

## Earth Science

### Chapter 14 – Weathering and Erosion

#### Section 4 - Erosion

**E.Q.: *Explain how the composition of rock affects soil composition and what types of soil form in different climates?***

#### STANDARDS:

**SES3. Students will explore the actions of water, wind, ice, and gravity that create landforms and systems of landforms (landscapes).**

- a. Describe how surface water and groundwater act as the major agents of physical and chemical weathering.
- b. Explain how soil results from weathering and biological processes acting on parent rock.
- c. Describe the processes and hazards associated with both sudden and gradual mass wasting.
- d. Relate the past and present actions of ice, wind, and water to landform distribution and landscape evolution.

**SES5. Students will investigate the interaction of insolation and Earth systems to produce weather and climate.**

- a. Explain how latitudinal variations in solar heating create atmospheric and ocean currents that redistribute heat globally.
- b. Explain the relationship between air masses and the surfaces over which they form.
- c. Relate weather patterns to interactions among ocean currents, air masses, and topography.
- d. Describe how temperature and precipitation produce the pattern of climate regions (classes) on Earth.
- e. Describe the hazards associated with extreme weather events and climate change (e.g., hurricanes, tornadoes, El Niño/La Niña, global warming).

#### Objectives:

- **Define erosion, and list four agents of erosion.**
- **Identify four farming methods that conserve soil.**
- **Discuss two ways gravity contributes to erosion.**
- **Describe the three major landforms shaped by weathering and erosion.**

#### Erosion

**erosion** - a process in which the materials of Earth's surface are loosened, dissolved, or worn away and transported from one place to another by a natural agent, such as wind, water, ice, or gravity

- When rock weathers, the resulting rock particles do not always stay near the parent rock.
- Various forces may move weathered fragments of rock away from where the weathering occurred.
- Ordinarily, new soil forms about as fast as existing soil erodes.
- Some farming and ranching practices increase soil erosion.
- Soil erosion is considered by some scientists to be the greatest environmental problem that faces the world today.
- This erosion prevents some countries from growing the crops needed to prevent widespread famine.

