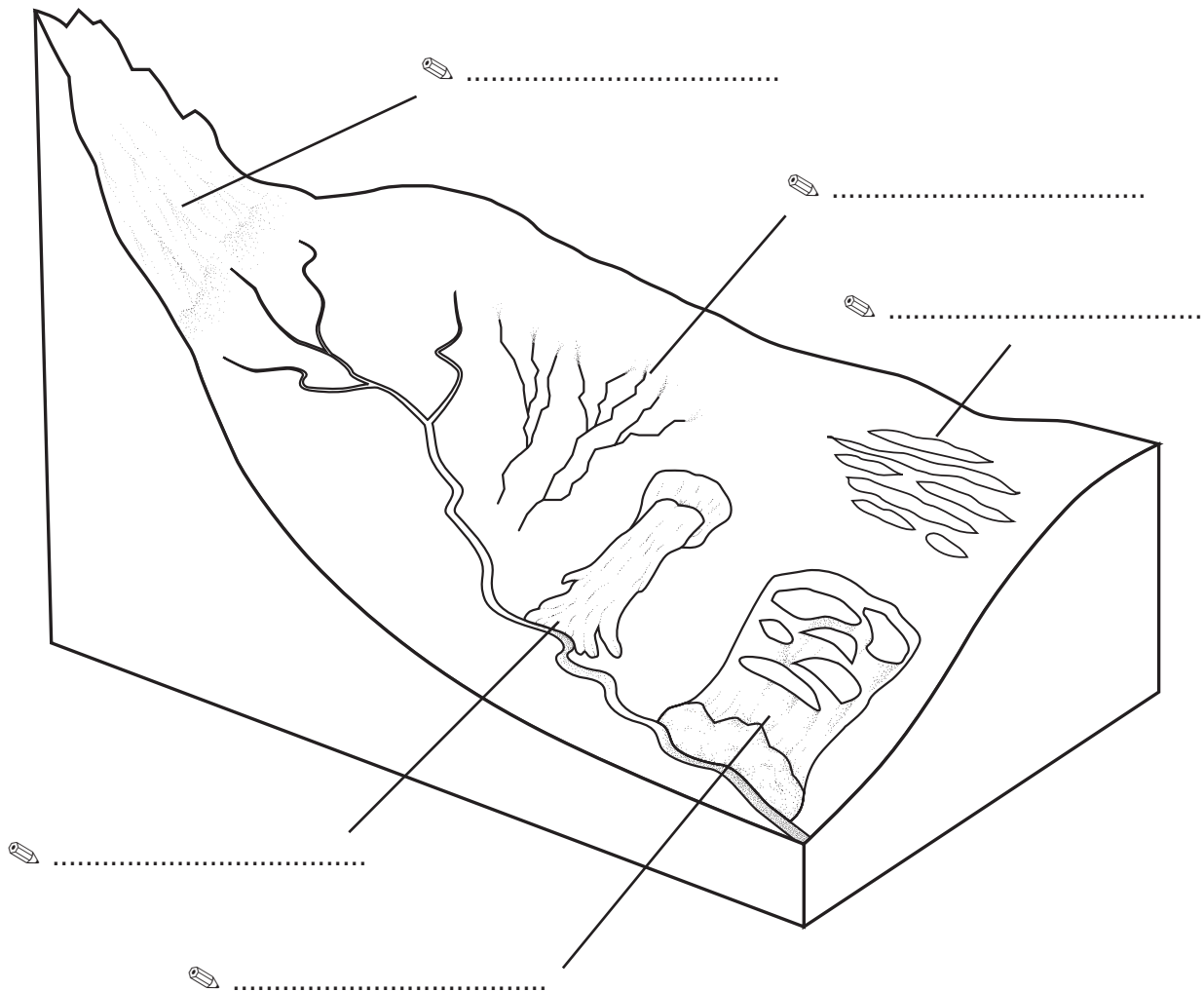


# Slopes on the move

The material that moves down a hillside to the river plays an important part in shaping a valley. Some of it is shattered rock, but much of it is soil.

**Q1.** On the diagram below, label each of the ways material is moved on a hillside.



**Q2.** Explain what is meant by frost shatter.



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**Q3.** What causes a scar?



