



Supplement of

Testing current estimates of the in situ cosmogenic ^{10}Be production rate in the north-western British Isles, with implications for ice sheet behaviour during Termination 1

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Table S1. Radiocarbon samples and measurement data for core LBA18-11R, Loch Bad na h-Achlaise, as reported by Simms et al. (2022). Calibrated ages were calculated with OxCal 4.4 (version 177) and IntCal20 (Reimer et al., 2020). Dated material is described by the original authors as “masses of small plant fibres and fragments (length <1 cm; diameter <50 mm)” (Simms et al., 2022, p.4).

UCI AMS #	Sample ID, depth (cm)	Material	¹⁴ C age (yrs)	1σ (yrs)	Calibrated mean age (yrs)	1σ (yrs)	95% probability range (yrs)
208,389	LBA18-11R, 233	Plant fibres	8385	25	9411	52	9305–9484
208,390	LBA18-11R, 268	Plant fibres	9885	30	11,285	44	11,222–11,394
208,391	LBA18-11R, 310	Plant fibres	10,900	30	12,802	31	12,751–12,885
208,393	LBA18-11R, 337	Plant fibres	11,165	30	13,102	31	13,009–13,165
208,394	LBA18-11R, 400	Plant fibres	12,280	35	14,241	161	14,078–14786
208,396	LBA18-11R, 530	Plant fibres	13,185	45	15,826	82	15,669–15,988
208,397	LBA18-11R, 536	Plant fibres	13,240	50	15,898	88	15,722–16,071

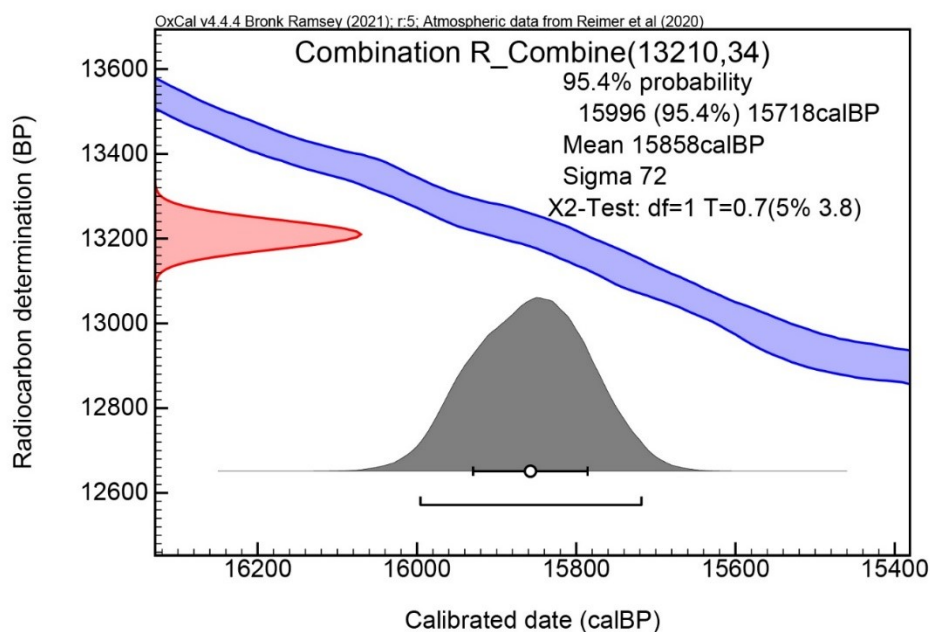


Figure S1. Samples 208,396 and 208,397 from core LBA18-11, combined using the ‘R_Combine’ function in OxCal 4.4 (version 177) and IntCal20 (Reimer et al., 2020), gives an average calibrated age of 15.9 ± 0.1 cal ka BP (95% range 15.7–16.0 cal ka BP). Adjusting for the 1950-present offset gives a minimum age of $15,932 \pm 72$ years (15.9 ± 0.1 cal ka) for the onset of ¹⁰Be accumulation in all the Redpoint Peninsula samples.

Table S2. Apparent ^{10}Be surface-exposure ages calculated with each production rate and the three default scaling methods employed in the UW online calculator (v.3). Italics denote outliers.

