

Supporting Information Appendix

Variability of stalagmite-inferred Indian Monsoon precipitation over the past 252,000 years

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SI Materials and Methods

The interpretation of XBL $\delta^{18}\text{O}_c$. As explained in the main text, the amplitude of $\delta^{18}\text{O}_c$ variations in the XBL speleothem implies a signal dominated by changes in precipitation $\delta^{18}\text{O}_p$, rather than a temperature effect alone. Each measurement of precipitation $\delta^{18}\text{O}_p$ therefore reflects the cumulative history of precipitation and evaporation of water vapor en route to our site. Our interpretation can be simplified through the lens of Rayleigh distillation (1). If we consider an idealized parcel of water vapor that flows from the Bay of Bengal to XBL without any environmental mixing, the $\delta^{18}\text{O}_v$ of the vapor should become isotopically depleted as a parcel rains out. In practice, Rayleigh distillation cannot be applied in regions with local recycling of vapor during transport or other fractionation processes such as the re-evaporation of raindrops, but the relatively dry terrain of the Yunnan Plateau and Northern Indochina Peninsula should be suitable for such an interpretation.

It is crucial to our proposed interpretation of the XBL record that the path from the Bay of Bengal to our site remains mostly fixed during LGM conditions, and that there are not significant changes in land cover en route. Model results show that the moisture source and transport route remained largely unchanged during the LGM (SI Appendix, Fig. S7; Fig. 4), and sea-land changes around the Bay of Bengal are minor, unlike the exposure of the Sunda Shelf to the southeast.

In an ideal scenario, another speleothem $\delta^{18}\text{O}_c$ record would be available upstream of XBL, in which case the difference in $\delta^{18}\text{O}_c$ between the two sites would reflect total rainout amount en route (2, 3). However, it is known that downwind $\delta^{18}\text{O}_c$ records amplify the variability of changes upstream, a relation observed between the high-altitude Tibetan Plateau and low-altitude Indian Monsoon region in the Holocene (3). As a result, the rainout quantity revealed by subtracting two $\delta^{18}\text{O}_c$ records should also be independently reflected in each of the individual records. Since precipitation over the Bay of Bengal should account for most precipitation en route, we argue that XBL $\delta^{18}\text{O}_c$ functions as an index of rainfall over the Bay of Bengal. The good agreement ($r=0.56$) of salinity record KL 126 from the northern Bay of Bengal (4) with XBL provides additional confirmation of this interpretation. We also observe good correlation in rain gauge data between June-July-August precipitation at XBL and precipitation over the Monsoon Region of India. We therefore conclude that XBL $\delta^{18}\text{O}_c$ serves as a proxy of Indian Monsoon strength, defined as the intensity of rainfall over both the Bay of Bengal and the Monsoon Zone.

The reliability of our isotope-enabled GCM simulations. The model used in this paper is the National Center for Atmospheric Research (NCAR) Community Atmospheric Model version 2 (CAM2)(5), into which we have added a water-isotope module (6). The resolution of the atmospheric component of CAM2 is T42 (approximately 2.8° latitude x 2.8° longitude), with 26 vertical atmospheric layers from the surface up to 2 hPa. The water isotope module estimates fractionation associated with evaporation from the surface and in-situ evaporation and

condensation associated with cloud processes. A unique feature is the treatment of temperature- and drop-size dependent isotopic disequilibrium between vapor and raindrops. For the present-day run, the model was forced by climatological monthly mean sea surface temperatures derived from observations from 1949-2001. For the LGM run, continental ice sheet extent and topography was prescribed from the ICE-5G reconstruction (7), and atmospheric CO₂, CH₄ and N₂O concentrations of 185ppm, 350 ppb, and 220 ppb respectively were specified. Monthly SST and sea ice distributions were taken from a fully coupled Community Climate System Model (8).

The model is very similar to CAM3 employed in (9) and (10). The limitations of the atmospheric model and isotopic scheme are described by (6). Our LGM and present-day runs have also been previously used to interpret ice core data (11) and precipitation $\delta^{18}\text{O}_p$ changes in South America (12). As is expected of a relatively coarse-resolution general circulation model, the modeled present-day precipitation and $\delta^{18}\text{O}_p$ show biases relative to observations in the vicinity of the Tibetan Plateau. Similar to (9), our model yields reasonable simulations of large-scale circulation changes and can be used to interpret changes over East Asia.

Supplementary Figures

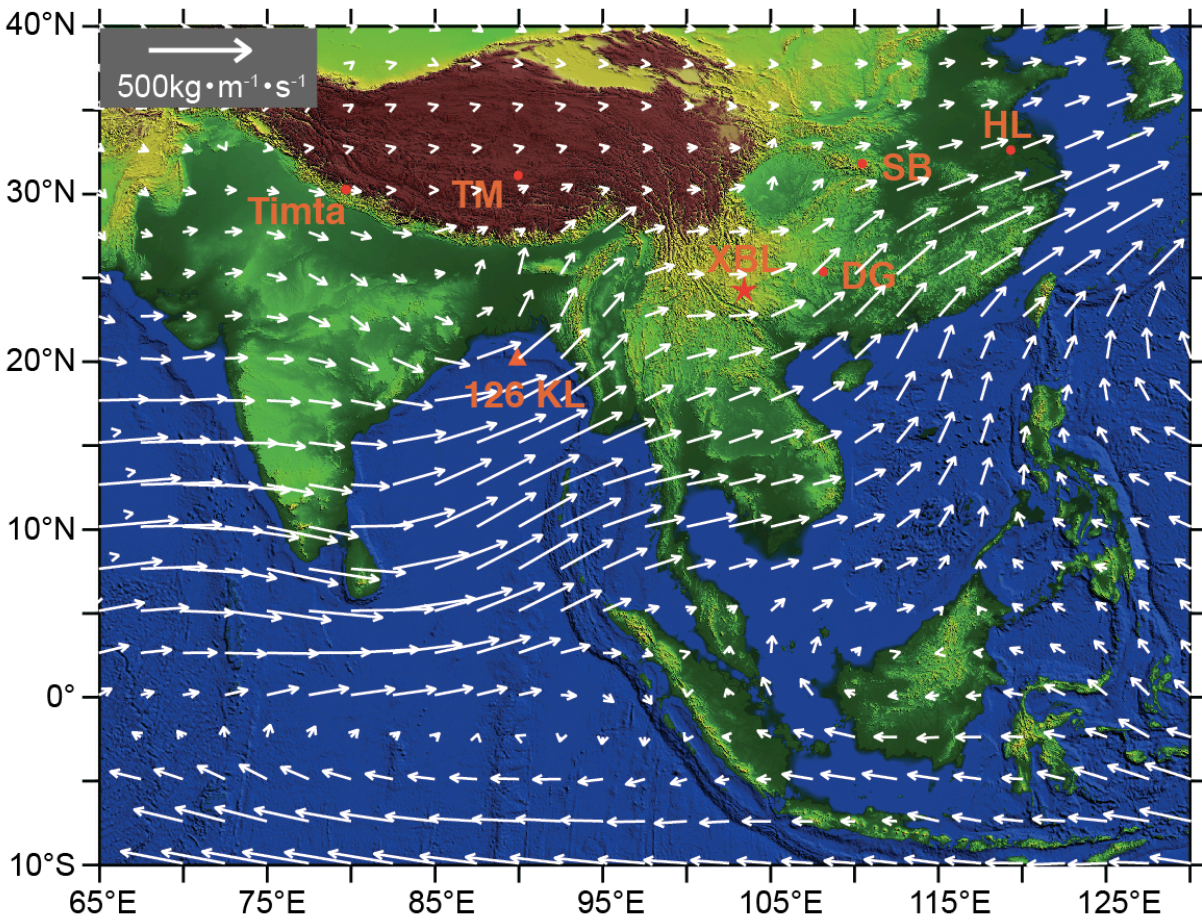


Figure S1. The location of Xiaobailong cave (XBL, red star, $24^{\circ}12'N$, $103^{\circ}21'E$) and present-day moisture transport patterns after the onset of monsoon (5^{th} pentad of May – 2^{nd} pentad of July, averaged from 1990-1999, adapted from (13)). The locations of other cave sites are indicated by red solid circles: Hulu cave (HL)(14); Dongge cave (DG) (15,16); Sanbao and Linzhu Caves (SB)(17, 18); Tianmen cave (TM) (3, 19) in China; and Timta cave in India (20). The red triangle indicates the location of marine core 126KL (4).

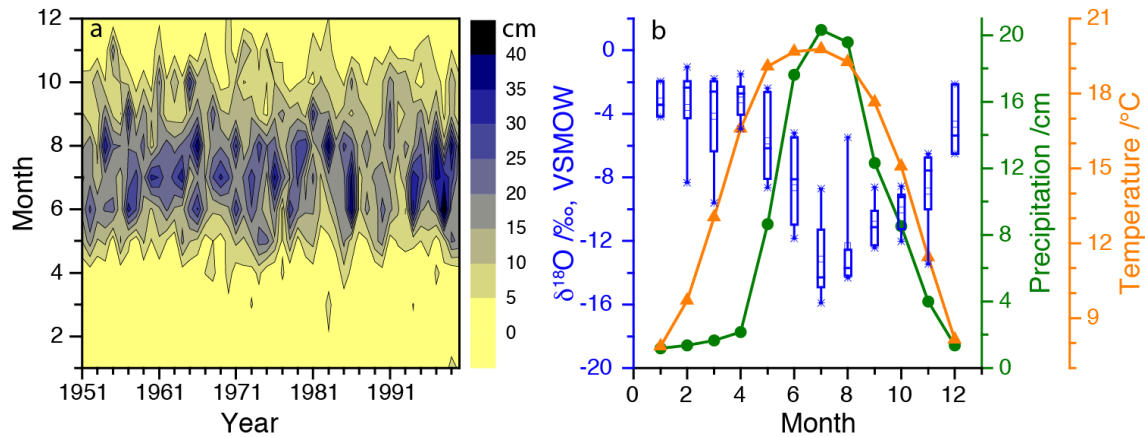


Figure S2. (a) Monthly precipitation for 1951-2000 observed at Kunming meteorological observatory, demonstrating that rainfall is concentrated between June and September. (b) Monthly mean precipitation (green solid circles), temperature (yellow triangles) and $\delta^{18}\text{O}$ of precipitation (blue box-and-whisker diagram) at Kunming ($25^{\circ}1' \text{N}$, $102^{\circ}24' \text{E}$) meteorological observatory. The $\delta^{18}\text{O}_p$ data are from the IAEA/WMO 2006 (<http://isohis.iaea.org>).

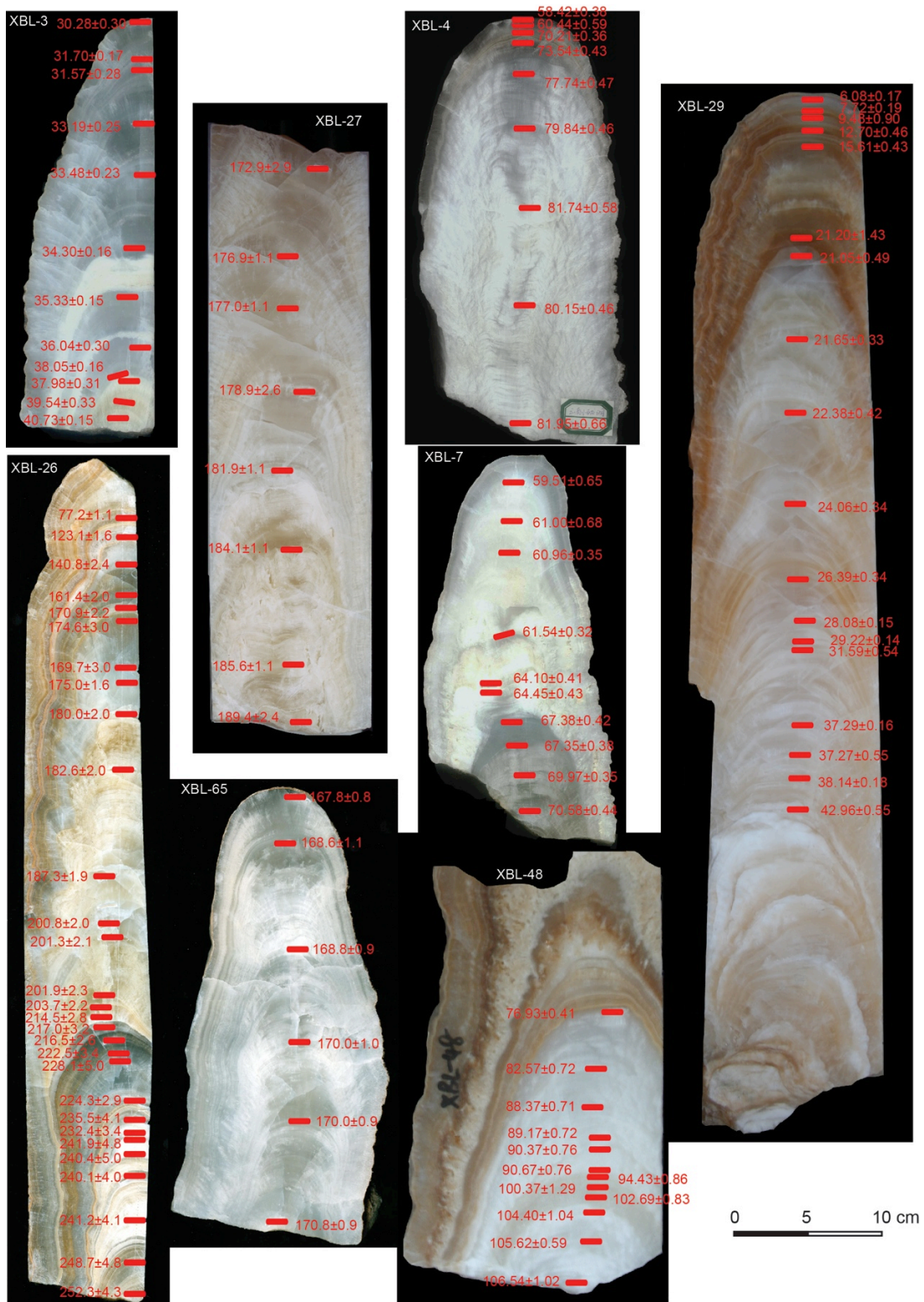


Figure S3. Images of stalagmites used to establish the XBL $\delta^{18}O_e$ record. All ^{230}Th dating positions are marked on the stalagmites with red rectangles, and ages (ka BP) are also labeled with 2σ error.

