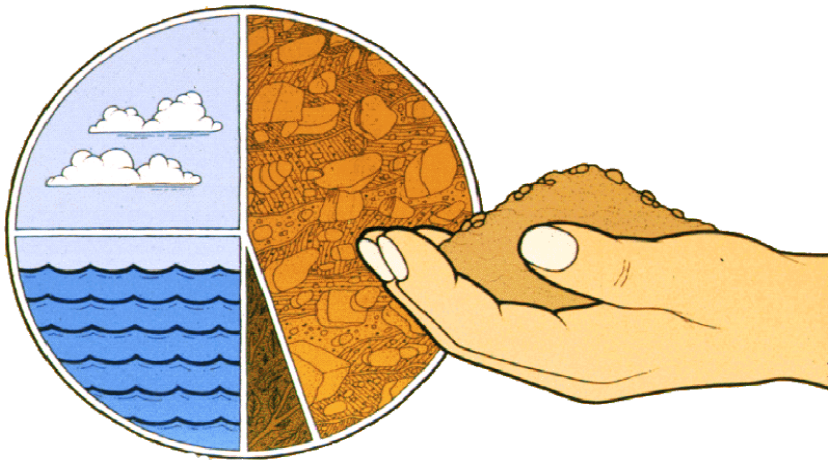
Five Factors of Formation of Soil

1. Climate
2. Organisms
3. Relief/Topography
4. Parent Material
5. Time



5 soil formation factors mnemonic

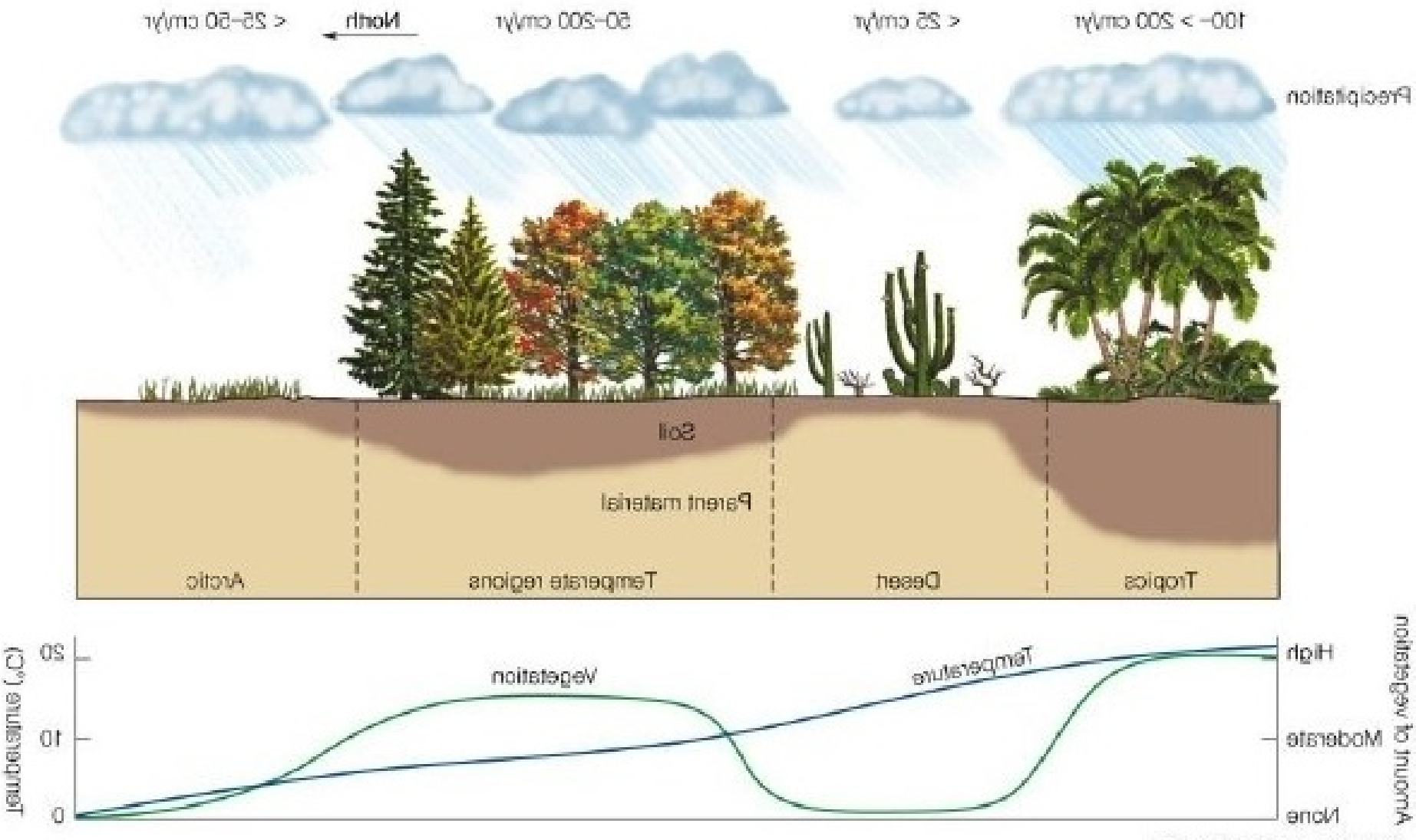
ClORPT

Five Factors of Formation of Soil

1. <u>Climate</u> - water and temperature interact to hasten or delay soil changes in soil we call “weathering”. Water and wind modify and transport soils

Interacts with organisms, topography, parent material and time

Five Factors of Formation of Soil



Five Factors of Formation of Soil

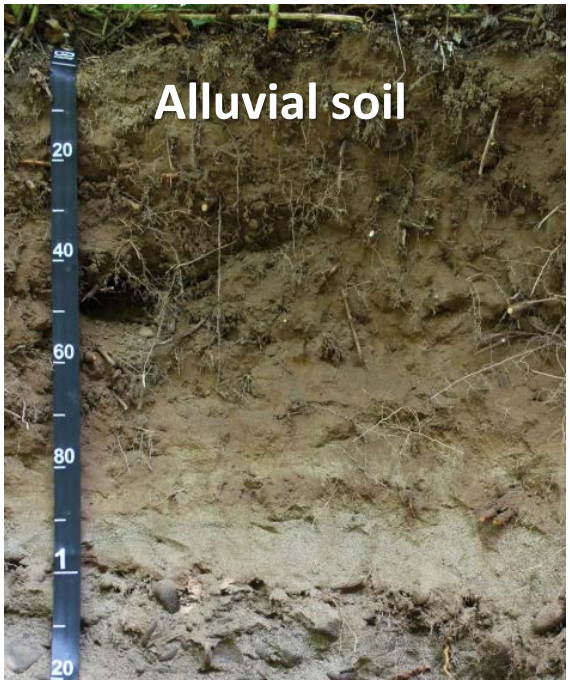
2. Organisms - bacteria, fungi, worms, crops, trees, humans, wildlife, etc. Disturb, modify, and transport soils

