

Factors that shape

Observing the Earth's surface

Atmosphere and hydrosphere get in contact with rocks and minerals on the Earth's surface, where rocks spontaneously adapt to the conditions of our planet. The Earth's surface is continuously evolving and modifying in time to create different landscapes. The elements that characterize a landscape are various and range from soil conformation (grasslands and mountains) to water bodies (lakes, rivers and waterfalls), animals (fauna) vegetation (flora), climate and man's works (cities, roads, castles and many infrastructures). A natural landscape, without any human intervention, is often the result of two opposite forces, a battle that has been going on for thousands of years, between the geological processes that occur inside the Earth (the movement of earth plates, volcanic activity, the processes that lead to the creation of new mountains) and the processes that occur externally to the Earth's surface (erosion and water transport of material, changes due to particular climate conditions and many others).

Factors and shape

The Earth's crust is affected by tectonic movements that hit continents, close oceans, build mountains and make the Earth's surface less uniform.

In fact there are regions with very high mountains, while others are characterized by deep depressions, like ocean trenches.

The creation of a mountain or creasing of the Earth's surface is due to factors that act from inside the earth and are called endogenous agents. During the years, mountains and hills are eroded: slopes become less inclined while rock debris are deposited on the most depressed areas (sedimentary basins). This erosive action occurs continuously as a consequence of exogenous agents.

The shape and the characteristics of a landscape derive from its structure (rocks and minerals it consists of), the processes that shape the structure and the length of time a specific process takes to act on it. But it is necessary to consider the activities that men carried out on the territory, modifying its shape and characteristics and contributing to the creation of anthropic landscapes, "humanized", to be distinguished from the natural ones. Anthropic landscapes, in fact, represent the historical result of human culture and activities on nature.

Ocean floor

When we explore an ocean floor, we meet huge and long underwater mountain chains, where earthquakes occur and which are characterized by an intense volcanic activity. These long mountain chains (ocean ridges) stretch without interruptions all along the Atlantic, Indian, Antarctic and Pacific ocean, for a total length of 80,000 km. They are very big and fragmented mountains, with an approximate height of 3 km from the ocean floor and an approximate width of 1500 km. The highest part is called the rift valley. It is formed of a deep cut (like a long and narrow trench), surrounded by mountains and plateaux. This valley is a volcano that has a very intense activity and the rocks that originated from the lava solidification form the ocean crust. The new ocean crust forms the new ocean floor and the ocean becomes bigger. In some cases the new ocean ridge emerges from the ocean surface and forms volcanic islands like, for example, Iceland and the Azores.

The earth does not increase its volume since the ocean crust, that forms on the ridges, is consumed in another area. This is typical of oceans. This area is called ocean trench. Here the ocean crust submerges under the continental crust, as it happens near the Andean Cordillera and volcanic arches.

Volcanic heights

A volcano is an opening of the Earth's surface from where lava and gases come out at high temperatures. The structure of the volcano is the result of the continuous accumulations of erupted material, which then cools down. The following volcanoes have to be distinguished:

- linear volcanoes, that release large quantities of very fluid lava, that expands on wide areas. A typical example of them are Iceland volcanoes: long fractures that open on the ground
- cone-shaped volcanoes, that develop close to a circular conduct, from which the erupted material comes out directly. They are characterized by very steep slopes that originate immediately after the accumulation of lava fragments, ashes, lapilli, volcanic bombs (the so-called pyroclastic materials), which are violently expelled from the volcano mouth. In some cases, during volcanic activity, lava and pyroclastic materials are alternatively erupted. As a consequence, the so-called layered volcanoes are created, such as Stromboli and Vesuvio volcanoes in Italy
- shield volcanoes, which have very wide structures, such as those existing in Hawaii. Their base can be hundreds of kilometres wide and their slopes are not very steep.

The creation of mountains

The origin of mountains (orogenesis) occurs after tectonic movements make rock layers fold and overlap. All the Earth's surface, the lithosphere, is divided into rigid areas called continental plates and oceanic plates. These lithospheric plates continuously move and whenever they bump into each other, they form mountain chains.

How were the Andes created?

The Andes Cordillera started to form 250 – 200 million years ago after the crash between an oceanic plate (Nazca plate) and a continental plate (South-American plate). During the crash, the oceanic plate submerged under the continental plate. The movement and friction between the rock layers provoked earthquakes and a partial melting of the rocks. The melted rocks, less dense than the surrounding ones, move towards the higher part, as an air bubble would do when submerged into the water. In this way volcanoes are created, and melted rocks (magma) reach the Earth's surface. The Andes include numerous volcanoes that have formed two parallel mountain chains. The most internal and oldest chain is close to the ocean. The two chains are called Western Cordillera and Eastern Cordillera.

