Geology of the Hawaiian Islands
Class 16
4 March 2004

Homework #4
Due Today!

Any Questions?

Rock Weathering and Soils
(Chapter 6)
Weathering

- Any rock at or near the earth's surface is constantly being attacked by wind, rain, chemicals, etc.
- This process is called weathering

Two major categories of weathering

- Mechanical
- Chemical

Two major categories of weathering

- Mechanical
  - When rock is broken down into small pieces without any accompanying changes in chemical composition
- Chemical
  - Involves the change of a rock's chemical composition.
Mechanical weathering

- Goes on everywhere
- In Hawaii it is often not noticed because the effects of chemical weathering are so severe

Mechanical weathering

- Dominates in areas subjected to freeze-thaw
- In Hawaii this is restricted to tops of highest volcanoes (Mauna Loa and Mauna Kea)
- During daytime, water penetrates into cracks
- At night, temperature drops and water freezes
- When water freezes, it expands, forcing apart the walls of the crack and causing the crack to propagate deeper into the rock

Large rocks broken up into smaller pieces by mechanical weathering

Mechanical weathering

- Also caused by Organic activity
- Plants send roots down into rock, causing the rock to crack
By breaking up the rock into many pieces, there is more surface area available for attack by chemical weathering agents.

### Chemical weathering

- Very important in tropical climates
- Most important elements are:
  - oxygen from the air
  - water from rainfall
  - carbon dioxide generated by animal respiration

### Most important chemical reaction

- Carbon dioxide combines with water to form carbonic acid:
  \[ H_2O + CO_2 \rightleftharpoons H_2CO_3 \]
- Carbonic acid then combines with calcium to form calcium bicarbonate:
  \[ CaCO_3 + H_2CO_3 \rightleftharpoons Ca(HCO_3)^2 \]

### Chemical weathering

Minerals that crystallize at high temperatures are less stable at the relatively cool temperatures at the surface of the earth than minerals that crystallized at lower temperatures.
Quartz very stable at the Earth’s surface
Olivine is very unstable
Na-feldspar is more stable than Ca-feldspar

Insoluble compounds
- Left behind during chemical weathering
- Minerals disintegrate due to chemical weathering
- Some elements combine with others to form new compounds that dissolve in the groundwater and are carried away
- Other elements left behind to combine with other elements and make new minerals

Clay minerals
- Most important “residue” minerals
- Silicate minerals that contain variable amounts of water, aluminum, potassium, sodium, etc.
- Often form a large part of a soil
- Control the stability of soils
Iron oxide (Fe₂O₃)
- Very common type of mineral generated by tropical weathering
- Gives our soils distinctive reddish color
- Brownish and yellowish-colored soils made contain hydrated iron oxides

Bauxite
- Aluminum oxides left after most silica removed from weathered clay minerals under extreme conditions
- Formed in several places in Hawai‘i
- Some concentrations great enough to be mined
- Aluminum is commercially marketable

Soil
- Ultimate result of chemical weathering
- Surficial material that has been sufficiently weathered so that it is capable of supporting plant life
- Engineers: Soil = surficial material that can be removed without blasting

Residual soils
- Formed in place
- Most soils in Hawaii
Transported soils

- Rock debris brought in by natural means
- Rubble at base of large slope
- Less common than residual

Soils: 3 major zones

- A horizon
  - rich in humus
  - chemical weathering most advanced
  - little trace of the original rock left
  - nearly all soluble products have been leached out
- B horizon
- C horizon

Soils: 3 major zones

- A horizon
  - (may include an upper “O” horizon)
- B horizon
- C horizon

Soils: 3 major zones

- A horizon
  - only most resistant of original rock-forming minerals remain
  - iron oxide and clays are redeposited in the B horizon.
- B horizon
- C horizon
Soils: 3 major zones

- A horizon
- B horizon
- C horizon
  - subsoil grading into bedrock

Weathered basalt and ash

Weathered soil in Hawaii -- A and C horizons; B not well developed
Important Clay minerals

- **Kaolinite** = most common type of clay in Hawai’i
  - Reasonably stable
- **Montmorillonite** is also very common
  - Very susceptible to incorporating water
  - The clay then swells

Questions?
For Tuesday

- Read Chapter 7 on Mass Wasting