Some dirt on soil

Keli Rutan-Jorgensen, MS

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1. Why soil?
2. Get to know your soil.
3. Hold on to your soil.

1. Why soil?

A cloak of loose, soft material,
held to the earth's hard surface by gravity,
is all that lies between life and lifelessness.
--- Wallace H. Fuller, Soils of the Desert Southwest, 1975

Now I know a refuge never grows
from a chin in the hand and a thoughtful pose
gotta tend the earth if you want a rose.
--- Emily Saliers, from the Indigo Girls Album Nomads, Indians, Saints; Epic, 1990

It takes about 100-200 years to form 1 cm soil

- One rainstorm can wash away 1 mm soil.

How long will it take natural processes to replace 1 mm soil?

10-20 years!

The *ecstatic skin of the Earth*

- Soil is a precious, nonrenewable resource.
- In just the last 40 years, soil erosion has rendered unproductive 30% of the world's arable land.
- Soil erosion is one of the biggest environmental problems of the world.
- How can we take care of our soil?

Our values affect how we care for soils.

Soil values

1) How do we value human and plant health?

- The way we care for our soil affects the health of plants AND humans
- Gardening provides regular exercise
- Time for meditation
- Meaning and direct value
- Life interest and constant learning

Our health is linked to the health of our soil

- Plants and animals uptake nutrients and pollutants from the soil.
- They can nullify some, and concentrate others.
- Some soil pollutants can stay in the soil for years.
  - Lead from car exhaust, paint, pipes
  - Pesticides such as DDT, Aldrin
  - Many substances in the groundwater can persist for decades

2. How we measure yield?

- How is yield measured according to conventional agriculture?
- What is the public cost to this yield?

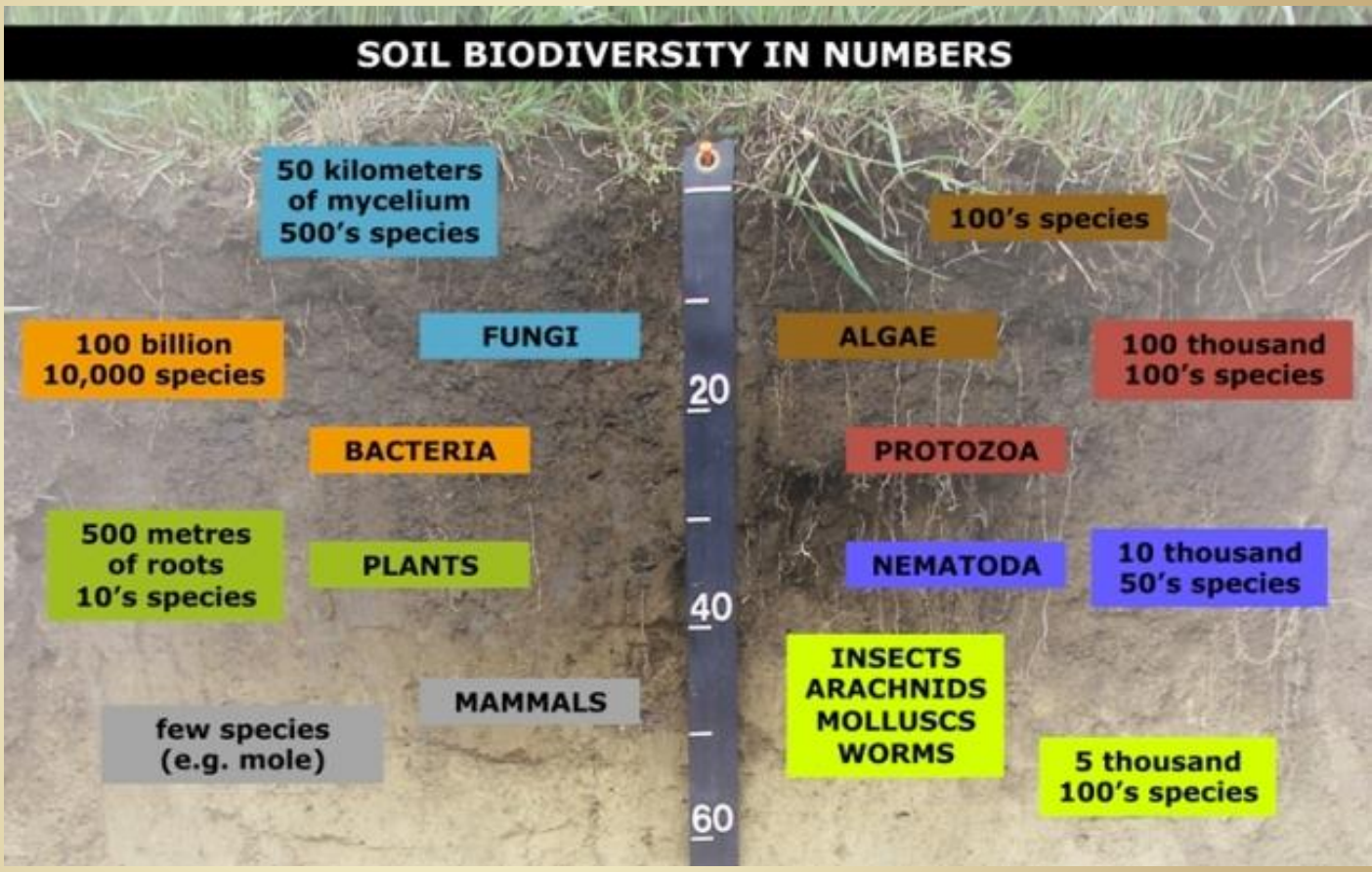
What are *other* measures of yield?

- How long it can be maintained
- Improvements on nutrition
- Effects on world hunger
- Effects on soils
- Effects on our health

3) How do we value life in the soil itself?

A handful of healthy soil is filled with life. These affect:

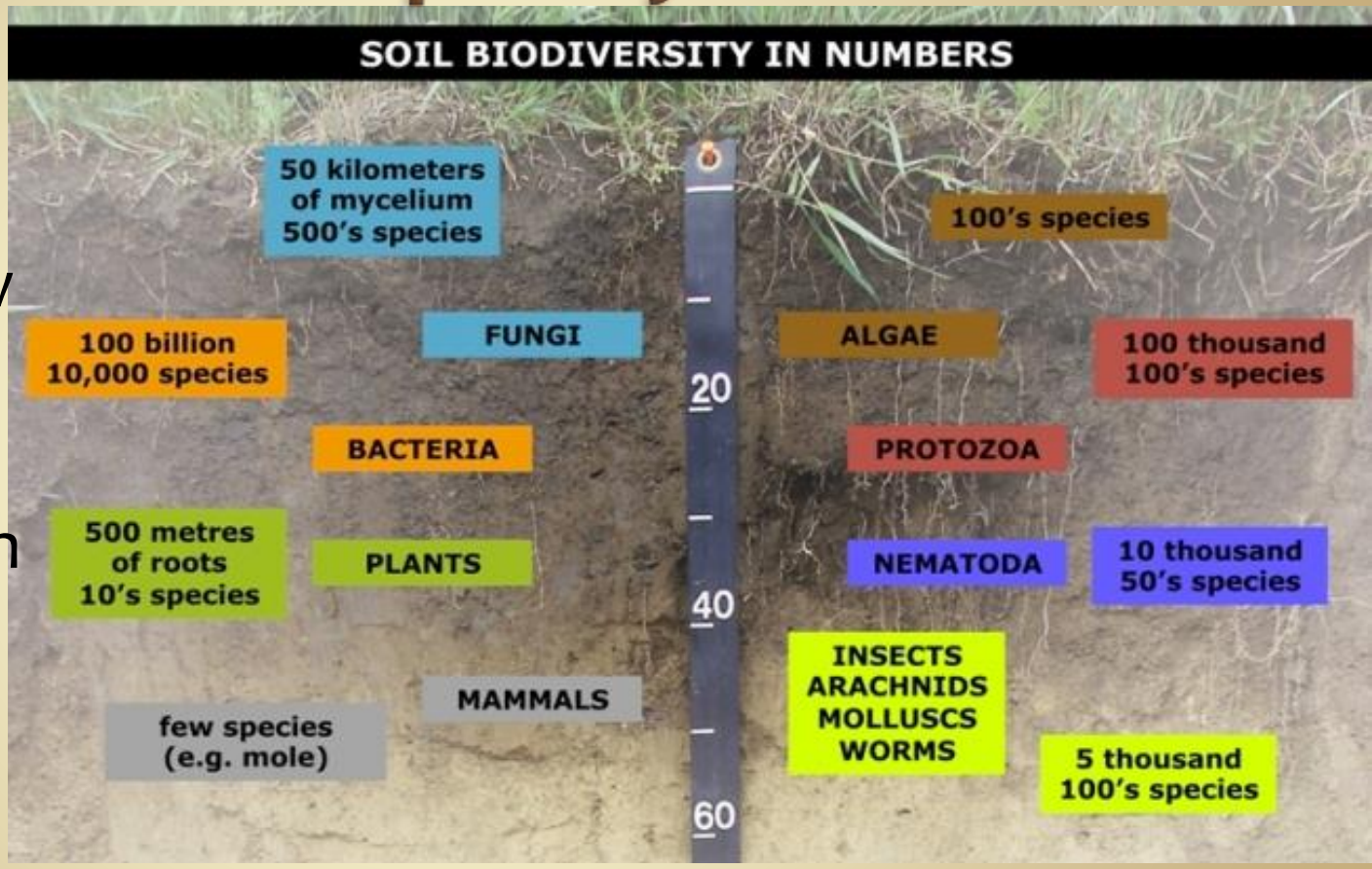
- pH
- mineral content and availability to plants
- soil structure
- erosion



From: http://eusoils.jrc.ec.europa.eu/library/themes/biodiversity/

Life in the soil affects soil quality

We are only just beginning to understand how soil microorganisms affect the health of soil



From: http://eusoils.jrc.ec.europa.eu/library/themes/biodiversity/

4) What is our role as stewards on this Earth?

- We restore and conserve soil for the sake of a healthy earth.
- We only need about 5 percent of Earth's arable land for our food production.

We know more about the movement of celestial bodies than about the soil underfoot.

--- Leonardo DaVinci

2. Get to know your soil

Every soil is unique

There are five factors that make every soil special

S = f(cl, o, r, p, t)

- **Cl**imate
- **O**rganic activity
- **R**elief
- **P**arent material
- **T**ime

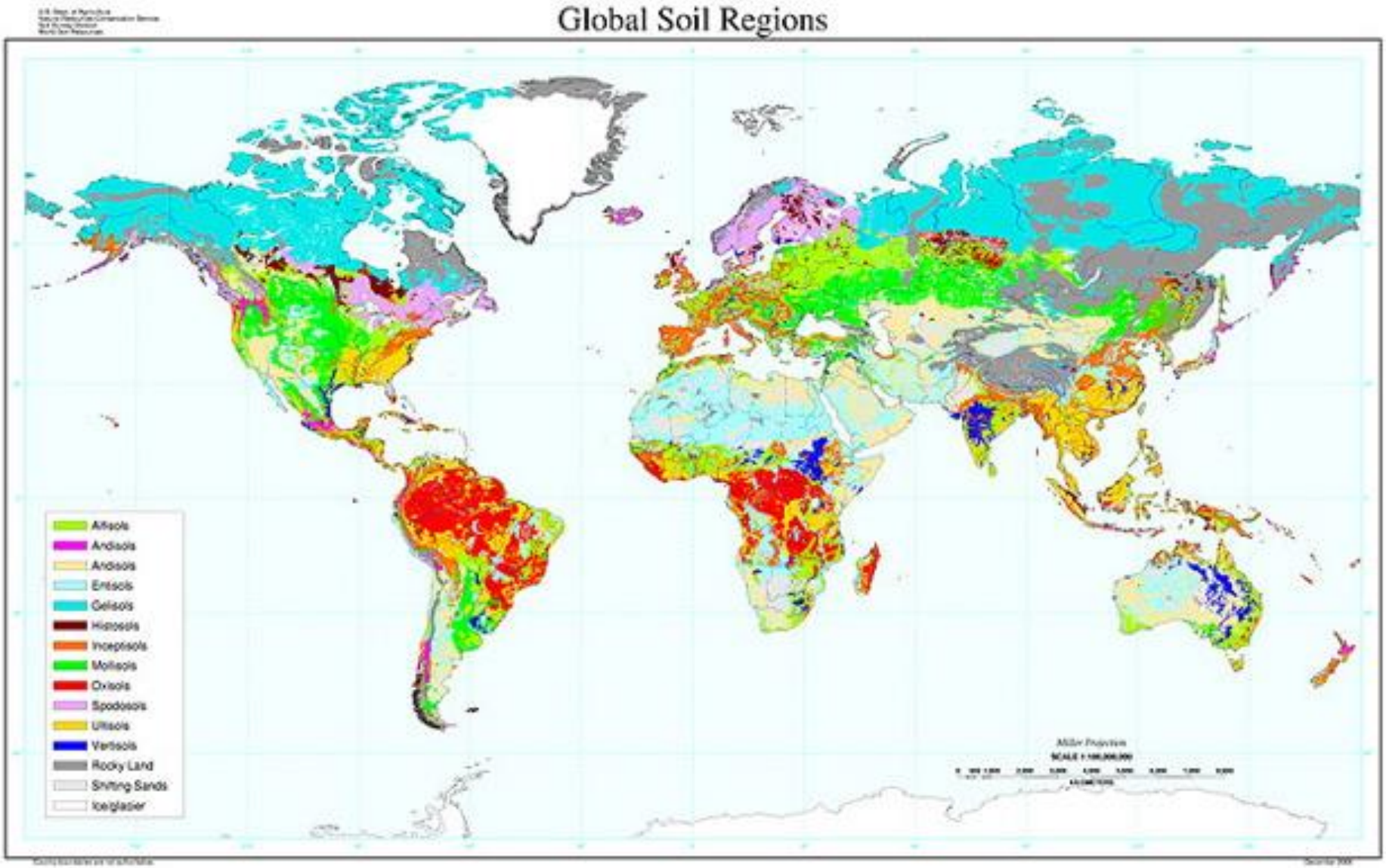
We can classify soil according to many criteria

- Some tribal soil classifications include:
- Potential usage
- Relative fertility
- Animal indicators
  - Eg. shape and size of termite mounds
- Vegetative indicators
  - How well certain plants grow there
- Suitability for a certain crop
  - “yam soil,” “taro soil”

