Weathering and Soil

Weathering*

- is the process that breaks down rocks into smaller and smaller fragments

Evidence of weathering

- **smaller rocks, sand and soil**

Mechanical weathering*

- **breaks apart rocks without changing their chemical makeup**
  - **Plants – can cause mechanical weathering by breaking rock apart when they grow**
  - **Animals by burrowing digging and walking**
  - **Ice wedging – the process by which water fills up a small area in the rock and it freezes and expands and breaks the rock**
    *Give three examples of mechanical weathering.**

Differential Weathering

mechanical weathering

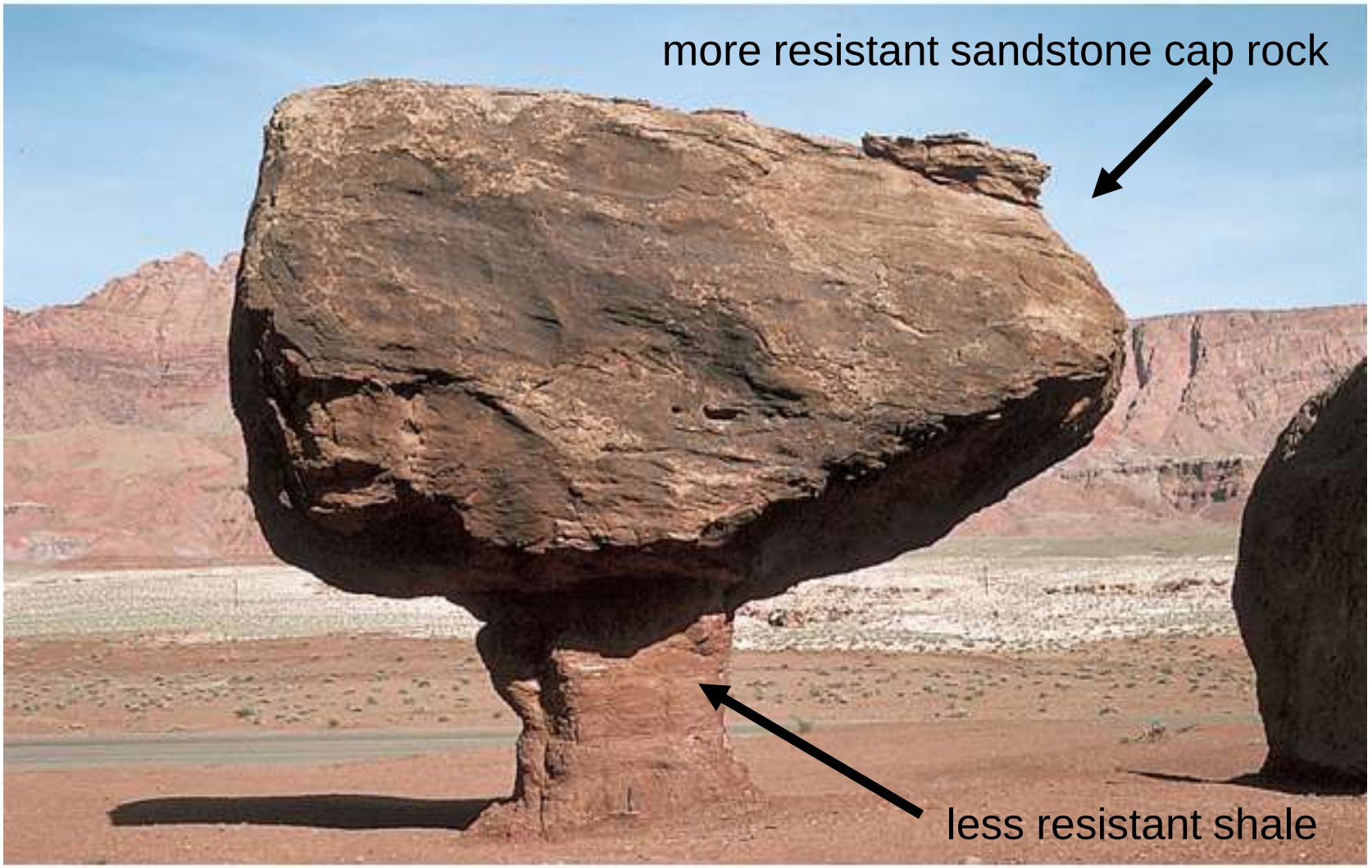
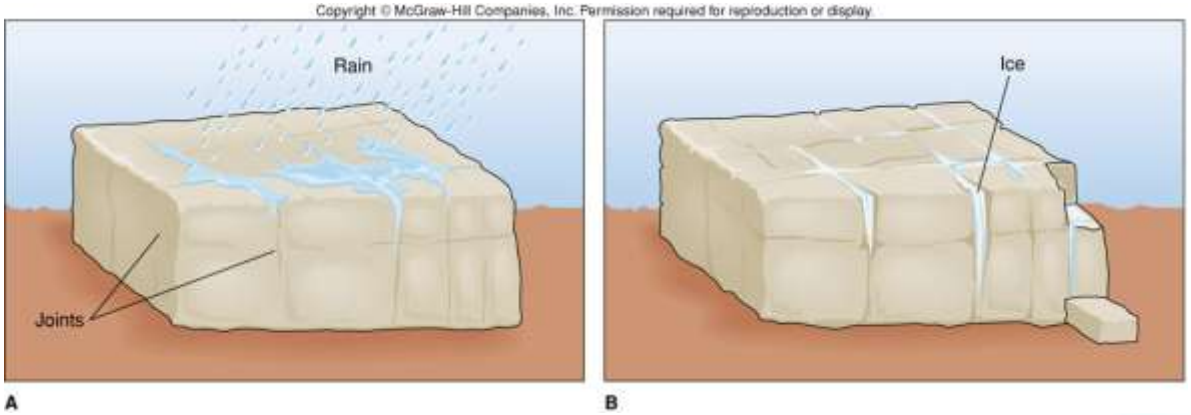


Photo by David McGeary

mechanical weathering: processes

frost action: **mechanic effect of freezing (and expanding) water on rocks**



where?

water expands about 9% when it freezes

- **upper surface freezes first (contact with atmosphere)**
- **water below freezes later and cannot expand upward**
- **ice expands and fractures rock**

plant growth: growing roots widen fractures

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

Photo by Diane Carlson

burrowing animals: activity breaks down rock

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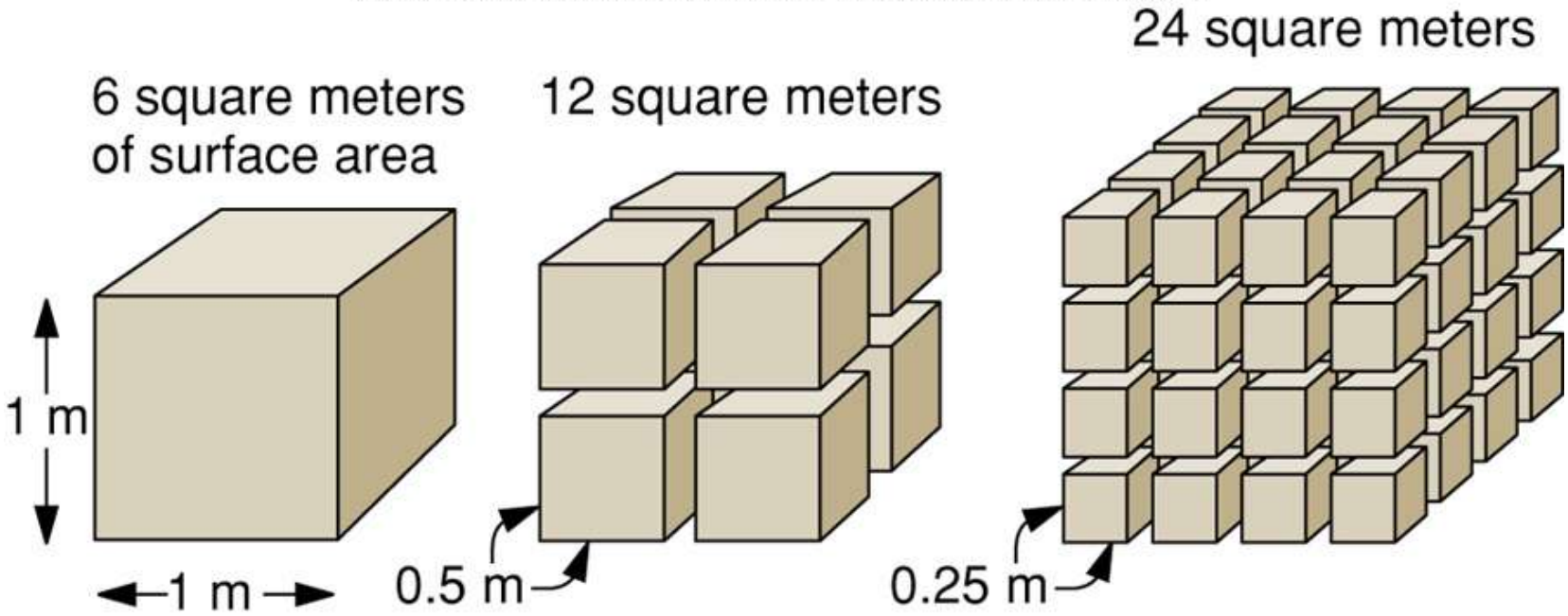
Tree roots growing in rock fractures, plus animal burrows, expose deep rocks to water

