Paleoceanography and Paleoclimatology

Supporting Information for

Comparative clumped isotope temperature relationships in freshwater carbonates

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Introduction

We provide supporting information including a discussion of the modeling methodology performed for hydroclimate reconstructions at Lake Surprise, along with 2 supporting figures and 9 supporting tables.

Text S1: Hydroclimate modeling methodology for Lake Surprise, CA

More detailed methodology regarding modeling hydroclimate parameters can be found in Santi et al. (2020). In brief, the equation derived in Linacre (1992) was used to estimate lake evaporation rates. This equation (Eq. 1) utilizes elevation (Z), latitude (Lat), mean annual air temperature (T), and dew point temperature (T_d) as inputs to derive estimates of past lake evaporation at Lake Surprise. Mean annual air temperature was estimated using the water-to-air temperature transfer functions outlined in Hren and Sheldon (2012) in concert with water temperatures derived from clumped isotope analysis.

$$E\ (mm/yr) = [0.015 + 4 \times 10^{-4}T + 10^{-6}Z] \times [\frac{480(T+0.006Z)}{84-Lat} - 40 + 2.3u(T - T_d)] \quad (1)$$

Following evaporation, past precipitation rates were estimated using an isotope mass balance equation developed in Ibarra et al. (2014) that factors in water balance and basin hypsometry. The derived precipitation equation (Eq. 2) utilizes lake evaporation (E_L), a runoff coefficient (k_{run}), lake (A_L) and tributary (A_W) area, along with the oxygen isotopic composition of evaporation, rainfall, and lake water ($\delta^{18}O_E$, $\delta^{18}O_W$, $\delta^{18}O_L$, respectively). Santi et al. (2020) expanded on this methodology, to estimate $\delta^{18}O_L$ using temperatures derived from clumped isotope analysis.

$$P\ (mm/yr)\ =\ \frac{E_L}{(1+\frac{k_{run}}{(\frac{A_L}{(A_W\ -\ A_L)})}} \times \frac{(\delta^{18}O_E - \delta^{18}O_L)}{(\delta^{18}O_W - \delta^{18}O_L)} \qquad (2)$$

To scale our lake evaporation rates, Santi et al. (2020) utilizes a parameter called 'weighted evaporation' to consider that all evaporation isn't occurring over a free water surface. The equation (Eq. 3) uses the results from the evaporation (E_L) and precipitation equation (P and k_{run}), along with the tributary, lake, and basin area (A_T, A_L, A_W, respectively) to estimate weighted evaporation rates:

$$WE\ =\ \frac{(P - k_{run} \times A_T)\ +\ E_L \times A_L}{(A_W\ -\ A_L)} \qquad (3)$$

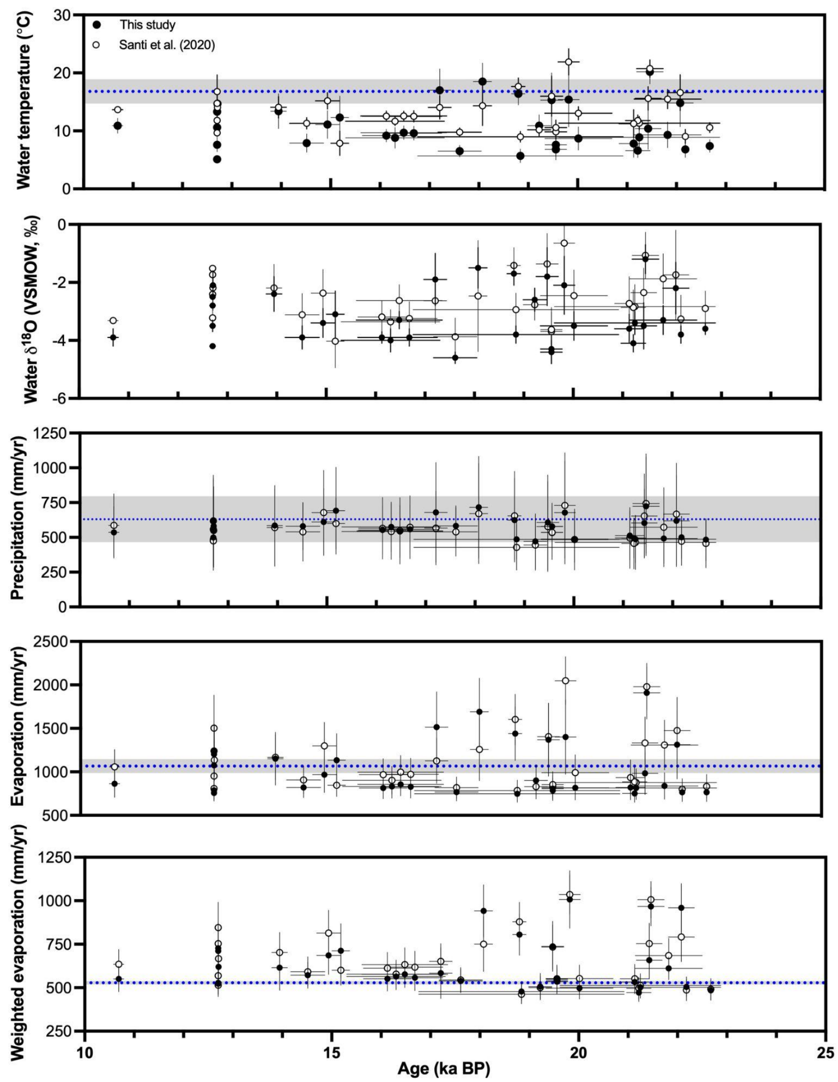

Figure S1. Supplementary Figure 1: Reconstruction of hydroclimate parameters at Lake Surprise, CA. These results indicate that since the LGM, there was a 5.3°C increase in water temperature, 7.4°C increase in MAAT, 3% decrease in evaporation, 20% decrease in weighted evaporation, and 10% increase in precipitation. Results indicate that since the deglacial, there was a 6.6°C increase in water temperature, 7.4°C increase in MAAT, 8% increase in evaporation, 19% decrease in weighted evaporation, and 8% increase in precipitation. Increases and decreases relative to modern are derived using modern values in Santi et al. (2020) and the references within. Thus, results support the inference from Santi et al. (2020) that temperature and evaporation were likely dominant controls on Lake Surprise's transgression and regression, and that increased evaporation relative to precipitation contributed to the eventual disappearance of Lake Surprise.

