Supplement of:
Tectonic controls of Holocene erosion in a glaciated orogen
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Figure S1. Basin sample location map. Samples marked with open circles are from Belmont et al. (2007).

Figure S2. Comparison of basin-averaged erosion rates and equilibrium line altitudes (ELA). Black and grey data are from the west and east sides of the range, respectively.

Calculation of snow depth estimations

For this study, we utilized the MODIS/Terra Snow Cover Monthly L3 Global 0.05°, Version 6 dataset (Hall and Riggs, 2015), to estimate the distribution of snow for a given month. For any given pixel in the scene the value can vary between 0 and 100. While we consider these values to be spatially accurate they are only qualitative in that they do not have a magnitude equal to a physical dimension. To scale these data to represent snow depth values, we consider the snow cover values to be analogous to a percentage of the maximum snow depth in the Olympic Mountain range.
Our best estimate of maximum snow depth in the range comes from the Buckinghorse SNOTEL meteorological station (https://www.ncdc.noaa.gov/cdo-web/datasets/; Network ID: GHCND:USS0023B18S), located at 1484 m in the southern reaches of the Elwha Valley in the core of the range (Fig. S4 and S5). This station records the highest monthly snow depth measurements within the range. In the final step, we smoothed mean monthly snow cover data (2001-2015) using a bilinear algorithm and multiplied these percentages by the mean monthly snow depth station data (2009-2015). We do not assert that the resulting maps (Fig. S4) are completely accurate. However, we have calculated them to constrain the possible effect snow shielding may have on the calculation of erosion rates across the range. We assume a snow density of 0.25 g/cm$^3$ for shielding calculations.

Figure S3. Monthly estimated snow depth map. The dot marks the position of the Buckinghorse SNOTEL meteorological
Figure S4. Mean monthly snow depth measurements from the Buckinghorse SNOTEL meteorological station. These means are calculated for the years 2009-2015.

Table S1. Laboratory and isotopic data for new Olympic Mountain samples.

| Sample Name | Effective Latitude (°N) | Centroid Longitude (°E) | Effective Elevation (m) | Quartz (g) | Be from spike (g) | Total Al from ICP (g) | Laboratory Be Number | Laboratory Al Number | ³⁰Be/²⁶Be from AMS | ³⁰Be/²⁶Be from AMS | Be Blank Used | ³⁰Al/²⁷Al from AMS | ³⁰Al/²⁷Al from AMS | Al Blank Used |
|-------------|------------------------|-------------------------|-------------------------|------------|------------------|---------------------|---------------------|---------------------|-------------------|-------------------|---------------|------------------|------------------|---------------|
| WA1501      | 47.761893              | -123.38950              | 1397                    | 90.382     | 3.29E-04         | 9.62640E-03         | s97728              | s99935              | 5.0260E-14       | 2.5300E-15       | BA10          | s99935          | 3.257E-14       | 2.850E-15       |
| WA1502      | 47.856058              | -123.57330              | 1266                    | 88.882     | 3.29E-04         | 1.81515E-02         | s97729              | s99935              | 3.9650E-14       | 2.0600E-15       | BA11          | s99935          | 1.065E-14       | 1.500E-15       |
| WA1503      | 47.96357               | -123.65440              | 1195                    | 88.350     | 3.28E-04         | 1.64485E-02         | s97730              | s99935              | 2.9910E-14       | 1.7300E-15       | BA11          | s99935          | 9.386E-15       | 1.400E-15       |
| WA1519      | 47.86627               | -123.65900              | 1421                    | 90.386     | 3.28E-04         | 1.86600E-02         | s97731              | s99935              | 1.4260E-14       | 1.1260E-15       | BA10          | s99947          | 2.6660E-15      | 7.492E-16       |
| WA1520      | 47.90246               | -123.77010              | 1184                    | 81.778     | 3.27E-04         | 2.06585E-02         | s97732              | s99935              | 4.2850E-14       | 2.1100E-15       | BA10          | s99951          | 1.303E-14       | 1.670E-15       |
| WA1522      | 47.977417              | -123.71920              | 1252                    | 51.239     | 3.26E-04         | 6.14435E-03         | s98046              | s99935              | 3.8700E-14       | 2.5900E-15       | BA11          | s10029          | 5.012E-14       | 3.490E-15       |
| WA1523      | 47.89053               | -123.63360              | 1404                    | 73.762     | 3.28E-04         | 9.11105E-03         | s97733              | s99935              | 1.4880E-14       | 1.0900E-15       | BA10          | s99955          | 3.876E-15       | 8.750E-16       |
| WA1524      | 47.832887              | -123.70700              | 1505                    | 99.716     | 3.47E-04         | 1.80045E-02         | s97739              | s99935              | 1.3250E-14       | 1.0000E-15       | BA19          | s9980           | 5.4300E-15      | 1.010E-15       |
| WA1525      | 47.862877              | -123.29530              | 1547                    | 84.053     | 3.27E-04         | 1.04215E-02         | s97735              | s99967              | 2.3500E-14       | 1.4600E-15       | BA10          | s99967          | 9.652E-15       | 1.450E-15       |
| WA1526      | 47.674477              | -124.06220              | 550                     | 99.299     | 3.28E-04         | 2.15585E-02         | s97734              | s99959              | 9.1580E-14       | 3.7000E-15       | BA10          | s99959          | 2.2960E-14      | 2.280E-15       |
| WA1527      | 47.616827              | -123.62340              | 1100                    | 92.130     | 3.27E-04         | 1.92015E-02         | s97735              | s99976              | 4.8860E-14       | 2.4200E-15       | BA10          | s99976          | 1.731E-14       | 1.810E-15       |
| WA1537      | 47.70025               | -123.41140              | 1147                    | 94.016     | 3.48E-04         | 8.34405E-03         | s97740              | s99984              | 2.2430E-14       | 1.4400E-15       | BA10          | s99984          | 1.722E-14       | 1.920E-15       |
| WA1538      | 47.73078               | -123.27090              | 1439                    | 59.680     | 3.48E-04         | 1.07050E-02         | s97741              | s99988              | 5.0490E-14       | 2.3900E-15       | BA19          | s99988          | 2.849E-14       | 2.450E-15       |
| WA1539      | 47.917853              | -123.76290              | 1258                    | 92.504     | 3.48E-04         | 1.49705E-02         | s97742              | s99992              | 8.6810E-14       | 3.5100E-15       | BA19          | s99992          | 4.037E-14       | 3.120E-15       |

