

THE CHANGING SURFACE OF THE EARTH

Key words

Drain geological agent weathering erosion
Sediment deposition transport

The landscape is a consequence of the action of two types of geological processes; **internal and external geological processes**.

- **Internal geological processes** are driven by the internal energy of our Earth. They build the land relief (e.g. they are the ones responsible for the appearance of mountain ranges etc). The internal geological processes are earthquakes and volcanic activity.
- **External geological processes** are driven by the external energy that comes from the Sun and gravity. The changes the land relief undergoes is because of these processes, which are weathering, erosion, transport and deposition.

Geological Agents

There are a series of natural systems that carry out the different geological processes, known as the **geological agents**. These geological agents carry out the modelling of the land relief. The external geological agents are the wind, the water, living beings and gravity.

The **wind** and the **water** are **dynamic agents**, which are driven by the energy that comes from the Sun. **Living beings**; animals, plants and microorganisms, are also dynamic agents that change the earth's surface. **Gravity** is a **static agent** which is always present in all the processes carried on by the dynamic agents.

- **The wind** acts mainly in areas where there is no vegetation, such as the beach or a desert. The wind can easily pick up the smallest, fine grains of material and transport them somewhere else. On the other hand, **water** is the most important external geological agent, acting in all of its forms, rain, glaciers, rivers, the sea etc.
- **Glaciers** have a great erosive and transportation capacity. Glaciers can only be found in permanent frost areas.
- **Rivers** are natural, usually permanent watercourses flowing toward an ocean, a sea, a lake or another river. Their erosive and transportation capacity will be determined

by the speed of their flow as well as their steepness, which at the same time will depend upon the climate of the area, and location of the river (high mountain or a valley).

- **Groundwater** flows principally downward under the influence of gravity, through soils, sediments, and rocks. They will dissolve soluble underground rocks, in particular limestone and gypsum. As a result we will have the formation of caves, stalactites, etc.
- **The sea** will act mainly along the shoreline, and we can see the result of this erosive agent on the cliffs.

The changes on the earth's surface are the best evidence of the action of these agents which act with a greater or lower intensity depending on the climate and the chemical composition of rocks.

External Geological Processes

The external geological processes driven by the energy provided by the Sun and gravity are: **weathering, erosion, transport and deposition (sedimentation)**.

Weathering

Rain, frost, and the heating effect of the Sun weaken and loosen the surface of the rock.

We will consider three types of weathering: mechanical, chemical and biological.

- **Mechanical weathering:** When the main agent responsible for the breaking of a rock is the temperature. Mechanical or physical weathering is the breaking down of rock into smaller pieces without any chemical changes in the rock itself.

This type of action can occur in a number of ways, one example being **frost or ice wedging** – water seeps into cracks and pores in a rock and freezes, expands, exerts pressure within the crack or pore and causes pieces of the rock to break off.

- **Chemical weathering:** In chemical weathering, chemical changes take place in the rock, forming new products that can be carried away more easily than the original rock. Areas where water is present or the air is humid are subject to chemical weathering. The main agents responsible for the alteration of rocks are the CO₂, water vapour and oxygen, found in the atmosphere.
- **Biological weathering:** It is a mixture of mechanical and chemical weathering carried out by living beings. Some plants can easily break rocks. The roots grow through existing cracks in the rocks. The growth causes the root to expand, forcing

the crack to expand, forcing the crack to widen. This force can eventually split the rock apart. Also, many plants, algae and fungi produce chemical substances that may alter some minerals. Animals that live in the soil (moles, insects, worms etc) cause a lot of weathering. By burrowing in the ground, these animals break up soil and loosen rocks to be exposed to further weathering.

Erosion, transport and deposition

1. **Erosion** or fragmentation of rocks, can be carried out by water, the wind, ice, and the particles transported by these agents. Erosion is a dynamic process with transportation of the materials.
2. **Transport** of the materials torn off by erosion which is usually carried out by water or wind.

These materials will be transported more or less distance depending on the agent and on the size of the fragmented rocks.

