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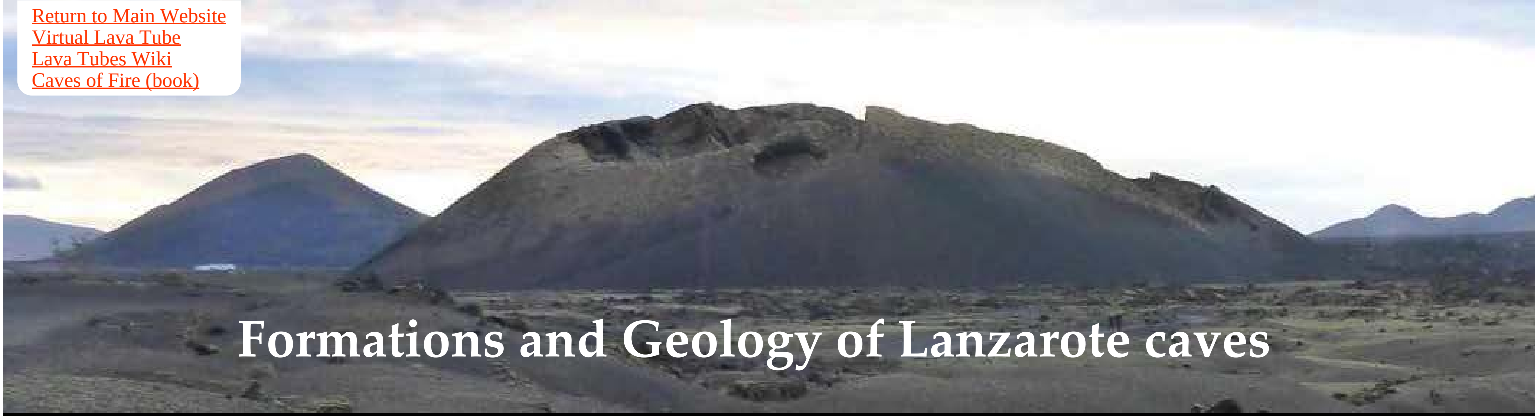


Formations and Geology of Lanzarote caves

Introduction

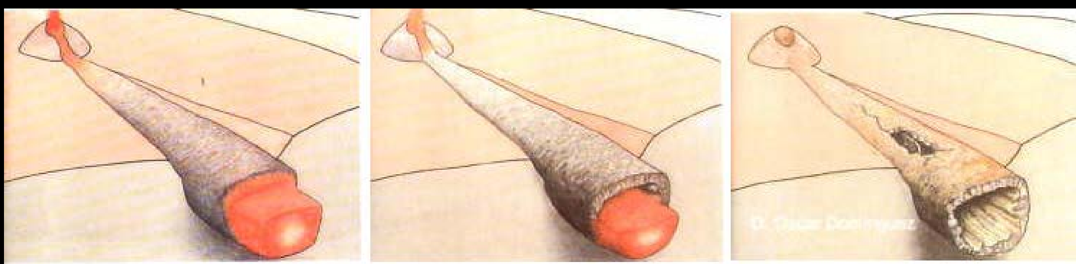
The morphology of the caves of Lanzarote whilst sharing many features typical in the formation of lava tubes also have some very unique deposits. These are noticable the copious ammounts of a fine white or fawn powdery substance gypsum, found scattered throughout many of the caves in very large quantities, often many feet thick.

Below is a non exhaustitive list of the some the formations to look out for in the caves of Lanzarote with a short description about their formation.

All the informatiion here will come from Dave Bunnells excellent website on Lava Tubes, as well as Cave minerals of the World by Carol Hill and Paulo Forti. The rest came from various Wikepedia sources readily available on the web.

