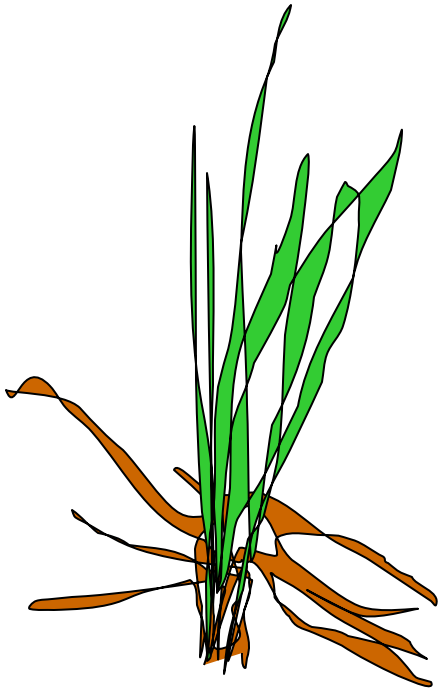


Understanding Soil as a Natural Resource

Part 1

I Soil Forming Factors

II Soil Properties

III Soil Drainage

IV Soil Erosion

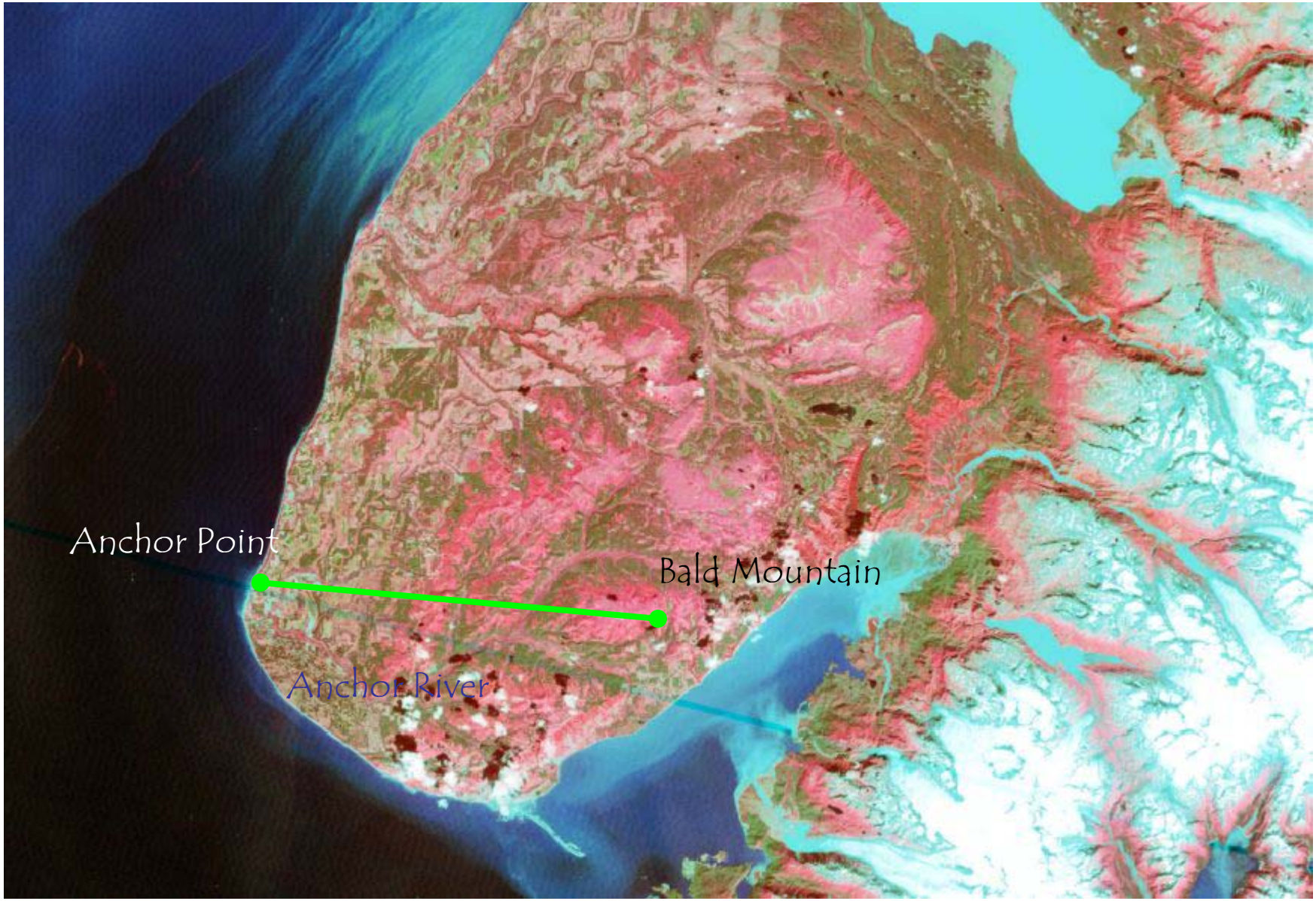
V Hydric Soils

VI Soil Survey

Part 2

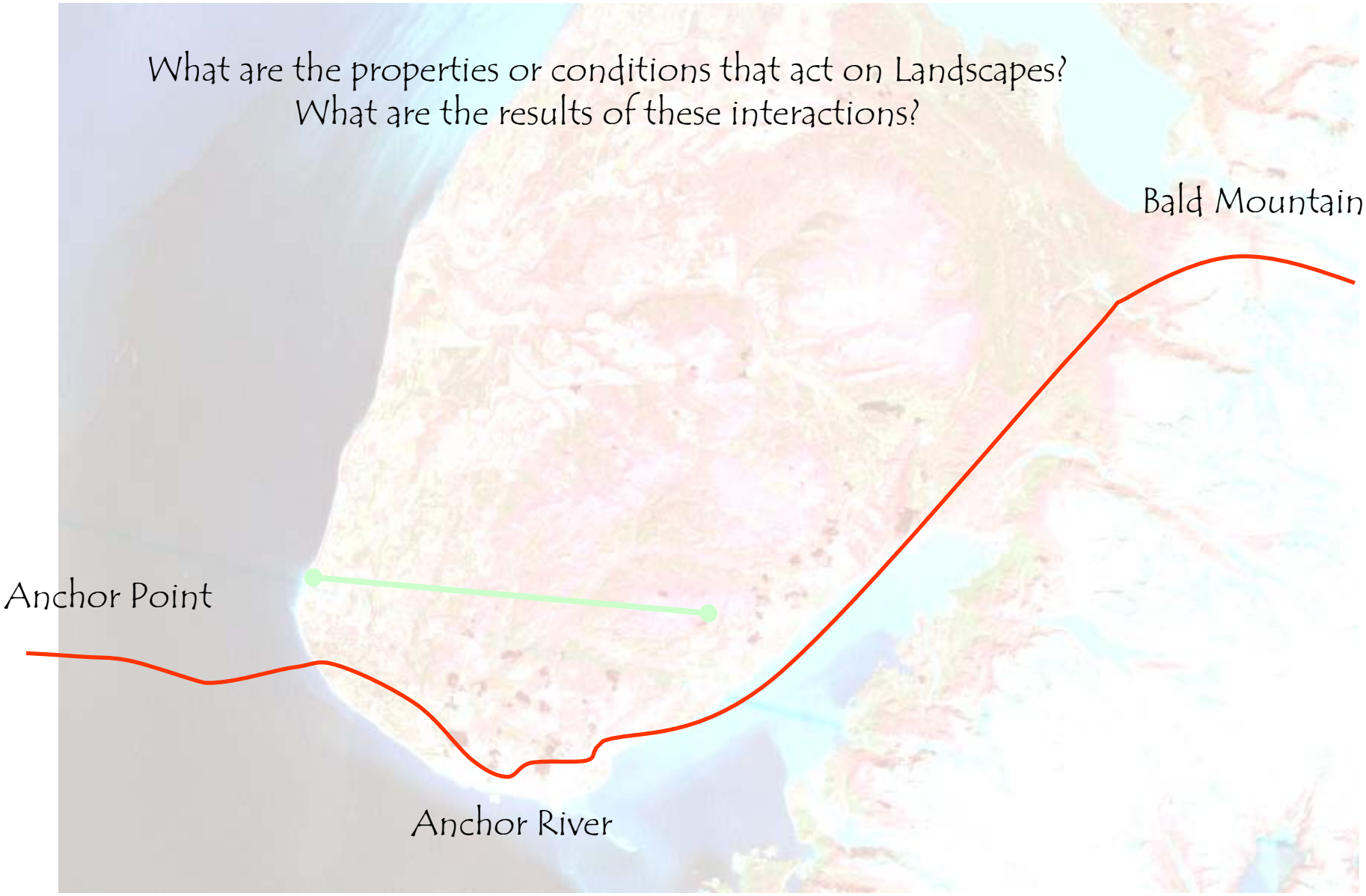
I Review

II Planning and Decision making



Lower Kenai Peninsula

What are the properties or conditions that act on Landscapes?
What are the results of these interactions?



