

Geomorphology

Chapters 13: Weathering, Karst Landscapes and Mass Movement

Chapter 15: Eolian Processes and Arid Landscapes

External Processes

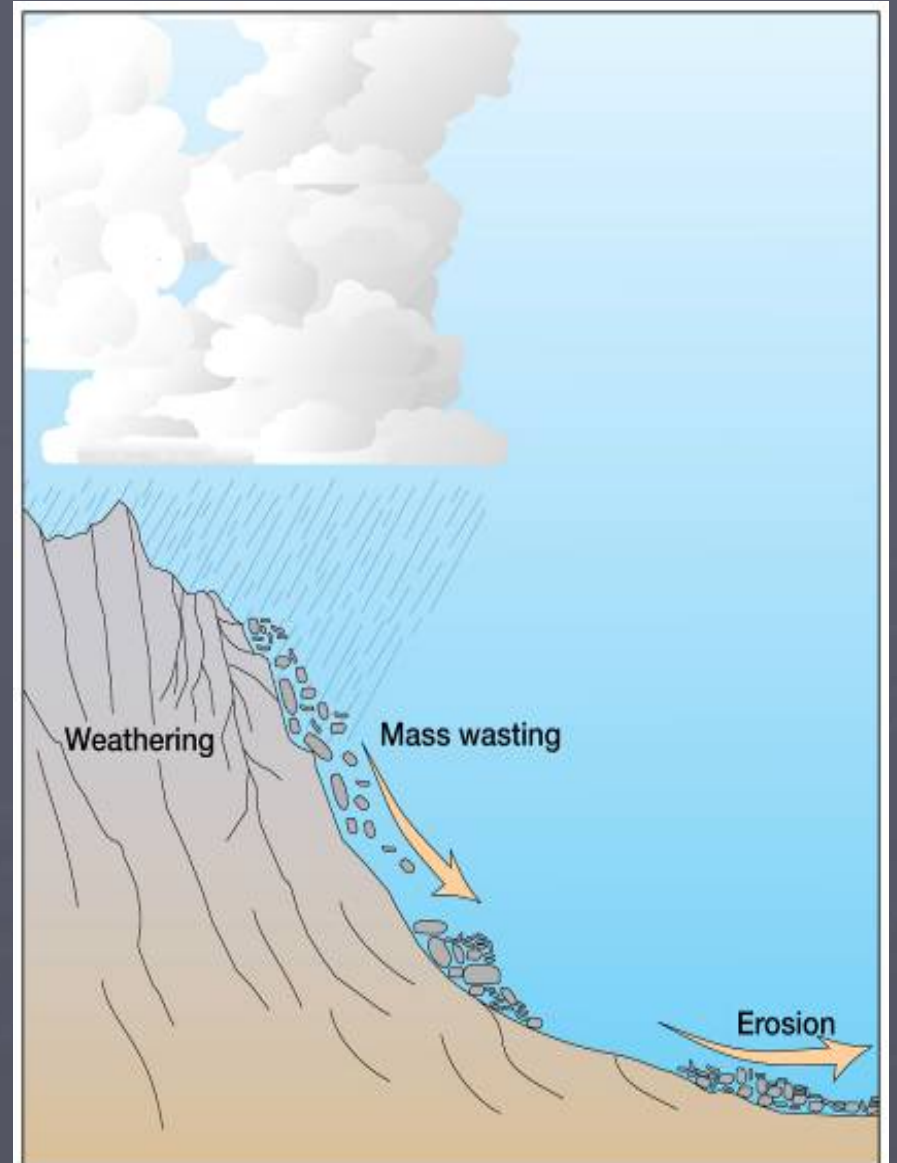
- **Geomorphology:** The changing of the earth's topography through physical, chemical, or biological processes
- **Denudation:** The gradual wearing away of the Earth's surface leading to a reduction in elevation and definition

Endogenic and Exogenic Processes

- Endogenic processes build initial landscapes.
- Exogenic processes develop sequential landscapes of low relief, gradual change, and stability.
- The internal and external countering processes act on landscapes simultaneously at different rates.

Erosional Systems

- **Erosion:** The movement of materials—usually by wind, water, or ice
- **Mass Wasting:** The transfer of rock material downslope by the forces of gravity



Forms of Weathering and Geomorphology

- Physical weathering, also called mechanical weathering, is the process of rock breakage without any chemical alteration.
 - Hillslope
 - Aeolian
 - Biological
 - Glacial (Discussed in chpt. 17)
 - Tectonic & Igneous (Discussed in chpt.12)
- Chemical weathering refers to actual decomposition and decay of the constituent minerals in rock due to chemical reaction, always in the presence of water.
 - Fluvial (Discussed in chpt. 14)
 - Marine

Geomorphological Processes: Slopes

- Main Force: Mechanical - Gravity
- Combining with other processes mountains/hills gradually break apart sending fragments downslope (singularly or as landslides)
 - Fragments collect at bottom forming new landscapes
 - Process aided by water and wind – increases weight or loosens materials



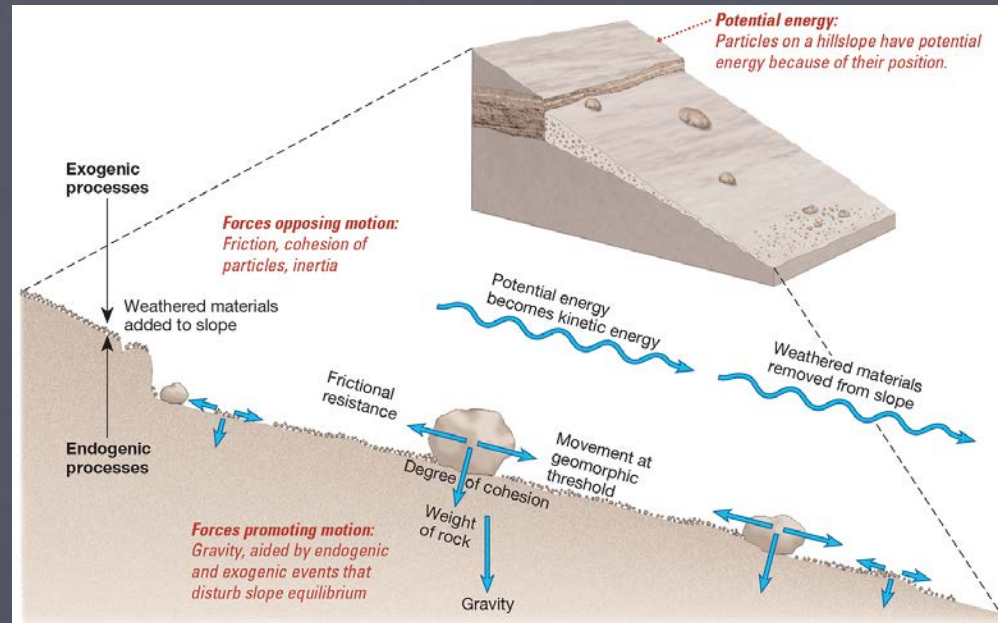
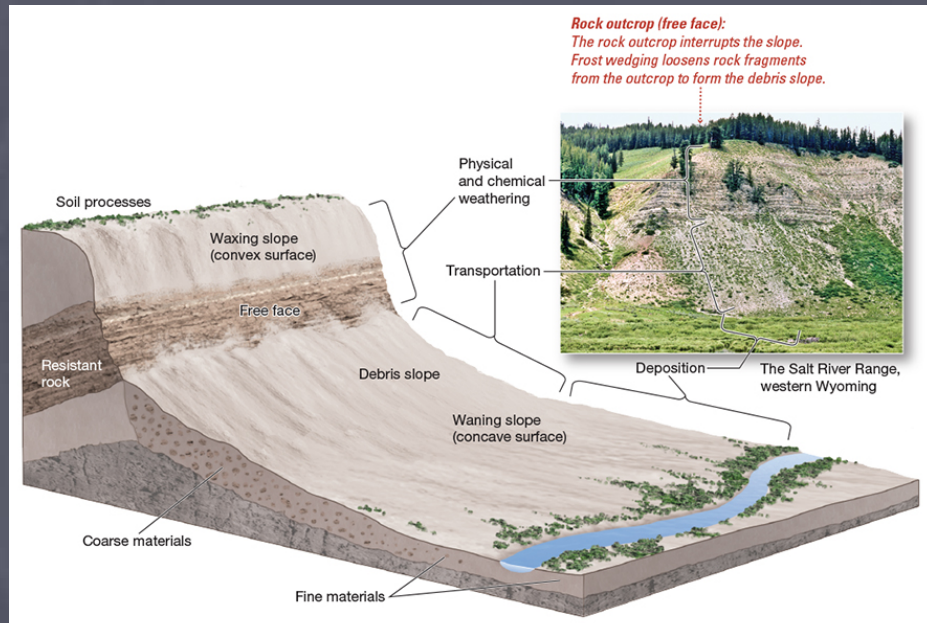
Slopes