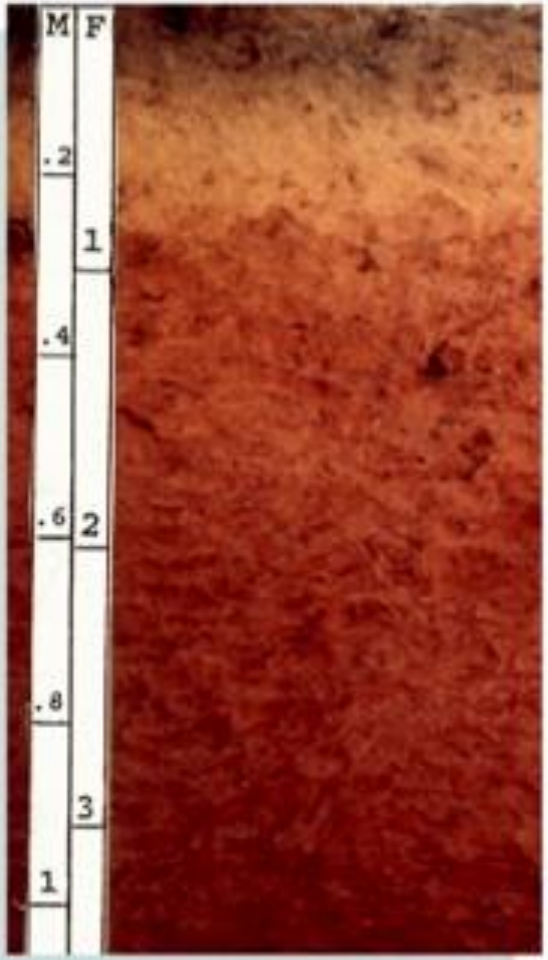
Other Traditional Soil Classifications

- Color
- Taste
- Moisture capacity
- Sand content
- General texture
- Structure
  - In dry soils, and in wet season
- Drainage
- Slope
- Elevation

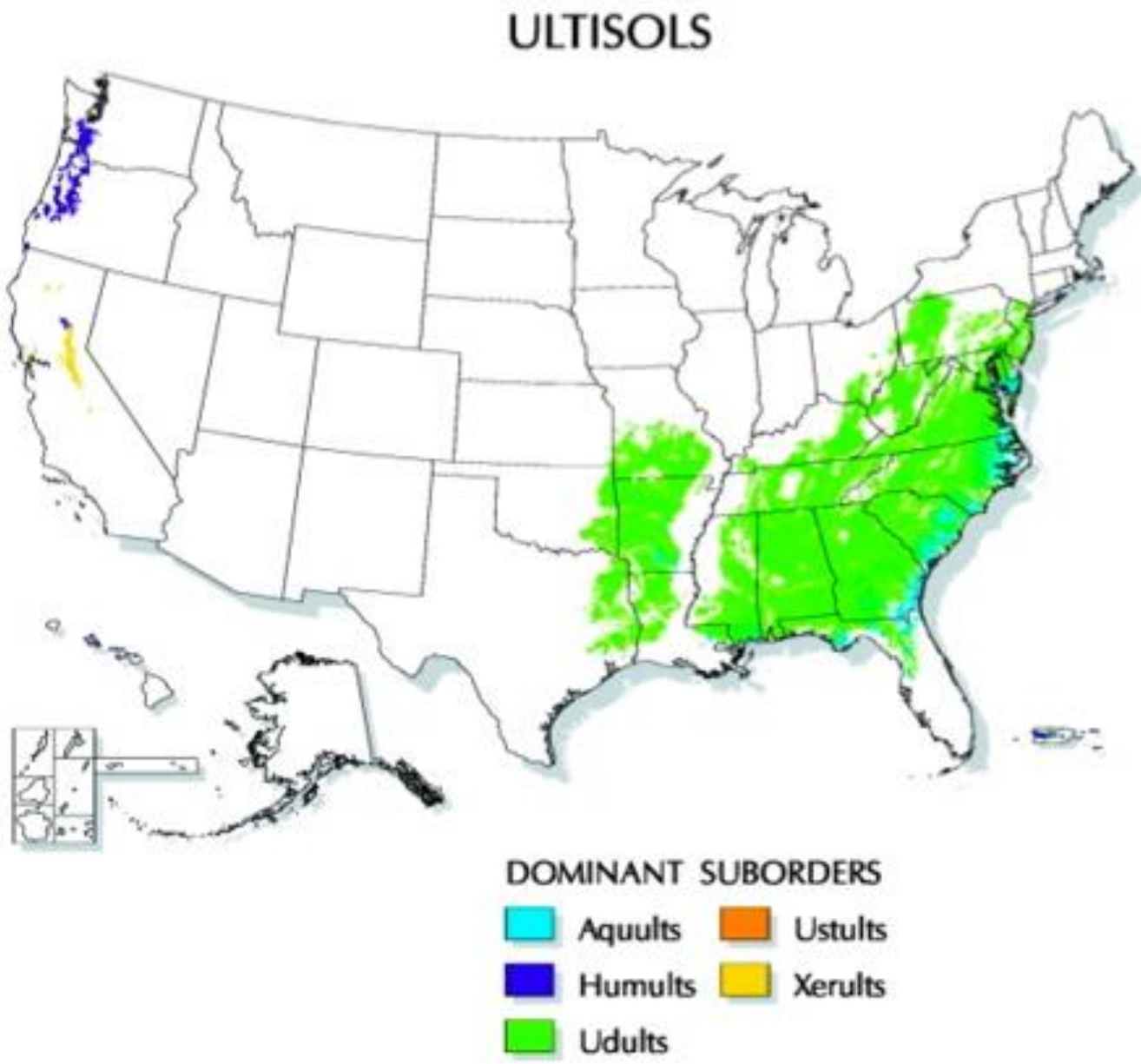
Modern soil classification uses complex nomenclature and standardized criteria



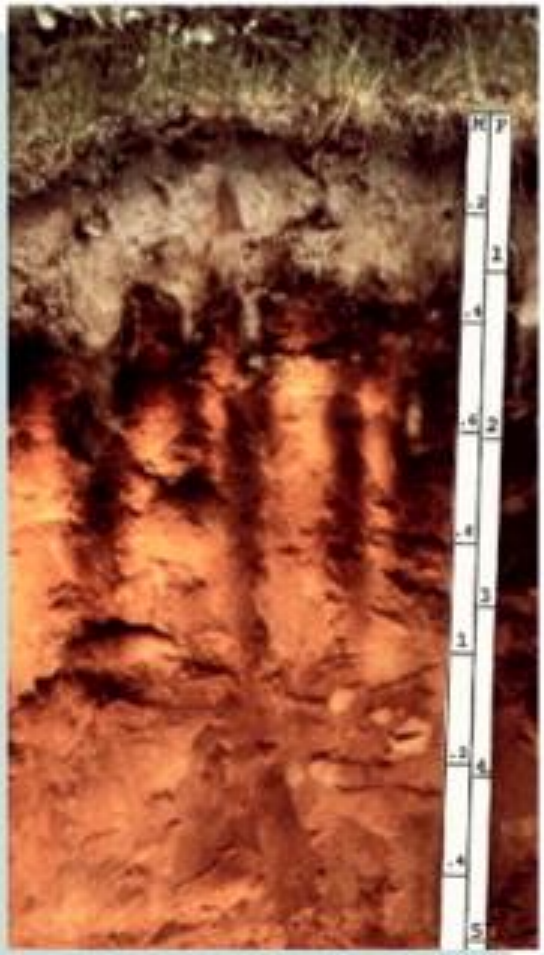
Weathered, old soils



Ultisols have an argillic or kandic horizon and a relatively low content of bases. They typically have an ochric epipdon. Some also have a fragipan. Most formed under forest vegetation.

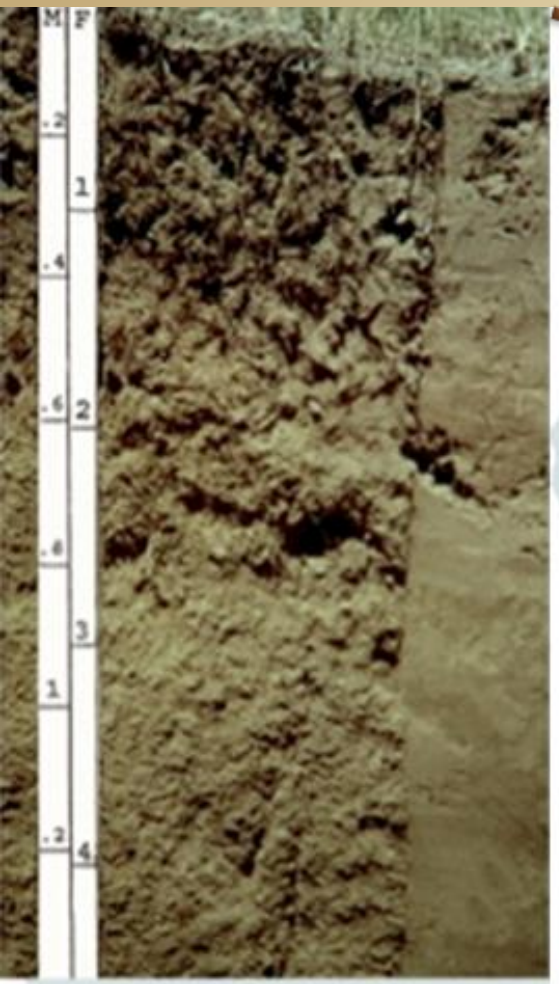


Forest soils

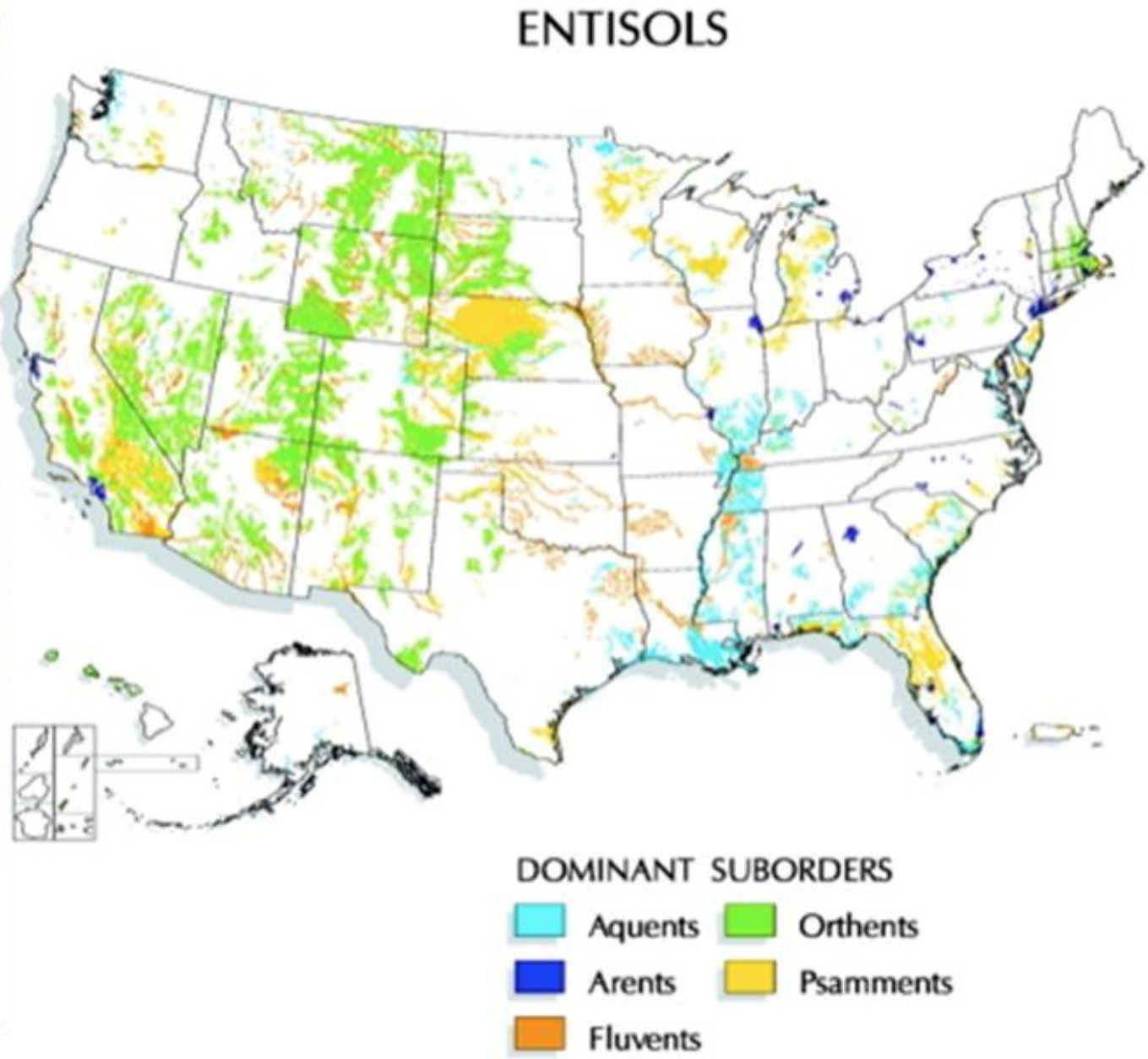


Spodosols have a spodic horizon and commonly an albic horizon and an ochric epipedon. Most formed under forest vegetation. Dominant processes are weathering and translocation of minerals. The colloidal fraction is dominated by Al-humus complexes and short-range-order minerals.

