The Water Cycle and Water Balance in Nutrient Management

Soil Formation and Soil Morphology

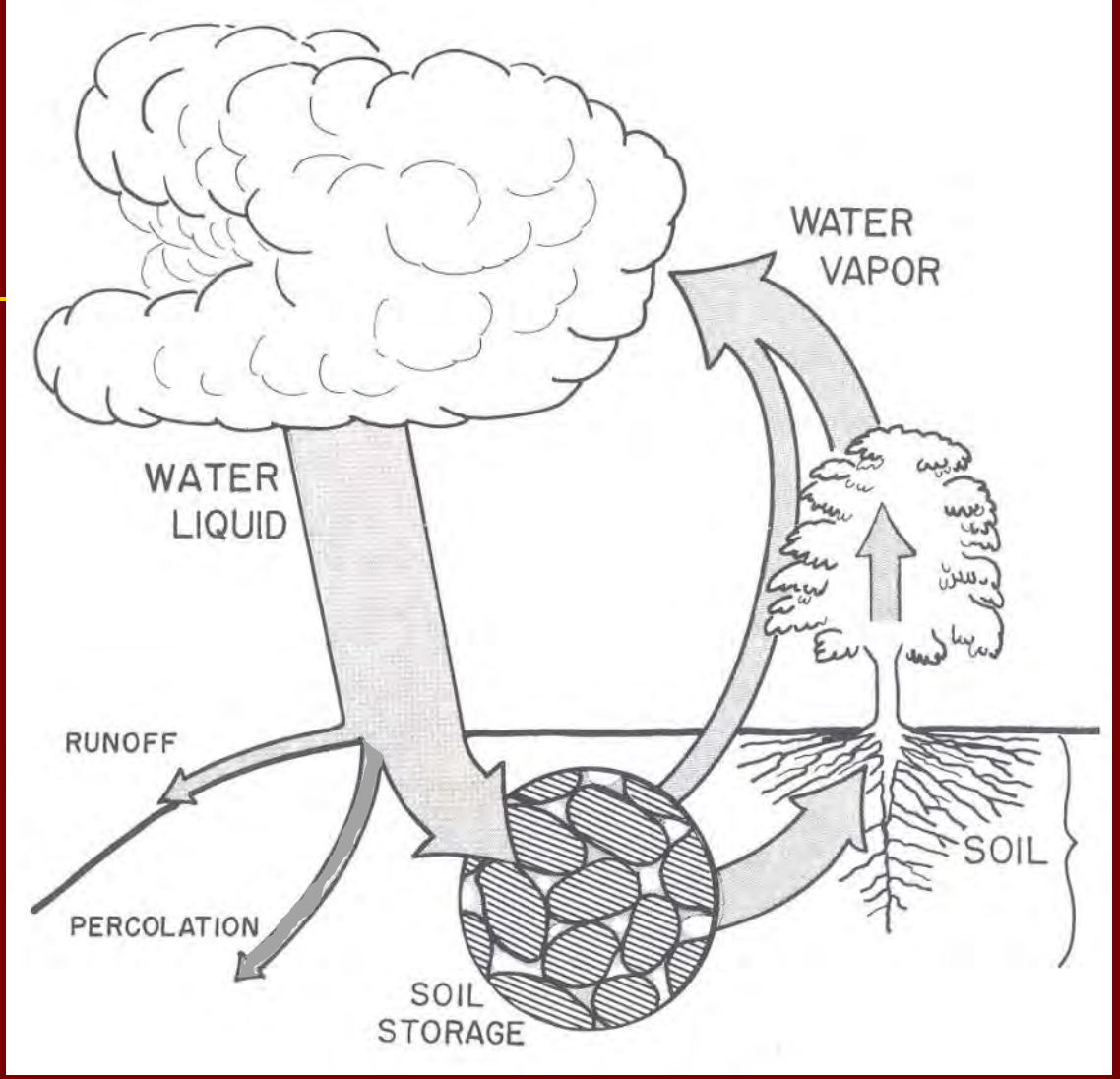
Soils and Landscapes of Virginia's Physiographic Provinces

Environmentally Sensitive Areas

By Dr. Steven C. Hodges

The Water Cycle

- Amount
  - Variability
  - Availability
- Distribution
  - Spatial
- Periodicity
  - Relative to crop

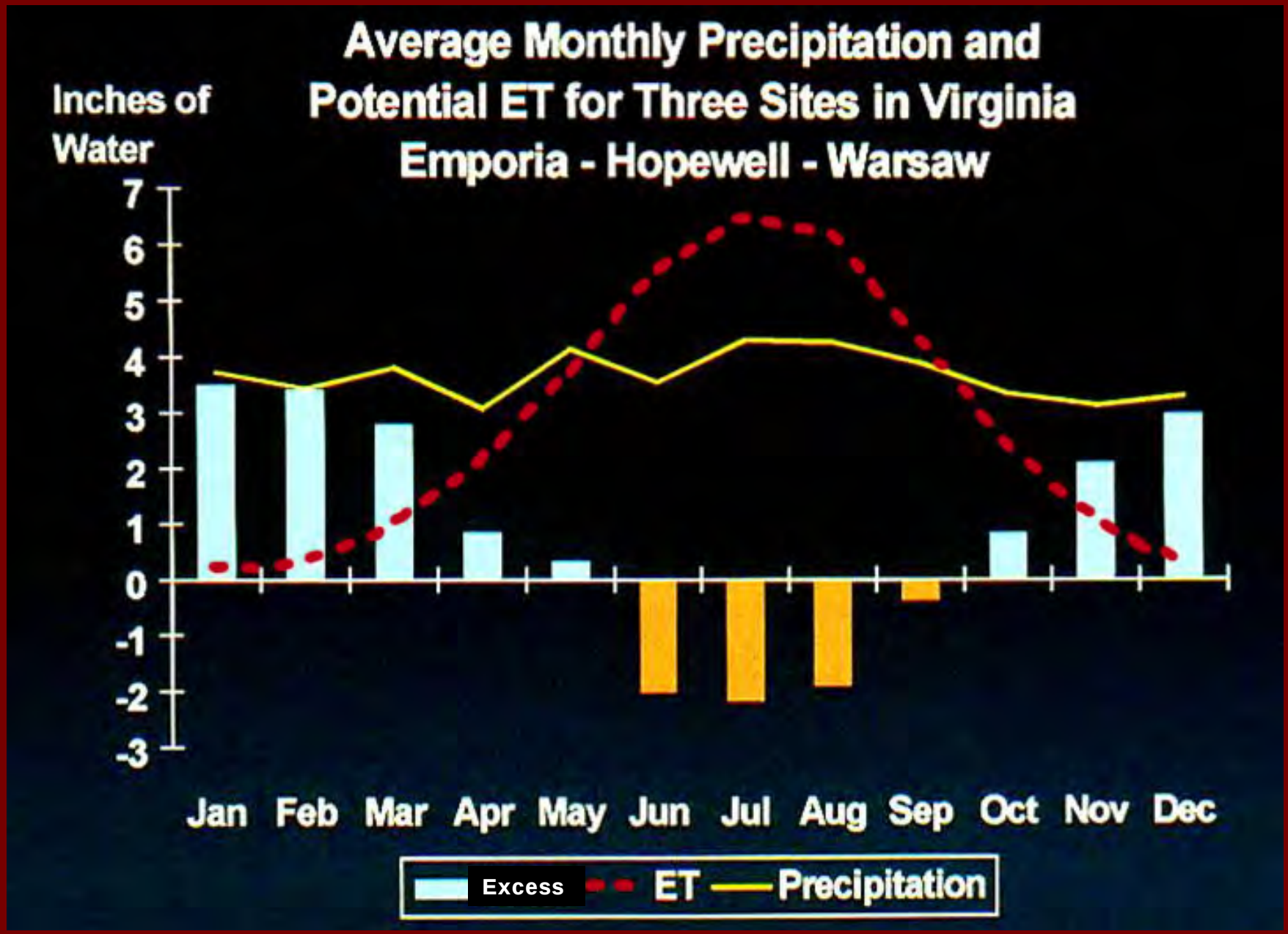


The thickness of arrows is proportional to approximate amounts of water at Blacksburg, VA, where long term averages of data indicate:

Annual precipitation = 41 in.

Annual runoff plus percolation = 13 in.

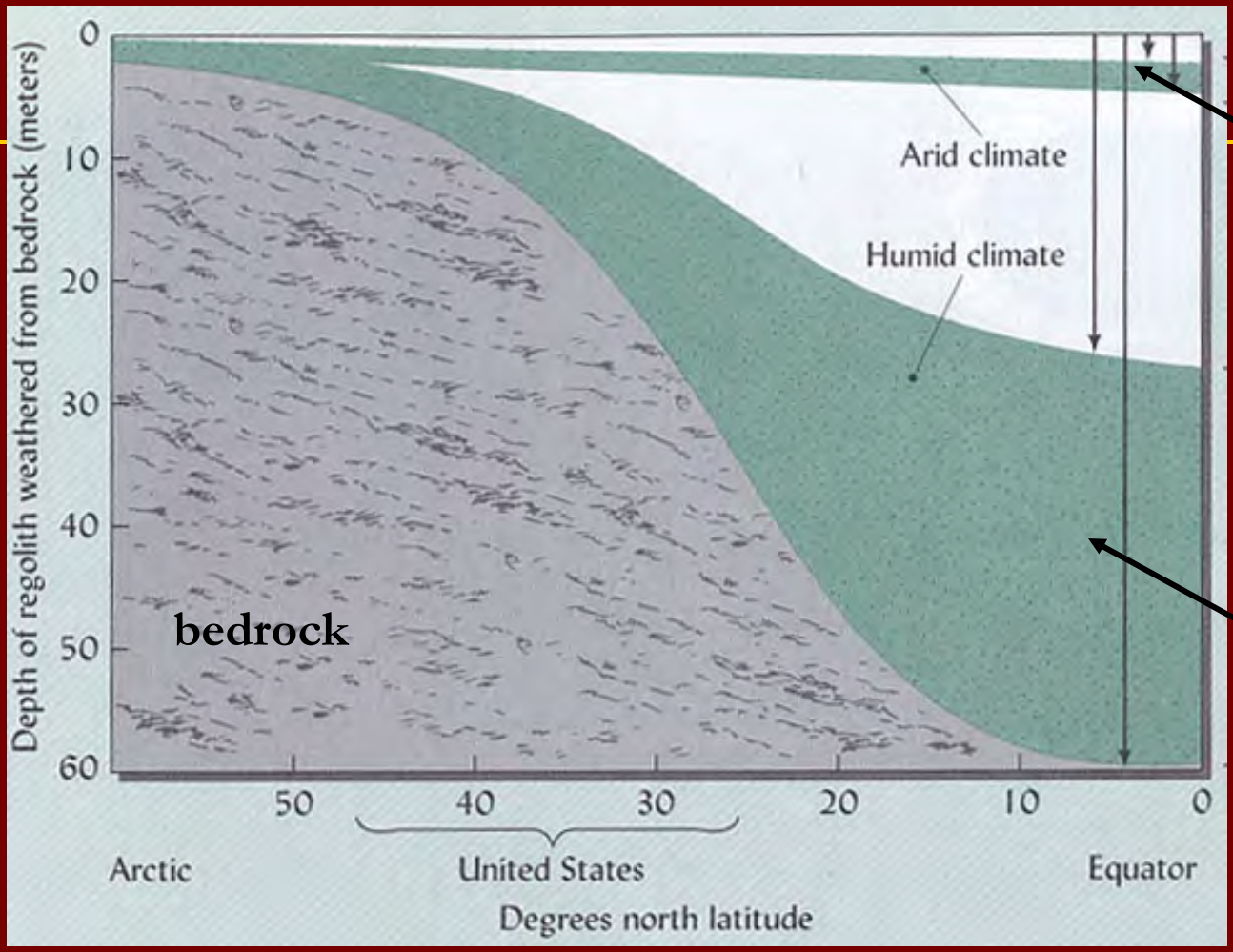
Annual evapotranspiration = 28 in.


