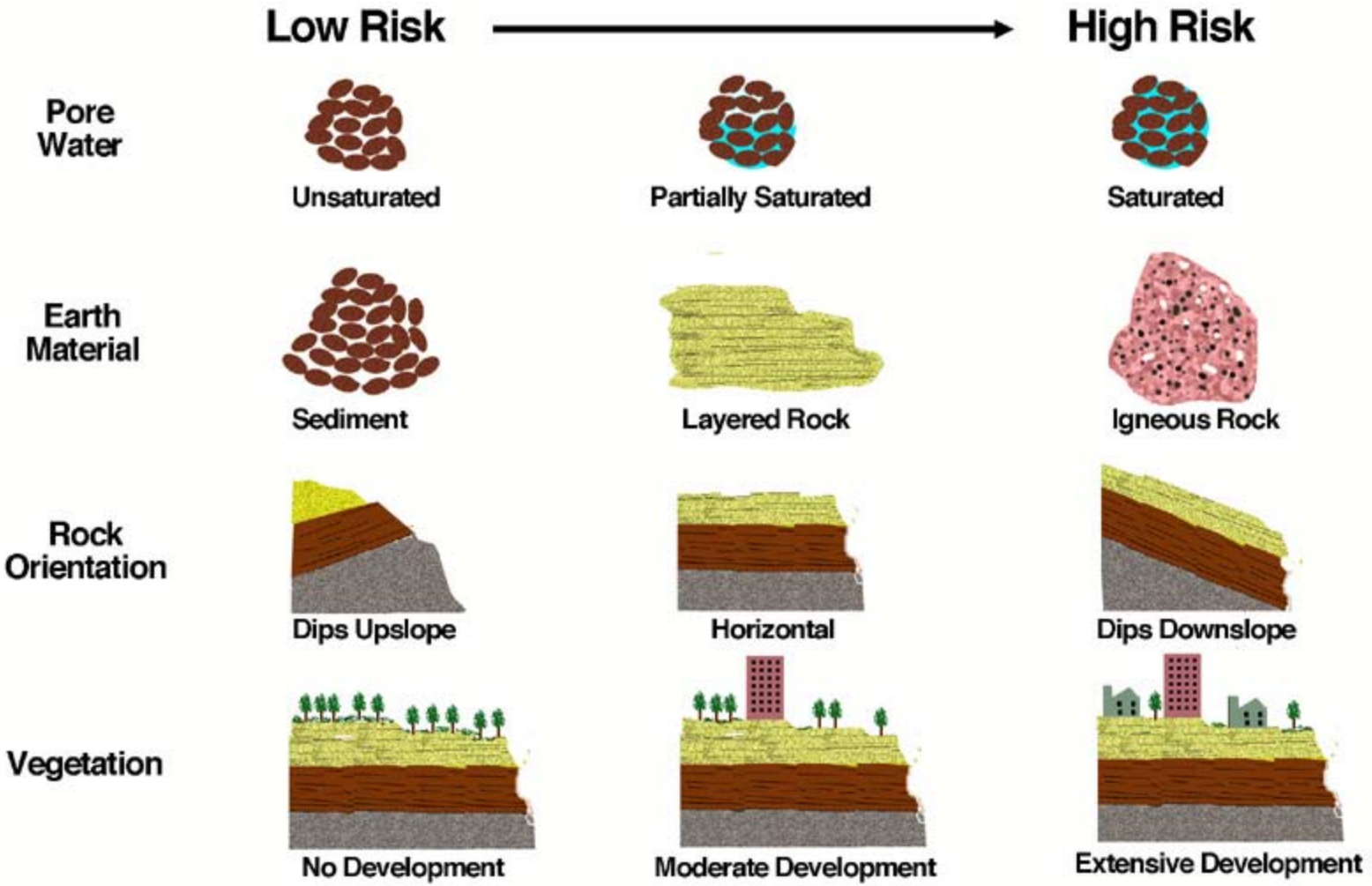
AP Environmental Science

Earth Systems-Part 6

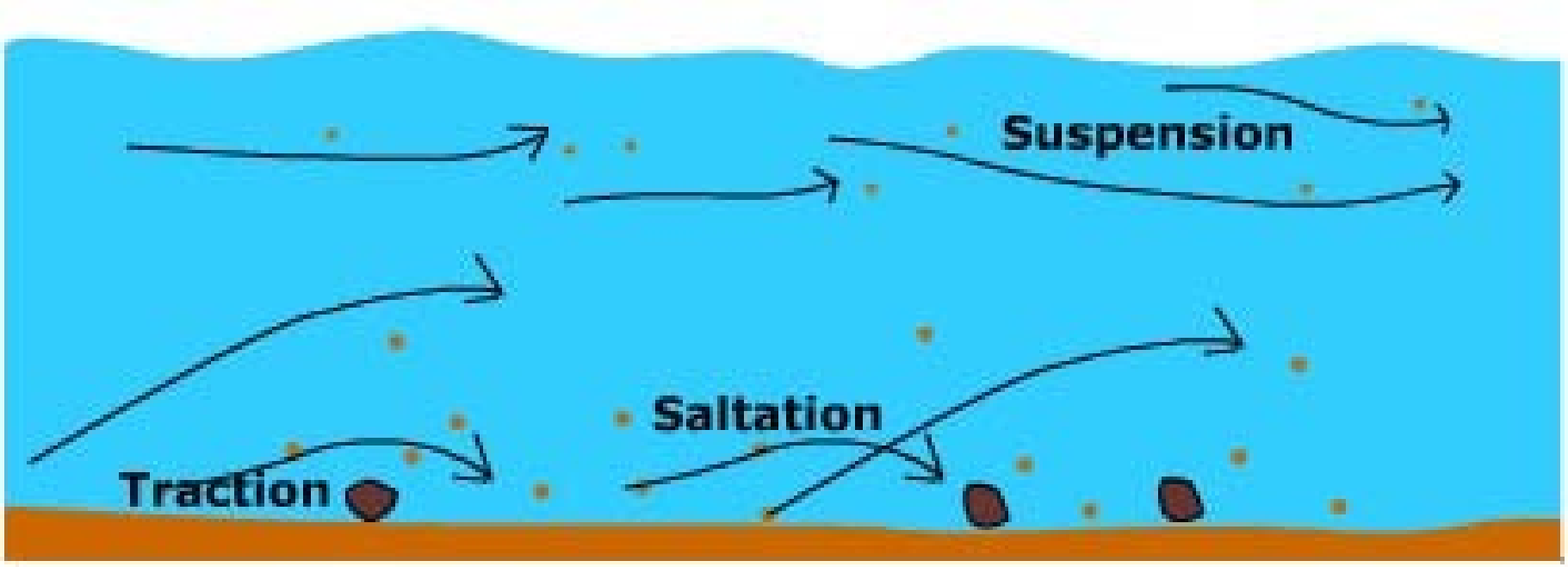

Low Risk
High Risk
Pore Water
Unsaturated
Partially Saturated
Saturated
Earth Material
Sediment
Layered Rock
Igneous Rock
Rock Orientation
Dips Upslope
Horizontal
Dips Downslope
Vegetation
No Development
Moderate Development
Extensive Development

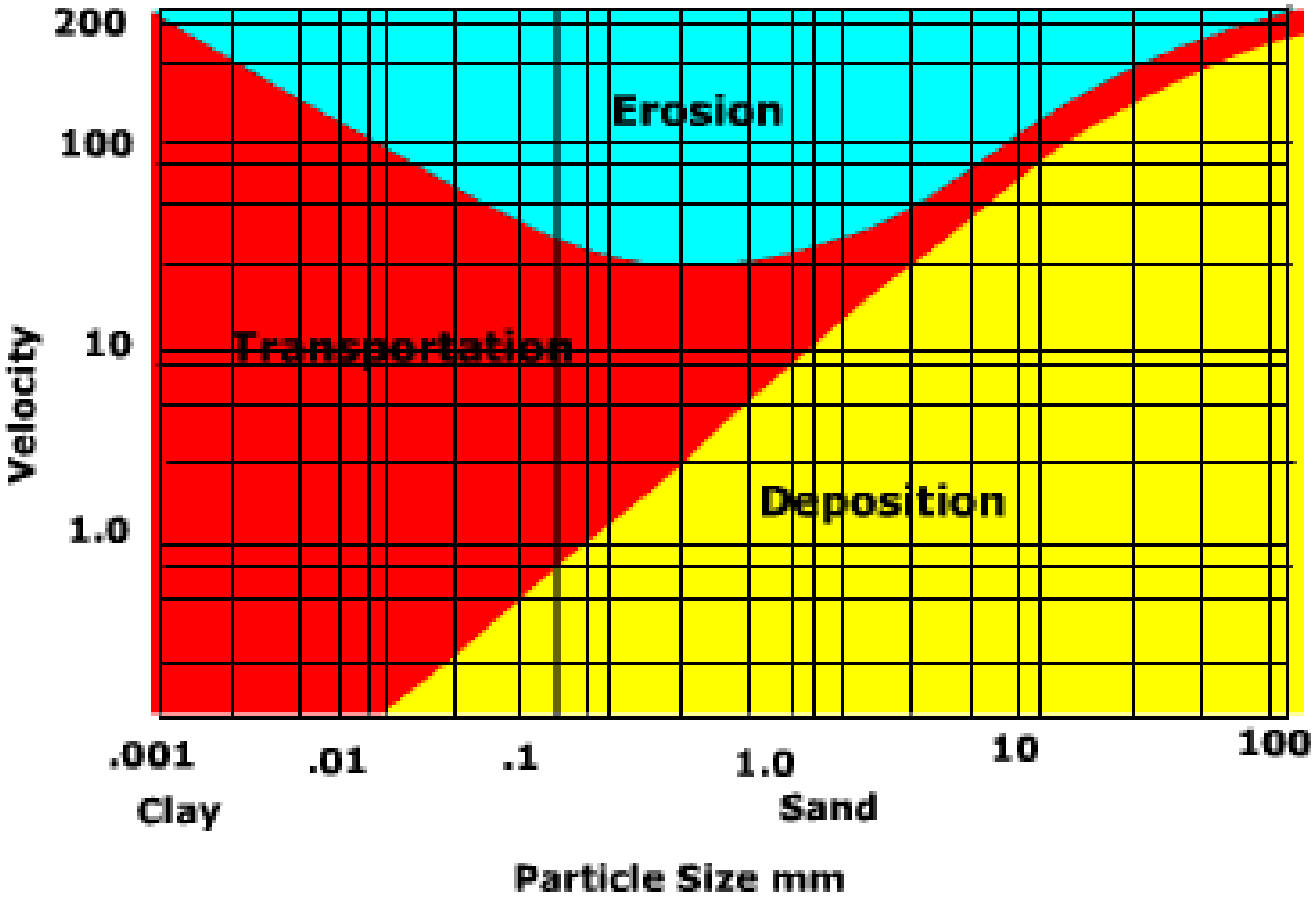
Rockslide on I-40, on NC and Tn Border

Erosion in Fluvial Systems

- Water is the most powerful agents of erosion
- The major factor affecting the erosive force of a stream is its velocity
  - Stream velocity is determined by the gradient of the stream
  - The faster a stream moves the more sediments it can move, the higher its sediment load can be- the higher its sediment capacity

- Sediment Load is divided up into three categories
  - **Bed Load-** large gravels, cobbles, boulders that move sporadically along the bottom of a stream
  - **Suspended Load-** total amount of finer silts, sands and clay particles that are carried by the flowing water
  - **Chemical Load-** chemical compounds taken into solution by the action of the water
- The total amount of sediment transported from a drainage basin is called the **sediment yield**


Suspension
Saltation
Traction


200
100
10
1.0
Velocity
Erosion
Transportation
Deposition
.001
.01
.1
1.0
10
100
Clay
Sand
Particle Size mm

- Factors affecting the sediment yield of a drainage basin
  - Geology
  - Vegetation (distribution, type, density)
  - Stream Gradients/ Hydrologic Characteristics
  - Climatic Conditions
  - Land use in the basin

Buffalo River – Minnesota – High Sediment Load

Skawa River in Poland during Flood in 2001

Splash Erosion

Sheet Erosion

Rill Erosion

Gully Erosion

Stream and Channel Erosion

- Influenced by the volume and velocity of runoff
  - Faster water cuts down deepening the channel, erosion of the stream banks widens the channel
  - Typically cuts V-shaped channels and river valleys

