

1 Erosion by running water

In almost all areas, running water is the dominant agent of erosion. When it rains, loose material is picked up and carried along by the rainwater running off the surface. (Even the splash of raindrops can loosen surface material.) As the runoff enters streams, it carries some of the loose weathered material along with it as mud, silt, sand, and pebbles. How far that material is carried depends on both the size of the particles of material and the force of the moving water.

Task 1: Complete the following paragraphs logically and grammatically correctly:

You may have seen rocks or pebbles at the

Chances are that they were carried to the stream by runoff water or that they fell into the stream because

The rocks and pebbles probably entered the stream closer to the stream's source and are being

Furthermore, rocks with rounder edges have probably been carried

The rocks and pebbles may not appear

But little by little, because of gravity and the force of the running water, the fragments and particles move downstream. Large fragments of rock may move only

Smaller fragments, like pebbles and gravel, travel much greater distances. Very small particles keep moving until the stream or river empties.....

- A very short distances
- B slowly carried downstream by the water.
- C of gravity.
- D into a lake, reservoir, or sea
- E farther by the stream
- F bottom of a stream.
- G to be moving

All the material transported by a river or stream is called the **stream load**. The smallest particles, which are too small to be seen with the naked eye, are being dissolved and carried in **solution**. Suppose you collected a sample of clear water and let the water evaporate. You would probably notice some very fine material that remained on the sides and bottom of the container.

Other small particles are suspended in the water and carried in **suspension**. When they reach a point where the water stops moving, they settle to the bottom. Muddy water contains small particles of clay that have been stirred by the moving water and are suspended in the water. Suppose you collected a jar of this water and left it to stand. Soon, the water would start to clear as particles in suspension settled to the bottom of the container.

The process of weathering continues while erosion is taking place. The particles carried by a stream strike each other and strike particles on the stream bed. The farther downstream they are carried, the smaller, rounder, and smoother they become. Through physical weathering, large fragments eventually break into bits small enough to be carried along in suspension. Through chemical weathering, some of the minerals in the fragments dissolve and are carried along in solution.

The amount of the stream load depends on the speed of the water and the volume of the water in the stream. A fast-moving stream can carry larger particles than a slower-moving stream. A slow-moving, large river can carry far more material than a fast-moving mountain stream.

1. How do particles in solution differ from particles that are in suspension?
2. What two factors affect stream load?

Task 2: Watch the video “Sedimentary rocks” and answer these questions:

1. What does the size of particles, the stream can carry, depend on?
2. What kind of material can a slow flow move?

Task 3: Read the text about the formation of a river valley and answer these questions:

1. Why wouldn't a flood plain develop at stage 1?
2. What can affect the type of a river valley and how?

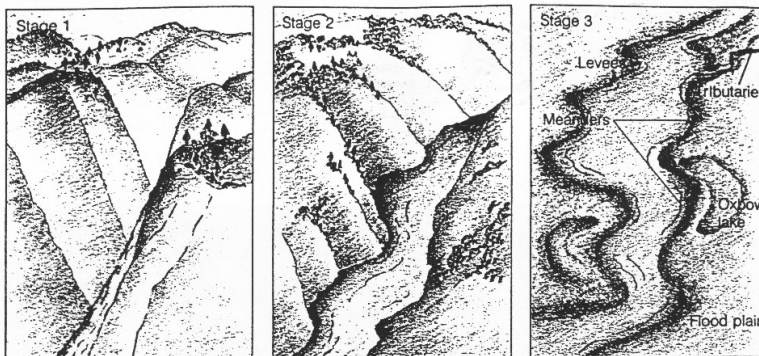
The formation of a river valley

Almost everywhere on the earth you can find landscapes carved by running water. One of the most common examples is a river valley that is formed between two mountains. At Stage 1, a fast-moving stream or river tumbles down the steep slopes between the sharp peaks of the two mountains. It begins to carve a valley between the peaks. Rainwater flows down the mountainsides, carrying small particles weathered from the rocky mountainsides. Eroded pieces, fragments, and particles of rock from the mountain peaks become the stream load and are transported down the slopes by water.

As time passes, the valley becomes wider and wider. Running water continually removes material from the sides of the mountains. The mountain peaks become lower and rounder because of the weathering and eroding action of the water. As the river erodes the mountain, it cuts its channel to a lower elevation. More streams form, capturing and draining water from a larger area into the river valley.

During Stage 2, the steepness of the river channel decreases, and the river valley becomes wider as the river curves and flood plains start to develop. A **flood plain** is a fairly flat area next to a river and nearly at river level. A flood plain is created by sideways erosion on the outside and deposition on the inside of a river's curve.

