Cosmogenic ^{3}He paleothermometry on post-LGM glacial bedrock within the central European Alps

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Data supplementary

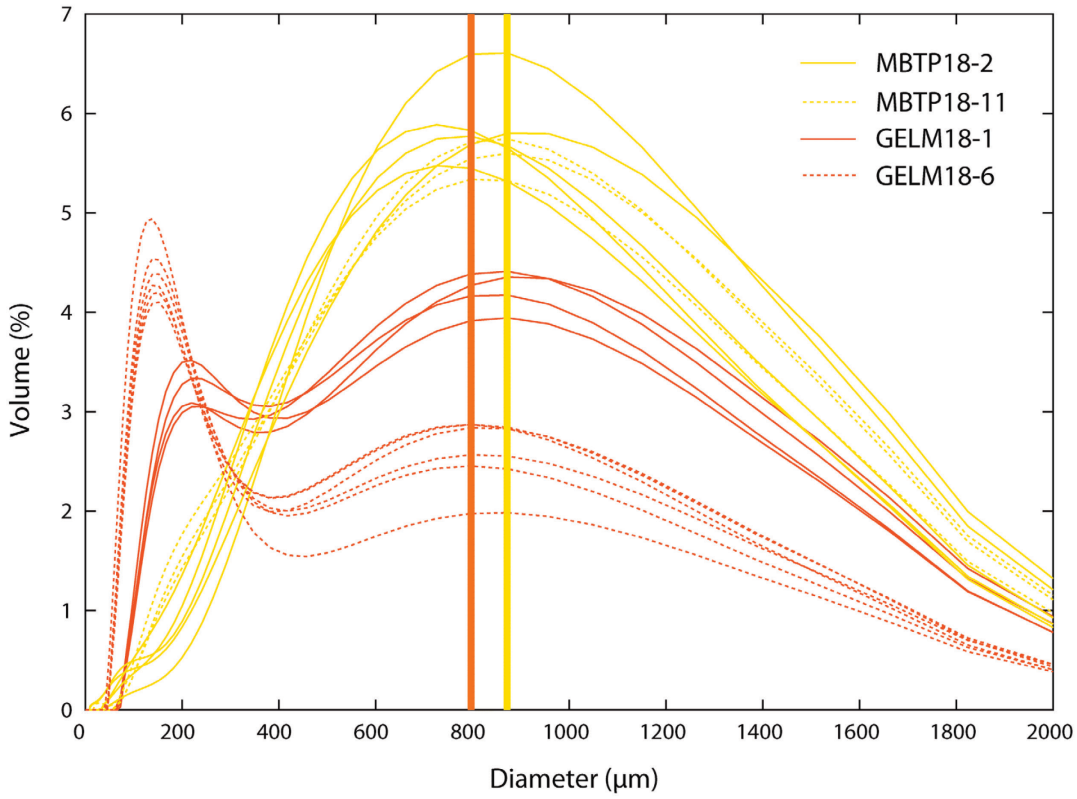

Figure S1: Grain-size distribution measured using laser diffraction after *Selfrag* crushing (fraction ≤ 1.5 mm) for two representative samples per study site: MBTP (MBTP18-2, -11) and GELM (GELM18-01, -06). Multiple lines represent replicates for each sample. Thick vertical lines indicate the averaged mode for the MBTP (yellow line) and the GELM (orange line) sites, when excluding the finer fraction (i.e. <200 µm).