Types of Water Induced Erosion

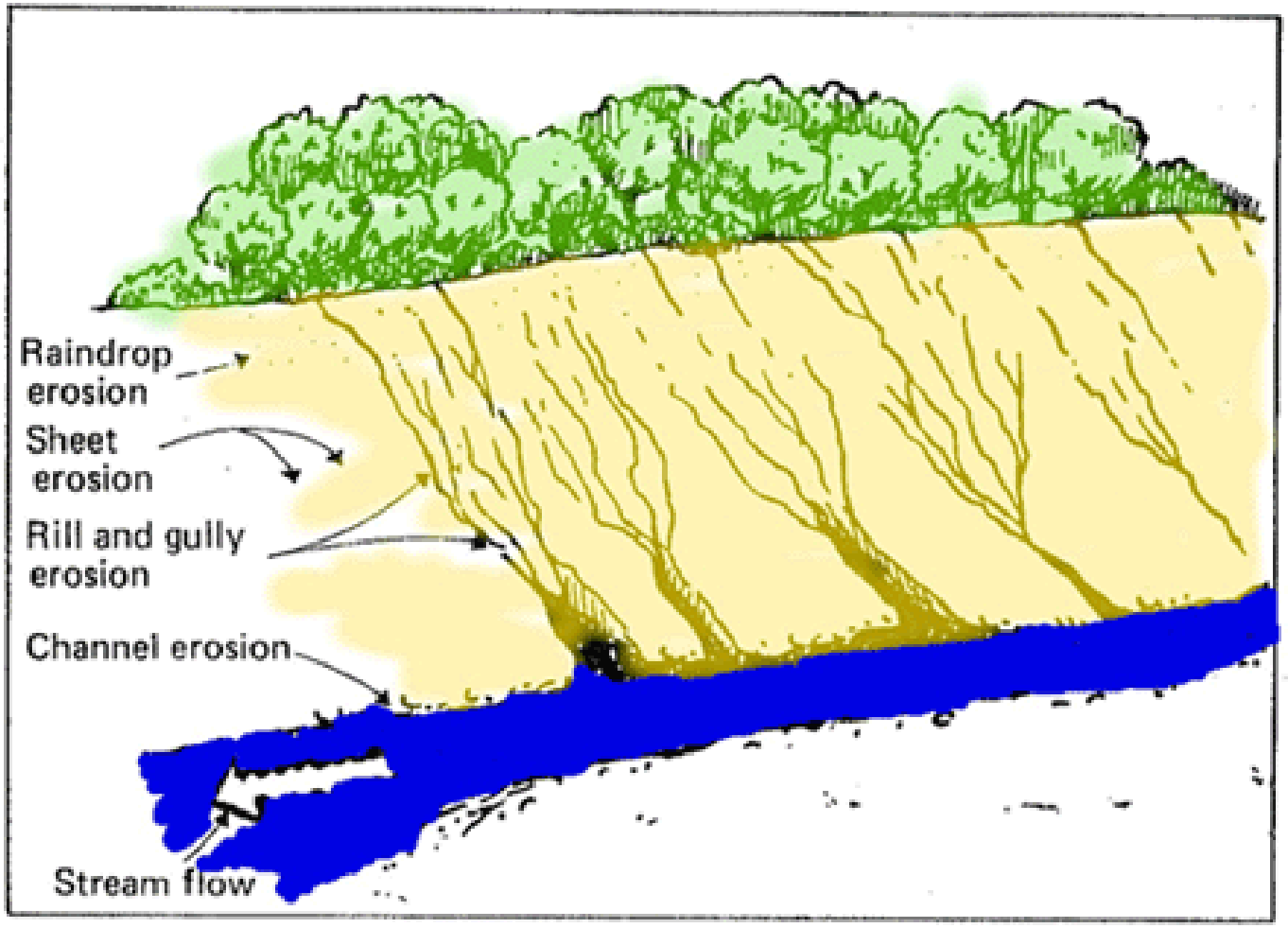
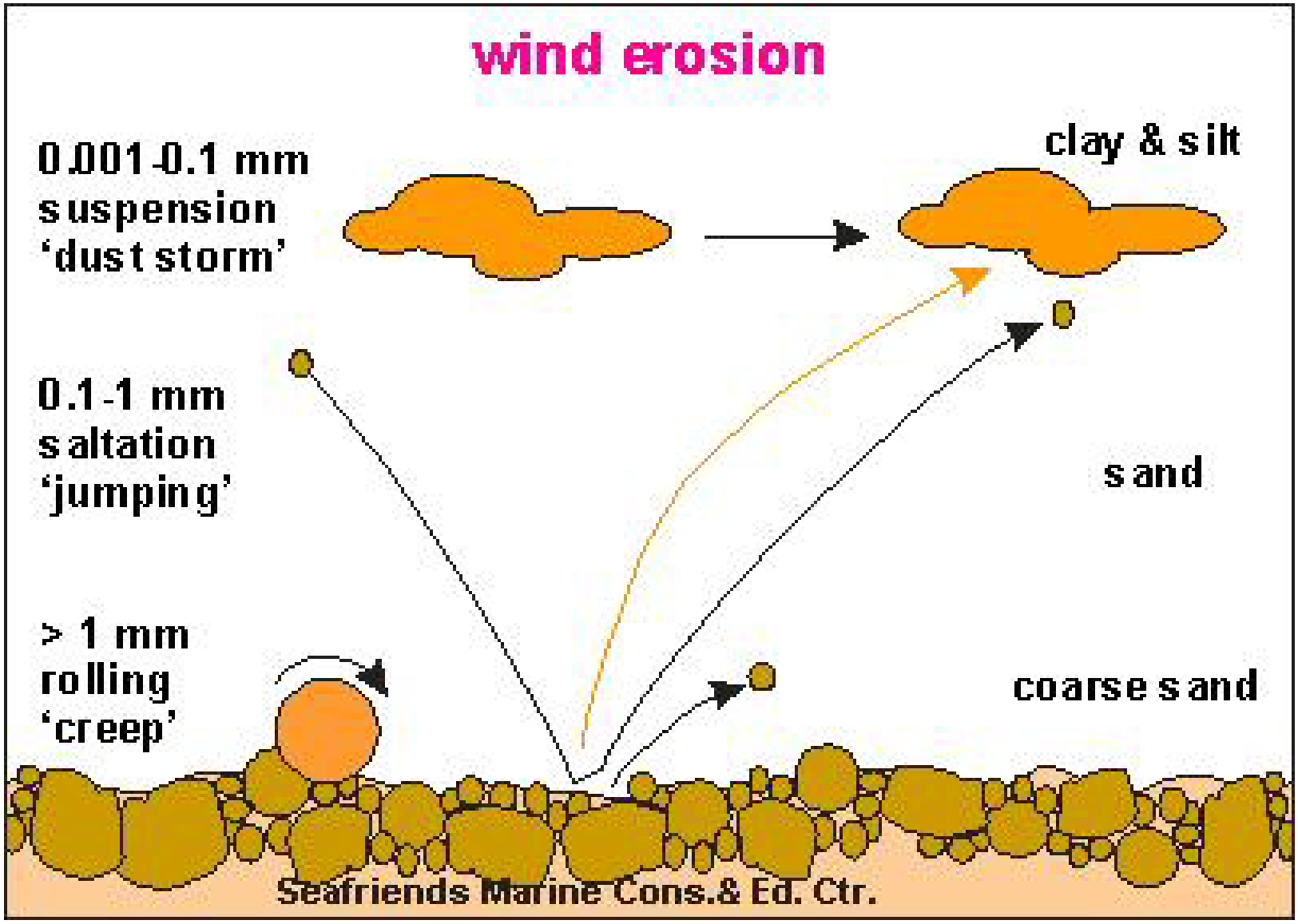


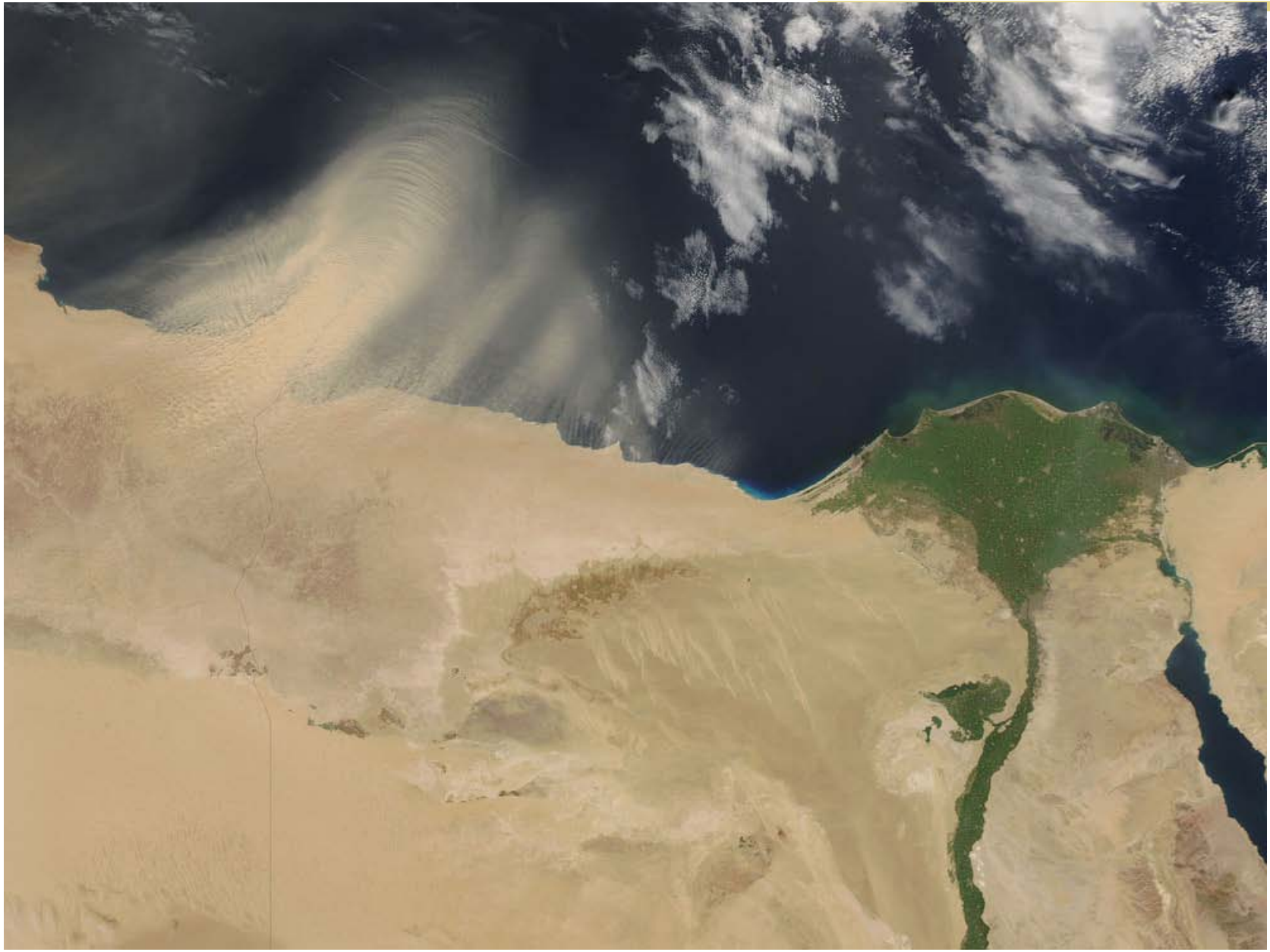
Fig. 1.3 Types of erosion. (Adapted from 1)

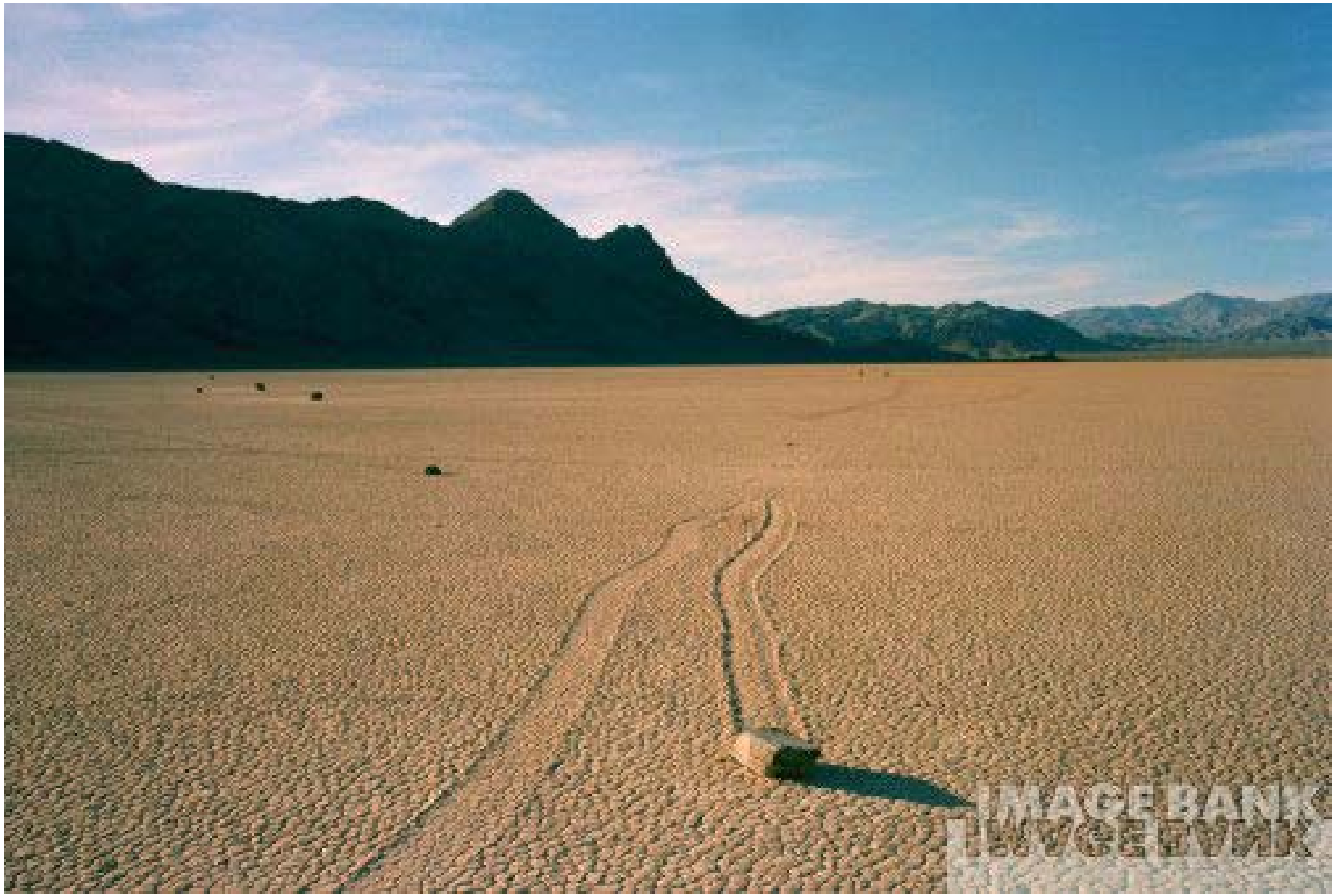
Other Erosive Agents

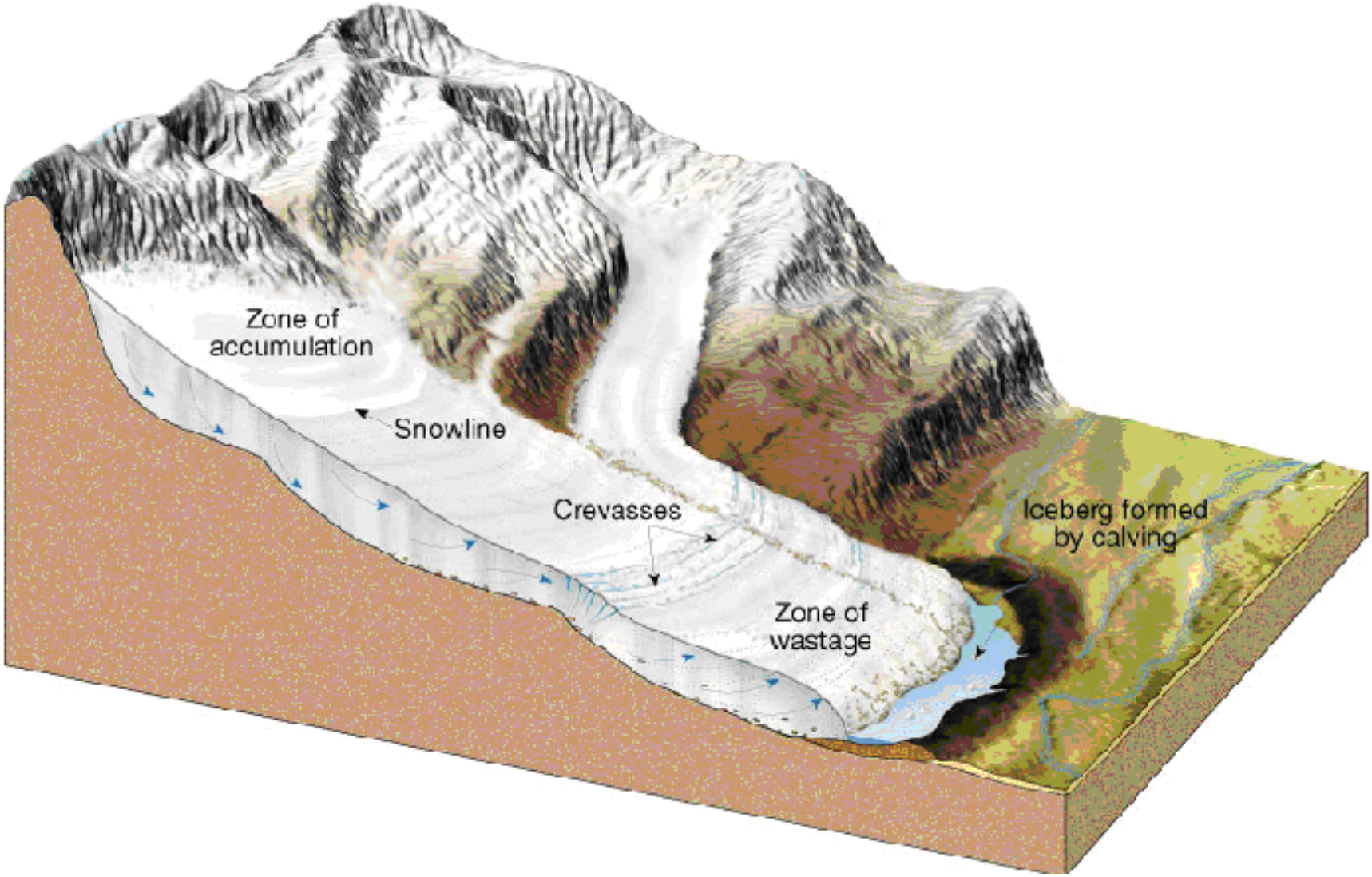
- Wind Erosion (Aeolian Erosion)
  - Wind is only capable of moving smaller sediments sand, silt and dust, it can on occasion push larger boulders
- Glacial Erosion
  - The enormous mass of glaciers can move and deposit any size sediments, and can move large objects very easily. Rocks imbedded in the bottom of the glacier leave scars in the bedrock and exposed rocks

