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The chronology of human and animal presence in the decorated and sepulchral cave of Cussac (France)

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ABSTRACT

In this article, we present a first synthesis of the chronology of Cussac Cave (Dordogne, SW France). This deep cavern (1.6 km), discovered in 2000, is very well preserved (*e.g.* intact floors) and thus favorable to research, especially given its rare association of parietal art and human remains, deposited in at least three locations. The scientific team working since 2009 presents here a first diachronic reconstruction of the natural (geological, biological) and anthropogenic (cultural, spiritual) elements relevant to the sectors of the cave accessible for study.

In addition to the nuclear dating methods commonly used in karst contexts and decorated sites (U–Th and ^{14}C for speleothems, ^{14}C-AMS for organic materials, bone and charcoal), we drew upon other disciplines to determine the relative chronology of the events that occurred in the cave: geosciences (karstology, sedimentary geology, geoarchaeology), biological anthropology, paleontology, zooarchaeology, anthracology, ichnology, lithic and osseous technology, and of course, the study of parietal art. Their integrated study enabled us to define a coherent and global chronological framework.

The results confirm that bears frequented the cavity several times before any human incursions. Humans later ventured into the cave after it had already undergone several phases of karstogenesis, collapse, sedimentation, erosion and concretion formation. The nuclear methods and relative dating

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methods employed concur in favor of the hypothesis of human incursions only during the Middle Gravettian period, approximately 28–29,000 cal BP, to carry out spiritual, graphic and sepulchral activities. After the cave was abandoned by Gravettian people, some final sedimentary and biological events occurred (partial flooding, concretion formation, presence of mesofauna and microfauna, etc.), but were insufficient to significantly modify the decorated and sepulchral sanctuary. Later human frequentations (Late Glacial, Late Magdalenian, Late Neolithic) are quantitatively anecdotal and, most importantly, were limited to the cave porch and vestibular areas, which were sealed-off from the internal zone by rockfall debris and Late Glacial or Holocene concretion formations.

1. Introduction

Understanding of the chronology of human and animal presence in decorated caves is a fundamental and recurring objective in Paleolithic research. A cave of major importance, such as Cussac (Dordogne region, France), is no exception.

Stratified deposits, which can enable the establishment of a chronological framework, are rare in decorated sites attributed to the Pleistocene (*e.g.* Daleau, 1896; Passemard, 1918; Roussot, 1984; Saint-Mathurin, 1984; Aubry et al., 2014). The discovery of fragments of decorated walls in archaeological deposits, as important as they are (*e.g.* Breuil, 1929; Clottes et al., 1990), provide only a minimum age (Sacchi, 1984; Jaubert, 2008). In recently discovered and exceptionally well-preserved sites (Chauvet-Pont d'Arc, La Garma, Cussac), researchers have developed ambitious multi- and inter-disciplinary approaches with the aim of reconstructing their global history (Anonymous, 1999; Clottes, 2001; Geneste, 2005; Jaubert et al., 2012), whether in relative, absolute or chronometric (physical dating) terms.

With few exceptions, decorated caves are characterized by the sole presence of a plastic entity commonly known as "parietal art" (at least in their current state). In the most favorable cases (Clottes et al., 1997) they may be accompanied by a few sparse artifacts (when we knew what to look for) and, very rarely, long-term occupation zones (Arias Cabal et al., 2005). Cussac cave, on the other hand, is not only a decorated cave, but a sepulchral one as well (Aujoulat et al., 2001a,b, 2002). The parietal art in this cave consists only of panels of intertwined engravings, single engravings, and rare ochre or black-colored non-figurative marks. Lacking paintings with pigments containing charcoal or other organic elements that can be "directly" dated (Valladas et al., 2001a,b; Valladas et al., 2013), it is difficult to obtain an age for the art of Cussac, at least through physical dating methods. The classic method therefore consists of a thematic, technical, formal and iconographic analysis of the graphic depictions; if they can then be compared with the depictions in other dated sites, it may be possible to propose a "relative" chronology. The artifacts lying on the ground or slightly buried and thought to be contemporary with the graphic entities can contribute indirect chronological indices (*e.g.* Baffier and Girard, 1998), along with the charcoal residues lost or preserved on the walls, *e.g.* torch smears (Clottes, 1993). The presence of funerary deposits in Cussac cave provides evidence that is as rare as it is invaluable, and the question of the contemporaneity of the parietal art and the human remains was immediately raised (Aujoulat et al., 2001a,b, 2002). Finally, studies of the pedo-sedimentary processes in cave sites, especially in the entrance (and therefore sealed) areas, along with analyses of speleothems, are increasingly used to complete the chronological framework more or less established through other methods (*e.g.* Delannoy et al., 2001, 2010; Genty, 2010; Genty et al., 2004, 2005).

In this article, we present the first results of a multi- and inter-disciplinary study of the "sanctuary" cave of Cussac, remarkable for its association of monumental parietal art and mortuary or sepulchral deposits, both believed to be of Gravettian age. These elements will be replaced within the more general framework of the anterior and/or posterior presence of animals and humans in the cave.

2. Cussac Cave

2.1. Geographic context

Cussac cave (entrance: 44°82′94″N, 0°87′31″E), located in the district of Le Buisson-de-Cadouin (France), opens onto a small tributary of the Dordogne River (Fig. 1), the Bélingou, between Bergerac in the Dordogne Department (downstream) and Souillac in the Lot Department (upstream). This area to the south of the Dordogne River, like all of the Périgord region in which it is located, is situated at the north-eastern border of the Aquitaine Basin, mainly composed of Cretaceous deposits. This temperate zone of south-western Europe is subject to oceanic conditions and occupied by Mediterranean vegetation on its southern slopes. The cave (116 m asl) is hollowed into sandy, Upper Campanian limestones of the Couzé formation (C_5Cz), 30 m above the current valley bottom.

2.2. The discovery

The cave was discovered in 2000 by a group of speleologists directed by one of us (Delluc, 2000), and then authenticated by N. Aujoulat and Chr. Archambeau (Aujoulat et al., 2001a,b, 2002, 2004). Diverse work has since been undertaken in and for the cave, explored along 1.6 km, to ensure its preservation and protection: a topographic survey, installation of a secure entrance door, legal protection, and the marking and construction of a single path within the cave, the same as that taken by the discoverers (Fourment et al., 2012), in order to preserve the floors that have remained untouched since the last animal or human presence. Inside the cave there are numerous bear hibernation hollows, animal and even human prints, many bear claw marks and other various remains. The karstic massif has also been studied to delimit and understand the nature of the aquifer, as well as to determine its hydrogeological (Peyraube, 2011), climatic and environmental properties in order to understand its origin and functioning, with the ultimate goal of defining an appropriate protection zone (Fourment et al., 2012). The cave is closed to visits and reserved for scientific study only.

2.3. History of interventions

Immediately following its discovery, from the end of 2000 to the summer of 2001, the modification of the entrance of Cussac cave, coordinated by the Regional Conservation of Historic Monuments (*CRMH*) and supervised by Chr. Archambeau, consisted of flattening the entrance zone and digging a stone-

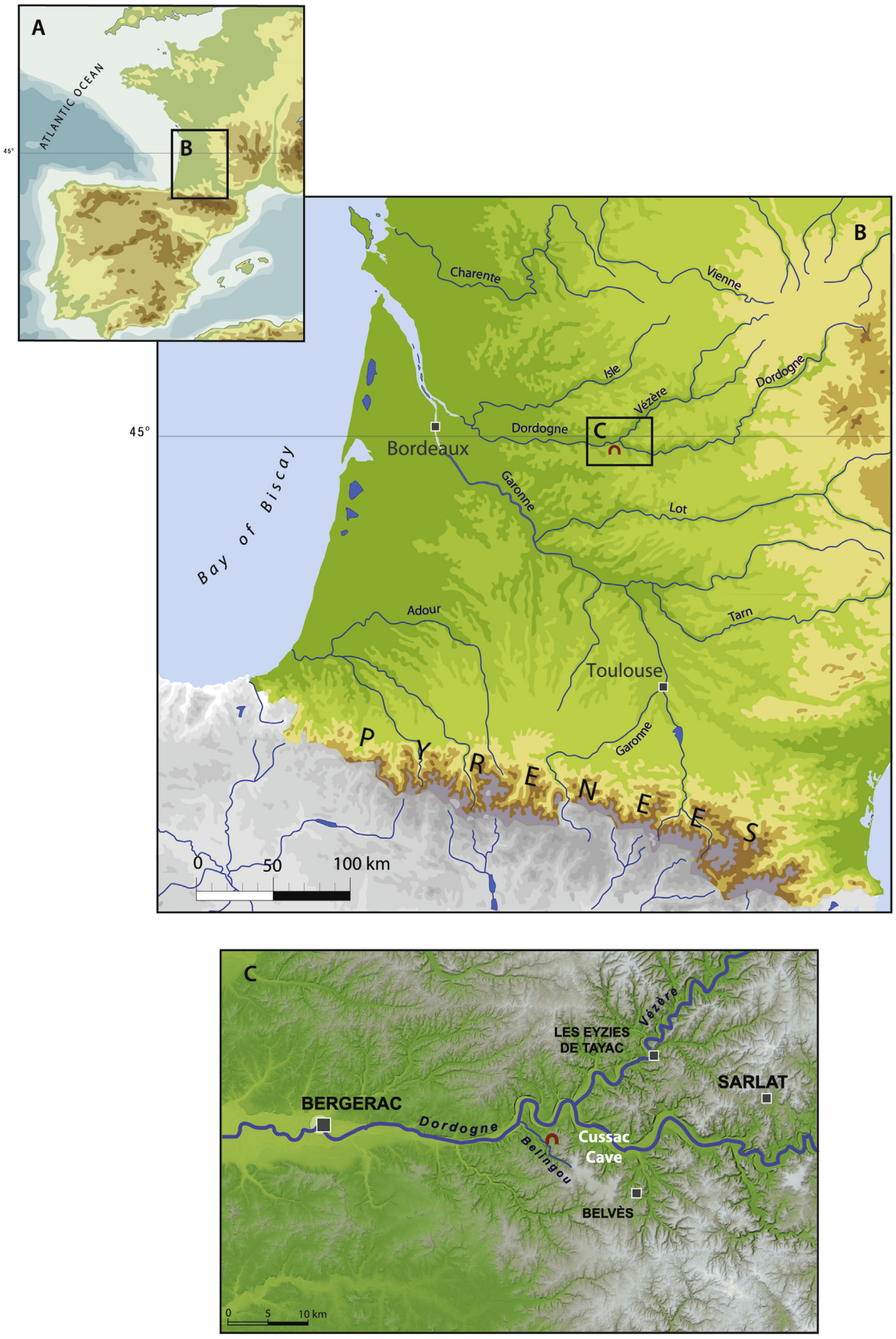

Fig. 1. Geographic location of Cussac Cave (Le Buisson-de-Cadouin, Dordogne) in south-western France.

lined tunnel through the rockfall debris that sealed-off the decorated area. P. Buraud sieved the sediments removed from the entrance zone and recovered paleontological and archaeological artifacts.

Soon after the discovery, N. Aujoulat and his collaborators were appointed by the Ministry of Culture to conduct an evaluation of the decorated part of the cave (Aujoulat et al., 2001a,b, 2002). This evaluation is summarized in a report submitted in 2005, but remains partially unpublished. In 2008, in collaboration with the Regional Services of the Ministry of Culture, and once the cave had been protected and equipped, we constituted a group of researchers to begin an initial fieldwork session (end 2009). Since 2010, this research group has grown (Jaubert et al., 2012) and we have completed two three-year programs (2010–12 and 2013–15).