Source: Runk/Schoenberger/Grant Heilman

what happens during mechanical weathering?

rock breaks down into smaller pieces...

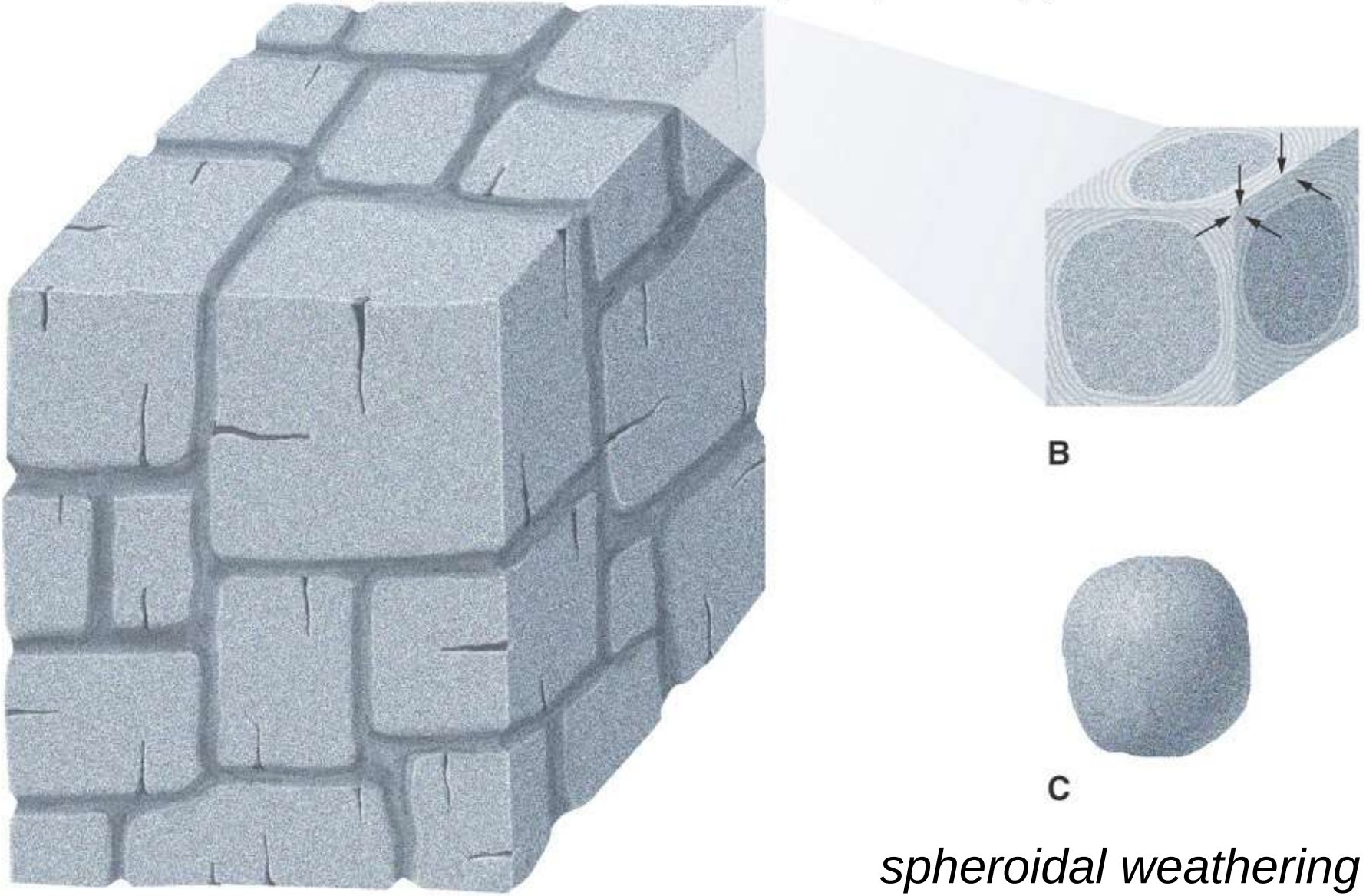


for a cube that is 1 m on each side…mechanical weathering breaks it down into smaller pieces, exposing more surfaces

surface area to volume ratio increases

(volume remains constant at 1 m^3)

over time, can make rectangular pieces “spheroidal”



spheroidal weathering

Give three agents or causes of chemical weathering and explain each.

Chemical weathering*

- **when the chemical composition of the rock is changed***
  - **Water**
    - **When the hydrogen and the oxygen in the water react with the chemicals in the rock to form new compounds**
  - **Acids**
    - **Naturally formed acids dissolve rock and rock making minerals**
    - **Acids from plant roots also cause this weathering**
  - **Oxygen**
    - **Oxidation – is when oxygen reacts with other minerals**
      1) Rust is the result of iron reacting with oxygen