Lower Kenai Peninsula

5 SOIL FORMING FACTORS

Organisms

Plants

Animals

Climate

Precipitation

Temperature

Physical aspects

Chemical aspects

Parent material

Elevation

Slope

Aspect

Depth to water

Relief

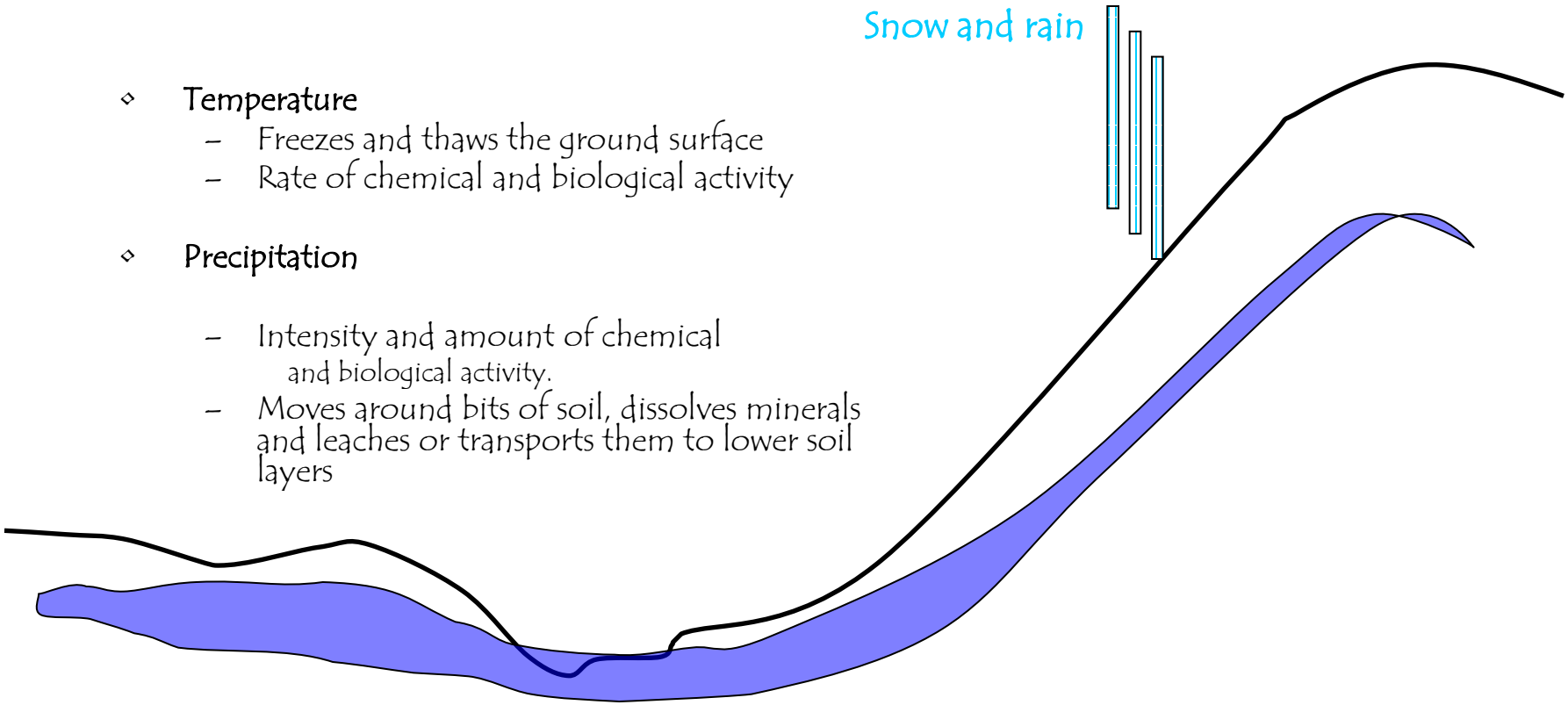
Time

Soil = (cl,o,r,p,t)

Climate

Overall temperature and precipitation conditions

- Temperature
  - Freezes and thaws the ground surface
  - Rate of chemical and biological activity
- Precipitation
  - Intensity and amount of chemical and biological activity.
  - Moves around bits of soil, dissolves minerals and leaches or transports them to lower soil layers



Climate controls
- presence or absence of water table
- amount of heat available to drive biologic and chemical reactions
- plant/soil interactions
- long term direction of soil development

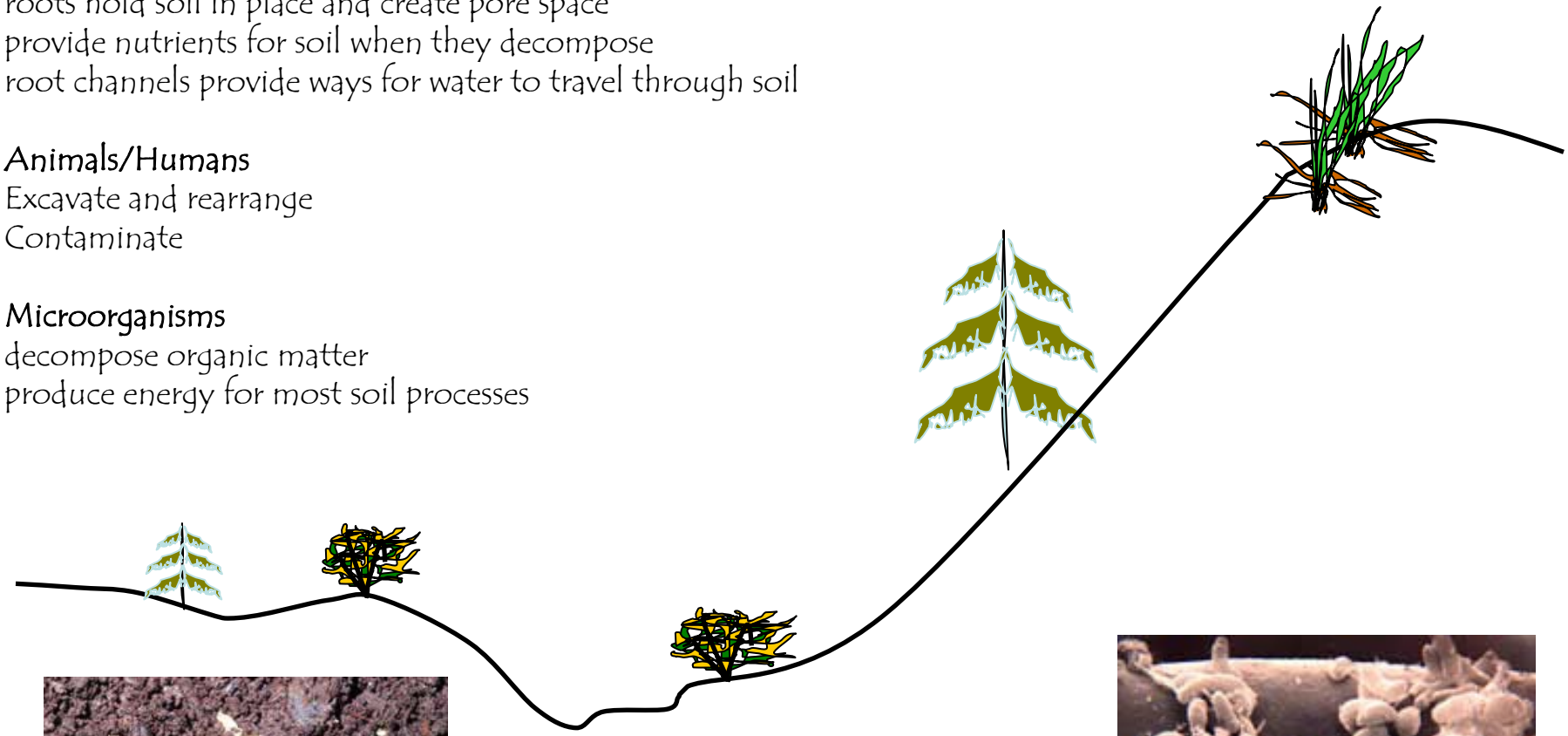
Organisms

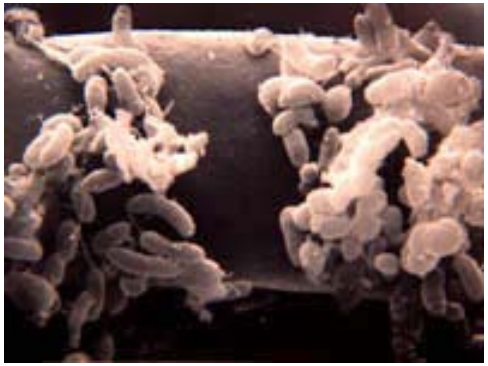
Climate

Plants
roots hold soil in place and create pore space
provide nutrients for soil when they decompose
root channels provide ways for water to travel through soil

Animals/Humans
Excavate and rearrange
Contaminate

Microorganisms
decompose organic matter
produce energy for most soil processes



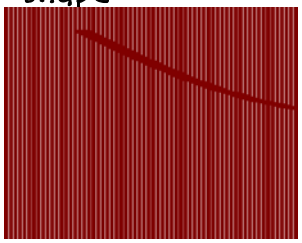


Climate
Organisms

Relief (topography)

The relative difference in elevation between uplands and lowlands of a given region.

