The Archaeological Record

- a (continuous) scatter of artifacts *in their matrices.*

- making observations on the record usually requires destroying part of it.

- transcription is impossible.

- what should you record??

Geoarchaeology

- "archaeology pursued with the help of geological models and methods"

- geological methods offer clues about which attributes of the record are likely to be informative about …

    - formation processes
        - depositional processes
        - post-depositional alteration

    - landscape and environmental reconstruction

Two kinds of matrix in which artifacts occur

Soil

- the result of *in-situ* pedogenic processes at work on stable parent material over a long period of time (centuries, millenia)

Sediment

- particles accumulated, precipitated, or deposited by natural and cultural processes.

Four Kinds of Sediment

- clastic: fragments of rock (***clasts***) deposited by water, gravity, wind, ice, people.

- chemical: precipitation of ions and oxides dissolved in water (e.g. salts left by evaporation)

Clasts created by physical and chemical weathering

- organic: decomposition or accumulation of organic matter (dead stuff).

- pyroclastic sediments: volcanics.

Clastic Sediments: Basic Concepts

Clastic Sediments occur in deposits.

-a ***deposit*** is a sedimentary unit formed under constant physical conditions with constant delivery of the same material during deposition.

How do you recognize a deposit?

- look for zones with homogeneous, visible **lithology** (clast size, morphology, composition, and arrangement).

- these are "**lithostratigraphic units**" (layers, zones)

Homogeneous lithology allows you to *infer*

- constant source (where the clasts came from).

- constant transport agent (how the clasts got there).

How many lithostratigraphic units?...

Clastic Sediments

Transport agents for clastic sediments

- water (“alluvium”)
- gravity (“colluvium”)
- wind (“loess”)
- ice (“till”)
- people (“fill”)

Transport agents cause variation in deposit lithology

- clast size
- size sorting
- roundness
- fabric : clast vs. matrix support
- bedding (massive vs. laminations)

Clast or Grain Size

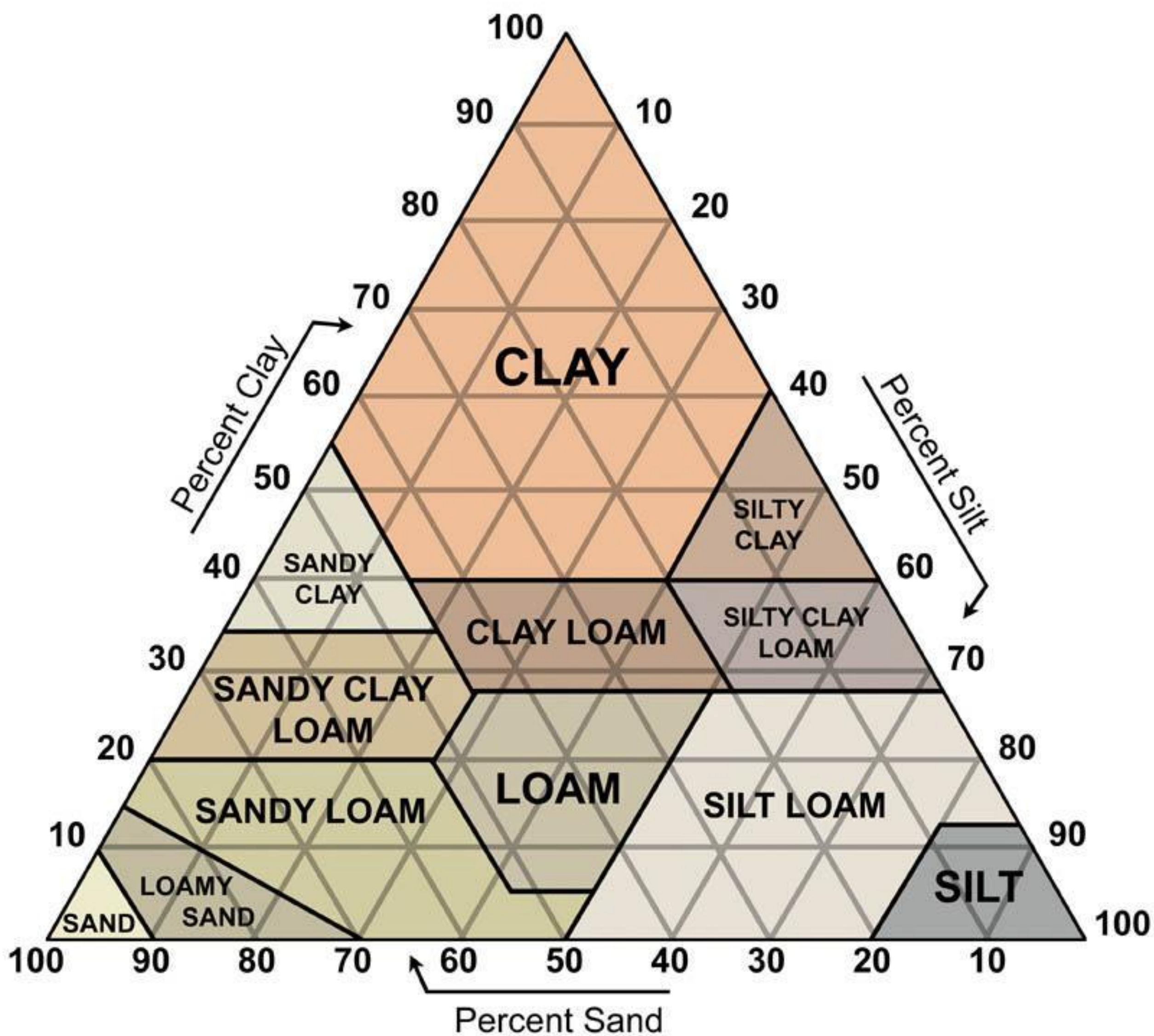
phi=-log$_2$(diameter in *mm*)

