

Denudation

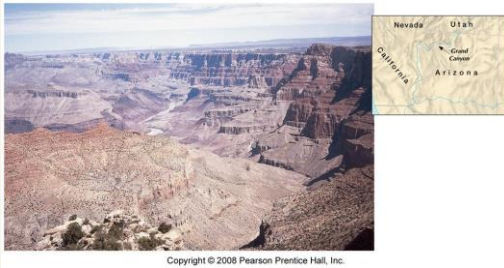
- ❑ Disintegration, wearing away, and removal of rock material
- ❑ Involves three activities:
 - ❑ Weathering is the break down of rocks into smaller components by atmospheric and biotic agents
 - ❑ Mass wasting is the relatively short-distance down-slope movement of broken rock material due to gravity
 - ❑ Erosion is more extensive and involves more long distance. And involves eventual deposition.
- ❑ Results in the lowering of continental surfaces

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The Impact of Weathering and Mass Wasting Processes on the Landscape

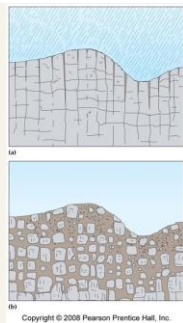
- Weathering and mass wasting work relentlessly to shape Earth's surface
- The deeply scarred walls of valleys are evidence of their tremendous potential for shaping the land.
- The two processes aid erosion by either disintegrating rocks on slopes or by sending the weathered debris into turbulent streams below.

Grand Canyon



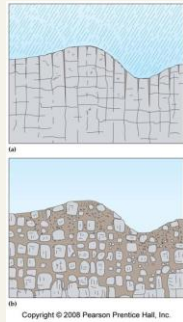
Weathering and Rock Openings

- 3 Main Types of Weathering
 - Mechanical weathering
 - Chemical weathering
 - Biological weathering



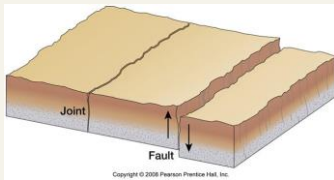
Weathering and Rock Openings

- Openings in Rock
 - Microscopic Openings
 - Joints
 - Faults
 - Lava vesicles: holes in cooling lava
 - Solution cavities e.g. limestone (sink holes, Mammoth Cave, KY, etc)



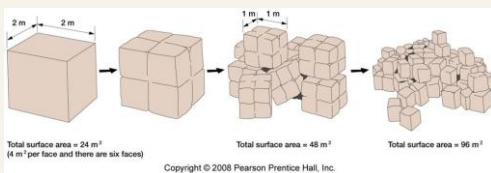
The Importance of Jointing

- Plain of weakness in rock
 - Makes rock susceptible to weathering
- Joint versus Fault: one shows displacement of rock, and the other does not.



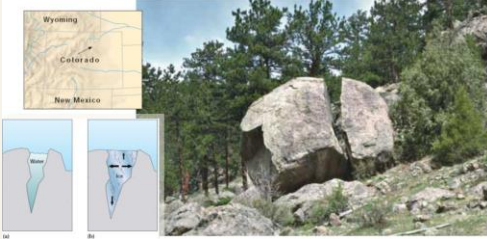
Mechanical Weathering

- Physical disintegration of rock into smaller fragments
 - No change in its chemical composition
 - Increases surface area for chemical weathering
 - There are 4 main types : frost wedging, salt wedging, temperature changes, and exfoliation.



Frost Wedging

- ❑ The most important type of mechanical weathering; freeze-thaw repetition.
- ❑ Also responsible for pot-holes.



Salt Wedging

- ❑ Growth of salt crystals in rock openings, as water evaporates
- ❑ The salts grow over time and leads to granular disintegration
- ❑ Not as intense a process as frost-wedging; found in dry climates



Temperature Changes

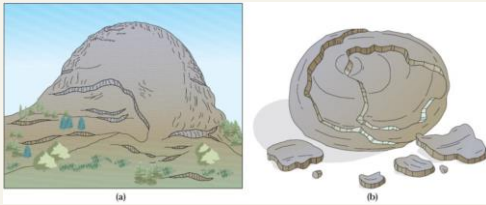
- ❑ It could be the daily day to night (diurnal) changes
- ❑ Or winter to summer (seasonal) changes
- ❑ This causes the rocks to expand and contract repeatedly, and over a long period of time the stresses will break them down
- ❑ Especially effective in high mountain elevations and in arid areas (deserts) where it is hotter during the day and cold at night.
- ❑ A much slower process than frost-wedging

Temperature Changes



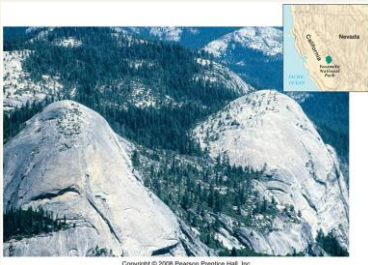
Exfoliation

- Curved and concentric sets of joints; leads to rocks that peel off in curved layers.
- Like peeling an onion
- Mainly in granite and related intrusive igneous rocks



Exfoliation

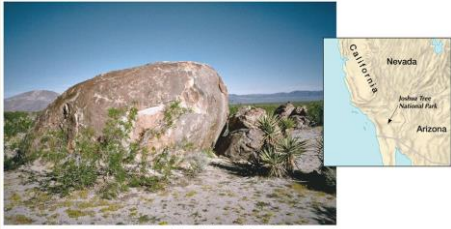
- Two large exfoliation domes in Yosemite National Park



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Exfoliation

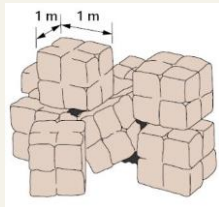
- Exfoliated boulder in Joshua Tree National Park