RANNOCH MOOR	<i>St (ka)</i>		<i>Lm (ka)</i>		<i>LSDn (ka)</i>	
ANT-24-01	16.1	0.3	16.1	0.3	16.0	0.3
ANT-24-02	16.4	0.3	16.4	0.3	16.3	0.3
ANT-24-03	16.2	0.3	16.2	0.3	16.1	0.3
ANT-24-06	16.4	0.4	16.3	0.4	16.3	0.4
ANT-24-07	15.9	0.4	15.9	0.4	15.8	0.4
ANT-24-08	12.7	0.4	12.6	0.3	12.6	0.3
ANT-24-09	11.8	0.4	11.7	0.4	11.6	0.4
ANT-24-10	15.7	0.4	15.7	0.4	15.4	0.4
ANT-24-11	15.8	0.5	15.7	0.5	15.5	0.5
ANT-24-12	16.3	0.4	16.3	0.4	16.00	0.4
ANT-24-13	15.9	0.4	15.9	0.4	15.6	0.3
MEAN $\pm 1\sigma$	16.1	0.1	16.0	0.1	15.9	0.1
CHIRONICO	<i>St (ka)</i>		<i>Lm (ka)</i>		<i>LSDn (ka)</i>	
ANT-24-01	15.8	0.3	15.7	0.3	15.0	0.3
ANT-24-02	16.1	0.3	16.0	0.3	15.3	0.3
ANT-24-03	15.9	0.3	15.8	0.3	15	0.3
ANT-24-06	16.1	0.4	16.0	0.4	15.2	0.4
ANT-24-07	15.7	0.4	15.5	0.4	14.8	0.4
ANT-24-08	12.4	0.3	12.3	0.3	11.8	0.3
ANT-24-09	11.6	0.4	11.5	0.4	10.8	0.4
ANT-24-10	15.4	0.4	15.3	0.4	14.4	0.4
ANT-24-11	15.5	0.5	15.4	0.5	14.4	0.4
ANT-24-12	16.1	0.4	15.9	0.4	15.0	0.4
ANT-24-13	15.7	0.4	15.5	0.4	14.6	0.3
MEAN $\pm 1\sigma$	15.8	0.1	15.7	0.1	14.9	0.1
BORCHERS	<i>St (ka)</i>		<i>Lm (ka)</i>		<i>LSDn (ka)</i>	
ANT-24-01	15.4	0.3	15.1	0.3	14.9	0.3
ANT-24-02	15.7	0.3	15.4	0.3	15.2	0.3
ANT-24-03	15.5	0.3	15.2	0.3	15.0	0.3
ANT-24-06	15.6	0.4	15.4	0.4	15.2	0.4
ANT-24-07	15.2	0.4	14.9	0.4	14.7	0.4
ANT-24-08	12.1	0.3	11.9	0.3	11.7	0.3
ANT-24-09	11.2	0.4	11.0	0.4	10.8	0.7
ANT-24-10	15.0	0.4	14.7	0.4	14.3	0.4
ANT-24-11	15.1	0.4	14.8	0.4	14.4	0.4
ANT-24-12	15.6	0.4	15.3	0.4	14.9	0.4
ANT-24-13	15.1	0.4	14.9	0.4	14.6	0.3
MEAN $\pm 1\sigma$	15.3	0.1	15.1	0.1	14.8	0.1
NENA	<i>St (ka)</i>		<i>Lm (ka)</i>		<i>LSDn (ka)</i>	
ANT-24-01	15.6	0.3	15.6	0.3	14.7	0.3
ANT-24-02	15.9	0.3	15.9	0.3	15.0	0.3
ANT-24-03	15.7	0.3	15.7	0.3	14.7	0.3
ANT-24-06	15.9	0.4	15.9	0.4	14.9	0.4
ANT-24-07	15.4	0.4	15.4	0.4	14.5	0.4
ANT-24-08	12.3	0.3	12.3	0.3	11.5	0.3
ANT-24-09	11.4	0.4	11.4	0.4	10.6	0.4
ANT-24-10	15.2	0.4	15.2	0.4	14.1	0.4
ANT-24-11	15.3	0.4	15.3	0.4	14.2	0.4
ANT-24-12	15.8	0.4	15.8	0.4	14.7	0.4
ANT-24-13	15.5	0.4	15.5	0.4	14.3	0.3
MEAN $\pm 1\sigma$	15.6	0.1	15.6	0.1	14.5	0.1

Table S2 continued.