industrial pollution -- generating acid rain

Photo by David McGeary

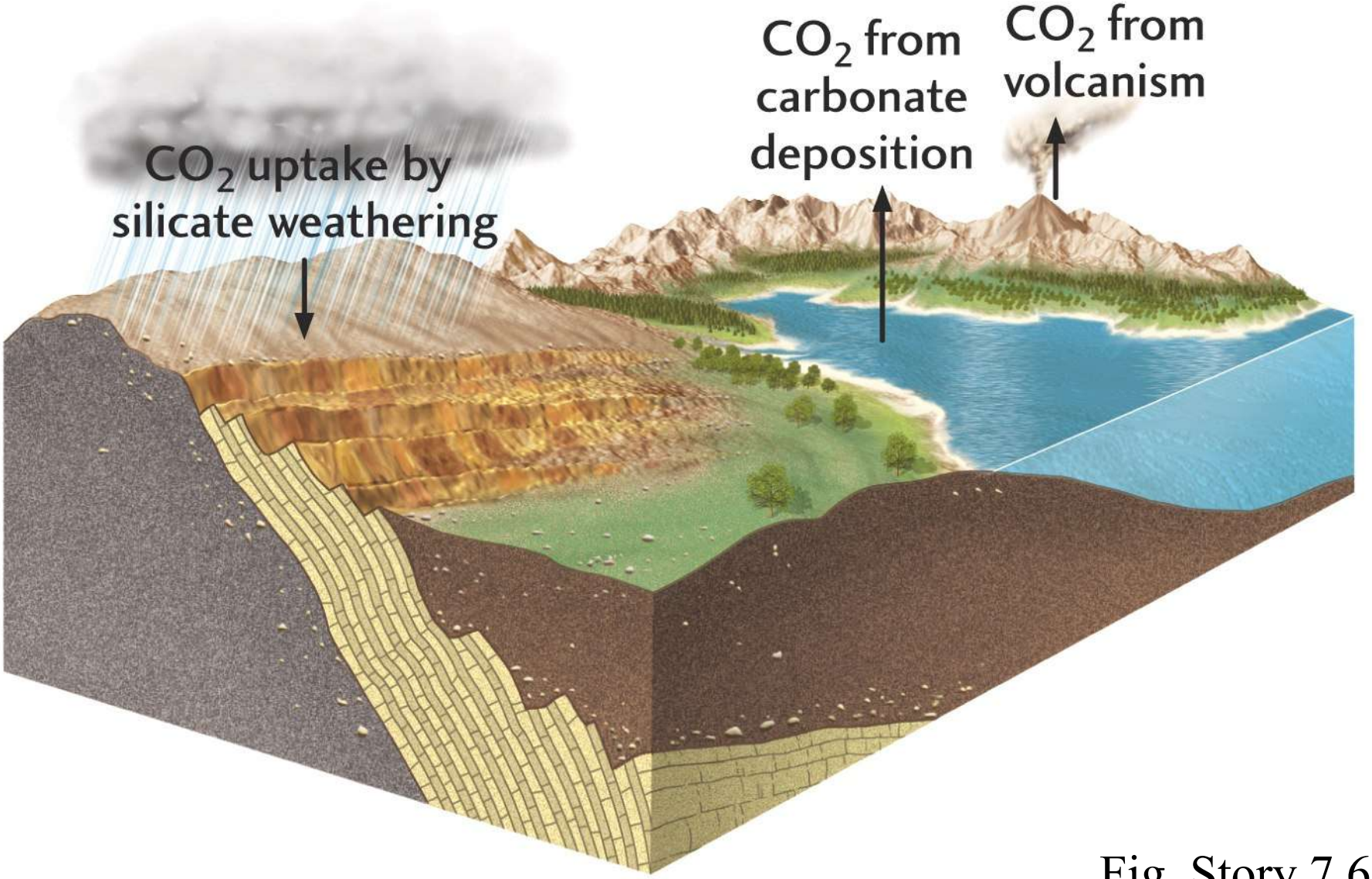

CO_2 uptake by silicate weathering
CO_2 from carbonate deposition
CO_2 from volcanism

