

Caves knowledge

What are caves?

Most rocks have pores and cavities within them. Generally, however, these are not large enough for a person to explore. Caves are cavities or hollow spaces inside a rocky mass that are large enough for a person to explore (Foto1). There are many types of caves formed through different processes : some are small, and it is difficult for man to penetrate into; others, on the contrary, stretch underground for tens or hundreds of kilometres, reaching depths of over 2,000 m. Formation processes control length, development and shape of a cave, and also the difficulties that will arise when exploring them. Most of the longest and deepest caves do not consist in an isolated cavity, but they form a system, which at times may be very complex, made of rooms, sinkholes, shafts, meanders, canyons, interconnecting galleries, which are arranged to form a system or karst complex.

Large quantities of underground water move through karst systems, caves may therefore be classified in different sub-areas, i.e. occupied by air and completely dry or scoured by streams, they may be flooded at times, or permanently invaded by fresh and salt water.

Processes to form a void

There are many mechanisms leading to the formation of cavities and voids underground. Some caves are classified as “primary” because they are generated at the same time as the rocks containing them, others instead form subsequently, due to rock weathering that modify their original characteristics.

PRIMARY CAVES

- Formed by biologic processes (in coral reefs)
- Formed by lava flows
- Formed by cooling processes

SECONDARY CAVES

- Eolian caves
- Sea caves
- Tectonic caves
- Karst caves

First a void and then the rock

Caves formed by biologic processes

Among the primary caves, the most widespread are caves forming when corals and coralline algae grow forming encrusted coral reefs: the growth of these organisms is neither uniform nor homogeneous and voids of various shapes and sizes are created, which are often large enough for a man to visit. All those who have done scuba-diving near a coral reef must have observed these caves. Most are practically anfractuositities or recesses and, at times, small irregularly shaped channels or galleries are formed, through which it is possible to cross the reef from one side to the other. The entrances of the galleries may be at different levels (e.g. the Dahab Blue Hole in the Red Sea belongs to this category – as we will see later, the term “blue hole” is used in an improper manner in this case), furthermore these cavities are rarely larger than a few tens of metres. The presence of large size cavities in fossil reefs, in sub-aerial continental environments is very rare. During the transformation of the reef into rocks, in fact, the primary cavities are generally filled with sediments that fossilize them completely.

Volcanic caves

Primary caves can form during the cooling process of a lava flow. Volcanic caves are created when a lava flow, generally basaltic lava that is very fluid, cools on the surface forming a solid “crust” underneath which liquid lava continues flowing. At the end of the eruption lava stops flowing outwards, the last emissions flow underneath the solidified crust and come out at the base of the lava flow, leaving channels that are real tunnels with a circular or elliptical shaped cross section. Lava tubes can reach remarkable lengths, as in the case of the Kazumura Cave in Hawaii, that is over 60 km long, with depth of over 1100 m. These are prevalently horizontal caves, with a very modest slope, however, when they stretch over long distances, they can reach remarkable depths.

Rocks are generally very dark in colour, with a vitreous appearance due to the rapid cooling, near the walls characteristic steps form due to a supra-excitation that lava flows carries out on the floor of the caves, and also features similar to stalactites and stalagmites are formed due to the dripping of lava as it cools. In fact, on the ceiling the heat released by the cooling flow causes a new melting process of the rock, which drips downwards solidifying in stalactites-like features (whose origin however is completely different) while the drops falling on the floor form curious slender and contorted “stalagmites” (similar to the towers built by children on the beach, with droplets of sand and water).

These caves, due to the particular mechanism by which they are formed, are always very close to the surface: their ceiling often crumbles and fall, and therefore lava tubes are scattered with external pits, in the form of small shafts, which often have a circular section, known as sky-lights. This type of caves always forms in continental environments, and therefore in sub-aerial conditions. If a lava flow comes into contact with sea water, the violent cooling that follows gives rise to explosions that shatter the rock and the formation of lava tubes stops. For different reasons, however, the sea can subsequently flood part of these caves when these form near the coast as, for example, in the Canaries, on Lanzarote island, in the complex Atlantida system, which has a flooded part that is over 1600 m long. Here, the pressure created by water occupying the galleries helps preserving the tunnels. These are on the contrary very fragile on the surface due to the short thickness of the ceiling and are subjected to rapid degradation due to the caving in of the vault.