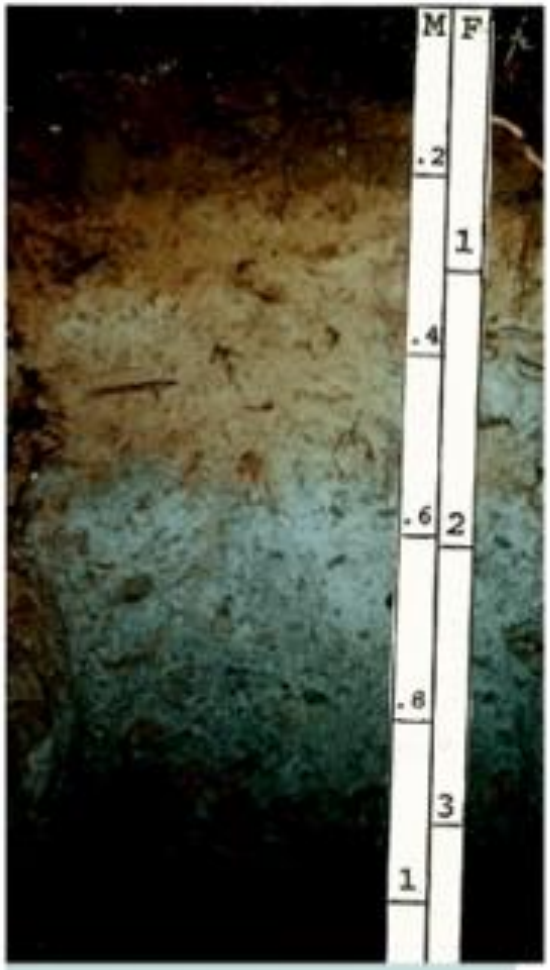
Sort-of new soils



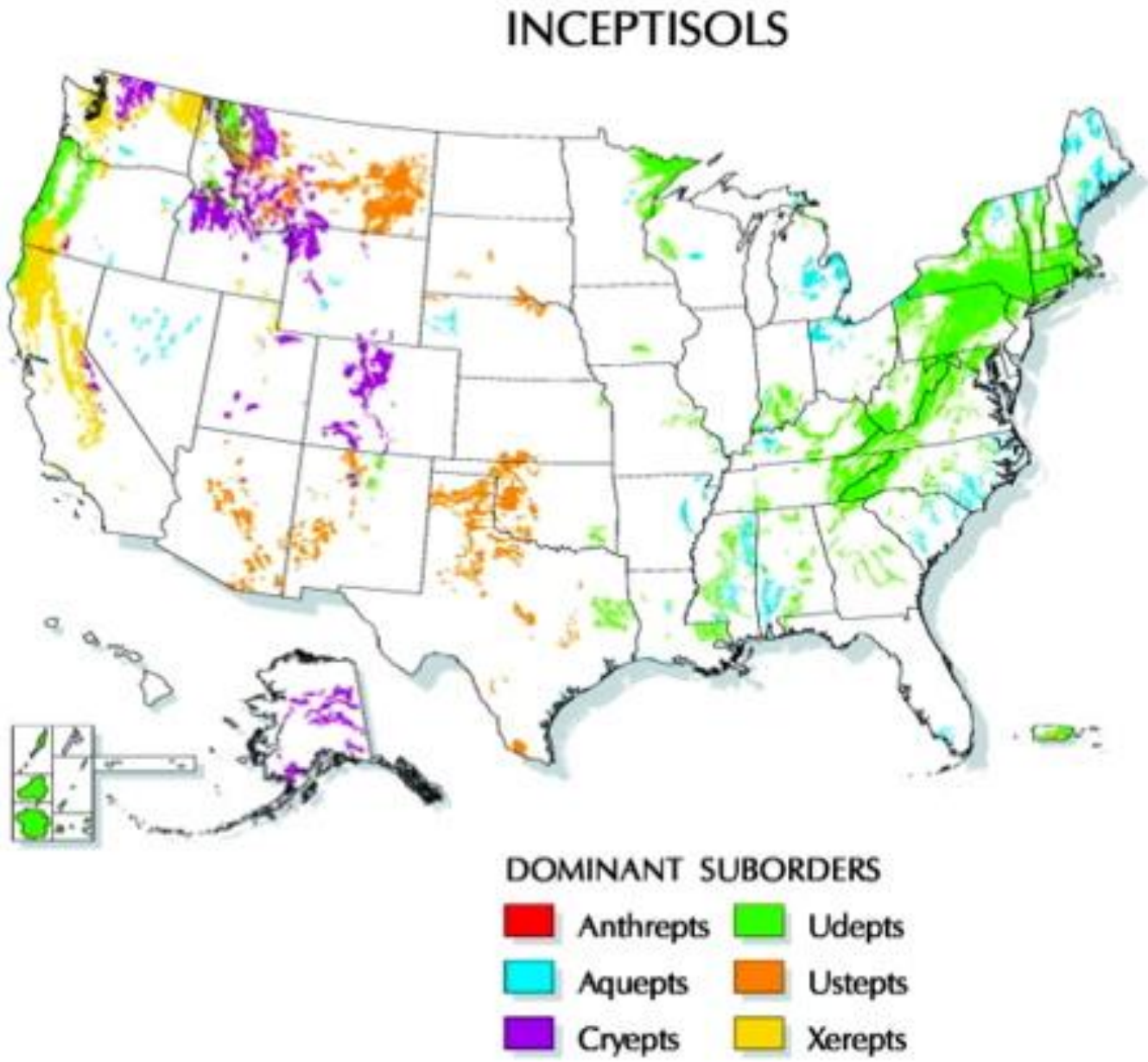
Entisols have little or no evidence of the development of diagnostic horizons. Many have an ochric epipedon. Many are sandy or very shallow.



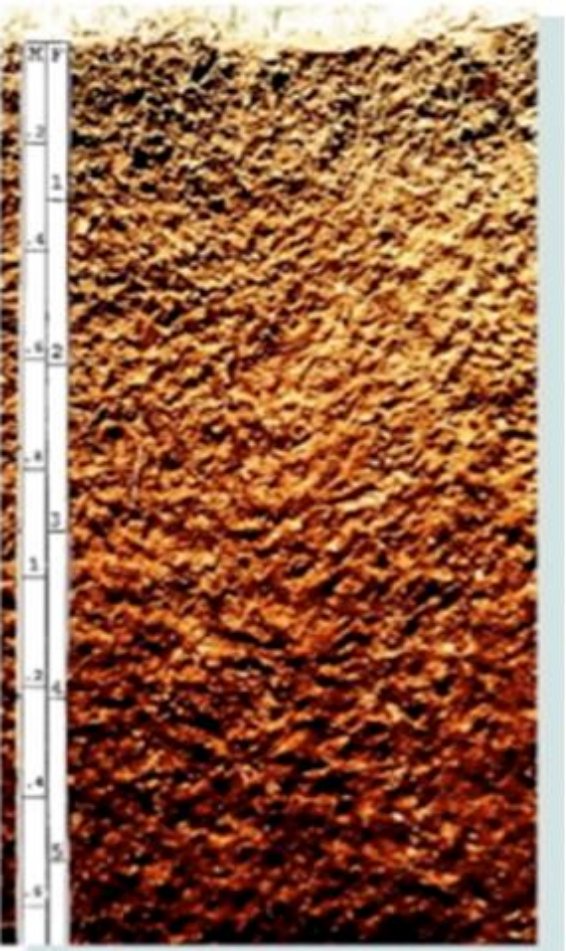
Brand-new soils



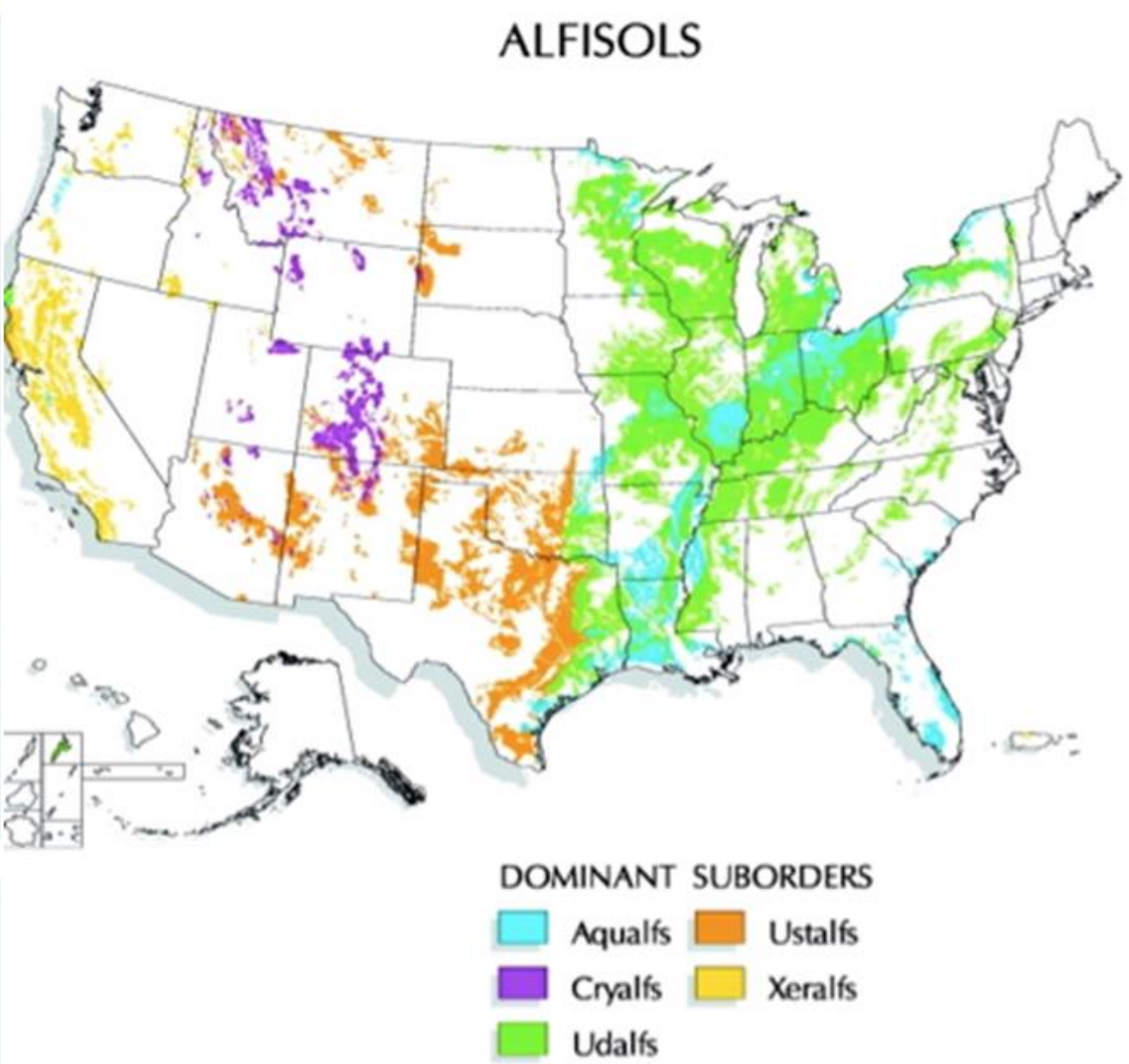
Inceptisols have many kinds of diagnostic horizons but cannot have an argillic, kandic, natric, oxic, or spodic horizon. They commonly have a cambic horizon and an ochric or umbric epipedon.



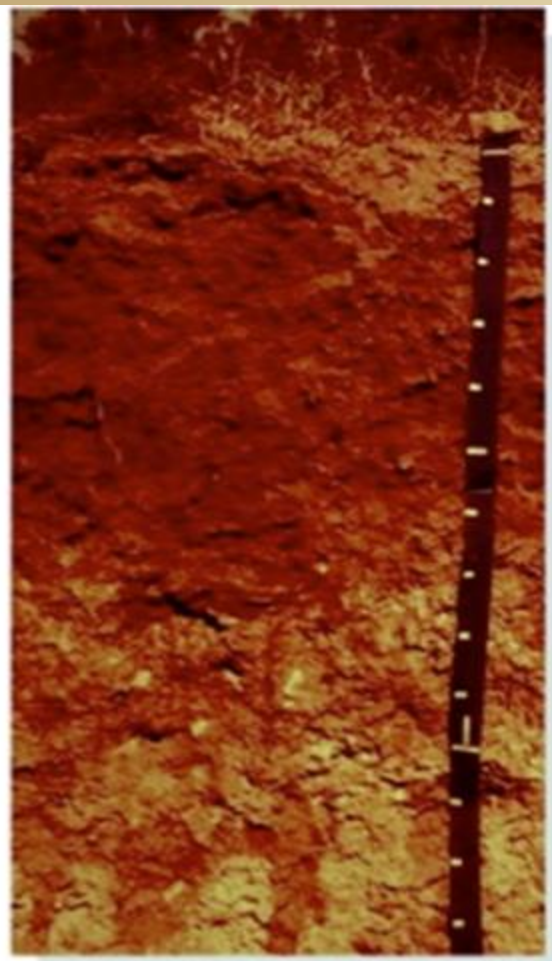
Mildly-weathered soils



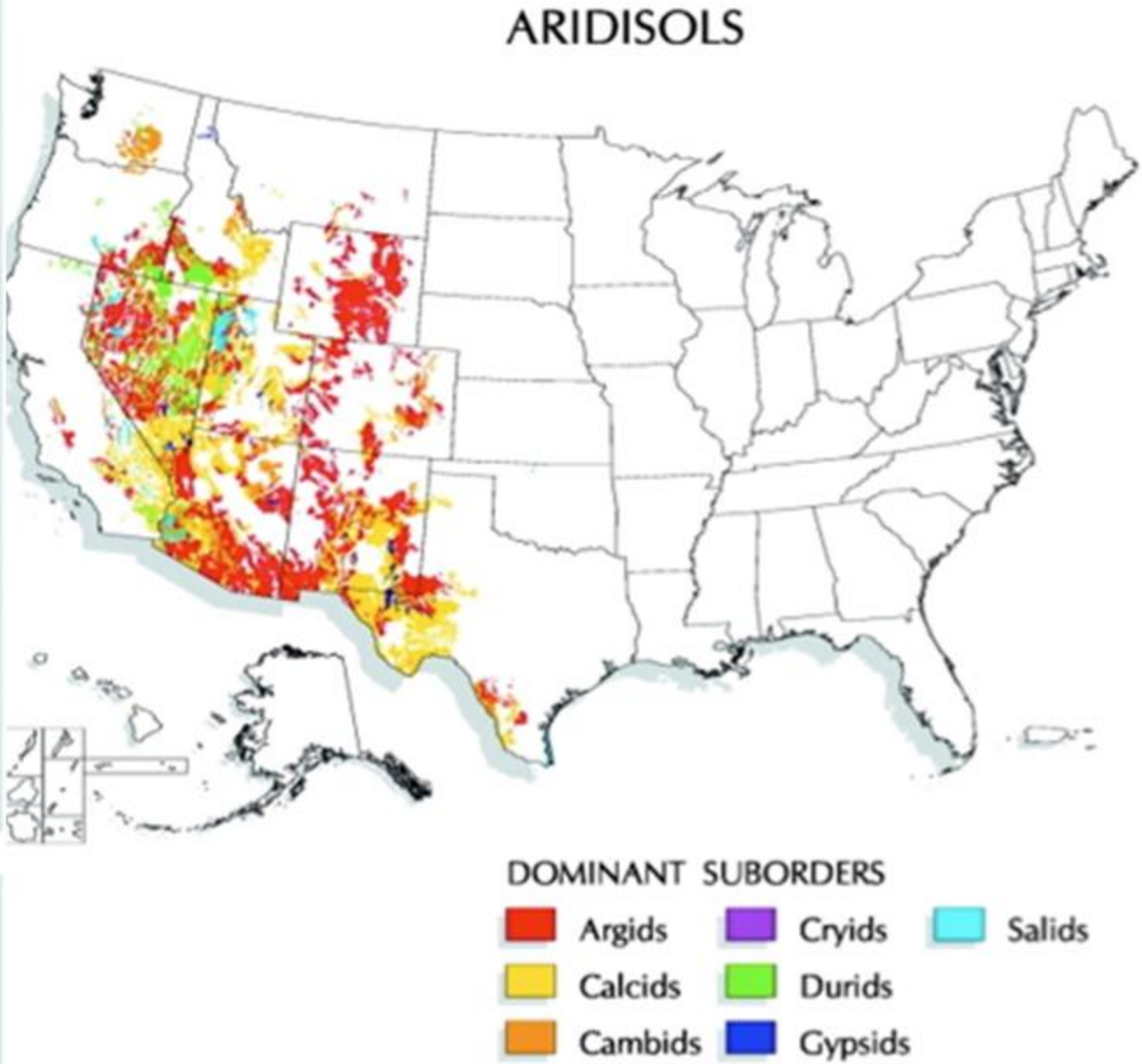
Alfisols have an argillic, kandic, or natric horizon and a relatively high content of bases. They typically have an ochric epipedon. Some also have a duripan, a fragipan, or a petrocalcic horizon. Most formed under forest or savanna vegetation.