Inclusions

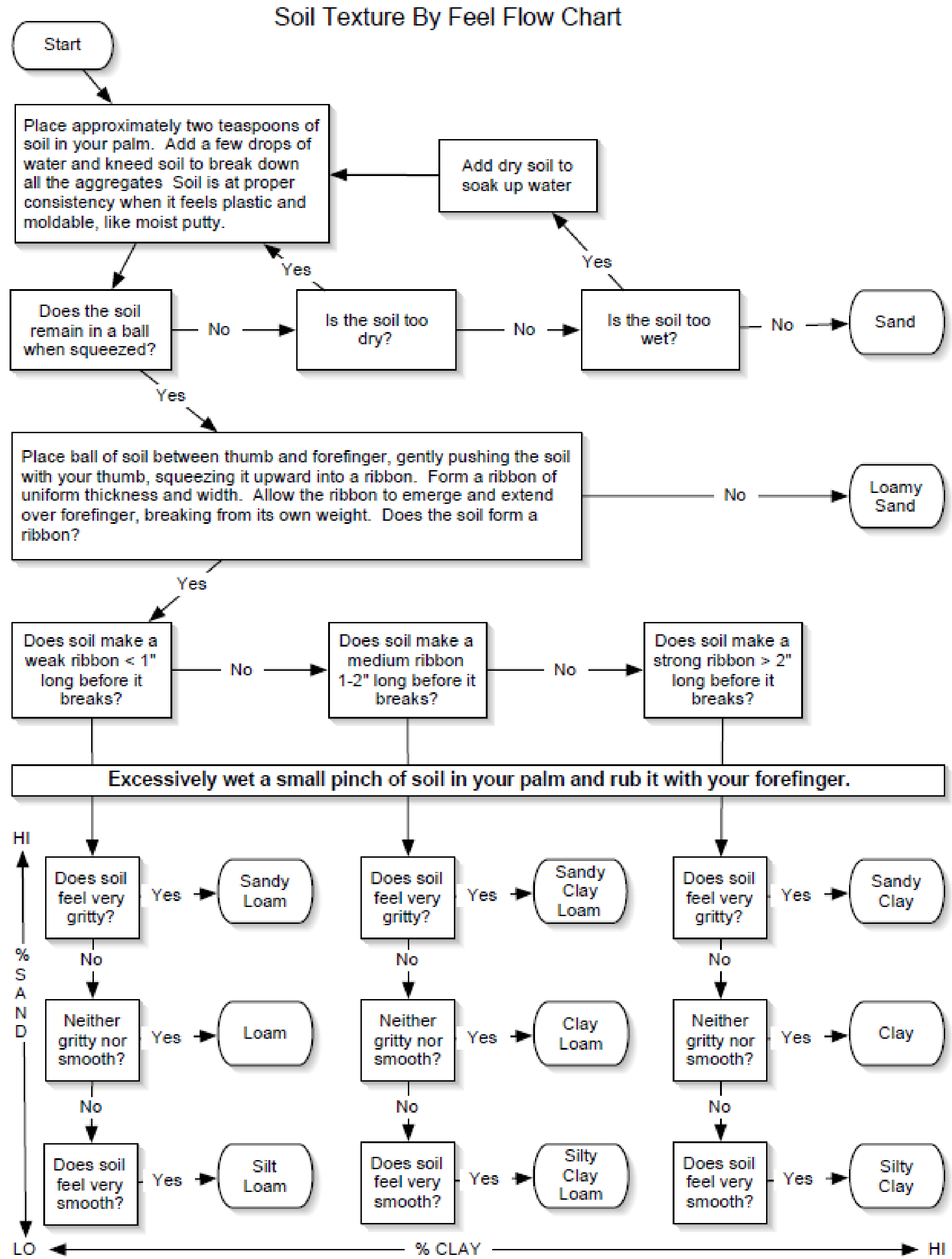
Fines

Class Name		Size Range (mm)	Size Range (m m)	Phi Units
Boulders	Very Large	4096-2048		-11
	Large	2048-1024		-10
	Medium	1024-512		-9
	Small	512-256		-8
Cobbles	Large	256-128		-7
	Small	128-64		-6
Gravel **Pebbles**	Very Coarse	64-32		-5
	Coarse	32-16		-4
	Medium	16-8		-3
	Fine	8-4		-2
Granules	Very Fine	4-2		-1
Sand	Very Coarse	2-1	2000-1000	0
	Coarse	1-0.5	1000-500	1
	Medium	0.5-0.25	500-250	2
	Fine		250-125	3
	Very Fine		125-62	4
Silt	Coarse		62-31	5
	Medium		31-16	6
	Fine		16-8	7
	Very Fine		8-4	8
Clay	Coarse		4-2	9
	Medium		2-1	10
	Fine		1-0.5	11
	Very Fine		0.5-0.24	12

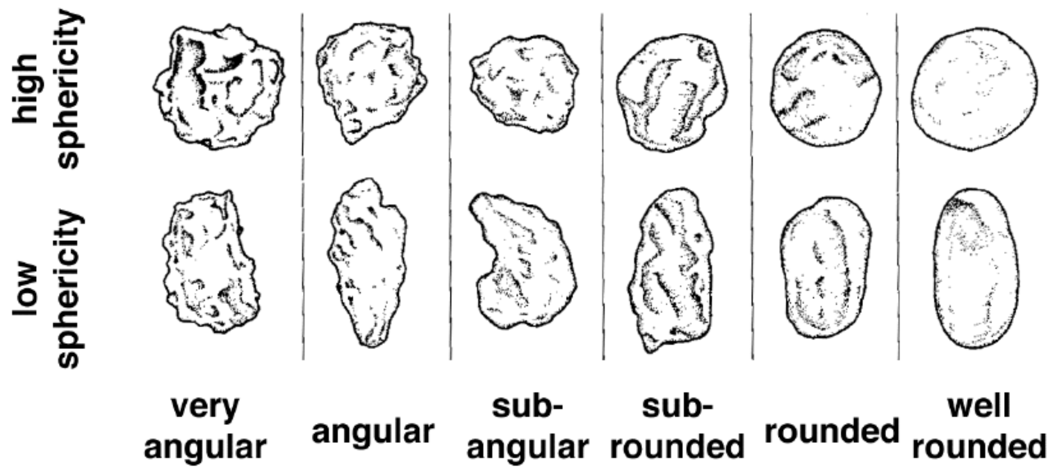
USDA Textural Classes for Mixtures of Fines



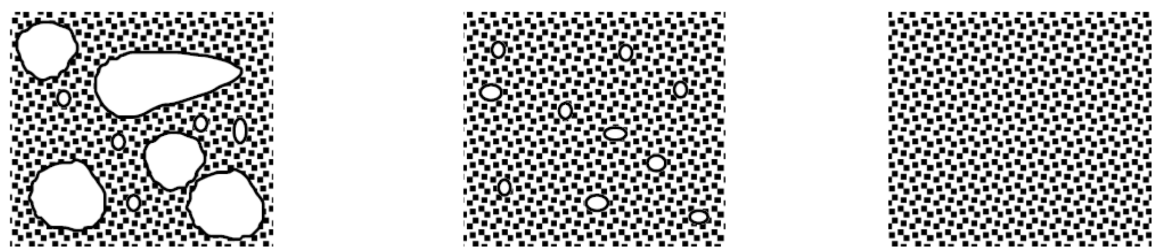
Field Key for USDA Textural Classes



Roundness



Sorting



POORLY SORTED

Melting ice (till)
Debris flows
Mudflows

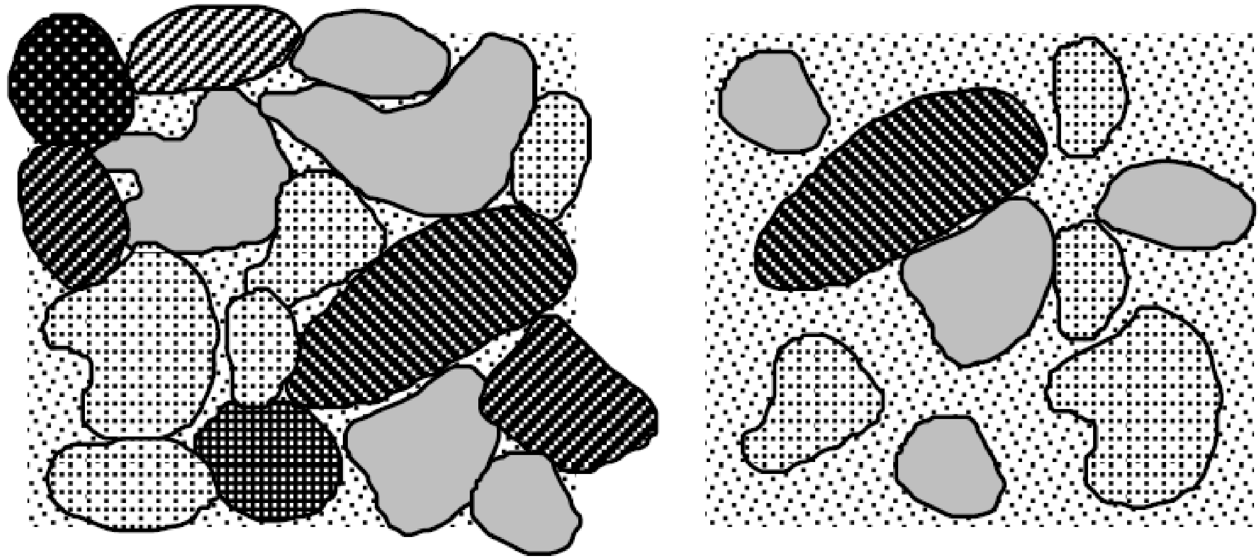
MOD. SORTED

Rivers
Tidal currents
Surf

WELL SORTED

Wind
Some beaches

Fabric



Clast Support Matrix Support

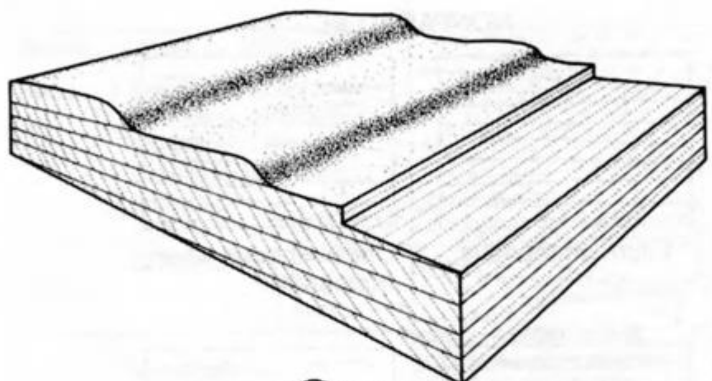
- Matrix support is common in poorly sorted sediments

Alluvial and Eaolian Sediments: Bedding

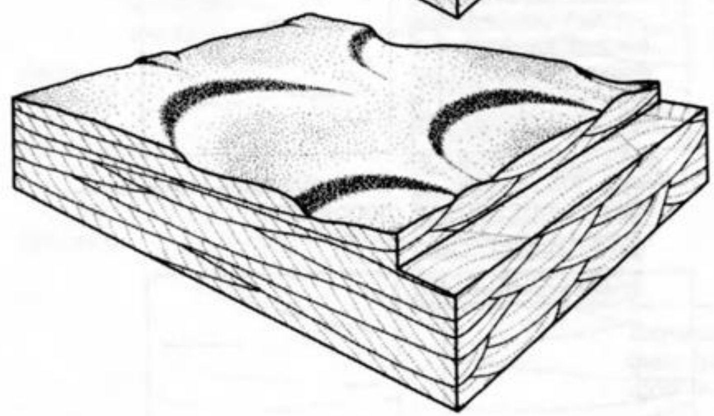
- small-scale sedimentary structures within larger deposits (layers)

