Working Out What People Built at La Garma (Spain) Deep in the Past—and How and When They Did It—Through Archaeomorphological Mapping

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The cave of La Garma, in Cantabrian Spain, was occupied many times over many tens of thousands of years, beginning in the Middle Pleistocene to the time of the Visigoths in the 6th to 7th centuries CE (Arias & Ontañon 2020). The topographically staggered chambers and corridors that connect them at La Garma were not all frequented at the same time: each storey was once open to the outside world by a variety of entrances (Figure 1). Over time, each entrance closed off especially through rockfall and colluvial build up, allowing archaeological deposits, rock art and even human footprints to be preserved in a kind of 'time capsule'. Particularly noteworthy, the cave's rich and spatially well-structured Magdalenian floors remained undisturbed (Ontañon 2003; Arias et al. 2006). This is so of the Lower Gallery, whose ground surface exhibits a dense and complex archaeological assemblage consisting of many objects and installations requiring careful investigation. This is because across the gallery a number of anthropogenically arranged spaces are apparent, but their exact configurations, and what they mean for what people did there (including how they shaped, modified and maintained each area), needs to be worked out. Among these are four installations constructed of a combination of limestone blocks, flowstone slabs and broken pieces of columns and/or stalagmites. They are all thought to be Magdalenian in age—although none have actually been dated—because they are spatially closely integrated with archaeologically rich floors that contain flowstone plaquettes and other archaeological materials engraved with Magdalenian motifs, next to painted walls and an overhead ceiling also with Magdalenian motifs. Archaeomorphological mapping was thus undertaken to better determine and understand these structures and how they fit in the history of the site.

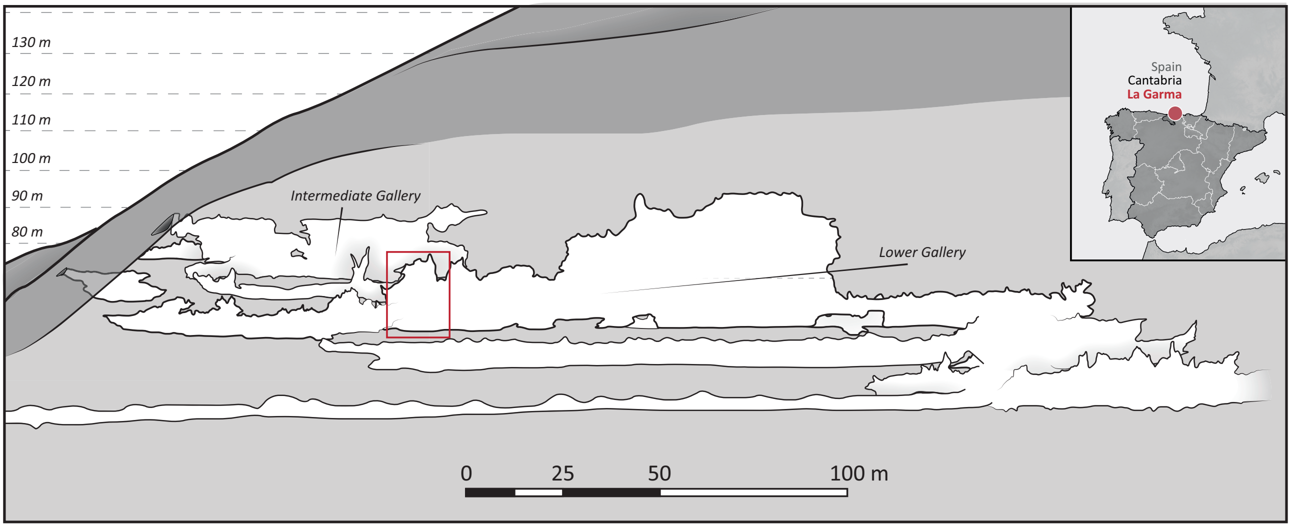

Figure 1. Profile through the La Garma cave network, exposing the vertically staggered galleries and chambers. The red rectangle marks Zone IV of the Lower Gallery.

