SOIL FORMING FACTORS

Conceptual Model - Soil is a function of the combined effects of Climate and Organisms, conditioned by Relief, acting on Parent Material through Time.

S = f (C, O, PM, R, T)

Soil forming factors:

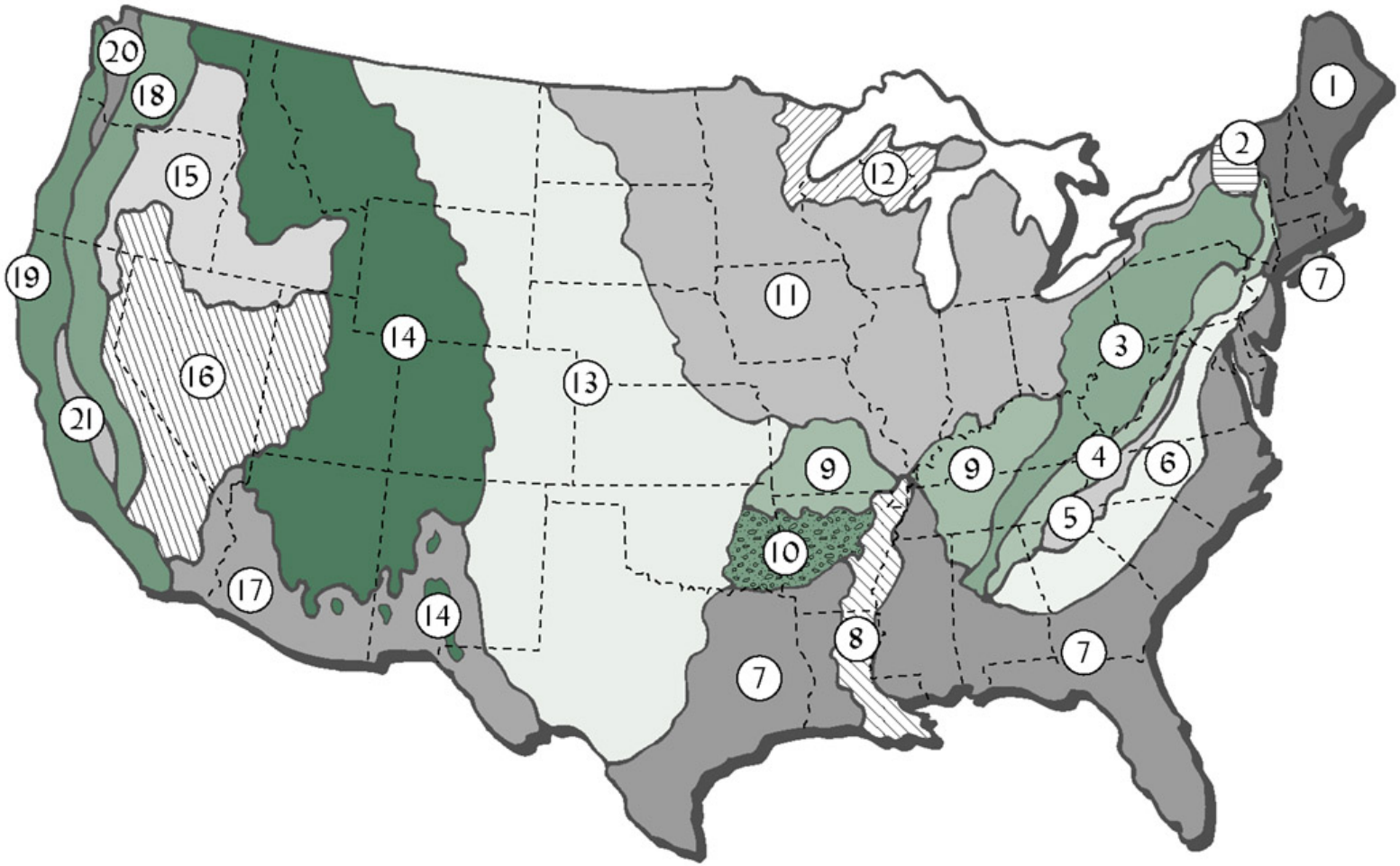
C	=	**climate**
O	=	**organisms**
PM	=	**parent material**
R	=	**relief or topography**
T	=	**time**

PARENT MATERIAL

Includes:

- Organic deposits
- Mineral deposits derived from chemical and/or physical weathering of rocks. (Usually transported)

Figure 2.11



Types of PM

Direct Effects (inherited) vs. Indirect Effects (acquired)

