

Earth Science

Chapter 14 – Weathering and Erosion

Section 2 – Rates of Weathering

E.Q.: *What are the two main types of weathering and what are some examples of each?*

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:

- **Explain how rock composition affects the rate of weathering.**
- **Discuss how surface area affects the rate at which rock weathers.**
- **Describe the effects of climate and topography on the rate of weathering.**

Rates of Weathering

- The processes of mechanical and chemical weathering generally work very slowly.
- The rate at which rock weathers depends on a number of factors, including rock composition, climate, and topography.

Differential Weathering

differential weathering - the process by which softer, less weather resistant rocks wear away at a faster rate than harder, more weather resistant rocks do

- When igneous rocks that are rich in the mineral quartz are exposed on Earth's surface, they remain basically unchanged, even after all of the surrounding sedimentary rock has weathered away.
- They remain unchanged because the chemical composition and crystal structure of quartz make quartz resistant to chemical weathering.

Rock Composition

- Limestone and other sedimentary rocks that contain calcite are weathered most rapidly. They weather rapidly because they commonly undergo carbonation.
- Other sedimentary rocks are affected mainly by mechanical weathering processes.
- The rates at which these rocks weather depend mostly on the material that holds the sediment grains together.
- For example, shales and sandstones that are not firmly cemented together gradually break up to become clay and sand particles.

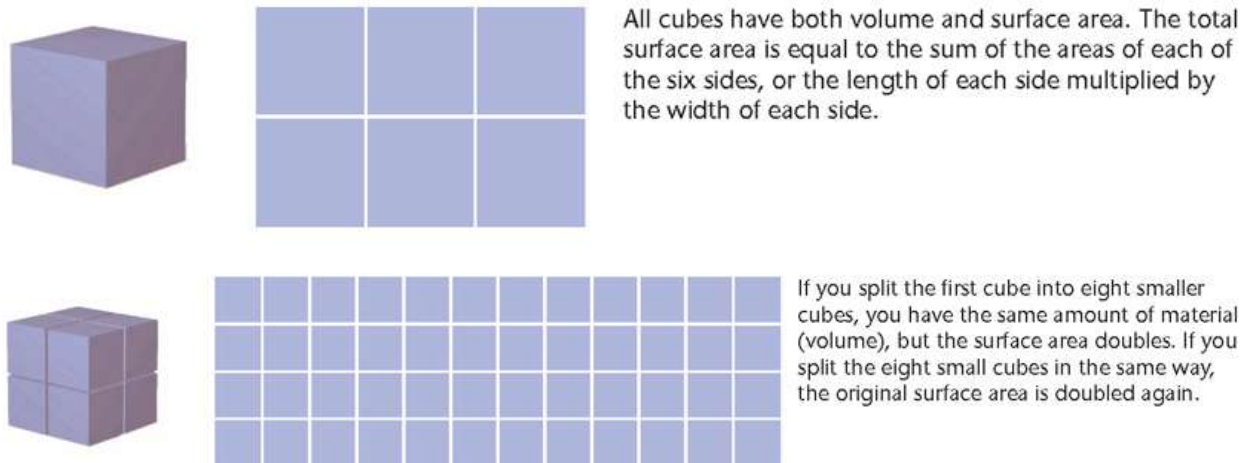
Amount of Exposure

Surface Area

- Both chemical and mechanical weathering may split rock into a number of smaller rocks.

- The part of a rock that is exposed to air, water, and other agents of weathering is called the rock's *surface area*.
- As a rock breaks into smaller pieces, the surface area that is exposed increases.

The image below shows the ratio of total surface area to volume.



Fractures and Joints

- Most rocks on Earth's surface contain natural fractures and joints.
- These structures are natural zones of weakness within the rock.
- Fractures and joints increase the surface area of a rock and allow weathering to take place more rapidly.
- They also form natural channels through which water flows.

READING CHECK

How do fractures and joints affect surface area?

Fractures and joints in a rock increase surface area and allow weathering to occur more rapidly.

Climate

- In general, climates that have alternating periods of hot and cold weather allow the fastest rates of weathering.
- In warm, humid climates, chemical weathering is also fairly rapid. The constant moisture is highly destructive to exposed surfaces.
- The slowest rates of weathering occur in hot, dry climates. The lack of water limits many weathering processes, such as carbonation and ice wedging.
- Weathering is also slow in very cold climates.

Topography

- Because temperatures are generally cold at high elevations, ice wedging is more common at high elevations than at low elevations.
- On steep slopes, such as mountainsides, weathered rock fragments are pulled downhill by gravity and washed out by heavy rains.
- As a result of the removal of these surface rocks, new surfaces of the mountain are continually exposed to weathering.

Human Activities

- Mining and construction often expose rock surfaces to agents of weathering.
- Mining also often exposes rock to strong acids and other chemical compounds that are used in mining processes.
- Recreational activities such as hiking or riding all-terrain vehicles can also speed up weathering by exposing new rock surfaces.
- Rock that is disturbed or broken by human activities weathers more rapidly than undisturbed rock does.

Plant and Animal Activities

- **Rock that is disturbed or broken by plants or animals also weathers more rapidly than undisturbed rock does.**
- **The roots of plants and trees often break apart rock.**
- **Burrowing animals dig holes into rock and soil.**
- **Some biological wastes of animals can cause chemical weathering.**