After a first year of exploring the cave and refining the research project, during the first three-year program, we began a strictly non-invasive study consisting of surveying, analyses from a distance, and topographic, photographic, photogrammetric and lasergrammetric recording. During the second three-year program, we collected the first samples while continuing the non-invasive surveys and analyses. We will summarize here the methods and first results of this work, which are relevant to the relative and/or "absolute" chronology of the sedimentary and calcitic deposits, as well as the human and animal presence in the cave.

2.4. The site and its localities

The cave opens into a rock bar mid-way up the valley slope. A travertine massif is maintained by the resurgence of a stream that runs just below this entrance (Hoffmann, 1998, 2005).

The outer part of the cave is composed of porch (closed since 2001 by a barred fence) and an entrance gallery with an artificially flattened floor and cemented central path, now closed by a masoned metal door. Beyond this second door, a cemented tunnel traverses the center of the rockfall debris and opens into the endokarst through the internal talus fan. After crossing this scree, one can progress through the cave only within a single, sub-horizontal gallery (Fig. 2): to the right (Upstream Branch) along approximately 1 km, or to the left (Downstream Branch), along 0.6 km, most of the time in standing position except in a few low or narrow areas. The Upstream Branch ends with a double horizontal narrow passage and several piles of collapsed blocks or clay taluses. The Downstream Branch, the one mainly concerned by the authentication and evaluation missions, and the only one currently equipped for scientific research (up to the Grand Panel), was subdivided by N. Aujoulat into seven sectors (1–7).

Only the first segments of the Upstream Branch have been thus far been grouped into a single sector, numbered sector 8.

The morphology of Cussac Cave is very linear and follows the ancient course of an underground river with a succession of meanders, sinuous passages, and low or raised passages that sometimes cut through these meanders (Fig. 2). The meanders (M) of the Downstream Sector have been topographically mapped with great precision and given alphanumeric designations: M2-Av-RD, M3-Av-RG, M4-Av-RD and so on (*M* = Meander; *RG*: *Rive gauche*/Left bank; *RD* = *Rive droite*/Right bank; *Av* = *Aval*/Downstream) until meander M27-Av-RG. A combination of rockfalls, several shafts connecting to a lower level, an intermittent waterfall, large clay accumulations, and the ubiquitous presence of different generations of calcitic deposits, partitions or complicates the ancient natural path that it is sometimes necessary to bypass.

3. Methodology, sampling

The loci with human remains were numbered from 1 to 3: *L1*, *L2*, *L3*. *L4* designates a fourth hypothetical locus in the Grand Panel sector, beyond our reach for authentication or study.

The decorated panels, in addition to their vernacular names (ex: Panel of the Discovery, Grand Panel, etc.) were also given alphanumeric designations: Aujoulat sector number; *D* (*Droite*) or *G* (*Gauche*) for the right wall or left wall respectively, *S* (*Sol*) for ground, *V* (*Voûte*) for ceiling; followed by a continuous numeration from *1* to *n* for each graphic entity. For example: Panel of the Discovery 2D1-1 to 2D1-n.

3.1. Relative chronology

3.1.1. Karstogenesis

Once the precise topography was completed and presented in the form of an atlas in A3 format (Camus and coll., unpublished), using the conventions established for the Chauvet-Pont d'Arc cave (Delannoy et al., 2001), we synthesized the observations enabling a general reconstruction of the karst development: excavation and gradual lowering of the aquifer, identification of the collapse, erosion, sedimentation and concretioning phases. An initial diachronic scheme was thus realized (H.C.) and serves as a base for the integration of the phases of animal and human presence. This work is nonetheless preliminary and non-invasive, awaiting more detailed studies of the selected localities, supported when needed by cores, test-pits and samples.

3.1.2. Geoarchaeology

The chronological elements contributed by the geoarchaeological study concern on one hand, the entrance sector and its filling processes, and on the other, the succession of events that preceded and followed the human funerary deposits in loci LI and L2. In both cases, the approach is based on the mapping of the morpho-sedimentary units visible on the ground surfaces, thus entailing local observations integrated into the global functioning of the cave. A test-pit (1 m^2) around 1 m deep (Fig. 3) permitted an analysis of the lithostratigraphic units constituting the talus fan that obstructs the entrance and the underlying substratum. The main phases of the filling could thus be identified. For loci 1 and 2 with human remains, the mapping of the ground surfaces was accompanied by a reconstruction of the inundation levels of the gallery before and after the funerary deposits. This is based on the identification of evidence, in the field, for floods (decantation clays) and their recording on the 3D model of the sector (Fig. 4).

3.1.3. Animal presence

The marks left by passing animals, as well as their remains, are being surveyed and systematically inventoried. Currently, this work has been completed in two thirds of the Downstream Branch; the other sectors have not yet been equipped or are not accessible (Upstream Branch). Bears, represented by hibernation hollows, tracks and claw marks, were the main animal present in the cave, though we also find marks left by small carnivores, chiropters and other meso- and microfauna. In addition to the TrAcs team ("Activity Traces"), several specialists have intervened (S.C., J.-B.M., V. Laroulandie for the avifauna).

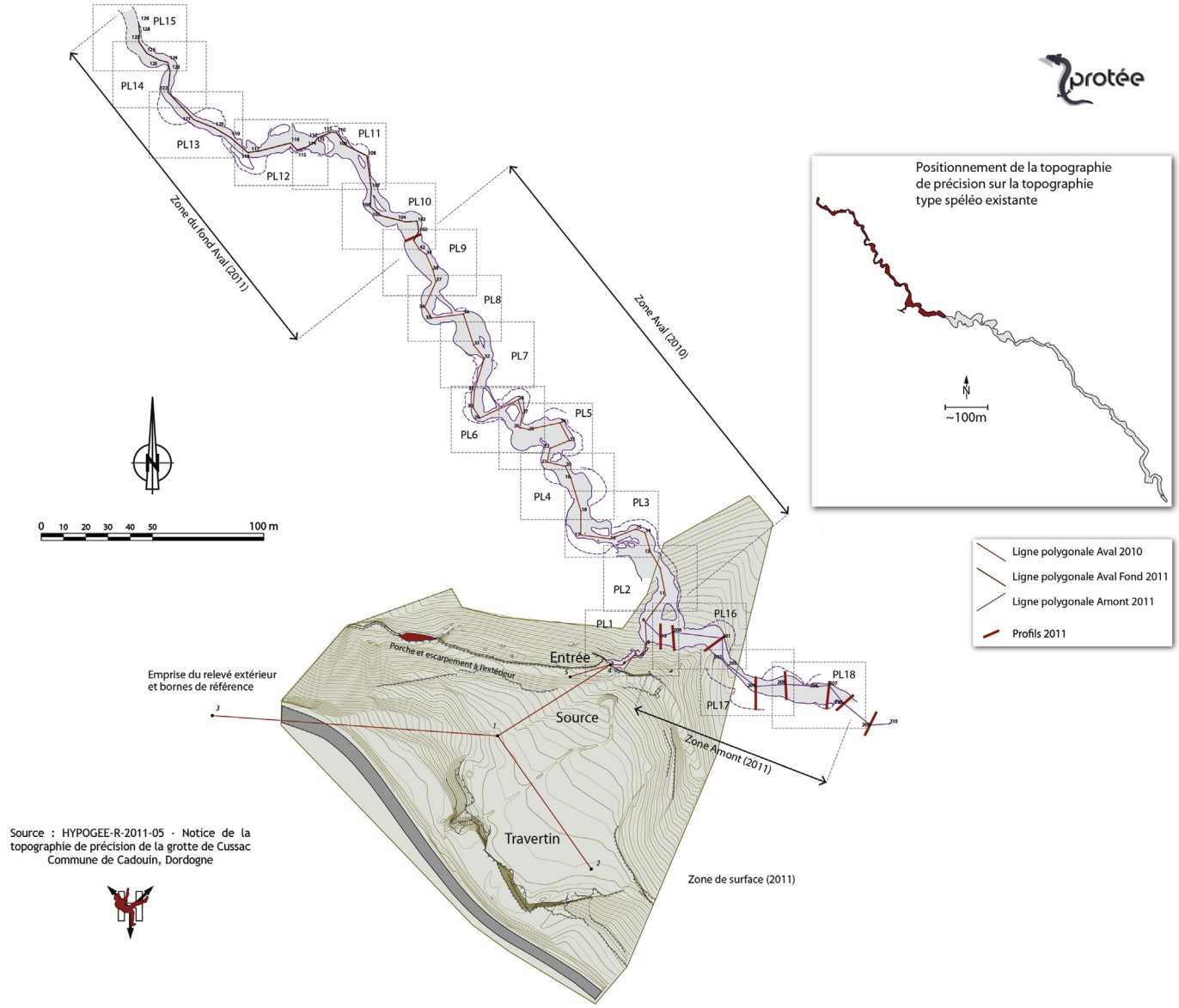

Fig. 2. Topography of Cussac Cave. (H. Camus & collaborators, Hypogée).

The animal remains collected during the construction work in 2011, or found during our section cleanings in the entrance zone and test-pit *S1*, are added to the remains recorded in the decorated chamber.

3.1.4. Human presence

Except in the entrance zone, human presence in Cussac cave is represented by: 1) parietal engravings (around thirty panels in the Downstream Branch: Figs. 2 and 7); 2) human remains (loci 1 to 3, and perhaps locus 4: Fig. 8); 3) lithic and osseous artifacts, and wood charcoal (Aujoulat et al., 2001a,b, 2002, 2004, 2013; Jaubert et al., 2012; Jaubert, 2014), and; 4) prints on the ground and various marks or signs of passing humans (Ledoux et al., in press). These two latter elements are part of what F. Rouzaud called *paleospeleology* (Rouzaud, 1978).

Once the first observations were formalized (Aujoulat et al., 2001a,b, 2002, 2004), we chose to study the parietal art using 3D tools (Jaubert et al., 2012; Aujoulat et al., 2013). It was first useful, however, to make a global assessment of the graphic depictions in the cave. We thus identified the accessible decorated zones (Downstream Branch and beginning of the Upstream Branch), and then compiled a database describing the panels and their graphic entities (EG = *entité graphique*, GRAPP, 1993) and recorded them using site GIS shared by the research team. At the same time, the testing of 3D supports being compiled led to the creation of a specific computer program that is shared on-line (Feruglio et al., 2015). The aim of this tool is to compile the observations made by parietal art specialists, archaeologists, zooarchaeologists and ichnologists, while remaining within a 3D database. The panels are analyzed conjointly by different teams and this work is in progress for the most accessible ones. Currently, this analysis mainly concerns the taphonomy of the walls (Ferrier et al., in press) and the superpositions of graphic entities. The parietal art of Cussac, even if we are currently still in the process of inventorying it in the Downstream Branch (Aujoulat et al., 2013), is sufficiently rich, representative and characteristic to merit a chrono-cultural approach including comparisons with other well-dated European sites in the Franco-Iberian region.