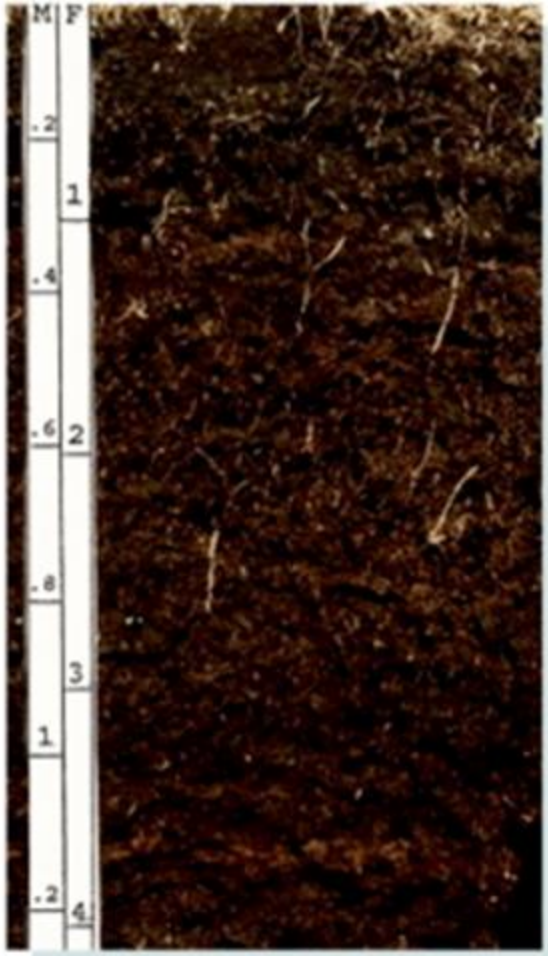
Desert soils



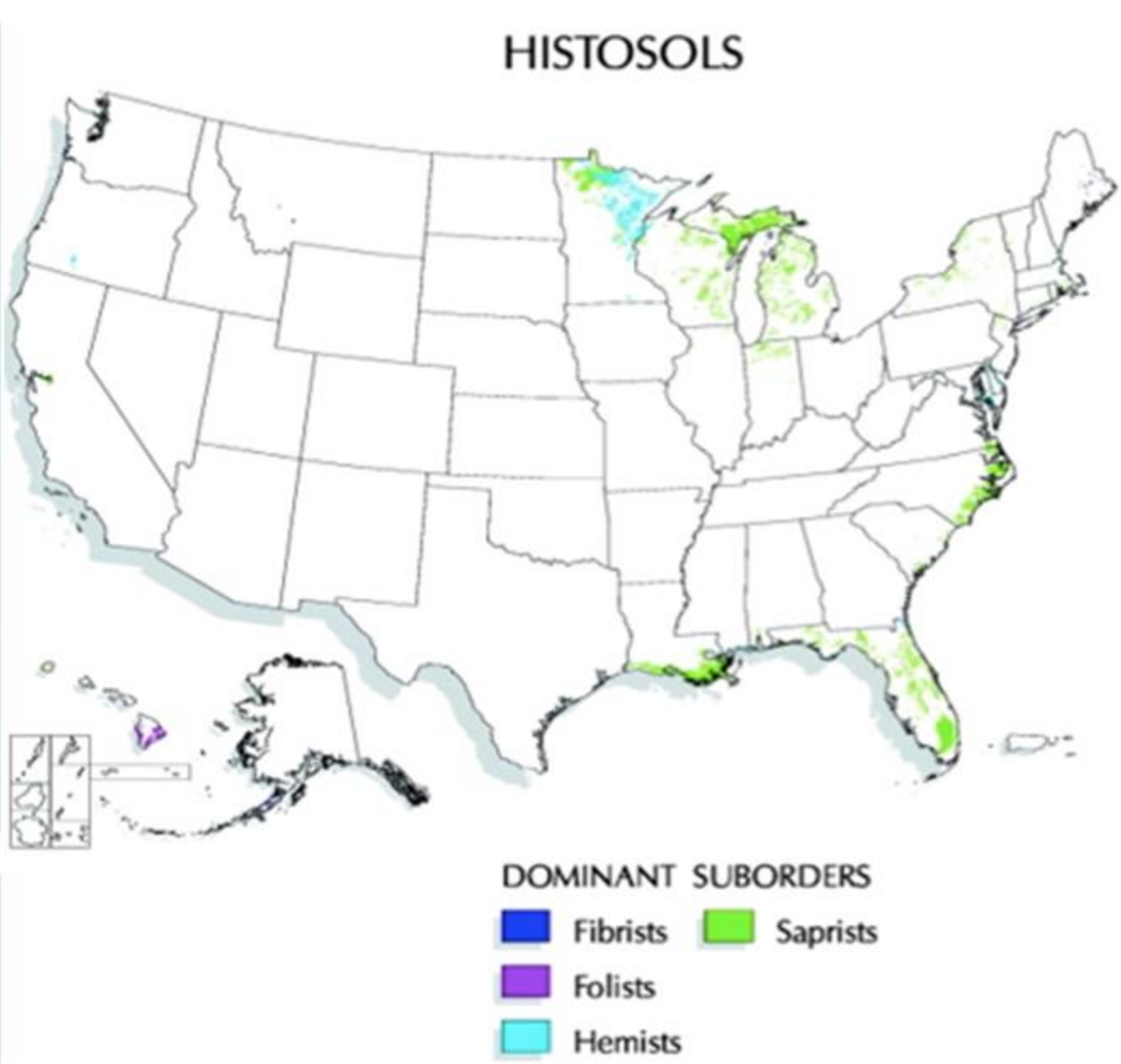
Aridisols have an aridic moisture regime. They also have one or more of the following diagnostic horizons: an argillic, calcic, cambic, gypsic, natric, petrocalcic, petrogypsic, or salic horizon or a duripan. These soils typically have an ochric epipdon.



Peat moss soils

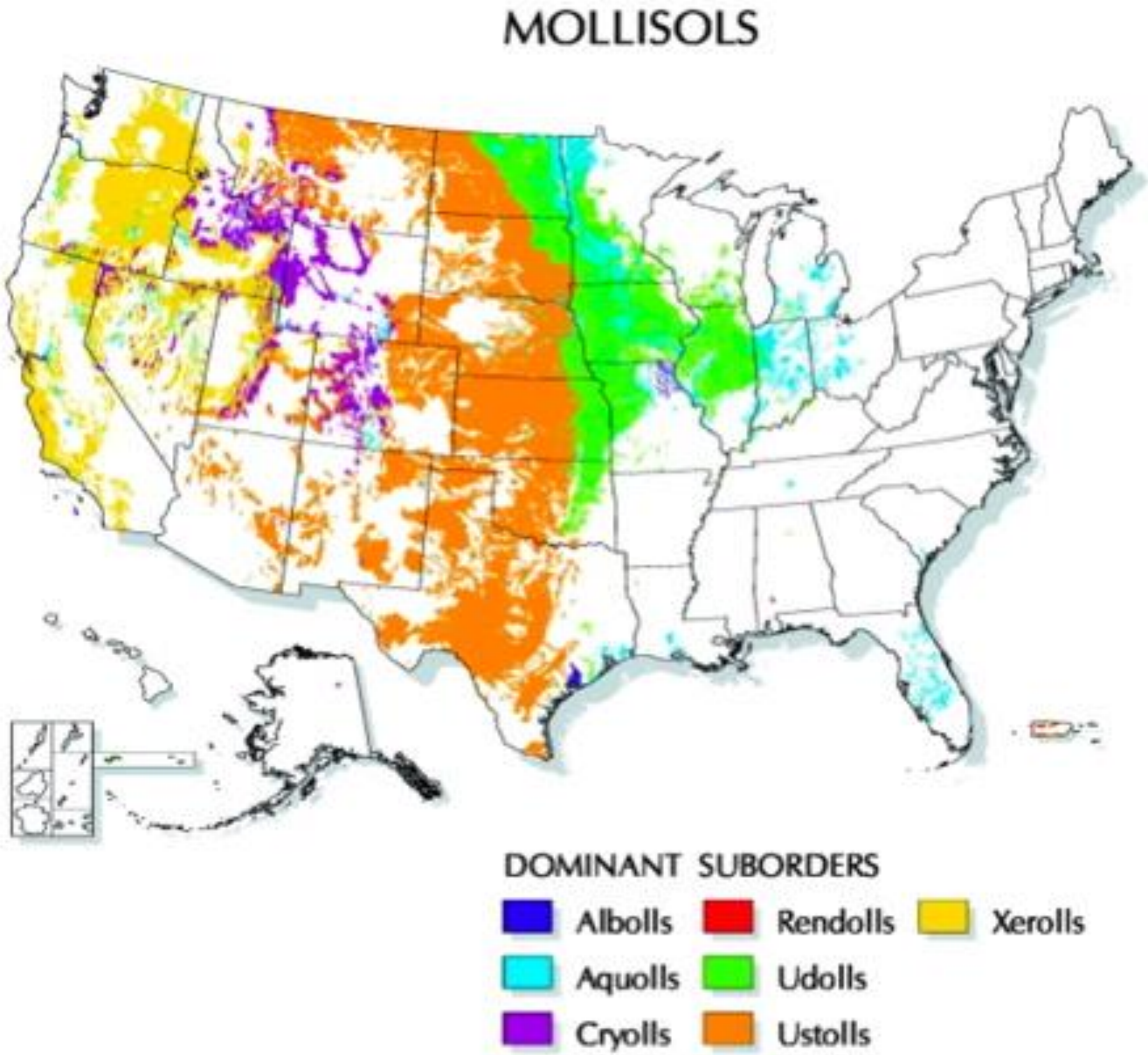


Histosols are dominated by organic soil materials. They are mostly soils commonly called bogs, moors, peats, or mucks. Some consist of a thin layer of organic materials over a root-limiting layer or fragmental materials.



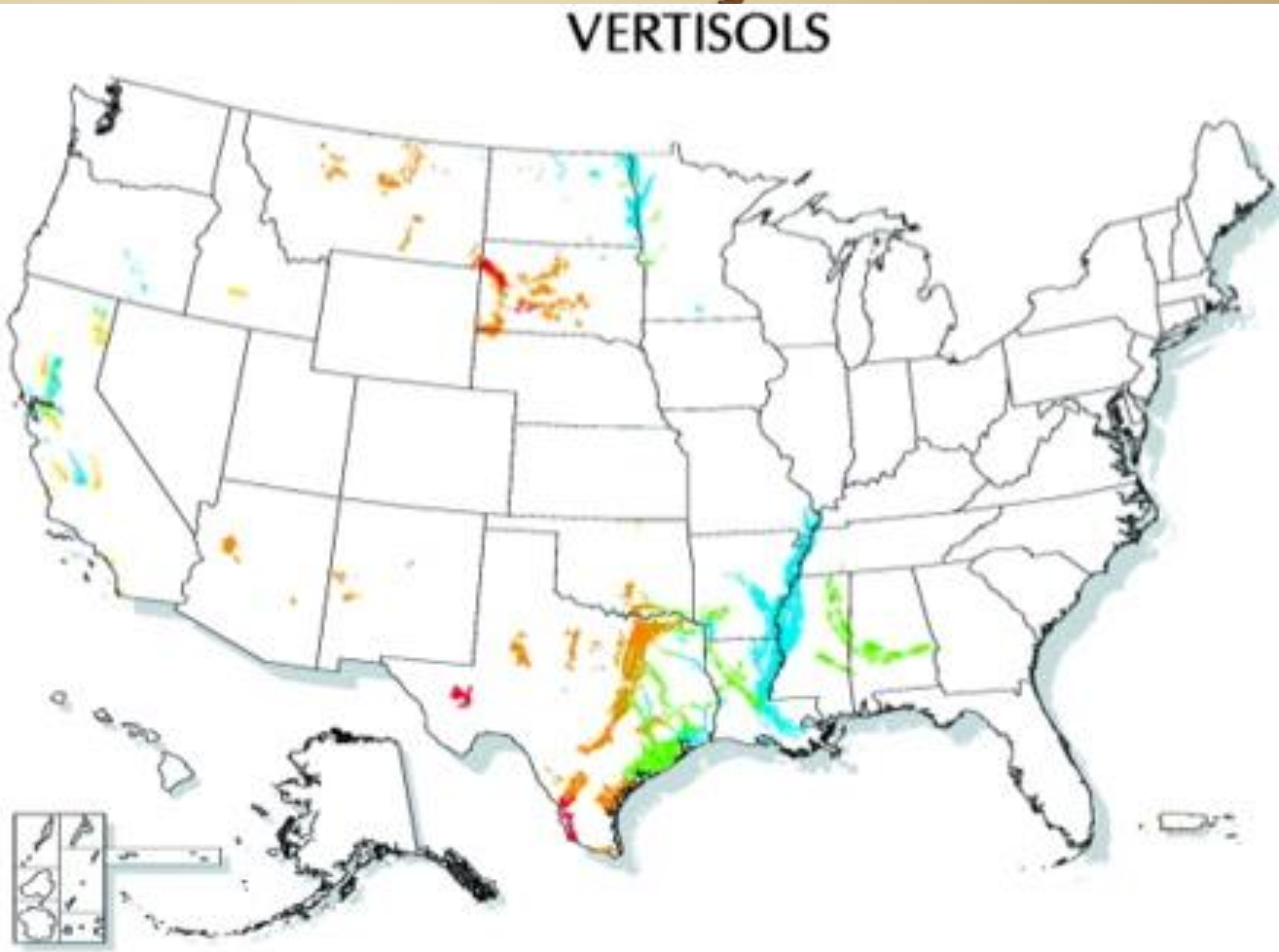
Prairie soils

Mollisols have a mollic epipedon and a relatively high content of bases. Many also have an argillic, natric, or calcic horizon. Some have a duripan or a petrocalcic horizon. Most formed under grass or savanna vegetation.