Table S2. Blank data for new Olympic Mountain samples.

| Blank Name | Laboratory Be Number | Be from spike (g) | ³⁰Be/²⁶Be from AMS | ³⁰Be/²⁶Be from AMS | Be Standard | Laboratory Al Number | Al from spike (g) | ³⁰Al/²⁷Al from AMS | ³⁰Al/²⁷Al from AMS | Al Standard |
|------------|----------------------|------------------|-------------------|-------------------|-------------|----------------------|------------------|------------------|------------------|-------------|
| BA1        | s09045               | 3.2750E-04       | 1.8410E-15        | 4.9500E-16       | 07KNSTD     | --                   | --               | --               | --               | --          |
| BA10       | s09737               | 3.2739E-04       | 1.9620E-15        | 3.6900E-16       | 07KNSTD     | --                   | --               | --               | --               | --          |
| BA19       | s09746               | 3.4758E-04       | 2.1870E-15        | 4.2600E-16       | 07KNSTD     | --                   | --               | --               | --               | --          |
| BA3        | --                   | --               | --                | --                | --          | s10024               | 2.5761E-03      | 1.647E-15       | 1.028E-15       | KNSTD       |
| BA11       | --                   | --               | --                | --                | --          | s99967               | 2.5512E-03      | 1.905E-16       | 6.079E-16       | KNSTD       |
| BA20       | --                   | --               | --                | --                | --          | s10008               | 2.5582E-03      | 2.077E-16       | 6.176E-16       | KNSTD       |
Table S3. Shielding and erosion rate comparisons.

| Sample Name | Topographic Shielding | Snow/Ice Shielding | Total Shielding | Topo+Snow Erosion Rate (m/Myr) | Erosion Rate 2σ (m/Myr) | Topo Only Erosion Rate (m/Myr) | Erosion Rate 2σ (m/Myr) | Percent Difference (%) |
|-------------|-----------------------|--------------------|----------------|-------------------------------|-------------------------|-------------------------------|-------------------------|------------------------|
| WA1501      | 0.95                  | 0.87               | 0.82           | 638                           | 118                     | 726                           | 136                     | 12                     |
| WA1502      | 0.96                  | 0.85               | 0.80           | 718                           | 134                     | 842                           | 160                     | 15                     |
| WA1503      | 0.95                  | 0.86               | 0.81           | 930                           | 183                     | 1068                          | 212                     | 13                     |
| WA1519      | 0.95                  | 0.85               | 0.80           | 2511                          | 618                     | 2922                          | 725                     | 14                     |
| WA1520      | 0.94                  | 0.90               | 0.85           | 610                           | 112                     | 666                           | 123                     | 8                      |
| WA1522      | 0.95                  | 0.87               | 0.82           | 432                           | 90                      | 492                           | 103                     | 12                     |
| WA1523      | 0.95                  | 0.83               | 0.78           | 1881                          | 442                     | 2238                          | 265                     | 16                     |
| WA1524      | 0.94                  | 0.87               | 0.81           | 3117                          | 782                     | 3558                          | 898                     | 12                     |
| WA1525      | 0.95                  | 0.85               | 0.80           | 1451                          | 301                     | 1691                          | 355                     | 14                     |
| WA1526      | 0.97                  | 0.96               | 0.92           | 224                           | 37                      | 235                           | 39                      | 4                      |
| WA1527      | 0.95                  | 0.87               | 0.82           | 564                           | 104                     | 622                           | 115                     | 9                      |
| WA1537      | 0.93                  | 0.86               | 0.79           | 1213                          | 256                     | 1396                          | 297                     | 13                     |
| WA1538      | 0.95                  | 0.84               | 0.79           | 635                           | 116                     | 748                           | 138                     | 15                     |
| WA1539      | 0.96                  | 0.87               | 0.83           | 318                           | 55                      | 361                           | 63                      | 12                     |
| U-EFMC      | 0.98                  | 0.97               | 0.95           | 171                           | 34                      | 176                           | 35                      | 2                      |
| L-EFMC      | 0.98                  | 0.97               | 0.96           | 129                           | 20                      | 131                           | 20                      | 2                      |
| U-WC        | 0.97                  | 0.96               | 0.93           | 158                           | 25                      | 164                           | 26                      | 4                      |
| L-WC        | 0.98                  | 0.96               | 0.93           | 199                           | 31                      | 207                           | 32                      | 4                      |
| DEN104      | 0.99                  | 0.97               | 0.96           | 114                           | 43                      | 117                           | 44                      | 2                      |
| DEN106      | 0.97                  | 0.96               | 0.93           | 237                           | 110                     | 246                           | 114                     | 3                      |
| DEN101      | 0.98                  | 0.96               | 0.94           | 223                           | 176                     | 231                           | 182                     | 3                      |

References
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