- For material to move downslope, the forces of erosion must overcome other forces: friction, inertia (the resistance to movement), and the cohesion of particles to one another.



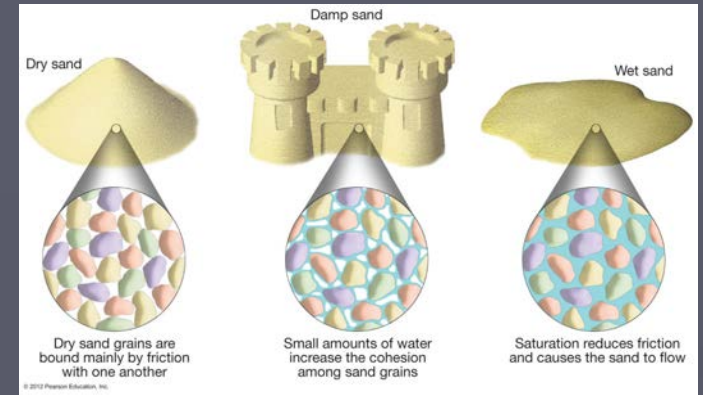
Stable and Unstable Slopes

- A slope is stable if its strength is able to exceed forces of weathering and erosion
 - All materials can certain amounts of saturation, or external forces of wind and gravity
 - Friction, gravity, and potential energy all factors



Forces of Mass Wasting

1. Saturation with water
2. Removal of anchor vegetation
3. Earthquakes
4. Gravity
5. Climate (Temperature and Moisture)



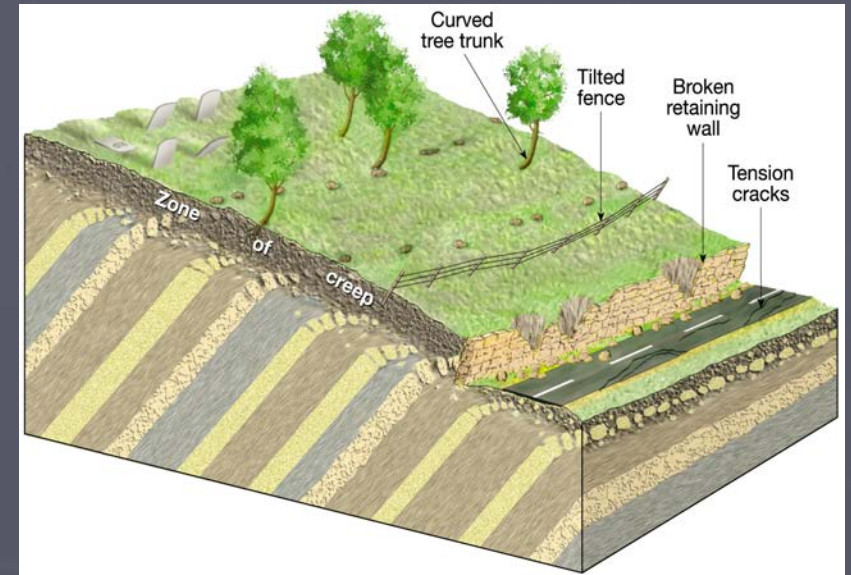
Types of Mass Wasting

- Mass Wasting Defined by
 - Materials involved – soil, rock, mud, etc...
 - Movement of the material
 - Fall – vertical
 - Slide – along a well defined surface
 - Slump – along a curved surface
 - Flow – Move as a viscous fluid
 - Speed – sudden to imperceptible