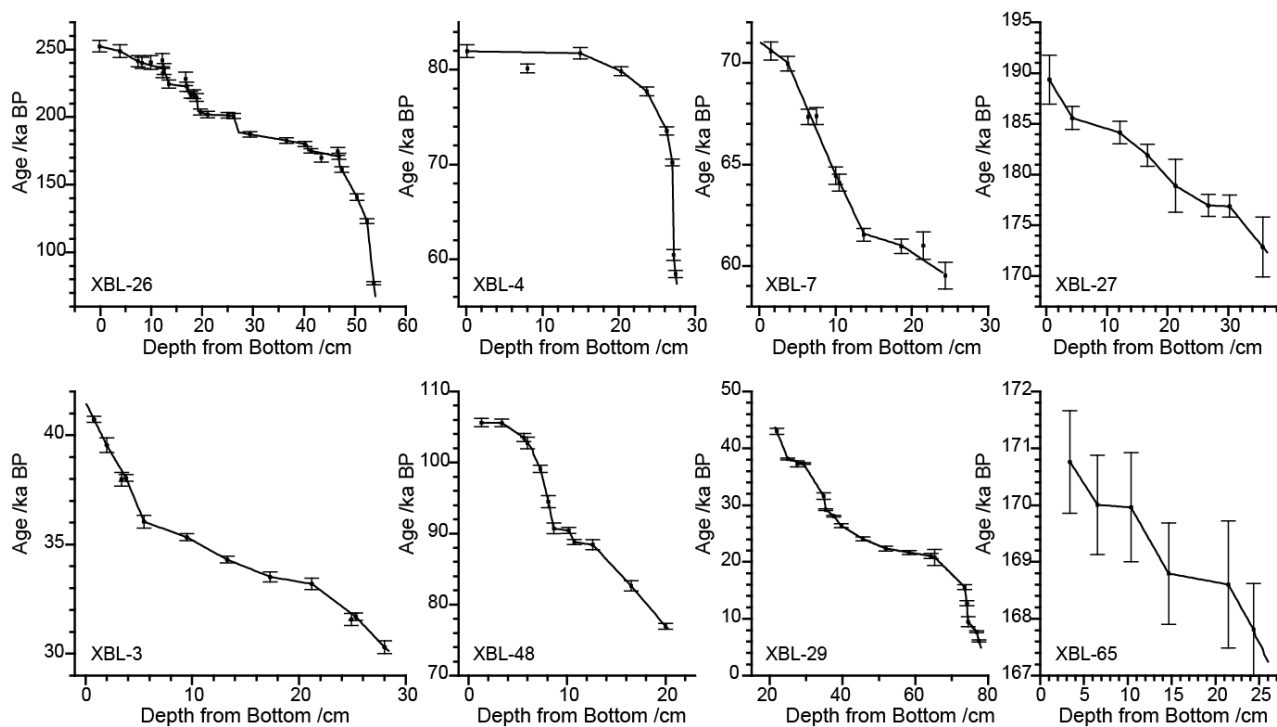


Figure S4. Plots of age versus depth for stalagmites XBL-3, XBL-4, XBL-7, XBL-26, XBL-27, XBL-29, XBL-48 and XBL-65 from Xiaobailong cave. All ages are reported in units of thousands of years before present (1950 AD), ka BP. The age errors indicated in the plots are 2σ error. Linear interpolation is used to establish the chronology for each sample.

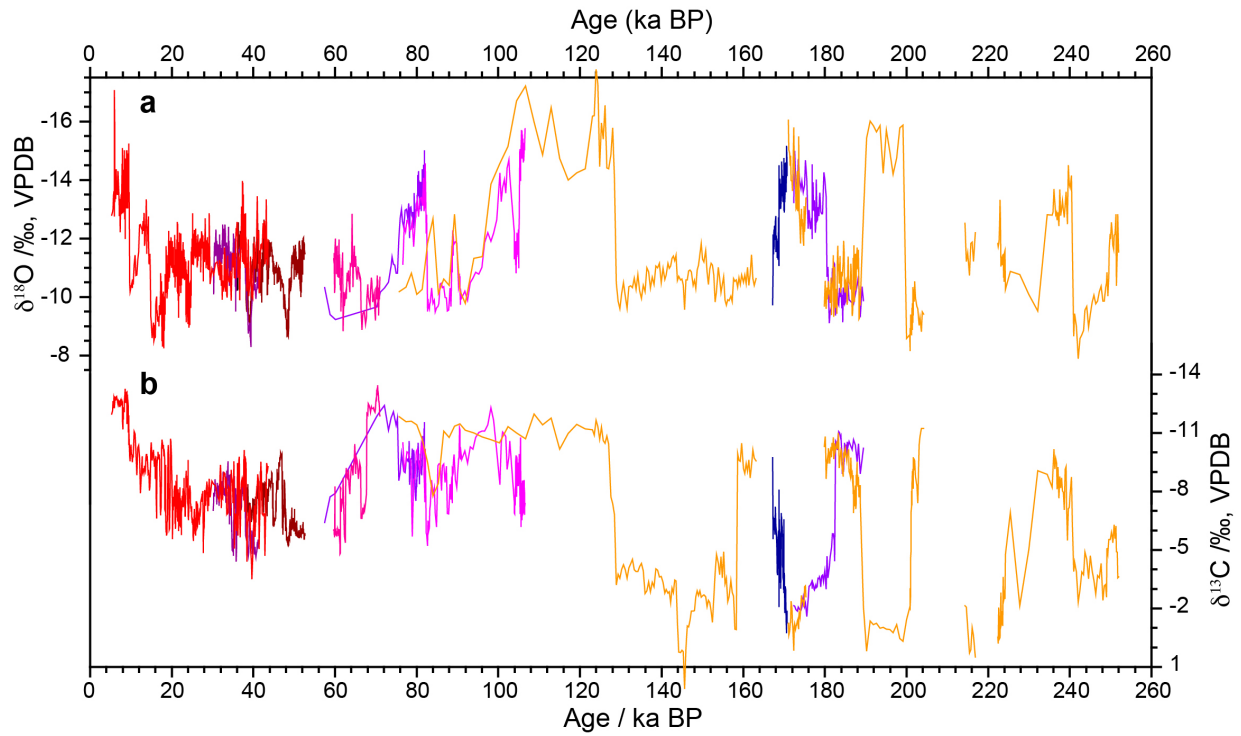


Figure S5. The time series of speleothem $\delta^{18}\text{O}_c$ and $\delta^{13}\text{C}$ obtained from Xiaobailong Cave. The different colors denote different stalagmites (the same as in Fig. 1). Replications in both $\delta^{18}\text{O}_c$ and $\delta^{13}\text{C}$ profiles indicate that the variations of $\delta^{18}\text{O}_c$ are dominated by climate variations, i.e., changes in the oxygen isotopic composition of meteoric precipitation and cave temperature at the time of calcite precipitation.

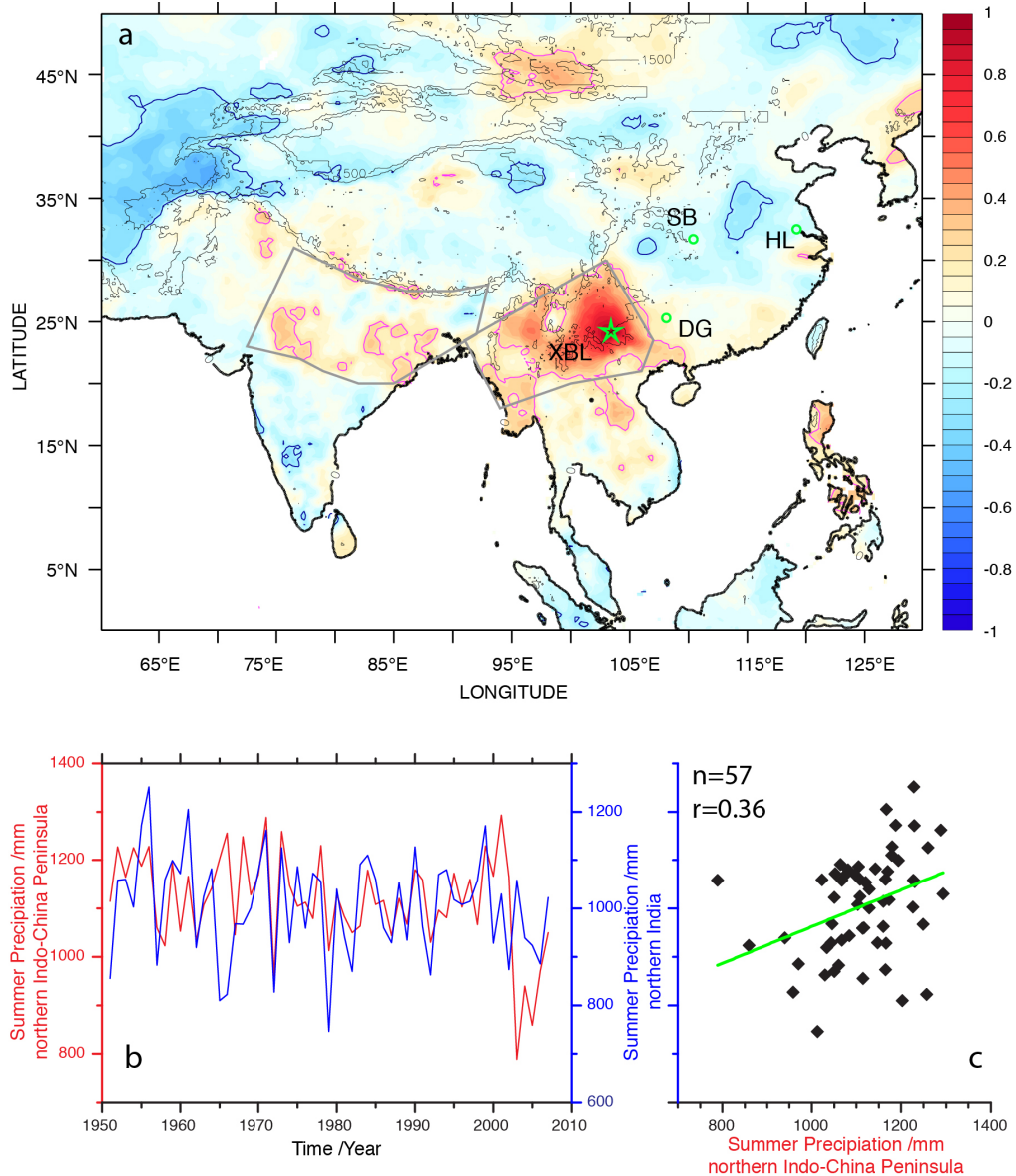


Figure S6. (a) Correlation between summer half-year (May to October) precipitation at XBL cave site and other regions during the period 1951-2007. The pink (blue) contour denotes the region of positive (negative) correlation above 95% confidence level. (b) Comparison of summer half-year average precipitation at northern India and northern Indo-China Peninsula (as denoted by gray polygons in panel a) from 1951-2007. (c) Precipitation of northern India versus that of northern Indo-China Peninsula, indicating the precipitations at these two regions are positively correlated. Data source: APHRODITE (Asian Precipitation - Highly-Resolved Observational Data Integration Towards Evaluation of Water Resources, APHRO_MA_V1101R2 product, (21)).

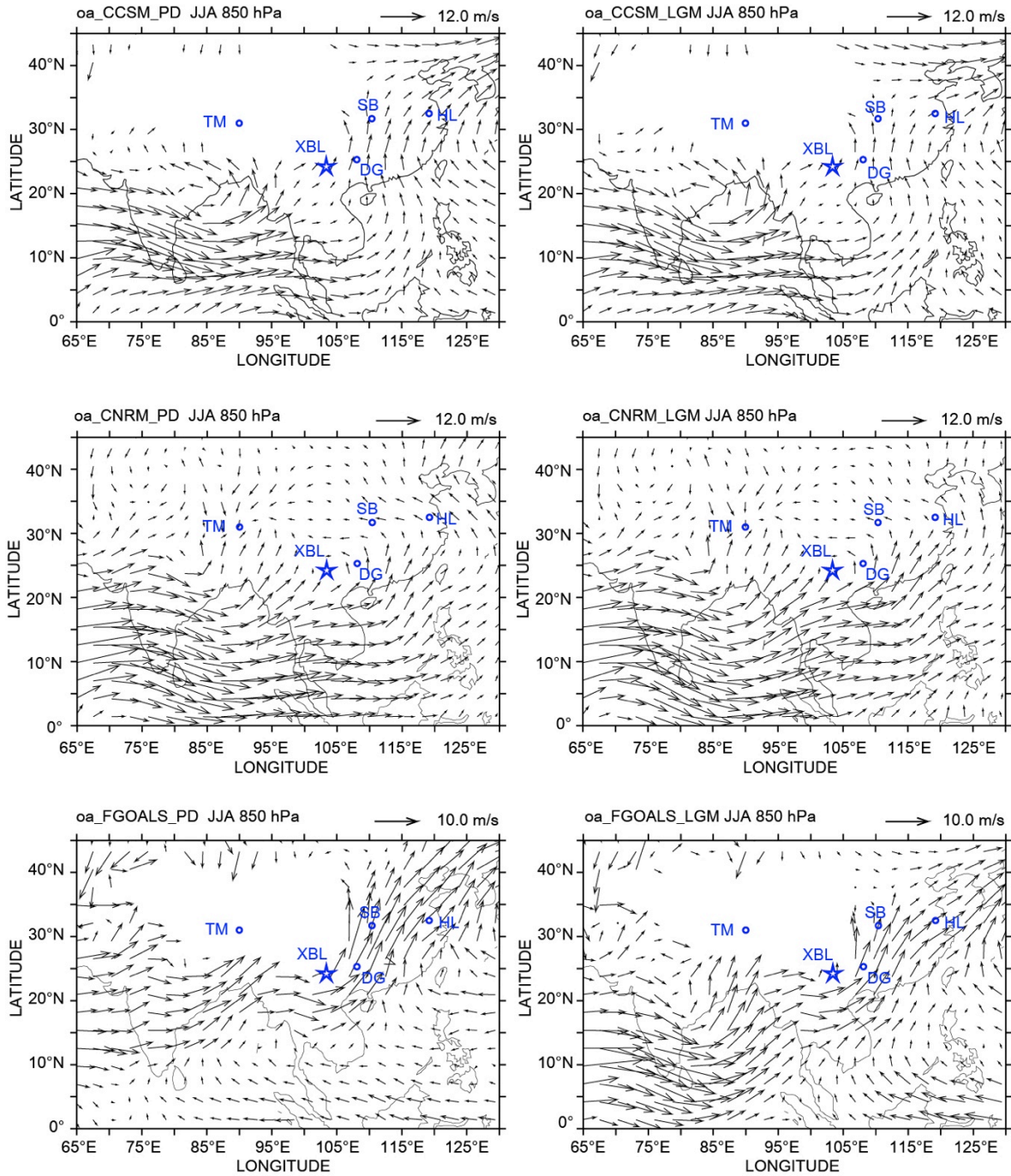


Figure S7-a. South Asia JJA 850 hPa wind for Present Day and the Last Glacial Maximum (LGM) in ocean-atmosphere coupled global circulation models (GCMs) from the PMIP2 (Paleoclimate Modeling Intercomparison Project, Phase II) database (22). Markers indicate the locations of the following caves: XBL, Xiaobailong cave; TM, Tianmen cave; SB, Sanbao cave; DG, Dongge cave; HL, Hulu cave. Comparing the LGM to Present Day, the wind field upstream of XBL cave does not show significant change in any of the models, indicating that the Bay of Bengal was the primary source of the moisture of the XBL cave.