Mapping the Site as a Way of Getting to Understand It

Here I present details of the mapping of the Lower Gallery's floor. All items more than 4 cm long were included. This enabled the exact locations of individual archaeological items such as stone artefacts, animal bones and 'speleofacts' (see below) to be drawn on the map, along with different kinds of geological phenomena, geomorphological features and soil formations. Mapping is above all a work of observation and identification of forms. At La Garma, the identified items were laid over, and thus 'mapped onto', a shaded Digital Terrain Model (DTM) and ortho-rectified photos. Much of the fieldwork involved identifying 1) what the individual items were made of (e.g. speleothems, sediment types, blocks of rock and their lithologies); 2) the causes of their markings, such as human-induced flaking scars on rocks; and 3) their associations, such as conceptually connecting a displaced broken stalagmite with its in situ parent base. The map also seeks to represent their relative chronology: *relative to each other*, when did one item get to be where it now lies on the floor; or when was a particular mark such as a scratch on the rock, or an animal or human track on the floor made? Different 'generations' of speleothem growth could thus be identified and marked on the map, as could when some of them were broken and taken to other parts of the gallery, or when rock fell from the roof, for example, enabling the reader to literally see how the gallery changed through time (see below).

An important step in archaeomorphological mapping is sketching (Figure 2). As the researcher examines and gradually sees more and more details of each individual item in the field, they begin to make spatial and temporal connections between them, increasingly coming to conclusions about how those items came to be where they are today. In the process of becoming increasingly familiar with each item and their spatial relationships through observation and sketching, so, too, do the sketches also become a geomorphological inventory of what is there. The sketches bring order to the whole as it is being worked out. They render intelligible the complexity of all the individual items and marks in the gallery's three-dimensional space, and by focusing on the key elements for the question at hand, it does so much more effectively than a photograph. To do the job properly, however, the researcher needs to allocate sufficient time, as this work is by necessity a slow process: the entire aim is for the researcher to familiarise themselves with *what* is there (including the finer details of tell-tale manufacture, use-related, and taphonomic markings), *where* things are now, *how* each item relates to each other in three-dimensional space, and *what* the taphonomic processes that have acted on the deposits and surfaces have been. The question of *when* also begins to unfold in the process (see below).

Typically, field mapping involves turning objects around, looking at them from all angles, asking questions about their origins, their modifications, how broken or shaped pieces conjoin, and their temporality. The sketches become integral to the interrogation of each item and their spatial and temporal relationships; they are tools of observation that lead to the detailed geomorphological mapping of floor, wall and ceiling surfaces and deposits and how they articulate in three-dimensional space.