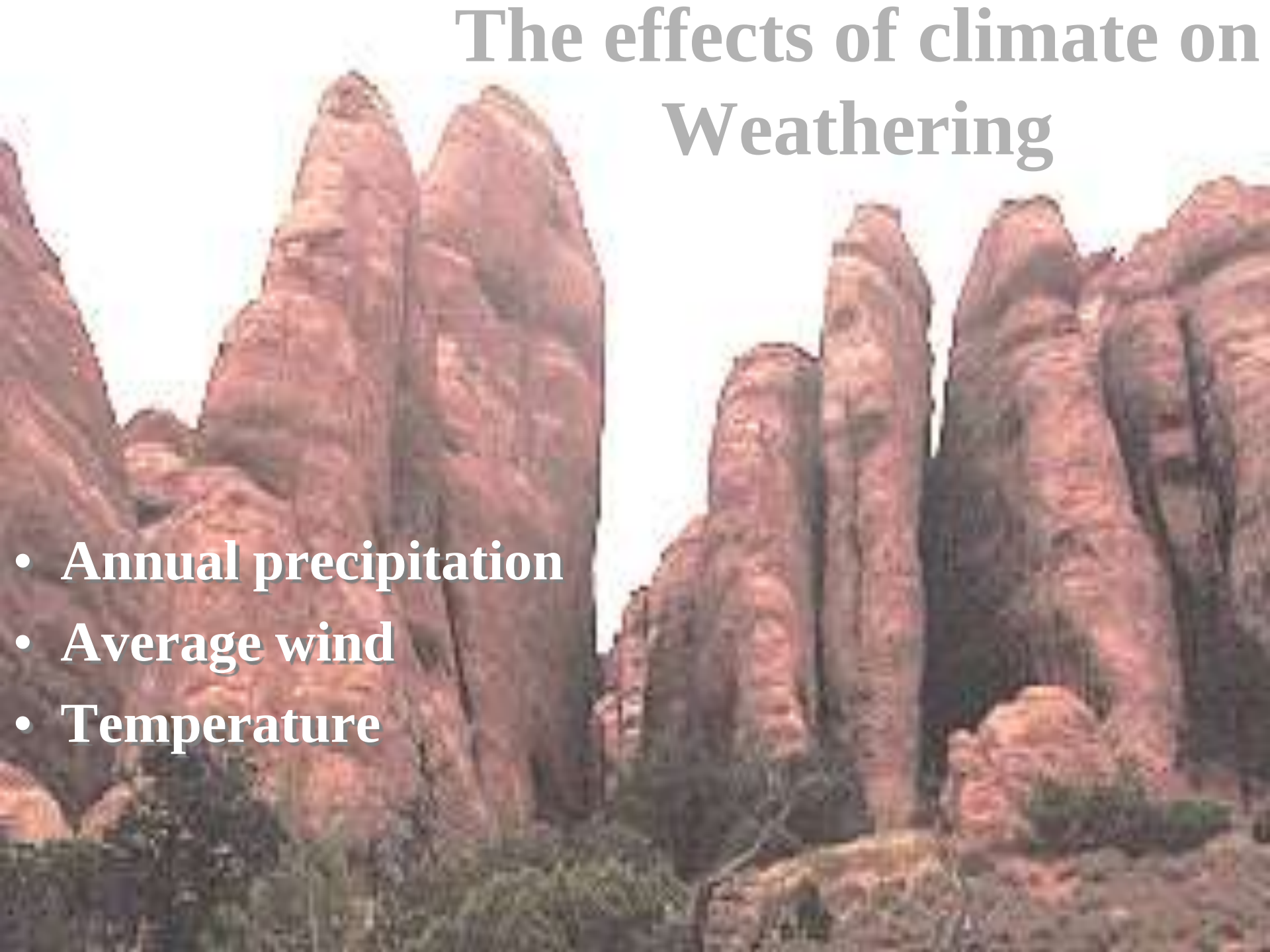
Fig. Story 7.6

Chemical Weathering in the Graveyard

Fig. 7.1

Owens Lake, CA

The effects of climate on Weathering



- Annual precipitation
- Average wind
- Temperature

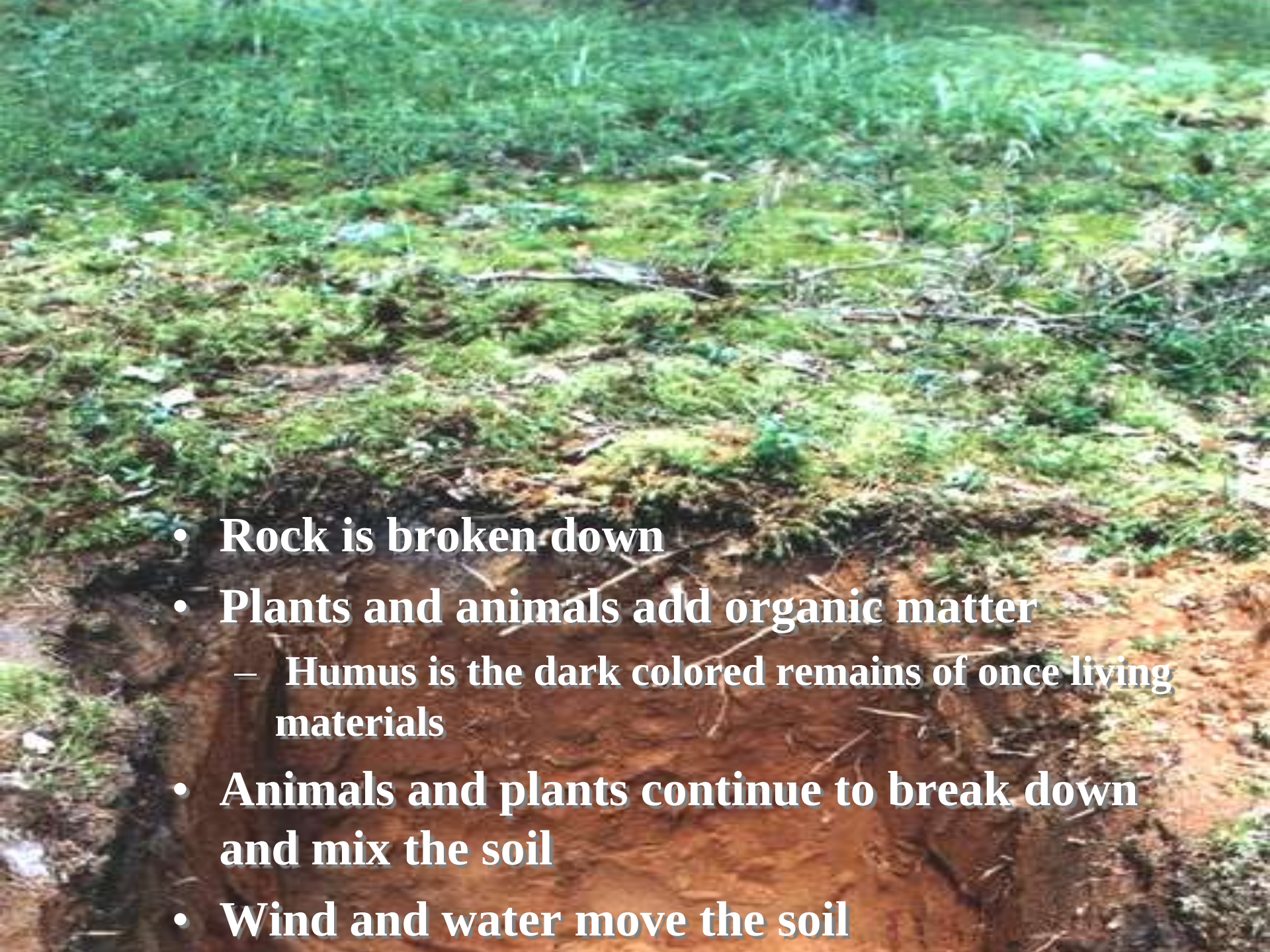
Fig. 7.9


Fire shatters rock

Quiz

- 1. What are the two types of weathering?
- 2. Name three agents of mechanical weathering.
- 3. Name three agents of chemical weathering.
- 4. Name three climate conditions that effect the rate of weathering.

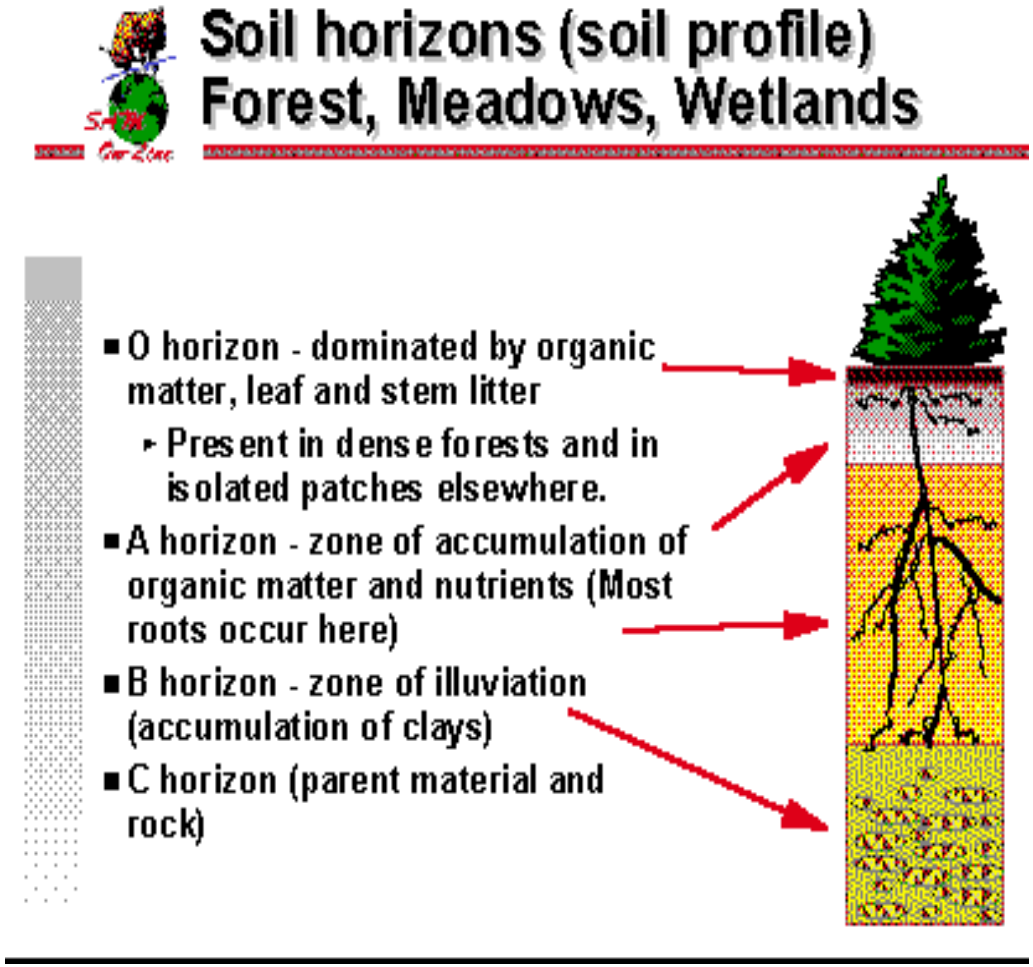
Fig. 7.14



- Rock is broken down
- Plants and animals add organic matter
  - Humus is the dark colored remains of once living materials
- Animals and plants continue to break down and mix the soil
- Wind and water move the soil

Soil profile

- **is the different layers that the soil makes up**
  - **Each layer is called a horizon**
    - **Horizon A – top soil with very fine rock and humus (the darkest soil)**
    - **Horizon B – the area just below horizon A that contains some plant roots, less humus and is lighter colored**
    - **Horizon C – is below B and contains partly weathered rock**



Types of soils

- Types of soils depends on several things
  - Proportion of sand, silt or clay
  - The climate where the soil type developed
  - Type of rock that it developed on
  - Slope of land
  - Elevation
  - Latitude

influences on soil formation

- parent material
- climate
- topography
- vegetation
- time

soil - a layer of weathered, unconsolidated material on top of bedrock

contains:

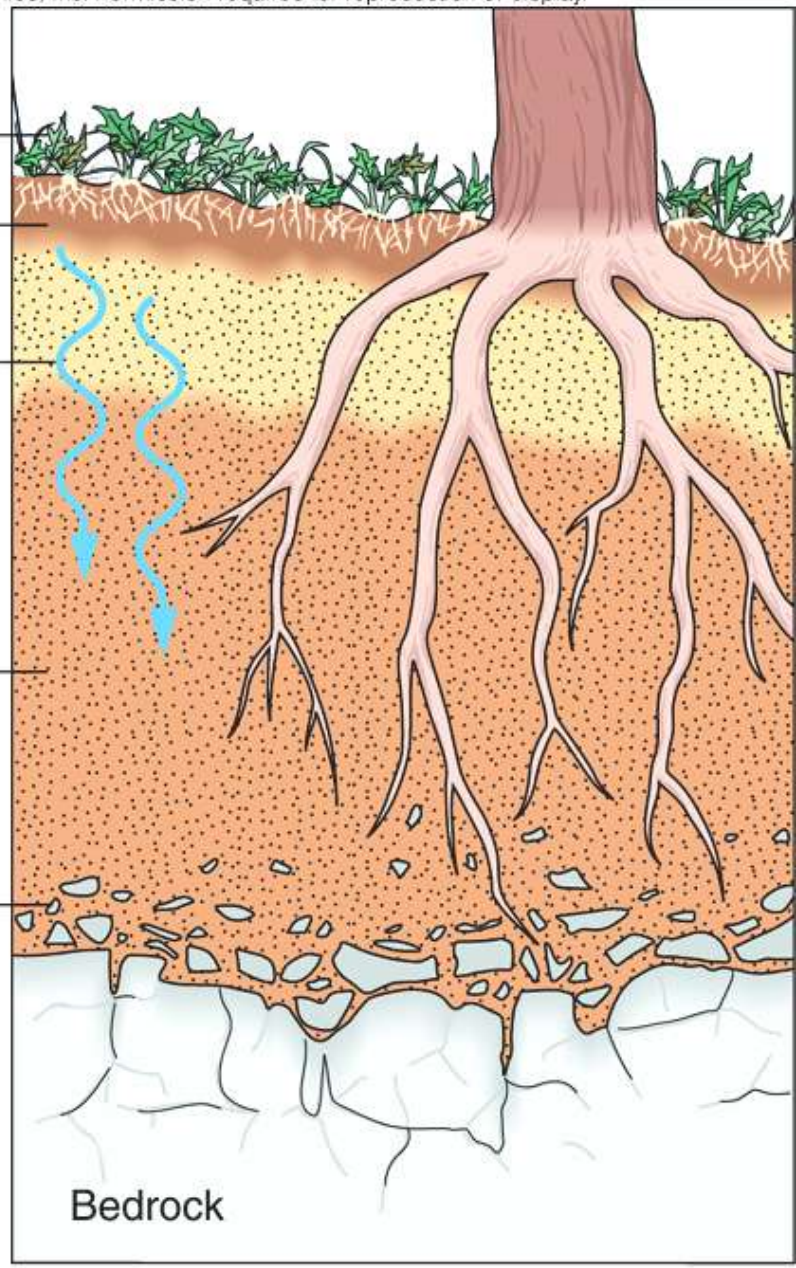
- clay minerals
- quartz
- water
- organic material