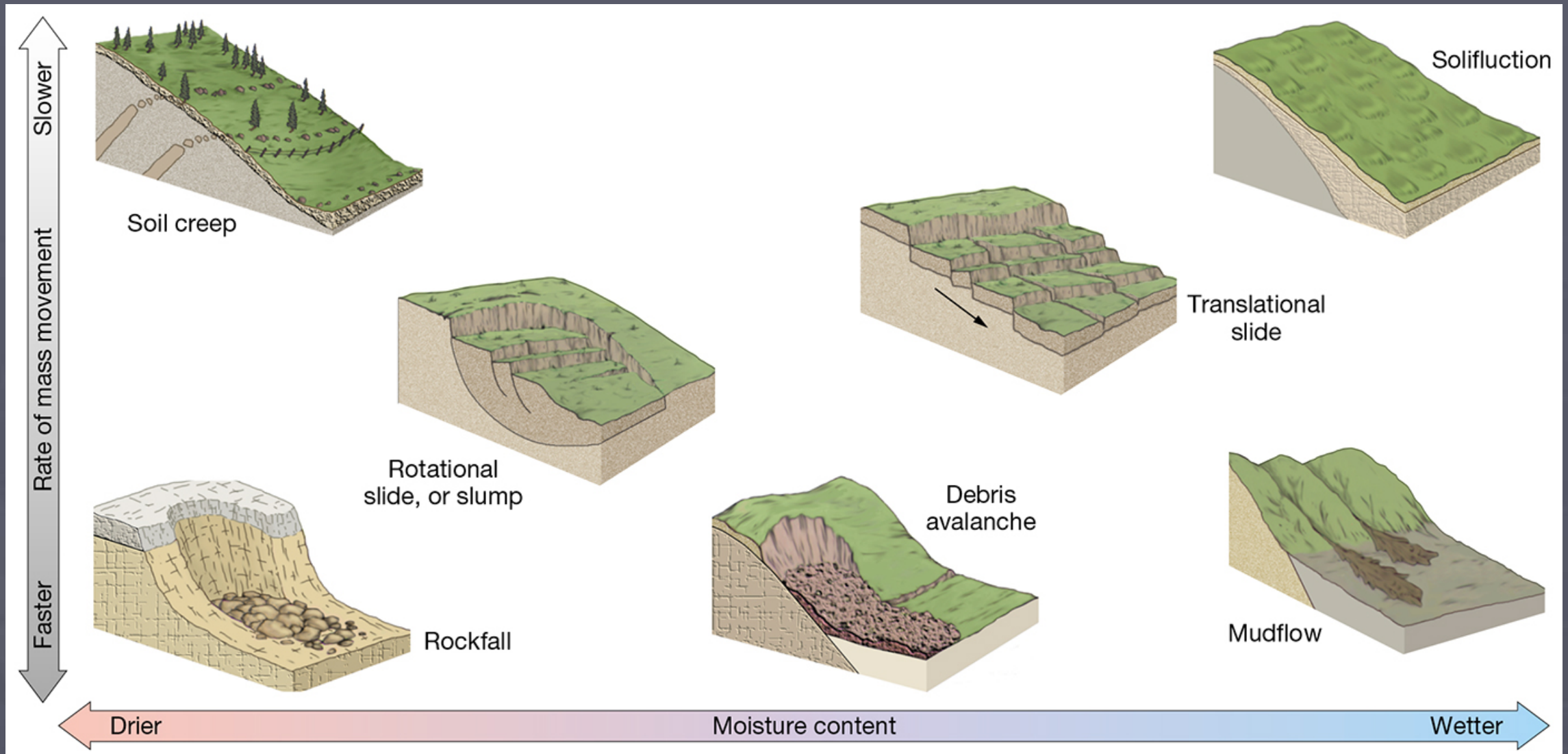


Classes of Mass Wasting

- Slump – sudden movement along a curved edge (usually along a steep slope)
- Creep – Slow movements of soil downslope
- Solifluction – Movement caused by contracting and expanding soil over permafrost
- Mudflow – Movement of earth (usually along a channel) due to sudden saturation
- Rock Slide – Sudden, builds size with inertia



Mass Wasting visualized



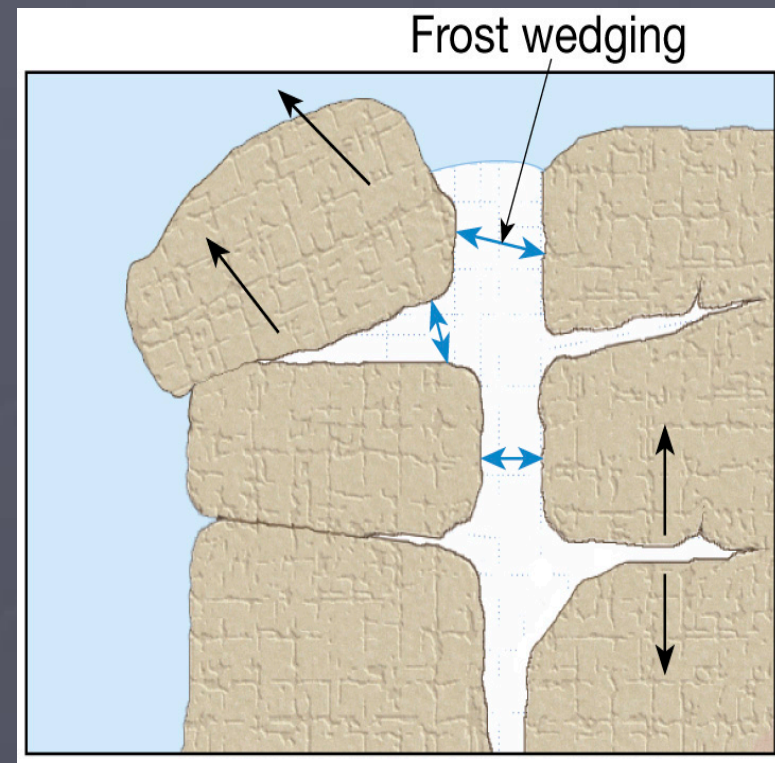
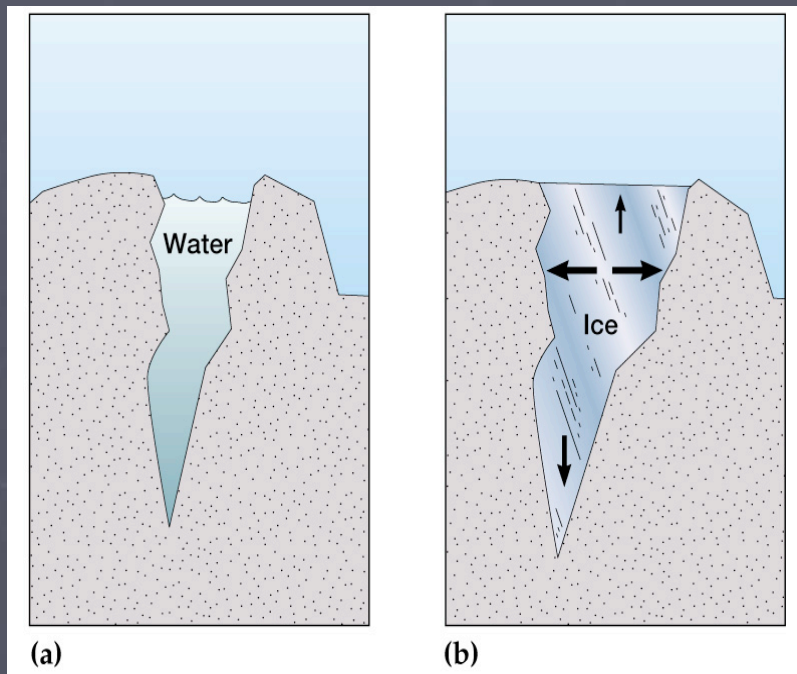
Mass Wasting and the Human Environment



Big Sur Highway, 2017

Physical Erosion - Frost Wedging

- Water expands when it freezes
 - Over time water infiltrates cracks in rocks, freezes, expands, and can break apart formations



Physical Weathering – Salt Weathering

- The physical disintegration of rocks and stone over time due to the growth and expansion of salt crystals