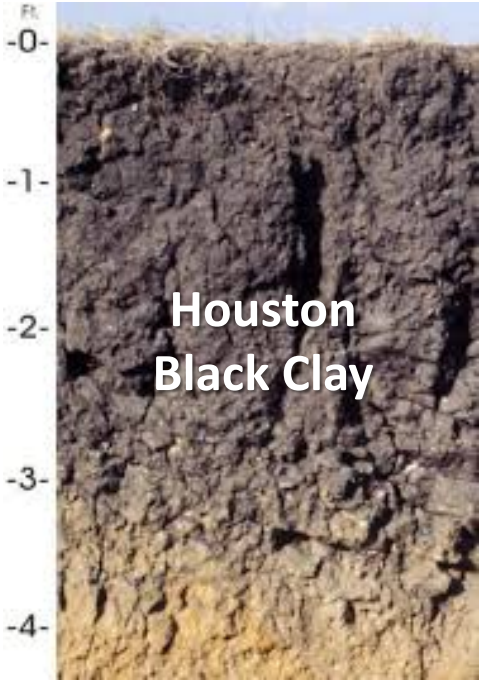
Interacts with climate, topography, parent material and time

Five Factors of Formation of Soil

3. Parent material - What rock is the soil made of?

Interacts with climate, topography, organisms, and time

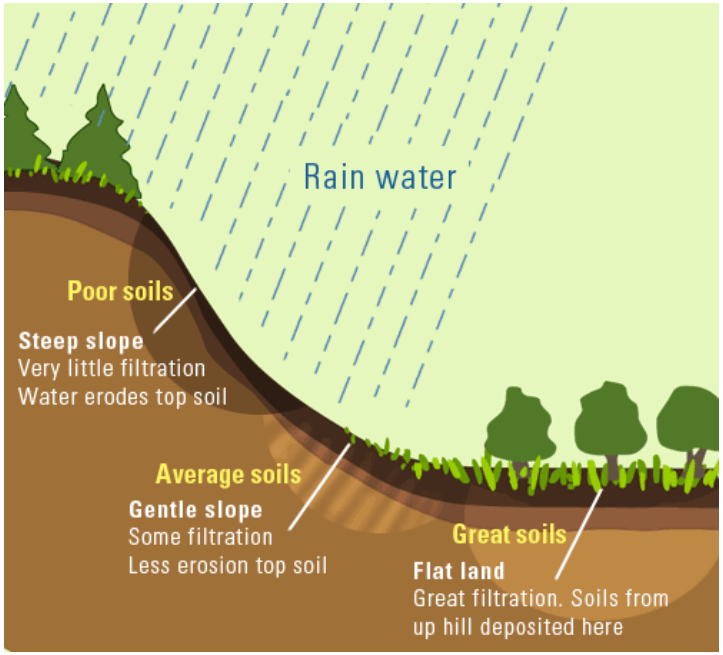




Five Factors of Formation of Soil

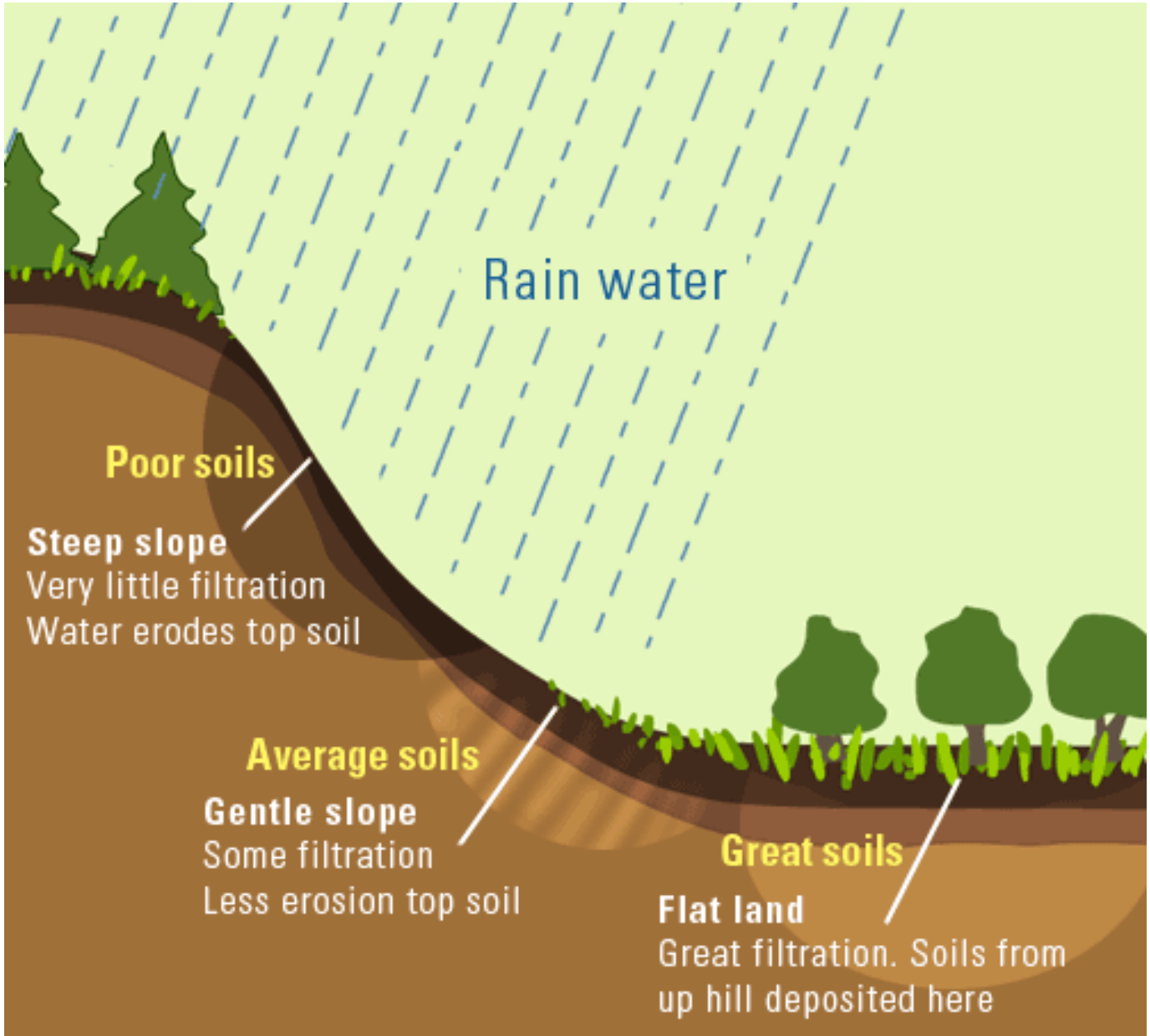
4. Topography - slope affects transport of soil by water.