MOUNT BILLINGEN	<i>St (ka)</i>		<i>Lm (ka)</i>		<i>LSDn (ka)</i>	
ANT-24-01	14.8	0.3	14.8	0.3	15.0	0.3
ANT-24-02	15.1	0.3	15.1	0.3	15.3	0.3
ANT-24-03	14.9	0.3	14.9	0.3	15.0	0.3
ANT-24-06	15.1	0.4	15.1	0.4	15.2	0.4
ANT-24-07	14.6	0.4	14.7	0.4	14.8	0.4
ANT-24-08	11.6	0.3	11.7	0.3	11.8	0.3
ANT-24-09	10.8	0.4	10.8	0.4	10.8	0.4
ANT-24-10	14.4	0.4	14.4	0.4	14.4	0.4
ANT-24-11	14.5	0.4	14.5	0.4	14.5	0.4
ANT-24-12	15.0	0.4	15.0	0.4	15.0	0.4
ANT-24-13	14.7	0.3	14.7	0.3	14.6	0.3
MEAN ± 1σ	14.8	0.1	14.8	0.1	14.9	0.1
WESTERN NORWAY	<i>St (ka)</i>		<i>Lm (ka)</i>		<i>LSDn (ka)</i>	
ANT-24-01	14.9	0.3	14.9	0.3	15.2	0.3
ANT-24-02	15.2	0.3	15.2	0.3	15.5	0.3
ANT-24-03	15.0	0.3	15.0	0.3	15.2	0.3
ANT-24-06	15.1	0.4	15.2	0.4	15.4	0.4
ANT-24-07	14.7	0.4	14.7	0.4	15.0	0.4
ANT-24-08	11.7	0.3	11.7	0.3	11.9	0.3
ANT-24-09	10.9	0.4	10.9	0.4	11.0	0.4
ANT-24-10	14.5	0.4	14.5	0.4	14.6	0.4
ANT-24-11	14.6	0.4	14.6	0.4	14.6	0.4
ANT-24-12	15.1	0.4	15.1	0.4	15.2	0.4
ANT-24-13	14.7	0.3	14.8	0.3	14.8	0.4
MEAN ± 1σ	14.9	0.1	14.9	0.1	15.0	0.1
ISLE OF SKYE & HIGHLANDS	<i>St (ka)</i>		<i>Lm (ka)</i>		<i>LSDn (ka)</i>	
ANT-24-01	14.9	0.3	14.9	0.3	14.9	0.3
ANT-24-02	15.2	0.3	15.2	0.3	15.2	0.3
ANT-24-03	15.0	0.3	15.0	0.3	15.0	0.3
ANT-24-06	15.2	0.4	15.2	0.4	15.1	0.4
ANT-24-07	14.8	0.4	14.8	0.4	14.7	0.4
ANT-24-08	11.7	0.3	11.7	0.3	11.7	0.3
ANT-24-09	10.9	0.4	10.9	0.4	10.8	0.4
ANT-24-10	14.5	0.4	14.5	0.4	14.3	0.4
ANT-24-11	14.6	0.4	14.6	0.4	14.4	0.4
ANT-24-12	15.1	0.4	15.1	0.4	14.9	0.4
ANT-24-13	14.8	0.4	14.8	0.3	14.6	0.3
MEAN ± 1σ	14.9	0.1	14.9	0.1	14.8	0.1
GLEN ROY	<i>St (ka)</i>		<i>Lm (ka)</i>		<i>LSDn (ka)</i>	
ANT-24-01	14.8	0.3	14.8	0.3	14.8	0.3
ANT-24-02	15.1	0.3	15.1	0.3	15.1	0.3
ANT-24-03	14.9	0.3	14.9	0.3	14.8	0.3
ANT-24-06	15.1	0.4	15.1	0.4	15.0	0.4
ANT-24-07	14.7	0.4	14.6	0.4	14.6	0.4
ANT-24-08	11.7	0.3	11.7	0.3	11.6	0.3
ANT-24-09	10.8	0.4	10.8	0.4	10.6	0.4
ANT-24-10	14.4	0.4	14.4	0.4	14.2	0.4
ANT-24-11	14.5	0.4	14.5	0.4	14.3	0.4
ANT-24-12	15.0	0.4	15.0	0.4	14.8	0.4
ANT-24-13	14.7	0.3	14.7	0.3	14.4	0.3
MEAN ± 1σ	14.8	0.1	14.8	0.1	14.6	0.1