- usually associated with fluid (water or wind) deposition

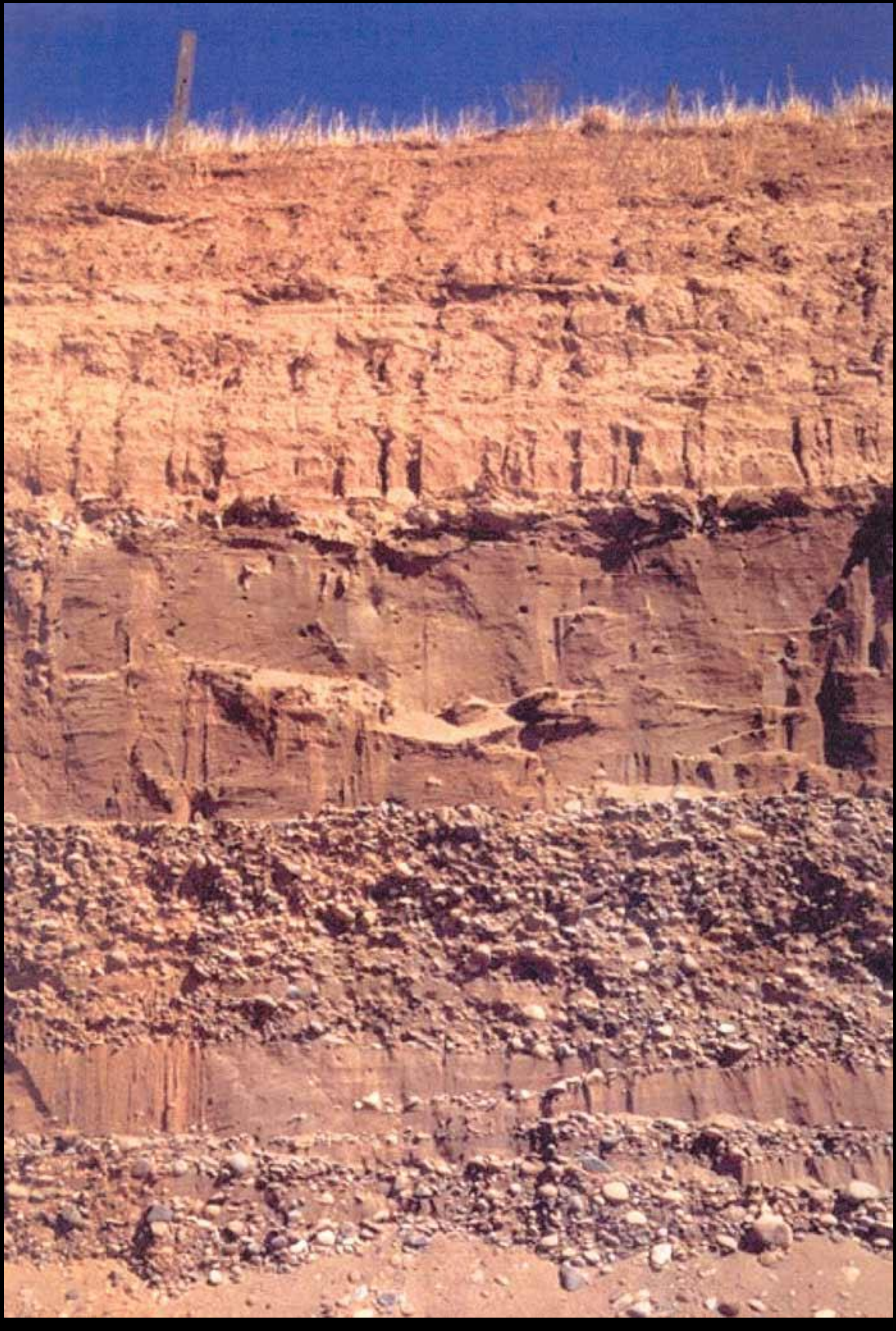
Lamina



Cross-bedding



Clastic: Alluvium



Clastic:Till

Clastic:Loess (wind)

Clastic:Colluvium (gavity, “lubricated” by water)

Clastic: Pyroclastic Flow


Clastic: Fill (people)

Lithology is not the only dimension of variation

- We can look to other attributes of clasts so define homogeneous units within and among "**lithostratigraphic units**" .

  - chemistry: "chemostratigraphic units"

  - biological taxa: "biostratigraphic units"
    - -fauna
    - -pollen
    - -phytoliths

  - artifacts: "enthostratigraphic units"

- Lots to be learned by comparing litho-, bio-, and ethnostratigraphic units.

  - one motivation for excavating in "arbitrary" vertical units with a single lithological unit.

Stratigraphy: (sensu stricto) the study of relationships among different kinds of stratigraphic units.

Stratification: phenomenon of the layers in the ground.

Soil

*Soil is the result of in-situ **pedogenic processes** at work on stable parent material over a prolonged period of time.*

Pedogenic processes?

- Addition

  rain adds water, dust adds minerals, dead plants and animals and poop from live animals all add organic mater.

- Loss

  water evaporates, plants take up nutrients or elements, elements are leached into ground water

- Translocation

  gravity pulls water and dissolved materials, including clay, down, evaporation can pull dissolved materials up. OM can move in many directions due to roots and critters (***bioturbation***)

- Transformation

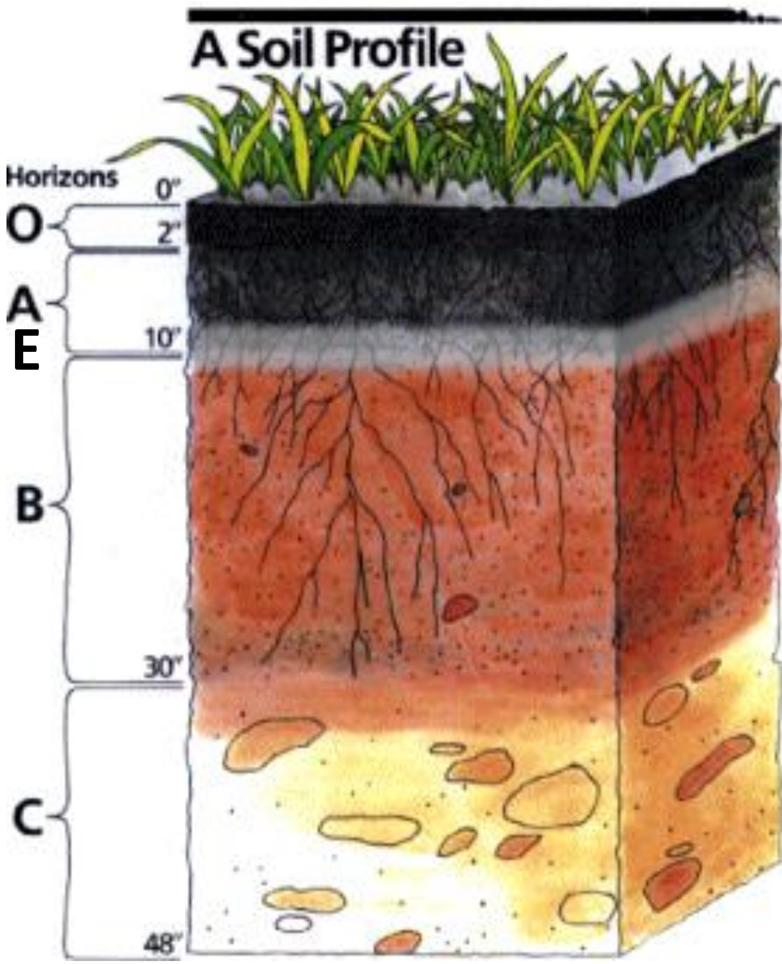
  decomposition, physical and chemical weathering, oxidation/reduction (reddening/graying of iron compounds), formation of clay minerals

Soil Profile

- If the parent material is stable and exposed at the surface, a ***soil profile*** will develop over time. Stable means no erosion and no deposition.

