Supplementary figures

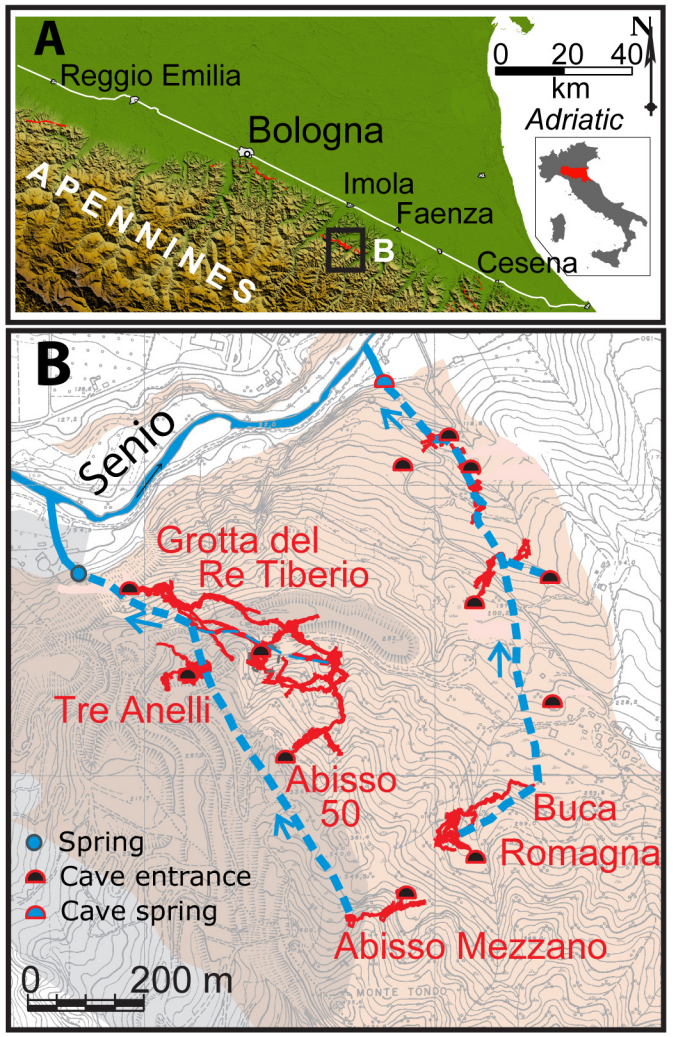
Suppl. Fig. 1 – Location of the study area: A) Emilia-Romagna region (shown in red on the inset map of Italy), the northern part of the Apennines and study area (black square); B) The Senio River, and the investigated caves, including the Re Tiberio system. The shaded areas represent gypsum outcrops.