Sample name	No. of samples	No. of analyses	Elevation (m)	System	Water temperature data source
Bivalves					
Red Rock	1	7	1207	River	U.S.G.S, 2018 - Stn. 09504440
Colorado River	4	12	38	River	U.S.G.S, 2018 - Stn. 09522000
Vail Lake	2	6	432	Lake	Preszler, 2018
Wulungu Lake	1	2	482	Lake	Li et al., 2021
Gastropods					
Santa Clara River	1	4	2123	Spring	U.S.G.S, 2018 - Stn. 09409100
Painter Spring	1	4	1633	Spring	Stephens, 1977
Lake Warner	1	3	1367	Lake	Phillips and Van Denburgh, 1971
Clear Lake	2	8	1401	Lake	Hovingh, personal communication
Lake Tanganyika	6	16	774	Lake	Crul, 1997
Lake Towuti	3	15	293	Lake	Tierney and Russell, 2009
Nimgun Lake	3	5	320	Lake	MacDonald, 1996
Fuxian Lake	1	6	1722	Lake	Roy et al., 2019
Lake Manasarovar	1	14	4600	Lake	Roy et al., 2019
Yamdrok Yumco	1	3	4430	Lake	Yu et al., 2011 (Fig. 4)
Yamdrok Yumco	1	11	4435	Lake	Wang et al., 2020
Tso Nag	1	1	4810	Lake	Huntington et al., 2015
Tsangpo	1	1	4580	Creek	Huntington et al., 2015
Zhongba	1	1	4570	Interdune pool	Huntington et al., 2015
Bosten Lake	1	5	1044	Lake	Li et al., 2021
Cuona Lake	1	4	4592	Lake	Li et al., 2021
Dajia Co	1	3	5156	Lake	Li et al., 2021
Jinzihai Lake	1	4	2985	Lake	Li et al., 2021
Wulungu Lake	1	2	482	Lake	Li et al., 2021
Micrite					
Laguna Pozuelos	1	1	3600	Lake	Ferrero et al., 2004
Mar Chiquita	1	3	68	Lake	Reati et al., 1997
El Potosi	2	7	1880	Lake	Roy et al., 2016
Kusai	2	6	4475	Lake	Liu et al., 2014
Laguna La Salada	2	4	2035	Lake	Roy et al., 2014
Laguna Las Cruces	1	4	2106	Lake	Roy et al., 2013
Zaca Lake	1	5	730	Lake	Dickman, 1987
Pipahai Lake	1	2	1770	Lake	Li et al., 2021
Chagan Lake	1	2	1021	Lake	Li et al., 2021
Gahai Lake	1	1	3192	Lake	Li et al., 2021
Qinghai Lake	1	2	3196	Lake	Li et al., 2021
Kuhai Lake	1	2	4133	Lake	Li et al., 2021
Eling Lake	1	2	4272	Lake	Li et al., 2021
Zhaling Lake	1	2	4298	Lake	Li et al., 2021
Xingxinghai Lake	1	2	4224	Lake	Li et al., 2021
Koucha Lake	1	4	4537	Lake	Li et al., 2021
Donggi Cona Lake	1	1	4092	Lake	Li et al., 2021
Gahai Lake2	1	1	2859	Lake	Li et al., 2021
Tuosu Lake	1	3	2804	Lake	Li et al., 2021
Hala Lake	1	3	4081	Lake	Li et al., 2021
Cuona Lake	1	3	4592	Lake	Li et al., 2021
Pung Co	1	4	4540	Lake	Li et al., 2021

Jiang Co	1	2	4616	Lake	Li et al., 2021
Bam Co	1	3	4575	Lake	Li et al., 2021
Shen Co	1	6	4744	Lake	Li et al., 2021
Selin Co	1	4	4553	Lake	Li et al., 2021
Dagze Co	1	4	4480	Lake	Li et al., 2021
Zharinanmu Co	1	3	4629	Lake	Li et al., 2021
Dajia Co	1	3	5156	Lake	Li et al., 2021
Angrenjin Co	1	2	4295	Lake	Li et al., 2021
Lang Co	1	3	4303	Lake	Li et al., 2021
Sailimu Lake	1	4	2078	Lake	Li et al., 2021
Ailike Lake	1	3	270	Lake	Li et al., 2021
Wulungu Lake	1	3	482	Lake	Li et al., 2021
Sugan Lake	1	5	3000	Lake	Li et al., 2021
Blue Eagle Lake	1	4	2552	Lake	Huntington et al., 2010
Emerald Lake	1	4	3093	Lake	Huntington et al., 2010
South Grizzly Lake	1	3	3242	Lake	Huntington et al., 2010
Microbialites					
Laguna Bacalar	1	3	2	Lake	Tobón Velázquez, 2017
Lago Sarmiento	1	3	77	Lake	Airo, 2010
South Arm, Great Salt Lake	1	3	1280	Lake	Gwynn, J.W., 2007
North Arm, Great Salt Lake	1	2	1280	Lake	Gwynn, J.W., 2007
Kelly Lake	1	3	1070	Lake	Petryshyn et al., 2015
Pavillion Lake	1	3	823	Lake	Petryshyn et al., 2015
Ooids					
South Arm, Great Salt Lake	7	19	1280	Lake	Gwynn, J.W., 2007
North Arm, Great Salt Lake	4	14	1280	Lake	Gwynn, J.W., 2007
Tufas					
Lake Surprise	1	1	1363.5	Lake	Costa et al., 2008
Walker Lake	1	11	1190	Lake	Petryshyn et al., 2016
Cannatoppa*	1	29	254	Stream	Kele et al., 2015
Cannatoppa^	1	8	254	Stream	Kele et al., 2015
La Pigna*	1	31	1359	Stream	Kele et al., 2015
La Pigna^	1	9	1359	Stream	Kele et al., 2015
Sarteano*	1	29	1400	Stream	Kele et al., 2015
Sarteano^	1	9	1400	Stream	Kele et al., 2015
Szalajka	1	30	1414	Stream	Kele et al., 2015
Szalajka*	1	29	1414	Stream	Kele et al., 2015
Szalajka^	1	9	1414	Stream	Kele et al., 2015
Szalajka	1	29	1414	Stream	Kele et al., 2015
Kailas	2	6	4780	Lake	Huntington et al., 2015
Lake Crowley	1	3	2058	Lake	Huntington et al., 2010
Lake Mead	1	3	372	Lake	Huntington et al., 2010
Mono Lake	1	2	1899	Lake	Huntington et al., 2010
Travertines					
Aqua Borra*	1	30	192	Natural spring	Kele et al., 2015
Aqua Borra^	1	11	192	Natural spring	Kele et al., 2015
Bagnoli	1	32	178	Natural spring	Kele et al., 2015
BSF Fosso Bianco	1	30	526	Natural spring	Kele et al., 2015
Bük*	1	28	169	Thermal well	Kele et al., 2015