Interacts with climate, organisms, parent material and time



Five Factors of Formation of Soil

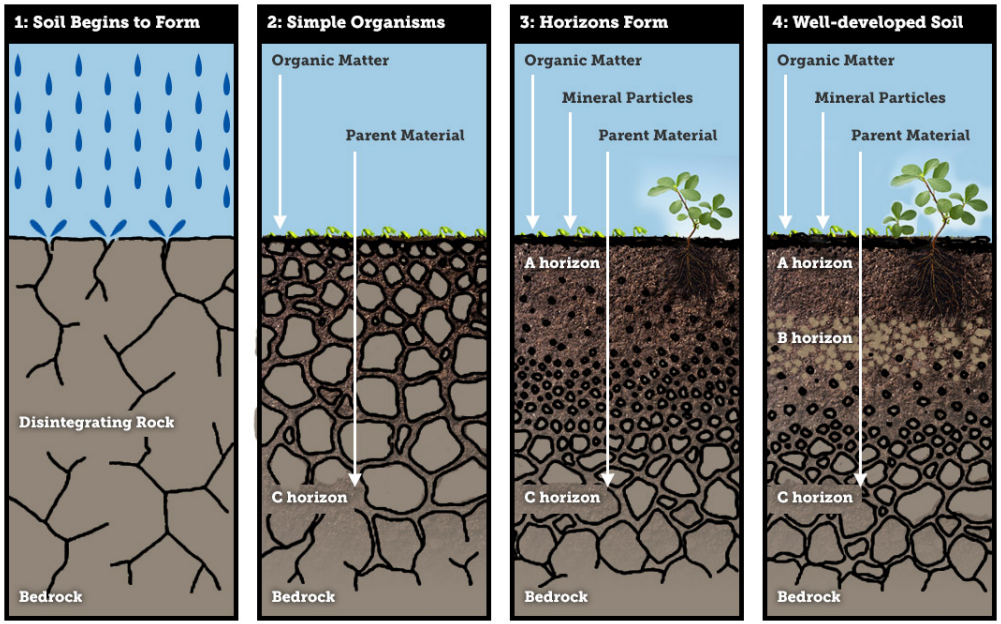
Topography



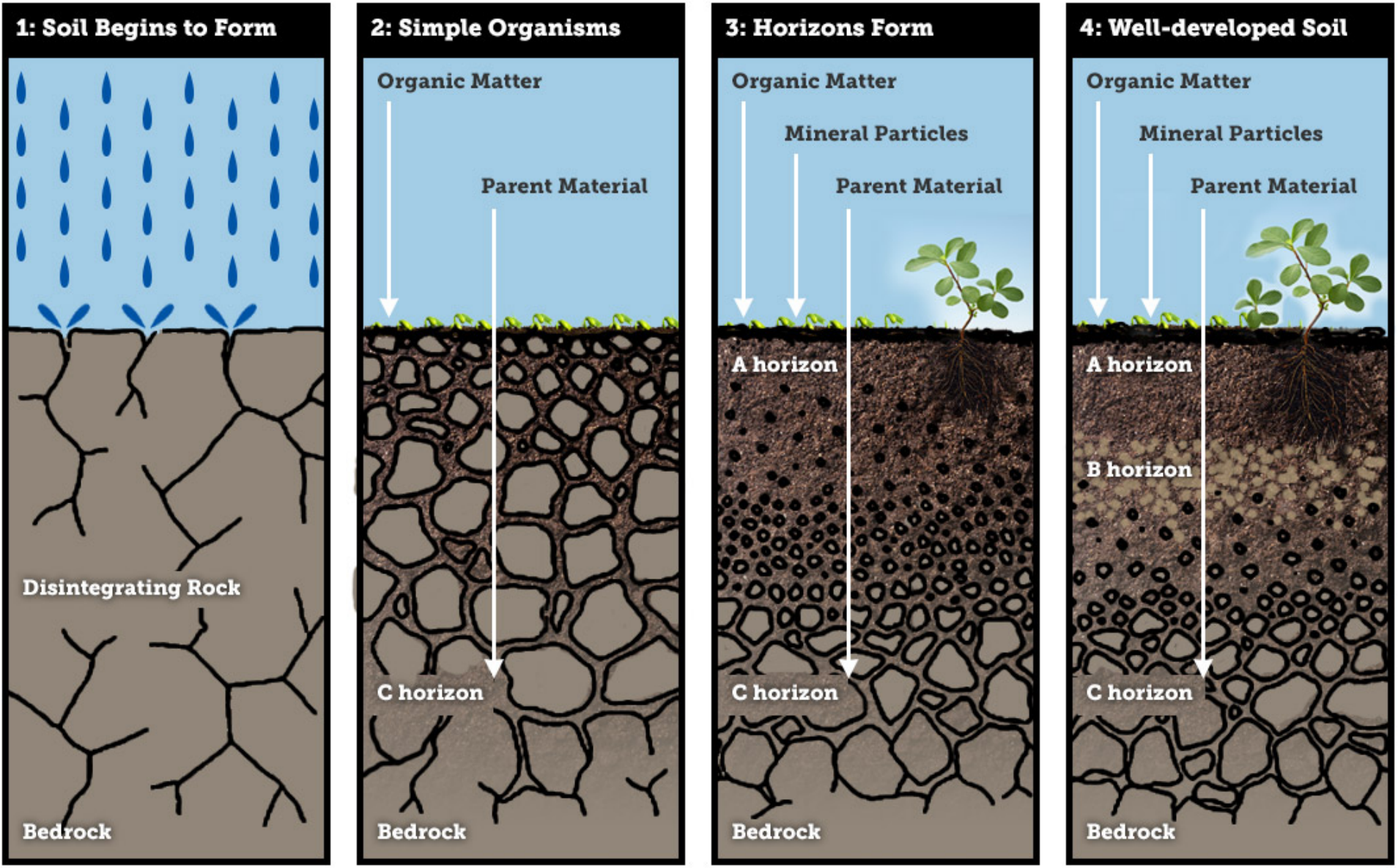
Five Factors of Formation of Soil

4. Time - how long has the soil been subjected to relative formation factors?

Interacts with climate, topography, organisms, and parent material

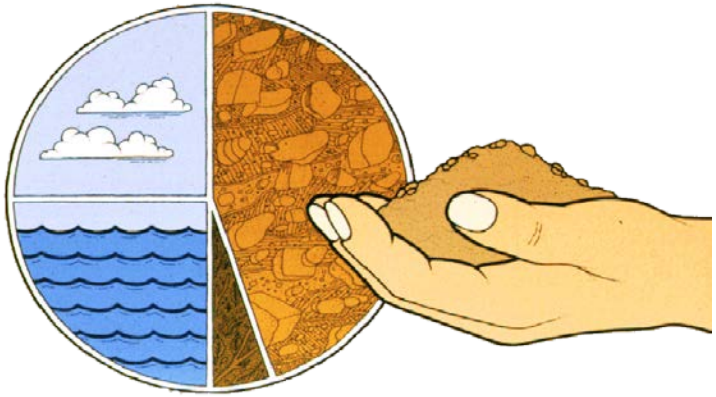


Five Factors of Formation of Soil



Five Factors of Formation of Soil

Together these factors produce soils that have different colors, textures, productivity, and behavior on the landscape.