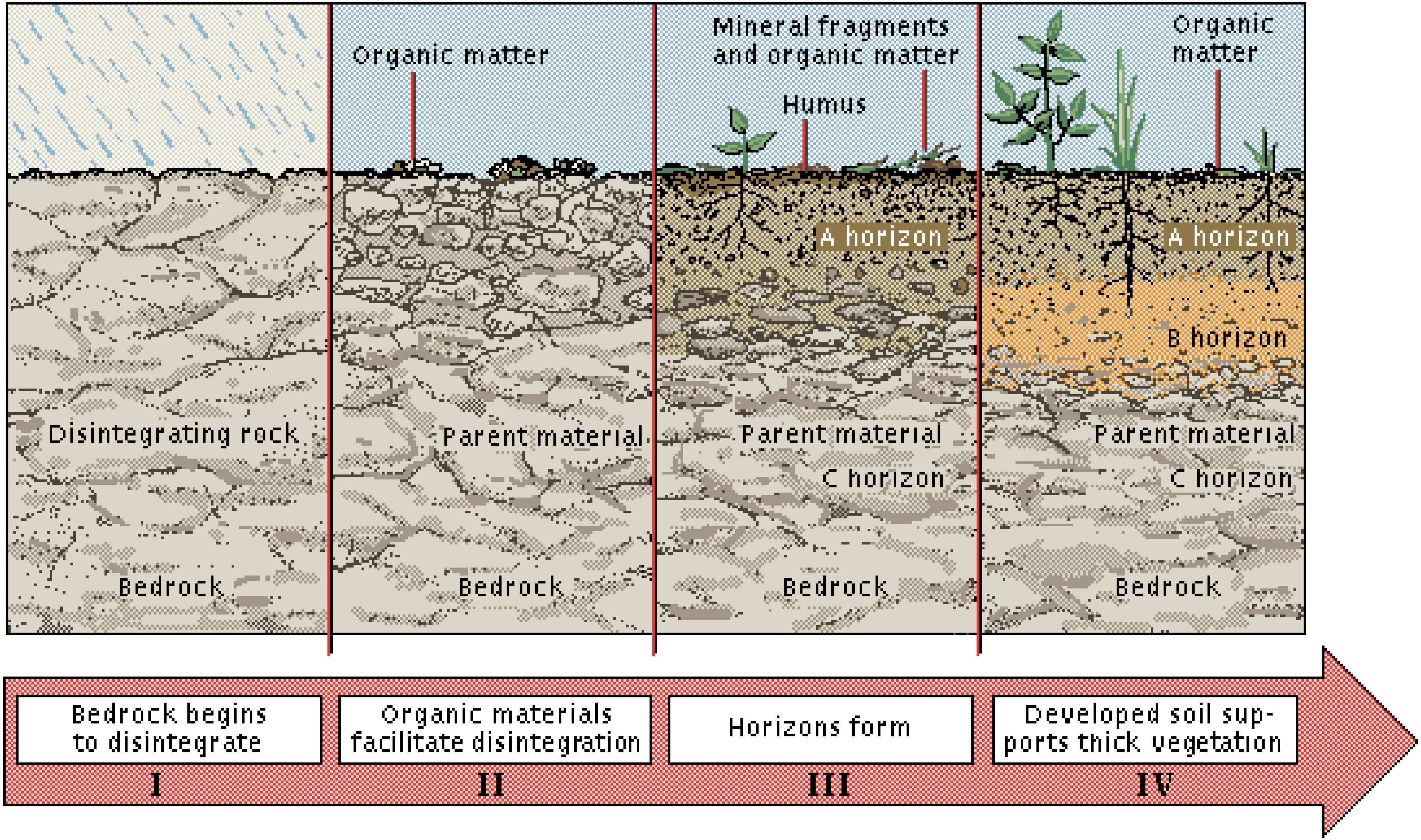
- Comprise of ***soil horizons***

O: organic matter (dead stuff).
A: eluvial horizon, mineral matter mixed with humified (decomposed) organics. **Ap**– plowzone.
[**E:** eluvial horizon, less organics than A and less clay than B.]
B: illuvial horizon, concentrated clay –"argillic", (iron and aluminum oxides).
[**K:** illuvial horizon, calcium oxides, mainly lime (CaO), calcium carbonate $CaCO_3$: *drier climates only]*
[**G:** Gleyed horizons (reduced, anoxic): *water logged soils only*]
C: weathered parent material.
R: regolith – unaltered parent material.



Soil Formation

- Requires time and a stable surface!



Soil Formation

Five Soil Forming Factors (Hans Jenny) control what the outcome of these ***pedogenic processes*** looks like.

- Climate: temperature, rainfall
    - higher temperature, ***and*** rainfall interact to speed up soil formation

- Parent material: rock *vs.* sediment.

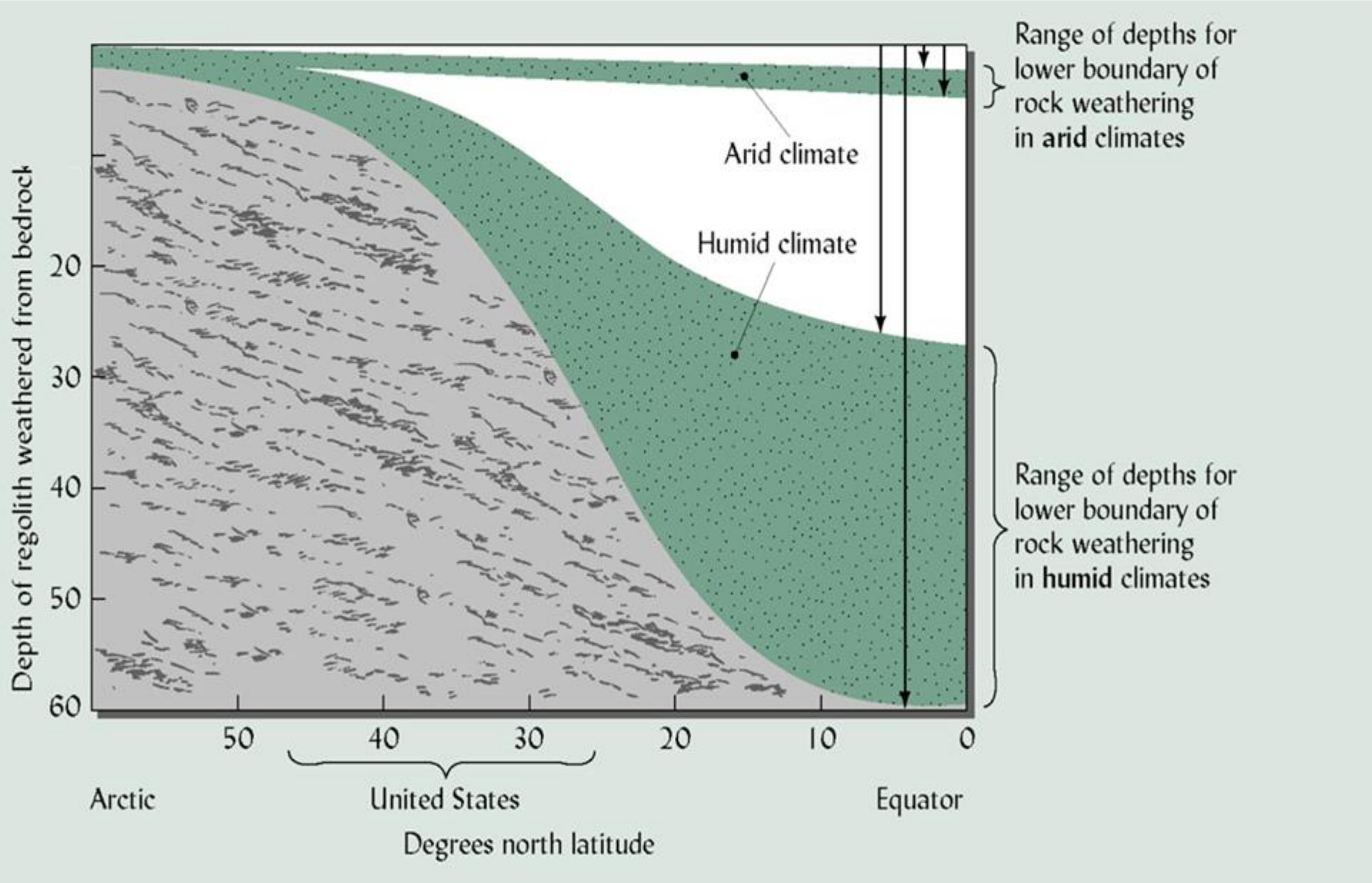
- Topography: slope, drainage patterns.

- Organisms: effects of plants and animals including humans.
    - move stuff around within a soil horizon
    - add organic material to it

- Time: length of time over which soil formation has taken place.
    - ***no time, no soil!!***

Climate

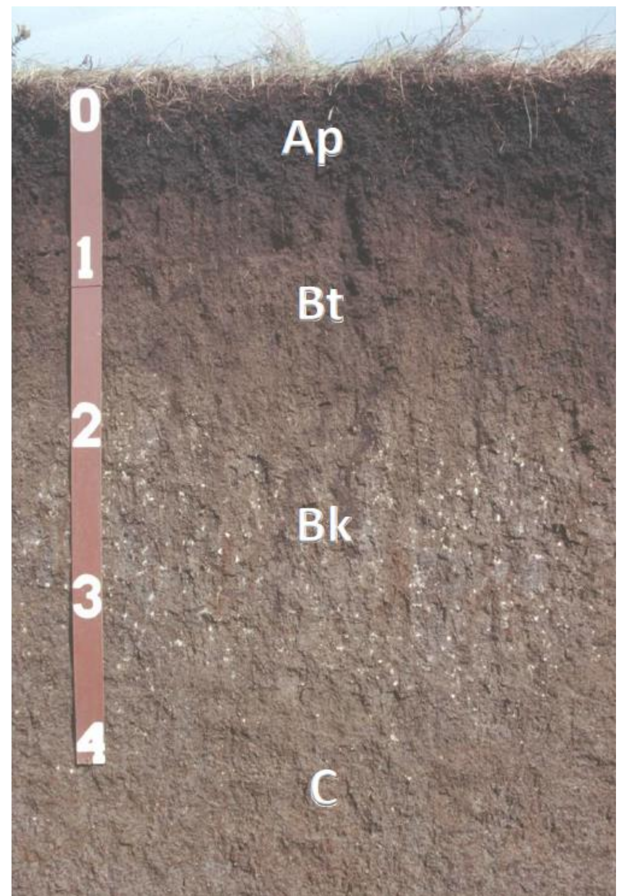
- higher temperature ***and*** rainfall interact to speed up soil formation