The human remains, after being authenticated at the time of their discovery (Aujoulat et al., 2001a,b, 2002), have been studied

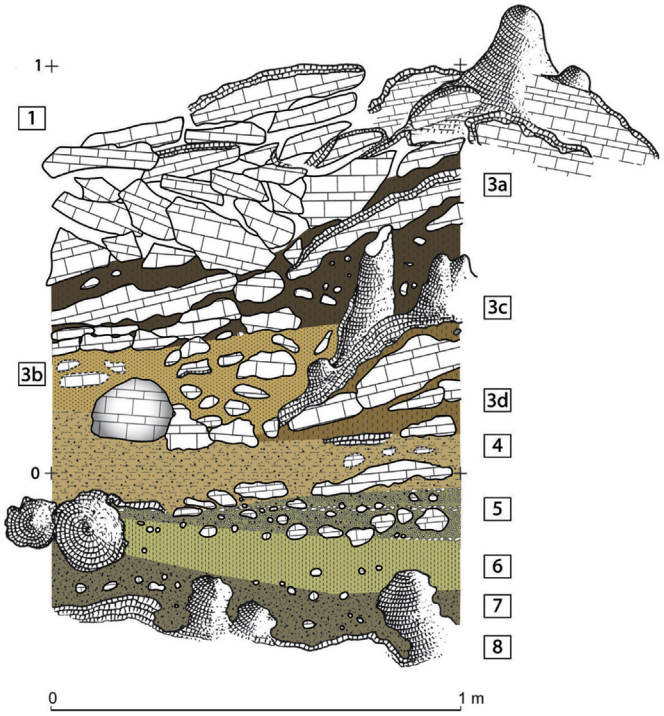

Fig. 3. Cussac Cave. Test-pit S1 in the cave entrance, at he bottom of the rockfall debris. 1, limestone slabs; 3, Sealed deposit of limestone fragments, 3a Silty clay matrix; 3b, Yellowish sandy matrix; 3c, Flowstone with stalagmites (U–Th 22,570 ± 1200 BP); 3d, Silty clay matrix with massive structure; 4, Silty grained sand; 5, Calcite fragments grading into fine sand; 6, Yellow plastic clay; 7, Yellow red brown clay; 8, flowstone with stalagmites (U–Th dates in progress). (Drawing J. Jaubert-G. Devilder). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

osseous material despite a silty coating, the subject of Locus 2 has currently provided the most complete biological information (Villotte et al., 2015a,b). Because Locus 1 contains the fragmented remains of at least two subjects, it is not immediately possible to determine its function. In the near future, the two main depressions in this locus will be the object of a multidisciplinary analysis including an archaeological exploration.

All of the sampled artifacts and remains have been recorded in a database, georeferenced, photographed, and for some, photogrammetrically recorded (P. Mora, UMS 3D-SHS, University of Bordeaux Montaigne).

The two lithic artifacts collected were studied according to the usual methods and procedures: macroscopic identification of the raw material ((S. Caux), functional usewear analysis and photography (H. Plisson), 3D replica in resin, technological analysis L.K.), and drawing (J.-M. Geneste for the laminar flake in 2001; J.J. for the blade collected in 2012: Fig. 9). A sorted lithic assemblage originating from an early excavation before the discovery of the decorated cave (Peyrony, 1950), conserved at the *Musée National de Préhistoire* under the name "*Grotte de la Truffière*" was the object of a techno-typological and raw material analysis indicating its status and age (M.L.).

For conservation reasons, after a first analysis *in situ* (Fig. 10), it was necessary to collect some osseous artifacts in 2014. A technological and usewear analysis was made of them (N.G. and A. Legrand-Pineau) at the Imagery and Optical Microscopy Service of the *Maison d'Archéologie et Ethnologie René-Ginouvès* in Nanterre (CNRS USR 3225). A stereoscopic microscope (Nikon SMZ1500) examination was realized to identify and localize the technical stigmata and usewear zones, and to measure their volume and surface (10× to 50× magnifications). A more detailed examination of the used surfaces was then realized with a reflected light microscope (Nikon ME600) at magnifications of 100× and 200×.

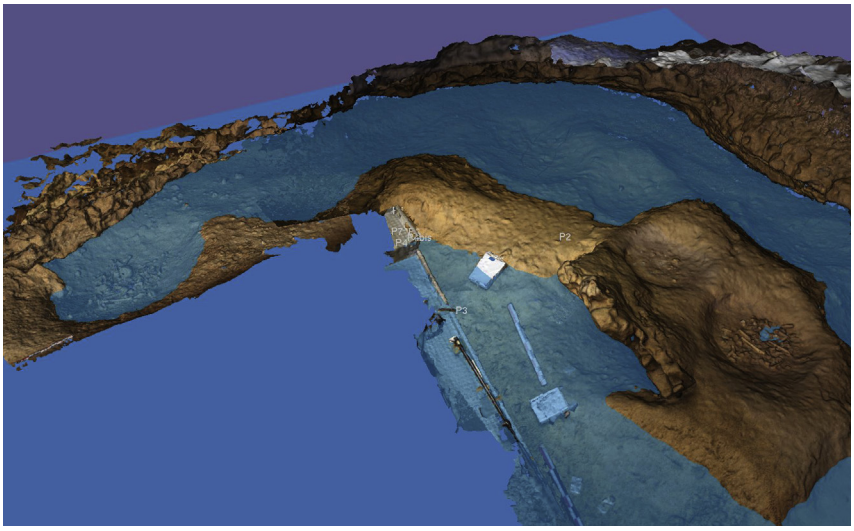

Fig. 4. Cussac Cave. Reconstruction of the flood level corresponding to the drowning of Locus 2. The hibernation hollows of Locus 1 were not flooded due to their higher position (A. Queffelec, C. Ferrier, S. Konik, B. Dutailly, P. Mora – PCR Cussac).

from a distance, photographed and photogrammetrically recorded in order to determine the nature and number of remains and the minimum number of individuals. A first evaluation of their taphonomic evolution and biological characteristics was also made (Henry-Gambier et al., 2013a,b). Due to its accessibility, the relative completeness of the skeleton and the good preservation of the

3.2. Chronometry: physical dating methods (^{14}C, U–Th)

The presence of organic remains (animal and human bones, charcoal and antler) placed or lost on the ground surface by the animals or humans that frequented the cave, offers the possibility to obtain precise ^{14}C dates. A first set of samples was collected soon

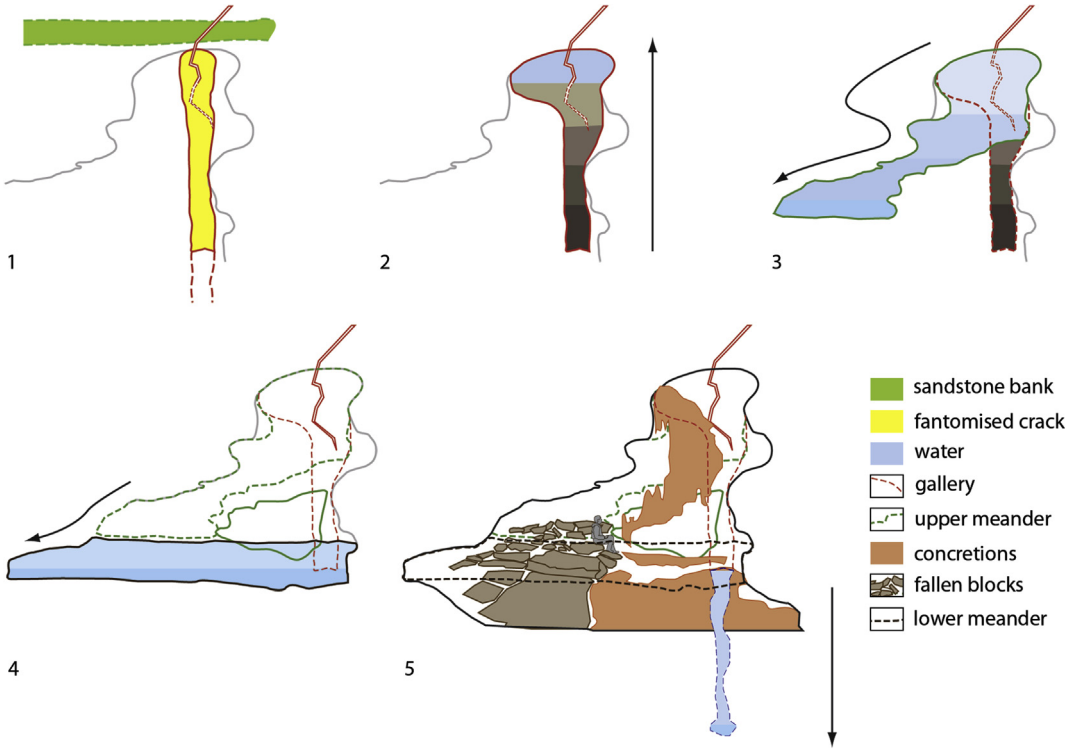

Fig. 5. The four main conduit or paleoconduit levels (+3, +2, +1, −1) identified in Cussac Cave. Cf. details of the caption in the text (drawing H. Camus).

after the discovery in order to date the human remains (Aujoulat et al., 2001a). Since the beginning of the current research project, samples have been taken only after several fieldwork sessions, once the remains have been clearly identified, recorded (photogrammetry), georeferenced and described by the team responsible for the study of the remains associated with human and animal presence in the cave, TrAcs (Ledoux et al., in press). In addition to those found on the surface by the discoverers or the TrAcs team, several remains have been fortuitously discovered under a thin film of sediment, such as during the field seasons dedicated to 3D laser recording.

3.2.1. Bones

When animal bones were discovered, the paleontologists and zooarchaeologists (S.C., J.-B.M.) inventoried, described and photographed them. For the only bone currently collected, an additional photogrammetric recording was realized as well.

3.2.2. Charcoal

The wood charcoal on the walls has not yet been sampled and only one charcoal has been identified on the ground. This charcoal, originating from a torch spear on the wall, was collected (N.F., F.M.) and then taxonomically identified (I.T.-P.) before being dated (H.V. and coll.). The charcoal sample was studied with a reflected light microscope according to the classic observation method of examining the three anatomical surfaces of the wood. This determination prior to the dating permits a limitation or identification of potential biases that are introduced when the dated species have a very long life-span (old wood effect).

Due to the small mass of the sampled charcoal, the chemical treatment realized at the Laboratory of Climate and Environment Sciences (LSCE) was limited to a diluted hydrochloric acid (0.5 N) wash to eliminate the carbonates, followed by rinsing with distilled water (neutral PH). The sample was then oxidized in carbon dioxide, furnishing 0.48 mg of carbon. This was reduced into graphite and analyzed with the Artémis device (accelerator mass spectrometry) of the of the Laboratoire de Mesure du Carbone 14 at CEN, Saclay (Cottereau et al., 2007).

3.2.3. Speleothems

Currently, speleothems have been studied (D.G.) only in the entrance zone, and specifically the in the rockfall debris located at the entrance to the gallery after traversing the cemented tunnel extending from the exterior entrance. The first cores were taken from toppled stalagmites or stalagmites on the surface and sealing the entrance rockfall debris (Fig. 12). The realization of a test-pit in the distal part of this debris, on the decorated gallery side, permitted the identification of new formations, such as two generations of speleothems older that the superficial stalagmites (Fig. 3).

Once selected, the stalagmites covering the rockfall debris were sampled by manual collection for the most accessible ones (with a hammer), or with a diamond-core bit permitting the extraction of their base with only minor impact to the environment. Inside the test-pit, whole or decapitated stalagmites (probably during a rockfall phase) were sawed and collected for dating in the same manner. The flowstone at the bottom of the test-pit was cored.

The calcite cores were sawed and polished in order to highlight the calcite/rock contact point. Samples of 100–400 mg collected with the aid of a micro-drill were used for the analyses: after dissolution in HCl and the addition of a ^{229}Th–^{233}U–^{236}U spike, the uranium and thorium fractions were separated on U-TEVA resin following a procedure modified from Pons-Branchu et al. (2005) and Douville et al. (2010). The U and Th fractions were then analyzed simultaneously with the MC-ICPMS Thermo Neptune Plus installed at the LSCE following the procedure defined by Pons-Branchu et al., 2014b. After correction of the mass bias, hydrides, peak tailing and chemical blanks, the ages were determined by iterative calculations using the equations of Broecker (1963).

Fig. 6. Cussac Cave. Reindeer (Rangifer tarandus) metatarsal bone found on the surface of the rockfall debris, at the beginning of the Upper stream.

