



Supplement of

^{230}Th / U isochron dating of cryogenic cave carbonates

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Addendum (2) Study Site:

The entrance to Water Icicle Close Cavern (53.1781 °N, 1.7605 °W) is situated on a gently undulating upland surface at 335-340m asl that has been incised by deep valleys that are largely dry under present climatic conditions. No natural entrance is known and the system is entered through a 32 m deep shaft that was excavated during historical lead mining operations. The position of this shaft (fig. S1), which intersects the natural cave system exactly at the intersection of the three major passages, was apparently determined precisely, suggesting that miners must have entered the system through another path, which is unknown today. A more detailed description of the exploration history including descriptions of the individual passages is provided in Gunn et al. (2020) who identify dolines that may once have been inlets that provided concentrated recharge. Land-use above the cave is presently pastoral agriculture.

The CCCs in Water Icicle Close Cavern occur as distinct patches of loose calcite crystals covering an area between 0.5 and 2 m² of the cave floor. Figure S1 shows the position of CCC patches reported in this study along with other known occurrences which will be the subject of future investigations. All occurrences are situated at between 31 and 42 m below the surface. It is noteworthy, that some patches are found underneath or close to vadose shafts that narrow upwards and were formed by concentrated flow from the epikarst. It is considered likely that these features were the primary pathways of water infiltration, which lead to pooling and subsequent CCC formation. However, other pathways, such as lateral movement of water through the cave system, cannot be ruled out.

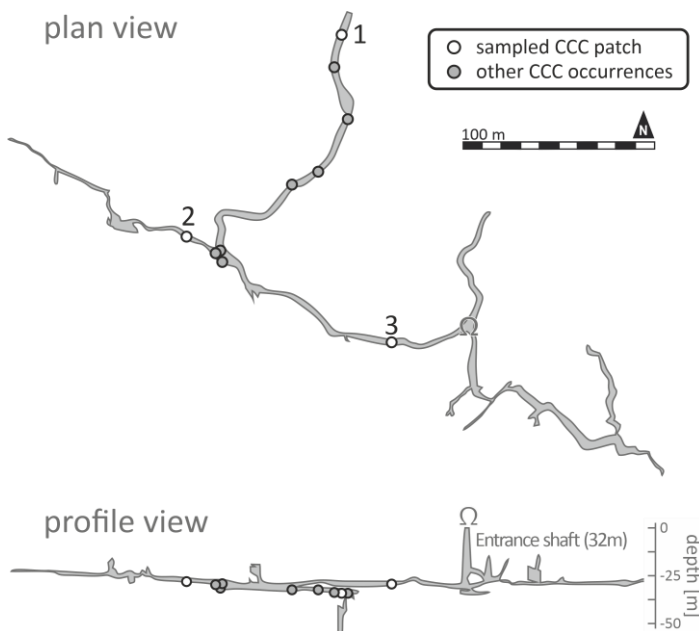


Figure S1: Cave plan of Water Icicle Close Cavern in plan view and projected profile view. Sites where CCCs have been documented are marked with grey circles and the three patches samples in the course of this study are marked with white circles. The numbers correspond to the numbering of patches in the main text (modified from Gunn et al. (2020); original survey by Simon Brookes and Chris Jackson).