Climate

Rainfall

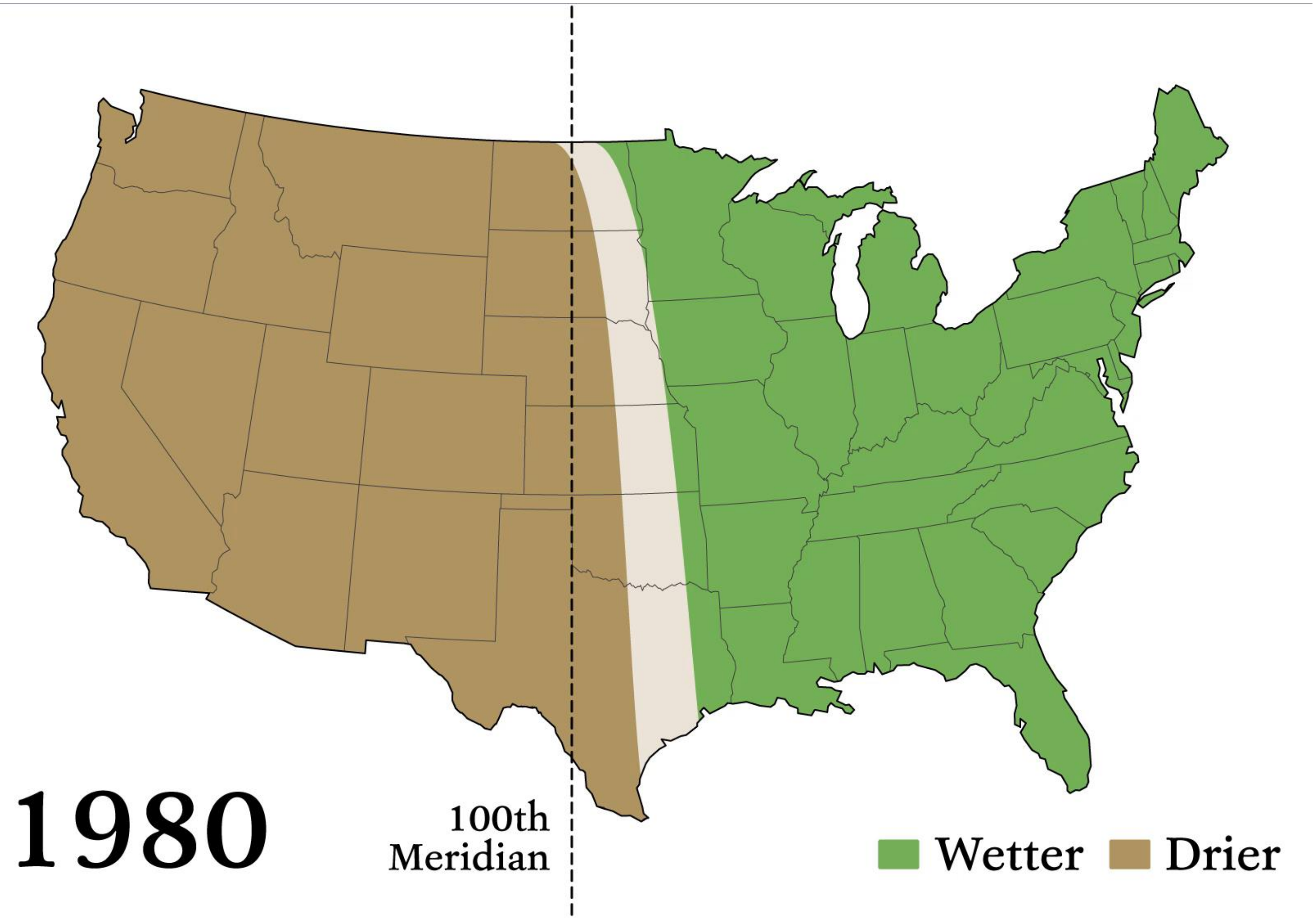
- With less rainfall, you get a Bk (or K) horizon in addition to or instead of a Bt horizon
- Bt horizon: dominated by clays, Fe and Al Oxides (t=translocated: lots of illuviated clay)
- Bk horizon: carbonate accumulation – usually nodules of calcium carbonate