Formation of Lava tubes

Different kinds of caves can form in volcanic rocks by many mechanisms, but the most common of these are lava tubes. A lava tube is a tunnel in lava which forms when the cooling surface of a molten lava flow solidifies, while the higher temperature interior remains fluid. When an advancing lava flow moves down a slope, the fluid drains out of the interior of the tunnel under the force of gravity. A tubular void is left within which lava stalactites, stalagmites and other features form. Image from http://www.ewpnet.com/azores/caves.htm



Lava formations form rapidly, from flowing, dripping, splashing, accreting and pulling apart of molten, or half-consolidated lava, often interacting with associated volcanic gases.

Depending on the gas content of the lava and the time over which the features cool, the formations can either be very glassy or dissolved volcanic gases can cause a frothy internal honeycomb texture.

Examples of these formations Stalactites, stalagmites, columns, draperies, flowstone-like features (sometimes called lava falls), helictites, coralloids, conulites, rafts and blisters of lava.

Later, post cooling of the lava tubes, chemistry plays an important part in the production of secondary formations

Minerals

The most important Lava tube minerals are sulphates of which the most prolific in this class is gypsum.

The reason why such a large number of sulphate minerals exist in caves is because of the relatively common occurrence of sulphate ions in groundwater and the relatively high reactivity of the SO4(2+) ion.

The deposition of sulphate minerals in caves is not as well understood due to the complexity and variety of processes involved. In most cases, however, the transportation of sulphate in solution is straightforward enough: the sulphate ion moves from its source toward a dry cave passage whereupon evaporation results in its deposition.

In basaltic (volcanic) rock, gypsum($CaSO_4 \cdot 2H_2O$), mirabilite ($Na_2SO_4 \cdot 10H_2O$) epsomite ($MgSO_4 \cdot 7H_2O$) and thenardite (Na_2SO_4) are common minerals within lava tubes.

Mirabilite is typically found around saline springs and along saline playa lakes, is unstable and quickly dehydrates in dry air, the prismatic crystals turning into a white powder, thenardite.

In the field it is impossible for us to determine whether the white powder is predominantly gypsum or a mix of other common minerals so for the purpose of this website it will all be classed as gypsum.

Gypsum or selenite

Gypsum and selenite are the same mineral .

Chemistry: $CaSO_4 \cdot 2H_2O$ Hydrated calcium sulphate

Class: Sulphates.

Group: gypsum.

Colour: White to colourless, and transparent to translucent. In some varieties, shades of red, brown, green and yellow may be present due to inclusions of other minerals.

Crystal Habit: Tabular, bladed or block crystals with a slanted parallelogram form; also needle-like crystals. May be massive, granular, crusty or fibrous.

Tabular varieties show pinacoidal faces with jutting prismatic edges. In the long, thin crystal variety, some may exhibit bending

Other Characteristics: Crystals are flexible but not elastic. Some specimens exhibit fluorescence or phosphorescence. Gypsum has a very low thermal conductivity . A crystal will feel noticeably warmer than a crystal of Quartz or the like.

All varieties of gypsum are very soft minerals (hardness: 2 on Mohs Scale). This is the most important identifying characteristic of gypsum in the field.

The main mechanism for the deposition in Lanzarote's lava caves is most likely simple growth (or precipitation) through evaporation;this is the usual mechanism operating in gypsum caves.

Normally sulphate speleothems deposit where capillary water is slowly seeping through pores in the bedrock,

Under these conditions sulphate deposition is a simple matter of the sulphate ion moving toward a dry passage due to an evaporation gradient at the wall zone; when sulphate solutions reach the cave wall, crystallisation by evaporation ensues.

With crystallisation and hydration, sulphate minerals are extruded through small pores or cracks in the rock. Wright (1898) was the first to propose this process: “gypsum crystals are extruded from the walls as a result of the pressure created by their hydration, the act of crystallisation fracturing the rock strata between ledges and in every direction

Selenite, satin spar, desert rose, and gypsum flower are four varieties of the mineral gypsum; all four varieties show obvious crystalline structure. The four "crystalline" varieties of gypsum are sometimes grouped together and called selenite.