– Rocks – indurated or consolidated material

    Sedimentary

    Igneous

    Metamorphic

– Unconsolidated material

– Secondary Minerals

– Unconsolidated material

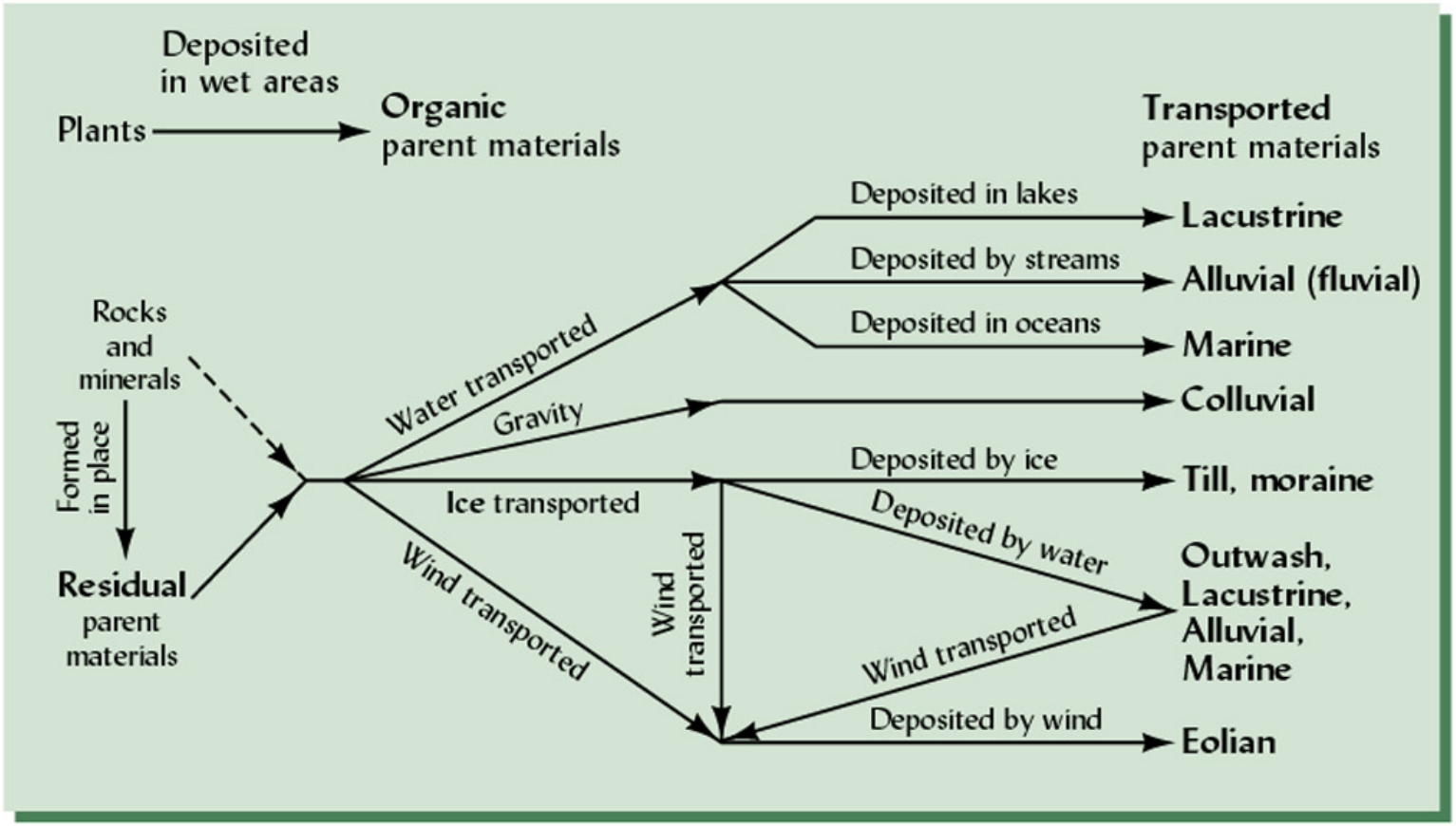


Figure 2.10

CLIMATE

Climatic factors influencing soil formation:

PRECIPITATION
TEMPERATURE

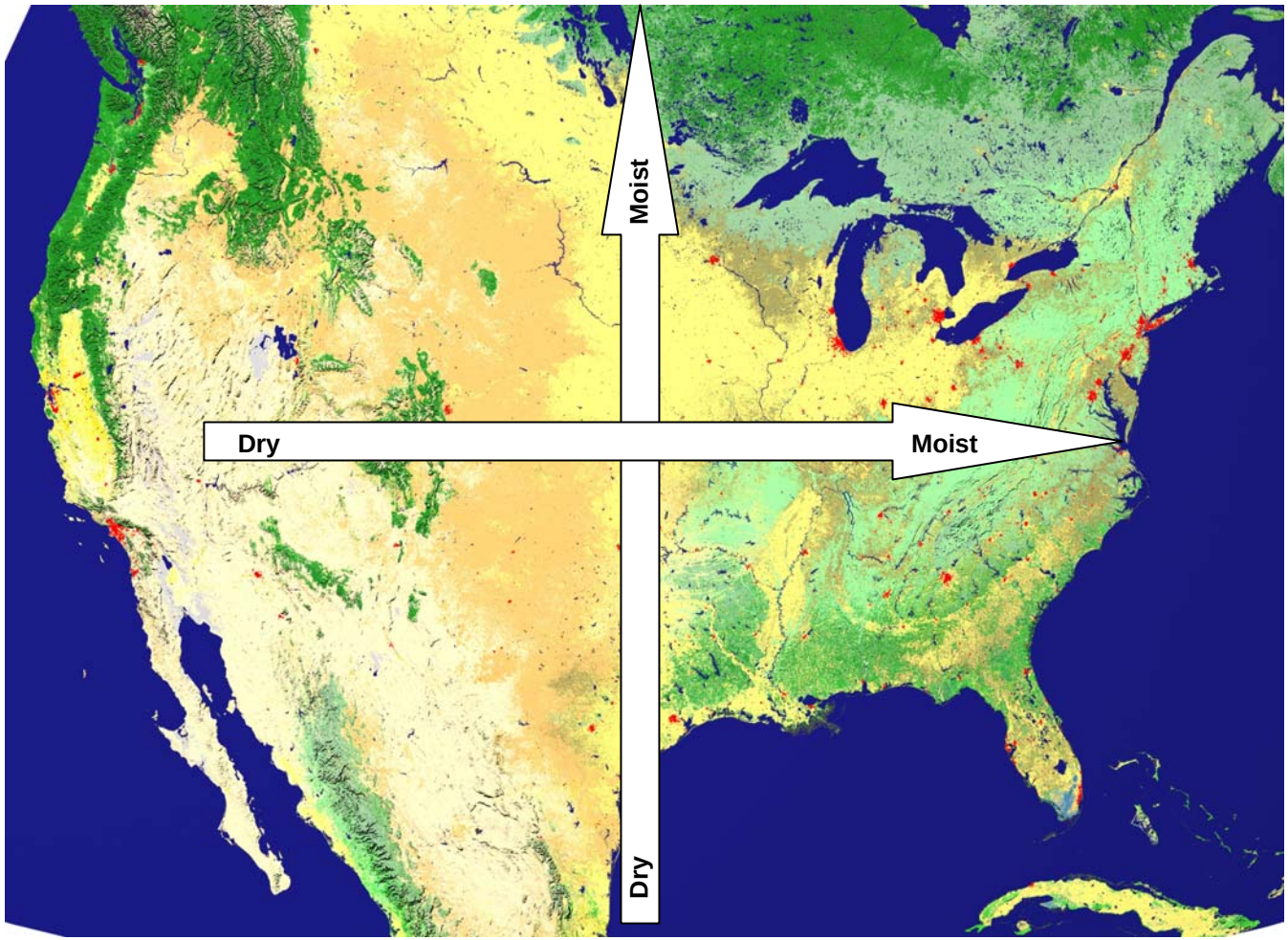
Water is the main agent of weathering

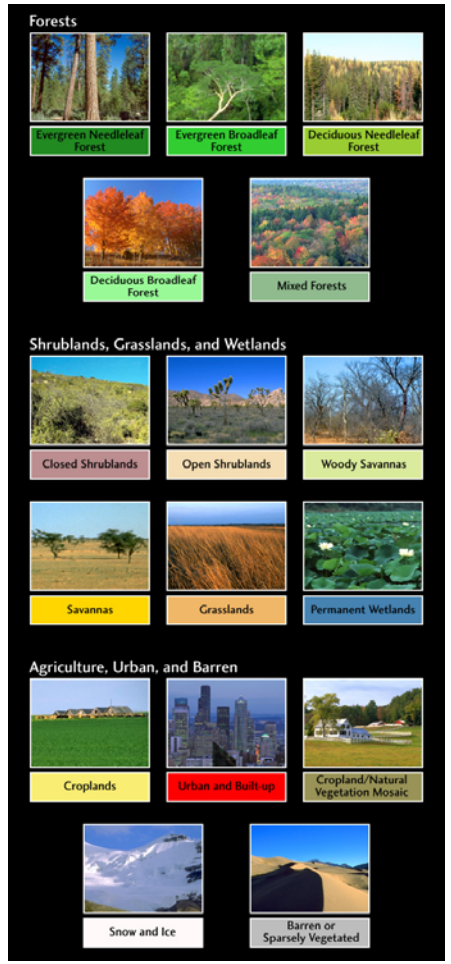
Organic matter accumulation ---> favored under cool (not extreme) temperatures

Clay formation ---> most rapid at high rainfall levels

Vegetation depends on climate ---> affects soil formation

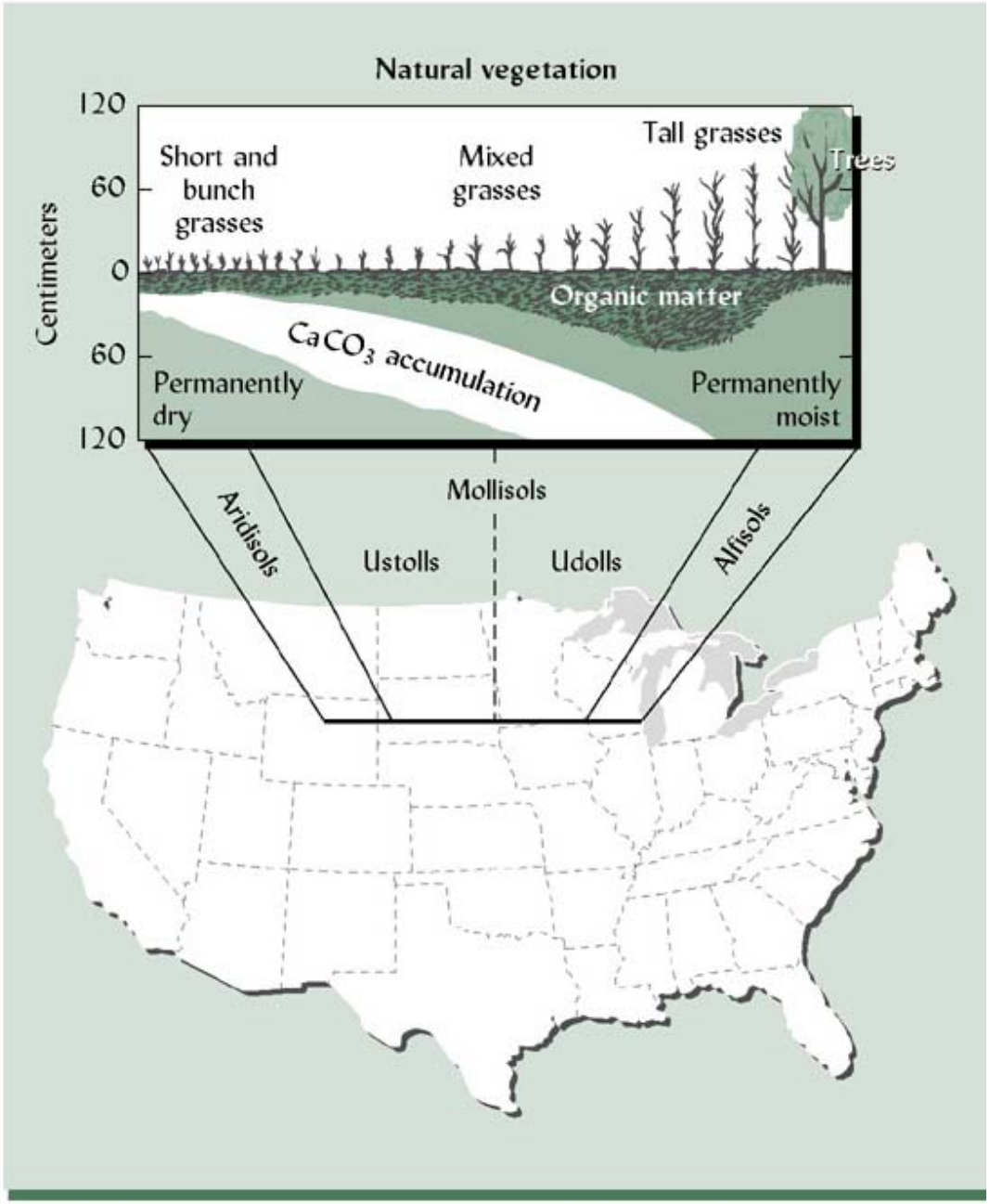
Temperature	Precipitation		
	Low	High	Intense
Low	Slow Soil Development	Moderate Soil Development (kaolinite, oxides)	Soil Destruction, Erosion
High	Little Soil Development (Smectites)	Rapid Soil Development (kalinite, oxides)	Soil Destruction, Erosion