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

B
Photo by United States Department of Agriculture

idealized soil profile

not all horizons will be present everywhere

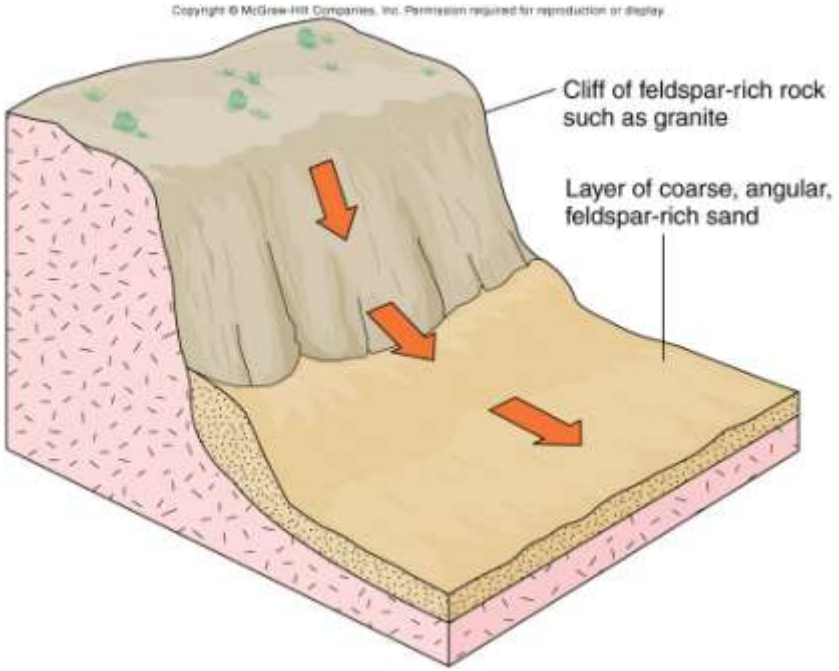


A

topography: differences in elevation

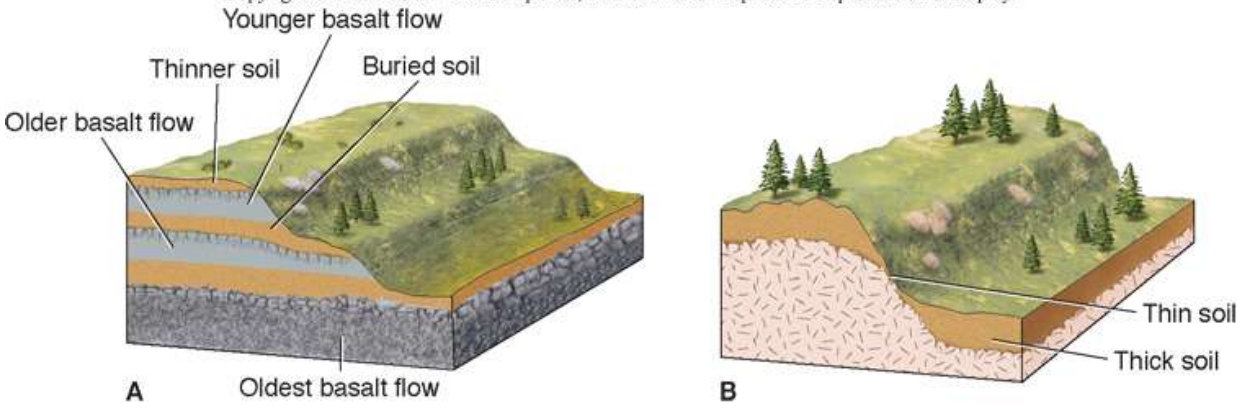
- relief (elevation change--valley bottoms to hill tops)
- steepness of slopes

think about what water does…



water flows quickly down steep slopes -- little soil formation

water accumulates in low-lying areas -- high soil formation



soil classification

- *residual soil* - “what is left” -- weathering of bedrock
- *transported soil* - soil from “elsewhere”
  - – flood plain deposits (soils) from rivers.
  - – wind-transported deposits (soils) are called *loess*
- *soil composition*
  - – parent rock is deciding factor
  - – chemical weathering through time determines composition
- *soil thickness*
  - – time increases soil thickness
  - – wet climate increases soil thickness
  - – low slopes also increase thickness