shape

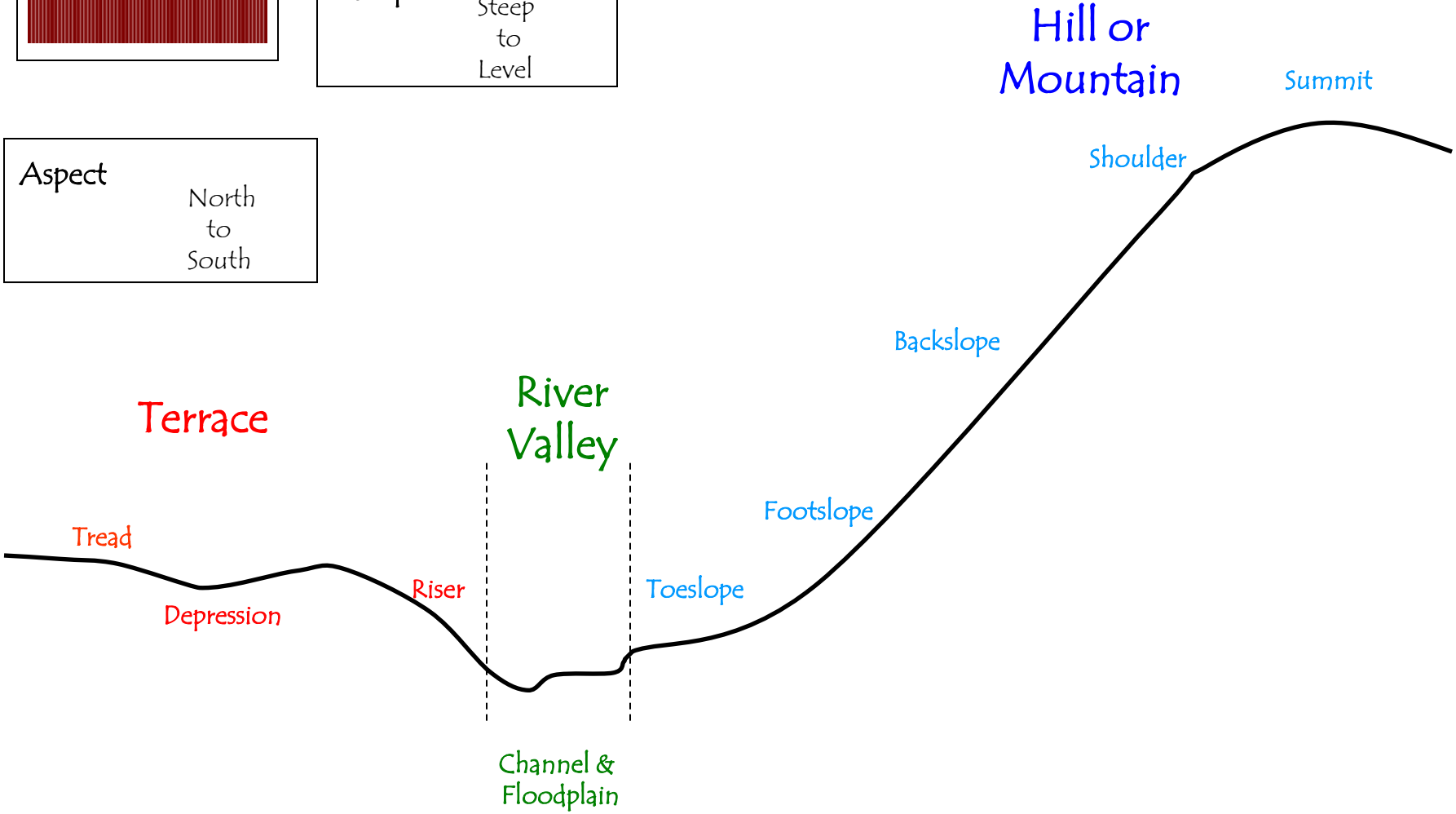


Slope

Steep
to
Level

Aspect

North
to
South



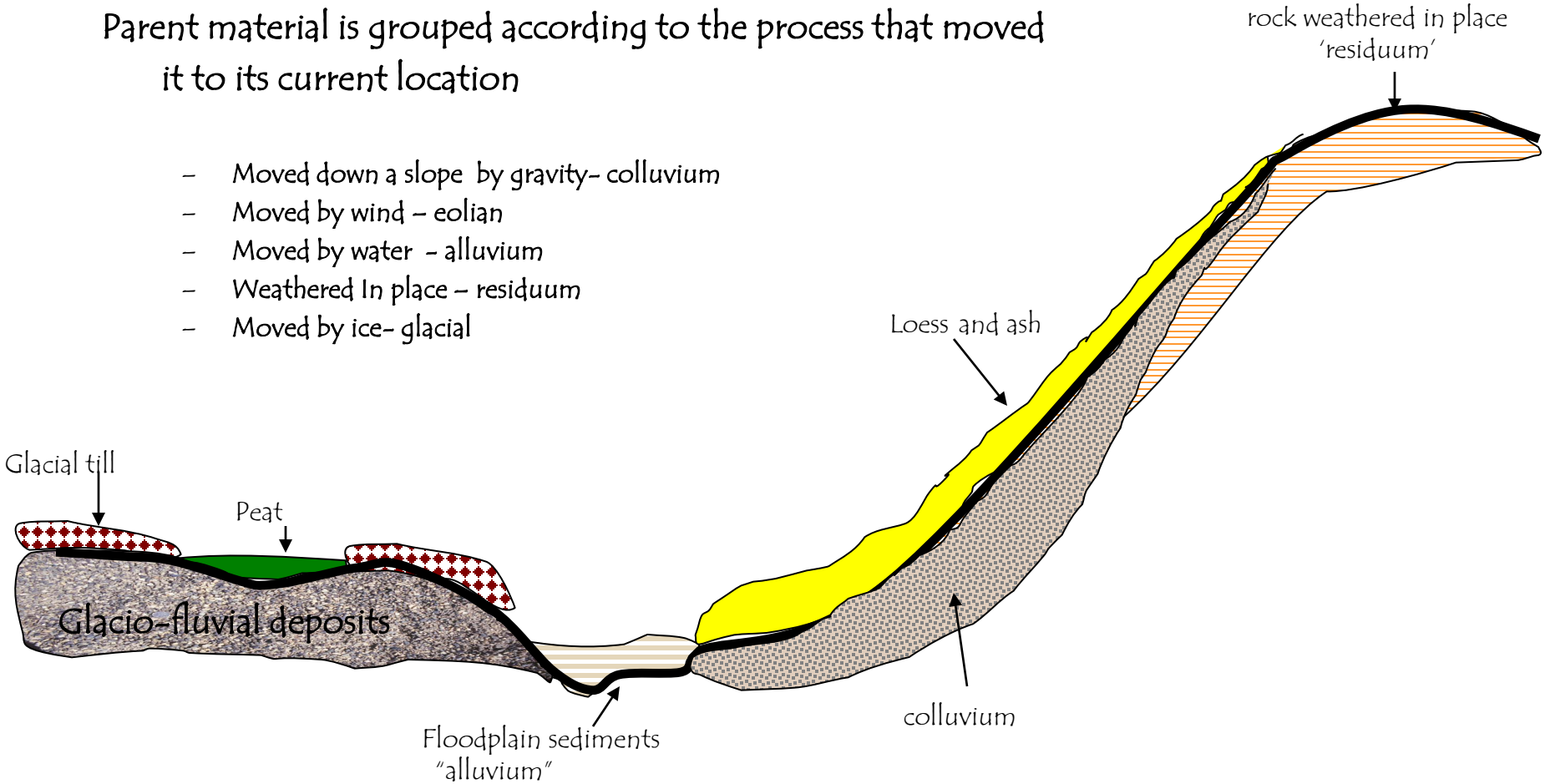
Parent material

Climate
Organisms
Relief

Unconsolidated material in which soil forms
Parent material is derived from physical and chemical weathering of rocks and plants

Parent material is grouped according to the process that moved it to its current location

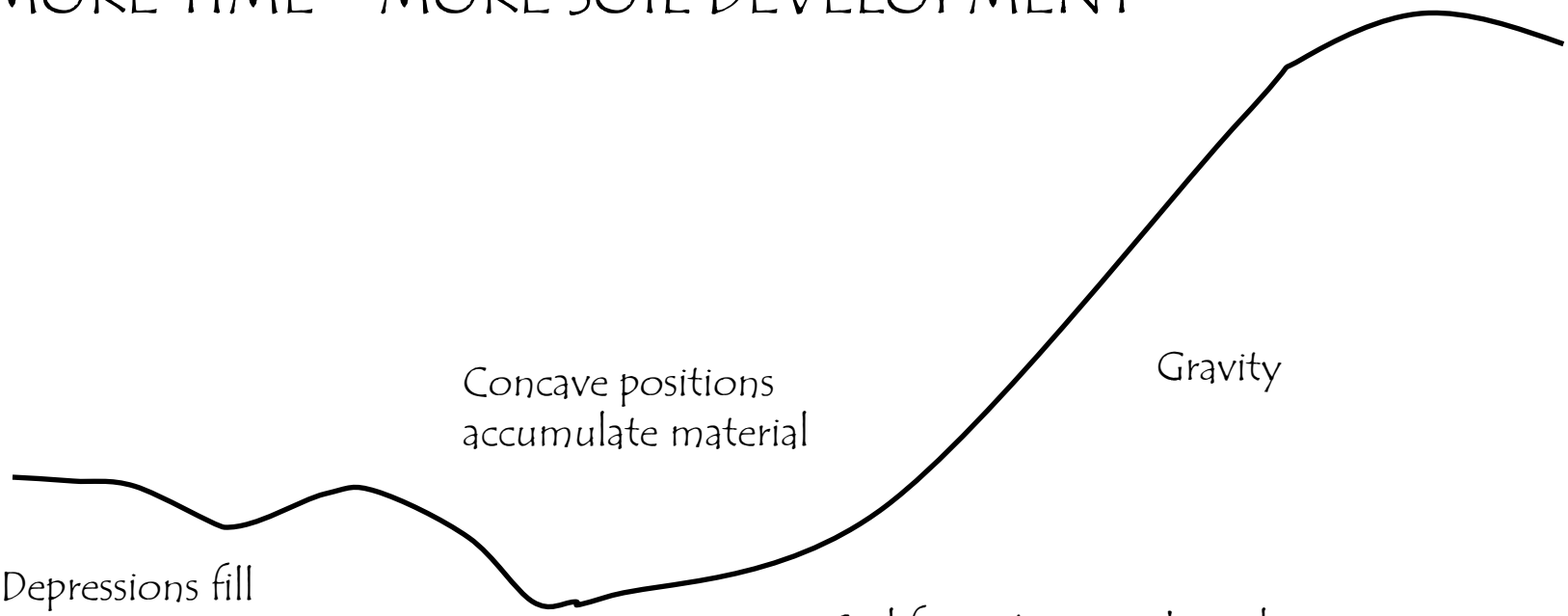
- Moved down a slope by gravity- colluvium
- Moved by wind – eolian
- Moved by water - alluvium
- Weathered In place – residuum
- Moved by ice- glacial



Time

Climate
Organisms
Relief
Parent Material

MORE TIME = MORE SOIL DEVELOPMENT

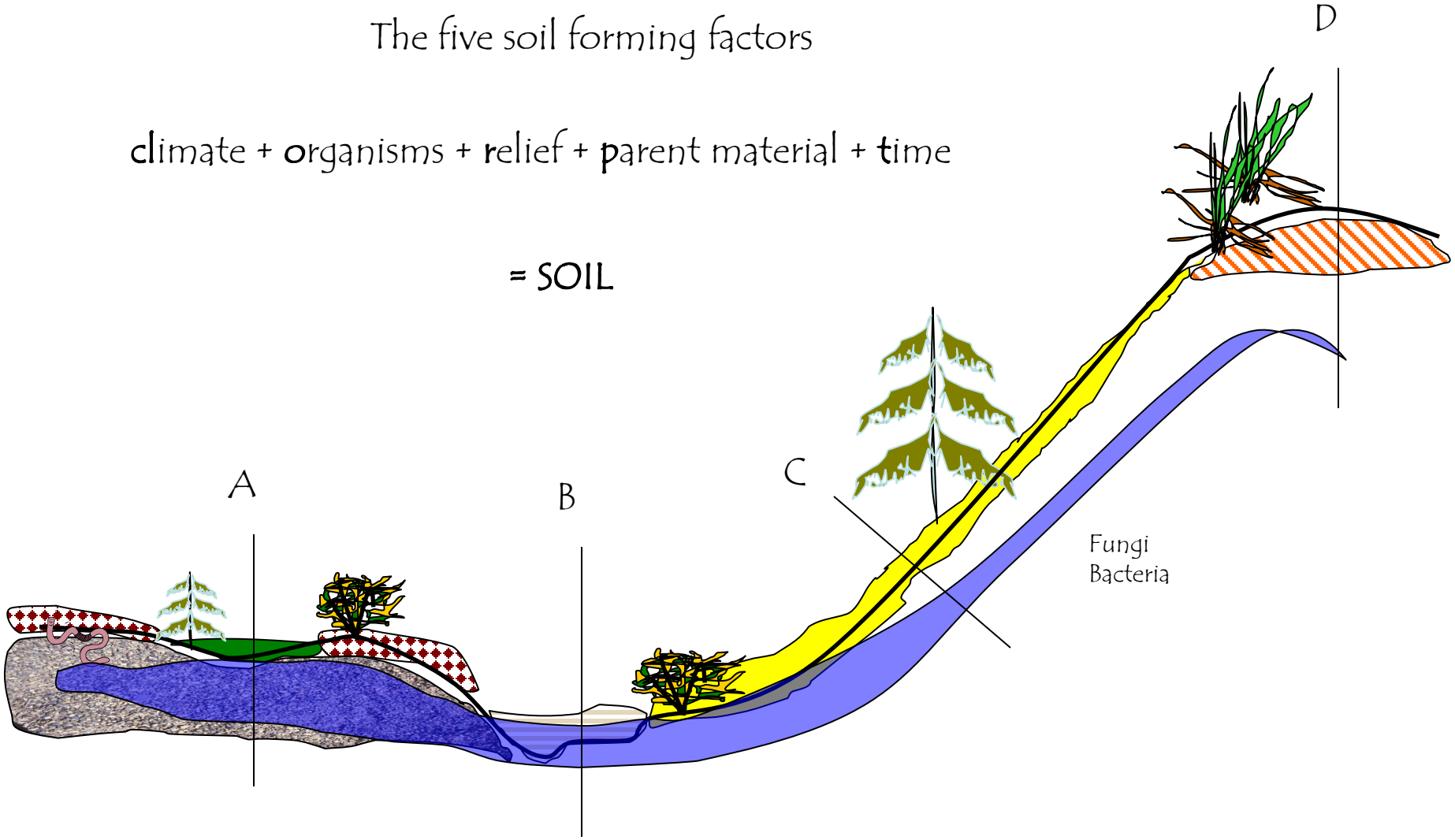


Soil formation can be a slow process
Long term changes happen over hundreds, thousands, or millions of years
Short term changes can be caused for example by human activity, fire, or floods