4. Results

4.1. The decorated and sepulchral cave: relative chronology

4.1.1. Karstogenesis

The map of the cave (Fig. 2) and the distribution of surrounding karstic elements show a structural system of underground meander cutoffs (Nicod, 1997; Mocochain et al., 2010). This morphology is the result of successive hydrogeological cutoffs with each phase of valley downcutting. In the cave, four main conduit or paleoconduit levels have been identified (+3, +2, +1, −1) (Fig. 5):

- **Level +3**: a network of conduits and ceiling channels following the fracturation grid in the dominant direction of the N150° fault line (Aujoulat et al., 2001a,b). This fracturation grid was dug by the flows exploiting ghostrock weathering (alteration) network. These channels constitute the upper part of a canyon-shaped gallery, which sometimes occupies all of the visible height of the conduit. The canyon-shaped cross-section was formed by a gradual sedimentary infilling and subsequent erosion of the ceiling by rising waters, corresponding to a paragenetic canyon dynamic (Renault, 1970).
- Between the high parts of Level +3 and the inaccessible the lower level, Level −1, this polygenetic system is characterized by meandering underground river morphologies. During the process of meander downcutting, the lower levels escaped the confines of the fracturation grid. We distinguish two superimposed levels:
  - o **Level +2**: the upper level of meanders, which constitute the ceiling of the meanders and more generally, the galleries that deviate from the axis of the upper conduits.
  - o **Level +1**: the lower level of meanders, which often corresponds to the level in which we currently are currently working and its lowered extensions in the meander convexities, as well as incisions and collapses at the base of the wall, forming the overhanging levels (Level +1) and the undercut level (Level 0).
- **Level -1**: an overdeepened network underneath the level in which we usually work (+1); like Level +3, it is guided by the fracturation grid and water still contains circulation water. It displays phases of water logging and extravasation, which led to the flooding of the gallery (*infra*).

Detailed topographic observations enable a reconstruction of the structural history of the speleogenetic system of Cussac Cave, characterized by meander cutoffs. After the retreat of the underground river contemporary with the downcutting of these meander cutoffs, the cave underwent several phases of evolution, displayed in the associated sedimentary deposits and morphologies. The analysis of these deposits permitted the identification of the following main sedimentary units:

- allochthonous fluvial deposits (mixed alterites): we observe these deposits in the lower part of the paragenetic canyon corresponding to the formation of the ceiling channel +3, in the incisions cut by the river into the ceiling channel or as subsisting

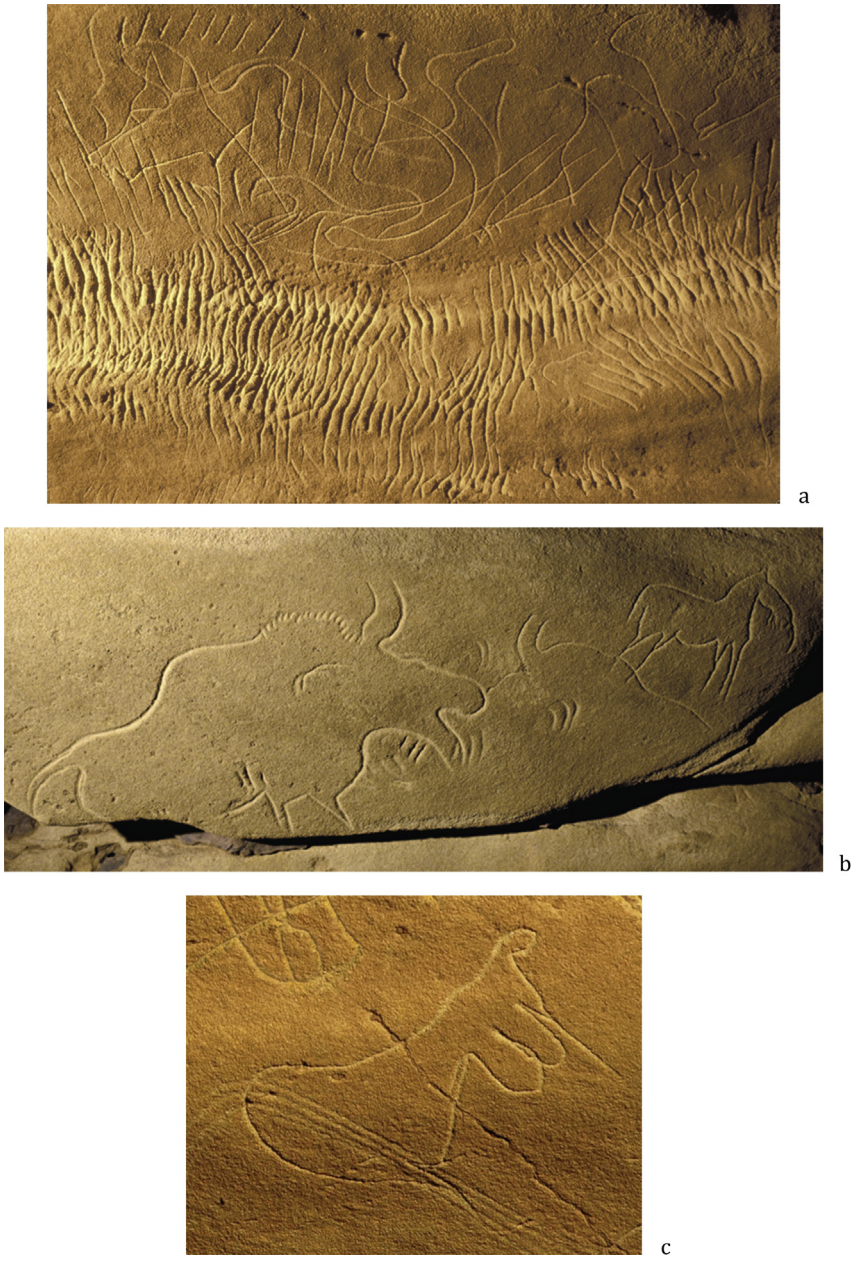

Fig. 7. Parietal art of Cussac Cave. 7a – Grand Panel in an area where the bear claw marks are underneath the engravings (Photo N. Aujoulat MCC-CNP Périgueux). 7b – Panel of the Facing Animals, an example of the formal unity of the art shown by a bison and a horse (Photo N. Aujoulat MCC-CNP Périgueux). 7c – Grand Panel, Female profile (Photo V. Feruglio – PCR Cussac).

superficial deposits, and/or as deposits intermingled with later fluvial deposits.
- Decanted clays.
- Homometric limestone gravels originating from the introduction of elements generated by the erosion of the limestone substratum, probably redeposited gelifracts.
- Gravitational deposits: tilting due to the undercutting of meander necks, compaction and withdrawing, ceiling collapse linked to sandier strata or release around the cave entrance.
- Speleothems.

Based on these results, it is possible to reconstruct the configuration of the underground spaces accessible to animals and humans during several phases of the karstic evolution of the cave.

4.1.2. Geoarchaeology

The test-pit realized near the cave entrance revealed two major lithostratigraphic units. They show the evolution of the sedimentation processes and enable a reconstruction of the phases resulting in the filling and sealing of the entry. The bottom of the sequence corresponds to the formation of gours and a low velocity deposition or detrital materials (clay or sand) by water flow across the ground surface. During this period, limestone and calcite fragments resulting from ceiling and wall breakdown, as well as transport from outside the cave, are absent. At the top of the sequence, the sedimentation processes change: a gravitational detrital cone gradually filled the cave entrance. This fill was sealed by slabs originating from local collapses of portions of the ceiling. Datings of the speleothems

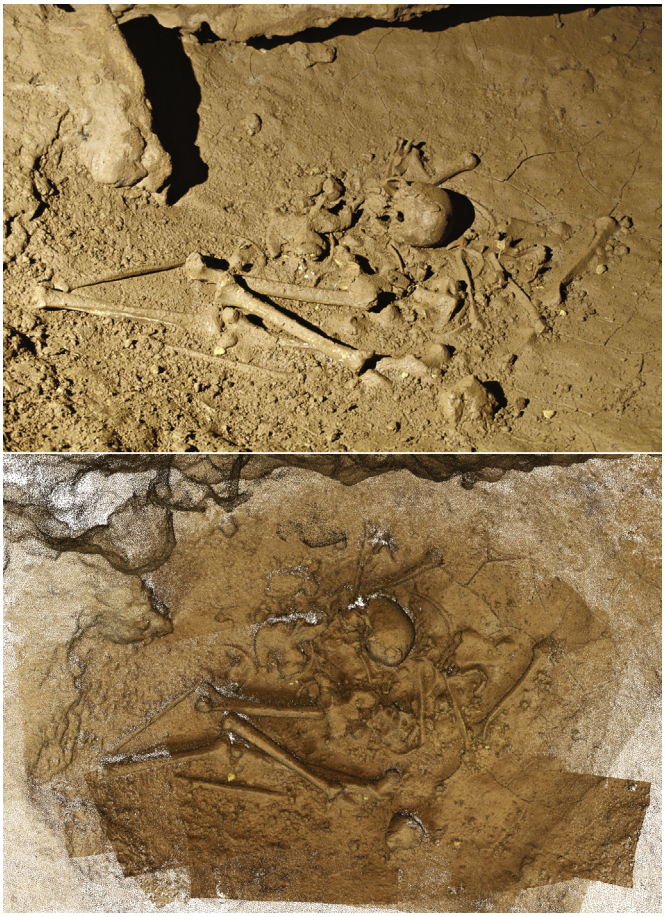

Fig. 8. Cussac Cave: the Locus 2 skeleton (photo N. Aujoulat/MCC) and its photogrammetry: detailed view – 3D model, scatter plot at a 1 cm resolution (P. Mora and B. Dutailly, UPS SHS 3D Archéovision, CNRS – PCR Cussac).

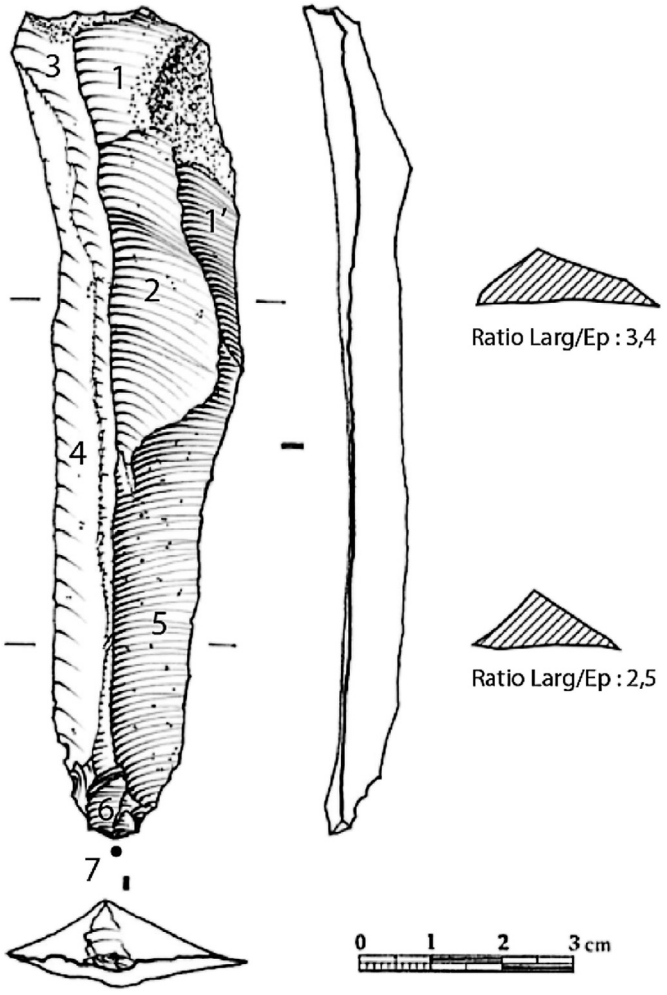

Fig. 9. Cussac Cave. Flint blade (Bergeracois) discovered on the floor of the gallery of Facing Animals (drawing J. Jaubert).

intercalated within the deposits, as well as of the stalagmites formed after the collapse of the slabs, contribute chronological information (cf. *infra*).