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## Answers

- Q1. The labels on the diagram are the same as those on page 26 in the student book.**
- Q2. Frost shatter is the process of breaking up and loosening small pieces of rock due to frost action during wet weather. It only works on steep, bare rock surfaces such as mountain cliffs. Overnight, any water held in the surface cracks of a rock will freeze. As ice occupies more volume than water, the rock will be pushed out of place as the ice forms. The next day, when it melts, the rock will fall away from the cliff.**
- Q3. A scar is left behind when a slab of soil moves as a landslide.**

## Resources

- ▶ A sand tray with dry and wet sand. Tilt the tray to see when landslides occur in the two types of material.

## Background support

Rivers are only partly responsible for shaping most of the Earth's land surface. Indeed, they directly shape only a tiny part of the landscape – the part within the flat floor of the valley – a region called the floodplain. If rivers were the only agent eroding the land, then all landscapes would consist of gorges.

### Valley processes

The majority of valley shapes depend on slow weathering of the land into soil and its transfer to rivers for removal.

In a valley, a number of processes occur at the same time. For example, over the centuries, as a river cuts into the land, rain and frost erode the rocks of the landscape, reducing them to soil. Rainwater 'dissolves' rocks, leaving clay behind. Frost turns rainwater in rocks into ice that expands and breaks up the surface. Together, these and similar processes are called weathering.

On steep slopes, materials may slither and slide down the slope. This is common in areas where there is little vegetation to bind the material together. On all other slopes, the material sometimes moves slowly, a process called soil creep, and at other times moves more quickly, as landslides and mudflows.

In a landscape with gentle slopes, rivers have little energy to erode and only solution is at work on hillsides, so the rate of landscape change is often slow.

Rivers also act as natural conveyor belts, carrying sediment to the sea. So valley shapes are a combination of river action and hillside processes.

Rivers are most effective at transporting materials during floods. Floods do not last very long, so most of the material is not carried right through a river basin, but only for a short distance within it. At the end of the flood, as the water level falls and the water flow slows, the sediment being carried is dropped onto the river bed or the valley floor, making the flat area by the river called the floodplain. As a result, in most river banks there is no hard rock to be seen, just material deposited from previous floods.

### Rockfalls, landslides, and mudflows

Whereas rivers are an obvious source of erosion, the processes at work on slopes are not. Thus it is probably easiest to introduce the idea of slope processes through the more dramatic sources of erosion, such as landslides and frost shattering, than through the more usual chemical erosion that goes unnoticed within soils and rocks.

The first distinction to be made between different slope processes is between those that work on soil and those that work on shattered rock. Only cliffs, or slopes above the angle of stability of material (say 40 degrees), are altered by frost shatter. All other slopes are covered by soil and are altered by the two stages of weathering (chemical rotting of rock) to form soil, and then the gradual movement of soil to the river bank for further transport.

The most common kinds of landslides and mudflows are movements of soil. Slopes above 10 degrees are most vulnerable. The main requirement is that the soil becomes saturated. Thus, the time when most landslides and mudflows occur is after a prolonged period of rainfall (rather than after a single downpour). This time is usually, but not exclusively, toward the end of winter. The water does not act as a lubricant, but rather it takes up part of the weight of the soil, allowing its particles to unlock and move (it is a buoyancy effect).

Landslides and mudflows need a surface to slip over. Shale rocks, for example, are impermeable and so water stays within the soil and is liable to become saturated and slip more easily than soil on permeable sandstone.

The difference between a landslide and a mudflow relates to the kind of bonding in the soil. A mudflow happens when water gets between the soil particles and pushes them apart – that is, the soil liquifies. The whole soil and water mass can then move as a liquid. Landslides move as sheets of material because there is a weak subsoil layer that, on becoming saturated with water, allows the soil to slip over it. When landslides begin, the whole soil is shaken and this may shake violently enough for the soil to liquify and turn into a mudflow.

Gullies are the result of a stream of water flowing over the surface, and are found where violent and heavy thunderstorms are common.

Soil creep is a slow, down-slope movement of soil in wide ridges, almost like wide, shallow landslides. However, the movement is caused by a sawtooth movement of clay soils as they expand on wetting and shrink on drying.