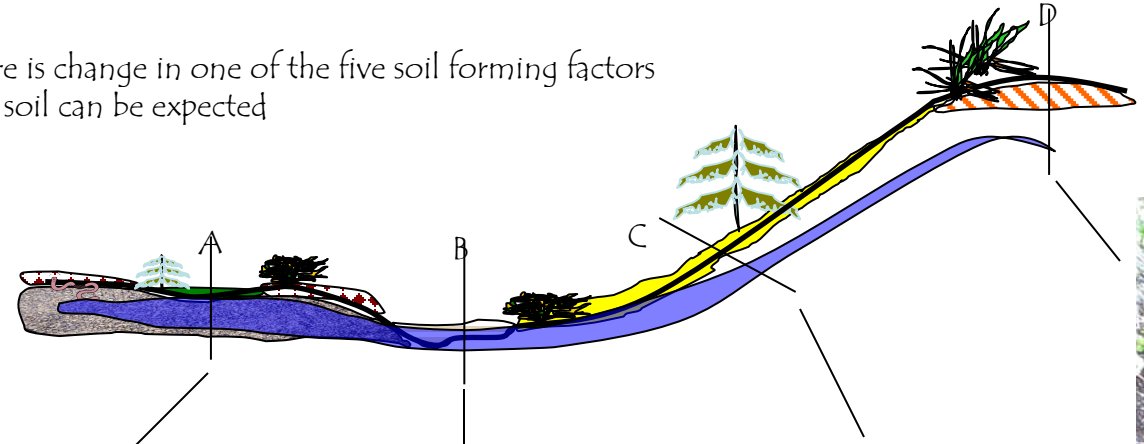
The five soil forming factors

climate + organisms + relief + parent material + time

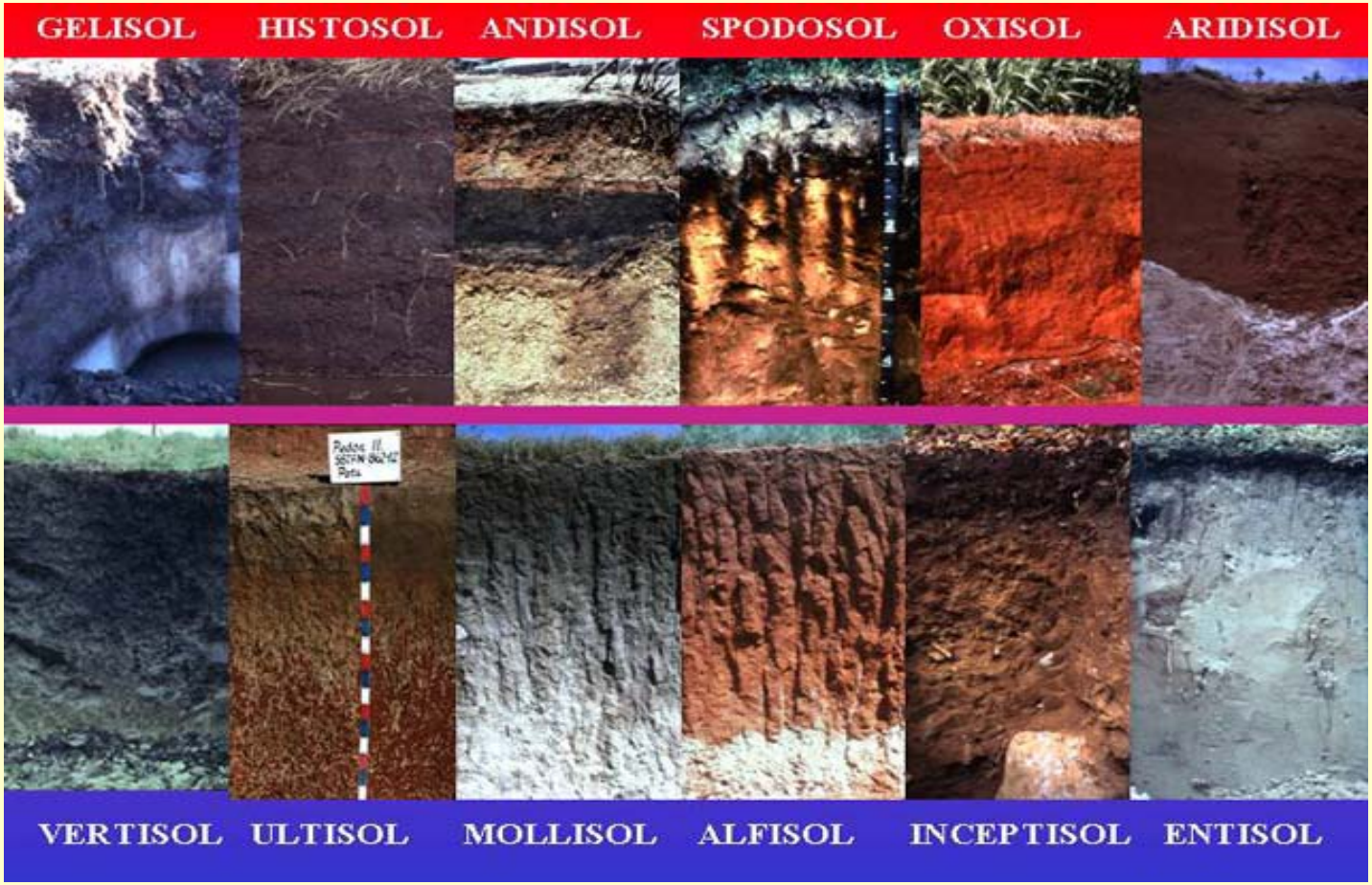
= SOIL



When there is change in one of the five soil forming factors
a different soil can be expected



Soil Orders



Entisols – new soils
Inceptisols – young soils
Gelisols – permafrost soils
Spodosols – conifer forest soils
Andisols – volcanic soils
Histosols – organic soils
Mollisols – prairie soils

Aridisols – desert soils
Vertisols – swelling clay soils
Alfisols – high-nutrient soils
Ultisols – low-nutrient soils
Oxisols – tropical forest soils

Climate
Organisms
Relief
Parent material
Time

Soil Properties

Soil Properties

Soil properties are characteristics of a soil

Depth
Texture
Structure
Color
Wetness
Available Water Holding Capacity
Permeability
Bulk Density
Erodibility
Temperature
Soil Fertility
pH

Soil Texture

- Three particle sizes determine the textural class

Sand 0.02 - 2.0 mm — largest "fine", often resistant minerals, e.g. quartz

Silt 0.002 to .05 mm — susceptible to erosion, very low chemical activity

Clay < .002 mm — very chemically active, large surface area, lots of "behavior"

pore size distribution
pore continuity
water holding capacity
soil fertility
soil reaction (pH)
hydraulic conductivity
strength
soil permeability

Gravels & cobbles

Small gravels

Sands & silt

clays

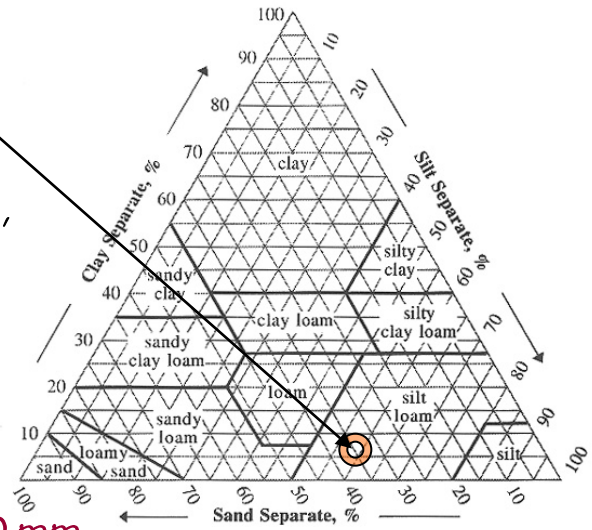
Textural Class

The percentage of sand sized particles
+ % of silt sized particles
+ % of clay sized particles

35 % sand
55 % silt
10 % clay

Texture is 'silt loam'

Clay < .002 mm



Sand 0.05 – 2.0 mm

Silt 0.002 to .05 mm

silt
Silt loam
loam
silty clay loam
loam
sandy loam
loamy sand
sandy clay loam
clay loam
clay
loamy sand
sand

→ SOIL TEXTURAL CLASSES

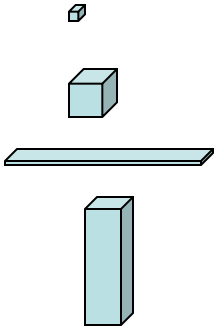
STRUCTURE

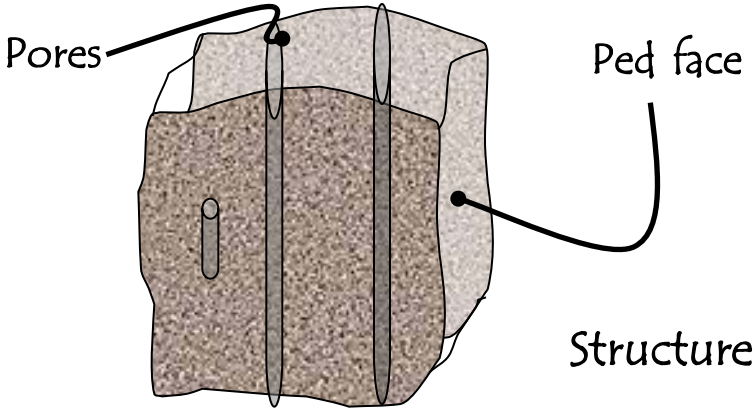
The aggregation of primary particles into secondary units surrounded by planes of weakness.