Average Monthly Precipitation and
Potential ET for Three Sites in Virginia
Emporia - Hopewell - Warsaw
Inches of
Water
7
6
5
4
3
2
1
0
-1
-2
-3
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Excess
ET
Precipitation

Five General Factors of Soil Formation

- **Climate**
- **Organisms**
- **Relief**
- **Parent material**
- **Time**

Climate Effects

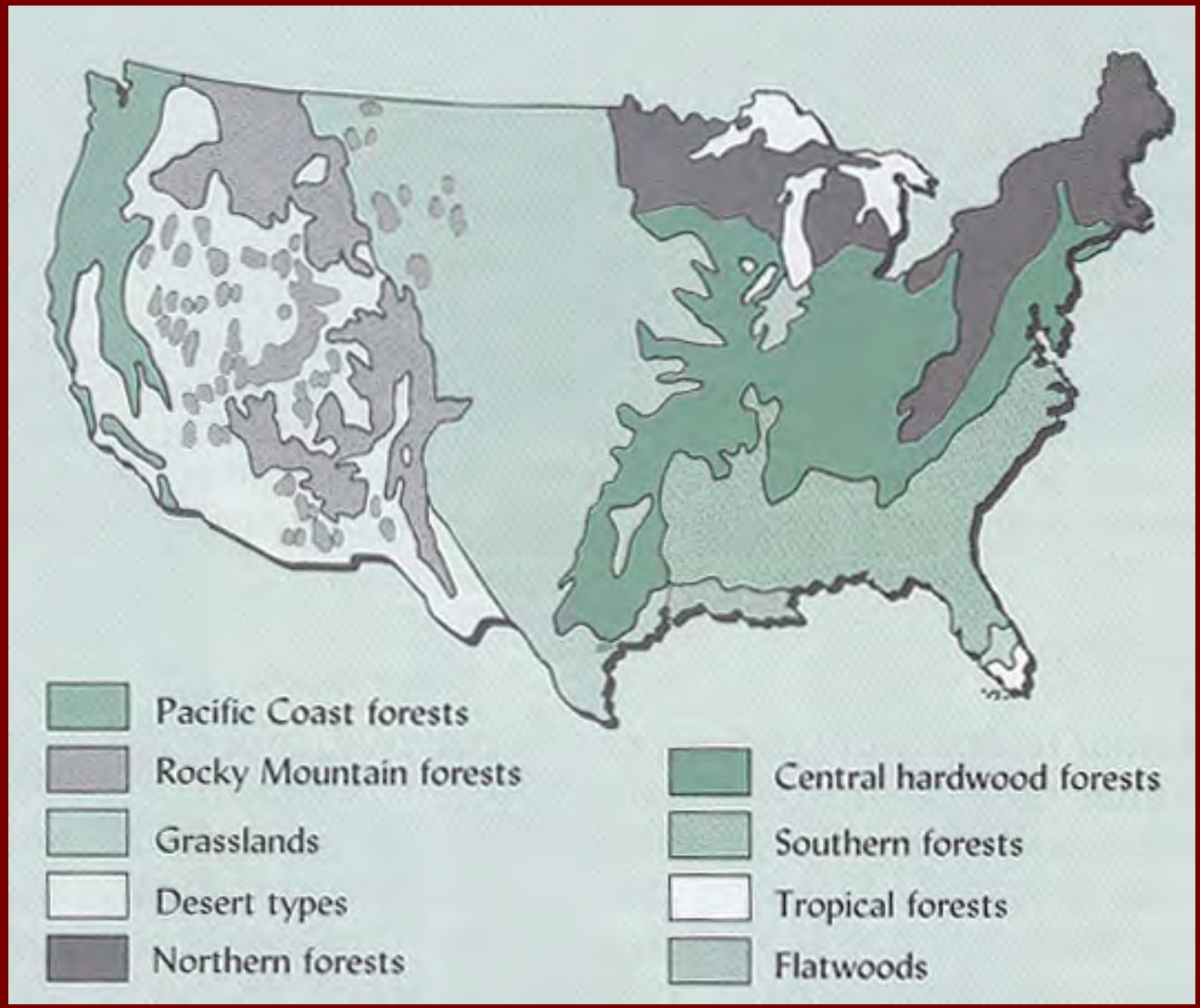


Shallow Soils

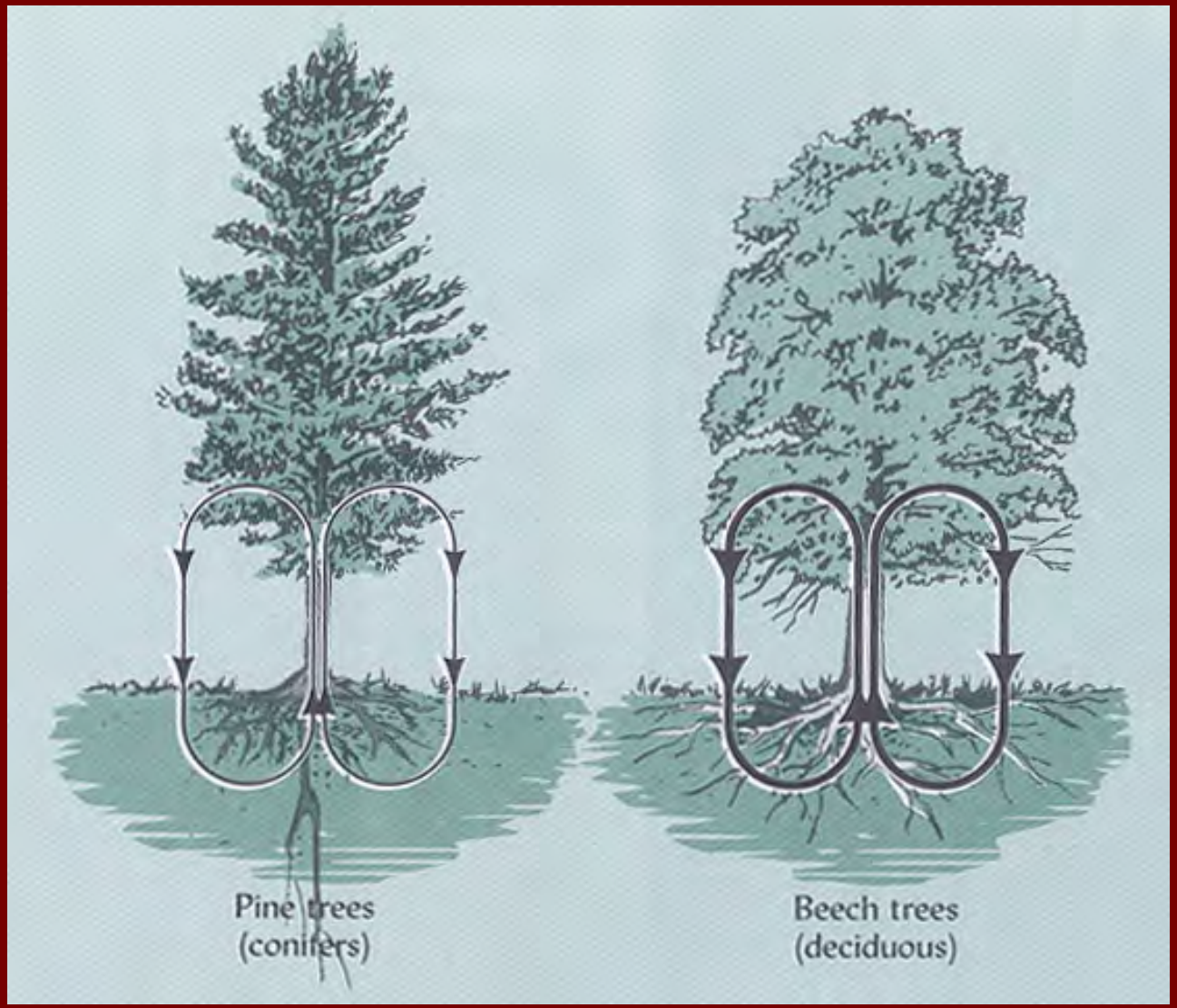
Thick, deeply weathered soils

- Illustration of the effects of two climatic variables, temperature and moisture (precipitation) on the depth of weathering as indicated by regolith depth. In cold climates (arctic regions) the regolith is shallow under both humid and arid conditions. At lower latitudes (higher temperatures), the depth of the regolith increases sharply in humid areas but is little affected in arid regions. In humid tropical climates, the regolith may be 50 m or more in depth.