5 soil formation factors mnemonic

ClORPT

Different soils will be more successfully applied to different purposes

USDA NRCS

United States Department of Agriculture
Natural Resources Conservation Service

General Soil Map of Texas

For more detailed soil information go to:
http://websoilsurvey.nrcs.usda.gov

This map was produced by the USDA - Natural Resources Conservation Service MO9 Soil Survey Office: Temple, TX September 25, 2008

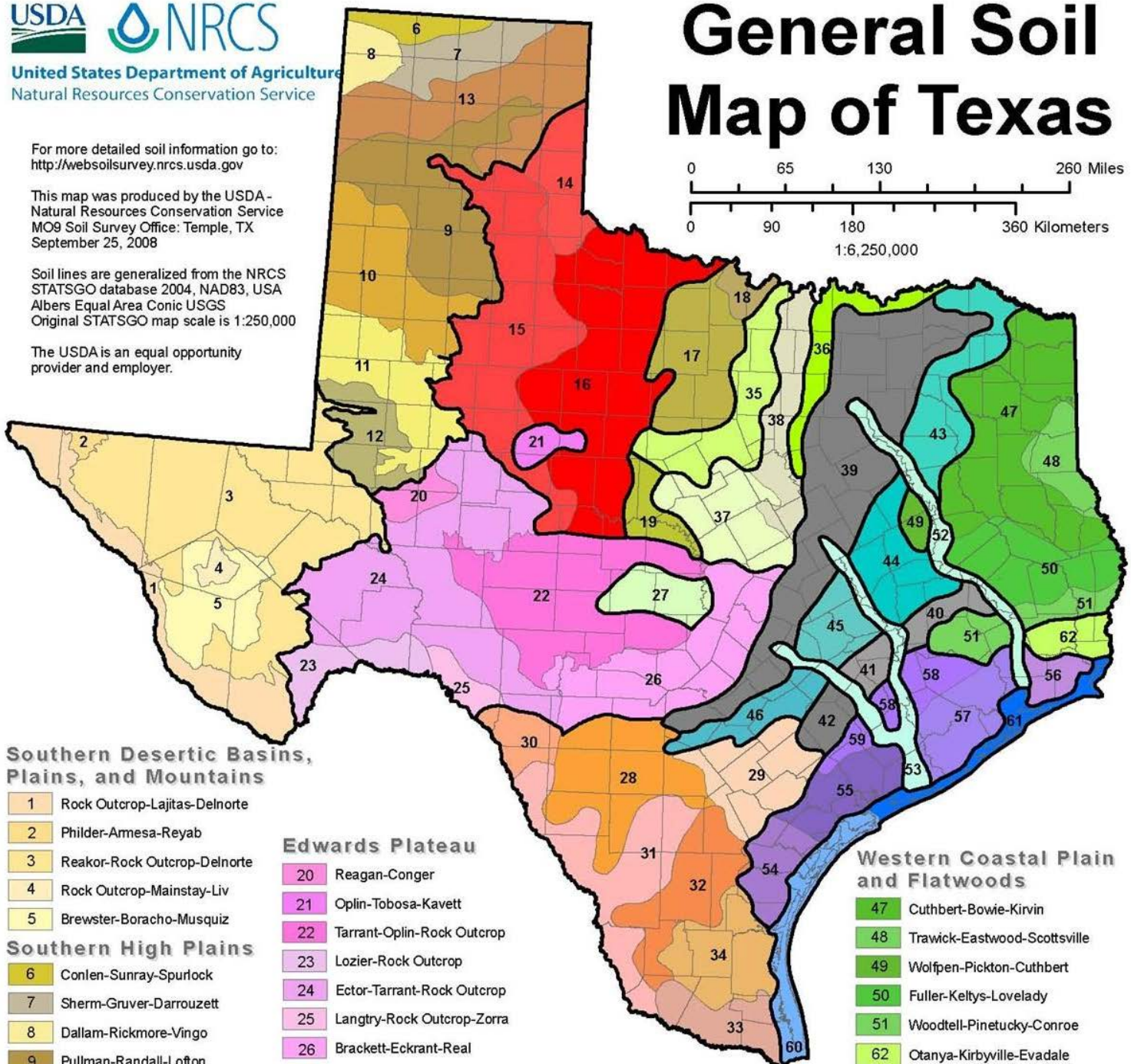
Soil lines are generalized from the NRCS STATSGO database 2004, NAD83, USA Albers Equal Area Conic USGS Original STATSGO map scale is 1:250,000

The USDA is an equal opportunity provider and employer.

0 65 130 260 Miles

0 90 180 360 Kilometers

1:6,250,000



Southern Desertic Basins, Plains, and Mountains

- 1 Rock Outcrop-Lajitas-Delnorte
- 2 Philder-Armesa-Reyab
- 3 Reakor-Rock Outcrop-Delnorte
- 4 Rock Outcrop-Mainstay-Liv
- 5 Brewster-Boracho-Musquiz

Southern High Plains

- 6 Conlen-Sunray-Spurlock
- 7 Sherm-Gruver-Darrouzett
- 8 Dallam-Rickmore-Vingo
- 9 Pullman-Randall-Lofton