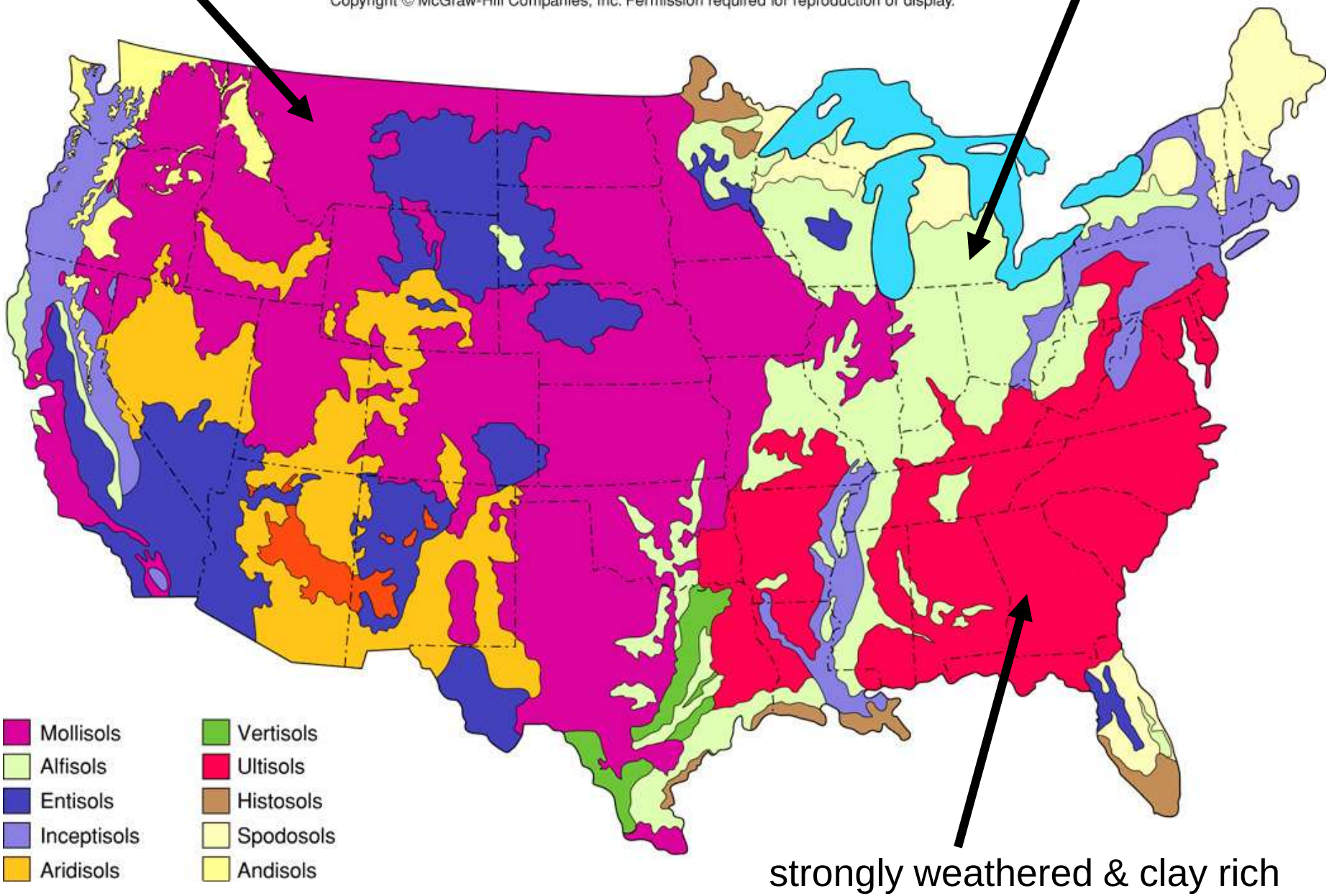
The three basic types

- Prairie
- Temperate
- Desert

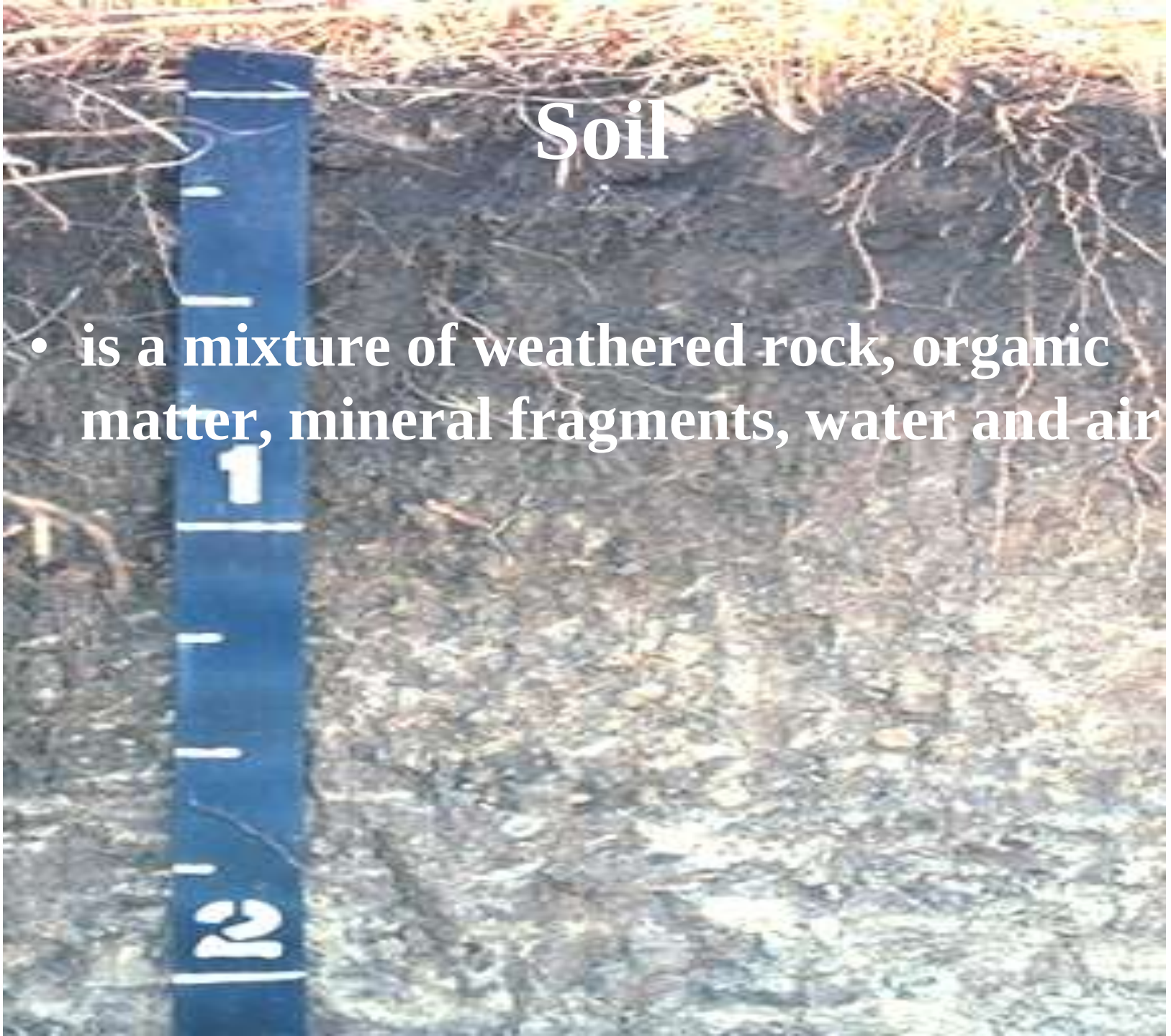
US Soil map

soft & organic rich

gray-brown & moist

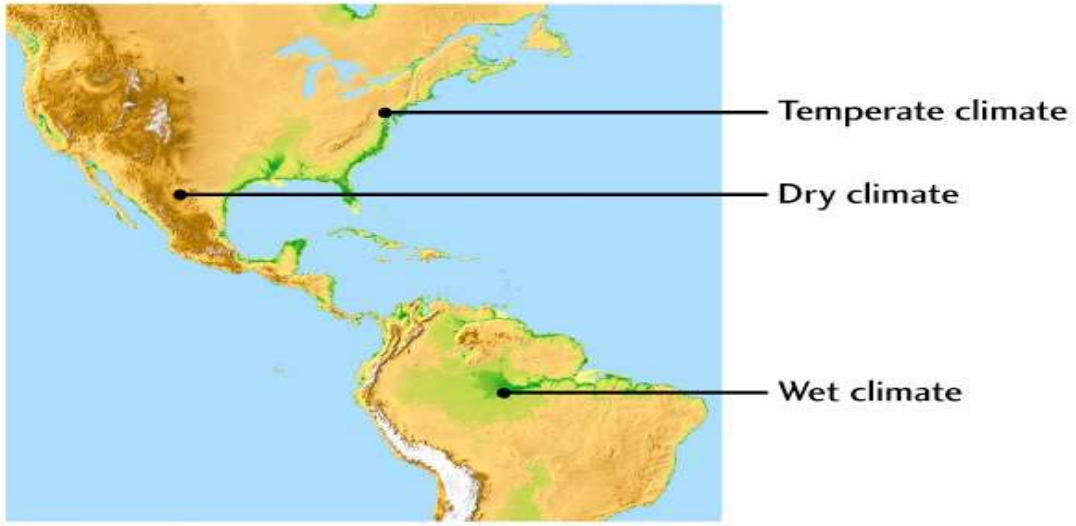


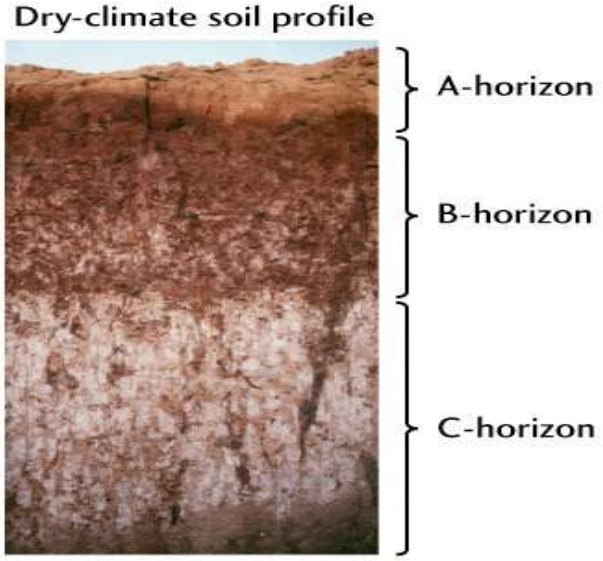
strongly weathered & clay rich



Soil

- is a mixture of weathered rock, organic matter, mineral fragments, water and air