General Types of Natural Vegetation in the United States

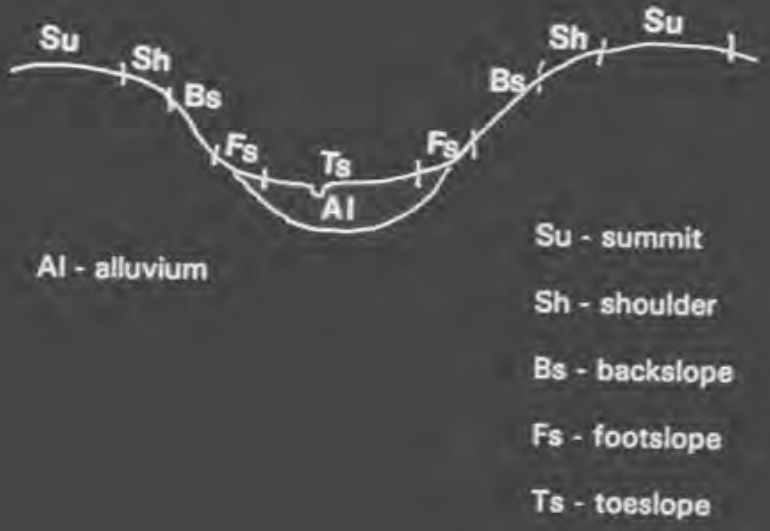


Nutrient Recycling

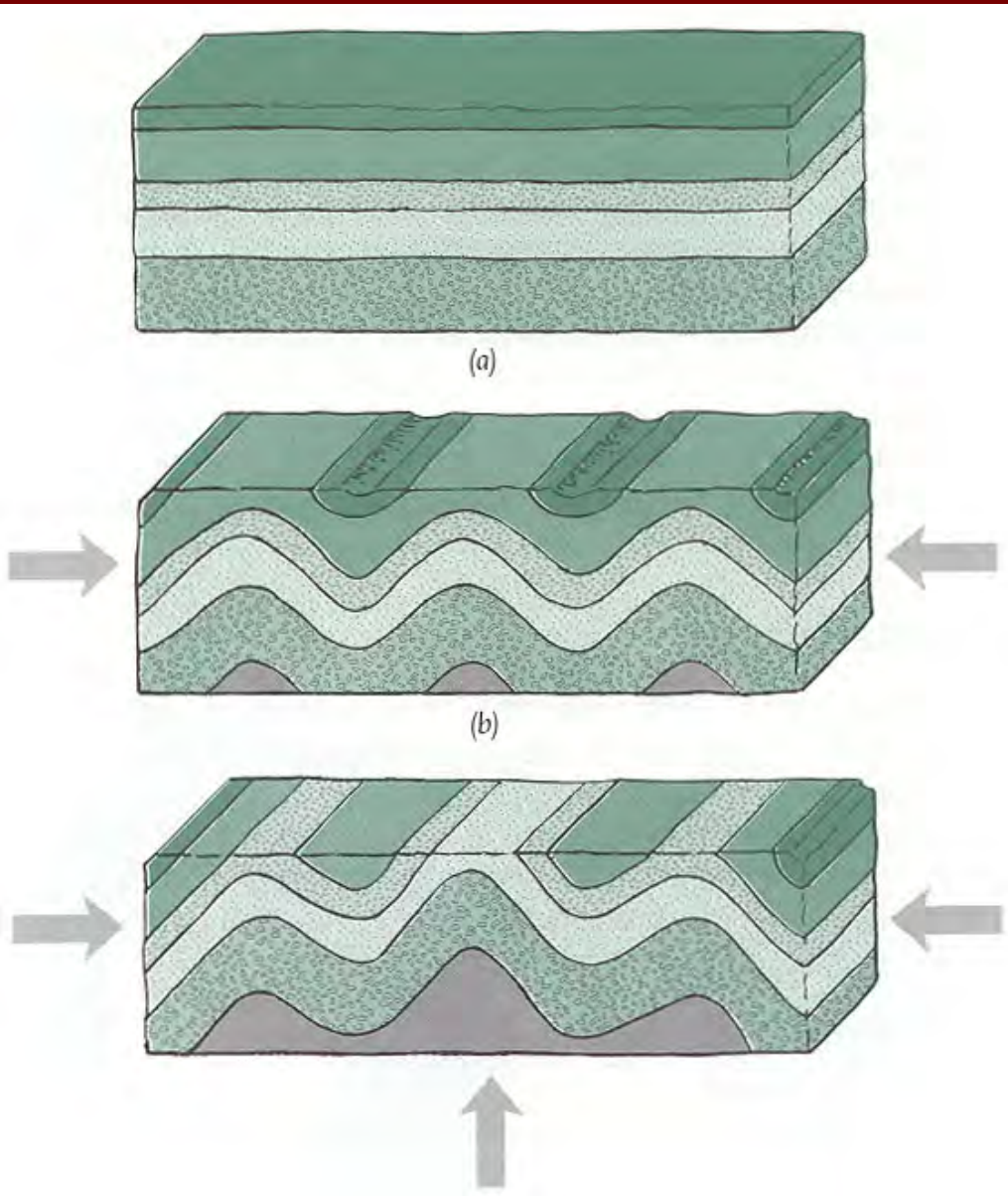


Relief

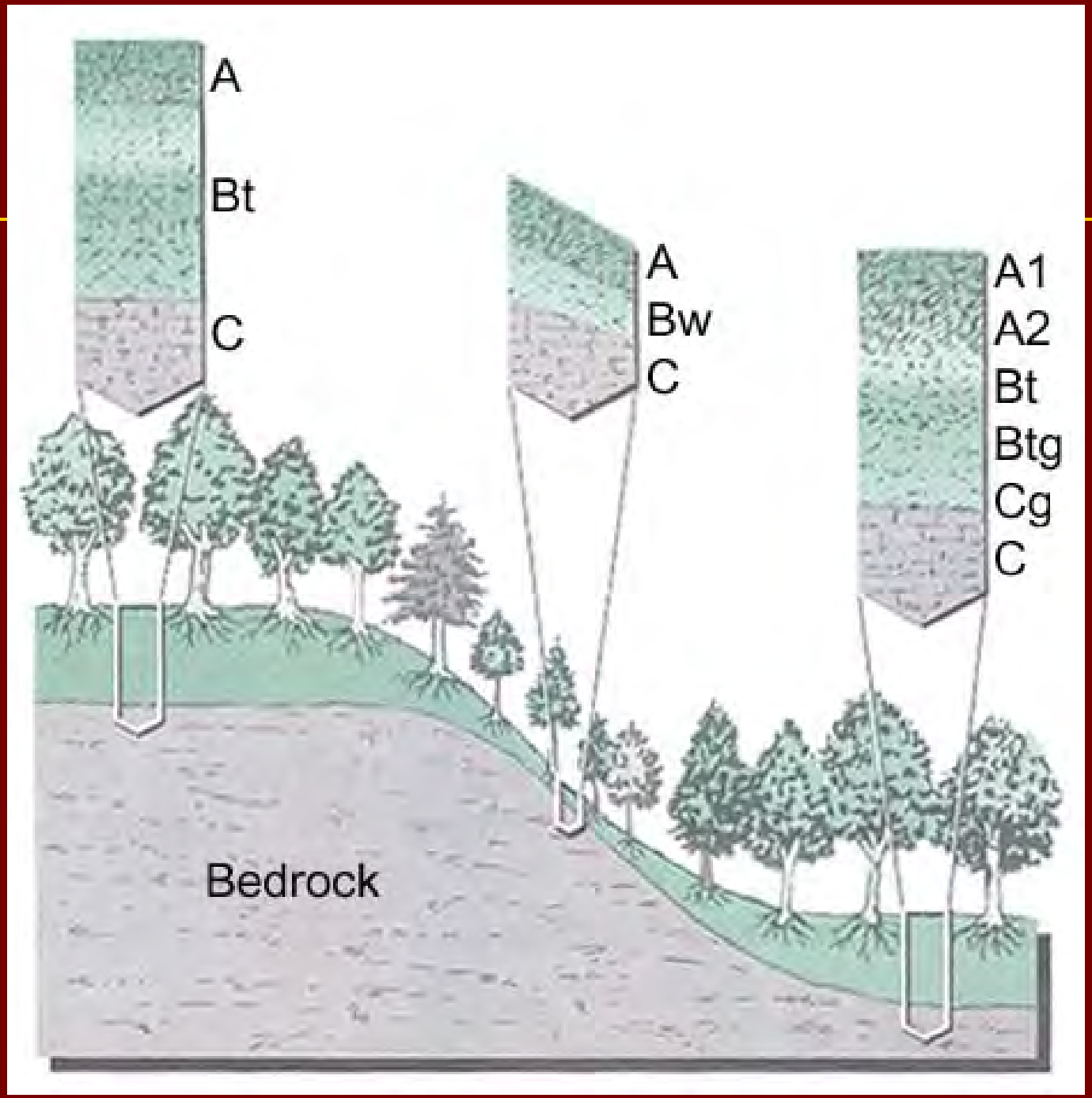
Ruhe's Hill Slope Model



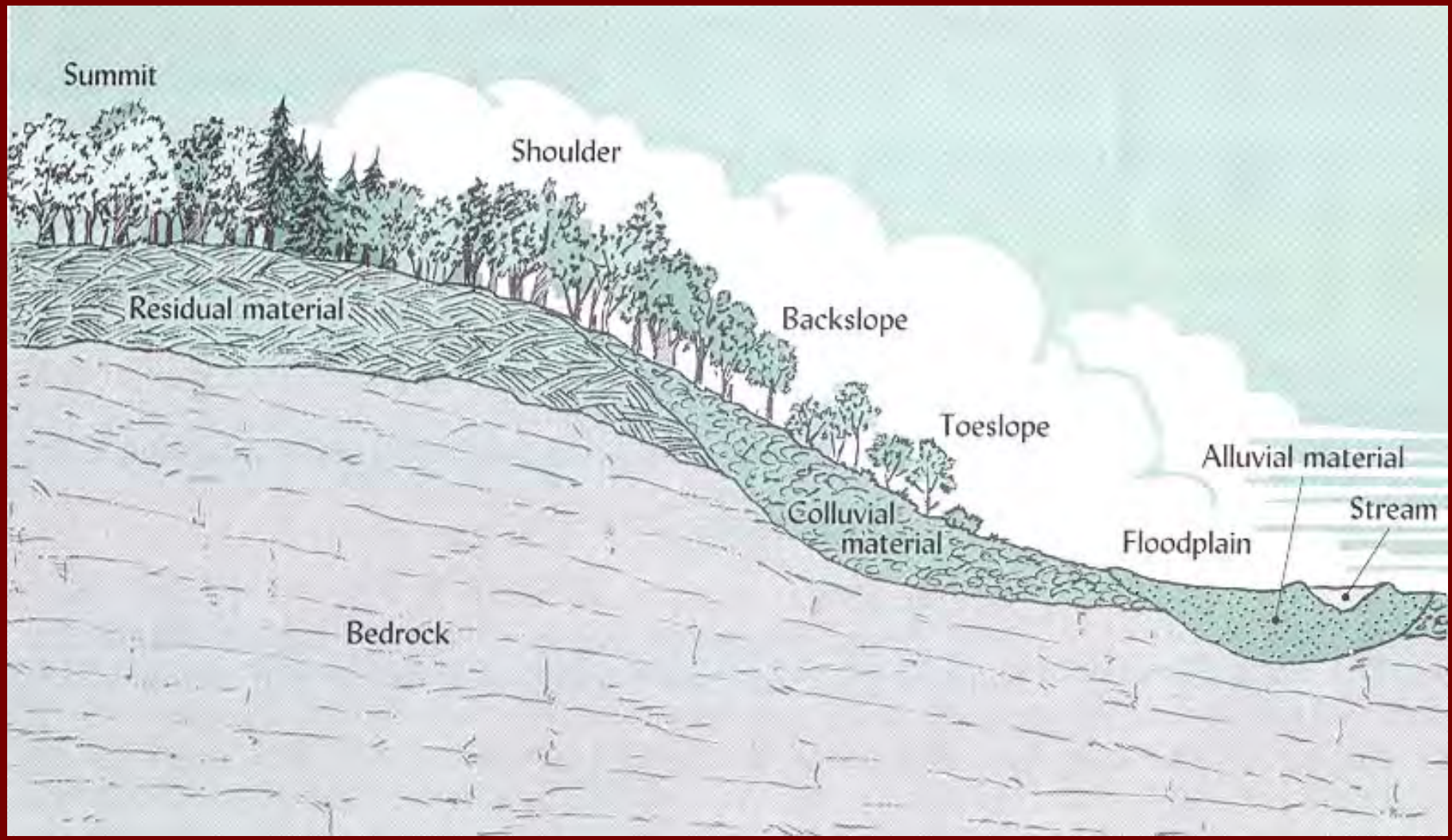
Geologic Processes



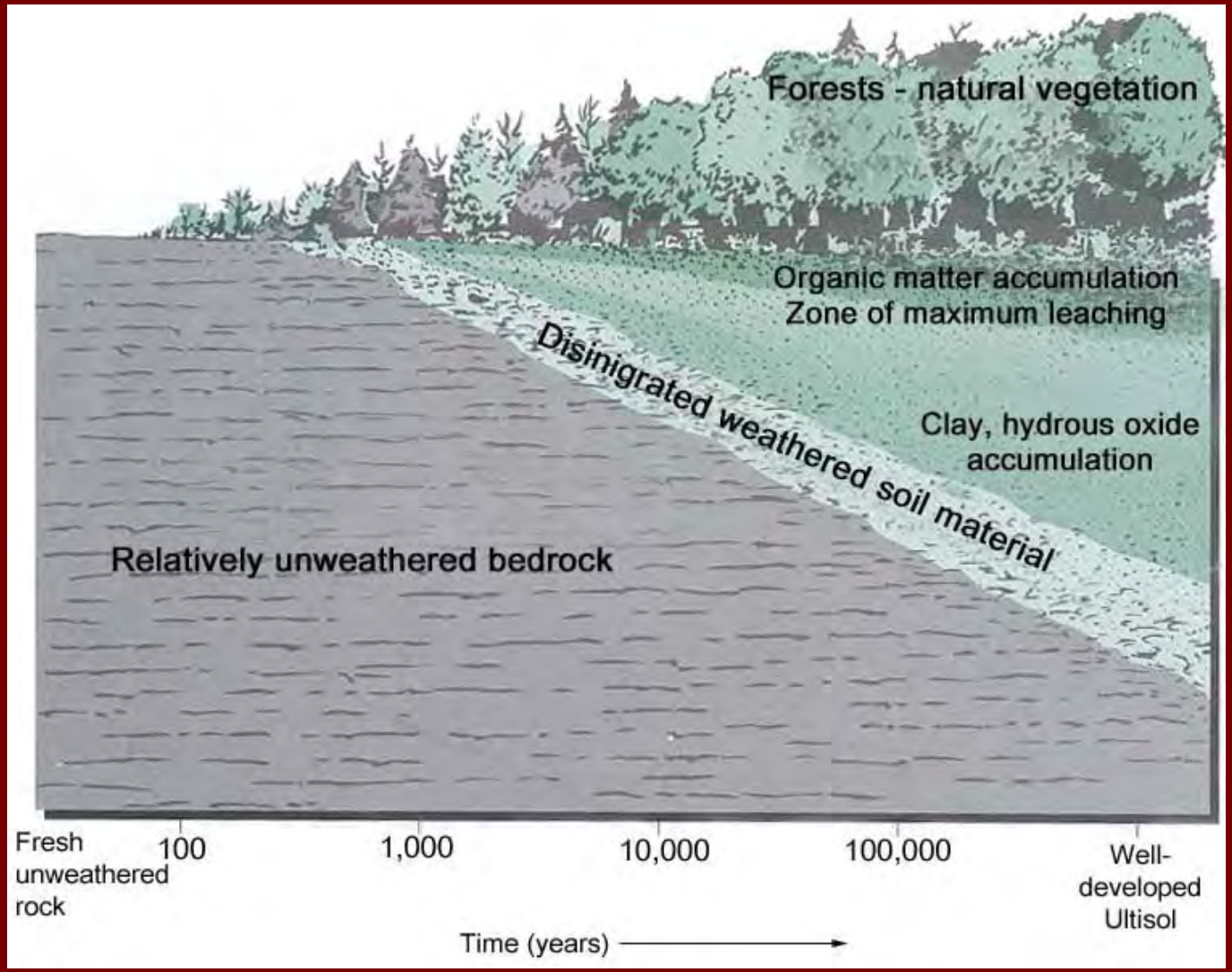
- Unaltered layers of sedimentary rock with only the uppermost layer exposed.
- Lateral geologic pressures deform the rock layers. At the same time, erosion removes much of the top layer, exposing part of the first underlying layer.
- Localized upward pressure further reforms the layers, thereby exposing two more underlying layers. As these four rock layers are weathered, they give rise to the parent materials on which different kinds of soils are formed.