Gypsum Formations

Gypsum Flower

Found predominately in the dry larger caves in the East of Lanzarote

Rosette shaped gypsum with spreading fibers – can include outer druse the difference between desert roses and gypsum flowers is that desert roses look like roses, whereas gypsum flowers form a myriad of shapes

Desert Rose

Found in caves on the West coast of Lanzarote.

Rosette shaped gypsum with outer druse of sand or with sand throughout – most often sand colored (in all the colors that sand can exhibit)

Fine gypsum needles

It is thought that this image may show the initial formation of gypsum "cotton balls". Fine gypsum needles are extruded from the rock through evaporation.

Gypsum cotton is known to be composed of very fine grained single crystals of gypsum less than 0.1mm in diameterand up to a centimetre or so long whereelongate fibres are flexible and easily bent.

Gypsum cotton balls (fibrous speleothems)

Over time, these crystals build up to form large growths of these gypsum cotton balls.

In the picture here there is also evidence of further types of formation.

The early stages of gypsum flowers, the fibrous form of gypsum, can also be seen

Gypsum

Tabular crystals of gypsum.

These have a simlar appearance to the cottom wool balls ut appear to have the surface coated with larger square like crystals

Gypsum covered walls

This image suggests the change of gypsum cotton balls to a more tabular form of gypsum coating the surface. cause unknown

Green Selenite

Selenite crystals commonly occur as tabular, reticular, and columnar crystals, often with no imperfections or inclusions, and thereby can appear water or glass-like. Many collectible selenite crystals have interesting inclusions such as, accompanying related minerals, interior druse, dendrites, and fossils.

Gypsum crystals are colorless (most often selenite), white (or pearly – most often satin spar), gray, brown, beige, orange, pink, yellow, light red, and green. Colors are caused by the presence of other mineral inclusions such as, copper ores, sulfur and sulfides, silver, iron ores, coal, calcite, dolomite, and opal.

Calcite formation

Found in caves on the West coast of Lanzarote.

This formation could be calcite or selenite. However reports from the locals suggest it is calcite, perhaps due to the hardness of the mineral and its resistance to scratching.

Lava Straws

Tubular lava stalactites are common in many lava tubes and have a concentric tubular shape, are (initially) hollow, and range in diameter from .4 to 1 cm. They are formed by "segregations extruded by expanding gas into cave passages" (Allred & Allred, 1998) as the lava tube cools. In the cooling walls of the cave, some minerals solidify first, forming a coarse, porous matrix. Boiling causes gases to force the remaining segregated liguid material out of the walls, forming tubular lava stalactites. Growth rings are found on the skin of the stalactites, each ring formed from dripping. Considerable material may be carried out of the stalactite and pile up on the floor beneath, forming a drip stalagmite.

http://www.goodearthgraphics.com/virtual_tube/tubular_stal.html

Lava Stalagmite (drip stalagmite)

Lava stalagmites are generally tall and globular, occasionally they may be bulbous, and even rarer still tall thin columns of lava cascade through holes in the roof to form free-falling tongues, e.g. lava flowstone or falls, and such a molten column may yet separate into a lava stalactite and stalagmite during cooling.

http://www.goodearthgraphics.com/virtual_tube/dripstal.html

Lava Helictites

Lava helictites are not as curved as their calcite counterparts, instead they usually lack axial curves and are straighter, or at an angle from lava walls or pendants to which they are attached. Often, lava straw-type stalactites morph into lava helictites; it is believed these formations occur as a result of molten lava being forced under pressure through small cracks or holes during cooling; whether hot gases have a part to play is not known.

http://www.goodearthgraphics.com/virtual_tube/helictites.html

Sharkstooth stalactite

Unlike tubular lava stalactites, which are extruded by escaping gases, the shark tooth stalactite grows by accretion. In most cases, as the level of flowing lava inside an active tube fluctuates, it coats protrusions on the ceiling with a thin veneer of lava. The original protrusion may have been a small driplet formed as the molten ceiling cooled. This results in a broad stalactite, usually tapering to a point. A cross section of such a stalactite will show successive layers, just as tube passages contain linings that may be several layers thick from successive flows.

http://www.goodearthgraphics.com/virtual_tube/sharktooth.html

Lava Bridge

Bridges are either spans of lava tube roofs left after collapses, or roofed-over segments of lava trenches. They may form between two closely spaced skylights, or may be found in isolation spanning trenches. There is no formal definition that distinguishes between a bridge and a short passage segment, which it most often represents.

