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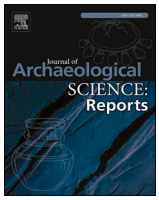

Hydrological staging of a second carved shelter in the Paris basin: emergence of new Palaeolithic symbols

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ABSTRACT

A second female sexual figuration has been found in a cramped cavity shelter in a quartzitic sandstone megaclast at Courdimanche, some 10 km from that recently described in the La Ségognole 3 shelter at Noisy-sur-Ecole. As in the latter, modifications to the quartzitic sandstone hosting the figuration had been undertaken to deliver water flows on demand, presumably to enhance its 'power'. The Courdimanche figuration is a spectacular, annular, essentially natural structure with a sandstone protrusion at its centre. The encompassing shelter is engraved with a large motif of neat and deep grooves which evoke a phallus and several smaller convergent grooves evoking vulvar features: almost all point to the annulus.

The proximity of the Courdimanche shelter to the La Ségognole shelter, both featuring modifications that enhance natural structures to form a sexual figuration, is noteworthy. The two sites are likely to have a cultural link (technological and possibly also spiritual) and thereby the same Magdalenian age as that attributed to the Ségognole 3 shelter by the style of the horse engraving associated with the sexual feature. Staging the sexual figuration by hydrological modifications, as at Ségognole 3, connects femininity with water. This is fundamentally different from the engraved or sculpted static Palaeolithic feminine representations throughout southwestern Europe. We explore a territorial cultural identity that links water to the symbol of fertility: a semiological change that could indicate changes in the socio-economic functioning of regional groups.

1. Introduction

The Ségognole 3 shelter in Noisy-sur-Ecole (Seine-et-Marne, France) was known for its two horses engraved symmetrically on either side of three grooves that distinctly evoke a pubic triangle. The proportions of the complete horse and its stylistic analogy with several horses in Lascaux cave indicates a chrono-cultural attribution between Solutrean and late Magdalenian (Bénard, 2010; Guy, 2017; Petrognani, 2018). Two of the three pubic slot grooves were shown to have been significantly worked (Caldwell, 2012). Further studies highlighted additional modifications of the quartzitic sandstone at the back of the engraved panel to promote water infiltration and direct it to the base of the pubic triangle to flow out of the vulvar slot (Thiry et al., 2020). Experiments demonstrated that two days of supply in the modified basin at the back of the panel caused the water to flow. This feminine figuration is thus a true installation, and our hydrological experimentation was the first demonstration of a direct relationship between a Late Palaeolithic female sexual figuration and water. (Fig. 1).

In the same shelter, additional modifications to natural features were made to direct rainwater infiltration to a network engraved onto the floor to form a functional installation of watercourses. Water converges towards a basin, the quartzitic sandstone rim of which has been broken by percussion so that the water flows towards the chamber of the engraved panel. The comparison of the morphological motifs of the network of carved grooves with major hydrographic features in the proximal landscapes led to the suggestion that this arrangement on the shelter floor is a miniature model of the surrounding landscape (Thiry and Milnes, 2025). Just like the sexual representation, this flow network can be fed by water inputs. Both sexual and river network figurations are hydraulic stagings that have never been demonstrated elsewhere in a Palaeolithic site, nor in a younger one.

At Courdimanche-sur-Essonne (Essonne), a natural shelter within a

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quartzitic sandstone megaclast containing an annular structure that evokes a distinct likeness to feminine genitals was discovered in 2003 by M−C and J-P Auffret. In view of the associated engravings that are neither abundant nor exceptional, the shelter appeared to be like hundreds of other shelters identified in the region and was not the subject of any particular scientific study. However, interest in it was sparked by the studies and experiments in the Ségognole 3 shelter (Thiry et al., 2020). Subsequent detailed studies of the Courdimanche LFO 1 shelter cavity, including hydrological experimentation and monitoring, showed that this sexual representation also displayed intermittent water flow and that it could be controlled (Thiry et al., 2021).

Here we describe this new shelter in detail and explore the hypothesis that the two hydraulic arrangements of a feminine sexual figuration (at Ségognole 3 and Courdimanche LFO 1) could be from the same period and culturally related. As well, we consider how these unique installations might fit into the suite of Palaeolithic rock art symbols.

2. Settings

2.1. Distribution of Palaeolithic sites

The Sables et Grès de Fontainebleau that crop out in the southern Paris Basin are famous for their rocky landscapes with lag deposits of 1 to 7 m-sized quartzitic sandstone megaclasts. More than 2000 carved shelters are known within the lag deposits (Fig. 1). The carvings are essentially non-figurative and geometric and associated lithic artefacts suggests that they were made by hunter-gatherers of the Mesolithic Period (Guéret and Benard, 2017; Cantin, 2022). Amongst the carved shelters only three are known to have figurative representations of Palaeolithic style: an incomplete animal painted on a split plate (Leroi-Gourhan, 1976) from La Justice 1 shelter destroyed by quarrying in Boutigny-sur-Essonne (Essonne); a carved auroch in the La Saboterie 1 shelter (Bénard and Valois, 2014; Robert and Veysset, 2023) located in Buno-Bonnevaux (Essonne) and the engraving of two horses connected with a female sexual figuration in the La Ségognole 3 shelter (Bénard, 2010) in Noisy-sur-Ecole (Seine-et-Marne).

Detailed geomorphological analysis of the rare Late Palaeolithic shelters revealed new aspects unknown in other Palaeolithic sites. In particular, these are:

- modifications of natural features in the shelter to make the first known staging of a feminine sexual figuration with vulvar outflow on demand (Thiry et al., 2020) and additional modifications to create a hydraulic animation of water flow on the shelter floor (Thiry and Milnes, 2025);
- the occurrence of two megaclasts erected by humans close to two of the Palaeolithic shelters, never previously described, the pairing expected to date from the late Palaeolithic (Thiry and Milnes, 2024a); and now
- a second site with female sexual representation arranged to promote flow.

The uniqueness of these Palaeolithic shelters could offer insights into regional community specificities.

Although Palaeolithic engraved shelters are rare in the region, there are numerous Upper Palaeolithic open-air sites. Foremost are Pincevent (Leroi-Gourhan and Brézillon, 1966) and Étioles (Olive, 2005; Caron-Laviolette et al., 2018) that are located on the Seine River and have been long studied. These open-air sites were large camps with hunting and residential functions where hunter-gatherer groups aggregated (Bodu et al., 2011). They are located within 35–45 km of both the Courdimanche LFO 1 and Ségognole 3 shelters which were clearly accessible for exploration and exploitation by Palaeolithic hunter-gatherer groups.

The three recognised Palaeolithic shelters are located at the top of a triangle and are approximately 10 km apart. The LFO 1 shelter in Courdimanche-sur-Essonne is only about 2.5 km SW of the Justice 1 shelter in Boutigny-sur-Ecole. It is located in a landscape of relatively

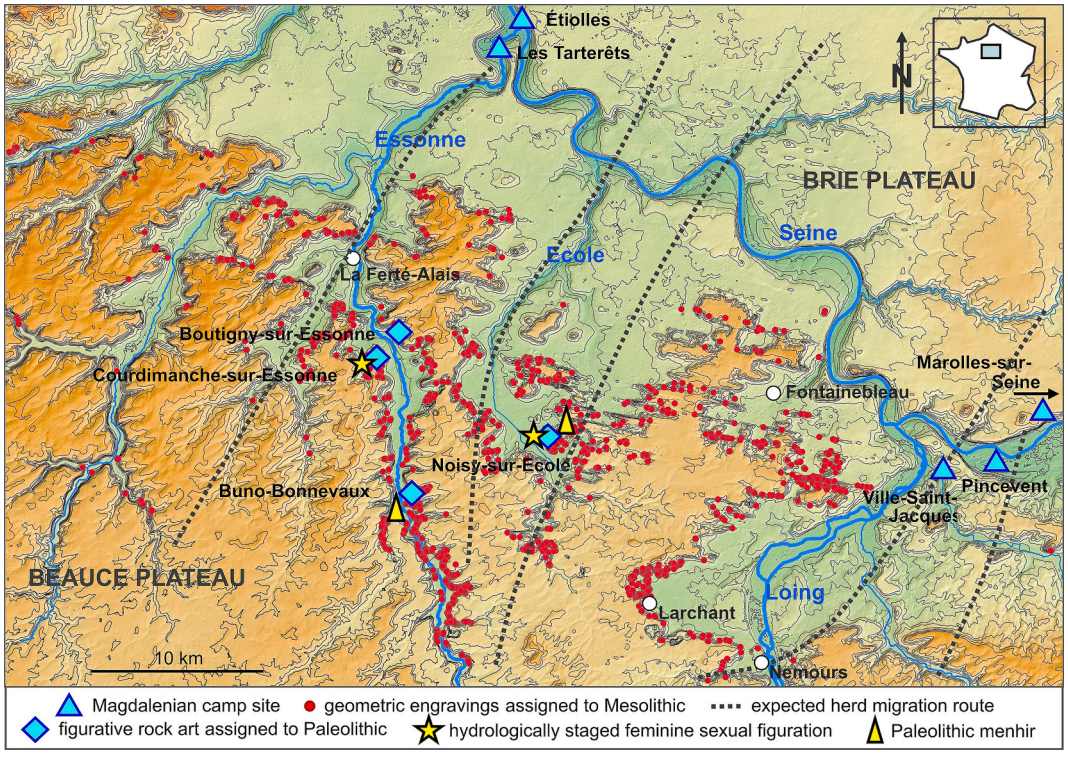

Fig. 1. Map of engraved and painted shelters recorded in the rock lags of the Sables et Grès de Fontainebleau south of Paris. Included particularly are shelters attributed to the Palaeolithic, the main Late Palaeolithic open-air camps along the rivers, and expected herd migration routes. Geometric engravings assigned to the Mesolithic are also shown. Data from GERSAR, Magdalenian open-air sites from Bodu et al. (2011) and map DAO by Michel Rey. After Thiry and Milnes (2024a).

dispersed quartzitic sandstone megaclasts from one to a few cubic meters in volume, rounded, and without fresh fractures. The megaclasts frequently contain small, irregular, natural cavities that have convoluted internal morphologies intersected by fractures. The LFO 1 megaclast is the only one with an accessible cavity but it and adjacent megaclasts have smaller holes and cavities on their upper surfaces.

2.2. Climate variability and human adaptation

Two complementary aspects lead to an understanding of the climatic-environmental context for the Upper Paleolithic sites in the Paris Basin. In the North of France, the diversity of the occurrences provided the opportunity to focus on the chronology of the sites, which highlights the temporal variability of human occupations. In the Paris Basin, the exceptional preservation of the sites, due to recurrent flooding, provided the opportunity to focus on the spatial dimension with the clearing of large habitation areas, and to distinguish occupational units on a seasonal scale.

In northern France, only 200 km north of the Fontainebleau sandstone sites, there is no evidence of human occupation during the coldest and driest period of the Late Pleniglacial. After this time (around 15 ka cal BP), the region was a cold steppe occupied by the last reindeer and horse hunters of the Late Magdalenian (Paris et al., 2017; Fagnart et al., 2021). It has been suggested that these hunters were linked to the settlements of the central Paris Basin. Climate warming at the end of the Bølling Oscillation (14.3 ka cal. BP) led to the disappearance of the cold climate reindeer and horse fauna of the end of the Upper Pleniglacial and its replacement by non-migratory fauna bound to a less open environment (deer, roe deer, aurochs). This change ended the hunting economy of the Magdalenian world and gave way to the bow hunters of the Azilian-Federmesser tradition (Bridault, 1997). It was followed between 13.7 and 12.7 ka cal. BP by the densest human settlement in the region during the Allerød Oscillation (Fagnart, 1997; Coudret and Fagnart, 2006). During the subsequent Younger Dryas climatic deterioration, which lasted slightly more than a millennium, human occupation appears to have again fallen sharply with environmental conditions close to those of the end of the Upper Pleniglacial. It was only at the very end of the Younger Dryas or at the very beginning of the Preboreal (around 11.6 ka cal. BP) that the region was again significantly occupied by the very last Paleolithic hunters, linked to a fauna composed of deer, aurochs and horses. Thus, there was great variability of climatic-environmental conditions which clearly led to major migrations of Upper Paleolithic populations.