Caves formed by cooling

Much smaller size primary caves in volcanic rocks can also form in particular effusive rocks, i.e. basalts, when a rapid cooling creates a “column” like structure, with the formation of large columns several metres high, characterized by a hexagonal cross-section. Collapses along the cooling fissures may give origin to suggestive cavities, specially near the coast where collapses are facilitated by the wave action: a very well-known example is the famous Fingal's cave on the Island of Staffa in Scotland.

First the rock and then a void

Unlike primary caves formed at the same time as the rock in which they are formed, the origins of secondary caves imply different processes acting on rocks that already exist. At times these processes take place many millions or tens of millions of years after the formation of the rock.

Eolian caves

These caves do not have a great length, no more than a few metres, and are formed by the abrasive action of the wind and due to particular weathering processes in arid and desert zones, or near the coasts on tender rocks that are particularly flaky, such as poorly cemented sandstone or rocks such as granite, particularly subjected to weathering processes due to hydrolysis (which weathers feldspathic minerals forming clay and transforming the rock into a sand made of quartz crystals). Cavities in this category include, for example, the famous “tafoni” in Sardinia. Due to their origin and due to the nature of the rocks containing them, these caves generally have short lives and are not very interesting for both cavers and speleologists.

Tectonic caves

A large number of secondary caves have a tectonic origin, due to collapses and breaking down along joints, fractures or faults that weaken a rock. Faults and fractures form due to the effect of tectonic deformations affecting rocks deeply buried inside the Earth's crust: when rocks are uncovered by erosion, the presence of large hollow spaces or high walls determines the opening of breaking surfaces, with the consequent collapse of blocks that can be of a remarkable size.

This process can lead to the formation of large caves that are however rarely very deep and long. These caves are characterized by typical geometric squared walls formed along the surface of the fractures or fault that determined the break-down, and large heaps of crumbled material and fallen blocks on the floor. These caves often are large, high and narrow rooms. These caves do not form in underwater environments where the water pressure decreases the possibility of break-down and detachment of blocks, but these types of cavities are commonly found near large mountain walls, often at the base of cliffs along the coast line, where the action of waves can contribute to break-down processes and water can easily erode and take away the material from the floor. These caves may form in any type of rock and generally they are not of any particular speleological interest.

Sea caves

All sea caves are secondary caves. It must be pointed out that caves of marine origin are relatively few and generally they are not very long or deep, their length being not much more than a few tens of metres, and their depth being quite modest, not much more than a few metres. Caves occupied by sea water, but whose development is more complex and whose depth is greater, are, as will be seen hereunder, of another origin, even though the sea that invades them can contribute to modify them in various ways. Sea caves, in the strict sense, are created by the mechanical action of waves that shatter the rock with their striking force, by the erosion carried out by the debris they carry, and mainly by the chemical corrosive action that sea water, specially when mixed with meteoric waters, can carry out on rock, together with the biological action of sea organisms. Generally, these cavities are only a few metres or tens of metres in size, even though at times they may have large portals at their opening. They tend to have a sub-horizontal stretching and form a few metres above or below the water surface. The origin of notches or "solchi di battente" is similar to that of sea caves and can often be a continuation of the same. These are a typical coastal formation and are often clearly visible, like a marked indentation at the base of walls and cliffs, at sea level. The presence of sea caves at levels that differ from the present sea level can be a precious instrument to reconstruct the evolution of sea level oscillations. Sea caves of this type can form in different types of rock, however their size grows to an interesting one only in rocks that are particularly sensitive to the corrosive action of sea water, such as carbonatic rocks (which are described in greater detail in the next chapter). Also sea caves can actually be classified in the large category of karst caves.