Geomorphological Processes: Aeolian

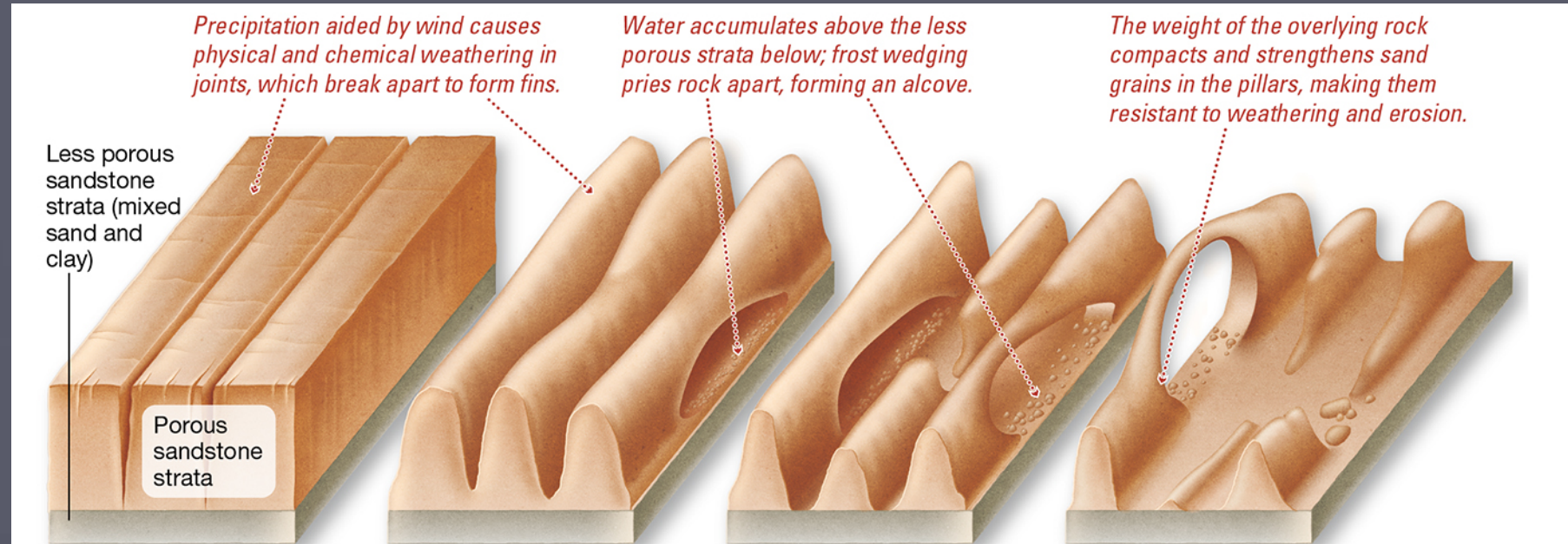
- Main Force: Mechanical – Wind
- The process by which wind shapes and reshapes the landscape through the erosion of surfaces or the redistribution of sediment
 - Deflation: removing and lifting individual loose particles
 - Abrasion: grinding rock surface by the “sandblasting” action of particles captured in the air



Mesas, Buttes, and Arches



Formation of an Arch



(a) Stages in the formation of sandstone arches. Note that a natural arch differs from a natural bridge, which forms over a flowing stream.



(b) Double O Arch. Note the second smaller arch at bottom left center.



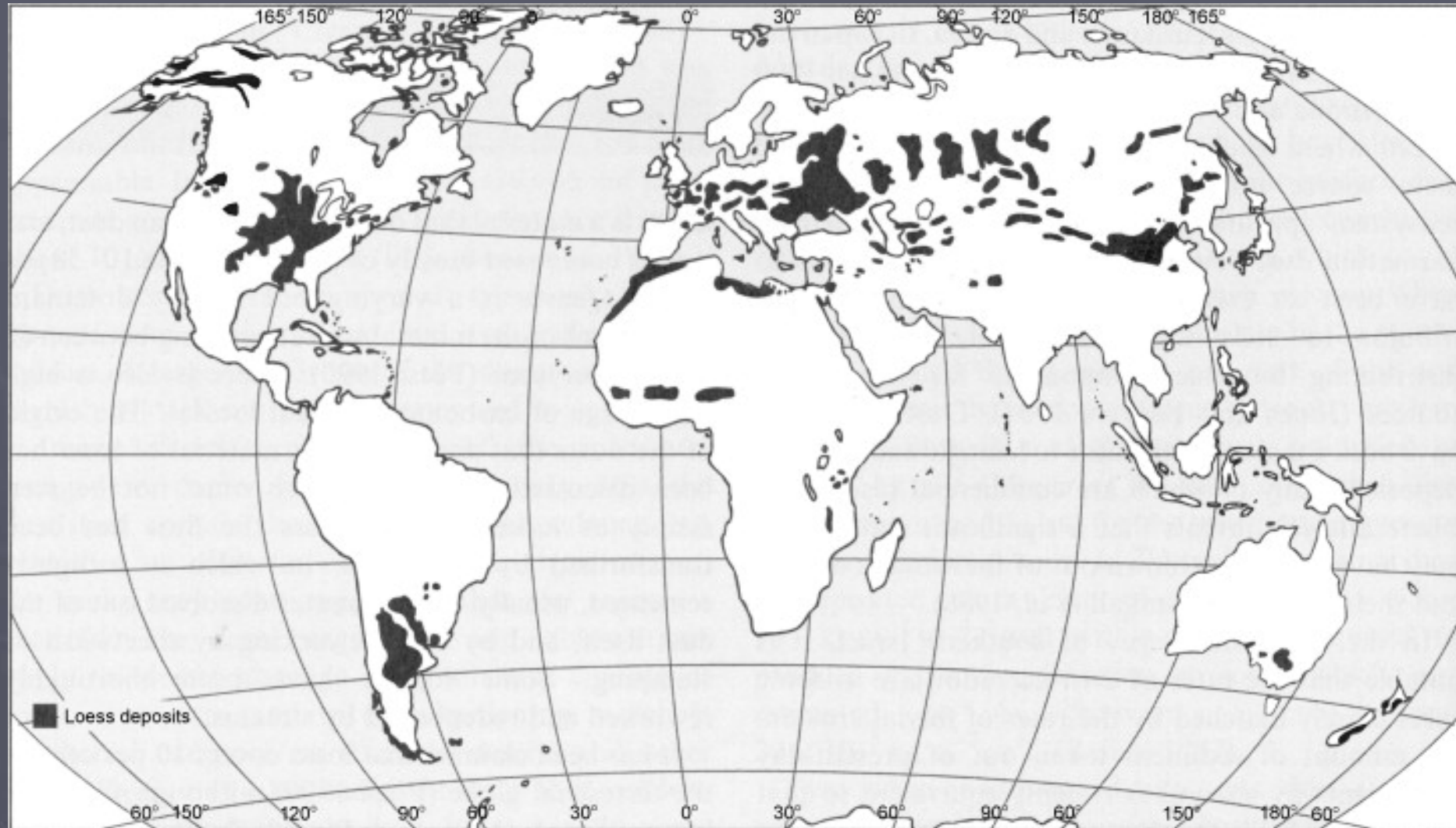
(c) Delicate Arch, probably the most well-known and photographed arch in the park.

Loess

- Large glacial deposits of clay and silts that had been exposed and redeposited in unstratified deposits
- Loess deposits are very fertile and well-drained, making them ideal for agriculture

