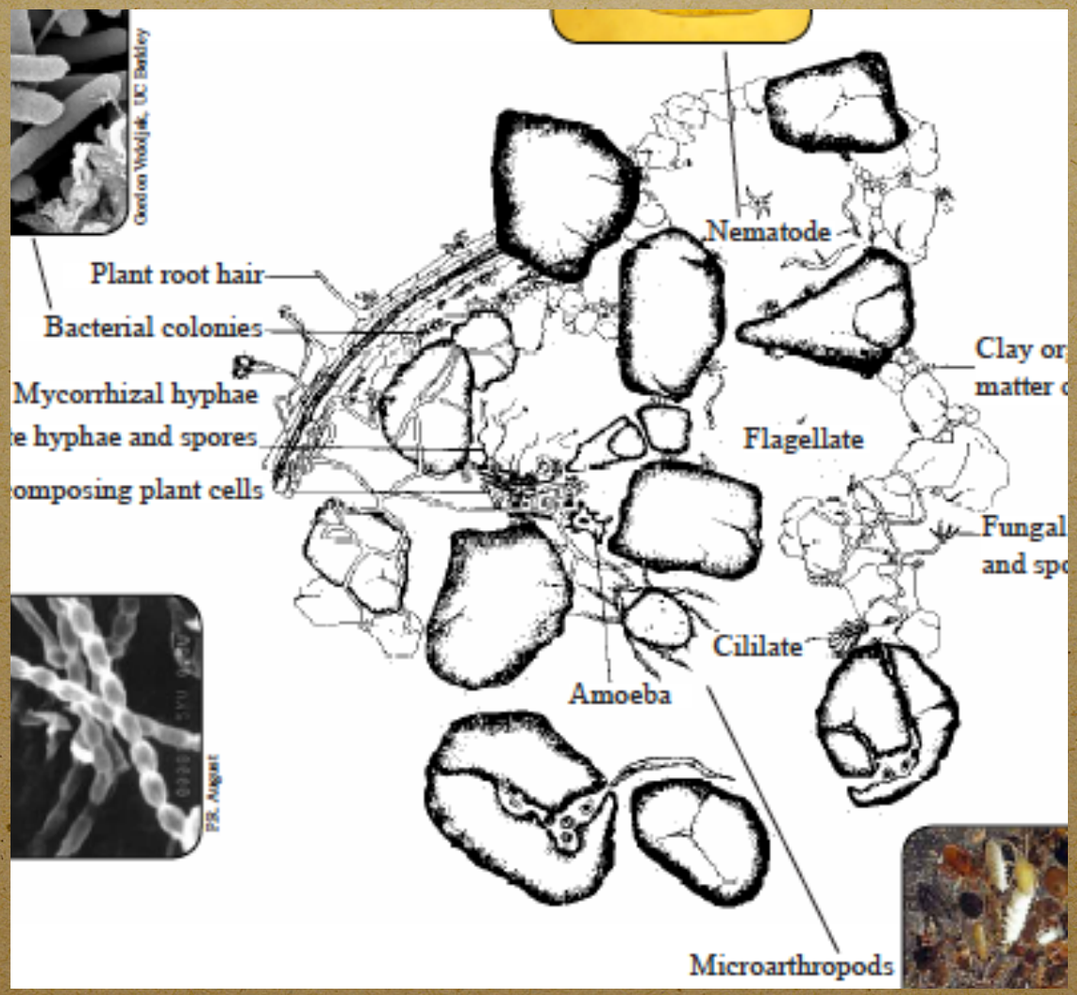
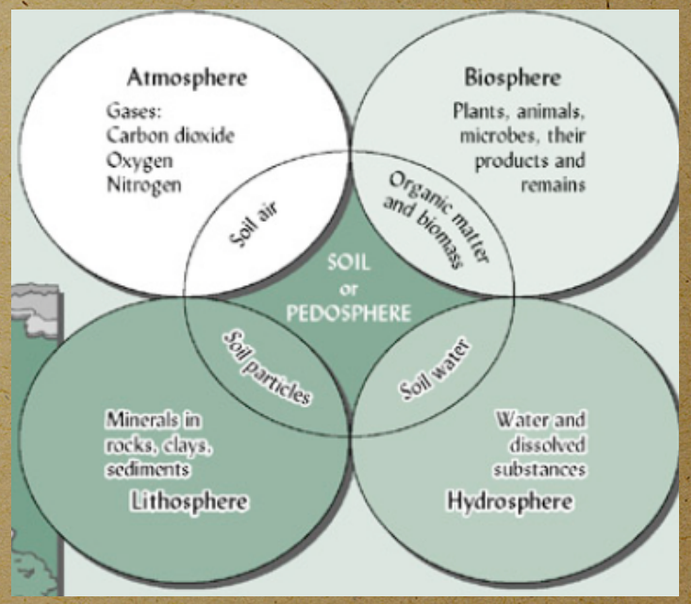
Introduction to Soils

Honeoye (NY)





Soil Quotes

"For all things come from the earth, and all things end by becoming earth" -Xenophanes 580 B.C.

"No matter how many...books on your shelf, it is plants ability to capture solar energy that is at the root of it all. Without fertile soil what is life." –Vandana Shiva

"We know more about the movement of celestial bodies than about the soil underfoot." –Leonardo da Vinci

"We take the soil for granted because it's there, it's everywhere, except when all of it is taken by the wind or by the running water. And then you are left with bare rock, and you realize you can't do much with bare rock." –Wangari Maathai

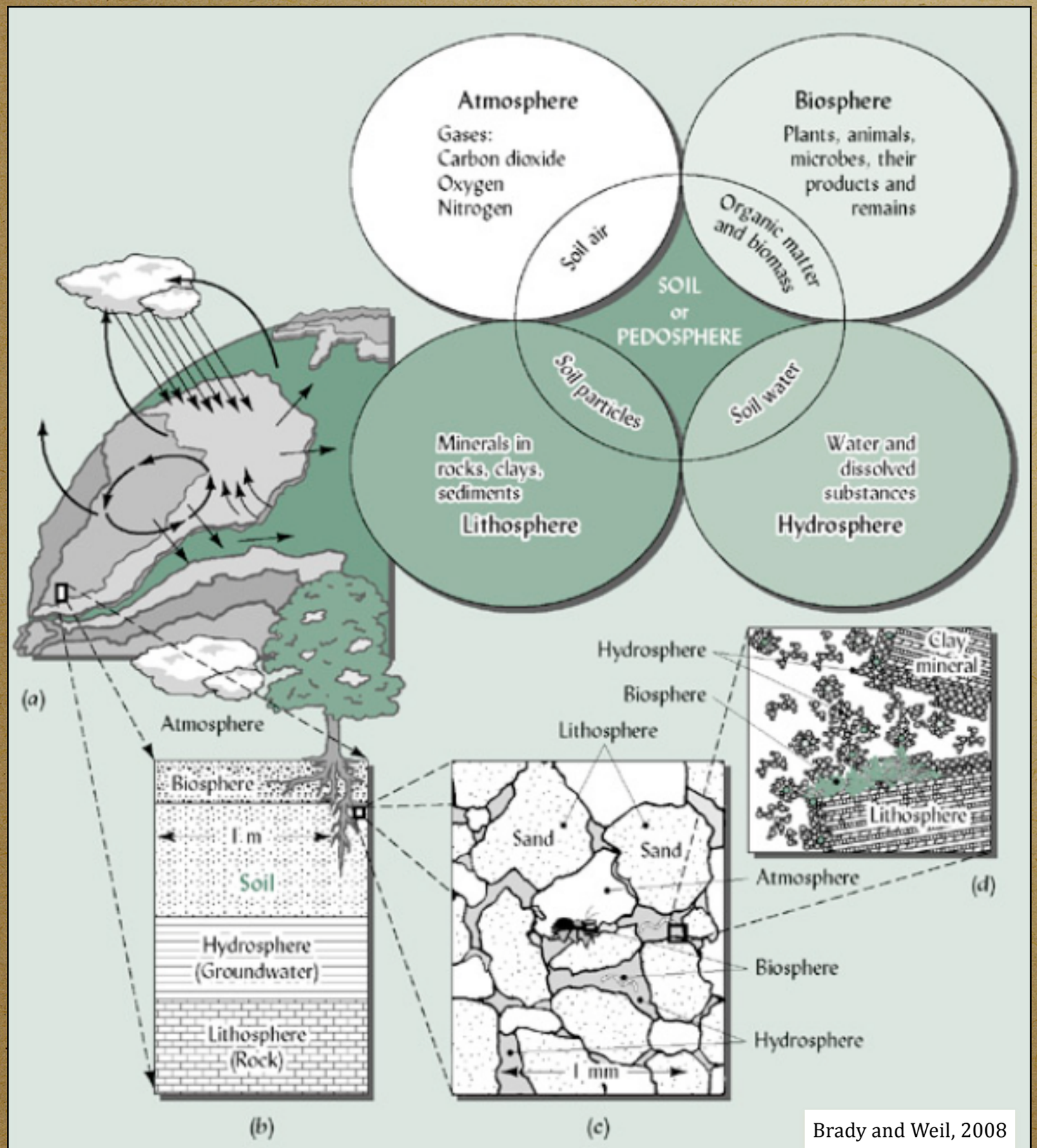
"While the farmer holds the title to the land, actually it belongs to all the people because civilization itself rests upon the soil." –Thomas Jefferson

"The nation that destroys its soil, destroys itself"
- Franklin Delano Roosevelt

Outline:

- Soils as dynamic volumes that sit at the interface of the atmosphere-hydrosphere-lithosphere-biosphere
- Soil Fundamentals: Components of the Soil Volume
- An introduction to soil formation and the five soil forming factors
- Soils are Unique: Geologic and Pedologic History of Tompkins County, The Midwest, and Hawai'i and An introduction to the 12 Soil Orders
- Web Soil Survey Activity

The Interface Between Air, Water, Solid Earth, and Life



Brady and Weil, 2008

Soil (or the Pedosphere) is an interface between the:

- Atmosphere (air)
- Hydrosphere (water)
- Lithosphere (surface geology)
- Biosphere (life: plants, animals, microbes; life's products, and death: life's remains)

The Soil is a zone of complex interactions between these components

Soil is a Dynamic Volume

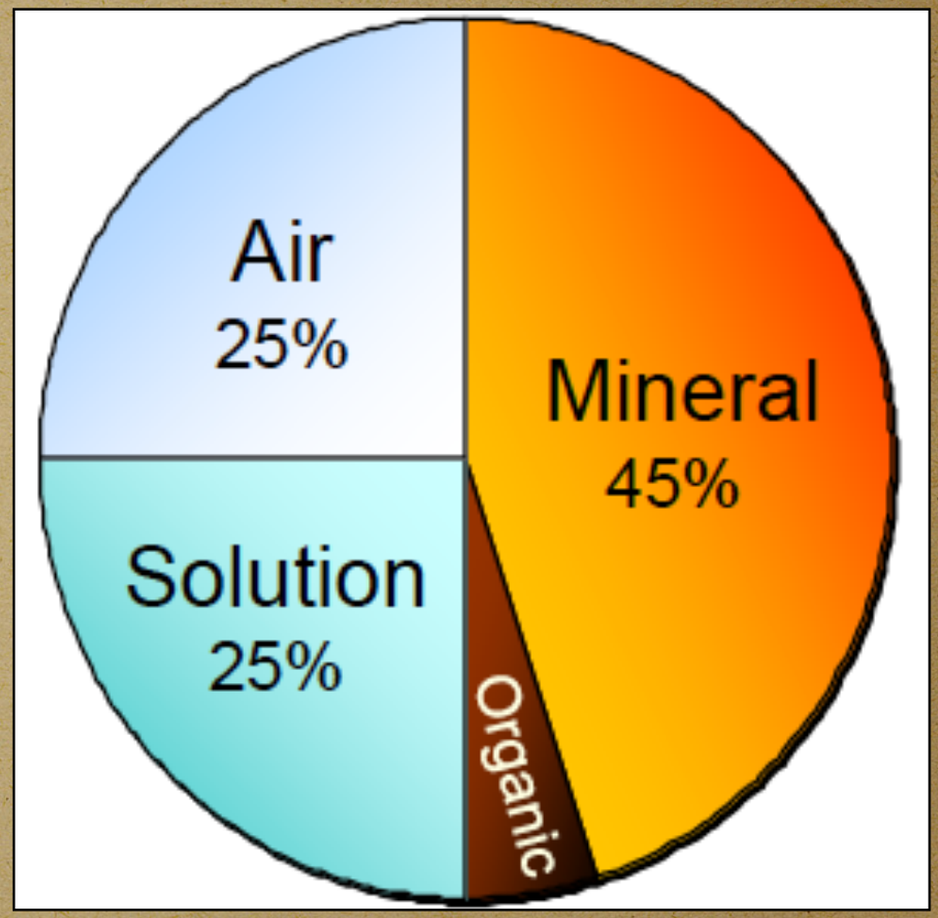
- Soil is not just a solid thing, it's a dynamic volume

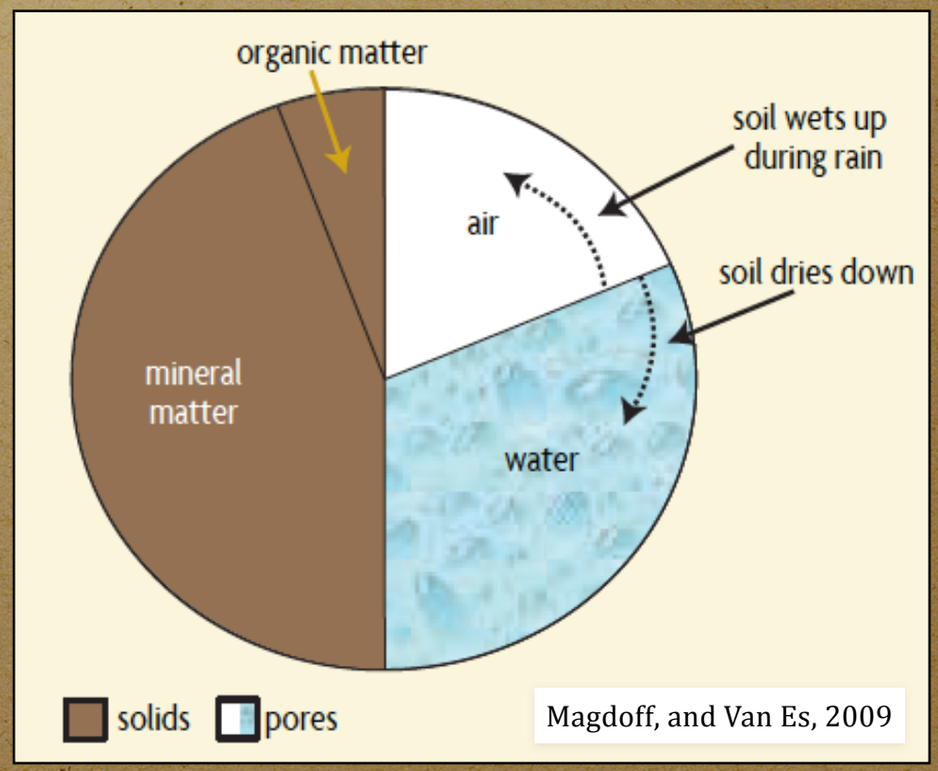
- **Soil is composed of:**
- Solids:
  - Mineral: rock fragments, sand, silt, clay
  - Organic Matter: living, dead, and very dead (CHNOPS)

