 50	10 - 20	2 - 5
4	5 - 10	50 - 100	20 - 50	5 - 10
5	> 10	> 100	> 50	> 10

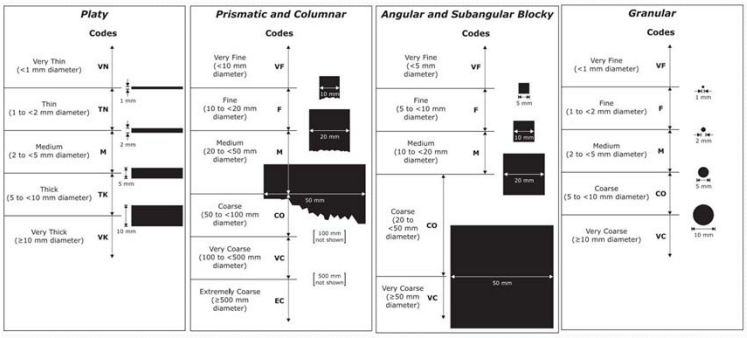
1. In describing plates, "thin" is used instead of "fine" and "thick" instead of "coarse."

The size is complex but the smaller the units, the greater surface area for water and gas exchange and root growth.

Field Book for Describing Soils Ver. 3.0

- http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/ref/?cid=nrcs142p2_054184





Great reference, get one for free.

Describing Structure

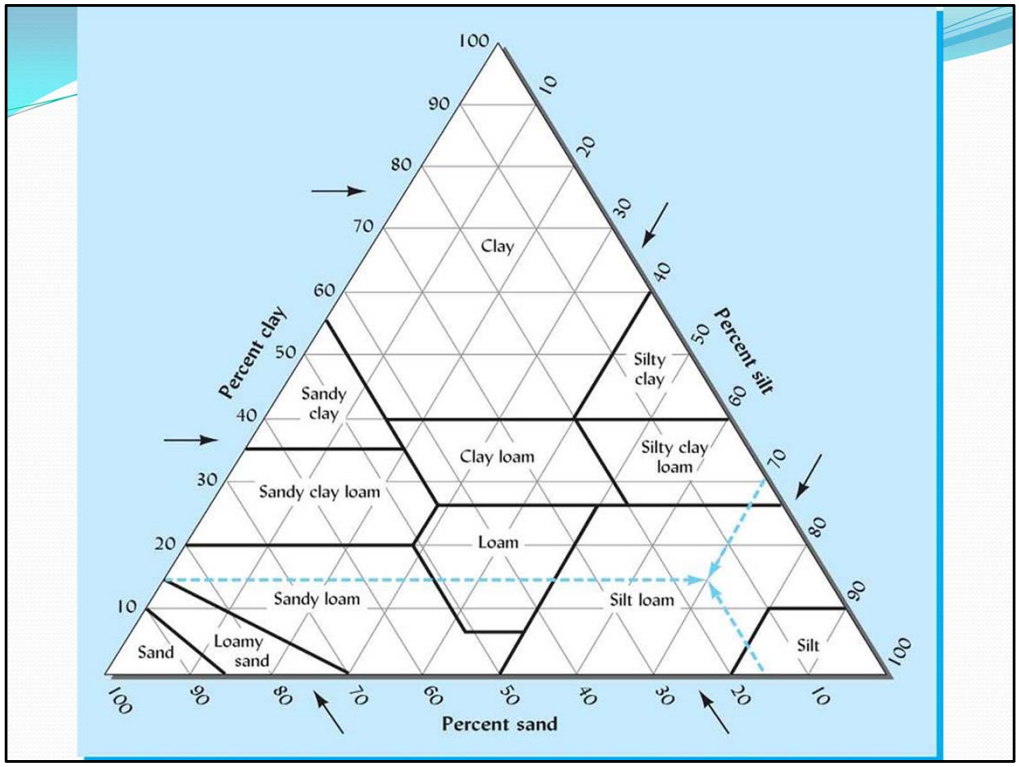
- Shape – which shape of structure or other mass (described earlier) do you see?
- Granular, subangular blocky, angular blocky, prismatic, columnar, wedge, platy

Shapes reviewed earlier.