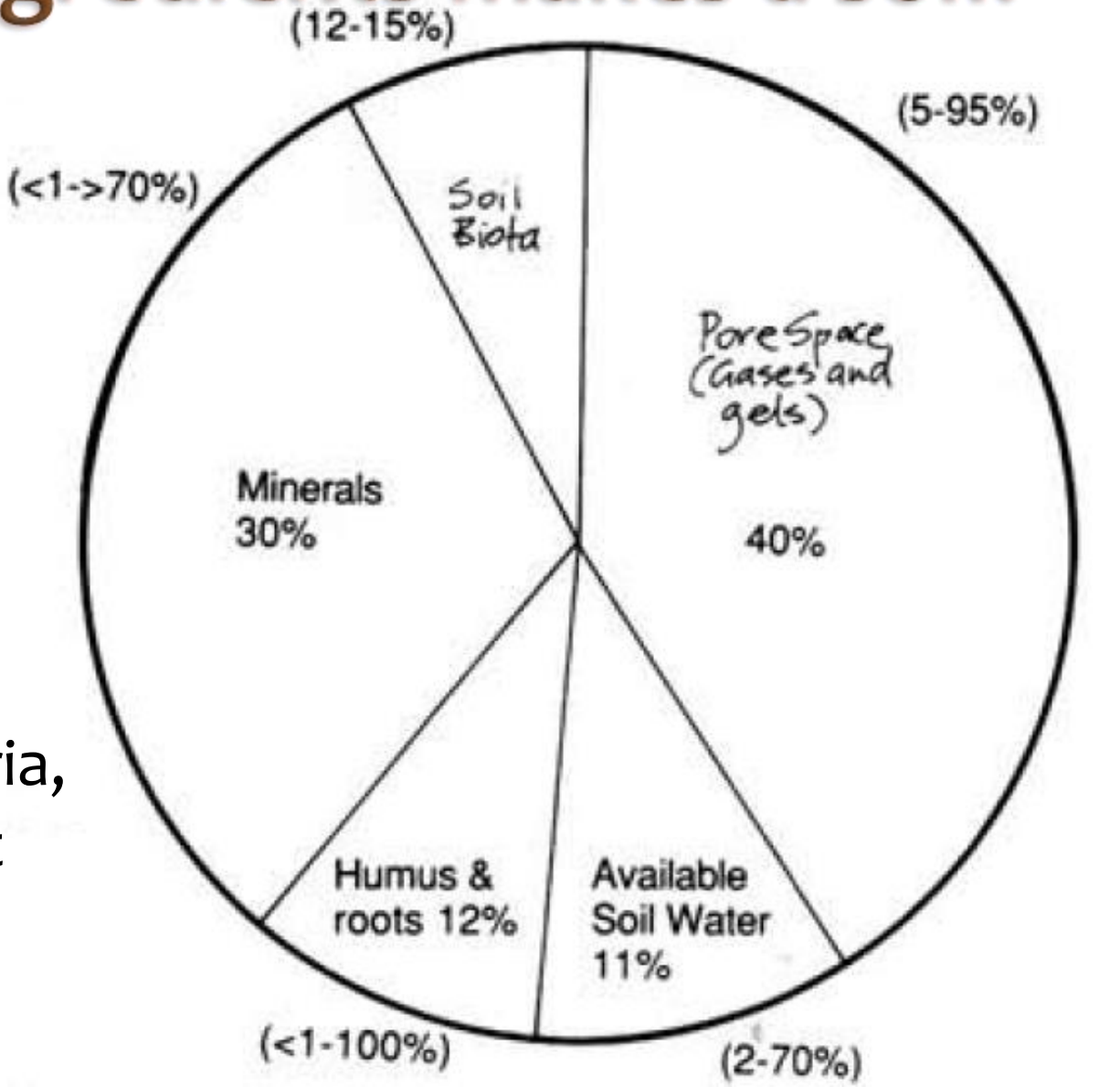
Shrink-and-swell clay soils

Vertisols are high in expanding clays that shrink when the soils become dry and swell when they become moist. Vertisols commonly have slickensides and develop deep, wide cracks when dry.



What 4 ingredients makes a soil?

1. Minerals
2. Water
3. Gases
4. Living and once-living material
   - Fungi, bacteria, worms, plant roots



The Mineral Content: Size matters

Soil texture is the sizes of the mineral fraction of soil. Texture determines:

- How water moves through the soil
- How well it holds together
- How well it holds onto nutrients

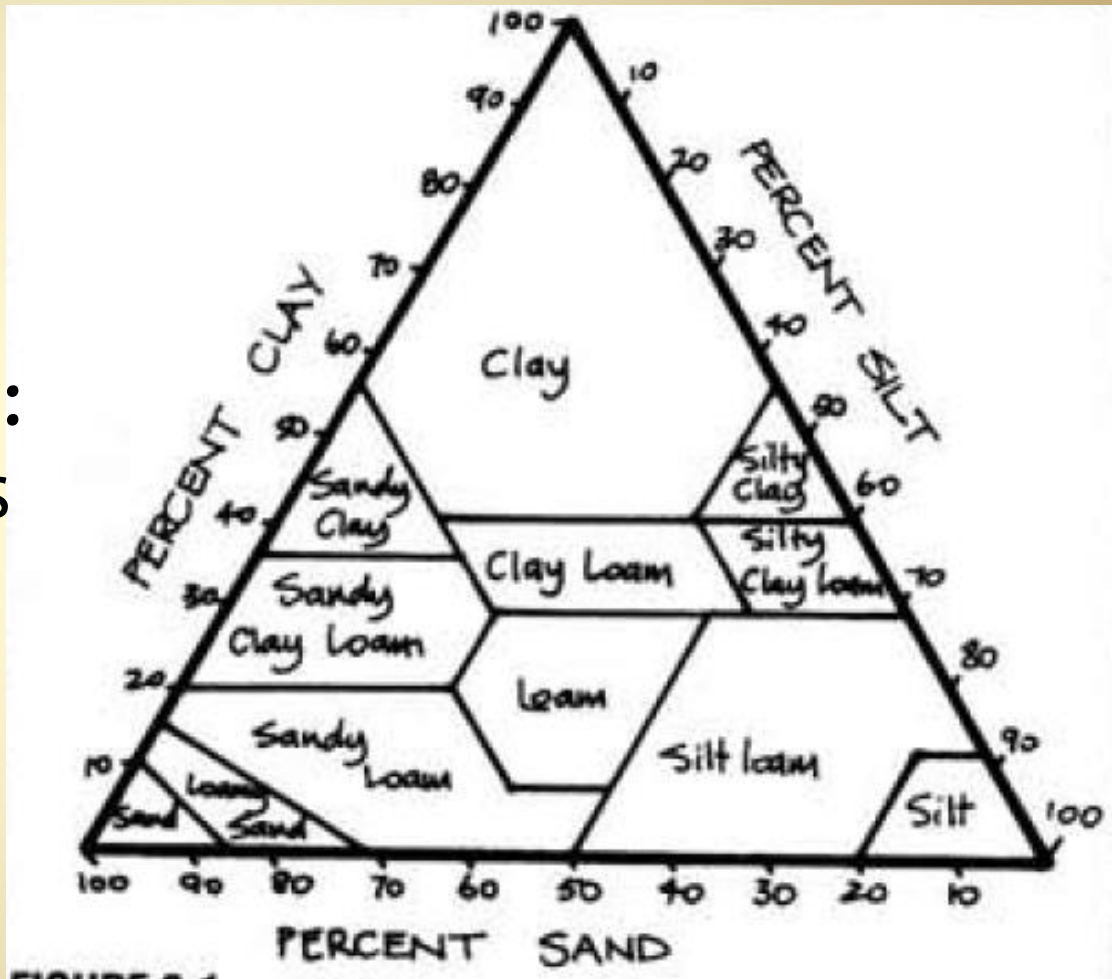


FIGURE 8.1
SOIL PROCESSES.
The USDA classification of soil types by particle size.

The ideal texture for growing

The ideal soil for plants has roughly:

- 20% clay
- 40% silt
- 40% sand
- What is this on the chart?

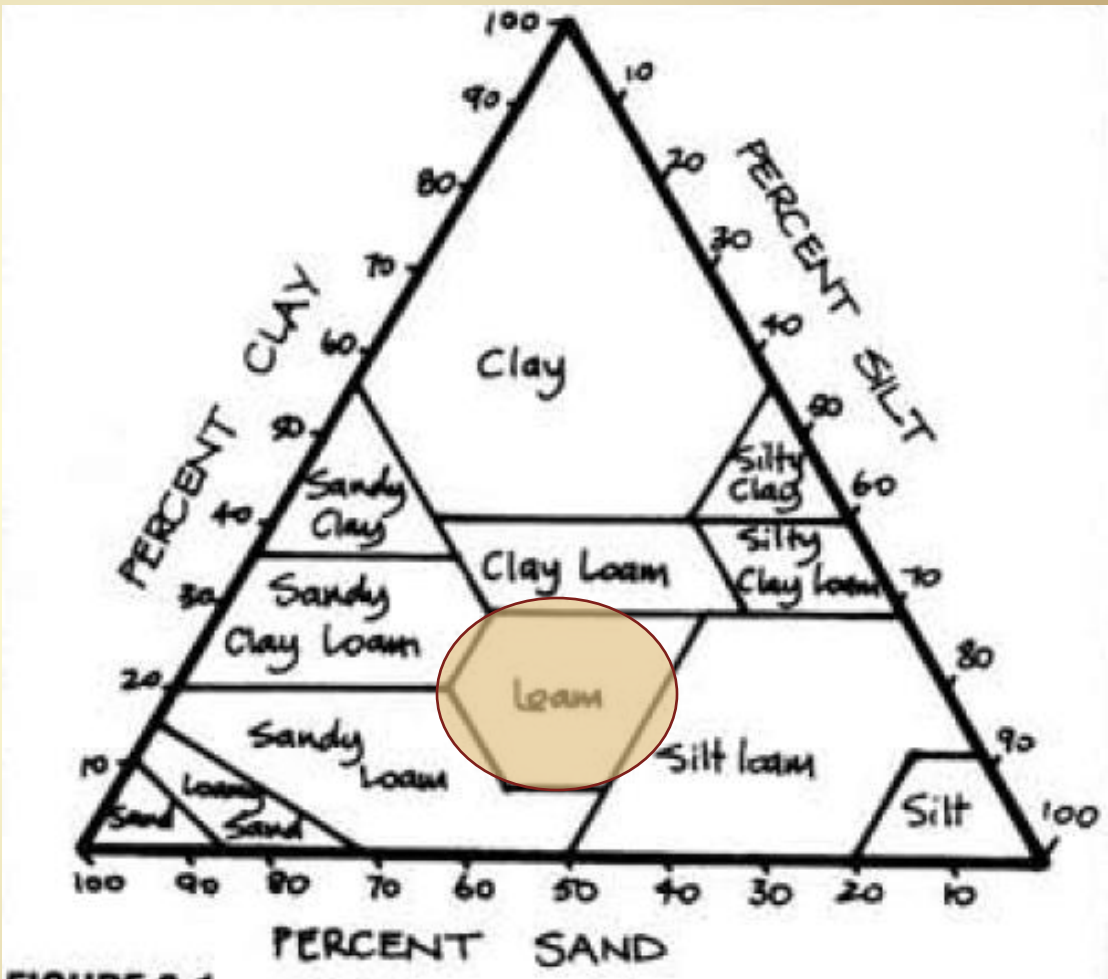


FIGURE 8.1
SOIL PROCESSES.
The USDA classification of soil types by particle size.

The ideal texture for building

Cob is made with soil that has:

- 12-30% clay
- 50-70% sand
- What is this on the chart?