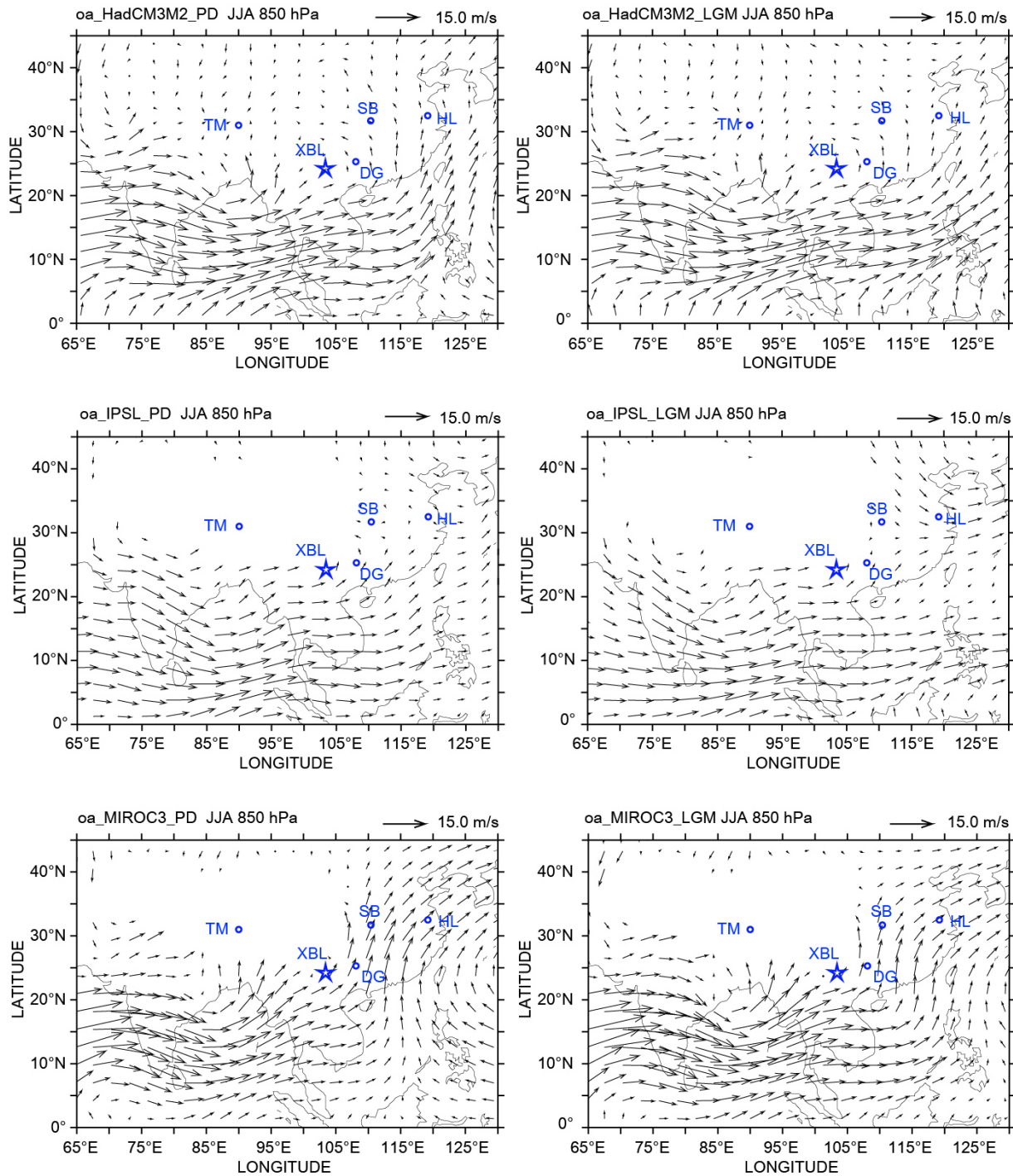


Figure S7-b. South Asia JJA 850 hPa wind for Present Day and the Last Glacial Maximum (LGM) in ocean-atmosphere coupled global circulation models (GCMs) from the PMIP2 (Paleoclimate Modeling Intercomparison Project, Phase II) database (22). Markers indicate the locations of the following caves: XBL, Xiaobailong cave; TM, Tianmen cave; SB, Sanbao cave; DG, Dongge cave; HL, Hulu cave. Comparing the LGM to Present Day, the wind field upstream of XBL cave does not show significant change in any of the models, indicating that the Bay of Bengal was the primary source of the moisture of the XBL cave.

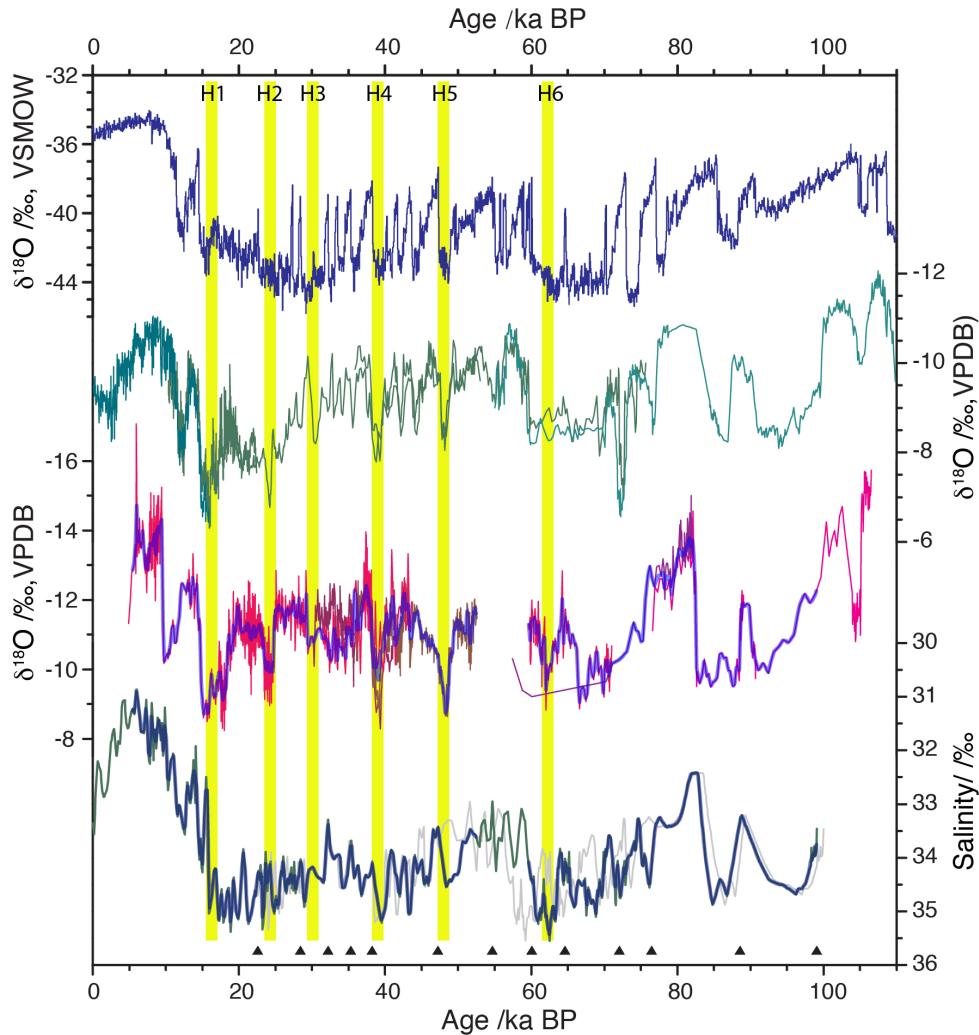


Figure S8. Comparison of speleothem $\delta^{18}\text{O}_c$ records from Xiaobailong and Hulu-Dongge-Sanbao caves (17) with salinity records reconstructed from 126 KL, Bay of Bengal (4) and NGRIP ice core $\delta^{18}\text{O}$ record (23) over the last 110 kyrs. The gray line in the salinity record uses the original published chronology while the green line is a new chronology tuned to the updated NGRIP ice core record. The triangles beneath the curve indicate the tie points. The yellow bars indicate the weak monsoon intervals coincident with cold Heinrich events in North Atlantic. There is a clear visual match between the XBL $\delta^{18}\text{O}_c$ and the ODP 126 KL reconstructed salinity records and the two 200-yr smoothed records (blue thick lines) have a correlation coefficient of $r=0.56$ ($n=435$), indicating that a correlation exists between these two records on centennial to orbital time scales.

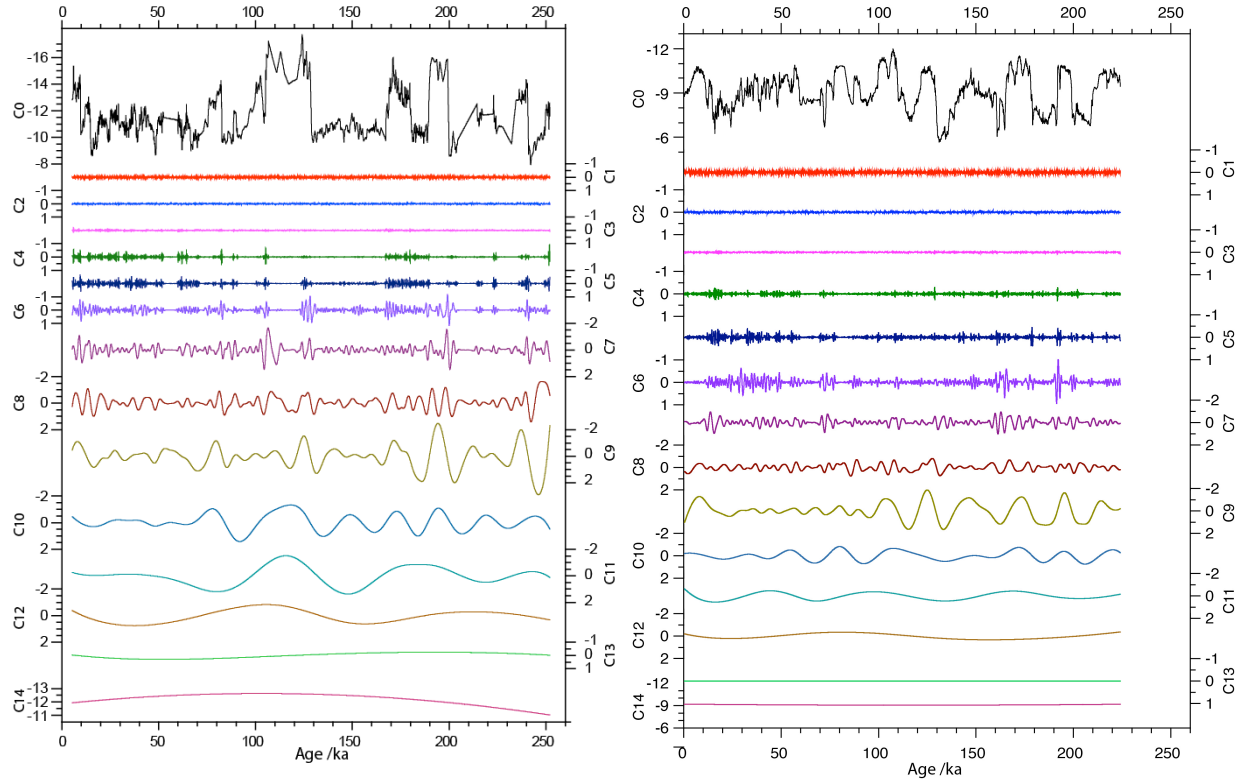


Figure S9. Intrinsic components of the ensemble empirical mode decomposition (EEMD) of the (a) XBL and (b) Hulu-Dongge-Sanbao composite $\delta^{18}\text{O}_c$ records. We combined the different stalagmite records by interpolating each to 10 yr resolution and averaging to produce the XBL composite record. White noise of 0.4 (0.2 standard deviations of the data) and the ensemble number of 500 are used for the first EEMD decomposition. To remove high-frequency fluctuations, new time series were formed by summing components C5-14 from the first decomposition (C0 in the figure). EEMD analysis (24) was repeated for new time series with white noise of 0.4 and ensemble size of 300, producing the components shown above.

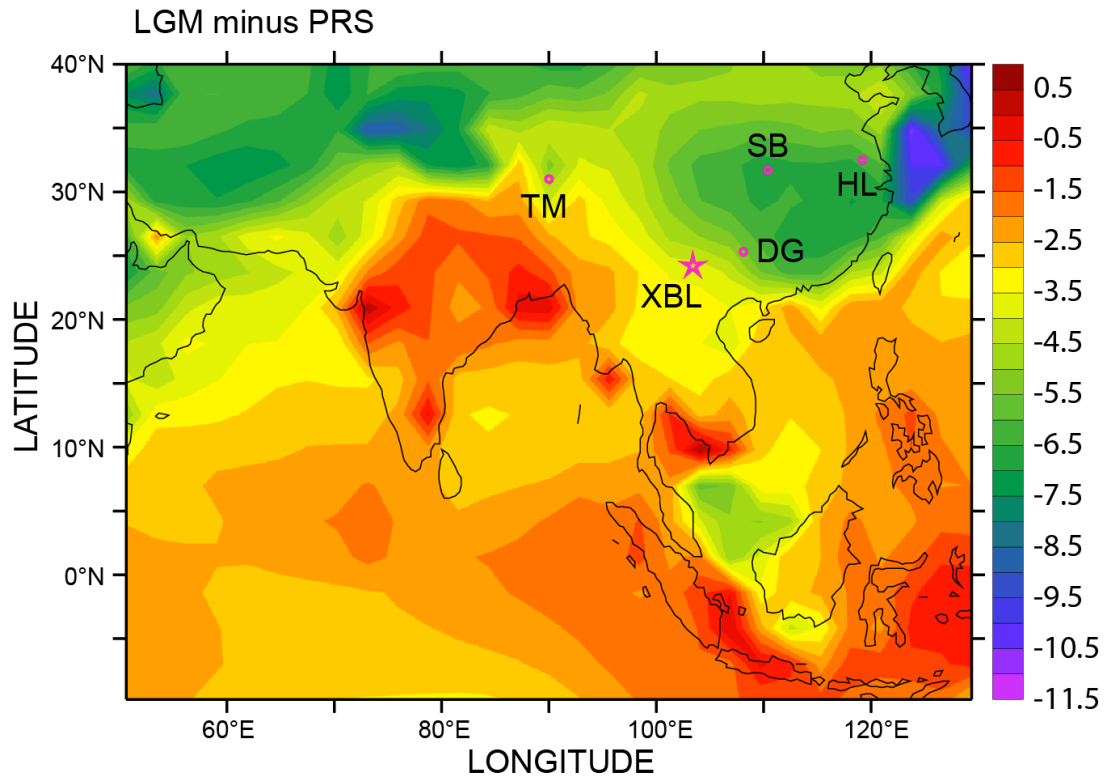


Figure S10. Modeled temperature difference between LGM and Present Day. It indicates that the temperature changes are $\sim 4 \pm 0.5^\circ\text{C}$ at XBL cave, $\sim 6 \pm 0.5^\circ\text{C}$ at Hulu and Sanbao caves. Here we use the 4°C and 6°C for XBL and HL-DG-SB caves respectively to calculate the speleothem calcite $\delta^{18}\text{O}$ by using the temperature dependent fraction (25).

