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TABLE DR-1. COSMOGENIC RESULTS FOR GREAT SMOKY MOUNTAIN SAMPLES

Sample name	Measured ^{10}Be (10^6 atoms g^{-1})	^{10}Be model ε (m/m.y.)	Drainage area (km^2)	^{10}Be production factor
GSRF-1 (T)	0.434 ± 0.011	19.3 ± 2.5	36.9	2.69
GSRF-2 (T)	0.335 ± 0.009	22.7 ± 2.9	1.4	2.44
GSRF-3 (T)	0.461 ± 0.012	16.9 ± 2.2	1.0	2.51
GSRF-5 (T)	0.322 ± 0.009	23.7 ± 3.0	1.0	2.45
GSRF-6 (T)	0.341 ± 0.009	25.1 ± 3.2	27.3	2.74
*GSRF-7 (T)	0.376 ± 0.011	20.4 ± 2.6	7.7	2.46
GSRF-8 (T)	0.297 ± 0.009	27.2 ± 3.5	3.6	2.58
GSRF-9 (T)	0.274 ± 0.008	27.4 ± 3.5	2.9	2.40
*GSRF-10 (T)	0.325 ± 0.009	24.6 ± 3.1	51.9	2.56
*GSRF-11 (T)	0.452 ± 0.011	19.3 ± 2.4	55.7	2.80
*GSRF-12 (T)	0.310 ± 0.009	24.8 ± 3.2	191.5	2.47
†GSCO-1 (B)	0.264 ± 0.010	28.0 ± 3.6	330.2	2.37
*GSCO-2 (T)	0.234 ± 0.007	30.1 ± 3.8	134.9	2.25
GSCO-3 (T)	0.312 ± 0.008	23.3 ± 3.0	9.4	2.34
GSCO-4 (T)	0.200 ± 0.006	35.1 ± 4.5	51.4	2.25
GSCO-5 (T)	0.317 ± 0.008	26.2 ± 3.3	11.6	2.67
GSCO-6 (T)	0.361 ± 0.012	20.2 ± 2.6	3.3	2.34
GSCO-7 (T)	0.278 ± 0.007	30.5 ± 3.9	2.3	2.71
GSBC-1 (B)	0.234 ± 0.006	33.7 ± 4.3	74.8	2.52
§GSBC-2 (R)	0.247 ± 0.008	33.0 ± 4.2	65.7	2.60
GSDC-1 (B)	0.316 ± 0.008	21.6 ± 2.7	104.9	2.19
GSLP-1 (B)	0.225 ± 0.007	31.8 ± 4.0	117.3	2.28
GSLR-1 (B)	0.264 ± 0.007	24.8 ± 3.1	155.8	2.10
GSMP-1 (B)	0.267 ± 0.007	22.0 ± 2.8	118.3	1.88
GSWP-1 (B)	0.242 ± 0.006	31.0 ± 3.9	63.6	2.40
GSCS-1 (B)	0.191 ± 0.005	36.9 ± 4.7	7.1	2.25
GSCS-2 (T)	0.333 ± 0.009	17.4 ± 2.2	0.8	1.87

Note: (B) Outlet rivers of the Great Smoky Mountains. (T) Tributary of Oconaluftee River (GSCO), or Raven Fork (GSRF), or Cosby Creek (GSCS). (R) Replicate sample. Model erosion rates calculated using sea-level, high-latitude ^{10}Be production rate of 5.17 atoms g^{-1} yr^{-1} supported by data from Bierman et al. (1996), Stone (2000), and Gosse and Stone (2001), and normalized for latitude and elevation using nucleon-only scaling of Lal (1991). Uncertainties in measured ^{10}Be are analytical errors. ^{10}Be model ε are calculated propagating 10% (1σ) uncertainty in production rates and scaling factors. ^{10}Be production factor expresses the integrated surface production in each basin relative to sea-level, high-latitude production.

*Tributary samples that include upstream samples.