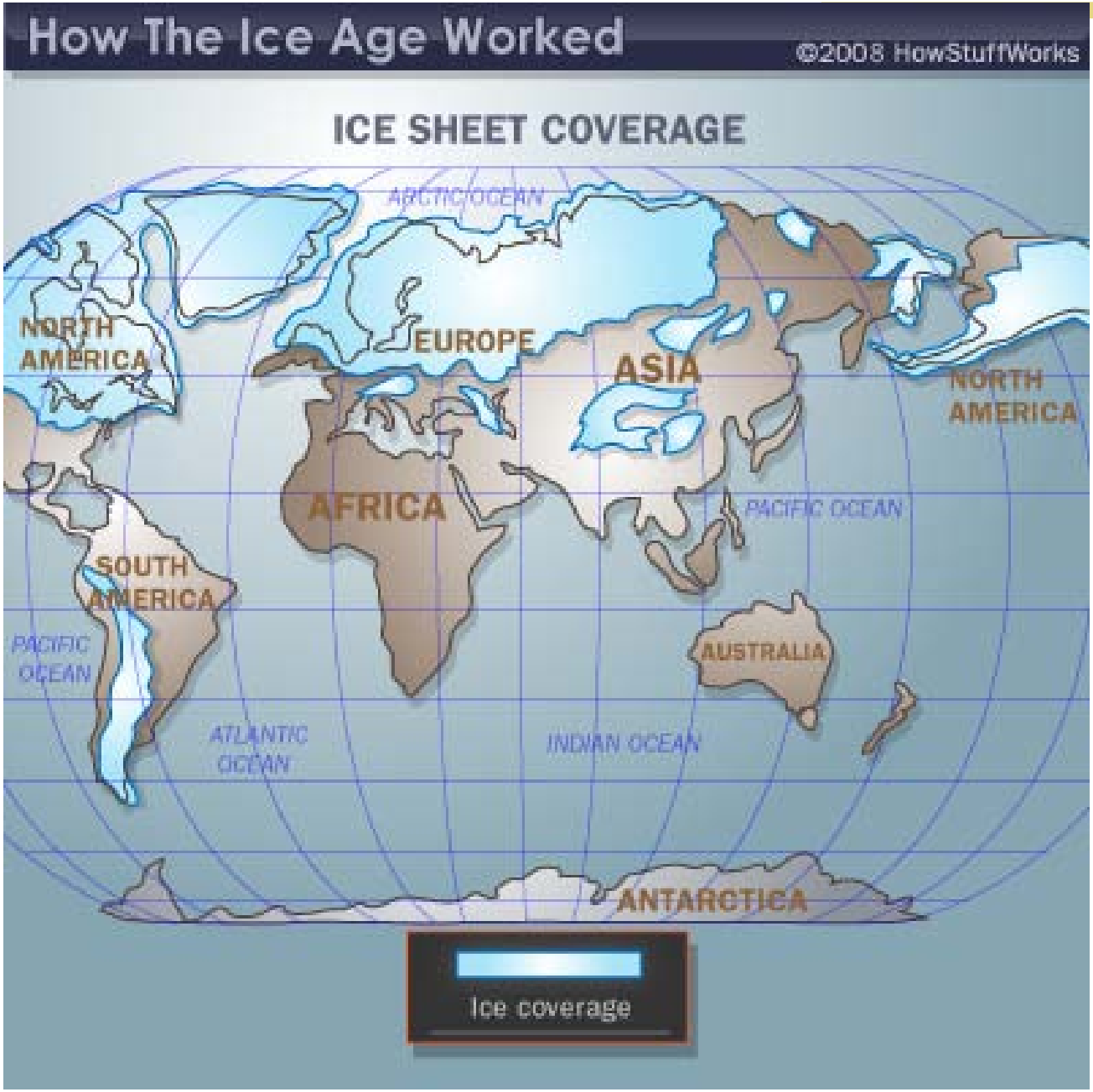

wind erosion
0.001-0.1 mm
suspension
'dust storm'
clay & silt
0.1-1 mm
saltation
'jumping'
sand
> 1 mm
rolling
'creep'
coarse sand
Seafriends Marine Cons.& Ed. Ctr.

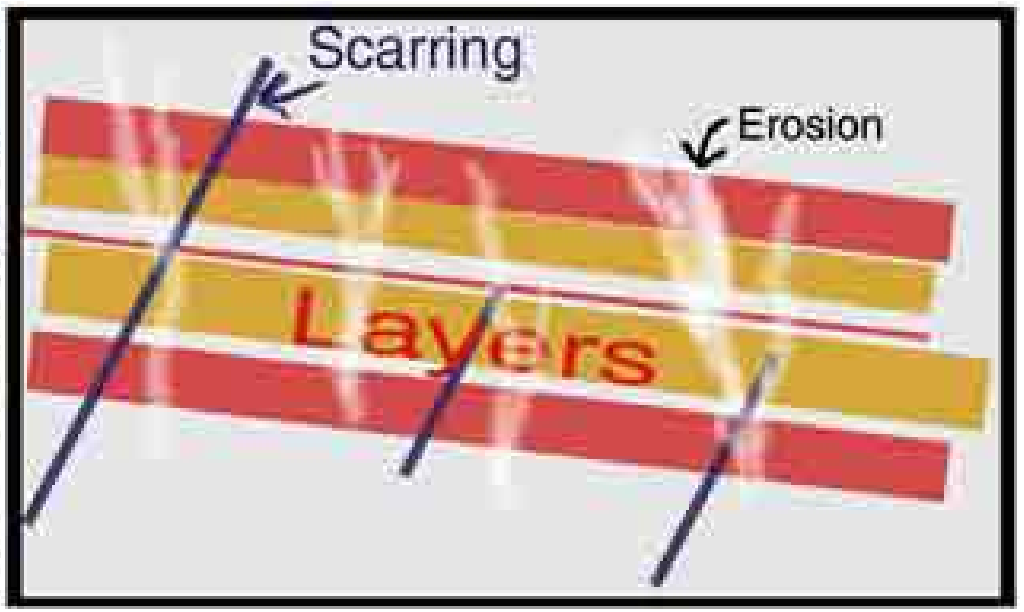
Rock sculpted by wind, Utah




IMAGEBANK

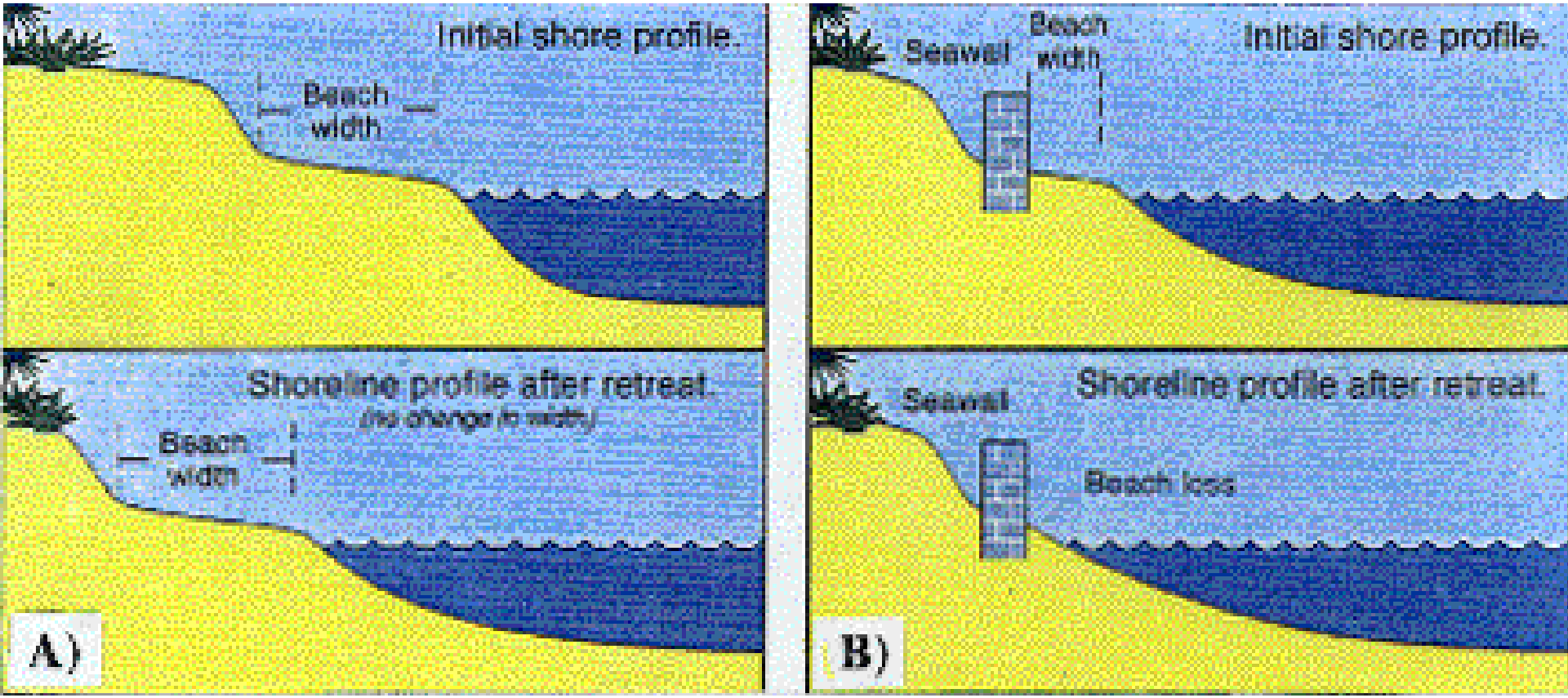

Zone of accumulation
Snowline
Crevasses
Zone of wastage
Iceberg formed by calving


How The Ice Age Worked
©2008 HowStuffWorks
ICE SHEET COVERAGE
ARCTIC OCEAN
NORTH AMERICA
EUROPE
ASIA
NORTH AMERICA
AFRICA
PACIFIC OCEAN
SOUTH AMERICA
PACIFIC OCEAN
AUSTRALIA
ATLANTIC OCEAN
INDIAN OCEAN
ANTARCTICA
Ice coverage



Scarring on Red Eagle Mountain, Montana

- Coastal Erosion
  - Affected by sea level rise, wave and current action, sediment deficiencies, coastal zone development, storm surge
  - Sea level rises about 2.5 cm/ decade


Initial shore profile.
Beach width
Shoreline profile after retreat.
(no change in width)
Beach width
A)
Seawall
Beach width
Initial shore profile.
Seawall
Shoreline profile after retreat.
Beach loss
B)

Sea-Level Rise

Wave/Current Action

COASTAL EROSION

Sediment Deficiencies

sand mining
dune grading
sand impoundment
(behind shoreline structures)
water quality degradation
harbor/navigational channel
construction


1999
2004
© GARY BRAASCH

Houses undermined by coastal erosion in Pacifica, California. Photograph courtesy of NASA.

