GY4027
Landscape Evolution

Learning Outcomes

On successful completion of this module, you will be able to:

1. Describe and explain the tectonic, sedimentary, and anthropogenic processes which create and shape landscapes
2. Review the landscape-shaping processes operating in various environments and settings
3. Apply geospatial and laboratory techniques to interpret processes, environments, and the evolution of landscapes
4. Analyse environments and landscape evolution in particular geographic areas
5. Display an appreciation of the scales of time and distance in landscape evolution
6. Acknowledge the dynamic nature of all landscapes and environments

Weathering

e.g. Granite: formed deep underground, now uplands

Granite: Mourne Mountains, Co. Down, Ireland

Weathering

- Mechanical weathering
- Chemical weathering
- Biological weathering

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Weathering

e.g. Granite: formed deep underground, now uplands

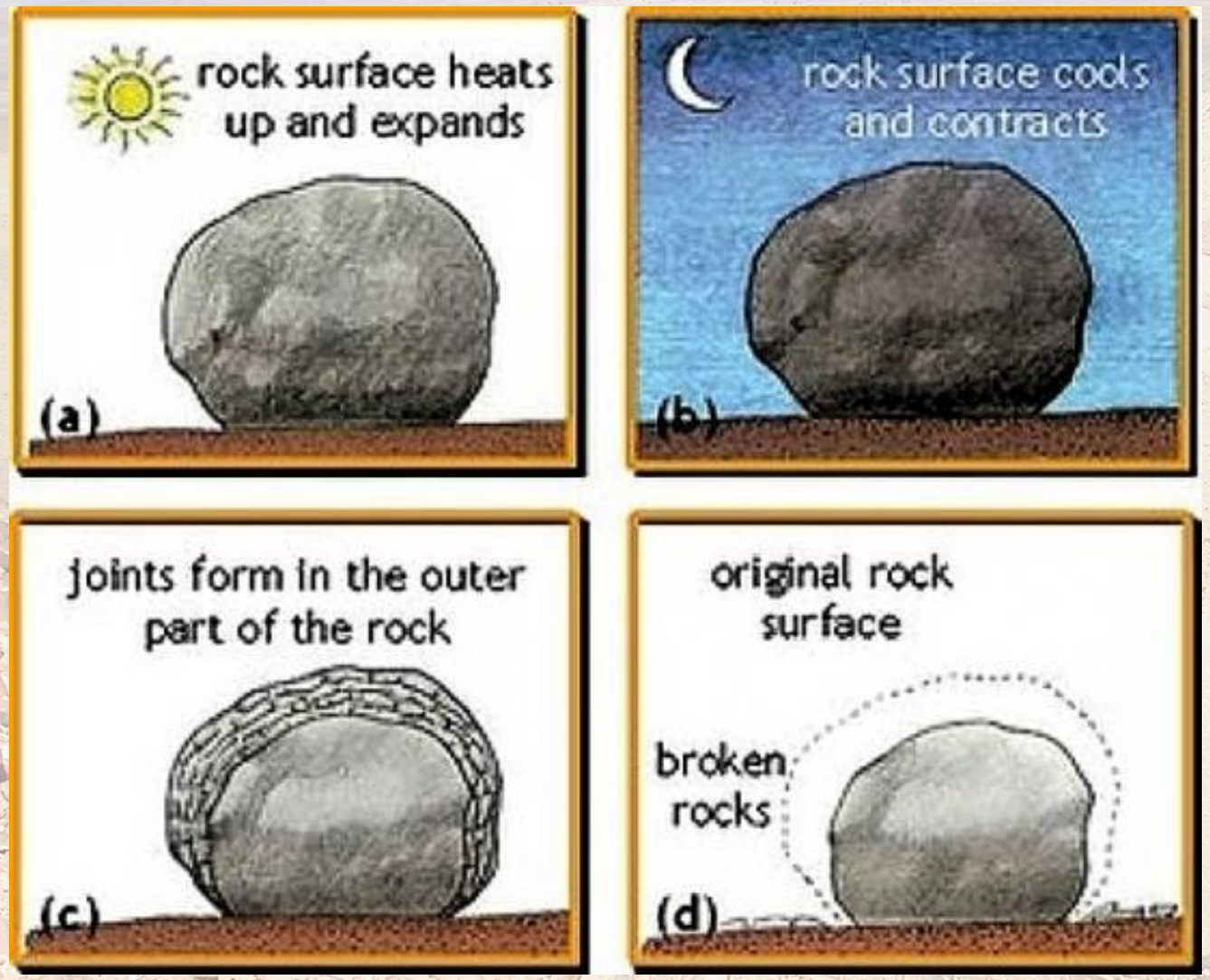
As it becomes exposed, changes in:

- Depth
- Temperature
- Pressure

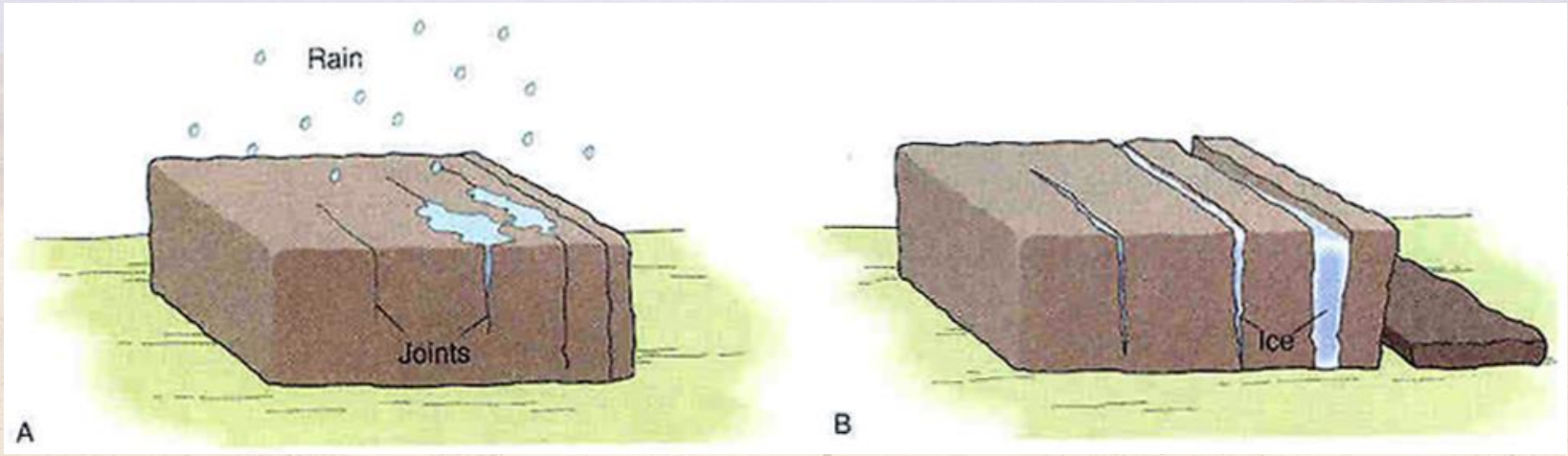
All decrease

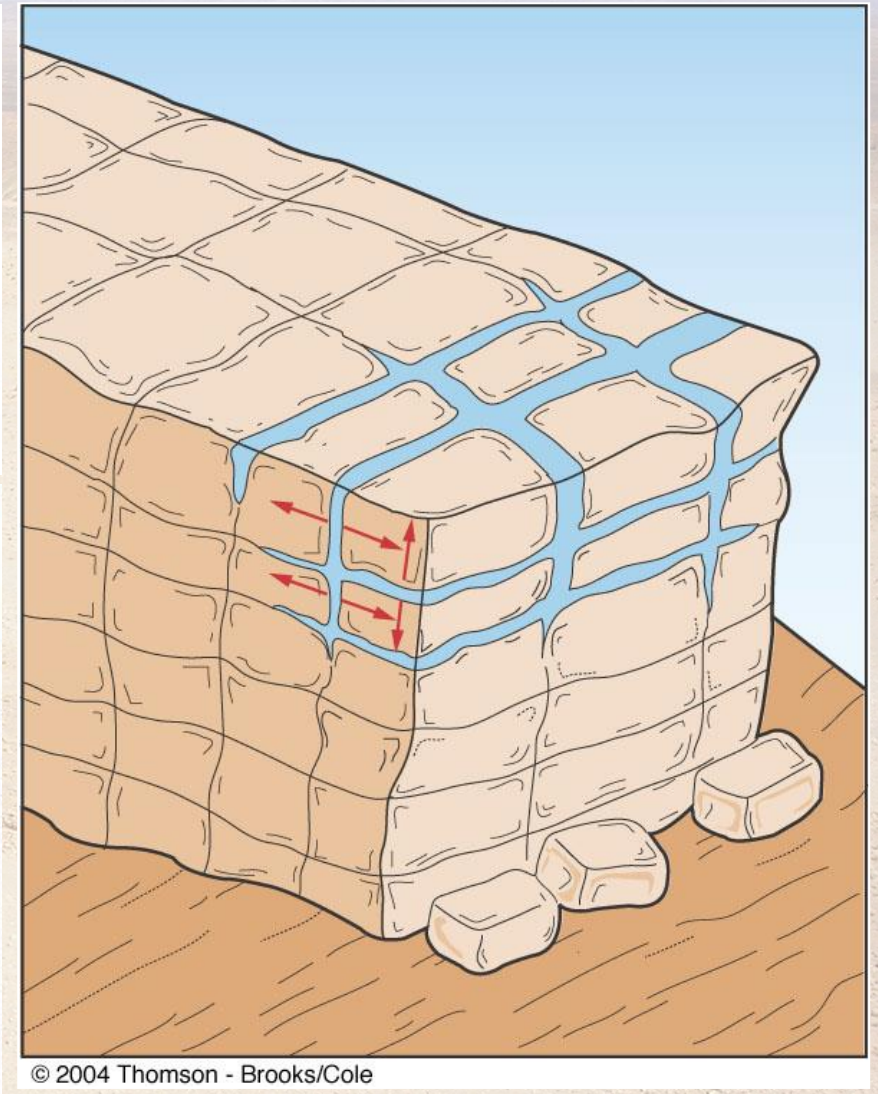
Granite: Mourne Mountains, Co. Down, Ireland