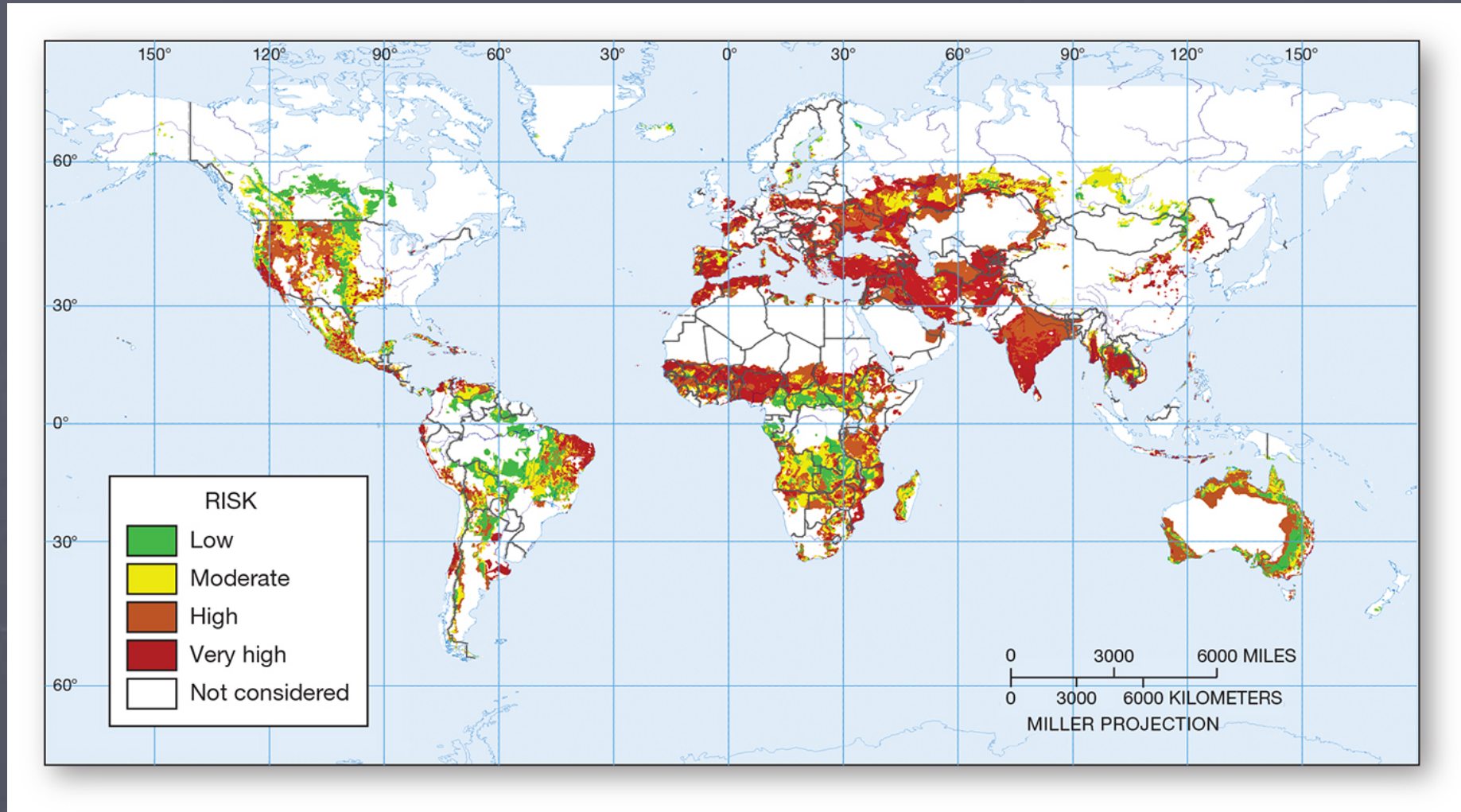


Loess Deposits



Desertification

- The growth of desert through aeolian spread and land degradation



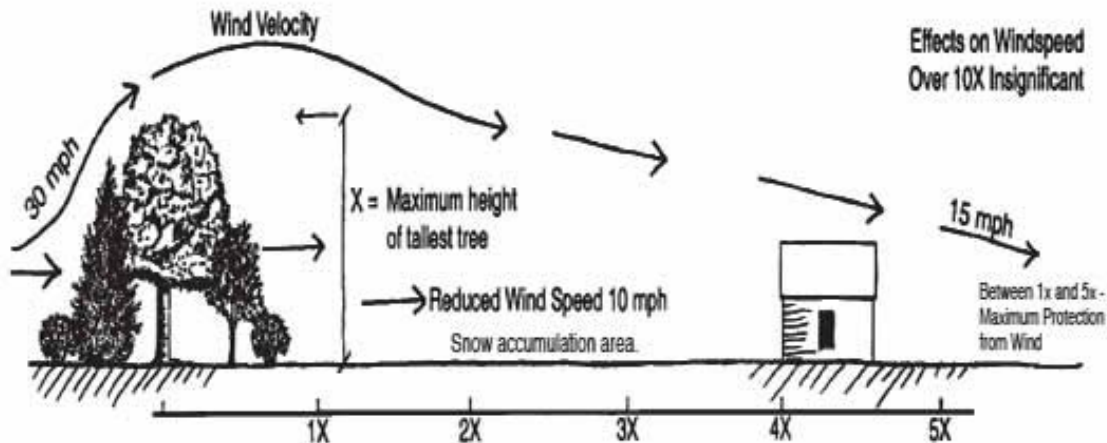
Combating Aeolian Erosion



THE GREAT GREEN WALL INITIATIVE

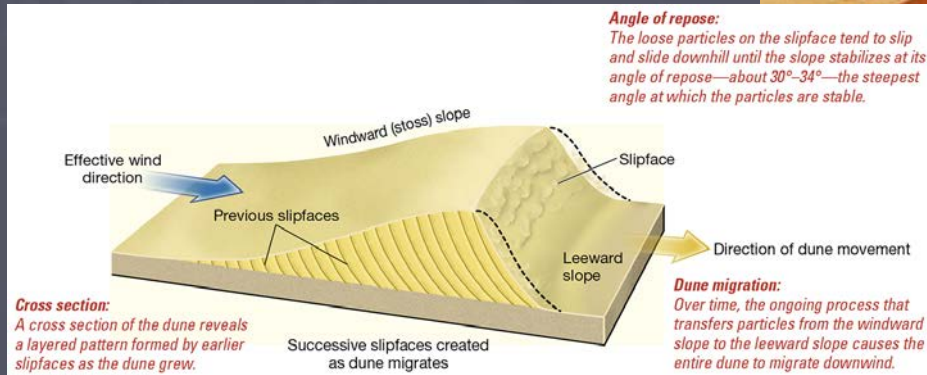


An Example of the Effects of a Windbreak on Wind Speed.



Deserts and Sand Dunes

- Wind direction, speed, frequency all determine building of sand dunes, their shape and their size.
- Mapping them is more or less a futile task