†Below the confluence of GSRF-12 and GSCO-2. This site was sampled to verify sediment mixing and sampling strategy.

§Replicate of sample GSBC-1 collected 1.5 km upstream.

Erosion rate calculation

In order to interpret nuclide data for each basin, we calculated basin-integrated nuclide production rates by combining basin hypsometery and the altitude production-rate function of Lal (1991) in 100 meter bins (Bierman and Steig, 1996). For large basins (>60 km^2), we determined basin hypsometry using DEMs. For small basins (<60 km^2), we digitized topographic maps.

Erosion rates were calculated using the approach of Bierman and Steig (1996):

$$N = P/(\varepsilon\rho\Lambda^{-1}) \qquad (1)$$

Sediment generation rates were calculated using:

$$N = P/(m\Lambda^{-1}) \qquad (2)$$

Where N = measured activity (atoms ^{10}Be g^{-1} quartz), P = basin integrated production rate (atoms ^{10}Be g^{-1} quartz yr^{-1}), ε = erosion rate (cm yr^{-1}), m = sediment generation rate (g yr^{-1}cm^{-2}), ρ = density (g cm^{-3}), and Λ = attenuation depth (g cm^{-2}). This approach has been successfully tested in several studies using drainage basins of different sizes (Brown et al., 1995; Granger et al., 1996; Clapp et al., 2000, 2001; Bierman et al., 2001; Schaller et al., 2001).

Evidence for thorough mixing

Thorough mixing of sediment from different tributaries can be tested by a mass balance calculation. For example, the sediment generation rate at sample location GSCO-1 (Figs. 2 and 3) is $7.32*10^{-3}$ (g yr^{-1} cm^{-2}) using the area weighted average of GSCO-2 and GSRF-12 and $7.69*10^{-3}$ (g yr^{-1} cm^{-2}) using ^{10}Be activity in sample GSCO-1 (Fig. 3). The difference between the two calculations is ~5% indicating the agreement between expected and measured sediment generation rates and verifying the assumption of thorough mixing.

Mass balance calculation can also be done considering the tributaries in the Raven Fork and in the Oconaluftee River. Although the sampled tributaries in each river system do not cover 100% of the area sampled by the downstream sample (GSRF-2, GSRF-3, GSRF-5, GSRF-6, GSRF-8, and GSRF-9 compared with GSRF-10; GSCO-3, GSCO-4, GSCO-5, GSCO-6, and GSCO-7 compared with GSCO-2; GSLR-2, GSLR-3, GSLR-4, GSLR-5, and GSLR-6 compared with GSLR-7), mass balance calculations show that the percentage of sediment contributed by the sampled tributaries (out of the total calculated from the ^{10}Be activity of the down stream sample) is equal to the area of the tributaries relative to the total sampled area of the downstream sample.

Evidence for thorough mixing (cont.)

Name	Total basin area (km^2)	Basin-wide sediment generation (tons/yr)	% area of sampled tributaries	% sediment from sampled tributaries	Sediment generation rate (tons/(km^2*yr))
GSRF-2, GSRF-3, GSRF-5, GSRF-6, GSRF-8, and GSRF-9	37	252	72	73	6.8
GSRF-10	52	345			6.6
GSCO-3, GSCO-4, GSCO-5, GSCO-6, and GSCO-7	78	665	58	61	8.5
GSCO-2	135	1097			8.1
GSLR-2, GSLR-3, GSLR-4, GSLR-5, and GSLR-6	70	600	70	73	8.6
GSLR-7	101	819			8.2

Limited storage effects

Most Great Smoky Mountain river valleys are steep and narrow. There is no significant long-term storage of sediment in the mountainous drainage basins where we collected most of our samples. For example, all our samples from Oconaluftee River tributaries (GSCO-3 through GSCO-7) were collected upstream of alluviated reaches. However, sediment is stored in fans and alluvial terraces along some Great Smoky rivers, mainly on the northern slope (Hadley and Goldsmith, 1963; King, 1964). Here, we collected several samples specifically to test the influence of long-term alluvial storage on the activity of ^{10}Be in present-day alluvial sediments.