Thermal stress



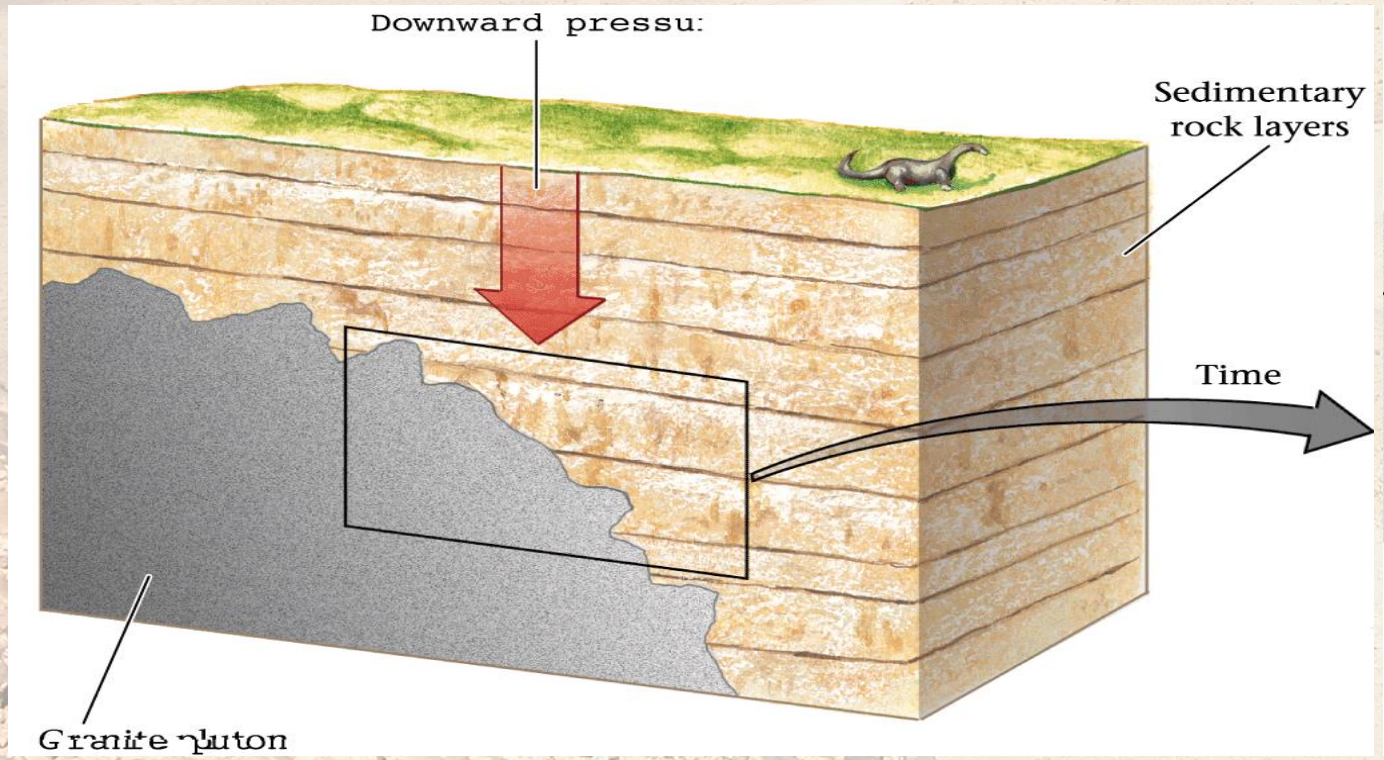
Freeze-thaw

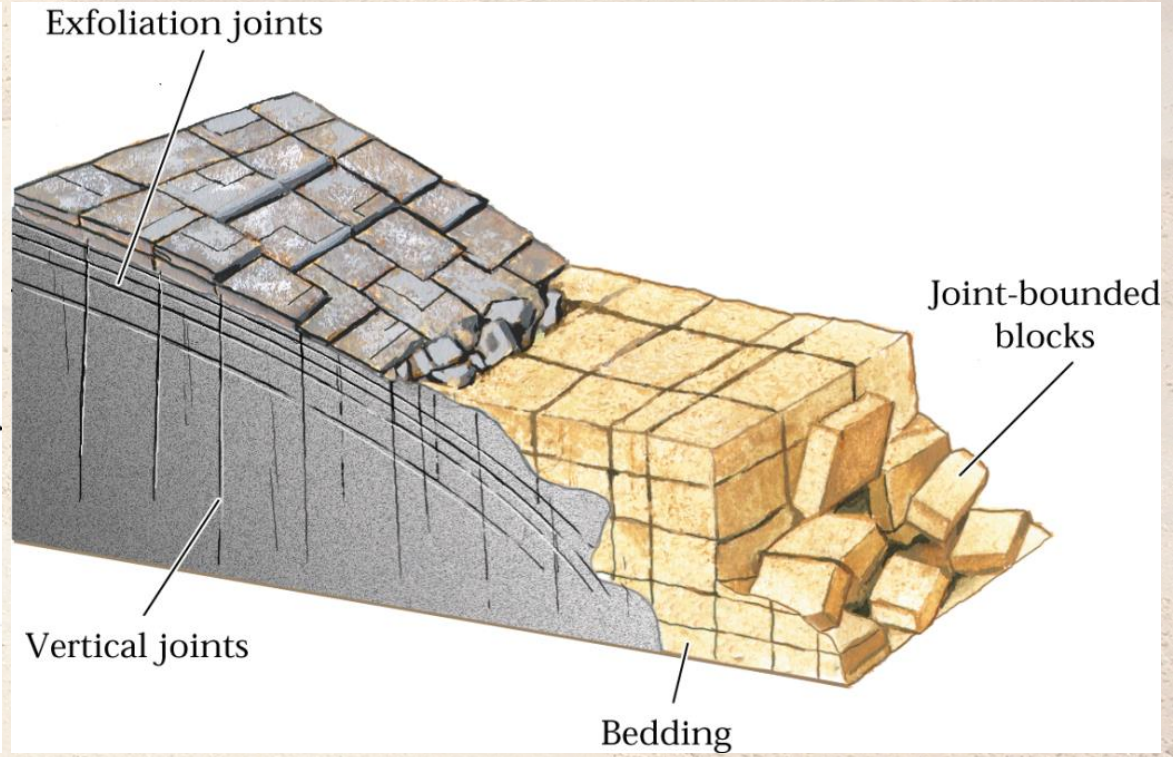




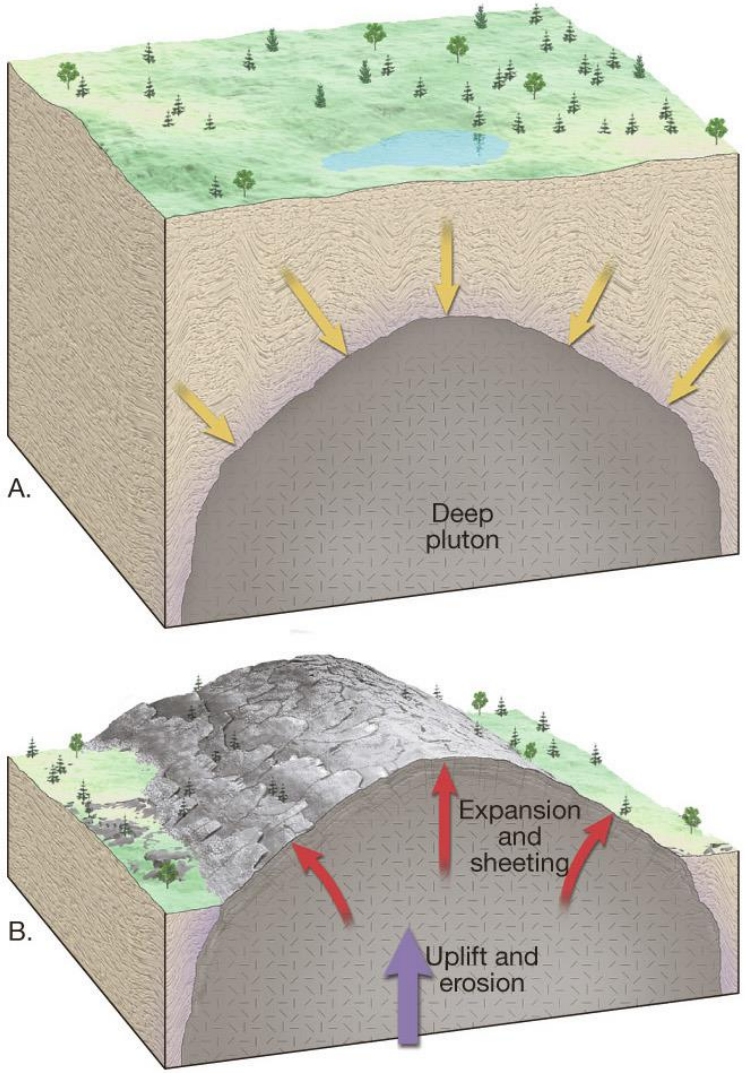
Note: Similar results can be produced by wetting and drying through clay mineral expansion, and through salt crystal growth