Table S3. Statistical output from the one- and two-tailed Welch’s unequal-variances t-tests, which evaluate the similarity at 0.05 significance between the mean values of the minimum-limiting ^{14}C control (adjusted for 1950-present offset) and the apparent surface-exposure ages derived from each ^{10}Be production rate dataset. When $p > \alpha$, the null hypothesis (H_0 : the two mean values are statistically equal) cannot be rejected; when $p < \alpha$ (red text), the H_0 is rejected. To account fully for uncertainties associated with the two different dating methods, rather than just the standard deviations, we employed the external ^{10}Be uncertainties (SEM propagated with production rate uncertainty) and the 2σ range of the mean calibrated ^{14}C age.

	t-statistic	Two-tailed t-test		One-tailed t-test	
		p-value	Outcome	p-value	Outcome
Rannoch Moor	0.708	0.5047	$p > \alpha$	0.2523	$p > \alpha$
Chironico	-0.3905	0.7055	$p > \alpha$	0.3526	$p > \alpha$
NENA	-1.0056	0.341	$p > \alpha$	0.1705	$p > \alpha$
Global Primary	-1.658	0.1319	$p > \alpha$	0.06595	$p > \alpha$
Glen Roy	-10.1292	0.008008	$p < \alpha$	0.01602	$p < \alpha$
Isle of Skye & Highlands	-4.9541	0.0009012	$p < \alpha$	0.0004506	$p < \alpha$
Mt. Billingen	-4.4733	0.001622	$p < \alpha$	0.0008112	$p < \alpha$
Norway	-7.3182	0.0002288	$p < \alpha$	0.0001144	$p < \alpha$
Patagonia	1.4544	0.1799	$p > \alpha$	0.08997	$p > \alpha$
New Zealand	-0.2864	0.7887	$p > \alpha$	0.3943	$p > \alpha$
Quelccaya	0.1412	0.8909	$p > \alpha$	0.5546	$p > \alpha$