How was the Himalayas formed?

All big Asian chains, starting from Turkish mountains, to Iran, Afghanistan, Nepal, China, Sumatra and Java result from the crash between continental plates. In particular, the Himalayan chain formed after the crash between the Indian plate and the Euro-Asian plate that 30 million years ago were still separated by an ocean called Thetis. The plate collision, that started 45 million years ago, led to the disappearance of the ocean and the compression of rocks, which corrugated, folded and were lifted towards the top. The collision between the plates has not finished yet and Himalayan mountains are still lifting at a speed of 5 centimetres every year.

The Dead Sea, the Caspian Sea and the Lake of Aral are the remains of the Thetis Ocean, that disappear after the approach and crashing of the plates.

How were the Alps formed?

The Alps were formed after a crash between the Euro-Asian continental plate and the African continental plate, which were also separated by the Thetis ocean. In particular, 100 million years ago, the African plate changed its movement direction and went northwards with a speed of few centimetres a year. It compressed the rocks of the Thetis ocean crust against the Euro-Asian plate. The African plate moved like a huge bulldozer, scratching and piling up all the material that encountered during its journey. When the two continents crashed, part of the rocks that formed the ocean floor were trapped by the rocks that formed the continents and pushed to the top to form the Alps.

Subsequent and more complex movements occurred into different directions and led to the creation of the Apennines.

Change the shape of mountains

As a consequence of rain and storms, water fell in a more or less uniform way down the slopes and the rocky walls of the mountains, changing and breaking the rocks into many fragments. Those fragments fell towards the bottom of the mountains due to the force of gravity, forming piles of debris called debris layers.

Debris layers can be easily recognized at the bottom of rocky walls on the Dolomites.

Movements and landslides

Chemical alterations and the degradation of rocks on a slope facilitate the force of gravity. This leads to the slope moving fast or slowly towards the bottom of the mountain. Landslides are the rapid movement of compact rocks, debris masses, large quantities of clay and water or a mixture of mud, soil and rock debris. Landslides originate after or during intense rainy periods. Those slopes that are characterized by dry mud after a long period of draught absorb a big quantity of water after a prolonged rain. The muddy material becomes very fluid and heavy and moves at a speed of up to several kilometres an hour.

Landslides can be dangerous and have catastrophic consequences.

Climate and shape

All processes that shape the Earth's surface are interlinked and connected to climatic conditions. As a consequence, they are typical of some areas on the Earth. The Mediterranean area, the Polar area, the Tropical area, etc. are named morphoclimatic zones, and are characterized by particular exogenous and climatic factors.

Hot-wet regions

Hot-wet regions are characterized by plenty of water and high temperatures that provoke intense processes of chemical alterations. Their soil is rich in humus and covered by a dense green area that protects the land from river erosion and allows water absorption.

When the mountains consist of granitic rocks, the landscape is gentle and characterized by dome-shaped heights, called inselbergs. Inselbergs can be found isolated or in groups, without soil or vegetation cover. Instead, if the mountains are made of calcareous rocks, they look like pinnacles and towers and characterize the landscapes of Vietnam and Southern China.

Dry regions

There are two different types of dry regions:

- the area of tropical deserts and the savannah, which are characterized by a strong temperature range, lack of rain and absence of vegetation cover. Rock alteration is mainly due to temperature differences, as well as to the presence of dew and wind action. There are hollows, mushroom shapes and tafones, which are typical excavations at the bottom of the rocks created by wind action
- Antarctica belongs to dry regions because it is covered by perennial ice, humidity is extremely low and snow is the only precipitation. There are shapes created by wind action.

Mild regions

In mild regions, initially rainwater runs in a uniform way on the mountainsides and then it progressively collects along water streams. Distribution and intensity of rains vary according to the regions:

- oceanic regions are characterized by rain falls all year long and the soil has a continuous vegetation cover
- mediterranean regions are characterised by showers after the dry season. The vegetation cover is not continuous and it is degraded.

Rainwater that runs on the Earth's surface erodes the soil and forms a series of cracks of different dimensions. In particular:

- if the slope is very steep and is made of clay rocks, the cracks are deep and separated by crests, as the gullies on the Apennines
- if the land is formed of superficial fragments that are bigger than the ones underneath, the water forms deep cracks around the main rocks. With time passing earth pyramids form, which can reach 20-30 m height, and

have the shape of a mushroom with a hat (a big rock) and a stem (made of finer compact material). We can observe earth pyramids in some places on the Alps and near the Lake of Iseo.

Periglacial regions

Rock fragmentation occurs as a consequence of ice action in the areas near the North Pole. Until 30 metres of depth the soil is frozen, but then it swells on the surface forming the permafrost.