Even though the river is getting wider, it cannot contain the increased flow volumes that occur after heavy precipitation and runoff. At such times, the river overflows its banks and leaves deposits of sediments. The coarser sediments fall out of the flood waters as they first move out of the riverbed and over the bank. These deposits form a natural **levee** on both sides



of the river.

As the steepness of the river channel decreases, the river's course forms bends called **meanders**. Although the river is still eroding downward, the sideways erosion is increasing. The surrounding slopes are becoming less steep and the valley is being widened. River water velocity in non-desert climates stays the same or slightly decreases from Stage 1 to Stage 3. The energy in the moving water from Stages 1 to 2 to 3 is gradually shifted from downward erosion to sideways erosion. Every river has a limit to its downward erosion. This limit is the level of a lake or ocean that the river empties into, and it is called **base level**.

By Stage 3, the valley has become very wide and approaches base level. The river has such large meanders that they sometimes intersect each other, and the river flow then bypasses the cut-off meander. Sediment slowly fills in both ends of the cut-off meander, forming what is known as an **oxbow lake**. The wide, Stage 3 flood plain makes excellent farmland because the deposits from floods continually add nutrients to the soil.

Task 4: Compare the Susquehanna Valley and the Grand Canyon. Prepare a table.

Where does the Susquehanna River start? Follow its flow on the map.

S. Valley	The Grand Canyon
Climate.....
Shape.....
Slopes.....

The climate of an area can affect the type of river valley that forms. As examples, consider the Susquehanna Valley and the Grand Canyon. Both landscape systems have been forming for millions of years. Both have been produced by running water. But both are very different in appearance.

The Susquehanna Valley is located in an area with a high annual rate of precipitation. It has a very wide flood plain. The mountains that form this valley have gently sloping sides. Precipitation can increase rates of erosion and weathering, which cause a valley to widen. Humid climates with high annual amounts of precipitation often produce wide river valleys with gently sloping mountainsides.

The Grand Canyon, on the other hand, is narrow with steep walls. Its flood plain is very small. The Grand Canyon is located in a very arid climate, where there is little rainfall. Arid climates produce deep and narrow river valleys with steep canyon walls.

Task 5: Translate:

1. Čím dále po proudu jsou částice unášeny, tím jsou menší, zakulacenější a hladší.
2. Po velkých srážkách/deštích a při velkém odtoku se řeka vylévá z břehů a zanechává nánosy sedimentů, které tvoří přirozený ochranný val/hráz.
3. Když se zmenšuje prudkost říčního koryta, tok řeky tvoří zákruty zvané meandry.

Task 6: Listen to the story of the Grand Canyon Explorations and say whether these statements are true or false. If false, explain or underline why and correct.

Part One:

1. In the 15th century a group of Spanish explorers walked across the south-eastern American desert.
2. The purpose of their walk was to find seven gold cities.
3. Captain Cardenas forbade his soldiers to cross the canyon.
4. It took fewer than three centuries before European explorers came to the Grand Canyon again.
5. In 1776 two Spanish clergymen failed to find the Grand Canyon.
6. At the beginning of the 19th century the Grand Canyon still formed a natural barrier to expanding travelers and it was impossible to cross the Colorado river.

Part Two:

1. Major Powell became a professor of ethnology at Illinois Wesleyan University, but unfortunately was not an expert in geology.
2. Water does not play an important role in the formation of the GC because it is situated in the middle of the desert.
3. When rain comes, it totally disappears in the dry soil.
4. Different kinds of rocks can be seen at eight levels in the sides of the river.

Věra Hranáčová, 2011

Task 7: Fill in the tables with a suitable vocabulary.

	Stage 1	Stage 2	Stage 3
Speed of the flow	f.....	stays or slightly in non desert areas	..... down slower
Gradient of the flow	s..... /precipitous	.....	approaches level
Decline of slopes / mountainsides	s.....	.....	g..... sloping
Shape of a valley	V-..... n.....	..... (verb) becomes	w.....
Erosion	down.....	down..... side.....	.....
Riverbed / bottom	completely with water	f..... plains on the outside of a meander.....ion on the inside	ox..... lakes

Slant drill	šikmý	precipitous	příkrý
gradient curve	spádová	precipitous path	spádová stezka
gradient angle	klesání	precipitous decision	unáhlené ...
steep-sided	s příkrými	deficite	srážkový deficit
tilt of the head	úklon hlavou	shadow	srážkový stín
tilt window	okénko	precipitation amount	srážkový úhrn
base level	báze	district	srážková oblast
gold rush	zlatá		

Word formation:

noun	adjective	verb
slant=náklon / šikmá zlomk. čára	..... drill, news / slanted roof, news / slanting eyes	.....
precipitation	of rain(fall) /of precipitation	! = tvořit srážky
(gold) rush	! precipitous / precipitate	
Steep.....	steep	steep....
Wi.....	wide	wid.....