The morphology of loci 1 and 2 at the moment of the funerary deposits is attributed to an anterior phase of water circulation, responsible for channel cutting along the right wall and the accumulation of sand and gravel alluvium on the periphery (cf. *supra* 4.1.1). The presence of bears, contemporary with a dry phase in the cave, is attested by numerous hibernation hollows, three of which were later used by humans. After the human remains were deposited in bear hollows, the gallery was subject to numerous flooding events, some of which drowned the bear hollow of Locus 2, as shown by the fine laminated deposit covering the bones contained within (Fig. 11). In contrast, the absence of a sediment covering on the remains contained in the two hollows of Locus 1 show that, due to their higher positions, they were not drowned by flooding (Fig. 4).

4.1.3. Animal presence and animal remains

Animal presence is attested by two types of remains: 1) bone remains, which are rare in the cave, at least for elements that may have been introduced by humans, and; 2) marks left by their presence: tracks, polish, hibernation hollows and claw marks.

For the second category, we will discuss only bears, and not the mesofauna and microfauna (chiroptera claw marks, mustelid tracks, avifauna, etc.) that generally frequented the cave after humans or at the same time, circulating through miniscule anfractuosities and fissures after the cave was sealed.

All of the observations currently made by the team responsible for the study of activity traces (*TrAcs*) concur with the first observations made: bears were the first to frequent the cave and there is currently no proof of their presence after the realization of the mortuary deposits or engravings. Bear tracks cover several dozens of meters and have been mapped in a large part of the Downstream Branch. The panels of claw marks cover hundreds of square meters, sometimes at impressive heights, indicating that they are older than the sedimentary erosions, rockfalls and karstic draining. Moreover, humans deposited bodies in at least four of the numerous hibernation hollows. This, along with the claw marks that are covered with engravings, confirms that the bear presence was systematically earlier than that of humans.

Very few faunal remains have been identified on the ground surface near the current designated path. Despite a meticulous survey, no bear remains have been found in the Downstream Branch. On the contrary, microfauna and mesofauna remains are abundant. Originating from carnivore feces in the process of decomposition, or animals that died inside the cave, the presence of these animals is exclusively natural and modern. The same is true for most of the ungulate remains, very few of which have been found (N = 11). The taxa identified near the cave entrance are those of domestic animals or temperate species (ovicaprids, suids,

Fig. 10. Cussac Cave. In situ Reindeer stag antler beam discovered at 618 m in the Upstream Branch (photo N. Goutas).

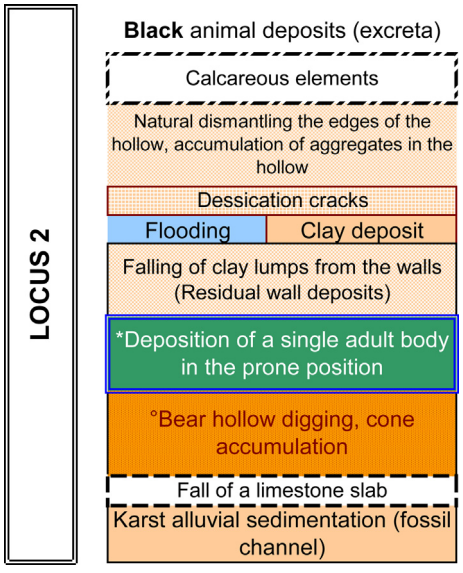

Fig. 11. Cussac Cave. Reconstitution of the relative chronology of natural (geological, animal) and anthropogenic (funeral) events used to establish locus 2.

Capreolus capreolus) whose remains could have been introduced by a small fox-sized carnivore. In the current state of research, the link between the Gravettian frequentations and the faunal remains is tenuous. The following elements are currently known:

Fig. 12. Cussac Cave. U–Th dating of stalagmite from S1 test-pit (layer 3c).

- in the vestibular area of the cave entrance, a lower left, first molar attributed to bison was discovered in place at the base of the coarse-grained, brownish-yellow diamicton massif sealed by a matrix;
- the spiral fracture edge on a reindeer (*Rangifer tarandus*) metatarsal bone found on the surface of the rockfall debris could suggest an anthropogenic origin. However, no evidence of butchery has been observed on this specimen collected for dating (Fig. 6);
- at the beginning of the Downstream Branch, a rib body fragment appears to belong to a bear, though a specific attribution is not possible (*Ursus* sp.);
- due to its size, the horse (*Equus caballus*) pelvis fragment found on the ground beyond the Grand Panel could not have been introduced by the carnivores that frequented the cavity. Therefore, while an anthropogenic origin is possible, it would be very difficult to demonstrate its association with the Gravettian occupations. A sampling for dating could contribute to answering this question.

4.1.4. Parietal art

The parietal art in Cussac Cave consists almost exclusively of engravings. Only a few non-figurative elements (most often dots) marking the path all along the cavity were realized in black or red paint. The most striking aspect of this art is its monumental appearance, expressed by the impressive size of the animals depicted, despite the use of the engraving technique, which is often reserved for detailed depictions of small animals (Aujoulat et al., 2001a,b). The figurative themes represented are also unusual, and are more subtly accompanied by numerous motifs on the panels. These panels constitute the other remarkable element of the gallery, grouping graphic ensembles which are unequally distributed along nearly 1000 m of space. There are no friezes like at Lascaux, Font-de-Gaume or Rouffignac, and no depictions outside of the defined spaces. The subjects are presented alone, in groups or profusely intertwined with each other on panels that are difficult to decipher. The last prominent feature is the great formal unity of the parietal art as a whole; the time is limited to only the moment necessary for the creative acts, which adhere to the conventions of a condensed chronology. As we have seen, the preferred technique was engraving. The lines thus produced are most often wide and incisive, made with a hard tool, though the nature of the support, a soft limestone (Ferrier et al., in press), also permitted the use of soft

tools, or even fingers. The technique itself, even that of finger-tracings, has no influence on the chronological attribution, as it is atemporal in quaternary art. The chronological argument is based on the fact that the animal contours were realized with a single line, with no reworking. The resulting image has clean lines, in contrast to those of Magdalenian engravers, who preferred vacillating lines. There are also no filled zones to indicate the nuances of fur, for example, or shading or anatomical forms; these techniques are more often encountered in the later periods of the Upper Paleolithic. The graphic expression at Cussac therefore evokes earlier periods.

Bison is the animal most often represented, followed respectively by (other than the large number of undetermined figures) mammoths, bovids and horses. Other herbivores are rare, as are other megafauna and avifauna species. Carnivores are nearly absent. Humans are represented by stylistic female silhouettes and male and female genitalia. This category is intercalated between the most and less frequent animals. These themes, in particular the recurrence of bison accompanied by an abundance mammoths and the association of horses, evoke the cultures at the transition between those who depicted mostly megafauna, the Aurignacian (Chauvet-Pont d'Arc, Clottes, 2001.), and those who depicted more common herbivores, the Solutrean-Magdalenian (Feruglio et al., 2015). Also notable is the similarity of percentages of depicted species with those of the Gravettian portable art at Isturitz (Rivero and Garate, 2014).

From the perspective of formal conventions (which we group together as "style"), often used to orient chronological attributions, their great unity in Cussac Cave (mostly in the manner of representing horns and appendages, and the frequent absence of internal details: *e.g.* Guy, 2010) facilitates their analysis. For example, the portable art of Gargas, found in stratigraphic units dated to the Middle Gravettian with Noailles burins (Breuil and Cheynier, 1958; Foucher et al., 2012b), offers a clear point of comparison that can be extended to the parietal art of this cave, and there are numerous formal similarities between the art of Cussac and that of Gargas (Barrière, 1976).

The compositions are also chronologically significant. For example, the frequent associations observed in Cussac Cave, such as female profiles and mammoths, are also present in the Gravettian cave of Pech Merle (Aujoulat et al., 2001a,b; Lorblanchet, 2010).

Even if style is the main key to drawing analogies between Cussac and other decorated caves, the options of rendering, theme and composition provide additional elements to support these comparisons. From several perspectives, multiple lines of evidence therefore converge toward an attribution of this art to the Gravettian, and more precisely to the Middle Gravettian phase of this period (Feruglio et al., 2011; Aujoulat et al., 2013; Jaubert and Feruglio, 2013).

4.1.5. Human remains

Gravettian funerary practices are characterized by a dominance of primary individual burials (as in Locus 2: Fig. 8), while multiple burials are much less common (Henry-Gambier, 2008). At the time of its discovery, therefore, the surface deposition of several individuals in association with ochre at Cussac appeared to be original. This has since changed, however, following a new study of the human remains from Abri Pataud (Dordogne, France) (Henry-Gambier et al., 2013a,b; Villotte et al., 2015a), the discovery of Vilhonneur (Charente, France) (Henry-Gambier et al., 2007), and a reconsideration of earlier discoveries (Baousso da Torre, Cro-Magnon) showing that during the Gravettian human bodies were sometimes deposited on the surface, or very superficially buried (Henry-Gambier et al., 2013a,b). In this sense, Cussac thus corresponds to what is known for the Gravettian period, especially in south-western France (Henry-Gambier et al., 2013a,b).

It is interesting to note that if the sexual determination of the subject of Locus 2 is correct, the osteometric features of this male individual would fall within the range of variability known for the end of the Upper Paleolithic (Late Glacial) (Villotte et al., 2015b). It will require a laboratory analysis of this skeleton, however, to more precisely determine the biological affinities between this subject and others attributed to the Upper Paleolithic.

4.1.6. Lithic industry

Currently, only 3 lithic artifacts have been found in the decorated part of Cussac Cave: a laminar flake on the path near Locus 1, and two flint blades on the floor of the gallery of Facing Animals. One of the blades, found close to the path, was collected in 2013, while the second is still in place and has been examined only from a distance (it is covered with a silty film and appears to be similar to the other one).

The first laminar flake, in chalcedony flint, collected in 2001 by J.-M Geneste, does not display features that enable a chrono-cultural attribution. It was nonetheless the subject of an interesting usewear analysis by H. Plisson (CNRS, PACEA Université de Bordeaux) whose results are beyond the scope of this article. The recently collected blade found on the ground is in a Bergeracois flint (archeo-petrography: S. Caux and J.-G. Bordes) originating from approximately 30 km to the west of the site, on the right bank of the Dordogne River. It is a rather small piece, 118 mm long, 28 mm wide and an average of 8 mm thick (Fig. 9). It displays features coherent with unidirectional, arched laminar debitage, and has a very straight in profile with a slight distal curve. The technical stigmata on its proximal end indicate that it was detached by direct soft hammer percussion. The angle of the striking platform relative to the flaking surface (nearly 90°), the blunting of the platform overhang, and the absence of a ventral lip suggest the use of a soft stone hammer. We should also note, however, that the dimensions of the butt (approximately 5 mm wide × 2 mm thick), and its light faceting to form a slight dihedral spur, while not incompatible with the use of a soft stone hammer, are also coherent with a soft organic hammer.

We must nonetheless remain cautious in the absence of other criteria typical of this technique (punctiform or filiform butt, regular posterior line of the butt, bulb chipping, thin and narrow undulations: Pelegrin, 2000; Klaric, 2004). The technical attribution of a single piece or small set of pieces can be very difficult, especially when clear, recognizable and quantifiable stigmata are lacking (Pelegrin, 2000). The attribution of an isolated piece, such as that from Cussac, thus forcibly remains uncertain, hence the tenuous interpretation proposed here. The "straight and sleek" appearance of the blade, as well as the possible use of soft stone percussion nonetheless tend to exclude an attribution to the known Aurignacian or Magdalenian laminar productions, more closely corresponding to the variability of certain phases of the Gravettian or Solutrean.