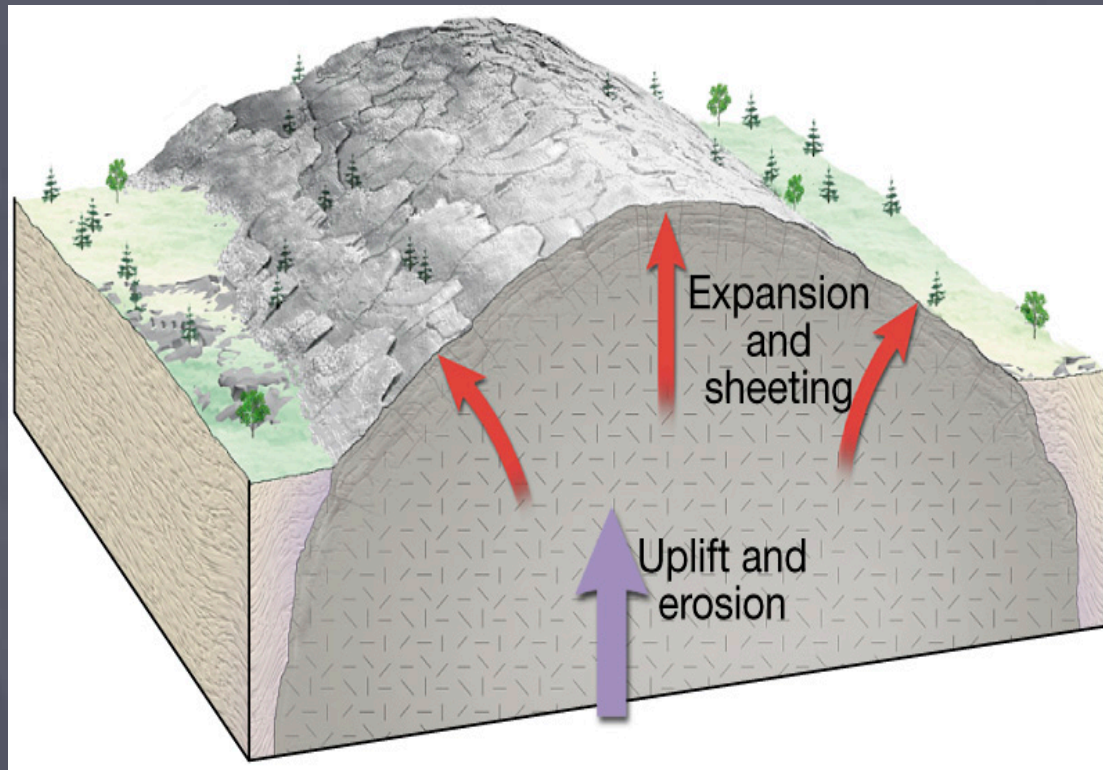
Geomorphological Processes: Biological

- The physical force of plants working between rocks (tree roots splitting rocks) can gradually break apart rock and cause weathering
 - Animals too can have an affect on the landscape through the removal of vegetation allowing erosion



Geomorphological Processes Unloading

- Tectonic uplift and erosion removes ice and rock, relieving pressure underneath allowing the ground to expand



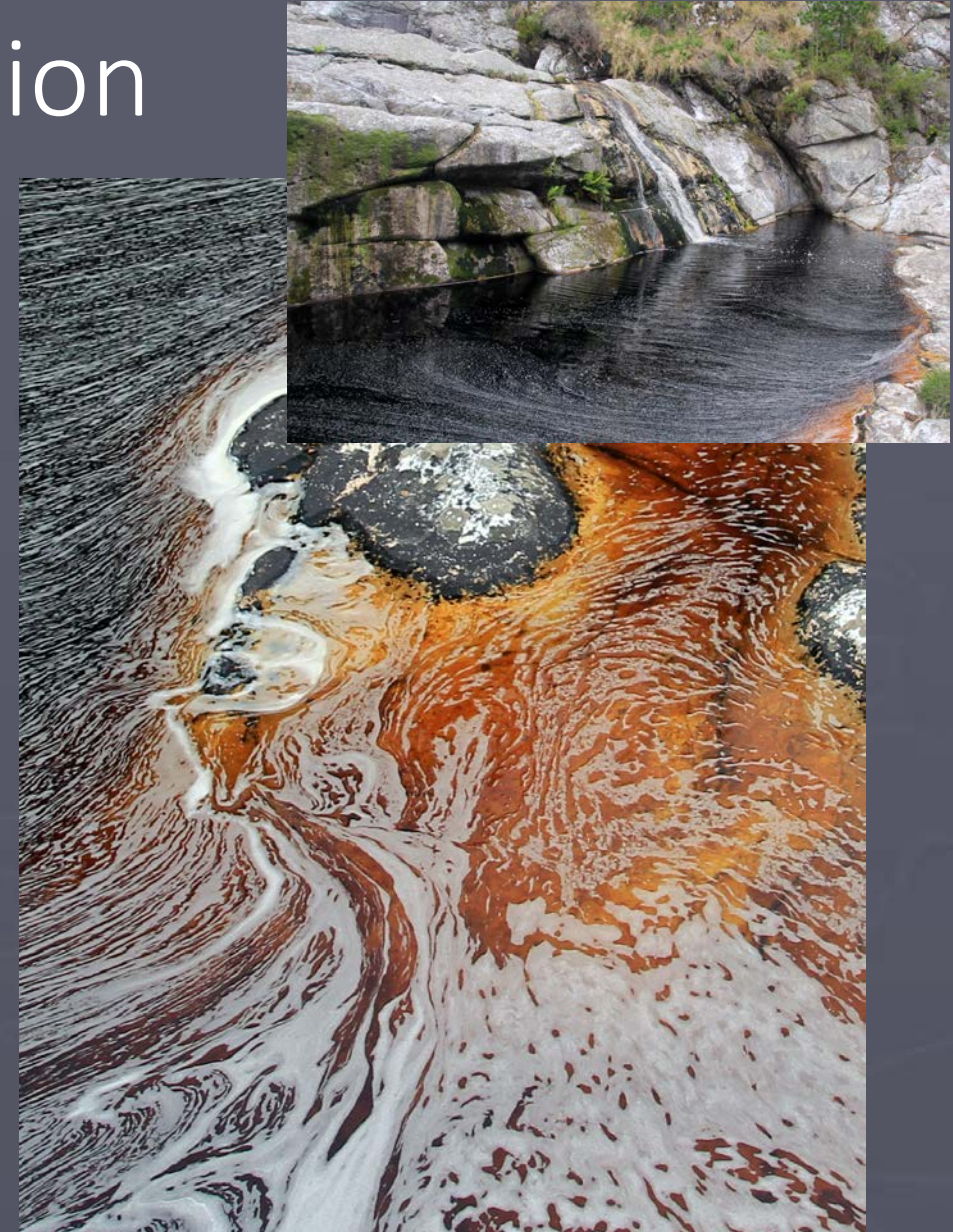
Enchanted
Rock, Texas

Geomorphological Processes: Chemical Weathering

- Alters the internal structures of minerals by removing or adding elements
- Water especially important in process
 - Oxidation -- oxygen dissolved in water oxidizes materials (iron oxide)
 - Hydrolysis – the addition of water breaks bonds
 - Carbonation -- carbon dioxide (CO_2) dissolved in water forms carbonic acid attacking and altering the material chemically