In the Paris Basin, most Magdalenian sites are dated to the Bølling interstadial episode (14,700–14,000 cal BP), or to the period between the Bølling and the following Alleröd episode (13,800–12,700 cal BP); that is to say significantly later than most Magdalenian occupations in other areas in Western Europe (Debout et al., 2012). The Pincevent site, some 200 km SSE of the northern France sites, was frequented for a relatively short period of time, estimated to be 100 or 150 years at most (Orliac, 1996). It was a strategic location for intercepting reindeer herds beginning their autumn migration, swimming across river channels to head south. Occupations are estimated to have lasted only 5 or 6 weeks, given the relatively short time taken for the reindeer migrations to pass through. Such occupations characterize the great mobility of regional populations, with families dispersed during the summer but assembled to practice large collective hunts (Julien, 2006). There are very rare occupational units for which hunting appears to have been spread over several months, including the winter season. One site, located in a sedimentation-free area (probably protected from flooding), where there was year-round horse hunting, was estimated to have been a more perennial site (Alix et al., 1993).

It is of note that the boundaries between the beginning and the end of the Late Glacial period are marked by major incisions of the fluvial system (Antoine et al., 2000, 2003) which resulted from intense runoff due to increased rainfall while soils and subsoils remained frozen (Cojan et al., 2007). Moreover, the meander wavelengths of the Marne, Seine and Eure rivers of the Paris Basin show that these rivers were calibrated by flows that were multiplied by 6 to 10 during the glacial stages together with increased sediment supply in response to enhanced mechanical erosion during cold episodes (Cojan et al., 2007). These data should be linked to the exceptionally fine preservation of occupational units at Pincevent and Etiolles that were regularly covered by flood deposits. On the other hand, hydrological conditions surely also influenced the behavior of populations and probably partly explain the almost systematic abandonment of the dwellings before winter and the recurrent sudden spring floods.

3. Methodology

Our method for studying the quartzitic sandstone megaclasts forming the impressive lag deposits in the Fontainebleau region is in the spirit and lineage of the geomorphological studies applied to prehistoric sites, as advocated and successfully implemented in a series of recent works (for example: Burns, 2005; Bradley and Phillips, 2008; Delannoy et al., 2012; Sellier, 2013; Thiry et al., 2020; Ard et al., 2021). It focusses on morphological aspects from centimetres to metres in size and aims to distinguish and explain, using objective criteria, the processes at the origin of each of the morphogenic elements on and in the megaclasts. This extends to sediments variously infilling hollows and cavities.

The basis of the methodology is a detailed knowledge of the characteristics and morphologies of the Fontainebleau quartzitic sandstone in situ within freshly exposed materials in sand pits and in exposed and weathered outcrops (Thiry et al., 1984; Thiry, 2005; Thiry et al., 2017). These are of prime importance in geo-archaeology because they are primary surface features of natural origin and not structures of possible anthropogenic origin. In this study we pay particular attention to:

- anomalies or incongruities in or on a natural primary or secondary feature that could potentially related to an anthropogenic action. Thus, any disruption of natural features like cavities, holes, primary mineral coatings, secondary weathering crusts and surface smoothing are generally the first clues that trigger detailed observations and a search for arguments that could allow us to interpret the feature(s);
- the disposition of weathering crusts (Fig. 2A & B) due to alteration by moisture in the shelters and the mechanisms and periodicity of water infiltration and drainage; and,
- the morphologies of the quartzitic sandstone megaclasts in relation to broader elements of the surrounding landscape to detect characteristics that may be at odds with their distribution and orientation in the lag deposits.

Special attention was paid to the weathering crusts that have developed on the walls of the cavities. These crusts are very often only fragile films but can be hard and reach 1 to 2 mm in thickness, particularly near fractures infiltrated by rainwater. They did not form by alteration of the sandstone (they are devoid of quartz grains) but formed by coating of the sandstone surface (Fig. 2A & B; and supplementary file 01 of Thiry et al., 2020). They are composed of micro-rosettes of lenticular gypsum crystals formed by evaporation of pore waters from within the sandstone. They can develop relatively rapidly, as for example on the engraved panel of the Ségognole 3 shelter where the carved furrows of the horse are encrusted (supplementary file 01 of Thiry et al., 2020). However, in other cases, the coatings have been disrupted by the engraving.

We were not able to recognize micro-wear marks left by tools during the engraving, partly because the nature of the quartzitic sandstone is such that they are probably not made. The walls of the shelters mark the original boundaries between silica-cemented and non-cemented primary sand masses: the non-cemented sand spilled from the megaclasts when they became exposed in outcrop, leaving the shelter cavity. The walls have millimetre- to centimetre-thick transition zones between

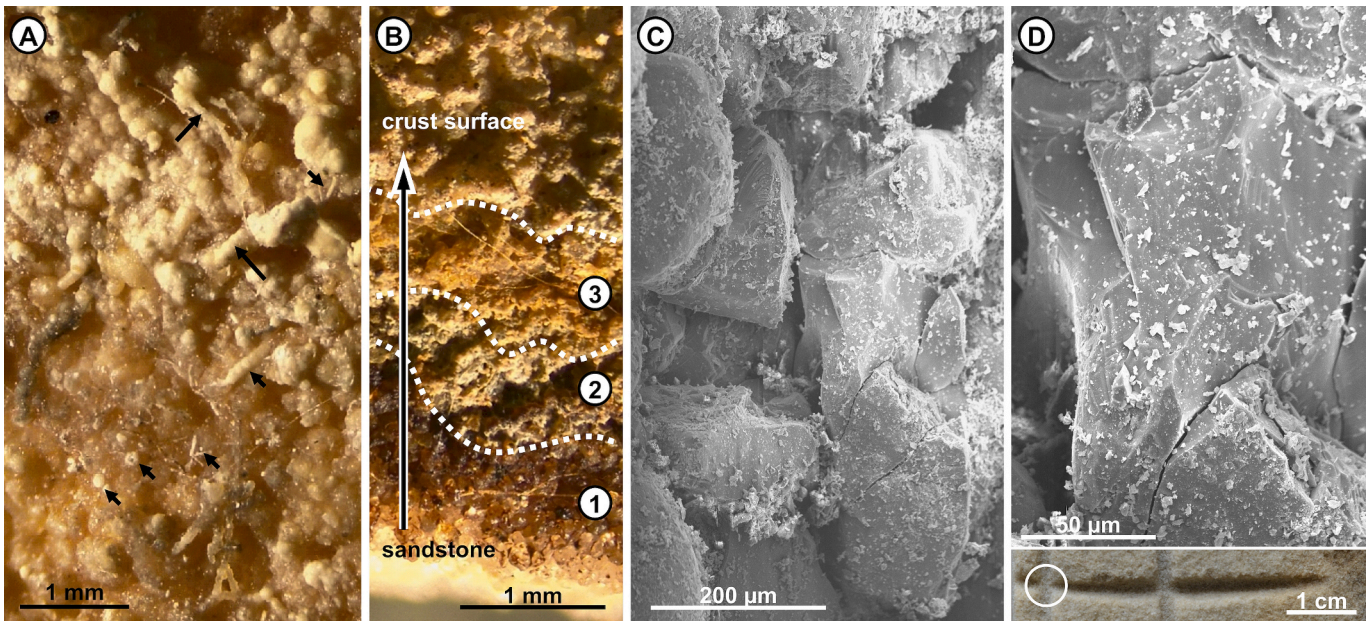

Fig. 2. (A) & (B) Characteristic weathering crust inside the shelters observed by binocular magnifying glass after treatment with bleach to remove any coatings of organic matter. (A) The crust does not show quartz grains but only spherulites (without discernible structure) and biological remnants (pollen grains and other organic debris) (arrows). (B) Oblique section of a crust: (1) sandstone with sub-euhedral overgrown quartz grains, (2) porous sandstone infilled by crust-material, (3) granular crust without visible quartz grains. (C) & (D) Scanning Electron Microscope images of material scraped from the bottom of experimentally engraved grooves. (C) Partly overgrown quartz grains broken by the flint scraper and covered by residual dust from the chips crushed by the successive passes of the tool. (D) Detail of the conchoidal bursts. Image at bottom shows three experimental grooves cut down in slightly friable cortex until meeting quartzitic sandstone with less than 3% porosity. Circle indicates the analysed furrow bottoms. SEM pictures by Lydia Zotkina.

primary sand and quartzitic sandstone (Thiry, 2017). Engraving experiments with flint tools showed that the tools penetrated the friable cortex very easily but that penetrating the underlying hard quartzitic sandstone was difficult (Cantin et al., 2022). Examination of the bottoms of these grooves showed that the passages of the flint tool shattered the quartz grains and crushed rock flakes but did not inscribe traces of wear (Fig. 2C & D). Quartz grains in the quartzite sandstones do not interpenetrate but are simply stacked together and thus tend to be dislodged by the engraving tool rather than remaining embedded in the matrix to be scratched by the tool. A second factor is that alteration/dissolution of the sandstone due to infiltrating water post-engraving has the potential to smooth and erase any micro-traces of the engraving.

In our investigations, so far, we have relied on a 'best interpretation' of the anomalous or incongruent features as man-induced or not. Observations of disruption, mostly at the decimetric and centimetric scale, were the most obvious signs of human intervention.

As part of these investigations, sediments infilling holes and depressions in the sandstone megaclasts were excavated for analysis, and soils both on-site and in an adjacent agricultural field were collected and analysed for comparison. Coarse clasts (>60 mm) were extracted, and the remaining material was sieved to determine its particle size composition (20–60 mm, <20 mm, <3mm). The relative abundance of each size class was calculated in relation to the volume of < 3 mm material.

4. Megaclast morphologies

The Courdimanche LFO 1 megaclast is a roughly quadrangular sandstone block with rounded edges, about 7 m long and 2 m wide, and 1.50 m above ground (Fig. 3B). The entrance to the shelter cavity that is the main subject of this study is roughly isometric and very narrow, about 40 cm wide and 30 cm high (Fig. 3D). At the winter solstice, the rising sun enters and illuminates part of an annular structure within the cavity. Prior to and following the solstice, the rising sun illuminates the cavity but not the annular structure within. The shelter cavity is hemispherical, with a base about 1 m in diameter and a volume of about 0.25 m^3 (250 L). A maximum of two people can enter only by folding into themselves.

A hole on top of the megaclast (Fig. 3B) is connected to a slot corresponding to a fracture that originates at the hole and runs across the top of the clast but does not reach the back face (Fig. 3C). The fracture results from extensional strains caused by bending of the megaclast during the formation of the lag deposit. A schematic section (Fig. 3E) shows the main morphological features of the megaclast and the cavities.

4.1. Main shelter cavity

The walls of the shelter are somewhat irregular with arched fractures intersecting them and converging towards an oculus at the apex of the roof vault (Fig. 4A). The walls have a thin, light brown, friable cortex that is common in all the shelters in the Fontainebleau Sandstone and is relatively easy to engrave (Cantin et al., 2022). Protrusions of quartzitic sandstone demarcated by fractures are hard and difficult to engrave. The lower parts of the walls of the shelter cavity are covered by dark crusts haloed by white gypsum efflorescence as a result of weathering. Above the entrance, the roof of the shelter vault is a 45°-inclined, even surface, about 0.2 m^2, which displays most of the engravings.