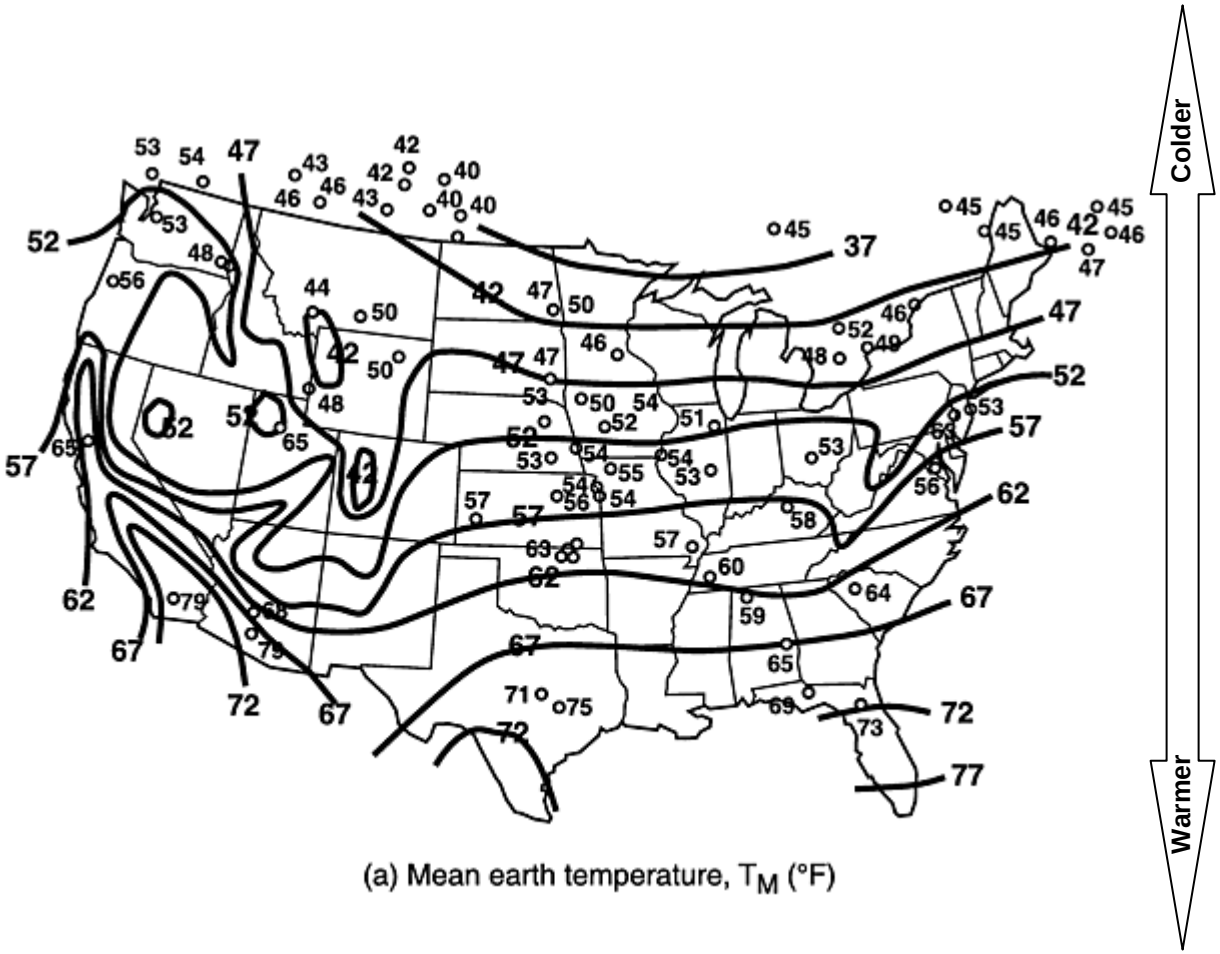




http://earthobservatory.nasa.gov/Newsroom/LCC/

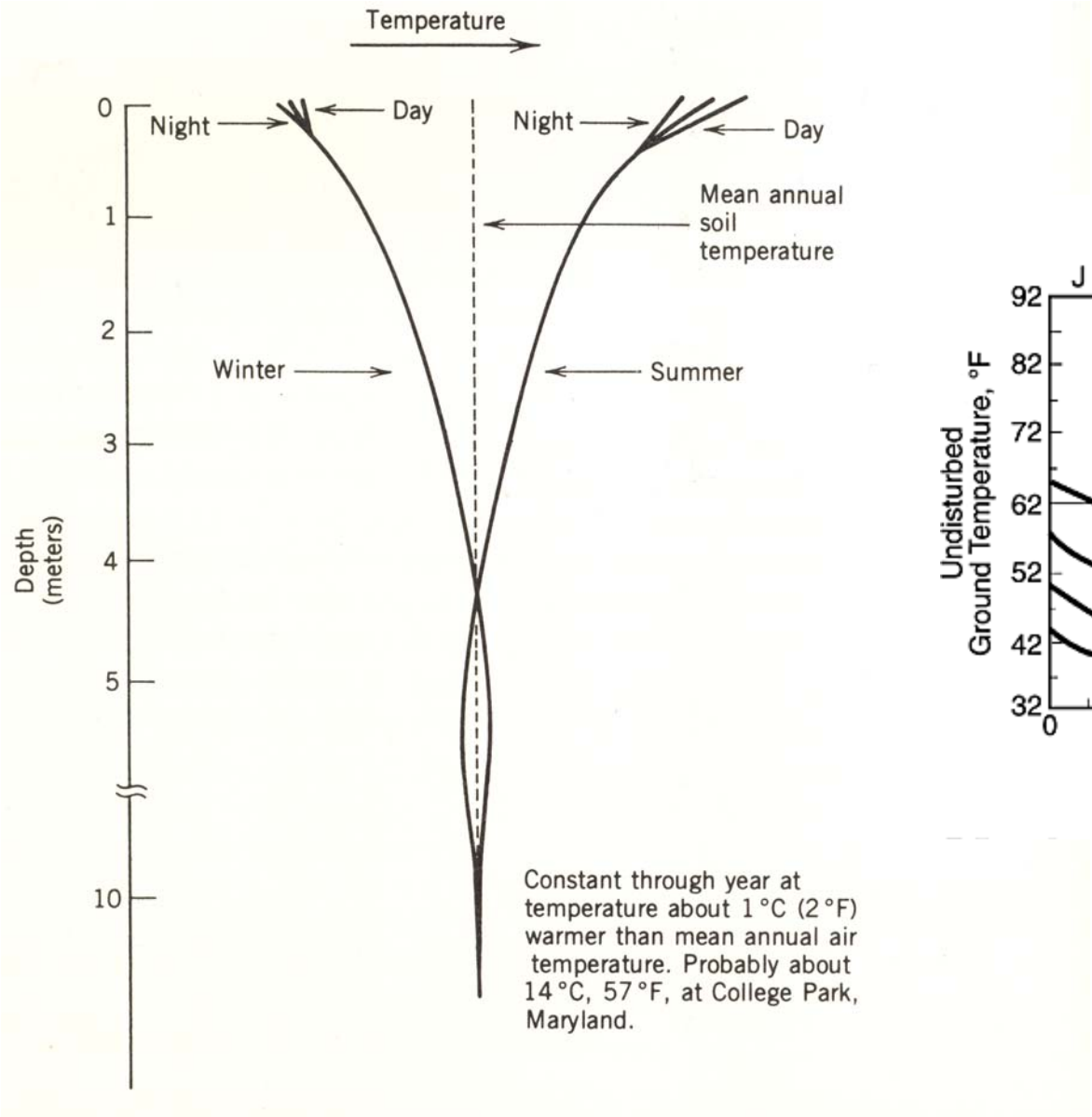
Figure 3.22


Natural vegetation
120
60
0
60
120
Centimeters
Short and bunch grasses
