

Volcanism

- There are about 600 active volcanoes on Earth. In addition to the volcanic activity that is visible on the surface, there are continuous emissions of lava on the ocean floor along more than 60,000 km of the ocean ridges.
- Volcanic activity can manifest itself in very different ways, but essentially it is a unitary phenomenon, its distribution on the Earth's surface is far from random.
- Volcanism is a phenomenon that has involved, for billions of years, the entire planet. It is due to the rise of **magma**, molten rock material mixed with gases, from the interior of the Earth up to its surface.
- Magmas originate inside the crust and upper part of the mantle, between 15 and 100 km in depth. The melting process occurs under specific chemical and physical conditions (such as temperature rise, pressure drop, arrival of fluids).
- The process of melting the rocks takes place gradually: originally very hot material, though still solid, becomes a pasty mass, in which there are droplets of magma that separate from the refractory residue. When a volume equal to 5-20% of the original material has melted, the individual drops have enough space to move and merge with others. Because the magmas are liquids, they are less dense than the rocks that produced them; therefore, as magma accumulates, it begins to rise buoyantly (float upward) through the lithosphere.
- The rate of ascent of a mass of magma depends on its viscosity, volume, depth of the zone from which it arises, and the temperature of the surrounding rocks.

Volcanic structures, eruptions and products of volcanic activity

- When magma erupts out of the earth's surface it loses much of the gas it contained and becomes what is called **lava**.
- Volcanic activity on the Earth's surface gives rise to **volcanic structures**, which develop at the end of a volcanic vent (**central eruptions**) or along large fissures (**fissural eruptions**).
- The shape of the volcano depends on the type of material erupted. There are:
 - **Stratovolcanoes (or Composite volcanoes)**, with the typical cone shape, characteristic of explosive eruptions;
 - **Shield volcanoes**, with broad, shield-shaped edifices, characterized by effusive eruptions.
- The type of eruption depends on the viscosity of the magma and gas amount it contains.
 - Magmas with low viscosity, which are therefore very fluid, and very small amounts of gas exhibit **dominant effusive activity** (Hawaiian and Icelandic type eruptions).
 - Magmas less fluid and with modest amounts of gas exhibit **prevalent effusive activity** (Strombolian type eruptions).
- Viscous and gas-rich magmas result in **mixed (effusive-explosive) activity** (Vulcan, Plinian and Peléan type eruptions).
- Interaction between hot magma and groundwater or seawater results in vast quantities of superheated steam which produce **explosive activity** (hydromagmatic or phreatic explosions).
- The products emitted by volcanic eruptions can be gaseous, liquid and solid.
- **Gaseous materials** have contributed to the formation of the atmosphere and promote the ascent of magma and explosive eruptions.
- Liquid materials give rise to **lava flows** that form **effusive rocks** upon solidifying. Magma that is extruded under water forms typical **pillow lava** formations.
- **Solid materials** cause the formation of volcanic structures. The accumulation of volcanic material of varying size and nature is termed **pyroclastic deposit** (scoria, lapilli, ash).
- Volcanic activity also explains **lahars** (torrential mudflows of wet volcanic debris) and **hydrothermal activity** (mineral-rich waters, geysers).

Effusive and explosive volcanism

- The geographical distribution of volcanic activity is neither uniform nor random. Volcanoes are distributed mostly along specific bands that cross the Earth's surface. In addition, the two main types of volcanism (effusive and explosive) have different geographical patterns.
- The most impressive manifestation of effusive volcanism is associated with the mid-**ocean ridges**. The magmas responsible for this volcanism originate directly from the mantle.
- Effusive volcanic activity also occurs at **hot spots**: limited zones of the earth's surface with diameters of 100-200 km. Beneath the hot spots there is a continuous melting of material that is replaced by the ascent of columns of very hot material from great depths in the mantle.
- Volcanoes with explosive activity are distributed **along the margins of continents** or **along chains of islands** that border the **ocean trenches**. More than 60% of these volcanoes are located around the rim of the Pacific Ocean, nicknamed the "Ring of Fire". Explosive volcanism is associated with magma coming from the continental crust as a result of ultra-metamorphic processes (anatexis or palingenesis).

Volcanoes and Man

- In Italy there are numerous volcanoes, mainly concentrated in the central-south peninsula. Many of these are active volcanoes such as Etna, Vesuvius and the volcanoes of the Aeolian Islands.
- The expansion of urban areas leads to a volcanic hazard for the people who live in the immediate vicinity of volcanoes.
- **Volcanic risk** is defined as the product of the likelihood of a volcanic phenomenon taking place and the damage it could cause.
- For volcanoes with explosive activity, the only defense is in **prevention**, with the study of the characteristics of a volcano's possible eruption (based on the analysis of its previous activity) and the monitoring of various chemical and physical parameters in the surveillance area, to detect the approach of an eruption. In the case of effusive volcanoes, however, it is possible to implement **active defense**, during the eruption.