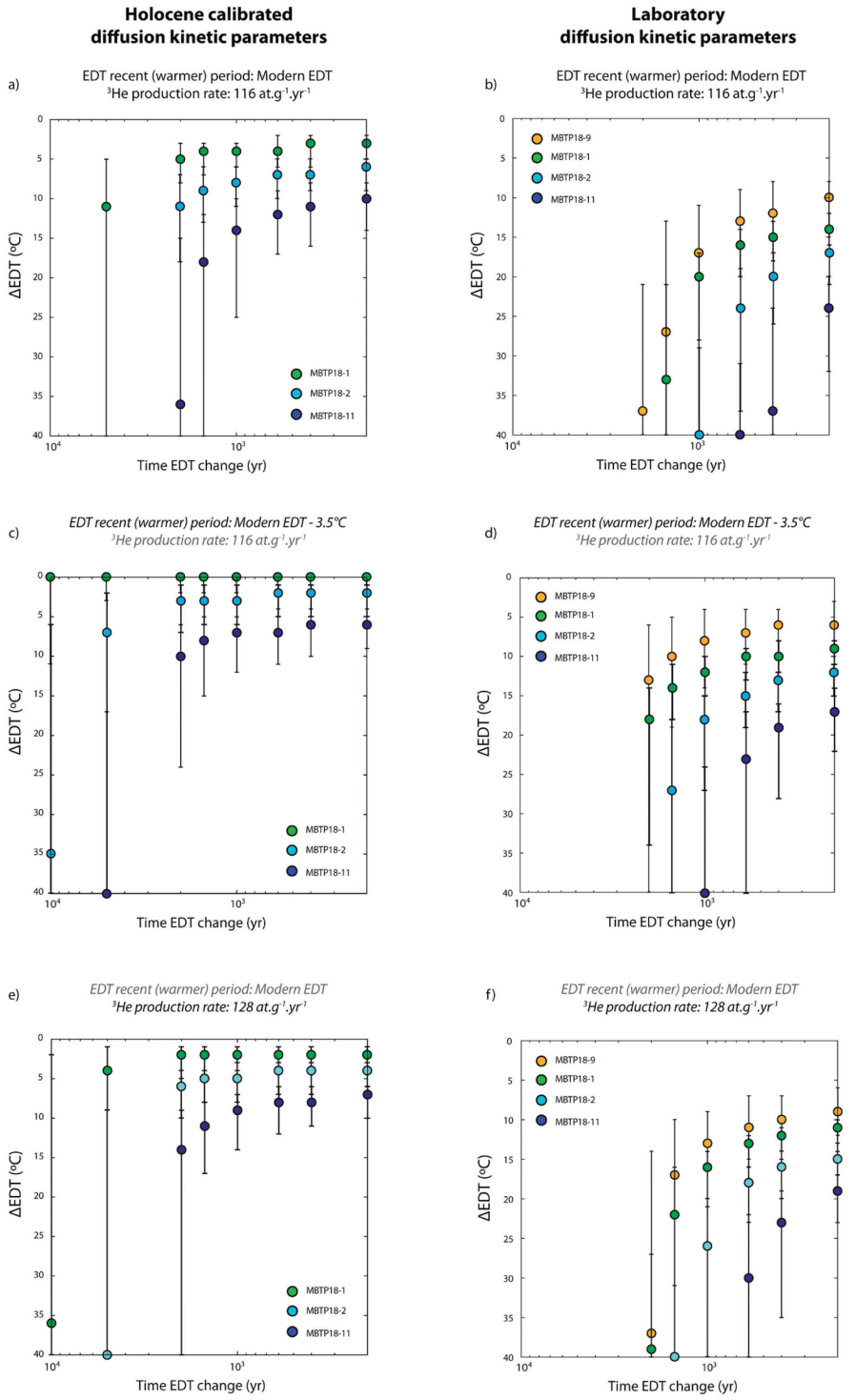

Figure S2: ΔEDT solutions as function of time of EDT change from time-varying EDT forward simulations conducted using MBTP diffusion kinetics calibrated with Holocene samples (left panels) or solely based on laboratory experiments (right panels), with a) and b): recent EDT equal to the Modern EDT and using a ^{3}He production rate at 116 at.g^{-1}.yr^{-1}; c) and d): recent EDT equal to the Modern EDT minus 3.5°C; e) and f): ^{3}He production increased by 10% (128 at.g^{-1}.yr^{-1}).