Mixed grasses
Tall grasses
Trees
Organic matter
$CaCO_3$ accumulation
Permanently dry
Permanently moist
Aridisols
Ustolls
Mollisols
Udolls
Alfisols

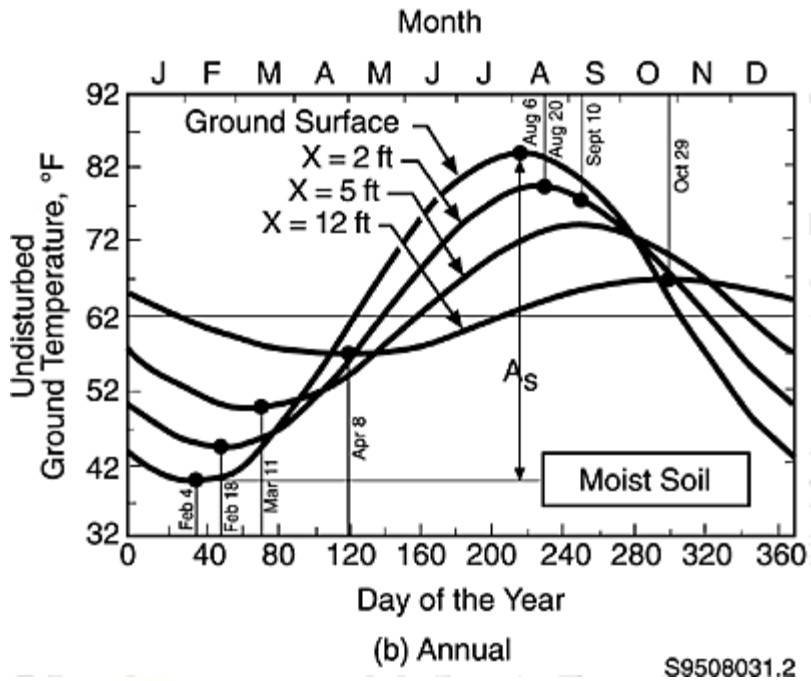


(a) Mean earth temperature, T_M (°F)