The right-hand wall of the shelter is relatively vertical and extends laterally for nearly a metre at its base. It has two main sandstone morphologies: an annular structure on the left and a recess on the right (Fig. 4B). The annular structure consists of a dome formed of three quartzitic sandstone rings, the diameters of which narrow towards the back, and a pierced centre with a rounded protuberance forming the back of the structure (Fig. 4C). The central protuberance and surrounding rings of quartzitic sandstone reflect successive envelopes of silicification in the parent Fontainebleau Sand (Thiry and Milnes, 2024b). The morphology of the annular structure, and that of the cavity, emerged when non-silicified sand spilled from it. To the right of the annular structure there is a recess approximately 50 cm deep that ends in

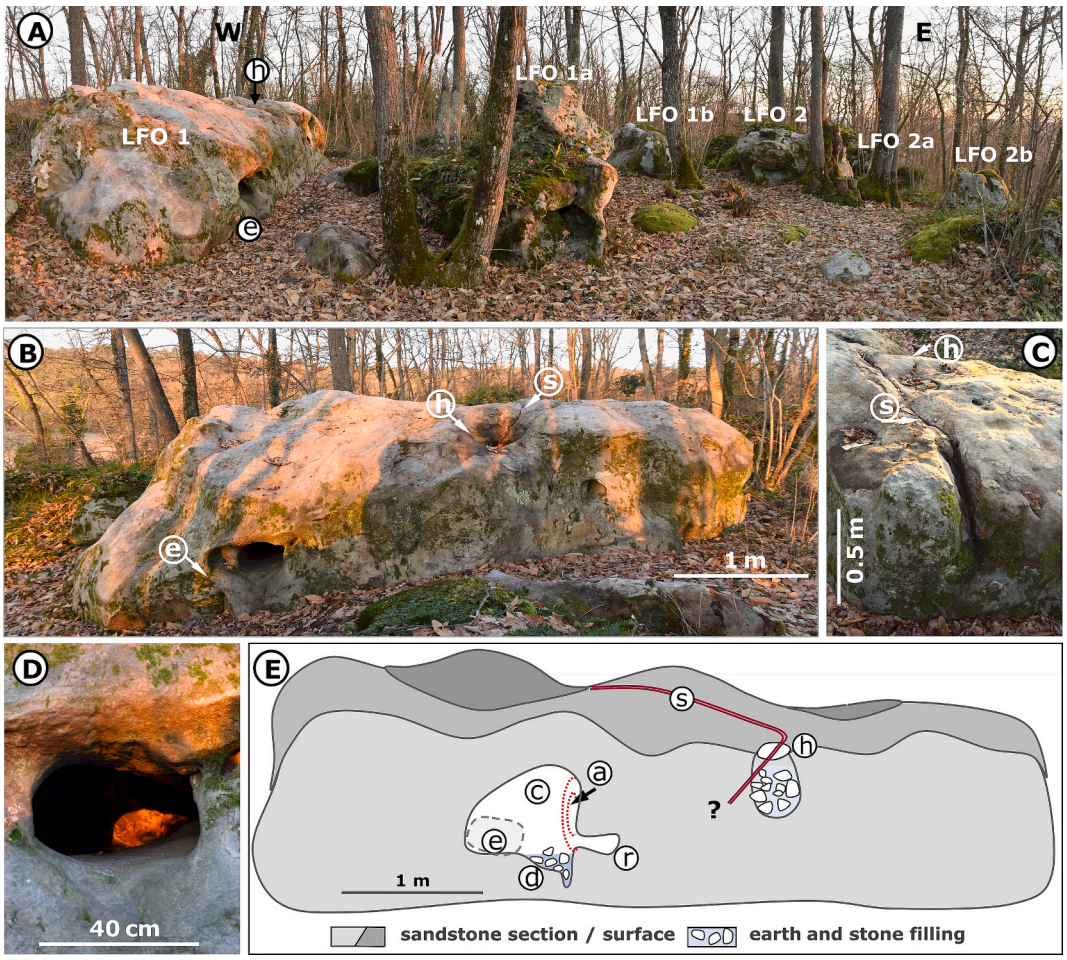

Fig. 3. Morphologies of LFO 1 quartzitic sandstone megaclast. (A) Assemblage of rocks (numbered) downslope of the LFO 1 megaclast. (B) Frontal view of megaclast LFO 1 illuminated by the rising sun: view slightly downwards from the top of an adjacent rock. Note that the open fracture slot (s) at the top of the megaclast does not extend to the front face. (C) Open fracture slot (s) on the top does also not reach the base of the rear face of the megaclast. (D) Entrance to the shelter cavity illuminated by the rising sun January 11, 2023. (E) Schematic section: (s) fracture slot; (h) hole; (c) shelter cavity; (e) entrance; (a) annular structure; (r) recess; (d) depression in the cavity floor.

a cul de sac about 20 cm from the protuberance. The cul de sac gives a hollow sound when struck with a finger, suggesting that there is a void around the protuberance or between the concentric sandstone envelopes.

The floor of the shelter is horizontal at the entrance and rises to connect with the left-hand wall. It slopes gradually towards the back and ends in a depression about 40 cm deep, with rounded morphologies, in front of the annular structure (Fig. 4B). On first inspection, the depression was filled with gray to black sediment containing 2 to 10 cm sized clasts.

The shelter cavity corresponds to an initial volume of sand which was not cemented during the silicification of the megaclast. This residual sand spilled out as the megaclast became exposed in outcrop. The hollowing of the annular structure similarly results from differential cementation. Although visible in the shelter cavity, these structures extend more or less deeply into the sandstone. Also of note is the number of fractures that emerge in the shelter while only one is visible on the outside of the megaclast. This arrangement results from the weathering that shaped the megaclast, rounding and reducing those parts that were fractured in contrast to parts that were more strongly cemented and thus non-fractured.

A particularly notable character of the shelter cavity is its acoustics. It has a tremendous resonance, with echoes bouncing from one wall to the other amplifying low frequencies. The source and location of any sound are blurred or vanish entirely while within the shelter, overtaken by the 'cavernous' nature of sound which tends to 'depersonalize' voices. When moving inside the cavity, friction against the walls is amplified and delocalized, giving doubt as to the source of the noise. At times, noises are perceived to come from outside while one is indeed alone at the site, which is impressive and destabilizing.

4.2. *Holes in the tops of megaclasts*

In addition to the hole in the top of the main LFO 1 megaclast, holes in the tops of two neighbouring megaclasts have also been examined: one in LFO 2 about 20 m downslope and another in LFO 2b about 4 m to one side of LFO 2 (Fig. 3A).

The hole in the top of LFO 1 megaclast is 40 cm in diameter with a flared spillway and a multi-lobed bottom (Fig. 5A) and was filled with sediment, including clasts, on first inspection. The fracture across the top of the megaclast has a source on the inner edge of the hole and an opening of 0.5 to 1 cm. The fracture slot was clogged with sediment infused with plant roots. The hole is asymmetrical, 80 cm deep at the side where the fracture is located, and 30 cm deep at the spillway on the opposite side. Its capacity is about 100 L. The surface of the quartzitic sandstone around and inside the hole is relatively smooth and typical of surfaces on the Fontainebleau Sandstone, whereas surfaces on both side of the fracture slot are rough and irregular (Fig. 5A).

The hole in the smaller megaclast LFO 2 is very different from that in LFO 1. It is a regular cylinder 50 cm in diameter and 50 cm deep with a

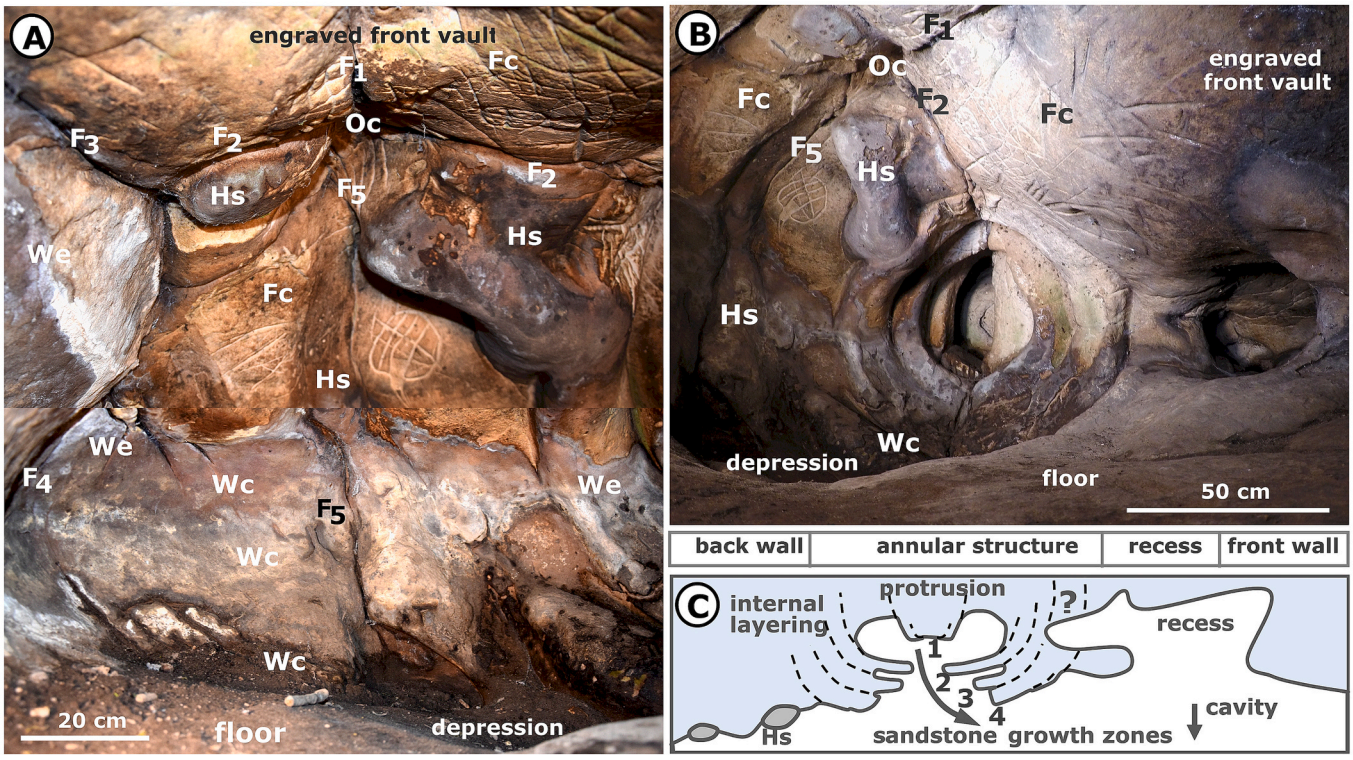

Fig. 4. Morphologies of the shelter cavity. (A) Rear wall and vault – assembly of 2 photos (insufficient space to photograph the entire wall). (B) Right hand wall showing annular structure – 'wide-angle' view brings the central part forward. Photo by Pascal Crapet. (C) Schematic cross-section showing a horizontal plane 'cut through' the shelter cavity and the concentric arrangement of rings (labelled 1 to 4) of centrifugal silicification of the sandstone around the central protuberance. Fnumber – fracture; Fc – yellowish friable cortex that includes the carvings; Hs – hard sandstone protrusion; Oc – oculus in the roof vault; Wc. gypsum indurated weathering crust; We – white gypsum efflorescences.

