Soil Properties and Behavior

Soil is a heterogeneous, multiphase, disperse and porous system. It is the most common media for plant growth.

Soil Phases

- Soil Particles — Mainly alumino-silicates from weathered rocks and organic matter from the decay of vegetation. Organic matter usually limited to the top layers of the soil. The soil particles provide rigid support for plant growth.

- Soil Water — Soil water contains dissolved minerals which plants need for growth and cell integrity. Almost all the nutrients used by the plants are obtained from the soil solution.

- Soil Air — The air provides oxygen for root respiration and for microbial activity.

Irrigation and drainage are concerned with maintaining the optimum balance between soil water and soil air.

- Too much water : Shallow root growth; Roots may rot; Anaerobic reactions produce toxic byproducts that reduces growth

- Too little water : Limited nutrient supply retards plant growth; Wilting occurs; reduced yields; If conditions are dry enough plants can die.

Some plants are adapted for growth in extremely wet or in extremely dry conditions. These plants have efficient mechanisms for supplying oxygen or for conserving water.

Soil Particles

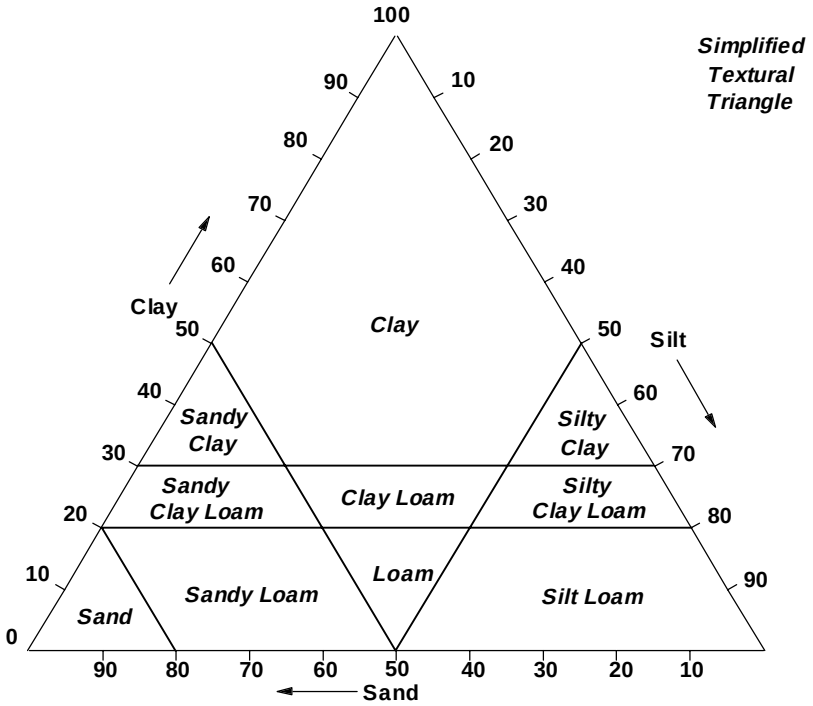
Soil particles are mainly weathered rock particles. These particles are classified according to their diameters.

USDA Classification		International Classification	
Clay	< 0.002 mm	Clay	< 0.002 mm
Silt	0.002 - 0.05 mm	Silt	0.002 - 0.02 mm
Very Fine Sand	0.05 - 0.10 mm	Fine Sand	0.02 - 0.20 mm
Fine Sand	0.10 - 0.25 mm		
Medium Sand	0.25 - 0.50 mm	Coarse Sand	0.20 - 2.00 mm
Coarse Sand	0.50 - 1.00 mm		
Very Coarse Sand	1.00 - 2.00 mm		
Gravel	> 2.00 mm	Gravel	> 2.00 mm

Qualitatively, soil texture refers to the *feel* of the soil material, whether coarse and gritty, or fine and smooth. In general, soil behavior can be inferred from the texture. A coarse-grain sandy soil tends to be loose, well aerated and easy to cultivate. Water moves through sands relatively quickly and they do not retain much water since they have few small pores. A fine-textured soil tends to absorb much water and become plastic and sticky when wet, and tight compact and cohesive when dry. Water move through clays more slowly but because they have a lot of small pores, they tend to retain more water. Sands are often referred to as light soils and clays as heavy soils. In actual fact a given volume of a clay soil is lighter than an equal volume of a sandy soil. Thus the use of the terms heavy and light must be understood in their historic content.

Qualitatively, texture is determined by the proportions of sand, silt, and clay that make up the mineral portion of the soil (that is, excluding the organic matter in the soil). There is a separate classification for soils that are mainly composed of organic matter.

Soil texture information is conveniently displayed in a textural triangle.



- Soils with more than 30% clay are clays
- Soils with 20 - 30% clay are clay loams
- Soils with less than 20% clay are loams unless they have more than 80% sand
- Soils with more than 80% sand are sands
- Soils with more than 50% sand are sandy
- Soils with more than 50% silt are silty

In this triangle the axis for each component runs parallel to the baseline that is opposite the apex representing 100% of that component.