4.1.7. Osseous industry

The osseous industry is as scarce as the lithic industry, but still holds some interest due to the relative chronological information that it contributes, as well as the socio-economic questions raised by its presence at great distance from the cave entrance (618 m). The fifteen fragments found on the left side of the path in the Upstream Branch belong to a single worked tool, very likely made on a reindeer stag antler beam (Fig. 10). This tool was not in primary position when it was discovered; after it was lost or

intentionally discarded, it was moved and suffered various post-depositional modifications. In its original state, it was probably around 200 mm long. It has a narrow, elongated, cylinder shape, around 15 mm wide and thick, with a sub-rectangular outline. One extremity consists of a dull, massive point, very superficially incised. The other extremity consists of a very short and dull bevel. The only directly analogous elements in the French Upper Paleolithic originate from Gravettian contexts (Goutas, 2004). The piece from Cussac is nonetheless distinct in terms of the context of its discovery (decorated and sepulchral cave), the care taken in its manufacturing, and its geometric decoration. Its dull extremities and mechanical properties exclude its use as a hunting weapon. Its use as an engraving tool is possible due to the specific wear on both of its extremities (two active areas?) and its proximity to a decorated panel (around 15 m away). A technological analysis of the engravings, coupled with experimentation, will be realized to test this hypothesis. This program will be completed by an attempt to date the piece, preceded by a CT-scan of this tool.

4.1.8. Charcoal

Despite its poor state of preservation, the charcoal fragment collected (Fig. 13) displays mechanical modification stigmata (cellular crushing) suggesting that the active area of the torch was rubbed against the wall (torch smear). The anatomical structure was nonetheless sufficiently well preserved to propose a determination before the piece was dated. The fragment is attributed to the gender *Juniperus* and a heliophilous taxon, characteristic of the shrub formations of the cold flora of the Last Glacial.

In the Upstream Branch, black marks are more numerous and suggest the presence of torch smears (visible line). At least six of them (TrAc 20-26-27-28-39-15) could indicate the presence of vegetal fibers (angular micro-segments) that could enable species determinations.

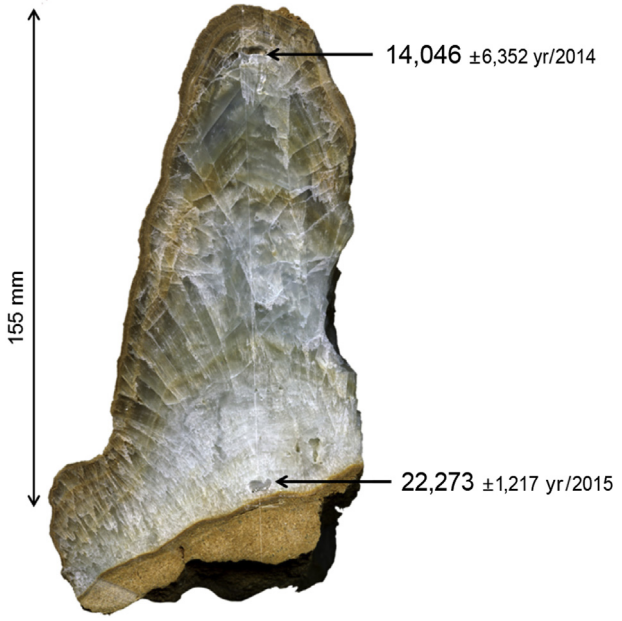

Fig. 13. Cussac Cave. Charcoal (Junipurus sp.) found on the ground, originating from a torch smear located above and vertically in-line with this piece, in the area between the Clay Bridge (Pont d'argile) and Locus 1. This sample has been dated to 29,704–28,714 cal BP (TrAc n°170, photography N. Fourment).

4.2. The decorated and sepulchral cave: chronometric elements

4.2.1. Speleothems

The first results of U–Th datings of speleothem calcite (Table 2) reveal the following elements (a synthetic article is in preparation):

- the youngest rockfall debris levels, positioned in the highest part, at the arrival to the current access gallery, are older than 5900 ± 1700 years (Table 2 # DG10);
- the ages of the stalagmite bases sampled in the lower part of the rockfall debris, on stone blocks or broken concretions, are between 12,370 ± 720 years and 1940 ± 700 years old (Table 1 # DG3, DG4, stm1, stm2, stm4);
- the presence of speleothems (stalagmites and flowstone) trapped in the various levels exposed in the test-pit suggest that this was a multi-phased collapse. An age of 22,570 ± 1200 years (Table 1, # stm6) was obtained for the base of a stalagmite exposed in place within the rockfall debris, 30 cm below the surface. The bottom of the test-pit S1, corresponding more or less to the base of the rockfall debris, is occupied by a second stalagmitic floor whose dating is currently in progress.

4.2.2. Human remains

Following the discovery of the cave, human remains from each of the three loci were collected for radiometric dating (Table 1). Only the bone from Locus 1 had a sufficient amount of collagen, and yielded a date within the range of the Gravettian period: 25,120 ± 120 BP (Beta-156643) or 29,500–28,835 cal BP (95.4% probability) after calibration (OxCal 4.2 © Christopher Bronk Ramsey 2014; IntCal 13, Reimer et al., 2013). The result obtained from Locus 2, 15,750 ± 50 BP (Beta 156,644), was considered as unreliable by the laboratory due to doubts concerning the purity of the dated collagen (Aujoulat et al., 2004). If we accept the only available result, there is no reason to believe that these two deposits are not contemporary.

4.2.3. Charcoal

In the sector of the lower meander at the descent of the Clay Bridge (5Av-RG), the charcoal sample collected (*supra*) was discovered on the ground by the TrAcs team (2013). It was positioned in line with a torch smear (TrAc n°170) and near other charcoal fragments (TrAc n°171), some of which are larger (approximately ½ cm). Logically, all appear to originate from the same torch smear(s) located directly above them (Fig. 13).

The charcoal fragments display clear ligneous structures, but they are few and heavily mixed with clay. When calibrated, the ^{14}C date of 25,150 ± 210 BP (GifA 13150) gives an interval of 29,704–28,714 cal BP (95.4 de % probability) (Table 1; Fig. 14; OxCal 4.2 © Christopher Bronk Ramsey 2014 – IntCal 13, Reimer et al., 2013).

4.2.4. Fauna

Among the faunal remains considered to be of Pleistocene age, we have currently sampled and submitted only one piece for dating: the reindeer diaphysis identified on the surface of the rockfall debris in the cave entrance. The ^{14}C date obtained (Table 1) is 16,400 ± 130 BP (GifA 15087 – SacA 41511), for a calibrated age of 20,125–19,485 cal BP (2 sigma). This date indicates that this bone originates from the very end of the Last Glacial Maximum, before the Older Dryas and the Heinrich 1 event (H1), and is thus contemporary with the Lower Magdalenian techno-complexes in

Table 1
Cussac Cave. Table of samples and C-14 dating.

Sample#	Author sampling	Method	Laboratory reerence	Age C-14 BP	σ	Calibrated ages (cal BP), 2 s	Chronology	Note	Reference
_	J.-B. Mallye (S. Costamagno)	C14-AMS	GifA 15087/SacA 41511	16.400	± 130	20,125–19,485			Unpublished
#1	H. Duday, D. Henry–Gambier & coll.	C14-AMS	Beta-156643	25.120	± 120	29,500–28,835	Gravettien moyen		Aujoulat et al., 2001a,b
#3	H. Duday, D. Henry–Gambier & coll.	C14-AMS	Beta-156644	15.750	± 50			insufficient collagen	Aujoulat et al., 2002
#5	H. Duday, D. Henry–Gambier & coll.	C14-AMS	Beta-Analytic, Miami	–	–			Absence of collagen	Unpublished
_	D. Henry–Gambier & coll.	C14-AMS	GrA-52412	4.575	± 35	3497–3105	Néolithique récent		Unpublished
#1	H. Valladas, J.-M. Geneste, N. Aujoulat	C14	modern	–	–			# modern	Unpublished
#2	H. Valladas, J.-M. Geneste, N. Aujoulat	identification		–	–			# too smal	Unpublished
#3	H. Valladas, J.-M. Geneste, N. Aujoulat	identification		–	–			# too smal	Unpublished
TrAc 171	N. Fourment	C14-AMS	GifA 13150/SacA 33773	25.150	± 210	29,704–28,714	Gravettien moyen		Unpublished

south-western France (Langlais, 2010). As this bone remain displays no anthropogenic stigmata, the most logical hypothesis that it was transported naturally from the cave porch, or by a predator, across the surface of the rockfall debris, which was in the process of accumulating but still left enough space for small predators to cross.

4.3. The vestibule area

Diverse remains were found in this entrance sector communicating with the internal rockfall debris slope. In addition to Holocene fauna, including artiodactyles (undetermined ungulates, ovicaprids, suids), small carnivores (mainly fox and badger; dog, cat), leporids (hare, rabbit), avifauna and rodents, only one reindeer bone was found.

A small assemblage of human bones, all fragmentary (femur, ulna, scapula and rib fragments), were also recovered during the work in 2001. Due to their similar patina and texture, along with the absence of duplicate pieces, we believe that they all originate from the same immature individual (*Homo sapiens*). A sample submitted for dating by D. Henry-Gambier in 2011 (Table 1) yielded a date of 4575 ± 35 BP (GrA-52412), or 3497–3105 cal BC (2σ), thus contemporary with the Late Neolithic.

4.4. La Truffière Cave

The material published by D. Peyrony in 1950 was collected in 1912 in front of the site known as *La Truffière* Cave, which appears to correspond to the current entrance of Cussac Cave, though we cannot be certain.[1] If this is confirmed, the assemblage of "La Truffière Cave" would come from the vestibule area of the current entrance to Cussac Cave.

The Peyrony assemblage is composed of 26 lithic artifacts, mostly in Campanian flint. They are very monotonous in terms of their blanks, a sad consequence of being sorted when they were collected. Blades and laminar flakes with a more or less pronounced profile curvature are dominant (N = 24), accompanied by one blade core and one bladelet with a straight profile. The rare butts display careful abrasion of the striking platform lip, slight faceting (no spur) and stigmata coherent with soft organic percussion. The tools include burins (Fig. 15, n°13), endscrapers (5), endscraper-burins (2), one backed bladelet (Fig. 15, n°6) and a blunted perforator. The small assemblage can be attributed to an undifferentiated Middle-Upper Magdalenian, the high deficit of bladelets (and thus weapon armatures) complicating the distinction between these two phases.

[1] The original name of the land parcel on which Cussac Cave is located is "La Truffière", but in 2000 the name "Cussac Cave" was preferred, after the name of the old neighboring parish).

5. Discussion

In this section, we reconstruct and discuss the general chronology of Cussac Cave, and then focus on the Gravettian period.

5.1. Broad diachronic framework

After determining the general morphology of the aquifer, including the flooding periods before the first bear incursions, an integration of the data drawn from the relative and radiometric chronology enables us to propose a first chronological scenario for Cussac Cave (Fig. 16). This scenario is of course not composed of a series disjointed events since many of them could have been partially contemporaneous (*e.g.* speleothem formation, aquifer recharge, bear presence, etc.), and were certainly as complex as the cave is vast. The following is thus a summary, partially schematic, which is not concretely reconstructed until isotope stage 3.