The one here is a bridge seperating an upper and a lower gallery seen downflow from Puerta Falsa entrance

http://www.goodearthgraphics.com/virtual_tube/bridges.html

Flow Ledge or Bench

Ledges are often left along the edges of sinuous lava tube passages, and are usually somewhat rectangular in cross section, joining walls and floor. Curbs, benches, and shelves are another names commonly applied to these features, which mark the edges of late-stage flows. Ledges may also occur higher on walls and be undercut, leaving catwalk like suspended ledges. These features are more common near entrances since cooling is more rapid in those areas.

http://www.goodearthgraphics.com/virtual_tube/flow_ledge.html

Lava Crisps

I havnt managed to yet attribute this feature to any known existing formation.

These are wafer thin, crisp like ribbons of lava.

The ends are translucent whe a light is shone behind them they are so fine.

Mineral colours

Lava tubes can be black as night and totally devoid of any color. Mineral deposits can coat black lava and provide color, usually as white or yellowish crusts. But lava itself can take on many colors in lava tubes, sometimes with spectacular results.

The color it takes depends on both its chemical composition and oxidation state. Iron compounds will turn red on exposure to air, and red lavas are often found around skylights or other openings that bring fresh air into the tube. Green lava has a high pyroxene or olivine content.

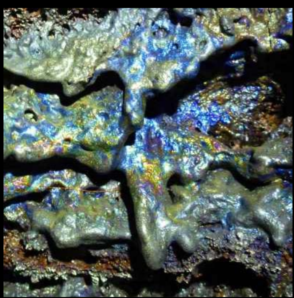
http://www.goodearthgraphics.com/virtual_tube/color.html

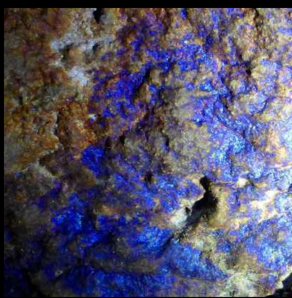
During or after a caves cooling phase, minerals may deposit as crusts, crystals, or as more familiar speleothems like stalactites and stalagmites.

Deposits can occur in two major ways. As the cave initially cools, minerals can condense from gaseous vapors, typically forming crusts or small crystals. The deposits in the first two photos probably formed that way. After the cave has formed, water from rainfall begins to seep in through the porous lava. Initially this will dissolve away crusts formed from gaseous vapors

But water passing through the rock may slowly leach out minerals that can be re-deposited inside the cave. The most common minerals in lava tubes tend to be sulfate minerals such as gypsum (calcium sulfate) and thenardite (sodium sulfate), but calcite (calcium carbonate) is common as well. Unlike in limestone caves, dissolved minerals are generally deposited from simple evaporation rather than off-gassing of carbon dioxide, the mechanism behind most dripstone deposits in solution caves.

http://www.goodearthgraphics.com/virtual_tube/minerals.html





Graffitti!!

Increasingly abundant in caves where the local council has opened the cave to all by installing a huge gate/ladder originally designed to hinder access.

Due to the porous nature of the lava, unfortunately its removal by wire brush is largely inaffective.

Roots

Lava tube passages tend to be fairly close to the surface, generally with less than 20 feet of overburden and sometimes less than a foot! Trees growing above the passage will often send down roots in search of water.

When exploring the caves, care must be taken not to damage the roots. Not only is that not good for the trees, but the roots themselves are host to a complex and fragile community of cave-adapted insect life. Often these insects are endemic species found in only a few caves in an area.

http://www.goodearthgraphics.com/virtual_tube/roots.html

This website is a work in progress. Please feel free to contribute

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