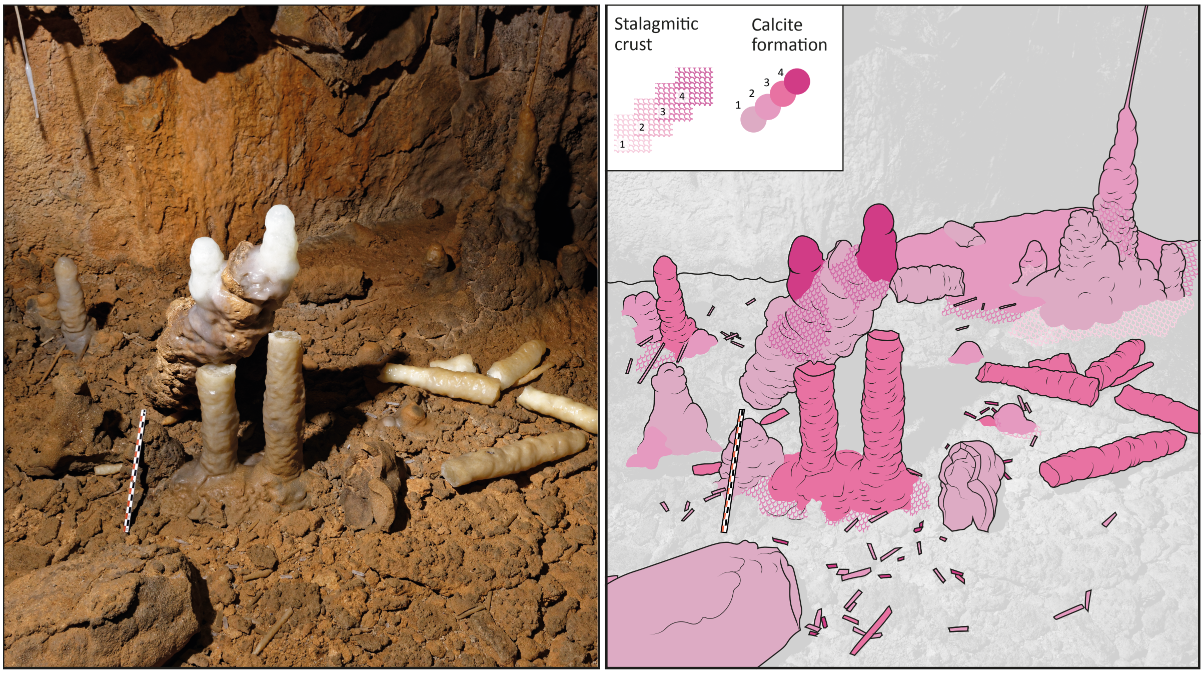

Figure 2. Identifying progressive generations of speleothem growth and deposition via sketching. The darker the pink, the more recent the speleothem growth (photo by Stéphane Jaillet 2021, sketch by Jules Kemper).

As the geomorphological study of the Lower Gallery's floor progressed, profiles were drawn across the gallery, so that details of the floor, walls and ceiling could be cross-correlated in three-dimensional space. As with the floor, the archaeomorphological observations determined what was recorded from the walls and ceiling. Areas with diverse contents and/or rich morphogenic details were especially chosen for where to draw the profiles. Where possible, the relative antiquity of each profile's features could then be converted into a Harris Matrix, one profile at a time (Harris 1979). Originally developed to help visualise complex stratigraphies as revealed by archaeological excavations, Harris Matrices have since been adopted by a broad range of researchers who deal with patterns of superposition, such as rock art researchers who work with sequences of overlying rock art motifs, or geomorphologists who deal with the build-up of materials in and on the ground (Harris & Gunn 2018; Monney & Jaillet 2019).

Harris Matrices graphically show the temporal relationships of stratigraphic layers, or of components of deposits, by constructing logical sequences after feeding into the program all the available relative chronological information available about the assorted items in a profile. Once the superposition details across each profile have been entered into the Harris Matrix program, the individual matrices produced can then be compared and cross-correlated to construct a sequence for how the gallery's various features developed over time. These results can be fed back to the archaeomorphological map, to enrich it again with further chronological details (Figure 5).

Reading the Lower Gallery's Built Environment Through Archaeomorphology

For purposes of study, La Garma's Lower Gallery was divided into nine analytical zones numbered from I to IX. Zone I begins at the palaeo-entrance, the subsequent zones progressing increasingly further away from it. Here I refer to those closest to the palaeo-entrance as the 'proximal' zones, those further away as the 'distal' ones. A number of built structures ('installations') associated with Magdalenian deposits are found in the proximal zones, especially in Zone IV where occupation floors, rock art and installations inter-digitate. A major aim of the archaeomorphology is to understand exactly where the installations fit in the history of the gallery and in relation to both each other and to the other observed traces of people in the cave.

Of particular interest are what at first view appear to be chaotic sets of blocks towards the southern end of Zone IV. They accumulated over the course of two successive wall and ceiling collapses. The first occurred along the east wall and was probably associated with the fall of an overlying ceiling (a false floor). The second is smaller and represents the collapse of a localised section of the Lower Gallery's current ceiling about 10 m overhead. The two sets of rockfall are separated by flowstone growth that partially sealed the first collapse.

Figure 3. Stepped structure constructed in a recess in the southern floor of Zone IV. Limestone blocks and speleothem slabs were added and interlocked by people to fill a dug cavity and thus create a safe passageway among the chaos of rocks. A boulder from rockfall Collapse 2 is here shaded in yellow to better differentiate it from the Collapse Cone 1 rockfall. It is the detailed examination of the spatial layout of these items, and the configuration of the sediments in which they lie, that enable the work of people in the past to be identified.