Initial material

wetting and drying
freezing and thawing
root action
animal activity

Granular
Blocky
Platy
Prismatic
Columnar
Massive





Porosity 30 to 60 % of ped volume

Structure is strongly correlated to many properties, particularly soil hydrology

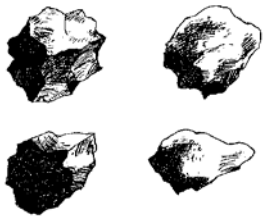
Soil Structure

-Types of Structure

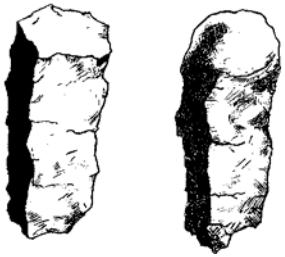
Granular – small and rounded

Platy – flattened

Angular and Sub angular Blocky – sharp and rounded edges respectively



Prismatic and Columnar – vertically elongated with flat and rounded tops respectively



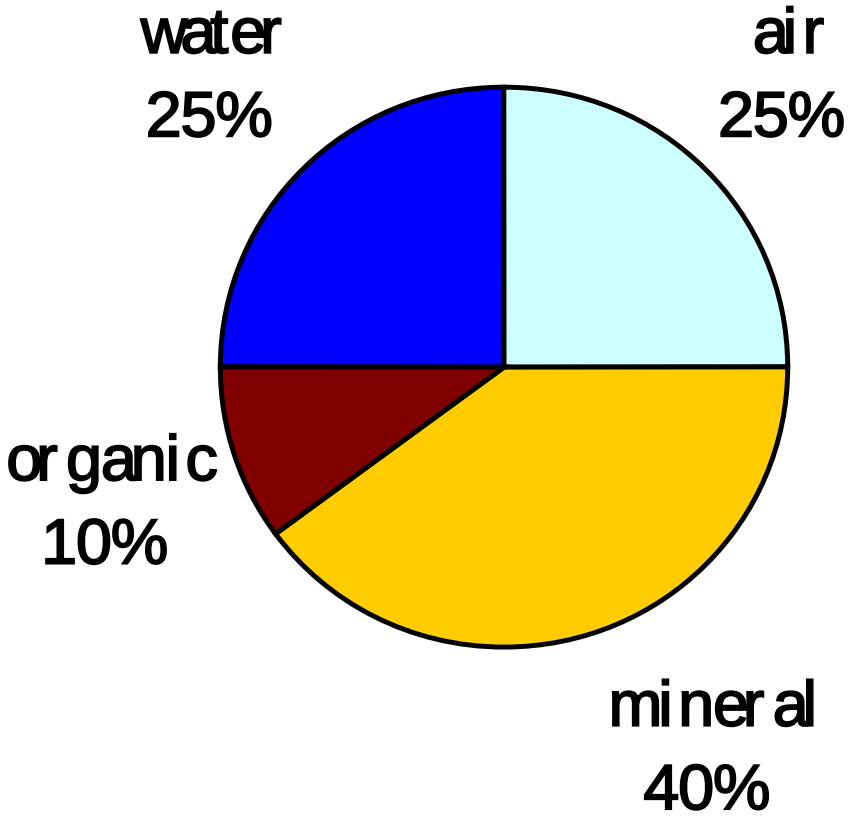
Single Grain – falls apart into loose grains (sands)

Massive – does not fall apart naturally into any coherent structure

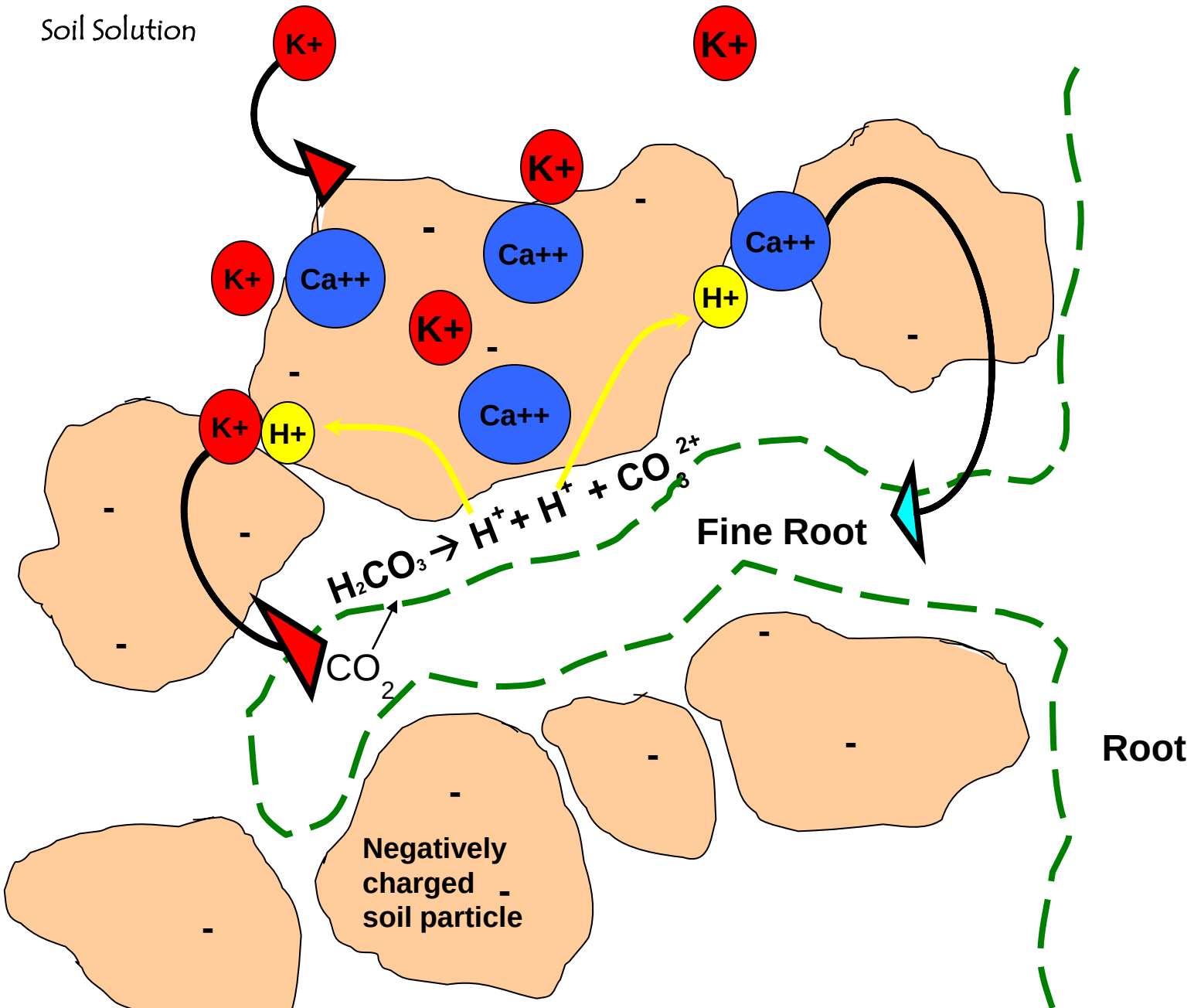
Structure influences

- -Pore space
- -Liquid and gas movement
- -Permeability

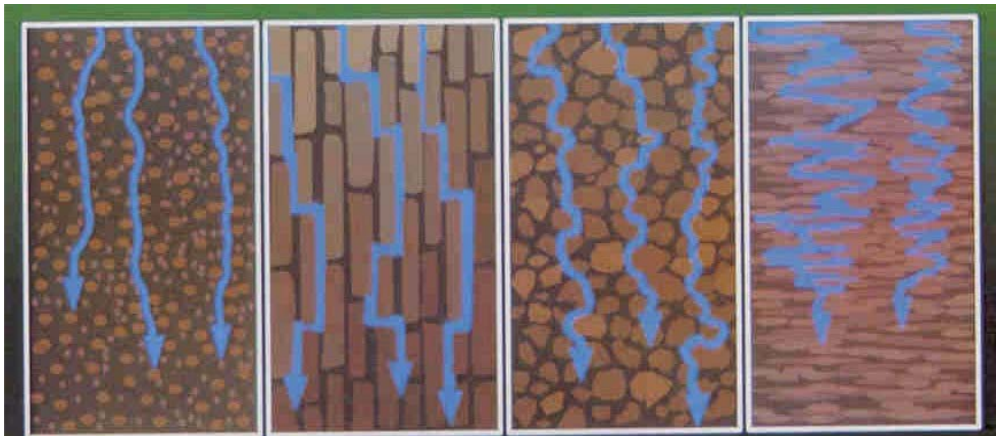
General proportions of a healthy soil



Cation Exchange in soils



Water movement through granular, prismatic, blocky, and platy structure



The ease at which water and other things such as gasses and plant roots move through soil is called **soil permeability**

Soil Color

- Color is an indication of
  - **Organic Compounds** – black or dark brown
  - **Iron Oxides** – red, orange, yellow
  - **Color of Mineral grains** – variable
- Observed using moist soil and a Munsell Color Book
  - Example: 10YR3/4
  - Color referred to by:
    - Hue = 10YR
    - Value = 3
    - Chroma = 4
- Matrix Color
    - Dominant color of soil horizon
    - Less dominant colors are recorded as secondary colors
    - Mottles (splotches of color) are also recorded
      - Redoximorphic features or relic from parent material
- Redoximorphic (oxidation/reduction) Features
  - Indication that soil is saturated for sometime during the year
  - Redox **depletions** (reduction)
    - low chroma
      - Fe and Mn have been stripped from soil
  - Redox **concentrations** (oxidation)
    - high chroma
      - Accumulation of Fe and Mn oxides

Redox Concentrations and Depletions

Soil Color

Organic matter accumulation

Iron

-Fe –

-depletion

&

accumulation

wet conditions

Aluminum accumulation

Color may not tell us much about fertility unless organic matter is involved

Soil pH

- pH is the measure of the acidity or alkalinity of the soil and is based on a scale from 0 to 14 with 0 being ultra acid and 14 being ultra alkaline
- pH influences nutrient availability, rate of biological and chemical processes, the amount and types of plants and microorganisms present, and the corrosion potential of concrete or steel structures in the soil
- Examples of pH classes:
  - Very strongly acid: 4.5 to 5.0
  - Strongly Acid: 5.1 to 5.5
  - Moderately Acid: 5.6 to 6.0
  - Slightly Acid: 6.1 to 6.5
  - Neutral: 6.6 to 7.3
  - Slightly Alkaline: 7.4 to 7.8
  - Moderately Alkaline: 7.9 to 8.4
- You can alter the soil pH by incorporating compounds in to the soil. The most common is to add lime (calcium carbonate, $CaCO_3$) to increase the pH.