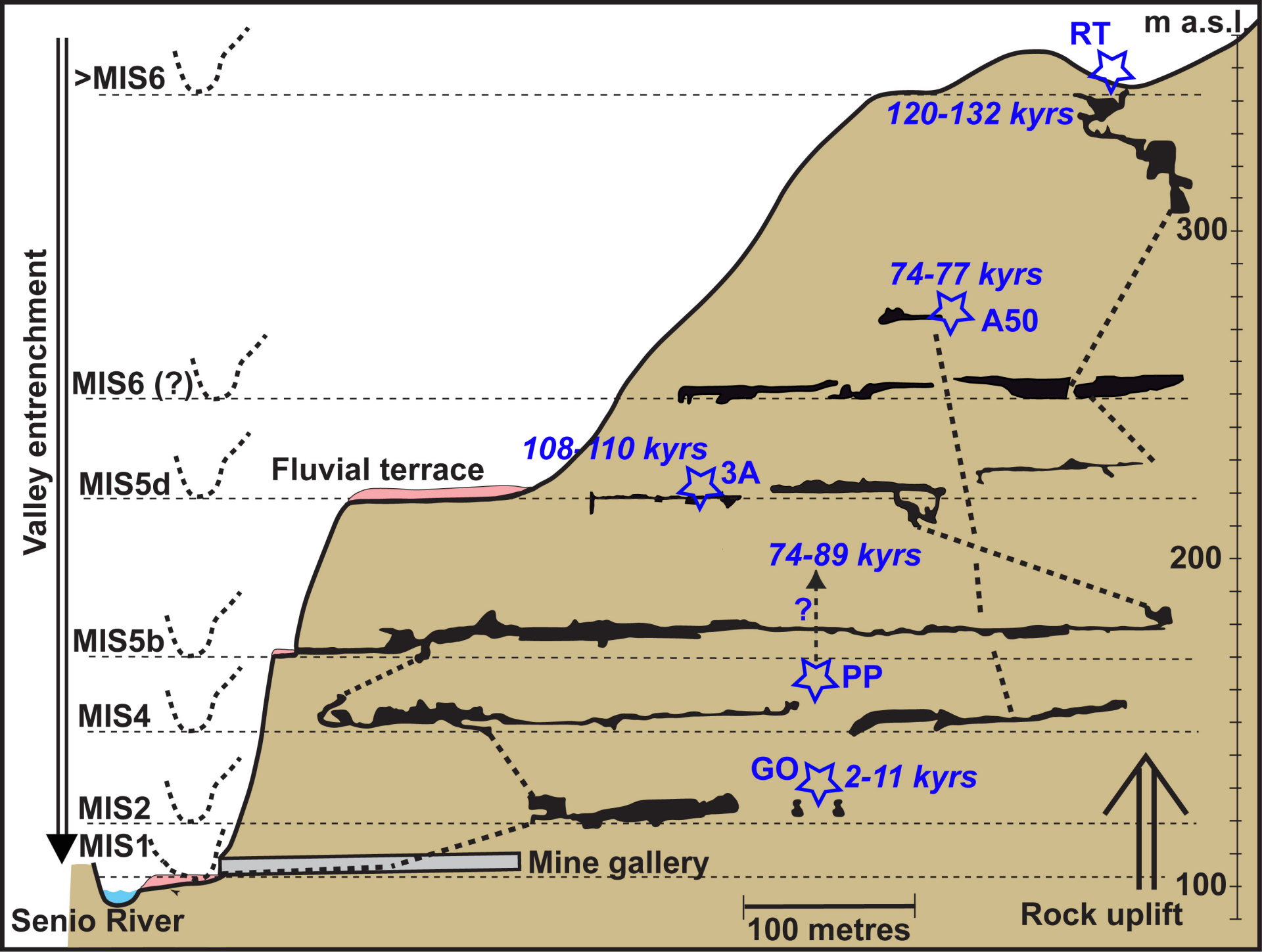
Suppl. Fig. 2 – Schematic section of the Re Tiberio cave system. Black dotted lines indicate vertical connections between different levels in a single cave. The stars indicate the sampled carbonate speleothems (see suppl. Table) with their age ranges in italics, while the valley profiles to the left reflect the altitudinal position of the paleo-Senio river and their most probable correlation to marine isotope stages (MIS).

Suppl. Fig. 3 – Speleothems used in this study. Red bars are 1 cm long. Sampling points for U-Th dating are reported with white (University of Melbourne) and gray (LSCE Gif-sur-Yvette) boxes. Bottom and top are indicated with yellow and green arrows respectively. The red star represents the area of the depositional hiatus.

Suppl. Fig. 4 - A) Paragenetic canyon passage cut by the open pit quarry at 105 m a.s.l. The passage is almost completely filled with fluvial sediments. B) Paragenetic ceiling pendants in the main level of Re Tiberio cave, at 180 m a.s.l. C) Undulating paragenetic notches carved on the walls of the main level of Re Tiberio cave at 180-185 m a.s.l. Photos by Piero Lucci.

Suppl. Table - U/Th ages of samples from the Re Tiberio cave system.

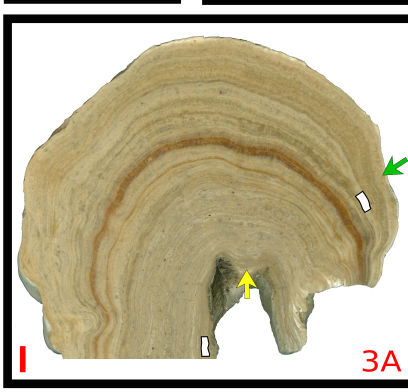

A
Reggio Emilia
Bologna
Imola
Faenza
Cesena
APENNINES
B
N
0 20 40
km
Adriatic
B
Senio
Grotta del
Re Tiberio
Tre Anelli
Abisso
50
Buca
Romagna
Abisso Mezzano
Spring
Cave entrance
Cave spring
0 200 m
MONTE TONDO