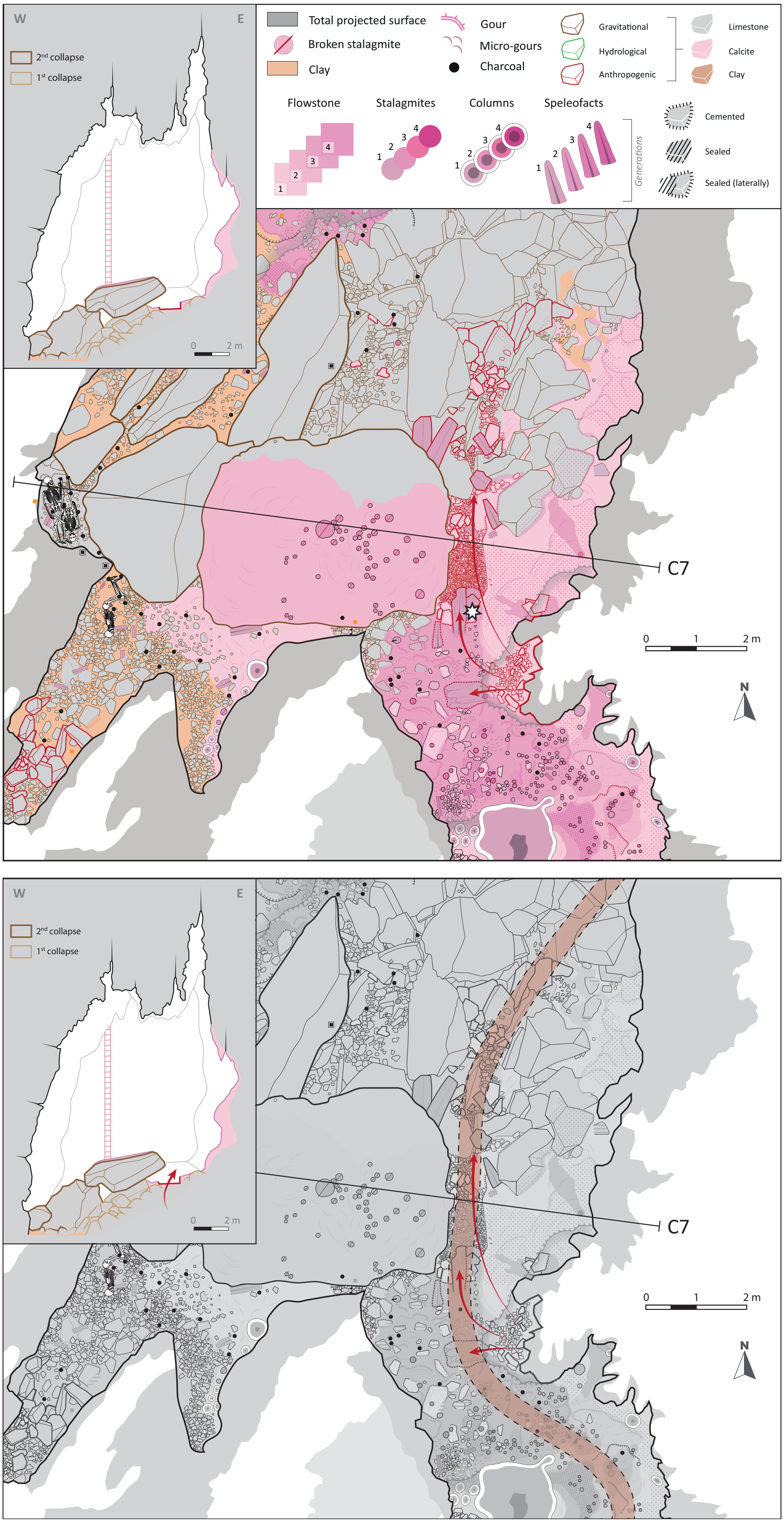

Figure 4. Floor plan showing the location of the constructed 'step' and 'pathway', and of profile C7 across the Lower Gallery. Top: The constructed step is shown by a white star. Bottom: Interpretation of the pathway that connects the areas constructed by the importation of broken slabs of speleothem. The area from which flowstone slabs were extracted to make the step and pathway is shown by the red arrows.

