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Supplementary Methods (SM)

SI-SM 1 | Sampling method

Calcite cores were taken with a 1.6 or 2.6 cm wide and ~15cm long diamond device mounted on a standard drill on batteries. A water flow system was added in between the drill and the core device in order to cool the material and samples.

All cores and the stalagmites were halved along the growth axis and the surface was polished with different grain sizes of SiC-paper. Each subsample for ^{230}Th dating was milled using 0.8 mm tungsten-carbide dental drills.

The calcite crust covering the bone was halved along the growth axis and three subsamples were taken following the method above.

SI-SM 2 | ^{230}Th dating method

The ^{230}Th dating work was performed at two laboratories, the Isotope Laboratory at Xi'an Jiaotong University and the Minnesota Isotope Laboratory, University of Minnesota, using Thermo-Scientific Neptune-Plus multi-collector inductively coupled plasma mass spectrometers (MC-ICP-MS). The methods are identical in the both laboratories. We use standard chemistry procedures to separate uranium and thorium for dating[1]. A triple-spike (^{229}Th–^{233}U–^{236}U) isotope dilution method was employed to correct for instrumental fractionation and determine U/Th isotopic ratios and concentrations. The instrumentation, standardization and half-lives are reported in detail in Cheng *et al*. (2000)[2] and Cheng *et al.* (2013)[3]. All U/Th isotopes were measured on a MasCom multiplier behind the retarding potential quadrupole in the peak-jumping mode. We followed similar procedures of characterizing the multiplier as described in H. Cheng *et al*. (2000)[2]. Uncertainties in U/Th isotopic data were calculated offline at 2s level, including corrections for blanks, multiplier dark noise, abundance sensitivity, and contents of the same nuclides in spike solution. Corrected ^{230}Th ages assume the initial ^{230}Th/^{232}Th atomic ratio of 4.4 ± 2.2 x10-6, the values for a material at secular equilibrium with the bulk earth ^{232}Th/^{238}U value of 3.8.

[1] Edwards, R.L., Chen, J.H., Wasserburg, G.J., *Earth Planet. Sci. Lett*. **81**, 175 (1987).
[2] Cheng, H. *et al*., The half-lives of uranium-234 and thorium-230, *Chem. Geol*. **169**, 17-33 (2000).
[3] Cheng, H. *et al.* Improvements in ^{230}Th dating, ^{230}Th and ^{234}U half-life values, and U-Th isotopic measurements by multi-collector inductively coupled plasma mass spectrometry. *Earth Planet. Sci. Lett.* **371**, 82-91 (2013).

Supplementary Tables

Supplementary Table 1: Description of the core samples

Zone	Core	Subsample	Subsample position from top of core (cm)	Thickness of the subsample (cm)	Subsample weight (mg)	Remarks
Structure A	BR-stm-SA249	2491	0.3	0.3	150	Maximum age for the structure
	BR-stm-SA59	59	2.7	0.5	200	Maximum age for the structure
	BR-stm-RA62	621	8.7	0.2	220	Minimum age for the structure
		622	9.0	0.2	250	Maximum age for the structure
		623	11.5	0.2	280	Maximum age for the structure
		624	12.5	0.2	300	Maximum age for the structure
Structure B	BR-stm-SB7	71	2.9	0.3	250	Maximum age for the structure
		72	3.8	0.2	300	Maximum age for the structure
		73	2.5	0.2	300	Minimum age for the structure
	BR-stm-RB7	74	8.3	0.2	360	Minimum age for the structure
		75	9.2	0.4	380	Maximum age for the structure
		76	10.1	0.2	160	Maximum age for the structure
		77	4.1	0.3	140	Minimum age for the structure
	BR-stm-RB23	231	7.5	0.2	350	Maximum age for the structure
		232	2.3	0.2	250	Minimum age for the structure
		233	3.0	0.2	160	Maximum age for the structure
		234	3.3	0.3	250	Maximum age for the structure
Entrance	BR-PL-P13	13	3.5	0.5	300	

The name of the cores, the name, exact position, extend (thickness) and weight of the subsamples taken for dating are given. The last column gives the presumed maximum (grey) or minimum (white) age compared to the age of the structure based on the sedimentological position of the subsamples in each core.

Supplementary Table 2: Differences Bears structures – anthropogenic structures

During their hibernation, bears are known to move small rocks and perhaps knock down stalagmites, and to dig hibernation hollows. Various studies have determined the size of these hollows for *Ursus spelaeus* and *U. arctos*, which are on average between 0.92 and 1.61 m, with a few exceptions reaching 2.10 (Croatia), 2.60 m (Pyrenees) and 3.10 (Cantabria, Spain) (Fosse *et al*. 2004)[454]. Even the largest of these hollows is much smaller than the dimensions of the large structure in Bruniquel cave. Moreover, even if bears move or knock down stalagmites, they don't transport them, or fracture and calibrate them, and even less so, accumulate them into structures supported by intermediary elements (wedges) to form 16 by 23 m^2 space, 16 to 6 times the average size of bear hollows. We can also add that around twenty heated zones, irrefutably of anthropogenic origin, are also associated with these structures.

