Earth's surface processes
Weathering – Physical breakdown and chemical alteration of rock at Earth’s surface

2 kinds of Weathering – mechanical and chemical

Mechanical Weathering
- Mechanical weathering – breaking of rocks into smaller pieces
  1) Frost Wedging
  2) Abrasion
  3) Plant/Animal Activity
  4) Gravity/Pressure
  5) Wetting/Drying
  6) Exfoliation / Joint Sheeting
  7) Thermal Stress

Mechanical Weathering:
- Frost Wedging
- Abrasion
- Plant/Animal Activity
- Gravity/Pressure
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Rockfall caused by frost wedging

Abrasion
Scraping of the surface by moving particles during their transport by wind, glacier, waves, gravity, running water or erosion.

Plant/Animal Activity
- The activity of organisms, including plants, burrowing animals, and humans, can also cause mechanical weathering.
Gravity/Pressure
- Bedrock is under pressure from overlying rock. When overlying rock layers are removed, the pressure on bedrock is reduced and it expands and cracks.

Wetting/Drying
- Wetting and drying causes clay minerals to expand and contract, and salts may dissolve and re-precipitate.

Mechanical Exfoliation / Joint Sheeting
Reduced pressure caused by “unloading” on igneous rock causes it to expand and allows slabs of outer rock to break off in layers in a process called exfoliation.

Thermal Stress
Heating up and cooling down makes rocks swell and shrink until they break.

Chemical Weathering
- Breaks down rock and minerals by changing their composition.

- 5 Types of Chemical Weathering:
  1. Dissolution (Carbon Dioxide)
  2. Hydrolysis
  3. Oxidation
  4. Acid Precipitation
  5. Organic (Plant) Acids

Dissolution of Soluble Compounds
- CO₂ mixed with water forms carbonic acid.
- Dissolves soluble compounds (calcium, limestone) in rocks
- Forms caves
Hydrolysis
- Water reacts with silicate and carbonate minerals. Pure water ionizes and reacts with silicate minerals and decomposes rocks.

Oxidation
- Chemical reaction where oxygen combines with minerals in rocks.
- Example: Oxygen combines with Iron (Fe) and forms rust (iron oxide).

Acid Precipitation
- Sulfur dioxide (SOx) forms from the burning of fossil fuels (factories & trucks) and turns into sulfuric acid.
- It rains down as acid rain, breaking down rock and buildings.

Organic (Plant) Acids
- Plants and fungi release chemicals that break down rocks and release minerals.
  2 Reasons For This:
  - Dissolving Nutrients
  - Making Surface for Growth

Warm Up 3/14/14
- Explain the difference between chemical and physical weathering.
Climate Affects Weathering Rates!

Cleopatra’s Needle was in Egypt for 3500 years. In 1880 it was moved to NYC. In 75 years it weathered so that most of the writing is gone. More water = more weathering.

Granite in a Dry Climate
Granite in a Wet Climate

Topography Affects Weathering Rates!

• Which area will weather the fastest? Why?

Rock Composition Affects Weathering Rates!

• Which rock will weather the fastest?
• Which rock will weather the slowest?

Weathering Overview

• Mechanical weathering breaks apart rocks so chemical weathering can change their composition.
• Mechanical weathering increases surface area available for chemical weathering.

Erosion and Deposition

• Erosion - the process that transports Earth materials from one place to another; can be on a small scale or can be a mass-movement.
• Deposition – the process that drops materials in another location.
Forces of Erosion

Gravity

- Gravity pulls materials downslope
- Running water moves across Earth from higher to lower elevations (gravity)
- Extreme examples: landslides, avalanches, & mudflows.

Gravity examples:

- Landslides
- Avalanches
- Mudflows

Slope Stabilization Efforts

Mountain Farmers use terracing (stair-steps) to avoid erosion

Slope Stabilization Efforts

Vegetation and rocks can also prevent erosion

Slope Stabilization Efforts

TECCO® high-tensile mesh slope stabilization system

Water

- Rain
- Streams and rivers
- Ocean waves and tides
- Ice (glaciers)
Streams & Rivers

- Flowing water has great power; can carry material long distances.
- The Mississippi River ("The Big Muddy") carries 750 million metric tons of eroded material into the Gulf of Mexico each year!

Streams and Rivers: Deposition

- Deposition: Sediments that erode inland and travel down rivers build up in deltas.

Ocean Waves and Tides

- Sand at the beach = weathered deposits
- Coasts – wind and waves erode and deposit sand; constantly shifting.

Cape Hatteras Lighthouse
- 1870 – built 500 m from the sea
- 1987 – only 50 m from the sea
- 1999 – moved ½ mile inland to protect it

Protecting Beaches

- Groins

Jetties

Seawalls

North Myrtle Beach, South Carolina
Beach Nourishment

From the town of Ocean City Website: "Ocean City's Beach Nourishment Project is an on-going effort. Twice a year the Army Corps of Engineers survey our beach to determine the need for any additional sand. In general, the dredging is on a four year cycle. The last project was completed in 2002. This year (2006) we will be pumping approximately 830,000 cubic yards of sand."

Replanting Dune Vegetation & Controlling Development

Glaciers

• Fields of ice that scrape against the bedrock, carrying huge rocks and piles of debris over great distances.

Glaciers

• Deposit material in piles called moraines.
• When they melt and recede, they release all of the dirt and gravel they picked up called glacial outwash.

Wind

• Especially important in areas with less vegetation to cover and hold soil in place.
• Wind picks up and moves fine, dry soil particles and deposits them elsewhere...BIG problem for farmers!

The Dust Bowl of the Great Plains

During the 1930s, a combination of drought & poor soil conservation led to severe wind erosion of topsoil in what is known as the Dust Bowl of the Great Plains.
Preventing Soil Erosion

- **Contour farming** follows natural land contours
- **Strip cropping** maintains strips of different vegetation between crops
- **Windbreaks** made from trees or other barriers reduce loss of soil by wind

Conservation–tillage farming minimizes soil disturbance by use of special tillers or by no–till methods that inject seeds, fertilizers, & herbicides in unplowed soil

“Pretty, green cotton plants emerge from a field that was previously planted to wheat. The sticks left from the wheat harvest provide the soil in the field with protection against erosion caused by high winds. The old wheat (crop) residues also keep more water on the fields and serve as a natural filter during heavy rains.”