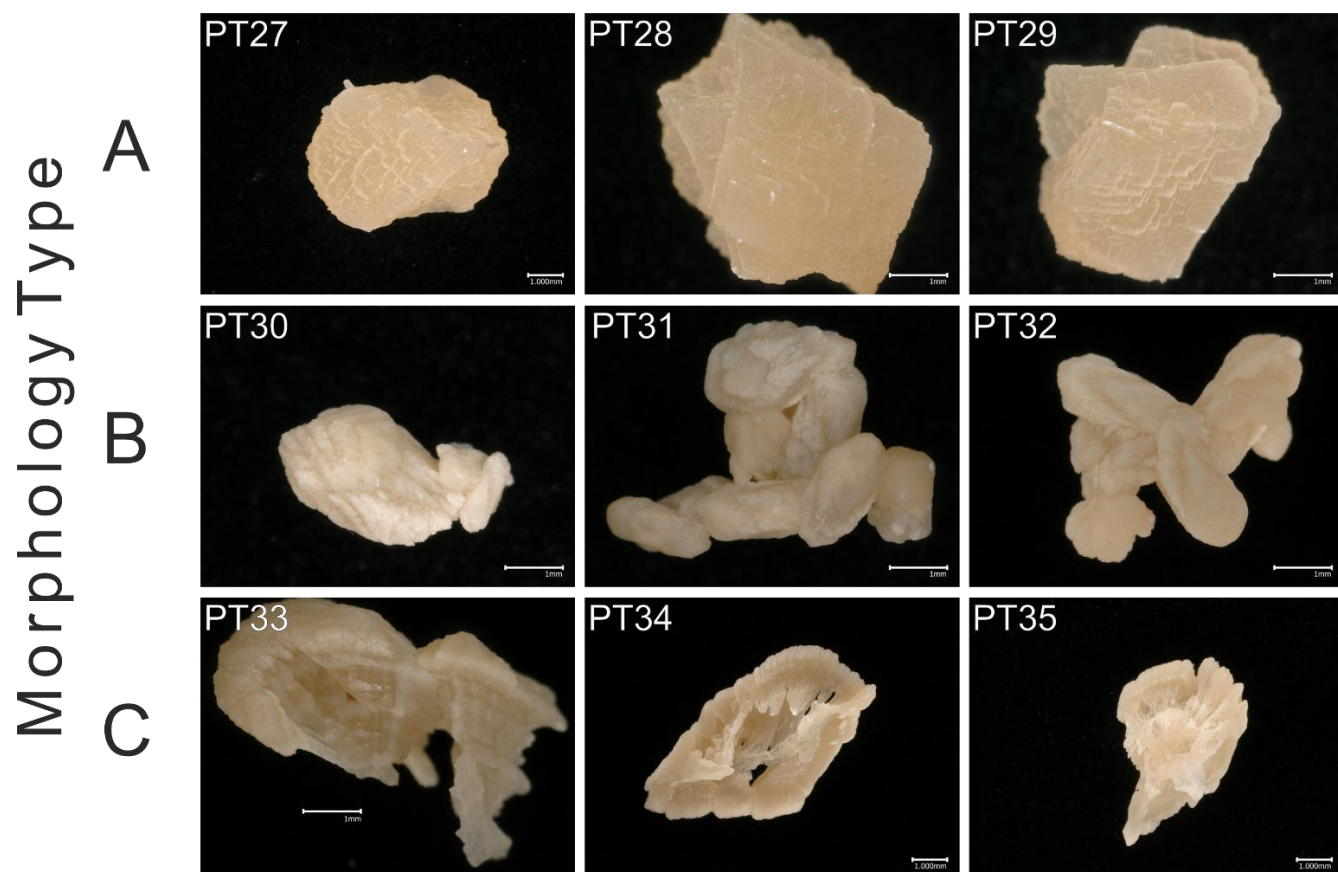


Figure S2: Selected CCC specimens of patch 1 for $^{230}\text{Th}/\text{U}$ analyses.