- **Formation of the last speleothem generations**, the oldest of which are currently dated and attributable to the Penultimate-Interglacial period (MIS 7). It is very likely that the speleothems that have not yet been sampled or dated are also attributable to the Last Interglacial period (MIS 5).
- **Presence of one or more bear generations** (*Ursus* sp.), the remains of which are nearly absent in the Downstream Branch – at least at this stage of research – and exceptional in the Upstream Branch. The age of this dense and diverse bear presence, probably repeated over long periods, is still unknown, but earlier than 30,000 BP. At least two generations of bear incursions appear to have occurred.
- **Sedimentation from upstream** (opposite the current entrance) **of a detrital deposit** consisting of cryoclastic gravels constituted during an epikarst regime. The age of this sedimentation remains to be determined: was it before, during or after the

Table 2
Cussac Cave. Table of U–Th dating obtained on speleothems. All the samples were obtained from samples taken in the entrance area.

Labcode	Sample	^{238}U (µg/g)		^{232}Th (ng/g)		δ^{234}Um		(^{230}Th/^{232}Th)		(^{230}Th/^{238}U)		Age (kyr)[a]		δ^{234}U(0)		Age (kyr)[b]	
Gif-3201	DG 3	0.051	0.0001	1.89	0.01	70.5	7.1	2.47	0.18	0.029	0.002	2.896	0.243	71.1	7.1	1.940	704
Gif-4624	CSS DG10, 5 mm	0.044	0.00002	4.05	0.02	102.0	2.8	2.91	0.23	0.080	0.006	8.123	0.709	103.7	2.9	5.915	1.731
Gif-4205	Cuss stm2-17	0.047	0.00001	0.50	0.000	132.9	1.6	20.85	0.23	0.071	0.001	7.033	0.092	135.5	1.6	6.761	221
Gif-3184	DG 12	0.055	0.0001	18.13	0.05	60.5	10.1	1.35	0.06	0.140	0.006	15.421	0.845	63.2	10.5	6.880	4.436
Gif-4201	Css stm4-4	0.051	0.00001	0.19	0.0001	56.5	1.4	61.37	0.58	0.076	0.001	8.036	0.092	57.8	1.5	7.931	141
Gif-4207	Css stm1-32	0.040	0.00001	2.62	0.001	126.6	1.8	4.57	0.04	0.096	0.001	9.695	0.111	129.4	1.9	8.016	886
Gif-3181	DG 0	0.123	0.0001	42.00	0.05	108.3	4.5	1.68	0.02	0.187	0.002	20.091	0.302	114.7	4.8	11.213	3937
Gif-4623	CSS DG4, 2 mm	0.143	0.0001	7.18	0.01	107.7	1.6	8.56	0.08	0.131	0.001	13.626	0.160	111.5	1.7	12.375	719
Gif-5393	CSS-Stm7-A	0.073	0.00001	17.27	0.02	111.6	1.4	3.08	0.02	0.237	0.001	26.060	0.205	116.5	2.3	19.746	2.684
Gif-5391	CSS-Stm6 -6	0.048	0.00001	4.44	0.00	120.6	1.8	7.62	0.04	0.231	0.001	25.080	0.208	128.0	2.1	22.573	1.217

$\delta 234U = ([234U/238U] - 1) \times 1000$.
[a] Ages expressed as year before 1950 (BP).
[b] Ages are corrected ages for detrital fraction, assuming a 230Th/232Th initial activity ratio of 0.8 ± 0.4.

presence of bears? Near Locus 3, hibernation hollows are indeed dug into the gravel near the left wall.

- **Flooding period(s)** in the cave system sometime between the gravel sedimentation and the arrival of the Gravettians.
- **At approximately 29,700–28,700, during the Middle Gravettian, a human appropriation of the entire cave for spiritual purposes**, consisting of graphic and funerary activities. This is attested by several hundreds of finger-tracings and figurative and non-figurative engravings, which are grouped locally on panels or in palimpsests. A minimum of five individuals (or body elements) are deposited in at least three loci. A few artifacts, including at least three flint blades or laminar flakes, an antler point, torch smears, and ochre marks accompany the funerary and graphic elements.
- **Abandonment of the Gravettian sanctuary.** This is indicated by the state of preservation of the cave floors and some of the remains, such as the nearly complete skeleton in Locus 2. A natural or anthropogenic obstruction of the entrance probably protected most of the cave from large carnivores until its discovery in 2000. Otherwise, it is difficult to imagine, for example, how the skeleton of locus 2 could have remained inaccessible to carnivores until re-flooding of the cave. Furthermore, there are no carnivore marks on any of the human remains in loci 1 to 3.
- **Sealing of the porch** by rockfall in the entrance area.
- Before or after the entrance sealing, **aquifer recharge**, flooding a major part of the Downstream Sector, including Locus 2 and the lower part of Locus 1. Silt deposits of an undetermined age.
- **Presence of Magdalenian groups** in “La Truffière Cave” (which may correspond to the current exterior porch of Cussac Cave, located in front of the vestibular zone sealing the decorated cave. This Middle-Late Magdalenian group does not appear to have had access to the inner part of the cave, which was sealed-off at the end of the last Pleniglacial period.
- More or less contemporaneous **faunal remains** could nonetheless have entered the cave through infiltration or movements across the rockfall debris, or may have been brought in by small carnivores.
- At the same time, **re-formation or continuing formation of concretions** (since at least 20,000 cal BP, and more regularly after 16,000 cal BP), further reducing the possibilities for intrusion.
- A few **human remains** belonging to an immature individual attest to a last Holocene presence in the porch during the **Late Neolithic**, before its obstruction was cleared in 2000.

5.2. Appropriation of the site by Middle Gravettian groups

For the period of human presence that interests us most, the one that is contemporary with the decorated sanctuary, we can propose the following chronological framework. These observations, already supposed, are now more concretely supported by a recent charcoal dating.

1. The age of the charcoal sample collected from the cave floor (TrAc-170), below and in-line with a torch smear on the cave wall, is chrono-culturally attributable to the middle-phase of the Gravettian period, contemporary with lithic industries characterized by Noailles burins (Pesesse, 2010). Chrono-climatically, this corresponds to the early isotope stage 2 (MIS 2) during the Middle-Pleniglacial, between the Heinrich 3 event (H3) and the LGM, close to interstadials 3 and 4 of the isotope curves resulting from the study of the Greenland ice cores (GI 3-4) (NGRIPmembers, 2004).

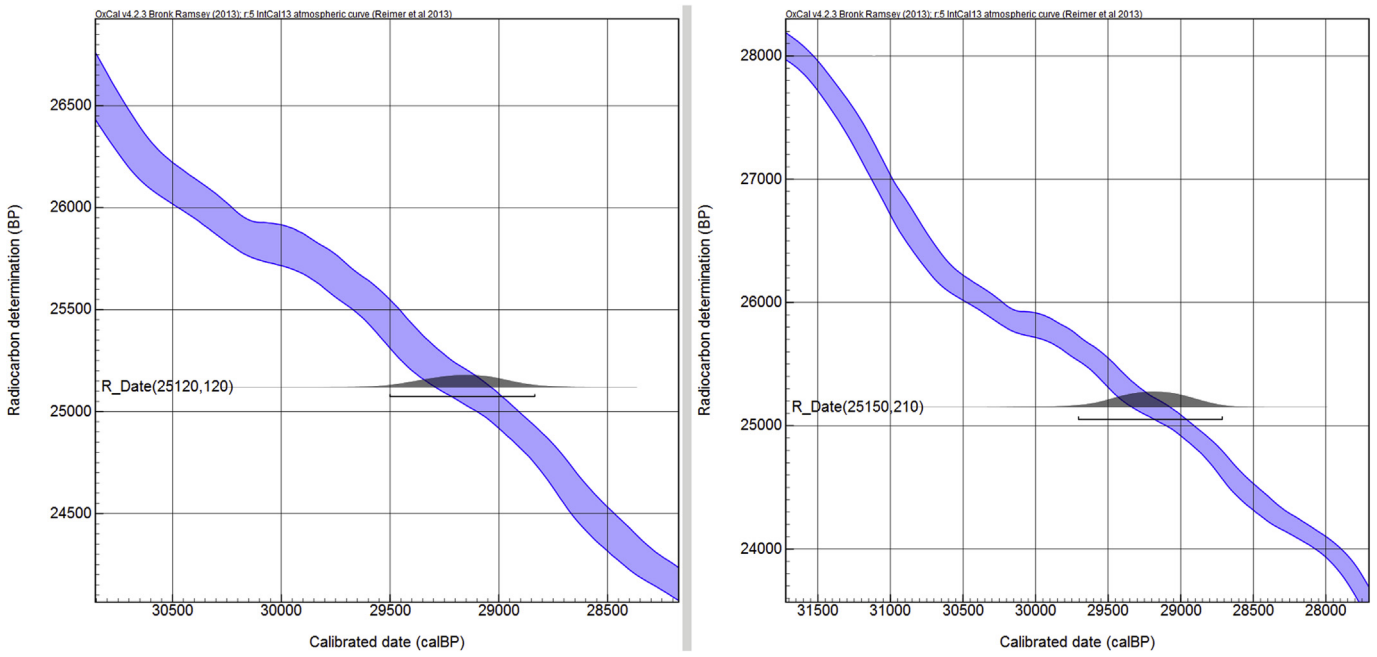

Fig. 14. Cussac Cave. Radiocarbon determination (BP) and Calibrated dates (cal BP) for the human bone (Beta-156643) and the charcoal TrAc 170 (GifA 13150). OxCal v4.2.3 Bronk Ramsey (2013); r:5 IntCal 13 atmospheric curve (Reimer et al., 2013).

2. This result is nearly identical to the only reliable date previously obtained at Cussac through the AMS ^{14}C dating of a human rib fragment from Locus 1 (Beta 156643), 25,120 ± 120 BP (Aujoulat et al., 2001a,b), or 29,500–28,835 cal BP (Fig. 16). The humans who deposited the body in Locus 1 could therefore have been the same as those who revived their torch a few dozen meters away at the base of the Clay Bridge, or at least belong to the same Gravettian group or "generation".
3. These two dated samples originate from sectors in the Upstream Branch that are close to each other, but sufficiently distant (between 12 and 20 m depending on the obstacles) to be topographically distinct. Interestingly, the torch smear is located near an engraving, even if modest (Toupillon, 2G1-1), positioned on the ceiling of this passage, as well as red dots marking the overhang where it is at shoulder-height. Moreover, beyond this smear, the path ends at the foot of the Panel of the Discovery, at a point from which it can be seen in its entirety (which is not the case from the promontory from which it was realized) and with a direct frontal view (which is not the case from the current designated path). We obviously cannot assume that all of these elements are strictly contemporaneous, but their proximity is intriguing.
4. Finally, from a documentary and technical perspective, this positive result bodes well for the future sampling of torch smears at Cussac, rare in the Downstream Branch, but much more numerous in the Upstream Branch. The latter have not yet been systematically inventoried, other than in a preliminary survey by the TrAcs team in 2010 (Ledoux et al., in press), nor have they been evaluated in place for an anthracological analysis (I.T.-P.) or dating possibilities (H.V.), as this Upstream Branch is still "frozen", awaiting the installation of the necessary equipment (permanent path marking, or a temporary installation of metallic paths).

Even if caves with evidence for multiple incursions by culturally different groups are rare, it seems that in contrast to Gravettians, who were capable of "respecting" the art works created by others before them (*e.g.* Chauvet-Pont d'Arc Cave, Clottes dir., 2001), Magdalenians had a strong tendency to reappropriate underground spaces, such as Les Trois Frères Cave (Bégouën et al., 2014). For example, in the network of caves hollowed out by the Volp stream, Gravettian presence is attested in Enlène Cave by archaeological artifacts found in its entrance. This cave is connected to Les Trois Frères Cave by a long, low tunnel that opens into the Gallery of Points, not far from the Gallery of Hands. As indicated by its name, the walls of this gallery are decorated with the typical red hand stencils that are generally attributed to the early-middle Upper Paleolithic. A suite of stenciled bent thumbs further supports the Gravettian attribution. Further along in the cave, the walls of one gallery were extensively engraved by Gravettian artists. Subsequently, Magdalenian groups who entered the cave around 10,000 years later superposed black drawings on top of these engravings and covered the entire space of the chambers, galleries and the rest of the cave system with sometimes very dense engravings, as well as paintings. In crevices all along the cave walls, they also left artifacts attesting to their passage. As a result, in the collective memory, Les Trois Frères Cave is still thought of as a Magdalenian cave (Bégouën and Breuil, 1958; Bégouën et al., 2014).