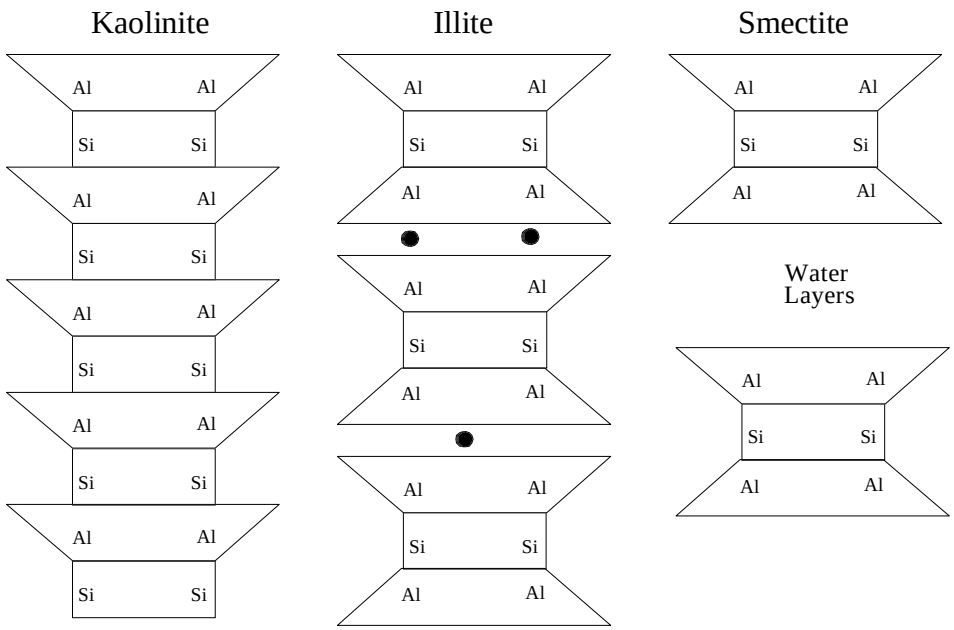
Sample problem: A particular soil contains 30% sand and 45% silt. To which textural class does this soil belong?

Clay and Clay Mineralogy

Clay plays an important role in soil behavior. Soils may be classified based on clay content or clay mineralogy.

- Below 30 - 35% clay : Clay particles are dispersed in a matrix formed by the coarse particles. Soil properties are determined by the clay content

- Above 30 - 35% clay : Coarse particles are dispersed in a continuous clay matrix. Properties are determined by the clay mineralogy. These soils are known as *clayey soils*.



Kaolinites under little volume change when they are wetted while smectites undergo dramatic volume changes. Illites are intermediate between the two extremes. Smectites tend to form irreversible cracks from repeated wetting and drying. These cracks can influence water movement and water holding capacity in these soils. Plant roots tend to converge in the vicinity of these cracks.

Classification for Irrigation

Land parcels can be classified according to its possible use for irrigation. This system was developed by the United States Bureau of Reclamation. Land parcels are classified based on their potential to earn money from irrigated farming. The system can be used to set rates for land rental. There are six classes:

- Class 1: The highest level of irrigation suitability and thus the highest payment capacity
- Class 2: Intermediate suitability and payment capacity
- Class 3: Lowest suitability and payment capacity
- Class 4: Land could be irrigable after some special problem or deficiency is corrected
- Class 5: Temporary designation for land requiring special study before a decision can be made
- Class 6: Land not suitable for irrigation development

	Class 1	**Class 2**	**Class 3**
Texture	Sandy Loam Silt Loam	Loamy Sand Silty Clay Loam	Loamy Sand Silty Clay
Minimum Depth	1000 mm	600 - 750 mm	450 - 600 mm
Length (m)	120	100	50
Size (ha)	3	2	1
Maximum excavation for drains (m^3/ha)	400	800	1400
Maximum land-leveling (m^3/ha)	400	800	1400

Special problems are indicated by suffixes: s for soil; t for topography; and d for drainage.

Hydric Soils

Wetlands have special protection under Federal and State law. The uses to which these systems can be put are often controlled. It is important to recognize wetlands and seek professional guidance before these lands are utilized. Wetland soils are known as hydric soils. The differentia for these soils are based on soil water regime. The concept of a hydric soil is akin to the aquic subgroups and aquic suborders in the US system of soil classification. There are several factors to look for if a hydric soil is suspected:

1. Is there free water on the soil surface or water within 18 inches of the soil surface for 5 or more days in the growing season?

2. Does the soil have a whitish or dull gray look?

3. Is there a smell of noxious gases (like rotten eggs)?

4. Is the vegetation typical of what grows in bogs or marshes?

If the answer to one or more of these questions is yes, then there is reason to consult a professional, such as an extension agent, before working the soil.