http://www.pnl.gov/fta/2_ground.htm

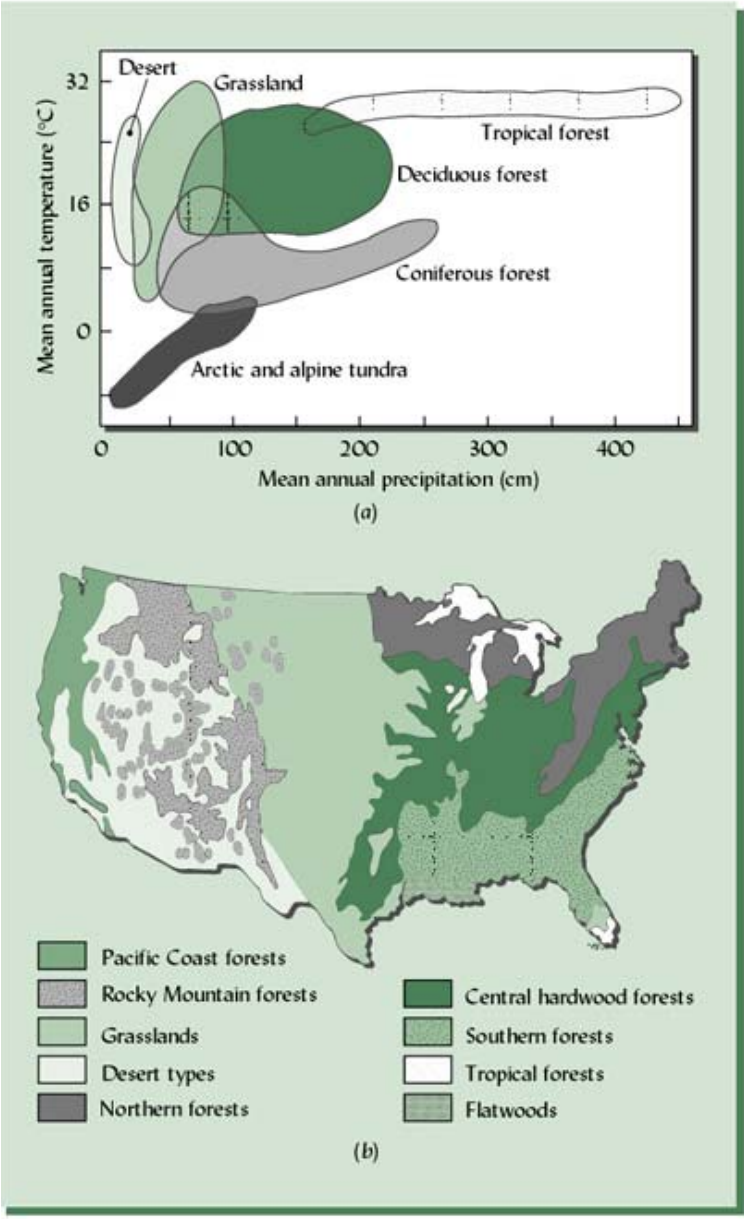


Fanning and Fanning, 1989



http://www.pnl.gov/fta/2_ground.htm

Figure 2.24



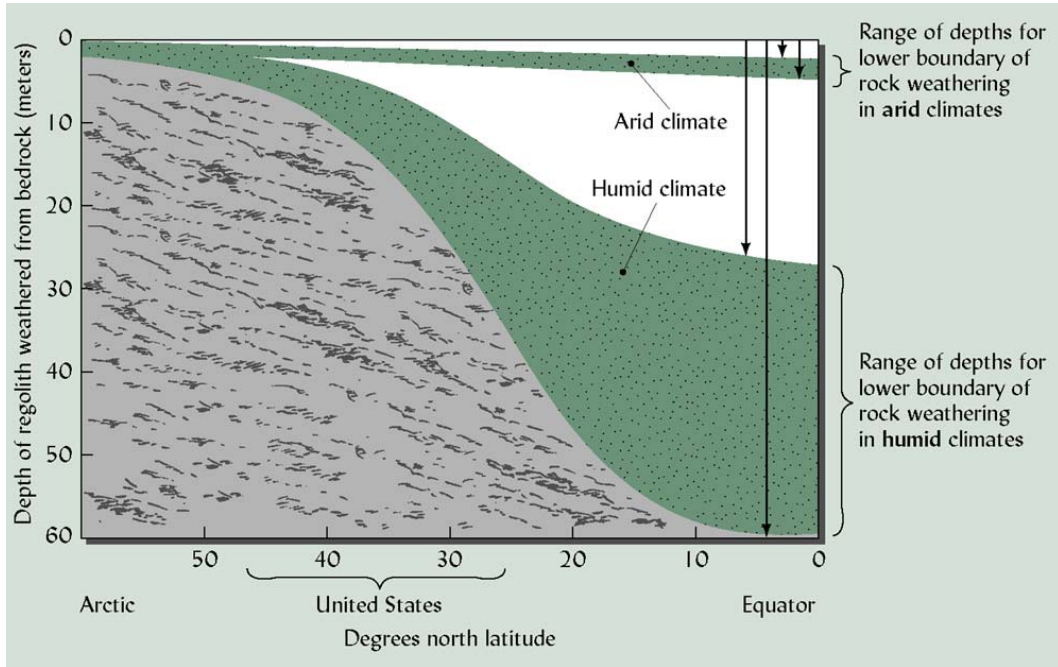


Figure 2.23

ORGANISMS

Most obvious first step in soil development is organic matter added to soil surface.