6. Conclusions

With few exceptions, such as some parts of Pyrenean caves exempt from earlier or later human incursions (*e.g.* Tuc d'Audoubert: Bégouën et al., 2009), the dating of decorated caves is often difficult and subject to fluctuation. This is true even in rich archaeological contexts, such as Lascaux Cave (Leroi-Gourhan and Allain, 1979; Delluc and Delluc, 2012 *contra* Aujoulat, 2004 or Clottes, 2003), and even more so if there were several periods of human frequentation (*e.g.* Trois Frères: Bégouën et al., 2014). In some cases, such as Chauvet-Pont d'Arc Cave, even if the dating is clear and based on solid foundations (Clottes et al., 1995; Valladas et al., 2001b), along with a relative

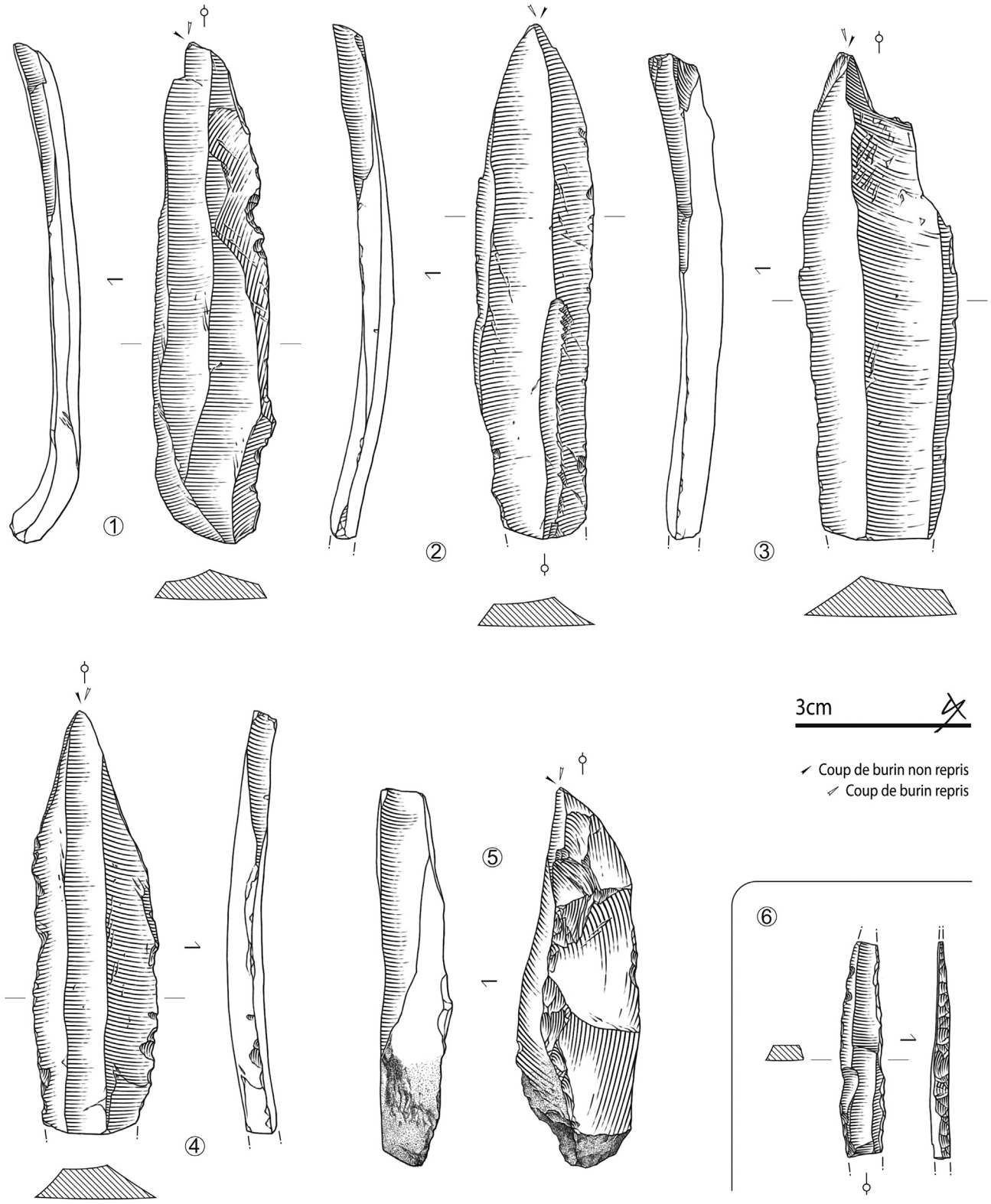

Fig. 15. Examples of lithic tools from Truffière Cave (excavation E. Peyrony), 1–5: burins, 6: backed bladelet (drawings S. Ducasse).

chronology (Feruglio and Baffier, 2005), it is nonetheless contested by a small number of authors (Pettitt, 2008; Pettitt and Bahn, 2015). After they were dated by the first charcoal samples collected from cave walls (Lorblanchet et al., 1990; Valladas et al., 1990, 1993), several other caves were spectacularly updated, such as Cougnac and the late phase at Pech Merle (Quercy, France), both passing from a "Solutrean-Lower Magdalenian" attribution (Leroi-Gourhan, 1965; Lorblanchet, 1974) to a Gravettian one (Lorblanchet et al., 1995; Lorblanchet, 2010), even if Lorblanchet believes that Cougnac was mainly decorated

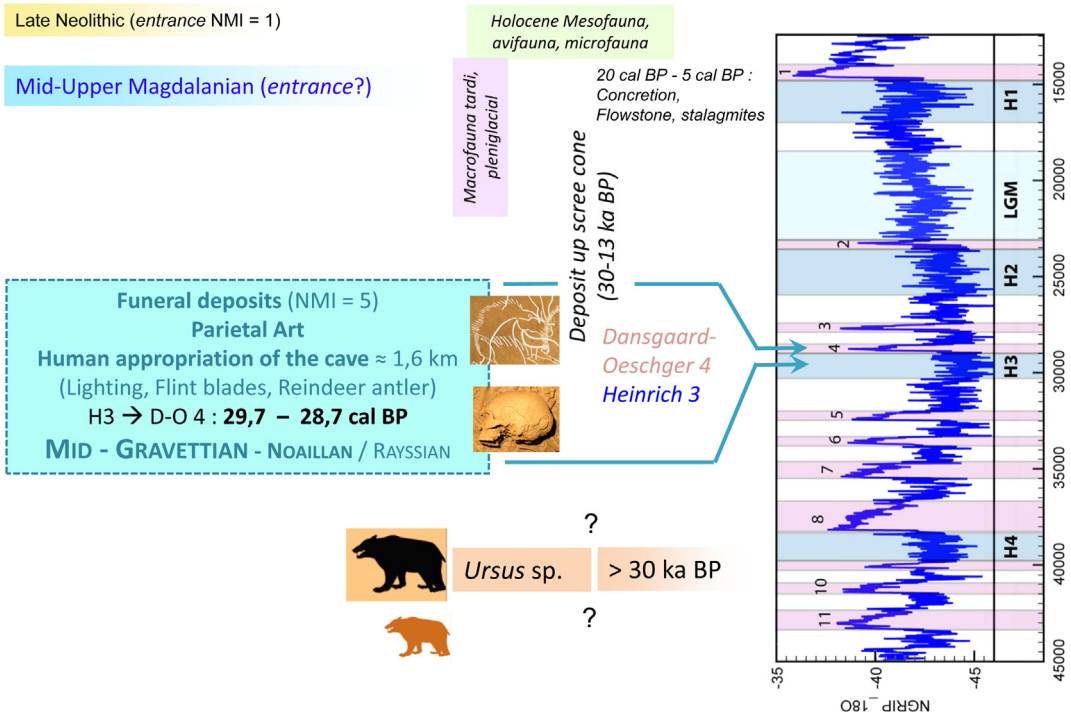

Fig. 16. Timeline of human and animal presence in Cussac Cave. (Last Glacial).

during the Gravettian, but with a few later additions (*contra* Sauvet, 2004).

Will we be lucky enough at Cussac to avoid such complex scenarios? Or will we tend to oversimplify the chronology of the appropriation of this cave "sanctuary", followed by its sudden abandonment or even interdiction, retaining only one period of human presence: the Middle Gravettian? The hypothesis of a well-argued, unique period of frequentation, or even a single event, indeed remains to be confirmed.

In addition to the Gravettian presence, we have evoked other frequentations that we can currently qualify as chronologically marginal and/or topographically peripheral (vestibular area, sealed entrance). They indicate a brief passage by Magdalenians (which remains to be confirmed), and then a Late Neolithic group, neither of which can be confused with the infinitely better documented frequentation of the decorated and sepulchral cave.

One observation that is astonishing but in no way weakens our interpretation is that the human presence in Cussac was brief and limited in time. This observation appears to hold true despite the incomplete and very unequal, or even anecdotal, evidence, whether in terms of physical dates (a single reliable ^{14}C of a human bone + a single ^{14}C date of a charcoal found on the ground), or relative chronology (definite Gravettian art + sepulchral practices that correspond to current knowledge of the funerary practices of Gravettian societies + a flint blade within the variability of Gravettian – or Solutrean – laminar productions + a reindeer antler point typical of the Gravettian). Despite this still tenuous and admittedly incomplete context, especially in terms of dates and the archaeological record other than the parietal art, we have encountered no element that contradicts this global framework (Fig. 16).

The demonstration of a relative contemporaneity between the parietal art and human remains at Cussac would be very important, of course within the margins of approximation inherent in the study of Upper Paleolithic periods contemporary with the Late Pleniglacial. Nonetheless, it remains impossible to affirm that: 1) the human deposits and the parietal art were realized by the same people, and; 2) that these two spiritual phenomena were really contemporaneous or successive, and then their relative chronology. If the coexistence of funerary deposits and parietal art at Cussac was nonetheless confirmed, it would open a new analytical field, or at least renew and enlarge an existing one by the inclusion of spiritual activities other than graphic depictions (Henry-Gambier et al., 2013a,b; Aujoulat et al., 2013; Jaubert, 2014). Their topographic cohabitation, despite the absence of a strict spatial association (except if the existence of Locus 4 is confirmed) reveals unusual, or even unknown, funerary practices for the Gravettians of south-western Europe (Henry-Gambier, 2008; Henry-Gambier et al., 2013a,b), involving the appropriation of a deep karst space. The caves of Paglicci (Apulia, Italy) (Mezzena and Palma di Cesnola, 1971, 1989-1990), Vilhonneur (Charente, France) (Henry-Gambier et al., 2007), the Pataud Rock Shelter (Dordogne, France) (Nespoulet et al., 2013), or even the caves of Isturitz (Gambier, 1996) and Gargas (Foucher et al., 2012a) in the Pyrenees, among many other sites, such as Cap Blanc, Barma di Caviglione, Grotta Romito and Riparo Tagliente (Bartolomei et al., 1974; Mussi, 1986; Fabbri et al., 1989; Henry-Gambier, 2008), all associate a decorated shelter or cave with human remains. At Cussac, however, the deposition of human bodies or remains deep within a karstic cave, far from its entrance, broadens the spectrum of spiritual manifestations. All of these sites, and Cussac more than any other, contribute to a renewal of our understanding of the relationship perceived by Gravettian peoples between death and decorated sites.

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