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Spatio-temporal variability and controlling factors for postglacial denudation rates in the Dora Baltea catchment (western Italian Alps)

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Supplementary material

Table S1. Additional analytical details for ^{10}Be measurements of river-sediment samples collected in the present study. Sample locations are reported in Table 1 in the main text.

Sample	Quartz dissolved (g)	Be carrier (mg)	$^{10}Be/^{9}Be$ not blank corrected (10^{-14})	$^{10}Be/^{9}Be$ blank corrected (10^{-14})[a]	^{10}Be concentration (10^{4} at g^{-1})
DB01	50.2785	0.1997	5.16±0.26	4.87±0.25	1.29±0.07
DB02	49.8504	0.1967	4.39±0.25	4.10±0.24	1.08±0.07
DB03	49.7478	0.1977	9.15±0.53	8.85±0.51	2.35±0.14
DB04	49.9469	0.1968	8.64±0.40	8.34±0.38	2.20±0.11
DB05	49.9931	0.1872	8.49±0.40	8.20±0.39	2.05±0.10
DB06	50.1976	0.1939	6.25±0.29	5.96±0.28	1.54±0.08
DB07	20.0443	0.1914	3.82±0.40	3.53±0.37	2.25±0.26
DB08	49.6077	0.1962	18.66±0.80	18.37±0.79	4.85±0.21
DB09	37.7201	0.1975	9.86±0.52	9.56±0.51	3.34±0.18
DB10	50.0416	0.1868	5.69±0.28	5.39±0.27	1.35±0.07
DB11	32.9841	0.1969	9.00±0.50	8.70±0.49	3.47±0.20
DB12	50.1821	0.1903	5.26±0.32	4.97±0.30	1.26±0.08
DB13	49.7747	0.1930	11.07±0.46	10.77±0.45	2.79±0.12
DB14	51.4029	0.1881	11.85±0.53	11.55±0.52	2.83±0.13
DB16	17.8550	0.2000	5.47±0.46	5.18±0.44	3.88±0.35
DB17	49.9150	0.1904	10.94±0.51	10.64±0.50	2.71±0.13
DB18	49.8754	0.1788	9.89±0.49	9.59±0.48	2.30±0.12
DB19	46.7700	0.1975	15.12±0.51	14.83±0.50	4.19±0.15

[a] Calculated ^{10}Be concentrations were corrected for full process blank $^{10}Be/^{9}Be$ ratio of 2.96 $\pm 0.32 \times 10^{-15}$.

Table S2. Mean catchment ^{10}Be production rates and denudation rates calculated by applying different correction factors (see main text for each correction description). Uncorrected results refer to values obtained by including only mean catchment topographic shielding. The last two columns report the results obtained by applying all the corrections and used in the main text.

Catchment	***Uncorrected***		***Snow correction***		***Lithology correction***		***LIA-glacier correction***		***All corrections***	
	Mean production rate (at g^{-1} yr^{-1})[a]	Denudation rate (mm yr^{-1})[b]	Mean production rate (at g^{-1} yr^{-1})	Denudation rate (mm yr^{-1})	Mean production rate (at g^{-1} yr^{-1})	Denudation rate (mm yr^{-1})	Mean production rate (at g^{-1} yr^{-1})	Denudation rate (mm yr^{-1})	Mean production rate (at g^{-1} yr^{-1})	Denudation rate (mm yr^{-1})
DB01	29.4	1.45±0.11	24.3	1.19±0.09	30.0	1.47±0.12	17.1	0.85±0.07	13.7	0.68±0.05
DB02	25.1	1.49±0.13	21.2	1.26±0.11	25.1	1.49±0.13	18.3	1.10±0.09	15.3	0.91±0.08
DB03	28.6	0.76±0.06	23.7	0.63±0.05	28.5	0.76±0.06	22.7	0.60±0.05	18.0	0.48±0.04
DB04	27.5	0.78±0.06	22.9	0.65±0.05	26.4	0.75±0.06	21.4	0.61±0.05	17.8	0.51±0.04
DB05	27.8	0.85±0.06	23.1	0.70±0.05	27.2	0.83±0.06	21.9	0.67±0.05	17.4	0.53±0.04
DB06	22.6	0.94±0.07	19.4	0.81±0.06	22.6	0.95±0.07	18.8	0.79±0.06	16.1	0.68±0.05
DB07	22.2	0.61±0.07	19.2	0.53±0.06	22.0	0.61±0.07	18.5	0.51±0.06	15.3	0.42±0.05
DB08	20.2	0.27±0.02	17.5	0.23±0.02	18.4	0.24±0.02	19.9	0.26±0.02	15.9	0.21±0.02
DB09	24.4	0.46±0.04	20.8	0.39±0.03	24.5	0.46±0.04	20.6	0.39±0.03	17.5	0.33±0.03
DB10	23.5	1.12±0.09	20.1	0.96±0.08	23.4	1.12±0.09	19.3	0.93±0.07	16.5	0.79±0.06
DB11	24.5	0.44±0.04	20.8	0.38±0.03	22.1	0.40±0.03	20.0	0.36±0.03	16.0	0.29±0.02
DB12	25.6	1.30±0.11	21.6	1.10±0.10	25.1	1.28±0.11	19.8	1.01±0.09	16.4	0.84±0.07
DB13	24.4	0.56±0.04	20.7	0.47±0.03	24.2	0.55±0.04	20.5	0.47±0.03	17.2	0.40±0.03
DB14	22.1	0.50±0.04	19.0	0.43±0.03	21.9	0.50±0.04	21.7	0.49±0.04	18.5	0.42±0.03
DB16	23.6	0.38±0.04	20.0	0.32±0.03	22.8	0.37±0.04	22.8	0.37±0.04	18.7	0.30±0.03
DB17	27.2	0.63±0.05	22.6	0.52±0.04	25.6	0.59±0.05	19.9	0.46±0.04	17.3	0.40±0.03
DB18	27.0	0.75±0.06	22.5	0.62±0.05	26.9	0.74±0.06	20.9	0.58±0.05	17.2	0.48±0.04
DB19	25.8	0.39±0.03	21.6	0.33±0.02	25.3	0.39±0.03	19.2	0.29±0.02	16.0	0.25±0.02