A
Bt
C
A
Bw
C
A1
A2
Bt
Btg
Cg
C
Bedrock

Relief, Organisms, & Parent Material

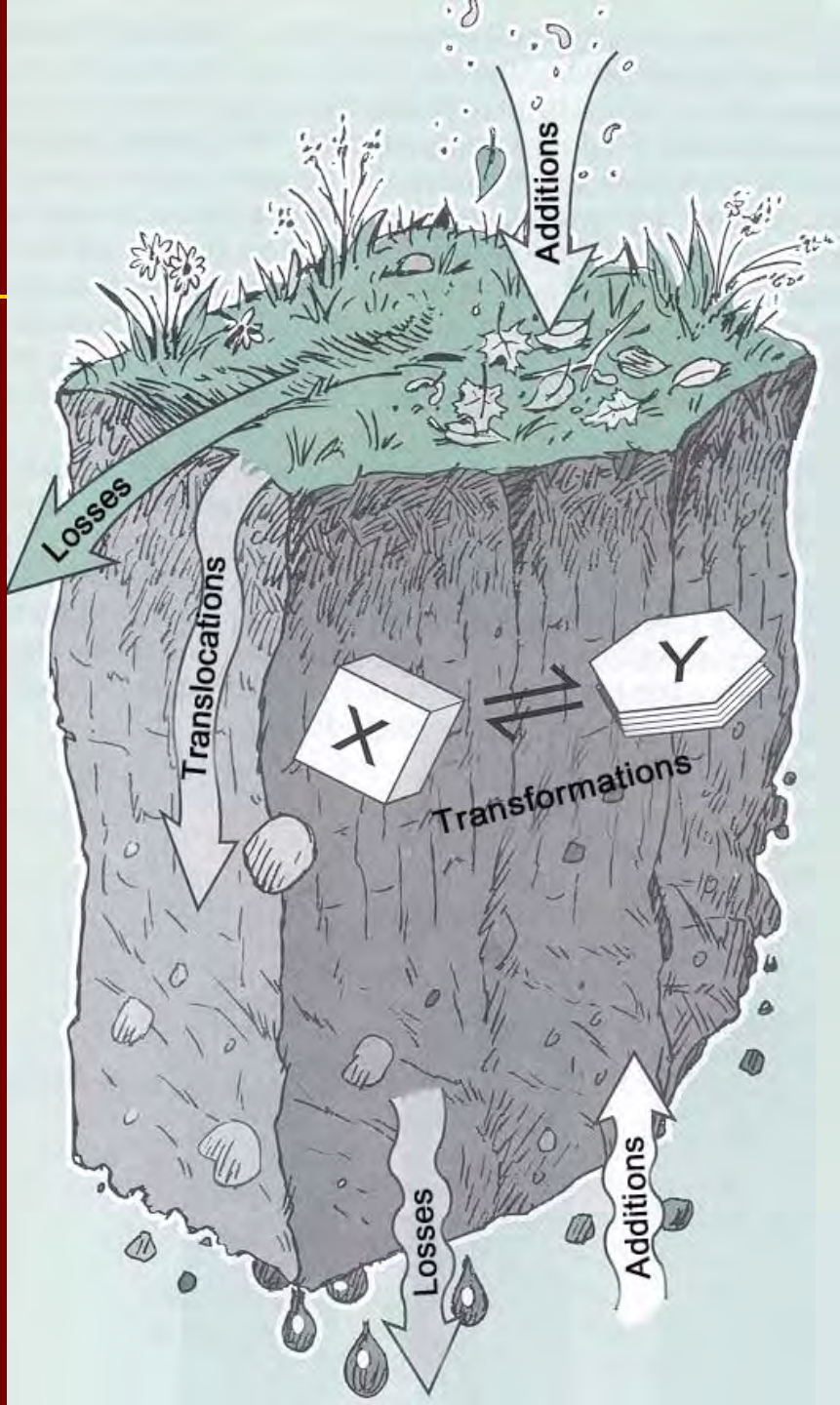


Development of a Soil Profile with Time

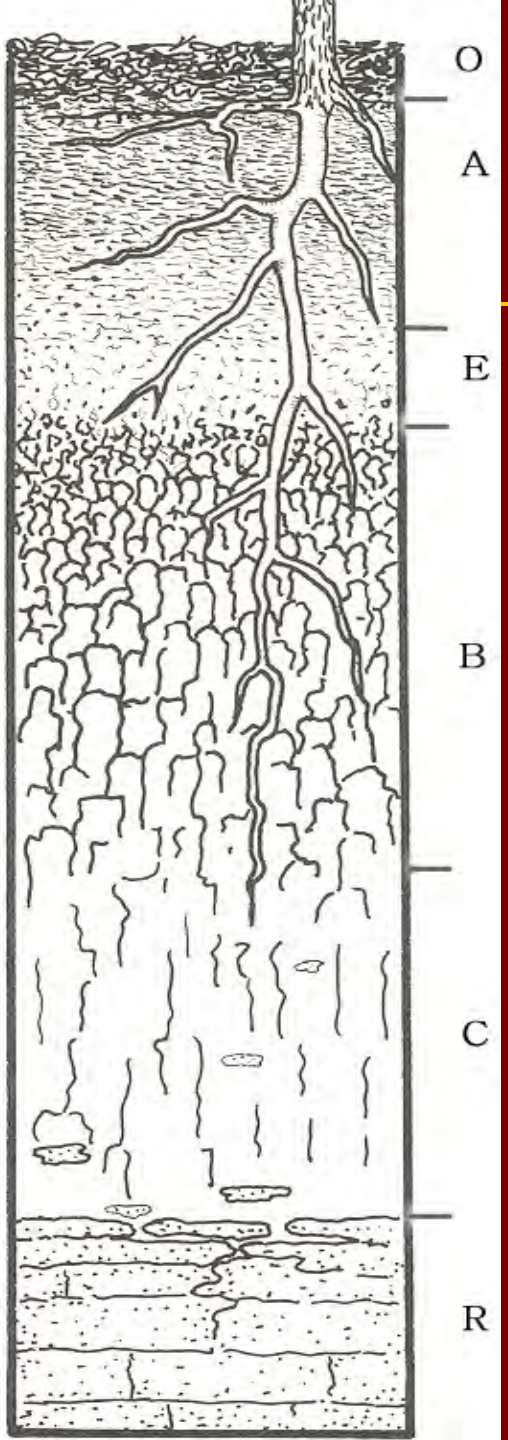


Soil Profile Forming Processes

- Additions
- Losses
- Translocations
- Transformations



- soil_formation - Flash Animation



The Soil Profile

O = layer dominated by organic matter

A = mineral horizon at the surface showing organic enrichment

E = subsurface horizon showing depletion of OM, clay, Fe, and Al compounds

B = horizon showing enrichment of clay minerals, Fe, Al, or organic compounds

C = horizon of loosened or unconsolidated material

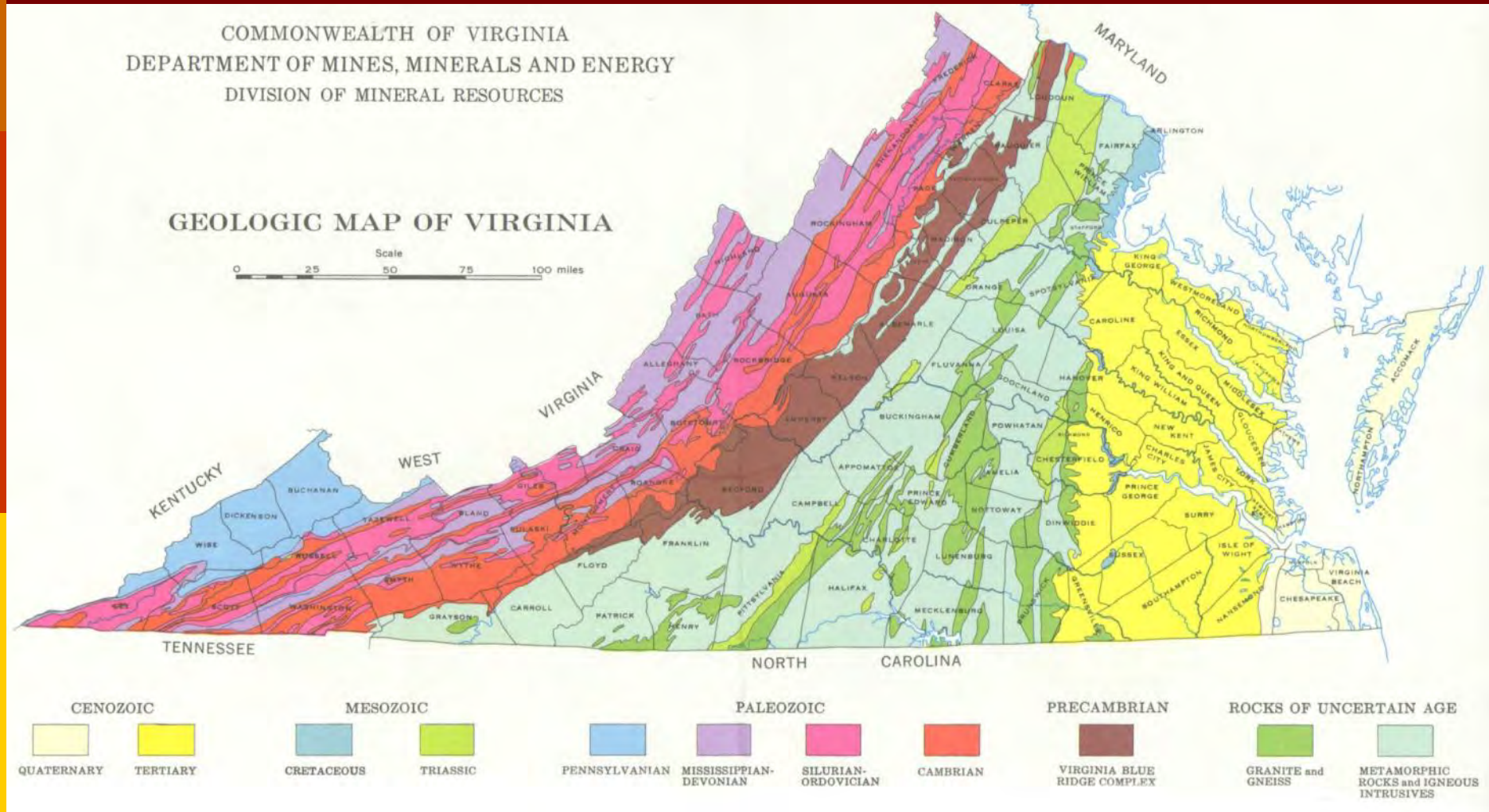
R = rock

- Soil Profile includes:
  - "A" Horizon
  - Thin "E" Horizon
  - Thick "B" Horizon

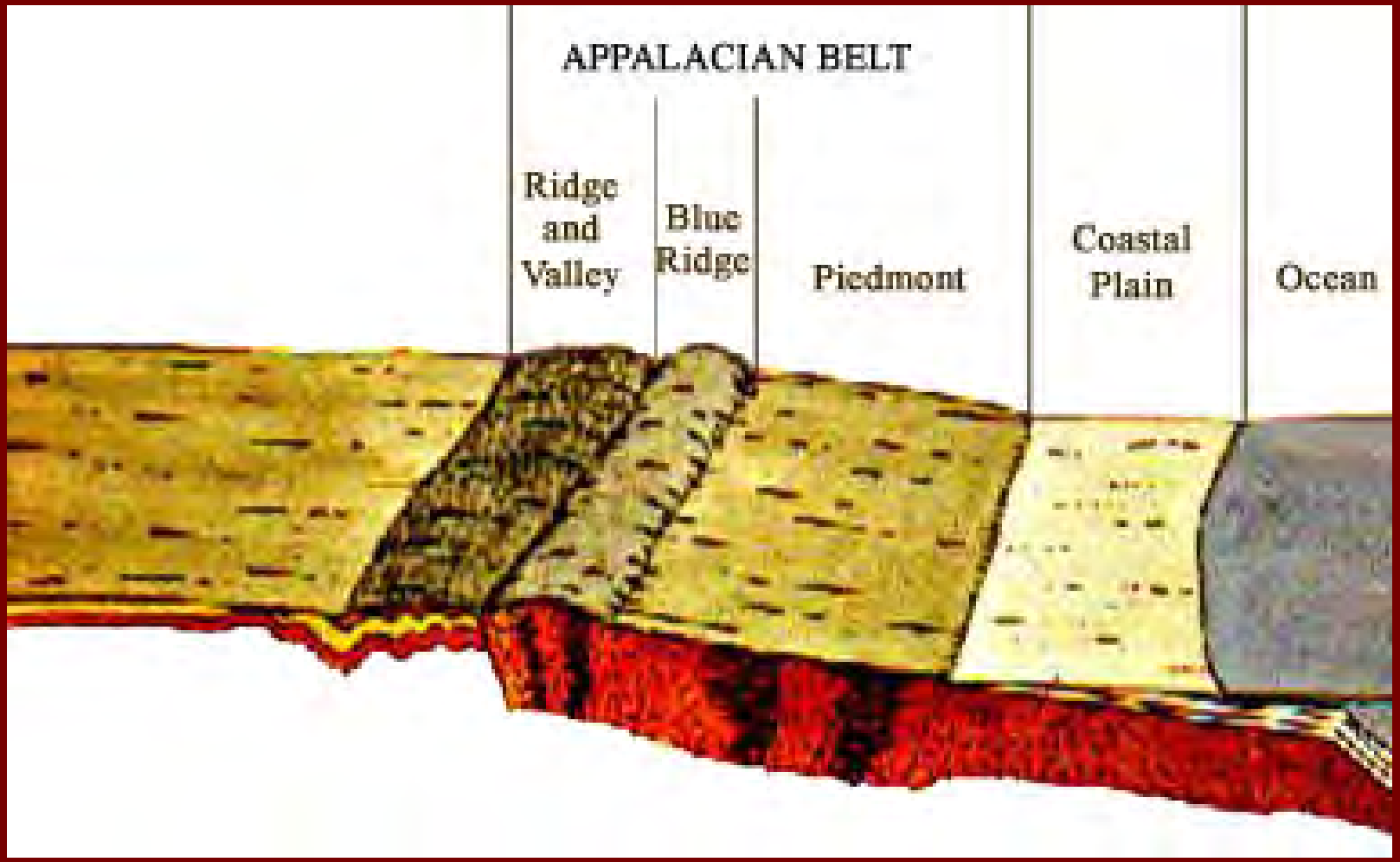
- Soil Profile includes:
  - Thick “A” Horizon
  - Prominent “E” Horizon
  - Thin “B” Horizon comprised of oxides