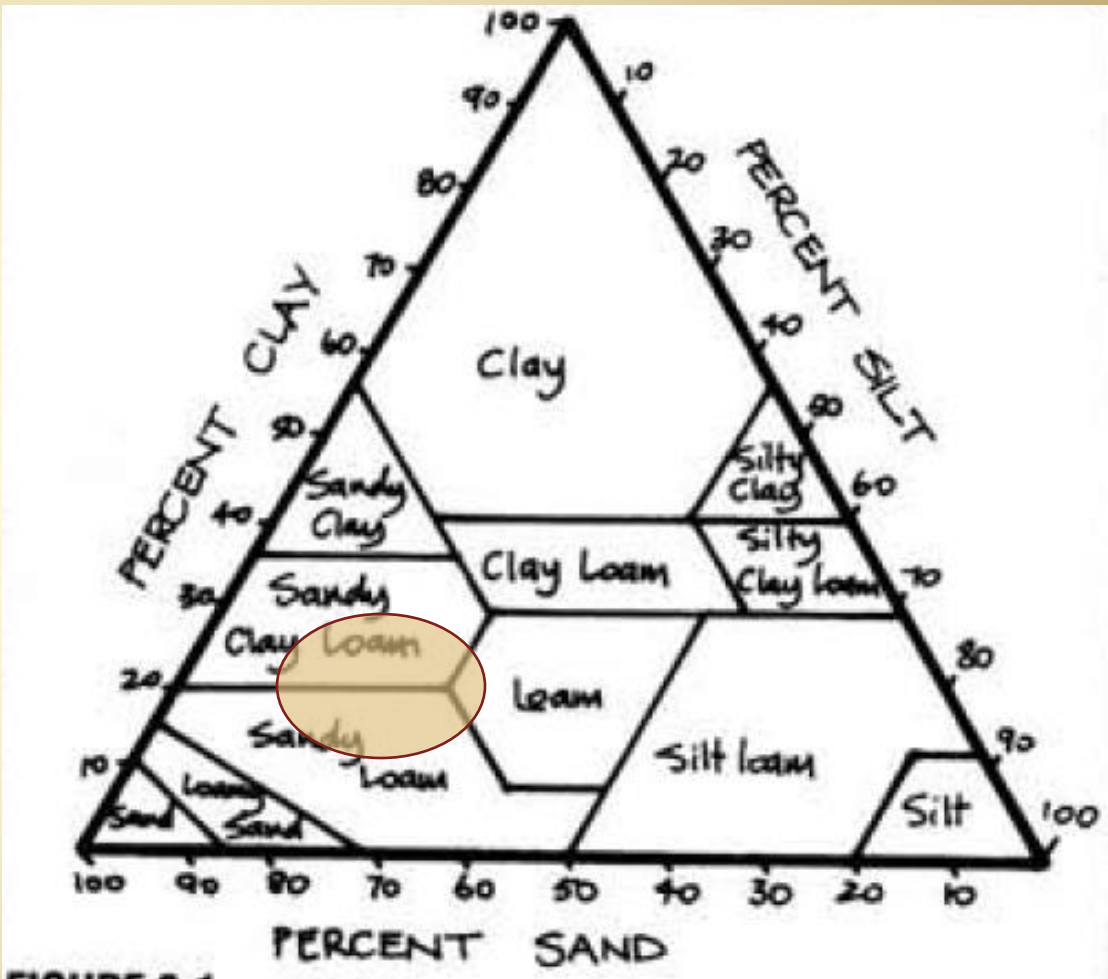
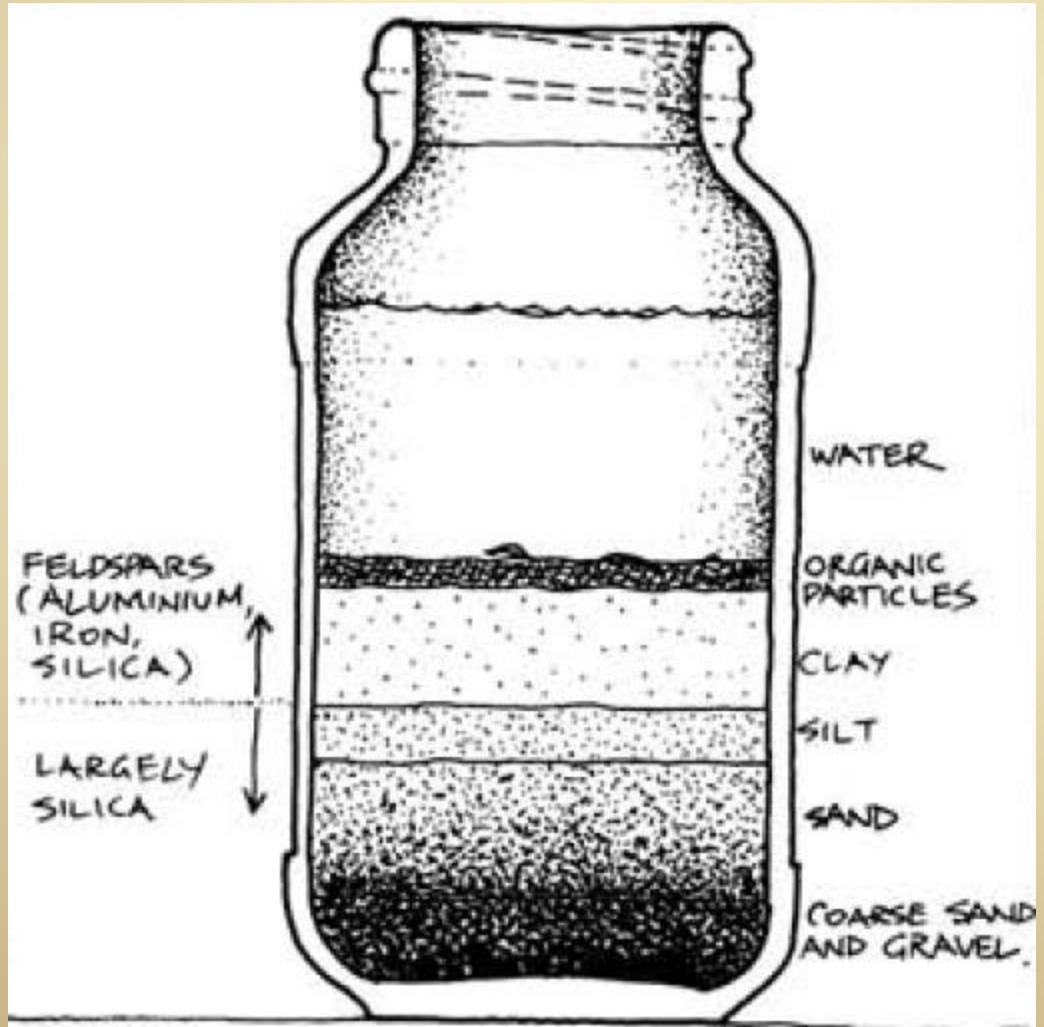


FIGURE 8.1
SOIL PROCESSES.
The USDA classification of soil types by particle size.

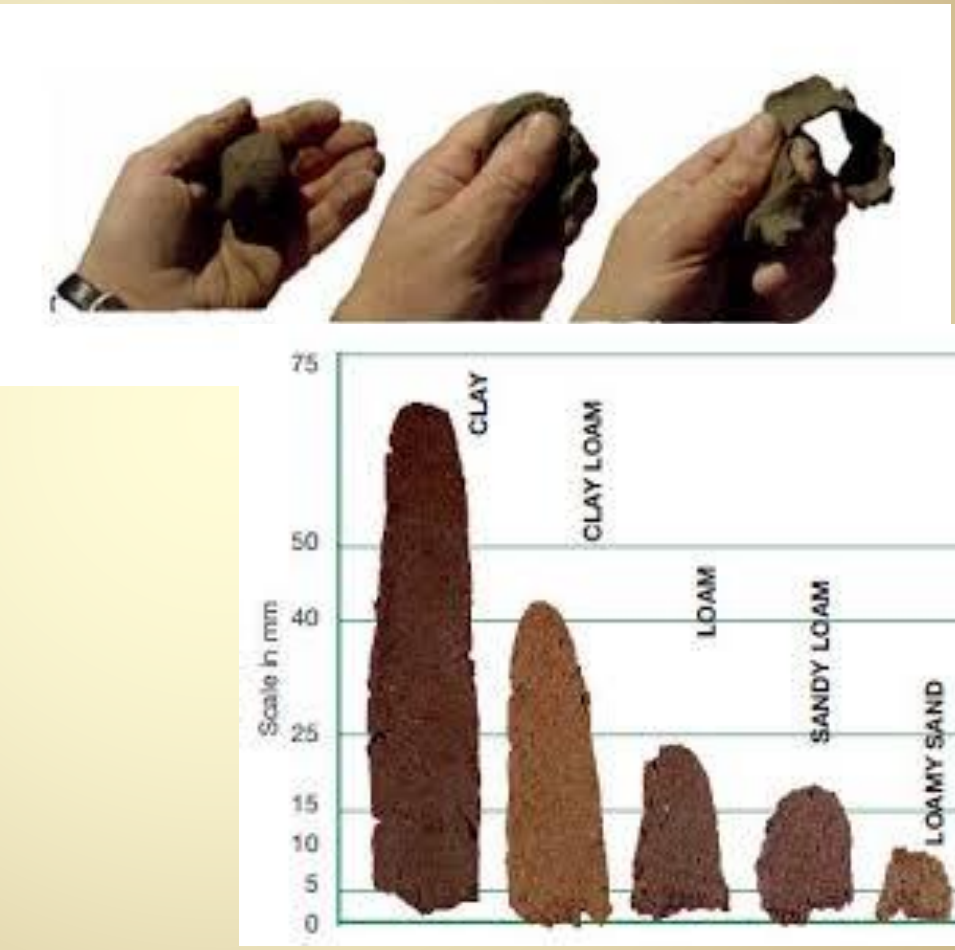
How can you determine the texture of your soil?

- One simple test is a soil milkshake.



There are many simple field tests for texture

- Ribbon test
- Drop test
- Taste

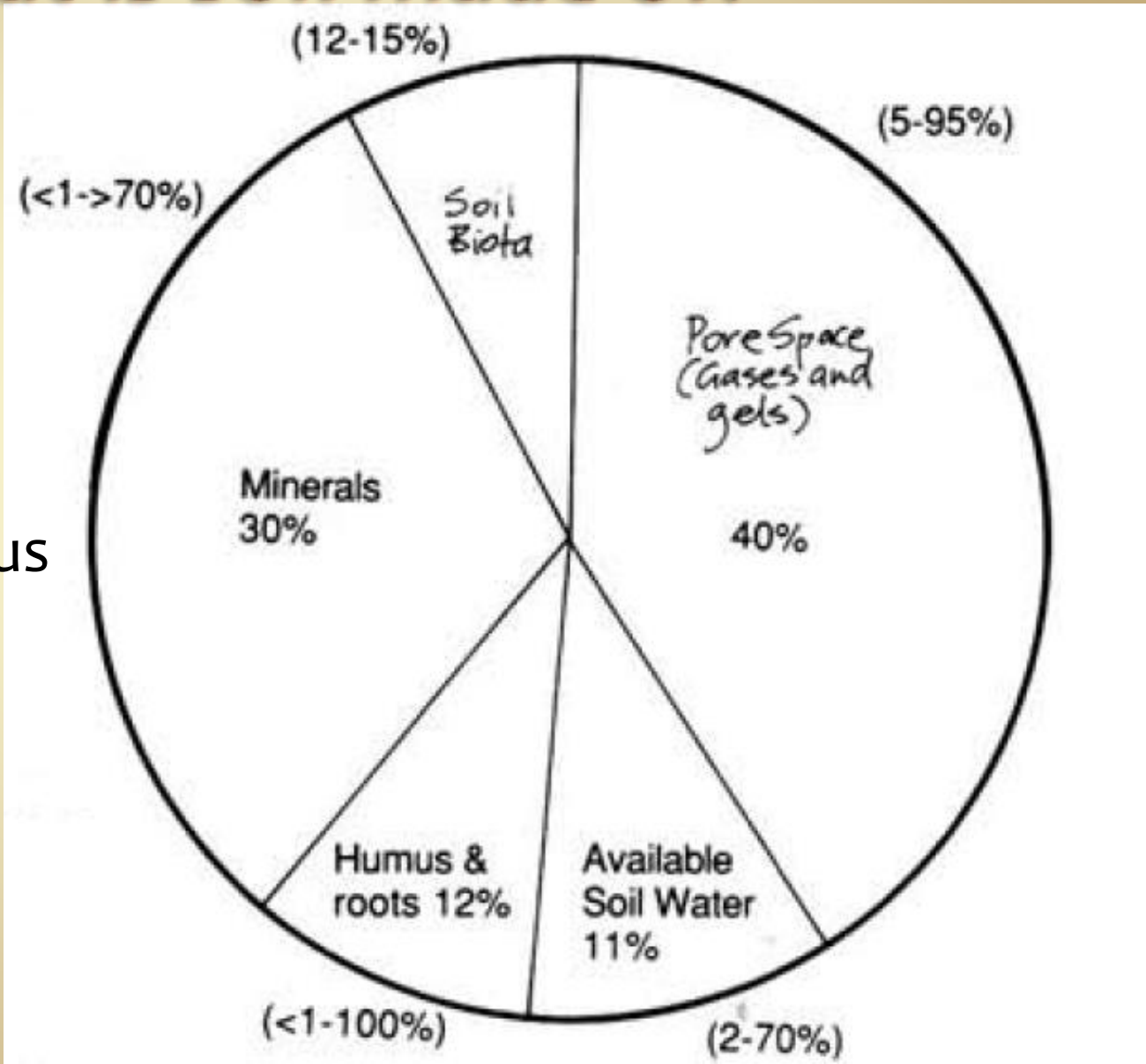


Review Question: What is soil made of?

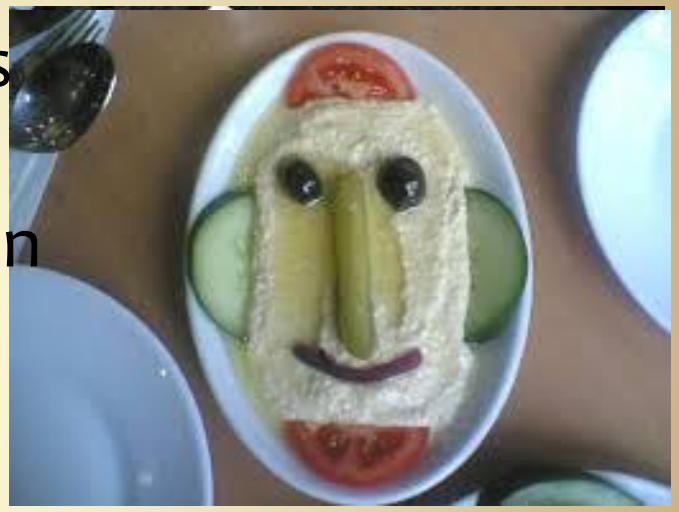
- Average soil is:
- Minerals
- Water
- Gases

(Pore space)

- Biota and humus



A sense of humus

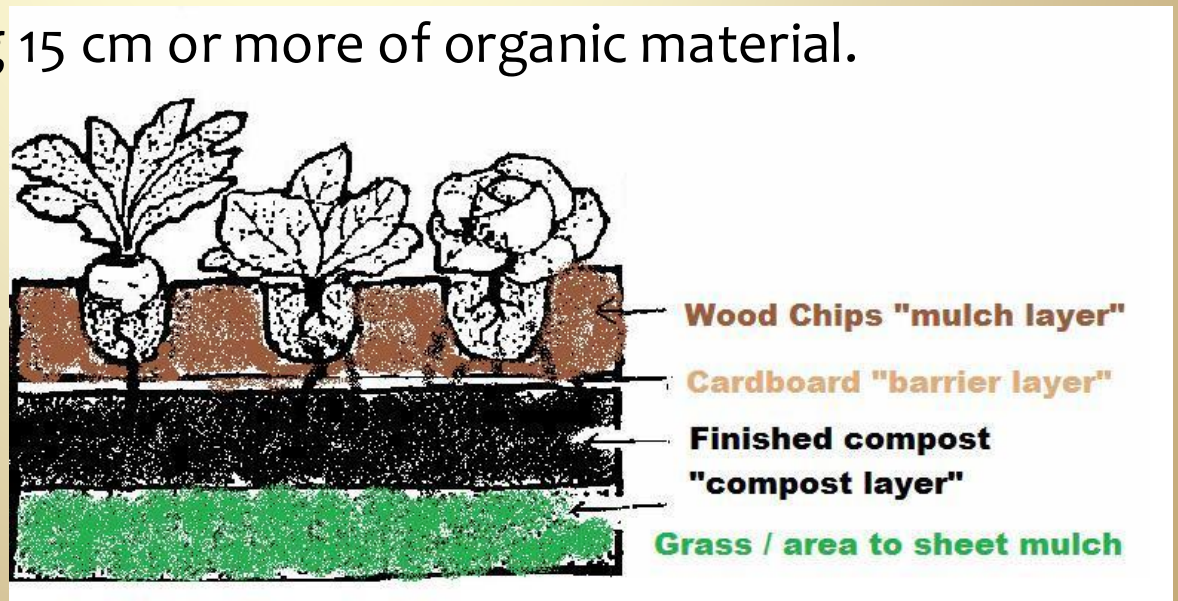


- Humus is what gives a rich soil its black color.
- It is the product of decomposition of plants and animals.
- Composted and mulched garden soils can be 30% humus.
- Benefits of humus:
  - Improved water retention
  - Reduced soil erosion
  - Improved nutrient availability for plants

"... the Latin name for man, homo, *derived from humus, the stuff of life in the soil."*
--- Dr. Daniel Hillel

You can increase humus content

- Use perennial and/or mulch-producing plants
- Return food wastes to the garden
  - Consider urine and well-composted poop as well.
- Humus is lost when soil is ploughed or burned.
  - It oxidizes when exposed to air
- Mulching adds humus
  - Mulching is adding 15 cm or more of organic material.