Temperate climate
Dry climate
Wet climate


Dry-climate soil profile
A-horizon
B-horizon
C-horizon

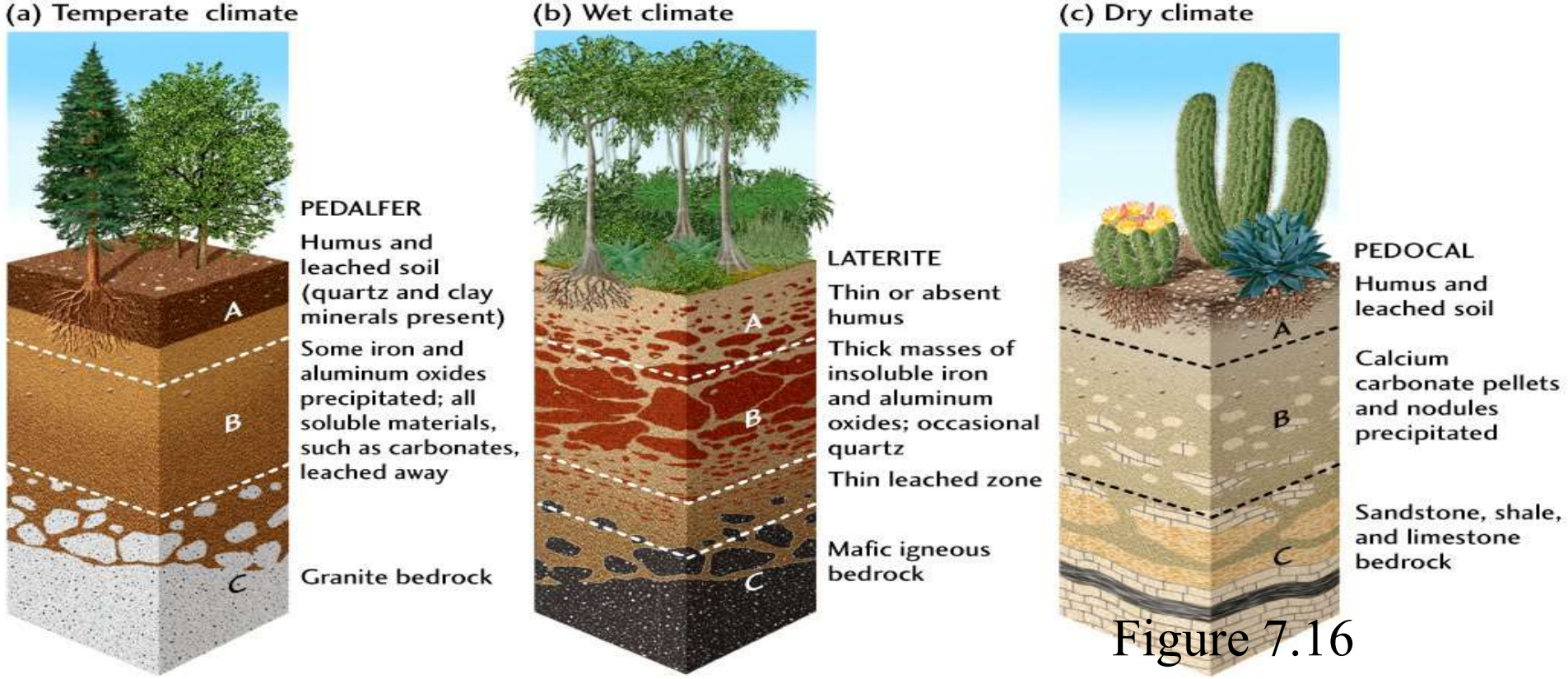
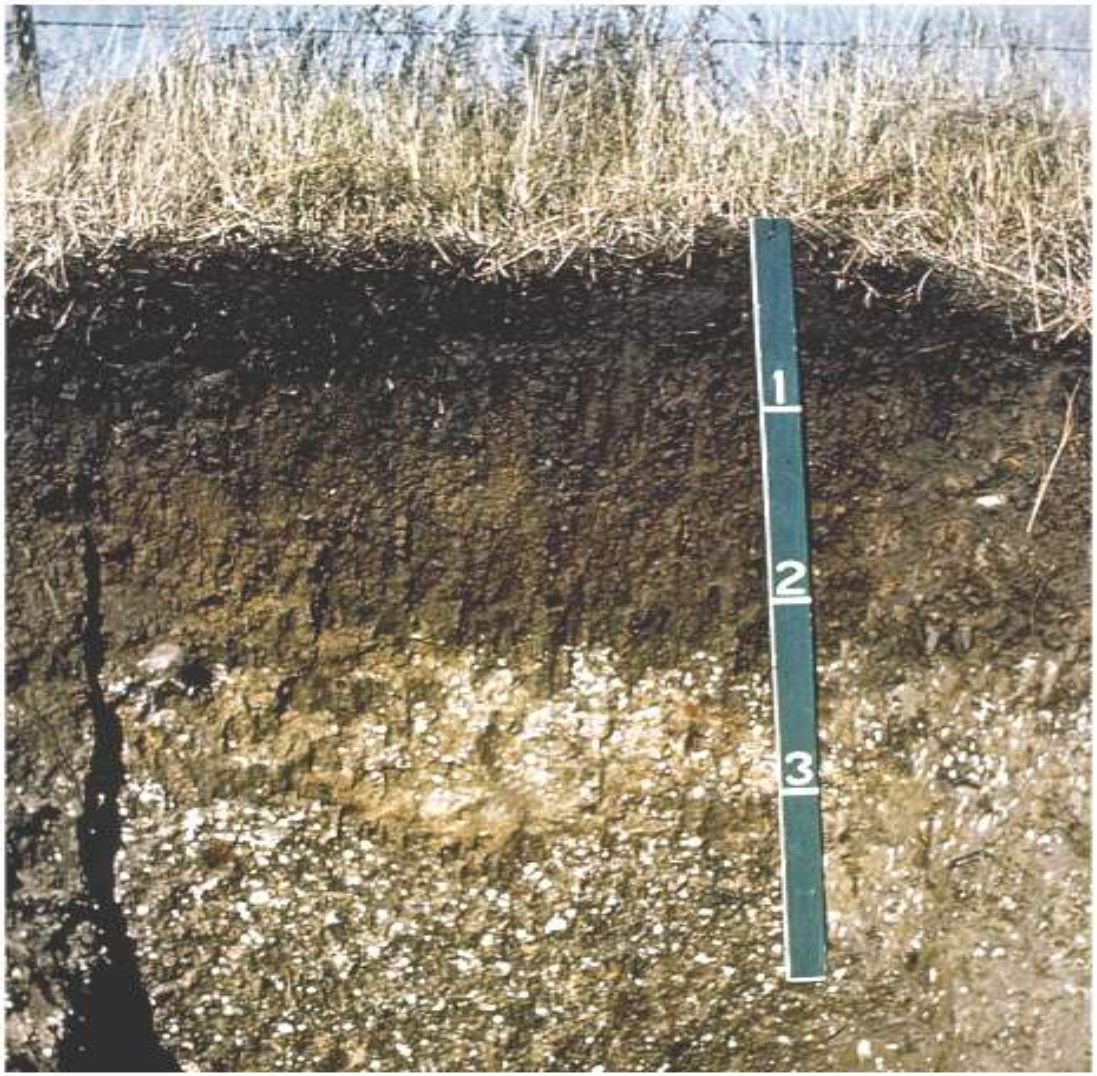

(a) Temperate climate
A
B
C
PEDALFER
Humus and leached soil (quartz and clay minerals present)
Some iron and aluminum oxides precipitated; all soluble materials, such as carbonates, leached away
Granite bedrock
(b) Wet climate
A
B
C
LATERITE
Thin or absent humus
Thick masses of insoluble iron and aluminum oxides; occasional quartz
Thin leached zone
Mafic igneous bedrock
(c) Dry climate
A
B
C
PEDOCAL
Humus and leached soil
Calcium carbonate pellets and nodules precipitated
Sandstone, shale, and limestone bedrock