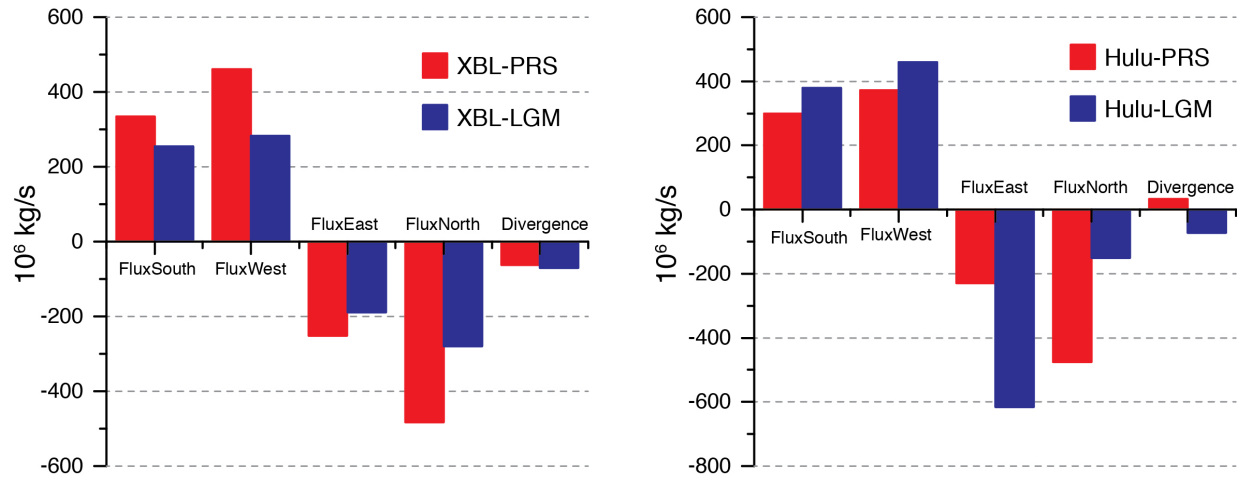


Figure S11. Vertically-integrated water vapor fluxes and divergence into and out of boxes around (a) XBL (100-110°E, 20-30°N) and (b) Hulu (115-125°E, 25-35°N). Present-day values are in red and LGM values are in blue. FluxSouth, FluxWest, FluxEast and FluxNorth denote integrated water vapor flux across the southern, western, eastern and northern boundaries of the boxes. Here positive values indicate fluxes into the boxes and negative values indicate fluxes out of the boxes. Unit is 10^6 kg s^{-1} .

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Supplementary Table S1. ²³⁰Th dating results. The error is 2σ error.

Sample Number	Distance from bottom/mm	²³⁸ U (ppb)	²³² Th (ppt)	²³⁰ Th / ²³² Th (atomic x10 ⁻⁶)	δ ²³⁴ U* (measured)	²³⁰ Th / ²³⁸ U (activity)	²³⁰ Th Age (ky) (uncorrected)	²³⁰ Th Age (ky BP)*** (corrected)	δ ²³⁴ U _{Initial} ** (corrected)
XBL3-8	8	5170.8±7.1	1615±14	17080±150	34.9±1.5	0.3232±0.0008	40.79±0.15	40.73±0.15	39.2±1.6
XBL3-20	20	6110.7±35.2	425±7	74910±1250	36.0±2.4	0.3156±0.0020	39.59±0.33	39.54±0.33	40.2±2.7
XBL3-34	34	7791.5±44.2	1081±8	36390±300	37.6±2.3	0.3058±0.0020	38.04±0.31	37.98±0.31	41.8±2.6
XBL3-38	38	3116.8±5.3	521±10	30310±560	39.8±1.8	0.3069±0.0009	38.11±0.16	38.05±0.16	44.3±2.0
XBL3-55	55	138.0±0.2	1279±9	525±5	38.6±2.3	0.2946±0.0017	36.35±0.27	36.04±0.30	42.8±2.6
XBL3-95	95	190.2±0.2	47±8	272280±63180	43.3±1.2	0.2892±0.0010	35.39±0.15	35.33±0.15	47.8±1.3
XBL3-133	133	161.8±0.2	56±8	42190±18900	50.3±1.3	0.2840±0.0011	34.36±0.16	34.30±0.16	55.4±1.4
XBL3-173	173	170.9±0.2	210±7	3720±130	46.0±2.2	0.2774±0.0015	33.57±0.23	33.48±0.23	50.6±2.4
XBL3-212	212	141.0±0.2	256±8	2500±80	45.3±2.4	0.2753±0.0017	33.30±0.25	33.19±0.25	49.8±2.6
XBL3-249	249	115.4±0.2	156±6	3240±130	52.7±2.5	0.2655±0.0019	31.66±0.28	31.57±0.28	57.6±2.7
XBL3-253	253	156.5±0.2	35±10	30850±13500	52.2±1.4	0.2659±0.0012	31.76±0.17	31.70±0.17	57.1±1.6
XBL3-280	280	120.6±0.3	358±13	1415±51	45.2±3.6	0.2546±0.0020	30.42±0.30	30.28±0.30	49.2±4.0
XBL7-15	15	397.9±1.0	837±6	3920±30	43.5±2.2	0.4993±0.0019	70.69±0.44	70.58±0.44	53.1±2.7
XBL7-37	37	427.7±0.6	485±6	7240±90	44.7±1.5	0.4967±0.0016	70.06±0.35	69.97±0.35	54.5±1.8
XBL7-64	64	298.0±0.4	78±7	30650±2570	55.3±1.6	0.4884±0.0018	67.41±0.38	67.35±0.38	66.9±2.0
XBL7-75	75	310.1±0.4	341±7	7270±140	46.3±1.5	0.4842±0.0021	67.47±0.42	67.38±0.42	56.0±1.8
XBL7-100	100	297.8±0.8	357±6	6460±110	47.4±2.3	0.4692±0.0020	64.53±0.43	64.45±0.43	56.8±2.7
XBL7-105	105	299.5±0.7	296±6	7780±160	44.0±2.1	0.4657±0.0020	64.18±0.41	64.10±0.41	52.8±2.5
XBL7-137	137	256.3±0.3	94±5	20280±1040	40.6±1.5	0.4501±0.0016	61.60±0.32	61.54±0.32	48.3±1.8
XBL7-186	186	3793.4±13.0	122±6	231030±11100	50.7±1.6	0.4516±0.0018	61.02±0.35	60.96±0.35	60.3±1.9
XBL7-215	215	4328.6±30.6	190±6	170620±5020	53.8±2.9	0.4533±0.0035	61.06±0.68	61.00±0.68	64.0±3.4
XBL7-244	244	1886.7±13.1	121±5	112710±4490	35.9±3.0	0.4368±0.0033	59.57±0.65	59.51±0.65	42.5±3.5
XBL65-4	4	131.0±0.1	104±2	17650±370	57.8±1.3	0.8466±0.0014	170.8±0.9	170.8±0.9	93.7±2.2
XBL65-66	66	135.3±0.1	42±1	44410±990	54.5±1.4	0.8418±0.0013	170.1±0.9	170.0±0.9	88.1±2.2
XBL65-104	104	159.6±0.2	65±1	34200±720	55.0±1.4	0.8422±0.0015	170.0±1.0	170.0±1.0	88.9±2.3
XBL65-147	147	150.7±0.2	72±2	28960±620	58.9±1.4	0.8435±0.0014	168.9±0.9	168.8±0.9	94.9±2.3
XBL65-215	215	185.9±0.2	111±2	23170±480	58.8±1.4	0.8429±0.0020	168.7±1.1	168.6±1.1	94.6±2.3
XBL65-244	244	197.9±0.2	103±2	26560±560	51.6±1.3	0.8344±0.0012	167.9±0.8	167.8±0.8	82.8±2.2
XBL27-5	5	221.4±0.5	53±9	59540±9710	36.8±2.2	0.8607±0.0035	189.4±2.4	189.4±2.4	62.8±3.7
XBL27-43	43	231.2±0.3	238±5	13740±280	40.4±1.5	0.8582±0.0014	185.7±1.1	185.6±1.1	68.2±2.5
XBL27-121	121	214.8±0.2	200±4	15250±310	44.2±1.4	0.8594±0.0014	184.2±1.1	184.1±1.1	74.4±2.4
XBL27-167	167	111.1±0.1	108±2	14520±300	43.0±1.4	0.8541±0.0014	182.0±1.1	181.9±1.1	71.8±2.3
XBL27-213	213	80.6±0.2	22±8	52470±20030	48.0±2.9	0.8528±0.0041	178.9±2.6	178.9±2.6	79.6±4.8
XBL27-267	267	57.5±0.0	153±3	5240±110	40.9±1.4	0.8428±0.0016	177.1±1.1	177.0±1.1	67.5±2.3
XBL27-302	302	68.6±0.1	46±1	20630±460	40.6±1.4	0.8422±0.0016	177.0±1.1	176.9±1.1	66.9±2.3
XBL27-357	357	34.0±0.1	47±6	9890±1260	40.5±3.4	0.8338±0.0049	172.9±2.9	172.9±2.9	66.0±5.5
XBL26-0.5	1	99.8±0.2	867±3	1780±10	28.8±2.1	0.9342±0.0033	252.6±4.3	252.3±4.3	58.7±4.4
XBL26-39	39	116.1±0.2	276±3	6430±80	25.0±2.7	0.9262±0.0036	248.8±4.8	248.7±4.8	50.4±5.4
XBL26-74	74	95.7±0.2	61±3	23900±1060	24.9±2.6	0.9184±0.0032	241.3±4.1	241.2±4.1	49.2±5.2
XBL26-82	82	205.8±0.4	31±2	101480±7830	25.6±2.6	0.9181±0.0031	240.2±4.0	240.1±4.0	50.5±5.2
XBL26-99	99	3377.4±14.3	53±3	973870±49520	30.5±2.4	0.9239±0.0046	240.5±5.0	240.4±5.0	60.2±4.7
XBL26-122	122	107.2±0.3	83±6	19570±1420	22.9±2.6	0.9170±0.0040	242.0±4.8	241.9±4.8	45.4±5.2
XBL26-123	123	172.7±0.2	409±5	6340±80	25.1±1.9	0.9092±0.0032	232.6±3.4	232.4±3.4	48.5±3.6
XBL26-125	125	171.3±0.3	625±3	4130±20	24.8±2.9	0.9123±0.0033	235.7±4.1	235.5±4.1	48.3±5.6
XBL26-135	135	226.7±0.3	696±8	4860±60	28.8±1.9	0.9036±0.0029	224.5±2.9	224.3±2.9	54.3±3.6
XBL26-168	168	61.3±0.2	1488±7	621±4	32.8±3.3	0.9133±0.0048	228.9±5.1	228.1±5.0	62.5±6.4
XBL26-170	170	222.0±0.4	225±3	14630±210	26.7±2.6	0.8989±0.0032	222.6±3.4	222.5±3.4	50.1±5.0

Table S1. (Cont.)

Sample Number	Distance from bottom/mm	²³⁸ U (ppb)	²³² Th (ppt)	²³⁰ Th / ²³² Th (atomic x10 ⁻⁶)	δ ²³⁴ U* (measured)	²³⁰ Th / ²³⁸ U (activity)	²³⁰ Th Age (ky) (uncorrected)	²³⁰ Th Age (ky BP)** (corrected)	δ ²³⁴ U _{initial} ** (corrected)
XBL26-178	178	157.0±0.2	639±6	3630±40	28.5±1.7	0.8933±0.0029	216.6±2.6	216.5±2.6	52.6±3.2
XBL26-184	184	152.8±0.3	1493±10	1510±10	28.9±2.1	0.8945±0.0035	217.3±3.2	217.0±3.2	53.3±4.0
XBL26-189	189	136.2±0.3	460±6	4390±60	37.0±2.4	0.8997±0.0029	214.6±2.8	214.5±2.8	67.9±4.4
XBL26-197	197	300.8±0.5	112±9	39500±3080	42.1±2.0	0.8894±0.0026	203.8±2.2	203.7±2.2	74.9±3.5
XBL26-211	211	244.9±0.3	19±7	188380±67760	39.3±1.6	0.8836±0.0031	201.9±2.3	201.9±2.3	69.6±2.9
XBL26-251	251	228.7±0.3	19±7	171340±59670	41.1±1.6	0.8846±0.0029	201.3±2.1	201.3±2.1	72.6±2.9
XBL26-262	262	97.9±0.1	50±10	28690±5990	39.2±1.8	0.8819±0.0024	200.9±2.0	200.8±2.0	69.2±3.1
XBL26-294	294	152.1±0.2	25±5	85260±18330	37.8±1.8	0.8580±0.0028	187.3±1.9	187.3±1.9	64.1±3.2
XBL26-366	366	193.0±0.3	73±7	36580±3570	29.8±2.1	0.8419±0.0029	182.7±2.0	182.6±2.0	50.0±3.5
XBL26-402	402	177.5±0.3	178±5	13950±380	38.3±2.1	0.8456±0.0030	180.1±2.0	180.0±2.0	63.7±3.6
XBL26-414	414	110.1±0.2	77±8	19660±1960	35.4±2.0	0.8330±0.0024	175.0±1.6	175.0±1.6	58.1±3.2
XBL26-434	434	66.5±0.2	32±6	27860±5480	37.8±4.5	0.8249±0.0044	169.8±3.0	169.7±3.0	61.1±7.3
XBL26-466	466	43.1±0.1	90±6	6630±450	39.0±3.8	0.8357±0.0047	174.7±3.0	174.6±3.0	63.8±6.2
XBL26-469	469	71.9±0.1	1935±11	511±4	41.2±1.7	0.8320±0.0042	171.7±2.2	170.9±2.2	66.9±2.8
XBL26-474	474	102.7±0.1	156±6	8830±340	40.9±2.5	0.8099±0.0039	161.5±2.0	161.4±2.0	64.5±4.0
XBL26-504	504	50.8±0.1	120±6	5320±290	43.5±3.8	0.7621±0.0054	140.9±2.4	140.8±2.4	64.8±5.7
XBL26-524	524	100.6±0.1	65±7	17980±1900	38.3±2.5	0.7063±0.0047	123.2±1.6	123.1±1.6	54.3±3.6
XBL26-535	535	96.2±0.1	286±6	2940±70	39.0±2.7	0.5295±0.0050	77.4±1.1	77.2±1.1	48.5±3.3
XBL48-13	13	313.4±0.8	871±3	4060±20	85.2±3.4	0.6840±0.0031	106.66±1.02	106.54±1.02	115.1±4.7
XBL48-34	34	285.0±0.4	90±5	35840±2090	87.4±1.7	0.6818±0.0020	105.69±0.59	105.62±0.59	117.9±2.2
XBL48-56	56	389.9±0.8	30±3	143870±13880	87.8±3.0	0.6773±0.0035	104.46±1.04	104.40±1.04	118.0±4.0
XBL48-67	67	396.1±0.9	200±3	21740±370	78.0±3.0	0.6643±0.0025	102.76±0.83	102.69±0.83	104.3±4.0
XBL48-73	73	201.3±0.6	53±3	41200±2250	75.5±5.4	0.6528±0.0037	100.43±1.30	100.37±1.29	100.3±7.2
XBL48-81	81	217.9±0.5	245±4	9150±150	69.2±3.4	0.6248±0.0029	94.52±0.86	94.43±0.86	90.3±4.4
XBL48-86	86	294.4±0.6	227±4	12850±210	57.2±3.1	0.6011±0.0026	90.75±0.76	90.67±0.76	73.8±4.0
XBL48-102	102	358.1±0.8	90±2	39450±1010	63.5±2.9	0.6032±0.0027	90.44±0.76	90.37±0.76	82.0±3.7
XBL48-108	108	283.2±0.5	110±3	25530±600	70.4±2.7	0.6023±0.0027	89.24±0.72	89.17±0.72	90.6±3.4
XBL48-126	126	267.3±0.6	372±3	7070±60	66.6±3.0	0.5971±0.0025	88.47±0.71	88.37±0.71	85.5±3.9
XBL48-165	165	229.2±0.5	216±3	9910±150	60.9±3.1	0.5673±0.0028	82.65±0.72	82.57±0.72	76.9±3.9
XBL48-200	200	216.1±0.3	87±4	22230±1030	64.1±1.6	0.5418±0.0018	77.00±0.41	76.93±0.41	79.7±2.0
XBL4-1	1	293.0±0.4	566±7	4970±70	90.5±2.2	0.5814±0.0029	82.06±0.66	81.95±0.66	114.2±2.7
XBL4-80	80	264.3±0.3	109±6	22600±1170	80.6±1.4	0.5667±0.0021	80.22±0.46	80.15±0.46	101.1±1.8
XBL4-150	150	299.1±0.4	526±9	5360±100	75.1±2.3	0.5713±0.0024	81.84±0.58	81.74±0.58	94.6±3.0
XBL4-203	203	295.9±0.4	71±6	38990±3290	79.4±1.6	0.5645±0.0020	79.90±0.46	79.84±0.46	99.5±2.0
XBL4-237	237	780.0±0.8	816±12	9120±140	120.7±1.9	0.5776±0.0022	77.82±0.47	77.74±0.47	150.4±2.4
XBL4-263	263	266.2±0.4	1112±6	2062±14	57.1±1.6	0.5217±0.0020	73.71±0.43	73.54±0.43	70.3±2.0
XBL4-270	270	475.9±0.7	810±5	5011±37	81.0±1.4	0.5169±0.0018	70.31±0.36	70.21±0.36	98.8±1.7
XBL4-272	272	209.5±0.3	2429±23	651±7	65.3±3.8	0.4572±0.0027	60.81±0.57	60.44±0.59	77.5±4.5
XBL4-275	275	162.7±0.2	133±5	9050±330	73.4±2.2	0.4476±0.0020	58.50±0.38	58.42±0.38	86.6±2.6
XBL29-39	39	63.7±0.1	447±7	803±14	41.0±3.3	0.3410±0.0033	43.21±0.54	42.96±0.55	46.3±3.8
XBL29-69	69	57.6±0.1	217±4	1351±28	38.3±2.3	0.3082±0.0009	38.31±0.17	38.14±0.18	42.7±2.6
XBL29-95	95	13.8±0.0	82±6	844±63	40.9±4.6	0.3031±0.0034	37.49±0.54	37.27±0.55	45.5±5.1
XBL29-112	112	34.3±0.0	45±1	3812±93	46.8±1.5	0.3045±0.0010	37.39±0.16	37.29±0.16	52.0±1.6
XBL29-168	168	35.5±0.1	447±9	348±8	44.6±3.1	0.2662±0.0034	32.00±0.48	31.59±0.54	48.7±3.4
XBL29-173	173	39.0±0.0	65±1	2429±53	44.6±1.4	0.2467±0.0009	29.32±0.13	29.22±0.14	48.4±1.5
XBL29-195	195	47.1±0.0	66±1	2771±62	37.5±1.7	0.2366±0.0010	28.17±0.15	28.08±0.15	40.6±1.8
XBL29-216	216	21.9±0.1	118±6	689±36	42.9±3.5	0.2258±0.0024	26.60±0.34	26.39±0.34	46.3±3.7
XBL29-275	275	58.9±0.1	82±3	2442±93	40.4±4.5	0.2068±0.0025	24.16±0.34	24.06±0.34	43.2±4.9
XBL29-338	338	9.3±0.0	21±6	1448±419	50.2±4.5	0.1958±0.0032	22.50±0.42	22.38±0.42	53.4±4.8