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Chemical Weathering

- Decomposition of rock because of chemical alteration of its minerals
- Enhanced by mechanical weathering, by exposing more surface
- Rates
 - High rates: Warm, moist environments e.g. wet tropics
 - Low rates: Cold lands and deserts

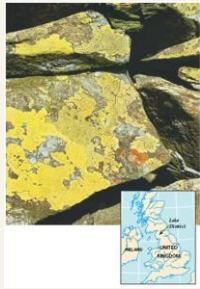


3 Types of Chemical Processes

- Oxidation:** rocks containing iron break down in the presence of oxygen. Also called rusting. Gives a reddish color to rocks; very common in tropical countries.
- Hydrolysis:** where water combines with minerals to form a softer, weaker surface.
- Carbonation:** where water dissolves rocks like limestone after combining with CO₂ to form a weak acid (carbonic acid - H₂CO₃). This leads to caves and spectacular Karst regions

Biological Weathering

- ❑ Root penetration. Also seen on city pavements/sidewalks
- ❑ Burrowing animals e.g. earthworms, prairie dogs, etc
- ❑ Organic acids
 - ❑ e.g., from lichens



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Mass Wasting

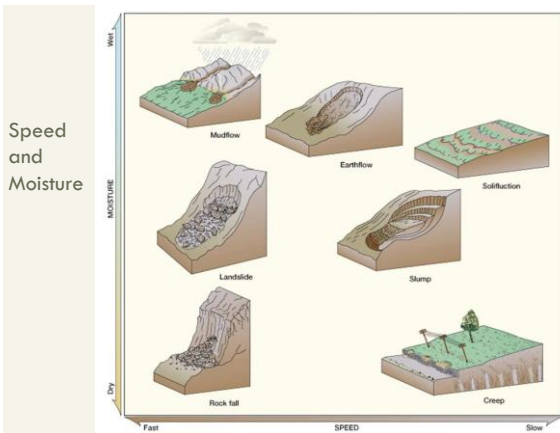
□ Gravity (downslope) transfer

■ Angle of repose

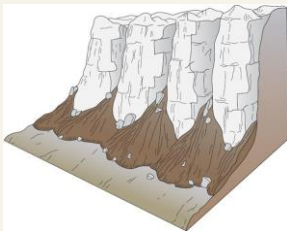
■ The steepest angle that can be assumed by loose fragments without downslope movement. Any fragments added after that *balance* is reached causes downslope movement (pull of gravity)

■ Accumulation of weathered material

- Soil
- Regolith
- Fragmented rock



Rock Fall

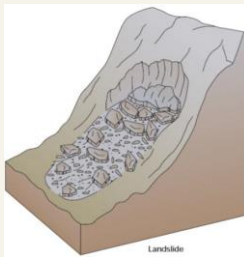


Rock Fall



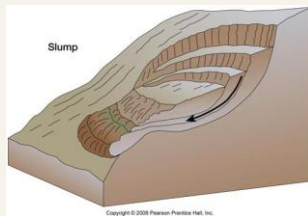
Landslide

- ❑ Instantaneous collapse of a slope (slope failure)
- ❑ This could be due to:
 - ❑ Heavy rains
 - ❑ Earthquake
 - ❑ Geological weakness (jointing)
 - ❑ Involves rapid down slope movement
 - ❑ Large, rigid mass of weathered rock (no fluid flow or water involved)



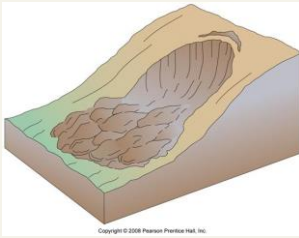
Slump

- ❑ Weathered debris rotates along a curved plane, with the concave side face upward
- ❑ Crescent-shaped scarp face marks the top
- ❑ Bulging lobe of water saturated material at the base of the slide



Flow

- Water-saturated weathered debris with high clay fraction is an important catalyst. There are 2 kinds of flow:
- Earth flow
 - Relatively rigid, slower moving than a mudflow



Mudflow

- Faster and more dangerous than an earthflow
- Found in arid and semi-arid slopes, where heavy rains cause cascading run-off after a prolonged dry spell, picking up large amount of debris
- Fluid flow follows stream network, but does not lead to slope collapse
- Alternate name: Debris flow, if large boulders are numerous

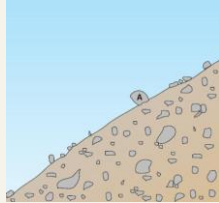
Mudflow

- Caraballeda, Venezuela (1999).



Creep (soil creep)

- ❑ Slowest moving mass wasting process
- ❑ Entire slope is involved
- ❑ Particle-by-particle movement
- ❑ Conditions
 - ❑ Wet environments experience more creep than dry ones.



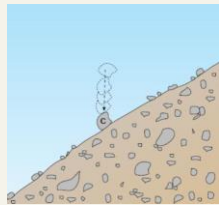
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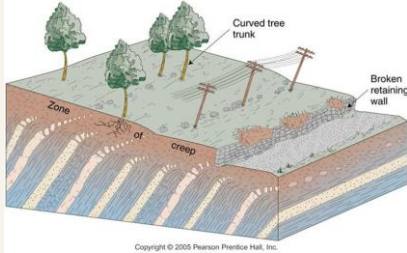
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Visual Evidence of Creep

- Displacement and/or bending of fences, trees, utility poles, and retaining walls.



Solifluction (“soil flowage”)

- A form of creep
- Found mostly in tundra areas, because the soil above the permafrost becomes saturated during the summer, but cannot drain downwards.