- Solution
  - Water
  - Dissolved Substances

- Air

- Biology
  - Plants
  - Animals
  - Microbes



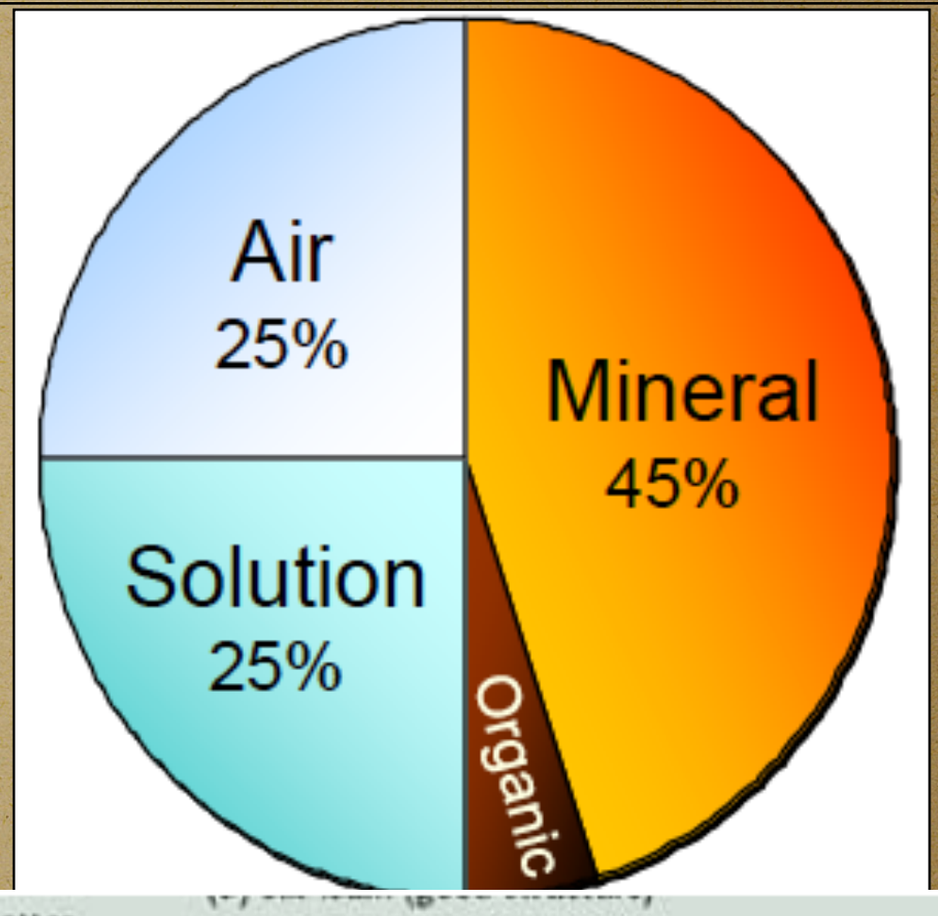


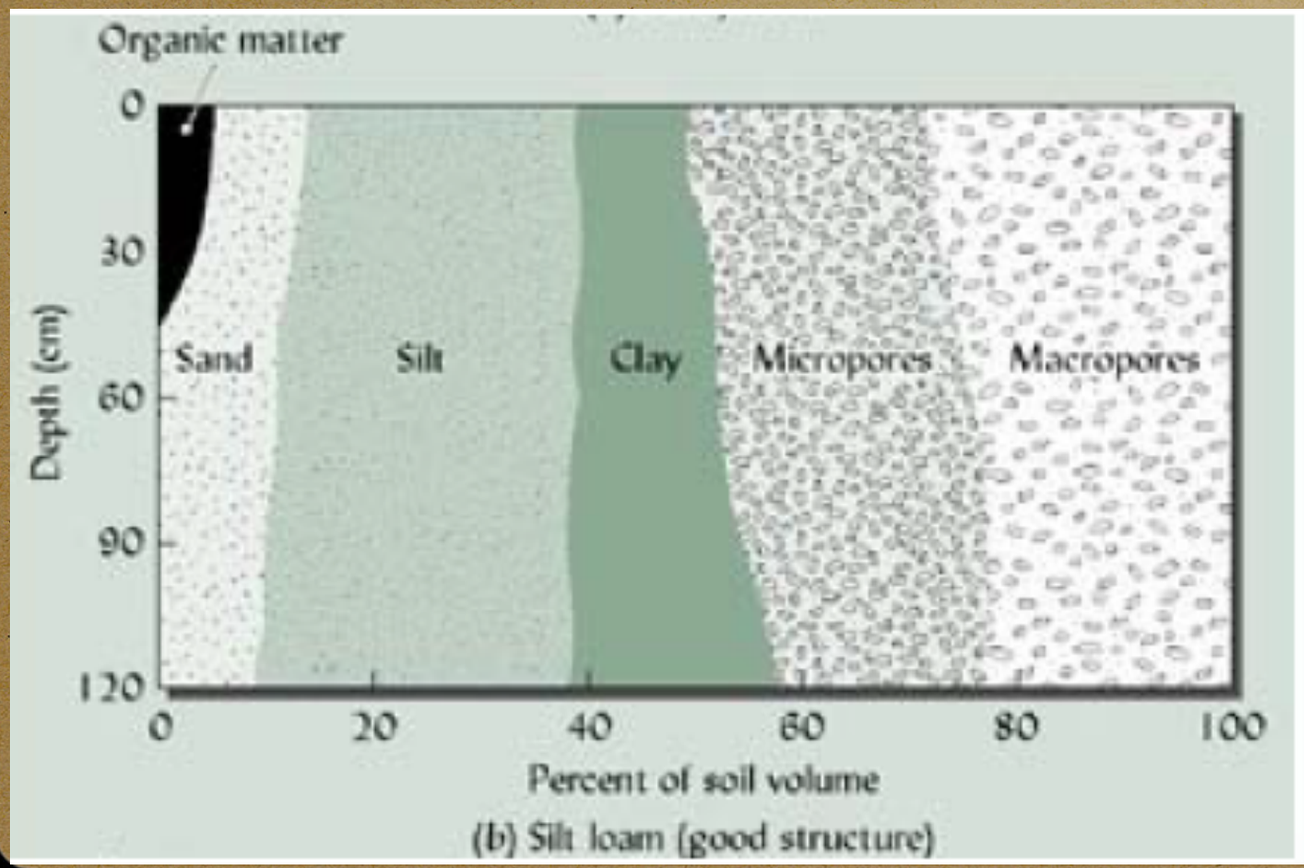
Soil is a Dynamic Volume

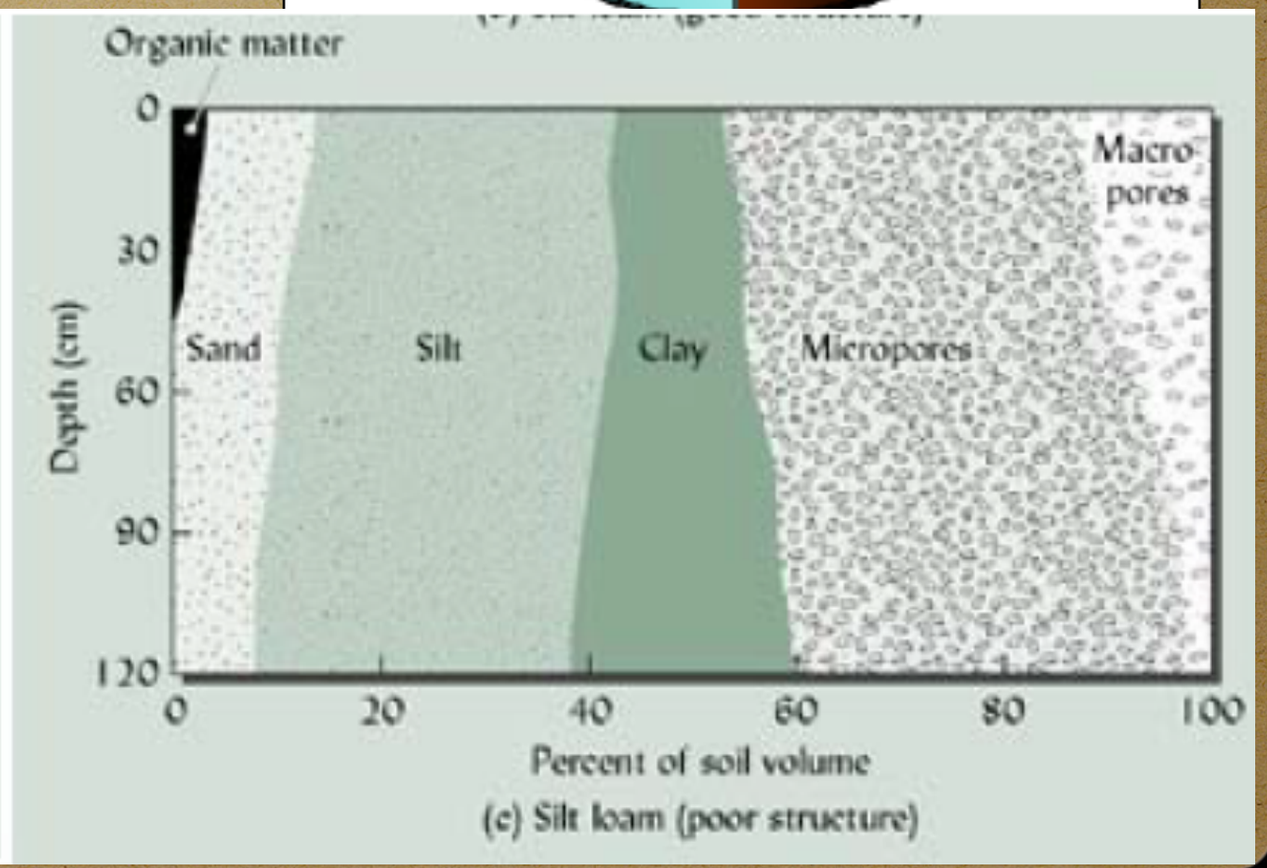
- A note on management: Soils have inherent quality and manageable quality.

- Inherent: Texture, Mineralogy

- Manageable: Nature of pore spaces, organic matter, and temporary chemistry (lime, fertilizers)