Edwards Plateau

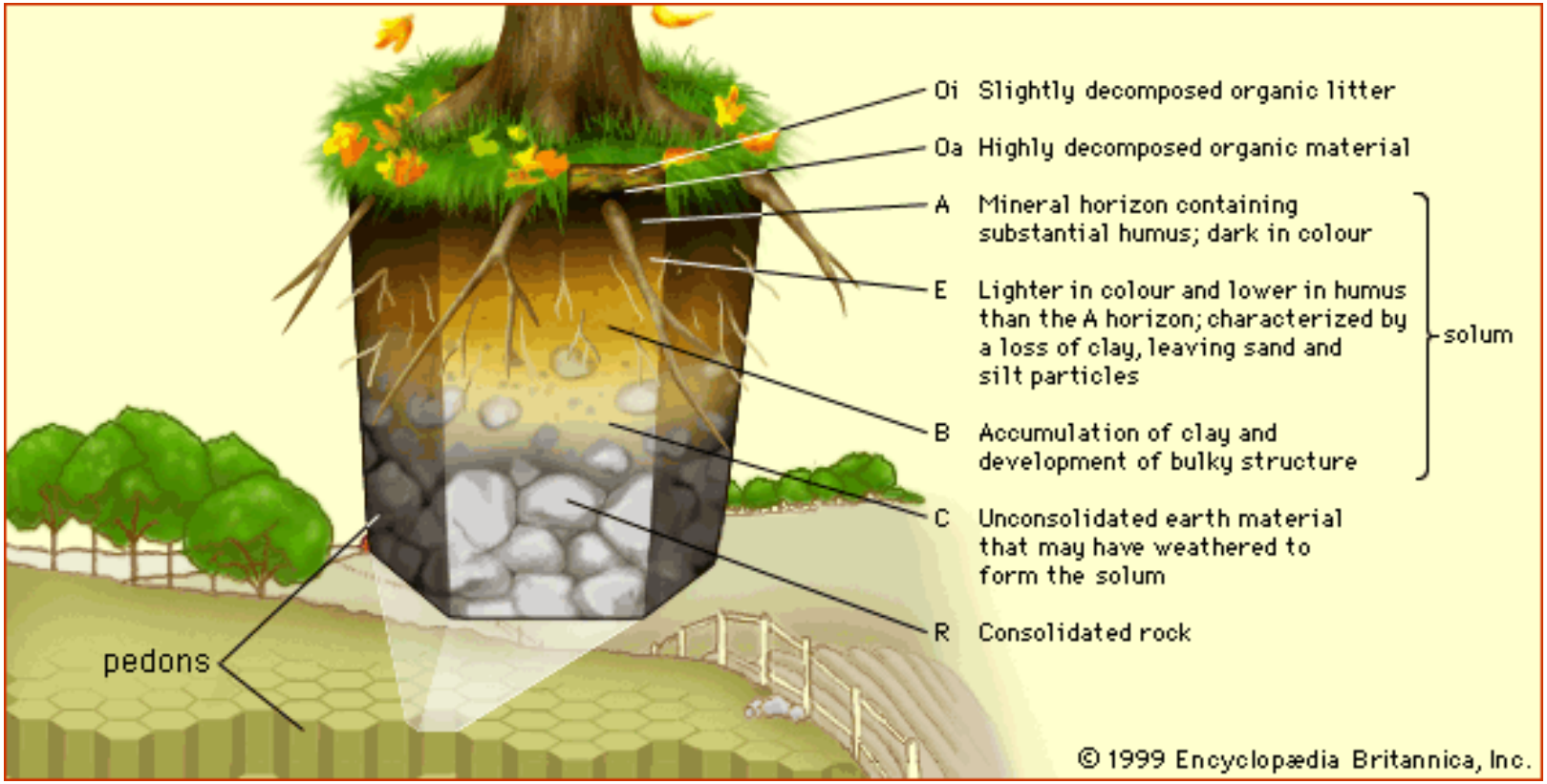
- 20 Reagan-Conger
- 21 Oplin-Tobosa-Kavett
- 22 Tarrant-Oplin-Rock Outcrop
- 23 Lozier-Rock Outcrop
- 24 Ector-Tarrant-Rock Outcrop
- 25 Langtry-Rock Outcrop-Zorra
- 26 Brackett-Eckrant-Real

Western Coastal Plain and Flatwoods

- 47 Cuthbert-Bowie-Kirvin
- 48 Trawick-Eastwood-Scottsville
- 49 Wolfpen-Pickton-Cuthbert
- 50 Fuller-Keltys-Lovelady
- 51 Woodtell-Pinetucky-Conroe
- 62 Otanya-Kirbyville-Evadale

Soil Classification system

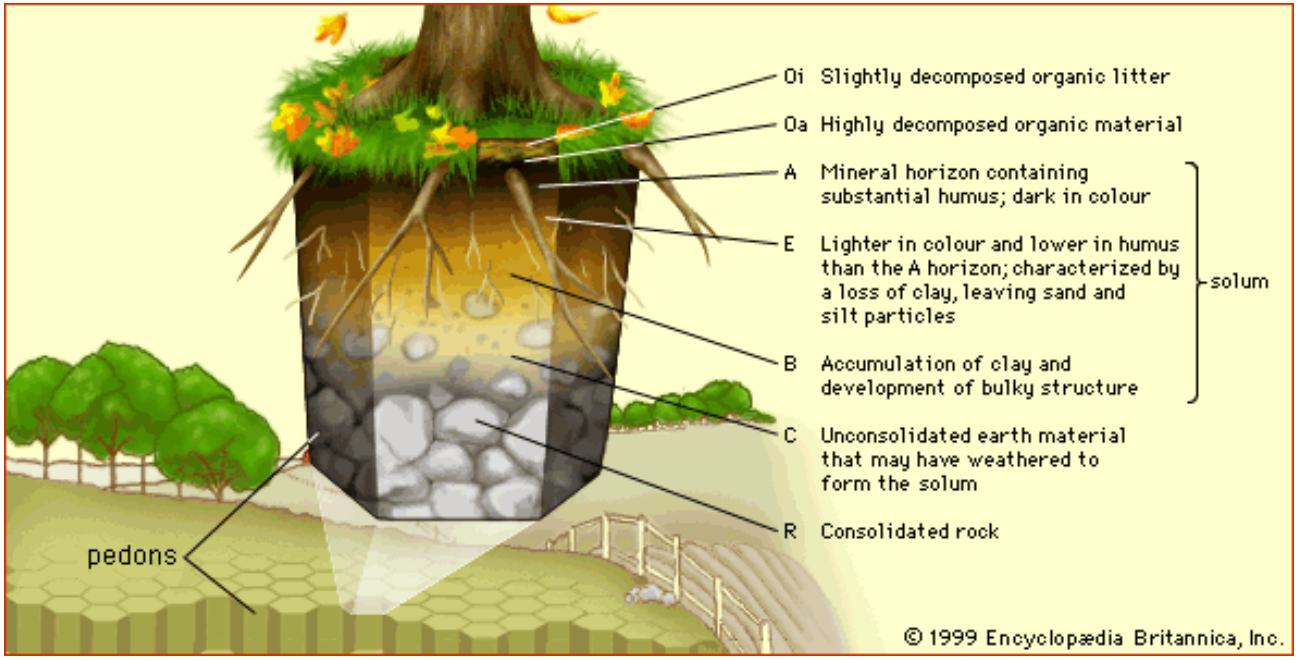
Let’s start understanding how soils are named with the concept of the pedon (ˈpɛdɒn - rhymes with bed- or head - on).