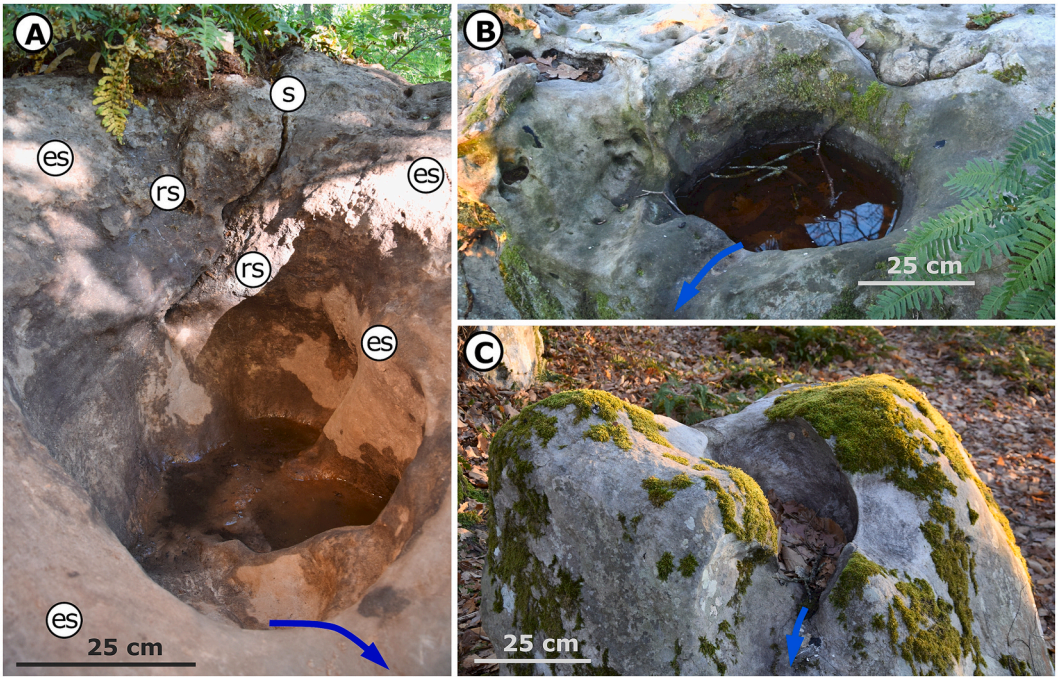

Fig. 5. Holes in the tops of megaclasts. (A) Hole in LFO 1 emptied of sediment. Multi-lobed shape at depth is characteristic of natural hollows at this site. (B) Water filled hole in LFO 2. (C) Hole filled with sediment in neighbouring megaclast LFO 2b. Blue arrows indicate spillways from the holes; (s) fracture slot; (es) even sandstone surface; (rs) rough sandstone surface.

capacity of 100 L and a conspicuous spillway (Fig. 5B and Supplementary file#1 for 3D model). The hole did not contain any sediment on first inspection, is watertight, and constantly holds water. Unlike the hole in LFO 1, it contains no rounded protrusions, and its walls are rough. The neighbouring megaclast LFO 2b is smaller in size and has in its top an asymmetrical hole, about 40 cm in diameter, crossed by a fracture: the bottom of the cavity is rounded and slightly bumpy (Fig. 5C). On first inspection the hole was filled with sediment.

5. Details of findings

It is clear from the engravings in the LFO 1 shelter that there has been human intervention. Our results also demonstrate that additional works have been undertaken.

5.1. Modifications to the quartzitic sandstone

The top of the entrance to the LFO 1 shelter cavity has three concave morphologies (Fig. 6A & 6B1) which are three sandstone spalls. The upper left rim of the entrance shows three flared grooves with small concave marks that do not tally with any sedimentary layering or fracture pattern and indicate removal of rock (Fig. 6B2). The bottom of the entrance has been gouged by a narrow, regular furrow (which is not an extension of a natural fracture; Fig. 6B3) to channel water from the

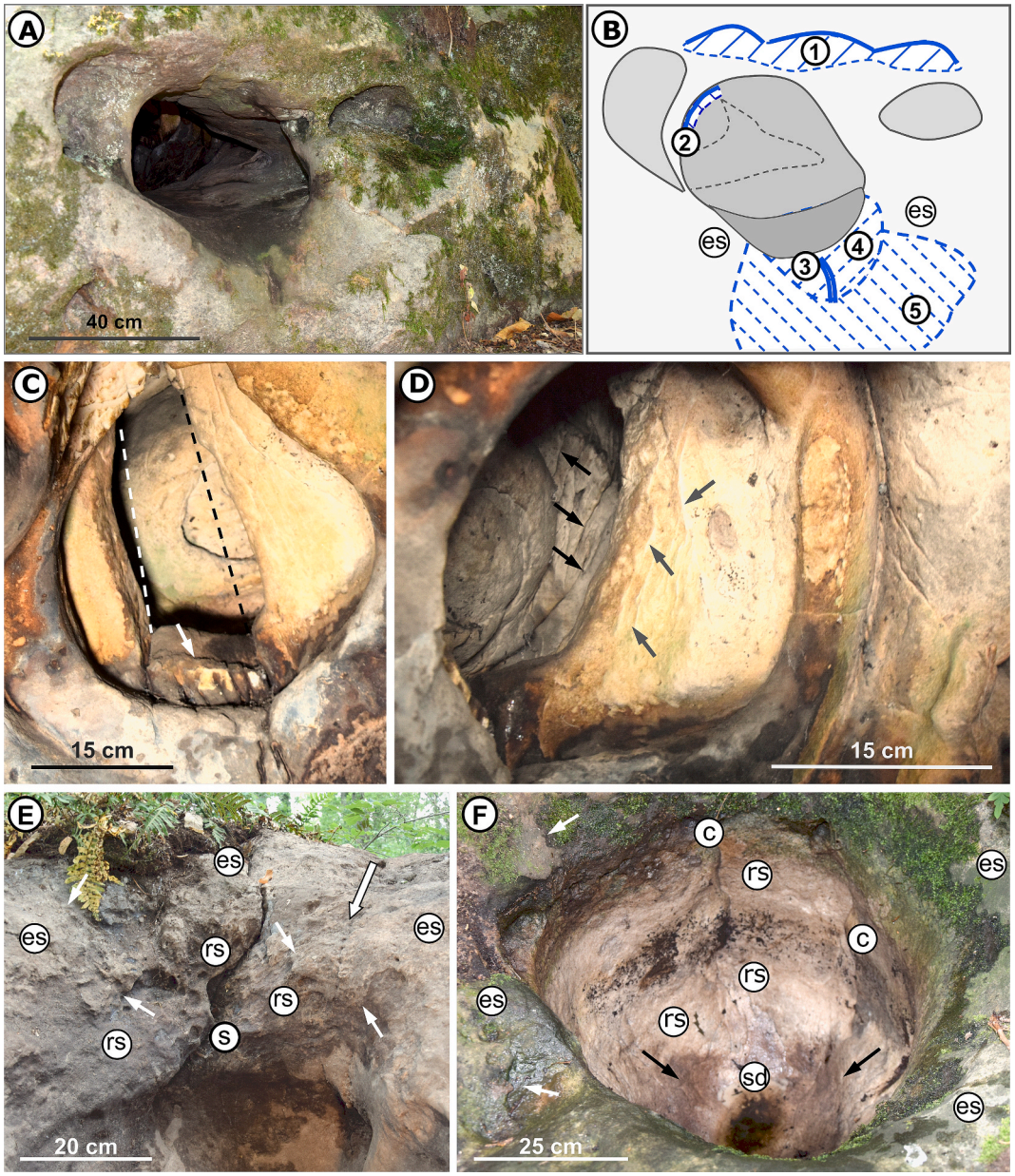

Fig. 6. Adjustments to quartzitic sandstone. (A) Entrance to LFO 1 shelter. The lighter patch visible at top left in the shelter cavity is the annular structure illuminated by a lamp. (B) Schematic diagram of the surfaces that make up the entrance shown in A. Numbers refer to the descriptions in the text. (C) Central opening of the annular structure. The curvature of the sides (highlighted by dashed lines) is due to widening by scraping. Visible scratches occur on the left-hand edge. The lower border is formed by two breakage planes (arrow). (D) Detail of the central opening showing scratches on the right-hand edge and central protrusion. (E) Hole in the top of LFO 1 showing the contrast between the smooth, even natural surface (es) of the quartzitic sandstone and the rough bare surface (rs); (s) slot. White arrows point to the embossed natural surface above the rough bare surface; double arrow points to an alignment of small pits or hollows. (F) Hole LFO 2 showing the contrast between even natural surfaces (es) of the quartzitic sandstone and the cracked, scaled and rough appearance (rs) of the wall of the cavity. (c) crack; (sd) smooth depression. White arrows point to breaks in the natural encrusted surface, black arrows point to finely cracked depressions.

shelter. The surface notched by the furrow is rough and contrasts with the smooth, natural surface to the left of the opening (Fig. 6B4). As well, the front surface beneath the entrance (Fig. 6B5) is rough and contrasts with the regular and smooth surface that forms the base of the quartzitic sandstone megaclast: it has numerous angular centimetric hollows that indicate removal of rock by spiking or percussion. Added together, these works have enlarged the entrance to the shelter and promoted the outflow of water from it.

The central opening of the annular structure has asymmetrical sigmoidal profiles that are incompatible with natural fractures (Fig. 6C). These features are marked by scratches that indicate that the sandstone has been worn away by scraping to widen the opening (Fig. 6D). Additionally, groove marks on the central protrusion are likely to be incisions caused by skidding of the tool during the reworking of the opening (Fig. 6D). The lower edge of the central plate has two surfaces (Fig. 6C) that are not encrusted like the grooved basal surface and so are more recent. They could be surfaces formed by breakage following the incision of a transverse guide groove.

The hole in the top of the LFO 1 megaclast shows a strong contrast between a smooth, even surface surround and a rough surface on either side of the fracture that extends onto the top of the megaclast (Fig. 5A). The transition between the two surfaces is highlighted by a break in the natural encrusted surface of the megaclast caused by the removal of material (Fig. 6E). The removal obviously widened the left-hand side of the hole to intersect the fracture. The series of small, aligned pits on the right-hand margin of the hole are considered to be artificial rather than natural.

The hole in the LFO 2 megaclast has the shape of a regular cylinder extending downwards to its base. Below the smoothed, rounded upper edge, the walls of the cavity are rough and scaly (Fig. 6F and Supplementary file#1 for 3D model). Two cracks with relatively sharp edges point to the removal of sandstone flakes. The bottom of the hole is almost flat and formed of four finely cracked depressions in roughened sandstone. A small, regular, smooth-walled depression in the centre was probably the original natural bottom of the cavity. Although there are no working stigmata due to weathering facilitated by stagnating water, the roughened sandstone walls and depressions point to rock removal by percussion, probably to increase its water-holding capacity.

5.2. Sediment infillings

Analysis of the infilling sediments shows that all include a fine fraction (<3mm) and silicified limestone clasts composed of large irregular, angular blocks > 60 mm and multiple fine splinters which are obviously gelifracts. On the basis of the abundance of these < 20 mm silicified limestone gelifracts, all infillings have an affiliation with colluvium that lines the flanks of the Essonne Valley. (Thiry, 2022). However, all the infillings contain a greater proportion of large elements than the soils and, above all, clasts of quartzitic sandstone that are not present in the soils. Even the limestone clasts in the depression of the shelter have not been found in the soils. Each infilling has a particular specificity.

- The hole in the top of the LFO 1 megaclast contained an abundance of fist-sized (>60mm) fragments of quartzitic sandstone and silicified limestone. On excavation, its base was found to contain only silicified limestone fragments with little earthy material: this suggests selective placement when the hole was empty.
- The depression in the LFO 1 shelter is distinguished by an abundance of small (<20 mm) quartzitic sandstone fragments that do not occur in the soils sampled at the site and in the nearby field (Thiry, 2022). A possibility is that they constitute the refuse from the workings recorded in the shelter. It is also unique in that it contains abundant > 20 mm limestone fragments that are not found in other cavities or in the local soil colluvium and have probably been deliberately introduced.
- The hole in the LFO 2b megaclast contained only five > 60 mm clasts, all were quartzitic sandstones and three were ferruginous sandstone, which is an unusual facies in the Fontainebleau Sandstone. Their occurrence in the infilling via some natural mechanism is completely improbable.

In addition, about half of the fist-sized and larger quartzitic sandstone fragments in the hole and cavity infills have characteristics that are neither the result of erosion nor natural breakage (Thiry, 2022). The most convincing characteristics include:

- the presence and almost systematic association of a flattened volume formed from an acute dihedron shape, with a multiple-sided contour, an overall symmetry (Fig. 7A & B) and the presence of scars of several secondary flakes (Fig. 7C & D);
- that out of a set of 59 samples, eight have one rounded end or edge while all the others are sharp, indicating wear by hammering or friction (Fig. 7E); and
- three samples have an acute and symmetrical pyramidal shape which is unlikely for a natural rock clast (Fig. 7F).

The implications for the combination of the unusual occurrence of the clasts in the holes and shelter cavity, their unnatural shapes, and their absence in the sandstone lag deposits in the shelter site, attests to human intervention.

5.3. Engravings

Three types of engravings are recognized on the vault of the shelter between the entrance and the recess, namely: ‘neat and tidy’ deep grooves; relatively deep but ‘clumsy engravings’, and ‘less precise’ superficial grooves with less distinct patterns (Fig. 8). They represent different engraving techniques and possibly tools.