Climate

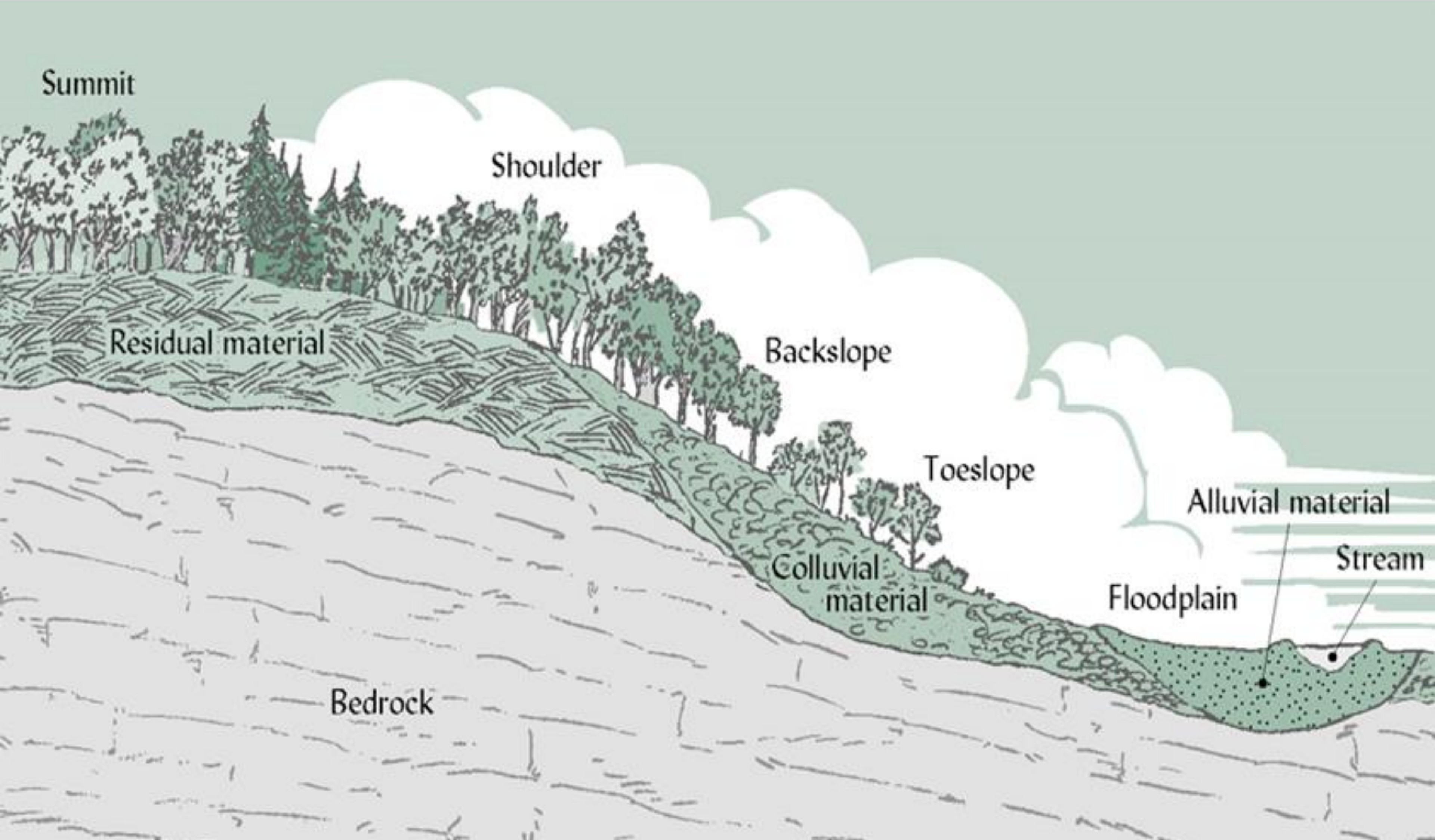
Rainfall

- Bk horizon occur in the U.S. west, areas with < 30 inches of rainfall/year



Parent Material

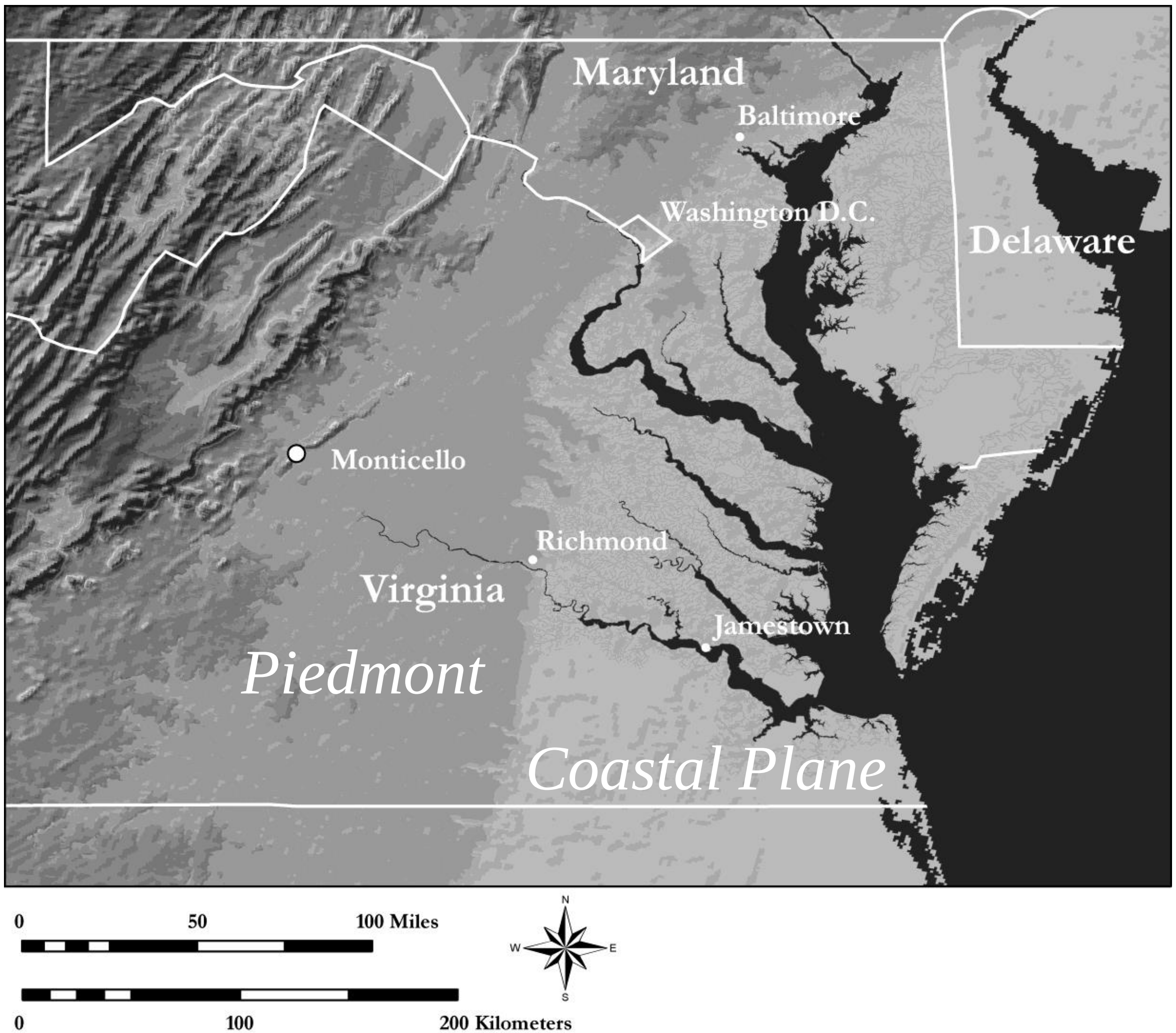
- soils formed on ***residual*** vs. ***transported parent material***



Classification of soils by kind of parent material

1. **Residual** parent material: formed in place on rock.

2. **Transported** parent material: formed on sediment.



Topography

- Flat valley floor and ridge tops: soil profile deepens at a greater rate than it is removed

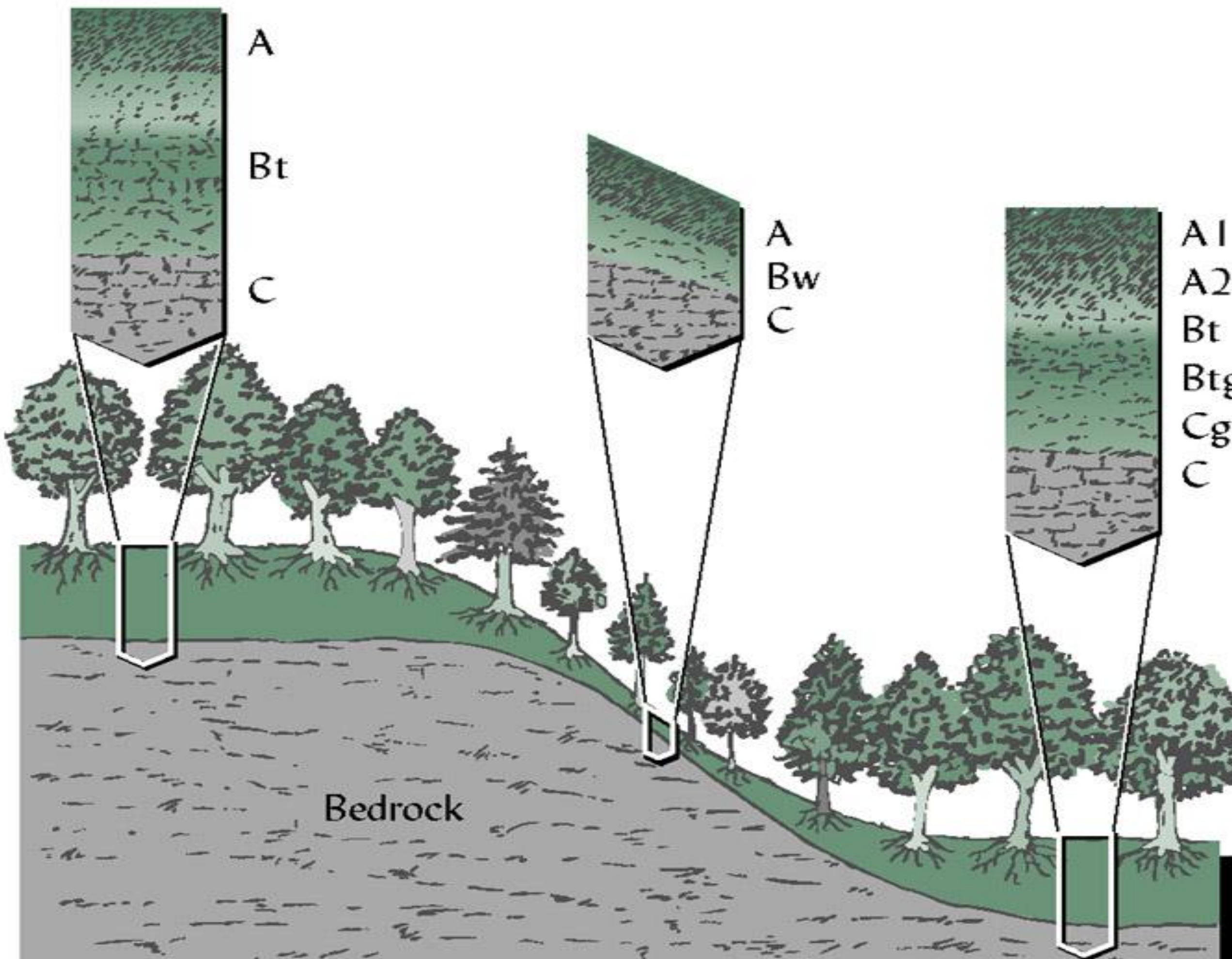
- Slopes: soil removal happens faster than profile deepening.

Pedological geekery:

Bt: Translocated. Lots of illuviated clay.

Bw: Weak. Color or structure difference, but not much illuviated clay.

Btg : Gleyed. Water logging leads to reduction (vs. oxidation).