Bük^	1	9	169	Thermal well	Kele et al., 2015
Madre del Agua*	1	29	1629	Natural spring	Kele et al., 2015
Madre del Agua^	1	8	1629	Natural spring	Kele et al., 2015
Igal*	1	30	172	Thermal well	Kele et al., 2015
Igal^	1	10	172	Thermal well	Kele et al., 2015
Köröm	1	36	99	Thermal well	Kele et al., 2015
Baishuitai - summer*	1	38	2688	Natural spring	Kele et al., 2015
Baishuitai - summer^	1	9	2688	Natural spring	Kele et al., 2015
Baishuitai - winter*	1	43	2688	Natural spring	Kele et al., 2015
Baishuitai - winter^	1	10	2688	Natural spring	Kele et al., 2015
Piscine Carletti	1	29	275	Natural spring	Kele et al., 2015
Rapolano Terme	1	28	257	Thermal well	Kele et al., 2015
Szèchenyi Spa	1	28	107	Thermal well	Kele et al., 2015
Terme Sangiovanni	1	28	258	Natural spring	Kele et al., 2015
Tura*	1	30	135	Thermal well	Kele et al., 2015
Tura^	1	9	135	Thermal well	Kele et al., 2015
Narrow Gauge, Yellowstone*	1	29	2632	Natural spring	Kele et al., 2015
Narrow Gauge, Yellowstone^	1	9	2632	Natural spring	Kele et al., 2015

Table S1. Sample site, analyses, and temperature data source for freshwater carbonates included in this study. *Denotes sample run at ETH. ^Denotes sample run at MIT.

UCLA Standards

Standard	Type	N	$\delta^{13}C$ (‰,VPDB)	$\delta^{18}O$ (‰,VPDB)	Δ_{47} (‰, I-CDES)
Bonedry Tank CO_2	25°C gas breakseal	—	—	—	25°C equilibration
Bonedry Tank CO_2	1000°C gas breakseal	—	—	—	Stochastic
Carmel Chalk	Carbonate	178	-2.2 ± 0.1	-4.0 ± 0.1	0.594 ± 0.001
Carrara Marble	Carbonate	63	2.1 ± 0.0	-1.5 ± 0.1	0.313 ± 0.003
Carrara Marble - CIT	Carbonate	97	2.3 ± 0.0	-1.8 ± 0.1	0.312 ± 0.002
CM Tile	Carbonate	45	2.0 ± 0.0	-1.5 ± 0.1	0.313 ± 0.002
ETH-1	Carbonate	63	2.0 ± 0.1	-2.2 ± 0.1	0.210 ± 0.003
ETH-2	Carbonate	47	-10.2 ± 0.0	-18.7 ± 0.1	0.206 ± 0.003
ETH-3	Carbonate	38	1.7 ± 0.1	-1.8 ± 0.1	0.618 ± 0.004
ETH-4	Carbonate	47	-10.2 ± 0.1	-18.8 ± 0.1	0.448 ± 0.002
Evap DI + Carrera Marble CO_2	25°C gas breakseal	—	—	—	25°C equilibration
Evap DI + Carrera Marble CO_2	1000°C gas breakseal	—	—	—	Stochastic
IAEA-C1	Carbonate	11	2.4 ± 0.1	-2.3 ± 0.1	0.302 ± 0.004
IAEA-C2	Carbonate	10	-8.1 ± 0.1	-8.8 ± 0.1	0.631 ± 0.005
MERCK	Carbonate	7	-41.9 ± 0.1	-15.6 ± 0.1	0.526 ± 0.011
Spel 2-8-E	Carbonate	14	-9.4 ± 0.4	-6.1 ± 0.1	0.617 ± 0.009
TV01	Carbonate	4	2.5 ± 0.1	-8.3 ± 0.1	0.628 ± 0.007
TV03	Carbonate	21	2.6 ± 0.1	-8.4 ± 0.1	0.620 ± 0.005
TV03 - CIT	Carbonate	26	3.3 ± 0.1	-8.2 ± 0.3	0.624 ± 0.003
Veinstrom	Carbonate	104	-6.2 ± 0.1	-12.6 ± 0.1	0.632 ± 0.002
102-GC-AZ01	Carbonate	9	0.4 ± 0.1	-13.9 ± 0.3	0.630 ± 0.019

Caltech Standards

Standard	Type	N	$\delta^{13}C$ (‰,VPDB)	$\delta^{18}O$ (‰,VPDB)	Δ_{47} (‰, I-CDES)
BOC	25°C gas breakseal	—	—	—	25°C equilibration
BOC	1000°C gas breakseal	—	—	—	Stochastic
Cararra Marble	Carbonate	78	2.3 ± 0.1	-1.9 ± 0.1	0.301 ± 0.002
Enriched BOC	25°C gas breakseal	—	—	—	25°C equilibration
Enriched BOC	1000°C gas breakseal	—	—	—	Stochastic
NBS-19	Carbonate	-	1.9 ± 0.0	-2.2 ± 0.1	0.298 ± 0.009
Spel 2-8-E	Carbonate	15	-8.1 ± 1.3	-6.3 ± 0.1	0.555 ± 0.054
TV01	Carbonate	59	2.4 ± 0.1	-8.5 ± 0.1	0.627 ± 0.003
102-GC-AZ01	Carbonate	13	0.5 ± 0.0	-14.4 ± 0.1	0.559 ± 0.058

Table S2. Stable and clumped isotope results for standards used for processing UCLA data and Caltech data based on best practices outlined in Upadhyay et al. (2021). $\delta^{13}C$ and $\delta^{18}O$ data are presented with one standard deviation, while Δ_{47} data is presented with one standard error.

Δ_{47} (‰, I-CDES)	Water Temperature (°C) Composite	Biologic	Micrite	Bio-mediated	Travertine	Anderson et al. (2021)	Petersen et al. (2019)*
0.550	42.0	40.9	41.9	48.7	40.3	41.1	44.3
0.575	33.1	31.0	33.7	37.0	31.1	31.6	34.4
0.600	24.9	21.9	26.2	26.7	22.6	22.9	25.3
0.625	17.3	13.6	19.2	17.4	14.8	15.0	17.0
0.650	10.3	6.0	12.7	8.9	7.6	7.6	9.3
0.675	3.8	-1.1	6.5	1.1	0.9	0.8	2.2
0.700	-2.3	-7.6	0.8	-6.1	-5.4	-5.5	-4.3

Table S3. Comparison of derived temperatures using regressions derived within this study to a recently published calibration (Anderson et al., 2021) and a 'universal' calibration (Petersen et al., 2019). *Data is presented in $CDES_{90}$ using AFF in Petersen et al. (2019).