[a] Catchment-averaged ^{10}Be production rates were calculated with Basinga (Charreau et al., 2019), based on SLHL total ^{10}Be production rate of 4.18±0.26 at g^{-1} yr^{-1} (Martin et al., 2017) and the Lal/Stone time-dependent scaling model (Lal, 1991; Stone, 2000).

[b] ^{10}Be-derived catchment denudation rates were calculated with Basinga (Charreau et al., 2019), using default attenuation length values of 160, 4320, and 1500 g cm^{-2}, for neutrons, fast muons, and slow muons, respectively (Charreau et al., 2019, after Braucher et al., 2011), and assuming a rock density of 2.7 g cm^{-3}. Denudation-rate uncertainties are estimated only based on values and relative errors of ^{10}Be concentrations and cosmogenic production rates from neutron and muons (Eq. 5 in Charreau et al., 2019).

Table S3. Statistical significance of investigated linear correlations between tributary-catchment denudation rates and metrics (see main text for details on metrics). Correlations were calculated both including (in red) and excluding (in black) sample DB01 (see text for details). Linear trends were considered significant (bold) if p-value < 0.05. Asterisks indicate correlations where DB01 is an outlier (i.e. DB01 Cook's distance larger than three times the data mean Cook's distance). Some representative correlations are shown in Figures 3 and 4 in the main text.

Catchment metric	***p-value (with DB01)***	***r^2 (with DB01)***	***p-value (no DB01)***	***r^2 (no DB01)***
Drainage area (km^2)	0.16	0.16	0.09	0.24
Mean elevation (m)	**0.00***	**0.58***	**0.01**	**0.46**
Mean slope (°)	**0.01***	**0.46***	0.06	0.29
Relative abundance of slopes > 40° (%)	**0.02***	**0.36***	0.08	0.25
Geophysical relief (5-km, m)	**0.00**	**0.59**	**0.04**	**0.33**
Hypsometric integral	0.17	0.15	0.19	0.15
Mean annual Precipitation (mm)	0.07*	0.25*	0.81	0.01
Relative abundance of bare-rock (%)	**0.01***	**0.49***	**0.01**	**0.46**
Basin area covered by LIA glaciers (%)	**0.00**	**0.51**	0.10	0.23
Mean LGM ice-thickness (m)	0.17	0.15	0.19	0.15
Basin area above LGM ELA (2103 m a.s.l.) (%)	**0.02***	**0.40***	**0.04**	**0.33**
Mean geodetic rock uplift (mm yr^{-1})	0.83	0.00	0.99	0.00

Table S4. Quartz river sand contents and fluxes. Sand quartz contents from Vezzoli et al. (2004) and bed-load sediment fluxes from Vezzoli (2004).