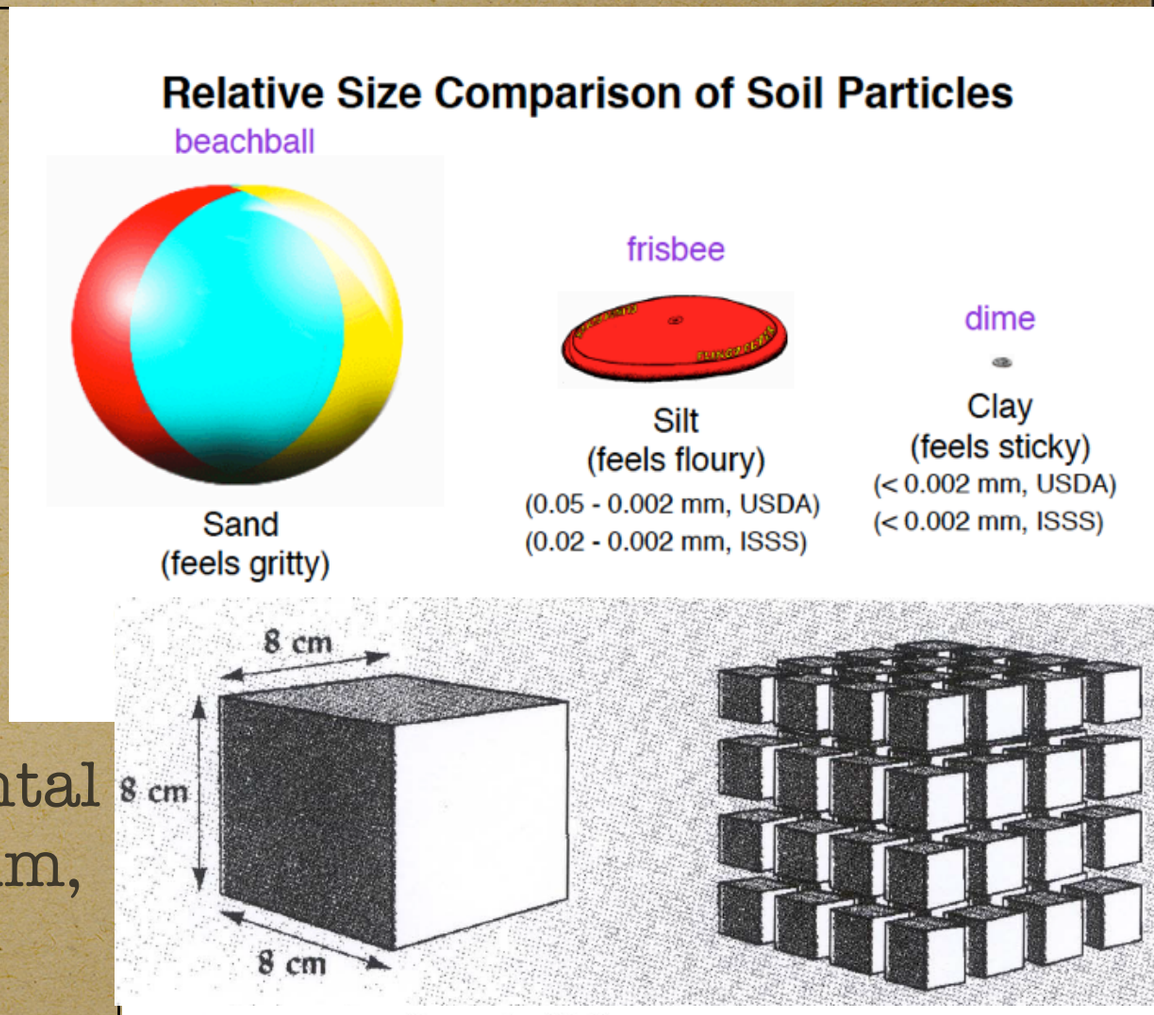




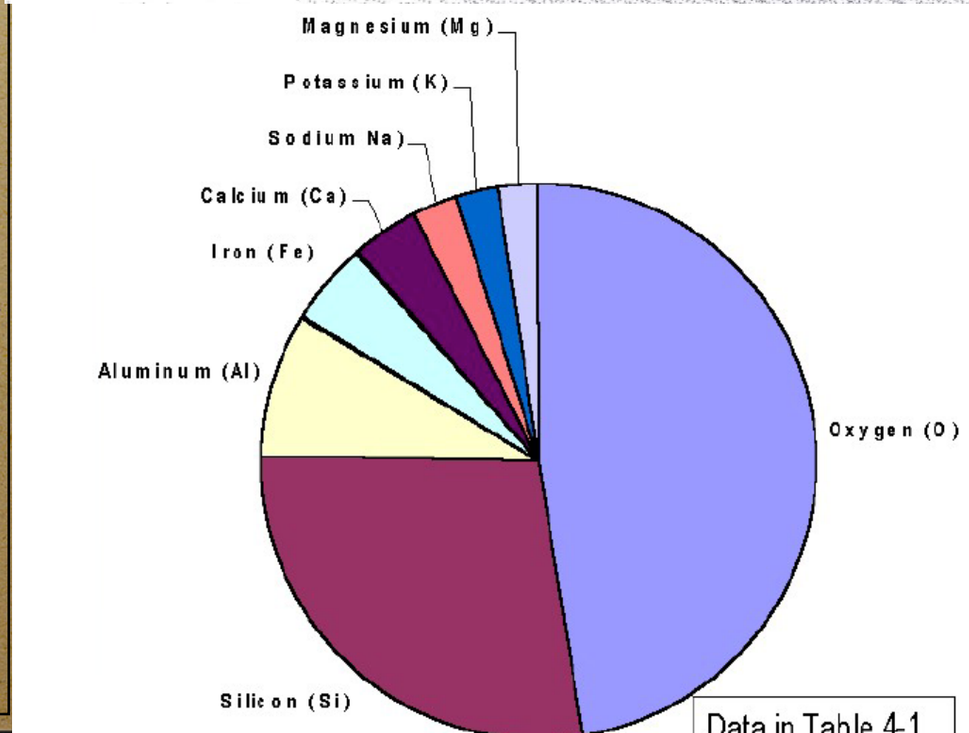
Mineral Fraction of Soil

- **Particle Size:** Sand, Silt, and Clay
- **Sand:** 2mm-.05mm
- **Silt:** .05mm-.002mm
- **Clay:** <.002mm

- It's all about **Surface Area!**



- **Chemistry of Mineral Fraction:** Elemental Composition of the Crust: Silicon, Aluminum, Iron, Calcium, Sodium, Potassium, Magnesium, also Phosphorus



- **Mineralogy:**
- Sand: **Primary Minerals**
- Clay: **Secondary Minerals**

- **Texture:** the proportion of sand, silt, and clay

Mineral Fraction of Soil

- **Texture:** the proportion of sand, silt, and clay

- **Macropores:** pores in between sand particles

- **Micropores:** pores between silt and clay particles

- Capillary Action, Adhesion, and Cohesion

- **Micropores:** hold water well (+), water drains more slowly, restrict aeration (-)

- **Macropores:** hold water poorly (-), water drains rapidly, improve aeration (+)

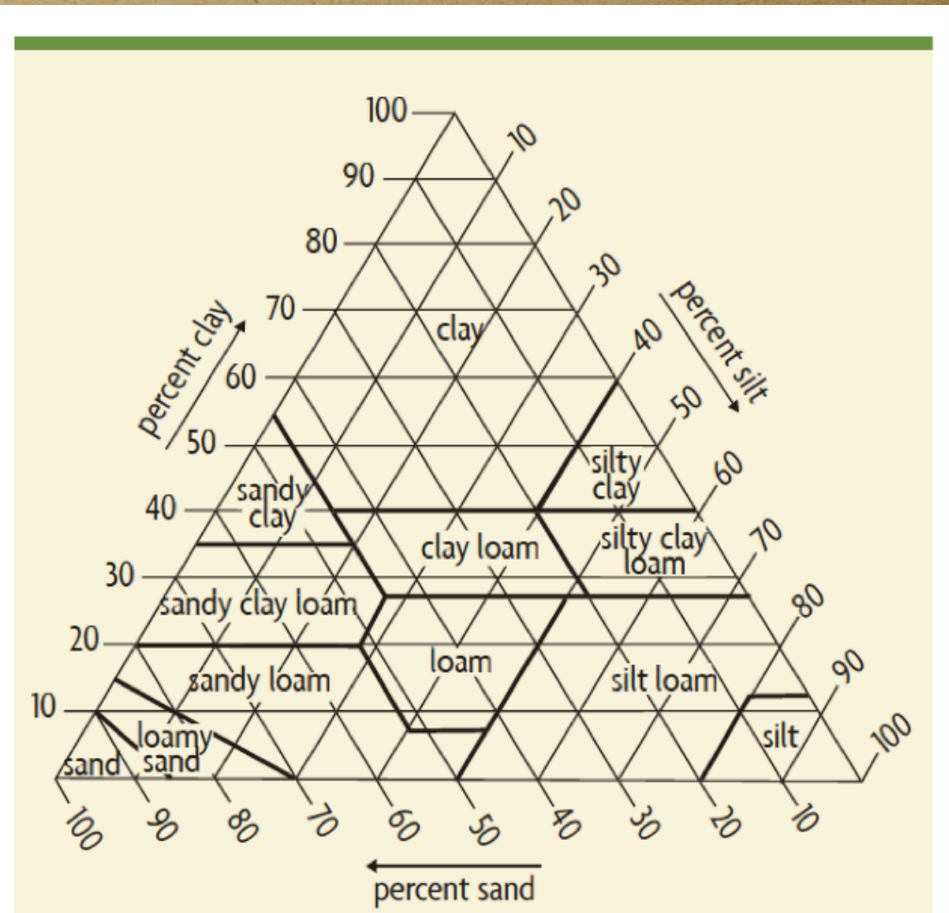
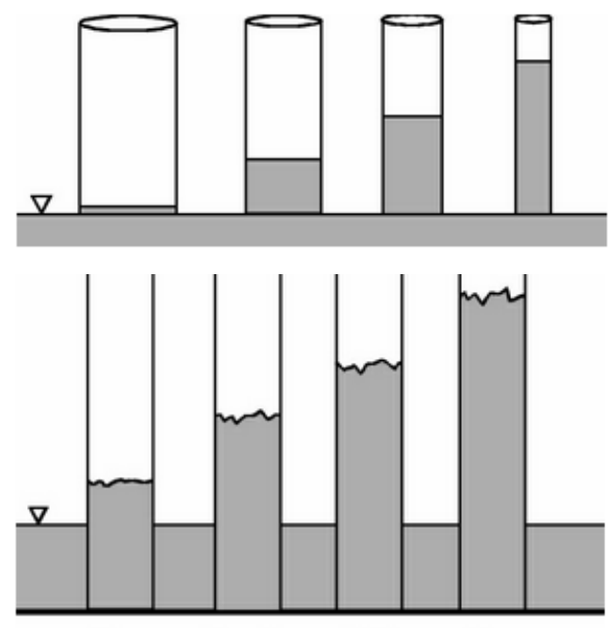
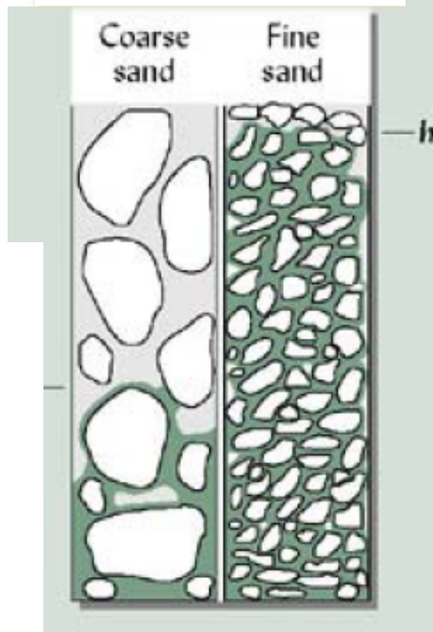


Figure 5.2. The percentages of sand, silt, and clay in the soil textural classes. From USDA-NRCS.

Magdoff, and Van Es, 2009





University of Nebraska

Movie Break:
SYMPHONY OF SOIL

Soil Forming Factors:

- **Definition of Soil:**
- A Collection of loose material that has been distinguished from the parent material by the **Soil Forming Factors** and/or

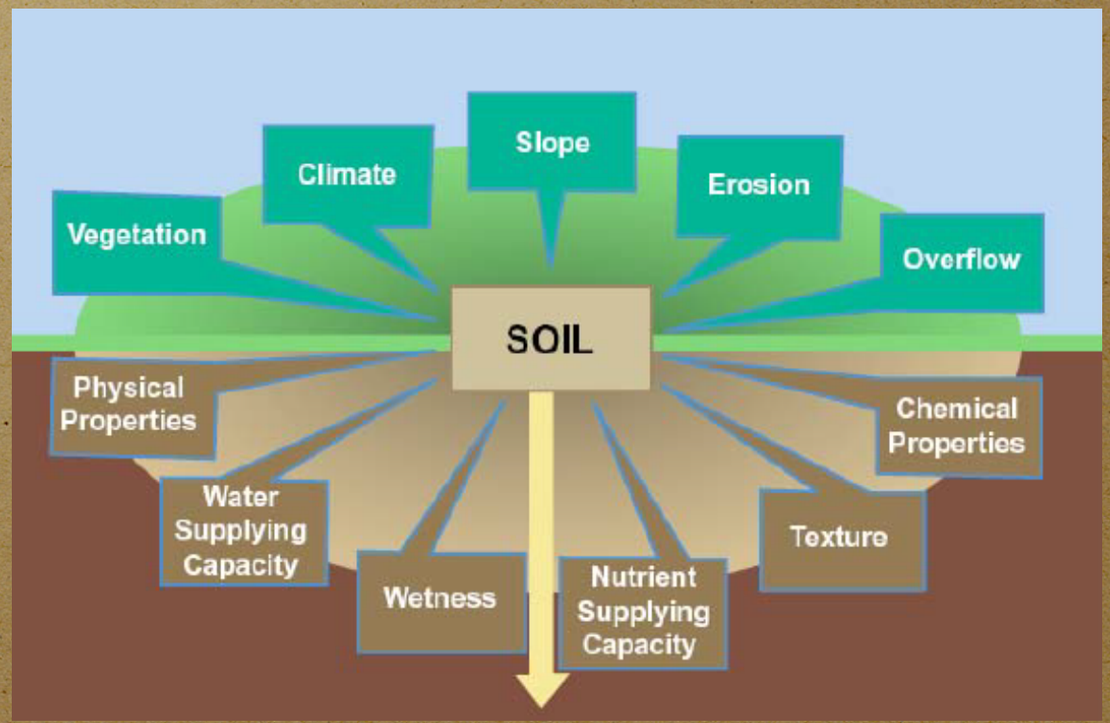
- Contains life and is capable of supporting plants in a natural setting

- **Soil Forming Factors**
- **Parent Material:** Mineralogy, Texture
- **Climate:** Temperature, Precipitation, Wind
- **Life:** Bacteria, Fungi, Protists, Plants, Animals
- **Topography:** Slope, Position on Landscape (Gravity)
- **Time**: Time the factors have acted on the soil

- **Soil Forming Processes** (Energy and Matter)
- **Additions**
- **Losses**
- **Translocations**
- **Transformations**

- Over time these processes distinguish the soil from the PM (Leave evidence): horizons
- Therefore: All Soils are unique