Chemical Weathering: Oxidation

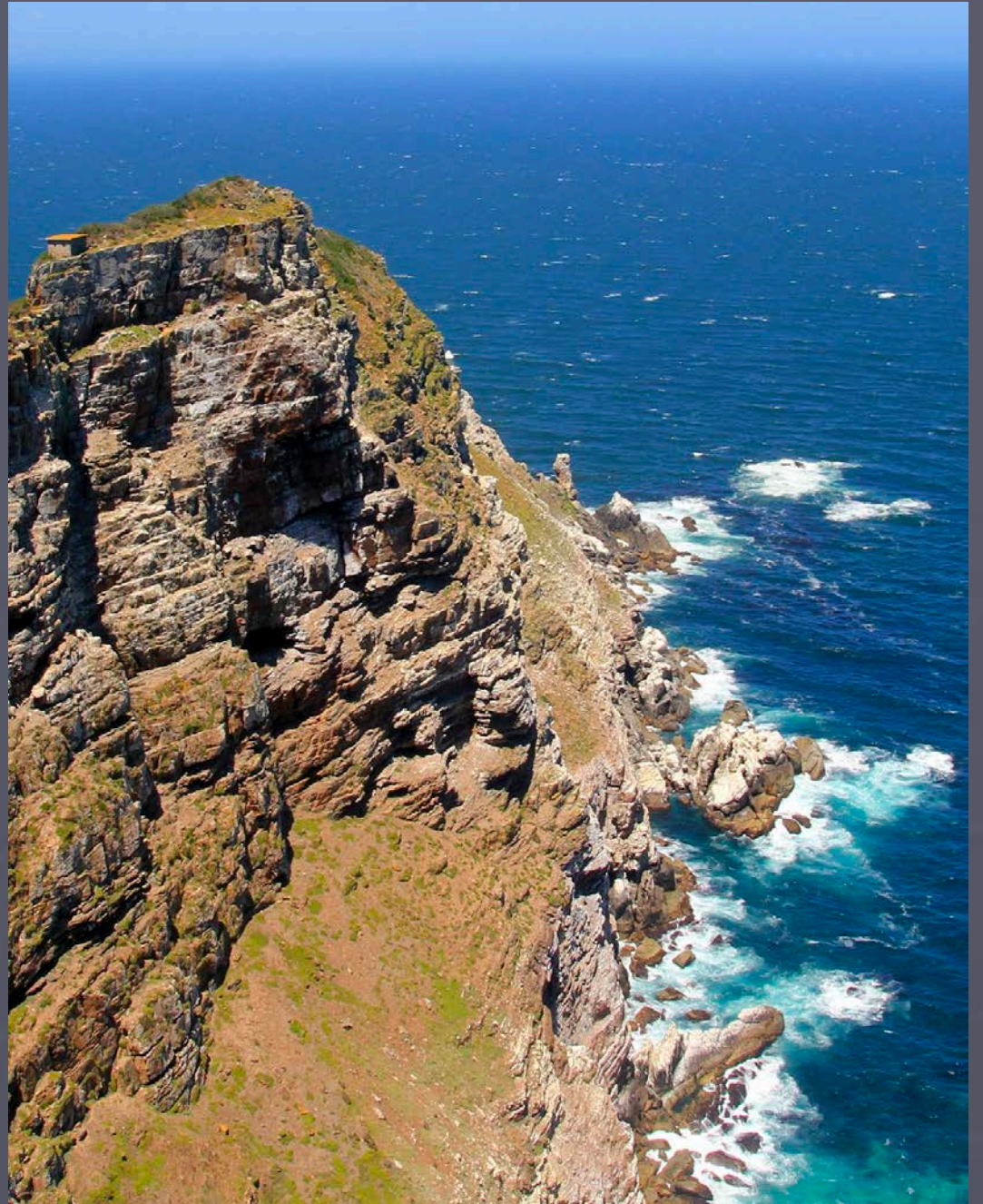
- Occurs when rock minerals react with oxygen (introduced with water)
 - Produces “rust”
 - Reaction makes them less resistant to weathering



Weathering: Marine Processes

- Combination of Mechanical and Chemical
- Gradual breakdown and shaping of rock faces from constant wave processes





Weathering and the Human Environment



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Weathering and the Human Environment



Differentiated Weathering

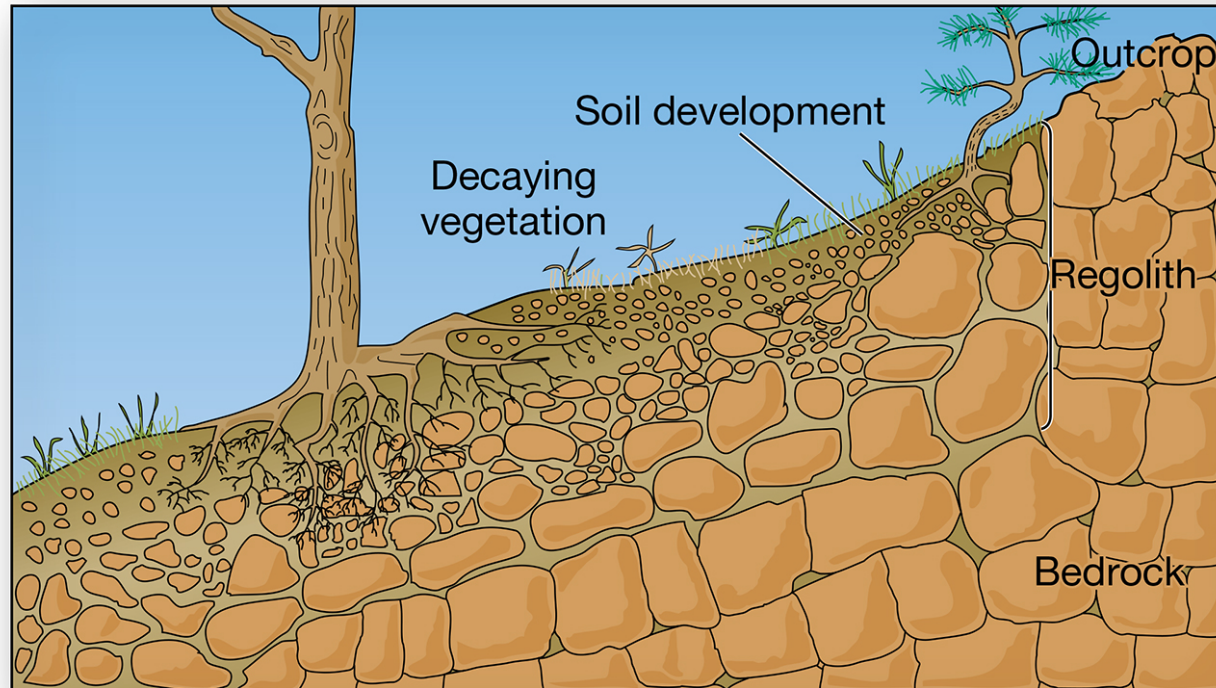
- Different substances or surfaces erode at different rates
 - Causing formation of unique landscapes



Regolith and Soil

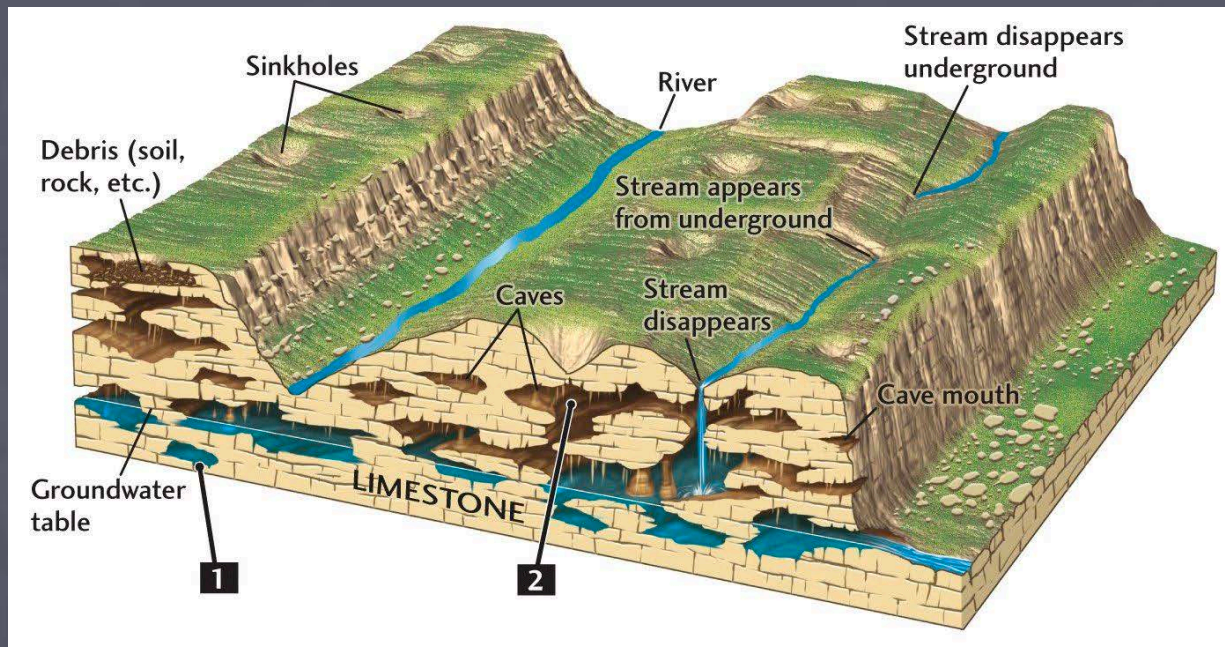
- Regolith is the broken-up rock due to weathering.
- Bedrock is the parent rock from which weathered regolith and soils develop.