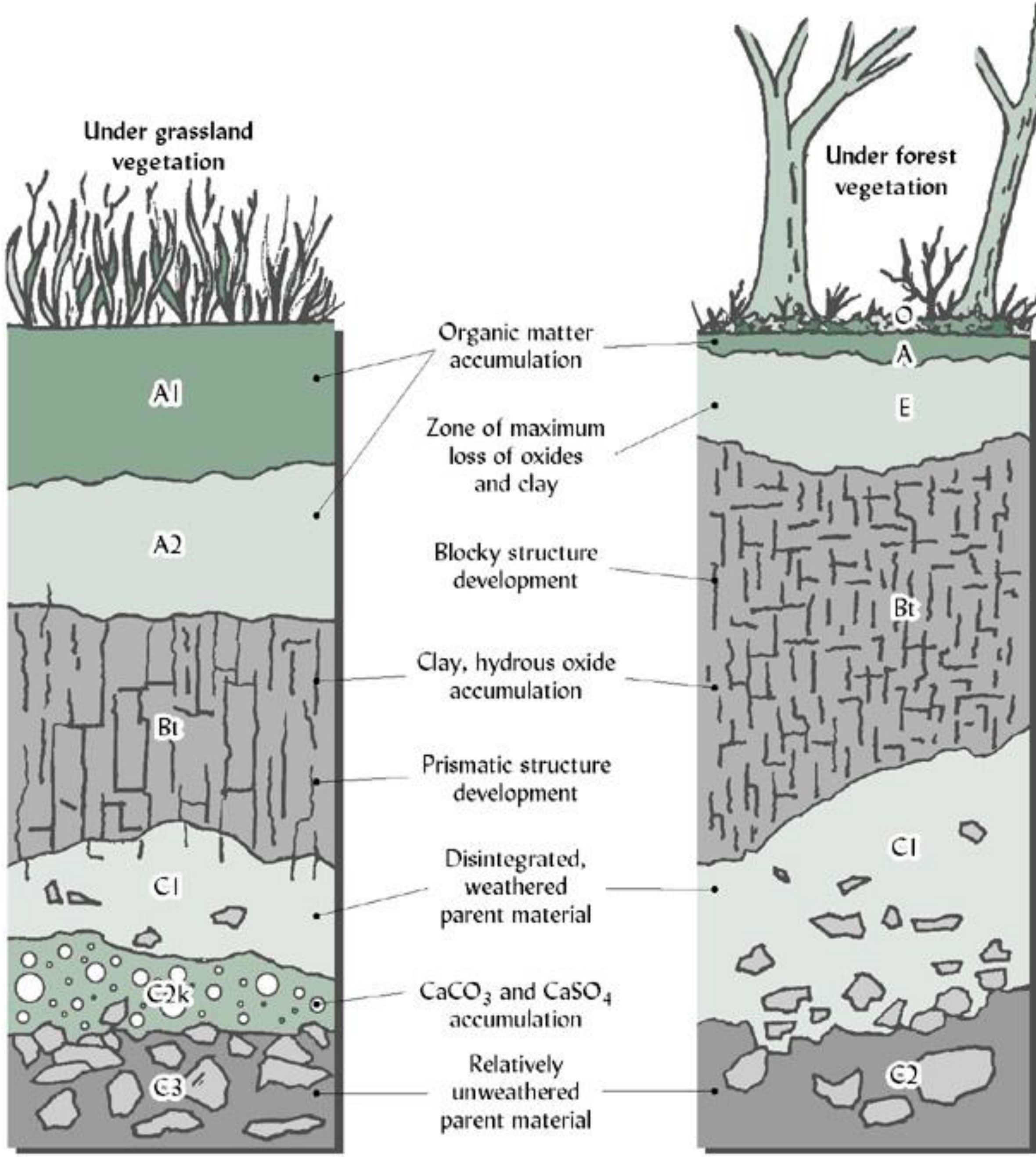


Organisms

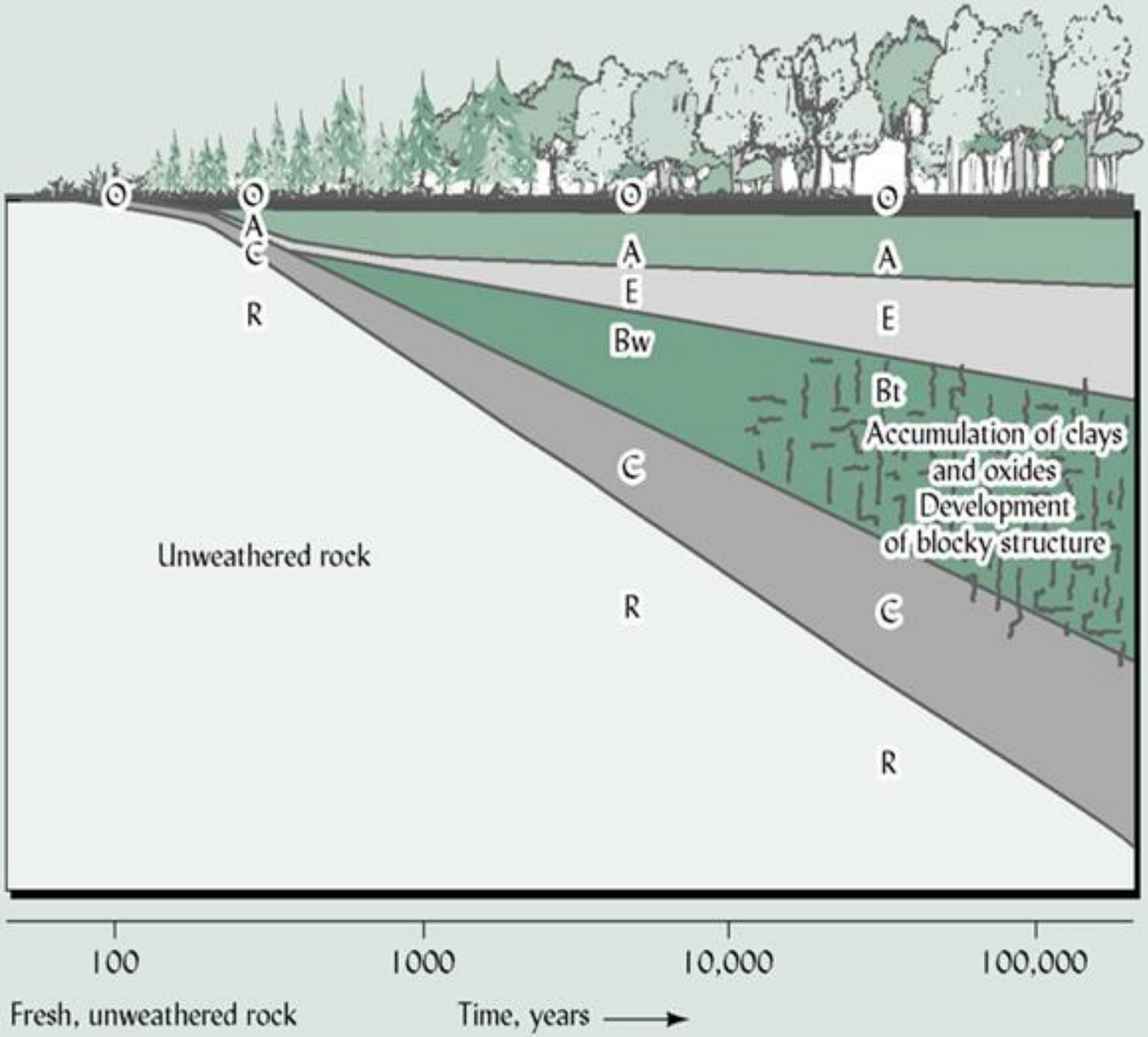
- *e.g.* plants

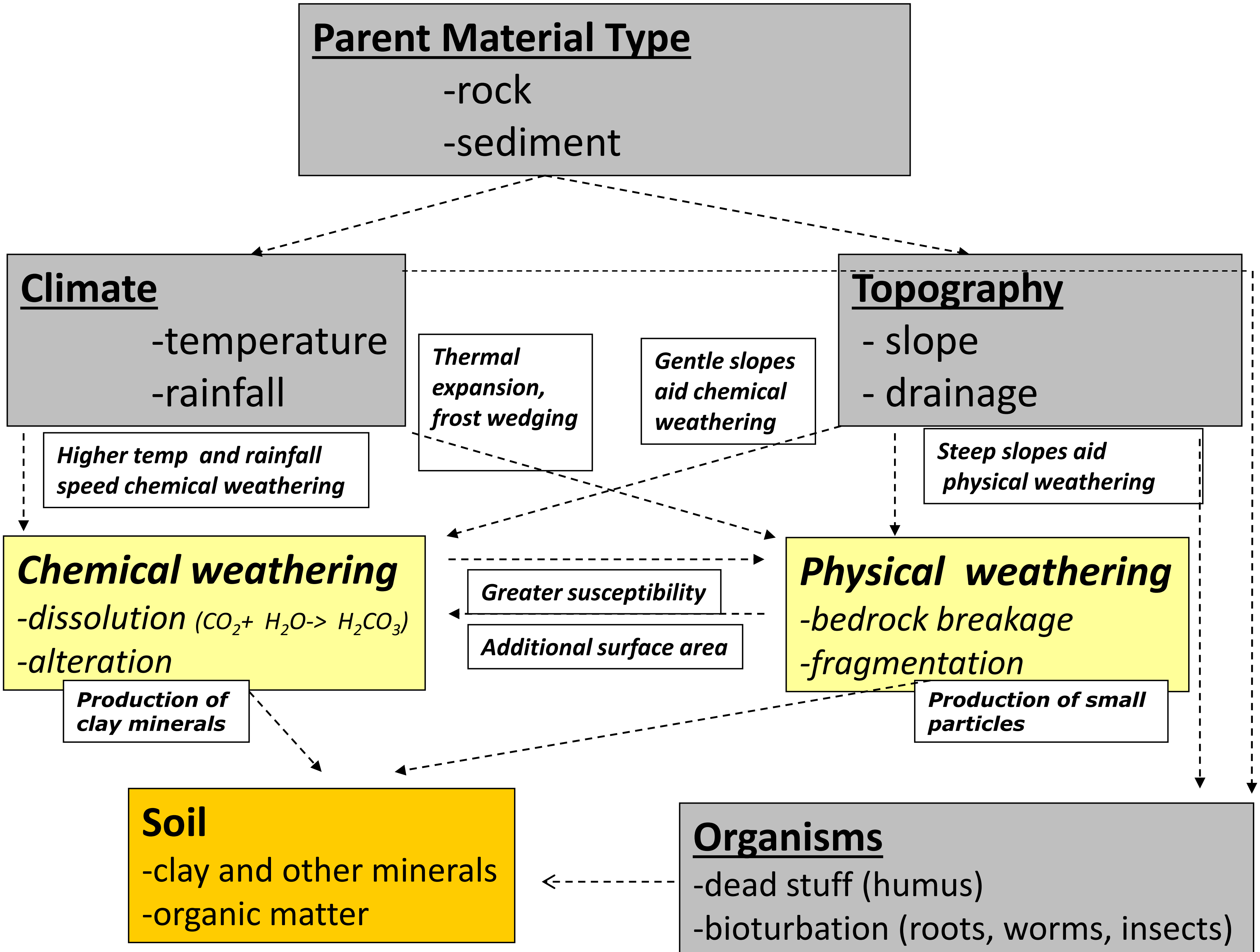
- Grass lands have thin O horizon, but thick A horizons because of dense grass root systems.