- **What's the Difference Between Soil and Dirt?**



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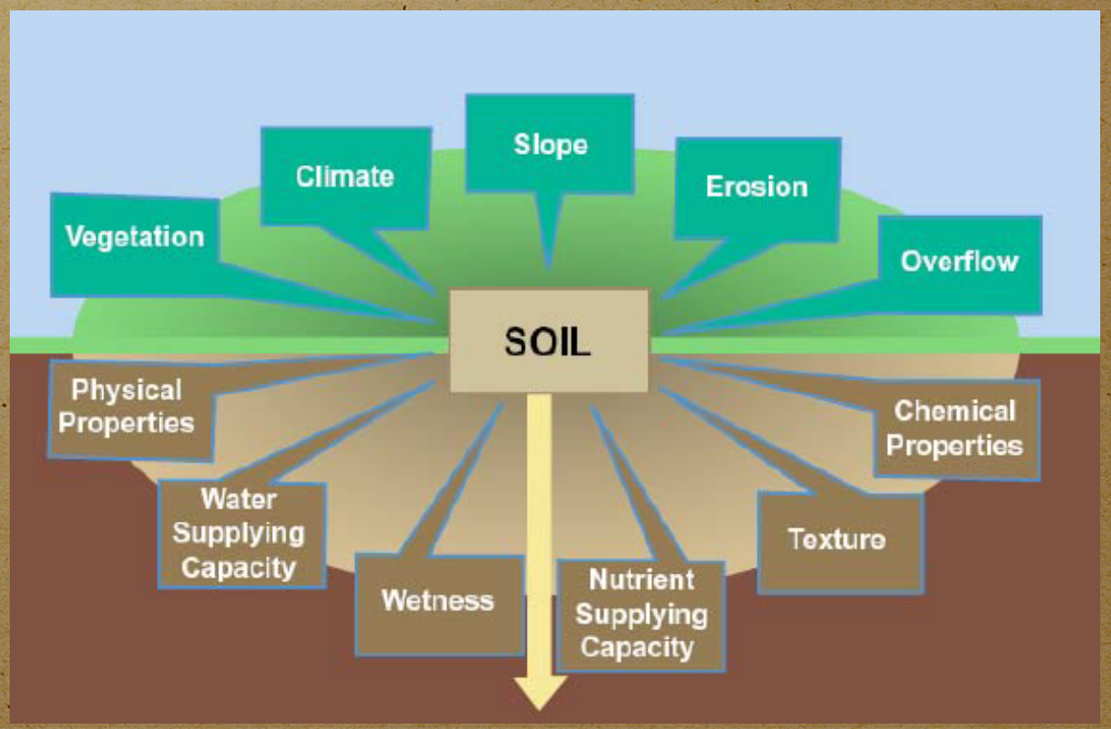
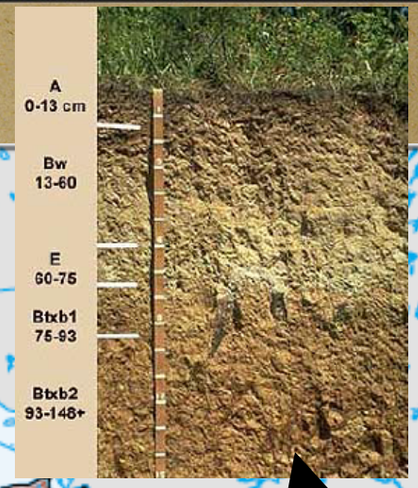
Soil

NYS State Soil: Honeoye

Dirt



MINANT SOIL ORDERS



1998 Dominant Soil Orders for STATSGO Mapunits

- ALFISOLS
- ANDISOLS
- ARIDISOLS
- ENTISOLS
- GELISOLS
- GELISOLS/INCEPTISOLS (AK)
- HISTOSOLS
- INCEPTISOLS
- MOLLISOLS
- OXISOLS
- SPODOSOLS
- ULTISOLS
- VERTISOLS

HAWAII

BELAU

YAP

KOSRAE

POHNPEI

MARIANA ISLANDS

AMERICAN SAMOA

GUAM

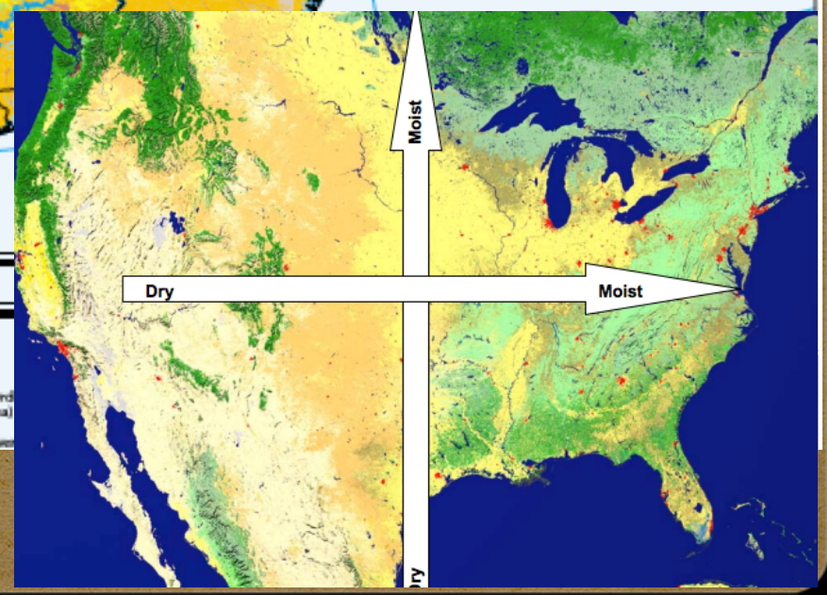
CANADA

ALASKA

Albers Equal Area Projection
Scale: 1:7,500,000

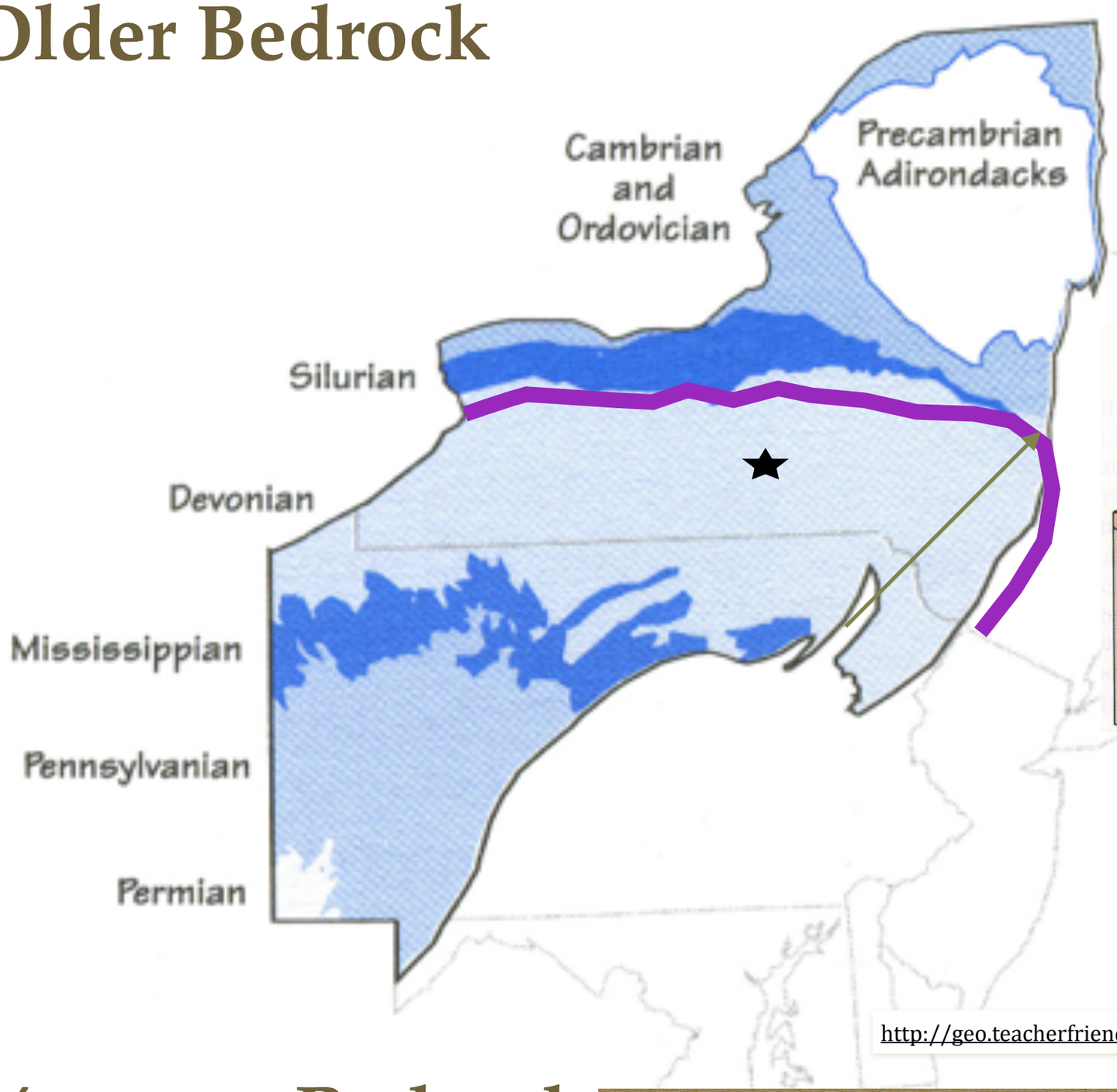
Dominant Soil Order/Suborder was identified as that Soil Ord
the largest summed component percentage (largest land area)

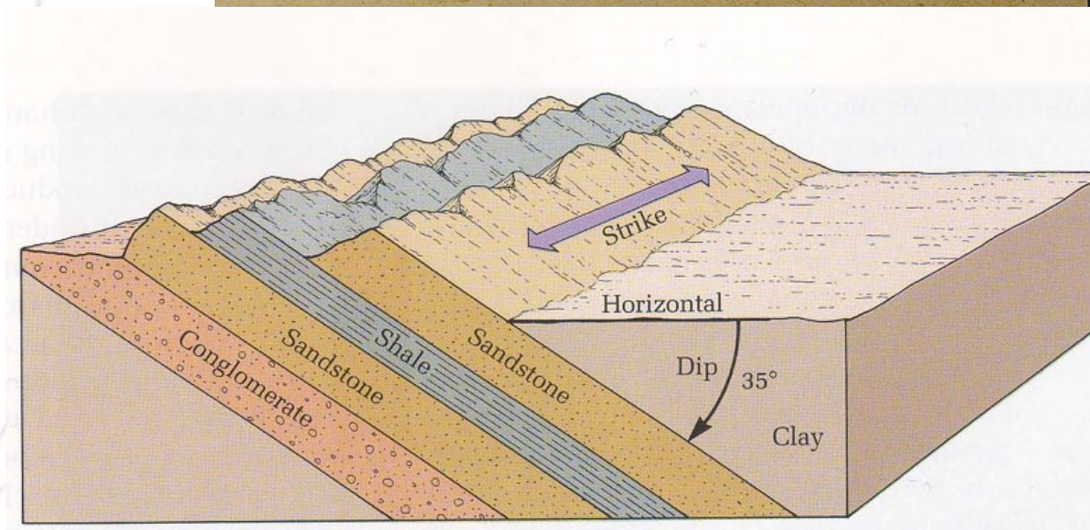
Order and Suborder concepts for each STATSGO mapunit wer