(a) A cross section of a typical hillside.

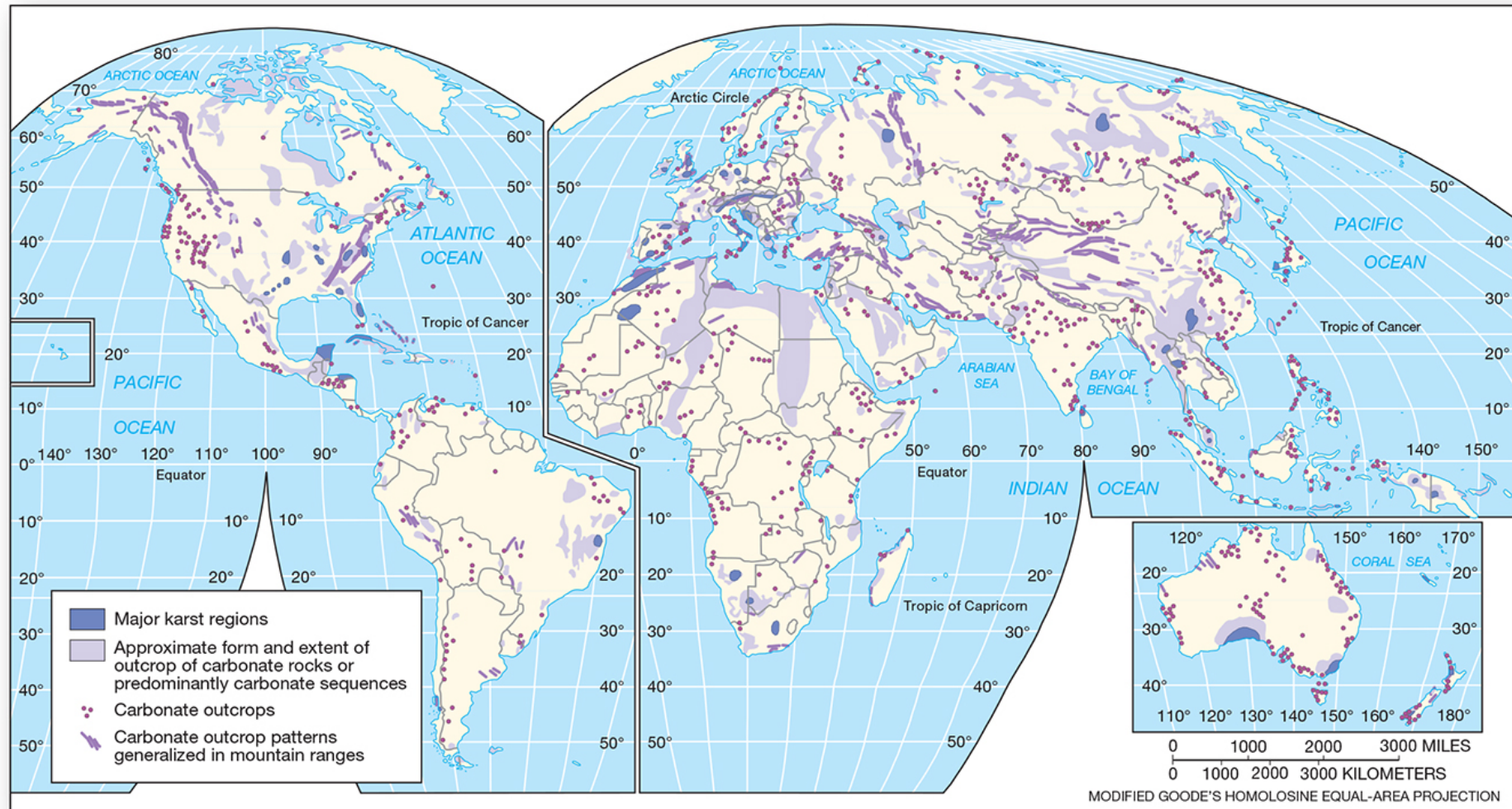


Karst Topography

- Karst is a type of landscape where the dissolving of the bedrock has created sinkholes, sinking streams, caves, springs, and other characteristic features
 - Associated with landscapes where bedrock is limestone, gypsum, and marble

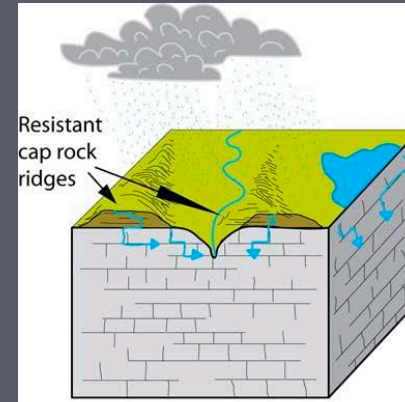


Karst Zones



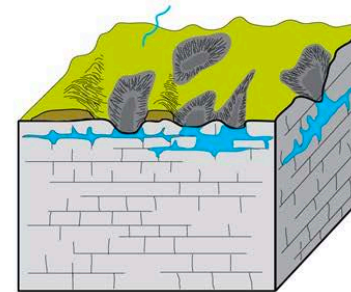
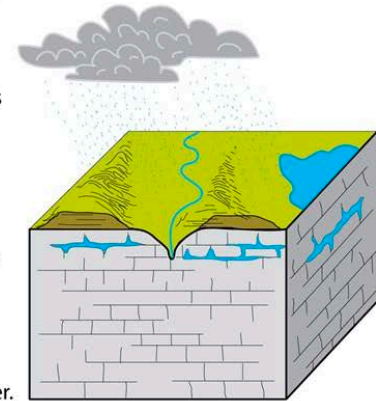
Karst Landforms

- Land appears pockmarked
 - Frequent sinkholes
 - Many caves



Rainwater and groundwater percolate through underground fissures and bedding planes, dissolving carbonate minerals, creating wider cavities and conduits.

Conduits continue to widen, creating underground network of cavities, frequently along one or more discrete zones. Larger conduits have larger flows and enlarge faster. Flow moves toward the local base level.



Rocks above cavities and voids subside or (less frequently) collapse forming dissolution holes and sinkholes. Lake and rivers may disappear underground.

Sinkholes overlap and eventually fill with surficial debris. Soils develop and vegetation is established across a rolling landscape. At the soil and bedrock interface, the chemical controls on conduit enlargement concentrate.