- Soil Profile includes:
  - Thick “A” Horizon
  - Gray, clayey “B” Horizon

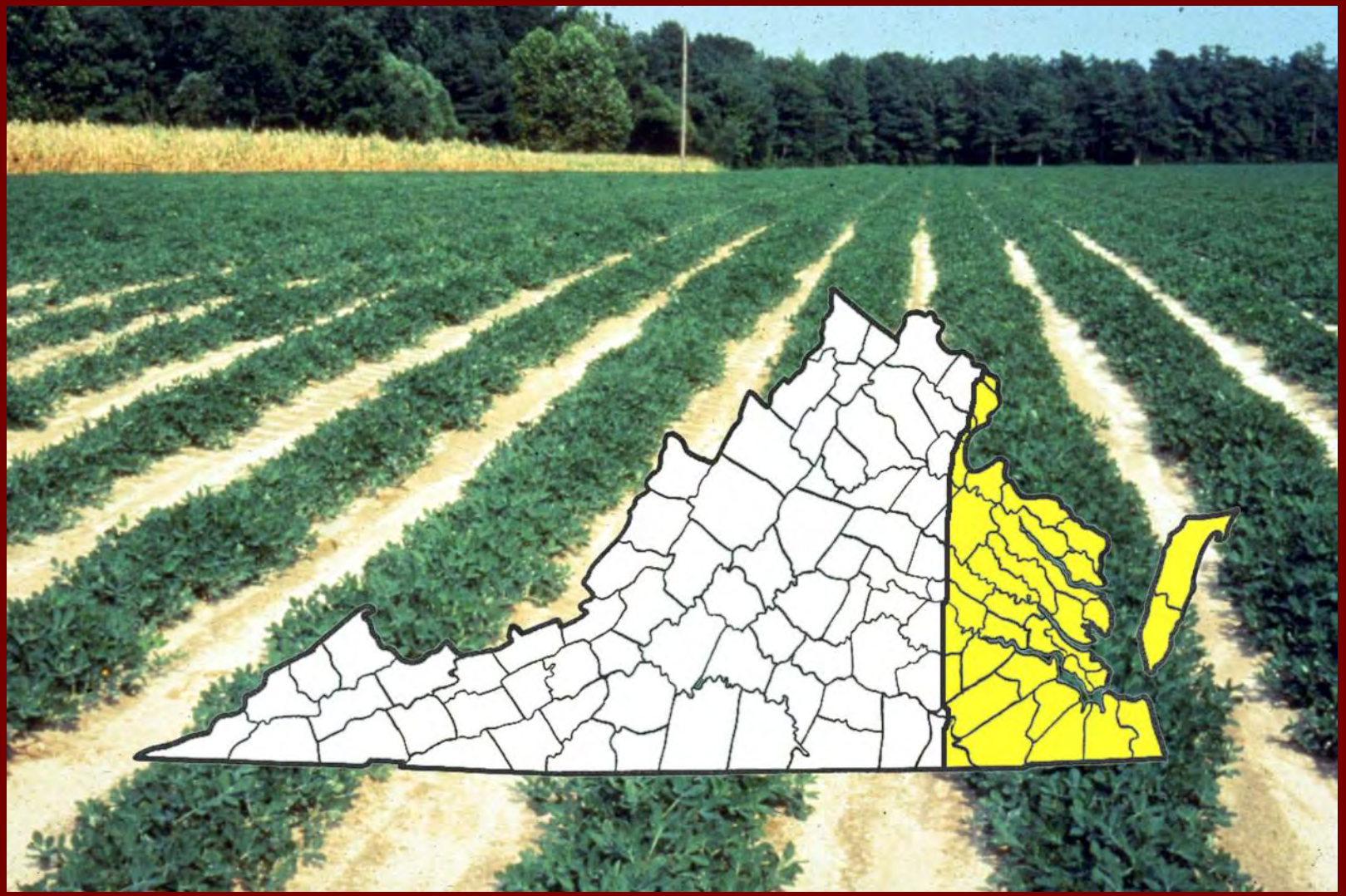
Geologic Map of Virginia



Sequence of Parent Materials



Coastal Plain Physiographic Province



Coastal Plain Deposits

- **Thick, cyclic deposits of sands, silts, clays and organics.**

Salt and Brackish Marshes

Lower Coastal Plain Soil

Well Drained Coastal Plain Soil

- **Prominent clay loam Bt horizon**

Croplands in Coastal Plain

- **Sandy loam surfaces**
- **Large fields**
- **Gentle Slopes**

Virginia's State Soil: Pamunkey

- **Middle coastal plains**
- **Loam/clay loam**
- **Well drained**

- Corn on intensively cropped soils
- Middle Coastal Plain

Norfolk Soil

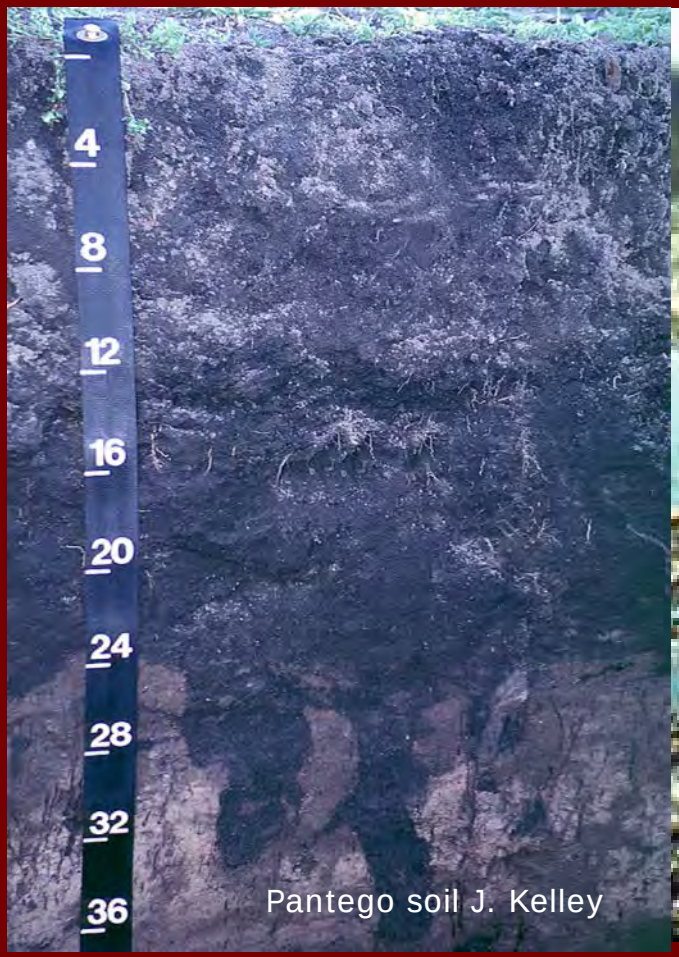
- Upper Coastal Plain
- Highly weathered
- Plinthite layer in Bt horizon

Upper Coastal Plain Cropland

- **Broad gentle slopes**
- **Cotton – corn – peanuts – soybeans – small grains**