Devonian Geology: Visible Geology of the Finger Lakes

Older Bedrock



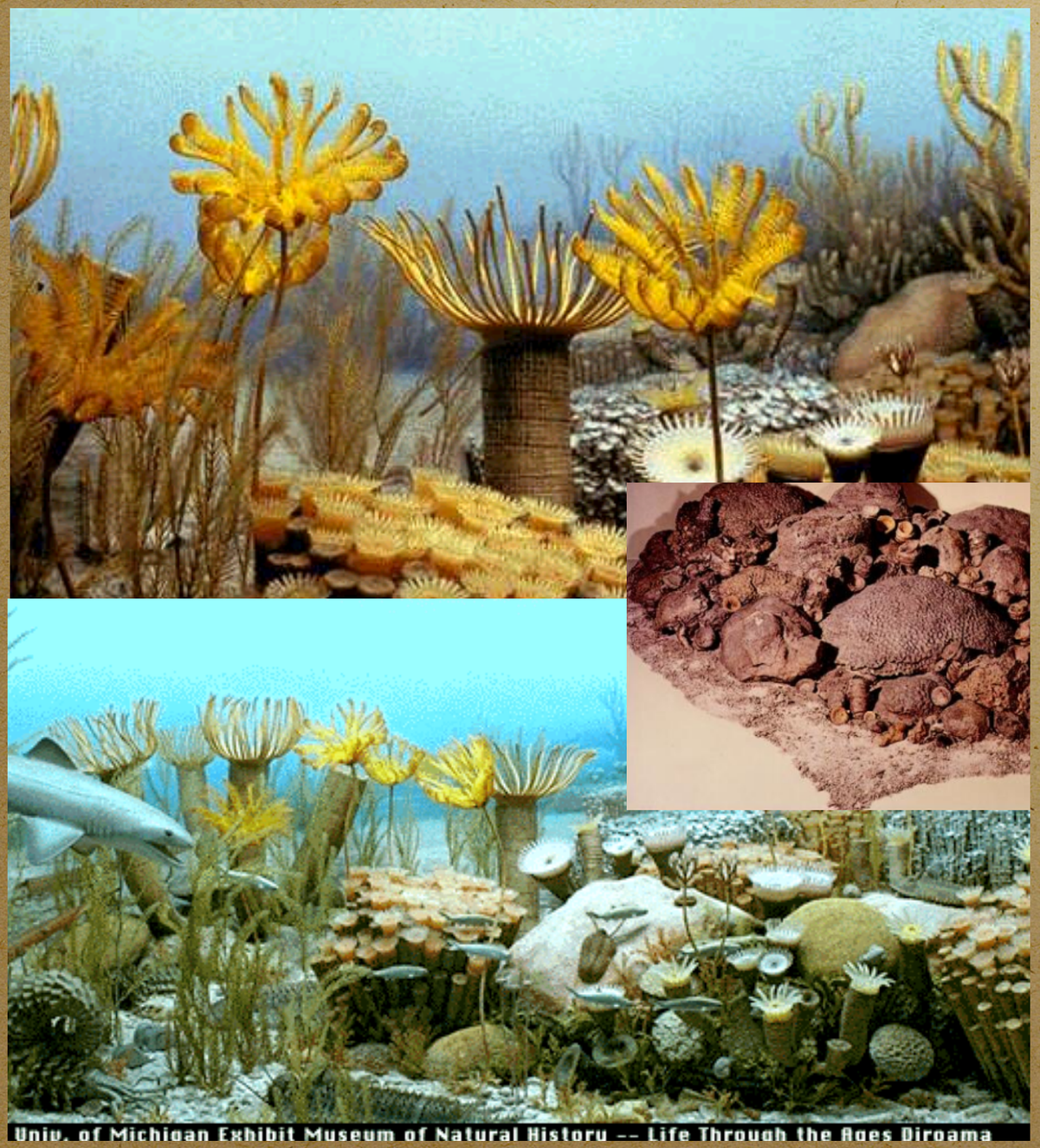


http://geo.teacherfriendlyguide.org

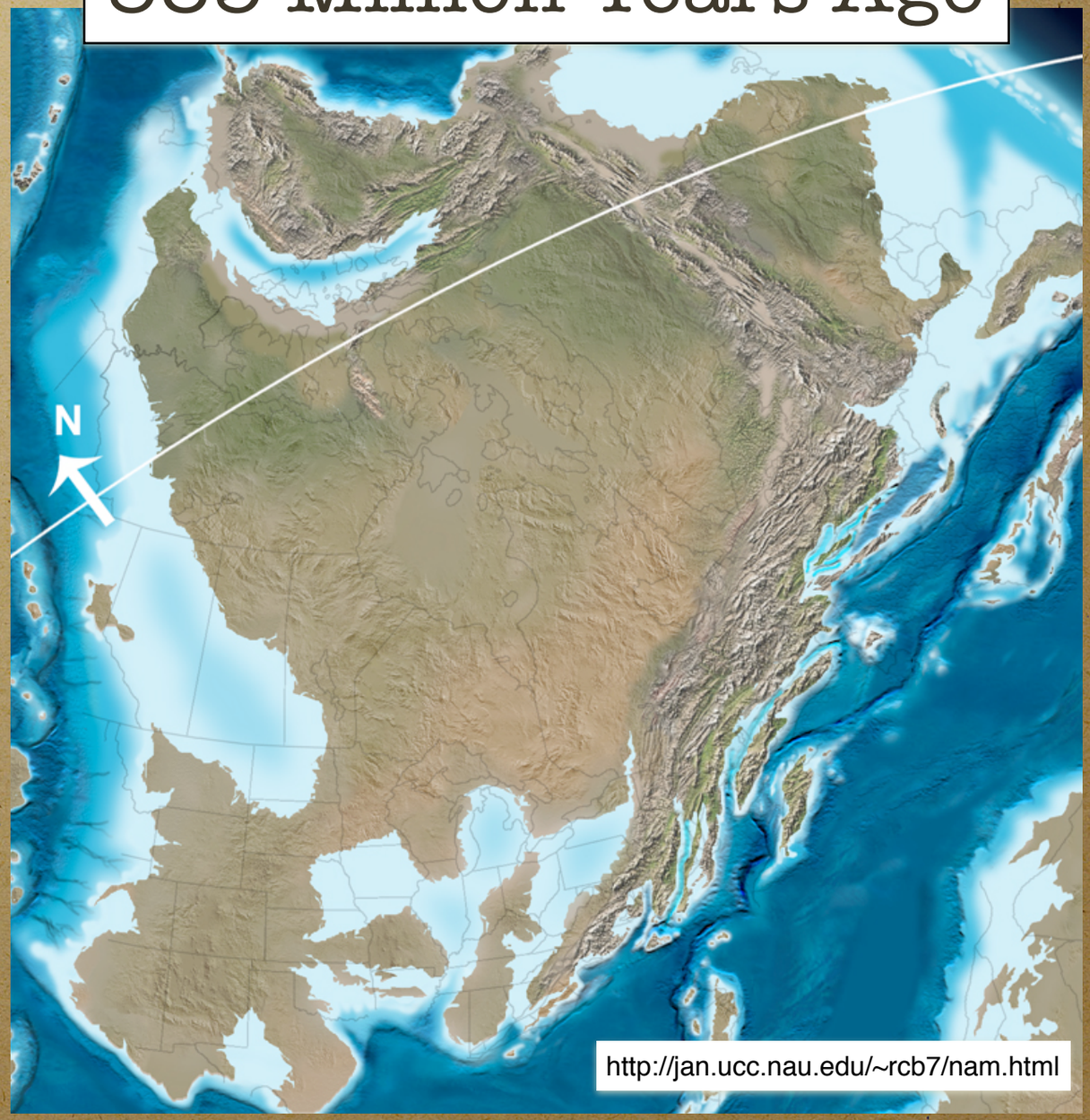
Younger Bedrock

North America during the Devonian Period: 416Ma-359Ma

Life in a Devonian Sea

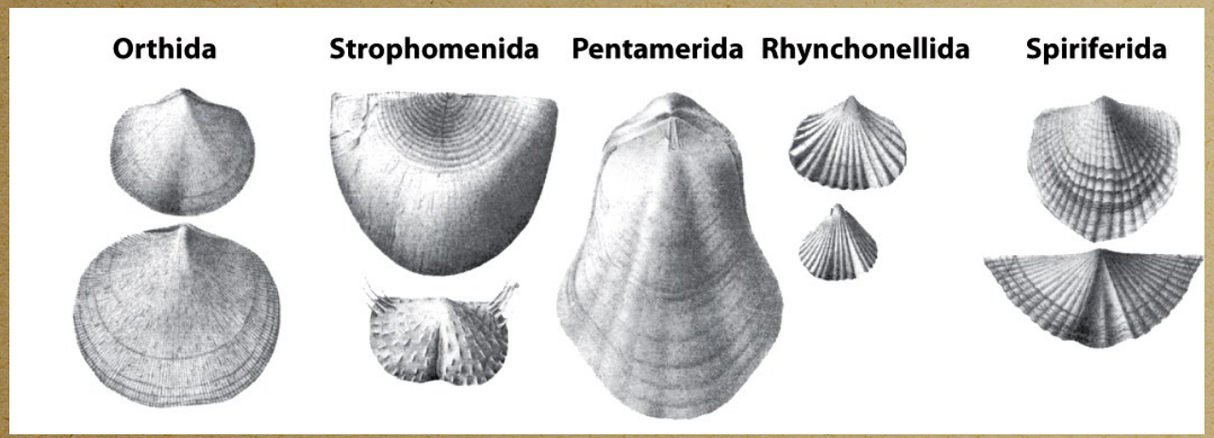


Middle Devonian 385 Million Years Ago

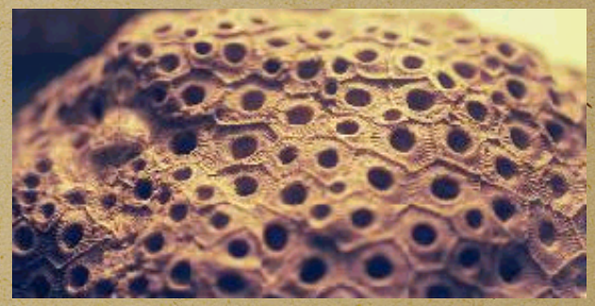


Fauna of the Devonian: Fossils Around Ithaca

Brachiopods



Rugose Coral



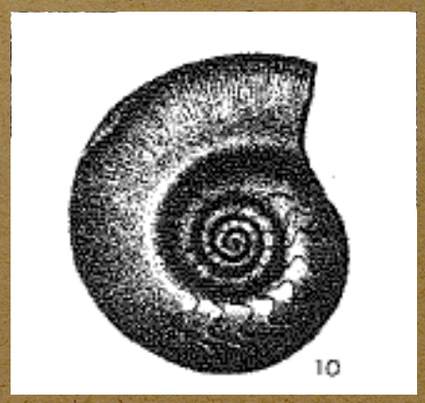
Crinoids

Trilobites

Clams (Bivalves)

Tabulate Coral

Ammonites



North America during the Devonian Period: 416Ma-359Ma

Acadian Orogeny

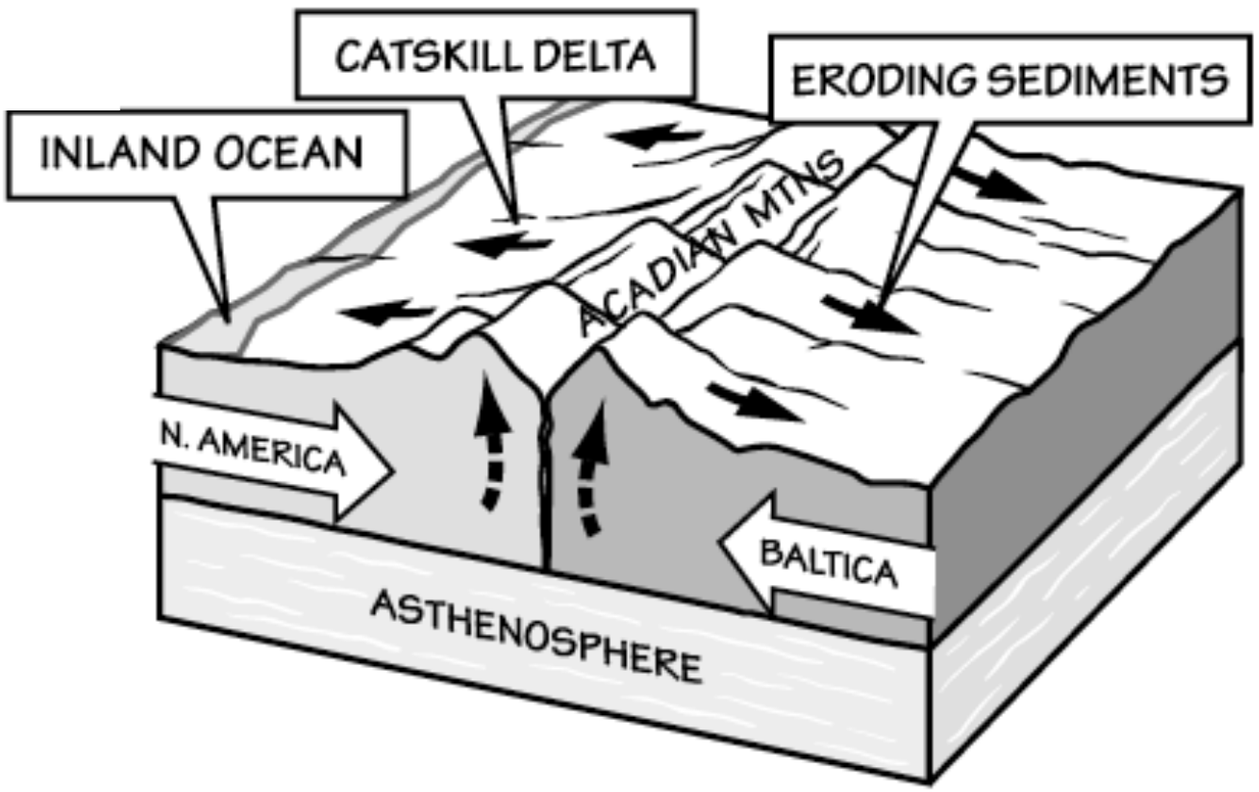
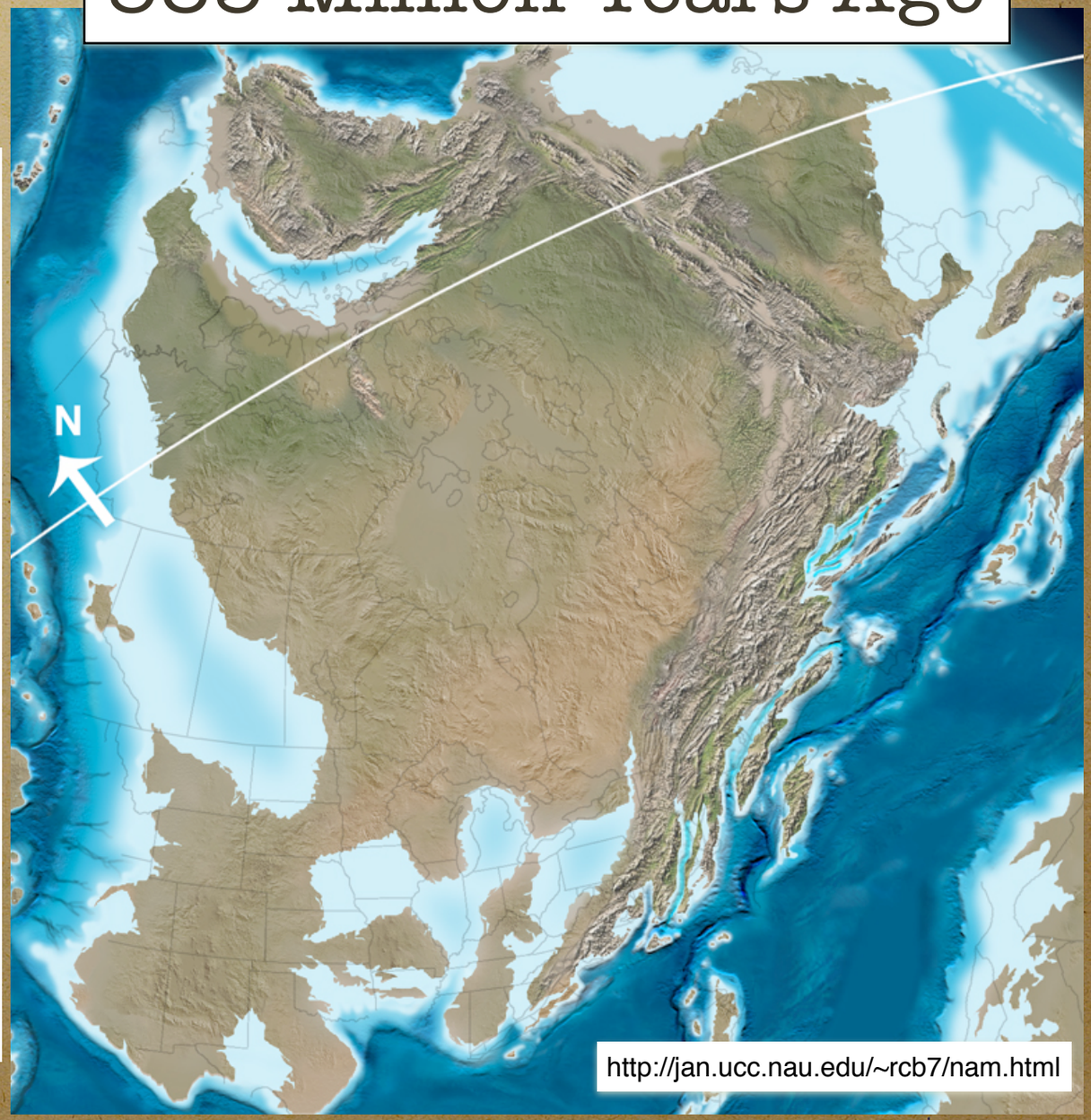
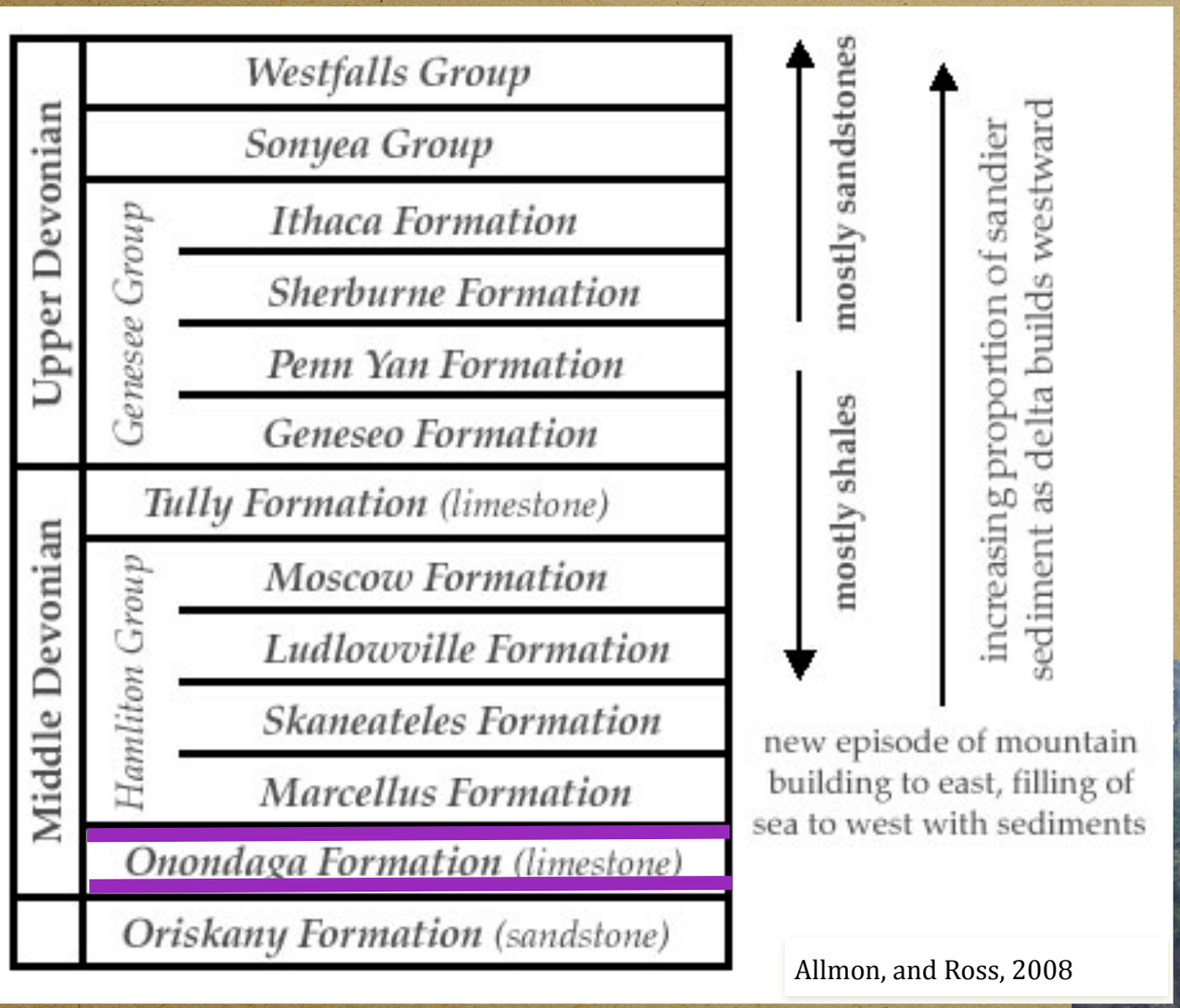