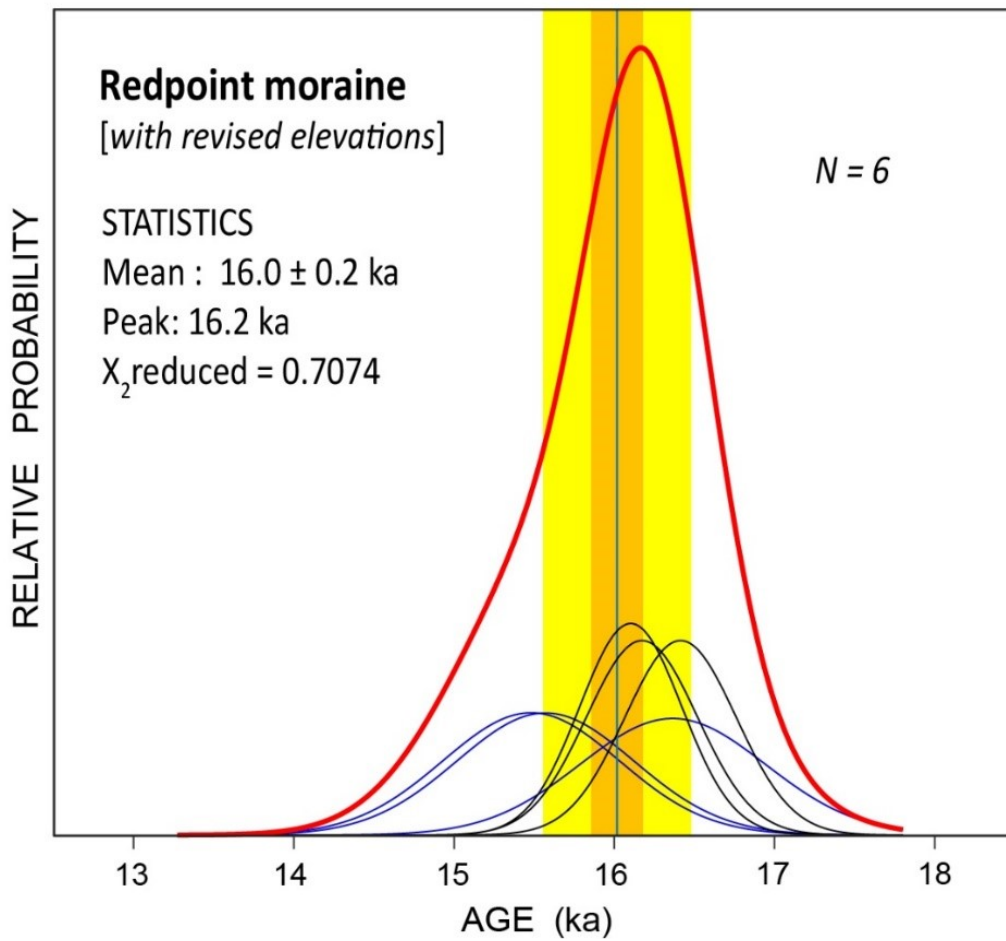


Figure S2. Normal kernel density plot and statistics for the Redpoint moraine, incorporating ^{10}Be exposure ages from this study and those recalculated from Ballantyne et al. (2009) with updated elevations. Mean age is reported with SEM [external] uncertainty. Thin black and blue curves are Gaussian approximations of individual ^{10}Be measurements made by this study and Ballantyne et al. (2009), respectively, while the thick red line is the summed probability for the entire population. Vertical blue line is the mean; vertical orange and yellow shading denote the SEM and external uncertainty (SEM propagated with 2.7% Rannoch Moor production rate uncertainty), respectively. The close agreement among the six ^{10}Be ages, constrained with the minimum-limiting ^{14}C control, suggests this is an accurate estimate of WRR moraine construction.