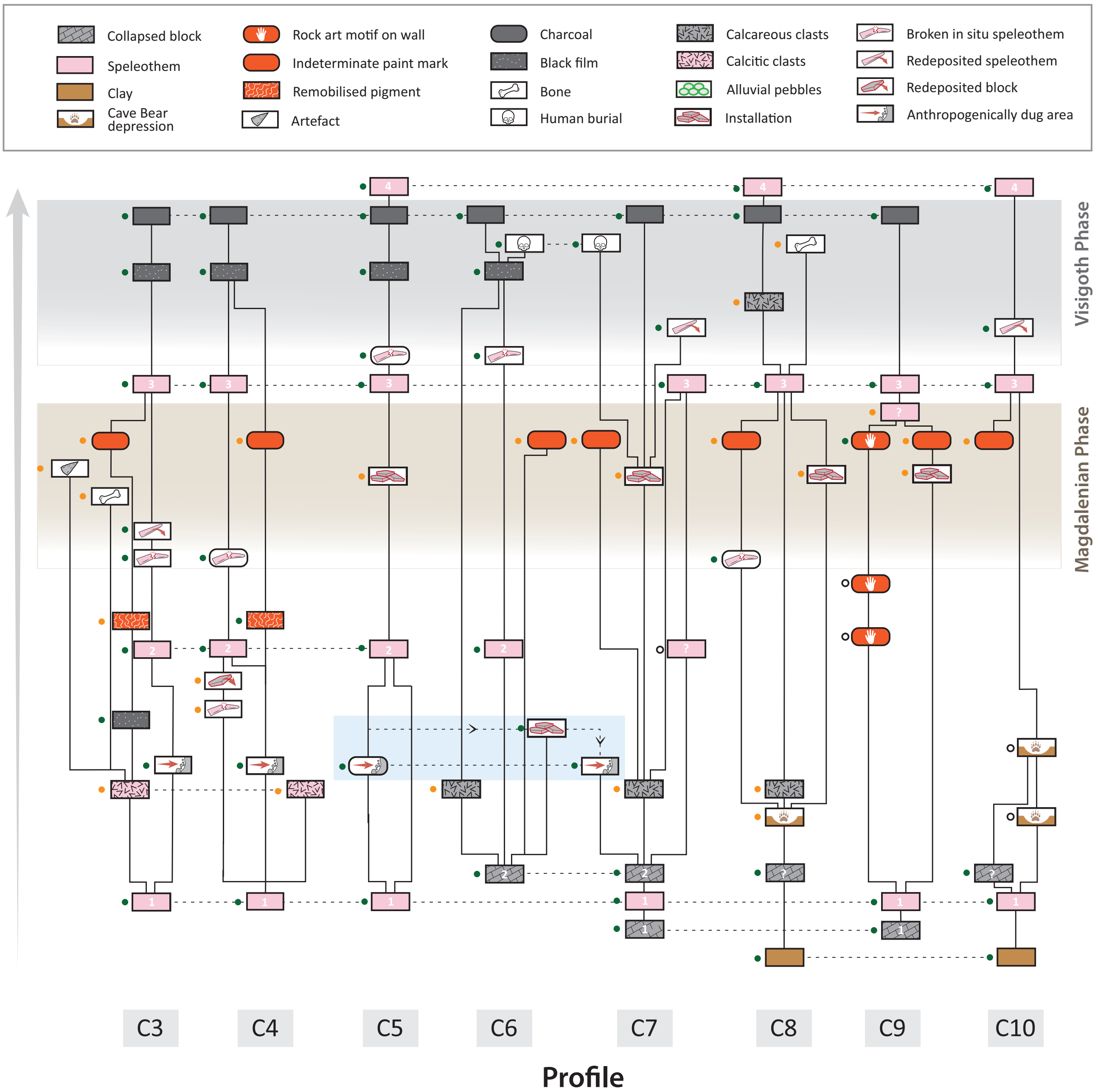

Figure 5. Part of the Lower Gallery's Harris Matrix. The Harris Matrix incorporates every element that lies in superimposition with another in the gallery's three-dimensional space. Each sequence, or 'lineage', corresponds to a profile across the gallery. Comparing the results across the gallery as a whole, both one-off events and a number of repeated patterns emerge. The vertical links between nodes represent superpositions between elements across that particular profile, i.e. across that part of the gallery. The horizontal links represent associations (often common themes) between profiles, enabling them to be positioned at the same chrono-stratigraphic level in the Harris Matrix. The reliability of the relative chronostratigraphic positions *between* profiles is represented by the colour of the nodes. White indicates that no two elements occur in superposition, therefore their relative positioning cannot be determined. Orange means that their relative positioning is based on several concordances (common themes), but not on actual superpositions. Green is based on multiple corroborating lines of evidence, so the interpretation can be considered secure. The grey area represents materials from the time of the Visigoths. The brown area relates to Magdalenian times. The blue area represents the constructed path structure of Zone IV: the two reworked areas (the step and nearby pathway) are aligned and apparently stratigraphically synchronous.