Table S1. (Cont.)

Sample Number	Distance from bottom/mm	²³⁸ U (ppb)	²³² Th (ppt)	²³⁰ Th / ²³² Th (atomic x10 ⁻⁶)	$\delta^{234}\text{U}^*$ (measured)	²³⁰ Th / ²³⁸ U (activity)	²³⁰ Th Age (ky) (uncorrected)	²³⁰ Th Age (ky BP) ^{***} (corrected)	$\delta^{234}\text{U}_{\text{initial}}^{**}$ (corrected)
XBL29-403	403	59.0±0.1	594±3	311±4	39.8±3.9	0.1899±0.0022	21.99±0.30	21.65±0.33	42.3±4.2
XBL29-463	463	93.8±0.2	2990±9	100±1	51.9±2.6	0.1921±0.0016	21.99±0.21	21.05±0.49	55.1±2.8
XBL29-473	473	72.2±0.1	6699±40	37±1	43.3±2.5	0.2051±0.0042	23.86±0.55	21.20±1.43	46.0±2.6
XBL29-555	555	15.1±0.0	296±6	120±3	34.6±4.4	0.1429±0.0026	16.22±0.33	15.61±0.43	36.1±4.6
XBL29-561	561	58.6±0.2	1290±6	89±2	31.0±4.7	0.1190±0.0028	13.38±0.35	12.70±0.46	32.1±4.9
XBL29-564	564	26.1±0.1	1424±5	30±1	41.5±5.6	0.1005±0.0040	11.08±0.46	9.48±0.90	42.7±5.7
XBL29-588	588	153.2±0.4	1679±5	112±2	45.2±3.1	0.0746±0.0010	8.08±0.12	7.72±0.19	46.2±3.2
XBL29-595	595	162.3±0.3	1882±7	85±1	43.7±2.0	0.0600±0.0006	6.46±0.07	6.08±0.17	44.5±2.0

* $\delta^{234}\text{U} = ([^{234}\text{U}/^{238}\text{U}]_{\text{activity}} - 1) \times 1000$. ** $\delta^{234}\text{U}_{\text{initial}}$ was calculated based on ²³⁰Th age (T), i.e., $\delta^{234}\text{U}_{\text{initial}} = \delta^{234}\text{U}_{\text{measured}} \times e^{\lambda_{234} \times T}$. Corrected ²³⁰Th ages assume the initial ²³⁰Th/²³²Th atomic ratio of $4.4 \pm 2.2 \times 10^{-6}$. Those are the values for a material at secular equilibrium, with the bulk earth ²³²Th/²³⁸U value of 3.8. The errors are arbitrarily assumed to be 50%. ***B.P. stands for “Before Present” where the “Present” is defined as the year 1950 A.D.

Supplementary Table S2. Oxygen isotopic data of stalagmites from Xiaobailong Cave. Depths are relative to the bottom (oldest end) of the stalagmites and are measured along the growth axis. Ages are linearly interpolated between ^{230}Th dates (see Table S1).

Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰, VPDB)	Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰, VPDB)	Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰, VPDB)	Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰, VPDB)
XBL-29											
598.18	5.34	-12.79	585.35	7.92	-13.54	568.32	9.20	-13.03	559.80	13.46	-11.83
597.30	5.54	-12.89	585.00	7.94	-13.42	567.95	9.22	-14.30	559.60	13.55	-12.41
596.85	5.65	-13.01	584.55	7.98	-15.08	567.58	9.25	-13.89	559.40	13.64	-12.44
596.41	5.75	-13.45	584.11	8.01	-12.85	567.20	9.28	-14.08	559.19	13.73	-13.33
595.97	5.85	-13.61	583.66	8.04	-13.09	566.83	9.31	-14.50	558.99	13.82	-12.26
595.75	5.91	-13.14	583.21	8.08	-13.37	566.46	9.34	-14.25	558.79	13.91	-11.46
595.66	5.93	-12.75	582.77	8.11	-14.34	566.08	9.36	-14.89	558.59	14.00	-12.28
595.53	5.96	-16.22	582.32	8.15	-13.64	565.71	9.39	-14.57	558.39	14.09	-12.35
595.44	5.98	-17.08	581.88	8.18	-12.91	565.34	9.42	-14.56	558.19	14.18	-12.26
595.31	6.01	-15.64	581.43	8.21	-13.28	564.96	9.45	-15.24	557.98	14.27	-12.74
595.22	6.03	-15.37	580.98	8.25	-13.70	564.88	9.46	-14.83	557.78	14.36	-11.92
595.09	6.06	-13.82	580.54	8.28	-13.81	564.75	9.46	-14.67	557.58	14.45	-11.11
595.00	6.08	-13.36	580.09	8.31	-13.70	564.67	9.47	-13.90	557.38	14.54	-11.31
594.89	6.11	-13.24	579.67	8.34	-13.58	564.55	9.48	-13.47	557.18	14.64	-11.47
594.81	6.12	-13.64	579.26	8.37	-15.00	564.46	9.52	-13.57	556.98	14.73	-10.83
594.70	6.15	-13.65	578.85	8.41	-14.54	564.34	9.66	-10.46	556.77	14.82	-9.55
594.33	6.24	-14.01	578.44	8.44	-12.65	564.26	9.75	-10.17	556.57	14.91	-9.33
593.96	6.32	-13.35	578.03	8.47	-14.00	564.13	9.88	-10.25	556.37	15.00	-9.17
593.59	6.41	-14.36	577.62	8.50	-14.40	564.05	9.97	-10.38	555.97	15.18	-8.60
593.22	6.50	-13.50	577.21	8.53	-13.78	563.93	10.10	-10.39	555.16	15.54	-9.12
592.85	6.58	-13.68	576.80	8.56	-12.66	563.84	10.19	-10.47	554.30	15.65	-8.50
592.48	6.67	-13.48	576.39	8.59	-11.98	563.72	10.32	-10.30	553.44	15.71	-8.57
592.11	6.76	-13.64	575.98	8.62	-13.02	563.64	10.41	-10.59	552.57	15.76	-9.03
591.74	6.84	-14.29	575.57	8.65	-13.89	563.51	10.54	-10.43	551.70	15.82	-8.82
591.37	6.93	-13.89	575.16	8.68	-13.13	563.31	10.76	-11.10	550.83	15.87	-8.70
591.00	7.02	-13.53	574.75	8.71	-14.17	563.10	10.99	-11.42	549.96	15.93	-8.65
590.63	7.10	-13.00	574.34	8.74	-14.73	562.89	11.21	-10.74	549.05	15.98	-8.59
590.26	7.19	-12.77	573.93	8.78	-13.56	562.69	11.43	-10.75	548.15	16.04	-9.38
589.90	7.28	-13.34	573.51	8.81	-13.46	562.48	11.65	-11.26	547.25	16.10	-9.68
589.55	7.36	-12.21	573.10	8.84	-14.07	562.27	11.87	-11.53	546.35	16.16	-9.91
589.20	7.44	-13.29	572.69	8.87	-13.03	562.07	12.10	-12.45	545.45	16.21	-9.89
588.85	7.52	-12.79	572.27	8.90	-14.81	561.86	12.32	-12.47	544.59	16.27	-10.01
588.50	7.60	-13.50	571.86	8.93	-15.01	561.65	12.54	-12.36	543.77	16.32	-9.52
588.15	7.68	-12.84	571.45	8.96	-14.63	561.45	12.73	-12.29	542.95	16.37	-9.45
587.80	7.73	-13.23	571.03	8.99	-13.50	561.24	12.82	-12.14	542.13	16.42	-9.54
587.45	7.76	-13.21	570.62	9.02	-15.00	561.03	12.91	-12.40	541.31	16.47	-9.27
587.10	7.79	-14.22	570.21	9.05	-13.70	560.83	13.00	-12.59	540.49	16.53	-9.23
586.75	7.81	-13.07	569.81	9.08	-13.38	560.62	13.10	-12.25	539.66	16.58	-9.14
586.40	7.84	-14.55	569.44	9.11	-13.89	560.41	13.19	-12.87	538.82	16.63	-9.24
586.05	7.87	-13.34	569.07	9.14	-14.08	560.21	13.28	-12.26	537.98	16.69	-9.33
585.70	7.89	-13.32	568.69	9.17	-13.60	560.00	13.37	-11.74	537.14	16.74	-9.23

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Supplementary Table S2 (Cont.)

Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰,VPDB)	Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰,VPDB)	Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰,VPDB)	Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰,VPDB)
536.30	16.79	-9.17	504	18.84	-9.95	457	21.11	-11.29	410	21.58	-10.32
535.46	16.84	-8.99	503	18.90	-10.23	456	21.12	-11.41	409	21.59	-10.87
534.61	16.90	-9.50	502	18.96	-10.67	455	21.13	-11.13	408	21.60	-9.87
533.73	16.95	-9.69	501	19.03	-10.27	454	21.14	-10.93	407	21.61	-11.65
532.85	17.01	-9.62	500	19.09	-10.71	453	21.15	-11.30	406	21.62	-11.25
531.97	17.07	-9.72	499	19.15	-10.91	452	21.16	-11.11	405	21.63	-10.80
531.10	17.12	-9.49	498	19.22	-12.25	451	21.17	-11.19	404	21.64	-10.59
530.22	17.18	-9.37	497	19.28	-10.52	450	21.18	-10.74	403	21.65	-11.24
529.43	17.23	-9.65	496	19.34	-11.24	449	21.19	-11.53	402	21.67	-9.28
528.67	17.27	-10.32	495	19.41	-11.08	448	21.20	-11.31	401	21.68	-10.93
527.92	17.32	-10.81	494	19.47	-11.06	447	21.21	-11.92	400	21.69	-11.61
527.16	17.37	-9.90	493	19.53	-10.65	446	21.22	-10.75	399	21.70	-11.48
526.40	17.42	-9.41	492	19.60	-11.92	445	21.23	-11.81	398	21.71	-10.46
525.64	17.47	-9.96	491	19.66	-11.30	444	21.24	-11.20	397	21.72	-11.76
524.86	17.52	-10.53	490	19.72	-11.07	443	21.25	-11.96	396	21.73	-10.85
523.91	17.58	-8.49	489	19.79	-12.05	442	21.26	-11.29	395	21.74	-10.70
522.95	17.64	-10.11	488	19.85	-12.03	441	21.27	-11.56	394	21.75	-10.02
522.00	17.70	-9.73	487	19.91	-11.80	440	21.28	-11.09	393	21.77	-11.38
521.05	17.76	-8.30	486	19.97	-10.99	439	21.29	-10.68	392	21.78	-10.54
520.10	17.82	-9.69	485	20.04	-11.79	438	21.30	-11.44	391	21.79	-10.56
519.18	17.88	-9.04	484	20.10	-11.90	437	21.31	-12.55	390	21.80	-10.42
518.27	17.93	-8.80	483	20.16	-11.26	436	21.32	-11.43	389	21.81	-11.53
517.82	17.96	-9.30	482	20.23	-11.05	435	21.33	-10.91	388	21.82	-10.75
517.36	17.99	-10.18	481	20.29	-10.84	434	21.34	-10.81	387	21.83	-11.52
516.91	18.02	-8.23	480	20.35	-11.70	433	21.35	-10.18	386	21.84	-11.09
516.46	18.05	-9.48	479	20.42	-10.81	432	21.36	-11.44	385	21.86	-11.12
515.55	18.11	-9.78	478	20.48	-11.09	431	21.37	-10.44	384	21.87	-12.19
514.53	18.17	-8.83	477	20.54	-10.67	430	21.38	-11.94	383	21.88	-10.50
513.35	18.24	-9.81	476	20.61	-10.79	429	21.39	-11.77	382	21.89	-10.61
513.00	18.27	-10.00	475	20.67	-11.08	428	21.40	-11.64	381	21.90	-11.51
512.18	18.32	-9.57	474	20.73	-12.12	427	21.41	-11.07	380	21.91	-11.26
512.00	18.33	-9.40	473	20.80	-11.64	426	21.42	-11.59	379	21.92	-11.51
511.50	18.39	-10.21	472	20.82	-10.63	425	21.43	-10.12	378	21.93	-11.11
510.80	18.39	-10.78	471	20.85	-10.32	424	21.44	-10.99	377	21.95	-11.65
510.00	18.46	-10.50	470	20.87	-11.43	423	21.45	-10.48	376	21.96	-10.99
509.86	18.46	-10.68	469	20.90	-11.08	422	21.46	-10.90	375	21.97	-11.81
509.00	18.52	-10.73	468	20.92	-11.04	421	21.47	-10.61	374	21.98	-11.19
508.94	18.52	-10.13	467	20.95	-11.08	420	21.48	-10.89	373	21.99	-11.53
508.01	18.58	-10.81	466	20.97	-11.31	419	21.49	-10.55	372	22.00	-11.61
508.00	18.58	-10.75	465	21.00	-10.71	418	21.50	-12.50	371	22.01	-11.26
507.08	18.64	-11.31	464	21.02	-11.63	417	21.51	-10.86	370	22.02	-12.11
507.00	18.65	-11.73	463	21.05	-10.99	416	21.52	-10.87	369	22.04	-11.08
506.16	18.70	-10.99	462	21.06	-11.16	415	21.53	-10.77	368	22.05	-11.66
506.00	18.71	-10.56	461	21.07	-10.74	414	21.54	-10.94	367	22.06	-10.72
505.23	18.76	-11.12	460	21.08	-11.22	413	21.55	-11.86	366	22.07	-10.37
504.79	18.77	-11.42	459	21.09	-11.30	412	21.56	-10.66	365	22.08	-10.73
504.38	18.77	-11.40	458	21.10	-11.10	411	21.57	-10.86	364	22.09	-10.75