Soil Classification system

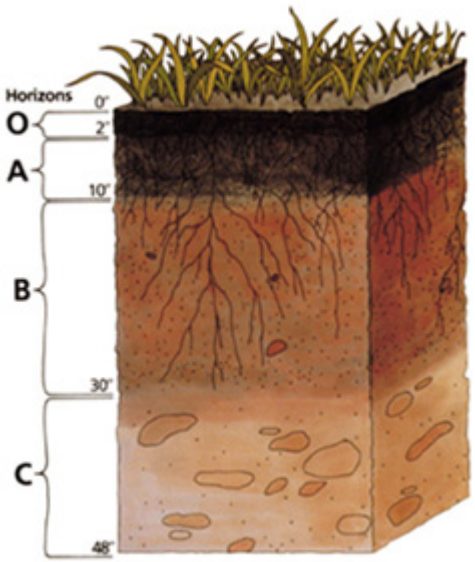
The Pedon is a ‘unit of sampling’. The concept solves the problem of setting a limit to an area of ‘a soil’. Picture the pedon as a ‘column’ of soil surrounded by many other columns that arranged together form a continuum of soil across the landscape

A Pedon has three dimensions. There is no pre-defined depth. The lower limit (e.g. between soil and non-soil) may be vague, or it may be crystal clear. There is no set lateral area, but minimums are considered to be 1 m^2 up to 10m^2. These limits will depend on the site and the innate variability of the soil being sampled



Soil Classification system

A major feature of a pedon is the layout of its horizons

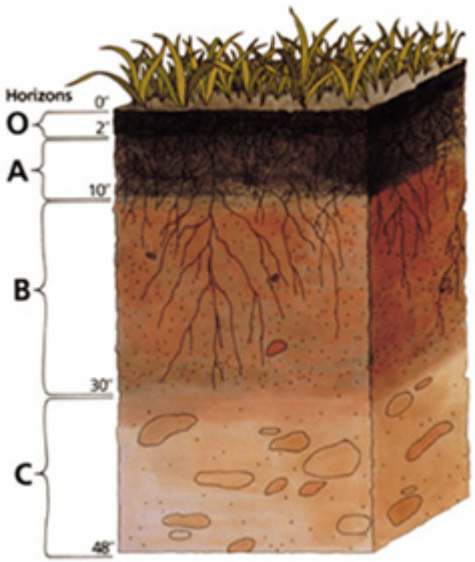


Horizon is the soil science term for layers in the soil

- Soil horizons are a major determinant in the classification system
- They are defined by their vertical placement in a pedon or column of soil
- They are defined by their composition with respect to organic matter, thickness, and parent material.
- They tell us a lot about how a soil was formed, and what formation factors played dominant roles

Soil Classification system

A major feature of a pedon is the layout of its horizons



A quick word about what differentiates a mineral soil from and organic soil

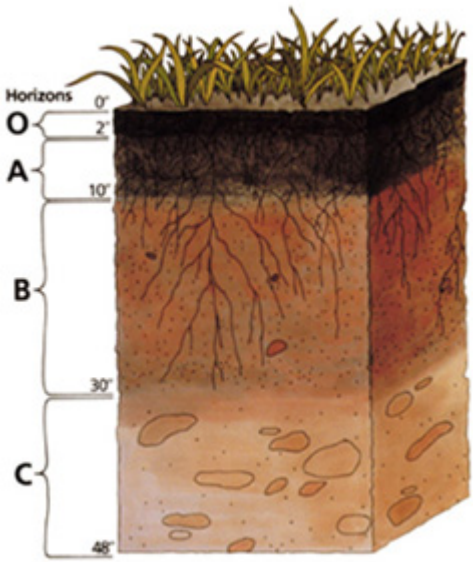
Mineral soils have mineral soil materials that are filled with 10 % or less organic materials

Organic soils have at least 10% organic materials in the void spaces

There are further and more complicated qualifications that are not covered in this course.

Soil Classification system

A major feature of a pedon is the layout of its <u>horizons</u>



Major common horizons defined.

O - organic. A layer of almost 100% organic material such as decaying plant litter. Older O horizons contain more humic materials at the bottom boundary

A - Surface or Topsoil. Mineral layer with the most organic matter, roots, and other life forms. Most strongly weathered horizon in many soils

E - Not always present, but a zone of 'elluviation' where soluble or mobile constituents such as very small clay particles, iron, aluminum, and organic matter may have moved downward from the A to resolidify or deposit at the boundary between the A and B, forming a new layer. The E horizon often presents as a lighter colored subsurface horizon.

B - Subsoil. Less organic matter than the A horizon. Therefore often lighter in color. There will be fewer roots, but should be characterized with some structure development.

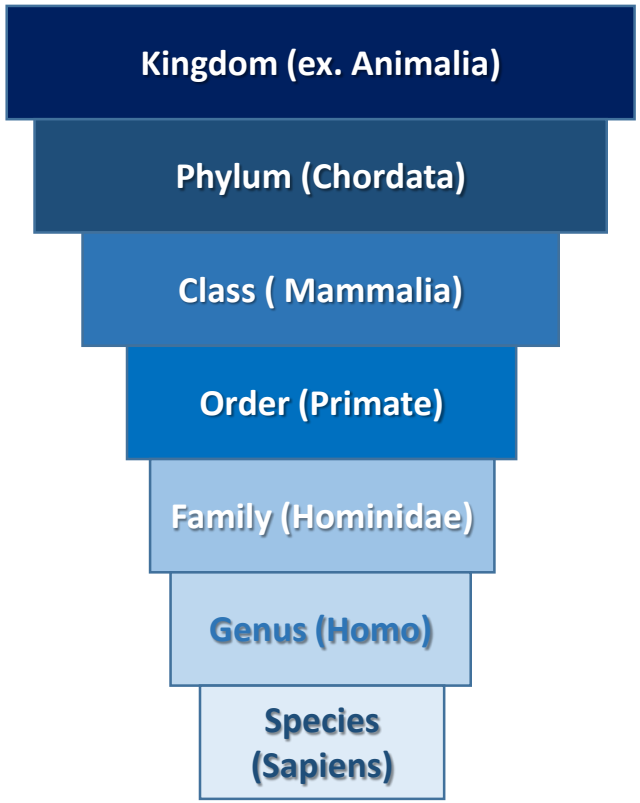
C - Lightly weathered, somewhat consolidated material above bedrock

R - **regolith**, or bedrock

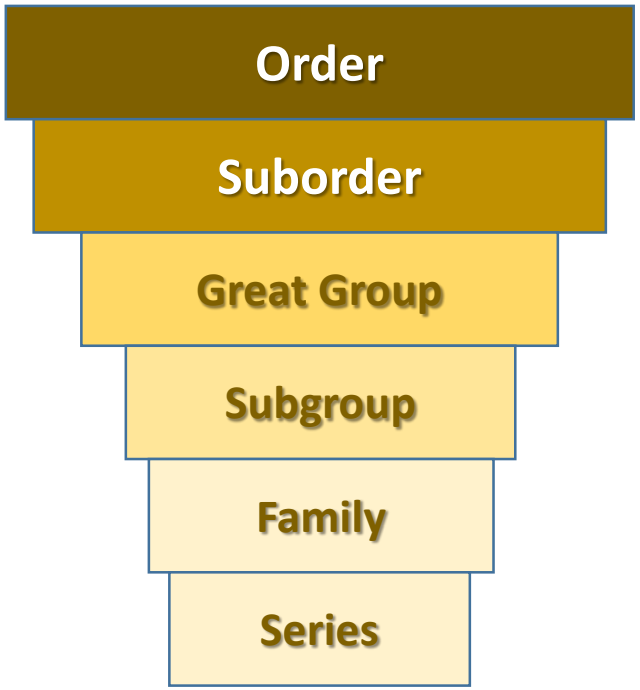
Soil Classification system

Everyone should be familiar with the system of classification for living organisms. This is a hierarchical taxonomic system. Kingdom is the most broad description or grouping for a type of organism. There are only 6 kingdoms of life. Species is the most detailed category with over 8 million distinct names. The soil taxonomic system we use was developed by the USDA NRCS. It is a hierarchical system as well, and includes 6 categories.

