

Speleothems break and regrowth testifying past visits in some caves of Southern France

Jean-Yves BIGOT⁽¹⁾, Philippe AUDRA⁽²⁾ & Laurent BRUXELLES⁽³⁾

(1) Association française de karstologie (AFK), Montpellier, jeanbigot536@gmail.com (corresponding author)

(2) Polytech'Lab - UPR 7498, Université Côte d'Azur, France, Philippe.AUDRA@univ-cotedazur.fr

(3) Laboratoire TRACES - UMR 5608, Université Toulouse Jean Jaurès, laurent.bruxelles@inrap.fr

Abstract

Various causes can be invoked to explain the anthropogenic broken speleothems: the exploration of caves, which sometimes requires the enlargement of passages, breakage by awkwardness, as a game, for different uses, profane or cult, and for many other reasons that still remain unknown. For scientist, the advantages of speleothems are multiple and are justified by a relative durability of the flows at the origin of their formation. This allows deducing a relative chronology recorded in the growth laminated layers. Paradoxically, the fragility of speleothems, very sensitive to destruction and collection, is a very good clue for the identification of past human frequentation.

1. Introduction



Figure 1: Location of the cited caves in the south of France (base map according Maps-for-free.com).

Although the break of speleothems is an excellent indication of human frequentation, it is not yet recognized as an

indisputable element of the passage of man in caves. For most archeologists, ceramic that were abundantly produced from the Neolithic, and more generally artefacts, remain the undisputed element. Since 2010, a karstological approach was carried out to identify broken speleothems, especially fragments which lie on the ground in an unnatural position. Breakages from a natural cause are not as widespread as generally considered and the causes of their fall can often be easily elucidated. Falls and natural ruptures of speleothems in caves can be attributed to various phenomena such as earthquakes, subsidence, decompression, creep of ice or sediment (GILLI, 2005).

From the observations made in caves of southern France (Fig. 1), we developed a new speleo-archeological approach centered on the breakage of speleothems. We discuss here some example of speleothem human breakage that could be explained by different motivations.

2. Breakage and speleothems: paradoxes and margins for progress

There are a number of causes and paradoxes that can justify the weakness of archeological investigations about broken speleothems. Likely, a too weak knowledge of caves and karstic processes in general did not allow speleothems reaching a better status in the clues of human frequentation recognized by the archeologists. After an attempt at explaining the reluctances regarding the recognition of broken speleothems as a proof, the various causes of their artificial breakage will be inventoried.

a) Recognition of intentional breakage: Bruniquet Cave

From the 1970s onwards, broken speleothems were considered as traces of the passage of man (ROUZAUD, 1978). In his study (« La paléospéléologie ») François ROUZAUD considered these « breakage of speleothems »

resulting of at least two physical actions classified among the traces of progression and stoppage.

Admittedly, the subject was not very developed in his study, however ROUZAUD continued to be interested in underground archeology throughout his career before being confronted with an accumulation of speleothems in the Bruniquet Cave (Tarn-et-Garonne).

Since he was in charge of the conservation of this exceptional archeological site, he was able to identify the very ancient age of the constructions made up of broken stalagmites. Dating of the structures allowed him to obtain a ¹⁴C age beyond the limits of the method (> 47,600 years) (ROUZAUD *et al.*, 1996). The Bruniquet site was indeed too old to be dated to ¹⁴C...

Twenty years later, improved dating technics have revealed an age of 176,500 years (JAUBERT *et al.*, 2016) to these construction, made of speleothems broken and arranged in the cave. When writing their article, the team of scientists first had to demonstrate that structures made up of stalagmite fragments could not be natural, before they could eventually present their results.

However, archeologists are generally not requested to provide such evidence when using ceramics as an anthropogenic product. Obviously, the recognition of broken speleothems, as clues of human frequentation, remains full of pitfalls and additional difficulties for researchers trying to interpret them.

b) The paradox of the karstologist

It is a well-known fact that karstologists hardly appreciate speleothems, especially when their abundance covers and hide other features, making difficult the identification of the original type of flow and thus the type of speleogenesis that produced cave passages.

However, karstologists are familiar with geomorphic methods integrating speleothems, whatever their environment. Their experience enables them to interpret more precisely the underground landscapes. Thus, their skills in speleogenesis allow them contributing to speleo-archeology (BIGOT, 2015).