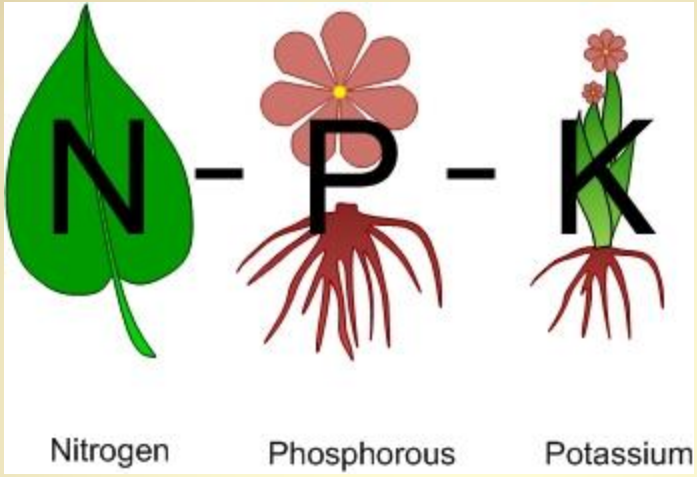


Anyone want to stretch your legs for a minute?

“Feed the soil, not the plants.”

Soil Fertility

Primary Nutrients for Plants



- The three main macronutrients: *N*, *P*, *K*
- These are usually the nutrients that soils lack

Plants need nitrogen for leaves and height

- Nitrogen is an important for making proteins, for growing new leaves.
- Some plants need more N than others
  - Eg. corn
- Our atmosphere is 78% nitrogen, but plants cannot absorb it.
- Plants get their nitrogen as NO^{3-} (nitrate) through their roots

Nitrogen deficiency

Nitrogen is mobile in the plant. It is carried to the baby leaves.

- Older leaves turn yellow and die.
- Baby leaves don't grow.

Nitrogen deficiency

- Best way to give your plants nitrogen is with a good supply of compost.
- Green manure
- Urine
  - 20 parts water to 1 part urine
- Fish tank water
- Water plants
- Interplant acacia trees

Nitrogen-fixation

- Leguminous plants have a symbiotic relationship with *rhizobia* (a bacteria) in their roots

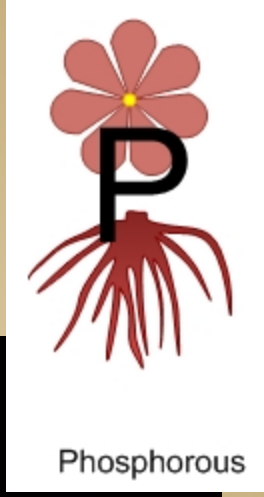
$N_2 + 8\ H^+ + 8\ e^- \rightarrow 2\ NH_3 + H_2$

- Legumes are good sources of protein because the plant has plenty of nitrogen.

Nitrogen-fixation

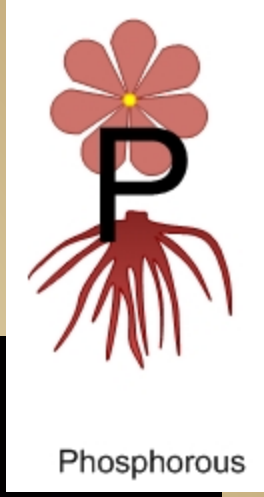
- When leguminous plants are left in the soil, all the remaining N is converted into NO^{3-} (nitrate).
- Other plants will be able to use this N as “green manure”

Plants need phosphorous for roots



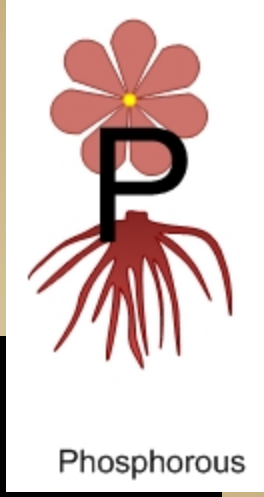
- Plants need P for:
- Energy
- Growing new roots
- Cell division

Phosphorous deficiency



- Deformation of leaves, reddish-purple discoloration of leaves and stem.
- Common in very acid, alkaline, or dry soils.

Phosphorous deficiency



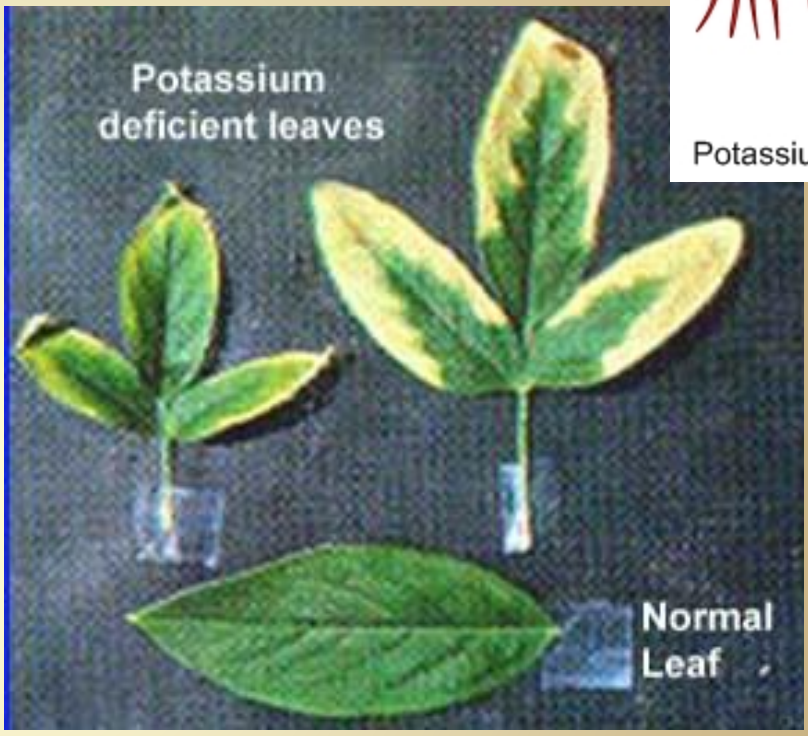
Begin by bringing soil to about pH 6.5.
Sources of P:

- Buried bones
- Bird manure tea
- Mulch
- Comfrey tea
- All animal manures

Plants need potassium for fruit

Plants need K for:

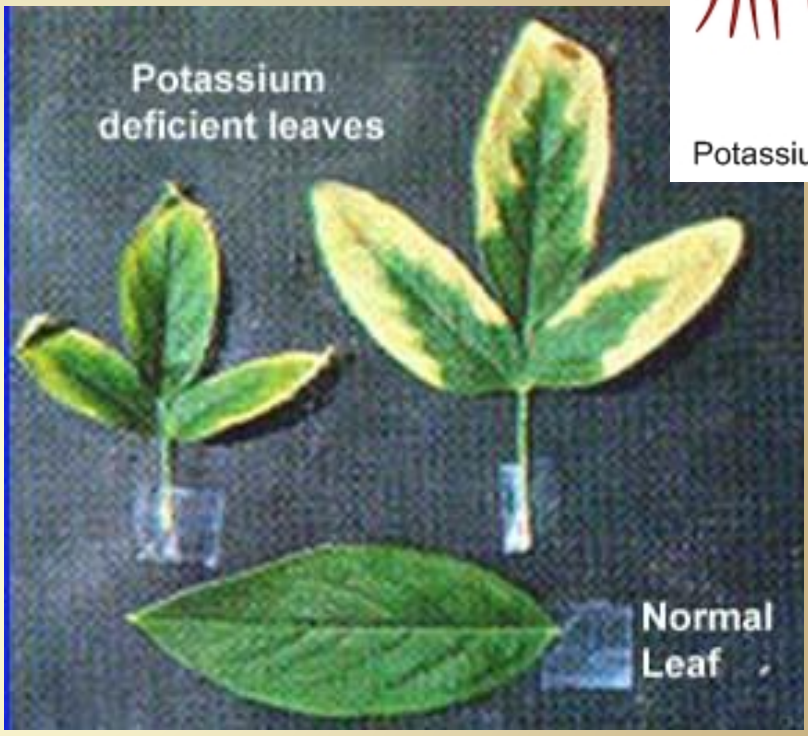
- Regulating “water pressure” in cells
- Plant immunity
- Flowering
- Fruiting
- Making bright pigments.



Potassium defficiency

Plants might look small or thinner than usual, or weak and spindley, attract more pests than usual, fruits are small, thin-skinned, lacking flavor.

Deficiency is common on acid soils.



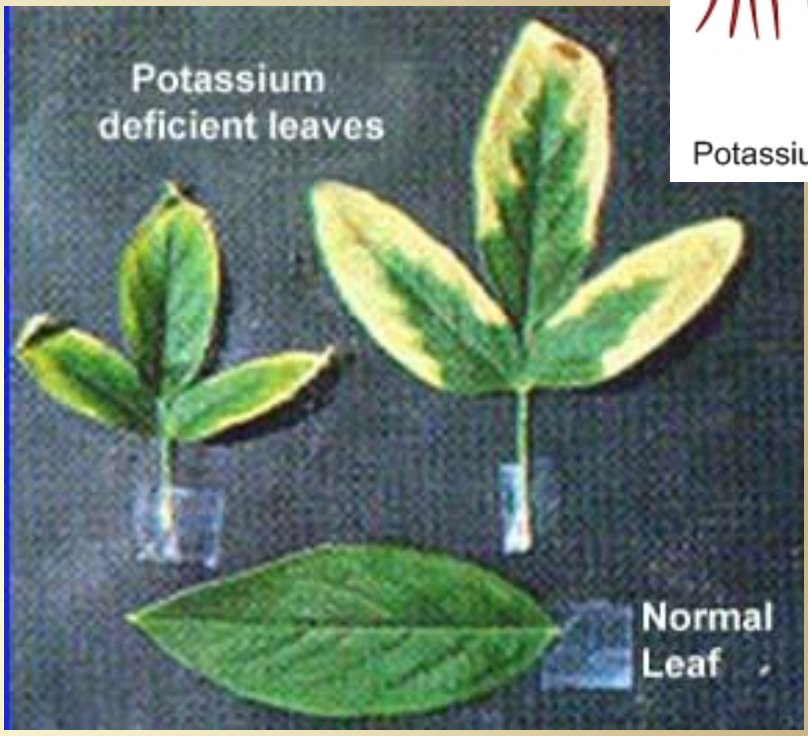
Potassium defficiency

Sources of K:

- Coffee grounds, banana peels
- Wood ashes

(will also raise soil pH!)

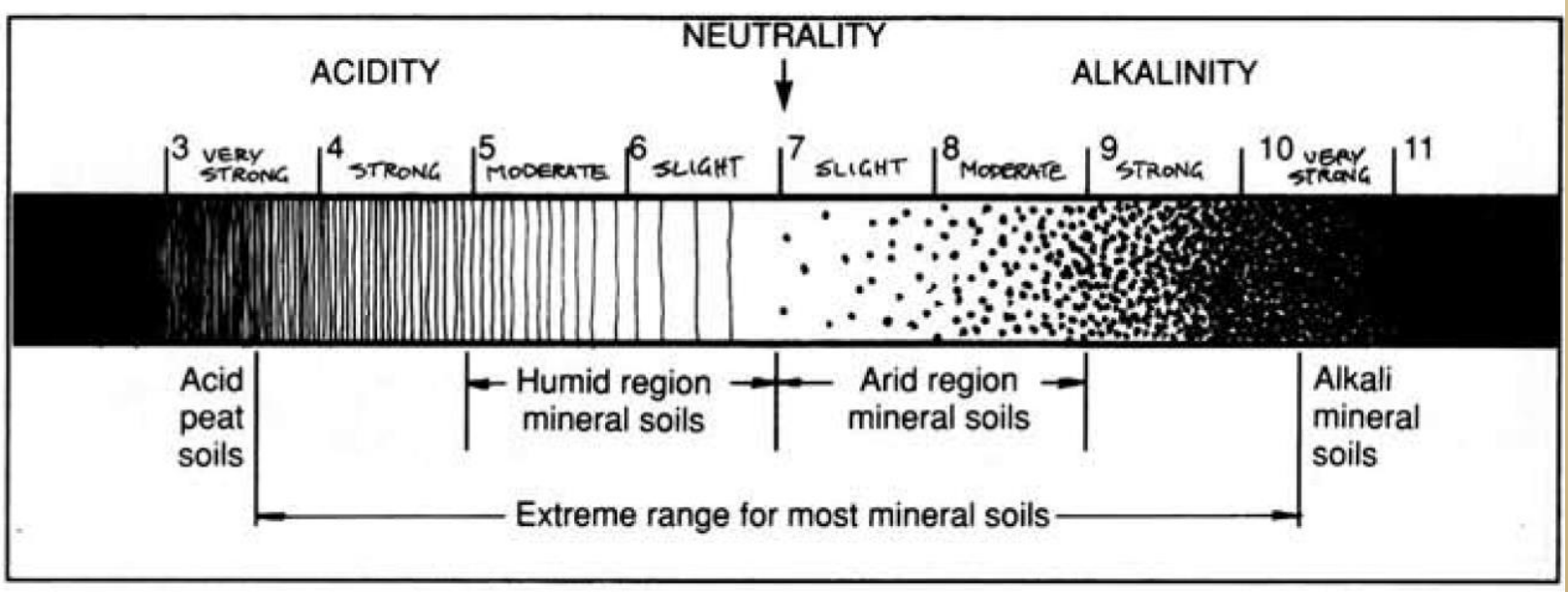
- Diluted urine
- Seaweed
  - Dried or fresh
- Bird manure tea