Figure 1.13: North America and Baltica collided finally in the mid-Devonian, crumpling the crust to form the Acadian Mountains. Sediments eroded from the highlands formed

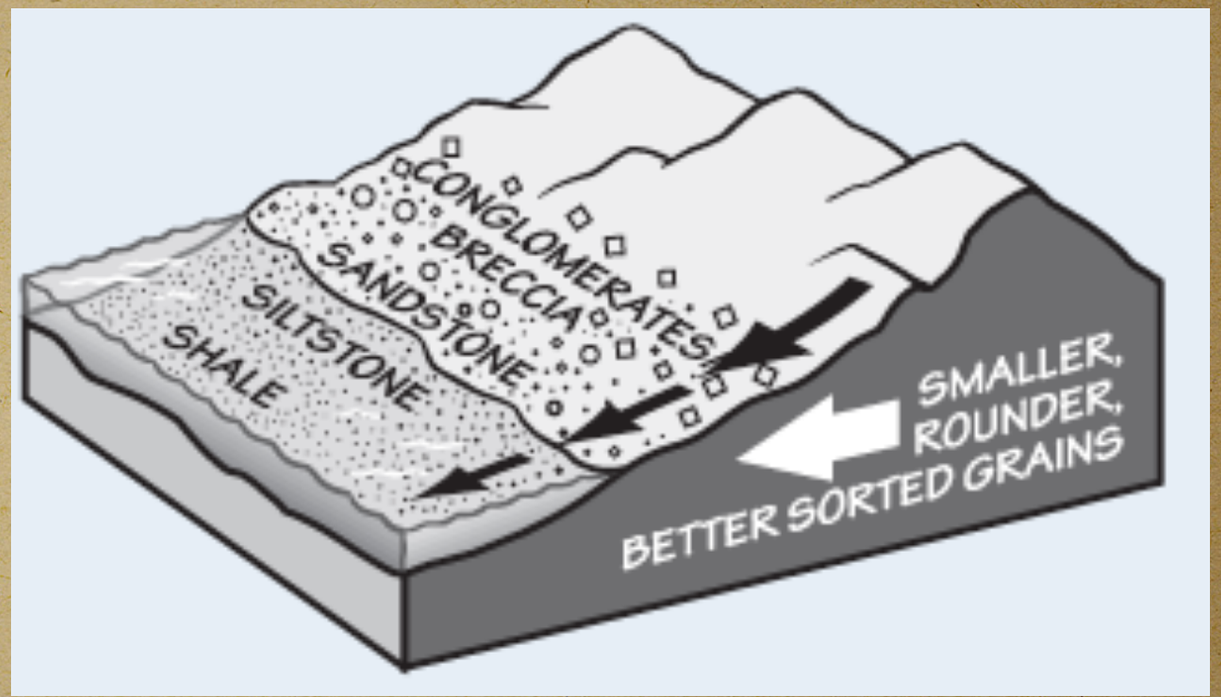
Middle Devonian 385 Million Years Ago



Devonian Geology: Visible Geology of the Finger Lakes



Allmon, and Ross, 2008



Pleistocene Glacial Geology:
Visible Geology of the Finger Lakes

- Pleistocene Epoch (1.8-.01Ma): Ice Age
- Imagine that there is a 2km ice sheet flowing south across NYS
- Dynamic Glacier: glacier flowing south vs. glacial front melting

Pleistocene Glacial Geology:
Visible Geology of the Finger Lakes

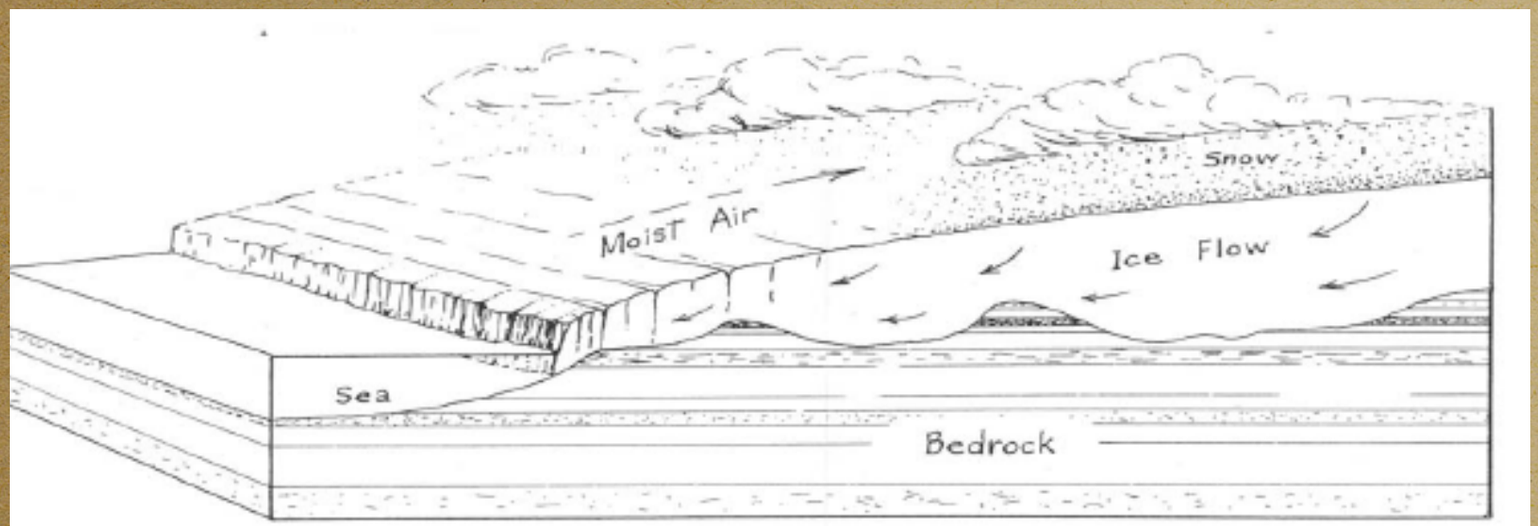
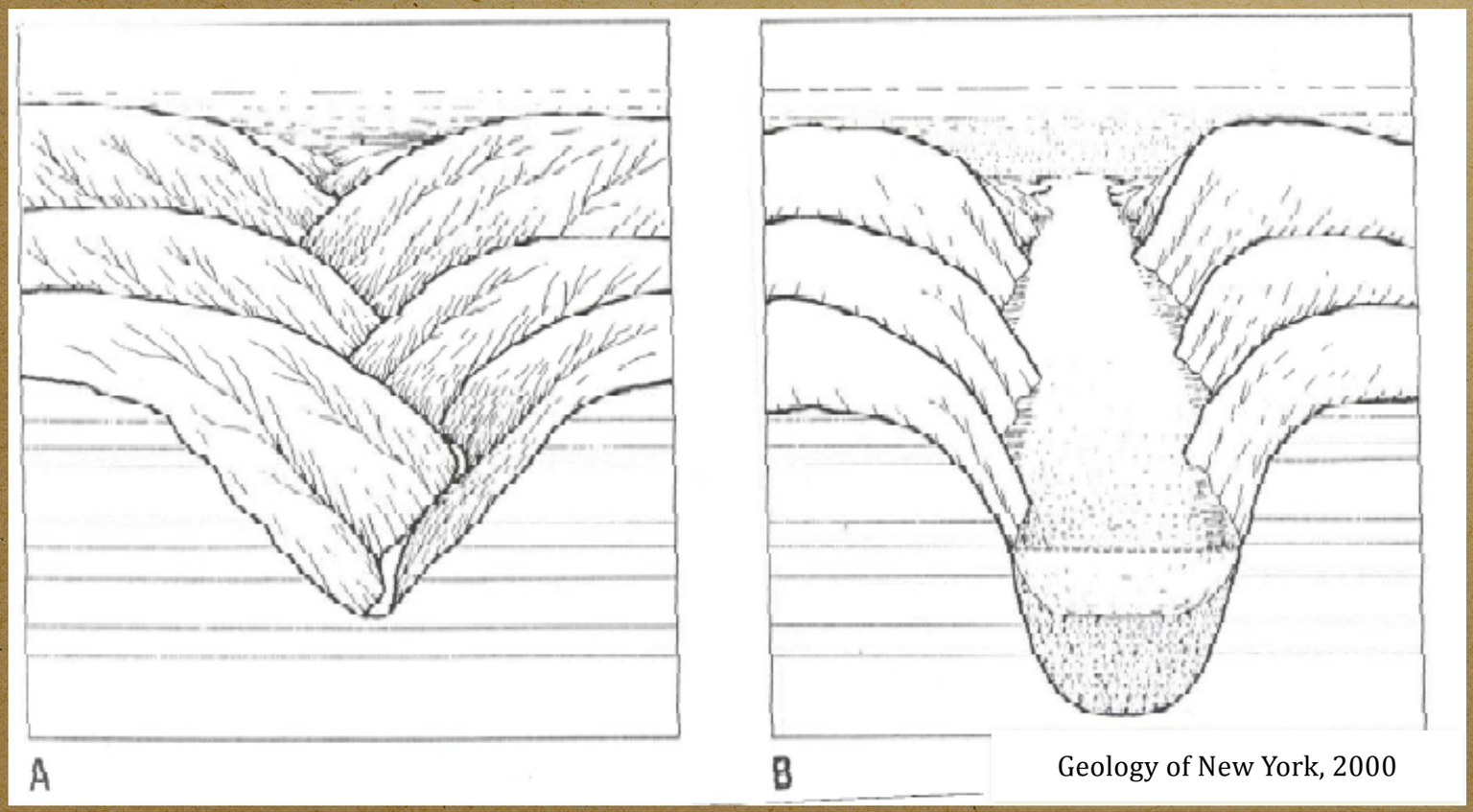


Figure 12.2. This diagram is a simplified cross section of an ice sheet. Notice the snow feeding the glacier b
even riding over low hills. (The vertical scale is highly exaggerated.)