Unloading jointing



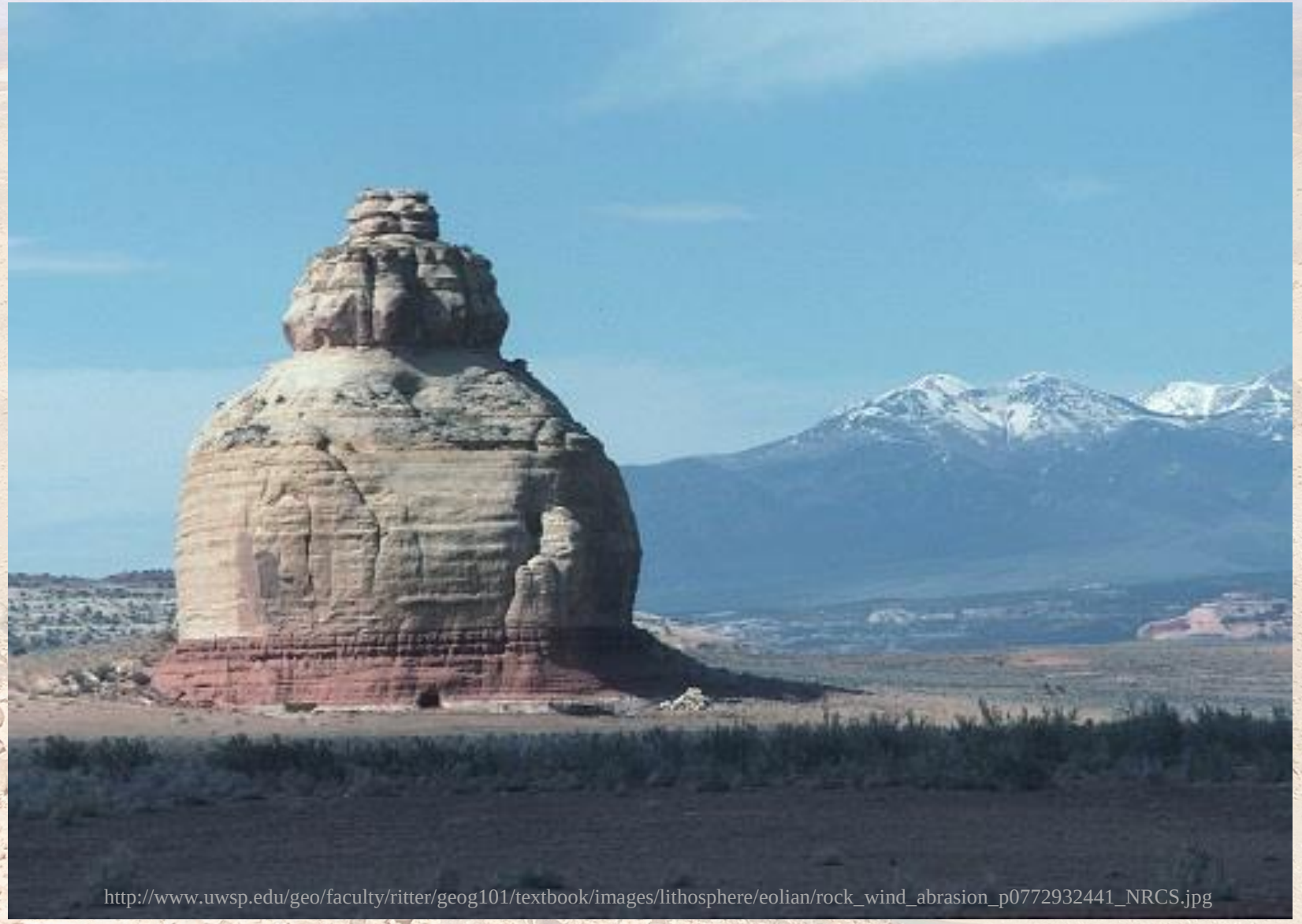


Exfoliation



Exfoliation

Abrasion



http://www.uwsp.edu/geo/faculty/ritter/geog101/textbook/images/lithosphere/eolian/rock_wind_abrasion_p0772932441_NRCS.jpg

Abrasion

Weathering

- Mechanical weathering
- Chemical weathering
- Biological weathering

Weathering

e.g. Granite: formed deep underground, now uplands

As it becomes exposed, changes in:

- Depth
- Temperature
- Pressure

All decrease

Not all minerals are stable at all temperatures and pressures

Granite: Mourne Mountains, Co. Down, Ireland

Common rock-forming minerals stability at Earth's surface

Most stable

Least stable

- Fe oxides
- Al oxides
- Quartz
- Clay minerals
- K feldspar (orthoclase)
- Biotite
- Na feldspar (albite)
- Amphibole
- Pyroxene
- Ca Feldspar (anorthite)
- Olivine

Granite: Mourne Mountains, Co. Down, Ireland

Main chemical weathering styles

Hydration

Solid mineral + water → new (hydrated) mineral (including chemically bonded water)

