[1]GSA Data Repository item 2003079. Cosmogenic radionuclide dating methods and cosmogenic radionuclide surface exposure ages.

Samples were collected from the tops of meter-size boulders that were partially buried in the moraine surface. Such boulders are not likely to have toppled or to have had sediment cover for a significant period of time. Boulders were selected on the basis of lack of evidence for deep weathering or signs of recent exhumation. The location of each boulder was determined using a handheld Global Positioning System device. Skyline elevations, the strike and dip of the sample and its thickness were recorded in order to allow correction for skyline shielding. Photographs of each boulder in its field context are provided as separate files as part of this repository. These photos are also available on a compact disc that can be obtained from Robert Finkel (rfinkel@llnl.gov) or Lewis Owen (Lewis.Owen@ucr.edu).

The samples were crushed and sieved and quartz was separated from the 250-500 µm size fraction using the methods of Kohl & Nishiizumi (1992). After addition of Be carrier, the Be was separated and purified by ion exchange chromatography and precipitation at pH>7. The hydroxides were oxidized by ignition in quartz crucibles. BeO was then mixed with Nb metal prior to determination of the ^{10}Be/Be ratios by accelerator mass spectrometry at the Lawrence Livermore National Laboratory (LLNL) Center for Accelerator Mass Spectrometry. Isotope ratios were standardized against ICN ^{10}Be prepared by K. Nishiizumi (personal communication, 1996).

The measured isotope ratios were converted to concentrations in quartz using the total beryllium in the samples and the sample weights. These concentrations were then converted to zero-erosion exposure ages using a sea level high latitude (SLHL) ^{10}Be production rate of 5.2 at/g-qtz/y. The ^{10}Be production rate used is based on a number of independent measurements of production rate as discussed by Owen et al. (2001and 2002). Production rates were scaled to the latitude and elevation of the Khumbu sampling sites using the star scaling factors of Lal (1991) as modified by Stone (2000) and an assumed 3% SLHL muon contribution to production rates and were further corrected for changes in the geomagnetic field over time. Details of the sample preparation and calculation are given in Owen et al. (2001 and 2002a).

Kohl, C.P., and Nishiizumi, K., 1992, Chemical isolation of quartz for measurement of in-situ-produced cosmogenic nuclides: Geochimica et Cosmochimica Acta, v. 56, p.3583-3587.

Lal, D., 1991, Cosmic ray labeling of erosion surfaces: in situ nuclide production rates and erosion models: Earth and Planetary Science Letters, v. 104, p. 429-439.

Owen, L.A. Gualtieri, L., Finkel, R.C., Caffee, M.W., Benn, D.I., and Sharma, M.C., 2001, Cosmogenic radionuclide dating of glacial landforms in the Lahul Himalaya, Northern India: defining the timing of Late Quaternary glaciation: Journal of Quaternary Science, v. 16, p. 555-563.

Owen, L.A., Finkel, R.C., Caffee, M.W., and Gualtieri, L., 2002, Timing of multiple late Quaternary glaciations in the Hunza Valley, Karakoram Mountains, Northern Pakistan: defined by cosmogenic radionuclide dating of moraines: Geological Society of America Bulletin, v. 114, p. 593-604.

Stone, J.O., 2000, Air pressure and cosmogenic isotope production: Journal of Geophysical Research, v. 105(B10), p. 23,753-23,759.