Sample Name	Measured $\delta^{18}O_w$ (‰, VSMOW)	$\delta^{18}O_w$ Data Source	Timescale of measurement
Bivalves			
Red Rock	-11.6	U.S.G.S, 2018 - Stn. 9504420	Multiple measurements (2009-2014)
Colorado River	-11.8	U.S.G.S, 2018 - Stn. 09522000	Multiple measurements (1997-2000; 2009-2010)
Vail Lake	-0.6	U.S.G.S, 2018 - Stn. 11042510	Point measurements (August 2011; September 2012)
Wulungu Lake	-4.7	Li et al., 2020	Point measurement (June - August)
Gastropods			
Lake Tanganyika	3.4	Dettman et al., 2005	Multiple measurements (1985-1999)
Fuxian Lake	-2.5	Roy et al., 2019	Multiple measurements (2013-2016)
Lake Manasarovar	-6.9	Roy et al., 2020	Point measurement (August 2007)
Yamdrok Yumco	-15.8	Yang et al., 2020	Point measurement (August 2013)
Tso Nag	-5.4	Huntington et al., 2015	Point measurement (mid-June)
Tsangpo	-17.0	Huntington et al., 2015	Point measurement (mid-June)
Zhongba	-9.9	Huntington et al., 2015	Point measurement (mid-June)
Bosten Lake	-8.0	Li et al., 2020	Point measurement (June - August)
Cuona Lake	-8.8	Li et al., 2020	Point measurement (June - August)
Dajia Co	-7.1	Li et al., 2020	Point measurement (June - August)
Jinzihai Lake	-8.6	Li et al., 2020	Point measurement (June - August)
Wulungu Lake	-4.7	Li et al., 2020	Point measurement (June - August)
Micrite			
Mar Chiquita	1.1	Piovano et al., 2001	Point measurement (Summer, 2 measurements)
Zaca Lake	-3.3	Feakins et al., 2014	Multiple measurements (2009-2012)
Pipahai Lake	2.9	Li et al., 2020	Point measurement (June - August)
Chagan Lake	-2.2	Li et al., 2020	Point measurement (June - August)
Gahai Lake	1.1	Li et al., 2020	Point measurement (June - August)
Qinghai Lake	1.4	Li et al., 2020	Point measurement (June - August)
Kuhai Lake	-0.9	Li et al., 2020	Point measurement (June - August)
Eling Lake	-3.5	Li et al., 2020	Point measurement (June - August)
Zhaling Lake	-1.6	Li et al., 2020	Point measurement (June - August)
Xingxinghai Lake	-0.8	Li et al., 2020	Point measurement (June - August)
Koucha Lake	-3.6	Li et al., 2020	Point measurement (June - August)
Donggi Cona Lake	-4.0	Li et al., 2020	Point measurement (June - August)
Gahai Lake2	3.5	Li et al., 2020	Point measurement (June - August)
Tuosu Lake	5.7	Li et al., 2020	Point measurement (June - August)
Hala Lake	1.5	Li et al., 2020	Point measurement (June - August)
Cuona Lake	-8.8	Li et al., 2020	Point measurement (June - August)
Pung Co	-3.7	Li et al., 2020	Point measurement (June - August)
Jiang Co	-6.0	Li et al., 2020	Point measurement (June - August)

Bam Co	-5.6	Li et al., 2020	Point measurement (June - August)
Shen Co	-3.8	Li et al., 2020	Point measurement (June - August)
Selin Co	-3.2	Li et al., 2020	Point measurement (June - August)
Dagze Co	-5.5	Li et al., 2020	Point measurement (June - August)
Zharinanmu Co	-7.5	Li et al., 2020	Point measurement (June - August)
Dajia Co	-7.1	Li et al., 2020	Point measurement (June - August)
Angrenjin Co	-4.5	Li et al., 2020	Point measurement (June - August)
Lang Co	-5.7	Li et al., 2020	Point measurement (June - August)
Sailimu Lake	-2.2	Li et al., 2020	Point measurement (June - August)
Ailike Lake	-4.6	Li et al., 2020	Point measurement (June - August)
Wulungu Lake	-4.7	Li et al., 2020	Point measurement (June - August)
Sugan Lake	2.1	Li et al., 2020	Point measurement (June - August)
Microbialites			
Laguna Bacalar	-2.4	Pérez et al., 2011	Point measurement (November - March)
Lago Sarmiento	-3.5	Solari et al., 2010	Biannual measurement (January/September)
South Arm, Great Salt Lake	-4.1	Pedone et al., 2002	Annual measurement (3 years; winter and summer)
North Arm, Great Salt Lake	-4.0	Pedone et al., 2002	Annual measurement (3 years; winter and summer)
Kelly Lake	-16.7	Petryshyn et al., 2015	Annual measurement (3 years; summer)
Pavillion Lake	-11.4	Petryshyn et al., 2015	Annual measurement (3 years; summer)
Ooids			
South Arm, Great Salt Lake	-4.0	Pedone et al., 2002	Annual measurement (3 years; winter and summer)
North Arm, Great Salt Lake	-2.0	Pedone et al., 2002	Annual measurement (3 years; winter and summer)
Tufas			
Walker Lake	0.2	Yuan et al., 2006	Point measurement (1985-1994)
Cannatoppa*	-6.5	Kele et al., 2015	Point measurement (October)
La Pigna*	-6.8	Kele et al., 2015	Point measurement (October)
Sarteano	-7.8	Kele et al., 2015	Point measurement (October)
Szalajka	-10.6	Kele et al., 2015	Point measurement (October)
Szalajka*	-10.6	Kele et al., 2015	Point measurement (October)
Szalajka	-10.7	Kele et al., 2015	Point measurement (October)
Kailas	-4.7	Huntington et al., 2015	Point measurement (mid-June)
Travertines			
Aqua Borra*	-5.2	Kele et al., 2015	Point measurement
Bagnoli	-7.0	Kele et al., 2015	Point measurement
BSF Fosso Bianco	-7.9	Kele et al., 2015	Point measurement
Bük*	-9.9	Kele et al., 2015	Point measurement
Madre del Agua*	-8.1	Kele et al., 2015	Point measurement

Igal*	-4.0	Kele et al., 2015	Point measurement
Köröm	-11.5	Kele et al., 2015	Point measurement
Piscine Carletti	-6.5	Kele et al., 2015	Point measurement
Rapolano Terme	-6.9	Kele et al., 2015	Point measurement
Szèchenyi Spa	-12.6	Kele et al., 2015	Point measurement
Terme Sangiovanni	-6.9	Kele et al., 2015	Point measurement
Tura*	-12.4	Kele et al., 2015	Point measurement
Narrow Gauge, Yellowstone*	-17.9	Kele et al., 2015	Point measurement

Table S4. Measured $\delta^{18}O$ values for selected sites and their respective sources.