Geology of New York, 2000



Geology of New York, 2000

- The Laurentide ice sheet gouged north-south oriented river valleys into the U-shaped Finger Lakes

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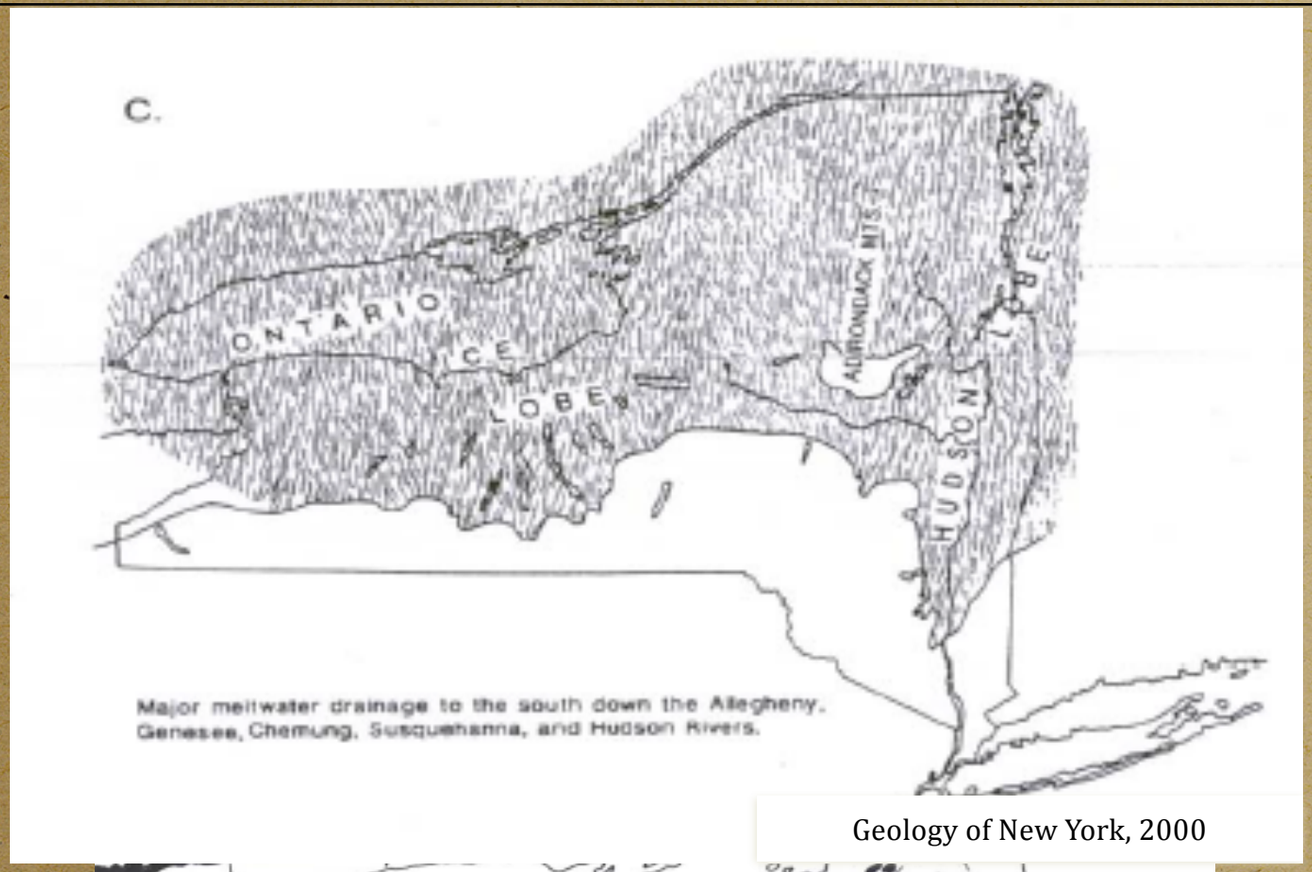

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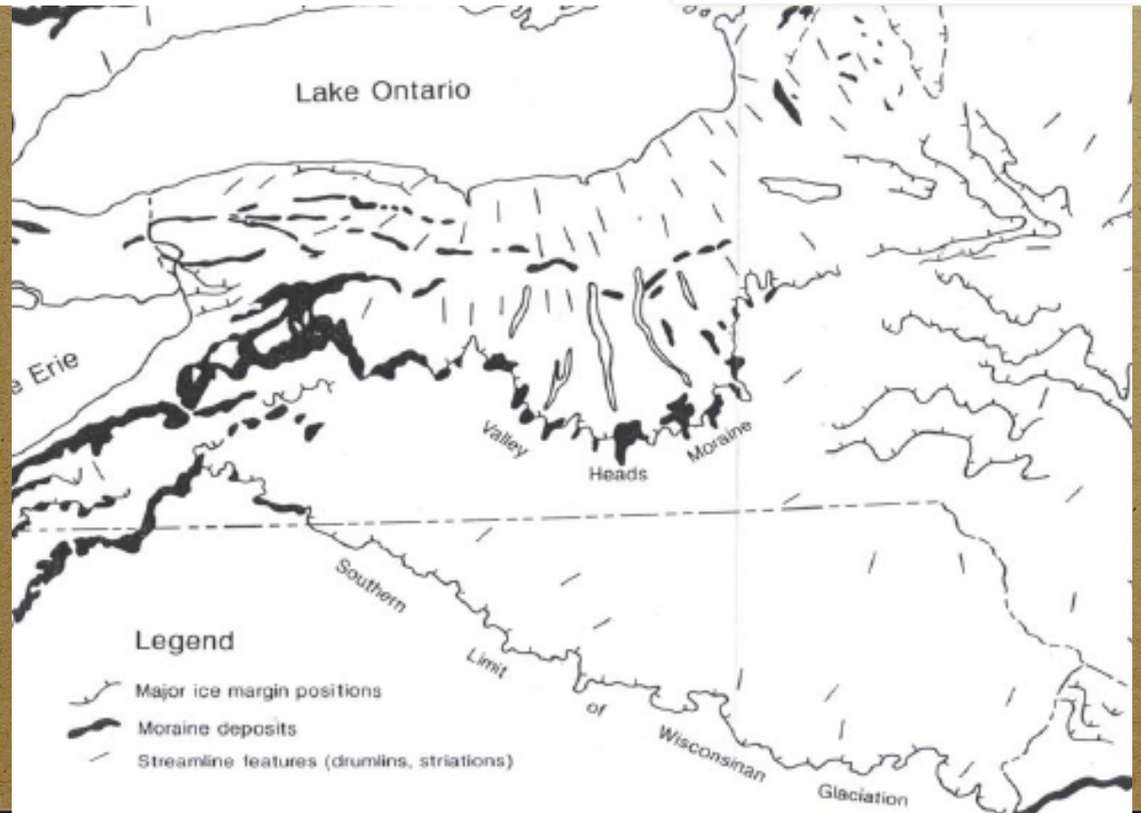
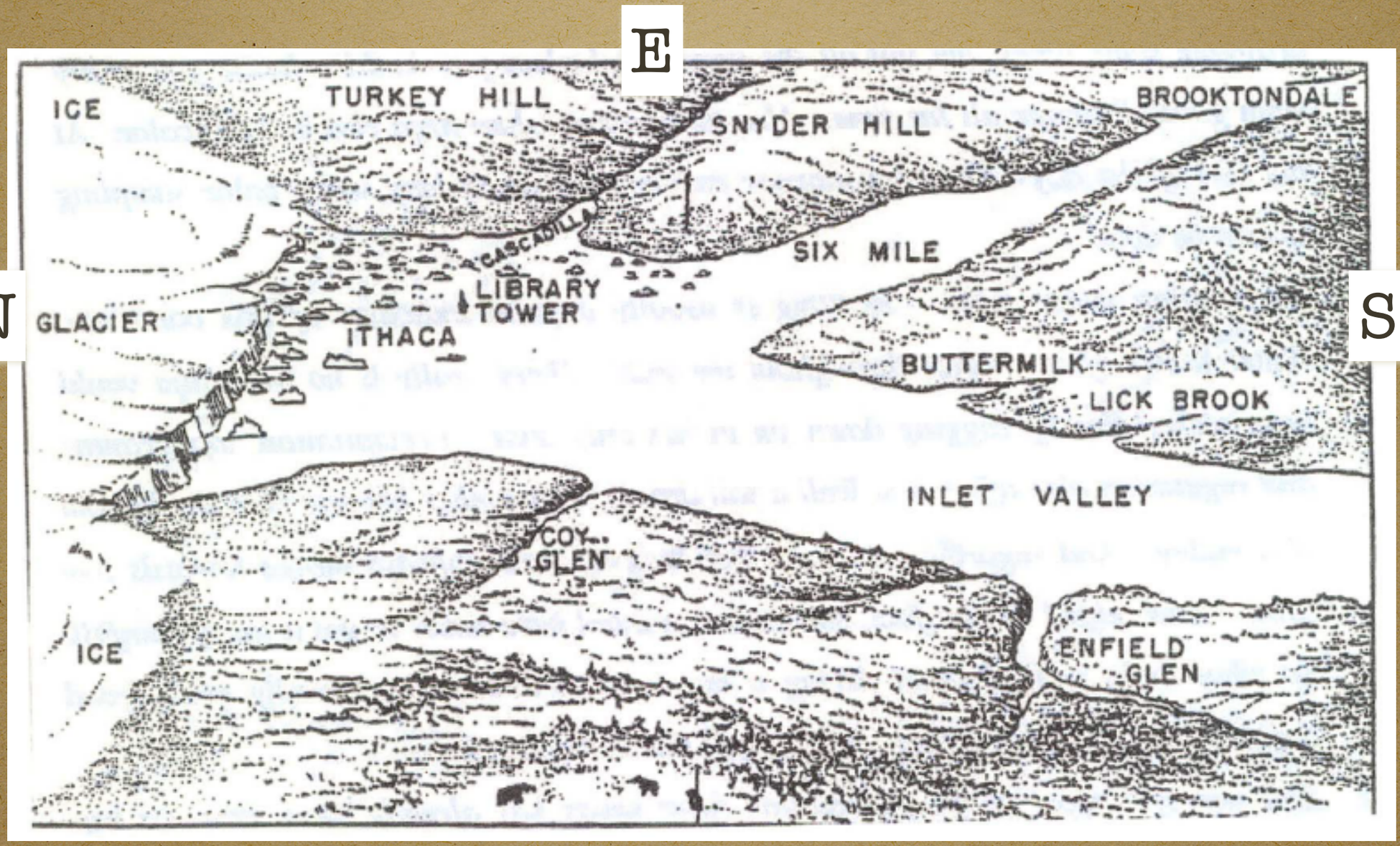


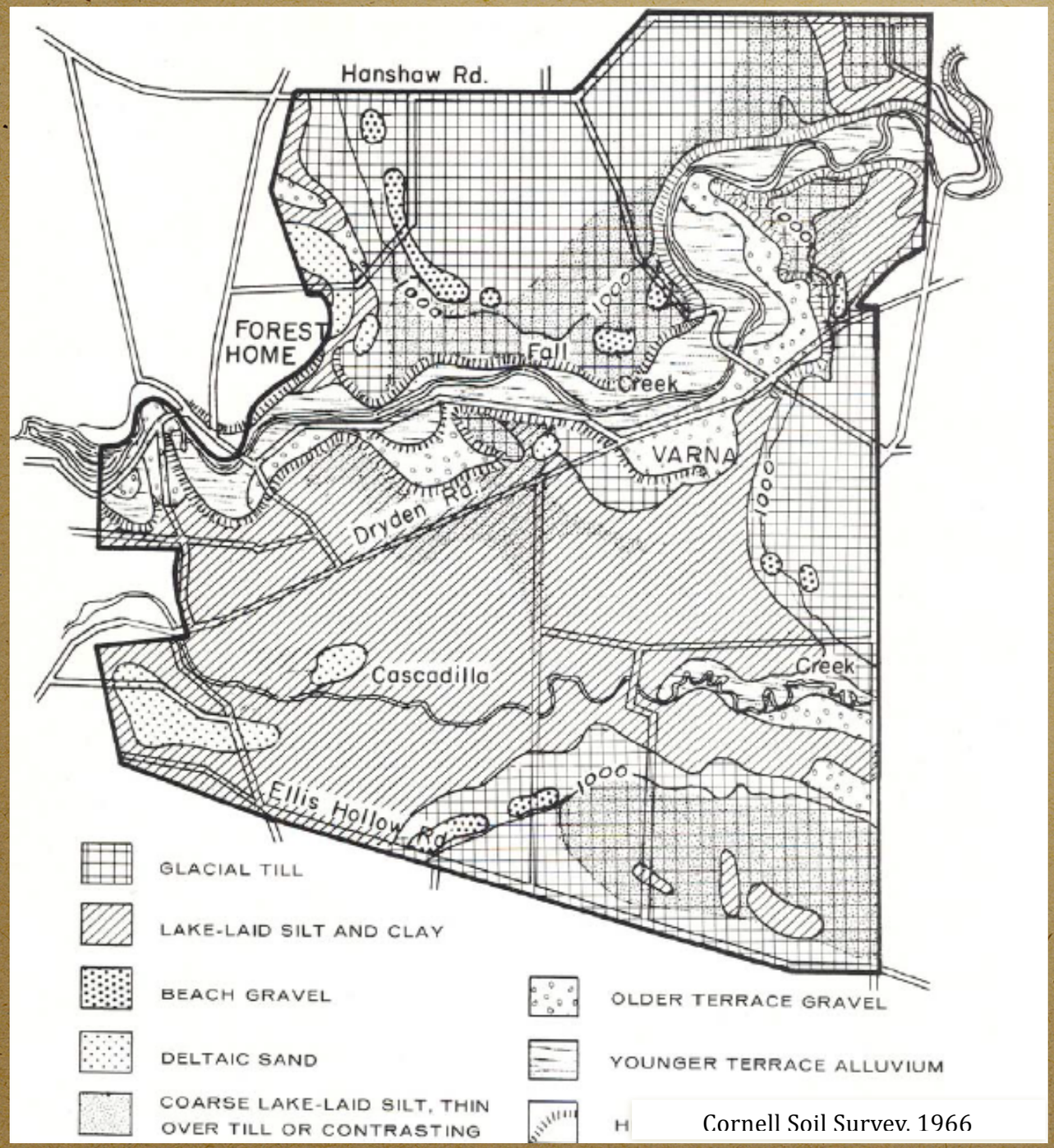
- Approx. 15,000 yrs. ago glacier Deposited the Valley Head Moraine (locally Danby/ Spencer) -->Drainage Divide between St. Lawrence Drainage Basin and Susquehanna
- As glacier retreated (melting>flowing)--> huge amounts of water filled the U-Shaped Valleys (Finger Lakes)

Illustration of the Pro Glacial Lake



- **Glacial Till:** Unsorted Mixture of gravel, sand, silt, and clay
- **Glacial Outwash:** Deposits of Sediment that was sorted by meltwater coming off of the glacier
- **Lacustrian:** Lake-laid sediments, silts and clays