Hematite + water → limonite

$Fe_2O_3 + 3H_2O \rightarrow 2Fe(OH)_3$

Dehydration

Solid (hydrated) mineral → new (dehydrated) mineral + water

Gypsum → anhydrite + water

$CaSO_4.2H_2O \rightarrow CaSO_4 + 2H_2O$

Main chemical weathering styles

Solution-dissolution

Solid mineral + acid or water → ions in solution

Halite + water → ions in solution

$NaCl + H_2O \rightarrow Na^+ + Cl^-$

Hydrolysis

Hydrogen ion + mineral with mobile cations → dissolved or partially altered mineral in which hydrogen ions replace ions that are put into solution

Olivine + hydrogen ions from acids in water → ions in solution + dissolved silica

$Mg_2SiO_4 + 4H^+ \rightarrow 2Mg^{2+} + H_4SiO_4$

Main chemical weathering styles

Oxidation-reduction

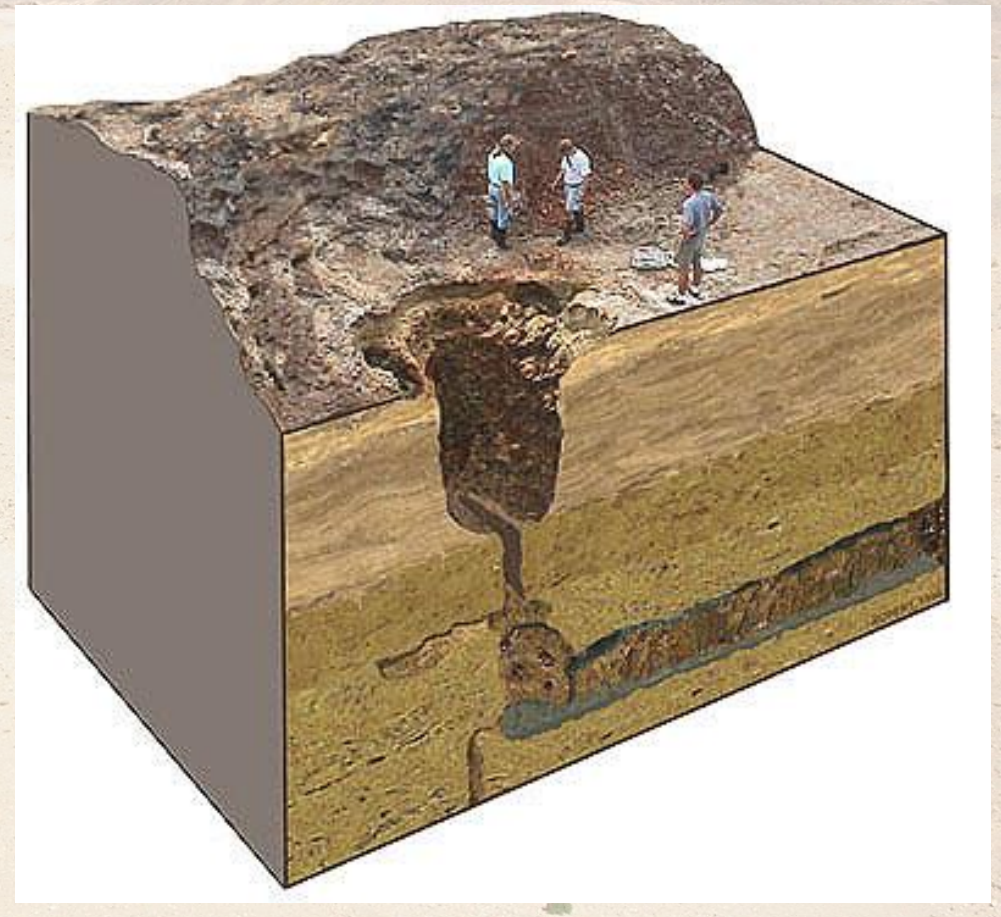
Atmospheric oxygen gains electrons (and so is itself reduced) as a mineral loses electrons (and so is oxidised) forming a new "rusty" mineral

Pyrite + atmospheric oxygen → hematite + dissolved sulphur

$2FeS_2 + O_2 \rightarrow Fe_2O_3 + 2S$

Liesegang banding

Limestone dissolution



Weathering

- Mechanical weathering
- Chemical weathering
- Biological weathering

Physical biological weathering

Orrest Head, Windermere, England

Chemical biological Weathering

Soils

Topsoil

Solum
"true soil"