Catchment	Sand quartz content %	Sediment flux (t/yr)	Quartz flux (t/yr)	Quartz flux over DB06 (%)
DB01	42	295120	123950	55.3
DB02	46	300489	138225	61.7
DB03	42	13650	5733	2.6
DB05	38	24817	9430	4.2
DB06	38	590000	224200	100.0
DB07	38	58226	22126	9.9
DB08	42	11941	5015	2.2
DB09	35	12546	4391	2.0
DB10	38	472316	179480	80.1
DB11	23	17936	4125	1.8
DB12	42	345525	145121	64.7
DB13	37	65593	24269	10.8
DB14	44	4408	1940	0.9
DB16	34	2822	959	0.4
DB17	45	3005	1352	0.6
DB18	37	61185	22638	10.1
DB19	35	2143	750	0.3

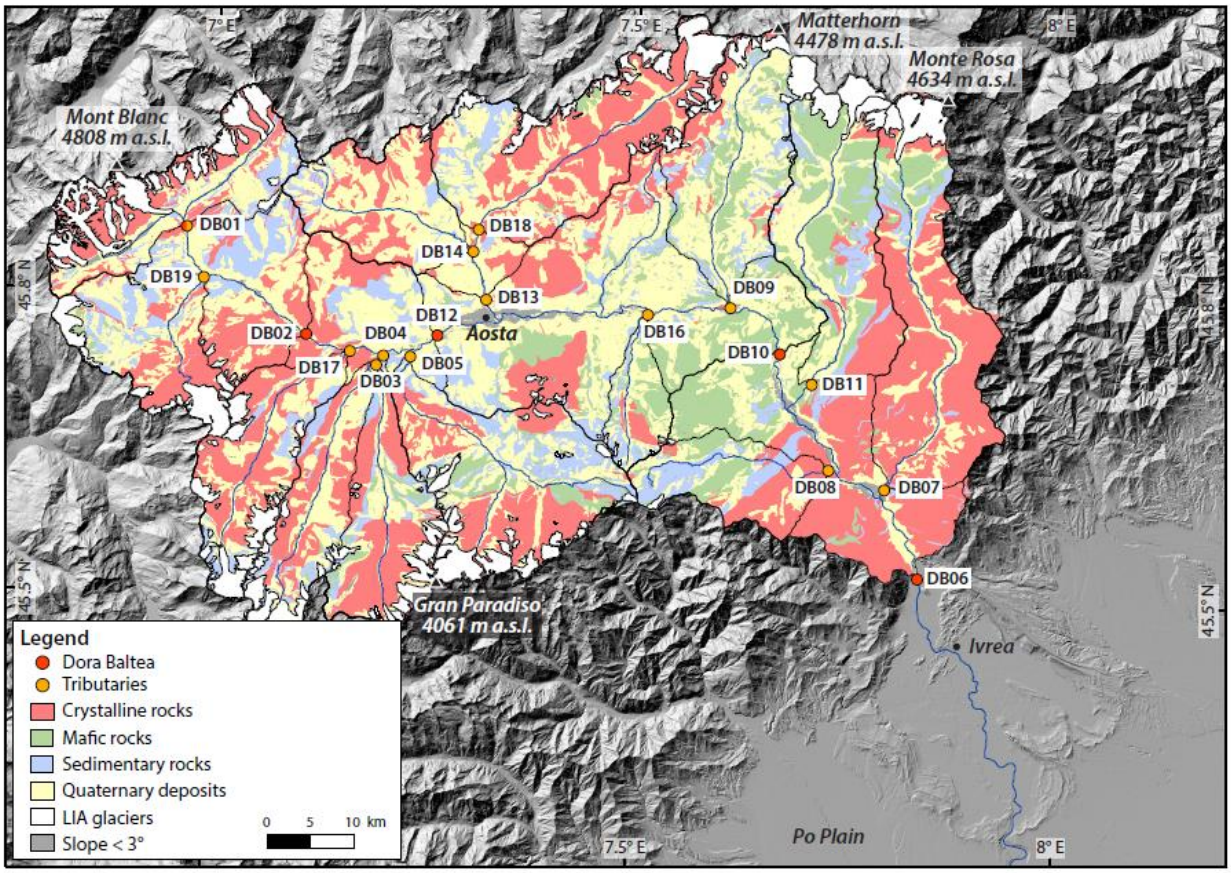

Figure S1. Spatial map of lithological/geomorphic correction factors employed for ^{10}Be production/denudation rate calculation, in addition to topographic and snow shielding. Crystalline rocks and Quaternary deposits (1/100,000- and 1/250,000-scale digital geological maps from Regione Autonoma Valle d'Aosta and Regione Piemonte) were considered as quartz-bearing lithologies and included in catchment production rate calculation. Mafic and sedimentary rocks were instead excluded based on assumption of no to minor quartz content. Low-lying areas (slope < 3°) were excluded from the calculations (no geomorphic link with stream network; Delunel et al., 2010). For LIA-glacier correction, ^{10}Be production rates were assumed to be null for areas covered by LIA glaciers (GlaRiskAlp Project, http://www.glariskalp.eu).