Types of Glacial Parent Material-->Soil



Cornell Soil Survey, 1966

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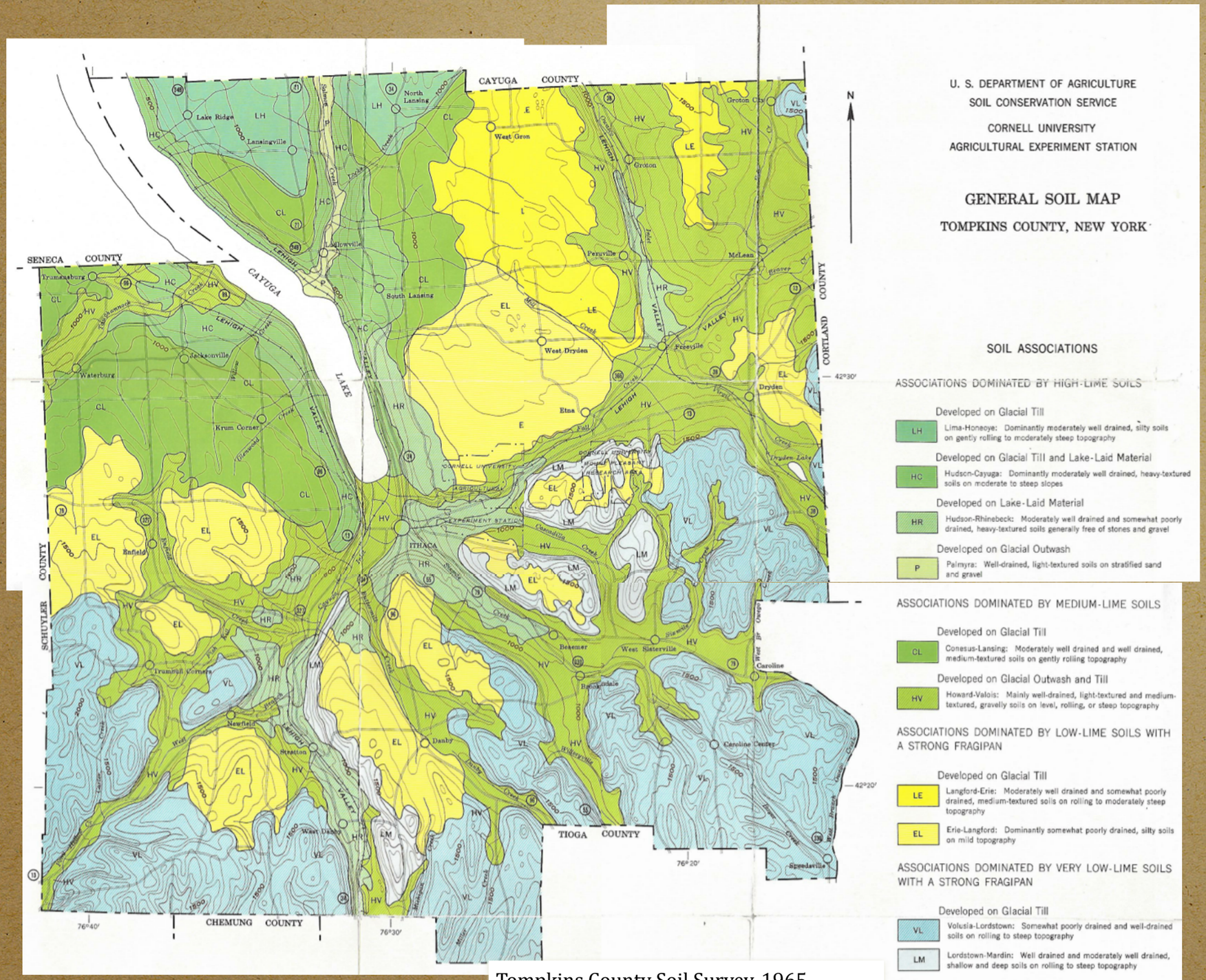
- Check out what happens at approximately 1000ft elevation

Tompkins County Soils:



U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
CORNELL UNIVERSITY
AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP
TOMPKINS COUNTY, NEW YORK

SOIL ASSOCIATIONS

ASSOCIATIONS DOMINATED BY HIGH-LIME SOILS

Developed on Glacial Till

LH — Lima-Honeoye: Dominantly moderately well drained, silty soils on gently rolling to moderately steep topography

Developed on Glacial Till and Lake-Laid Material

HC — Hudson-Cayuga: Dominantly moderately well drained, heavy-textured soils on moderate to steep slopes

Developed on Lake-Laid Material

HR — Hudson-Rhinebeck: Moderately well drained and somewhat poorly drained, heavy-textured soils generally free of stones and gravel

Developed on Glacial Outwash

P — Palmyra: Well-drained, light-textured soils on stratified sand and gravel

ASSOCIATIONS DOMINATED BY MEDIUM-LIME SOILS

Developed on Glacial Till

CL — Conesus-Lansing: Moderately well drained and well drained, medium-textured soils on gently rolling topography

Developed on Glacial Outwash and Till

HV — Howard-Valois: Mainly well-drained, light-textured and medium-textured, gravelly soils on level, rolling, or steep topography

ASSOCIATIONS DOMINATED BY LOW-LIME SOILS WITH A STRONG FRAGIPAN

Developed on Glacial Till

LE — Langford-Erie: Moderately well drained and somewhat poorly drained, medium-textured soils on rolling to moderately steep topography

EL — Erie-Langford: Dominantly somewhat poorly drained, silty soils on mild topography

ASSOCIATIONS DOMINATED BY VERY LOW-LIME SOILS WITH A STRONG FRAGIPAN

Developed on Glacial Till

VL — Volusia-Lordstown: Somewhat poorly drained and well-drained soils on rolling to steep topography

LM — Lordstown-Mardin: Well drained and moderately well drained, shallow and deep soils on rolling to steep topography

Tompkins County Soil Survey, 1965

- Why might we group soil based on limestone content?

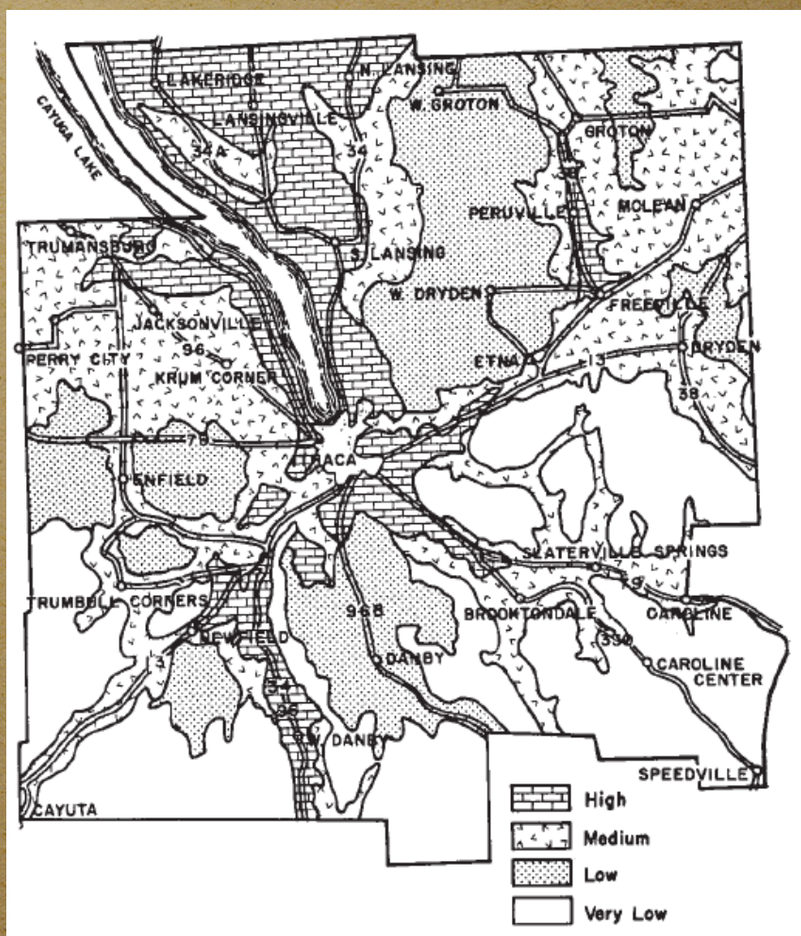


Figure 7.—Lime content (pH profile) of Tompkins County soils.

Tompkins County Soil Survey, 1965

Web Soil Survey

Map Unit Legend

Tompkins County, New York (NY109)

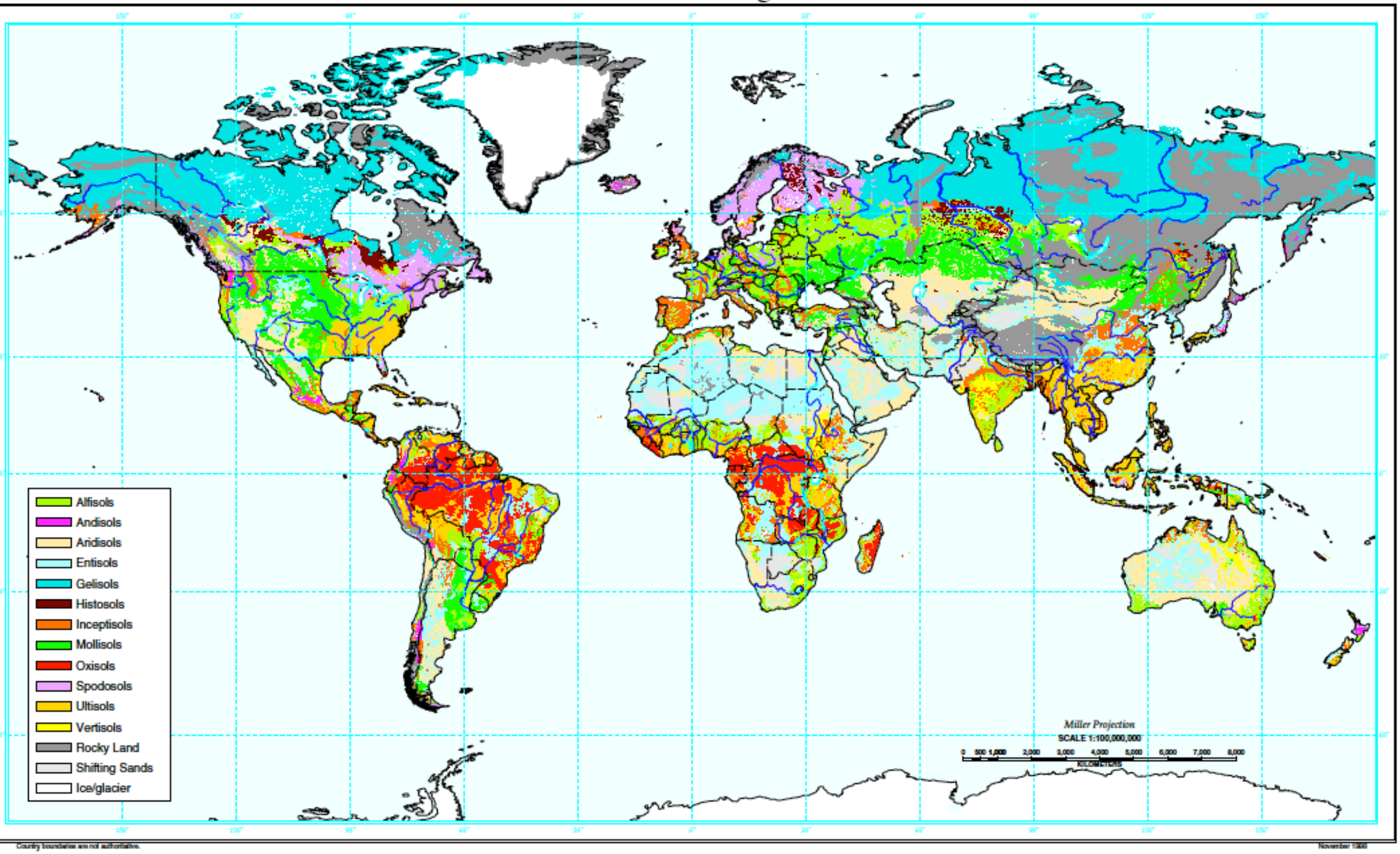
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
BgD	Bath and Valois soils, 15 to 25 percent slopes, eroded	5.5	19.2%
EbB	Erie channery silt loam, 3 to 8 percent slopes	5.5	19.0%
LaB	Langford channery silt loam, 2 to 8 percent slopes	17.9	61.8%
Totals for Area of Interest		**28.9**	**100.0%**

LANGFORD SERIES

The Langford series consists of very deep, moderately well drained soils formed in loamy till. These soils are in glaciated upland areas. They have a fragipan starting between 15 and 28 inches below the soil surface. Permeability is moderate above the fragipan, and slow or very slow in and below the fragipan. Slope ranges from 0 to 50 percent. Mean annual temperature is about 49 degrees F., and mean annual precipitation is about 38 inches.

U.S. Dept. of Agriculture
Natural Resources Conservation Service
Soil Survey Division
World Soil Resources

Global Soil Regions



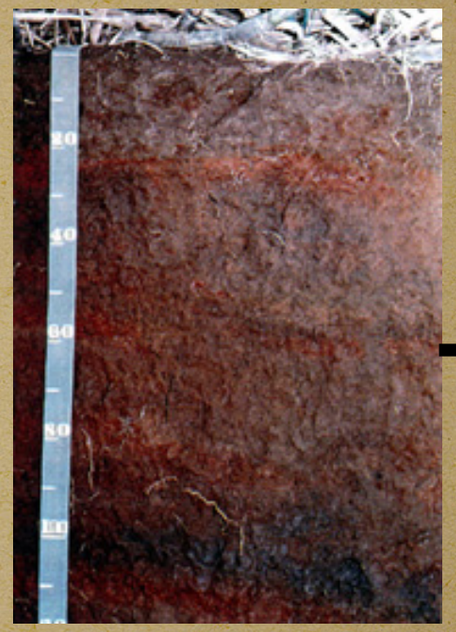
Country boundaries are not authoritative.

November 1998

Symphony of Soil Stories Revisited

Hawai'ian Soil Genesis

- Volcanic Soils (Andisols)
- Age Gradient (0-5Ma)
- Climate Gradient (MAP: 200mm-8,000mm)
- Parent Material is easily weatherable



Midwestern Soils: The Bread Basket of the U.S.

- Grassland Soils (Mollisols)
- Outwash deposits from glacier-->then wind sorted-->deep loess (silt) deposits
- Extremely Fertile and High in Organic Matter
- Deep rooted perennial grasses enrich whole profile with OM