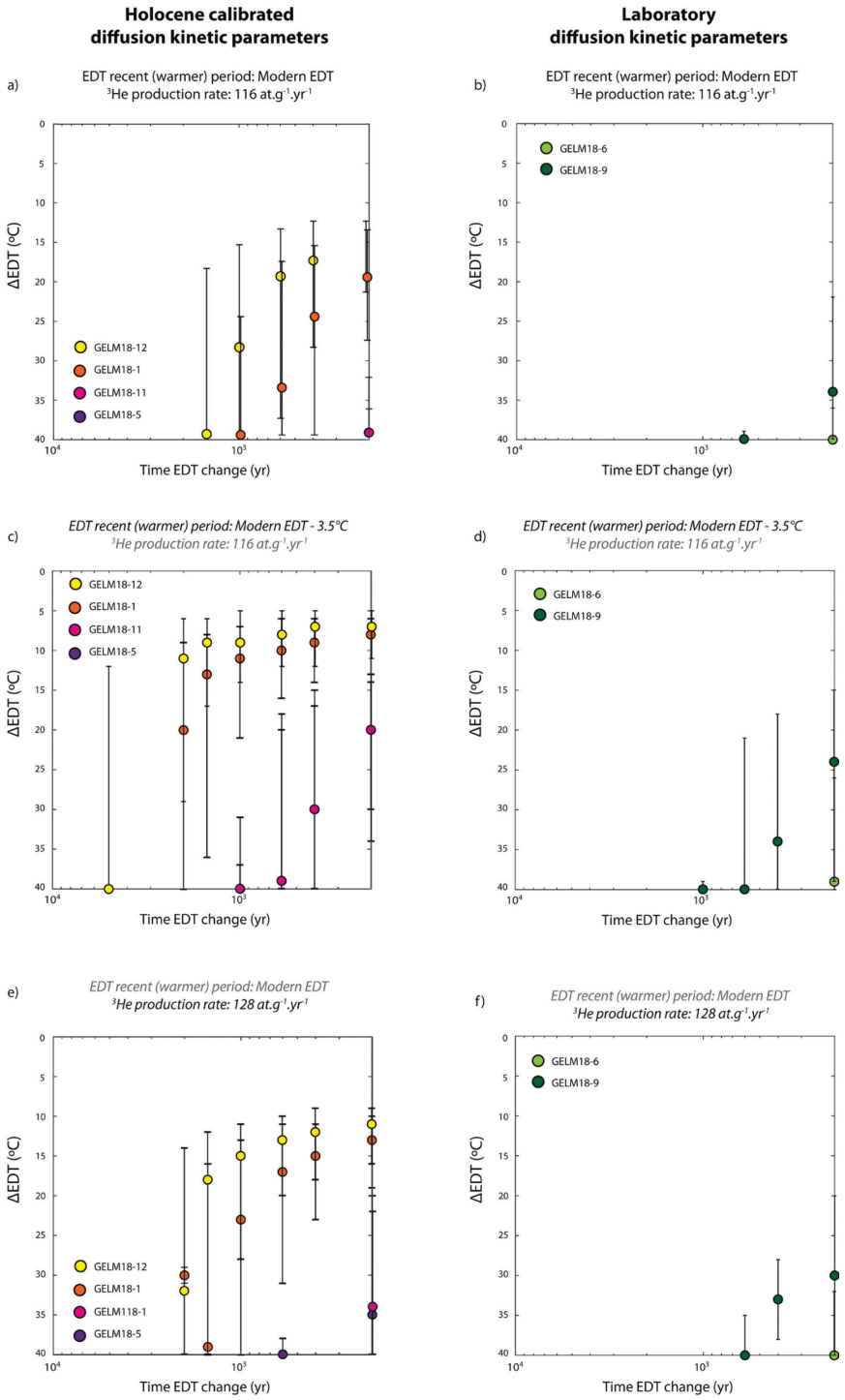

Figure S3: ΔEDT solutions as function of time of EDT change from time-varying EDT forward simulations conducted using GELM diffusion kinetics calibrated with Holocene samples (left panels) or solely based on laboratory experiments (right panels), with a) and b): recent EDT equal to the Modern EDT and using a ^{3}He production rate at 116 at.g^{-1}.yr^{-1}; c) and d): recent EDT equal to the Modern EDT minus 3.5°C; e) and f): ^{3}He production increased by 10% (128 at.g^{-1}.yr^{-1}). Only solutions for Holocene samples (GELM18-6 and -9) exist when using diffusion kinetics parameters solely based on laboratory experiments.