Soil Profiles

Soil Profile

An exposed vertical cut of the soil

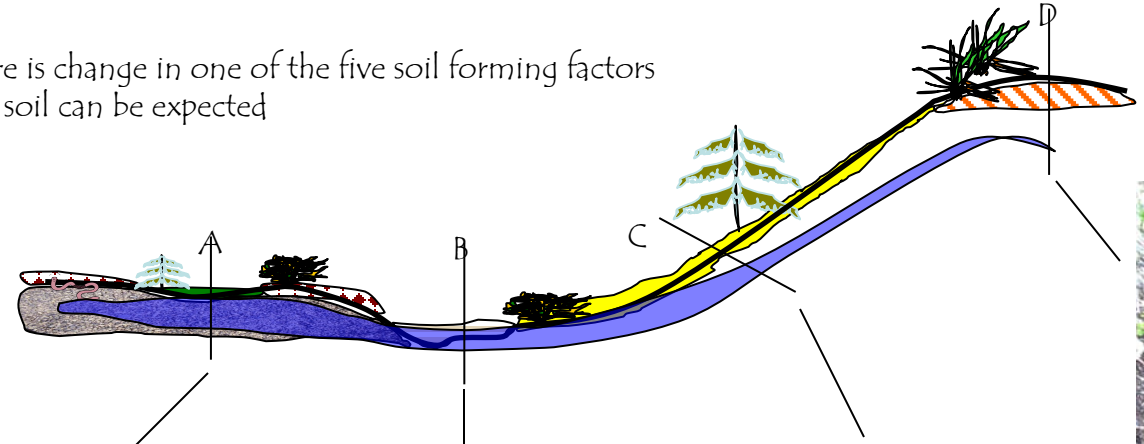
Soil Layers

- Tell a story about how the soil was formed
- Different soil layers have differences in soil properties
  - Texture
  - Color
  - pH
  - Structure

Soil Horizons

O	organic matter accumulation and decay
A	darkening due to organic matter accumulation
E	Depletion, **Elluviation**, loss
B	zones of **Illuviation**, accumulation, gain.
C	generally un- or very slightly weathered initial material
R	unweathered bedrock

When there is change in one of the five soil forming factors
a different soil can be expected



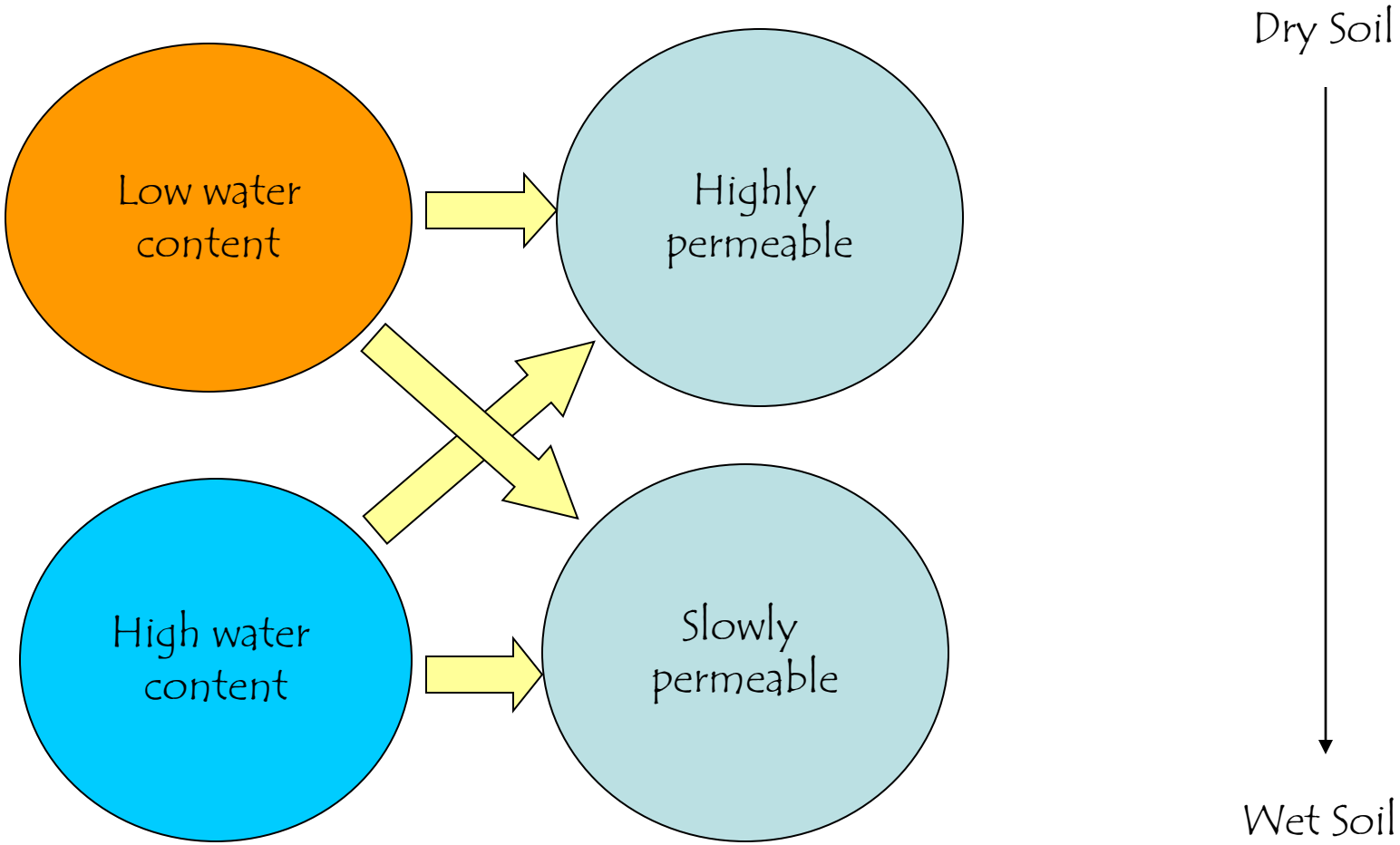
Soil Drainage

6 Soil drainage classes

Water saturates the soil at this depth for 2 weeks or more during the growing season

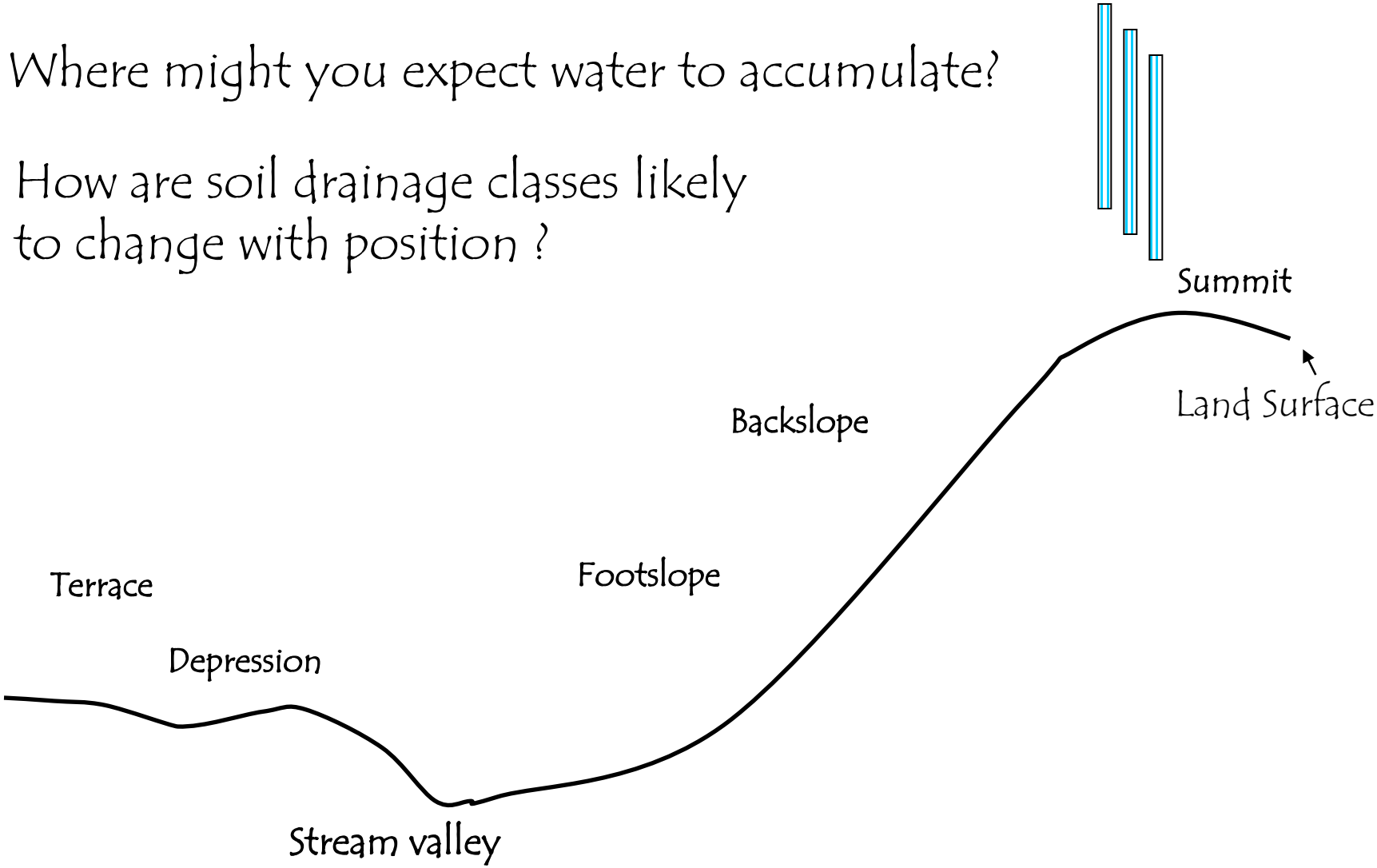
	Depth to water table
Very poorly drained →	< 25 cm
Poorly drained →	25 to 50 cm
Somewhat poorly drained →	50 to 75 cm
Moderately Well drained →	75 - 150cm
Well drained →	> 150 cm
Excessively drained →	> 150 cm

Wetness and permeability = Soil Drainage



Where might you expect water to accumulate?