Samples	Age	1 s.d.	Water Temperature (°C)			Water $\delta^{18}O$ (‰, VSMOW)			Evaporation (mm/yr)						Precipitation (mm/yr)			k_{run}		
			This study	1 s.d.	Santi et al. (2020)	This study	1 s.d.	Santi et al. (2020)	This study	1 s.d.	This study: weighted	1 s.d.	Santi et al. (2020)	Santi et al. (2020): weighted	This study	1 s.d.	Santi et al. (2020)	This study	1 s.d.	Santi et al. (2020)
SV15BM04	19.559	0.220	6.8	1.8	9.8	-4.4	0.4	-3.7	785	116	535	70	829	540	578	161	535	0.237	0.100	0.202
SVCW 17-PT1	16.303	1.000	8.8	1.8	11.7	-4.0	0.4	-3.4	832	135	564	77	903	578	575	179	543	0.221	0.105	0.180
SVCW 17-PT2	16.109	0.484	9.2	1.1	12.5	-3.9	0.2	-3.2	815	123	551	71	969	612	553	172	565	0.215	0.102	0.175
SVCW 17-PT3	16.684	0.566	9.6	1.2	12.5	-3.9	0.3	-3.2	828	130	557	75	971	618	558	178	573	0.212	0.103	0.185
SVCW 17-PT4	9.007	0.336	10.6	1.5	12.3	-4.3	0.3	-3.9	876	155	590	84	960	628	598	194	604	0.218	0.102	0.200
SVDI 11-T14-1A	12.701	0.057	7.6	1.1	11.8	-3.5	0.2	-2.4	788	110	528	64	951	569	500	163	484	0.197	0.103	0.155
SVDI 11-T14-1B	12.701	0.057	5.1	0.6	9.6	-4.2	0.1	-3.2	757	95	523	63	810	514	551	146	474	0.234	0.100	0.181
SVDI 11-T14-1C	12.708	0.057	14.7	2.2	14.0	-2.1	0.5	-2.2	1237	294	620	123	1137	667	581	284	549	0.142	0.102	0.143
SVDI 11-T14-E	12.701	0.057	13.3	4.0	16.8	-2.5	0.0	-1.5	1202	353	727	146	1504	846	616	312	618	0.152	0.100	0.122
SVDI 11-T2-1	19.223	0.235	10.9	1.9	10.2	-2.6	0.4	-2.8	900	175	506	77	831	500	471	199	446	0.162	0.102	0.161
SVDI 11-T3-2	21.247	1.630	8.9	1.7	11.3	-3.4	0.4	-2.8	814	134	502	63	877	513	487	171	464	0.183	0.099	0.161
SVDI 11-T4-1b	18.840	2.080	5.7	1.2	9.0	-3.8	0.3	-2.9	749	99	478	53	786	462	486	143	429	0.200	0.092	0.166
SVDI 12-T1	21.217	0.250	6.6	1.2	11.8	-4.1	0.3	-2.9	752	102	472	52	885	497	495	143	457	0.205	0.093	0.155
SVDI 12-T10-A	14.936	0.243	11.1	2.4	15.2	-3.4	0.5	-2.4	968	206	686	110	1299	814	611	242	678	0.199	0.110	0.158
SVDI 12-T10-B	16.480	0.870	9.7	1.2	12.6	-3.3	0.3	-2.6	855	132	577	77	997	633	542	188	547	0.196	0.108	0.171
SVDI 12-T13	21.134	0.298	7.8	2.4	11.3	-3.6	0.5	-2.7	820	141	533	68	934	551	513	175	496	0.194	0.098	0.161
SVDI 12-T14	15.185	0.180	12.3	3.7	7.9	-3.1	0.8	-4.0	1134	306	712	156	846	600	692	313	599	0.193	0.113	0.235
SVDI 12-T14-1C	12.701	0.057	10.6	4.2	14.7	-2.8	0.0	-1.7	1075	287	711	142	1240	753	623	289	559	0.179	0.109	0.133
SVDI 12-T15-B	19.474	0.226	15.3	4.7	16.0	-1.8	1.0	-1.4	1369	420	738	144	1405	734	607	342	577	0.130	0.096	0.123
SVDI 12-T3-A	21.823	0.680	9.3	2.2	15.5	-3.3	0.5	-1.9	839	154	611	66	1309	685	492	179	573	0.177	0.095	0.127
SVDI 12-T3-B	20.016	0.680	8.7	2.0	13.0	-3.5	0.5	-2.5	816	139	498	63	991	552	488	168	484	0.184	0.096	0.145
SVDI 12-T4-A	22.675	0.679	7.4	1.1	10.6	-3.6	0.2	-2.9	766	109	485	57	832	492	483	151	457	0.197	0.098	0.167
SVDI 12-T4-B	22.181	0.626	6.8	1.4	9.0	-3.8	0.3	-3.3	766	108	504	58	802	487	501	152	472	0.203	0.097	0.183
SVDI 12-T5b	10.688	0.107	10.9	1.3	13.7	-3.9	0.3	-3.3	864	157	550	74	1059	635	536	185	586	0.192	0.098	0.170
SVDI 12-T7	17.613	0.438	6.5	1.0	9.8	-4.6	0.2	-3.9	767	102	539	68	818	545	583	145	540	0.257	0.102	0.214
SVDI 12-T9	14.515	0.346	7.9	1.6	11.3	-3.9	0.4	-3.1	820	119	572	76	906	592	580	171	539	0.229	0.107	0.186
SVDI 15-AE01	18.800	0.137	16.4	1.9	17.7	-1.7	0.4	-1.4	1440	310	805	119	1604	879	624	302	655	0.129	0.096	0.120
SVDI 15-AE02	18.075	0.185	18.5	3.2	14.3	-1.5	0.7	-2.5	1692	388	942	150	1258	750	716	367	670	0.124	0.097	0.164
SVDI 15-AE03	13.945	0.159	13.4	3.0	14.1	-2.4	0.6	-2.2	1151	304	615	131	1167	702	585	288	570	0.154	0.105	0.151
SVDI 15-AE05	21.428	0.262	10.4	3.6	15.6	-3.5	0.8	-2.3	984	243	658	107	1332	753	604	247	654	0.191	0.104	0.142
SVDI 15-AE06	22.079	0.264	14.8	4.1	16.6	-2.2	0.9	-1.7	1312	394	959	140	1476	792	619	330	667	0.142	0.100	0.134
SVDI 15-BM03	17.208	0.232	17.0	3.7	14.0	-1.9	0.9	-2.6	1514	407	584	146	1126	651	680	360	567	0.131	0.098	0.152

SVDI 15-BM04	19.559	0.220	7.6	2.0	10.6	-4.3	0.5	-3.6	806	126	549	72	854	551	579	168	536	0.232	0.101	0.198
SVDI 15-BM08	21.462	0.270	20.2	2.1	20.7	-1.2	0.5	-1.1	1909	303	967	112	1979	1006	724	356	743	0.113	0.093	0.110
SVDI 15-BM09	19.819	0.213	15.4	4.7	21.9	-2.1	1.0	-0.6	1400	430	1007	166	2049	1036	678	371	730	0.144	0.102	0.103

Table S5. Comparison of hydroclimate parameters derived using the biologically mediated regression from reprocessed data on I-CDES and updated and restandardized estimates from Santi et al. (2020) for Lake Surprise, CA.