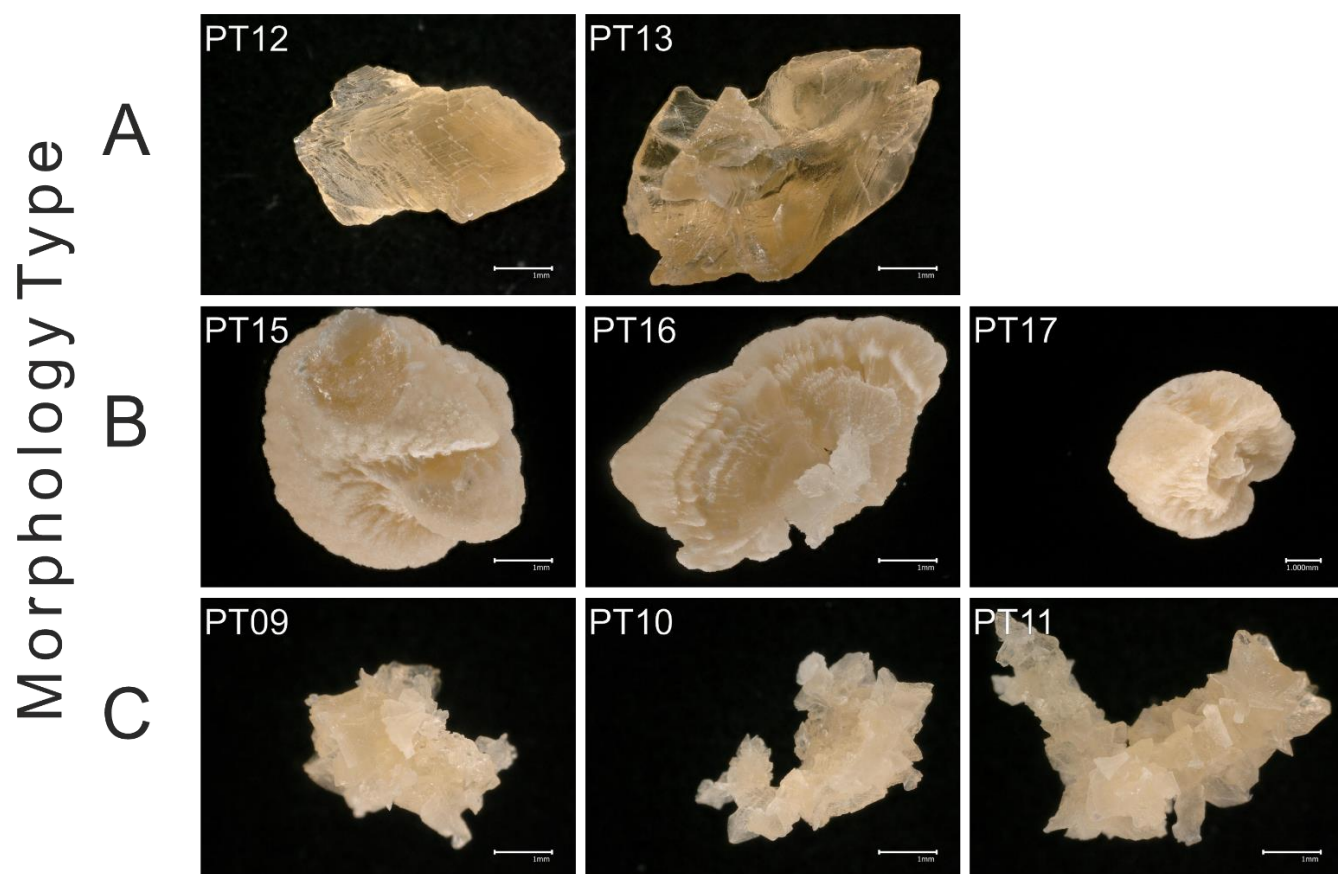


Figure S3: Selected CCC specimens of patch 2 for $^{230}\text{Th}/\text{U}$ analyses.