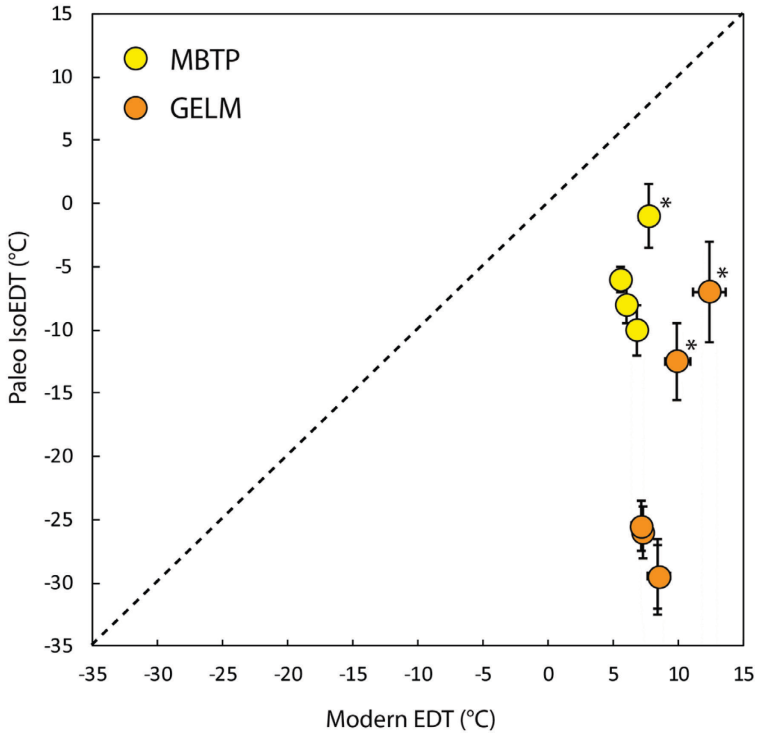

Figure S4: Comparison of modern EDTs and paleoIsoEDTs obtained using diffusion kinetics from laboratory experiments (without Holocene calibration), for both MBTP and GELM samples. The asterisks indicate the Holocene samples.

Table S1: ^{3}He step-degassing experiment data for MBTP18-9.

Step	Time (minutes)	Temperature (°C)	^{3}He (x10^{4} at.)[1]	±1σ (x10^{4} at.)
1	60	100.0	4545.5	2.9
2	120	100.0	4490.0	2.7
3	80	70.0	159.3	1.3
4	160	70.0	294.0	1.4
5	240	70.0	412.6	1.4
6	120	90.0	1071.6	1.8
7	180	90.0	1518.8	1.8
8	180	100.0	2468.7	2.4
9	60	120.0	2819.5	2.2
10	120	120.0	3925.4	2.5
11	180	120.0	3763.1	2.8
12	60	140.0	3763.9	2.7
13	120	140.0	5053.9	3.2
14	180	140.0	5802.7	3.0
15	60	160.0	5143.1	3.0
16	120	160.0	8313.4	3.5
17	180	160.0	7663.2	3.8
18	60	180.0	7649.0	3.4
19	120	180.0	11902.7	4.8
20	180	180.0	12152.2	4.7
21	60	200.0	8488.6	4.0
22	120	200.0	10957.0	4.7
23	180	200.0	8829.8	4.1
24	30	249.9	7760.8	3.8
25	60	250.0	4271.1	2.7
26	30	299.9	2572.0	2.2
27	60	300.0	919.9	1.7
28	30	324.9	209.0	1.3
29	60	324.9	64.6	1.3
30	30	349.9	7.3	1.2
31	60	349.9	-0.1	1.2
32	60	334.9	-0.9	1.2
33	60	310.0	-4.7	1.2
34	90	290.0	0.6	1.2
35	90	250.0	-1.8	1.2
36	120	250.0	-0.7	1.2
37	180	215.0	-1.1	1.2
38	120	265.0	1.0	1.2
39	90	285.0	1.0	1.2
40	60	299.9	-1.7	1.2
41	60	330.0	-0.8	1.2
42	60	359.9	2.6	1.2
43	60	379.9	-2.3	1.2
44	30	399.9	7.9	1.2
45	60	399.9	0.1	1.2
46	30	424.9	0.5	1.2
47	60	424.9	0.4	1.2
48	30	449.9	-0.5	1.2
49	60	449.9	-2.3	1.2
50	30	474.9	-1.3	1.2

51	60	474.9	-0.1	1.2
52	30	499.9	-0.1	1.2
53	30	549.9	0.8	1.2

[1]Measurements of ^{3}He were made on a quartz grain of 700µm spherical equivalent diameter and all ^{3}He abundances were background corrected using an averaged room temperature blank of 2.1±1.2x10^4 at.
Heating steps in gray were excluded from MDD models (Figure 3a) because measured ^{3}He abundances are below or close to below the detection level.

Table S2: ^{3}He step-degassing experiment data for GELM18-1.