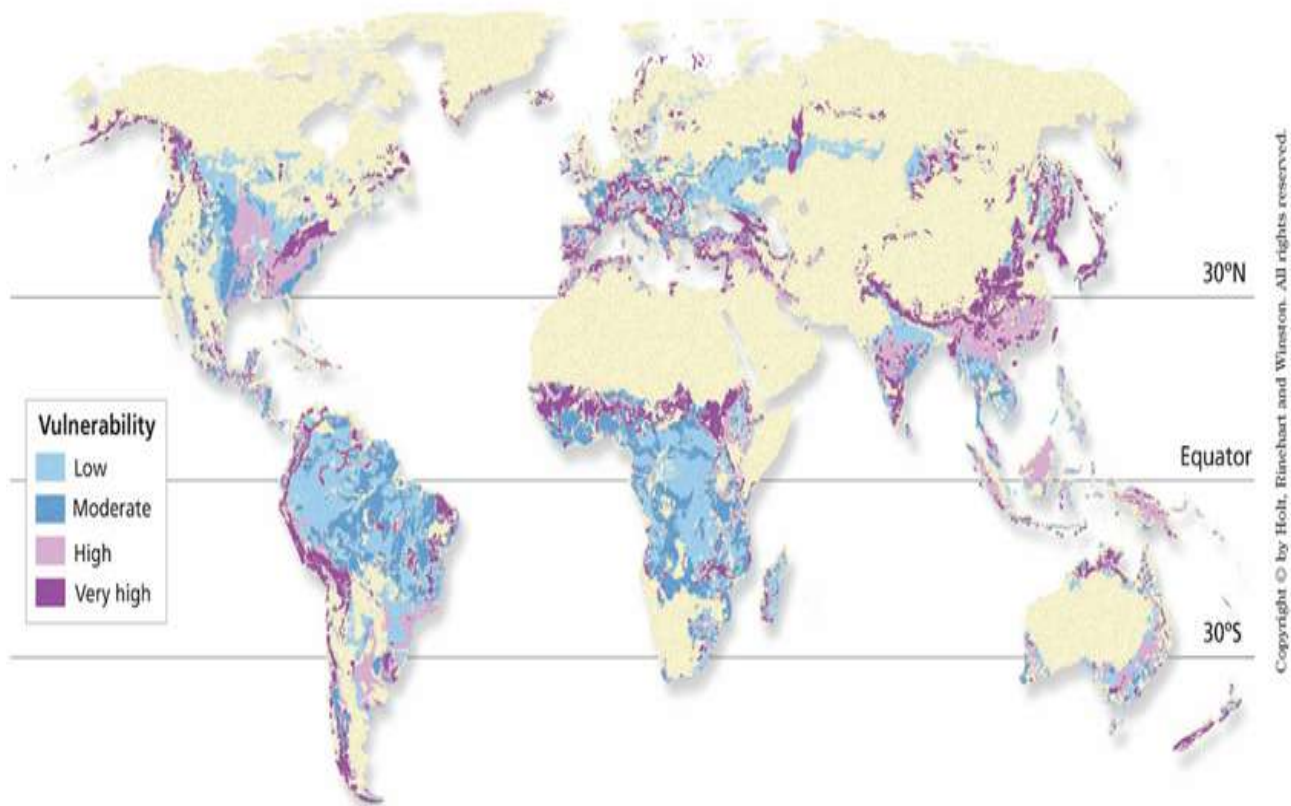
### **Gullying and Sheet Erosion**

- One farming technique that can accelerate soil erosion is the plowing of furrows, or long, narrow rows.
- As soil is washed away with each rainfall, a furrow becomes larger and forms a small gully.
- Eventually land that is plowed in this way can become covered with deep gullies.
- This type of accelerated soil erosion is called **gullying**.

**sheet erosion** - the process by which water flows over a layer of soil and removes the topsoil

- Another type of soil erosion strips away parallel layers of top soil.
- Sheet erosion may occur where continuous rainfall washes away layers of the topsoil.
- Wind also can cause sheet erosion during unusually dry periods.

**The image below shows a map of soil vulnerability worldwide to erosion by water.**



## **READING CHECK**

**Describe one way a dust storm may form, and explain how a dust storm can affect the fertility of land.**

***Dust storms may form during droughts when the soil is made dry and loose by lack of moisture and wind-caused sheet erosion carries it away in clouds of dust. If all of the topsoil is removed, the remaining subsoil will not contain enough nutrients to raise crops.***

## **Results of Soil Erosion**

- **Constant erosion reduces the fertility of the soil by removing the A horizon, which contains the fertile humus.**

- The B horizon, which does not contain much organic matter, is difficult to farm because it is much less fertile than the A horizon.
- Without plants, the B horizon has nothing to protect it from further erosion.
- So, within a few years, all the soil layers could be removed by continuous erosion.

### Soil Conservation

- Certain farming and grazing techniques and construction projects can also increase the rate of erosion.
- This land clearing removes protective ground cover plants and accelerates topsoil erosions.
- But rapid, destructive soil erosion can be prevented by soil conservation methods.

### Contour Plowing

- Farmers in countries around the world use planting techniques to reduce soil erosion.
- In one method, called *contour plowing*, soil is plowed in curved bands that follow the contour, or shape of the land.
- This method of planting prevents water from flowing directly down slopes, so the method prevents gullying.

### Strip-Cropping

- In *strip-cropping*, crops are planted in alternating bands.
- The *cover crop* protects the soil by slowing the runoff of rainwater.
- Strip-cropping is often combined with contour plowing. The combination of these two methods can reduce soil erosion by 75%.

### Terracing

- The construction of steplike ridges that follow the contours of a sloped field is called *terracing*.
- Terraces, especially those used for growing rice in Asia, prevent or slow the downslope movement of water and thus prevent rapid erosion.