Deep engravings are the result of repeated and focussed back and forth strokes of the tool. They are carved in relatively hard quartzitic sandstone and required more effort and time than the engravings in the friable cortex elsewhere on the rock surface. The latter are similar to the abundant engravings of Fontainebleau Sandstone attributed to the Mesolithic (Cantin et al., 2022). Moreover, the deep engravings are distinguished from the Mesolithic engravings by curving of the grooves that recall the figurative engravings of the aurochs panel in the La Saboterie 01 shelter in Buno-Bonnevaux identified as Palaeolithic (Bénard and Valois, 2014; Robert and Veysset, 2023). The second group of engravings that we describe as being relatively deep but ‘clumsy’ are representations of circles, punctuations, and convergences (the latter termed ‘chevrons’ in the typology of Cantin, 2022). The third group of many superficial furrows are not common in engraved shelters in the Fontainebleau lag deposits and appear to be more akin to ‘scribbles’ made by the single passage of a tool rather than to engravings. They include line overruns on geometric figures, which are also unusual for Mesolithic engravings in the Fontainebleau region and suggest fast engraving (central part of Fig. 8). It is of note that apart from the deep ‘neat and tidy’ parallel grooves related to the large, curved engraving, the shelter cavity does not have the series of elongated parallel furrows or furrow grids considered typical of rock engravings attributed to the Mesolithic in the region (Cantin, 2022).

The deep grooves form a composition with a polarity towards the recess and the annular structure (Fig. 8). It is neatly done with regular curves that recall a figurative engraving. The slightly shallower grooves towards the closing of the figure (bottom of Fig. 8) is a function of the harder sandstone above the shelter entrance. A cross and a series of parallel lines formed by deep and neat furrows (outline in Fig. 8) appear to be linked to the major curved furrow. The two deep grooves marking another cross inside the triangular closure of the composition are slightly sigmoidal and stick to a depression. A second cross inscribed in a square at the bottom of the panel (to the right of the deeply furrowed

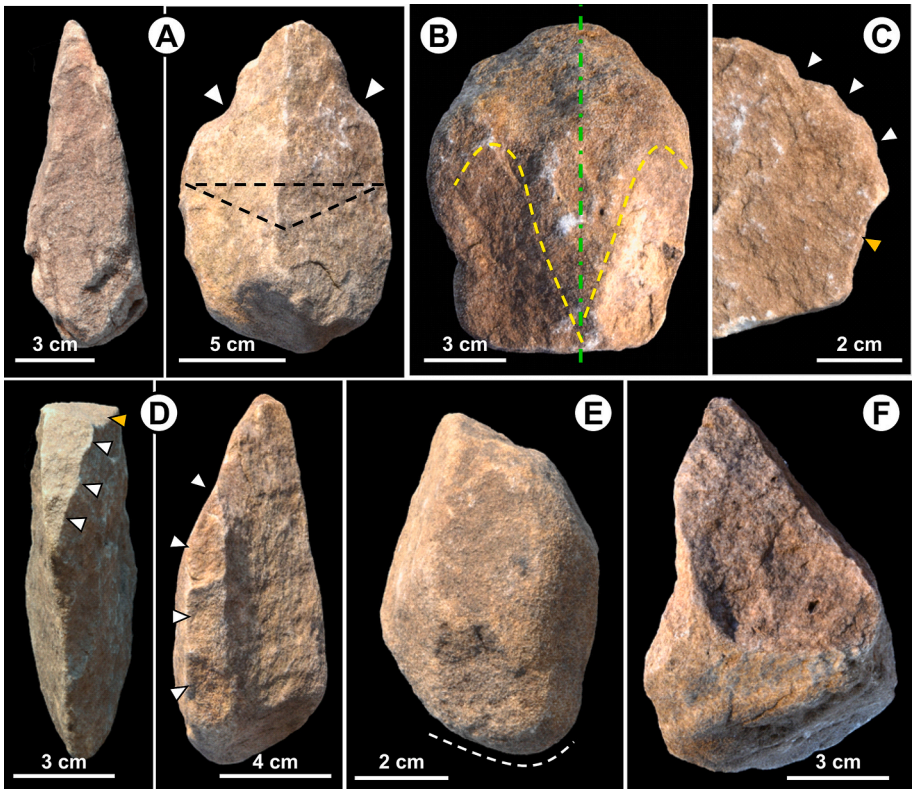

Fig. 7. Morphological characteristics of the large quartzitic sandstone fragments. (A) Acute trihedral-shaped clast. (B) Symmetrical plane on clast. (C) Regularly spaced 'splinter' negatives. (D) Multi-faced clast. (E) Rounded blunt end on a single edge. (F) Four-sided pyramidal tip on clast.

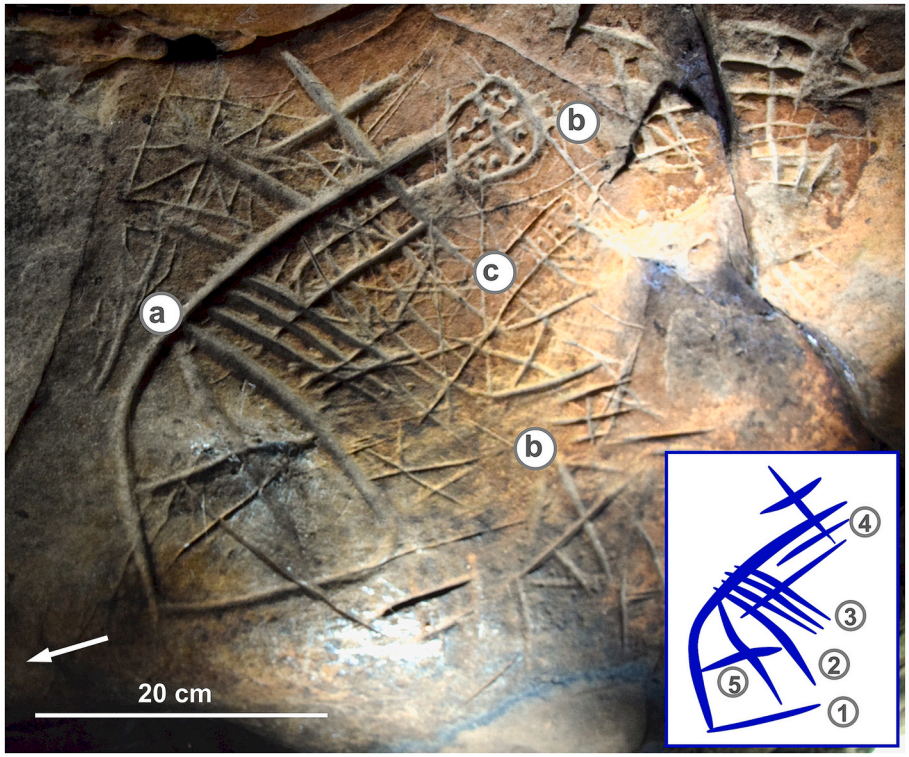

Fig. 8. Engraved panel to the right of the annular structure. The composition of 'neat' and deep furrows 'points' towards the annular structure (arrow). Styles of engravings: (a) neat deep grooves, (b) clumsy engravings, (c) superficial furrows. Insert shows the sketch of the deep furrows and numbers refer to interpretation made later in the text: (1) released glans, (2) balano preputial furrow, (3) folds of the foreskin, (4) dorsal vein, (5) scarification?

feature in Fig. 8) is less neatly executed.

Superficial furrows making geometric figures or simple curvilinear lines are more numerous than deep furrows (Fig. 8). They fill the spaces around the deeply grooved composition and are most densely seen on upper part of the panel where the sandstone is not as hard. They appear to cut through the deep grooves and intuitively would post-date them. The paucity of engravings away from the carved panel is due to a lack of flat surfaces and engravable friable cortex. The hard quartzitic sandstone protrusions hardly supports a single engraving.

Amongst the 'clumsy' engravings are several motifs formed of convergent grooves or chevrons and some that are crossed by one or two grooves. This grouping of engravings was not specifically distinguished by Cantin (2022) among the typical Fontainebleau motifs engraved by the last hunters at Mesolithic rock art sites. The most remarkable of these motifs are engraved directly onto the outer crown of the annular structure: one at the base of the structure, directly on the meridian line (Fig. 9A), and two others close to the meridian line at the top of the crown but on its inner face, hidden from a frontal view (Fig. 9B). Three similar motifs have been engraved on a bulge of the roof vault to the left of the annular structure and point to it (Fig. 9C). Two of them are crossed by a transverse groove: one of them is less well marked and the only engraving on a hard quartzitic sandstone protrusion. This body is surrounded by small flaking scars that, by their location on the vault, are likely to be intentional percussions using a hard, pointed and heavy tool.

Circle figures are rare to very rare amongst the Fontainebleau Sandstone Mesolithic engravings (Cantin, 2022). To the left of the annular structure, a circle 10 cm in diameter with a reticulated pattern composed of three almost parallel furrows crossed at right angles by two others is engraved at the base of the vault (Fig. 9D). Two of the three furrows converge and override the circle. The two perpendicular grooves are rounded against the inner edge of the circle on one side but go beyond the opposite side where they are crossed by another furrow that closes them. This inner pattern recalls the crossed convergent grooves described earlier (Fig. 9C) where two pairs of converging grooves point to the annular structure. To the right of the annular structure, the upper right-hand corner of the large panel (Fig. 8) shows three more or less complete circles associated with cupules hollowed out by the oscillation of a tool (Fig. 9E). The most complete circle is slightly smaller (5 cm in diameter) than the previously described reticulated circle: it has an irregular outline, divided by two crossing furrows, and is punctuated by 11 cupules. A second circle nearby (bottom of Fig. 9E) is punctuated by small cupules and less indented. A nearby third circle is crossed by somewhat disordered furrows. Some cupules indented on the panel occur outside the circles. It must be emphasized that if the circles and the overall medium sized carvings appear to be clumsily drawn, they were carved, mostly on the ceiling, whilst the carver would have