3. Possible reasons of anthropogenic speleothems breakage

Anthropogenic speleothem breakage can be distinguished into two main categories. The first is linked to underground progression, and the second to the constructions and exploitation of a site. The other cases could be games, awkwardness and, of course, motivations that are still unknown or for which interpretation still remains uncertain.

a) The underground progression

Broken speleothems in caves are first linked to the progression. In fact, before exploiting a cave, it must be first explored. The most common causes of breakage are related to the digging or widening of narrow passages. The Grosse Marguerite Cave (Gard) and the Sot Mani Cave (Hérault) show attempts to open passages between speleothems (BIGOT, 2018; BIGOT & BRUXELLES, 2019). Sometimes it is just a matter of cutting down stalagmites that get in the way. The stalagmites, lying and sealed on the floor of the Serre des Périers Cave (Hérault), show that men removed the speleothems that grew along their path (BIGOT & CAUMONT, 2019).

b) Constructions in exploitation site

The development of an underground site can sometimes be significant, in particular to allow collecting drink-water (BIGOT, 2018). The most remarkable identified developments are in the Mas de Rouquet and Sot Mani caves (Hérault).

The Fage Cave (Gard) also conceals a huge stalactite acting as a gutter, well wedged between two impressive stalagmites (Fig. 2). This stalactite, difficult to handle due to its weight, was broken from the vault just a few meters from its final destination.

Clay quarries are sometimes spectacular and require opening calcite flowstones first to gain access to the underlying clay deposit. In the Mas-d'Azil Cave (Ariège) the opening of a trench in a flowstone, in order to mine the clay, was done by hammering the calcite flowstone. A large pebble, still in place, was used as a hammer, and shows traces of percussion.

Accessibility always requires a special care. Similarly, when current cavers have to take the same route repeatedly, they alter it to make it more convenient. Elsewhere, steps or even ramps, made up of an accumulation of speleothems, have been built, such as in the Sot Mani Cave (Hérault). Steps

were also carved in an inclined slippery flowstone in the Besses Cave (Hérault).



Figure 2: The stalactite-gutter of the Fage Cave (Gard) was stuck between two large stalagmites to collect and concentrate the dripping water from ceilings.

c) Game, awkwardness and unknown causes

In caves, waiting places often exhibit finger holes in clay or fingerprints, the probable result of games meant to stave off boredom. Sometimes balls of clay are stuck to the walls; we know that the throw of dumplings is attested since the Paleolithic. Stalactites located 5 or 6 m high in the roof of the Fées Cave (Gard), were broken for no apparent reason, probably by throwing stones. Indeed, the points of those stalactites, sealed on the calcite soil, indicate that they have not been used. It underlines the gratuitous and destructive intention.

The breakages may or may not be intentional. It happens that speleothems were broken without apparent intention. A stalagmite which dominates a rimstone pool in the Radar Cave (Alpes-de-Haute-Provence) was broken by clumsily resting a hand on its apex. However, the person responsible for the breakage balanced the stalagmite back on its base, and it has since been naturally re-sealed.

Unexplained constructions have been identified in the Portalerie Cave (Aveyron). A piece of a 20 cm-long

stalagmite, about 8 to 10 cm in diameter, was planted vertically in a small pool. In the water of this pool, since the breakage, a ring of calcite crystals grown around the stalagmite, attesting to the antiquity of the anthropogenic composition. It is possible that this composition was intended to mark a route, further research must be undertaken to check this hypothesis.

4. Use of speleothems indicators

Speleothems often cover walls and floor of caves, especially in the late stages of speleogenesis. The growth of speleothems is rarely continuous and depends in particular on the presence of seepage and plant cover on the surface. However, the speleothems offer a relative chronology that can attest to a certain antiquity. Speleothems have other characteristics such as their fragility: their breakage is easy, and their growth laminas are clearly visible. In addition, they can be dated by various methods, notably by uranium/thorium (U/Th).

a) Relative chronology and sustainability of the flows

Examination of the fragments of speleothems sealed by calcite makes it possible to reconstruct the different actions that took place underground, since calcite authenticates the relative chronology of events. It is sometimes possible to deduce a gesture, or even an intention. The deposition of secondary calcite is a determinant fact in the recognition of the antiquity and the relative age of traces and clues.