How are soil drainage classes likely to change with position ?

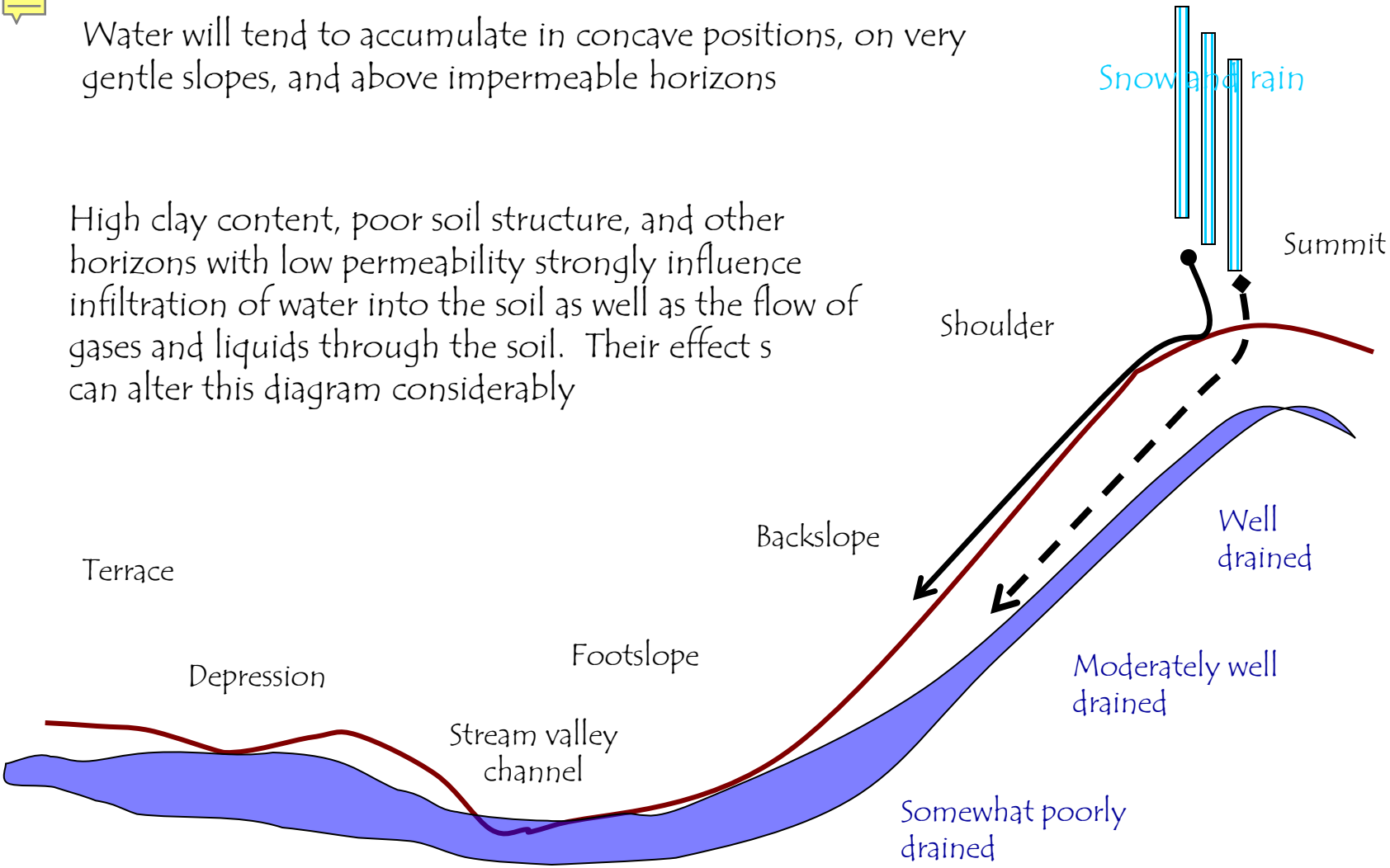


What are the properties of the landform that influence soil drainage?

How do soil properties affect water distribution?

Water will tend to accumulate in concave positions, on very gentle slopes, and above impermeable horizons

High clay content, poor soil structure, and other horizons with low permeability strongly influence infiltration of water into the soil as well as the flow of gases and liquids through the soil. Their effect s can alter this diagram considerably



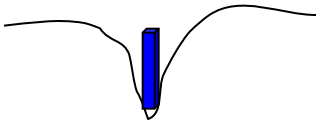
Slope shape
position relative to catchment area above
aspect
steepness
complexity, is it undulating, rolling,
distribution of stratigraphic layers

Recognize that rain also falls in the valley

Soil Erosion

Erosion – The wearing away of the land surface by running water, waves, moving ice, wind, or gravity .

If water concentrates and forms deep narrow channels that's called GULLEY erosion



A uniform, thin dispersed flow of water will erode shallow small channels in SHEET or RILL erosion

Gravity wants everything at the bottom

EROSION

How are the properties of the landform related to erosion?

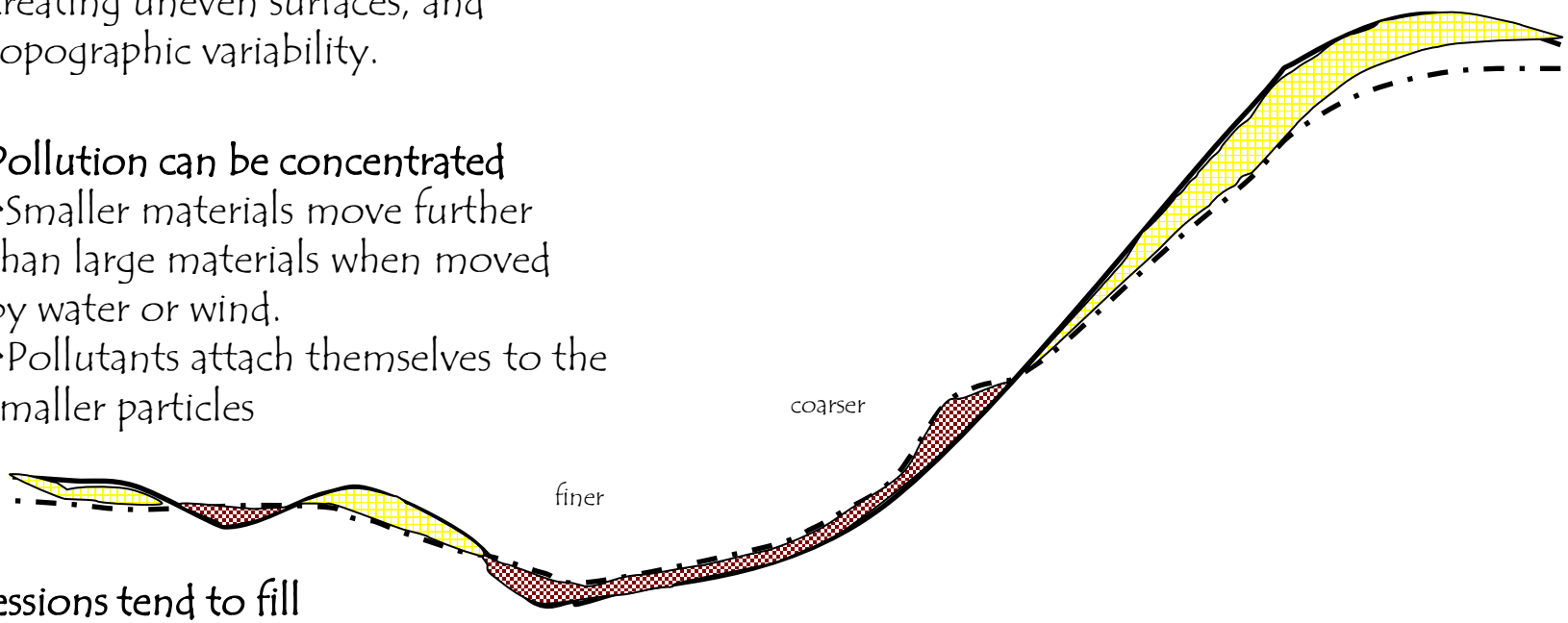
How will position on the landform affect the erosion process?

Landslides redistribute and mix material creating uneven surfaces, and topographic variability.

Pollution can be concentrated

- Smaller materials move further than large materials when moved by water or wind.
- Pollutants attach themselves to the smaller particles

Convex positions tend to lose material



Depressions tend to fill

Concave positions tend to accumulate material

Geologic erosion is a member of the set of processes that has formed the Homer bluff and bench

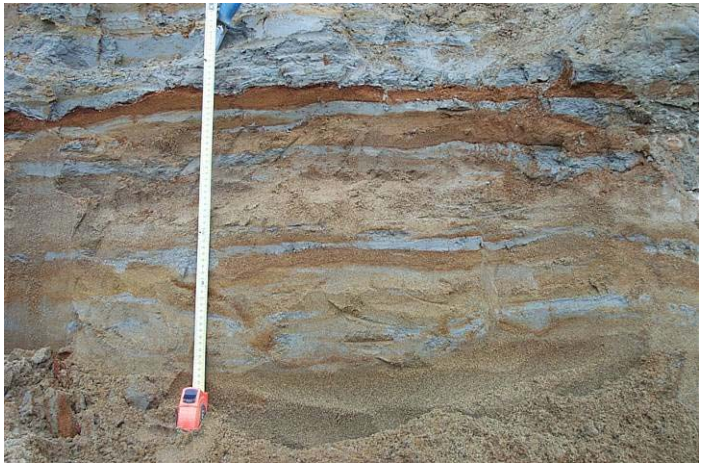
Hydric Soils

A **hydric soil** is a wet soil. It formed under conditions of saturation, flooding, or ponding.

Hydric soils are used to classify wetlands. To be classified as a wetland the site must have three things: hydric soils, hydrophytic vegetation and wetland hydrology.

Soils are the most stable of the three wetland indicators

Common criteria for hydric soils



- Hydric soils tend to have thick organic surfaces

- Redoximorphic features
  - Concentrations
  - Depletions
  - Gleyed matrix

Why do we want to protect wetlands?

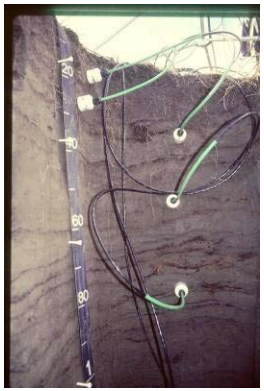
Wetlands…

- Provide wildlife and rare species habitat. Many species of fish utilize wetlands for spawning, food sources, or protection. 43 per cent of threatened or endangered species in the U.S. live in or depend on wetlands .
- Provide recreational opportunities for canoeing, bird watching, hunting, fishing, and photographing.
- Control floods by slowing runoff water, minimizing the frequency streams and rivers reach catastrophic flood levels.
- Provide erosion control along lakes and stream banks by reducing forces associated with wave action.
- Improve water quality by acting as a filter for pollutants and by allowing sediments to settle out.