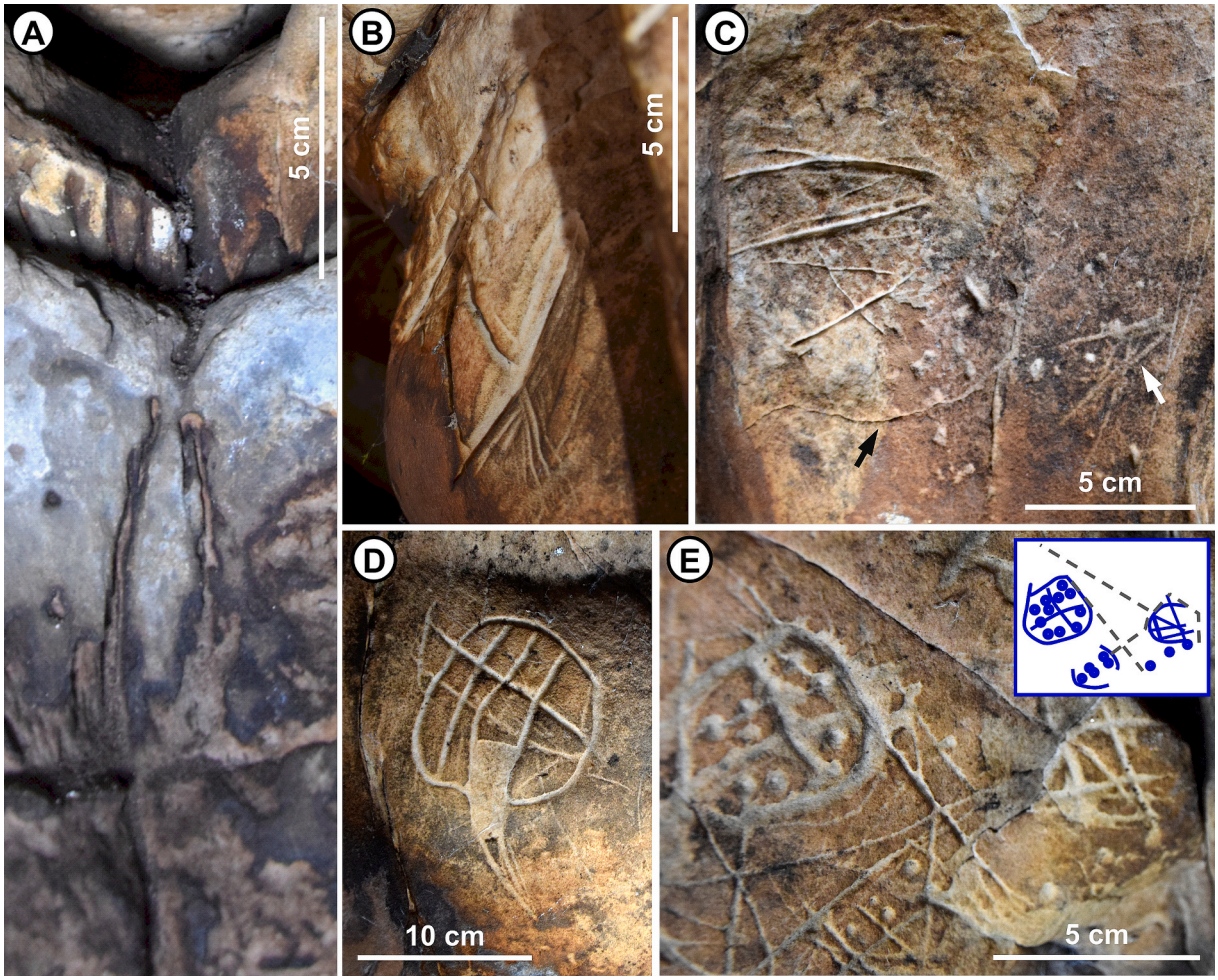

Fig. 9. 'Clumsy' carvings. (A) Converging furrows at the base of the annular structure. (B) Two deep composite furrows at the top of the annular structure and on the inner rim of the outer ring. (C) Three converging furrows on the roof vault to the left of the annular structure. The slightly marked sign on the right (white arrow) is engraved on a hard quartzitic sandstone. The arc of circle (black arrow) is not an engraving but a fine crack. Note that 5 of the 6 patterns are crossed by one or more transverse grooves. (D) Circle with two pairs of converging grooves overriding the contour (see location on Fig. 4). (E) Deeply engraved and partitioned circle with distinctive cupules (left); less precise circle with small cupules (bottom centre); third circle, more deeply engraved, without cupules (right); some isolated cupules (lower right) – see locations on Fig. 8. Dashed lines in the schematic insert show natural primary fractures.

been in a folded position. All motifs except the three described circles tend to point towards the annular structure.

5.4. Hydrology of the megaclast and shelter

The thick black crusts over the base of the annular structure in the LFO 1 shelter are alterations and fungi developed as a result of periodic flooding of the depression in front it and the adjacent recess (Fig. 10A). Water inflows follow rain events and are related to a rise in the water level in the hole on top of the LFO 1 megaclast (see Supplementary file#2 for details). This observation led us to undertake percolation tests after first emptying the hole during archaeological excavations. The infiltrated volumes versus time explain the hydrological behaviour of the hole, as follows:

- the quartzitic sandstone forming the lower portion of the hole, below the spillover level, is quite impermeable and experiences very low infiltration into its surrounds;
- flow rates through the fracture slot on top of the megaclast and through its intersection with the wall of the hole (6 cm below the top) are similar; and
- seepages start at the annular structure about two days after a water supply of about 35 L (less than two buckets of water per day) is added to the hole in the top of the megaclast.

The fracture slot at top of the megaclast channels surface water towards the annular structure in the shelter via the hole in the top of the megaclast (Fig. 10B): the height of water in the hole actually controls the hydrology. Two flow regimes are predictable:

- with a low water level in the hole, infiltration into the quartzitic sandstone is slow and seepage water passes below the shelter cavity;
- with a high water level in the hole, around 30 cm higher than in (1), infiltration into the sandstone is supplemented by water supply via the fracture slot and seepage flows into the shelter.

Experiments show the importance of the fracture slot in the top of the megaclast and its extension in the hole. This is probably why the wall of the hole was reworked by removal of sandstone in the vicinity of the slot, and the slot was possibly widened. On the top of LFO1 the slot begins to drain water into the megaclast as soon as it rains and the excess water feeds into the hole. When the rain stops, water in the hole continues to feed the slot long enough to reach the ring structure. This process clarifies the role of rock clasts and earth filling the hole: they effectively reduce the volume of the hole and facilitate a faster rate of filling to the level of the slot. In a similar way, the sediment and rock fill in the depression in the floor of the shelter cavity has the function of reducing volume to facilitate faster flooding of the cavity. One should not be misled by an apparent rudimentary filling using impermeable rock clasts: it is significantly more effective in reducing volume than just earth or clay that has a certain permeability and tendency to crack when dried out. This hydraulic arrangement reveals an important technical achievement.

It is difficult to imagine that the nearby LFO 2 megaclast and its hole is wholly independent of the setting of the LFO 1 shelter, although we have no evidence of this. One possibility is that it served as an additional 'water tank' to supply outflow on demand to the annular structure at a particular time or for a particular period. For example, the volume of the hole in LFO 2 is equivalent to about ten buckets of water, while four buckets of water in the hole in LFO 1 are sufficient to trigger flow.

6. Interpretations

It is of note that a sexual interpretation of the annular structure in the LFO 1 shelter cavity is spontaneously imposed on all visitors and so we adopted this perspective to make a direct analysis of the sexual figuration. We considered all perspectives that could contribute to ideas about the feature, in particular what it might have meant to the women and men who frequented it, their cultural practices and their thoughts on life. A comparison with the feminine sexual installation with a vulvar flow in the Ségognole 3 shelter in Noisy-sur-Ecole is essential and leads directly to questions about its age.

6.1. Dating

Determining an age for the features in the LFO 1 shelter cavity is the classical 'sticking point' for interpreting rupestrian sites in general. The strongest arguments for dating rupestrian panels come from dating deposits that rest on decorated walls, for example in open rock art sites located in valleys where there are related archaeological horizons, such as sites in the Coa Valley in Portugal (Aubry and Luís, 2012; Aubry et al., 2025) and the famous sites of SW France, including the Roc-aux-Sorciers (Iakovleva and Pinçon, 1997) and Cap-Blanc (Bourdier et al., 2010) sites. The shelters in the Fontainebleau sandstone megaclasts are quite the opposite. They are in lag deposits resulting from the erosion of sandy slopes and do not have correlative deposits. Thus, among the 2000 shelters recognized with geometric engravings attributed to the Mesolithic, only about forty have been the subject of archaeological excavations, with little success. Only three, in the sand beneath a quartzitic sandstone pan, actually contain substantial archaeological horizons that led to the dating of these engravings (Guéret and Benard, 2017; Guéret and Cantin, 2023). The problem also exists for the sites attributed or

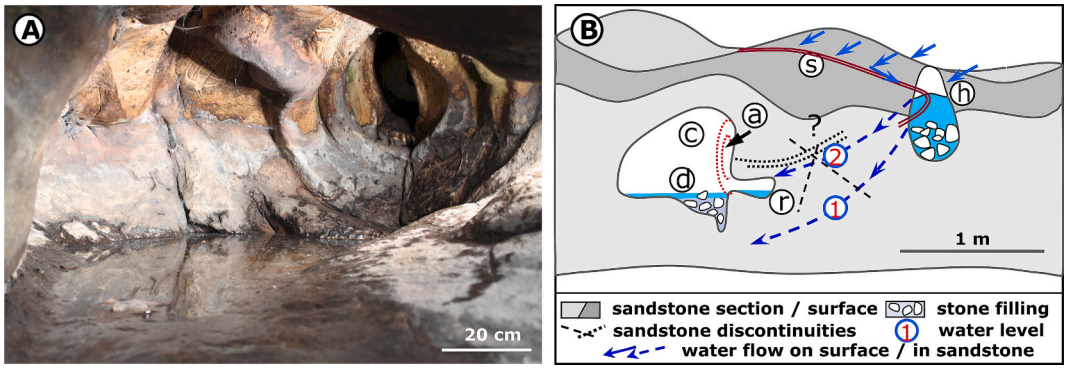

Fig. 10. (A) Flooding of the depression in front of the annular structure on 12/01/2022. Water arrived through the central opening and through the recess located slightly higher on the right (B) Schematic of the hydrogeology of the LFO 1 megaclast. Water filling the hole (h) feeds the outflows from the annular structure (a) and the recess (r) via discontinuities in the quartzitic sandstone and fills the depression (d) in front of the annular structure. Infiltration must occur at level (2), near the top of the hole, to reach the annular structure; seepage into the sandstone via a lower level (1), about 20 cm below the top of the hole, does not reach the fracture slot conducting water to the annular structure. (s) – slot; (c) – cavity.

presumed to be Paleolithic. Four test pits in front of the entrance of La Ségognole 3 shelter and around its perimeter, dug to about 1 m depth, yielded only a few pottery shards attributed to the Late Middle Ages (Nelh, 1983). Similarly, preliminary diggings at the LFO 1 site at Courdimanche provided only archaeological clues that the holes in the megaclasts had been obviously filled by humans. The hole and cavity infills in LFO 1 and the hole infills in LFO 2b did not yield any flint artifacts or other stratigraphic value: only 28 fist-sized quartzitic sandstone clasts, the unnatural shapes of which probably result from human intervention.

The difficulty of having stratigraphic references should not prevent the development of hypotheses and for this it is necessary to 'break' with the usual paradigms and try to reason using a variety of analytical approaches likely to provide substance and strength.

The hydraulic workings of La Ségognole 3 in Noisy-sur-Ecole and Les Fonds LFO 1 in Courdimanche-sur-Essonne can be considered twins. The correlation is supported by the similar engineering and other techniques used in both hydraulic installations. This has never been described, neither in the Palaeolithic, the Mesolithic, nor in more recent times or, to our knowledge, in ethnographic studies. That a second similar hydraulic arrangement has been discovered is both unexpected and exceptional. Moreover, the combination of the hydraulic staging with a sexual figuration in both sites is even more exceptional. The two staged sexual occurrences overlap spatially in the middle of the 'vast' European rupestrian world. The probability that this spatial proximity is chance is infinitesimally small. How could these two installations have nothing to do with each other? How could techniques, unique to this day, have been implemented at different times and in such close proximity?

Using the similarity of shelter arrangements as an argument for making correlations can be compared to using flint knapping techniques, or styles of painting and engraving, as elements of correlation. The establishment of relationships between common characteristics has been the basis of all correlations accepted in the so-called "natural" sciences: botany, zoology, medicine, geology and even archaeology. In our case, it is the uniqueness and specificity of the staging of water flows which is used as a correlation element, like the uniqueness and specificity of a fossil in stratigraphy. For us, all these convergent elements between the two nearby installations cannot be due to the chance of space and time. The two hydraulic installations can only be linked.

The hydraulic works around a female sexual representation are likely to correspond to a cultural expression. The cultural relationship that binds them is at least as strong as those that exist between the different Palaeolithic caves, or the graphic relationships taken as references for chrono-cultural correlations. In this context, would the images of two horses, one painted in Lascaux and the other engraved in La Ségognole, nearly 400 km away, create a stronger connection between these places than the setting up of a hydraulic installation linked to a feminine sexual figuration in two shelters 10 km apart? If there is a lack of reference it is because this kind of installation has never been described before. What if 5 or 6 similar installations were known? There is a forceful presumption that a cultural link exists between the two sites. The issue of a cultural relationship is a systemic approach, considering that 'culture' composed of multiple links forming the cohesion of a group would express tendencies greater than the sum of internal mechanisms such as lithic artifacts, rock art or movable art, and ornaments. (Deetz, 1971; Sinitsyn, 2007; Barton and Clark, 2021). We suggest that the LFO 1 shelter in Courdimanche is therefore the same age as the La Ségognole 3 shelter in Noisy-sur-Ecole, the latter being attributed to the Magdalenian by the style of the horse engraving that accompanies it (Bénard, 2010; Guy, 2017; Petrognani, 2018).