O horizon
Loose and partly decayed organic matter

A horizon
Mineral matter mixed with some organic matter

E horizon
Zone of eluviation and leaching

B horizon
Accumulation of clay+ transported from above

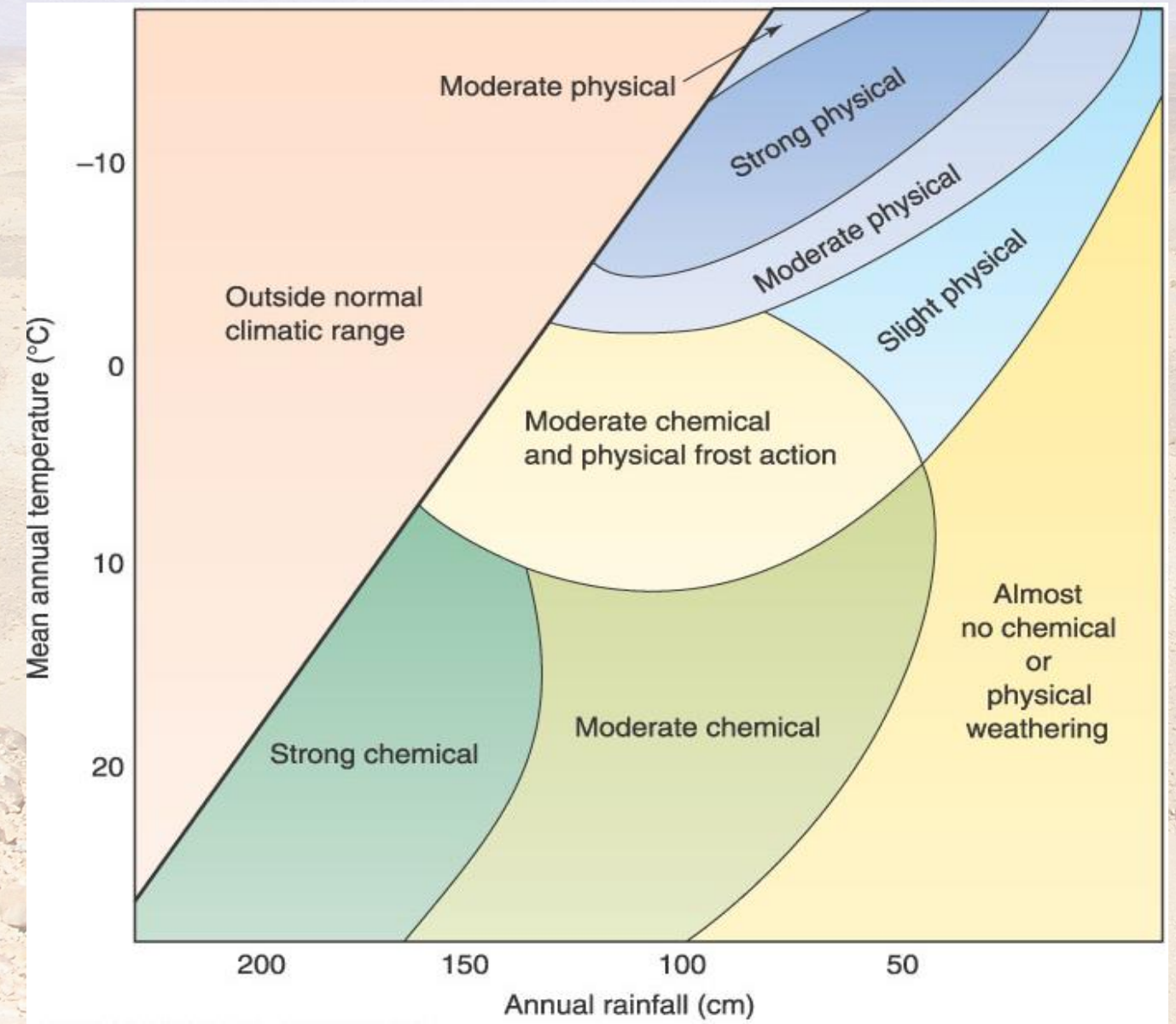
C horizon
Partially altered parent material