Classification System for Living Things



Classification System for Soils



Soil Classification system

Taxonomy - The science of naming, description, and classification for a group of things. The benefits of applying a taxonomic system to soils includes the application of unique identifiers to soils of unique sets of properties, grouping together like soils, separating unlike soils, and communicating fundamental and specific soil traits through the name.

Developing familiarity with the soil taxonomic system helps you develop an appreciation for the enormous diversity in soils. It helps with the conceptualization of like or different properties between soils that can affect the way they behave in nature, agriculture, construction, engineering, and recreation purposes. Because of the large number of soil types that arise from the diversity found in soils, the use of a common taxonomic system allows for a relatively complete description of the soil (and its potential function) in the fewest words possible.

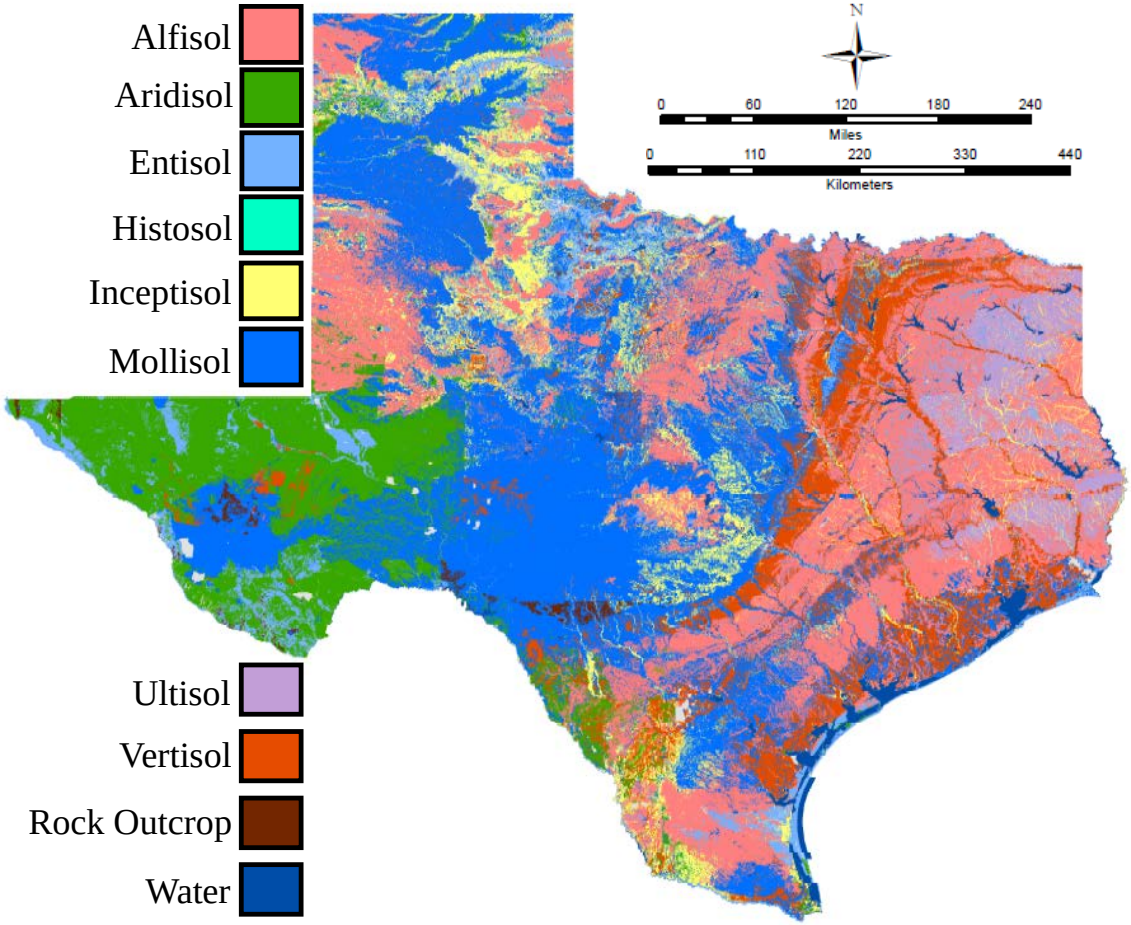
We will only provide an introduction to soil classification in this module, but encourage you to pursue a better understanding, if you do not already possess one, of soil taxonomy should you be working professionally with soils. This course will require at minimum an understanding of the names and general descriptions of the 12 soil orders. The category of soil order is most closely related to a description of soil forming processes.

Soil Classification system

Category (#)	Number of descriptors	Brief description of category
Order	12	Orders are differentiated by diagnostic horizons that reflect soil forming processes.
Suborder	64	As with orders, the differentiation is based on processes under which soils are formed. The number of suborders is different for each order, as required to fully describe these conditions.
Great Group	>300	This category groups soils that are either similar in base status, or similar in kind, arrangement, and variation in horizons. Emphasis may be placed on soil moisture regime or on pattern of horizons that affect depth of root growth.
Subgroup	>2,400	There are 3 kinds of subgroups: **Intergrades -** indicate transitional state. Can describe properties that result from one kind of soil developing into another kind. Can describe a soil where the properties of another Great group are present but subordinate to the properties of the Great group to which it is assigned. **Extragrades -** indicate a subgroup which has properties not associated with the Great group to which it is assigned, but do not necessarily indicate transition. **Typic** - represent soils that do not have the characteristics defined for other subgroups
Family	>4,500	Soils are grouped in this category as having similar physical and chemical properties that affect their response to management and fitness for intended use.
Series	>19,000	Most detailed category. Differentiations reflect some property of the soil, such as horizons, texture, moisture regime, temperature regime, or structure. May include differences from any of the above categories, however, *a series cannot range across the limits between any two classes of a higher category*.

Soil Classification system

TEXAS SOIL ORDER MAP



This map was produced by the USDA-NRCS Soils Section

There are 12 orders of soil recognized by the USDA NRCS. 9 of them can be found in Texas

Alfisols - this soil order is formed in semi-arid to relatively wet conditions. Alfisols are well-weathered to the point where finer clay particles have been leached over time from the surface horizon to form a subsurface clay layer. They are formed under forest or mixed vegetation. Native fertility for this soil order is high, and the associated higher percentages of basic cations (e.g. Ca2+, Mg2+, and K+) distinguish Alfisols from Ultisols.