A flat area at the apex of the rockfall from the first ceiling collapse ('Collapse Cone 1') does not conform to a rockfall deposit. Here flowstone had developed over the rockfall, a localised hollow intersects the flowstone—it had been dug through the flowstone by people—and a set of limestone blocks and flat broken flowstone slabs originating from elsewhere were stacked into the hollow to create a flat surface. The resulting 'step' filled in a space between the slope of Collapse Cone 1, from the first collapse, and a massive overlying block perched on the edge of the second collapse (Figures 2, 3). The imported flowstone slabs are sections of speleothem that originally grew nearby against the wall, as evident from their surface configurations. The arrangement signals an intentional construction (Figure 3).

The shallow hollowing out of this part of Collapse Cone 1 followed by its filling into a flat step, presumably to form a secure footing between the fallen rocks, has created layers of superposition by which to work out a *chaîne opératoire* with a relative chronology. The filled hollow that accommodates the limestone rock-and-flowstone slab step must have been constructed sometime after the second rockfall, because both the artificial hollow and the imported slabs that fill it abut the space between Collapse Cone 1 and an overlying large boulder from Rockfall 2. The resulting flat, infilled space created a smooth passageway amidst the chaos of rocks.

Further construction can also be seen nearby. The flowstone that had sealed parts of the first rockfall is again found a short distance to the south of the now flat-stepped walkway described above. Archaeomorphological mapping revealed that some of the blocks from the second rockfall, and large speleofacts from the stalagmites that grew before it and that along with the flowstone had sealed parts of the first rockfall, had been extracted and re-arranged by people sometime in the deep past, to make another flat linear area along the upper part of the first rockfall's otherwise uneven slope (Figure 4). The juxtapositioning of moved blocks and broken speleothems across this small area again signals a purposeful arrangement, apparently part of an old pathway among the chaos of rocks. This linear filled-in area aligns well with the first filled-in 'step' discussed above, extending the 'pathway' along part of Collapse Cone 1's upper slope. This worked area (Zone IV) is today, and was in the past, entirely in the dark, 80 m from the Palaeolithic entrance and entrance zone (Zone I) that received subdued sunlight.

A Question of Chronology: Building a Harris Matrix

A Harris Matrix was built to reveal the relative stratigraphic positioning of the inter-connected parts of the constructed pathway, and thus their chronological relationship to each other across the Lower Gallery (Figure 5). To understand the broader chronological context of the Lower Gallery's accumulated layers, we now need to introduce a further generation of flowstone that grew on top of the constructed step and against the side of parts of the rockfall from Collapse 2 discussed above. The Harris Matrix reveals that the constructed step *precedes* the Magdalenian structures found further to the north in Zone IV, as the step lies below the most recent growth of flowstone mentioned in the previous sentence, whereas the Magdalenian structures contain broken and anthropogenically repositioned speleothems made from that flowstone (so the Magdalenian structures must have been made after the flowstone had already formed). Thus, a constant toing and froing between relative chronology and spatial (including stratigraphic) relations among features of the site allows several phases of construction to be identified across the gallery.

Conclusion

Understanding the Lower Gallery's development over time requires detailed study of superpositions, and thus of the relative chronology of its physical components (rockfall blocks, flowstone growth, moved blocks, broken and repositioned speleothems etc.) across space—a spatial history. From this, the built features of the cave's other zones, in particular Zones III and IV, can also be anchored in a larger logic of modifications—an engaged space that was once inter-connected by a constructed pathway. Having worked out a relative chronology for various features of the gallery, the next step is now to date them so that their actual ages can be known. With this, different aspects of the archaeology can then be better inter-related, both inside the cave and beyond. Here again, the choice of items to be dated (speleothems by U-series dating; charcoal fragments on the ground, and rock art or torch marks on the walls by radiocarbon dating) can be both better informed by, and add to, the archaeomorphological map. It is thus possible, once individual features of the built environment and natural formations such as rockfall and speleothem growths have been identified and put in relative chronological order, to identify which can, should and will be dated, so that the precise ages of some of these features and the events they represent can be determined. But first the relative positioning of element in each part of the cave needs to be carefully worked out through meticulous observation and mapping.

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