Figure 7.16

Remember the different horizons



O **Organic**

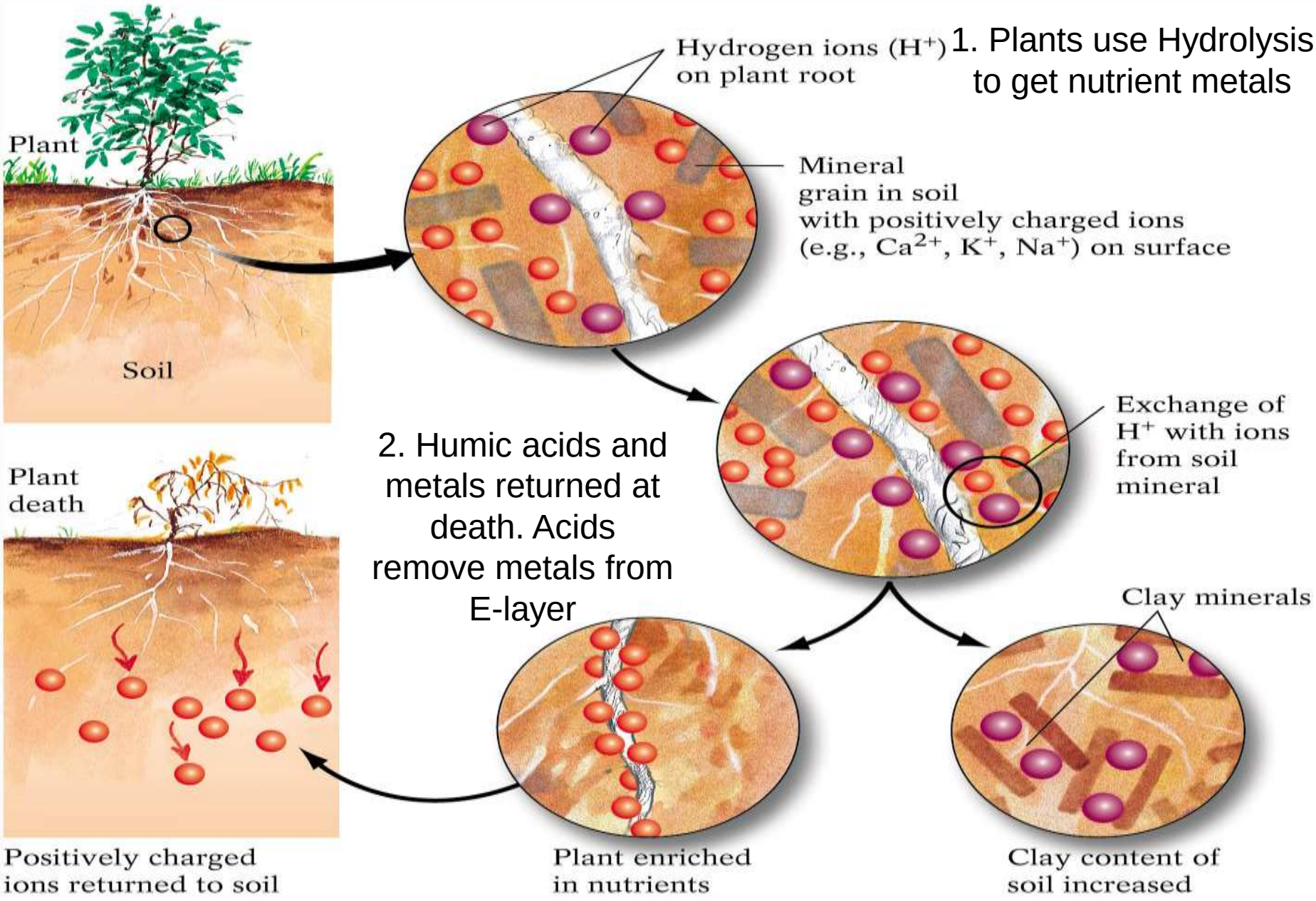
A **Animal Activity**

E Soluble Minerals **Exited**

B Soluble Minerals **Back**

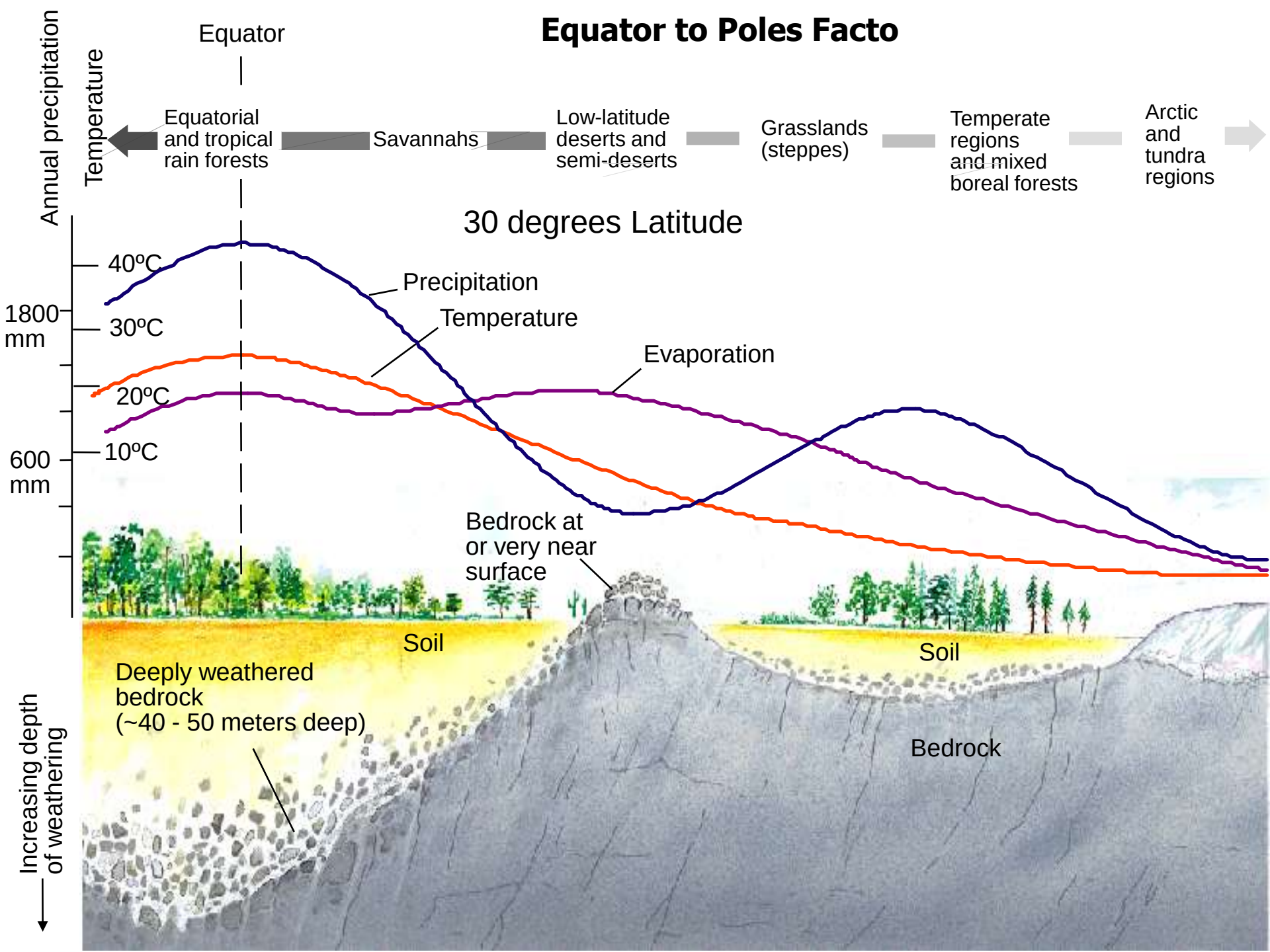
C **Crushed Rock**

Vegetation and Soil Development



Animal Activities in “A” horizon

Source: Runk/Schoenberger/Grant Heilman


Equator to Poles Facto
Equator
Annual precipitation
Temperature
Equatorial and tropical rain forests
Savannahs
Low-latitude deserts and semi-deserts
Grasslands (steppes)
Temperate regions and mixed boreal forests
Arctic and tundra regions
30 degrees Latitude
40ºC
30ºC
20ºC
10ºC
1800 mm
600 mm
Precipitation
Temperature
Evaporation
Bedrock at or very near surface
Soil
Soil
Deeply weathered bedrock (~40 - 50 meters deep)
Bedrock
Increasing depth of weathering

Earth's surface processes

- **Erosion – the physical removal of material by mobile agents like water, wind, ice, or gravity**

Soil Erosion

- **Soil erosion**
  - **Recycling of Earth materials**
  - **Natural rates of soil erosion depend on**
    - **Soil characteristics**
    - **Climate**
    - **Slope**
    - **Type of vegetation**

Erosion

Source: Ramesh Venkatakrishnan

Soil

- **Soil erosion**
  - **In many regions the rate of soil erosion is significantly greater than the rate of soil formation**
  - **Farmers now level fields with lasers to slow loss of topsoil**
  - **Terraces**

Stopping man caused erosion

page 164 and 165

Quiz

1. What is the difference between chemical and mechanical weathering?
2. Give three examples of Mechanical weathering
3. What is ice wedging?
4. Give the three types of chemical weathering.
5. Give the three layers of soil horizons and describe each.