Unit 4: Landscape Changes

Parent Guide

SES3. Obtain, evaluate, and communicate information to explore the actions of water, wind, ice, and gravity as they relate to landscape change.

Weathering, Soil, and Mass Wasting

Mechanical weathering is the physical breaking up of rock into smaller pieces. *Chemical weathering* alters a rock's chemistry, changing it into different substances. Rocks can be broken into smaller fragments by *frost wedging, unloading,* and *biological activity.* Water is by far the most important agent of chemical weathering. Oxygen in water can oxidize some materials, while carbon dioxide (CO_2) dissolved in water forms *carbonic acid*. The chemical weathering of silicate minerals frequently produces (1) soluble products containing sodium, calcium, potassium, and magnesium, (2) insoluble iron oxides, and (3) clay minerals.

The rate at which rock weathers depends on such factors as (1) *particle size*—small pieces generally weather faster than large pieces; (2) *mineral makeup*—calcite readily dissolves in mildly acidic solutions, and silicate minerals that form first from magma are least resistant to chemical weathering; and (3)*climatic factors*, particularly temperature and moisture. Frequently, rocks exposed at Earth's surface do not weather at the same rate. This *differential weathering* of rocks is influenced by such factors as mineral makeup and degree of jointing.

In the evolution of most landforms, mass wasting is the step that follows weathering. The combined effects of mass wasting and erosion by running water produce stream valleys. *Gravity is the controlling force of mass wasting.* Other factors that influence or trigger downslope movements are saturation of the material with water, oversteepening of slopes beyond the *angle of repose*, removal of anchoring vegetation, and ground vibrations from earthquakes.

The various processes included under the name of mass wasting are classified and described on the basis of (1) the type of material involved (debris, mud, earth, or rock), (2) the kind of motion (fall, slide, or flow), and (3) the rate of movement (fast, slow). The various kinds of mass wasting include the more rapid forms called *slump, rockslide, debris flow,* and *earthflow,* as well as the slow movements referred to as *creep and solifluction.*

Water

The factors that determine a stream's ***velocity are gradient*** (slope of the stream channel), ***shape, size,*** and ***roughness*** of the channel, and the stream's ***discharge*** (amount of water passing a given point per unit of time, frequently measured in cubic feet per second). Most often, the gradient and roughness of a stream decrease downstream, while width, depth, discharge, and velocity increase stream's ability to transport solid particles is described using two criteria: ***capacity*** (the maximum load of solid particles a stream can carry) and ***competence*** (the maximum particle size a stream can transport). Competence increases as the square of stream velocity, so if velocity doubles, water's force increases fourfold.

Streams deposit sediment when velocity slows and competence is reduced. This results in ***sorting***, the process by which like-sized particles are deposited together. Stream deposits are called ***alluvium*** and may occur as channel deposits called bars, as floodplain deposits, which include ***natural levees***, and as ***deltas*** or ***alluvial fans*** at the mouths of streams.

As a resource, ***groundwater*** represents the largest reservoir of freshwater that is readily available to humans. Geologically, the dissolving action of groundwater produces ***caves*** and ***sinkholes***. Groundwater is also an equalizer of streamflow.

Most ***caverns*** form in limestone at or below the water table when acidic groundwater dissolves rock along lines of weakness, such as joints and bedding planes. ***Karst topography*** exhibits an irregular terrain punctuated with many depressions, called ***sinkholes***.

Glaciers & Wind

A ***glacier*** is a thick mass of ice originating on land from the compaction and recrystallization of snow, and it shows evidence of past or present flow. Today, ***valley*** or ***alpine glaciers*** are found in mountain areas where they usually follow valleys that were originally occupied by streams. ***Ice sheets*** exist on a much larger scale, covering most of Greenland and Antarctica.

Glaciers erode land by ***plucking*** (lifting pieces of bedrock out of place) and abrasion (grinding and scraping of a rock surface). Erosional features produced by valley glaciers include ***glacial troughs, hanging valleys, cirques, arêtes, horns,*** and ***fiords***.

Any sediment of glacial origin is called ***drift***. The two distinct types of glacial drift are (1) ***till***, which is unsorted sediment deposited directly by the ice; and (2) ***stratified drift***, which is relatively well-sorted sediment laid down by glacial meltwater.

The most widespread features created by glacial deposition are layers or ridges of till, called ***moraines***. Associated with valley glaciers are ***lateral moraines***, formed along the sides of the valley, and ***medial moraines***, formed between two valley glaciers that have joined. ***End moraines***, which mark the former position of the front of a glacier, and ***ground moraine***, an undulating layer of till deposited as the ice front retreats, are common to both valley glaciers and ice sheets.

Perhaps the most convincing evidence for the occurrence of several glacial advances during the ***Ice Age*** is the widespread existence of ***multiple layers of drift*** and an uninterrupted record of climate cycles preserved in ***seafloor sediments***. In addition to massive erosional and depositional work, other effects of Ice Age glaciers included the ***migration of organisms, changes in stream courses, adjustment of the crust*** by rebounding after the removal of the immense load of ice, and ***climate changes*** caused by the existence of the glaciers themselves. In the sea, the most far-reaching effect of the Ice Age was the ***worldwide change in sea level*** that accompanied each advance and retreat of the ice sheets.

Practically all desert streams are dry most of the time and are said to be ***ephemeral***. Nevertheless, ***running water is responsible for most of the erosional work in a desert***. Although wind erosion is more significant in dry areas than elsewhere, the main role of wind in a desert is in the transportation and deposition of sediment.

Many of the landscapes of the Basin and Range region of the western and southwestern United States are the result of streams eroding uplifted mountain blocks and depositing the sediment in interior basins. ***Alluvial fans, playas,*** and ***playa lakes*** are features often associated with these landscapes.

For wind erosion to be effective, dryness and scant vegetation are essential. ***Deflation***, the lifting and removal of loose material, often produces shallow depressions called blowouts and can also lower the surface by removing sand and silt, leaving behind a stony veneer called ***desert pavement***. ***Abrasion***, the sandblasting effect of wind, is often given too much credit for producing desert features. However, abrasion does cut and polish rock near the surface.

Wind deposits are of two distinct types: (1) extensive ***blankets of silt***, called ***loess***, carried by wind in ***suspension***, and (2) ***mounds and ridges of sand***, called ***dunes***, which are formed from sediment that is carried as part of the wind's ***bed load***.