Potassium

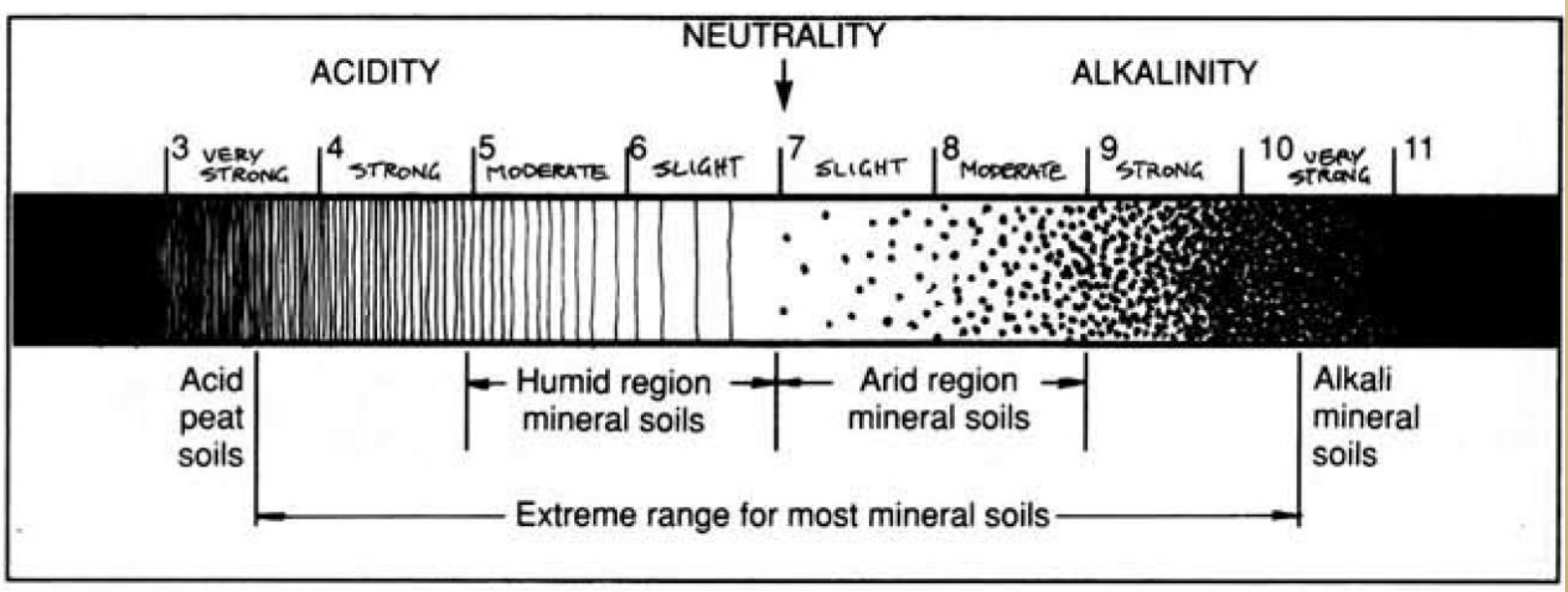
Soil pH

- Most nutrients are available to plants through water in the soil.
- The pH of the soil determines how well certain nutrients can dissolve.



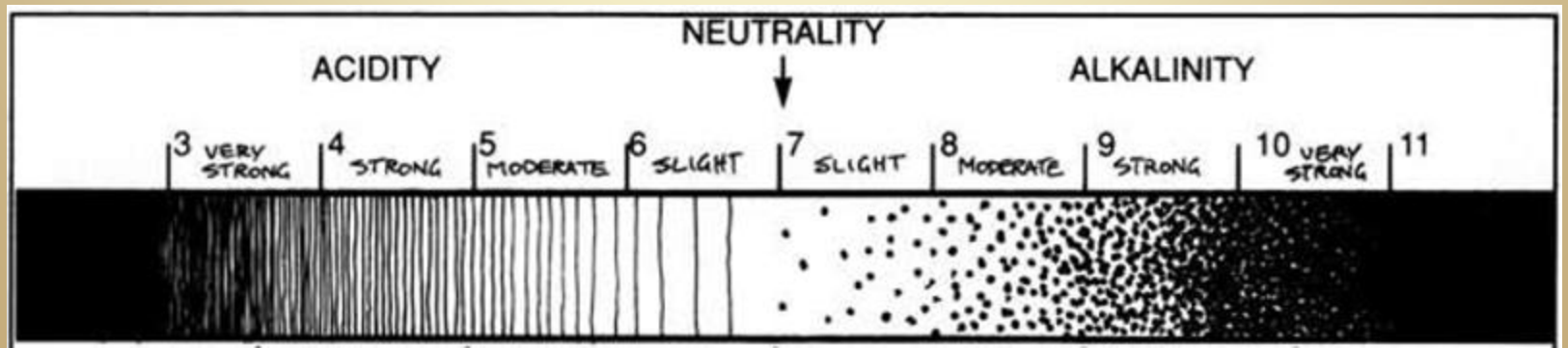
Soil pH

- Different plants do best within their own pH range.
- Beyond 0.5 outside a plant's range, consider planting something else, or amending your soil.



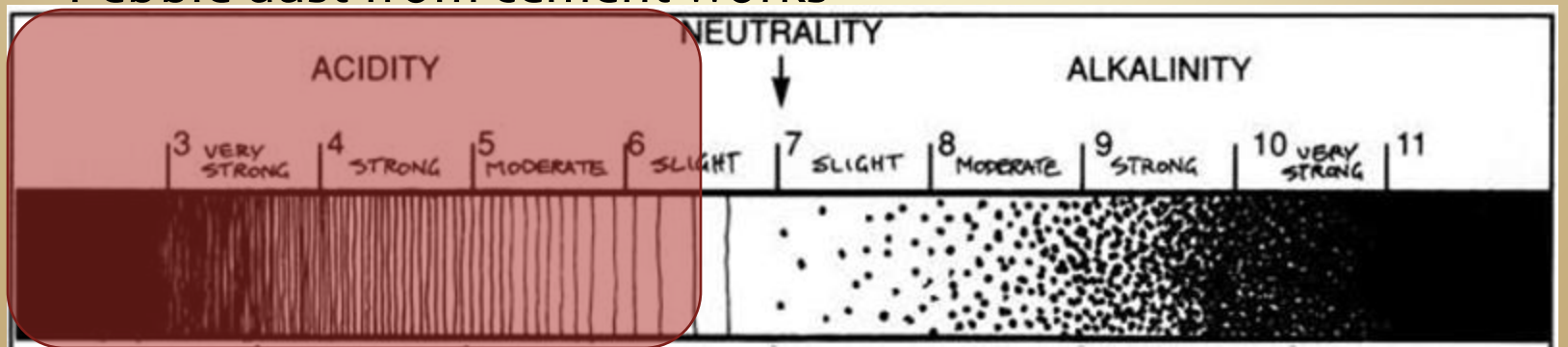
Soil pH varies.

- Soil pH varies all over the soil, between worm castings and surface mulch, between rain events.
- Many plants can grow between 4.5 and 10.
- Most vegetable plants can grow between pH 6.0-7.5.
- That is, as long as calcium is present.
- Soil humus, and calcium, act to buffer for pH.
- So use mulch and lime and you might not see any nutrient deficiencies in your plants.



Acid soils are sour.

- Acid soil is more likely when parent material has more silica, such as in granite, and/or is at higher elevations.
- You can raise the pH by adding:
  - Manures
  - Compost
  - Blood and bone, boiled eggshells
  - Dolomite
  - Seaweed
  - Pebble dust from cement works

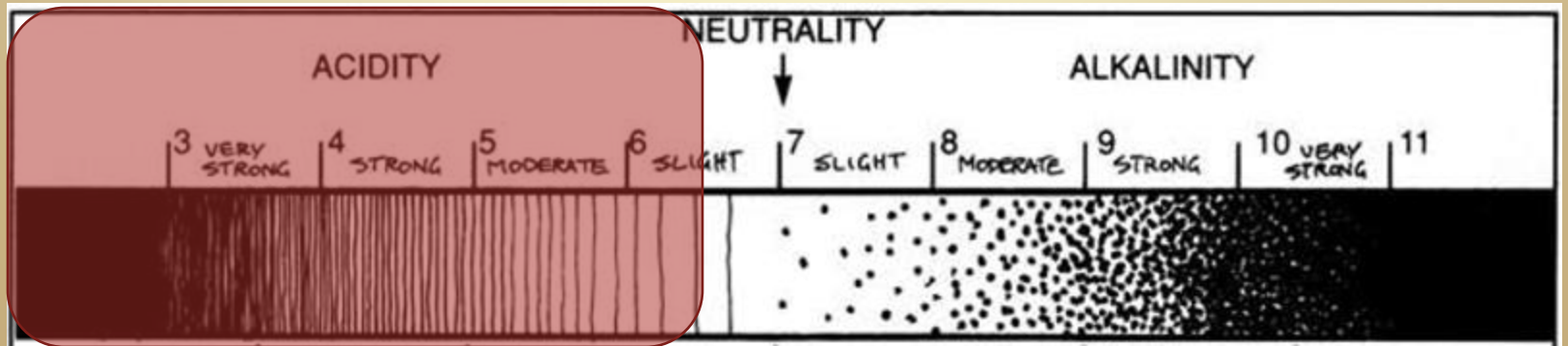


What kinds of plants like acid soils?

- Blueberry
- Endive
- Potato
- Fennel
- Shallot
- Watermelon

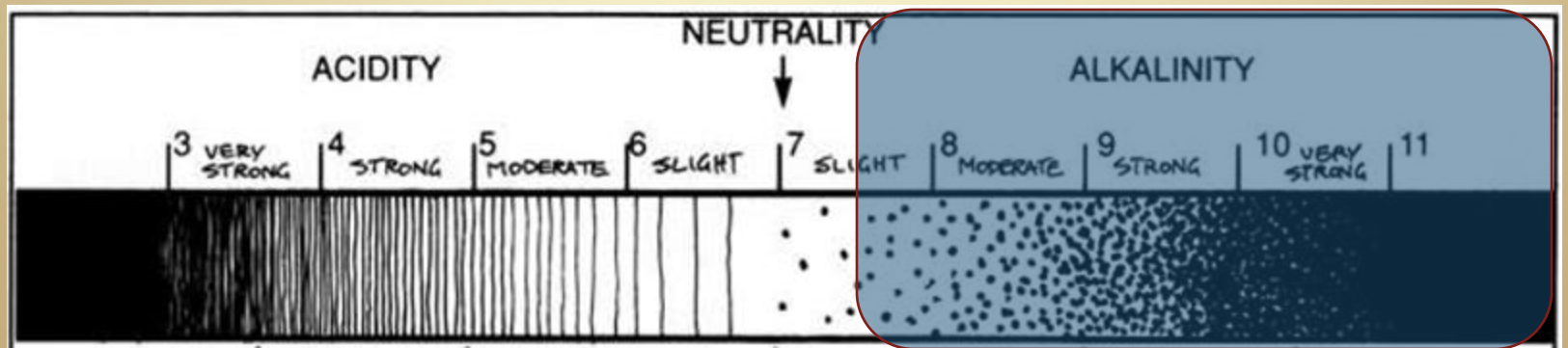
These tolerate acid soils:

- Lupin
- Oats
- White clover



Alkaline soils are soapy.

- Alkaline soil is more likely when parent material has less silica, such as in basalt, and/or is at lower elevations.
- You can lower the pH by adding:
  - Blood and bone
  - Manures
  - Compost
  - Acidic phosphate
  - Urine for potash
  - Foliar sprays of seaweed concentrate

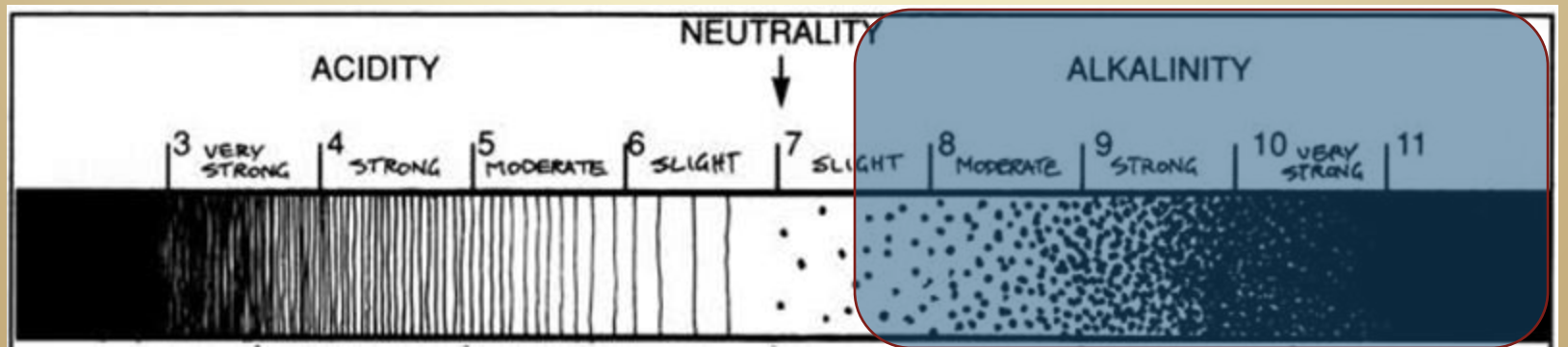


What kinds of plants like alkaline soils?

- Cauliflower
- Cabbage
- Asparagus
- Green peas, bush beans
- Celery
- Leek
- Beet
- Onion
- Chard
- Parsnip
- Spinach
- Broccoli

These tolerate it:

- Oats
- Kale
- Rye



To test, or Not to test?

- No need to, if all the plants in a garden are growing vigorously.
- Do-it-yourself soil tests are one option
  - This one was on Amazon for $14.00 and included 10 trials each for N, P, K, pH
- Lab soil tests are another option
  - Can be done every three or four years
- Best time to test is in fall
  - Labs are not back-logged
  - Fall is the time to add the amendments to adjust soil pH

In review

- Soil is the skin of our planet.
- Get your hands dirty.
- Feed your soil.

The soil is the great connector of lives,
the source and destination of all.
It is the healer and restorer and resurrector,
by which disease passes into health,
age into youth, death into life.
Without proper care for it we can have no community,
because without proper care for it we can have no life.

— Wendell Berry, *The Unsettling of America: Culture and Agriculture*


Questions?


Thank you!!!