Fill in the proper forms of the words from the table:

Do not in where angels fear to tread. The sun through the window pane. Drive carefully especially during the hour. There are many accidents. The Japanese have eyes. Their news is far from biased (=objective). Actually it is/..... (předpojaté). His action was and irresponsible. I try to avoid the Christmas California gold was an important era. Do not your head back too much - it may be dangerous.

2 Erosion by glaciers

The influence of glaciers, which are moving masses of ice, is confined to the cold regions where they are found. In these regions, snow does not completely melt in summer and thus builds up from season to season. In time, the mass of the snow on the top changes the snow on the bottom to ice. Under great pressure from its own weight, the ice begins to flow. A glacier has formed.

The rate of movement of a glacier is too slow to be seen directly. Scientists, however, have measured the rates of movement of glaciers and found them to move a few centimeters or more each day.

A glacier may flow down a mountainside. This kind of glacier is called a **valley glacier** (or sometimes an **alpine glacier** or a **mountain glacier**). Valley glaciers, which follow old river channels, flow down between walls of rock.

A glacier may flow outward from its thick center over wide regions of a landscape. This kind of glacier is called a **continental glacier** and is an ice sheet that covers much of a continent. The ice sheet that covers Antarctica is a continental glacier.

Thousands of years ago, huge ice sheets covered the northern part of North America.

As these glaciers moved down from the north, they carried with them loose material frozen in the ice. When the ice melted, the loose material was left behind. In some cases, the material included boulders 1 m or more in diameter. These large water-worn and ice-borne boulders are known as **erratics**.

How can scientists infer that a boulder was carried by a glacier? The scientists can study the boulder to see what kind of rock it is and what minerals it contains. They can then look for layers of rock that match that of the boulder. In many cases, the matching rock layers are many kilometers away. The scientists then study the slope between the boulder and the matching rock layers to see if a gravity-caused rockslide could explain the movement of the boulder. If gravity is unlikely, then glaciers are the only other agent of erosion capable of moving a boulder such a great distance.

The erosion produced by a glacier is different from the erosion produced by running water. Running water can carry only small particles. Glaciers can carry particles of all sizes—from tiny grains to large boulders. Also, in the case of a valley glacier, the glacier extends up the sides of the valley and erodes the valley walls at the same time it is eroding the base, changing a V-shaped valley to a U-shaped valley. A river of running water, on the other hand, flows along the floor of the valley.

1. How does a valley formed by a river differ from a valley shaped by a glacier?

2. How can scientists infer that a boulder was carried by a glacier?

Translate : Check the word order, grammar and vocabulary

1. Ledovec postupující napříč hlavním údolím přehradil řeku a vytvořilo se jezero.
2. Voda tekla pod ledovcem a vyhloubila v ledu tunel.
3. Toto jezero se však vyprazdňovalo nepravidelně, což vedlo k následnému protržení blokace tunelu.
4. Následky protržení jezer, vedoucí k velkým záplavám a rozsáhlému ničení, byly katastrofické.
5. Ačkoliv eroze větru může být v oblastech s nižší vlhkostí intenzivní, v modelování krajiny jsou většinou účinnější vodní toky nezávisle na klimatu.

The Victoria Glacier in the Rocky Mts - CBS report

Listen to the report and answer the following questions:

1. What is the difference between the two glaciers on Mount Victoria which are being discussed at the very beginning of the report?
2. Can the retreating of the glacier change the color of the lake it used to fill?
3. What effect will the retreating glacier have on the area round the lake?

3 Erosion by more than one agent

Often a landscape has been shaped by more than one agent of erosion. The landscape in a desert area, for example, is often the work of both running water and the wind. The sand dunes in a desert show the effect of the **wind** as an agent of erosion. During a windstorm, particles of sand may be carried many meters from their original location. But one period of **rainfall in a desert** can produce more erosion than several months of wind action. Also keep in mind that physical weathering and erosion occur together. As particles are eroded, they also become smaller by the physical weathering process of **abrasion**, in which particles rub and scrape and hit against each other.

Evidence of erosion may suggest which agents were active. It may not be possible, however, to determine which of the agents had the greater effect. In a **landslide**, it may appear that gravity is the only agent. But the landslide could have been started by rainwater running off the mountainside. In that case, both running water and gravity were the agents of erosion.

Where glaciers are active, the erosional system usually involves both glacial action and **running water**. The glacier carries the material down the side of the mountain. **At the base of the glacier**, running water from the melting ice carries some of the material farther along.

Gravity as an agent of erosion is most evident in **landslides, rockslides, or snowslides**. In a rockslide, weathering weakens the rock surface along a cliff. Fragments of rock break off. Gravity causes the fragments to fall to the base of the cliff.