TABLE DR1. CRN ^{10}Be EXPOSURE AGES

Sample number	Latitude N/ Longitude E (°± 0.01°)	Altitude (m)	Shielding Factor	^{10}Be* (10^6 atoms per 1 g qtz)	Exposure Age (ka)	Geomagnetic Correction (ka)
E5	27.89/86.82	4328	0.99	1.143 ± 0.033	17.34 ± 0.50	18.39 ± 0.53
E6	27.89/86.82	4433	0.99	0.966 ± 0.023	13.91 ± 0.34	14.83 ± 0.36
E7	27.89/86.82	4310	0.99	0.973 ± 0.024	14.88 ± 0.36	15.84 ± 0.38
E9	27.88/86.82	4401	0.99	1.466 ± 0.035	21.55 ± 0.52	22.71 ± 0.54
E10	27.88/86.82	4401	0.99	1.473 ± 0.033	21.65 ± 0.48	22.81 ± 0.51
E11	27.88/86.82	4401	0.99	1.473 ± 0.033	21.65 ± 0.48	22.81 ± 0.51
E29	27.90/86.87	4755	0.99	1.319 ± 0.016	16.32 ± 0.20	17.37 ± 0.21
E30	27.90/86.87	4837	0.99	0.710 ± 0.021	8.45 ± 0.25	8.95 ± 0.27
E31	27.90/86.87	4812	0.99	0.697 ± 0.016	8.39 ± 0.19	8.88 ± 0.20
E32	27.90/86.87	4773	0.99	0.053 ± 0.007	0.64 ± 0.09	0.62 ± 0.08
E36	27.91/86.87	4525	0.99	0.005 ± 0.003	0.07 ± 0.04	0.06 ± 0.03
E37	27.90/86.87	4691	0.99	0.075 ± 0.021	0.95 ± 0.26	0.98 ± 0.27
E38	27.90/86.87	4718	0.99	0.008 ± 0.003	0.10 ± 0.04	0.09 ± 0.03
E39	27.91/86.88	5074	0.99	1.714 ± 0.045	18.34 ± 0.48	19.50 ± 0.52
E40	27.91/86.88	5074	0.99	2.181 ± 0.054	23.36 ± 0.58	24.54 ± 0.61
E41	27.91/86.88	5060	0.99	5.096 ± 0.138	55.33 ± 1.50	54.74 ± 1.48
E45	27.91/86.87	5050	0.99	2.698 ± 0.047	29.29 ± 0.51	30.19 ± 0.52
E46	27.91/86.87	5047	0.99	1.606 ± 0.048	17.41 ± 0.52	18.53 ± 0.55
E57	27.92/86.89	5280	0.98	2.071 ± 0.066	20.47 ± 0.66	21.72 ± 0.70
E58	27.92/86.89	5064	0.98	2.179 ± 0.106	23.71 ± 1.15	24.88 ± 1.21
E59	27.92/86.89	5324	0.99	0.694 ± 0.017	7.40 ± 0.18	7.88 ± 0.20
E61	27.91/86.89	5005	0.99	0.297 ± 0.022	3.27 ± 0.25	3.93 ± 0.30
E62	27.91/86.88	4955	0.99	0.274 ± 0.011	3.09 ± 0.12	3.69 ± 0.14
E63	27.91/86.88	5032	0.98	0.257 ± 0.015	2.80 ± 0.17	3.31 ± 0.20
E71	27.91/86.81	4579	0.98	2.134 ± 0.122	28.85 ± 1.65	29.73 ± 1.70
E73	27.91/86.81	4557	0.98	1.047 ± 0.032	14.25 ± 0.44	15.20 ± 0.47
E75	27.92/86.81	4647	0.98	2.542 ± 0.038	33.33 ± 0.50	33.87 ± 0.50
E76	27.92/86.81	4651	0.98	2.980 ± 0.467	39.04 ± 6.12	38.30 ± 6.00
E77	27.92/86.81	4674	0.98	2.362 ± 0.077	30.63 ± 0.99	31.40 ± 1.02
E79	27.92/86.81	4624	0.98	0.660 ± 0.016	8.71 ± 0.21	9.22 ± 0.23
E80	27.92/86.81	4624	0.98	0.671 ± 0.031	8.86 ± 0.40	9.38 ± 0.43
E81	27.92/86.81	4628	0.98	0.676 ± 0.026	8.88 ± 0.34	9.40 ± 0.36
E82	27.92/86.81	4270	0.99	0.085 ± 0.010	1.32 ± 0.15	1.41 ± 0.16
E84	27.92/86.80	4739	0.99	7.233 ± 0.131	91.75 ± 1.66	91.19 ± 1.65
E85	27.92/86.80	4725	0.99	6.830 ± 0.123	87.11 ± 1.57	86.75 ± 1.57
E86	27.92/86.80	4739	0.99	6.254 ± 0.113	79.10 ± 1.43	78.53 ± 1.42
E87	27.93/86.80	4930	0.99	3.646 ± 0.094	41.79 ± 1.07	40.48 ± 1.04
E88	27.93/86.80	5017	0.99	2.514 ± 0.039	27.62 ± 0.42	28.63 ± 0.44
E89	27.93/86.80	5021	0.99	2.585 ± 0.088	28.35 ± 0.96	29.30 ± 0.99

Note: * Uncertainty includes only uncertainty in AMS measurement.