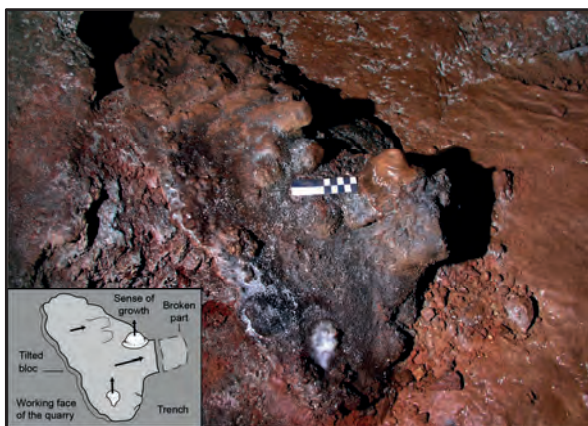


Figure 3: Part of a tilted calcite flowstone in the Vitalis Cave (Hérault). After the mining, new stalagmite regrowth appeared on the tilted flowstone. Scale: 10 cm.

Speleothems can cover the entire surface of the underground voids and constitute the last « coating » of the cave. The water supply, at the origin of calcite growth, often presents a relative continuity (at the scale of human visits duration), and above all, it is totally independent of human action.

Stalagmitic regrowth after an intentional breakage or an abandonment of the site are often visible (Fig. 3). The durability of the seepage allows the calcite to seal constructions or exploitation sites, like in the Vitalis Cave (Hérault) (BIGOT, 2020).

Indeed, calcite tends to cover everything, including artefacts (ceramic, charcoal, flint, etc.), making traditional techniques for identifying archeological sites entirely unsuitable. Other methods of investigation must therefore be considered to detect past human frequentation.

b) Fragility of speleothems

By nature, speleothems are fragile, while the host rock is generally harder. The fine stalactites therefore appear more exposed to the breakage. Natural breakages are well known, such as the tilting of stalagmitic pillars on a ground gradually undermined. However, the repeated passage of humans can even be more destructive. This overexposure of speleothems to human frequentation is the reason that today motivates cavers to set protection markings in the most fragile caves.

Paradoxically, the fragility of the speleothems is a boon for the search for traces of past frequentation, because they will first be broken to manage a place or enlarge a passage. In addition, in an environment where everything is sealed by calcite and where no free pebbles are lying on a calcified ground, a fine stalactite protruding from the ceiling can be easily broken by man.

c) Advantage of growth laminated calcite

Speleothems provide indications of their growth and reveal the conditions under which they developed. Cave speleothems have a specific morphology which provides information on their evolution, whether vertical (stalactite, stalagmite) or horizontal (rimstone, flowstone).

By comparison, the limestone host rock does not offer such advantages: it is much more difficult to find the anthropic origin of a displaced stone block than a broken speleothem. Indeed, speleothems have a certain traceability (laminated calcite growth) which can be easily exploited, for instance stalagmitic regrows following a breakage.

In addition, it is possible to sample and date speleothems, in particular by using the U-Th method.



Figure 4: laminated calcite eroded by a stream in the Portalerie Cave (Aveyron).

5. Conclusion

Broken speleothems did not always attract the attention of cavers or archeologists; very few ancient incursions were reported from the sole clue of broken speleothems, because of the too common consideration that destruction is due to the current frequentation. Nobody is no longer astonished to see devastated underground landscapes, which are often wrongly attributed to modern cavers.

However, for the men who frequented the caves, speleothems were just a practical and standard material that could easily be collected and used to build systems for collecting and redirecting water, to mark out a route, or simply to open a path.

d) Alternation of calcite laminations in speleothems

The alternation of dark and light laminations in the speleothems sections can be an indication of human frequentation.

Eroded and laminated speleothems showing such alternation of colors can be of anthropogenic origin (Fig. 4). Numerous caves, assiduously frequented at different periods, keep traces of past incursions. Some caves may have been visited for possible cult reasons (BIGOT, 2014), as in the sanctuary of Rajal del Gorp Cave (Aveyron), Mounios Cave (Hérault), or Auguste Cave (Hérault). However, the motivations for the incursions remain unknown in the Baumes-Chaude Cave (Lozère) and in the Portalerie Cave (Aveyron). Dark laminated calcite often originates from torch soot trapped in the calcite; a new approach by the fuligino-chronology (VANDEVELDE, 2019) allows us to better understand the frequency of visits.

Today, there is a conservative relationship between the cavers and the speleothems, which is at the origin of this misinterpretation. In reality, in the past, men were thoroughly insensitive to cave conservation, because their goal was completely different: they simply included the caves to their living environment, for surviving.

Consequently, the constructions made of broken speleothems must deserve the same respect as the stalactites or stalagmites protected by the cavers.

Identifying such an archeological heritage is already contributing to the protection of the world heritage of caves, whether natural or human.

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