Small Grains in Upper Coastal Plains

Restrictive Layers

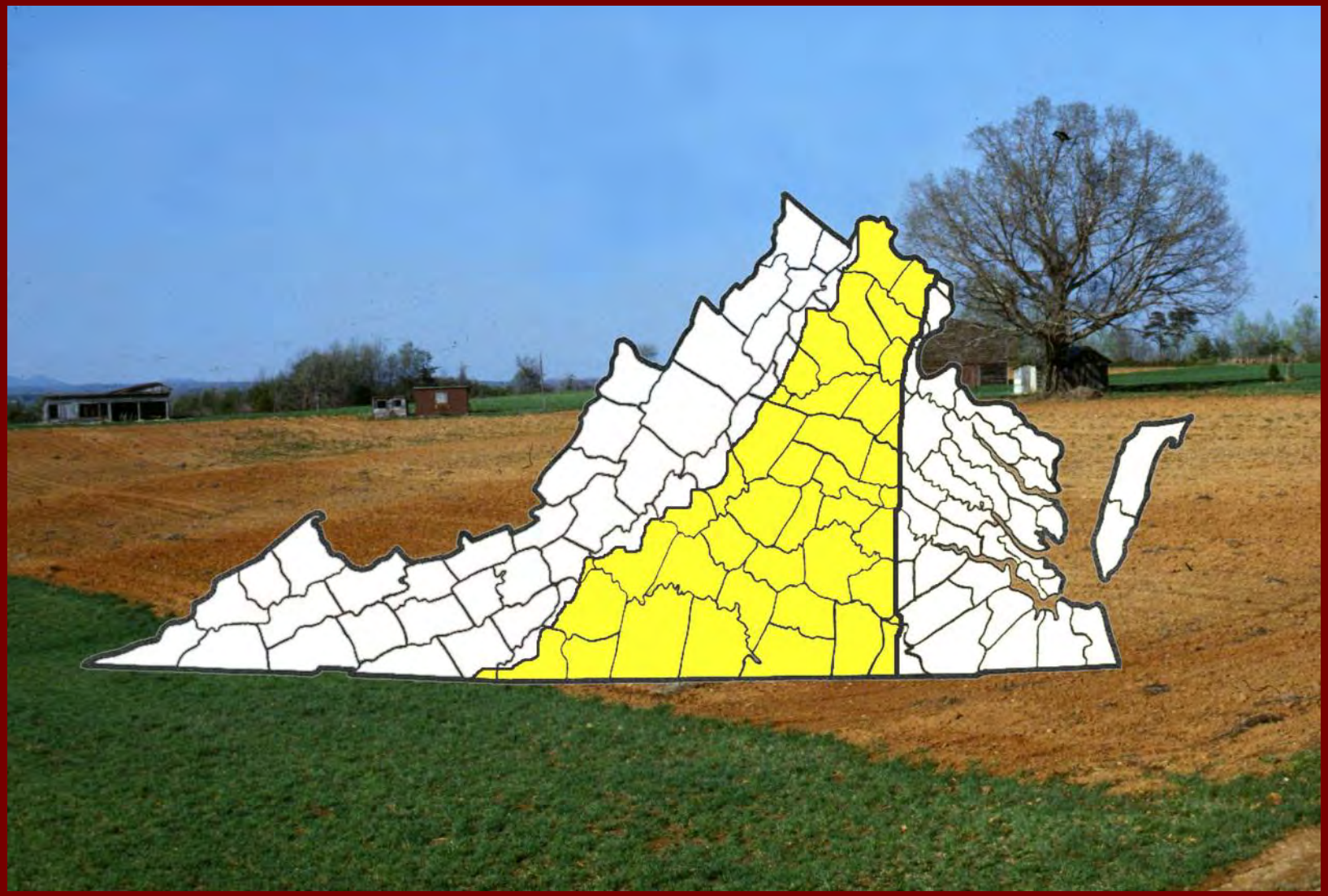


Pantego soil J. Kelley

- **Slow surface drainage**
- **Higher clay content**

Poorly Drained Soils

Piedmont Physiographic Province

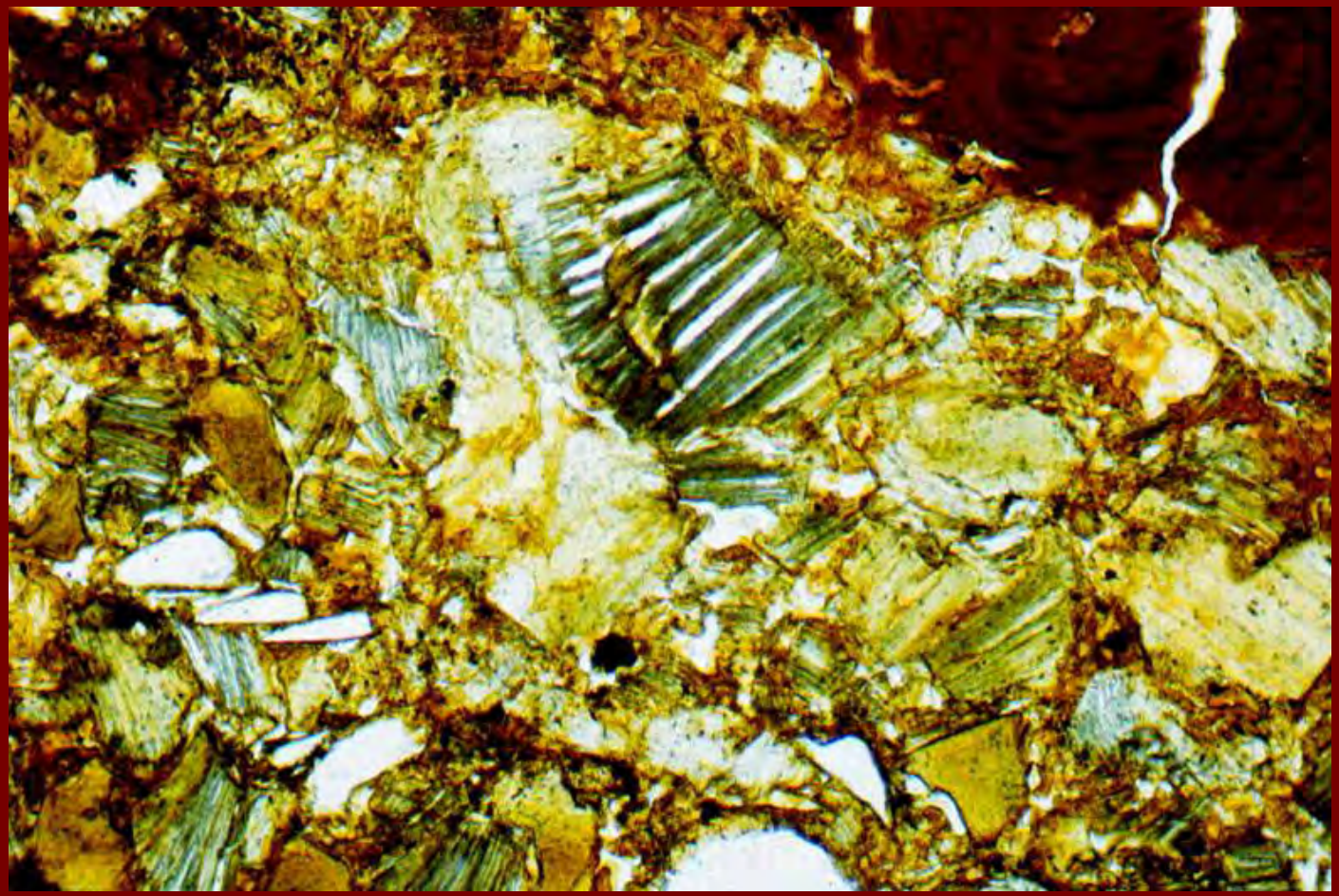


Rolling Landscapes

- Igneous and metamorphic rocks
- Red, clayey, soils common
- Usually eroded

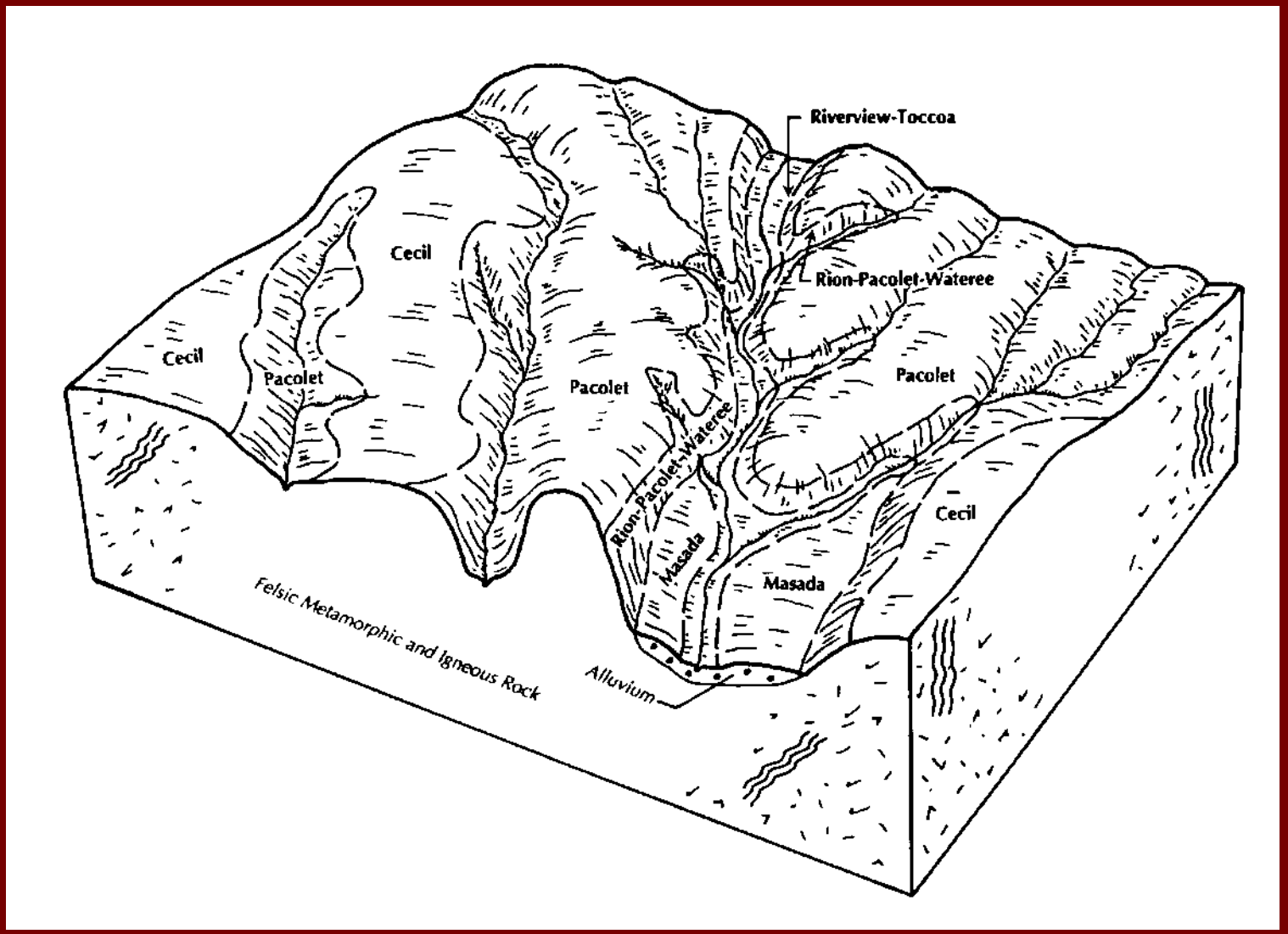
Weathered biotite mica gneiss

Rock Thin Section



- **Mica weathering to layered clays**
- **Kaolinites and vermiculites**

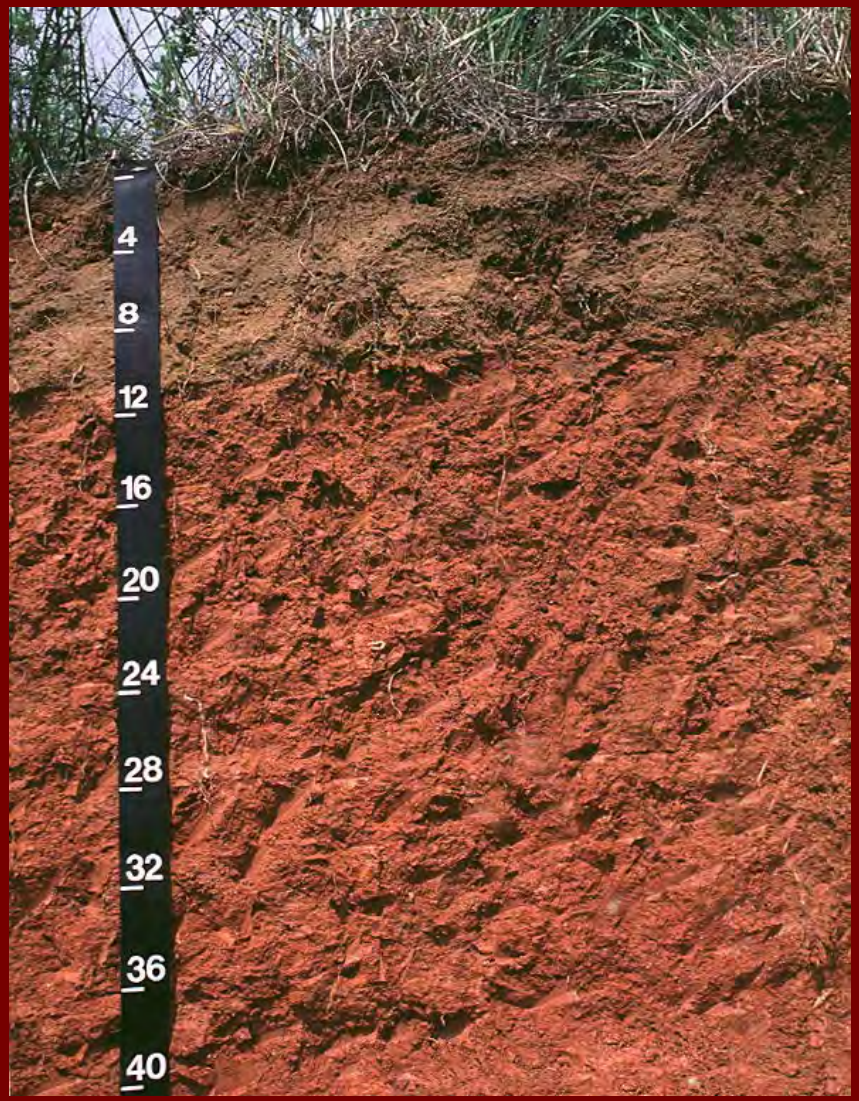
Landscape Diagram of Piedmont Soils



Piedmont Landscape with Cecil Soils

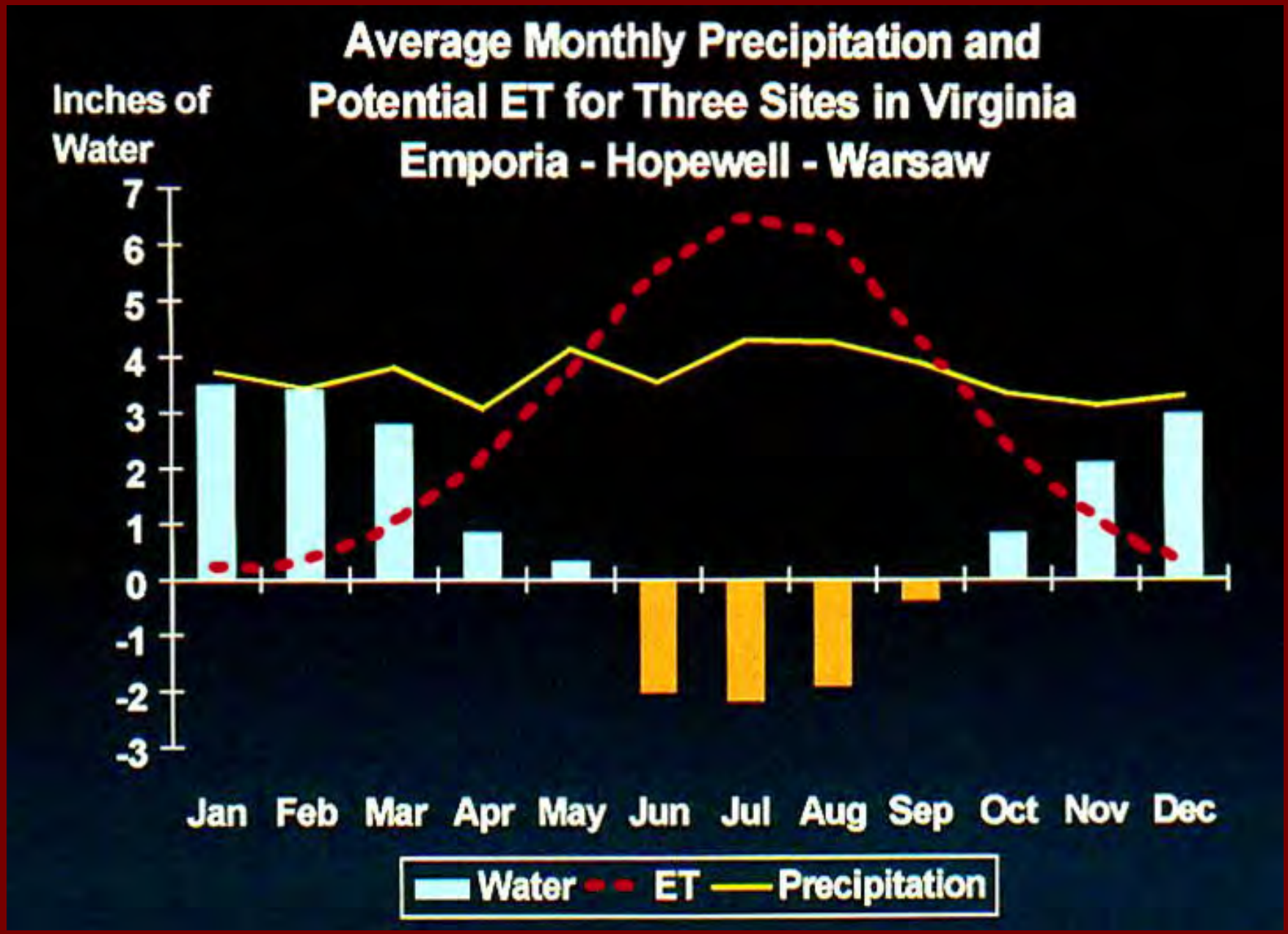
Tobacco on Red Soils in Western Piedmont

