Lecture 6: Weathering

1. Homework #6 due Tuesday 12pm

iClicker assignments – pick yours up

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Learning Objectives (LO)

Lecture 6: Weathering
** Chapter 7 **

What we’ll learn today:

1. Compare/contrast 3 types of weathering
2. Describe types of physical weathering
3. Describe the role of water in chemical weathering
4. List and define typical soil layers
5. Describe ways by which sediments are eroded
Monument Valley, Utah.

Several weathering processes contributed to the development of these remarkable rock formations.
The Rock Cycle
Weathering

- **Def.** processes that decompose rocks & convert them to loose gravel, sand, clay, & soil

- Three primary types:
  - Physical
  - Biological
  - Chemical

Arches Nat’l Park, Utah

Bryce Canyon Nat’l Park, Utah
Physical Weathering

- **Def.**: Physical breakdown of solid rock to smaller pieces, but with *no alterations to composition*
Types of Physical Weathering

- Pressure-release fracturing
- Abrasion
- Freeze-Thaw (frost wedging)
- Hydraulic Action
- Growth of Salts
Pressure-Release Fracturing

- **Def.:** Release of pressure (when rock is uplifted & exposed) causes expansion of rock
- Common in igneous rocks
- *Exfoliation*

Sheet joints (exfoliation)

Exfoliated domes
Yosemite Nat’l Park
Exfoliation

- rocks breaking loose along parallel fractures, like onion layers
Abrasion

- Abrasion: wearing or grinding by small sedimentary particles carried by wind, water, or ice
Wind Abrasion Forms Ventifacts
Some months after spending 2.5 billion USD to get a mobile science laboratory up to Mars...

Nope... that's not worth going back for. It's just something hard that came out of eroded sandstone.
Freeze-Thaw

- **Def.:** Crack formation & expansion due to freezing of water into ice
- **Need:** water supply, fractures, temperature changes
Talus slope created by ice-wedging
Hydraulic Action

- causes wave-cut platforms and cliff erosion on rocky shorelines

Scotland

Hanauma Bay
Growth of Salt Crystals

- Erosion due to salt crystal growth
- Typically forms a honeycomb pattern
Mechanical & Chemical Weathering

Mechanical weathering

fracturing

exposes more surface area

= more places for chemical action to occur
Chemical Weathering

- **Def.:** transformation of one mineral into another via chemical processes

- **Types:**
  - **Hydrolysis** (just add water…)
  - **Oxidation** (“rusting”)
  - **Dissolution** (“dissolving”)
Hydrolysis

- **Def.**: When water reacts with a mineral to form a new mineral with \( H_2O \) as part of its crystal structure.

- **Ex.**: Feldspar to clay

\[
H_2O + CO_2 = H_2CO_3
\]

Feldspar, most abundant mineral on Earth

Clay, most abundant sediment

+ silicic acid

\[ + H_2CO_3 \text{ (carbonic acid)} = \]

\[ CO_2 \]
The effects of weathering can produce climate change.

- Volcanic outgassing of greenhouse gas
- Part of carbon cycle
The Uplift Weathering Hypothesis

- Global rate of chemical weathering dependent on availability of fresh rock.
- Atmospheric carbon dioxide decreases as new silicate-rich crust is exposed to hydrolysis during orogenesis (i.e., raising the Himalayas).
Oxidation

**Def.:** Occurs when a mineral reacts with $O_2$

**Ex.:** Iron + $O_2$ = Rust

Rusted metal  
Mars’ rusty surface
Oxidation

Fe₂O₃ - Hematite
Dissolution

- **Def.:** when ionic and organic compounds dissolve in water
- **Ex.:** Silica, Na, Ca, Cl, CO$_3$
Dissolution

- occurs when carbonic acid dissolves the mineral calcite (found in limestone)

Widespread dissolution causes: Karst Topography and sink holes
Karst Topography & Sinkholes
Sink Holes in Hawaii?

https://www.youtube.com/watch?v=kh0SNz1oZN4
Moiliili Karst – A Cave Beneath UH Manoa

Moiliili Karst:
Video:  http://explorebiodiversity.com/Hawaii/hikes/Moiliili/cavemoiliili.html
Biological Weathering

- Involves both physical and chemical processes

1. Simple breaking
2. Movement and mixing
3. Carbon dioxide produced by respiration forms carbonic acid
4. Organisms influence moisture in soil
Weathering Produces Soil
Soil

- Def.: upper layers of regolith that support plants

- Regolith: thin layer of loose rock, clay, & sand that overlies bedrock
Examples of Soil Profiles

- Oxisol: Hawaii
- Histosol: N. Minnesota
- Alfisol: S. Minnesota
Baseball infields show differences between soils

Manoa District Park
(Oxisol)

S. Minnesota
(Alfisol)
12 Major Types of Soil

Five Soil Forming Factors:
- Climate
- Parent Rock
- Time
- Topography
- Biological Processes
Soil Development: Climate & Plants
Climate Is Critical For Soil Formation

- Physical weathering dominates in regions of low temperature and low rainfall.
- Chemical weathering dominates in regions of high temperature and high rainfall.
Erosion

**Def.:** removal of weathered particles by moving water, wind, ice, or gravity
Soil particles can become suspended and transported by moving water or wind. This destroys the soil.
Water Erosion

Results from:
• Flooding
• Poor drainage
• Changes in land use
• Loss of vegetation
• Exposed soil
Wind Erosion

Results from:
- Drought
- Changes in land use
- Loss of vegetation
- Exposed soil

1930s “Dust Bowl” in Midwest
Action Items for Tuesday, Sept. 15

1. Read Chapter 7
2. Complete homework assignment #6

What you should know from today:

1. Compare/contrast 3 types of weathering
2. Describe types of physical weathering
3. Describe the role of water in chemical weathering
4. List and define typical soil layers
5. Describe ways by which sediments are eroded