			Water Temperature (°C)			Water $\delta^{18}O$ (‰, VSMOW)			Evaporation (mm/yr)						Precipitation (mm/yr)			k_{run}		
Samples	**Age**	**1 s.d.**	**This study**	**1 s.d.**	**Santi et al. (2020)**	**This study**	**1 s.d.**	**Santi et al. (2020)**	**This study**	**1 s.d.**	**This study: weighted**	**1 s.d.**	**Santi et al. (2020)**	**Santi et al. (2020): weighted**	**This study**	**1 s.d.**	**Santi et al. (2020)**	**This study**	**1 s.d.**	**Santi et al. (2020)**
SV15BM04	19.559	0.220	8.6	1.5	9.8	-4.0	0.4	-3.7	804	122	534	123	829	540	545	166	535	0.218	0.103	0.202
SVCW 17-PT1	16.303	1.000	10.2	1.5	11.7	-3.7	0.3	-3.4	859	148	569	139	903	578	559	188	543	0.207	0.105	0.180
SVCW 17-PT2	16.109	0.484	10.5	0.9	12.5	-3.6	0.2	-3.2	848	141	559	137	969	612	543	185	565	0.200	0.103	0.175
SVCW 17-PT3	16.684	0.566	10.9	1.0	12.5	-3.6	0.2	-3.2	865	146	568	138	971	618	547	187	573	0.199	0.104	0.185
SVCW 17-PT4	9.007	0.336	11.7	1.3	12.3	-4.1	0.3	-3.9	920	176	609	158	960	628	597	211	604	0.204	0.104	0.200
SVDI 11-T14-1A	12.701	0.057	9.2	0.9	11.8	-3.1	0.2	-2.4	811	121	516	122	951	569	471	170	484	0.180	0.103	0.155
SVDI 11-T14-1B	12.701	0.057	7.1	0.5	9.6	-3.8	0.1	-3.2	770	101	517	109	810	514	513	154	474	0.211	0.103	0.181
SVDI 11-T14-1C	12.708	0.057	15.1	1.8	14.0	-2.0	0.4	-2.2	1277	281	738	228	1137	667	582	284	549	0.135	0.098	0.143
SVDI 11-T14-E	12.701	0.057	13.9	3.3	16.8	-2.3	0.0	-1.5	1210	335	722	255	1504	846	597	298	618	0.146	0.101	0.122
SVDI 11-T2-1	19.223	0.235	11.9	1.6	10.2	-2.3	0.4	-2.8	942	191	548	164	831	500	469	206	446	0.149	0.100	0.161
SVDI 11-T3-2	21.247	1.630	10.3	1.4	11.3	-3.1	0.3	-2.8	838	145	504	136	877	513	469	175	464	0.169	0.098	0.161
SVDI 11-T4-1b	18.840	2.080	7.7	1.0	9.0	-3.3	0.2	-2.9	764	109	465	114	786	462	451	149	429	0.184	0.098	0.166
SVDI 12-T1	21.217	0.250	8.4	1.0	11.8	-3.7	0.2	-2.9	768	113	468	116	885	497	466	148	457	0.187	0.095	0.155
SVDI 12-T10-A	14.936	0.243	12.1	2.0	15.2	-3.1	0.4	-2.4	1006	214	666	189	1299	814	604	252	678	0.188	0.111	0.158
SVDI 12-T10-B	16.480	0.870	11.0	1.0	12.6	-3.0	0.2	-2.6	890	153	589	145	997	633	530	203	547	0.184	0.107	0.171
SVDI 12-T13	21.134	0.298	9.3	2.0	11.3	-3.2	0.4	-2.7	836	148	510	137	934	551	485	177	496	0.178	0.099	0.161
SVDI 12-T14	15.185	0.180	13.1	3.0	7.9	-2.9	0.6	-4.0	1146	293	760	239	846	600	670	304	599	0.180	0.110	0.235
SVDI 12-T14-1C	12.701	0.057	11.7	3.5	14.7	-2.5	0.0	-1.7	1084	279	702	223	1240	753	589	276	559	0.165	0.106	0.133
SVDI 12-T15-B	19.474	0.226	15.5	3.9	16.0	-1.7	0.8	-1.4	1368	401	729	287	1405	734	597	326	577	0.128	0.096	0.123
SVDI 12-T3-A	21.823	0.680	10.6	1.8	15.5	-3.0	0.4	-1.9	867	164	506	145	1309	685	471	182	573	0.166	0.098	0.127
SVDI 12-T3-B	20.016	0.680	10.1	1.6	13.0	-3.1	0.4	-2.5	843	152	496	139	991	552	467	177	484	0.170	0.098	0.145
SVDI 12-T4-A	22.675	0.679	9.0	0.9	10.6	-3.2	0.2	-2.9	788	119	481	120	832	492	457	158	457	0.180	0.097	0.167
SVDI 12-T4-B	22.181	0.626	8.6	1.2	9.0	-3.4	0.3	-3.3	787	117	488	119	802	487	471	157	472	0.185	0.099	0.183
SVDI 12-T5b	10.688	0.107	12.0	1.1	13.7	-3.7	0.2	-3.3	917	177	570	157	1059	635	544	201	586	0.182	0.100	0.170
SVDI 12-T7	17.613	0.438	8.3	0.9	9.8	-4.2	0.2	-3.9	788	110	539	114	818	545	560	160	540	0.230	0.103	0.214
SVDI 12-T9	14.515	0.346	9.5	1.3	11.3	-3.6	0.3	-3.1	844	134	576	132	906	592	556	188	539	0.209	0.108	0.186
SVDI 15-AE01	18.800	0.137	16.5	1.6	17.7	-1.7	0.3	-1.4	1457	290	809	242	1604	879	631	303	655	0.127	0.097	0.120
SVDI 15-AE02	18.075	0.185	18.2	2.6	14.3	-1.5	0.6	-2.5	1678	353	936	283	1258	750	718	354	670	0.127	0.098	0.164
SVDI 15-AE03	13.945	0.159	14.0	2.5	14.1	-2.2	0.5	-2.2	1182	292	713	234	1167	702	583	289	570	0.149	0.105	0.151
SVDI 15-AE05	21.428	0.262	11.6	3.0	15.6	-3.2	0.7	-2.3	996	244	611	198	1332	753	579	244	654	0.178	0.103	0.142
SVDI 15-AE06	22.079	0.264	15.1	3.4	16.6	-2.1	0.8	-1.7	1313	374	721	273	1476	792	607	318	667	0.137	0.098	0.134
SVDI 15-BM03	17.208	0.232	17.0	3.0	14.0	-1.9	0.7	-2.6	1506	380	818	286	1126	651	671	340	567	0.131	0.097	0.152

SVDI 15-BM04	19.559	0.220	9.2	1.7	10.6	-3.9	0.4	-3.6	828	137	547	132	854	551	555	177	536	0.214	0.103	0.198
SVDI 15-BM08	21.462	0.270	19.6	1.7	20.7	-1.3	0.4	-1.1	1851	303	958	273	1979	1006	731	347	743	0.114	0.092	0.110
SVDI 15-BM09	19.819	0.213	15.6	3.9	21.9	-2.0	0.8	-0.6	1389	396	790	293	2049	1036	655	344	730	0.140	0.102	0.103

Table S6. Comparison of hydroclimate parameters derived using the composite regression from reprocessed data on I-CDES and updated and restandardized estimates from Santi et al. (2020) for Lake Surprise, CA.