R horizon
Unweathered parent bedrock material

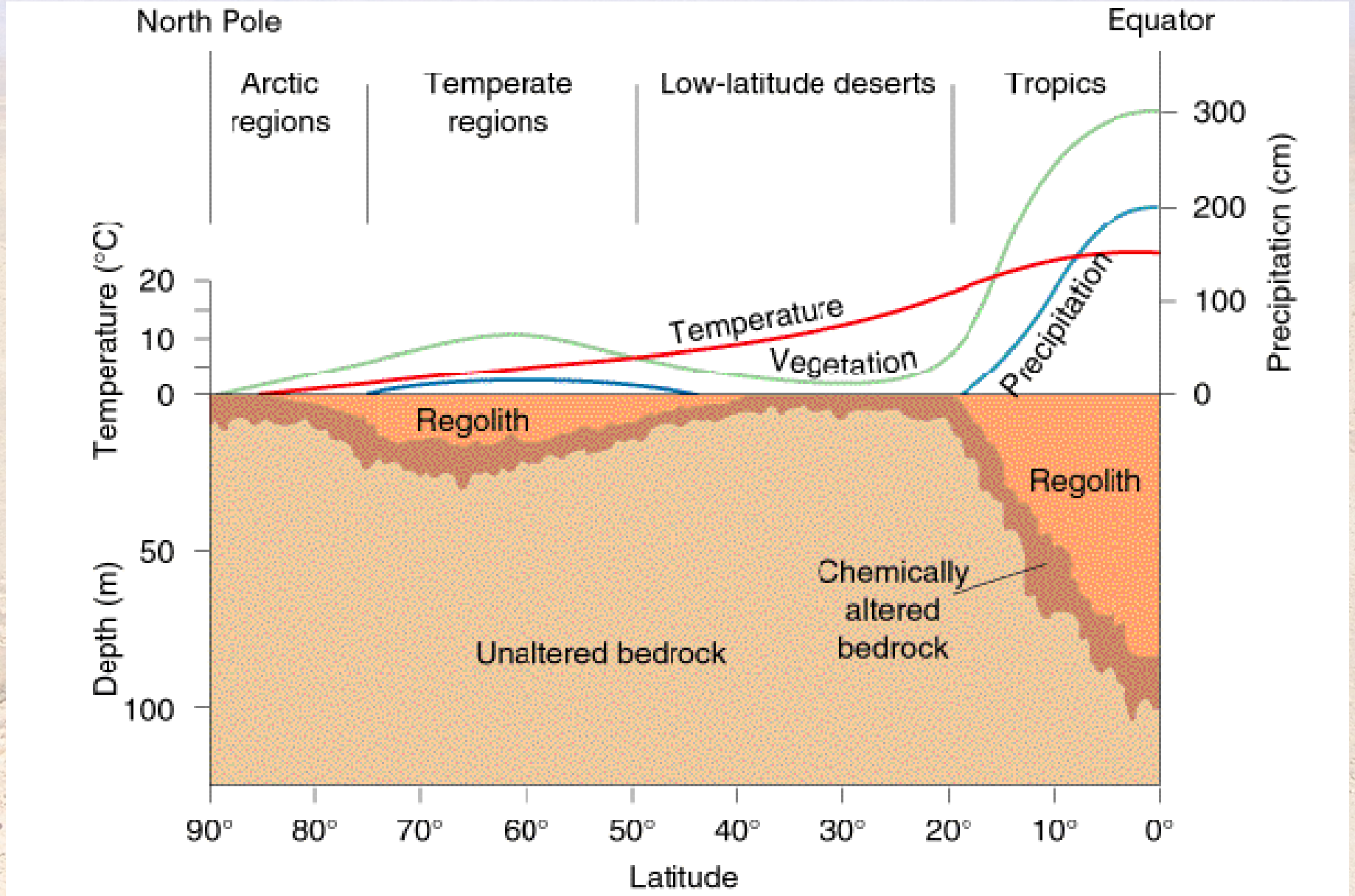
Regolith

Bedrock

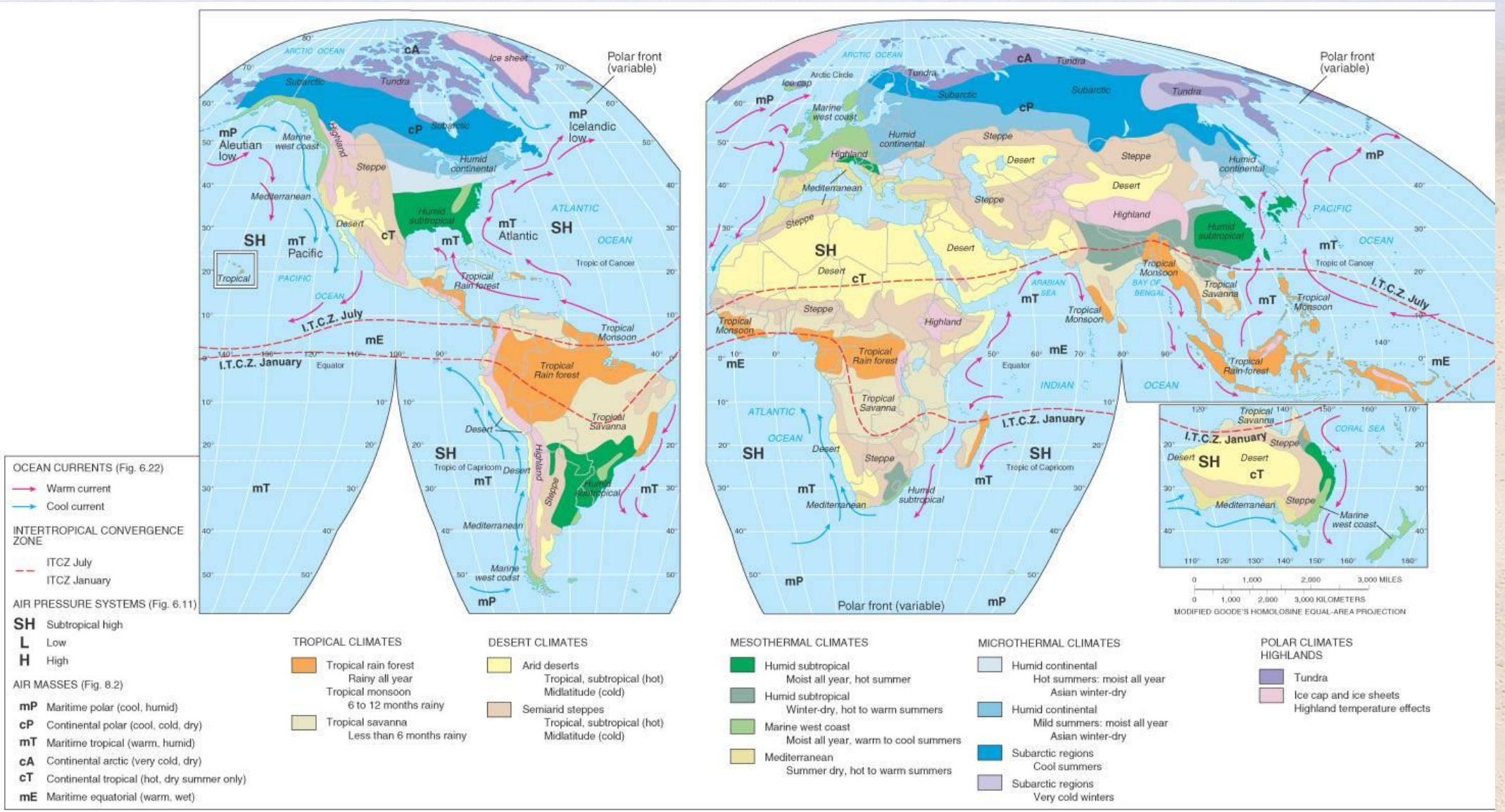
Temperature and Moisture



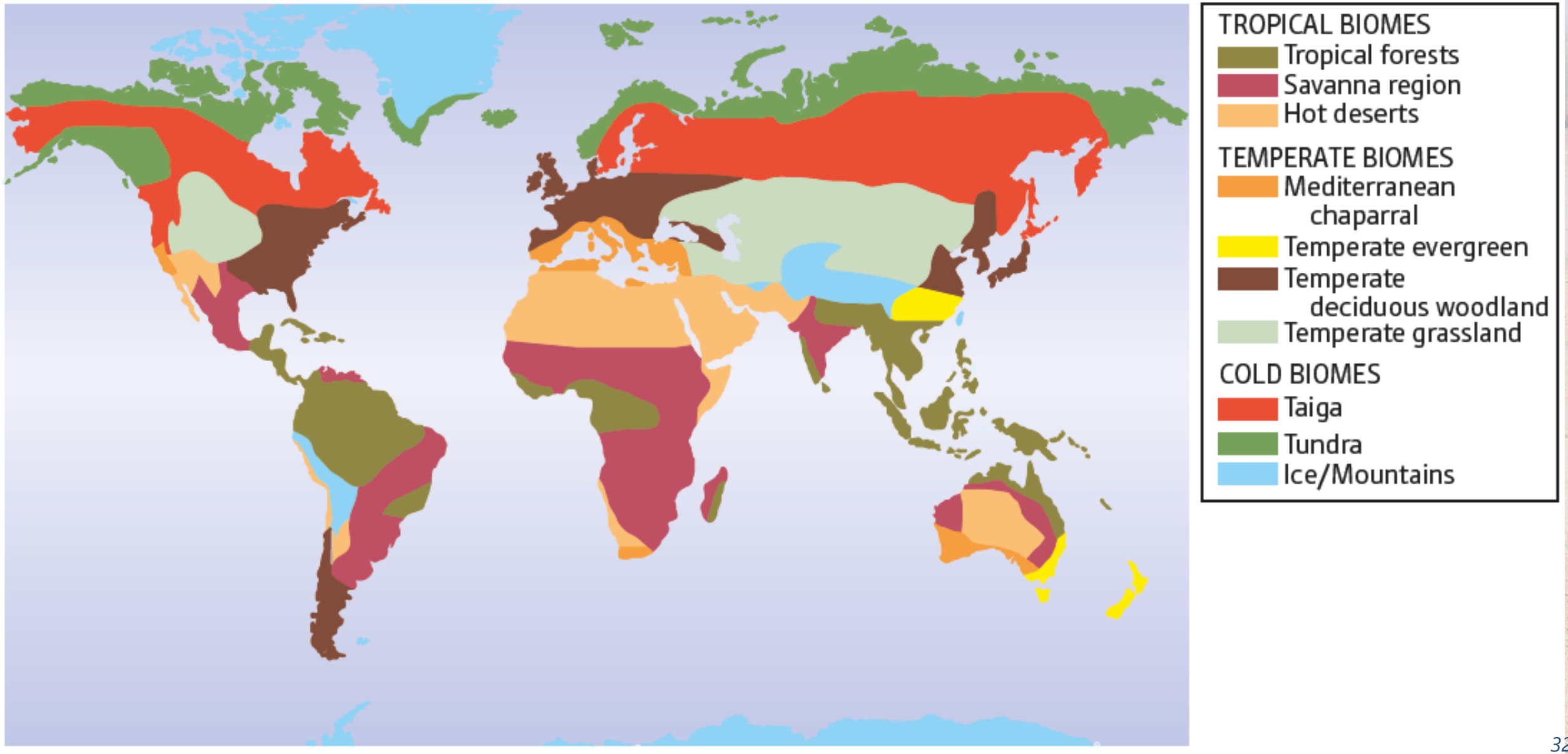
Climate Controls



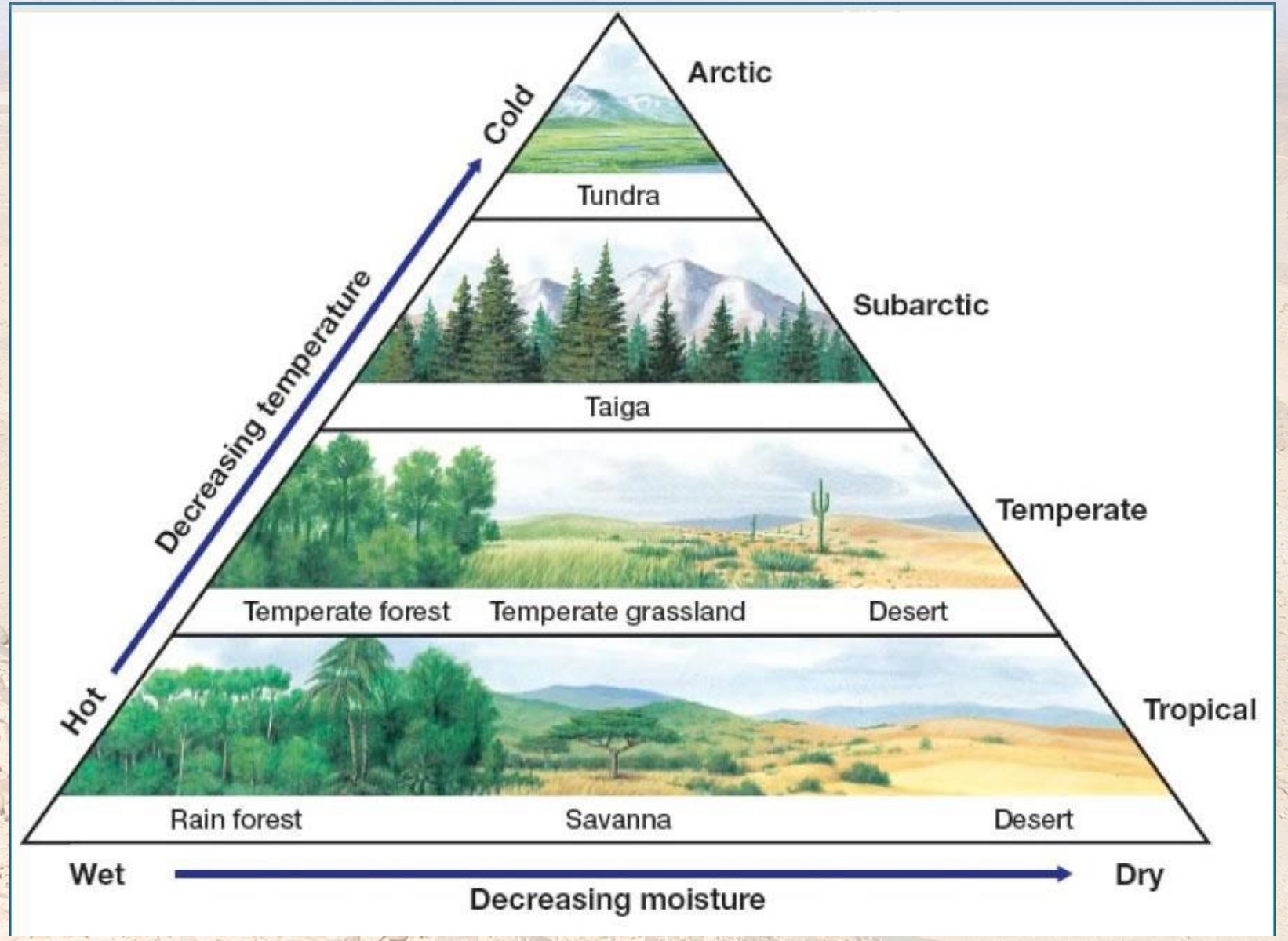
Climate Zones



Biomes


TROPICAL BIOMES
Tropical forests
Savanna region
Hot deserts
TEMPERATE BIOMES
Mediterranean chaparral
Temperate evergreen
Temperate deciduous woodland
Temperate grassland
COLD BIOMES
Taiga
Tundra
Ice/Mountains

Biomes


Arctic
Cold
Tundra
Subarctic
Decreasing temperature
Taiga
Temperate
Temperate forest
Temperate grassland
Desert
Hot
Tropical
Rain forest
Savanna
Desert
Wet
Dry
Decreasing moisture