SI-Table 2 Comparative size of hollows used by *Ursus spelaeus* and *U. arctos* in different regions (according to Fosse *et al*. 2004 modified).

Sites, loci, *Ursus* species	Length of hollow (min-X-max)	Width of hollow (min-X-max)
Arriurtor Cave, Pyrenees, *U. arctos*	0,70–1,26–2,60 m	0,70–1,09–1,70 m
Zazpigagna, Pyrenees, *U. arctos*	0,55–1,02–1,60 m	0,60–1,08–1,50 m
Cantabria, Spain *U. spelaeus*	0,65–1,61–3,40 m	0,50–1,03–1,70 m
Cantabria, Spain *U. arctos*	0,89–1,03–1,29 m	0,70–0,87–1,15 m
Croatia	0,26–0,92–2,10 m	0,26–0,73–1,27 m
Pech-Merle, France *U. spelaeus*	0,70–1,60 m	0,40–0,50 m
Oyanbeltza, France	0,90–1,54–1,93 m	0,20–0,30–0,40 m
Ciurului-Izbuc, Romania	1,20–1,80 m	± 0,45–0,60 m
Bruniquel Cave Structure A (internal)	**5,80 m**	**3,70 m**
Bruniquel Cave Structure A (external)	**6,70 m**	**4,50 m**

Dimensions (L x W) of bear hibernation hollows compared to the large structure (A) in Bruniquel cave. The two Bruniquel values cannot be part of the same statistical distribution as that of the bears, as is clearly shown in this simple figure. In this scatterplot, we show the *maximum* dimensions of the structures constructed by bears (and thus the most unfavourable measure for our argument) and draw the ellipses at 95% of this series of 8 points. We clearly see that the values at Bruniquel are far from the usual range of variability of bear hollows.

[4] Fosse, Ph. *et al*. Denning behaviour of "Modern" brown bear (*Ursus arctos*, L.) in caves: Biological and paleontological considerations from French Pyrenean sites. *Cahiers scientifiques* / Hors série n°2, 171-182 (2004).

Supplementary Data

1. Entrance zone

The entrance zone is composed of a 30,25 m long narrow passage ending on top of a large collapse. Two stalagmites and one flowstone sealing the collapse have been dated (ED fig. 2; Extended data Table 2). These preliminary results indicate that at least part of the collapse was already there before 366 ± 6 ka, and that most of the narrow passage has existed since 192.8 ± 8.9 ka.

Description of the cores with localization of subsamples for U-series dating

• *Core BR-PL-1 from the flowstone*

The core is 14.3 cm long and 2.5 cm large. The flowstone covers fallen blocks among which some pieces were embedded by the flowstone. The core presents white to brown finely layered calcite. The core was broken at 4 different levels probably related to the presence of less dense calcite or calcite containing more detrital material. The upper 2 cm is composed of a powdery white partly altered calcite. The lower part of the core is composed of dense calcite. Subsample 1 was taken at the base of the core, between 0.5 and 0.7 cm from the base. The age of the subsample is a minimum age for the deposition of the infillings.

• *Stalagmites BR-STM-2 and BR-STM-3*

Both stalagmites were sampled in the small entrance passage on top of the infillings. BR-STM2 stalagmite was in its original position. It partially covered the BR-STM-3 stalagmite, which laid horizontally in the infillings. Subsamples were taken for dating at the top and at the base of each stalagmite, subsamples 22 and 23 respectively for BR-STM-2 and 32 and 31 respectively for BR-STM-3. The age of these subsamples represent a minimum age for the deposition of the infillings and thus for the existence of the small and difficult passage in the current entrance zone.

2. Structure zone

Description of the core with localization of subsample for U-series dating

• *Core BR-stm-SA249 from stalagmite 249 in structure A*

The core was taken in the apex of stalagmite 249. It is 4 cm long and has a 2.5 cm diameter. The top of the stalagmite reveals a complex sedimentological structure of brown-yellow calcite with large millimetric inclusions. The upper five millimeters have a more regular layering without inclusions. On the top of the stalagmite, the water surrounding the structure deposited a small rim of calcite. A subsample was taken at the top of the stalagmite, just under the calcite rim. The age of this subsample represents a maximum age of the structure.

• *Core BR-stm-SA59 from stalagmite 59 in structure A*

The core was taken in the apex of stalagmite 59. It is 2 cm long and has a diameter of 1.5 mm. The top of the stalagmite is composed of a translucent white calcite and ends with a yellow-brown detrital-rich calcite crust. A subsample of white calcite was taken under the detrital-rich crust. The age of the subsample gives a maximum age of the structure.