Cecil Series



- **Clayey, kaolinitic, thermic**
- **Typic Kanhapludult**

- Weathered and “folded” schists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Jan
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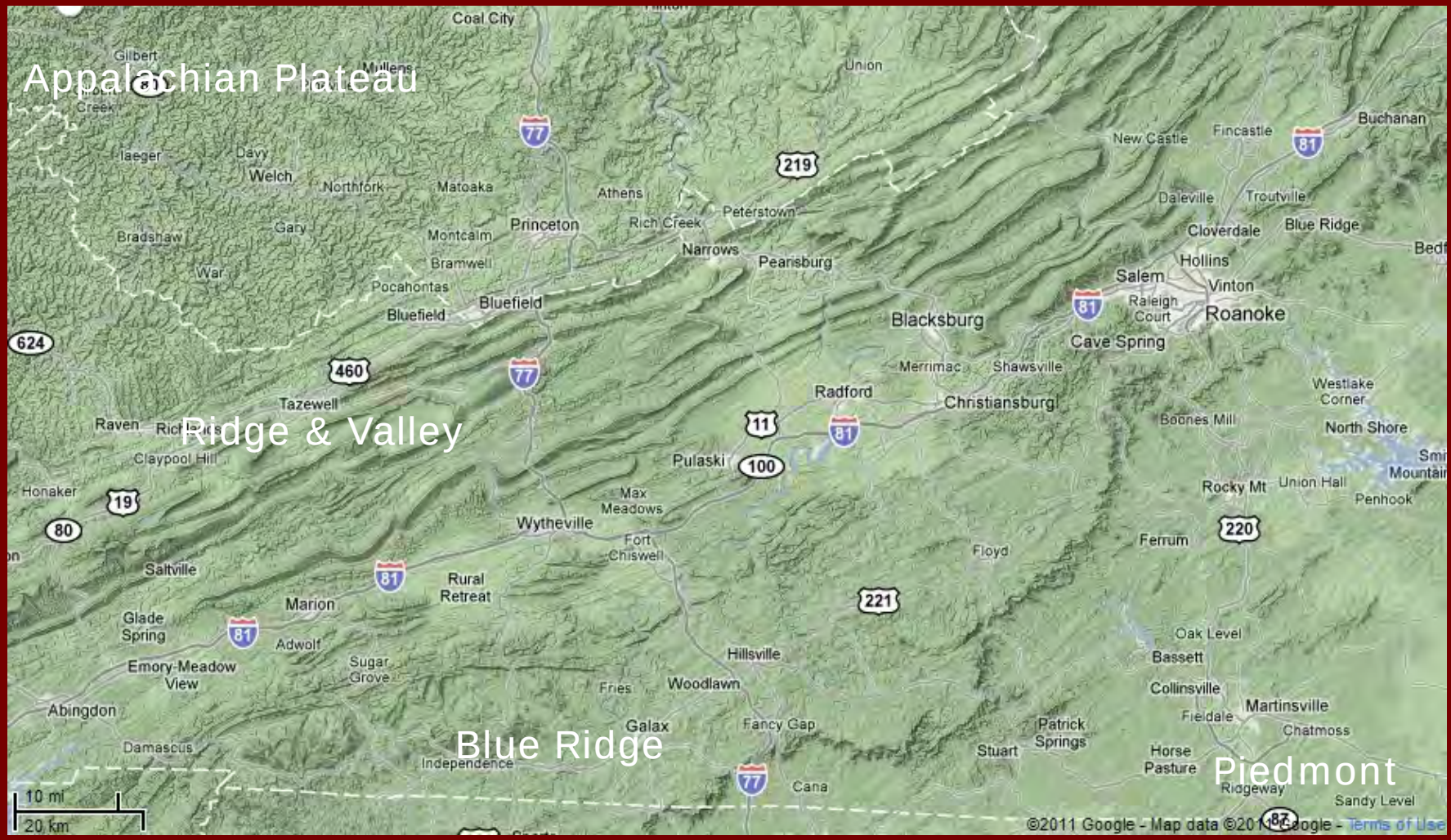
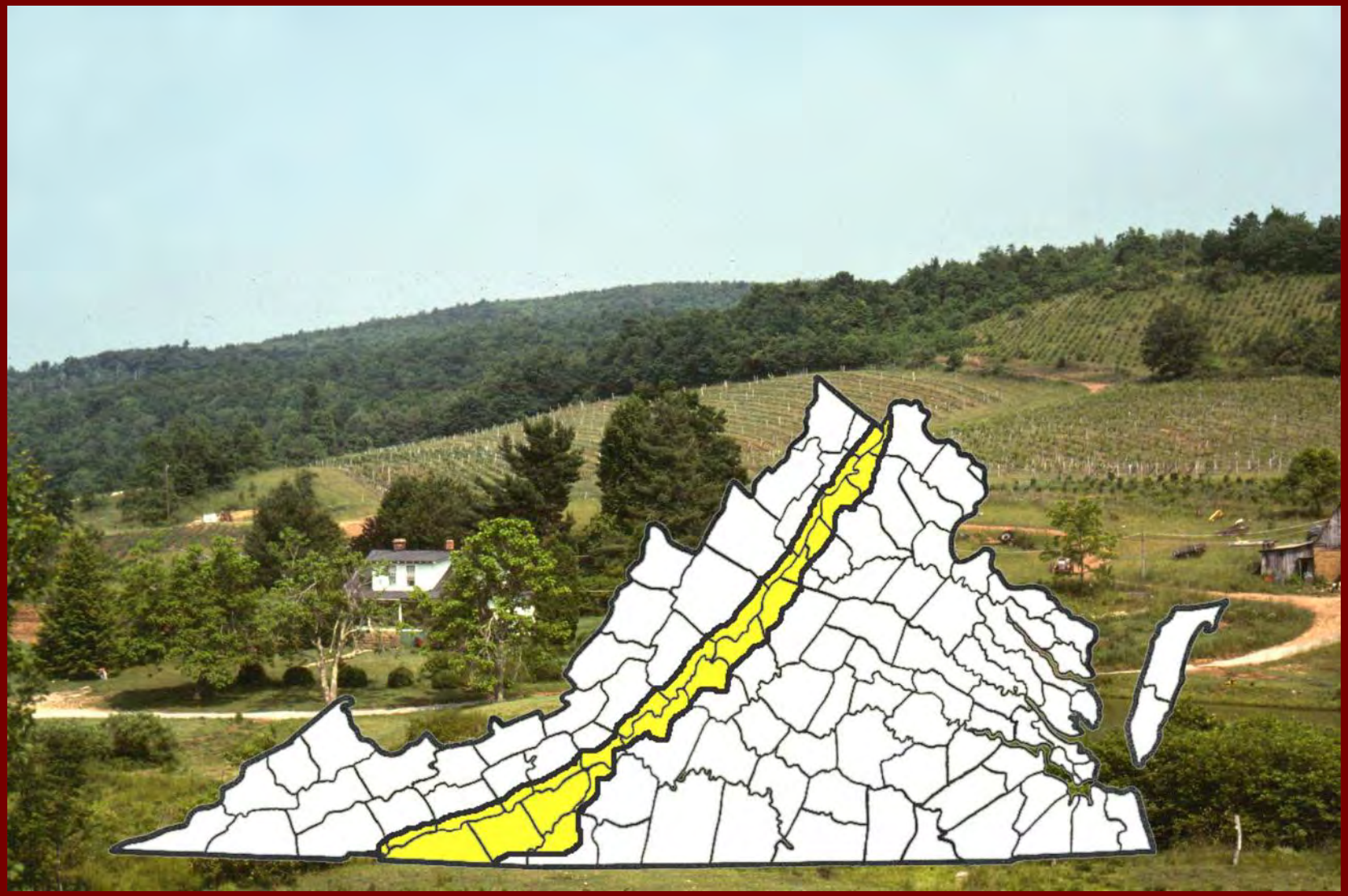
Sep
Oct
Nov
Dec
Water
ET
Precipitation

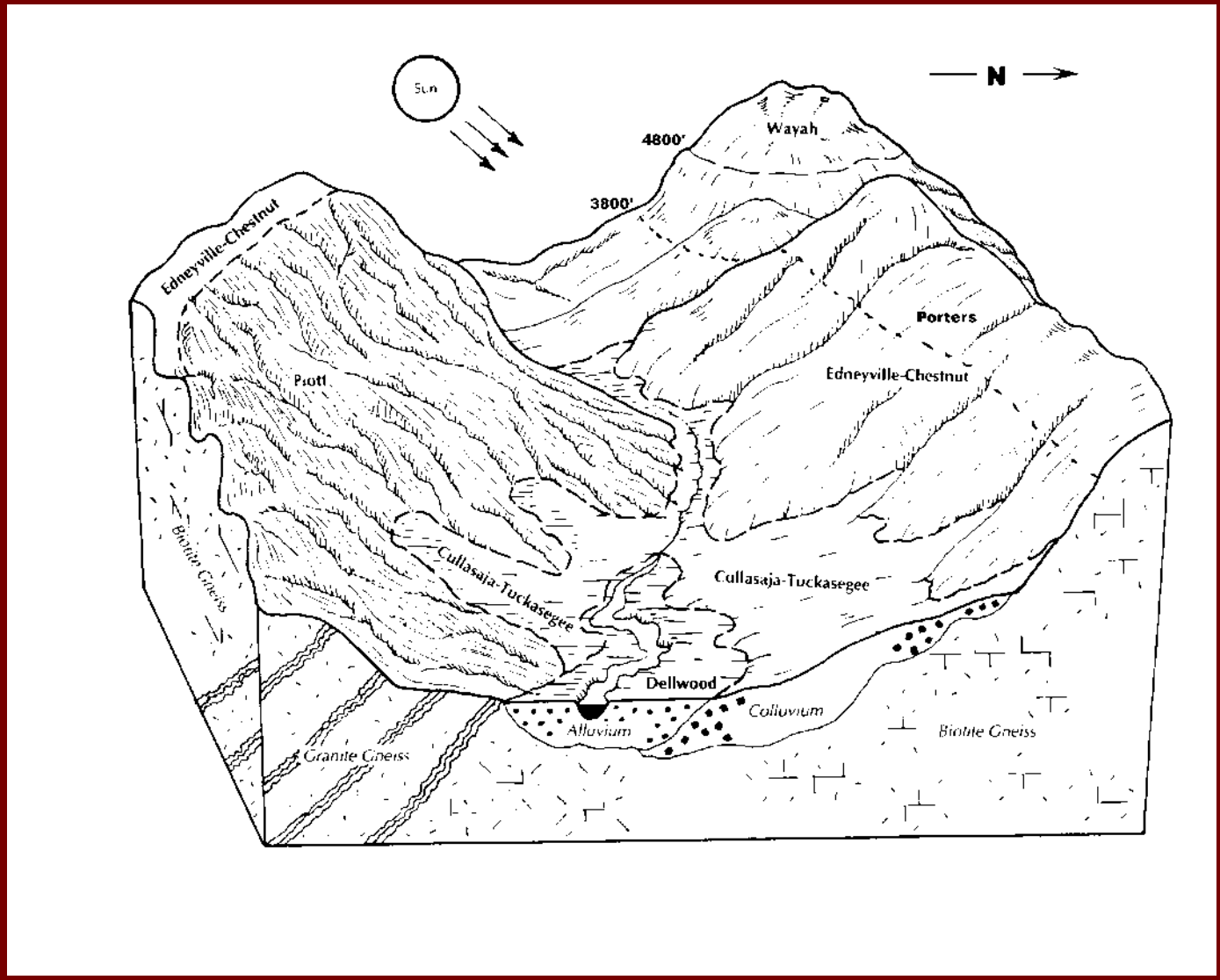
Physiographic Provinces – SW Virginia



Blue Ridge Physiographic Province



- Cool climates with higher rainfall
- Steep landscapes
- Folded parent materials