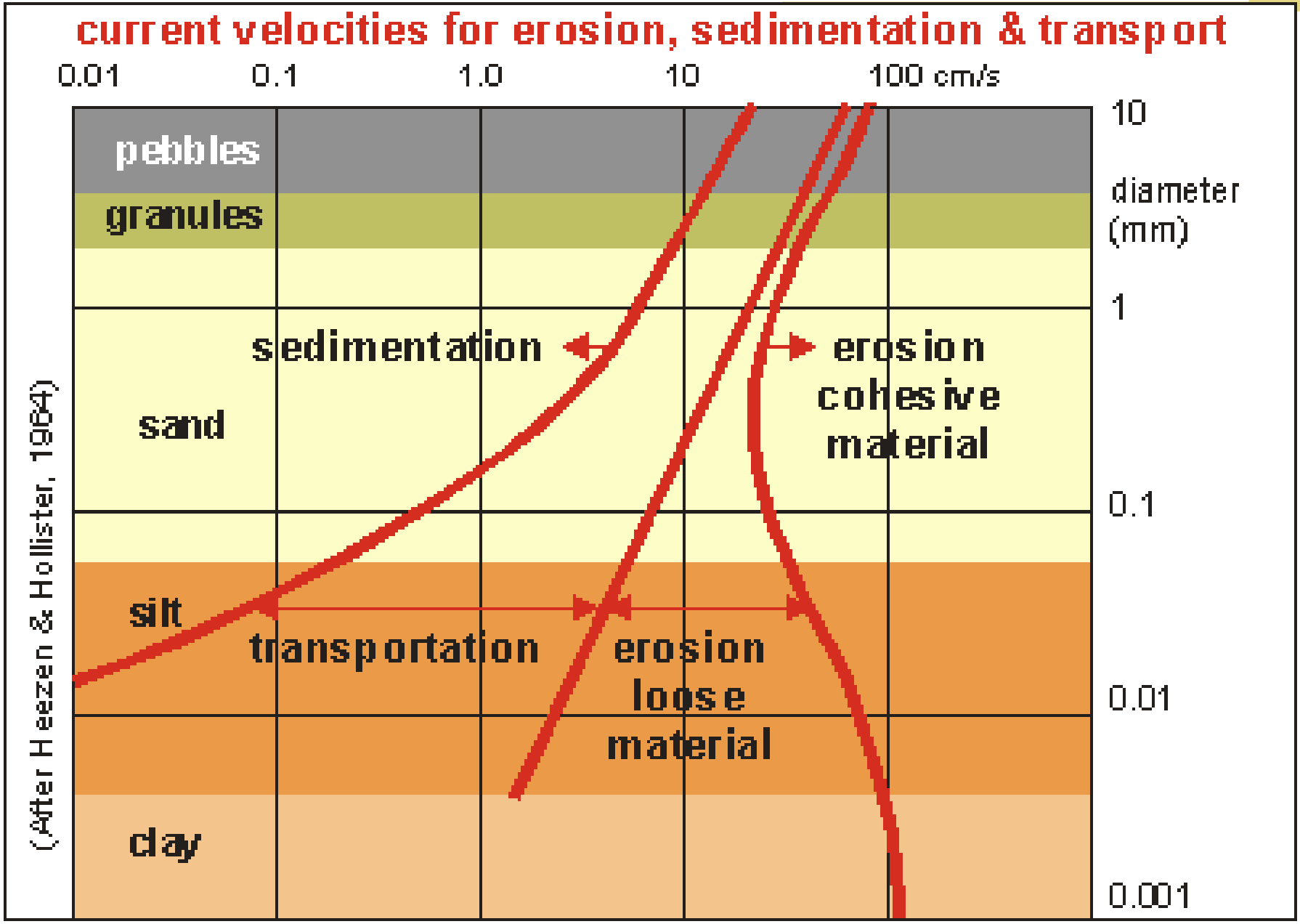

Pegu
Bassein
Yangón
Moulmein
Mouths of the Irrawaddy
Gulf of Martaban
25 km


Pegu
Bassein
Yangón
Moulmein

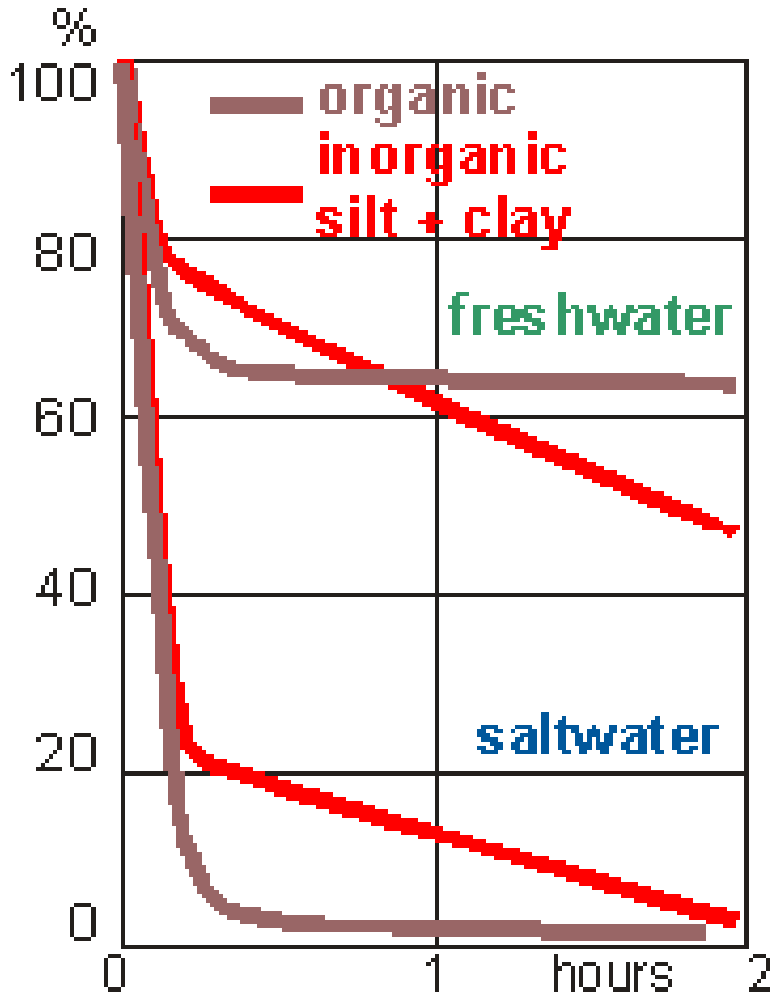
Deposition

- The movement of sediments is dependent upon the velocity of the agent moving it
- As the agent slows down, the heavier particles fall out and are deposited
- This is why flood plains are so important, as the water flows through the floodplain it slows and deposits sediment, replenishing nutrients and keeping them fertile
- Deposition also occurs when a stream enters a body of water

- The water slows down as it enters the pond/lake/ocean depositing the lightest sediments farthest from the mouth of the stream
- Produces delta and alluvial fans


current velocities for erosion, sedimentation & transport
0.01
0.1
1.0
10
100 cm/s
pebbles
granules
sand
silt
clay
sedimentation
transportation
erosion
loose
material
erosion
cohesive
material
10
diameter
(mm)
1
0.1
0.01
0.001
(After Heezen & Hollister, 1964)

sedimentation rates in fresh and salt water

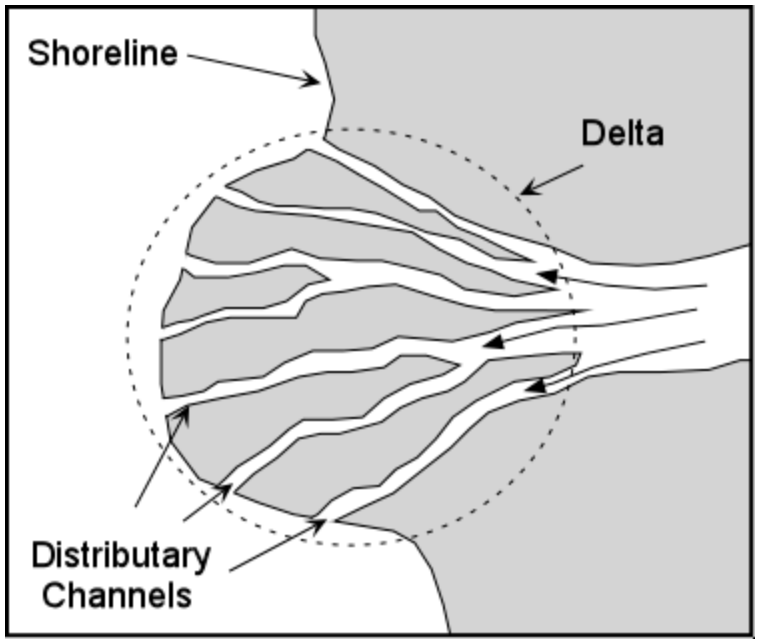


(after Williams & Brickell, 1983)

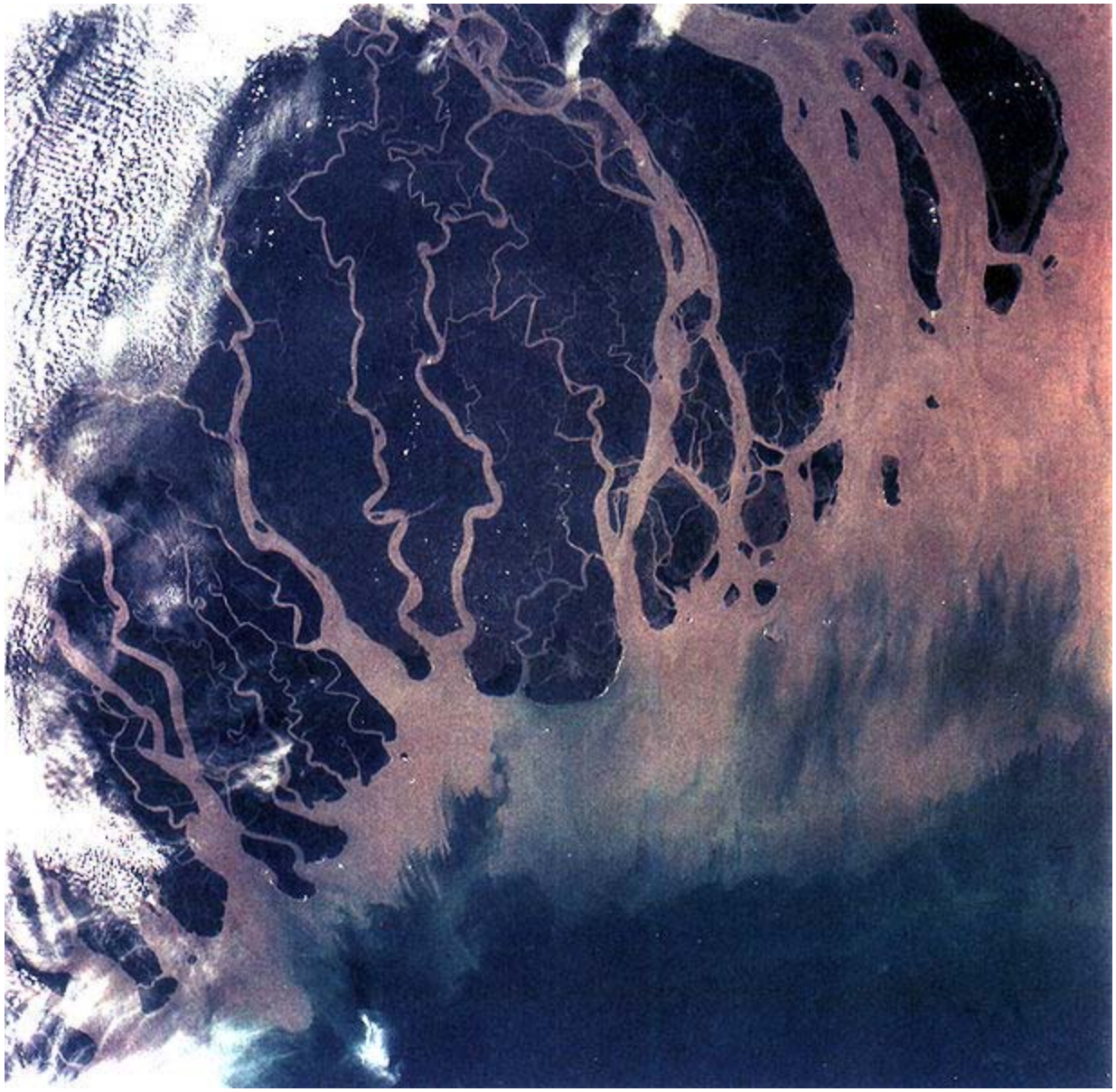
A mix of fine sand, silt, clay and organic matter, settles out much faster in salt water than in freshwater.

The red curves for inorganic matter show that large particles settle out first, then smaller ones. After two hours in fresh water, still 50% remains in solution. This is the clay partition.

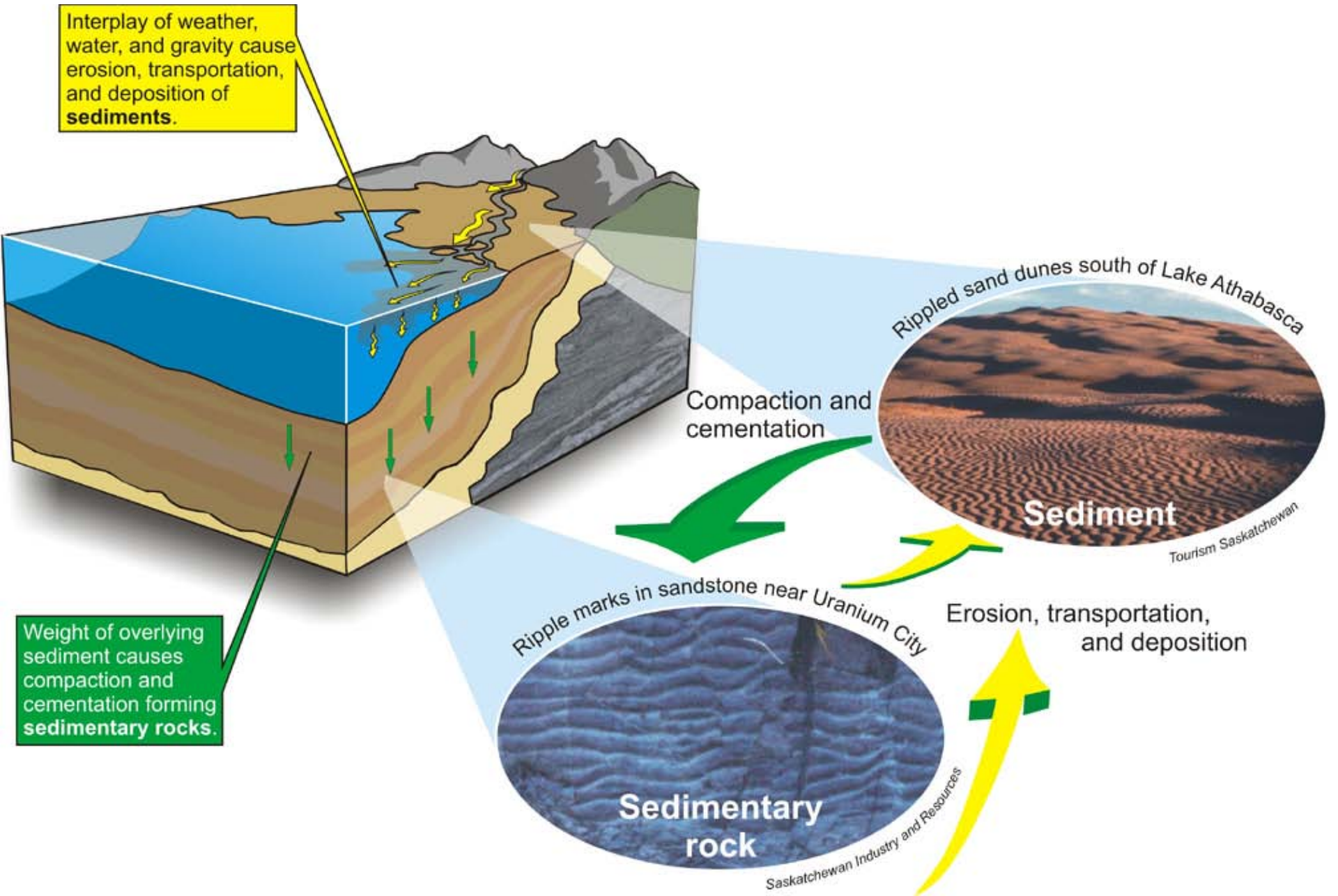
In salt water, the organic partition settles out fastest.