Soil Survey

Soil Survey

Process for inventory of distribution and characterization of soils and soil properties

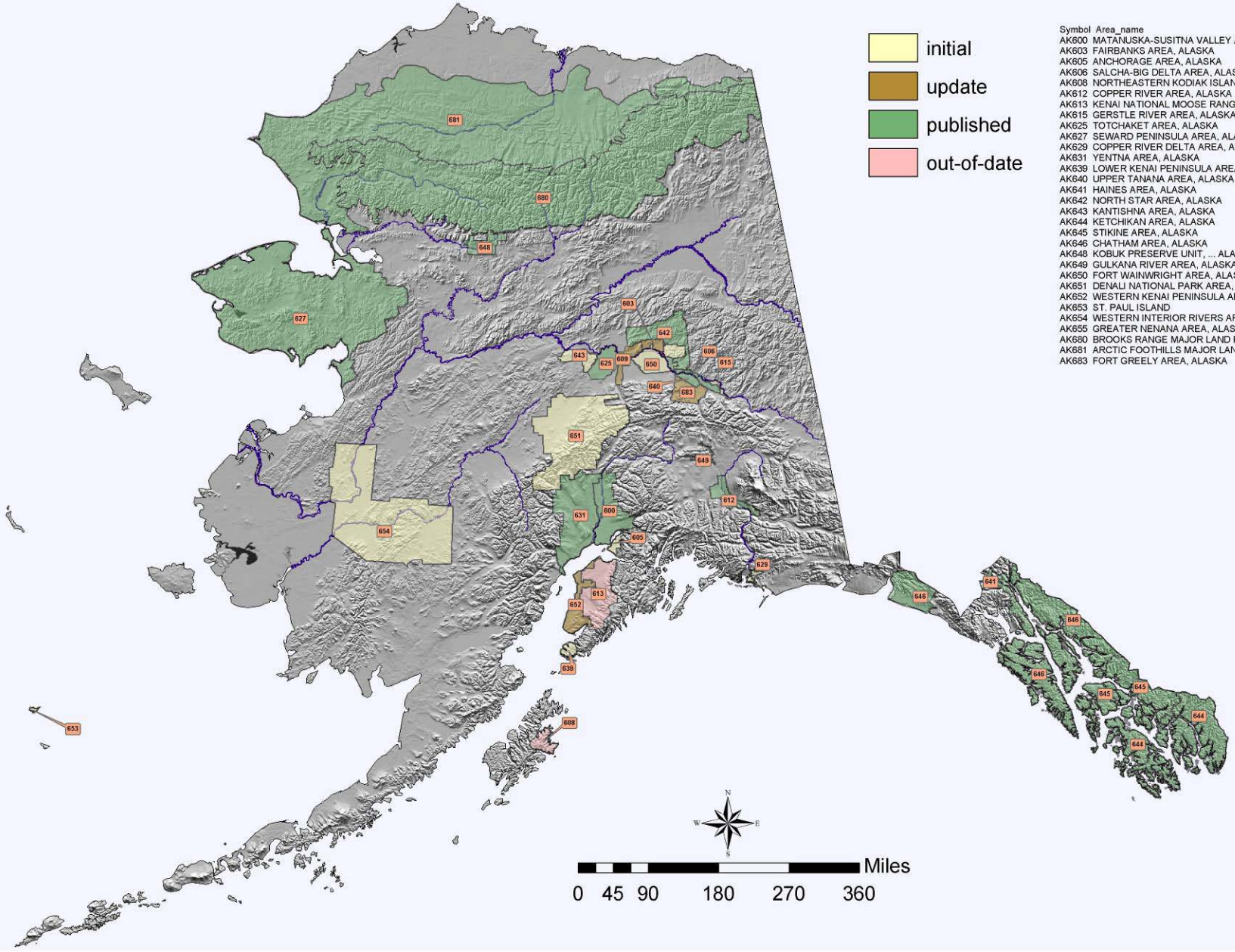


Field data
collection,
Interpretation
Aerial photo
interpretation
Map Unit
development
Map production

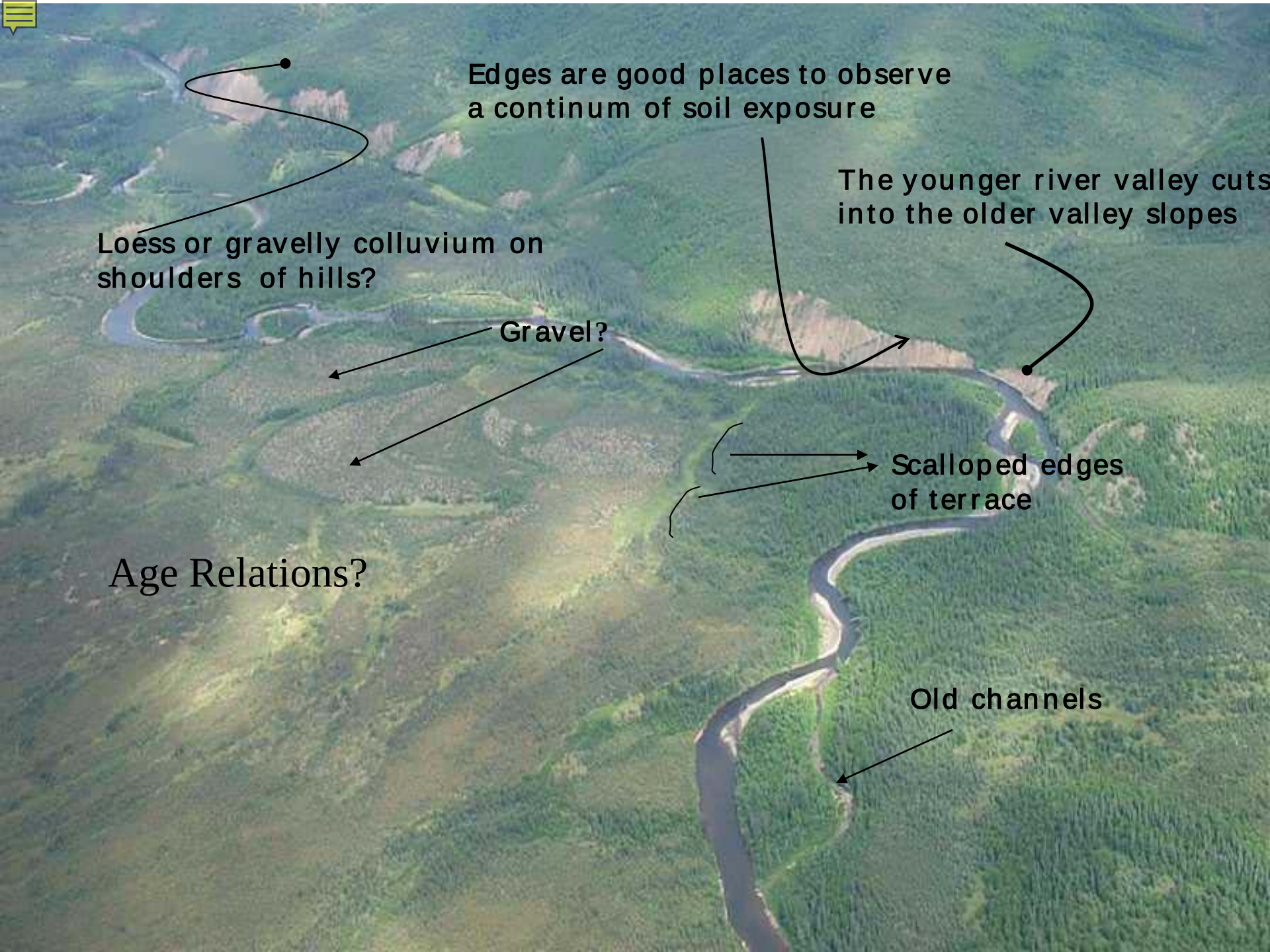
Spreadsheets
Imagery
Remote sensing
GIS
Terrain Analysis
Interpretation

Soil maps
Map Unit descriptions
Soil -Vegetation
correlations
Interpretations
Suitability tables
Limitation tables

Soil Survey in Alaska



Symbol	Area_name
AK600	MATANUSKA-SUSITNA VALLEY AREA, ALASKA
AK603	FAIRBANKS AREA, ALASKA
AK605	ANCHORAGE AREA, ALASKA
AK606	SALCHA-BIG DELTA AREA, ALASKA
AK608	NORTHEASTERN KODIAK ISLAND AREA, ALASKA
AK612	COPPER RIVER AREA, ALASKA
AK613	KENAI NATIONAL MOOSE RANGE AREA, ALASKA
AK615	GERSTLE RIVER AREA, ALASKA
AK625	TOTCHAKET AREA, ALASKA
AK627	SEWARD PENINSULA AREA, ALASKA
AK629	COPPER RIVER DELTA AREA, ALASKA
AK631	YENTNA AREA, ALASKA
AK639	LOWER KENAI PENINSULA AREA, ALASKA
AK640	UPPER TANANA AREA, ALASKA
AK641	HAINES AREA, ALASKA
AK642	NORTH STAR AREA, ALASKA
AK643	KANTISHNA AREA, ALASKA
AK644	KETCHIKAN AREA, ALASKA
AK645	STIKINE AREA, ALASKA
AK646	CHATHAM AREA, ALASKA
AK648	KOBUK PRESERVE UNIT, ... ALASKA
AK649	GULKANA RIVER AREA, ALASKA
AK650	FORT WAINWRIGHT AREA, ALASKA
AK651	DENALI NATIONAL PARK AREA, ALASKA
AK652	WESTERN KENAI PENINSULA AREA, ALASKA
AK653	ST. PAUL ISLAND
AK654	WESTERN INTERIOR RIVERS AREA, ALASKA
AK655	GREATER NENANA AREA, ALASKA
AK680	BROOKS RANGE MAJOR LAND RESOURCE AREA
AK681	ARCTIC FOOTHILLS MAJOR LAND RESOURCE AREA
AK683	FORT GREELY AREA, ALASKA


Edges are good places to observe
a continum of soil exposure
The younger river valley cuts
into the older valley slopes
Loess or gravelly colluvium on
shoulders of hills?
Gravel?
Scalloped edges
of terrace
Age Relations?
Old channels

CLORPT

Climate
Organisms
Relief
Parent material
Time