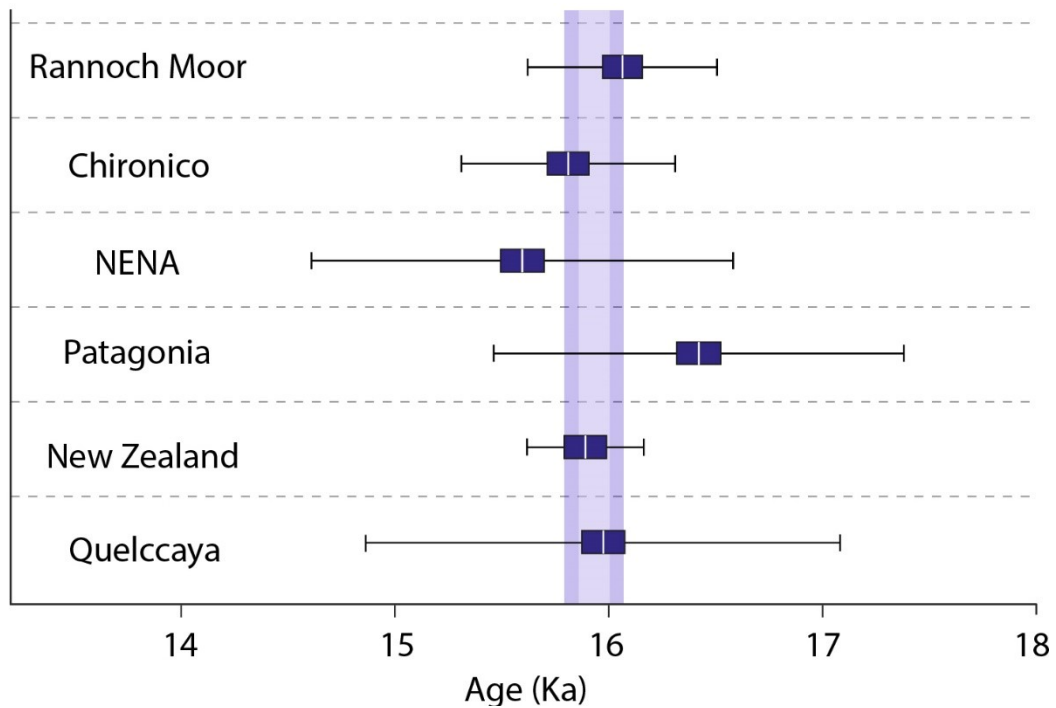


Figure S3. Redpoint ^{10}Be ages calculated with three Northern Hemisphere (Rannoch Moor: Putnam et al., 2019; Chironico: Claude et al., 2013; NENA: Balco et al., 2009) and three Southern Hemisphere (Patagonia: Kaplan et al., 2011; New Zealand: Putnam et al., 2010; Quelccaya: Kelly et al., 2015) production rate calibration datasets. All ages were calculated with the UW online calculator (v.3) and ‘St’ scaling. As in Fig. 8, blue boxes and vertical white stripes denote the standard error of the mean (SEM) and mean, respectively, while horizontal black whiskers are the external uncertainties (SEM propagated with production rate uncertainty). Light and dark vertical blue bands are the combined calibrated LB18-11 basal ^{14}C ages (adjusted for 1950-present offset) at 1σ and 95% confidence, respectively. Exposure ages calculated with these directly calibrated production rates fit the minimum-limiting ^{14}C control statistically and, with the exception of NENA output, stratigraphically.

Table S4. Input data for the UW online production rate calculator (https://hess.ess.washington.edu/math/v3/v3_cal_in.html) to derive a maximum-limiting production rate for Redpoint Peninsula.

ANT-24-01 15932 72 ;	57.63141	-5.65885 ANT-24-01	326 Be-10	std quartz	2.8 8.93E+04	2.7	0.999 0 1.76E+03	2024 ; 07KNSTD;	ANT-24-01	true_t REDPOINT
ANT-24-02 15932 72 ;	57.63142	-5.65894 ANT-24-02	326 Be-10	std quartz	1.9 9.17E+04	2.7	0.999 0 1.93E+03	2024 ; 07KNSTD;	ANT-24-02	true_t REDPOINT
ANT-24-03 15932 72 ;	57.63147	-5.65936 ANT-24-03	325 Be-10	std quartz	2.4 8.99E+04	2.7	0.999 0 1.92E+03	2024 ; 07KNSTD;	ANT-24-03	true_t REDPOINT
ANT-24-06 15932 72 ;	57.63119	-5.69757 ANT-24-06	287 Be-10	std quartz	2.7 8.75E+04	2.7	0.999 0 2.39E+03	2024 ; 07KNSTD;	ANT-24-06	true_t REDPOINT
ANT-24-07 15932 72 ;	57.63026	-5.69798 ANT-24-07	286 Be-10	std quartz	3.1 8.47E+04	2.7	0.999 0 2.21E+03	2024 ; 07KNSTD;	ANT-24-07	true_t REDPOINT
ANT-24-10 15932 72 ;	57.68979	-5.73235 ANT-24-10	96 Be-10	std quartz	2.0 6.96E+04	2.7	0.999 0 1.94E+03	2024 ; 07KNSTD;	ANT-24-10	true_t REDPOINT
ANT-24-11 15932 72 ;	57.69028	-5.73158 ANT-24-11	94 Be-10	std quartz	2.5 6.95E+04	2.7	0.999 0 2.02E+03	2024 ; 07KNSTD;	ANT-24-11	true_t REDPOINT
ANT-24-12 15932 72 ;	57.69009	-5.73130 ANT-24-12	95 Be-10	std quartz	1.0 7.30E+04	2.7	0.999 0 1.74E+03	2024 ; 07KNSTD;	ANT-24-12	true_t REDPOINT
ANT-24-13 15932 72 ;	57.68988	-5.73134 ANT-24-13	97 Be-10	std quartz	2.0 7.08E+04	2.7	0.999 0 1.67E+03	2024 ; 07KNSTD;	ANT-24-13	true_t REDPOINT