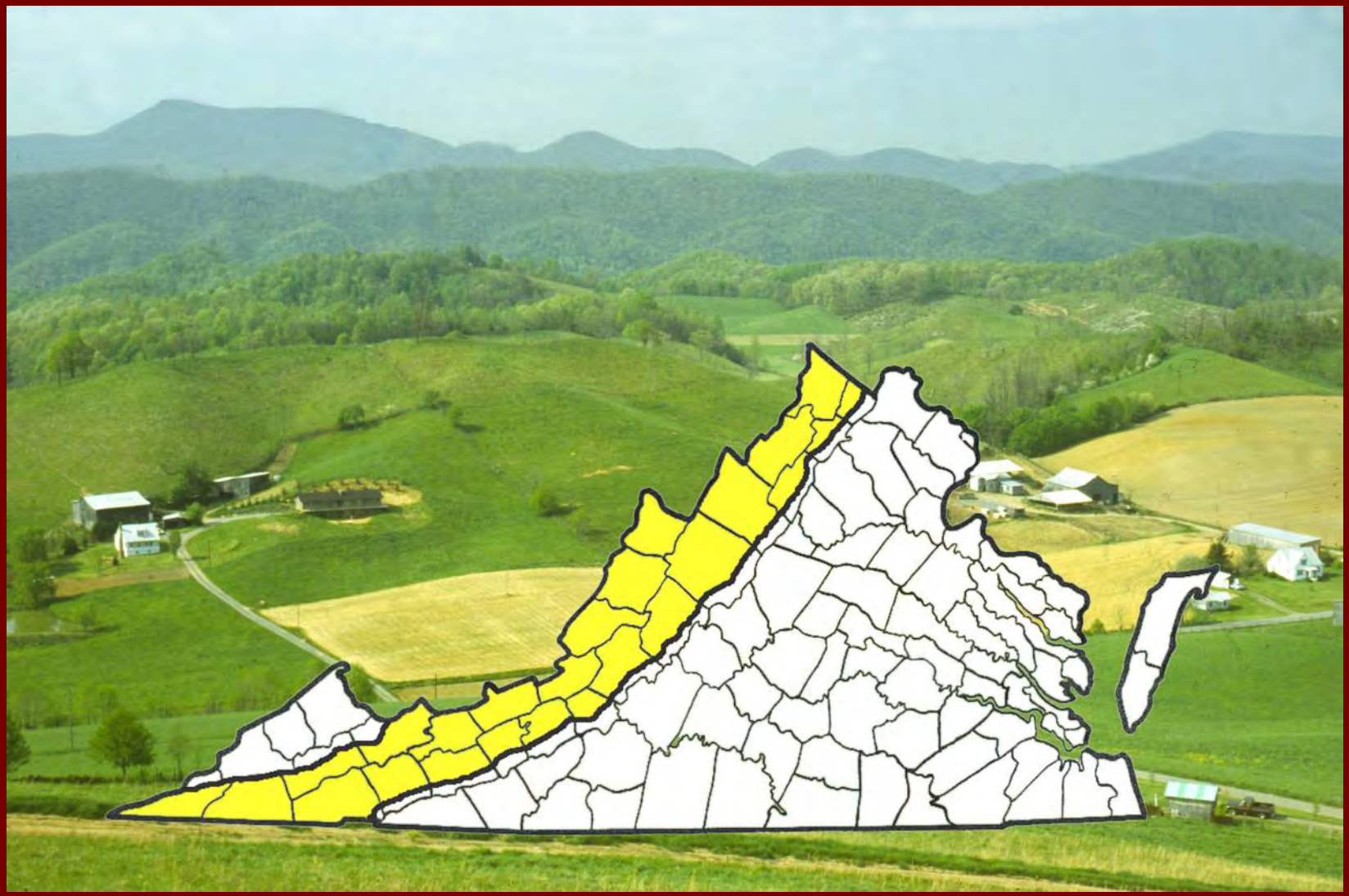

Sun
N
4800'
Wayah
3800'
Edneyville-Chestnut
Porters
Edneyville-Chestnut
Ptott
Biotite Gneiss
Cullasaja-Tuckasegee
Cullasaja-Tuckasegee
Dellwood
Colluvium
Alluvium
Biotite Gneiss
Granite Gneiss

- Well drained
- Well aggregated
- Less weathered

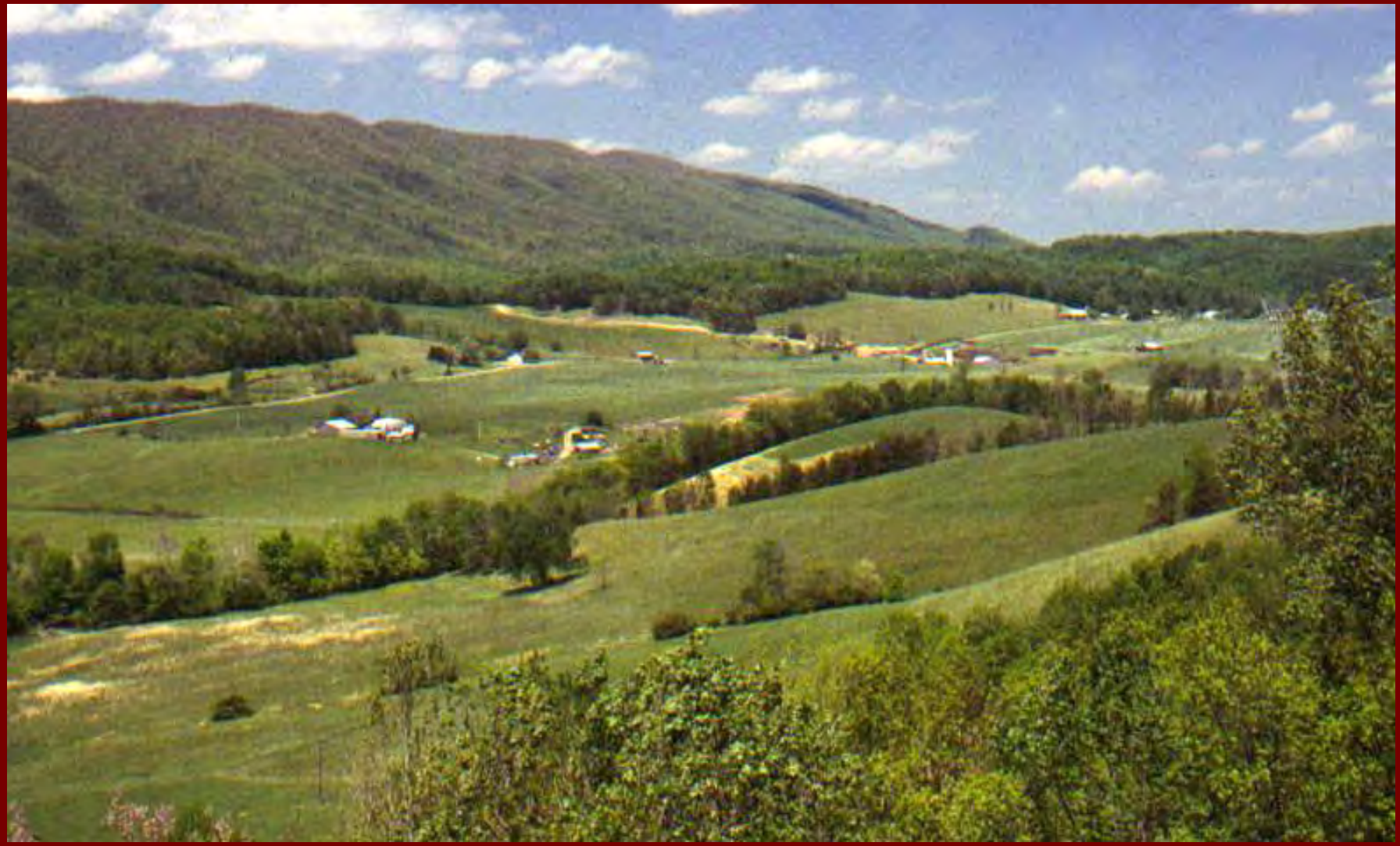
- Highest elevations
- High organic matter
- Less weathering
- Less clay

Forages and Woodlands

Ridge & Valley Physiographic Province



- Folded parent materials
- Shales
  Sandstone
  Carbonates
- Complex soil systems



- Limestone Valleys (cleared)
- Shale, Sandstone Ridges (wooded)

Productive Soils from Carbonate Rocks

Acid Shale Derived Soils

Groseclose Soil

- Well aggregated
- Well drained

- Carbonate derived soils with clayey Bt horizons
- Solum thickness varies

Fruit Crops

Course Fragments in Shallow Soils

Flat Bedded Geology

- In Applachian Plateau
- Cyclic beds of:
  - Carbonates
  - Shales
  - Sandstones
  - Clays
  - Coal

Environmentally Sensitive Areas

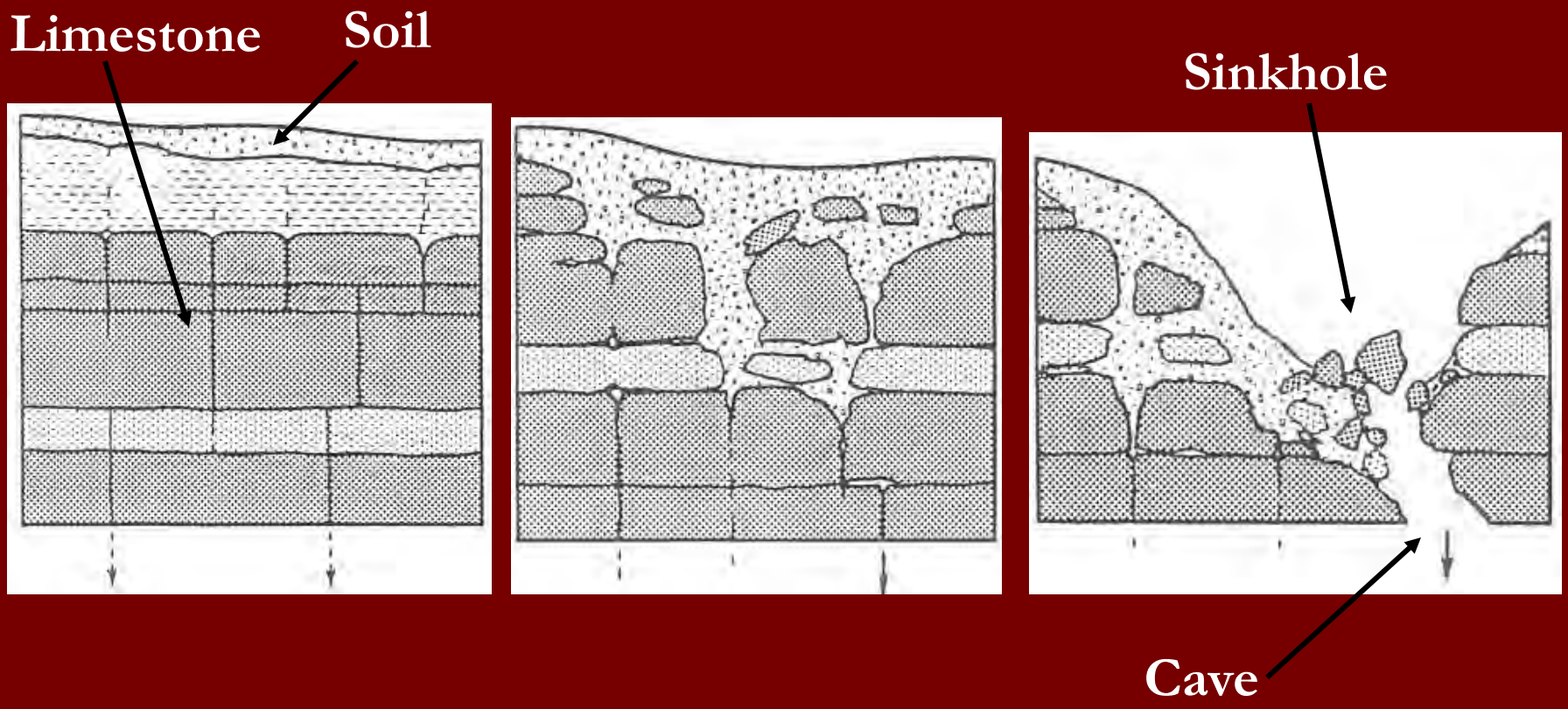
Permeable Sands

Restrictive Subsurface Layers

- **Fragipans, etc.**

Karst Topography

Channeling in Limestone



Springs

- **Common in carbonate-derived soil landscapes**

Shallow to Bedrock

- **Faulted or tilted bedrock**

Thin Soil Over Fractured Rock

Shallow Soil Over Bedrock

Artificially Drained Fields

- **Water tables near the surface**

Irrigated Sites

- **The traveling “gun”**

Irrigated Sites

- **Center pivot irrigation**

Steeply Sloping Areas

Areas that Overflow

Natural Wetlands

- Intensively cropped areas near large water bodies require buffer strips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