6.2. Shelter cavity with sexual depictions

Entering the cavity by crawling on one's back by necessity is a striking experience. The initial views are of the engravings on the vault and then, on the left, the monumental annular structure about 60 cm in diameter, a dominating feature, is a dizzying sight. With no view to the outside, the visitor is completely disoriented and gains an impression of being crushed by the structure towering over him. It appears above, whereas it was expected to be it in front of the visitor, based on a preliminary impression from outside the shelter. After several entries it is possible to gain your bearings but entering the shelter cavity after a year or so provokes the same shock as the first visit. The destabilization of the visitor seems to be due to the absence of any reference to the horizontal and vertical. The sexual figure appears at almost a 45° angle instead of vertical and the disorientation generates a condition akin to seasickness with palpitations of anxiety. Some visitors have been completely panicked and leave immediately.

The central structure of the cavity immediately evokes female sex, and this perception implicitly places the 'spectator' in front of the sex. The three superimposed quartzitic sandstone crowns are the large and small lips and the entrance to the vagina: it is an open vulva that narrows inwards. It is a figure in 3D, very different to the common 2D feminine sexual representations that include mainly engraved pelvic triangles or vulvar ovals. Graphically, it can be compared to the engraving in the corridor of La Cavaille cave (Couze-et-Saint-Front) the decoration of which is centred on a large vulvar image (about 60 cm in diameter, like that of the LFO 1 shelter). It is a roughly complete circle, including a circle notched by a linear invagination surrounded by two arcs, and is estimated to have been made at the very beginning of the Upper Palaeolithic (Delluc and Delluc, 2009).

An intuitive reading of the central protuberance is to imagine it is motherhood with the central protuberance being the head of the baby soon to emerge and the recess perceived as the anal orifice. Besides, if a female connotation is attributed to the cavity, as has often been suggested in Upper Palaeolithic European rock art (Leroi-Gourhan, 1965; Jung, 1972; Testart, 2016), the visitor would be curled up in a foetal position in a woman's womb. In this situation, the visitor would face vaginal intercourse with the protuberance in the centre of the ring structure depicting a phallus. There is no reason to eliminate this conjecture a priori, although coitus representations are rare in the Palaeolithic, with only three indisputable carved figures: one in Enlène, France (Bégouën et al., 1982) and two in Spain, in Riba de Saelices and Foz Coa (Angulo and Garcia-Diez, 2009). Whatever the interpretation, it is the intrinsic image that gives it strength. By its sheer size and proximity, it imposes itself on the visitor and dominates. Beyond that, we will never access the mythology, sanctity or stories transmitted by the culture of the people who attended this shelter cavity. The bass sounds amplified by the echo in the cavity de-personalize the visitor to the point of thinking that they are emitted by the shelter itself. Perhaps the hammering noticed on the vault was intended to produce sound effects?

6.3. Engravings

Despite the plethora of engravings on the panel, the wide and deep grooves are distinctive. Their arrangement suggests an oversized penis, about 35 cm long on which one may distinguish (Fig. 9): (1) the released glans, (2) the balano preputial furrow represented by a major groove, (3) the folds of the foreskin represented by three folds thrown back, and (4) two furrows in the lengthening of the penis likened to the dorsal vein. The characteristics of the erection are unambiguously marked. In addition, the size of the sex and its rigidity are consistent with proximity to the gigantic open vulva which is the determining element of the shelter. The two crosses engraved by deep grooves are of note. That on the upper part of the panel, rectilinear and at right angles, is undoubtedly independent of the anatomy. On the other hand, the two slightly curved furrows that bar the glans actually follow a depression of the panel: they are not at straight angles, appear to be an integral part of the glans and are fully contained within it (number 5 in Fig. 8). They may suggest scarification, like those known in Palaeolithic rupestrian and portable art through Europe (Angulo et al., 2011). Likewise, the lines on the preputial foreskin may possibly be interpreted as circumcision scars.

There are questions about the non-closing of the lower part of the phallic figuration. Mirroring the possible scarification suggested above, we speculate that this 'opening' corresponds to a subincision, a traditional practice of some Aboriginal tribes in Australia. Finally, the alleged phallic engraving explicitly points to the centre of female sexual morphology. It is noteworthy that it is on the ceiling, hidden from view from outside the shelter: one has to enter the 'uterine' cavity to see it.

The oval representation at the base of the annular structure undoubtedly evokes a vulva engraved in the exact alignment of the small indentation fitted out for water flow during saturation periods (Fig. 4A, 9A). The two discoid forms, deepened by several grooves on top of the external aureole of the feminine sexual morphology, strongly denote a vulvar interpretation (Fig. 9B). Finally, the isolated convergent furrows (Fig. 9C) linked to a partitioned circle (Fig. 9D) are less explicit, but in the context of this emblematic feminine sexual morphology, it seems reasonable to relate them to vulvar figurations. The transverse line often associated with these figurations is more problematic to translate. It is noteworthy that all these convergences point to the annular morphology. The three circles with associated cupules engraved with some skill (Fig. 9E), are more difficult to interpret. The simplest hypothesis is that they symbolize the annular sexual morphology and that other meanings are grafted onto this.

While male sexual representations are numerous in Upper Paleolithic figurative portable art (frequency of the carved tips of the bâtons percés), they are much less numerous in parietal art and are much rarer than parietal female sexual images (Delluc and Delluc, 2009). There are at whole only a dozen phalli cited (Clottes et al., 2005; Delluc and Delluc, 2009; Bégouën and Bégouën, 2013; Lorblanchet, 2020) compared to some 200 carved pubic triangles or split ovals in Palaeolithic caves just for France (Duhard et al., 2014). Phalli are often very large and isolated from any adjacent animal figuration. For example, a very large phallus is engraved on the ceiling in a maze of lines in Pech Merle cave (Lorblanchet, 2020), the human in Saint-Cirq with a penis as long as his limb (Angulo and Gracia-Diez, 2009), an oversized phallus with precise anatomical details engraved in the Trois Frères cave (Bégouën and Bégouën, 2013), and near the Tito Bustillo cave, famous for its numerous vulvar figurations, the La Lloseta cave shows a high and strong phallic stalagmite painted in red, isolated in the background of a gallery whose oval outline evokes a vulvar shape (de Balbín Behrmann et al., 2022, p. 296). Apparently vulvar and phallic images are often clearly associated. The outsized phallus of the Trois Frères cave is engraved just above a concavity evoking an even larger vulva (Bégouën and Bégouën, 2013). In the Fronsac cave, each of the two decorated galleries has a phallus engraved in a remarkable position (Delluc and Delluc, 1996): in the Women's gallery, a phallus is confronted with a trifid vulvar image and in the Animals gallery, the composition of the right wall is centred on a large (40 cm long), realistic phallus, with the balano-preputial groove striated by the folds of an uncircumcised foreskin, associated with two circular images evoking female sexual images. The Tito-Bustillo cave in Asturias shows a triangular stalactite ridge on which is drawn in red on one side an anthropomorphic figure with a penis of considerable size and a well-marked glans and on the other side a female figure with possibly small breasts, a vulva and a leg. This very suggestive association makes it possible to depict a sexual act (de Balbín Behrmann et al., 2002).

Unlike female sexual images, which are often multiple, even forming friezes, phallic representations are always isolated on each panel (Delluc and Delluc, 2009; Testart, 2016). It should be noted that the earliest known sexed anthropomorphic representation is a phallus-like pendant found in a 42,000 ca.-year-old Upper Paleolithic archaeological layer at the open-air site in Mongolia (Rigaud et al., 2023). It predates the earliest known sexed anthropomorphic representation in western Europe, where decorative purposes of the phallus only became fashionable, especially in France, in the upper Magdalenian period (Angulo et al., 2011). The social role of phallic symbols have been discussed in terms of group of identity and cohesion, emergence of social complexity and materialized symbolic thought on gender relations and sexuality (Kuijt and Chesson, 2007; Angulo and García-Díez, 2009; Rigaud et al., 2023). In this context, the phallic representation in the LFO 1 cavity in Courdimanche is as remarkable as the adjacent feminine sexual morphology.

6.4. *Hydrology*

The hydrologic arrangements in the La Ségognole and Courdimanche shelters were surely support for tales of extraordinary adventures and myths. Myths tell the World through stories and give meaning to reality as well as encouragement to stand up and live (d'Huy and Le Quellec, 2023). To transmit these truths, the amazing adventures of the myths are re-enacted by rites that unite a group around these stories. This is where we must seek the deep meaning of the arrangements behind the images and try to avoid projecting our own myths onto it. The water flows linked to the sexual figurations of La Ségognole and Courdimanche, as well as those of the miniature model of waterways in the La Ségognole shelter, have specific and primordial meaning because arrangements have been made to promote it and even control it. At least two points of view should be considered: firstly, water is the common thread between the different arrangements and carries symbols, myths and stories; and secondly, the sculptural figurations are meaningful narrative elements for which the water is an adjunct to stage the story. It is likely that the two points of view interact and complement each other. By way of context, it is of note that in the cold environments of the Magdalenian the shelters within the sandstone blocks were surely frozen and probably invaded by snow and ice for a large part of the year, during which time the hydraulic installations would have been inoperative.

Water, a primordial and essential element for life, occupies a central place in myths and cosmogonies. Its omnipresent presence in the world, and its ability to give life and destroy it, make it a primordial element, often associated with the creation and origin of the world. As a symbol of life and fertility, water is often associated with the cycles of nature. Rain nourishes lands and rivers.

In the context of the possible symbols of water in hunter-gatherer populations in the Upper Paleolithic, climate variability and human adaptation have to be considered. Several harmful effects of water may have affected hunter-gatherer populations by creating existential emergencies for them. Two dangers may be considered: the absence of water during lengthy periods of dry and cold weather, with frozen soils and rivers preventing access to water; or excess water, with sudden and catastrophic floods that wash away dwellings, endanger young individuals and disrupt and divert the migration routes of game. Snowstorms could also be included in the natural disasters that Paleolithic populations suffered. Thus, myths and rites devoted to these disasters could have been promulgated by the two hydraulic installations at La Ségognole and Courdimanche.

The female sexual figures from which water flows also carry symbols. The female sexual representations of Upper Paleolithic parietal art and the numerous 'Venuses' in portable art from the same period probably carry fertility symbols and relate to economic, social and reproductive roles of Palaeolithic women. Various consonances have been attached to this notion of fertility, depending on the interpretations and the social inclinations at the time of their interpretation. For example, fertility has been related to motherhood, attractiveness, and the central role of women in ancient societies at the end of the 20th and beginning of the 21st century (Rice, 1981; Cohen, 2003; Patou-Mathis, 2011; Dixson and Dixson, 2011), and even to health and obesity as an ideal in harsh survival conditions in glacial environments (Johnson et al., 2021).

In addition, there is a power in the superposition of symbols. Water, primordial and essential for life, sourced in the sandstone as a spring from the earth, and female fertility, represent not only human motherhood, but also fertility of the whole plant and animal environment and probably nature in general.

As the depression at the front of the annular structure was filled and

waterproofed, and a drainage gutter installed at the entrance to the cavity (Fig. 6A), then flooding of the cavity and its outward flow had a special meaning or even a power. From this perspective, it is possible that rainwater was part of this special meaning and that modifications to the hole in the top of LFO 2 would have been made to provide a rainwater reserve to operate the hydraulic installation. This may seem complicated, but one might speculate that the rite linked to sexual representation expressly required that rainwater fed the installation. Why? Water from the skies (rainwater) may have carried virtues, symbols and myths different to those of earth waters (springs or rivers), as has often been revealed by ethnographic studies of indigenous peoples. Among those, the Kanaks of New Caledonia recognize several waters: the water of stones, thunder, rain or sun, with inherent ritual properties and traditions of ownership and clan rights (Grochain, 2023). Indigenous people of the Andes valued water as vital and sacred. They associated it with the origin of the life, the blood of Mother Earth or *Pachamama* (as in the womb of a mother, as 'mother water'), sacred because it is the bosom of their *Pachamama* and gratitude towards it gives positive energy. It is thus like a person, a supernatural element (Trujillo et al., 2018). For the natives of the Amazon, earth water (a mineral spring) is a portal for the spirits and the life of the water is a sacred, essential and indispensable element for all (Munduruku and Valle, 2015).