Gravity is also the underlying force behind all erosion. It is gravity that causes water to run downhill. It is gravity that causes glaciers to flow. And it is gravity that produces winds by pulling heavy colder air down beneath lighter warmer air.

Check yourself

1. Using **glaciers** as an example, show how an erosional system usually involves more than one agent of erosion.
2. How is **gravity** also involved in erosion caused by running water, by glaciers, and by wind?

4 Controlling erosion

The activities of people can have a marked effect on the erosion of weathered material from the earth's surface. For example, the trees, shrubs, and grasses of undeveloped areas prevent soil erosion. When the land is **stripped of** this natural vegetation, there is nothing to prevent wind and water from eroding valuable topsoil.

The **roots** of natural vegetation hold the soil in place. The **stems** of grasses and other plants act to slow down the flow of runoff. The **leaves** break the force of falling raindrops. Slower runoff can mean that more water soaks into the ground. And less runoff means less erosion.

Complete the following paragraphs logically and grammatically correctly:

Farmers play an important role in The best farming methods are those that help If farmers decide not to plant crops on a field, they will let Lumber companies also play an important role when they replant forest areas after In replanting, preserve valuable soil and watersheds.

- A cutting down trees for lumber
- B to preserve topsoil
- C maintaining the soil
- D people act to
- F wild vegetation grow

People also **affect** erosion when they build dams in rivers. Dams, which provide sources for inexpensive electrical power, create lakes where rivers once flowed. The flow of water in the river below a dam can be **controlled**. Seasonal flooding can be prevented by dams that **trap and store** much of the sudden increases in water coming from the watershed areas. There are many places in the world where canals have been dug to provide artificial **waterways** and **irrigation channels**. **Diverting** the water in a river reduces the amount of water flowing in the river. This in turn reduces the amount of erosion that occurs farther down the river.

The erosion that takes place along coastlines is much harder for people to control. Over a long period of time, ocean waves erode the coastline. People who have built homes near the coast try to prevent this from happening. In most cases, such attempts have not been successful. Houses built back from the coast have actually fallen into the sea because of erosion by ocean waves.

Wherever people are, the landscape changes. To make roadways, hills are leveled and **stripped of** vegetation. Mountains are tunneled through. **Swamps** are filled. Wide paths are **cleared** through forests. To make room for homes and shopping centers, schools and factories, huge tracts of land are cleared.

Now complete the following text with these words:

- | | | | | |
|-------------------|------------------|--------------|----------------|--------------|
| <i>channeled</i> | <i>discharge</i> | <i>flash</i> | <i>funnels</i> | <i>mall</i> |
| <i>likelihood</i> | <i>lots</i> | <i>paved</i> | <i>soak</i> | <i>urban</i> |

Think of how a shopping can change the runoff pattern of an area. The impermeable surface of the rooftops and paved parking permits no rainfall to into the ground. All of this water can collect on the surface as runoff and be into a potentially erosive stream. The large areas of impermeable surface can act as, causing a rapid buildup of water and increasing the of a flood.

..... development greatly affects the landscape. It also affects how the agents of erosion will change that landscape in the future. Urban developers must therefore effectively plan for the of water from and developed areas.

What are two ways in which people can help prevent erosion?

Minulý infinitiv v odborném textu

Distinguish: What causes the problem now? x What caused the problem? (= in the past)
What may cause the problem now? x What may have caused the problem? (= in the past)

Ask these questions:

1. Co způsobuje / může způsobit sesuvy půdy?.....
2. Co způsobilo sesuv půdy?.....
3. Co asi způsobilo sesuvy půdy?.....
4. Čím může být sesuv půdy způsoben?.....
5. Čím mohl být sesuv půdy způsoben?.....

Practice the following sentence transformations:

Something may appear to be / not to be... (=now)

1. In a landslide, it may appear that gravity is the only agent of erosion.
In a landslide, gravity may appear

Something is unlikely to have happened. (= in the past)

1. It is not probable that gravity caused the rockslide.
Gravity is unlikely

An agent (=a cause) must/could/may/might (not) have caused an event (=effect)

1. Gravity probably did not cause the rockslide. (=možná, že ne)
Gravity may notthe rockslide.
2. It is obvious that gravity did not cause the rockslide. (= určitě ne)
Gravity could notthe rockslide.
3. It is sure that gravity caused the rockslide. (= určitě ano)
Gravity mustthe rockslide.

An event (=effect) may/might/can/could be caused by... =now)

1. It is possible that gravity starts the rockslide.
The rockslide cangravity.

An event (=effect) may/might/can/could have been caused by... =in the past)

1. It is possible that rainwater running off the mountainside started the rockslide.
The landslide could rainwater.