- The Duval series found in Frio County, TX is a sand formed in semi-arid conditions. Typical A horizon texture = 86% sand, 6% silt, 8% clay
- The Falba series found in Grimes County, TX is also a sand, but formed under a climate with more precipitation. Typical A horizon texture = 77% sand, 17% silt, 6% clay

There are 12 orders of soil recognized by the USDA NRCS. 9 of them can be found in Texas

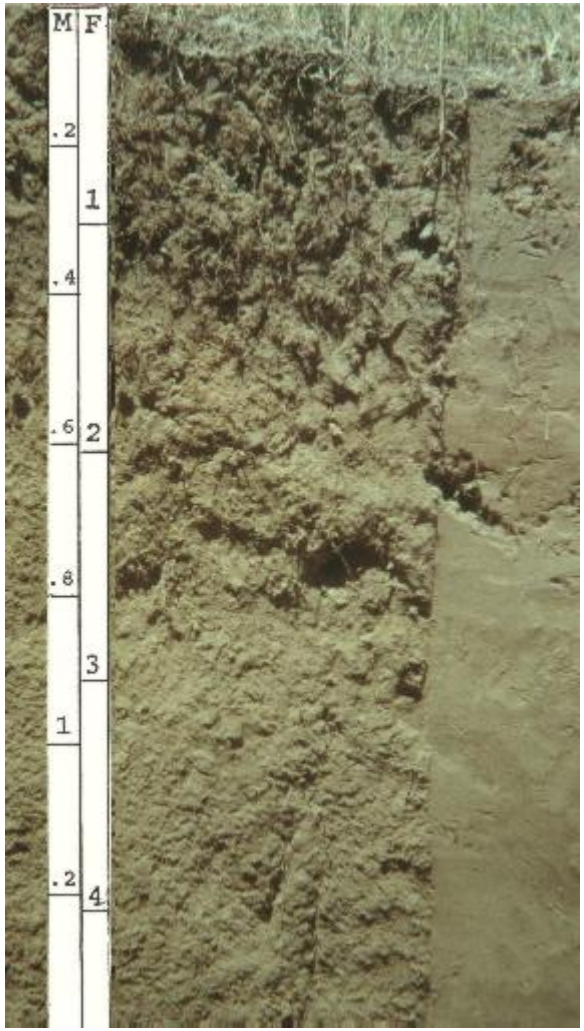
Aridisols - these are the dry soils found in desert regions. Aridisols often include horizons with carbonates (CO32-), gypsum (CaSO4), sodium chloride (NaCl). Used mainly for rangeland and recreation, but are fertile for agriculture where water for irrigation is available.

- The Hodgins series found in Pecos County, TX is a silty loam with calcareous deposits originating from limestone. Typical A horizon texture = 19% sand, 63% silt, 18% clay
- The Pandale series found in Crockett County, TX is a silty loam with fine and medium limestone gravel mixed in. Typical A horizon texture = 19% sand, 61% silt, 20% clay

There are 12 orders of soil recognized by the USDA NRCS. 9 of them can be found in Texas

Entisols - these are 'new' soils that show very few signs of soil formation or development. This order does not make up a large percentage of Texas' soils, and examples tend to be concentrated in the coastal region of the state, though a small amount can be found in far west Texas.

- The Mustang series found in Galveston County, TX is a sandy loam. Typical A horizon texture = 74% sand, 17% silt, 9% clay.
- The Harpersville series found in Brown County, TX is a clay loam. Typical A horizon texture = 43% sand, 29% silt, 28% clay.



There are 12 orders of soil recognized by the USDA NRCS. 9 of them can be found in Texas

Histosols - soils in this order are almost all decaying organic matter. Though not nearly as well represented as other orders, there are some small areas in southeast Texas where Histosols can be found. These areas often include permanently flooded marshes.

- The Allemands series found in Jefferson County, TX is a clay. Typical A horizon texture = 10% sand, 40% silt, 50% clay.

There are 12 orders of soil recognized by the USDA NRCS. 9 of them can be found in Texas

Inceptisols - these soils are defined by poorly developed subsurface horizons. They may be shallow or deep, flat or sloped.

- The Weswood series is found along the flood zone in the Brazos and Colorado River Valleys. Typical A horizon texture = 26% sand, 54% silt, 20% clay
- The Cedarlake series is found in depressions on basin floors in the Southern High Plains near Brownfield. Typical A horizon texture = 51% sand, 26% silt, 23% clay.

There are 12 orders of soil recognized by the USDA NRCS. 9 of them can be found in Texas

Mollisols - these are often formed under grasslands and exhibit that legacy as a clearly visible dark surface horizon rich in organic matter, which makes them naturally fertile.

- Pullman series soils are rich in Illite minerals which expand when wet. Typical A horizon texture = 38% sand, 35% silt, 27% clay.
- Topsey series soils are rich in calcium carbonates and can be found in Coryell Co. and surrounding areas. Typical A horizon texture = 19% sand, 40% silt, 41% clay.

There are 12 orders of soil recognized by the USDA NRCS. 9 of them can be found in Texas

Spodosols - acidic soils with deposits of organic matter and iron in the subsoil, often formed under forests. Spodosols are not a common soil in the state, but can be found in small areas in southeast Texas.

- Babco series soils are coarse (loamy fine sands) found in Hardin Co. and nearby areas. Typical A horizon texture = 80% sand, 8% silt, 12% clay.

There are 12 orders of soil recognized by the USDA NRCS. 9 of them can be found in Texas

Ultisols - these soils are very weathered (aged) with a clayey subsurface horizon. They are often formed under forested lands with gentle slopes and can be acidic.

- Darco series soils are loamy fine sands found near St. Augustine Co. TX. Typical A horizon texture = 19% sand, 40% silt, 41% clay.
- Kirbyville series soils are fine sandy loams found near Jasper Co. TX. Typical A horizon texture = 50% sand, 42% silt, 8% clay.

There are 12 orders of soil recognized by the USDA NRCS. 9 of them can be found in Texas

Vertisols - these soils are defined by the presence of smectite, a mineral clay that swells in size when wet and shrinks when dry. This property causes the easily noticeable surface cracking during long dry periods. These soils dominate the central Texas Blackland Prairies and the Gulf Marshes and Prairies Ecoregions. The soils in this order in Texas are often calcareous, meaning they contain quite a bit of calcium carbonate and are high in pH, but some are not.

- Houston Black series soils found throughout the middle section of the Blacklands Ecoregion are clayey, high in pH and very dark to black in color. This soil is also our (unofficial) state soil! Typical A horizon texture = 10% sand, 50% silt, 40% clay.
- Burleson series soils are found in the eastern middle Blacklands Ecoregion and can become acidic following years of nitrogen fertilizer applications. Typical A horizon texture = 35% sand, 26% silt, 39% clay.

Andisols (formed by volcanoes),

Gelisols (frozen soils), and

Oxisols (highly weathered tropical soils) are the only three soil orders you cannot find in Texas.