7. New symbols in Palaeolithic rock art

If an undeniable cultural coupling exists amongst the rock art of the caves in southwest France and the Fontainebleau shelters (Fritz and Tosello, 2011), it is possible that adaptations of cultural and ritual practices occurred under the influence of the relative remoteness of the region. This may have been an adaptation to local geomorphological arrangements, like in the Côa Valley in Portugal (Zilhão et al., 1997, Aubry and Luís, 2012), in the form of 'territories' or 'symbolic territories' (Fuentes et al., 2019). From the outset, it is obvious that the structural forms of large caves with internal sequential and/or hierarchical arrangements (Leroi-Gourhan, 1965; Pastoors and Weniger, 2011; Testart, 2016; de Balbín Behrmann et al., 2017; Intxaurbe et al., 2022) could not be implemented in the cramped Fontainebleau shelters. However, visibility, light and closeness to particular landscape features or 'landmarks' are major factors often discussed when dealing with the location of Palaeolithic caves (Monney, 2012; Garcia-Moreno, 2013; Aubry and Luís, 2012; Fano et al., 2022). These conditions may have applied in the Fontainebleau landscapes dominated by sandstone escarpments and spurs. Nevertheless, a menhir was attached to at least two of the three Palaeolithic rock art sites known in Fontainebleau rock lag deposits (Thiry and Milnes, 2024a). Although the rock lag deposits omnipresent in these landscapes may not have been remarkable enough to mark rock art sites which must have had deep cultural significance for Late Palaeolithic hunter-gatherer societies. Their specific markings provided significance and symbols that contributed to locate and anchor stories to landscape features and thus constructed a socialized or storied landscape (Aubry and Luís, 2012; Langley, 2013, de Balbín Behrmann et al., 2022). This opens up new possibilities for studying Palaeolithic social and cultural organisation, especially in such a remote Northern region as that addressed in this study. These cultural markers may ultimately reflect inter-regional and long-distance relationships, much like the origin of 'special' siliceous raw material for tools (Delvigne et al., 2019).

The two hydraulic installations staging feminine sexual representations have not been described elsewhere and yet appear to be specific to sandstone shelters in the southern Paris area. Why? How do we explain this? Perhaps, simply, because the hydraulic characteristics of the quartzitic sandstone allow it. But it may also have been possible to arrange a similar hydrology in a karst gallery in one of the many decorated caves in southwest France. This does not appear to have been done. Nor can one call upon an opportunistic arrangement inspired by natural water inflows or simple periodic wetting, as this could also occur in karst caves and yet has not been exploited. It may be that there was a territorial cultural identity linking water to the symbol of fertility in the Fontainebleau region. In both the Ségognole 3 and Courdimanche LFO 1 shelters the role of water is not limited to staging sexual representation by a vulvar flow but water is also retained to flood the cavity. The filling of the depression in front of the sexual representation in the LFO 1 shelter was undoubtedly organized to facilitate the flooding of the cavity and to promote water flow outwards by making a dedicated spillway. A similar spillway occurs at the exit of the chamber of the Ségognole 3 shelter. The operation of the hydraulic installation leads at both sites to progressive flooding of the space in front of the feminine sexual figuration. Testing of the La Ségognole 3 installation demonstrated that 3 days after the beginning of the vulvar flow the basin at foot of the sexual figuration was flooded by 3 cm of water. Flooding makes it uncomfortable to sit in the shelters. It would have been possible to dig a drainage channel, as in other parts of the Ségognole 3 shelter. We suggest that these water dams are an integral part of the installations and probably played a role in the rituals organized in the shelters. Further interpretation is not possible, but we conclude that the arrangements relate to a primordial link between feminine sexual figuration and water, as already argued by Bahn (1978).

The similarity of the hydraulic installations making it possible to obtain a natural flow or to trigger flow on demand reveals an undeniable cultural link between the Ségognole 3 and Courdimanche LFO 1 shelters. But why twin sites 10 km apart? The two sites may not have had the same function or possibly had complementary functions. They differ in composition and size: in particular, the Ségognole 3 engraved panel is dedicated to the sexual representation of the woman's body, with not only pubis representation, but also the pubic tuft, the groin folds and the entirety framed by the enlargement of the hips and surmounted by a pregnant belly (Thiry et al., 2020). There is also the fine engraving of a horse on either side of the pubic triangle. The chamber has no other engraving and is of ample size and appearance. At least eight people can occupy the shelter with a view of the engraved panel: four sitting in the chamber in front of the panel, 4 others lying on the ramp of upper gallery that dominates the chamber (Thiry et al., 2020). On the other hand, the Coudimanche LFO 1 shelter cavity is focussed on a gigantic and wide-open sexual figuration. The cavity is cramped and at most two people can sit in it with difficulty. It has a panel engraved with deep, purposeful grooves making up a large phallus covered with imprecise, superficial engravings suggesting rapid execution, together with a few small engravings scattered on the other walls. The magnitude and decoratively spare Ségognole 3 shelter compared with the small size and plethora of engravings in the Courdimanche LFO 1 shelter may indicate different practices and distinct social frequentation, as has often been advanced in the analysis of the locations and wall compositions in caves in southwest France and Spain (Bourdier et al., 2017; Feruglio et al., 2019; Groenen and Groenen, 2019; Jouteau et al., 2020; Garate et al., 2023). The larger Ségognole 3 shelter could have been intended for community groups and rituals whereas the Courdimanche LFO 1 cavity was for a more private audience, even isolated individuals. In addition, we can't dismiss the possibility that attendance might have corresponded to a separation of men and women, with prohibition of transgression, as in some Aboriginal tribes of Australia (Ellis, 1976; Merlan, 1992; Munn, 1996). With analogy to the internal sequential and/or hierarchical organization of Palaeolithic caves, a working hypothesis might be that these small shelters fit into a structural scheme or network within the landscape.

The relevance of the superficial engravings, executed quickly and with minimal effort, scattered over the entire available space, may possibly have been more to do with having done them rather than producing an image for show (Villeneuve and Hayden, 2005). The impact marks on the ceiling may have a similar meaning: simply to produce a sound and/or possibly to correspond to a spiritual solicitation of the wall, as seen in some of the oldest traditional civilizations in the world and particularly in Australia where old initiates challenge the

spirits residing in the shelters by rhythmizing their sacred songs by hammering the walls (Lorblanchet, 2020). Likewise, the superficial grooves with confused patterns made mainly by the fast passage of a tool, or percussion marks on the roof vault, were spontaneous gestures. These gestures could have been induced by altered states of consciousness, which in this limited space could have been caused by a decrease in oxygen caused by lighting lamps. The resulting hypoxia could potentially lead to hallucinations, out-of-body experiences and thought providing connections with the cosmos, as advocated by Kedar et al. (2021). The sound ambiance, and particularly the tremendous resonance and echoes of the cavity, may have added to this strange experience.

It must still be emphasized that these stagings were surely in support of a narrative. Accordingly, a story follows an action or an event leading to a change from an earlier to a later stage (Genette, 1988, 18–19). With this perspective, the initiation of a hydraulic animation forms a transformation or transition from one state to another, implying action patterns, eventually performed by agents, which are the bases of a narrative (Skoglund et al., 2023).

On a final note, we have observed that the annular structure in the shelter is illuminated by the winter solstice sunrise (Fig. 3D). The annular structure is a natural but uncommon feature in the Fontainebleau Sandstone. To deliver a flow of water to it requires a depression that retains water and a network of cracks that direct the water to the annular structure. It may be that these three sandstone features are united here by chance. With regard to illumination, the specific solar alignment is not simply due to the shelter entrance facing east. In terms of illuminating the annular structure in the back of the shelter, two directions must be aligned: the azimuth relative to the north and the dip of this direction between the entrance and the annular structure. This may be a coincidence but the probability that all these coincidences are brought together by chance is undoubtedly very low. The orientation of the opening could, for example, have been manipulated by manoeuvring the megaclast, as we have demonstrated for the erection of megaclasts near two shelters attributed to the Upper Paleolithic (Thiry and Milnes, 2024b). However, we currently do not have any tangible arguments to support this and further archaeological investigations are clearly required.

8. Conclusions

Described for first time in the La Ségognole 3 shelter (Thiry et al., 2020), and now in the Courdimanche LFO 1 shelter, water outflow from a female sexual figuration, and specifically the creation of water flow by modification of the host rock, represents a powerful staging and a true ‘installation’ in the modern artistic sense, both functional and evolutionary. These have not been previously described. The many recorded Palaeolithic female sexual representations, engraved or in round morphologies, are all static. Those in Fontainebleau quartzitic sandstone megaclasts are dynamic, with vulvar flow occurring over the seasons and during rain episodes or arranged for specific events. This is a major difference from the many female sexual figurations that have been described previously across the ages. Moreover, differentiated filling-in of holes in quartzitic sandstone megaclasts, particularly with sandstone fragments with rounded ends or edges that indicate hammering or friction, suggest that the Courdimanche LFO 1 shelter was not only a place of passage and contemplation, but that societal activities were probably linked to it.

The combination of the two attributes (sexual representation and flow) on a single object is itself exceptional. That a second similar representation, 10 km distant from the first, has now been highlighted is unexpected and unique. The probability that this spatial conjunction occurred by chance alone is improbable and so we suggest that the two installations are connected by a specific link that they share and are contemporary. With human involvement there is, in all likelihood, a technological and spiritual cultural link. Thus, Courdimanche LFO 1 shelter can be considered the same age as that of La Ségognole 3 in Noisy-sur-Ecole which was attributed to the Magdalenian by the style of the horse engraving that is tightly associated to it (Bénard, 2010). This raises questions about the meaning of the association, and what the uniquely constructed hydrology of the shelters adds to the images, narratives and myths conveyed previously by the numerous common sexual figurations in Late Palaeolithic rupestrian rock art.

The Paris Basin region is known for its rich record of late Palaeolithic open-air occupation sites. The lithic industries of the Paris Basin are distinct in that on one hand they systematically lack certain point types that are frequently present in sites in southern France but, on the other hand, there are clear similarities with some specific features of the industries in some northern sites (Debout et al., 2012). In addition, the engraved horse with the staged feminine sexual figure in the Ségognole 3 shelter has close stylistic affinities to several Magdalenian horses from the Lascaux cave (Bénard, 2010) and a stone engraved with two horses and a composite figure showing close links with the southern provinces at the open-air Magdalenian site in Étiolles (Fritz and Tosello, 2011). These long-distance analogies with Aquitaine groups and the Belgium and Germany plains occurred in a period when the symbolic unity of the Magdalenian was apparently breaking up (Fritz and Tosello, 2011).

It is possibly the hinge position between the southern and northern provinces that sourced an emergence of new semiotics. Indeed, the dynamic installations connecting femininity and water fundamentally differ from the engraved or sculpted static representations. These unprecedented stagings of feminine sexual figurations with vulvar flow surely related to different or at least complementary femininity and life symbols. They appear at odds with ‘static’ representations and are certainly so through the symbols, conventions, meanings and myths they convey. Furthermore, these arrangements perhaps intended to communicate human elements may point to certain anthropocentrism, signifying a turning point in human relationships with the surrounding biological and mineral world. Such semiological change could be linked, for example, to changes in the socio-economic functioning of regional groups. It is of note that Aboriginal populations that were isolated on an island in Australia for about a thousand years experienced social divisions marked by the development of new, unique, and frequently monumental sites, despite vibrant inter-relations, trade and exchange (David et al., 2009; McNiven et al., 2009; Wright, 2011).

The challenge for the future is to search for other features in the Fontainebleau Sandstone shelters that might confirm this first evidence of semiological change and perhaps find clues to the regional organization of space and communication networks. Maybe there are complementarities with open-air sites that could give clues about the integration of these engraved sites into the functioning and socio-cultural organization of the hunting camps that already have shown some aspects of a territorial occupation mode (Bodu et al., 2011).

CRediT authorship contribution statement

Médard Thiry: Writing – original draft, Investigation, Conceptualization. **Anthony Milnes:** Writing – review & editing, Validation, Resources, Investigation. **Marie Nieves Liron:** Investigation, Formal analysis. **Marie-Claude Auffret:** Investigation.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at: https://doi.org/10.6084/m9.figshare.29595968.v2 and https://doi.org/10.6084/m9.figshare.29604617.v1.

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