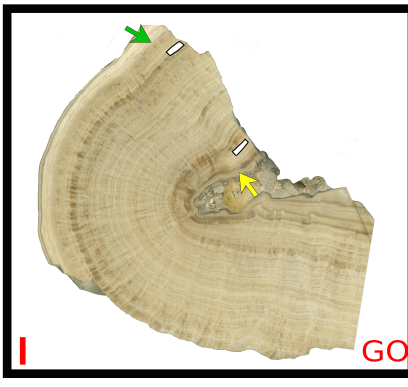

m a.s.l.
RT
120-132 kyrs
300
74-77 kyrs
A50
>MIS6
MIS6 (?)
108-110 kyrs
3A
Fluvial terrace
MIS5d
74-89 kyrs
200
?
MIS5b
PP
MIS4
GO
2-11 kyrs
MIS2
MIS1
Mine gallery
Valley entrenchment
Senio River
100 metres
Rock uplift
100

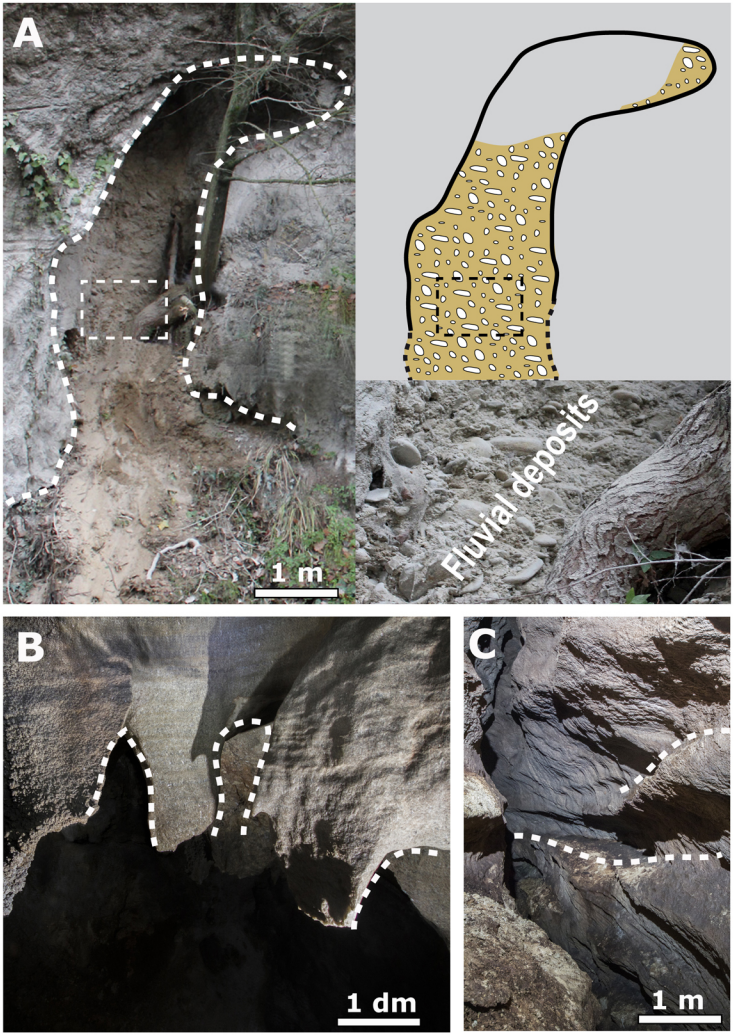

RTf


A50


PP


3A


GO


A
1 m
Fluvial deposits
B
1 dm
C
1 m

Sample location	Alt (m)	Length (cm)	Sampling point (cm from the top)	Sample ID	Lab number	^{238}U ng/g	^{230}Th/^{238}U	^{234}U/^{238}U	^{232}Th/^{238}U	^{230}Th/^{232}Th	Age corr kyr BP	*Age error (2σ- kyr)*	$[^{234}U/^{238}U]_i$	2σ
Re Tiberio Flow-stone (RT)	340	63	62.5	RT-A1 bis	**UMD131122-214**	848	0,6541	0,9446	0,000657	994,9	**130,9**	1,8	**0,9199**	0,0037
			47.5	RT-A2	**UMD131122-220**	883	0,6560	0,9525	0,000666	985,3	**129,1**	1,7	**0,9316**	0,0036
			47	RT-B1	**UMD131122-233**	934	0,6541	0,9562	0,000239	2732,7	**127,3**	1,8	**0,9372**	0,0038
			40	BII	**Gif 3939**	1624	0,6479	0,9556	0,000439	1477,3	**125,2**	1,7	**0,9368**	0,0014
			35.5	RT-B2	**UMD131122-236**	1068	0,6541	0,9618	0,000517	1265,7	**125,6**	1,6	**0,9456**	0,0043
			35	RT-C1	**UMD131122-237**	1004	0,6562	0,9654	0,000599	1095,4	**125,3**	1,8	**0,9507**	0,0039
			10	A	**Gif 3938**	1309	0,6429	0,9544	0,000954	674,0	**123,6**	1,4	**0,9354**	0,0012
			6.5	RT-C2	**UMD131122-252**	972	0,6450	0,9529	0,000215	3003,7	**124,9**	1,2	**0,9330**	0,0034
			1	D	**Gif 3940**	1725	0,6436	0,9590	0,001655	389,0	**122,5**	2,2	**0,9421**	0,0011
Abisso 50 (A50)	275	15.5	*14*	*A50b*	***UMD131122-280***	*355*	*0,5967*	*0,9585*	*0,096406*	*6,2*	***88,8***	*20,0*	***0,9466***	*0,0047*
			10	A50 1	**UMD140227-295**	1681	0,5176	0,9700	0,033461	15,5	**77,8**	6,0	**0,9626**	0,0026