Samples	Age	1 s.d.	Water Temperature (°C) Anderson et al. (2021)	1 s.d.	Santi et al. (2020)	Water $\delta^{18}O$ (‰, VSMOW) Anderson et al. (2021)	1 s.d.	Santi et al. (2020)	Evaporation (mm/yr) Anderson et al. (2021)	1 s.d.	Anderson et al. (2021): weighted	1 s.d.	Santi et al. (2020)	Santi et al. (2020): weighted	Precipitation (mm/yr) Anderson et al. (2021)	1 s.d.	Santi et al. (2020)	k_{run} Anderson et al. (2021)	1 s.d.	Santi et a (2020)
SV15BM04	19.559	0.220	5.8	1.5	9.8	-4.6	0.4	-3.7	770	106	530	67	829	540	586	148	535	0.251	0.101	0.202
SVCW 17-PT1	16.303	1.000	7.5	1.6	11.7	-4.3	0.4	-3.4	795	116	551	73	903	578	580	162	543	0.240	0.102	0.180
SVCW 17-PT2	16.109	0.484	7.8	1.0	12.5	-4.2	0.2	-3.2	786	108	540	68	969	612	563	158	565	0.233	0.102	0.175
SVCW 17-PT3	16.684	0.566	8.2	1.0	12.5	-4.2	0.2	-3.2	792	109	546	69	971	618	568	162	573	0.229	0.103	0.185
SVCW 17-PT4	9.007	0.336	9.0	1.3	12.3	-4.7	0.3	-3.9	816	126	562	77	960	628	593	173	604	0.233	0.103	0.200
SVDI 11-T14-1A	12.701	0.057	6.5	0.9	11.8	-3.7	0.2	-2.4	772	101	526	63	951	569	518	156	484	0.211	0.104	0.155
SVDI 11-T14-1B	12.701	0.057	4.3	0.5	9.6	-4.4	0.1	-3.2	752	95	526	64	810	514	567	144	474	0.249	0.099	0.181
SVDI 11-T14-1C	12.708	0.057	12.6	1.9	14.0	-2.5	0.4	-2.2	1017	215	560	94	1137	667	518	232	549	0.152	0.099	0.143
SVDI 11-T14-E	12.701	0.057	11.4	3.5	16.8	-2.9	0.0	-1.5	1031	259	652	114	1504	846	575	248	618	0.175	0.108	0.122
SVDI 11-T2-1	19.223	0.235	9.3	1.7	10.2	-2.9	0.4	-2.8	830	136	499	64	831	500	468	176	446	0.170	0.100	0.161
SVDI 11-T3-2	21.247	1.630	7.6	1.5	11.3	-3.7	0.4	-2.8	780	117	496	60	877	513	498	155	464	0.199	0.099	0.161
SVDI 11-T4-1b	18.840	2.080	4.8	1.1	9.0	-4.0	0.2	-2.9	743	97	480	53	786	462	499	140	429	0.213	0.092	0.166
SVDI 12-T1	21.217	0.250	5.6	1.0	11.8	-4.3	0.2	-2.9	740	101	472	53	885	497	504	141	457	0.218	0.094	0.155
SVDI 12-T10-A	14.936	0.243	9.5	2.1	15.2	-3.7	0.5	-2.4	888	156	623	91	1299	814	612	202	678	0.217	0.106	0.158
SVDI 12-T10-B	16.480	0.870	8.3	1.0	12.6	-3.6	0.2	-2.6	816	114	564	73	997	633	559	169	547	0.219	0.108	0.171
SVDI 12-T13	21.134	0.298	6.6	2.1	11.3	-3.8	0.5	-2.7	782	119	517	61	934	551	515	159	496	0.206	0.099	0.161
SVDI 12-T14	15.185	0.180	10.5	3.2	7.9	-3.5	0.7	-4.0	1000	221	664	121	846	600	665	263	599	0.210	0.111	0.235
SVDI 12-T14-1C	12.701	0.057	9.0	3.7	14.7	-3.1	0.0	-1.7	968	220	657	118	1240	753	605	247	559	0.196	0.110	0.133
SVDI 12-T15-B	19.474	0.226	13.1	4.0	16.0	-2.3	0.9	-1.4	1162	333	654	119	1405	734	561	285	577	0.143	0.097	0.123
SVDI 12-T3-A	21.823	0.680	7.9	1.9	15.5	-3.7	0.5	-1.9	794	125	534	60	1309	685	492	157	573	0.191	0.095	0.127
SVDI 12-T3-B	20.016	0.680	7.4	1.7	13.0	-3.8	0.4	-2.5	780	119	489	58	991	552	497	157	484	0.195	0.095	0.145
SVDI 12-T4-A	22.675	0.679	6.3	1.0	10.6	-3.9	0.2	-2.9	746	102	483	56	832	492	496	149	457	0.206	0.096	0.167
SVDI 12-T4-B	22.181	0.626	5.8	1.2	9.0	-4.0	0.3	-3.3	753	103	503	57	802	487	514	148	472	0.215	0.096	0.183
SVDI 12-T5b	10.688	0.107	9.3	1.2	13.7	-4.3	0.2	-3.3	804	122	525	66	1059	635	535	164	586	0.211	0.100	0.170
SVDI 12-T7	17.613	0.438	5.5	0.9	9.8	-4.9	0.2	-3.9	755	99	532	69	818	545	594	139	540	0.274	0.106	0.214
SVDI 12-T9	14.515	0.346	6.7	1.4	11.3	-4.2	0.3	-3.1	797	106	561	71	906	592	591	156	539	0.245	0.106	0.186
SVDI 15-AE01	18.800	0.137	14.1	1.7	17.7	-2.2	0.4	-1.4	1144	254	660	103	1604	879	540	251	655	0.145	0.102	0.120
SVDI 15-AE02	18.075	0.185	15.9	2.7	14.3	-2.0	0.6	-2.5	1369	342	806	136	1258	750	643	320	670	0.141	0.099	0.164
SVDI 15-AE03	13.945	0.159	11.5	2.6	14.1	-2.8	0.5	-2.2	996	232	576	111	1167	702	560	249	570	0.172	0.107	0.151
SVDI 15-AE05	21.428	0.262	8.9	3.1	15.6	-3.8	0.7	-2.3	893	187	586	87	1332	753	580	209	654	0.206	0.102	0.142
SVDI 15-AE06	22.079	0.264	12.6	3.6	16.6	-2.6	0.8	-1.7	1105	314	863	118	1476	792	564	282	667	0.154	0.102	0.134
SVDI 15-BM03	17.208	0.232	14.6	3.2	14.0	-2.4	0.8	-2.6	1249	342	546	127	1126	651	614	307	567	0.145	0.097	0.152

SVDI 15-BM04	19.559	0.220	6.4	1.7	10.6	-4.6	0.4	-3.6	778	112	534	69	854	551	581	152	536	0.246	0.100	0.198
SVDI 15-BM08	21.462	0.270	17.3	1.8	20.7	-1.8	0.4	-1.1	1527	299	836	109	1979	1006	650	307	743	0.127	0.095	0.110
SVDI 15-BM09	19.819	0.213	13.2	4.1	21.9	-2.5	0.9	-0.6	1191	347	940	141	2049	1036	626	316	730	0.160	0.104	0.103

Table S7. Comparison of hydroclimate parameters derived using Anderson et al. (2021) from reprocessed data on I-CDES and updated and restandardized estimates from Santi et al. (2020) for Lake Surprise, CA.