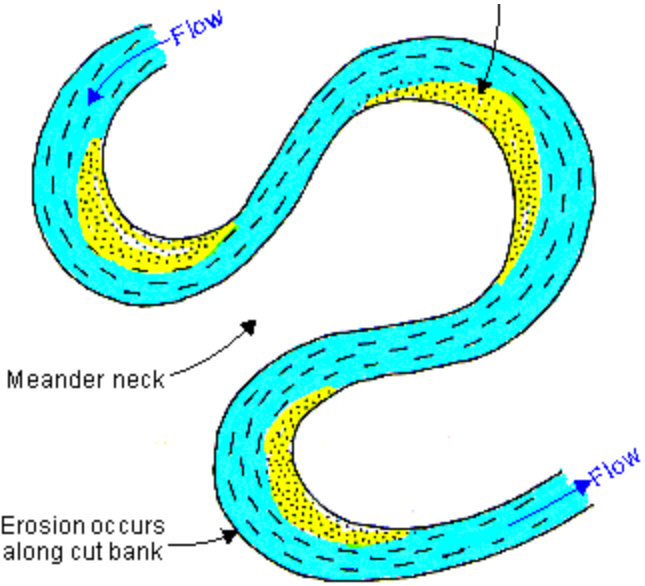
River Delta- deposit of sediments at the mouth of a river where it enters a still body of water- lake or ocean



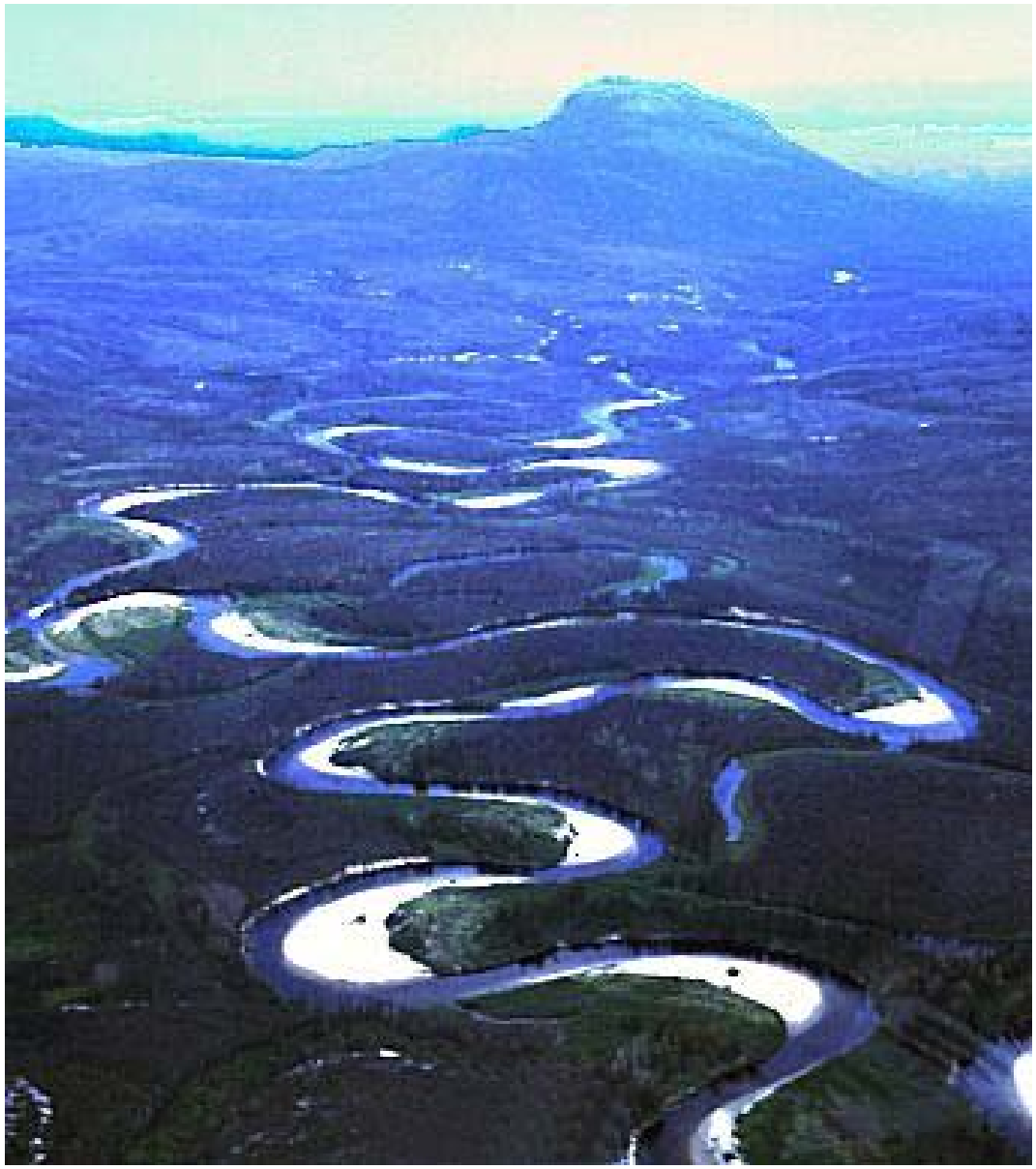
Ganges River Delta-one of the most fertile places on the planet


Interplay of weather, water, and gravity cause erosion, transportation, and deposition of **sediments**.
Weight of overlying sediment causes compaction and cementation forming **sedimentary rocks**.
Rippled sand dunes south of Lake Athabasca
Sediment
Tourism Saskatchewan
Compaction and cementation
Ripple marks in sandstone near Uranium City
Sedimentary rock
Saskatchewan Industry and Resources
Erosion, transportation, and deposition

Alluvial Fan- fan shape deposit of sediments typically at the end of a canyon , when the water moves across a flat plain, instead of water body



Erosion in a river channel happens on the outside of bends, at the same time sediments are deposited on the inside of the bends creating little pockets of beach



Pedology

Soils

- Soil is a complex mixture of eroded rock and mineral nutrients, decaying organic matter, water, air and billions of living organisms
- Soil is renewable, though formed very slowly through the processes of weathering, erosion and deposition
- Mature soils are arranged in zones/ layers called horizons
- Each horizon has unique traits that vary with soil type

Soil Layers

- **O Horizon** – layer of surface organic material (dead critters and plants, poop etc), typically brown or black
- **A Horizon** – topsoil- partial decomposed organic material(humus), typically dark colored and loose texture, agriculture required thick topsoil layers and lots of organic material
- Top layers are the foundation of civilization, hold and slowly release moisture

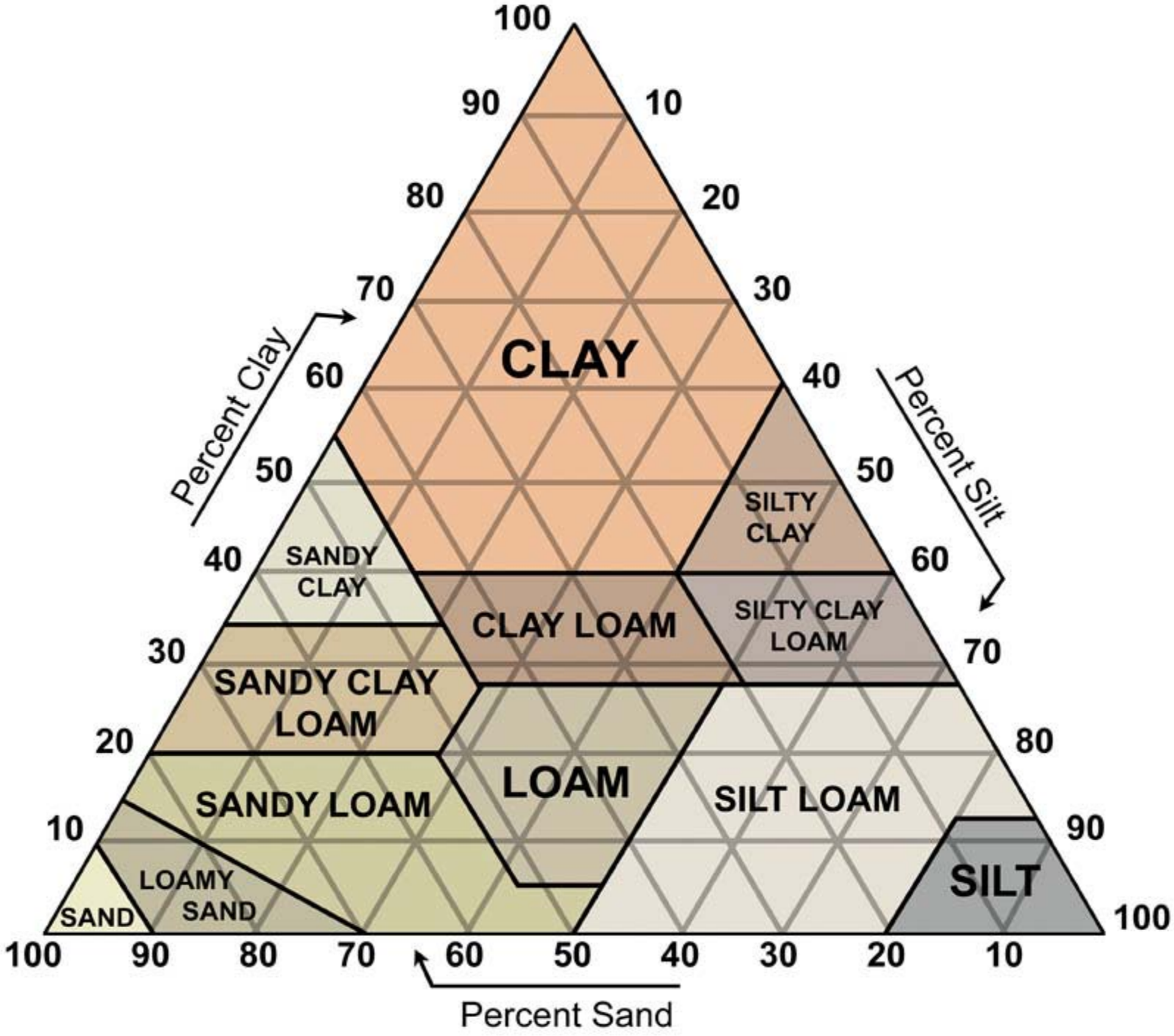
- Top layers also full of decomposers constantly cycling nutrients
- Topsoil color tells us volumes about soil quality – darker color- better for growing crops, grey/yellow/ red – low in organic material & need fertilization to support crops
- **B Horizon**-Subsoil & **C Horizon** – Parent material- varying mixture of sand, silt, clay and gravel
- **Bedrock-** bottom layer of unweathered rock

Soil Types

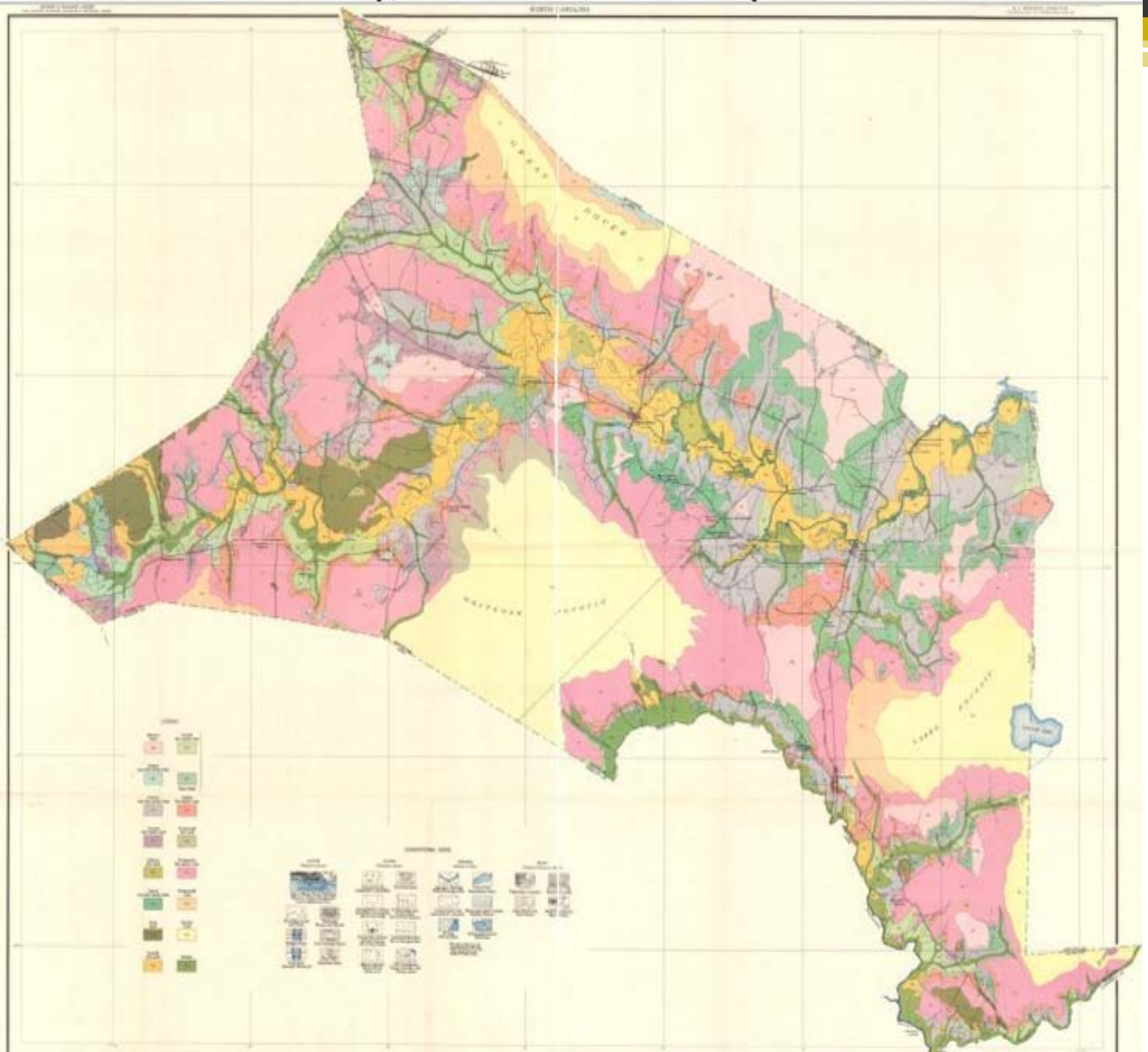
- Soil texture is dependent upon the mixture of differing sized sediments
- **Gravel →Sand→ Silt→ Clay**

Soil Texture	Nutrient Holding	Water Infiltration	Water Holding	Aeration	Workability
Clay	Good	Poor	Good	Poor	Poor
Silt	Medium	Medium	Medium	Medium	Medium
Sand	Poor	Good	Poor	Good	Good
Loam	Medium	Medium	Medium	Medium	medium

Table 10-1, p216 Miller LITE 13th Edition


100
90
80
70
60
50
40
30
20
10
Percent Clay
Percent Silt
Percent Sand
CLAY
SILTY CLAY
SANDY CLAY
CLAY LOAM
SILTY CLAY LOAM
SANDY CLAY LOAM
LOAM
SILT LOAM
SANDY LOAM
SILT
LOAMY SAND
SAND

Soil map, North Carolina, Jones County sheet



LEGEND

- Bayboro loam — Ba
- Norfolk fine sandy loam — Nf
- Bladen very fine sandy loam — Bv
- Nf — Deep phase
- Craven very fine sandy loam — Cv
- Onslow fine sandy loam — Of
- Dunbar fine sandy loam — Df
- Portsmouth fine sand — Ps
- Kalmia fine sand — Ka
- Portsmouth fine sandy loam — Pf
- Lenoir very fine sandy loam — Le
- Portsmouth loam — Pm
- Leon sand — Ls
- Pamlico muck — Pk
- Norfolk fine sand — No
- Swamp — Sw