HUMUS ----------> organic acids
decompositon

ORGANIC ACIDS

chelating agents

H +

SOIL MINERALS ----------> WEATHERED PRODUCTS

BIOTURBATION - plants & animals mix surface organic matter into subsurface


1
2
3
4

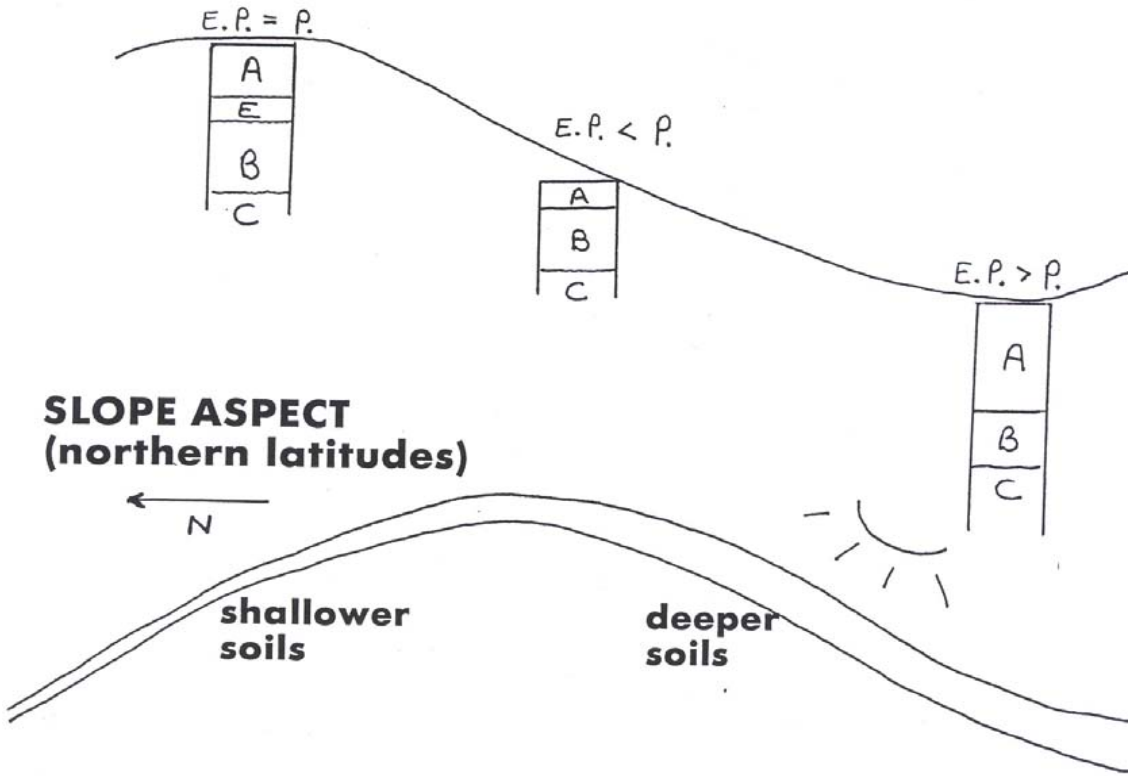

0
3"
6"
9"
1'
3"
6"
9"
2'
3"
6"
9"
3'
4

http://www.nrri.umn.edu/worms/withoutsoils.html

http://www.ento.vt.edu/Facilities/OnCampus/IDLab/insect_orders/isoptera.html

RELIEF

Determines EFFECTIVE PRECIPITATION, SOIL DESTRUCTION



http://helios.bto.ed.ac.uk/bto/deserts/bajada.htm

www.wsu.edu/ ~trodgers/saw.html

TIME

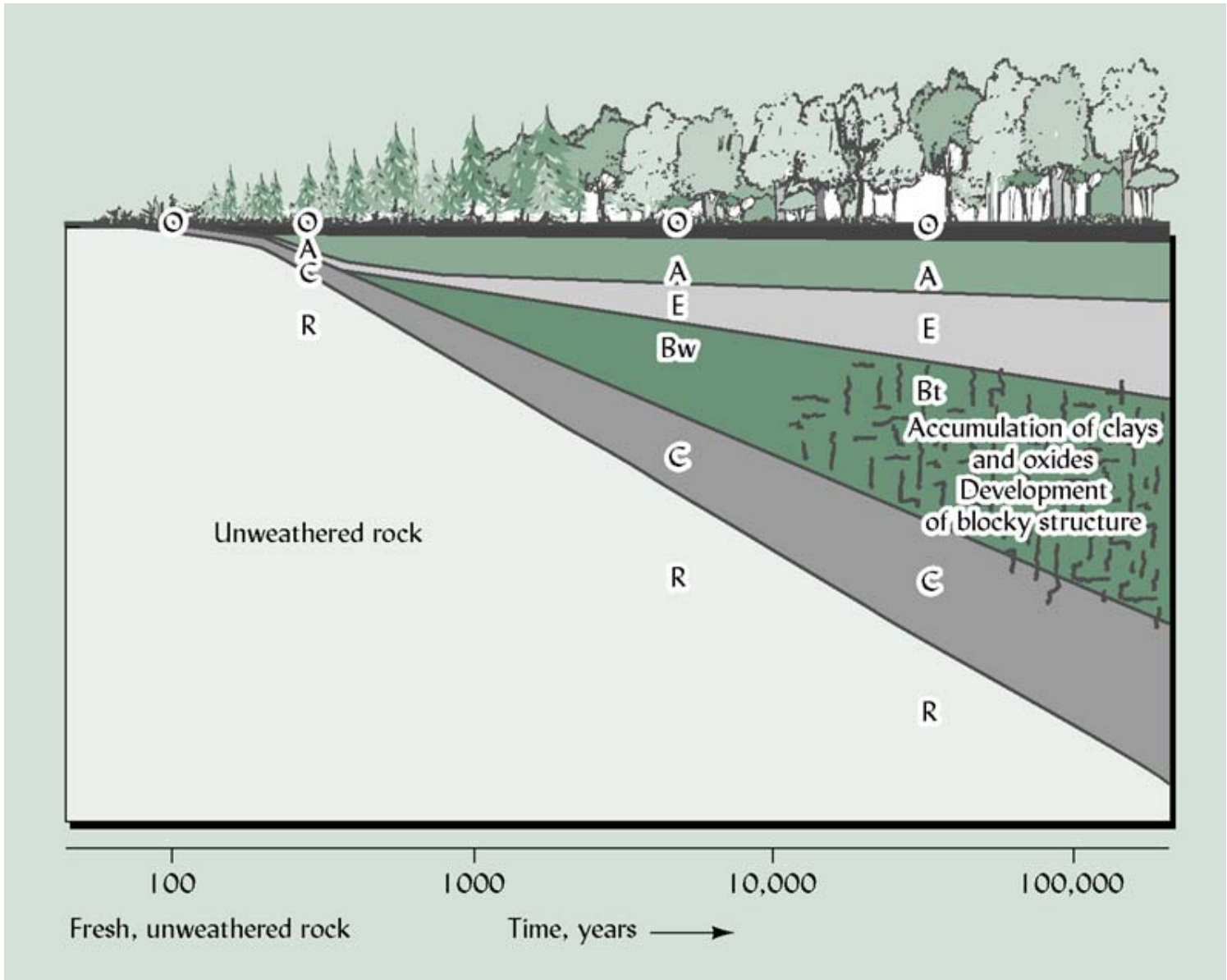
Soil formation rates are too slow to measure directly.