Alluvial storage does not affect our results. Within the two river systems that were sampled in detail (the Raven Fork and the Oconaluftee River), ^{10}Be activities do not increase downstream suggesting that the ^{10}Be we measured is produced mostly on the mountainous slopes and not during storage in river terraces. Even where terraces are present, the effect of terrace alluvium on ^{10}Be activity of the in-channel sediment is minimal. For example, GSBC-2 was collected in the Big Creek upstream of any significant alluvial storage whereas GSBC-1 was collected 1.5 km downstream in an alluviated reach. Both samples yielded similar ^{10}Be activities.

Data from the Cosby drainage system suggest that the mass of alluvium added to the channel by terrace erosion is inconsequential. Here, we sampled alluvium both from the main stream that incises the Cosby fan but originates at the Great Smoky Mountains main drainage divide and from a small stream that only drains the surface of the inactive, dissected Cosby Fan. The main stream sample (GSCS-1) had ^{10}Be activity similar to that of the other outlet rivers which do not incise mapped alluvial deposits. In contrast, sample GSCS-2, derived from the old fan surface, yielded higher ^{10}Be activity (Table DR-1). On the basis of these results, we can reliably assume that ^{10}Be activities measured in the few samples collected from channels bordered by alluvial deposits (GSLP-1 and GSMP-1) represent basin-wide sediment generation rates.

TABLE DR-2. CALCULATION OF AREA-WEIGHTED AVERAGE EROSION RATES IN THE GREAT SMOKY MOUNTAINS

Group	Sample name	Basin area km^2	^{10}Be ε m/m.y.
Tributaries (with no upstream samples; *n* =13)			
	GSRF-1	36.9	19.3 ± 2.5
	GSRF-2	1.4	22.7 ± 2.9
	GSRF-3	1.0	16.9 ± 2.2
	GSRF-5	1.0	23.7 ± 3.0
	GSRF-6	27.3	25.1 ± 3.2
	GSRF-8	3.6	27.2 ± 3.5
	GSRF-9	2.9	27.4 ± 3.5
	GSCO-3	9.4	23.3 ± 3.0
	GSCO 4	51.4	35.1 ± 4.5
	GSCO-5	11.6	26.2 ± 3.3
	GSCO-6	3.3	20.2 ± 2.6
	GSCO-7	2.3	30.5 ± 3.9
	GSCS-2	0.8	17.4 ± 4.4
	Total basin area =	152.7	
		Area weighted ε =	24.7 ± 4.8
Outlet rivers (*n* = 8)			
	GSCO-1	330.2	28.0 ± 3.6
	GSCS-1	7.1	36.9 ± 9.3
	GSDC-1	104.9	21.6 ± 2.7
	GSLP-1	117.3	31.8 ± 4.0
	GSMP-1	118.3	22.0 ± 2.8
	GSWP-1	63.6	31.0 ± 3.9
	GSLR-1	155.8	24.8 ± 3.1
	GSBC-1	74.8	33.7 ± 4.3
	Total basin area =	972.1	
		Area weighted ε =	27.2 ± 5.6
Rivers >100 km^2 (*n* = 7)			
	GSCO -1	330.2	28.0 ± 3.6
	GSRF-12	191.5	24.8 ± 3.2
	GSCO-2	134.9	30.1 ± 3.8
	GSDC-1	104.9	21.6 ± 2.7
	GSLP-1	117.3	31.8 ± 4.0
	GSMP-1	118.3	22.0 ± 2.8
	GSLR-1	155.8	24.8 ± 3.1
	Total basin area =	1153	
		Area weighted ε =	26.5 ± 4.0
Largest river (*n* = 1)			
	GSCO -1	330.2	28.0±3.6

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