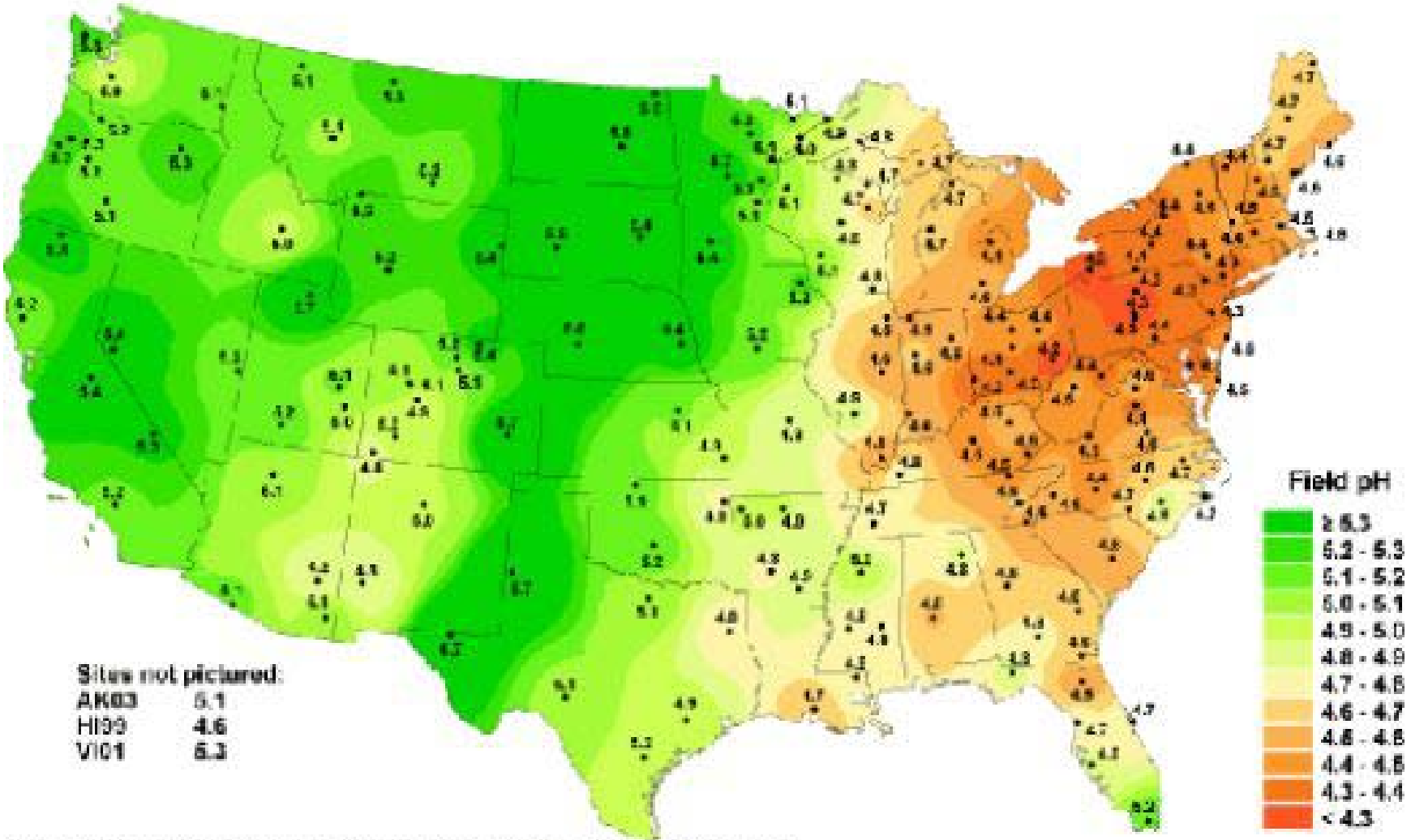
Soil Quality

- Soils vary in the amount of water it can hold (**porosity**) and the rate at which water can infiltrate the soil (**permeability**)
- The process of **leaching** carried nutrients from upper layers to lower layers of the soil
- Indicators
  - **Soil Organic Matter** – measures fertility, stability, nutrient retention, erosion
  - **Biological Tests-** measures soil productivity, Nitrogen supply potential, microbial activity

Percolation Animation

- **Physical Tests** – measures water retention and transport, estimate crop productivity potential, compaction, porosity, workability
  - Soil Structure, depth of soil, infiltration(percolation), porosity and compaction
- **Chemical Tests** – measures bio and chemical activity thresholds, plant and microbial activity thresholds, plant available nutrients, N and P loss
  - pH, Extractable N-P-K

Hydrogen ion concentration as pH from measurements made at the field laboratories, 2001



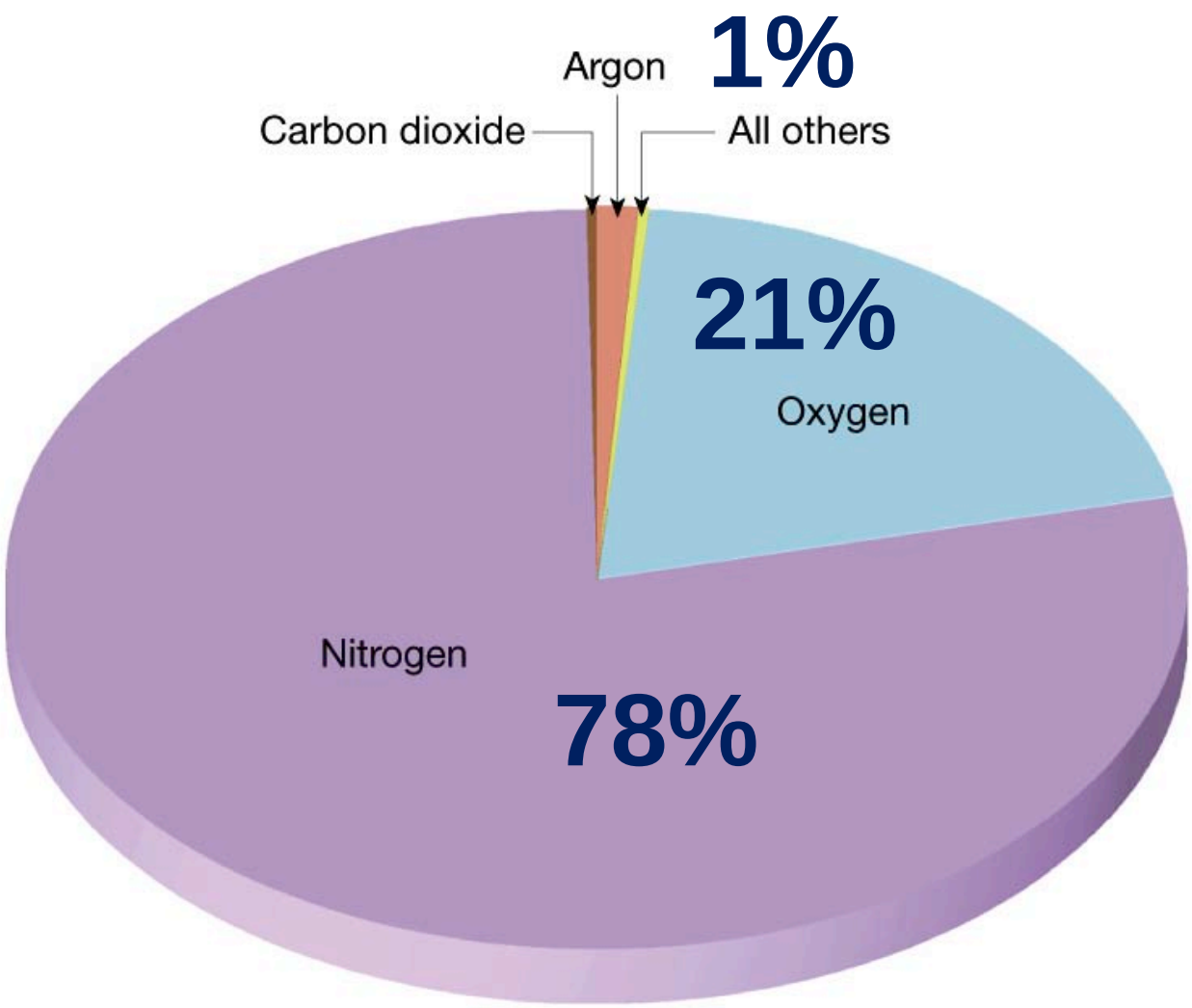
National Atmospheric Deposition Program/National Trends Network
http://nadp.sws.uiuc.edu

Climatology

Origin of the Atmosphere & History

- Earth's first atmosphere(4.6 bya) was predominately composed of hydrogen and helium
- Through the process of outgassing (release of gasses from earth's interior) other gases were released -Water Vapor, Carbon Dioxide, Nitrogen
- Millions of years of outgassing has caused the atmosphere to evolve over time to its current state