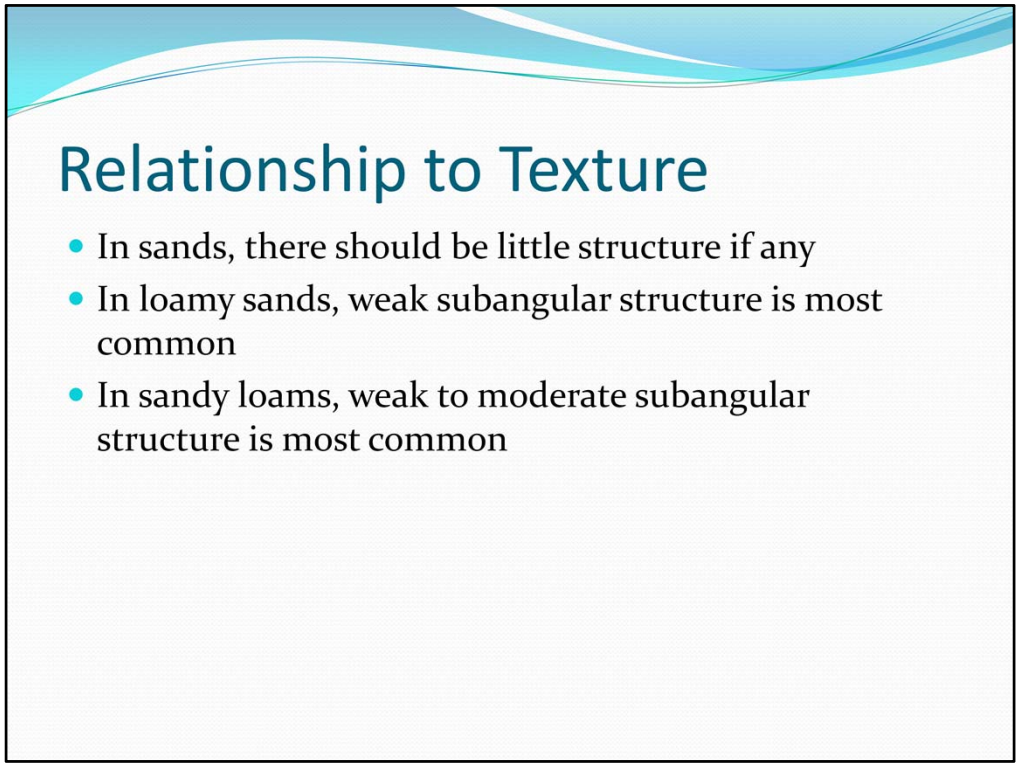
Put it all Together

Moderate, medium, subangular blocky

Put it all together. Grade, size, shape



Texture triangle for reference.



Sandy soil have little if any structure, clays have abundant structure if not compacted. Sandy textures have lower water holding capacity and organic matter and support fewer microbes, earthworms, insects, and roots, so have weaker structure.

Relationship to Texture

- At the surface:
  - In textures finer than sandy loam, uncompacted surfaces commonly have granular structure, esp. if in pasture or forest
  - Compacted surfaces of loamy texture have subangular blocky or platy structure
  - Clayey textures surfaces tend to form granular structure

Compaction makes a difference.

Structure Forming Influences

- Materials: Oxides, organic matter and clay (colloids) content are associated with structure formation. Sandy soils are low in these, so have less structure and weaker structure.
- Processes: Wetting and drying, freezing and thawing, and shrinking and swelling are all associated with structure formation. Soils that hold more water or have expansive clays have better structure. Soils that are always wet have poor structure.

Organic Textures – Thick Platy

Organic matter laid down in layers, form plates.

Soil Health

Compaction causes thick platy structure, prevents root growth, air and water movement

Crusting after loss of structure due to low aggregate stability. The crust prevents seedling emergence, air and water movement

Compaction from humans and their tools and practices form plates or crusts (surface plates).

Soil Health

- Root growth restricted to above the compacted zone, or along a few vertical edges. Very few roots or air penetrate these clods.

See the root distribution.

This soil looks like it has good structure. Good structure = good health.

Questions?

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