			9	A502	**UMD140227-305**	1867	0,4843	0,9647	0,002576	188,0	**76,1**	0,7	**0,9562**	0,0025
			1.5	A503	**UMD140227-312**	955	0,4829	0,9746	0,001806	267,3	**74,6**	0,6	**0,9686**	0,0030
Tre Anelli (3A)	215	7.5	*7*	*3Ab*	***UMD131122-284***	*372*	*0,7135*	*0,9542*	*0,124851*	*5,7*	***128,2***	*27,9*	***0,9342***	*0,0063*
			5.5	3A	**UMD140227-349**	2970	0,5932	0,9460	0,002052	289,1	**108,8**	0,9	**0,9266**	0,0027
Pozzo Pollini (PP)	190	17.8	17	D3	**Gif 4538**	513	0,5378	0,9728	0,002398	224,3	**87,8**	0,7	**0,9651**	0,0020
			13.5	PP	**UMD131122-289**	295	0,5207	0,9760	0,002766	188,2	**83,1**	1,2	**0,9696**	0,0035
			10	PP1	**UMD140227-352**	795	0,5201	0,9702	0,018004	28,9	**81,1**	3,2	**0,9625**	0,0030
			9	D2	**Gif 4475**	652	0,4886	0,9499	0,008241	59,3	**77,9**	1,4	**0,9376**	0,0009
			8.5	D4	**Gif 4539**	670	0,4912	0,9566	0,008062	60,9	**77,7**	1,4	**0,9459**	0,0017
			5	PP2	**UMD140227-361**	1165	0,4859	0,9682	0,007278	66,8	**75,2**	1,4	**0,9607**	0,0025
Grotta Oliver (GO)	130	7.8	5	GO1	**UMD140227-341**	1217	0,0921	0,9492	0,023011	4,0	**7,0**	4,1	**0,9482**	0,0020
			1.5	GO2	**UMD140227-342**	924	0,0962	0,9431	0,026957	3,6	**6,9**	4,9	**0,9420**	0,0022

Ages corrected using the ^{230}Th and ^{234}U decay constants of Cheng et al. (2013), assuming an initial ^{230}Th/^{232}Th activity ratio of 1.5±1.5. All isotope ratios are expressed as activities. The $[^{234}U/^{238}U]_i$ is the initial ^{234}U/^{238}U activity ratio based on the corrected age. Errors are expressed **σ** notation (standard deviation). The number of samples for dating was chosen according to the length of the speleothems and the presence of clean calcite layers. UMD (University of