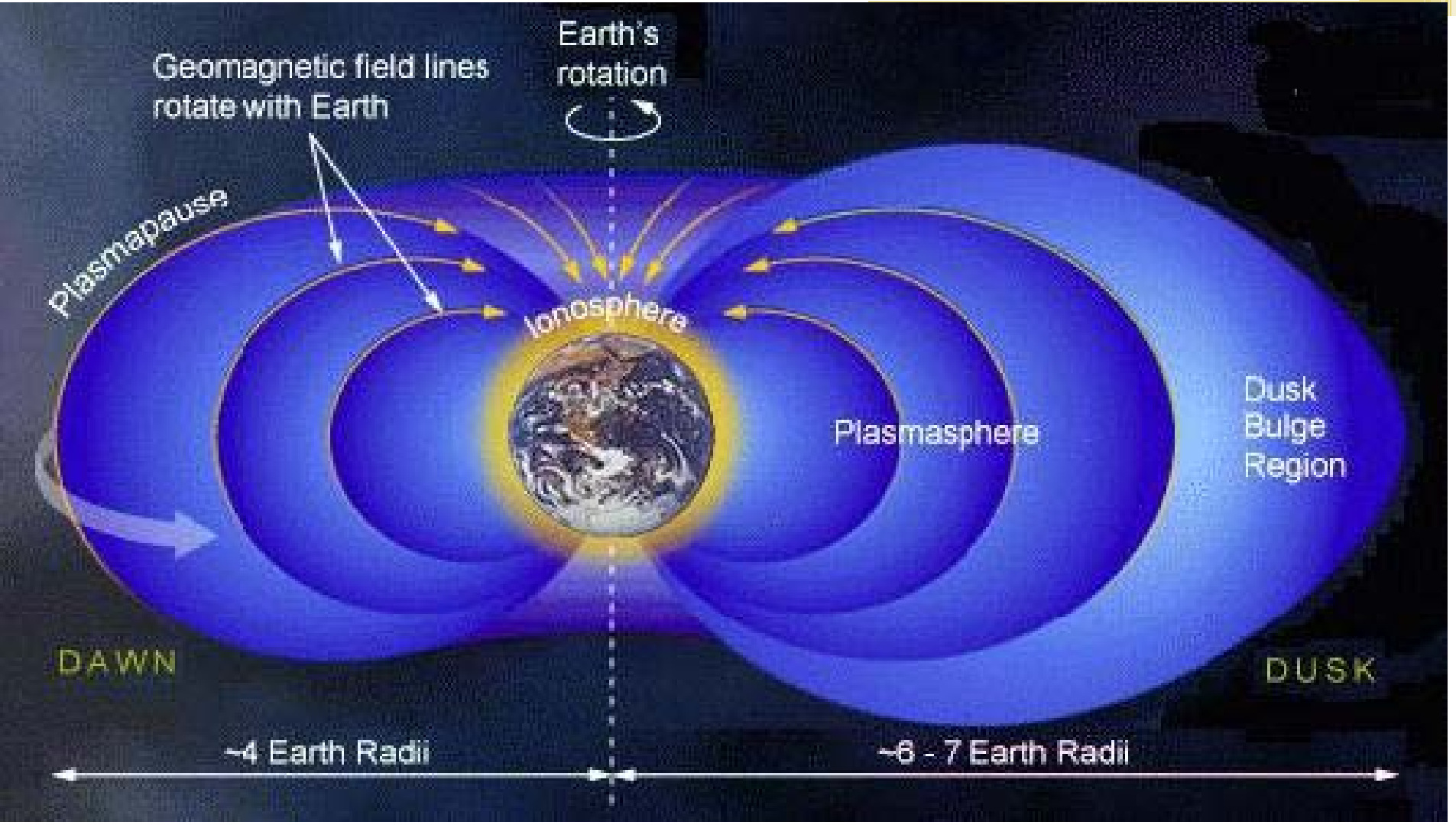
Atmospheric Composition

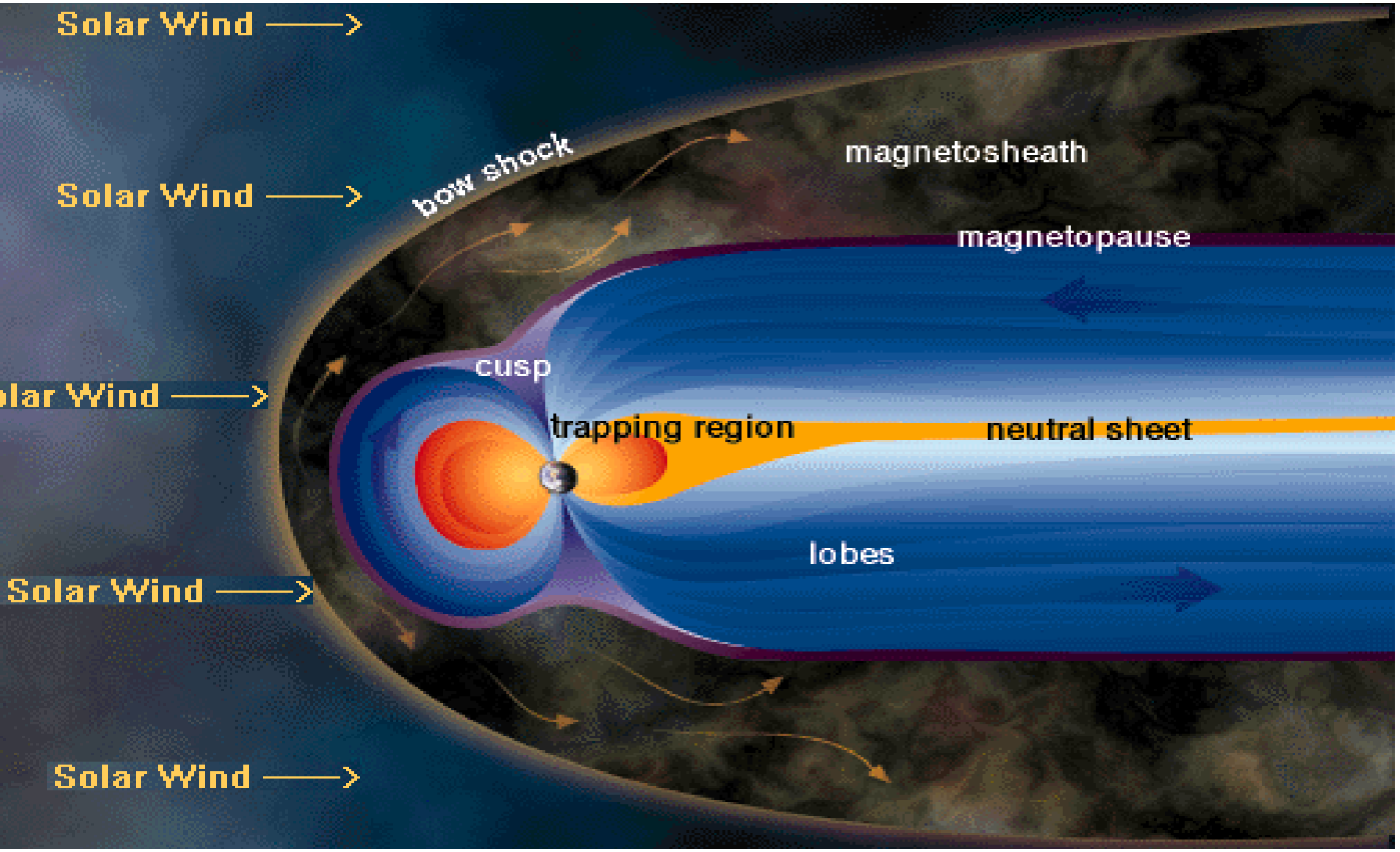


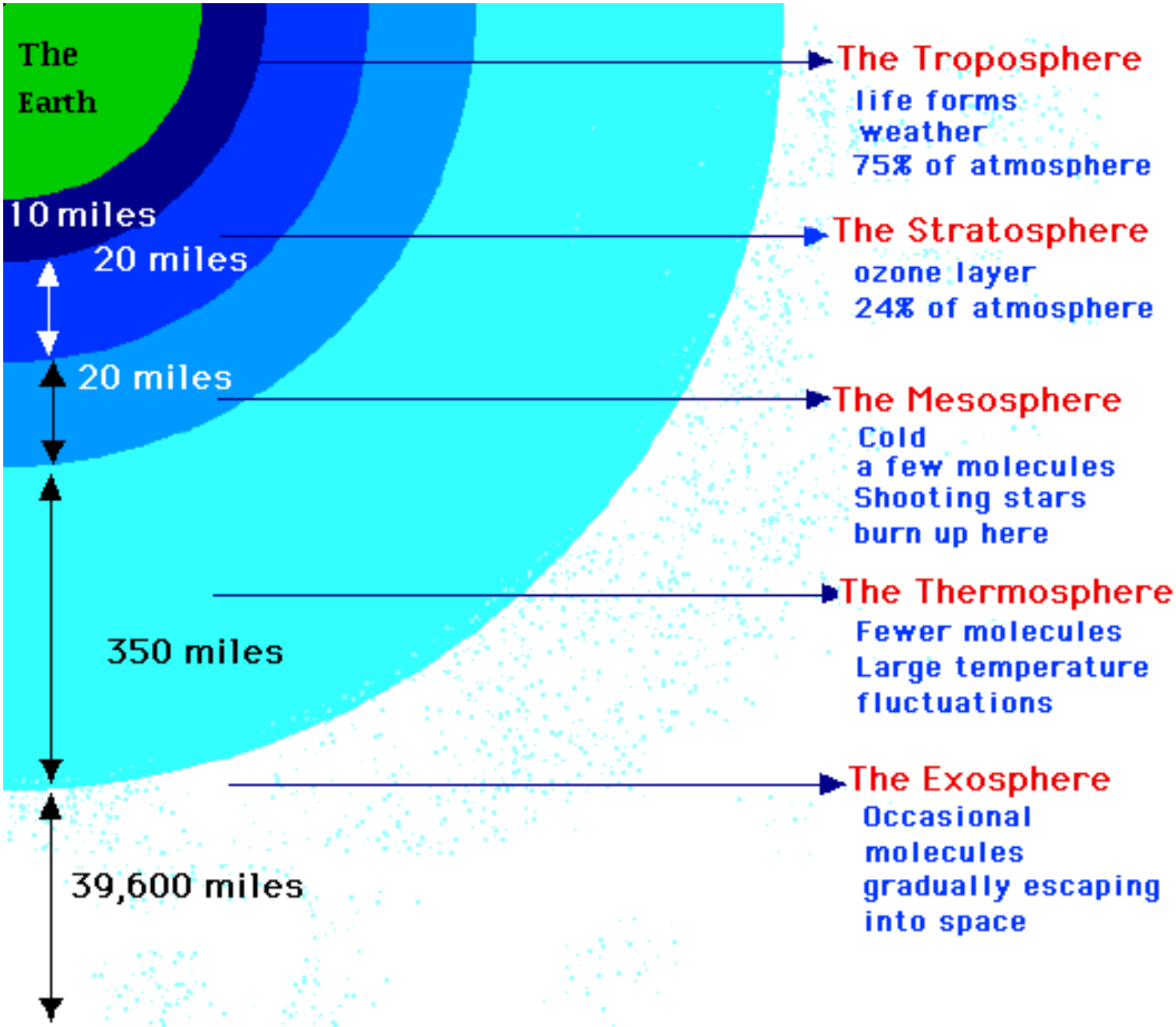
Atmospheric Structure

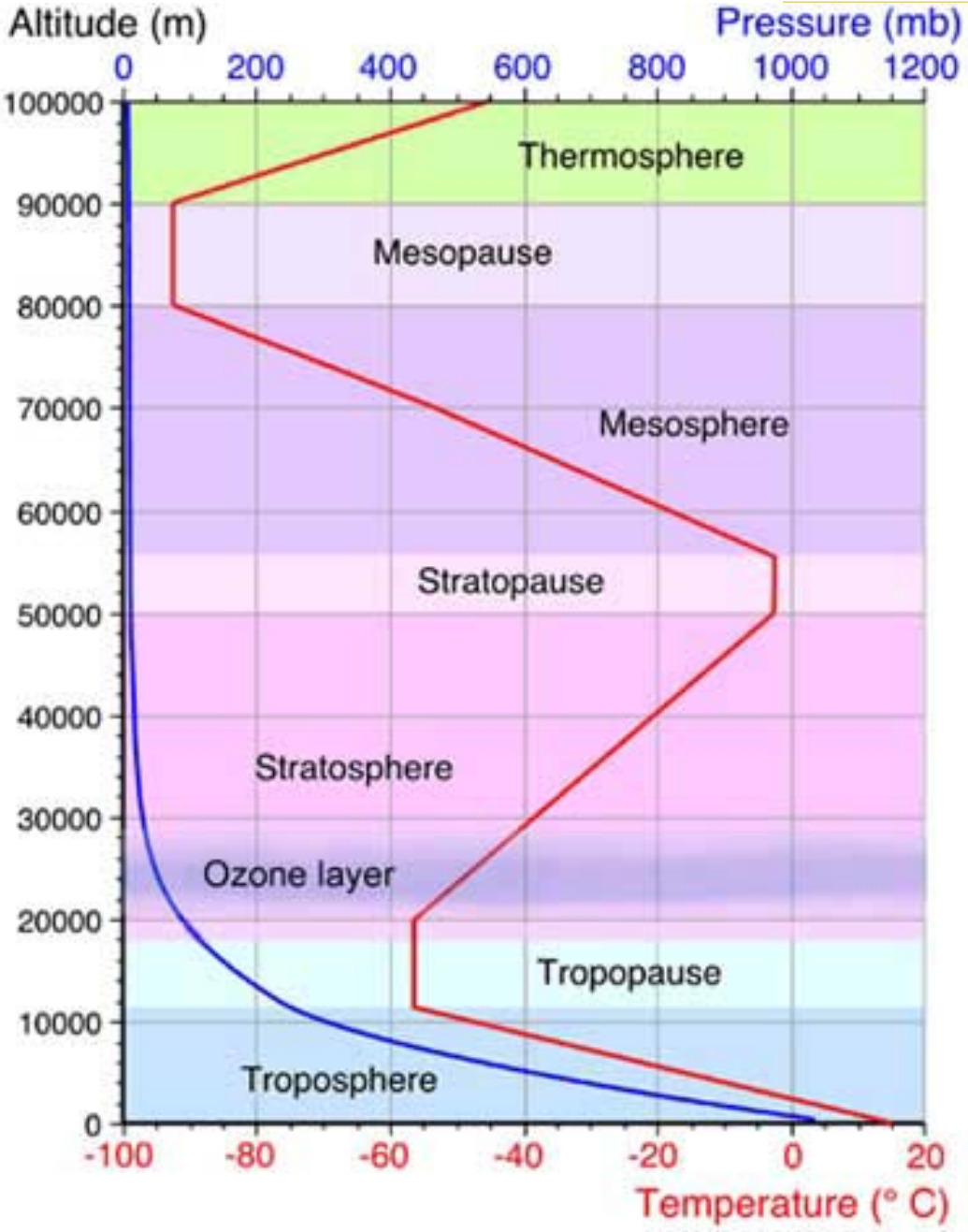
- **Troposphere** – closest to the planet, 80% of the atmosphere's mass. Temp and water vapor levels drop with altitude, contains 99% of all water vapor in the atmosphere, all weather phenomena occur here- extends from the surface to ~10 mi
- **Stratosphere**- second layer, contains the ozone layer (O_3) – centered between 10-15 miles, concentration 10ppm, absorbs the bulk of ultraviolet (UV-B) radiation, extends ~10 mi to 30mi

- **Mesosphere**- coldest temperatures on earth occur here, extends 30-50 miles up
- Thermosphere- between 600-3000^{o}F because of its absorption of solar radiation, filled with lighter gases, very sparse molecules.
- **Exosphere** – outer most layer, very low density of molecules
- **Ionosphere**-Region of atmosphere that is defined by how much radiation can move through
- **Magnetosphere**- protects us from the solar winds-extreme solar radiations

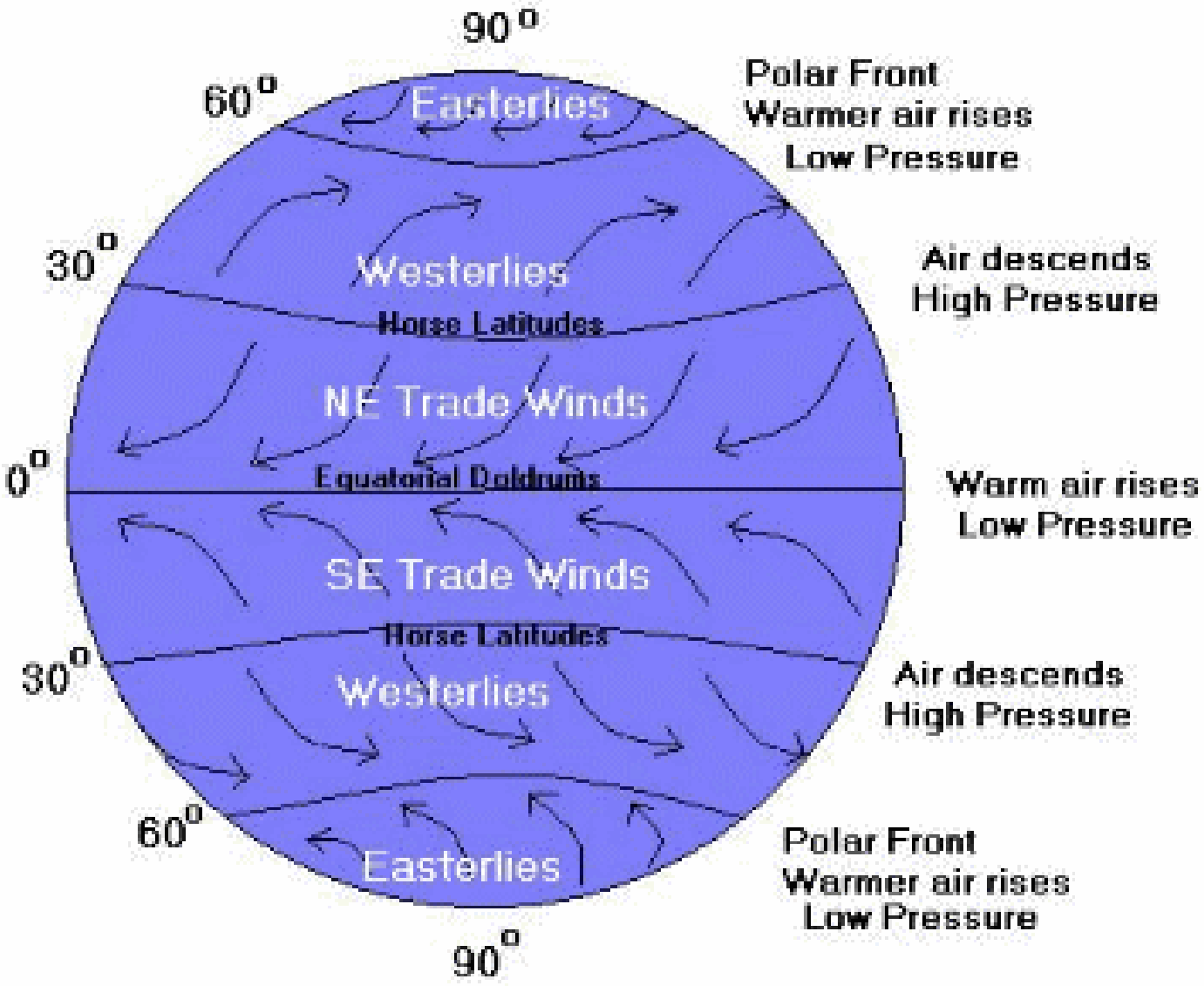

Earth's rotation
Geomagnetic field lines rotate with Earth
Plasmapause
Ionosphere
Plasmasphere
Dusk Bulge Region
DAWN
DUSK
~4 Earth Radii
~6 - 7 Earth Radii

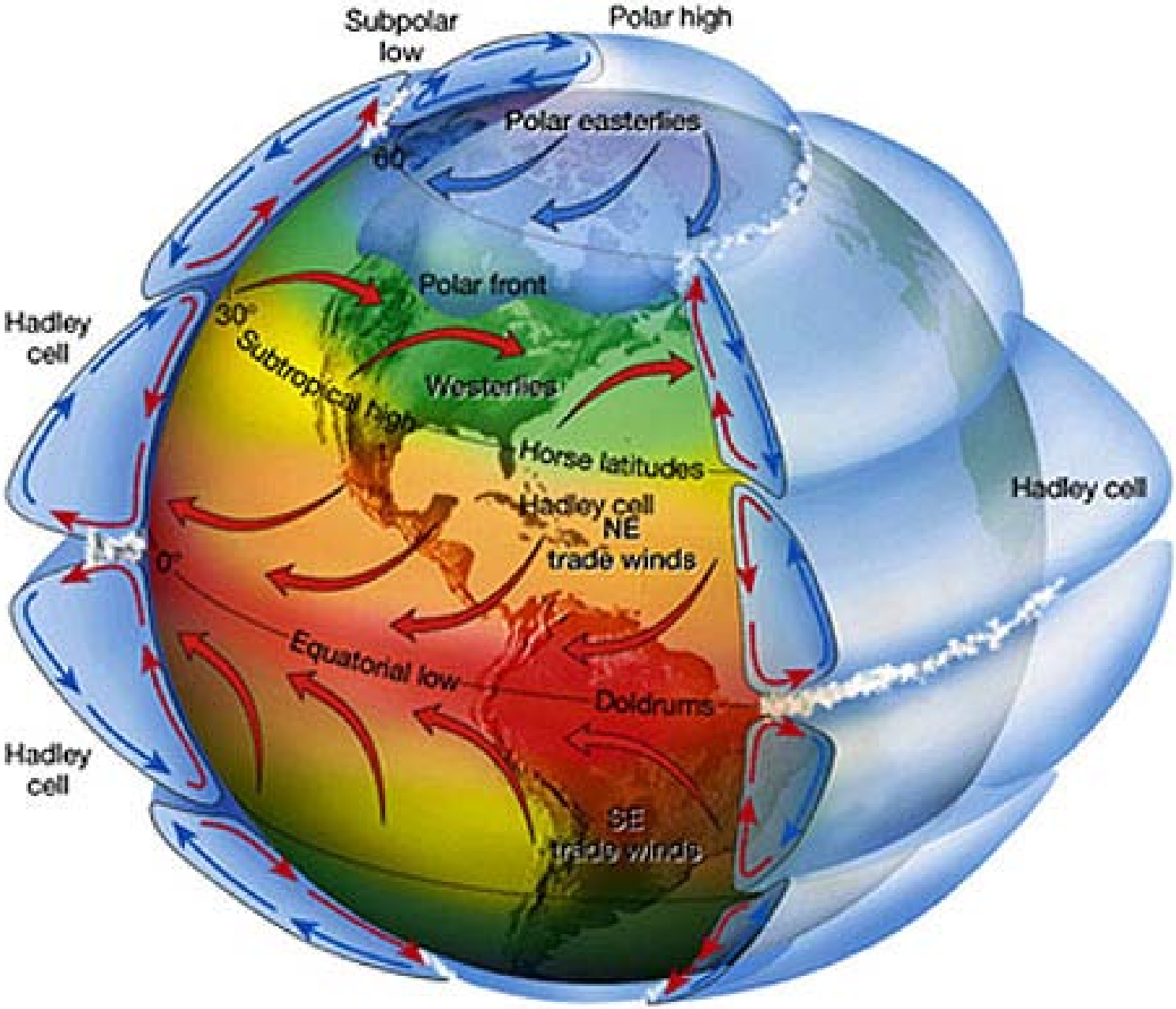

Solar Wind
Solar Wind
bow shock
magnetosheath
magnetopause
olar Wind
cusp
trapping region
neutral sheet
Solar Wind
lobes
Solar Wind