• *Core BR-stm-SB7 from stalagmite 7 in structure B*

The core was taken at the apex of stalagmite 7, which was entirely covered by a recent stalagmite, i.e. deposited after the construction of the structure. The core is 8.5 cm long and has a diameter of 2.5 cm. The lower 6 cm are composed of brown calcite, regularly layered with the presence of inclusions and/or dissolution vacuoles. The internal structure reveals a decrease in stalagmite diameter and shift in growth axis. The part with a smaller diameter presents some post-depositional alteration at the edge, i.e. partial dissolution. The lower part of the core ends with a ~0.5 mm thick clay layer. One subsample (71) was taken at the top of the stalagmite, under the clay layer, another subsample (72) was taken beneath it in the calcite presenting less alteration. Both subsamples give a maximum age for the structure. The upper 2.5 cm reveals a denser translucent slightly brownish calcite and is part of a younger stalagmite growing on the speleofact structure, as confirmed by the sedimentological layering. The layers of the covering calcite are first deposited around the top of stalagmite 7 and progressively more vertically following the flow of the water towards the floor. A subsample (73) was taken at the base of the calcite covering stalagmite 7. The age gives a minimum age of the structure.

• *Core BR-stm-RB7 from the stalagmite covering stalagmite 7 in structure B*
The core was taken in the base of the stalagmite covering stalagmite 7. The core is 12 cm long has a diameter of 2.5 cm. In the lower 3 cm, the calcite is brown and clear layering is visible. It has the same appearance as the lower 6 cm of core BR-stm-SB7, indicating that the core reached the underlying stalagmite 7 from the structure. The upper 9 cm are composed of yellow to brown translucent to opaque calcite. In between, a clay layer of ~5mm was deposited. One subsample (76) was taken under the clay layer in the brown layered calcite of stalagmite 7, giving a maximum age for the speleofact structure. A second subsample (76) was taken just under subsample 76 to confirm the age. One subsample (74) was taken just above the clay layer in the stalagmite covering stalagmite 7 and gives a minimum age for the structure. A fourth subsample (77) was taken at ~4 cm from the top of the core in the middle of the covering stalagmite, where the calcite changes from yellow-opaque to white- translucent.

• *Core BR-STM-RB23 from the stalagmite covering stalagmite 23 in structure B*
The core was taken through the top of a small stalagmite covering speleofact 23, a double speleothem (stalagmite or stalactite). The core is 8.4 cm long and has a diameter of 2.5 cm. It displays very white, finely layered calcite in the lower 5.5 cm of the core. This part has a complex structure probably related to the fact that the underlying speleothems are irregular stalactites rather than stalagmites. In the upper 3 cm, the dense translucent calcite finishes as a detrital-rich calcite crust and clearly corresponds to the covering stalagmite. In between the two parts, clay-rich calcite layers are deposited over ~0.5 cm, most probably part of the outer layers of the double speleothem 23. One subsample (232) was taken in the upper dense calcite just above the clay layer. It gives a minimum age for the structure. One subsample (233) was taken in the detrital layers and most likely gives a maximum age for the structure. One subsample (234) was taken just under the detrital-rich layers and in the white finely layered calcite from the underlying speleofact 23. The subsample gives a maximum age for the structure. A last subsample (231) was taken in the bottom of the core just above another clayey layer at the side of the core and is, based on the sedimentological structure, older than 234.

• *Core BR-STM-RA62 from the stalagmite covering stalagmite 62 in structure A*
The core was taken in the base of a stalagmite covering stalagmite 62. The core is 15.5 cm long and has a diameter of 2.5 cm. The lower ~3.5 cm of relatively dense translucent white calcite is covered by 2 to 3mm of clay. Above the clay layer, ~3.5 cm of detrital-rich calcite ends up in a ~1mm thick clay layer before the deposition of dense translucent white calcite ending in a succession of detrital-rich calcite layers. A subsample (621) was taken at the base of the upper dense translucent calcite, clearly part of the stalagmite covering stalagmite 62. It gives a minimum age for the structure. Subsamples 622 and 623 were taken at the upper an

the lower edge respectively of the detrital-rich layers in between the two clay layers. Since, based on the height of the core compared to the height of the speleofact and covering stalagmite, the detrital-rich calcite is part of the speleothem. However, precise height measurements were not possible without damaging the structure and, while less probable, this part could be the first layers deposited on the stalagmite. Subsample 624 was taken just under the clay layer in the lower part of the core, which is part of the stalagmite. Its age is a maximum age for the structure.

• *Core BR-PL-P13 from the flowstone pavement in the middle of the largest structure (structure A)*

The core taken in the calcite flowstone in the middle of structure A is 4 cm long and 2.5 cm large. It presents 2.5 cm of dense clay rich layered calcite. At 2 cm from top, an ancient flowstone surface is characterized by a thin clay layer. Underneath the dense calcite a pool-type deposition with bigger crystals and several vacuoles was deposited indicating the first steps of calcite deposition in a water pool. Subsample 13 was taken in the lower part of the core. The age can give an indication of the presence or not of the flowstone during human presence.