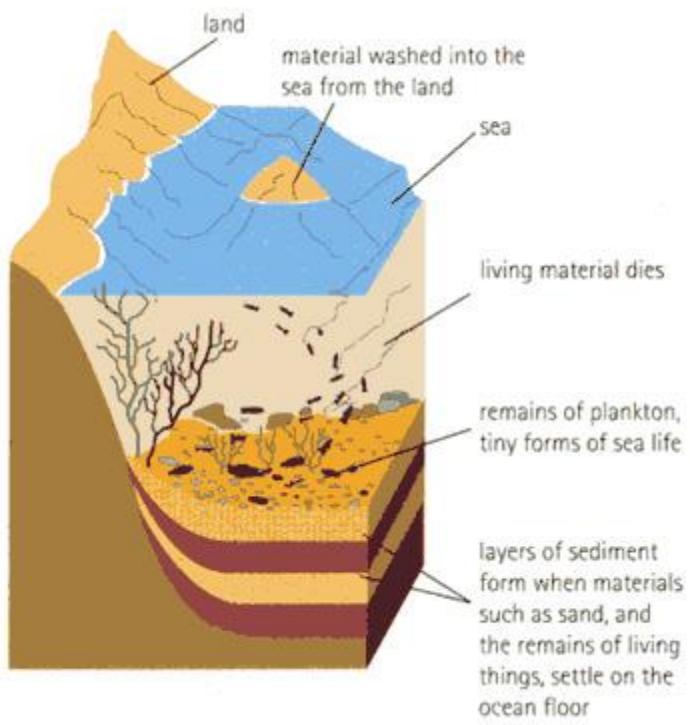
3. **Deposition** (or sedimentation) of the transported materials. It usually takes place in the lower parts of the crust, forming layers of sediments.

Types of rocks

Sedimentary rocks

Rock fragments, formed as a result of weathering and erosion, are **transported** by rivers, and the fragments get worn down. Small rock fragments are called **grains**. When the water slows down, some of the grains are **deposited** at the bottom of rivers, lakes or seas, and form **sediment**.

Layers of sediment collect on the sea bed, and the bottom layers get squashed. The grains of sediment are forced closer together (**compacted**) and the water is squeezed out from between the grains. Minerals in the sediment ‘glue’ the grains of rock together (**cementation**). Eventually, **sedimentary rock** is formed. The composition of sedimentary rocks varies and depends on the way they were formed. For example, there are different types of **limestone** – chalk is formed from the shells of microscopic animals, coquina is formed from larger shell fragments and oolite is formed from sediments deposited when sea water evaporated.



If any animals or plants get trapped in the sediment, they may form **fossils**.

Igneous rocks

Molten rock is called **magma**. If the molten rock flows out of volcanoes it is called **lava**. **Igneous rocks** are formed when magma cools down.

Lava cools down quite quickly, and forms igneous rocks with small crystals (like **basalt**). Magma underground cools down much more slowly and forms rocks, like **granite**, with bigger crystals.

Extrusive igneous rocks cool quickly and as a result these rocks are fine grained or has lack of crystal growth.



Intrusive igneous rocks are formed from magma that cools slowly and as a result these rocks are coarse grained.



Magma chamber

Metamorphic rocks

Sedimentary or igneous rocks can be changed by heat or pressure into new kinds of rock, called **metamorphic rocks**. Metamorphic rocks have different properties from the sedimentary or igneous rocks they were made from.

Type of rock	sedimentary	igneous	metamorphic
Examples	limestone, sandstone, mudstone, chalk	basalt, granite	marble, quartzite, slate, gneiss
Grains or crystals?	separate grains	crystals	crystals – often in bands of different colour
Hard or soft?	often soft or crumbly	hard	hard
Porous?	often	not usually	not usually

The rock cycle

The Earth is continually changing. Rocks are weathered and eroded and new rocks are being formed. The processes which make rocks, weather them and change them are linked together in the **rock cycle**.