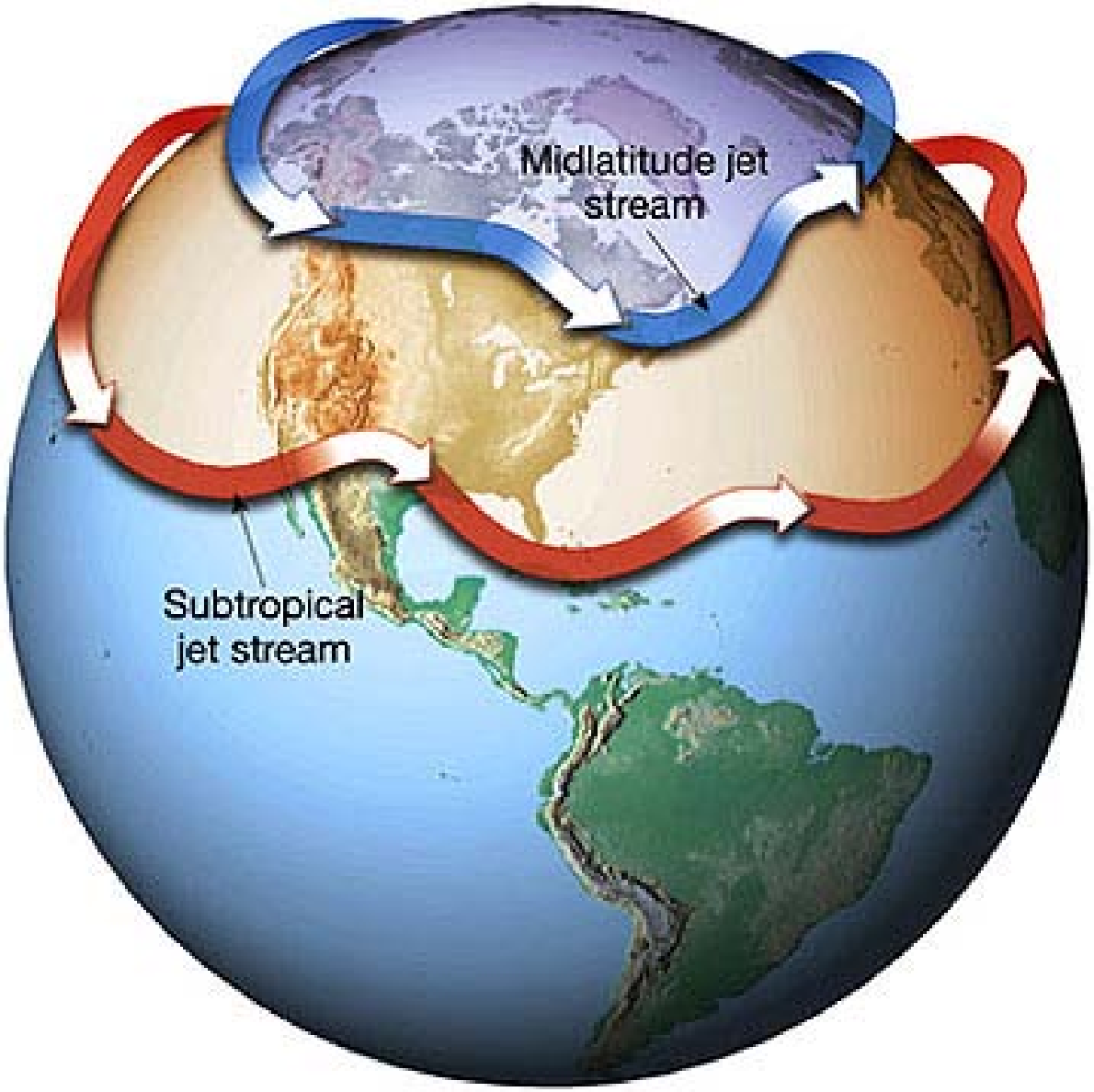

The
Earth
10 miles
20 miles
20 miles
350 miles
39,600 miles
The Troposphere
life forms
weather
75% of atmosphere
The Stratosphere
ozone layer
24% of atmosphere
The Mesosphere
Cold
a few molecules
Shooting stars
burn up here
The Thermosphere
Fewer molecules
Large temperature
fluctuations
The Exosphere
Occasional
molecules
gradually escaping
into space

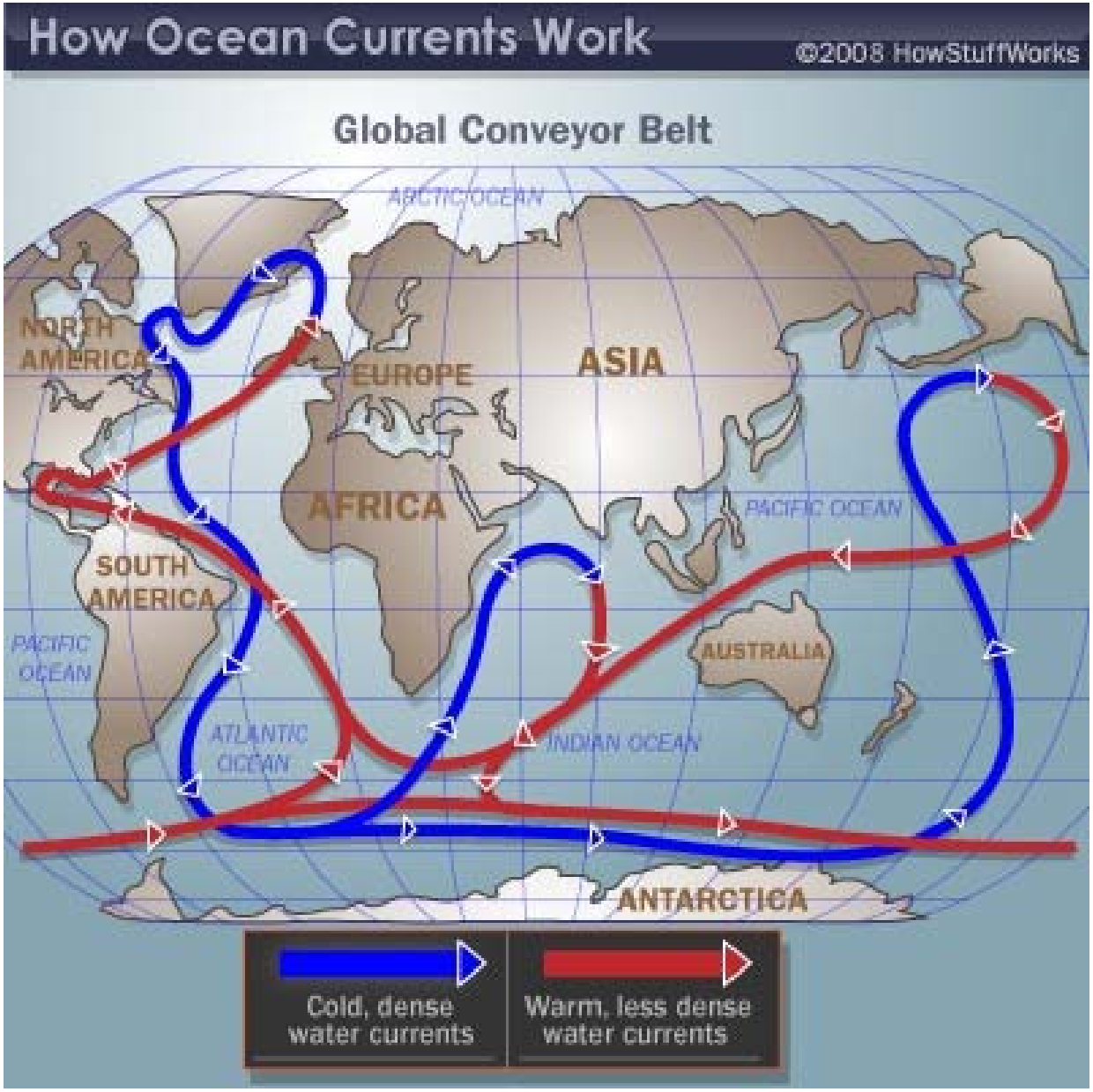

Altitude (m)
Pressure (mb)
0
200
400
600
800
1000
1200
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
Thermosphere
Mesopause
Mesosphere
Stratopause
Stratosphere
Ozone layer
Tropopause
Troposphere
-100
-80
-60
-40
-20
0
20
Temperature (° C)

- Difference between heat and temperature
- **Temperature**- measures the average about of kinetic energy
- **Heat** – measures the process of energy transfer
- Particles can have a lot of kinetic energy (high temp) but be so sparse they never hit each other or another object to transfer it(heat) – so you would freeze in the high temperatures


90°
60°
Easterlies
Polar Front
Warmer air rises
Low Pressure
30°
Westerlies
Air descends
High Pressure
Horse Latitudes
NE Trade Winds
0°
Equatorial Doldrums
Warm air rises
Low Pressure
SE Trade Winds
Horse Latitudes
30°
Westerlies
Air descends
High Pressure
60°
Easterlies
Polar Front
Warmer air rises
Low Pressure
90°


Subpolar low
Polar high
Polar easterlies
60°
Polar front
30°
Subtropical high
Westerlies
Horse latitudes
Hadley cell
NE trade winds
0°
Equatorial low
Doldrums
SE trade winds
Hadley cell
Hadley cell
Hadley cell


Midlatitude jet stream
Subtropical jet stream


How Ocean Currents Work
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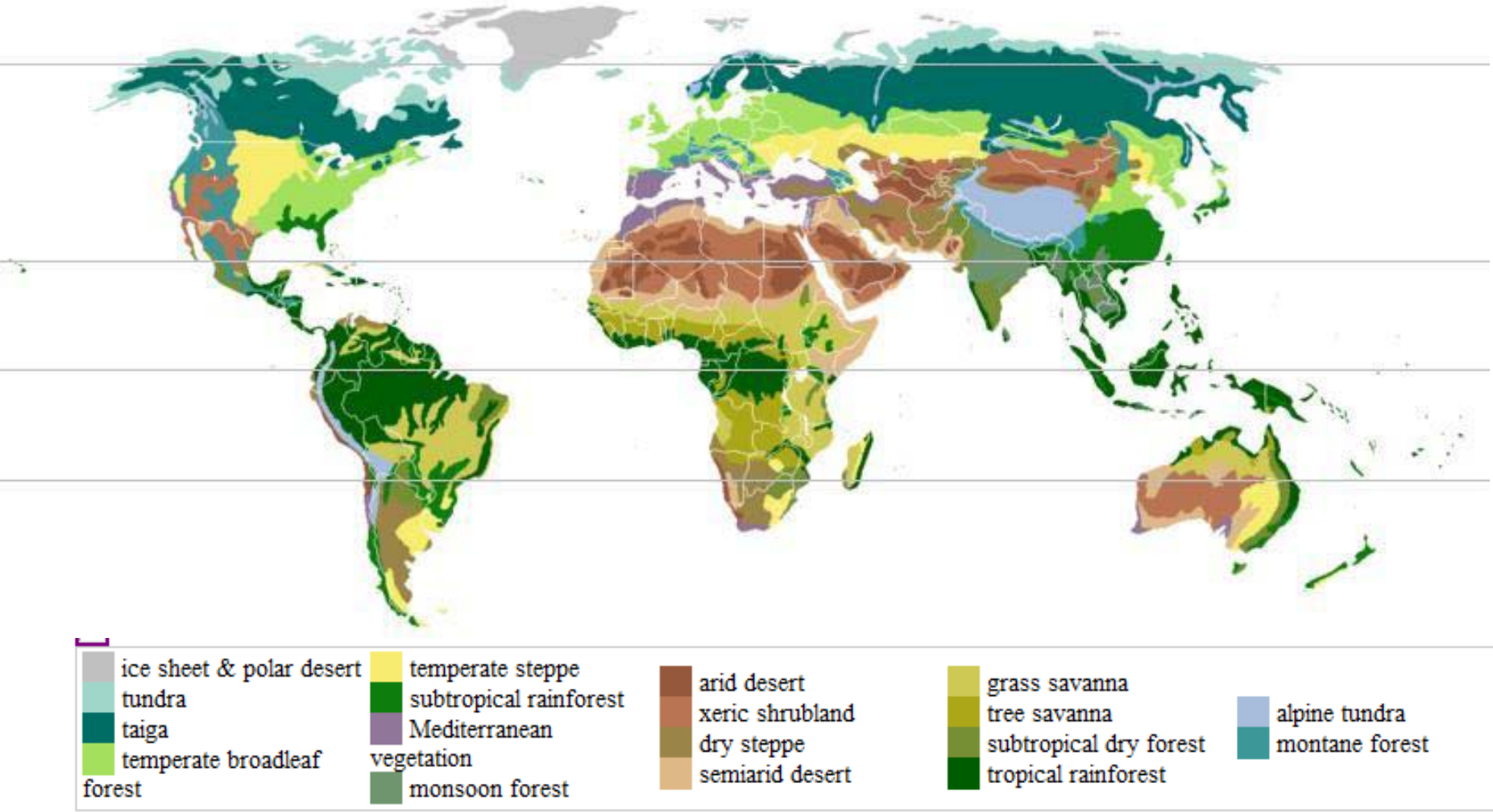
Global Conveyor Belt
ARCTIC OCEAN
NORTH AMERICA
EUROPE
ASIA
AFRICA
PACIFIC OCEAN
SOUTH AMERICA
PACIFIC OCEAN
AUSTRALIA
ATLANTIC OCEAN
INDIAN OCEAN
ANTARCTICA
Cold, dense water currents
Warm, less dense water currents


ice sheet & polar desert
tundra
taiga
temperate broadleaf forest
temperate steppe
subtropical rainforest
Mediterranean vegetation
monsoon forest
arid desert
xeric shrubland
dry steppe
semiarid desert
grass savanna
tree savanna
subtropical dry forest
tropical rainforest
alpine tundra
montane forest