Step	**Time (minutes)**	**Temperature (°C)**	**^{3}He (x10^4 at.)[1]**	**±1σ (x10^4 at.)**
1	60	100.04	21022.5	58.7
2	120	99.99	2616.0	21.3
3	80	69.99	134.7	7.3
4	160	69.99	226.1	7.7
5	240	70	263.6	8.3
6	120	89.99	584.8	12.0
7	180	89.98	664.6	11.8
8	180	99.99	1852.6	22.8
9	60	119.97	3044.8	23.7
10	120	119.98	3754.4	26.2
11	180	119.99	3218.5	25.1
12	60	139.95	3080.2	23.9
13	120	139.98	2976.3	25.3
14	180	139.98	3045.7	21.2
15	60	159.96	2171.2	23.3
16	120	159.98	4880.1	26.7
17	180	159.98	3679.0	24.0
18	60	179.96	2683.4	19.7
19	120	179.98	4284.9	28.4
20	180	179.99	3833.4	22.4
21	60	199.96	2037.0	19.6
22	120	199.98	2328.3	19.4
23	180	199.98	1963.4	19.1
24	30	249.89	1769.6	16.4
25	60	249.94	2248.4	20.2
26	30	299.67	4103.9	22.9
27	60	300.0	-1.5	5.1
28	30	325.1	-4.7	5.0
29	30	499.9	9.0	5.2

[1] Diffusion kinetics ^{3}He measurements were made on a quartz grain of 900µm spherical equivalent diameter and all ^{3}He abundances were background corrected using an averaged room temperature blank of 4.8±4.8x10^{4}at.
Heating steps in gray were excluded from MDD models (Figure 3b) because measured ^{3}He abundances are below or close to below the detection level.

Table S3: Measured ^{10}Be and ^{3}He concentrations.

Sample	Lat./Long. (°N/°E)	Alt. (m. asl)	Thick. (^{10}Be, cm)[1]	Shield.[1]	^{10}Be conc. (at.g^{-1})[1]	±1σ	^{3}He conc. (at.g^{-1})[2]	±1σ
MBTP18-1	45.9083/6.9311	2545	8	0.963	474750	600	6396493	520929
MBTP18-2	45.9086/6.9319	2460	8.5	0.949	403210	600	6327725	508608
MBTP18-9	45.9124/6.933	2133	6	0.656	160300	500	1872439	328634
MBTP18-11	45.9108/6.9315	2310	7	0.898	330490	500	5773930	505672
GELM18-1	46.6218/8.3257	2387	1	0.977	458000	1200	5445078	504014
GELM18-5	46.6185/8.3215	2155	1	0.979	304000	900	4449832	483189
GELM18-6	46.6151/8.3212	1888	4	0.934	173000	800	1246347	231974
GELM18-9	46.6136/8.3071	1418	1	0.949	139000	1000	642092	247299
GELM18-11	46.618/8.3217	2154	1	0.986	317000	900	4589051	399870
GELM18-12	46.6221/8.3258	2402	2.5	0.929	567000	1500	6153719	624435

[1]Reported from Lehmann et al. (2020; MBTP site) and Wirsig et al. (2016b; GELM site). [2]All samples for ^{3}He were collected at less than 3 cm depth, and mean ^{3}He concentrations from three replicate measurements (Table S2; 400-500 μm radii fraction) per sample were used as final ^{3}He concentrations.

Table S4: Detail of replicate measurements of ^{3}He concentrations.

Sample	Replicate	Mass (g)	^{3}He conc. (at.g^{-1})[1]	±1σ
MBTP18-1	a	0.108	5994723	523769
	b	0.087	6725368	611132
	c	0.109	6469388	427888
MBTP18-2	a	0.097	6917377	571202
	b	0.095	6558617	561876
	c	0.127	5507182	392741
MBTP18-9	a	0.103	1593779	318411
	b	0.096	1905925	346033
	c	0.115	2117615	321458
MBTP18-11	a	0.106	6308056	526209
	b	0.075	5372795	587753
	c	0.130	5640938	403056
GELM18-1	a	0.097	5760774	491090
	b	0.093	4629382	528326
	c	0.094	5945078	492625
GELM18-5	a	0.101	4487736	541743
	b	0.083	3500198	458624
	c	0.097	5361562	449200
GELM18-6	a	0.111	1366551	241982
	b	0.122	1191473	231274
	c	0.121	1181018	222666
GELM18-9	a	0.086	535331	285142
	b	0.122	728596	236666
	c	0.130	662351	220088
GELM18-11	a	0.119	4680068	416420
	b	0.125	3654077	366976
	c	0.102	5433011	416215
GELM18-12	a	0.057	6002823	842018
	b	0.091	6092740	599051
	c	0.128	6365596	432235

[1] ^{3}He concentration measurements were made on the 400-500 μm radii fraction, applying an analytical blank correction of 7.7 x 10^{3} atoms.