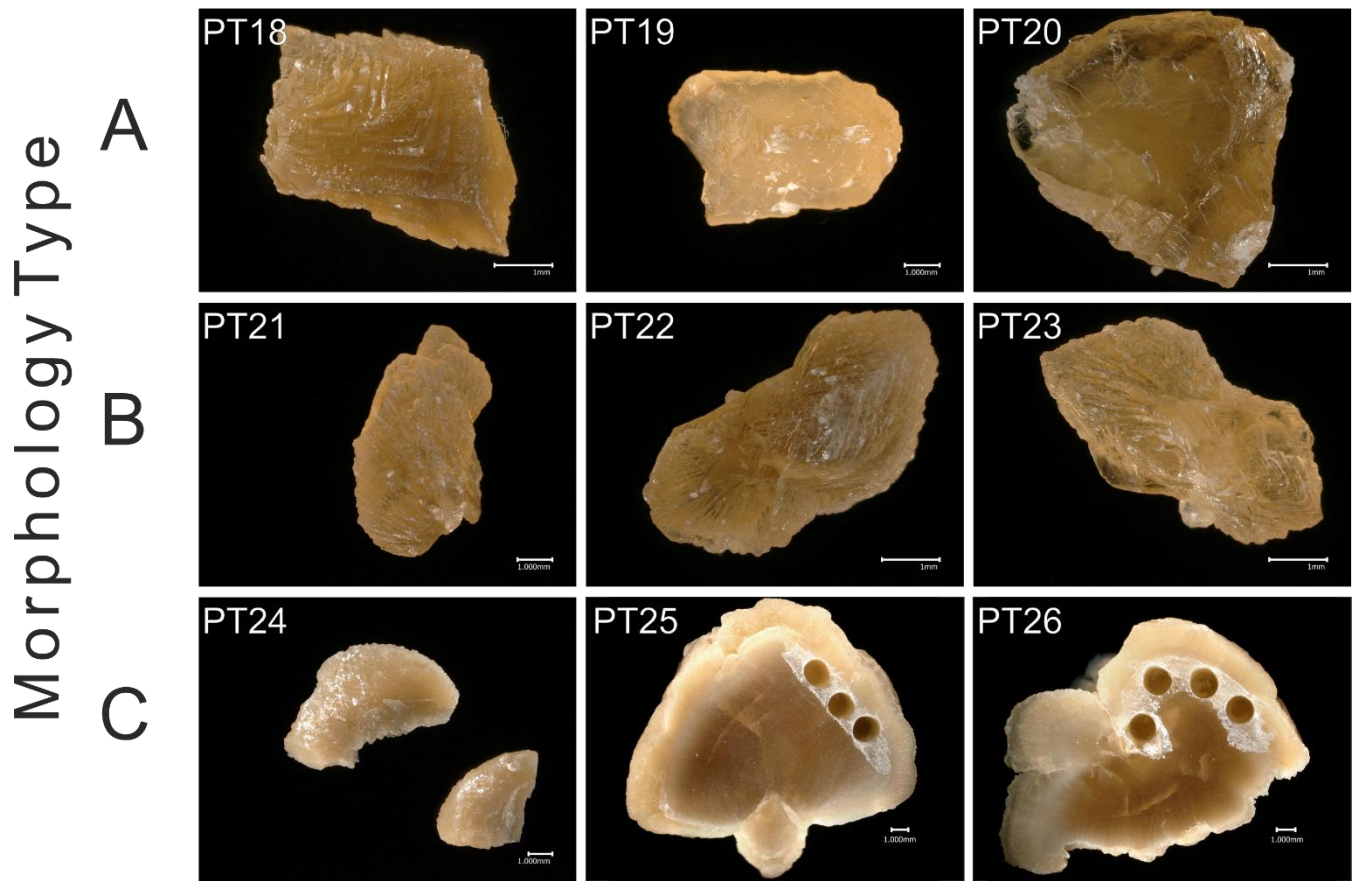


Figure S4: Selected CCC specimens of patch 3 for $^{230}\text{Th}/\text{U}$ analyses.

Table S1: Age and regression parameters of isochrons. Explanation of uncertainty ranges are given in the methods section of the main text.

ID	n	R ²	p	($^{230}\text{Th}/^{238}\text{U}$)	$\delta^{234}\text{U}_0$	($^{230}\text{Th}/^{232}\text{Th}$) ₀	Age [BCE]
r1.1	9	0.98	$7.1 \cdot 10^{-6}$	0.1600 ± 0.0031	509.9 ± 1.8	2.7 ± 0.2	12224 ± 478
r1.2	8	0.997	$5.0 \cdot 10^{-8}$	0.1554 ± 0.0010	507.6 ± 1.2	3.4 ± 0.1	11865 ± 172
r2.1	6	0.98	$6.0 \cdot 10^{-4}$	0.2077 ± 0.0007	1076.6 ± 0.8	7.3 ± 0.7	11524 ± 85
r3.1	6	0.89	0.02	0.3783 ± 0.0004	170.1 ± 0.8	4.2 ± 1.1	43065 ± 139
r3.2	3	0.9991	0.03	0.3731 ± 0.0004	169.14 ± 0.04	5.4 ± 0.2	42297 ± 109

References

Gunn, J., Fairchild, I. J., Moseley, G. E., Töchterle, P., Ashley, K. E., Hellstrom, J., and Edwards, R. L.: Palaeoenvironments in the central White Peak District (Derbyshire, UK): evidence from Water Icicle Close Cavern, Cave Karst Sci., 47, 153–168, 2020.