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Supplementary Table S2 (Cont.)

Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰,VPDB)	Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰,VPDB)	Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰,VPDB)	Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰,VPDB)
363	22.10	-10.50	316	22.97	-11.59	269	24.32	-10.18	222	26.15	-11.55
362	22.11	-11.51	315	23.00	-10.66	268	24.36	-10.41	221	26.19	-11.01
361	22.12	-11.49	314	23.03	-11.05	267	24.40	-10.45	220	26.23	-11.01
360	22.14	-11.33	313	23.05	-10.73	266	24.43	-9.04	219	26.27	-11.31
359	22.15	-11.96	312	23.08	-10.96	265	24.47	-10.07	218	26.31	-11.07
358	22.16	-10.60	311	23.11	-11.02	264	24.51	-10.18	217	26.35	-11.43
357	22.17	-10.86	310	23.14	-11.37	263	24.55	-10.23	216	26.39	-12.13
356	22.18	-10.50	309	23.16	-10.58	262	24.59	-9.70	215	26.47	-11.22
355	22.19	-10.88	308	23.19	-11.23	261	24.63	-9.62	214	26.55	-11.68
354	22.20	-11.14	307	23.22	-10.61	260	24.67	-10.03	213	26.64	-11.80
353	22.21	-11.13	306	23.24	-10.66	259	24.71	-10.05	212	26.72	-11.85
352	22.23	-12.16	305	23.27	-11.28	258	24.75	-10.05	211	26.80	-11.38
351	22.24	-11.57	304	23.30	-10.91	257	24.79	-11.55	210	26.88	-11.62
350	22.25	-10.13	303	23.32	-10.80	256	24.83	-11.10	209	26.97	-11.99
349	22.26	-11.04	302	23.35	-10.61	255	24.86	-11.50	208	27.05	-11.82
348	22.27	-10.26	301	23.38	-10.60	254	24.90	-11.70	207	27.13	-10.84
347	22.28	-11.14	300	23.40	-10.90	253	24.94	-11.25	206	27.21	-11.61
346	22.29	-10.40	299	23.43	-11.21	252	24.98	-11.12	205	27.29	-12.25
345	22.30	-10.71	298	23.46	-9.37	251	25.02	-12.00	204	27.38	-11.65
344	22.32	-10.49	297	23.49	-10.63	250	25.06	-11.24	203	27.46	-12.16
343	22.33	-10.67	296	23.51	-9.13	249	25.10	-12.85	202	27.54	-11.89
342	22.34	-10.88	295	23.54	-9.90	248	25.14	-12.03	201	27.62	-12.10
341	22.35	-11.23	294	23.57	-9.80	247	25.18	-11.15	200	27.71	-10.54
340	22.36	-10.91	293	23.59	-10.93	246	25.22	-11.96	199	27.79	-11.46
339	22.37	-11.00	292	23.62	-10.32	245	25.26	-11.46	198	27.87	-11.89
338	22.38	-10.91	291	23.65	-10.27	244	25.29	-12.00	197	27.95	-11.47
337	22.41	-11.44	290	23.67	-10.03	243	25.33	-11.08	196	28.04	-11.19
336	22.44	-11.18	289	23.70	-9.59	242	25.37	-12.14	195	28.10	-11.83
335	22.46	-11.04	288	23.73	-9.41	241	25.41	-11.39	194	28.15	-12.36
334	22.49	-11.30	287	23.75	-9.65	240	25.45	-11.69	193	28.21	-12.69
333	22.52	-10.79	286	23.78	-10.13	239	25.49	-12.28	192	28.26	-11.81
332	22.54	-11.58	285	23.81	-10.39	238	25.53	-12.22	191	28.31	-11.51
331	22.57	-11.41	284	23.83	-10.30	237	25.57	-12.14	190	28.36	-11.27
330	22.60	-10.89	283	23.86	-10.78	236	25.61	-11.50	189	28.41	-10.97
329	22.62	-10.91	282	23.89	-9.91	235	25.65	-11.65	188	28.47	-11.85
328	22.65	-10.63	281	23.92	-9.46	234	25.69	-11.68	187	28.52	-11.17
327	22.68	-11.39	280	23.94	-9.07	233	25.72	-11.31	186	28.57	-11.66
326	22.71	-11.39	279	23.97	-9.21	232	25.76	-11.48	185	28.62	-11.93
325	22.73	-11.87	278	24.00	-10.55	231	25.80	-11.46	184	28.67	-11.26
324	22.76	-11.51	277	24.02	-9.45	230	25.84	-11.93	183	28.72	-11.23
323	22.79	-11.53	276	24.05	-10.77	229	25.88	-12.32	183	28.72	-11.08
322	22.81	-11.13	275	24.08	-11.24	228	25.92	-11.84	182	28.78	-12.04
321	22.84	-10.63	274	24.12	-10.69	227	25.96	-11.52	181	28.83	-11.34
320	22.87	-11.23	273	24.16	-10.08	226	26.00	-12.09	180	28.88	-10.95
319	22.89	-11.39	272	24.20	-9.67	225	26.04	-11.64	179	28.93	-11.56
318	22.92	-11.39	271	24.24	-8.95	224	26.08	-11.63	178	28.98	-11.52
317	22.95	-11.61	270	24.28	-10.15	223	26.12	-11.37	177	29.04	-10.92

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Supplementary Table S2 (Cont.)

Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰,VPDB)	Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰,VPDB)	Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰,VPDB)	Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰,VPDB)
176	29.09	-11.68	140	34.47	-10.31	104	37.46	-11.98	68	38.38	-10.19
175	29.14	-11.62	139	34.57	-9.87	103	37.48	-11.98	67	38.54	-10.45
174	29.19	-12.85	138	34.67	-10.58	102	37.50	-13.44	66	38.70	-11.96
173	29.43	-10.44	137	34.77	-10.94	101	37.52	-11.89	65	38.86	-10.02
172	29.86	-10.96	136	34.88	-11.50	100	37.54	-13.50	64	39.02	-10.20
171	30.30	-10.76	135	34.98	-11.17	99	37.56	-11.69	63	39.17	-10.53
170	30.73	-11.15	134	35.08	-11.11	98	37.58	-12.49	62	39.33	-11.37
169	31.16	-11.20	133	35.18	-11.50	97	37.60	-12.51	61	39.49	-10.43
168	31.59	-10.72	132	35.29	-10.70	96	37.62	-12.21	60	39.65	-10.03
167	31.69	-11.25	131	35.39	-10.64	95	37.64	-12.84	59	39.81	-9.94
166	31.79	-10.57	130	35.49	-10.80	94	37.66	-11.14	58	39.97	-11.06
165	31.90	-11.09	129	35.60	-10.62	93	37.68	-12.79	57	40.13	-11.86
164	32.00	-11.18	128	35.70	-11.80	92	37.70	-12.14	56	40.29	-11.67
163	32.10	-10.38	127	35.80	-12.34	91	37.72	-12.46	55	40.45	-10.96
162	32.20	-10.69	126	35.90	-12.25	90	37.74	-12.60	54	40.61	-11.16
161	32.31	-11.09	125	36.01	-12.56	89	37.76	-12.73	53	40.76	-11.40
160	32.41	-9.91	124	36.11	-12.12	88	37.78	-12.84	52	40.92	-13.45
159	32.51	-10.57	123	36.21	-10.65	87	37.80	-11.29	51	41.08	-11.99
158	32.62	-10.18	122	36.31	-11.29	86	37.81	-12.81	50	41.24	-12.26
157	32.72	-10.29	121	36.42	-11.34	85	37.83	-11.09	49	41.40	-10.13
156	32.82	-10.35	120	36.52	-11.06	84	37.85	-12.04	48	41.56	-10.68
155	32.92	-11.69	119	36.62	-9.88	83	37.87	-12.51	47	41.72	-11.39
154	33.03	-11.48	118	36.73	-11.13	82	37.89	-12.76	46	41.88	-11.77
153	33.13	-10.17	117	36.83	-11.63	81	37.91	-12.51	45	42.04	-11.82
152	33.23	-10.94	116	36.93	-12.16	80	37.93	-11.97	44	42.20	-11.62
151	33.34	-10.91	115	37.03	-11.68	79	37.95	-12.75	43	42.35	-12.52
150	33.44	-10.08	114	37.14	-13.08	78	37.97	-10.99	42	42.51	-11.99
149	33.54	-9.98	113	37.24	-11.95	77	37.99	-11.78	41	42.67	-12.60
148	33.64	-11.41	112	37.30	-11.20	76	38.01	-11.01	40	42.83	-11.12
147	33.75	-10.65	111	37.32	-12.74	75	38.03	-11.33	39	42.99	-11.43
146	33.85	-10.62	110	37.34	-13.96	74	38.05	-12.50	38	43.15	-13.33
145	33.95	-10.65	109	37.36	-12.78	73	38.07	-11.39	37	43.31	-11.43
144	34.05	-10.54	108	37.38	-12.66	72	38.09	-12.86	36	43.47	-11.08
143	34.16	-10.52	107	37.40	-13.90	71	38.11	-12.40	35	43.63	-11.95
142	34.26	-10.58	106	37.42	-13.85	70	38.13	-12.08			
141	34.36	-10.89	105	37.44	-11.89	69	38.22	-11.96			
XBL-3											
1	41.42	-10.87	11	40.43	-10.44	21	39.45	-9.24	33	38.46	-9.78
2	41.32	-10.83	12	40.33	-10.22	22	39.37	-8.29	35	38.29	-10.36
3	41.22	-10.95	13	40.23	-10.38	23	39.29	-8.51	37	38.13	-10.48
4	41.12	-10.92	14	40.13	-10.85	24	39.2	-8.81	39	37.93	-11.42
5	41.02	-10.29	15	40.03	-10.81	25	39.12	-9.11	41	37.69	-11.53
6	40.92	-10.68	16	39.93	-10.19	26	39.04	-9.07	43	37.46	-11.92
7	40.82	-10.25	17	39.83	-10.28	27	38.96	-8.91	45	37.22	-11.89
8	40.73	-10.23	18	39.73	-9.96	28	38.87	-8.86	47	36.98	-11.66
9	40.63	-9.93	19	39.63	-9.74	29	38.79	-8.75	49	36.75	-11.69
10	40.53	-10.17	20	39.53	-9.47	31	38.63	-9.34	51	36.51	-11.53

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Supplementary Table S2 (Cont.)

Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰,VPDB)	Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰,VPDB)	Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰,VPDB)	Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰,VPDB)
53	36.27	-11.59	112	34.87	-11.29	172	33.54	-11.08	232	32.47	-12.47
55	36.04	-11.48	114	34.82	-11.01	174	33.51	-11.36	234	32.39	-11.31
57	36	-11.22	116	34.76	-11.25	176	33.49	-11.35	236	32.32	-11.92
58	35.99	-11.37	118	34.71	-11.34	178	33.48	-11.76	238	32.25	-11.13
60	35.95	-11.41	120	34.65	-11.51	180	33.46	-11.85	240	32.17	-11.28
62	35.91	-11.18	122	34.6	-10.85	182	33.44	-10.54	242	32.1	-11.67
64	35.88	-10.65	124	34.55	-11.08	184	33.43	-11.24	244	32.03	-11.53
66	35.84	-10.76	126	34.49	-11.01	186	33.41	-11.53	246	31.96	-11.06
68	35.81	-10.59	128	34.44	-11.55	188	33.39	-11.05	248	31.88	-11.78
70	35.77	-10.38	130	34.38	-11.12	190	33.38	-10.54	250	31.81	-11.26
72	35.74	-10.19	132	34.33	-11.39	192	33.36	-10.96	252	31.74	-12.13
74	35.7	-10.27	134	34.28	-11.38	194	33.34	-10.58	254	31.65	-11.49
76	35.67	-9.51	136	34.24	-10.9	196	33.33	-10.82	256	31.55	-11.05
78	35.63	-10.7	138	34.2	-10.74	198	33.31	-10.61	258	31.44	-11.49
80	35.6	-10.35	140	34.16	-11.47	200	33.29	-10.82	260	31.34	-11.79
82	35.56	-10.35	142	34.13	-10.38	202	33.28	-10.7	262	31.23	-11.42
84	35.53	-10.95	144	34.09	-10.76	204	33.26	-10.6	264	31.13	-11.13
86	35.49	-11.13	146	34.05	-11.91	206	33.24	-10.78	266	31.03	-11.91
88	35.46	-11.01	148	34.01	-11.67	208	33.23	-11	268	30.92	-11.41
90	35.42	-11.88	150	33.97	-11.5	210	33.21	-10.76	270	30.82	-12.3
92	35.39	-10.82	152	33.93	-10.98	212	33.19	-10.76	272	30.72	-11.84
94	35.35	-12	154	33.89	-11.7	214	33.12	-12.16	274	30.61	-11.4
96	35.31	-11.12	156	33.85	-12.4	216	33.05	-12.47	276	30.51	-11.85
98	35.25	-11.57	158	33.81	-11.35	218	32.98	-11.85	278	30.4	-11.22
100	35.2	-11.72	160	33.77	-11.71	220	32.9	-11.73	280	30.3	-10.09
102	35.14	-12.16	162	33.73	-11.6	222	32.83	-12.33	282	30.22	-10.57
104	35.09	-11.92	164	33.7	-11.45	224	32.76	-12.23	284	30.14	-10.97
106	35.03	-11.38	166	33.66	-11.7	226	32.68	-11.86			
108	34.98	-11	168	33.62	-11.72	228	32.61	-11.96			
110	34.93	-11.39	170	33.58	-11.23	230	32.54	-11.45			
XBL-7											
2	71.00	-10.68	34	70.11	-10.08	66	67.48	-9.07	98	64.68	-11.74
4	70.94	-10.20	36	70.05	-10.31	68	67.31	-9.38	100	64.50	-11.05
6	70.89	-9.91	38	69.94	-9.20	70	67.13	-9.49	102	64.36	-10.33
8	70.83	-10.31	40	69.76	-9.45	72	66.96	-9.46	104	64.22	-12.83
10	70.77	-10.08	42	69.59	-10.11	74	66.78	-9.42	106	64.07	-11.23
12	70.72	-9.35	44	69.41	-10.04	76	66.61	-8.86	108	63.91	-11.07
14	70.66	-10.09	46	69.23	-9.82	78	66.43	-9.56	110	63.75	-11.12
16	70.61	-9.76	48	69.06	-10.51	80	66.25	-10.62	112	63.59	-10.16
18	70.55	-9.64	50	68.88	-10.66	82	66.08	-10.75	114	63.43	-10.55
20	70.50	-10.59	52	68.71	-10.16	84	65.90	-10.67	116	63.27	-10.90
22	70.44	-10.30	54	68.53	-9.70	86	65.73	-11.00	118	63.11	-10.53
24	70.39	-9.91	56	68.36	-9.85	88	65.55	-11.01	120	62.95	-10.82
26	70.33	-10.73	58	68.18	-10.00	90	65.38	-10.60	122	62.79	-9.92
28	70.27	-9.92	60	68.01	-10.42	92	65.20	-10.91	124	62.63	-10.17
30	70.22	-10.37	62	67.83	-9.97	94	65.03	-11.39	126	62.47	-10.07
32	70.16	-10.03	64	67.66	-9.28	96	64.85	-11.03	128	62.31	-9.68