- Forests have thick O horizons, but thin A horizons.



Time


O
O
A
C
R
O
A
E
Bw
C
R
O
A
E
Bt
Accumulation of clays and oxides
Development of blocky structure
C
R
Unweathered rock
100
1000
10,000
100,000
Fresh, unweathered rock
Time, years


Parent Material Type
-rock
-sediment
Climate
-temperature
-rainfall
Thermal expansion, frost wedging
Gentle slopes aid chemical weathering
Topography
- slope
- drainage
Higher temp and rainfall speed chemical weathering
Steep slopes aid physical weathering
Chemical weathering
-dissolution (CO_2+ H_2O-> H_2CO_3)
-alteration
Greater susceptibility
Additional surface area
Physical weathering
-bedrock breakage
-fragmentation
Production of clay minerals
Production of small particles
Soil
-clay and other minerals
-organic matter
Organisms
-dead stuff (humus)
-bioturbation (roots, worms, insects)

How do you recognize a *soil horizon* with a *soil profile*?

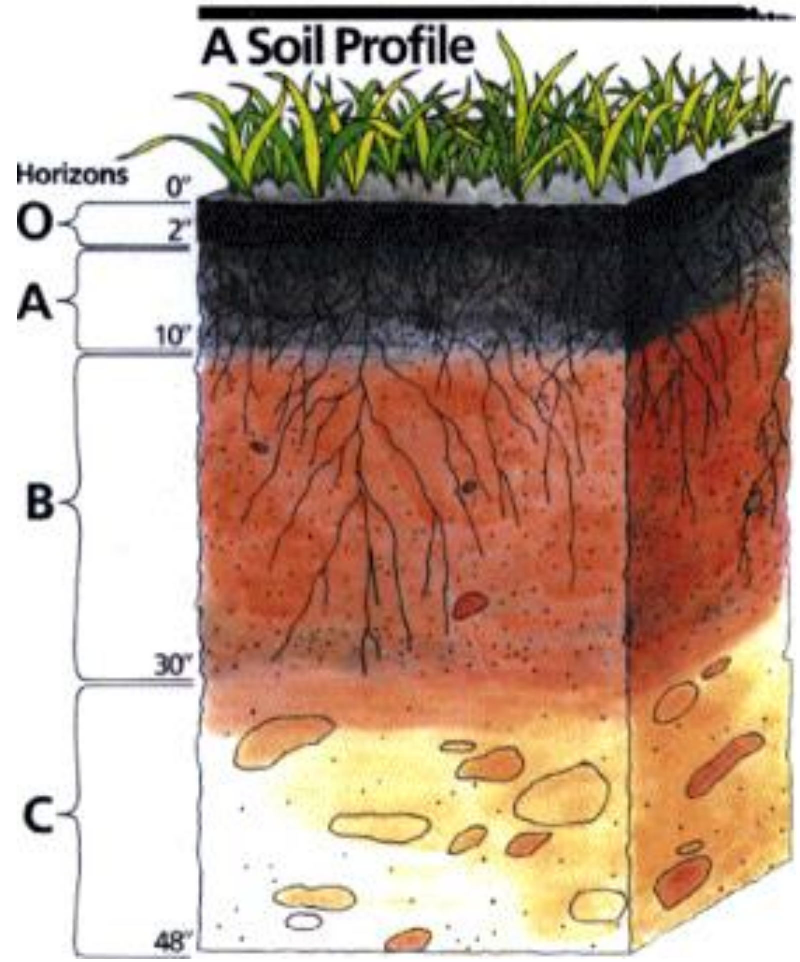
- Look for vertical, clinal variation in physical, chemical, organic properties predicted by the soil formation model.

- Illuviation concentrates clay (and Fe and Al) from the parent material in the B horizon,

- Illuviation and leaching and depletes more mobile elements: e.g. K, P, Ca.

- Novel input from the O horizon, leached into A and to a lesser extent the B horizon.

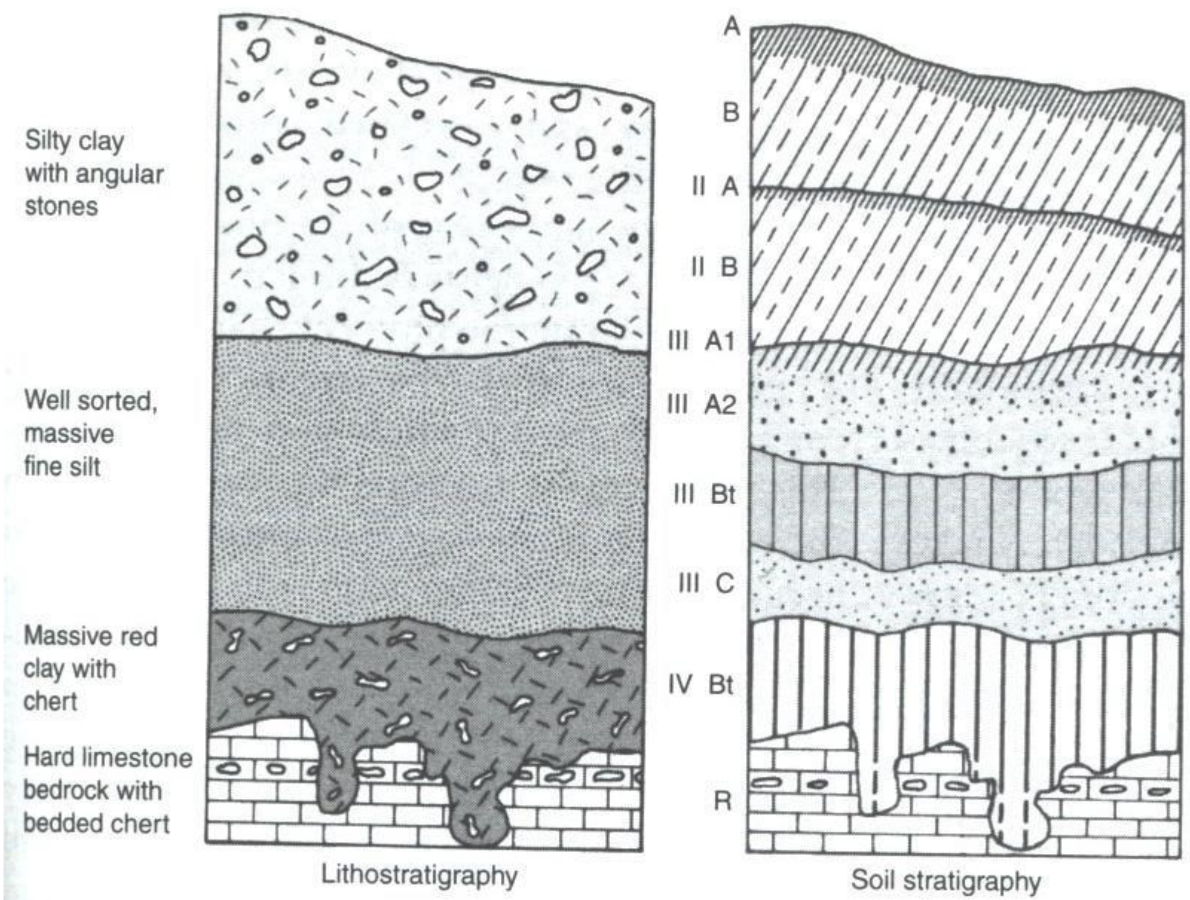
- Successive components of a soil horizon (A, B, C) are "**pedostratigraphic units**" (~layers, zones).



Soil vs. Sediment

Two Kinds of "natural" homogeneous zones.

- lithostratigraphic units
- pedostratigraphic units
- *these can be superimposed on one another*!



Soil vs. Sediment

Is it a pedostratigraphic unit or a lithostratigraphic unit?

- *an inference.*

Implications for excavation methodolology and recording.

- We need a neutral term – ***"context."***

- Context descriptions are informed by sedimentology and pedology.

- Context descriptions should record attribute or variable values.

- Keep inference about their meaning separate: "interpretation"