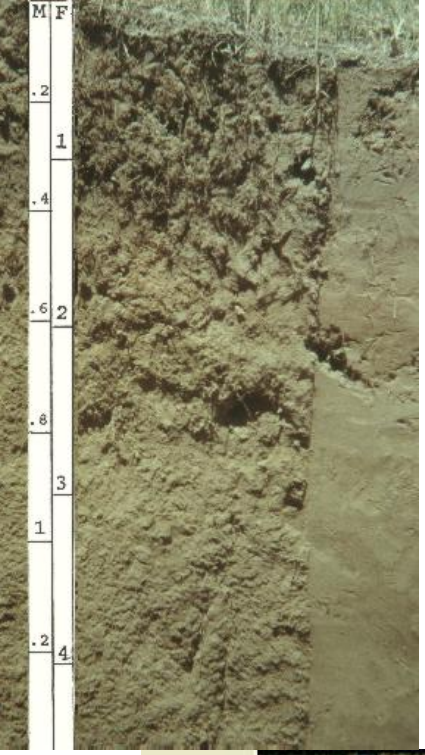
Ages can be etimated by -

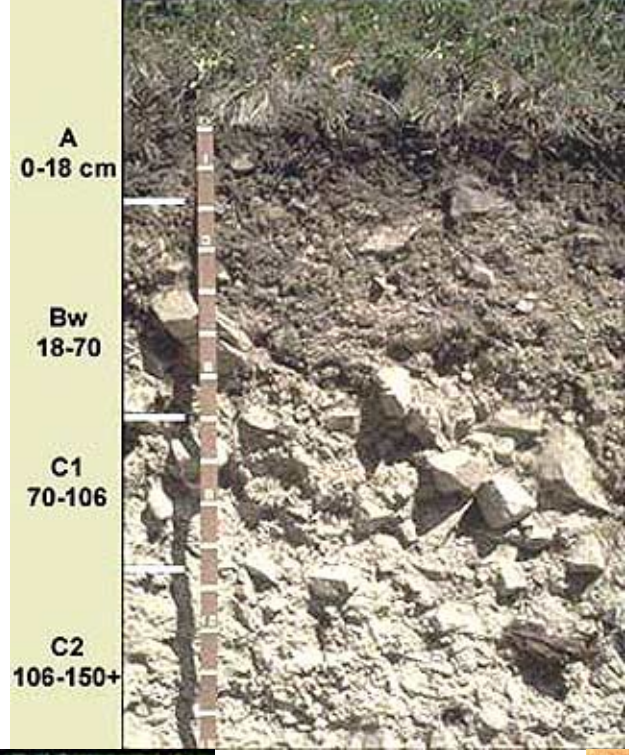
- C-14 dating of organic matter
- volcanic ash layers
- datable artifacts

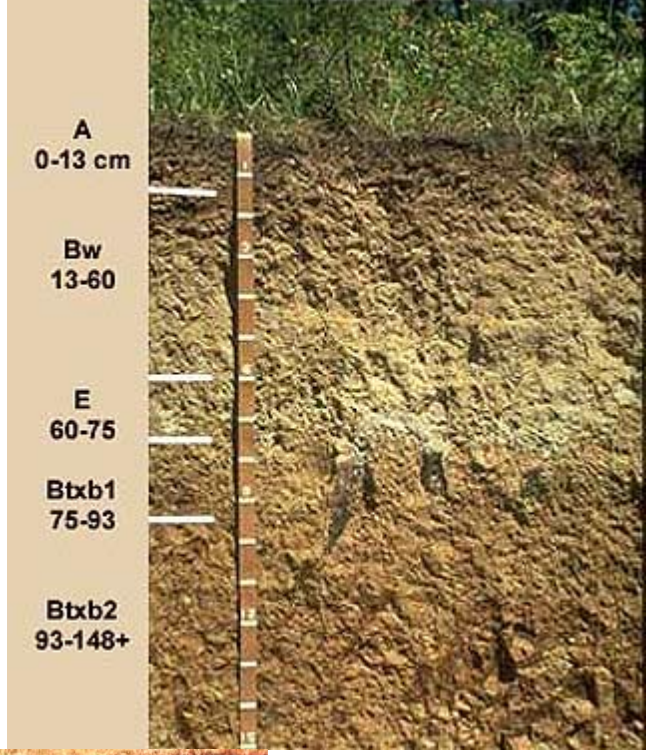
Time Zero?

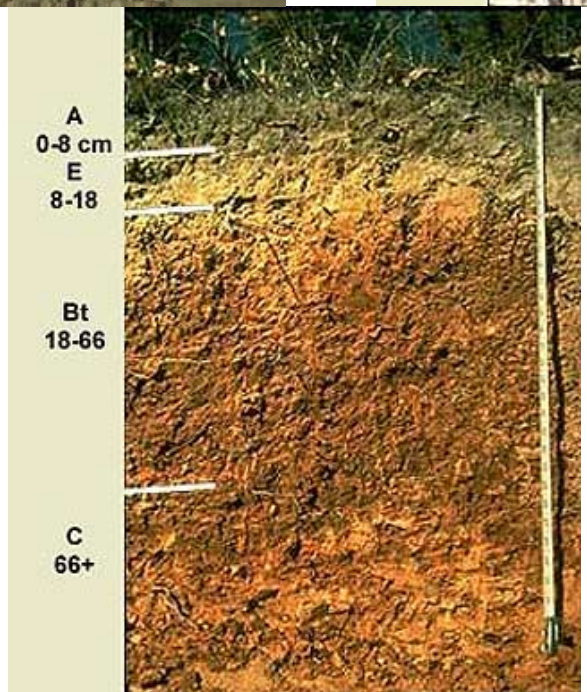
Figure 2.31

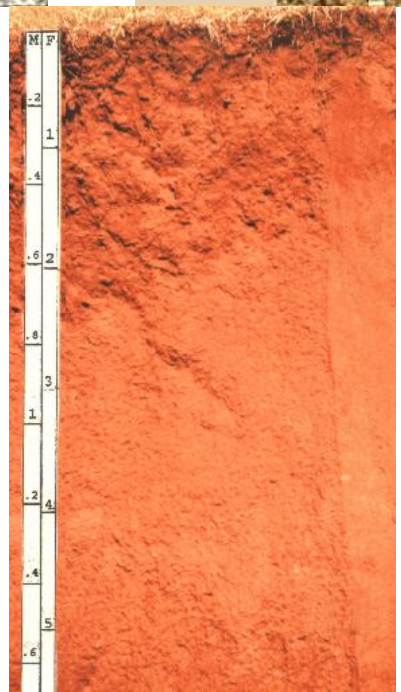

O
A
C
R
A
E
Bw
C
R
A
E
Bt
Accumulation of clays
and oxides
Development
of blocky structure
C
R
Unweathered rock
100
1000
10,000
100,000
Fresh, unweathered rock
Time, years




A
0-18 cm
Bw
18-70
C1
70-106
C2
106-150+


A
0-13 cm
Bw
13-60
E
60-75
Btxb1
75-93
Btxb2
93-148+


A
0-8 cm
E
8-18
Bt
18-66
C
66+



www.soils.umn.edu/.../ soil2125/doc/s4chp4.htm