### Crop Rotation

- In *crop rotation*, farmers plant one type of crop one year and a different type of crop the next.
- For example, crops that expose the soil to the full effects of erosion may be planted one year, and a cover crop will be planted the next year.
- Crop rotation stops erosion in its early stages, which allows small gullies that formed during one growing season to fill with soil during the next one.

### Gravity and Erosion

***mass movement*** - the movement of a large mass of sediment or a section of land down a slope

- Gravity causes rock fragments to move down inclines.
- Some mass movements occur rapidly, and others occur very slowly.

### Rockfalls and Landslides

- The most dramatic and destructive mass movements occur rapidly.
- The fall of rock from a steep cliff is called a *rockfall*. A rockfall is the fastest kind of mass movement.
- When masses of loose rock combined with soil suddenly fall down a slope, the event is called a *landslide*.
- Heavy rainfall, spring thaws, volcanic eruptions, and earthquakes can trigger landslides.

### READING CHECK

What is the difference between a rockfall and a landslide?

**Landslides are masses of loose rock combined with soil that suddenly fall down a slope. A rockfall consists of rock falling from a steep cliff.**

### **Mudflows and Slumps**

- The rapid movement of a large amount of mud creates a *mudflow*.
- Mudflows occur in dry, mountainous regions during sudden, heavy rainfall or as a result of volcanic eruptions.
- Mud churns and tumbles as it moves down slopes and through valleys, and it frequently spreads out in a large fan shape at the base of the slope.
- Sometimes, a large block of soil and rock becomes unstable and moves downhill in one piece.
- The block of soil then slides along the curved slope of the surface. This type of movement is called a *slump*.
- Slumping occurs along very steep slopes. Saturation by water and loss of friction within underlying rock causes loose soil to slip downhill over the solid rock.

### **Solifluction**

**solifluction** - the slow, downslope flow of soil saturated with water in areas surrounding glaciers at high elevations

- Solifluction occurs in arctic and mountainous climates where the subsoil is permanently frozen. In the spring and summer, only the top layer of soil thaws.
- Solifluction can also occur in warmer regions, where the subsoil consists of hard clay.

### **Creep**

**creep** - the slow downhill movement of weathered rock material

- Soil creep moves the most soil of all types of mass movements. But creep may go unnoticed unless

buildings, fences, or other surface objects move along with the soil.

- Many factors contribute to soil creep.

### Erosion and Landforms

***landforms*** - a physical feature of Earth's surface

- There are three major landforms that are shaped by weathering and erosion—*mountains, plains, and plateaus*. Minor landforms include hills, valleys, and dunes.
- All landforms are subject to two opposing processes. One process bends, breaks and lifts Earth's crust and thus creates elevated, or uplifted, landforms. The other process is weathering and erosion, which wears down land surfaces.

### Erosion of Mountains

- During the early stages in the history of a mountain, the mountain undergoes uplift.
- When the forces stop uplifting the mountain, weathering and erosion wear down the rugged peaks to rounded peaks and gentle slopes. An example would be the Appalachian Mountains which have rounded peaks because of weathering.
- Over millions of years, mountains that are not being uplifted become low, featureless surfaces. These areas are called *peniplains*, which means "almost flat."

### READING CHECK

Describe how a mountain changes after it is no longer uplifted.

***When a mountain is no longer being uplifted, weathering and erosion wear down its jagged peaks to low, featureless surfaces called peniplains.***

### Erosion of Plains and Plateaus

- A *plain* is a relatively flat landform near sea level. A *plateau* is a broad, flat landform that has a high elevation.
- A plateau is subject to much more erosion than a plain.
- The effect of weathering and erosion on a plateau depends on the climate and the composition and structure of the rock.
- As a plateau ages, erosion may dissect the plateau into smaller, tablelike areas called *mesas*.
- Mesas ultimately erode to small, narrow-topped formations called *buttes*.

### Mass Movement and Angle of Repose