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Supplementary Table S2 (Cont.)

Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰,VPDB)	Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰,VPDB)	Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰,VPDB)	Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰,VPDB)
130	62.15	-10.15	160	61.32	-10.24	188	60.97	-11.96	216	60.27	-11.27
132	61.99	-8.82	162	61.30	-10.45	190	60.92	-11.01	218	60.22	-11.47
134	61.83	-11.51	164	61.27	-10.39	192	60.87	-10.65	220	60.17	-11.70
136	61.67	-10.71	166	61.25	-10.42	194	60.82	-11.42	222	60.12	-11.73
138	61.58	-11.00	168	61.23	-10.62	196	60.77	-11.37	224	60.07	-12.00
140	61.55	-10.25	170	61.20	-10.75	198	60.72	-11.07	226	60.02	-11.68
142	61.53	-10.79	172	61.18	-10.43	200	60.67	-10.74	228	59.97	-10.37
144	61.51	-10.48	174	61.16	-10.94	202	60.62	-10.69	230	59.92	-10.14
146	61.48	-10.04	176	61.13	-11.38	204	60.57	-11.48	232	59.87	-10.27
148	61.46	-9.50	178	61.11	-11.16	206	60.52	-11.75	234	59.82	-11.50
150	61.44	-10.12	180	61.09	-10.97	208	60.47	-11.56	236	59.77	-11.26
154	61.39	-10.20	182	61.06	-10.77	210	60.42	-11.42	238	59.72	-11.14
156	61.37	-10.28	184	61.04	-11.46	212	60.37	-11.52	240	59.67	-11.30
158	61.34	-10.65	186	61.02	-11.13	214	60.32	-10.78			
XBL-4											
2	81.951	-13.73	50	81.882	-14.40	114	81.790	-13.59	168	81.081	-12.94
4	81.948	-14.23	52	81.879	-14.58	116	81.787	-14.00	170	81.010	-13.32
6	81.945	-14.18	54	81.876	-15.01	118	81.784	-13.60	172	80.939	-13.93
7	81.943	-14.09	56	81.873	-14.88	120	81.781	-13.32	171	80.974	-13.46
8	81.942	-13.22	58	81.870	-14.33	122	81.778	-13.83	174	80.868	-13.11
10	81.939	-13.27	60	81.867	-14.18	124	81.776	-13.96	176	80.796	-13.52
12	81.936	-13.46	62	81.865	-14.31	125	81.774	-13.38	177	80.761	-13.43
14	81.933	-13.64	64	81.862	-14.19	126	81.773	-13.66	178	80.725	-12.99
16	81.930	-14.25	66	81.859	-14.10	127	81.771	-13.71	180	80.654	-13.38
18	81.928	-14.27	68	81.856	-14.39	128	81.770	-13.84	182	80.583	-13.98
20	81.925	-13.81	70	81.853	-13.92	130	81.767	-13.47	184	80.512	-13.73
22	81.922	-13.59	72	81.850	-14.04	132	81.764	-13.73	186	80.441	-14.30
24	81.919	-14.01	74	81.847	-14.08	132	81.764	-13.97	187	80.405	-13.79
26	81.916	-13.99	76	81.844	-14.14	134	81.761	-14.11	188	80.370	-13.44
27	81.915	-13.87	78	81.842	-13.86	136	81.758	-13.84	190	80.298	-14.16
28	81.913	-13.46	80	81.839	-13.93	138	81.755	-13.43	192	80.227	-13.56
29	81.912	-14.37	82	81.836	-14.50	140	81.753	-13.48	194	80.156	-13.36
30	81.910	-14.18	84	81.833	-13.55	142	81.750	-13.41	196	80.085	-13.49
31	81.909	-14.01	86	81.830	-13.31	144	81.747	-13.55	198	80.014	-12.92
32	81.908	-13.27	88	81.827	-13.90	146	81.744	-13.74	200	79.943	-13.23
34	81.905	-13.68	90	81.824	-13.99	148	81.741	-14.18	202	79.872	-13.23
36	81.902	-13.89	92	81.821	-14.46	150	81.721	-14.51	204	79.773	-12.82
38	81.899	-13.79	94	81.819	-14.22	152	81.650	-13.98	206	79.648	-12.89
40	81.896	-14.25	96	81.816	-14.01	154	81.579	-13.18	208	79.523	-12.53
41	81.895	-14.08	98	81.813	-13.74	156	81.508	-14.10	209	79.460	-13.07
42	81.893	-13.61	100	81.810	-13.69	157	81.472	-13.67	210	79.398	-13.55
43	81.892	-14.13	102	81.807	-13.79	158	81.437	-14.15	211	79.335	-12.75
44	81.890	-14.37	104	81.804	-14.00	160	81.366	-14.36	212	79.272	-12.49
45	81.889	-14.68	106	81.801	-14.10	162	81.294	-13.37	214	79.147	-12.35
46	81.887	-13.73	108	81.799	-13.91	163	81.259	-13.93	216	79.022	-12.90
47	81.886	-13.71	110	81.796	-14.30	164	81.223	-13.73	218	78.897	-12.73
48	81.885	-14.69	112	81.793	-14.02	166	81.152	-13.40	220	78.771	-12.78

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Supplementary Table S2 (Cont.)

Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰, VPDB)	Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰, VPDB)	Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰, VPDB)	Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰, VPDB)
222	78.646	-13.06	236	77.769	-12.68	250	75.602	-11.95	264	73.069	-10.50
224	78.521	-13.06	238	77.501	-12.99	252	75.285	-10.80	266	72.116	-10.30
226	78.396	-12.93	240	77.184	-12.95	254	74.969	-10.80	268	71.164	-10.17
228	78.270	-12.01	242	76.868	-12.37	256	74.653	-11.08	270	70.211	-9.65
230	78.145	-12.93	244	76.551	-12.60	258	74.336	-11.12	272	60.103	-9.22
232	78.020	-13.19	246	76.235	-13.00	260	74.020	-11.37	274	58.761	-9.40
234	77.895	-12.97	248	75.918	-12.68	262	73.703	-11.06	276	57.418	-10.31
XBL-48											
13	106.54	-15.74	48	104.85	-11.55	83	93.12	-10.48	146	85.46	-9.76
14	106.49	-15.19	49	104.79	-11.75	84	92.44	-9.88	148	85.16	-9.67
15	106.45	-15.14	50	104.74	-11.60	85	91.75	-10.20	150	84.86	-9.63
16	106.40	-15.00	51	104.68	-11.44	86	91.07	-9.96	152	84.56	-9.49
17	106.36	-15.23	52	104.62	-12.20	87	90.71	-10.29	154	84.27	-9.88
18	106.32	-15.04	53	104.57	-11.37	88	90.69	-9.74	156	83.97	-9.78
19	106.27	-14.64	54	104.51	-11.92	89	90.67	-9.84	158	83.67	-10.29
20	106.23	-15.24	55	104.46	-11.54	90	90.64	-10.34	160	83.37	-9.82
21	106.19	-15.27	56	104.40	-10.93	92	90.60	-10.45	161	83.22	-9.76
22	106.14	-14.59	57	104.35	-10.80	94	90.55	-10.70	162	83.08	-9.58
23	106.10	-14.61	58	104.29	-11.90	96	90.50	-10.60	163	82.93	-9.67
24	106.06	-15.32	59	104.24	-11.09	98	90.46	-10.79	164	82.78	-9.93
25	106.01	-15.40	60	104.18	-11.78	100	90.41	-10.43	165	82.63	-9.51
26	105.97	-15.08	61	104.13	-11.79	102	90.27	-10.33	166	82.47	-12.82
27	105.93	-15.14	62	104.07	-11.90	104	89.87	-11.85	167	82.30	-12.16
28	105.88	-15.55	63	104.02	-11.64	106	89.47	-11.89	168	82.14	-14.57
29	105.84	-15.30	64	103.96	-11.29	108	89.15	-11.80	169	81.98	-13.11
30	105.80	-14.73	65	103.90	-12.21	110	89.07	-11.87	170	81.82	-12.93
31	105.75	-15.69	66	102.83	-14.13	112	88.99	-12.14	171	81.65	-14.07
32	105.71	-15.12	67	102.57	-14.69	114	88.91	-11.41	172	81.49	-13.11
33	105.67	-15.48	68	102.20	-14.41	116	88.83	-12.27	174	81.17	-13.39
34	105.62	-15.70	69	101.83	-13.54	118	88.75	-11.85	176	80.84	-13.36
35	105.57	-15.07	70	101.47	-14.00	120	88.67	-10.84	178	80.51	-12.75
36	105.51	-15.12	71	101.10	-13.73	122	88.59	-11.74	180	80.19	-13.32
37	105.46	-14.55	72	100.73	-13.26	124	88.51	-10.27	182	79.86	-13.11
38	105.40	-13.96	73	100.37	-14.25	126	88.43	-9.68	184	79.54	-12.44
39	105.34	-14.93	74	99.63	-12.65	128	88.13	-10.30	186	79.21	-11.71
40	105.29	-15.06	75	98.90	-12.18	130	87.83	-9.54	188	78.89	-12.59
41	105.23	-14.93	76	98.16	-11.90	132	87.54	-9.52	190	78.56	-12.31
42	105.18	-14.55	77	97.43	-12.19	134	87.24	-9.96	192	78.24	-12.26
43	105.12	-12.58	78	96.69	-11.85	136	86.94	-9.98	194	77.91	-12.61
44	105.07	-12.11	79	95.96	-11.00	138	86.64	-10.35	196	77.59	-12.62
45	105.01	-10.98	80	95.22	-10.77	140	86.35	-10.32	198	77.26	-12.22
46	104.96	-12.31	81	94.49	-10.84	142	86.05	-10.46	200	76.94	-12.39
47	104.90	-11.78	82	93.80	-10.64	144	85.75	-10.44	202	76.61	-11.11
XBL-65											
35	170.73	-14.15	38	170.66	-15.17	44	170.52	-13.78	48	170.42	-14.31
36	170.71	-14.55	40	170.62	-14.81	45	170.50	-14.51	50	170.38	-14.60
37	170.69	-14.56	42	170.57	-14.43	46	170.47	-13.57	52	170.33	-14.17

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Supplementary Table S2 (Cont.)

Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰,VPDB)	Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰,VPDB)	Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰,VPDB)	Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰,VPDB)
54	170.28	-14.57	108	169.84	-13.92	160	168.76	-12.65	212	168.61	-11.52
55	170.26	-13.70	110	169.79	-13.25	162	168.75	-11.97	214	168.61	-12.34
56	170.23	-13.24	112	169.73	-13.49	164	168.75	-13.31	215	168.59	-12.38
58	170.18	-14.22	114	169.68	-13.95	165	168.74	-11.59	216	168.56	-11.41
60	170.14	-14.37	115	169.65	-14.14	166	168.74	-11.70	218	168.51	-11.27
65	170.02	-12.89	116	169.62	-13.44	168	168.74	-11.77	220	168.45	-11.61
66	170.00	-13.61	118	169.57	-13.96	170	168.73	-11.76	222	168.40	-11.33
68	170.00	-13.80	120	169.51	-14.02	172	168.73	-11.94	224	168.34	-11.92
70	170.00	-14.26	122	169.46	-14.63	174	168.72	-12.54	225	168.32	-11.34
72	170.00	-12.94	124	169.41	-14.51	175	168.72	-12.11	226	168.29	-11.59
74	170.00	-14.75	125	169.38	-13.69	176	168.71	-11.67	228	168.23	-11.99
75	169.99	-14.09	126	169.35	-13.27	178	168.71	-11.12	230	168.18	-11.74
76	169.99	-13.81	128	169.30	-13.79	180	168.70	-11.94	232	168.12	-12.11
78	169.99	-14.49	130	169.24	-13.42	182	168.70	-11.05	234	168.07	-12.04
80	169.99	-13.62	132	169.19	-13.00	184	168.69	-12.05	235	168.04	-12.07
82	169.99	-14.63	134	169.14	-13.49	185	168.69	-12.00	236	168.02	-11.54
84	169.98	-13.32	135	169.11	-13.87	186	168.69	-11.43	238	167.96	-12.76
85	169.98	-13.82	136	169.08	-13.76	188	168.68	-12.00	240	167.91	-12.57
86	169.98	-13.70	138	169.03	-13.46	190	168.67	-12.21	242	167.85	-12.27
88	169.98	-13.65	140	168.97	-14.03	192	168.67	-11.81	244	167.80	-12.37
90	169.98	-13.84	142	168.92	-13.80	194	168.66	-11.42	245	167.74	-12.44
92	169.97	-13.58	144	168.87	-13.00	195	168.66	-11.27	246	167.69	-11.94
94	169.97	-13.51	145	168.84	-13.55	196	168.66	-12.34	248	167.63	-12.42
95	169.97	-13.81	146	168.81	-13.64	198	168.65	-12.12	250	167.58	-11.62
96	169.97	-13.69	148	168.79	-14.13	200	168.65	-11.81	252	167.52	-12.30
98	169.97	-13.39	150	168.79	-14.50	202	168.64	-12.59	254	167.47	-11.90
100	169.97	-13.85	152	168.78	-13.11	204	168.63	-12.15	255	167.41	-11.45
102	169.96	-13.78	154	168.78	-13.02	205	168.63	-12.23	256	167.36	-12.12
104	169.95	-13.31	155	168.77	-11.88	206	168.63	-12.71	258	167.30	-11.04
105	169.92	-13.75	156	168.77	-12.27	208	168.62	-12.67	260	167.25	-9.74
106	169.89	-13.37	158	168.76	-11.36	210	168.62	-11.45			
XBL-27											
4	189.46	-9.87	64	185.19	-10.34	124	183.98	-10.28	184	180.79	-11.02
8	189.06	-10.35	68	185.11	-10.23	128	183.79	-9.99	188	180.53	-10.68
12	188.66	-9.30	72	185.04	-9.85	132	183.6	-10.30	192	180.26	-13.43
16	188.26	-10.71	76	184.97	-9.80	136	183.4	-9.71	196	180	-14.04
20	187.87	-10.41	80	184.89	-10.36	140	183.21	-9.80	200	179.74	-14.25
24	187.47	-10.09	84	184.82	-10.25	144	183.02	-10.28	202	179.6	-13.76
28	187.07	-9.75	88	184.74	-10.10	148	182.82	-10.19	204	179.47	-12.85
32	186.68	-9.79	92	184.67	-9.84	152	182.63	-9.36	208	179.21	-12.84
36	186.28	-9.86	96	184.59	-9.71	156	182.44	-11.12	212	178.95	-12.91
40	185.88	-9.90	100	184.52	-10.31	160	182.25	-11.14	216	178.78	-13.56
44	185.56	-10.55	104	184.44	-10.32	164	182.05	-10.61	220	178.63	-13.33
48	185.49	-9.75	108	184.37	-9.13	168	181.84	-10.97	224	178.49	-12.76
52	185.41	-10.16	112	184.29	-10.07	172	181.58	-9.65	228	178.35	-13.07
56	185.34	-10.29	116	184.22	-9.77	176	181.32	-9.50	232	178.21	-12.63
60	185.26	-10.33	120	184.14	-9.60	180	181.05	-9.11	236	178.07	-12.60

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Supplementary Table S2 (Cont.)

Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰,VPDB)	Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰,VPDB)	Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰,VPDB)	Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰,VPDB)
240	177.92	-14.00	272	176.95	-13.42	304	176.73	-12.70	336	174.39	-13.95
244	177.78	-12.38	276	176.94	-13.34	308	176.44	-12.31	340	174.1	-13.70
248	177.64	-12.19	280	176.93	-12.61	312	176.14	-12.96	344	173.8	-13.96
252	177.5	-13.30	284	176.92	-13.34	316	175.85	-12.33	348	173.51	-14.71
256	177.35	-13.00	288	176.91	-13.20	320	175.56	-14.00	352	173.22	-13.56
260	177.21	-12.98	292	176.9	-14.54	324	175.27	-14.67	356	172.93	-13.78
264	177.07	-13.91	296	176.89	-12.55	328	174.97	-13.81	360	172.63	-14.99
268	176.96	-13.45	300	176.88	-11.98	332	174.68	-13.58	364	172.34	-13.23
XBL-26											
2	251.96	-11.53	78	240.63	-11.75	154	223.32	-11.32	230	201.59	-10.33
4	251.79	-12.82	80	240.36	-14.15	156	223.22	-11.35	232	201.56	-9.41
6	251.61	-11.62	82	240.09	-13.73	158	223.11	-11.04	234	201.53	-9.28
8	251.43	-10.38	84	239.88	-13.84	160	223.01	-12.65	236	201.50	-9.12
10	251.26	-12.83	86	239.67	-14.50	162	222.90	-13.31	238	201.47	-9.78
12	251.08	-12.14	88	239.46	-12.48	164	222.80	-12.46	240	201.45	-9.11
14	250.91	-12.10	90	239.25	-13.27	166	222.69	-11.94	242	201.42	-9.39
16	250.73	-11.63	92	239.04	-13.60	168	222.59	-11.80	244	201.39	-8.87
18	250.55	-11.76	94	238.83	-13.13	170	222.48	-11.71	246	201.36	-9.28
20	250.38	-12.13	96	238.62	-12.72	172	222.38	-11.83	248	201.34	-9.62
22	250.20	-12.54	98	238.41	-12.97	174	217.17	-11.68	250	201.31	-9.32
24	250.03	-11.98	100	238.20	-13.29	176	216.81	-12.19	252.7	201.23	-8.69
26	249.85	-12.15	102	237.99	-13.00	178	216.46	-11.21	253.4	201.20	-8.91
28	249.67	-11.64	104	237.78	-12.77	180	216.10	-11.87	254	201.17	-9.03
30	249.50	-10.67	106	237.57	-13.67	182	215.74	-11.82	254.7	201.14	-8.99
32	249.32	-10.03	108	237.36	-12.43	184	215.38	-10.73	255.4	201.11	-9.17
34	249.15	-10.84	110	237.15	-12.89	186	215.02	-11.50	256	201.08	-8.79
36	248.97	-10.49	112	236.94	-12.62	188	214.66	-11.21	256.7	201.05	-9.04
38	248.79	-10.30	114	236.73	-12.89	190	214.30	-12.51	257.4	201.02	-9.39
40	248.49	-9.85	116	236.52	-12.81	192	204.41	-9.82	258	201.00	-8.99
42	248.06	-9.85	118	236.31	-13.23	194	204.14	-9.41	258.7	200.96	-8.72
44	247.63	-10.36	120	236.10	-13.68	196	203.87	-9.48	259.4	200.93	-8.93
46	247.20	-10.18	122	235.89	-12.90	198	203.60	-8.81	260	200.91	-8.82
48	246.77	-9.85	124	235.68	-12.79	200	203.33	-9.29	260.7	200.88	-8.61
50	246.34	-9.76	126	234.45	-12.81	202	203.06	-9.02	261.4	200.85	-8.15
52	245.91	-10.05	128	232.20	-9.51	204	202.79	-9.60	262	200.82	-8.70
54	245.48	-9.81	130	229.95	-10.09	206	202.52	-9.67	262.7	199.97	-8.57
56	245.05	-9.41	132	227.69	-10.76	208	202.26	-9.95	263.4	199.12	-15.87
58	244.62	-8.96	134	225.44	-10.87	210	201.99	-10.53	264	198.39	-15.77
60	244.19	-9.67	136	224.26	-10.25	212	201.84	-9.84	264.7	197.54	-14.74
62	243.76	-9.54	138	224.16	-11.57	214	201.81	-10.26	265.4	196.69	-14.20
64	243.33	-8.85	140	224.05	-11.51	216	201.78	-10.17	266	195.96	-14.95
66	242.90	-8.70	142	223.95	-10.52	218	201.75	-10.06	266.7	195.11	-15.70
68	242.47	-8.57	144	223.85	-10.78	220	201.73	-10.12	267.4	194.26	-14.23
70	242.04	-7.89	146	223.74	-10.65	222	201.70	-10.21	268	193.53	-15.86
72	241.61	-8.99	148	223.64	-11.44	224	201.67	-9.36	268.7	192.68	-15.64
74	241.18	-9.43	150	223.53	-11.43	226	201.64	-9.60	269.4	191.82	-15.85
76	240.90	-8.66	152	223.43	-11.09	228	201.61	-10.06	270	191.10	-16.01

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Supplementary Table S2 (Cont.)

Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰, VPDB)	Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰, VPDB)	Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰, VPDB)	Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰, VPDB)
270.7	190.24	-15.43	304	186.61	-10.20	398	180.33	-9.59	475.5	160.34	-10.74
271.4	189.39	-12.80	306	186.49	-10.89	400	180.19	-9.88	476	160.00	-10.5
272	188.66	-9.83	308	186.36	-11.13	402	180.04	-10.54	476.5	159.66	-10.74
272.7	188.62	-9.70	310	186.23	-10.25	404	179.90	-9.69	477	159.31	-10.43
273.4	188.57	-10.06	312	186.10	-10.43	406	179.75	-9.34	477.5	158.97	-10.66
274	188.54	-10.02	314	185.97	-10.48	408	175.36	-13.38	478	158.63	-10.33
274.7	188.49	-9.93	316	185.84	-10.72	410	175.22	-12.86	478.5	158.29	-10.58
275.4	188.45	-9.71	318	185.72	-11.38	412	175.08	-12.22	479	157.95	-10.53
276	188.41	-9.27	320	185.59	-10.78	414	174.93	-13.10	479.5	157.60	-10.62
276.7	188.36	-9.24	322	185.46	-9.73	416	174.79	-11.74	480	157.26	-9.84
277.4	188.32	-10.29	324	185.33	-10.16	418	174.64	-11.94	480.5	156.92	-10.03
278	188.28	-11.39	326	185.20	-10.57	420	174.50	-12.66	481	156.58	-9.87
278.7	188.23	-10.85	328	185.08	-10.53	422	174.36	-12.41	481.5	156.23	-9.9
279.4	188.19	-11.61	330	184.95	-10.15	424	174.21	-13.01	482	155.89	-9.71
280	188.15	-11.12	332	184.82	-10.27	426	174.07	-11.82	482.5	155.55	-9.88
280.7	188.11	-10.96	334	184.69	-11.55	428	173.93	-12.30	483	155.21	-10.68
281.4	188.06	-11.05	336	184.56	-11.92	430	173.78	-12.74	483.5	154.86	-10.42
282	188.02	-11.32	338	184.43	-11.18	431	173.71	-12.86	484	154.52	-10.15
282.7	187.98	-11.03	340	184.31	-10.70	432	173.64	-15.48	484.5	154.18	-10.63
283.4	187.93	-11.68	342	184.18	-10.85	433	173.57	-13.26	485	153.84	-11.01
284	187.90	-10.97	344	184.05	-10.32	434	173.49	-13.18	485.5	153.49	-10.2
284.7	187.85	-11.61	346	183.92	-10.85	436	173.35	-12.93	486	153.15	-9.82
285.4	187.81	-11.45	348	183.79	-10.14	438	173.21	-14.30	486.5	152.81	-10.74
286	187.77	-10.93	350	183.67	-11.40	440	173.06	-13.03	487	152.47	-11.09
286.7	187.72	-11.28	352	183.54	-10.46	442	172.92	-13.00	487.5	152.13	-11.15
287.4	187.68	-10.66	354	183.41	-11.13	444	172.77	-13.79	488	151.78	-10.95
288	187.64	-10.97	356	183.28	-10.87	446	172.63	-14.27	488.5	151.44	-10.42
288.7	187.59	-10.22	358	183.15	-11.75	448	172.49	-14.59	489	151.10	-10.86
289.4	187.55	-11.10	360	183.02	-11.27	450	172.34	-15.79	489.5	150.76	-11.58
290	187.51	-11.28	362	182.90	-9.42	452	172.20	-14.20	490	150.41	-11.2
290.7	187.47	-10.67	364	182.77	-10.27	454	172.06	-13.62	490.5	150.07	-11.29
291.4	187.42	-11.47	366	182.64	-9.63	456	171.91	-13.96	491	149.73	-11.83
292	187.38	-10.59	368	182.50	-10.08	458	171.77	-13.97	491.5	149.39	-11.45
292.7	187.34	-10.82	370	182.35	-11.03	460	171.62	-14.82	492	149.04	-11.08
293.4	187.29	-10.42	372	182.21	-9.32	462	171.48	-14.49	492.5	148.70	-10.92
294	187.25	-10.58	374	182.06	-11.43	464	171.34	-14.90	493	148.36	-10.29
294.7	187.21	-9.82	376	181.92	-10.56	466	171.19	-15.02	493.5	148.02	-10.56
295.4	187.16	-10.64	378	181.77	-10.27	468	171.05	-16.04	494	147.67	-10.39
296	187.13	-10.56	380	181.63	-9.37	470	164.11	-10.14	494.5	147.33	-10.85
296.7	187.08	-11.76	382	181.49	-10.66	471.5	163.08	-10.63	495	146.99	-10.91
297.4	187.04	-10.39	384	181.34	-9.79	472	162.74	-10.39	495.5	146.65	-10.88
298	187.00	-10.60	386	181.20	-10.24	472.5	162.40	-10.63	496	146.31	-10.57
298.7	186.95	-11.33	388	181.05	-10.09	473	162.05	-11.44	496.5	145.96	-10.58
299.4	186.91	-10.64	390	180.91	-10.53	473.5	161.71	-10.77	497	145.62	-9.56
300	186.87	-9.98	392	180.76	-10.08	474	161.37	-10.39	497.5	145.28	-10.41
300.7	186.83	-9.45	394	180.62	-9.91	474.5	161.03	-11.01	498	144.94	-10.61
302	186.74	-9.34	396	180.48	-10.32	475	160.68	-10.46	498.5	144.59	-10.57

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Supplementary Table S2 (Cont.)

Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰,VPDB)	Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰,VPDB)	Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰,VPDB)	Distance (mm)	Age (ky, BP)	$\delta^{18}\text{O}$ (‰,VPDB)
499	144.25	-10.7	508.5	136.84	-10.86	518	128.41	-14	527.5	108.50	-15.98
499.5	143.91	-10.56	509	136.39	-11	518.5	127.97	-15.78	528	106.42	-17.21
500	143.57	-11.43	509.5	135.95	-10.18	519	127.53	-14.85	528.5	104.33	-16.7
500.5	143.22	-11.24	510	135.51	-10.39	519.5	127.08	-14.37	529	102.25	-15.14
501	142.88	-11.39	510.5	135.06	-9.94	520	126.64	-14.41	529.5	100.16	-14.53
501.5	142.54	-11.32	511	134.62	-10.21	520.5	126.20	-16.55	530	98.08	-13.85
502	142.20	-11.05	511.5	134.18	-10.76	521	125.75	-15.39	530.5	95.99	-11.37
502.5	141.85	-10.97	512	133.73	-10.25	521.5	125.31	-15.94	531	93.91	-11.32
503	141.51	-11.14	512.5	133.29	-10.64	522	124.87	-14.46	531.5	91.82	-9.78
503.5	141.17	-10.75	513	132.85	-10.31	522.5	124.42	-17.27	532	89.74	-10.21
504	140.83	-10.59	513.5	132.40	-10.37	523	123.98	-17.78	532.5	87.65	-12.82
504.5	140.38	-10.98	514	131.96	-10.35	523.5	123.54	-16.2	533	85.57	-10.39
505	139.94	-10.49	514.5	131.52	-9.61	524	123.09	-16.17	533.5	83.49	-10.61
505.5	139.50	-11.14	515	131.07	-10.03	524.5	121.01	-14.38	534	81.40	-10.12
506	139.05	-10.99	515.5	130.63	-10.48	525	118.92	-14.24	534.5	79.32	-12.67
506.5	138.61	-11.05	516	130.19	-10.12	525.5	116.84	-14	535	77.23	-11.83
507	138.17	-10.43	516.5	129.74	-9.59	526	114.75	-14.73	535.5	75.15	-10.26
507.5	137.72	-10.67	517	129.30	-9.85	526.5	112.67	-16.47	536	73.06	-10.08
508	137.28	-10.3	517.5	128.86	-10.47	527	110.58	-14.86			