												This study: material-specific				This study: composite				Anderson et al. (2021)			
Sample name	**Type**	**Age**	**1 s.d.**	**Mineralogy**	**n**	**$\delta^{13}C$ (‰, VPDB)**	**1 s.d.**	**$\delta^{18}O$ (‰, VPDB)**	**1 s.d.**	**Δ_{47} (‰, I-CDES)**	**1 s.e.**	**Average temperature [°C]**	**1 s.e.**	**$\delta^{18}O_w$ (‰, VSMOW)**	**1 s.d.**	**Average temperature [°C]**	**1 s.e.**	**$\delta^{18}O_w$ (‰, VSMOW)**	**1 s.d.**	**Average temperature [°C]**	**1 s.e.**	**$\delta^{18}O_w$ (‰, VSMOW)**	**1 s.d.**
AIN4-CI1	Travertine	14.23	0.08	Aragonite	4	1.0	0.1	-10.8	0.1	0.645	0.010	9.0	2.9	-12.6	0.6	11.7	2.9	-12.0	0.6	9.0	3.0	-12.6	0.7
AIN4-Cl2	Travertine	14.21	0.08	Calcite	6	-1.5	0.1	-11.6	0.1	0.631	0.011	13.3	3.4	-11.7	0.7	15.9	3.3	-11.2	0.7	13.5	3.5	-11.7	0.7
AIN5-Cl1	Travertine	14.33	0.06	Aragonite	4	0.2	0.5	-11.0	0.2	0.624	0.005	15.1	1.6	-11.4	0.2	17.6	1.5	-10.9	0.2	15.2	1.6	-11.4	0.2
AIN7-CI1	Tufa	13.4	1.04	Calcite	7	-2.9	0.6	-11.2	0.3	0.645	0.006	10.7	1.7	-11.8	0.4	11.8	1.7	-11.6	0.4	9.1	1.7	-12.2	0.4
AIN8-Cl1	Travertine	13.87	0.08	Aragonite	6	-2.1	0.5	-11.5	0.1	0.628	0.006	14.0	1.7	-12.2	0.3	16.6	1.7	-11.7	0.3	14.2	1.8	-12.2	0.3

Table S8. Δ_{47} results for a travertine sequence in Austria. Temperature and water $\delta^{18}O$ estimates derived using the travertine calibration in this study.

Sample Name	Kelson et al. (2017) Temperature (°C)	1 s.e.	$\delta^{18}O_w$ (‰, VSMOW)	1 s.e.	This study - material specific Temperature (°C)	1 s.e.	$\delta^{18}O_w$ (‰, VSMOW)	1 s.e.	This study - composite Temperature (°C)	1 s.e.	$\delta^{18}O_w$ (‰, VSMOW)	1 s.e.	Anderson et al. (2021) Temperature (°C)	1 s.e.	$\delta^{18}O_w$ (‰, VSMOW)	1 s.e.
'16NQ02'	28.1	1.6	-7.3	0.3	27.8	1.9	-7.4	0.4	26.6	2.0	-7.6	0.4	24.8	2.2	-8.0	0.4
'16NQ04'	26.0	0.8	-9.2	0.2	26.8	1.8	-9.1	0.4	25.6	1.9	-9.3	0.4	23.6	2.0	-9.7	0.4
'16NQ05'	20.5	0.9	-5.9	0.2	19.3	0.9	-6.0	0.3	17.4	1.0	-6.4	0.4	15.1	1.0	-6.9	0.4
'16NQ08'	24.7	2.0	-2.2	0.4	26.4	1.5	-1.5	0.2	25.1	1.6	-1.8	0.2	23.2	1.7	-2.2	0.3
'16NQ19'	56.5	1.4	-1.8	0.2	50.8	2.2	-2.8	0.4	51.9	2.5	-2.6	0.4	51.7	2.7	-2.7	0.5
'16NQ20'	76.5	3.5	0.8	0.5	67.8	3.3	-0.6	0.5	70.8	3.8	-0.2	0.5	72.2	4.1	0.0	0.6
'16NQ21'	68.5	2.1	0.9	0.3	62.7	2.0	0.0	0.2	65.2	2.2	0.3	0.2	66.0	2.4	0.5	0.3
'16NQ22'	48.1	1.5	-3.3	0.3	44.2	1.5	-4.0	0.3	44.5	1.7	-3.9	0.3	43.8	1.8	-4.1	0.3
'16NQ23'	45.4	1.7	-3.6	0.5	43.8	1.7	-3.9	0.3	44.2	1.8	-3.8	0.3	43.4	2.0	-3.9	0.3
'16NQ25'	35.0	2.5	-7.3	0.9	32.3	2.1	-7.8	0.4	31.6	2.3	-8.0	0.4	30.0	2.4	-8.3	0.4
'16NQ26'	35.2	1.8	-4.2	0.6	35.5	1.7	-4.2	0.4	35.1	1.9	-4.3	0.4	33.7	2.0	-4.6	0.4
'16NQ34'	28.8	1.2	-9.1	0.5	27.4	1.2	-9.4	0.3	26.2	1.3	-9.7	0.3	24.3	1.4	-10.0	0.4
'16NQ35'	27.9	1.9	-3.0	0.7	27.2	1.5	-2.8	0.3	26.1	1.6	-3.0	0.3	24.2	1.7	-3.4	0.4
'16NQ36'	35.1	1.8	-5.0	0.5	32.6	2.5	-5.5	0.4	31.9	2.7	-5.7	0.4	30.4	2.9	-6.0	0.5
'16NQ37'	27.0	2.1	-7.6	0.6	28.6	1.8	-7.3	0.4	27.5	1.9	-7.5	0.4	25.7	2.0	-7.8	0.4

Table S9. Comparison of derived water temperatures and water $\delta^{18}O$ published in L. Li et al (2019) from the Nangqian Basin. Estimates derived in the original publication used the calibration of Kelson et al. (2017).